Real-time spectrum analysis of frequency hoppers and ultrashort interference signals

With a new option, the R&S®FSW signal and spectrum analyzer characterizes frequency agile systems at a real-time bandwidth of 512 MHz and reliably detects even extremely short interference signals.

Cordless communications systems such as headsets or handsfree equipment in vehicles often use frequency hopping in order to be less susceptible to interference signals or other applications in the same frequency range. In tactical communications systems and in radar applications, frequency hopping is used to increase protection against eavesdropping and to minimize the influence of wanted interferences. To analyze frequency agile systems of this type, the signals must be displayed accurately, quickly and seamlessly in real time. This is the only way to analyze short unwanted signals in detail.

Up to now, the R&S®FSW signal and spectrum analyzer was equipped with the R&S®FSW-B160R option for these tasks. The new R&S®FSW-B512R option makes it possible to measure at a real-time bandwidth of 512 MHz and to calculate up to 1.1 million spectra per second. It covers the real-time bandwidth more than three times and doubles measurement speed (Fig. 1). With a probability of intercept (POI) of 100 %, the analyzer accurately detects signals with a duration of only 0.91 µs and even captures those with a duration of only a few nanoseconds – although with reduced level accuracy. Because the human eye can only process approx. 30 images per second, the options offer different display modes and features to investigate the events in the frequency and time domain in detail and provide access to the information contained in the many spectra. With a conventional real-time display, a detector analyzes many thousands of traces to form a spectrum of maximum values. The display shows if a signal or interferer is present, even if the event lasted only a few nanoseconds. Thanks to the spectrogram display that presents all spectra with color-coded signal levels in horizontal lines, users are able to resolve the behavior in the frequency domain over time. Frequency hoppers are shown without any interruptions. Fig. 2 shows hop sequences of a Bluetooth® transmitter as well as a WLAN signal that is also found in the ISM band (bottom right). The minimum time resolution is 55 µs. If the user stops continuous recording, a time resolution of 20 ns can be achieved via the zoom function during postprocessing of the spectral display. This makes it possible to easily resolve the preamble as well as modulation details of WLAN signals (Fig. 3).

In the persistence spectrum, the analyzer writes all available traces on top of each other and color-codes them according to their probability of occurrence: frequently occurring signals in red, and sporadic ones in blue, for example. If a signal no longer occurs, it disappears from the persistence spectrum after a certain time (Fig. 2, top). The persistence spectrum provides an overview of the dynamic range of frequency agile systems. Frequency hops, such as those occurring in the ISM band where Bluetooth® and WLAN signals collide, reducing data rates, can be accurately analyzed and better frequency hopping algorithms can be found. The analyzer also helps detect extremely short interferers or hidden signals that are hardly detected by conventional spectrum analyzers.

Key parameters in real-time analysis

	R&S®FSW-B512R	R&S®FSW-B160R
FFT length	1024 to 32k	1024 to 16k
Maximum real-time analysis bandwidth	512 MHz	160 MHz
Maximum FFT rate	1,171,875	585,938
POI	0.91 µs	1.87 µs
User-configurable resolution bandwidth (RBW) for span/RBW ratio	6.25 to 6400	6.35 to 3200

Fig. 1: Comparison of the real-time analysis options for the R&S®FSW signal and spectrum analyzer.

Frequency mask trigger (FMT)

The frequency mask trigger should be used if only one specific signal, perhaps one that has been discovered in the spectrogram or the persistence display, or whose frequency is known, is of interest. The user defines a mask in the frequency domain and the analyzer compares this mask with up to 1.1 million spectra per second. If a signal violates the mask, the analyzer stops real-time analysis and records it. The time before (pre-trigger) and after (post-trigger) the signal to be recorded can be set. The user can also select whether the analysis should automatically continue after recording. Continuing the analysis provides an overview of how often certain signals occur and whether they behave similarly each time.

Thanks to multistandard real-time (MSRT) analysis, the recorded data can also be used for other applications such as analog modulation analysis or vector signal analysis (R&S®FSW-K7 / R&S®FSW-K70 options), in order to find out for example, how interference affects the modulation characteristics of a wanted signal. The R&S®FSW-K6 option is used for extensive analysis of pulsed signals and the R&S®FSW-K60 / -K60H options are used for automatic analysis of hop sequences.

Summary

With the new option, the R&S®FSW high-end signal and spectrum analyzer characterizes frequency agile systems at a large real-time bandwidth. This makes it possible to detect extremely short interferers – a valuable additional feature for developers of radar or communications applications, who can also use the instrument to accurately measure all RF parameters of an application.

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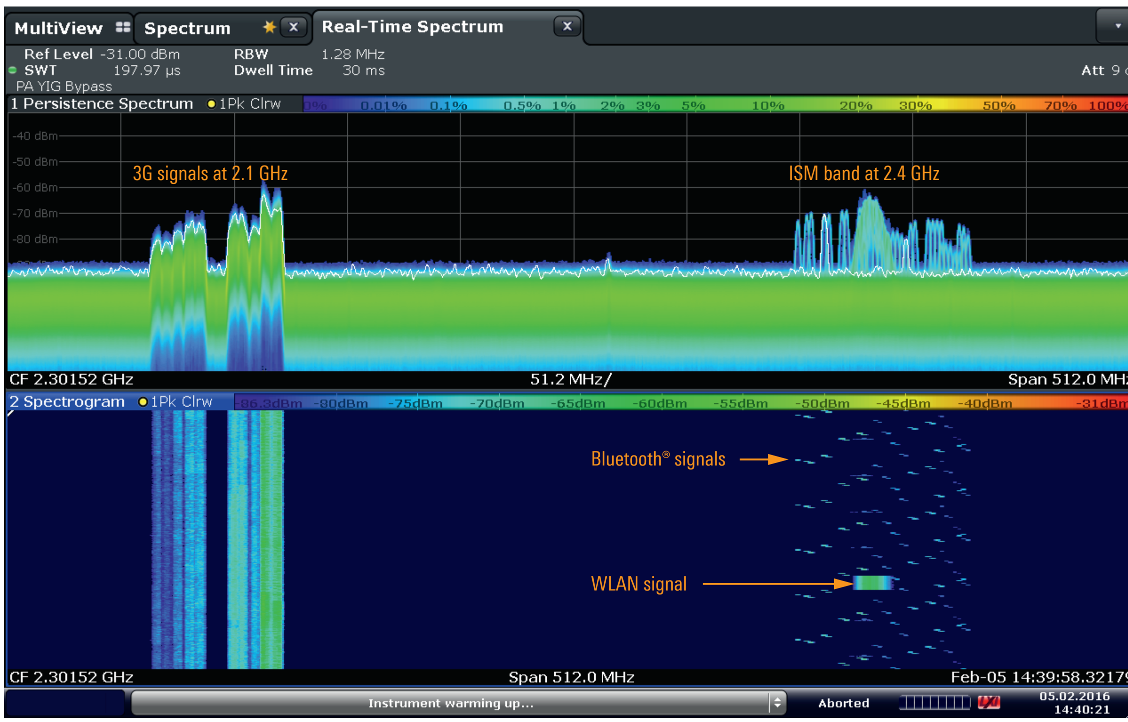

Fig. 2: 3G signals at 2.1 GHz and Bluetooth® / WLAN signals in the ISM band can be simultaneously analyzed with the R&S®FSW-B512R option (top: persistence spectrum, bottom: spectrogram).

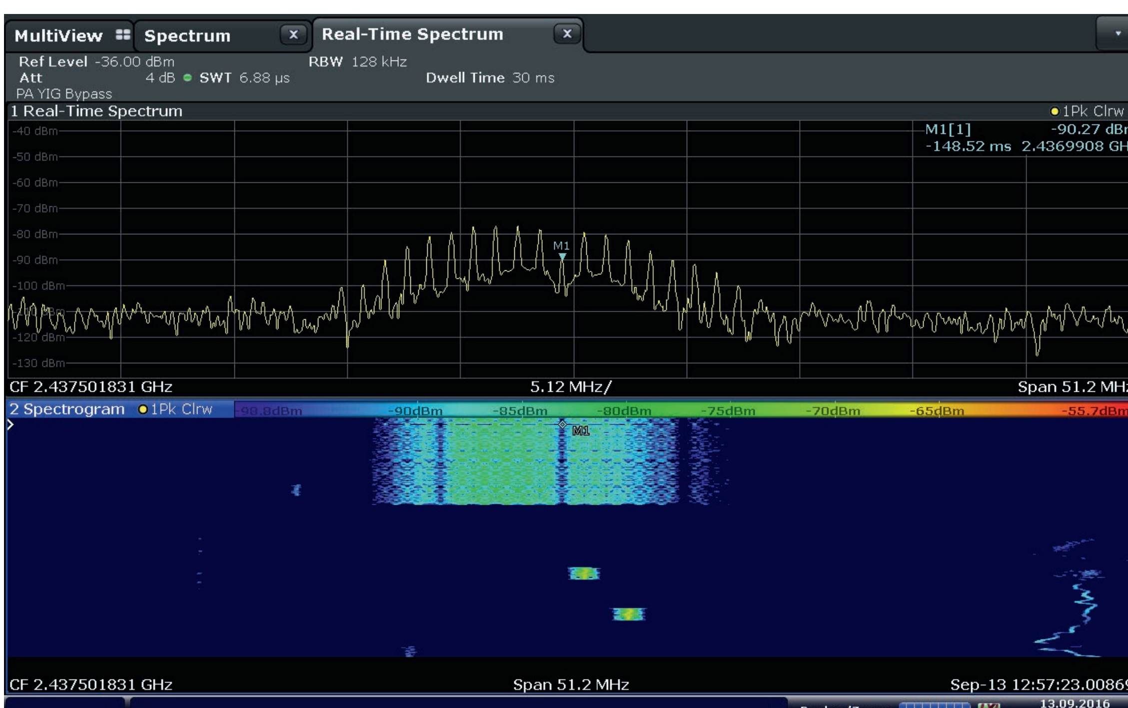

Fig. 3: The time resolution in postprocessing can be significantly increased via the zoom function. This makes it possible to quickly analyze frequency hopping systems or detect modulation details.