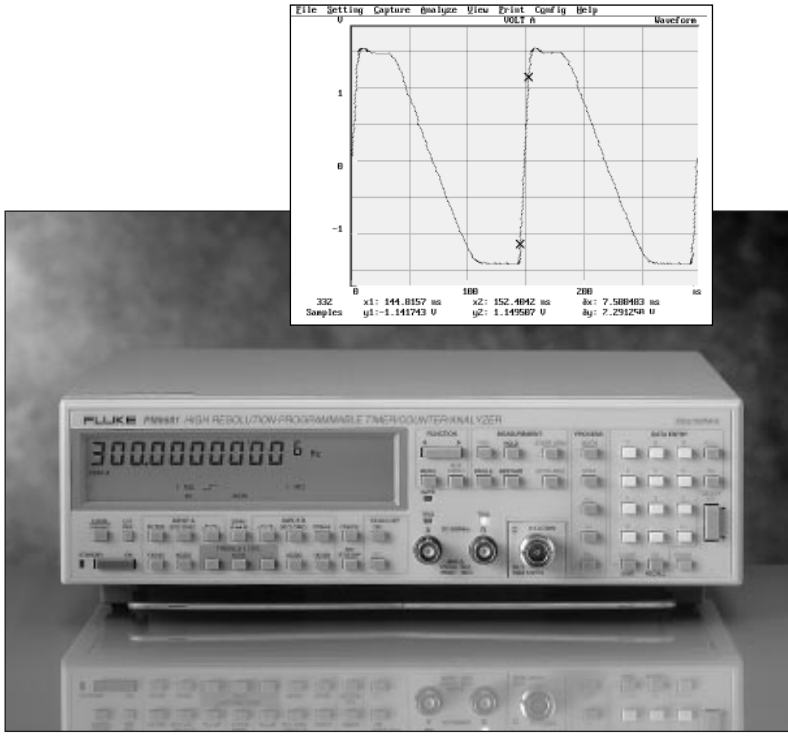
FLUKE®

Vertical Waveform Sampling Application Note



The PM 6681 and TimeView™ can sample a repetitive input signal waveform, and give a high-resolution visualization of the signal. For many signal types, the quality of the visualization is comparable to that obtained with high-speed digital oscilloscopes.

Traditional "horizontal" sampling

In a DSO, the voltage level is sampled at regular time intervals. With this sampling mode a DSO can capture single shot events, as well as repetitive signals. We call this mode horizontal sampling. Voltage samples are taken at successive time intervals.

TimeView "vertical" sampling

TimeView uses a new vertical sampling principle to capture the waveform of repetitive signals. Successive time interval measurements are made at various trigger levels. When enough samples have been taken, the signal is reconstructed. TimeView measures the time interval from a unique start trigger point of the signal to several stop trigger points at various trigger levels. The stop trigger level is swept between the signal's peak voltages, and TimeView measures the time interval again and again. Time samples are taken at successive voltage increments.

Resolution, bandwidth and risetime

Vertical sampling in TimeView, using PM 6681 as sampling front-end, gives a time resolution in any measured point of the curve of 50 ps, independent of range. The voltage resolution is 1.25 mV. The 50 ps time resolution per measured value corresponds to the performance of single-shot sampling (horizontal sampling) by a 20 GS/s DSO! The absolute accuracy is less than 500 ps (approx. 150 ps after calibration), independent of the timescale. Bandwidth should not be confused with sampling speed. The bandwidth of a waveform recorder of any kind, for example an oscilloscope, is normally referred to as the frequency at which the displayed amplitude of a sine-wave has fallen by 3 dB or approx. 30%. Another (indirect) measure of the analog band-width is the internal risetime. In other words, at what risetime is an ideal pulse shown?
The internal risetime of PM 6681 is approx. 800 ps, corresponding to an analog bandwidth (in oscilloscope terms) of approx. 450 MHz.

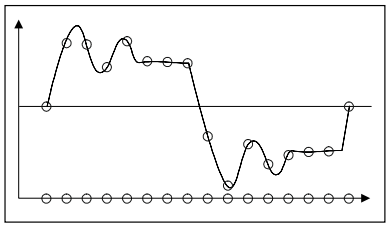


Fig. 1 Horizontal sampling time is incremented, voltage is sampled.

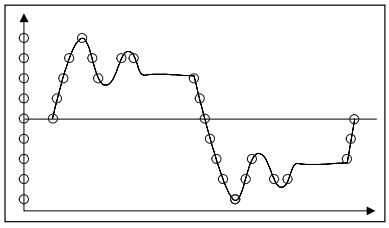


Fig. 2 Vertical sampling voltage is incremented, time is sampled.

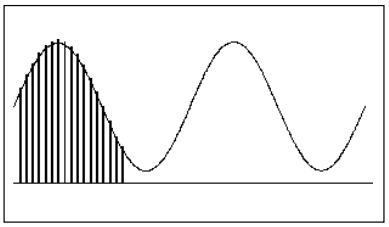


Fig. 3 Limited resolution in horizontal sampling gives a display with noise.

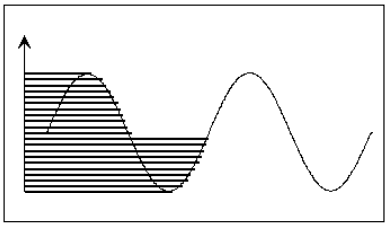


Fig. 4 Limited resolution in vertical sampling gives a display with jitter.

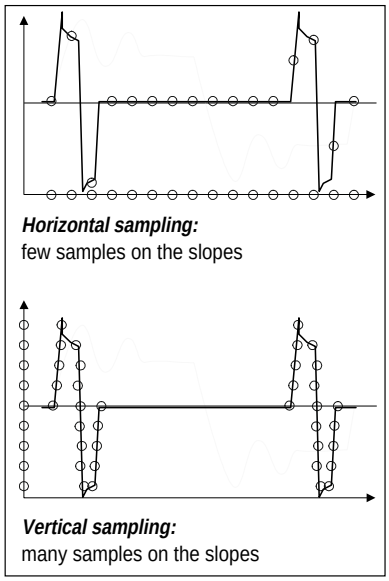


Fig. 5 Vertical sampling is better at sampling fast transitions

Different characteristics

Both horizontal and vertical sampling have similarities. They both produce an array of measurement points, expressed as (V(t),t). However horizontal sampling produces an array (V(t), t), whereas vertical sampling gives an array (V, t(V)). This leads to important differences between the methods (Fig.1 and 2).
For example, a limited resolution of the sampled values, or disturbances of a signal, is shown as amplitude variations or noise with horizontal sampling, and as time variations or jitter with vertical sampling (Fig.3 and 4).

Advantages of vertical sampling

- The timescale resolution is always very high, <50 ps, also at long time intervals.
- High-precision capture of pulses with a low duty cycle is done with a few samples (hundreds), while traditional (horizontal) sampling may require thousands or millions

of samples to be stored.

An example:
We want to capture two 1V, 10µs pulses that occur every 100 ms, and we want at least 1% accuracy of the pulse width (Fig.5). Vertical sampling requires a few hundred samples to capture and display these two pulses during the 100 ms. The pulsewidth is measured with <0.5 ns accuracy, that is 0.005%. (Amplitude resolution is 1.25 mV and accuracy <5%).
Horizontal sampling requires at least 100 ns sample intervals during 100 ms, resulting in 1 million samples to be stored, and the accuracy of the pulse width is about 1%.

Disadvantages of vertical sampling

- Long capture time, because of repeated measurements
- No single-shot capture
- Not all periodic signals can be captured correctly, e.g. AM-modulated signals

Samples of some selected signals

The following pictures show some typical signals, for which you can judge the vertical capture principles. We have used a PM 6681 timer/counter/analyzer plus TimeView for vertical sampling.

Example 1, High-frequency sinewave (20 MHz)

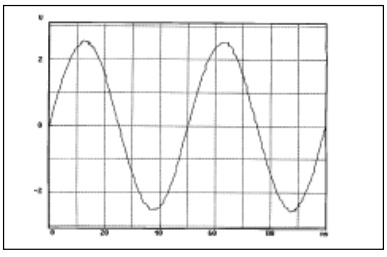


Fig. 6 Vertical sampling of a sinewave.

Example 2, FM signal, 1 kHz modulation, 2% deviation

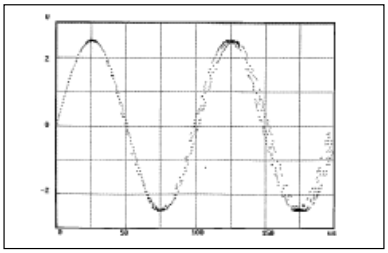


Fig. 7 Vertical sampling of an FM signal.

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