# PicoScope® 4000 Series

PC Oscilloscopes

## Programmer's Guide

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# Contents



  

  

  


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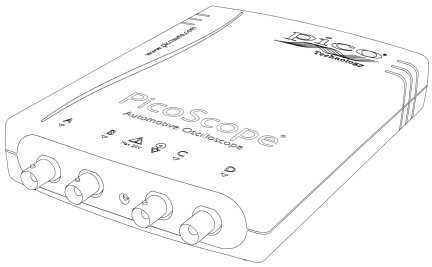
# 1 Introduction

## 1.1 Welcome

The **PicoScope 4000 Series** of PC Oscilloscopes from Pico Technology is a range of compact, high-resolution scope units designed to replace traditional bench-top oscilloscopes.




This manual explains how to use the Application Programming Interface (API) for the PicoScope 4000 Series scopes. The API supports the following models:

- PicoScope 4224 and 4424 12-bit oscilloscopes with optional IEPE interface
- PicoScope 4262 16-bit high-resolution oscilloscope
- PicoScope 4226 and 4227 oscilloscopes (discontinued)

For more information on the hardware, see the *PicoScope 4000 Series User's Guide,* available as a separate manual.

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## 1.4 System requirements

**Using with PicoScope for Windows**

To ensure that your PicoScope 4000 Series PC Oscilloscope operates correctly with the PicoScope software, you must have a computer with at least the minimum system requirements to run one of the supported operating systems, as shown in the following table. The performance of the oscilloscope will be better with a more powerful PC. Please note the PicoScope software is not installed as part of the SDK.

| Item | Specification |
|---|---|
| **Operating system** | Windows 7, Windows 8 or Windows 10<br>32 bit and 64 bit versions supported |
| **Processor** | As required by the operating system |
| **Memory** | |
| **Free disk space** | |
| **Ports** | USB 3.0 compliant port<br>USB 2.0 compliant port<br>USB 1.1 compliant port (not recommended) |

**Using with custom applications**

Drivers are available for the operating systems mentioned above.

# 2 Programming with the PicoScope 4000 Series

The ps4000.dll dynamic link library in the lib subdirectory of the Pico Technology SDK installation directory allows you to program a PicoScope 4000 Series oscilloscope using standard C function calls.

A typical program for capturing data consists of the following steps:

- Open the scope unit.
- Set up the input channels with the required voltage ranges and coupling mode.
- Set up triggering.
- Start capturing data. (See Sampling modes, where programming is discussed in more detail).
- Wait until the scope unit is ready.
- Copy data to a buffer.
- Stop capturing data.
- Close the scope unit.

Numerous sample programs are installed with the SDK. These show how to use the functions of the driver software in each of the modes available.

## 2.1 Driver

Your application will communicate with a PicoScope 4000 API driver called ps4000.dll, which is supplied in 32-bit and 64-bit versions. The driver exports the ps4000 function definitions in standard C format, but this does not limit you to programming in C. You can use the API with any programming language that supports standard C calls.

The API driver depends on a low-level driver called WinUsb.sys. This and another DLL, picoipp.dll (supplied in 32-bit and 64-bit versions), are installed by the SDK and configured when you plug the oscilloscope into each USB port for the first time. Your application does not call these drivers directly.

# 2.2 Voltage ranges

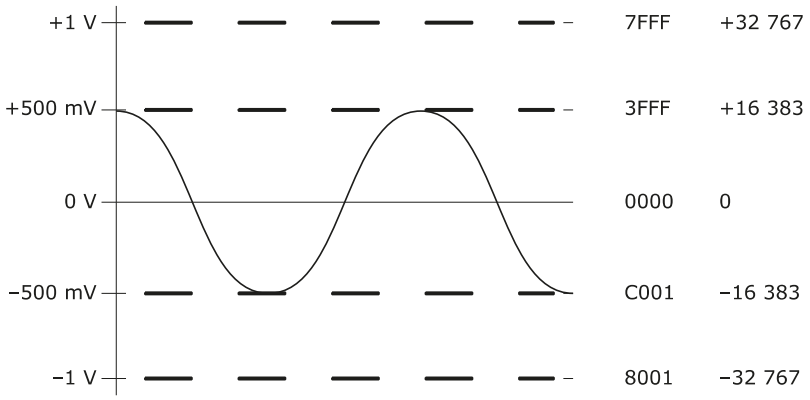
The ps4000SetChannel function allows you to set the voltage range of each input channel of the scope. Each device in the PicoScope 4000 Series has its own set of voltage ranges described in its data sheet. Each sample is normalized to 16 bits resulting in values returned to your application as follows:

| Constant | Voltage | Value returned | |
|---|---|---|---|
| | | decimal | hex |
| PS4000_MIN_VALUE or PS4262_MIN_VALUE | minimum | −32 764<br>−32 767 | 8004<br>8001 |
| N/A | zero | 0 | 0000 |
| PS4000_MAX_VALUE or PS4262_MAX_VALUE | maximum | 32 764<br>32 767 | 7FFC<br>7FFF |
| PS4000_LOST_DATA | Note 1 | -32 768 | 8000 |

1. In streaming mode, this special value indicates a buffer overrun.

**Example, using the PicoScope 4262**

1. Call ps4000SetChannel with range set to PS4000_1V.
2. Apply a sine wave input of 500 mV amplitude to the oscilloscope.
3. Capture some data using the desired sampling mode.
4. The data will be encoded as shown opposite.




**External trigger input**

The PicoScope 4226, 4227 and 4262 models have an external trigger input (marked EXT). The external trigger input is scaled to a 16-bit value as follows. Note that the PicoScope 4262 has two external trigger input voltage ranges.

**PicoScope 4262**

| Voltage | Constant | Digital value |
|---|---|---|
| −500 mV | PS4000_EXT_MIN_VALUE | −32 767 |
| 0 V | | 0 |
| +500 mV | PS4000_EXT_MAX_VALUE | +32 767 |

| Voltage | Constant | Digital value |
|---|---|---|
| −5 V | PS4000_EXT_MIN_VALUE | −32 767 |
| 0 V | | 0 |
| +5 V | PS4000_EXT_MAX_VALUE | +32 767 |

**PicoScope 4226 and 4227**

| Voltage | Constant | Digital value |
|---|---|---|
| –20 V | PS4000_EXT_MIN_VALUE | –32 767 |
| 0 V | | 0 |
| +20 V | PS4000_EXT_MAX_VALUE | +32 767 |

## 2.3 Channel selection

You can switch each channel on and off, and set its coupling mode to either AC or DC, using the ps4000SetChannel function.

- **DC coupling:** The scope accepts all input frequencies from zero (DC) up to its maximum analog bandwidth.
- **AC coupling:** The scope accepts input frequencies from a few hertz up to its maximum analog bandwidth. The lower -3 dB cutoff frequency is about 1 hertz.

## 2.4 Triggering

PicoScope 4000 Series PC Oscilloscopes can either start collecting data immediately, or be programmed to wait for a **trigger** event to occur. In both cases you need to use the trigger function ps4000SetSimpleTrigger, which in turn calls:

- ps4000SetTriggerChannelConditions
- ps4000SetTriggerChannelDirections
- ps4000SetTriggerChannelProperties

These can also be called individually, rather than using ps4000SetSimpleTrigger, in order to set up advanced trigger types such as pulse width.

A trigger event can occur when one of the signal or trigger input channels crosses a threshold voltage on either a rising or a falling edge. It is also possible to combine up to four inputs using the logic trigger function.

The driver supports these triggering methods:

- Simple Edge
- Advanced Edge
- Windowing
- Pulse width
- Logic
- Delay
- Drop-out
- Runt

The pulse width, delay and drop-out triggering methods additionally require the use of the pulse width qualifier function, ps4000SetPulseWidthQualifier.

## 2.5 Oversampling

When the oscilloscope is operating at sampling rates less than its maximum, it is possible to **oversample**. Oversampling is taking more than one measurement during a time interval and returning the average as one sample. The number of measurements per sample is called the oversampling factor. If the signal contains a small amount of Gaussian noise, this technique can increase the effective vertical resolution of the oscilloscope by *n* bits, where *n* is given approximately by the equation below:

$$n = log\ (\text{oversampling factor}) / log\ 4$$

Conversely, for an improvement in resolution of *n* bits, the oversampling factor you need is given approximately by:

$$\text{oversampling factor} = 4^n$$

| | |
|---|---|
| **Applicability** | Available in block mode only.<br><br>Cannot be used at the same time as aggregation. |

# 2.6 Timebases

The API allows you to select one of $2^{30}$ different timebases related to the maximum sampling rate of the oscilloscope. The timebases allow slow enough sampling in block mode to overlap the streaming mode sampling intervals, so that you can make a smooth transition between block mode and streaming mode.

For all PicoScope 4000 Series scopes except the PicoScope 4262, the range of timebase values is divided into "low" and "high" subranges, with the low subrange specifying a power of 2 and the high subrange specifying a fraction of the clock frequency. The PicoScope 4262 has a single range of timebases specifying a fraction of the clock frequency.

| **Timebase (n)** | **Sampling interval (t)** | | |
|---|---|---|---|
| | **PicoScope 4223<br>PicoScope 4224<br>PicoScope 4423<br>PicoScope 4424** | **PicoScope 4226<br>PicoScope 4227** | **PicoScope 4262** |
| Low | $2^n$ / 80,000,000<br><br>n=0: 12.5 ns<br>n=1: 25 ns<br>n=2: 50 ns | $2^n$ / 250,000,000<br><br>n=0*: 4 ns<br>n=1: 8 ns<br>n=2: 16 ns<br>n=3: 32 ns | (n+1) / 10,000,000<br><br>n=0: 100 ns<br>n=1: 200 ns<br>n=2: 300 ns<br>...<br>$n=2^{30}-1$:~107 s |
| High | (n-1) / 20,000,000<br><br>n=3: 100 ns<br>n=4: 150 ns<br>n=5: 200 ns<br>...<br>$n=2^{30}-1$: ~54 s | (n-2) / 31,250,000<br><br>n=4: 64 ns<br>n=5: 96 ns<br>n=6: 128 ns<br>...<br>$n=2^{30}-1$: ~34 s | |

* PicoScope 4227 only

Note: The fastest available sampling rate may depend on which channels are enabled and on the sampling mode. Please refer to the oscilloscope data sheet for sampling rate specifications. In streaming mode, the speed of the USB port may affect the rate of data transfer.

| | |
|---|---|
| **Applicability** | Use ps4000GetTimebase API call. |

# 3 Sampling modes

PicoScope 4000 Series PC Oscilloscopes can run in various **sampling modes**.

- **Block mode**. In this mode, the scope stores data in its buffer memory and then transfers it to the PC. When the data has been collected it is possible to examine the data, with an optional aggregation factor. The data is lost when a new run is started in the same segment, the settings are changed, or the scope is powered down.
- **Rapid block mode**. This is a variant of block mode that allows you to capture more than one waveform at a time with a minimum of delay between captures. You can use aggregation in this mode if you wish.
- **Streaming mode**. In this mode, data is passed directly to the PC without being stored in the scope's buffer memory. This enables long periods of slow data collection for chart recorder and data-logging applications. Streaming mode provides fast streaming at up to 6.6 MS/s (150 ns per sample). Aggregation and triggering are supported in this mode.

In all sampling modes, the driver returns data asynchronously using a *callback*. This is a call to one of the functions in your own application. When you request data from the scope, you pass to the driver a pointer to your callback function. When the driver has written the data to your buffer, it makes a callback (calls your function) to signal that the data is ready. The callback function then signals to the application that the data is available.

Because the callback is called asynchronously from the rest of your application, in a separate thread, you must ensure that it does not corrupt any global variables while it runs.

In block mode and rapid block mode, you can also poll the driver instead of using a callback.

## 3.1 Block mode

In **block mode**, the computer prompts a PicoScope 4000 Series PC Oscilloscope to collect a block of data into its internal memory. When the oscilloscope has collected the whole block, it signals that it is ready and then transfers the whole block to the computer's memory through the USB port.

- **Block size.** The maximum number of values depends upon the size of the oscilloscope's memory. The memory buffer is shared between the enabled channels, so if two channels are enabled, each receives half the memory. These features are handled transparently by the driver. The block size also depends on the number of memory segments in use (see `ps4000MemorySegments`).
- **Sampling rate.** The PicoScope 4000 Series PC Oscilloscopes can sample at a number of different rates according to their model, selected timebase and the combination of channels that are enabled. The maximum sampling rate can be achieved with a single channel enabled, or with these two-channel combinations: AC, AD, BC and BD. All other combinations limit the maximum sampling rate of scope, as specified in its Data Sheet.
- **Setup time.** The driver normally performs a number of setup operations, which can take up to 50 milliseconds, before collecting each block of data. If you need to collect data with the minimum time interval between blocks, use rapid block mode and avoid calling setup functions between calls to `ps4000RunBlock`, `ps4000Stop` and `ps4000GetValues`.

- **Aggregation.** When the data has been collected, you can set an optional aggregation factor and examine the data. Aggregation is a process that reduces the amount of data by combining adjacent samples using a maximum/minimum algorithm. It is useful for zooming in and out of the data without having to repeatedly transfer the entire contents of the scope's buffer to the PC.

- **Memory segmentation.** The scope's internal memory can be divided into segments so that you can capture several waveforms in succession. Configure this using ps4000MemorySegments.

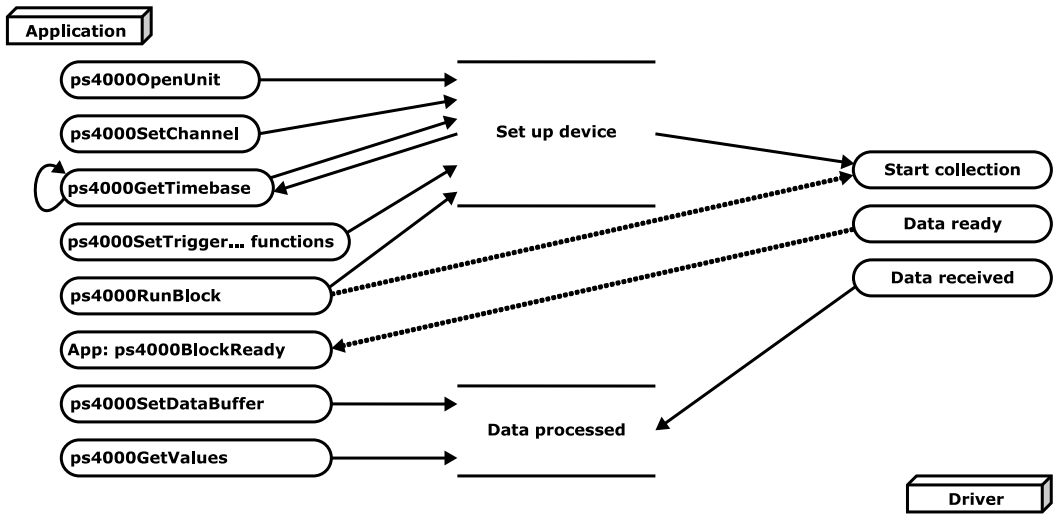
- **Data retention.** The data is lost when a new run is started in the same segment or the scope is powered down.

See Using block mode for programming details.

### 3.1.1 Using block mode

This is the general procedure for reading and displaying data in block mode using a single memory segment:

1. Open the oscilloscope using ps4000OpenUnit.
2. Select channel ranges and AC/DC coupling using ps4000SetChannel.
3. Using ps4000GetTimebase, select timebases until the required nanoseconds per sample is located.
4. Use the trigger setup functions ps4000SetTriggerChannelConditions, ps4000SetTriggerChannelDirections and ps4000SetTriggerChannelProperties to set up the trigger if required.
5. Start the oscilloscope running using ps4000RunBlock.
6. Wait until the oscilloscope is ready using the ps4000BlockReady callback.
7. Use ps4000SetDataBuffer to tell the driver where your memory buffer is. For greater efficiency with multiple captures, you can call this function outside the loop, after step 4.
8. Transfer the block of data from the oscilloscope using ps4000GetValues.
9. Display the data.
10. Repeat steps 5 to 9.
11. Stop the oscilloscope using ps4000Stop.




12. Request new views of stored data using different aggregation parameters: see Retrieving stored data.

13. Close the device using ps4000CloseUnit.

## 3.2 Rapid block mode

In normal block mode, the PicoScope 4000 Series scopes collect one waveform at a time. You start the device running, wait until all samples are collected by the device, and then download the data to the PC or start another run. There is a time overhead of tens of milliseconds associated with starting a run, causing a gap between waveforms. When you collect data from the device, there is another minimum time overhead which is most noticeable when using a small number of samples.

**Rapid block mode** allows you to sample several waveforms at a time with the minimum time between waveforms. It reduces the gap from milliseconds to about 2.5 microseconds, at the fastest timebase. See Using rapid block mode for details.

### 3.2.1 Using rapid block mode

You can use **rapid block mode** with or without aggregation. The following procedure shows you how to use it without aggregation.

**Without aggregation**

1. Open the oscilloscope using ps4000OpenUnit.
2. Select channel ranges and AC/DC coupling using ps4000SetChannel.
3. Set the number of memory segments equal to or greater than the number of captures required using ps4000MemorySegments. Use ps4000SetNoOfCaptures before each run to specify the number of waveforms to capture.
4. Using ps4000GetTimebase, select timebases until the required nanoseconds per sample is located. This will indicate the number of samples per channel available for each segment. If you know that the number of samples you will collect will not exceed the limit, you can call this function after step 5, unless you are using a pulse width qualifier.
5. Use the trigger setup functions ps4000SetTriggerChannelConditions, ps4000SetTriggerChannelDirections and ps4000SetTriggerChannelProperties to set up the trigger if required.
6. Start the oscilloscope running using ps4000RunBlock.
7. Wait until the oscilloscope is ready using the ps4000BlockReady callback.
8. Use ps4000SetDataBufferBulk to tell the driver where your memory buffers are. Call the function once for each channel/segment combination for which you require data. For greater efficiency of data retrieval or for multiple captures, you can call this function outside the loop, after step 5.
9. Transfer the blocks of data from the oscilloscope using ps4000GetValuesBulk.
10. Retrieve the time offset for each data segment using ps4000GetValuesTriggerTimeOffsetBulk64.
11. Display the data.
12. Repeat steps 6 to 11 if necessary.
13. Stop the oscilloscope using ps4000Stop.
14. Close the device using ps4000CloseUnit.

**With aggregation**

To use rapid block mode with aggregation, follow steps 1 to 9 above and then proceed as follows:

10a. Call ps4000SetDataBuffers to set up one pair of buffers for every waveform segment required.
11a. Call ps4000GetValues for each pair of buffers.

12a. Retrieve the time offset for each data segment using ps4000GetTriggerTimeOffset64.

Continue from step 13 above.

### 3.2.2 Rapid block mode example 1: no aggregation

```
#define MAX_WAVEFORMS 100
#define MAX_SAMPLES 1000
```

Set up the device up as usual.

- Open the device
- Channels
- Trigger
- Number of memory segments (this should be equal or more than the no of captures required)

```
// Set the number of waveforms to MAX_WAVEFORMS
ps4000SetNoOfCaptures (handle,  MAX_WAVEFORMS);

pParameter = false;
ps4000RunBlock
(
  handle,
  0, //noOfPreTriggerSamples,
  10000, // noOfPostTriggerSamples,
  1, // timebase to be used,
  1, // oversample
  &timeIndisposedMs,
  0, // segmentIndex
  lpReady,
  &pParameter
);
```

Comment: these variables have been set as an example and can be any valid value. pParameter will be set true by your callback function lpReady.

```
while (!pParameter) Sleep (0);

for (int32_t i = 0; i < 10; i++)
{
  for (int32_t c = PS4000_CHANNEL_A; c <= PS4000_CHANNEL_D; c++)
  {
    ps4000SetDataBufferBulk
    (
      handle,
      c,
      buffer[c][i],
      MAX_SAMPLES,
      i
    );
  }
}
```

Comments: buffer has been created as a two-dimensional array of pointers to `int16_t`, which will contain 1000 samples as defined by `MAX_SAMPLES`. There are only 10 buffers set, but it is possible to set up to the number of captures you have requested.

```
ps4000GetValuesBulk
(
  handle,
  &noOfSamples, // set to MAX_SAMPLES on entering the function
  10, // fromSegmentIndex,
  19, // toSegmentIndex,
  overflow // an array of size 10 int16_t
)
```

Comments: the number of samples could be up to `noOfPreTriggerSamples + noOfPostTriggerSamples`, the values set in `ps4000RunBlock`. The samples are always returned from the first sample taken, unlike the `ps4000GetValues` function which allows the sample index to be set. This function does not support aggregation. The above segments start at 10 and finish at 19 inclusive. It is possible for the `fromSegmentIndex` to wrap around to the `toSegementIndex`, by setting the `fromSegmentIndex` to 98 and the `toSegmentIndex` to 7.

```
ps4000GetValuesTriggerTimeOffsetBulk64
(
  handle,
  times,
  timeUnits,
  10,
  19
)
```

Comments: the above segments start at 10 and finish at 19 inclusive. It is possible for the `fromSegmentIndex` to wrap around to the `toSegmentIndex`, if the `fromSegmentIndex` is set to 98 and the `toSegmentIndex` to 7.

### 3.2.3 Rapid block mode example 2: using aggregation

```
#define MAX_WAVEFORMS 100
#define MAX_SAMPLES 1000
```

Set up the device up as usual.

- Open the device
- Channels
- Trigger
- Number of memory segments (this should be equal or more than the no of captures required)

```
// Set the number of waveforms to MAX_WAVEFORMS
ps4000SetNoOfCaptures (handle,  MAX_WAVEFORMS);

pParameter = false;
ps4000RunBlock
(
  handle,
  0, //noOfPreTriggerSamples,
  1000000, // noOfPostTriggerSamples,
  1, // timebase to be used,
  1, // oversample
  &timeIndisposedMs,
  0, //segmentIndex
  lpReady,
  &pParameter
);
```

Comments: the set-up for running the device is exactly the same whether or not aggregation will be used when you retrieve the samples.

```
for (int32_t c = PS4000_CHANNEL_A; c <= PS4000_CHANNEL_D; c++)
{
  ps4000SetDataBuffers
  (
    handle,
    c,
    bufferMax[c],
    bufferMin[c]
    MAX_SAMPLES,
  );
}
```

Comments: since only one waveform will be retrieved at a time, you only need to set up one pair of buffers; one for the maximum samples and one for the minimum samples. Again, the buffer sizes are 1000 samples.

```
for (int32_t segment = 10; segment < 20; segment++)
{
  ps4000GetValues
  (
    handle,
    0,
    &noOfSamples, // set to MAX_SAMPLES on entering
    1000,
```

```
      downSampleRatioMode, //set to RATIO_MODE_AGGREGATE
      index,
      overflow
    );

    ps4000GetTriggerTimeOffset64
    (
      handle,
      &time,
      &timeUnits,
      index
    )
  }
```

Comments: each waveform is retrieved one at a time from the driver with an aggregation of 1000.

## 3.3 ETS (Equivalent Time Sampling)

Note: only the PicoScope 4226 and 4227 oscilloscopes support ETS mode.

**ETS** is a way of increasing the effective sampling rate of the scope when capturing repetitive signals. It is a modified form of block mode, and is controlled by the `ps4000SetTrigger` and `ps4000SetEts` functions.

- **Overview.** ETS works by capturing several cycles of a repetitive waveform, then combining them to produce a composite waveform that has a higher effective sampling rate than the individual captures. The maximum effective sampling rates that can be achieved with this method are listed in the User's Guide for the scope device.
- **Trigger stability.** Because of the high sensitivity of ETS mode to small time differences, the trigger must be set up to provide a stable waveform that varies as little as possible from one capture to the next.
- **Callback.** ETS mode returns data to your application using the `ps4000BlockReady` callback function.

| | |
|---|---|
| **Applicability** | Available in block mode only.<br><br>Not suitable for one-shot (non-repetitive) signals.<br><br>Aggregation and oversampling are not supported.<br><br>Edge-triggering only.<br><br>Auto trigger delay (`autoTriggerMilliseconds`) is ignored. |

### 3.3.1 Using ETS mode

This is the general procedure for reading and displaying data in ETS mode using a single memory segment:

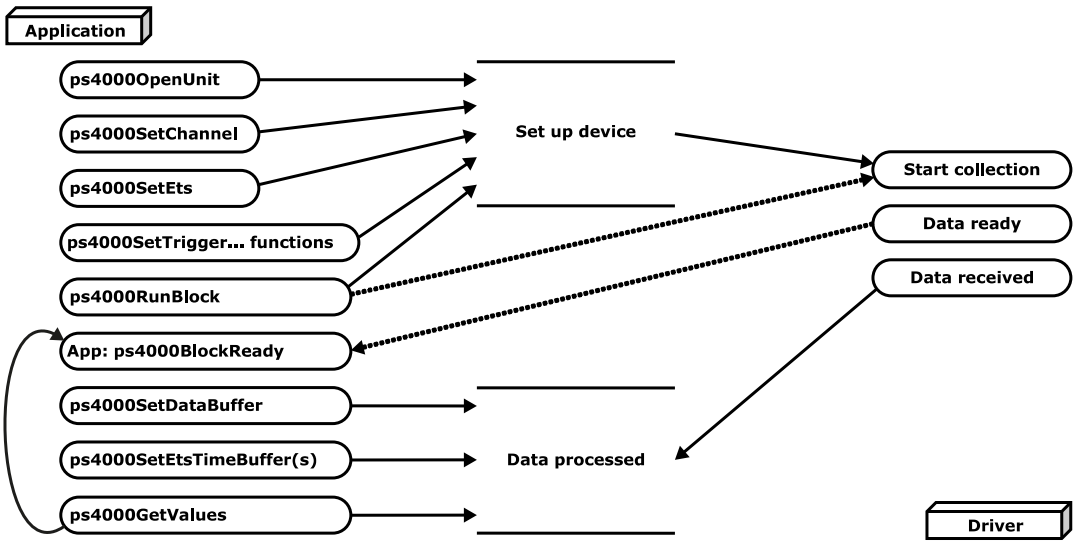
1. Open the oscilloscope using `ps4000OpenUnit`.
2. Select channel ranges and AC/DC coupling using `ps4000SetChannel`.
3. Use `ps4000GetTimebase` to verify the number of samples to be collected.

4. Set up ETS using ps4000SetEts.
5. Use the trigger setup functions ps4000SetTriggerChannelConditions, ps4000SetTriggerChannelDirections and ps4000SetTriggerChannelProperties to set up the trigger if required.
6. Start the oscilloscope running using ps4000RunBlock.
7. Wait until the oscilloscope is ready using the ps4000BlockReady callback (or poll using ps4000IsReady).
8. Use ps4000SetDataBuffer to tell the driver where to store sampled data.

8a. Use ps4000SetEtsTimeBuffer or ps4000SetEtsTimeBuffers to tell the driver where to store sample times.

9. Transfer the block of data from the oscilloscope using ps4000GetValues.
10. Display the data.
11. While you want to collect updated captures, repeat steps 7 to 10.
12. Stop the oscilloscope using ps4000Stop.
13. Repeat steps 6 to 12.
14. Close the device driver using ps4000CloseUnit.




## 3.4 Streaming mode

**Streaming mode** can capture data without the gaps that occur between blocks when using block mode. It can transfer data to the PC at speeds of up to 6.6 million samples per second (150 nanoseconds per sample), depending on the computer's performance. This makes it suitable for **high-speed data acquisition**, allowing you to capture long data sets limited only by the computer's memory.

- **Aggregation.** The driver returns aggregated readings while the device is streaming. If aggregation is set to 1 then only one buffer is returned per channel. When aggregation is set above 1 then two buffers (maximum and minimum) per channel are returned.
- **Memory segmentation.** The memory can be divided into segments to reduce the latency of data transfers to the PC. However, this increases the risk of losing data if the PC cannot keep up with the device's sampling rate.

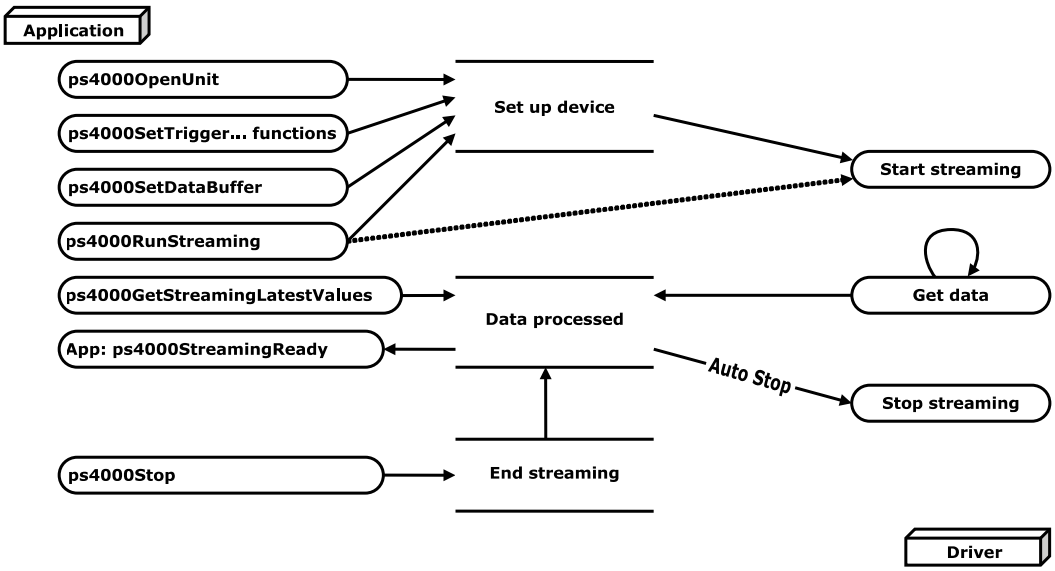
See Using streaming mode for programming details.

### 3.4.1 Using streaming mode

This is the general procedure for reading and displaying data in streaming mode using a single memory segment:

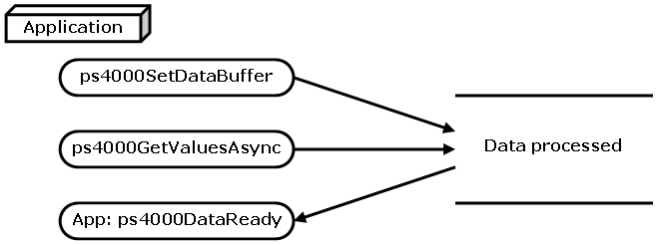
1. Open the oscilloscope using ps4000OpenUnit.
2. Select channels, ranges and AC/DC coupling using ps4000SetChannel.
3. Use the trigger setup functions [1] [2] [3] to set up the trigger if required.
4. Call ps4000SetDataBuffer to tell the driver where your data buffer is.
5. Set up aggregation and start the oscilloscope running using ps4000RunStreaming.
6. Call ps4000GetStreamingLatestValues to get data.
7. Process data returned to your application's function. This example is using autoStop, so after the driver has received all the data points requested by the application, it stops the device streaming.
8. Call ps4000Stop, even if autoStop is enabled.




9. Request new views of stored data using different aggregation parameters: see Retrieving stored data.
10. Close the oscilloscope using ps4000CloseUnit.

## 3.5 Retrieving stored data

You can collect data from the PicoScope 4000 driver with a different aggregation factor when ps4000RunBlock or ps4000RunStreaming has already been called and has successfully captured all the data. Use ps4000GetValuesAsync.



# 4 Combining several oscilloscopes

It is possible to collect data using up to 64 PicoScope 4000 Series PC Oscilloscopes at the same time, depending on the capabilities of the PC. Each oscilloscope must be connected to a separate USB port. The ps4000OpenUnit function returns a handle to an oscilloscope. All the other functions require this handle for oscilloscope identification. For example, to collect data from two oscilloscopes at the same time:

```
CALLBACK ps4000BlockReady(...)
// Define callback function specific to application

handle1 = ps4000OpenUnit
handle2 = ps4000OpenUnit

ps4000SetChannel(handle1)
// Set up unit 1
ps4000RunBlock(handle1)

ps4000SetChannel(handle2)
// Set up unit 2
ps4000RunBlock(handle2)

// Data will be stored in buffers and application will be
// notified using callback

ready = FALSE
while not ready
   ready = handle1_ready
   ready &= handle2_ready
```

Note: It is not possible to synchronize the collection of data between oscilloscopes that are being used in combination.

# 5 API functions

The PicoScope 4000 Series API exports the following functions for you to use in your own applications. All functions are C functions using the standard call naming convention (`__stdcall`). They are all exported with both decorated and undecorated names.

ps4000BlockReady: receive notification when block-mode data ready
ps4000CloseUnit: close a scope device
ps4000DataReady: indicate when post-collection data ready
ps4000EnumerateUnits: find out how many units are connected
ps4000FlashLed: flash the front-panel LED
ps4000GetChannelInformation: find out if extra ranges available
ps4000GetMaxDownSampleRatio: find out aggregation ratio for data
ps4000GetStreamingLatestValues: get streaming data while scope is running
ps4000GetTimebase: find out what timebases are available
ps4000GetTimebase2: find out what timebases are available
ps4000GetTriggerChannelTimeOffset: get trigger times from specified channel
ps4000GetTriggerChannelTimeOffset64: get trigger times from specified channel
ps4000GetTriggerTimeOffset: find out when trigger occurred (32-bit)
ps4000GetTriggerTimeOffset64: find out when trigger occurred (64-bit)
ps4000GetUnitInfo: read information about scope device
ps4000GetValues: retrieve block-mode data with callback
ps4000GetValuesAsync: retrieve streaming data with callback
ps4000GetValuesBulk: retrieve more than one waveform at a time
ps4000GetValuesTriggerChannelTimeOffsetBulk: retrieve time offset from a channel
ps4000GetValuesTriggerChannelTimeOffsetBulk64: retrieve time offset (64-bit)
ps4000GetValuesTriggerTimeOffsetBulk: retrieve time offset for a group of waveforms
ps4000GetValuesTriggerTimeOffsetBulk64: set the buffers for each waveform (64-bit)
ps4000HoldOff: set trigger holdoff
ps4000IsLedFlashing: read status of LED
ps4000IsReady: poll driver in block mode
ps4000IsTriggerOrPulseWidthQualifierEnabled: find out whether trigger is enabled
ps4000MemorySegments: divide scope memory into segments
ps4000NoOfStreamingValues: get number of samples in streaming mode
ps4000OpenUnit: open a scope device
ps4000OpenUnitAsync: open a scope device without waiting
ps4000OpenUnitAsyncEx: open a specified device without waiting
ps4000OpenUnitEx: open a specified device
ps4000OpenUnitProgress: check progress of ps4000OpenUnit call
ps4000RunBlock: start block mode
ps4000RunStreaming: start streaming mode
ps4000RunStreamingEx: start streaming mode with a specified data reduction mode
ps4000SetChannel: set up input channels
ps4000SetDataBuffer: register data buffer with driver
ps4000SetDataBufferBulk: set the buffers for each waveform
ps4000SetDataBuffers: register min/max data buffers with driver
ps4000SetDataBuffersWithMode: register data buffers and specify aggregation mode
ps4000SetDataBufferWithMode: register data buffer and specify aggregation mode
ps4000SetEts: set up equivalent-time sampling (ETS)
ps4000SetEtsTimeBuffer: set up 64-bit buffer for ETS time data
ps4000SetEtsTimeBuffers: set up 32-bit buffers for ETS time data
ps4000SetExtTriggerRange: set EXT trigger input range
ps4000SetPulseWidthQualifier: set up pulse width triggering
ps4000SetSigGenArbitrary: set up arbitrary waveform generator
ps4000SetSigGenBuiltIn: set up function generator
ps4000SetSimpleTrigger: set up level triggers only
ps4000SetTriggerChannelConditions: specify which channels to trigger on
ps4000SetTriggerChannelDirections: set up signal polarities for triggering
ps4000SetTriggerChannelProperties: set up trigger thresholds
ps4000SetTriggerDelay: set up post-trigger delay
ps4000SigGenArbitraryMinMaxValues: get AWG sample value limits
ps4000SigGenFrequencyToPhase: get phase increment for signal generator
ps4000SigGenSoftwareControl: trigger the signal generator
ps4000Stop: stop data capture
ps4000StreamingReady: indicate when streaming-mode data ready

# 5.1 ps4000BlockReady

```
typedef void (CALLBACK *ps4000BlockReady)
(
  int16_t          handle,
  PICO_STATUS      status,
  void           * pParameter
)
```

This callback function is part of your application. You register it with the PicoScope 4000 Series driver using ps4000RunBlock, and the driver calls it back when block-mode data is ready. You can then download the data using the ps4000GetValues function.

| | |
|---|---|
| **Applicability** | Block mode only |
| **Arguments** | handle, identifies the scope device returning the samples<br><br>status, indicates whether an error occurred during collection of the data<br><br>pParameter, a void pointer passed from ps4000RunBlock. The callback function can write to this location to send any data, such as a status flag, back to your application. |
| **Returns** | nothing |

## 5.2 ps4000CloseUnit

```
PICO_STATUS ps4000CloseUnit
(
  int16_t    handle
)
```

This function shuts down a PicoScope 4000 scope device.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, returned by `ps4000OpenUnit`, identifies the scope device to be closed |
| **Returns** | `PICO_OK`<br>`PICO_HANDLE_INVALID` |

# 5.3 ps4000DataReady

```
typedef void (CALLBACK *ps4000DataReady)
(
  int16_t       handle,
  int32_t       noOfSamples,
  int16_t       overflow,
  uint32_t      triggerAt,
  int16_t       triggered,
  void        * pParameter
)
```

This function handles post-collection data returned by the driver after a call to ps4000GetValuesAsync. It is a callback function that is part of your application. You register it with the PicoScope 4000 Series driver using ps4000GetValuesAsync, and the driver calls it back when the data is ready.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device returning the samples<br><br>`noOfSamples`, the number of samples collected<br><br>`overflow`, returns a flag that indicates whether an overvoltage has occurred on any of the channels. It is a bit pattern with bit 0 denoting Channel A and bit 1 Channel B.<br><br>`triggerAt`, an index to the buffer indicating the location of the trigger point. This parameter is valid only when `triggered` is non-zero.<br><br>`triggered`, a flag indicating whether a trigger occurred. If non-zero, a trigger occurred at the location indicated by `triggerAt`.<br><br>`pParameter`, a void pointer passed from ps4000GetValuesAsync. The callback function can write to this location to send any data, such as a status flag, back to the application. The data type is defined by the application programmer. |
| **Returns** | nothing |

## 5.4 ps4000EnumerateUnits

```
PICO_STATUS ps4000EnumerateUnits
(
  int16_t    * count,
  int8_t     * serials,
  int16_t    * serialLth
)
```

This function counts the number of PicoScope 4000 Series units connected to the computer, and returns a list of serial numbers as a string. Note that this function will only detect devices that are not yet being controlled by an application.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `* count,` on exit, the number of scopes found<br><br>`* serials,` on exit, a list of serial numbers separated by commas and terminated by a final null. Example: `AQ005/139,VDR61/356,ZOR14/107`. Can be NULL on entry if serial numbers are not required.<br><br>`* serialLth,` on entry, the length of the `int8_t` buffer pointed to by `serials`; on exit, the length of the string written to `serials` |
| **Returns** | `PICO_OK`<br>`PICO_BUSY`<br>`PICO_NULL_PARAMETER`<br>`PICO_FW_FAIL`<br>`PICO_CONFIG_FAIL`<br>`PICO_MEMORY_FAIL`<br>`PICO_ANALOG_BOARD`<br>`PICO_CONFIG_FAIL_AWG`<br>`PICO_INITIALISE_FPGA` |

# 5.5 ps4000FlashLed

```
PICO_STATUS ps4000FlashLed
(
  int16_t    handle,
  int16_t    start
)
```

This function flashes the LED on the front of the scope without blocking the calling thread. Calls to ps4000RunStreaming and ps4000RunBlock cancel any flashing started by this function.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device<br><br>`start`, the action required:<br>< 0 : flash the LED indefinitely.<br>0 : stop the LED flashing.<br>> 0 : flash the LED `start` times. If the LED is already flashing on entry to this function, the flash count will be reset to `start`. |
| **Returns** | `PICO_OK`<br>`PICO_HANDLE_INVALID`<br>`PICO_BUSY` |

# 5.6 ps4000GetChannelInformation

```
PICO_STATUS ps4000GetChannelInformation
(
  int16_t                 handle,
  PS4000_CHANNEL_INFO     info,
  int32_t                 probe,
  int32_t               * ranges,
  int32_t               * length,
  int32_t                 channel
)
```

This function queries which extra ranges are available on a scope device.

| | |
|---|---|
| **Applicability** | Reserved for future expansion |
| **Arguments** | `handle`, identifies the scope device<br><br>`info`, the type of information required, chosen from the list of `PS4000_CHANNEL_INFO` values<br><br>`probe`, not used, must be set to 0<br><br>`ranges`, an array that will be populated with available ranges for the given value of `info`. May be `NULL`. See `PS4000_RANGE` for possible values.<br><br>`length`, on entry: the length of the `ranges` array; on exit: the number of elements written to `ranges` or, if `ranges` is `NULL`, the number of elements that would have been written<br><br>`channel`, the channel for which the information is required. See `PS4000_CHANNEL` for possible values. |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_INVALID_PARAMETER` |

# 5.7 ps4000GetMaxDownSampleRatio

```
PICO_STATUS ps4000GetMaxDownSampleRatio
(
  int16_t       handle,
  uint32_t      noOfUnaggregatedSamples,
  uint32_t    * maxDownSampleRatio,
  int16_t       downSampleRatioMode,
  uint16_t      segmentIndex
)
```

This function returns the maximum downsampling ratio that can be used for a given number of samples.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device<br><br>`noOfUnaggregatedSamples`, the number of unaggregated samples to be used to calculate the maximum downsampling ratio<br><br>`maxDownSampleRatio`, returns the aggregation ratio<br><br>`downSampleRatioMode`, see `ps4000GetValues`<br><br>`segmentIndex`, the memory segment where the data is stored |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_NO_SAMPLES_AVAILABLE`<br>`PICO_NULL_PARAMETER`<br>`PICO_INVALID_PARAMETER`<br>`PICO_SEGMENT_OUT_OF_RANGE`<br>`PICO_TOO_MANY_SAMPLES` |

# 5.8 ps4000GetNoOfCaptures

```
PICO_STATUS ps4000GetNoOfCaptures
(
  int16_t       handle,
  uint16_t    * nCaptures
)
```

This function returns the number of captures the device has made in rapid block mode, since you called ps4000RunBlock. You can call ps4000GetNoOfCaptures during device capture, after collection has completed or after interrupting waveform collection by calling ps4000Stop. The returned value (nCaptures) can then be used to iterate through the number of segments using ps4000GetValues, or in a single call to ps4000GetValuesBulk, where it is used to calculate the toSegmentIndex parameter.

| | |
|---|---|
| **Applicability** | Rapid block mode |
| **Arguments** | handle, handle of the required device.<br><br>* nCaptures, output: the number of available captures that has been collected from calling ps4000RunBlock. |
| **Returns** | PICO_OK<br>PICO_DRIVER_FUNCTION<br>PICO_INVALID_HANDLE<br>PICO_NOT_RESPONDING<br>PICO_NO_SAMPLES_AVAILABLE<br>PICO_NULL_PARAMETER<br>PICO_INVALID_PARAMETER<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_TOO_MANY_SAMPLES |

# 5.9 ps4000GetStreamingLatestValues

```
PICO_STATUS ps4000GetStreamingLatestValues
(
  int16_t                 handle,
  ps4000StreamingReady    lpPs4000Ready,
  void                    * pParameter
)
```

This function is used to collect the next block of values while streaming is running. You must call ps4000RunStreaming beforehand to set up streaming.

| | |
|---|---|
| **Applicability** | Streaming mode only |
| **Arguments** | handle, identifies the scope device<br><br>lpPs4000Ready, a pointer to your ps4000StreamingReady callback function that will return the latest aggregated values<br><br>pParameter, a void pointer that will be passed to the ps4000StreamingReady callback function |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NO_SAMPLES_AVAILABLE<br>PICO_INVALID_CALL<br>PICO_BUSY<br>PICO_NOT_RESPONDING |

# 5.10 ps4000GetTimebase

```
PICO_STATUS ps4000GetTimebase
(
  int16_t       handle,
  uint32_t      timebase,
  int32_t       noSamples,
  int32_t     * timeIntervalNanoseconds,
  int16_t       oversample,
  int32_t     * maxSamples
  uint16_t      segmentIndex
)
```

This function discovers which timebases are available on the oscilloscope. You should set up the channels using ps4000SetChannel first.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | handle, identifies the scope device<br><br>timebase, a code between 0 and $2^{30}-1$ that specifies the sampling interval (see timebase guide)<br><br>noSamples, the number of samples required. This value is used to calculate the most suitable time unit to use.<br><br>timeIntervalNanoseconds, a pointer to the time interval between readings at the selected timebase. If a null pointer is passed, nothing will be written here.<br><br>oversample, the amount of oversample required. An oversample of 4, for example, would quadruple the time interval and quarter the maximum samples, and at the same time would increase the effective resolution by one bit. See the topic on oversampling.<br><br>maxSamples, a pointer to the maximum number of samples available. The scope allocates a certain amount of memory for internal overheads and this may vary depending on the number of segments, number of channels enabled, the timebase chosen and the oversample selected. If this pointer is null, nothing will be written here.<br><br>segmentIndex, the number of the memory segment to use |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_TOO_MANY_SAMPLES<br>PICO_INVALID_CHANNEL<br>PICO_INVALID_TIMEBASE<br>PICO_INVALID_PARAMETER |

# 5.11 ps4000GetTimebase2

```
PICO_STATUS ps4000GetTimebase2
(
  int16_t        handle,
  uint32_t       timebase,
  int32_t        noSamples,
  float       *  timeIntervalNanoseconds,
  int16_t        oversample,
  int32_t     *  maxSamples
  uint16_t       segmentIndex
)
```

This function differs from ps4000GetTimebase only in the `float *` type of the `timeIntervalNanoseconds` argument.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `timeIntervalNanoseconds`, a pointer to the time interval between readings at the selected timebase. If a null pointer is passed, nothing will be written here.<br><br>All others as in ps4000GetTimebase. |
| **Returns** | See ps4000GetTimebase. |

# 5.12 ps4000GetTriggerChannelTimeOffset

```
PICO_STATUS ps4000GetTriggerChannelTimeOffset
(
  int16_t                 handle,
  uint32_t              * timeUpper,
  uint32_t              * timeLower,
  PS4000_TIME_UNITS     * timeUnits,
  uint16_t                segmentIndex,
  PS4000_CHANNEL          channel
)
```

This function is for use in applications that display signal data graphically, and is suitable for use with oscilloscopes that use interleaved sampling: PicoScope 4224, 4424 and 4262.

With a digital signal, the trigger point occurs after the last pre-trigger sample and at or before the first post-trigger sample, so there may be a time offset between the trigger point and the post-trigger sample point. `ps4000GetTriggerChannelTimeOffset` retrieves this time offset, as lower and upper 32-bit values, for a waveform obtained in block mode or rapid block mode, adjusted for the time skew of the specified channel relative to the trigger source. This allows you to plot a stable trace relative to the trigger point.

A 64-bit version of this function, `ps4000GetTriggerChannelTimeOffset64`, is available for use with programming languages that support 64-bit integers.

| | |
|---|---|
| **Applicability** | Block mode, rapid block mode<br><br>Recommended for PicoScope 4224, 4424 and 4262 variants only<br><br>You can also call this function on the PicoScope 4226 and 4227 variants, which use simultaneous sampling, but the results will be the same for all four channels: we recommend users of these models call ps4000GetTriggerTimeOffset instead. |
| **Arguments** | handle, identifies the scope device<br><br>timeUpper, a pointer to the most significant 32 bits of the time offset for segmentIndex. The array must be long enough to hold the number of requested times.<br><br>timeLower, a pointer to the least significant 32 bits of the time offset for segmentIndex. The array must be long enough to hold the number of requested times.<br><br>timeUnits, a pointer to PS4000_TIME_UNITS, which returns the units in which timeUpper and timeLower are measured. The allowable values are:<br>PS4000_FS: femtoseconds<br>PS4000_PS: picoseconds<br>PS4000_NS: nanoseconds<br>PS4000_US: microseconds<br>PS4000_MS: milliseconds<br>PS4000_S: seconds<br><br>segmentIndex, the number of the memory segment for which the information is required<br><br>channel, the scope channel for which the information is required |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_DEVICE_SAMPLING<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_NULL_PARAMETER<br>PICO_NO_SAMPLES_AVAILABLE |

# 5.13 ps4000GetTriggerChannelTimeOffset64

```
PICO_STATUS ps4000GetTriggerChannelTimeOffset64
(
  int16_t                 handle,
  int64_t               * time,
  PS4000_TIME_UNITS     * timeUnits,
  uint16_t                segmentIndex,
  PS4000_CHANNEL          channel
)
```

This function gets the trigger time offset for a waveform. It is equivalent to ps4000GetTriggerChannelTimeOffset except that the time offset is returned as a single 64-bit value instead of two 32-bit values.

ps4000GetTriggerChannelTimeOffset64 is for use in applications that display signal data graphically, and is suitable for use with oscilloscopes that use interleaved sampling: PicoScope 4224, 4424 and 4262.

| | |
|---|---|
| **Applicability** | Block mode, rapid block mode<br><br>Recommended for PicoScope 4224, 4424 and 4262 variants only, as these models use interleaved sampling<br><br>You can also call this function on the PicoScope 4226 and 4227 variants, which use simultaneous sampling, but the results will be the same for all four channels: we recommend users of these models call ps4000GetTriggerTimeOffset64 instead. |
| **Arguments** | handle, identifies the scope device<br><br>time, a pointer to the time offset for segmentIndex. The array must be long enough to hold the number of requested times.<br><br>timeUnits, a pointer to PS4000_TIME_UNITS, which returns the units in which timeUpper and timeLower are measured. The allowable values are:<br>PS4000_FS: femtoseconds<br>PS4000_PS: picoseconds<br>PS4000_NS: nanoseconds<br>PS4000_US: microseconds<br>PS4000_MS: milliseconds<br>PS4000_S: seconds<br><br>segmentIndex, the number of the memory segment for which the information is required<br><br>channel, the scope channel for which the information is required |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_DEVICE_SAMPLING<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_NULL_PARAMETER<br>PICO_NO_SAMPLES_AVAILABLE |

# 5.14 ps4000GetTriggerTimeOffset

```
PICO_STATUS ps4000GetTriggerTimeOffset
(
  int16_t                 handle
  uint32_t              * timeUpper
  uint32_t              * timeLower
  PS4000_TIME_UNITS     * timeUnits
  uint16_t                segmentIndex
)
```

This function retrieves the trigger time offset for multiple waveforms obtained in block mode or rapid block mode, and is suitable for use with oscilloscopes that use interleaved sampling: PicoScope 4224, 4424 and 4262. It is a more efficient alternative to calling ps4000GetTriggerChannelTimeOffset once for each waveform required. See ps4000GetTriggerTimeOffset for an explanation of trigger time offsets.

A 64-bit version of this function, ps4000GetValuesTriggerChannelTimeOffsetBulk64, is available for use with programming languages that support 64-bit integers.

| | |
|---|---|
| **Applicability** | Block mode, rapid block mode<br><br>Recommended for PicoScope 4226 and 4227 variants only<br><br>You can also call this function on the PicoScope 4224, 4424 and 4262 variants, which use interleaved sampling, but the results will only be accurate to one sample period: users of these models can obtain greater accuracy by calling ps4000GetTriggerChannelTimeOffset instead. |
| **Arguments** | handle, identifies the scope device<br><br>timeUpper, a pointer to the most significant 32 bits of the time offset for segmentIndex. The array must be long enough to hold the number of requested times.<br><br>timeLower, a pointer to the least significant 32 bits of the time offset for segmentIndex. The array must be long enough to hold the number of requested times.<br><br>timeUnits, a pointer to PS4000_TIME_UNITS, which returns the units in which timeUpper and timeLower are measured. The allowable values are:<br>PS4000_FS: femtoseconds<br>PS4000_PS: picoseconds<br>PS4000_NS: nanoseconds<br>PS4000_US: microseconds<br>PS4000_MS: milliseconds<br>PS4000_S: seconds<br><br>segmentIndex, the number of the memory segment for which the information is required. |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_DEVICE_SAMPLING<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_NULL_PARAMETER<br>PICO_NO_SAMPLES_AVAILABLE |

# 5.15 ps4000GetTriggerTimeOffset64

```
PICO_STATUS ps4000GetTriggerTimeOffset64
(
  int16_t                 handle,
  int64_t               * time,
  PS4000_TIME_UNITS     * timeUnits,
  uint16_t                segmentIndex
)
```

This function is for use in applications that display signal data graphically, and is suitable for use with oscilloscopes that use simultaneous sampling: PicoScope 4226 and 4227. It is equivalent to ps4000GetTriggerTimeOffset except that the time offset is returned as a single 64-bit value instead of two 32-bit values.

| | |
|---|---|
| **Applicability** | Block mode, rapid block mode<br><br>Recommended for PicoScope 4226 and 4227 variants only<br><br>You can also call this function on the PicoScope 4224, 4424 and 4262 variants, which use interleaved sampling, but the results will only be accurate to one sample period: users of these models can obtain greater accuracy by calling ps4000GetTriggerChannelTimeOffset instead. |
| **Arguments** | handle, identifies the scope device<br><br>time, a pointer to the time offset for segmentIndex. The array must be long enough to hold the number of requested times.<br><br>timeUnits, a pointer to PS4000_TIME_UNITS, which returns the units in which timeUpper and timeLower are measured. The allowable values are:<br>PS4000_FS: femtoseconds<br>PS4000_PS: picoseconds<br>PS4000_NS: nanoseconds<br>PS4000_US: microseconds<br>PS4000_MS: milliseconds<br>PS4000_S: seconds<br><br>segmentIndex, the number of the memory segment for which the information is required |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_DEVICE_SAMPLING<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_NULL_PARAMETER<br>PICO_NO_SAMPLES_AVAILABLE |

# 5.16 ps4000GetUnitInfo

```
PICO_STATUS ps4000GetUnitInfo
(
  int16_t        handle,
  int8_t       * string,
  int16_t        stringLength,
  int16_t      * requiredSize
  PICO_INFO      info
)
```

This function writes information about the specified scope device to an `int8_t` string. If the device fails to open, only the driver version and error code are available to explain why the last open unit call failed.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device from which information is required. If an invalid handle is passed, the error code from the last unit that failed to open is returned.<br><br>`string`, a pointer to the `int8_t` string buffer in the calling function where the unit information string (selected with `info`) will be stored. If a null pointer is passed, only the `requiredSize`, pointer to an `int16_t`, of the `int8_t` string buffer is returned.<br><br>`stringLength`, used to return the size of the `int8_t` string buffer<br><br>`requiredSize`, used to return the required `int8_t` string buffer size<br><br>`info`, an enumerated type specifying what information is required from the driver |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_NULL_PARAMETER`<br>`PICO_INVALID_INFO`<br>`PICO_INFO_UNAVAILABLE` |

| **PICO_INFO constant** | **Example** |
|---|---|
| `0: PICO_DRIVER_VERSION`, version number of PicoScope 4000 DLL | `1,0,0,1` |
| `1: PICO_USB_VERSION`, type of USB connection to device: 1.1 or 2.0 | `2.0` |
| `2: PICO_HARDWARE_VERSION`, hardware version of device | `1` |
| `3: PICO_VARIANT_INFO`, variant number of device | `4224` |
| `4: PICO_BATCH_AND_SERIAL`, batch and serial number of device | `KJL87/6` |
| `5: PICO_CAL_DATE`, calibration date of device | `11Nov08` |
| `6: PICO_KERNEL_VERSION`, version of kernel driver | `1,1,2,4` |

# 5.17 ps4000GetValues

```
PICO_STATUS ps4000GetValues
(
  int16_t       handle,
  uint32_t      startIndex,
  uint32_t    * noOfSamples,
  uint32_t      downSampleRatio,
  int16_t       downSampleRatioMode,
  uint16_t      segmentIndex,
  int16_t     * overflow
)
```

This function retrieves block-mode data, either with or without downsampling, starting at the specified sample number. It is used to get the stored data from the scope after data collection has stopped, and store it in a user buffer previously passed to ps4000SetDataBuffer() or ps4000SetDataBuffers(). It blocks the calling function while retrieving data.

If multiple channels are enabled, a single call to this function is sufficient to retrieve data for all channels.

Note that if you are using block mode and call this function before the oscilloscope is ready, no capture will be available and the driver will return PICO_NO_SAMPLES_AVAILABLE.

| | |
|---|---|
| **Applicability** | Block mode, rapid block mode |
| **Arguments** | handle, identifies the scope device<br><br>startIndex, a zero-based index that indicates the start point for data collection. It is measured in sample intervals from the start of the buffer.<br><br>noOfSamples, on entry: the number of samples requested; on exit, the number of samples actually returned<br><br>downSampleRatio, the aggregation factor that will be applied to the raw data<br><br>downSampleRatioMode, whether to use aggregation to reduce the amount of data. The available values are:<br>RATIO_MODE_NONE (downSampleRatio is ignored)<br>RATIO_MODE_AGGREGATE (uses aggregation)<br>RATIO_MODE_AVERAGE<br><br>RATIO_MODE_AGGREGATE and RATIO_MODE_AVERAGE are single-bit constants that can be ORed to apply multiple downsampling modes to the same data.<br><br>segmentIndex, the zero-based number of the memory segment where the data is stored<br><br>overflow, returns a set of flags that indicate whether an overvoltage has occurred on any of the channels. It is a bit pattern with bit 0 denoting Channel A and bit 1 Channel B. |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NO_SAMPLES_AVAILABLE<br>PICO_DEVICE_SAMPLING<br>PICO_NULL_PARAMETER<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_INVALID_PARAMETER<br>PICO_TOO_MANY_SAMPLES<br>PICO_DATA_NOT_AVAILABLE<br>PICO_STARTINDEX_INVALID<br>PICO_INVALID_SAMPLERATIO<br>PICO_INVALID_CALL<br>PICO_NOT_RESPONDING<br>PICO_MEMORY |

# 5.18 ps4000GetValuesAsync

```
PICO_STATUS ps4000GetValuesAsync
(
  int16_t       handle,
  uint32_t      startIndex,
  uint32_t      noOfSamples,
  uint32_t      downSampleRatio,
  int16_t       downSampleRatioMode,
  uint16_t      segmentIndex,
  void        * lpDataReady,
  void        * pParameter
)
```

This function returns streaming data, either with or without aggregation, starting at the specified sample number. It is used to get the stored data from the device (in block mode) or the driver (in streaming mode) after data collection has stopped. It returns the data using a callback.

| | |
|---|---|
| **Applicability** | Streaming mode only |
| **Arguments** | `handle`, identifies the scope device<br><br>`startIndex`,<br>`noOfSamples`,<br>`downSampleRatio`,<br>`downSampleRatioMode`,<br>`segmentIndex`: see `ps4000GetValues`<br><br>`lpDataReady`, a pointer to the `ps4000StreamingReady` function that is called when the data is ready<br><br>`pParameter`, a void pointer that will be passed to the `ps4000StreamingReady` callback function. The data type depends on the design of the callback function, which is determined by the application programmer. |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_NO_SAMPLES_AVAILABLE`<br>`PICO_DEVICE_SAMPLING` – streaming only<br>`PICO_NULL_PARAMETER`<br>`PICO_STARTINDEX_INVALID`<br>`PICO_SEGMENT_OUT_OF_RANGE`<br>`PICO_INVALID_PARAMETER`<br>`PICO_DATA_NOT_AVAILABLE`<br>`PICO_INVALID_SAMPLERATIO`<br>`PICO_INVALID_CALL` |

# 5.19 ps4000GetValuesBulk

```
PICO_STATUS ps4000GetValuesBulk
(
  int16_t       handle,
  uint32_t    * noOfSamples,
  uint16_t      fromSegmentIndex,
  uint16_t      toSegmentIndex,
  int16_t     * overflow
)
```

This function allows more than one waveform to be retrieved at a time in rapid block mode. The waveforms must have been collected sequentially and in the same run. This method of collection does not support aggregation.

| | |
|---|---|
| **Applicability** | Rapid block mode |
| **Arguments** | `handle`, identifies the scope device<br><br>`* noOfSamples`, On entry, the number of samples required. On exit, the actual number retrieved. The number of samples retrieved will not be more than the number requested. The data retrieved always starts with the first sample captured.<br><br>`fromSegmentIndex`, the first segment from which the waveform should be retrieved<br><br>`toSegmentIndex`, the last segment from which the waveform should be retrieved<br><br>`* overflow`, equal to or larger than the number of waveforms to be retrieved. Each segment index has a separate `overflow` element, with `overflow[0]` containing the `fromSegmentIndex`, and the last index the `toSegmentIndex`. Each element in the array is a bit field as described under `ps4000GetValues`. |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_INVALID_PARAMETER`<br>`PICO_SEGMENT_OUT_OF_RANGE`<br>`PICO_NO_SAMPLES_AVAILABLE`<br>`PICO_STARTINDEX_INVALID`<br>`PICO_NOT_RESPONDING` |

# 5.20 ps4000GetValuesTriggerChannelTimeOffsetBulk

```
PICO_STATUS ps4000GetValuesTriggerChannelTimeOffsetBulk
(
  int16_t                 handle,
  uint32_t              * timesUpper,
  uint32_t              * timesLower,
  PS4000_TIME_UNITS     * timeUnits,
  uint16_t                fromSegmentIndex,
  uint16_t                toSegmentIndex,
  PS4000_CHANNEL          channel
)
```

This function retrieves the trigger time offset for multiple waveforms obtained in rapid block mode, and is suitable for use with oscilloscopes that use interleaved sampling: PicoScope 4224, 4424 and 4262. It is a more efficient alternative to calling ps4000GetTriggerChannelTimeOffset once for each waveform required. See ps4000GetTriggerTimeOffset for an explanation of trigger time offsets.

A 64-bit version of this function, ps4000GetValuesTriggerChannelTimeOffsetBulk64, is available for use with programming languages that support 64-bit integers.

| | |
|---|---|
| **Applicability** | Rapid block mode |
| **Arguments** | handle, identifies the scope device<br><br>* timesUpper, a pointer to 32-bit integers. This will hold the most significant 32 bits of the time offset for each requested segment index. times[0] will hold the fromSegmentIndex time offset and the last times index will hold the toSegmentIndex time offset. The array must be long enough to hold the number of requested times.<br><br>* timesLower, a pointer to 32-bit integers. This will hold the least-significant 32 bits of the time offset for each requested segment index. times[0] will hold the fromSegmentIndex time offset and the last times index will hold the toSegmentIndex time offset. The array must be long enough to hold the number of requested times.<br><br>* timeUnits, a pointer to a range of PS4000_TIME_UNITS. This must be equal to or larger than the number of requested times. timeUnits[0] will contain the time unit for fromSegmentIndex and the last index will contain the time unit for toSegmentIndex.<br><br>fromSegmentIndex, the first segment for which the time offset is required<br><br>toSegmentIndex, the last segment for which the time offset is required. If toSegmentIndex is less than fromSegmentIndex then the driver will wrap around from the last segment to the first.<br><br>channel, the channel for which the information is required |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NULL_PARAMETER<br>PICO_DEVICE_SAMPLING<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_NO_SAMPLES_AVAILABLE |

# 5.21 ps4000GetValuesTriggerChannelTimeOffsetBulk64

```
PICO_STATUS ps4000GetValuesTriggerChannelTimeOffsetBulk64
(
  int16_t                 handle,
  int64_t               * times,
  PS4000_TIME_UNITS     * timeUnits,
  uint16_t                fromSegmentIndex,
  uint16_t                toSegmentIndex,
  PS4000_CHANNEL          channel
)
```

This function is equivalent to ps4000GetValuesTriggerChannelTimeOffsetBulk but retrieves the trigger time offsets as 64-bit values instead of pairs of 32-bit values.

| | |
|---|---|
| **Applicability** | Rapid block mode |
| **Arguments** | handle, identifies the scope device<br><br>* times, a pointer to 64-bit integers. This will hold the time offset for each requested segment index. times[0] will hold the time offset for fromSegmentIndex, and the last times index will hold the time offset for toSegmentIndex. The array must be long enough to hold the number of times requested.<br><br>* timeUnits, a pointer to a range of PS4000_TIME_UNITS. This must be equal or larger than the number of requested times. timeUnits[0] will contain the time unit for fromSegmentIndex, and the last index will contain the time unit for toSegmentIndex.<br><br>fromSegmentIndex, the first segment for which the time offset is required. The result will be placed in times[0] and timeUnits[0].<br><br>toSegmentIndex, the last segment for which the time offset is required. The result will be placed in the last elements of the times and timeUnits arrays. If toSegmentIndex is less than fromSegmentIndex then the driver will wrap around from the last segment to the first.<br><br>channel, the scope channel for which information is required |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NULL_PARAMETER<br>PICO_DEVICE_SAMPLING<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_NO_SAMPLES_AVAILABLE |

# 5.22 ps4000GetValuesTriggerTimeOffsetBulk

```
PICO_STATUS ps4000GetValuesTriggerTimeOffsetBulk
(
  int16_t                 handle,
  uint32_t              * timesUpper,
  uint32_t              * timesLower,
  PS4000_TIME_UNITS     * timeUnits,
  uint16_t                fromSegmentIndex,
  uint16_t                toSegmentIndex
)
```

This function retrieves the trigger time offset for multiple waveforms obtained in rapid block mode. It is a more efficient alternative to calling ps4000GetTriggerTimeOffset once for each waveform required. See ps4000GetTriggerTimeOffset for an explanation of trigger time offsets.

ps4000GetValuesTriggerTimeOffsetBulk is suitable for use with oscilloscopes that use simultaneous sampling: PicoScope 4226 and 4227. A 64-bit version of this function, ps4000GetValuesTriggerTimeOffsetBulk64, is available for use with programming languages that support 64-bit integers.

| | |
|---|---|
| **Applicability** | Rapid block mode<br><br>Recommended for PicoScope 4226 and 4227 variants only<br><br>You can also call this function on the PicoScope 4224, 4424 and 4262 variants, which use interleaved sampling, but the results will only be accurate to one sample period: users of these models can obtain greater accuracy by calling ps4000GetValuesTriggerChannelTimeOffsetBulk instead. |
| **Arguments** | handle, identifies the scope device<br><br>* timesUpper, a pointer to 32-bit integers. This will hold the most significant 32 bits of the time offset for each requested segment index. times[0] will hold the fromSegmentIndex time offset and the last times index will hold the toSegmentIndex time offset. The array must be long enough to hold the number of requested times.<br><br>* timesLower, a pointer to 32-bit integers. This will hold the least-significant 32 bits of the time offset for each requested segment index. times[0] will hold the fromSegmentIndex time offset and the last times index will hold the toSegmentIndex time offset. The array must be long enough to hold the number of requested times.<br><br>* timeUnits, a pointer to a range of PS4000_TIME_UNITS. This must be equal to or larger than the number of requested times. timeUnits[0] will contain the time unit for fromSegmentIndex and the last index will contain the time unit for toSegmentIndex.<br><br>fromSegmentIndex, the first segment for which the time offset is required<br><br>toSegmentIndex, the last segment for which the time offset is required. If toSegmentIndex is less than fromSegmentIndex then the driver will wrap around from the last segment to the first. |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NULL_PARAMETER<br>PICO_DEVICE_SAMPLING<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_NO_SAMPLES_AVAILABLE |

# 5.23 ps4000GetValuesTriggerTimeOffsetBulk64

```
PICO_STATUS ps4000GetValuesTriggerTimeOffsetBulk64
(
  int16_t                 handle,
  int64_t               * times,
  PS4000_TIME_UNITS     * timeUnits,
  uint16_t                fromSegmentIndex,
  uint16_t                toSegmentIndex
)
```

This function is equivalent to ps4000GetValuesTriggerTimeOffsetBulk but retrieves the trigger time offsets as 64-bit values instead of pairs of 32-bit values.

| | |
|---|---|
| **Applicability** | Rapid block mode<br><br>Recommended for PicoScope 4226 and 4227 variants only<br><br>You can also call this function on the PicoScope 4224, 4424 and 4262 variants, which use interleaved sampling, but the results will only be accurate to one sample period: users of these models can obtain greater accuracy by calling ps4000GetValuesTriggerChannelTimeOffsetBulk64 instead. |
| **Arguments** | `handle`, identifies the scope device<br><br>`* times`, a pointer to 64-bit integers. This will hold the time offset for each requested segment index. `times[0]` will hold the time offset for `fromSegmentIndex`, and the last `times` index will hold the time offset for `toSegmentIndex`. The array must be long enough to hold the number of times requested.<br><br>`* timeUnits`, a pointer to a range of `PS4000_TIME_UNITS`. This must be equal or larger than the number of requested times. `timeUnits[0]` will contain the time unit for `fromSegmentIndex`, and the last index will contain the time unit for `toSegmentIndex`.<br><br>`fromSegmentIndex`, the first segment for which the time offset is required. The result will be placed in `times[0]` and `timeUnits[0]`.<br><br>`toSegmentIndex`, the last segment for which the time offset is required. The result will be placed in the last elements of the `times` and `timeUnits` arrays. If `toSegmentIndex` is less than `fromSegmentIndex` then the driver will wrap around from the last segment to the first. |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_NULL_PARAMETER`<br>`PICO_DEVICE_SAMPLING`<br>`PICO_SEGMENT_OUT_OF_RANGE`<br>`PICO_NO_SAMPLES_AVAILABLE` |

# 5.24 ps4000HoldOff

```
PICO_STATUS ps4000HoldOff
(
  int16_t                handle,
  uint64_t               holdoff,
  PS4000_HOLDOFF_TYPE    type
)
```

This function sets the holdoff time - the time that the scope waits after each trigger event before allowing the next trigger event.

| | |
|---|---|
| **Applicability** | Not currently supported. Reserved for future use. |
| **Arguments** | `holdoff`, the number of samples between trigger events. The time is calculated by multiplying the sample interval by the hold-off.<br><br>`type`, the type of hold-off. Only hold-off by time is currently supported:<br>`PS4000_TIME` |
| **Returns** | `PICO_OK` - success<br>`PICO_DRIVER_FUNCTION`<br>`PICO_INVALID_PARAMETER` |

# 5.25 ps4000IsLedFlashing

```
PICO_STATUS ps4000IsLedFlashing
(
  int16_t      handle,
  int16_t    * status
)
```

This function reports whether or not the LED is flashing.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle,` identifies the scope device<br><br>`status,` returns a flag indicating the status of the LED:<br><> 0 : flashing<br>0 : not flashing |
| **Returns** | `PICO_OK`<br>`PICO_HANDLE_INVALID`<br>`PICO_NULL_PARAMETER` |

# 5.26 ps4000IsReady

```
PICO_STATUS ps4000IsReady
(
  int16_t      handle,
  int16_t    * ready
)
```

This function may be used instead of a callback function to receive data from ps4000RunBlock. To use this method, pass a NULL pointer as the lpReady argument to ps4000RunBlock. You must then poll the driver to see if it has finished collecting the requested samples.

| | |
|---|---|
| **Applicability** | Block mode |
| **Arguments** | handle, identifies the scope device<br><br>ready, on exit, indicates the state of the collection. If zero, the device is still collecting. If non-zero, the device has finished collecting and ps4000GetValues can be used to retrieve the data. |
| **Returns** | |

# 5.27 ps4000IsTriggerOrPulseWidthQualifierEnabled

```
PICO_STATUS ps4000IsTriggerOrPulseWidthQualifierEnabled
(
  int16_t      handle,
  int16_t    * triggerEnabled,
  int16_t    * pulseWidthQualifierEnabled
)
```

This function discovers whether a trigger, or pulse width triggering, is enabled.

| | |
|---|---|
| **Applicability** | Call after setting up the trigger, and just before calling either ps4000RunBlock or ps4000RunStreaming. |
| **Arguments** | handle, identifies the scope device<br><br>triggerEnabled, indicates whether the trigger will successfully be set when ps4000RunBlock or ps4000RunStreaming is called. A non-zero value indicates that the trigger is set, otherwise the trigger is not set.<br><br>pulseWidthQualifierEnabled, indicates whether the pulse width qualifier will successfully be set when ps4000RunBlock or ps4000RunStreaming is called. A non-zero value indicates that the pulse width qualifier is set, otherwise the pulse width qualifier is not set. |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NULL_PARAMETER |

# 5.28 ps4000MemorySegments

```
PICO_STATUS ps4000MemorySegments
(
  int16_t       handle
  uint16_t      nSegments,
  int32_t     * nMaxSamples
)
```

This function sets the number of memory segments that the scope device will use.

By default, each capture fills the scope device's available memory. This function allows you to divide the memory into a number of segments so that the scope can store several captures sequentially. The number of segments defaults to 1 when the scope device is opened.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device<br><br>`nSegments`, the number of segments to be used, from 1 to 8192<br><br>`nMaxSamples`, returns the number of samples that are available in each segment. This is independent of the number of channels, so if more than one channel is in use then the number of samples available to each channel is `nMaxSamples` divided by the number of channels. |
| **Returns** | `PICO_OK`<br>`PICO_USER_CALLBACK`<br>`PICO_INVALID_HANDLE`<br>`PICO_TOO_MANY_SEGMENTS`<br>`PICO_MEMORY` |

# 5.29 ps4000NoOfStreamingValues

```
PICO_STATUS ps4000NoOfStreamingValues
(
  int16_t        handle,
  uint32_t     * noOfValues
)
```

This function returns the available number of samples from a streaming run.

| | |
|---|---|
| **Applicability** | Streaming mode. Call after ps4000Stop. |
| **Arguments** | handle, identifies the scope device<br><br>noOfValues, returns the number of samples |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NULL_PARAMETER<br>PICO_NO_SAMPLES_AVAILABLE<br>PICO_NOT_USED<br>PICO_BUSY |

# 5.30 ps4000OpenUnit

```
PICO_STATUS ps4000OpenUnit
(
  int16_t    * handle
)
```

This function opens a scope device. The maximum number of units that can be opened is determined by the operating system, the kernel driver and the PC's hardware.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, pointer to an `int16_t` that receives the handle number:<br>-1 : if the unit fails to open,<br>0 : if no unit is found<br>> 0 : if successful (value is handle of the device opened)<br>The handle number must be used in all subsequent calls to API functions to identify this scope device. |
| **Returns** | `PICO_OK`<br>`PICO_OS_NOT_SUPPORTED`<br>`PICO_OPEN_OPERATION_IN_PROGRESS`<br>`PICO_EEPROM_CORRUPT`<br>`PICO_KERNEL_DRIVER_TOO_OLD`<br>`PICO_FW_FAIL`<br>`PICO_MAX_UNITS_OPENED`<br>`PICO_NOT_FOUND`<br>`PICO_NOT_RESPONDING` |

# 5.31 ps4000OpenUnitAsync

```
PICO_STATUS ps4000OpenUnitAsync
(
  int16_t    * status
)
```

This function opens a scope device without blocking the calling thread. You can find out when it has finished by periodically calling ps4000OpenUnitProgress until that function returns a non-zero value.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | status, pointer to an int16_t that indicates:<br>0 if there is already an open operation in progress<br>1 if the open operation is initiated |
| **Returns** | PICO_OK<br>PICO_OPEN_OPERATION_IN_PROGRESS<br>PICO_OPERATION_FAILED |

# 5.32 ps4000OpenUnitAsyncEx

```
PICO_STATUS ps4000OpenUnitAsyncEx
(
  int16_t    * status,
  int8_t     * serial
)
```

This function opens a scope device selected by serial number without blocking the calling thread. You can find out when it has finished by periodically calling ps4000OpenUnitProgress until that function returns a non-zero value.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | status, pointer to a int16_t that indicates:<br>0 if there is already an open operation in progress<br>1 if the open operation is initiated<br><br>serial, the serial number of the device to be opened. A null-terminated string. |
| **Returns** | PICO_OK<br>PICO_OPEN_OPERATION_IN_PROGRESS<br>PICO_OPERATION_FAILED |

# 5.33 ps4000OpenUnitEx

```
PICO_STATUS ps4000OpenUnitEx
(
  int16_t     * handle,
  int8_t      * serial
)
```

This function opens a scope device. The maximum number of units that can be opened is determined by the operating system, the kernel driver and the PC's hardware.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, pointer to an `int16_t` that receives the handle number:<br>-1 : if the unit fails to open,<br>0 : if no unit is found or<br>> 0 : if successful (value is handle to the device opened)<br>The handle number must be used in all subsequent calls to API functions to identify this scope device.<br><br>`serial`, the serial number of the device to be opened. A null-terminated string. |
| **Returns** | `PICO_OK`<br>`PICO_OS_NOT_SUPPORTED`<br>`PICO_OPEN_OPERATION_IN_PROGRESS`<br>`PICO_EEPROM_CORRUPT`<br>`PICO_KERNEL_DRIVER_TOO_OLD`<br>`PICO_FW_FAIL`<br>`PICO_MAX_UNITS_OPENED`<br>`PICO_NOT_FOUND`<br>`PICO_NOT_RESPONDING` |

# 5.34 ps4000OpenUnitProgress

```
PICO_STATUS ps4000OpenUnitProgress
(
  int16_t    * handle,
  int16_t    * progressPercent,
  int16_t    * complete
)
```

This function checks on the progress of ps4000OpenUnitAsync.

| | |
|---|---|
| **Applicability** | Use after ps4000OpenUnitAsync |
| **Arguments** | handle, pointer to an int16_t where the unit handle is to be written. -1 if the unit fails to open, 0 if no unit is found or a non-zero handle to the device.<br><br>**Note:** This handle is not valid unless the function returns PICO_OK.<br><br>progressPercent, pointer to an int16_t to which the percentage progress is to be written. 100% implies that the open operation is complete.<br><br>complete, pointer to an int16_t that is set to 1 when the open operation has finished |
| **Returns** | PICO_OK<br>PICO_NULL_PARAMETER<br>PICO_OPERATION_FAILED |

# 5.35 ps4000PingUnit

```
PICO_STATUS ps4000PingUnit
(
  int16_t    handle
)
```

This function can be used to check that the already opened device is still connected to the USB port and communication is successful.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_DRIVER_FUNCTION`<br>`PICO_POWER_SUPPLY_CONNECTED`<br>`PICO_POWER_SUPPLY_NOT_CONNECTED`<br>`PICO_BUSY`<br>`PICO_NOT_RESPONDING` |

# 5.36 ps4000RunBlock

```
PICO_STATUS ps4000RunBlock
(
  int16_t               handle,
  int32_t               noOfPreTriggerSamples,
  int32_t               noOfPostTriggerSamples,
  uint32_t              timebase,
  int16_t               oversample,
  int32_t             * timeIndisposedMs,
  uint16_t              segmentIndex,
  ps4000BlockReady      lpReady,
  void                * pParameter
)
```

This function starts a collection of data points (samples) in block mode.

The number of samples is determined by `noOfPreTriggerSamples` and `noOfPostTriggerSamples` (see below for details). The total number of samples must not be more than the memory depth of the segment referred to by `segmentIndex`.

| | |
|---|---|
| **Applicability** | Block mode, rapid block mode |
| **Arguments** | handle, identifies the scope device<br><br>noOfPreTriggerSamples, the number of samples to return before the trigger event. If no trigger has been set, then this argument is added to noOfPostTriggerSamples to give the maximum number of data points (samples) to collect.<br><br>noOfPostTriggerSamples, the number of samples to return after the trigger event. If no trigger event has been set, then this argument is added to noOfPreTriggerSamples to give the maximum number of data points to collect. If a trigger condition has been set, this specifies the number of data points to collect after a trigger has fired, and the number of data points to be collected is:<br><br>noOfPreTriggerSamples + noOfPostTriggerSamples<br><br>timebase, a number in the range 0 to $2^{30}-1$. See the guide to calculating timebase values.<br><br>oversample, the oversampling factor, a number in the range 1 to 16<br><br>timeIndisposedMs, returns the time, in milliseconds, that the device will spend collecting samples. This does not include any auto trigger timeout. If this pointer is null, nothing will be written here.<br><br>segmentIndex, zero-based, specifies which memory segment to use<br><br>lpReady, a pointer to the ps4000BlockReady callback that the driver will call when the data has been collected. To use the ps4000IsReady polling method instead of a callback function, set this pointer to NULL.<br><br>pParameter, a void pointer that is passed to the ps4000BlockReady callback function. The callback can use the pointer to return arbitrary data to your application. |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_USER_CALLBACK<br>PICO_SEGMENT_OUT_OF_RANGE<br>PICO_INVALID_CHANNEL<br>PICO_INVALID_TRIGGER_CHANNEL<br>PICO_INVALID_CONDITION_CHANNEL<br>PICO_TOO_MANY_SAMPLES<br>PICO_INVALID_TIMEBASE<br>PICO_NOT_RESPONDING<br>PICO_CONFIG_FAIL<br>PICO_INVALID_PARAMETER<br>PICO_NOT_RESPONDING<br>PICO_TRIGGER_ERROR |

# 5.37 ps4000RunStreaming

```
PICO_STATUS ps4000RunStreaming
(
  int16_t                 handle,
  uint32_t              * sampleInterval,
  PS4000_TIME_UNITS       sampleIntervalTimeUnits
  uint32_t                maxPreTriggerSamples,
  uint32_t                maxPostTriggerSamples,
  int16_t                 autoStop
  uint32_t                downSampleRatio,
  uint32_t                overviewBufferSize
)
```

This function tells the oscilloscope to start collecting data in streaming mode. When data has been collected from the device it is aggregated and the values returned to the application. Call ps4000GetStreamingLatestValues to retrieve the data.

When a trigger is set, the sum of maxPreTriggerSamples and maxPostTriggerSamples is the total number of samples stored in the driver. If autoStop is false then this will become the maximum number of unaggregated samples.

| | |
|---|---|
| **Applicability** | Streaming mode only |
| **Arguments** | handle, identifies the scope device<br><br>sampleInterval, a pointer to the requested time interval between data points on entry and the actual time interval assigned on exit<br><br>sampleIntervalTimeUnits, the unit of time that the sampleInterval is set to. Use one of these values:<br>PS4000_FS<br>PS4000_PS<br>PS4000_NS<br>PS4000_US<br>PS4000_MS<br>PS4000_S<br><br>maxPreTriggerSamples, the maximum number of raw samples before a trigger condition for each enabled channel. If no trigger condition is set this argument is ignored.<br><br>maxPostTriggerSamples, the maximum number of raw samples after a trigger condition for each enabled channel. If no trigger condition is set this argument states the maximum number of samples to be stored.<br><br>autoStop, a flag to specify if the streaming should stop when all of maxSamples have been taken<br><br>downSampleRatio, the number of raw values to each aggregated value<br><br>overviewBufferSize, the size of the overview buffers. These are temporary buffers used for storing the data before returning it to the application. The size is the same as the bufferLth value passed to ps4000SetDataBuffer. |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_USER_CALLBACK<br>PICO_NULL_PARAMETER<br>PICO_INVALID_PARAMETER<br>PICO_STREAMING_FAILED<br>PICO_NOT_RESPONDING<br>PICO_TRIGGER_ERROR<br>PICO_INVALID_SAMPLE_INTERVAL<br>PICO_INVALID_BUFFER |

# 5.38 ps4000RunStreamingEx

```
PICO_STATUS ps4000RunStreamingEx
(
  int16_t                 handle,
  uint32_t              * sampleInterval,
  PS4000_TIME_UNITS       sampleIntervalTimeUnits
  uint32_t                maxPreTriggerSamples,
  uint32_t                maxPostTriggerSamples,
  int16_t                 autoStop
  uint32_t                downSampleRatio,
  int16_t                 downSampleRatioMode,
  uint32_t                overviewBufferSize
)
```

This function tells the oscilloscope to start collecting data in streaming mode and with a specified data reduction mode. When data has been collected from the device it is aggregated and the values returned to the application. Call `ps4000GetStreamingLatestValues` to retrieve the data.

When a trigger is set, the sum of `maxPreTriggerSamples` and `maxPostTriggerSamples` is the total number of samples stored in the driver. If `autoStop` is false then this will become the maximum number of unaggregated samples.

| | |
|---|---|
| **Applicability** | Streaming mode only |
| **Arguments** | handle, identifies the scope device<br><br>sampleInterval, a pointer to the requested time interval between data points on entry and the actual time interval assigned on exit<br><br>sampleIntervalTimeUnits, the unit of time that the sampleInterval is set to. Use one of these values:<br>PS4000_FS<br>PS4000_PS<br>PS4000_NS<br>PS4000_US<br>PS4000_MS<br>PS4000_S<br><br>maxPreTriggerSamples, the maximum number of raw samples before a trigger condition for each enabled channel. If no trigger condition is set this argument is ignored.<br><br>maxPostTriggerSamples, the maximum number of raw samples after a trigger condition for each enabled channel. If no trigger condition is set this argument states the maximum number of samples to be stored.<br><br>autoStop, a flag to specify if the streaming should stop when all of maxSamples have been taken<br><br>downSampleRatio, the number of raw values to each aggregated value<br><br>downSampleRatioMode, the data reduction mode to use<br><br>overviewBufferSize, the size of the overview buffers. These are temporary buffers used for storing the data before returning it to the application. The size is the same as the bufferLth value passed to ps4000SetDataBuffer. |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_USER_CALLBACK<br>PICO_NULL_PARAMETER<br>PICO_INVALID_PARAMETER<br>PICO_STREAMING_FAILED<br>PICO_NOT_RESPONDING<br>PICO_TRIGGER_ERROR<br>PICO_INVALID_SAMPLE_INTERVAL<br>PICO_INVALID_BUFFER |

# 5.39 ps4000SetBwFilter

```
PICO_STATUS ps4000SetBwFilter
(
  int16_t           handle,
  PS4000_CHANNEL    channel,
  int16_t           enable
)
```

This function enables or disables the bandwidth-limiting filter on the specified channel.

| | |
|---|---|
| **Applicability** | PicoScope 4262 only |
| **Arguments** | `handle`, identifies the scope device<br><br>`channel`, an enumerated type. The values are:<br>`PS4000_CHANNEL_A`<br>`PS4000_CHANNEL_B`<br><br>`enable`, whether to enable or disable the filter:<br>`TRUE` = enable<br>`FALSE` = disable |
| **Returns** | `PICO_OK`<br>`PICO_USER_CALLBACK`<br>`PICO_INVALID_HANDLE`<br>`PICO_INVALID_CHANNEL` |

# 5.40 ps4000SetChannel

```
PICO_STATUS ps4000SetChannel
(
  int16_t           handle,
  PS4000_CHANNEL    channel,
  int16_t           enabled,
  int16_t           dc,
  PS4000_RANGE      range
)
```

This function specifies whether an input channel is to be enabled, the AC/DC coupling mode and the voltage range.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device<br><br>`channel`, an enumerated type. The values are:<br>`PS4000_CHANNEL_A`<br>`PS4000_CHANNEL_B`<br>`PS4000_CHANNEL_C` (4-channel scopes only)<br>`PS4000_CHANNEL_D` (4-channel scopes only)<br><br>`enabled`, specifies if the channel is active. The values are:<br>`TRUE` = active<br>`FALSE` = inactive<br><br>`dc`, specifies the AC/DC coupling mode. The values are:<br>`TRUE` = DC<br>`FALSE` = AC<br><br>`range`, specifies the measuring range. Measuring ranges 0 to 12, for standard scopes, are shown in the table below. Additional ranges for special-purpose scopes are listed under `PS4000_RANGE`. For example, to enable IEPE input mode on an IEPE-enabled scope, select one of the ranges beginning with `PS4000_ACCELEROMETER_`. |
| **Returns** | `PICO_OK`<br>`PICO_USER_CALLBACK`<br>`PICO_INVALID_HANDLE`<br>`PICO_INVALID_CHANNEL`<br>`PICO_INVALID_VOLTAGE_RANGE` |

| range | | Voltage range |
|---|---|---|
| 0 | PS4000_10MV | ±10 mV |
| 1 | PS4000_20MV | ±20 mV |
| 2 | PS4000_50MV | ±50 mV |
| 3 | PS4000_100MV | ±100 mV |
| 4 | PS4000_200MV | ±200 mV |
| 5 | PS4000_500MV | ±500 mV |
| 6 | PS4000_1V | ±1 V |
| 7 | PS4000_2V | ±2 V |
| 8 | PS4000_5V | ±5 V |
| 9 | PS4000_10V | ±10 V |
| 10 | PS4000_20V | ±20 V |
| 11 | PS4000_50V | ±50 V |
| 12 | PS4000_100V | ±100 V |

# 5.41 ps4000SetDataBuffer

```
PICO_STATUS ps4000SetDataBuffer
(
  int16_t             handle,
  PS4000_CHANNEL      channel,
  int16_t           * buffer,
  int32_t             bufferLth
)
```

This function registers your data buffer, for non-aggregated data, with the PicoScope 4000 driver. You need to allocate the buffer before calling this function.

| | |
|---|---|
| **Applicability** | All modes.<br><br>For aggregated data, use ps4000SetDataBuffers instead. |
| **Arguments** | handle, identifies the scope device<br><br>channel, the channel for which you want to set the buffers. Use one of these values:<br>PS4000_CHANNEL_A<br>PS4000_CHANNEL_B<br>PS4000_CHANNEL_C (4-channel scopes only)<br>PS4000_CHANNEL_D (4-channel scopes only)<br><br>buffer, a buffer to receive the data values<br><br>bufferLth, the size of the buffer array |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_INVALID_CHANNEL |

# 5.42 ps4000SetDataBufferBulk

```
PICO_STATUS ps4000SetDataBufferBulk
(
    int16_t             handle,
    PS4000_CHANNEL      channel,
    int16_t           * buffer,
    int32_t             bufferLth,
    uint16_t            waveform
)
```

This function allows the buffers to be set for each waveform in rapid block mode. The number of waveforms captured is determined by the `nCaptures` argument sent to `ps4000SetNoOfCaptures`. There is only one buffer for each waveform, because bulk collection does not support aggregation.

| | |
|---|---|
| **Applicability** | Rapid block mode |
| **Arguments** | `handle`, identifies the scope device<br><br>`channel`, the scope channel with which the buffer is to be associated. The data should be retrieved from this channel by calling one of the GetValues functions.<br><br>`* buffer`, an array in which the captured data is stored<br><br>`bufferLth`, the size of the buffer<br><br>`waveform`, an index to the waveform number, between `0` and `nCaptures-1` |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_INVALID_CHANNEL`<br>`PICO_INVALID_PARAMETER` |

# 5.43 ps4000SetDataBuffers

```
PICO_STATUS ps4000SetDataBuffers
(
  int16_t             handle,
  PS4000_CHANNEL      channel,
  int16_t           * bufferMax,
  int16_t           * bufferMin,
  int32_t             bufferLth
)
```

This function registers your data buffers, for receiving aggregated data, with the PicoScope 4000 driver. You need to allocate memory for the buffers before calling this function.

| | |
|---|---|
| **Applicability** | All sampling modes.<br><br>For non-aggregated data, use ps4000SetDataBuffer instead. |
| **Arguments** | handle, identifies the scope device<br><br>channel, the channel for which you want to set the buffers. Use one of these constants:<br>PS4000_CHANNEL_A<br>PS4000_CHANNEL_B<br>PS4000_CHANNEL_C (4-channel scopes only)<br>PS4000_CHANNEL_D (4-channel scopes only)<br><br>bufferMax, a buffer to receive the maximum data values in aggregation mode, or the non-aggregated values otherwise<br><br>bufferMin, a buffer to receive the minimum data values when downSampleRatio > 1. Not used when downSampleRatio is 1.<br><br>bufferLth, specifies the size of the bufferMax and bufferMin arrays |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_INVALID_CHANNEL |

# 5.44 ps4000SetDataBuffersWithMode

```
PICO_STATUS ps4000SetDataBuffersWithMode
(
  int16_t             handle,
  PS4000_CHANNEL      channel,
  int16_t           * bufferMax,
  int16_t           * bufferMin,
  int32_t             bufferLth,
  RATIO_MODE          mode
)
```

This function registers your data buffers, for receiving aggregated data, with the PicoScope 4000 driver. You need to allocate memory for the buffers before calling this function.

| | |
|---|---|
| **Applicability** | All sampling modes.<br><br>For non-aggregated data, use ps4000SetDataBuffer instead. |
| **Arguments** | handle, identifies the scope device<br><br>channel, the channel for which you want to set the buffers. Use one of these constants:<br>PS4000_CHANNEL_A<br>PS4000_CHANNEL_B<br>PS4000_CHANNEL_C (4-channel scopes only)<br>PS4000_CHANNEL_D (4-channel scopes only)<br><br>bufferMax, a buffer to receive the maximum data values in aggregation mode, or the non-aggregated values otherwise<br><br>bufferMin, a buffer to receive the minimum data values when downSampleRatio > 1. Not used when downSampleRatio is 1.<br><br>bufferLth, specifies the size of the bufferMax and bufferMin arrays<br><br>mode, the data reduction mode to use |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_INVALID_CHANNEL |

# 5.45 ps4000SetDataBufferWithMode

```
PICO_STATUS ps4000SetDataBufferWithMode
(
  int16_t             handle,
  PS4000_CHANNEL      channel,
  int16_t           * buffer,
  int32_t             bufferLth,
  RATIO_MODE          mode
)
```

This function registers your data buffer, for non-aggregated data, with the PicoScope 4000 driver. You need to allocate the buffer before calling this function.

| | |
|---|---|
| **Applicability** | All modes.<br><br>For aggregated data, use ps4000SetDataBuffers instead. |
| **Arguments** | handle, identifies the scope device<br><br>channel, the channel for which you want to set the buffers. Use one of these values:<br>PS4000_CHANNEL_A<br>PS4000_CHANNEL_B<br>PS4000_CHANNEL_C (4-channel scopes only)<br>PS4000_CHANNEL_D (4-channel scopes only)<br><br>buffer, a buffer to receive the data values<br><br>bufferLth, the size of the buffer array<br><br>mode, the type of data reduction to use |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_INVALID_CHANNEL |

# 5.46 ps4000SetEts

```
PICO_STATUS ps4000SetEts
(
  int16_t              handle,
  PS4000_ETS_MODE      mode,
  int16_t              etsCycles,
  int16_t              etsInterleave,
  int32_t            * sampleTimePicoseconds
)
```

This function is used to enable or disable ETS (equivalent time sampling) and to set the ETS parameters.

| | |
|---|---|
| **Applicability** | Block mode only. ETS is only supported by PicoScope 4226 and 4227. |
| **Arguments** | `handle`, identifies the scope device<br><br>`mode`, the ETS mode. Use one of these values:<br>`PS4000_ETS_OFF` disables ETS<br>`PS4000_ETS_FAST` enables ETS and provides `etsCycles` cycles of data, which may contain data from previously returned cycles<br>`PS4000_ETS_SLOW` enables ETS and provides fresh data every `etsCycles` cycles. This mode takes longer to provide each data set, but the data sets are more stable and are guaranteed to contain only new data.<br><br>`etsCycles`, the number of cycles to store: the computer can then select `etsInterleave` cycles to give the most uniform spread of samples. `etsCycles` should be between two and five times the value of `etsInterleave`.<br><br>`etsInterleave`, the number of ETS interleaves to use. If the sample time is 20 ns and the interleave is 10, the approximate time per sample will be 2 ns.<br><br>`sampleTimePicoseconds`, returns the effective sample time used by the function |
| **Returns** | `PICO_OK`<br>`PICO_USER_CALLBACK`<br>`PICO_INVALID_HANDLE`<br>`PICO_INVALID_PARAMETER` |

# 5.47 ps4000SetEtsTimeBuffer

```
PICO_STATUS ps4000SetEtsTimeBuffer
(
  int16_t      handle,
  int64_t    * buffer,
  int32_t      bufferLth
)
```

This function tells the PicoScope 4000 driver where to find your application's ETS time buffers. These buffers contain the 64-bit timing information for each ETS sample after you run a block-mode ETS capture.

| | |
|---|---|
| **Applicability** | ETS mode only. ETS is only supported by PicoScope 4226 and 4227.<br><br>If your programming language does not support 64-bit data, use the 32-bit version ps4000SetEtsTimeBuffers instead. |
| **Arguments** | handle, identifies the scope device<br><br>buffer, a pointer to a set of 64-bit words, each representing the time in femtoseconds ($10^{-15}$ s) at which the sample was captured<br><br>bufferLth, the size of the buffer array |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NULL_PARAMETER |

# 5.48 ps4000SetEtsTimeBuffers

```
PICO_STATUS ps4000SetEtsTimeBuffers
(
  int16_t       handle,
  uint32_t    * timeUpper,
  uint32_t    * timeLower,
  int32_t       bufferLth
)
```

This function tells the PicoScope 4000 driver where to find your application's ETS time buffers. These buffers contain the timing information for each ETS sample after you run a block-mode ETS capture. There are two buffers containing the upper and lower 32-bit parts of the timing information, to allow programming languages that do not support 64-bit data to retrieve the timings correctly.

| | |
|---|---|
| **Applicability** | ETS mode only. ETS is only supported by PicoScope 4226 and 4227.<br><br>If your programming language supports 64-bit data, then you can use ps4000SetEtsTimeBuffer instead. |
| **Arguments** | `handle`, identifies the scope device<br><br>`timeUpper`, a pointer to a set of 32-bit words, each representing the upper 32 bits of the time in femtoseconds ($10^{-15}$ s) at which the sample was captured<br><br>`timeLower`, a pointer to a set of 32-bit words, each representing the lower 32 bits of the time in femtoseconds at which the sample was captured<br><br>`bufferLth`, the size of the `timeUpper` and `timeLower` arrays |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_NULL_PARAMETER` |

# 5.49 ps4000SetExtTriggerRange

```
PICO_STATUS ps4000SetExtTriggerRange
(
  int16_t          handle,
  PS4000_RANGE     extRange
)
```

This function sets the range of the external trigger.

| | |
|---|---|
| **Applicability** | PicoScope 4262 only |
| **Arguments** | `handle`, identifies the scope device<br><br>`extRange`, specifies the range for the external trigger (±500 mV or ±5 V) |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_PARAMETER` |

| extRange | | Voltage range |
|---|---|---|
| 5 | `PS4000_500MV` | ±500 mV |
| 8 | `PS4000_5V` | ±5 V |

# 5.50 ps4000SetNoOfCaptures

```
PICO_STATUS ps4000SetNoOfCaptures
(
  int16_t     handle,
  uint16_t    nCaptures
)
```

This function sets the number of captures to be collected in one run of rapid block mode. If you do not call this function before a run, the driver will capture one waveform.

| | |
|---|---|
| **Applicability** | Rapid block mode |
| **Arguments** | `handle`, identifies the scope device<br><br>`nCaptures`, the number of waveforms to be captured in one run |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_INVALID_PARAMETER` |

# 5.51 ps4000SetPulseWidthQualifier

```
PICO_STATUS ps4000SetPulseWidthQualifier
(
  int16_t                 handle,
  PWQ_CONDITIONS        * conditions,
  int16_t                 nConditions,
  THRESHOLD_DIRECTION     direction,
  uint32_t                lower,
  uint32_t                upper,
  PULSE_WIDTH_TYPE        type
)
```

This function sets up pulse width qualification, which can be used on its own for pulse width triggering or combined with threshold triggering, level triggering or window triggering to produce more complex triggers. The pulse width qualifier is set by defining one or more conditions structures that are then ORed together. Each structure is itself the AND of the states of one or more of the inputs. This AND-OR logic allows you to create any possible Boolean function of the scope's inputs.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device<br><br>`conditions`, a pointer to an array of PWQ_CONDITIONS structures specifying the conditions that should be applied to each channel. In the simplest case, the array consists of a single element. When there are several elements, the overall trigger condition is the logical OR of all the elements. If `conditions` is set to `null` then the pulse width qualifier is not used.<br><br>`nConditions`, the number of elements in the `conditions` array. If `nConditions` is zero then the pulse width qualifier is not used.<br><br>`direction`, the direction of the signal required for the trigger to fire<br><br>`lower`, the lower limit of the pulse width counter<br><br>`upper`, the upper limit of the pulse width counter. This parameter is used only when the type is set to `PW_TYPE_IN_RANGE` or `PW_TYPE_OUT_OF_RANGE`.<br><br>`type`, the pulse width type, one of these constants:<br>`PW_TYPE_NONE` (do not use the pulse width qualifier)<br>`PW_TYPE_LESS_THAN` (pulse width less than `lower`)<br>`PW_TYPE_GREATER_THAN` (pulse width greater than `lower`)<br>`PW_TYPE_IN_RANGE` (pulse width between `lower` and `upper`)<br>`PW_TYPE_OUT_OF_RANGE` (pulse width not between `lower` and `upper`) |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_USER_CALLBACK`<br>`PICO_CONDITIONS`<br>`PICO_PULSE_WIDTH_QUALIFIER` |

## 5.51.1 PWQ_CONDITIONS structure

A structure of this type is passed to ps4000SetPulseWidthQualifier in the conditions argument to specify the trigger conditions, and is defined as follows:

```
typedef struct tPwqConditions
{
  TRIGGER_STATE channelA;
  TRIGGER_STATE channelB;
  TRIGGER_STATE channelC;
  TRIGGER_STATE channelD;
  TRIGGER_STATE external;
  TRIGGER_STATE aux;
} PWQ_CONDITIONS
```

Each structure is the logical AND of the states of the scope's inputs. The ps4000SetPulseWidthQualifier function can OR together a number of these structures to produce the final pulse width qualifier, which can be any possible Boolean function of the scope's inputs.

| | |
|---|---|
| **Elements** | channelA, channelB, channelC, channelD: the type of condition that should be applied to each channel. Use these constants:<br>CONDITION_DONT_CARE<br>CONDITION_TRUE<br>CONDITION_FALSE<br><br>The channels that are set to CONDITION_TRUE or CONDITION_FALSE must all meet their conditions simultaneously to produce a trigger. Channels set to CONDITION_DONT_CARE are ignored.<br><br>external, aux: not used |

# 5.52 ps4000SetSigGenArbitrary

```
PICO_STATUS ps4000SetSigGenArbitrary
(
  int16_t                handle,
  int32_t                offsetVoltage,
  uint32_t               pkToPk,
  uint32_t               startDeltaPhase,
  uint32_t               stopDeltaPhase,
  uint32_t               deltaPhaseIncrement,
  uint32_t               dwellCount,
  int16_t              * arbitraryWaveform,
  int32_t                arbitraryWaveformSize,
  SWEEP_TYPE             sweepType,
  int16_t                operationType,
  INDEX_MODE             indexMode,
  uint32_t               shots,
  uint32_t               sweeps,
  SIGGEN_TRIG_TYPE       triggerType,
  SIGGEN_TRIG_SOURCE     triggerSource,
  int16_t                extInThreshold
)
```

This function instructs the signal generator to produce an arbitrary waveform.

The arbitrary waveform generator (AWG) uses direct digital synthesis (DDS). It maintains a 32-bit phase accumulator that indicates the present location in the waveform. The top bits of the phase accumulator are used as an index into a buffer containing the arbitrary waveform. The remaining bits act as the fractional part of the index, enabling high-resolution control of output frequency and allowing the generation of lower frequencies.

This document provides some useful guidance on how to call the API functions in order to trigger the signal generator output.

| **Applicability** | PicoScope 4226, 4227 and 4262 only |
|---|---|
| **Arguments** | |
| `handle`, identifies the scope device<br><br>`offsetVoltage`, the voltage offset, in microvolts, to be applied to the waveform<br><br>`pkToPk`, the peak-to-peak voltage, in microvolts, of the waveform signal<br><br>`startDeltaPhase`, the initial value added to the phase counter as the generator begins to step through the waveform buffer. Call `ps4000SigGenFrequencyToPhase` to calculate this.<br><br>`stopDeltaPhase`, the final value added to the phase counter before the generator restarts or reverses the sweep. When frequency sweeping is not required, set equal to `startDeltaPhase`. Call `ps4000SigGenFrequencyToPhase` to calculate this.<br><br>`deltaPhaseIncrement`, the amount added to the delta phase value every time the `dwellCount` period expires. This determines the amount by which the generator sweeps the output frequency in each dwell period. When frequency sweeping is not required, set to zero. | |

dwellCount, the time, in multiples of *dacPeriod,* between successive additions of deltaPhaseIncrement to the delta phase counter. This determines the rate at which the generator sweeps the output frequency. Minimum allowable values are as follows:

| | |
|---|---|
| PicoScope 4226 and 4227: | MIN_DWELL_COUNT (10) |
| PicoScope 4262: | PS4262_MIN_DWELL_COUNT (3) |

arbitraryWaveform, a pointer to a buffer that holds the waveform pattern as a set of samples equally spaced in time. You can obtain the range of allowable values by calling ps4000SigGenArbitraryMinMaxValues. Sample value ranges are as follows:

| | |
|---|---|
| PicoScope 4226 and 4227: | [0, 4095] |
| PicoScope 4262: | [–32768, 32767] |

arbitraryWaveformSize, the size of the arbitrary waveform buffer, in samples:

| | |
|---|---|
| All models: | Min: MIN_SIG_GEN_BUFFER_SIZE (1) |
| PicoScope 4226 and 4227: | Max: MAX_SIG_GEN_BUFFER_SIZE (8192) |
| PicoScope 4262: | Max: PS4262_MAX_WAVEFORM_BUFFER_SIZE (4096) |

sweepType, determines whether the startDeltaPhase is swept up to the stopDeltaPhase, or down to it, or repeatedly up and down. Use one of the following values: UP, DOWN, UPDOWN, DOWNUP.

operationType, configures the white noise/PRBS (pseudo-random binary sequence) generator:

| | |
|---|---|
| PS4000_OP_NONE: | White noise/PRBS output disabled. The waveform is defined by the other arguments. |
| PS4000_WHITENOISE: | The signal generator produces white noise and ignores all settings except offsetVoltage and pkToPk |
| PS4000_PRBS: | The signal generator produces a PRBS (PicoScope 4262 only) |

indexMode, specifies how the signal will be formed from the arbitrary waveform data. SINGLE, DUAL and QUAD index modes are possible (see AWG index modes).

shots, the number of cycles of the waveform to be produced after a trigger event. If this is set to a non-zero value [1, MAX_SWEEPS_SHOTS], then sweeps must be set to zero.

sweeps, the number of times to sweep the frequency after a trigger event, according to sweepType. If this is set to a non-zero value [1, MAX_SWEEPS_SHOTS], then shots must be set to zero.

triggerType, the type of trigger that will be applied to the signal generator:

| | |
|---|---|
| SIGGEN_RISING: | rising edge |
| SIGGEN_FALLING: | falling edge |
| SIGGEN_GATE_HIGH: | high level |
| SIGGEN_GATE_LOW: | low level |

triggerSource, the source that will trigger the signal generator:

| | |
|---|---|
| SIGGEN_NONE: | no trigger (free-running) |
| SIGGEN_SCOPE_TRIG: | the selected oscilloscope channel (see ps4000SetSimpleTrigger) |
| SIGGEN_EXT_IN: | the EXT input |
| SIGGEN_SOFT_TRIG: | a software trigger (see ps4000SigGenSoftwareControl) |

If a trigger source other than SIGGEN_NONE is specified, then either shots or sweeps, but not both, must be set to a non-zero value.

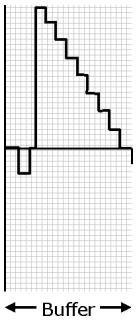
  

| | |
|---|---|
| extInThreshold, an ADC count for use when the trigger source is SIGGEN_EXT_IN. If the EXT input is also being used as the scope trigger then the same ADC count must be specified in both places, otherwise a warning will be issued. Minimum and maximum 16-bit values correspond to the following voltages:<br>PicoScope 4226 & 4227: ±20 V<br>PicoScope 4262: ±500 mV or ±5 V depending on range selected by ps4000SetExtTriggerRange | |
| **Returns** | 0: if successful.<br>Error code: if failed |

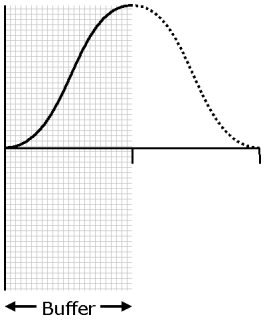
## 5.52.1 AWG index modes

The arbitrary waveform generator supports SINGLE, DUAL and QUAD index modes to make the best use of the waveform buffer.

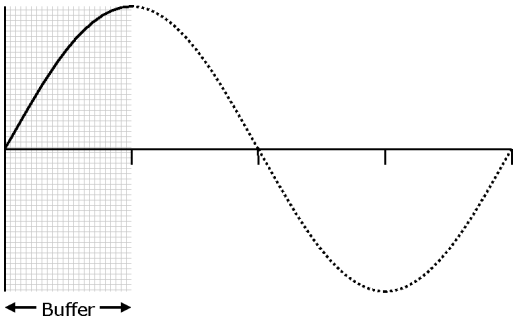
SINGLE **mode**. The generator outputs the raw contents of the buffer repeatedly. This mode is the only one that can generate asymmetrical waveforms. You can also use this mode for symmetrical waveforms, but the dual and quad modes make more efficient use of the buffer memory.




DUAL **mode**. The generator outputs the contents of the buffer from beginning to end, and then does a second pass in the reverse direction through the buffer. This allows you to specify only the first half of a waveform with twofold symmetry, such as a Gaussian function, and let the generator fill in the other half.




QUAD **mode**. The generator outputs the contents of the buffer, then on its second pass through the buffer outputs the same data in reverse order as in dual mode. On the third and fourth passes it does the same but with a negative version of the data. This allows you to specify only the first quarter of a waveform with fourfold symmetry, such as a sine wave, and let the generator fill in the other three quarters.




## 5.52.2 Calculating deltaPhase

The AWG steps through the waveform by adding a *deltaPhase* value between 1 and *phaseAccumulatorSize*–1 to the phase accumulator every *dacPeriod* (1/*dacFrequency*). If the *deltaPhase* is constant, the AWG produces a waveform at a constant frequency that can be calculated as follows:

$$outputFrequency = dacFrequency \times \left(\frac{deltaPhase}{phaseAccumulatorSize}\right) \times \left(\frac{awgBufferSize}{arbitraryWaveformSize}\right)$$

where:

| | | |
|---|---|---|
| *outputFrequency* | = | repetition rate of the complete arbitrary waveform |
| *dacFrequency* | = | update rate of AWG DAC (see table below) |
| *deltaPhase* | = | calculated from *startDeltaPhase* and *deltaPhaseIncrement* |
| *phaseAccumulatorSize* | = | maximum count of phase accumulator (see table below) |
| *awgBufferSize* | = | maximum AWG buffer size (see table below) |
| *arbitraryWaveformSize* | = | length in samples of the user-defined waveform |

You can call ps4000SigGenFrequencyToPhase to calculate *deltaPhase*.

It is also possible to sweep the frequency by continually modifying the *deltaPhase.* This is done by setting up a *deltaPhaseIncrement* that the oscilloscope adds to the *deltaPhase* at specified intervals.

| Parameter | PicoScope 4226/4227 | PicoScope 4262 |
|---|---|---|
| *phaseAccumulatorSize* | 32 bits | 32 bits |
| *bufferAddressWidth* | 13 bits | 12 bits |
| *dacFrequency* | 20 MHz | 192 kHz |
| *dacPeriod* (= 1/*dacFrequency*) | 50 ns | ≈ 5.208 µs |

# 5.53 ps4000SetSigGenBuiltIn

```
PICO_STATUS ps4000SetSigGenBuiltIn
(
  int16_t                handle,
  int32_t                offsetVoltage,
  uint32_t               pkToPk,
  int16_t                waveType,
  float                  startFrequency,
  float                  stopFrequency,
  float                  increment,
  float                  dwellTime,
  SWEEP_TYPE             sweepType,
  int16_t                operationType,
  uint32_t               shots,
  uint32_t               sweeps,
  SIGGEN_TRIG_TYPE       triggerType,
  SIGGEN_TRIG_SOURCE     triggerSource,
  int16_t                extInThreshold
)
```

This function sets up the signal generator to produce a signal from a list of built-in waveforms. If different start and stop frequencies are specified, the oscilloscope will sweep either up, down or up and down.

This document provides some useful guidance on how to call the API functions in order to trigger the signal generator output.

| | |
|---|---|
| **Applicability** | PicoScope 4226, 4227 and 4262 only |
| **Arguments** | `handle`, identifies the scope device<br><br>`offsetVoltage`, the voltage offset, in microvolts, to be applied to the waveform<br><br>`pkToPk`, the peak-to-peak voltage, in microvolts, of the waveform signal<br><br>`waveType`, the type of waveform to be generated by the oscilloscope:<br>`PS4000_SINE` sine wave<br>`PS4000_SQUARE` square wave<br>`PS4000_TRIANGLE` triangle wave<br>`PS4000_RAMP_UP` rising sawtooth<br>`PS4000_RAMP_DOWN` falling sawtooth<br>`PS4000_SINC` sin(x)/x<br>`PS4000_GAUSSIAN` normal distribution<br>`PS4000_HALF_SINE` full-wave rectified sinusoid<br>`PS4000_DC_VOLTAGE` DC voltage<br>`PS4000_WHITE_NOISE` random values<br><br>`startFrequency`, the frequency at which the signal generator should begin. Range: `MIN_SIG_GEN_FREQ` to `MAX_SIG_GEN_FREQ`. |

| | |
|---|---|
| | stopFrequency, the frequency at which the sweep should reverse direction or return to the start frequency. Range: MIN_SIG_GEN_FREQ to MAX_SIG_GEN_FREQ.<br><br>increment, the amount by which the frequency rises or falls every dwellTime seconds in sweep mode<br><br>dwellTime, the time in seconds between frequency changes in sweep mode<br><br>sweepType,<br>operationType,<br>shots,<br>sweeps,<br>triggerType,<br>triggerSource,<br>extInThreshold: see ps4000SigGenArbitrary |
| **Returns** | 0: if successful.<br>Error code: if failed. |

# 5.54 ps4000SetSimpleTrigger

```
PICO_STATUS ps4000SetSimpleTrigger
(
    int16_t                 handle,
    int16_t                 enable,
    PS4000_CHANNEL          source,
    int16_t                 threshold,
    THRESHOLD_DIRECTION     direction,
    uint32_t                delay,
    int16_t                 autoTrigger_ms
)
```

This function simplifies arming the trigger. It supports only the LEVEL trigger types on analog channels, and does not allow more than one channel to have a trigger applied to it. Any previous pulse width qualifier is canceled. The trigger threshold includes a small, fixed amount of hysteresis.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device<br><br>`enabled`, zero to disable the trigger, any non-zero value to set the trigger<br><br>`source`, the channel on which to trigger<br><br>`threshold`, the ADC count at which the trigger will fire<br><br>`direction`, the direction in which the signal must move to cause a trigger. The following directions are supported: `ABOVE`, `BELOW`, `RISING`, `FALLING` and `RISING_OR_FALLING`.<br><br>`delay`, the time, in sample periods, between the trigger occurring and the first sample being taken<br><br>`autoTrigger_ms`, the number of milliseconds the device will wait if no trigger occurs |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_USER_CALLBACK`<br>`PICO_DRIVER_FUNCTION` |

# 5.55 ps4000SetTriggerChannelConditions

```
PICO_STATUS ps4000SetTriggerChannelConditions
(
  int16_t                 handle,
  TRIGGER_CONDITIONS    * conditions,
  int16_t                 nConditions
)
```

This function sets up trigger conditions on the scope's inputs. The trigger is set up by defining one or more TRIGGER_CONDITIONS structures that are then ORed together. Each structure is itself the AND of the states of one or more of the inputs. This AND-OR logic allows you to create any possible Boolean function of the scope's inputs.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device<br><br>`conditions`, a pointer to an array of TRIGGER_CONDITIONS structures specifying the conditions that should be applied to each channel. In the simplest case, the array consists of a single element. When there are several elements, the overall trigger condition is the logical OR of all the elements.<br><br>`nConditions`, the number of elements in the `conditions` array. If `nConditions` is zero then triggering is switched off. |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_USER_CALLBACK`<br>`PICO_CONDITIONS`<br>`PICO_MEMORY_FAIL` |

## 5.55.1 TRIGGER_CONDITIONS structure

A structure of this type is passed to ps4000SetTriggerChannelConditions in the conditions argument to specify the trigger conditions, and is defined as follows:

```
typedef struct tTriggerConditions
{
  TRIGGER_STATE channelA;
  TRIGGER_STATE channelB;
  TRIGGER_STATE channelC;
  TRIGGER_STATE channelD;
  TRIGGER_STATE external;
  TRIGGER_STATE aux;
  TRIGGER_STATE pulseWidthQualifier;
} TRIGGER_CONDITIONS
```

Each structure is the logical AND of the states of the scope's inputs. The ps4000SetTriggerChannelConditions function can OR together a number of these structures to produce the final trigger condition, which can be any possible Boolean function of the scope's inputs.

| | |
|---|---|
| **Elements** | channelA, channelB, channelC, channelD, external, pulseWidthQualifier: the type of condition that should be applied to each channel. Use these constants:<br>CONDITION_DONT_CARE<br>CONDITION_TRUE<br>CONDITION_FALSE<br><br>The channels that are set to CONDITION_TRUE or CONDITION_FALSE must all meet their conditions simultaneously to produce a trigger. Channels set to CONDITION_DONT_CARE are ignored.<br><br>aux, not used |

# 5.56 ps4000SetTriggerChannelDirections

```
PICO_STATUS ps4000SetTriggerChannelDirections
(
  int16_t                handle,
  THRESHOLD_DIRECTION    channelA,
  THRESHOLD_DIRECTION    channelB,
  THRESHOLD_DIRECTION    channelC,
  THRESHOLD_DIRECTION    channelD,
  THRESHOLD_DIRECTION    ext,
  THRESHOLD_DIRECTION    aux
)
```

This function sets the direction of the trigger for each channel.

| | |
|---|---|
| **Applicability** | All modes. |
| **Arguments** | `handle`, identifies the scope device<br><br>`channelA`, `channelB`, `channelC`, `channelD`, `ext` all specify the direction in which the signal must pass through the threshold to activate the trigger. See the table below.<br><br>`aux`, not used |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_USER_CALLBACK`<br>`PICO_INVALID_PARAMETER` |

**Trigger direction constants**

| Constant | Type | Direction |
|---|---|---|
| ABOVE | gated | above the upper threshold |
| ABOVE_LOWER | gated | above the lower threshold |
| BELOW | gated | below the upper threshold |
| BELOW_LOWER | gated | below the lower threshold |
| RISING | threshold | rising edge, using upper threshold |
| RISING_LOWER | threshold | rising edge, using lower threshold |
| FALLING | threshold | falling edge, using upper threshold |
| FALLING_LOWER | threshold | falling edge, using lower threshold |
| RISING_OR_FALLING | threshold | either edge |
| INSIDE | window-qualified | inside window |
| OUTSIDE | window-qualified | outside window |
| ENTER | window | entering the window |
| EXIT | window | leaving the window |
| ENTER_OR_EXIT | window | either entering or leaving the window |
| POSITIVE_RUNT | window-qualified | entering and leaving from below |
| NEGATIVE_RUNT | window-qualified | entering and leaving from above |
| NONE | none | none |

# 5.57 ps4000SetTriggerChannelProperties

```
PICO_STATUS ps4000SetTriggerChannelProperties
(
  int16_t                          handle,
  TRIGGER_CHANNEL_PROPERTIES     * channelProperties
  int16_t                          nChannelProperties
  int16_t                          auxOutputEnable,
  int32_t                          autoTriggerMilliseconds
)
```

This function is used to enable or disable triggering and set its parameters.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device<br><br>`channelProperties`, a pointer to an array of `TRIGGER_CHANNEL_PROPERTIES` structures describing the requested properties. The array can contain a single element describing the properties of one channel, or a number of elements describing several channels. If `null` is passed, triggering is switched off.<br><br>`nChannelProperties`, the size of the `channelProperties` array. If zero, triggering is switched off.<br><br>`auxOutputEnable`, not used<br><br>`autoTriggerMilliseconds`, the time in milliseconds for which the scope device will wait before collecting data if no trigger event occurs. If this is set to zero, the scope device will wait indefinitely for a trigger. |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_USER_CALLBACK`<br>`PICO_TRIGGER_ERROR`<br>`PICO_MEMORY_FAIL`<br>`PICO_INVALID_TRIGGER_PROPERTY` |

## 5.57.1 TRIGGER_CHANNEL_PROPERTIES structure

A structure of this type is passed to ps4000SetTriggerChannelProperties in the channelProperties argument to specify the trigger mechanism, and is defined as follows:

```
typedef struct tTriggerChannelProperties
{
  int16_t           thresholdUpper;
  uint16_t          thresholdUpperHysteresis;
  int16_t           thresholdLower;
  uint16_t          thresholdLowerHysteresis;
  PS4000_CHANNEL    channel;
  THRESHOLD_MODE    thresholdMode;
} TRIGGER_CHANNEL_PROPERTIES
```

| | |
|---|---|
| **Elements** | thresholdUpper, the upper threshold at which the trigger must fire. This is scaled in 16-bit ADC counts at the currently selected range for that channel.<br><br>thresholdUpperHysteresis, the hysteresis by which the trigger must exceed the upper threshold before it will fire. It is scaled in 16-bit counts.<br><br>thresholdLower, the lower threshold at which the trigger must fire. This is scaled in 16-bit ADC counts at the currently selected range for that channel.<br><br>thresholdLowerHysteresis, the hysteresis by which the trigger must exceed the lower threshold before it will fire. It is scaled in 16-bit counts.<br><br>channel, the channel to which the properties apply. See ps4000SetChannel for possible values.<br><br>thresholdMode, either a level or window trigger. Use one of these constants:<br>LEVEL<br>WINDOW |

# 5.58 ps4000SetTriggerDelay

```
PICO_STATUS ps4000SetTriggerDelay
(
  int16_t     handle,
  uint32_t    delay
)
```

This function sets the post-trigger delay, which causes capture to start a defined time after the trigger event.

| | |
|---|---|
| **Applicability** | Block mode and rapid block mode only |
| **Arguments** | `handle`, identifies the scope device<br><br>`delay`, the time between the trigger occurring and the first sample, in sample periods. For example, if `delay` = 100 then the scope would wait 100 sample periods before sampling. Example: with the PicoScope 4224, at a timebase of 80 MS/s, or 12.5 ns per sample (`timebase` = 0) the total delay would then be 100 x 12.5 ns = 1.25 µs. |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_USER_CALLBACK` |

# 5.59 ps4000SigGenArbitraryMinMaxValues

```
PICO_STATUS ps4000SigGenArbitraryMinMaxValues
(
  int16_t       handle,
  int16_t     * minArbitraryWaveformValue,
  int16_t     * maxArbitraryWaveformValue,
  uint32_t    * minArbitraryWaveformSize,
  uint32_t    * maxArbitraryWaveformSize
)
```

This function returns the range of possible sample values and waveform buffer sizes that can be supplied to ps4000SetSigGenArbitrary for setting up the arbitrary waveform generator (AWG). These values may vary between different models.

| | |
|---|---|
| **Applicability** | All models with AWG |
| **Arguments** | handle, identifies the scope device<br><br>minArbitraryWaveformValue, on exit, the lowest sample value allowed in the arbitraryWaveform buffer supplied to ps4000SetSigGenArbitrary<br><br>maxArbitraryWaveformValue, on exit, the highest sample value allowed in the arbitraryWaveform buffer supplied to ps4000SetSigGenArbitrary<br><br>minArbitraryWaveformSize, on exit, the minimum value allowed for the arbitraryWaveformSize argument supplied to ps4000SetSigGenArbitrary<br><br>maxArbitraryWaveformSize, on exit, the maximum value allowed for the arbitraryWaveformSize argument supplied to ps4000SetSigGenArbitrary |
| **Returns** | PICO_OK<br>PICO_NOT_SUPPORTED_BY_THIS_DEVICE, if the device does not have an arbitrary waveform generator.<br>PICO_NULL_PARAMETER, if all the parameter pointers are NULL.<br>PICO_INVALID_HANDLE<br>PICO_DRIVER_FUNCTION |

# 5.60 ps4000SigGenFrequencyToPhase

```
PICO_STATUS ps4000SigGenFrequencyToPhase
(
  int16_t              handle,
  double               frequency,
  PS4000_INDEX_MODE    indexMode,
  uint32_t             bufferLength,
  uint32_t           * phase
)
```

This function converts a frequency to a phase count for use with the arbitrary waveform generator (AWG). The value returned depends on the length of the buffer, the index mode passed and the device model. The phase count can then be sent to the driver through ps4000SetSigGenArbitrary.

| | |
|---|---|
| **Applicability** | All models with AWG |
| **Arguments** | handle, identifies the scope device<br><br>frequency, the required AWG output frequency<br><br>indexMode, see AWG index modes<br><br>bufferLength, the number of samples in the AWG buffer<br><br>phase, on exit, the deltaPhase argument to be sent to the AWG setup function |
| **Returns** | PICO_OK<br>PICO_NOT_SUPPORTED_BY_THIS_DEVICE, if the device does not have an AWG.<br>PICO_SIGGEN_FREQUENCY_OUT_OF_RANGE, if the frequency is out of range.<br>PICO_NULL_PARAMETER, if phase is a NULL pointer.<br>PICO_SIG_GEN_PARAM, if indexMode or bufferLength is out of range.<br>PICO_INVALID_HANDLE<br>PICO_DRIVER_FUNCTION |

# 5.61 ps4000SigGenSoftwareControl

```
PICO_STATUS ps4000SigGenSoftwareControl
(
  int16_t    handle,
  int16_t    state
)
```

This function causes a trigger event, or starts and stops gating. It is used when the signal generator is set to SIGGEN_SOFT_TRIG .

| | |
|---|---|
| **Applicability** | Use with ps4000SetSigGenBuiltIn or ps4000SetSigGenArbitrary. |
| **Arguments** | handle, identifies the scope device<br><br>state, sets the trigger gate high or low when the trigger type is set to either SIGGEN_GATE_HIGH or SIGGEN_GATE_LOW. Ignored for other trigger types. |
| **Returns** | PICO_OK<br>PICO_INVALID_HANDLE<br>PICO_NO_SIGNAL_GENERATOR<br>PICO_SIGGEN_TRIGGER_SOURCE |

# 5.62 ps4000Stop

```
PICO_STATUS ps4000Stop
(
  int16_t    handle
)
```

This function stops the scope device from sampling data. If this function is called before a trigger event occurs, the oscilloscope may not contain valid data.

When running the device in streaming mode, you should always call this function after the end of a capture to ensure that the scope is ready for the next capture.

| | |
|---|---|
| **Applicability** | All modes |
| **Arguments** | `handle`, identifies the scope device |
| **Returns** | `PICO_OK`<br>`PICO_INVALID_HANDLE`<br>`PICO_USER_CALLBACK` |

# 5.63 ps4000StreamingReady

```
typedef void (CALLBACK *ps4000StreamingReady)
(
  int16_t     handle,
  int32_t     noOfSamples,
  uint32_t    startIndex,
  int16_t     overflow,
  uint32_t    triggerAt,
  int16_t     triggered,
  int16_t     autoStop,
  void      * pParameter
)
```

This callback function is part of your application. You register it with the PicoScope 4000 Series driver using ps4000GetStreamingLatestValues, and the driver calls it back when streaming-mode data is ready. You can then download the data using the ps4000GetValuesAsync function. Your callback function should do nothing more than copy the data to another buffer within your application. To maintain the best application performance, the function should return as quickly as possible without attempting to process or display the data.

| | |
|---|---|
| **Applicability** | Streaming mode only |
| **Arguments** | `handle`, identifies the scope device returning the samples<br><br>`noOfSamples`, the number of samples to collect<br><br>`startIndex`, an index to the first valid sample in the buffer. This is the buffer that was previously passed to ps4000SetDataBuffer or ps4000SetDataBuffers.<br><br>`overflow`, returns a set of flags that indicate whether an overvoltage has occurred on any of the channels. It is a bit pattern with bit 0 corresponding to Channel A and so on.<br><br>`triggerAt`, an index to the buffer indicating the location of the trigger point relative to `startIndex`. This parameter is valid only when `triggered` is non-zero.<br><br>`triggered`, a flag indicating whether a trigger occurred. If non-zero, a trigger occurred at the location indicated by `triggerAt`.<br><br>`autoStop`, the flag that was set in the call to ps4000RunStreaming<br><br>`pParameter`, a void pointer passed from ps4000GetStreamingLatestValues. The callback function can write to this location to send any data, such as a status flag, back to the application. |
| **Returns** | nothing |

## 5.64 Wrapper functions

The Software Development Kits (SDKs) for PicoScope devices contain wrapper dynamic link library (DLL) files in the `lib` subdirectory of your SDK installation for 32-bit and 64-bit systems. The wrapper functions provided by the wrapper DLLs are for use with programming languages such as MathWorks MATLAB, National Instruments LabVIEW and Microsoft Excel VBA that do not support features of the C programming language such as callback functions.

The source code contained in the Wrapper projects contains a description of the functions and the input and output parameters.

Below we explain the sequence of calls required to capture data in streaming mode using the wrapper API functions.

The `ps4000Wrap.dll` wrapper DLL has a callback function for streaming data collection that copies data from the driver buffer specified to a temporary application buffer of the same size. To do this, the driver and application buffers must be registered with the wrapper and the corresponding channel(s) must be specified as being enabled. You should process the data in the temporary application buffer accordingly, for example by copying the data into a large array.

**Procedure:**

1. Open the oscilloscope using `ps4000OpenUnit`.

1a. Inform the wrapper of the number of channels on the device by calling `setChannelCount`.

2. Select channels, ranges and AC/DC coupling using `ps4000SetChannel`.

2a. Inform the wrapper which channels have been enabled by calling `setEnabledChannels`.

3. Use the appropriate trigger setup functions. For programming languages that do not support structures, use the wrapper's advanced trigger setup functions.

4. Call `ps4000SetDataBuffer` (or for aggregated data collection `ps4000SetDataBuffers`) to tell the driver where your data buffer(s) is(are).

4a. Register the data buffer(s) with the wrapper and set the application buffer(s) into which the data will be copied. Call `setAppAndDriverBuffers` (or `setMaxMinAppAndDriverBuffers` for aggregated data collection).

5. Start the oscilloscope running using `ps4000RunStreaming`.

6. Loop and call `GetStreamingLatestValues` and `IsReady` to get data and flag when the wrapper is ready for data to be retrieved.

6a. Call the wrapper's `AvailableData` function to obtain information on the number of samples collected and the start index in the buffer.

6b. Call the wrapper's `IsTriggerReady` function for information on whether a trigger has occurred and the trigger index relative to the start index in the buffer.

7. Process data returned to your application data buffers.

8. Call `AutoStopped` if the `autoStop` parameter has been set to `TRUE` in the call to `ps4000RunStreaming`.

9. Repeat steps 6 to 8 until `AutoStopped` returns true or you wish to stop data collection.

10. Call `ps4000Stop`, even if the `autoStop` parameter has been set to `TRUE`.

11. To disconnect a device, call `ps4000CloseUnit`.

# 6 Further information

## 6.1 Programming examples

Your SDK installation includes programming examples in several languages and development environments. Please refer to the SDK for details.

## 6.2 Driver status codes

Every function in the `ps4000.dll` driver returns a **driver status code** from the list of `PICO_STATUS` values in the `PicoStatus.h` header file, which is included in the `inc` subdirectory of the Pico Technology SDK.

## 6.3 Enumerated types and constants

Enumerated types and constants are defined in the file `ps4000Api.h`, which is included in the `inc` subdirectory of your Pico Technology SDK installation. We recommend that you refer to these constants by name unless your programming language allows only numerical values.

## 6.4 Numeric data types

Here is a list of the sizes and ranges of the numeric data types used in the PicoScope 4000 Series API.

| Type | Bits | Signed or unsigned? |
|---|---|---|
| `int16_t` | 16 | signed |
| `enum` | 32 | enumerated |
| `int32_t` | 32 | signed |
| `uint32_t` | 32 | unsigned |
| `float` | 32 | signed (IEEE 754) |
| `int64_t` | 64 | signed |
| `uint64_t` | 64 | unsigned |

# 7 Glossary

**ADC.** Analog-to-digital converter. The electronic component in a PC oscilloscope that converts analog signals from the inputs into digital data suitable for transmission to the PC.

**Aggregation.** The PicoScope 4000 driver can use this method to reduce the amount of data your application needs to process. This means that for every block of consecutive samples, it stores only the minimum and maximum values. You can set the number of samples in each block, called the aggregation parameter, when you call `PS4000RunStreaming` for real-time capture, and when you call `ps4000GetStreamingLatestValues` to obtain post-processed data.

**Block mode.** A sampling mode in which the computer prompts the oscilloscope to collect a block of data into its internal memory before stopping the oscilloscope and transferring the whole block into computer memory. Choose this mode of operation when the input signal being sampled contains high frequencies. Note: To avoid sampling errors, the maximum input frequency must be less than half the sampling rate.

**Buffer size.** The size of the oscilloscope buffer memory, measured in samples. The buffer allows the oscilloscope to sample data faster than it can transfer it to the computer.

**Callback.** A mechanism that the PicoScope 4000 driver uses to communicate asynchronously with your application. At design time, you add a function (a *callback* function) to your application to deal with captured data. At run time, when you request captured data from the driver, you also pass it a pointer to your function. The driver then returns control to your application, allowing it to perform other tasks until the data is ready. When this happens, the driver calls your function in a new thread to signal that the data is ready. It is then up to your function to communicate this fact to the rest of your application.

**Coupling mode.** This mode selects either AC or DC coupling in the oscilloscope's input path. Use AC mode for small signals that may be superimposed on a DC level. Use DC mode for measuring absolute voltage levels. Set the coupling mode using `ps4000SetChannel`.

**Driver.** A program that controls a piece of hardware. The driver for the PicoScope 4000 Series PC Oscilloscopes is supplied in the form of a 32-bit or 64-bit Windows DLL, `ps4000.dll`. This is used by the PicoScope software, and by user-designed applications, to control the oscilloscopes.

**ETS.** Equivalent-time sampling. A technique for increasing the effective sampling rate of an oscilloscope beyond the maximum sampling rate of its ADC. The scope triggers on successive cycles of a repetitive waveform and collects one sample from each cycle. Each sample is delayed relative to the trigger by a time that increases with each cycle, so that after a number of cycles a complete period of the waveform has been sampled. The waveform must be stable and repetitive for this method to work.

**GS/s.** Gigasamples per second. A gigasample is equal to one billion samples.

**IEPE.** Integrated Electronics Piezoelectric. A standard for accelerometers and other piezoelectric sensors that require an external power supply. Special IEPE-enabled PicoScope 4000 Series scopes have a phantom-powered input that supports these sensors.

**Maximum sampling rate.** A figure indicating the maximum number of samples the oscilloscope can acquire per second. The higher the sampling rate of the oscilloscope, the more accurate the representation of the high-frequency details in a fast signal.

**MS/s.** Megasamples per second. A megasample is equal to one million samples.

**Oversampling.** Oversampling is taking measurements more frequently than the requested sample rate, and then combining them to produce the required number of samples. If, as is usually the case, the signal contains a small amount of noise, this technique can increase the effective vertical resolution of the oscilloscope.

**PC Oscilloscope.** A virtual instrument consisting of a PicoScope oscilloscope unit and a software application.

**PicoScope 4000 Series.** A range of high-resolution PC Oscilloscopes from Pico Technology. The range includes two-channel and four-channel models, with or without a built-in function generator and arbitrary waveform generator.

**Streaming mode.** A sampling mode in which the oscilloscope samples data and returns it to the computer in an unbroken stream. This mode allows the capture of data sets whose size is not limited by the size of the scope's memory buffer, at sampling rates up to 6.6 million samples per second.

**Timebase.** The sampling rate that the scope uses to acquire data. The timebase can be set to any value returned by the `ps4000GetTimebase` or `ps4000GetTimebase2` functions.

**Trigger bandwidth.** The external trigger input is less sensitive to very high-frequency input signals than to low-frequency signals. The trigger bandwidth is the frequency at which a trigger signal will be attenuated by 3 decibels.

**USB 1.1.** Universal Serial Bus (Full Speed). This is a standard port used to connect external devices to PCs. A typical USB 1.1 port supports a data transfer rate of 12 megabits per second, so is much faster than an RS232 COM port.

**USB 2.0.** Universal Serial Bus (High Speed). This is a standard port used to connect external devices to PCs. A typical USB 2.0 port supports a data transfer rate 40 times faster than USB 1.1 when used with a USB 2.0 device, but can also be used with USB 1.1 devices.

**USB 3.0.** A faster version of the Universal Serial Bus standard. Your PicoScope is fully compatible with USB 3.0 ports and will operate with the same performance as on a USB 2.0 port.

**Vertical resolution.** A value, in bits, indicating the precision with which the oscilloscope converts input voltages to digital values. Oversampling (see above) can improve the effective vertical resolution.

**Voltage range.** The range of input voltages that the oscilloscope can measure. For example, a voltage range of ±100 mV means that the oscilloscope can measure voltages between –100 mV and +100 mV. Input voltages outside this range will not damage the instrument as long as they remain within the protection limits of ±200 V.

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