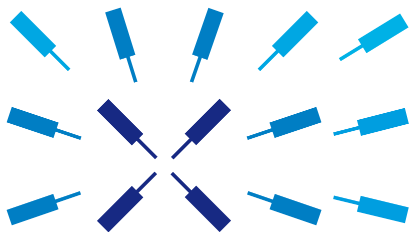
LabOne Programming Manual



Zurich
Instruments

LabOne Programming Manual

Zurich Instruments AG

Revision 20.07.0

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Revision History

Revision 20.07.0, 28-Aug-2020:

Update of the LabOne Programming Manual for LabOne Release 20.07.

- All APIs: Improved error handling when setting an invalid wildcard path.
- Python and MATLAB APIs: Enumerated integer nodes can be set using keyword strings using the setString function to improve code readability.
- C API: Scope module support added.

Revision 20.01.0, 28-Feb-2020:

Update of the LabOne Programming Manual for LabOne Release 20.01.

- LabOne API: Added quantum analyzer API module
- LabOne API: improved error handling when a device is not connected or misspelled
- LabOne API: included full revision information as a packed decimal in the revision node
- API Log: removed module prefix from API log entries as it is no longer required
- Python API: added deprecation warning for users of Python versions 2.7 and 3.5
- C and .NET API: impedance flags added to `ZISweeperImpedanceWave` class

Revision 64000, 12-Aug-2019:

Update of the LabOne Programming Manual for LabOne Release 19.05.

- Added precompensation API module
- It is no longer required to prefix the module parameter path with the module name.
- Added `listNodesJSON()` and `help()` functions to API modules
- The function `vectorWrite` has been renamed to `setVector`
- Improved performance and functionality of the high-level `get()` function
- Support of vector data in modules

Revision 58608, 15-Dec-2018:

Update of the LabOne Programming Manual for LabOne Release 18.12.

- Updated the Python Programming chapter to reflect improvements in the `zhinst` LabOne Python API package and its distribution via the `PyPi` package repository.
- Updated the required Matlab version for the LabOne Matlab API on Linux.

Revision 53400, 17-Jun-2018:

Update of the LabOne Programming Manual for LabOne Release 18.05.

- Added a new chapter **Instrument Communication** which explains the various methods to obtain data from instruments.
- Major improvements to the AWG Module, PID Advisor Module, Scope Module sections.
- Improvements to the Data Acquisition Module including a comprehensive table of the possible signal paths that the module may be subscribed to (Table 3.9).

Revision 49900, 22-Dec-2017:

Update of the LabOne Programming Manual for LabOne Release 17.12.

- Added a new section for the new Data Acquisition Module which supersedes both the Software Trigger (Recorder) and Spectrum (ZoomFFT) Modules.
- Added a sub-section describing how to use the SW Trigger's findLevel functionality.

Revision 45917, 06-Jul-2017:

Update of the LabOne Programming Manual for LabOne Release 17.06.

- Added description of API Level 6.
- Documented new API functions `setString()` and `getString()`.
- Documented new `streamingonly` and `subscribedonly` flags for `listNodes()`.
- Documented new `settingsonly` flag for `get()`.
- Corrections to parameter documentation, in particular for the Multi-Device Synchronisation Module.

Revision 42453, 11-Jan-2017:

Update of the LabOne Programming Manual for LabOne Release 16.12.

- Added a new chapter for the LabOne .NET API.
- Re-worked the instrument communication section which describes how to stream data from and configure instruments. Added documentation for Data Server nodes types and a table of the available instrument streaming nodes. Elaborated the description of working with the subscribe and poll commands.
- Improved the Initializing a Connection to a Data Server section for the case of using an MFLI connected via USB.
- Added new sections to the ziCore Chapter for the new Core Modules added in 16.12:
  - PID Advisor Module,
  - Scope Module,
  - Impedance Module,
  - Multi-Device Synchronisation Module,
  - AWG Module.
- Removed the PLL Advisor Core Module section as the PLL Advisor Module is deprecated as of 16.12; users should use the PID Advisor Module instead.
- Updated Matlab and Python reference documentation to include Discovery documentation.
- Added a short section Using the SW Trigger with a Digital Trigger which explains the `trigger/bits` and `trigger/mask` parameters.

Revision 38200, 12-Jul-2016:

Update of the LabOne Programming Manual for LabOne Release 16.04.

- Update of Core Module parameter tables.

Revision 34390, 23-Dec-2015:

Update of the LabOne Programming Manual for LabOne Release 15.11.

- Sweeper Module parameter and description update; explanation of `sweep/inaccuracy`.

- LabOne Matlab, Python and C APIs: Documentation added describing the APIs logging capabilities.
- LabOne C API Documentation added for Core Module functionality.
- LabOne C API: Updates to the Error Handling section following the introduction of the `ziGetLastError` function.

Revision 31421, 8-Jul-2015:

Update of the LabOne Programming Manual for LabOne Release 15.05.

- The LabOne LabVIEW and C (ziAPI) APIs are now `ziCore`-based.
- Additions and modifications for MFLI support.

Revision 28870, 18-Mar-2015:

Update of the LabOne Programming Manual for LabOne Release 15.01.

- Added description of API Level 5.

Revision 26206, 01-Oct-2014:

Update of the LabOne Programming Manual for LabOne Release 14.08.

- Added PLL Advisor Module section to ziCore Modules.
- Consistency update of ziCore Module parameters.
- Improvements to plots in Software Trigger ziCore Module section.

Revision 23212, 23-Apr-2014:

- First release of the LabOne Programming Manual.

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Chapter 1. Introduction

This chapter briefly describes the different possibilities to interface with a Zurich Instruments device, other than via the LabOne User Interface. Zurich Instruments devices are designed with the concept that "the computer is the cockpit"; there are no controls on the front panel of the instrument, instead the user can configure their instrument from and stream data directly to their computer. The aim of this approach is to give the user the freedom to choose where they connect to, and how they control, their instrument.

Refer to:

- Section 1.1 for a LabOne Programming Quick Start Guide.
- Section 1.2 for an overview of the LabOne Software Architecture.
- Section 1.3 for a Comparison of the LabOne APIs.
- Section 1.4 for help Initializing a Connection to a Data Server.

Instrument Specifics

The LabOne Programming Manual is intended to be used in parallel to the corresponding user manual for the instrument you are using. Please refer to the instrument-specific manual for comprehensive documentation of its functionality and settings; a full list of settings can be found in the "Device Node Tree" Chapter.

HF2 Real-time Option

The Real-time Option (RTK) for the HF2 Series is not a PC-based interface for controlling an instrument and is documented in the HF2 User Manual.

1.1. LabOne Programming Quick Start Guide

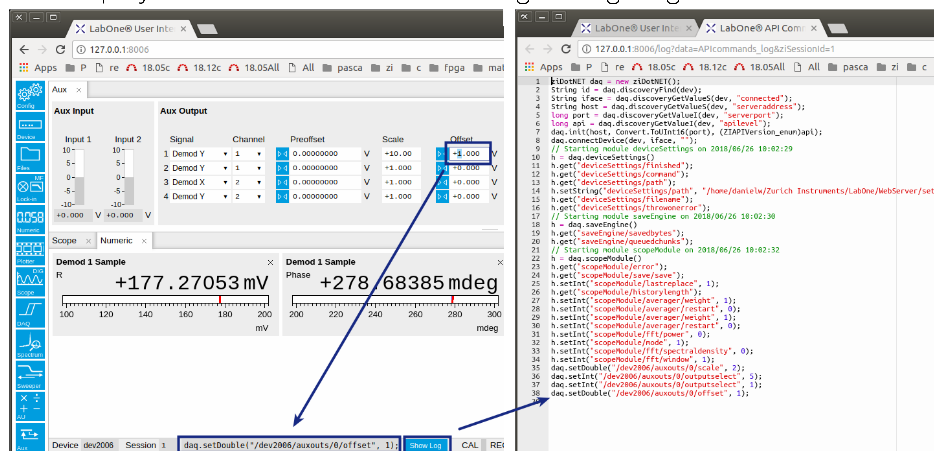
This section contains a collection of tips to help you get started programming with your instrument as quickly as possible.

Use the LabOne User Interface to develop measurement methods

LabOne's high-level measurement tools, such as the Sweeper are available in the LabOne User Interface (UI) and APIs. Since they use the same internal library, these tools have consistent behaviour across all interfaces; their parameters may first be tuned in the UI before transferring them to the API. Documentation for all the available high-level tools are provided in Chapter 3.

Let the LabOne User Interface write code for you

Use the command logging functionality of the the UI to copy code from the UI's log to your Matlab, Python or .NET program. When you change a setting in the UI the corresponding API command is displayed in the status bar. If "Show Log" is clicked, then the full history of corresponding API commands is displayed. More information on finding settings is given in Section 2.1.2.



Use Device Discovery to connect to your device

Device Discovery is included in every API and provides information on all the devices connected via USB or that are visible on your local network. For example, from Python: Import the module, create an instance of the Discovery tool and request discovery information on a specific device:

```
import zhinst.ziPython
dev = 'dev2006'
d = zhinst.ziPython.ziDiscovery()
props = d.get(d.find(dev))
```

Device Discovery returns a dictionary that contains connectivity information for the specified device; we can use this information to create an API session (connect to a Data Server) and subsequently connect the device on a physical interface (e.g. USB, ethernet) and start communicating with the device:

```
api_session = zhinst.ziPython.ziDAQServer(props['serveraddress'],
 props['serverport'], props['apilevel'])
api_session.connectDevice(dev, props['interfaces'][0])
api_session.getDouble('/{}/demods/0/rate'.format(dev))
# Out: 1.81e3
```

Further explanation about creating an API session with the appropriate the Data Server is provided in Section 1.4.1.

Use the distributed examples as a base for your program

Each LabOne API contains many examples to help you get started. Refer to the API-specific chapter on information on locating the examples: Matlab, Python, LabVIEW, .NET, C.

Use the API's logging capabilities

The LabOne APIs write log files containing useful debugging and status information. Enable the API log to monitor the behaviour of your program and add your own log entries with the `writeDebugLog()` command. For example, in Python: Import the ziPython module, create an API session and enable logging with the `setDebugLevel()` command:

```
import zhinst.ziPython
api_session = zhinst.ziPython.ziDAQServer('localhost', 8004, 6)
api_session.setDebugLevel(0)
```

Then create an instance of the Sweeper and write to the log:

```
h = api_session.sweep()
api_session.writeDebugLog(0, 'Will now configure and start the sweeper...')
h.set('sweep/device', 'dev2006')
h.execute()
```

These commands generate the log:

```
Will log to directory '/tmp/ziPythonLog_danielw'
11:55.25.805 [0] [status] Opening session: 127.0.0.1
11:55.25.805 [1] [trace] Will now configure and start the sweeper...
11:55.30.877 [2] [debug] Sweep execute, averaging 1 samples 0.001 s or 5 x tc,
 settling 0s or 5 x tc (0.01)
11:55.30.886 [3] [debug] Oscillator index 0 for path oscs/0/freq
11:55.30.887 [4] [warning] Sweeper will run in slower synchronous set mode. Enable
 controlled demodulators to get fast mode.
11:55.30.888 [5] [debug] Sweep fast: false, bandwidth control: 2, bw: 2000
11:55.30.889 [6] [debug] Used settlingTimeFactor 9.99805
```

See the API-specific chapter for more details: Matlab, Python, C.

Use the API utility functions

The APIs are distributed with utility functions that replicate functionality incorporated in the UI. For example, the Matlab and Python APIs have utility functions to convert a demodulator's time constant to its corresponding 3dB bandwidth (`tc2bw`).

Load LabOne User Interface settings files from the APIs

The XML files used for device settings can not only be loaded and saved from the LabOne User Interface but from any of the APIs. See Section 3.6, Device Settings Module for more information.

1.2. LabOne Software Architecture

Zurich Instruments devices use a server-based connectivity methodology. Server-based means that all communication between the user and the instrument takes place via a computer program called a server, the Data Server. The Data Server recognizes available instruments and manages all communication between the instrument and the host computer on one side, and communication to all the connected clients on the other side. This allows for:

- A multi-client configuration: Multiple interfaces (even from multiple computers on the network) can access the settings and data on an instrument. Settings are synchronized between all interfaces by the single instance of the Data Server.
- A multi-device setup: Any of the Data Server's clients can access multiple devices simultaneously.

This software architecture is organized in layers, see Figure 1.1 for a schematic of the software layers.

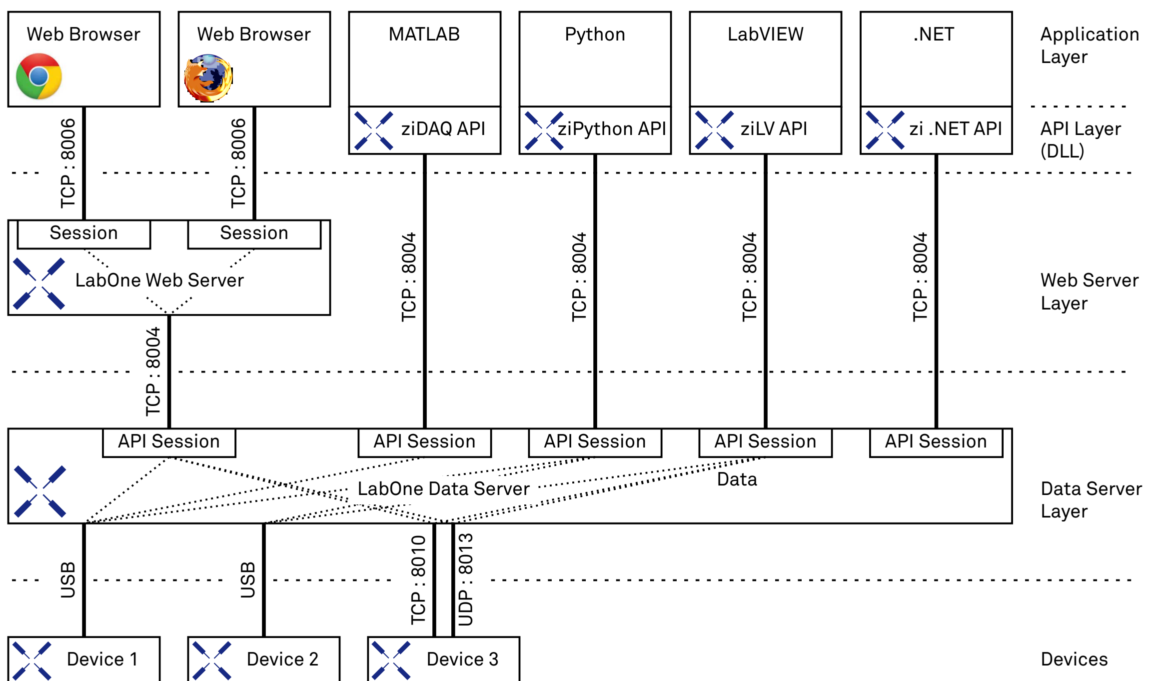


Figure 1.1. LabOne Software Architecture. The above diagram depicts the software architecture when using UHF, HDAWG and HF2 Instruments. In the case of MF Instruments the Data Server runs on the device itself instead of on a PC; only one MF device can be accessed from the Data Server. Web Server and API usage for the MF is analogous to that of other instruments.

First, we briefly explain some terminology that is used throughout this manual.

- Host computer: The computer where the Data Server is running and that is directly connected to the instrument. Multiple remote computers on a local area network can access the instrument by creating an API connection to the Data Server running on the host computer.
- Data Server: A computer program that runs on the host computer and manages settings on, and data transfer to and from instruments by receiving commands from clients. It always has the most up-to-date configuration of the device and ensures that the configuration is synchronized between different clients.
- ziServer.exe: The Data Server that handles communication with HF2 Instruments.

- ziDataServer.exe: The Data Server that handles communication with HDAWG, MF and UHF Instruments. Note, in the case of MFLI Instruments the Data Server runs on the instrument itself.
- Remote computer: A computer, available on the same network as the host computer, that can communicate with an instrument via the Data Server program running on the host.
- Client: A computer program that communicates with an instrument via the Data Server. The client can be running either on the host or the remote computer.
- API (Application Programming Interface): a collection of functions and data structures which enable communication between software components. In our case, the various APIs (e.g., LabVIEW, Matlab®) provide functions to configure instruments and receive measured experimental data.
- Interface: Either a client or an API.
- GUI (Graphical User Interface): A computer program that the user can operate via images as opposed to text-based commands.
- LabOne User Interface: The browser-based user interface that connects to the Web Server.
- LabOne Web Server: The program that generates the browser-based LabOne User Interface.
- ziControl: The standard GUI shipped for use with HF2 Instruments (before software release 15.11). HF2 support was added to the LabOne User Interface for devices with the WEB Option installed in LabOne software release 15.11 .
- ziCore: The internal core library upon which many APIs are based, see Chapter 3 for more information.
- Modules: `ziCore` software components that provide a unified interface to APIs to perform a specific high-level common task such as sweeping data.

1.2.1. MFLI /MFIA Software Configuration

In their simplest form, The MFLI/MFIA instruments are self contained. The LabOne Web Server and Data Server run on the instrument itself. Only the LabOne APIs run on an external PC.

However, to improve performance, other software configurations are possible. By installing the LabOne software on an external PC, the MFLI/MFIA instrument can be accessed via a LabOne Web Server running there. This gives advantages due to the improved computing power and the greater memory resources of the external PC. Moreover, if performing measurements with two or more synchronized MFLI/MFIA instruments, a LabOne Data Server running on the external PC can also be used. Indeed, to synchronize multiple MFLI/MFIA instruments, this software configuration is mandatory.

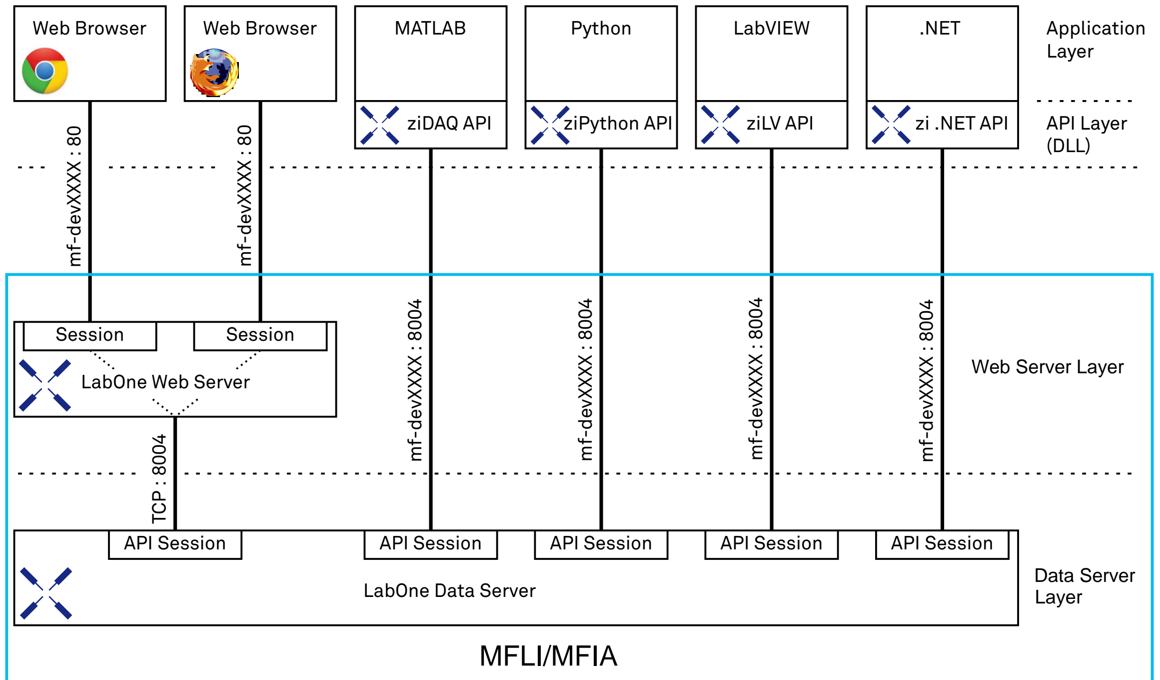


Figure 1.2. LabOne Software Configuration MFLI/MFIA. The above diagram shows the simplest software configuration for the MFLI/MFIA instruments. The Data Server and Web Server run on the device itself (devXXXX represents the serial number of the instrument).

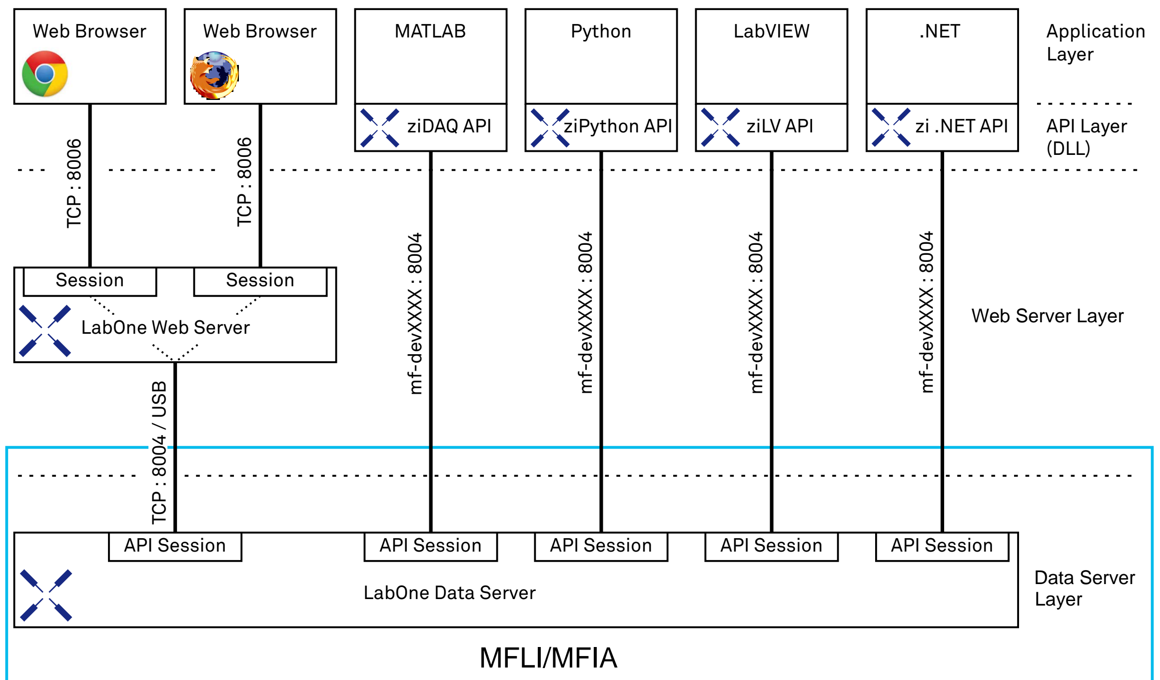


Figure 1.3. LabOne Software Configuration for the MFLI with the LabOne Web Server running on an external PC (devXXXX represents the serial number of the instrument).

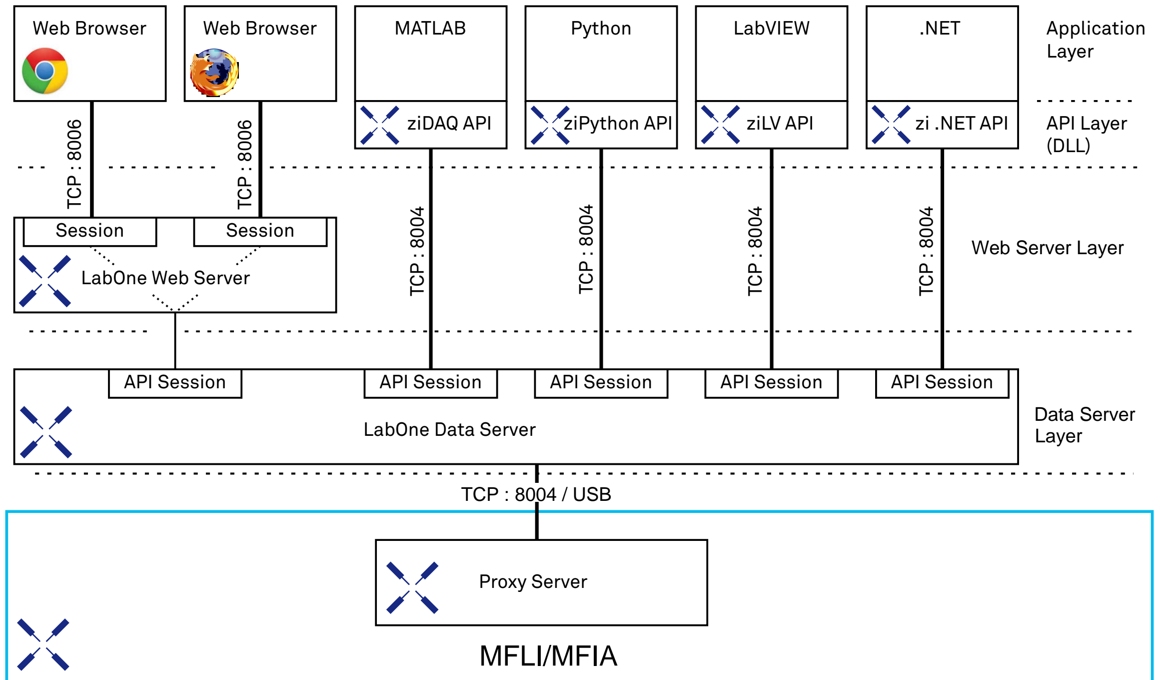


Figure 1.4. LabOne Software Configuration for the MFLI with LabOne Web Server and Data Server running on an external PC. This software configuration is mandatory when synchronizing multiple MFLI/MFIA instruments.

1.3. Comparison of the LabOne APIs

The various software interfaces available in LabOne allow the user to pick a programming environment they are familiar with to achieve fast results. All other things being equal, here is a brief discussion of the merits of each interface.

- The LabVIEW interface allows for quick and efficient implementation of virtual instruments that run independently. These can easily be integrated in existing experiment control performed in LabVIEW. This interface requires a National Instruments LabVIEW license and LabVIEW 2009 (or higher).
- The Matlab® interface allows the user to directly obtain measurement data within the Matlab programming environment, where they can make use of the many built-in functions available. This interface requires a MathWorks Matlab license, but no additional Matlab Toolboxes.
- The Python interface allows the user to directly obtain measurement data within python. Python is available as free and open source software; no license is required to use it.
- The .NET interface allows the user to directly obtain measurement data within the .NET programming framework using the C#, Visual Basic or #F programming languages. To use the .NET API a Microsoft Visual Studio installation is required.
- The C API, ziAPI, is a very versatile interface that will run on most platforms. However, since C is a low-level programming language, the development cycle is slower than with the other programming environments.
- The text-based interface (HF2 Series only) allows the user to manually connect to the HF2 Data Server in a console via telnet. While this interface is a very useful tool for HF2 programmers to verify instrument configuration set by other interfaces, it is limited in terms of performance and maximum demodulator sample rate. See the HF2 User Manual for more details.

Note

From LabOne Release 15.05 onwards the Sweeper and Software Trigger Modules are also available in the LabVIEW and C APIs and from 16.12 onwards all Modules are available. All modules were previously available in the Matlab and Python LabOne APIs.

1.4. Initializing a Connection to a Data Server

As described in Section 1.2 an API client communicates with an instrument via a data server over a TCP/IP socket connection. As such, the first step towards communicating with an instrument is initializing an API session to the correct data server for the target device.

The choice of data server depends on the device class and on the network topology. HF2 instruments operate via a different data server program than HDAWG, MF and UHF instruments. Users of MF instruments should be aware that the data server runs on the MF instrument itself and not on a separate PC. Finally, in the case of MF instruments, the way to connect to the data server depends on the interface (USB or 1GbE). In all cases, the desired data server is specified by providing three parameters:

- the data server host's address (hostname),
- the data server port,
- the API level to use for the session.

1.4.1. Specifying the Data Server Hostname and Port

For users working with a single device, this section describes how to quickly connect to the correct data server by manually specifying the required data server's hostname and port and the required API Level. Each API has a connect function which takes these three parameters in order to initialize an API session, for example, in the LabOne Matlab API:

```
>>> ziDAQ('connect', serverHostname, serverPort, apiLevel);
```

Data Server Port

A LabOne API client connects to the correct Data Server for their instrument by specifying the appropriate port. By default, the data server programs for HDAWG, MF and UHF Instruments listen to port `8004` for API connections and the data server program for HF2 instruments listens to port `8005`. The value of the port that the data server listens to can be changed using the `--port` command-line option when starting the data server.

Data Server Hostname (HDAWG, HF2 and UHF Instruments)

In the simplest configuration for HDAWG, HF2 and UHF instruments, the instrument is attached to the same PC where both the data server and API client are running. Since the API client is running on the same PC as the data server, the `'localhost'` (equivalently, `'127.0.0.1'`) should be specified as the data server address, Figure 1.5.

The API client may also connect to a data server running on a different PC from the client. In this case, the data server address should be the IP address (or hostname, if available) of the PC where the data server is running. Note, remote data server access is not enabled by default and the data server must be configured in order to listen to non-localhost connections by either enabling the `--open-override` command-line option when starting the data server or by setting the value of the server node `/zi/config/open` to 1 on a running data server (clearly only possible from a client running on the localhost). See Section 2.1 for more information on nodes.

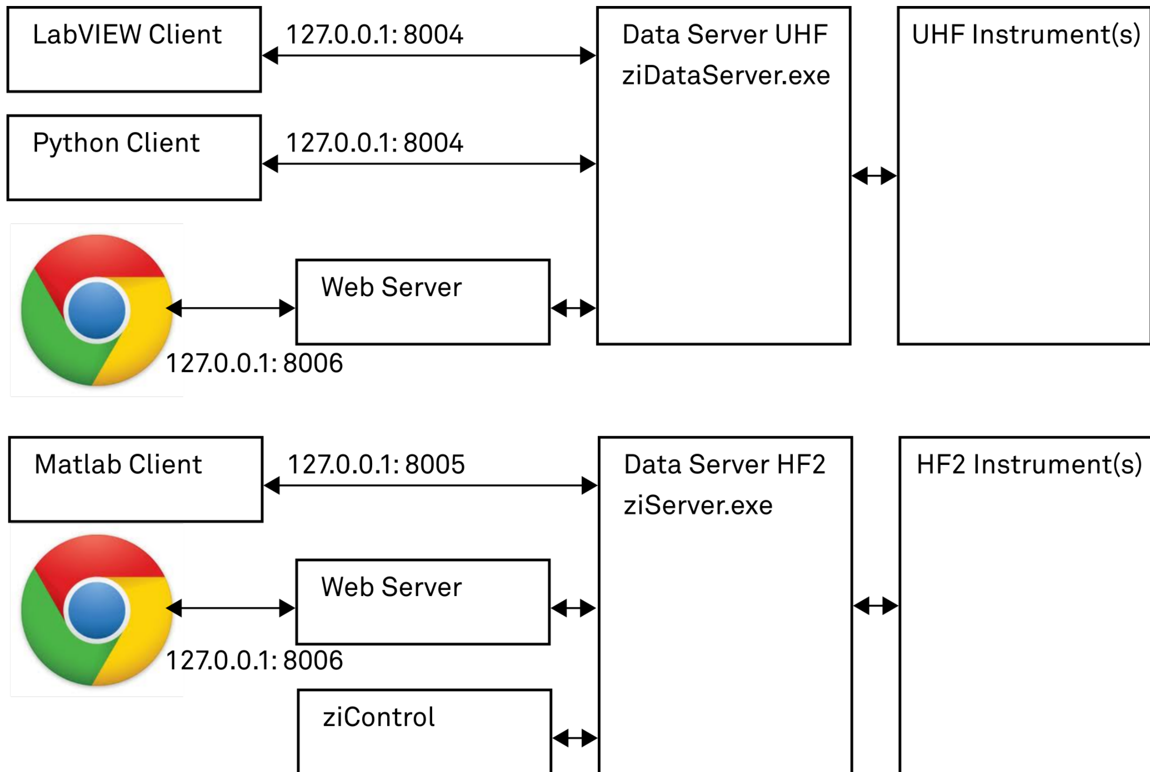


Figure 1.5. Server address and port handling for HDAWG, HF2 and UHF instruments for the case where the API client and data server are running on the same PC. In this case the server hostname is `localhost` and the default port value is 8004 for HDAWG and UHF Instruments and 8005 for HF2 Instruments.

Data Server Hostname (MF Instruments)

In the case of MF instruments the data server runs on the instrument itself and as such an API client from a PC always accesses the data server remotely. Thus, in this case the data server hostname is that of the instrument itself. This will be the same hostname (but not port) that is used to run the LabOne User Interface in a web browser (when the Web Server is running on the MF instrument), see Figure 1.6.

As described in more detailed in the Getting Started chapter of the MFLI User Manual, the MF instrument hostname can either be its instrument serial of the form `mf-dev3001`, or its IP address. The former is however only valid if the MF instrument is connected to a LAN with domain name system via 1GbE. If it's connected via the USB interface, finding out the IP address is easiest by using the Start Menu Entry "LabOne User Interface MF USB" and then copying the IP address from the browser's address bar.

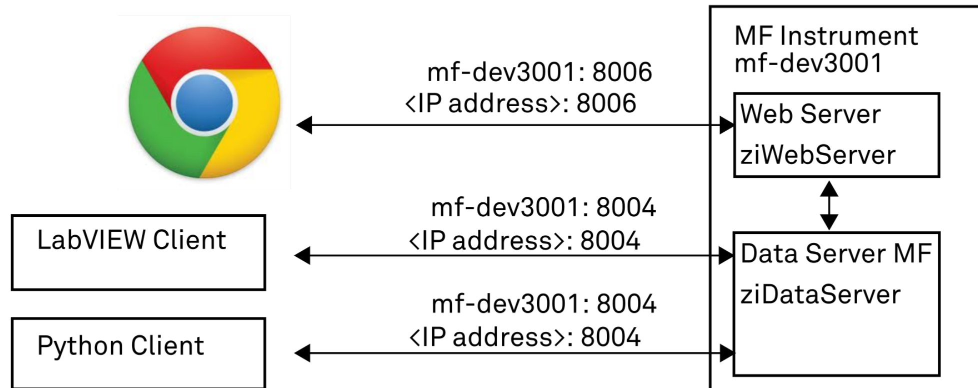


Figure 1.6. Server address and port handling on MF Instruments. The data server runs on the instrument and the server hostname is the same as the instrument's hostname. Using a hostname of the form mf-dev3001 is only applicable when using the 1GbE interface. The default data server port is 8004 for MF Instruments.

API Level and Connectivity Examples

The last parameter to specify, the API level, specifies the version of the API to use for the session. In short, an API Level of 1 must be used for HF2 devices and an API Level 6 is recommended for other instruments. Since the default API Level is 1, it is necessary to specify this parameter for UHF, MF and HDAWG instruments. A more detailed explanation of API Levels is provided in Section 1.4.2.

For example, to initialize a session to the HF2's data server running on the `localhost` with the LabOne Python API, the following commands should be used:

```
>>> import zhinst.ziPython
>>> daq = zhinst.ziPython.ziDAQServer('localhost', 8005, 1)
```

and in order to connect to the data server running on the MF instrument connected via 1GbE with device serial `'dev3001'` with the LabOne Matlab API:

```
>> ziDAQ('connect', 'mf-dev3001', 8004, 6)
```

On an MF instrument connected via USB, the device serial cannot be directly used as the hostname, instead one needs to use the instrument's IP address. Unless this is known beforehand, it can be determined by the network discovery functionality of the API. The following python example shows how this can be done:

```
>>> import zhinst.ziPython
>>> d = zhinst.ziPython.ziDiscovery()
>>> d.find('mf-dev3001')
>>> devProp = d.get('mf-dev3001')
>>> daq = zhinst.ziPython.ziDAQServer(devProp['serveraddress'],
 devProp['serverport'], 6)
```

Working in a Multi-threaded Program

It is important to note that API session objects are not thread-safe, i.e. a single API session cannot be shared between multiple client threads. If you want to use a LabOne API in a multi-threaded program, for each client thread, use a separate API session.

1.4.2. LabOne API Levels

All of the LabOne APIs are based on an internal core API. Needless to say, we try as hard as possible to make any improvements in our core API backwards compatible for the convenience of our users. We take care that existing programs do not need to be changed upon a new software release.

Occasionally, however, we do have to make a breaking change in our API by removing some old functionality. This old functionality is, however, phased out over several software releases. First, the functionality is marked as deprecated and the user is informed via a deprecation warning (this can be turned off). This indicator warns that this function may be unsupported in the future. If we have to break some functionality we use a so-called **API level**.

With support of new devices and features we need to break functionality on the ziAPI.h e.g. data returned by poll commands. In order to still support the old functionality we introduced API levels. If a program only uses old functionality the API level 1 (default) can be used. If a user needs new functionality, they need to use a higher API level. This will usually need some changes to the existing code.

The current available API levels are:

- API Level 1: HF2 support, basic UHF support.
- API Level 4: UHF support, timestamp support in poll, PWA, name clean-up.
- API Level 5: Introduction of scope offset for extended (non-hardware) scope inputs (UHF, MF Instruments).
- API Level 6: Timestamp support in poll for nodes that return a byte array.

Note that Levels 2 and 3 are used only internally and are not available to the general public.

Note

The HF2 Series only supports API Level 1.

Note

New HDAWG, MF and UHF API users are recommended to use API Level 6.

API Level 4 Features

The new features in API Level 4 are:

- Timestamps are available for any settings or data node (that is either integer or float).
- Greatly improved Scope data transfer rates (and new Scope data structure).
- Greatly improved UHF Boxcar and PWA support.

API Level 5 Features

API Level 5 was introduced in LabOne Release 15.01 to accommodate a necessary change in the Scope data structure:

- The Scope data structure was extended with the new field "channeloffset" which contains the offset value that must be added to the scaled wave value in order to obtain the physical value recorded by the scope. For previous hardware scope "inputselects" there is essentially no change, since their offset is always zero. However, for the extended values of "inputselects", such as PID Out value, (available with the DIG option) the offset is determined by the values of "limitlower" and "limitupper" configured by the user.

API Level 6 Features

API Level 6 was introduced in LabOne Release 17.06 to make the behavior of poll for nodes that return a byte array consistent with nodes that return integer and float data:

- Timestamps are returned for all byte array nodes.
- New commands `setString` and `getString` are available and should be used instead of `setByte` and `getByte`.

1.5. Compatibility

Controlling an instrument requires the combination of several software components: The instrument's firmware, a Data Server and an API. In general, whenever possible, it is recommended to use the latest (and same) software release version (e.g., "20.01") of all these components. If you are bound to a certain version for technical reasons, then it is recommended to use the same version of all components. However, this is not strictly necessary in all cases. If it is absolutely necessary to mix versions, this section explains how to verify whether different versions of various software components may be mixed with each other.

1.5.1. API and Data Server Compatibility

Although it is recommended to use the same software release version (e.g. "20.01") of both API and Data Server, it is not strictly necessary. The interface between API and Data Server remains the same between versions. However, there may be a change in some nodes that effects specific functionality.

If you do need to mix versions, then please check the Release Notes (included in a LabOne installation) to see if the functionality you require has changed. If so, then the same version of API and Data Server must be used. Otherwise, it is possible to mix versions. If after checking the Release Notes you are still not sure, then please contact Zurich Instruments customer support.

All the LabOne APIs have a utility function to check whether the API being used is the same version as the Data Server it is connected to, e.g., `api_server_version_check()` in the Python API and `ziApiServerVersionCheck()` in the Matlab API.

Chapter 2. Instrument Communication

This section describes the main concepts in LabOne software that allow high-speed data acquisition and guides the user to the best acquisition method for their measurement task. It is divided into sub-sections as follows:

- Section 2.1 explains how device settings and data are organized and accessible in The Data Server's Node Tree.
- Section 2.2 explains Zurich Instruments' Data Streaming concept for data acquisition.
- Section 2.3 compares the methods available for Comparison of Data Acquisition Methods.
- Section 2.5 documents some Instrument-Specific Considerations.

2.1. The Data Server's Node Tree

This section provides an overview of how an instrument's configuration and output is organized by the Data Server.

All communication with an instrument occurs via the Data Server program the instrument is connected to (see Section 1.2 for an overview of LabOne's software components). Although the instrument's settings are stored locally on the device, it is the Data Server's task to ensure it maintains the values of the current settings and makes these settings (and any subscribed data) available to all its current clients. A client may be the LabOne User Interface or a user's own program implemented using one of the LabOne Application Programming Interfaces, e.g., Python.

The instrument's settings and data are organized by the Data Server in a file-system-like hierarchical structure called the node tree. When an instrument is connected to a Data Server, it's device ID becomes a top-level branch in the Data Server's node tree. The features of the instrument are organised as branches underneath the top-level device branch and the individual instrument settings are leaves of these branches.

For example, the auxiliary outputs of the instrument with device ID "dev2006" are located in the tree in the branch:

/DEV2006/AUXOUTS/

In turn, each individual auxiliary output channel has it's own branch underneath the "AUXOUTS" branch.

/DEV2006/AUXOUTS/0/
/DEV2006/AUXOUTS/1/
/DEV2006/AUXOUTS/2/
/DEV2006/AUXOUTS/3/

Whilst the auxiliary outputs and other channels are labelled on the instrument's panels and the User Interface using 1-based indexing, the Data Server's node tree uses 0-based indexing. Individual settings (and data) of an auxiliary output are available as leaves underneath the corresponding channel's branch:

/DEV2006/AUXOUTS/0/DEMODSELECT
/DEV2006/AUXOUTS/0/LIMITLOWER
/DEV2006/AUXOUTS/0/LIMITUPPER
/DEV2006/AUXOUTS/0/OFFSET
/DEV2006/AUXOUTS/0/OUTPUTSELECT
/DEV2006/AUXOUTS/0/PREOFFSET
/DEV2006/AUXOUTS/0/SCALE
/DEV2006/AUXOUTS/0/VALUE

These are all individual node paths in the node tree; the lowest-level nodes which represent a single instrument setting or data stream. Whether the node is an instrument setting or data-stream and which type of data it contains or provides is well-defined and documented on a per-node basis in the Reference Node Documentation section in the relevant instrument-specific user manual. The different properties and types are explained in Section 2.1.1.

For instrument settings, a Data Server client modifies the node's value by specifying the appropriate path and a value to the Data Server as a (path, value) pair. When an instrument's setting is changed in the LabOne User Interface, the path and the value of the node that was changed are displayed in the Status Bar in the bottom of the Window. This is described in more detail in Section 2.1.2.

Module Parameters

LabOne Core Modules, such as the Sweeper, also use a similar tree-like structure to organize their parameters. Please note, however, that module nodes are not visible in the Data Server's node tree; they are local to the instance of the module created in a LabOne client and are not synchronized between clients.

2.1.1. Node Properties and Data Types

A node may have one or more of the following properties:

Read	Data can be read from the node.
Write	Data can be written to the node.
Setting	A node with write attribute corresponding to an instrument configuration. The data in these nodes will be saved to and loaded from LabOne XML settings files.
Streaming	A node with the read attribute that provides instrument data, typically at a user-configured rate. The data is usually a more complex data type, for example demodulator data is returned as ZIDemodSample. A full list of streaming nodes is available in Table 2.1.

A node may contain data of the following types:

Integer	Integer data.
Double	Double precision floating point data. Note that the actual value on the device may only be calculated in single precision.
String	A string array.
Enumerated (integer)	As for Integer, but the node only allows certain values.
Composite data type	For example, ZIDemodSample. These custom data types are structures whose fields contain the instrument output, a timestamp and other relevant instrument settings such as the demodulator oscillator frequency. Documentation of custom data types is available in the C Programming chapter.

2.1.2. Exploring the Node Tree

In the LabOne User Interface

A convenient method to learn which node is responsible for a specific instrument setting is to check the Command Log history in the bottom of the LabOne User Interface. The command in the Status Bar gets updated every time a configuration change is made. Figure 2.1 shows how the equivalent Matlab command is displayed after modifying the value of the auxilliary output 1's offset. The format of the LabOne UI's command history can be configured in the Config Tab (Matlab, Python and .NET are available). The entire history generated in the current UI session can be viewed by clicking the "Show Log" button.

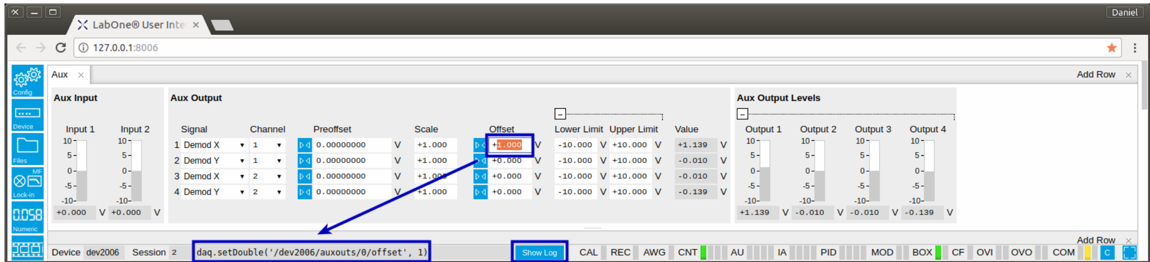


Figure 2.1. When a device's configuration is modified in the LabOne User Interface, the Status Bar displays the equivalent command to perform the same configuration via a LabOne programming interface. Here, the Matlab code to modify auxiliary output 1's offset value is provided. When "Show Log" is clicked the entire configuration history is displayed in a new browser tab.

In the Instrument-specific User Manual

Each instrument user manual has a "Device Node Tree" chapter that contains complete reference documentation of every node available on the device. This documentation may be explored by branch to obtain a complete overview of which settings are available on the instrument.

In a LabOne Programming Interface

A list of nodes (under a specific branch) can be requested from the Data Server in an API client using the `listNodes` command (Matlab, Python, .NET) or `ziAPIListNodes()` function (C API). Please see each API's command reference for more help using the `listNodes` command. To obtain a list of all the nodes that provide data from an instrument at a high rate, so-called streaming nodes, the `streamingonly` flag can be provided to `listNodes`. More information on data streaming and streaming nodes is available in in Section 2.2).

The detailed descriptions of nodes that is provided in the instrument-specific user manual section "Reference Node Documentation" is accessible directly in the LabOne Matlab or Python programming interfaces using the "help" command. The `help` command is `daq.help(path)` in Python and `ziDAQ('help', path)` in Matlab. The command returns a description of the instrument node including access properties, data type, units and available options. The "help" command also handles wildcards to return a detailed description of all nodes matching the path. An example is provided below.

```
daq = zhinst.ziPython.ziDAQServer('localhost', 8004, 6)
daq.help('/dev2006/auxouts/0/offset')
# Out:
# /DEV2006/AUXOUTS/0/OFFSET
# Add the specified offset voltage to the signal after scaling. Auxiliary Output
# Value = (Signal+Preoffset)*Scale + Offset
# Properties: Read, Write, Setting
# Type: Double
# Unit: V
```

2.1.3. Data Server Nodes

The Data Server has nodes in the node tree available under the top-level /ZI/ branch. These nodes give information about the version and state of the Data Server the client is connected to. For example, the nodes:

- /ZI/ABOUT/VERSION

- /ZI/ABOUT/REVISION

are read-only nodes that contain information about the release version and revision of the Data Server. The nodes under the /ZI/DEVICES/ list which devices are connected, discoverable and visible to the Data Server.

The nodes:

- /ZI/CONFIG/OPEN
- /ZI/CONFIG/PORT

are settings nodes that can be used to configure which port the Data Server listens to for incoming client connections and whether it may accept connections from clients on hosts other than the localhost. See Section 1.4 for more information about specifying the Data Server host and port.

Nodes that are of particualar use to programmers are:

- /ZI/DEBUG/LOGPATH - the location of the Data Server's log in the PC's filesystem,
- /ZI/DEBUG/LEVEL - the current log-level of the Data Server (configurable; has the Write attribute),
- /ZI/DEBUG/LOG - the last Data Server log entries as a string array.

For documentation of all Data Server nodes see the /ZI/ section in the Reference Node Documentation section in the instrument-specific user manual.

2.2. Data Streaming

Zurich Instrument's Data Servers and devices allow high-speed data acquisition using the "data streaming" concept. The term "data streaming" refers to the fact that the discrete values of a device's output are continuously pushed at a high rate from the device to an API client (via the device's physical connection and Data Server) analogously to media streaming where, for example, video is continuously streamed from one computer to another over the internet.

Data streaming is only available for device outputs such as demodulator and pulse counters, where it is relevant to acquire the instrument's discrete data at a very high time resolution. Settings nodes, for example, are not streamed but rather sent upon request. Some device outputs additionally allow their data stream to be gated based on the value of another device signal, such as a trigger input, for example. This allows even higher data transfer rates for short bursts, that would otherwise not be possible when data is continuously sent from the device.

To optimize the bandwidth of the instrument's physical connection to the Data Server (e.g. USB, Ethernet), streaming data for all nodes is, by default, not sent by the device, rather each node must be enabled at the desired rate by a client. When streaming data from a device output is enabled, then it is always sent from the device to the Data Server. It is not sent from the Data Server to the client, however, until the API client explicitly requests the data by "subscribing" to the data server node providing the streaming data.

The advantage of Zurich Instruments' streaming concept is that it allows extremely high data acquisition rates. Whereas "fixed rate" data transfer or "fixed-buffer size" data transfer (for all nodes) allows very simple interfaces for data acquisition, it does not optimize the available interface bandwidth since low update rates must be imposed to ensure that data loss does not occur in all situations. Users who prefer a fixed rate or fixed-size buffer transfer may use the Data Acquisition Module, which adds an additional layer of software on top of data streaming that emulates these kinds of transfer.

In general, unless extremely fast update rates or high performance data transfer is required by the client, the Data Acquisition Module is the recommended method to obtain data (as opposed to the low-level subscribe and poll commands). This is due to the additional complexities involved when working directly with "raw" streaming data, since users must:

- Be aware that data loss may occur and must be correctly handled in their API client program.
- Organize data that may be split across subsequent poll commands.
- Align/interpolate streaming data from multiple nodes onto a common time grid (if required).

The following sections explain these points in further detail, users who acquire the data from Data Acquisition Module may prefer to skip ahead Section 2.3.

2.2.1. Streaming Nodes

When streaming nodes are recorded directly via the the low-level subscribe and poll commands they continuously deliver either:

- Continuous equidistantly spaced data in time, e.g., DEMODS/0/SAMPLE or CNTS/0/SAMPLE,
- Continuous non-equidistantly spaced data in time, e.g., BOXCARS/0/SAMPLE when the boxcar is configured with an external reference-controlled oscillator (but this is somewhat of a special case).
- Non-continuous framed "block" data that consist of chunks of data, e.g., SCOPES/0/WAVE.

The qualifier "continuous" deserves further explanation. Each sample point is a discrete data point sent from the device. Continuous means that the samples are not only continually sent, but

also that all the data from that device unit/output is sent without gaps in time. Block data on the other hand is not continuous; it is a single burst of data from a device unit (e.g. scope) that provides data at a very high data rate.

Nodes that deliver high-speed streaming data have the streaming property set (see Section 2.1.1). This property can be used with the listNodes command in order to list all the streaming nodes available on a particular device. For example, in Python:

```
daq = zhinst.ziPython.ziDAQServer('localhost', 8004, 6)
from zhinst.ziPython import ziListEnum
flags = ziListEnum.recursive | ziListEnum.absolute | ziListEnum.streamingonly
print(int(ziListEnum.streamingonly), flags)
# Out:
# 16, 19
daq.connectDevice('dev2006', 'usb')
daq.listNodes('/dev2006/*/0', flags)
# Out:
# ['/DEV2006/AUCARTS/0/SAMPLE',
#  '/DEV2006/AUPOLARS/0/SAMPLE',
#  '/DEV2006/AUXINS/0/SAMPLE',
#  '/DEV2006/BOXCARS/0/SAMPLE',
#  '/DEV2006/CNTS/0/SAMPLE',
#  '/DEV2006/DEMODS/0/SAMPLE',
#  '/DEV2006/DIOS/0/INPUT',
#  '/DEV2006/INPUTPWAS/0/WAVE',
#  '/DEV2006/OUTPUTPWAS/0/WAVE',
#  '/DEV2006/PIDS/0/STREAM/ERROR',
#  '/DEV2006/PIDS/0/STREAM/SHIFT'
#  '/DEV2006/PIDS/0/STREAM/VALUE',
#  '/DEV2006/SCOPES/0/STREAM/SAMPLE',
#  '/DEV2006/SCOPES/0/WAVE']
```

The table below gives an overview of the available streaming nodes on different devices.

Table 2.1. Device streaming nodes. Their availability depends on the device class (e.g. MF) and the option set installed on the device.

Device Node Path	Availability	Type	Description
AUCARTS/n/SAMPLE	UHF	Continuous	The output samples of a Cartesian Arithmetic Unit
AUPOLARS/n/SAMPLE	UHF	Continuous	The output samples of a Polar Arithmetic Unit
AUXINS/n/SAMPLE	All instruments	Continuous	The auxiliary input samples. Typically not used; these values are included as fields in demodulator samples where available.
BOXCARS/n/SAMPLE	UHF with Box Option	Continuous	The output samples of a boxcar.
CNTS/n/SAMPLE	UHF or HDAWG with CNT Option	Continuous	The output samples of a counter unit.
DEMODS/n/SAMPLE	UHFLI, HF2LI, MFLI	Continuous	The output samples of a demodulator.
DIOS/n/INPUT	All instruments	Continuous	The DIO connector input values. Rarely used; the input values are included as a field in demodulator samples where available.

Device Node Path	Availability	Type	Description
IMPS/n/SAMPLE	MFIA, MFLI with IA Option	Continuous	The output samples of an impedance channel.
INPUTPWAS/n/WAVE	UHF with BOX Option	Block	The value of the input PWA.
OUTPUTPWAS/n/WAVE	UHF with BOX Option	Block	The value of the output PWA.
PIDS/n/STREAM/ERROR	UHF or MF with PID Option	Continuous	The error value of a PID.
PIDS/n/STREAM/SHIFT	UHF or MF with PID Option	Continuous	The shift of a PID; the difference between the center and the the output value.
PIDS/n/STREAM/VALUE	UHF or MF with PID Option	Continuous	The output value of the PID.
SCOPES/n/STREAM/ SAMPLE	UHF or MF with DIG Option	Block	Scope values as a continuous block streaming node.
SCOPES/n/WAVE	All instruments	Block	Scope values as a triggered block streaming node.
TRIGGERS/STREAMS/n/ SAMPLE	HDAWG	Block	Trigger values.

2.2.2. Alignment of Streaming Node Data

In general, streaming nodes deliver equidistantly-spaced samples in time (assuming no sample loss has occurred). However, different streaming nodes have different timestamp grids. This is best explained in Figure 2.2.

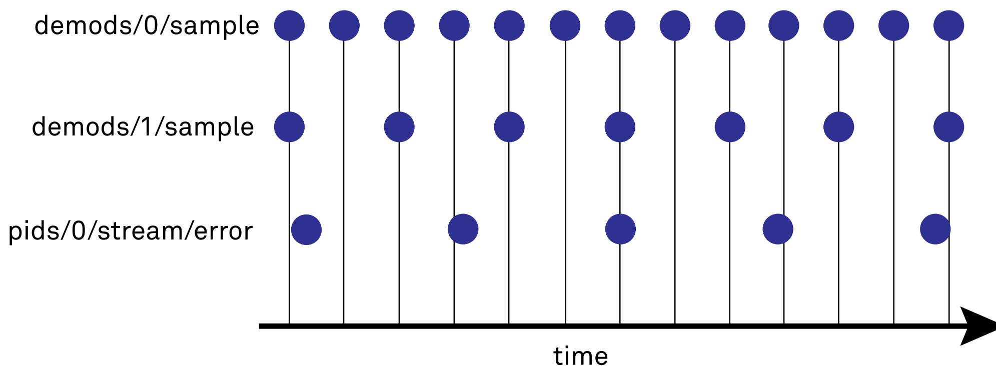


Figure 2.2. Samples from different streaming nodes configured with different rates: Demod 1 at 2N kSamples/s, Demod 2 at N kSamples/s and PID Error 1 at M kSample/s (N not divisible by M). Although each stream consists of equidistantly samples in time, the sample timestamps from different streams are not necessarily aligned due to the different sampling rates.

2.2.3. Data Loss

While streaming nodes deliver equidistantly sampled data in time (with the exception of a boxcar output based on an external reference controlled oscillator), they may be subject to data loss

(also called "sample loss"). This refers to the loss of data between instrument and Data Server over the physical interface. Since data streaming is optimized for transfer speed, there is no resend mechanism available that would automatically request that missing data be transferred again to the Data Server; the data is lost and this case must be handled appropriately in API programs. In the case of data loss, the returned data will simply be missing, i.e. data will no longer be equidistantly sampled in time due to to the missing samples. As such, to check for data loss on streaming node data, the user is advised to calculate the difference between timestamps and verify that all differences correspond to the expected difference as defined by the configured data streaming rate.

Data rates are not limited or throttled by the instrument to ensure that data loss does not occur; the user is responsible to configure streaming data rates for the required nodes such that data loss does not occur in their system. Data rates are not artificially limited due to the fact that continuous and hardware triggered data acquisition may be combined. If the cumulative data sent by the instrument over the physical interface exceeds the available bandwidth then data loss will occur. The maximum available bandwidth of the physical interface is influenced by the following factors:

- Choice of physical interface (USB, 1GbE).
- Additional load on the interface (Ethernet / USB hub) from other network traffic or devices.
- Speed of the PC where the Data Server is running.
- For the case of 1GbE interface only: The PC's network card.
- MF instruments only: Whether the Data and/or Web Servers are running on the instrument or on the PC.

2.3. Comparison of Data Acquisition Methods

In this section we briefly compare the methods available to obtain data from continuous streaming instrument nodes (not for block streaming nodes, see Scope Data). Which method is most appropriate depends on the requirements of the specific application. Table 2.2 provides a top-level overview.

Table 2.2. Comparison of data acquisition methods available in the LabOne APIs.

Method	Good for:	Not appropriate for:
The `getSample` function	1. Simple single-shot measurements of demodulator data.	1. Non-demodulator streaming nodes. 2. Continuous data acquisition. 3. Triggered data acquisition.
Data Acquisition Module in Triggered Mode	1. Triggered data acquisition. 2. Aligned data from multiple streams.	
Data Acquisition Module in Continuous Mode	1. Continuous data acquisition. 2. Aligned data from multiple streams.	
The poll and subscribe functions	1. Extremely high performance.	1. Data from between different streaming nodes may not be aligned by timestamp. 2. Data alignment between polls not guaranteed.

Scope Data

It is recommended to use the Scope Module for acquiring scope data (from the node SCOPES/n/WAVE). Although scope data can be acquired using the low-level subscribe and poll commands, the Scope Module provides additional functionality such as multiple block assembly (SCOPES/n/WAVE is a "block" streaming node, cf Section 2.1.1) and FFT of the data.

2.4. Demodulator Sample Data Structure

An instrument's demodulator data is returned as a data structure (typically a `struct`) with the following fields (regardless of which API Level is used):

`timestamp`	The instrument's timestamp of the measured demodulator data `uint64`. Divide by the instrument's clockbase (`/dev123/clockbase`) to obtain the time in seconds.
`x`	The demodulator x value in Volts `[double]`.
`y`	The demodulator y value in Volts `[double]`.
`frequency`	The current frequency used by the demodulator in Hertz `[double]`.
`phase`	The oscillator's phase in Radians (not the demodulator phase) `[double]`.
`auxin0`	The auxiliary input channel 0 value in Volts `[double]`.
`auxin1`	The auxiliary input channel 1 value in Volts `[double]`.
`bits`	The value of the digital input/output (DIO) connector. `[integer]`.
`time.dataloss`	Indicator of sample loss (including block loss) `[bool]`.
`time.blockloss`	Indication of data block loss over the socket connection. This may be the result of a too long break between subsequent poll commands `[bool]`.
`time.invalidtimestamp`	Indication of invalid time stamp data as a result of a sampling rate change during the measurement `[bool]`.

Note

Chapter 8 contains details of other data structures.

2.5. Instrument-Specific Considerations

This section describes some instrument-specific considerations when programming with the LabOne APIs.

2.5.1. MF-Specific Considerations

Identifying which Data Server the MF device is connected to

If /DEV..../SYSTEM/ACTIVEINTERFACE has the value "pcie" the device is connected via the Data Server running locally on the MF instrument itself. If it has the value "1GbE" it is connected via a Data Server running on a PC.

2.5.2. UHF-Specific Considerations

UHF Lock-in Amplifiers perform an automatic calibration 10 minutes after power-up of the Instrument. This internal calibration is necessary to achieve the specifications of the system. However, if necessary, it can be ran manually by setting the device node /DEV..../SYSTEM/CALIB/CALIBRATE to 1 and then disabled using the /DEV..../SYSTEM/CALIB/AUTO node.

The calibration routine takes about 200 ms and during that time the transfer of measurement data will be stopped on the Data Server level. If a ziAPI (LabOne C API) or LabVIEW client is polling data during this time, the user will experience data loss; ziAPI has no functionality to deal with such a streaming interrupt. Clients polling data will be informed of data loss, which allows the user to ignore this data.

Please see the UHF User Manual for more information about device calibration.

Chapter 3. LabOne API Programming

Each of the LabOne APIs (LabVIEW, Matlab, Python, C, .NET) provide an interface to configure and acquire data from your instrument. All these programming interfaces are, however, thin application layers based on a shared core API, `ziCore`. This chapter describes the low-level command and high-level functionality provided by LabOne Modules that's available in all the LabOne interfaces.

Refer to:

- Section 3.1 for An Introduction to LabOne Modules.
- Section 3.2 for Low-level LabOne API Commands.
- Section 3.4 for the AWG Module.
- Section 3.5 for the Data Acquisition Module.
- Section 3.6 for the Device Settings Module.
- Section 3.7 for the Impedance Module.
- Section 3.8 for the Multi-Device Synchronisation Module.
- Section 3.9 for the PID Advisor Module.
- Section 3.10 for the Precompensation Advisor Module.
- Section 3.11 for the Scope Module.
- Section 3.12 for the Sweeper Module.

The following modules are still maintained, but will be made deprecated in a future release. As of LabOne 17.12 the Data Acquisition Module combines and replaces the functionality of the Software Trigger (Recorder) Module and the Spectrum (ZoomFFT) Module. New users should use the Data Acquisition Module instead of these modules.

- Section 3.13 for the Software Trigger (Recorder) Module.
- Section 3.14 for the Spectrum Analyzer Module.

3.1. An Introduction to LabOne Modules

All of the LabOne APIs are based on a central API called `ziCore`. This allows them to share a common structure which provides a uniform interface for programming Zurich Instruments devices. The aim of this section is to familiarize the user with the key `ziCore` programming concepts which can then be used in any of the LabOne APIs (LabVIEW, Matlab, Python, .Net, and C).

3.1.1. Software Architecture

Each of the `ziCore`-based APIs is designed to have a minimal code footprint: They are simply small interface layers that use the functionality derived from `ziCore`, a central C++ API. The derived API interfaces (LabVIEW, Matlab, Python, .NET and C) provide a familiar interface to the user and allow the them to receive and manipulate data from their instrument using the API language's native data types and formats. See Section 1.2 for an overview of the LabOne software architecture.

3.1.2. ziCore Modules

In addition to the usual API commands available for instrument configuration and data retrieval, e.g., `setInt`, `poll`), `ziCore`-based APIs also provide a number of so-called **Modules**: high-level interfaces that perform common tasks such as sweeping data or performing FFTs.

The Module's functionality is implemented in `ziCore` and each derived high-level API simply provides an interface to that module from the API's native environment. This design ensures that the user can expect the same behavior from each module irrespective of which API is being used; if the user is familiar with a module available in one high-level programming API, it is quick and easy to start using the module in a different API. In particular, the LabOne User Interface is also based on `ziCore` and as such, the user can expect the same behavior using a `ziCore`-based API that is experienced in the LabOne User Interface, see Figure 3.1.

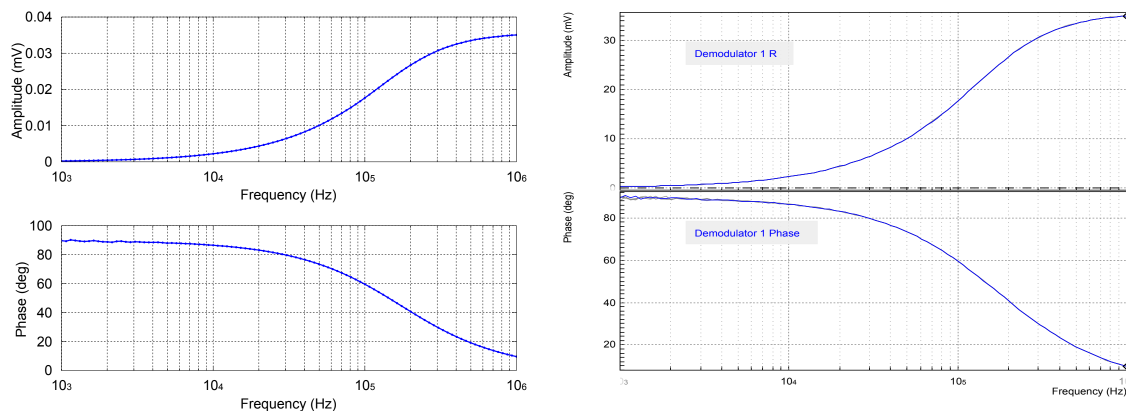


Figure 3.1. The same results and behavior can be obtained from Modules in any `ziCore`-based interface; Sweeper Module results from the LabOne Matlab API (left) and the LabOne User Interface (right) using the same Sweeper and instrument settings.

The modules currently available in `ziCore` are:

- The Sweeper Module for obtaining data whilst performing a sweep of one of the instrument's setting, e.g., measuring a frequency response.
- The Data Acquisition Module for recording instrument data asynchronously based upon user-defined triggers.

- The Spectrum Analyzer Module for calculating the FFT of demodulator output. This module is deprecated. We recommend using the Data Acquisition Module instead.
- The Software Trigger (Recorder) Module for recording instrument data asynchronously based upon user-defined triggers. This module is deprecated. We recommend using the Data Acquisition Module instead.
- The Device Settings Module for saving and loading instrument settings to and from (XML) files.
- The PID Advisor Module for modeling and simulating the PID incorporated in the instrument.
- The Scope Module for obtaining scope data from the instrument.
- The Impedance Module for performing impedance measurements.
- The Multi-Device Synchronisation Module for synchronizing the timestamps of multiple instruments.
- The AWG Module for working with the AWG.
- The Precompensation Advisor Module also for working with the AWG.

In addition to providing a unified-interface between APIs, modules also provide a uniform workflow regardless of the functionality the module performs (e.g., sweeping, recording data).

An important difference to low-level `ziCore` API commands is that Modules execute their commands **asynchronously**, see Section 3.1.3.

3.1.3. Synchronous versus Asynchronous Commands

The low-level API commands such as `setInt` and `poll` are **synchronous** commands, that is the interface will be blocked until that command has finished executing; the user cannot run any commands in the meantime. Another feature of `ziCore`'s Modules is that each instantiation of a Module creates a new Thread and, as such, the commands executed by a Module are performed **asynchronously**. Asynchronous means that the task is performed in the background and the interface's process is available to perform other tasks in the meantime, i.e., Module commands are non-blocking for the user.

3.1.4. Converting LabOne's "systemtime" to Local Time

Data returned by Core Modules, for example the data of a single sweep, contain a header with a `systemtime`; field whose value is the POSIX time in microseconds at the point in time when the data was acquired. It may correspond to the start of data acquisition or the end, depending on the module, but will be consistent for all objects returned from one module. In order to help convert this timestamp to an API environment's native time format there are utility functions in the LabOne APIs, where appropriate the example code in the function's docstring demonstrates their use. Please check the utility function of the respective API for more details.

3.2. Low-level LabOne API Commands

This section describes the API commands `getSample()`, `subscribe` and `poll()`. For continuous data acquisition, however, it is recommended to use the Data Acquisition Module in continuous mode.

3.2.1. The getSample command

For one-shot measurement demodulator data

The simplest function to obtain demodulator data is the `getSample` command. It returns a single sample from one demodulator channel, i.e., it returns the sample fields (not only the demodulator outputs X and Y) described in Section 2.4 at one timestamp. The `getSample` function returns the last sample for the specified demodulator that the Data Server has received from the instrument.

Please note, the `getSample` function only works with the demodulator data type. It does not work with other data types such as impedance or auxiliary input samples. For non-demodulator sample types the recommended way to get data is via the subscribe and poll commands.

The `getSample` command raises a `ZIAPITimeoutException` if no demodulator data is received from the device within 5 seconds. This is the case if the requested demodulator is not enabled. As `getSample` only returns data from a single demodulator, wildcard path specification (e.g., `/devn/demods/*/sample`) is not supported.

If multiple samples (even from one demodulator channel) are required, it is recommended to use either subscribe and poll (for high performance API applications) or Data Acquisition Module. Using `getSample` in anything other than low-speed loops data is not recommended.

3.2.2. The subscribe and poll commands

For high-performance continuous or block streaming data

The subscribe and poll functions are low-level commands that allow high-speed data transfer from the instrument to the API. The idea is as follows: The user may subscribe to one or more nodes in the API session by calling subscribe for each node. This tells the Data Server to create a buffer for each subscribed node and to start accumulating the data corresponding to the node that is streamed from the instrument (or instruments, as the case may be). The user can then call poll (in the same API session) to transfer the data from the Data Server's buffers to the API's client code. If poll is not called within 5 seconds of either subscribing, the last call to poll or calling the sync command (more information on sync below), the Data Server clears its buffers for the subscribed nodes and starts accumulating data again. This means that for continuous transfer of data, the user must regularly poll data from the Data Server to ensure that no data is lost in between polls.

Simple Example

For example, the following Python code subscribes to the first and fifth demodulator sample streaming nodes on a lock-in amplifier:

```
import zhinst.ziPython
daq = zhinst.ziPython('localhost', 8004, 6)
# Enable the demodulator output and set the transfer rate.
# This ensure the device actually pushes data to the Data Server.
daq.setInt('/dev2006/demods/0/enable', 1)
daq.setInt('/dev2006/demods/4/enable', 1)
# This value will be corrected to the nearest legal value by the instrument's FW.
daq.setDouble('/dev2006/demods/0/rate, 10e3)
daq.setDouble('/dev2006/demods/4/rate, 10e3)
daq.subscribe('/dev2006/demods/0/sample')
```

```
daq.subscribe('/dev2006/demods/4/sample')
time.sleep(1)  # Subscribed data is being accumulated by the Data Server.
data = daq.poll(0.020, 10, 0, True)
data.keys()
# Out: dict_keys(['/dev2006/demods/0/sample', '/dev2006/demods/4/sample'])
len(data['/dev2006/demods/0/sample']['timestamp'])
# Out: 13824
len(data['/dev2006/demods/4/sample']['timestamp'])
# Out: 13746
```

Example 3.1. Python code demonstrating basic subscribe/poll behaviour

The subscribe and poll commands return data from streaming nodes as sent from the instrument's firmware at the configured data rate. The data returned is the discrete device data as sampled or calculated by the digital signal processing algorithms on the instrument. As explained in Section 2.2.1, Streaming Nodes the data from multiple nodes may not be aligned due to different sampling rates or different streaming node sources.

When you call subscribe on a node the Data Server starts accumulating data in a dedicated buffer (for that node and the API session from which subscribe was called). When the buffer becomes full, then the data is discarded by the Data Server (poll must be called frequently enough to ensure that data is not lost in between multiple poll calls). When you call poll, then all the data that has accumulated in the Data Server's buffers (of subscribed nodes) is returned (it is transferred to the API client) and is deleted from the Data Server's buffers. The Data Server continues to accumulate new data sent from the device for the subscribed nodes after polling and will continue to do so until unsubscribe is called for that node. It is good practice to call unsubscribe on the nodes when you no longer want to poll data from them so that the Data Server stops accumulating data and can free up the system's memory.

If you would like to continue recording new data for a subscribed node, but discard older data, then either poll can be called (and the returned older data simply discarded) or the sync command can be used. Sync clears the Data Server's buffers of subscribed data but has an additional function. Additionally, the sync command blocks (it is a synchronous command) until all set commands have been sent to the device and have taken effect. E.g., if you enable the instrument's signal output and want to ensure that you only receive data from poll after the setting has taken effect the device, then sync should be called after calling set and before calling poll.

The first two mandatory parameters to poll are the "poll duration" and the "poll timeout" parameters: Poll is also a synchronous command and will block for the specified poll duration. It will return the data accumulated during the time in seconds specified by the poll duration, and as mentioned above, it will also return the data previously accumulated data before calling poll. If you would like to poll data continuously in a loop, then a very small poll duration should be used, e.g., 0.05 seconds, so that it only blocks for this time. The poll timeout parameter typically must not be set very carefully and a value of 100 ms is sufficient. It is indeed only relevant if set to a larger value than poll duration. In this case, if no data arrives from the instrument, poll will wait for poll timeout milliseconds before returning. If data does arrive after poll duration but before the poll timeout, poll returns immediately. It is recommended to simply use a poll timeout of 100 ms (or if poll_duration is smaller, to set it equal to the poll_duration). Unfortunately, the units of poll duration and poll timeout differ: The poll duration is in seconds, whereas poll timeout is in milliseconds.

Ensure synchronization of settings before streaming data (sync)

To ensure that any settings have taken effect on the instrument before streaming data is processed, a special sync command is provided which ensures that the API blocks during the full command execution of sending down a marker to the device and receiving it again over the API. During that time all buffers are cleaned. Therefore, after the sync command the newly recorded

poll data will be later in time than the previous set commands. Be aware that this command is quite expensive ~100ms.

Asking poll to always return a value for a settings node (getAsEvent)

The poll command only returns value changes for subscribed nodes; no data will be returned for the node if it has not changed since subscribing to it. If poll should also return the value of a node that has not changed since subscribing, then `getAsEvent` may be used instead of or in addition to subscribe. This ensures that a settings node value is always pushed.

```
daq = zhinst.ziPython.ziDAQServer('localhost', 8004, 6)
# Without getAsEvent no value would be returned by poll.
daq.getAsEvent('/dev2006/sigouts/0/amplitudes/3')
daq.subscribe('/dev2006/sigouts/0/amplitudes/3')
daq.poll(0.200, 10, 0, True)
# Out: {'/dev2006/sigouts/0/amplitudes/0': {'timestamp': array([26980521883432],
 dtype=uint64),
#  'value': array([ 0.30001831])}}
```

Example 3.2. Python code demonstrating `getAsEvent` usage

If no data was stored in the Data Server's data buffer after issuing a `poll`, the command will wait for the data until the timeout time. If the buffer is empty after the timeout time passed, `poll` will either simply return an empty data structure (for example, an empty dictionary in Python) or throw an error, depending which flags it have been provided.

Note

Often one of the LabOne `ziCore` Modules provide an easier and more efficient choice for data acquisition than the comparably low-level `poll` command. Each `ziCore` Module is a software component that performs a specific high-level measurement task, for example, the Data Acquisition Module can be used to record bursts of data when a defined trigger condition is fulfilled or the Sweeper Module can be used to perform a frequency response analysis. See Section ziCore Modules for an overview of the available Modules.

Explanation of buffering in the Data Server and API Client

The following graphics illustrate how data are stored and transferred between the Instrument, the Data Server, and the API session in the case when the API session is the only client of the Data Server. Figure 3.2 shows the situation when the API session has subscribed to a node, but no `poll` command is being sent. Figure 3.3 corresponds to the situation when the `poll` command with a recording time of 0 is sent at regular intervals, and illustrates the moment just before the last `poll` command. Figure 3.4 then illustrates the moment just after the last `poll` command.

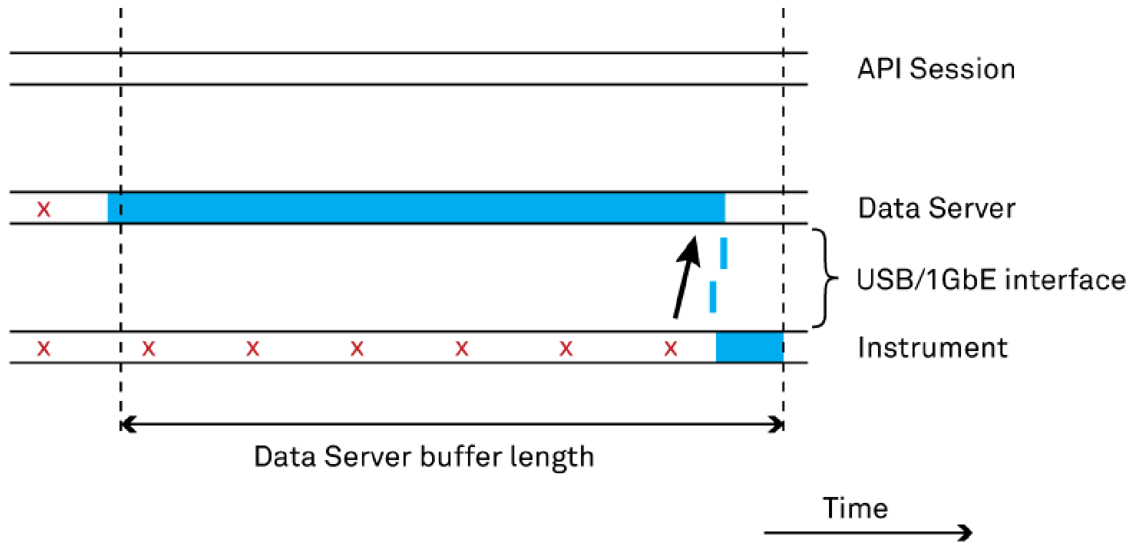


Figure 3.2. Illustration of data storage and transfer: the API Session (no other Data Server clients) is subscribed to a node (blue bars representing data stream) but never issues a `poll` command. The data are stored in the Data Server's buffer for a certain time and dumped afterwards.

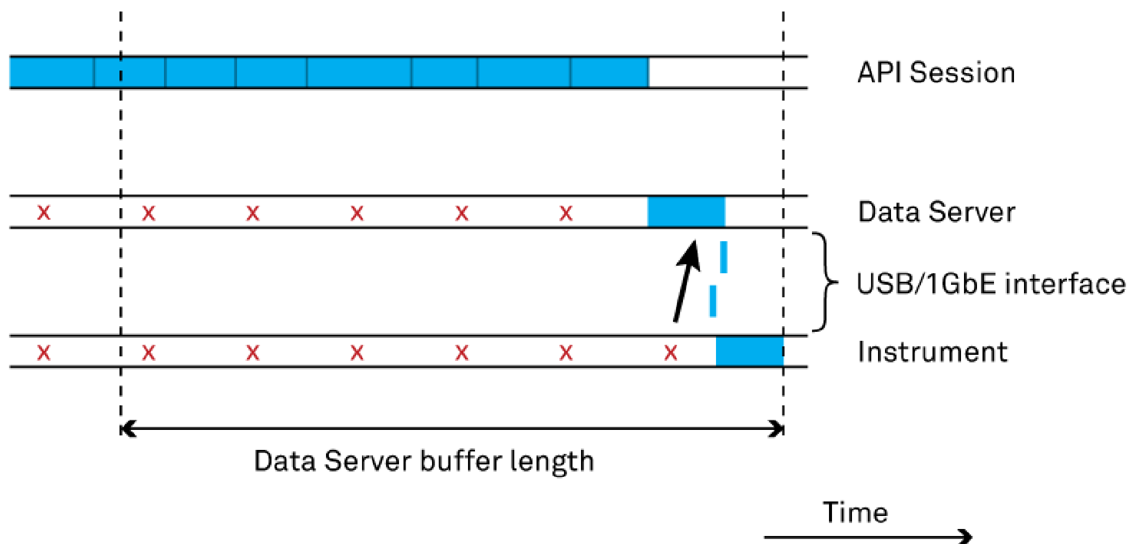


Figure 3.3. Illustration of data storage and transfer: the API Session is subscribed to a node and regularly issues a `poll` command. The Data Server holds only the data in the memory that were accumulated since the last `poll` command.

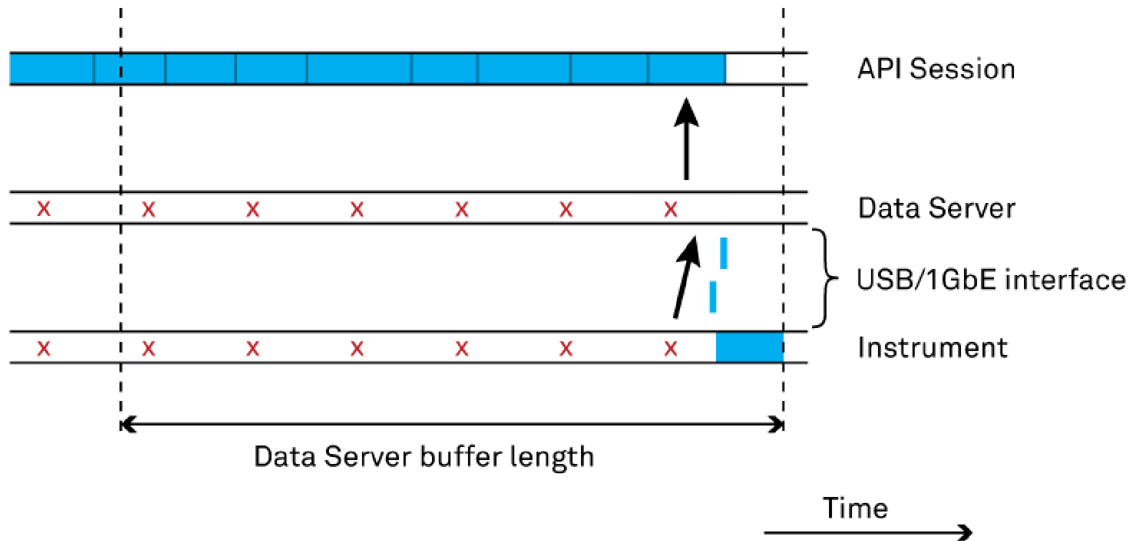


Figure 3.4. Illustration of data storage and transfer: the API Session is subscribed to a node and regularly issues a `poll` command. Upon a new `poll` command, all data accumulated in the Data Server buffer are transferred to the API Session and subsequently cleared from the Data Server buffer.

In the following cases, the picture above needs to be modified:

1. **Multiple Data Server clients**: in case multiple clients (API sessions, Web Server) are subscribed to the same node, the Data Server will keep the corresponding data in the buffer until all clients have polled the data (or until it's older than the buffer length). This means different clients will not interfere with each other.
2. **LabVIEW, C, and .NET APIs**: in these APIs (unlike in MATLAB and Python), it's not guaranteed that a single `poll` command leads to the transfer of all data in the Data Server buffer because the block size of transferred data is limited. Nonetheless, by calling `poll` frequently enough, a gapless stream of data can be obtained.
3. **HF2 Series instruments**: the buffer Data Server for HF2 Series instruments is defined by its memory size rather than by its length in units of time. This means that the duration for which the Data Server will store data depends on the sampling rate.

3.3. Common Core Module Parameters

Many of the LabOne Core Modules have the `save/*` branch of parameters which control data saving from the module, see:

- Table 3.1 for input/output parameters and,
- Table 3.2 for input parameters.

Table 3.1. Common Core Module `save/` branch Input/Output Parameters.

Path	Type	Unit	Description
`save/save`	bool	-	Initiate the saving of data to file. The saving is done in the background. When the save has finished, the module resets this parameter to 0.

Table 3.2. Core Module `save/` branch Input Parameters.

Path	Type	Unit	Description
`save/directory`	string	-	The base directory where files are saved.
`save/filename`	string	-	Defines the sub-directory where files are saved. The actual sub-directory has this name with a sequence count (per save) appended, e.g. daq_000.
`save/fileformat`	string	-	The format of the file for saving data: 0: Matlab. 1: CSV. 2: ZView (for impedance measurements). 3: SXM (Image format). 4: HDF5.
`save/csvseparator`	string	-	The character to use as CSV separator when saving files in this format.
`save/csvlocale`	string	-	The locale to use for the decimal point character and digit grouping character for numerical values in CSV files: "C": Dot for the decimal point and no digit grouping (default). "" (empty string): Use the symbols set in the language and region settings of the computer.
`save/saveonread`	bool	-	Automatically save the data to file immediately before reading out the data from the module using the read() command. Set this parameter to 1 if you want to save data to file when running the module continuously and performing intermediate reads.

3.4. AWG Module

The AWG Module allows programmers to access the functionality available in the LabOne User Interface AWG tab. It allows users to compile and upload sequencer programs to the arbitrary waveform generator on UHF and HDAWG instruments from any of the LabOne APIs.

This chapter only explains the specifics for working with an AWG from an API; reference documentation of the LabOne AWG Sequencer Programming Language can be found in the UHF or HDAWG User Manual.

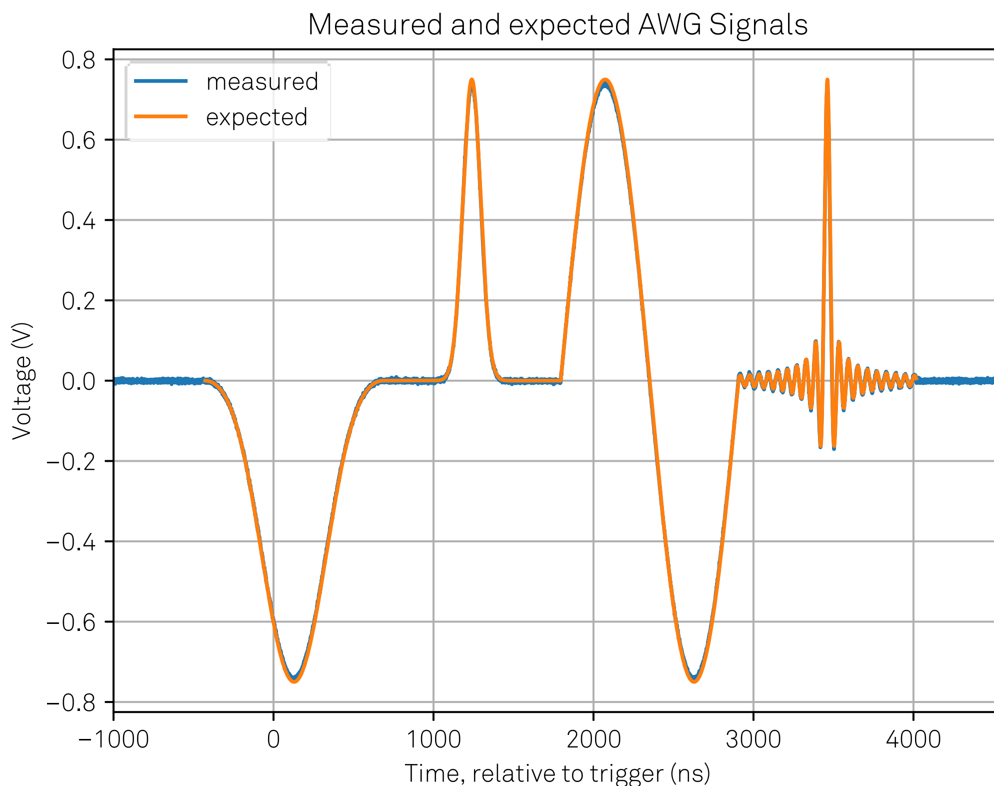


Figure 3.5. An AWG signal generated and measured using a UHFLI with the AWG Option. The waveform data was measured via a feedback cable using the UHF's Scope. The plot was generated by the Python API example for the UHF, `example_awg.py`, which also generates the expected waveform and cross-correlates it with the measured waveform in order to overlay the expected signal on the measurement data.

3.4.1. Getting Started with the AWG Module

The following API examples demonstrating AWG Module use are available:

- Matlab and Python, `example_awg.{py,m}`: Compiles and uploads an AWG sequencer program from a string. It demonstrates how to define waveforms using the four methods listed below in Section 3.4.3. Separate versions of these examples are available for both UHF and HDAWG instruments.
- Matlab and Python, `example_awg_sourcefile.{py,m}`: Demonstrates how to compile and upload an AWG sequencer program from a `.seqc` file. Separate versions of these examples are available for both UHF and HDAWG instruments.

- LabVIEW `ziExample-UHFLI-Module-AWG.vi`: Compiles and uploads an AWG sequencer program from a string and captures the generated waveform in the scope (UHF only).
- .NET, `ExampleAwgModule()` (in `Examples.cs`): Compiles and uploads an AWG sequencer program from a string. It demonstrates how to define waveforms using the four methods listed below in Section 3.4.3.
- C API, `ExampleAWGUpload.c`: Demonstrates how to compile and upload an AWG sequencer program from a `.seqc` file.

3.4.2. Sequencer Program Compilation and Upload

Programming an AWG with a sequencer program is a 2-step process. First, the source code must be compiled to a binary ELF file and secondly the ELF file must be uploaded from the PC to the AWG on the UHF or HDAWG instrument. Both steps are performed by an instance of the AWG Module regardless of whether the module is used in the API or the LabOne User Interface's AWG Sequencer tab.

Compilation

An AWG sequencer program can be provided to the AWG module for compilation as either a:

1. Source file: In this case the sequencer program file must reside in the "awg/src" sub-directory of the LabOne user directory. The filename (without full directory path) must be specified via the `awgModule/compiler/sourcefile` parameter and compilation is started when the in-out parameter `awgModule/compiler/start` is set to 1.
2. String: A sequencer program may also be sent directly to the AWG Module as a string (comprising of a valid sequencer program) without the need to create a file on disk. The string is sent to the module by writing it to the `awgModule/compiler/sourcestring` using the module `setString()` function. In this case, compilation is started automatically after writing the source string.

Upload

If the `awgModule/compiler/upload` parameter is set to 1 the ELF file is automatically uploaded to the AWG after successful compilation. Otherwise, it must be uploaded by setting the in-out parameter `awgModule/elf/upload` to 1. A running AWG must be disabled first in order to upload a new sequencer program and it must be enabled again after upload.

3.4.3. Methods to define Waveforms in Sequencer Programs

The waveforms played by an AWG sequencer program can be defined, or in the last case, modified, using the following four methods. These methods are demonstrated by the examples listed in Section 3.4.1.

1. By using one of the waveform generation functions such as `sine()`, `sinc()`, `gauss()`, etc. defined in the LabOne AWG Sequencer programming language. See the UHF or HDAWG User Manual for full reference documentation.
2. By defining a waveform in floating point format in a CSV file. Such waveform CSV files must be located in the "awg/waveforms" sub-directory of the LabOne user directory (see explanation of `awgModule/directory` in Table 3.7). In order to compile a sequencer program that uses CSV-defined waveforms a comma-separated list of the CSV filenames (without extension) must be specified via the `awgModule/compiler/waveforms` parameter.

3. By defining a short waveform as an array of floating point numbers within the sequencer program and playing it using the AWG Sequencer function `vect()`. Note, this method should only be used for short waveforms (less than 100 points); a compiler warning is issued when `vect()` is used with a larger number of input arguments. For longer waveforms it's recommended to define the waveform in a CSV file as described above instead.
4. A waveform that has been previously defined, even as an array of zeros with, for example, `zeros(10000)`, may be replaced at program runtime as follows:
   a. Writing the new waveform vector using the setVector command to the node /DEV.../AWGS/0/WAVEFORM/WAVES/<index>, where <index> corresponds to the desired waveform to replace.

   Note that the new waveform must be the same length as the original defined in the sequence program. Note also that the /DEV.../AWGS/0/WAVEFORM/WAVES/<index> nodes have the property SILENTWRITE. This means that subscribing to such a node has no effect, i.e. changes to the node will not be returned in `poll`. To obtain the contents of such nodes, `getAsEvent` has to be called followed by `poll`. For short vectors `get` may be used.

   The index of the waveform to replace is defined as follows: Let N be the total number of waveforms and M>0 be the number of waveforms used in the sequencer program defined from CSV file. Then the index of the waveform to replace is defined as follows:

   - index=0,...,M-1 for all waveforms defined from CSV alphabetically ordered by filename,
   - index=M,...,N-1 in the order that the other (non-CSV defined) waveforms are defined in the sequencer program.

   If no waveforms are defined by CSV file (M=0), then the index is defined by:

   - index=0,...,N-1 in the order that the waveforms are defined in the sequencer program.

   Alternatively, the index of the waveform to be replaced can be determined using the Waveform sub-tab in the AWG tab of the LabOne User Interface.

   The waveform nodes use the internal raw format of the instrument and map the hardware capabilities of an AWG core. Thus, each waveform node can hold up to two analog waveforms and four markers. The length, number of waves and the presence of markers must be the same as the original. An analog waveform is represented as array of signed int16. The markers are represented as array of int16, with the marker values defined in the four LSB; the other 12 bits must be zeros (see Figure 3.6). If there is more than one analog waveform and/or markers, the arrays representing them must be interleaved; the order should be the first wave, then the second and finally the markers.

```
wave_int16 = int16((1 << 15 - 1) * wave_float);
```

```
markers = int16(mk1_out1 * 1 << 0 + mk2_out1 * 1 << 1 + mk1_out2 * 1 << 2 + mk2_out2 * 1 << 3);
```

   It's convenient to use the helper Python functions `zhinst.utils.convert_awg_waveform` and `zhinst.utils.parse_awg_waveform` to write and read these nodes.

w1[0]	w2[0]	mk[0]	w1[1]	w2[1]	mk[1]	...	w1[n]	w2[n]	mk[n]

Figure 3.6. Interleaving of waves and markers in AWG raw format

3.4.4. HDAWG Channel Grouping

This section explains how to configure the `awgModule/index` parameter and which AWGS node branch must be used for different channel grouping configurations. The channel grouping is defined by the value of the the node /DEV..../SYSTEM/AWG/CHANNELGROUPING as follows:

0: Use the outputs in groups of 2; each sequencer program controls 2 outputs. Each group n=0,1,2,3 of AWGs (respectively n=0,1 on HDAWG4 instruments) is configured by the /DEV..../AWGS/n branches. Each of these 4 groups requires its own instance of the AWG Module and `awgModule/index` should be set to n=0,1,2,3 for each group accordingly.

1: Use the outputs in groups of 4; each sequencer program controls 4 outputs. Each group n=0,1 of AWGs (respectively n=0 on HDAWG4 instruments) is configured by the /DEV..../AWGS/0 and /DEV..../AWGS/2 branches. Each of these two groups requires its own instance of the AWG Module and `awgModule/index` should be set to n=0,1 for each group accordingly. For HDAWG4 instruments, there is only one group of 4 outputs which is configured by the /DEV..../AWGS/0 branch.

2: HDAWG8 devices only. Use the outputs in a single group of 8; the (single) sequencer program controls 8 outputs. There is only one group (n=0) of 8 AWGs which is configured by the /DEV..../AWGS/0 branch. Only one instance of the AWG Module is required and its value of `awgModule/index` should be 0.

Table 3.3. Overview of the device nodes and the value of `awgModule/index` used in different channel grouping configurations on HDAWG8 instruments.

Value of CHANNELGROUPING	Number of Cores	AWG Core	Corresponding device AWG branch index	Value of `awgModule/index`
0	4	1	/DEV..../AWGS/0	0
		2	/DEV..../AWGS/1	1
		3	/DEV..../AWGS/2	2
		4	/DEV..../AWGS/3	3
1	2	1	/DEV..../AWGS/0	0
		2	/DEV..../AWGS/2	1
2	1	1	/DEV..../AWGS/0	0

Table 3.4. Overview of the device nodes and the value of `awgModule/index` used in different channel grouping configurations on HDAWG4 instruments.

Value of CHANNELGROUPING	Number of Cores	AWG Core	Corresponding device AWG branch index	Value of `awgModule/index`
0	2	1	/DEV..../AWGS/0	0
		2	/DEV..../AWGS/1	1
1	1	1	/DEV..../AWGS/0	0

3.4.5. AWG Module Parameters

The following tables provide a comprehensive list of the module's parameters, see:

- Table 3.5 for input/output parameters,
- Table 3.6 for input parameters and,
- Table 3.7 for output parameters.

Table 3.5. AWG Module Input/Output Parameters.

Setting/Path	Type	Unit	Description
`compiler/start`	bool	-	Set to 1 to start compiling the AWG sequencer program specified by `compiler/sourcefile`. The module sets `compiler/start` to 0 once compilation has successfully completed (or failed). If `compiler/upload` is enabled then the sequencer program will additionally be uploaded to the AWG upon after successful compilation.
`elf/upload`	bool	-	Set to 1 to start uploading the AWG sequencer program to the device. The module sets `elf/upload` to 0 once the upload has finished.

Table 3.6. AWG Module Input Parameters.

Setting/Path	Type	Unit	Description
`compiler/sourcefile`	string	-	The filename of an AWG sequencer program file to compile and load. The file must be located in the "awg/src" sub-directory of the LabOne user directory. This directory path is provided by the value of the read-only `directory` parameter.
`compiler/sourcestring`	string	-	A string containing an AWG sequencer program may directly loaded to this parameter using the module command `setString`. This allows compilation and upload of a sequencer program without saving it to a file first. Compilation starts automatically after `compiler/sourcestring` has been set.
`compiler/upload`	bool	-	Specify whether the sequencer program should be automatically uploaded to the AWG following successful compilation.
`compiler/waveforms`	string	-	A comma-separated list of waveform CSV files to be used by the AWG sequencer program.
`device`	string	-	The target device for AWG sequencer programs upload, e.g. 'dev2006'.
`elf/file`	string	-	The filename of the compiled binary ELF file. If not set, the name is automatically set based on the source filename. The ELF file will be saved by the AWG Module in the "awg/elf" sub-directory of the LabOne user directory. This directory path is provided by the value of the read-only `directory` parameter.
`index`	bool	-	The index of the current AWG Module to use when running with multiple AWG groups, see Section 3.4.4 for further explanation.

Setting/Path	Type	Unit	Description
`mds/enable`	bool	-	Enables grouping of multiple synchronized instruments for AWG playback.
`mds/group`	int	-	The MDS group (`multiDeviceSyncModule/group`) to use for synchronized AWG playback.

Table 3.7. AWG Module Output (read-only) Parameters.

Setting/Path	Type	Unit	Description
`compiler/status`	int	-	Compilation status: 1: Idle. 0: Compilation successful. 1: Compilation failed. 2: Compilation completed with warnings.
`compiler/statusstring`	string	-	Status message of the compiler.
`directory`	string	-	The path of the LabOne user directory (this may not be modified). The AWG Module uses the following subdirectories in the LabOne user directory: awg/src: Contains AWG sequencer program source files (user created). awg/elf: Contains compiled AWG binary (ELF) files (created by the module). awg/waves: Contains CSV waveform files (user created).
`elf/status`	int	-	Status of the ELF file upload: 1: Idle. 0: Upload successful. 1: Upload failed. 2: Upload in progress.
`elf/checksum`	int	-	The checksum of the generated ELF file.
`progress`	double	-	Reports the progress of the upload as a value between 0 and 1.

3.5. Data Acquisition Module

The Data Acquisition Module corresponds to the Data Acquisition tab of the LabOne User Interface. It enables the user to record and align time and frequency domain data from multiple instrument signal sources at a defined data rate. The data may be recorded either continuously or in bursts based upon trigger criteria analogous to the functionality provided by laboratory oscilloscopes.

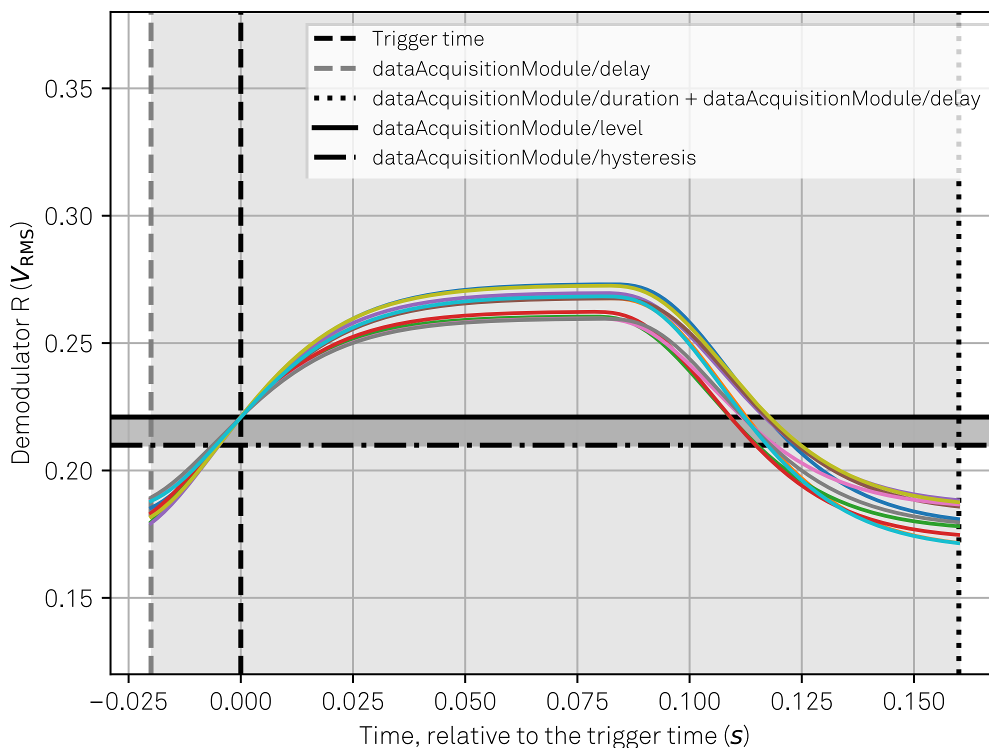


Figure 3.7. The plot produced by `example_data_acquisition_edge.py`, an example distributed with the LabOne Python API. The plot shows 10 bursts of data acquired from a demodulator; each burst was recorded when the demodulator's R value exceeded a specified threshold using a positive edge trigger. See Section 5.2.3 for help getting started with the Python examples.

Historical Note

The Data Acquisition Module was introduced in LabOne Release 17.12 and improved and unified the functionality of the Software Trigger (Recorder) Module and the Spectrum Analyzer Module. The DAQ and Spectrum tabs in the LabOne User Interface both use the Data Acquisition Module. The main new features of the DAQ Module (in comparison to the Software Trigger Module) are:

- Simultaneous triggered time and frequency domain (FFT) data acquisition.
- Exact mode, in addition to linear or nearest neighbour interpolation sampling modes. Exact mode ensures that all the subscribed data is sampled onto the grid defined by the subscribed signal with the highest data rate.
- A continuous acquisition mode.

- Dot notation for specifying the exact signal to acquire and any operations to be performed on the data, e.g. averaging, standard deviation, FFT.

Please note that the Software Trigger (Recorder) Module and the Spectrum Analyzer Module will be deprecated in a future release. Section 3.5.4 and Section 3.5.5 explain how to migrate existing Software Trigger, respectively zoomFFT, API programs to the Data Acquisition Module.

3.5.1. DAQ Module Acquisition Modes and Trigger Types

This section lists the required parameters and special considerations for each trigger mode. For reference documentation of the module's parameters please see Section 3.5.6.

Table 3.8. Overview of the acquisition modes available in the Data Acquisition Module.

Mode / Trigger Type	Description	Value of `dataAcquisitionModule/type`
Continuous	Continuous recording of data.	0
Edge	Edge trigger with noise rejection.	1
Pulse	Pulse width trigger with noise rejection.	3
Tracking (Edge or Pulse)	Level tracking trigger to compensate for signal drift.	4
Digital	Digital trigger with bit masking.	2
Hardware	Trigger on one of the instrument's hardware trigger channels (not available on HF2).	6
Pulse Counter	Trigger on the value of an instrument's pulse counter (requires CNT Option).	8

Continuous Acquisition

This mode performs back-to-back recording of the subscribed signal paths. The data is returned by `read()` in bursts of a defined length (`dataAcquisitionModule/duration`). This length is defined either:

- Directly by the user via `dataAcquisitionModule/duration` for the case of nearest or linear sampling (specified by `dataAcquisitionModule/grid/mode`).
- Set by the module in the case of exact grid mode based on the value of `dataAcquisitionModule/grid/cols` and the highest sampling rate rate of all subscribed signal paths.

Acquisition using Level Edge Triggering

Parameters specific to edge triggering are:

- `dataAcquisitionModule/level`,
- `dataAcquisitionModule/hysteresis`.

The user can request automatic calculation of the `level` and `hysteresis` parameters by setting the `findlevel` parameter to 1. Please see Section 3.5.2 for more information.

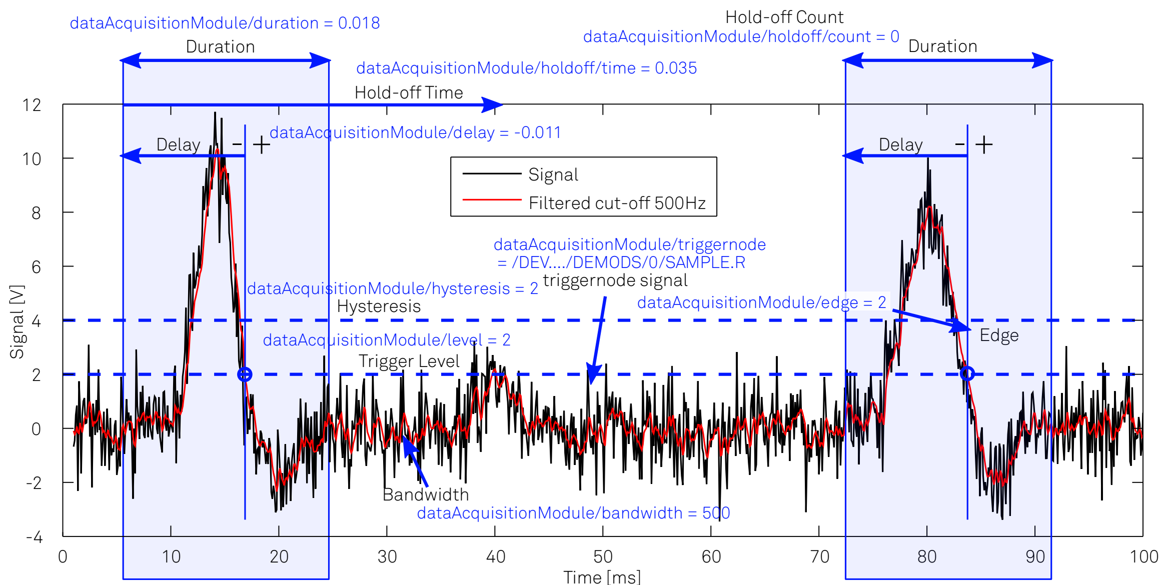


Figure 3.8. Explanation of the Data Acquisition Module's parameters for an Edge Trigger.

Acquisition using Pulse Triggering

Parameters specific to pulse triggering are:

- `dataAcquisitionModule/level`,
- `dataAcquisitionModule/hysteresis`,
- `dataAcquisitionModule/pulse/min`,
- `dataAcquisitionModule/pulse/max`.

The user can request automatic calculation of the `level` and `hysteresis` parameters by setting the `findlevel` parameter to 1. Please see Section 3.5.2 for more information.

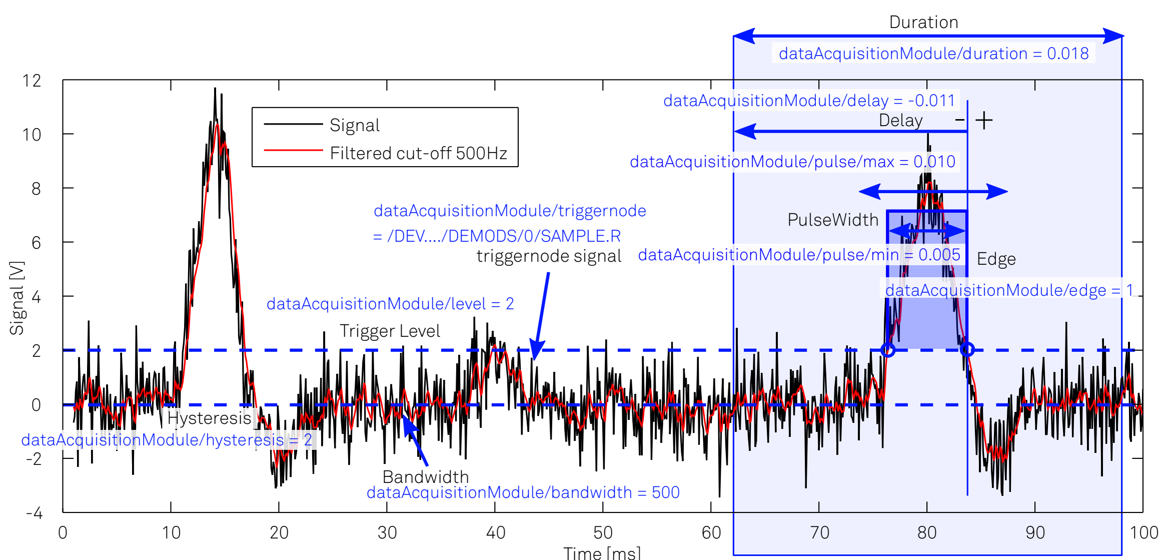


Figure 3.9. Explanation of the Data Acquisition Module's parameters for a positive Pulse Trigger.

Acquisition using Tracking Edge or Pulse Triggering

In addition to the parameters specific to edge and pulse triggers, the parameter that is of particular importance when using a tracking trigger type is:

- `dataAcquisitionModule/bandwidth`,

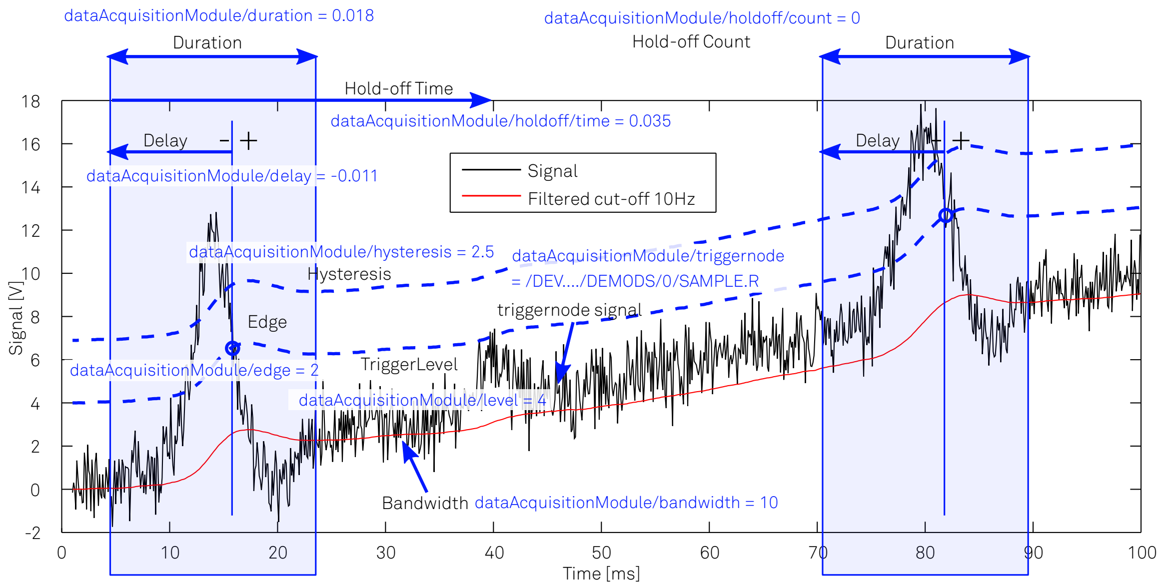


Figure 3.10. Explanation of the Data Acquisition Module's parameters for a Tracking Trigger.

Acquisition using Digital Triggering

To use the DAQ Module with a digital trigger, it must be configured to use a digital trigger type (by setting `dataAcquisitionModule/type` to 2) and to use the output value of the instrument's DIO port as it's trigger source. This is achieved by setting `dataAcquisitionModule/triggernode` to the device node /DEV..../DEMODS/N/SAMPLE.bits). It is important to be aware that the Data Acquisition Module takes its value for the DIO output from the demodulator sample field `bits`, not from a node in the /DEV..../DIOS/ branch. As such, the specified demodulator must be enabled and and an appropriate transfer rate configured that meets the required trigger resolution (the Data Acquisition Module can only resolve triggers at the resolution of 1/(/DEV..../DEMODS/N/RATE); it is not possible to interpolate a digital signal to improve trigger resolution and if the incoming trigger pulse on the DIO port is shorter than this resolution, it may be missed).

The Digital Trigger allows not only the trigger bits (`dataAcquisitionModule/bits`) to be specified but also a bit mask (`dataAcquisitionModule/bitmask`) in order to allow an arbitrary selection of DIO pins to supply the trigger signal. When a positive, respectively, negative edge trigger is used, all of these selected pins must become high, respectively low. The bit mask is applied as following. For positive edge triggering (`dataAcquisitionModule/edge` set to value 1), the Data Acquisition Module recording is triggered when the following equality holds for the DIO value:

```
(/DEV..../DEMODS/N/SAMPLE.bits BITAND dataAcquisitionModule/bitmask) ==
 (dataAcquisitionModule/bits BITAND dataAcquisitionModule/bitmask)
```

and this equality has not been met for the previous value in time (the previous sample) of /DEV..../DEMODS/N/SAMPLE.bits. For negative edge triggering (`dataAcquisitionModule/edge` set to value 2), the Data Acquisition Module recording is triggered when the following inequality holds for the current DIO value:

```
(/DEV..../DEMODS/N/SAMPLE.bits BITAND dataAcquisitionModule/bitmask) !=
 (dataAcquisitionModule/bits BITAND dataAcquisitionModule/bitmask)
```

and this inequality was not met (there was equality) for the previous value of the DIO value.

Acquisition using Hardware Triggering

There are no parameters specific only to hardware triggering since the hardware trigger defines the trigger criterion itself; only the trigger edge must be specified. For a hardware trigger the `dataAcquisitionModule/triggernode` must be one of:

- `/DEV.../CNTS/N/SAMPLE.TrigAWGTrigN` (requires CNT Option),
- `/DEV.../DEMODS/N/SAMPLE.TrigAWGTrigN`,
- `/DEV.../DEMODS/N/SAMPLE.TrigDemod4Phase`,
- `/DEV.../DEMODS/N/SAMPLE.TrigDemod8Phase`,
- `/DEV.../CNTS/N/SAMPLE.TrigInN` (requires CNT Option),
- `/DEV.../DEMODS/N/SAMPLE.TrigInN`,
- `/DEV.../DEMODS/N/SAMPLE.TrigOutN`.

The hardware trigger type is not supported on HF2 instruments.

Acquisition using Pulse Counter Triggering

Pulse Counter triggering requires the CNT Option. Parameters specific to the pulse counter trigger type:

- `eventcount/mode`.

The `dataAcquisitionModule/triggernode` must be configured to be a pulse counter sample:

- `/DEV..../CNTS/N/SAMPLE.value`

3.5.2. Determining the Trigger Level automatically

The Data Acquisition Module can calculate the `dataAcquisitionModule/level` and `dataAcquisitionModule/hysteresis` parameters based on the current input signal for edge, pulse, tracking edge and tracking pulse trigger types. This is particularly useful when using a tracking trigger, where the trigger level is relative to the output of the low-pass filter tracking the input signal's average (see Figure 3.10). In the LabOne User Interface this functionality corresponds to the "Find" button in the Settings sub-tab of the Data Acquisition Tab.

This functionality is activated via API by setting the `dataAcquisitionModule/findlevel` parameter to 1. This is a single-shot calculation of the level and hysteresis parameters, meaning that it is performed only once, not continually. The Data Acquisition Module monitors the input signal for a duration of 0.1 seconds and sets the level parameter to the average of the largest and the smallest values detected in the signal and the hysteresis to 10% of the difference between largest and smallest values. When the Data Acquisition Module has finished its calculation of the level and hysteresis parameters it sets the value of the `dataAcquisitionModule/findlevel` parameter to 0 and writes the values to the `dataAcquisitionModule/level` and `dataAcquisitionModule/hysteresis` parameters. Note that the calculation is only

performed if the Data Acquisition Module is currently running, i.e., after `execute()` has been called. See Example 3.4 for Python code demonstrating how to use this behaviour.

```
# Arm the Data Acquisition Module: ready for trigger acquisition.
trigger.execute()
# Tell the Data Acquisition Module to determine the trigger level.
trigger.set('dataAcquisitionModule/findlevel', 1)
findlevel = 1
timeout = 10  # [s]
t0 = time.time()
while findlevel == 1:
    time.sleep(0.05)
    findlevel = trigger.getInt('dataAcquisitionModule/findlevel')
    if time.time() - t0 > timeout:
        trigger.finish()
        trigger.clear()
        raise RuntimeError("Data Acquisition Module didn't find trigger level after
 %.3f seconds." % timeout)
level = trigger.getDouble('dataAcquisitionModule/level')
hysteresis = trigger.getDouble('dataAcquisitionModule/hysteresis')
```

Example 3.3. Python code demonstrating how to use the `dataAcquisitionModule/findlevel` parameter. Taken from the Python example `example_data_acquisition_grid`.

3.5.3. Signal Subscription

The Data Acquisition Module uses dot notation for subscribing to the signals. Whereas with the Software Trigger (Recorder Module) you subscribe to an entire streaming node, e.g. /DEV..../DEMODS/N/SAMPLE and get all the signal components of this node back, with the Data Acquisition Module you specify the exact signal you are interested in capturing, e.g. /DEV..../DEMODS/N/SAMPLE.r, /DEV..../DEMOD/0/SAMPLE.phase.

In addition, by appending suffixes to the signal path, various operations can be applied to the source signal and cascaded to obtain the desired result. Some examples are given below (the /DEV.../DEMODS/n/SAMPLE prefix has been omitted):

`x`	Demod sample x component.
`r.avg`	Average of demod sample abs(x + iy).
`x.std`	Standard deviation of demod sample x component.
`xiy.fft.abs.std`	Standard deviation of complex FFT of x + iy.
`phase.fft.abs.avg`	Average of real FFT of linear corrected phase.
`freq.fft.abs.pwr`	Power of real FFT of frequency.
`r.fft.abs`	Real FFT of abs(x + iy).
`df.fft.abs`	Real FFT of demodulator phase derivative ((dΘ/dt)/(2π)).
`xiy.fft.abs.pwr`	Power of complex FFT of x + iy.
`xiy.fft.abs.filter`	Demodulator low-pass filter transfer function. Divide xiy.fft.abs by this to obtain a compensated FFT.

The specification for signal subscription is given below together with the possible options. Angle brackets <> indicate mandatory fields. Square brackets [] indicate optional fields.

```
<node_path><.source_signal>[.fft<.complex_selector>[.filter]][.pwr]
[.math_operation]
```

Table 3.9. Signal Subscription Options

Name		Description	Comment
node_path		Path of the node containing the signal(s)	
source_signal			
Node	Signal Name	Description	Comment
demod	x	Demodulator output in-phase component	
	y	Demodulator output quadrature component	
	r	Demodulator output amplitude	
	theta	Demodulator output phase	
	frequency	Oscillator frequency	
	auxin0	Auxilliary input channel 1	
	auxin1	Auxilliary input channel 2	
	xiy	Combined demodulator output in-phase and quadrature components	complex output (can only be used as FFT input))
	df	Demodulator output phase derivative (can only be used for FFT(dθ/dt)/(2π)	
impedance	realz	In-phase component of impedance sample	
	imagz	Quadrature component of impedance sample	
	absz	Amplitude of impedance sample	
	phasez	Phase of impedance sample	
	frequency	Oscillator frequency	
	param0	Measurement parameter that depends on circuit configuration	
	param1	Measurement parameter that depends on circuit configuration	
	drive	Amplitude of the AC signal applied to the device under test	
	bias	DC Voltage applied to the device under test	
	z	Combined impedance in-phase and quadrature components	complex (can only be used as FFT input)
other		Nodes not listed here	Nodes containing only one signal do not have a source_signal field.
FFT (optional)			
Name		Description	Comment
FFT			complex output

complex_selector (mandatory with FFT)		
Name	Description	Comment
real	Real component of FFT	
imag	Imaginary component of FFT	
abs	Absolute component of FFT	
phase	Phase component of FFT	
filter (optional)		
Name	Description	Comment
filter	Helper signal representing demodulator low-pass filter transfer function. It can only be applied to 'abs' FFT output of complex demodulator source signal, i.e. 'xiy.fft.abs.filter'. No additional operations are permitted. Can be used to compensate the FFT result for the demodulator low-pass filter.	
pwr (optional)		
Name		Comment
pwr	Power calculation	
math_operation (optional)		
Name	Description	Comment
avg	Average of grid repetitions (parameter grid/repetitions)	
std	Standard deviation	

3.5.4. Migrating a SW Trigger program to the DAQ Module

We strongly recommend updating API programs that use the Software Trigger Module to use the Data Acquisition Module since the former may no longer be supported in future releases. This section provides a guide on which parameters to change in order to achieve this.

- Replace the instantiation of the Software Trigger Module with the Data Acquisition Module ('dataAcquisitionModule') .
- Replace "trigger/0" with "dataAcquisitionModule" in parameter paths.
- Replace "trigger/" with "dataAcquisitionModule"/ in all parameter paths.
- Decide on which grid mode to use ("none" is no longer available).
- If exact grid mode is selected, set grid/cols to an appropriate value, i.e. the number of samples to capture for each trigger. The duration then automatically becomes ("grid/cols") / sampling rate (of the signal with the highest sampling rate when more than one is subscribed).
- If using a non-exact mode (either nearest or linear interpolation), set the duration to the desired value.

- Subscribe individually to the signals to be captured using dot notation the same way as setting the trigger node, e.g. "/DEV..../DEMODS/N/SAMPLE.r". If averaging is activated (grid/repetitions > 1), subscribe using the .avg suffix, e.g. "/DEV..../DEMODS/N/SAMPLE.r.avg".
- The module can now be started by setting the enable parameter to 1 instead of calling execute().
- Remove any setting of the parameter dataAcquisitionModule/buffersize, this is automatically set by the module and is now read-only.
- Access the data read from the module in the normal way but note that in the case of demodulator data, the signal is part of the path, e.g. "/DEV..../DEMODS/N/SAMPLE.r". Note also that in the case of MATLAB, the dot is replaced by underscore, e.g. "/DEV..../DEMODS/N/SAMPLE_r", to prevent conflicts with the syntax for accessing fields.
- Note that the retrigger feature that was in the Software Trigger Module is not supported in the Data Acquisition Module.

An important point to remember is that the DAQ Module always returns a grid of samples given by the parameters `dataAcquisitionModule/grid/cols` and `dataAcquisitionModule/grid/rows`. In exact grid mode, the trigger duration is given by the subscribed signal with the highest sampling rate. Signals with lower sampling rates are up-sampled using linear interpolation to give the required number of grid samples.

3.5.5. Migrating a zoomFFT program to the DAQ Module

We strongly recommend updating API programs that use the old zoomFFT Module to use the Data Acquisition Module since the former may no longer be supported in future releases. This section provides a guide on which parameters to change in order to achieve this.

- Replace the instantiation of the zoomFFT Module with Data Acquisition Module ('dataAcquisitionModule').
- Replace "zoomFFT/" with "dataAcquisitionModule/" in all parameter paths.
- Remove any references to zoomFFT/bit.
- Set "dataAcquisitionModule/grid/cols" to a binary power to set the number of samples.
- Set the "dataAcquisitionModule/type" to 0 for untriggered FFTs. Alternatively specify a different value to enable triggered FFTs.
- Subscribe individually to the signals on which FFTs are to be performed and add the ".fft" operator followed by the complex operator (".real", ".imag", ".abs", ".phase"), e.g. "/DEV..../DEMODS/N/SAMPLE.xiy.fft.abs". If averaging is activated (grid/repetitions > 1), subscribe using the .avg suffix, e.g. "/DEV..../DEMODS/N/SAMPLE.xiy.fft.abs.avg".
- If overlapped FFTs are enabled, remove any setting of parameter `dataAcquisitionModule/overlap` (this used to set the proportion of overlap between 0.0 and 1.0). Instead set the parameter `dataAcquisitionModule/spectrum/overlapped` to 1 and set the parameter `dataAcquisitionModule/refreshrate` value (Hz) to give the rate of overlap.
- Set the parameter `dataAcquisitionModule/preview` to 1 to get lower resolution previews for longer FFTs.
- Note that the Data Acquisition Module has many more features for FFT compared to the zoomFFT module, such as grid operation, averaging, waterfall, overwrite, triggered FFTs, which can also be activated. Note also that time-domain and FFT data can be returned from the module simultaneously (i.e. the data used for the FFT is the returned time-domain data) by subscribing the the appropriate signals. There is also a greater selection of signals on which an FFT can be performed, e.g. PID, AuxIn, Boxcar, AU, Pulse Counter, DIO.

3.5.6. Data Acquisition Module Parameters

The following tables provide a comprehensive list of the module's parameters, see:

- Table 3.10 for input/output parameters,
- Table 3.11 for input parameters and,
- Table 3.12 for output parameters.

Table 3.10. Data Acquisition Module In/Out Parameters.

Setting/Path	Type	Unit	Description
`clearhistory`	bool	-	Set to 1 to clear all the acquired data from the module. The module immediately resets `clearhistory` to 0 after it has been set to 1.
`duration`	double	s	The recording length of each trigger event. This is an input parameter when the sampling mode (`grid/mode`) is either nearest or linear interpolation. In exact sampling mode `duration` is an output parameter; it is calculated and set by the module based on the value of `grid/cols` and the highest rate of all the subscribed signal paths.
`findlevel`	bool	-	Set to 1 to automatically find appropriate values of the trigger `level` and `hysteresis` based on the current `triggernode` signal value. The module sets `findlevel` to 0 once the values have been found and set. See Section 3.5.2 for further explanation.
`forcetrigger`	bool	-	Set to 1 to force acquisition of a single trigger for all subscribed signal paths (when running in a triggered acquisition mode). The module immediately resets `forcetrigger` to 0 after it has been set to 1.
`spectrum/autobandwidth`	bool	-	Set to 1 to initiate automatic adjustment of the subscribed demodulator bandwidths to obtain optimal alias rejection for the selected frequency span which is equivalent to the sampling rate. The FFT mode has to be enabled (`spectrum/enable`) and the module has to be running for this function to take effect. The module resets `spectrum/autobandwidth` to 0 when the adjustment has finished.

Table 3.11. Data Acquisition Module Input Parameters.

Setting/Path	Type	Unit	Description
`awgcontrol`	bool	-	Enable interaction with the AWG. If enabled, the row number is identified based on the digital row ID number set by the AWG. If disabled, every new trigger event is attributed to a new row sequentially.

Setting/Path	Type	Unit	Description
`bandwidth`	double	Hz	Set to a value other than 0 in order to apply a low-pass filter with the specified bandwidth to the `triggernode` signal before applying the trigger criteria. For edge and pulse trigger use a bandwidth larger than the trigger signal's sampling rate divided by 20 to keep the phase delay. For tracking filter use a bandwidth smaller than the trigger signal's sampling rate divided by 100 to track slow signal components like drifts. The value of the filtered signal is returned by `read()` under the path /DEV..../TRIGGER/LOWPASS.
`bitmask`	int	-	Specify a bit mask for the DIO trigger value. The trigger value is bits AND bit mask (bitwise).. Only used when the trigger type is digital. See Acquisition using Digital Triggering for more information.
`bits`	int	-	Specify the value of the DIO to trigger on. All specified bits have to be set in order to trigger. Only used when the trigger type is digital. See Acquisition using Digital Triggering for more information.
`count`	int	-	The number of trigger events to acquire in single-shot mode (when `endless` is set to 0).
`delay`	double	s	Time delay of trigger frame position (left side) relative to the trigger edge. delay = 0: Trigger edge at left border. delay < 0: Trigger edge inside trigger frame (pre-trigger). delay > 0 Trigger edge before trigger frame (post-trigger).
`device`	string	-	The device serial to be used with the Data Acquisition Module, e.g. dev123 (compulsory parameter).
`edge`	int	-	The trigger edge to trigger upon when running an triggered acquisition mode: 1: Rising edge 2: Falling edge 3: Both rising and falling
`enable`	bool	-	Set to 1 to enable the module and start data acquisition (is equivalent to calling `execute()`).
`endless`	bool	-	Set to 1 to enable endless triggering. Set to 0 and use `count` if the module should only acquire a certain number of trigger events.
`eventcount/mode`	int	-	Specifies the trigger mode when the `triggernode` is configured as a pulse

Setting/Path	Type	Unit	Description
			counter sample value (/DEV..../CNTS/0/SAMPLE.value): 0: Trigger on every sample from the pulse counter, regardless of the counter value. 1: Trigger on incrementing counter values.
`fft/absolute`	bool	-	Set to 1 to shift the frequencies in the FFT result so that the center frequency becomes the demodulation frequency rather than 0 Hz (when disabled).
`fft/window`	int	-	The FFT window function to use (default 1 = Hann). Depending on the application it makes a huge difference which of the provided window function is used. Please check the literature to find out the best trade off for your needs. 0: Rectangular 1: Hann 2: Hamming 3: Blackman Harris 4 term 16: Exponential (ring-down) 17: Cosine (ring-down) 18: Cosine squared (ring-down)
`flags`	int	-	Record flags. FILL = 0x0001 Fill data loss holes (this flag is always enabled). ALIGN = 0x0002 Align data from multiple subscribed signals (this flag is always enabled). THROW = 0x0004 Throw an exception if sample loss is detected. DETECT = 0x0008 Just detect data loss holes (this flag is always enabled).
`grid/cols`	int	-	Specify the number of columns in the returned data grid (matrix). The data along the horizontal axis is resampled to the number of samples defined by `grid/cols`. The `grid/mode` parameter specifies how the data is sample onto the time, respectively frequency, grid.
`grid/direction`	int	-	The direction to organize data in the grid's matrix:

Setting/Path	Type	Unit	Description
			0: Forward. The data in each row is ordered chronologically, e.g., the first data point in each row corresponds to the first timestamp in the trigger data. 1: Reverse. The data in each row is ordered reverse chronologically, e.g., the first data point in each row corresponds to the last timestamp in the trigger data. 2: Bidirectional. The ordering of the data alternates between Forward and Backward ordering from row-to-row. The first row is Forward ordered.
`grid/mode`	int	-	Specify how the acquired data is sample onto the matrix's horizontal axis (time or frequency). Each trigger event becomes a row in the matrix and each trigger event's subscribed data is sampled onto the grid defined by the number of columns (`grid/cols`) and resampled as following: 1: Use the closest data point (nearest neighbour interpolation). 2: Use linear interpolation. 4: Do not resample the data from the subscribed signal path(s) with the highest sampling rate; the horizontal axis data points are determined from the sampling rate and the value of `grid/cols`. Subscribed signals with a lower sampling rate are upsampled onto this grid using linear interpolation.
`grid/overwrite`	bool	-	If enabled, the module will return only one data chunk (grid) when it is running, which will then be overwritten by subsequent trigger events.
`grid/repetitions`	int	-	Number of statistical operations performed per grid. Only applied when the subscribed signal path is, for example, an average or a standard deviation.
`grid/rowrepetition`	int	-	Enable row-wise repetition. With row-wise repetition, each row is calculated from successive repetitions before starting the next row. With grid-wise repetition, the entire grid is calculated with each repetition.
`grid/rows`	int	-	Specify the number of rows in the grid's matrix. Each row is the data recorded from one trigger event.
`grid/waterfall`	int	-	Set to 1 to enable waterfall mode: Move the data upwards upon each trigger event; the data from newest trigger event is placed in row 0.

Setting/Path	Type	Unit	Description
historylength	bool	-	Sets an upper limit for the number of data captures stored in the module.
holdoff/count	int	-	The number of skipped trigger events until the next trigger event is acquired.
holdoff/time	double	s	The hold-off time before trigger acquisition is re-armed again. A hold-off time smaller than the duration will produce overlapped trigger frames.
hysteresis	double	many	If non-zero, hysteresis specifies an additional trigger criteria to level in the trigger condition. The trigger signal must first go higher, respectively lower, than the hysteresis value and then the trigger level for positive, respectively negative edge triggers. The hysteresis value is applied below the trigger level for positive trigger edge selection. It is applied above for negative trigger edge selection, and on both sides for triggering on both edges. A non-zero hysteresis value is helpful to trigger on the correct edge in the presence of noise to avoid false positives.
level	double	many	The trigger level value.
preview	bool	-	If set to 1, enable the data of an incomplete trigger to be read. Useful for long trigger durations (or FFTs) by providing access to the intermediate data.
refreshrate	double	Hz	Set the maximum refresh rate of updated data in the returned grid. The actual refresh rate depends on other factors such as the hold-off time and duration.
pulse/max	double	s	The maximum pulse width to trigger on when using a pulse trigger.
pulse/min	double	s	The minimum pulse width to trigger on when using a pulse trigger.
save/*	-	-	Core module save/ branch parameters, see Table 3.1 and Table 3.2 for a description of the parameters.
spectrum/enable	bool	-	Enables the FFT mode of the data Acquisition module, in addition to time domain data acquisition. Note that when the FFT mode is enabled, the grid/cols parameter value is rounded down to the nearest binary power.
spectrum/frequencyspan	double	-	Sets the desired frequency span of the FFT.
spectrum/overlapped	bool	-	Enables overlapping FFTs. If disabled (0), FFTs are performed on distinct abutting data sets. If enabled, the data sets of successive FFTs overlap based on the defined refresh rate.

Setting/Path	Type	Unit	Description
`triggernode`	string	-	The node path and signal that should be used for triggering, the node path and signal should be separated by a dot (.), e.g. /DEV.../DEMODS/0/SAMPLE.X.
`type`	int	-	Specifies when the module should acquire data: 0: Continuous acquisition. 1: Level edge trigger. 2: Digital trigger mode (on DIO source). 3: Pulse trigger. 4: Level tracking trigger, see also `bandwidth`.. 6: Hardware trigger (on trigger line source). 7: Pulse tracking trigger, see also `bandwidth`. 8: Event count trigger (on pulse counter source).

Table 3.12. Data Acquisition Module Output (read-only) Parameters.

Setting/Path	Type	Unit	Description
`buffercount`	int	-	The number of buffers used internally by the module for data recording.
`buffersize`	double	s	The buffersize of the module's internal data buffers.
`triggered`	bool	-	Indicates whether the module has recently triggered: 1=Yes, 0=No.

3.6. Device Settings Module

The Device Settings Module provides functionality for saving and loading device settings to and from file. The file is saved in XML format.

In general, users are recommended to use the utility functions provided by the APIs instead of using the Device Settings module directly. The Matlab API provides `ziSaveSettings()` and `ziLoadSettings()` and the Python API provides `zhinst.utils.save_settings()` and `zhinst.utils.load_settings`. These are convenient wrappers to the Device Settings module for loading settings synchronously, i.e., these functions block until loading or saving has completed, the desired behavior in most cases. Advanced users can use the Device Settings module directly if they need to implement loading or saving asynchronously (non-blocking).

See Table 3.13 for the input parameters to configure the Device Settings Module.

Table 3.13. Device Settings Input Parameters

Setting/Path	Type	Description
`device`	string	The device ID to save the settings for, e.g., `dev123` (compulsory parameter).
`command`	string	The command to issue: "load" (load settings from file); "save" (read device settings and save to file) or "read" (just read the device settings) (compulsory parameter).
`filename`	string	The name of the file to load or save to.
`path`	string	The path containing the file to load from or save to.

Table 3.14. Device Settings Parameters reserved for use by the LabOne Web Server.

Setting/Path	Type	Description
`throwonerror`	uint64	Throw an exception is there was error executing the command.
`errortext`	string	The error text used in error messages.
`finished`	uint64	The status of the command (read-only).

3.7. Impedance Module

The Impedance Module corresponds to the Cal sub-tab in the LabOne User Interface Impedance Analyzer tab. It allows the user to perform a compensation that will be applied to impedance measurements.

Table 3.15. Impedance Module Parameters.

Setting/Path	Type	Unit	Description
`directory`	string	-	The directory where files are saved.
`calibrate`	bool	-	If set to true will execute a compensation for the specified compensation condition.
`device`	string	-	Device string defining the device on which the compensation is performed.
`step`	int	-	Compensation step to be performed when calibrate indicator is set to true. step=0: First load; step=1: Second load; step=2: Third load; step=3: Fourth load.
`mode`	int	-	Compensation mode to be used. Defines which load steps need to be compensated: 3: SO (Short-Open) 4: L (Load) 5: SL (Short-Load) 6: OL (Open-Load) 7: SOL (Short-Open-Load) 8: LLL (Load-Load-Load)
`status`	int	-	Bit coded field of the already compensated load conditions (bit 0 = first load).
`loads/0/r`	double	Ohm	Resistance value of first compensation load (SHORT).
`loads/1/r`	double	Ohm	Resistance value of second compensation load (OPEN).
`loads/2/r`	double	Ohm	Resistance value of third compensation load (LOAD).
`loads/3/r`	double	Ohm	Resistance value of the fourth compensation load (LOAD). This load setting is only used if high impedance load is enabled.
`loads/0/c`	double	F	Parallel capacitance of the first compensation load (SHORT).
`loads/1/c`	double	F	Parallel capacitance of the second compensation load (OPEN).
`loads/2/c`	double	F	Parallel capacitance of the third compensation load (LOAD).
`loads/3/c`	double	F	Parallel capacitance of the fourth compensation load (LOAD).
`freq/start`	double	Hz	Start frequency of compensation traces.
`freq/stop`	double	Hz	Stop frequency of compensation traces.

Setting/Path	Type	Unit	Description
`freq/samplecount`	int	-	Number of samples of a compensation trace
`highimpedanceload`	bool	-	Enable a second high impedance load compensation for the low current ranges.
`expectedstatus`	int	-	Bit field of the load condition that the corresponds a full compensation. If status is equal the expected status the compensation is complete.
`message`	string	-	Message string containing information, warnings or error messages during compensation.
`comment`	string	-	Comment string that will be saved together with the compensation data.
`validation`	bool	-	Enable the validation of compensation data. If enabled the compensation is checked for too big deviation from specified load.
`precision`	int	-	Precision of the compensation. Will affect time of a compensation and reduces the noise on compensation traces, precision=0: Standard speed; precision=1: Low speed / high precision
`todevice`	bool	-	If enabled will automatically transfer compensation data to the persistent flash memory in case of a valid compensation.
`progress`	double	-	Progress of a compensation condition.

3.8. Multi-Device Synchronisation Module

The Multi-Device Synchronisation Module corresponds to the MDS tab in the LabOne User Interface. In essence, the module enables the clocks of multiple instruments to be synchronized such that timestamps of the same value delivered by different instruments correspond to the same point in time, thus allowing several instruments to operate in unison and their measurement results to be directly compared. The User Manual gives a more comprehensive description of multi-instrument synchronization, and also details the cabling required to achieve this.

Table 3.16. Multi-Device Synchronisation Module Parameters.

Setting/Path	Type	Unit	Description
`devices`	string	-	Defines which instruments should be included in the synchronization. Expects a comma-separated list of devices in the order the devices are connected.
`group`	int	-	Defines which synchronization group should be accessed by the module.
`message`	string	-	Status message of the module.
`start`	bool	-	Set to true to start the synchronization process.
`status`	int	-	Status of the synchronization process: -1 = error; 0 = idle; 1 = synchronization in progress; 2 = successful synchronization.

3.9. PID Advisor Module

The PID Advisor Module provides the functionality available in the Advisor, Tuner and Display sub-tabs of the LabOne User Interface's PID / PLL tab. The PID Advisor is a mathematical model of the instrument's PID and can be used to calculate PID controller parameters for optimal feedback loop performance. The controller gains calculated by the module can be easily transferred to the device via the API and the results of the Advisor's modelling are available as Bode and step response plot data as shown in Figure 3.11.

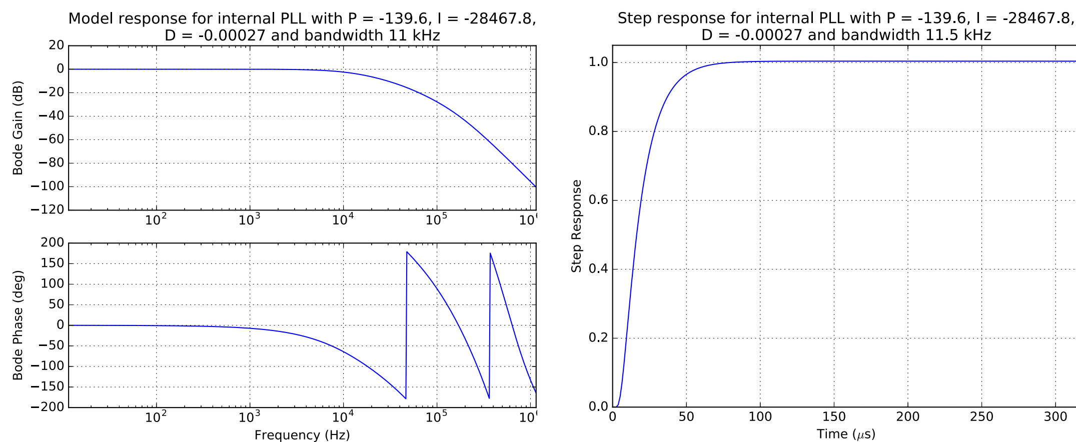


Figure 3.11. The plots generated by the LabOne Python API PID Advisor example (`example_pid_advisor_pll.py`) which configures the PID Advisor to optimize an internal PLL control loop. The data used in the Bode and step response plots is returned by the PID Advisor in the `bode` respectively `step` output parameters. See Section 5.2.3 for help getting started with the Python examples.

3.9.1. PID Advisor Module Work-Flow

PID Advisor usage via the LabOne APIs closely follows the work-flow used in the LabOne User Interface. Here are the steps required to calculate optimal PID parameters, transfer the parameters to an instrument and then continually modify the instrument's parameters to minimize the residual error using Auto Tune.

1. Create an instance of the PID Advisor module.
2. Configure the module's parameters using `set()` to specify, for example, which of the instrument's PIDs to use and which type of device under test (DUT) to model. If values are specified for the P, I and D gains they serve as initial values for the optimization process. See Table 3.21 for a full list of PID Advisor parameters.
3. Start the module by calling `execute()`.
4. Start optimization of the PID parameters by setting the `calculate` parameter to 1. The optimization process has finished when the value of `calculate` returns to 0. Optimization may take up to a minute to complete, but is much quicker in most cases.
5. Read out the optimized parameters, Bode and step response plot data (see Figure 3.11) for inspection using `get()`.
6. Transfer the optimized gain parameters from the Advisor Module to the instrument's nodes by setting the `todevice` parameter to 1.
7. Enable the instrument's PID (/DEV..../PIDS/n/ENABLE).
8. The Auto Tune functionality may be additionally enabled by setting `tune` to 1 and configuring the parameters in the `tuner` branch. This functionality continuously updates the instrument's

PID parameters specified by tuner/mode in order to minimize the residual error signal. Note, Auto Tune is not available for HF2 instruments.

The reader is encouraged to refer to the instrument-specific User Manual for more details on the Advisor optimization and Tuner process. Each of the LabOne APIs include an example to help get started programming with PID Advisor Module.

3.9.2. PLL Parameter Optimization on HF2 Instruments

On HF2 instruments the PID and PLL are implemented as two separate entities in the device's firmware. On all other devices there is only a PID unit and a PLL is created by configuring a PID appropriately (by setting the device node /devN/pids/0/mode to 1, see your instrument User Manual for more information). Since both a PID and a PLL exist on HF2 devices, when the PID Advisor Module is used to model a PLL, the pid/type parameter must be set to either pid or pll to indicate which hardware unit on the HF2 is to be modelled by the Advisor.

The Matlab and Python APIs have additional HF2-specific examples for using the PID Advisor Module with the HF2's PLL.

3.9.3. Instrument Settings written by todevice

This section lists which device nodes are configured upon setting the todevice parameter to 1. Note, the parameter is immediately set back to 0 and no sync() is performed, if a synchronization of instrument settings is required before proceeding, the user must execute a sync command manually.

For HF2 instruments there are two main cases to differentiate between, defined by whether type is set to "pid" or "pll" (see Section 3.9.2 for an explanation). For UHF and MF devices type can only be set to "pid", for these devices Table 3.17 and Table 3.18 describe which device nodes are configured.

Table 3.17. The device nodes configured when type is "pid" (default behaviour). The value of n in device nodes corresponds to the value of index.

Device node (/DEV.../)	Value set (prefix omitted)	Device class
PIDS/n/P	Advised pid/p.	All devices
PIDS/n/I	Advised pid/i.	All devices
PIDS/n/D	Advised pid/d.	All devices
PIDS/n/DEMOD/ TIMECONSTANT	User-configured or advised pid/ timeconstant.	All devices
PIDS/n/DEMOD/ORDER	User-configured pid/order.	All devices
PIDS/n/DEMOD/HARMONIC	User-configured pid/harmonic.	All devices
PIDS/n/RATE	User-configured pid/rate.	Not HF2
PIDS/n/DLIMITTIMECONSTANT	User-configured or advised pid/ dlimittimeconstant.	Not HF2

Table 3.18. The additional device nodes configured when type is "pid" (default behaviour) and dut/source=4 (internal PLL). The value of n in device nodes corresponds to the value of index.

Device node (/DEV.../)	Value set	Device class
PIDS/n/CENTER	User-configured dut/fcenter.	All devices
PIDS/n/LIMITLOWER	Calculated -bw*2, if autolimit=1.	Not HF2
PIDS/n/LIMITUPPER	Calculated bw*2, if autolimit=1.	Not HF2

Device node (/DEV.../)	Value set	Device class
PIDS/n/RANGE	Calculated `bw*2`, if `autolimit=1`.	HF2 only

Table 3.19. The device nodes configured when `type` is "pll" (HF2 instruments only - see Section 3.9.2 for an explanation). The value of n in device nodes corresponds to the value of `index`.

Device node (/DEV.../)	Value set
PLLS/n/AUTOTIMECONSTANT	Set to 0.
PLLS/n/AUTOPID	Set to 0.
PLLS/n/P	Advised `pid/p`.
PLLS/n/I	Advised `pid/i`.
PLLS/n/D	Advised `pid/d`.
PLLS/n/HARMONIC	Advised `demod/harmonic`.
PLLS/n/ORDER	Advised `demod/order`.
PLLS/n/TIMECONSTANT	User-configured or advised `demod/timeconstant`.

3.9.4. Monitoring the PID's Output

This section is not directly related to the functionality of the PID Advisor itself, but describes how to monitor the PID's behaviour by accessing the corresponding device's nodes on the Data Server.

MF and UHF Instruments

On MF and UHF instruments, the PID's error, shift and output value are available from the device's PID streaming nodes:

- /DEV..../PIDS/n/STREAM/ERROR,
- /DEV..../PIDS/n/STREAM/SHIFT,
- /DEV..../PIDS/n/STREAM/VALUE.

These are high-speed streaming nodes with timestamps available for each value. They may be recorded using the Data Acquisition Module (recommended) or via the subscribe and poll commands (very high-performance applications). The PID streams are aligned by timestamp with demodulator streams. A specific streaming rate may be requested by setting the /DEV.../PIDS/n/STREAM/RATE node; the device firmware will set the next lowest configurable rate (which corresponds to a legal demodulator rate). The configured rate can be read out from the /DEV.../PIDS/n/STREAM/EFFECTIVERATE node. If the instrument has the DIG Option installed, the PID's outputs can also be obtained using the instrument's scope at rates of up to 1.8 GHz (although not continuously). Note, that /DEV.../PIDS/n/STREAM/{RATE,EFFECTIVERATE} do not effect the rate of the PID itself, only the rate at which data is transferred to the PC. The rate of an instrument's PID is configured by /DEV.../PIDS/n/RATE.

HF2 Instruments

On HF2 instruments the PID's error, shift and center values are available using the device nodes:

- /DEV..../PIDS/n/ERROR (output node),
- /DEV..../PIDS/n/SHIFT (output node),
- /DEV..../PIDS/n/CENTER (setting node),

where the PID's output can be calculated as `OUT = CENTER + SHIFT`. When data is acquired from these nodes using the subscribe and poll commands the node values do not have timestamps

associated with them (since the HF2 Data Server only supports API Level 1). Additionally, these nodes are not high-speed streaming nodes; they are updated at a low rate that depends on the rate of the PID, this is a approximately 10 Hz if one PID is enabled. It is not possible to configure the rate of the PID on HF2 instruments. It is possible, however, to subscribe to the /DEV.../PIDS/n/ERROR node in the Data Acquisition Module, here, timestamps are approximated for each error value. It is not possible to view these values in the HF2 scope.

The PLL Module

The PLL Advisor Module introduced in LabOne 14.08 became deprecated as of LabOne 16.12. In LabOne 16.12 the PLL Advisor's functionality was combined within the PID Advisor module. Users of the PLL Advisor Module should use the PID Advisor Module instead.

3.9.5. PID Advisor Module Parameters

The following tables provide a comprehensive list of the module's parameters, see:

- Table 3.20 for input/output parameters,
- Table 3.21 for input parameters and,
- Table 3.22 for output parameters.

Table 3.20. PID Advisor Input/Output Parameters.

Path	Type	Unit	Description
`calculate`	int	-	Set to 1 to start the PID Advisor's modelling process and calculation of optimal parameters. The module sets `calculate` to 0 when the calculation is finished.
`response`	int	-	Set to 1 to calculate the Bode and the step response plot data from the current `pid/*` parameters (only relevant when `auto=0`). The module sets `response` back to 0 when the plot data has been calculated.
`todevice`	int	-	Set to 1 to transfer the calculated PID advisor data to the device, the module will immediately reset the parameter to 0 and configure the instrument's nodes, see Section 3.9.3 for more information.
`pid/d`	double	(Output Unit . s)/ Input Unit	The initial value to use in the Advisor for the differential gain. After optimization has finished it contains the optimal value calculated by the Advisor.
`pid/i`	double	Output Unit/(Input Unit . s)	The initial value to use in the Advisor for the integral gain. After optimization has finished it contains the optimal value calculated by the Advisor.
`pid/p`	double	Output Unit/ Input Unit	The initial value to use in the Advisor for the proportional gain. After optimization has finished it contains the optimal value calculated by the Advisor.

Path	Type	Unit	Description
pid/ dlimittimeconstant	double	s	The initial value to use in the Advisor for the differential filter timeconstant gain. After optimization has finished it contains the optimal value calculated by the Advisor.

Table 3.21. PID Advisor Input Parameters.

Path	Type	Unit	Description
advancedmode	int	-	If enabled, automatically calculate the start and stop value used in the Bode and step response plots.
auto	int	-	If enabled, automatically trigger a new optimization process upon an input parameter value change.
demod/harmonic	int	-	Only relevant when /DEV.../PIDS/n/INPUT is configured to be a demodulator output. Specifies the demodulator's harmonic to use in the PID Advisor model. This value will be transferred to the instrument node (/DEV..../ DEMODS/m/HARMONIC) when the PID is enabled.
demod/order	int	-	Only relevant when /DEV.../PIDS/n/INPUT is configured to be a demodulator output. Specifies the demodulator's order to use in the PID Advisor model. This value will be transferred to the instrument node (/ DEV..../DEMODS/m/ORDER) when the PID is enabled.
demod/timeconstant	double	s	Only relevant when /DEV.../PIDS/n/INPUT is configured to be a demodulator output and pid/autobw=0. Specify the demodulator's timeconstant to use in the PID Advisor model. This value will be transferred to the instrument node (/DEV..../DEMODS/m/ TIMECONSTANT) when the PID is enabled.
display/freqstart	double	Hz	Start frequency for Bode plot. If advancedmode=0 the start value is automatically derived from the system properties.
display/freqstop	double	Hz	Stop frequency for Bode plot.
display/timestart	double	s	Start time for step response. If advancedmode=0 the start value is 0.
display/timestop	double	s	Stop time for step response.
dut/bw	double	Hz	Bandwidth of the DUT (device under test).
dut/damping	double	-	Damping of the second order low pass filter.
dut/delay	double	s	IO Delay of the feedback system describing the earliest response for a step change.
dut/fcenter	double	Hz	Resonant frequency of the of the modelled resonator.

Path	Type	Unit	Description
dut/gain	double	Depends on Input, Output and DUT model	Gain of the DUT transfer function.
dut/q	double	-	Quality factor of the modelled resonator.
dut/source	int	-	Specifies the model used for the external DUT (device under test) to be controlled by the PID: 1: Low-pass first order. 2: Low-pass second order. 3: Resonator frequency. 4: Internal PLL. 5: Voltage-controlled oscillator (VCO). 6: Resonator amplitude.
index	int	-	The 0-based index of the PID on the instrument to use for parameter detection.
pid/autobw	int	-	If enabled, adjust the demodulator bandwidth to fit best to the specified target bandwidth of the full system. In this case, demod/timeconstant is ignored.
pid/autolimit	int	-	If enabled, set the instrument PID limits based upon the calculated bw value. See Table 3.18 for more information.
pid/mode	double	-	Select PID Advisor mode; bit encoded: bit 0: Optimize P gain. bit 1: Optimize I gain. bit 2: Optimize D gain. bit 3: Optimize D filter limit.
pid/rate	double	Hz	PID Advisor sampling rate of the PID control loop.
pid/targetbw	double	Hz	PID system target bandwidth.
pid/type	string	-	HF2 instruments only. Specify whether to model the instrument's PLL or PID hardware unit when dut/source=4 (internal PLL). See Section 3.9.2.
targetbw	double	Hz	Requested PID bandwidth. Higher frequencies may need manual tuning.
tf/closedloop	int	-	Switch the response calculation mode between closed or open loop.
tf/input	int	-	Start point for the plant response simulation for open or closed loops.
tf/output	int	-	End point for the plant response simulation for open or closed loops.

Path	Type	Unit	Description
tune	int	-	If enabled, optimize the instrument's PID parameters so that the noise of the closed-loop system gets minimized. The HF2 doesn't support tuning.
tuner/mode	int	-	Select tuner mode; bit encoded: bit 0: Tune P gain. bit 1: Tune I gain. bit 2: Tune D gain. bit 3: Tune D filter limit.
tuner/averagetime	double	s	Time for a tuner iteration.

Table 3.22. PID Advisor Output (read-only) Parameters.

Path	Type	Unit	Description
bode	struct	-	The resulting Bode plot data of the PID Advisor's simulation, see Figure 3.11 for an example. Contains the following fields: flags: Reserved for future use. grid: An array containing the frequency axis values for the complex Bode data. samplecount: Reserved for future use. sampleformat: Indicates that this struct contains Bode plot data (always equal to 0). x: An array containing the real component values of the complex Bode data. y: An array containing the imaginary component values of the complex Bode data.
bw	double	Hz	Calculated system bandwidth.
impulse	struct	-	Reserved for future use - not yet supported.
pm	double	deg	Simulated phase margin of the PID with the current settings. The phase margin should be greater than 45 deg and preferably greater than 65 deg for stable conditions.
pmfreq	double	Hz	Simulated phase margin frequency.
stable	int	-	If equal to 1, the PID Advisor found a stable solution with the given settings. If equal to 0, the solution was deemed instable - revise your settings and rerun the PID Advisor.
step	struct	-	The resulting step response data of the PID Advisor's simulation, see Figure 3.11 for an example. Contains the following fields:

Path	Type	Unit	Description	
			flags	Reserved for future use.
			grid	An array containing the time axis values for the step response data.
			samplecount	Reserved for future use.
			sampleformat	Indicates that this struct contains step response plot data (always equal to 1).
			x	An array containing the values of the step response.
			y	Unused (all values=0).
targetfail	int	-	A value of 1 indicates the simulated PID BW is smaller than the Target BW.	

3.10. Precompensation Advisor Module

The Precompensation Advisor Module provides the functionality available in the LabOne User Interface's Precompensation Tab. In essence the precompensation allows a pre-distortion or pre-emphasis to be applied to a signal before it leaves the instrument, to compensate for undesired distortions caused by the device under test (DUT). The Precompensation Advisor module simulates the precompensation filters in the device, allowing the user to experiment with different filter settings and filter combinations to obtain an optimal output signal, before using the setup in the actual device.

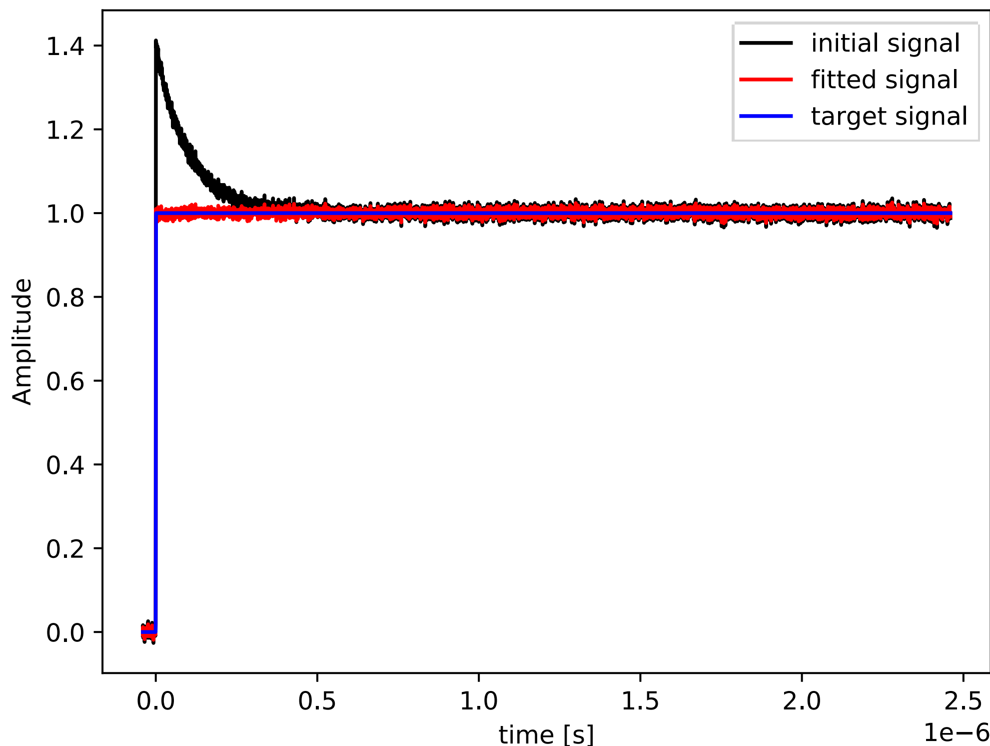


Figure 3.12. Plot generated by the LabOne Python API Precompensation Advisor example. See Section 5.2.3 for help getting started with the Python examples.

3.10.1. Precompensation Advisor Module Work-Flow

Precompensation Advisor usage via the LabOne APIs closely follows the work-flow used in the LabOne User Interface.

1. Create an instance of the Precompensation Advisor module (one instance is required for each AWG waveform output in use).
2. Decide which filters to use.
3. Set the coefficients/time constants of the filters.
4. Read and analyse the results of the simulation via the `wave/output`, `wave/output/forwardwave` and `wave/output/backwardwave` parameters.
5. Adjust filter coefficients and repeat the previous two steps until an optimal output waveform is achieved.

Refer to the appropriate user manual for a comprehensive description of the Precompensation Advisor.

Note that with the Precompensation Advisor module, the execute(), finish(), finished() read(), progress(), subscribe() and unsubscribe() commands serve no purpose. Indeed some APIs do not provide all of these commands. Each time one or more filter parameters are changed, the module re-runs the simulation and the results can be read via the `wave/output`, `wave/output/forwardwave` and `wave/output/backwardwave` parameters.

3.10.2. Precompensation Advisor Module Parameters

The following tables provide a comprehensive list of the module's parameters, see:

- Table 3.23 for input/output parameters,
- Table 3.24 for input parameters and,
- Table 3.25 for output parameters.

Table 3.23. Precompensation Advisor Input/Output Parameters.

Path	Type	Unit	Description
`device`	string	-	Device string defining the device on which the compensation is performed.
`bounces/0/enable`	bool	-	Enable the bounce compensation filter.
`bounces/0/amplitude`	double	-	Amplitude of the bounce compensation filter.
`bounces/0/delay`	double	-	Enable the exponential filter.
`exponentials/([0-7])/enable`	bool	-	Enable the exponential filter.
`exponentials/[0-7]/amplitude`	double	-	Amplitude of the exponential filter.
`exponentials/[0-7]/timeconstant`	double	s	Time constant (tau) of the exponential filter.
`highpass/0/enable`	bool	-	Enable the high-pass compensation filter.
`highpass/0/timeconstant`	double	s	Time constant (tau) of the high-pass compensation filter.

Table 3.24. Precompensation Advisor Input Parameters.

Path	Type	Unit	Description
`advancedmode`	bool	-	Disable automatic calculation of the start and stop value.
`fir/enable`	bool	-	Enable the FIR filter.
`fir/coefficients`	double	-	Vector of FIR filter coefficients. Maximum length 40 elements. The first 8 coefficients are applied to 8 individual samples, whereas the following 32 Coefficients are applied to two consecutive samples each.
`latency/enable`	bool	-	Enable latency simulation for the calculated waves.
`wave/input/length`	int	-	Number of points in the simulated wave.
`wave/input/source`	int	-	Type of wave used for the simulation.

Path	Type	Unit	Description
			0: Step function 1: Pulse 2: Load AWG with the wave specified by the `wave/input/waveindex` and `wave/input/awgindex` nodes 3: Manually loaded wave through the `inputvector` node
`wave/input/awgindex`	int	-	Defines with which AWG output the module is associated. This is used for loading an AWG wave as the source.
`wave/input/waveindex`	int	-	Determines which AWG wave is loaded from the the AWG output. Internally, all AWG sequencer waves are indexed and stored. With this specifier, the respective AWG wave is loaded into the Simulation.
`wave/input/inputvector`	double	-	Node to upload a vector of amplitude data used as a signal source. It is assumed the data are equidistantly spaced in time with the sampling rate as defined in the `samplingfreq` node.

Table 3.25. Precompensation Advisor Output (read-only) Parameters.

Path	Type	Unit	Description
`samplingfreq`	double	Hz	Sampling frequency for the simulation (read-only). The value comes from the /device/system/clocks/sampleclock/freq node if available. Default is 2.4 GHz.
`latency/value`	double	-	Total delay of the output signal accumulated by all filter stages (read-only).
`wave/output`	double	-	Wave onto which the filters are applied.
`wave/output/forwardwave`	double	-	Initial wave upon which the filters have been applied. This wave is a representation of the AWG output when precompensation is enabled with the filter settings specified in the respective nodes.
`wave/output/backwardwave`	double	-	Initial wave upon which the filters have been applied in the reverse direction. This wave is a simulation of signal path response which can be compensated with the filter settings specified in the respective nodes.

3.11. Scope Module

The Scope Module corresponds to the functionality available in the Scope tab in the LabOne User Interface and provides API users with an interface to acquire assembled and scaled scope data from the instrument programatically.

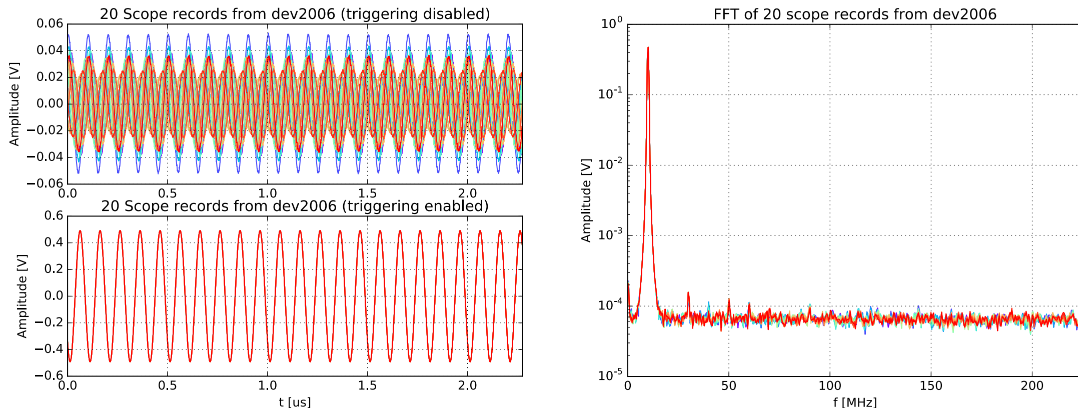


Figure 3.13. The plots generated by the LabOne Python API Scope Module example when ran with a UHF Instrument (`example_scope.py`). The example runs the Scope Module in both time and frequency mode with scope record averaging enabled. See Section 5.2.3 for help getting started with the Python examples.

3.11.1. Introduction to Scope Data Transfer

In general, an instrument's scope can generate a large amount of data which requires special treatment by the instrument's firmware, the Data Server, LabOne API and API client in order to process it correctly and efficiently. The Scope Module was introduced in LabOne 16.12 to simplify scope data acquisition for the user. This section provides a top-level overview of how scope data can be acquired and define the terminology used in subsequent sections before looking at the special and more simplified case when the Scope Module is used.

There are three methods of obtaining scope data from the device:

1. By subscribing directly to the instrument node /DEV..../SCOPES/n/WAVE and using the `poll()` command. This refers to the lower-level interface provided by the `ziDAQServer` class `subscribe()` and `poll()` commands.
2. By subscribing to the instrument node /DEV..../SCOPES/n/WAVE in the Scope Module and using using the Scope Module's `read()` command.
3. By subscribing to the instrument's scope streaming node (/DEV..../SCOPES/n/STREAM/SAMPLE), which continuously streams scope data as a block stream. This is only available on MF and UHF instruments with the DIG Option enabled. The Scope Module does not support acquisition from the scope streaming node.

Segmented Mode

Additionally, MF and UHF instruments which have the DIG option enabled can optionally record data in "segmented" mode which allows back-to-back measurements with very small hold-off times between measurements. Segmented mode enables the user to make a fixed number of

measurements (the segments), which are stored completely in the memory of the instrument, before they are transferred to the Data Server (this overcomes the data transfer rate limitation of the device's connected physical interface, e.g., USB or 1GbE for a fixed number of measurements). The advantage to this mode is precisely that the hold-off time, i.e. the delay between two measurements, can be very low. Data recorded in segmented mode is still available from the instrument node /DEV..../SCOPES/n/WAVE as for non-segmented data, but requires an additional reshaping described in Section 3.11.6.

Scope Data Nomenclature

We'll use the following terminology to describe the scope data streamed from the device:

Wave The name of the leaf (/DEV..../SCOPES/n/WAVE) in the device node tree that contains scope data pushed from the instrument's firmware to the Data Server. The data structure returned by this node is defined by the API Level of the connected session. It is also the name of the structure member in scope data structures that holds the actual scope data samples. See Scope Data Structures below for detailed information.

Record Refers to one complete scope data element returned by the Scope Module. It may consist of one or multiple segments.

Segment A segment is a completely assembled and scaled wave. If the instrument's scope is used in segmented mode, each record will consist of multiple segments. If not used in segmented mode, each record comprises of a single segment and the terms record and segment can be used interchangeably.

Block When the length of data (/DEV..../SCOPES/n/LENGTH) in a scope segment is very large the segment returned by the device node (/DEV..../SCOPES/n/WAVE) is split into multiple blocks. When using the poll/subscribe method the user must assemble these blocks; the Scope Module assembles them for the user into complete segments.

Shot The term shot is often used when discussing data acquired from laboratory oscilloscopes, we try to avoid it in the following in order to more easily distinguish between records and segments when recording in segmented mode.

Scope Data Structures

The device node /DEV..../SCOPES/n/WAVE (and /DEV..../SCOPES/n/STREAM/SAMPLE, DIG Option enabled, API level > 4) return the following data structures based on the API level used by the session:

ScopeWave API Level 1, HF2 only. The simplest scope data structure. The `wave` structure member in the data structure always has a fixed length of 2048. Scope records are never split into multiple blocks; no assembly required. The HF2 does not support segmented recording; a segment is equivalent to a record.

ZIScopeWave API Level 4. An extended scope data structure used with MF and UHF instruments. The data in the `wave` structure member consists of one scope block; for long scope segments, complete scope segments must be assembled by combining these blocks. The data in `wave` is not scaled or offset.

ZIScopeWaveEx API Level > 5. As for ZIScopeWave, but contains the additional structure member `channelOffset`.

The Scope Module always returns scope data in the ZIScopeWaveEx format, regardless of which supported API level (1, >4) was used in the session where the Scope Module was instantiated. However, the data in the `wave` structure member always consists of complete segments (it does not need to be reassembled from multiple blocks). More differences between the data returned

by the node /DEV..../SCOPES/n/WAVE and the Scope Module are highlighted in 3.11.2 Advantages of the Scope Module.

3.11.2. Advantages of the Scope Module

Although it is possible to acquire scope data using the lower-level subscribe/poll method, the Scope Module provides API users with several advantages. Specifically, the Scope Module:

1. Provides a uniform interface to acquire scope data from all instrument classes (HF2 scope usage differs from and MF and UHF devices, especially with regards to scaling).
2. Scales and offsets the scope wave data to get physically meaningful values. If data is polled from the device node using subscribe/poll the scaling and offset must be applied manually.
3. Assembles large multi-block transferred scope data into single complete records. When the scope is configured to record large scope lengths and data is directly polled from the device node /DEV.../SCOPES/n/WAVE, the data is split into multiple blocks for efficient transfer of data from the Data Server to the API; these must then be programatically reassembled. The Scope Module performs this assembly and returns complete scope records (unless used in pass-through mode, `mode=0`).
4. Can be configured to return the FFT of the acquired scope records (with `mode=3`) as provided by the Scope Tab in the LabOne UI. FFT data is not available from the device nodes in the / DEV/..../SCOPES/ branch using subscribe/poll.
5. Can be configured to average the acquired scope records the `averager/` parameters.
6. Can be configured to return a specific number of scope records using the `historylength` parameter.

3.11.3. Working with Scope Module

It is important to note that the instrument's scope is implemented in the firmware of the instrument itself and most of the parameters relevant to scope data recording are configured as device nodes under the /DEV.../SCOPES/ branch. Please refer to the instrument-specific User Manual for a description of the Scope functionality and a list of the available nodes.

The Scope Module does not modify the instrument's scope configuration and, as such, processes the data arriving from the instrument in a somewhat passive manner. The Scope Module simply reassembles data transferred in multiple blocks into complete segments (so that they consist of the configured /DEV..../SCOPES/n/LENGTH) and applies the offset and scaling required to get physically meaningful values to the (integer) data sent by the instrument.

The following steps should be used as a guideline for a Scope Module work-flow:

1. Create an instance of the Scope Module. This instance may be re-used for recording data with different instrument settings or Scope Module configurations.
2. Subscribe in the Scope Module to the scope's streaming block node (/DEV..../SCOPES/n/ WAVE) to specify which device and scope to acquire data from. Data will only be acquired after enabling the scope and calling Scope Module `execute()`.
3. Configure the instrument ready for the experiment. When acquiring data from the signal inputs it is important to specify an appropriate value the for input range (/DEV..../SIGINS/n/ RANGE) to obtain the best bit resolution in the scope. The signal input range on MF and UHF instruments can be adjusted automatically, see the /DEV..../SIGINS/n/AUTORANGE node and API utility functions demonstrating its use (e.g. `zhinst.utils.sigin_autorange()` in the LabOne Python API).
4. Configure the instrument's scope as required for the measurement. If recording signals other than hardware channel signals (such as a PID's error or a demodulator R output), be sure to

configure the /DEV..../SCOPES/n/CHANNELS/n/LIMIT{LOWER,UPPER} accordingly to obtain the best bit resolution in the scope).

5. Configure the * parameters as required, in particular:
   - Set `mode` in order to specify whether to return time or frequency domain data. See Section 3.11.4 for more information on the Scope Module's modes.
   - Set the `historylength` parameter to tell the Scope Module to only return a certain number of records. Note, as the Scope Module is acquiring data the `records` output parameter may grow larger than `historylength`; the Scope Module will return the last number of records acquired.
   - Set `averager/weight` to a value larger than 1 to enable averaging of scope records, see Section 3.11.5.
6. Enable the scope (if not previously enabled) and call Scope Module `execute()` to start acquiring data.
7. Wait for the Scope Module to acquire the specified number of records. Note, if certain scope parameters are modified during recording, the history of the Scope Module will be cleared, see Section 3.11.7 for the list of parameters that trigger a Scope Module reset.
8. Call Scope Module `read()` to transfer data from the Module to the client. Data may be read out using `read()` before acquisition is complete (advanced use). Note, an intermediate read will create a copy in the client of the incomplete record which could be critical for memory consumption in the case of very long scope lengths or high segment counts. The data structure returned by `read()` is of type ZIScopeWaveEx, see Section 8.3.29 for detailed information.
9. Check the flags of each record indicating whether any problems occurred during acquisition.
10. Extract the data for each recorded scope channel and, if recording data in segmented mode, reshape the wave data to allow easier access to multi-segment records (see Section 3.11.6). Note, the scope data structure only returns data for enabled scope channels.

Data Acquisition and Transfer Speed

It is important to note that the time to transfer long scope segments from the device to the Data Server can be much longer than the duration of the scope record itself. This is not due to the Scope Module but rather due to the limitation of the physical interface that the device is connected on (USB, 1GbE). Please ensure that the PC being used has adequate memory to hold the scope records.

3.11.4. Scope Module Modes

The `mode` is applied for all scope channels returned by the Scope Module. Although it is not possible to return both time and frequency domain data in one instance of the Scope Module, multiple instances may be used to obtain both.

The Scope Module does not return an array consisting of the points in time (time mode) or frequencies (FFT mode) corresponding to the samples in ZIScopeWaveEx. These can be constructed as arrays of n points, where n is the configured scope length (/DEV.../SCOPES/n/LENGTH)), spanning the intervals:

Time mode: [0, `dt*totalsamples`], where `dt` and `totalsamples` are fields in ZIScopeWaveEx.

In order to get a time array relative to the trigger position, `(timestamp - triggertimestamp)/float(clockbase)` must be substracted from the times in the interval, where `timestamp` and `triggerstamp` are fields in ZIScopeWaveEx.

FFT mode [0, (clockbase/2^scope_time)/2], where scope_time is the value of the device node /DEV..../SCOPES/n/TIME.

and clockbase is the value of /DEV..../CLOCKBASE.

3.11.5. Averaging

When averager/weight is set to be greater than 1, then each new scope record in the history element is an exponential moving average of all the preceding records since either execute() was called or averager/restart was set to 1. The average is calculated by the Scope Module as following:

```
alpha = 2/(weight + 1);
newVal = alpha * lastRecord + (1 - alpha) * history;
history = newVal
```

where newVal becomes the last record in the Scope Module's history. If the scope is in Single mode, no averaging is performed. The weight corresponds to the number of segments to achieve 63% settling, doubling the value of weight achieves 86% settling.

It is important to note that the averaging functionality is performed by the Scope Module on the PC where the API client runs, not on the device. Enabling averaging does not mean that less data is sent from the instrument to the Data Server.

The average calculation can be restarted by setting averager/restart to 1. It is currently not possible to tell how many scope segments have been averaged (since the reset). In general, however, the way to track the current scope record is via the sequenceNumber field in ZIScopeWaveEx.

3.11.6. Segmented Recording

When the instrument's scope runs segmented mode the wave structure member in the ZIScopeWaveEx is an array consisting of length*segment_count where length is the value of /DEV..../SCOPES/0/LENGTH and num_segments is /DEV..../SCOPES/n/SEGMENTS/COUNT. This is equal to the value of the totalsamples structure member.

The Scope Module's progress() method can be used to check the progress of the acquisition of a single segmented recording. It is possible to read out intermediate data before the segmented recording has finished. This will however, perform a copy of the data; the user should ensure that adequate memory is available.

If the segment count in the instrument's scope is changed, the Scope Module must be re-executed. It is not possible to read multiple records consisting of different numbers of segments within one Scope Module execution.

3.11.7. Scope Parameters that reset the Scope Module

The Scope Module parameter records and progress are reset and all records are cleared from the Scope Module's history when the following critical instrument scope settings are changed:

- /DEV.../SCOPES/n/LENGTH
- /DEV.../SCOPES/n/RATE
- /DEV.../SCOPES/n/CHANNEL
- /DEV..../SCOPES/n/SEGMENTS/COUNT
- /DEV..../SCOPES/n/SEGMENTS/ENABLE

3.11.8. Device-specific considerations

Scope Module Use on HF2 Instruments

The HF2 scope is supported by the Scope Module, in which case the API connects to the HF2 Data Server using API Level 1 (the HF2 Data Server does not support higher levels). When using the Scope Module with HF2 Instruments the parameter `externalscaling` must be additionally configured based on the currently configured scope signal's input/output hardware range, see the `externalscaling` entry in Table 3.27 for more details. This is not necessary for other instrument classes.

Scope Module Use on MF and UHF Instruments

For MF and UHF instruments no special considerations must be made except that API Level 4 is not supported by the Scope Module; a higher API level must be used.

Whilst not specific to the Scope Module, it should be noted that the instrument's scope is not affected by loading device presets, in particular, default scope settings are not obtained by loading the instrument's factory preset.

3.11.9. Scope Module Parameters

The following tables provide a comprehensive list of the module's parameters, see:

- Table 3.26 for input/output parameters,
- Table 3.27 for input parameters and,
- Table 3.28 for output parameters.

Table 3.26. Scope Module Input/Output Parameters.

Path	Type	Unit	Description
`averager/restart`	bool	-	Set to 1 to reset the averager. The module sets `averager/restart` back to 0 automatically.

Table 3.27. Scope Module Parameters.

Path	Type	Unit	Description
`averager/weight`	int	-	Specify the averaging behaviour: `weight=1` Averaging disabled. `weight>1` Exponentially average the incoming scope records, updating the last scope record in the history with the averaged record, see Section 3.11.5.
`averager/resamplingmode`	int	-	Specifies the resampling mode. When averaging scope data recorded at a low sampling rate that is aligned by a high resolution trigger, scope data must be resampled to keep the corresponding

Path	Type	Unit	Description
			samples between averaged recordings aligned correctly in time relative to the trigger time. The mode is either: 0: Linear interpolation, 1: PCHIP interpolation.
`clearhistory`	bool	-	Remove all records from the history list.
`externalscaling`	double	-	Only relevant for HF2 Instruments. Specify the scaling to apply to the scope data based on the range of the instrument channel (/DEV..../SCOPES/0/CHANNEL) that is being recorded. For the following values of /DEV.../SCOPES/0/CHANNEL set `externalscaling` to the value of the corresponding device RANGE node: 0: /DEV..../SIGINS/0/RANGE 1: /DEV..../SIGINS/1/RANGE 2: /DEV..../SIGOUTS/0/RANGE 3: /DEV..../SIGOUTS/1/RANGE
`fft/power`	bool	-	Enable calculation of the power value.
`fft/spectraldensity`	bool	-	Enable calculation of the spectral density value.
`fft/window`	int	-	FFT Window: window=0: Rectangular; window=1: Hann (default); window=2: Hamming; windows=3: Blackman Harris.
`historylength`	int	-	Maximum number of entries stored in the measurement history.
`lastreplace`	int	-	Reserved for LabOne User Interface use.
`mode`	int	-	The Scope Module's data processing mode: 0: Pass-through: scope segments assembled and returned unprocessed, non-interleaved. 1: Moving average: entire scope recording assembled, scaling applied, averager if enabled (see `averager/weight`), data returned in float non-interleaved format. 2: Reserved for future use (average n segments). 3: FFT, same as mode 1, except an FFT is applied to every segment of the scope recording before averaging. See the `fft/*` parameters for FFT parameters.

Path	Type	Unit	Description
save/*	-	-	Core module save/ branch parameters, see Table 3.1 and Table 3.2 for a description of the parameters.

Table 3.28. Scope Module Output (read-only) Parameters.

Path	Type	Unit	Description
error	int	-	Indicates whether an error occurred whilst processing the current scope record; set to non-zero when a scope flag indicates an error. The value indicates the accumulated error for all the processed segments in the current record and is reset for every new incoming scope record. It corresponds to the status LED in the LabOne User Interface's Scope tab - API users are recommended to use the flags structure member in ZIScopeWaveEx instead of this output parameter.
records	int	-	The number of scope records that have been processed by the Scope Module since execute() was called or a critical scope setting has been modified (see Section 3.11.7 for a list of scope settings that trigger a reset).

3.12. Sweeper Module

The Sweeper Module allows the user to perform sweeps as in the Sweeper Tab of the LabOne User Interface. In general, the Sweeper can be used to obtain data when measuring a DUT's response to varying (or **sweeping**) one instrument setting while other instrument settings are kept constant.

3.12.1. Configuring the Sweeper

In this section we briefly describe how to configure the Sweeper Module. See Table 3.29 for a full list of the Sweeper's parameters and Table 3.30 for a description of the Sweeper's outputs.

Specifying the Instrument Setting to Sweep

The Sweeper's `gridnode` parameter, the so-called **sweep parameter**, specifies the instrument's setting to be swept, specified as a path to an instrument's node. This is typically an oscillator frequency in a Frequency Response Analyzer, e.g., `/dev123/oscs/0/freq`, but a wide range of instrument settings can be chosen, such as a signal output amplitude or a PID controller's setpoint.

Specifying the Range of Values for the Sweep Parameter

The Sweeper will change the sweep parameter's value `samplecount` times within the **range** of values specified by `start` and `stop`. The `xmapping` parameter specifies whether the spacing between two sequential values in the range is linear (=0) or logarithmic (=1).

Controlling the Scan mode: The Selection of Range Values

The `scan` parameter defines the **order** that the values in the specified range are written to the sweep parameter. In sequential scan mode (=0), the sweep parameter's values change incrementally from smaller to larger values, see Figure 3.16. In order to scan the sweep parameter's in the opposite direction, i.e., from larger to smaller values, reverse scan mode (=3) can be used.

In binary scan mode (=1) the first sweep parameter's value is taken as the value in the middle of the range, then the range is split into two halves and the next two values for the sweeper parameter are the values in the middle of those halves. This process continues until all the values in the range were assigned to the sweeper parameter, see Figure 3.18. Binary scan mode ensures that the sweep parameter uses values from the entire range near the beginning of a measurement, which allows the user to get feedback quickly about the measurement's entire range. Since the Sweeper Module is an asynchronous interface, it's possible to continuously read and plot data whilst the sweep measurement is ongoing and update points in a graph dynamically.

In bidirectional scan mode (=2) the sweeper parameter's values are first set from smaller to larger values as in sequential mode, but are then set in reverse order from larger to smaller values, see Figure 3.17. This allows for effects in the sweep parameter to be observed that depend on the order of changes in the sweep parameter's values.

Controlling how the Sweeper sets the Demodulator's Time Constant

The `bandwidthcontrol` parameter specifies which demodulator filter bandwidth (equivalently time constant) the Sweeper should set for the current measurement point. The user can either specify the bandwidth manually (=0), in which case the value of the current demodulator filter's bandwidth is simply used for all measurement points; specify a fixed bandwidth (=1), specified by `bandwidth`, for all measurement points; or specify that the Sweeper sets the demodulator's

bandwidth automatically (=2). Note, to use either Fixed or Manual mode, `bandwidth` must be set to a value > 0 (even though in manual mode it is ignored).

Specifying the Sweeper's Settling Time

For each change in the sweep parameter that takes effect on the instrument the Sweeper waits before recording measurement data in order to allow the measured signal to settle. This behavior is configured by two parameters in the `settling/` branch: `settling/time` and `settling/inaccuracy`.

The `settling/time` parameter specifies the minimum time in seconds to wait before recording measurement data for that sweep point. This can be used to specify to the settling time required by the user's experimental setup before measuring the response in their system.

The `settling/inaccuracy` parameter is used to derive the settling time to allow for the lock-in amplifier's demodulator filter response to settle following a change of value in the sweep parameter. More precisely, the `settling/inaccuracy` parameter specifies the amount of settling time as the time required to attain the specified remaining proportion [1e-13, 0.1] of an incoming step function. Based upon the value of `settling/inaccuracy` and the demodulator filter order, the number of demodulator filter time constants to wait is calculated and written to `settling/tc` (upon calling the module's `execute()` command) which can then be read back by the user. See Table 3.29 for recommended values of `settling/inaccuracy`. The relationship between `settling/inaccuracy` and `settling/tc` is plotted in Figure 3.14.

The actual amount of time the Sweeper Module will wait after setting a new sweep parameter value before recording measurement data is defined in Equation 3.1. For a frequency sweep, the `settling/inaccuracy` parameter will tend to influence the settling time at lower frequencies, whereas `settling/time` will tend to influence the settling time at higher frequencies.

$$t_s = \max(\text{sweep_settling_tc} \times \text{tc},\ \text{sweep_settling_time})$$

Equation 3.1. The settling time t_s used by the Sweeper for each measurement point; the amount of time between setting the sweep parameter and recording measurement data is determined by the `settling/tc` and `settling/time`.

Note, although it is recommended to use `settling/inaccuracy`, it is still possible to set the settling time via `settling/tc` instead of `settling/inaccuracy` (the parameter applied will be simply the last one that is set by the user).

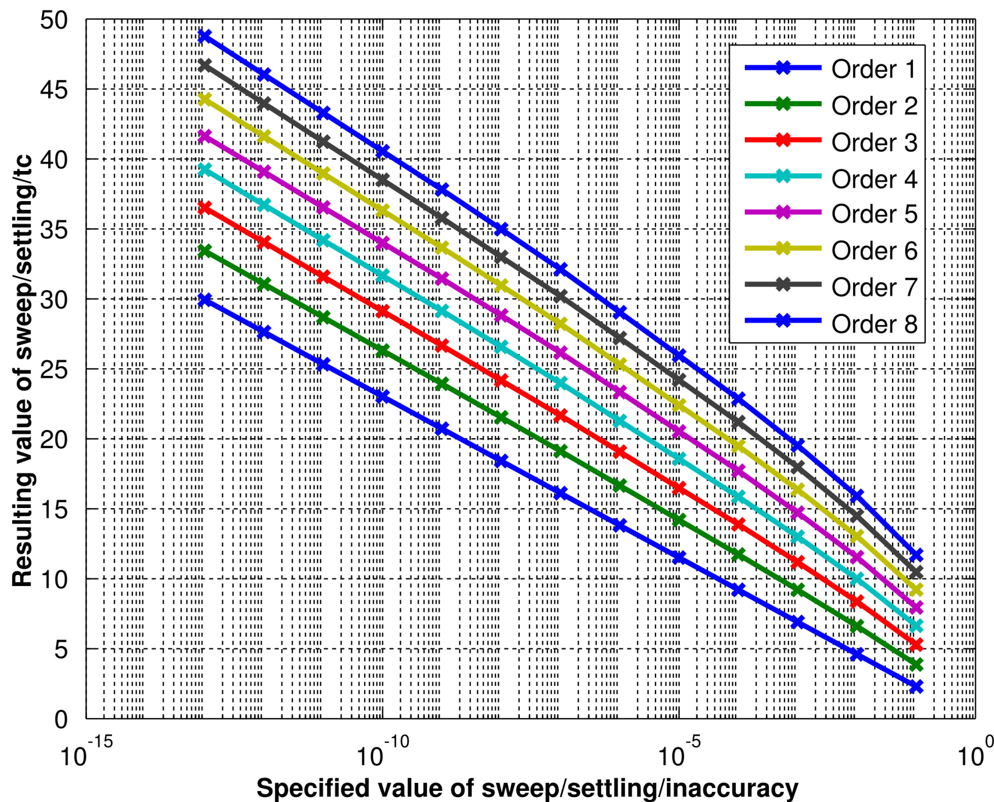


Figure 3.14. A plot showing the values of the Sweeper's `settling/tc` as calculated from `settling/inaccuracy` parameter and their dependency on demodulator order filter.

Specifying which Data to Measure

Which measurement data is actually returned by the Sweeper's `read` command is configured by subscribing to node paths using the Sweeper Module's `subscribe` command.

Specifying how the Measurement Data is Averaged

One Sweeper measurement point is obtained by averaging recorded data which is configured via the parameters in the `averaging/` branch.

The `averaging/tc` parameter specifies the minimum time window in factors of demodulator filter time constants during which samples will be recorded in order to average for one returned sweeper measurement point. The `averaging/sample` parameter specifies the minimum number of data samples that should be recorded and used for the average. The Sweeper takes both these settings into account for the measurement point's average according to Equation 3.2.

$$N = \max(\text{averaging_tc} \times \text{tc} \times \text{sampling_rate},\ \text{averaging_sample})$$

Equation 3.2. The number of samples N used to average one sweeper measurement point is determined by the parameters `averaging/tc` and `averaging/sample`.

Note, the value of the demodulator filter's time constant may be controlled by the Sweeper depending on the value of `bandwidthcontrol` and `bandwidth`, see above, Controlling how the Sweeper sets the Demodulator's Time Constant. For a frequency sweep, the `averaging/tc` parameter will tend to influence the number of samples recorded at lower frequencies, whereas `averaging/sample` will influence averaging behavior at higher frequencies.

An Explanation of Settling and Averaging Times in a Frequency Sweep

Figure 3.15 shows which demodulator samples are used in order to calculate an averaged measurement point in a frequency sweep. This explanation of the Sweeper's parameters is specific to the following commonly-used Sweeper settings:

- `gridnode` is set to an oscillator frequency, e.g., `/dev123/oscs/0/freq`.
- `bandwidthcontrol` is set to 2, corresponding to automatic bandwidth control, i.e., the Sweeper will set the demodulator's filter bandwidth settings optimally for each frequency used.
- `scan` is set to 0, corresponding to sequential scan mode for the range of frequency values swept, i.e, the frequency is increasing for each measurement point made.

Each one of the three red segments in the demodulator data correspond to the data used to calculate one single Sweeper measurement point. The light blue bars correspond to the time the sweeper should wait as indicated by `settling/tc` (this is calculated by the Sweeper Module from the specified `settling/inaccuracy` parameter). The purple bars correspond to the time specified by the `settling/time` parameter. The sweeper will wait for the maximum of these two times according to Equation 3.1. When measuring at lower frequencies the Sweeper sets a smaller demodulator filter bandwidth (due to automatic `bandwidthcontrol`) corresponding to a larger demodulator filter time constant. Therefore, the `settling/tc` parameter dominates the settling time used by the Sweeper at low frequencies and at high frequencies the `settling/time` parameter takes effect. Note, that the light blue bars corresponding to the value of `settling/tc` get shorter for each measurement point (larger frequency used → shorter time constant required), whereas the purple bars corresponding to `settling/time` stay a constant length for each measurement point. Similarly, the `averaging/tc` parameter (yellow bars) dominates the Sweeper's averaging behavior at low frequencies, whereas `averaging/samples` (green bars) specifies the behavior at higher frequencies, see also Equation 3.2.

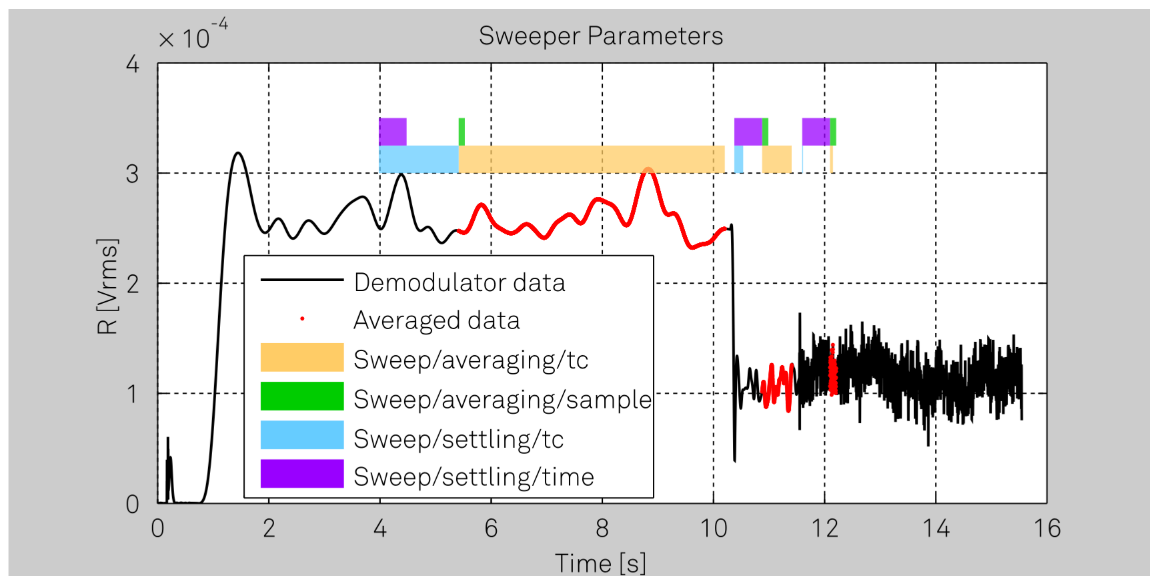


Figure 3.15. Plot demonstrating how the Sweeper records three measurement points from demodulator data when using automatic bandwidth control in a frequency sweep. Please see An Explanation of Settling and Averaging Times in a Frequency Sweep, above, for a detailed explanation.

Average Power and Standard Deviation of the Measured Data

The Sweeper returns measurement data upon calling the Sweeper's `read()` function. This returns not only the averaged measured samples (e.g. `r`) but also their average power (`rpwr`) and

standard deviation (`rstddev`). In order to obtain reliable values from this statistical data, please ensure that the `averaging` branch parameters are configured correctly. It's recommended to use at least a value of 12 for `averaging/sample` to ensure enough values are used to calculate the standard deviation and 5 for `averaging/tc` in order to prevent aliasing effects from influencing the result.

Table 3.29. Sweeper Parameters

Setting/Path	Type	Unit	Description
`device`	string	-	The device ID to perform the sweep on, e.g., `dev123` (compulsory parameter).
`gridnode`	string	Node	The device parameter (specified by node) to be swept, e.g., "oscs/0/freq".
`start`	double	Many	The start value of the sweep parameter.
`stop`	double	Many	The stop value of the sweep parameter.
`samplecount`	uint64	-	The number of measurement points to set the sweep on.
`endless`	bool	-	Enable Endless mode; run the sweeper continuously.
`remainingtime`	double	Seconds	Read only: Reports the remaining time of the current sweep. A valid number is only displayed once the sweeper has been started. An undefined sweep time is indicated as NAN.
`averaging/sample`	uint64	Samples	Sets the number of data samples per sweeper parameter point that is considered in the measurement. The maximum of this value and `averaging/tc` is taken as the effective calculation time. See Figure 3.15.
`averaging/tc`	double	Seconds	Sets the effective measurement time per sweeper parameter point that is considered in the measurement. The maximum between of this value and `averaging/sample` is taken as the effective calculation time. See Figure 3.15.
`bandwidthcontrol`	uint64	-	Specify how the sweeper should specify the bandwidth of each measurement point, Automatic is recommended, in particular for logarithmic sweeps and assures the whole spectrum is covered. 0=Manual (the sweeper module leaves the demodulator bandwidth settings entirely untouched); 1=Fixed (use the value from `bandwidth`); 2=Automatic. Note, to use either Fixed or Manual mode, `bandwidth` must be set to a value > 0 (even though in manual mode it is ignored).
`bandwidthoverlap`	bool	-	If enabled the bandwidth of a sweep point may overlap with the frequency of neighboring sweep points. The effective bandwidth is only limited by the maximal bandwidth setting and omega suppression. As a result, the bandwidth is independent of

Setting/Path	Type	Unit	Description
			the number of sweep points. For frequency response analysis bandwidth overlap should be enabled to achieve maximal sweep speed.
`bandwidth`	double	Hz	Defines the measurement bandwidth when using Fixed bandwidth mode (`bandwidthcontrol=1`), and corresponds to the noise equivalent power bandwidth (NEP).
`order`	uint64	-	Defines the filter roll off to use in Fixed bandwidth mode (`bandwidthcontrol=1`). Valid values are between 1 (6 dB/octave) and 8 (48 dB/octave).
`maxbandwidth`	double	Hz	Specifies the maximum bandwidth used when in Auto bandwidth mode (`bandwidthcontrol=2`) (`bandwidthcontrol=2`). The default is 1.25 MHz.
`omegasuppression`	double	dB	Damping of omega and 2omega components when in Auto bandwidth mode (`bandwidthcontrol=2`). Default is 40dB in favor of sweep speed. Use a higher value for strong offset values or 3omega measurement methods.
`loopcount`	uint64	-	The number of sweeps to perform.
`phaseunwrap`	bool	-	Enable unwrapping of slowly changing phase evolutions around the +/-180 degree boundary.
`sincfilter`	bool	-	Enables the sinc filter if the sweep frequency is below 50 Hz. This will improve the sweep speed at low frequencies as omega components do not need to be suppressed by the normal low pass filter.
`scan`	uint64	-	Selects the scanning type: 0=Sequential (incremental scanning from start to stop value, see Figure 3.16); 1=Binary (Non-sequential sweep continues increase of resolution over entire range, see Figure 3.18), 2=Bidirectional (Sequential sweep from Start to Stop value and back to Start again, Figure 3.17), 3=Reverse (reverse sequential scanning from stop to start value).
`settling/time`	double	Seconds	Minimum wait time in seconds between setting the new sweep parameter value and the start of the measurement. The maximum between this value and `settling/tc` is taken as effective settling time. See Figure 3.15.
`settling/inaccuracy`	double	-	Demodulator filter settling inaccuracy defining the wait time between a sweep parameter change and recording of the next sweep point. The settling time is

Setting/Path	Type	Unit	Description
			calculated as the time required to attain the specified remaining proportion [1e-13, 0.1] of an incoming step function. Typical inaccuracy values: 10m for highest sweep speed for large signals, 100u for precise amplitude measurements, 100n for precise noise measurements. Depending on the order of the demodulator filter the settling inaccuracy will define the number of filter time constants the sweeper has to wait. The maximum between this value and the settling time is taken as wait time until the next sweep point is recorded. The relationship between `settling/inaccuracy` and `settling/tc` is plotted in Figure 3.14.
`settling/tc`	double	TC	Minimum wait time in factors of the time constant (TC) between setting the new sweep parameter value and the start of the measurement. This filter settling time is preferably configured via the `settling/inaccuracy` (see discussion in Section 3.12.1 and Figure 3.14). The maximum between this value and `settling/time` is taken as effective settling time. See Figure 3.15.
`xmapping`	uint64	-	Selects the spacing of the grid used by `gridnode` (the sweep parameter): 0=linear and 1=logarithmic distribution of sweep parameter values.
`historylength`	uint64		Maximum number of entries stored in the measurement history.
`clearhistory`	bool	-	Remove all records from the history list.
`directory`	string	-	The directory to which sweeper measurements are saved to via `save()`.
`savepath`	string	-	This parameter is deprecated, see `directory`.
`fileformat`	string	-	The format of the file for saving sweeper measurements. 0=Matlab, 1=CSV, 2=ZView (for impedance measurements only), 4=HDF5.

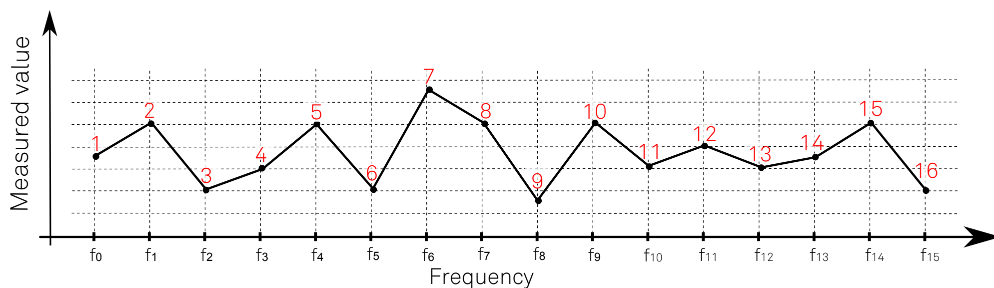


Figure 3.16. Sweeper scanning modes: Sequential (`scan` = 0).

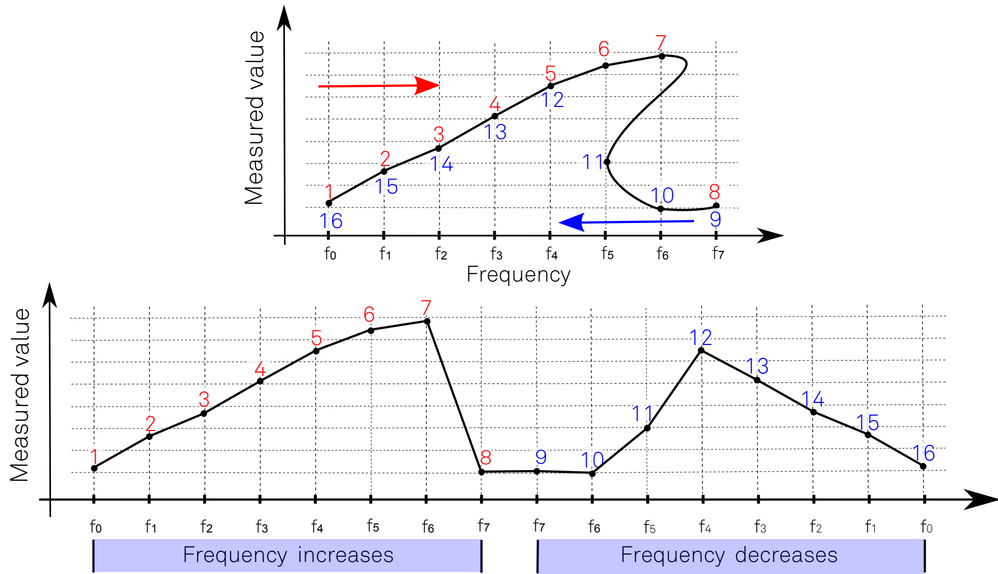


Figure 3.17. Sweeper scanning modes: Bidirectional (`scan` = 2).

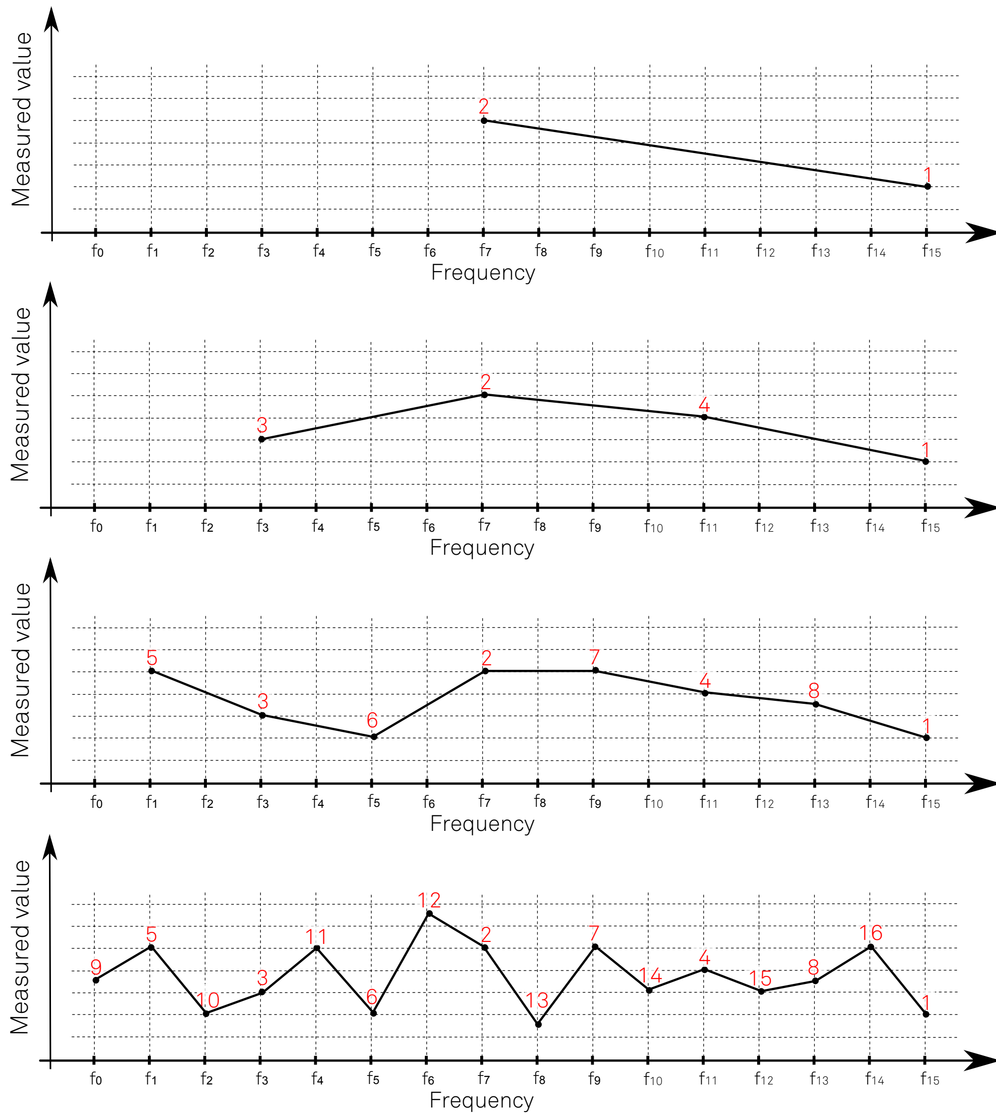


Figure 3.18. Sweeper scanning modes: Binary (`scan` = 1).

Table 3.30. Sweeper Output Values

Name	Type	Unit	Description
`auxin0`	double	Volts	Auxiliary Input 1 value.
`auxin1`	double	Volts	Auxiliary Input 2 value.
`auxin0pwr`	double	$Volts^2$	Average power of Auxiliary Input 1 value.
`auxin1pwr`	double	$Volts^2$	Average power of Auxiliary Input 2 value.
`auxin0stddev`	double	Volts	Standard deviation of Auxiliary Input 1 value.
`auxin1stddev`	double	Volts	Standard deviation of Auxiliary Input 2 value.
`frequency`	double	Hz	The oscillator frequency for each measurement point (for a frequency sweep this is the same as grid).
`frequencypwr`	double	Hz^2	Average power of the oscillator frequency.
`frequencystddev`	double	Hz	Standard deviation of the oscillator frequency.

Name	Type	Unit	Description
`phase`	double	Radians	Demodulator phase value.
`phasestddev`	double	Radians	Standard deviation of demodulator phase value (phase noise).
`phaserpwr`	double	$Radians^2$	Average power of demodulator phase value (phase noise).
`r`	double	VoltsRMS	Demodulator R value.
`rstddev`	double	VoltsRMS	Standard deviation of demodulator R value.
`rpwr`	double	$Volts^2$	Average power of demodulator x value.
`x`	double	Volts	Demodulator x value.
`xstddev`	double	Volts	Standard deviation of demodulator x value.
`xpwr`	double	$Volts^2$	Average power of demodulator x value.
`y`	double	Volts	Demodulator y value.
`ystddev`	double	Volts	Standard deviation of demodulator y value.
`ypwr`	double	$Volts^2$	Average power of demodulator y value.
`bandwidth`	double	Hz	Demodulator filter's bandwidth as calculated from `tc` (if performing a frequency sweep).
`bandwidthmode`	integer	-	The value of the `bandwidthcontrol` used for the sweep.
`count`	integer	-	The number of measurement points actually used by the sweeper when averaging the data. This depends on the values of the parameters in the `averaging/` branch.
`grid`	double	Many	Values of sweeping setting (frequency values at which demodulator samples where recorded).
`flags`	integer	-	Reserved for future use.
`settling`	double	Seconds	The waiting time for each measurement point.
`samplecount`	uint64	-	The number of swept measurement points (the value of `samplecount`).
`sampleformat`	integer	-	Reserved for future use.
`sweepmode`	integer	-	The value of the `scan` used for the sweep.
`tc`	double	Seconds	Demodulator's filter time constant as set for each measurement point.
`tcmeas`	double	Seconds	Reserved for future use.
`timestamp`	uint64	Ticks	A timestamp that gets updated each time a new measurement point has been recorded by the sweeper (divide by the device's clockbase to obtain seconds). It is not part of the sweeper's measurement data and only relevant for intermediate reads of sweeper data (before the current sweep has finished).
`settimestamp`	uint64	Ticks	The timestamp at which we verify that the frequency for the current measurement point was set on the device (by reading back demodulator data).

Name	Type	Unit	Description
`nexttimestamp`	uint64	Ticks	The timestamp at which we can obtain the data for that measurement point, i.e., `nexttimestamp` - `settimestamp` corresponds roughly to the demodulator filter settling time.

3.13. Software Trigger (Recorder) Module

In LabOne Releases prior to 17.12, the Recorder Module corresponds to the Software Trigger Tab of the LabOne User Interface. It allows the user to record bursts of instrument data based upon pre-defined trigger criteria similar to that of a laboratory oscilloscope, see Figure 3.19 for an example. The types of trigger available are listed in Table 3.31.

Future Deprecation Warning

In LabOne Release 17.12 and subsequent releases the Recorder Module has been superceded by the Data Acquisition Module. We strongly recommend using the Data Acquisition Module instead of the Recorder Module for time (and frequency) domain data acquisition. See Section 3.5 for a description of the Data Acquisition Module. In particular, existing users of the Recorder module can use the guide in Section 3.5.4, Migrating a SW Trigger program to the DAQ Module.

Table 3.31. Overview of the trigger types available in the Software Trigger Module.

Trigger Type	Description	`N/type`
Manual	For simple recording.	0
Edge	Edge trigger with level hysteresis and noise rejection, see Figure 3.20.	1
Digital	Digital trigger with bit masking.	2
Pulse	Pulse width trigger with level hysteresis and noise reduction, see Figure 3.21 and Figure 3.22.	3
Tracking (edge or pulse)	Level tracking trigger to compensate signal drift, see Figure 3.23.	4
Hardware Trigger	UHFLI and MFLI only. Trigger on one of the instrument's hardware trigger channels.	6

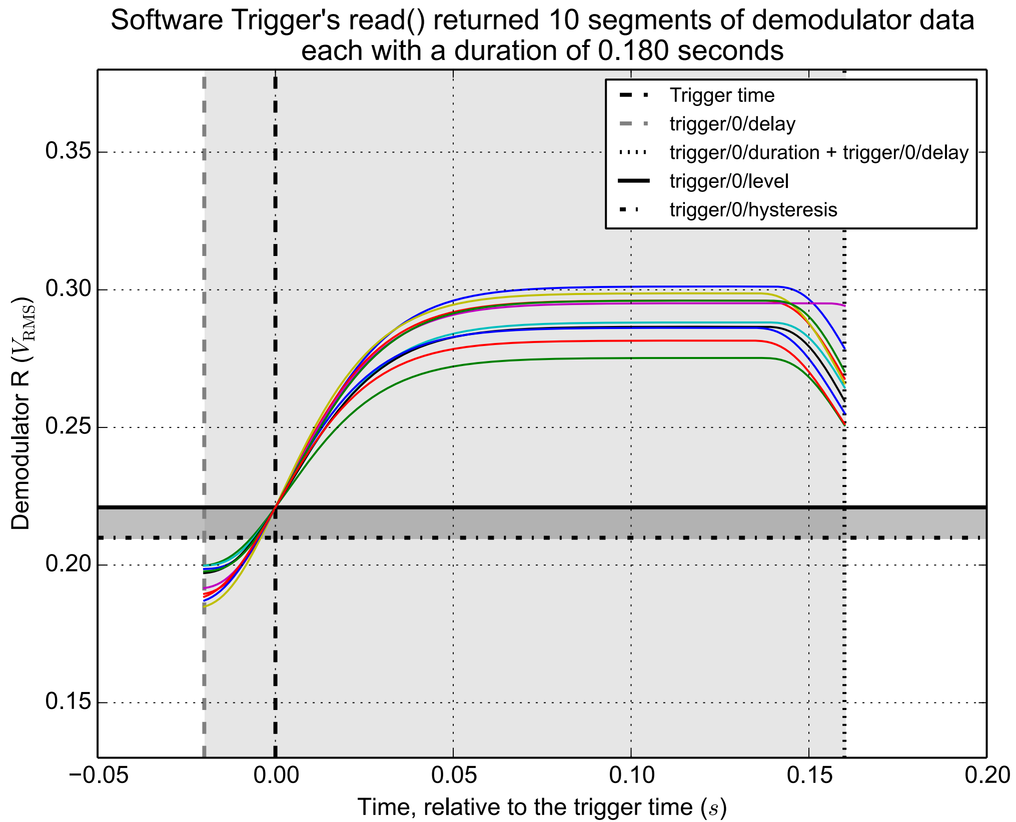


Figure 3.19. The plot produced by `example_swtrigger_edge.py`, an example distributed with the LabOne Python API. The plot shows 10 bursts of data from a single demodulator; each burst was recorded when the demodulator's R value exceeded a specified threshold using a positive edge trigger. See Section 5.2.3 for help getting started with the Python examples.

See Table 3.32 for the input parameters to configure the Software Trigger's Module. Note that some parameters effect all triggers, e.g., `endless`, whereas some are configured on a per-trigger basis, e.g., `N/duration`, where `N` is the index of the trigger, starting at zero. The data output when using the Software Trigger's `read` command has the same format as returned by `ziCore`'s `poll` command.

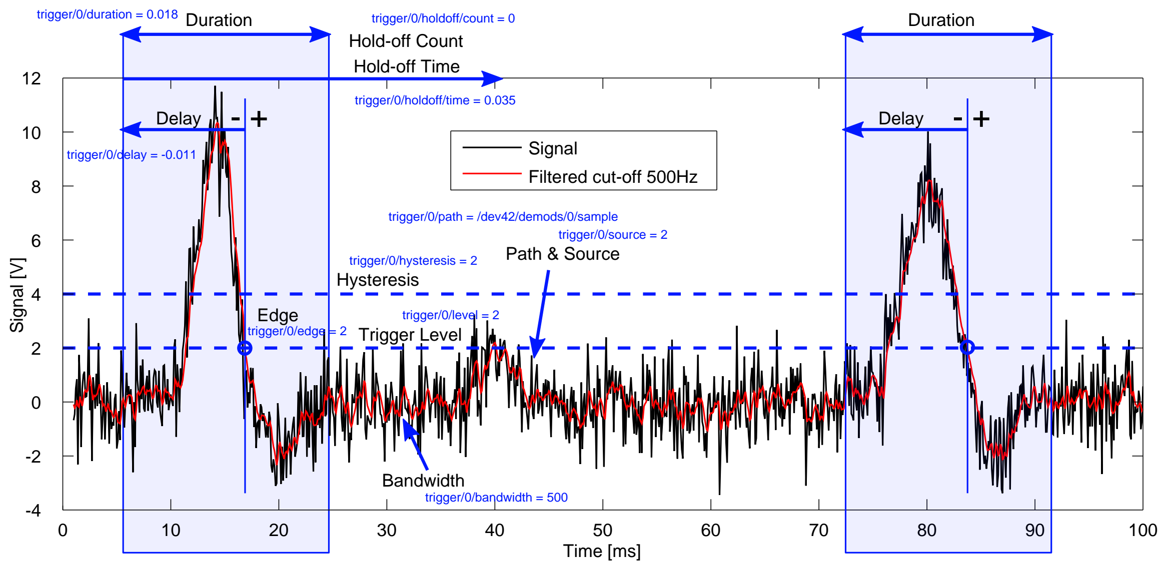


Figure 3.20. Explanation of the Software Trigger Module's parameters for an Edge Trigger.

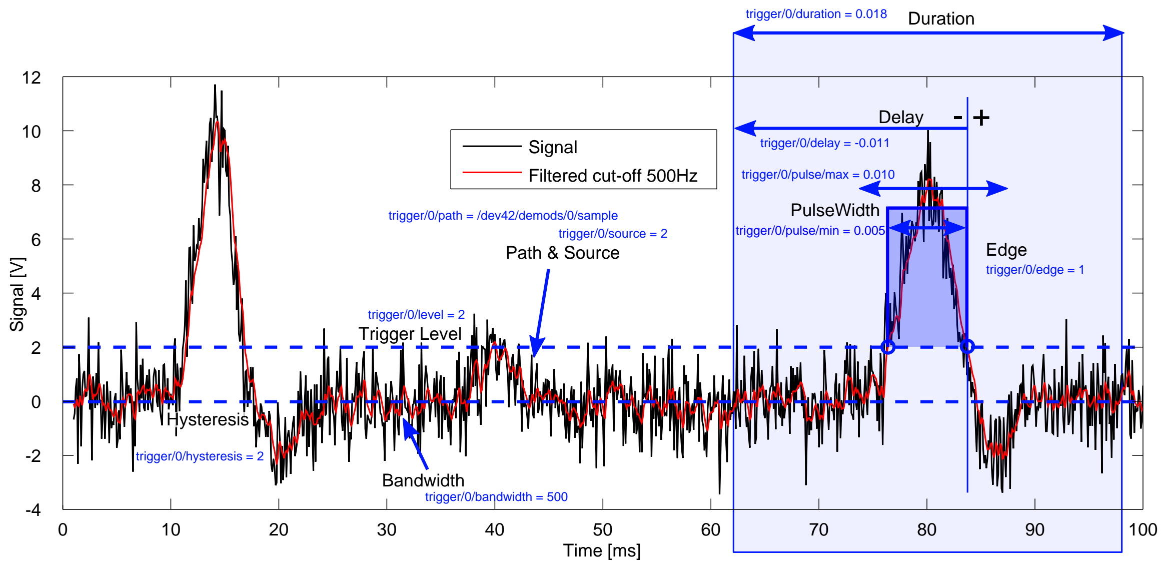


Figure 3.21. Explanation of the Software Trigger Module's parameters for a positive Pulse Trigger.

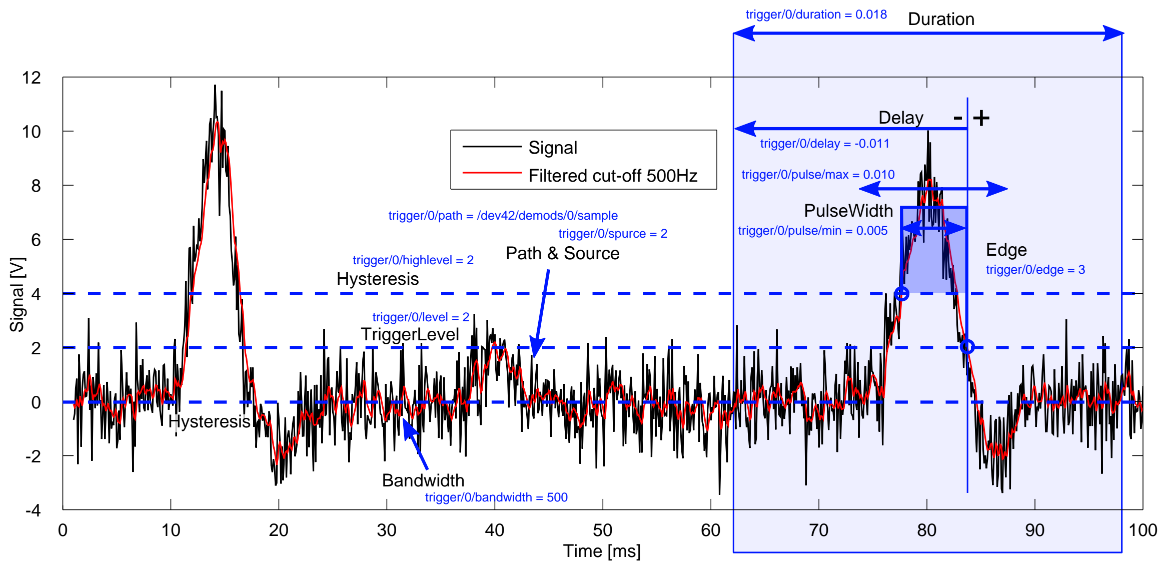


Figure 3.22. Explanation of the Software Trigger parameters for a positive or negative Pulse Trigger.

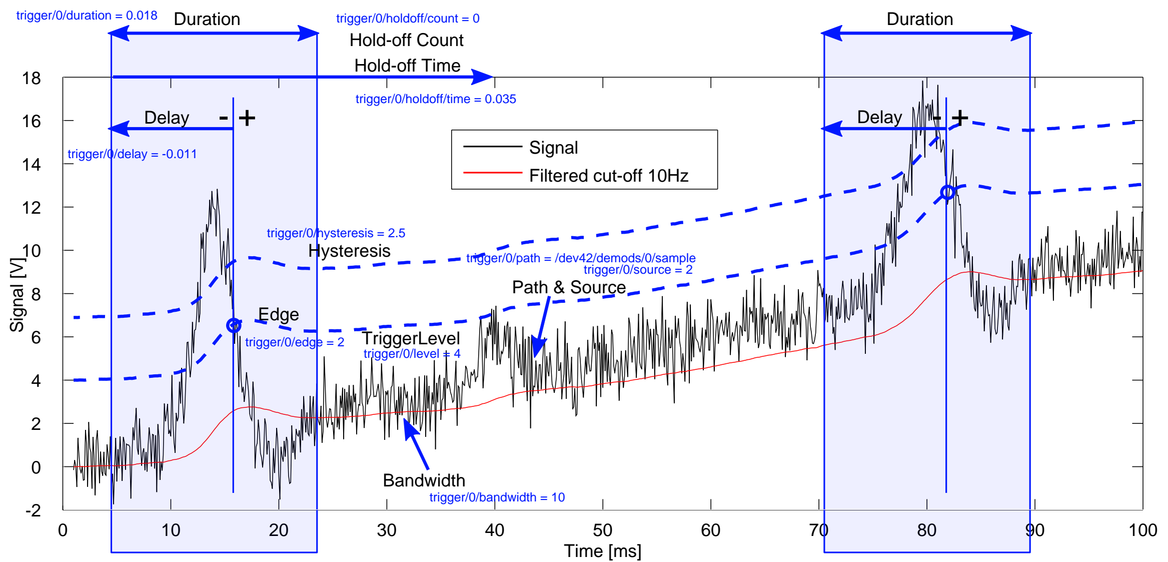


Figure 3.23. Explanation of the Software Trigger Module's parameters for a Tracking Trigger.

3.13.1. Determining the Trigger Level automatically

The SW Trigger Module can calculate the `0/level` and `0/hysteresis` parameters based on the current input signal for edge, pulse, tracking edge and tracking pulse trigger types. This is particularly useful when using a tracking trigger, where the trigger level is relative to the output of the low-pass filter tracking the input signal's average (see Figure 3.23). In the LabOne User Interface this functionality corresponds to the "Find" button in the Settings sub-tab of the SW Trigger Tab.

This functionality is activated via API by setting the `0/findlevel` parameter to 1. This is a single-shot calculation of the level and hysteresis parameters, meaning that it is performed only once, not continually. The SW Trigger monitors the input signal for a duration of 0.1 seconds and sets the level parameter to the average of the largest and the smallest values detected in the signal and the hysteresis to 10% of the difference between largest and smallest values. When the SW Trigger has finished its calculation of the level and hysteresis parameters it sets the value of

the 0/findlevel parameter to 0 and writes the values to the 0/level and 0/hysteresis parameters. Note that the calculation is only performed if the SW Trigger Module is currently running, i.e., after execute() has been called. See Example 3.4 for Python code demonstrating how to use this behaviour.

```
        # Start the Software Trigger's thread. Ready to record triggers.
        trigger.execute()
        # Tell the SW Trigger to determine the trigger level.
        trigger.set('0/findlevel', 1)
        time.sleep(0.1) # Ensure findlevel has been set before continuing.
        trigger_params = trigger.get('*', True)
        timeout = 10  # [s]
        t0 = time.time()
        # Wait until the levels have been found (when findlevel is set to 0).
        while trigger_params['/0/findlevel'] == 1:
        time.sleep(0.05)
        trigger_params = trigger.get('*', True)
        if time.time() - t0 > timeout:
        trigger.finish()
        trigger.clear()
        raise RuntimeError("SW Trigger didn't find trigger level after %.3f seconds."
 % timeout)
        print("Level: {}.".format(trigger_params['/0/level'][0])
      print("Hysteresis: {}.".format(trigger_params['/0/hysteresis'][0]))
```

Example 3.4. Python code demonstrating how to use the 0/findlevel parameter. Taken from the Python example example_swtrigger_grid.

3.13.2. Using the SW Trigger with a Digital Trigger

To use the SW Trigger with a digital trigger, it must be configured to use a digital trigger type (by setting 0/type to 2) and to use the output value of the instrument's DIO port as it's trigger source. This is achieved by setting 0/triggernode to the device node /devn/demods/m/sample.dio). It is important to be aware that the SW Trigger takes its value for the DIO output from the demodulator sample field bits, not from a node in the /devn/dios/ branch. As such, the specified demodulator must be enabled and and an appropriate transfer rate configured that meets the required trigger resolution (the SW Trigger can only resolve triggers at the resolution of 1/(/devn/demods/m/rate); it is not possible to interpolate a digital signal to improve trigger resolution and if the incoming trigger pulse on the DIO port is shorter than this resolution, it may be missed).

The Digital Trigger allows not only the trigger bits (0/bits) to be specified but also a bit mask (0/mask) in order to allow an arbitrary selection of DIO pins to supply the trigger signal. When a positive, respectively, negative edge trigger is used, all of these selected pins must become high, respectively low. The bit mask is applied as following. For positive edge triggering (0/edge set to value 1), the SW Trigger is triggered when the following equality holds for the DIO value:

```
(/devn/demods/m/sample.dio BITAND 0/mask) == (0/bits BITAND 0/mask)
```

and this equality has not been met for the previous value in time (the previous sample) of /devn/demods/m/sample.dio. For negative edge triggering (0/edge set to value 2), the SW Trigger is triggered when the following inequality holds for the current DIO value:

```
(/devn/demods/m/sample.dio BITAND 0/mask) != (0/bits BITAND 0/mask)
```

and this inequality was not met (there was equality) for the previous value of the DIO value.

3.13.3. The Software Trigger's "retrigger" functionality

If the parameter 0/retrigger is enabled (set to 1), then the length of the current trigger's data segment is extended if another trigger event occurs with the configured 0/duration. In other

words, the returned data will have a length greater than 0/duration and contain multiple trigger events. The maximum size of the returned data corresponds to the value of buffersize; it is not possible to retrigger beyond this time and a new trigger data segment will be started if required. Note, if a longer buffersize is desired it should be configured after setting the 0/duration parameter to avoid an automatic adjustment of buffersize by the Software Trigger.

Table 3.32. Software Trigger Input Parameters.

Setting/Path	Type	Unit	Description
device	string	-	The device ID to execute the software trigger, e.g., dev123 (compulsory parameter).
buffersize	double	Seconds	Set the buffer size of the trigger object. The recommended buffer size is 2*N/duration.
flags	uint64	-	Define the SW Trigger's behaviour if sampleloss is encountered: Fill holes (=0x01), align data that contains a timestamp (=0x02), throw EOFError if sampleloss is detected.
endless	uint64	-	Enable endless triggering 1=enable; 0=disable.
forcetrigger	uint64	-	Force a trigger.
filename	string	-	This parameter is deprecated. If specified, i.e. not empty, it enables automatic saving of data in single triggering mode (endless = 0).
savepath	string	-	The directory where files are saved when saving data.
fileformat	string	-	The format of the file for saving data. 0=Matlab, 1=CSV, 3=SXM (Image Format), 4=HDF5.
historylength	uint64	-	Maximum number of entries stored in the measurement history.
clearhistory	uint64	-	Clear the measurement history
triggered	uint64	-	Has the software trigger triggered? 1=Yes, 0=No (read only).
N/bandwidth	double	Hz	Only for Tracking Triggers. The bandwidth used in the calculation of the exponential running average of the source signal.
N/bitmask	uint64	-	Only for Digital triggers. Specify the bitmask used with N/bits. The trigger value is bits AND bit mask (bitwise).
N/bits	uint64	-	Only for Digital triggers. Specify the bits used for the Digital trigger value. The trigger value is bits AND bit mask (bitwise)
N/count	uint64	-	The number of triggers to save.
N/delay	uint64	Seconds	The amount of time to record data before the trigger was activated, Delay: Time delay of trigger frame position (left side) relative to the trigger edge. For delays smaller than 0, trigger edge inside trigger frame (pre trigger).

Setting/Path	Type	Unit	Description
			For delays greater than 0, trigger edge before trigger frame (post trigger), see Figure 3.20.
`N/duration`	double	Seconds	The length of time to record data for, see Figure 3.20.
`N/edge`	uint64	-	Define on which signal edge to trigger. Triggers when the trigger input signal crosses the trigger level from either low to high (edge=1), high to low (edge=2) or both (edge=3). Used for Trigger Type edge, pulse, tracking edge and tracking pulse. In the case of pulse trigger, the value specifies a positive (edge=1) or negative (edge=2) pulse relative to the trigger level (edge=3 specifies either positive or negative).
`N/findlevel`	uint64	-	Automatically find the value of `N/level` based on the current signal value.
`N/level`	uint64	Many	Specify the main trigger level value.
`N/holdoff/count`	uint64	-	The holdoff count, the number of skipped triggers until the next trigger is recorded again.
`N/holdoff/time`	double	Seconds	The holdoff time, the amount of time until the next trigger is recorded again. A hold off time smaller than @0/duration@ will produce overlapping trigger frames.
`N/hysteresis`	double	Many	Specify the hysteresis value (the trigger is re-armed after the signal exceeds `N/level` and then falls below `N/hysteresis`, if using positive edge).
`N/pulse/max`	double	-	Only for Pulse triggers: The maximum pulse width to trigger on. See Figure 3.21.
`N/pulse/min`	double	-	Only for Pulse triggers: The minimum pulse width to trigger on. See Figure 3.21.
`N/retrigger`	uint64	-	1=enable, 0=disable. Enable to allow re-triggering within one trigger duration. If enabled continue recording data in one segment if another trigger comes within the previous trigger's duration. If disabled the triggers will be recorded as separate events.
`N/triggernode`	string	-	Path and signal of the node that should be used for triggering, separated by a dot (.), e.g. `/devN/demods/0/sample.x`. `SAMPLE.X` Demodulator X value `SAMPLE.Y` Demodulator Y value `SAMPLE.R` Demodulator Magnitude `SAMPLE.THETA` Demodulator Phase `SAMPLE.AUXIN0` Auxiliary Input 1 value `SAMPLE.AUXIN1` Auxiliary Input 2 value `SAMPLE.DIO` Digital I/O value

Setting/Path	Type	Unit	Description
			Over HW Trigger paths may also be specified (device-class dependent). Overrides values from `0/path` and `0/source`.
`N/type`	uint64	-	The trigger type, see Table 3.31
`0/grid/mode`	int	-	Enable grid mode. In Grid Mode a matrix instead of a vector is returned by `read()`. Each trigger becomes a row in the matrix and each trigger's data is interpolated onto a new grid defined by the number of columns: 0: Disable, 1: Enable grid mode with nearest neighbour interpolation, 2: Enable grid mode with linear interpolation.
`0/grid/repetitions`	int	-	The number of times to perform `0/grid/operation` on the data in one grid.
`0/grid/operation`	int	-	If `0/grid/repetitions` is greater than 1, either replace or average the data in the grid's matrix.
`0/grid/cols`	int	-	Specify the number of columns in the grid's matrix. The data from each row is interpolated onto a grid with the specified number of columns.
`0/grid/rows`	int	-	Specify the number of rows in the grid's matrix. Each row is the data recorded from one trigger interpolated onto the columns.
`0/grid/direction`	int	-	The direction to organize data in the grid's matrix: 0: Forward. 1: Reverse. 2: Bidirectional. Forward - the data in each row is ordered chronologically, e.g., the first data point in each row corresponds to the first timestamp in the trigger data. Reverse - the data in each row is ordered reverse chronologically, e.g., the first data point in each row corresponds to the last timestamp in the trigger data. Bidirectional - the ordering of the data alternates between Forward and Backward ordering from row-to-row, the first row is Forward ordered.
`N/path`	string	-	This parameter is deprecated, see the `N/triggernode` parameter.
`N/source`	uint64	-	This parameter is deprecated, see the `N/triggernode` parameter.
`N/hwtrigsource`	uint64	-	This parameter is deprecated, see the `N/triggernode` parameter.

Level and Hysteresis Settings with a Pulse Trigger

For the pulse trigger type, there is a subtle difference between the way the trigger level and the hysteresis are used for positive/negative pulse triggering (N/edge= 1 or 2) and both (N/edge= 3). The difference can be seen in Figure 3.21 and Figure 3.22.

3.14. Spectrum Analyzer Module

In LabOne Releases prior to 17.12, the Spectrum Analyzer Module allows access to the functionality available in the Spectrum Analyzer Tab of the LabOne User Interface from an API. It's a measurement tool that performs Fast Fourier Transforms (FFT) on demodulator output.

Future Deprecation Warning

In LabOne Release 17.12 and subsequent releases the Spectrum Analyzer (zoomFFT) Module has been superceded by the Data Acquisition Module. We strongly recommend using the Data Acquisition Module instead of the Recorder Module for frequency (and time) domain data acquisition. See Section 3.5 for a description of the Data Acquisition Module. In particular, existing users of the Recorder module can use the guide in Section 3.5.5, Migrating a zoomFFT program to the DAQ Module.

To get started please refer to the Spectrum Analyzer Tab in the relevant instrument-specific User Manual. An example is available in the each of the LabVIEW, Matlab, Python or .NET APIs.

See Table 3.33 for the input parameters to configure the Spectrum Module and Table 3.34 for a description of the Spectrum Module outputs.

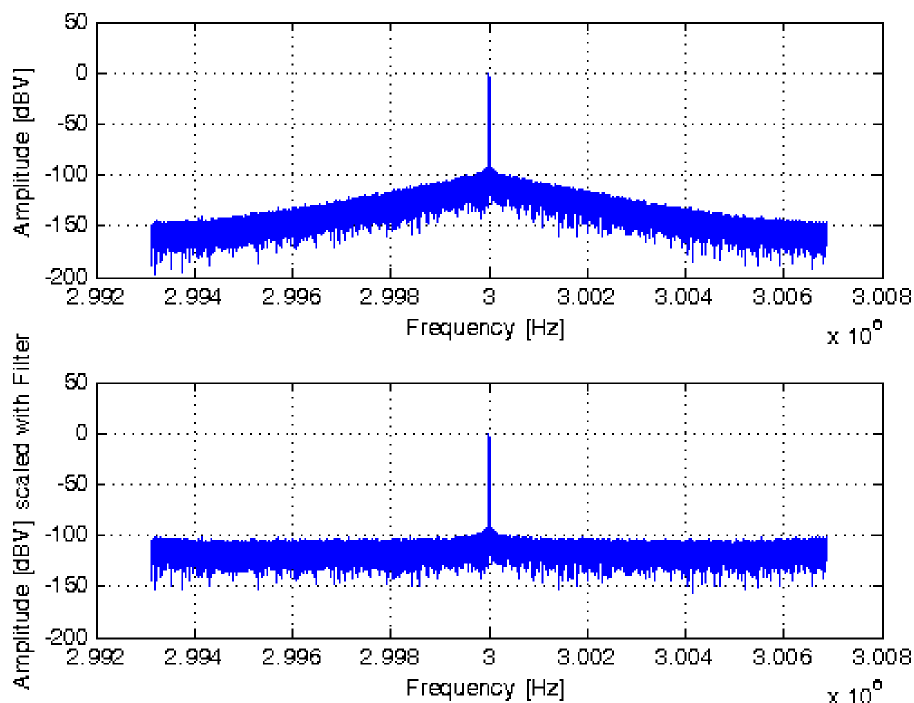


Figure 3.24. The FFT result from the LabOne Matlab API Spectrum Module example.

Table 3.33. Spectrum Module Input Parameters

Setting/Path	Type	Unit	Description
`device`	string	-	The device ID that is being used for the measurement; the demodulator data is taken from this device. For example, `dev123` (compulsory parameter).

Setting/Path	Type	Unit	Description
`absolute`	bool	-	When enabled, shifts the frequencies in the output grid so that the center frequency corresponds to the demodulation frequency. If not enabled, the center frequency is 0 Hz.
`bit`	uint64	-	Number of lines of the FFT spectrum (powers of 2). A higher value increases the frequency resolution of the spectrum.
`endless`	bool	-	Enable Endless mode; Run the FFT spectrum analysis continuously.
`loopcount`	uint64	-	The number of FFTs to perform if not running in Endless mode.
`mode`	uint64	-	Select the source signal for the FFT. `0=FFT(x+iy)` Complex FFT of the demodulator result. `1=FFT(R)` FFT of the demodulator amplitude sqrt(x^2 + y^2). The FFT is single-sided as performed on real data. `2=FFT(phase)` FFT of the demodulator phase atan2(y, x). The FFT is single-sided as performed on real data. `3=FFT(f)` FFT of the oscillator frequency of the selected demodulator. This mode is only interesting if the oscillator is controlled by a PID / PLL controller. The FFT is single-sided as performed on real data. `4=FFT(dΘ/dt)/(2π)` FFT of the demodulator phase derivative. This value is equivalent to the frequency noise observed on the demodulated signal. The FFT is single-sided as performed on real data.

Setting/Path	Type	Unit	Description
`overlap`	double	-	Overlap of the demodulator data used for the FFT. Use 0 for no overlap and 0.99 for maximal overlap.
`settling/tc`	double	TC	Minimum wait time in factors of the demodulator time constant (TC) before starting the measurement. The maximum of this value and `settling/time` is taken as the effective settling time.
`settling/time`	double	s	Minimum wait time in seconds before starting the measurement. The maximum of this value and `settling/tc` is taken as effective settling time.
`window`	uint64	-	The type of FFT window to use. 0=Rectangular, 1=Hann, 2=Hamming, 3=Blackman Harris.

Table 3.34. Spectrum Module Output Values

Name	Type	Unit	Description
`x`	double	VoltsRMS	The real part, x, of the complex FFT result.
`y`	double	VoltsRMS	The imaginary part, y, of the complex FFT result.
`r`	double	VoltsRMS	The absolute value, R=Abs(X+iY), of the complex FFT result.
`timestamp`	uint64	Ticks	Demodulator timestamp of the measurement (divide by the device's clockbase to obtain seconds).
`center`	double	Hz	The center frequency (corresponds to the demodulation frequency) of the spectrum.
`rate`	double	1/s	Sampling rate of the demodulator.
`filter`	double	-	The absolute values of the demodulator's low-pass filter transfer function for each grid point. The FFT result, x, y or R, may be divided by this value to obtain a filter compensated spectrum.
`bandwidth`	double	Hz	The noise-equivalent power bandwidth of the demodulator
`grid`	double	Hz	The frequency grid.
`nenbw`	double	-	The normalized equivalent noise bandwidth. If calculating spectral densities multiply your spectrum by this value to correct for windowing effects.
`resolution`	double	Hz	FFT resolution: Spectral resolution defined by the reciprocal acquisition time (sampling rate/number of samples recorded).
`aliasingreject`	double	dB	The damping of the demdodulator present at the border of the spectrum.

Chapter 4. Matlab Programming

The MathWorks' numerical computing environment Matlab® has powerful tools for data analysis and visualization that can be used to create graphical user interfaces or automatically generate reports of experimental results in various formats. LabOne's Matlab API, also known as `ziDAQ`, "Zurich Instruments Data Acquisition", enables the user to stream data from their instrument directly into Matlab allowing them to take full advantage of this powerful environment.

This chapter aims to help you get started using Zurich Instruments LabOne's Matlab API, `ziDAQ`, to control your instrument, please refer to:

- Section 4.1 for help Installing the LabOne Matlab API.
- Section 4.2 for help Getting Started with the LabOne Matlab API and Running the Examples.
- Section 4.3 for some LabOne Matlab API Tips and Tricks.
- Section 4.4 for help Troubleshooting the LabOne Matlab API.
- Section 4.5 for LabOne Matlab API (ziDAQ) Command Reference.

Note

This section and the provided examples are not intended to be a Matlab tutorial. See either MathWorks' online Documentation Center or one of the many online resources, for example, the Matlab Programming Wikibook for help to get started programming with Matlab.

4.1. Installing the LabOne Matlab API

4.1.1. Requirements

One of the following platforms and Matlab versions (with valid license) is required to use the LabOne Matlab API:

1. 32 or 64-bit Windows with Matlab R2009b or newer.
2. 64-bit Linux with Matlab R2016b or newer.
3. 64-bit Mac OS X and Matlab R2013b or newer.

The LabOne Matlab API `ziDAQ` is included in a standard LabOne installation and is also available as a separate package (see below, Separate Matlab Package). No installation as such is required, only a few configuration steps must be performed to use `ziDAQ` in Matlab. Both the main LabOne installer and the separate LabOne Matlab API package are available from Zurich Instruments' download page.

Separate Matlab Package

The separate Matlab API package should be used if you would like to:

1. Use the Matlab API to work with an instrument remotely (i.e., on a separate PC from where the Data Server is running) and you do not require a full LabOne installation. This is the case, for example, with MF Instruments.
2. Use the Matlab API on a PC where you do not have administrator rights.

4.1.2. Windows, Linux or Mac

No additional installation steps are required to use `ziDAQ` on either Windows, Linux or Mac; it's only necessary to add the folder containing LabOne's Matlab Driver to Matlab's search path. This is done as following:

1. Start Matlab and either set the "Current Folder" (current working directory) to the Matlab API folder in your LabOne installation or the extracted zip archive of the separate Matlab API package (see above, Separate Matlab Package) as appropriate.

   If using a LabOne installation on Windows this is typically:

   ```
   C:\Program Files\Zurich Instruments\LabOne\API\MATLAB\
   ```

   and on Linux this is the location where you unpacked the LabOne `.tar.gz` file:

   ```
   [PATH]/LabOne64/API/MATLAB/
   ```

2. In the Matlab Command Window, run the Matlab script `ziAddPath` located in the `MATLAB` directory:

   ```
   >> ziAddPath;
   ```

   On Windows (similar for Linux and Mac) you should see the following output in Matlab's Command Window:

   ```
   Added ziDAQ's Driver, Utilities and Examples directories to Matlab's path
   for this session.
   ```

```
To make this configuration persistent across Matlab sessions either:

1. Run the 'pathtool' command in the Matlab Command Window and add the
   following paths WITH SUBFOLDERS to the Matlab search path:

   C:\Program Files\Zurich Instruments\LabOne\API\MATLAB\

or

2. Add the following line to your Matlab startup.m file:

   run('C:\Program Files\Zurich Instruments\LabOne\API\MATLAB\ziAddPath');
```

This is sufficient configuration if you would only like to use `ziDAQ` in the current Matlab session.

3. To make this configuration persistent between Matlab sessions do either one of the next two steps (as also indicated by the output of `ziAddPath`):
   a. Run the `pathtool` and click "Add with Subfolders". Browse to the "MATLAB" directory that was located above in Step 1and click "OK".
   b. Edit your `startup.m` to contain the line indicated in the output from Step 2 above. For more help on Matlab's `startup.m` file, type the following in Matlab's Command Window:

      ```
      >> docsearch('startup.m')
      ```
4. Verify your Matlab configuration as described in Section 4.1.3.

4.1.3. Verifying Successful Matlab Configuration

In order to verify that Matlab is correctly configured to use `ziDAQ` please perform the following steps:

1. Ensure that the correct Data Server is running for your HDAWG, HF2 or UHF Instrument (the Data Server on MF Instruments starts when the device is powered on). The quickest way to check is to start the User Interface for your device, see Section 1.2 for more details.
2. Proceed either of the following two ways:
   a. The easiest way to verify correct configuration is run one of the Matlab API's examples. In the Matlab command Window run, for example, `example_poll` with your device ID as the input argument:

      ```
      >> example_poll('dev123'); % Replace with your device ID.
      ```

      If this fails, please try issuing the `connect` command, as described in the next method.
   b. If a device is not currently available, correct Matlab API configuration can be checked by initializing an API session to the Data Server without device communication.

      An API session with the Data Server is created using `ziDAQ`'s `connect` (the port specifies which Data Server to connect to on the localhost) cf. Section 1.4.1). In the Matlab command window type one of the following:

      - `>> ziDAQ('connect', 'localhost', 8005) % 8005 for HF2 Series`
      - `>> ziDAQ('connect', 'localhost', 8004, 6) % 8004 for HDAWG, UHFLI`
      - `>> ziDAQ('connect', mf-hostname, 8004, 6) % 8004 for MFLI (see below)`

      Note, using `'localhost'` above assumes that the Data Server is running on the same computer from which you are using Matlab. See Section 1.4.1 for information about ports

and hostnames when connecting to the Data Server. For MFLI instruments the hostname/ IP address of the MFLI instrument must be provided (the value of `mf-hostname`), see Section 1.4.1 and the Getting Started chapter of the MFLI User Manual for more information.

3. If no error is reported then Matlab is correctly configured to use `ziDAQ` - congratulations! Otherwise, please try the steps listed in Troubleshooting the LabOne Matlab API.

4.2. Getting Started with the LabOne Matlab API

This section introduces the user to the LabOne Matlab API.

4.2.1. Contents of the LabOne Matlab API

Alongside the driver for interfacing with your Zurich Instruments device, the LabOne Matlab API includes many files for documentation, utility functions and examples. See the `Contents.m` file located in a LabOne Matlab API directory (see Step 1 in Section 4.1.2 for its typical location) for a description of the API's sub-folders and files. Run the command:

```
>> doc('Contents')
```

in the Matlab Command Window in the LabOne Matlab API directory to access the following contents interactively in Matlab.

```
        % ziDAQ : The LabOne Matlab API for interfacing with Zurich Instruments
 Devices
%
% FILES
%   ziAddPath  - add the LabOne Matlab API drivers, utilities and examples to
%                Matlab's Search Path for the current session
%   README.txt - a README briefly describing how to get started with ziDAQ
%
% DIRECTORIES
%   Driver/    - contains Matlab driver for interfacing with Zurich Instruments
%                devices
%   Utils/     - contains some utility functions for common tasks
%   Examples/  - contains examples for performing measurements on Zurich
%                Instruments devices
%
% DRIVER
%   Driver/ziDAQ.m          - ziDAQ command reference documentation.
%   Driver/ziDAQ.mex*       - ziDAQ API driver
%
% UTILS
%   ziAPIServerVersionCheck - check the versions of API and Data Server match
%   ziAutoConnect      - Create a connection to a Zurich Instruments
%                        server (Deprecated: See ziCreateAPISession).
%   ziAutoDetect       - Return the ID of a connected device (if only one
%                        device is connected)
%   ziBW2TC            - Convert demodulator 3dB bandwidth to timeconstant
%   ziCheckPathInData  - Check whether a node is present in data and non-empty
%   ziCreateAPISession - Create an API session for the specified device with
%                        the correct Data Server.
%   ziDevices          - Return a cell array of connected Zurich Instruments
%                        devices
%   ziDisableEverything - Disable all functional units and streaming nodes
%   ziGetDefaultSettingsPath - Get the default settings file path from the
%                        ziDeviceSettings ziCore module
%   ziGetDefaultSigoutMixerChannel - return the default output mixer channel
%   ziLoadSettings     - Load instrument settings from file
%   ziSaveSettings     - Save instrument settings to file
%   ziSiginAutorange   - Activate the device's autorange functionality
%   ziSystemtime2Matlabtime - Convert the LabOne system time to Matlab time
%   ziTC2BW            - Convert demodulator timeconstants to 3 dB Bandwidth
%
% EXAMPLES/COMMON - Examples that will run on most Zurich Instruments Devices
%   example_connect                  - A simple example to demonstrate how to
%                                      connect to a Zurich Instruments device
%   example_connect_config           - Connect to and configure a Zurich
%                                      Instruments device
%   example_save_device_settings_simple - Save and load device settings
```

```
%                                           synchronously using ziDAQ's utility
%                                           functions
%   example_save_device_settings_expert - Save and load device settings
%                                           asynchronously with ziDAQ's
%                                           devicesettings module
%   example_data_acquisition_continuous - Record data continuously using the
%                                           DAQ Module
%   example_data_acquisition_edge       - Record bursts of demodulator data upon
%                                           a rising edge using the DAQ Module
%   example_data_acquisition_fft        - Record the FFT of demodulator data
%                                           using the DAQ Module
%   example_data_acquisition_grid       - Record bursts of demodulator data
%                                           and align the data in a 2D array.
%   example_data_acquisition_grid_average - Record bursts of demodulator data
%                                           and align and average the data
%                                           row-wise in a 2D array.
%   example_sweeper                     - Perform a frequency sweep using ziDAQ's
%                                           sweep module
%   example_sweeper_rstddev_fixedbw     - Perform a frequency sweep plotting the
%                                           stddev in demodulator output R using
%                                           ziDAQ's sweep module
%   example_sweeper_two_demods          - Perform a frequency sweep saving data
%                                           from 2 demodulators using ziDAQ's sweep
%                                           module
%   example_poll                        - Record demodulator data using
%                                           ziDAQServer's synchronous poll function
%   example_poll_impedance              - Record impedance data using
%                                           ziDAQServer's synchronous poll function
%   example_scope                       - Record scope data using ziDAQServer's
%                                           synchronous poll function
%   example_pid_advisor_pll             - Setup and optimize a PID for internal
%                                           PLL mode
%   example_autoranging_impedance       - Demonstrate how to perform a manually
%                                           triggered autoranging for impedance
%                                           while working in manual range mode
%   example_multidevice_data_acquisition - Acquire data from 2 synchronized
%                                           devices using the DAQ Module
%   example_multidevice_sweep           - Perform a sweep on 2 synchronized
%                                           devices using the Sweeper Module
%
% EXAMPLES/HDAWG - Examples specific to the HDAWG Series
%   hdawg_example_awg                   - demonstrate different methods to
%                                           create waveforms and compile and
%                                           upload a SEQC program to the AWG
%   hdawg_example_awg_sourcefile        - demonstrate how to compile/upload a
%                                           SEQC from file.
%
% EXAMPLES/HF2 - Examples specific to the HF2 Series
%   hf2_example_autorange             - determine and set an appropriate range
%                                         for a sigin channel
%   hf2_example_poll_hardware_trigger - Poll demodulator data in combination
%                                         with a HW trigger
%   hf2_example_scope                 - Record scope data using ziDAQServer's
%                                         synchronous poll function
%   hf2_example_zsync_poll            - Synchronous demodulator sample timestamps
%                                         from multiple HF2s via the Zsync feature
%   hf2_example_pid_advisor_pll       - Setup and optimize a PLL using the PID
%                                         Advisor
%
% EXAMPLES/UHF - Examples specific to the UHF Series
%   uhf_example_awg                     - demonstrate different methods to
%                                           create waveforms and compile and
%                                           upload a SEQC program to the AWG
%   uhf_example_awg_sourcefile          - demonstrate how to compile/upload a
%                                           SEQC from file.
%   uhf_example_boxcar                  - Record boxcar data using ziDAQServer's
%                                           synchronous poll function
```

```
%
%
% EXAMPLES/DEPRECATED - Examples that use functionality that either is or will
%                       be made deprecated in a future release
%   example_spectrum                    - Perform an FFT using ziDAQ's zoomFFT
%                                         module (Spectrum Tab of the LabOne UI)
%   example_swtrigger_edge              - Record demodulator data upon a rising
%                                         edge trigger via ziDAQ's SW Trigger
%                                         module
%   example_swtrigger_digital           - Record data using a digital trigger via
%                                         ziDAQ's SW Trigger module
%   example_swtrigger_grid              - Record demodulator data, interpolated
%                                         on a grid from multiple triggers
%                                         using the SW Trigger's Grid Mode.
%   example_swtrigger_grid_average      - Record demodulator data, interpolated
%                                         on a grid from multiple triggers
%                                         using the SW Trigger's
%                                         Grid Mode. This example additionally
%                                         demonstrates Grid Mode's averaging
%                                         functionality.
```

Matlab Driver Naming

On Windows the MEX-file (the `ziDAQ` Matlab Driver/DLL) is called either `ziDAQ.mexw64` or `ziDAQ.mexw32` for 64-bit and 32-bit platforms respectively, on Linux it's called `ziDAQ.mexa64` and on Mac it's called `ziDAQ.mexmaci64`. When more than one MEX-file is present, Matlab automatically selects the correct MEX-file for the current platform.

4.2.2. Using the Built-in Documentation

To access `ziDAQ`'s documentation within Matlab, type either of the following in the Matlab Command Window:

```
>> help ziDAQ
```

```
>> doc ziDAQ
```

This documentation is located in the file `MATLAB/Driver/ziDAQ.m`. See Section 4.5, LabOne Matlab API (ziDAQ) Command Reference for a printer friendly version.

4.2.3. Running the Examples

Prerequisites for running the Matlab examples:

1. Matlab is configured for `ziDAQ` as described above in Section 4.1.
2. The Data Server program is running and the instrument is discoverable, this is the case if the instrument can be seen in the User Interface.
3. Signal Output 1 of the instrument is connected to Signal Input 1 via a BNC cable; many of the Matlab examples measure on this hardware channel.

See Section 4.2.1 for a list of available examples bundled with the LabOne Matlab API. All the examples follow the same structure and take one input argument: the device ID of the instrument they are to be ran with. For example:

```
>> example_sweeper('dev123');
```

The example should produce some output in the Matlab Command Window, such as:

```
        ziDAQ version Jul 7 2015 accessing server localhost 8005.
Will run the example on `dev123`, an `HF2LI` with options `MFK|PLL|MOD|RTK|PID`.
Sweep progress 9%
Sweep progress 19%
Sweep progress 30%
Sweep progress 42%
Sweep progress 52%
Sweep progress 58%
Sweep progress 68%
Sweep progress 79%
Sweep progress 91%
Sweep progress 100%
ziDAQ: AtExit called
```

Most examples will also plot some data in a Matlab figure, see Figure 4.1 for an example. If you encounter an error message please ensure that the above prerequisites are fulfilled and see Section 4.4 for help troubleshooting the error.

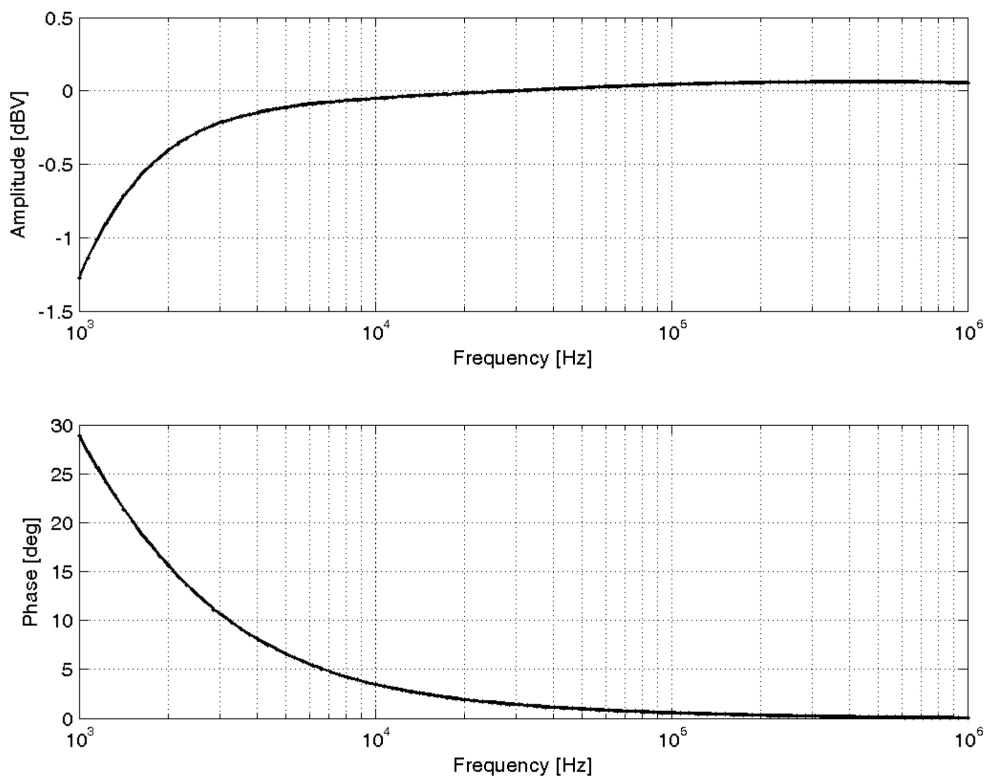


Figure 4.1. The plot produced by the LabOne Matlab API example `example_sweeper.m`; the plots show the instruments demodulator output when performing a frequency sweep over a simple feedback cable.

Note

The examples serve as a starting point for your own measurement needs. However, before editing the m-files, be sure to copy them to your own user space (they could be overwritten upon updating your LabOne installation) and give them a unique name to avoid name conflicts in Matlab.

4.2.4. Using ziCore Modules in the LabOne Matlab API

In the LabOne Matlab API `ziCore` Modules are configured and controlled via Matlab "handles". For example, in order to use the Sweeper Module a handle is created via:

```
>> h = ziDAQ('sweep');
```

and the Module's parameters are configured using the `set` command and specifying the Module's handle with a `path`, `value` pair, for example:

```
>> ziDAQ('set', h, 'start', 1.2e5);
```

The parameters can be read-back using the `get` command, which supports wildcards, for example:

```
>> sweep_params = ziDAQ('get', h, '*');
```

The variable `sweep_params` now contains a `struct` of all the Sweeper's parameters. The other main Module commands are used similarly, e.g., `ziDAQ('execute', h)` to start the sweeper. See Section 3.1.2 for more help with Modules and a description of their parameters.

Note

The Data Acquisition Module uses dot notation for subscribing to signals. In the data structure returned by the MATLAB API, the dots are replaced by underscores in order not to conflict with the dot notation used for member selection in MATLAB, e.g. /devNNN/demods/0/sample.r is accessed using devNNN.demods(1).sample_r.

4.2.5. Enabling Logging in the LabOne Matlab API

Logging from the API is not enabled by default upon initializing a server session with `ziDAQ`, it must be enabled (after using `connect`) with the `setDebugLevel` command. For example,

```
>> ziDAQ('setDebugLevel', 0);
```

sets the API's logging level to 0, which provides the most verbose logging output. The other log levels are defined as follows:

```
trace:0, debug:1, info:2, status:3, warning:4, error:5, fatal:6.
```

It is also possible for the user to write their own messages directly to `ziDAQ`'s log using the `writeDebugLog` command. For example to write a log message of `info` severity level:

```
>> ziDAQ('writeDebugLog', 1, 'Hello log!');
```

On Windows the logs are located in the directory `C:\Users\[USER]\AppData\Local\Temp\Zurich Instruments\LabOne` Note that `AppData` is a hidden directory. The easiest way to find it is to open a File Explorer window and type the text `%AppData%\..` in the address bar, and navigate from there. The directory contains folders containing log files from various LabOne components, in particular, the `ziDAQLog` folder contains logs from the LabOne Matlab API. On Linux, the logs can be found at "/tmp/ziDAQLog_USERNAME", where "USERNAME" is the same as the output of the "whoami" command.

4.3. LabOne Matlab API Tips and Tricks

In this section some tips and tricks for working with the LabOne Matlab API are provided.

The structure of **ziDAQ** commands.

All LabOne Matlab API commands are based on a call to the Matlab function `ziDAQ()`. The first argument to `ziDAQ()` specifies the API command to be executed and is an obligatory argument. For example, a session is instantiated between the API and the Data Server with the Matlab command `ziDAQ('connect')`. Depending on the type of command specified, optional arguments may be required. For example, to obtain an integer node value, the node path must be specified as a second argument to the `'getInt'` command:

```
s = ziDAQ('getInt','/dev123/sigouts/0/on');
```

where the output argument contains the current value of the specified node.

To set an integer node value, both the node path and the value to be set must be specified as the second and third arguments:

```
ziDAQ('setInt','/dev123/sigouts/0/on', 1);.
```

See the LabOne Matlab API (ziDAQ) Command Reference for a list of all available commands.

Data Structures returned by **ziDAQ**.

The output arguments that `ziDAQ` returns are designed to use the native data structures that Matlab users are familiar with and that reflect the data's location in the instruments node hierarchy. For example, when the `poll` command returns data from the instruments fourth demodulator (located in the node hierarchy as `/dev123/demods/3/sample`), the output argument contains a nested `struct` in which the data can be accessed by

```
data = ziDAQ('poll', poll_length, poll_timeout);
x = data.dev123.demods(4).sample.x;
y = data.dev123.demods(4).sample.y;
```

The instrument's node tree uses zero-based indexing; Matlab uses one-based indexing.

See the tip Data Structures returned by `ziDAQ`. : The **fourth** demodulator sample located at `/dev123/demods/`*`3`*`/sample`, is indexed in the data structure returned by poll as `data.dev123.demods(`*`4`*`).sample`.

Explicitly convert **uint64** data types to **double**.

Matlab's native data type is double-precision floating point and doesn't support performing calculations with with other data types such as 64-bit unsigned integers, for example:

```
>> a = uint64(2); b = uint64(1); a - b
? Undefined function or method 'minus' for input arguments of type 'uint64'.
```

Due to this limitation, be sure to convert demodulator timestamps to `double` before performing calculations. For example, in the following, both clockbase and timestamp (both 64-bit unsigned

integers) need to be converted to double before converting the timestamps from the instrument's native "ticks" to seconds via the instrument's clockbase:

```
data = ziDAQ('poll', 1.0, 500);          % poll data
sample = data.(device).demods(0).sample; % get the sample from the zeroth demod
% convert timestamps from ticks to seconds via the device's clockbase
% (the ADC's sampling rate), specify reference start time via t0.
clockbase = double(ziDAQ('getInt',['/' device '/clockbase']));
t = (double(sample.timestamp) - double(sample.timestamp(1)))/clockbase;
```

Use the utility function **ziCheckPathInData**.

Checking that a sub-structure in the nested data structure returned by `poll` actually exists can be cumbersome and can require multiple nested `if` statements; this can be avoided by using the utility function `ziCheckPathInData`. For example, the code:

```
data = ziDAQ('poll', poll_length, poll_timeout );
if isfield(data,device)
  if isfield(data.(device),'demods')
    if length(data.(device).demods) >= channel
      if ~isempty(data.(device).demods(channel).sample)
        % do something with the demodulator sample...
```

can be replaced by:

```
data = ziDAQ('poll', poll_length, poll_timeout );
if ziCheckPathInData( data, ['/' device '/demods/' demod_c '/sample']);
  % do something with the demodulator sample...
```

4.4. Troubleshooting the LabOne Matlab API

This section intends to solve possible error messages than can occur when using `ziDAQ` in Matlab.

Error message: "Undefined function or method 'ziDAQ' for input arguments of type '*'"

Matlab can not find the LabOne Matlab API library. Check whether the `MATLAB/Driver` subfolder of your LabOne installation is in the Matlab Search Path by using the command:

```
>> path
```

and repeating the steps to configure Matlab's search path in Section 4.1.2.

Error message: "Undefined function or method 'example_sweeper'"

Matlab can not find the example. Check whether the `MATLAB/Examples/Common` subfolder (respectively `MATLAB/Examples/HDAWG`, `MATLAB/Examples/HF2` or `MATLAB/Examples/UHF`) of your LabOne installation are in the Matlab Search Path by using the command:

```
>> path
```

and repeating the steps to configure Matlab's search path in Section 4.1.2.

Error message: "Error using: ziDAQ ZIAPIException with status code: 32870. Connection invalid."

The Matlab API can not connect to the Data Server. Please check that the correct port was used; that the correct server is running for your device and that the device is connected to the server, see Section 1.4.1.

Error Message: "Error using: ziAutoConnect at 63 ziAutoConnect(): failed to find a running server or failed to find a connected a device..."

The utility function `ziAutoConnect()` located in `MATLAB/Utils/` tries to determine which Data Server is running and whether any devices are connected to that Data Server. It is only supported by UHFLI and HF2 Series instruments, MFLI instruments are not supported. Some suggestions to verify the problem:

- Please verify in the User Interface, whether a device is connected to the Data Server running on your computer.
- If the Data Server is running on a different computer, connect manually to the Data Server via `ziDAQ`'s `connect` function:

  ```
  >> ziDAQ('connect', hostname, port, api_level);
  ```

  where `hostname` should be replaced by the IP of the computer where the Data Server is running, `port` is specified as in Section 1.4.1 and `api_level` is specified as described in Section 1.4.2.

Error Message: "Error using: ziDAQ ZIAPIException on path /dev123/sigins/0/imp50 with status code: 16387. Value or Node not found"

The API is connected to the Data Server, but the command failed to find the specified node. Please:

- Check whether your instrument is connected to the Data Server in the User Interface; if it is not connected the instruments device node tree, e.g., `/dev123/`, will not be constructed by the Data Server.
- Check whether the node path is spelt correctly.
- Explore the node tree to verify the node actually exists with the `listNodes` command:

```
>> ziDAQ('listNodes', '/dev123/sigins/0', 3)
```

Error Message: "using: ziDAQ Server not connected. Use 'ziDAQ('connect', ...) first."

A `ziDAQ` command was issued before initializing a connection to the Data Server. First use the `connect` command:

```
>> ziDAQ('connect', hostname, port, api_level);
```

where `hostname` should be replaced by the IP address of the computer where the Data Server is running, `port` is specified as in Section 1.4.1 and `api_level` is specified as described in Section 1.4.2. If the Data Server is running on the same computer, use `'localhost'` as the `hostname`.

Error Message: "Attempt to execute SCRIPT ziDAQ as a function: ziDAQ.m"

There could be a problem with your LabOne Matlab API installation. The call to `ziDAQ()` is trying to call the help file `ziDAQ.m` as a function instead of calling the `ziDAQ()` function defined in the MEX-file. In this case you need to ensure that the `ziDAQ` MEX-file is in your search path as described in Section 4.1 and navigate away from the `Driver` directory. Secondly, ensure that the LabOne Matlab MEX-file is in the `Driver` folder as described in Section 4.2.1.

4.5. LabOne Matlab API (ziDAQ) Command Reference

```
    %
% Copyright 2009-2018, Zurich Instruments Ltd, Switzerland
% This software is a preliminary version. Function calls and
% parameters may change without notice.
%
% This version of ziDAQ is linked against:
% * Matlab 7.9.0.529, R2009b, Windows,
% * Matlab 8.4.0.145, R2014b, Linux64.
% You can check which version of Matlab you are using Matlab's `ver` command.
% A list of compatible Matlab and ziDAQ versions is available here:
% www.zhinst.com/labone/compatibility
%
% ziDAQ is an interface for communication with Zurich Instruments Data Servers.
%
% Usage: ziDAQ(command, [option1], [option2])
%        command = 'awgModule', 'clear', 'commitHash', 'connect', 'connectDevice',
%                  'dataAcquisitionModule', 'deviceSettings',
%                  'disconnectDevice', 'discoveryFind', 'discoveryGet',
%                  'finished', 'flush', 'get', 'getAsEvent', 'getAuxInSample',
%                  'getByte', 'getComplex', 'getDIO', 'getDouble', 'getInt',
%                  'getString', 'getSample', 'help', 'impedanceModule',
%                  'listNodes', 'listNodesJSON', 'logOn',
%                  'logOff', 'multiDeviceSyncModule', 'pidAdvisor',
 'precompensationAdvisor',
%                  'poll', 'pollEvent', 'programRT', 'progress',
%                  'read', 'record', 'revision', 'setByte', 'setComplex',
 'setDouble',
%                  'syncSetDouble', 'setInt', 'syncSetInt', 'setString',
%                  'syncSetString', 'subscribe', 'sweep', 'unsubscribe',
%                  'update', 'version', 'zoomFFT'
%
% Preconditions: ZI Server must be running (check task manager)
%
%           ziDAQ('version');
%                 Returns the version of the API.
%
%           ziDAQ('revision');
%                 Returns the revision of the API.
%
%           ziDAQ('commitHash');
%                 Returns a unique key that identifies the source
%                 code used to build the API.
%
%           ziDAQ('connect', [host = '127.0.0.1'], [port = 8005], [apiLevel = 1]);
%                  [host] = Server host string (default is localhost)
%                  [port] = Port number (double)
%                           Use port 8005 to connect to the HF2 Data Server
%                           Use port 8004 to connect to the MF or UHF Data Server
%                  [apiLevel] = Compatibility mode of the API interface (int64)
%                           Use API level 1 to use code written for HF2.
%                           Higher API levels are currently only supported
%                           for MF and UHF devices. To get full functionality for
%                           MF and UHF devices use API level 5.
%                 To disconnect use 'clear ziDAQ'
%
%  result = ziDAQ('getConnectionAPILevel');
%                 Returns ziAPI level used for the active connection.
%
%  result = ziDAQ('discoveryFind', device);
%                 device (string) = Device address string (e.g. 'UHF-DEV2000')
```

```
%                 Return the device ID for a given device address.
%
%   result = ziDAQ('discoveryGet', deviceId);
%                 deviceId (string) = Device id string (e.g. DEV2000)
%                 Return the device properties for a given device id.
%
%           ziDAQ('connectDevice', device, interface);
%                 device (string) = Device serial to connect (e.g. 'DEV2000')
%                 interface (string) = Interface, e.g., 'USB', '1GbE'.
%                 Connect with the data server to a specified device over the
%                 specified interface. The device must be visible to the server.
%                 If the device is already connected the call will be ignored.
%                 The function will block until the device is connected and
%                 the device is ready to use. This method is useful for UHF
%                 devices offering several communication interfaces.
%
%           ziDAQ('disconnectDevice', device);
%                 device (string) = Device serial of device to disconnect.
%                 This function will return immediately. The disconnection of
%                 the device may not yet finished.
%
%   result = ziDAQ('listNodes', path, flags);
%                 path (string) = Node path or partial path, e.g.,
%                          '/dev100/demods/'.
%                 flags (int64) = Define which nodes should be returned, set the
%                         following bits to obtain the described behavior:
%                         int64(0) -> ZI_LIST_NODES_ALL 0x00
%                           The default flag, returning a simple
%                           listing of the given node
%                         int64(1) -> ZI_LIST_NODES_RECURSIVE 0x01
%                           Returns the nodes recursively
%                         int64(2) -> ZI_LIST_NODES_ABSOLUTE 0x02
%                           Returns absolute paths
%                         int64(4) -> ZI_LIST_NODES_LEAVESONLY 0x04
%                           Returns only nodes that are leaves,
%                           which means the they are at the
%                           outermost level of the tree.
%                         int64(8) -> ZI_LIST_NODES_SETTINGSONLY 0x08
%                           Returns only nodes which are marked
%                           as setting
%                         int64(16) -> ZI_LIST_NODES_STREAMINGONLY 0x10
%                           Returns only streaming nodes
%                         int64(32) -> ZI_LIST_NODES_SUBSCRIBEDONLY 0x20
%                           Returns only subscribed nodes
%                 Returns a list of nodes with description found at the specified
%                 path. Flags may also be combined, e.g., set flags to bitor(1, 2)
%                 to return paths recursively and printed as absolute paths.
%
%   result = ziDAQ('listNodesJSON', path, flags);
%                 path (string) = Node path or partial path, e.g.,
%                          '/dev100/demods/'.
%                 flags (int64) = Define which nodes should be returned, set the
%                         following bits to obtain the described behavior.
%                         They are the same as for listNodes(), except that
%                         0x01, 0x02 and 0x04 are enforced:
%                         int64(8) -> ZI_LIST_NODES_SETTINGSONLY 0x08
%                           Returns only nodes which are marked
%                           as setting
%                         int64(16) -> ZI_LIST_NODES_STREAMINGONLY 0x10
%                           Returns only streaming nodes
%                         int64(32) -> ZI_LIST_NODES_SUBSCRIBEDONLY 0x20
%                           Returns only subscribed nodes
%                         int64(64) -> ZI_LIST_NODES_BASECHANNEL 0x40
%                           Return only one instance of a node in case of multiple
%                           channels
%                         int64(128) -> ZI_LIST_NODES_GETONLY 0x80
%                           Return only nodes which can be used with the get
```

```
%                             command
%                   Returns a list of nodes with description found at the specified
%                   path as a JSON formatted string. Only UHF and MF devices support
%                   this functionality. Flags may also be combined, e.g., set flags
%                   to bitor(1, 2) to return paths recursively and printed as
%                   absolute paths.
%
%   result = ziDAQ('help', path);
%                   path (string) = Node path or partial path, e.g.,
%                            '/dev100/demods/'.
%                   Returns a formatted description of the nodes in the supplied path.
%                   Only UHF and MF devices support this functionality.
%
%   result = ziDAQ('getSample', path);
%                   path (string) = Node path
%                   Returns a single demodulator sample (including
%                   DIO and AuxIn). For more efficient data recording
%                   use the subscribe and poll functions.
%
%   result = ziDAQ('getAuxInSample', path);
%                   path (string) = Node path
%                   Returns a single auxin sample. Note, the auxin data
%                   is averaged in contrast to the auxin data embedded
%                   in the demodulator sample.
%
%   result = ziDAQ('getDIO', path);
%                   path (string) = Node path.
%                   Returns a single DIO sample.
%
%   result = ziDAQ('getDouble', path);
%                   path (string) = Node path
%
%   result = ziDAQ('getComplex', path);
%                   path (string) = Node path
%
%   result = ziDAQ('getInt', path);
%                   path (string) = Node path
%
%   result = ziDAQ('getByte', path);
%                   path (string) = Node path
%
%   result = ziDAQ('getString', path);
%                   path (string) = Node path
%
%            ziDAQ('setDouble', path, value);
%                   path (string) = Node path
%                   value (double) = Setting value
%
%            ziDAQ('setComplex', path, value);
%                   path (string) = Node path
%                   value (complex double) = Setting value
%
%            ziDAQ('syncSetDouble', path, value);
%                   Deprecated, see the 'sync' command.
%                   path (string) = Node path
%                   value (double) = Setting value
%
%            ziDAQ('setInt', path, value);
%                   path (string) = Node path
%                   value (int64) = Setting value
%
%            ziDAQ('syncSetInt', path, value);
%                   Deprecated, see the 'sync' command.
%                   path (string) = Node path
%                   value (int64) = Setting value
%
%            ziDAQ('setByte', path, value);
```

```
%                    path (string) = Node path
%                    value (double) = Setting value
%
%              ziDAQ('setString', path, value);
%                    path (string) = Node path
%                    value (string) = Setting value
%
%              ziDAQ('syncSetString', path, value);
%                    path (string) = Node path
%                    value (string) = Setting value
%
%              ziDAQ('asyncSetString', path, value);
%                    path (string) = Node path
%                    value (string) = Setting value
%
%              ziDAQ('setVector', path, value);
%                    path (string) = Vector node path
%                    value (vector of (u)int8, (u)int16, (u)int32, (u)int64,
%                           float, double; or string) = Setting value
%
%              ziDAQ('subscribe', path);
%                    path (string) = Node path
%                    Subscribe to the specified path to receive streaming data
%                    or setting data if changed. Use either 'poll' command to
%                    obtain the subscribed data.
%
%              ziDAQ('unsubscribe', path);
%                    path (string) = Node path
%                    Unsubscribe from the node paths specified via 'subscribe'.
%                    Use a wildcard ('*') to unsubscribe from all data.
%
%              ziDAQ('getAsEvent', path);
%                    path (string) = Node path. Note: Wildcards and paths referring
%                                    to streaming nodes are not permitted.
%                    Triggers a single event on the path to return the current
%                    value. The result can be fetched with the 'poll' or 'pollEvent'
%                    command.
%
%              ziDAQ('update');
%                    Detect HF2 devices connected to the USB. On Windows this
%                    update is performed automatically.
%
%              ziDAQ('get', path, [flags]);
%                    path (string) = Node path
%                    Gets a structure of the node data from the specified
%                    branch. High-speed streaming nodes (e.g. /devN/demods/0/sample)
%                    are not returned. Wildcards (*) may be used.
%                    Note: Flags are ignored for a path that specifies one or
%                          more leaf nodes.
%                    Specifying flags is mandatory if an empty set would be returned
%                    given the default flags (settingsonly).
%                    [flags] (uint32) = Specify which types of node to include
%                    in the result. Allowed:
%                          ZI_LIST_NODES_SETTINGSONLY = 8 (default)
%                          ZI_LIST_NODES_ALL = 0 (all nodes)
%                          Moreover, all flags supported by listNodes() can be used.
%
%              ziDAQ('flush');
%                    Deprecated, see the 'sync' command.
%                    Flush all data in the socket connection and API buffers.
%                    Call this function before a subscribe with subsequent poll
%                    to get rid of old streaming data that might still be in
%                    the buffers.
%
%              ziDAQ('echoDevice', device);
%                    Deprecated, see the 'sync' command.
%                    device (string) = device serial, e.g. 'dev100'.
```

```
%                  Sends an echo command to a device and blocks until
%                  answer is received. This is useful to flush all
%                  buffers between API and device to enforce that
%                  further code is only executed after the device executed
%                  a previous command.
%
%            ziDAQ('sync');
%                  Synchronize all data paths. Ensures that get and poll
%                  commands return data which was recorded after the
%                  setting changes in front of the sync command. This
%                  sync command replaces the functionality of all 'syncSet*',
%                  'flush', and 'echoDevice' commands.
%
%            ziDAQ('programRT', device, filename);
%                  device (string) = device serial, e.g. 'dev100'.
%                  filename (string) = filename of RT program.
%                  HF2 devices only; writes down a real-time program. Requires
%                  the Real time Option must be available for the specified
%                  HF2 device.
%
%   result = ziDAQ('secondsTimeStamp', [timestamps]);
%                  timestamps (uint64) = vector of uint64 device ticks
%                  Deprecated. In order to convert timestamps to seconds divide the
%                  timestamps by the value of the instrument's clockbase device node,
%                  e.g., /dev99/clockbase.
%                  [Converts a timestamp vector of uint64 ticks
%                  into a double vector of timestamps in seconds (HF2 Series).]
%
% Synchronous Interface
%
%            ziDAQ('poll', duration, timeout, [flags]);
%                  duration (double) = Time in [s] to continuously check for value
%                                      changes in subscribed nodes before
%                                      returning
%                  timeout (int64)   = Poll timeout in [ms]; recommended: 10 ms
%                  [flags] (uint32)  = Flags specifying data polling properties
%                            Bit[0] FILL : Fill data loss holes
%                            Bit[2] THROW : Throw if data loss is detected (only
%                                   possible in combination with DETECT).
%                            Bit[3] DETECT: Just detect data loss holes.
%                  Continuously check for value changes (by calling pollEvent) in
%                  all subscribed nodes for the specified duration and return the
%                  data. If no value change occurs in subscribed nodes before
%                  duration + timeout, poll returns no data. This function call is
%                  blocking (it is synchronous). However, since all value changes
%                  are returned since either subscribing to the node or the last
%                  poll (assuming no buffer overflow has occurred on the Data
%                  Server), this function may be used in a quasi-asynchronous
%                  manner to return data spanning a much longer time than the
%                  specified duration. The timeout parameter is only relevant when
%                  communicating in a slow network. In this case it may be set to
%                  a value larger than the expected round-trip time in the
%                  network.
%
%   result = ziDAQ('pollEvent', timeout);
%                  timeout (int64) = Poll timeout in [ms]
%                  Return the value changes that occurred in one single subscribed
%                  node. This is a low-level function. The poll function is better
%                  suited in nearly all cases.
%
%% LabOne API Modules
% Shared Interface (common for all modules)
%
%   result = ziDAQ('listNodes', handle, path, flags);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Module parameter path
```

```
%                  flags (int64) = Define which module parameters paths should be
%                          returned, set the following bits to obtain the
%                          described behaviour:
%                  flags = int64(0) -> ZI_LIST_NODES_ALL 0x00
%                            The default flag, returning a simple
%                            listing of the given path
%                          int64(1) -> ZI_LIST_NODES_RECURSIVE 0x01
%                            Returns the paths recursively
%                          int64(2) -> ZI_LIST_NODES_ABSOLUTE 0x02
%                            Returns absolute paths
%                          int64(4) -> ZI_LIST_NODES_LEAVESONLY 0x04
%                            Returns only paths that are leaves,
%                            which means the they are at the
%                            outermost level of the tree.
%                          int64(8) -> ZI_LIST_NODES_SETTINGSONLY 0x08
%                            Returns only paths which are marked
%                            as setting
%                  Flags may also be combined, e.g., set flags to bitor(1, 2)
%                  to return paths recursively and printed as absolute paths.
%
%   result = ziDAQ('listNodesJSON', handle, path, flags);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Module parameter path
%                  flags (int64) = Define which module parameters paths should be
%                          returned, set the following bits to obtain the
%                          described behaviour:
%                  flags = int64(0) -> ZI_LIST_NODES_ALL 0x00
%                            The default flag, returning a simple
%                            listing of the given path
%                          int64(1) -> ZI_LIST_NODES_RECURSIVE 0x01
%                            Returns the paths recursively
%                          int64(2) -> ZI_LIST_NODES_ABSOLUTE 0x02
%                            Returns absolute paths
%                          int64(4) -> ZI_LIST_NODES_LEAVESONLY 0x04
%                            Returns only paths that are leaves,
%                            which means the they are at the
%                            outermost level of the tree.
%                          int64(8) -> ZI_LIST_NODES_SETTINGSONLY 0x08
%                            Returns only paths which are marked
%                            as setting
%                  Returns a list of nodes with description found at the specified
%                  path as a JSON formatted string. Flags may also be combined.
%
%            ziDAQ('help', handle, [path]);
%                  path (string) = Module parameter path
%                  Returns a formatted description of the nodes in the supplied path.
%
%            ziDAQ('subscribe', handle, path);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Node path to process data received from the
%                           device. Use wildcard ('*') to select all.
%                  Subscribe to device nodes. Call multiple times to
%                  subscribe to multiple node paths. After subscription the
%                  processing can be started with the 'execute'
%                  command. During the processing paths can not be
%                  subscribed or unsubscribed.
%
%            ziDAQ('unsubscribe', handle, path);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Node path to process data received from the
%                           device. Use wildcard ('*') to select all.
%                  Unsubscribe from one or several nodes. During the
%                  processing paths can not be subscribed or
%                  unsubscribed.
```

```
%
%            ziDAQ('getInt', handle, path);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Path string of the module parameter. Must
%                           start with the module name.
%                  Get integer module parameter. Wildcards are not supported.
%
%            ziDAQ('getDouble', handle, path);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Path string of the module parameter. Must
%                           start with the module name.
%                  Get floating point double module parameter. Wildcards are not
%                  supported.
%
%            ziDAQ('getString', handle, path);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Path string of the module parameter. Must
%                           start with the module name.
%                  Get string module parameter. Wildcards are not supported.
%
%            ziDAQ('get', handle, path);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Path string of the module parameter. Must
%                           start with the module name.
%                  Get module parameters. Wildcards are supported, e.g. 'sweep/*'.
%
%            ziDAQ('set', handle, path, value);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  path (string) = Path string of the module parameter. Must
%                           start with the module name.
%                  value = The value to set the module parameter to, see the list
%                           of module parameters for the correct type.
%                  Set the specified module parameter value. Use 'help' to learn more
%                  about available parameters.
%
%            ziDAQ('execute', handle);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  Start the module thread. Subscription or unsubscription
%                  is not possible until the module is finished.
%
%   result = ziDAQ('finished', handle);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  Returns 1 if the processing is finished, otherwise 0.
%
%   result = ziDAQ('read', handle);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  Read out the recorded data; transfer the module data to
%                  Matlab.
%
%            ziDAQ('finish', handle);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  Stop executing. The thread may be restarted by
%                  calling 'execute' again.
%
%   result = ziDAQ('progress', handle);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  Report the progress of the measurement with a number
```

```
%                  between 0 and 1.
%
%            ziDAQ('clear', handle);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the module class.
%                  Stop the module's thread, Release memory and resources. This
%                  command is especially important if modules are created
%                  repetitively in a while or for loop, in order to prevent
%                  excessive memory and resource consumption.
%
%
%% Sweep Module
%
%   handle = ziDAQ('sweep', timeout);
%                  timeout = Poll timeout in [ms] - DEPRECATED, ignored
%                  Creates a sweep class. The thread is not yet started.
%                  Before the thread start subscribe and set command have
%                  to be called. To start the real measurement use the
%                  execute function.
%
%
%% Device Settings Module
%
%   handle = ziDAQ('deviceSettings', timeout);
%                  timeout = Poll timeout in [ms] - DEPRECATED, ignored
%                  Creates a device settings class for saving/loading device
%                  settings to/from a file. Before starting the module, set the path,
%                  filename and command parameters. To run the command, use the
%                  execute function.
%
%
%% PLL Advisor Module, DEPRECATED (use PID Advisor instead)
%
%   The PLL advisor module for the UHF is removed and fully replaced
%   by the generic PID advisor module for all Zurich Instruments devices.
%
%% PID Advisor Module
%
%   handle = ziDAQ('pidAdvisor', timeout);
%                  timeout = Poll timeout in [ms] - DEPRECATED, ignored
%                  Creates a PID Advisor class for simulating the PID in the
%                  device. Before the thread start, set the command parameters,
%                  call execute() and then set the "calculate" parameter to start
%                  the simulation.
%
%
%% AWG Module
%
%   handle = ziDAQ('awgModule');
%                  Creates an AWG compiler class for compiling the AWG sequence and
%                  pattern downloaded to the device .
%
%
%% Impedance Module
%
%   handle = ziDAQ('impedanceModule');
%                  Creates a impedance class for executing a user compenastion.
%
%
%% Scope Module
%
%   handle = ziDAQ('scopeModule');
%                  handle = Matlab handle (reference) specifying an instance of
%                           the DataAcquisitionModule class.
%                  Create an instance of the Scope Module class
%                  and return a Matlab handle with which to access it.
%
```

```
%
%% Multi-Device Sync Module
%
%   handle = ziDAQ('multiDeviceSyncModule');
%                  handle = Matlab handle (reference) specifying an instance of
%                           the DataAcquisitionModule class.
%                  Create an instance of the Multi-Device Sync Module class
%                  and return a Matlab handle with which to access it.
%
%
%% Data Acquisition Module
%
%   handle = ziDAQ('dataAcquisitionModule');
%                  handle = Matlab handle (reference) specifying an instance of
%                           the DataAcquisitionModule class.
%                  Create an instance of the Data Acquisition Module class
%                  and return a Matlab handle with which to access it.
%                  Before the thread can actually be started (via 'execute'):
%                  - the desired data to record must be specified via the module's
%                    'subscribe' command,
%                  - the device serial (e.g., dev100) that will be used must be
%                    set.
%                  The real measurement is started upon calling the 'execute'
%                  function. After that the module will start recording data and
%                  verifying for incoming triggers.
%                  Force a trigger to manually record one duration of the
%                  subscribed data.
%
%
%% Precompensation Advisor Module
%
%   handle = ziDAQ('precompensationAdvisor');
%                  handle = Matlab handle (reference) specifying an instance of
%                           the DataAcquisitionModule class.
%                  Create an instance of the Precompensation Advisor Module class
%                  and return a Matlab handle with which to access it.
%
%
%% Debugging Functions
%
%            ziDAQ('setDebugLevel', debuglevel);
%                  debuglevel (int) = Debug level (trace:0, debug:1, info:2,
%                  status:3, warning:4, error:5, fatal:6).
%                  Enables debug log and sets the debug level.
%
%            ziDAQ('writeDebugLog', severity, message);
%                  severity (int) = Severity (trace:0, debug:1, info:2, status:3,
%                  warning:4, error:5, fatal:6).
%                  message (str) = Message to output to the log.
%                  Outputs message to the debug log (if enabled).
%
%            ziDAQ('logOn', flags, filename, [style]);
%                  flags = LOG_NONE:             0x00000000
%                          LOG_SET_DOUBLE:       0x00000001
%                          LOG_SET_INT:          0x00000002
%                          LOG_SET_BYTE:         0x00000004
%                          LOG_SET_STRING:       0x00000008
%                          LOG_SYNC_SET_DOUBLE:  0x00000010
%                          LOG_SYNC_SET_INT:     0x00000020
%                          LOG_SYNC_SET_BYTE:    0x00000040
%                          LOG_SYNC_SET_STRING:  0x00000080
%                          LOG_GET_DOUBLE:       0x00000100
%                          LOG_GET_INT:          0x00000200
%                          LOG_GET_BYTE:         0x00000400
%                          LOG_GET_STRING:       0x00000800
%                          LOG_GET_DEMOD:        0x00001000
%                          LOG_GET_DIO:          0x00002000
```

```
%                          LOG_GET_AUXIN:        0x00004000
%                          LOG_GET_COMPLEX:      0x00008000
%                          LOG_LISTNODES:        0x00010000
%                          LOG_SUBSCRIBE:        0x00020000
%                          LOG_UNSUBSCRIBE:      0x00040000
%                          LOG_GET_AS_EVENT:     0x00080000
%                          LOG_UPDATE:           0x00100000
%                          LOG_POLL_EVENT:       0x00200000
%                          LOG_POLL:             0x00400000
%                          LOG_ALL :             0xffffffff
%                  filename = Log file name
%                  [style] = LOG_STYLE_TELNET: 0 (default)
%                            LOG_STYLE_MATLAB: 1
%                            LOG_STYLE_PYTHON: 2
%                  Log all API commands sent to the Data Server. This is useful
%                  for debugging.
%
%            ziDAQ('logOff');
%                  Turn of message logging.
%
%
%% SW Trigger Module (this module will be made deprecated in a future release - new
%  users should use the DAQ Module instead).
%
%   handle = ziDAQ('record' duration, timeout);
%                  duration (double) = The module's internal buffersize to use when
%                                      recording data [s]. The recommended size is
%                                      2*/0/duration parameter. Note that
%                                      this can be modified via the
%                                      buffersize parameter.
%                                      DEPRECATED, set 'buffersize' param instead.
%                  timeout (int64) = Poll timeout [ms]. - DEPRECATED, ignored
%                  Create an instance of the ziDAQRecorder and return a Matlab
%                  handle with which to access it.
%                  Before the thread can actually be started (via 'execute'):
%                  - the desired data to record must be specified via the module's
%                    'subscribe' command,
%                  - the device serial (e.g., dev100) that will be used must be
%                    set.
%                  The real measurement is started upon calling the 'execute'
%                  function. After that the trigger will start recording data and
%                  verifying for incoming triggers.
%
%            ziDAQ('trigger', handle);
%                  handle = Matlab handle (reference) specifying an instance of
%                           the ziDAQRecorder class.
%                  Force a trigger to manually record one duration of the
%                  subscribed data.
%
%
%% Spectrum Module (this module will be made deprecated in a future release - new
%  users should use the DAQ Module instead).
%
%   handle = ziDAQ('zoomFFT', timeout);
%                  timeout = Poll timeout in [ms] - DEPRECATED, ignored
%                  Creates a zoom FFT class. The thread is not yet started.
%                  Before the thread start subscribe and set command have
%                  to be called. To start the real measurement use the
%                  execute function.
%
```

Chapter 5. Python Programming

The Zurich Instruments LabOne Python API is distributed as the `zhinst` Python package via PyPi, the official third-party software repository for Python. The `zhinst` package contains the `ziPython` binary extension that is used to communicate with Zurich Instruments data servers and devices. It allows users to configure and stream data from their instrument directly into a Python programming environment using Python's own native data structures and `numpy` arrays.

This chapter aims to help you get started using the Zurich Instruments LabOne Python API to control your instrument, please refer to:

- Section 5.1 for help Installing the LabOne Python API.
- Section 5.2 for help Getting Started with the LabOne Python API and Running the Examples.
- Section 5.3 for LabOne Python API Tips and Tricks.
- Section 5.4 for the LabOne Python API (ziPython) Command Reference.

About Python

Python is open source software, freely available for download from Python's official website. Python is a high-level programming language with an extensive standard library renowned for its "batteries included" approach. Combined with the `numpy` package for scientific computing, Python is a powerful computational tool for scientists that does not require an expensive software license.

This chapter and the provided examples are not intended to be a Python tutorial. For help getting started with Python itself, see either the Python Tutorial or one of the many online resources, for example, the learnpython.org. The Interactive Python Course is an interesting resource for those already familiar with Python basics.

5.1. Installing the LabOne Python API

This section lists detailed requirements. In most cases, installing the LabOne Python API should be as simple as searching for and installing the `zhinst` package in your Python distribution's package manager or running the command-line command:

```
pip install zhinst
```

5.1.1. Requirements

The following requirements must be fulfilled in order to install and use the LabOne Python API:

1. One of the following supported platforms and Python versions:
   a. 32 or 64-bit Windows with a Python 2.7, 3.5, 3.6 or 3.7 installation.
   b. 64-bit Linux with a Python 2.7, 3.5, 3.6 or 3.7 installation.
   c. 64-bit Mac OS X and the system Python 2.7 (shipped pre-installed with OS X; other Python installations are not supported). The Data Server, which is unavailable on OS X, must run remotely on either an instrument or on a separate Windows or Linux PC.
2. The `pip` Python package, Python's most popular package management system.
3. The `numpy` Python package (automatically installed by `pip` if `zhinst` is installed over the internet).

   Although the newest version of `numpy` is recommended, the `zhinst` package supports the following `numpy` versions:

   Python 2.7: >=1.6

   Python 3.5: >=1.10

   Python 3.6: >=1.12

   Python 3.7: >=1.14
4. The correct version of the `zhinst` Python package for the target Python version and platform (automatically detected by `pip` if `zhinst` is installed over the internet).

   Note, it's necessary to first uninstall/remove `zhinst` when down or upgrading to release 14.08 and it's recommend to first uninstall `zhinst` when down or upgrading to release 18.12. See below for more details.

Upgrading to the LabOne Python API release 14.08

Important: If you your system already has an existing `ziPython` installation older than version 14.08, please be sure to either manually uninstall `ziPython` or manually remove the existing `zhinst` installation folder. This is due to improvements in the `zhinst` package structure in 14.08 (examples for different device classes are now organized in separate module/sub-directories) and the Python installer simply overwrites the existing installation, leading to a duplication of some files. For help locating `[PYTHONROOT]\lib\site-packages\zhinst\` on your system, please see the section called “Locating the `zhinst` Installation Folder and Examples”.

Packaging changes to the LabOne Python API in 18.12

The LabOne Python API prior to LabOne software release 18.12 was distributed as an MSI installer (Windows) or tarball (Linux, Mac), downloadable from the Zurich Instruments download page. From LabOne software release 18.12 onwards the LabOne Python API is distributed as a

Python wheel which can be either downloaded via pip (or manually) from PyPi as the `zhinst` Python package. If installing `zhinst` from a wheel for the first time it is recommended to uninstall the `ziPython` installer first in Windows. On Linux, if `zhinst` was installed using pip, it's recommended to first uninstall the old installation before installing the wheel:

```
pip uninstall ziPython
```

Note, in releases prior to 18.12, the Python API package was called `ziPython`. Since the top-level package is actually called `zhinst` and `ziPython` is the binary extension contained within it, the Python API package was renamed in 18.12 to `zhinst` for consistency.

5.1.2. Recommended Python Packages

The following Python packages can additionally be useful for programming with the LabOne Python API:

1. `matplotlib` - recommended to plot the output from many of `zhinst`'s examples.
2. `scipy` - recommended to load data saved from the LabOne UI in binary Matlab format (.mat).

5.1.3. Installation (Windows, Linux, Mac OS X)

The following installs the `zhinst` package from PyPi over the internet locally for the user performing the installation and does not require administrator rights. If the target PC for installation does not have access to the internet, please additionally see Offline Installation.

1. Determine the path to the target Python installation. If the Python executable is not in your path, you can obtain the full path to your Python executable as follows:

   ```
   from __future__ import print_function
   import sys
   print(sys.executable)
   ```

   On Windows this will print something similar to:

   ```
   C:\Python27\python.exe
   ```

2. Install the `zhinst` package. Using the full path to the Python executable, `PATH_TO_PYTHON_EXE`, as determined above in Step 1, open a command prompt and run Python with the `pip` module to install the `zhinst` package:

   ```
   PATH_TO_PYTHON_EXE -m pip install --user zhinst
   ```

   The `--user` flag tells `pip` to install the `zhinst` package locally for the user executing the command. Normally administrator rights are required in order to install the `zhinst` package for all users of the computer, for more information see below.

Global Installation as Administrator

In order to install the `zhinst` package for all users of the target Python installation, it must be installed using administrator rights and `pip`'s `--user` command-line flag should be not be used. On Windows, Step 2 must be ran in a command prompt opened with administrator rights, this is normally achieved by doing a mouse right-click on the shortcut to `cmd.exe` and selecting "Run as administrator". On Linux, the package can be installed by preceding the installation step by "`sudo`".

5.1.4. Offline Installation

To install `zhinst` package on a computer without access to the internet, please download the correct wheel file for your system and Python version from https://pypi.org/project/zhinst/ from another computer and copy it to the offline computer. If the target Python installation is Python 2.7 on a Linux 64-bit computer, please see Determining the correct Unicode version for Python 2.7 distributions below. If the `numpy` package is not yet installed, it can also be downloaded from either https://pypi.org/project/numpy/ or from Christoph Gohlke's pythonlibs page. Then the wheels can be installed as described above using `pip`, except that the name of the wheel file must be provided as the last argument to `pip` instead of the name of the package, `zhinst`.

Determining the correct Unicode version for Python 2.7 distributions

In order to determine which version of Unicode your Python 2.7 distribution uses, please type the following commands in the interactive shell of your target Python distribution:

```
import sys
print sys.maxunicode
```

If the last command prints:

- `65535`, use the UCS2 version of `zhinst`:

  `zhinst-xx.xx.xxxxx-cp27-cp27m-manylinux1_x86_64.whl`
- `1114111`, use the UCS4 version of `zhinst` (note the additional "u"):

  `zhinst-xx.xx.xxxxx-cp27-cp27mu-manylinux1_x86_64.whl`

5.2. Getting Started with the LabOne Python API

This section introduces the user to the LabOne Python API.

5.2.1. Contents of the LabOne Python API

Alongside the binary extension `ziPython` for interfacing with Zurich Instruments Data Servers and devices, the LabOne Python API includes utility functions and examples. See:

- Section 5.4.1 to see which examples are available in `zhinst`.
- Section 5.4.2 to see which utility functions are available in `zhinst`.

5.2.2. Using the Built-in Documentation

`ziPython`'s built-in documentation can be accessed using the `help` command in a python interactive shell:

- On module level:

```
>>> import zhinst.ziPython as ziPython
>>> help(ziPython)
```

- On class level, for example, for the Sweeper Module:

```
>>> import zhinst.ziPython as ziPython
>>> help(ziPython.SweeperModule)
```

- On function level, for example, for the `ziDAQServer` `poll` method:

```
>>> import zhinst.ziPython as ziPython
>>> help(ziPython.ziDAQServer.poll)
```

See Section 5.4, LabOne Python API (ziPython) Command Reference for a printer friendly version of the built-in documentation.

5.2.3. Running the Examples

Prerequisites for running the Python examples:

1. The `zhinst` package is installed as described above in Section 5.1.
2. The Data Server program is running and the instrument is discoverable, this is the case if the instrument can be seen in the User Interface.
3. Signal Output 1 of the instrument is connected to Signal Input 1 via a BNC cable; many of the Python examples measure on this hardware channel.

It's also recommended to install the `matplotlib` Python package in order to plot the data obtained in many of the examples, see Section 5.1.2.

The API examples are available in the module `zhinst.examples`, which is organized into sub-modules according to the target Instrument class:

- `zhinst.examples.common`: examples compatible with any class of instrument,
- `zhinst.examples.hdawg`: examples only compatible with HDAWG Instruments,
- `zhinst.examples.hf2`: examples only compatible with HF2 Series Instruments,
- `zhinst.examples.uhf`: examples only compatible with the UHF Lock-in Amplifier.

All the examples follow the same structure and take one input argument: The device ID of the instrument to run the example with. The recommended way to run a `zhinst` example is to import

the example's module in an interactive shell and call the `run_example()` function. For example, to run the Data Acquisition Module FFT example:

```
import zhinst.examples.common.example_data_acquisition_edge_fft as example
example.run_example('dev123', do_plot=True);
```

which will produce some output in the Python shell, such as:

```
Discovered device `dev196`: HF2LI with options MFK, PLL, MOD, RTK, PID, WEB.
Creating an API session for device `dev196` on `127.0.0.1`, `8005` with apilevel `1`.
Setting trigger/0/level to 0.221.
Setting trigger/0/hysteresis 0.011.
Data Acquisition Module progress (acquiring 10 triggers): 100.00%.
Trigger is finished.
Data Acquisition's read() returned 10 signal segments.
```

Specify `do_plot=False` if `matplotlib` is unavailable. If `matplotlib` is installed, most examples will also plot the retrieved data, see Figure 5.1 for an example. If you encounter an error message please ensure that the above prerequisites are fulfilled.

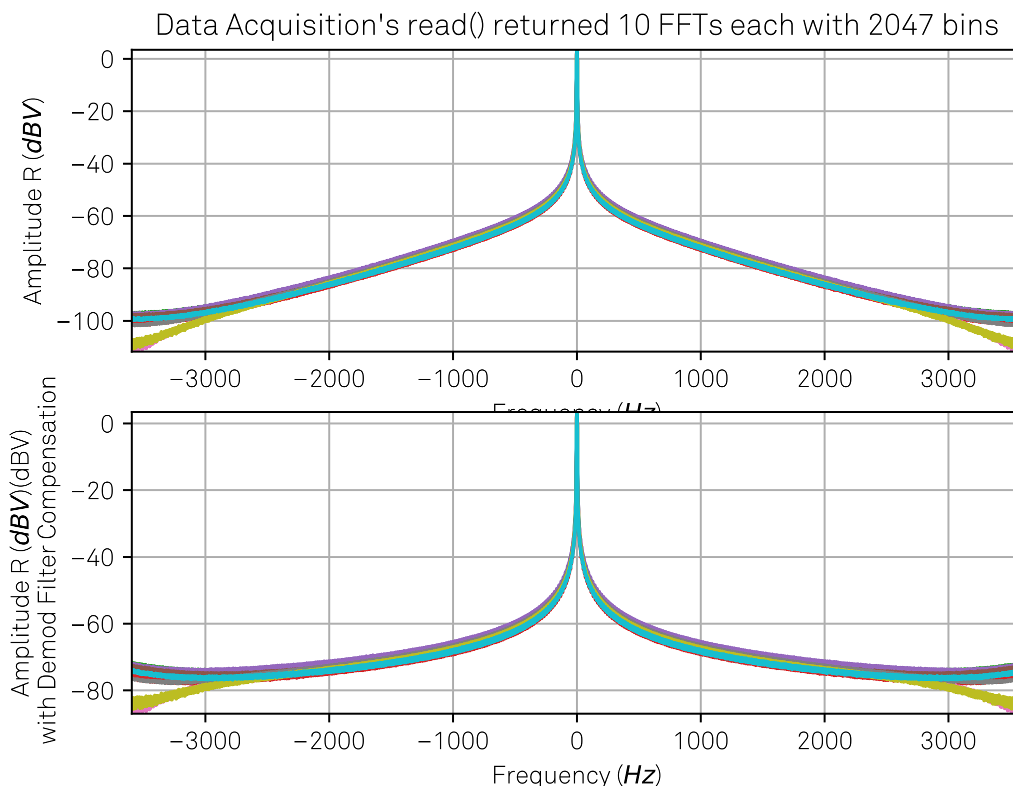


Figure 5.1. The plot produced by the LabOne Python API example demonstrating how to record the Fast Fourier Transform (FFT) applied to demodulator data using the Data Acquisition Module (`example_data_acquisition_edge_fft.py`).

Exploring which Examples are available

Python's help system can be used to see which examples are available for a particular device class; when help is called on the module the available examples are listed under the "Package Contents" section.

Examples for all Instrument Classes

Here is a list of examples that can run with any instrument classes in the `zhinst.examples.common` package:

```
>>> help('zhinst.examples.common')

Help on package zhinst.examples.common in zhinst.examples:

NAME
    zhinst.examples.common - Zurich Instruments LabOne Python API Examples (for any
 instrument class).

PACKAGE CONTENTS
    example_autoranging_impedance
    example_connect
    example_connect_config
    example_data_acquisition_continuous
    example_data_acquisition_edge
    example_data_acquisition_edge_fft
    example_data_acquisition_grid
    example_data_acquisition_trackingedge
    example_multidevice_data_acquisition
    example_multidevice_sweep
    example_pid_advisor_pll
    example_poll
    example_poll_impedance
    example_save_device_settings_expert
    example_save_device_settings_simple
    example_scope
    example_scope_dig_dualchannel
    example_scope_dig_segmented
    example_scope_dig_stream
    example_sweeper

DATA
    __all__ = ['example_autoranging_impedance', 'example_connect', 'exampl...

FILE
    /home/ci/.pyenv/versions/3.7.1/lib/python3.7/site-packages/zhinst/examples/
common/__init__.py
```

Examples for HDAWG Instruments

Here is a list of the examples available for HDAWG Instruments in the `zhinst.examples.hdawg` package:

```
>>> help('zhinst.examples.hdawg')

Help on package zhinst.examples.hdawg in zhinst.examples:

NAME
    zhinst.examples.hdawg - Zurich Instruments LabOne Python API Examples for the
 HDAWG.

PACKAGE CONTENTS
    example_awg
    example_awg_sourcefile
    example_precompensation_curve_fit

DATA
    __all__ = ['example_awg', 'example_awg_sourcefile', 'example_precompen...

FILE
```

```
    /home/ci/.pyenv/versions/3.7.1/lib/python3.7/site-packages/zhinst/examples/hdawg/
__init__.py
```

Examples for HF2 Instruments

Here is a list of the examples available for HF2 Instruments in the `zhinst.examples.hf2` package:

```
>>> help('zhinst.examples.hf2')

Help on package zhinst.examples.hf2 in zhinst.examples:

NAME
    zhinst.examples.hf2 - Zurich Instruments LabOne Python API Examples for the HF2
 Lock-in Amplifier.

PACKAGE CONTENTS
    example_pid_advisor_pll
    example_scope

DATA
    __all__ = ['example_pid_advisor_pll', 'example_scope']

FILE
    /home/ci/.pyenv/versions/3.7.1/lib/python3.7/site-packages/zhinst/examples/hf2/
__init__.py
```

Examples for UHF Instruments

Here is a list of the examples available for UHF Instruments in the `zhinst.examples.uhf` package:

```
>>> help('zhinst.examples.uhf')

Help on package zhinst.examples.uhf in zhinst.examples:

NAME
    zhinst.examples.uhf - Zurich Instruments LabOne Python API Examples for the UHF
 Lock-in Amplifier.

PACKAGE CONTENTS
    example_awg
    example_awg_sourcefile
    example_boxcar

DATA
    __all__ = ['example_awg', 'example_awg_sourcefile', 'example_boxcar']

FILE
    /home/ci/.pyenv/versions/3.7.1/lib/python3.7/site-packages/zhinst/examples/uhf/
__init__.py
```

Locating the **zhinst** Installation Folder and Examples

The examples distributed with the `zhinst` package can serve as a starting point to program your own measurement needs. The example python files, however, are generally not installed in user space. In order to ensure that you have sufficient permission to edit the examples and that your modifications are not overwritten by a later upgrade of the `zhinst` package, please copy them to your own user space before editing them.

The examples are contained in a subfolder of the `zhinst` package installation folder

```
[PYTHONROOT]\lib\site-packages\zhinst\
```

If you are unsure about the location of your `PYTHONROOT`, the `__path__` attribute of the `zhinst` module can be used in order to determine its location, for example,

```
from __future__ import print_function
import zhinst
print zhinst.__path__
```

will output something similar to:

```
C:\Python27\lib\site-packages\zhinst
```

5.2.4. Using ziCore Modules in the LabOne Python API

In the LabOne Python API `ziCore` Modules are configured and controlled via an instance of the Module's class. This Module object is created using the relevant function from `ziPython.ziDAQServer`. For example, an instance of the Sweeper Module is created using `ziPython.ziDAQServer`'s `sweep()` function. As such, an API session must be instantiated first using `ziPython.ziDAQServer` (see Section 1.4.1 for more information about initializing API session) and then a sweeper object is created from instance of the API session as following:

```
>>> daq = ziPython.ziDAQServer('localhost', 8004, 6) # Create a connection to the
# Data Server ('localhost' means the Server is running on the same PC as the
# API client, use the device serial of the form 'mf-dev3000' if using an MF
 Instrument.
>>> sweeper = daq.sweep();
```

Note, that since creating a Module object without an API connection to the Data Server does not make sense, the Sweeper object is instantiated via the `sweep` method of the `ziDAQServer` class, not directly from the `SweeperModule` class.

The Module's parameters are configured using the Module's `set` method and specifying a `path`, `value` pair, for example:

```
>>> sweeper.set('sweep/start', 1.2e5);
```

The parameters can be read-back using the `get` method, which supports wildcards, for example:

```
>>> sweep_params = sweeper.get('sweep/*');
```

The variable `sweep_params` now contains a dictionary of all the Sweeper's parameters. The other main Module commands are similarly used, e.g., `sweeper.execute()`, to start the sweeper. See Section 3.1.2 for more help with Modules and a description of their parameters.

5.2.5. Enabling Logging in the LabOne Python API

Logging from the API is not enabled by default upon initializing a server session with `ziPython`, it must be enabled (after using `connect`) with the `setDebugLevel` command. For example,

```
>>> daq.setDebugLevel(0)
```

sets the API's logging level to 0, which provides the most verbose logging output. The other log levels are defined as following:

```
trace:0, debug:1, info:2, status:3, warning:4, error:5, fatal:6.
```

It is also possible for the user to write their own messages directly to `ziPythonwith` 's log using the `writeDebugLog` command. For example to write a log message of `info` severity level:

```
>>> daq.writeDebugLog(1, 'Hello log!')
```

On Windows the logs are located in the directory `C:\Users\[USER]\AppData\Local\Temp\Zurich Instruments\LabOne` Note that `AppData` is a hidden directory. The easiest way to find it is to open a File Explorer window and type the text `%AppData%\..` in the address bar, and navigate from there. The directory contains folders containing log files from various LabOne components, in particular, the `ziPythonLog` folder contains logs from the LabOne Python API. On Linux, the logs can be found at "/tmp/ziPythonLog_USERNAME", where "USERNAME" is the same as the output of the "whoami" command.

5.3. LabOne Python API Tips and Tricks

In this section some tips and tricks for working with the LabOne Python API are provided.

Data Structures returned by **ziPython**.

The output arguments that ziPython returns are designed to use the native data structures that Python users are familiar with and that reflect the data's location in the instruments node hierarchy. For example, when the poll command returns data from the instruments fourth demodulator (located in the node hierarchy as /dev123/demods/3/sample), the output argument contains a tree of nested dictionaries in which the data can be accessed by

```
data = daq.poll( poll_length, poll_timeout);
x = data['dev123']['demods']['4']['sample']['x'];
y = data['dev123']['demods']['4']['sample']['y'];
```

Tell **poll** to return a flat dictionary

By default, the data returned by poll is contained in a tree of nested dictionaries that closely mimics the tree structure of the instrument node hierarchy. By setting the optional fifth argument of poll to True, the data will be a flat dictionary. This can help avoid many nested if statements in order to check that the expected data was returned by poll. For example:

```
daq.subscribe('/dev123/demods/0/sample')
flat_dictionary_key = False
data = daq.poll(0.1, 200, 1, flat_dictionary_key)
if 'dev123' in data:
    if 'demods' in data['device']:
        if '0' in data['device']['demods']:
            # access the demodulator data:
            x = data['dev123']['demods']['0']['sample']['x']
            y = data['dev123']['demods']['0']['sample']['y']
```

Could be rewritten more concisely as:

```
daq.subscribe('/dev123/demods/0/sample')
flat_dictionary_key = True
data = daq.poll(0.1, 200, 1, flat_dictionary_key)
if '/dev123/demods/0/sample' in data:
    # access the demodulator data:
    x = data['/dev123/demods/0/sample']['x']
    y = data['/dev123/demods/0/sample']['y']
```

Use the Utility Routines to load Data saved from the LabOne UI and ziControl in Python.

The utilities package zhinst.utils contains several routines to help loading .csv or .mat files saved from either the LabOne User Interface or ziControl into Python. These functions are generally minimal wrappers around NumPy (genfromtxt()) or scipy (loadmat()) routines. However, the function load_labone_demod_csv() is optimized to load demodulator data saved in .csv format by the LabOne UI (since it specifies the .csv columns' dtypes explicitly) and the function load_zicontrol_zibin() can directly load data saved in binary format from ziControl. See Section 5.4.2 for reference documentation on these commands.

5.4. LabOne Python API (ziPython) Command Reference

The following reference documentation for ziPython is available in from within a python session using python's help (see Section 5.2.2) command; It is included here for convenience.

The documentation is grouped by module and class as following:

- Help for the `zhinst` Python Package
- Help for zhinst's Utility Functions
- Help for ziPython's `ziDiscovery` class
- Help for ziPython's `ziDAQServer` class
- Help for the `AwgModule` class
- Help for the `DataAcquisitionModule` class
- Help for the `DeviceSettingsModule` class
- Help for the `ImpedanceModule` class
- Help for the `MultiDeviceSyncModule` class
- Help for the `PidAdvisorModule` class
- Help for the `PrecompensationAdvisorModule` class
- Help for the `ScopeModule` class
- Help for the `SweeperModule` class

The following two modules will be marked as deprecated in a future release, they are however currently still maintained:

- Help for the `RecorderModule` class
- Help for the `ZoomFFTModule` class

5.4.1. Help for the **zhinst** Python Package

```
>>> help('zhinst')

Help on package zhinst:

NAME
    zhinst - Zurich Instruments LabOne Python API

DESCRIPTION
    Contains the API driver, utility functions and examples for Zurich Instruments
    devices.

PACKAGE CONTENTS
    examples (package)
    utils
    ziPython

DATA
    __all__ = ['ziPython', 'utils']

FILE
    /home/ci/.pyenv/versions/3.7.1/lib/python3.7/site-packages/zhinst/__init__.py
```

5.4.2. Help for zhinst's Utility Functions

```
>>> help('zhinst.utils')

Help on module zhinst.utils in zhinst:

NAME
    zhinst.utils - Zurich Instruments LabOne Python API Utility Functions.

DESCRIPTION
    This module provides basic utility functions for:

    - Creating an API session by connecting to an appropriate Data Server.

    - Detecting devices.

    - Loading and saving device settings.

    - Loading data saved by either the Zurich Instruments LabOne User Interface or
      ziControl into Python as numpy structured arrays.

FUNCTIONS
    api_server_version_check(daq)
        Issue a warning and return False if the release version of the API used in
 the session (daq) does not have the same
        release version as the Data Server (that the API is connected to). If the
 versions match return True.

        Args:

          daq (ziDAQServer): An instance of the ziPython.ziDAQServer class
            (representing an API session connected to a Data Server).

        Returns:

          Bool: Returns True if the versions of API and Data Server match, otherwise
 returns False.

    autoConnect(default_port=None, api_level=None)
        Try to connect to a Zurich Instruments Data Server with an attached
        available UHF or HF2 device.

        Important: autoConnect() does not support MFLI devices.

        Args:

          default_port (int, optional): The default port to use when connecting to
            the Data Server (specify 8005 for the HF2 Data Server and 8004 for the
            UHF Data Server).

          api_level (int, optional): The API level to use, either 1, 4 or 5. HF2 only
            supports Level 1, Level 5 is recommended for UHF and MFLI devices.

        Returns:

          ziDAQServer: An instance of the ziPython.ziDAQServer class that is used
            for communication to the Data Server.

        Raises:

          RunTimeError: If no running Data Server is found or no device is found
            that is attached to a Data Server.x

        If default_port is not specified (=None) then first try to connect to a HF2,
```

```
    if no server devices are found then try to connect to an UHF. This behaviour
    is useful for the API examples. If we cannot connect to a server and/or
    detect a connected device raise a RunTimeError.

    If default_port is 8004 try to connect to a UHF; if it is 8005 try to
    connect to an HF2. If no server and device is detected on this port raise
    a RunTimeError.

autoDetect(daq, exclude=None)
    Return a string containing the first device ID (not in the exclude list)
    that is attached to the Data Server connected via daq, an instance of the
    ziPython.ziDAQServer class.

    Args:

      daq (ziDAQServer): An instance of the ziPython.ziDAQServer class
        (representing an API session connected to a Data Server).

      exclude (list of str, optional): A list of strings specifying devices to
        exclude. autoDetect() will not return the name of a device in this
        list.

    Returns:

      A string specifying the first device ID not in exclude.

    Raises:

      RunTimeError: If no device was found.
      RunTimeError: If daq is not an instance of ziPython.ziDAQServer.

    Example:

      zhinst.utils
      daq = zhinst.utils.autoConnect()
      device = zhinst.utils.autoDetect(daq)

bw2tc(bandwidth, order)
    Convert the demodulator 3 dB bandwidth to its equivalent timeconstant for the
    specified demodulator order.

    Inputs:

      bandwidth (double): The demodulator 3dB bandwidth to convert.

      order (int): The demodulator order (1 to 8) for which to convert the
      bandwidth.

    Output:

      timeconstant (double): The equivalent demodulator timeconstant.

bwtc_scaling_factor(order)
    Return the appropriate scaling factor for bandwidth to timeconstant
    converstion for the provided demodulator order.

check_for_sampleloss(timestamps)
    Check whether timestamps are equidistantly spaced, it not, it is an
    indication that sampleloss has occurred whilst recording the demodulator
    data.

    This function assumes that the timestamps originate from continuously saved
    demodulator data, during which the demodulator sampling rate was not
    changed.

    Arguments:
```

```
          timestamp (numpy array): a 1-dimensional array containing
          demodulator timestamps

        Returns:

          idx (numpy array): a 1-dimensional array indicating the indices in
          timestamp where sampleloss has occurred. An empty array is returned in no
          sampleloss was present.

    convert_awg_waveform(wave1, wave2=None, markers=None)
        Converts one or multiple arrays with waveform data to the native AWG
        waveform format (interleaved waves and markers as uint16).

        Waveform data can be provided as integer (no conversion) or floating point
        (range -1 to 1) arrays.

        Arguments:

          wave1 (array): Array with data of waveform 1.
          wave2 (array): Array with data of waveform 2.
          markers (array): Array with marker data.

        Returns:

          The converted uint16 waveform is returned.

    create_api_session(device_serial, maximum_supported_apilevel,
 required_devtype='.*', required_options=None, required_err_msg='')
        Create an API session for the specified device.

        Args:

          device_serial (str): A string specifying the device serial number. For
            example, 'uhf-dev2123' or 'dev2123'.

          maximum_supported_apilevel (int): The maximum API Level that is supported
            by the code where the returned API session will be used. The maximum API
            Level you may use is defined by the device class. HF2 only supports API
            Level 1 and other devices support API Level 5. You should try to use the
            maximum level possible to enable extended API features.

         required_devtype (str): The required device type, e.g., 'HF2LI' or
           'MFLI'. This is given by the value of the device node
           '/devX/features/devtype' or the 'devicetype' discovery property. Raise an
           exception if the specified device_serial's devtype does not match the
           `required_devtype`.

         required_options (list of str|None): The required device option set. E.g.,
           ['MF', 'PID'].  This is given by the value of the device node
           '/devX/features/options' or the 'options' discovery property. Raise an
           exception if the specified device_serial's option set does contain the
           `required_options`.

         required_error_msg (str) : An additional error message to print if either
           the device specified by the `device_serial` is not the `required_devtype`
           or does not have the `required_options`.

        Returns:

          daq (ziDAQServer): An instance of the ziPython.ziDAQServer class
            (representing an API session connected to a Data Server).

          device (str): The device's ID, this is the string that specifies the
            device's node branch in the data server's node tree.


          props (dict): The device's discovery properties as returned by the
```

```
            ziDiscovery get() method.

    default_output_mixer_channel(discovery_props, output_channel=0)
        Return an instrument's default output mixer channel based on the specified
        `devicetype` and `options` discovery properties and the hardware output
        channel.

        This utility function is used by the ziPython examples and returns a node
        available under the /devX/sigouts/0/{amplitudes,enables}/ branches.

        Args:

          discovery_props (dict): A device's discovery properties as returned by
            ziDiscovery's get() method.

          output_channel (int, optional): The zero-based index of the hardware
            output channel for which to return an output mixer channel.

        Returns:

          output_mixer_channel (int): The zero-based index of an available signal
          output mixer channel.

        Raises:

          Exception: If an invalid signal input index was provided.

    devices(daq)
        Return a list of strings containing the device IDs that are attached to the
        Data Server connected via daq, an instance of the ziPython.ziDAQServer
        class. Returns an empty list if no devices are found.

        Args:

          daq (ziDAQServer): An instance of the ziPython.ziDAQServer class
            (representing an API session connected to a Data Server).

        Returns:

          A list of strings of connected device IDs. The list is empty if no devices
          are detected.

        Raises:

          RunTimeError: If daq is not an instance of ziPython.ziDAQServer.

        Example:

          import zhinst.utils
          daq = zhinst.utils.autoConnect()  # autoConnect not supported for MFLI
devices
          device = zhinst.utils.autoDetect(daq)

    disable_everything(daq, device)
        Put the device in a known base configuration: disable all extended
        functionality; disable all streaming nodes.

        Output:

          settings (list): A list of lists as provided to ziDAQServer's set()
          command. Each sub-list forms a nodepath, value pair. This is a list of
          nodes configured by the function and may be reused.

        Warning: This function is intended as a helper function for the API's
        examples and it's signature or implementation may change in future releases.

    get_default_settings_path(daq)
```

```
        Return the default path used for settings by the ziDeviceSettings module.

        Arguments:

          daq (instance of ziDAQServer): A ziPython API session.

        Returns:

          settings_path (str): The default ziDeviceSettings path.

    load_labone_csv(fname)
        Load a CSV file containing generic data as saved by the LabOne User
        Interface into a numpy structured array.

        Arguments:

          filename (str): The filename of the CSV file to load.

        Returns:

          sample (numpy ndarray): A numpy structured array of shape (num_points,)
          whose field names correspond to the column names in the first line of the
          CSV file. num_points is the number of lines in the CSV file - 1.

        Example:

          import zhinst.utils
          # Load the CSV file of PID error data (node: /dev2004/pids/0/error)
          data = zhinst.utils.load_labone_csv('dev2004_pids_0_error_00000.csv')
          import matplotlib.pyplot as plt
          # Plot the error
          plt.plot(data['timestamp'], data['value'])

    load_labone_demod_csv(fname, column_names=('chunk', 'timestamp', 'x', 'y',
'freq', 'phase', 'dio', 'trigger', 'auxin0', 'auxin1'))
        Load a CSV file containing demodulator samples as saved by the LabOne User
        Interface into a numpy structured array.

        Arguments:

          fname (file or str): The file or filename of the CSV file to load.

          column_names (list or tuple of str, optional): A list (or tuple) of column
          names to load from the CSV file. Default is to load all columns.

        Returns:

          sample (numpy ndarray): A numpy structured array of shape (num_points,)
          whose field names correspond to the column names in the first line of the
          CSV file. num_points is the number of lines in the CSV file - 1.

        Example:

          import zhinst.utils
          sample =
zhinst.utils.load_labone_demod_csv('dev2004_demods_0_sample_00000.csv',
('timestamp', 'x', 'y'))
          import matplotlib.pyplot as plt
          import numpy as np
          plt.plot(sample['timestamp'], np.abs(sample['x'] + 1j*sample['y']))

    load_labone_mat(filename)
        A wrapper function for loading a MAT file as saved by the LabOne User
        Interface with scipy.io's loadmat() function. This function is included
        mainly to document how to work with the data structure return by
        scipy.io.loadmat().
```

```
    Arguments:

      filename (str): the name of the MAT file to load.

    Returns:

      data (dict): a nested dictionary containing the instrument data as
      specified in the LabOne User Interface. The nested structure of ``data``
      corresponds to the path of the data's node in the instrument's node
      hierarchy.

    Further comments:

      The MAT file saved by the LabOne User Interface (UI) is a Matlab V5.0 data
      file. The LabOne UI saves the specified data using native Matlab data
      structures in the same format as are returned by commands in the LabOne
      Matlab API. More specifically, these data structures are nested Matlab
      structs, the nested structure of which correspond to the location of the
      data in the instrument's node hierarchy.

      Matlab structs are returned by scipy.io.loadmat() as dictionaries, the
      name of the struct becomes a key in the dictionary. However, as for all
      objects in MATLAB, structs are in fact arrays of structs, where a single
      struct is an array of shape (1, 1). This means that each (nested)
      dictionary that is returned (corresponding to a node in node hierarchy) is
      loaded by scipy.io.loadmat as a 1-by-1 array and must be indexed as
      such. See the ``Example`` section below.

      For more information please refer to the following link:
      http://docs.scipy.org/doc/scipy/reference/tutorial/io.html#matlab-structs

    Example:

      device = 'dev88'
      # See ``Further explanation`` above for a comment on the indexing:
      timestamp = data[device][0,0]['demods'][0,0]['sample'][0,0]['timestamp'][0]
      x = data[device][0,0]['demods'][0,0]['sample'][0,0]['x'][0]
      y = data[device][0,0]['demods'][0,0]['sample'][0,0]['y'][0]
      import matplotlib.pyplot as plt
      import numpy as np
      plt.plot(timestamp, np.abs(x + 1j*y))

      # If multiple demodulator's are saved, data from the second demodulator,
      # e.g., is accessed as following:
      x = data[device][0,0]['demods'][0,1]['sample'][0,0]['x'][0]

load_settings(daq, device, filename)
    Load a LabOne settings file to the specified device. This function is
    synchronous; it will block until loading the settings has finished.

    Arguments:

      daq (instance of ziDAQServer): A ziPython API session.

      device (str): The device ID specifying where to load the settings,
      e.g., 'dev123'.

      filename (str): The filename of the xml settings file to load. The
      filename can include a relative or full path.

    Raises:

      RunTimeError: If loading the settings times out.

    Examples:

      import zhinst.utils as utils
```

```
daq = utils.autoConnect()
dev = utils.autoDetect(daq)

# Then, e.g., load settings from a file in the current directory:
utils.load_settings(daq, dev, 'my_settings.xml')
# Then, e.g., load settings from the default LabOne settings path:
filename = 'default_ui.xml'
path = utils.get_default_settings_path(daq)
utils.load_settings(daq, dev, path + os.sep + filename)
```

```
load_zicontrol_csv(filename, column_names=('t', 'x', 'y', 'freq', 'dio',
'auxin0', 'auxin1'))
    Load a CSV file containing demodulator samples as saved by the ziControl
    User Interface into a numpy structured array.

    Arguments:

      filename (str): The file or filename of the CSV file to load.

      column_names (list or tuple of str, optional): A list (or tuple) of column
      names (demodulator sample field names) to load from the CSV file. Default
      is to load all columns.

    Returns:

      sample (numpy ndarray): A numpy structured array of shape (num_points,)
      whose field names correspond to the field names of a ziControl demodulator
      sample. num_points is the number of lines in the CSV file - 1.

    Example:

      import zhinst.utils
      sample = zhinst.utils.load_labone_csv('Freq1.csv', ('t', 'x', 'y'))
      import matplotlib.plt as plt
      import numpy as np
      plt.plot(sample['t'], np.abs(sample['x'] + 1j*sample['y']))
```

```
load_zicontrol_zibin(filename, column_names=('t', 'x', 'y', 'freq', 'dio',
'auxin0', 'auxin1'))
    Load a ziBin file containing demodulator samples as saved by the ziControl
    User Interface into a numpy structured array. This is for data saved by
    ziControl in binary format.

    Arguments:

      filename (str): The filename of the .ziBin file to load.

      column_names (list or tuple of str, optional): A list (or tuple) of column
      names to load from the CSV file. Default is to load all columns.

    Returns:

      sample (numpy ndarray): A numpy structured array of shape (num_points,)
      whose field names correspond to the field names of a ziControl demodulator
      sample. num_points is the number of sample points saved in the file.

    Further comments:

      Specifying a fewer names in ``column_names`` will not result in a speed-up
      as all data is loaded from the binary file by default.

    Example:

      import zhinst.utils
      sample = zhinst.utils.load_zicontrol_zibin('Freq1.ziBin')
      import matplotlib.plt as plt
      import numpy as np
```

```
    plt.plot(sample['t'], np.abs(sample['x'] + 1j*sample['y']))

parse_awg_waveform(wave_uint, channels=1, markers_present=False)
    Converts a received waveform from the AWG waveform node into floating point
    and separates its contents into the respective waves (2 waveform waves and 1
    marker wave), depending on the input.

    Arguments:

      wave (array): A uint16 array from the AWG waveform node.
      channels (int): Number of channels present in the wave.
      markers_present (bool): Indicates if markers are interleaved in the wave.

    Returns:

      Three separated arrays are returned. The waveforms are scaled to be in the
      range [-1 and 1]. If no data is present the respective array is empty.

save_settings(daq, device, filename)
    Save settings from the specified device to a LabOne settings file. This
    function is synchronous; it will block until saving the settings has
    finished.

    Arguments:

      daq (instance of ziDAQServer): A ziPython API session.

      device (str): The device ID specifying where to load the settings,
      e.g., 'dev123'.

      filename (str): The filename of the LabOne xml settings file. The filename
      can include a relative or full path.

    Raises:

      RunTimeError: If saving the settings times out.

    Examples:

      import zhinst.utils as utils
      daq = utils.autoConnect()
      dev = utils.autoDetect(daq)

      # Then, e.g., save settings to a file in the current directory:
      utils.save_settings(daq, dev, 'my_settings.xml')

      # Then, e.g., save settings to the default LabOne settings path:
      filename = 'my_settings_example.xml'
      path = utils.get_default_settings_path(daq)
      utils.save_settings(daq, dev, path + os.sep + filename)

sigin_autorange(daq, device, in_channel)
    Perform an automatic adjustment of the signal input range based on the
    measured input signal. This utility function starts the functionality
    implemented in the device's firmware and waits until it has completed. The
    range is set by the firmware based on the measured input signal's amplitude
    measured over approximately 100 ms.

    Requirements:

      A devtype that supports autorange functionality on the firmware level,
      e.g., UHFLI, MFLI, MFIA.

    Arguments:

      daq (instance of ziDAQServer): A ziPython API session.
```

```
          device (str): The device ID on which to perform the signal input autorange.

          in_channel (int): The index of the signal input channel to autorange.

        Raises:

          AssertionError: If the functionality is not supported by the device or an
            invalid in_channel was specified.

          RunTimeError: If autorange functionality does not complete within the
            timeout.

        Example:

          import zhinst.utils
          device_serial = 'dev2006'
          (daq, _, _) = zhinst.utils.create_api_session(device_serial, 5)
          input_channel = 0
          zhinst.utils.sigin_autorange(daq, device_serial, input_channel)

    systemtime_to_datetime(systemtime)
        Convert the LabOne "systemtime" returned in LabOne data headers from
        microseconds since Unix epoch to a datetime object with microsecond
        precision.

        Example:

          import zhinst.examples as ziex
          import zhinst.utils as ziutils
          data = ziex.common.example_sweeper.run_example('dev2006')
          systemtime = data[0][0]['header']['systemtime'][0]
          t_datetime = ziutils.systemtime_to_datetime(systemtime)
          t_datetime.strftime('%Y-%m-%dT%H:%M:%S.%f')

    tc2bw(timeconstant, order)
        Convert the demodulator timeconstant to its equivalent 3 dB bandwidth for the
        specified demodulator order.

        Inputs:

          timeconstant (double): The equivalent demodulator timeconstant.

          order (int): The demodulator order (1 to 8) for which to convert the
          bandwidth.

        Output:

          bandwidth (double): The demodulator 3dB bandwidth to convert.

DATA
    LABONE_DEMOD_DTYPE = [('chunk', 'u8'), ('timestamp', 'u8'), ('x', 'f8'...
    LABONE_DEMOD_FORMATS = ('u8', 'u8', 'f8', 'f8', 'f8', 'f8', 'u4', 'u4'...
    LABONE_DEMOD_NAMES = ('chunk', 'timestamp', 'x', 'y', 'freq', 'phase',...
    ZICONTROL_DTYPE = [('t', 'f8'), ('x', 'f8'), ('y', 'f8'), ('freq', 'f8...
    ZICONTROL_FORMATS = ('f8', 'f8', 'f8', 'f8', 'u4', 'f8', 'f8')
    ZICONTROL_NAMES = ('t', 'x', 'y', 'freq', 'dio', 'auxin0', 'auxin1')
    print_function = _Feature((2, 6, 0, 'alpha', 2), (3, 0, 0, 'alpha', 0)...

FILE
    /home/ci/.pyenv/versions/3.7.1/lib/python3.7/site-packages/zhinst/utils.py
```

5.4.3. Help for ziPython's **ziDiscovery** class

```
>>> help('zhinst.ziPython.ziDiscovery')
```

```
Help on class ziDiscovery in zhinst.ziPython:

zhinst.ziPython.ziDiscovery = class ziDiscovery(Boost.Python.instance)
 |  Class to find devices and get their connectivity properties.
 |
 |  Method resolution order:
 |      ziDiscovery
 |      Boost.Python.instance
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      __init__( (object)arg1) -> None
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  find(...)
 |      find( (ziDiscovery)self, (str)dev) -> str :
 |          Return the device id for a given device address.
 |              dev: Device address string e.g. UHF-DEV2000.
 |
 |  findAll(...)
 |      findAll( (ziDiscovery)self) -> list :
 |          Return a list of all discoverable devices.
 |
 |  get(...)
 |      get( (ziDiscovery)self, (str)dev) -> object :
 |          Return the device properties for a given device id.
 |              dev: Device id string e.g. DEV2000.
 |
 |  setDebugLevel(...)
 |      setDebugLevel( (ziDiscovery)self, (int)severity) -> None :
 |          Set debug level.
 |              severity: debug level.
 |
 |  ----------------------------------------------------------------------
 |  Data and other attributes defined here:
 |
 |  __instance_size__ = 64
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.4. Help for ziPython's **`ziDAQServer`** class

```
>>> help('zhinst.ziPython.ziDAQServer')

Help on class ziDAQServer in zhinst.ziPython:

zhinst.ziPython.ziDAQServer = class ziDAQServer(Boost.Python.instance)
 |  Class to connect with a Zurich Instruments data server.
 |
 |  Method resolution order:
```

```
|      ziDAQServer
|      Boost.Python.instance
|      builtins.object
|
|  Static methods defined here:
|
|  __init__(...)
|      __init__( (object)arg1) -> None
|
|      __init__( (object)self, (str)host, (int)port) -> None :
|          Connect to the server by using host address and port number.
|              host: Host string e.g. '127.0.0.1' for localhost.
|              port: Port number e.g. 8004 for the ziDataServer.
|
|      __init__( (object)self, (str)host, (int)port, (int)api_level) -> None :
|          Connect to the server by using host address and port number.
|              host: Host string e.g. '127.0.0.1' for localhost.
|              port: Port number e.g. 8004 for the ziDataServer.
|              api_level: API level number.
|
|  __reduce__ = <unnamed Boost.Python function>(...)
|
|  asyncSetDouble(...)
|      asyncSetDouble( (ziDAQServer)self, (str)path, (float)value) -> None :
|          Use with care: returns immediately, any errors silently ignored.
|              path:  Path string of the node.
|              value: Value of the node.
|
|  asyncSetInt(...)
|      asyncSetInt( (ziDAQServer)self, (str)path, (int)value) -> None :
|          Use with care: returns immediately, any errors silently ignored.
|              path:  Path string of the node.
|              value: Value of the node.
|
|  asyncSetString(...)
|      asyncSetString( (ziDAQServer)self, (str)path, (object)value) -> None :
|          Use with care: returns immediately, any errors silently ignored.
|              path:  Path string of the node.
|              value: Value of the node.
|
|  awgModule(...)
|      awgModule( (ziDAQServer)self) -> AwgModule :
|          Create a AwgModule class. This will start a thread for running an
|          asynchronous AwgModule.
|
|  connect(...)
|      connect( (ziDAQServer)self) -> None
|
|  connectDevice(...)
|      connectDevice( (ziDAQServer)self, (str)dev, (str)interface [,
(str)params='']) -> None :
|          Connect with the data server to a specified device over the specified
|          interface. The device must be visible to the server. If the device is
|          already connected the call will be ignored. The function will block
|          until the device is connected and the device is ready to use. This
|          method is useful for UHF devices offering several communication
|          interfaces.
|              dev: Device serial.
|              interface: Device interface.
|              params: Optional interface parameters string.
|
|  dataAcquisitionModule(...)
|      dataAcquisitionModule( (ziDAQServer)self) -> DataAcquisitionModule :
|          Create a DataAcquisitionModule class. This will start a thread for
|          running an asynchronous Data Acquisition Module.
|
|  deviceSettings(...)
```

```
 |      deviceSettings( (ziDAQServer)self) -> DeviceSettingsModule :
 |          Create a DeviceSettingsModule class. This will start a thread for running
 |          an asynchronous DeviceSettingsModule.
 |
 |      deviceSettings( (ziDAQServer)self, (int)timeout_ms) -> DeviceSettingsModule :
 |          DEPRECATED, use deviceSettings() without arguments.
 |          Create a DeviceSettingsModule class. This will start a thread for running
 |          an asynchronous DeviceSettingsModule.
 |              timeout_ms: Timeout in [ms]. Recommended value is 500ms.
 |                    DEPRECATED, ignored
 |
 |  disconnect(...)
 |      disconnect( (ziDAQServer)self) -> None
 |
 |  disconnectDevice(...)
 |      disconnectDevice( (ziDAQServer)self, (str)dev) -> None :
 |          Disconnect a device on the data server. This function will return
 |          immediately. The disconnection of the device may not yet finished.
 |              dev: Device serial string of device to disconnect.
 |
 |  echoDevice(...)
 |      echoDevice( (ziDAQServer)self, (str)dev) -> None :
 |          Sends an echo command to a device and blocks until
 |          answer is received. This is useful to flush all
 |          buffers between API and device to enforce that
 |          further code is only executed after the device executed
 |          a previous command.
 |              dev: Device string e.g. 'dev100'.
 |
 |  flush(...)
 |      flush( (ziDAQServer)self) -> None :
 |          Flush all data in the socket connection and API buffers.
 |          Call this function before a subscribe with subsequent poll
 |          to get rid of old streaming data that might still be in
 |          the buffers.
 |
 |  get(...)
 |      get( (ziDAQServer)self, (str)paths [, (bool)flat_ [, (int)flags]],
 |          *, (bool)flat=False, (bool)all=False, (bool)settingsonly=True, **kwargs)
 |          -> dict :
 |         Return a dict with all nodes from the specified sub-tree.
 |         Note: Flags are ignored for a path that specifies one or more leaf nodes.
 |               Specifying flags, either as positional or keyword argument is
 |               mandatory if an empty set would be returned given the
 |               default flags (settingsonly).
 |               High-speed streaming nodes (e.g. /devN/demods/0/sample) are
 |               are never returned.
 |
 |         Positional arguments:
 |             paths: Path string of the node. Multiple paths can be specified
 |                    as a comma-separated list. Wild cards are supported to
 |                    select multiple matching nodes.
 |             flat_: Superseded by keyword argument `flat` which takes
 |                    precedence (see below).
 |             flags: Flags to specify which type of nodes to include in the
 |                    result (see zhinst.ziListEnum). Flags specified as
 |                    keyword arguments take precedence (see below).
 |
 |         Keyword arguments:
 |             flat:  Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False, default).
 |             all:   Return all nodes. Is evaluated first and resets the flags if
 |                    set to True (default: False).
 |             settingsonly: Return only nodes which are marked as setting
 |                     (default: True).
 |         Moreover, all flags supported by listNodes() can be used.
```

```
|
|  getAsEvent(...)
|      getAsEvent( (ziDAQServer)self, (str)path) -> None :
|          Trigger an event on the specified node. The node data is returned by a
|          subsequent poll command.
|              path:  Path string of the node. Note: Wildcards and paths
|                     referring to streaming nodes are not permitted.
|              value: Value of the node.
|
|  getAuxInSample(...)
|      getAuxInSample( (ziDAQServer)self, (str)path) -> object :
|          Returns a single auxin sample. The auxin data is averaged in contrast to
|          the auxin data embedded in the demodulator sample.
|              path: Path string
|
|  getByte(...)
|      getByte( (ziDAQServer)self, (str)path) -> object :
|          Get a byte array (string) value from the specified node.
|              path: Path string of the node.
|
|  getComplex(...)
|      getComplex( (ziDAQServer)self, (str)path) -> complex :
|          Get a complex double value from the specified node.
|              path: Path string of the node.
|
|  getConnectionAPILevel(...)
|      getConnectionAPILevel( (ziDAQServer)self) -> int :
|          Returns ziAPI level used for the active connection.
|
|  getDIO(...)
|      getDIO( (ziDAQServer)self, (str)path) -> object :
|          Returns a single DIO sample.
|              path: Path string
|
|  getDebugLogpath(...)
|      getDebugLogpath( (ziDAQServer)self) -> str :
|          Returns the path where logfiles are stored. Note, it will return
|          the empty string if logging has not been enabled via setDebugLevel().
|
|  getDouble(...)
|      getDouble( (ziDAQServer)self, (str)path) -> float :
|          Get a double value from the specified node.
|              path: Path string of the node.
|
|  getInt(...)
|      getInt( (ziDAQServer)self, (str)path) -> int :
|          Get a integer value from the specified node.
|              path: Path string of the node.
|
|  getLastError(...)
|      getLastError( (ziDAQServer)self) -> object :
|          Return the last error message of the API.
|
|  getList(...)
|      getList( (ziDAQServer)self, (str)path [, (int)flags=8]) -> object :
|          DEPRECATED: superseded by get(...).
|          Return a list with all nodes from the specified sub-tree.
|              path:  Path string of the node. Use wild card to
|                     select all.
|              flags: Specify which type of nodes to include in the
|                     result. Allowed:
|                     ZI_LIST_NODES_SETTINGSONLY = 0x08 (default)
|                     ZI_LIST_NODES_ALL = 0x00 (all nodes)
|
|  getSample(...)
|      getSample( (ziDAQServer)self, (str)path) -> object :
|          Returns a single demodulator sample (including DIO and AuxIn). For more
```

```
 |          efficient data recording use subscribe and poll methods.
 |              path: Path string
 |
 |  getString(...)
 |      getString( (ziDAQServer)self, (str)path) -> object :
 |          Get a string value from the specified node.
 |              path: Path string of the node.
 |
 |  getStringUnicode(...)
 |      getStringUnicode( (ziDAQServer)self, (str)path) -> object :
 |          Get a unicode string value from the specified node.
 |          The returned string is unicode encoded.
 |          Only relevant for Python versions older than V3.0.
 |          For Python versions 3.0 and later, getString can be used instead.
 |              path: Path string of the node.
 |
 |  help(...)
 |      help( (ziDAQServer)self, (str)path) -> None :
 |          Returns a well-formatted description of a node. Only UHF and MF devices
 |          support this functionality.
 |              path: Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |
 |  impedanceModule(...)
 |      impedanceModule( (ziDAQServer)self) -> ImpedanceModule :
 |          Create a ImpedanceModule class. This will start a thread for
 |          running an asynchronous ImpedanceModule.
 |
 |  listNodes(...)
 |      listNodes( (ziDAQServer)self, (str)path [, (int)flags], **opts) -> list :
 |         This function returns a list of node names found at the specified path.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below.
 |
 |         Keyword arguments:
 |             all: Return all nodes (resets flags if set to True).
 |             recursive: Returns the nodes recursively (default: False)
 |             absolute: Returns absolute paths (default: True)
 |             leavesonly: Returns only nodes that are leaves, which means they
 |                    are at the outermost level of the tree (default: False).
 |             settingsonly: Returns only nodes which are marked as setting
 |                    (default: False).
 |             streamingonly: Returns only streaming nodes (default: False).
 |             subscribedonly: Returns only subscribed nodes (default: False).
 |             basechannelonly: Return only one instance of a node in case of
 |                    multiple channels (default: False).
 |             excludestreaming: Exclude streaming nodes (default: False).
 |             excludevectors: Exclude vector nodes (default: False).
 |
 |  listNodesJSON(...)
 |      listNodesJSON( (ziDAQServer)self, (str)path [, (int)flags], **opts) -> str :
 |         Returns a list of nodes with description found at the specified path.
 |         Only UHF and MF devices support this functionality.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
```

```
 |                     the keyword arguments below. They are the same as for
 |                     listNodes(), except that recursive, absolute, and leavesonly
 |                     are enforced.
 |
 |          Keyword arguments:
 |              all: Return all nodes (resets flags if set to True).
 |              settingsonly: Returns only nodes which are marked as setting
 |                     (default: False).
 |              streamingonly: Returns only streaming nodes (default: False).
 |              subscribedonly: Returns only subscribed nodes (default: False).
 |              basechannelonly: Return only one instance of a node in case of
 |                     multiple channels (default: False).
 |              excludestreaming: Exclude streaming nodes (default: False).
 |              excludevectors: Exclude vector nodes (default: False).
 |
 |  logOff(...)
 |      logOff( (ziDAQServer)self) -> None :
 |          Disables logging of commands sent to a server.
 |
 |  logOn(...)
 |      logOn( (ziDAQServer)self, (int)flags, (str)filename [, (int)style=2]) ->
None :
 |          Enables logging of commands sent to a server.
 |              flags: Flags (LOG_NONE:             0x00000000
 |                            LOG_SET_DOUBLE:       0x00000001
 |                            LOG_SET_INT:          0x00000002
 |                            LOG_SET_BYTE:         0x00000004
 |                            LOG_SET_STRING:       0x00000008
 |                            LOG_SYNC_SET_DOUBLE:  0x00000010
 |                            LOG_SYNC_SET_INT:     0x00000020
 |                            LOG_SYNC_SET_BYTE:    0x00000040
 |                            LOG_SYNC_SET_STRING:  0x00000080
 |                            LOG_GET_DOUBLE:       0x00000100
 |                            LOG_GET_INT:          0x00000200
 |                            LOG_GET_BYTE:         0x00000400
 |                            LOG_GET_STRING:       0x00000800
 |                            LOG_GET_DEMOD:        0x00001000
 |                            LOG_GET_DIO:          0x00002000
 |                            LOG_GET_AUXIN:        0x00004000
 |                            LOG_GET_COMPLEX:      0x00008000
 |                            LOG_LISTNODES:        0x00010000
 |                            LOG_SUBSCRIBE:        0x00020000
 |                            LOG_UNSUBSCRIBE:      0x00040000
 |                            LOG_GET_AS_EVENT:     0x00080000
 |                            LOG_UPDATE:           0x00100000
 |                            LOG_POLL_EVENT:       0x00200000
 |                            LOG_POLL:             0x00400000
 |                            LOG_ALL :             0xffffffff)
 |              filename: Log file name.
 |              style: Log style (LOG_STYLE_TELNET: 0, LOG_STYLE_MATLAB: 1,
 |                     LOG_STYLE_PYTHON: 2 (default)).
 |
 |  multiDeviceSyncModule(...)
 |      multiDeviceSyncModule( (ziDAQServer)self) -> MultiDeviceSyncModule :
 |          Create a MultiDeviceSyncModule class. This will start a thread for
 |          running an asynchronous MultiDeviceSync module.
 |
 |  pidAdvisor(...)
 |      pidAdvisor( (ziDAQServer)self) -> PidAdvisorModule :
 |          Create a PidAdvisorModule class. This will start a thread for running an
 |          asynchronous PidAdvisorModule.
 |
 |      pidAdvisor( (ziDAQServer)self, (int)timeout_ms) -> PidAdvisorModule :
 |          DEPRECATED, use pidAdvisor() without arguments.
 |          Create a PidAdvisorModule class. This will start a thread for running an
 |          asynchronous PidAdvisorModule.
 |              timeout_ms: Timeout in [ms]. Recommended value is 500ms.
```

```
|                    DEPRECATED, ignored
|
|  poll(...)
|      poll( (ziDAQServer)self, (float)recording_time_s, (int)timeout_ms [,
(int)flags=0 [, (bool)flat=False]]) -> object :
|          Continuously check for value changes (by calling pollEvent) in all
|          subscribed nodes for the specified duration and return the data. If
|          no value change occurs in subscribed nodes before duration + timeout,
|          poll returns no data. This function call is blocking (it is
|          synchronous). However, since all value changes are returned since
|          either subscribing to the node or the last poll (assuming no buffer
|          overflow has occurred on the Data Server), this function may be used
|          in a quasi-asynchronous manner to return data spanning a much longer
|          time than the specified duration. The timeout parameter is only
|          relevant when communicating in a slow network. In this case it may be
|          set to a value larger than the expected round-trip time in the
|          network.
|          Poll returns a dict tree containing the recorded data (see `flat`).
|              recording_time_s: Recording time in [s]. The function will block
|                    during that time.
|              timeout_ms: Poll timeout in [ms]. Recommended value is 500ms.
|              flags: Poll flags.
|                    DEFAULT = 0x0000: Default.
|                    FILL    = 0x0001: Fill holes.
|                    THROW   = 0x0004: Throw EOFError exception if sample
|                                      loss is detected (only possible in
|                                      combination with DETECT).
|                    DETECT  = 0x0008: Detect data loss holes.
|              flat: Specify which type of data structure to return.
|                    Return data either as a flat dict (True) or as a nested
|                    dict tree (False). Default = False.
|
|  pollEvent(...)
|      pollEvent( (ziDAQServer)self, (int)timeout_ms) -> object :
|          Return the value changes that occurred in one single subscribed node.
|          This is a low-level function. The poll function is better suited in
|          nearly all cases. To get all data waiting in the buffers this command
|          should be executed continuously until nothing is returned anymore.
|              timeout_ms: Poll timeout in [ms]. Recommended value is 500ms.
|
|  precompensationAdvisor(...)
|      precompensationAdvisor( (ziDAQServer)self) -> PrecompensationAdvisorModule :
|          Create a PrecompensationAdvisorModule class. This will start a thread
|          for running an asynchronous Precempensation Advisor Module.
|
|  programRT(...)
|      programRT( (ziDAQServer)self, (str)dev, (str)filename) -> None :
|          Program RT.
|              dev: Device identifier e.g. 'dev99'.
|              filename: File name of the RT program.
|
|  quantumAnalyzerModule(...)
|      quantumAnalyzerModule( (ziDAQServer)self) -> ModuleBase :
|          Create a QuantumAnalyzerModule class. This will start a thread for
|          running an asynchronous module.
|
|  record(...)
|      record( (ziDAQServer)self) -> RecorderModule :
|          Create a recording class. This will start a thread for asynchronous
|          recording.
|
|      record( (ziDAQServer)self, (float)duration_s, (int)timeout_ms [,
(int)flags=1]) -> RecorderModule :
|          DEPRECATED, use record() without arguments.
|              duration_s: Maximum recording time for single triggers in [s].
|                     DEPRECATED, set 'buffersize' param instead.
|              timeout_ms: Timeout in [ms]. Recommended value is 500ms.
```

```
 |                      DEPRECATED, ignored.
 |               flags: Record flags.
 |                      DEPRECATED, set 'flags' param instead.
 |                      FILL  = 0x0001 : Fill holes.
 |                      ALIGN = 0x0002 : Align data that contains a
 |                                       timestamp.
 |                      THROW = 0x0004 : Throw EOFError exception if
 |                                       sample loss is detected.
 |                      DETECT = 0x0008: Detect data loss holes.
 |
 |  revision(...)
 |      revision( (ziDAQServer)self) -> int :
 |          Get the revision number of the Python interface of Zurich Instruments.
 |
 |  scopeModule(...)
 |      scopeModule( (ziDAQServer)self) -> ScopeModule :
 |          Create a ScopeModule class. This will start a thread for running an
 |          asynchronous ScopeModule
 |
 |  set(...)
 |      set( (ziDAQServer)self, (object)items) -> None :
 |          Set multiple nodes. A transaction is used if more than a single
 |          path/value pair is specified.
 |              items: A list of path/value pairs.
 |
 |  setByte(...)
 |      setByte( (ziDAQServer)self, (str)path, (object)value) -> None :
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |  setComplex(...)
 |      setComplex( (ziDAQServer)self, (str)path, (complex)value) -> None :
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |  setDebugLevel(...)
 |      setDebugLevel( (ziDAQServer)self, (int)severity) -> None :
 |          Enables debug log and sets the debug level.
 |              severity: Debug level (trace:0, debug:1, info:2, status:3, warning:4,
 |                        error:5, fatal:6).
 |
 |  setDeprecated(...)
 |      setDeprecated( (ziDAQServer)self, (object)items) -> None :
 |          Set multiple nodes.
 |              items: A list of path/value pairs.
 |
 |  setDouble(...)
 |      setDouble( (ziDAQServer)self, (str)path, (float)value) -> None :
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |  setInt(...)
 |      setInt( (ziDAQServer)self, (str)path, (int)value) -> None :
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |  setLastError(...)
 |      setLastError( (ziDAQServer)self, (str)error) -> None :
 |          Update the last error message with the given error string.
 |              error: Error string.
 |
 |  setString(...)
 |      setString( (ziDAQServer)self, (str)path, (object)value) -> None :
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |  setVector(...)
```

```
 |      setVector( (ziDAQServer)self, (str)path, (object)value) -> None :
 |              path:  Path string of the node.
 |              value: Vector ((u)int8, (u)int16, (u)int32, (u)int64, float, double)
 |                     or string to write.
 |
 |  subscribe(...)
 |      subscribe( (ziDAQServer)self, (object)path) -> None :
 |          Subscribe to one or several nodes. Fetch data with the poll
 |          command. In order to avoid fetching old data that is still in the
 |          buffer execute a flush command before subscribing to data streams.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  sweep(...)
 |      sweep( (ziDAQServer)self) -> SweeperModule :
 |          Create a sweeper class. This will start a thread for asynchronous
 |          sweeping.
 |
 |      sweep( (ziDAQServer)self, (int)timeout_ms) -> SweeperModule :
 |          DEPRECATED, use sweep() without arguments.
 |          Create a sweeper class. This will start a thread for asynchronous
 |          sweeping.
 |              timeout_ms: Timeout in [ms]. Recommended value is 500ms.
 |                    DEPRECATED, ignored
 |
 |  sync(...)
 |      sync( (ziDAQServer)self) -> None :
 |          Synchronize all data path. Ensures that get and poll
 |          commands return data which was recorded after the
 |          setting changes in front of the sync command. This
 |          sync command replaces the functionality of all syncSet,
 |          flush, and echoDevice commands.
 |
 |  syncSetDouble(...)
 |      syncSetDouble( (ziDAQServer)self, (str)path, (float)value) -> float :
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |  syncSetInt(...)
 |      syncSetInt( (ziDAQServer)self, (str)path, (int)value) -> int :
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |  syncSetString(...)
 |      syncSetString( (ziDAQServer)self, (str)path, (object)value) -> None :
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |  unsubscribe(...)
 |      unsubscribe( (ziDAQServer)self, (object)path) -> None :
 |          Unsubscribe data streams. Use this command after recording to avoid
 |          buffer overflows that may increase the latency of other command.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  update(...)
 |      update( (ziDAQServer)self) -> None :
 |          Check if additional devices are attached. This function is not needed
 |          for servers running under windows as devices will be detected
 |          automatically.
 |
 |  version(...)
 |      version( (ziDAQServer)self) -> str :
 |          Get version string of the Python interface of Zurich Instruments.
 |
```

```
 |  writeDebugLog(...)
 |      writeDebugLog( (ziDAQServer)self, (int)severity, (str)message) -> None :
 |          Outputs message to the debug log (if enabled).
 |              severity: Debug level (trace:0, debug:1, info:2, status:3, warning:4,
 |                        error:5, fatal:6).    message:  Message to output to the
 log.
 |
 |  zoomFFT(...)
 |      zoomFFT( (ziDAQServer)self) -> ZoomFFTModule :
 |          Create a ZoomFFTModule class. This will start a thread for running an
 |          asynchronous ZoomFFTModule.
 |
 |      zoomFFT( (ziDAQServer)self, (int)timeout_ms) -> ZoomFFTModule :
 |          DEPRECATED, use zoomFFT() without arguments.
 |          Create a ZoomFFTModule class. This will start a thread for running an
 |          asynchronous ZoomFFTModule.
 |              timeout_ms: Timeout in [ms]. Recommended value is 500ms.
 |                    DEPRECATED, ignored
 |
 |  ----------------------------------------------------------------------
 |  Data and other attributes defined here:
 |
 |  __instance_size__ = 80
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.5. Help for the **`AwgModule`** class

An instance of `AwgModule` is initialized using the `awgModule` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.awgModule')

Help on built-in function awgModule in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.awgModule = awgModule(...)
    awgModule( (ziDAQServer)self) -> AwgModule :
        Create a AwgModule class. This will start a thread for running an
        asynchronous AwgModule.
```

Reference help for the `AwgModule` class.

```
>>> help('zhinst.ziPython.AwgModule')

Help on class AwgModule in zhinst.ziPython:

zhinst.ziPython.AwgModule = class AwgModule(ModuleBase)
 |  Method resolution order:
 |      AwgModule
 |      ModuleBase
 |      Boost.Python.instance
 |      builtins.object
 |
 |  Static methods defined here:
 |
```

```
|  __init__(...)
|      Raises an exception
|      This class cannot be instantiated from Python
|
|  __reduce__ = <unnamed Boost.Python function>(...)
|
|  clear(...)
|      clear( (AwgModule)self) -> None :
|          End the awgModule thread.
|
|  execute(...)
|      execute( (AwgModule)self) -> None :
|          Starts the awgModule if not yet running.
|
|  finish(...)
|      finish( (AwgModule)self) -> None :
|          Stop the awgModule.
|
|  finished(...)
|      finished( (AwgModule)self) -> bool :
|          Check if the command execution has finished. Returns True if finished.
|
|  get(...)
|      get( (AwgModule)self, (str)path [, (bool)flat=False]) -> object :
|          Return a dict with all nodes from the specified sub-tree.
|              path: Path string of the node. Use wild card to
|                    select all.
|              flat: Specify which type of data structure to return.
|                    Return data either as a flat dict (True) or as a nested
|                    dict tree (False). Default = False.
|
|  getDouble(...)
|      getDouble( (AwgModule)self, (str)path) -> float :
|          Return the floating point double value for the specified path.
|              path: Path string of the node.
|
|  getInt(...)
|      getInt( (AwgModule)self, (str)path) -> int :
|          Return the integer value for the specified path.
|              path: Path string of the node.
|
|  getString(...)
|      getString( (AwgModule)self, (str)path) -> object :
|          Return the string value for the specified path.
|              path: Path string of the node.
|
|  getStringUnicode(...)
|      getStringUnicode( (AwgModule)self, (str)path) -> object :
|          Get a unicode string value from the specified node.
|          The returned string is unicode encoded.
|          Only relevant for Python versions older than V3.0.
|          For Python versions 3.0 and later, getString can be used instead.
|              path: Path string of the node.
|
|  help(...)
|      help( (AwgModule)self [, (str)path='*']) -> None :
|          Returns a well-formatted description of a module parameter.
|              path: Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|
|  listNodes(...)
|      listNodes( self, (str)path [, (int)flags], **opts) -> list :
|         This function returns a list of node names found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
```

```
 |                      contain wildcards so that the returned nodes do not
 |                      necessarily have to have the same parents.
 |               flags: Flags specifying how the selected nodes are listed
 |                      (see ziPython.ziListEnum). Flags can also specified by
 |                      the keyword arguments below.
 |
 |           Keyword arguments:
 |               recursive: Returns the nodes recursively (default: False)
 |               absolute: Returns absolute paths (default: True)
 |               leavesonly: Returns only nodes that are leaves, which means they
 |                      are at the outermost level of the tree (default: False).
 |               settingsonly: Returns only nodes which are marked as setting
 |                      (default: False).
 |               streamingonly: Returns only streaming nodes (default: False).
 |               subscribedonly: Returns only subscribed nodes (default: False).
 |               basechannelonly: Return only one instance of a node in case of
 |                      multiple channels (default: False).
 |               excludestreaming: Exclude streaming nodes (default: False).
 |               excludevectors: Exclude vector nodes (default: False).
 |
 |  listNodesJSON(...)
 |      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
 |         Returns a list of nodes with description found at the specified path.
 |
 |           Positional arguments:
 |               path:  Path for which the nodes should be listed. The path may
 |                      contain wildcards so that the returned nodes do not
 |                      necessarily have to have the same parents.
 |               flags: Flags specifying how the selected nodes are listed
 |                      (see ziPython.ziListEnum). Flags can also specified by
 |                      the keyword arguments below. They are the same as for
 |                      listNodes(), except that recursive, absolute, and leavesonly
 |                      are enforced.
 |
 |           Keyword arguments:
 |               settingsonly: Returns only nodes which are marked as setting
 |                      (default: False).
 |               streamingonly: Returns only streaming nodes (default: False).
 |               subscribedonly: Returns only subscribed nodes (default: False).
 |               basechannelonly: Return only one instance of a node in case of
 |                      multiple channels (default: False).
 |               excludestreaming: Exclude streaming nodes (default: False).
 |               excludevectors: Exclude vector nodes (default: False).
 |
 |  progress(...)
 |      progress( (AwgModule)self) -> object :
 |          Reports the progress of the command with a number between 0 and 1.
 |
 |  save(...)
 |      save( (AwgModule)self, (str)path) -> None :
 |          Not relevant for the awgModule module.
 |
 |  set(...)
 |      set( (AwgModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (AwgModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (AwgModule)self, (str)path) -> None :
 |          Not relevant for the awgModule module.
 |
 |  trigger(...)
```

```
 |      trigger( (AwgModule)self) -> None :
 |          Not applicable to this module.
 |
 |  unsubscribe(...)
 |      unsubscribe( (AwgModule)self, (str)path) -> None :
 |          Not relevant for the awgModule module.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from ModuleBase:
 |
 |  read(...)
 |      read( (ModuleBase)self [, (bool)flat=False]) -> object :
 |          Read the module output data. If the module execution is still ongoing
 |          only a subset of data is returned. If huge data sets are produced call
 |          this method to keep memory usage reasonable.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.6. Help for the **DataAcquisitionModule** class

An instance of `DataAcquisitionModule` is initialized using the `dataAcquisitionModule` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.dataAcquisitionModule')

Help on built-in function dataAcquisitionModule in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.dataAcquisitionModule = dataAcquisitionModule(...)
    dataAcquisitionModule( (ziDAQServer)self) -> DataAcquisitionModule :
        Create a DataAcquisitionModule class. This will start a thread for
        running an asynchronous Data Acquisition Module.
```

Reference help for the `DataAcquisitionModule` class.

```
>>> help('zhinst.ziPython.DataAcquisitionModule')

Help on class DataAcquisitionModule in zhinst.ziPython:

zhinst.ziPython.DataAcquisitionModule = class DataAcquisitionModule(ModuleBase)
 |  Method resolution order:
 |      DataAcquisitionModule
 |      ModuleBase
 |      Boost.Python.instance
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
```

```
|
|  __reduce__ = <unnamed Boost.Python function>(...)
|
|  clear(...)
|      clear( (DataAcquisitionModule)self) -> None :
|          End the acquisition thread.
|
|  execute(...)
|      execute( (DataAcquisitionModule)self) -> None :
|          Start the data acquisition. After that command any
|          trigger will start the measurement.
|          Subscription or unsubscription is not
|          possible until the acquisition is finished.
|
|  finish(...)
|      finish( (DataAcquisitionModule)self) -> None :
|          Stop acquisition. The acquisition may be restarted by calling
|          'execute' again.
|
|  finished(...)
|      finished( (DataAcquisitionModule)self) -> bool :
|          Check if the acquisition has finished. Returns True if finished.
|
|  get(...)
|      get( (DataAcquisitionModule)self, (str)path [, (bool)flat=False]) -> object :
|          Return a dict with all nodes from the specified sub-tree.
|              path: Path string of the node. Use wild card to
|                    select all.
|              flat: Specify which type of data structure to return.
|                    Return data either as a flat dict (True) or as a nested
|                    dict tree (False). Default = False.
|
|  getDouble(...)
|      getDouble( (DataAcquisitionModule)self, (str)path) -> float :
|          Return the floating point double value for the specified path.
|              path: Path string of the node.
|
|  getInt(...)
|      getInt( (DataAcquisitionModule)self, (str)path) -> int :
|          Return the integer value for the specified path.
|              path: Path string of the node.
|
|  getString(...)
|      getString( (DataAcquisitionModule)self, (str)path) -> object :
|          Return the string value for the specified path.
|              path: Path string of the node.
|
|  getStringUnicode(...)
|      getStringUnicode( (DataAcquisitionModule)self, (str)path) -> object :
|          Return the unicode encoded string value for the specified path.
|          Only relevant for Python versions older than V3.0.
|          For Python versions 3.0 and later, getString can be used instead.
|              path: Path string of the node.
|
|  help(...)
|      help( (DataAcquisitionModule)self [, (str)path='*']) -> None :
|          Returns a well-formatted description of a module parameter.
|              path: Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|
|  listNodes(...)
|      listNodes( self, (str)path [, (int)flags], **opts) -> list :
|         This function returns a list of node names found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
```

```
 |                     contain wildcards so that the returned nodes do not
 |                     necessarily have to have the same parents.
 |              flags: Flags specifying how the selected nodes are listed
 |                     (see ziPython.ziListEnum). Flags can also specified by
 |                     the keyword arguments below.
 |
 |          Keyword arguments:
 |              recursive: Returns the nodes recursively (default: False)
 |              absolute: Returns absolute paths (default: True)
 |              leavesonly: Returns only nodes that are leaves, which means they
 |                     are at the outermost level of the tree (default: False).
 |              settingsonly: Returns only nodes which are marked as setting
 |                     (default: False).
 |              streamingonly: Returns only streaming nodes (default: False).
 |              subscribedonly: Returns only subscribed nodes (default: False).
 |              basechannelonly: Return only one instance of a node in case of
 |                     multiple channels (default: False).
 |              excludestreaming: Exclude streaming nodes (default: False).
 |              excludevectors: Exclude vector nodes (default: False).
 |
 |  listNodesJSON(...)
 |      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
 |          Returns a list of nodes with description found at the specified path.
 |
 |          Positional arguments:
 |              path:  Path for which the nodes should be listed. The path may
 |                     contain wildcards so that the returned nodes do not
 |                     necessarily have to have the same parents.
 |              flags: Flags specifying how the selected nodes are listed
 |                     (see ziPython.ziListEnum). Flags can also specified by
 |                     the keyword arguments below. They are the same as for
 |                     listNodes(), except that recursive, absolute, and leavesonly
 |                     are enforced.
 |
 |          Keyword arguments:
 |              settingsonly: Returns only nodes which are marked as setting
 |                     (default: False).
 |              streamingonly: Returns only streaming nodes (default: False).
 |              subscribedonly: Returns only subscribed nodes (default: False).
 |              basechannelonly: Return only one instance of a node in case of
 |                     multiple channels (default: False).
 |              excludestreaming: Exclude streaming nodes (default: False).
 |              excludevectors: Exclude vector nodes (default: False).
 |
 |  progress(...)
 |      progress( (DataAcquisitionModule)self) -> object :
 |          Reports the progress of the measurement with a number between
 |          0 and 1.
 |
 |  read(...)
 |      read( (DataAcquisitionModule)self [, (bool)flat=False]) -> object :
 |          Read acquired data. If the acquisition is still ongoing only a subset
 |          of the data is returned. If many triggers or huge data sets
 |          are acquired call this method to keep memory usage reasonable.
 |              flat: Specify which type of data structure to return.
 |                     Return data either as a flat dict (True) or as a nested
 |                     dict tree (False). Default = False.
 |
 |  save(...)
 |      save( (DataAcquisitionModule)self, (str)filename) -> None :
 |          Save trigger data to file.
 |              filename: File name string (without extension).
 |
 |  set(...)
 |      set( (DataAcquisitionModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
```

```
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (DataAcquisitionModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (DataAcquisitionModule)self, (str)path) -> None :
 |          Subscribe to one or several nodes. After subscription the acquisition
 |          process can be started with the 'execute' command. During the
 |          acquisition process paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  trigger(...)
 |      trigger( (DataAcquisitionModule)self) -> None :
 |          Execute a manual trigger.
 |
 |  unsubscribe(...)
 |      unsubscribe( (DataAcquisitionModule)self, (str)path) -> None :
 |          Unsubscribe from one or several nodes. During the
 |          acquisition process paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.7. Help for the `DeviceSettingsModule` class

An instance of `DeviceSettingsModule` is initialized using the `deviceSettings` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.deviceSettings')

Help on built-in function deviceSettings in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.deviceSettings = deviceSettings(...)
    deviceSettings( (ziDAQServer)self) -> DeviceSettingsModule :
        Create a DeviceSettingsModule class. This will start a thread for running
        an asynchronous DeviceSettingsModule.

    deviceSettings( (ziDAQServer)self, (int)timeout_ms) -> DeviceSettingsModule :
        DEPRECATED, use deviceSettings() without arguments.
        Create a DeviceSettingsModule class. This will start a thread for running
        an asynchronous DeviceSettingsModule.
            timeout_ms: Timeout in [ms]. Recommended value is 500ms.
                  DEPRECATED, ignored
```

Reference help for the `DeviceSettingsModule` class.

```
>>> help('zhinst.ziPython.DeviceSettingsModule')
```

```
Help on class DeviceSettingsModule in zhinst.ziPython:

zhinst.ziPython.DeviceSettingsModule = class DeviceSettingsModule(ModuleBase)
 |  Method resolution order:
 |      DeviceSettingsModule
 |      ModuleBase
 |      Boost.Python.instance
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  clear(...)
 |      clear( (DeviceSettingsModule)self) -> None :
 |          End the deviceSettings thread.
 |
 |  execute(...)
 |      execute( (DeviceSettingsModule)self) -> None :
 |          Execute the save/load command.
 |
 |  finish(...)
 |      finish( (DeviceSettingsModule)self) -> None :
 |          Stop the load/save command. The command may be restarted by calling
 |          'execute' again.
 |
 |  finished(...)
 |      finished( (DeviceSettingsModule)self) -> bool :
 |          Check if the command execution has finished. Returns True if finished.
 |
 |  get(...)
 |      get( (DeviceSettingsModule)self, (str)path [, (bool)flat=False]) -> object :
 |          Return a dict with all nodes from the specified sub-tree.
 |              path: Path string of the node. Use wild card to
 |                    select all.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  getDouble(...)
 |      getDouble( (DeviceSettingsModule)self, (str)path) -> float :
 |          Return the floating point double value for the specified path.
 |              path: Path string of the node.
 |
 |  getInt(...)
 |      getInt( (DeviceSettingsModule)self, (str)path) -> int :
 |          Return the integer value for the specified path.
 |              path: Path string of the node.
 |
 |  getString(...)
 |      getString( (DeviceSettingsModule)self, (str)path) -> object :
 |          Return the string value for the specified path.
 |              path: Path string of the node.
 |
 |  getStringUnicode(...)
 |      getStringUnicode( (DeviceSettingsModule)self, (str)path) -> object :
 |          Get a unicode string value from the specified node.
 |          The returned string is unicode encoded.
 |          Only relevant for Python versions older than V3.0.
 |          For Python versions 3.0 and later, getString can be used instead.
 |              path: Path string of the node.
 |
```

```
|  help(...)
|      help( (DeviceSettingsModule)self [, (str)path='*']) -> None :
|          Returns a well-formatted description of a module parameter.
|              path: Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|
|  listNodes(...)
|      listNodes( self, (str)path [, (int)flags], **opts) -> list :
|         This function returns a list of node names found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|             flags: Flags specifying how the selected nodes are listed
|                    (see ziPython.ziListEnum). Flags can also specified by
|                    the keyword arguments below.
|
|         Keyword arguments:
|             recursive: Returns the nodes recursively (default: False)
|             absolute: Returns absolute paths (default: True)
|             leavesonly: Returns only nodes that are leaves, which means they
|                    are at the outermost level of the tree (default: False).
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
|  listNodesJSON(...)
|      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
|         Returns a list of nodes with description found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|             flags: Flags specifying how the selected nodes are listed
|                    (see ziPython.ziListEnum). Flags can also specified by
|                    the keyword arguments below. They are the same as for
|                    listNodes(), except that recursive, absolute, and leavesonly
|                    are enforced.
|
|         Keyword arguments:
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
|  progress(...)
|      progress( (DeviceSettingsModule)self) -> object :
|          Reports the progress of the command with a number between
|          0 and 1.
|
|  read(...)
|      read( (DeviceSettingsModule)self [, (bool)flat=False]) -> object :
|          Read device settings. Only relevant for the save command.
|              flat: Specify which type of data structure to return.
|                    Return data either as a flat dict (True) or as a nested
```

```
 |                     dict tree (False). Default = False.
 |
 |  save(...)
 |      save( (DeviceSettingsModule)self, (str)path) -> None :
 |          Not relevant for the deviceSettings module.
 |
 |  set(...)
 |      set( (DeviceSettingsModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (DeviceSettingsModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (DeviceSettingsModule)self, (str)path) -> None :
 |          Not relevant for the deviceSettings module.
 |
 |  trigger(...)
 |      trigger( (DeviceSettingsModule)self) -> None :
 |          Not applicable to this module.
 |
 |  unsubscribe(...)
 |      unsubscribe( (DeviceSettingsModule)self, (str)path) -> None :
 |          Not relevant for the deviceSettings module.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.8. Help for the `ImpedanceModule` class

An instance of `ImpedanceModule` is initialized using the `impedanceModule` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.impedanceModule')

Help on built-in function impedanceModule in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.impedanceModule = impedanceModule(...)
    impedanceModule( (ziDAQServer)self) -> ImpedanceModule :
        Create a ImpedanceModule class. This will start a thread for
        running an asynchronous ImpedanceModule.
```

Reference help for the `ImpedanceModule` class.

```
>>> help('zhinst.ziPython.ImpedanceModule')

Help on class ImpedanceModule in zhinst.ziPython:

zhinst.ziPython.ImpedanceModule = class ImpedanceModule(ModuleBase)
 |  Method resolution order:
 |      ImpedanceModule
```

```
 |      ModuleBase
 |      Boost.Python.instance
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  clear(...)
 |      clear( (ImpedanceModule)self) -> None :
 |          End the ImpedanceModule thread.
 |
 |  execute(...)
 |      execute( (ImpedanceModule)self) -> None :
 |          Starts the ImpedanceModule if not yet running.
 |
 |  finish(...)
 |      finish( (ImpedanceModule)self) -> None :
 |          Stop the ImpedanceModule.
 |
 |  finished(...)
 |      finished( (ImpedanceModule)self) -> bool :
 |          Check if the command execution has finished. Returns True if finished.
 |
 |  get(...)
 |      get( (ImpedanceModule)self, (str)path [, (bool)flat=False]) -> object :
 |          Return a dict with all nodes from the specified sub-tree.
 |              path: Path string of the node. Use wild card to
 |                    select all.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  getDouble(...)
 |      getDouble( (ImpedanceModule)self, (str)path) -> float :
 |          Return the floating point double value for the specified path.
 |              path: Path string of the node.
 |
 |  getInt(...)
 |      getInt( (ImpedanceModule)self, (str)path) -> int :
 |          Return the integer value for the specified path.
 |              path: Path string of the node.
 |
 |  getString(...)
 |      getString( (ImpedanceModule)self, (str)path) -> object :
 |          Return the string value for the specified path.
 |              path: Path string of the node.
 |
 |  getStringUnicode(...)
 |      getStringUnicode( (ImpedanceModule)self, (str)path) -> object :
 |          Get a unicode string value from the specified node.
 |          The returned string is unicode encoded.
 |          Only relevant for Python versions older than V3.0.
 |          For Python versions 3.0 and later, getString can be used instead.
 |              path: Path string of the node.
 |
 |  help(...)
 |      help( (ImpedanceModule)self [, (str)path='*']) -> None :
 |          Returns a well-formatted description of a module parameter.
 |              path: Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |
```

```
 |  listNodes(...)
 |      listNodes( self, (str)path [, (int)flags], **opts) -> list :
 |         This function returns a list of node names found at the specified path.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below.
 |
 |         Keyword arguments:
 |             recursive: Returns the nodes recursively (default: False)
 |             absolute: Returns absolute paths (default: True)
 |             leavesonly: Returns only nodes that are leaves, which means they
 |                    are at the outermost level of the tree (default: False).
 |             settingsonly: Returns only nodes which are marked as setting
 |                    (default: False).
 |             streamingonly: Returns only streaming nodes (default: False).
 |             subscribedonly: Returns only subscribed nodes (default: False).
 |             basechannelonly: Return only one instance of a node in case of
 |                    multiple channels (default: False).
 |             excludestreaming: Exclude streaming nodes (default: False).
 |             excludevectors: Exclude vector nodes (default: False).
 |
 |  listNodesJSON(...)
 |      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
 |         Returns a list of nodes with description found at the specified path.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below. They are the same as for
 |                    listNodes(), except that recursive, absolute, and leavesonly
 |                    are enforced.
 |
 |         Keyword arguments:
 |             settingsonly: Returns only nodes which are marked as setting
 |                    (default: False).
 |             streamingonly: Returns only streaming nodes (default: False).
 |             subscribedonly: Returns only subscribed nodes (default: False).
 |             basechannelonly: Return only one instance of a node in case of
 |                    multiple channels (default: False).
 |             excludestreaming: Exclude streaming nodes (default: False).
 |             excludevectors: Exclude vector nodes (default: False).
 |
 |  progress(...)
 |      progress( (ImpedanceModule)self) -> object :
 |          Reports the progress of the command with a number between 0 and 1.
 |
 |  save(...)
 |      save( (ImpedanceModule)self, (str)filename) -> None :
 |          Not relevant for the ImpedanceModule.
 |
 |  set(...)
 |      set( (ImpedanceModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (ImpedanceModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
```

```
 |
 |  subscribe(...)
 |      subscribe( (ImpedanceModule)self, (str)path) -> None :
 |          Not relevant for the ImpedanceModule.
 |
 |  trigger(...)
 |      trigger( (ImpedanceModule)self) -> None :
 |          Not applicable to this module.
 |
 |  unsubscribe(...)
 |      unsubscribe( (ImpedanceModule)self, (str)path) -> None :
 |          Not relevant for the ImpedanceModule.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from ModuleBase:
 |
 |  read(...)
 |      read( (ModuleBase)self [, (bool)flat=False]) -> object :
 |          Read the module output data. If the module execution is still ongoing
 |          only a subset of data is returned. If huge data sets are produced call
 |          this method to keep memory usage reasonable.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.9. Help for the `MultiDeviceSyncModule` class

An instance of `MultiDeviceSyncModule` is initialized using the `multiDeviceSyncModule` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.multiDeviceSyncModule')

Help on built-in function multiDeviceSyncModule in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.multiDeviceSyncModule = multiDeviceSyncModule(...)
    multiDeviceSyncModule( (ziDAQServer)self) -> MultiDeviceSyncModule :
        Create a MultiDeviceSyncModule class. This will start a thread for
        running an asynchronous MultiDeviceSync module.
```

Reference help for the `MultiDeviceSyncModule` class.

```
>>> help('zhinst.ziPython.MultiDeviceSyncModule')

Help on class MultiDeviceSyncModule in zhinst.ziPython:

zhinst.ziPython.MultiDeviceSyncModule = class MultiDeviceSyncModule(ModuleBase)
 |  Method resolution order:
 |      MultiDeviceSyncModule
 |      ModuleBase
 |      Boost.Python.instance
 |      builtins.object
```

```
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  clear(...)
 |      clear( (MultiDeviceSyncModule)self) -> None :
 |          End the MultiDeviceSyncModule thread.
 |
 |  execute(...)
 |      execute( (MultiDeviceSyncModule)self) -> None :
 |          Starts the MultiDeviceSyncModule if not yet running.
 |
 |  finish(...)
 |      finish( (MultiDeviceSyncModule)self) -> None :
 |          Stop the MultiDeviceSync module.
 |
 |  finished(...)
 |      finished( (MultiDeviceSyncModule)self) -> bool :
 |          Check if the command execution has finished. Returns True if finished.
 |
 |  get(...)
 |      get( (MultiDeviceSyncModule)self, (str)path [, (bool)flat=False]) -> object :
 |          Return a dict with all nodes from the specified sub-tree.
 |              path: Path string of the node. Use wild card to
 |                    select all.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  getDouble(...)
 |      getDouble( (MultiDeviceSyncModule)self, (str)path) -> float :
 |          Return the floating point double value for the specified path.
 |              path: Path string of the node.
 |
 |  getInt(...)
 |      getInt( (MultiDeviceSyncModule)self, (str)path) -> int :
 |          Return the integer value for the specified path.
 |              path: Path string of the node.
 |
 |  getString(...)
 |      getString( (MultiDeviceSyncModule)self, (str)path) -> object :
 |          Return the string value for the specified path.
 |              path: Path string of the node.
 |
 |  getStringUnicode(...)
 |      getStringUnicode( (MultiDeviceSyncModule)self, (str)path) -> object :
 |          Get a unicode string value from the specified node.
 |          The returned string is unicode encoded.
 |          Only relevant for Python versions older than V3.0.
 |          For Python versions 3.0 and later, getString can be used instead.
 |              path: Path string of the node.
 |
 |  help(...)
 |      help( (MultiDeviceSyncModule)self [, (str)path='*']) -> None :
 |          Returns a well-formatted description of a module parameter.
 |              path: Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |
 |  listNodes(...)
 |      listNodes( self, (str)path [, (int)flags], **opts) -> list :
 |         This function returns a list of node names found at the specified path.
```

```
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below.
 |
 |         Keyword arguments:
 |             recursive: Returns the nodes recursively (default: False)
 |             absolute: Returns absolute paths (default: True)
 |             leavesonly: Returns only nodes that are leaves, which means they
 |                    are at the outermost level of the tree (default: False).
 |             settingsonly: Returns only nodes which are marked as setting
 |                    (default: False).
 |             streamingonly: Returns only streaming nodes (default: False).
 |             subscribedonly: Returns only subscribed nodes (default: False).
 |             basechannelonly: Return only one instance of a node in case of
 |                    multiple channels (default: False).
 |             excludestreaming: Exclude streaming nodes (default: False).
 |             excludevectors: Exclude vector nodes (default: False).
 |
 |  listNodesJSON(...)
 |      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
 |         Returns a list of nodes with description found at the specified path.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below. They are the same as for
 |                    listNodes(), except that recursive, absolute, and leavesonly
 |                    are enforced.
 |
 |         Keyword arguments:
 |             settingsonly: Returns only nodes which are marked as setting
 |                    (default: False).
 |             streamingonly: Returns only streaming nodes (default: False).
 |             subscribedonly: Returns only subscribed nodes (default: False).
 |             basechannelonly: Return only one instance of a node in case of
 |                    multiple channels (default: False).
 |             excludestreaming: Exclude streaming nodes (default: False).
 |             excludevectors: Exclude vector nodes (default: False).
 |
 |  progress(...)
 |      progress( (MultiDeviceSyncModule)self) -> object :
 |          Reports the progress of the command with a number between 0 and 1.
 |
 |  save(...)
 |      save( (MultiDeviceSyncModule)self, (str)filename) -> None :
 |          Not relevant for the multiDeviceSyncModule.
 |
 |  set(...)
 |      set( (MultiDeviceSyncModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (MultiDeviceSyncModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (MultiDeviceSyncModule)self, (str)path) -> None :
```

```
 |          Not relevant for the multiDeviceSyncModule.
 |
 |  trigger(...)
 |      trigger( (MultiDeviceSyncModule)self) -> None :
 |          Not applicable to this module.
 |
 |  unsubscribe(...)
 |      unsubscribe( (MultiDeviceSyncModule)self, (str)path) -> None :
 |          Not relevant for the multiDeviceSyncModule.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from ModuleBase:
 |
 |  read(...)
 |      read( (ModuleBase)self [, (bool)flat=False]) -> object :
 |          Read the module output data. If the module execution is still ongoing
 |          only a subset of data is returned. If huge data sets are produced call
 |          this method to keep memory usage reasonable.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.10. Help for the **`PidAdvisorModule`** class

An instance of `PidAdvisorModule` is initialized using the `pidAdvisor` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.pidAdvisor')

Help on built-in function pidAdvisor in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.pidAdvisor = pidAdvisor(...)
    pidAdvisor( (ziDAQServer)self) -> PidAdvisorModule :
        Create a PidAdvisorModule class. This will start a thread for running an
        asynchronous PidAdvisorModule.

    pidAdvisor( (ziDAQServer)self, (int)timeout_ms) -> PidAdvisorModule :
        DEPRECATED, use pidAdvisor() without arguments.
        Create a PidAdvisorModule class. This will start a thread for running an
        asynchronous PidAdvisorModule.
            timeout_ms: Timeout in [ms]. Recommended value is 500ms.
                  DEPRECATED, ignored
```

Reference help for the `PidAdvisorModule` class.

```
>>> help('zhinst.ziPython.PidAdvisorModule')

Help on class PidAdvisorModule in zhinst.ziPython:

zhinst.ziPython.PidAdvisorModule = class PidAdvisorModule(ModuleBase)
 |  Method resolution order:
```

```
|      PidAdvisorModule
|      ModuleBase
|      Boost.Python.instance
|      builtins.object
|
|  Static methods defined here:
|
|  __init__(...)
|      Raises an exception
|      This class cannot be instantiated from Python
|
|  __reduce__ = <unnamed Boost.Python function>(...)
|
|  clear(...)
|      clear( (PidAdvisorModule)self) -> None :
|          End the pidAdvisor thread.
|
|  execute(...)
|      execute( (PidAdvisorModule)self) -> None :
|          Starts the pidAdvisor if not yet running.
|
|  finish(...)
|      finish( (PidAdvisorModule)self) -> None :
|          Stop the pidAdvisor.
|
|  finished(...)
|      finished( (PidAdvisorModule)self) -> bool :
|          Check if the command execution has finished. Returns True if finished.
|
|  get(...)
|      get( (PidAdvisorModule)self, (str)path [, (bool)flat=False]) -> object :
|          Return a dict with all nodes from the specified sub-tree.
|              path: Path string of the node. Use wild card to
|                    select all.
|              flat: Specify which type of data structure to return.
|                    Return data either as a flat dict (True) or as a nested
|                    dict tree (False). Default = False.
|
|  getDouble(...)
|      getDouble( (PidAdvisorModule)self, (str)path) -> float :
|          Return the floating point double value for the specified path.
|              path: Path string of the node.
|
|  getInt(...)
|      getInt( (PidAdvisorModule)self, (str)path) -> int :
|          Return the integer value for the specified path.
|              path: Path string of the node.
|
|  getString(...)
|      getString( (PidAdvisorModule)self, (str)path) -> object :
|          Return the string value for the specified path.
|              path: Path string of the node.
|
|  getStringUnicode(...)
|      getStringUnicode( (PidAdvisorModule)self, (str)path) -> object :
|          Get a unicode string value from the specified node.
|          The returned string is unicode encoded.
|          Only relevant for Python versions older than V3.0.
|          For Python versions 3.0 and later, getString can be used instead.
|              path: Path string of the node.
|
|  help(...)
|      help( (PidAdvisorModule)self [, (str)path='*']) -> None :
|          Returns a well-formatted description of a module parameter.
|              path: Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
```

```
|
|  listNodes(...)
|      listNodes( self, (str)path [, (int)flags], **opts) -> list :
|         This function returns a list of node names found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|             flags: Flags specifying how the selected nodes are listed
|                    (see ziPython.ziListEnum). Flags can also specified by
|                    the keyword arguments below.
|
|         Keyword arguments:
|             recursive: Returns the nodes recursively (default: False)
|             absolute: Returns absolute paths (default: True)
|             leavesonly: Returns only nodes that are leaves, which means they
|                    are at the outermost level of the tree (default: False).
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
|  listNodesJSON(...)
|      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
|         Returns a list of nodes with description found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|             flags: Flags specifying how the selected nodes are listed
|                    (see ziPython.ziListEnum). Flags can also specified by
|                    the keyword arguments below. They are the same as for
|                    listNodes(), except that recursive, absolute, and leavesonly
|                    are enforced.
|
|         Keyword arguments:
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
|  progress(...)
|      progress( (PidAdvisorModule)self) -> object :
|          Reports the progress of the command with a number between 0 and 1.
|
|  read(...)
|      read( (PidAdvisorModule)self [, (bool)flat=False]) -> object :
|          Read pidAdvisor data. If the simulation is still ongoing, only a subset
|          of the data is returned.
|              flat: Specify which type of data structure to return.
|                    Return data either as a flat dict (True) or as a nested
|                    dict tree (False). Default = False.
|
|  save(...)
|      save( (PidAdvisorModule)self, (str)filename) -> None :
|          Save PID advisor data to file.
|              filename: File name string (without extension).
```

```
 |
 |  set(...)
 |      set( (PidAdvisorModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (PidAdvisorModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (PidAdvisorModule)self, (str)path) -> None :
 |          Subscribe to one or several nodes.
 |
 |  trigger(...)
 |      trigger( (PidAdvisorModule)self) -> None :
 |          Not applicable to this module.
 |
 |  unsubscribe(...)
 |      unsubscribe( (PidAdvisorModule)self, (str)path) -> None :
 |          Unsubscribe from one or several nodes.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.11. Help for the **PrecompensationAdvisorModule** class

An instance of `PrecompensationAdvisorModule` is initialized using the `precompensationAdvisor` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.precompensationAdvisor')

Help on built-in function precompensationAdvisor in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.precompensationAdvisor = precompensationAdvisor(...)
    precompensationAdvisor( (ziDAQServer)self) -> PrecompensationAdvisorModule :
        Create a PrecompensationAdvisorModule class. This will start a thread
        for running an asynchronous Precempensation Advisor Module.
```

Reference help for the `PrecompensationAdvisorModule` class.

```
>>> help('zhinst.ziPython.PrecompensationAdvisorModule')

Help on class PrecompensationAdvisorModule in zhinst.ziPython:

zhinst.ziPython.PrecompensationAdvisorModule = class
 PrecompensationAdvisorModule(ModuleBase)
 |  Method resolution order:
 |      PrecompensationAdvisorModule
 |      ModuleBase
 |      Boost.Python.instance
```

```
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  get(...)
 |      get( (PrecompensationAdvisorModule)self, (str)path [, (bool)flat=False]) ->
object :
 |          Return a dict with all nodes from the specified sub-tree.
 |              path: Path string of the node. Use wild card to
 |                    select all.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  getDouble(...)
 |      getDouble( (PrecompensationAdvisorModule)self, (str)path) -> float :
 |          Return the floating point double value for the specified path.
 |              path: Path string of the node.
 |
 |  getInt(...)
 |      getInt( (PrecompensationAdvisorModule)self, (str)path) -> int :
 |          Return the integer value for the specified path.
 |              path: Path string of the node.
 |
 |  getString(...)
 |      getString( (PrecompensationAdvisorModule)self, (str)path) -> object :
 |          Return the string value for the specified path.
 |              path: Path string of the node.
 |
 |  getStringUnicode(...)
 |      getStringUnicode( (PrecompensationAdvisorModule)self, (str)path) -> object :
 |          Get a unicode string value from the specified node.
 |          The returned string is unicode encoded.
 |          Only relevant for Python versions older than V3.0.
 |          For Python versions 3.0 and later, getString can be used instead.
 |              path: Path string of the node.
 |
 |  help(...)
 |      help( (PrecompensationAdvisorModule)self [, (str)path='*']) -> None :
 |          Returns a well-formatted description of a module parameter.
 |              path: Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |
 |  listNodes(...)
 |      listNodes( self, (str)path [, (int)flags], **opts) -> list :
 |         This function returns a list of node names found at the specified path.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below.
 |
 |         Keyword arguments:
 |             recursive: Returns the nodes recursively (default: False)
 |             absolute: Returns absolute paths (default: True)
 |             leavesonly: Returns only nodes that are leaves, which means they
 |                    are at the outermost level of the tree (default: False).
```

```
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
|  listNodesJSON(...)
|      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
|         Returns a list of nodes with description found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|             flags: Flags specifying how the selected nodes are listed
|                    (see ziPython.ziListEnum). Flags can also specified by
|                    the keyword arguments below. They are the same as for
|                    listNodes(), except that recursive, absolute, and leavesonly
|                    are enforced.
|
|         Keyword arguments:
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
|  set(...)
|      set( (PrecompensationAdvisorModule)self, (str)path, (object)value) -> None :
|          Set the specified module parameter value. Use 'help' to learn more
|          about available parameters.
|              path:  Path string of the node.
|              value: Value of the node.
|
|      set( (PrecompensationAdvisorModule)self, (object)items) -> None :
|              items: A list of path/value pairs.
|
|  subscribe(...)
|      subscribe( (PrecompensationAdvisorModule)self, (str)path) -> None :
|          Subscribe to one or several nodes.
|
|  unsubscribe(...)
|      unsubscribe( (PrecompensationAdvisorModule)self, (str)path) -> None :
|          Unsubscribe from one or several nodes.
|
|  ----------------------------------------------------------------------
|  Static methods inherited from ModuleBase:
|
|  clear(...)
|      clear( (ModuleBase)self) -> None :
|          End the module thread.
|
|  execute(...)
|      execute( (ModuleBase)self) -> None :
|          Start the module execution. Subscription or unsubscription is not
|          possible until the execution is finished.
|
|  finish(...)
|      finish( (ModuleBase)self) -> None :
|          Stop the execution. The execution may be restarted by calling
|          'execute' again.
```

```
 |
 |  finished(...)
 |      finished( (ModuleBase)self) -> bool :
 |          Check if the execution has finished. Returns True if finished.
 |
 |  progress(...)
 |      progress( (ModuleBase)self) -> object :
 |          Reports the progress of the execution with a number between
 |          0 and 1.
 |
 |  read(...)
 |      read( (ModuleBase)self [, (bool)flat=False]) -> object :
 |          Read the module output data. If the module execution is still ongoing
 |          only a subset of data is returned. If huge data sets are produced call
 |          this method to keep memory usage reasonable.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  save(...)
 |      save( (ModuleBase)self, (str)filename) -> None :
 |          Save measured data to file.
 |              filename: File name string (without extension).
 |
 |  trigger(...)
 |      trigger( (ModuleBase)self) -> None :
 |          Execute a manual trigger, if applicable.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.12. Help for the `ScopeModule` class

An instance of `ScopeModule` is initialized using the `scopeModule` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.scopeModule')

Help on built-in function scopeModule in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.scopeModule = scopeModule(...)
    scopeModule( (ziDAQServer)self) -> ScopeModule :
        Create a ScopeModule class. This will start a thread for running an
        asynchronous ScopeModule
```

Reference help for the `ScopeModule` class.

```
>>> help('zhinst.ziPython.ScopeModule')

Help on class ScopeModule in zhinst.ziPython:

zhinst.ziPython.ScopeModule = class ScopeModule(ModuleBase)
 |  Method resolution order:
 |      ScopeModule
 |      ModuleBase
 |      Boost.Python.instance
```

```
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  clear(...)
 |      clear( (ScopeModule)self) -> None :
 |          End the ScopeModule thread.
 |
 |  execute(...)
 |      execute( (ScopeModule)self) -> None :
 |          Starts the ScopeModule if not yet running.
 |
 |  finish(...)
 |      finish( (ScopeModule)self) -> None :
 |          Stop the ScopeModule module.
 |
 |  finished(...)
 |      finished( (ScopeModule)self) -> bool :
 |          Scope module is always running, use progress instead
 |
 |  get(...)
 |      get( (ScopeModule)self, (str)path [, (bool)flat=False]) -> object :
 |          Return a dict with all nodes from the specified sub-tree.
 |              path: Path string of the node. Use a wildcard to
 |                    select all.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  getDouble(...)
 |      getDouble( (ScopeModule)self, (str)path) -> float :
 |          Return the floating point double value for the specified path.
 |              path: Path string of the node.
 |
 |  getInt(...)
 |      getInt( (ScopeModule)self, (str)path) -> int :
 |          Return the integer value for the specified path.
 |              path: Path string of the node.
 |
 |  getString(...)
 |      getString( (ScopeModule)self, (str)path) -> object :
 |          Return the string value for the specified path.
 |              path: Path string of the node.
 |
 |  getStringUnicode(...)
 |      getStringUnicode( (ScopeModule)self, (str)path) -> object :
 |          Get a unicode string value from the specified node.
 |          The returned string is unicode encoded.
 |          Only relevant for Python versions older than V3.0.
 |          For Python versions 3.0 and later, getString can be used instead.
 |              path: Path string of the node.
 |
 |  help(...)
 |      help( (ScopeModule)self [, (str)path='*']) -> None :
 |          Returns a well-formatted description of a module parameter.
 |              path: Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |
 |  listNodes(...)
 |      listNodes( self, (str)path [, (int)flags], **opts) -> list :
```

```
 |        This function returns a list of node names found at the specified path.
 |
 |        Positional arguments:
 |            path:  Path for which the nodes should be listed. The path may
 |                   contain wildcards so that the returned nodes do not
 |                   necessarily have to have the same parents.
 |            flags: Flags specifying how the selected nodes are listed
 |                   (see ziPython.ziListEnum). Flags can also specified by
 |                   the keyword arguments below.
 |
 |        Keyword arguments:
 |            recursive: Returns the nodes recursively (default: False)
 |            absolute: Returns absolute paths (default: True)
 |            leavesonly: Returns only nodes that are leaves, which means they
 |                   are at the outermost level of the tree (default: False).
 |            settingsonly: Returns only nodes which are marked as setting
 |                   (default: False).
 |            streamingonly: Returns only streaming nodes (default: False).
 |            subscribedonly: Returns only subscribed nodes (default: False).
 |            basechannelonly: Return only one instance of a node in case of
 |                   multiple channels (default: False).
 |            excludestreaming: Exclude streaming nodes (default: False).
 |            excludevectors: Exclude vector nodes (default: False).
 |
 |  listNodesJSON(...)
 |      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
 |        Returns a list of nodes with description found at the specified path.
 |
 |        Positional arguments:
 |            path:  Path for which the nodes should be listed. The path may
 |                   contain wildcards so that the returned nodes do not
 |                   necessarily have to have the same parents.
 |            flags: Flags specifying how the selected nodes are listed
 |                   (see ziPython.ziListEnum). Flags can also specified by
 |                   the keyword arguments below. They are the same as for
 |                   listNodes(), except that recursive, absolute, and leavesonly
 |                   are enforced.
 |
 |        Keyword arguments:
 |            settingsonly: Returns only nodes which are marked as setting
 |                   (default: False).
 |            streamingonly: Returns only streaming nodes (default: False).
 |            subscribedonly: Returns only subscribed nodes (default: False).
 |            basechannelonly: Return only one instance of a node in case of
 |                   multiple channels (default: False).
 |            excludestreaming: Exclude streaming nodes (default: False).
 |            excludevectors: Exclude vector nodes (default: False).
 |
 |  progress(...)
 |      progress( (ScopeModule)self) -> object :
 |          Reports the progress of the command with a number between 0 and 1.
 |
 |  read(...)
 |      read( (ScopeModule)self [, (bool)flat=False]) -> object :
 |          Read scope data. If the recording is still ongoing only a subset
 |          of data is returned.
 |              flat: Specify which type of data structure to return.
 |                   Return data either as a flat dict (True) or as a nested
 |                   dict tree (False). Default = False.
 |
 |  save(...)
 |      save( (ScopeModule)self, (str)filename) -> None :
 |          Save scope data to file.
 |              filename: File name string (without extension).
 |
 |  set(...)
 |      set( (ScopeModule)self, (str)path, (object)value) -> None :
```

```
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (ScopeModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (ScopeModule)self, (str)path) -> None :
 |          Subscribe to one or several scope nodes. After subscription the scope
 |          module can be started with the 'execute' command. During the
 |          module run paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Wildcards allowed.
 |                    Alternatively also a list of path
 |                    strings can be specified.
 |
 |  trigger(...)
 |      trigger( (ScopeModule)self) -> None :
 |          Not applicable to this module.
 |
 |  unsubscribe(...)
 |      unsubscribe( (ScopeModule)self, (str)path) -> None :
 |          Unsubscribe from one or several nodes. During the
 |          module run paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wildcard to
 |                    unsibscribe all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.13. Help for the **SweeperModule** class

An instance of `SweeperModule` is initialized using the `sweep` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.sweep')

Help on built-in function sweep in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.sweep = sweep(...)
    sweep( (ziDAQServer)self) -> SweeperModule :
        Create a sweeper class. This will start a thread for asynchronous
        sweeping.

    sweep( (ziDAQServer)self, (int)timeout_ms) -> SweeperModule :
        DEPRECATED, use sweep() without arguments.
        Create a sweeper class. This will start a thread for asynchronous
        sweeping.
            timeout_ms: Timeout in [ms]. Recommended value is 500ms.
                  DEPRECATED, ignored
```

Reference help for the `SweeperModule` class.

```
>>> help('zhinst.ziPython.SweeperModule')
```

```
Help on class SweeperModule in zhinst.ziPython:

zhinst.ziPython.SweeperModule = class SweeperModule(ModuleBase)
 |  Method resolution order:
 |      SweeperModule
 |      ModuleBase
 |      Boost.Python.instance
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  clear(...)
 |      clear( (SweeperModule)self) -> None :
 |          End the sweeper thread.
 |
 |  execute(...)
 |      execute( (SweeperModule)self) -> None :
 |          Start the sweeper. Subscription or unsubscription is not
 |          possible until the sweep is finished.
 |
 |  finish(...)
 |      finish( (SweeperModule)self) -> None :
 |          Stop sweeping. The sweeping may be restarted by calling
 |          'execute' again.
 |
 |  finished(...)
 |      finished( (SweeperModule)self) -> bool :
 |          Check if the sweep has finished. Returns True if finished.
 |
 |  get(...)
 |      get( (SweeperModule)self, (str)path [, (bool)flat=False]) -> object :
 |          Return a dict with all nodes from the specified sub-tree.
 |              path: Path string of the node. Use wild card to
 |                    select all.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  getDouble(...)
 |      getDouble( (SweeperModule)self, (str)path) -> float :
 |          Return the floating point double value for the specified path.
 |              path: Path string of the node.
 |
 |  getInt(...)
 |      getInt( (SweeperModule)self, (str)path) -> int :
 |          Return the integer value for the specified path.
 |              path: Path string of the node.
 |
 |  getString(...)
 |      getString( (SweeperModule)self, (str)path) -> object :
 |          Return the string value for the specified path.
 |              path: Path string of the node.
 |
 |  getStringUnicode(...)
 |      getStringUnicode( (SweeperModule)self, (str)path) -> object :
 |          Return the unicode encoded string value for the specified path.
 |          Only relevant for Python versions older than V3.0.
 |          For Python versions 3.0 and later, getString can be used instead.
 |              path: Path string of the node.
 |
```

```
|  help(...)
|      help( (SweeperModule)self [, (str)path='*']) -> None :
|          Returns a well-formatted description of a module parameter.
|              path: Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|
|  listNodes(...)
|      listNodes( self, (str)path [, (int)flags], **opts) -> list :
|         This function returns a list of node names found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|             flags: Flags specifying how the selected nodes are listed
|                    (see ziPython.ziListEnum). Flags can also specified by
|                    the keyword arguments below.
|
|         Keyword arguments:
|             recursive: Returns the nodes recursively (default: False)
|             absolute: Returns absolute paths (default: True)
|             leavesonly: Returns only nodes that are leaves, which means they
|                    are at the outermost level of the tree (default: False).
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
|  listNodesJSON(...)
|      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
|         Returns a list of nodes with description found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|             flags: Flags specifying how the selected nodes are listed
|                    (see ziPython.ziListEnum). Flags can also specified by
|                    the keyword arguments below. They are the same as for
|                    listNodes(), except that recursive, absolute, and leavesonly
|                    are enforced.
|
|         Keyword arguments:
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
|  progress(...)
|      progress( (SweeperModule)self) -> object :
|          Reports the progress of the measurement with a number between
|          0 and 1.
|
|  read(...)
|      read( (SweeperModule)self [, (bool)flat=False]) -> object :
|          Read sweep data. If the sweeping is still ongoing only a subset
|          of sweep data is returned. If huge data sets are recorded call
|          this method to keep memory usage reasonable.
```

```
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  save(...)
 |      save( (SweeperModule)self, (str)filename) -> None :
 |          Save sweeper data to file.
 |              filename: File name string (without extension).
 |
 |  set(...)
 |      set( (SweeperModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (SweeperModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (SweeperModule)self, (str)path) -> None :
 |          Subscribe to one or several nodes. After subscription the sweep
 |          process can be started with the 'execute' command. During the
 |          sweep process paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  trigger(...)
 |      trigger( (SweeperModule)self) -> None :
 |          Execute a manual trigger.
 |
 |  unsubscribe(...)
 |      unsubscribe( (SweeperModule)self, (str)path) -> None :
 |          Unsubscribe from one or several nodes. During the
 |          sweep process paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.14. Help for the **RecorderModule** class

An instance of `RecorderModule` is initialized using the `record` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.record')

Help on built-in function record in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.record = record(...)
    record( (ziDAQServer)self) -> RecorderModule :
        Create a recording class. This will start a thread for asynchronous
        recording.
```

```
    record( (ziDAQServer)self, (float)duration_s, (int)timeout_ms [, (int)flags=1]) -
> RecorderModule :
        DEPRECATED, use record() without arguments.
            duration_s: Maximum recording time for single triggers in [s].
                   DEPRECATED, set 'buffersize' param instead.
            timeout_ms: Timeout in [ms]. Recommended value is 500ms.
                   DEPRECATED, ignored.
            flags: Record flags.
                   DEPRECATED, set 'flags' param instead.
                   FILL  = 0x0001 : Fill holes.
                   ALIGN = 0x0002 : Align data that contains a
                                    timestamp.
                   THROW = 0x0004 : Throw EOFError exception if
                                    sample loss is detected.
                   DETECT = 0x0008: Detect data loss holes.
```

Reference help for the `RecorderModule` class.

```
>>> help('zhinst.ziPython.RecorderModule')

Help on class RecorderModule in zhinst.ziPython:

zhinst.ziPython.RecorderModule = class RecorderModule(ModuleBase)
 |  Method resolution order:
 |      RecorderModule
 |      ModuleBase
 |      Boost.Python.instance
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  clear(...)
 |      clear( (RecorderModule)self) -> None :
 |          End the recording thread.
 |
 |  execute(...)
 |      execute( (RecorderModule)self) -> None :
 |          Start the recorder. After that command any trigger will start
 |          the measurement. Subscription or unsubscription is not
 |          possible until the recording is finished.
 |
 |  finish(...)
 |      finish( (RecorderModule)self) -> None :
 |          Stop recording. The recording may be restarted by calling
 |          'execute' again.
 |
 |  finished(...)
 |      finished( (RecorderModule)self) -> bool :
 |          Check if the recording has finished. Returns True if finished.
 |
 |  get(...)
 |      get( (RecorderModule)self, (str)path [, (bool)flat=False]) -> object :
 |          Return a dict with all nodes from the specified sub-tree.
 |              path: Path string of the node. Use wild card to
 |                    select all.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
```

```
 |  getDouble(...)
 |      getDouble( (RecorderModule)self, (str)path) -> float :
 |          Return the floating point double value for the specified path.
 |              path: Path string of the node.
 |
 |  getInt(...)
 |      getInt( (RecorderModule)self, (str)path) -> int :
 |          Return the integer value for the specified path.
 |              path: Path string of the node.
 |
 |  getString(...)
 |      getString( (RecorderModule)self, (str)path) -> object :
 |          Return the string value for the specified path.
 |              path: Path string of the node.
 |
 |  getStringUnicode(...)
 |      getStringUnicode( (RecorderModule)self, (str)path) -> object :
 |          Return the unicode encoded string value for the specified path.
 |          Only relevant for Python versions older than V3.0.
 |          For Python versions 3.0 and later, getString can be used instead.
 |              path: Path string of the node.
 |
 |  help(...)
 |      help( (RecorderModule)self [, (str)path='*']) -> None :
 |          Returns a well-formatted description of a module parameter.
 |              path: Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |
 |  listNodes(...)
 |      listNodes( self, (str)path [, (int)flags], **opts) -> list :
 |         This function returns a list of node names found at the specified path.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below.
 |
 |         Keyword arguments:
 |             recursive: Returns the nodes recursively (default: False)
 |             absolute: Returns absolute paths (default: True)
 |             leavesonly: Returns only nodes that are leaves, which means they
 |                    are at the outermost level of the tree (default: False).
 |             settingsonly: Returns only nodes which are marked as setting
 |                    (default: False).
 |             streamingonly: Returns only streaming nodes (default: False).
 |             subscribedonly: Returns only subscribed nodes (default: False).
 |             basechannelonly: Return only one instance of a node in case of
 |                    multiple channels (default: False).
 |             excludestreaming: Exclude streaming nodes (default: False).
 |             excludevectors: Exclude vector nodes (default: False).
 |
 |  listNodesJSON(...)
 |      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
 |         Returns a list of nodes with description found at the specified path.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below. They are the same as for
 |                    listNodes(), except that recursive, absolute, and leavesonly
```

```
 |                     are enforced.
 |
 |          Keyword arguments:
 |              settingsonly: Returns only nodes which are marked as setting
 |                     (default: False).
 |              streamingonly: Returns only streaming nodes (default: False).
 |              subscribedonly: Returns only subscribed nodes (default: False).
 |              basechannelonly: Return only one instance of a node in case of
 |                     multiple channels (default: False).
 |              excludestreaming: Exclude streaming nodes (default: False).
 |              excludevectors: Exclude vector nodes (default: False).
 |
 |  progress(...)
 |      progress( (RecorderModule)self) -> object :
 |          Reports the progress of the measurement with a number between
 |          0 and 1.
 |
 |  read(...)
 |      read( (RecorderModule)self [, (bool)flat=False]) -> object :
 |          Read recorded data. If the recording is still ongoing only a subset
 |          of recorded data is returned. If many triggers or huge data sets
 |          are recorded call this method to keep memory usage reasonable.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  save(...)
 |      save( (RecorderModule)self, (str)filename) -> None :
 |          Save trigger data to file.
 |              filename: File name string (without extension).
 |
 |  set(...)
 |      set( (RecorderModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (RecorderModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (RecorderModule)self, (str)path) -> None :
 |          Subscribe to one or several nodes. After subscription the recording
 |          process can be started with the 'execute' command. During the
 |          recording process paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  trigger(...)
 |      trigger( (RecorderModule)self) -> None :
 |          Execute a manual trigger.
 |
 |  unsubscribe(...)
 |      unsubscribe( (RecorderModule)self, (str)path) -> None :
 |          Unsubscribe from one or several nodes. During the
 |          recording process paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
```

```
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

5.4.15. Help for the **ZoomFFTModule** class

An instance of `ZoomFFTModule` is initialized using the `zoomFFT` method from `ziDAQServer`:

```
>>> help('zhinst.ziPython.ziDAQServer.zoomFFT')

Help on built-in function zoomFFT in zhinst.ziPython.ziDAQServer:

zhinst.ziPython.ziDAQServer.zoomFFT = zoomFFT(...)
    zoomFFT( (ziDAQServer)self) -> ZoomFFTModule :
        Create a ZoomFFTModule class. This will start a thread for running an
        asynchronous ZoomFFTModule.

    zoomFFT( (ziDAQServer)self, (int)timeout_ms) -> ZoomFFTModule :
        DEPRECATED, use zoomFFT() without arguments.
        Create a ZoomFFTModule class. This will start a thread for running an
        asynchronous ZoomFFTModule.
            timeout_ms: Timeout in [ms]. Recommended value is 500ms.
                  DEPRECATED, ignored
```

Reference help for the `ZoomFFTModule` class.

```
>>> help('zhinst.ziPython.ZoomFFTModule')

Help on class ZoomFFTModule in zhinst.ziPython:

zhinst.ziPython.ZoomFFTModule = class ZoomFFTModule(ModuleBase)
 |  Method resolution order:
 |      ZoomFFTModule
 |      ModuleBase
 |      Boost.Python.instance
 |      builtins.object
 |
 |  Static methods defined here:
 |
 |  __init__(...)
 |      Raises an exception
 |      This class cannot be instantiated from Python
 |
 |  __reduce__ = <unnamed Boost.Python function>(...)
 |
 |  clear(...)
 |      clear( (ZoomFFTModule)self) -> None :
 |          End the zoom FFT thread.
 |
 |  execute(...)
 |      execute( (ZoomFFTModule)self) -> None :
 |          Start the zoom FFT. Subscription or unsubscription is not
 |          possible until the zoom FFT is finished.
 |
 |  finish(...)
 |      finish( (ZoomFFTModule)self) -> None :
 |          Stop the zoom FFT. The zoom FFT may be restarted by calling
 |          'execute' again.
 |
 |  finished(...)
 |      finished( (ZoomFFTModule)self) -> bool :
```

```
|         Check if the zoom FFT has finished. Returns True if finished.
|
|  get(...)
|      get( (ZoomFFTModule)self, (str)path [, (bool)flat=False]) -> object :
|          Return a dict with all nodes from the specified sub-tree.
|              path: Path string of the node. Use wild card to
|                    select all.
|              flat: Specify which type of data structure to return.
|                    Return data either as a flat dict (True) or as a nested
|                    dict tree (False). Default = False.
|
|  getDouble(...)
|      getDouble( (ZoomFFTModule)self, (str)path) -> float :
|          Return the floating point double value for the specified path.
|              path: Path string of the node.
|
|  getInt(...)
|      getInt( (ZoomFFTModule)self, (str)path) -> int :
|          Return the integer value for the specified path.
|              path: Path string of the node.
|
|  getString(...)
|      getString( (ZoomFFTModule)self, (str)path) -> object :
|          Return the string value for the specified path.
|              path: Path string of the node.
|
|  getStringUnicode(...)
|      getStringUnicode( (ZoomFFTModule)self, (str)path) -> object :
|          Get a unicode string value from the specified node.
|          The returned string is unicode encoded.
|          Only relevant for Python versions older than V3.0.
|          For Python versions 3.0 and later, getString can be used instead.
|              path: Path string of the node.
|
|  help(...)
|      help( (ZoomFFTModule)self [, (str)path='*']) -> None :
|          Returns a well-formatted description of a module parameter.
|              path: Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|
|  listNodes(...)
|      listNodes( self, (str)path [, (int)flags], **opts) -> list :
|         This function returns a list of node names found at the specified path.
|
|         Positional arguments:
|             path:  Path for which the nodes should be listed. The path may
|                    contain wildcards so that the returned nodes do not
|                    necessarily have to have the same parents.
|             flags: Flags specifying how the selected nodes are listed
|                    (see ziPython.ziListEnum). Flags can also specified by
|                    the keyword arguments below.
|
|         Keyword arguments:
|             recursive: Returns the nodes recursively (default: False)
|             absolute: Returns absolute paths (default: True)
|             leavesonly: Returns only nodes that are leaves, which means they
|                    are at the outermost level of the tree (default: False).
|             settingsonly: Returns only nodes which are marked as setting
|                    (default: False).
|             streamingonly: Returns only streaming nodes (default: False).
|             subscribedonly: Returns only subscribed nodes (default: False).
|             basechannelonly: Return only one instance of a node in case of
|                    multiple channels (default: False).
|             excludestreaming: Exclude streaming nodes (default: False).
|             excludevectors: Exclude vector nodes (default: False).
|
```

```
 |  listNodesJSON(...)
 |      listNodesJSON( self, (str)path [, (int)flags], **opts) -> str :
 |         Returns a list of nodes with description found at the specified path.
 |
 |         Positional arguments:
 |             path:  Path for which the nodes should be listed. The path may
 |                    contain wildcards so that the returned nodes do not
 |                    necessarily have to have the same parents.
 |             flags: Flags specifying how the selected nodes are listed
 |                    (see ziPython.ziListEnum). Flags can also specified by
 |                    the keyword arguments below. They are the same as for
 |                    listNodes(), except that recursive, absolute, and leavesonly
 |                    are enforced.
 |
 |         Keyword arguments:
 |             settingsonly: Returns only nodes which are marked as setting
 |                    (default: False).
 |             streamingonly: Returns only streaming nodes (default: False).
 |             subscribedonly: Returns only subscribed nodes (default: False).
 |             basechannelonly: Return only one instance of a node in case of
 |                    multiple channels (default: False).
 |             excludestreaming: Exclude streaming nodes (default: False).
 |             excludevectors: Exclude vector nodes (default: False).
 |
 |  progress(...)
 |      progress( (ZoomFFTModule)self) -> object :
 |          Reports the progress of the measurement with a number between
 |          0 and 1.
 |
 |  read(...)
 |      read( (ZoomFFTModule)self [, (bool)flat=False]) -> object :
 |          Read zoom FFT data. If the zoom FFT is still ongoing only a subset
 |          of zoom FFT data is returned.
 |              flat: Specify which type of data structure to return.
 |                    Return data either as a flat dict (True) or as a nested
 |                    dict tree (False). Default = False.
 |
 |  save(...)
 |      save( (ZoomFFTModule)self, (str)filename) -> None :
 |          Save zoom FFT data to file.
 |              path: File name string (without extension).
 |
 |  set(...)
 |      set( (ZoomFFTModule)self, (str)path, (object)value) -> None :
 |          Set the specified module parameter value. Use 'help' to learn more
 |          about available parameters.
 |              path:  Path string of the node.
 |              value: Value of the node.
 |
 |      set( (ZoomFFTModule)self, (object)items) -> None :
 |              items: A list of path/value pairs.
 |
 |  subscribe(...)
 |      subscribe( (ZoomFFTModule)self, (str)path) -> None :
 |          Subscribe to one or several nodes. After subscription the zoom FFT
 |          process can be started with the 'execute' command. During the
 |          zoom FFT process paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  trigger(...)
 |      trigger( (ZoomFFTModule)self) -> None :
 |          Execute a manual trigger.
 |
 |  unsubscribe(...)
 |      unsubscribe( (ZoomFFTModule)self, (str)path) -> None :
```

```
 |          Unsubscribe from one or several nodes. During the
 |          zoom FFT process paths can not be subscribed or unsubscribed.
 |              path: Path string of the node. Use wild card to
 |                    select all. Alternatively also a list of path
 |                    strings can be specified.
 |
 |  ----------------------------------------------------------------------
 |  Static methods inherited from Boost.Python.instance:
 |
 |  __new__(*args, **kwargs) from Boost.Python.class
 |      Create and return a new object.  See help(type) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors inherited from Boost.Python.instance:
 |
 |  __dict__
 |
 |  __weakref__
```

Chapter 6. LabVIEW Programming

Interfacing with your Zurich Instruments device via National Instruments' LabVIEW® is an efficient choice in terms of development time and run-time performance. LabVIEW is a graphical programming language designed to interface with laboratory equipment via so-called VIs ("virtual instruments"), whose key strength is the ease of displaying dynamic signals obtained from your instrument.

This chapter aims to help you get started using the Zurich Instruments LabOne LabVIEW API to control your instrument, please refer to:

- Section 6.1 for help Installing the LabOne LabVIEW API.
- Section 6.2 for help Getting Started with the LabOne LabVIEW API and running the examples.
- Section 6.3 for some LabVIEW Programming Tips and Tricks.

Note

This section and the provided examples are not intended to be a general LabVIEW tutorial. See, for example, the National Instruments website for help to get started programming with LabVIEW.

6.1. Installing the LabOne LabVIEW API

6.1.1. Requirements

One of the following platforms and LabVIEW versions is required to use the LabOne LabVIEW API:

1. 32 or 64-bit Windows with LabVIEW 2009 or newer.
2. 32 or 64-bit Linux with LabVIEW 2009 or newer.
3. 32 or 64-bit Mac OS X and LabVIEW 2010 or newer.

The LabOne LabVIEW API is included in a standard LabOne installation and is also available as a separate package (see below, Separate LabVIEW Package). In order to make the LabOne LabVIEW API available for use within LabVIEW, a directory needs to be copied to a specific directory of your LabVIEW installation. Both the main LabOne installer and the separate LabOne LabVIEW API package are available from Zurich Instruments' download page.

Separate LabVIEW Package

The separate LabVIEW API package should be used if you would like to either:

1. Use the LabVIEW API on Mac OS X (the main LabOne installer is not available for Mac OS X).
2. Use the LabVIEW API to work with an instrument remotely (i.e., on a separate PC from where the Data Server is running) and you do not require a full LabOne installation. This is the case, for example, with MF Instruments.

6.1.2. Windows Installation

1. Locate the `instr.lib` directory in your LabVIEW installation and delete any previous Zurich Instruments API directories. The `instr.lib` directory is typically located at:

   ```
   C:\Program Files\National Instruments\LabVIEW 201x\instr.lib\
   ```

   Previous Zurich Instruments installations will be directories located in the `instr.lib` directory that are named either:

   - `Zurich Instruments HF2`, or
   - `Zurich Instruments LabOne`.

   These folders may simply be deleted (administrator rights required).
2. On Windows, either navigate to the `API\LabVIEW` subdirectory of your LabOne installation or, in the case of the separate installer (see Separate LabVIEW Package), the directory of the unzipped LabOne LabVIEW package, and copy the subdirectory

   ```
   Zurich Instruments LabOne
   ```

   to the `instr.lib` directory in your LabVIEW installation as located in Step 1. Note, you will need administrator rights to copy to this directory.

   In the case of copying from a LabOne installation, this folder is typically located at:

   ```
   C:\Program Files\Zurich Instruments\LabOne\API\LabVIEW\
   ```
3. Restart LabVIEW and verify your installation as described in Section 6.1.4.

6.1.3. Linux and Mac Installation

1. Locate the `instr.lib` directory in your LabVIEW installation and remove any previous Zurich Instruments API installations. The `instr.lib` directory is typically located on Linux at:

   ```
   /usr/local/natinst/LabVIEW-201x/instr.lib/
   ```

   and on Mac OS X at:

   ```
   /Applications/National Instruments/LabVIEW 201x/instr.lib/
   ```

   Previous Zurich Instruments installations will be folders located in the `instr.lib` directory that are named either:

   - `Zurich Instruments HF2`, or
   - `Zurich Instruments LabOne`.

   These folders may simply be deleted (administrator rights required).
2. Navigate to the path where you unpacked LabOne or the Separate LabVIEW Package and copy the subdirectory

   ```
   Zurich Instruments LabOne/
   ```

   to the `instr.lib` directory in your LabVIEW installation as located in Step 1. Note, you will need administrator rights to copy to this directory.

   Note, when copying frmo the main LabOne tarball (Linux only), the `Zurich Instruments LabOne/` directory is located in

   ```
   [PATH]/LabOneLinux64/API/LabVIEW/
   ```
3. Restart LabVIEW and verify your installation as described in Section 6.1.4.

6.1.4. Verifying your Installation

If the LabOne LabVIEW API palette can be accessed from within LabVIEW, the LabOne LabVIEW API is correctly installed. See Section 6.2.1 for help finding the palette.

6.2. Getting Started with the LabOne LabVIEW API

6.2.1. Locating the LabOne LabVIEW VI Palette

In order to locate the LabOne LabVIEW VIs start LabVIEW and create a new VI. In the VI's "Block Diagram" (CTRL-e) you can to access the LabOne LabVIEW API palette with a mouse right-click and browsing the tree under "Instrument I/O" → "Instr. Drivers", see Figure 6.1.

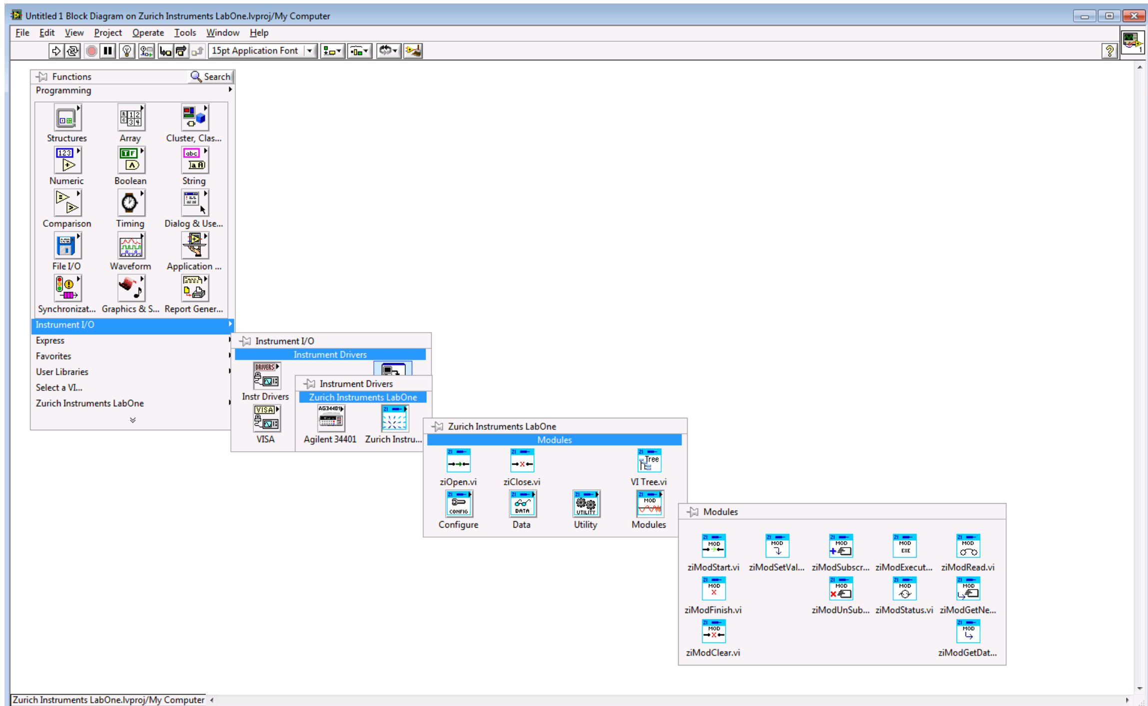


Figure 6.1. Locating the LabOne LabVIEW Palette

6.2.2. LabOne LabVIEW Programming Concepts

As described in Section 1.2 a LabVIEW program communicates to a Zurich Instrument device via a software program running on the PC called the data server. In general, the outline of the instruction flow for a LabVIEW virtual instrument is as following:

1. Initialization: Open a connection from the API to the data server program.
2. Configuration: Perform the instrument's settings. For example, using the virtual instrument `ziSetValueDouble.vi`.
3. Data: Read data from the instrument.
4. Utility: Perform data analysis on the read data, potentially repeating Step 2 and/or Step 3.
5. Close: Terminate the API's connection to the data server program.

The `VI Tree.vi` included the LabOne LabVIEW API demonstrates this flow and lists common VIs used for working with a Zurich Instruments device, see Figure 6.2. The `VI Tree.vi` can be found either via the LabOne VI palette, see Section 6.2.1, or by opening the file in the `Public` folder of your LabOne LabVIEW installation, typically located at:

```
C:\Program Files\National Instruments\LabVIEW 2012\instr.lib\Zurich
Instruments LabOne\Public\VI Tree.vi
```

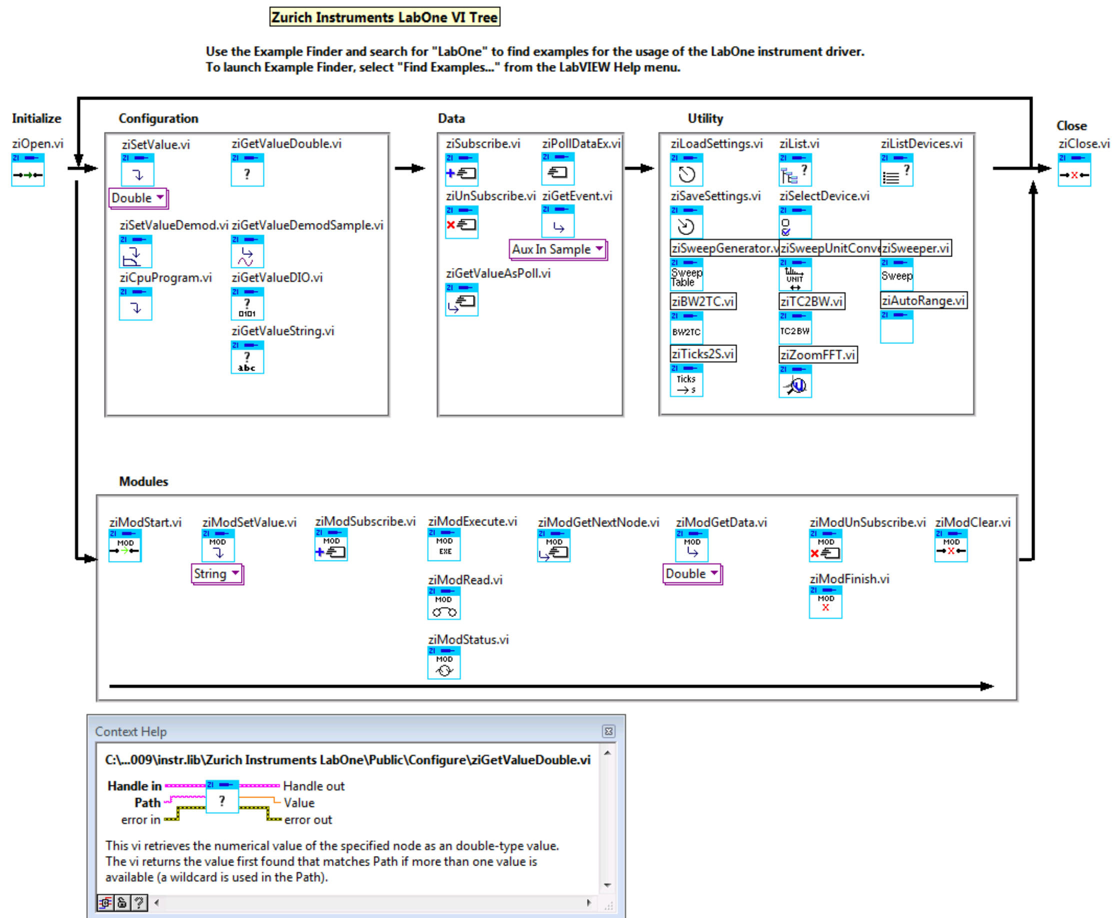


Figure 6.2. An overview of the LabOne LabVIEW VIs is given in `VI Tree.vi`. Press CTRL-h after selecting one of the VIs to obtain help.

6.2.3. Using ziCore Modules in the LabOne LabVIEW API

LabOne `ziCore` Modules Modules (e.g. Sweeper) enable high-level measurement tools to use with your Zurich instrument device in LabVIEW. The outline of the instruction flow for a LabVIEW Module is as following:

1. Initialization: Create a ziModHandle from a ziHandle `ziModStart.vi`.
2. Configuration: Perform the module's settings. For example, using the virtual instrument `ziModSetValue.vi`.
3. Subscribe: Define the recorded data node `ziModSubscribe.vi`.
4. Execute: Start the operation of the module `ziModExecute.vi`.
5. Data: Read data from the module. For example, using the `ziModGetNextNode.vi` and `ziModGetData.vi`.
6. Utility: Perform data analysis on the read data, potentially repeating Step 2, Step 3 and/or Step 4.
7. Clear: Terminate the API's connection to the module `ziModClear.vi`.

6.2.4. Finding help for the LabOne VIs from within LabVIEW

As is customary for LabVIEW, built-in help for LabOne's VIs can be obtained by selecting the VI with the mouse in a block diagram and pressing CTRL-h to view the VI's context help. See Figure 6.2 for an example.

6.2.5. Finding the LabOne LabVIEW API Examples

Many examples come bundled with the LabOne LabVIEW API which demonstrate the most important concepts of working with Zurich Instrument devices. The easiest way to browse the list of available examples is via the NI Example Finder: In LabVIEW select "Find Examples..." from the "Help" menu-bar and search for "LabOne", see Figure 6.3.

The examples are located in the directory `instr.lib/Zurich Instruments LabOne/Examples` found in LabVIEW installation directory. In order to modify an example for your needs, please copy it to your local workspace.

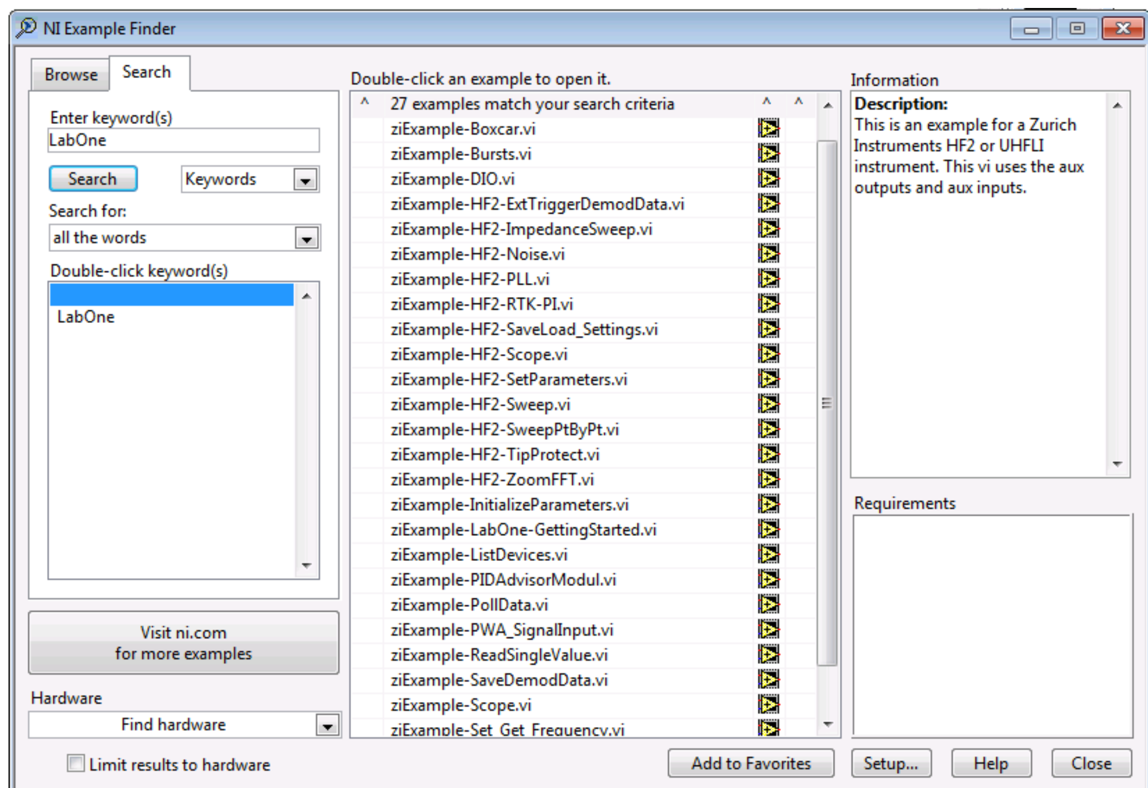


Figure 6.3. Search for "LabOne" in NI's Example Finder to find examples to run with your instrument.

6.2.6. Running the LabOne Example VIs

This section describes how to run a LabOne LabVIEW example on your instrument.

Note

Please ensure that the example you would like to run is supported by your instrument class and its options set. For example, examples for HF2 Instruments can be found in the Example Finder

(see Section 6.2.5) by searching for "HF2", examples for the UHFLI by searching for "UHFLI" and examples for the MFLI by searching for "MFLI".

Device Connection

After opening one of the LabOne LabVIEW examples, please ensure that the example is configured to run on the desired instrument type. `ziOpen.vi` establishes a connection to a Data Server. The address is of the format `{<host>}{:<port>}::{<Device ID>}`. Usually it is sufficient to provide the Device ID only highlighted in Figure 6.4. The Device ID corresponds to the serial number (S/N) found on the instrument rear panel. The host and port are then determined by network discovery. Should the discovery not work, prepend `<host>:<port>::` to the Device ID. Examples are "myhf2.company.com:8004::dev466" or "myhf2.company.com:8004". In the latter case the first found instrument on the data server listening on "myhf2.company.com:8004" will be selected.

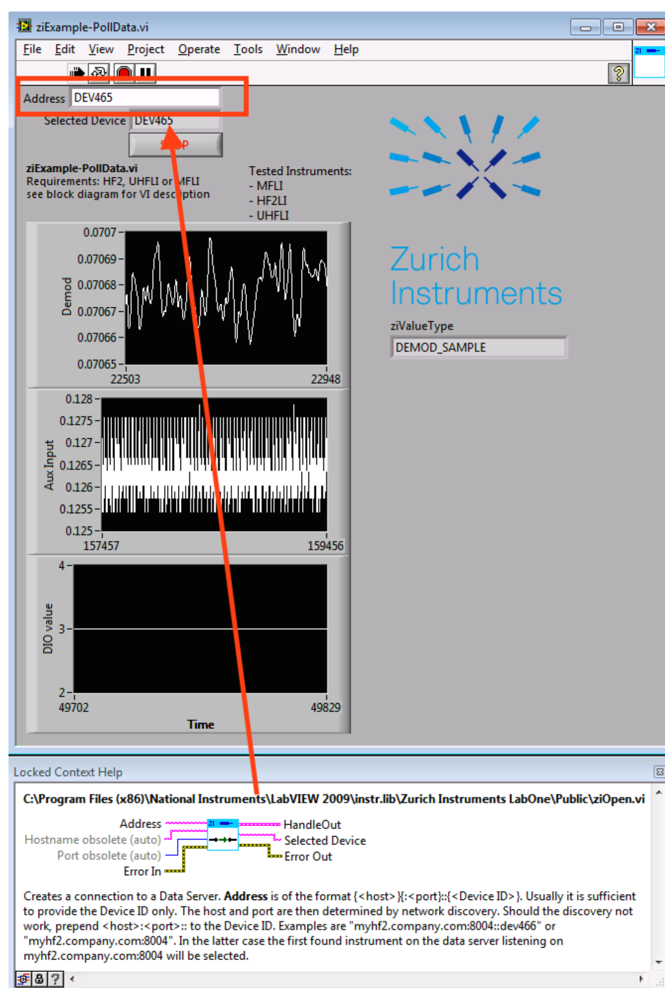


Figure 6.4. LabOne LabVIEW Example Poll Data: Device selection.

Running the VI and Block Diagram

The example can be ran as any LabVIEW program; by clicking the "Run" icon in the icon bar. Be sure to check the example's code and explanation by pressing CTRL-e to view the example's block diagram, see Figure 6.5.

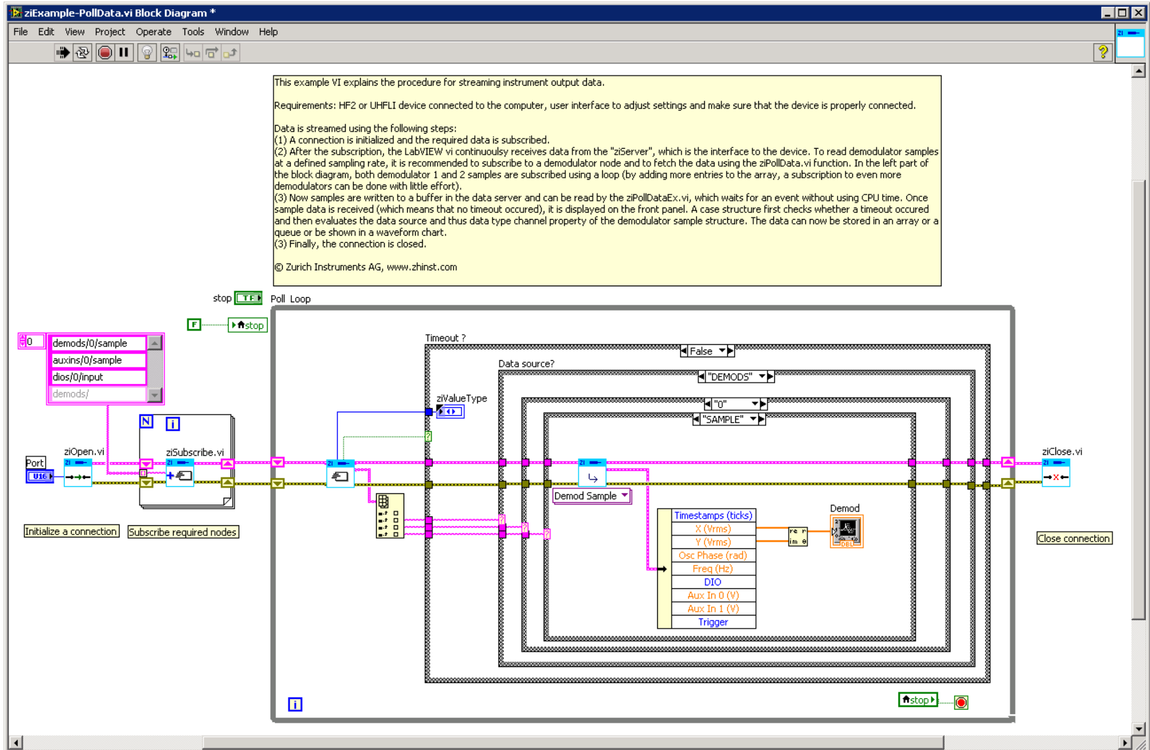


Figure 6.5. LabOne LabVIEW Example Poll Data: Block Diagram.

6.3. LabVIEW Programming Tips and Tricks

Use the User Interface's command log or Server's text interface while programming with LabVIEW

As with all other interfaces, LabVIEW uses the "path" and "nodes" concept to address settings on an instrument, see Section 1.2. In order to learn about or verify the nodes available it can be very helpful to view the command log in the User Interface (see the bar in the bottom of the screen) to see which node has been configured during a previous setting change. The text interface (HF2 Series) provides a convenient way to explore the node hierarchy.

Always close ziHandles and ziModHandles or LabVIEW runs out of memory

If you use the "Abort Execution" button of LabVIEW, your LabVIEW program will not close any existing connections to the ziServer. Any open connection inside of LabVIEW will persist and continue to consume about 12 MB of RAM so that with time you will run out of memory. Completely exit LabVIEW in order to release the memory again.

Use shift registers

The structure of efficient LabVIEW code is distinguished by signals being "piped through" by use of shift registers in loops and by the absence of object replication. Using shift registers in LabVIEW avoids copying of data and, more important, running the garbage collector frequently.

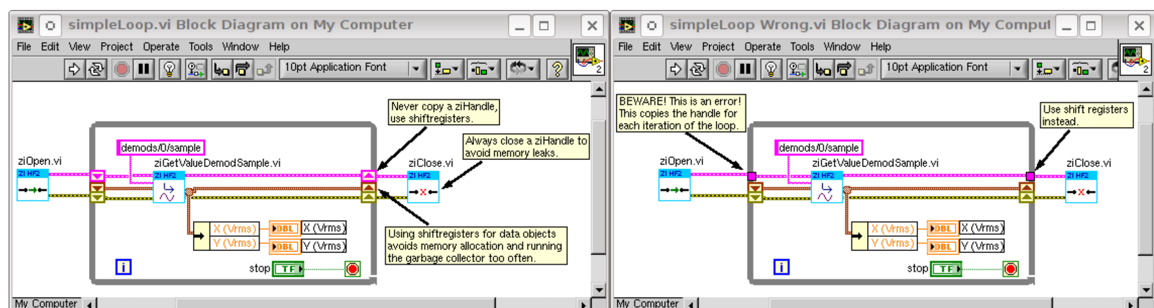


Figure 6.6. Examples of simple LabVIEW programs for the Zurich Instruments HF2 Series. Left: A well implemented loop, Right: An example for-loop gone wrong.

Chapter 7. .NET Programming

This chapter helps you get started using Zurich Instruments LabOne's .NET API to control your instrument or integrate your instrument into an established .NET based control framework.

- Section 7.1 for help Installing the LabOne .NET API.
- Section 7.2 for help Getting Started with the LabOne .NET API,
- Section 7.3 for LabOne .NET API Examples.

Note

This chapter and the examples are not intended to be a .NET and Visual Studio or an introduction to any specific programming language.

7.1. Installing the LabOne .NET API

7.1.1. Requirements

To use LabOne's .NET API, `ziDotNET`, a Microsoft Visual Studio installation is required. The .NET API is a class library supporting x64 and win32 platforms. As the API is platform specific the project also needs to be platform specific.

The LabOne .NET API `ziDotNET` is included in a standard LabOne installation. No installation as such is required, but the corresponding dynamically linked library (DLL) files need to be copied to the folder of the Visual Studio solution, and a few configuration steps must be performed. The main LabOne installer is available from Zurich Instruments' download page.

7.2. Getting Started with the LabOne .NET API

This section introduces the user to the LabOne .NET API. In order to use the LabOne API for .NET applications two DLL libraries should be copied to the application execution folder. The libraries are platform specific. Therefore, the project platform of the project should be restricted either to x64 or win32 CPU architecture. The following figures illustrate the initial steps to create a C# project using the LabOne API. The setup for other languages like Visual Basic or F# is equivalent.

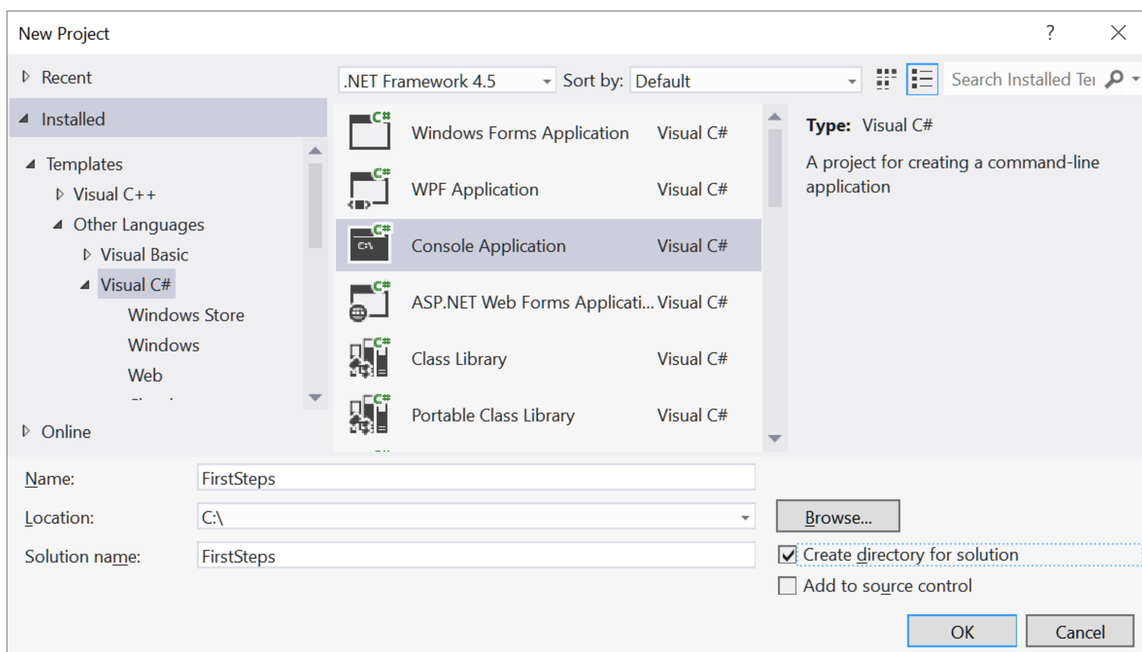
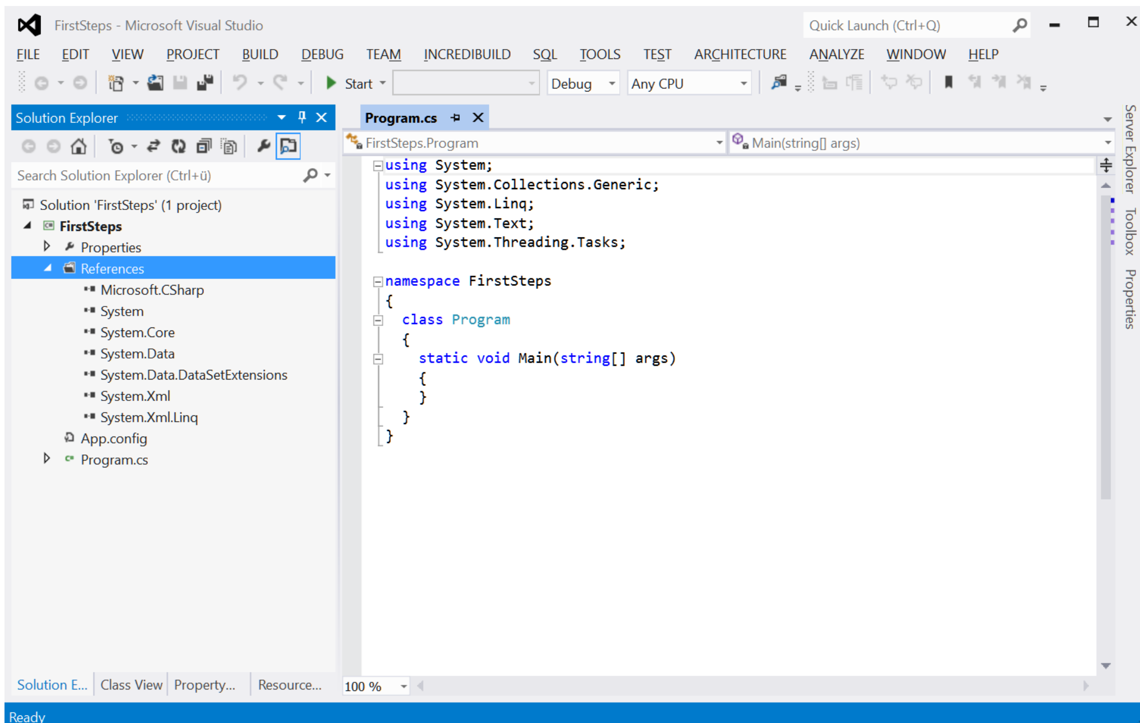


Figure 7.1. Creating a new C# project based on a solution.

Create a new project and choose Visual C# as a programming language and Console Aplication as target.




```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;

namespace FirstSteps
{
    class Program
    {
        static void Main(string[] args)
        {
        }
    }
}
```

Figure 7.2. C# project with main program code opened in editor. Initially the project will support any CPU architecture. The ziDotNET API only supports x64 and win32 platforms.

The first step which needs to be done is to define the target platform as initially a Visual C# project is platform independent. To do this, click on the `Active solution platform` box, select `Configuration Manager...` to open the the `Configuration Manager`. In the following window click on the arrow under platform add a New target and choose x64 (Figure 7.3).

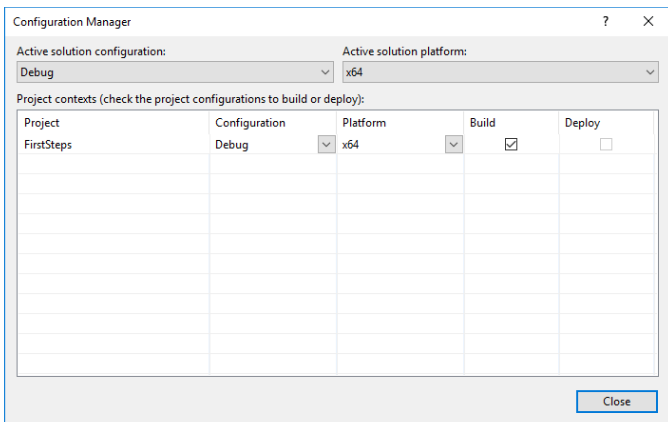


Figure 7.3. C# project with main program code opened in editor. Initially the project will support any CPU architecture. The ziDotNET API only supports x64 and win32 platforms.

The LabOne API for .NET consists of two DLLs for each platform that supply all functionality for connecting to the LabOne Data Servers on the specific platform (x64 and win32) and executing LabOne Modules. For simplicity we only discuss the x64 plattform in this section, but the needed steps are analogous for the win32 platform. For x64 the two DLLs are ziDotNETCore-win64.dll and ziDotNET-win64.dll. The two DLL must accompany the executable using the functionality. The dll files are installed under your LabOne installation path in the API/DotNet folder (usually `C:\Program Files\Zurich Instruments\LabOne\API\DotNET`). Copy the two DLLs for your platform into the solution folder.

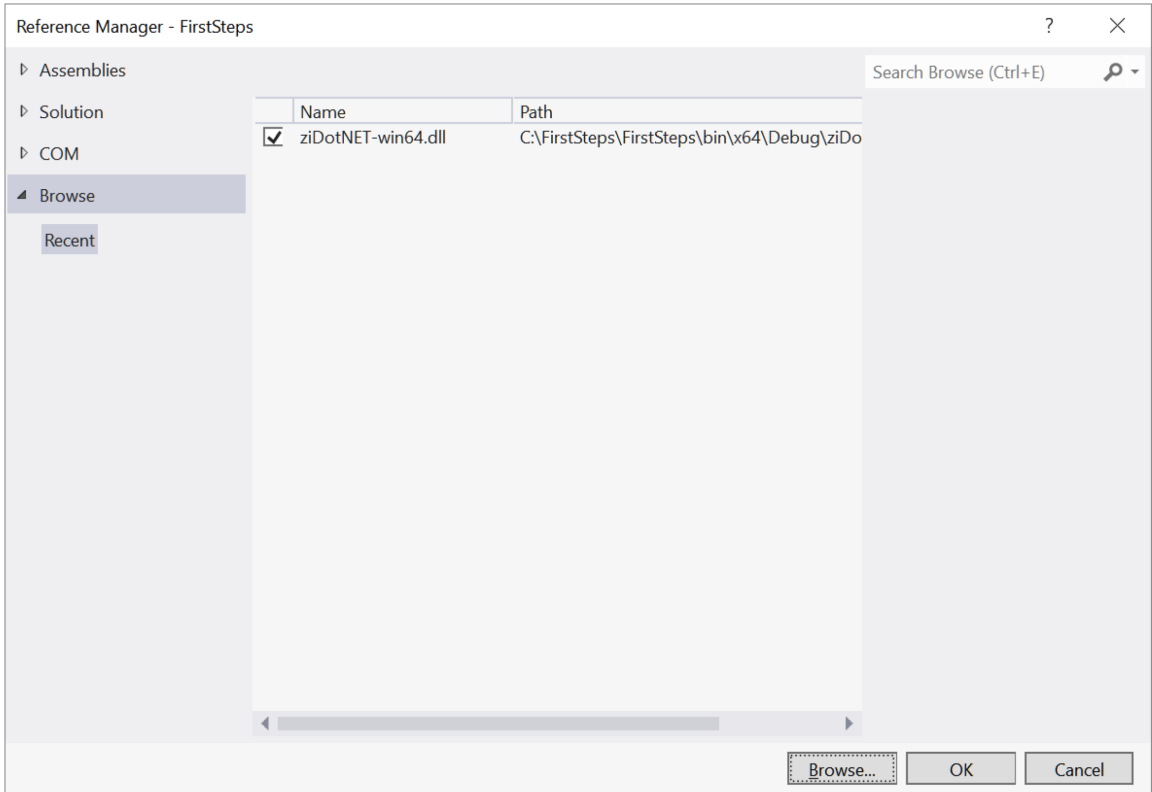


Figure 7.4. Reference to the API DLL ziDotNET for the specific platform.

To add the DLL to the project go to the solution explorer of your project (Figure 7.2) and right click on References and add the ziDotNET-win64.dll (Figure 7.4)

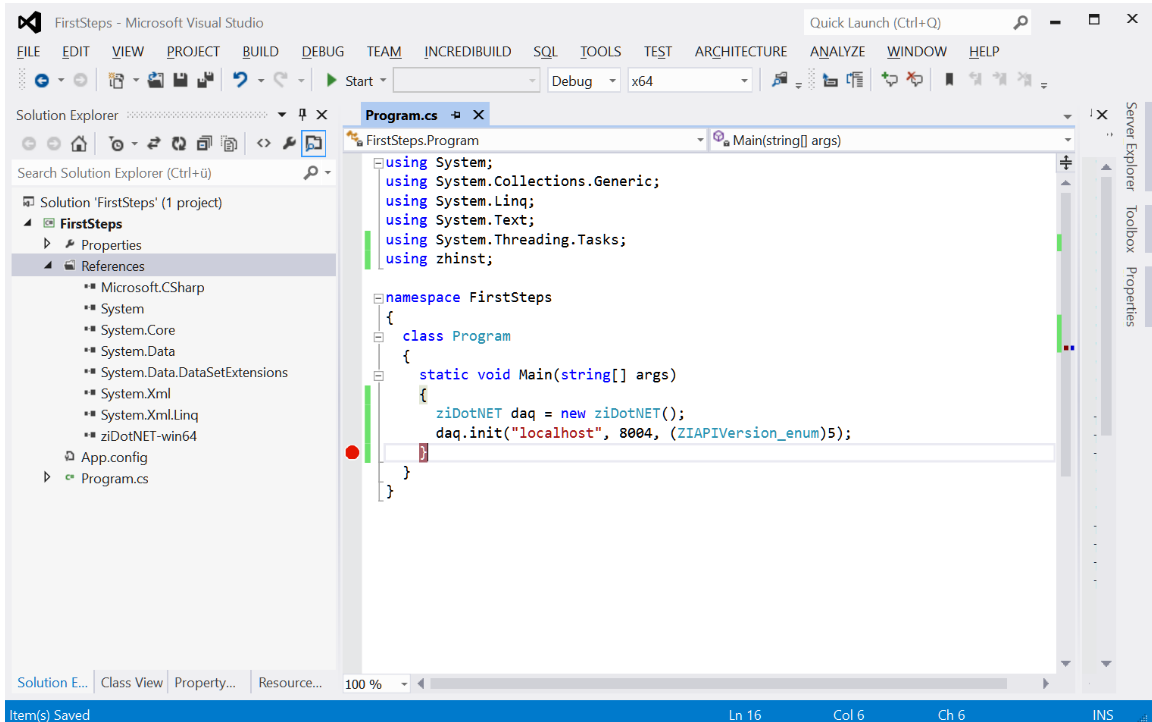


Figure 7.5. Added `using zhinst;` statement and code to open the connection to the server.

Figure 7.5 shows a first simple program which is done by adding `using zhinst;` to the include directive and the following code to the main body.

```
ziDotNET daq = new ziDotNET();
daq.init("localhost",8004,(ZIAPIVersion_enum)5);
```

If everything is configured correctly, the code compiles and when executed opens a session to a running LabOne data server and closes it before exiting the program.

7.3. LabOne .NET API Examples

The source code for the following program (Examples.cs) can be found in your LabOne installation path in the `API/DotNet` folder (usually `C:\Program Files\Zurich Instruments\LabOne\API\DotNET`).

```
      using System;
using System.Collections.Generic;
using System.Diagnostics;
using System.Globalization;
using System.IO;
using System.Linq;
using zhinst;

namespace ziDotNetExamples
{
  /// <summary>
  /// This exception is used to notify that the example could not be executed.
  ///
  /// <param name="msg">The reason why the example was ot executed</param>
  /// </summary>
  public class SkipException : Exception
  {
    public SkipException(string msg) : base(msg) { }
  }

  public class Examples
  {
    const string DEFAULT_DEVICE = "dev8047";

    // The resetDeviceToDefault will reset the device settings
    // to factory default. The call is quite expensive
    // in runtime. Never use it inside loops!
    private static void resetDeviceToDefault(ziDotNET daq, string dev)
    {
      if (isDeviceFamily(daq, dev, "HDAWG"))
      {
        // The HDAWG device does currently not support presets
        return;
      }
      if (isDeviceFamily(daq, dev, "HF2"))
      {
        // The HF2 devices do not support the preset functionality.
        daq.setDouble(String.Format("/{0}/demods/*/rate", dev), 250);
        return;
      }

      daq.setInt(String.Format("/{0}/system/preset/index", dev), 0);
      daq.setInt(String.Format("/{0}/system/preset/load", dev), 1);
      while (daq.getInt(String.Format("/{0}/system/preset/busy", dev)) != 0)
      {
        System.Threading.Thread.Sleep(100);
      }
      System.Threading.Thread.Sleep(1000);
    }

    // The isDeviceFamily checks for a specific device family.
    // Currently available families: "HF2", "UHF", "MF"
    private static bool isDeviceFamily(ziDotNET daq, string dev, String family)
    {
      String path = String.Format("/{0}/features/devtype", dev);
      String devType = daq.getByte(path);
      return devType.StartsWith(family);
    }
```

```
    // The hasOption function checks if the device
    // does support a specific functionality, thus
    // has installed the option.
    private static bool hasOption(ziDotNET daq, string dev, String option)
    {
      String path = String.Format("/{0}/features/options", dev);
      String options = daq.getByte(path);
      return options.Contains(option);
    }

    public static void SkipRequiresOption(ziDotNET daq, string dev, string option)
    {
      if (hasOption(daq, dev, option))
      {
        return;
      }
      daq.disconnect();
      Skip($"Required a device with option {option}.");
    }

    public static void SkipForDeviceFamily(ziDotNET daq, string dev, string family)
    {
      if (isDeviceFamily(daq, dev, family))
      {
        Skip($"This example may not be run on a device of familiy {family}.");
        daq.disconnect();
      }
    }

    public static void SkipForDeviceFamilyAndOption(ziDotNET daq, string dev, string
family, string option)
    {
      if (isDeviceFamily(daq, dev, family))
      {
        SkipRequiresOption(daq, dev, option);
      }
    }

    // Please handle version mismatches depending on your
    // application requirements. Version mismatches often relate
    // to functionality changes of some nodes. The API interface is still
    // identical. We strongly recommend to keep the version of the
    // API and data server identical. Following approaches are possible:
    // - Convert version mismatch to a warning for the user to upgrade / downgrade
    // - Convert version mismatch to an error to enforce full matching
    // - Do an automatic upgrade / downgrade
    private static void apiServerVersionCheck(ziDotNET daq)
    {
      String serverVersion = daq.getByte("/zi/about/version");
      String apiVersion = daq.version();

      AssertEqual(serverVersion, apiVersion,
             "Version mismatch between LabOne API and Data Server.");
    }

    // Connect initializes a session on the server.
    private static ziDotNET connect(string dev)
    {
      ziDotNET daq = new ziDotNET();
      String id = daq.discoveryFind(dev);
      String iface = daq.discoveryGetValueS(dev, "connected");
      if (string.IsNullOrWhiteSpace(iface))
      {
        // Device is not connected to the server
        String ifacesList = daq.discoveryGetValueS(dev, "interfaces");
        // Select the first available interface and use it to connect
```

```
        string[] ifaces = ifacesList.Split('\n');
        if (ifaces.Length > 0)
        {
          iface = ifaces[0];
        }
      }
      String host = daq.discoveryGetValueS(dev, "serveraddress");
      long port = daq.discoveryGetValueI(dev, "serverport");
      long api = daq.discoveryGetValueI(dev, "apilevel");
      System.Diagnostics.Trace.WriteLine(
        String.Format("Connecting to server {0}:{1} wich API level {2}",
        host, port, api));
      daq.init(host, Convert.ToUInt16(port), (ZIAPIVersion_enum)api);
      // Ensure that LabOne API and LabOne Data Server are from
      // the same release version.
      apiServerVersionCheck(daq);
      // If device is not yet connected a reconnect
      // will not harm.
      System.Diagnostics.Trace.WriteLine(
        String.Format("Connecting to {0} on inteface {1}", dev, iface));
      daq.connectDevice(dev, iface, "");

      return daq;
    }

    private static void Skip(string msg)
    {
      throw new SkipException($"SKIP: {msg}");
    }

    private static void Fail(string msg = null)
    {
      if (msg == null)
      {
        throw new Exception("FAILED!");
      }
      throw new SkipException($"FAILED: {msg}!");
    }

    private static void AssertNotEqual<T>(T expected, T actual, string msg = null)
 where T : IComparable<T>
    {
      if (msg != null)
      {
        Debug.Assert(!expected.Equals(actual));
        return;
      }
      Debug.Assert(!expected.Equals(actual));
    }

    private static void AssertEqual<T>(T expected, T actual, string msg = null) where
 T : IComparable<T>
    {
      if (msg != null)
      {
        Debug.Assert(expected.Equals(actual), msg);
        return;
      }
      Debug.Assert(expected.Equals(actual));
    }

    // ExamplePollDemodSample connects to the device,
    // subscribes to a demodulator, polls the data for 0.1 s
    // and returns the data.
    public static void ExamplePollDemodSample(string dev = DEFAULT_DEVICE)
    {
      ziDotNET daq = connect(dev);
```

```
      SkipForDeviceFamily(daq, dev, "HDAWG");

      resetDeviceToDefault(daq, dev);
      String path = String.Format("/{0}/demods/0/sample", dev);
      daq.subscribe(path);
      // After the subscribe the poll can be executed
      // continuously within a loop
      Lookup lookup = daq.poll(0.1, 100, 0, 1);
      Dictionary<String, Chunk[]> nodes = lookup.nodes;  // Iterable nodes
      Chunk[] chunks = lookup[path];  // Iterable chunks
      Chunk chunk = lookup[path][0];  // Single chunk
                                      // Vector of samples
      ZIDemodSample[] demodSamples = lookup[path][0].demodSamples;
      // Single sample
      ZIDemodSample demodSample0 = lookup[path][0].demodSamples[0];
      daq.disconnect();

      Debug.Assert(0 != demodSample0.timeStamp);
    }

    // ExamplePollImpedanceSample connects to the device,
    // subscribes to a impedance stream, polls the data for 0.1 s
    // and returns the data.
    public static void ExamplePollImpedanceSample(string dev = DEFAULT_DEVICE)
    {
      ziDotNET daq = connect(dev);
      // This example only works for devices with installed
      // Impedance Analyzer (IA) option.
      if (!hasOption(daq, dev, "IA"))
      {
        daq.disconnect();
        Skip("Not supported by device.");
      }
      resetDeviceToDefault(daq, dev);
      // Enable impedance control
      daq.setInt(String.Format("/{0}/imps/0/enable", dev), 1);
      // Return R and Cp
      daq.setInt(String.Format("/{0}/imps/0/model", dev), 0);
      // Enable user compensation
      daq.setInt(String.Format("/{0}/imps/0/calib/user/enable", dev), 1);
      // Wait until auto ranging has settled
      System.Threading.Thread.Sleep(4000);
      // Subscribe to the impedance data stream
      String path = String.Format("/{0}/imps/0/sample", dev);
      daq.subscribe(path);
      // After the subscribe the poll can be executed
      // continuously within a loop
      Lookup lookup = daq.poll(0.1, 100, 0, 1);
      Dictionary<String, Chunk[]> nodes = lookup.nodes;  // Iterable nodes
      Chunk[] chunks = lookup[path];  // Iterable chunks
      Chunk chunk = lookup[path][0];  // Single chunk
                                      // Vector of samples
      ZIImpedanceSample[] impedanceSamples = lookup[path][0].impedanceSamples;
      // Single sample
      ZIImpedanceSample impedanceSample0 = lookup[path][0].impedanceSamples[0];
      // Extract the R||C representation values
      System.Diagnostics.Trace.WriteLine(
              String.Format("Impedance Resistor value: {0} Ohm.",
impedanceSample0.param0));
      System.Diagnostics.Trace.WriteLine(
              String.Format("Impedance Capacitor value: {0} F.",
impedanceSample0.param1));
      daq.disconnect();

      AssertNotEqual(0ul, impedanceSample0.timeStamp);
    }
```

```
    // ExamplePollDoubleData is similar to ExamplePollDemodSample,
    // but it subscribes and polls floating point data.
    public static void ExamplePollDoubleData(string dev = DEFAULT_DEVICE)
    {
      ziDotNET daq = connect(dev);
      String path = String.Format("/{0}/oscs/0/freq", dev);
      daq.getAsEvent(path);
      daq.subscribe(path);
      Lookup lookup = daq.poll(1, 100, 0, 1);
      Dictionary<String, Chunk[]> nodes = lookup.nodes;  // Iterable nodes
      Chunk[] chunks = lookup[path];  // Iterable chunks
      Chunk chunk = lookup[path][0];  // Single chunk
      ZIDoubleData[] doubleData = lookup[path][0].doubleData;  // Vector of samples
      ZIDoubleData doubleData0 = lookup[path][0].doubleData[0];  // Single sample
      daq.disconnect();

      AssertNotEqual(0ul, doubleData0.timeStamp);
    }

    // ExamplePollPwaData is similar to ExamplePollDemodSample,
    // but it subscribes and polls periodic waveform analyzer
    // data from a device with the Boxcar option.
    public static void ExamplePollPwaData(string dev = DEFAULT_DEVICE) //
 Timeout(10000)
    {
      ziDotNET daq = connect(dev);
      // The PWA example only works for devices with installed Boxcar (BOX) option
      if (hasOption(daq, dev, "BOX"))
      {
        String enablePath = String.Format("/{0}/inputpwas/0/enable", dev);
        daq.setInt(enablePath, 1);
        String path = String.Format("/{0}/inputpwas/0/wave", dev);
        daq.subscribe(path);
        Lookup lookup = daq.poll(1, 100, 0, 1);
        UInt64 timeStamp = lookup[path][0].pwaWaves[0].timeStamp;
        UInt64 sampleCount = lookup[path][0].pwaWaves[0].sampleCount;
        UInt32 inputSelect = lookup[path][0].pwaWaves[0].inputSelect;
        UInt32 oscSelect = lookup[path][0].pwaWaves[0].oscSelect;
        UInt32 harmonic = lookup[path][0].pwaWaves[0].harmonic;
        Double frequency = lookup[path][0].pwaWaves[0].frequency;
        Byte type = lookup[path][0].pwaWaves[0].type;
        Byte mode = lookup[path][0].pwaWaves[0].mode;
        Byte overflow = lookup[path][0].pwaWaves[0].overflow;
        Byte commensurable = lookup[path][0].pwaWaves[0].commensurable;
        double[] grid = lookup[path][0].pwaWaves[0].binPhase;
        double[] x = lookup[path][0].pwaWaves[0].x;
        double[] y = lookup[path][0].pwaWaves[0].y;
        String fileName = Environment.CurrentDirectory + "/pwa.txt";
        System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);
        file.WriteLine("TimeStamp: {0}", timeStamp);
        file.WriteLine("Sample Count: {0}", sampleCount);
        file.WriteLine("Input Select: {0}", inputSelect);
        file.WriteLine("Osc Select: {0}", oscSelect);
        file.WriteLine("Frequency: {0}", frequency);
        for (int i = 0; i < grid.Length; ++i)
        {
          file.WriteLine("{0} {1} {2}", grid[i], x[i], y[i]);
        }
        file.Close();

        AssertNotEqual(0ul, timeStamp);
        AssertNotEqual(0ul, sampleCount);
        AssertNotEqual(0, grid.Length);
      }
      daq.disconnect();
    }
```

```
    // ExamplePollScopeData is similar to ExamplePollDemodSample,
    // but it subscribes and polls scope data.
    public static void ExamplePollScopeData(string dev = DEFAULT_DEVICE)
    {
      ziDotNET daq = connect(dev);
      SkipForDeviceFamily(daq, dev, "HDAWG");

      resetDeviceToDefault(daq, dev);

      String enablePath = String.Format("/{0}/scopes/0/enable", dev);
      daq.setInt(enablePath, 1);
      String path = String.Format("/{0}/scopes/0/wave", dev);
      daq.subscribe(path);
      Lookup lookup = daq.poll(1, 100, 0, 1);
      UInt64 timeStamp = lookup[path][0].scopeWaves[0].header.timeStamp;
      UInt64 sampleCount = lookup[path][0].scopeWaves[0].header.totalSamples;
      daq.disconnect();

      AssertNotEqual(0ul, timeStamp);
      AssertNotEqual(0ul, sampleCount);
    }

    // ExamplePollVectorData connects to the device, requests data from
    // vector nodes, and polls until data is received.
    public static void ExamplePollVectorData(string dev = DEFAULT_DEVICE)
    {
      ziDotNET daq = connect(dev);

      // This example only works for devices with the AWG option
      if (hasOption(daq, dev, "AWG") || isDeviceFamily(daq, dev, "UHFQA") ||
 isDeviceFamily(daq, dev, "UHFAWG") || isDeviceFamily(daq, dev, "HDAWG"))
      {
        resetDeviceToDefault(daq, dev);

        // Request vector node from device
        String path = String.Format("/{0}/awgs/0/waveform/waves/0", dev);
        daq.getAsEvent(path);

        // Poll until the node path is found in the result data
        double timeout = 20;
        double poll_time = 0.1;
        Lookup lookup = null;
        for (double time = 0; ; time += poll_time)
        {
          lookup = daq.poll(poll_time, 100, 0, 1);
          if (lookup.nodes.ContainsKey(path))
            break;
          if (time > timeout)
            Fail("Vector node data not received within timeout");
        }

        Chunk[] chunks = lookup[path]; // Iterable chunks
        Chunk chunk = chunks[0];       // Single chunk
        ZIVectorData vectorData = chunk.vectorData[0];

        // The vector attribute of a ZIVectorData object holds a ZIVector object,
        // which can contain a String or arrays of the following types:
        // byte, UInt16, Uint32, Uint64, float, double

        // Waveform vector data is stored as 32-bit unsigned integer
        if (vectorData.vector != null)  // Check for empty container
        {
          UInt32[] vector = vectorData.vector.data as UInt32[];
        }

        AssertNotEqual(0ul, vectorData.timeStamp);
      }
```

```
      daq.disconnect();
    }

    // ExampleGetDemodSample reads the demodulator sample value of the specified
node.
    public static void ExampleGetDemodSample(string dev = DEFAULT_DEVICE)
    {
      ziDotNET daq = connect(dev);
      SkipForDeviceFamily(daq, dev, "HDAWG");

      resetDeviceToDefault(daq, dev);
      String path = String.Format("/{0}/demods/0/sample", dev);
      ZIDemodSample sample = daq.getDemodSample(path);
      System.Diagnostics.Trace.WriteLine(sample.frequency, "Sample frequency");
      daq.disconnect();

      AssertNotEqual(0ul, sample.timeStamp);
    }

    // ExampleSweeper instantiates a sweeper module and executes a sweep
    // over 100 data points from 1kHz to 100kHz and writes the result into a file.
    public static void ExampleSweeper(string dev = DEFAULT_DEVICE) // Timeout(40000)
    {
      ziDotNET daq = connect(dev);
      SkipForDeviceFamily(daq, dev, "HDAWG");

      resetDeviceToDefault(daq, dev);
      ziModule sweep = daq.sweeper();
      sweep.setByte("device", dev);
      sweep.setDouble("start", 1e3);
      sweep.setDouble("stop", 1e5);
      sweep.setDouble("samplecount", 100);
      String path = String.Format("/{0}/demods/0/sample", dev);
      sweep.subscribe(path);
      sweep.execute();
      while (!sweep.finished())
      {
        System.Threading.Thread.Sleep(100);
        double progress = sweep.progress() * 100;
        System.Diagnostics.Trace.WriteLine(progress, "Progress");
      }
      Lookup lookup = sweep.read();
      double[] grid = lookup[path][0].sweeperDemodWaves[0].grid;
      double[] x = lookup[path][0].sweeperDemodWaves[0].x;
      double[] y = lookup[path][0].sweeperDemodWaves[0].y;
      String fileName = Environment.CurrentDirectory + "/sweep.txt";
      System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);
      ZIChunkHeader header = lookup[path][0].header;
      // Raw system time is the number of microseconds since linux epoch
      file.WriteLine("Raw System Time: {0}", header.systemTime);
      // Use the utility function ziSystemTimeToDateTime to convert to DateTime
of .NET
      file.WriteLine("Converted System Time: {0}",
ziUtility.ziSystemTimeToDateTime(lookup[path][0].header.systemTime));
      file.WriteLine("Created Timestamp: {0}", header.createdTimeStamp);
      file.WriteLine("Changed Timestamp: {0}", header.changedTimeStamp);
      for (int i = 0; i < grid.Length; ++i)
      {
        file.WriteLine("{0} {1} {2}", grid[i], x[i], y[i]);
      }
      file.Close();

      AssertEqual(1.0, sweep.progress());
      AssertNotEqual(0, grid.Length);

      sweep.clear();  // Release module resources. Especially important if modules
are created
```

```
                  // inside a loop to prevent excessive resource consumption.
      daq.disconnect();
    }

    // ExampleImpedanceSweeper instantiates a sweeper module and prepares
    // all settings for an impedance sweep over 30 data points.
    // The results are written to a file.
    public static void ExampleImpedanceSweeper(string dev = DEFAULT_DEVICE) //
Timeout(40000)
    {
      ziDotNET daq = connect(dev);
      // This example only works for devices with installed
      // Impedance Analyzer (IA) option.
      if (!hasOption(daq, dev, "IA"))
      {
        daq.disconnect();
        Skip("Not supported by device.");
      }

      resetDeviceToDefault(daq, dev);
      // Enable impedance control
      daq.setInt(String.Format("/{0}/imps/0/enable", dev), 1);
      // Return D and Cs
      daq.setInt(String.Format("/{0}/imps/0/model", dev), 4);
      // Enable user compensation
      daq.setInt(String.Format("/{0}/imps/0/calib/user/enable", dev), 1);

      // ensure correct settings of order and oscselect
      daq.setInt(String.Format("/{0}/imps/0/demod/order", dev), 8);
      daq.setInt(String.Format("/{0}/imps/0/demod/oscselect", dev), 0);
      daq.sync();

      ziModule sweep = daq.sweeper();
      // Sweeper settings
      sweep.setByte("device", dev);
      sweep.setDouble("start", 1e3);
      sweep.setDouble("stop", 5e6);
      sweep.setDouble("samplecount", 30);
      sweep.setDouble("order", 8);
      sweep.setDouble("settling/inaccuracy", 0.0100000);
      sweep.setDouble("bandwidthcontrol", 2);
      sweep.setDouble("maxbandwidth", 10.0);
      sweep.setDouble("bandwidthoverlap", 1);
      sweep.setDouble("xmapping", 1);
      sweep.setDouble("omegasuppression", 100.0);
      sweep.setDouble("averaging/sample", 200);
      sweep.setDouble("averaging/time", 0.100);
      sweep.setDouble("averaging/tc", 20.0);
      String path = String.Format("/{0}/imps/0/sample", dev);
      sweep.subscribe(path);
      sweep.execute();
      while (!sweep.finished())
      {
        System.Threading.Thread.Sleep(100);
        double progress = sweep.progress() * 100;
        System.Diagnostics.Trace.WriteLine(progress, "Progress");
      }
      Lookup lookup = sweep.read();
      double[] grid = lookup[path][0].sweeperImpedanceWaves[0].grid;
      double[] x = lookup[path][0].sweeperImpedanceWaves[0].realz;
      double[] y = lookup[path][0].sweeperImpedanceWaves[0].imagz;
      double[] param0 = lookup[path][0].sweeperImpedanceWaves[0].param0;
      double[] param1 = lookup[path][0].sweeperImpedanceWaves[0].param1;
      UInt64[] flags = lookup[path][0].sweeperImpedanceWaves[0].flags;
      // Save measurement data to file
      String fileName = Environment.CurrentDirectory + "/impedance.txt";
      System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);
```

```
      ZIChunkHeader header = lookup[path][0].header;
      // Raw system time is the number of microseconds since linux epoch
      file.WriteLine("Raw System Time: {0}", header.systemTime);
      // Use the utility function ziSystemTimeToDateTime to convert to DateTime
of .NET
      file.WriteLine("Converted System Time: {0}",
ziUtility.ziSystemTimeToDateTime(lookup[path][0].header.systemTime));
      file.WriteLine("Created Timestamp: {0}", header.createdTimeStamp);
      file.WriteLine("Changed Timestamp: {0}", header.changedTimeStamp);
      for (int i = 0; i < grid.Length; ++i)
      {
        file.WriteLine("{0} {1} {2} {3} {4} {5}",
          grid[i],
          x[i],
          y[i],
          param0[i],
          param1[i],
          flags[i]);
      }
      file.Close();

      AssertEqual(1.0, sweep.progress());
      AssertNotEqual(0, grid.Length);

      sweep.clear();  // Release module resources. Especially important if modules
are created
                      // inside a loop to prevent excessive resource consumption.
      daq.disconnect();
    }

    // ExampleImpedanceCompensation does a user compensation
    // of the impedance analyser.
    public static void ExampleImpedanceCompensation(string dev = DEFAULT_DEVICE) //
Timeout(30000)
    {
      ziDotNET daq = connect(dev);
      // This example only works for devices with installed
      // Impedance Analyzer (IA) option.
      if (!hasOption(daq, dev, "IA"))
      {
        daq.disconnect();
        Skip("Not supported by device.");
      }

      resetDeviceToDefault(daq, dev);

      // Enable impedance control
      daq.setInt(String.Format("/{0}/imps/0/enable", dev), 1);
      ziModule calib = daq.impedanceModule();
      calib.execute();
      calib.setByte("device", dev);
      System.Threading.Thread.Sleep(200);
      calib.setInt("mode", 4);
      calib.setDouble("loads/2/r", 1000.0);
      calib.setDouble("loads/2/c", 0.0);
      calib.setDouble("freq/start", 100.0);
      calib.setDouble("freq/stop", 500e3);
      calib.setDouble("freq/samplecount", 21);

      daq.setInt(String.Format("/{0}/imps/0/demod/order", dev), 8);
      daq.setInt(String.Format("/{0}/imps/0/demod/oscselect", dev), 0);
      daq.sync();


      calib.setInt("step", 2);
      calib.setInt("calibrate", 1);
      while (true)
```

```
      {
        System.Threading.Thread.Sleep(100);
        double progress = calib.progress() * 100;
        System.Diagnostics.Trace.WriteLine(progress, "Progress");
        Int64 calibrate = calib.getInt("calibrate");
        if (calibrate == 0)
        {
          break;
        }
      }
      String message = calib.getString("message");
      System.Diagnostics.Trace.WriteLine(message, "Message");
      AssertNotEqual(0, calib.progress());

      calib.clear();  // Release module resources. Especially important if modules
are created
                      // inside a loop to prevent excessive resource consumption.
      daq.disconnect();
    }

    // ExampleSpectrum instantiates the spectrum module,
    // reads the data and writes the result in to a file.
    public static void ExampleSpectrum(string dev = DEFAULT_DEVICE) // Timeout(20000)
    {
      ziDotNET daq = connect(dev);
      SkipForDeviceFamily(daq, dev, "HDAWG");
      resetDeviceToDefault(daq, dev);
      ziModule spectrum = daq.spectrum();
      spectrum.setByte("device", dev);
      spectrum.setInt("bit", 10);
      String path = String.Format("/{0}/demods/0/sample", dev);
      spectrum.subscribe(path);
      spectrum.execute();
      while (!spectrum.finished())
      {
        System.Threading.Thread.Sleep(100);
        double progress = spectrum.progress() * 100;
        System.Diagnostics.Trace.WriteLine(progress, "Progress");
      }
      Lookup lookup = spectrum.read();
      double[] grid = lookup[path][0].spectrumWaves[0].grid;
      double[] x = lookup[path][0].spectrumWaves[0].x;
      double[] y = lookup[path][0].spectrumWaves[0].y;
      String fileName = Environment.CurrentDirectory + "/spectrum.txt";
      System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);
      for (int i = 0; i < grid.Length; ++i)
      {
        file.WriteLine("{0} {1} {2}", grid[i], x[i], y[i]);
      }
      file.Close();

      AssertEqual(1.0, spectrum.progress());
      AssertNotEqual(0, grid.Length);

      spectrum.clear();  // Release module resources. Especially important if modules
are created
                         // inside a loop to prevent excessive resource consumption.
      daq.disconnect();
    }

    // ExampleSwTrigger uses the software trigger to record data
    // and writes the result in to a file.
    public static void ExampleSwTrigger(string dev = DEFAULT_DEVICE) //
Timeout(20000)
    {
      ziDotNET daq = connect(dev);
      SkipForDeviceFamily(daq, dev, "HDAWG");
```

```
      SkipForDeviceFamilyAndOption(daq, dev, "MF", "MD");
      SkipForDeviceFamilyAndOption(daq, dev, "HF2", "HF2");


      resetDeviceToDefault(daq, dev);
      daq.setInt(String.Format("/{0}/demods/0/oscselect", dev), 0);
      daq.setInt(String.Format("/{0}/demods/1/oscselect", dev), 1);
      daq.setDouble(String.Format("/{0}/oscs/0/freq", dev), 2e6);
      daq.setDouble(String.Format("/{0}/oscs/1/freq", dev), 2.0001e6);
      daq.setInt(String.Format("/{0}/sigouts/0/enables/*", dev), 0);
      daq.setInt(String.Format("/{0}/sigouts/0/enables/0", dev), 1);
      daq.setInt(String.Format("/{0}/sigouts/0/enables/1", dev), 1);
      daq.setInt(String.Format("/{0}/sigouts/0/on", dev), 1);
      daq.setDouble(String.Format("/{0}/sigouts/0/amplitudes/0", dev), 0.2);
      daq.setDouble(String.Format("/{0}/sigouts/0/amplitudes/1", dev), 0.2);
      ziModule trigger = daq.swTrigger();
      trigger.setByte("device", dev);
      trigger.setInt("/0/type", 1);
      trigger.setDouble("/0/level", 0.1);
      trigger.setDouble("/0/hysteresis", 0.01);
      trigger.setDouble("/0/bandwidth", 0.0);
      String path = String.Format("/{0}/demods/0/sample", dev);
      trigger.subscribe(path);
      String triggerPath = String.Format("/{0}/demods/0/sample.R", dev);
      trigger.setByte("/0/triggernode", triggerPath);
      trigger.execute();
      while (!trigger.finished())
      {
        System.Threading.Thread.Sleep(100);
        double progress = trigger.progress() * 100;
        System.Diagnostics.Trace.WriteLine(progress, "Progress");
      }
      Lookup lookup = trigger.read();
      ZIDemodSample[] demodSample = lookup[path][0].demodSamples;
      String fileName = Environment.CurrentDirectory + "/swtrigger.txt";
      System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);
      ZIChunkHeader header = lookup[path][0].header;
      // Raw system time is the number of microseconds since linux epoch
      file.WriteLine("Raw System Time: {0}", header.systemTime);
      // Use the utility function ziSystemTimeToDateTime to convert to DateTime
of .NET
      file.WriteLine("Converted System Time: {0}",
ziUtility.ziSystemTimeToDateTime(lookup[path][0].header.systemTime));
      file.WriteLine("Created Timestamp: {0}", header.createdTimeStamp);
      file.WriteLine("Changed Timestamp: {0}", header.changedTimeStamp);
      file.WriteLine("Flags: {0}", header.flags);
      file.WriteLine("Name: {0}", header.name);
      file.WriteLine("Status: {0}", header.status);
      file.WriteLine("Group Index: {0}", header.groupIndex);
      file.WriteLine("Color: {0}", header.color);
      file.WriteLine("Active Row: {0}", header.activeRow);
      file.WriteLine("Trigger Number: {0}", header.triggerNumber);
      file.WriteLine("Grid Rows: {0}", header.gridRows);
      file.WriteLine("Grid Cols: {0}", header.gridCols);
      file.WriteLine("Grid Mode: {0}", header.gridMode);
      file.WriteLine("Grid Operation: {0}", header.gridOperation);
      file.WriteLine("Grid Direction: {0}", header.gridDirection);
      file.WriteLine("Grid Repetitions: {0}", header.gridRepetitions);
      file.WriteLine("Grid Col Delta: {0}", header.gridColDelta);
      file.WriteLine("Grid Col Offset: {0}", header.gridColOffset);
      file.WriteLine("Bandwidth: {0}", header.bandwidth);
      file.WriteLine("Center: {0}", header.center);
      file.WriteLine("NENBW: {0}", header.nenbw);
      for (int i = 0; i < demodSample.Length; ++i)
      {
        file.WriteLine("{0} {1} {2}",
          demodSample[i].frequency,
```

```
          demodSample[i].x,
          demodSample[i].y);
      }
      file.Close();

      AssertEqual(1, trigger.progress());
      AssertNotEqual(0, demodSample.Length);

      trigger.clear();  // Release module resources. Especially important if modules
are created
                        // inside a loop to prevent excessive resource consumption.
      daq.disconnect();
    }

    // ExampleScopeModule instantiates a scope module.
    public static void ExampleScopeModule(string dev = DEFAULT_DEVICE) //
Timeout(20000)
    {
      ziDotNET daq = connect(dev);
      if (isDeviceFamily(daq, dev, "HDAWG"))
      {
        daq.disconnect();
        Skip("Not supported by device.");
      }
      resetDeviceToDefault(daq, dev);
      ziModule scopeModule = daq.scopeModule();
      String path = String.Format("/{0}/scopes/0/wave", dev);
      scopeModule.subscribe(path);
      scopeModule.execute();
      // The HF2 devices do not have a single event functionality.
      if (!isDeviceFamily(daq, dev, "HF2"))
      {
        daq.setInt(String.Format("/{0}/scopes/0/single", dev), 1);
        daq.setInt(String.Format("/{0}/scopes/0/trigenable", dev), 0);
      }
      daq.setInt(String.Format("/{0}/scopes/0/enable", dev), 1);

      Lookup lookup;
      bool allSegments = false;
      do
      {
        System.Threading.Thread.Sleep(100);
        double progress = scopeModule.progress() * 100;
        System.Diagnostics.Trace.WriteLine(progress, "Progress");
        lookup = scopeModule.read();
        if (lookup.nodes.ContainsKey(path))
        {
          ZIScopeWave[] scopeWaves = lookup[path][0].scopeWaves;
          UInt64 totalSegments = scopeWaves[0].header.totalSegments;
          UInt64 segmentNumber = scopeWaves[0].header.segmentNumber;
          allSegments = (totalSegments == 0) ||
                        (segmentNumber >= totalSegments - 1);
        }
      } while (!allSegments);
      ZIScopeWave[] scopeWaves1 = lookup[path][0].scopeWaves;
      float[,] wave = SimpleValue.getFloatVec2D(scopeWaves1[0].wave);
      // ...
      System.Diagnostics.Trace.WriteLine(wave.Length, "Wave Size");
      AssertNotEqual(0, wave.Length);

      scopeModule.clear();  // Release module resources. Especially important if
modules are created
                            // inside a loop to prevent excessive resource
consumption.
      daq.disconnect();
    }
```

```
    // ExampleDeviceSettings instantiates a deviceSettings module and performs a save
    // and load of device settings. The LabOne UI uses this module to save and
    // load the device settings.
    public static void ExampleDeviceSettings(string dev = DEFAULT_DEVICE) //
Timeout(15000)
    {
      ziDotNET daq = connect(dev);
      resetDeviceToDefault(daq, dev);
      ziModule settings = daq.deviceSettings();
      // First save the current device settings
      settings.setString("device", dev);
      settings.setString("command", "save");
      settings.setString("filename", "test_settings");
      settings.setString("path", Environment.CurrentDirectory);
      settings.execute();
      while (!settings.finished())
      {
        System.Threading.Thread.Sleep(100);
      }
      // Remember the current device parameter for later comparison
      String path = String.Format("/{0}/oscs/0/freq", dev);
      Double originalValue = daq.getDouble(path);
      // Change the parameter
      daq.setDouble(path, 2 * originalValue);
      // Load device settings from file
      settings.setString("device", dev);
      settings.setString("command", "load");
      settings.setString("filename", "test_settings");
      settings.setString("path", Environment.CurrentDirectory);
      settings.execute();
      while (!settings.finished())
      {
        System.Threading.Thread.Sleep(100);
      }
      // Check the restored parameter
      Double newValue = daq.getDouble(path);

      AssertEqual(originalValue, newValue);

      settings.clear();  // Release module resources. Especially important if modules
are created
                         // inside a loop to prevent excessive resource consumption.
      daq.disconnect();
    }

    // ExamplePidAdvisor shows the usage of the PID advisor
    public static void ExamplePidAdvisor(string dev = DEFAULT_DEVICE) //
Timeout(40000)
    {
      ziDotNET daq = connect(dev);
      if (!hasOption(daq, dev, "PID"))
      {
        daq.disconnect();
        Skip("Not supported by device.");
      }

      resetDeviceToDefault(daq, dev);

      daq.setInt(String.Format("/{0}/demods/*/rate", dev), 0);
      daq.setInt(String.Format("/{0}/demods/*/trigger", dev), 0);
      daq.setInt(String.Format("/{0}/sigouts/*/enables/*", dev), 0);
      daq.setInt(String.Format("/{0}/demods/*/enable", dev), 0);
      daq.setInt(String.Format("/{0}/scopes/*/enable", dev), 0);

      // now the settings relevant to this experiment
      // PID configuration.
      double target_bw = 10e3;    // Target bandwidth (Hz).
```

```
      int pid_input = 3;          // PID input (3 = Demod phase).
      int pid_input_channel = 0;  // Demodulator number.
      double setpoint = 0.0;      // Phase setpoint.
      int phase_unwrap = 1;       //
      int pid_output = 2;         // PID output (2 = oscillator frequency).
      int pid_output_channel = 0; // The index of the oscillator controlled by PID.
      double pid_center_frequency = 500e3;  // (Hz).
      double pid_limits = 10e3;             // (Hz).


      if (!isDeviceFamily(daq, dev, "HF2"))
      {
        daq.setInt(String.Format("/{0}/pids/0/input", dev), pid_input);
        daq.setInt(String.Format("/{0}/pids/0/inputchannel", dev),
 pid_input_channel);
        daq.setDouble(String.Format("/{0}/pids/0/setpoint", dev), setpoint);
        daq.setInt(String.Format("/{0}/pids/0/output", dev), pid_output);
        daq.setInt(String.Format("/{0}/pids/0/outputchannel", dev),
 pid_output_channel);
        daq.setDouble(String.Format("/{0}/pids/0/center", dev),
 pid_center_frequency);
        daq.setInt(String.Format("/{0}/pids/0/enable", dev), 0);
        daq.setInt(String.Format("/{0}/pids/0/phaseunwrap", dev), phase_unwrap);
        daq.setDouble(String.Format("/{0}/pids/0/limitlower", dev), -pid_limits);
        daq.setDouble(String.Format("/{0}/pids/0/limitupper", dev), pid_limits);
      }
      // Perform a global synchronisation between the device and the data server:
      // Ensure that the settings have taken effect on the device before starting
      // the pidAdvisor.
      daq.sync();

      // set up PID Advisor
      ziModule pidAdvisor = daq.pidAdvisor();

      // Turn off auto-calc on param change. Enabled
      // auto calculation can be used to automatically
      // update response data based on user input.
      pidAdvisor.setInt("auto", 0);
      pidAdvisor.setByte("device", dev);
      pidAdvisor.setDouble("pid/targetbw", target_bw);

      // PID advising mode (bit coded)
      // bit 0: optimize/tune P
      // bit 1: optimize/tune I
      // bit 2: optimize/tune D
      // Example: mode = 7: Optimize/tune PID
      pidAdvisor.setInt("pid/mode", 7);

      // PID index to use (first PID of device: 0)
      pidAdvisor.setInt("index", 0);

      // DUT model
      // source = 1: Lowpass first order
      // source = 2: Lowpass second order
      // source = 3: Resonator frequency
      // source = 4: Internal PLL
      // source = 5: VCO
      // source = 6: Resonator amplitude
      pidAdvisor.setInt("dut/source", 4);

      if (isDeviceFamily(daq, dev, "HF2"))
      {
        // Since the PLL and PID are 2 separate hardware units on the
        // device, we need to additionally specify that the PID
        // Advisor should model the HF2's PLL.
        pidAdvisor.setByte("pid/type", "pll");
      }
```

```
// IO Delay of the feedback system describing the earliest response
// for a step change. This parameter does not affect the shape of
// the DUT transfer function
pidAdvisor.setDouble("dut/delay", 0.0);

// Other DUT parameters (not required for the internal PLL model)
// pidAdvisor.setDouble('dut/gain', 1.0)
// pidAdvisor.setDouble('dut/bw', 1000)
// pidAdvisor.setDouble('dut/fcenter', 15e6)
// pidAdvisor.setDouble('dut/damping', 0.1)
// pidAdvisor.setDouble('dut/q', 10e3)

// Start values for the PID optimization. Zero
// values will imitate a guess. Other values can be
// used as hints for the optimization process.
pidAdvisor.setDouble("pid/p", 0);
pidAdvisor.setDouble("pid/i", 0);
pidAdvisor.setDouble("pid/d", 0);
pidAdvisor.setInt("calculate", 0);

// Start the module thread
pidAdvisor.execute();
System.Threading.Thread.Sleep(1000);

// Advise
pidAdvisor.setInt("calculate", 1);
System.Diagnostics.Trace.WriteLine(
  "Starting advising. Optimization process may run up to a minute...");

var watch = System.Diagnostics.Stopwatch.StartNew();
while (true)
{
  double progress = pidAdvisor.progress() * 100;
  System.Diagnostics.Trace.WriteLine(progress, "Progress");
  System.Threading.Thread.Sleep(1000);
  Int64 calc = pidAdvisor.getInt("calculate");
  if (calc == 0)
  {
    break;
  }
}

watch.Stop();
var elapsedMs = watch.ElapsedMilliseconds;

System.Diagnostics.Trace.WriteLine(
  String.Format("Advice took {0} s.", watch.ElapsedMilliseconds / 1000.0));

// Get the advised values
double p_adv = pidAdvisor.getDouble("pid/p");
double i_adv = pidAdvisor.getDouble("pid/i");
double d_adv = pidAdvisor.getDouble("pid/d");
double dlimittimeconstant_adv =
  pidAdvisor.getDouble("pid/dlimittimeconstant");
double rate_adv = pidAdvisor.getDouble("pid/rate");
double bw_adv = pidAdvisor.getDouble("bw");

System.Diagnostics.Trace.WriteLine(p_adv, "P");
System.Diagnostics.Trace.WriteLine(i_adv, "I");
System.Diagnostics.Trace.WriteLine(d_adv, "D");
System.Diagnostics.Trace.WriteLine(dlimittimeconstant_adv, "D_tc");
System.Diagnostics.Trace.WriteLine(rate_adv, "rate");
System.Diagnostics.Trace.WriteLine(bw_adv, "bw");

// copy the values from the Advisor to the device
pidAdvisor.setInt("todevice", 1);
```

```
      // Get all calculated parameters.
      Lookup result = pidAdvisor.get("*");

      // extract bode plot and step response
      double[] grid = result["/bode"][0].advisorWaves[0].grid;
      double[] x = result["/bode"][0].advisorWaves[0].x;
      double[] y = result["/bode"][0].advisorWaves[0].y;
      String fileName = Environment.CurrentDirectory + "/pidAdvisor.txt";
      System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);
      for (int i = 0; i < grid.Length; ++i)
      {
        file.WriteLine("{0} {1} {2}", grid[i], x[i], y[i]);
      }
      file.Close();

      AssertEqual(1.0, pidAdvisor.progress());
      AssertNotEqual(0, grid.Length);

      pidAdvisor.clear();  // Release module resources. Especially important if
modules are created
                           // inside a loop to prevent excessive resource
consumption.
      daq.disconnect();
    }

    static double Sinc(double x)
    {
      return x != 0.0 ? Math.Sin(Math.PI * x) / (Math.PI * x) : 1.0;
    }

    // ExampleAwgModule shows the usage of the AWG module.
    // It uses the AWG sequencer to generate a wave form.
    // The defined waveform is applied, measured and the
    // results are written to a file.
    public static void ExampleAwgModule(string dev = DEFAULT_DEVICE) //
Timeout(10000)
    {
      ziDotNET daq = connect(dev);
      resetDeviceToDefault(daq, dev);

      // check device type, option
      if (!isDeviceFamily(daq, dev, "UHFAWG") && !isDeviceFamily(daq, dev, "UHFQA")
&& !hasOption(daq, dev, "AWG"))
      {
        Skip("Test does not support this device.");
      }

      // Create instrument configuration: disable all outputs, demods and scopes.
      daq.setInt(String.Format("/{0}/demods/*/enable", dev), 0);
      daq.setInt(String.Format("/{0}/demods/*/trigger", dev), 0);
      daq.setInt(String.Format("/{0}/sigouts/*/enables/*", dev), 0);
      daq.setInt(String.Format("/{0}/scopes/*/enable", dev), 0);
      if (hasOption(daq, dev, "IA"))
      {
        daq.setInt(String.Format("/{0}/imps/*/enable", dev), 0);
      }
      daq.sync();

      // Now configure the instrument for this experiment. The following channels
      // and indices work on all device configurations. The values below may be
      // changed if the instrument has multiple input/output channels and/or either
      // the Multifrequency or Multidemodulator options installed.
      int in_channel = 0;
      double frequency = 1e6;
      double amp = 1.0;
```

```
      daq.setDouble(String.Format("/{0}/sigouts/0/amplitudes/*", dev), 0.0);
      daq.sync();

      daq.setInt(String.Format("/{0}/sigins/0/imp50", dev), 1);
      daq.setInt(String.Format("/{0}/sigins/0/ac", dev), 0);
      daq.setInt(String.Format("/{0}/sigins/0/diff", dev), 0);
      daq.setInt(String.Format("/{0}/sigins/0/range", dev), 1);
      daq.setDouble(String.Format("/{0}/oscs/0/freq", dev), frequency);
      daq.setInt(String.Format("/{0}/sigouts/0/on", dev), 1);
      daq.setInt(String.Format("/{0}/sigouts/0/range", dev), 1);
      daq.setInt(String.Format("/{0}/sigouts/0/enables/3", dev), 1);
      daq.setDouble(String.Format("/{0}/awgs/0/outputs/0/amplitude", dev), amp);
      daq.setInt(String.Format("/{0}/awgs/0/outputs/0/mode", dev), 0);
      daq.setInt(String.Format("/{0}/awgs/0/time", dev), 0);
      daq.setInt(String.Format("/{0}/awgs/0/userregs/0", dev), 0);

      daq.sync();

      // Number of points in AWG waveform
      int AWG_N = 2000;

      // Define an AWG program as a string stored in the variable awg_program,
 equivalent to what would
      // be entered in the Sequence Editor window in the graphical UI.
      // This example demonstrates four methods of definig waveforms via the API
      // - (wave w0) loaded directly from programmatically generated CSV file
 wave0.csv.
      //             Waveform shape: Blackman window with negative amplitude.
      // - (wave w1) using the waveform generation functionalities available in the
 AWG Sequencer language.
      //             Waveform shape: Gaussian function with positive amplitude.
      // - (wave w2) using the vect() function and programmatic string replacement.
      //             Waveform shape: Single period of a sine wave.
      string awg_program =
        "const AWG_N = _c1_;\n" +
        "wave w0 = \"wave0\";\n" +
        "wave w1 = gauss(AWG_N, AWG_N/2, AWG_N/20);\n" +
        "wave w2 = vect(_w2_);\n" +
        "wave w3 = zeros(AWG_N);\n" +
        "setTrigger(1);\n" +
        "setTrigger(0);\n" +
        "playWave(w0);\n" +
        "playWave(w1);\n" +
        "playWave(w2);\n" +
        "playWave(w3);\n";

      // Reference waves

      // Define an array of values that are used to write values for wave w0 to a CSV
 file in the
      // module's data directory (Blackman windows)
      var waveform_0 = Enumerable.Range(0, AWG_N).Select(
        v => -1.0 * (0.42 - 0.5 * Math.Cos(2.0 * Math.PI * v / (AWG_N - 1)) + 0.08 *
 Math.Cos(4 * Math.PI * v / (AWG_N - 1))));
      double width = AWG_N / 20;
      var linspace = Enumerable.Range(0, AWG_N).Select(
        v => (v * AWG_N / ((double)AWG_N - 1.0d)) - AWG_N / 2);
      var waveform_1 = linspace.Select(
        v => Math.Exp(-v * v / (2 * width * width)));
      linspace = Enumerable.Range(0, AWG_N).Select(
        v => (v * 2 * Math.PI / ((double)AWG_N - 1.0d)));
      var waveform_2 = linspace.Select(
        v => Math.Sin(v));
      linspace = Enumerable.Range(0, AWG_N).Select(
        v => (v * 12 * Math.PI / ((double)AWG_N - 1.0d)) - 6 * Math.PI);
      var waveform_3 = linspace.Select(
        v => Sinc(v));
```

```
      // concatenated reference wave
      double f_s = 1.8e9; // sampling rate of scope and AWG
      double full_scale = 0.75;
      var y_expected =
waveform_0.Concat(waveform_1).Concat(waveform_2).Concat(waveform_3).Select(
        v => v * full_scale * amp).ToArray();
      var x_expected = Enumerable.Range(0, 4 * AWG_N).Select(v => v / f_s).ToArray();

      // Replace placeholders in program
      awg_program = awg_program.Replace("_w2_", string.Join(",", waveform_2));
      awg_program = awg_program.Replace("_c1_", AWG_N.ToString());

      // Create an instance of the AWG Module
      ziModule awgModule = daq.awgModule();
      awgModule.setByte("device", dev);
      awgModule.execute();


      // Get the modules data directory
      string data_dir = awgModule.getString("directory");
      // All CSV files within the waves directory are automatically recognized by the
AWG module
      data_dir = data_dir + "\\awg\\waves";
      if (!Directory.Exists(data_dir))
      {
        // The data directory is created by the AWG module and should always exist.
If this exception is raised,
        // something might be wrong with the file system.
        Fail($"AWG module wave directory {data_dir} does not exist or is not a
directory");
      }
      // Save waveform data to CSV
      string csv_file = data_dir + "\\wave0.csv";
      // The following line always formats a double as "3.14" and not "3,14".
      var waveform_0_formatted = waveform_0.Select(v =>
v.ToString(CultureInfo.InvariantCulture));
      File.WriteAllText(@csv_file, string.Join(",", waveform_0_formatted));

      // Transfer the AWG sequence program. Compilation starts automatically.
      // Note: when using an AWG program from a source file (and only then), the
      //       compiler needs to be started explicitly with
      //       awgModule.set("compiler/start", 1)
      awgModule.setByte("compiler/sourcestring", awg_program);
      while (awgModule.getInt("compiler/status") == -1)
      {
        System.Threading.Thread.Sleep(100);
      }

      // check compiler result
      long status = awgModule.getInt("compiler/status");
      if (status == 1)
      {
        // compilation failed
        String message = awgModule.getString("compiler/statusstring");
        System.Diagnostics.Trace.WriteLine("AWG Program:");
        System.Diagnostics.Trace.WriteLine(awg_program);
        System.Diagnostics.Trace.WriteLine("---");
        System.Diagnostics.Trace.WriteLine(message, "Compiler message:");
        Fail("Compilation failed");
      }
      if (status == 0)
      {
        System.Diagnostics.Trace.WriteLine("Compilation successful with no warnings"
+
          ", will upload the program to the instrument.");
      }
```

```
      if (status == 2)
      {
        System.Diagnostics.Trace.WriteLine("Compilation successful with warnings" +
          ", will upload the program to the instrument.");
        String message = awgModule.getString("compiler/statusstring");
        System.Diagnostics.Trace.WriteLine("Compiler warning:");
        System.Diagnostics.Trace.WriteLine(message);
      }

      // wait for waveform upload to finish
      while (awgModule.getDouble("progress") < 1.0)
      {
        System.Diagnostics.Trace.WriteLine(
          awgModule.getDouble("progress"), "Progress");
        System.Threading.Thread.Sleep(100);
      }

      // Replace w3 with waveform_3 using vector write.
      // Let N be the total number of waveforms and M>0 be the number of waveforms
defined from CSV file. Then the index
      // of the waveform to be replaced is defined as following:
      // - 0,...,M-1 for all waveforms defined from CSV file alphabetically ordered
by filename,
      // - M,...,N-1 in the order that the waveforms are defined in the sequencer
program.
      // For the case of M=0, the index is defined as:
      // - 0,...,N-1 in the order that the waveforms are defined in the sequencer
program.
      // Of course, for the trivial case of 1 waveform, use index=0 to replace it.
      // Here we replace waveform w3, the 4th waveform defined in the sequencer
program. Using 0-based indexing the
      // index of the waveform we want to replace (w3, a vector of zeros) is 3:
      // Write the waveform to the memory. For the transferred array, only 16-bit
unsigned integer
      // data (0...65536) is accepted.
      // For dual-channel waves, interleaving is required.

      // The following function corresponds to ziPython utility function
'convert_awg_waveform'.
      Func<double, ushort> convert_awg_waveform = v => (ushort)((32767.0) * v);
      daq.setVector(String.Format("/{0}/awgs/0/waveform/waves/3", dev),
waveform_3.Select(convert_awg_waveform).ToArray());

      // Configure the Scope for measurement
      daq.setInt(
        String.Format("/{0}/scopes/0/channels/0/inputselect", dev), in_channel);
      daq.setInt(String.Format("/{0}/scopes/0/time", dev), 0);
      daq.setInt(String.Format("/{0}/scopes/0/enable", dev), 0);
      daq.setInt(String.Format("/{0}/scopes/0/length", dev), 16836);

      // Now configure the scope's trigger to get aligned data.
      daq.setInt(String.Format("/{0}/scopes/0/trigenable", dev), 1);
      // Here we trigger on UHF signal input 1. If the instrument has the DIG Option
installed we could
      // trigger the scope using an AWG Trigger instead (see the `setTrigger(1);`
line in `awg_program` above).
      // 0:   Signal Input 1
      // 192: AWG Trigger 1
      long trigchannel = 0;
      daq.setInt(String.Format("/{0}/scopes/0/trigchannel", dev), trigchannel);
      if (trigchannel == 0)
      {
        // Trigger on the falling edge of the negative blackman waveform `w0` from
our AWG program.
        daq.setInt(String.Format("/{0}/scopes/0/trigslope", dev), 2);
        daq.setDouble(String.Format("/{0}/scopes/0/triglevel", dev), -0.600);
```

```
        // Set hysteresis triggering threshold to avoid triggering on noise
        // 'trighysteresis/mode' :
        //  0 - absolute, use an absolute value ('scopes/0/trighysteresis/absolute')
        //  1 - relative, use a relative value ('scopes/0trighysteresis/relative') of
the trigchannel's input range
        //      (0.1=10%).
        daq.setDouble(String.Format("/{0}/scopes/0/trighysteresis/mode", dev), 0);
        daq.setDouble(String.Format("/{0}/scopes/0/trighysteresis/relative", dev),
0.025);

        // Set a negative trigdelay to capture the beginning of the waveform.
        daq.setDouble(String.Format("/{0}/scopes/0/trigdelay", dev), -1.0e-6);
      }
      else
      {
        // Assume we're using an AWG Trigger, then the scope configuration is simple:
Trigger on rising edge.
        daq.setInt(String.Format("/{0}/scopes/0/trigslope", dev), 1);

        // Set trigdelay to 0.0: Start recording from when the trigger is activated.
        daq.setDouble(String.Format("/{0}/scopes/0/trigdelay", dev), 0.0);
      }

      // the trigger reference position relative within the wave, a value of 0.5
corresponds to the center of the wave
      daq.setDouble(String.Format("/{0}/scopes/0/trigreference", dev), 0.0);

      // Set the hold off time in-between triggers.
      daq.setDouble(String.Format("/{0}/scopes/0/trigholdoff", dev), 0.025);

      // Set up the Scope Module.
      ziModule scopeModule = daq.scopeModule();
      scopeModule.setInt("mode", 1);
      scopeModule.subscribe(String.Format("/{0}/scopes/0/wave", dev));
      daq.setInt(String.Format("/{0}/scopes/0/single", dev), 1);
      scopeModule.execute();
      daq.setInt(String.Format("/{0}/scopes/0/enable", dev), 1);
      daq.sync();
      System.Threading.Thread.Sleep(100);

      // Start the AWG in single-shot mode
      daq.setInt(String.Format("/{0}/awgs/0/single", dev), 1);
      daq.setInt(String.Format("/{0}/awgs/0/enable", dev), 1);

      // Read the scope data (manual timeout of 1 second)
      double local_timeout = 1.0;
      while (scopeModule.progress() < 1.0 && local_timeout > 0.0)
      {
        System.Diagnostics.Trace.WriteLine(
          scopeModule.progress() * 100.0, "Scope Progress");
        System.Threading.Thread.Sleep(20);
        local_timeout -= 0.02;
      }
      string path = String.Format("/{0}/scopes/0/wave", dev);
      Lookup lookup = scopeModule.read();
      ZIScopeWave[] scopeWaves1 = lookup[path][0].scopeWaves;
      float[,] y_measured_in = SimpleValue.getFloatVec2D(scopeWaves1[0].wave);
      float[] y_measured = new float[y_measured_in.Length];
      for (int i = 0; i < y_measured_in.Length; ++i)
      {
        y_measured[i] = y_measured_in[0, i];
      }

      var x_measured = Enumerable.Range(0, y_measured.Length).Select(
        v => -(long)v * scopeWaves1[0].header.dt +
          (scopeWaves1[0].header.timeStamp -
          scopeWaves1[0].header.triggerTimeStamp) / f_s
```

```
        ).ToArray();

      // write signals to files
      String fileName = Environment.CurrentDirectory + "/awg_measured.txt";
      System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);
      file.WriteLine("t [ns], measured signal [V]");
      for (int i = 0; i < y_measured.Length; ++i)
      {
        file.WriteLine("{0} {1}", x_measured[i] * 1e9, y_measured[i]);
      }
      file.Close();

      fileName = Environment.CurrentDirectory + "/awg_expected.txt";
      file = new System.IO.StreamWriter(fileName);
      file.WriteLine("t [ns], expected signal [V]");
      for (int i = 0; i < y_expected.Length; ++i)
      {
        file.WriteLine("{0} {1}", x_expected[i] * 1e9, y_expected[i]);
      }
      file.Close();

      // checks
      AssertNotEqual(0, x_measured.Length);
      AssertNotEqual(0, y_measured.Length);

      // find minimal difference
      double dMinMax = 1e10;
      for (int i = 0; i < x_measured.Length - x_expected.Length; i++)
      {
        double dMax = 0;
        for (int k = 0; k < x_expected.Length; k++)
        {
          double d = Math.Abs(y_expected[k] - y_measured[k + i]);
          if (d > dMax)
          {
            dMax = d;
          }
        }

        if (dMax < dMinMax)
        {
          dMinMax = dMax;
        }
      }
      Debug.Assert(dMinMax < 0.1);

      scopeModule.clear();  // Release module resources. Especially important if
modules are created
                            // inside a loop to prevent excessive resource
consumption.
      awgModule.clear();
      daq.disconnect();
    }

    // ExampleAutorangingImpedance shows how to perform a manually triggered
autoranging for impedance while working in manual range mode.
    public static void ExampleAutorangingImpedance(string dev = DEFAULT_DEVICE) //
Timeout(25000)
    {
      ziDotNET daq = connect(dev);
      // check device type, option
      SkipRequiresOption(daq, dev, "IA");

      resetDeviceToDefault(daq, dev);
      // Create instrument configuration: disable all outputs, demods and scopes.
      daq.setInt(String.Format("/{0}/demods/*/enable", dev), 0);
      daq.setInt(String.Format("/{0}/demods/*/trigger", dev), 0);
```

```
      daq.setInt(String.Format("/{0}/sigouts/*/enables/*", dev), 0);
      daq.setInt(String.Format("/{0}/scopes/*/enable", dev), 0);
      daq.setInt(String.Format("/{0}/imps/*/enable", dev), 0);
      daq.sync();

      int imp = 0;
      long curr = daq.getInt(String.Format("/{0}/imps/{1}/current/inputselect", dev,
imp));
      long volt = daq.getInt(String.Format("/{0}/imps/{1}/voltage/inputselect", dev,
imp));
      double manCurrRange = 10e-3;
      double manVoltRange = 10e-3;

      // Now configure the instrument for this experiment. The following channels and
indices work on all devices with IA option.
      // The values below may be changed if the instrument has multiple IA modules.
      daq.setInt(String.Format("/{0}/imps/{1}/enable", dev, imp), 1);
      daq.setInt(String.Format("/{0}/imps/{1}/mode", dev, imp), 0);
      daq.setInt(String.Format("/{0}/imps/{1}/auto/output", dev, imp), 1);
      daq.setInt(String.Format("/{0}/imps/{1}/auto/bw", dev, imp), 1);
      daq.setDouble(String.Format("/{0}/imps/{1}/freq", dev, imp), 500);
      daq.setInt(String.Format("/{0}/imps/{1}/auto/inputrange", dev, imp), 0);
      daq.setDouble(String.Format("/{0}/currins/{1}/range", dev, curr),
manCurrRange);
      daq.setDouble(String.Format("/{0}/sigins/{1}/range", dev, volt), manVoltRange);
      daq.sync();

      // After setting the device in manual ranging mode we want to trigger manually
a one time auto ranging to find a suitable range.
      // Therefore, we trigger the  auto ranging for the current input as well as for
the voltage input.
      daq.setInt(String.Format("/{0}/currins/{1}/autorange", dev, curr), 1);
      daq.setInt(String.Format("/{0}/sigins/{1}/autorange", dev, volt), 1);

      // The auto ranging takes some time. We do not want to continue before the best
range is found.
      // Therefore, we implement a loop to check if the auto ranging is finished.
      int count = 0;
      System.Threading.Thread.Sleep(100);
      bool finished = false;
      var watch = System.Diagnostics.Stopwatch.StartNew();
      while (!finished)
      {
        ++count;
        System.Threading.Thread.Sleep(500);
        finished = (daq.getInt(String.Format("/{0}/currins/{1}/autorange", dev,
curr)) == 0 &&
                   daq.getInt(String.Format("/{0}/sigins/{1}/autorange", dev, volt))
== 0);
      }
      watch.Stop();
      System.Diagnostics.Trace.WriteLine(
        String.Format("Auto ranging finished after {0} s.",
watch.ElapsedMilliseconds / 1e3));

      double autoCurrRange = daq.getDouble(String.Format("/{0}/currins/{1}/range",
dev, curr));
      double autoVoltRange = daq.getDouble(String.Format("/{0}/sigins/{1}/range",
dev, volt));
      System.Diagnostics.Trace.WriteLine(
        String.Format("Current range changed from {0} A to {1} A.", manCurrRange,
autoCurrRange));
      System.Diagnostics.Trace.WriteLine(
        String.Format("Voltage range changed from {0} A to {1} A.", manVoltRange,
autoVoltRange));
      Debug.Assert(count > 1);
    }
```

```
    // ExampleDataAcquisition uses the new data acquisition module to record data
    // and writes the result in to a file.
    public static void ExampleDataAcquisition(string dev = DEFAULT_DEVICE) //
Timeout(20000)
    {
      ziDotNET daq = connect(dev);

      SkipForDeviceFamilyAndOption(daq, dev, "MF", "MD");
      SkipForDeviceFamilyAndOption(daq, dev, "HF2", "MD");
      SkipForDeviceFamily(daq, dev, "HDAWG");

      resetDeviceToDefault(daq, dev);
      daq.setInt(String.Format("/{0}/demods/0/oscselect", dev), 0);
      daq.setInt(String.Format("/{0}/demods/1/oscselect", dev), 1);
      daq.setDouble(String.Format("/{0}/oscs/0/freq", dev), 2e6);
      daq.setDouble(String.Format("/{0}/oscs/1/freq", dev), 2.0001e6);
      daq.setInt(String.Format("/{0}/sigouts/0/enables/*", dev), 0);
      daq.setInt(String.Format("/{0}/sigouts/0/enables/0", dev), 1);
      daq.setInt(String.Format("/{0}/sigouts/0/enables/1", dev), 1);
      daq.setInt(String.Format("/{0}/sigouts/0/on", dev), 1);
      daq.setDouble(String.Format("/{0}/sigouts/0/amplitudes/0", dev), 0.2);
      daq.setDouble(String.Format("/{0}/sigouts/0/amplitudes/1", dev), 0.2);
      ziModule trigger = daq.dataAcquisitionModule();
      trigger.setInt("grid/mode", 4);
      double demodRate = daq.getDouble(String.Format("/{0}/demods/0/rate", dev));
      double duration = trigger.getDouble("duration");
      Int64 sampleCount = System.Convert.ToInt64(demodRate * duration);
      trigger.setInt("grid/cols", sampleCount);
      trigger.setByte("device", dev);
      trigger.setInt("type", 1);
      trigger.setDouble("level", 0.1);
      trigger.setDouble("hysteresis", 0.01);
      trigger.setDouble("bandwidth", 0.0);
      String path = String.Format("/{0}/demods/0/sample.r", dev);
      trigger.subscribe(path);
      String triggerPath = String.Format("/{0}/demods/0/sample.R", dev);
      trigger.setByte("triggernode", triggerPath);
      trigger.execute();
      while (!trigger.finished())
      {
        System.Threading.Thread.Sleep(100);
        double progress = trigger.progress() * 100;
        System.Diagnostics.Trace.WriteLine(progress, "Progress");
      }
      Lookup lookup = trigger.read();
      ZIDoubleData[] demodSample = lookup[path][0].doubleData;
      String fileName = Environment.CurrentDirectory + "/dataacquisition.txt";
      System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);
      ZIChunkHeader header = lookup[path][0].header;
      // Raw system time is the number of microseconds since linux epoch
      file.WriteLine("Raw System Time: {0}", header.systemTime);
      // Use the utility function ziSystemTimeToDateTime to convert to DateTime
of .NET
      file.WriteLine("Converted System Time: {0}",
ziUtility.ziSystemTimeToDateTime(lookup[path][0].header.systemTime));
      file.WriteLine("Created Timestamp: {0}", header.createdTimeStamp);
      file.WriteLine("Changed Timestamp: {0}", header.changedTimeStamp);
      file.WriteLine("Flags: {0}", header.flags);
      file.WriteLine("Name: {0}", header.name);
      file.WriteLine("Status: {0}", header.status);
      file.WriteLine("Group Index: {0}", header.groupIndex);
      file.WriteLine("Color: {0}", header.color);
      file.WriteLine("Active Row: {0}", header.activeRow);
      file.WriteLine("Trigger Number: {0}", header.triggerNumber);
      file.WriteLine("Grid Rows: {0}", header.gridRows);
      file.WriteLine("Grid Cols: {0}", header.gridCols);
```

```
      file.WriteLine("Grid Mode: {0}", header.gridMode);
      file.WriteLine("Grid Operation: {0}", header.gridOperation);
      file.WriteLine("Grid Direction: {0}", header.gridDirection);
      file.WriteLine("Grid Repetitions: {0}", header.gridRepetitions);
      file.WriteLine("Grid Col Delta: {0}", header.gridColDelta);
      file.WriteLine("Grid Col Offset: {0}", header.gridColOffset);
      file.WriteLine("Bandwidth: {0}", header.bandwidth);
      file.WriteLine("Center: {0}", header.center);
      file.WriteLine("NENBW: {0}", header.nenbw);
      for (int i = 0; i < demodSample.Length; ++i)
      {
        file.WriteLine("{0}", demodSample[i].value);
      }
      file.Close();

      AssertEqual(1, trigger.progress());
      AssertNotEqual(0, demodSample.Length);

      trigger.clear();  // Release module resources. Especially important if modules
are created
                        // inside a loop to prevent excessive resource consumption.
      daq.disconnect();
    }

    // ExampleMultiDeviceDataAcquisition
    //
    // Run the example: Capture demodulator data from two devices using the Data
Acquisition module.
    // The devices are first synchronized using the MultiDeviceSync Module.
    //
    // Hardware configuration:
    // The cabling of the instruments must follow the MDS cabling depicted in
    // the MDS tab of LabOne.
    // Additionally, Signal Out 1 of the master device is split into Signal In 1 of
the master and slave.
    //
    // ATTENTION: test ignored because it requires special device setup
    public void SKIP_MULTIDEVICE_ExampleMultiDeviceDataAcquisition() //
Timeout(25000)
    {
      String[] device_ids = { "dev3133", "dev3144" };

      ziDotNET daq = new ziDotNET();
      daq.init("localhost", 8004, zhinst.ZIAPIVersion_enum.ZI_API_VERSION_6);
      apiServerVersionCheck(daq);
      daq.connectDevice(device_ids[0], "1gbe", "");
      daq.connectDevice(device_ids[1], "1gbe", "");

      // Create instrument configuration: disable all outputs, demods and scopes.
      foreach (String dev in device_ids)
      {
        daq.setInt(String.Format("/{0}/demods/*/enable", dev), 0);
        daq.setInt(String.Format("/{0}/demods/*/trigger", dev), 0);
        daq.setInt(String.Format("/{0}/sigouts/*/enables/*", dev), 0);
        daq.setInt(String.Format("/{0}/scopes/*/enable", dev), 0);
        daq.setInt(String.Format("/{0}/imps/*/enable", dev), 0);
        daq.sync();
      }

      System.Diagnostics.Trace.WriteLine("Synchronizing devices " + String.Join(",",
device_ids) + "...\n");

      ziModule mds = daq.multiDeviceSyncModule();
      mds.setInt("start", 0);
      mds.setInt("group", 0);
      mds.execute();
      mds.setString("devices", String.Join(",", device_ids));
```

```
      mds.setInt("start", 1);

      // Wait for MDS to complete
      double local_timeout = 20.0;
      long status = 0;
      while (status != 2 && local_timeout > 0.0)
      {
        status = mds.getInt("status");
        System.Threading.Thread.Sleep(100);
        local_timeout -= 0.1;
      }

      if (status != 2)
      {
        System.Diagnostics.Trace.WriteLine("Error during synchronization.\n");
        Fail();
      }
      System.Diagnostics.Trace.WriteLine("Devices successfully synchronized.");

      // Device settings
      int demod_c = 0; // demod channel, for paths on the device
      int out_c = 0;  // signal output channel
      int out_mixer_c = 0;
      int in_c = 0;  // signal input channel
      int osc_c = 0;  // oscillator

      double time_constant = 1.0e-3;  // [s]
      double demod_rate = 10e3;  // [Sa/s]
      int filter_order = 8;
      double osc_freq = 1e3;  // [Hz]
      double out_amp = 0.600;   // [V]

      // Device settings
      foreach (String dev in device_ids)
      {
        daq.setDouble(String.Format("/{0}/demods/{1}/phaseshift", dev, demod_c), 0);
        daq.setInt(String.Format("/{0}/demods/{1}/order", dev, demod_c),
filter_order);
        daq.setDouble(String.Format("/{0}/demods/{1}/rate", dev, demod_c),
demod_rate);
        daq.setInt(String.Format("/{0}/demods/{1}/harmonic", dev, demod_c), 1);
        daq.setInt(String.Format("/{0}/demods/{1}/enable", dev, demod_c), 1);
        daq.setInt(String.Format("/{0}/demods/{1}/oscselect", dev, demod_c), osc_c);
        daq.setInt(String.Format("/{0}/demods/{1}/adcselect", dev, demod_c), in_c);
        daq.setDouble(String.Format("/{0}/demods/{1}/timeconstant", dev, demod_c),
time_constant);
        daq.setDouble(String.Format("/{0}/oscs/{1}/freq", dev, osc_c), osc_freq);
        daq.setInt(String.Format("/{0}/sigins/{1}/imp50", dev, in_c), 1);
        daq.setInt(String.Format("/{0}/sigins/{1}/ac", dev, in_c), 0);
        daq.setDouble(String.Format("/{0}/sigins/{1}/range", dev, in_c), out_amp /
2);

      }
      // settings on master
      daq.setInt(String.Format("/{0}/sigouts/{1}/on", device_ids[0], out_c), 1);
      daq.setDouble(String.Format("/{0}/sigouts/{1}/range", device_ids[0], out_c),
1);
      daq.setDouble(String.Format("/{0}/sigouts/{1}/amplitudes/{2}", device_ids[0],
out_c, out_mixer_c), out_amp);
      daq.setDouble(String.Format("/{0}/sigouts/{1}/enables/{2}", device_ids[0],
out_c, out_mixer_c), 0);

      // Synchronization
      daq.sync();

      // measuring the transient state of demodulator filters using DAQ module
```

```
      // DAQ module
      // Create a Data Acquisition Module instance, the return argument is a handle
to the module
      ziModule daqMod = daq.dataAcquisitionModule();
      // Configure the Data Acquisition Module
      // Device on which trigger will be performed
      daqMod.setString("device", device_ids[0]);
      // The number of triggers to capture (if not running in endless mode).
      daqMod.setInt("count", 1);
      daqMod.setInt("endless", 0);
      // 'grid/mode' - Specify the interpolation method of
      //   the returned data samples.
      //
      // 1 = Nearest. If the interval between samples on the grid does not match
      //     the interval between samples sent from the device exactly, the nearest
      //     sample (in time) is taken.
      //
      // 2 = Linear interpolation. If the interval between samples on the grid does
      //     not match the interval between samples sent from the device exactly,
      //     linear interpolation is performed between the two neighbouring
      //     samples.
      //
      // 4 = Exact. The subscribed signal with the highest sampling rate (as sent
      //     from the device) defines the interval between samples on the DAQ
      //     Module's grid. If multiple signals are subscribed, these are
      //     interpolated onto the grid (defined by the signal with the highest
      //     rate, "highest_rate"). In this mode, duration is
      //     read-only and is defined as num_cols/highest_rate.
      int grid_mode = 2;
      daqMod.setInt("grid/mode", grid_mode);
      //   type:
      //     NO_TRIGGER = 0
      //     EDGE_TRIGGER = 1
      //     DIGITAL_TRIGGER = 2
      //     PULSE_TRIGGER = 3
      //     TRACKING_TRIGGER = 4
      //     HW_TRIGGER = 6
      //     TRACKING_PULSE_TRIGGER = 7
      //     EVENT_COUNT_TRIGGER = 8
      daqMod.setInt("type", 1);
      //   triggernode, specify the triggernode to trigger on.
      //     SAMPLE.X = Demodulator X value
      //     SAMPLE.Y = Demodulator Y value
      //     SAMPLE.R = Demodulator Magnitude
      //     SAMPLE.THETA = Demodulator Phase
      //     SAMPLE.AUXIN0 = Auxilliary input 1 value
      //     SAMPLE.AUXIN1 = Auxilliary input 2 value
      //     SAMPLE.DIO = Digital I/O value
      string triggernode = String.Format("/{0}/demods/{1}/sample.r", device_ids[0],
demod_c);
      daqMod.setString("triggernode", triggernode);
      //   edge:
      //     POS_EDGE = 1
      //     NEG_EDGE = 2
      //     BOTH_EDGE = 3
      daqMod.setInt("edge", 1);
      demod_rate = daq.getDouble(String.Format("/{0}/demods/{1}/rate", device_ids[0],
demod_c));
      // Exact mode: To preserve our desired trigger duration, we have to set
      // the number of grid columns to exactly match.
      double trigger_duration = time_constant * 30;
      int sample_count = Convert.ToInt32(demod_rate * trigger_duration);
      daqMod.setInt("grid/cols", sample_count);
      // The length of each trigger to record (in seconds).
      daqMod.setDouble("duration", trigger_duration);
      daqMod.setDouble("delay", -trigger_duration / 4);
      // Do not return overlapped trigger events.
```

```
      daqMod.setDouble("holdoff/time", 0);
      daqMod.setDouble("holdoff/count", 0);
      daqMod.setDouble("level", out_amp / 6);
      // The hysterisis is effectively a second criteria (if non-zero) for triggering
      // and makes triggering more robust in noisy signals. When the trigger `level`
      // is violated, then the signal must return beneath (for positive trigger edge)
      // the hysteresis value in order to trigger.
      daqMod.setDouble("hysteresis", 0.01);
      // synchronizing the settings
      daq.sync();

      // Recording

      // Subscribe to the demodulators
      daqMod.unsubscribe("*");
      foreach (String dev in device_ids)
      {
        string node = String.Format("/{0}/demods/{1}/sample.r", dev, demod_c);
        daqMod.subscribe(node);
      }

      // Execute the module
      daqMod.execute();
      // Send a trigger
      daq.setDouble(String.Format("/{0}/sigouts/{1}/enables/{2}", device_ids[0],
out_c, out_mixer_c), 1);
      while (!daqMod.finished())
      {
        System.Threading.Thread.Sleep(1000);
        System.Diagnostics.Trace.WriteLine(String.Format("Progress {0}",
daqMod.progress()));
      }

      // Read the result
      Lookup result = daqMod.read();

      // Turn off the trigger
      daq.setDouble(String.Format("/{0}/sigouts/{1}/enables/{2}", device_ids[0],
out_c, out_mixer_c), 0);
      // Finish the DAQ module
      daqMod.finish();

      daqMod.clear();  // Release module resources. Especially important if modules
are created
                       // inside a loop to prevent excessive resource consumption.

      // Stop the MDS module, release memory and resources
      mds.clear();

      // Extracting and saving the data
      double mClockbase = daq.getDouble(String.Format("/{0}/clockbase",
device_ids[0]));

      List<ZIDoubleData[]> data = new List<ZIDoubleData[]>();
      foreach (String dev in device_ids)
      {
        string node = string.Format("/{0}/demods/{1}/sample.r", dev, demod_c);
        data.Add(result[node][0].doubleData);
      }

      String fileName = Environment.CurrentDirectory + "/mds_dataacquisition.txt";
      System.IO.StreamWriter file = new System.IO.StreamWriter(fileName);

      for (int i = 0; i < data[0].Length; ++i)
      {
        file.WriteLine("{0},{1},{2}", (data[0][i].timeStamp - data[0][0].timeStamp) /
mClockbase,
```

```
          data[0][i].value, data[1][i].value);
      }
      file.Close();

      daq.disconnect();
    }
  }

}
```

Chapter 8. C Programming

The LabOne C API, also known as ziAPI, provides a simple and robust way to communicate with the Data Server. It enables you to get or set parameters and receive streaming data.

8.1. Getting Started

After installing the LabOne software package and relevant drivers for your instrument you are ready start programming with ziAPI. All you need is a C compiler, linker and editor.

The structure of a program using ziAPI can be split into three parts: initialization/connection, data manipulation and disconnection/cleanup. The basic object that is always used is the ziConnection data structure. First, ziConnection is has to be initialized by calling ziAPIInit. After initialization ziConnection is ready to connect to a ziServer by calling ziAPIConnect. Then ziConnection is ready to be used for getting and setting parameters and streaming data. When ziConnection is not needed anymore the established connection to the ziServer has to be hung up using ziAPIDisconnect before cleaning it up by calling ziAPIDestroy.

8.1.1. Examples

Along with the LabOne C API DLL, a LabOne installation includes examples to help getting started with the LabOne C API. On Windows they are located in the folder:

```
C:\Program Files\Zurich Instruments\LabOne\API\C\examples\
```

and on Linux, after extracting the LabOne tarball, they are located in the folder:

```
API/C/examples.
```

Below you find a simple program, which sets the demodulator rate of all demods for all devices.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

int main() {
  ZIResult_enum retVal;
  ZIConnection conn;
  char* errBuffer;
  const char serverAddress[] = "localhost";

  // Initialize ZIConnection.
  retVal = ziAPIInit(&conn);
  if (retVal != ZI_INFO_SUCCESS) {
    ziAPIGetError(retVal, &errBuffer, NULL);
    fprintf(stderr, "Can't init Connection: %s\n", errBuffer);
    return 1;
  }

  // Connect to the Data Server: Use port 8005 for the HF2 Data Server, use
  // 8004 for the UHF and MF Data Servers. HF2 only support ZI_API_VERSION_1,
  // see the LabOne Programming Manual for an explanation of API Levels.
  retVal = ziAPIConnectEx(conn, serverAddress, 8004, ZI_API_VERSION_6, NULL);
  if (retVal != ZI_INFO_SUCCESS) {
    ziAPIGetError(retVal, &errBuffer, NULL);
    fprintf(stderr, "Error, can't connect to the Data Server: `%s`.\n", errBuffer);
  } else {
    // Set all demodulator rates of device dev1046 to 150 Hz
    retVal = ziAPISetValueD(conn, "/dev1046/demods/*/rate", 150);
    if (retVal != ZI_INFO_SUCCESS) {
      ziAPIGetError(retVal, &errBuffer, NULL);
      fprintf(stderr, "Can't set parameter: %s\n", errBuffer);
    }

    // Disconnect from the Data Server. Since ZIAPIDisconnect always returns
    // ZI_INFO_SUCCESS no error handling is required.
```

```
    ziAPIDisconnect(conn);
  }

  // Destroy the ZIConnection. Since ZIAPIDestroy always returns
  // ZI_INFO_SUCCESS, no error handling is required.
  ziAPIDestroy(conn);

  return 0;
}
```

8.2. Module Documentation

8.2.1. Connecting to Data Server

This section describes how to initialize the ZIConnection and establish a connection to Data Server as well as how to disconnect after all data handling is done and cleanup the ZIConnection.

Typedefs

- typedef ZIConnection

  The ZIConnection is a connection reference; it holds information and helper variables about a connection to the Data Server. There is nothing in this reference which the user user may use, so it is hidden and instead a dummy pointer is used. See ziAPIInit for how to create a ZIConnection.

Enumerations

- enum ZIAPIVersion_enum { ZI_API_VERSION_0, ZI_API_VERSION_1, ZI_API_VERSION_4, ZI_API_VERSION_5, ZI_API_VERSION_6, ZI_API_VERSION_MAX }

Functions

- ZIResult_enum ziAPIInit (ZIConnection* conn)

  Initializes a ZIConnection structure.

- ZIResult_enum ziAPIDestroy (ZIConnection conn)

  Destroys a ZIConnection structure.

- ZIResult_enum ziAPIConnect (ZIConnection conn, const char* hostname, uint16_t port)

  Connects the ZIConnection to Data Server.

- ZIResult_enum ziAPIDisconnect (ZIConnection conn)

  Disconnects an established connection.

- ZIResult_enum ziAPIListImplementations (char* implementations, uint32_t bufferSize)

  Returns the list of supported implementations.

- ZIResult_enum ziAPIConnectEx (ZIConnection conn, const char* hostname, uint16_t port, ZIAPIVersion_enum apiLevel, const char* implementation)

  Connects to Data Server and enables extended ziAPI.

- ZIResult_enum ziAPIGetConnectionAPILevel (ZIConnection conn, ZIAPIVersion_enum* apiLevel)

  Returns ziAPI level used for the connection conn.

- ZIResult_enum ziAPIGetVersion (const char** version)

  Retrieves the release version of ziAPI.

- ZIResult_enum ziAPIGetCommitHash (const char** commitHash)

  Retrieves the exact commit hash key of ziAPI.

- ZIResult_enum ziAPIGetRevision (uint32_t* revision)

  Retrieves the version and build number of ziAPI.

Detailed Description

```
// Copyright [2016] Zurich Instruments AG
#include <stdio.h>

#include "ziAPI.h"

int connection() {
  ZIResult_enum retVal;
  ZIConnection conn;
  char* errBuffer;
  const char serverAddress[] = "localhost";

  // Initialize ZIConnection.
  retVal = ziAPIInit(&conn);
  if (retVal != ZI_INFO_SUCCESS) {
    ziAPIGetError(retVal, &errBuffer, NULL);
    fprintf(stderr, "Can't init Connection: %s\n", errBuffer);
    return 1;
  }

  // Connect to the Data Server: Use port 8005 for the HF2 Data Server, use
  // 8004 for the UHF and MF Data Servers. HF2 only support ZI_API_VERSION_1,
  // see the LabOne Programming Manual for an explanation of API Levels.
  retVal = ziAPIConnectEx(conn, serverAddress, 8004, ZI_API_VERSION_6, NULL);
  if (retVal != ZI_INFO_SUCCESS) {
    ziAPIGetError(retVal, &errBuffer, NULL);
    fprintf(stderr, "Error, can't connect to the Data Server: `%s`.\n", errBuffer);
  } else {
    /*
      Do something using ZIConnection here.
    */

    // Since ZIAPIDisconnect always returns ZI_INFO_SUCCESS
    // no error handling is required.
    ziAPIDisconnect(conn);
  }

  // Since ZIAPIDestroy always returns ZI_INFO_SUCCESS
  // no error handling is required.
  ziAPIDestroy(conn);

  return 0;
}
```

Enumeration Type Documentation

Enumerator:

- ZI_API_VERSION_0
- ZI_API_VERSION_1
- ZI_API_VERSION_4
- ZI_API_VERSION_5
- ZI_API_VERSION_6
- ZI_API_VERSION_MAX

Function Documentation

ziAPIInit

ZIResult_enum ziAPIInit (ZIConnection* conn)

Initializes a ZIConnection structure.

This function initializes the structure so that it is ready to connect to Data Server. It allocates memory and sets up the infrastructure needed.

Parameters:

[out] conn

Pointer to ZIConnection that is to be initialized

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_MALLOC on memory allocation failure
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDestroy, ziAPIConnect, ziAPIDisconnect

See Connection for an example

ziAPIDestroy

ZIResult_enum ziAPIDestroy (ZIConnection conn)

Destroys a ZIConnection structure.

This function frees all memory that has been allocated by ziAPIInit. If it is called with an uninitialized ZIConnection struct it may result in segmentation faults as well when it is called with a struct for which ZIAPIDestroy already has been called.

Parameters:

[in] conn

Pointer to ZIConnection struct that has to be destroyed

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIInit, ziAPIConnect, ziAPIDisconnect

See Connection for an example

ziAPIConnect

ZIResult_enum ziAPIConnect (ZIConnection conn, const char* hostname, uint16_t port)

Connects the ZIConnection to Data Server.

Connects to Data Server using a ZIConnection and prepares for data exchange. For most cases it is enough to just give a reference to the connection and give NULL for hostname and 0 for the port, so it connects to localhost on the default port.

Parameters:

[in] conn

Pointer to ZIConnection with which the connection should be established

[in] hostname

Name of the Host to which it should be connected, if NULL "localhost" will be used as default

[in] port

The Number of the port to connect to. If 0, default port of the local Data Server will be used (8005)

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_HOSTNAME if the given host name could not be found
- ZI_ERROR_SOCKET_CONNECT if no connection could be established
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_SOCKET_INIT if initialization of the socket failed
- ZI_ERROR_CONNECTION when the Data Server didn't return the correct answer
- ZI_ERROR_TIMEOUT when initial communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDisconnect, ziAPIInit, ziAPIDestroy

See Connection for an example

ziAPIDisconnect

ZIResult_enum ziAPIDisconnect (ZIConnection conn)

Disconnects an established connection.

Disconnects from Data Server. If the connection has not been established and the function is called it returns without doing anything.

Parameters:

[in] conn

Pointer to ZIConnection to be disconnected

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnect, ziAPIInit, ziAPIDestroy

See Connection for an example

ziAPIListImplementations

ZIResult_enum ziAPIListImplementations (char* implementations, uint32_t bufferSize)

Returns the list of supported implementations.

Returned names are defined by implementations in the linked library and may change depending on software version.

Parameters:

[out] implementations

Pointer to a buffer receiving a newline-delimited list of the names of all the supported ziAPI implementations. The string is zero-terminated.

[in] bufferSize

The size of the buffer assigned to the implementations parameter

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_LENGTH if the length of the char-buffer given by MaxLen is too small for all elements
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnectEx

ziAPIConnectEx

ZIResult_enum ziAPIConnectEx (ZIConnection conn, const char* hostname, uint16_t port, ZIAPIVersion_enum apiLevel, const char* implementation)

Connects to Data Server and enables extended ziAPI.

With apiLevel=ZI_API_VERSION_1 and implementation=NULL, this call is equivalent to plain ziAPIConnect. With other version and implementation values enables corresponding ziAPI extension and connection using different implementation.

Parameters:

[in] conn

Pointer to the ZIConnection with which the connection should be established

[in] hostname

Name of the host to which it should be connected, if NULL "localhost" will be used as default

[in] port

The number of the port to connect to. If 0 the port of the local Data Server will be used

[in] apiLevel

Specifies the ziAPI compatibility level to use for this connection (1 or 4).

[in] implementation

Specifies implementation to use for a connection, must be one of the returned by ziAPIListImplementations or NULL to select default implementation

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_HOSTNAME if the given host name could not be found
- ZI_ERROR_SOCKET_CONNECT if no connection could be established
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_SOCKET_INIT if initialization of the socket failed
- ZI_ERROR_CONNECTION when the Data Server didn't return the correct answer or requested implementation is not found or doesn't support requested ziAPI level
- ZI_ERROR_TIMEOUT when initial communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIListImplementations, ziAPIConnect, ziAPIDisconnect, ziAPIInit, ziAPIDestroy, ziAPIGetConnectionVersion

See Connection for an example

ziAPIGetConnectionAPILevel

ZIResult_enum ziAPIGetConnectionAPILevel (ZIConnection conn, ZIAPIVersion_enum* apiLevel)

Returns ziAPI level used for the connection conn.

Parameters:

[in] conn

Pointer to ZIConnection

[out] apiLevel

Pointer to preallocated ZIAPIVersion_enum, receiving the ziAPI level

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION if level can not be determined due to conn is not connected

See Also:

ziAPIConnectEx, ziAPIGetVersion, ziAPIGetCommitHash, ziAPIGetRevision

ziAPIGetVersion

ZIResult_enum ziAPIGetVersion (const char** version)

Retrieves the release version of ziAPI.

Sets the passed pointer to point to the null-terminated release version string of ziAPI.

Parameters:

[in] version
Pointer to const char pointer.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:
ziAPIConnectEx, ziAPIGetRevision, ziAPIGetCommitHash, ziAPIGetConnectionAPILevel

ziAPIGetCommitHash

ZIResult_enum ziAPIGetCommitHash (const char** commitHash)

Retrieves the exact commit hash key of ziAPI.

Sets the passed pointer to point to the null-terminated commit hash string of ziAPI.

Parameters:

[in] commitHash

Pointer to const char pointer.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnectEx, ziAPIGetRevision, ziAPIGetVersion, ziAPIGetConnectionAPILevel

ziAPIGetRevision

ZIResult_enum ziAPIGetRevision (uint32_t* revision)

Retrieves the version and build number of ziAPI.

Sets an unsigned int with the version and build number of the ziAPI you are using.

The number is a packed representation of YY.MM.BUILD as a 32-bit unsigned integer: (YY << 24) | (MM << 16) | BUILD.

Note: prior to LabOne 19.10, the packed representation did not contain YY.MM.

Parameters:

[in] revision

Pointer to an unsigned int to fill up with the packed version number.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnectEx, ziAPIGetVersion, ziAPIGetCommitHash, ziAPIGetConnectionAPILevel

8.2.2. Tree

All parameters and streams are organized in a tree. You can list the whole tree, parts of it or single items using ziAPIListNodes or you may update the tree with nodes of newly connected devices by using ziAPIUpdateDevices.

Enumerations

- enum ZIListNodes_enum { ZI_LIST_NODES_ALL, ZI_LIST_NODES_RECURSIVE, ZI_LIST_NODES_ABSOLUTE, ZI_LIST_NODES_LEAVESONLY, ZI_LIST_NODES_SETTINGSONLY, ZI_LIST_NODES_STREAMINGONLY, ZI_LIST_NODES_SUBSCRIBEDONLY, ZI_LIST_NODES_BASECHANNEL, ZI_LIST_NODES_GETONLY, ZI_LIST_NODES_EXCLUDESTREAMING, ZI_LIST_NODES_EXCLUDEVECTORS }

  Defines the values of the flags used in ziAPIListNodes.

Functions

- ZIResult_enum ziAPIListNodes (ZIConnection conn, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

  Returns all child nodes found at the specified path.

- ZIResult_enum ziAPIListNodesJSON (ZIConnection conn, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

  Returns all child nodes found at the specified path.

Detailed Description

```
// Copyright [2016] Zurich Instruments AG
#include <stdio.h>

#include "ziAPI.h"

void PrintChildren(ZIConnection Conn,
                   char*        Path) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  char NodesBuffer[8192];

  if ((RetVal = ziAPIListNodes(Conn,
                               Path,
                               NodesBuffer,
                               8192,
                               ZI_LIST_NODES_ALL)) != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Can't List Nodes: %s\n", ErrBuffer);
  } else {
    char* Ptr = NodesBuffer;
    char* LastPtr = Ptr;

    // print out each node on a separate line with dash as prefix
    for (; *Ptr != 0; Ptr++) {
      if (*Ptr == '\n') {
        *Ptr = 0;
```

```
            printf("- %s\n", LastPtr);
            LastPtr = Ptr + 1;
          }
        }

        // print out the last node
        if (Ptr != LastPtr) {
          printf("- %s\n", LastPtr);
        }
      }
    }
```

Enumeration Type Documentation

Defines the values of the flags used in ziAPIListNodes.

Enumerator:

- ZI_LIST_NODES_ALL

  Default, return a simple listing of the given node immediate descendants.

- ZI_LIST_NODES_RECURSIVE

  List the nodes recursively.

- ZI_LIST_NODES_ABSOLUTE

  Return absolute paths.

- ZI_LIST_NODES_LEAVESONLY

  Return only leaf nodes, which means the nodes at the outermost level of the tree.

- ZI_LIST_NODES_SETTINGSONLY

  Return only nodes which are marked as setting.

- ZI_LIST_NODES_STREAMINGONLY

  Return only streaming nodes (nodes that can be pushed from the device at a high data rate)

- ZI_LIST_NODES_SUBSCRIBEDONLY

  Return only nodes that are subscribed to in the API session.

- ZI_LIST_NODES_BASECHANNEL

  Return only one instance of a node in case of multiple channels.

- ZI_LIST_NODES_GETONLY

  Return only nodes which can be used with the get command.

- ZI_LIST_NODES_EXCLUDESTREAMING

  Exclude streaming nodes.

- ZI_LIST_NODES_EXCLUDEVECTORS

  Exclude node vectors.

Function Documentation

ziAPIListNodes

ZIResult_enum ziAPIListNodes (ZIConnection conn, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

Returns all child nodes found at the specified path.

This function returns a list of node names found at the specified path. The path may contain wildcards so that the returned nodes do not necessarily have to have the same parents. The list is returned in a null-terminated char-buffer, each element delimited by a newline. If the maximum length of the buffer (bufferSize) is not sufficient for all elements, nothing will be returned and the return value will be ZIResult_enum::ZI_LENGTH.

Parameters:

[in] conn

Pointer to the ZIConnection for which the node names should be retrieved.

[in] path

Path for which all children will be returned. The path may contain wildcard characters.

[out] nodes

Upon call filled with newline-delimited list of the names of all the children found. The string is zero-terminated.

[in] bufferSize

The length of the buffer used for the nodes output parameter.

[in] flags

A combination of flags (applied bitwise) as defined in ZIListNodes_enum.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by bufferSize is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Tree Listing for an example

See Also:

ziAPIUpdate

ziAPIListNodesJSON

ZIResult_enum ziAPIListNodesJSON (ZIConnection conn, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

Returns all child nodes found at the specified path.

This function returns a list of node names found at the specified path, formatted as JSON. The path may contain wildcards so that the returned nodes do not necessarily have to have the same parents. The list is returned in a null-terminated char-buffer. If the maximum length of the buffer (bufferSize) is not sufficient for all elements, nothing will be returned and the return value will be ZIResult_enum::ZI_LENGTH.

Parameters:

[in] conn

Pointer to the ZIConnection for which the node names should be retrieved.

[in] path

Path for which all children will be returned. The path may contain wildcard characters.

[out] nodes

Upon call filled with JSON-formatted list of the names of all the children found. The string is zero-terminated.

[in] bufferSize

The length of the buffer used for the nodes output parameter.

[in] flags

A combination of flags (applied bitwise) as defined in ZIListNodes_enum.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by bufferSize is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Tree Listing for an example

See Also:

ziAPIUpdate

8.2.3. Set and Get Parameters

This section describes several functions for getting and setting parameters of different datatypes.

Functions

- ZIResult_enum ziAPIGetValueD (ZIConnection conn, const char* path, ZIDoubleData* value)

  gets the double-type value of the specified node

- ZIResult_enum ziAPIGetComplexData (ZIConnection conn, const char* path, ZIDoubleData* real, ZIDoubleData* imag)

  gets the complex double-type value of the specified node

- ZIResult_enum ziAPIGetValueI (ZIConnection conn, const char* path, ZIIntegerData* value)

  gets the integer-type value of the specified node

- ZIResult_enum ziAPIGetDemodSample (ZIConnection conn, const char* path, ZIDemodSample* value)

  Gets the demodulator sample value of the specified node.

- ZIResult_enum ziAPIGetDIOSample (ZIConnection conn, const char* path, ZIDIOSample* value)

  Gets the Digital I/O sample of the specified node.

- ZIResult_enum ziAPIGetAuxInSample (ZIConnection conn, const char* path, ZIAuxInSample* value)

  gets the AuxIn sample of the specified node

- ZIResult_enum ziAPIGetValueB (ZIConnection conn, const char* path, unsigned char* buffer, unsigned int* length, unsigned int bufferSize)

  gets the Bytearray value of the specified node

- ZIResult_enum ziAPIGetValueString (ZIConnection conn, const char* path, char* buffer, unsigned int* length, unsigned int bufferSize)

  gets a null-terminated string value of the specified node

- ZIResult_enum ziAPIGetValueStringUnicode (ZIConnection conn, const char* path, wchar_t* wbuffer, unsigned int* length, unsigned int bufferSize)

  gets a null-terminated string value of the specified node

- ZIResult_enum ziAPISetValueD (ZIConnection conn, const char* path, ZIDoubleData value)

  asynchronously sets a double-type value to one or more nodes specified in the path

- ZIResult_enum ziAPISetComplexData (ZIConnection conn, const char* path, ZIDoubleData real, ZIDoubleData imag)

  asynchronously sets a double-type complex value to one or more nodes specified in the path

- ZIResult_enum ziAPISetValueI (ZIConnection conn, const char* path, ZIIntegerData value)

  asynchronously sets an integer-type value to one or more nodes specified in a path

- ZIResult_enum ziAPISetValueB (ZIConnection conn, const char* path, unsigned char* buffer, unsigned int length)

  asynchronously sets the binary-type value of one or more nodes specified in the path

- ZIResult_enum ziAPISetValueString (ZIConnection conn, const char* path, const char* str)

  asynchronously sets a string value of one or more nodes specified in the path

- ZIResult_enum ziAPISetValueStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

  asynchronously sets a unicode encoded string value of one or more nodes specified in the path

- ZIResult_enum ziAPISyncSetValueD (ZIConnection conn, const char* path, ZIDoubleData* value)

  synchronously sets a double-type value to one or more nodes specified in the path

- ZIResult_enum ziAPISyncSetValueI (ZIConnection conn, const char* path, ZIIntegerData* value)

  synchronously sets an integer-type value to one or more nodes specified in a path

- ZIResult_enum ziAPISyncSetValueB (ZIConnection conn, const char* path, uint8_t* buffer, uint32_t* length, uint32_t bufferSize)

  Synchronously sets the binary-type value of one ore more nodes specified in the path.

- ZIResult_enum ziAPISyncSetValueString (ZIConnection conn, const char* path, const char* str)

  Synchronously sets a string value of one or more nodes specified in the path.

- ZIResult_enum ziAPISyncSetValueStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

  Synchronously sets a unicode string value of one or more nodes specified in the path.

- ZIResult_enum ziAPISync (ZIConnection conn)

  Synchronizes the session by dropping all pending data.

- ZIResult_enum ziAPIEchoDevice (ZIConnection conn, const char* deviceSerial)

  Sends an echo command to a device and blocks until answer is received.

- __inline ZIResult_enum ziAPIGetValueS (ZIConnection conn, char* path, DemodSample* value)

- __inline ZIResult_enum ziAPIGetValueDIO (ZIConnection conn, char* path, DIOSample* value)

- __inline ZIResult_enum ziAPIGetValueAuxIn (ZIConnection conn, char* path, AuxInSample* value)

Function Documentation

ziAPIGetValueD

ZIResult_enum ziAPIGetValueD (ZIConnection conn, const char* path, ZIDoubleData* value)

gets the double-type value of the specified node

This function retrieves the numerical value of the specified node as an double-type value. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] value

Pointer to a double in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2018] Zurich Instruments AG

#include <algorithm>
#include <ctime>
#include <iostream>
#include <map>
#include <string>

#include "ziAPI.h"
#include "ziUtils.h"

void setDemodRate(ZIConnection conn, const char** deviceId, uint32_t index,
 ZIDoubleData rate) {
  char nodePath[1024];
  snprintf(nodePath, sizeof(nodePath), "/%s/demods/%d/rate", *deviceId, index);
  checkError(ziAPISetValueD(conn, nodePath, rate));
}
```

```
ZIDoubleData getDemodRate(ZIConnection conn, const char** deviceId, uint32_t index) {
  ZIDoubleData rate;
  char nodePath[1024];
  snprintf(nodePath, sizeof(nodePath), "/%s/demods/%d/rate", *deviceId, index);
  checkError(ziAPIGetValueD(conn, nodePath, &rate));
  return rate;
}

int main() {
  // The device address of the device to run the example on.
  char deviceAddress[] = "dev2006";
  // The maximum API Level supported by this example.
  // Please use ZI_API_VERSION_1 if using an HF2 Instrument.
  ZIAPIVersion_enum apiLevel = ZI_API_VERSION_6;

  // The ZIConnection is actually a pointer.
  ZIConnection conn;
  if (isError(ziAPIInit(&conn))) {
    return 1;
  }

  ziAPISetDebugLevel(0);
  ziAPIWriteDebugLog(0, "Logging enabled.");

  const char *deviceId;
  if (!ziCreateAPISession(conn, deviceAddress, apiLevel, &deviceId)) {
    try {
      ziApiServerVersionCheck(conn);

      // Set a device configuration.
      uint32_t index = 0;
      ZIDoubleData rate = 10e3;
      setDemodRate(conn, &deviceId, index, rate);

      // Read it back.
      rate = getDemodRate(conn, &deviceId, index);
      std::cout << "[INFO] " << "Device " << deviceId << " demod " << index << " has
 rate " << rate << ".\n";

    } catch (std::runtime_error& e) {
      char extErrorMessage[1024] = "";
      ziAPIGetLastError(conn, extErrorMessage, 1024);
      fprintf(stderr, "[ERROR] %s\ndetails: `%s`\n.", e.what(), extErrorMessage);
    } catch (...) {
      // Ensure all exceptions are caught.
      fprintf(stderr, "[ERROR] Unexpected error\n.");
    }
    ziAPIDisconnect(conn);
  } else {
    char extErrorMessage[1024] = "";
    ziAPIGetLastError(conn, extErrorMessage, 1024);
    fprintf(stderr, "[ERROR] Details: `%s`.\n", extErrorMessage);
  }
  ziAPIDestroy(conn);

  return 0;
}
```

See Also:

ziAPISetValueD, ziAPIGetValueAsPollData

ziAPIGetComplexData

ZIResult_enum ziAPIGetComplexData (ZIConnection conn, const char* path, ZIDoubleData* real, ZIDoubleData* imag)

gets the complex double-type value of the specified node

This function retrieves the numerical value of the specified node as an complex double-type value. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] real

Pointer to a double in which the real value should be written

[out] imag

Pointer to a double in which the imaginary value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2018] Zurich Instruments AG

#include <algorithm>
#include <ctime>
#include <iostream>
#include <map>
#include <string>

#include "ziAPI.h"
#include "ziUtils.h"

void setDemodRate(ZIConnection conn, const char** deviceId, uint32_t index,
 ZIDoubleData rate) {
  char nodePath[1024];
  snprintf(nodePath, sizeof(nodePath), "/%s/demods/%d/rate", *deviceId, index);
  checkError(ziAPISetValueD(conn, nodePath, rate));
```

```
}

ZIDoubleData getDemodRate(ZIConnection conn, const char** deviceId, uint32_t index) {
  ZIDoubleData rate;
  char nodePath[1024];
  snprintf(nodePath, sizeof(nodePath), "/%s/demods/%d/rate", *deviceId, index);
  checkError(ziAPIGetValueD(conn, nodePath, &rate));
  return rate;
}

int main() {
  // The device address of the device to run the example on.
  char deviceAddress[] = "dev2006";
  // The maximum API Level supported by this example.
  // Please use ZI_API_VERSION_1 if using an HF2 Instrument.
  ZIAPIVersion_enum apiLevel = ZI_API_VERSION_6;

  // The ZIConnection is actually a pointer.
  ZIConnection conn;
  if (isError(ziAPIInit(&conn))) {
    return 1;
  }

  ziAPISetDebugLevel(0);
  ziAPIWriteDebugLog(0, "Logging enabled.");

  const char *deviceId;
  if (!ziCreateAPISession(conn, deviceAddress, apiLevel, &deviceId)) {
    try {
      ziApiServerVersionCheck(conn);

      // Set a device configuration.
      uint32_t index = 0;
      ZIDoubleData rate = 10e3;
      setDemodRate(conn, &deviceId, index, rate);

      // Read it back.
      rate = getDemodRate(conn, &deviceId, index);
      std::cout << "[INFO] " << "Device " << deviceId << " demod " << index << " has
 rate " << rate << ".\n";

    } catch (std::runtime_error& e) {
      char extErrorMessage[1024] = "";
      ziAPIGetLastError(conn, extErrorMessage, 1024);
      fprintf(stderr, "[ERROR] %s\ndetails: `%s`\n.", e.what(), extErrorMessage);
    } catch (...) {
      // Ensure all exceptions are caught.
      fprintf(stderr, "[ERROR] Unexpected error\n.");
    }
    ziAPIDisconnect(conn);
  } else {
    char extErrorMessage[1024] = "";
    ziAPIGetLastError(conn, extErrorMessage, 1024);
    fprintf(stderr, "[ERROR] Details: `%s`.\n", extErrorMessage);
  }
  ziAPIDestroy(conn);

  return 0;
}
```

See Also:

ziAPISetComplexData, ziAPIGetValueAsPollData

ziAPIGetValueI

ZIResult_enum ziAPIGetValueI (ZIConnection conn, const char* path, ZIIntegerData* value)

gets the integer-type value of the specified node

This function retrieves the numerical value of the specified node as an integer-type value. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] value

Pointer to an 64bit integer in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPISetValueI, ziAPIGetValueAsPollData

ziAPIGetDemodSample

ZIResult_enum ziAPIGetDemodSample (ZIConnection conn, const char* path, ZIDemodSample* value)

Gets the demodulator sample value of the specified node.

This function retrieves the value of the specified node as an DemodSample struct. The value first found is returned if more than one value is available (a wildcard is used in the path). This function is only applicable to paths matching DEMODS/[0-9]+/SAMPLE.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] value

Pointer to a ZIDemodSample struct in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void GetSampleS(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  ZIDemodSample DemodSample;

  if ((RetVal = ziAPIGetDemodSample(Conn,
                                    "/dev1046/demods/0/sample",
                                    &DemodSample)) != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, can't get Parameter: %s.\n", ErrBuffer);
  } else {
```

```
            printf("TS = %f, X=%f, Y=%f\n",
                   (float)DemodSample.timeStamp,
                   DemodSample.x,
                   DemodSample.y);
          }
        }
```

See Also:

ziAPIGetValueAsPollData

ziAPIGetDIOSample

ZIResult_enum ziAPIGetDIOSample (ZIConnection conn, const char* path, ZIDIOSample* value)

Gets the Digital I/O sample of the specified node.

This function retrieves the newest available DIO sample from the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path). This function is only applicable to nodes ending in "/DIOS/[0-9]+/INPUT".

Parameters:

[in] conn

Pointer to the ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] value

Pointer to a ZIDIOSample struct in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void GetDIOSample(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  ZIDIOSample DIOSample;

  if ((RetVal = ziAPIGetDIOSample(Conn,
                                  "/dev1046/dios/0/output",
                                  &DIOSample)) != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, can't get Parameter: %s.\n", ErrBuffer);
  } else {
```

```
        printf("TS = %f, bits=%08x\n",
               (float)DIOSample.timeStamp,
               DIOSample.bits);
      }
    }
```

See Also:

ziAPIGetValueAsPollData

ziAPIGetAuxInSample

ZIResult_enum ziAPIGetAuxInSample (ZIConnection conn, const char* path, ZIAuxInSample* value)

gets the AuxIn sample of the specified node

This function retrieves the newest available AuxIn sample from the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path). This function is only applicable to nodes ending in "/AUXINS/[0-9]+/SAMPLE".

Parameters:

[in] conn

Pointer to the ziConnection with which the Value should be retrieved

[in] path

Path to the Node holding the value

[out] value

Pointer to an ZIAuxInSample struct in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void GetSampleAuxIn(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  ZIAuxInSample AuxInSample;

  if ((RetVal = ziAPIGetAuxInSample(Conn,
                                    "/dev1046/auxins/0/sample",
                                    &AuxInSample)) != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, can't get Parameter: %s\n", ErrBuffer);
```

```
    } else {
      printf("TS = %f, ch0=%f, ch1=%f\n",
             (float)AuxInSample.timeStamp,
             AuxInSample.ch0,
             AuxInSample.ch1);
    }
  }
```

See Also:

ziAPIGetValueAsPollData

ziAPIGetValueB

ZIResult_enum ziAPIGetValueB (ZIConnection conn, const char* path, unsigned char* buffer, unsigned int* length, unsigned int bufferSize)

gets the Bytearray value of the specified node

This function retrieves the newest available DIO sample from the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] path

Path to the Node holding the value

[out] buffer

Pointer to a buffer to store the retrieved data in

[out] length

Pointer to an unsigned int to store the length of data in. if an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void PrintVersion(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;
```

```
    const char* Path = "ZI/ABOUT/VERSION";
    unsigned char Buffer[0xff];
    unsigned int Length;

    if ((RetVal = ziAPIGetValueB(Conn,
                                 Path,
                                 Buffer,
                                 &Length,
                                 sizeof(Buffer) - 1)) != ZI_INFO_SUCCESS) {
      ziAPIGetError(RetVal, &ErrBuffer, NULL);
      fprintf(stderr, "Error, can't get value: %s.\n", ErrBuffer);
    } else {
      Buffer[Length] = 0;
      printf("%s=\"%s\"\n", Path, Buffer);
    }
  }
```

See Also:

ziAPISetValueB, ziAPIGetValueAsPollData

ziAPIGetValueString

ZIResult_enum ziAPIGetValueString (ZIConnection conn, const char* path, char* buffer, unsigned int* length, unsigned int bufferSize)

gets a null-terminated string value of the specified node

This function retrieves the newest string value for the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] path

Path to the Node holding the value

[out] buffer

Pointer to a buffer to store the retrieved null-terminated string

[out] length

Pointer to an unsigned int to store the length of the string in (including the null terminator). If an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPISetValueString, ziAPIGetValueAsPollData

ziAPIGetValueStringUnicode

ZIResult_enum ziAPIGetValueStringUnicode (ZIConnection conn, const char* path, wchar_t* wbuffer, unsigned int* length, unsigned int bufferSize)

gets a null-terminated string value of the specified node

This function retrieves the newest unicode string value for the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] path

Path to the Node holding the value

[out] wbuffer

Pointer to a buffer to store the retrieved null-terminated string

[out] length

Pointer to an unsigned int to store the length of the string in (including the null terminator). If an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPISetValueStringUnicode, ziAPIGetValueAsPollData

ziAPISetValueD

ZIResult_enum ziAPISetValueD (ZIConnection conn, const char* path, ZIDoubleData value)

asynchronously sets a double-type value to one or more nodes specified in the path

This function sets the values of the nodes specified in path to Value. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set.

[in] path

Path to the Node(s) for which the value(s) will be set to Value.

[in] value

The double-type value that will be written to the node(s).

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueD, ziAPISyncSetValueD

ziAPISetComplexData

ZIResult_enum ziAPISetComplexData (ZIConnection conn, const char* path, ZIDoubleData real, ZIDoubleData imag)

asynchronously sets a double-type complex value to one or more nodes specified in the path

This function sets the values of the nodes specified in path to the complex value (real, imag). More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set. If the node does not support complex values only the real value will be updated.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set.

[in] path

Path to the Node(s) for which the value(s) will be set to Value.

[in] real

The real value that will be written to the node(s).

[in] imag

The imag value that will be written to the node(s).

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetComplexData. ziAPISyncSetComplexData

ziAPISetValueI

ZIResult_enum ziAPISetValueI (ZIConnection conn, const char* path, ZIIntegerData value)

asynchronously sets an integer-type value to one or more nodes specified in a path

This function sets the values of the nodes specified in path to Value. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] value

The int-type value that will be written to the node(s)

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueI, ziAPISyncSetValueI

ziAPISetValueB

ZIResult_enum ziAPISetValueB (ZIConnection conn, const char* path, unsigned char* buffer, unsigned int length)

asynchronously sets the binary-type value of one or more nodes specified in the path

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] buffer

Pointer to the byte array with the data

[in] length

Length of the data in the buffer

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void ProgramCPU(ZIConnection   Conn,
                unsigned char* Buffer,
                int            Len) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  if ((RetVal = ziAPISetValueB(Conn,
```

```
                                 "/dev1046/cpus/0/program",
                                 Buffer,
                                 Len)) != ZI_INFO_SUCCESS) {
      ziAPIGetError(RetVal, &ErrBuffer, NULL);
      fprintf(stderr, "Error, can't set Parameter: %s.\n", ErrBuffer);
    }
  }
```

See Also:

ziAPIGetValueB. ziAPISyncSetValueB

ziAPISetValueString

ZIResult_enum ziAPISetValueString (ZIConnection conn, const char* path, const char* str)

asynchronously sets a string value of one or more nodes specified in the path

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] str

Pointer to a null terminated string (max 64k characters)

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueString, ziAPISyncSetValueString

ziAPISetValueStringUnicode

ZIResult_enum ziAPISetValueStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

asynchronously sets a unicode encoded string value of one or more nodes specified in the path

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] wstr

Pointer to a null terminated unicode string (max 64k characters)

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueStringUnicode. ziAPISyncSetValueStringUnicode

ziAPISyncSetValueD

ZIResult_enum ziAPISyncSetValueD (ZIConnection conn, const char* path, ZIDoubleData* value)

synchronously sets a double-type value to one or more nodes specified in the path

This function sets the values of the nodes specified in path to Value. More than one value can be set if a wildcard is used. The function sets the value synchronously. After returning you know that it is set and to which value it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set to value

[in] value

Pointer to a double-type containing the value to be written. When the function returns value holds the effectively written value.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueD, ziAPISetValueD

ziAPISyncSetValueI

ZIResult_enum ziAPISyncSetValueI (ZIConnection conn, const char* path, ZIIntegerData* value)

synchronously sets an integer-type value to one or more nodes specified in a path

This function sets the values of the nodes specified in path to value. More than one value can be set if a wildcard is used. The function sets the value synchronously. After returning you know that it is set and to which value it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the node(s) for which the value(s) will be set

[in] value

Pointer to a int-type containing then value to be written. when the function returns value holds the effectively written value.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueI, ziAPISetValueI

ziAPISyncSetValueB

ZIResult_enum ziAPISyncSetValueB (ZIConnection conn, const char* path, uint8_t* buffer, uint32_t* length, uint32_t bufferSize)

Synchronously sets the binary-type value of one ore more nodes specified in the path.

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. This function sets the value synchronously. After returning you know that it is set and to which value it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] buffer

Pointer to the byte array with the data

[in] length

Length of the data in the buffer

[in] bufferSize

Length of the data in the buffer

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueB, ziAPISetValueB

ziAPISyncSetValueString

ZIResult_enum ziAPISyncSetValueString (ZIConnection conn, const char* path, const char* str)

Synchronously sets a string value of one or more nodes specified in the path.

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. This function sets the value synchronously. After returning you know that it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in/out] str

Pointer to a null terminated string (max 64k characters)

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueString, ziAPISetValueString

ziAPISyncSetValueStringUnicode

ZIResult_enum ziAPISyncSetValueStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

Synchronously sets a unicode string value of one or more nodes specified in the path.

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. This function sets the value synchronously. After returning you know that it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in/out] wstr

Pointer to a null terminated unicode string (max 64k characters)

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueStringUnicode, ziAPISetValueStringUnicode

ziAPISync

ZIResult_enum ziAPISync (ZIConnection conn)

Synchronizes the session by dropping all pending data.

This function drops any data that is pending for transfer. Any data (including poll data) retrieved afterwards is guaranteed to be produced not earlier than the call to ziAPISync. This ensures in particular that any settings made prior to the call to ziAPISync have been propagated to the device, and the data retrieved afterwards is produced with the new settings already set to the hardware. Note, however, that this does not include any required settling time.

Parameters:

[in] conn

Pointer to the ZIConnection that is to be synchronized

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIEchoDevice

ZIResult_enum ziAPIEchoDevice (ZIConnection conn, const char* deviceSerial)

Sends an echo command to a device and blocks until answer is received.

This is useful to flush all buffers between API and device to enforce that further code is only executed after the device executed a previous command. Per device echo is only implemented for HF2. For other device types it is a synonym to ziAPISync, and deviceSerial parameter is ignored.

Parameters:

[in] conn

Pointer to the ZIConnection that is to be synchronized

[in] deviceSerial

The serial of the device to get the echo from, e.g., dev2100

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIGetValueS

__inline ZIResult_enum ziAPIGetValueS (ZIConnection conn, char* path, DemodSample* value)

ziAPIGetValueDIO

__inline ZIResult_enum ziAPIGetValueDIO (ZIConnection conn, char* path, DIOSample* value)

ziAPIGetValueAuxIn

__inline ZIResult_enum ziAPIGetValueAuxIn (ZIConnection conn, char* path, AuxInSample* value)

8.2.4. Data Streaming

This section describes how to perform data streaming. It allows for recording at high data rates without sample loss.

Data Structures

- struct ZIEvent

  This struct holds event data forwarded by the Data Server.

- struct ziEvent

  This struct holds event data forwarded by the Data Server.
  Deprecated: See ZIEvent.

Functions

- ZIEvent* ziAPIAllocateEventEx ( )

  Allocates ZIEvent structure and returns the pointer to it. Attention!!! It is the client code responsibility to deallocate the structure by calling ziAPIDeallocateEventEx!

- void ziAPIDeallocateEventEx (ZIEvent* ev)

  Deallocates ZIEvent structure created with ziAPIAllocateEventEx().

- ZIResult_enum ziAPISubscribe (ZIConnection conn, const char* path)

  subscribes the nodes given by path for ziAPIPollDataEx

- ZIResult_enum ziAPIUnSubscribe (ZIConnection conn, const char* path)

  unsubscribes to the nodes given by path

- ZIResult_enum ziAPIPollDataEx (ZIConnection conn, ZIEvent* ev, uint32_t timeOutMilliseconds)

  checks if an event is available to read

- ZIResult_enum ziAPIGetValueAsPollData (ZIConnection conn, const char* path)

  triggers a value request, which will be given back on the poll event queue

- __inline ZIResult_enum ziAPIPollData (ZIConnection conn, ziEvent* ev, int timeOut)

  Checks if an event is available to read. Deprecated: See ziAPIPollDataEx().

Detailed Description

```
// Copyright [2016] Zurich Instruments AG

// Suppress Microsoft deprecation warning for use of strtok
// (the suggested replacement strtok_s is not portable)
#ifdef _WIN32
  #ifndef _CRT_SECURE_NO_WARNINGS
    #define _CRT_SECURE_NO_WARNINGS
  #endif
```

```
#endif

#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#include "ziAPI.h"


void EventLoop(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  ZIEvent* Event;
  unsigned int Cnt = 0;
  const char* separator = "\n";
  char  demodRatePaths[256];

  /*
     Allocate ZIEvent in heap memory instead of getting it from stack will
     secure against stack overflows especially in windows.
  */
  if ((Event = ziAPIAllocateEventEx()) == NULL) {
    fprintf(stderr, "Can't allocate memory\n");
    return;
  }

  // Subscribe to a node, e.g., a demodulator sample.
  if ((RetVal = ziAPISubscribe(Conn, "/dev2005/demod/0/sample")) != ZI_INFO_SUCCESS)
 {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, can't subscribe: %s\n", ErrBuffer);

    ziAPIDeallocateEventEx(Event);

    return;
  }

  // Use ziAPIListNodes to get the list of all demod rates.
  // This is needed for the calls to ziAPIGetValueAsPollData.
  if ((RetVal = ziAPIListNodes(Conn, "/dev2005/demods/*/rate", demodRatePaths, 256,
                               ZI_LIST_NODES_SETTINGSONLY |
                               ZI_LIST_NODES_LEAVESONLY |
                               ZI_LIST_NODES_ABSOLUTE)) != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, Cannot list nodes: %s\n", ErrBuffer);
  }
  // loop 1000 times
  while (Cnt < 1000) {
    // get all demod rates from all devices every 10th cycle.
    // ziAPIGetValueAsPollData does not accept wildcards so we tokenize
    // the output of ziAPIListNodes.
    if (++Cnt % 10 == 0) {
      char* token = strtok(demodRatePaths, separator);
      while (token != NULL) {
        if ((RetVal = ziAPIGetValueAsPollData(Conn, token)) != ZI_INFO_SUCCESS) {
          ziAPIGetError(RetVal, &ErrBuffer, NULL);
          fprintf(stderr, "Error, can't get value as poll data: %s.\n",
                  ErrBuffer);
          break;

        }
        token = strtok(NULL, separator);
      }
    }

    // Poll data until no more data is available.
```

```
    while (1) {
      if ((RetVal = ziAPIPollDataEx(Conn, Event, 0)) != ZI_INFO_SUCCESS) {
        ziAPIGetError(RetVal, &ErrBuffer, NULL);
        fprintf(stderr, "Error, can't poll data: %s.\n", ErrBuffer);

        break;
      } else {
        // The field Count of the Event struct is zero when no data has been
        // polled
        if (Event->valueType != ZI_VALUE_TYPE_NONE && Event->count > 0) {
          /*
            process the received event here
          */
        } else {
          // no more data is available so go on
          break;
        }
      }
    }
  }

  if (ziAPIUnSubscribe(Conn, "*") != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, can't unsubscribe: %s.\n", ErrBuffer);
  }

  ziAPIDeallocateEventEx(Event);
}
```

Data Structure Documentation

struct ZIEvent

This struct holds event data forwarded by the Data Server.

```
#include "ziAPI.h"
```

```
typedef struct ZIEvent {
  uint32_t valueType;
  uint32_t count;
  uint8_t path[256];
  void* untyped;
  ZIDoubleData* doubleData;
  ZIDoubleDataTS* doubleDataTS;
  ZIIntegerData* integerData;
  ZIIntegerDataTS* integerDataTS;
  ZIComplexData* complexData;
  ZIByteArray* byteArray;
  ZIByteArrayTS* byteArrayTS;
  ZICntSample* cntSample;
  ZITrigSample* trigSample;
  ZITreeChangeData* treeChangeData;
  TreeChange* treeChangeDataOld;
  ZIDemodSample* demodSample;
  ZIAuxInSample* auxInSample;
  ZIDIOSample* dioSample;
  ZIScopeWave* scopeWave;
  ZIScopeWaveEx* scopeWaveEx;
  ScopeWave* scopeWaveOld;
  ZIPWAWave* pwaWave;
  ZISweeperWave* sweeperWave;
  ZISpectrumWave* spectrumWave;
  ZIAdvisorWave* advisorWave;
  ZIAsyncReply* asyncReply;
  ZIVectorData* vectorData;
  ZIImpedanceSample* impedanceSample;
  uint64_t alignment;
  union ZIEvent::@6 value;
  uint8_t data[0x400000];
} ZIEvent;
```

Data Fields

- uint32_t valueType

  Specifies the type of the data held by the ZIEvent, see ZIValueType_enum.

- uint32_t count

  Number of values available in this event.

- uint8_t path

  The path to the node from which the event originates.

- void* untyped

  For convenience. The void field doesn't have a corresponding data type.

- ZIDoubleData* doubleData

  when valueType == ZI_VALUE_TYPE_DOUBLE_DATA

- ZIDoubleDataTS* doubleDataTS

when valueType == ZI_VALUE_TYPE_DOUBLE_DATA_TS

- ZIIntegerData* integerData
  when valueType == ZI_VALUE_TYPE_INTEGER_DATA
- ZIIntegerDataTS* integerDataTS
  when valueType == ZI_VALUE_TYPE_INTEGER_DATA_TS
- ZIComplexData* complexData
  when valueType == ZI_VALUE_TYPE_COMPLEX_DATA
- ZIByteArray* byteArray
  when valueType == ZI_VALUE_TYPE_BYTE_ARRAY
- ZIByteArrayTS* byteArrayTS
  when valueType == ZI_VALUE_TYPE_BYTE_ARRAY_TS
- ZICntSample* cntSample
  when valueType == ZI_VALUE_TYPE_CNT_SAMPLE
- ZITrigSample* trigSample
  when valueType == ZI_VALUE_TYPE_TRIG_SAMPLE
- ZITreeChangeData* treeChangeData
  when valueType == ZI_VALUE_TYPE_TREE_CHANGE_DATA
- TreeChange* treeChangeDataOld
  when valueType ==
  ZI_VALUE_TYPE_TREE_CHANGE_DATA_OLD
- ZIDemodSample* demodSample
  when valueType == ZI_VALUE_TYPE_DEMOD_SAMPLE
- ZIAuxInSample* auxInSample
  when valueType == ZI_VALUE_TYPE_AUXIN_SAMPLE
- ZIDIOSample* dioSample
  when valueType == ZI_VALUE_TYPE_DIO_SAMPLE
- ZIScopeWave* scopeWave
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE
- ZIScopeWaveEx* scopeWaveEx
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE_EX
- ScopeWave* scopeWaveOld
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE_OLD
- ZIPWAWave* pwaWave
  when valueType == ZI_VALUE_TYPE_PWA_WAVE
- ZISweeperWave* sweeperWave
  when valueType == ZI_VALUE_TYPE_SWEEPER_WAVE
- ZISpectrumWave* spectrumWave

when valueType == ZI_VALUE_TYPE_SPECTRUM_WAVE

- ZIAdvisorWave* advisorWave

  when valueType == ZI_VALUE_TYPE_ADVISOR_WAVE

- ZIAsyncReply* asyncReply

  when valueType == ZI_VALUE_TYPE_ASYNC_REPLY

- ZIVectorData* vectorData

  when valueType == ZI_VALUE_TYPE_VECTOR_DATA

- ZIImpedanceSample* impedanceSample

  when valueType == ZI_VALUE_TYPE_IMPEDANCE_SAMPLE

- uint64_t alignment

  ensure union size is 8 bytes

- union ZIEvent::@6 value

  Convenience pointer to allow for access to the first entry in Data using the correct type according to ZIEvent.valueType field.

- uint8_t data

  The raw value data.

Detailed Description

ZIEvent is used to give out events like value changes or errors to the user. Event handling functionality is provided by ziAPISubscribe and ziAPIUnSubscribe as well as ziAPIPollDataEx.

```
// Copyright [2016] Zurich Instruments AG
#include <stdio.h>

#include "ziAPI.h"

void ProcessEvent(ZIEvent* Event) {
  unsigned int j;

  switch (Event->valueType) {
  case ZI_VALUE_TYPE_DOUBLE_DATA:

    printf("%u elements of double data: %s.\n",
           Event->count,
           Event->path);

    for (j = 0; j < Event->count; j++)
      printf("%f\n", Event->value.doubleData[j]);

    break;

  case ZI_VALUE_TYPE_INTEGER_DATA:

    printf("%u elements of integer data: %s.\n",
           Event->count,
           Event->path);

    for (j = 0; j < Event->count; j++)
      printf("%f\n", (float)Event->value.integerData[j]);

    break;
```

```
      case ZI_VALUE_TYPE_DEMOD_SAMPLE:

        printf("%u elements of sample data %s\n",
               Event->count,
               Event->path);

        for (j = 0; j < Event->count; j++)
          printf("TS=%f, X=%f, Y=%f.\n",
                 (float)Event->value.demodSample[j].timeStamp,
                 Event->value.demodSample[j].x,
                 Event->value.demodSample[j].y);

        break;

      case ZI_VALUE_TYPE_TREE_CHANGE_DATA:

        printf("%u elements of tree-changed data, %s.\n",
               Event->count,
               Event->path);

        for (j = 0; j < Event->count; j++) {
          switch (Event->value.treeChangeDataOld[j].Action) {
          case ZI_TREE_ACTION_REMOVE:
            printf("Tree removed: %s\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;

          case ZI_TREE_ACTION_ADD:
            printf("treeChangeDataOld added: %s.\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;

          case ZI_TREE_ACTION_CHANGE:
            printf("treeChangeDataOld changed: %s.\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;
          }
        }

        break;

      default:

        printf("Unexpected event value type: %d.\n", Event->valueType);
        break;
      }
    }
```

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIPollDataEx

struct ziEvent

This struct holds event data forwarded by the Data Server. Deprecated: See ZIEvent.

```
#include "ziAPI.h"

typedef struct ziEvent {
  uint32_t Type;
  uint32_t Count;
  unsigned char Path[256];
  union ziEvent::Val Val;
  unsigned char Data[0x400000];
} ziEvent;
```

Data Structures

- union ziEvent::Val

Data Fields

- uint32_t Type
- uint32_t Count
- unsigned char Path
- union ziEvent::Val Val
- unsigned char Data

Detailed Description

ziEvent is used to give out events like value changes or errors to the user. Event handling functionality is provided by ziAPISubscribe and ziAPIUnSubscribe as well as ziAPIPollDataEx.

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIPollDataEx

```
// Copyright [2016] Zurich Instruments AG
#include <stdio.h>

#include "ziAPI.h"

void ProcessEvent(ZIEvent* Event) {
  unsigned int j;

  switch (Event->valueType) {
  case ZI_VALUE_TYPE_DOUBLE_DATA:

    printf("%u elements of double data: %s.\n",
           Event->count,
           Event->path);

    for (j = 0; j < Event->count; j++)
      printf("%f\n", Event->value.doubleData[j]);
```

```
      break;

    case ZI_VALUE_TYPE_INTEGER_DATA:

      printf("%u elements of integer data: %s.\n",
             Event->count,
             Event->path);

      for (j = 0; j < Event->count; j++)
        printf("%f\n", (float)Event->value.integerData[j]);

      break;

    case ZI_VALUE_TYPE_DEMOD_SAMPLE:

      printf("%u elements of sample data %s\n",
             Event->count,
             Event->path);

      for (j = 0; j < Event->count; j++)
        printf("TS=%f, X=%f, Y=%f.\n",
               (float)Event->value.demodSample[j].timeStamp,
               Event->value.demodSample[j].x,
               Event->value.demodSample[j].y);

      break;

    case ZI_VALUE_TYPE_TREE_CHANGE_DATA:

      printf("%u elements of tree-changed data, %s.\n",
             Event->count,
             Event->path);

      for (j = 0; j < Event->count; j++) {
        switch (Event->value.treeChangeDataOld[j].Action) {
        case ZI_TREE_ACTION_REMOVE:
          printf("Tree removed: %s\n",
                 Event->value.treeChangeDataOld[j].Name);
          break;

        case ZI_TREE_ACTION_ADD:
          printf("treeChangeDataOld added: %s.\n",
                 Event->value.treeChangeDataOld[j].Name);
          break;

        case ZI_TREE_ACTION_CHANGE:
          printf("treeChangeDataOld changed: %s.\n",
                 Event->value.treeChangeDataOld[j].Name);
          break;
        }
      }

      break;

    default:

      printf("Unexpected event value type: %d.\n", Event->valueType);
      break;
    }
  }
```

Data Structure Documentation

union ziEvent::Val

```
typedef union ziEvent::Val {
  void* Void;
  DemodSample* SampleDemod;
  AuxInSample* SampleAuxIn;
  DIOSample* SampleDIO;
  ziDoubleType* Double;
  ziIntegerType* Integer;
  TreeChange* Tree;
  ByteArrayData* ByteArray;
  ScopeWave* Wave;
  uint64_t alignment;
} ziEvent::Val;
```

Data Fields

- void* Void
- DemodSample* SampleDemod
- AuxInSample* SampleAuxIn
- DIOSample* SampleDIO
- ziDoubleType* Double
- ziIntegerType* Integer
- TreeChange* Tree
- ByteArrayData* ByteArray
- ScopeWave* Wave
- uint64_t alignment

Function Documentation

ziAPIAllocateEventEx

ZIEvent* ziAPIAllocateEventEx ( )

Allocates ZIEvent structure and returns the pointer to it. Attention!!! It is the client code responsibility to deallocate the structure by calling ziAPIDeallocateEventEx!

This function allocates a ZIEvent structure and returns the pointer to it. Free the memory using ziAPIDeallocateEventEx.

See Also:

ziAPIDeallocateEventEx

ziAPIDeallocateEventEx

void ziAPIDeallocateEventEx (ZIEvent* ev)

Deallocates ZIEvent structure created with ziAPIAllocateEventEx().

Parameters:

[in] ev

Pointer to ZIEvent structure to be deallocated..

See Also:

ziAPIAllocateEventEx

This function is the compliment to ziAPIAllocateEventEx()

ziAPISubscribe

ZIResult_enum ziAPISubscribe (ZIConnection conn, const char* path)

subscribes the nodes given by path for ziAPIPollDataEx

This function subscribes to nodes so that whenever the value of the node changes the new value can be polled using ziAPIPollDataEx. By using wildcards or by using a path that is not a leaf node but contains sub nodes, more than one leaf can be subscribed to with one function call.

Parameters:

[in] conn

Pointer to the ziConnection for which to subscribe for

[in] path

Path to the nodes to subscribe

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Data Handling for an example

See Also:

ziAPIUnSubscribe, ziAPIPollDataEx, ziAPIGetValueAsPollData

ziAPIUnSubscribe

ZIResult_enum ziAPIUnSubscribe (ZIConnection conn, const char* path)

unsubscribes to the nodes given by path

This function is the complement to ziAPISubscribe. By using wildcards or by using a path that is not a leaf node but contains sub nodes, more than one node can be unsubscribed with one function call.

Parameters:

[in] conn

Pointer to the ziConnection for which to unsubscribe for

[in] path

Path to the Nodes to unsubscribe

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Data Handling for an example

See Also:

ziAPISubscribe, ziAPIPollDataEx, ziAPIGetValueAsPollData

ziAPIPollDataEx

ZIResult_enum ziAPIPollDataEx (ZIConnection conn, ZIEvent* ev, uint32_t timeOutMilliseconds)

checks if an event is available to read

This function returns immediately if an event is pending. Otherwise it waits for an event for up to timeOutMilliseconds. All value changes that occur in nodes that have been subscribed to or in children of nodes that have been subscribed to are sent from the Data Server to the ziAPI session. For a description of how the data are available in the struct, refer to the documentation of struct ziEvent. When no event was available within timeOutMilliseconds, the ziEvent::Type field will be ZI_DATA_NONE and the ziEvent::Count field will be zero. Otherwise these fields hold the values corresponding to the event that occurred.

Parameters:

[in] conn

Pointer to the ZIConnection for which events should be received

[out] ev

Pointer to a ZIEvent struct in which the received event will be written

[in] timeOutMilliseconds

Time to wait for an event in milliseconds. If -1 it will wait forever, if 0 the function returns immediately.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Data Handling for an example

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIGetValueAsPollData, ziEvent

ziAPIGetValueAsPollData

ZIResult_enum ziAPIGetValueAsPollData (ZIConnection conn, const char* path)

triggers a value request, which will be given back on the poll event queue

Use this function to receive the value of one or more nodes as one or more events using ziAPIPollDataEx, even when the node is not subscribed or no value change has occurred.

Parameters:

[in] conn

Pointer to the ZIConnection with which the value should be retrieved

[in] path

Path to the Node holding the value. Note: Wildcards and paths referring to streamimg nodes are not permitted.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Data Handling for an example

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIPollDataEx

ziAPIPollData

__inline ZIResult_enum ziAPIPollData (ZIConnection conn, ziEvent* ev, int timeOut)

Checks if an event is available to read. Deprecated: See ziAPIPollDataEx().

Parameters:

[in] conn

Pointer to the ZIConnection for which events should be received

[out] ev

Pointer to a ziEvent struct in which the received event will be written

[in] timeOut

Time to wait for an event in milliseconds. If -1 it will wait forever, if 0 the function returns immediately.

Returns:

- ZI_SUCCESS On success.
- ZI_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_OVERFLOW When a FIFO overflow occurred.

See Data Handling for an example

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIGetValueAsPollData, ziEvent

8.2.5. API for fast asynchronous operation

Functions in this group are non-blocking, and on return only report errors that can be identified directly on a client side (e.g. not connected). Any further results (including errors like node not found) of the command processing is returned as a special event in poll data. Tags are used to match the asynchronous replies with the sent commands.

Functions

- ZIResult_enum ziAPIAsyncSetDoubleData (ZIConnection conn, const char* path, ZIDoubleData value)

- ZIResult_enum ziAPIAsyncSetIntegerData (ZIConnection conn, const char* path, ZIIntegerData value)

- ZIResult_enum ziAPIAsyncSetByteArray (ZIConnection conn, const char* path, uint8_t* buffer, uint32_t length)

- ZIResult_enum ziAPIAsyncSetString (ZIConnection conn, const char* path, const char* str)

- ZIResult_enum ziAPIAsyncSetStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

- ZIResult_enum ziAPIAsyncSubscribe (ZIConnection conn, const char* path, ZIAsyncTag tag)

- ZIResult_enum ziAPIAsyncUnSubscribe (ZIConnection conn, const char* path, ZIAsyncTag tag)

- ZIResult_enum ziAPIAsyncGetValueAsPollData (ZIConnection conn, const char* path, ZIAsyncTag tag)

Function Documentation

ziAPIAsyncSetDoubleData

ZIResult_enum ziAPIAsyncSetDoubleData (ZIConnection conn, const char* path, ZIDoubleData value)

ziAPIAsyncSetIntegerData

ZIResult_enum ziAPIAsyncSetIntegerData (ZIConnection conn, const char* path, ZIIntegerData value)

ziAPIAsyncSetByteArray

ZIResult_enum ziAPIAsyncSetByteArray (ZIConnection conn, const char* path, uint8_t* buffer, uint32_t length)

ziAPIAsyncSetString

ZIResult_enum ziAPIAsyncSetString (ZIConnection conn, const char* path, const char* str)

ziAPIAsyncSetStringUnicode

ZIResult_enum ziAPIAsyncSetStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

ziAPIAsyncSubscribe

ZIResult_enum ziAPIAsyncSubscribe (ZIConnection conn, const char* path, ZIAsyncTag tag)

ziAPIAsyncUnSubscribe

ZIResult_enum ziAPIAsyncUnSubscribe (ZIConnection conn, const char* path, ZIAsyncTag tag)

ziAPIAsyncGetValueAsPollData

ZIResult_enum ziAPIAsyncGetValueAsPollData (ZIConnection conn, const char* path, ZIAsyncTag tag)

8.2.6. Error Handling and Logging in the LabOne C API

This section describes how to get more information when an error occurs.

Functions

- ZIResult_enum ziAPIGetError (ZIResult_enum result, char** buffer, int* base)

  Returns a description and the severity for a ZIResult_enum.

- ZIResult_enum ziAPIGetLastError (ZIConnection conn, char* buffer, uint32_t bufferSize)

  Returns the message from the last error that occurred.

- void ziAPISetDebugLevel (int32_t debugLevel)

  Enable ziAPI's log and set the severity level of entries to be included in the log.

- void ziAPIWriteDebugLog (int32_t debugLevel, const char* message)

  Write a message to ziAPI's log with the specified severity.

Detailed Description

In general, two types of errors can occur when using ziAPI. The two types are distinguished by the origin of the error: Whether it occurred within ziAPI itself or whether it occurred internally in the Zurich Instruments Core library.

All ziAPI functions (apart from a very few exceptions) return an exit code ZIResult_enum, which will be non-zero if the function call was not entirely successful. If the error originated in ziAPI itself, the exit code describes precisely the type of error that occurred (in other words, the exit code is not ZI_ERROR_GENERAL). In this case the error message corresponding to the exit code can be obtained with the function ziAPIGetError.

However, if the error has occurred internally, the exit code will be ZI_ERROR_GENERAL. In this case, the exit code does not describe the type of error precisely, instead a detailed error message is available to the user which can be obtained with the function ziAPIGetLastError. The function ziAPIGetLastError may be used with any function that takes a ZIConnection as an input argument (with the exception of ziAPIInit, ziAPIDestroy, ziAPIConnect, ziAPIConnectEx) and is the recommended function to use, if applicable, otherwise ziAPIGetError should be used.

The function ziAPIGetLastError was introduced in LabOne 15.11 due to the availability of ziCoreModules" in ziAPI - its not desirable in general to map every possible error to an exit code in ziAPI; what is more relevant is the associated error message.

In addition to these two functions, ziAPI's log can be very helpful whilst debugging ziAPI-based programs. The log is not enabled by default; it's enabled by specifying a logging level with ziAPISetDebugLevel.

Function Documentation

ziAPIGetError

ZIResult_enum ziAPIGetError (ZIResult_enum result, char** buffer, int* base)

Returns a description and the severity for a ZIResult_enum.

This function returns a static char pointer to a description string for the given ZIResult_enum error code. It also provides a parameter returning the severity (info, warning, error). If the given error code does not exist a description for an unknown error and the base for an error will be returned. If a description or the base is not needed NULL may be passed. In general, it's recommended to use ziAPIGetLastError instead to get detailed error messages.

Parameters:

[in] result

A ZIResult_enum for which the description or base will be returned

[out] buffer

A pointer to a char array to return the description. May be NULL if no description is needed.

[out] base

The severity for the provided Status parameter:

- ZI_INFO_BASE For infos.
- ZI_WARNING_BASE For warnings.
- ZI_ERROR_BASE For errors.

Returns:

- ZI_INFO_SUCCESS Upon success.

ziAPIGetLastError

ZIResult_enum ziAPIGetLastError (ZIConnection conn, char* buffer, uint32_t bufferSize)

Returns the message from the last error that occurred.

This function can be used to obtain the error message from the last error that occurred associated with the provided ZIConnection. If the last ziAPI call is successful, then the last error message returned by ziAPIGetError is empty. Only ziAPI function calls that take ZIConnection as an input argument influence the message returned by ziAPIGetLastError, if they do not take ZIConnection as an input argument the last error message will neither be reset to be empty or set to an error message (in the case of the error). There are some exceptions to this rule, ziAPIGetLastError can also not be used with ziAPIInit, ziAPIConnect, ziAPIConnectEx and ziAPIDestroy. Note, a call to ziAPIGetLastError will also reset the last error message to empty if its call was successful. Since the buffer is left unchanged in the case of an error occurring in the call to ziAPIGetLastError it is safest to initialize the buffer with a known value, for example, "ziAPIGetLastError was not successful".

Parameters:

[in] conn

The ZIConnection from which to get the error message.

[out] buffer

A pointer to a char array to return the message.

[in] bufferSize

The length of the provided buffer.

Returns:

- ZI_INFO_SUCCESS Upon success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred. In this case the provided buffer is left unchanged.
- ZI_ERROR_LENGTH If the message's length exceeds the provided bufferSize, the message is truncated and written to buffer.

ziAPISetDebugLevel

void ziAPISetDebugLevel (int32_t debugLevel)

Enable ziAPI's log and set the severity level of entries to be included in the log.

Calling this function enables ziAPI's log at the specified severity level. On Windows the logs can be found by navigating to the Zurich Instruments "Logs" folder entry in the Windows Start Menu: Programs -> Zurich Instruments -> LabOne Servers -> Logs. This will open an Explorer window displaying folders containing log files from various LabOne components, in particular, the `ziAPILog` folder contains logs from ziAPI. On Linux, the logs can be found at "/tmp/ziAPILog_USERNAME", where "USERNAME" is the same as the output of the "whoami" command.

Parameters:

[in] debugLevel

An integer specifying the log's severity level:

- trace: 0,
- debug: 1,
- info: 2,
- status: 3,
- warning: 4,
- error: 5,
- fatal: 6,

See Also:

ziAPIWriteDebugLog

ziAPIWriteDebugLog

void ziAPIWriteDebugLog (int32_t debugLevel, const char* message)

Write a message to ziAPI's log with the specified severity.

This function may be used to write a message to ziAPI's log from client code to assist with debugging. Note, this function is only available if the implementation used in ziAPIConnectEx is "ziAPI_Core" (the default implementation). Also logging must be first enabled using ziAPISetDebugLevel.

Parameters:

[in] debugLevel

An integer specifying the severity of the message to write in the log:

- trace: 0,
- debug: 1,
- info: 2,
- status: 3,
- warning: 4,
- error: 5,
- fatal: 6,

[in] message

A character array comprising of the message to be written.

See Also:

ziAPISetDebugLevel

8.2.7. Using ziCore Modules in the LabOne C API

This sections describes ziAPI's interface for working with ziCore Modules. Modules provide a high-level interface for performing common measurement tasks such as sweeping data (Sweeper Module) or recording bursts of when certain trigger criteria have been fulfilled (Software Trigger Module). For an introduction to working with Modules please see the "ziCore Modules" section in the LabOne Programming Manual: .

Data Structures

- struct ZIChunkHeader

  Structure to hold generic chunk data header information.

- struct ZIModuleEvent

  This struct holds data of a single chunk from module lookup.

Typedefs

- typedef ZIModuleEventPtr

  The pointer to a Module's data chunk to read out, updated via ziAPIModGetChunk.

Enumerations

- enum ZIChunkHeaderFlags_enum { ZI_CHUNK_HEADER_FLAG_FINISHED, ZI_CHUNK_HEADER_FLAG_ROLLMODE, ZI_CHUNK_HEADER_FLAG_DATALOSS, ZI_CHUNK_HEADER_FLAG_VALID, ZI_CHUNK_HEADER_FLAG_DATA, ZI_CHUNK_HEADER_FLAG_DISPLAY, ZI_CHUNK_HEADER_FLAG_FREQDOMAIN, ZI_CHUNK_HEADER_FLAG_SPECTRUM, ZI_CHUNK_HEADER_FLAG_OVERLAPPED, ZI_CHUNK_HEADER_FLAG_ROWFINISHED, ZI_CHUNK_HEADER_FLAG_ONGRIDSAMPLING, ZI_CHUNK_HEADER_FLAG_ROWREPETITION, ZI_CHUNK_HEADER_FLAG_PREVIEW }

  Defines the flags returned in the chunk header for all modules.

- enum ZIChunkHeaderModuleFlags_enum { ZI_CHUNK_HEADER_MODULE_FLAGS_WINDOW }

  Defines flags returned in the chunk header that only apply for certain modules.

- enum ZIAnnotationFlags_enum { ZI_ANNOTATION_SHOW_X, ZI_ANNOTATION_SHOW_Y, ZI_ANNOTATION_SHOW_GRID, ZI_ANNOTATION_SHOW_LABEL }

Functions

- ZIResult_enum ziAPIModCreate (ZIConnection conn, ZIModuleHandle* handle, const char* moduleId)

Create a ZIModuleHandle that can be used for asynchronous measurement tasks.

- ZIResult_enum ziAPIModSetDoubleData (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIDoubleData value)

  Sets a module parameter to the specified double type.

- ZIResult_enum ziAPIModSetIntegerData (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIIntegerData value)

  Sets a module parameter to the specified integer type.

- ZIResult_enum ziAPIModSetByteArray (ZIConnection conn, ZIModuleHandle handle, const char* path, uint8_t* buffer, uint32_t length)

  Sets a module parameter to the specified byte array.

- ZIResult_enum ziAPIModSetString (ZIConnection conn, ZIModuleHandle handle, const char* path, const char* str)

  Sets a module parameter to the specified null-terminated string.

- ZIResult_enum ziAPIModSetStringUnicode (ZIConnection conn, ZIModuleHandle handle, const char* path, const wchar_t* wstr)

  Sets a module parameter to the specified null-terminated unicode string.

- ZIResult_enum ziAPIModSetVector (ZIConnection conn, ZIModuleHandle handle, const char* path, const void* vectorPtr, ZIVectorElementType_enum elementType, unsigned int numElements)

  Sets a module parameter to the specified vector.

- ZIResult_enum ziAPIModGetInteger (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIIntegerData* value)

  Gets the integer-type value of the specified module parameter path.

- ZIResult_enum ziAPIModGetDouble (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIDoubleData* value)

  Gets the double-type value of the specified module parameter path.

- ZIResult_enum ziAPIModGetString (ZIConnection conn, ZIModuleHandle handle, const char* path, char* buffer, unsigned int* length, unsigned int bufferSize)

  gets the null-terminated string value of the specified module parameter path

- ZIResult_enum ziAPIModGetStringUnicode (ZIConnection conn, ZIModuleHandle handle, const char* path, wchar_t* wbuffer, unsigned int* length, unsigned int bufferSize)

Gets the null-terminated string value of the specified module parameter path.

- ZIResult_enum ziAPIModGetVector (ZIConnection conn, ZIModuleHandle handle, const char* path, void* buffer, unsigned int* bufferSize, ZIVectorElementType_enum* elementType, unsigned int* numElements)

  Gets the vector stored at the specified module parameter path.

- ZIResult_enum ziAPIModListNodes (ZIConnection conn, ZIModuleHandle handle, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

  Returns all child parameter node paths found under the specified parent module parameter path.

- ZIResult_enum ziAPIModListNodesJSON (ZIConnection conn, ZIModuleHandle handle, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

  Returns all child parameter node paths found under the specified parent module parameter path.

- ZIResult_enum ziAPIModSubscribe (ZIConnection conn, ZIModuleHandle handle, const char* path)

  Subscribes to the nodes specified by path, these nodes will be recorded during module execution.

- ZIResult_enum ziAPIModUnSubscribe (ZIConnection conn, ZIModuleHandle handle, const char* path)

  Unsubscribes to the nodes specified by path.

- ZIResult_enum ziAPIModExecute (ZIConnection conn, ZIModuleHandle handle)

  Starts the module's thread and its associated measurement task.

- ZIResult_enum ziAPIModTrigger (ZIConnection conn, ZIModuleHandle handle)

  Manually issue a trigger forcing data recording (SW Trigger Module only).

- ZIResult_enum ziAPIModProgress (ZIConnection conn, ZIModuleHandle handle, ZIDoubleData* progress)

  Queries the current state of progress of the module's measurement task.

- ZIResult_enum ziAPIModFinished (ZIConnection conn, ZIModuleHandle handle, ZIIntegerData* finished)

  Queries whether the module has finished its measurement task.

- ZIResult_enum ziAPIModFinish (ZIConnection conn, ZIModuleHandle handle)

  Stops the module performing its measurement task.

- ZIResult_enum ziAPIModSave (ZIConnection conn, ZIModuleHandle handle, const char* fileName)

Saves the currently accumulated data to file.

- ZIResult_enum ziAPIModRead (ZIConnection conn, ZIModuleHandle handle, const char* path)

  Make the currently accumulated data available for use in the C program.

- ZIResult_enum ziAPIModNextNode (ZIConnection conn, ZIModuleHandle handle, char* path, uint32_t bufferSize, ZIValueType_enum* valueType, uint64_t* chunks)

  Make the data for the next node available for reading with ziAPIModGetChunk.

- ZIResult_enum ziAPIModGetChunk (ZIConnection conn, ZIModuleHandle handle, uint64_t chunkIndex, ZIModuleEventPtr* ev)

  Get the specified data chunk from the current node.

- ZIResult_enum ziAPIModEventDeallocate (ZIConnection conn, ZIModuleHandle handle, ZIModuleEventPtr ev)

  Deallocate the ZIModuleEventPtr being used by the module.

- ZIResult_enum ziAPIModClear (ZIConnection conn, ZIModuleHandle handle)

  Terminates the module's thread and destroys the module.

Data Structure Documentation

struct ZIChunkHeader

Structure to hold generic chunk data header information.

```
#include "ziAPI.h"
```

```
typedef struct ZIChunkHeader {
  ZITimeStamp systemTime;
  ZITimeStamp createdTimeStamp;
  ZITimeStamp changedTimeStamp;
  uint32_t flags;
  uint32_t moduleFlags;
  uint32_t status;
  uint32_t reserved0;
  uint64_t chunkSizeBytes;
  uint64_t triggerNumber;
  char name[32];
  uint32_t groupIndex;
  uint32_t color;
  uint32_t activeRow;
  uint32_t gridRows;
  uint32_t gridCols;
  uint32_t gridMode;
  uint32_t gridOperation;
  uint32_t gridDirection;
  uint32_t gridRepetitions;
  double gridColDelta;
  double gridColOffset;
  double gridRowDelta;
  double gridRowOffset;
  double bandwidth;
  double center;
  double nenbw;
} ZIChunkHeader;
```

Data Fields

- ZITimeStamp systemTime

  System timestamp.

- ZITimeStamp createdTimeStamp

  Creation timestamp.

- ZITimeStamp changedTimeStamp

  Last changed timestamp.

- uint32_t flags

  Flags (bitmask of values from ZIChunkHeaderFlags_enum)

- uint32_t moduleFlags

  moduleFlags (bitmask of values from ZIChunkHeaderModuleFlags_enum, module-specific)

- uint32_t status

  Status Flag: [0] : selected [1] : group assigned [2] : color edited [4] : name edited.

- uint32_t reserved0

- uint64_t chunkSizeBytes
  Size in bytes used for memory usage calculation.
- uint64_t triggerNumber
  SW Trigger counter since execution start.
- char name
  Name in history list.
- uint32_t groupIndex
  Group index in history list.
- uint32_t color
  Color in history list.
- uint32_t activeRow
  Active row in history list.
- uint32_t gridRows
  Number of grid rows.
- uint32_t gridCols
  Number of grid columns.
- uint32_t gridMode
  Grid mode interpolation mode (0 = off, 1 = nearest, 2 = linear, 3 = Lanczos)
- uint32_t gridOperation
  Grid mode operation (0 = replace, 1 = average)
- uint32_t gridDirection
  Grid mode direction (0 = forward, 1 = revers, 2 = bidirectional)
- uint32_t gridRepetitions
  Number of repetitions in grid mode.
- double gridColDelta
  Delta between grid points in SI unit.
- double gridColOffset
  Offset of first grid point relative to trigger.
- double gridRowDelta
  Delta between grid rows in SI unit.
- double gridRowOffset
  Delay of first grid row relative to trigger.
- double bandwidth
  For FFT the bandwidth of the signal.
- double center
  The FFT center frequency.
- double nenbw

For FFT the normalized effective noise bandwidth.

struct ZIModuleEvent

This struct holds data of a single chunk from module lookup.

```
#include "ziAPI.h"
```

```
typedef struct ZIModuleEvent {
  uint64_t allocatedSize;
  ZIChunkHeader* header;
  ZIEvent
                    value[0];
} ZIModuleEvent;
```

Data Fields

- uint64_t allocatedSize

  For internal use - never modify!

- ZIChunkHeader* header

  Chunk header.

- ZIEvent value

  Defines location of stored ZIEvent.

Enumeration Type Documentation

Defines the flags returned in the chunk header for all modules.

Enumerator:

- ZI_CHUNK_HEADER_FLAG_FINISHED
  Indicates that the chunk data is complete. This flag will be set if data is read out from the module before the measurement (e.g. sweep) has finished.
- ZI_CHUNK_HEADER_FLAG_ROLLMODE
  Unused.
- ZI_CHUNK_HEADER_FLAG_DATALOSS
  Indicates that dataloss has occurred.
- ZI_CHUNK_HEADER_FLAG_VALID
  Indcates that the data is valid.
- ZI_CHUNK_HEADER_FLAG_DATA
  Indicates whether then chunk contains data (opposite to setting).
- ZI_CHUNK_HEADER_FLAG_DISPLAY
  Internal use only.
- ZI_CHUNK_HEADER_FLAG_FREQDOMAIN
  chunk contains frequency domain data, opposite to time domain.
- ZI_CHUNK_HEADER_FLAG_SPECTRUM
  chunk recorded in spectrum mode.
- ZI_CHUNK_HEADER_FLAG_OVERLAPPED
  chunk results overlap with neighboring chunks, see spectrum.
- ZI_CHUNK_HEADER_FLAG_ROWFINISHED
  indicates that the current row is finished - useful for row first averaging.
- ZI_CHUNK_HEADER_FLAG_ONGRIDSAMPLING
  exact sampling was used.
- ZI_CHUNK_HEADER_FLAG_ROWREPETITION
  row first averaging is enabled.
- ZI_CHUNK_HEADER_FLAG_PREVIEW
  chunk contains preview (fft with less points).

Defines flags returned in the chunk header that only apply for certain modules.

Enumerator:

- ZI_CHUNK_HEADER_MODULE_FLAGS_WINDOW

  FFT Window used in the Data Acquisition Module: 0 - Rectangular, 1 - Hann, 2 - Hamming, 3 - Blackmanharris, 4 - Exponential, 5 - Cosine, 6 - CosineSquare.

Enumerator:

- ZI_ANNOTATION_SHOW_X

  display xValue if it is set, should be alays the same as ZI_ANNOTATION_SHOW_Y at the moment
- ZI_ANNOTATION_SHOW_Y

  display yValue if it is set, should be alays the same as ZI_ANNOTATION_SHOW_X at the moment
- ZI_ANNOTATION_SHOW_GRID

  display gridValue if it is set
- ZI_ANNOTATION_SHOW_LABEL

  display label if set

Function Documentation

ziAPIModCreate

ZIResult_enum ziAPIModCreate (ZIConnection conn, ZIModuleHandle* handle, const char* moduleId)

Create a ZIModuleHandle that can be used for asynchronous measurement tasks.

This function initializes a ziCore module and provides a pointer (handle) with which to access and work with it. Note that this function does not start the module's thread. Before the thread can be started (with ziAPIModExecute):

- the device serial (e.g., "dev100") to be used with module must be specified via ziAPIModSetByteArray.
- the desired data (node paths) to record during the measurement must be specified via ziAPIModSubscribe. The module's thread is stopped with ziAPIModClear.

Parameters:

[in] conn

The ZIConnection which should be used to initialize the module.

[out] handle

Pointer to the initialized ZIModuleHandle, which from then on can be used to reference the module.

[in] moduleId

The name specifying the type the module to create (only the following ziCore Modules are currently supported in ziAPI):

- "sweep" to initialize an instance of the Sweeper Module.
- "record" to initialize an instance of the Software Trigger (Recorder) Module.
- "zoomFFT" to initialize an instance of the Spectrum Module.
- "deviceSettings" to initialize an instance to save/load device settings.
- "pidAdvisor" to initialize an instance of the PID Advisor Module.
- "awgModule" to initialize an instance of the AWG Compiler Module.
- "impedanceModule" to initialize an instance of the Impedance Compensation Module.
- "scopeModule" to initialize an instance of the Scope Module to assembly scope shots.
- "multiDeviceSyncModule" to initialize an instance of the Device Synchronization Module.
- "dataAcquisitionModule" to initialize an instance of the Data Acquisition Module.
- "precompensationAdvisor" to initialize an instance of the Precompensation Advisor Module.

- "quantumAnalyzerModule" to initialize an instance of the Quantum Analyzer Module.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_WARNING_NOTFOUND if the provided moduleId was invalid.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModClear

ziAPIModSetDoubleData

ZIResult_enum ziAPIModSetDoubleData (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIDoubleData value)

Sets a module parameter to the specified double type.

This function is used to configure (set) module parameters which have double types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] value

The double data to write to the path.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetIntegerData, ziAPIModSetByteArray, ziAPIModSetString

ziAPIModSetIntegerData

ZIResult_enum ziAPIModSetIntegerData (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIIntegerData value)

Sets a module parameter to the specified integer type.

This function is used to configure (set) module parameters which have integer types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] value

The integer data to write to the path.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetByteArray, ziAPIModSetString

ziAPIModSetByteArray

ZIResult_enum ziAPIModSetByteArray (ZIConnection conn, ZIModuleHandle handle, const char* path, uint8_t* buffer, uint32_t length)

Sets a module parameter to the specified byte array.

This function is used to configure (set) module parameters which have byte array types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] buffer

Pointer to the byte array with the data.

[in] length

Length of the data in the buffer.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetIntegerData, ziAPIModSetString

ziAPIModSetString

ZIResult_enum ziAPIModSetString (ZIConnection conn, ZIModuleHandle handle, const char* path, const char* str)

Sets a module parameter to the specified null-terminated string.

This function is used to configure (set) module parameters which have string types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] str

Pointer to a null-terminated string (max 64k characters).

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetIntegerData, ziAPIModSetByteArray

ziAPIModSetStringUnicode

ZIResult_enum ziAPIModSetStringUnicode (ZIConnection conn, ZIModuleHandle handle, const char* path, const wchar_t* wstr)

Sets a module parameter to the specified null-terminated unicode string.

This function is used to configure (set) module parameters which have string types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] wstr

Pointer to a null-terminated unicode string (max 64k characters).

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetIntegerData, ziAPIModSetByteArray

ziAPIModSetVector

ZIResult_enum ziAPIModSetVector (ZIConnection conn, ZIModuleHandle handle, const char* path, const void* vectorPtr, ZIVectorElementType_enum elementType, unsigned int numElements)

Sets a module parameter to the specified vector.

This function is used to configure (set) module parameters which have vector types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] vectorPtr

Pointer to the vector data.

[in] elementType

Type of elements stored in the vector.

[in] numElements

Number of elements of the vector.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetIntegerData, ziAPIModSetByteArray

ziAPIModGetInteger

ZIResult_enum ziAPIModGetInteger (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIIntegerData* value)

Gets the integer-type value of the specified module parameter path.

This function is used to retrieve module parameter values of type integer.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] value

Pointer to an 64bit integer in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetDouble, ziApiModGetString

ziAPIModGetDouble

ZIResult_enum ziAPIModGetDouble (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIDoubleData* value)

Gets the double-type value of the specified module parameter path.

This function is used to retrieve module parameter values of type floating point double.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] value

Pointer to an floating point double in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetInteger, ziApiModGetString

ziAPIModGetString

ZIResult_enum ziAPIModGetString (ZIConnection conn, ZIModuleHandle handle, const char* path, char* buffer, unsigned int* length, unsigned int bufferSize)

gets the null-terminated string value of the specified module parameter path

This function is used to retrieve module parameter values of type string.

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] buffer

Pointer to a buffer to store the retrieved null-terminated string

[out] length

Pointer to an unsigned int to store the length of the string in (including the null terminator). If an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetInteger, ziApiModGetDouble

ziAPIModGetStringUnicode

ZIResult_enum ziAPIModGetStringUnicode (ZIConnection conn, ZIModuleHandle handle, const char* path, wchar_t* wbuffer, unsigned int* length, unsigned int bufferSize)

Gets the null-terminated string value of the specified module parameter path.

This function is used to retrieve module parameter values of type string.

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] wbuffer

Pointer to a buffer to store the retrieved null-terminated string

[out] length

Pointer to an unsigned int to store the length of the string in (including the null terminator). If an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetInteger, ziApiModGetDouble, ziAPIModGetString

ziAPIModGetVector

ZIResult_enum ziAPIModGetVector (ZIConnection conn, ZIModuleHandle handle, const char* path, void* buffer, unsigned int* bufferSize, ZIVectorElementType_enum* elementType, unsigned int* numElements)

Gets the vector stored at the specified module parameter path.

This function is used to retrieve module parameter values of type vector.

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved.

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] buffer

Pointer to a buffer to store the retrieved vector buffer.

[in/out] bufferSize

Pointer to an unsigned int indicating the length of the buffer. If the length of the passed buffer is insufficient to store the vector, the value is modified to indicate the required minimum buffer size and ZI_ERROR_LENGTH is returned.

[out] elementType

Pointer to store the type of vector elements.

[out] numElements

Pointer to an unsigned int to store the number of elements of the vector. If the length of the passed buffer is insufficient, a zero will be returned.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the vector's length exceeds the buffer size
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path

- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetInteger, ziApiModGetDouble, ziAPIModGetString

ziAPIModListNodes

ZIResult_enum ziAPIModListNodes (ZIConnection conn, ZIModuleHandle handle, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

Returns all child parameter node paths found under the specified parent module parameter path.

This function returns a list of parameter names found at the specified path. The path may contain wildcards. The list is returned in a null-terminated char-buffer, each element delimited by a newline. If the maximum length of the buffer (bufferSize) is not sufficient for all elements, nothing will be returned and the return value will be ZI_ERROR_LENGTH.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle from which the parameter names should be retrieved.

[in] path

Path for which all children will be returned. The path may contain wildcard characters.

[out] nodes

Upon call filled with newline-delimited list of the names of all the children found. The string is zero-terminated.

[in] bufferSize

The length of the buffer specified as the nodes output parameter.

[in] flags

A combination of flags (applied bitwise) as defined in ZIListNodes_enum.

Returns:

- ZI_INFO_SUCCESS On success
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH If the path's length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by bufferSize is too small for all elements.
- ZI_WARNING_OVERFLOW When a FIFO overflow occurred.
- ZI_ERROR_COMMAND On an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL If an internal error occurred in Data Server.
- ZI_WARNING_NOTFOUND If the given path could not be resolved.
- ZI_ERROR_TIMEOUT When communication timed out.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.

- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIModListNodesJSON

ZIResult_enum ziAPIModListNodesJSON (ZIConnection conn, ZIModuleHandle handle, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

Returns all child parameter node paths found under the specified parent module parameter path.

This function returns a list of node names found at the specified path, formatted as JSON. The path may contain wildcards so that the returned nodes do not necessarily have to have the same parents. The list is returned in a null-terminated char-buffer. If the maximum length of the buffer (bufferSize) is not sufficient for all elements, nothing will be returned and the return value will be ZI_ERROR_LENGTH.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle from which the parameter names should be retrieved.

[in] path

Path for which all children will be returned. The path may contain wildcard characters.

[out] nodes

Upon call filled with JSON-formatted list of the names of all the children found. The string is zero-terminated.

[in] bufferSize

The length of the buffer used for the nodes output parameter.

[in] flags

A combination of flags (applied bitwise) as defined in ZIListNodes_enum.

Returns:

- ZI_INFO_SUCCESS On success
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH If the path's length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by bufferSize is too small for all elements.
- ZI_WARNING_OVERFLOW When a FIFO overflow occurred.
- ZI_ERROR_COMMAND On an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL If an internal error occurred in Data Server.
- ZI_WARNING_NOTFOUND If the given path could not be resolved.
- ZI_ERROR_TIMEOUT When communication timed out.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.

- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIModSubscribe

ZIResult_enum ziAPIModSubscribe (ZIConnection conn, ZIModuleHandle handle, const char* path)

Subscribes to the nodes specified by path, these nodes will be recorded during module execution.

This function subscribes to nodes so that whenever the value of the node changes while the module is executing the new value will be accumulated and then read using ziAPIModRead. By using wildcards or by using a path that is not a leaf node but contains sub nodes, more than one leaf can be subscribed to with one function call.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module in which the nodes should be subscribed to.

[in] path

Path specifying the nodes to subscribe to, may contain wildcards.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or a general error occurred, enable ziAPI's log for detailed information, see ziAPISetDebugLevel.
- ZI_ERROR_LENGTH If the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW When a FIFO overflow occurred.
- ZI_ERROR_COMMAND On an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL If an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND If the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT When communication timed out.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModUnSubscribe, ziAPIModRead

ziAPIModUnSubscribe

ZIResult_enum ziAPIModUnSubscribe (ZIConnection conn, ZIModuleHandle handle, const char* path)

Unsubscribes to the nodes specified by path.

This function is the complement to ziAPIModSubscribe. By using wildcards or by using a path that is not a leaf node but contains sub nodes, more than one node can be unsubscribed with one function call.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifyin the module in which the nodes should be unsubscribed from.

[in] path

Path specifying the nodes to unsubscribe from, may contain wildcards.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH If the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW When a FIFO overflow occurred.
- ZI_ERROR_COMMAND On an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL If an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND If the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT When communication timed out.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSubscribe, ziAPIModRead

ziAPIModExecute

ZIResult_enum ziAPIModExecute (ZIConnection conn, ZIModuleHandle handle)

Starts the module's thread and its associated measurement task.

Once the module's parameters has been configured as required via, e.g. ziAPIModSetDoubleData, this function starts the module's thread. This starts the module's main measurement task which will run asynchronously. The thread will run until either the module has completed its task or until ziAPIModFinish is called. Subscription or unsubscription is not possible while the module is executing. The status of the module can be obtained with either ziAPIModFinished or ziAPIModProgress.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModCreate, ziAPIModProgress, ziAPIModFinish

ziAPIModTrigger

ZIResult_enum ziAPIModTrigger (ZIConnection conn, ZIModuleHandle handle)

Manually issue a trigger forcing data recording (SW Trigger Module only).

This function is used with the Software Trigger Module in order to manually issue a trigger in order to force recording of data. A burst of subscribed data will be recorded as configured via the SW Trigger's parameters as would a regular trigger event.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIModProgress

ZIResult_enum ziAPIModProgress (ZIConnection conn, ZIModuleHandle handle, ZIDoubleData* progress)

Queries the current state of progress of the module's measurement task.

This function can be used to query the module's progress in performing its current measurement task, the progress is returned as a double in [0, 1], where 1 indicates task completion.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[out] progress

A pointer to ZIDoubleData indicating the current progress of the module.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModFinish, ziAPIModFinished

ziAPIModFinished

ZIResult_enum ziAPIModFinished (ZIConnection conn, ZIModuleHandle handle, ZIIntegerData* finished)

Queries whether the module has finished its measurement task.

This function can be used to query whether the module has finished its task or not.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[out] finished

A pointer to ZIIntegerData, upon return this will be 0 if the module is still executing or 1 if it has finished executing.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModFinish, ziAPIModProgress

ziAPIModFinish

ZIResult_enum ziAPIModFinish (ZIConnection conn, ZIModuleHandle handle)

Stops the module performing its measurement task.

This functions stops the module performing its associated measurement task and stops recording any data. The task and data recording may be restarted by calling ziAPIModExecute' again.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModProgress, ziAPIModFinished

ziAPIModSave

ZIResult_enum ziAPIModSave (ZIConnection conn, ZIModuleHandle handle, const char* fileName)

Saves the currently accumulated data to file.

This function saves the currently accumulated data to a file. The path of the file to save data to is specified via the module's directory parameter.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[in] fileName

The basename of the file to save the data in.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModFinish, ziAPIModFinished

ziAPIModRead

ZIResult_enum ziAPIModRead (ZIConnection conn, ZIModuleHandle handle, const char* path)

Make the currently accumulated data available for use in the C program.

This function can be used to either read (get) module parameters, in this case a path that addresses the module must be specified, or it can be used to read out the currently accumulated data from subscribed nodes in the module. In either case the actual data must then be accessed by the user using ziAPIModNextNode and ziAPIModGetChunk.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[in] path

The path specifying the module parameter(s) to get, specify NULL to obtain all subscribed data.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetChunk, ziAPIModNextNode

ziAPIModNextNode

ZIResult_enum ziAPIModNextNode (ZIConnection conn, ZIModuleHandle handle, char* path, uint32_t bufferSize, ZIValueType_enum* valueType, uint64_t* chunks)

Make the data for the next node available for reading with ziAPIModGetChunk.

After callin ziAPIModRead, subscribed data (or module parameters) may now be read out on a node-by-node and chunk-by-chunk basis. All nodes with data available in the module can be iterated over by using ziAPIModNextNode, then for each node the chunks of data available are read out using ziAPIModGetChunk. Calling this function makes the data from the next node available for read.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[out] path

A string specifying the node's path whose data chunk points to.

[in] bufferSize

The length of the buffer specified as the path output parameter.

[out] valueType

The ZIValueType_enum of the node's data.

[out] chunks

The number of chunks of data available for the node.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModRead, ziAPIModGetChunk, ziAPIModEventDeallocate

ziAPIModGetChunk

ZIResult_enum ziAPIModGetChunk (ZIConnection conn, ZIModuleHandle handle, uint64_t chunkIndex, ZIModuleEventPtr* ev)

Get the specified data chunk from the current node.

Data is read out node-by-node and then chunk-by-chunk. This function can be used to obtain specific data chunks from the current node that data is being read from. More precisely, it ppreallocates space for an event structure big enough to hold the node's data at the specified chunk index, updates ZIModuleEventPtr to point to this space and then copies the chunk data to this space.

Note, before the very first call to ziAPIModGetChunk, the ZIModuleEventPtr should be initialized to NULL and then left untouched for all subsequent calls (even after calling ziAPIModNextNode to get data from the next node). This is because ziAPIModGetChunk internally manages the required space allocation for the event and then in subsequent calls only reallocates space when it is required. It is optimized to reduce the number of required space reallocations for the event.

The ZIModuleEventPtr should be deallocated using ziAPIModEventDeallocate, otherwise the lifetime of the ZIModuleEventPtr is the same as the lifetime of the module. Indeed, the same ZIModuleEventPtr can be used, even for subsequent reads. It is also possible to work with multiple ZIModuleEventPtr so that some pointers can be kept for later processing.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[out] chunkIndex

The index of the data chunk to update the pointer to.

[out] ev

The module's ZIModuleEventPtr that points to the currently available data chunk.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModRead, ziAPIModNextNode, ziAPIModEventDeallocate

ziAPIModEventDeallocate

ZIResult_enum ziAPIModEventDeallocate (ZIConnection conn, ZIModuleHandle handle, ZIModuleEventPtr ev)

Deallocate the ZIModuleEventPtr being used by the module.

This function deallocates the ZIModuleEventPtr. Since a module event's allocated space is managed internally by ziAPIModGetChunk, when the user no longer requires the event (all data has been read out) it must be deallocated by the user with this function.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[in] ev

The ZIModuleEventPtr to deallocate.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetChunk, ziAPIModRead

ziAPIModClear

ZIResult_enum ziAPIModClear (ZIConnection conn, ZIModuleHandle handle)

Terminates the module's thread and destroys the module.

This function terminates the module's thread, releases memory and resources. After calling ziAPIModClear the module's handle may not be used any more. A new instance of the module must be initialized if required. This command is especially important if modules are created repetitively inside a while or for loop, in order to prevent excessive memory and resource consumption.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModFinish

8.2.8. Vector operations

Functions for working with vector data.

Functions

- ZIResult_enum ziAPISetVector (ZIConnection conn, const char* path, const void* vectorPtr, uint8_t vectorElementType, uint64_t vectorSizeElements)

  vectorElementType - see ZIVectorElementType_enum

Function Documentation

ziAPISetVector

ZIResult_enum ziAPISetVector (ZIConnection conn, const char* path, const void* vectorPtr, uint8_t vectorElementType, uint64_t vectorSizeElements)

vectorElementType - see ZIVectorElementType_enum

8.2.9. Device discovery

Functions for working with device Discovery.

Functions

- ZIResult_enum ziAPIDiscoveryFindAll (ZIConnection conn, char* deviceIds, uint32_t bufferSize)
- ZIResult_enum ziAPIDiscoveryFind (ZIConnection conn, const char* deviceAddress, const char** deviceId)
- ZIResult_enum ziAPIDiscoveryGet (ZIConnection conn, const char* deviceId, const char** propsJSON)
- ZIResult_enum ziAPIDiscoveryGetValueI (ZIConnection conn, const char* deviceId, const char* propName, ZIIntegerData* value)
- ZIResult_enum ziAPIDiscoveryGetValueS (ZIConnection conn, const char* deviceId, const char* propName, const char** value)

Function Documentation

ziAPIDiscoveryFindAll

ZIResult_enum ziAPIDiscoveryFindAll (ZIConnection conn, char* deviceIds, uint32_t bufferSize)

Perform a Discovery property look-up for the specified deviceAddress and return its device ID. Attention! This invalidates all pointers previously returned by ziAPIDiscovery* calls. The deviceId need not be deallocated by the user.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[out] deviceIds

Pointer to a buffer that is to contain the list of newline-separated IDs of the devices found, e.g. "DEV2006\nDEV2007\n".

[in] bufferSize

The size of the buffer pointed to by deviceIds. If the buffer is too small to hold the complete list of device IDs, its contents remain unchanged.

Returns:

- ZI_INFO_SUCCESS
- ZI_ERROR_LENGTH The provided buffer is too small to hold the list.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFind, ziAPIDiscoveryGet, ziAPIDiscoveryGetValueI, ziAPIDiscoveryGetValueS

ziAPIDiscoveryFind

ZIResult_enum ziAPIDiscoveryFind (ZIConnection conn, const char* deviceAddress, const char** deviceId)

Perform a Discovery property look-up for the specified deviceAddress and return its device ID. Attention! This invalidates all pointers previously returned by ziAPIDiscovery* calls. The deviceId need not be deallocated by the user.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] deviceAddress

The address or ID of the device to find, e.g., 'uhf-dev2006' or 'dev2006'.

[out] deviceId

The ID of the device that was found, e.g. 'DEV2006'.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFindAll, ziAPIDiscoveryGet, ziAPIDiscoveryGetValueI, ziAPIDiscoveryGetValueS

ziAPIDiscoveryGet

ZIResult_enum ziAPIDiscoveryGet (ZIConnection conn, const char* deviceId, const char** propsJSON)

Returns the device Discovery properties for a given device ID in JSON format. The function ziAPIDiscoveryFind must be called before ziAPIDiscoveryGet can be used. The propsJSON need not be deallocated by the user.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] deviceId

The ID of the device to get Discovery information for, as returned by ziAPIDiscoveryFind, e.g., 'dev2006'.

[out] propsJSON

The Discovery properites in JSON format of the specified device.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFind, ziAPIDiscoveryGetValueI, ziAPIDiscoveryGetValueS

ziAPIDiscoveryGetValueI

ZIResult_enum ziAPIDiscoveryGetValueI (ZIConnection conn, const char* deviceId, const char* propName, ZIIntegerData* value)

Returns the specified integer Discovery property value for a given device ID. The function ziAPIDiscoveryFind must be called with the required device ID before using ziAPIDiscoveryGetValueI.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] deviceId

The ID of the device to get Discovery information for, as returned by ziAPIDiscoveryFind, e.g., 'dev2006'.

[in] propName

The name of the desired integer Discovery property.

[out] value

Pointer to the value of the specified Discovery property.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFind, ziAPIDiscoveryGet, ziAPIDiscoveryGetValueS

ziAPIDiscoveryGetValueS

ZIResult_enum ziAPIDiscoveryGetValueS (ZIConnection conn, const char* deviceId, const char* propName, const char** value)

Returns the specified string Discovery property value for a given device ID. The function ziAPIDiscoveryFind must be called with the required device ID before using ziAPIDiscoveryGetValueS. The value must not be deallocated by the user.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] deviceId

The ID of the device to get Discovery information for, as returned by ziAPIDiscoveryFind, e.g., 'dev2006'.

[in] propName

The name of the desired integer Discovery property.

[out] value

Pointer to the value of the specified Discovery property.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFind, ziAPIDiscoveryGet, ziAPIDiscoveryGetValueI

8.3. Data Structure Documentation

8.3.1. struct AuxInSample

The AuxInSample struct holds data for the ZI_DATA_AUXINSAMPLE data type. Deprecated: See ZIAuxInSample.

```
#include "ziAPI.h"
```

```
typedef struct AuxInSample {
  ziTimeStampType TimeStamp;
  double Ch0;
  double Ch1;
} AuxInSample;
```

Data Fields

- ziTimeStampType TimeStamp
- double Ch0
- double Ch1

8.3.2. struct ByteArrayData

The ByteArrayData struct holds data for the ZI_DATA_BYTEARRAY data type. Deprecated: See ZIByteArray.

```
#include "ziAPI.h"
```

```
typedef struct ByteArrayData {
  unsigned int Len;
  unsigned char Bytes[0];
} ByteArrayData;
```

Data Fields

- unsigned int Len

- unsigned char Bytes

8.3.3. struct DemodSample

The DemodSample struct holds data for the ZI_DATA_DEMODSAMPLE data type. Deprecated: See ZIDemodSample.

```
#include "ziAPI.h"
```

```
typedef struct DemodSample {
  ziTimeStampType TimeStamp;
  double X;
  double Y;
  double Frequency;
  double Phase;
  unsigned int DIOBits;
  unsigned int Reserved;
  double AuxIn0;
  double AuxIn1;
} DemodSample;
```

Data Fields

- ziTimeStampType TimeStamp
- double X
- double Y
- double Frequency
- double Phase
- unsigned int DIOBits
- unsigned int Reserved
- double AuxIn0
- double AuxIn1

8.3.4. struct DIOSample

The DIOSample struct holds data for the ZI_DATA_DIOSAMPLE data type. Deprecated: See ZIDIOSample.

```
#include "ziAPI.h"
```

```
typedef struct DIOSample {
  ziTimeStampType TimeStamp;
  unsigned int Bits;
  unsigned int Reserved;
} DIOSample;
```

Data Fields

- ziTimeStampType TimeStamp

- unsigned int Bits

- unsigned int Reserved

8.3.5. struct ScopeWave

The structure used to hold a single scope shot (API Level 1). If the client is connected to the Data Server using API Level 4 (recommended if supported by your device class) please see ZIScopeWave instead (ZIScopeWaveEx for API Level 5 and above).

```
#include "ziAPI.h"
```

```
typedef struct ScopeWave {
  double dt;
  uint32_t ScopeChannel;
  uint32_t TriggerChannel;
  uint32_t BWLimit;
  uint32_t Count;
  int16_t Data[0];
} ScopeWave;
```

Data Fields

- double dt

  Time difference between samples.

- uint32_t ScopeChannel

  Scope channel of the represented data.

- uint32_t TriggerChannel

  Trigger channel of the represented data.

- uint32_t BWLimit

  Bandwidth-limit flag.

- uint32_t Count

  Count of samples.

- int16_t Data

  First wave data.

8.3.6. struct TreeChange

The structure used to hold info about added or removed nodes. This is the version without timestamp used in API v1 compatibility mode.

```
#include "ziAPI.h"
```

```
typedef struct TreeChange {
  uint32_t Action;
  char Name[32];
} TreeChange;
```

Data Fields

- uint32_t Action

  field indicating which action occurred on the tree. A value of the ZITreeAction_enum (TREE_ACTION) enum.

- char Name

  Name of the Path that has been added, removed or changed.

8.3.7. union ziEvent::Val

```
typedef union ziEvent::Val {
  void* Void;
  DemodSample* SampleDemod;
  AuxInSample* SampleAuxIn;
  DIOSample* SampleDIO;
  ziDoubleType* Double;
  ziIntegerType* Integer;
  TreeChange* Tree;
  ByteArrayData* ByteArray;
  ScopeWave* Wave;
  uint64_t alignment;
} ziEvent::Val;
```

Data Fields

- void* Void
- DemodSample* SampleDemod
- AuxInSample* SampleAuxIn
- DIOSample* SampleDIO
- ziDoubleType* Double
- ziIntegerType* Integer
- TreeChange* Tree
- ByteArrayData* ByteArray
- ScopeWave* Wave
- uint64_t alignment

8.3.8. struct ZIAdvisorHeader

```
typedef struct ZIAdvisorHeader {
  uint64_t sampleCount;
  uint8_t flags;
  uint8_t sampleFormat;
  uint8_t reserved0[6];
  uint8_t reserved1[8];
} ZIAdvisorHeader;
```

Data Fields

- uint64_t sampleCount

  Total sample count considered for advisor.

- uint8_t flags

  Flags.

- uint8_t sampleFormat

  Sample format Bode = 0, Step = 1, Impulse = 2.

- uint8_t reserved0

  Reserved space for future use.

- uint8_t reserved1

  Reserved space for future use.

8.3.9. struct ZIAdvisorSample

```
typedef struct ZIAdvisorSample {
  double grid;
  double x;
  double y;
} ZIAdvisorSample;
```

Data Fields

- double grid

  Grid.

- double x

  X.

- double y

  Y.

8.3.10. struct ZIAdvisorWave

```
typedef struct ZIAdvisorWave {
  ZITimeStamp timeStamp;
  ZIAdvisorHeader header;
  ZIAdvisorSample data[0];
  union ZIAdvisorWave::@4 data;
} ZIAdvisorWave;
```

Data Fields

- ZITimeStamp timeStamp
  Time stamp at which the data was updated.
- ZIAdvisorHeader header
- ZIAdvisorSample data
- union ZIAdvisorWave::@4 data
  Advisor data vector.

8.3.11. struct ZIAsyncReply

```
typedef struct ZIAsyncReply {
  ZITimeStamp timeStamp;
  ZITimeStamp sampleTimeStamp;
  uint16_t command;
  uint16_t resultCode;
  ZIAsyncTag tag;
} ZIAsyncReply;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp of the reply (server clock)

- ZITimeStamp sampleTimeStamp

  Time stamp of the target node sample, to which the reply belongs.

- uint16_t command

  Command: 1 - ziAPIAsyncSetDoubleData 2 - ziAPIAsyncSetIntegerData 3 - ziAPIAsyncSetByteArray 4 - ziAPIAsyncSubscribe 5 - ziAPIAsyncUnSubscribe 6 - ziAPIAsyncGetValueAsPollData.

- uint16_t resultCode

  Command result code (cast to ZIResult_enum)

- ZIAsyncTag tag

  Tag sent along with the async command.

8.3.12. struct ZIAuxInSample

The structure used to hold data for a single auxiliary inputs sample.

```
#include "ziAPI.h"
```

```
typedef struct ZIAuxInSample {
  ZITimeStamp timeStamp;
  double ch0;
  double ch1;
} ZIAuxInSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the values have been measured.

- double ch0

  Channel 0 voltage.

- double ch1

  Channel 1 voltage.

8.3.13. struct ZIByteArray

The structure used to hold an arbitrary array of bytes. This is the version without timestamp used in API Level 1 compatibility mode.

```
#include "ziAPI.h"
```

```
typedef struct ZIByteArray {
  uint32_t length;
  uint8_t bytes[0];
} ZIByteArray;
```

Data Fields

- uint32_t length

  Length of the data readable from the Bytes field.

- uint8_t bytes

  The data itself. The array has the size given in length.

8.3.14. struct ZIByteArrayTS

The structure used to hold an arbitrary array of bytes. This is the same as ZIByteArray, but with timestamp.

```
#include "ziAPI.h"
```

```
typedef struct ZIByteArrayTS {
  ZITimeStamp timeStamp;
  uint32_t length;
  uint8_t bytes[0];
} ZIByteArrayTS;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the data was updated.

- uint32_t length

  length of the data readable from the bytes field

- uint8_t bytes

  the data itself. The array has the size given in length

8.3.15. struct ZIChunkHeader

Structure to hold generic chunk data header information.

```
#include "ziAPI.h"
```

```
typedef struct ZIChunkHeader {
  ZITimeStamp systemTime;
  ZITimeStamp createdTimeStamp;
  ZITimeStamp changedTimeStamp;
  uint32_t flags;
  uint32_t moduleFlags;
  uint32_t status;
  uint32_t reserved0;
  uint64_t chunkSizeBytes;
  uint64_t triggerNumber;
  char name[32];
  uint32_t groupIndex;
  uint32_t color;
  uint32_t activeRow;
  uint32_t gridRows;
  uint32_t gridCols;
  uint32_t gridMode;
  uint32_t gridOperation;
  uint32_t gridDirection;
  uint32_t gridRepetitions;
  double gridColDelta;
  double gridColOffset;
  double gridRowDelta;
  double gridRowOffset;
  double bandwidth;
  double center;
  double nenbw;
} ZIChunkHeader;
```

Data Fields

- ZITimeStamp systemTime

  System timestamp.

- ZITimeStamp createdTimeStamp

  Creation timestamp.

- ZITimeStamp changedTimeStamp

  Last changed timestamp.

- uint32_t flags

  Flags (bitmask of values from ZIChunkHeaderFlags_enum)

- uint32_t moduleFlags

  moduleFlags (bitmask of values from ZIChunkHeaderModuleFlags_enum, module-specific)

- uint32_t status

  Status Flag: [0] : selected [1] : group assigned [2] : color edited [4] : name edited.

- uint32_t reserved0

- uint64_t chunkSizeBytes

Size in bytes used for memory usage calculation.

- uint64_t triggerNumber

  SW Trigger counter since execution start.

- char name

  Name in history list.

- uint32_t groupIndex

  Group index in history list.

- uint32_t color

  Color in history list.

- uint32_t activeRow

  Active row in history list.

- uint32_t gridRows

  Number of grid rows.

- uint32_t gridCols

  Number of grid columns.

- uint32_t gridMode

  Grid mode interpolation mode (0 = off, 1 = nearest, 2 = linear, 3 = Lanczos)

- uint32_t gridOperation

  Grid mode operation (0 = replace, 1 = average)

- uint32_t gridDirection

  Grid mode direction (0 = forward, 1 = revers, 2 = bidirectional)

- uint32_t gridRepetitions

  Number of repetitions in grid mode.

- double gridColDelta

  Delta between grid points in SI unit.

- double gridColOffset

  Offset of first grid point relative to trigger.

- double gridRowDelta

  Delta between grid rows in SI unit.

- double gridRowOffset

  Delay of first grid row relative to trigger.

- double bandwidth

  For FFT the bandwidth of the signal.

- double center

  The FFT center frequency.

- double nenbw

For FFT the normalized effective noise bandwidth.

8.3.16. struct ZICntSample

The structure used to hold data for a single counter sample.

```
#include "ziAPI.h"
```

```
typedef struct ZICntSample {
  ZITimeStamp timeStamp;
  int32_t counter;
  uint32_t trigger;
} ZICntSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the values have been measured.

- int32_t counter

  Counter value.

- uint32_t trigger

  Trigger bits.

8.3.17. struct ZIComplexData

The structure used to hold a complex double value.

```
#include "ziAPI.h"
```

```
typedef struct ZIComplexData {
  ZITimeStamp timeStamp;
  ZIDoubleData real;
  ZIDoubleData imag;
} ZIComplexData;
```

Data Fields

- ZITimeStamp timeStamp
  Time stamp at which the value has changed.
- ZIDoubleData real
- ZIDoubleData imag

8.3.18. struct ZIDemodSample

The structure used to hold data for a single demodulator sample.

```
#include "ziAPI.h"
```

```
typedef struct ZIDemodSample {
  ZITimeStamp timeStamp;
  double x;
  double y;
  double frequency;
  double phase;
  uint32_t dioBits;
  uint32_t trigger;
  double auxIn0;
  double auxIn1;
} ZIDemodSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the sample has been measured.

- double x

  X part of the sample.

- double y

  Y part of the sample.

- double frequency

  oscillator frequency at that sample.

- double phase

  oscillator phase at that sample.

- uint32_t dioBits

  the current bits of the DIO.

- uint32_t trigger

  trigger bits

- double auxIn0

  value of Aux input 0.

- double auxIn1

  value of Aux input 1.

8.3.19. struct ZIDIOSample

The structure used to hold data for a single digital I/O sample.

```
#include "ziAPI.h"
```

```
typedef struct ZIDIOSample {
  ZITimeStamp timeStamp;
  uint32_t bits;
  uint32_t reserved;
} ZIDIOSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the values have been measured.

- uint32_t bits

  The digital I/O values.

- uint32_t reserved

  Filler to keep 8 bytes alignment in the array of ZIDIOSample structures.

8.3.20. struct ZIDoubleDataTS

The structure used to hold a single IEEE double value. Same as ZIDoubleData, but with timestamp.

```
#include "ziAPI.h"
```

```
typedef struct ZIDoubleDataTS {
  ZITimeStamp timeStamp;
  ZIDoubleData value;
} ZIDoubleDataTS;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the value has changed.

- ZIDoubleData value

8.3.21. struct ZIEvent

This struct holds event data forwarded by the Data Server.

```
#include "ziAPI.h"
```

```
typedef struct ZIEvent {
  uint32_t valueType;
  uint32_t count;
  uint8_t path[256];
  void* untyped;
  ZIDoubleData* doubleData;
  ZIDoubleDataTS* doubleDataTS;
  ZIIntegerData* integerData;
  ZIIntegerDataTS* integerDataTS;
  ZIComplexData* complexData;
  ZIByteArray* byteArray;
  ZIByteArrayTS* byteArrayTS;
  ZICntSample* cntSample;
  ZITrigSample* trigSample;
  ZITreeChangeData* treeChangeData;
  TreeChange* treeChangeDataOld;
  ZIDemodSample* demodSample;
  ZIAuxInSample* auxInSample;
  ZIDIOSample* dioSample;
  ZIScopeWave* scopeWave;
  ZIScopeWaveEx* scopeWaveEx;
  ScopeWave* scopeWaveOld;
  ZIPWAWave* pwaWave;
  ZISweeperWave* sweeperWave;
  ZISpectrumWave* spectrumWave;
  ZIAdvisorWave* advisorWave;
  ZIAsyncReply* asyncReply;
  ZIVectorData* vectorData;
  ZIImpedanceSample* impedanceSample;
  uint64_t alignment;
  union ZIEvent::@6 value;
  uint8_t data[0x400000];
} ZIEvent;
```

Data Fields

- uint32_t valueType

  Specifies the type of the data held by the ZIEvent, see ZIValueType_enum.

- uint32_t count

  Number of values available in this event.

- uint8_t path

  The path to the node from which the event originates.

- void* untyped

  For convenience. The void field doesn't have a corresponding data type.

- ZIDoubleData* doubleData

  when valueType == ZI_VALUE_TYPE_DOUBLE_DATA

- ZIDoubleDataTS* doubleDataTS

  when valueType == ZI_VALUE_TYPE_DOUBLE_DATA_TS

- ZIIntegerData* integerData
  when valueType == ZI_VALUE_TYPE_INTEGER_DATA
- ZIIntegerDataTS* integerDataTS
  when valueType == ZI_VALUE_TYPE_INTEGER_DATA_TS
- ZIComplexData* complexData
  when valueType == ZI_VALUE_TYPE_COMPLEX_DATA
- ZIByteArray* byteArray
  when valueType == ZI_VALUE_TYPE_BYTE_ARRAY
- ZIByteArrayTS* byteArrayTS
  when valueType == ZI_VALUE_TYPE_BYTE_ARRAY_TS
- ZICntSample* cntSample
  when valueType == ZI_VALUE_TYPE_CNT_SAMPLE
- ZITrigSample* trigSample
  when valueType == ZI_VALUE_TYPE_TRIG_SAMPLE
- ZITreeChangeData* treeChangeData
  when valueType == ZI_VALUE_TYPE_TREE_CHANGE_DATA
- TreeChange* treeChangeDataOld
  when valueType ==
  ZI_VALUE_TYPE_TREE_CHANGE_DATA_OLD
- ZIDemodSample* demodSample
  when valueType == ZI_VALUE_TYPE_DEMOD_SAMPLE
- ZIAuxInSample* auxInSample
  when valueType == ZI_VALUE_TYPE_AUXIN_SAMPLE
- ZIDIOSample* dioSample
  when valueType == ZI_VALUE_TYPE_DIO_SAMPLE
- ZIScopeWave* scopeWave
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE
- ZIScopeWaveEx* scopeWaveEx
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE_EX
- ScopeWave* scopeWaveOld
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE_OLD
- ZIPWAWave* pwaWave
  when valueType == ZI_VALUE_TYPE_PWA_WAVE
- ZISweeperWave* sweeperWave
  when valueType == ZI_VALUE_TYPE_SWEEPER_WAVE
- ZISpectrumWave* spectrumWave
  when valueType == ZI_VALUE_TYPE_SPECTRUM_WAVE
- ZIAdvisorWave* advisorWave

when valueType == ZI_VALUE_TYPE_ADVISOR_WAVE

- ZIAsyncReply* asyncReply

  when valueType == ZI_VALUE_TYPE_ASYNC_REPLY

- ZIVectorData* vectorData

  when valueType == ZI_VALUE_TYPE_VECTOR_DATA

- ZIImpedanceSample* impedanceSample

  when valueType == ZI_VALUE_TYPE_IMPEDANCE_SAMPLE

- uint64_t alignment

  ensure union size is 8 bytes

- union ZIEvent::@6 value

  Convenience pointer to allow for access to the first entry in Data using the correct type according to ZIEvent.valueType field.

- uint8_t data

  The raw value data.

Detailed Description

ZIEvent is used to give out events like value changes or errors to the user. Event handling functionality is provided by ziAPISubscribe and ziAPIUnSubscribe as well as ziAPIPollDataEx.

```
// Copyright [2016] Zurich Instruments AG
#include <stdio.h>

#include "ziAPI.h"

void ProcessEvent(ZIEvent* Event) {
  unsigned int j;

  switch (Event->valueType) {
  case ZI_VALUE_TYPE_DOUBLE_DATA:

    printf("%u elements of double data: %s.\n",
           Event->count,
           Event->path);

    for (j = 0; j < Event->count; j++)
      printf("%f\n", Event->value.doubleData[j]);

    break;

  case ZI_VALUE_TYPE_INTEGER_DATA:

    printf("%u elements of integer data: %s.\n",
           Event->count,
           Event->path);

    for (j = 0; j < Event->count; j++)
      printf("%f\n", (float)Event->value.integerData[j]);

    break;

  case ZI_VALUE_TYPE_DEMOD_SAMPLE:

    printf("%u elements of sample data %s\n",
```

```
                  Event->count,
                  Event->path);

          for (j = 0; j < Event->count; j++)
            printf("TS=%f, X=%f, Y=%f.\n",
                   (float)Event->value.demodSample[j].timeStamp,
                   Event->value.demodSample[j].x,
                   Event->value.demodSample[j].y);

          break;

        case ZI_VALUE_TYPE_TREE_CHANGE_DATA:

          printf("%u elements of tree-changed data, %s.\n",
                  Event->count,
                  Event->path);

          for (j = 0; j < Event->count; j++) {
            switch (Event->value.treeChangeDataOld[j].Action) {
            case ZI_TREE_ACTION_REMOVE:
              printf("Tree removed: %s\n",
                     Event->value.treeChangeDataOld[j].Name);
              break;

            case ZI_TREE_ACTION_ADD:
              printf("treeChangeDataOld added: %s.\n",
                     Event->value.treeChangeDataOld[j].Name);
              break;

            case ZI_TREE_ACTION_CHANGE:
              printf("treeChangeDataOld changed: %s.\n",
                     Event->value.treeChangeDataOld[j].Name);
              break;
            }
          }

          break;

        default:

          printf("Unexpected event value type: %d.\n", Event->valueType);
          break;
        }
      }
```

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIPollDataEx

8.3.22. struct ziEvent

This struct holds event data forwarded by the Data Server. Deprecated: See ZIEvent.

```
#include "ziAPI.h"
```

```
typedef struct ziEvent {
  uint32_t Type;
  uint32_t Count;
  unsigned char Path[256];
  union ziEvent::Val Val;
  unsigned char Data[0x400000];
} ziEvent;
```

Data Structures

- union ziEvent::Val

Data Fields

- uint32_t Type
- uint32_t Count
- unsigned char Path
- union ziEvent::Val Val
- unsigned char Data

Detailed Description

ziEvent is used to give out events like value changes or errors to the user. Event handling functionality is provided by ziAPISubscribe and ziAPIUnSubscribe as well as ziAPIPollDataEx.

See Also:
ziAPISubscribe, ziAPIUnSubscribe, ziAPIPollDataEx

```
// Copyright [2016] Zurich Instruments AG
#include <stdio.h>

#include "ziAPI.h"

void ProcessEvent(ZIEvent* Event) {
  unsigned int j;

  switch (Event->valueType) {
  case ZI_VALUE_TYPE_DOUBLE_DATA:

    printf("%u elements of double data: %s.\n",
           Event->count,
           Event->path);
```

```
      for (j = 0; j < Event->count; j++)
        printf("%f\n", Event->value.doubleData[j]);

      break;

    case ZI_VALUE_TYPE_INTEGER_DATA:

      printf("%u elements of integer data: %s.\n",
             Event->count,
             Event->path);

      for (j = 0; j < Event->count; j++)
        printf("%f\n", (float)Event->value.integerData[j]);

      break;

    case ZI_VALUE_TYPE_DEMOD_SAMPLE:

      printf("%u elements of sample data %s\n",
             Event->count,
             Event->path);

      for (j = 0; j < Event->count; j++)
        printf("TS=%f, X=%f, Y=%f.\n",
               (float)Event->value.demodSample[j].timeStamp,
               Event->value.demodSample[j].x,
               Event->value.demodSample[j].y);

      break;

    case ZI_VALUE_TYPE_TREE_CHANGE_DATA:

      printf("%u elements of tree-changed data, %s.\n",
             Event->count,
             Event->path);

      for (j = 0; j < Event->count; j++) {
        switch (Event->value.treeChangeDataOld[j].Action) {
        case ZI_TREE_ACTION_REMOVE:
          printf("Tree removed: %s\n",
                 Event->value.treeChangeDataOld[j].Name);
          break;

        case ZI_TREE_ACTION_ADD:
          printf("treeChangeDataOld added: %s.\n",
                 Event->value.treeChangeDataOld[j].Name);
          break;

        case ZI_TREE_ACTION_CHANGE:
          printf("treeChangeDataOld changed: %s.\n",
                 Event->value.treeChangeDataOld[j].Name);
          break;
        }
      }

      break;

    default:

      printf("Unexpected event value type: %d.\n", Event->valueType);
      break;
    }
  }
```

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union ziEvent::Val

```
typedef union ziEvent::Val {
  void* Void;
  DemodSample* SampleDemod;
  AuxInSample* SampleAuxIn;
  DIOSample* SampleDIO;
  ziDoubleType* Double;
  ziIntegerType* Integer;
  TreeChange* Tree;
  ByteArrayData* ByteArray;
  ScopeWave* Wave;
  uint64_t alignment;
} ziEvent::Val;
```

Data Fields

- void* Void
- DemodSample* SampleDemod
- AuxInSample* SampleAuxIn
- DIOSample* SampleDIO
- ziDoubleType* Double
- ziIntegerType* Integer
- TreeChange* Tree
- ByteArrayData* ByteArray
- ScopeWave* Wave
- uint64_t alignment

8.3.23. struct ZIImpedanceSample

The structure used to hold data for a single impedance sample.

```
#include "ziAPI.h"
```

```
typedef struct ZIImpedanceSample {
  ZITimeStamp timeStamp;
  double realz;
  double imagz;
  double frequency;
  double phase;
  uint32_t flags;
  uint32_t trigger;
  double param0;
  double param1;
  double drive;
  double bias;
} ZIImpedanceSample;
```

Data Fields

- ZITimeStamp timeStamp
  Timestamp at which the sample has been measured.
- double realz
  Real part of the impedance sample.
- double imagz
  Imaginary part of the impedance sample.
- double frequency
  Frequency at that sample.
- double phase
  Phase at that sample.
- uint32_t flags
  Flags (see ZIImpFlags_enum)
- uint32_t trigger
  Trigger bits.
- double param0
  Value of model parameter 0.
- double param1
  Value of model parameter 1.
- double drive
  Drive amplitude.
- double bias
  Bias voltage.

8.3.24. struct ZIIntegerDataTS

The structure used to hold a single 64bit signed integer value. Same as ZIIntegerData, but with timestamp.

```
#include "ziAPI.h"
```

```
typedef struct ZIIntegerDataTS {
  ZITimeStamp timeStamp;
  ZIIntegerData value;
} ZIIntegerDataTS;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the value has changed.

- ZIIntegerData value

8.3.25. struct ZIModuleEvent

This struct holds data of a single chunk from module lookup.

```
#include "ziAPI.h"
```

```
typedef struct ZIModuleEvent {
  uint64_t allocatedSize;
  ZIChunkHeader* header;
  ZIEvent
            value[0];
} ZIModuleEvent;
```

Data Fields

- uint64_t allocatedSize
  For internal use - never modify!
- ZIChunkHeader* header
  Chunk header.
- ZIEvent value
  Defines location of stored ZIEvent.

8.3.26. struct ZIPWASample

Single PWA sample value.

```
#include "ziAPI.h"
```

```
typedef struct ZIPWASample {
  double binPhase;
  double x;
  double y;
  uint32_t countBin;
  uint32_t reserved;
} ZIPWASample;
```

Data Fields

- double binPhase

  Phase position of each bin.

- double x

  Real PWA result or X component of a demod PWA.

- double y

  Y component of the demod PWA.

- uint32_t countBin

  Number of events per bin.

- uint32_t reserved

  Reserved.

8.3.27. struct ZIPWAWave

PWA Wave.

```
#include "ziAPI.h"
```

```
typedef struct ZIPWAWave {
  ZITimeStamp timeStamp;
  uint64_t sampleCount;
  uint32_t inputSelect;
  uint32_t oscSelect;
  uint32_t harmonic;
  uint32_t binCount;
  double frequency;
  uint8_t pwaType;
  uint8_t mode;
  uint8_t overflow;
  uint8_t commensurable;
  uint32_t reservedUInt;
  ZIPWASample
            data[0];
} ZIPWAWave;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the data was updated.

- uint64_t sampleCount

  Total sample count considered for PWA.

- uint32_t inputSelect

  Input selection used for the PWA.

- uint32_t oscSelect

  Oscillator used for the PWA.

- uint32_t harmonic

  Harmonic setting.

- uint32_t binCount

  Bin count of the PWA.

- double frequency

  Frequency during PWA accumulation.

- uint8_t pwaType

  Type of the PWA.

- uint8_t mode

  PWA Mode [0: zoom PWA, 1: harmonic PWA].

- uint8_t overflow

  Overflow indicators. overflow[0]: Data accumulator overflow, overflow[1]: Counter at limit, overflow[6..2]: Reserved, overflow[7]: Invalid (missing frames).

- uint8_t commensurable

Commensurability of the data.

- uint32_t reservedUInt
  Reserved 32bit.
- ZIPWASample data
  PWA data vector.

8.3.28. struct ZIScopeWave

The structure used to hold scope data (when using API Level 4). Note that ZIScopeWave does not contain the structure member channelOffset, whereas ZIScopeWaveEx does. The data may be formatted differently, depending on settings. See the description of the structure members for details.

```
#include "ziAPI.h"
```

```
typedef struct ZIScopeWave {
  ZITimeStamp timeStamp;
  ZITimeStamp triggerTimeStamp;
  double dt;
  uint8_t channelEnable[4];
  uint8_t channelInput[4];
  uint8_t triggerEnable;
  uint8_t triggerInput;
  uint8_t reserved0[2];
  uint8_t channelBWLimit[4];
  uint8_t channelMath[4];
  float channelScaling[4];
  uint32_t sequenceNumber;
  uint32_t segmentNumber;
  uint32_t blockNumber;
  uint64_t totalSamples;
  uint8_t dataTransferMode;
  uint8_t blockMarker;
  uint8_t flags;
  uint8_t sampleFormat;
  uint32_t sampleCount;
  int16_t dataInt16[0];
  int32_t dataInt32[0];
  float dataFloat[0];
  union ZIScopeWave::@0 data;
} ZIScopeWave;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp of the last sample in this data block.

- ZITimeStamp triggerTimeStamp

  The timestamp of the trigger (may also fall between samples and in another block)

- double dt

  Time difference between samples in seconds.

- uint8_t channelEnable

  Up to four channels: if channel is enabled, corresponding element is non-zero.

- uint8_t channelInput

  Specifies the input source for each of the scope four channels.

  Value of channelInput and corresponding input source:

  - 0 = Signal Input 1,
  - 1 = Signal Input 2,

- 2 = Trigger Input 1,
- 3 = Trigger Input 2,
- 4 = Aux Output 1,
- 5 = Aux Output 2,
- 6 = Aux Output 3,
- 7 = Aux Output 4,
- 8 = Aux Input 1,
- 9 = Aux Input 2.

- uint8_t triggerEnable
  Non-zero if trigger is enabled:

  Bit encoded:
  - Bit (0): 1 = Trigger on rising edge,
  - Bit (1): 1 = Trigger on falling edge.
- uint8_t triggerInput
  Trigger source (same values as for channel input)
- uint8_t reserved0

- uint8_t channelBWLimit
  Bandwidth-limit flag, per channel.

  Bit encoded:
  - Bit (0): 1 = Enable bandwidth limiting.
  - Bit (7...1): Reserved
- uint8_t channelMath
  Enable/disable math operations such as averaging or FFT.

  Bit encoded:
  - Bit(0): 1 = Perform averaging,
  - Bit(1): 1 = Perform FFT,
  - Bit(7...2): Reserved
- float channelScaling
  Data scaling factors for up to 4 channels.
- uint32_t sequenceNumber
  Current scope shot sequence number. Identifies a scope shot.
- uint32_t segmentNumber
  Current segment number.
- uint32_t blockNumber
  Current block number from the beginning of a scope shot.
  Large scope shots are split into blocks, which need to be
  concatenated to obtain the complete scope shot.

- uint64_t totalSamples

  Total number of samples in one channel in the current scope shot, same for all channels.

- uint8_t dataTransferMode

  Data transfer mode.

  Value and the corresponding data transfer mode:

  - 0 - SingleTransfer,
  - 1 - BlockTransfer,
  - 3 - ContinuousTransfer. Other values are reserved.

- uint8_t blockMarker

  Block marker:

  Bit encoded:

  - Bit (0): 1 = End marker for continuous or multi-block transfer,
  - Bit (7..0): Reserved.

- uint8_t flags

  Indicator Flags.

  Bit encoded:

  - Bit (0): 1 = Data loss detected (samples are 0),
  - Bit (1): 1 = Missed trigger,
  - Bit (2): 1 = Transfer failure (corrupted data).

- uint8_t sampleFormat

  Data format of samples:

  Value is one of ZIScopeSampleFormat_enum

- uint32_t sampleCount

  Number of samples in one channel in the current block, same for all channels.

- int16_t dataInt16

  Wave data when sampleFormat==0 or sampleFormat==4.

- int32_t dataInt32

  Wave data when sampleFormat==1 or sampleFormat==5.

- float dataFloat

  Wave data when sampleFormat==2 or sampleFormat==6.

- union ZIScopeWave::@0 data

  Wave data, access via union member dataInt16, dataInt32 or dataFloat depending on sampleFormat. Indexing scheme also depends on sampleFormat.

  Example for interleaved int16 wave, 4096 samples, 2 channels:

- data.dataInt16[0] - sample 0 of channel 0,
- data.dataInt16[1] - sample 0 of channel 1,
- data.dataInt16[2] - sample 1 of channel 0,
- data.dataInt16[3] - sample 1 of channel 1,
- ...
- data.dataInt16[8190] - sample 4095 of channel 0,
- data.dataInt16[8191] - sample 4095 of channel 1.

Example for non-interleaved int16 wave, 4096 samples, 2 channels:

- data.dataInt16[0] - sample 0 of channel 0,
- data.dataInt16[1] - sample 1 of channel 0,
- .. - ...
- data.dataInt16[4095] - sample 4095 of channel 0,
- data.dataInt16[4096] - sample 0 of channel 1,
- data.dataInt16[4097] - sample 1 of channel 1,
- ...
- data.dataInt16[8191] - sample 4095 of channel 1.

8.3.29. struct ZIScopeWaveEx

The structure used to hold scope data (extended, when using API Level 5). Note that ZIScopeWaveEx contains the structure member channelOffset; ZIScopeWave does not. The data may be formatted differently, depending on settings. See the description of the structure members for details.

```
#include "ziAPI.h"
```

```
typedef struct ZIScopeWaveEx {
  ZITimeStamp timeStamp;
  ZITimeStamp triggerTimeStamp;
  double dt;
  uint8_t channelEnable[4];
  uint8_t channelInput[4];
  uint8_t triggerEnable;
  uint8_t triggerInput;
  uint8_t reserved0[2];
  uint8_t channelBWLimit[4];
  uint8_t channelMath[4];
  float channelScaling[4];
  uint32_t sequenceNumber;
  uint32_t segmentNumber;
  uint32_t blockNumber;
  uint64_t totalSamples;
  uint8_t dataTransferMode;
  uint8_t blockMarker;
  uint8_t flags;
  uint8_t sampleFormat;
  uint32_t sampleCount;
  double channelOffset[4];
  uint32_t totalSegments;
  uint32_t reserved1;
  uint64_t reserved2[31];
  int16_t dataInt16[0];
  int32_t dataInt32[0];
  float dataFloat[0];
  union ZIScopeWaveEx::@1 data;
} ZIScopeWaveEx;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp of the last sample in this data block.

- ZITimeStamp triggerTimeStamp

  The Timestamp of the trigger (may also fall between samples and in another block).

- double dt

  Time difference between samples in seconds.

- uint8_t channelEnable

  Up to four channels: If channel is enabled, the corresponding element is non-zero.

- uint8_t channelInput

  Specifies the input source for each of the scope four channels.

  Value of channelInput and corresponding input source:

- 0 = Signal Input 1,
- 1 = Signal Input 2,
- 2 = Trigger Input 1,
- 3 = Trigger Input 2,
- 4 = Aux Output 1,
- 5 = Aux Output 2,
- 6 = Aux Output 3,
- 7 = Aux Output 4,
- 8 = Aux Input 1,
- 9 = Aux Input 2.

- uint8_t triggerEnable
  Non-zero if trigger is enabled.

  Bit encoded:
  - Bit (0): 1 = Trigger on rising edge,
  - Bit (1): 1 = Trigger on falling edge.

- uint8_t triggerInput
  Trigger source (same values as for channel input)

- uint8_t reserved0

- uint8_t channelBWLimit
  Bandwidth-limit flag, per channel.

  Bit encoded:
  - Bit (0): 1 = Enable bandwidth limiting.
  - Bit (7...1): Reserved

- uint8_t channelMath
  Enable/disable math operations such as averaging or FFT.

  Bit encoded:
  - Bit(0): 1 = Perform averaging,
  - Bit(1): 1 = Perform FFT,
  - Bit(7...2): Reserved

- float channelScaling
  Data scaling factors for up to 4 channels.

- uint32_t sequenceNumber
  Current scope shot sequence number. Identifies a scope shot.

- uint32_t segmentNumber
  Current segment number.

- uint32_t blockNumber

Current block number from the beginning of a scope shot. Large scope shots are split into blocks, which need to be concatenated to obtain the complete scope shot.

- uint64_t totalSamples

  Total number of samples in one channel in the current scope shot, same for all channels.

- uint8_t dataTransferMode

  Data transfer mode.

  Value and the corresponding data transfer mode:

  - 0 - SingleTransfer,
  - 1 - BlockTransfer,
  - 3 - ContinuousTransfer. Other values are reserved.

- uint8_t blockMarker

  Block marker providing additional information about the current block.

  Bit encoded:

  - Bit (0): 1 = End marker for continuous or multi-block transfer,
  - Bit (7..0): Reserved.

- uint8_t flags

  Indicator Flags.

  Bit encoded:

  - Bit (0): 1 = Data loss detected (samples are 0),
  - Bit (1): 1 = Missed trigger,
  - Bit (2): 1 = Transfer failure (corrupted data).
  - Bit (3): 1 = Assembled scope recording. 'sampleCount' will be set to 0, use 'totalSamples' instead.
  - Bit (7...4): Reserved.

- uint8_t sampleFormat

  Data format of samples:

  Value is one of ZIScopeSampleFormat_enum

- uint32_t sampleCount

  Number of samples in one channel in the current block, same for all channels.

- double channelOffset

  Data offset (scaled) for up to 4 channels.

- uint32_t totalSegments

  Number of segments in the recording. Only valid if 'flags' bit (3) is set.

- uint32_t reserved1

- uint64_t reserved2

- int16_t dataInt16

  Wave data when sampleFormat==0 or sampleFormat==4.

- int32_t dataInt32

  Wave data when sampleFormat==1 or sampleFormat==5.

- float dataFloat

  Wave data when sampleFormat==2 or sampleFormat==6.

- union ZIScopeWaveEx::@1 data

  Wave data, access via union member dataInt16, dataInt32 or dataFloat depending on sampleFormat. Indexing scheme also depends on sampleFormat.

  Example for interleaved int16 wave, 4096 samples, 2 channels:

  - data.dataInt16[0] - sample 0 of channel 0,
  - data.dataInt16[1] - sample 0 of channel 1,
  - data.dataInt16[2] - sample 1 of channel 0,
  - data.dataInt16[3] - sample 1 of channel 1,
  - ...
  - data.dataInt16[8190] - sample 4095 of channel 0,
  - data.dataInt16[8191] - sample 4095 of channel 1.

  Example for non-interleaved int16 wave, 4096 samples, 2 channels:

  - data.dataInt16[0] - sample 0 of channel 0,
  - data.dataInt16[1] - sample 1 of channel 0,
  - .. - ...
  - data.dataInt16[4095] - sample 4095 of channel 0,
  - data.dataInt16[4096] - sample 0 of channel 1,
  - data.dataInt16[4097] - sample 1 of channel 1,
  - ...
  - data.dataInt16[8191] - sample 4095 of channel 1.

8.3.30. struct ZISpectrumDemodSample

```
typedef struct ZISpectrumDemodSample {
  double grid;
  double filter;
  double x;
  double y;
  double r;
} ZISpectrumDemodSample;
```

Data Fields

- double grid

  Grid.

- double filter

  Filter strength at the specific grid point.

- double x

  X.

- double y

  Y.

- double r

  R.

8.3.31. struct ZISpectrumHeader

```
typedef struct ZISpectrumHeader {
  uint64_t sampleCount;
  uint8_t flags;
  uint8_t sampleFormat;
  uint8_t spectrumMode;
  uint8_t window;
  uint8_t reserved0[4];
  uint8_t reserved1[8];
  double bandwidth;
  double rate;
  double center;
  double resolution;
  double aliasingReject;
  double nenbw;
  double overlap;
} ZISpectrumHeader;
```

Data Fields

- uint64_t sampleCount

  Total sample count considered for spectrum.

- uint8_t flags

  Flags Bit 0: Power Bit 1: Spectral density Bit 2: Absolute frequency Bit 3: Full span.

- uint8_t sampleFormat

  Sample format Demodulator = 0.

- uint8_t spectrumMode

  Spectrum mode FFT(x+iy) = 0, FFT(r) = 1, FFT(theta) = 2, FFT(freq) = 3, FFT(dtheta/dt)/2pi = 4.

- uint8_t window

  Window Rectangular = 0, Hann = 1, Hamming = 2, Blackman Harris = 3, Exponential = 16 (ring-down), Cosine = 17 (ring-down), Cosine squared = 18 (ring-down)

- uint8_t reserved0

  Reserved space for future use.

- uint8_t reserved1

  Reserved space for future use.

- double bandwidth

  Filter bandwidth.

- double rate

  Rate of the sampled data.

- double center

  FFT center value.

- double resolution

  FFT bin resolution.

- double aliasingReject

  Aliasing reject (dB)

- double nenbw

  Correction factor for the used window when calculating spectral density.

- double overlap

  FFT overlap [0 .. 1[.

8.3.32. struct ZISpectrumWave

```
typedef struct ZISpectrumWave {
  ZITimeStamp timeStamp;
  ZISpectrumHeader header;
  ZISpectrumDemodSample dataDemod[0];
  union ZISpectrumWave::@3 data;
} ZISpectrumWave;
```

Data Fields

- ZITimeStamp timeStamp
  Time stamp at which the data was updated.
- ZISpectrumHeader header
- ZISpectrumDemodSample dataDemod
- union ZISpectrumWave::@3 data
  Spectrum data vector.

8.3.33. struct ZIStatisticSample

```
typedef struct ZIStatisticSample {
  double avg;
  double stddev;
  double pwr;
} ZIStatisticSample;
```

Data Fields

- double avg
  Average value or single value.
- double stddev
  Standard deviation.
- double pwr
  Power value.

8.3.34. struct ZISweeperDemodSample

```
typedef struct ZISweeperDemodSample {
  double grid;
  double bandwidth;
  uint64_t count;
  double tc;
  double tcMeas;
  double settling;
  ZITimeStamp setTimeStamp;
  ZITimeStamp nextTimeStamp;
  ZIStatisticSample x;
  ZIStatisticSample y;
  ZIStatisticSample r;
  ZIStatisticSample phase;
  ZIStatisticSample frequency;
  ZIStatisticSample auxin0;
  ZIStatisticSample auxin1;
} ZISweeperDemodSample;
```

Data Fields

- double grid

  Grid value (x-axis)

- double bandwidth

  Demodulator bandwidth used for the specific sweep point.

- uint64_t count

  Sample count used for statistic calculation.

- double tc

  Time constant calculated for the specific sweep point.

- double tcMeas

  Time constant used by the device.

- double settling

  Settling time (s) used to wait until averaging operation is started.

- ZITimeStamp setTimeStamp

  Time stamp when the grid value was set on the device.

- ZITimeStamp nextTimeStamp

  Time stamp when the first statistic value was recorded.

- ZIStatisticSample x

  Sweep point statistic result of X.

- ZIStatisticSample y

  Sweep point statistic result of Y.

- ZIStatisticSample r

  Sweep point statistic result of R.

- ZIStatisticSample phase

  Sweep point statistic result of phase.

- ZIStatisticSample frequency
  Sweep point statistic result of frequency.
- ZIStatisticSample auxin0
  Sweep point statistic result of auxin0.
- ZIStatisticSample auxin1
  Sweep point statistic result of auxin1.

8.3.35. struct ZISweeperDoubleSample

```
typedef struct ZISweeperDoubleSample {
  double grid;
  double bandwidth;
  uint64_t count;
  ZIStatisticSample value;
} ZISweeperDoubleSample;
```

Data Fields

- double grid
  Grid value (x-axis)
- double bandwidth
  Bandwidth.
- uint64_t count
  Sample count used for statistic calculation.
- ZIStatisticSample value
  Result value (y-axis)

8.3.36. struct ZISweeperHeader

```
typedef struct ZISweeperHeader {
  uint64_t sampleCount;
  uint8_t flags;
  uint8_t sampleFormat;
  uint8_t sweepMode;
  uint8_t bandwidthMode;
  uint8_t reserved0[4];
  uint8_t reserved1[8];
} ZISweeperHeader;
```

Data Fields

- uint64_t sampleCount

  Total sample count considered for sweeper.

- uint8_t flags

  Flags Bit 0: Phase unwrap Bit 1: Sinc filter.

- uint8_t sampleFormat

  Sample format Double = 0, Demodulator = 1, Impedance = 2.

- uint8_t sweepMode

  Sweep mode Sequential = 0, Binary = 1, Bidirectional = 2, Reverse = 3.

- uint8_t bandwidthMode

  Bandwidth mode Manual = 0, Fixed = 1, Auto = 2.

- uint8_t reserved0

  Reserved space for future use.

- uint8_t reserved1

  Reserved space for future use.

8.3.37. struct ZISweeperImpedanceSample

```
typedef struct ZISweeperImpedanceSample {
  double grid;
  double bandwidth;
  uint64_t count;
  double tc;
  double tcMeas;
  double settling;
  ZITimeStamp setTimeStamp;
  ZITimeStamp nextTimeStamp;
  ZIStatisticSample realz;
  ZIStatisticSample imagz;
  ZIStatisticSample absz;
  ZIStatisticSample phasez;
  ZIStatisticSample frequency;
  ZIStatisticSample param0;
  ZIStatisticSample param1;
  ZIStatisticSample drive;
  ZIStatisticSample bias;
  uint32_t flags;
} ZISweeperImpedanceSample;
```

Data Fields

- double grid

  Grid value (x-axis)

- double bandwidth

  Demodulator bandwidth used for the specific sweep point.

- uint64_t count

  Sample count used for statistic calculation.

- double tc

  Time constant calculated for the specific sweep point.

- double tcMeas

  Time constant used by the device.

- double settling

  Settling time (s) used to wait until averaging operation is started.

- ZITimeStamp setTimeStamp

  Time stamp when the grid value was set on the device.

- ZITimeStamp nextTimeStamp

  Time stamp when the first statistic value was recorded.

- ZIStatisticSample realz

  Sweep point statistic result of X.

- ZIStatisticSample imagz

  Sweep point statistic result of Y.

- ZIStatisticSample absz

  Sweep point statistic result of R.

- ZIStatisticSample phasez
  Sweep point statistic result of phase.
- ZIStatisticSample frequency
  Sweep point statistic result of frequency.
- ZIStatisticSample param0
  Sweep point statistic result of param0.
- ZIStatisticSample param1
  Sweep point statistic result of param1.
- ZIStatisticSample drive
  Sweep point statistic result of drive amplitude.
- ZIStatisticSample bias
  Sweep point statistic result of bias.
- uint32_t flags
  Flags (see ZIImpFlags_enum)

8.3.38. struct ZISweeperWave

```
typedef struct ZISweeperWave {
  ZITimeStamp timeStamp;
  ZISweeperHeader header;
  ZISweeperDoubleSample dataDouble[0];
  ZISweeperDemodSample dataDemod[0];
  ZISweeperImpedanceSample dataImpedance[0];
  union ZISweeperWave::@2 data;
} ZISweeperWave;
```

Data Fields

- ZITimeStamp timeStamp
  Time stamp at which the data was updated.
- ZISweeperHeader header
- ZISweeperDoubleSample dataDouble
- ZISweeperDemodSample dataDemod
- ZISweeperImpedanceSample dataImpedance
- union ZISweeperWave::@2 data
  Sweeper data vector.

8.3.39. struct ZITreeChangeData

The struct is holding info about added or removed nodes.

```
#include "ziAPI.h"
```

```
typedef struct ZITreeChangeData {
  ZITimeStamp timeStamp;
  uint32_t action;
  char name[32];
} ZITreeChangeData;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the data was updated.

- uint32_t action

  field indicating which action occurred on the tree. A value of the ZITreeAction_enum.

- char name

  Name of the Path that has been added, removed or changed.

8.3.40. struct ZITrigSample

The structure used to hold data for a single counter sample.

```
#include "ziAPI.h"
```

```
typedef struct ZITrigSample {
  ZITimeStamp timeStamp;
  ZITimeStamp sampleTick;
  uint32_t trigger;
  uint32_t missedTriggers;
  uint32_t awgTrigger;
  uint32_t dio;
  uint32_t sequenceIndex;
} ZITrigSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the values have been measured.

- ZITimeStamp sampleTick

  The sample tick at which the values have been measured.

- uint32_t trigger

  Trigger bits.

- uint32_t missedTriggers

  Missed trigger bits.

- uint32_t awgTrigger

  AWG trigger values at the time of trigger.

- uint32_t dio

  Dio values at the time of trigger.

- uint32_t sequenceIndex

  AWG sequencer index at the time of trigger.

8.3.41. struct ZIVectorData

The structure used to hold vector data block. See the description of the structure members for details.

```
#include "ziAPI.h"

typedef struct ZIVectorData {
  ZITimeStamp timeStamp;
  uint32_t sequenceNumber;
  uint32_t blockNumber;
  uint64_t totalElements;
  uint64_t blockOffset;
  uint32_t blockElements;
  uint8_t flags;
  uint8_t elementType;
  uint8_t reserved0[2];
  uint32_t extraHeaderInfo;
  uint8_t reserved1[4];
  uint64_t reserved2[31];
  uint8_t dataUInt8[0];
  uint16_t dataUInt16[0];
  uint32_t dataUInt32[0];
  uint64_t dataUInt64[0];
  int8_t dataInt8[0];
  int16_t dataInt16[0];
  int32_t dataInt32[0];
  int64_t dataInt64[0];
  double dataDouble[0];
  float dataFloat[0];
  union ZIVectorData::@5 data;
} ZIVectorData;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp of this array data block.

- uint32_t sequenceNumber

  Current array transfer sequence number. Incremented for each new transfer. Stays same for all blocks of a single array transfer.

- uint32_t blockNumber

  Current block number from the beginning of an array transfer. Large array transfers are split into blocks, which need to be concatenated to obtain the complete array.

- uint64_t totalElements

  Total number of elements in the array.

- uint64_t blockOffset

  Offset of the current block first element from the beginning of the array.

- uint32_t blockElements

  Number of elements in the current block.

- uint8_t flags

Block marker: Bit (0): 1 = End marker for multi-block transfer
Bit (1): 1 = Transfer failure Bit (7..2): Reserved.

- uint8_t elementType

  Vector element type, see ZIVectorElementType_enum.

- uint8_t reserved0

- uint32_t extraHeaderInfo

  For internal use only.

- uint8_t reserved1

- uint64_t reserved2

- uint8_t dataUInt8

- uint16_t dataUInt16

- uint32_t dataUInt32

- uint64_t dataUInt64

- int8_t dataInt8

- int16_t dataInt16

- int32_t dataInt32

- int64_t dataInt64

- double dataDouble

- float dataFloat

- union ZIVectorData::@5 data

  First data element of the current block.

8.4. File Documentation

8.4.1. File ziAPI.h

Header File for the LabOne C/C++ API.

```
#include "wchar.h"
```

Data Structures

- struct ZIDoubleDataTS

  The structure used to hold a single IEEE double value. Same as ZIDoubleData, but with timestamp.

- struct ZIIntegerDataTS

  The structure used to hold a single 64bit signed integer value. Same as ZIIntegerData, but with timestamp.

- struct ZIComplexData

  The structure used to hold a complex double value.

- struct ZITreeChangeData

  The struct is holding info about added or removed nodes.

- struct TreeChange

  The structure used to hold info about added or removed nodes. This is the version without timestamp used in API v1 compatibility mode.

- struct ZIDemodSample

  The structure used to hold data for a single demodulator sample.

- struct ZIAuxInSample

  The structure used to hold data for a single auxiliary inputs sample.

- struct ZIDIOSample

  The structure used to hold data for a single digital I/O sample.

- struct ZIByteArray

  The structure used to hold an arbitrary array of bytes. This is the version without timestamp used in API Level 1 compatibility mode.

- struct ZIByteArrayTS

  The structure used to hold an arbitrary array of bytes. This is the same as ZIByteArray, but with timestamp.

- struct ZICntSample

  The structure used to hold data for a single counter sample.

- struct ZITrigSample

  The structure used to hold data for a single counter sample.

- struct ScopeWave

The structure used to hold a single scope shot (API Level 1). If the client is connected to the Data Server using API Level 4 (recommended if supported by your device class) please see ZIScopeWave instead (ZIScopeWaveEx for API Level 5 and above).

- struct ZIScopeWave

  The structure used to hold scope data (when using API Level 4). Note that ZIScopeWave does not contain the structure member channelOffset, whereas ZIScopeWaveEx does. The data may be formatted differently, depending on settings. See the description of the structure members for details.

- struct ZIScopeWaveEx

  The structure used to hold scope data (extended, when using API Level 5). Note that ZIScopeWaveEx contains the structure member channelOffset; ZIScopeWave does not. The data may be formatted differently, depending on settings. See the description of the structure members for details.

- struct ZIPWASample

  Single PWA sample value.

- struct ZIPWAWave

  PWA Wave.

- struct ZIImpedanceSample

  The structure used to hold data for a single impedance sample.

- struct ZIStatisticSample

- struct ZISweeperDoubleSample

- struct ZISweeperDemodSample

- struct ZISweeperImpedanceSample

- struct ZISweeperHeader

- struct ZISweeperWave

- struct ZISpectrumDemodSample

- struct ZISpectrumHeader

- struct ZISpectrumWave

- struct ZIAdvisorSample
- struct ZIAdvisorHeader
- struct ZIAdvisorWave
- struct ZIVectorData

  The structure used to hold vector data block. See the description of the structure members for details.
- struct ZIAsyncReply
- struct ZIEvent

  This struct holds event data forwarded by the Data Server.
- struct ZIChunkHeader

  Structure to hold generic chunk data header information.
- struct ZIModuleEvent

  This struct holds data of a single chunk from module lookup.
- struct DemodSample

  The DemodSample struct holds data for the ZI_DATA_DEMODSAMPLE data type. Deprecated: See ZIDemodSample.
- struct AuxInSample

  The AuxInSample struct holds data for the ZI_DATA_AUXINSAMPLE data type. Deprecated: See ZIAuxInSample.
- struct DIOSample

  The DIOSample struct holds data for the ZI_DATA_DIOSAMPLE data type. Deprecated: See ZIDIOSample.
- struct ByteArrayData

  The ByteArrayData struct holds data for the ZI_DATA_BYTEARRAY data type. Deprecated: See ZIByteArray.
- struct ziEvent

  This struct holds event data forwarded by the Data Server. Deprecated: See ZIEvent.
- union ziEvent::Val

Defines

- #define MAX_PATH_LEN 256

The maximum length that has to be used for passing paths to functions (including terminating zero)

- #define MAX_EVENT_SIZE 0x400000

  The maximum size of an event's data block.

- #define MAX_NAME_LEN 32

  The maximum length of the node name (in tree change event)

Typedefs

- typedef ZIModuleHandle

  A handle with which to reference an instance of a ziCore Module created with ziAPIModCreate.

- typedef ZIConnection

  The ZIConnection is a connection reference; it holds information and helper variables about a connection to the Data Server. There is nothing in this reference which the user user may use, so it is hidden and instead a dummy pointer is used. See ziAPIInit for how to create a ZIConnection.

- typedef ZIModuleEventPtr

  The pointer to a Module's data chunk to read out, updated via ziAPIModGetChunk.

Enumerations

- enum ZIResult_enum { ZI_INFO_BASE, ZI_INFO_SUCCESS, ZI_INFO_MAX, ZI_WARNING_BASE, ZI_WARNING_GENERAL, ZI_WARNING_UNDERRUN, ZI_WARNING_OVERFLOW, ZI_WARNING_NOTFOUND, ZI_WARNING_NO_ASYNC, ZI_WARNING_MAX, ZI_ERROR_BASE, ZI_ERROR_GENERAL, ZI_ERROR_USB, ZI_ERROR_MALLOC, ZI_ERROR_MUTEX_INIT, ZI_ERROR_MUTEX_DESTROY, ZI_ERROR_MUTEX_LOCK, ZI_ERROR_MUTEX_UNLOCK, ZI_ERROR_THREAD_START, ZI_ERROR_THREAD_JOIN, ZI_ERROR_SOCKET_INIT, ZI_ERROR_SOCKET_CONNECT, ZI_ERROR_HOSTNAME, ZI_ERROR_CONNECTION, ZI_ERROR_TIMEOUT, ZI_ERROR_COMMAND, ZI_ERROR_SERVER_INTERNAL, ZI_ERROR_LENGTH, ZI_ERROR_FILE, ZI_ERROR_DUPLICATE, ZI_ERROR_READONLY, ZI_ERROR_DEVICE_NOT_VISIBLE, ZI_ERROR_DEVICE_IN_USE, ZI_ERROR_DEVICE_INTERFACE, ZI_ERROR_DEVICE_CONNECTION_TIMEOUT, ZI_ERROR_DEVICE_DIFFERENT_INTERFACE, ZI_ERROR_DEVICE_NEEDS_FW_UPGRADE, ZI_ERROR_ZIEVENT_DATATYPE_MISMATCH, ZI_ERROR_DEVICE_NOT_FOUND, ZI_ERROR_NOT_SUPPORTED, ZI_ERROR_TOO_MANY_CONNECTIONS, ZI_ERROR_NOT_ON_HF2, ZI_ERROR_COM_NACK_BASE, ZI_ERROR_COM_NACK_NO_ERROR, ZI_ERROR_COM_NACK_INVALID_AP_ADDRESS, ZI_ERROR_COM_NACK_INVALID_AP_OFFSET,

ZI_ERROR_COM_NACK_INVALID_AP_LENGTH,
ZI_ERROR_COM_NACK_READONLY_AP,
ZI_ERROR_COM_NACK_NOT_SERVED_AP,
ZI_ERROR_COM_NACK_NOT_INDEXED_AP,
ZI_ERROR_COM_NACK_INVALID_VECT_LEN,
ZI_ERROR_COM_NACK_INVALID_VECT_FRAME,
ZI_ERROR_COM_NACK_INVALID_VECT_OFFSET,
ZI_ERROR_COM_NACK_INVALID_VECT_EXTRA,
ZI_ERROR_COM_NACK_INVALID_VECT_SEQUENCE,
ZI_ERROR_COM_NACK_INVALID_VECT_IDX_OFFSET,
ZI_ERROR_COM_NACK_INVALID_VECT_TYPE,
ZI_ERROR_COM_NACK_INVALID_VECT_DATA_LEN,
ZI_ERROR_COM_NACK_INVALID_VECT_EXTRA_LEN,
ZI_ERROR_COM_NACK_TIMEOUT,
ZI_ERROR_COM_NACK_RESOURCE_INACTIVE,
ZI_ERROR_COM_NACK_RESOURCE_BUSY,
ZI_ERROR_COM_NACK_EXECUTION_ERROR,
ZI_ERROR_COM_NACK_VECTOR_QUEUE_FULL,
ZI_ERROR_COM_NACK_INTERNAL_BASE,
ZI_ERROR_COM_NACK_INTERNAL_NO_PAYLOAD,
ZI_ERROR_COM_NACK_INTERNAL_TOO_MANY_PENDING,
ZI_ERROR_MAX }

Defines return value for all ziAPI functions. Divided into 3 regions: info, warning and error.

- enum ZIValueType_enum { ZI_VALUE_TYPE_NONE,
ZI_VALUE_TYPE_DOUBLE_DATA,
ZI_VALUE_TYPE_INTEGER_DATA,
ZI_VALUE_TYPE_DEMOD_SAMPLE,
ZI_VALUE_TYPE_SCOPE_WAVE_OLD,
ZI_VALUE_TYPE_AUXIN_SAMPLE,
ZI_VALUE_TYPE_DIO_SAMPLE,
ZI_VALUE_TYPE_BYTE_ARRAY, ZI_VALUE_TYPE_PWA_WAVE,
ZI_VALUE_TYPE_TREE_CHANGE_DATA_OLD,
ZI_VALUE_TYPE_DOUBLE_DATA_TS,
ZI_VALUE_TYPE_INTEGER_DATA_TS,
ZI_VALUE_TYPE_COMPLEX_DATA,
ZI_VALUE_TYPE_SCOPE_WAVE,
ZI_VALUE_TYPE_SCOPE_WAVE_EX,
ZI_VALUE_TYPE_BYTE_ARRAY_TS,
ZI_VALUE_TYPE_CNT_SAMPLE,
ZI_VALUE_TYPE_TRIG_SAMPLE,
ZI_VALUE_TYPE_TREE_CHANGE_DATA,
ZI_VALUE_TYPE_ASYNC_REPLY,
ZI_VALUE_TYPE_SWEEPER_WAVE,
ZI_VALUE_TYPE_SPECTRUM_WAVE,
ZI_VALUE_TYPE_ADVISOR_WAVE,
ZI_VALUE_TYPE_VECTOR_DATA,
ZI_VALUE_TYPE_IMPEDANCE_SAMPLE }

  Enumerates all types that data in a ZIEvent may have.

- enum ZITreeAction_enum { ZI_TREE_ACTION_REMOVE,
ZI_TREE_ACTION_ADD, ZI_TREE_ACTION_CHANGE }

  Defines the actions that are performed on a tree, as returned in the ZITreeChangeData::action or ZITreeChangeDataOld::action.

- enum ZIScopeSampleFormat_enum
{ ZI_SCOPE_SAMPLE_FORMAT_INT16,
ZI_SCOPE_SAMPLE_FORMAT_INT32,
ZI_SCOPE_SAMPLE_FORMAT_FLOAT,
ZI_SCOPE_SAMPLE_FORMAT_INT16_INTERLEAVED,
ZI_SCOPE_SAMPLE_FORMAT_INT32_INTERLEAVED,
ZI_SCOPE_SAMPLE_FORMAT_FLOAT_INTERLEAVED }

  Defines the data format of scope samples:

- enum ZIScopeSampleFormatMask_enum
{ ZI_SCOPE_SAMPLE_FORMAT_MASK_DATA_TYPE,
ZI_SCOPE_SAMPLE_FORMAT_MASK_INTERLEAVED }

  Helper enum to enable testing certain properties of the scope sample format.

- enum ZIImpFlags_enum { ZI_IMP_FLAGS_NONE,
ZI_IMP_FLAGS_VALID_INTERNAL,
ZI_IMP_FLAGS_VALID_USER,
ZI_IMP_FLAGS_AUTORANGE_GATING,
ZI_IMP_FLAGS_OVERFLOW_VOLTAGE,
ZI_IMP_FLAGS_OVERFLOW_CURRENT,
ZI_IMP_FLAGS_UNDERFLOW_VOLTAGE,
ZI_IMP_FLAGS_UNDERFLOW_CURRENT,
ZI_IMP_FLAGS_FREQ_EXACT,
ZI_IMP_FLAGS_FREQ_INTERPOLATION,
ZI_IMP_FLAGS_FREQ_EXTRAPOLATION,
ZI_IMP_FLAGS_LOWDUT2T,
ZI_IMP_FLAGS_SUPPRESSION_PARAM0,
ZI_IMP_FLAGS_SUPPRESSION_PARAM1,
ZI_IMP_FLAGS_FREQLIMIT_RANGE_VOLTAGE,
ZI_IMP_FLAGS_FREQLIMIT_RANGE_CURRENT,
ZI_IMP_FLAGS_STRONGCOMPENSATION_PARAM0,
ZI_IMP_FLAGS_STRONGCOMPENSATION_PARAM1,
ZI_IMP_FLAGS_NEGATIVE_QFACTOR,
ZI_IMP_FLAGS_ONE_PERIOD,
ZI_IMP_FLAGS_ONE_PERIOD_INVALID,
ZI_IMP_FLAGS_BWC_BIT1, ZI_IMP_FLAGS_BWC_BIT2,
ZI_IMP_FLAGS_BWC_BIT3, ZI_IMP_FLAGS_BWC_MASK,
ZI_IMP_FLAGS_OPEN_DETECTION,
ZI_IMP_FLAGS_OVERFLOW_SIGIN0,
ZI_IMP_FLAGS_OVERFLOW_SIGIN1,
ZI_IMP_FLAGS_MODEL_MASK }

  Enumerates the bits set in an ZIImpedanceSample's flags.

- enum ZIVectorElementType_enum
{ ZI_VECTOR_ELEMENT_TYPE_UINT8,
ZI_VECTOR_ELEMENT_TYPE_UINT16,
ZI_VECTOR_ELEMENT_TYPE_UINT32,
ZI_VECTOR_ELEMENT_TYPE_UINT64,
ZI_VECTOR_ELEMENT_TYPE_FLOAT,
ZI_VECTOR_ELEMENT_TYPE_DOUBLE,
ZI_VECTOR_ELEMENT_TYPE_ASCIIZ,
ZI_VECTOR_ELEMENT_TYPE_COMPLEX_FLOAT,
ZI_VECTOR_ELEMENT_TYPE_COMPLEX_DOUBLE }

  Enumerates all the types that a ZIVectorData::elementType may have.

- enum ZIAPIVersion_enum { ZI_API_VERSION_0, ZI_API_VERSION_1, ZI_API_VERSION_4, ZI_API_VERSION_5, ZI_API_VERSION_6, ZI_API_VERSION_MAX }

- enum ZIListNodes_enum { ZI_LIST_NODES_ALL, ZI_LIST_NODES_RECURSIVE, ZI_LIST_NODES_ABSOLUTE, ZI_LIST_NODES_LEAVESONLY, ZI_LIST_NODES_SETTINGSONLY, ZI_LIST_NODES_STREAMINGONLY, ZI_LIST_NODES_SUBSCRIBEDONLY, ZI_LIST_NODES_BASECHANNEL, ZI_LIST_NODES_GETONLY, ZI_LIST_NODES_EXCLUDESTREAMING, ZI_LIST_NODES_EXCLUDEVECTORS }

  Defines the values of the flags used in ziAPIListNodes.

- enum ZIChunkHeaderFlags_enum { ZI_CHUNK_HEADER_FLAG_FINISHED, ZI_CHUNK_HEADER_FLAG_ROLLMODE, ZI_CHUNK_HEADER_FLAG_DATALOSS, ZI_CHUNK_HEADER_FLAG_VALID, ZI_CHUNK_HEADER_FLAG_DATA, ZI_CHUNK_HEADER_FLAG_DISPLAY, ZI_CHUNK_HEADER_FLAG_FREQDOMAIN, ZI_CHUNK_HEADER_FLAG_SPECTRUM, ZI_CHUNK_HEADER_FLAG_OVERLAPPED, ZI_CHUNK_HEADER_FLAG_ROWFINISHED, ZI_CHUNK_HEADER_FLAG_ONGRIDSAMPLING, ZI_CHUNK_HEADER_FLAG_ROWREPETITION, ZI_CHUNK_HEADER_FLAG_PREVIEW }

  Defines the flags returned in the chunk header for all modules.

- enum ZIChunkHeaderModuleFlags_enum { ZI_CHUNK_HEADER_MODULE_FLAGS_WINDOW }

  Defines flags returned in the chunk header that only apply for certain modules.

- enum ZIAnnotationFlags_enum { ZI_ANNOTATION_SHOW_X, ZI_ANNOTATION_SHOW_Y, ZI_ANNOTATION_SHOW_GRID, ZI_ANNOTATION_SHOW_LABEL }

- enum TREE_ACTION { TREE_ACTION_REMOVE, TREE_ACTION_ADD, TREE_ACTION_CHANGE }

  TREE_ACTION defines the values for the TreeChange::Action Variable.

Functions

- ZIResult_enum ziAPIInit (ZIConnection* conn)

  Initializes a ZIConnection structure.

- ZIResult_enum ziAPIDestroy (ZIConnection conn)

  Destroys a ZIConnection structure.

- ZIResult_enum ziAPIConnect (ZIConnection conn, const char* hostname, uint16_t port)

  Connects the ZIConnection to Data Server.

- ZIResult_enum ziAPIDisconnect (ZIConnection conn)

  Disconnects an established connection.

- ZIResult_enum ziAPIListImplementations (char* implementations, uint32_t bufferSize)

  Returns the list of supported implementations.

- ZIResult_enum ziAPIConnectEx (ZIConnection conn, const char* hostname, uint16_t port, ZIAPIVersion_enum apiLevel, const char* implementation)

  Connects to Data Server and enables extended ziAPI.

- ZIResult_enum ziAPIGetConnectionAPILevel (ZIConnection conn, ZIAPIVersion_enum* apiLevel)

  Returns ziAPI level used for the connection conn.

- ZIResult_enum ziAPIGetVersion (const char** version)

  Retrieves the release version of ziAPI.

- ZIResult_enum ziAPIGetCommitHash (const char** commitHash)

  Retrieves the exact commit hash key of ziAPI.

- ZIResult_enum ziAPIGetRevision (uint32_t* revision)

  Retrieves the version and build number of ziAPI.

- ZIResult_enum ziAPIListNodes (ZIConnection conn, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

  Returns all child nodes found at the specified path.

- ZIResult_enum ziAPIListNodesJSON (ZIConnection conn, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

  Returns all child nodes found at the specified path.

- ZIResult_enum ziAPIUpdateDevices (ZIConnection conn)

  Search for the newly connected devices and update the tree.

- ZIResult_enum ziAPIConnectDevice (ZIConnection conn, const char* deviceSerial, const char* deviceInterface, const char* interfaceParams)

  Connect a device to the server.

- ZIResult_enum ziAPIDisconnectDevice (ZIConnection conn, const char* deviceSerial)

  Disconnect a device from the server.

- ZIResult_enum ziAPIGetValueD (ZIConnection conn, const char* path, ZIDoubleData* value)

  gets the double-type value of the specified node

- ZIResult_enum ziAPIGetComplexData (ZIConnection conn, const char* path, ZIDoubleData* real, ZIDoubleData* imag)

  gets the complex double-type value of the specified node

- ZIResult_enum ziAPIGetValueI (ZIConnection conn, const char* path, ZIIntegerData* value)

  gets the integer-type value of the specified node

- ZIResult_enum ziAPIGetDemodSample (ZIConnection conn, const char* path, ZIDemodSample* value)

  Gets the demodulator sample value of the specified node.

- ZIResult_enum ziAPIGetDIOSample (ZIConnection conn, const char* path, ZIDIOSample* value)

  Gets the Digital I/O sample of the specified node.

- ZIResult_enum ziAPIGetAuxInSample (ZIConnection conn, const char* path, ZIAuxInSample* value)

  gets the AuxIn sample of the specified node

- ZIResult_enum ziAPIGetValueB (ZIConnection conn, const char* path, unsigned char* buffer, unsigned int* length, unsigned int bufferSize)

  gets the Bytearray value of the specified node

- ZIResult_enum ziAPIGetValueString (ZIConnection conn, const char* path, char* buffer, unsigned int* length, unsigned int bufferSize)

  gets a null-terminated string value of the specified node

- ZIResult_enum ziAPIGetValueStringUnicode (ZIConnection conn, const char* path, wchar_t* wbuffer, unsigned int* length, unsigned int bufferSize)

  gets a null-terminated string value of the specified node

- ZIResult_enum ziAPISetValueD (ZIConnection conn, const char* path, ZIDoubleData value)

  asynchronously sets a double-type value to one or more nodes specified in the path

- ZIResult_enum ziAPISetComplexData (ZIConnection conn, const char* path, ZIDoubleData real, ZIDoubleData imag)

  asynchronously sets a double-type complex value to one or more nodes specified in the path

- ZIResult_enum ziAPISetValueI (ZIConnection conn, const char* path, ZIIntegerData value)

  asynchronously sets an integer-type value to one or more nodes specified in a path

- ZIResult_enum ziAPISetValueB (ZIConnection conn, const char* path, unsigned char* buffer, unsigned int length)

  asynchronously sets the binary-type value of one or more nodes specified in the path

- ZIResult_enum ziAPISetValueString (ZIConnection conn, const char* path, const char* str)

  asynchronously sets a string value of one or more nodes specified in the path

- ZIResult_enum ziAPISetValueStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

  asynchronously sets a unicode encoded string value of one or more nodes specified in the path

- ZIResult_enum ziAPISyncSetValueD (ZIConnection conn, const char* path, ZIDoubleData* value)

  synchronously sets a double-type value to one or more nodes specified in the path

- ZIResult_enum ziAPISyncSetValueI (ZIConnection conn, const char* path, ZIIntegerData* value)

  synchronously sets an integer-type value to one or more nodes specified in a path

- ZIResult_enum ziAPISyncSetValueB (ZIConnection conn, const char* path, uint8_t* buffer, uint32_t* length, uint32_t bufferSize)

  Synchronously sets the binary-type value of one ore more nodes specified in the path.

- ZIResult_enum ziAPISyncSetValueString (ZIConnection conn, const char* path, const char* str)

  Synchronously sets a string value of one or more nodes specified in the path.

- ZIResult_enum ziAPISyncSetValueStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

  Synchronously sets a unicode string value of one or more nodes specified in the path.

- ZIResult_enum ziAPISync (ZIConnection conn)

  Synchronizes the session by dropping all pending data.

- ZIResult_enum ziAPIEchoDevice (ZIConnection conn, const char* deviceSerial)

  Sends an echo command to a device and blocks until answer is received.

- ZIEvent* ziAPIAllocateEventEx ( )

  Allocates ZIEvent structure and returns the pointer to it. Attention!!! It is the client code responsibility to deallocate the structure by calling ziAPIDeallocateEventEx!

- void ziAPIDeallocateEventEx (ZIEvent* ev)

  Deallocates ZIEvent structure created with ziAPIAllocateEventEx().

- ZIResult_enum ziAPISubscribe (ZIConnection conn, const char* path)

subscribes the nodes given by path for ziAPIPollDataEx

- ZIResult_enum ziAPIUnSubscribe (ZIConnection conn, const char* path)

  unsubscribes to the nodes given by path

- ZIResult_enum ziAPIPollDataEx (ZIConnection conn, ZIEvent* ev, uint32_t timeOutMilliseconds)

  checks if an event is available to read

- ZIResult_enum ziAPIGetValueAsPollData (ZIConnection conn, const char* path)

  triggers a value request, which will be given back on the poll event queue

- ZIResult_enum ziAPIAsyncSetDoubleData (ZIConnection conn, const char* path, ZIDoubleData value)

- ZIResult_enum ziAPIAsyncSetIntegerData (ZIConnection conn, const char* path, ZIIntegerData value)

- ZIResult_enum ziAPIAsyncSetByteArray (ZIConnection conn, const char* path, uint8_t* buffer, uint32_t length)

- ZIResult_enum ziAPIAsyncSetString (ZIConnection conn, const char* path, const char* str)

- ZIResult_enum ziAPIAsyncSetStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

- ZIResult_enum ziAPIAsyncSubscribe (ZIConnection conn, const char* path, ZIAsyncTag tag)

- ZIResult_enum ziAPIAsyncUnSubscribe (ZIConnection conn, const char* path, ZIAsyncTag tag)

- ZIResult_enum ziAPIAsyncGetValueAsPollData (ZIConnection conn, const char* path, ZIAsyncTag tag)

- ZIResult_enum ziAPIGetError (ZIResult_enum result, char** buffer, int* base)

  Returns a description and the severity for a ZIResult_enum.

- ZIResult_enum ziAPIGetLastError (ZIConnection conn, char* buffer, uint32_t bufferSize)

  Returns the message from the last error that occurred.

- void ziAPISetDebugLevel (int32_t debugLevel)

Enable ziAPI's log and set the severity level of entries to be included in the log.

- void ziAPIWriteDebugLog (int32_t debugLevel, const char* message)

  Write a message to ziAPI's log with the specified severity.

- ZIResult_enum ReadMEMFile (const char* filename, char* buffer, int32_t bufferSize, int32_t* bytesUsed)

- ZIResult_enum ziAPIModCreate (ZIConnection conn, ZIModuleHandle* handle, const char* moduleId)

  Create a ZIModuleHandle that can be used for asynchronous measurement tasks.

- ZIResult_enum ziAPIModSetDoubleData (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIDoubleData value)

  Sets a module parameter to the specified double type.

- ZIResult_enum ziAPIModSetIntegerData (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIIntegerData value)

  Sets a module parameter to the specified integer type.

- ZIResult_enum ziAPIModSetByteArray (ZIConnection conn, ZIModuleHandle handle, const char* path, uint8_t* buffer, uint32_t length)

  Sets a module parameter to the specified byte array.

- ZIResult_enum ziAPIModSetString (ZIConnection conn, ZIModuleHandle handle, const char* path, const char* str)

  Sets a module parameter to the specified null-terminated string.

- ZIResult_enum ziAPIModSetStringUnicode (ZIConnection conn, ZIModuleHandle handle, const char* path, const wchar_t* wstr)

  Sets a module parameter to the specified null-terminated unicode string.

- ZIResult_enum ziAPIModSetVector (ZIConnection conn, ZIModuleHandle handle, const char* path, const void* vectorPtr, ZIVectorElementType_enum elementType, unsigned int numElements)

  Sets a module parameter to the specified vector.

- ZIResult_enum ziAPIModGetInteger (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIIntegerData* value)

  Gets the integer-type value of the specified module parameter path.

- ZIResult_enum ziAPIModGetDouble (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIDoubleData* value)

Gets the double-type value of the specified module parameter path.

- ZIResult_enum ziAPIModGetString (ZIConnection conn, ZIModuleHandle handle, const char* path, char* buffer, unsigned int* length, unsigned int bufferSize)

  gets the null-terminated string value of the specified module parameter path

- ZIResult_enum ziAPIModGetStringUnicode (ZIConnection conn, ZIModuleHandle handle, const char* path, wchar_t* wbuffer, unsigned int* length, unsigned int bufferSize)

  Gets the null-terminated string value of the specified module parameter path.

- ZIResult_enum ziAPIModGetVector (ZIConnection conn, ZIModuleHandle handle, const char* path, void* buffer, unsigned int* bufferSize, ZIVectorElementType_enum* elementType, unsigned int* numElements)

  Gets the vector stored at the specified module parameter path.

- ZIResult_enum ziAPIModListNodes (ZIConnection conn, ZIModuleHandle handle, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

  Returns all child parameter node paths found under the specified parent module parameter path.

- ZIResult_enum ziAPIModListNodesJSON (ZIConnection conn, ZIModuleHandle handle, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

  Returns all child parameter node paths found under the specified parent module parameter path.

- ZIResult_enum ziAPIModSubscribe (ZIConnection conn, ZIModuleHandle handle, const char* path)

  Subscribes to the nodes specified by path, these nodes will be recorded during module execution.

- ZIResult_enum ziAPIModUnSubscribe (ZIConnection conn, ZIModuleHandle handle, const char* path)

  Unsubscribes to the nodes specified by path.

- ZIResult_enum ziAPIModExecute (ZIConnection conn, ZIModuleHandle handle)

  Starts the module's thread and its associated measurement task.

- ZIResult_enum ziAPIModTrigger (ZIConnection conn, ZIModuleHandle handle)

  Manually issue a trigger forcing data recording (SW Trigger Module only).

- ZIResult_enum ziAPIModProgress (ZIConnection conn, ZIModuleHandle handle, ZIDoubleData* progress)

Queries the current state of progress of the module's measurement task.

- ZIResult_enum ziAPIModFinished (ZIConnection conn, ZIModuleHandle handle, ZIIntegerData* finished)

  Queries whether the module has finished its measurement task.

- ZIResult_enum ziAPIModFinish (ZIConnection conn, ZIModuleHandle handle)

  Stops the module performing its measurement task.

- ZIResult_enum ziAPIModSave (ZIConnection conn, ZIModuleHandle handle, const char* fileName)

  Saves the currently accumulated data to file.

- ZIResult_enum ziAPIModRead (ZIConnection conn, ZIModuleHandle handle, const char* path)

  Make the currently accumulated data available for use in the C program.

- ZIResult_enum ziAPIModNextNode (ZIConnection conn, ZIModuleHandle handle, char* path, uint32_t bufferSize, ZIValueType_enum* valueType, uint64_t* chunks)

  Make the data for the next node available for reading with ziAPIModGetChunk.

- ZIResult_enum ziAPIModGetChunk (ZIConnection conn, ZIModuleHandle handle, uint64_t chunkIndex, ZIModuleEventPtr* ev)

  Get the specified data chunk from the current node.

- ZIResult_enum ziAPIModEventDeallocate (ZIConnection conn, ZIModuleHandle handle, ZIModuleEventPtr ev)

  Deallocate the ZIModuleEventPtr being used by the module.

- ZIResult_enum ziAPIModClear (ZIConnection conn, ZIModuleHandle handle)

  Terminates the module's thread and destroys the module.

- ZIResult_enum ziAPISetVector (ZIConnection conn, const char* path, const void* vectorPtr, uint8_t vectorElementType, uint64_t vectorSizeElements)

  vectorElementType - see ZIVectorElementType_enum

- ZIResult_enum ziAPIDiscoveryFindAll (ZIConnection conn, char* deviceIds, uint32_t bufferSize)

- ZIResult_enum ziAPIDiscoveryFind (ZIConnection conn, const char* deviceAddress, const char** deviceId)

- ZIResult_enum ziAPIDiscoveryGet (ZIConnection conn, const char* deviceId, const char** propsJSON)

- ZIResult_enum ziAPIDiscoveryGetValueI (ZIConnection conn, const char* deviceId, const char* propName, ZIIntegerData* value)

- ZIResult_enum ziAPIDiscoveryGetValueS (ZIConnection conn, const char* deviceId, const char* propName, const char** value)

- __inline ziEvent* ziAPIAllocateEvent ( )

  Deprecated: See ziAPIAllocateEventEx().

- __inline void ziAPIDeallocateEvent (ziEvent* ev)

  Deprecated: See ziAPIDeallocateEventEx().

- __inline ZIResult_enum ziAPIPollData (ZIConnection conn, ziEvent* ev, int timeOut)

  Checks if an event is available to read. Deprecated: See ziAPIPollDataEx().

- __inline ZIResult_enum ziAPIGetValueS (ZIConnection conn, char* path, DemodSample* value)

- __inline ZIResult_enum ziAPIGetValueDIO (ZIConnection conn, char* path, DIOSample* value)

- __inline ZIResult_enum ziAPIGetValueAuxIn (ZIConnection conn, char* path, AuxInSample* value)

- double ziAPISecondsTimeStamp (ziTimeStampType TS)

Detailed Description

ziAPI provides all functionality to establish a connection with the Data Server and to communicate with it. It has functions for setting and getting parameters in a single call as well as an event-framework with which the user may subscribe the parameter tree and receive the events which occur when values change.

- All functions do not check passed pointers if they're NULL pointers. In that case a segmentation fault will occur.
- The ZIConnection is not thread-safe. One connection can only be used in one thread. If you want to use the ziAPI in a multi-threaded program you will have to use one ZIConnection for each thread that is communicating or implement a mutual exclusion.
- The Data Server is able to handle connections from threads simultaneously. The Data Server takes over the synchronization.

Data Structure Documentation

struct ZIDoubleDataTS

The structure used to hold a single IEEE double value. Same as ZIDoubleData, but with timestamp.

```
#include "ziAPI.h"
```

```
typedef struct ZIDoubleDataTS {
  ZITimeStamp timeStamp;
  ZIDoubleData value;
} ZIDoubleDataTS;
```

Data Fields

- ZITimeStamp timeStamp
  Time stamp at which the value has changed.
- ZIDoubleData value

struct ZIIntegerDataTS

The structure used to hold a single 64bit signed integer value. Same as ZIIntegerData, but with timestamp.

```
#include "ziAPI.h"
```

```
typedef struct ZIIntegerDataTS {
  ZITimeStamp timeStamp;
  ZIIntegerData value;
} ZIIntegerDataTS;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the value has changed.

- ZIIntegerData value

struct ZIComplexData

The structure used to hold a complex double value.

```
#include "ziAPI.h"
```

```
typedef struct ZIComplexData {
  ZITimeStamp timeStamp;
  ZIDoubleData real;
  ZIDoubleData imag;
} ZIComplexData;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the value has changed.

- ZIDoubleData real

- ZIDoubleData imag

struct ZITreeChangeData

The struct is holding info about added or removed nodes.

```
#include "ziAPI.h"
```

```
typedef struct ZITreeChangeData {
  ZITimeStamp timeStamp;
  uint32_t action;
  char name[32];
} ZITreeChangeData;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the data was updated.

- uint32_t action

  field indicating which action occurred on the tree. A value of the ZITreeAction_enum.

- char name

  Name of the Path that has been added, removed or changed.

struct TreeChange

The structure used to hold info about added or removed nodes. This is the version without timestamp used in API v1 compatibility mode.

```
#include "ziAPI.h"
```

```
typedef struct TreeChange {
  uint32_t Action;
  char Name[32];
} TreeChange;
```

Data Fields

- uint32_t Action

  field indicating which action occurred on the tree. A value of the ZITreeAction_enum (TREE_ACTION) enum.

- char Name

  Name of the Path that has been added, removed or changed.

struct ZIDemodSample

The structure used to hold data for a single demodulator sample.

```
#include "ziAPI.h"
```

```
typedef struct ZIDemodSample {
  ZITimeStamp timeStamp;
  double x;
  double y;
  double frequency;
  double phase;
  uint32_t dioBits;
  uint32_t trigger;
  double auxIn0;
  double auxIn1;
} ZIDemodSample;
```

Data Fields

- ZITimeStamp timeStamp
  The timestamp at which the sample has been measured.
- double x
  X part of the sample.
- double y
  Y part of the sample.
- double frequency
  oscillator frequency at that sample.
- double phase
  oscillator phase at that sample.
- uint32_t dioBits
  the current bits of the DIO.
- uint32_t trigger
  trigger bits
- double auxIn0
  value of Aux input 0.
- double auxIn1
  value of Aux input 1.

struct ZIAuxInSample

The structure used to hold data for a single auxiliary inputs sample.

```
#include "ziAPI.h"
```

```
typedef struct ZIAuxInSample {
  ZITimeStamp timeStamp;
  double ch0;
  double ch1;
} ZIAuxInSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the values have been measured.

- double ch0

  Channel 0 voltage.

- double ch1

  Channel 1 voltage.

struct ZIDIOSample

The structure used to hold data for a single digital I/O sample.

```
#include "ziAPI.h"
```

```
typedef struct ZIDIOSample {
  ZITimeStamp timeStamp;
  uint32_t bits;
  uint32_t reserved;
} ZIDIOSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the values have been measured.

- uint32_t bits

  The digital I/O values.

- uint32_t reserved

  Filler to keep 8 bytes alignment in the array of ZIDIOSample structures.

struct ZIByteArray

The structure used to hold an arbitrary array of bytes. This is the version without timestamp used in API Level 1 compatibility mode.

```
#include "ziAPI.h"
```

```
typedef struct ZIByteArray {
  uint32_t length;
  uint8_t bytes[0];
} ZIByteArray;
```

Data Fields

- uint32_t length

  Length of the data readable from the Bytes field.

- uint8_t bytes

  The data itself. The array has the size given in length.

struct ZIByteArrayTS

The structure used to hold an arbitrary array of bytes. This is the same as ZIByteArray, but with timestamp.

```
#include "ziAPI.h"
```

```
typedef struct ZIByteArrayTS {
  ZITimeStamp timeStamp;
  uint32_t length;
  uint8_t bytes[0];
} ZIByteArrayTS;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the data was updated.

- uint32_t length

  length of the data readable from the bytes field

- uint8_t bytes

  the data itself. The array has the size given in length

struct ZICntSample

The structure used to hold data for a single counter sample.

```
#include "ziAPI.h"
```

```
typedef struct ZICntSample {
  ZITimeStamp timeStamp;
  int32_t counter;
  uint32_t trigger;
} ZICntSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the values have been measured.

- int32_t counter

  Counter value.

- uint32_t trigger

  Trigger bits.

struct ZITrigSample

The structure used to hold data for a single counter sample.

```
#include "ziAPI.h"
```

```
typedef struct ZITrigSample {
  ZITimeStamp timeStamp;
  ZITimeStamp sampleTick;
  uint32_t trigger;
  uint32_t missedTriggers;
  uint32_t awgTrigger;
  uint32_t dio;
  uint32_t sequenceIndex;
} ZITrigSample;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp at which the values have been measured.

- ZITimeStamp sampleTick

  The sample tick at which the values have been measured.

- uint32_t trigger

  Trigger bits.

- uint32_t missedTriggers

  Missed trigger bits.

- uint32_t awgTrigger

  AWG trigger values at the time of trigger.

- uint32_t dio

  Dio values at the time of trigger.

- uint32_t sequenceIndex

  AWG sequencer index at the time of trigger.

struct ScopeWave

The structure used to hold a single scope shot (API Level 1). If the client is connected to the Data Server using API Level 4 (recommended if supported by your device class) please see ZIScopeWave instead (ZIScopeWaveEx for API Level 5 and above).

```
#include "ziAPI.h"
```

```
typedef struct ScopeWave {
  double dt;
  uint32_t ScopeChannel;
  uint32_t TriggerChannel;
  uint32_t BWLimit;
  uint32_t Count;
  int16_t Data[0];
} ScopeWave;
```

Data Fields

- double dt

  Time difference between samples.

- uint32_t ScopeChannel

  Scope channel of the represented data.

- uint32_t TriggerChannel

  Trigger channel of the represented data.

- uint32_t BWLimit

  Bandwidth-limit flag.

- uint32_t Count

  Count of samples.

- int16_t Data

  First wave data.

struct ZIScopeWave

The structure used to hold scope data (when using API Level 4). Note that ZIScopeWave does not contain the structure member channelOffset, whereas ZIScopeWaveEx does. The data may be formatted differently, depending on settings. See the description of the structure members for details.

```
#include "ziAPI.h"
```

```
typedef struct ZIScopeWave {
  ZITimeStamp timeStamp;
  ZITimeStamp triggerTimeStamp;
  double dt;
  uint8_t channelEnable[4];
  uint8_t channelInput[4];
  uint8_t triggerEnable;
  uint8_t triggerInput;
  uint8_t reserved0[2];
  uint8_t channelBWLimit[4];
  uint8_t channelMath[4];
  float channelScaling[4];
  uint32_t sequenceNumber;
  uint32_t segmentNumber;
  uint32_t blockNumber;
  uint64_t totalSamples;
  uint8_t dataTransferMode;
  uint8_t blockMarker;
  uint8_t flags;
  uint8_t sampleFormat;
  uint32_t sampleCount;
  int16_t dataInt16[0];
  int32_t dataInt32[0];
  float dataFloat[0];
  union ZIScopeWave::@0 data;
} ZIScopeWave;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp of the last sample in this data block.

- ZITimeStamp triggerTimeStamp

  The timestamp of the trigger (may also fall between samples and in another block)

- double dt

  Time difference between samples in seconds.

- uint8_t channelEnable

  Up to four channels: if channel is enabled, corresponding element is non-zero.

- uint8_t channelInput

  Specifies the input source for each of the scope four channels.

  Value of channelInput and corresponding input source:

  - 0 = Signal Input 1,
  - 1 = Signal Input 2,
  - 2 = Trigger Input 1,

  - 3 = Trigger Input 2,
  - 4 = Aux Output 1,
  - 5 = Aux Output 2,
  - 6 = Aux Output 3,
  - 7 = Aux Output 4,
  - 8 = Aux Input 1,
  - 9 = Aux Input 2.
- uint8_t triggerEnable

  Non-zero if trigger is enabled:

  Bit encoded:
  - Bit (0): 1 = Trigger on rising edge,
  - Bit (1): 1 = Trigger on falling edge.
- uint8_t triggerInput

  Trigger source (same values as for channel input)
- uint8_t reserved0
- uint8_t channelBWLimit

  Bandwidth-limit flag, per channel.

  Bit encoded:
  - Bit (0): 1 = Enable bandwidth limiting.
  - Bit (7...1): Reserved
- uint8_t channelMath

  Enable/disable math operations such as averaging or FFT.

  Bit encoded:
  - Bit(0): 1 = Perform averaging,
  - Bit(1): 1 = Perform FFT,
  - Bit(7...2): Reserved
- float channelScaling

  Data scaling factors for up to 4 channels.
- uint32_t sequenceNumber

  Current scope shot sequence number. Identifies a scope shot.
- uint32_t segmentNumber

  Current segment number.
- uint32_t blockNumber

  Current block number from the beginning of a scope shot.
  Large scope shots are split into blocks, which need to be
  concatenated to obtain the complete scope shot.
- uint64_t totalSamples

Total number of samples in one channel in the current scope shot, same for all channels.

- uint8_t dataTransferMode

  Data transfer mode.

  Value and the corresponding data transfer mode:

  - 0 - SingleTransfer,
  - 1 - BlockTransfer,
  - 3 - ContinuousTransfer. Other values are reserved.

- uint8_t blockMarker

  Block marker:

  Bit encoded:

  - Bit (0): 1 = End marker for continuous or multi-block transfer,
  - Bit (7..0): Reserved.

- uint8_t flags

  Indicator Flags.

  Bit encoded:

  - Bit (0): 1 = Data loss detected (samples are 0),
  - Bit (1): 1 = Missed trigger,
  - Bit (2): 1 = Transfer failure (corrupted data).

- uint8_t sampleFormat

  Data format of samples:

  Value is one of ZIScopeSampleFormat_enum

- uint32_t sampleCount

  Number of samples in one channel in the current block, same for all channels.

- int16_t dataInt16

  Wave data when sampleFormat==0 or sampleFormat==4.

- int32_t dataInt32

  Wave data when sampleFormat==1 or sampleFormat==5.

- float dataFloat

  Wave data when sampleFormat==2 or sampleFormat==6.

- union ZIScopeWave::@0 data

  Wave data, access via union member dataInt16, dataInt32 or dataFloat depending on sampleFormat. Indexing scheme also depends on sampleFormat.

  Example for interleaved int16 wave, 4096 samples, 2 channels:

  - data.dataInt16[0] - sample 0 of channel 0,

- data.dataInt16[1] - sample 0 of channel 1,
- data.dataInt16[2] - sample 1 of channel 0,
- data.dataInt16[3] - sample 1 of channel 1,
- ...
- data.dataInt16[8190] - sample 4095 of channel 0,
- data.dataInt16[8191] - sample 4095 of channel 1.

Example for non-interleaved int16 wave, 4096 samples, 2 channels:

- data.dataInt16[0] - sample 0 of channel 0,
- data.dataInt16[1] - sample 1 of channel 0,
- .. - ...
- data.dataInt16[4095] - sample 4095 of channel 0,
- data.dataInt16[4096] - sample 0 of channel 1,
- data.dataInt16[4097] - sample 1 of channel 1,
- ...
- data.dataInt16[8191] - sample 4095 of channel 1.

struct ZIScopeWaveEx

The structure used to hold scope data (extended, when using API Level 5). Note that ZIScopeWaveEx contains the structure member channelOffset; ZIScopeWave does not. The data may be formatted differently, depending on settings. See the description of the structure members for details.

```
#include "ziAPI.h"
```

```
typedef struct ZIScopeWaveEx {
  ZITimeStamp timeStamp;
  ZITimeStamp triggerTimeStamp;
  double dt;
  uint8_t channelEnable[4];
  uint8_t channelInput[4];
  uint8_t triggerEnable;
  uint8_t triggerInput;
  uint8_t reserved0[2];
  uint8_t channelBWLimit[4];
  uint8_t channelMath[4];
  float channelScaling[4];
  uint32_t sequenceNumber;
  uint32_t segmentNumber;
  uint32_t blockNumber;
  uint64_t totalSamples;
  uint8_t dataTransferMode;
  uint8_t blockMarker;
  uint8_t flags;
  uint8_t sampleFormat;
  uint32_t sampleCount;
  double channelOffset[4];
  uint32_t totalSegments;
  uint32_t reserved1;
  uint64_t reserved2[31];
  int16_t dataInt16[0];
  int32_t dataInt32[0];
  float dataFloat[0];
  union ZIScopeWaveEx::@1 data;
} ZIScopeWaveEx;
```

Data Fields

- ZITimeStamp timeStamp

  The timestamp of the last sample in this data block.

- ZITimeStamp triggerTimeStamp

  The Timestamp of the trigger (may also fall between samples and in another block).

- double dt

  Time difference between samples in seconds.

- uint8_t channelEnable

  Up to four channels: If channel is enabled, the corresponding element is non-zero.

- uint8_t channelInput

  Specifies the input source for each of the scope four channels.

  Value of channelInput and corresponding input source:

  - 0 = Signal Input 1,
  - 1 = Signal Input 2,
  - 2 = Trigger Input 1,
  - 3 = Trigger Input 2,
  - 4 = Aux Output 1,
  - 5 = Aux Output 2,
  - 6 = Aux Output 3,
  - 7 = Aux Output 4,
  - 8 = Aux Input 1,
  - 9 = Aux Input 2.

- uint8_t triggerEnable
  Non-zero if trigger is enabled.

  Bit encoded:

  - Bit (0): 1 = Trigger on rising edge,
  - Bit (1): 1 = Trigger on falling edge.

- uint8_t triggerInput
  Trigger source (same values as for channel input)

- uint8_t reserved0

- uint8_t channelBWLimit
  Bandwidth-limit flag, per channel.

  Bit encoded:

  - Bit (0): 1 = Enable bandwidth limiting.
  - Bit (7…1): Reserved

- uint8_t channelMath
  Enable/disable math operations such as averaging or FFT.

  Bit encoded:

  - Bit(0): 1 = Perform averaging,
  - Bit(1): 1 = Perform FFT,
  - Bit(7…2): Reserved

- float channelScaling
  Data scaling factors for up to 4 channels.

- uint32_t sequenceNumber
  Current scope shot sequence number. Identifies a scope shot.

- uint32_t segmentNumber
  Current segment number.

- uint32_t blockNumber

Current block number from the beginning of a scope shot. Large scope shots are split into blocks, which need to be concatenated to obtain the complete scope shot.

- uint64_t totalSamples

  Total number of samples in one channel in the current scope shot, same for all channels.

- uint8_t dataTransferMode

  Data transfer mode.

  Value and the corresponding data transfer mode:

  - 0 - SingleTransfer,
  - 1 - BlockTransfer,
  - 3 - ContinuousTransfer. Other values are reserved.

- uint8_t blockMarker

  Block marker providing additional information about the current block.

  Bit encoded:

  - Bit (0): 1 = End marker for continuous or multi-block transfer,
  - Bit (7..0): Reserved.

- uint8_t flags

  Indicator Flags.

  Bit encoded:

  - Bit (0): 1 = Data loss detected (samples are 0),
  - Bit (1): 1 = Missed trigger,
  - Bit (2): 1 = Transfer failure (corrupted data).
  - Bit (3): 1 = Assembled scope recording. 'sampleCount' will be set to 0, use 'totalSamples' instead.
  - Bit (7...4): Reserved.

- uint8_t sampleFormat

  Data format of samples:

  Value is one of ZIScopeSampleFormat_enum

- uint32_t sampleCount

  Number of samples in one channel in the current block, same for all channels.

- double channelOffset

  Data offset (scaled) for up to 4 channels.

- uint32_t totalSegments

  Number of segments in the recording. Only valid if 'flags' bit (3) is set.

- uint32_t reserved1

- uint64_t reserved2

- int16_t dataInt16

  Wave data when sampleFormat==0 or sampleFormat==4.

- int32_t dataInt32

  Wave data when sampleFormat==1 or sampleFormat==5.

- float dataFloat

  Wave data when sampleFormat==2 or sampleFormat==6.

- union ZIScopeWaveEx::@1 data

  Wave data, access via union member dataInt16, dataInt32 or dataFloat depending on sampleFormat. Indexing scheme also depends on sampleFormat.

  Example for interleaved int16 wave, 4096 samples, 2 channels:

  - data.dataInt16[0] - sample 0 of channel 0,
  - data.dataInt16[1] - sample 0 of channel 1,
  - data.dataInt16[2] - sample 1 of channel 0,
  - data.dataInt16[3] - sample 1 of channel 1,
  - ...
  - data.dataInt16[8190] - sample 4095 of channel 0,
  - data.dataInt16[8191] - sample 4095 of channel 1.

  Example for non-interleaved int16 wave, 4096 samples, 2 channels:

  - data.dataInt16[0] - sample 0 of channel 0,
  - data.dataInt16[1] - sample 1 of channel 0,
  - .. - ...
  - data.dataInt16[4095] - sample 4095 of channel 0,
  - data.dataInt16[4096] - sample 0 of channel 1,
  - data.dataInt16[4097] - sample 1 of channel 1,
  - ...
  - data.dataInt16[8191] - sample 4095 of channel 1.

struct ZIPWASample

Single PWA sample value.

```
#include "ziAPI.h"
```

```
typedef struct ZIPWASample {
  double binPhase;
  double x;
  double y;
  uint32_t countBin;
  uint32_t reserved;
} ZIPWASample;
```

Data Fields

- double binPhase

  Phase position of each bin.

- double x

  Real PWA result or X component of a demod PWA.

- double y

  Y component of the demod PWA.

- uint32_t countBin

  Number of events per bin.

- uint32_t reserved

  Reserved.

struct ZIPWAWave

PWA Wave.

```
#include "ziAPI.h"
```

```
typedef struct ZIPWAWave {
  ZITimeStamp timeStamp;
  uint64_t sampleCount;
  uint32_t inputSelect;
  uint32_t oscSelect;
  uint32_t harmonic;
  uint32_t binCount;
  double frequency;
  uint8_t pwaType;
  uint8_t mode;
  uint8_t overflow;
  uint8_t commensurable;
  uint32_t reservedUInt;
  ZIPWASample
                data[0];
} ZIPWAWave;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the data was updated.

- uint64_t sampleCount

  Total sample count considered for PWA.

- uint32_t inputSelect

  Input selection used for the PWA.

- uint32_t oscSelect

  Oscillator used for the PWA.

- uint32_t harmonic

  Harmonic setting.

- uint32_t binCount

  Bin count of the PWA.

- double frequency

  Frequency during PWA accumulation.

- uint8_t pwaType

  Type of the PWA.

- uint8_t mode

  PWA Mode [0: zoom PWA, 1: harmonic PWA].

- uint8_t overflow

  Overflow indicators. overflow[0]: Data accumulator overflow, overflow[1]: Counter at limit, overflow[6..2]: Reserved, overflow[7]: Invalid (missing frames).

- uint8_t commensurable

  Commensurability of the data.

- uint32_t reservedUInt
  Reserved 32bit.
- ZIPWASample data
  PWA data vector.

struct ZIImpedanceSample

The structure used to hold data for a single impedance sample.

```
#include "ziAPI.h"
```

```
typedef struct ZIImpedanceSample {
  ZITimeStamp timeStamp;
  double realz;
  double imagz;
  double frequency;
  double phase;
  uint32_t flags;
  uint32_t trigger;
  double param0;
  double param1;
  double drive;
  double bias;
} ZIImpedanceSample;
```

Data Fields

- ZITimeStamp timeStamp
  Timestamp at which the sample has been measured.
- double realz
  Real part of the impedance sample.
- double imagz
  Imaginary part of the impedance sample.
- double frequency
  Frequency at that sample.
- double phase
  Phase at that sample.
- uint32_t flags
  Flags (see ZIImpFlags_enum)
- uint32_t trigger
  Trigger bits.
- double param0
  Value of model parameter 0.
- double param1
  Value of model parameter 1.
- double drive
  Drive amplitude.
- double bias
  Bias voltage.

struct ZIStatisticSample

```
typedef struct ZIStatisticSample {
  double avg;
  double stddev;
  double pwr;
} ZIStatisticSample;
```

Data Fields

- double avg

  Average value or single value.

- double stddev

  Standard deviation.

- double pwr

  Power value.

struct ZISweeperDoubleSample

```
typedef struct ZISweeperDoubleSample {
  double grid;
  double bandwidth;
  uint64_t count;
  ZIStatisticSample value;
} ZISweeperDoubleSample;
```

Data Fields

- double grid

  Grid value (x-axis)

- double bandwidth

  Bandwidth.

- uint64_t count

  Sample count used for statistic calculation.

- ZIStatisticSample value

  Result value (y-axis)

struct ZISweeperDemodSample

```
typedef struct ZISweeperDemodSample {
  double grid;
  double bandwidth;
  uint64_t count;
  double tc;
  double tcMeas;
  double settling;
  ZITimeStamp setTimeStamp;
  ZITimeStamp nextTimeStamp;
  ZIStatisticSample x;
  ZIStatisticSample y;
  ZIStatisticSample r;
  ZIStatisticSample phase;
  ZIStatisticSample frequency;
  ZIStatisticSample auxin0;
  ZIStatisticSample auxin1;
} ZISweeperDemodSample;
```

Data Fields

- double grid

  Grid value (x-axis)

- double bandwidth

  Demodulator bandwidth used for the specific sweep point.

- uint64_t count

  Sample count used for statistic calculation.

- double tc

  Time constant calculated for the specific sweep point.

- double tcMeas

  Time constant used by the device.

- double settling

  Settling time (s) used to wait until averaging operation is started.

- ZITimeStamp setTimeStamp

  Time stamp when the grid value was set on the device.

- ZITimeStamp nextTimeStamp

  Time stamp when the first statistic value was recorded.

- ZIStatisticSample x

  Sweep point statistic result of X.

- ZIStatisticSample y

  Sweep point statistic result of Y.

- ZIStatisticSample r

  Sweep point statistic result of R.

- ZIStatisticSample phase

  Sweep point statistic result of phase.

- ZIStatisticSample frequency
  Sweep point statistic result of frequency.
- ZIStatisticSample auxin0
  Sweep point statistic result of auxin0.
- ZIStatisticSample auxin1
  Sweep point statistic result of auxin1.

struct ZISweeperImpedanceSample

```
typedef struct ZISweeperImpedanceSample {
  double grid;
  double bandwidth;
  uint64_t count;
  double tc;
  double tcMeas;
  double settling;
  ZITimeStamp setTimeStamp;
  ZITimeStamp nextTimeStamp;
  ZIStatisticSample realz;
  ZIStatisticSample imagz;
  ZIStatisticSample absz;
  ZIStatisticSample phasez;
  ZIStatisticSample frequency;
  ZIStatisticSample param0;
  ZIStatisticSample param1;
  ZIStatisticSample drive;
  ZIStatisticSample bias;
  uint32_t flags;
} ZISweeperImpedanceSample;
```

Data Fields

- double grid

  Grid value (x-axis)

- double bandwidth

  Demodulator bandwidth used for the specific sweep point.

- uint64_t count

  Sample count used for statistic calculation.

- double tc

  Time constant calculated for the specific sweep point.

- double tcMeas

  Time constant used by the device.

- double settling

  Settling time (s) used to wait until averaging operation is started.

- ZITimeStamp setTimeStamp

  Time stamp when the grid value was set on the device.

- ZITimeStamp nextTimeStamp

  Time stamp when the first statistic value was recorded.

- ZIStatisticSample realz

  Sweep point statistic result of X.

- ZIStatisticSample imagz

  Sweep point statistic result of Y.

- ZIStatisticSample absz

  Sweep point statistic result of R.

- ZIStatisticSample phasez

Sweep point statistic result of phase.

- ZIStatisticSample frequency
  Sweep point statistic result of frequency.
- ZIStatisticSample param0
  Sweep point statistic result of param0.
- ZIStatisticSample param1
  Sweep point statistic result of param1.
- ZIStatisticSample drive
  Sweep point statistic result of drive amplitude.
- ZIStatisticSample bias
  Sweep point statistic result of bias.
- uint32_t flags
  Flags (see ZIImpFlags_enum)

struct ZISweeperHeader

```
typedef struct ZISweeperHeader {
  uint64_t sampleCount;
  uint8_t flags;
  uint8_t sampleFormat;
  uint8_t sweepMode;
  uint8_t bandwidthMode;
  uint8_t reserved0[4];
  uint8_t reserved1[8];
} ZISweeperHeader;
```

Data Fields

- uint64_t sampleCount

  Total sample count considered for sweeper.

- uint8_t flags

  Flags Bit 0: Phase unwrap Bit 1: Sinc filter.

- uint8_t sampleFormat

  Sample format Double = 0, Demodulator = 1, Impedance = 2.

- uint8_t sweepMode

  Sweep mode Sequential = 0, Binary = 1, Bidirectional = 2, Reverse = 3.

- uint8_t bandwidthMode

  Bandwidth mode Manual = 0, Fixed = 1, Auto = 2.

- uint8_t reserved0

  Reserved space for future use.

- uint8_t reserved1

  Reserved space for future use.

struct ZISweeperWave

```
typedef struct ZISweeperWave {
  ZITimeStamp timeStamp;
  ZISweeperHeader header;
  ZISweeperDoubleSample dataDouble[0];
  ZISweeperDemodSample dataDemod[0];
  ZISweeperImpedanceSample dataImpedance[0];
  union ZISweeperWave::@2 data;
} ZISweeperWave;
```

Data Fields

- ZITimeStamp timeStamp
  Time stamp at which the data was updated.
- ZISweeperHeader header
- ZISweeperDoubleSample dataDouble
- ZISweeperDemodSample dataDemod
- ZISweeperImpedanceSample dataImpedance
- union ZISweeperWave::@2 data
  Sweeper data vector.

struct ZISpectrumDemodSample

```
typedef struct ZISpectrumDemodSample {
  double grid;
  double filter;
  double x;
  double y;
  double r;
} ZISpectrumDemodSample;
```

Data Fields

- double grid

  Grid.

- double filter

  Filter strength at the specific grid point.

- double x

  X.

- double y

  Y.

- double r

  R.

struct ZISpectrumHeader

```
typedef struct ZISpectrumHeader {
  uint64_t sampleCount;
  uint8_t flags;
  uint8_t sampleFormat;
  uint8_t spectrumMode;
  uint8_t window;
  uint8_t reserved0[4];
  uint8_t reserved1[8];
  double bandwidth;
  double rate;
  double center;
  double resolution;
  double aliasingReject;
  double nenbw;
  double overlap;
} ZISpectrumHeader;
```

Data Fields

- uint64_t sampleCount

  Total sample count considered for spectrum.

- uint8_t flags

  Flags Bit 0: Power Bit 1: Spectral density Bit 2: Absolute frequency Bit 3: Full span.

- uint8_t sampleFormat

  Sample format Demodulator = 0.

- uint8_t spectrumMode

  Spectrum mode FFT(x+iy) = 0, FFT(r) = 1, FFT(theta) = 2, FFT(freq) = 3, FFT(dtheta/dt)/2pi = 4.

- uint8_t window

  Window Rectangular = 0, Hann = 1, Hamming = 2, Blackman Harris = 3, Exponential = 16 (ring-down), Cosine = 17 (ring-down), Cosine squared = 18 (ring-down)

- uint8_t reserved0

  Reserved space for future use.

- uint8_t reserved1

  Reserved space for future use.

- double bandwidth

  Filter bandwidth.

- double rate

  Rate of the sampled data.

- double center

  FFT center value.

- double resolution

  FFT bin resolution.

- double aliasingReject

Aliasing reject (dB)

- double nenbw

  Correction factor for the used window when calculating spectral density.

- double overlap

  FFT overlap [0 .. 1[.

struct ZISpectrumWave

```
typedef struct ZISpectrumWave {
  ZITimeStamp timeStamp;
  ZISpectrumHeader header;
  ZISpectrumDemodSample dataDemod[0];
  union ZISpectrumWave::@3 data;
} ZISpectrumWave;
```

Data Fields

- ZITimeStamp timeStamp
  Time stamp at which the data was updated.
- ZISpectrumHeader header
- ZISpectrumDemodSample dataDemod
- union ZISpectrumWave::@3 data
  Spectrum data vector.

struct ZIAdvisorSample

```
typedef struct ZIAdvisorSample {
  double grid;
  double x;
  double y;
} ZIAdvisorSample;
```

Data Fields

- double grid

  Grid.

- double x

  X.

- double y

  Y.

struct ZIAdvisorHeader

```
typedef struct ZIAdvisorHeader {
  uint64_t sampleCount;
  uint8_t flags;
  uint8_t sampleFormat;
  uint8_t reserved0[6];
  uint8_t reserved1[8];
} ZIAdvisorHeader;
```

Data Fields

- uint64_t sampleCount

  Total sample count considered for advisor.

- uint8_t flags

  Flags.

- uint8_t sampleFormat

  Sample format Bode = 0, Step = 1, Impulse = 2.

- uint8_t reserved0

  Reserved space for future use.

- uint8_t reserved1

  Reserved space for future use.

struct ZIAdvisorWave

```
typedef struct ZIAdvisorWave {
  ZITimeStamp timeStamp;
  ZIAdvisorHeader header;
  ZIAdvisorSample data[0];
  union ZIAdvisorWave::@4 data;
} ZIAdvisorWave;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp at which the data was updated.

- ZIAdvisorHeader header

- ZIAdvisorSample data

- union ZIAdvisorWave::@4 data

  Advisor data vector.

struct ZIVectorData

The structure used to hold vector data block. See the description of the structure members for details.

```
#include "ziAPI.h"
```

```
typedef struct ZIVectorData {
  ZITimeStamp timeStamp;
  uint32_t sequenceNumber;
  uint32_t blockNumber;
  uint64_t totalElements;
  uint64_t blockOffset;
  uint32_t blockElements;
  uint8_t flags;
  uint8_t elementType;
  uint8_t reserved0[2];
  uint32_t extraHeaderInfo;
  uint8_t reserved1[4];
  uint64_t reserved2[31];
  uint8_t dataUInt8[0];
  uint16_t dataUInt16[0];
  uint32_t dataUInt32[0];
  uint64_t dataUInt64[0];
  int8_t dataInt8[0];
  int16_t dataInt16[0];
  int32_t dataInt32[0];
  int64_t dataInt64[0];
  double dataDouble[0];
  float dataFloat[0];
  union ZIVectorData::@5 data;
} ZIVectorData;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp of this array data block.

- uint32_t sequenceNumber

  Current array transfer sequence number. Incremented for each new transfer. Stays same for all blocks of a single array transfer.

- uint32_t blockNumber

  Current block number from the beginning of an array transfer. Large array transfers are split into blocks, which need to be concatenated to obtain the complete array.

- uint64_t totalElements

  Total number of elements in the array.

- uint64_t blockOffset

  Offset of the current block first element from the beginning of the array.

- uint32_t blockElements

  Number of elements in the current block.

- uint8_t flags

  Block marker: Bit (0): 1 = End marker for multi-block transfer Bit (1): 1 = Transfer failure Bit (7..2): Reserved.

- uint8_t elementType
  Vector element type, see ZIVectorElementType_enum.
- uint8_t reserved0
- uint32_t extraHeaderInfo
  For internal use only.
- uint8_t reserved1
- uint64_t reserved2
- uint8_t dataUInt8
- uint16_t dataUInt16
- uint32_t dataUInt32
- uint64_t dataUInt64
- int8_t dataInt8
- int16_t dataInt16
- int32_t dataInt32
- int64_t dataInt64
- double dataDouble
- float dataFloat
- union ZIVectorData::@5 data
  First data element of the current block.

struct ZIAsyncReply

```
typedef struct ZIAsyncReply {
  ZITimeStamp timeStamp;
  ZITimeStamp sampleTimeStamp;
  uint16_t command;
  uint16_t resultCode;
  ZIAsyncTag tag;
} ZIAsyncReply;
```

Data Fields

- ZITimeStamp timeStamp

  Time stamp of the reply (server clock)

- ZITimeStamp sampleTimeStamp

  Time stamp of the target node sample, to which the reply belongs.

- uint16_t command

  Command: 1 - ziAPIAsyncSetDoubleData 2 - ziAPIAsyncSetIntegerData 3 - ziAPIAsyncSetByteArray 4 - ziAPIAsyncSubscribe 5 - ziAPIAsyncUnSubscribe 6 - ziAPIAsyncGetValueAsPollData.

- uint16_t resultCode

  Command result code (cast to ZIResult_enum)

- ZIAsyncTag tag

  Tag sent along with the async command.

struct ZIEvent

This struct holds event data forwarded by the Data Server.

```
#include "ziAPI.h"
```

```
typedef struct ZIEvent {
  uint32_t valueType;
  uint32_t count;
  uint8_t path[256];
  void* untyped;
  ZIDoubleData* doubleData;
  ZIDoubleDataTS* doubleDataTS;
  ZIIntegerData* integerData;
  ZIIntegerDataTS* integerDataTS;
  ZIComplexData* complexData;
  ZIByteArray* byteArray;
  ZIByteArrayTS* byteArrayTS;
  ZICntSample* cntSample;
  ZITrigSample* trigSample;
  ZITreeChangeData* treeChangeData;
  TreeChange* treeChangeDataOld;
  ZIDemodSample* demodSample;
  ZIAuxInSample* auxInSample;
  ZIDIOSample* dioSample;
  ZIScopeWave* scopeWave;
  ZIScopeWaveEx* scopeWaveEx;
  ScopeWave* scopeWaveOld;
  ZIPWAWave* pwaWave;
  ZISweeperWave* sweeperWave;
  ZISpectrumWave* spectrumWave;
  ZIAdvisorWave* advisorWave;
  ZIAsyncReply* asyncReply;
  ZIVectorData* vectorData;
  ZIImpedanceSample* impedanceSample;
  uint64_t alignment;
  union ZIEvent::@6 value;
  uint8_t data[0x400000];
} ZIEvent;
```

Data Fields

- uint32_t valueType

  Specifies the type of the data held by the ZIEvent, see ZIValueType_enum.

- uint32_t count

  Number of values available in this event.

- uint8_t path

  The path to the node from which the event originates.

- void* untyped

  For convenience. The void field doesn't have a corresponding data type.

- ZIDoubleData* doubleData

  when valueType == ZI_VALUE_TYPE_DOUBLE_DATA

- ZIDoubleDataTS* doubleDataTS

  when valueType == ZI_VALUE_TYPE_DOUBLE_DATA_TS

- ZIIntegerData* integerData
  when valueType == ZI_VALUE_TYPE_INTEGER_DATA
- ZIIntegerDataTS* integerDataTS
  when valueType == ZI_VALUE_TYPE_INTEGER_DATA_TS
- ZIComplexData* complexData
  when valueType == ZI_VALUE_TYPE_COMPLEX_DATA
- ZIByteArray* byteArray
  when valueType == ZI_VALUE_TYPE_BYTE_ARRAY
- ZIByteArrayTS* byteArrayTS
  when valueType == ZI_VALUE_TYPE_BYTE_ARRAY_TS
- ZICntSample* cntSample
  when valueType == ZI_VALUE_TYPE_CNT_SAMPLE
- ZITrigSample* trigSample
  when valueType == ZI_VALUE_TYPE_TRIG_SAMPLE
- ZITreeChangeData* treeChangeData
  when valueType == ZI_VALUE_TYPE_TREE_CHANGE_DATA
- TreeChange* treeChangeDataOld
  when valueType ==
  ZI_VALUE_TYPE_TREE_CHANGE_DATA_OLD
- ZIDemodSample* demodSample
  when valueType == ZI_VALUE_TYPE_DEMOD_SAMPLE
- ZIAuxInSample* auxInSample
  when valueType == ZI_VALUE_TYPE_AUXIN_SAMPLE
- ZIDIOSample* dioSample
  when valueType == ZI_VALUE_TYPE_DIO_SAMPLE
- ZIScopeWave* scopeWave
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE
- ZIScopeWaveEx* scopeWaveEx
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE_EX
- ScopeWave* scopeWaveOld
  when valueType == ZI_VALUE_TYPE_SCOPE_WAVE_OLD
- ZIPWAWave* pwaWave
  when valueType == ZI_VALUE_TYPE_PWA_WAVE
- ZISweeperWave* sweeperWave
  when valueType == ZI_VALUE_TYPE_SWEEPER_WAVE
- ZISpectrumWave* spectrumWave
  when valueType == ZI_VALUE_TYPE_SPECTRUM_WAVE
- ZIAdvisorWave* advisorWave

when valueType == ZI_VALUE_TYPE_ADVISOR_WAVE

- ZIAsyncReply* asyncReply

  when valueType == ZI_VALUE_TYPE_ASYNC_REPLY

- ZIVectorData* vectorData

  when valueType == ZI_VALUE_TYPE_VECTOR_DATA

- ZIImpedanceSample* impedanceSample

  when valueType == ZI_VALUE_TYPE_IMPEDANCE_SAMPLE

- uint64_t alignment

  ensure union size is 8 bytes

- union ZIEvent::@6 value

  Convenience pointer to allow for access to the first entry in Data using the correct type according to ZIEvent.valueType field.

- uint8_t data

  The raw value data.

Detailed Description

ZIEvent is used to give out events like value changes or errors to the user. Event handling functionality is provided by ziAPISubscribe and ziAPIUnSubscribe as well as ziAPIPollDataEx.

```
// Copyright [2016] Zurich Instruments AG
#include <stdio.h>

#include "ziAPI.h"

void ProcessEvent(ZIEvent* Event) {
  unsigned int j;

  switch (Event->valueType) {
  case ZI_VALUE_TYPE_DOUBLE_DATA:

    printf("%u elements of double data: %s.\n",
           Event->count,
           Event->path);

    for (j = 0; j < Event->count; j++)
      printf("%f\n", Event->value.doubleData[j]);

    break;

  case ZI_VALUE_TYPE_INTEGER_DATA:

    printf("%u elements of integer data: %s.\n",
           Event->count,
           Event->path);

    for (j = 0; j < Event->count; j++)
      printf("%f\n", (float)Event->value.integerData[j]);

    break;

  case ZI_VALUE_TYPE_DEMOD_SAMPLE:

    printf("%u elements of sample data %s\n",
           Event->count,
```

```
                Event->path);

        for (j = 0; j < Event->count; j++)
          printf("TS=%f, X=%f, Y=%f.\n",
                 (float)Event->value.demodSample[j].timeStamp,
                 Event->value.demodSample[j].x,
                 Event->value.demodSample[j].y);

        break;

      case ZI_VALUE_TYPE_TREE_CHANGE_DATA:

        printf("%u elements of tree-changed data, %s.\n",
               Event->count,
               Event->path);

        for (j = 0; j < Event->count; j++) {
          switch (Event->value.treeChangeDataOld[j].Action) {
          case ZI_TREE_ACTION_REMOVE:
            printf("Tree removed: %s\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;

          case ZI_TREE_ACTION_ADD:
            printf("treeChangeDataOld added: %s.\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;

          case ZI_TREE_ACTION_CHANGE:
            printf("treeChangeDataOld changed: %s.\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;
          }
        }

        break;

      default:

        printf("Unexpected event value type: %d.\n", Event->valueType);
        break;
      }
    }
```

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIPollDataEx

struct ZIChunkHeader

Structure to hold generic chunk data header information.

```
#include "ziAPI.h"
```

```
typedef struct ZIChunkHeader {
  ZITimeStamp systemTime;
  ZITimeStamp createdTimeStamp;
  ZITimeStamp changedTimeStamp;
  uint32_t flags;
  uint32_t moduleFlags;
  uint32_t status;
  uint32_t reserved0;
  uint64_t chunkSizeBytes;
  uint64_t triggerNumber;
  char name[32];
  uint32_t groupIndex;
  uint32_t color;
  uint32_t activeRow;
  uint32_t gridRows;
  uint32_t gridCols;
  uint32_t gridMode;
  uint32_t gridOperation;
  uint32_t gridDirection;
  uint32_t gridRepetitions;
  double gridColDelta;
  double gridColOffset;
  double gridRowDelta;
  double gridRowOffset;
  double bandwidth;
  double center;
  double nenbw;
} ZIChunkHeader;
```

Data Fields

- ZITimeStamp systemTime

  System timestamp.

- ZITimeStamp createdTimeStamp

  Creation timestamp.

- ZITimeStamp changedTimeStamp

  Last changed timestamp.

- uint32_t flags

  Flags (bitmask of values from ZIChunkHeaderFlags_enum)

- uint32_t moduleFlags

  moduleFlags (bitmask of values from ZIChunkHeaderModuleFlags_enum, module-specific)

- uint32_t status

  Status Flag: [0] : selected [1] : group assigned [2] : color edited [4] : name edited.

- uint32_t reserved0

- uint64_t chunkSizeBytes

Size in bytes used for memory usage calculation.

- uint64_t triggerNumber
  SW Trigger counter since execution start.
- char name
  Name in history list.
- uint32_t groupIndex
  Group index in history list.
- uint32_t color
  Color in history list.
- uint32_t activeRow
  Active row in history list.
- uint32_t gridRows
  Number of grid rows.
- uint32_t gridCols
  Number of grid columns.
- uint32_t gridMode
  Grid mode interpolation mode (0 = off, 1 = nearest, 2 = linear, 3 = Lanczos)
- uint32_t gridOperation
  Grid mode operation (0 = replace, 1 = average)
- uint32_t gridDirection
  Grid mode direction (0 = forward, 1 = revers, 2 = bidirectional)
- uint32_t gridRepetitions
  Number of repetitions in grid mode.
- double gridColDelta
  Delta between grid points in SI unit.
- double gridColOffset
  Offset of first grid point relative to trigger.
- double gridRowDelta
  Delta between grid rows in SI unit.
- double gridRowOffset
  Delay of first grid row relative to trigger.
- double bandwidth
  For FFT the bandwidth of the signal.
- double center
  The FFT center frequency.
- double nenbw

For FFT the normalized effective noise bandwidth.

struct ZIModuleEvent

This struct holds data of a single chunk from module lookup.

```
#include "ziAPI.h"
```

```
typedef struct ZIModuleEvent {
  uint64_t allocatedSize;
  ZIChunkHeader* header;
  ZIEvent
                      value[0];
} ZIModuleEvent;
```

Data Fields

- uint64_t allocatedSize
  For internal use - never modify!
- ZIChunkHeader* header
  Chunk header.
- ZIEvent value
  Defines location of stored ZIEvent.

struct DemodSample

The DemodSample struct holds data for the ZI_DATA_DEMODSAMPLE data type. Deprecated: See ZIDemodSample.

```
#include "ziAPI.h"
```

```
typedef struct DemodSample {
  ziTimeStampType TimeStamp;
  double X;
  double Y;
  double Frequency;
  double Phase;
  unsigned int DIOBits;
  unsigned int Reserved;
  double AuxIn0;
  double AuxIn1;
} DemodSample;
```

Data Fields

- ziTimeStampType TimeStamp
- double X
- double Y
- double Frequency
- double Phase
- unsigned int DIOBits
- unsigned int Reserved
- double AuxIn0
- double AuxIn1

struct AuxInSample

The AuxInSample struct holds data for the ZI_DATA_AUXINSAMPLE data type. Deprecated: See ZIAuxInSample.

```
#include "ziAPI.h"
```

```
typedef struct AuxInSample {
  ziTimeStampType TimeStamp;
  double Ch0;
  double Ch1;
} AuxInSample;
```

Data Fields

- ziTimeStampType TimeStamp

- double Ch0

- double Ch1

struct DIOSample

The DIOSample struct holds data for the ZI_DATA_DIOSAMPLE data type. Deprecated: See ZIDIOSample.

```
#include "ziAPI.h"
```

```
typedef struct DIOSample {
  ziTimeStampType TimeStamp;
  unsigned int Bits;
  unsigned int Reserved;
} DIOSample;
```

Data Fields

- ziTimeStampType TimeStamp

- unsigned int Bits

- unsigned int Reserved

struct ByteArrayData

The ByteArrayData struct holds data for the ZI_DATA_BYTEARRAY data type. Deprecated: See ZIByteArray.

```
#include "ziAPI.h"
```

```
typedef struct ByteArrayData {
  unsigned int Len;
  unsigned char Bytes[0];
} ByteArrayData;
```

Data Fields

- unsigned int Len

- unsigned char Bytes

struct ziEvent

This struct holds event data forwarded by the Data Server. Deprecated: See ZIEvent.

```
#include "ziAPI.h"

typedef struct ziEvent {
  uint32_t Type;
  uint32_t Count;
  unsigned char Path[256];
  union ziEvent::Val Val;
  unsigned char Data[0x400000];
} ziEvent;
```

Data Structures

- union ziEvent::Val

Data Fields

- uint32_t Type
- uint32_t Count
- unsigned char Path
- union ziEvent::Val Val
- unsigned char Data

Detailed Description

ziEvent is used to give out events like value changes or errors to the user. Event handling functionality is provided by ziAPISubscribe and ziAPIUnSubscribe as well as ziAPIPollDataEx.

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIPollDataEx

```
// Copyright [2016] Zurich Instruments AG
#include <stdio.h>

#include "ziAPI.h"

void ProcessEvent(ZIEvent* Event) {
  unsigned int j;

  switch (Event->valueType) {
  case ZI_VALUE_TYPE_DOUBLE_DATA:

    printf("%u elements of double data: %s.\n",
           Event->count,
           Event->path);

    for (j = 0; j < Event->count; j++)
      printf("%f\n", Event->value.doubleData[j]);
```

```
        break;

      case ZI_VALUE_TYPE_INTEGER_DATA:

        printf("%u elements of integer data: %s.\n",
               Event->count,
               Event->path);

        for (j = 0; j < Event->count; j++)
          printf("%f\n", (float)Event->value.integerData[j]);

        break;

      case ZI_VALUE_TYPE_DEMOD_SAMPLE:

        printf("%u elements of sample data %s\n",
               Event->count,
               Event->path);

        for (j = 0; j < Event->count; j++)
          printf("TS=%f, X=%f, Y=%f.\n",
                 (float)Event->value.demodSample[j].timeStamp,
                 Event->value.demodSample[j].x,
                 Event->value.demodSample[j].y);

        break;

      case ZI_VALUE_TYPE_TREE_CHANGE_DATA:

        printf("%u elements of tree-changed data, %s.\n",
               Event->count,
               Event->path);

        for (j = 0; j < Event->count; j++) {
          switch (Event->value.treeChangeDataOld[j].Action) {
          case ZI_TREE_ACTION_REMOVE:
            printf("Tree removed: %s\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;

          case ZI_TREE_ACTION_ADD:
            printf("treeChangeDataOld added: %s.\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;

          case ZI_TREE_ACTION_CHANGE:
            printf("treeChangeDataOld changed: %s.\n",
                   Event->value.treeChangeDataOld[j].Name);
            break;
          }
        }

        break;

      default:

        printf("Unexpected event value type: %d.\n", Event->valueType);
        break;
      }
    }
```

Data Structure Documentation

union ziEvent::Val

```
typedef union ziEvent::Val {
  void* Void;
  DemodSample* SampleDemod;
  AuxInSample* SampleAuxIn;
  DIOSample* SampleDIO;
  ziDoubleType* Double;
  ziIntegerType* Integer;
  TreeChange* Tree;
  ByteArrayData* ByteArray;
  ScopeWave* Wave;
  uint64_t alignment;
} ziEvent::Val;
```

Data Fields

- void* Void
- DemodSample* SampleDemod
- AuxInSample* SampleAuxIn
- DIOSample* SampleDIO
- ziDoubleType* Double
- ziIntegerType* Integer
- TreeChange* Tree
- ByteArrayData* ByteArray
- ScopeWave* Wave
- uint64_t alignment

union ziEvent::Val

```
typedef union ziEvent::Val {
  void* Void;
  DemodSample* SampleDemod;
  AuxInSample* SampleAuxIn;
  DIOSample* SampleDIO;
  ziDoubleType* Double;
  ziIntegerType* Integer;
  TreeChange* Tree;
  ByteArrayData* ByteArray;
  ScopeWave* Wave;
  uint64_t alignment;
} ziEvent::Val;
```

Data Fields

- void* Void
- DemodSample* SampleDemod
- AuxInSample* SampleAuxIn
- DIOSample* SampleDIO
- ziDoubleType* Double
- ziIntegerType* Integer
- TreeChange* Tree
- ByteArrayData* ByteArray
- ScopeWave* Wave
- uint64_t alignment

Enumeration Type Documentation

Defines return value for all ziAPI functions. Divided into 3 regions: info, warning and error.

Enumerator:

- ZI_INFO_BASE
- ZI_INFO_SUCCESS
  Success (no error)
- ZI_INFO_MAX
- ZI_WARNING_BASE
- ZI_WARNING_GENERAL
  Warning (general);.
- ZI_WARNING_UNDERRUN
  FIFO Underrun.
- ZI_WARNING_OVERFLOW
  FIFO Overflow.
- ZI_WARNING_NOTFOUND
  Value or Node not found.
- ZI_WARNING_NO_ASYNC
  Async command executed in sync mode (will be no async reply)
- ZI_WARNING_MAX
- ZI_ERROR_BASE
- ZI_ERROR_GENERAL
  Error (general)
- ZI_ERROR_USB
  USB Communication failed.
- ZI_ERROR_MALLOC
  Memory allocation failed.
- ZI_ERROR_MUTEX_INIT
  Unable to initialize mutex.
- ZI_ERROR_MUTEX_DESTROY
  Unable to destroy mutex.
- ZI_ERROR_MUTEX_LOCK
  Unable to lock mutex.
- ZI_ERROR_MUTEX_UNLOCK
  Unable to unlock mutex.
- ZI_ERROR_THREAD_START

Unable to start thread.

- ZI_ERROR_THREAD_JOIN
  Unable to join thread.
- ZI_ERROR_SOCKET_INIT
  Can't initialize socket.
- ZI_ERROR_SOCKET_CONNECT
  Unable to connect socket.
- ZI_ERROR_HOSTNAME
  Hostname not found.
- ZI_ERROR_CONNECTION
  Connection invalid.
- ZI_ERROR_TIMEOUT
  Command timed out.
- ZI_ERROR_COMMAND
  Command internally failed.
- ZI_ERROR_SERVER_INTERNAL
  Command failed in server.
- ZI_ERROR_LENGTH
  Provided Buffer length is too small.
- ZI_ERROR_FILE
  Can't open file or read from it.
- ZI_ERROR_DUPLICATE
  There is already a similar entry.
- ZI_ERROR_READONLY
  Attempt to set a read-only node.
- ZI_ERROR_DEVICE_NOT_VISIBLE
  Device is not visible to the server.
- ZI_ERROR_DEVICE_IN_USE
  Device is already connected by a different server.
- ZI_ERROR_DEVICE_INTERFACE
  Device does currently not support the specified interface.
- ZI_ERROR_DEVICE_CONNECTION_TIMEOUT
  Device connection timeout.
- ZI_ERROR_DEVICE_DIFFERENT_INTERFACE
  Device already connected over a different Interface.
- ZI_ERROR_DEVICE_NEEDS_FW_UPGRADE
  Device needs FW upgrade.

- ZI_ERROR_ZIEVENT_DATATYPE_MISMATCH

  Trying to get data from a poll event with wrong target data type.

- ZI_ERROR_DEVICE_NOT_FOUND

  Device not found.

- ZI_ERROR_NOT_SUPPORTED

  Provided arguments are not supported for the command.

- ZI_ERROR_TOO_MANY_CONNECTIONS

  Connection invalid.

- ZI_ERROR_NOT_ON_HF2

  Command not supported on HF2.

- ZI_ERROR_COM_NACK_BASE

  Errors reported by device.

- ZI_ERROR_COM_NACK_NO_ERROR
- ZI_ERROR_COM_NACK_INVALID_AP_ADDRESS
- ZI_ERROR_COM_NACK_INVALID_AP_OFFSET
- ZI_ERROR_COM_NACK_INVALID_AP_LENGTH
- ZI_ERROR_COM_NACK_READONLY_AP
- ZI_ERROR_COM_NACK_NOT_SERVED_AP
- ZI_ERROR_COM_NACK_NOT_INDEXED_AP
- ZI_ERROR_COM_NACK_INVALID_VECT_LEN
- ZI_ERROR_COM_NACK_INVALID_VECT_FRAME
- ZI_ERROR_COM_NACK_INVALID_VECT_OFFSET
- ZI_ERROR_COM_NACK_INVALID_VECT_EXTRA
- ZI_ERROR_COM_NACK_INVALID_VECT_SEQUENCE
- ZI_ERROR_COM_NACK_INVALID_VECT_IDX_OFFSET
- ZI_ERROR_COM_NACK_INVALID_VECT_TYPE
- ZI_ERROR_COM_NACK_INVALID_VECT_DATA_LEN
- ZI_ERROR_COM_NACK_INVALID_VECT_EXTRA_LEN
- ZI_ERROR_COM_NACK_TIMEOUT
- ZI_ERROR_COM_NACK_RESOURCE_INACTIVE
- ZI_ERROR_COM_NACK_RESOURCE_BUSY
- ZI_ERROR_COM_NACK_EXECUTION_ERROR
- ZI_ERROR_COM_NACK_VECTOR_QUEUE_FULL
- ZI_ERROR_COM_NACK_INTERNAL_BASE

SW-generated extension of device errors.

- ZI_ERROR_COM_NACK_INTERNAL_NO_PAYLOAD
- ZI_ERROR_COM_NACK_INTERNAL_TOO_MANY_PENDING
- ZI_ERROR_MAX

Enumerates all types that data in a ZIEvent may have.

Enumerator:

- ZI_VALUE_TYPE_NONE

  No data type, event is invalid.

- ZI_VALUE_TYPE_DOUBLE_DATA

  ZIDoubleData type. Use the ZIEvent.value.doubleData pointer to read the data of the event.

- ZI_VALUE_TYPE_INTEGER_DATA

  ZIIntegerData type. Use the ZIEvent.value.integerData pointer to read the data of the event.

- ZI_VALUE_TYPE_DEMOD_SAMPLE

  ZIDemodSample type. Use the ZIEvent.value.demodSample pointer to read the data of the event.

- ZI_VALUE_TYPE_SCOPE_WAVE_OLD

  ScopeWave type, used in v1 compatibility mode. use the ZIEvent.value.scopeWaveOld pointer to read the data of the event.

- ZI_VALUE_TYPE_AUXIN_SAMPLE

  ZIAuxInSample type. Use the ZIEvent.value.auxInSample pointer to read the data of the event.

- ZI_VALUE_TYPE_DIO_SAMPLE

  ZIDIOSample type. Use the ZIEvent.value.dioSample pointer to read the data of the event.

- ZI_VALUE_TYPE_BYTE_ARRAY

  ZIByteArray type. Use the ZIEvent.value.byteArray pointer to read the data of the event.

- ZI_VALUE_TYPE_PWA_WAVE

  ZIPWAWave type. Use the ZIEvent.value.pwaWave pointer to read the data of the event.

- ZI_VALUE_TYPE_TREE_CHANGE_DATA_OLD

  TreeChange type - a list of added or removed nodes, used in v1 compatibility mode. Use the ZIEvent.value.treeChangeDataOld pointer to read the data of the event.

- ZI_VALUE_TYPE_DOUBLE_DATA_TS

  ZIDoubleDataTS type. Use the ZIEvent.value.doubleDataTS pointer to read the data of the event.

- ZI_VALUE_TYPE_INTEGER_DATA_TS

  ZIIntegerDataTS type. Use the ZIEvent.value.integerDataTS pointer to read the data of the event.

- ZI_VALUE_TYPE_COMPLEX_DATA

ZIComplexData type. Use the ZIEvent.value.complexData pointer to read the data of the event.

- ZI_VALUE_TYPE_SCOPE_WAVE

  ZIScopeWave type. Use the ZIEvent.value.scopeWave pointer to read the data of the event.

- ZI_VALUE_TYPE_SCOPE_WAVE_EX

  ZIScopeWaveEx type. Use the ZIEvent.value.scopeWaveEx pointer to read the data of the event.

- ZI_VALUE_TYPE_BYTE_ARRAY_TS

  ZIByteArrayTS type. Use the ZIEvent.value.byteArrayTS pointer to read the data of the event.

- ZI_VALUE_TYPE_CNT_SAMPLE

  ZICntSample type. Use the ZIEvent.value.cntSample pointer to read the data of the event.

- ZI_VALUE_TYPE_TRIG_SAMPLE

  ZITrigSample type. Use the ZIEvent.value.trigSample pointer to read the data of the event.

- ZI_VALUE_TYPE_TREE_CHANGE_DATA

  ZITreeChangeData type - a list of added or removed nodes. Use the ZIEvent.value.treeChangeData pointer to read the data of the event.

- ZI_VALUE_TYPE_ASYNC_REPLY

  ZIAsyncReply type. Use the ZIEvent.value.asyncReply pointer to read the data of the event.

- ZI_VALUE_TYPE_SWEEPER_WAVE

  ZISweeperWave type. Use the ZIEvent.value.sweeperWave pointer to read the data of the event.

- ZI_VALUE_TYPE_SPECTRUM_WAVE

  ZISpectrumWave type. Use the ZIEvent.value.spectrumWave pointer to read the data of the event.

- ZI_VALUE_TYPE_ADVISOR_WAVE

  ZIAdvisorWave type. Use the ZIEvent.value.advisorWave pointer to read the data of the event.

- ZI_VALUE_TYPE_VECTOR_DATA

  ZIVectorData type. Use the ZIEvent.value.vectorData pointer to access the data of the event.

- ZI_VALUE_TYPE_IMPEDANCE_SAMPLE

  ZIImpedanceSample type. Use the ZIEvent.value.impedanceSample pointer to access the data of the event.

Defines the actions that are performed on a tree, as returned in the ZITreeChangeData::action or ZITreeChangeDataOld::action.

Enumerator:

- ZI_TREE_ACTION_REMOVE
  A node has been removed.
- ZI_TREE_ACTION_ADD
  A node has been added.
- ZI_TREE_ACTION_CHANGE
  A node has been changed.

Defines the data format of scope samples:

Enumerator:

- ZI_SCOPE_SAMPLE_FORMAT_INT16

  Int16 Non-Interleaved, the samples for each enabled scope channel are stored together one channel after the other,.

- ZI_SCOPE_SAMPLE_FORMAT_INT32

  Int32, Non-Interleaved.

- ZI_SCOPE_SAMPLE_FORMAT_FLOAT

  Float, Non-Interleaved.

- ZI_SCOPE_SAMPLE_FORMAT_INT16_INTERLEAVED

  Int16 Interleave d, the samples for each enabled scope channel are stored in successive elements in the data buffer, e.g. channel0-sample0,channel1-sample0,channel0-sample1,channel1-sample1,channel0-sample2,channel1-sample2.

- ZI_SCOPE_SAMPLE_FORMAT_INT32_INTERLEAVED

  Int32 Interleaved as described for ZI_SCOPE_SAMPLE_FORMAT_INT16INTERLEAVED.

- ZI_SCOPE_SAMPLE_FORMAT_FLOAT_INTERLEAVED

  Float Interleaved as described for ZI_SCOPE_SAMPLE_FORMAT_INT16INTERLEAVED.

Helper enum to enable testing certain properties of the scope sample format.

Enumerator:

- ZI_SCOPE_SAMPLE_FORMAT_MASK_DATA_TYPE

  Mask to enable determining only the data type in ZIScopeSampleFormat_enum.

- ZI_SCOPE_SAMPLE_FORMAT_MASK_INTERLEAVED

  Mask to test the interleaved bit in ZIScopeSampleFormat_enum.

Enumerates the bits set in an ZIImpedanceSample's flags.

Enumerator:

- ZI_IMP_FLAGS_NONE
- ZI_IMP_FLAGS_VALID_INTERNAL
  Internal calibration is applied.
- ZI_IMP_FLAGS_VALID_USER
  User compensation is applied.
- ZI_IMP_FLAGS_AUTORANGE_GATING
  Reserved for future use.
- ZI_IMP_FLAGS_OVERFLOW_VOLTAGE
  Overflow on voltage input.
- ZI_IMP_FLAGS_OVERFLOW_CURRENT
  Overflow on current input.
- ZI_IMP_FLAGS_UNDERFLOW_VOLTAGE
  Underflow on voltage input.
- ZI_IMP_FLAGS_UNDERFLOW_CURRENT
  Underflow on current input.
- ZI_IMP_FLAGS_FREQ_EXACT
  Reserved for future use.
- ZI_IMP_FLAGS_FREQ_INTERPOLATION
  Reserved for future use.
- ZI_IMP_FLAGS_FREQ_EXTRAPOLATION
  Reserved for future use.
- ZI_IMP_FLAGS_LOWDUT2T
  LowDUT impedance detected.
- ZI_IMP_FLAGS_SUPPRESSION_PARAM0
  Suppression of first parameter PARAM0.
- ZI_IMP_FLAGS_SUPPRESSION_PARAM1
  Suppression of second parameter PARAM1.
- ZI_IMP_FLAGS_FREQLIMIT_RANGE_VOLTAGE
  Reserved for future use.
- ZI_IMP_FLAGS_FREQLIMIT_RANGE_CURRENT
  Frequency bigger than the frequency limit of active current input range.
- ZI_IMP_FLAGS_STRONGCOMPENSATION_PARAM0
  Strong compensation detected on PARAM0.
- ZI_IMP_FLAGS_STRONGCOMPENSATION_PARAM1

Strong compensation detected on PARAM1.

- ZI_IMP_FLAGS_NEGATIVE_QFACTOR
  Non-reasonable values for Q/D measurement.
- ZI_IMP_FLAGS_ONE_PERIOD
  One-period measurement enabled.
- ZI_IMP_FLAGS_ONE_PERIOD_INVALID
  One-period measurement values are invalid.
- ZI_IMP_FLAGS_BWC_BIT1
  Reserved for future use.
- ZI_IMP_FLAGS_BWC_BIT2
  Reserved for future use.
- ZI_IMP_FLAGS_BWC_BIT3
  Reserved for future use.
- ZI_IMP_FLAGS_BWC_MASK
  Reserved for future use.
- ZI_IMP_FLAGS_OPEN_DETECTION
  Open detected on 4T measurement.
- ZI_IMP_FLAGS_OVERFLOW_SIGIN0
  Overflow on sigin0.
- ZI_IMP_FLAGS_OVERFLOW_SIGIN1
  Overflow on sigin1.
- ZI_IMP_FLAGS_MODEL_MASK
  Model selected for the measurement.

Enumerates all the types that a ZIVectorData::elementType may have.

Enumerator:

- ZI_VECTOR_ELEMENT_TYPE_UINT8
- ZI_VECTOR_ELEMENT_TYPE_UINT16
- ZI_VECTOR_ELEMENT_TYPE_UINT32
- ZI_VECTOR_ELEMENT_TYPE_UINT64
- ZI_VECTOR_ELEMENT_TYPE_FLOAT
- ZI_VECTOR_ELEMENT_TYPE_DOUBLE
- ZI_VECTOR_ELEMENT_TYPE_ASCIIZ
- ZI_VECTOR_ELEMENT_TYPE_COMPLEX_FLOAT
- ZI_VECTOR_ELEMENT_TYPE_COMPLEX_DOUBLE

Enumerator:

- ZI_API_VERSION_0
- ZI_API_VERSION_1
- ZI_API_VERSION_4
- ZI_API_VERSION_5
- ZI_API_VERSION_6
- ZI_API_VERSION_MAX

Defines the values of the flags used in ziAPIListNodes.

Enumerator:

- ZI_LIST_NODES_ALL

  Default, return a simple listing of the given node immediate descendants.

- ZI_LIST_NODES_RECURSIVE

  List the nodes recursively.

- ZI_LIST_NODES_ABSOLUTE

  Return absolute paths.

- ZI_LIST_NODES_LEAVESONLY

  Return only leaf nodes, which means the nodes at the outermost level of the tree.

- ZI_LIST_NODES_SETTINGSONLY

  Return only nodes which are marked as setting.

- ZI_LIST_NODES_STREAMINGONLY

  Return only streaming nodes (nodes that can be pushed from the device at a high data rate)

- ZI_LIST_NODES_SUBSCRIBEDONLY

  Return only nodes that are subscribed to in the API session.

- ZI_LIST_NODES_BASECHANNEL

  Return only one instance of a node in case of multiple channels.

- ZI_LIST_NODES_GETONLY

  Return only nodes which can be used with the get command.

- ZI_LIST_NODES_EXCLUDESTREAMING

  Exclude streaming nodes.

- ZI_LIST_NODES_EXCLUDEVECTORS

  Exclude node vectors.

Defines the flags returned in the chunk header for all modules.

Enumerator:

- ZI_CHUNK_HEADER_FLAG_FINISHED

  Indicates that the chunk data is complete. This flag will be set if data is read out from the module before the measurement (e.g. sweep) has finished.

- ZI_CHUNK_HEADER_FLAG_ROLLMODE

  Unused.

- ZI_CHUNK_HEADER_FLAG_DATALOSS

  Indicates that dataloss has occurred.

- ZI_CHUNK_HEADER_FLAG_VALID

  Indcates that the data is valid.

- ZI_CHUNK_HEADER_FLAG_DATA

  Indicates whether then chunk contains data (opposite to setting).

- ZI_CHUNK_HEADER_FLAG_DISPLAY

  Internal use only.

- ZI_CHUNK_HEADER_FLAG_FREQDOMAIN

  chunk contains frequency domain data, opposite to time domain.

- ZI_CHUNK_HEADER_FLAG_SPECTRUM

  chunk recorded in spectrum mode.

- ZI_CHUNK_HEADER_FLAG_OVERLAPPED

  chunk results overlap with neighboring chunks, see spectrum.

- ZI_CHUNK_HEADER_FLAG_ROWFINISHED

  indicates that the current row is finished - useful for row first averaging.

- ZI_CHUNK_HEADER_FLAG_ONGRIDSAMPLING

  exact sampling was used.

- ZI_CHUNK_HEADER_FLAG_ROWREPETITION

  row first averaging is enabled.

- ZI_CHUNK_HEADER_FLAG_PREVIEW

  chunk contains preview (fft with less points).

Defines flags returned in the chunk header that only apply for certain modules.

Enumerator:

- ZI_CHUNK_HEADER_MODULE_FLAGS_WINDOW

  FFT Window used in the Data Acquisition Module: 0 - Rectangular, 1 - Hann, 2 - Hamming, 3 - Blackmanharris, 4 - Exponential, 5 - Cosine, 6 - CosineSquare.

Enumerator:

- ZI_ANNOTATION_SHOW_X

  display xValue if it is set, should be alays the same as ZI_ANNOTATION_SHOW_Y at the moment

- ZI_ANNOTATION_SHOW_Y

  display yValue if it is set, should be alays the same as ZI_ANNOTATION_SHOW_X at the moment

- ZI_ANNOTATION_SHOW_GRID

  display gridValue if it is set

- ZI_ANNOTATION_SHOW_LABEL

  display label if set

TREE_ACTION defines the values for the TreeChange::Action Variable.

Enumerator:

- TREE_ACTION_REMOVE
  a tree has been removed
- TREE_ACTION_ADD
  a tree has been added
- TREE_ACTION_CHANGE
  a tree has changed

Function Documentation

ziAPIInit

ZIResult_enum ziAPIInit (ZIConnection* conn)

Initializes a ZIConnection structure.

This function initializes the structure so that it is ready to connect to Data Server. It allocates memory and sets up the infrastructure needed.

Parameters:

[out] conn

Pointer to ZIConnection that is to be initialized

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_MALLOC on memory allocation failure
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDestroy, ziAPIConnect, ziAPIDisconnect

See Connection for an example

ziAPIDestroy

ZIResult_enum ziAPIDestroy (ZIConnection conn)

Destroys a ZIConnection structure.

This function frees all memory that has been allocated by ziAPIInit. If it is called with an uninitialized ZIConnection struct it may result in segmentation faults as well when it is called with a struct for which ZIAPIDestroy already has been called.

Parameters:

[in] conn

Pointer to ZIConnection struct that has to be destroyed

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIInit, ziAPIConnect, ziAPIDisconnect

See Connection for an example

ziAPIConnect

ZIResult_enum ziAPIConnect (ZIConnection conn, const char* hostname, uint16_t port)

Connects the ZIConnection to Data Server.

Connects to Data Server using a ZIConnection and prepares for data exchange. For most cases it is enough to just give a reference to the connection and give NULL for hostname and 0 for the port, so it connects to localhost on the default port.

Parameters:

[in] conn

Pointer to ZIConnection with which the connection should be established

[in] hostname

Name of the Host to which it should be connected, if NULL "localhost" will be used as default

[in] port

The Number of the port to connect to. If 0, default port of the local Data Server will be used (8005)

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_HOSTNAME if the given host name could not be found
- ZI_ERROR_SOCKET_CONNECT if no connection could be established
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_SOCKET_INIT if initialization of the socket failed
- ZI_ERROR_CONNECTION when the Data Server didn't return the correct answer
- ZI_ERROR_TIMEOUT when initial communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDisconnect, ziAPIInit, ziAPIDestroy

See Connection for an example

ziAPIDisconnect

ZIResult_enum ziAPIDisconnect (ZIConnection conn)

Disconnects an established connection.

Disconnects from Data Server. If the connection has not been established and the function is called it returns without doing anything.

Parameters:

[in] conn

Pointer to ZIConnection to be disconnected

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnect, ziAPIInit, ziAPIDestroy

See Connection for an example

ziAPIListImplementations

ZIResult_enum ziAPIListImplementations (char* implementations, uint32_t bufferSize)

Returns the list of supported implementations.

Returned names are defined by implementations in the linked library and may change depending on software version.

Parameters:

[out] implementations

Pointer to a buffer receiving a newline-delimited list of the names of all the supported ziAPI implementations. The string is zero-terminated.

[in] bufferSize

The size of the buffer assigned to the implementations parameter

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_LENGTH if the length of the char-buffer given by MaxLen is too small for all elements
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnectEx

ziAPIConnectEx

ZIResult_enum ziAPIConnectEx (ZIConnection conn, const char* hostname, uint16_t port, ZIAPIVersion_enum apiLevel, const char* implementation)

Connects to Data Server and enables extended ziAPI.

With apiLevel=ZI_API_VERSION_1 and implementation=NULL, this call is equivalent to plain ziAPIConnect. With other version and implementation values enables corresponding ziAPI extension and connection using different implementation.

Parameters:

[in] conn

Pointer to the ZIConnection with which the connection should be established

[in] hostname

Name of the host to which it should be connected, if NULL "localhost" will be used as default

[in] port

The number of the port to connect to. If 0 the port of the local Data Server will be used

[in] apiLevel

Specifies the ziAPI compatibility level to use for this connection (1 or 4).

[in] implementation

Specifies implementation to use for a connection, must be one of the returned by ziAPIListImplementations or NULL to select default implementation

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_HOSTNAME if the given host name could not be found
- ZI_ERROR_SOCKET_CONNECT if no connection could be established
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_SOCKET_INIT if initialization of the socket failed
- ZI_ERROR_CONNECTION when the Data Server didn't return the correct answer or requested implementation is not found or doesn't support requested ziAPI level
- ZI_ERROR_TIMEOUT when initial communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIListImplementations, ziAPIConnect, ziAPIDisconnect, ziAPIInit, ziAPIDestroy, ziAPIGetConnectionVersion

See Connection for an example

ziAPIGetConnectionAPILevel

ZIResult_enum ziAPIGetConnectionAPILevel (ZIConnection conn, ZIAPIVersion_enum* apiLevel)

Returns ziAPI level used for the connection conn.

Parameters:

[in] conn

Pointer to ZIConnection

[out] apiLevel

Pointer to preallocated ZIAPIVersion_enum, receiving the ziAPI level

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION if level can not be determined due to conn is not connected

See Also:

ziAPIConnectEx, ziAPIGetVersion, ziAPIGetCommitHash, ziAPIGetRevision

ziAPIGetVersion

ZIResult_enum ziAPIGetVersion (const char** version)

Retrieves the release version of ziAPI.

Sets the passed pointer to point to the null-terminated release version string of ziAPI.

Parameters:

[in] version
Pointer to const char pointer.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:
ziAPIConnectEx, ziAPIGetRevision, ziAPIGetCommitHash, ziAPIGetConnectionAPILevel

ziAPIGetCommitHash

ZIResult_enum ziAPIGetCommitHash (const char** commitHash)

Retrieves the exact commit hash key of ziAPI.

Sets the passed pointer to point to the null-terminated commit hash string of ziAPI.

Parameters:

[in] commitHash
Pointer to const char pointer.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnectEx, ziAPIGetRevision, ziAPIGetVersion, ziAPIGetConnectionAPILevel

ziAPIGetRevision

ZIResult_enum ziAPIGetRevision (uint32_t* revision)

Retrieves the version and build number of ziAPI.

Sets an unsigned int with the version and build number of the ziAPI you are using.

The number is a packed representation of YY.MM.BUILD as a 32-bit unsigned integer: (YY << 24) | (MM << 16) | BUILD.

Note: prior to LabOne 19.10, the packed representation did not contain YY.MM.

Parameters:

[in] revision

Pointer to an unsigned int to fill up with the packed version number.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnectEx, ziAPIGetVersion, ziAPIGetCommitHash, ziAPIGetConnectionAPILevel

ziAPIListNodes

ZIResult_enum ziAPIListNodes (ZIConnection conn, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

Returns all child nodes found at the specified path.

This function returns a list of node names found at the specified path. The path may contain wildcards so that the returned nodes do not necessarily have to have the same parents. The list is returned in a null-terminated char-buffer, each element delimited by a newline. If the maximum length of the buffer (bufferSize) is not sufficient for all elements, nothing will be returned and the return value will be ZIResult_enum::ZI_LENGTH.

Parameters:

[in] conn

Pointer to the ZIConnection for which the node names should be retrieved.

[in] path

Path for which all children will be returned. The path may contain wildcard characters.

[out] nodes

Upon call filled with newline-delimited list of the names of all the children found. The string is zero-terminated.

[in] bufferSize

The length of the buffer used for the nodes output parameter.

[in] flags

A combination of flags (applied bitwise) as defined in ZIListNodes_enum.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by bufferSize is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Tree Listing for an example

See Also:

ziAPIUpdate

ziAPIListNodesJSON

ZIResult_enum ziAPIListNodesJSON (ZIConnection conn, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

Returns all child nodes found at the specified path.

This function returns a list of node names found at the specified path, formatted as JSON. The path may contain wildcards so that the returned nodes do not necessarily have to have the same parents. The list is returned in a null-terminated char-buffer. If the maximum length of the buffer (bufferSize) is not sufficient for all elements, nothing will be returned and the return value will be ZIResult_enum::ZI_LENGTH.

Parameters:

[in] conn

Pointer to the ZIConnection for which the node names should be retrieved.

[in] path

Path for which all children will be returned. The path may contain wildcard characters.

[out] nodes

Upon call filled with JSON-formatted list of the names of all the children found. The string is zero-terminated.

[in] bufferSize

The length of the buffer used for the nodes output parameter.

[in] flags

A combination of flags (applied bitwise) as defined in ZIListNodes_enum.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by bufferSize is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Tree Listing for an example

See Also:

ziAPIUpdate

ziAPIUpdateDevices

ZIResult_enum ziAPIUpdateDevices (ZIConnection conn)

Search for the newly connected devices and update the tree.

This function forces the Data Server to search for newly connected devices and to connect to run them

Parameters:

[in] conn

Pointer to ZIConnection

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIListNodes

ziAPIConnectDevice

ZIResult_enum ziAPIConnectDevice (ZIConnection conn, const char* deviceSerial, const char* deviceInterface, const char* interfaceParams)

Connect a device to the server.

This function connects a device with deviceSerial via the specified deviceInterface for use with the server.

Parameters:

[in] conn

Pointer to the ZIConnection with which the connection should be established

[in] deviceSerial

The serial of the device to connect to, e.g., dev2100

[in] deviceInterface

The interface to use for the connection, e.g., USB|1GbE

[in] interfaceParams

Parameters for interface configuration (currently reserved for future use, NULL may be specified).

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDisconnectDevice, ziAPIConnect, ziAPIDisconnect, ziAPIInit

ziAPIDisconnectDevice

ZIResult_enum ziAPIDisconnectDevice (ZIConnection conn, const char* deviceSerial)

Disconnect a device from the server.

This function disconnects a device specified by deviceSerial from the server.

Parameters:

[in] conn

Pointer to the ZIConnection with which the connection should be established

[in] deviceSerial

The serial of the device to connect to, e.g., dev2100

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIConnectDevice, ziAPIConnect, ziAPIDisconnect, ziAPIInit

ziAPIGetValueD

ZIResult_enum ziAPIGetValueD (ZIConnection conn, const char* path, ZIDoubleData* value)

gets the double-type value of the specified node

This function retrieves the numerical value of the specified node as an double-type value. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] value

Pointer to a double in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2018] Zurich Instruments AG

#include <algorithm>
#include <ctime>
#include <iostream>
#include <map>
#include <string>

#include "ziAPI.h"
#include "ziUtils.h"

void setDemodRate(ZIConnection conn, const char** deviceId, uint32_t index,
 ZIDoubleData rate) {
  char nodePath[1024];
  snprintf(nodePath, sizeof(nodePath), "/%s/demods/%d/rate", *deviceId, index);
  checkError(ziAPISetValueD(conn, nodePath, rate));
}

ZIDoubleData getDemodRate(ZIConnection conn, const char** deviceId, uint32_t index) {
  ZIDoubleData rate;
```

```
  char nodePath[1024];
  snprintf(nodePath, sizeof(nodePath), "/%s/demods/%d/rate", *deviceId, index);
  checkError(ziAPIGetValueD(conn, nodePath, &rate));
  return rate;
}

int main() {
  // The device address of the device to run the example on.
  char deviceAddress[] = "dev2006";
  // The maximum API Level supported by this example.
  // Please use ZI_API_VERSION_1 if using an HF2 Instrument.
  ZIAPIVersion_enum apiLevel = ZI_API_VERSION_6;

  // The ZIConnection is actually a pointer.
  ZIConnection conn;
  if (isError(ziAPIInit(&conn))) {
    return 1;
  }

  ziAPISetDebugLevel(0);
  ziAPIWriteDebugLog(0, "Logging enabled.");

  const char *deviceId;
  if (!ziCreateAPISession(conn, deviceAddress, apiLevel, &deviceId)) {
    try {
      ziApiServerVersionCheck(conn);

      // Set a device configuration.
      uint32_t index = 0;
      ZIDoubleData rate = 10e3;
      setDemodRate(conn, &deviceId, index, rate);

      // Read it back.
      rate = getDemodRate(conn, &deviceId, index);
      std::cout << "[INFO] " << "Device " << deviceId << " demod " << index << " has
 rate " << rate << ".\n";

    } catch (std::runtime_error& e) {
      char extErrorMessage[1024] = "";
      ziAPIGetLastError(conn, extErrorMessage, 1024);
      fprintf(stderr, "[ERROR] %s\ndetails: `%s`\n.", e.what(), extErrorMessage);
    } catch (...) {
      // Ensure all exceptions are caught.
      fprintf(stderr, "[ERROR] Unexpected error\n.");
    }
    ziAPIDisconnect(conn);
  } else {
    char extErrorMessage[1024] = "";
    ziAPIGetLastError(conn, extErrorMessage, 1024);
    fprintf(stderr, "[ERROR] Details: `%s`.\n", extErrorMessage);
  }
  ziAPIDestroy(conn);

  return 0;
}
```

See Also:

ziAPISetValueD, ziAPIGetValueAsPollData

ziAPIGetComplexData

ZIResult_enum ziAPIGetComplexData (ZIConnection conn, const char* path, ZIDoubleData* real, ZIDoubleData* imag)

gets the complex double-type value of the specified node

This function retrieves the numerical value of the specified node as an complex double-type value. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] real

Pointer to a double in which the real value should be written

[out] imag

Pointer to a double in which the imaginary value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2018] Zurich Instruments AG

#include <algorithm>
#include <ctime>
#include <iostream>
#include <map>
#include <string>

#include "ziAPI.h"
#include "ziUtils.h"

void setDemodRate(ZIConnection conn, const char** deviceId, uint32_t index,
 ZIDoubleData rate) {
  char nodePath[1024];
  snprintf(nodePath, sizeof(nodePath), "/%s/demods/%d/rate", *deviceId, index);
  checkError(ziAPISetValueD(conn, nodePath, rate));
```

```
}

ZIDoubleData getDemodRate(ZIConnection conn, const char** deviceId, uint32_t index) {
  ZIDoubleData rate;
  char nodePath[1024];
  snprintf(nodePath, sizeof(nodePath), "/%s/demods/%d/rate", *deviceId, index);
  checkError(ziAPIGetValueD(conn, nodePath, &rate));
  return rate;
}

int main() {
  // The device address of the device to run the example on.
  char deviceAddress[] = "dev2006";
  // The maximum API Level supported by this example.
  // Please use ZI_API_VERSION_1 if using an HF2 Instrument.
  ZIAPIVersion_enum apiLevel = ZI_API_VERSION_6;

  // The ZIConnection is actually a pointer.
  ZIConnection conn;
  if (isError(ziAPIInit(&conn))) {
    return 1;
  }

  ziAPISetDebugLevel(0);
  ziAPIWriteDebugLog(0, "Logging enabled.");

  const char *deviceId;
  if (!ziCreateAPISession(conn, deviceAddress, apiLevel, &deviceId)) {
    try {
      ziApiServerVersionCheck(conn);

      // Set a device configuration.
      uint32_t index = 0;
      ZIDoubleData rate = 10e3;
      setDemodRate(conn, &deviceId, index, rate);

      // Read it back.
      rate = getDemodRate(conn, &deviceId, index);
      std::cout << "[INFO] " << "Device " << deviceId << " demod " << index << " has
 rate " << rate << ".\n";

    } catch (std::runtime_error& e) {
      char extErrorMessage[1024] = "";
      ziAPIGetLastError(conn, extErrorMessage, 1024);
      fprintf(stderr, "[ERROR] %s\ndetails: `%s`\n.", e.what(), extErrorMessage);
    } catch (...) {
      // Ensure all exceptions are caught.
      fprintf(stderr, "[ERROR] Unexpected error\n.");
    }
    ziAPIDisconnect(conn);
  } else {
    char extErrorMessage[1024] = "";
    ziAPIGetLastError(conn, extErrorMessage, 1024);
    fprintf(stderr, "[ERROR] Details: `%s`.\n", extErrorMessage);
  }
  ziAPIDestroy(conn);

  return 0;
}
```

See Also:

ziAPISetComplexData, ziAPIGetValueAsPollData

ziAPIGetValueI

ZIResult_enum ziAPIGetValueI (ZIConnection conn, const char* path, ZIIntegerData* value)

gets the integer-type value of the specified node

This function retrieves the numerical value of the specified node as an integer-type value. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] value

Pointer to an 64bit integer in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPISetValueI, ziAPIGetValueAsPollData

ziAPIGetDemodSample

ZIResult_enum ziAPIGetDemodSample (ZIConnection conn, const char* path, ZIDemodSample* value)

Gets the demodulator sample value of the specified node.

This function retrieves the value of the specified node as an DemodSample struct. The value first found is returned if more than one value is available (a wildcard is used in the path). This function is only applicable to paths matching DEMODS/[0-9]+/SAMPLE.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] value

Pointer to a ZIDemodSample struct in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void GetSampleS(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  ZIDemodSample DemodSample;

  if ((RetVal = ziAPIGetDemodSample(Conn,
                                    "/dev1046/demods/0/sample",
                                    &DemodSample)) != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, can't get Parameter: %s.\n", ErrBuffer);
  } else {
```

```
        printf("TS = %f, X=%f, Y=%f\n",
               (float)DemodSample.timeStamp,
               DemodSample.x,
               DemodSample.y);
    }
}
```

See Also:

ziAPIGetValueAsPollData

ziAPIGetDIOSample

ZIResult_enum ziAPIGetDIOSample (ZIConnection conn, const char* path, ZIDIOSample* value)

Gets the Digital I/O sample of the specified node.

This function retrieves the newest available DIO sample from the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path). This function is only applicable to nodes ending in "/DIOS/[0-9]+/INPUT".

Parameters:

[in] conn

Pointer to the ZIConnection with which the value should be retrieved

[in] path

Path to the node holding the value

[out] value

Pointer to a ZIDIOSample struct in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void GetDIOSample(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  ZIDIOSample DIOSample;

  if ((RetVal = ziAPIGetDIOSample(Conn,
                                  "/dev1046/dios/0/output",
                                  &DIOSample)) != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, can't get Parameter: %s.\n", ErrBuffer);
  } else {
```

```
        printf("TS = %f, bits=%08x\n",
               (float)DIOSample.timeStamp,
               DIOSample.bits);
    }
  }
```

See Also:

ziAPIGetValueAsPollData

ziAPIGetAuxInSample

ZIResult_enum ziAPIGetAuxInSample (ZIConnection conn, const char* path, ZIAuxInSample* value)

gets the AuxIn sample of the specified node

This function retrieves the newest available AuxIn sample from the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path). This function is only applicable to nodes ending in "/AUXINS/[0-9]+/SAMPLE".

Parameters:

[in] conn

Pointer to the ziConnection with which the Value should be retrieved

[in] path

Path to the Node holding the value

[out] value

Pointer to an ZIAuxInSample struct in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void GetSampleAuxIn(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  ZIAuxInSample AuxInSample;

  if ((RetVal = ziAPIGetAuxInSample(Conn,
                                    "/dev1046/auxins/0/sample",
                                    &AuxInSample)) != ZI_INFO_SUCCESS) {
    ziAPIGetError(RetVal, &ErrBuffer, NULL);
    fprintf(stderr, "Error, can't get Parameter: %s\n", ErrBuffer);
```

```
    } else {
      printf("TS = %f, ch0=%f, ch1=%f\n",
             (float)AuxInSample.timeStamp,
             AuxInSample.ch0,
             AuxInSample.ch1);
    }
  }
```

See Also:

ziAPIGetValueAsPollData

ziAPIGetValueB

ZIResult_enum ziAPIGetValueB (ZIConnection conn, const char* path, unsigned char* buffer, unsigned int* length, unsigned int bufferSize)

gets the Bytearray value of the specified node

This function retrieves the newest available DIO sample from the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] path

Path to the Node holding the value

[out] buffer

Pointer to a buffer to store the retrieved data in

[out] length

Pointer to an unsigned int to store the length of data in. if an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void PrintVersion(ZIConnection Conn) {
  ZIResult_enum RetVal;
  char* ErrBuffer;
```

```
    const char* Path = "ZI/ABOUT/VERSION";
    unsigned char Buffer[0xff];
    unsigned int Length;

    if ((RetVal = ziAPIGetValueB(Conn,
                                 Path,
                                 Buffer,
                                 &Length,
                                 sizeof(Buffer) - 1)) != ZI_INFO_SUCCESS) {
      ziAPIGetError(RetVal, &ErrBuffer, NULL);
      fprintf(stderr, "Error, can't get value: %s.\n", ErrBuffer);
    } else {
      Buffer[Length] = 0;
      printf("%s=\"%s\"\n", Path, Buffer);
    }
  }
```

See Also:

ziAPISetValueB, ziAPIGetValueAsPollData

ziAPIGetValueString

ZIResult_enum ziAPIGetValueString (ZIConnection conn, const char* path, char* buffer, unsigned int* length, unsigned int bufferSize)

gets a null-terminated string value of the specified node

This function retrieves the newest string value for the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] path

Path to the Node holding the value

[out] buffer

Pointer to a buffer to store the retrieved null-terminated string

[out] length

Pointer to an unsigned int to store the length of the string in (including the null terminator). If an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPISetValueString, ziAPIGetValueAsPollData

ziAPIGetValueStringUnicode

ZIResult_enum ziAPIGetValueStringUnicode (ZIConnection conn, const char* path, wchar_t* wbuffer, unsigned int* length, unsigned int bufferSize)

gets a null-terminated string value of the specified node

This function retrieves the newest unicode string value for the specified node. The value first found is returned if more than one value is available (a wildcard is used in the path).

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] path

Path to the Node holding the value

[out] wbuffer

Pointer to a buffer to store the retrieved null-terminated string

[out] length

Pointer to an unsigned int to store the length of the string in (including the null terminator). If an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPISetValueStringUnicode, ziAPIGetValueAsPollData

ziAPISetValueD

ZIResult_enum ziAPISetValueD (ZIConnection conn, const char* path, ZIDoubleData value)

asynchronously sets a double-type value to one or more nodes specified in the path

This function sets the values of the nodes specified in path to Value. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set.

[in] path

Path to the Node(s) for which the value(s) will be set to Value.

[in] value

The double-type value that will be written to the node(s).

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueD, ziAPISyncSetValueD

ziAPISetComplexData

ZIResult_enum ziAPISetComplexData (ZIConnection conn, const char* path, ZIDoubleData real, ZIDoubleData imag)

asynchronously sets a double-type complex value to one or more nodes specified in the path

This function sets the values of the nodes specified in path to the complex value (real, imag). More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set. If the node does not support complex values only the real value will be updated.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set.

[in] path

Path to the Node(s) for which the value(s) will be set to Value.

[in] real

The real value that will be written to the node(s).

[in] imag

The imag value that will be written to the node(s).

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetComplexData. ziAPISyncSetComplexData

ziAPISetValueI

ZIResult_enum ziAPISetValueI (ZIConnection conn, const char* path, ZIIntegerData value)

asynchronously sets an integer-type value to one or more nodes specified in a path

This function sets the values of the nodes specified in path to Value. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] value

The int-type value that will be written to the node(s)

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueI, ziAPISyncSetValueI

ziAPISetValueB

ZIResult_enum ziAPISetValueB (ZIConnection conn, const char* path, unsigned char* buffer, unsigned int length)

asynchronously sets the binary-type value of one or more nodes specified in the path

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] buffer

Pointer to the byte array with the data

[in] length

Length of the data in the buffer

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

```
// Copyright [2016] Zurich Instruments AG
#include <stdlib.h>
#include <stdio.h>

#include "ziAPI.h"

void ProgramCPU(ZIConnection   Conn,
                unsigned char* Buffer,
                int            Len) {
  ZIResult_enum RetVal;
  char* ErrBuffer;

  if ((RetVal = ziAPISetValueB(Conn,
```

```
                                    "/dev1046/cpus/0/program",
                                    Buffer,
                                    Len)) != ZI_INFO_SUCCESS) {
      ziAPIGetError(RetVal, &ErrBuffer, NULL);
      fprintf(stderr, "Error, can't set Parameter: %s.\n", ErrBuffer);
    }
  }
```

See Also:

ziAPIGetValueB, ziAPISyncSetValueB

ziAPISetValueString

ZIResult_enum ziAPISetValueString (ZIConnection conn, const char* path, const char* str)

asynchronously sets a string value of one or more nodes specified in the path

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] str

Pointer to a null terminated string (max 64k characters)

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueString, ziAPISyncSetValueString

ziAPISetValueStringUnicode

ZIResult_enum ziAPISetValueStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

asynchronously sets a unicode encoded string value of one or more nodes specified in the path

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. The function sets the value asynchronously which means that after the function returns you have no security to which value it is finally set nor at what point in time it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] wstr

Pointer to a null terminated unicode string (max 64k characters)

Returns:

- ZI_INFO_SUCCESS on success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred.
- ZI_ERROR_READONLY on attempt to set a read-only node.
- ZI_ERROR_COMMAND on an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT when communication timed out.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueStringUnicode. ziAPISyncSetValueStringUnicode

ziAPISyncSetValueD

ZIResult_enum ziAPISyncSetValueD (ZIConnection conn, const char* path, ZIDoubleData* value)

synchronously sets a double-type value to one or more nodes specified in the path

This function sets the values of the nodes specified in path to Value. More than one value can be set if a wildcard is used. The function sets the value synchronously. After returning you know that it is set and to which value it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set to value

[in] value

Pointer to a double-type containing the value to be written. When the function returns value holds the effectively written value.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueD, ziAPISetValueD

ziAPISyncSetValueI

ZIResult_enum ziAPISyncSetValueI (ZIConnection conn, const char* path, ZIIntegerData* value)

synchronously sets an integer-type value to one or more nodes specified in a path

This function sets the values of the nodes specified in path to value. More than one value can be set if a wildcard is used. The function sets the value synchronously. After returning you know that it is set and to which value it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the node(s) for which the value(s) will be set

[in] value

Pointer to a int-type containing then value to be written. when the function returns value holds the effectively written value.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueI, ziAPISetValueI

ziAPISyncSetValueB

ZIResult_enum ziAPISyncSetValueB (ZIConnection conn, const char* path, uint8_t* buffer, uint32_t* length, uint32_t bufferSize)

Synchronously sets the binary-type value of one ore more nodes specified in the path.

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. This function sets the value synchronously. After returning you know that it is set and to which value it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in] buffer

Pointer to the byte array with the data

[in] length

Length of the data in the buffer

[in] bufferSize

Length of the data in the buffer

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueB, ziAPISetValueB

ziAPISyncSetValueString

ZIResult_enum ziAPISyncSetValueString (ZIConnection conn, const char* path, const char* str)

Synchronously sets a string value of one or more nodes specified in the path.

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. This function sets the value synchronously. After returning you know that it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in/out] str

Pointer to a null terminated string (max 64k characters)

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueString, ziAPISetValueString

ziAPISyncSetValueStringUnicode

ZIResult_enum ziAPISyncSetValueStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

Synchronously sets a unicode string value of one or more nodes specified in the path.

This function sets the values at the nodes specified in a path. More than one value can be set if a wildcard is used. This function sets the value synchronously. After returning you know that it is set.

Parameters:

[in] conn

Pointer to the ziConnection for which the value(s) will be set

[in] path

Path to the Node(s) for which the value(s) will be set

[in/out] wstr

Pointer to a null terminated unicode string (max 64k characters)

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_READONLY on attempt to set a read-only node
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIGetValueStringUnicode, ziAPISetValueStringUnicode

ziAPISync

ZIResult_enum ziAPISync (ZIConnection conn)

Synchronizes the session by dropping all pending data.

This function drops any data that is pending for transfer. Any data (including poll data) retrieved afterwards is guaranteed to be produced not earlier than the call to ziAPISync. This ensures in particular that any settings made prior to the call to ziAPISync have been propagated to the device, and the data retrieved afterwards is produced with the new settings already set to the hardware. Note, however, that this does not include any required settling time.

Parameters:

[in] conn

Pointer to the ZIConnection that is to be synchronized

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIEchoDevice

ZIResult_enum ziAPIEchoDevice (ZIConnection conn, const char* deviceSerial)

Sends an echo command to a device and blocks until answer is received.

This is useful to flush all buffers between API and device to enforce that further code is only executed after the device executed a previous command. Per device echo is only implemented for HF2. For other device types it is a synonym to ziAPISync, and deviceSerial parameter is ignored.

Parameters:

[in] conn

Pointer to the ZIConnection that is to be synchronized

[in] deviceSerial

The serial of the device to get the echo from, e.g., dev2100

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIAllocateEventEx

ZIEvent* ziAPIAllocateEventEx ( )

Allocates ZIEvent structure and returns the pointer to it. Attention!!! It is the client code responsibility to deallocate the structure by calling ziAPIDeallocateEventEx!

This function allocates a ZIEvent structure and returns the pointer to it. Free the memory using ziAPIDeallocateEventEx.

See Also:

ziAPIDeallocateEventEx

ziAPIDeallocateEventEx

void ziAPIDeallocateEventEx (ZIEvent* ev)

Deallocates ZIEvent structure created with ziAPIAllocateEventEx().

Parameters:

[in] ev

Pointer to ZIEvent structure to be deallocated..

See Also:

ziAPIAllocateEventEx

This function is the compliment to ziAPIAllocateEventEx()

ziAPISubscribe

ZIResult_enum ziAPISubscribe (ZIConnection conn, const char* path)

subscribes the nodes given by path for ziAPIPollDataEx

This function subscribes to nodes so that whenever the value of the node changes the new value can be polled using ziAPIPollDataEx. By using wildcards or by using a path that is not a leaf node but contains sub nodes, more than one leaf can be subscribed to with one function call.

Parameters:

[in] conn

Pointer to the ziConnection for which to subscribe for

[in] path

Path to the nodes to subscribe

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Data Handling for an example

See Also:

ziAPIUnSubscribe, ziAPIPollDataEx, ziAPIGetValueAsPollData

ziAPIUnSubscribe

ZIResult_enum ziAPIUnSubscribe (ZIConnection conn, const char* path)

unsubscribes to the nodes given by path

This function is the complement to ziAPISubscribe. By using wildcards or by using a path that is not a leaf node but contains sub nodes, more than one node can be unsubscribed with one function call.

Parameters:

[in] conn

Pointer to the ziConnection for which to unsubscribe for

[in] path

Path to the Nodes to unsubscribe

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no node given by path is able to hold values
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Data Handling for an example

See Also:

ziAPISubscribe, ziAPIPollDataEx, ziAPIGetValueAsPollData

ziAPIPollDataEx

ZIResult_enum ziAPIPollDataEx (ZIConnection conn, ZIEvent* ev, uint32_t timeOutMilliseconds)

checks if an event is available to read

This function returns immediately if an event is pending. Otherwise it waits for an event for up to timeOutMilliseconds. All value changes that occur in nodes that have been subscribed to or in children of nodes that have been subscribed to are sent from the Data Server to the ziAPI session. For a description of how the data are available in the struct, refer to the documentation of struct ziEvent. When no event was available within timeOutMilliseconds, the ziEvent::Type field will be ZI_DATA_NONE and the ziEvent::Count field will be zero. Otherwise these fields hold the values corresponding to the event that occurred.

Parameters:

[in] conn

Pointer to the ZIConnection for which events should be received

[out] ev

Pointer to a ZIEvent struct in which the received event will be written

[in] timeOutMilliseconds

Time to wait for an event in milliseconds. If -1 it will wait forever, if 0 the function returns immediately.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Data Handling for an example

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIGetValueAsPollData, ziEvent

ziAPIGetValueAsPollData

ZIResult_enum ziAPIGetValueAsPollData (ZIConnection conn, const char* path)

triggers a value request, which will be given back on the poll event queue

Use this function to receive the value of one or more nodes as one or more events using ziAPIPollDataEx, even when the node is not subscribed or no value change has occurred.

Parameters:

[in] conn

Pointer to the ZIConnection with which the value should be retrieved

[in] path

Path to the Node holding the value. Note: Wildcards and paths referring to streamimg nodes are not permitted.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the Path's Length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by MaxLen is too small for all elements
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in the Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the node
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Data Handling for an example

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIPollDataEx

ziAPIAsyncSetDoubleData

ZIResult_enum ziAPIAsyncSetDoubleData (ZIConnection conn, const char* path, ZIDoubleData value)

ziAPIAsyncSetIntegerData

ZIResult_enum ziAPIAsyncSetIntegerData (ZIConnection conn, const char* path, ZIIntegerData value)

ziAPIAsyncSetByteArray

ZIResult_enum ziAPIAsyncSetByteArray (ZIConnection conn, const char* path, uint8_t* buffer, uint32_t length)

ziAPIAsyncSetString

ZIResult_enum ziAPIAsyncSetString (ZIConnection conn, const char* path, const char* str)

ziAPIAsyncSetStringUnicode

ZIResult_enum ziAPIAsyncSetStringUnicode (ZIConnection conn, const char* path, const wchar_t* wstr)

ziAPIAsyncSubscribe

ZIResult_enum ziAPIAsyncSubscribe (ZIConnection conn, const char* path, ZIAsyncTag tag)

ziAPIAsyncUnSubscribe

ZIResult_enum ziAPIAsyncUnSubscribe (ZIConnection conn, const char* path, ZIAsyncTag tag)

ziAPIAsyncGetValueAsPollData

ZIResult_enum ziAPIAsyncGetValueAsPollData (ZIConnection conn, const char* path, ZIAsyncTag tag)

ziAPIGetError

ZIResult_enum ziAPIGetError (ZIResult_enum result, char** buffer, int* base)

Returns a description and the severity for a ZIResult_enum.

This function returns a static char pointer to a description string for the given ZIResult_enum error code. It also provides a parameter returning the severity (info, warning, error). If the given error code does not exist a description for an unknown error and the base for an error will be returned. If a description or the base is not needed NULL may be passed. In general, it's recommended to use ziAPIGetLastError instead to get detailed error messages.

Parameters:

[in] result

A ZIResult_enum for which the description or base will be returned

[out] buffer

A pointer to a char array to return the description. May be NULL if no description is needed.

[out] base

The severity for the provided Status parameter:

- ZI_INFO_BASE For infos.
- ZI_WARNING_BASE For warnings.
- ZI_ERROR_BASE For errors.

Returns:

- ZI_INFO_SUCCESS Upon success.

ziAPIGetLastError

ZIResult_enum ziAPIGetLastError (ZIConnection conn, char* buffer, uint32_t bufferSize)

Returns the message from the last error that occurred.

This function can be used to obtain the error message from the last error that occurred associated with the provided ZIConnection. If the last ziAPI call is successful, then the last error message returned by ziAPIGetError is empty. Only ziAPI function calls that take ZIConnection as an input argument influence the message returned by ziAPIGetLastError, if they do not take ZIConnection as an input argument the last error message will neither be reset to be empty or set to an error message (in the case of the error). There are some exceptions to this rule, ziAPIGetLastError can also not be used with ziAPIInit, ziAPIConnect, ziAPIConnectEx and ziAPIDestroy. Note, a call to ziAPIGetLastError will also reset the last error message to empty if its call was successful. Since the buffer is left unchanged in the case of an error occurring in the call to ziAPIGetLastError it is safest to initialize the buffer with a known value, for example, "ziAPIGetLastError was not successful".

Parameters:

[in] conn

The ZIConnection from which to get the error message.

[out] buffer

A pointer to a char array to return the message.

[in] bufferSize

The length of the provided buffer.

Returns:

- ZI_INFO_SUCCESS Upon success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred. In this case the provided buffer is left unchanged.
- ZI_ERROR_LENGTH If the message's length exceeds the provided bufferSize, the message is truncated and written to buffer.

ziAPISetDebugLevel

void ziAPISetDebugLevel (int32_t debugLevel)

Enable ziAPI's log and set the severity level of entries to be included in the log.

Calling this function enables ziAPI's log at the specified severity level. On Windows the logs can be found by navigating to the Zurich Instruments "Logs" folder entry in the Windows Start Menu: Programs -> Zurich Instruments -> LabOne Servers -> Logs. This will open an Explorer window displaying folders containing log files from various LabOne components, in particular, the `ziAPILog` folder contains logs from ziAPI. On Linux, the logs can be found at "/tmp/ziAPILog_USERNAME", where "USERNAME" is the same as the output of the "whoami" command.

Parameters:

[in] debugLevel

An integer specifying the log's severity level:

- trace: 0,
- debug: 1,
- info: 2,
- status: 3,
- warning: 4,
- error: 5,
- fatal: 6,

See Also:

ziAPIWriteDebugLog

ziAPIWriteDebugLog

void ziAPIWriteDebugLog (int32_t debugLevel, const char* message)

Write a message to ziAPI's log with the specified severity.

This function may be used to write a message to ziAPI's log from client code to assist with debugging. Note, this function is only available if the implementation used in ziAPIConnectEx is "ziAPI_Core" (the default implementation). Also logging must be first enabled using ziAPISetDebugLevel.

Parameters:

[in] debugLevel

An integer specifying the severity of the message to write in the log:

- trace: 0,
- debug: 1,
- info: 2,
- status: 3,
- warning: 4,
- error: 5,
- fatal: 6,

[in] message

A character array comprising of the message to be written.

See Also:

ziAPISetDebugLevel

ReadMEMFile

ZIResult_enum ReadMEMFile (const char* filename, char* buffer, int32_t bufferSize, int32_t* bytesUsed)

ziAPIModCreate

ZIResult_enum ziAPIModCreate (ZIConnection conn, ZIModuleHandle* handle, const char* moduleId)

Create a ZIModuleHandle that can be used for asynchronous measurement tasks.

This function initializes a ziCore module and provides a pointer (handle) with which to access and work with it. Note that this function does not start the module's thread. Before the thread can be started (with ziAPIModExecute):

- the device serial (e.g., "dev100") to be used with module must be specified via ziAPIModSetByteArray.
- the desired data (node paths) to record during the measurement must be specified via ziAPIModSubscribe. The module's thread is stopped with ziAPIModClear.

Parameters:

[in] conn

The ZIConnection which should be used to initialize the module.

[out] handle

Pointer to the initialized ZIModuleHandle, which from then on can be used to reference the module.

[in] moduleId

The name specifying the type the module to create (only the following ziCore Modules are currently supported in ziAPI):

- "sweep" to initialize an instance of the Sweeper Module.
- "record" to initialize an instance of the Software Trigger (Recorder) Module.
- "zoomFFT" to initialize an instance of the Spectrum Module.
- "deviceSettings" to initialize an instance to save/load device settings.
- "pidAdvisor" to initialize an instance of the PID Advisor Module.
- "awgModule" to initialize an instance of the AWG Compiler Module.
- "impedanceModule" to initialize an instance of the Impedance Compensation Module.
- "scopeModule" to initialize an instance of the Scope Module to assembly scope shots.
- "multiDeviceSyncModule" to initialize an instance of the Device Synchronization Module.
- "dataAcquisitionModule" to initialize an instance of the Data Acquisition Module.
- "precompensationAdvisor" to initialize an instance of the Precompensation Advisor Module.
- "quantumAnalyzerModule" to initialize an instance of the Quantum Analyzer Module.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred.
- ZI_WARNING_NOTFOUND if the provided moduleId was invalid.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModClear

ziAPIModSetDoubleData

ZIResult_enum ziAPIModSetDoubleData (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIDoubleData value)

Sets a module parameter to the specified double type.

This function is used to configure (set) module parameters which have double types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] value

The double data to write to the path.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetIntegerData, ziAPIModSetByteArray, ziAPIModSetString

ziAPIModSetIntegerData

ZIResult_enum ziAPIModSetIntegerData (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIIntegerData value)

Sets a module parameter to the specified integer type.

This function is used to configure (set) module parameters which have integer types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] value

The integer data to write to the path.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetByteArray, ziAPIModSetString

ziAPIModSetByteArray

ZIResult_enum ziAPIModSetByteArray (ZIConnection conn, ZIModuleHandle handle, const char* path, uint8_t* buffer, uint32_t length)

Sets a module parameter to the specified byte array.

This function is used to configure (set) module parameters which have byte array types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] buffer

Pointer to the byte array with the data.

[in] length

Length of the data in the buffer.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetIntegerData, ziAPIModSetString

ziAPIModSetString

ZIResult_enum ziAPIModSetString (ZIConnection conn, ZIModuleHandle handle, const char* path, const char* str)

Sets a module parameter to the specified null-terminated string.

This function is used to configure (set) module parameters which have string types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] str

Pointer to a null-terminated string (max 64k characters).

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetIntegerData, ziAPIModSetByteArray

ziAPIModSetStringUnicode

ZIResult_enum ziAPIModSetStringUnicode (ZIConnection conn, ZIModuleHandle handle, const char* path, const wchar_t* wstr)

Sets a module parameter to the specified null-terminated unicode string.

This function is used to configure (set) module parameters which have string types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] wstr

Pointer to a null-terminated unicode string (max 64k characters).

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetIntegerData, ziAPIModSetByteArray

ziAPIModSetVector

ZIResult_enum ziAPIModSetVector (ZIConnection conn, ZIModuleHandle handle, const char* path, const void* vectorPtr, ZIVectorElementType_enum elementType, unsigned int numElements)

Sets a module parameter to the specified vector.

This function is used to configure (set) module parameters which have vector types.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to set data on.

[in] path

Path of the module parameter to set.

[in] vectorPtr

Pointer to the vector data.

[in] elementType

Type of elements stored in the vector.

[in] numElements

Number of elements of the vector.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSetDoubleData, ziAPIModSetIntegerData, ziAPIModSetByteArray

ziAPIModGetInteger

ZIResult_enum ziAPIModGetInteger (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIIntegerData* value)

Gets the integer-type value of the specified module parameter path.

This function is used to retrieve module parameter values of type integer.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] value

Pointer to an 64bit integer in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetDouble, ziApiModGetString

ziAPIModGetDouble

ZIResult_enum ziAPIModGetDouble (ZIConnection conn, ZIModuleHandle handle, const char* path, ZIDoubleData* value)

Gets the double-type value of the specified module parameter path.

This function is used to retrieve module parameter values of type floating point double.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] value

Pointer to an floating point double in which the value should be written

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetInteger, ziApiModGetString

ziAPIModGetString

ZIResult_enum ziAPIModGetString (ZIConnection conn, ZIModuleHandle handle, const char* path, char* buffer, unsigned int* length, unsigned int bufferSize)

gets the null-terminated string value of the specified module parameter path

This function is used to retrieve module parameter values of type string.

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] buffer

Pointer to a buffer to store the retrieved null-terminated string

[out] length

Pointer to an unsigned int to store the length of the string in (including the null terminator). If an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetInteger, ziApiModGetDouble

ziAPIModGetStringUnicode

ZIResult_enum ziAPIModGetStringUnicode (ZIConnection conn, ZIModuleHandle handle, const char* path, wchar_t* wbuffer, unsigned int* length, unsigned int bufferSize)

Gets the null-terminated string value of the specified module parameter path.

This function is used to retrieve module parameter values of type string.

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] wbuffer

Pointer to a buffer to store the retrieved null-terminated string

[out] length

Pointer to an unsigned int to store the length of the string in (including the null terminator). If an error occurred or the length of the passed buffer is insufficient, a zero will be returned

[in] bufferSize

The length of the passed buffer

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the path's length exceeds MAX_PATH_LEN
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path
- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetInteger, ziApiModGetDouble, ziAPIModGetString

ziAPIModGetVector

ZIResult_enum ziAPIModGetVector (ZIConnection conn, ZIModuleHandle handle, const char* path, void* buffer, unsigned int* bufferSize, ZIVectorElementType_enum* elementType, unsigned int* numElements)

Gets the vector stored at the specified module parameter path.

This function is used to retrieve module parameter values of type vector.

Parameters:

[in] conn

Pointer to the ziConnection with which the value should be retrieved.

[in] handle

The ZIModuleHandle specifying the module to get the value from.

[in] path

The path of the module parameter to get data from.

[out] buffer

Pointer to a buffer to store the retrieved vector buffer.

[in/out] bufferSize

Pointer to an unsigned int indicating the length of the buffer. If the length of the passed buffer is insufficient to store the vector, the value is modified to indicate the required minimum buffer size and ZI_ERROR_LENGTH is returned.

[out] elementType

Pointer to store the type of vector elements.

[out] numElements

Pointer to an unsigned int to store the number of elements of the vector. If the length of the passed buffer is insufficient, a zero will be returned.

Returns:

- ZI_INFO_SUCCESS on success
- ZI_ERROR_CONNECTION when the connection is invalid (not connected) or when a communication error occurred
- ZI_ERROR_LENGTH if the vector's length exceeds the buffer size
- ZI_WARNING_OVERFLOW when a FIFO overflow occurred
- ZI_ERROR_COMMAND on an incorrect answer of the server
- ZI_ERROR_SERVER_INTERNAL if an internal error occurred in Data Server
- ZI_WARNING_NOTFOUND if the given path could not be resolved or no value is attached to the path

- ZI_ERROR_TIMEOUT when communication timed out
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetInteger, ziApiModGetDouble, ziAPIModGetString

ziAPIModListNodes

ZIResult_enum ziAPIModListNodes (ZIConnection conn, ZIModuleHandle handle, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

Returns all child parameter node paths found under the specified parent module parameter path.

This function returns a list of parameter names found at the specified path. The path may contain wildcards. The list is returned in a null-terminated char-buffer, each element delimited by a newline. If the maximum length of the buffer (bufferSize) is not sufficient for all elements, nothing will be returned and the return value will be ZI_ERROR_LENGTH.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle from which the parameter names should be retrieved.

[in] path

Path for which all children will be returned. The path may contain wildcard characters.

[out] nodes

Upon call filled with newline-delimited list of the names of all the children found. The string is zero-terminated.

[in] bufferSize

The length of the buffer specified as the nodes output parameter.

[in] flags

A combination of flags (applied bitwise) as defined in ZIListNodes_enum.

Returns:

- ZI_INFO_SUCCESS On success
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH If the path's length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by bufferSize is too small for all elements.
- ZI_WARNING_OVERFLOW When a FIFO overflow occurred.
- ZI_ERROR_COMMAND On an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL If an internal error occurred in Data Server.
- ZI_WARNING_NOTFOUND If the given path could not be resolved.
- ZI_ERROR_TIMEOUT When communication timed out.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.

- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIModListNodesJSON

ZIResult_enum ziAPIModListNodesJSON (ZIConnection conn, ZIModuleHandle handle, const char* path, char* nodes, uint32_t bufferSize, uint32_t flags)

Returns all child parameter node paths found under the specified parent module parameter path.

This function returns a list of node names found at the specified path, formatted as JSON. The path may contain wildcards so that the returned nodes do not necessarily have to have the same parents. The list is returned in a null-terminated char-buffer. If the maximum length of the buffer (bufferSize) is not sufficient for all elements, nothing will be returned and the return value will be ZI_ERROR_LENGTH.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle from which the parameter names should be retrieved.

[in] path

Path for which all children will be returned. The path may contain wildcard characters.

[out] nodes

Upon call filled with JSON-formatted list of the names of all the children found. The string is zero-terminated.

[in] bufferSize

The length of the buffer used for the nodes output parameter.

[in] flags

A combination of flags (applied bitwise) as defined in ZIListNodes_enum.

Returns:

- ZI_INFO_SUCCESS On success
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH If the path's length exceeds MAX_PATH_LEN or the length of the char-buffer for the nodes given by bufferSize is too small for all elements.
- ZI_WARNING_OVERFLOW When a FIFO overflow occurred.
- ZI_ERROR_COMMAND On an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL If an internal error occurred in Data Server.
- ZI_WARNING_NOTFOUND If the given path could not be resolved.
- ZI_ERROR_TIMEOUT When communication timed out.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.

- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIModSubscribe

ZIResult_enum ziAPIModSubscribe (ZIConnection conn, ZIModuleHandle handle, const char* path)

Subscribes to the nodes specified by path, these nodes will be recorded during module execution.

This function subscribes to nodes so that whenever the value of the node changes while the module is executing the new value will be accumulated and then read using ziAPIModRead. By using wildcards or by using a path that is not a leaf node but contains sub nodes, more than one leaf can be subscribed to with one function call.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module in which the nodes should be subscribed to.

[in] path

Path specifying the nodes to subscribe to, may contain wildcards.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or a general error occurred, enable ziAPI's log for detailed information, see ziAPISetDebugLevel.
- ZI_ERROR_LENGTH If the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW When a FIFO overflow occurred.
- ZI_ERROR_COMMAND On an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL If an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND If the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT When communication timed out.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModUnSubscribe, ziAPIModRead

ziAPIModUnSubscribe

ZIResult_enum ziAPIModUnSubscribe (ZIConnection conn, ZIModuleHandle handle, const char* path)

Unsubscribes to the nodes specified by path.

This function is the complement to ziAPIModSubscribe. By using wildcards or by using a path that is not a leaf node but contains sub nodes, more than one node can be unsubscribed with one function call.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifyin the module in which the nodes should be unsubscribed from.

[in] path

Path specifying the nodes to unsubscribe from, may contain wildcards.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_LENGTH If the Path's Length exceeds MAX_PATH_LEN.
- ZI_WARNING_OVERFLOW When a FIFO overflow occurred.
- ZI_ERROR_COMMAND On an incorrect answer of the server.
- ZI_ERROR_SERVER_INTERNAL If an internal error occurred in the Data Server.
- ZI_WARNING_NOTFOUND If the given path could not be resolved or no node given by path is able to hold values.
- ZI_ERROR_TIMEOUT When communication timed out.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModSubscribe, ziAPIModRead

ziAPIModExecute

ZIResult_enum ziAPIModExecute (ZIConnection conn, ZIModuleHandle handle)

Starts the module's thread and its associated measurement task.

Once the module's parameters has been configured as required via, e.g. ziAPIModSetDoubleData, this function starts the module's thread. This starts the module's main measurement task which will run asynchronously. The thread will run until either the module has completed its task or until ziAPIModFinish is called. Subscription or unsubscription is not possible while the module is executing. The status of the module can be obtained with either ziAPIModFinished or ziAPIModProgress.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModCreate, ziAPIModProgress, ziAPIModFinish

ziAPIModTrigger

ZIResult_enum ziAPIModTrigger (ZIConnection conn, ZIModuleHandle handle)

Manually issue a trigger forcing data recording (SW Trigger Module only).

This function is used with the Software Trigger Module in order to manually issue a trigger in order to force recording of data. A burst of subscribed data will be recorded as configured via the SW Trigger's parameters as would a regular trigger event.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

ziAPIModProgress

ZIResult_enum ziAPIModProgress (ZIConnection conn, ZIModuleHandle handle, ZIDoubleData* progress)

Queries the current state of progress of the module's measurement task.

This function can be used to query the module's progress in performing its current measurement task, the progress is returned as a double in [0, 1], where 1 indicates task completion.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[out] progress

A pointer to ZIDoubleData indicating the current progress of the module.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModFinish, ziAPIModFinished

ziAPIModFinished

ZIResult_enum ziAPIModFinished (ZIConnection conn, ZIModuleHandle handle, ZIIntegerData* finished)

Queries whether the module has finished its measurement task.

This function can be used to query whether the module has finished its task or not.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[out] finished

A pointer to ZIIntegerData, upon return this will be 0 if the module is still executing or 1 if it has finished executing.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModFinish, ziAPIModProgress

ziAPIModFinish

ZIResult_enum ziAPIModFinish (ZIConnection conn, ZIModuleHandle handle)

Stops the module performing its measurement task.

This functions stops the module performing its associated measurement task and stops recording any data. The task and data recording may be restarted by calling ziAPIModExecute' again.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModProgress, ziAPIModFinished

ziAPIModSave

ZIResult_enum ziAPIModSave (ZIConnection conn, ZIModuleHandle handle, const char* fileName)

Saves the currently accumulated data to file.

This function saves the currently accumulated data to a file. The path of the file to save data to is specified via the module's directory parameter.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[in] fileName

The basename of the file to save the data in.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModFinish, ziAPIModFinished

ziAPIModRead

ZIResult_enum ziAPIModRead (ZIConnection conn, ZIModuleHandle handle, const char* path)

Make the currently accumulated data available for use in the C program.

This function can be used to either read (get) module parameters, in this case a path that addresses the module must be specified, or it can be used to read out the currently accumulated data from subscribed nodes in the module. In either case the actual data must then be accessed by the user using ziAPIModNextNode and ziAPIModGetChunk.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[in] path

The path specifying the module parameter(s) to get, specify NULL to obtain all subscribed data.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetChunk, ziAPIModNextNode

ziAPIModNextNode

ZIResult_enum ziAPIModNextNode (ZIConnection conn, ZIModuleHandle handle, char* path, uint32_t bufferSize, ZIValueType_enum* valueType, uint64_t* chunks)

Make the data for the next node available for reading with ziAPIModGetChunk.

After callin ziAPIModRead, subscribed data (or module parameters) may now be read out on a node-by-node and chunk-by-chunk basis. All nodes with data available in the module can be iterated over by using ziAPIModNextNode, then for each node the chunks of data available are read out using ziAPIModGetChunk. Calling this function makes the data from the next node available for read.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[out] path

A string specifying the node's path whose data chunk points to.

[in] bufferSize

The length of the buffer specified as the path output parameter.

[out] valueType

The ZIValueType_enum of the node's data.

[out] chunks

The number of chunks of data available for the node.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModRead, ziAPIModGetChunk, ziAPIModEventDeallocate

ziAPIModGetChunk

ZIResult_enum ziAPIModGetChunk (ZIConnection conn, ZIModuleHandle handle, uint64_t chunkIndex, ZIModuleEventPtr* ev)

Get the specified data chunk from the current node.

Data is read out node-by-node and then chunk-by-chunk. This function can be used to obtain specific data chunks from the current node that data is being read from. More precisely, it ppreallocates space for an event structure big enough to hold the node's data at the specified chunk index, updates ZIModuleEventPtr to point to this space and then copies the chunk data to this space.

Note, before the very first call to ziAPIModGetChunk, the ZIModuleEventPtr should be initialized to NULL and then left untouched for all subsequent calls (even after calling ziAPIModNextNode to get data from the next node). This is because ziAPIModGetChunk internally manages the required space allocation for the event and then in subsequent calls only reallocates space when it is required. It is optimized to reduce the number of required space reallocations for the event.

The ZIModuleEventPtr should be deallocated using ziAPIModEventDeallocate, otherwise the lifetime of the ZIModuleEventPtr is the same as the lifetime of the module. Indeed, the same ZIModuleEventPtr can be used, even for subsequent reads. It is also possible to work with multiple ZIModuleEventPtr so that some pointers can be kept for later processing.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[out] chunkIndex

The index of the data chunk to update the pointer to.

[out] ev

The module's ZIModuleEventPtr that points to the currently available data chunk.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModRead, ziAPIModNextNode, ziAPIModEventDeallocate

ziAPIModEventDeallocate

ZIResult_enum ziAPIModEventDeallocate (ZIConnection conn, ZIModuleHandle handle, ZIModuleEventPtr ev)

Deallocate the ZIModuleEventPtr being used by the module.

This function deallocates the ZIModuleEventPtr. Since a module event's allocated space is managed internally by ziAPIModGetChunk, when the user no longer requires the event (all data has been read out) it must be deallocated by the user with this function.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

[in] ev

The ZIModuleEventPtr to deallocate.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModGetChunk, ziAPIModRead

ziAPIModClear

ZIResult_enum ziAPIModClear (ZIConnection conn, ZIModuleHandle handle)

Terminates the module's thread and destroys the module.

This function terminates the module's thread, releases memory and resources. After calling ziAPIModClear the module's handle may not be used any more. A new instance of the module must be initialized if required. This command is especially important if modules are created repetitively inside a while or for loop, in order to prevent excessive memory and resource consumption.

Parameters:

[in] conn

The ZIConnection from which the module was created.

[in] handle

The ZIModuleHandle specifying the module to execute.

Returns:

- ZI_INFO_SUCCESS On success.
- ZI_ERROR_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_ERROR_GENERAL If a general error occurred, use ziAPIGetLastError for a detailed error message.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIModExecute, ziAPIModFinish

ziAPISetVector

ZIResult_enum ziAPISetVector (ZIConnection conn, const char* path, const void* vectorPtr, uint8_t vectorElementType, uint64_t vectorSizeElements)

vectorElementType - see ZIVectorElementType_enum

ziAPIDiscoveryFindAll

ZIResult_enum ziAPIDiscoveryFindAll (ZIConnection conn, char* deviceIds, uint32_t bufferSize)

Perform a Discovery property look-up for the specified deviceAddress and return its device ID. Attention! This invalidates all pointers previously returned by ziAPIDiscovery* calls. The deviceId need not be deallocated by the user.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[out] deviceIds

Pointer to a buffer that is to contain the list of newline-separated IDs of the devices found, e.g. "DEV2006\nDEV2007\n".

[in] bufferSize

The size of the buffer pointed to by deviceIds. If the buffer is too small to hold the complete list of device IDs, its contents remain unchanged.

Returns:

- ZI_INFO_SUCCESS
- ZI_ERROR_LENGTH The provided buffer is too small to hold the list.
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFind, ziAPIDiscoveryGet, ziAPIDiscoveryGetValueI, ziAPIDiscoveryGetValueS

ziAPIDiscoveryFind

ZIResult_enum ziAPIDiscoveryFind (ZIConnection conn, const char* deviceAddress, const char** deviceId)

Perform a Discovery property look-up for the specified deviceAddress and return its device ID. Attention! This invalidates all pointers previously returned by ziAPIDiscovery* calls. The deviceId need not be deallocated by the user.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] deviceAddress

The address or ID of the device to find, e.g., 'uhf-dev2006' or 'dev2006'.

[out] deviceId

The ID of the device that was found, e.g. 'DEV2006'.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFindAll, ziAPIDiscoveryGet, ziAPIDiscoveryGetValueI, ziAPIDiscoveryGetValueS

ziAPIDiscoveryGet

ZIResult_enum ziAPIDiscoveryGet (ZIConnection conn, const char* deviceId, const char** propsJSON)

Returns the device Discovery properties for a given device ID in JSON format. The function ziAPIDiscoveryFind must be called before ziAPIDiscoveryGet can be used. The propsJSON need not be deallocated by the user.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] deviceId

The ID of the device to get Discovery information for, as returned by ziAPIDiscoveryFind, e.g., 'dev2006'.

[out] propsJSON

The Discovery properites in JSON format of the specified device.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFind, ziAPIDiscoveryGetValueI, ziAPIDiscoveryGetValueS

ziAPIDiscoveryGetValueI

ZIResult_enum ziAPIDiscoveryGetValueI (ZIConnection conn, const char* deviceId, const char* propName, ZIIntegerData* value)

Returns the specified integer Discovery property value for a given device ID. The function ziAPIDiscoveryFind must be called with the required device ID before using ziAPIDiscoveryGetValueI.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] deviceId

The ID of the device to get Discovery information for, as returned by ziAPIDiscoveryFind, e.g., 'dev2006'.

[in] propName

The name of the desired integer Discovery property.

[out] value

Pointer to the value of the specified Discovery property.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFind, ziAPIDiscoveryGet, ziAPIDiscoveryGetValueS

ziAPIDiscoveryGetValueS

ZIResult_enum ziAPIDiscoveryGetValueS (ZIConnection conn, const char* deviceId, const char* propName, const char** value)

Returns the specified string Discovery property value for a given device ID. The function ziAPIDiscoveryFind must be called with the required device ID before using ziAPIDiscoveryGetValueS. The value must not be deallocated by the user.

Parameters:

[in] conn

Pointer to ZIConnection with which the value should be retrieved.

[in] deviceId

The ID of the device to get Discovery information for, as returned by ziAPIDiscoveryFind, e.g., 'dev2006'.

[in] propName

The name of the desired integer Discovery property.

[out] value

Pointer to the value of the specified Discovery property.

Returns:

- ZI_INFO_SUCCESS
- Other return codes may also be returned, for a detailed error message use ziAPIGetLastError.

See Also:

ziAPIDiscoveryFind, ziAPIDiscoveryGet, ziAPIDiscoveryGetValueI

ziAPIAllocateEvent

__inline ziEvent* ziAPIAllocateEvent ( )

Deprecated: See ziAPIAllocateEventEx().

ziAPIDeallocateEvent

__inline void ziAPIDeallocateEvent (ziEvent* ev)

Deprecated: See ziAPIDeallocateEventEx().

ziAPIPollData

__inline ZIResult_enum ziAPIPollData (ZIConnection conn, ziEvent* ev, int timeOut)

Checks if an event is available to read. Deprecated: See ziAPIPollDataEx().

Parameters:

[in] conn

Pointer to the ZIConnection for which events should be received

[out] ev

Pointer to a ziEvent struct in which the received event will be written

[in] timeOut

Time to wait for an event in milliseconds. If -1 it will wait forever, if 0 the function returns immediately.

Returns:

- ZI_SUCCESS On success.
- ZI_CONNECTION When the connection is invalid (not connected) or when a communication error occurred.
- ZI_OVERFLOW When a FIFO overflow occurred.

See Data Handling for an example

See Also:

ziAPISubscribe, ziAPIUnSubscribe, ziAPIGetValueAsPollData, ziEvent

ziAPIGetValueS

__inline ZIResult_enum ziAPIGetValueS (ZIConnection conn, char* path, DemodSample* value)

ziAPIGetValueDIO

__inline ZIResult_enum ziAPIGetValueDIO (ZIConnection conn, char* path, DIOSample* value)

ziAPIGetValueAuxIn

__inline ZIResult_enum ziAPIGetValueAuxIn (ZIConnection conn, char* path, AuxInSample* value)

ziAPISecondsTimeStamp

double ziAPISecondsTimeStamp (ziTimeStampType TS)

Deprecated: timestamps should instead be converted to seconds by dividing by the instrument's "clockbase". This is available as an leaf under the instrument's root "device" branch in the node hierarchy, e.g., /dev2001/clockbase.

Parameters:

[in] TS

the timestamp to convert to seconds

Returns:

The timestamp in seconds as a double

Glossary

This glossary provides easy to understand descriptions for many terms related to measurement instrumentation including the abbreviations used inside this user manual.

A

A/D
: Analog to Digital
See Also ADC.

AC
: Alternate Current

ADC
: Analog to Digital Converter

AM
: Amplitude Modulation

Amplitude Modulated AFM (AM-AFM)
: AFM mode where the amplitude change between drive and measured signal encodes the topography or the measured AFM variable.
See Also Atomic Force Microscope.

API
: Application Programming Interface

ASCII
: American Standard Code for Information Interchange

Atomic Force Microscope (AFM)
: Microscope that scans surfaces by means an oscillating mechanical structure (e.g. cantilever, tuning fork) whose oscillating tip gets so close to the surface to enter in interaction because of electrostatic, chemical, magnetic or other forces. With an AFM it is possible to produce images with atomic resolution.
See Also Amplitude Modulated AFM, Frequency Modulated AFM, Phase modulation AFM.

AVAR
: Allen Variance

B

Bandwidth (BW)
: The signal bandwidth represents the highest frequency components of interest in a signal. For filters the signal bandwidth is the cut-off point, where the transfer function of a system shows 3 dB attenuation versus DC. In this context the bandwidth is a synonym of cut-off frequency $f_{cut-off}$ or 3dB frequency f_{-3dB}. The concept of bandwidth is used when the dynamic behavior of a signal is important or separation of different signals is required.

In the context of a open-loop or closed-loop system, the bandwidth can be used to indicate the fastest speed of the system, or the highest signal update change rate that is possible with the system.

Sometimes the term bandwidth is erroneously used as synonym of frequency range.
See Also Noise Equivalent Power Bandwidth.

BNC
: Bayonet Neill-Concelman Connector

C

CF
: Clock Fail (internal processor clock missing)

Common Mode Rejection Ratio (CMRR)	Specification of a differential amplifier (or other device) indicating the ability of an amplifier to obtain the difference between two inputs while rejecting the components that do not differ from the signal (common mode). A high CMRR is important in applications where the signal of interest is represented by a small voltage fluctuation superimposed on a (possibly large) voltage offset, or when relevant information is contained in the voltage difference between two signals. The simplest mathematical definition of common-mode rejection ratio is: CMRR = 20 * log(differential gain / common mode gain).
CSV	Comma Separated Values

D

D/A	Digital to Analog
DAC	Digital to Analog Converter
DC	Direct Current
DDS	Direct Digital Synthesis
DHCP	Dynamic Host Configuration Protocol
DIO	Digital Input/Output
DNS	Domain Name Server
DSP	Digital Signal Processor
DUT	Device Under Test
Dynamic Reserve (DR)	The measure of a lock-in amplifier's capability to withstand the disturbing signals and noise at non-reference frequencies, while maintaining the specified measurement accuracy within the signal bandwidth.

E

XML	Extensible Markup Language. See Also XML.

F

FFT	Fast Fourier Transform
FIFO	First In First Out
FM	Frequency Modulation
Frequency Accuracy (FA)	Measure of an instrument's ability to faithfully indicate the correct frequency versus a traceable standard.
Frequency Modulated AFM (FM-AFM)	AFM mode where the frequency change between drive and measured signal encodes the topography or the measured AFM variable. See Also Atomic Force Microscope.
Frequency Response Analyzer (FRA)	Instrument capable to stimulate a device under test and plot the frequency response over a selectable frequency range with a fine granularity.

Frequency Sweeper	See Also Frequency Response Analyzer.

G

Gain Phase Meter	See Also Vector Network Analyzer.
GPIB	General Purpose Interface Bus
GUI	Graphical User Interface

I

I/O	Input / Output
Impedance Spectroscope (IS)	Instrument suited to stimulate a device under test and to measure the impedance (by means of a current measurement) at a selectable frequency and its amplitude and phase change over time. The output is both amplitude and phase information referred to the stimulus signal.
Input Amplitude Accuracy (IAA)	Measure of instrument's capability to faithfully indicate the signal amplitude at the input channel versus a traceable standard.
Input voltage noise (IVN)	Total noise generated by the instrument and referred to the signal input, thus expressed as additional source of noise for the measured signal.
IP	Internet Protocol

L

LAN	Local Area Network
LED	Light Emitting Diode
Lock-in Amplifier (LI, LIA)	Instrument suited for the acquisition of small signals in noisy environments, or quickly changing signal with good signal to noise ratio - lock-in amplifiers recover the signal of interest knowing the frequency of the signal by demodulation with the suited reference frequency - the result of the demodulation are amplitude and phase of the signal compared to the reference: these are value pairs in the complex plane (X, Y), (R, Θ).

M

Media Access Control address (MAC address)	Refers to the unique identifier assigned to network adapters for physical network communication.
Multi-frequency (MF)	Refers to the simultaneous measurement of signals modulated at arbitrary frequencies. The objective of multi-frequency is to increase the information that can be derived from a measurement which is particularly important for one-time, non-repeating events, and to increase the speed of a measurement since different frequencies do not have to be applied one after the other. See Also Multi-harmonic.
Multi-harmonic (MH)	Refers to the simultaneous measurement of modulated signals at various harmonic frequencies. The objective of multi-frequency is to increase the

information that can be derived from a measurement which is particularly important for one-time, non-repeating events, and to increase the speed of a measurement since different frequencies do not have to be applied one after the other.
See Also Multi-frequency.

N

Noise Equivalent Power Bandwidth (NEPBW)	Effective bandwidth considering the area below the transfer function of a low-pass filter in the frequency spectrum. NEPBW is used when the amount of power within a certain bandwidth is important, such as noise measurements. This unit corresponds to a perfect filter with infinite steepness at the equivalent frequency. See Also Bandwidth.
Nyquist Frequency (NF)	For sampled analog signals, the Nyquist frequency corresponds to two times the highest frequency component that is being correctly represented after the signal conversion.

O

Output Amplitude Accuracy (OAA)	Measure of an instrument's ability to faithfully output a set voltage at a given frequency versus a traceable standard.
OV	Over Volt (signal input saturation and clipping of signal)

P

PC	Personal Computer
PD	Phase Detector
Phase-locked Loop (PLL)	Electronic circuit that serves to track and control a defined frequency. For this purpose a copy of the external signal is generated such that it is in phase with the original signal, but with usually better spectral characteristics. It can act as frequency stabilization, frequency multiplication, or as frequency recovery. In both analog and digital implementations it consists of a phase detector, a loop filter, a controller, and an oscillator.
Phase modulation AFM (PM-AFM)	AFM mode where the phase between drive and measured signal encodes the topography or the measured AFM variable. See Also Atomic Force Microscope.
PID	Proportional-Integral-Derivative
PL	Packet Loss (loss of packets of data between the instruments and the host computer)

R

RISC	Reduced Instruction Set Computer
Root Mean Square (RMS)	Statistical measure of the magnitude of a varying quantity. It is especially useful when variates are positive and negative, e.g., sinusoids, sawtooth, square waves. For a sine wave the following relation holds between the

amplitude and the RMS value: $U_{RMS} = U_{PK} / \sqrt{2} = U_{PK} / 1.41$. The RMS is also called quadratic mean.

RT — Real-time

S

Scalar Network Analyzer (SNA) — Instrument that measures the voltage of an analog input signal providing just the amplitude (gain) information.
See Also Spectrum Analyzer, Vector Network Analyzer.

SL — Sample Loss (loss of samples between the instrument and the host computer)

Spectrum Analyzer (SA) — Instrument that measures the voltage of an analog input signal providing just the amplitude (gain) information over a defined spectrum.
See Also Scalar Network Analyzer.

SSH — Secure Shell

T

TC — Time Constant

TCP/IP — Transmission Control Protocol / Internet Protocol

Thread — An independent sequence of instructions to be executed by a processor.

Total Harmonic Distortion (THD) — Measure of the non-linearity of signal channels (input and output)

TTL — Transistor to Transistor Logic level

U

UHF — Ultra-High Frequency

UHS — Ultra-High Stability

USB — Universal Serial Bus

V

VCO — Voltage Controlled Oscillator

Vector Network Analyzer (VNA) — Instrument that measures the network parameters of electrical networks, commonly expressed as s-parameters. For this purpose it measures the voltage of an input signal providing both amplitude (gain) and phase information. For this characteristic an older name was gain phase meter.
See Also Gain Phase Meter, Scalar Network Analyzer.

X

XML — Extensible Markup Language: Markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

Z

ZCtrl	Zurich Instruments Control bus
ZoomFFT	This technique performs FFT processing on demodulated samples, for instance after a lock-in amplifier. Since the resolution of an FFT depends on the number of point acquired and the spanned time (not the sample rate), it is possible to obtain very highly resolution spectral analysis.
ZSync	Zurich Instruments Synchronization bus

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