COMPARISON OF JITTER MEASUREMENTS IN THE TIME AND FREQUENCY DOMAIN

When analyzing the robustness of data transmission systems, jitter is a key indicator. It is recommended to use jitter measurement instruments for both the time and frequency domain to differentiate between fast and slow moving artifacts.

Your task

Your task is to measure jitter with high sensitivity. Random jitter in the time domain spreads the signal in the frequency domain and can be interpreted as unintentional phase modulation or phase noise. Phase noise in the frequency domain can be measured with a higher sensitivity than jitter in time domain with the R&S®FSWP phase noise analyzer, which gives unbeatable sensitivity in terms of jitter measurement, whereas the R&S®RTO oscilloscope is capable to detect the jitter of dynamic spurs, e.g. transients or moving spurs in time domain.

Comparison of measurement results

For the comparison, a 1 GHz signal with a FM modulation at 1 MHz and additive noise with a bandwidth from 0 Hz to 4 MHz is used. For a comparable measurement, the time interval error (TIE) of the R&S®RTO is chosen because both instruments track the oscillator. However, as the measurement principles of the instruments are different, there are differences between these two analyzers. The R&S®FSWP integrates several cycles of the signal.

The R&S®FSWP is best suited for measuring random (RJ) and periodic jitter (PJ), whereas the R&S®RTO can also detect duty cycle distortion and data dependent jitter.

Characteristics for jitter measurement

Parameter	R&S®FSWP	R&S®RTO
Sensitivity	≤ 5 fs	600 fs (jitter noise floor)
Detection of dynamic signals	–	detection with the track function
Maximum measurable input frequency	up to 50 GHz	up to 6 GHz
Aliasing	no	yes
Measurement close to carrier	0.01 Hz	limited by the maximum record length

The top of Fig. 1 on next page shows the R&S®RTO measurement waveform as a track function (TIE versus time). The middle diagram shows the FFT of the track function. The FFT displays the jitter spectrum with the PJ. The area under the curve corresponds to the total jitter (TJ) of the signal. The results are displayed in dBps. At the bottom, the histogram of the TIE measurement is shown.

In Fig. 2, the R&S®FSWP measurement results are displayed in dBc (1 Hz). The R&S®FSWP also calculates the PJ of each spur, the total PJ and the RJ of the phase noise spectrum in ps.

To compare the results, the units of both measurements are converted to ps. In addition, the random jitter for the R&S®RTO and the total jitter for the R&S®FSWP are calculated using the following equation:

$$TJ^2 = RJ^2 + PJ^2$$

The table on the next page shows the individual measurements and the differences. The R&S®RTO and R&S®FSWP results are nearly identical. They detect the PJ at the same frequencies, and the difference in their values is less than 0.5 ps. The difference between the detected RJ and TJ values is less than 0.5 ps. This good correspondence proves the comparability of the two instruments.

Measurement results

Parameter	Frequency	R&S®RTO	R&S®FSWP	Difference
Periodic jitter	1.0 MHz	4.64 ps	4.63 ps	0.01 ps
Random jitter (mean)		7.34 ps	7.44 ps	0.10 ps
Total jitter (mean)		8.68 ps	8.76 ps	0.08 ps

Summary

The R&S®RTO oscilloscopes and the R&S®FSWP phase noise analyzer measure jitter signals (TIE) comparably and precisely – the R&S®RTO in the time domain, the R&S®FSWP in the frequency domain. The R&S®RTO offers more capability with additional results such as duty cycle or data dependent jitter and analysis of fast transient signals at limited sensitivity. The R&S®FSWP offers easy separation of periodic and random jitter at an unbeatable sensitivity of a few fs. The R&S®RTO and the R&S®FSWP complement one another well and present an ideal solution for jitter measurements.

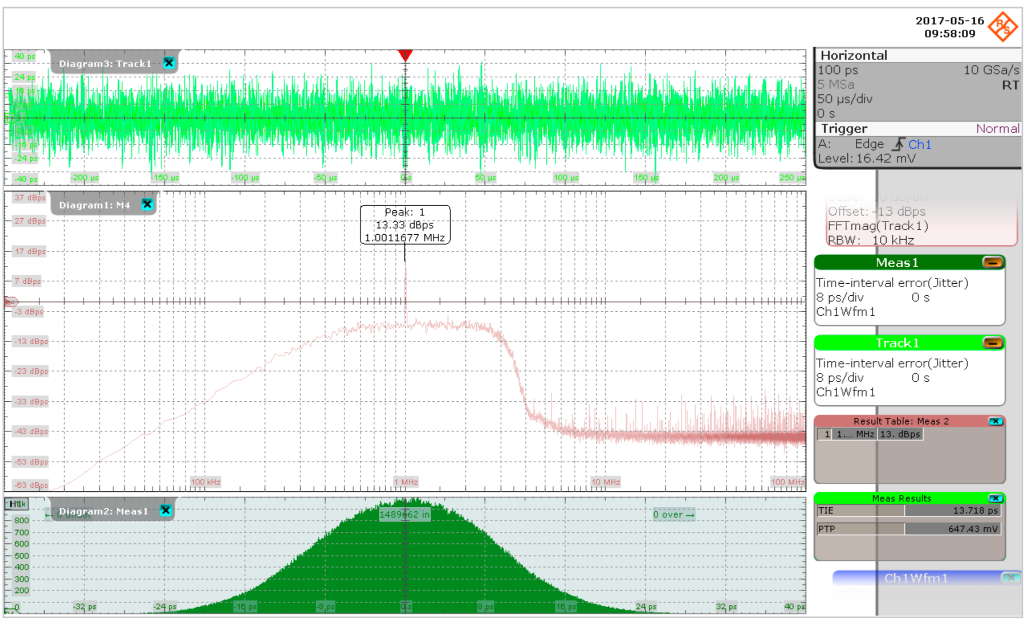

Fig. 1: R&S®RTO oscilloscope measurement results

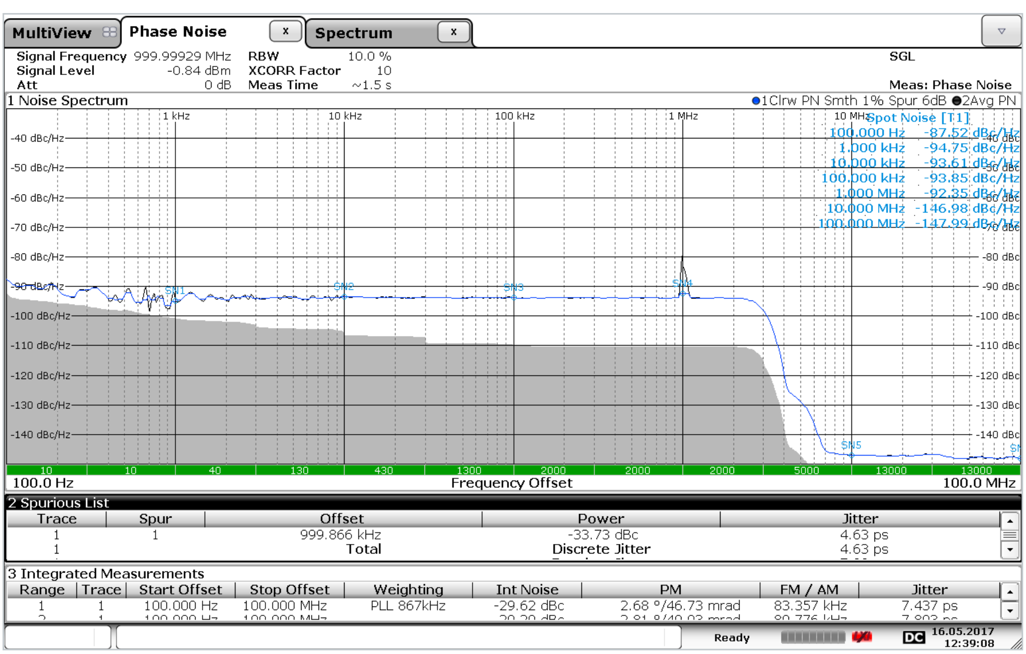

Fig. 2: R&S®FSWP phase noise analyzer measurement results

Rohde & Schwarz GmbH & Co. KG
www.rohde-schwarz.com

Rohde & Schwarz training
www.training.rohde-schwarz.com
Rohde & Schwarz customer support
www.rohde-schwarz.com/support

PD 5215.3279.92 | Version 02.00 | July 2024 (sk)
Comparison of jitter measurements in the time and frequency domain