Equipment usage note

# Pico ADC20 and PicoScope 2000

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# Pico technology data acquisition and data logging systems

## Summary

The Pico ADC20 and PicoScope 2000 are tools for digitally sampling analogue signals. The operation of the devices is not complicated; however, the best results will be obtained with some understanding of the devices and how to correctly configure the acquisition software.

### Common pitfalls

Common issues encountered whilst using the Pico ADC20:

- **The `PicoLog recorder` software does not permit data acquisition**
  - Ensure that the device is connected correctly (as verified using the *Device Manager* applet)
  - Verify that a channel is set to acquire date (follow detailed configuration instructions below)
  - Power cycle the acquisition computer
- **Data is being recorded, but it is not what I expect**
  - Check you experimental setup: the logger simply records the input signal and cannot correct for incorrectly connected cables or inappropriate apparatus configurations

The Pico PicoScope 2000 tends not to present commonly experienced difficulties; however, should an issue arise, one can follow the configuration procedure outlined below.

## The devices

### Pico ADC20

The Pico ADC20 is a high-resolution Analogue-to-Digital Converter (ADC), which is a system designed to digitise an analogue signal so it can then be further processed. One of the most common use cases of an ADC is to take the output of a detector or instrument and record its magnitude at specific time intervals, so one can collect a time series for the measurement of interest. This particular device is designed to sample voltages with high resolution such that one can discriminate between small changes in the signal as produced by the detector.

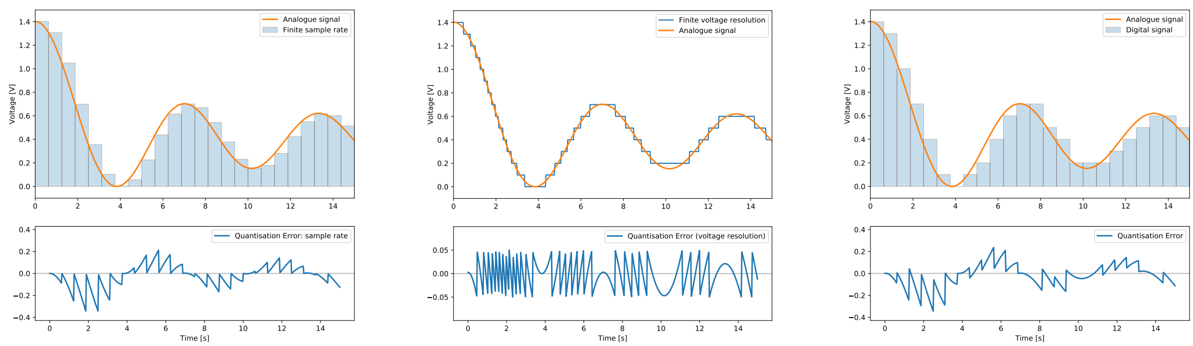
### PicoScope 2000

The PicoScope 2000 is in essence a standard oscilloscope without a monitor. Oscilloscopes are designed to display time varying voltage signals, with *cathode ray oscilloscopes* performing this task in an analogue manner and modern *digital storage oscilloscopes* performing this task digitally. In the latter case, the device functions by recording the signal for some period of time, and then displaying this recorded signal. The key element of the device is the component which records of the signal of interest, which is usually an Analogue-to-Digital Converter (ADC).

Both devices are reliant on analogue-to-digital conversion, so the functioning of an ADC is briefly described. As with all scientific devices: having an understanding of how the device functions and upon what principles it operates not only facilitates usage of the device, but is key to determining when the usage of such a device is appropriate.

### How does an ADC function?

Consider the output of a detector which is analogue: for example, it could be a transducer measuring displacement, or a probe measuring an induced voltage. Depending on the experiment and the what is desired from the measurement, the signal may be conditioned and manipulated, but it remains an analogue signal. At some point, we want to interface this signal with a computer, which means translating the signal into something which a computer can interpret. Such a translation is achieved with an Analogue-to-Digital Converter (ADC), which functions exactly as one might expect: a signal continuous is both time and voltage is *sampled* and a signal which is discritised in time and voltage is produced and used as a digital version of the signal. Hopefully it is clear that the digital signal is not necessarily a perfect representation of the analogue signal, and the quality of the approximation is ultimately governed by two parameters: the quantisation error (often expressed as bit-depth) and the sampling rate. Figure 1 gives a brief illustration of the digitisation process: an analogue signal is sampled at some finite sample rate, the amplitude of the signal is discretised, and the digital signal which is both discretised and sampled.




(a) Finite sampling rate (b) Discrete voltage steps (c) A digitised signal

Figure 1: An analogue signal discretely sampled in time, voltage, and both time and voltage.

For both devices, the signal as produced by the ADC is registered and displayed. For the Pico ADC20 the signal is directly recorded/displayed, whereas for the PicoScope 2000, a number of samples is recorded over a time interval $T$ and the signal over that time period is displayed; however it is also possible to operate the device in direct sampling mode, and this is the primary usage method described here.

Important considerations when using a ADC are:

- What is the voltage range of the device?
- What is the resolution of the device?
- What is the sampling rate of the device?

In the case of the Pico ADC20, the answers to the above questions are $V_{\max} = \pm 1250\ 2500 mV$ (depending on setting), the voltage is represented with a bit depth of $N = 20$, and the signal has a conversion time of 60 ms, which limits the sampling rate. For the PicoScope 2000, the voltage range is widely tuneable: $V_{\max} = \pm 10\,\mathrm{mV} - 20V$, the voltage is represented with a bit depth of $N = 8$, and the sample rate is 1 kHz

**How does one drive it?**

Both devices approximate *plug-and-play* utilities, albeit to different extents. The Pico ADC20 and PicoScope 2000 must be configured differently and are not compatible with the same software, and thus separate operating instructions are provided for both devices.

**Pico ADC20**

The Pico ADC20 unit connects via USB, but also uses a *breakout board* to facilitate sampling signals connected via cables with a BNC connector. With a signal connected to the breakout board, open the `PicoLog recorder` software. The first task is to set up a *measurement*, which requires input to tell the device how to sample, and which channel should be sampled.

- Begin by selecting `File` → `New settings`, which will open the `Recording` window. Here one can set the `Recording Method` (*Real Time Continuous*, *Streaming*, or *Fast Block*), the `Action at end of run` and the `Restart Delay`; for direct observation, the `Recording Method` should be set to *Real Time Continuous*.
- Confirming the `Recording` settings will open the `Sampling Rate Window`, where one can set the `Sampling Interval`, `Stop after`, and the `Readings per sample`. Note that there is a conversion time of 60 ms, so any `Sampling Interval` shorter than this value will not function as expected.
- The next window is the `Converter details`, where the device is selected. If no device appears, check the physical connection to the ADC20 and troubleshoot as required
- If the USB device has been selected, this will open the `Channels` window. **Double click on the appropriate channel** which should open the `Edit channel` window, where the `Conversion time` and `Voltage range` can be set. Upon confirming these parameters, the `Status` of the channel should change from *Available* to *In use*, and voltage measurements should be visible.

To begin recording data, select `File` → `New data` and create a file in which to store the data. The default .plw file format is not widely interpretable, but data can be exported to a .txt or .csv using the `Save as...` function.

**PicoScope 2000**

Operating the PicoScope 2000 is a streamlined process. Open the `PicoLog 6` software and navigate to the (USB) devices tab and select the device. Should it not appear, check the physical connection to the PicoScope 2000 and troubleshoot as required. Using the graphical interface, select a channel and set the desired values for the acquisition parameters, the `Sample interval` and `Input range`. It is also worthwhile customising the channel label with a meaningful name. Data can then be acquired using the *record* button.

Data can be displayed either on a plot or in a table. Basic data processing can be performed on the data, and can be configured in the table tab: select `Configure data table`, and set the desired `Sample rate` and the `Measurement`. The sample rate is better labelled time interval, as the sample rate is set by the device, and this setting allows for the data to be resampled. If the data is resampled, there will necessarily be a computation applied to the values recorded during the time interval, which can be controlled through the `Measurement` setting.

To export the data for use with another program, use the `Export CSV` feature found on the graph tab.

## Additional resources

- POLUS is a resource for all things related to experimental physics at UTAS

### Pico ADC20

- The manufacturer's website, including download links for the software and driver
- The instruction manual

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