Recent Innovation of Waveform Acquisition Methods: Residue Sampling and Metallic Ratio Sampling

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This paper describes recent innovation of waveform acquisition methods developed in our group. The first one is the residue sampling, which provides high-frequency signal estimation using multiple low-frequency sampling circuits following an analog Hilbert filter and ADCs; the sampling frequencies are relatively prime. It is based on aliasing phenomena in the frequency domain for waveform sampling and the residue number theory. Since the high frequency signal is sampled with low frequency clocks, aliasing (spectrum folding) occurs. However, each aliased frequency is different because each sampling clock frequency is different in the sampling circuits. Based on the Chinese remainder theorem, this difference allows the input frequency to be estimated. We have also considered its applications to RF/AMS device testing, such as two tone testing for high frequency narrow band devices and wireless communication device testing as well as analog filter testing. The second one is the metallic ratio sampling in equivalent-sampling. We show the metallic ratio of the sampling frequency and the input frequency can be used for efficient waveform acquisition, ADC histogram testing and TDC linearity self-calibration. We came up with this method from the waveform missing phenomena in a sampling oscilloscope. The third one is proactive use of finite aperture time in sampling circuit for sensor interface, for effective low pass filtering. We also show that the long aperture time reduces the pedestal output voltage error of the sampling circuit due to the MOS switch charge injection and clock feedthrough.