ООО «4ТЕСТ»
Телефон: +7 (499) 685-4444
info@4test.ru
www.4test.ru

R&S®FSPN PHASE NOISE ANALYZER AND VCO TESTER

Unrivaled sensitivity meets high speed

Product Brochure
Version 02.00

ROHDE&SCHWARZ
Make ideas real

AT A GLANCE

The R&S®FSPN phase noise analyzer and VCO tester is very sensitive with very high metrological accuracy for absolute reliability. It measures phase noise from highly stable sources such as synthesizers, VCOs, OCXOs and DROs in radar and satellite applications.

The R&S®FSPN phase noise analyzer and VCO tester has everything you need to keep up with demanding measurements, from lab to production.

The high measurement speed and easy usability make it ideal for efficient phase noise analysis both in R&D and on production lines.

The low-noise internal local oscillators let the R&S®FSPN measure all commercially available synthesizers and oscillators without requiring the purchase of additional options.

SCPI compatibility between the R&S®FSPN and R&S®FSWP enables a quick transition from R&D to production. The built-in SCPI recorder helps easily generate test automation scripts directly from the user interface.

Front view of the R&S®FSPN.

KEY FACTS

- Frequency range from 1 MHz to 8 GHz/26.5 GHz/50 GHz
- Very high sensitivity for phase noise measurements thanks to dual synthesizers and cross-correlation included in the base unit, typ. –163 dBc (1 Hz) at 1 GHz carrier frequency and 10 kHz offset
- Extremely low-noise internal DC sources for automatic VCO characterization
- High measurement speed with hardware-implemented real-time cross-correlation
- Simultaneous measurement of phase noise and amplitude noise
- SCPI recorder for the quick setup of automated measurements and test sequences

BENEFITS

Measurement speed taken to the limit
▶ page 4

SCPI recorder – move from development to production
▶ page 5

Phase noise measurements with highest sensitivity
▶ page 6

Fastest VCO characterization
▶ page 8

Transient response analysis
▶ page 10

Rear view of the R&S®FSPN with all common interfaces for remote control such as LAN, USB and IEEE-488 (GPIB).

MEASUREMENT SPEED TAKEN TO THE LIMIT

Save time and multiply measurement throughput in production

Speed is crucial, especially in manufacturing. The phase noise sensitivity of the R&S®FSPN requires a hundred times fewer correlations relative to other available solutions for measuring highly sensitive oscillators such as DROs and OCXOs, saving measurement time and multiplying measurement throughput, two core parameters for production lines.

The state-of-the-art hardware makes it all possible: a fast processor and FPGAs for instantaneous data processing and analysis. Built-in high-quality internal sources reduce the number of correlations needed for phase noise measurements.

Speed up development of your devices

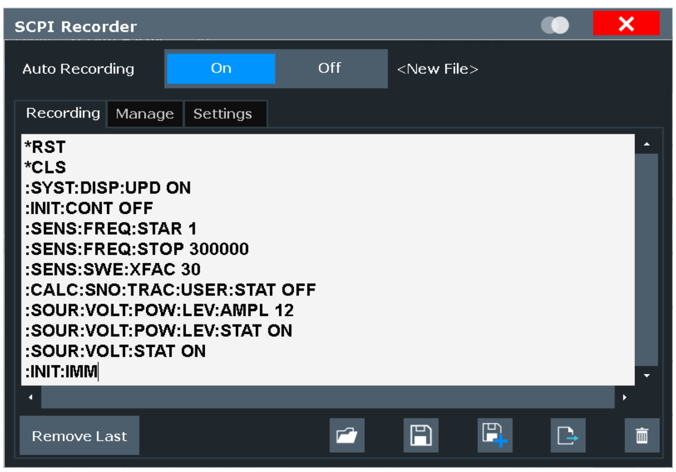
Signal sources can be developed and optimized faster with a Rohde & Schwarz instrument delivering quicker results with shorter measurement times. The R&S®FSPN takes just a few seconds to display the phase noise trace for high-end sources such as OCXOs or DROs.

SCPI RECORDER – MOVE FROM DEVELOPMENT TO PRODUCTION

Create test automation scripts directly in the user interface

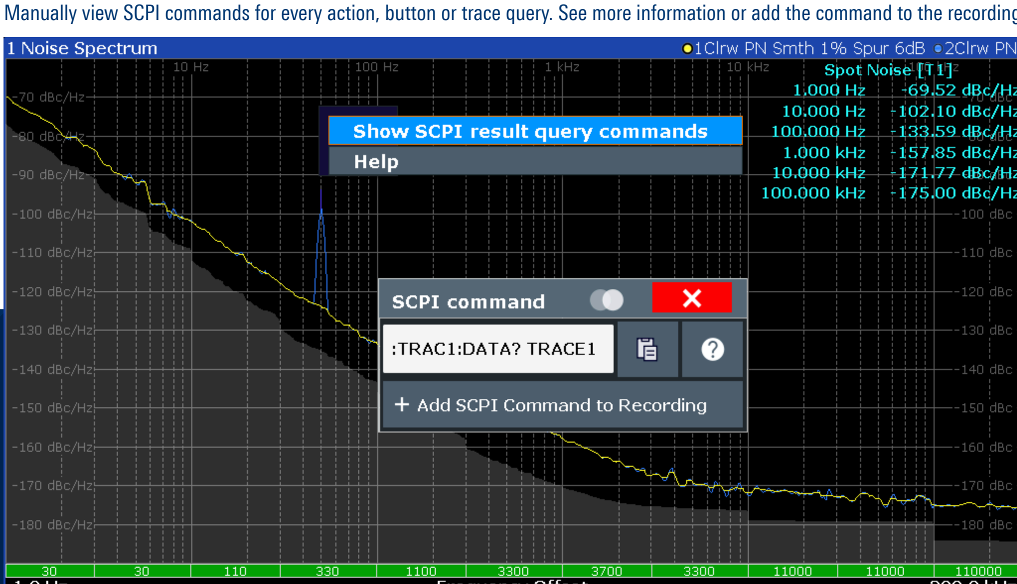
SCPI commands are human readable communications between control software and test and measurement instruments. Users can completely configure a device with SCPI commands. To simplify the move from operator-controlled measurements to automated testing, the R&S®FSPN supports the automatic generation of SCPI scripts.

The SCPI commands for changing settings, pressing buttons or querying data can be viewed and manually added to the current SCPI command list. The SCPI recorder can also be enabled and all user interactions with the the instrument are automatically translated into SCPI commands. Instrument firmware supports the export of the plain command list or ready-to-use scripts in different languages such as Matlab®, Python and C#.



View and export in plain SCPI or as fully functional programs.

Manually view SCPI commands for every action, button or trace query. See more information or add the command to the recording.



PHASE NOISE MEASUREMENTS WITH HIGHEST SENSITIVITY

Cross-correlation for improved phase noise sensitivity

The R&S®FSPN base unit includes cross-correlation functions to measure sources with very low phase noise even lower than in internal high-end sources. The expected improvement from the function is as follows:

$$\Delta L = 5 \cdot log(n)$$

- ΔL: improvement in phase noise sensitivity through cross-correlation (in dB)
- n: number of correlations/averages

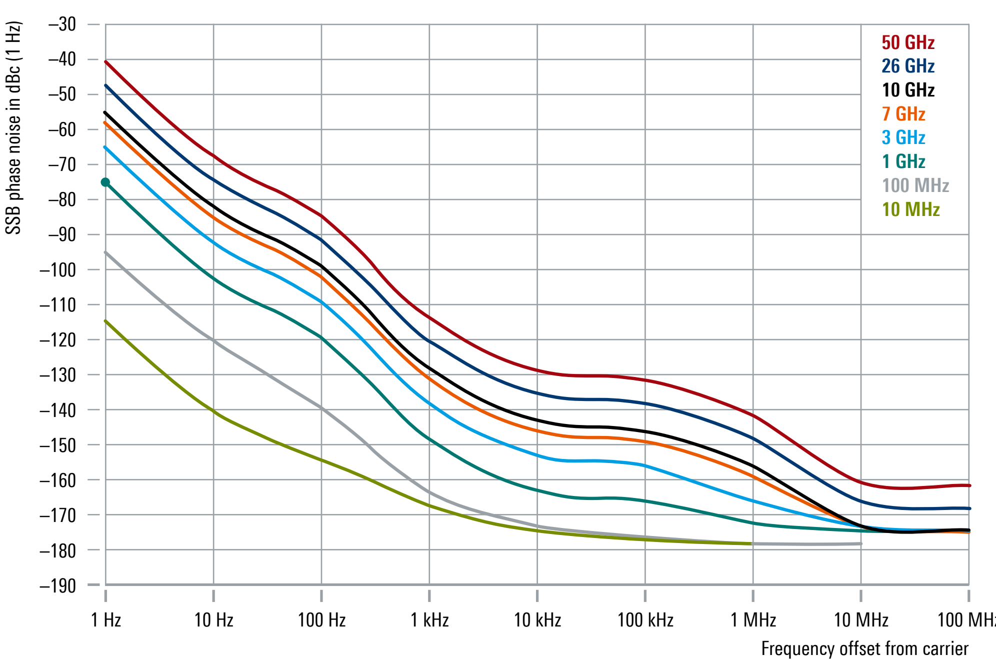
Using the R&S®FSPN, only a few correlations are needed to measure a high quality oscillator. This reduces measurement time which is essential in production environments. Increasing the number of correlations by a factor of 10 lowers the inherent phase noise of the R&S®FSPN by 5 dB.

Display multiple measurements in parallel

The R&S®FSPN can measure amplitude noise and phase noise simultaneously, displaying results for both measurements in a common diagram or in separate windows.

Sometimes it is difficult to know how many correlations will be needed to measure a signal source. A gray area below the trace helps estimate the feasible sensitivity and cross-correlation gain for the selected number of correlations.

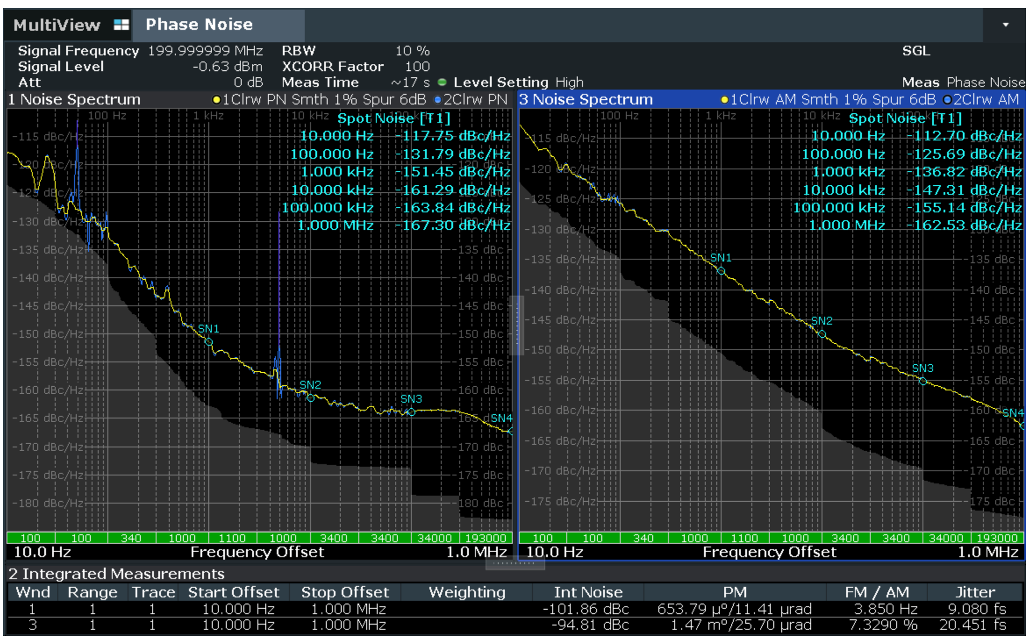
Typical phase noise sensitivity (cross-correlation factor = 1, signal level = 10 dBm)



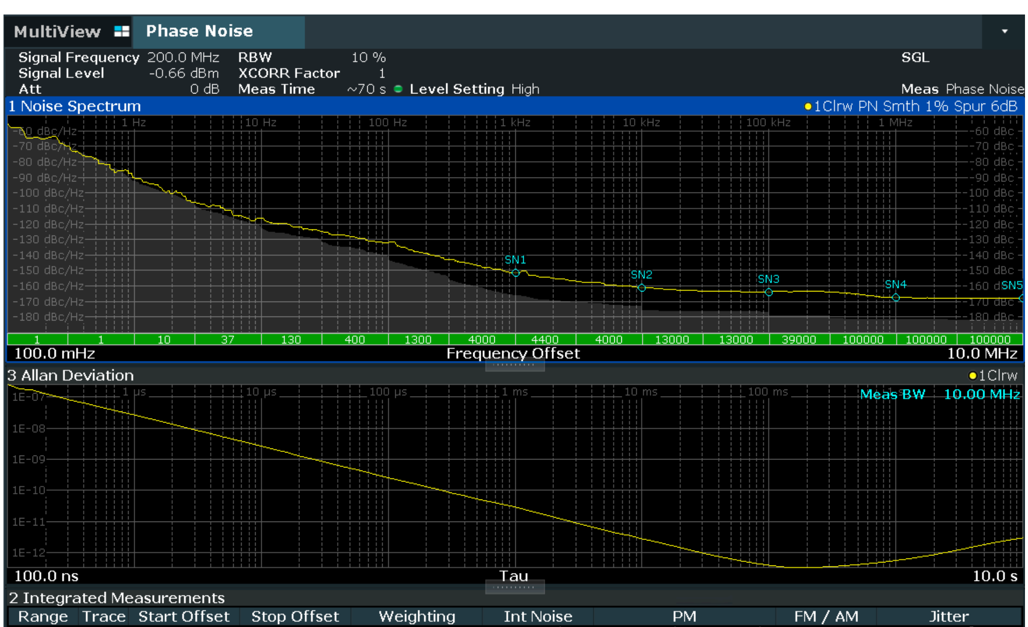
Measuring Allan variance

To characterize long-term oscillator frequency stability, frequencies are measured in the time domain at fixed time intervals and the deviation of the measurements are calculated. These deviations are called the Allan variance. The R&S®FSPN calculates the Allan variance for phase noise measurements, where cross-correlation can be applied and spurs suppressed.

This parameter is typically plotted over time, unlike phase noise, which is displayed in the frequency domain. The Allan variance or deviation is especially important for characterizing highly stable sources such as those used in satellite navigation systems.



The R&S®FSPN can measure phase noise and amplitude noise simultaneously. The gray area below the traces shows the cross-correlation gain of the R&S®FSPN.



The R&S®FSPN calculates the Allan variance based on the phase noise measurement (upper window). For example, an offset range of 100 mHz to 10 MHz corresponds to a time-domain display of 100 ns to 10 s.

FASTEST VCO CHARACTERIZATION

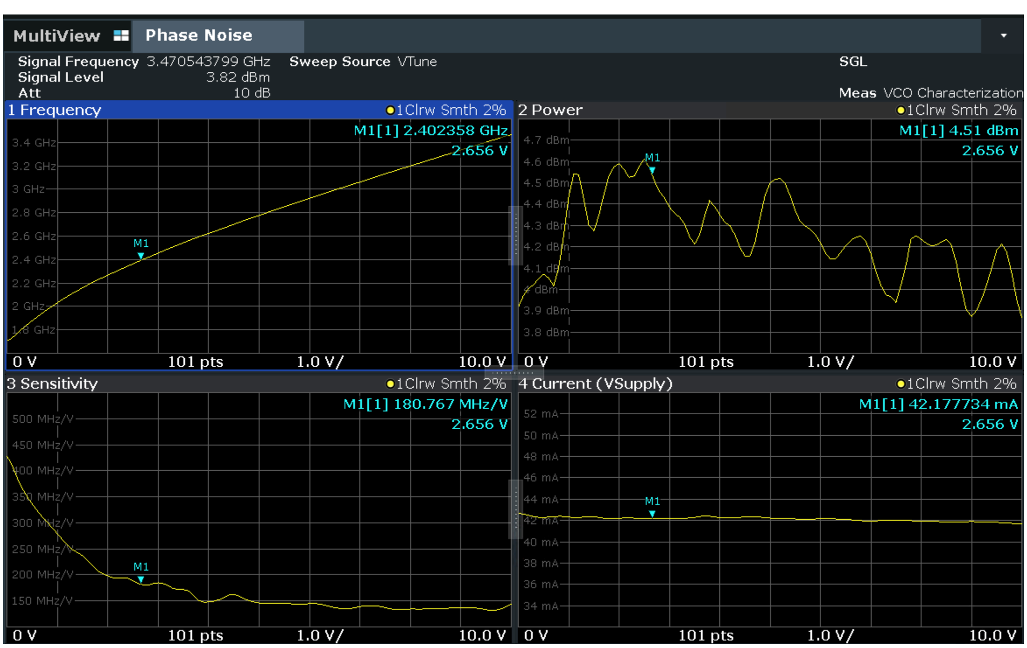
Thanks to internal low-noise DC sources, the R&S®FSPN can measure the phase noise of voltage-controlled oscillators (VCO) at various tuning and supply voltages. VCO characterization varying the tuning voltage or the supply voltage can be completed quickly. The following parameters are delivered instantaneously:

- Frequency versus voltage
- Sensitivity versus voltage
- Output power versus voltage
- Current drain versus voltage
- Output power versus frequency

Specifications for internal DC source	
Supply voltage	0 V to 16 V
Maximum current load	2000 mA
Tuning voltage	–10 V to +28 V
Maximum current load	20 mA

Harmonics suppression measurement

One problem for many VCO manufacturers is trying to suppress harmonics that can cause interference in the system. The R&S®FSPN measures the power of the higher VCO harmonics relative to the tuning voltage.

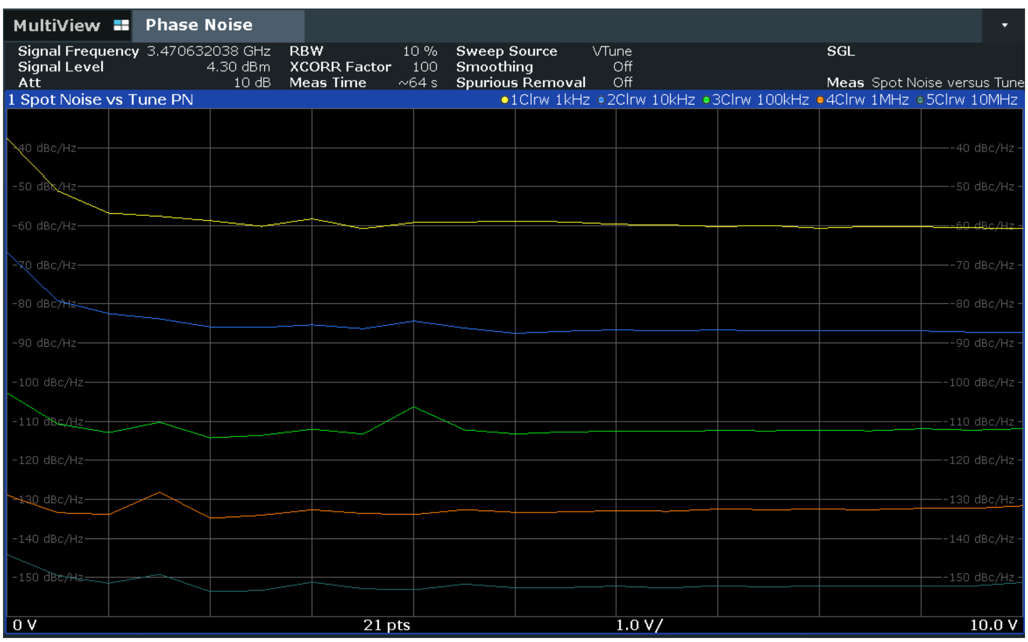


A typical VCO measurement. Key parameters such as frequency, power, sensitivity and current consumption are measured relative to the tuning voltage.

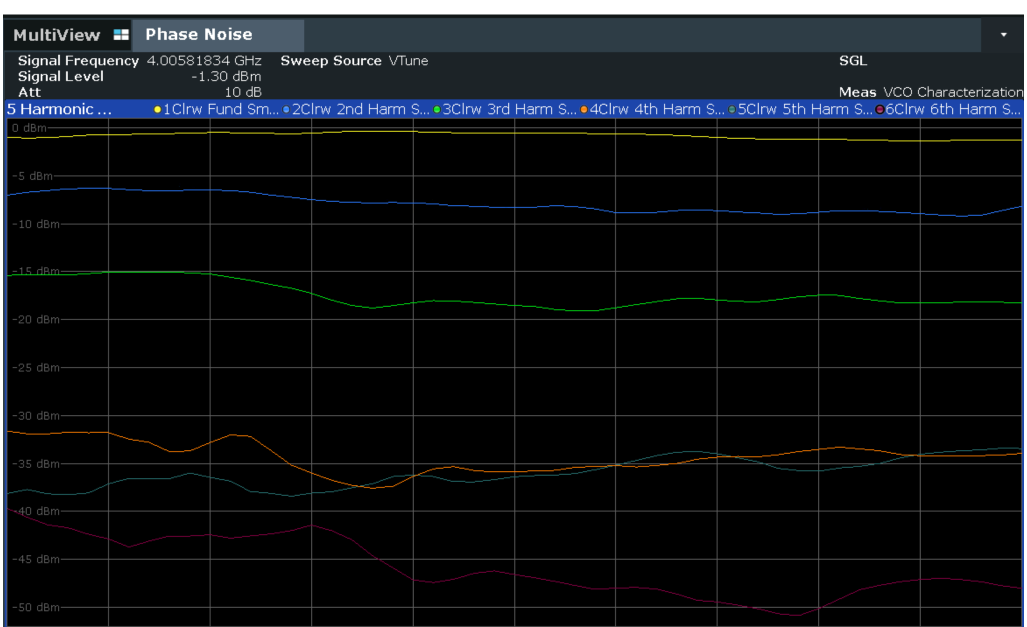
Enhanced tuning voltage capabilities

Verifying whether the VCO phase noise is dependent on frequency (as expected), or whether additional noise comes from interference at specific frequencies is a typical component development task. This can only be seen once the phase noise is measured over the entire tuning voltage range.

In seconds, the R&S®FSPN can automatically display the phase noise at various offset frequencies relative to the tuning voltage.



VCO's phase noise at offset frequencies of 1 kHz, 10 kHz, 100 kHz, 1 MHz and 10 MHz relative to the tuning voltages.



Display of higher harmonics power compared to the fundamental (yellow line) relative to the tuning voltage.

TRANSIENT RESPONSE ANALYSIS

Up to 8 GHz wideband analysis for frequency and phase measurements in the time domain

Detailed characterization of synthesizers and signal sources is essential when designing frequency agile systems. The design process includes wideband frequency and phase measurements in the time domain (transient analysis).

The R&S®FSPN offers up to 8 GHz of bandwidth for detailed characterization of switched sources, synthesizer frequency hops and frequency ramps.

Along with wideband analysis, the R&S®FSPN offers narrowband analysis down to 40 MHz for detailed examination of the transient PLL response.

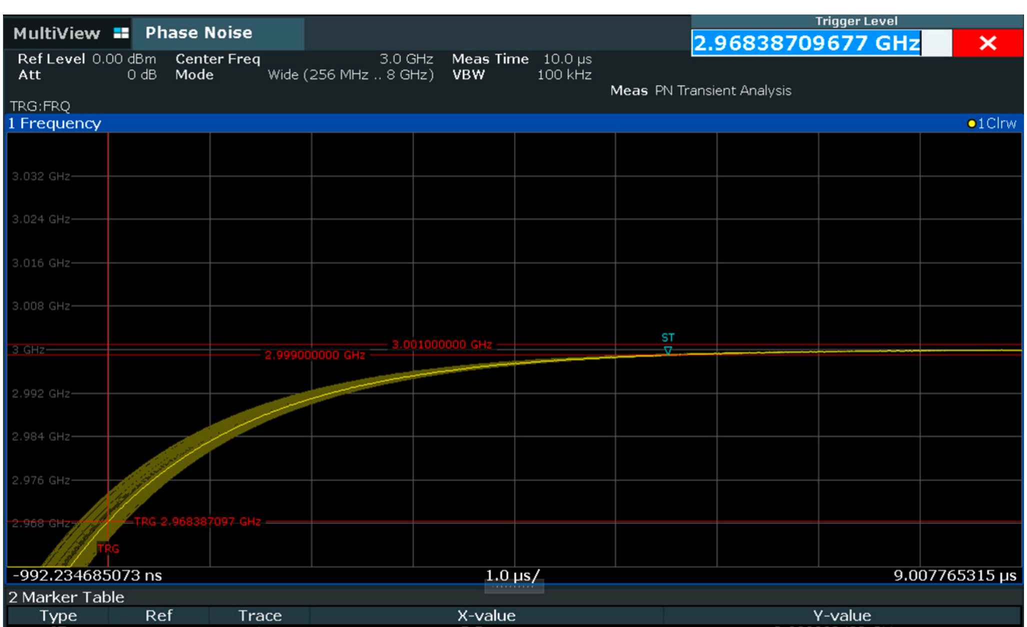
A persistent display of all traces can be used to estimate how strongly parameters scatter or determine the presence of any outliers.

Trigger capabilities for reproducible measurements

Detailed examination of transient responses should use a trigger to obtain comparable and reproducible measurement results. In addition to external triggers or power triggers, users can also trigger transient analysis on a frequency.

Available triggers include:

- External trigger
- I/Q power
- External power sensor
- Frequency



Transient response of a synthesizer in persistence mode. The horizontal red line shows the frequency trigger threshold, the vertical line the trigger offset. The bright yellow trace is the current measurement, the dull yellow traces show all previous measurements.

Linearity analysis of FMCW chirps

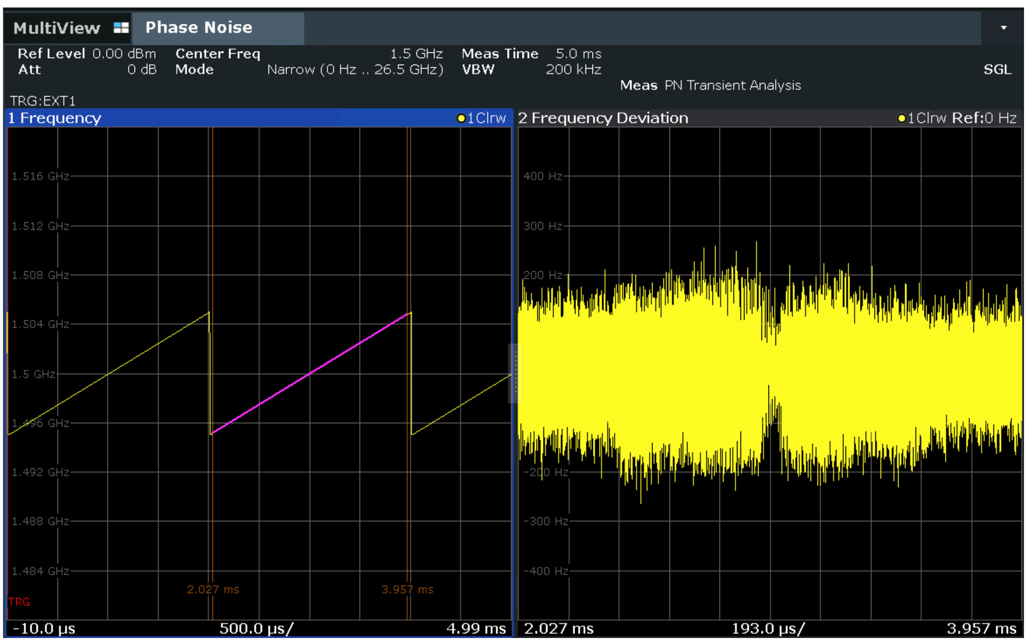
Deviations from linear chirp signal behavior in the frequency domain can be analyzed in detail with transient analysis.

The R&S®FSPN inserts a reference line (the calculated regression line between two user-defined points in time) that users can easily adapt on the touch screen. An additional window is available to display where the measured frequency deviates from the linear reference line.

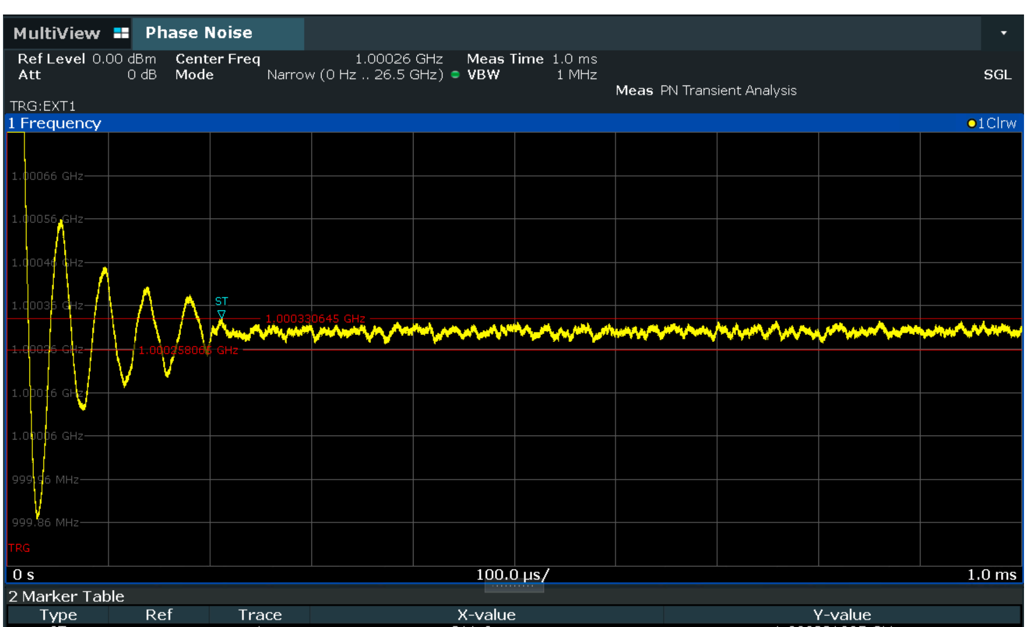
Automatic settling time measurement

After a trigger event, the R&S®FSPN automatically measures the settling time needed for the synthesizer to remain within a defined tolerance range.

Users can define the tolerance range according to their requirements and have the result displayed on the screen. No complex configurations with limit lines and delta marker functions are needed.



Analysis of FMCW chirp linearity. Left: the pink reference line can be seen. Right: the deviation of the frequency from linear behavior is displayed.



Settling time until the frequency of the synthesizer stays within a certain tolerance range.

SPECIFICATIONS IN BRIEF

Base unit		
Frequency range, RF input		
Phase noise, amplitude noise measurement	R&S®FSPN8	1 MHz to 8 GHz
	R&S®FSPN26	1 MHz to 26.5 GHz
	R&S®FSPN50	1 MHz to 50 GHz
Phase noise measurement		
Measurement results		SSB phase noise, spurious signals, integrated RMS phase deviation, residual FM, AM noise, time jitter, RMS jitter, periodic jitter
Offset frequency range	carrier frequency ≤ (maximum input frequency – 1 GHz)	1 µHz to (maximum input frequency – carrier frequency)
	carrier frequency ≥ (maximum input frequency – 1 GHz)	1 µHz to 1 GHz
Amplitude noise measurement		
Offset frequency range	input signal ≤ 100 MHz	1 µHz to 40 % of carrier frequency
	input signal > 100 MHz	1 µHz to 40 MHz

Phase noise sensitivity in dBc (1 Hz) 1) 2)

RF input frequency	Offset frequency from carrier							
	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
10 MHz	(–115)	(–140)	–140 (–146)	–158 (–164)	–170 (–176)	–170 (–176)	–170 (–176)	
100 MHz	(–95)	(–120)	–133 (–139)	–157 (–163)	–167 (–173)	–170 (–176)	–172 (–178)	–172 (–178)
1 GHz	(–75)	(–102)	–113 (–119)	–142 (–148)	–157 (–163)	–160 (–166)	–167 (–173)	–168 (–174)
3 GHz	(–65)	(–92)	–103 (–109)	–132 (–138)	–147 (–153)	–150 (–156)	–160 (–166)	–168 (–174)
7 GHz	(–58)	(–85)	–96 (–102)	–125 (–131)	–140 (–146)	–143 (–149)	–153 (–159)	–168 (–174)
10 GHz	(–55)	(–82)	–93 (–99)	–122 (–128)	–137 (–143)	–140 (–146)	–150 (–156)	–168 (–174)
16 GHz	(–51)	(–78)	–89 (–95)	–118 (–124)	–133 (–139)	–136 (–142)	–146 (–152)	–165 (–171)
26 GHz	(–47)	(–74)	–85 (–91)	–114 (–120)	–129 (–135)	–132 (–138)	–142 (–148)	–161 (–167)
50 GHz	(–41)	(–68)	–79 (–85)	–108 (–114)	–123 (–129)	–126 (–132)	–136 (–142)	–155 (–161)

AM noise sensitivity in dBc (1 Hz) 1) 2)

RF input frequency	Offset frequency from carrier								
	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz	30 MHz
100 MHz ≤ f ≤ 1 GHz	–102 (–108)	–117 (–123)	–132 (–138)	–147 (–153)	–155 (–161)	–165 (–171)	–165 (–171)	–165 (–171)	–165 (–171)
1 GHz < f ≤ 12 GHz	–97 (–103)	–112 (–118)	–127 (–133)	–142 (–148)	–152 (–158)	–160 (–166)	–165 (–171)	–165 (–171)	–165 (–171)
12 GHz < f ≤ 18 GHz	–87 (–93)	–102 (–108)	–117 (–123)	–132 (–138)	–147 (–153)	–160 (–166)	–165 (–171)	–165 (–171)	–165 (–171)
f > 18 GHz	–77 (–83)	–92 (–98)	–107 (–113)	–122 (–128)	–137 (–143)	–150 (–156)	–160 (–166)	–165 (–171)	–165 (–171)

Improvement of noise sensitivity by number of cross-correlations				
Cross-correlations	10	100	1000	10 000
Improvement	5 dB	10 dB	15 dB	20 dB

1) Start offset = 1 Hz, cross-correlation factor = 1, numbers in brackets are typical values in dBc (1 Hz).
2) Signal level ≥ +10 dBm; for signal level < +10 dBm, the AM noise sensitivity is limited by the thermal noise floor of –177 dBm (1 Hz).