

It detects everything: the R&S®FSVR real-time spectrum analyzer

Premiere: The R&S®FSVR is the first device on the market to combine a full-featured spectrum and signal analyzer and a real-time spectrum analyzer. It seamlessly captures and displays the frequency spectrum over a 40 MHz bandwidth. The spectrogram display and the persistence mode ensure that even infrequent or ultrashort events are detected. Sporadically occurring signals in the spectrum can be reliably detected and investigated using the analyzer's frequency-selective trigger.

Real-time spectrum analysis up to 40 GHz

Interference caused by sporadic and brief events in the frequency range, spectral behavior of signal sources during frequency changeovers, digital circuits that affect RF signals – these are problems that are all too familiar to developers in the field of RF engineering. Until now, the causes of such problems were usually difficult and time-consuming to locate. This is now a thing of the past with the R&S®FSVR (FIG 1), which is based on the R&S®FSV*, because it detects everything in real-time mode. In real-time mode, it seamlessly records RF signals with a bandwidth of 40 MHz in

the time domain, converts them into the frequency domain and displays them as a spectrum. To achieve high time resolution and therefore accurate level measurements, even of short-term or pulsed signals, the R&S®FSVR can overlap the time windows for fast Fourier transformation (FFT) by at least 80 percent. Since all the data captured is processed in real time without any gaps, users do not miss even very short signals. The R&S®FSVR is the first analyzer to provide this real-time capability for input frequencies up to 40 GHz, and even up to 110 GHz with external mixers.

* The fastest and most accurate signal analyzer in the medium class. NEWS (2008) No. 197, pp. 18–23.

FIG 1 The R&S®FSVR real-time spectrum analyzer is available in four models up to 7 GHz, 13 GHz, 30 GHz or 40 GHz.



The analyzer digitizes the RF signal with a sampling rate of 100 MHz and converts it into the frequency domain in real time, calculating up to 250000 spectra per second in the process. Since this is too fast for the human eye, the R&S®FSVR combines the measurements in a detector and displays the result on the screen about 30 times per second. This is roughly the refresh rate the human eye is capable of processing. The peak detector ensures that no RF signal in the observed frequency range is lost, and that every signal that occurs during the monitoring period is also displayed.

Since the R&S®FSVR combines several spectra into one trace in this mode, the time resolution is reduced significantly. In order to provide a clear picture of the spectrum variation versus time, the analyzer is equipped with various display and measurement functions.

Persistence mode visualizes signal occurrence probability

The persistence mode is an effective means of visualizing ultrashort signals. The R&S®FSVR superimposes the gapless spectra in a diagram. Depending on how often a specific signal with a given amplitude occurs, the R&S®FSVR changes the color of the corresponding pixel on the display. Signals that are continuously present are displayed in red, for example, and extremely infrequent signals are displayed in blue. If specific signals cease to occur, they disappear from the display when the chosen persistence time has elapsed. The persistence mode represents a kind of spectral histogram. It is an unbeatable tool for examining signals that change over time. For example, users are now able to analyze the fast transient response of phase-locked loops (PLL). Gapless visualization of all frequencies and amplitudes that occur, including probability weighting, provides a completely new impression of the system's dynamic behavior in the frequency range. Users can see whether a transmitter makes rapid frequency hops or whether there are significant changes in amplitude for brief periods of time. Effects like these, which can considerably affect the behavior of an entire system, are difficult to detect using sweeping spectrum analyzers.

FIG 2 shows a typical measurement. The analyzer captures and displays even very short signals, providing a complete picture of the time variation of the frequencies and amplitudes occurring in the frequency domain. In this display mode, superimposed signals can be separated if they have different frequency level probabilities, which could be due to different modulation types or symbol rates, for example (FIG 3).

Spectrogram function seamlessly records spectra

The persistence mode provides users with new ways of analyzing errors by visualizing the time variation of signals in the

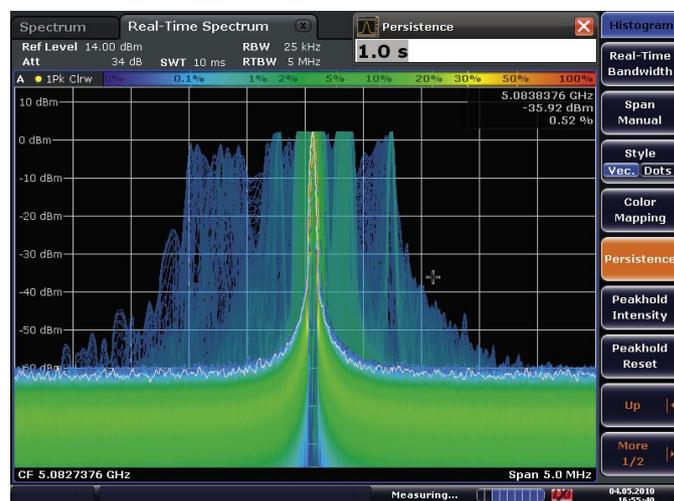


FIG 2 Transient response of a VCO for WLAN applications in persistence mode.



FIG 3 Superposition of a WLAN and Bluetooth® signal in the ISM band. The persistence mode makes it possible to clearly identify the different signals.

frequency domain. To accurately capture this time variation, the R&S®FSVR uses the spectrogram function. It assigns a color to the signal amplitude, allowing the spectrum to be displayed with just a single horizontal line. The spectrogram is created by continuously lining up the horizontal lines next to each other. In real-time mode, it provides a seamless display of the spectrum over time. In this mode, the R&S®FSVR captures and records up to 10000 traces per second and writes them to a ring buffer. Here, too, the analyzer uses a detector to reduce the data for the display. The ring buffer memory depth is sufficient to store up to 100000 traces. Depending on the selected update rate, the R&S®FSVR can measure continuously for a period of up to five hours.

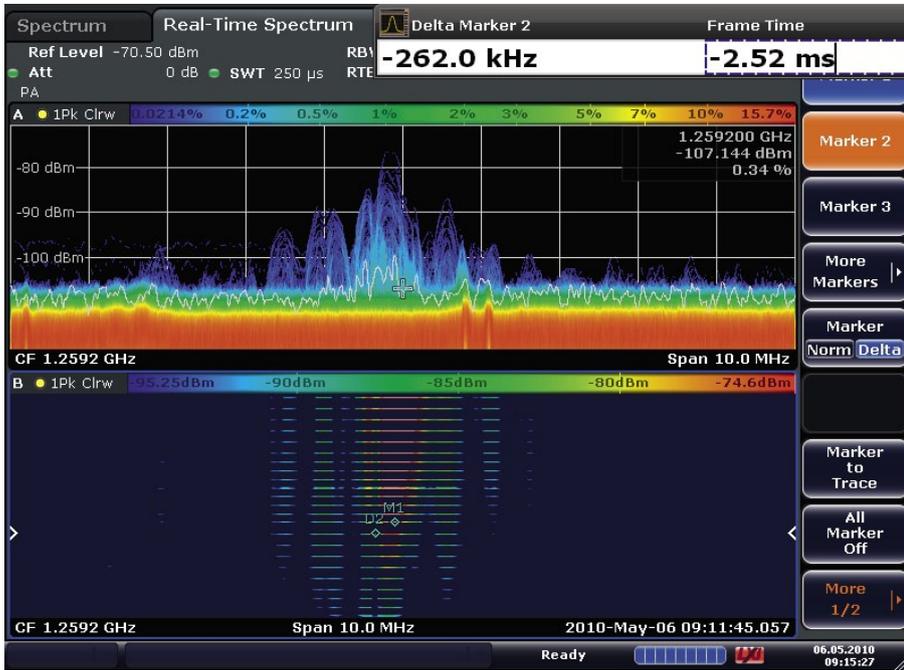


FIG 4 Airport radar signal. The spectrogram shows the pulsed structure of the signal and allows the pulse repetition rate to be measured, in this example 2.5 ms.

To allow completed measurements to be examined in detail, the analyzer provides markers that users can move along the time and frequency axes. This allows the duration of events or time intervals between events, for example, to be measured at a certain frequency (FIG 4), making it easy to seamlessly monitor frequency bands. This is also useful when hunting for sporadically occurring interference signals. The R&S®FSVR is also an invaluable tool for radio transmissions with frequency changes, such as the ones that occur in RFID and Bluetooth® applications, since it tracks frequency hops and characterizes transmitter characteristics. Finding sporadically occurring faults during frequency switching of transmitters or interference sources from digital circuits is easier and significantly faster.

Triggering on events in the signal spectrum

The information that is collected using the spectrogram can subsequently also be used to define a trigger in the spectral range. This frequency mask trigger (FMT) responds to events in the spectrum. The R&S®FSVR evaluates each individual spectrum – up to 250 000 per second – and compares each spectrum with a defined, frequency-dependent mask. If a trace violates this mask, the R&S®FSVR generates a trigger event, displays the current spectrum and provides the recorded data for further processing, for example in a test application. The impact of interference from RF transmitters or frequency changes can be quickly and specifically analyzed. Via a trigger output, other T&M instruments needed to analyze a fault can be triggered on a certain frequency event.

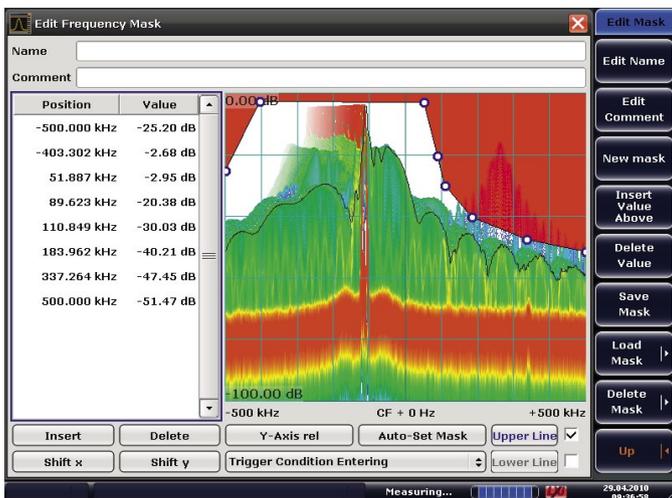


FIG 5 Input window for the limit line of the frequency mask trigger (FMT). The current trace is displayed, and the individual points for the limit line can either be entered manually, moved to the desired position on the screen, or adjusted automatically. Here, the user is triggering on an error signal approximately 400 kHz above the actual signal frequency of a swept source. The error signal is extremely short and would be difficult to detect using a conventional analyzer.

The mask for the spectral trigger can be conveniently defined on the R&S®FSVR touchscreen, but can also be generated automatically. Clearly structured tables and graphics provide users with the means to adapt masks quickly to changing situations. FIG 5 provides an impression of how easy and straightforward it is to operate the instrument. Both an upper and a lower limit line can be defined. The above trigger conditions can be especially useful when the signal being monitored has to remain within a specific tolerance band.

Its 200 Msample I/Q memory depth allows the R&S®FSVR to continuously record spectra over a long period, even at large bandwidths and correspondingly high sampling rates. The signal can be analyzed in more detail during post-processing.

Full-featured signal and spectrum analyzer

If it is not in the real-time mode, the R&S®FSVR behaves like a sweeping spectrum analyzer or a signal analyzer. It sweeps the selected frequency range (up to 40 GHz, depending on the model) and displays the spectrum. It is extremely fast, with a minimum sweep time of less than one tenth of a second for the full display range. The resolution bandwidths are user-selectable. Unlike in real-time mode, there are no restrictions with regard to the number of FFT points and real-time bandwidth. In addition to sweep filters that have been adjusted for maximum speed, channel filters and filters for wireless communications standards are also available.

Like all Rohde&Schwarz spectrum analyzers, the R&S®FSVR provides numerous special measurement functions as standard. These include adjacent channel power, spectrum emission mask, intermodulation, CCDF and spurious emission measurements. With a level measurement uncertainty of 0.4 dB up to 7 GHz, the R&S®FSVR delivers precise and reliable results. In terms of total measurement uncertainty, it delivers leading performance, just like the R&S®FSV signal and spectrum analyzer. With the R&S®FSV-K9 option, power sensors from the R&S®NRP-Z product range can be connected, eliminating the need for a separate power meter in situations requiring especially high measurement accuracy. The R&S®FSVR offers outstanding RF characteristics for a general-purpose spectrum analyzer (see box).

With more than 1000 sweeps/s in spectrum analysis mode, the R&S®FSVR is up to five times faster than other spectrum and signal analyzers. This fast measurement rate not only speeds up systems during production. It also shortens the measurement time if a large number of measurements have to be averaged, as prescribed by many standards.

RF characteristics of the R&S®FSVR

- Displayed average noise level (DANL) –155 dBm (1 Hz) at 1 GHz, –147 dBm (1 Hz) at 30 GHz
- DANL with preamplifier: –165 dBm (1 Hz) at 1 GHz, –162 dBm (1 Hz) at 30 GHz
- DANL of only –140 dBm (1 Hz) starting as low as 9 kHz
- Third-order intercept (TOI) typ. +16 dBm (f < 3.6 GHz)
- Phase noise at 10 kHz offset from carrier: –106 dBc (1 Hz), typ. –110 dBc (1 Hz)
- ACLR dynamic range for 3GPP WCDMA: 73 dB
- Resolution bandwidths from 1 Hz to 10 MHz, 20 MHz / 40 MHz in zero span

In addition to the extensive functionality incorporated as standard, the R&S®FSVR offers options for measuring basic physical characteristics, including phase noise (R&S®FSV-K40), noise figure (R&S®FSV-K30), and the parameters of signals with analog (AM / FM / Φ M) and digital modulation (R&S®FSV-K70).

The R&S®FSVR is not just the right instrument for classic spectrum analysis applications, it is also ideal for verifying compliance with wireless communications standards. It currently supports the following standards:

- GSM / EDGE / EDGE Evolution
- WCDMA
- TD-SCDMA
- CDMA2000®
- 1xEV-DO
- WLAN 802.11 a/b/g/n
- WiMAX™
- LTE (TDD / FDD)

Summary

The R&S®FSVR, a combination of real-time analyzer and full-featured signal and spectrum analyzer, is unique on the market. The comprehensive and easy-to-operate real-time functions provide users with new, powerful analysis facilities. At the same time, they can continue to work with the same signal and spectrum analysis functions with which they are already familiar. The intuitive user interface, which is designed along the same lines as spectrum analyzers, simplifies the use of the instrument and integrates real-time analysis within a cohesive overall design concept.

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