1. How are the PicoScope 9000 Series Sampling Oscilloscopes different from normal digital storage oscilloscopes?

All digital storage oscilloscopes (DSOs) work by sampling the input signal. The standard type of DSO uses “real-time sampling”, which is illustrated in Fig. 1.

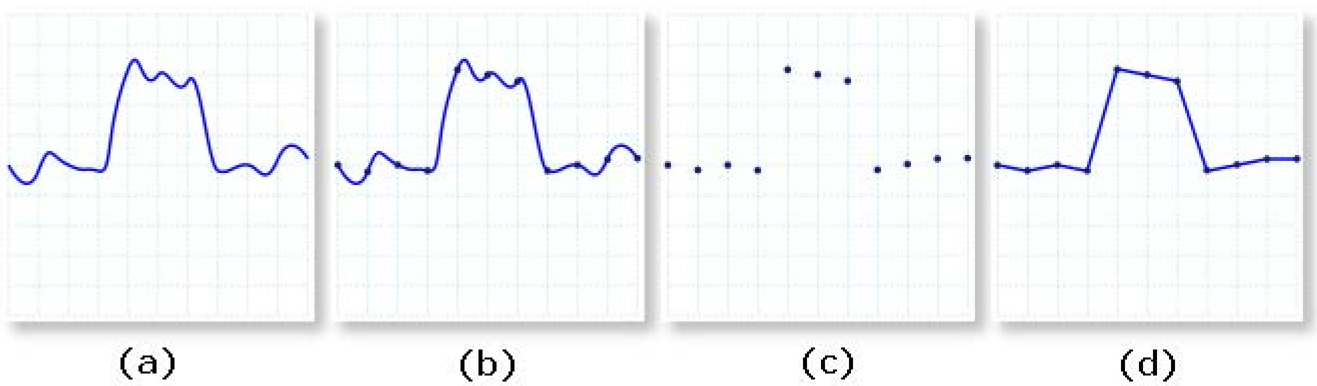


Fig. 1 – Real-time sampling. (a) The original signal. (b) The scope samples the signal in several places. (c) The samples are stored in memory. (d) The scope reconstructs the signal using the stored samples. (Straight-line interpolation is shown here, but other methods exist.)

A sampling oscilloscope is a special type of DSO that exclusively uses a technique called “sequential equivalent-time sampling” or just “sequential sampling”. This type of sampling is best suited to repetitive waveforms such as serial data streams, clock waveforms and pulses in digital circuits, some of the data patterns used in semiconductor testing, and amplifier pulse-response and rise-time tests. A sampling scope captures just one sample from one cycle of the waveform and then repeats the process over a large number of cycles, varying the timing of the sample in a known pattern from one sample to the next. The resulting collection of samples is then assembled into a picture of the whole waveform.

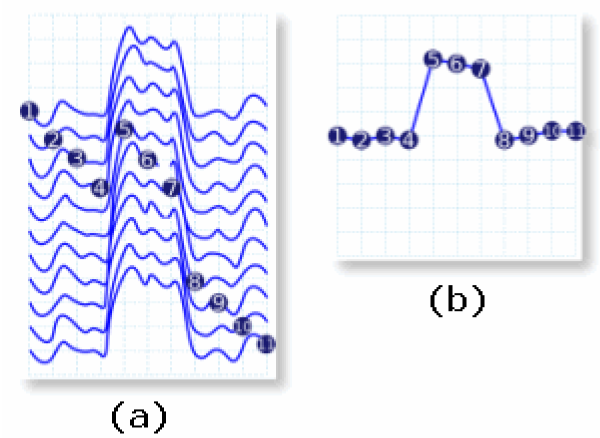


Fig. 2 – Sequential sampling. (a) One sample is taken from each of a number of similar waveforms. (b) The samples are assembled to form a composite waveform.

The advantage of a sampling scope is that its analogue-to-digital converter (ADC) only needs to be fast enough to capture one sample in each cycle of the waveform, rather than the tens or hundreds of samples that a real–time scope would require. This allows the scope to capture waveforms with much higher bandwidths, up to 20 GHz in the case of the PicoScope 9300 Series, and to capture each sample with higher precision. A real–time DSO that could capture a single cycle of the same 20 GHz waveform would be prohibitively expensive. For example the 20 GHz Agilent DSOX92004A, with a real–time sample rate of 80 GS/s, has a base price of $177,000 — almost 12 times the price of the PicoScope 9301.

2. Are the PicoScope 9000 Series Sampling Oscilloscopes digital signal analysers (DSAs)?

Yes. Some manufacturers use that term for sampling scopes that are aimed at the digital signal market. We chose to call the PicoScope 9000 Series sampling oscilloscopes because they can do more than just measure digital signals: they can also be used to analyze repetitive analog waveforms.

3. What is the difference between the real-time sampling rate and the equivalent-time sampling rate?

The real-time sampling rate of an oscilloscope is the rate at which its ADC can reliably sample the input waveform. If you wish to capture a single event such as a one-off glitch in a digital circuit, then the oscilloscope has only one chance to acquire enough samples to represent the waveform accurately. In such cases, there is no substitute for an oscilloscope with a high real-time sampling rate. A common rule of thumb is that at least 10 samples are needed for each cycle of the waveform. For example, if the signal in question is a 2 GHz square wave, then a scope with a real-time sampling rate of at least 20 GS/s would be needed to capture a realistic-looking picture. For accurate analysis of the timing and shape of the waveform, as required in mask testing, several hundred samples are needed. This would entail a real-time sampling rate of 200 GS/s or more, which is beyond the capabilities of today's off-the-shelf instruments and, even if such a scope existed, it would be prohibitively expensive.

The equivalent–time sampling (ETS) speed of a scope is not a measure of the speed of its ADC, but an estimate of the speed of an imaginary ADC that could capture a single–shot waveform at the same timebase, and with the same number of samples, as the sampling scope in question. If a sampling scope had perfectly accurate timing, then it could achieve an ETS rate as large as you wished just by waiting for the necessary number of cycles of the input waveform to pass by. In real life, however, the ETS rate of the scope is limited by the timing and trigger circuitry. The smaller the timing uncertainty (called jitter), the more non-overlapping samples the scope can take to form the final picture, and therefore the higher the equivalent-time sampling rate. Thanks to their low jitter, the fastest PicoScope 9000 Series Sampling Oscilloscopes have a maximum effective sampling rate of 15 TS/s.

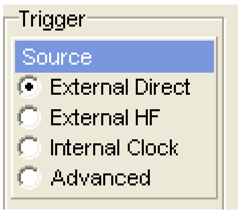
Many of today's DSOs list both real-time and equivalent-time, or sequential, sampling rates in their specifications. When choosing an oscilloscope, you need to make sure that both sampling rates are adequate for your application.

4. Can I use the PicoScope 9000 Series Sampling Oscilloscopes in general test and measurement applications?

The PicoScope 9000 Series Sampling Oscilloscopes are not intended to replace the general-purpose oscilloscope on your workbench. The main differences between oscilloscopes in the PicoScope 9000 Series and a general-purpose scope are as follows:

- **SMA input connectors**. General-purpose scopes usually have BNC connectors on their inputs, but these connectors do not have a well-defined impedance above about 2 GHz. SMA connectors are better suited to high-frequency signals and are widely used in microwave applications.
- **50 ohm inputs**. The PicoScope 9000 Series have low-impedance inputs that do not work with passive high-impedance scope probes but work well with low-impedance probes. The low input impedance is necessary to match the scope to standard high-frequency signal cables and connectors without causing reflections. Most instruments designed for signals above about 500 MHz have input and output impedances of 50 ohms.
- **±2 volt safe input range**. The sensitive, high–bandwidth input circuitry of the PicoScope 9000 Series does not allow the same wide range of input voltages as found on general-purpose scopes. If your signal is larger than ±1 volt (the maximum measuring range) then you must use an external attenuator. You must also protect the inputs against electrostatic discharges.
- **< 1 GS/s real–time sampling.** The PicoScope 9000 Series scopes are optimised for use as sequential sampling oscilloscopes. Their precision ADCs have very low jitter, providing an effective sequential sampling rate of up to 15 TS/s for repetitive signals. However, they can also operate in a real-time mode with up to 1 MS/s sampling rate and a triggering bandwidth of 100 MHz. This mode is equipped with a random equivalent-time sampling feature giving 4 ns timing resolution and therefore an effective sampling rate of 250 MS/s for repetitive signals.
- **Dedicated software**. The software supplied with the PicoScope 9000 Series is designed to work only with sampling oscilloscopes. It contains advanced display features such as eye diagrams and histograms, and specialised measurements and industry-standard mask tests that do not apply to real-time oscilloscopes. This software is very different from PicoScope 6, our general-purpose oscilloscope software, in both appearance and function, and data files cannot be exchanged between the two programs.

5. What is the difference between the Direct Trigger and HF (Prescaled) Trigger inputs?



The Direct Trigger is a full-function trigger input with a bandwidth of 1 to 2.5 GHz, and is applied directly to the trigger circuitry. This input allows variable slope, hysteresis and trigger level. The HF (Prescaled) Trigger input passes through an internal prescaler before being applied to the trigger circuitry. This input has a higher bandwidth, from 10 to 14 GHz, but lacks the adjustments available on the Direct Trigger input.

6. What is the histogram function for?

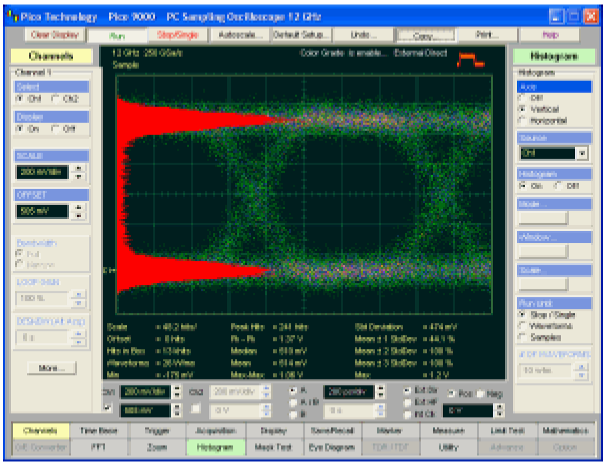


Fig. 3 – Histogram. A vertical histogram shows the signal density as a function of voltage, and helps to visualise noise.

The PicoScope 9000 Series Sampling Oscilloscopes can collect large numbers of waveforms and perform statistical analysis on them. The results of the analysis can be displayed as histograms against voltage (vertical histograms) or time (horizontal histograms). A vertical histogram shows how much time the signal spends at each voltage level, and is useful for visualising RMS noise and noise margins; while a horizontal histogram shows how fast the signal voltage changes during each time interval, and shows RMS jitter and timing margins. Histograms help you to visualise the quality of your signal, but if you prefer you can also get statistics in numerical form by using the built-in statistics functions.

7. Only £5995? What's the catch?

There are no hidden extra costs. When you buy a PicoScope 9000 Series Sampling Oscilloscope, you get a complete system: the front-end hardware to plug into your USB port, a mains power adapter, and Windows-based software for your PC. You just provide the computer. You also get valuable extra services: free, time-unlimited support from our technical specialists, and free software updates for as long as we continue to support the product.

Of course, every lab needs more than just a scope. You will need cables, connectors, and possibly coaxial splitters and attenuators, but these are all application-specific and you are likely to have them on your shelf anyway. To keep costs down, the PicoScope 9000 Series kits do not include probes, which are not needed if you have a 50 ohm signal source.