Choice of Oscilloscope or Digitizer as the Optimal Instrument for your Application

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Oscilloscopes and digitizers are a critical instrument selection when it comes to signal analysis. Both include ADC technology for waveform acquisition but the implementation for each is quite different. Some engineers have used these instruments interchangeably for their waveform analysis applications. This may be convenient, but it is important to understand that oscilloscopes and digitizers are optimized for different functions which when used inappropriately can impact the measurement results. This article describes some key attributes to consider when selecting an oscilloscope or digitizer and shares examples to demonstrate the optimal instrument for a specific application.

Consider these attributes when selecting a digitizer or oscilloscope:

- Resolution and dynamic range. A good measure of this will be the effective number of bits (ENOB). ENOB will digitize a high quality sinusoidal signal and calculate the overall signal to noise ratio.
- Input bandwidth and sample rate. Dr Harry Nyquist's sampling theorem states, for a sampling system the Nyquist frequency Fn is equal to ½ the sample frequency fs. Signal energy above the Nyquist frequency will mix with the ADC sample rate and products will fold back on top of the single of interest. Input bandwidth limiting filters are used to prevent aliasing products.
- Memory reduction techniques. Techniques such as DDC (digital down conversion) and segmented memory can reduce memory requirements.
- Input range. Scale the maximum signal level to closely match the range of the ADC. Oscilloscopes have programmable 50 ohm or 1 Megohm input terminations, AC and DC coupling. Advance probing can expand options.
- Triggering. Triggering capabilities can range from something as simple as when to start an acquisition to the complex triggering on a pattern, burst, or even serial protocol specific triggering.
- Measurements. There's a large variety of measurement and analysis tools built into many oscilloscopes providing on-board analysis. Digitizers, instead rely on the PC based application software where a bulk of the analysis is done. Some digitizers also allow access to the on-board FPGA (Field Programmable Gate Array) so that users can add their own custom code, filter, corrections or data reduction schemes into the instrument.

Oscilloscope applications

Oscilloscopes are designed for very wide bandwidths and are optimized with a large variety of usability features. They provide visualization of time variant waveforms with a view of important signal details such as noise and jitter. Various types of oscilloscope probes enable a view of signals at different points within a design.

There are several examples of applications that rely on the oscilloscope specific signal analysis capabilities.

- When performing debug and troubleshooting on a design, an oscilloscope enables a view of signal details, with extremely fast waveform updates that reveal waveform details such as glitches and anomalies and probing ability for targeted areas within the design.
- Capturing infrequent communication errors is critical for serial protocol decoding and can be achieved using an oscilloscope with hardware based triggering and serial protocol decode.
- Oscilloscopes are essential to characterize and validate digital I/O performance and the integration of the COTS technologies including CAN, DDR1, DDR2, DDR3, DisplayPort, DVI, Ethernet and Fibre channel.

Digitizer applications

Wideband digitizers are used in applications where signal fidelity is important. High resolution and dynamic range are required and results are often sent to the PC for analysis. ATE systems and high density multichannel signal analysis applications benefit from digitizers with high resolution analog to digital (ADC) technologies.

Signal analysis application examples that benefit most from digitizer capabilities include:

- A digitizer, with one to multiple channels, is ideal for monitoring electrical signals to determine physical propertied of an event and is often used in stimulus response experiments. Signal characteristics can be recorded at instants of time for post analysis of what happened during the time surrounding the event.
- Multichannel antennas are calibrated by making many cross-channel magnitude and phase measurements, then, compared to ensure there is less than 1 degree phase difference between channels/elements. Multi-channel digitizers are used to quickly acquire cross-channel magnitudes and phase measurements for comparison.
- High speed digitizers are used for sounding signal acquisition. Signals are sampled and either processed by an on-board FPGA or I and Q are stored for post processing to create the effective CIR data in a 5G mmWave MIMO Channel Sounding application.

Summary

To ensure accurate waveform analysis, it is essential to select the instrument, oscilloscope or digitizer, that can provide the optimized functions required for the application. You now have a basic understanding of the key attributes that should be considered when choosing your signal analysis instrument. To learn the details, advantages and disadvantages, involved when selecting a scope or digitizer for wideband signal acquisitions, read Understanding the Differences Between Oscilloscopes and Digitizers for Wideband Signal Acquisitions

Or view the "Oscilloscope or Digitizer for Wideband analysis - Why care?" webcast.