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WaveForms™ SDK Reference Manual

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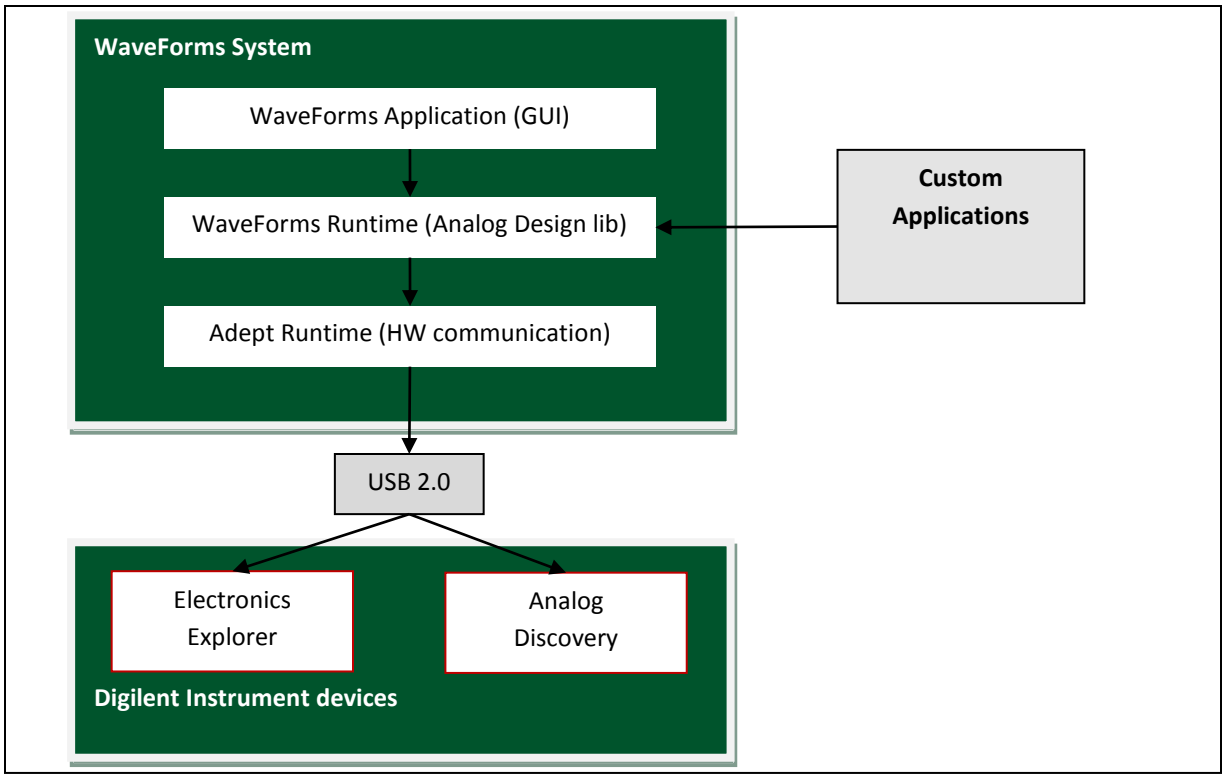
Overview

WaveForms™ provides an interface that allows users to interact with Digilent Analog Design hardware, such as the Analog Discovery™ and Electronics Explorer™. While the WaveForms application offers a refined graphical interface, the WaveForms SDK provides access to a public application programming interface (API) that gives users the ability to create custom PC applications.

This WaveForms SDK manual describes the main components and architecture of the WaveForms system and details each function contained in the WaveForms API. The SDK package also offers examples demonstrating how to identify, connect to, and control analog hardware devices.



1 The System

The WaveForms System is comprised of multiple components. The most visible component is the WaveForms Application; a suite of graphical instrument panels that give full access to the analog and digital instruments in the connected hardware. The WaveForms application uses the WaveForms Runtime to communicate with the device. For a custom application it is suffice to access only the WaveForms Runtime, but both of these Runtimes are required on target machine in order to run the application. The WaveForms Runtime is comprised of the *DWF* Dynamic Library and several configuration files. This library is located in:

- Windows in System Directory: C: \Windows\System32\dwf.dll
- Linux: /usr/lib/libdwf.so.x.x.x

The static library is located in Windows through the install path:

- Windows 32-bit: C:\Program Files\Digilent\WaveFormsSDK\lib\x86
- Windows 64-bit: C:\Program Files (x86)\Digilent\WaveFormsSDK\lib\x64

The C header file is located in:

- Windows: C:\Program Files\Digilent\WaveFormsSDK\inc
- Windows 64-bit: C:\Program Files (x86)\Digilent\WaveFormsSDK\inc
- Linux: /usr/include/digilent/waveforms

Working code examples are provided with the SDK to demonstrate basic use of each API function set. You can find samples in the installation directory, which are located here:

- Windows 32-bit: C:\Program Files\Digilent\WaveFormsSDK\samples
- Windows 64-bit: C:\Program Files (x86)\Digilent\WaveFormsSDK\samples
- Linux: /usr/share/digilent/waveforms/samples
- OS X: /Applications/WaveForms.app/Contents/Resources/SDK/

The DWF Library uses the Digilent Adept Runtime, which provides basic communication with the targeted hardware instruments (i.e., Analog Discovery and Electronics Explorer). Although the Adept Runtime is an integral part of the WaveForms System, knowledge of its structure *is not required* to write custom applications.

On Mac OS X the WaveFroms Runtime (including Adept Runtime) is installed to:

- /Library/Frameworks/dwf.framework

1.1 The API

Everything needed to write custom applications is included in the WaveForms SDK, which provides the header/library files and documentation to access the API for the DWF Library. A custom application must properly link to these files to make the appropriate API function calls. Every function in the WaveForms public API is declared in the dwf.h header file.

Basic usage of the WaveForms API can be broken down into the following steps:

1. Call enumeration functions to discover connected hardware devices.
2. Call *FDwfDeviceOpen* function to establish a connection to specific hardware device.
3. Call function to enable instrument within hardware device.
4. Call functions to configure instrument and acquire/generate signals.
5. Call function to disable instrument.
6. Call *FDwfDeviceClose* function to disconnect from device.

There are nine main groups of API functions, each named with different prefixes:

Main Groups of API Functions	Instrument Function	Prefix
Device Enumeration	Controls the enumeration of connected and supported devices.	*DwfEnum*
Device Control	Controls opening and closing specific devices.	*DwfDevice*
AnalogIn (Oscilloscope)	Acquires samples from each enabled channel synchronously.	*DfwAnalogIn*
AnalogOut (Arbitrary Waveform Generator)	Drives signals from each channel independently.	*DfwAnalogOut*
AnalogIO	Acquires and drives various analog signals.	*DfwAnalogIO*
DigitalIn (Logic Analyzer)	Acquires samples from digital I/O pins.	*DfwDigitalIn*
DigitalOut (Pattern Generator)	Drives digital I/O signals.	*DfwDigitalOut*
DigitalIO	Acquires and drives digital I/O signals.	*DfwDigitalIO*
System	Obtain basic system information that is instrument and device independent.	*DfwGet*

Each instrument is directly controlled using three types of functions in the API:

API Functions	Instrument Function	Example
Reset function	This function resets all of the instrument parameters to default values.	*FDwfAnalogInReset*
		FDwfAnalogOutReset
		FDwfDigitalIOReset
Configure function	This function configures and/or starts the instrument.	*FDwfAnalogInConfigure*
		FDwfAnalogOutConfigure
		FDwfDigitalIOConfigure
Status function	This function polls and reads all information from the instrument.	*FDwfAnalogInStatus*
		FDwfAnalogOutStatus
		FDwfDigitalIOStatus

Note: Although there are multiple "Status" functions for each instrument, these functions are the only ones that actually read data from the device.

There are a number of type definitions and corresponding constants in the dwf.h include file. The majority of them are used as parameters. When a hardware device is opened, a handle is returned (HDWF), which is used to access and finally close in all instrument API functions.

The following examples are provided in Python and C++ language.

File	Description
Device_Enumeration	List the supported and connected devices.
AnalogIO_AnalogDiscovery_SystemMonitor	Reading the system monitor information
AnalogIO_AnalogDiscovery_Power	Enable power supplies.
AnalogOut_Sine	Generate sine waveform on analog out channel.
AnalogOut_Sweep	Generate frequency sweep.
AnalogOut_Custom	Arbitrary waveform generation.
AnalogOut_Sync	How to synchronize the analog output channels
AnalogOutIn	Generate analog output signal and perform analog in acquisition.
AnalogIn_Sample	Open the first device, configure analog in and read single sample.
AnalogIn_Acquisition	Perform acquisition and plot data for first channel.
AnalogIn_Trigger	Perform triggered acquisition.
AnalogIn_Record	Performs recording of large number of samples.
DigitalIO	Drive and read digital IO pins
DigitalOut_Pins	Generate pulse, random and custom signal on digital out pins.
DigitalOut_BinrayCounter	Generate binary counter
DigitalIn_Acquisition	Generate signals on digital out and perform acquisition on digital in.
DigitalIn_Record	Perform recording of large number of digital in samples.

1.2 Calling API Functions

The API functions are C style and return a Boolean value: TRUE if the call is successful, FALSE if unsuccessful. This Boolean value is an integer type definition, *not* the standard c-type bool. In general, the API functions contain variations of the following parameters:

Parameters	Parameter Function
***Info**	Returns detailed information about the parameter support for the instrument (i.e., minimum/maximum values, supported modes, etc.)
***Set**	Sets an instrument parameter. When the AutoConfigure is enabled (by default), the instrument is reconfigured and stopped.
***Get**	Gets the actual instrument parameter. Use this function to get the actual set value. For instance, an arbitrary voltage offset is set and Get returns the real DAC output value.
***Status**	Returns the parameter value from the device.

The API functions won't fail when a parameter pointer is NULL or when a setting (*Set) parameter value is out of limits. To verify the actual setting value, use the *Get API return the actual value.

The indices used in function parameters are zero based.

The supported discrete parameters are retrieved in bit field value. To decode the capabilities of the device use the `IsBitSet` macro.

```
int fsfilter;
FDwfAnalogInChannelFilterInfo(h, &fsfilter)
if(IsBitSet(fsfilter, filterAverage)){
    FDwfAnalogInChannelFilterSet(hdwf, 0, filterAverage)
}
```

2 System

FDwfGetLastError(DWFERC *pdwferc)

Parameters:
- pdwferc - Variable to receive error code.

The function above is used to retrieve the last error code in the calling process. The error code is cleared when other API functions are called and is only set when an API function fails during execution. Error codes are declared in dwf.h:

API Error Codes	Error Code Definition
dwfercNoErc	No error occurred.
dwfercUnknownError	Call waiting on pending API time out.
dwfercApiLockTimeout	Call waiting on pending API time out.
dwfercAlreadyOpened	Device already opened.
dwfercNotSupported	Device not supported.
dwfercInvalidParameter0	Parameter 0 was invalid in last API call.
dwfercInvalidParameter1	Parameter 1 was invalid in last API call.
dwfercInvalidParameter2	Parameter 2 was invalid in last API call.
dwfercInvalidParameter3	Parameter 3 was invalid in last API call.

FDwfGetLastErrorMsg(char szError[512])

Parameters:
- szError - Pointer to buffer to receive error string.

The function above is used to retrieve the last error message. This may consist of a chain of messages, separated by a new line character, that describe the events leading to the failure.

FDwfGetVersion(char szVersion[32])

Parameters:
- szVersion - Pointer to buffer to receive version string.

The function above is used to retrieve the version string. The version string is composed of major, minor, and build numbers (i.e., “2.0.19”).

3 Device Enumeration

The *FDwfEnum* functions are used to discover all connected, compatible devices.

See Device_Enumeration.py example.

FDwfEnum(ENUMFILTER enumfilter, int *pnDevice)

Parameters:
- enumfilter – Filter value to be used for device enumeration. Use the *enumfilterAll* constant to discover all compatible devices.
- pnDevice – Integer pointer to return count of found devices by reference.

Calling the function above will build an internal list of detected devices filtered by the *enumfilter* parameter. The function above must be called before using other *FDwfEnum* functions because they obtain information about enumerated devices from this list identified by the device index.

FDwfEnumDeviceType(int idxDevice, DEVID *pDeviceId, DEVVER *pDeviceRevision)

Parameters:
- idxDevice – Zero based index of the enumerated device for which to return the type and revision.
- pDeviceId – Variable to return the device id.
- pDeviceRevision – Pointer to DEVVER instance to return the device revision by reference.

The function above is used to return the device ID and version ID.

FDwfEnumDeviceIsOpened(int idxDevice, BOOL *pfIsUsed)

Parameters:
- idxDevice – Index of the enumerated device.
- pfIsUsed – Pointer to variable to receive Boolean indicating if the device is in use.

The function above is used to retrieve a Boolean specifying if a device is already opened by this, or any other process.

FDwfEnumUserName(int idxDevice, char szUserName[32])

Parameters:
- idxDevice – Index of the enumerated device.
- szUserName – Pointer to character array to return the user name string by reference.

The function above is used to retrieve the user name of the enumerated device.

FDwfEnumDeviceName(int idxDevice, char szDeviceName[32])

Parameters:

- idxDevice – Index of the enumerated device.
- szDeviceName – Pointer to character array to return the device name by reference.

The function above is used to retrieve the device name of the enumerated device.

FDwfEnumSN(int idxDevice, char szSN[32])

Parameters:

- idxDevice – Index of the enumerated device.
- szSN – Pointer to character array to return the serial number by reference.

The function above is used to retrieve the 12-digit, unique serial number of the enumerated device.

FDwfEnumConfig(int idxDevice, int *pcConfig)

Parameters:

- idxDevice – Index of the enumerated device.
- pcConfig – Integer pointer to return count of found configurations by reference.

Calling the function above will build an internal list of detected configurations for the selected device. The function above must be called before using other *FDwfEnumConfigInfo* function because this obtains information about configurations from this list identified by the configuration index.

FDwfEnumConfigInfo(int idxConfig, DwfEnumConfigInfo info, int *pValue)

Parameters:

- idxConfig – Index of the configuration for which to return the information.
- info – Information type.
- pValue – Integer pointer to return selected information type by reference.

The function above is used to return information about the configuration. The information types, `DwfEnumConfigInfo`, are declared in dwf.h:

- `DECIAnalogInChannelCount`
- `DECIAnalogOutChannelCount`
- `DECIAnalogIOChannelCount`
- `DECIDigitalInChannelCount`
- `DECIDigitalOutChannelCount`
- `DECIDigitalIOChannelCount`
- `DECIAnalogInBufferSize`
- `DECIAnalogOutBufferSize`
- `DECIDigitalInBufferSize`
- `DECIDigitalOutBufferSize`

4 Device Control

FDwfDeviceOpen(int idxDevice, HDWF *phdwf)

Parameters:
- idxDevice – Zero based index of the enumerated device.
- phdwf – Pointer to *HDWF* variable to receive opened interface handle by reference.

The function above opens a device identified by the enumeration index and retrieves a handle. To automatically enumerate all connected devices and open the first discovered device, use index -1.

FDwfDeviceConfigOpen(int idxDevice, int idxCfg, HDWF *phdwf)

Parameters:
- idxDevice – Index of the enumerated device.
- idxCfg – Index of the device configuration.
- phdwf – Pointer to *HDWF* variable to receive opened interface handle by reference.

The function above opens a device identified by the enumeration index with the selected configuration and retrieves a handle.

FDwfDeviceClose(HDWF hdwf)

Parameters:
- hdwf – Interface handle to be closed.

The function above is used to close an interface handle when access to the device is no longer needed. Once the function above has returned, the specified interface handle can no longer be used to access the device.

FDwfDeviceCloseAll()

Parameters: None.

The function above is used to close all opened devices by the calling process. It does not close all devices across all processes.

FDwfDeviceAutoConfigureSet(HDWF hdwf, BOOL fAutoConfigure)

Parameters:
- hdwf – Interface handle.
- fAutoConfigure– Value for this option: 0 disable, 1 enable, 3 dynamic

The function above enables or disables the AutoConfig setting for a specific device. When this setting is enabled, the device is automatically configured every time an instrument parameter is set. For example, when AutoConfigure is enabled, FDwfAnalogOutConfigure does *not* need to be called after FDwfAnalogOutRunSet. This adds latency to every Set function; just as much latency as calling the corresponding Configure function directly afterward. With value 3 the analog-out configuration will be applied dynamically, without stopping the instrument.

FDwfDeviceAutoConfigureGet(HDWF hdwf, BOOL *pfAutoConfigure)

Parameters:
- hdwf – Interface handle.
- pfAutoConfigure– Pointer to variable to receive the current value of this option.

The function above returns the AutoConfig setting in the device. See the function description for *FDwfDeviceAutoConfigureSet* for details on this setting.

DwfDeviceReset(HDWF hdwf)

Parameters:
- hdwf – Interface handle.

The function above resets and configures (by default, having auto configure enabled) all device and instrument parameters to default values.

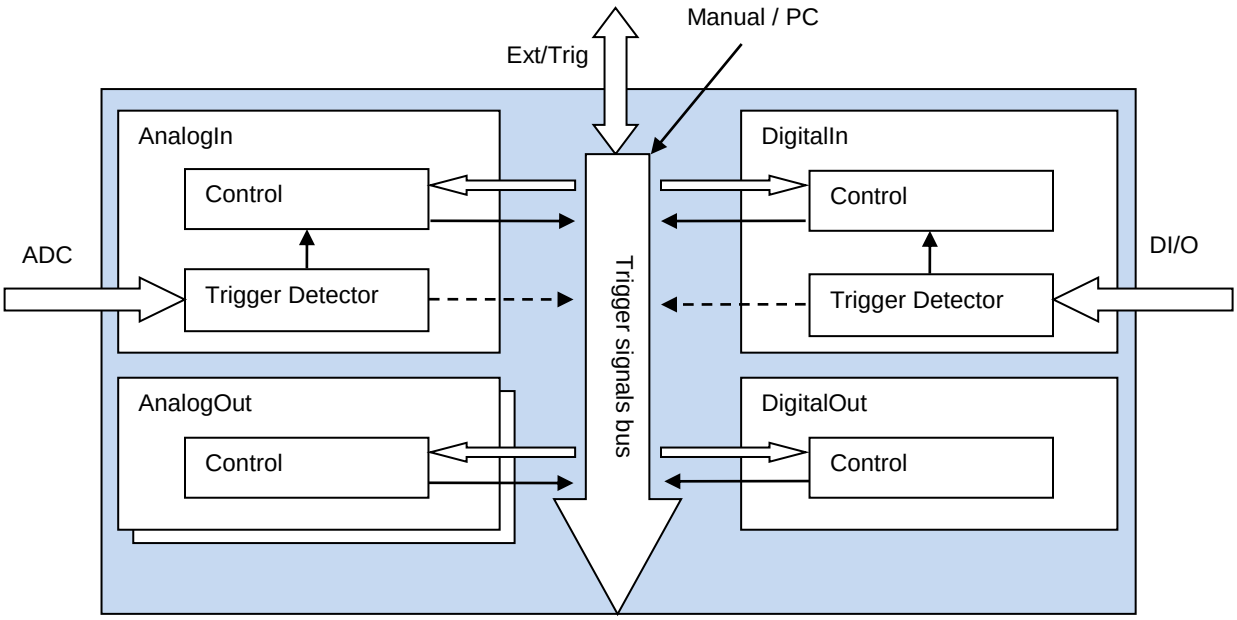
FDwfDeviceTriggerInfo(HDWF hdwf, int *pfstrigsrc)

Parameters:
- hdwf – Interface handle.
- pfstrigsrc – Variable to receive the supported trigger sources.

The function above returns the supported trigger source options for the global trigger bus. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the TRIGSRC constants in dwf.h.

The global trigger bus allows multiple instruments to trigger each other. These trigger source options are:

Trigger Source Options	Trigger Source Function
trigsrcNone	The trigger pin is high impedance, input. This is the default setting.
trigsrcPC	Trigger from PC, this can be used to synchronously start multiple instruments.
trigsrcDetectorAnalogIn	Trigger detector on analog in channels.
trigsrcDetectorDigitalIn	Trigger on digital input channels.
trigsrcAnalogIn	Trigger on device instruments, these output high when running.
trigsrcDigitalIn	Trigger on device instruments, these output high when running.
trigsrcDigitalOut	Trigger on device instruments, these output high when running.
trigsrcAnalogOut1	Trigger on device instruments, these output high when running.
trigsrcAnalogOut2	Trigger on device instruments, these output high when running.
trigsrcAnalogOut3	Trigger on device instruments, these output high when running.
trigsrcAnalogOut4	Trigger on device instruments, these output high when running.
trigsrcExternal1	External trigger signal.
trigsrcExternal2	External trigger signal.
trigsrcExternal3	External trigger signal.
trigsrcExternal4	External trigger signal.




```
FDwfDeviceTriggerSet(HDWF hdwf, int idxPin, TRIGSRC trigsrc)
```

Parameters:

- hdwf – Interface handle.
- idxPin – External trigger, I/O pin index.
- trigsrc – Trigger source to set.

The function above is used to configure the trigger I/O pin with a specific TRIGSRC option.

```
FDwfDeviceTriggerGet(HDWF hdwf, int idxPin, TRIGSRC *ptrigsrc)
```

Parameters:

- hdwf – Interface handle.
- idxPin - External trigger, I/O pin index.
- ptrigsrc – Variable to receive the current trigger source.

The function above returns the configured trigger setting for a trigger I/O pin. The trigger source can be “none”, an internal instrument, or an external trigger.

```
FDwfDeviceTriggerPC(HDWF hdwf)
```

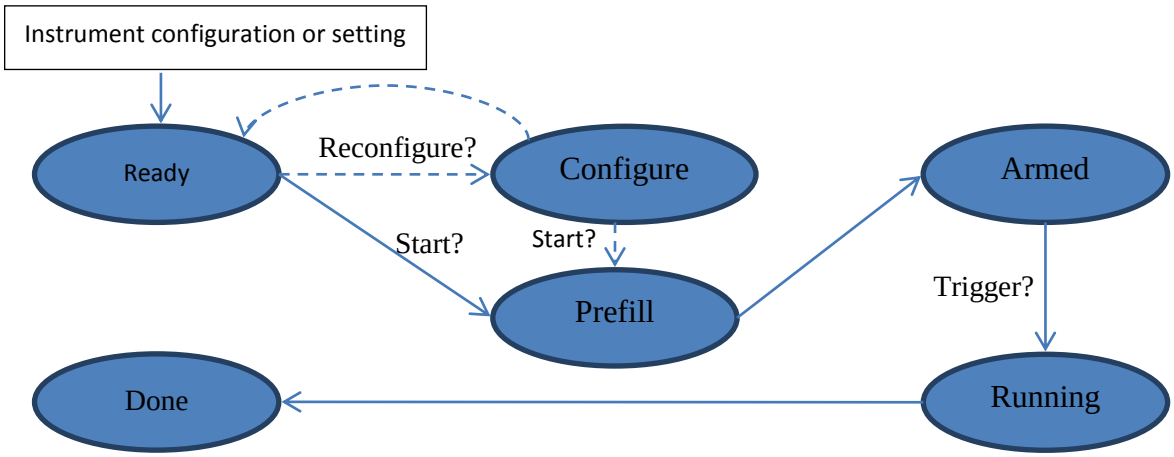
Parameters:

- hdwf – Interface handle.

The function above generates one pulse on the PC trigger line.

5 Analog In (Oscilloscope)

The Analog In instrument states:



The states are defined in dwf.h DwfState type.

- **Ready**: Initial state. After *FDwfAnalogInConfigure* or any *FDwfAnalogIn*Set* function call goes to this state. With *FDwfAnalogInConfigure,* reconfigure goes to Configure state.
- **Configure**: The needed configurations are performed and auto trigger is reset.
- **Prefill**: Prefills the buffer with samples needed before trigger.
- **Armed**: Waits for the trigger.
- **Running**:
    - Single acquisition mode: remains in this state to acquire samples after trigger according trigger position parameter.
    - Scan screen and shift modes: remains in this state until configure or any set function of this instrument.
    - Record mode: the time period according record length parameter.
- **Done**: Final state.

See the following examples: AnalogIn_Sample/Acquisition/Trigger/Record.py AnalogOutIn.py

5.1 Control

5.1 Control

FDwfAnalogInReset(HDWF hdwf)

Parameters:

- hdwf – Interface handle.

The function above resets and configures (by default, having auto configure enabled) all AnalogIn instrument parameters to default values.

FDwfAnalogInConfigure(HDWF hdwf, BOOL fReconfigure, BOOL fStart)

Parameters:
- hdwf – Interface handle.
- fReconfigure – Configure the device.
- fStart – Start the acquisition.

The function above is used to configure the instrument and start or stop the acquisition. To reset the Auto trigger timeout, set fReconfigure to TRUE.

FDwfAnalogInStatus(HDWF hdwf, BOOL fReadData, DwfState *psts)

Parameters:
- hdwf – Interface handle.
- fReadData – TRUE if data should be read.
- psts – Variable to receive the acquisition state.

The function above is used to check the state of the acquisition. To read the data from the device, set fReadData to TRUE. For single acquisition mode, the data will be read only when the acquisition is finished.

Note: To ensure simultaneity of information and data, all of the following AnalogInStatus *functions do not communicate with the device. These functions only return information and data from the last FDwfAnalogInStatus call.**

FDwfAnalogInStatusSamplesLeft(HDWF hdwf, int *pcSamplesLeft)

Parameters:
- hdwf – Interface handle.
- pcSamplesLeft – Variable to receive the remaining samples to acquire.

The function above is used to retrieve the number of samples left in the acquisition.

FDwfAnalogInStatusSamplesValid(HDWF hdwf, int *pcSamplesValid)

Parameters:
- hdwf – Interface handle.
- pcSamplesValid – Variable to receive the number of valid samples.

The function above is used to retrieve the number of valid/acquired data samples.

FDwfAnalogInStatusIndexWrite(HDWF hdwf, int *pidxWrite)

Parameters:
- hdwf – Interface handle.
- pidxWrite – Variable to receive the position of the acquisition.

The function above is used to retrieve the buffer write pointer. This is needed in ScanScreen acquisition mode to display the scan bar.

FDwfAnalogInStatusAutoTriggered(HDWF hdwf, BOOL *pfAuto)

Parameters:
- hdwf – Interface handle.
- pfAuto – Returns TRUE if the acquisition was auto triggered.

The function above is used to verify if the acquisition is auto triggered.

FDwfAnalogInStatusData(
HDWF hdwf, int idxChannel, double *rgdVoltData, int cdData)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- rgdVoltData – Pointer to allocated buffer to copy the acquisition data.
- cdData – Number of samples to copy.

The function above is used to retrieve the acquired data samples from the specified idxChannel on the AnalogIn instrument. It copies the data samples to the provided buffer.

FDwfAnalogInStatusData2(
HDWF hdwf, int idxChannel, double *rgdVoltData, int idxData, int cdData)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- rgdVoltData – Pointer to allocated buffer to copy the acquisition data.
- idxData – First sample index to copy.
- cdData – Number of samples to copy.

The function above is used to retrieve the acquired data samples from the specified idxChannel on the AnalogIn instrument. It copies the data samples to the provided buffer.

FDwfAnalogInStatusData16(
HDWF hdwf, int idxChannel, short*rgs16Data, int idxData, int cdData)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- rgs16VoltData – Pointer to allocated buffer to copy the acquisition data.
- idxData – Source sample index to copy.
- cdData – Number of samples to copy.

The function above is used to retrieve the acquired raw data samples from the specified idxChannel on the AnalogIn instrument. It copies the data samples to the provided buffer.
To convert raw data voltage value:
rgs16Data[i] * FDwfAnalogInChannelRangeGet / 65536+FDwfAnalogInChannelOffsetGet

FDwfAnalogInStatusNoise(
HDWF hdwf, int idxChannel, double *rgdMin, double *rgdMax, int cdData)

Parameters:

- hdwf – Interface handle.
- idxChannel – Channel index.
- rgdMin – Pointer to allocated buffer to copy the minimum noise data.
- rgdMax – Pointer to allocated buffer to copy the maximum noise data.
- cdData – Number of min/max samples to copy.

The function above is used to retrieve the acquired noise samples from the specified idxChannel on the AnalogIn instrument. It copies the data samples to the provided buffer.

FDwfAnalogInStatusSample(HDWF hdwf, int idxChannel, double *pdVoltSample)

Parameters:

- hdwf – Interface handle.
- idxChannel – Channel index.
- pdVoltSample – Variable to receive the sample value.

The function above gets the last ADC conversion sample from the specified idxChannel on the AnalogIn instrument.

FDwfAnalogInStatusRecord(
HDWF hdwf, int *pcdDataAvailable, int *pcdDataLost, int *pcdDataCorrupt)

Parameters:

- hdwf – Interface handle.
- pcdDataAvailable – Pointer to variable to receive the available number of samples.
- pcdDataLost – Pointer to variable to receive the lost samples after the last check.
- pcdDataCorrupt – Pointer to variable to receive the number of samples that could be corrupt.

The function above is used to retrieve information about the recording process. The data loss occurs when the device acquisition is faster than the read process to PC. In this case, the device recording buffer is filled and data samples are overwritten. Corrupt samples indicate that the samples have been overwritten by the acquisition process during the previous read. In this case, try optimizing the loop process for faster execution or reduce the acquisition frequency or record length to be less than or equal to the device buffer size (record length <= buffer size/frequency).

FDwfAnalogInRecordLengthSet(HDWF hdwf, double sLegth)

Parameters:

- hdwf – Interface handle.
- sLegth – Record length to set expressed in seconds.

The function above is used to set the Record length in seconds.

FDwfAnalogInRecordLengthGet(HDWF hdwf, double *psLegth)

Parameters:

- hdwf – Interface handle.
- sLegth – Pointer to variable to receive the record length.

The function above is used to get the current Record length in seconds.

5.2 Configuration

FDwfAnalogInFrequencyInfo(HDWF hdwf, double *phzMin, double *phzMax)

Parameters:
- hdwf – Interface handle.
- phzMin – Pointer to return the minimum allowed frequency.
- phzMax – Pointer to return the maximum allowed frequency.

The function above is used to retrieve the minimum and maximum (ADC frequency) settable sample frequency.

FDwfAnalogInFrequencySet(HDWF hdwf, double hzFrequency)

Parameters:
- hdwf – Interface handle.
- hzFrequency – Acquisition frequency to set.

The function above is used to set the sample frequency for the instrument.

FDwfAnalogInFrequencyGet(HDWF hdwf, double *phzFrequency)

Parameters:
- hdwf – Interface handle.
- phzFrequency – Variable to receive the acquisition frequency.

The function above is used to read the configured sample frequency. The AnalogIn ADC always runs at maximum frequency, but the method in which the samples are stored in the buffer can be individually configured for each channel with `FDwfAnalogInChannelFilterSet` function.

FDwfAnalogInBitsInfo(HDWF hdwf, int *pnBits)

Parameters:
- hdwf – Interface handle.
- pnBits – Variable to receive the number of ADC bits.

The function above is used to retrieve the number bits used by the AnalogIn ADC.

FDwfAnalogInBufferSizeInfo(HDWF hdwf, int *pnSizeMin, int *pnSizeMax)

Parameters:
- hdwf – Interface handle.
- pnMin – Pointer to return the minimum buffer size.
- pnMax – Pointer to return the maximum buffer size.

The function above returns the minimum and maximum allowable buffer sizes for the instrument.

FDwfAnalogInBufferSizeSet(HDWF hdwf, int nSize)

Parameters:
- hdwf – Interface handle.
- nSize – Buffer size to set.

The function above is used to adjust the AnalogIn instrument buffer size.

FDwfAnalogInBufferSizeGet(HDWF hdwf, int *pnSize)

Parameters:
- hdwf – Interface handle.
- pnSize – Variable to receive the current buffer size.

The function above returns the used AnalogIn instrument buffer size.

FDwfAnalogInNoiseSizeInfo(HDWF hdwf, int *pnSizeMax)

Parameters:
- hdwf – Interface handle.
- pnMax – Pointer to return the maximum noise buffer size.

The function above returns the maximum buffer size for the instrument.

FDwfAnalogInNoiseSizeGet(HDWF hdwf, int *pnSize)

Parameters:
- hdwf – Interface handle.
- pnSize – Variable to receive the current noise buffer size.

The function above returns the used AnalogIn instrument noise buffer size. This is automatically adjusted according the sample buffer size. For instance, having maximum buffer size of 8192 and noise buffer size of 512, setting the sample buffer size to 4096 the noise buffer size will be 256.

FDwfAnalogInAcquisitionModeInfo(HDWF hdwf, int *pfsacqmode)

Parameters:
- hdwf – Interface handle.
- pfsacqmode – Pointer to return the supported acquisition modes.

The function above returns the supported AnalogIn acquisition modes. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the ACQMODE constants in dwf.h. The acquisition mode selects one of the following modes, ACQMODE:

ACQMODE Constants	FUNC Constant Capabilities
acqmodeSingle	Perform a single buffer acquisition. This is the default setting.
acqmodeScanShift	Perform a continuous acquisition in FIFO style. The trigger setting is ignored. The last sample is at the end of buffer. The `FDwfAnalogInStatusSamplesValid` function is used to show the number of the acquired samples, which will grow until reaching the BufferSize. Then the waveform "picture" is shifted for every new sample.
acqmodeScanScreen	Perform continuous acquisition circularly writing samples into the buffer. The trigger setting is ignored. The IndexWrite shows the buffer write position. This is similar to a heart monitor display.
acqmodeRecord	Perform acquisition for length of time set by `FDwfAnalogInRecordLengthSet.`

`FDwfAnalogInAcquisitionModeSet``(HDWF hdwf, ACQMODE acqmode)`

Parameters:
- hdwf – Interface handle.
- acqmode – Acquisition mode to set.

The function above is used to set the acquisition mode.

`FDwfAnalogInAcquisitionModeGet``(HDWF hdwf, ACQMODE *pacqmode)`

Parameters:
- hdwf – Interface handle.
- pacqmode – Variable to receive the current acquisition mode.

The function above is used to get retrieve the acquisition mode.

`FDwfAnalogInSamplingSourceSet``(HDWF hdwf, TRIGSRC trigsrc)`

Parameters:
- hdwf – Interface handle.
- trigsrc – Trigger source to be used as data sampling clock.

The function above is used to configure the AnalogIn acquisition data sampling source.

`FDwfAnalogInSamplingSourceGet``(HDWF hdwf, TRIGSRC *ptrigsrc)`

Parameters:
- hdwf – Interface handle.
- ptrigsrc – Variable to receive the current sampling source.

The function above returns the configured sampling source.

FDwfAnalogInSamplingSlopeSet(HDWF hdwf, DwfTriggerSlope slope)

Parameters:
- hdwf – Interface handle.
- slope – Sampling clock slope to set.

The function above is used to set the sampling slope for the instrument.

FDwfAnalogInSamplingSlopeGet(HDWF hdwf, DwfTriggerSlope *pslope)

Parameters:
- hdwf – Interface handle.
- pslope – Variable to receive the current sampling slope.

The function above returns the sampling for the instrument.

FDwfAnalogInSamplingDelaySet(HDWF hdwf, double sec)

Parameters:
- hdwf – Interface handle.
- hzFrequency – Sampling delay to set.

The function above is used to set the sampling delay for the instrument.

FDwfAnalogInSamplingDelayGet(HDWF hdwf, double *psec)

Parameters:
- hdwf – Interface handle.
- phzFrequency – Variable to receive the sampling delay.

The function above the configured sampling delay.

5.3 Channels

The oscilloscope channel settings are identical across all channels.

FDwfAnalogInChannelCount(HDWF hdwf, int *pcChannel)

Parameters:
- hdwf – Interface handle.
- pcChannel – Variable to receive the number of channels.

The function above is used to read the number of AnalogIn channels of the device.

FDwfAnalogInChannelEnableSet(HDWF hdwf, int idxChannel, BOOL fEnable)

Parameters:
- hdwf – Interface handle.
- idxChannel – Zero based index of channel to enable/disable.
- fEnable – Set TRUE to enable, FALSE to disable.

The function above is used to enable or disable the specified AnalogIn channel.

FDwfAnalogInChannelEnableGet(HDWF hdwf, int idxChannel, BOOL *pfEnable)

Parameters:
- hdwf – Interface handle.
- idxChannel – Index of channel.
- pfEnable – Variable to return enable/disable status of channel.

The function above is used to get the current enable/disable status of the specified AnalogIn channel.

FDwfAnalogInChannelFilterInfo(HDWF hdwf, int *pfsfilter)

Parameters:
- hdwf – Interface handle.
- pfsfilter – Pointer to return the supported acquisition modes.

The function above returns the supported acquisition filters. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the FILTER constants in dwf.h. When the acquisition frequency (`FDwfAnalogInFrequencySet`) is less than the ADC frequency (maximum acquisition frequency), the samples can be stored in one of the following ways using FILTER:

- `filterDecimate`: Store every Nth ADC conversion, where N = ADC frequency /acquisition frequency.
- `filterAverage`: Store the average of N ADC conversions.
- `filterMinMax`: Store interleaved, the minimum and maximum values, of 2xN conversions.

FDwfAnalogInChannelFilterSet(HDWF hdwf, int idxChannel, FILTER filter)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- filter – Acquisition sample filter to set.

The function above is used to set the acquisition filter for each AnalogIn channel. With channel index -1, each enabled AnalogIn channel filter will be configured to use the same, new option.

FDwfAnalogInChannelFilterGet(HDWF hdwf, int idxChannel, FILTER *pfilter)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pfilter– Variable to receive the current sample filter.

The function above returns the configured acquisition filter.

FDwfAnalogInChannelRangeInfo(
HDWF hdwf, double *pvoltsMin, double *pvoltsMax, double *pnSteps)

Parameters:
- hdwf – Interface handle.
- pvoltsMin – Variable to receive the minimum voltage range.
- pvoltsMax – Variable to receive the maximum voltage range.
- pnSteps – Variable to receive number of steps.

The function above returns the minimum and maximum range, peak to peak values, and the number of adjustable steps.

FDwfAnalogInChannelRangeSteps(
HDWF hdwf, double rgVoltsStep[32], int *pnSteps)

Parameters:
- hdwf – Interface handle.
- rgVoltsStep – Pointer to buffer to receive the range steps.
- pnSteps – Variable to receive number range steps.

The function above is used to read the range of steps supported by the device. For instance: 1, 2, 5, 10, etc.

FDwfAnalogInChannelRangeSet(HDWF hdwf, int idxChannel, double voltsRange)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- voltsRange – Voltage range to set.

The function above is used to configure the range for each channel. With channel index -1, each enabled Analog In channel range will be configured to the same, new value.

FDwfAnalogInChannelRangeGet(HDWF hdwf, int idxChannel, double *pvoltsRange)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pvoltsRange – Variable to receive the current voltage range.

The function above returns the real range value for the given channel.

FDwfAnalogInChannelOffsetInfo(
HDWF hdwf, double *pvoltsMin, double *pvoltsMax, double *pnSteps)

Parameters:
- hdwf – Interface handle.
- pvoltsMin – Variable to receive the minimum offset voltage.
- pvoltsMax – Variable to receive the maximum offset voltage.
- pnSteps – Variable to receive the number offset steps.

The function above returns the minimum and maximum offset levels supported, and the number of adjustable steps.

FDwfAnalogInChannelOffsetSet(HDWF hdwf, int idxChannel, double voltOffset)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- voltsRange – Channel offset voltage to set.

The function above is used to configure the offset for each channel. When channel index is specified as -1, each enabled AnalogIn channel offset will be configured to the same level.

```
FDwfAnalogInChannelOffsetGet(HDWF hdwf, int idxChannel, double *pvoltOffset)
```

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pvoltsRange – Variable to receive the offset voltage obtained.

The function above returns for each AnalogIn channel the real offset level.

```
FDwfAnalogInChannelAttenuationSet(
HDWF hdwf, int idxChannel, double xAttenuation)
```

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- voltsRange – Channel offset voltage to set.

The function above is used to configure the attenuation for each channel. When channel index is specified as -1, each enabled AnalogIn channel attenuation will be configured to the same level. The attenuation does not change the attenuation on the device, just informs the library about the externally applied attenuation.

```
FDwfAnalogInChannelAttenuationGet(
HDWF hdwf, int idxChannel, double *pxAttenuation)
```

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pxAttenuation – Variable to receive the attenuation value.

The function above returns for each AnalogIn channel the configured attenuation.

5.4 Trigger

The trigger is used for Single and Record acquisitions. For ScanScreen and ScanShift, the trigger is ignored.
To achieve the classical trigger types:
- **None**: Set *FDwfAnalogInTriggerSourceSet* to *trigsrcNone.*
- **Auto***:* Set *FDwfAnalogInTriggerSourceSet* to something other than *trigsrcNone,* such as trigsrcDetectorAnalogIn and *FDwfAnalogInTriggerAutoTimeoutSet* to other than zero.
- **Normal**: Set *FDwfAnalogInTriggerSourceSet* to something other than *trigsrcNone,* such as *trigsrcDetectorAnalogIn* or *FDwfAnalogInTriggerAutoTimeoutSet* to zero.

See the description of **FDwfDeviceTriggerInfo**.

FDwfAnalogInTriggerSourceSet(HDWF hdwf, TRIGSRC trigsrc)

Parameters:
- hdwf – Interface handle.
- trigsrc – Trigger source to set.

The function above is used to configure the AnalogIn acquisition trigger source.

FDwfAnalogInTriggerSourceGet(HDWF hdwf, TRIGSRC *ptrigsrc)

Parameters:
- hdwf – Interface handle.
- ptrigsrc – Variable to receive the current trigger source.

The function above returns the configured trigger source. The trigger source can be “none” or an internal instrument or external trigger. To use the trigger on AnalogIn channels (edge, pulse, etc.), use trigsrcDetectorAnalogIn.

FDwfAnalogInTriggerPositionInfo(HDWF hdwf, double *psecMin, double *psecMax, double *pnSteps)

Parameters:
- hdwf – Interface handle.
- psecMin – Variable to receive the minimum trigger position.
- psecMax – Variable to receive the maximum trigger position.
- pnSteps – Variable to return the number of steps.

The function above returns the minimum and maximum values of the trigger position in seconds. The horizontal trigger position is used for Single acquisition mode and it is relative to the buffer middle point.

FDwfAnalogInTriggerPositionSet(HDWF hdwf, double secPosition)

Parameters:
- hdwf – Interface handle.
- secPosition – Trigger position to set.

The function above is used to configure the horizontal trigger position in seconds.

FDwfAnalogInTriggerPositionGet(HDWF hdwf, double *psecPosition)

Parameters:
- hdwf – Interface handle.
- psecPosition – Variable to receive the current trigger position.

The function above returns the configured trigger position in seconds.

FDwfAnalogInTriggerAutoTimeoutInfo(
HDWF hdwf, double *psecMin, double *psecMax, int *pnSteps)

Parameters:

- hdwf – Interface handle.
- psecMin – Variable to receive the minimum timeout.
- psecMax – Variable to receive the maximum timeout.
- pnSteps – Variable to return the number of steps.

The function above returns the minimum and maximum auto trigger timeout values, and the number of adjustable steps. The acquisition is auto triggered when the specified time elapses. With zero value the timeout is disabled, performing “Normal” acquisitions.

FDwfAnalogInTriggerAutoTimeoutSet(HDWF hdwf, double secTimeout)

Parameters:

- hdwf – Interface handle.
- secTimeout – Timeout to set.

The function above is used to configure the auto trigger timeout value in seconds.

FDwfAnalogInTriggerAutoTimeoutGet(HDWF hdwf, double *psecTimeout)

Parameters:

- hdwf – Interface handle.
- psecTimeout – Variable to receive the current timeout.

The function above returns the configured auto trigger timeout value in seconds.

```
FDwfAnalogInTriggerHoldOffInfo(
HDWF hdwf, double *psecMin, double *psecMax, double *pnStep)
```

Parameters:
- hdwf – Interface handle.
- psecMin – Variable to receive the minimum hold off value.
- psecMax – Variable to receive the maximum hold off value.

The function above returns the supported range of the trigger Hold-Off time in Seconds. The trigger hold-off is an adjustable period of time during which the acquisition will not trigger. This feature is used when you are triggering on burst waveform shapes, so the oscilloscope triggers only on the first eligible trigger point.

```
FDwfAnalogInTriggerHoldOffSet(HDWF hdwf, double secHoldOff)
```

Parameters:
- hdwf – Interface handle.
- secHoldOff – Holdoff to set.

The function above is used to set the trigger hold-off for the AnalongIn instrument in Seconds.

```
FDwfAnalogInTriggerHoldOffGet(HDWF hdwf, double *psecHoldOff)
```

Parameters:
- hdwf – Interface handle.
- psecHoldOff – Variable to receive the current holdoff value.

The function above is used to get the current trigger hold-off for the AnalongIn instrument in Seconds.

5.5 Trigger Detector

The following functions configure the trigger detector on analog in channels. To use this, set trigger source with FDwfAnalogInTriggerSourceSet to trigsrcDetectorAnalogIn.
See the AnalogIn_Trigger.py example.

```
FDwfAnalogInTriggerTypeInfo(HDWF hdwf, int *pfstrigtype)
```

Parameters:
- hdwf – Interface handle.
- pfstrigtype – Variable to receive the supported trigger types.

The function above returns the supported trigger type options for the instrument. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the *TRIGTYPE* constants in dwf.h. These trigger type options are:

- trigtypeEdge: trigger on rising or falling edge. This is the default setting.
- trigtypePulse: trigger on positive or negative; less, timeout, or more pulse lengths.
- trigtypeTransition: trigger on rising or falling; less, timeout, or more transition times.

FDwfAnalogInTriggerTypeSet(HDWF hdwf, TRIGTYPE trigtype)

Parameters:
- hdwf – Interface handle.
- trigtype – Trigger type to set.

The function above is used to set the trigger type for the instrument.

FDwfAnalogInTriggerTypeGet(HDWF hdwf, TRIGTYPE *ptrigtype)

Parameters:
- hdwf – Interface handle.
- ptrigtype – Variable to receive the current trigger type.

The function above is used to get the current trigger type for the instrument.

FDwfAnalogInTriggerChannelInfo(HDWF hdwf, int *pidxMin, int *pidxMax)

Parameters:
- hdwf – Interface handle.
- pidxMin – Variable to receive the minimum channel index.
- pidxMax – Variable to receive the maximum channel index.

The function above returns the range of channels that can be triggered on.

FDwfAnalogInTriggerChannelSet(HDWF hdwf, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxChannel – Trigger channel index to set.

The function above is used to set the trigger channel.

FDwfAnalogInTriggerChannelGet(HDWF hdwf, int *pidxChannel)

Parameters:
- hdwf – Interface handle.
- pidxChannel – Variable to receive the current trigger channel index.

The function above is used to retrieve the current trigger channel index.

FDwfAnalogInTriggerFilterInfo(HDWF hdwf, int *pfsfilter)

Parameters:
- hdwf – Interface handle.
- pfsFilter – Variable to receive the supported trigger filters.

The function above returns the supported trigger filters. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the FILTER constants in DWF.h. Select trigger detector sample source, FILTER:

- filterDecimate: Looks for trigger in each ADC conversion, can detect glitches.
- filterAverage: Looks for trigger only in average of N samples, given by FDwfAnalogInFrequencySet.

FDwfAnalogInTriggerFilterSet(HDWF hdwf, FILTER filter)

Parameters:
- hdwf – Interface handle.
- filter – Trigger filter to set.

The function above is used to set the trigger filter.

FDwfAnalogInTriggerFilterGet(HDWF hdwf, FILTER *pfilter)

Parameters:
- hdwf – Interface handle.
- pfilter – Variable to receive the current trigger filter.

The function above is used to get the trigger filter.

FDwfAnalogInTriggerConditionInfo(HDWF hdwf, int *pfstrigcond)

Parameters:
- hdwf – Interface handle.
- pfstrigcond – Variable to receive the supported trigger conditions.

The function above returns the supported trigger type options for the instrument. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the DwfTriggerSlope constants in dwf.h. These trigger condition options are:

- DwfTriggerSlopeRise (This is the default setting):
  - For edge and transition trigger on rising edge.
  - For pulse trigger on positive pulse.
- DwfTriggerSlopeFall:
  - For edge and transition trigger on falling edge.
  - For pulse trigger on negative pulse.
- DwfTriggerSlopeEither:
  - For edge and transition trigger on either edge.
  - For pulse trigger on either positive or negative pulse.

FDwfAnalogInTriggerConditionSet(HDWF hdwf, DwfTriggerSlope trigcond)

Parameters:
- hdwf – Interface handle.
- trigcond – Trigger condition to set.

The function above is used to set the trigger condition for the instrument.

FDwfAnalogInTriggerConditionGet(HDWF hdwf, DwfTriggerSlope *ptrigcond)

Parameters:
- hdwf – Interface handle.
- ptrigcond – Variable to receive the current trigger condition.

The function above is used to set the trigger condition for the instrument.

FDwfAnalogInTriggerLevelInfo(
HDWF hdwf, double *pvoltsMin, double *pvoltsMax, int *pnSteps)

Parameters:
- hdwf – Interface handle.
- pvoltsMin – Variable to receive the minimum voltage level.
- pvoltsMax – Variable to receive the maximum voltage level.
- pnSteps – Variable to receive the number of voltage level steps.

The function above is used to retrieve the range of valid trigger voltage levels for the AnalogIn instrument in Volts.

FDwfAnalogInTriggerLevelSet(HDWF hdwf, double voltsLevel)

Parameters:
- hdwf – Interface handle.
- voltsLevel – Trigger voltage level to set.

The function above is used to set the trigger voltage level in Volts.

FDwfAnalogInTriggerLevelGet(HDWF hdwf, double *pvoltsLevel)

Parameters:
- hdwf – Interface handle.
- pvoltsLevel – Variable to receive the current trigger voltage level.

The function above is used to get the current trigger voltage level in Volts.

FDwfAnalogInTriggerHysteresisInfo(
HDWF hdwf, double *pvoltsMin, double *pvoltsMax, int *pnSteps)

Parameters:
- hdwf – Interface handle.
- pvoltsMin – Variable to receive the minimum hysteresis level.
- pvoltsMax – Variable to receive the maximum hysteresis level.
- pnSteps – Variable to receive the number of hysteresis level steps.

The function above is used to retrieve the range of valid trigger hysteresis voltage levels for the AnalogIn instrument in Volts. The trigger detector uses two levels: low level (TriggerLevel - Hysteresis) and high level (TriggerLevel + Hysteresis). Trigger hysteresis can be used to filter noise for Edge or Pulse trigger. The low and high levels are used in transition time triggering.

FDwfAnalogInTriggerHysteresisSet(HDWF hdwf, double voltsLevel)

Parameters:
- hdwf – Interface handle.
- voltsLevel – Trigger hysteresis level to set.

The function above is used to set the trigger hysteresis level in Volts.

FDwfAnalogInTriggerHysteresisGet(HDWF hdwf, double *pvoltsHysteresis)

Parameters:
- hdwf – Interface handle.
- pvoltsLevel – Variable to receive the current trigger hysteresis level.

The function above is used to get the current trigger hysteresis level in Volts.

FDwfAnalogInTriggerLengthConditionInfo(HDWF hdwf, int *pfstriglen)

Parameters:
- hdwf – Interface handle.
- pfsstriglen – Variable to receive the supported trigger length conditions.

The function above returns the supported trigger length condition options for the AnalogIn instrument. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the TRIGLEN constants in DWF.h. These trigger length condition options are:

- triglenLess: Trigger immediately when a shorter pulse or transition time is detected.
- triglenTimeout: Trigger immediately as the pulse length or transition time is reached.
- triglenMore: Trigger when the length/time is reached and pulse or transition has ended.

FDwfAnalogInTriggerLengthConditionSet(HDWF hdwf, TRIGLEN triglen)

Parameters:
- hdwf – Interface handle.
- triglen – Trigger length condition to set.

The function above is used to set the trigger length condition for the AnalongIn instrument.

FDwfAnalogInTriggerLengthConditionGet(HDWF hdwf, TRIGLEN *ptriglen)

Parameters:
- hdwf – Interface handle.
- ptriglen – Variable to receive the current trigger length condition.

The function above is used to get the current trigger length condition for the AnalongIn instrument.

FDwfAnalogInTriggerLengthInfo(
HDWF hdwf, double *psecMin, double *psecMax, double *pnStep)

Parameters:
- hdwf – Interface handle.
- psecMin – Variable to receive the minimum trigger length.
- psecMax – Variable to receive the maximum trigger length.

The function above returns the supported range of trigger length for the instrument in Seconds. The trigger length specifies the minimal or maximal pulse length or transition time.

FDwfAnalogInTriggerLengthSet(HDWF hdwf, double secLength)

Parameters:
- hdwf – Interface handle.
- secLength – Trigger length to set.

The function above is used to set the trigger length in Seconds.

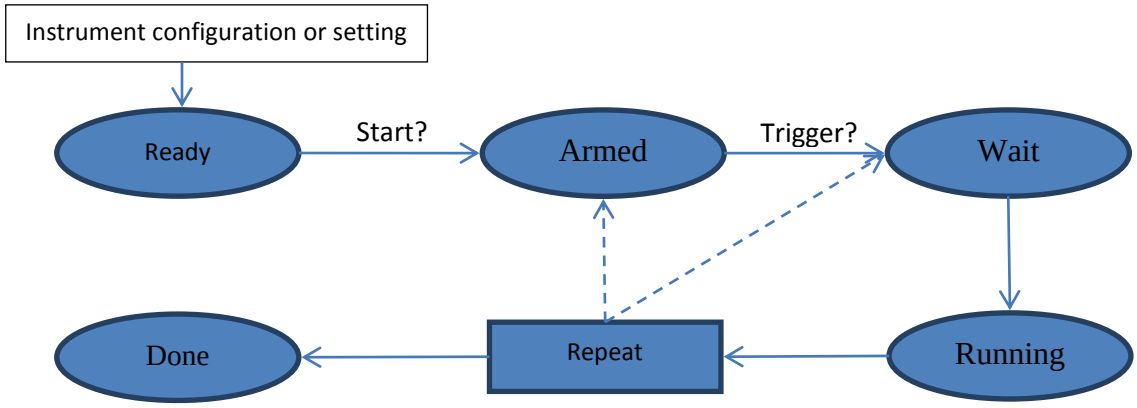
FDwfAnalogInTriggerLengthGet(HDWF hdwf, double *psecLength)

Parameters:
- hdwf – Interface handle.
- secLength – Variable to receive the current trigger length.

The function above is used to get the current trigger length in Seconds.

6 Analog Out (Arbitrary Waveform Generator)

The Analog Out instrument states:

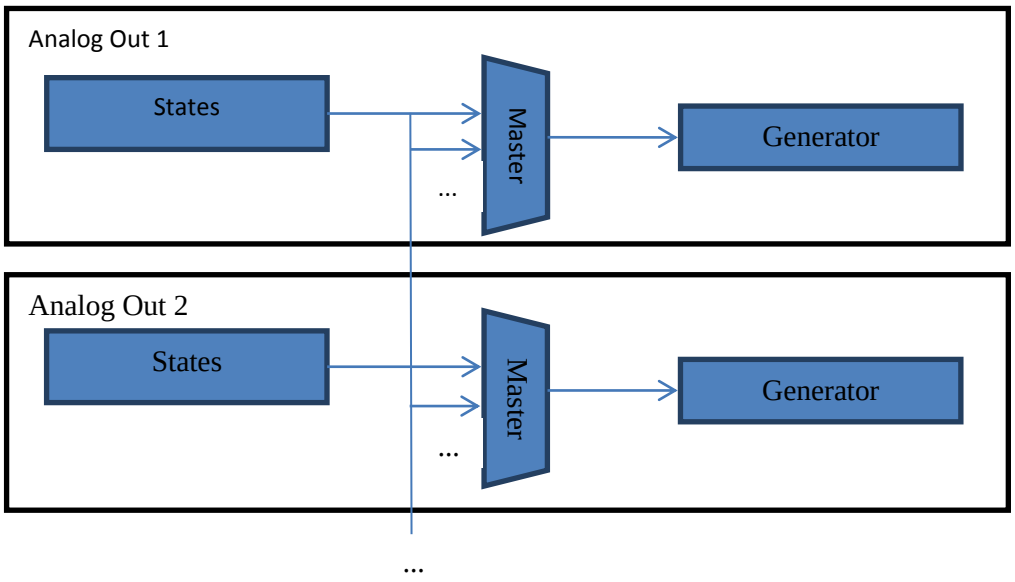


The states are defined in dwf.h DwfState type.

- **Ready**: Initial state. After *FDwfAnalogOutConfigure* or any *FDwfAnalogOut*Set* function call goes to this state. With digital out, configure start command goes to Armed state.
- **Armed**: It waits for trigger.
- **Wait**: Remains in this state for the time period specified by *FDwfAnalogOutWaitSet* function.
- **Running**: Remains in this state for the time period specified by *FDwfAnalogOutRunSet* function.
- **Repeat**: Goes to Armed or Wait state according to the FDwfAnalogOutRepeatTriggerSet setting for the number of times specified by FDwfAnalogOutRepeatSet.
- **Done**: Final state.

The analog out channels can run independently or synchronized using the master parameter. The states are defined by trigger, wait, run, and repeat options. It is enough to start with FDwfAnalogOutConfigure (the master channel) the slave channels will also start.

See the following examples: AnalogOut_Sine/Sweep/Custom/Sync.py AnalogOutIn.py



6.1 Control

FDwfAnalogOutReset(HDWF hdwf, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.

The function above resets and configures (by default, having auto configure enabled) all AnalogOut instrument parameters to default values for the specified channel. To reset instrument parameters across all channels, set idxChannel to -1.

FDwfAnalogOutConfigure(HDWF hdwf, int idxChannel, BOOL fStart)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- fStart – Start the instrument: 0 stop, 1 start, 3 apply

The function above is used to start or stop the instrument. Value 3 will apply the condifugration dynamically without changing the state of the instrument. With channel index -1, each enabled Analog Out channel will be configured.

FDwfAnalogOutStatus(HDWF hdwf, int idxChannel, DwfState *psts)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- psts – Pointer to variable to return the state.

The function above is used to check the state of the instrument.

FDwfAnalogOutNodePlayStatus(HDWF hdwf, int idxChannel, AnalogOutNode node, int *cdDataFree, int *cdDataLost, int *cdDataCorrupted)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- cdDataFree – Pointer to variable to return the available free buffer space, the number of new samples that can be sent.
- cdDataLost – Pointer to variable to return the number of lost samples.
- cdDataCorrupted – Pointer to variable to return the number of samples that could be corrupted.

The function above is used to retrieve information about the play process. The data lost occurs when the device generator is faster than the sample send process from the PC. In this case, the device buffer gets emptied and generated samples are repeated. Corrupt samples are a warning that the buffer might have been emptied while

samples were sent to the device. In this case, try optimizing the loop for faster execution; or reduce the frequency or run time to be less or equal to the device buffer size (run time <= buffer size/frequency).

FDwfAnalogOutNodePlayData(
HDWF hdwf, int idxChannel, AnalogOutNode node, double *rgdData, int cdData)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- rgdData – Pointer to samples array to be sent to the device.
- cdData – Number of samples to send.

The function above is used to sending new data samples for play mode. Before starting the Analog Out instrument, prefill the device buffer with the first set of samples using the AnalogOutNodeDataSet function. In the loop of sending the following samples, first call AnalogOutStatus to read the information from the device, then AnalogOutPlayStatus to find out how many new samples can be sent, then send the samples with AnalogOutPlayData.

6.2 Configuration

FDwfAnalogOutCount(HDWF hdwf, int *pcChannel)

Parameters:
- hdwf – Open interface handle on a device.
- pcChannel – Pointer to variable to receive the number of channels in the instrument.

The function above returns the number of Analog Out channels by the device specified by hdwf.

FDwfAnalogOutNodeInfo(HDWF hdwf, int idxChannel, int *pfsnode)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pfsnode – Variable to receive the supported nodes.

The function above returns the supported AnalogOut nodes of the AnalogOut channel. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the AnalogOutNode constants in dwf.h. These node types are:

- AnalogOutNodeCarrier
- AnalogOutNodeFM
- AnalogOutNodeAM

FDwfAnalogOutNodeEnableSet(
HDWF hdwf, int idxChannel, AnalogOutNode node, BOOL fEnable)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- fEnable – TRUE to enable, FALSE to disable.

The function above enables or disables the channel node specified by idxChannel and node. The Carrier node enables or disables the channel and AM/FM the modulation. With channel index -1, each Analog Out channel enable will be configured to use the same, new option.

FDwfAnalogOutNodeEnableGet(
HDWF hdwf, int idxChannel, AnalogOutNode node, BOOL *pfEnable)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pfEnable – Pointer to variable to receive enabled state.

The function above is used to verify if a specific channel and node is enabled or disabled.

FDwfAnalogOutNodeFunctionInfo(
HDWF hdwf, int idxChannel, AnalogOutNode node, int *pfsfunc)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pfsfunc – Variable to receive the supported generator function options.

The function above returns the supported generator function options. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the FUNC constants in dwf.h. These are:

FUNC Constants	FUNC Constant Capabilities
funcDC	Generate DC value set as offset.
funcSine	Generate sine waveform.
funcSquare	Generate square waveform.
funcTriangle	Generate triangle waveform.
funcRampUp	Generate a waveform with a ramp-up voltage at the beginning.
funcRampDown	Generate a waveform with a ramp-down voltage at the end.
funcNoise	Generate noise waveform from random samples.
funcCustom	Generate waveform from custom repeated data.
funcPlay	Generate waveform from custom data in stream play style.

FDwfAnalogOutNodeFunctionSet(
HDWF hdwf, int idxChannel, AnalogOutNode node, FUNC func)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- func – Generator function option to set.

The function above is used to set the generator output function for the specified instrument channel. With channel index -1, each enabled Analog Out channel function will be configured to use the same, new option.

FDwfAnalogOutNodeFunctionGet(
HDWF hdwf, int idxChannel, AnalogOutNode node, FUNC *pfunc)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- ptrigsrc – Pointer to variable to receive the generator function option.

The function above is used to retrieve the current generator function option for the specified instrument channel.

FDwfAnalogOutNodeFrequencyInfo(HDWF hdwf, int idxChannel, AnalogOutNode node, double *phzMin, double *phzMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Zero based channel index.
- node – Zero based node index.
- phzMin – Variable to receive the supported minimum frequency.
- phzMax – Variable to receive the supported maximum frequency.

The function above is used to return the supported frequency range for the instrument. The maximum value shows the DAC frequency. The frequency of the generated waveform: repetition frequency for standard types and custom data; DAC update for noise type; sample rate for play type.

FDwfAnalogOutNodeFrequencySet(
HDWF hdwf, int idxChannel, AnalogOutNode node, double hzFrequency)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- hzFrequency – Frequency value to set expressed in Hz.

The function above is used to set the frequency. With channel index -1, each enabled Analog Out channel frequency will be configured to use the same, new option.

FDwfAnalogOutNodeFrequencyGet(
HDWF hdwf, int idxChannel, AnalogOutNode node, double *phzFrequency)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- hzFrequency – Pointer to variable to receive frequency value in Hz.

The function above is used to get the currently set frequency for the specified channel-node on the instrument.

FDwfAnalogOutNodeAmplitudeInfo(
HDWF hdwf, int idxChannel, AnalogOutNode node, double *pvMin, double *pvMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pvMin – Minimum amplitude level or modulation index.
- pvMax – Maximal amplitude level or modulation index.

The function above is used to retrieve the amplitude range for the specified channel-node on the instrument. The amplitude is expressed in Volt units for carrier and in percentage units (modulation index) for AM/FM.

FDwfAnalogOutNodeAmplitudeSet(
HDWF hdwf, int idxChannel, AnalogOutNode node, double vAmplitude)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- vAmplitude – Amplitude of channel in Volts or modulation index in percentage.

The function above is used to set the amplitude or modulation index for the specified channel-node on the instrument. With channel index -1, each enabled Analog Out channel amplitude (or modulation index) will be configured to use the same, new option.

FDwfAnalogOutNodeAmplitudeGet(
HDWF hdwf, int idxChannel, AnalogOutNode node, double *pvAmplitude)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pvAmplitude – Pointer to variable to receive amplitude value in Volts or modulation index in percentage.

The function above is used to get the currently set amplitude or modulation index for the specified channel-node on the instrument.

FDwfAnalogOutNodeOffsetInfo(
HDWF hdwf, int idxChannel, AnalogOutNode node, double *pvMin, double *pvMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pvMin – Minimum offset voltage or modulation offset percentage.
- pvMax – Maximum offset voltage or modulation offset percentage.

The function above is used to retrieve available the offset range. For carrier node in units of volts, and in percentage units for AM/FM nodes.

FDwfAnalogOutNodeOffsetSet(
HDWF hdwf, int idxChannel, AnalogOutNode node, double vOffset)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- vOffset – Value to set voltage offset in Volts or modulation offset percentage.

The function above is used to set the offset value for the specified channel-node on the instrument. With channel index -1, each enabled Analog Out channel offset will be configured to use the same, new option.

FDwfAnalogOutNodeOffsetGet(HDWF hdwf, int idxChannel, AnalogOutNode node, double *pvOffset)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pvOffset – Pointer to variable to receive offset value in Volts or modulation offset percentage.

The function above is used to get the current offset value for the specified channel-node on the instrument.

FDwfAnalogOutNodeSymmetryInfo(HDWF hdwf, int idxChannel, AnalogOutNode node, double *ppercentageMin, double *ppercentageMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- ppercentageMin – Minimum value of Symmetry percentage.
- ppercentageMax – Maximum value of Symmetry percentage.

The function above is used to obtain the symmetry (or duty cycle) range (0..100). This symmetry is supported for standard signal types. It the pulse duration divided by the pulse period.

FDwfAnalogOutNodeSymmetrySet(HDWF hdwf, int idxChannel, AnalogOutNode node, double percentageSymmetry)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- percentageSymmetry –Value of percentage of Symmetry (duty cycle).

The function above is used to set the symmetry (or duty cycle) for the specified channel-node on the instrument. With channel index -1, each enabled Analog Out channel symmetry will be configured to use the same, new option.

FDwfAnalogOutNodeSymmetryGet(
HDWF hdwf, int idxChannel, AnalogOutNode node, double *ppercentageSymmetry)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- ppercentageSymmetry — Pointer to variable to receive value of Symmetry (duty cycle).

The function above is used to get the currently set symmetry (or duty cycle) for the specified channel-node of the instrument.

FDwfAnalogOutNodePhaseInfo(HDWF hdwf, int idxChannel, AnalogOutNode node, double *pdegreeMin, double *pdegreeMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pdegreeMin – Minimum value of Phase (in degrees).
- pdegreeMax – Maximum value of Phase (in degrees).

The function above is used to retrieve the phase range (in degrees 0...360) for the specified channel-node of the instrument.

FDwfAnalogOutNodePhaseSet(
HDWF hdwf, int idxChannel, AnalogOutNode node, double degreePhase)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- degreePhase – Value of Phase in degrees.

The function above is used to set the phase for the specified channel-node on the instrument. With channel index -1, each enabled Analog Out channel phase will be configured to use the same, new option.

FDwfAnalogOutNodePhaseGet(HDWF hdwf, int idxChannel, AnalogOutNode node, double *pdegreePhase)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pdegreePhase – Pointer to variable to receive Phase value (in degrees).

The function above is used to get the current phase for the specified channel-node on the instrument.

FDwfAnalogOutNodeDataInfo(HDWF hdwf, int idxChannel, AnalogOutNode node, int *pnSamplesMin, double *pnSamplesMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- pnSamplesMin - Minimum number of samples available for custom data.
- pnSamplesMax – Maximum number of samples available for custom data.

The function above is used to retrieve the minimum and maximum number of samples allowed for custom data generation.

FDwfAnalogOutNodeDataSet(
HDWF hdwf, int idxChannel, AnalogOutNode node, double *rgdData, int cdData)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- node – Node index.
- rgbData – Buffer of samples to set.
- cData – Number of samples to set in rgbData.

The function above is used to set the custom data or to prefill the buffer with play samples. The samples are double precision floating point values (rgdData) normalized to ±1.
With the custom function option, the data samples (cdData) will be interpolated to the device buffer size. The output value will be Offset + Sample*Amplitude, for instance:

- 0 value sample will output: Offset.
- +1 value sample will output: Offset + Amplitude.
- -1 value sample will output: Offset – Amplitude.

FDwfAnalogOutLimitationInfo(
HDWF hdwf, int idxChannel, double *pvMin, double *pvMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pvMin – Minimum limitation value.
- pvMax – Maximum offset voltage or modulation offset percentage.

The function above is used to retrieve available the limitation range. This option is supported on Electronics Explorer Analog Out Channel 3 and 4, Positive and Negative Power supplies, to set current or voltage limitation.

FDwfAnalogOutLimitationSet(HDWF hdwf, int idxChannel, double limit)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- limit – Value to set voltage offset in Volts or modulation offset percentage.

The function above is used to set the limitation value for the specified channel on the instrument. With channel index -1, each enabled Analog Out channel limitation will be configured to use the same, new option.

FDwfAnalogOutLimitationGet(HDWF hdwf, int idxChannel, double *plimit)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- limit – Pointer to variable to receive offset value in Volts or modulation offset percentage.

The function above is used to get the current limitation value for the specified channel on the instrument.

FDwfAnalogOutModeSet(HDWF hdwf, int idxChannel, DwfAnalogOutMode mode)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- mode – Generator mode option to set.

The function above is used to set the generator output mode for the specified instrument channel. With channel index -1, each enabled Analog Out channel mode will be configured to use the same, new option. This option is supported on Electronics Explorer Analog Out Channel 3 and 4, Positive and Negative Power supplies, to set current or voltage waveform generator mode.

The DwfAnalogOutMode options are:

- DwfAnalogOutModeVoltage
- DwfAnalogOutModeCurren

FDwfAnalogOutModeGet(HDWF hdwf, int idxChannel, DwfAnalogOutMode *pmode)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- mode – Pointer to variable to receive the generator mode option.

The function above is used to retrieve the current generator mode option for the specified instrument channel.

FDwfAnalogOutIdleInfo(HDWF hdwf, int idxChannel, int *pfsidle)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pfsidlec – Variable to receive the supported generator idle options.

The function above returns the supported generator idle output options. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the DwfAnalogOutIdle constants in dwf.h. These are:

Idle Constants	Idle Constant Capabilities
DwfAnalogOutIdleDisable	Supported on Electronics Explorer: Channel 1&2 0V ouput Channel 3&4. having 1 kΩ resistor to GND and diode
DwfAnalogOutIdleOffset	The idle output is the configured Offset level.
DwfAnalogOutIdleInitial	The idle output voltage level has the initial waveform value of the current configuration. This depends on the selected signal type, Offset, Amplitude and Amplitude Modulator configuration.

FDwfAnalogOutIdleSet(HDWF hdwf, int idxChannel, DwfAnalogOutIdle idle)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- idle – Generator function option to set.

The function above is used to set the generator idle output for the specified instrument channel. The idle output selects the output while not running, Ready, Stopped, Done or Wait states.

FDwfAnalogOutIdleGet(HDWF hdwf, int idxChannel, DwfAnalogOutIdle *pidle)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pidle – Pointer to variable to receive the generator function option.

The function above is used to retrieve the generator idle output option for the specified instrument channel.

6.3 States

See the description of **FDwfDeviceTriggerInfo**.

FDwfAnalogOutTriggerSourceSet(HDWF hdwf, int idxChannel, TRIGSRC trigsrc)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- trigsrc – Trigger source to set.

The function above is used to set the trigger source for the channel on instrument.

FDwfAnalogOutTriggerSourceGet(HDWF hdwf, int idxChannel, TRIGSRC *ptrigsrc)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- ptrigsrc – Pointer to variable to receive the trigger source.

The function above is used to get the current trigger source setting for the channel on instrument.

FDwfAnalogOutTriggerSlopeSet(
HDWF hdwf, int idxChannel, DwfTriggerSlope slope)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- slope – Trigger slope to set.

The function above is used to set the trigger slope for the channel on instrument.

FDwfAnalogOutTriggerSlopeGet(
HDWF hdwf, int idxChannel, DwfTriggerSlope *pslope)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pslope – Pointer to variable to receive the trigger slope.

The function above is used to get the current trigger slope setting for the channel on instrument.

FDwfAnalogOutRunInfo(
HDWF hdwf, int idxChannel, double *psecMin, double *psecMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- psecMin – Variable to receive the supported minimum run length.
- psecMax – Variable to receive the supported maximum run length.

The function above is used to return the supported run length range for the instrument in Seconds. Zero values represent an infinite (or continuous) run. Default value is zero.

FDwfAnalogOutRunSet(HDWF hdwf, int idxChannel, double secRun)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- secRun – Run length to set expressed in seconds.

The function above is used to set the run length for the instrument in Seconds.

FDwfAnalogOutRunGet(HDWF hdwf, int idxChannel, double *psecRun)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- psecRun – Pointer to variable to receive the run length.

The function above is used to read the configured run length for the instrument in Seconds.

FDwfAnalogOutRunStatus(HDWF hdwf, int idxChannel, double *psecRun)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- psecRun – Pointer to variable to receive the remaining run length.

The function above is used to read the remaining run length. It returns data from the last FDwfAnalogOutStatus call.

FDwfAnalogOutWaitInfo(
HDWF hdwf, int idxChannel, double *psecMin, double *psecMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- psecMin/Max – Variable to receive the supported minimum/maximum wait length.

The function above is used to return the supported wait length range in Seconds. The wait length is how long the instrument waits after being triggered to generate the signal. Default value is zero.

FDwfAnalogOutWaitSet(HDWF hdwf, int idxChannel, double secWait)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- secWait – Wait length to set expressed in seconds.

The function above is used to set the wait length for the channel on instrument.

FDwfAnalogOutWaitGet(HDWF hdwf, int idxChannel, double *psecWait)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- psecWait – Pointer to variable to receive the wait length.

The function above is used to get the current wait length for the channel on instrument.

FDwfAnalogOutRepeatInfo(HDWF hdwf, int idxChannel, int *pnMin, int *pnMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pnMin – Variable to receive the supported minimum repeat count.
- pnMax – Variable to receive the supported maximum repeat count.

The function above is used to return the supported repeat count range. This is how many times the generated signal will be repeated upon. Zero value represents infinite repeat. Default value is one.

FDwfAnalogOutRepeatSet(HDWF hdwf, int idxChannel, int cRepeat)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- cRepeat – Repeat count to set.

The function above is used to set the repeat count.

FDwfAnalogOutRepeatGet(HDWF hdwf, int idxChannel, int *pcRepeat)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pcRepeat – Pointer to variable to receive the repeat count.

The function above is used to read the current repeat count.

FDwfAnalogOutRepeatStatus(HDWF hdwf, int idxChannel, int *pcRepeat)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pcRepeat – Pointer to variable to receive the remaining repeat counts.

The function above is used to read the remaining repeat counts. It only returns information from the last FDwfAnalogOutStatus function call, it does not read from the device.

FDwfAnalogOutRepeatTriggerSet(HDWF hdwf, int idxChannel, BOOL fRepeatTrigger)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- fRepeatTrigger – Boolean used to specify if the trigger should be included in a repeat cycle.

The function above is used to set the repeat trigger option. To include the trigger in wait-run repeat cycles, set fRepeatTrigger to TRUE. It is disabled by default.

FDwfAnalogOutRepeatTriggerGet(
HDWF hdwf, int idxChannel, BOOL *pfRepeatTrigger)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pfRepeatTrigger – Pointer to variable to receive the repeat trigger option.

The function above is used to verify if the trigger has been included in wait-run repeat cycles.

FDwfAnalogOutMasterSet(HDWF hdwf, int idxChannel, int idxMaster)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- idxMaster – Node index.

The function above sets the state machine master of the channel generator. With channel index -1, each enabled Analog Out channel will be configured to use the same, new option.

FDwfAnalogOutMasterGet(HDWF hdwf, int idxChannel, int *pidxMaster)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pidxMaster – Pointer to variable to receive parameter.

The function above is used to verify the parameter.

7 Analog I/O

The AnalogIO functions are used to control the power supplies, reference voltage supplies, voltmeters, ammeters, thermometers, and any other sensors on the device. These are organized into channels which contain a number of nodes. For instance, a power supply channel might have three nodes: an enable setting, a voltage level setting/reading, and current limitation setting/reading.

See the AnalogIO.py example.

FDwfAnalogIOReset(HDWF hdwf)

Parameters:
- hdwf – Open interface handle on a device.

The function above resets and configures (by default, having auto configure enabled) all AnalogIO instrument parameters to default values.

FDwfAnalogIOConfigure(HDWF hdwf)

Parameters:
- hdwf – Open interface handle on a device.

The function above is used to configure the instrument.

FDwfAnalogIOStatus(HDWF hdwf)

Parameters:
- hdwf – Open interface handle on a device.

The function above reads the status of the device and stores it internally. The following status functions will return the information that was read from the device when the function above was called.

FDwfAnalogIOEnableInfo(HDWF hdwf, BOOL *pfSet, BOOL *pfStatus)

Parameters:
- hdwf – Open interface handle on a device.
- pfSet – Returns true when the master enable setting is supported.
- pfStatus – Return true when the status of the master enable can be read.

The function above is used to verify if Master Enable Setting and/or Master Enable Status are supported for the AnalogIO instrument. The Master Enable setting is essentially a software switch that “enables” or “turns on” the AnalogIO channels. If supported, the status of this Master Enable switch (Enabled/Disabled) can be queried by calling **FDwfAnalogIOEnableStatus**.

FDwfAnalogIOEnableSet(HDWF hdwf, BOOL fMasterEnable)

Parameters:
- hdwf – Open interface handle on a device.
- fMasterEnable – Set TRUE to enable the master switch; FALSE to disable the master switch.

The function above is used to set the master enable switch.

FDwfAnalogIOEnableGet(HDWF hdwf, BOOL *pfMasterEnable)

Parameters:
- hdwf – Open interface handle on a device.
- pfMasterEnable – Pointer to variable to return the enabled configuration.

The function above returns the current state of the master enable switch. This is not obtained from the device.

FDwfAnalogIOEnableStatus(HDWF hdwf, BOOL *pfMasterEnable)

Parameters:
- hdwf – Open interface handle on a device.
- pfMasterEnabled – Pointer to variable to return the active status.

The function above returns the master enable status (if the device supports it). This can be a switch on the board or an overcurrent protection circuit state.

FDwfAnalogIOChannelCount(HDWF hdwf, int *pnChannel)

Parameters:
- hdwf – Open interface handle on a device.
- pnChannel – Pointer to variable to return the number of channels.

The function above returns the number of AnalogIO channels available on the device.

FDwfAnalogIOChannelName(
HDWF hdwf, int idxChannel, char szName[32], char szLabel[16])

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- szName – Pointer to character array to return the user name.
- szLabel – Pointer to character array to return the label.

The function above returns the name (long text) and label (short text, printed on the device) for a channel.

FDwfAnalogIOChannelInfo(HDWF hdwf, int idxChannel, int *pnNodes)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pnNodes – Pointer to variable to return the number of node .

The function above returns the number of nodes associated with the specified channel.

FDwfAnalogIOChannelNodeName(
HDWF hdwf, int idxChannel, int idxNode,
char szNodeName[32], char szUnits[16])

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- idxNode – Node index.
- szNodeName – Pointer to character array to return the node name.
- szUnits – Pointer to character array to return the value units.

The function above returns the node name (“Voltage”, “Current”…) and units (“V”, “A”) for an Analog I/O node **.**

FDwfAnalogIOChannelNodeInfo(
HDWF hdwf, int idxChannel, int idxNode, ANALOGIO *panalogio)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- idxNode – Node index.
- panalogio – Pointer to variable to return the node type.

The function above returns the supported channel nodes. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the *ANALOGIO* constants in dwf.h. The acquisition mode selects one of the following modes, *ANALOGIO*:

ANALOGIO Modes	*ANALOGIO* Mode Functions
analogioEnable	Enable I/O node; used to enable a power supply, reference voltage, etc.
analogioVoltage	Voltage I/O node; used to input/output voltage levels.
analogioCurrent	Current I/O node; used to input/output current levels.
analogioTemperature	Temperature I/O node; used to retrieve read values from a temperature sensor.

FDwfAnalogIOChannelNodeSetInfo(HDWF hdwf, int idxChannel, int idxNode, double *pmin, double *pmax, int *pnSteps)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Analog I/O channel index of the device.
- idxNode – Node index.
- pmin – Minimum settable value.
- pmax – Maximum settable value.
- pnSteps – Number of steps between minimum and maximum values.

These functions return node value limits. Since a Node can represent many things (Power supply, Temperature sensor, etc.), the *Minimum*, *Maximum*, and *Steps* parameters also represent different types of values. In broad terms, the (Maximum – Minimum)/Steps = the number of specific input/output values.
FDwfAnalogIOChannelNodeInfo returns the type of values to expect and
FDwfAnalogIOChannelNodeName returns the units of these values.

FDwfAnalogIOChannelNodeSet(
HDWF hdwf, int idxChannel, int idxNode, double value)

Parameters:
- hdwf – Open interface handle on a device.
- idxNode – Node index.
- idxChannel – Analog I/O channel index of the device.
- value – Value to set.

The function above is used to set the node value for the specified node on the specified channel.

FDwfAnalogIOChannelNodeGet(
HDWF hdwf, int idxChannel, int idxNode, double *pvalue)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Analog I/O channel index of the device.
- idxNode – Node index.
- pvalue – Pointer to variable to return the configured value.

The function above returns the currently set value of the node on the specified channel.

FDwfAnalogIOChannelNodeStatusInfo(
HDWF hdwf, int idxChannel, int idxNode, double *pmin, double *pmax, int *pnSteps)

Parameters:
- hdwf – Interface handle.
- idxChannel –Channel index .
- idxNode – Node index.
- pmin – Minimum reading value.
- pmax – Maximum reading value.
- pnSteps – Number of steps between minimum and maximum values.

The function above returns node the range of reading values available for the specified node on the specified channel.

FDwfAnalogIOChannelNodeStatus(
HDWF hdwf, int idxChannel, int idxNode, double *pvalue)

Parameters:
- hdwf –Interface handle.
- idxChannel –Channel index .
- idxNode – Node index.
- pvalue – Pointer to variable to return the value reading.

The function above returns the value reading of the node.

8 Digital I/O

See the DigitalIO.py example.

FDwfDigitalIOReset(HDWF hdwf)

Parameters:
- hdwf – Open interface handle on a device.

The function above resets and configures (by default, having auto configure enabled) all DigitalIO instrument parameters to default values. It sets the output enables to zero (tri-state), output value to zero, and configures the DigitalIO instrument.

FDwfDigitalIOConfigure(HDWF hdwf)

Parameters:
- hdwf – Open interface handle on a device.

The function above is used to configure the DigitalIO instrument. This doesn't have to be used if AutoConfiguration is enabled.

FDwfDigitalIOStatus(HDWF hdwf)

Parameters:
- hdwf – Open interface handle on a device.

The function above reads the status and input values, of the device DigitalIO to the PC. The status and values are accessed from the **FDwfDigitalIOInputStatus** function.

FDwfDigitalIOOutputEnableInfo(HDWF hdwf, unsigned int *pfsOutputEnableMask)

Parameters:
- hdwf – Open interface handle on a device.
- pfsOutputEnableMask – Variable to return the OE mask bit field.

The function above returns the output enable mask (bit set) that can be used on this device. These are the pins that can be used as outputs on the device.

FDwfDigitalIOOutputEnableSet(HDWF hdwf, unsigned int fsOutputEnable)

Parameters:
- hdwf – Open interface handle on a device.
- fsOutputEnable – Output enable bit set.

The function above is used to enable specific pins for output. This is done by setting bits in the fsOutEnable bit field (1 for enabled, 0 for disabled).

FDwfDigitalIOOutputEnableGet(HDWF hdwf, unsigned int *pfsOutputEnable)

Parameters:
- hdwf – Open interface handle on a device.
- pfsOutputEnable – Pointer to variable to returns output enable bit set.

The function above returns a bit field that specifies which output pins have been enabled.

FDwfDigitalIOOutputInfo(HDWF hdwf, unsigned int *pfsOutputMask)

Parameters:
- hdwf – Open interface handle on a device.
- pfsOutputMask – Variable to return the output value mask.

The function above returns the settable output value mask (bit set) that can be used on this device.

FDwfDigitalIOOutputSet(HDWF hdwf, unsigned int fsOutput)

Parameters:
- hdwf – Open interface handle on a device.
- fsOutput – Output bit set.

The function above is used to set the output logic value on all output pins.

FDwfDigitalIOOutputGet(HDWF hdwf, unsigned int *pfsOutput)

Parameters:
- hdwf – Open interface handle on a device.
- pfsOutput – Pointer to variable to returns output bit set.

The function above returns the currently set output values across all output pins.

FDwfDigitalIOInputInfo(HDWF hdwf, unsigned int *pfsInputMask)

Parameters:
- hdwf – Open interface handle on a device.
- pfsInputMask – Variable to return the input value mask.

The function above returns the readable input value mask (bit set) that can be used on the device.

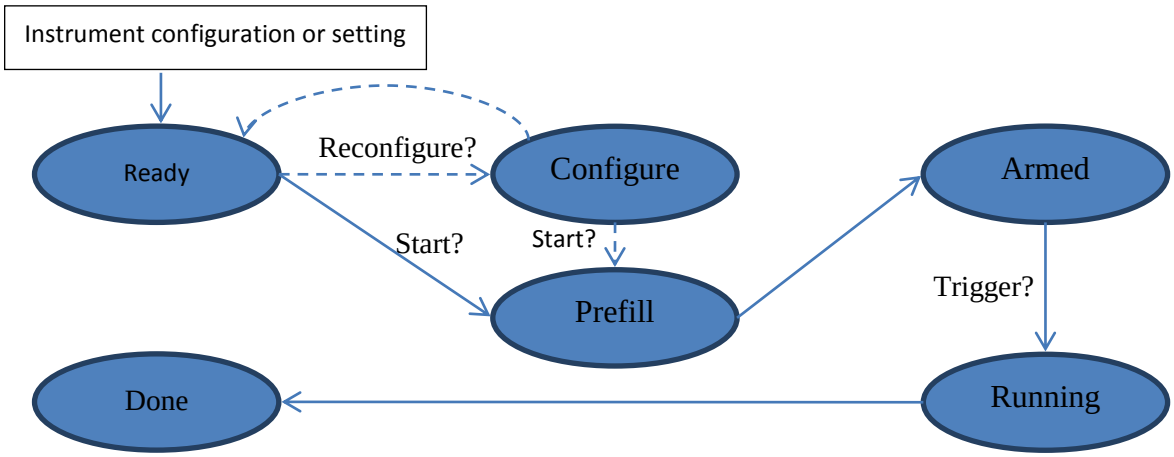
FDwfDigitalIOInputStatus(HDWF hdwf, unsigned int *pfsInput)

Parameters:
- hdwf – Open interface handle on a device.
- pfsInput – Variable to return the input value.

The function above returns the input states of all I/O pins. Before calling the function above, call the `FDwfDigitalIOStatus` function to read the Digital I/O states from the device.

9 Digital In (Logic Analyzer)

The Digital In instrument states:



The states are defined in dwf.h DwfState type.

- **Ready**: Initial state. After *FDwfDigitalInConfigure* or any *FDwfDigitalIn*Set* function call goes to this state. With *FDwfDigitalInConfigure,* reconfigure goes to Configure state.
- **Configure**: The digital in auto trigger is reset.
- **Prefill**: Prefills the buffer with samples need before trigger.
- **Armed**: It waits for trigger.
- **Running**: For single acquisition mode remains in this state to acquire samples after trigger set by *FDwfDigitalInTriggerPositionSet*. Scan screen and shift modes remain until configure or any set function of this instrument.
- **Done**: Final state.

See the following examples: DigitalIn_Acquisition/Record.py.

9.1 Control

FDwfDigitalInReset(HDWF hdwf)

Parameters:
- hdwf – Interface handle.

The function above resets and configures (by default, having auto configure enabled) all DigitalIn instrument parameters to default values.

FDwfDigitalInConfigure(HDWF hdwf, BOOL fReconfigure, BOOL fStart)

Parameters:
- hdwf – Interface handle.
- fReconfigure – Configure the device.
- fStart – Start the acquisition.

The function above is used to configure the instrument and start or stop the acquisition. To reset the Auto trigger timeout, set fReconfigure to TRUE.

FDwfDigitalInStatus(HDWF hdwf, BOOL fReadData, DwfState *psts)

Parameters:
- hdwf – interface handle.
- fReadData – TRUE if data should be read.
- psts – Variable to receive the acquisition state.

The function above is used to check the state of the instrument. To read the data from the device, set fReadData to TRUE. For single acquisition mode, the data will be read only when the acquisition is finished.

FDwfDigitalInStatusSamplesLeft(HDWF hdwf, int *pcSamplesLeft)

Parameters:
- hdwf – Interface handle.
- pcSamplesLeft – Variable to receive the remaining samples to acquire.

The function above is used to retrieve the number of samples left in the acquisition.

FDwfDigitalInStatusSamplesValid(HDWF hdwf, int *pcSamplesValid)

Parameters:
- hdwf – Interface handle.
- pcSamplesValid – Variable to receive the number of valid samples.

The function above is used to retrieve the number of valid/acquired data samples.

FDwfDigitalInStatusIndexWrite(HDWF hdwf, int *pidxWrite)

Parameters:
- hdwf – Interface handle.
- pidxWrite – Variable to receive the position of the acquisition.

The function above is used to retrieve the buffer write pointer. This is needed in ScanScreen acquisition mode to display the scan bar.

FDwfDigitalInStatusAutoTriggered(HDWF hdwf, BOOL *pfAuto)

Parameters:
- hdwf – Interface handle.
- pfAuto – Returns TRUE if the acquisition was auto triggered.

The function above is used to verify if the acquisition is auto triggered.

FDwfDigitalInStatusData(HDWF hdwf, void *rgData, int countOfDataBytes)

Parameters:
- hdwf – Interface handle.
- rgData – Pointer to allocated buffer to copy the acquisition data.
- countOfDataBytes – Number of bytes to copy.

The function above is used to retrieve the acquired data samples from the instrument. It copies the data samples to the provided buffer. The sample format is specified by **FDwfDigitalInSampleFormatSet**function.

FDwfDigitalInStatusData2(HDWF hdwf,
void *rgData, int idxSample, int countOfDataBytes)

Parameters:
- hdwf – Interface handle.
- rgData – Pointer to allocated buffer to copy the acquisition data.
- idxSample – First sample index to copy.
- countOfDataBytes – Number of bytes to copy.

The function above is used to retrieve the acquired data samples from the instrument. It copies the data samples to the provided buffer. The sample format is specified by **FDwfDigitalInSampleFormatSet**function.

FDwfDigitalInStatusRecord(
HDWF hdwf, int *pcdDataAvailable, int *pcdDataLost, int *pcdDataCorrupt)

Parameters:

- hdwf – Interface handle.
- pcdDataAvailable – Pointer to variable to receive the available number of samples.
- pcdDataLost – Pointer to variable to receive the lost samples after the last check.
- pcdDataCorrupt – Pointer to variable to receive the number of samples that could be corrupt.

The function above is used to retrieve information about the recording process. The data loss occurs when the device acquisition is faster than the read process to PC. In this case, the device recording buffer is filled and data samples are overwritten. Corrupt samples indicate that the samples have been overwritten by the acquisition process during the previous read. In this case, try optimizing the loop process for faster execution or reduce the acquisition frequency or record length to be less than or equal to the device buffer size (record length <= buffer size/frequency).

9.2 Configuration

FDwfDigitalInInternalClockInfo(HDWF hdwf, double *phzFreq)

Parameters:
- hdwf – Interface handle.
- phzFreq – Pointer to return the internal clock frequency.

The function above is used to retrieve the internal clock frequency.

FDwfDigitalInClockSourceInfo(HDWF hdwf, int *pfsDwfDigitalInClockSource)

Parameters:
- hdwf – Open interface handle on a device.
- pfsDwfDigitalInClockSource – Pointer to variable to return the available clock source options.

The function above returns the supported clock sources for Digital In instrument. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the *DwfDigitalInClockSource* constants in dwf.h:

- DwfDigitalInClockSourceInternal: Internal clock.
- DwfDigitalInClockSourceExternal: External clock source.

FDwfDigitalInClockSourceSet(HDWF hdwf, DwfDigitalInClockSource v)

Parameters:
- hdwf – Open interface handle on a device.
- v – Clock source.

The function above is used to set the clock source of instrument.

FDwfDigitalInClockSourceGet(HDWF hdwf, DwfDigitalInClockSource *pv)

Parameters:
- hdwf – Open interface handle on a device.
- pv – Pointer to variable to return the configured value.

The function above is used to get the clock source of instrument.

FDwfDigitalInDividerInfo(HDWF hdwf, unsigned int *pdivMax)

Parameters:
- hdwf –Interface handle.
- pdivMax – Pointer to variable to return the available maximum divider value.

The function above returns the maximum supported clock divider value. This specifies the sample rate.

FDwfDigitalInDividerSet(HDWF hdwf, unsigned int div)

Parameters:
- hdwf – Interface handle.
- div – Divider value.

The function above is used to set the clock divider value.

FDwfDigitalInDividerGet(HDWF hdwf, unsigned int *pdiv)

Parameters:
- hdwf – Interface handle.
- pdiv –Pointer to return configured value.

The function above is used to get the configured clock divider value.

FDwfDigitalInBitsInfo(HDWF hdwf, int *pnBits)

Parameters:
- hdwf – Interface handle.
- pnBits – Pointer to variable to return the number of bits.

The function above returns the number of Digital In bits.

FDwfDigitalInInputOrderSet(HDWF hdwf, bool fDioFirst)

Parameters:
- hdwf – Interface handle.
- fDioFirst – DIO or DIN lines start from index zero.

The function above is valid for Digital Discovery device.

FDwfDigitalInSampleFormatSet(HDWF hdwf, int nBits)

Parameters:
- hdwf – Interface handle.
- nBits – Sample format.

The function above is used to set the sample format, the number of bits starting from least significant bit. Valid options are 8, 16, and 32.

FDwfDigitalInSampleFormatGet(HDWF hdwf, int *pnBits)

Parameters:
- hdwf –Interface handle.
- pnBits –Pointer to return configured value.

The function above is used to return the configured sample format.

FDwfDigitalInBufferSizeInfo(HDWF hdwf, int *pnSizeMax)

Parameters:
- hdwf – Interface handle.
- pnSizeMax – Pointer to variable to return maximum buffer size.

The function above returns the Digital In maximum buffer size.

FDwfDigitalInBufferSizeSet(HDWF hdwf, int nSize)

Parameters:
- hdwf – Interface handle.
- nSize – Buffer size.

The function above is used to set the buffer size.

FDwfDigitalInBufferSizeGet(HDWF hdwf, int *pnSize)

Parameters:
- hdwf – Interface handle.
- nSize – Pointer to return configured value.

The function above is used to return the configured buffer size.

FDwfDigitalInSampleModeInfo(HDWF hdwf, int *pfsDwfDigitalInSampleMode)

Parameters:
- hdwf – Interface handle.
- pfsDwfDigitalInSampleMode – Pointer to return the supported sample modes.

The function above returns the supported sample modes. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the DwfDigitalInSampleMode constants in dwf.h:

- **DwfDigitalInSampleModeSimple**: Stores one sample on every divider clock pulse.
- **DwfDigitalInSampleModeNoise**: Stores alternating noise and sample values, where noise is more than one transition between two samples. This could indicate glitches or ringing. It is available when sample rate is less than maximum clock frequency, divider is greater than one.

FDwfDigitalInSampleModeSet(HDWF hdwf, DwfDigitalInSampleMode v)

Parameters:
- hdwf – Open interface handle on a device.
- v – Sample mode.

The function above is used to set the sample mode.

FDwfDigitalInSampleModeGet(HDWF hdwf, DwfDigitalInSampleMode *pv)

Parameters:
- hdwf – Open interface handle on a device.
- pv – Pointer to return configured value.

The function above is used to return the configured sample mode.

FDwfDigitalInAcquisitionModeInfo(HDWF hdwf, int *pfsacqmode)

Parameters:
- hdwf – Interface handle.
- pfsacqmode – Pointer to return the supported acquisition modes.

The function above returns the supported DigitalIn acquisition modes. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the ACQMODE constants in DWF.h. The acquisition mode selects one of the following modes, ACQMODE:

- **acqmodeSingle:** Perform a single buffer acquisition. This is the default setting.
- **acqmodeScanShift:** Perform a continuous acquisition in FIFO style. The trigger setting is ignored. The last sample is at the end of buffer. The FDwfDigitalInStatusSamplesValid function is used to show the number of the acquired samples, which will grow until reaching the BufferSize. Then the waveform "picture" is shifted for every new sample.
- **acqmodeScanScreen:** Perform continuous acquisition circularly writing samples into the buffer. The trigger setting is ignored. The IndexWrite shows the buffer write position. This is similar to a heart monitor display.

FDwfDigitalInAcquisitionModeSet(HDWF hdwf, ACQMODE acqmode)

Parameters:
- hdwf – Interface handle.
- acqmode – Acquisition mode to set.

The function above is used to set the acquisition mode.

FDwfDigitalInAcquisitionModeGet(HDWF hdwf, ACQMODE *pacqmode)

Parameters:
- hdwf – Interface handle.
- pacqmode – Variable to receive the current acquisition mode.

The function above is used to get retrieve the acquisition mode.

FDwfDigitalInSampleSensibleSet(HDWF hdwf, unsigned int fs)

Parameters:
- hdwf – Interface handle.
- fs – bit field set of signals to look for compression.

The function above is used to select the interested signals that will be used for data compression in record acquisition mode

FDwfDigitalInSampleSensibleGet(HDWF hdwf, unsigned int *pfs)

Parameters:
- hdwf – Interface handle.
- pfs – Pointer to variable to receive configured value

9.3 Trigger

See the description of **FDwfDeviceTriggerInfo**.

FDwfDigitalInTriggerSourceSet(HDWF hdwf, TRIGSRC trigsrc)

Parameters:
- hdwf – Interface handle.
- trigsrc – Trigger source to set.

The function above is used to set the trigger source for the instrument.

FDwfDigitalInTriggerSourceGet(HDWF hdwf, TRIGSRC *ptrigsrc)

Parameters:
- hdwf – Interface handle.
- ptrigsrc – Pointer to variable to receive the trigger source.

The function above is used to get the current trigger source setting for the instrument.

FDwfDigitalInTriggerSlopeSet(HDWF hdwf, DwfTriggerSlope slope)

Parameters:
- hdwf – Interface handle.
- slope – Trigger source to set.

The function above is used to set the trigger slope for the instrument.

FDwfDigitalInTriggerSlopeGet(HDWF hdwf, DwfTriggerSlope *pslope)

Parameters:
- hdwf – Interface handle.
- pslope – Pointer to variable to receive the trigger slope.

The function above is used to get the current trigger source setting for the instrument.

FDwfDigitalInTriggerPositionInfo(
HDWF hdwf, unsigned int *pnSamplesAfterTriggerMax)

Parameters:
- hdwf – Interface handle.
- pnSamplesAfterTriggerMax – Variable to receive the maximum trigger position.

The function above returns maximum values of the trigger position in samples. This can be greater than the specified buffer size.

FDwfDigitalInTriggerPositionSet(HDWF hdwf, unsigned int cSamplesAfterTrigger)

Parameters:
- hdwf – Interface handle.
- cSamplesAfterTrigger – Samples after trigger.

The function above is used to set the number of samples to acquire after trigger.

FDwfDigitalInTriggerPositionGet(
HDWF hdwf, unsigned int *pcSamplesAfterTrigger)

Parameters:
- hdwf – Interface handle.
- pcSamplesAfterTrigger – Pointer to variable to receive configured value

The function above is used to get the configured trigger position.

FDwfDigitalInTriggerPrefillSet(HDWF hdwf, unsigned int cSamplesBeforeTrigger)

Parameters:
- hdwf – Interface handle.
- cSamplesBeforeTrigger – Samples before trigger.

The function above is used to set the number of samples to acquire before arming.
Only used in Record acquisition mode.

FDwfDigitalInTriggerPrefillGet(
HDWF hdwf, unsigned int *pcSamplesBeforeTrigger)

Parameters:
- hdwf – Interface handle.
- pcSamplesBeforeTrigger – Pointer to variable to receive configured value

The function above is used to get the configured trigger prefill.

FDwfDigitalInTriggerAutoTimeoutInfo(
HDWF hdwf, double *psecMin, double *psecMax, double *pnSteps)

Parameters:
- hdwf – Interface handle.
- psecMin – Variable to receive the minimum timeout.
- psecMax – Variable to receive the maximum timeout.
- pnSteps – Variable to return the number of steps.

The function above returns the minimum and maximum auto trigger timeout values, and the number of adjustable steps.

FDwfDigitalInTriggerAutoTimeoutSet(HDWF hdwf, double secTimeout)

Parameters:
- hdwf – Interface handle.
- secTimeout – Timeout to set.

The function above is used to configure the auto trigger timeout value in seconds.

FDwfDigitalInTriggerAutoTimeoutGet(HDWF hdwf, double *psecTimeout)

Parameters:
- hdwf – Interface handle.
- psecTimeout – Variable to receive the current timeout.

The function above returns the configured auto trigger timeout value in seconds. The acquisition is auto triggered when the specified time elapses. With zero value the timeout is disabled, performing “Normal” acquisitions.

9.4 Trigger Detector

In order to use trigger on digital in pins, set trigger source with FDwfDigitalInTriggerSourceSet to trigsrcDetectorDigitalIn.

```
FDwfDigitalInTriggerInfo(HDWF hdwf,
unsigned int *pfsLevelLow, unsigned int *pfsLevelHigh,
unsigned int *pfsEdgeRise, unsigned int *pfsEdgeFall)
```

Parameters:

- hdwf – Interface handle.
- pfsLevelLow – Variable to receive the supported low state triggers.
- pfsLevelHigh – Variable to receive the supported low state triggers.
- pfsEdgeRise – Variable to receive the supported rising edge triggers.
- pfsEdgeFall – Variable to receive the supported falling edge triggers.

The function above returns the supported digital in triggers. The bits of the arguments represent pins.

The logic for the trigger bits is: *Low and High and (Rise or Fall)*. Setting a bit in both rise and fall will trigger on any edge, any transition. For instance FDwfDigitalInTriggerInfo(hdwf, 1, 2, 4, 8) will generate trigger when DIO-0 is low and DIO-1 is high and DIO-2 is rising or DIO-3 is falling.

```
FDwfDigitalInTriggerSet(HDWF hdwf,
unsigned int fsLevelLow, unsigned int fsLevelHigh,
unsigned int fsEdgeRise, unsigned int fsEdgeFall)
```

Parameters:

- hdwf – Interface handle.
- fsLevelLow – Set low state condition.
- fsLevelHigh – Set high state condition.
- fsEdgeRise – Set rising edge condition.
- fsEdgeFall – Set falling edge condition.

The function above is used to configure the digital in trigger detector.

```
FDwfDigitalInTriggerGet(HDWF hdwf,
unsigned int *pfsLevelLow, unsigned int *pfsLevelHigh,
unsigned int *pfsEdgeRise, unsigned int *pfsEdgeFall)
```

Parameters:

- hdwf – Interface handle.
- pfsLevelLow – Variable to receive the configured value.
- pfsLevelHigh – Variable to receive the configured value.
- pfsEdgeRise – Variable to receive the configured value.
- pfsEdgeFall – Variable to receive the configured value.

The function above returns the configured digital in trigger detector option.

```
FDwfDigitalInTriggerResetSet(HDWF hdwf,
unsigned int fsLevelLow, unsigned int fsLevelHigh,
unsigned int fsEdgeRise, unsigned int fsEdgeFall)
```

Parameters:

- hdwf – Interface handle.
- fsLevelLow – Set low state condition.
- fsLevelHigh – Set high state condition.
- fsEdgeRise – Set rising edge condition.
- fsEdgeFall – Set falling edge condition.

The function above is used to configure the digital in trigger reset condition.

```
FDwfDigitalInTriggerCountSet(HDWF hdwf, int cCount, int fRestart)
```

Parameters:

- hdwf – Interface handle.
- cCount – Set event count.
- fRestart – Set to restart counter after expires or not and wait for next reset condition.

The function above is used to configure trigger counter.

```
FDwfDigitalInTriggerLengthSet(HDWF hdwf,
double secMin, double secMax, int idxSync)
```

Parameters:

- hdwf – Interface handle.
- secMin – Set minimum length in seconds, up to 20sec.
- secMax – Set maximum length in seconds, up to 20sec.
- idxSync – Set synchronization mode.

The function above is used to configure the trigger timing. The synchronization modes are the following:

0 – Normal

1 – Timing: use for UART, CAN. The min length specifies bit length and max the timeout length.

2 – PWM: use for 1-Wire. The min length specifies sampling time and max the timeout length.

```
FDwfDigitalInTriggerMatchSet(HDWF hdwf,
int iPin, unsigned int fsMask, unsigned int fsValue, int cBitStuffing)
```

Parameters:

- hdwf – Interface handle.
- iPin – Set pin to deserialize.
- fsMask – Set bit mask pattern.
- fsValue – Set bit match pattern.
- cBitStuffing – Set bit stuffing count.

The function above is used to configure the deserializer. The bits are left shifted. The mask and value should be specified according to this, in MSBit first order. Like to trigger on first to fourth bits received from a sequence of 8, b1010XXXX, set mask to 0x000000F0 and value to 0x000000A0.

Pulse: To trigger on a pulse configure the following:
- For positive pulse specify rising and for negative falling edge reset.
FDwfDigitalInTriggerResetSet(hdwf, 0, 0, positive?1<<dio:0, negative?1<<dio:0);
- For positive pulse specify high and for negative low level trigger.
FDwfDigitalInTriggerSet(hdwf, negative?1<<dio:0, positive?1<<dio:0, 0, 0);

Glitch: To trigger on glitch, a pulse length at most the specified value:
FDwfDigitalInTriggerLengthSet(hdwf, 0, max, 0); // maximum pulse length in seconds

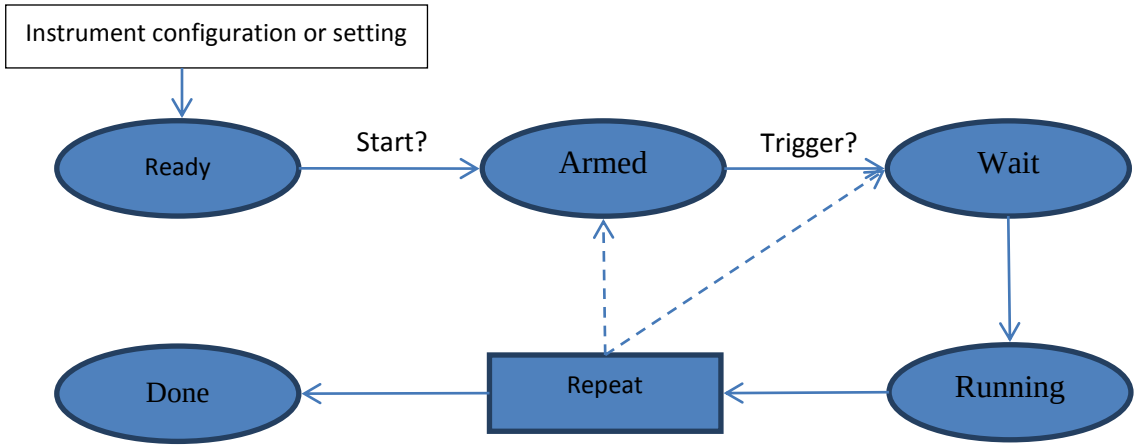
Timeout: To trigger on pulse timeout, on a pulse after the specified minimum time expires:
FDwfDigitalInTriggerLengthSet(hdwf, min, 0, 0); // minimum pulse length in seconds

More: To trigger on pulse ending slope which is longer than the specified minimum time:
FDwfDigitalInTriggerLengthSet(hdwf, min, -1, 0); // minimum pulse length in seconds

Length: To trigger on a pulse length with the specified minimum and maximum lengths use:
FDwfDigitalInTriggerLengthSet(hdwf, min, max, 0); // min/max pulse length in seconds

10 Digital Out (Pattern Generator)

The DigitalOut instrument states:



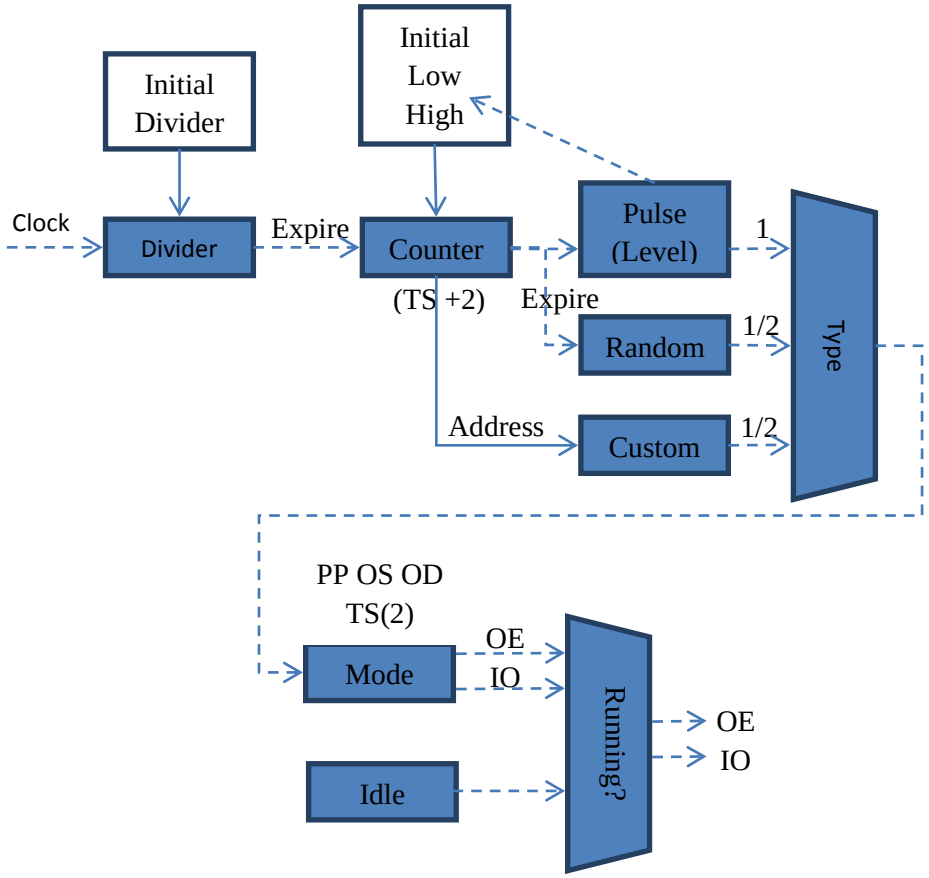
The states are described defined in dwf.h DwfState type.

- **Ready**: Initial state. After *FDwfDigitalOutConfigure* or any *FDwfDigitalOut*Set* function call goes to this state. With digital out, configure start command goes to Armed state
- **Armed**: It waits for trigger.
- **Wait**: Remains in this state for the time period specified by *FDwfDigitalOutWaitSet* function.
- **Running**: Remains in this state for the time period specified by *FDwfDigitalOutRunSet* function.
- ***Repeat***: Goes to Armed or Wait state according to the FDwfDigitalOutRepeatTriggerSet setting for the number of times specified by FDwfDigitalOutRepeatSet.
- **Done**: Final state.

This states machine controls all digital out channels.

See the following examples: DigitalOut_BinaryCounter/Pins.py

Channel configuration:

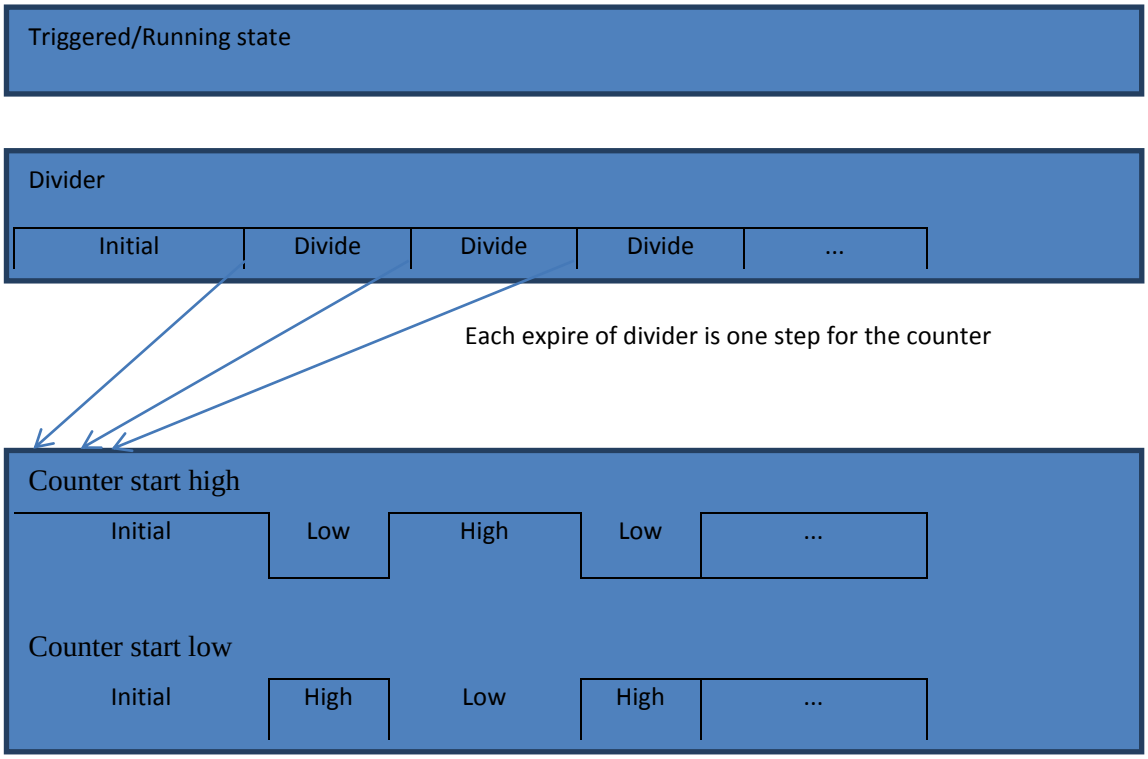


The initial values, for divider and counter, specify the initially loaded values, initial delay, when entering in Running state. The Divider specifies the clock division. This rate will be the custom sample frequency and step for the counter. When entering Running state, the initial value specified with *FDwfDigitalOutDividerInitSet* is loaded. When this expires, the value specified by *FDwfDigitalOutDividerSet* will be loaded upon each expiration.
The Counter initial value is set by *FDwfDigitalOutCounterInitSet* function. This function also sets the initial level. When this expires the level values specified by *FDwfDigitalOutCounterSet* are loaded upon further expiration. On counter expiration the level is toggled and this directs the low or high value loading. In case one of these is zero, the level is not toggled.

The Counter is used for:
- Pulse to generate the low and high state lengths.
- Random to set update rate.
- Custom to address buffer. The samples are configured by *FDwfDigitalOutDataSet* function. This also configures the counter low/high according *countOfBits* parameter. In TS mode the counter step is double, providing two bits of samples for output: value and enable.

The output Mode (*FDwfDigitalOutModeSet*) selects between: PP, OS, OD and TS.
The Idle output (*FDwfDigitalOutIdleSet*) selects the output while not in *Running* state.

Pulse signal:



For pulse signal the initial level and initial value are specified with *FDwfDigitalOutCounterInitSet* function. These are loaded when entering Running state.

10.1 Control

FDwfDigitalOutReset(HDWF hdwf)

Parameters:
- hdwf – Interface handle.

The function above resets and configures (by default, having auto configure enabled) all of the instrument parameters to default values.

FDwfDigitalOutConfigure(HDWF hdwf, BOOL fStart)

Parameters:
- hdwf – Interface handle.
- fStart – Start the instrument. To stop, set to FALSE.

The function above is used to start or stop the instrument.

FDwfDigitalOutStatus(HDWF hdwf, DwfState *psts)

Parameters:
- hdwf – Interface handle.
- psts – Pointer to variable to return the state.

The function above is used to check the state of the instrument.

10.2 Configuration

FDwfDigitalOutInternalClockInfo(HDWF hdwf, double *phzFreq)

Parameters:
- hdwf – Interface handle.
- phzFreq – Pointer to return the internal clock frequency.

The function above is used to retrieve the internal clock frequency.

See the description of **FDwfDeviceTriggerInfo**.

FDwfDigitalOutTriggerSourceSet(HDWF hdwf, TRIGSRC trigsrc)

Parameters:
- hdwf – Interface handle.
- trigsrc – Trigger source to set .

The function above is used to set the trigger source for the instrument. Default setting is trigsrcNone.

FDwfDigitalOutTriggerSourceGet(HDWF hdwf, TRIGSRC *ptrigsrc)

Parameters:
- hdwf – Interface handle.
- ptrigsrc – Pointer to variable to receive the trigger source.

The function above is used to get the current trigger source setting for the instrument.

FDwfDigitalOutTriggerSlopeSet(HDWF hdwf, DwfTriggerSlope slope)

Parameters:
- hdwf – Interface handle.
- slope – Trigger source to set.

The function above is used to set the trigger slope for the instrument.

FDwfDigitalOutTriggerSlopeGet(HDWF hdwf, DwfTriggerSlope *pslope)

Parameters:
- hdwf – Interface handle.
- pslope – Pointer to variable to receive the trigger slope.

The function above is used to get the current trigger source setting for the instrument.

FDwfDigitalOutRunInfo(HDWF hdwf, double *psecMin, double *psecMax)

Parameters:
- hdwf – Interface handle.
- psecMin – Variable to receive the supported minimum run length.
- psecMax – Variable to receive the supported maximum run length.

The function above is used to return the supported run length range for the instrument in seconds. Zero value (default) represent an infinite (or continuous) run.

FDwfDigitalOutRunSet(HDWF hdwf, double secRun)

Parameters:
- hdwf – Interface handle.
- secRun – Run length to set expressed in seconds.

The function above is used to set the run length for the instrument in Seconds.

FDwfDigitalOutRunGet(HDWF hdwf, double *psecRun)

Parameters:
- hdwf – Interface handle.
- psecRun – Pointer to variable to receive the run length.

The function above is used to read the configured run length for the instrument in seconds.

FDwfDigitalOutRunStatus(HDWF hdwf, double *psecRun)

Parameters:
- hdwf – Interface handle.
- psecRun – Pointer to variable to receive the remaining run length.

The function above is used to read the remaining run length. It returns data from the last FDwfDigitalOutStatus call.

FDwfDigitalOutWaitInfo(HDWF hdwf, double *psecMin, double *psecMax)

Parameters:
- hdwf – Interface handle.
- psecMin – Variable to receive the supported minimum wait length.
- psecMax – Variable to receive the supported maximum wait length.

The function above is used to return the supported wait length range in seconds. The wait length is how long the instrument waits after being triggered to generate the signal. Default value is zero.

FDwfDigitalOutWaitSet(HDWF hdwf, double secWait)

Parameters:
- hdwf – Interface handle.
- secWait – Wait length to set expressed in seconds.

The function above is used to set the wait length.

FDwfDigitalOutWaitGet(HDWF hdwf, double *psecWait)

Parameters:
- hdwf – Interface handle.
- psecWait – Pointer to variable to receive the wait length.

The function above is used to get the current wait length.

FDwfDigitalOutRepeatInfo(HDWF hdwf, unsigned int *pnMin, unsigned int *pnMax)

Parameters:
- hdwf – Interface handle.
- pnMin – Variable to receive the supported minimum repeat count.
- pnMax – Variable to receive the supported maximum repeat count.

The function above is used to return the supported repeat count range. This is how many times the generated signal will be repeated. Zero value represents infinite repeats. Default value is one.

FDwfDigitalOutRepeatSet(HDWF hdwf, unsigned int cRepeat)

Parameters:
- hdwf – Interface handle.
- cRepeat – Repeat count to set.

The function above is used to set the repeat count.

FDwfDigitalOutRepeatGet(HDWF hdwf, unsigned int *pcRepeat)

Parameters:
- hdwf – Interface handle.
- pcRepeat – Pointer to variable to receive the repeat count.

The function above is used to read the current repeat count.

FDwfDigitalOutRepeatStatus(HDWF hdwf, unsigned int *pcRepeat)

Parameters:
- hdwf – Interface handle.
- pcRepeat – Pointer to variable to receive the remaining repeat counts.

The function above is used to read the remaining repeat counts. It only returns information from the last FDwfDigitalOutStatus function call, it does not read from the device.

FDwfDigitalOutRepeatTriggerSet(HDWF hdwf, BOOL fRepeatTrigger)

Parameters:
- hdwf – Interface handle.
- fRepeatTrigger – Boolean used to specify if the trigger should be included in a repeat cycle.

The function above is used to set the repeat trigger option. To include the trigger in wait-run repeat cycles, set fRepeatTrigger to TRUE. It is disabled by default.

FDwfDigitalOutRepeatTriggerGet(HDWF hdwf, BOOL *pfRepeatTrigger)

Parameters:
- hdwf – Open interface handle on a device.
- pfRepeatTrigger – Pointer to variable to receive the repeat trigger option.

The function above is used to verify if the trigger has been included in wait-run repeat cycles.

FDwfDigitalOutCount(HDWF hdwf, int *pcChannel)

Parameters:
- hdwf – Interface handle.
- pcChannel – Pointer to variable to receive the number of channels in the instrument.

The function above returns the number of Digital Out channels by the device specified by hdwf.

FDwfDigitalOutEnableSet(HDWF hdwf, int idxChannel, BOOL fEnable)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- fEnable – TRUE to enable, FALSE to disable.

The function above enables or disables the channel specified by idxChannel.

FDwfDigitalOutEnableGet(HDWF hdwf, int idxChannel, BOOL *pfEnable)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pfEnable – Pointer to variable to receive enabled state.

The function above is used to verify if a specific channel is enabled or disabled.

FDwfDigitalOutOutputInfo(
HDWF hdwf, int idxChannel, int *pfsDwfDigitalOutOutput)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pfsDwfDigitalOutOutput – Pointer to variable to receive the supported output modes.

The function above returns the supported output modes of the channel. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the DwfDigitalOutOutput constants in DWF.h:

- **DwfDigitalOutOutputPushPull**: Default setting.
- **DwfDigitalOutOutputOpenDrain**: External pull needed.
- **DwfDigitalOutOutputOpenSource**: External pull needed.
- **DwfDigitalOutOutputThreeState**: Available with custom and random types.

FDwfDigitalOutOutputSet(HDWF hdwf, int idxChannel, DwfDigitalOutOutput v)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- v – Output mode.

The function above specifies output mode of the channel.

FDwfDigitalOutOutputGet(HDWF hdwf, int idxChannel, DwfDigitalOutOutput *pv)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pfEnable – Pointer to variable to receive enabled state.

The function above is used to verify if a specific channel output mode.

FDwfDigitalOutTypeInfo(HDWF hdwf, int idxChannel, int *pfsDwfDigitalOutType)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pfsDwfDigitalOutType – Pointer to variable to receive the supported output types.

The function above returns the supported types of the channel. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the DwfDigitalOutType constants in dwf.h:

- **DwfDigitalOutTypePulse**: Frequency = internal frequency/divider/(low + high counter).
- **DwfDigitalOutTypeCustom**: Sample rate = internal frequency / divider.
- **DwfDigitalOutTypeRandom**: Random update rate = internal frequency/divider/counter alternating between low and high values.

FDwfDigitalOutTypeSet(HDWF hdwf, int idxChannel, DwfDigitalOutType v)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- v – Output mode.

The function above sets the output type of the specified channel.

FDwfDigitalOutTypeGet(HDWF hdwf, int idxChannel, DwfDigitalOutType *pv)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pfEnable – Pointer to variable to receive enabled state.

The function above is used to verify the type of a specific channel.

FDwfDigitalOutIdleInfo(HDWF hdwf, int idxChannel, int *pfsDwfDigitalOutIdle)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pfsDwfDigitalOutIdle – Pointer to variable to receive the supported idle output types.

The function above returns the supported idle output types of the channel. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the DwfDigitalOutIdle constants in dwf.h. Output while not running:

- **DwfDigitalOutIdleInit**: Output initial value.
- **DwfDigitalOutIdleLow**: Low level.
- **DwfDigitalOutIdleHigh**: High level.
- **DwfDigitalOutIdleZet**: Three state.

FDwfDigitalOutIdleSet(HDWF hdwf, int idxChannel, DwfDigitalOutIdle v)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- v – Value to set idle output.

The function above sets the idle output of the specified channel.

FDwfDigitalOutIdleGet(HDWF hdwf, int idxChannel, DwfDigitalOutIdle *pv)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pv – Pointer to variable to receive configured value.

The function above is used to verify the idle output of a specific channel.

FDwfDigitalOutDividerInfo(
HDWF hdwf, int idxChannel, unsigned int *vMin, unsigned int *vMax)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pnMin – Variable to receive the supported minimum divider value.
- pnMax – Variable to receive the supported maximum divider value.

The function above is used to return the supported clock divider value range.

FDwfDigitalOutDividerInitSet(HDWF hdwf, int idxChannel, unsigned int v)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- v – Divider initial value.

The function above sets the initial divider value of the specified channel.

FDwfDigitalOutDividerInitGet(HDWF hdwf, int idxChannel, unsigned int *pv)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pv – Pointer to variable to receive configured value.

The function above is used to verify the initial divider value of the specified channel.

FDwfDigitalOutDividerSet(HDWF hdwf, int idxChannel, unsigned int v)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- v – Divider value.

The function above sets the divider value of the specified channel.

FDwfDigitalOutDividerGet(HDWF hdwf, int idxChannel, unsigned int *pv)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pv – Pointer to variable to receive configured value.

The function above is used to verify the divider value of the specified channel.

FDwfDigitalOutCounterInfo(
HDWF hdwf, int idxChannel, unsigned int *vMin, unsigned int *vMax)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pnMin – Variable to receive the supported minimum counter value.
- pnMax – Variable to receive the supported maximum counter value.

The function above is used to return the supported counter value range.

FDwfDigitalOutCounterInitSet(
HDWF hdwf, int idxChannel, BOOL fHigh, unsigned int v)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- fHigh – Start high.
- v – Divider initial value.

The function above sets the initial state and counter value of the specified channel.

FDwfDigitalOutCounterInitGet(
HDWF hdwf, int idxChannel, int *pfHigh, unsigned int *pv)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pfHigh – Pointer to variable to receive configured value.
- pv – Pointer to variable to receive configured value.

The function above is used to verify the initial state and counter value of the specified channel.

FDwfDigitalOutCounterSet(
HDWF hdwf, int idxChannel, unsigned int vLow, unsigned int vHigh)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- vLow – Counter low value.
- vHigh – Counter high value.

The function above sets the counter low and high values of the specified channel.

FDwfDigitalOutCounterGet(
HDWF hdwf, int idxChannel, unsigned int *pvLow, unsigned int *pvHigh)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pvLow – Pointer to variable to receive configured value.
- pvHigh – Pointer to variable to receive configured value.

The function above is used to verify the low and high counter value of the specified channel.

FDwfDigitalOutDataInfo(
HDWF hdwf, int idxChannel, unsigned int *pcountOfBitsMax)

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- pcountOfBitsMax – Variable to receive the maximum number of bits.

The function above is used to return the maximum buffers size, the number of custom data bits.

```
FDwfDigitalOutDataSet(
HDWF hdwf, int idxChannel, void *rgBits, unsigned int countOfBits)
```

Parameters:
- hdwf – Interface handle.
- idxChannel – Channel index.
- rgBits – Custom data array.
- countOfBits –Number of bits.

The function above is used to set the custom data bits. The function also sets the counter initial, low and high value, according the number of bits. The data bits are sent out in LSB first order. For TS output, the count of bits is the total number of output value (I/O) and output enable (OE) bits, which should be an even number.

Custom Data Bits									
BYTE	0						1		
Bits	0	1	2	3	...	7	0	1	...
Output	I/O(0)	OE(0)	I/O(1)	OE(1)	...	OE(3)	I/O(4)	OE(4)	...

11 Digital Protocols

The protocols use the Digital-In/Out resources to create various communication protocols. Only one of the protocols can be used at a time and no digital-io or out other functions.
Nore: The DIO channe indexing for Digital Discovery starts from 0, 0 is DIO-24, 1 is DIO-25…

11.1 UART

```
FDwfDigitalUartReset(HDWF hdwf)
```

Parameters:
- hdwf – Interface handle.

The function above resets the UART configuration to default value. Use FDwfDigitalOutReset to reset the output.

```
FDwfDigitalUartRateSet(HDWF hdwf, double hz)
```

Parameters:
- hdwf – Interface handle.
- hz – data rate to set

The function above sets the data rate.

```
FDwfDigitalUartBitsSet(HDWF hdwf, double cBits)
```

Parameters:
- hdwf – Interface handle.
- cBits – character length

The function above sets the character length, typically 8, 7, 6 or 5.

```
FDwfDigitalUartParitySet(HDWF hdwf, int parity)
```

Parameters:
- hdwf – Interface handle.
- parity – parity mode to set

The function above sets the parity bit: 0 for no parity, 1 for odd and 2 for even parity.

```
FDwfDigitalUartStopSet(HDWF hdwf, double cBits)
```

Parameters:
- hdwf – Interface handle.
- cBits – stop length

The function above sets the stop length as number of bits.

```
FDwfDigitalUartTxSet(HDWF hdwf, int idxChannel)
```

Parameters:
- hdwf – Interface handle.
- idxChannel – DIO channel to use for TX

The function above specifies the DIO channel to use for transmission.

FDwfDigitalUartRxSet(HDWF hdwf, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxChannel – DIO channel to use for RX

The function above specifies the DIO channel to use for reception.

FDwfDigitalUartTx(HDWF hdwf, char *szTx, int cTx)

Parameters:
- hdwf – Interface handle.
- szTX – array of characters to send
- cTX – number of characters to send

The function above transmits the specified characters.

FDwfDigitalUartRx(HDWF hdwf, char *szRx, int cRxMax, int *pcRx, int *pParity)

Parameters:
- hdwf – Interface handle.
- szRX – buffer to receive characters
- cRxMax – the maximum number of characters to receive, the buffer size
- pcRX – pointer to return the number of characters received
- pParity – pointer to return:
  - negative value for buffer overflow, in case the buffer got full since the previos call of this function
  - the first parity check failure as one based index
  - zero for no error

The function above initializes the reception with cRxMax zero. Otherwise returns the received characters since the last call.

11.2 SPI

FDwfDigitalSpiReset(HDWF hdwf)

Parameters:
- hdwf – Interface handle.

The function above resets the SPI configuration to default value. Use FDwfDigitalOutReset to reset the outputs.

FDwfDigitalSpiFrequencySet(HDWF hdwf, double hz)

Parameters:
- hdwf – Interface handle.
- hz – bit rate to set (default 1kHz)

The function above sets the SPI frequency.

FDwfDigitalSpiClockSet(HDWF hdwf, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxChannel – DIO channel to use for SPI clock (default DIO1)

The function above specifies the DIO channel to use for SPI clock.

FDwfDigitalSpiDataSet(HDWF hdwf, int idxDQ, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxDQ – specify data index to set, 0 = DQ0_MOSI_SISO, 1 = DQ1_MISO, 2 = DQ2, 3 = DQ3
- idxChannel – DIO channel to use for SPI data

The function above specifies the DIO channels to use for SPI data.

FDwfDigitalSpiModeSet(HDWF hdwf, int iMode)

Parameters:
- hdwf – Interface handle.
- iMode – specify SPI mode, bit1 CPOL and bit0 CPHA

The function above sets the SPI mode.

iMode	CPOL	CPHA
0	0	0
1	0	1
2	1	0
3	1	1

FDwfDigitalSpiOrderSet(HDWF hdwf, int fMSBLSB)

Parameters:
- hdwf – Interface handle.
- fMSB – specify bit order, 1 MSB first (default), 0 LSB first

The function above sets the bit order for SPI data.

FDwfDigitalSpiSelect(HDWF hdwf, int idxChannel, int iLevel)

Parameters:
- hdwf – Interface handle.
- idxChannel – specify DIO channel for which to set the level
- iLevel– set the channel level: 0 low, 1 high, -1 release (Z, high impedance)

The function above controls the SPI CS signal(s).

FDwfDigitalSpiWriteRead(HDWF hdwf, int cDQ, int cBitPerWord, unsigned char *rgTX, int cTX, unsigned char *rgRX, int cRX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data:
  0 – SISO, use only DQ0 for read and write
  1 – MISI/MISO, use DQ0 for write and DQ1 to read data
  2 – dual, use DQ0 for even and DQ1 for odd bits
  4 – quad, use DQ0 for 0,4,8…, DQ1 for 1,5,9…, DQ2 for 2,6,10…, DQ3 for 3,7,11… data bits
- cBitPerWord – specify the number of bits to transfer for each word
- rgTX – array of 8bit values (byte words) to write
- cTX – number of words to write
- rgRx – buffer for read words
- cRx – number of words to read

The function above performs SPI transfer of up to 8bit words. This function is intended for standard MOSI/MISO (cDQ 1) operations, but it can be used for other modes as long only write (rgTX/cTX) or read (rgRX/cRX) is specified. The number of clock signals generated is the maximum of cTX and cRX.

FDwfDigitalSpiWriteOne(HDWF hdwf, int cDQ, int cBits, unsigned int vTX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBits – specify the number of bits to transmit
- vTX – specify the data to transmit

The function above performs SPI transmit of up to 32 bits. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiReadOne(HDWF hdwf, int cDQ, int cBits, unsigned int *pRX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBits – specify the number of bits to receive
- pRX – pointer to variable to return the received bits

The function above performs SPI reception of up to 32 bits. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiWrite(HDWF hdwf, int cDQ, int cBitPerWord, unsigned char *rgTX, int cTX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBitPerWord – specify the number of bits to transfer for each word
- rgTX – array of 8bit values (words) to transmit
- cTX – number of words to transmit

The function above performs SPI transmission of up to 8bit words. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiRead(HDWF hdwf, int cDQ, int cBitPerWord, unsigned char *rgRX, int cRX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBitPerWord – specify the number of bits to transfer for each word
- rgRx – buffer for receive words
- cRx – number of words to received

The function above performs SPI reception of up to 8bit words. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiWriteRead16(HDWF hdwf, int cDQ, int cBitPerWord, unsigned short *rgTX, int cTX, unsigned short *rgRX, int cRX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBitPerWord – specify the number of bits to transfer for each word
- rgTX – array of 16bit values (words) to transmit
- cTX – number of words to transmit
- rgRx – buffer for read words
- cRx – number of words to read

The function above performs SPI transfer of up to 16bit words. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiWriteRead32(HDWF hdwf, int cDQ, int cBitPerWord, unsigned int *rgTX, int cTX, unsigned int *rgRX, int cRX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBitPerWord – specify the number of bits to transfer for each word
- rgTX – array of 32bit values (words) to write
- cTX – number of words to write
- rgRx – buffer for read words
- cRx – number of words to read

The function above performs SPI transfer of up to 32bit words. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiRead16(HDWF hdwf, int cDQ, int cBitPerWord, unsigned short *rgRX, int cRX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBitPerWord – specify the number of bits to transfer for each word
- rgRx – buffer for read words
- cRx – number of words to read

The function above performs SPI read of up to 16bit words. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiRead32(HDWF hdwf, int cDQ, int cBitPerWord, unsigned int *rgRX, int cRX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBitPerWord – specify the number of bits to transfer for each word
- rgRx – buffer for read words
- cRx – number of words to read

The function above performs SPI read of up to 32bit words. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiWrite16(HDWF hdwf, int cDQ, int cBitPerWord, unsigned short *rgTX, int cTX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBitPerWord – specify the number of bits to transfer for each word
- rgTX – array of 16bit values (words) to write
- cTX – number of words to write

The function above performs SPI read of up to 16bit words. See FDwfDigitalSpiWriteRead for more information.

FDwfDigitalSpiWrite32(HDWF hdwf, int cDQ, int cBitPerWord, unsigned int *rgTX, int cTX)

Parameters:
- hdwf – Interface handle.
- cDQ – specify the DQ lines to use to transfer data
- cBitPerWord – specify the number of bits to transfer for each word
- rgTX – array of 32bit values (int) to write
- cTX – number of bytes to write

The function above performs SPI read of up to 32bit words. See FDwfDigitalSpiWriteRead for more information

11.3 I2C

FDwfDigitalI2cReset(HDWF hdwf)

Parameters:
- hdwf – Interface handle.

The function above resets the I2C configuration to default value.

FDwfDigitalI2cClear(HDWF hdwf, int *pfFree)

Parameters:
- hdwf – Interface handle.
- pfFree – pointer to return the

The function above verifies and tries to solve eventual bus lockup. The argument returns true, non zero value if the bus is free.

FDwfDigitalI2cRateSet(HDWF hdwf, double hz)

Parameters:
- hdwf – Interface handle.
- hz – bit rate to set (default 100kHz)

The function above sets the data rate.

FDwfDigitalI2cReadNakSet(HDWF hdwf, int fNakLastReadByte)

Parameters:
- hdwf – Interface handle.
- fNakLastReadByte – value to set (default 1, true)

The function above specifies if the last read byte should be acknowledged or not. The I2C specifications require NAK, this parameter set to true.

FDwfDigitalI2cSclSet(HDWF hdwf, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxChannel – DIO channel to use for SCL

The function above specifies the DIO channel to use for I2C clock.

FDwfDigitalI2cSdaSet(HDWF hdwf, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxChannel – DIO channel to use for SDA

The function above specifies the DIO channel to use for I2C data.

```
FDwfDigitalI2cWriteRead(HDWF hdwf, unsigned char adr8bits,
unsigned char *rgbTx, int cTx, unsigned char *rgbRx, int cRx, int *pNak)
```

Parameters:
- hdwf – Interface handle.
- adr8bits – specify the address in 8bit format, bAAAAAAAX
- rgbTX – array of bytes to write
- cTX – number of bytes to write
- rgbRx – buffer for read bytes
- cRx – number of bytes to read
- pNak – pointer to variable to return eventual NAK index

The function above performs I2C write, repeated start and read. In case zero bytes are specified for read (cRx) only write and for zero write (cTx) only read is peformed. The read/write bit in the address is controlled by the function. The returned NAK index returns one based index of the first negative ackedged transfer byte, zero when all the bytes where acknowledged. When the first address is acknowledged it returns 1. Returns negative value for other communication falures like timeout.

```
FDwfDigitalI2cRead(HDWF hdwf, unsigned char adr8bits,
unsigned char *rgbRx, int cRx, int *pNak)
```

Parameters:
- hdwf – Interface handle.
- adr8bits – specify the address
- rgbRx – buffer for read bytes
- cRx – number of bytes to read
- pNak – pointer to variable to return eventual NAK index

The function above performs I2C read. See DwfDigitalI2cWriteRead function for more information.

```
FDwfDigitalI2cWrite(HDWF hdwf, unsigned char adr8bits,
unsigned char *rgbTx, int cTx, int *pNak)
```

Parameters:
- hdwf – Interface handle.
- adr8bits – specify the address
- rgbTX – array of bytes to write
- cTX – number of bytes to write
- pNak – pointer to variable to return eventual NAK index

The function above performs I2C write. See DwfDigitalI2cWriteRead function for more information.

```
FDwfDigitalI2cWriteOne(HDWF hdwf, unsigned char adr8bits,
unsigned char bTx, int *pNak)
```

Parameters:
- hdwf – Interface handle.
- adr8bits – specify the address
- bTX –bytes to write
- pNak – pointer to variable to return eventual NAK index

The function above performs I2C write of one byte. See DwfDigitalI2cWriteRead function for more information.

11.4 CAN

FDwfDigitalCanReset(HDWF hdwf)

Parameters:
- hdwf – Interface handle.

The function above resets the CAN configuration to default value. Use FDwfDigitalOutReset to reset the output.

FDwfDigitalCanRateSet(HDWF hdwf, double hz)

Parameters:
- hdwf – Interface handle.
- hz – data rate to set

The function above sets the data rate.

FDwfDigitalCanPolaritySet(HDWF hdwf, double fInvert)

Parameters:
- hdwf – Interface handle.
- fInvert – 0 normal, 1 invert

The function above sets the signal polarity.

FDwfDigitalCanTxSet(HDWF hdwf, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxChannel – DIO channel to use for TX

The function above specifies the DIO channel to use for transmission.

FDwfDigitalCanRxSet(HDWF hdwf, int idxChannel)

Parameters:
- hdwf – Interface handle.
- idxChannel – DIO channel to use for RX

The function above specifies the DIO channel to use for reception.

FDwfDigitalCanTx(HDWF hdwf, int vID, int fExtended, int fRemote, int cDLC, unsigned char *rgTX)

Parameters:
- hdwf – Interface handle.
- vID – identifier
- fExtended – 0 base frame, 1 extended frame; 11 or 29 bit identifier
- fRemote – 0 data frame, 1 remote request
- rgTX - array of data bytes to send

The function above performs a CAN transmission. Specifying -1 for vID it initializes the TX channel.

FDwfDigitalCanRx(HDWF hdwf, int *pvID, int *pfExtended, int *pfRemote, int *pcDLC, unsigned char *rgRX, int cRX, int *pvStatus)

Parameters:
- hdwf – Interface handle.
- pvID – pointer to return the identifier
- pfExtended - pointer to return the extended bit value
- pfRemote – pointer to return the remote bit value
- pcDLC – pointer to return the data length code
- rgRX – poiter to array to return the data bytes
- cRX - the maximum number of data bytes to receive, rgRX buffer size
- pvStatus – pointer to return the function status:
  0 - nothing received
  1 – frame received without error
  2 – frame received with bit stuffing error
  3 – frame received with CRC error

The function above returns the received frames since the last call. With cRX zero initializes the reception

12 Devices

12.1 Electronics Explorer

The Electronics Explorer has nine AnalogIO channels. The master enable validates the power supplies and reference voltages.

Channel	Node	Name	Description
0		Vcc	Fixed supply
	0	Enable	Enables or disables the supply channel, 1/0
	1	Voltage	Select voltage 3.3V or 5V Status returns the voltage reading
	2	Current	Status returns the current reading
0		VP+	Positive supply
	0	Enable	Enables or disables the supply channel, 1/0
	1	Voltage	Specify voltage level, 0 to 9V Status returns the voltage reading
	2	Current	Specify the current limitation between 0 and 1.5A Status returns the current reading
1		VP-	Negative supply
	0	Enable	Specify voltage level, 0 to -9V Status returns the voltage reading
	1	Voltage	Specify voltage level, -0.5 to -5V
	2	Current	Specify the current limitation between 0 and -1.5A Status returns the current reading
2		Ref1	Voltage Reference 1
	0	Enable	Enables or disables the supply channel, 1/0
	1	Voltage	Specify voltage level between -10V and -10V
3		Ref2	Voltage Reference 2
	0	Enable	Enables or disables the supply channel, 1/0
	1	Voltage	Specify voltage level between -10V and -10V
4		Vmtr1	Voltmeter 1
	0	Voltage	Status returns the voltage reading, -15V to 15V
5		Vmtr2	Voltmeter 2
	0	Voltage	Status returns the voltage reading, -15V to 15V
6		Vmtr3	Voltmeter 3
	0	Voltage	Status returns the voltage reading, -15V to 15V
7		Vmtr4	Voltmeter 4
	0	Voltage	Status returns the voltage reading, -15V to 15V

12.2 Analog Discovery

The Analog Discovery has four AnalogIO channels. The master enable validates the power supplies.

Channel	Node	Name	Description
0		V+	Positive supply
	0	Enable	Enables or disables the supply channel, 1/0
1		V-	Negative supply
	0	Enable	Enables or disables the supply channel, 1/0
2		SYS	USB power monitor
	0	Voltage	Status returns the line voltage
	1	Current	Status returns the line current
	2	Temp	Status returns the device temperature
3		V+-	Power supply monitor
	0	Voltage	Status returns the voltage input for the supply regulators
	1	Current	Status returns the current taken by the supply regulators

12.3 Analog Discovery 2

The Analog Discovery 2 has four AnalogIO channels. The master enable validates the power supplies.

Channel	Node	Name	Description
0		V+	Positive supply
	0	Enable	Enables or disables the supply channel, 1/0
	1	Voltage	Specify voltage level, 0.5 to 5V
1		V-	Negative supply
	0	Enable	Enables or disables the supply channel, 1/0
	1	Voltage	Specify voltage level, -0.5 to -5V
2		USB	USB power monitor
	0	Voltage	Status returns the line voltage
	1	Current	Status returns the line current
	2	Temp	Status returns the device temperature
3		AUX	AUX power monitor
	0	Voltage	Status returns the line voltage
	1	Current	Status returns the line current

12.4 Digital Discovery

For the DigitalOut and IO functions, and AnalogIO DIOPP/PE the indexing 15:0 refers to DIO39:24.
The Digital Discovery has tree AnalogIO channels. The master enable activates the VIO output.

Channel	Node	Name	Description
0	0	Voltage	Configures the digital voltage between 1.2V and 3.3V
	1	DINPP	Configures the week pull for DIN lines with values: 0 down, 0.5 middle, 0.75 up, 1 up See Digital Discovery RM Input Dividers
	2	DIOPE	Configure pull enable (1) for DIO 39-24 as bit field set, like: 0x00F1 enables for DIO 31,30,29,28 and 24 See Digital Discovery RM I/O Level Translators
	3	DIOPP	Configure pull up/down (1/0) for DIO 39-24 as bit field set
	4	Drive	Configure drive strength for DIO lines: 0 (auto), 2mA, 4mA, 6mA, 8mA, 12mA, 16mA
	5	Slew	Configure slew rate for DIO lines: quietio, slow, fast See Xilinx DS162
1		VIO	VIO power monitor See Digital Discovery RM Power Supplies
	0	Voltage	Status returns the VIO voltage reading
	1	Current	Status returns the VIO current reading
2		USB	USB power monitor
	0	Voltage	Status returns the USB voltage reading
	1	Current	Status returns the USB current reading

13 Deprecated functions

The following functions are replaced by FDwfAnalogOutNode *providing access to the Amplitude and Frequency Modulation of Analog Out channels.

```
FDwfAnalogOutPlayStatus(HDWF hdwf, int idxChannel,
int *cdDataFree, int *cdDataLost, int *cdDataCorrupted)
```

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- cdDataFree – Pointer to variable to return the available free buffer space, the number of new samples that can be sent.
- cdDataLost – Pointer to variable to return the number of lost samples.
- cdDataCorrupted – Pointer to variable to return the number of samples that could be corrupted.

The function above is used to retrieve information about the play process. The data lost occurs when the device generator is faster than the sample send process from the PC. In this case, the device buffer gets emptied and generated samples are repeated. Corrupt samples are a warning that the buffer might have been emptied while samples were sent to the device. In this case, try optimizing the loop for faster execution; or reduce the frequency or run time to be less or equal to the device buffer size (run time <= buffer size/frequency).

```
FDwfAnalogOutPlayData(HDWF hdwf, int idxChannel, double *rgdData, int cdData)
```

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- rgdData – Pointer to samples array to be sent to the device.
- cdData – Number of samples to send.

The function above is used to sending new data samples for play mode. Before starting the Analog Out instrument, prefill the device buffer with the first set of samples using the AnalogOutDataSet function. In the loop of sending the following samples, first call AnalogOutStatus to read the information from the device, then AnalogOutPlayStatus to find out how many new samples can be sent, then send the samples with AnalogOutPlayData.

```
FDwfAnalogOutEnableSet(HDWF hdwf, int idxChannel, BOOL fEnable)
```

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- fEnable – TRUE to enable, FALSE to disable.

The function above enables or disables the channel specified by idxChannel. With channel index -1, each Analog Out channel enable will be configured to use the same, new option.

FDwfAnalogOutEnableGet(HDWF hdwf, int idxChannel, BOOL *pfEnable)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pfEnable – Pointer to variable to receive enabled state.

The function above is used to verify if a specific channel is enabled or disabled.

FDwfAnalogOutFunctionInfo(HDWF hdwf, int idxChannel, int *pfsfunc)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pfsfunc – Variable to receive the supported generator function options.

The function above returns the supported generator function options. They are returned (by reference) as a bit field. This bit field can be parsed using the IsBitSet Macro. Individual bits are defined using the FUNC constants in dwf.h. These are:

FUNC Constants	FUNC Constant Capabilities
funcDC	Generate DC value set as offset.
funcSine	Generate sine waveform.
funcSquare	Generate square waveform.
funcTriangle	Generate triangle waveform.
funcRampUp	Generate a waveform with a ramp-up voltage at the beginning.
funcRampDown	Generate a waveform with a ramp-down voltage at the end.
funcNoise	Generate noise waveform from random samples.
funcCustom	Generate waveform from custom repeated data.
funcPlay	Generate waveform from custom data in stream play style.

FDwfAnalogOutFunctionSet(HDWF hdwf, int idxChannel, FUNC func)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- func – Generator function option to set.

The function above is used to set the generator output function for the specified instrument channel. With channel index -1, each enabled Analog Out channel function will be configured to use the same, new option.

FDwfAnalogOutFunctionGet(HDWF hdwf, int idxChannel, FUNC *pfunc)

Parameters:

- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- ptrigsrc – Pointer to variable to receive the generator function option.

The function above is used to retrieve the current generator function option for the specified instrument channel.

FDwfAnalogOutFrequencyInfo(
HDWF hdwf, int idxChannel, double *phzMin, double *phzMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- phzMin – Variable to receive the supported minimum frequency.
- phzMax – Variable to receive the supported maximum frequency.

The function above is used to return the supported frequency range for the instrument. The maximum value shows the DAC frequency. The frequency of the generated waveform: repetition frequency for standard types and custom data; DAC update for noise type; sample rate for play type.

FDwfAnalogOutFrequencySet(HDWF hdwf, int idxChannel, double hzFrequency)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- hzFrequency – Frequency value to set expressed in Hz.

The function above is used to set the frequency. With channel index -1, each enabled Analog Out channel frequency will be configured to use the same, new option.

FDwfAnalogOutFrequencyGet(HDWF hdwf, int idxChannel, double *phzFrequency)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- hzFrequency – Pointer to variable to receive frequency value in Hz.

The function above is used to get the currently set frequency for the specified channel on the instrument.

FDwfAnalogOutAmplitudeInfo(
HDWF hdwf, int idxChannel, double *pvMin, double *pvMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pvMin – Minimum amplitude level or modulation index.
- pvMax – Maximal amplitude level or modulation index.

The function above is used to retrieve the amplitude range for the specified channel on the instrument. The amplitude is expressed in Volts units for carrier and in percentage units (modulation index) for AM/FM.

FDwfAnalogOutAmplitudeSet(HDWF hdwf, int idxChannel, double vAmplitude)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- vAmplitude – Amplitude of channel in Volts or modulation index in percentage.

The function above is used to set the amplitude or modulation index for the specified channel on the instrument. With channel index -1, each enabled Analog Out channel amplitude will be configured to use the same, new option.

FDwfAnalogOutAmplitudeGet(HDWF hdwf, int idxChannel, double *pvAmplitude)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pvAmplitude – Pointer to variable to receive amplitude value in Volts or modulation index in percentage.

The function above is used to get the currently set amplitude or modulation index for the specified channel on the instrument.

FDwfAnalogOutOffsetInfo(HDWF hdwf, int idxChannel, double *pvMin, double *pvMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pvMin – Minimum offset voltage or modulation offset percentage.
- pvMax – Maximum offset voltage or modulation offset percentage.

The function above is used to retrieve available the offset range in units of volts.

FDwfAnalogOutOffsetSet(HDWF hdwf, int idxChannel, double vOffset)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- vOffset – Value to set voltage offset in Volts or modulation offset percentage.

The function above is used to set the offset value for the specified channel on the instrument. With channel index -1, each enabled Analog Out channel offset will be configured to use the same, new option.

FDwfAnalogOutOffsetGet(HDWF hdwf, int idxChannel, double *pvOffset)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pvOffset – Pointer to variable to receive offset value in Volts or modulation offset percentage.

The function above is used to get the current offset value for the specified channel on the instrument.

FDwfAnalogOutSymmetryInfo(
HDWF hdwf, int idxChannel, double *ppercentageMin, double *ppercentageMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- ppercentageMin – Minimum value of Symmetry percentage.
- ppercentageMax – Maximum value of Symmetry percentage.

The function above is used to obtain the symmetry (or duty cycle) range (0..100). This symmetry is supported for standard signal types. It the pulse duration divided by the pulse period.

FDwfAnalogOutSymmetrySet(
HDWF hdwf, int idxChannel, double percentageSymmetry)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- percentageSymmetry –Value of percentage of Symmetry (duty cycle).

The function above is used to set the symmetry (or duty cycle) for the specified channel on the instrument. With channel index -1, each enabled Analog Out channel symmetry will be configured to use the same, new option.

FDwfAnalogOutSymmetryGet(
HDWF hdwf, int idxChannel, double *ppercentageSymmetry)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- ppercentageSymmetry — Pointer to variable to receive value of symmetry (duty cycle).

The function above is used to get the currently set symmetry (or duty cycle) for the specified channel of the instrument.

FDwfAnalogOutPhaseInfo(
HDWF hdwf, int idxChannel, double *pdegreeMin, double *pdegreeMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pdegreeMin – Minimum value of Phase (in degrees).
- pdegreeMax – Maximum value of Phase (in degrees).

The function above is used to retrieve the phase range (in degrees 0...360) for the specified channel of the instrument.

FDwfAnalogOutPhaseSet(
HDWF hdwf, int idxChannel, double degreePhase)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- degreePhase – Value of Phase in degrees.

The function above is used to set the phase for the specified channel on the instrument. With channel index -1, each enabled Analog Out channel phase will be configured to use the same, new option.

FDwfAnalogOutPhaseGet(HDWF hdwf, int idxChannel, double *pdegreePhase)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pdegreePhase – Pointer to variable to receive Phase value (in degrees).

The function above is used to get the current phase for the specified channel on the instrument.

FDwfAnalogOutDataInfo(
HDWF hdwf, int idxChannel, int *pnSamplesMin, double *pnSamplesMax)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- pnSamplesMin - Minimum number of samples available for custom data.
- pnSamplesMax – Maximum number of samples available for custom data.

The function above is used to retrieve the minimum and maximum number of samples allowed for custom data generation.

FDwfAnalogOutDataSet(HDWF hdwf, int idxChannel, double *rgdData, int cdData)

Parameters:
- hdwf – Open interface handle on a device.
- idxChannel – Channel index.
- rgbData – Buffer of samples to set.
- cData – Number of samples to set in rgbData.

The function above is used to set the custom data or to prefill the buffer with play samples. The samples are double precision floating point values (rgdData) normalized to ±1.
With the custom function option, the data samples (cdData) will be interpolated to the device buffer size. The output value will be Offset + Sample*Amplitude, for instance:

- 0 value sample will output: Offset.
- +1 value sample will output: Offset + Amplitude.
- -1 value sample will output: Offset – Amplitude.