USB DrDAQ

Data Logger

Programmer's Guide

usbdrdaqpg.en r7


pico
Technology

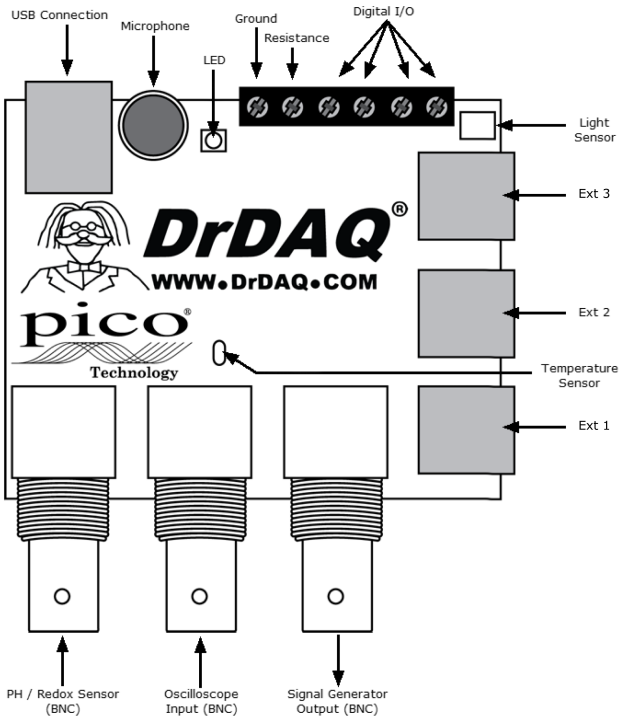
Contents

1 Introduction

1.1 Overview

The USB DrDAQ® PC Data Logger is a medium-speed, multichannel voltage-input device for sampling data using a PC. This manual explains how to use the Application Programming Interface and drivers to write your own programs to control the unit. You should read it in conjunction with the USB DrDAQ User's Guide.

The Software Development Kit for the USB DrDAQ is compatible with 32-bit and 64-bit editions of Microsoft Windows® XP SP3, Windows Vista, Windows 7 and Windows 8.



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Upgrades. We provide upgrades, free of charge, from our web site at www.picotech.com. We reserve the right to charge for updates or replacements sent out on physical media.

1.3 Contact details

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1.4 Software updates

Our software is regularly updated with new features. To check what version of the software you are running, start PicoScope or PicoLog and select the **Help > About** menu. The latest version of software can be downloaded free of charge from the DrDAQ web site at:

http://www.drdaq.com

Alternatively, the latest software can be purchased on disk from Pico Technology.

To be kept up-to-date with news of new software releases join our e-mail mailing list. This can be done from the main Pico Technology web site at:

http://www.picotech.com/

2 Writing your own software

2.1 About the driver

USB DrDAQ is supplied with a kernel driver, and a DLL containing routines that you can build into your own programs. The driver is supported by the following operating systems:

- Microsoft Windows XP (SP3 or later)
- Microsoft Windows Vista
- Microsoft Windows 7
- Microsoft Windows 8 (not Windows RT)

and is supplied in 32-bit and 64-bit versions.

The SDK contains the drivers, a selection of examples of how to use them, and the current *Programmer's Guide*.

The DLL can be used with any programming language or application that can interface with DLLs: for example, C, Embarcadero Delphi, Microsoft Visual Basic, Microsoft Excel and National Instruments LabVIEW. The SDK contains an example for Excel, a C console example that demonstrates all of the facilities in the driver and a LabVIEW interface and examples.

The driver supports up to 64 units at one time.

2.2 Installing the driver

The driver is supplied with the USB DrDAQ SDK. You can download the latest version of the SDK from our website at:

http://www.picotech.com/software.html

Select *DrDAQ Data Logger (USB)* as the hardware product and then *Software Development Kit* as the software product.

The easiest way to install the USB DrDAQ kernel driver is to install PicoScope or PicoLog. These programs are available free of charge from the Pico Technology website. If you prefer to install the driver manually, proceed as follows:

1. Unzip the USB DrDAQ SDK
2. Go to the `system\` directory in the SDK
3. Run `dpinst.exe`
4. Plug the device in and follow any instructions in the New Hardware Wizard if it appears

2.3 Connecting the logger

Before you connect your logger, you must first install the driver.

To connect the data logger, plug the cable provided into any available USB port on your PC. The first time you connect the unit, some versions of Windows may display a New Hardware Wizard. Follow any instructions in the Wizard and wait for the driver to be installed. The unit is then ready for use.

2.4 Capture modes

Three modes are available for capturing data:

- BM_SINGLE: collect a single block of data and exit
- BM_WINDOW: collect a series of overlapping blocks of data
- BM_STREAM: collect a continuous stream of data

BM_SINGLE is useful when you wish to collect data at high speed for a short period: for example, to collect 1000 readings in 50 milliseconds. The maximum block size is 16,384 samples, shared between all active channels.

BM_WINDOW is useful when collecting several blocks of data at low speeds - for example when collecting 10,000 samples over 10 seconds. Collecting a sequence of single blocks like this would take 10 seconds for each block, so displayed data would not be updated frequently. Using windowing, it is possible to ask for a new block more frequently, for example every second, and to receive a block containing 9 seconds of repeat data and 1 second of new data. The block is effectively a 10-second window that advances one second per cycle.

BM_STREAM is useful when you need to collect data continuously for long periods. In principle, it could be used to collect data indefinitely. Every time UsbDrDaqGetValues is called, it returns the new readings since the last time it was called. The noOfValues argument passed to UsbDrDaqRun must be sufficient to ensure that the buffer does not overflow between successive calls to UsbDrDaqGetValues. For example, if you call UsbDrDaqGetValues every second and you are collecting 500 samples per second, noOfValues must be at least 500, or preferably 1000, to allow for delays in the operating system.

2.5 USB DrDAQ scaling files (.DDS)

The DrDAQ driver has built-in scaling for each of the built-in and Pico-supplied sensors. You can incorporate scaling for your own sensors by adding a file called scaling.dds (where *'scaling'* can be replaced with a name of your choice). This file will contain the details of your sensor.

The values returned by the driver are integers that represent fixed-point decimal numbers. For example, the driver treats pH as a value with two decimal places, so a pH of 7.65 is returned as 765.

You can call the routine UsbDrDaqGetChannelInfo to find out how many decimal places a channel is using, and also to get a divider that converts the integer value to the corresponding real number. For pH, the returned divider is 100, so 765 divided by 100 gives 7.65.

For some sensors, there is more than one possible scaling available. You can call UsbDrDaqGetScalings to get a list of valid scaling codes, then call UsbDrDaqSetScalings to select one of them. Once selected, UsbDrDaqGetChannelInfo will return full information about the selected scaling. If you do not use UsbDrDaqSetScalings, the driver will automatically select the first available scaling for each channel.

USB DrDAQ scaling files can be used to supplement the scalings built into the driver. Several DDS files may be used, and these must be placed in the current working directory where the USB DrDAQ software is installed. The total number of sets of scaling data in all the files used must not exceed 99.

Each scaling file may contain more than one set of scaling data. Each scaling must have a unique scaling number, contained in the `[Scale...]` section heading.

A set of typical entries from a `.DDS` file is shown below:

```
[Scale1]
Resistor=1
LongName=CustomTemperature1
ShortName=TempC
Units=C
MinValue=-40
MaxValue=120
OutOfRange=0
Places=1
Method=0
IsFast=Yes
NoOfPoints=32
Raw1=2.385
Scaled1=-30
...
Raw32=1.32
Scaled32=100

[Scale2]
Resistor=2.2
LongName=CustomTemperature2
ShortName=TempF
Units=F
MinValue=32
MaxValue=160
...
[Scale3]
Resistor=3.3
LongName=CustomLight
ShortName=Light
Units=lux
MinValue=0
MaxValue=20000
...
```

The meanings of the terms in the `.DDS` file are as follows:

`[Scale1]`

A unique number, from 1 to 99, to identify this entry. (Pico-created numbers are from 100 upwards.)

`Resistor=1`

The ID resistor value in kiloohms. In this example "`1`" represents 1k, "`2.2`" represents 2k2 and so on.

For external sensors, this resistor should be fitted in the sensor. You must use one of the following resistors: 1k0, 2k2, 3k3, 5k6, 7k5 or 10k. The resistor must be 1% tolerance or better.

For internal sensors, use the following 'virtual' resistor values:

Channel	Resistor value
Sound Waveform	1200
Sound Level	1300
Voltage	1500
Resistance	1600
pH	1400
Temperature	1100
Light	1000

```
LongName=Temperature
```

Used in PicoLog

```
ShortName=TempC
```

This field is not used by USB DrDAQ running PicoScope or PicoLog.

```
Units=C
```

Displayed on graphs

```
MinValue=-40
MaxValue=120
```

Note: For PicoScope these values will determine the maximum and minimum values displayed in Scope View. For PicoLog these values determine what Maximum range is displayed in the Graph View (set in the **Graph Options** dialog).

```
Places=1
```

Number of decimal places. The options are 0, 1, 2 and 3. With `places=1` the value 15.743 would be returned as 157, meaning 15.7. With `places=2`, the same value would be returned as 1574.

```
Method=0
```

This specifies the scaling method. 0 specifies table lookup and 1 specifies linear scaling.

```
Offset=0
Gain=1
```

These are the offset and gain values for linear scaling.

```
OutOfRange=0
```

This specifies what to do if the raw value is outside the range of the table lookup. The options are:
0 - treat as a sensor failure
1 - clip the value to the minimum or maximum table value
2 - extrapolate the value using the nearest two table entries.

```
ScopeRange=1.25V
```

This is used when scaling the oscilloscope channel. It specifies the range of the oscilloscope channel that should be used. Possible values are 10 V, 5 V, 2.5 V, and 1.25 V.

```
NoOfPoints=32
```

This is the number of table lookup points.

```
Raw1=2.385
```

Raw value for the first point in the look up table. The value is in V (volts) and should not be greater than 2.500 V.

```
Scaled1=-30
```

Scaled value for the first point in the look up table. The units are specified by the units parameter.

3 USB DrDAQ API functions

3.1 Summary

The following table explains each of the driver functions supplied with the USB DrDAQ data logger:

Routine	Description
UsbDrDaqCloseUnit	close the unit
UsbDrDaqEnableRGBLED	enable or disable RGB mode on the LED
UsbDrDaqGetChannelInfo	return a set of information about the currently selected scaling for the specified channel
UsbDrDaqGetInput	configure the general-purpose I/Os as digital inputs
UsbDrDaqGetPulseCount	return the current pulse count
UsbDrDaqGetScalings	discover the scalings, both built-in and custom, that are available
UsbDrDaqGetSingle	get a single value from a specified channel
UsbDrDaqGetSingleF	get a single floating-point value
UsbDrDaqGetTriggerTimeOffsetNs	return the time between the trigger point and the first post-trigger sample
UsbDrDaqGetUnitInfo	return various items of information about the unit
UsbDrDaqGetValues	get a number of sample values after a run
UsbDrDaqGetValuesF	get floating-point values after a run
UsbDrDaqOpenUnit	open and enumerate the unit
UsbDrDaqOpenUnitAsync	open the unit without waiting for completion
UsbDrDaqOpenUnitProgress	report progress of UsbDrDaqOpenUnitAsync
UsbDrDaqPingUnit	check that a device is connected
UsbDrDaqReady	indicate when UsbDrDaqRun has captured data
UsbDrDaqRun	tell the unit to start capturing data
UsbDrDaqSetDO	control the digital outputs
UsbDrDaqSetInterval	set the sampling speed of the unit (integer)
UsbDrDaqSetIntervalF	set the sampling speed of the unit (floating-point)
UsbDrDaqSetPWM	configure the general-purpose I/Os as pulse-width modulation outputs
UsbDrDaqSetRGBLED	set the colour of the LED once RGB mode has been enabled
UsbDrDaqSetScalings	set the scaling for a particular channel
UsbDrDaqSetSigGenArbitrary	allow full control of the arbitrary waveform generator
UsbDrDaqSetSigGenBuiltIn	set the arbitrary waveform generator using standard waveform types
UsbDrDaqSetTrigger	set the trigger on the unit
UsbDrDaqStartPulseCount	configure the general-purpose I/Os for pulse counting and start counting
UsbDrDaqStop	abort data collection
UsbDrDaqStopSigGen	turn the AWG off

The driver allows you to do the following:

- Identify and open the logger
- Take a single reading from a particular channel
- Collect a block of samples at fixed time intervals from one or more channels
- Set up a trigger event for a particular channel
- Get information about scalings available for a channel
- Select a scaling for a channel
- Control and read general-purpose I/Os
- Control arbitrary waveform generator

You can specify a sampling interval from 1 microsecond to 1 second. The shortest interval that the driver will accept depends on the capture mode selected.

The normal calling sequence to collect a block of data is as follows:

```
Check that the driver version is correct
Open the driver
Set trigger mode (if required)
Set sampling mode (channels and time per sample)

While you want to take measurements,
  Run
  While not ready
    Wait
  End while
  ... Get a block of data ...
End While
Close the driver
```


3.2 UsbDrDaqCloseUnit

```
PICO_STATUS UsbDrDaqCloseUnit(
  int16_t            handle
)
```

This function closes the unit.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress.
Returns:	`PICO_OK` `PICO_HANDLE_INVALID`

3.3 UsbDrDaqEnableRGBLED

```
PICO_STATUS UsbDrDaqEnableRGBLED(
  int16_t            handle,
  int16_t            enabled
)
```

This function enables or disables RGB mode on the LED.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress `enabled`: if non-zero, RGB mode is enabled. If zero RGB mode is disabled and the LED returns to normal operation (flashing when sampling).

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_NOT_RESPONDING`

3.4 UsbDrDaqGetChannelInfo

```
PICO_STATUS UsbDrDaqGetChannelInfo(
  int16_t            handle,
  float            * min,
  float            * max,
  int16_t          * places,
  int16_t          * divider,
  USB_DRDAQ_INPUTS   channel
)
```

This procedure returns a set of information about the currently selected scaling for the specified channel. If a parameter is not required, you can pass a null pointer to the routine.

Arguments:	handle: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. min: on exit, the minimum value that the channel can take. max: on exit, the maximum value that the channel can take. places: on exit, the number of decimal places. divider: on exit, the number that values should be divided by to give real numbers. channel: the channel to return details for. See Channel numbers.
Returns:	PICO_OK PICO_NOT_FOUND PICO_INVALID_PARAMETER

3.5 UsbDrDaqGetInput

```
PICO_STATUS UsbDrDaqGetInput(
  int16_t            handle,
  USB_DRDAQ_GPIO     IOChannel,
  int16_t            pullUp,
  int16_t          * value
)
```

This function is used to configure the general-purpose I/Os as digital inputs.

Arguments:	`handle:` device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress `IOChannel:` all GPIOs can be used as digital inputs. See Channel numbers. `pullUp:` used to specify whether pull-up resistor is used. `value:` on exit, indicates the state of the input (0 or 1).

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_NOT_RESPONDING`
	`PICO_INVALID_PARAMETER`

3.6 UsbDrDaqGetPulseCount

```
PICO_STATUS UsbDrDaqGetPulseCount(
  int16_t            handle,
  USB_DRDAQ_GPIO     IOChannel,
  int16_t          * count
)
```

This function will return the current pulse count. It should be called after pulse counting has been started using UsbDrDaqStartPulseCount.

Arguments:	handle: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress IOChannel: which GPIO to use. See Channel numbers. count: on exit, contains the current count.
Returns:	PICO_OK PICO_NOT_FOUND PICO_NOT_RESPONDING PICO_INVALID_PARAMETER

3.7 UsbDrDaqGetScalings

```
PICO_STATUS UsbDrDaqGetScalings(
  int16_t            handle
  USB_DRDAQ_INPUTS   channel,
  int16_t          * nScales,
  int16_t          * currentScale,
  int8_t           * names,
  int16_t            namesSize
)
```

This function discovers the scalings, both built-in and custom, that are available for a particular channel.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. `channel`: the channel number. `nScales`: output: the function writes the number of available scales here. `currentScale`: output: an index to the currently selected scale here. `names`: output: a string containing the scaling names and indices. `namesSize`: the size of `names`

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_INVALID_CHANNEL`

3.8 UsbDrDaqGetSingle

```
PICO_STATUS UsbDrDaqGetSingle(
  int16_t            handle,
  USB_DRDAQ_INPUTS   channel,
  int16_t          * value,
  uint16_t         * overflow
)
```

This function returns a single sample value from the specified input channel.

See UsbDrDaqGetSingleF for a similar function that returns a floating-point sample value.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. `channel`: which channel to sample. See Channel numbers. `value`: on exit, the sample value. `overflow`: on exit, a bit field indicating which, if any, input channels overflowed the input range of the device. A bit set to 1 indicates an overflow. The least significant bit corresponds to channel 1. May be `NULL` if an overflow warning is not required.

Returns:	`PICO_OK`
	`PICO_INVALID_HANDLE`
	`PICO_NO_SAMPLES_AVAILABLE`
	`PICO_DEVICE_SAMPLING`
	`PICO_NULL_PARAMETER`
	`PICO_INVALID_PARAMETER`
	`PICO_DATA_NOT_AVAILABLE`
	`PICO_INVALID_CALL`
	`PICO_NOT_RESPONDING`
	`PICO_MEMORY`

3.9 UsbDrDaqGetSingleF

```
PICO_STATUS UsbDrDaqGetSingleF(
  int16_t            handle,
  USB_DRDAQ_INPUTS   channel,
  float            * value,
  uint16_t         * overflow
)
```

This function returns a single floating-point sample value from the specified input channel. In all other respects it is the same as UsbDrDaqGetSingle.

3.10 UsbDrDaqGetTriggerTimeOffsetNs

```
PICO_STATUS UsbDrDaqGetTriggerTimeOffsetNs(
  int16_t            handle,
  int64_t          * time
)
```

This function returns the time between the trigger point and the first post-trigger sample. This is calculated using linear interpolation.

Arguments:	`handle:` device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. `time:` on exit, trigger time in nanoseconds.
Returns:	`PICO_OK` `PICO_NOT_FOUND`

3.11 UsbDrDaqGetUnitInfo

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

This function returns a string containing the specified item of information about the unit.

If you want to find out the length of the string before allocating a buffer for it, call the function with `string` = `NULL` first.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress.
	
	`string`: location of a buffer where the function writes the requested information, or `NULL` if you are only interested in the value of `requiredSize`.
	
	`stringLength`: the maximum number of characters that the function should write to `string`.
	
	`requiredSize`: on exit, the length of the information string before it was truncated to `stringLength`. If the string was not truncated, `requiredSize` will be less than or equal to `stringLength`.
	
	`info`: the information that the driver should return. These values are specified in `picoStatus.h`.
	`PICO_DRIVER_VERSION`
	`PICO_USB_VERSION`
	`PICO_HARDWARE_VERSION`
	`PICO_VARIANT_INFO`
	`PICO_BATCH_AND_SERIAL`
	`PICO_CAL_DATE`
	`PICO_KERNEL_DRIVER_VERSION`

Returns:	`PICO_OK`
	`PICO_INVALID_HANDLE`
	`PICO_NULL_PARAMETER`
	`PICO_INVALID_INFO`
	`PICO_INFO_UNAVAILABLE`

3.12 UsbDrDaqGetValues

```
PICO_STATUS UsbDrDaqGetValues(
  int16_t            handle,
  int16_t          * values,
  uint32_t         * noOfValues,
  uint16_t         * overflow,
  uint32_t         * triggerIndex
)
```

This function is used to get values after calling UsbDrDaqRun.

See UsbDrDaqGetValuesF for a similar function that gets floating-point values.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. `values`: an array of sample values returned by the function. The size of this buffer must be the number of enabled channels multiplied by the number of samples to be collected. Note: The order of the channels will be as stated in Channel numbers, regardless of the order used in the UsbDrDaqSetInterval `channels` array. `noOfValues`: on entry, the number of sample values per channel that the function should collect. On exit, the number of samples per channel that were actually written to the buffer. `overflow`: on exit, a bit field indicating which, if any, input channels overflowed the input range of the device. A bit set to 1 indicates an overflow. The least significant bit corresponds to channel 1. May be `NULL` if an overflow warning is not required. `triggerIndex`: on exit, a number indicating when the trigger event occurred. The number is a zero-based index to the `values` array, or 0xFFFFFFFF if the information is not available. On entry, the pointer may be `NULL` if a trigger index is not required.

Returns:	`PICO_OK`
	`PICO_INVALID_HANDLE`
	`PICO_NO_SAMPLES_AVAILABLE`
	`PICO_DEVICE_SAMPLING`
	`PICO_NULL_PARAMETER`
	`PICO_INVALID_PARAMETER`
	`PICO_TOO_MANY_SAMPLES`
	`PICO_DATA_NOT_AVAILABLE`
	`PICO_INVALID_CALL`
	`PICO_NOT_RESPONDING`
	`PICO_MEMORY`

3.13 UsbDrDaqGetValuesF

```
PICO_STATUS UsbDrDaqGetValuesF(
  int16_t            handle,
  float            * values,
  uint32_t         * noOfValues,
  uint16_t         * overflow,
  uint32_t         * triggerIndex
)
```

This function is used to get floating-point values after calling UsbDrDaqRun. In all other respects it is the same as UsbDrDaqGetValues.

3.14 UsbDrDaqOpenUnit

```
PICO_STATUS UsbDrDaqOpenUnit(
  int16_t          * handle
)
```

This function opens and enumerates the unit.

Arguments:	`handle:` on exit, a value that uniquely identifies the data logger that was opened. Use this as the `handle` parameter when calling any other `UsbDrDaq` API function.

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`
	`PICO_NOT_RESPONDING`

3.15 UsbDrDaqOpenUnitAsync

```
PICO_STATUS UsbDrDaqOpenUnitAsync(
  int16_t          * status
)
```

This function opens a USB DrDAQ data logger without waiting for the operation to finish. You can find out when it has finished by periodically calling UsbDrDaqOpenUnitProgress until that function returns a non-zero value and a valid data logger handle.

The driver can support up to 64 data loggers.

Arguments:	`status`: on exit, a status flag: `0` if there is already an open operation in progress `1` if the open operation is initiated

Returns:	`PICO_OK`
	`PICO_OPEN_OPERATION_IN_PROGRESS`
	`PICO_OPERATION_FAILED`

3.16 UsbDrDaqOpenUnitProgress

```
PICO_STATUS UsbDrDaqOpenUnitProgress(
  int16_t          * handle,
  int16_t          * progress,
  int16_t          * complete
)
```

This function checks on the progress of UsbDrDaqOpenUnitAsync.

Arguments:	`* handle:` on exit, the device identifier of the opened data logger, if the operation was successful. Use this as the `handle` parameter when calling any other USB DrDAQ API function. `0:` if no unit is found or the unit fails to open `<>0:` handle of unit (valid only if function returns `PICO_OK`) `progress:` on exit, an estimate of the progress towards opening the data logger. The value is between 0 to 100. `complete:` on exit, a non-zero value if the operation has completed, otherwise zero.

Returns:	`PICO_OK`
	`PICO_NULL_PARAMETER`
	`PICO_OPERATION_FAILED`

3.17 UsbDrDaqPingUnit

```
PICO_STATUS UsbDrDaqPingUnit(
  int16_t          * handle
)
```

This function checks that the specified USB DrDAQ is connected.

Arguments:	`handle`: the device identifier returned by UsbDrDaqOpenUnit or related function

Returns:	`PICO_OK`
	`PICO_NOT_RESPONDING`
	`PICO_BUSY`
	`PICO_DRIVER_FUNCTION`
	`PICO_NOT_FOUND`

3.18 UsbDrDaqReady

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

This function indicates when UsbDrDaqRun has captured the requested number of samples.

Arguments:	handle: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. ready: TRUE if ready, FALSE otherwise.
Returns:	PICO_OK PICO_INVALID_HANDLE PICO_NOT_RESPONDING

3.19 UsbDrDaqRun

```
PICO_STATUS UsbDrDaqRun(
  int16_t            handle,
  uint32_t           no_of_values,
  BLOCK_METHOD       method
)
```

This function tells the unit to start capturing data.

Arguments:	handle: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. no_of_values: the number of samples the unit should collect. method: which method to use to collect the data, from the following list: BM_SINGLE BM_WINDOW BM_STREAM See "Capture modes" for details.
Returns:	PICO_OK PICO_INVALID_HANDLE PICO_USER_CALLBACK PICO_INVALID_CHANNEL PICO_TOO_MANY_SAMPLES PICO_INVALID_TIMEBASE PICO_NOT_RESPONDING PICO_CONFIG_FAIL PICO_INVALID_PARAMETER PICO_NOT_RESPONDING PICO_TRIGGER_ERROR

3.20 UsbDrDaqSetDO

```
PICO_STATUS UsbDrDaqSetDO(
  int16_t            handle,
  USB_DRDAQ_GPIO     IOChannel,
  int16_t            value
)
```

This function is used to configure the general-purpose I/Os as digital outputs.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress `IOChannel`: identifies the channel. See Channel numbers. `value`: any non-zero value sets the digital output and zero clears it.

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_NOT_RESPONDING`
	`PICO_INVALID_PARAMETER`

3.21 UsbDrDaqSetInterval

```
PICO_STATUS UsbDrDaqSetInterval(
  int16_t            handle,
  uint32_t         * us_for_block,
  uint32_t           ideal_no_of_samples,
  USB_DRDAQ_INPUTS * channels,
  int16_t            no_of_channels
)
```

This function sets the sampling interval of the unit. Sampling of multiple channels is sequential.

The minimum possible sampling interval (`si_min`, in microseconds) depends on the capture mode and number of active channels (`n`) as follows:

- `BM_SINGLE` mode:

  `si_min = n`

- `BM_WINDOW` and `BM_STREAM` modes:

  `si_min = 10*n`

If you wish to know the effective sampling interval (`si`, in microseconds) set by this function, you can calculate it as follows:

```
si = (ideal_no_of_samples * no_of_channels) / us_for_block
```

Arguments:	`handle`: on exit, device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. `us_for_block`: on entry, the target total time in which to collect `ideal_no_of_samples`, in microseconds. On exit, the actual total time that was set. For more accurate setting of total time as a floating-point value, use UsbDrDaqSetIntervalF. `ideal_no_of_samples`: the number of samples per channel that you want to collect. This number is used only for timing calculations. In `BM_SINGLE` mode the total for all active channels must not exceed 16,384 samples. `channels`: an array of constants identifying the channels from which you wish to capture data. See the list at Channel numbers. If you specify the channels in a different order from that shown in that list, the function will re-order them. `no_of_channels`: the number of channels in the `channels` array.

Returns:	`PICO_OK`
	`PICO_INVALID_HANDLE`
	`PICO_INVALID_CHANNEL`
	`PICO_INVALID_TIMEBASE`
	`PICO_NOT_RESPONDING`
	`PICO_CONFIG_FAIL`
	`PICO_INVALID_PARAMETER`
	`PICO_NOT_RESPONDING`
	`PICO_TRIGGER_ERROR`

3.22 UsbDrDaqSetIntervalF

```
PICO_STATUS UsbDrDaqSetIntervalF(
  int16_t            handle,
  float            * us_for_block,
  uint32_t           ideal_no_of_samples,
  USB_DRDAQ_INPUTS * channels,
  int16_t            no_of_channels
)
```

This function sets the sampling interval of the unit. It works in the same way as UsbDrDaqSetInterval except that the `us_for_block` argument is a `float` instead of an integer.

3.23 UsbDrDaqSetPWM

```
PICO_STATUS UsbDrDaqSetPWM(
  int16_t            handle,
  USB_DRDAQ_GPIO     IOChannel,
  uint16_t           period,
  uint8_t            cycle
)
```

This function is used to configure the general-purpose I/Os as pulse-width modulation outputs.

Arguments:	`handle:` device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress `IOChannel:` GPIOs 1 and 2 can be used as PWM outputs. See UsbDrDaqSetDO for values. `period:` the period of the waveform in microseconds. `cycle:` duty cycle as a percentage.

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_NOT_RESPONDING`
	`PICO_INVALID_PARAMETER`

3.24 UsbDrDaqSetRGBLED

```
PICO_STATUS UsbDrDaqSetRGBLED(
  int16_t            handle,
  uint16_t           red,
  uint16_t           green,
  uint16_t           blue
)
```

This function is used to set the color of the LED once RGB mode has been enabled using USBDRDaqEnableRGBLED.

Arguments:	handle: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. red, green, blue: components of the required LED color, in the range 0 to 255.
Returns:	PICO_OK PICO_NOT_FOUND PICO_NOT_RESPONDING

3.25 UsbDrDaqSetScalings

```
PICO_STATUS UsbDrDaqSetScalings(
  int16_t            handle
  USB_DRDAQ_INPUTS   channel,
  int16_t            scalingNumber
)
```

This function sets the scaling for a specified channel.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. `channel`: the channel to set. See Channel numbers. `scalingNumber`: the number of the required scale, as given by UsbDrDaqGetScalings.

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_INVALID_CHANNEL`
	`PICO_INVALID_PARAMETER`

3.26 UsbDrDaqSetSigGenArbitrary

```
PICO_STATUS UsbDrDaqSetSigGenArbitrary(
  int16_t            handle,
  int32_t            offsetVoltage,
  uint32_t           pkToPk,
  int16_t          * arbitraryWaveform,
  int16_t            arbitraryWaveformSize,
  int32_t            updateRate
)
```

This function allows full control of the arbitrary waveform generator by allowing an arbitrary waveform to be passed to the driver.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress `offsetVoltage`: the offset voltage in microvolts. The offset voltage must be in the range –1.5 V to 1.5 V. `pkToPk`: the peak-to-peak voltage in microvolts. The maximum allowed is 3 V. `arbitraryWaveform`: an array containing the waveform. The waveform values must be in the range –1000 to 1000. `arbitraryWaveformSize`: the number of points in the waveform. `updateRate`: the rate at which the AWG steps through the points in the waveform. This value must be in the range 1 to 2,000,000 points per second.

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_NOT_RESPONDING`
	`PICO_INVALID_PARAMETER`

3.27 UsbDrDaqSetSigGenBuiltIn

```
PICO_STATUS UsbDrDaqSetSigGenBuiltIn(
  int16_t            handle,
  int32_t            offsetVoltage,
  uint32_t           pkToPk,
  int16_t            frequency,
  USB_DRDAQ_WAVE     waveType
)
```

This function sets the arbitrary waveform generator using standard waveform types.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress.
	
	`offsetVoltage`: the offset voltage in microvolts. The offset voltage must be in the range –1.5 V to 1.5 V.
	
	`pkToPk`: the peak-to-peak voltage in microvolts. The maximum allowed is 3 V.
	
	`frequency`: frequency in hertz. The maximum allowed frequency is 20 kHz.
	
	`waveType`: an enumerated data type that has the following values corresponding to standard waveforms:
	`USB_DRDAQ_SINE,`
	`USB_DRDAQ_SQUARE,`
	`USB_DRDAQ_TRIANGLE,`
	`USB_DRDAQ_RAMP_UP,`
	`USB_DRDAQ_RAMP_DOWN,`
	`USB_DRDAQ_DC`

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_NOT_RESPONDING`
	`PICO_INVALID_PARAMETER`

3.28 UsbDrDaqSetTrigger

```
PICO_STATUS UsbDrDaqSetTrigger(
  int16_t            handle,
  uint16_t           enabled,
  uint16_t           auto_trigger,
  uint16_t           auto_ms,
  uint16_t           channel,
  uint16_t           dir,
  int16_t            threshold,
  uint16_t           hysteresis,
  float              delay
)
```

This function sets up the trigger, which controls when the unit starts capturing data.

Arguments:	`handle`: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. `enabled`: whether to enable or disable the trigger: 0: disable the trigger 1: enable the trigger `auto_trigger`: whether or not to re-arm the trigger automatically after each trigger event: 0: do not auto-trigger 1: auto-trigger `auto_ms`: time in milliseconds after which the unit will auto-trigger if the trigger condition is not met `channel`: which channel to trigger on. See Channel numbers. `dir`: which edge to trigger on: 0: rising edge 1: falling edge `threshold`: trigger threshold (the level at which the trigger will activate) in the currently selected scaling, multiplied to remove any decimal places. The number of decimal places can be found by calling UsbDrDAQGetChannelInfo. `hysteresis`: trigger hysteresis in ADC counts. This is the difference between the upper and lower thresholds. The signal must then pass through both thresholds in the same direction in order to activate the trigger, so that there are fewer unwanted trigger events caused by noise. The minimum value allowed is 1. `delay`: delay between the trigger event and the start of the block as a percentage of the block size. 0% means that the trigger event is the first data value in the block, and −50% means that the trigger event is in the middle of the block.

Returns:	`PICO_OK`
	`PICO_INVALID_HANDLE`
	`PICO_USER_CALLBACK`
	`PICO_TRIGGER_ERROR`
	`PICO_MEMORY_FAIL`

3.29 UsbDrDaqStartPulseCount

```
PICO_STATUS UsbDrDaqStartPulseCount(
  int16_t            handle,
  USB_DRDAQ_GPIO     IOChannel,
  int16_t            direction
)
```

This function is used to configure the general-purpose I/Os for pulse counting and to start counting.

Arguments:	`handle:` device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress. `IOChannel:` specifies the GPIO channel to use: either GPIO 1 or GPIO 2. See Channel numbers. `direction:` the direction of the edges to count (0:rising, 1:falling).

Returns:	`PICO_OK`
	`PICO_NOT_FOUND`
	`PICO_NOT_RESPONDING`
	`PICO_INVALID_PARAMETER`

3.30 UsbDrDaqStop

```
PICO_STATUS UsbDrDaqStop(
  int16_t            handle
)
```

This function aborts data collection.

Arguments:	handle: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress.
Returns:	PICO_OK PICO_INVALID_HANDLE

3.31 UsbDrDaqStopSigGen

```
PICO_STATUS UsbDrDaqStopSigGen(
  int16_t            handle
)
```

This function turns the AWG off.

Arguments:	handle: device identifier returned from UsbDrDaqOpenUnit or UsbDrDaqOpenUnitProgress.
Returns:	PICO_OK PICO_NOT_FOUND PICO_NOT_RESPONDING

3.32 Channel numbers

Use the following values for the channel argument in the API functions that deal with a specified input channel or channels:

```
typedef enum enUsbDrDaqInputs
{
  USB_DRDAQ_CHANNEL_EXT1 = 1,  //Ext. sensor 1          //  1
  USB_DRDAQ_CHANNEL_EXT2,      //Ext. sensor 2          //  2
  USB_DRDAQ_CHANNEL_EXT3,      //Ext. sensor 3          //  3
  USB_DRDAQ_CHANNEL_SCOPE,     //Scope channel          //  4
  USB_DRDAQ_CHANNEL_PH,        //PH                     //  5
  USB_DRDAQ_CHANNEL_RES,       //Resistance             //  6
  USB_DRDAQ_CHANNEL_LIGHT,     //Light                  //  7
  USB_DRDAQ_CHANNEL_TEMP,      //Thermistor             //  8
  USB_DRDAQ_CHANNEL_MIC_WAVE,  //Microphone waveform    //  9
  USB_DRDAQ_CHANNEL_MIC_LEVEL, //Microphone level       // 10
  USB_DRDAQ_MAX_CHANNELS = USB_DRDAQ_CHANNEL_MIC_LEVEL
} USB_DRDAQ_INPUTS;
```

Use the following values for the IOChannel argument in the API functions that deal with a specified GPIO channel:

```
typedef enum enUsbDrDaqDO
{
  USB_DRDAQ_GPIO_1 = 1,     // 1
  USB_DRDAQ_GPIO_2,         // 2
  USB_DRDAQ_GPIO_3,         // 3
  USB_DRDAQ_GPIO_4          // 4
}USB_DRDAQ_GPIO;
```

Source: usbDrDaqApi.h 2013-01-22

3.33 PICO_STATUS values

Every function in the USB DrDAQ API returns a status code from the following list of PICO_STATUS values:

Code (hex)	Enum	Description
00	PICO_OK	The Data Logger is functioning correctly
01	PICO_MAX_UNITS_OPENED	An attempt has been made to open more than UsbDrDaq_MAX_UNITS
02	PICO_MEMORY_FAIL	Not enough memory could be allocated on the host machine
03	PICO_NOT_FOUND	No USB DrDAQ device could be found
04	PICO_FW_FAIL	Unable to download firmware
05	PICO_OPEN_OPERATION_IN_PROGRESS	A request to open a device is in progress
06	PICO_OPERATION_FAILED	The operation was unsuccessful
07	PICO_NOT_RESPONDING	The device is not responding to commands from the PC
08	PICO_CONFIG_FAIL	The configuration information in the device has become corrupt or is missing
09	PICO_KERNEL_DRIVER_TOO_OLD	The picopp.sys file is too old to be used with the device driver
0A	PICO_EEPROM_CORRUPT	The EEPROM has become corrupt, so the device will use a default setting
0B	PICO_OS_NOT_SUPPORTED	The operating system on the PC is not supported by this driver
0C	PICO_INVALID_HANDLE	There is no device with the handle value passed
0D	PICO_INVALID_PARAMETER	A parameter value is not valid
0E	PICO_INVALID_TIMEBASE	The time base is not supported or is invalid
0F	PICO_INVALID_VOLTAGE_RANGE	The voltage range is not supported or is invalid
10	PICO_INVALID_CHANNEL	The channel number is not valid on this device or no channels have been set
11	PICO_INVALID_TRIGGER_CHANNEL	The channel set for a trigger is not available on this device
12	PICO_INVALID_CONDITION_CHANNEL	The channel set for a condition is not available on this device
13	PICO_NO_SIGNAL_GENERATOR	The device does not have a signal generator
14	PICO_STREAMING_FAILED	Streaming has failed to start or has stopped without user request
15	PICO_BLOCK_MODE_FAILED	Block failed to start - a parameter may have been set wrongly
16	PICO_NULL_PARAMETER	A parameter that was required is NULL
18	PICO_DATA_NOT_AVAILABLE	No data is available from a run block call
19	PICO_STRING_BUFFER_TOO_SMALL	The buffer passed for the information was too small
1A	PICO_ETS_NOT_SUPPORTED	ETS is not supported on this device
1B	PICO_AUTO_TRIGGER_TIME_TOO_SHORT	The auto trigger time is less than the time it will take to collect the data
1C	PICO_BUFFER_STALL	The collection of data has stalled as unread data would be overwritten
1D	PICO_TOO_MANY_SAMPLES	The number of samples requested is more than available in the current memory segment
1E	PICO_TOO_MANY_SEGMENTS	Not possible to create number of segments requested
1F	PICO_PULSE_WIDTH_QUALIFIER	A null pointer has been passed in the trigger function or one of the parameters is out of range

20	PICO_DELAY	One or more of the hold-off parameters are out of range
21	PICO_SOURCE_DETAILS	One or more of the source details are incorrect
22	PICO_CONDITIONS	One or more of the conditions are incorrect
23	PICO_USER_CALLBACK	The driver's thread is currently in the UsbDrDaqReady callback function and therefore the action cannot be carried out
24	PICO_DEVICE_SAMPLING	An attempt is being made to get stored data while streaming. Either stop streaming by calling UsbDrDaqStop
25	PICO_NO_SAMPLES_AVAILABLE	...because a run has not been completed
26	PICO_SEGMENT_OUT_OF_RANGE	The memory index is out of range
27	PICO_BUSY	Data cannot be returned yet
28	PICO_STARTINDEX_INVALID	The start time to get stored data is out of range
29	PICO_INVALID_INFO	The information number requested is not a valid number
2A	PICO_INFO_UNAVAILABLE	The handle is invalid so no information is available about the device. Only PICO_DRIVER_VERSION is available.
2B	PICO_INVALID_SAMPLE_INTERVAL	The sample interval selected for streaming is out of range
2C	PICO_TRIGGER_ERROR	Not used
2D	PICO_MEMORY	Driver cannot allocate memory
36	PICO_DELAY_NULL	NULL pointer passed as delay parameter
37	PICO_INVALID_BUFFER	The buffers for overview data have not been set while streaming
3A	PICO_CANCELLED	A block collection has been cancelled
3B	PICO_SEGMENT_NOT_USED	The segment index is not currently being used
3C	PICO_INVALID_CALL	The wrong GetValues function has been called for the collection mode in use
3F	PICO_NOT_USED	The function is not available
41	PICO_INVALID_STATE	Device is in an invalid state
43	PICO_DRIVER_FUNCTION	You called a driver function while another driver function was still being processed

4 Example code

4.1 Introduction

We supply examples for the following programming languages:

- C and C++
- Excel
- LabVIEW

4.2 C and C++

C

To compile the program, create a new project for an Application containing the following files:

`usbdrdaqcon.c`

and

`usbdrdaq.lib` (Microsoft Visual C 32-bit applications).

or

`usbdrdaqbc.lib` (Borland 32-bit applications)

The following files must be in the compilation directory:

`usbdrdaqapi.h`
`picostatus.h`

The following file must be in the same directory as the executable, or in the search path.

`usbdrdaq.dll`

C++

C++ programs can access all versions of the driver. If `ubsdrdaqapi.h` is included in a C++ program, the `PREF1` macro expands to `extern "C"`: this disables name-decoration, and enables C++ routines to make calls to the driver routines using C headers.

4.3 Excel

The easiest way to transfer data to Excel is to use PicoLog. However, you can also write an Excel macro which calls `ubsdrdaq.dll` to read in a set of data values. The Excel macro language is similar to Visual Basic.

The example `ubsdrdaq.xls` reads in 20 values from Channels 1 and 2, one per second, and assigns them to cells A1..B20.

Use Excel Version 7 or higher.

Note that it is usually necessary to copy the DLL file to the `\windows\system` directory.

4.4 LabVIEW

The SDK contains a library of VIs that can be used to control the USB DrDAQ and two examples of using these VIs:

`DrDAQBlockExample.vi` – a simple block mode example that demonstrates using block mode on a single channel with a trigger.

DrDAQStreamingExample.vi – demonstrates streaming mode acquisition on all channels with triggering. It also demonstrates use of the general-purpose I/Os, the arbitrary waveform generator, channel scaling and the RGB LED.

The LabVIEW library (UsbDrDaq.llb) can be placed in the user.lib subdirectory to make the VIs available on the 'User Libraries' palette. You should also copy UsbDrDaq.dll to the folder containing your LabVIEW project.

The library contains the following VIs:

PicoErrorHandler.vi – takes an error cluster and, if an error has occurred, displays a message box indicating the source of the error and the status code returned by the driver

PicoStatus.vi – checks the status value returned by calls to the driver If the driver returns an error, the status member of the error cluster is set to 'true' and the error code and source are set.

UsbDrDaqChannelScaling.vi – is used to discover available scales for a given channel, the scale that is currently being used and to change the scale.

UsbDrDaqClose.vi – closes the USB DrDAQ.

UsbDrDaqGetBlock.vi – is used to get a block of data from the USB DrDAQ. The method can be either single or windowed and the VI returns the trigger index and the values. The acquisition settings must be specified first using UsbDrDaqSettings.vi.

UsbDrDaqGetStreamingData.vi – is used to get samples once streaming has been started (using UsbDrDaqStartStreaming.vi). The size of the buffer created by this VI must be specified. This should be large enough to contain all the samples returned when the VI is called. The VI returns the number of values collected, the trigger index and the values themselves.

UsbDrDaqGPIO.vi – is used to control the general-purpose I/Os. GPIOs 1 & 2 can be used as digital inputs, digital outputs, PWM outputs and pulse-counting inputs. GPIOs 3 & 4 can be used as digital inputs and digital outputs.

UsbDrDaqLEDControl.vi – can be used to enable and control the RGB LED.

UsbDrDaqOpen.vi – opens a USB DrDAQ and returns a handle to the device.

UsbDrDaqSettings.vi – is used to set up data acquisition and the trigger and should be called before starting streaming or block-mode collection.

UsbDrDaqSigGen.vi – is used to control the signal generator. There are a set of standard waveforms that can be selected and "arbitrary waveform" can also be selected. When selecting an arbitrary waveform, an array of values and the number of values should be specified. The update rate can also be selected. Selecting 'none' under 'waveform' stops the signal generator.

UsbDrDaqStartStreaming.vi – starts the device streaming data after the USB DrDAQ has been set up using UsbDrDaqSettings.vi. The 'number of values' input is used by the driver to create its buffer. Once this VI has been called, values can be obtained from the driver using UsbDrDaqGetStreamingData.vi.

5 Glossary

Analog bandwidth. The input frequency at which the measured signal amplitude is 3 dB below the true signal amplitude.

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

Device Manager. Device Manager is a Windows program that displays the current hardware configuration of your computer. Right-click 'My Computer,' choose 'Properties', then click the 'Hardware' tab and the 'Device Manager' button.

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

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

MS. Megasamples (1,000,000 samples).

PC Oscilloscope. A virtual instrument formed by connecting a PicoScope oscilloscope to a computer running the PicoScope software.

PicoScope software. A software product that accompanies all PicoScope oscilloscopes. It turns your PC into an oscilloscope, spectrum analyzer and multimeter.

Timebase. The timebase controls the time interval that each horizontal division of a scope view represents. There are ten divisions across the scope view, so the total time across the view is ten times the timebase per division.

USB 2.0. Universal Serial Bus. This is a standard port used to connect external devices to PCs. The port supports a data transfer rate of up to 480 megabits per second, so is much faster than the RS-232 COM ports found on older PCs.

Vertical resolution. A value, in bits, indicating the precision with which the oscilloscope converts input voltages to digital values.

Voltage range. The range of input voltages that the oscilloscope can measure. For example, a voltage range of ±100 mV means that the oscilloscope can measure voltages between –100 mV and +100 mV. Input voltages outside this range will not damage the instrument as long as they remain within the protection limits stated in the Specifications table in the User's Guide.

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