R&S®FSW signal and spectrum analyzer: best in class now up to 50 GHz

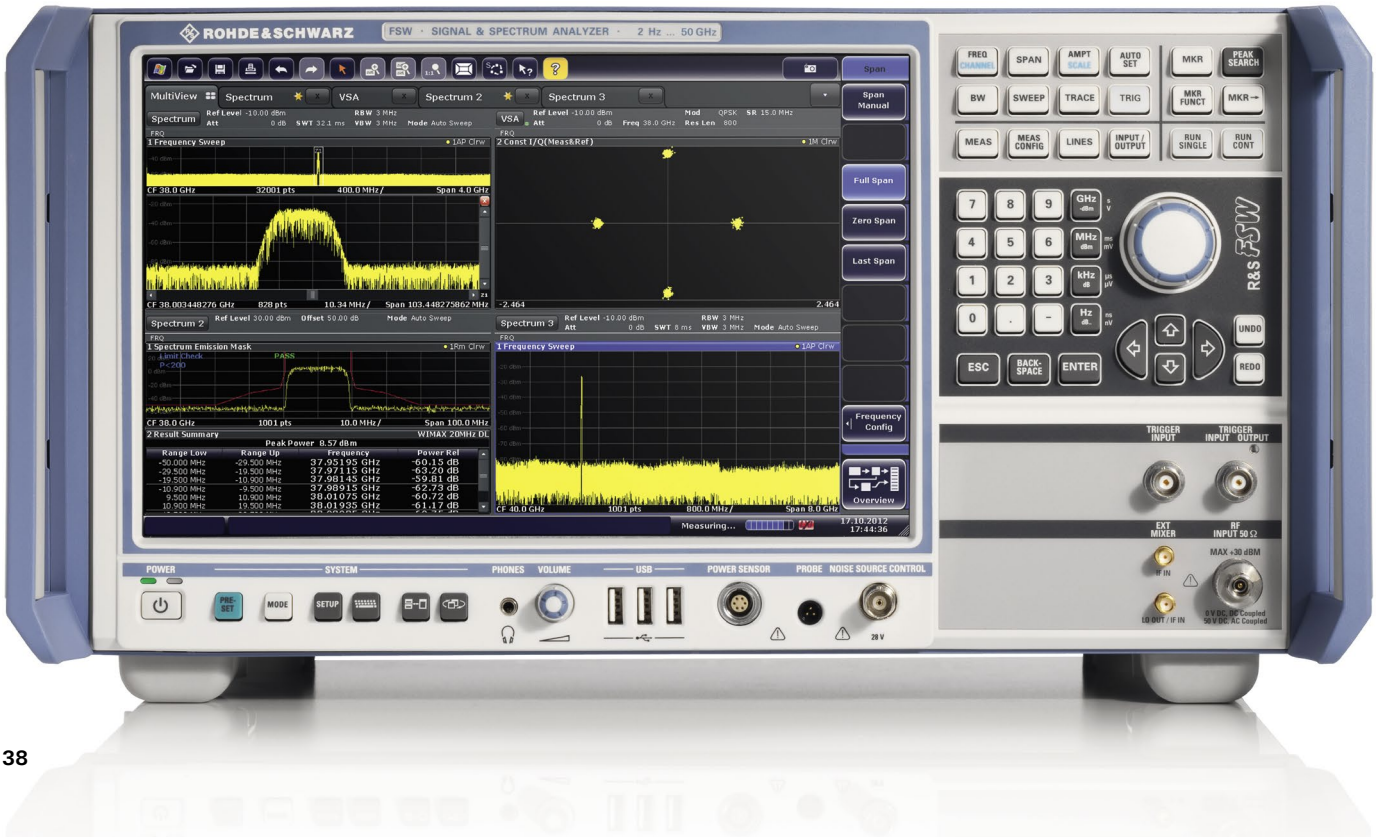
The new R&S®FSW43 and R&S®FSW50 signal and spectrum analyzers make the outstanding features of the R&S®FSW family available now also in the microwave range up to 50 GHz: excellent RF performance with unmatched phase noise and exceptionally low inherent noise, wide analysis bandwidths and convenient operation via touchscreen. Harmonic mixers extend the frequency range up to 110 GHz and beyond.

Best performance in the microwave range for sophisticated users

Measurements on microwave components and systems used in radar or microwave transmission systems are typical applications for the new R&S®FSW43 and R&S®FSW50 signal and spectrum analyzer models (Fig. 1). High demands on the analyzer phase noise are standard, e.g. when developing local oscillators for radar transmitters or communications systems, or when measuring densely occupied spectra with widely differing signal levels or unwanted emissions in neighboring channels in microwave transmission systems. Like the R&S®FSW models available to date, which are among the world's top performers, the new models exhibit values that even many signal generators cannot achieve: –117 dBc (1 Hz) at 40 GHz at 10 kHz offset from the carrier. At 1 GHz they typically achieve –137 dBc (1 Hz), same as the other R&S®FSW models.

Low inherent noise and high dynamic range are essential for measuring spurious emissions. The new analyzers offer exceptional values. For example, the R&S®FSW43 measures low signal levels with a good signal-to-noise ratio, i.e. with low measurement uncertainty, with a displayed average noise level (DANL) of typically –144 dBm (1 Hz) at 40 GHz or –164 dBm with activated preamplifier (Fig. 2). Nonetheless, it is usually necessary to perform the measurements with a

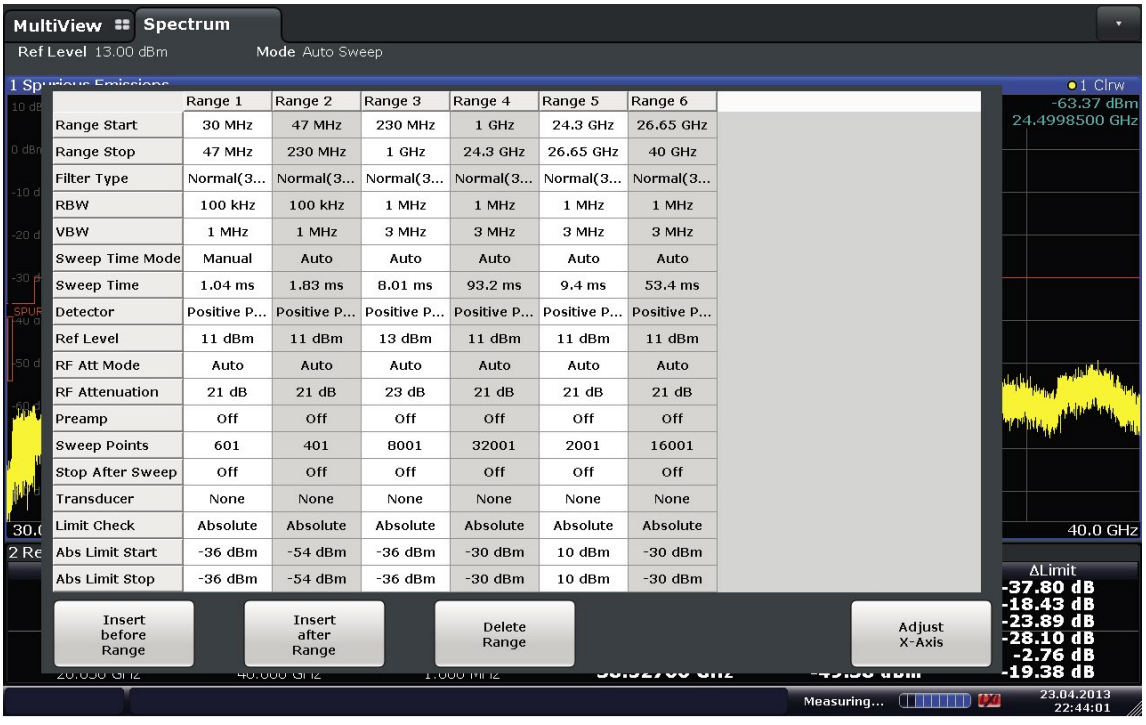
Fig. 1 The high-performance R&S®FSW signal and spectrum analyzer was developed to meet demanding customer requirements. Offering low phase noise, wide analysis bandwidth and straightforward and intuitive operation, the analyzer makes measurements fast and easy.



very narrow resolution bandwidth to minimize inherent noise to an extent that leaves sufficient margin relative to the stipulated limit. If conventional analyzers are used, this considerably prolongs the measurement time, especially when a wide frequency range is to be analyzed. With this scenario, the R&S®FSW in FFT sweep mode delivers high measurement repetition rates, even with narrow resolution bandwidths and a wide span. The previously time-consuming spurious emissions measurements are quickly completed [1].

In the spurious emissions measurement window, users enter the settings for the various frequency ranges in a table (Fig. 3).

Fig. 2 Displayed average noise level (DANL) of the R&S®FSW43 signal and spectrum analyzer up to 43 GHz with preamplifier off (yellow) and on (blue).



	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
Range Start	30 MHz	47 MHz	230 MHz	1 GHz	24.3 GHz	26.65 GHz
Range Stop	47 MHz	230 MHz	1 GHz	24.3 GHz	26.65 GHz	40 GHz
Filter Type	Normal(3...	Normal(3...	Normal(3...	Normal(3...	Normal(3...	Normal(3...
RBW	100 kHz	100 kHz	1 MHz	1 MHz	1 MHz	1 MHz
VBW	1 MHz	1 MHz	3 MHz	3 MHz	3 MHz	3 MHz
Sweep Time Mode	Manual	Auto	Auto	Auto	Auto	Auto
Sweep Time	1.04 ms	1.83 ms	8.01 ms	93.2 ms	9.4 ms	53.4 ms
Detector	Positive P...	Positive P...	Positive P...	Positive P...	Positive P...	Positive P...
Ref Level	11 dBm	11 dBm	13 dBm	11 dBm	11 dBm	11 dBm
RF Att Mode	Auto	Auto	Auto	Auto	Auto	Auto
RF Attenuation	21 dB	21 dB	23 dB	21 dB	21 dB	21 dB
Preamp	Off	Off	Off	Off	Off	Off
Sweep Points	601	401	8001	32001	2001	16001
Stop After Sweep	Off	Off	Off	Off	Off	Off
Transducer	None	None	None	None	None	None
Limit Check	Absolute	Absolute	Absolute	Absolute	Absolute	Absolute
Abs Limit Start	-36 dBm	-54 dBm	-36 dBm	-30 dBm	10 dBm	-30 dBm
Abs Limit Stop	-36 dBm	-54 dBm	-36 dBm	-30 dBm	10 dBm	-30 dBm

Fig. 3 The spurious emissions measurement function carries out measurements using different settings for the various frequency ranges. The desired settings are entered in a clearly structured table

The R&S®FSW processes this table in a single sweep and lists measured spurious signals and their margins relative to the limit. Spurious measurements can be performed easily using different bandwidths and optimized level settings for the various frequency ranges (Fig. 4).

Reliable analysis of signals up to 110 GHz and beyond

The frequency ranges above 50 GHz, respectively 67 GHz, have become increasingly important over the past few years. The number of commercial applications, e.g. at 77 GHz (automotive radar) and 85 GHz (microwave links), is on the rise. Plus, an increasing number of standards require spurious emissions measurements up to 110 GHz and beyond.

Signals that are beyond the upper frequency limit of the R&S®FSW26, R&S®FSW43 and R&S®FSW50 models are usually analyzed with external harmonic mixers. The mixers can be operated on these models using the R&S®FSW-B21 option, which provides the ports for the LO and IF signals for the external mixer. Rohde&Schwarz also supplies matching harmonic mixers, i.e. the R&S®FS-Z60, R&S®FS-Z75, R&S®FS-Z90 and R&S®FS-Z110, which seamlessly cover frequencies from 40 GHz to 110 GHz. The frequency response, respectively conversion loss, for the individual mixers are loaded into the R&S®FSW from a USB stick with just a few keystrokes. In addition to Rohde&Schwarz mixers, the R&S®FSW can also be used with other types of mixers. It supports three-port mixers (LO input and IF output on separate ports) as well as two-port mixers (LO input and IF output on the same port). The diplexer required for operation is integrated in the R&S®FSW-B21 option. The analyzer supports harmonic numbers higher than 100, making it possible to analyze signals up to 1.1 THz.

A few points must be observed when employing harmonic mixers. They downconvert the signal to be analyzed to the IF by mixing it with harmonics from the LO signal. The harmonics are generated in the mixer itself, meaning that there are always several LO frequencies and that the signal of interest is mixed not only with the desired harmonic, but with all others as well. By displaying a large frequency range (large span), the mixing products, which are at the wrong frequencies, become visible (Fig. 5). If the frequency of the signal to be analyzed is unknown, it must be determined which of the possibly numerous signals is the signal of interest and which are multiple response signals, i.e. signals produced through mixing with an unwanted harmonic. This task is handled using the signal identification (signal ID) function, which marks multiple response signals and suppresses them if desired (Fig. 6). For details, refer to [2].

Fig. 4 Result of a measurement using the spurious emissions function.

A particularly important requirement is that the LO frequency be as high as possible. This reduces the number of multiple response signals displayed as well as the phase noise. The R&S®FSW has a very high LO frequency range at 7.65 GHz to 17.45 GHz. This means that a lower harmonic will suffice to analyze a given frequency range (75 GHz to 110 GHz: e.g. n = 8 instead of n = 16).

Harmonic mixers have no input filter, so that reception of the image frequency at a distance of twice the intermediate frequency is not suppressed. This means that mostly pairs of signals are displayed. The signal ID function is helpful for stationary and not very wideband signals. Nonstationary, e.g. pulsed or wideband modulated, signals, such as those

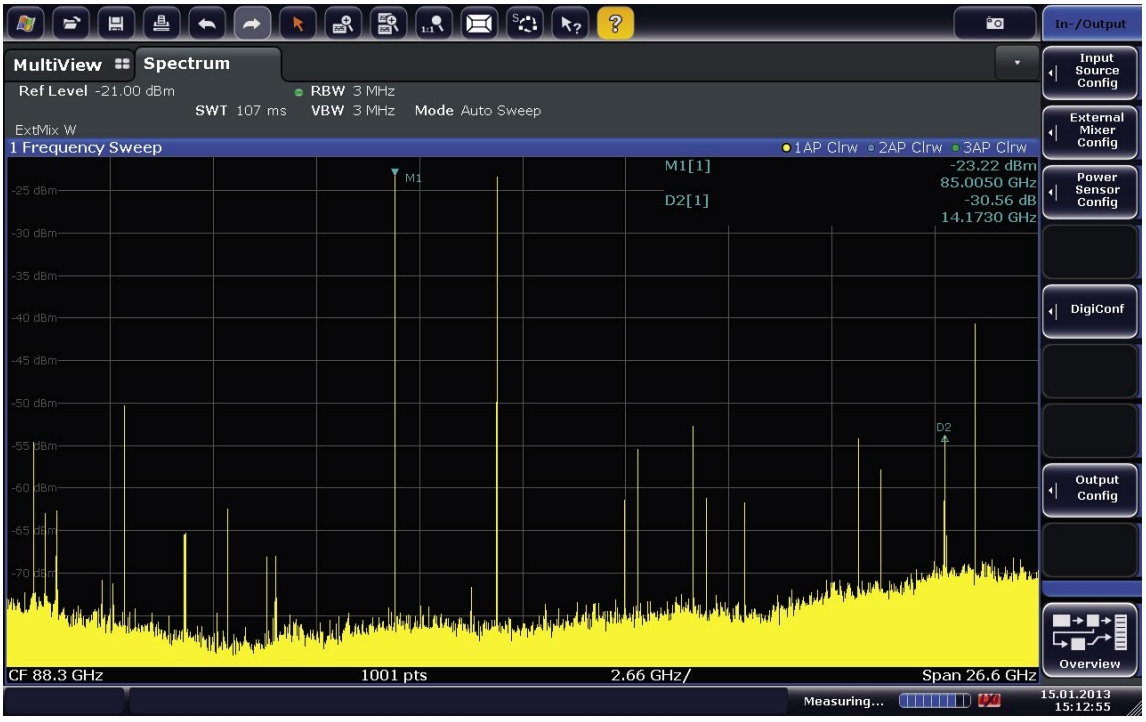


Fig. 5 Result of a measurement using a harmonic mixer to upconvert a 14 GHz signal to an 85 GHz signal. The display shows numerous multiple response signals in addition to the signal of interest.

Fig. 6 The built-in signal identification function detects and suppresses multiple response signals so that only the signal of interest is displayed.

frequently used in the millimeter-wave range are more difficult to handle because of the large available frequency range, for example in FMWC radar systems for automotive applications or in microwave systems in the 80 GHz band. For these and other types of signals for which signal identification fails, high intermediate frequency is especially important. Without applying signal ID routines, a large unambiguous frequency range can be achieved in which neither multiple response nor image frequency signals are displayed. With an IF of 1.3 GHz, the R&S®FSW outperforms most of the conventional analyzers (which have significantly lower IF, often in the order of just a few hundred megahertz). The R&S®FSW therefore provides unambiguous spectral analysis of signals with bandwidths of up to 2.6 GHz.

R&S®FSW-B10 external generator control

The R&S®FSW-B10 external generator control transforms the R&S®FSW signal and spectrum analyzer into a scalar network analyzer. It controls signal generators such as the R&S®SMB, R&S®SMF or instruments from other manufacturers in such a way that they work as tracking generators. Transmission measurements can be conducted without any extra equipment or accessories. An SWR bridge or a directional coupler is required for reflection measurements (scalar). To compensate for the frequency response of feeder lines, the R&S®FSW offers normalization functions for transmission and reflection measurements. Using external generators makes it easy to carry out measurements also on frequency-converting DUTs. The R&S®FSW can be configured to measure even multipliers or dividers.

Group delay measurements using signal analyzer functionality

The R&S®FSW uses a multicarrier signal with equally spaced carriers to perform group delay measurements, traditionally a task for network analyzers. The R&S®FSW measures the carrier phases before and after the DUT. Based on the differences, it calculates the gain or insertion loss and the group delay. This function is especially beneficial if a network analyzer would have to be included in a test system for the sole purpose of measuring group delay. With the R&S®FSW signal and spectrum analyzer providing this functionality, test systems become less complex and require fewer cables (see article on page 43).

Summary

The R&S®FSW43 and R&S®FSW50 with the R&S®FSW-B21 option now make the outstanding RF characteristics, large analysis bandwidths and innovative analysis functions of the R&S®FSW signal and spectrum analyzer family available also for applications in the microwave range.

Herbert Schmitt

References
[1] Rohde&Schwarz Application Note 1EF80 ("Speed Considerations for Spurious Level Measurements with Spectrum Analyzers").
[2] Rohde&Schwarz Application Notes 1EF43 ("Frequency Range Extension of Spectrum Analyzers with Harmonic Mixers") and 1EF75 ("Using Harmonic External Mixers To Extend the Frequency Range").

All application notes can be downloaded from the Internet.