PicoScope® 3000E and 5000E Series

psospa API

Programmer's Guide

Contents

1 Introduction

Oscilloscopes from Pico Technology are compact high-performance units designed to replace traditional benchtop oscilloscopes.

This manual explains how to use the psospa API (application programming interface) for the following supported PicoScope series:

PicoScope 3000E Series
PicoScope 5000E Series

For more information about the hardware, see the following data sheets:

PicoScope 3000E Series Data Sheet
PicoScope 5000E Series Data Sheet

Because the psospa API supports both the PicoScope 3000E and 5000E Series, it is possible to write a single program using this driver which works interchangeably with any of these PicoScope devices.

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psospa-4 programmer's guide (Available online and as a PDF)

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2 Programming overview

The psospa library allows you to program your 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 types.
- Set up triggering.
- Start capturing data. (See Sampling modes, where programming is discussed in more detail.)
- Wait until the scope unit is ready.
- Stop capturing data.
- Copy data to a buffer.
- Close the scope unit.

Numerous sample programs are available on the *picotech* channel of GitHub. These demonstrate how to use the functions of the driver software in each of the modes available.

2.1 System requirements

To ensure that your supported PicoScope operates correctly, 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, and will benefit from a multi-core processor.

Item	Specification
Operating system	Microsoft Windows, 64-bit only Linux: Ubuntu or openSUSE, 64-bit only macOS, 64-bit only See picotech.com/downloads for information on currently supported versions of these operating systems.
Processor architecture	Intel/AMD (x64), ARM64
Processor, memory, free disk space	As required by the operating system.
Ports	USB 5Gbps (recommended) or Hi-Speed USB (compatible)

The software development kit or driver libraries for all supported operating systems can be found at picotech.com/downloads

The psospa driver offers three different methods of recording data, all of which support USB 5Gbps and legacy Hi-Speed USB. A USB 5Gbps port will offer the best performance especially in streaming mode or when retrieving large amounts of data from the oscilloscope.

2.2 Driver

Your application will communicate with a PicoScope library called psospa. The driver exports the 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 driver names for each supported operating system are listed in the following table:

Windows: `psospa.dll`

macOS: `libpsospa.dylib`

Linux: `libpsospa.so`

The API depends on OS-specific low-level drivers. These drivers are installed by the SDK and configured when you plug the oscilloscope into a USB port for the first time. Your application does not call these drivers directly.

If you want to deploy your application which uses the `psospa` driver on other computer systems, you'll need to include these dependencies in your package / installer or, in the case of Linux systems, list `psospa` as a dependency of your package and ensure the Pico package repository is available on the target system.

2.2.1 Interoperability with different PicoScope models

A program using the `psospa` driver can work with any of the supported PicoScope series listed in the introduction. Each of these devices has differences in features and specifications, defined by its particular PicoScope model. For example, some devices differ in:

- available resolutions
- MSO (mixed-signal oscilloscope) capability
- available bandwidth filter settings.

If you are intending to create a program which works smoothly across multiple PicoScope models within the supported series, we have provided the function psospaGetVariantDetails to make this easier and avoid the need to hard-code lists of PicoScope models and capabilities in your program. It returns the capabilities of each supported device in JSON format, allowing your program to adapt to those features which differ between device models.

2.3 Voltage ranges

You can set a input channel to any available voltage range with the psospaSetChannelOn() function.

The voltage range is chosen by specifying its minimum and maximum range and units, which must correspond to one of the available voltage ranges specified in the data sheet for your oscilloscope.

By default, each sample is scaled as a signed 16-bit integer, regardless of the hardware resolution in use. The minimum and maximum values returned to your application depend on the sampling resolution in use and can be queried by psospaGetAdcLimits(). This function replies with the following values:

Resolution	8 bits	10 bits	16 bits
Voltage	**Value returned**		
maximum	+32 512 (0x7F00)	+32 704 (0x7FC0)	+32 767 (0x7FFF)
zero	0	0	0
minimum	−32 512 (0x8100)	−32 704 (0x8040)	−32 767(0x8001)

Available resolutions vary depending on your PicoScope model.

Example at 8-bit resolution

1. Call psospaSetChannelOn() with arguments:

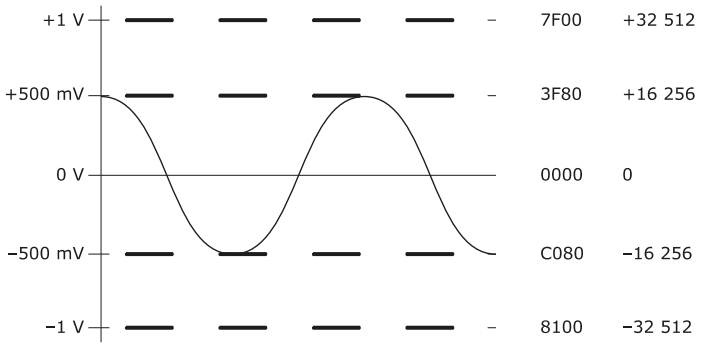
```
rangeMin = −1 000 000 000
rangeMax = +1 000 000 000
rangeType = PICO_PROBE_NONE_NV
```

to select the ±1 V range.

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 below:



Digital inputs:

See psospaSetDigitalPortOn() and psospaSetDigitalPortOff()

2.4 MSO digital data

Applicability

Supported MSO models have two 8-bit digital ports—**PORT0** and **PORT1**—making a total of 16 digital channels.

Use the psospaSetDataBuffer() and psospaSetDataBuffers() functions to set up buffers into which the driver will write data from each port individually. For compatibility with the analog channels, each buffer is an array of 16-bit words. The 8-bit port data occupies the lower 8 bits of the word. The upper 8 bits of the word are undefined.

	PORT0 buffer	PORT1 buffer
$Sample_0$	$[XXXXXXXX,D7...D0]_0$	$[XXXXXXXX,D15...D8]_0$
...	...	...
$Sample_{n-1}$	$[XXXXXXXX,D7...D0]_{n-1}$	$[XXXXXXXX,D15...D8]_{n-1}$

Retrieving stored digital data
The following C code snippet shows how to combine data from the two 8-bit ports into a single 16-bit word, and then how to extract individual bits from the 16-bit word.

```
// Mask Port 1 values to get lower 8 bits
portValue = 0x00ff & sampleFromPort1Buffer;

// Shift by 8 bits to place in upper 8 bits of 16-bit word
portValue <<= 8;

// Mask Port 0 values to get lower 8 bits,
// then OR with shifted Port 1 bits to get 16-bit word
portValue |= 0x00ff & sampleFromPort0Buffer;

for (bit = 0; bit < 16; bit++)
{
  // Shift value 32768 (binary 1000 0000 0000 0000).
  // AND with value to get 1 or 0 for channel.
  // Order will be D15 to D0.

  bitValue = (0x8000 >> bit) & portValue? 1 : 0;
}
```

2.5 Triggering

Your PicoScope 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 functions:

- psospaSetTriggerChannelConditions()
- psospaSetTriggerChannelDirections()
- psospaSetTriggerChannelProperties()
- psospaSetTriggerDigitalPortProperties()

These can be run collectively by calling psospaSetSimpleTrigger(), or singly.

A trigger event can occur when one of the 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 triggering methods, including:

- 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 functions:

- psospaSetPulseWidthQualifierProperties()
- psospaSetPulseWidthQualifierConditions()
- psospaSetPulseWidthQualifierDirections()
- psospaSetPulseWidthDigitalPortProperties()

Additional trigger parameters can be set using the functions:

- psospaSetTriggerDelay()
- psospaSetTriggerHoldoffCounterBySamples()

2.6 Sampling modes

Your PicoScope 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 downsampling 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.

  The driver can return data asynchronously using a callback, which 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.

  If you do not wish to use a callback, you can poll the driver instead.

- **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 downsampling in this mode if you wish.
- **Streaming mode.** This mode enables long periods of data collection. In raw mode (no downsampling) it provides fast data transfer of unlimited amounts of data at up to 312 MB/s (3.2 ns per sample) in 8-bit mode with USB 5Gbps.

  If downsampling is enabled, raw data can be sampled at up to 1 GS/s for a single channel in 8-bit mode. Downsampled data is returned while capturing is in progress, at up to 312 MB/s. The raw data can then be retrieved after the capture is complete. The number of raw samples is limited by the memory available on the device, the selected resolution and the number of channels enabled.

2.6.1 Block mode

In **block mode**, the computer prompts your PicoScope 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.

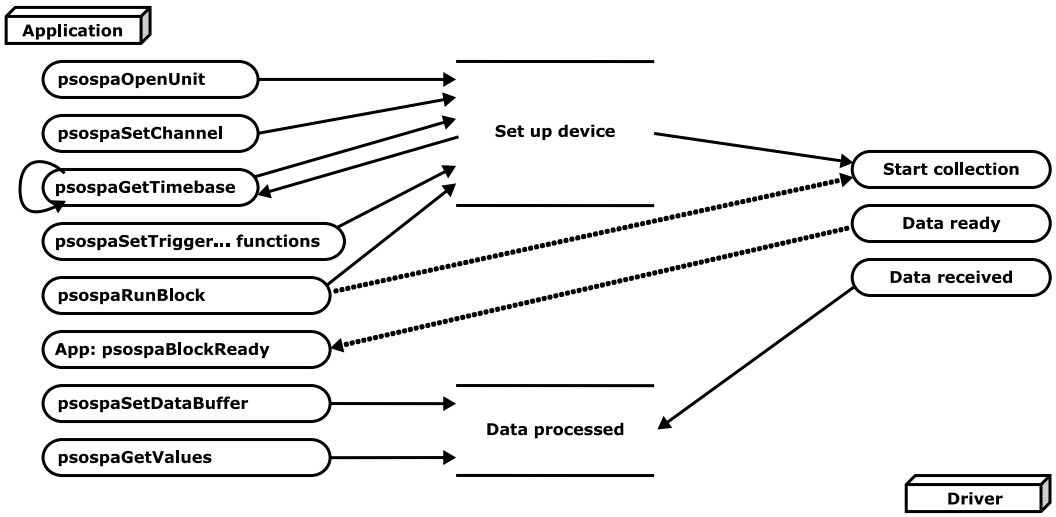
- **Block size.** The maximum number of values depends upon the size of the oscilloscope's memory. The memory buffer is shared between the enabled channels, so if two channels are enabled, each receives half the memory. These features are handled transparently by the driver. The block size also depends on the number of memory segments in use (see `psospaMemorySegments()`) and the sampling resolution.
- **Sampling rate.** PicoScope devices can sample at a number of different rates according to the selected timebase and the combination of channels that are enabled. See the *PicoScope 3000E Series Data Sheet* or the PicoScope 5000E Series Data Sheet for the specifications that apply to your scope model.
- **Setup time.** The driver normally performs a number of setup operations, which can take tens of 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 `psospaRunBlock()`, `psospaStop()` and `psospaGetValues()`.
- **Downsampling.** When the data has been collected, you can set an optional downsampling factor and examine the data. Downsampling is a process that reduces the amount of data by combining adjacent samples. 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 `psospaMemorySegments()` or `psospaMemorySegmentsBySamples()`.
- **Data retention.** The data is lost when a new run is started in the same segment, the settings are changed, or the scope is powered down.

See Using block mode for programming details.

2.6.1.1 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 psospaOpenUnit().
2. Select channel ranges and AC/DC/50 Ω coupling using psospaSetChannelOn() and psospaSetChannelOff().
3. Use psospaNearestSampleIntervalStateless() to get the closest valid sample interval to the requested.
4. Use the trigger setup functions psospaSetTriggerChannelConditions(), psospaSetTriggerChannelDirections(), psospaSetTriggerChannelProperties() or psospaSetSimpleTrigger() to set up the trigger if required.
5. Start the oscilloscope running using psospaRunBlock().
6. Wait until the oscilloscope is ready using the psospaBlockReady() callback (or poll using psospaIsReady()).
7. Use psospaSetDataBuffer() to tell the driver where your memory buffer is. For greater efficiency with multiple captures, you can do this outside the loop after step 4.
8. Transfer the block of data from the oscilloscope using psospaGetValues().
9. Display or process the data.
10. Repeat steps 5 to 9.
11. Stop the oscilloscope using psospaStop().
12. Request new views of stored data using different downsampling parameters: see Retrieving stored data.
13. Close the device using psospaCloseUnit().



2.6.1.2 Asynchronous calls in block mode

psospaGetValues() may take a long time to complete if a large amount of data is being collected. To avoid blocking the calling thread, it is possible to call psospaGetValuesAsync() instead. This immediately returns control to the calling thread, which then has the option of waiting for the data or calling psospaStop() to abort the operation.

2.6.2 Rapid block mode

In normal block mode, PicoScopes 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 less than 1 microsecond.

See Using rapid block mode for details.

2.6.2.1 Using rapid block mode

You can use **rapid block mode** with or without aggregation. With aggregation, you need to set up two buffers for each channel, to receive the minimum and maximum values.

Without aggregation

1. Open the oscilloscope using `psospaOpenUnit()`.
2. Select channel ranges and AC/DC coupling using `psospaSetChannelOn()` and `psospaSetChannelOff()`.
3. Use `psospaNearestSampleIntervalStateless()`, to find a valid sampling interval to use.
4. Use the trigger setup functions `psospaSetTriggerChannelConditions()`, `psospaSetTriggerChannelDirections()`, `psospaSetTriggerChannelProperties()` and `psospaSetSimpleTrigger()` to set up the trigger if required.
5. Start the oscilloscope running using `psospaRunBlock()`.
6. Wait until the oscilloscope is ready using the `psospaBlockReady()` callback.
7. Use `psospaSetDataBuffer()` 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 with multiple captures, you could do this outside the loop after step 4.
8. Transfer the blocks of data from the oscilloscope using `psospaGetValuesBulk()`.
9. Display or process the data.
10. Repeat steps 5 to 9 if necessary.
11. Stop the oscilloscope using `psospaStop()`.
12. Close the device using `psospaCloseUnit()`.

With aggregation

To use rapid block mode with aggregation, follow steps 1 to 6 above and then proceed as follows:

7a. Call `psospaSetDataBuffers()` to set up one pair of buffers for every waveform segment required.

8a. Call `psospaGetValuesBulk()` for each pair of buffers.

Continue from step 9 above.

2.6.2.2 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 number of captures required)

```
// set the number of waveforms to MAX_WAVEFORMS
psospaSetNoOfCaptures(handle, MAX_WAVEFORMS);

psospaRunBlock
(
  handle,
  0,                  // noOfPreTriggerSamples
  10000,              // noOfPostTriggerSamples
  400,                // sample interval in picoseconds
  &timeIndisposedMs,
  0,                  // first segment index to capture
  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);

PICO_ACTION action = PICO_CLEAR_ALL | PICO_ADD;
int32_t first_segment_to_read = 10;

for (int32_t i = 0; i < 10; i++)
{
  for (int32_t c = PICO_CHANNEL_A; c <= PICO_CHANNEL_D; c++)
  {
    psospaSetDataBuffer
    (
      handle,
      c,
      buffer[c][i],
      MAX_SAMPLES,
      PICO_INT16_T,
      first_segment_to_read + i,
      PICO_RATIO_MODE_RAW,
      action
    );
    action = PICO_ADD;
  }
}
```

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`. Only 10 buffers are set, but it is possible to set up to the number of captures you have requested.

```
psospaGetValuesBulk
(
  handle,
  0,                      // startIndex
  &noOfSamples,           // set to MAX_SAMPLES on entering the function
  10,                     // fromSegmentIndex
  19,                     // toSegmentIndex
  1,                      // downsampling ratio
```



```
    PICO_RATIO_MODE_RAW,      // downsampling ratio mode
    overflow                  // indices 0 to 9 will be populated (index always
      starts from 0)
  )
```

Comments: the number of samples could be up to `noOfPreTriggerSamples + noOfPostTriggerSamples`, the values set in `psospaRunBlock()`. The samples are returned starting from the sample index. This function does not support aggregation. The above segments start at 10 and finish at 19 inclusive. It is possible for `fromSegmentIndex` to wrap around to `toSegmentIndex`, for example by setting `fromSegmentIndex` to 98 and `toSegmentIndex` to 7.

2.6.2.3 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 number of captures required)

```
// set the number of waveforms to MAX_WAVEFORMS
psospaSetNoOfCaptures(handle, MAX_WAVEFORMS);

pParameter = false;
psospaRunBlock
(
  handle,
  0,                // noOfPreTriggerSamples,
  1000000,          // noOfPostTriggerSamples,
  400,              // sample interval in picoseconds,
  &timeIndisposedMs,
  0,                // first segment index to be captured,
  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.

```
PICO_ACTION action = PICO_CLEAR_ALL | PICO_ADD;

for (int32_t c = PICO_CHANNEL_A; c <= PICO_CHANNEL_D; c++)
{
  psospaSetDataBuffers
  (
    handle,
    c,
    bufferMax[c],
    bufferMin[c]
    MAX_SAMPLES,
    PICO_INT16_T,
    0,
    PICO_RATIO_MODE_AGGREGATE,
    action
  );
  action = PICO_ADD;
}
```

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++)
{
  psospaGetValues
```



```
    (
      handle,
      0,
      &noOfSamples,          // set to MAX_SAMPLES on entering
      1000,
      &downSampleRatioMode, // set to RATIO_MODE_AGGREGATE
      index,
      overflow
    );
  }
```

Comments: each waveform is retrieved one at a time from the driver with an aggregation of 1000. Alternatively, it would be equally valid to use psospaGetValuesBulk() to retrieve multiple waveforms at once as shown in the previous example.

2.6.3 Streaming mode

Streaming mode can capture data without the gaps that occur between blocks when using block mode. This makes it suitable for **high-speed data acquisition**, allowing you to capture long data sets limited only by the computer's memory. (At the highest sampling rates, the size of the device's capture buffer may limit the capture size.)

The device can return either raw or downsampled data to your application while streaming is in progress. When downsampled data is returned, the raw samples remain stored on the device and can be read after streaming is completed.

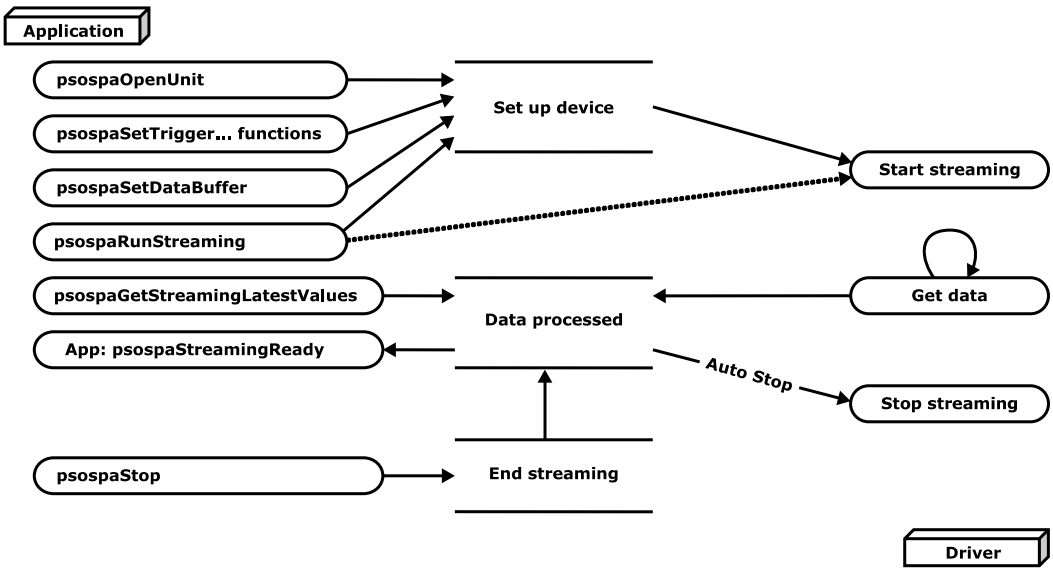
- **Downsampling.** The driver can return either raw or downsampled data. You should set up the number of buffers needed to accept the requested data. Aggregation requires two buffers, one for the minimum values and one for the maximum values. Other downsampling modes require only a single buffer.

See Using streaming mode for programming details.

2.6.3.1 Using streaming mode

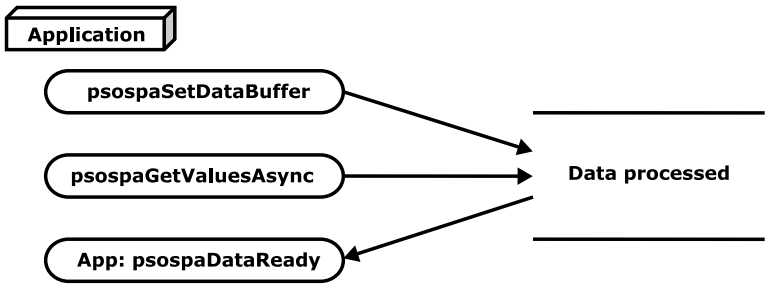
This is the general procedure for reading and displaying data in streaming mode using a single memory segment:

1. Open the oscilloscope using psospaOpenUnit().
2. Select channels, ranges and AC/DC/50 Ω coupling using psospaSetChannelOn() and psospaSetChannelOff().
3. Use psospaNearestSampleIntervalStateless() to get the closest valid sample interval to the requested.
4. Use the trigger setup functions psospaSetTriggerChannelConditions(), psospaSetTriggerChannelDirections(), psospaSetTriggerChannelProperties() or psospaSetSimpleTrigger() to set up the trigger if required.
5. Call psospaSetDataBuffer() to tell the driver where your data buffer is.
6. Set up aggregation and start the oscilloscope running using psospaRunStreaming().
7. Call psospaGetStreamingLatestValues() to get data. If the function runs out of buffer space, call psospaSetDataBuffer() again to provide more buffers. You can provide the same buffer repeatedly, if you have finished processing the data already in the buffer before resubmitting it for further samples.
8. 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.
9. Call psospaStop(), even if autoStop is enabled.
10. Request new views of stored data using different downsampling parameters: see Retrieving stored data.
11. Close the device using psospaCloseUnit().



2.6.4 Retrieving stored data

You can retrieve data from the psospa driver with a different downsampling factor when psospaRunBlock() or psospaRunStreaming() has already been called and has successfully captured all the data. Use psospaGetValuesAsync().



2.7 Timebases

The available sample intervals for PicoScopes are multiples of the minimum sampling interval for the chosen resolution and number of enabled channels. Not all possible sample intervals are supported, therefore you can use psospaNearestSampleIntervalStateless to determine the nearest valid sample interval to your requirements.

In block mode, the timebase argument passed to psospaRunBlock directly represents the required sample interval in picoseconds. In streaming mode, the sample interval is specified using the sampleInterval and sampleIntervalTimeUnits arguments to psospaRunStreaming.

Applicability	Calls to psospaGetTimebase()

Notes

1. The maximum possible sampling rate depends on the selected resolution, the number of enabled channels and on the sampling mode. Please refer to the data sheet for details.
2. In streaming mode, the speed of the USB port may affect the rate of data transfer.

2.8 Combining several oscilloscopes

It is possible to collect data using up to 64 supported PicoScopes at the same time, depending on the capabilities of the PC. Each oscilloscope must be connected to a separate USB port. The psospaOpenUnit() 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 psospaBlockReady(...)
// define callback function specific to application

handle1 = psospaOpenUnit()
handle2 = psospaOpenUnit()

psospaSetChannelOn(handle1)
// set up unit 1
psospaRunBlock(handle1)

psospaSetChannelOn(handle2)
// set up unit 2
psospaRunBlock(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: a trigger may be fed into the **Aux Trig (AUX I/O)** input to provide some degree of synchronization between multiple oscilloscopes.

3 API functions

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

3.1 psospaCheckForUpdate - check if firmware update is available

```
PICO_STATUS psospaCheckForUpdate
(
  int16_t              handle,
  PICO_FIRMWARE_INFO * firmwareInfos,
  int16_t            * nFirmwareInfos,
  uint16_t           * updatesRequired
)
```

This function checks whether a firmware update for the device is available. Firmware updates, when required, are distributed as part of the driver library and this function checks whether the currently-running driver contains more up-to-date firmware than that on the connected device.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`firmwareInfos`, a pointer to a buffer of `PICO_FIRMWARE_INFO` structs which, on exit, will be populated with detailed information about the available updates. Information about firmware which is already up to date will also be provided. You may pass NULL if you do not require the detailed information.

`nFirmwareInfos`, on entry, a pointer to a value which is the length of the `firmwareInfos` buffer, if `firmwareInfos` is not NULL. On exit, the number of populated entries in `firmwareInfos` (or the available number of `PICO_FIRMWARE_INFOs` if `firmwareInfos` is NULL). May be NULL if the caller does not need detailed firmware information (in which case `firmwareInfos` must also be NULL).

`updatesRequired`, on entry, a pointer to a flag which will be set by the function to indicate if updates are required. On exit, 1 if updates are required and 0 otherwise.

Returns

`PICO_OK`

3.2 psospaCloseUnit - close a scope device

```
PICO_STATUS psospaCloseUnit
(
  int16_t    handle
)
```

This function shuts down a supported PicoScope. Closing the unit correctly after use returns it to a low-power state, turning off the fan and LED indicators, and leaves it in a known state ready to be re-opened when required.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

Returns

`PICO_OK`

3.3 psospaCommitCurrentAdjustmentSettingsToDevice

```
PICO_STATUS psospaCommitCurrentAdjustmentSettingsToDevice
(
  int16_t                 handle,
  PICO_CAL_TYPE           calType
)
```

Commits the current user adjustment settings created by psospaRunAutomaticOffsetAdjustment to the device , along with the current system date and any identifying strings set via psospaSetAdjustmentSettingDetails. This produces a checksum and a hash for the current settings and saves them to the device's non-volatile memory.

The hash can be read with psospaGetAdjustmentSettingDetails and used to verify that the settings have been committed to the device and have not been tampered with.

See psospaRunAutomaticOffsetAdjustment for more information on the user offset adjustment process.

Applicability

All modes

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`calType,` the type of calibration to write the data from the adjustment to. Currently it must be set to `PICO_USER_CAL`, all other values are reserved.

Returns

`PICO_OK`
`PICO_NOT_SUPPORTED_BY_THIS_DEVICE,` when the `PICO_CAL_TYPE` requested is not supported.
`PICO_INVALID_HANDLE,` when the handle used is not in use.
`PICO_DRIVER FUNCTION,` if there is another API call currently being processed by the driver.
`PICO_INTERNAL_ERROR,` if there is an unknown failure in the driver or device upon attempting to write the data down to the device.

3.4 psospaEnumerateUnits - get a list of unopened units

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

This function counts the number of PicoScope units, supported by the psospa driver, connected to the computer and returns a list of serial numbers and other optional information as a string. Note that this function can only detect devices that are not yet being controlled by an application. To query opened devices, use psospaGetUnitInfo().

Applicability

All modes

Arguments

count, on exit, the number of PicoScope units found.

serials, if an empty string on entry, serials is populated on exit with a list of serial numbers separated by commas and terminated by a final null. Example:

```
AQ005/139,VDR61/356,ZOR14/107
```

On entry, serials can optionally contain the following parameter(s) to request information:

- -v : model number
- -c : calibration date
- -h : hardware version
- -u : USB version
- -f : firmware version

Example (any separator character can be used):

```
-v:-c:-h:-u:-f
```

On exit, with all the above parameters specified, each serial number has the requested information appended in the following format:

```
10001/0001[3418E,01Jun24,769,2.0,1.7.16.0]
```

serials can be NULL if device information or serial numbers are not required.

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
PICO_BUSY
PICO_NULL_PARAMETER
PICO_FW_FAIL
PICO_CONFIG_FAIL
PICO_CONFIG_FAIL_AWG
PICO_INITIALISE_FPGA

3.5 psospaGetAdcLimits - get min and max sample values

```
PICO_STATUS psospaGetAdcLimits
(
  int16_t                  handle,
  PICO_DEVICE_RESOLUTION   resolution,
  int16_t                * minValue,
  int16_t                * maxValue
)
```

This function gets the maximum and minimum sample values that the ADC can produce at a given resolution. These values can be used to scale the returned sample values from the driver into voltages, using the full-scale voltage of the current input range.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`resolution`, the vertical resolution about which you require information.

`minValue`, the minimum sample value.

`maxValue`, the maximum sample value.

Returns

`PICO_OK`

`PICO_NULL_PARAMETER`, if both `maxValue` and `minValue` are `NULL`.

3.6 psospaGetAdjustmentSettingDetails

```
PICO_STATUS psospaGetAdjustmentSettingDetails
(
  int16_t                handle,
  PICO_CAL_TYPE          calType,
  int8 *                 detailsString,
  int32 *                stringLength,
  PICO_TEXT_FORMAT       textFormat
)
```

Retrieves details of any current user offset adjustment settings set using psospaSetAdjustmentSettingDetails. The settings are in JSON format, which includes the name and address strings, as well as the commit date and hash of the current settings. The JSON details the adjustment settings currently cached in the driver, which may not match the data on the device if adjustment settings have been created or reset in this session and not yet committed. If the device has different data then the Hash field in the JSON will read "Must commit calibration to the device to generate a hash".

Calling this method with a null pointer for the string will allow you to get the required length of the string to then fetch the details with a correctly sized buffer.

See psospaRunAutomaticOffsetAdjustment for more information on the user offset adjustment process.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`calType`, the type of calibration to retrieve details for. Currently it must be `PICO_USER_CAL`

`detailsString`, pointer to a buffer to receive the details string.

`stringLength`, pointer to an `int32_t` containing the length of the string buffer. Should include the null terminator.

`textFormat`, Specifies type of data returned. It must be `PICO_JSON_DATA`.

Returns

`PICO_OK`
`PICO_NULL_PARAMETER`, if the length of a requested string is null.
`PICO_INVALID_PARAMETER`, if the length provided is too small.

3.7 psospaGetAnalogueOffsetLimits - get analog offset information

```
PICO_STATUS psospaGetAnalogueOffsetLimits
(
  int16_t                    handle,
  int64_t                    rangeMin,
  int64_t                    rangeMax,
  PICO_PROBE_RANGE_INFO      rangeType,
  PICO_COUPLING              coupling,
  double                   * maximumVoltage,
  double                   * minimumVoltage
)
```

This function is used to get the maximum and minimum allowable analog offset for a specific voltage range.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`rangeMin`, `rangeMax`, `rangeType`, the voltage range for which scaling factors are required. See `psospaSetChannelOn()`.

`coupling`, the type of AC/DC/50 Ω coupling used

`maximumVoltage`, on output, the maximum (most positive) analog offset voltage allowed for the range. Set to `NULL` if not required.

`minimumVoltage`, on output, the minimum (most negative) analog offset voltage allowed for the range. Set to `NULL` if not required.

Returns

`PICO_OK`
`PICO_INVALID_VOLTAGE_RANGE`, the device doesn't support the requested voltage range.
`PICO_NULL_PARAMETER`, if both `maximumVoltage` and `minimumVoltage` are `NULL`.
`PICO_INVALID_COUPLING`

3.8 psospaGetAutoTriggerStatus - check if capture was triggered by a real event or by the auto trigger

```
PICO_STATUS psospaGetAutoTriggerStatus
(
  int16_t                    handle,
  PICO_AUTO_TRIGGER_STATUS * autoTriggerStatus
  uint64_t                   firstSegmentIndex,
  uint64_t                   segmentCount
)
```

This function retrieves information about the auto trigger status once the capture has completed for one or more buffer segments. Call this function after data has been captured or when data has been retrieved from a previous capture.

Applicability

All modes

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`* autoTriggerStatus,` a list of values, one for each buffer segment, containing auto trigger status.

`firstSegmentIndex,` the index of the first segment of interest.

`segmentCount,` the number of segments of interest. Must be equal to (or less than) the number of values in `*autoTriggerStatus`

Returns

`PICO_OK`
`PICO_INVALID_HANDLE`
`PICO_TOO_MANY_SAMPLES`
`PICO_INVALID_PARAMETER`
`PICO_SEGMENT_NOT_USED`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_HARDWARE_CAPTURING_CALL_STOP`
`PICO_DRIVER_FUNCTION`

3.8.1 PICO_AUTO_TRIGGER_STATUS enumerated type

```
typedef enum enPicoAutoTriggerStatus
{
  PICO_TRIGGER_NOT_SET = 0,
  PICO_REAL_TRIGGER = 1,
  PICO_AUTO_TRIGGER = 2,
} PICO_AUTO_TRIGGER_STATUS;
```

Definitions

PICO_TRIGGER_NOT_SET, no trigger was enabled when this segment was captured.

PICO_REAL_TRIGGER, this segment was triggered by an event in the input signal matching the trigger conditions.

PICO_AUTO_TRIGGER, this segment was triggered by the auto-trigger timeout elapsing without a trigger event in the input signal having been detected.

3.9 psospaGetDeviceResolution – retrieve the device resolution

```
PICO_STATUS psospaGetDeviceResolution
(
  int16_t                 handle,
  PICO_DEVICE_RESOLUTION * resolution
)
```

This function retrieves the currently selected vertical resolution of the oscilloscope.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`resolution`, on exit, the resolution of the device.

Returns

`PICO_OK`
`PICO_NULL_PARAMETER`

3.10 psospaGetMaximumAvailableMemory - find max memory at a given resolution

```
PICO_STATUS psospaGetMaximumAvailableMemory
(
  int16_t                  handle,
  uint64_t               * nMaxSamples,
  PICO_DEVICE_RESOLUTION   resolution
)
```

This function returns the maximum number of samples that can be stored at a given hardware resolution.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`nMaxSamples`, on exit, the number of samples.

`resolution`, the resolution as one of the `PICO_DEVICE_RESOLUTION` enum values.

Returns

`PICO_OK`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_NULL_PARAMETER`
`PICO_INVALID_PARAMETER`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_TOO_MANY_SAMPLES`

3.11 psospaGetMinimumTimebaseStateless - find fastest available timebase

```
PICO_STATUS psospaGetMinimumTimebaseStateless
(
  int16_t                  handle,
  PICO_CHANNEL_FLAGS       enabledChannelFlags,
  uint32_t               * timebase,
  double                 * timeInterval,
  PICO_DEVICE_RESOLUTION   resolution
)
```

This function returns the shortest timebase that could be selected with a proposed configuration of the oscilloscope. It does not set the oscilloscope to the proposed configuration.

Applicability

All modes

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`enabledChannelFlags,` a bit field indicating which channels are enabled in the proposed configuration. Channel A is bit 0 and so on.

`timebase,` on exit, the number of the shortest timebase possible with the proposed configuration, in picoseconds.

`timeInterval,` on exit, the sample period in seconds corresponding to `timebase`.

`resolution,` the vertical resolution in the proposed configuration.

Returns

`PICO_OK`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_NULL_PARAMETER`
`PICO_INVALID_PARAMETER`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_TOO_MANY_SAMPLES`
`PICO_NO_CHANNELS_OR_PORTS_ENABLED`
`PICO_INVALID_DIGITAL_PORT`

3.12 psospaGetNoOfCaptures - query how many captures made

```
PICO_STATUS psospaGetNoOfCaptures
(
  int16_t     handle,
  uint64_t  * nCaptures
)
```

This function returns the number of captures collected in one run of rapid block mode. You can call this function during device capture, after collection has completed or after interrupting waveform collection by calling psospaStop().

The returned value (nCaptures) can then be used to iterate through the number of segments using psospaGetValues(), or in a single call to psospaGetValuesBulk() where it is used to calculate the toSegmentIndex parameter.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

nCaptures, on output, the number of available captures that have been collected from calling psospaRunBlock().

Returns

PICO_OK
PICO_NO_SAMPLES_AVAILABLE
PICO_NULL_PARAMETER
PICO_INVALID_PARAMETER
PICO_SEGMENT_OUT_OF_RANGE
PICO_TOO_MANY_SAMPLES

3.13 psospaGetNoOfProcessedCaptures - query how many captures processed

```
PICO_STATUS psospaGetNoOfProcessedCaptures
(
  int16_t     handle,
  uint64_t  * nProcessedCaptures
)
```

This function gets the number of captures collected and processed in one run of rapid block mode. It enables your application to start processing captured data while the driver is still transferring later captures from the device to the computer.

The function returns the number of captures the driver has processed since you called psospaRunBlock(). It is for use in rapid block mode, alongside the psospaGetValuesOverlapped() function, when the driver is set to transfer data from the device automatically as soon as the psospaRunBlock() function is called. You can call psospaGetNoOfProcessedCaptures() during device capture, after collection has completed or after interrupting waveform collection by calling psospaStop().

The returned value (nProcessedCaptures) can then be used to iterate through the number of segments using psospaGetValues(), or in a single call to psospaGetValuesBulk(), where it is used to calculate the toSegmentIndex parameter.

When capture is stopped
If nProcessedCaptures = 0, you will also need to call psospaGetNoOfCaptures(), in order to determine how many waveform segments were captured, before calling psospaGetValues() or psospaGetValuesBulk().

Applicability

Rapid block mode

Arguments

handle, the device identifier returned by psospaOpenUnit().

nProcessedCaptures, on exit, the number of waveforms captured and processed.

Returns

PICO_OK
PICO_INVALID_PARAMETER

3.14 psospaGetScalingValues - get gain and offset scaling factors for oscilloscope data

```
PICO_STATUS psospaGetScalingValues
(
  int16_t                                          handle,
  PICO_SCALING_FACTORS_FOR_RANGE_TYPES_VALUES * scalingValues,
  int16_t                                          nChannels
)
```

This function is included for compatibility with other PicoScope series and will always return zero offset and unity scaling factor.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`scalingValues`, an array of `PICO_SCALING_FACTORS_FOR_RANGE_TYPES_VALUES` indicating the channels and ranges for which to retrieve scaling factors.

`nChannels`, the number of elements in the `scalingValues` array.

Returns

`PICO_OK`
`PICO_NULL_PARAMETER`
`PICO_ARGUMENT_OUT_OF_RANGE`

3.14.1 PICO_SCALING_FACTORS_FOR_RANGE_TYPES_VALUES structure

```
typedef struct tPicoScalingFactorsForRangeTypes
{
  PICO_CHANNEL              channel;
  int64_t                   rangeMin;
  int64_t                   rangeMax;
  PICO_PROBE_RANGE_INFO     rangeType;
  int16_t                   offset;
  double                    scalingFactor
}
PICO_SCALING_FACTORS_FOR_RANGE_TYPES_VALUES;
```

This structure contains information needed to convert the source data to a measurement in volts.

Applicability

Calls to `psospaGetScalingValues()`.

Elements

`source`, the channel or port to which the information applies.

`rangeMin, rangeMax, rangeType,` the voltage range for which scaling factors are required. See `psospaSetChannelOn()`.

`offset`, the offset applied to the specified channel or port.

`scalingFactor`, the number that the specified channel or port has been multiplied by.

3.15 psospaGetStreamingLatestValues - read streaming data

```
PICO_STATUS psospaGetStreamingLatestValues
(
  int16_t                            handle,
  PICO_STREAMING_DATA_INFO         * streamingDataInfo,
  uint64_t                           nStreamingDataInfos,
  PICO_STREAMING_DATA_TRIGGER_INFO * triggerInfo
)
```

This function populates the `streamingDataInfo` structures with a description of the samples available and the `triggerInfo` structure to indicate that a trigger has occurred and at what location.

`streamingDataInfo` should point to an array of structures, one per combination of enabled channel, downsampling mode and data type, to determine how many samples are available for that combination. For example, if you have enable two channels with both raw data and min-max aggregation, the array should contain four structures. The number of available samples at a given instant may not be the same for each channel due to the way samples are processed in blocks. If your application requires the same number of samples on each channel, process the minimum number of samples reported by any channel. The later samples remain in the buffer and can be processed on the next call.

Applicability

Streaming mode only

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`streamingDataInfo`, a list of structures. See `PICO_STREAMING_DATA_INFO`.

`nStreamingDataInfos`, the number of structures in the `streamingDataInfo` list.

`triggerInfo`, a structure containing trigger information. See `PICO_STREAMING_DATA_TRIGGER_INFO`.

Returns	`PICO_OK` `PICO_WAITING_FOR_DATA_BUFFERS` - indicates that you need to call `psospaSetDataBuffer()` again as the previously supplied buffers have been filled. Note this return status does not mean the call has failed: if the `streamingDataInfo` structures indicate a non-zero number of samples (completing the previous buffer) then these are still valid data which should be read by the user.

3.15.1 PICO_STREAMING_DATA_INFO

A list of structures of this type is passed to psospaGetStreamingLatestValues() in the streamingDataInfo argument to specify parameters for streaming mode data capture. It is defined as follows:

```
typedef struct tPicoStreamingDataInfo
{
  PICO_CHANNEL    channel_;
  PICO_RATIO_MODE mode_;
  PICO_DATA_TYPE  type_;
  int32_t         noOfSamples_;
  uint64_t        bufferIndex_;
  int32_t         startIndex_;
  int16_t         overflow_;
} PICO_STREAMING_DATA_INFO;
```

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

Elements

Set by the user:

channel_, the oscilloscope channel that the parameters apply to.

mode_, the downsampling mode to use.

type_, the data type to use for the sample data.

Set by driver when the function returns:

noOfSamples_, the number of samples made available by the driver.

bufferIndex_, an index to the waveform buffer within the capture buffer.

startIndex_, an index to the starting sample within the specified waveform buffer.

overflow_, a flag indicating whether a sample value overflowed (1) or not (0).

3.15.2 PICO_STREAMING_DATA_TRIGGER_INFO

A structure of this type is returned by psospaGetStreamingLatestValues() in the triggerInfo argument to return information about trigger events.

```
typedef struct tPicoStreamingDataTriggerInfo
{
  uint64_t  triggerAt_;
  int16_t   triggered_;
  int16_t   autoStop_;
} PICO_STREAMING_DATA_TRIGGER_INFO;
```

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

Elements

triggerAt_, an index to the sample on which the trigger occurred.

triggered_, a flag indicating whether a trigger occurred (1) or did not occur (0).

autoStop_, a flag indicating whether the oscilloscope has stopped capturing due to autoStop being set and the requested number of samples having been collected (1) or not (0).

3.16 psospaGetTimebase - get available timebases

```
PICO_STATUS psospaGetTimebase
(
  int16_t     handle,
  uint32_t    timebase,
  uint64_t    noSamples,
  double    * timeIntervalNanoseconds,
  uint64_t  * maxSamples
  uint64_t    segmentIndex
)
```

This function calculates the sampling rate and maximum number of samples for a given timebase under the specified conditions. The result will depend on the number of channels enabled by the last call to psospaSetChannelOn() or psospaSetChannelOff().

The easiest way to find a suitable timebase is to call psospaNearestSampleIntervalStateless(). Alternatively, you can estimate the timebase number that you require, representing a desired sample interval in picoseconds, then pass this timebase to psospaGetTimebase() and check the returned timeIntervalNanoseconds argument. Repeat until you obtain the time interval that you need.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

timebase, in picoseconds, see timebase guide.

noSamples, the number of samples required. This value is used to calculate the most suitable time interval.

timeIntervalNanoseconds, on exit, the time interval between readings at the selected timebase. Use NULL if not required.

maxSamples, on exit, 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, and the timebase chosen. Use NULL if not required.

segmentIndex, the index of the memory segment to use.

Returns

PICO_OK
PICO_TOO_MANY_SAMPLES
PICO_INVALID_CHANNEL
PICO_INVALID_TIMEBASE
PICO_INVALID_PARAMETER
PICO_SEGMENT_OUT_OF_RANGE
PICO_NO_CHANNELS_OR_PORTS_ENABLED

3.17 psospaGetTriggerInfo - get trigger timing information

```
PICO_STATUS psospaGetTriggerInfo
(
  int16_t              handle
  PICO_TRIGGER_INFO  * triggerInfo,
  uint64_t             firstSegmentIndex,
  uint64_t             segmentCount
)
```

This function gets trigger timing information from one or more buffer segments.

Call this function after data has been captured or when data has been retrieved from a previous capture.

Applicability

Block mode, rapid block mode

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`triggerInfo`, a list of structures, one for each buffer segment, containing trigger information.

`firstSegmentIndex`, the index of the first segment of interest.

`segmentCount`, the number of segments of interest. Must be equal to (or less than) the number of structures in `*triggerInfo`.

Returns

`PICO_OK`
`PICO_DEVICE_SAMPLING`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_NULL_PARAMETER`
`PICO_NO_SAMPLES_AVAILABLE`

3.17.1 PICO_TRIGGER_INFO - structure

A list of structures of this type containing trigger information is written by psospaGetTriggerInfo() to the triggerInfo location. The structure is defined as follows:

```
typedef struct tPicoTriggerInfo
{
  PICO_STATUS       status;
  uint64_t          segmentIndex;
  uint64_t          triggerIndex;
  double            triggerTime;
  PICO_TIME_UNITS   timeUnits;
  uint64_t          missedTriggers;
  uint64_t          timeStampCounter;
} PICO_TRIGGER_INFO;
```

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

Elements

status, indicates success or failure. This value may be the logical OR of multiple status values:

PICO_DEVICE_TIME_STAMP_RESET, the time stamp per waveform segment has been reset.

PICO_TRIGGER_TIME_NOT_REQUESTED, when requesting the psospaGetTriggerTimeOffset the trigger time has not been set as described under triggerTime below.

PICO_TRIGGER_TIME_BUFFER_NOT_SET, trigger time buffer not set (see below).

PICO_TRIGGER_TIME_FAILED_TO_CALCULATE, the trigger time failed to be calculated.

For example the value 0x03000001 is a combination of:

PICO_DEVICE_TIME_STAMP_RESET bit or'ed with PICO_TRIGGER_TIME_NOT_REQUESTED

segmentIndex, the number of the segment.

triggerIndex, the index of the sample at which the trigger ocurred.

triggerTime, the time at which the trigger occurred. This is interpolated to greater precision than one sample interval, using adjacent sample values. triggerTime is only available when trigger data has been requested from the oscilloscope either by using PICO_RATIO_MODE_TRIGGER with psospaGetValues() or its comparable bulk or async versions, or by using PICO_RATIO_MODE_TRIGGER_DATA_FOR_TIME_CALCULATION with psospaGetValuesOverlapped(). See Retrieving interpolated trigger times for more information. Otherwise, status includes the value PICO_TRIGGER_TIME_NOT_REQUESTED and the triggerTime is zero.

timeUnits, the unit multiplier to use with triggerTime.

`missedTriggers`, the number of trigger events, if any, detected since the trigger point of the previous segment. The trigger circuit is constantly counting events, regardless of whether the trigger is armed, so this includes events which may have occurred during the post-trigger time of the previous capture, or the pre-trigger time of the current capture, or in the "dead time" between captures (trigger re-arm time). By dividing `missedTriggers` by the `timeStampCounter` difference between the previous and current capture, you can calculate the input signal frequency even if this is faster than the scope's trigger re-arm time.

`timeStampCounter`, the time in samples from the first capture to the current capture. See Time stamping.

3.17.2 Time stamping

The `timeStampCounter` parameter in the `PICO_TRIGGER_INFO` structure allows you to determine the time interval between the trigger points of consecutive captures with the same settings, in block or rapid block mode. Only events causing the scope to trigger are timestamped. Additional trigger events occurring within a capture or in the trigger rearm time between captures cannot be timestamped.

To get the offset between the respective segment trigger points, in sample intervals at the current timebase, subtract the `timeStampCounter` for each segment from the previous segment's timestamp. The timestamps are accurate to one sample interval at the current timebase.

The timestamp of the first segment captured after changing any scope settings is arbitrary, and is only provided to allow you to calculate the offset of subsequent segments. The timestamp counter may either maintain or reset its value when scope settings are changed, and your code must not rely on particular behavior in this respect but should instead check the status code.

The status code returned for each segment indicates whether the timestamp is valid. For example, if you set up 10 segments in memory and then carry out two rapid block runs of 5 captures each, the status codes for segments 0 and 5 may have the bit-flag `PICO_DEVICE_TIME_STAMP_RESET` set, if you changed any settings since the previous run, indicating that the timestamp for that segment is arbitrary. The other segments will not have this flag set, indicating that the timestamp is valid and can be used to determine the time offset from the previous segment. `PICO_DEVICE_TIME_STAMP_RESET` is a bit-flag so may be masked with any other status flag that relates to that segment.

You can convert the intervals between segments from sample counts to time intervals if required. The current sample interval can be found by using the timebase that was passed to `psospaRunBlock` in conjunction with `psospaGetTimebase`.

`timeStampCounter` is a 56-bit unsigned value and will eventually wrap around. Your code must handle this correctly, for example by masking the results of any arithmetic to the lower 56 bits. If the timestamp wraps around more than once between two adjacent segments, this cannot be detected. This will only happen if the interval between two adjacent trigger events exceeds 100 days (at the fastest timebase, or longer for slower timebases), so is unlikely to be a concern in practical applications. Note that calculating the time offset between adjacent segments, rather than to the first segment, reduces the complexity of dealing with wraparounds.

3.17.3 Retrieving interpolated trigger times

The `triggerTime` field in the PICO_TRIGGER_INFO structure represents the time at which the trigger event occurred, interpolated more precisely than one sample interval by using adjacent sample values. The `triggerTime` is only calculated when trigger data has been requested from the oscilloscope using one of the methods below. Otherwise, the returned status includes `PICO_TRIGGER_TIME_NOT_REQUESTED`, and the `triggerTime` field is set to zero.

Scenario 1

Tell the driver to calculate the trigger time offset before calling run block. Internally the driver takes control of getting the trigger values and performing the calculation.

1. Open the oscilloscope and set up the channels, timebase and trigger as required.
2. Configure data acquisition parameters using psospaGetValuesOverlapped() with trigger data mode for time calculation. (Set downSampleRatioMode to `PICO_RATIO_MODE_TRIGGER_DATA_FOR_TIME_CALCULATION`)
3. Start the oscilloscope running using psospaRunBlock().
4. Wait until the oscilloscope is ready using the psospaBlockReady() callback (or poll using psospaIsReady()).
5. Retrieve trigger timing information using psospaGetTriggerInfo() for the captured segment.
6. Close the oscilloscope device using psospaCloseUnit().

Scenario 2

Explicitly retrieve samples around the trigger point using `PICO_RATIO_MODE_TRIGGER`, which the driver also uses to perform the trigger time calculation.

1. Open the oscilloscope and set up the channels, timebase and trigger as required.
2. Start the oscilloscope running using psospaRunBlock().
3. Wait until the oscilloscope is ready using the psospaBlockReady() callback (or poll using psospaIsReady()).
4. Create a data buffer with size 40 elements (20 points around the trigger point) and configure it using psospaSetDataBuffer() with downSampleRatioMode set to `PICO_RATIO_MODE_TRIGGER`.
5. Transfer the block of data from the oscilloscope using psospaGetValues() with trigger ratio mode for the specified segment.
6. Retrieve trigger timing information using psospaGetTriggerInfo() for the captured segment.
7. Close the oscilloscope device using psospaCloseUnit().

3.18 psospaGetTriggerTimeOffset - get timing corrections

```
PICO_STATUS psospaGetTriggerTimeOffset
(
  int16_t                 handle
  int64_t              * time,
  PICO_TIME_UNITS      * timeUnits,
  uint64_t                segmentIndex
)
```

This function gets the trigger time offset for waveforms obtained in block mode or rapid block mode. The trigger time offset is an adjustment value used for correcting jitter in the waveform, and is intended mainly for applications that wish to display the waveform with reduced jitter. The offset is zero if the waveform crosses the threshold at the trigger sampling instant, or a positive or negative value if jitter correction is required. The value should be added to the nominal trigger time to get the corrected trigger time.

This is the same as the `triggerTime` value obtained from `psospaGetTriggerInfo()`, which also provides additional information. There is no need to call both functions.

Call this function after data has been captured or when data has been retrieved from a previous capture.

The trigger time offset is only available when trigger data has been requested from the oscilloscope either by using `PICO_RATIO_MODE_TRIGGER` with `psospaGetValues()` or its comparable bulk or async versions, or by using `PICO_RATIO_MODE_TRIGGER_DATA_FOR_TIME_CALCULATION` with `psospaGetValuesOverlapped()`. See Retrieving interpolated trigger times for more information. Otherwise, `PICO_TRIGGER_TIME_NOT_REQUESTED` is returned.

Applicability

Block mode, rapid block mode

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`time`, on exit, the time at which the trigger point occurred

`timeUnits`, on exit, the time units in which `time` is measured. The possible values are:

- `PICO_FS`
- `PICO_PS`
- `PICO_NS`
- `PICO_US`
- `PICO_MS`
- `PICO_S`

`segmentIndex`, the number of the memory segment for which the information is required.

Returns

`PICO_OK`
`PICO_DEVICE_SAMPLING`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_NULL_PARAMETER`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_TRIGGER_TIME_NOT_REQUESTED`

3.19 psospaGetUnitInfo - get information about device

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

This function retrieves information about the specified oscilloscope. If the device fails to open, only the driver version and error code are available to explain why the last open unit call failed. To find out about unopened devices, call `psospaEnumerateUnits()`.

Applicability

All modes

Arguments

`handle,` identifies the 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.

`string,` on exit, the unit information string selected specified by the `info` argument. If `string` is `NULL`, only `requiredSize` is returned – an initial call like this allows you to determine the required length of the string before allocating it.

`stringLength,` the maximum number of `int8_t` values that may be written to `string`.

`requiredSize,` on exit, the required length of the `string` array.

`info,` a number specifying what information is required. The possible values are listed in the table below.

Returns

`PICO_OK`
`PICO_NULL_PARAMETER`
`PICO_INVALID_INFO`
`PICO_INFO_UNAVAILABLE`
`PICO_STRING_BUFFER_TO_SMALL,` `stringLength` is insufficient for the required data, but non-zero.

info		Example
0x00	PICO_DRIVER_VERSION - Version number of psospa DLL	1,0,0,1
0x01	PICO_USB_VERSION - Type of USB connection to device: 2.0 or 3.0	3.0
0x02	PICO_HARDWARE_VERSION - Hardware version of device	1
0x03	PICO_VARIANT_INFO - Model number of device	3418E
0x04	PICO_BATCH_AND_SERIAL - Batch and serial number of device	10001/0001
0x05	PICO_CAL_DATE - Calibration date of device	30Sep24
0x06	PICO_KERNEL_VERSION - Version of kernel driver	1,1,2,4
0x07	PICO_DIGITAL_HARDWARE_VERSION - Hardware version of the digital section	1
0x08	PICO_ANALOGUE_HARDWARE_VERSION - Hardware version of the analog section	1
0x09	PICO_FIRMWARE_VERSION_1 - Version information of Firmware 1	1,0,0,1
0x0A	PICO_FIRMWARE_VERSION_2 - Version information of Firmware 2	1,0,0,1
0x0F	PICO_FIRMWARE_VERSION_3 - Version information of Firmware 3	1,0,0,1
0x10	PICO_FRONT_PANEL_FIRMWARE_VERSION - Version of front-panel microcontroller firmware	1,0,0,1

3.20 psospaGetValues - get data after a capture has completed

```
PICO_STATUS psospaGetValues
(
  int16_t                 handle,
  uint64_t                startIndex,
  uint64_t              * noOfSamples,
  uint64_t                downSampleRatio,
  PICO_RATIO_MODE         downSampleRatioMode,
  uint64_t                segmentIndex,
  int16_t               * overflow
)
```

This function retrieves 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 psospaSetDataBuffer() or psospaSetDataBuffers(). It blocks the calling function while retrieving data.

Applicability

All modes.

Arguments

handle, the device identifier returned by psospaOpenUnit().

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.

noOfSamples, on entry, the number of raw samples to be processed. On exit, the actual number retrieved. The number of samples retrieved will not be more than the number requested, and the data retrieved always starts with the first sample captured.

downSampleRatio, the downsampling factor that will be applied to the raw data. Must be greater than zero.

downSampleRatioMode, which downsampling mode to use. The available values are:

- PICO_RATIO_MODE_AGGREGATE
- PICO_RATIO_MODE_DECIMATE
- PICO_RATIO_MODE_AVERAGE
- PICO_RATIO_MODE_TRIGGER - cannot be combined with any other ratio mode
- PICO_RATIO_MODE_RAW

segmentIndex, the zero-based number of the memory segment where the data is stored.

overflow, on exit, a set of flags that indicate whether an overvoltage has occurred on any of the channels. It is a bit field with bit 0 denoting Channel A.

Returns

PICO_OK
PICO_NO_SAMPLES_AVAILABLE
PICO_DEVICE_SAMPLING
PICO_NULL_PARAMETER
PICO_SEGMENT_OUT_OF_RANGE
PICO_INVALID_PARAMETER
PICO_TOO_MANY_SAMPLES
PICO_DATA_NOT_AVAILABLE
PICO_STARTINDEX_INVALID
PICO_INVALID_SAMPLERATIO
PICO_INVALID_CALL
PICO_MEMORY
PICO_RATIO_MODE_NOT_SUPPORTED

3.20.1 Downsampling modes

Various methods of data reduction, or **downsampling**, are possible with supported PicoScopes. The downsampling is done at high speed by dedicated hardware inside the scope, making your application faster and more responsive than if you had to do all the data processing in software.

You specify the downsampling mode when you call one of the data collection functions, such as psospaGetValues(). The following modes are available:

PICO_RATIO_MODE_AGGREGATE	Reduces every block of *n* values to just two values: a minimum and a maximum. The minimum and maximum values are returned in two separate buffers.
PICO_RATIO_MODE_AVERAGE	Reduces every block of *n* values to a single value representing the average (arithmetic mean) of all the values.
PICO_RATIO_MODE_DECIMATE	Reduces every block of *n* values to just the first value in the block, discarding all the other values.
PICO_RATIO_MODE_DISTRIBUTION	Not implemented.
PICO_RATIO_MODE_TRIGGER	Gets 20 samples either side of the trigger point. When using trigger delay, this is the original event causing the trigger and not the delayed point. This data is available even when the original trigger point falls outside the main preTrigger and postTrigger data. Trigger data must be retrieved before attempting to get the trigger time using psospaGetTriggerInfo(), psospaGetTriggerTimeOffset() or psospaGetValuesTriggerTimeOffsetBulk()
PICO_RATIO_MODE_RAW	No downsampling. Returns raw data values.

PICO_RATIO_MODE_TRIGGER_DATA_FOR_TIME_CALCULATION	In overlapped mode only, causes trigger data to be retrieved from the scope to calculate the trigger time for psospaGetTriggerInfo(), psospaGetTriggerTimeOffset() or psospaGetValuesTriggerTimeOffsetBulk(), without requiring a user buffer to be set for this data. See psospaGetValuesOverlapped().

3.21 psospaGetValuesAsync - read data without blocking

```
PICO_STATUS psospaGetValuesAsync
(
  int16_t           handle,
  uint64_t          startIndex,
  uint64_t          noOfSamples,
  uint64_t          downSampleRatio,
  PICO_RATIO_MODE   downSampleRatioMode,
  uint64_t          segmentIndex,
  PICO_POINTER      lpDataReady,
  PICO_POINTER      pParameter
)
```

This function obtains data from the oscilloscope, with downsampling if requested, starting at the specified sample number. It delivers the data using a callback.

Applicability

Streaming mode and block mode

Arguments

`handle`,
`startIndex`,
`noOfSamples`,
`downSampleRatio`,
`downSampleRatioMode`,
`segmentIndex`: see `psospaGetValues()`

`lpDataReady`, a pointer to the user-supplied `psospaDataReady()` callback function that will be called when the data is ready.

`pParameter`, a void pointer that will be passed to the callback function. The data type is determined by the application.

Returns

`PICO_OK`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_DEVICE_SAMPLING`
`PICO_NULL_PARAMETER`
`PICO_STARTINDEX_INVALID`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_INVALID_PARAMETER`
`PICO_DATA_NOT_AVAILABLE`
`PICO_INVALID_SAMPLERATIO`
`PICO_INVALID_CALL`

3.22 psospaGetValuesBulk - read multiple segments

```
PICO_STATUS psospaGetValuesBulk
(
  int16_t           handle,
  uint64_t          startIndex,
  uint64_t        * noOfSamples,
  uint64_t          fromSegmentIndex,
  uint64_t          toSegmentIndex,
  uint64_t          downSampleRatio,
  PICO_RATIO_MODE   downSampleRatioMode,
  int16_t         * overflow
)
```

This function retrieves waveforms captured using rapid block mode. The waveforms must have been collected sequentially and in the same run.

Applicability

Rapid block mode

Arguments

`handle`, `startIndex`, `noOfSamples`, `downSampleRatio`, `downSampleRatioMode`, `overflow`: see `psospaGetValues()`

`fromSegmentIndex`, `toSegmentIndex`: zero-based numbers of the first and last memory segments where the data is stored.

Returns

`PICO_OK`
`PICO_INVALID_PARAMETER`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_STARTINDEX_INVALID`
`PICO_INVALID_SAMPLERATIO`

3.23 psospaGetValuesBulkAsync - read multiple segments without blocking

```
PICO_STATUS psospaGetValuesBulkAsync
(
  int16_t            handle,
  uint64_t           startIndex,
  uint64_t           noOfSamples,
  uint64_t           fromSegmentIndex,
  uint64_t           toSegmentIndex,
  uint64_t           downSampleRatio,
  PICO_RATIO_MODE    downSampleRatioMode,
  PICO_POINTER       lpDataReady,
  PICO_POINTER       pParameter
)
```

This function retrieves more than one waveform at a time from the driver in rapid block mode after data collection has stopped. The waveforms must have been collected sequentially and in the same run. The data is returned using a callback.

Applicability

Rapid block mode

Arguments

handle,
startIndex,
noOfSamples,
downSampleRatio,
downSampleRatioMode: see psospaGetValues()

fromSegmentIndex,
toSegmentIndex: see psospaGetValuesBulk()

lpDataReady,
pParameter:see psospaGetValuesAsync()

Returns

PICO_OK
PICO_INVALID_PARAMETER
PICO_SEGMENT_OUT_OF_RANGE
PICO_NO_SAMPLES_AVAILABLE
PICO_STARTINDEX_INVALID

3.24 psospaGetValuesOverlapped - make a deferred request for data before running the scope

```
PICO_STATUS psospaGetValuesOverlapped
(
  int16_t             handle,
  uint64_t            startIndex,
  uint64_t          * noOfSamples,
  uint64_t            downSampleRatio,
  PICO_RATIO_MODE     downSampleRatioMode,
  uint64_t            fromSegmentIndex,
  uint64_t            toSegmentIndex,
  int16_t           * overflow
)
```

This function allows you to make a deferred data-collection request in block or rapid block mode. The request will be executed, and the arguments validated, when you call psospaRunBlock(). The advantage of this method is that the driver makes contact with the scope only once, when you call psospaRunBlock(), compared with the two contacts that occur when you use the conventional psospaRunBlock(), psospaGetValues() calling sequence. This slightly reduces the dead time between successive captures.

After calling psospaRunBlock(), you can optionally use psospaGetValues() to request further copies of the data. This might be required if you wish to display the data with different data reduction settings.

To stop collecting data, call psospaStopUsingGetValuesOverlapped().

Applicability

Rapid block mode

Arguments

handle,
startIndex,
noOfSamples,
downSampleRatio,
downSampleRatioMode,
overflow, see psospaGetValues()

fromSegmentIndex,
toSegmentIndex, see psospaGetValuesBulk().

Returns

PICO_OK
PICO_INVALID_PARAMETER

3.24.1 Using GetValuesOverlapped()

1. Open the oscilloscope using psospaOpenUnit().
2. Select channel ranges and AC/DC coupling using psospaSetChannelOn().
3. Use psospaNearestSampleIntervalStateless(), to find a valid sampling interval to use
4. Use the trigger setup functions psospaSetTriggerChannelConditions(), psospaSetTriggerChannelDirections() and psospaSetTriggerChannelProperties() to set up the trigger if required.
5. Use psospaSetDataBuffer() to tell the driver where your memory buffer is.
6. Set up the transfer of the block of data from the oscilloscope using psospaGetValuesOverlapped().
7. Start the oscilloscope running using psospaRunBlock().
8. Wait until the oscilloscope is ready using the psospaBlockReady() callback (or poll using psospaIsReady()).
9. Display or process the data.
10. Repeat steps 7 to 9 if needed.
11. Stop the oscilloscope by calling psospaStop().

A similar procedure can be used with rapid block mode.

3.25 psospaGetValuesTriggerTimeOffsetBulk - get trigger time offsets for multiple segments

```
PICO_STATUS psospaGetValuesTriggerTimeOffsetBulk
(
int16_t             handle,
int64_t           * times,
PICO_TIME_UNITS   * timeUnits,
uint64_t            fromSegmentIndex,
uint64_t            toSegmentIndex
)
```

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

Applicability

Rapid block mode

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`times`, an array of integers. On exit, 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.

`timeUnits`, an array of integers. The array must be long enough to hold the number of requested times. On exit, `timeUnits[0]` will contain the time unit for `fromSegmentIndex` and the last element will contain the time unit for `toSegmentIndex`. `PICO_TIME_UNITS` values are listed under `psospaGetTriggerTimeOffset()`.

`fromSegmentIndex`, the first segment for which the time offset is required.

`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`
`PICO_NULL_PARAMETER`
`PICO_DEVICE_SAMPLING`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_TRIGGER_TIME_NOT_REQUESTED`

3.26 psospaGetVariantDetails - get specification details in JSON format

```
PICO_STATUS psospaGetVariantDetails
(
  const int8_t*    variantName,
  int16_t          variantNameLength,
  int8_t*          outputString,
  int32_t*         outputStringLength
  PICO_TEXT_FORMAT textFormat
)
```

This function returns a string (in the requested `textFormat` format) containing specification details of the `psospa` variant requested by `variantName`. The data is copied into the location provided by `outputString` only if a non-null location is provided and `outputStringLength` is sufficient. If making an initial call to find the required buffer size, call with `outputStringLength` set to zero. `outputString` may be `nullptr` in this case and `PICO_OK` will still be returned.

Applicability

All modes

Arguments

`variantName,` the string variant name for which data is being requested, for example "3418E". The variant name for a currently connected device can be found using `psospaGetUnitInfo()` if the unit is open, or `psospaEnumerateUnits()` before opening. Passing a `variantName` of "`all-series`" returns a list of all supported variant names for each series supported by the driver.

`variantNameLength,` the size of the variantName array.

`outputString,` the location to copy the 'textFormat' formatted object string to.

`outputStringLength,` the size of the outputString array. On return, the size of the buffer that has been copied if successful, or otherwise the size of the buffer that would be required to contain the requested data.

`textFormat,` the text format type to request. Supplying `PICO_JSON_DATA` will return the given device's capabilities structured in json. Supplying `PICO_JSON_SCHEMA` will return the given device's `JSON` schema.

Returns

`PICO_OK`
`PICO_INVALID_PARAMETER`
`PICO_INVALID_VARIANT`
`PICO_NULL_PARAMETER,` a required parameter is `nullptr`
`PICO_STRING_BUFFER_TO_SMALL, outputStringLength` is insufficient for the required data, but non-zero.

3.26.1 PICO_TEXT_FORMAT textFormat

```
typedef enum enPicoTextFormat
{
  PICO_JSON_DATA,
  PICO_JSON_SCHEMA,
} PICO_TEXT_FORMAT;
```

This is used to identify the format of the text data requested.

Applicability

Calls to psospaGetVariantDetails

Values

PICO_JSON_DATA, is used as an identifier for JSON data
PICO_JSON_SCHEMA, is used as an identifier for JSON schema

3.27 psospaIsReady - get status of block capture

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

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

Applicability

Block mode

Arguments

handle, the device identifier returned by psospaOpenUnit().

ready, output: indicates the state of the collection. If zero, the device is still collecting. If non-zero, the device has finished collecting and psospaGetValues() can be used to retrieve the data.

Returns

PICO_OK
PICO_NULL_PARAMETER

3.28 psospaMemorySegments - set number of memory segments

```
PICO_STATUS psospaMemorySegments
(
  int16_t     handle
  uint64_t    nSegments,
  uint64_t  * nMaxSamples
)
```

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

When the scope is opened, the number of segments defaults to 1, meaning that each capture can use up to the scope's available memory. This function allows you to divide the memory into a number of segments so that the scope can store several waveforms sequentially.

See also psospaMemorySegmentsBySamples() which sets up the memory segments to each fit a required number of samples.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

nSegments, the number of segments required. See data sheet for capacity of each model.

nMaxSamples, on exit, the number of samples available in each segment. This is the total number over all 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
PICO_TOO_MANY_SEGMENTS
PICO_MEMORY

3.29 psospaMemorySegmentsBySamples - set size of memory segments

```
PICO_STATUS psospaMemorySegmentsBySamples
(
  int16_t     handle
  uint64_t    nSamples,
  uint64_t  * nMaxSegments
)
```

This function sets the number of samples per memory segment. Like psospaMemorySegments() it controls the segmentation of the capture memory, but in this case you specify the number of samples rather than the number of segments.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

nSamples, the number of samples required in each segment. See data sheet for capacity of each model. This is the total number over *n* channels, where *n* is the number of enabled channels or MSO ports rounded up to the next power of 2. For example, with 5 channels or ports enabled, *n* is 8. If *n* > 1, the number of segments available will be reduced accordingly.

nMaxSegments, on exit, the number of segments into which the capture memory has been divided.

Returns

PICO_OK
PICO_TOO_MANY_SEGMENTS
PICO_MEMORY

3.30 psospaNearestSampleIntervalStateless - get nearest sampling interval

```
PICO_STATUS psospaNearestSampleIntervalStateless
(
  int16_t                  handle,
  PICO_CHANNEL_FLAGS       enabledChannelFlags,
  double                   timeIntervalRequested,
  uint8_t                  roundFaster,
  PICO_DEVICE_RESOLUTION   resolution,
  uint32_t               * timebase,
  double                 * timeIntervalAvailable
)
```

This function returns the nearest possible sample interval to the requested sample interval. It does not change the configuration of the oscilloscope.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`enabledChannelFlags`, see `psospaGetMinimumTimebaseStateless()`.

`timeIntervalRequested`, the time interval, in seconds, that you would like to obtain.

`roundFaster`, if the requested time interval cannot be exactly achieved then, when `0`, the timebase slower than the requested is returned, when 1 the timebase faster than the requested is returned.

`resolution`, the vertical resolution (number of bits) for which the oscilloscope will be configured.

`timebase`, on exit, the number of the nearest available timebase, in picoseconds.

`timeIntervalAvailable`, on exit, the nearest available time interval, in seconds.

Returns

`PICO_OK`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_NULL_PARAMETER`
`PICO_INVALID_PARAMETER`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_TOO_MANY_SAMPLES`
`PICO_NO_CHANNELS_OR_PORTS_ENABLED`
`PICO_INVALID_DIGITAL_PORT`

3.31 psospaNoOfStreamingValues - get number of captured samples

```
PICO_STATUS psospaNoOfStreamingValues
(
  int16_t     handle,
  uint64_t  * noOfValues
)
```

This function returns the number of samples available after data collection in streaming mode. Call it after calling psospaStop().

Applicability

Streaming mode

Arguments

handle, the device identifier returned by psospaOpenUnit().

noOfValues, on exit, the number of samples of raw data, per enabled channel, available for retrieval after the end of the capture.

Returns

PICO_OK
PICO_NULL_PARAMETER
PICO_NO_SAMPLES_AVAILABLE
PICO_NOT_USED
PICO_BUSY

3.32 psospaOpenUnit - open a scope device

```
PICO_STATUS psospaOpenUnit
(
  int16_t                * handle,
  int8_t                 * serial,
  PICO_DEVICE_RESOLUTION   resolution
  PICO_USB_POWER_DETAILS * powerDetails
)
```

This function opens the scope attached to the computer. The maximum number of units that can be opened depends on the operating system, the kernel driver and the computer.

If the function returns PICO_FIRMWARE_UPDATE_REQUIRED_TO_USE_DEVICE_WITH_THIS_DRIVER, all other API calls that perform operations with the same device will fail with the same return value until psospaStartFirmwareUpdate() is called. Users should avoid unplugging the device during this operation, otherwise there is a small chance that the firmware could be corrupted.

Applicability

All modes

Arguments

handle, on exit, the result of the attempt to open a scope:
- −1 : if the scope fails to open
- 0 : if no scope is found
- > 0 : a number that uniquely identifies the scope

If a valid handle is returned, it must be used in all subsequent calls to API functions to identify this scope.

serial, on entry, a null-terminated string containing the serial number of the scope to be opened. If serial is NULL then the function opens the first scope found; otherwise, it tries to open the scope that matches the string.

resolution, the required vertical resolution (in bits).

powerDetails, returns details about the unit power setup, can be null if not required.

Returns

PICO_OK
PICO_OS_NOT_SUPPORTED
PICO_OPEN_OPERATION_IN_PROGRESS
PICO_EEPROM_CORRUPT
PICO_KERNEL_DRIVER_TOO_OLD
PICO_FW_FAIL
PICO_MAX_UNITS_OPENED
PICO_NOT_FOUND (if the specified unit was not found)
PICO_CONFIG_FAIL_AWG
PICO_INITIALISE_FPGA
PICO_FIRMWARE_UPDATE_REQUIRED_TO_USE_DEVICE_WITH_THIS_DRIVER - call psospaCheckForUpdate() and then psospaStartFirmwareUpdate()
PICO_POWER_MANAGER (power setup is invalid)
PICO_USB_VERSION_NOT_SUPPORTED (USB 1.x connections not supported)

3.32.1 PICO_USB_POWER_DETAILS

```
typedef struct tPicoUsbPowerDetails
{
  uint8_t powerErrorLikely_;
  PICO_USB_POWER_DELIVERY dataPort_;
  PICO_USB_POWER_DELIVERY powerPort_;
} PICO_USB_POWER_DETAILS;
```

Applicability

Set by psospaOpenUnit() if a non-null pointer is passed for powerDetails

Elements

powerErrorLikely_, If psospaOpenUnit fails, this indicates whether it was likely that the failure was due to an issue with the power supply. Non-zero indicates that a power failure was likely, zero indicates that it was unlikely

dataPort_, USB power details for the data port. See PICO_USB_POWER_DELIVERY

powerPort_, USB power details for the power port. See PICO_USB_POWER_DELIVERY

3.32.2 PICO_USB_POWER_DELIVERY

```
typedef struct tPicoUsbPowerDelivery
{
  uint8_t valid_;
  uint32_t busVoltagemV_;
  uint32_t rpCurrentLimitmA_;
  uint8_t partnerConnected_;
  uint8_t ccPolarity_;
  PICO_USB_POWER_DELIVERY_DEVICE_TYPE attachedDevice_;
  uint8_t contractExists_;
  uint32_t currentPdo_;
  uint32_t currentRdo_;
} PICO_USB_POWER_DELIVERY;
```

Applicability

Forms part of the PICO_USB_POWER_DETAILS set by psospaOpenUnit()

Elements

valid_, non-zero, indicates that the following data is valid. Zero indicates that they are not (likely no USB connection on this port)

busVoltagemV_, the USB voltage in mV

rpCurrentLimitmA_, the current limit set by the USB CC lines in mA

partnerConnected_, non-zero indicates that there is a compatible USB-C power connected.

`ccPolarity_,` indicates which way up the USB-C connector is

`attachedDevice_,` indicates the type of device connected to the unit via this port

`contractExists_,` non-zero indicates that an explicit PD contract exists between the unit and its partner

`currentPdo_,` current power data object, refer to chapter 6.4 of the PD 2.0 or 3.0 specifications

`currentRdo_,` current request data object, refer to chapter 6.4 of the PD 2.0 or 3.0 specifications

3.33 psospaPingUnit - check if device is still connected

```
PICO_STATUS psospaPingUnit
(
  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`, the device identifier returned by `psospaOpenUnit()`.

Returns

`PICO_OK`
`PICO_BUSY`
`PICO_NOT_RESPONDING`

3.34 psospaQueryMaxSegmentsBySamples - get number of segments

```
PICO_STATUS psospaQueryMaxSegmentsBySamples
(
  int16_t                 handle,
  uint64_t                nSamples,
  uint32_t                nChannelEnabled,
  uint64_t              * nMaxSegments,
  PICO_DEVICE_RESOLUTION  resolution
)
```

This function returns the maximum number of memory segments available given the number of samples per segment. It does not change the current segment configuration of the scope.

Applicability

All modes

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`nSamples,` the number of samples per segment.

`nChannelEnabled,` the number of channels enabled.

`nMaxSegments,` on exit, the maximum number of segments that can be requested.

`resolution,` an enumerated type representing the hardware resolution.

Returns

`PICO_OK`
`PICO_NO_SAMPLES_AVAILABLE`
`PICO_NULL_PARAMETER`
`PICO_INVALID_PARAMETER`
`PICO_SEGMENT_OUT_OF_RANGE`
`PICO_TOO_MANY_SAMPLES`

3.35 psospaQueryOutputEdgeDetect – check if output edge detection is enabled

```
PICO_STATUS psospaQueryOutputEdgeDetect
(
  int16_t   handle,
  int16_t * state
)
```

This function queries the state of the trigger function edge detection, set with psospaSetOutputEdgeDetect().

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

state, on exit, the current state of trigger function edge detection.

0 = off

1 = on

Returns

PICO_OK

3.36 psospaResetAdjustmentSettings

```
PICO_STATUS psospaResetAdjustmentSettings
(
  int16_t                 handle,
  PICO_CAL_TYPE           calType
)
```

Resets all adjustment settings (including the adjustments, date and any name or address strings associated with them) to their default values. Only affects the driver image of the adjustment settings and needs to be committed to the device with psospaCommitCurrentAdjustmentSettingsToDevice to take effect on the device.

See psospaRunAutomaticOffsetAdjustment for more information on the user offset adjustment process.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`calType`, the type of calibration to be reset. Must be set to `PICO_USER_CAL` , all other values are reserved.

Returns

`PICO_OK`, Upon successful completion of the operation
`PICO_NOT_SUPPORTED_BY_THIS_DEVICE`, When the `PICO_CAL_TYPE` requested is not supported.
`PICO_INVALID_HANDLE`, When the handle used is not in use
`PICO_DRIVER FUNCTION`, If there is another API call currently being processed by the driver

3.37 psospaResetChannelsAndReportAllChannelsOvervoltageTripStatus - reset 50 Ω input protection

```
PICO_STATUS psospaResetChannelsAndReportAllChannelsOvervoltageTripStatus
(
  int16_t                              handle,
  PICO_CHANNEL_OVERVOLTAGE_TRIPPED   * allChannelsTrippedStatus,
  uint8_t                              nChannelTrippedStatus
)
```

In 50Ω coupling mode, the oscilloscope hardware includes an overvoltage protection circuit which disconnects the input to prevent damage.

This function resets all oscilloscope channels and then reports the overvoltage trip status for all channels. Use this to reset after an overvoltage trip event, and check that the channels haven't immediately tripped again due to a continuing overvoltage.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`allChannelsTrippedStatus`, a pointer to an array of `PICO_CHANNEL_OVERVOLTAGE_TRIPPED` structs. On exit, the overvoltage trip status of each channel will be written to this array.

`nChannelTrippedStatus`, the number of `PICO_CHANNEL_OVERVOLTAGE_TRIPPED` structs in the above array.

Returns

`PICO_OK`
`PICO_HARDWARE_CAPTURING_CALL_STOP`
`PICO_NULL_PARAMETER`
`PICO_INVALID_PARAMETER`
`PICO_NOT_SUPPORTED_BY_THIS_DEVICE`

3.38 psospaReportAllChannelsOvervoltageTripStatus- check if 50 Ω input protection has tripped

```
PICO_STATUS psospaReportAllChannelsOvervoltageTripStatus
(
  int16_t                              handle,
  PICO_CHANNEL_OVERVOLTAGE_TRIPPED   * allChannelsTrippedStatus,
  uint8_t                              nChannelTrippedStatus
)
```

This function reports the overvoltage trip status for all channels without resetting their status. Use it to find out which channels caused an overvoltage trip event.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`allChannelsTrippedStatus`, a pointer to an array of `PICO_CHANNEL_OVERVOLTAGE_TRIPPED` channel status flags. On exit, the overvoltage trip status of each channel will be written to this array.

`nChannelTrippedStatus`, the number of `PICO_CHANNEL_OVERVOLTAGE_TRIPPED` structs in the above array.

Returns

`PICO_OK`

`PICO_NULL_PARAMETER`
`PICO_INVALID_PARAMETER`
`PICO_NOT_SUPPORTED_BY_THIS_DEVICE`

3.38.1 PICO_CHANNEL_OVERVOLTAGE_TRIPPED structure

```
typedef struct tPicoChannelOvervoltageTripped
{
  PICO_CHANNEL   channel_;
  uint8_t        tripped_;
} PICO_CHANNEL_OVERVOLTAGE_TRIPPED;
```

This structure contains information about the overvoltage trip on a given channel. An overvoltage trip occurs when an oscilloscope channel in 50 Ω coupling mode detects an excessive voltage on its input, and disconnects the scope input to prevent damage.

Applicability

Analog input channels

Elements

`channel_`, the oscilloscope channel to which the information applies.

`tripped_`, a flag indicating whether the overvoltage trip occurred (non-zero) or did not occur (zero).

3.39 psospaRunAutomaticOffsetAdjustment

```
PICO_STATUS psospaRunAutomaticOffsetAdjustment
(
  int16_t                 handle,
  PICO_CAL_TYPE           calType
)
```

This function runs an automated adjustment routine to calibrate the analog offset of each channel. The analog channels must be disconnected from any input signal before running this adjustment. The device will remain unresponsive while the adjustment is running, approximately 15 seconds.

The new adjustment settings are applied as soon as this function returns, but at this point they are only stored in the driver and will be lost when the device is closed or disconnected. The function psospaCommitCurrentAdjustmentSettingsToDevice allows the settings to be saved to the device's non-volatile memory, meaning they can persist between sessions and on whatever host PC the device is used with.

Automatic offset adjustment is a new feature from psospa driver version 1.0.178. If a unit which has been adjusted is opened in an older driver version, the user adjustment settings will not be applied.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`calType`, the type of calibration to adjust. Must be set to `PICO_USER_CAL`, all other values are reserved.

Returns

`PICO_OK`

`PICO_INVALID_VOLTAGE_RANGE`, there is significant voltage detected on one or more channels indicating something remains connected to the ports and it must be removed before the adjustment can take place.

`PICO_TIMEOUT`, the offset adjustment process could not complete within a reasonable time. In such a case it may work upon a re-run or there is a more significant undetected issue preventing adjustment.

`PICO_NOT_SUPPORTED_BY_THIS_DEVICE`, when the `PICO_CAL_TYPE` requested is not supported.

`PICO_INVALID_HANDLE`, when the handle used is not in use.

`PICO_DRIVER FUNCTION`, if there is another API call currently being processed by the driver.

`PICO_INTERNAL_ERROR`, if there is an unknown failure in the driver or device upon attempting to run the adjustment.

3.39.1 PICO_CAL_TYPE enumerated type

```
typedef enum enPicoCalType
{
  int32 PICO_CAL_HOUSE  = 0,
  int32 PICO_USER_CAL = 1,
}
```

Describes which type of calibration values an API user is interacting with. Currently only PICO_USER_CAL is supported.

Applicability

Used with functions relating to user calibration adjustment.

Values

PICO_CAL_HOUSE, reserved for future use
PICO_USER_CAL, identifies user adjustment settings

3.40 psospaRunBlock - start block mode capture

```
PICO_STATUS psospaRunBlock
(
  int16_t               handle,
  uint64_t              noOfPreTriggerSamples,
  uint64_t              noOfPostTriggerSamples,
  uint32_t              timebase,
  double              * timeIndisposedMs,
  uint64_t              segmentIndex,
  psospaBlockReady      lpReady,
  PICO_POINTER          pParameter
)
```

This function starts collecting data in block mode. For a step-by-step guide to this process, see Using 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 size of the segment referred to by `segmentIndex`.

Applicability

Block mode, rapid block mode

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`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.

`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 samples to be collected is:

```
noOfPreTriggerSamples + noOfPostTriggerSamples
```

`timebase`, a number, indicating the sample interval, in picoseconds. See the guide to calculating timebase values. If the value you pass does not correspond to a valid sampling rate for the current scope setup, the scope will select the nearest available sampling rate. It is recommended to call `psospaNearestSampleIntervalStateless()` to determine a valid sample interval before calling this function.

`timeIndisposedMs`, on exit, the time in milliseconds that the scope will spend collecting samples. This does not include any auto trigger timeout. If this pointer is null, nothing will be written here.

`segmentIndex`, zero-based, specifies which memory segment to use.

`lpReady`, a pointer to the `psospaBlockReady()` callback function that the driver will call when the data has been collected. To use the `psospaIsReady()` polling method instead of a callback function, set this pointer to `NULL`.

`pParameter`, a void pointer that is passed to the `psospaBlockReady()` callback function. The callback can use this pointer to return arbitrary data to the application.

Returns

PICO_OK
PICO_SEGMENT_OUT_OF_RANGE
PICO_INVALID_CHANNEL
PICO_INVALID_TRIGGER_CHANNEL
PICO_INVALID_CONDITION_CHANNEL
PICO_TOO_MANY_SAMPLES
PICO_INVALID_TIMEBASE
PICO_CONFIG_FAIL
PICO_INVALID_PARAMETER
PICO_TRIGGER_ERROR
PICO_FW_FAIL
PICO_PULSE_WIDTH_QUALIFIER
PICO_SEGMENT_OUT_OF_RANGE (in Overlapped mode)
PICO_STARTINDEX_INVALID (in Overlapped mode)
PICO_INVALID_SAMPLERATIO (in Overlapped mode)
PICO_CONFIG_FAIL
PICO_SIGGEN_GATING_AUXIO_ENABLED (signal generator is set to trigger on AUX input with incompatible trigger type)

3.41 psospaRunStreaming - start streaming mode capture

```
PICO_STATUS psospaRunStreaming
(
  int16_t              handle,
  double             * sampleInterval,
  PICO_TIME_UNITS      sampleIntervalTimeUnits
  uint64_t             maxPreTriggerSamples,
  uint64_t             maxPostTriggerSamples,
  int16_t              autoStop,
  uint64_t             downSampleRatio,
  PICO_RATIO_MODE      downSampleRatioMode
)
```

This function tells the oscilloscope to start collecting data in streaming mode. The device can return either raw or downsampled data to your application while streaming is in progress. Call psospaGetStreamingLatestValues() to retrieve the data. See Using streaming mode for a step-by-step guide to this process.

When a trigger is set, the total number of samples is the sum of maxPreTriggerSamples and maxPostTriggerSamples. If autoStop is false then this will become the maximum number of samples without downsampling.

When downsampled data is returned, the raw samples remain stored on the device. The maximum number of raw samples that can be retrieved after streaming has stopped is **(scope's memory size) / (resolution data size * channels),** where **channels** is the number of active channels rounded up to a power of 2.

Applicability

Streaming mode

Arguments

handle, the device identifier returned by psospaOpenUnit().

sampleInterval, on entry, the requested time interval between samples; on exit, the actual time interval used

sampleIntervalTimeUnits, the unit of time used for sampleInterval. Use one of these values:

- PICO_FS
- PICO_PS
- PICO_NS
- PICO_US
- PICO_MS
- PICO_S

maxPreTriggerSamples, the maximum number of raw samples before a trigger event for each enabled channel. If no trigger condition is set this argument is ignored.

maxPostTriggerSamples, the maximum number of raw samples after a trigger event for each enabled channel. If no trigger condition is set, this argument states the maximum number of samples to be stored.

autoStop, a flag that specifies if the streaming should stop when all of maxSamples have been captured.

downSampleRatio, downSampleRatioMode: see psospaGetValues().

Returns

PICO_OK
PICO_NULL_PARAMETER
PICO_INVALID_PARAMETER
PICO_STREAMING_FAILED
PICO_TRIGGER_ERROR
PICO_INVALID_SAMPLE_INTERVAL
PICO_INVALID_BUFFER
PICO_FW_FAIL
PICO_MEMORY
PICO_SIGGEN_GATING_AUXIO_ENABLED (signal generator is set to trigger on AUX input with incompatible trigger type)
PICO_HARDWARE_CAPTURING_CALL_STOP
PICO_STREAMING_COMBINATION_OF_RAW_DATA_AND_ONE_AGGREGATION_DATA_TYPE_ALLOWED
PICO_TIME_UNITS_OUT_OF_RANGE
PICO_NO_SAMPLES_REQUESTED
PICO_TOO_FEW_REQUESTED_STREAMING_SAMPLES
PICO_TOO_MANY_SAMPLES
PICO_NOT_USED_IN_THIS_CAPTURE_MODE
PICO_INVALID_RATIO_MODE
PICO_STREAMING_DOES_NOT_SUPPORT_TRIGGER_RATIO_MODES
PICO_RATIO_MODE_NOT_SUPPORTED
PICO_THRESHOLD_UPPER_LOWER_MISMATCH
PICO_TRIGGER_CHANNEL_NOT_ENABLED
PICO_CONDITION_HAS_NO_TRIGGER_PROPERTY
PICO_INVALID_DIGITAL_PORT
PICO_TRIGGER_PORT_NOT_ENABLED
PICO_DIGITAL_DIRECTION_NOT_SET
PICO_WARNING_AUX_OUTPUT_CONFLICT
PICO_READ_SELECTION_OUT_OF_RANGE
PICO_RATIO_MODE_TRIGGER_MASKING_INVALID
PICO_USE_THE_TRIGGER_READ
PICO_USE_A_DATA_READ
PICO_RATIO_MODE_REQUIRES_NUMBER_OF_SAMPLES_TO_BE_SET
PICO_OPERATION_FAILED
PICO_ARGUMENT_OUT_OF_RANGE
PICO_BUFFERS_NOT_SET
PICO_STREAMING_ONLY_SUPPORTS_ONE_READ
PICO_NOT_RESPONDING_OVERHEATED
PICO_ENDPOINT_MISSING
PICO_UNKNOWN_ENDPOINT_REQUEST

3.42 psospaSetAdjustmentSettingDetails

```
PICO_STATUS psospaSetAdjustmentSettingDetails
(
  int16_t                handle,
  PICO_CAL_TYPE          calType,
  int8 *                 nameString,
  int32 *                nameStringLength,
  int8 *                 addressString,
  int32 *                addressStringLength
)
```

Sets the adjustment setting name and/or address strings which allow you to save information on where or by whom the user adjustment was most recently saved. To set only the name or address, pass `nullptr` for the other string.

After calling this function, use psospaCommitCurrentAdjustmentSettingsToDevice to save the adjustment data along with these name and address strings to the device's non-volatile memory, so they persist between sessions and on whatever host PC the device is used with.

See psospaRunAutomaticOffsetAdjustment for more information on the user offset adjustment process.

Applicability

All modes

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`calType,` the type of calibration to write the data from the adjustment to. Currently it must be `PICO_USER_CAL`

`nameString,` Pointer to a string containing the name of the adjustment setting.

`nameStringLength,` Pointer to an `int32_t` containing the length of the name string. Length given should include the null terminator. The maximum is 80 characters including the null terminator. If either of these lengths are exceeded, the function will return `PICO_INVALID_PARAMETER`.

`addressString,` Pointer to a string containing the address associated with the adjustment setting.

`addressStringLength,` Pointer to an `int32_t` containing the length of the address string. Length given should include the null terminator. The maximum is 80 characters including the null terminator. If either of these lengths are exceeded, the function will return `PICO_INVALID_PARAMETER`.

Returns

`PICO_OK`
`PICO_NULL_PARAMETER`
`PICO_INVALID_PARAMETER`

3.43 psospaSetAuxIoMode - configure the AUX IO connector

```
PICO_STATUS psospaSetAuxIoMode
(
  int16_t             handle
  PICO_AUXIO_MODE     auxIoMode
)
```

Configures the AuxIO mode/function using the PICO_AUXIO_MODE enum values.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

auxIoMode, required AuxIO mode:

- PICO_AUXIO_INPUT, high-impedance input for use triggering the scope or AWG if configured.
- PICO_AUXIO_HIGH_OUT, constant logic high output.
- PICO_AUXIO_LOW_OUT, constant logic low output.
- PICO_AUXIO_TRIGGER_OUT, logic high pulse during the post-trigger acquisition time.

The Aux IO is a 3.3 V CMOS logic input/output.

Returns

PICO_OK

PICO_OPERATION_FAILED, failed to change AuxIO mode

PICO_WARNING_AUX_OUTPUT_CONFLICT, the AuxIO mode has been set to an output mode while the scope or AWG is set to trigger on it. This is allowed but will result in the scope or AWG triggering on the output value of the AuxIO.

3.44 psospaSetChannelOff - disable one channel

```
PICO_STATUS psospaSetChannelOff
(
  int16_t        handle,
  PICO_CHANNEL   channel
)
```

This function switches an analog input channel off. It has the opposite function to psospaSetChannelOn().

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

channel, see psospaSetChannelOn().

Returns

PICO_OK
PICO_INVALID_CHANNEL

3.45 psospaSetChannelOn - enable and set options for one channel

```
PICO_STATUS psospaSetChannelOn
(
  int16_t                  handle,
  PICO_CHANNEL             channel,
  PICO_COUPLING            coupling,
  int64_t                  rangeMin,
  int64_t                  rangeMax,
  PICO_PROBE_RANGE_INFO    rangeType,
  double                   analogueOffset,
  PICO_BANDWIDTH_LIMITER   bandwidth;
)
```

This function switches an analog input channel on and specifies its input coupling type, voltage range, analog offset and bandwidth limit.

To switch off, use psospaSetChannelOff().

For digital ports, see psospaSetDigitalPortOn().

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

channel, the channel to be configured. The values (subject to the number of channels on your oscilloscope model) are:
PICO_CHANNEL_A, PICO_CHANNEL_B, PICO_CHANNEL_C, PICO_CHANNEL_D

coupling, the impedance and coupling type. The values supported are:

PICO_AC, 1 MΩ impedance, AC coupling. The channel accepts input frequencies from about 1 hertz up to its maximum –3 dB analog bandwidth.

PICO_DC, 1 MΩ impedance, DC coupling. The scope accepts all input frequencies from zero (DC) up to its maximum –3 dB analog bandwidth.

PICO_DC_50OHM, 50 Ω impedance, DC coupling. The higher-voltage input ranges may not be available in this mode - consult data sheet.

rangeMin, minimum value of the input range, expressed in the units selected by rangeType below.
rangeMax, maximum value of the range , expressed in the units selected by rangeType below.

rangeType, defines the units of rangeMin/rangeMax and any multiplication factor of the probe:

PICO_PROBE_NONE_NV, range is defined in nanovolts (nV) with no probe scaling
PICO_X1_PROBE_NV, range is defined in nanovolts (nV) with scaling for a 1:1 probe (same as no probe scaling)
PICO_X10_PROBE_NV, range is defined in nanovolts (nV) with scaling for a 10:1 probe

rangeMin and rangeMax must correspond to one of the available input voltage ranges of the oscilloscope as described in the datasheet or returned by psospaGetVariantDetails(). For example, the 5 mV range would be represented as rangeMin –5 000 000, rangeMax 5 000 000, rangeType PICO_PROBE_NONE_NV.

analogueOffset, a voltage to add to the input channel before digitization. The allowable analog offset for a given input voltage range can be read from psospaGetAnalogueOffsetLimits(), or the values for all ranges are included in the JSON returned by psospaGetVariantDetails().

bandwidth, the bandwidth limiter setting:

PICO_BW_FULL, the scope's full specified bandwidth. This may vary depending on selected resolution and voltage range as described in the device datasheet, in which case the driver will automatically select the highest available bandwidth for the channel based on those settings.

PICO_BW_20MHZ: –3 dB bandwidth limited to 20 MHz
PICO_BW_50MHz: –3 dB bandwidth limited to 50 MHz
PICO_BW_60MHZ: –3 dB bandwidth limited to 60 MHz
PICO_BW_100MHz: –3 dB bandwidth limited to 100 MHz
PICO_BW_200MHZ: –3 dB bandwidth limited to 200 MHz
PICO_BW_350MHz: –3 dB bandwidth limited to 350 MHz
PICO_BW_500MHz: –3 dB bandwidth limited to 500 MHz

Available values vary by device model as described in the data sheet or reported by psospaGetVariantDetails().

Returns

PICO_OK
PICO_INVALID_CHANNEL
PICO_INVALID_VOLTAGE_RANGE
PICO_INVALID_COUPLING
PICO_COUPLING_NOT_SUPPORTED
PICO_INVALID_ANALOGUE_OFFSET
PICO_INVALID_BANDWIDTH
PICO_BANDWIDTH_NOT_SUPPORTED
PICO_WARNING_PROBE_CHANNEL_OUT_OF_SYNC

3.46 psospaSetDataBuffer - provide location of data buffer

```
PICO_STATUS psospaSetDataBuffer
(
  int16_t             handle,
  PICO_CHANNEL        channel,
  PICO_POINTER        buffer,
  uint64_t            nSamples,
  PICO_DATA_TYPE      dataType,
  uint64_t            waveform,
  PICO_RATIO_MODE     downSampleRatioMode,
  PICO_ACTION         action
)
```

This function tells the driver where to store the data, either unprocessed or downsampled, that will be returned after the next call to one of the `GetValues` functions. The function allows you to specify only a single buffer, so for aggregation mode, which requires two buffers, you must call `psospaSetDataBuffers()` instead.

The buffer persists between captures until it is replaced with another buffer or `buffer` is set to NULL. The buffer can be replaced at any time between calls to `psospaGetValues()`.

You must allocate memory for the buffer before calling this function.

Applicability

Block, rapid block and streaming modes. All downsampling modes except aggregation.

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`channel`, the channel you want to use with the buffer. You must call this function for each channel for which you want to retrieve data.

`buffer`, the location of the buffer.

`nSamples`, the length of the `buffer` array.

`dataType`, the data type that you wish to use for the sample values:

- `PICO_INT8_T`, 8-bit signed integer
- `PICO_INT16_T`, 16-bit signed integer
- `PICO_INT32_T`, 32-bit signed integer
- `PICO_UINT32_T`, 32-bit unsigned integer
- `PICO_INT64_T`, 64-bit signed integer

Note: valid data types vary by resolution and downsample ratio mode.

`waveform`, the segment index.

`downSampleRatioMode`, the downsampling mode. See `psospaGetValues()` for the available modes, but note that a single call to `psospaSetDataBuffer()` can only associate one buffer with one downsampling mode. If you intend to call `psospaGetValues()` with more than one downsampling mode activated, then you must call `psospaSetDataBuffer()` several times to associate a separate buffer with each downsampling mode.

action, the method to use when creating the buffer. The buffers are added to a unique list for the channel, data type and segment. Therefore you must use PICO_CLEAR_ALL to remove all buffers already written. PICO_ACTION values can be ORed together to allow clearing and adding in one call.

Returns

PICO_OK
PICO_INVALID_CHANNEL
PICO_RATIO_MODE_NOT_SUPPORTED
PICO_INVALID_PARAMETER

3.47 psospaSetDataBuffers - provide locations of both data buffers

```
PICO_STATUS psospaSetDataBuffers
(
  int16_t             handle,
  PICO_CHANNEL        channel,
  PICO_POINTER        bufferMax,
  PICO_POINTER        bufferMin,
  uint64_t            nSamples,
  PICO_DATA_TYPE      dataType,
  uint64_t            waveform,
  PICO_RATIO_MODE     downSampleRatioMode,
  PICO_ACTION         action
)
```

This function tells the driver the location of one or two buffers for receiving data. You need to allocate memory for the buffers before calling this function. If you do not need two buffers, because you are not using aggregate mode, then you can optionally use psospaSetDataBuffer() instead.

Applicability

Block and streaming modes with aggregation.

Arguments

handle, the device identifier returned by psospaOpenUnit().

channel, the channel for which you want to set the buffers.

bufferMax, a buffer to receive the maximum data values in aggregation mode, or the non-aggregated values otherwise.

bufferMin, a buffer to receive the minimum aggregated data values. Not used in other downsampling modes.

nSamples,
dataType,
waveform, see psospaSetDataBuffer().

downSampleRatioMode, the downsampling mode. See psospaGetValues() for the available modes, but note that a single call to psospaSetDataBuffers() can only associate buffers with one downsampling mode. If you intend to call psospaGetValues() with more than one downsampling mode activated, then you must call psospaSetDataBuffers() several times to associate buffers with each downsampling mode.

action, see psospaSetDataBuffer().

Returns

PICO_OK
PICO_INVALID_CHANNEL
PICO_RATIO_MODE_NOT_SUPPORTED
PICO_INVALID_PARAMETER

3.48 psospaSetDeviceResolution – set the hardware resolution

```
PICO_STATUS psospaSetDeviceResolution
(
  int16_t                 handle,
  PICO_DEVICE_RESOLUTION  resolution
)
```

This function sets the sampling resolution of the device. At 10-bit or higher resolution, the maximum capture buffer length and sample rate is half that of 8-bit mode.

When you change the device resolution, the driver discards all previously captured data.

It is not necessary to call this function if your PicoScope device only has a single hardware resolution.

Applicability

All modes.

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`resolution`, determines the resolution of the device when opened, the available values are one of the `PICO_DEVICE_RESOLUTION`.

Returns

`PICO_INVALID_DEVICE_RESOLUTION` if resolution is out of range.

3.48.1 PICO_DEVICE_RESOLUTION enumerated type

```
typedef enum enPicoDeviceResolution
{
  PICO_DR_8BIT  = 0,
  PICO_DR_10BIT = 10,
  PICO_DR_16BIT = 4,
} PICO_DEVICE_RESOLUTION;
```

These values specify the resolution of the sampling hardware in the oscilloscope. Each mode divides the input voltage range into a number of levels as listed below.

Applicability

Calls to `psospaSetDeviceResolution()` etc.

Values

`PICO_DR_8BIT` – 8-bit resolution (255 levels)
`PICO_DR_10BIT` – 10-bit resolution (1023 levels)
`PICO_DR_16BIT` – 16-bit resolution (65535 levels)

3.49 psospaSetDigitalPortOff – switch off a digital port

```
PICO_STATUS psospaSetDigitalPortOff
(
  int16_t                       handle,
  PICO_CHANNEL                  port
)
```

This function switches off a given digital port.

Applicability

All modes.
Any model with MSO channels fitted.

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`port`, see `psospaSetDigitalPortOn()`.

Returns

`PICO_OK`
`PICO_INVALID_DIGITAL_PORT`
`PICO_NOT_SUPPORTED_BY_THIS_DEVICE`

3.50 psospaSetDigitalPortOn – set up and enable a digital port

```
PICO_STATUS psospaSetDigitalPortOn
(
  int16_t                       handle,
  PICO_CHANNEL                  port,
  double                        logicThresholdLevelVolts
)
```

This function switches on a digital port and sets its corresponding logic threshold voltage.

Refer to the data sheet for the fastest sampling rates available with different combinations of analog and digital inputs.

Sampling the digital inputs alone, without any analog channels enabled, is only supported in the lowest resolution mode available on a given scope model. This allows the fastest sampling rate and highest memory depth. This means on scopes supporting more than one resolution, you must change to 8-bit mode to sample on digital inputs alone.

Applicability

All modes.
Any model with MSO channels fitted.

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`port,` identifies the digital port on the oscilloscope:
- `PICO_PORT0,` channels D0–D7
- `PICO_PORT1,` channels D8–D15

`logicThresholdLevelVolts,` the threshold voltage for the port in volts, used to distinguish the digital 0 and 1 states.

Returns

`PICO_OK,` the PicoScope is functioning correctly.
`PICO_INVALID_DIGITAL_PORT,` the requested digital port number is out of range.
`PICO_INVALID_PARAMETER,` the `logicThresholdLevelVolts` parameter is not valid.
`PICO_NOT_SUPPORTED_BY_THIS_DEVICE,` the PicoScope does not have digital ports.

3.51 psospaSetLedBrightness - set brightness of LEDs

```
PICO_STATUS psospaSetLedBrightness
(
  int16_t                           handle,
  uint8_t                           brightness
)
```

Sets the brightness of all configurable LEDs. The new brightness will only take effect the next time that LED is applied by calling psospaRunBlock(), psospaRunStreaming(), psospaSetAuxIoMode() or psospaSigGenApply() as appropriate.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

brightness, brightness of the LEDs. 0-100 inclusive (default 79).

Returns

PICO_OK

PICO_INVALID_PARAMETER (brightness is out of range)

3.52 psospaSetLedColours - set the colors of specified LEDs

```
PICO_STATUS psospaSetLedColours
(
  int16_t                           handle,
  PICO_LED_COLOUR_PROPERTIES*       colourProperties,
  uint32_t                          nColourProperties
)
```

Sets the colors of the specified LEDs. The new color will only take effect the next time that LED is applied by calling psospaRunBlock(), psospaRunStreaming(), psospaSetAuxIoMode() or psospaSigGenApply() as appropriate.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

colourProperties, array of the LEDs to set and the colour to set them to. Duplicate LEDs will take the colour of the last in the list.

nColourProperties, number of elements in the colourProperties array

Returns

PICO_OK

PICO_NULL_PARAMETER (the colourProperties pointer is null)

PICO_INVALID_PARAMETER (array length is invalid, one or more of the specified LEDs is not present on the device, one or more of the hue or saturation are out of range)

3.52.1 PICO_LED_COLOUR_PROPERTIES structure

```
typedef struct tPicoLedColourProperties
{
  PICO_LED_SELECT led_;
  uint16_t hue_;
  uint8_t saturation_;
} PICO_LED_COLOUR_PROPERTIES
```

This structure is used with psospaSetLedColours() to define the color for one LED using hue and saturation (HSV) values for the color.

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

Elements

led_, LED to set the colour of

hue_, hue of the LED, 0-359 inclusive

saturation_, saturation of the LED, 0-100 inclusive

3.52.2 PICO_LED_SELECT enumerated type

```
typedef enum enPicoLedSelect
{
  PICO_LED_CHANNEL_A = 0x00000000,
  PICO_LED_CHANNEL_B = 0x00000001,
  PICO_LED_CHANNEL_C = 0x00000002,
  PICO_LED_CHANNEL_D = 0x00000003,
  PICO_LED_AWG = 0x00010000,
  PICO_LED_AUX = 0x00020000
} PICO_LED_SELECT;
```

These values specify the LED channel within PICO_LED_COLOUR_PROPERTIES and PICO_LED_STATE_PROPERTIES structures.

3.53 psospaSetLedStates - set the states of specified LEDs

```
PICO_STATUS psospaSetLedStates
(
  int16_t                           handle,
  PICO_LED_STATE_PROPERTIES*        stateProperties,
  uint32_t                          nStateProperties
)
```

Sets the states of the specified LEDs.

Applicability

All modes

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`stateProperties:` array of the LEDs to set and the state to set them to. Duplicate LEDs will take the state of the last in the list.

`nStateProperties:` number of elements in the `stateProperties` array.

Returns

`PICO_OK`

`PICO_NULL_PARAMETER` (the `stateProperties` pointer is null)

`PICO_INVALID_PARAMETER` (array length is invalid, one or more of the specified LEDs is not present on the device)

3.53.1 PICO_LED_STATE_PROPERTIES structure

```
typedef struct tPicoLedStateProperties
{
  PICO_LED_SELECT               led_
  PICO_LED_STATE                state_;
} PICO_LED_STATE_PROPERTIES
```

This structure is used with psospaSetLedStates() to define the state for one LED using PICO_LED_STATE values below.

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

Elements

led_, LED to be configured

state_, new state of the LED:

- PICO_LED_AUTO, LED is controlled automatically to match the enabled state of its associated connector. This is the default behavior for all LEDs unless changed by the user.
- PICO_LED_OFF, LED is set off
- PICO_LED_ON, LED is set on

3.54 psospaSetNoOfCaptures - configure rapid block mode

```
PICO_STATUS psospaSetNoOfCaptures
(
  int16_t     handle,
  uint64_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 only one waveform.

Applicability

Rapid block mode

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`nCaptures,` the number of waveforms to capture in one run.

Returns

`PICO_OK`
`PICO_INVALID_PARAMETER`

3.55 psospaSetOutputEdgeDetect – change triggering behavior

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

This function enables or disables edge detection on the output of the trigger function. In the default mode (edge detection on) the trigger will only fire when there is a change in the state of the trigger function. For example, if you set up trigger conditions representing “A OR B above threshold”, the scope will only trigger at the moment the output of the logic function “A OR B” transitions from false to true. If either or both of the channels A or B are constantly high, the scope will not trigger. With edge detection off, the scope will trigger immediately when set running at any time that channel A or B is high.

To find out whether output edge detection is enabled, use psospaQueryOutputEdgeDetect().

Applicability

All modes

Arguments

`handle`, the device identifier returned by psospaOpenUnit().

`state`, enable (1) or disable (0) the trigger function output edge detection.

Returns

`PICO_OK`

3.56 psospaSetPulseWidthDigitalPortProperties – set the digital port pulse-width trigger settings

```
PICO_STATUS psospaSetPulseWidthDigitalPortProperties
(
  int16_t                              handle,
  PICO_CHANNEL                         port,
  PICO_DIGITAL_CHANNEL_DIRECTIONS    * directions,
  int16_t                              nDirections
)
```

This function sets the individual digital channels' pulse-width trigger directions. Each digital channel's direction consists of a channel name and a direction. If the channel is not included in the array of PICO_DIGITAL_CHANNEL_DIRECTIONS, the driver assumes the digital channel's pulse-width trigger direction is PICO_DIGITAL_DONT_CARE.

Applicability

All modes.
Any model with MSO channels fitted.

Arguments

handle, the device identifier returned by psospaOpenUnit().

port, identifies the digital port on the oscilloscope:

PICO_PORT0, channels D0–D7
PICO_PORT1, channels D8–D15

directions, a pointer to an array of PICO_DIGITAL_CHANNEL_DIRECTIONS 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 digital channels. If directions is NULL, all the digital channels' directions for the given port are set to PICO_DIGITAL_DONT_CARE. A digital channel that is not included in the array is also set to PICO_DIGITAL_DONT_CARE.

nDirections, the number of digital channel directions being passed to the driver.

Returns

PICO_OK
PICO_INVALID_DIGITAL_PORT, the requested digital port number is out of range.
PICO_INVALID_DIGITAL_CHANNEL, the digital channel is not a value within the supported PICO_PORT_DIGITAL_CHANNEL range.
PICO_INVALID_DIGITAL_TRIGGER_DIRECTION, the digital trigger direction is not a valid trigger direction within the supported PICO_DIGITAL_DIRECTION range.

3.57 psospaSetPulseWidthQualifierConditions - specify how to combine channels

```
PICO_STATUS psospaSetPulseWidthQualifierConditions
(
  int16_t                 handle,
  PICO_CONDITION        * conditions,
  int16_t                 nConditions,
  PICO_ACTION             action
)
```

This function is used to set conditions for the pulse width qualifier, which is an optional input to the triggering condition.

Multiple conditions can be combined as described in psospaSetTriggerChannelConditions() . When the pulse width condition is met, the pulse width timer is reset and this signifies the start of a "pulse". The main trigger condition signifies the end of the "pulse" and if the pulse width qualifier is enabled and the time between these events meets the time condition set with psospaSetPulseWidthQualifierProperties(), the scope will trigger.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

conditions, on entry, an array of structures specifiying the pulse width qualifier conditions. See PICO_CONDITION.

nConditions, the number of structures in the conditions array.

action, how to combine the array of conditions with existing pulse width qualifier conditions. See psospaSetTriggerChannelConditions() for the list of actions.

Returns

PICO_OK
PICO_NULL_PARAMETER
PICO_INVALID_ACTION

3.58 psospaSetPulseWidthQualifierDirections - specify threshold directions

```
PICO_STATUS psospaSetPulseWidthQualifierDirections
(
  int16_t          handle,
  PICO_DIRECTION * directions,
  int16_t          nDirections
)
```

This function is used to set the trigger direction for each channel used in the pulse width time qualifier, which is an optional input to the triggering condition.

This function works in the same way as psospaSetTriggerChannelDirections() . Each channel has two trigger threshold comparators, so when using simple level triggers you can use one for the pulse width direction (for example, RISING), and the other for the main trigger direction (for example, FALLING_LOWER) signifying a positive pulse.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

directions, an array of structures specifying the pulse width qualifier directions. See PICO_DIRECTION.

nDirections, the number of structures in the directions array.

Returns

PICO_OK
PICO_NULL_PARAMETER

3.59 psospaSetPulseWidthQualifierProperties - specify threshold logic

```
PICO_STATUS psospaSetPulseWidthQualifierProperties
(
  int16_t                 handle,
  uint32_t                lower,
  uint32_t                upper,
  PICO_PULSE_WIDTH_TYPE   type
)
```

This function is used to set parameters for the pulse width time qualifier, which is an optional input to the triggering condition.

The pulse width timer is reset when an event occurs matching the user's conditions set using psospaSetPulseWidthQualifierConditions(), this represents the start of a "pulse". The qualifier is true when the time since the most recent start-of-pulse event meets the conditions set by this function (for example, less than 100 sample intervals ago).

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

lower, the lower pulse width threshold in sample intervals.

upper, the upper pulse width threshold in sample intervals

type, the pulse width qualifier type:

- PICO_PW_TYPE_NONE = 0, no pulse width qualifier required
- PICO_PW_TYPE_LESS_THAN = 1, pulse width must be less than threshold
- PICO_PW_TYPE_GREATER_THAN = 2, pulse width must be greater than threshold
- PICO_PW_TYPE_IN_RANGE = 3, pulse width must be between two thresholds
- PICO_PW_TYPE_OUT_OF_RANGE = 4, pulse width must not be between two thresholds

Returns

PICO_OK
PICO_NULL_PARAMETER

3.60 psospaSetSimpleTrigger - set up basic triggering

```
PICO_STATUS psospaSetSimpleTrigger
(
  int16_t                     handle,
  int16_t                     enable,
  PICO_CHANNEL                source,
  int16_t                     threshold,
  PICO_THRESHOLD_DIRECTION    direction,
  uint64_t                    delay,
  uint32_t                    autoTriggerMicroSeconds
)
```

This function simplifies arming the trigger. It supports only the LEVEL trigger types and does not allow more than one channel to have a trigger applied to it. Any previous pulse width qualifier is canceled.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

enable: disable (0) or enable (1) the trigger.

source: the channel on which to trigger. This can be any of the input channels listed under psospaSetChannelOn(), or PICO_TRIGGER_AUX for the Aux IO input.

. input.

threshold: the ADC count at which the trigger will fire. Note: the AUX IO channel has a fixed threshold suitable for 3.3 V CMOS logic when used as a trigger input. Please ensure to set the threshold values to zero, otherwise PICO_THRESHOLD_OUT_OF_RANGE will be returned.

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.

delay: the time between the trigger occurring and the first post-trigger sample being taken, in sample intervals.

autoTriggerMicroSeconds: the time in microseconds 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

3.61 psospaSetTriggerChannelConditions - set triggering logic

```
PICO_STATUS psospaSetTriggerChannelConditions
(
  int16_t             handle,
  PICO_CONDITION    * conditions,
  int16_t             nConditions,
  PICO_ACTION         action
)
```

This function sets up trigger conditions on the scope's inputs. The trigger is defined by one or more PICO_CONDITION structures that are then ANDed together. By calling the function multiple times, additional sets of trigger conditions can be defined which are then ORed together. This AND-OR logic allows you to create any possible Boolean function of the scope's inputs.

If complex triggering is not required, use psospaSetSimpleTrigger().

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

conditions, an array of PICO_CONDITION structures specifying the conditions that should be applied to each channel. In the simplest case, the array consists of a single element. When there is more than one element, the overall trigger condition is the logical AND of all the elements.

nConditions, the number of elements in the conditions array. If nConditions is zero then triggering is switched off.

action, specifies how to apply the PICO_CONDITION array to any existing trigger conditions:

- PICO_CLEAR_ALL, resets any previous conditions
- PICO_ADD, adds this condition to any previous conditions

To apply only the conditions passed in the current call, specify both PICO_CLEAR_ALL | PICO_ADD together.

Returns

PICO_OK

PICO_NO_TRIGGER_CONDITIONS_SET, returned when no trigger conditions are set while the action is PICO_ADD.

PICO_INVALID_ACTION, returned when the action contains invalid flags.

PICO_CLEAR_DATA_BUFFER_INVALID, returned when the action contains invalid buffer clear flags.

PICO_INVALID_CHANNEL, returned when a specified channel is invalid.

PICO_INVALID_TRIGGER_STATES, returned when a specified trigger state is invalid.

PICO_DUPLICATE_CONDITION_SOURCE, returned when a duplicate condition source is detected.

3.61.1 PICO_CONDITION structure

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

```
typedef struct tPicoCondition
{
  PICO_CHANNEL       source;
  PICO_TRIGGER_STATE condition;
} PICO_CONDITION
```

Each structure specifies a condition for just one of the scope's inputs. The psospaSetTriggerChannelConditions() function can AND together a number of these structures to produce the final trigger condition.

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

Elements

source, the signal that forms an input to the trigger condition:
- PICO_CHANNEL_A, PICO_CHANNEL_B, PICO_CHANNEL_C, PICO_CHANNEL_D, one of the analog input channels
- PICO_PORT0, channels D0–D7, the first 8 digital inputs on MSO models
- PICO_PORT1, channels D8–D15, the next 8 digital inputs on MSO models
- PICO_TRIGGER_AUX, the **AUX** input
- PICO_PULSE_WIDTH_SOURCE, the output of the pulse width qualifier

condition, the type of condition that should be applied to each channel. Use these constants:
- PICO_CONDITION_DONT_CARE
- PICO_CONDITION_TRUE
- PICO_CONDITION_FALSE

The channels that are set to PICO_CONDITION_TRUE or PICO_CONDITION_FALSE must all meet their conditions simultaneously to produce a trigger. Channels set to PICO_CONDITION_DONT_CARE are ignored.

3.62 psospaSetTriggerChannelDirections - set trigger directions

```
PICO_STATUS psospaSetTriggerChannelDirections
(
  int16_t            handle,
  PICO_DIRECTION   * directions,
  int16_t            nDirections
)
```

This function sets the direction of the trigger for one or more channels.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`directions`, an array of structures specifying the trigger direction for each channel. See `PICO_DIRECTION`.

`nDirections`, the number of structures in the `directions` array.

Returns

`PICO_OK`
`PICO_INVALID_PARAMETER`

3.62.1 PICO_DIRECTION structure

A structure of this type is passed to psospaSetTriggerChannelDirections() in the directions argument to specify the trigger directions, and is defined as follows:

```
typedef struct tPicoDirection
{
  PICO_CHANNEL             channel;
  PICO_THRESHOLD_DIRECTION direction;
  PICO_THRESHOLD_MODE      thresholdMode;
} PICO_DIRECTION
```

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

Elements

channel, the channel whose direction you want to set.

direction, the direction required for the channel.

thresholdMode, the type of threshold to use. Each channel has two threshold comparators, designated as "upper" and "lower". These can be used independently, for example to set different directions or thresholds for the start and end of a time-qualified trigger using psospaSetPulseWidthQualifierDirections(), or used both together to set up a window or runt trigger as described below:

PICO_THRESHOLD_DIRECTION values:

Constant	Trigger type	Threshold	Polarity
PICO_ABOVE = 0	Gated	Upper	Above
PICO_ABOVE_LOWER = 5	Gated	Lower	Above
PICO_BELOW = 1	Gated	Upper	Below
PICO_BELOW_LOWER = 6	Gated	Lower	Below
PICO_RISING = 2	Threshold	Upper	Rising
PICO_RISING_LOWER = 7	Threshold	Lower	Rising
PICO_FALLING = 3	Threshold	Upper	Falling
PICO_FALLING_LOWER = 8	Threshold	Lower	Falling
PICO_RISING_OR_FALLING = 4	Threshold	Lower (for rising edge) Upper (for falling edge)	
PICO_INSIDE = 0	Window-qualified	Both	Inside
PICO_OUTSIDE = 1	Window-qualified	Both	Outside
PICO_ENTER = 2	Window	Both	Entering
PICO_EXIT = 3	Window	Both	Leaving
PICO_ENTER_OR_EXIT = 4	Window	Both	Either entering or leaving
PICO_POSITIVE_RUNT = 9	Window-qualified	Both	Entering from below
PICO_NEGATIVE_RUNT	Window-qualified	Both	Entering from above
PICO_NONE = 2	None	None	None

PICO_THRESHOLD_MODE values:

Constant	Mode
PICO_LEVEL = 0	Active when input is above or below a single threshold
PICO_WINDOW = 1	Active when input is between two thresholds

3.63 psospaSetTriggerChannelProperties - set up triggering

```
PICO_STATUS psospaSetTriggerChannelProperties
(
  int16_t                             handle,
  PICO_TRIGGER_CHANNEL_PROPERTIES   * channelProperties
  int16_t                             nChannelProperties
  uint32_t                            autoTriggerMicroSeconds
)
```

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

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`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.

`nChannelProperties`, the size of the `channelProperties` array. If zero, triggering is switched off.

`autoTriggerMicroSeconds`, the time in microseconds 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`
`PICO_NULL_CHANNEL_PROPERTIES`, returned if `channelProperties` is `nullptr` and `nChannelProperties` is greater than `0`.
`PICO_INVALID_CHANNEL`, returned if a channel is not valid.
`PICO_DUPLICATED_CHANNEL`, returned if a channel appears more than once in `channelProperties`.
`PICO_THRESHOLD_OUT_OF_RANGE`, returned if the upper or lower threshold of a channel is out of the valid range.

3.63.1 TRIGGER_CHANNEL_PROPERTIES structure

A structure of this type is passed to psospaSetTriggerChannelProperties() 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;
  PICO_CHANNEL   channel;
} PICO_TRIGGER_CHANNEL_PROPERTIES
```

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

There are two trigger thresholds called Upper and Lower. Each trigger type uses one or other of these thresholds, or both, as specified in psospaSetTriggerChannelDirections(). Each trigger threshold has its own hysteresis setting.

Elements

thresholdUpper, the upper threshold at which the trigger fires. It is scaled in 16-bit ADC counts at the currently selected range for that channel. Use when "Upper" or "Both" is specified in psospaSetTriggerChannelDirections().

hysteresisUpper, the distance by which the signal must fall below the upper threshold (for rising edge triggers) or rise above the upper threshold (for falling edge triggers) in order to rearm the trigger for the next event. It is scaled in 16-bit counts.

thresholdLower, lower threshold (see thresholdUpper). Use when "Lower" or "Both" is specified in psospaSetTriggerChannelDirections().

hysteresisLower, lower threshold hysteresis (see hysteresisUpper).

channel, the channel to which the properties apply. This can be one of the input channels listed under psospaSetChannelOn().

Note: the AUX IO channel has a fixed threshold suitable for 3.3 V CMOS logic when used as a trigger input. Please ensure to set threshold values to zero, otherwise PICO_THRESHOLD_OUT_OF_RANGE will be returned.

3.64 psospaSetTriggerDelay - set post-trigger delay

```
PICO_STATUS psospaSetTriggerDelay
(
  int16_t     handle,
  uint64_t    delay
)
```

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

Applicability

Block and rapid block modes

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`delay,` the time between the trigger event occurring and the first post-trigger sample being captured. For example, if `delay=100`, the post-trigger samples will be counted starting 100 sample periods after the trigger event. At a timebase of 5 GS/s, or 200 ps per sample, the delay would be 100 x 200 ps = 20 ns. If pre-trigger samples are requested, these are immediately preceding the post-trigger samples, i.e. overlapping with the trigger delay time.

Returns

`PICO_OK`

3.65 psospaSetTriggerDigitalPortProperties - set digital port trigger directions

```
PICO_STATUS psospaSetTriggerDigitalPortProperties
(
  int16_t                          handle,
  PICO_CHANNEL                     port,
  PICO_DIGITAL_CHANNEL_DIRECTIONS * directions,
  int16_t                          nDirections
)
```

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

Applicability

All modes
Any model with MSO channels fitted.

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`port,` identifies the digital port on the oscilloscope:
`PICO_PORT0,` channels D0–D7
`PICO_PORT1,` channels D8–D15

`directions,` an array of structures specifying the channel directions.

`nDirections,` the number of items in the `directions` array.

Returns

`PICO_OK`
`PICO_INVALID_DIGITAL_PORT,` indicates that the provided port is not valid.
`PICO_INVALID_DIGITAL_CHANNEL,` indicates that one of the provided digital channels is not in range.
`PICO_INVALID_DIGITAL_TRIGGER_DIRECTION,` indicates that one of the provided digital trigger directions is not in range.

3.65.1 PICO_DIGITAL_CHANNEL_DIRECTIONS structure

A list of structures of this type is passed to psospaSetTriggerDigitalPortProperties() in the directions argument to specify the digital channel trigger directions, and is defined as follows:

```
typedef struct tDigitalChannelDirections
{
  PICO_PORT_DIGITAL_CHANNEL         channel;
  PICO_DIGITAL_DIRECTION            direction;
} PICO_DIGITAL_CHANNEL_DIRECTIONS
```

The structure is byte-aligned. In C++, for example, you should specify this using the #pragma pack() instruction.

Elements

channel, identifies the digital channel within the selected port from PICO_PORT_DIGITAL_CHANNEL0 up to PICO_PORT_DIGITAL_CHANNEL7. For example, if you have selected PICO_PORT_1 then PICO_PORT_DIGITAL_CHANNEL0 represents D8 and PICO_PORT_DIGITAL_CHANNEL7 represents D15.

direction, the trigger direction from the following list:

PICO_DIGITAL_DONT_CARE:	channel has no effect on trigger
PICO_DIGITAL_DIRECTION_LOW:	channel must be low to trigger
PICO_DIGITAL_DIRECTION_HIGH:	channel must be high to trigger
PICO_DIGITAL_DIRECTION_RISING:	channel must transition from low to high to trigger
PICO_DIGITAL_DIRECTION_FALLING:	channel must transition from high to low to trigger
PICO_DIGITAL_DIRECTION_RISING_OR_FALLING:	channel must transition (in either direction) to trigger

3.66 psospaSetTriggerHoldoffCounterBySamples - set the trigger holdoff time in sample intervals

```
PICO_STATUS psospaSetTriggerHoldoffCounterBySamples
(
  int16_t       handle,
  uint64_t      holdoffSamples,
)
```

This function sets the trigger holdoff time in sample intervals. Trigger holdoff allows you to set a period when the scope won't look for further trigger events after each triggered acquisition.

Applicability

All modes

Arguments

`handle,` the device identifier returned by `psospaOpenUnit()`.

`holdoffSamples,` the time in sample intervals to disable looking for further triggers after the trigger event of each acquisition.

Returns

`PICO_OK`
`PICO_ARGUMENT_OUT_OF_RANGE`

3.67 psospaSigGenApply - set the signal generator running

```
PICO_STATUS psospaSigGenApply
(
  int16_t             handle,
  int16_t             sigGenEnabled,
  int16_t             sweepEnabled,
  int16_t             triggerEnabled,
  double            * frequency,
  double            * stopFrequency,
  double            * frequencyIncrement,
  double            * dwellTime
)
```

This function sets the signal generator running using parameters previously configured by the other psospaSigGen... functions.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`sigGenEnabled`, switches the signal generator on (1) or off (0).

`sweepEnabled`, switches sweep mode on (1) or off (0).

`triggerEnabled`, switches triggering of the signal generator on (1) or off (0).

`frequency`, on exit, the actual achieved signal generator frequency (or start frequency in sweep mode).

`stopFrequency`, on exit, the actual achieved signal generator frequency at the end of the sweep.

`frequencyIncrement`, on exit, the actual achieved frequency step size in sweep mode.

`dwellTime`, on exit, the actual achieved time in seconds between frequency steps in sweep mode.

Returns

`PICO_OK`
`PICO_WARNING_AUX_OUTPUT_CONFLICT`, indicates a conflict with the auxiliary output.
`PICO_BUSY`, indicates that the device is busy.

3.68 psospaSigGenFrequency - set output frequency

```
PICO_STATUS psospaSigGenFrequency
(
  int16_t                   handle,
  double                    frequencyHz
)
```

This function sets the frequency of the signal generator.

After configuring all required signal generator settings, call psospaSigGenApply() to apply them to the device.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

frequencyHz, the desired frequency in hertz.

Returns

PICO_OK
PICO_SIGGEN_FREQUENCY_OUT_OF_RANGE

3.69 psospaSigGenFrequencyLimits - get signal generator limit values

```
PICO_STATUS psospaSigGenFrequencyLimits
(
  int16_t                 handle,
  PICO_WAVE_TYPE          waveType,
  uint64_t              * numSamples,
  double                * minFrequencyOut,
  double                * maxFrequencyOut,
  double                * minFrequencyStepOut,
  double                * maxFrequencyStepOut,
  double                * minDwellTimeOut,
  double                * maxDwellTimeOut
)
```

This function queries the maximum and minimum values for the signal generator in fixed-frequency or sweep mode.

Applicability

All models

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`waveType`, the waveform that you intend to use.

`numSamples`, for arbitrary waveforms only, the number of samples in the AWG buffer.

`minFrequencyOut`, on exit, the lowest possible output frequency that can be achieved.

`maxFrequencyOut`, on exit, the highest possible output frequency that can be achieved.

`minFrequencyStepOut`, on exit, the smallest possible frequency step for frequency sweep mode.

`maxFrequencyStepOut`, on exit, the largest possible frequency step for frequency sweep mode.

`minDwellTimeOut`, on exit, the smallest possible dwell time for frequency sweep mode.

`maxDwellTimeOut`, on exit, the largest possible dwell time for frequency sweep mode.

Returns

`PICO_OK`
`PICO_SIGGEN_WAVETYPE_NOT_SUPPORTED`, returned if the `waveType` is not supported.
`PICO_SIGGEN_NULL_PARAMETER`, returned if `numSamples` is `nullptr` when `waveType` is `PICO_ARBITRARY`.
`PICO_SIG_GEN_PARAM`, returned if `numSamples` is `0` or greater than the maximum buffer size when `waveType` is `PICO_ARBITRARY`.

3.70 psospaSigGenFrequencySweep - set signal generator to frequency sweep mode

```
PICO_STATUS psospaSigGenFrequencySweep
(
  int16_t                 handle,
  double                  stopFrequencyHz,
  double                  frequencyIncrement,
  double                  dwellTimeSeconds,
  PICO_SWEEP_TYPE         sweepType
)
```

This function sets frequency sweep parameters for the signal generator. It assumes that you have previously called psospaSigGenFrequency() to set the start frequency.

After configuring all required signal generator settings, call psospaSigGenApply() to apply them to the device.

Applicability

Signal generator.

Arguments

handle, the device identifier returned by psospaOpenUnit().

stopFrequencyHz, the frequency in hertz at which the sweep should stop.

frequencyIncrement, the amount by which the frequency should change, in hertz, at each step of the sweep.

dwellTimeSeconds, the time for which the generator should wait between frequency steps.

sweepType, the direction of the sweep, from the following list:

- PICO_UP = 0, to sweep from startFrequency up to stopFrequency and then repeat.
- PICO_DOWN = 1, to sweep from startFrequency down to stopFrequency and then repeat.
- PICO_UPDOWN = 2, to sweep from startFrequency up to stopFrequency , then down to startFrequency, and then repeat.
- PICO_DOWNUP = 3, to sweep from startFrequency down to stopFrequency , then up to startFrequency, and then repeat.

Returns

PICO_OK

PICO_SIGGEN_FREQUENCY_OUT_OF_RANGE, returned if stopFrequencyHz or frequencyIncrement is out of the valid range.

PICO_SIGGEN_SWEEPTYPE_INVALID, returned if sweepType is not in the list of supported sweep types.

PICO_SIGGEN_INVALID_SWEEP_PARAMETERS, returned if the dwell count calculated from dwell time is outside the valid range.

3.71 psospaSigGenLimits - get signal generator parameters

```
PICO_STATUS psospaSigGenLimits
(
  int16_t                  handle,
  PICO_SIGGEN_PARAMETER    parameter,
  double                 * minimumPermissibleValue,
  double                 * maximumPermissibleValue,
  double                 * step
)
```

This function queries the maximum and minimum allowable values for a given signal generator parameter.

Applicability

All models

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`parameter`, one of the following enumerated values:

- `PICO_SIGGEN_PARAM_OUTPUT_VOLTS = 0`, the signal generator output voltage
- `PICO_SIGGEN_PARAM_SAMPLE = 1`, the value of a sample in the arbitrary waveform buffer
- `PICO_SIGGEN_PARAM_BUFFER_LENGTH = 2`, the length of the arbitrary waveform buffer in samples

`minimumPermissibleValue`, on exit, the minimum value

`maximumPermissibleValue`, on exit, the maximum value

`step`, on exit, the smallest increment in the parameter that will cause a change in the signal generator output.

Returns

`PICO_OK`

`PICO_NULL_PARAMETER`, returned if all pointers are `nullptr`.

`PICO_SIG_GEN_PARAM`, indicates that an invalid `PICO_SIGGEN_PARAMETER` was passed to the function.

3.72 psospaSigGenPause - stop the signal generator

```
PICO_STATUS psospaSigGenPause
(
  int16_t                   handle
)
```

This function stops the signal generator. The output will remain at a constant voltage until the generator is restarted with psospaSigGenRestart().

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

Returns

PICO_OK
PICO_SIGGEN_SETTINGS_CHANGED_CALL_APPLY

3.73 psospaSigGenPhase - set signal generator using delta-phase value instead of a frequency

```
PICO_STATUS psospaSigGenPhase
(
  int16_t                   handle,
  uint64_t                  deltaPhase
)
```

This function sets the signal generator output frequency (or the starting frequency, in the case of a frequency sweep) using a delta-phase value instead of a frequency. See Calculating deltaPhase for more information on how to calculate this value.

After configuring all required signal generator settings, call `psospaSigGenApply()` to apply them to the device.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`deltaPhase`, the desired delta phase.

Returns

`PICO_OK`
`PICO_SIGGEN_FREQUENCY_OUT_OF_RANGE`

3.73.1 Calculating deltaPhase

The signal generator uses direct digital synthesis (DDS) with a 48-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.

The signal generator steps through the waveform by adding a *deltaPhase* value between 1 and *phaseAccumulatorSize*-1 to the phase accumulator every *dacPeriod* (= 1/*dacFrequency*). The generator produces a waveform at a frequency that can be calculated as follows:

$$outputFrequency = \frac{dacFrequency}{arbitraryWaveformSize} \times \frac{deltaPhase}{2^{(phaseAccumulatorSize - bufferAddressWidth)}}$$

where:

outputFrequency = repetition rate of the complete arbitrary waveform
dacFrequency = update rate of AWG DAC (see table below)
deltaPhase = delta-phase value supplied to this function
phaseAccumulatorSize = width in bits of phase accumulator (see table below)
bufferAddressWidth = width in bits of AWG buffer address (see table below)
arbitraryWaveformSize = length in samples of the user-defined waveform

Parameter	Value
dacFrequency	200 MHz
dacPeriod	1/*dacFrequency*. 5 ns.
phaseAccumulatorSize	48
bufferAddressWidth	15

3.74 psospaSigGenPhaseSweep - sweep using delta-phase values instead of frequency values

```
PICO_STATUS psospaSigGenPhaseSweep
(
  int16_t                   handle,
  uint64_t                  stopDeltaPhase,
  uint64_t                  deltaPhaseIncrement,
  uint64_t                  dwellCount,
  PICO_SWEEP_TYPE           sweepType
)
```

This function sets frequency sweep parameters for the signal generator using delta-phase values instead of frequency values. It assumes that you have previously called psospaSigGenPhase() to set the starting delta-phase.

After configuring all required signal generator settings, call psospaSigGenApply() to apply them to the device.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

stopDeltaPhase, the delta-phase at which the sweep should stop. You must set the starting delta-phase, deltaPhase, beforehand by calling psospaSigGenPhase().

deltaPhaseIncrement, the amount by which the delta-phase should change at each step of the sweep.

dwellCount, the number of samples for which the generator should wait between sweep steps.

sweepType, the direction of the sweep, from the following list:

- PICO_UP = 0, to sweep from deltaPhase up to stopDeltaPhase and then repeat.
- PICO_DOWN = 1, to sweep from deltaPhase down to stopDeltaPhase and then repeat.
- PICO_UPDOWN = 2, to sweep from deltaPhase up to stopDeltaPhase , then down to deltaPhase, and then repeat.
- PICO_DOWNUP = 3, to sweep from deltaPhase down to stopDeltaPhase , then up to deltaPhase, and then repeat.

Returns

PICO_OK
PICO_SIGGEN_FREQUENCY_OUT_OF_RANGE
PICO_SIGGEN_INVALID_SWEEP_PARAMETERS
PICO_SIGGEN_SWEEPTYPE_INVALID

3.75 psospaSigGenRange - set signal generator output voltages

```
PICO_STATUS psospaSigGenRange
(
  int16_t   handle,
  double    peakToPeakVolts,
  double    offsetVolts
)
```

This function sets the amplitude (peak to peak measurement) and offset (voltage corresponding to data value of zero) of the signal generator.

After configuring all required signal generator settings, call psospaSigGenApply() to apply them to the device.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

peakToPeakVolts, the signal generator's peak-to-peak output range in volts.

offsetVolts, the signal generator's output offset in volts.

The total output voltage accounting for both peak-to-peak and offset must fall within the signal generator's output voltage range described in the data sheet for your PicoScope model, or returned by psospaSigGenLimits().

Returns

PICO_OK
PICO_SIGGEN_PK_TO_PK
PICO_SIGGEN_OFFSET_VOLTAGE
PICO_SIGGEN_OUTPUT_OVER_VOLTAGE, if peakToPeak and offset are within their individual ranges but the combination is out of range.

3.76 psospaSigGenRestart - continue after pause

```
PICO_STATUS psospaSigGenRestart
(
  int16_t                   handle
)
```

This function restarts the signal generator after it was paused with psospaSigGenPause().

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

Returns

PICO_OK

PICO_SIGGEN_SETTINGS_CHANGED_CALL_APPLY, the signal generator has been partially reconfigured and the new settings must be applied before it can be paused or restarted.

3.77 psospaSigGenSoftwareTriggerControl - set software triggering

```
PICO_STATUS psospaSigGenSoftwareTriggerControl
(
  int16_t                     handle,
  PICO_SIGGEN_TRIG_TYPE       triggerState
)
```

This function causes the signal generator trigger to fire, if a software trigger has been set up using psospaSigGenTrigger() and the signal generator is waiting for a trigger event.

If the trigger type set using psospaSigGenTrigger() is PICO_SIGGEN_RISING or PICO_SIGGEN_FALLING, calling this function will trigger the defined number of waveform cycles or sweeps and the triggerState parameter is not used.

If the trigger type set using psospaSigGenTrigger() is PICO_SIGGEN_GATE_HIGH or PICO_SIGGEN_GATE_LOW, calling this function will start the signal generator running when triggerState = PICO_SIGGEN_GATE_HIGH , or pause it when any other value.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

triggerState, when the trigger type is set to gating, runs the signal generator if triggerState = PICO_SIGGEN_GATE_HIGH or pauses it otherwise.

Returns

PICO_OK
PICO_SIGGEN_TRIGGER_SOURCE

3.78 psospaSigGenTrigger - choose the trigger event

```
PICO_STATUS psospaSigGenTrigger
(
  int16_t                    handle,
  PICO_SIGGEN_TRIG_TYPE      triggerType,
  PICO_SIGGEN_TRIG_SOURCE    triggerSource,
  uint64_t                   cycles,
  uint64_t                   autoTriggerPicoSeconds
)
```

This function sets up triggering for the signal generator. This feature causes the signal generator to start and stop under the control of a signal or event.

After configuring all required signal generator settings, call psospaSigGenApply() to apply them to the device.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

triggerType, whether an edge trigger (starts on a specified edge) or a gated trigger (runs while trigger is in the specified state):

```
PICO_SIGGEN_RISING = 0,
PICO_SIGGEN_FALLING = 1,
PICO_SIGGEN_GATE_HIGH = 2,
PICO_SIGGEN_GATE_LOW = 3
```

triggerSource, the signal used as a trigger:

```
PICO_SIGGEN_NONE = 0,
PICO_SIGGEN_SCOPE_TRIG = 1,
PICO_SIGGEN_AUX_IN = 2,
PICO_SIGGEN_SOFT_TRIG = 4,
```

cycles, the number of waveform cycles to generate after the trigger edge or after entering the active trigger state. Set to zero to make the signal generator run indefinitely.

autoTriggerPicoSeconds, reserved for future use, set to zero.

Returns

PICO_OK

PICO_SIGGEN_TRIGGERTYPE_NOT_SUPPORTED, this indicates that the provided trigger type is not supported.

PICO_SIGGEN_TRIGGERSOURCE_NOT_SUPPORTED, indicates that the provided trigger source is not supported.

PICO_SIGGEN_CYCLES_OUT_OF_RANGE, this indicates that the provided cycles value exceeds the maximum allowed value.

3.79 psospaSigGenWaveform - choose signal generator waveform

```
PICO_STATUS psospaSigGenWaveform
(
  int16_t          handle,
  PICO_WAVE_TYPE   waveType,
  int16_t        * buffer,
  uint64_t         bufferLength
)
```

This function specifies which waveform the signal generator will produce. After configuring all required signal generator settings, call psospaSigGenApply() to apply them to the device.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

waveType, specifies the type of waveform to generate, for example PICO_SINE

buffer, an array of sample values to be used by the arbitrary waveform generator (AWG). Used only when waveType = PICO_ARBITRARY. Each sample value should be in the range (–32767 to 32767) as returned by psospaSigGenLimits(), representing the full output voltage span of the waveform generator.

bufferLength, the number of samples in the buffer array. Used only when waveType = PICO_ARBITRARY.

Returns

PICO_OK
PICO_SIGGEN_WAVETYPE_NOT_SUPPORTED, indicates that the provided wave type is not supported.
PICO_SIGGEN_BUFFER_NOT_SUPPLIED, indicates that the buffer is nullptr when the wave type is PICO_ARBITRARY.
PICO_SIGGEN_EMPTY_BUFFER_SUPPLIED, indicates that the buffer length is zero when the wave type is PICO_ARBITRARY.
PICO_SIGGEN_TOO_MANY_SAMPLES, indicates that the buffer length exceeds the maximum allowed samples.

3.80 psospaSigGenWaveformDutyCycle - set duty cycle

```
PICO_STATUS psospaSigGenWaveformDutyCycle
(
  int16_t   handle,
  double    dutyCyclePercent
)
```

This function sets the duty cycle of the signal generator waveform in square wave and triangle wave modes.

The duty cycle of a pulse waveform is defined as the time spent in the high state divided by the period. The default duty cycle is 50% (representing a square wave with equal high and low times, or a triangle wave with equal rise and fall times) and it is only necessary to call this function if a different duty cycle is required.

After configuring all required signal generator settings, call psospaSigGenApply() to apply them to the device.

Applicability

Square wave and triangle wave outputs only.

Arguments

`handle`, the device identifier returned by psospaOpenUnit().

`dutyCyclePercent`, the percentage duty cycle of the waveform from 0.0 to 100.0.

Returns

`PICO_OK`

`PICO_SIGGEN_DUTYCYCLE_OUT_OF_RANGE`, indicates that the provided duty cycle percentage is out of the valid range (`0.0` to `100.0`)

3.81 psospaStartFirmwareUpdate - update the device firmware

```
PICO_STATUS psospaStartFirmwareUpdate
(
  int16_t                     handle,
  PicoUpdateFirmwareProgress  progress
)
```

This function updates the device's firmware (the embedded instructions stored in nonvolatile memory in the device). Updates may fix bugs or add new features.

The function applies any firmware update to the device which is included in the current driver. It does not check online for updates or require internet access.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

`progress`, a user-supplied function that receives callbacks when the status of the update changes. See `PicoUpdateFirmwareProgress()`. May be NULL if not required.

Returns

`PICO_FIRMWARE_UP_TO_DATE`, the firmware update was performed successfully or firmware was already up to date

3.82 psospaStop - stop sampling

```
PICO_STATUS psospaStop
(
  int16_t    handle
)
```

This function stops the scope device from sampling data.

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

When running the device in block mode or rapid block mode, you can call this function to interrupt data capture.

If this function is called before a trigger event occurs, the oscilloscope may not contain valid data.

Applicability

All modes

Arguments

`handle`, the device identifier returned by `psospaOpenUnit()`.

Returns

`PICO_OK`

3.83 psospaStopUsingGetValuesOverlapped - complements psospaGetValuesOverlapped

```
PICO_STATUS psospaStopUsingGetValuesOverlapped
(
  int16_t           handle
)
```

This function stops deferred data-collection that was started by calling psospaGetValuesOverlapped().

Applicability

Block and rapid block mode

Arguments

handle, the device identifier returned by psospaOpenUnit().

Returns

PICO_OK

3.84 psospaTriggerWithinPreTriggerSamples - switch feature on or off

```
PICO_STATUS psospaTriggerWithinPreTriggerSamples
(
  int16_t                          handle,
  PICO_TRIGGER_WITHIN_PRE_TRIGGER  state
)
```

When this feature is enabled, the scope will trigger if a trigger event is detected during the pre-trigger samples. Effectively, the user-specified pre-trigger count becomes a maximum pre-trigger count and the actual number of pre-trigger samples returned will be between zero and that number depending on when the trigger occurs. You can find the actual trigger point by calling psospaGetTriggerInfo() after the capture has completed.

Applicability

All modes

Arguments

`handle,` the device identifier returned by psospaOpenUnit().

`state,` 0 to enable, 1 to disable.

Returns

`PICO_OK`

`PICO_INVALID_TRIGGER_WITHIN_PRE_TRIGGER_STATE,` indicates that the provided state is invalid.

4 Callbacks

4.1 psospaBlockReady - indicate when block-mode data ready

```
typedef void (*psospaBlockReady)
(
  int16_t        handle,
  PICO_STATUS    status,
  PICO_POINTER   pParameter
)
```

This callback function is part of your application. You register it with the psospa driver using psospaRunBlock() and the driver calls it back when block-mode data is ready. You can then download the data using the psospaGetValues() function.

Applicability

Block mode only

Arguments

handle, the device identifier returned by psospaOpenUnit().

status, indicates whether an error occurred during collection of the data.

pParameter, a pointer passed from psospaRunBlock(). Your callback function can write to this location to send any data, such as a status flag, back to your application.

Returns

nothing

4.2 psospaDataReady - indicate when post-collection data is ready

```
typedef void(*psospaDataReady)
(
  int16_t          handle,
  PICO_STATUS      status,
  uint64_t         noOfSamples,
  int16_t          overflow,
  PICO_POINTER     pParameter
)
```

This is a callback function that you write to collect data from the driver. You supply a pointer to the function when you call psospaGetValuesAsync() and the driver calls your function back when the data is ready.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

status, a PICO_STATUS code returned by the driver.

noOfSamples, the number of samples collected.

overflow, a set of flags that indicates whether an overvoltage has occurred and on which channels. It is a bit field with bit 0 representing Channel A.

pParameter, a void pointer passed from psospaGetValuesAsync(). 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

4.3 PicoUpdateFirmwareProgress - get status of firmware update

```
typedef void (* PicoUpdateFirmwareProgress)
(
  int16_t        handle,
  uint16_t       progress
)
```

You should write this callback function and register it with the driver using psospaStartFirmwareUpdate(). The driver calls it back when the firmware update status changes.

Applicability

All modes

Arguments

handle, the device identifier returned by psospaOpenUnit().

progress, a progress indicator.

Returns

nothing

5 Reference

5.1 Numeric data types

Here is a list of the numeric data types used in the psospa API:

Type	Bits	Signed or unsigned?
int8_t	8	signed
uint8_t	8	unsigned
int16_t	16	signed
uint16_t	16	unsigned
enum	32	enumerated
int32_t	32	signed
uint32_t	32	unsigned
float	32	signed (IEEE 754)
double	64	signed (IEEE 754)
int64_t	64	signed
uint64_t	64	unsigned

5.2 Enumerated types and constants

The enumerated types and constants used in the psospa API are defined in header files included in the SDK. We recommend that you refer to these constants by name unless your programming language allows only numerical values.

5.3 Driver status codes

Every function in the psospa driver returns a **driver status code** from the list of PICO_STATUS values in the file PicoStatus.h, which is included in the Pico Technology SDK. Not all codes in PicoStatus.h apply to the psospa driver.

In addition to the function-specific error codes described in this guide, functions may also return a generic error code such as one of the following:

PICO_INVALID_HANDLE, the handle passed does not refer to an open PicoScope unit.

PICO_MEMORY_FAIL, could not allocate sufficient memory on the host PC to complete the operation.

PICO_NOT_RESPONDING, the PicoScope did not respond to a command, for example if it has been disconnected.

PICO_INTERNAL_ERROR, an unexpected error has occurred in the driver. Contact Pico technical support for assistance.

PICO_DRIVER_FUNCTION, a driver function has already been called and not yet finished. Only one call to the driver can be made at any one time.

5.4 Glossary

Callback. A mechanism that the PicoScope 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.

Driver. A program that controls a piece of hardware. The psospa driver, which supports PicoScope 3000E and 5000E oscilloscopes, is supplied in the form of 64-bit Windows DLLs called psospa.dll and macOS and Linux libraries called libpsospa. These are used by your application to control the oscilloscopes.

Hi-Speed USB: Also known as USB 2.0, these legacy ports support a data transfer rate of up to 480 megabits per second.

PicoScope 3000E Series. A range of PC Oscilloscopes from Pico Technology, with bandwidths up to 500 MHz, maximum sampling rate of up to 5 GS/s, sampling resolutions of 8/10 bits and a capture memory size of 2 GS.

PicoScope 5000E Series. A range of PC Oscilloscopes from Pico Technology, with bandwidths up to 500 MHz, maximum sampling rate of up to 5 GS/s, sampling resolutions of 16-bit (PicoScope 5000E models) and 8-/16-bit (PicoScope 5000E+ models) and a capture memory size of up to 2 GS.

USB 5Gbps: Also known as USB 3.0 and USB 3.1 Gen1, this port uses signaling speeds of 5 Gb/s and is backwards compatible with Hi-Speed USB.

UK headquarters:

Pico Technology
James House
Colmworth Business Park
St. Neots
Cambridgeshire
PE19 8YP
United Kingdom

Tel: +44 (0) 1480 396 395

sales@picotech.com
support@picotech.com

US regional office:

Pico Technology
320 N Glenwood Blvd
Tyler
TX 75702
USA

Tel: +1 800 591 2796

sales@picotech.com
support@picotech.com

Asia-Pacific regional office:

pico.asia-pacific@picotech.com

Germany regional office and EU Authorised Representative:

Pico Technology GmbH
Emmericher Str. 60
47533 Kleve
Germany

Tel: +49 (0) 5131 907 62 90

info.de@picotech.com

www.picotech.com

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