The benefits of longer memory in oscilloscopes

By Clive Davis
Yokogawa Test & Measurement - Europe & Africa

In the early days of digital storage oscilloscopes (DSOs) in the 1980s, a memory size of 500 points was the state-of-the-art. Nowadays tens and hundreds of megapoints or even gigapoints are available. How a user can benefit from this offer of a larger memory may not be immediately obvious. Fundamentally, larger memories offer two advantages. The first obvious point is that more memory allows a longer acquisition time. The second is that, for the same acquisition time, using a larger memory can result in a higher sample rate - which actually means that the effective bandwidth of the measurement is increased.

More memory means higher sample rate

So how does the memory size determine the effective bandwidth of an oscilloscope? A 100 microsecond per division timebase setting means that a total of one millisecond is captured. With a memory size of 10 kpoints selected, the sample period is thus 1 ms/10k = 0.1 µs, which means that the sample rate is 10 MS/s. If the memory size is increased by a factor of ten to 100 kpoints, the sample rate will also increase to 100 MS/s, as long as the analogue to digital converters (ADCs) are capable of this speed.

More memory means higher bandwidth

Nyquist's theorem indicates that the highest frequency which can be correctly determined without aliasing effects is half the sample rate. A sampling rate of 100 MS/s thus provides a Nyquist bandwidth of 50 MHz. This is fine if the scope is only being used to measure frequency.

However, the normal use of an oscilloscope is to look at wave shapes and to capture and analyse higher speed anomalies, and therefore sampling the waveform cycle just twice is not fast enough. The rule of thumb is that the period of a waveform should be sampled between five and ten times in order to be able to see the real wave shape - and much more if the user is looking for very fast events or anomalies. Thus a 100 MS/s sample rate provides an effective bandwidth of 10 to 20 MHz regardless of the possibly much higher stated bandwidth of the DSO.

History memory

There is yet a third benefit of a larger memory, which comes into play if the whole memory is not required for a particular measurement. For example, if the DSO is equipped with a one megapoint memory and the instrument is set to use 100 kpoints, theoretically it could capture ten acquisitions before the memory needed to be overwritten. This is the basis of the "history memory".

Many types of DSO provide high-speed waveform acquisition which attempts to recreate the key attribute of an analogue storage scope: the inherently very low dead time that allows the instrument to capture very occasional events and show them on the display. Many DSOs with this capability do not save all the successive acquisitions into memory but instead just show the accumulated waveforms on the display.

The limitation of this approach is that the individual waveforms cannot be analysed because the waveform data is not available in memory. As a result, this feature is mainly used to try to identify the characteristics of the anomaly so that an appropriate trigger setting can be established to recapture the anomaly when and if it reappears. The analysis capabilities of the DSO can then be used.

An alternative approach is to combine the history memory capability with a fast waveform acquisition rate, making it possible to capture occasional anomalies and analyse them without having to rearm and retrigger the DSO. The search features can be used to isolate individual waveform acquisitions, which means that not only can the anomaly be analysed on its own channel waveform but the other input channels can also be analysed to help identify the cause of the anomaly.

In this regard, one of the benefits of more analogue input channels can also be appreciated.

YOKOGAWA EUROPE B.V.
Euroweg 2, 3825 HD Amersfoort, The Netherlands
E-mail: tmi@nl.yokogawa.com