ADC-200/212/216 PC Oscilloscopes

User's Manual

adc200.en-3.0

Contents

1 Introduction

This manual covers the ADC-200, ADC-212 and ADC-216 products. Where information applies equally to all three product groups, the abbreviation ADC-2xx is used

The ADC-2xx products are high-speed analogue-to-digital converters (ADCs) with two input channels and software-controlled input ranges. They can be used as PC-based oscilloscopes / spectrum analysers with the supplied PicoScope software or as dataloggers with the PicoLog software; alternatively, you can use the ADC-2xx driver software to develop your own programs to collect and analyse data from the unit.

The ADC-2xx package contains the following items:

- ADC-2xx unit
- 25 way parallel port cable
- power supply (12 volt @ 500 mA)
- software CD
- installation guide

1.1 Connecting to the PC

The ADC-2xx can be connected to the PC in two ways: -

- directly to a parallel port (printer port) on the computer
- to a USB port on the computer, via a Pico USB parallel port adapter

Parallel port operation

When you install the application software from the Pico CD, the computer will ask you which port to use. Select LPT1, LPT2 or LPT3 (**Note:** you can change the port at a later stage if you need to).

To use the ADC, connect it to the parallel port on your computer, using a the 25-way cable provided.

USB Parallel port operation

USB printer port interfaces are not suitable for use with Pico products. If you wish to connect a Pico product to a USB port, you will need a Pico USB Parallel Port adapter.

When you install the application software from the Pico CD: -

1. the computer asks you which port to use, select USB-PP1
2. once the USB driver software is installed, connect the Pico USB parallel port adapter to your PC: the computer will automatically configure the drivers

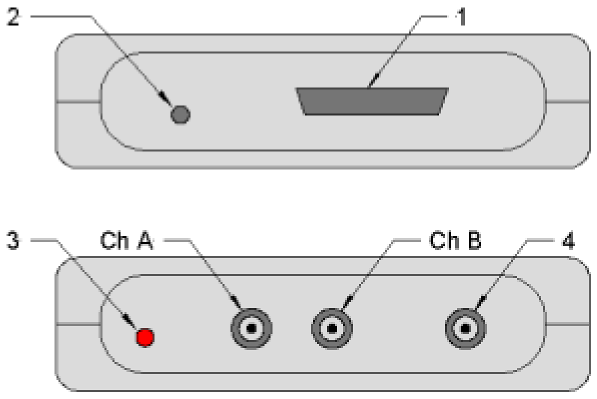
Checking the installation

1. Connect DC power by plugging the power adapter into a mains socket and plugging the DC power jack into the socket on the ADC-2xx. The red light should now be on, showing that the unit is powered. The light may switch off when data is not being processed.
2. To check that the unit is working, start up PicoScope. PicoScope should now display the voltage that you have connected. If you are using scope probes, when you touch the scope probe tip with your finger, you should see a small 50 Hz mains signal.

The ADC-2xx has the same connectors as an oscilloscope, so you can use standard oscilloscope probes. The input impedance is also the same, so the x10 function on a scope probe works correctly.

The BNC connector labelled 4 below ('E' on the unit) has two functions; in normal use it is the external trigger input and accepts a TTL compatible signal. This connector can also be used as a simple (square wave) generator. This signal generator can be used to compensate x10 scope probes.

Connector diagram



1. D25 Parallel port connector
2. DC 12 volt @ 500mA power socket
3. 'Running' LED
4. External trigger/Signal generator

1.2 Safety Warning

We strongly recommend that you read the general safety information below before using your product for the first time. If the equipment is not used in the manner specified, then the protection provided may be impaired. This could result in damage to your computer and injury to yourself or others.

Maximum input range

The ADC-2xx product is designed to measure voltages in the range -20V to +20V. Any voltages in excess of ±100V may cause permanent damage to the units.

Mains voltages

No Pico products are designed for use with mains voltages. To measure mains we recommend the use of a differential isolating probe specifically designed for such measurements.

Safety grounding

The ground of every product is connected directly to the ground of your computer via the provided interconnecting cable. This is done in order to minimise interference. Always use the provided cable to attach the product to your computer.

As with most oscilloscopes and data loggers, you should take care to avoid connecting the ground input of the product to anything which may be at some voltage other than ground. If in doubt, use a meter to check that there is no significant AC or DC voltage. Failure to check may cause damage to the product and computer and could cause injury to yourself or others.

You should assume that the product does not have a protective safety earth. Misconfiguration and/or use on voltages outside the maximum input range can be hazardous.

Repairs

The unit contains no user serviceable parts: repair or calibration of the unit requires specialised test equipment and must be performed by Pico Technology Limited or their authorised distributors.

2 Product Features

2.1 Specifications

Product	**ADC-200/20**	**ADC-200/50**	**ADC-200/100**	**ADC-212/3**	**ADC-212/50**	**ADC-212/100**	**ADC-216**
Resolution / bits	8			12			16
Input Channels	2 x BNC connectors 1 Mohm impedance AC/DC coupling						
External Trigger	Ext BNC Input: TTL Level Trigger Output: Square Wave Signal Generator						
Voltage Ranges	±50 mV to ±20 V in 1,2,5 Steps (in 9 Ranges) ADC-212/3 and ADC-216 also have ±20 mV and ±10 mV Ranges						
Accuracy / %	±3			±1			
Overload Protection / V	±100						
Sampling Rate / Samples/s							
1 Channel	20M	50M	100M	3M	50M	100M	333k
2 Channel	10M	50M	50M	1.5M	50M	50M	166k
Repetitive Signal with ETS					5G	5G	
Buffer Size / kSamples	8	16	32	32	128	128	32
Signal Generator	<250 kHz TTL square wave						
Power Supply	12 V DC nominal at 500 mA max DC 1.3mm connector (center positive)						
Dimensions / mm	140 x 190 x 45						

2.2 Equivalent Time Sampling (ETS)

Equivalent time sampling (ETS) is a way of increasing the effective sample rate when working with repetitive signals. It is not possible to use ETS with one-shot signals.

ETS works because the trigger event can be assumed to be asynchronous with respect to the sampling clock. If the unit collects blocks of data from 100 successive trigger events, there should be a reasonable spread of time intervals between the trigger event and the next sample. If the unit records this time interval from each cycle, the computer can interleave the samples from successive blocks to give approximately 100 times the sampling rate.

Because the time interval between the trigger event and the next is somewhat random, there is likely to be bunching in some areas and gaps in others. In order to get a reasonable distribution, it is necessary to collect, say, 300 blocks, then to select the best 100 from them.

ETS is managed using three routines:

- adc200_get_max_ets - this indicates the maximum number of ETS interleaves allowed: it will be zero if the particular unit in use does not support ETS.
- adc200_get_ets_time - get the time per sample when running in ETS mode
- adc200_set_ets - set the interleave and max cycles

The minimum equivalent sample time can be calculated as:

```
adc200_get_ets_time() / adc200_get_max_ets()
```

For example, for a 20 ns sample time and max interleave of 100, the minimum equivalent sample time is 200 ps, which corresponds to 5 GS/s.

Notes:

1. When using ETS, the samples are not evenly spaced. The use of adc200_get_times_and_values (rather than adc200_get_values) is therefore essential.

2. When ETS is enabled, adc200_set_timebase is ignored.

2.3 Principles of Operation

This section explains how the ADC-2xx works. This information is intended for people writing their own software and is not required if you are only using the product with PicoScope or PicoLog software.

The ADC-2xx range includes both high-speed analog-to-digital converters (eg ADC-200/100) and high-resolution converters (eg ADC-216). These devices take sequences of voltage measurements and feed the information into a computer.

Block sampling

When running at high speeds, the ADC-2xx can collect data much faster than the PC can read it, so the ADC-2xx reads in a block of data into internal memory, then transfers it to the PC once the block is completed. At very low speeds, it may be unacceptable to wait until the block is completed before being able to inspect the first few readings. Therefore in addition to the **Fast mode**, the driver routine: `adc200_get_single`, is provided to obtain single readings.

Fast mode

In fast mode, the computer starts the ADC-2xx to collect a block of data into its internal memory. When the ADC has collected the whole block, the computer stops the ADC and transfers the whole block into computer memory.

The maximum number of values depends upon the size of the ADC-2xx memory. The unit can sample at a number of different rates which are the clock frequency divided by powers of two (half, quarter, eighth, etc). There are between 16 and 20 sampling rates, depending on the ADC-2xx model.

There is a separate buffer for each channel: on the faster models, one input can be routed into both buffers, thus doubling the effective sampling rate.

The ADC-2xx driver normally performs a number of setup operation before collecting each block of data. This can take up to 50 milliseconds. If it is necessary to collect data with the minimum time interval between blocks, use the `adc200_set_rapid` option.

adc200_get_single

The `adc200_get_single` routine provides a way of collecting a single reading averaged from a number of samples. This can be used instead of **Fast mode**, where the screen needs to be updated regularly.

Triggering

The ADC-2xx can either start collecting data immediately, or it can be programmed to wait for a trigger event to occur with the `adc200_set_trigger` routine. The trigger event can occur when the channel A or B input crosses a threshold voltage, or on a change of state of the external (digital) trigger input. The trigger event can be either a rising or a falling edge.

The ADC-2xx can be programmed to place the trigger event at the beginning of the buffer, like an analogue scope, or at the end of the buffer (pre-trigger), or any point in between.

The external trigger input is the same as the signal generator output, so these two functions cannot be used at the same time.

Voltage ranges

It is possible to set the gain for each channel with the adc200_set_range routine, to give an input voltage range from 50 mV to 20 V (10 mV to 20 V for the ADC-212/3 and ADC-216).

AC/DC operation

Test whether the ADC can set the AC/DC switch through software, using the adc200_has_relays routine. Using the adc200_set_dc routine, each channel can be set to either AC or DC coupling. When AC coupled, any DC component of the signal is filtered out. For some older versions, there is a physical AC/DC switch for each channel on the front of the unit: for newer versions, it is controlled by software.

Oversampling

When the unit is operating at speeds below maximum, it is possible to oversample with adc200_set_oversample - to take more than one measurement during each time interval. This reduces the effects of aliasing, and increases the apparent resolution of the ADC.

Scaling

The ADC-200 is an 8-bit ADC, which returns a value between 0 and 255 to represent the currently selected voltage range. To facilitate software development, the numbers are adjusted so that 0 ADC counts corresponds to 0 volts. All values returned by the driver are scaled as if 16x oversampling is selected, so the maximum positive voltage in the selected range is represented by 2047 and the maximum negative voltage by -2048.

The ADC-212 is a 12-bit ADC, which returns a value between 2047 and -2048 regardless of the oversampling selected..

The ADC-216 is a 16-bit ADC, which returns a value between 32767 and -32768.

Signal generator

The ADC-2xx has a built-in signal generator which may be set using adc200_set_frequency. It produces a selection of accurate frequencies from 1 kHz to 250 kHz. These are selected under software control. The waveform is approximately square at low frequencies, but it rounds off above about 100 kHz.

The signal generator output is the same as the signal generator input, so these two functions cannot be used at the same time.

Multi-unit operation

It is possible to collect data using up to three ADC-2xx units at the same time. Each ADC-2xx must be connected to a separate parallel port. The routine adc200_set_unit select which unit the driver should access next.

For example, to collect data from units on LPT1 and LPT3 at the same time:

```
adc200_open (1)
adc200_open (3)

adc200_set_unit (1)
... set up unit 1
adc200_run

adc200_set_unit (3)
... set up unit 3
adc200_run

ready = FALSE
```

```
while not ready
   adc200_set_unit (1)
   ready = adc200_ready
   adc200_set_unit (3)
   ready = ready & adc200_ready ()

adc200_set_unit (1)
adc200_get_values
adc200_set_unit (3)
adc200_get_values
```

3 Driver Formats & Routines

Formats

The drivers are available in two formats: -

- Windows XP/Vista DLL
- Linux driver

Routines

The driver contains the following routines: -

Procedure	Description
adc200_get_driver_version	Determine the driver version
adc200_open_unit	Open an ADC-2xx unit
adc200_set_unit	Switch to the ADC-2xx on a different port (multi-unit operation only)
adc200_close_unit	Shut down an ADC-2xx unit
adc200_has_relays	Find out whether the ADC-2xx has software-controlled AC/DC switches
adc200_set_dc	Set the AC/DC switch
adc200_set_range	Set the input voltage range
adc200_set_channels	Specify channels to use (A, B, Both)
adc200_set_oversample	Specify the oversample factor
adc200_set_timebase	Set the time interval between samples
adc200_set_time_units	Set the units for times (default ps)
adc200_set_trigger	Specify the triggering parameters
adc200_set_rapid	Enable rapid block repeat mode
adc200_max_samples	Find out how many samples can be taken, using current settings
adc200_run	Start the ADC-2xx collecting data
adc200_ready	Find out whether the ADC-2xx has collected some data
adc200_stop	Stop the ADC-2xx
adc200_get_values	Get a block of samples from the ADC-2xx
adc200_get_times_and_values	Get a block of samples and the times at which they were taken
adc200_get_overflow	Determine whether an overflow occurred during the last adc200_get_values operation
adc200_get_single	Get a single value from each channel
adc200_get_unit_info	If open failed, get fault info. If open succeeded, get unit details
adc200_get_status	Get the error code from the most recent adc200_open_unit operation
adc200_get_product	Find out what type of unit (200/212/216) is connected
adc200_get_max_ets	Get the maximum ETS interleave
adc200_get_ets_time	Get the time per sample in ETS mode
adc200_set_ets	Set ETS parameters
adc200_set_frequency	Controls the signal generator

Sequence of calls

The C sample program, `a200con.c`, show how to use all of the functions of the driver, and includes examples showing each mode of operation.

This is the general procedure for reading and displaying a block of data:

1. open the ADC-2xx
2. select ranges until the required mV range is located
3. set AC/DC switches, channels, trigger and oversampling
4. select timebases until the required ns per sample is located
5. set the signal generator frequency (if required)
6. start the ADC-2xx running
7. wait till the ADC-2xx says that it is ready

8. stop the ADC-2xx
9. transfer the block of data from the ADC
10. display the data

3.1 Driver Formats

3.1.1 Windows 32-bit Driver

The Windows XP/Vista driver, `adc200.sys`, is installed in Windows. This file is normally loaded when you install the software. To check that the driver is loaded:

1. press the **Start** button
2. select **Settings**
3. select **Control panel**
4. select **System**
5. choose the **Device manager** tab
6. check that ADC-2xx is present and marked as started

If not, check that the driver is present and then use the `regdrive.exe` program which is copied into the Pico directory. Type in:

```
regdrive adc200
```

The Windows 32-bit drivers are accessed using the file `ADC20032.DLL,` which is installed in the `Examples` subdirectory. The DLL uses STDCALL linkage conventions, and undecorated names.

Note: The Windows XP/Vista driver does not have access to the actual base addresses for the parallel ports. It assumes that they are:

LPT1	0x278
LPT2	0x378
LPT3	0x3BC

If your computer does not conform to this standard, you should enter the port number corresponding to the actual port base address in the `adc200_open_unit` call.

3.1.2 Linux driver

See the man information in the `adc200.tar` file for more information.

3.2 Routines

3.2.1 adc200_get_driver_version

```
unsigned short adc200_get_driver_version (void)
```

If it is possible that your software might be used with other drivers, you can use this routine to determine whether the driver is more recent than the one the that you used to develop the software.

Arguments

None

Returns

16-bit code that identifies the driver version. The upper byte contains the major version, and the lower byte contains the minor version.

3.2.2 adc200_open_unit

```
unsigned short adc200_open_unit (unsigned short port)
```

This routine opens the ADC-2xx on the specified port. The initialisation process takes a couple of seconds.

Arguments

`port`	The number of the parallel port that the ADC2xx is connected to (1 for LPT1, 2 for LPT2, etc ... 101 for USB-PP1, 102 for USB-PP2, etc - USB ports are named in the order they were connected in)

Returns

TRUE if successful or FALSE if unsuccessful.

The driver can handle up to three ADC-2xx units at the same time. If you wish to use more than one unit, call `adc200_open_unit` once for each unit, then call `adc200_set_unit` to select which unit to use next.

Note: for the Windows version, the ADC-2xx does not have access to the actual base addresses for the parallel ports. It assumes that they are:

LPT1	0x278
LPT2	0x378
LPT3	0x3BC

If your computer does not conform to this standard, you should enter the port number corresponding to the actual port base address.

3.2.3 adc200_set_unit

```
unsigned short adc200_set_unit (unsigned short port)
```

The driver can handle up to three ADC-2xx units at the same time: if you wish to use more than one unit, call `adc200_open_unit` once for each unit, then call `adc200_set_unit` to select which unit to access next.

Arguments

`port`	The number of the parallel port that the ADC-2xx is connected to (1 for LPT1, 2 for LPT2, etc ... 101 for USB-PP1, 102 for USB-PP2, etc - USB ports are named in the order they were connected in)

Returns

TRUE if successful or FALSE if unsuccessful.

3.2.4 adc200_close_unit

```
void adc200_close (unsigned short port)
```

This routine stops the specified ADC-2xx and powers the unit down.

Arguments

`port`	The number of the parallel port that the ADC-2xx is connected to (1 for LPT1, 2 for LPT2, etc ... 101 for USB-PP1, 102 for USB-PP2, etc - USB ports are named in the order they were connected in)

Returns

Nothing

3.2.5 adc200_has_relays

```
short adc200_has_relays (void)
```

This routine determines whether the ADC-2xx unit has relays to control the AC/DC switches.

Use `adc200_set_dc` to set the relay.

Arguments

None

Returns

TRUE if the `adc200_set_dc` routine can be used to set the AC/DC switches, otherwise it returns FALSE.

3.2.6 adc200_set_dc

```
unsigned short adc200_set_dc
(
    unsigned short channel,
    unsigned short dc
)
```

This routine specifies the position of the AC/DC switch.

Use `adc200_has_relays` to determine if this routine will work with the ADC.

Arguments

`channel`	Use A200_CHANNEL_A or A200_CHANNEL_B.
`dc`	1 = DC 0 = AC

Returns

TRUE if successful or FALSE if unsuccessful.

3.2.7 adc200_set_range

```
unsigned short adc200_set_range
(
    unsigned short channel,
    A200_GAIN      gain
)
```

This routine specifies the input voltage range for a channel. If you wish to find out all of the ranges, you can call this routine repeatedly and note the returned voltages until it returns zero.

Arguments

`channel`	Use `A200_CHANNEL_A` (0) or `A200_CHANNEL_B` (1).
`gain`	EITHER a code between 0 and 10 (`adc200.h` contains #defines for these codes) OR the required millivolt range.

Returns

`voltage range` if the parameters are valid, otherwise it returns ZERO

The following ranges are available: -

`gain`	`voltage range`
0	10 mV (ADC-212/3 and ADC-216 only)
1	20 mV (ADC-212/3 and ADC-216 only)
2	50 mV
3	100 mV
4	200 mV
5	500 mV
6	1 V
7	2 V
8	5 V
9	10 V
10	20 V

3.2.8 adc200_set_channels

```
unsigned short adc200_set_channels (A200_MODE mode)
```

This routine defines whether the ADC-2xx is to collect data from one or from both channels. It returns the number of channels (1 or 2) if successful, otherwise it returns zero.

See the product specifications for the sampling rates of each product in one and two channel modes.

Arguments

`mode`	0 - `A200_CHANNEL_A` - channel A only 1 - `A200_CHANNEL_B` - channel B only 2 - `A200_BOTH_CHANNELS` - both channels

Returns

Number of channels (1 or 2) if successful, otherwise it returns ZERO.

3.2.9 adc200_set_oversample

```
unsigned short adc200_set_oversample
(
    unsigned short factor
)
```

This routine specifies the number of measurements to take for each reading. As the oversample factor increases, the maximum sampling rate and the maximum number of samples per block decreases.

Arguments

`factor`	The oversample factor must be a number between 1 and 16

Returns

FALSE if oversample factor is out of range.

3.2.10 adc200_set_timebase

```
unsigned short adc200_set_timebase
(
    unsigned long * ns,
    unsigned char * is_slow,
    A200_TIME       timebase
)
```

This routine is used to specify the time interval between readings.

Arguments

`ns`	This is the time interval, in nanoseconds, between readings at the selected timebase.
`is_slow`	This is always set to FALSE by the driver
`timebase`	a code between 0 and 19 (not all codes are valid for all units- check the return value). Timebase 0 is the fastest timebase, Timebase 1 is twice the time per sample, Timebase 2 is four times, etc.

Returns

If the requested timebase is valid, this routine returns TRUE and sets the variable `ns`, otherwise it returns FALSE

The time per sample is normally ns(*fastest*) * (1 + timebase) * oversample

For an ADC-200/50 (20 ns fastest) with oversample 1, the timebases are: -

0	20 ns
1	40 ns
2	80 ns
3	160 ns
...	...
18	5 242 880 ns
19	10 485 760 ns

For an ADC-212/3 (333 ns fastest) with oversample 8:

0	2 664 ns
1	5 328 ns
2	10 656 ns
...	...
15	87 293 952 ns
16	174 587 904 ns

Note: that this function has no effect when ETS mode is enabled using `adc200_set_ets`.

3.2.11 adc200_set_time_units

```
void adc200_set_time_units
(
    unsigned short units
)
```

Arguments

`units` The time units, which can be one of:

1 - A200_PS	picoseconds
2 - A200_NS	nanoseconds (default)
3 - A200_US	microseconds
4 - A200_MS	milliseconds
5 - A200_S	seconds

Returns

Nothing

This function specifies the time units to be used for times returned by `adc200_get_times_and_values`.

3.2.12 adc200_set_trigger

```
void adc200_set_trigger
(
    unsigned char  enabled,
    A200_TSOURCE   source,
    A200_TDIR      direction,
    A200_TDELAY    delay_percent,
    short          threshold
)
```

This routine defines a trigger event and specifies what data block to collect, with respect to the trigger.

Arguments

`enabled`	This is TRUE if the ADC-2xx is to wait for a trigger event, and FALSE if the ADC-2xx is to start collecting data immediately.
`source`	0 - `A200_TSOURCE_A` 1 - `A200_TSOURCE_B` 2 - `A200_TSOURCE_E` - use external logic input as trigger
`direction`	0 - `A200_RISING` 1 - `A200_FALLING`
`delay_percent`	This specifies the delay, as a percentage of the block size, between the trigger event and the start of the block. It should be in the range -100% to +100%. Thus, 0% means that the first data value in the block, and -50% means that the trigger event is in the middle of the block.
`threshold`	This is the threshold at which a trigger event on channel A or B takes place. It is scaled in ADC counts.

Returns

Nothing

3.2.13 adc200_set_rapid

```
void adc200_set_rapid
(
    unsigned short enabled
)
```

This routine enables rapid repeat mode, where the driver initialises the ADC-2xx only once, then several blocks can be collected in rapid succession. Block repeat rates of 200 per second are possible.

Arguments

`enabled`	This is TRUE to enable rapid repeat mode, FALSE to disable it.

Returns

Nothing

The following example shows how to collect 50 blocks of 100 samples. Note that the first call to `adc200_run` will take 50 to 100 ms longer than subsequent calls:

```
adc200_set_rapid (TRUE);
for (i = 1; i < 50; i++)
   {
   adc200_run (100);
   while (!adc200_ready ())
        {};
   adc200_stop ();
   adc200_get_values (buffer, buffer, 100);
   }
adc200_set_rapid (FALSE);
```

3.2.14 adc200_max_samples

```
unsigned long adc200_max_samples (void)
```

This routine returns the maximum number of samples that you can ask for. This is affected by a number of factors:

- ADC-2xx model
- channel mode (single/dual)
- oversampling factor
- trigger delay

Therefore, call this routine after you have selected the parameters listed above.

Arguments
None

Returns
Maximum number of samples as a long integer.

The ADC-2xx operates so fast that it takes a couple of hundred readings to start and stop the converter.

The buffer is allocated in blocks of up to 512 bytes one after the other (block size depends on the type and speed of the product). Depending on when the trigger condition is reached and what trigger delay is specified, some of the data will not be used. This unused data can be up to 511 bytes per channel.

The following formula can be used to approximate the maximum number of samples available:

max sample = (buffer size - 1000) / oversample

For some 8-bit units, the same channel can be routed to both memory banks, so the effective number of samples is doubled.

3.2.15 adc200_run

```
unsigned short adc200_run
(
    unsigned long no_of_values
)
```

This routine tells the ADC-2xx to start collecting data.

Arguments

`no_of_values`	In Fast mode, this is the number of data values that you require.

Returns

TRUE if the ADC-2xx is started successfully, otherwise it returns FALSE.

3.2.16 adc200_ready

```
unsigned short adc200_ready (void)
```

Arguments
None

Returns
TRUE when the ADC-2xx has collected a complete block of data, otherwise it returns FALSE.

3.2.17 adc200_stop

```
void adc200_stop (void)
```

Call this routine to stop the ADC-2xx. If you call it before a trigger event occurs, the ADC-2xx may not contain valid data.

Arguments
None

Returns
Nothing

3.2.18 adc200_get_values

```
void adc200_get_values
(
     short huge    * buffer_a,
     short huge    * buffer_b,
     unsigned long   no_of_values
)
```

This routine gets data from the ADC-2xx.

For the ADC-200 and ADC-212, zero corresponds to zero volts: 2047 and -2047 correspond to the maximum and minimum voltage on the currently selected range.

For the ADC-216, zero corresponds to zero volts: 32767 and -32767 correspond to the minimum and maximum voltage on the currently selected range.

In Fast mode, this routine reads in the whole block of data from the ADC-2xx. The number of readings returned are put into the buffer.

Arguments

`buffer_a`	a pointer to the buffer to put data from channel A into. It is unused if the ADC is collecting only from channel B.
`buffer_b`	a pointer to the buffer to put data from channel B into. It is unused if the ADC is collecting only from channel A.
`no_of_values`	The maximum number of data values to transfer.

Returns

Nothing

3.2.19 adc200_get_times_and_values

```
void adc200_get_times_and_values
(
    long huge      * times,
    short huge     * buffer_a,
    short huge     * buffer_b,
    unsigned long no_of_values
)
```

This routine gets samples, and the times that samples were taken, from the ADC-2xx. By default, the time is in nanoseconds: the function `adc200_set_time_units` can be used to select other time units, for example microseconds.

For the ADC-200 and ADC-212, zero corresponds to zero volts: 2047 and -2047 correspond to the maximum and minimum voltage on the currently selected range.

For the ADC-216, zero corresponds to zero volts: 32767 and -32767 correspond to the minimum and maximum voltage on the currently selected range.

Arguments

`times`	a pointer to the buffer for the times. Each time is the interval between the trigger event and the corresponding sample.Times before the trigger event are negative, and times after the trigger event are positive.
`buffer_a`	a pointer to the buffer to put data from channel A into. It is unused if the ADC is collecting only from channel B.
`buffer_b`	a pointer to the buffer to put data from channel B into. It is unused if the ADC is collecting only from channel A.
`no_of_values`	The maximum number of data values to transfer.

Returns

Nothing

In non-ETS mode, the samples will always be evenly spaced. If, for example, you were to request 10 samples with 20% pre-trigger and 20 ns per sample, the times buffer might contain the following:

-40, -20, 0, 20, 40, 60, 80, 100, 120, 140

3.2.20 adc200_get_overflow

```
short adc200_get_overflow
(
    short channel
)
```

This routine determines whether an overflow occurred (the input voltage went above or below the limits of the selected range) on the specified channel.

Arguments

`channel`	0 - channel A 1 - channel B

Returns

TRUE if an overflow occured, otherwise it returns FALSE.

3.2.21 adc200_get_single

```
void adc200_get_single
(
    short far * buffer
)
```

This routine starts the ADC-2xx, collects a small number of samples and then returns the average of these samples.

Arguments

`buffer`	A pointer to a buffer containing two integers. On return from this routine, the first entry contains a reading from channel A and the second entry contains a reading from channel B.

Returns

Nothing

3.2.22 adc200_get_unit_info

```
short adc200_get_unit_info
(
    char  * str,
    short   str_lth,
    short   line,
    short   port
)
```

This routine writes unit information to a character string. There are four lines of unit information available. If the unit fails to open, only lines 1 and 2 are available, to explain why the unit failed to open.

line	Type of information
1	information about the ADC-200 DLL
2	information about the harware version and the connection type / status
3	the batch number of the unit
4	the calibration date

Arguments

*str	a pointer to the character string buffer in the calling function where the unit information string (selected with line) will be stored
str_lth	length of character string buffer
line	selects which line of text to return (see table above)
port	the parallel or USB port number to return information for (1 for LPT1, 2 for LPT2, etc ... 101 for USB-PP1, 102 for USB-PP2, etc - USB ports are named in the order they were connected)

Returns

The length of the string written to the character string buffer in the calling function.

3.2.23 adc200_get_status

```
short adc200_get_status (void)
```

This routine returns the status from the most recent call to adc200_open_unit.

Arguments

None

Returns

code representing the status of the ADC-2xx.

The codes are defined in ADC200.h: -

code	status	description
0	A200_OK	All is ok.
1	A200_INVALID_PORT	The port number supplied to the most recent call to adc200_open_unit is unavailable or invalid.
2	A200_INVALID_HW_VERSION	-The version of the ADC2xx hardware is not recognised by the driver.
3	A200_INVALID_SW_VERSION	The version of the ADC-2xx firmware is not recognised by the driver.
4	A200_CONFIG_FAILED	The ADC-2xx cannot be initialised properly.
5	A200_ADDR_READ_FAILED	The ADC-2xx cannot be initialised properly.
6	A200_NVR_FAIL	The unit's internal calibration information has been corrupted.

7	`A200_UNIT_NOT_FOUND`	The ADC-2xx cannot be found on the specified port.
8	`A200_INVALID_LENGTH`	This is for Pico internal use only. Contact Pico Technical Support if this error occurs.
9	`A200_DRIVER_NOT_FOUND`	The adc200.sys, pico.vxd or pico.386 drivers cannot be found or have not been initialised.
10	`A200_OLD_DRIVER_VERSION`	The adc200.sys, pico.vxd or pico.386 drivers is to earlier a version to support the current DLL.
11	`A200_USB_ADAPTER_NOT_FOUND`	The USB adapter cannot be found on the port number supplied to the most recent call to adc200_open_unit.
12	`A200_USB_ADAPTER_NOT_CONFIGURED`	The USB adapter cannot be configured.

3.2.24 adc200_get_product

```
short adc200_get_product (void)
```

Arguments
None

Returns
`value` which indicates what type of ADC-2xx is attached: -

`value`	**Type of ADC**
0	No ADC attached
200	ADC-200 8-bit converter (but the driver returns 12-bit values)
212	ADC-212 12-bit converter
216	ADC-216 16-bit converter

3.2.25 adc200_get_max_ets

```
unsigned short adc200_get_max_ets (void)
```

Arguments
None

Returns
Maximum interleave factor that can be used for ETS. If the ADC-2xx unit does not support ETS, it will return ZERO.

With the ADC-212/50 & ADC-212/100, it will return a value of 100.

3.2.26 adc200_get_ets_time

```
unsigned long adc200_get_ets_time (void)
```

Arguments

None

Returns

Sample time that will be used in ETS mode.

When ETS is selected, the effective sample time will be the returned sample time divided by the interleave factor. For example, if the ETS sample time is 20 ns, an interleave factor of 10 would give samples approximately every 2 ns.

The time value is in the time units specified in the most recent call to `adc200_set_time_units`: the default is nanoseconds.

Use `adc200_set_ets` to enable/disable ETS.

3.2.27 adc200_set_ets

```
void adc200_set_ets
(
    unsigned short interleave,
    unsigned short max_cycles,
    unsigned short mode
)
```

This function is used to enable or disable ETS, and to set the ETS parameters.

Arguments

`interleave`	Specifies the number of ETS interleaves to use. If the ETS sample time is 20 ns and the interleave is set to 10, the approximate time per sample will be 2 ns.
`max_cycles`	Specifies the number of cycles to store: the computer can then select interleave cycles to give the most uniform spread of samples. Max_cycles should be between two and five times the value of interleave.
`mode`	`ETS_OFF` - disables ETS `ETS_SLOW` - enable ETS and provide data every max_cycles cycles `ETS_FAST` - enable ETS and provide data every interleave cycles. `ETS_SLOW` takes longer to provide each dataset, but the datasets are more stable and unique.

Returns

Nothing

3.2.28 adc200_set_frequency

```
long adc200_set_frequency (long frequency)
```

This routine controls the signal generator. If the frequency is zero, the signal generator is turned off. If the frequency is between 1 and 250,000, the driver starts the signal generator at the nearest available frequency. The returned value is the actual frequency.

Note: The signal generator stops if you call any routine other than `adc200_ready`.

Arguments

`frequency`	The required frequency, in hertz.

Returns

Actual frequency of the signal generator.

4 Programming Support

4.1 C (Windows)

There are two C example programs: one is a very simple GUI application, and the other is a more comprehensive console mode program that demonstrates all of the facilities of the driver.

The GUI example program is a generic windows application - ie it does not use Borland AppExpert or Microsoft AppWizard. To compile the program, create a new project for an Application containing the following files:

`a200test.c`
`a200test.rc`

`adc20032.lib` (Borland 32-bit applications)
or
`adc200ms.lib` (Microsoft Visual C 32-bit applications)

The following files must be in the compilation directory: -

`a200test.rch`
`adc200.h`

and the following file must be in the same directory as the executable: -

`adc20032.dll` (All 32-bit applications)

The console example program is a generic windows application - ie it does not use Borland AppExpert or Microsoft AppWizard. To compile the program, create a new project for an Application containing the following files:

`a200con.c`

`adc20032.lib` (Borland 32-bit applications)
or
`adc200ms.lib` (Microsoft Visual C 32-bit applications).

The following files must be in the compilation directory: -

`adc200.h`

and the following file must be in the same directory as the executable: -

`adc20032.dll` (All 32-bit applications)

4.2 Visual Basic

Versions 4 and 5

The `Examples` subdirectory contains the following files: -

```
  adc20032.vbp - project file
  adc20032.bas - procedure protypes
  adc20032.frm - form and program
```

Note: The routines which return a TRUE/FALSE value, return 0 for FALSE and 1 for TRUE, whereas Visual basic expects 65 535 for TRUE. Check for > 0 rather than =TRUE.

4.3 Delphi

The program `adc200.dpr` demonstrates how to operate the ADC-2xx. The file `adc200.inc` contains procedure prototypes that you can include in your own programs. This has been tested with Delphi versions 1, 2 and 3.

4.4 Excel

Excel 7 (Office 95 etc)

1. Load the spreadsheet `adc20032.xls`
2. Select **Tools | macro**
3. Select **getadc200**
4. Select **Run**

Note: The Excel Macro language is similar to Visual Basic. The routines which return a TRUE/FALSE value, return 0 for FALSE and 1 for TRUE, whereas Visual basic expects 65 535 for TRUE. Check for > 0 rather than =TRUE.

4.5 Agilent-Vee

The example routine `adc200.vee` is in the `Examples` subdirectory. It uses procedures that are defined in `adc200.vh.` It was tested using HP-Vee version 5 under Windows 95.

4.6 LabView

The routines described here were tested using LabVIEW for Windows 95 version 4.0.

The `adc200.vi` module in the `Examples` subdirectory shows how to access these routines. To use this example: -

- Copy `adc200.vi` and `adc20032.dll` to your LabVIEW `user.lib` directory
- Use LabVIEW to open the `adc200.vi`
- Select the printer port to which your ADC-200 is connected
- Press **RUN**

Note: for the ADC-216, you will need to alter the scaling in frame 7 by replacing 2 048 by 32 768.

5 Glossary

AC/DC Switch - The AC/DC switches for the ADC-2xx operate under software control, rather than manually.

ADC - **Analog to Digital Converters** capture analogue data and convert it into digital data for storage and further processing.

Channel - This specifies which channel to measure data from (A and/or B).

Equivalent Time Sampling (ETS) - Some products support Equivalent Time Sampling (ETS), which offers a higher effective sampling rate when used with repetitive signals. Note that ETS should not be used for one-shot or non-repetitive signals.

Range - This allows you to specify an input voltage range.

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Pico Technology Ltd

The Mill House
Cambridge Street
St Neots PE19 1QB
United Kingdom
Tel: +44 (0) 1480 396 395
Fax: +44 (0) 1480 396 296
Web: www.picotech.com