The complete family of wireless LAN standards: 802.11 a, b, g, j, n

The option R&S®FSQ-K91 combines the complete family of WLAN standards in one analyzer and offers standard-conforming measurements as well as diverse analysis features for tasks in development labs.

Analyzer subject to numerous requirements

The IEEE802.11 family of wireless LAN standards covers both single-carrier and multicarrier methods with data rates from 1 Mbit/s to 54 Mbit/s. Future enhancements that can double the data rate to 108 Mbit/s are already planned. A WLAN module that is equipped with all functions for standard 802.11g must, for example, be able to switch between the modulation modes DSSS, CCK, PBCC, OFDM and DSSS-OFDM and support 14 different data rates (FIG 1). The WLAN option R&S®FSQ-K91 for the high-end Signal Analyzer R&S®FSQ follows the DUT by automatically detecting all modulation modes and adapts standard-specific measurements to the transmission standard that is detected.

The R&S®FSQ is a powerful tool for analyzing WLAN signals. It can perform diverse tasks such as detailed analyses of the outer carriers of a OFDM burst or automatic checks of the spectral mask of standard 802.11b. It offers numerous convenient measurements and the complete functionality of a spectrum analyzer.

FIG 1
All standards supported by the option R&S®FSQ-K91.

Standard	Modulation mode	Channel bandwidth	Data rate in Mbit/s
802.11 a	OFDM	20 MHz	6 to 54
802.11 b	DSSS, CCK, PBCC	20 MHz	1 to 11
802.11 g	DSSS, CCK, PBCC	20 MHz	1 to 33
	OFDM, DSSS-OFDM		6 to 54
802.11 j	OFDM	10 MHz	3 to 27
		20 MHz	6 to 54
Turbo mode	OFDM	40 MHz	12 to 108

Intelligent burst detection

As an example of how the R&S®FSQ works when combined with the option R&S®FSQ-K91, consider a typical measurement case for standard 802.11g: WLAN module A communicates with WLAN module B via the fast 54 Mbit/s OFDM method. WLAN module C, which is of an earlier design, is added and all three modules drop back to the slower CCK mode with 11 Mbit/s. The R&S®FSQ measures directly at the antenna of module A.

After evaluating the signal field of each recorded burst, the option R&S®FSQ-K91 will output an overview of the data rates used (FIG 2) at the press of a button. If automatic demodulation is on, the first burst in the capture buffer determines the modulation type and the data rate for further measurements. Thus, no manual readjustments are necessary when changing the transmission mode since both single-carrier and OFDM methods are reliably detected. In addition, an auto-level function ensures optimum modulation of the input signals during the entire measurement, thus freeing you from having to make complex level and attenuation settings.

In addition to automatic evaluation, bursts of a certain modulation type and length can be specifically analyzed. You can easily exclude the short acknowledge bursts from the evaluation by predefining a minimum length for the useful range. Moreover, you can define the number of bursts to be evaluated. Thus, you need to make only a few settings if you want to analyze, for example, 500 bursts at 11 Mbit/s CCK and a short preamble whose useful range is between 100 µs and 150 µs.

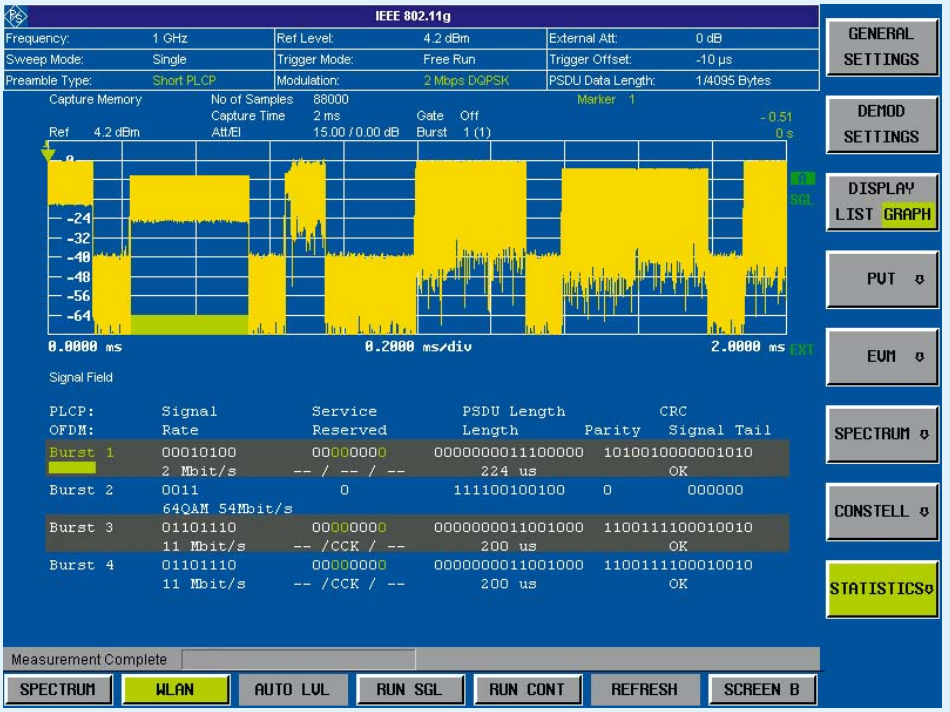

FIG 2 Four detected bursts in the capture buffer. The signal field indicates the data rates.

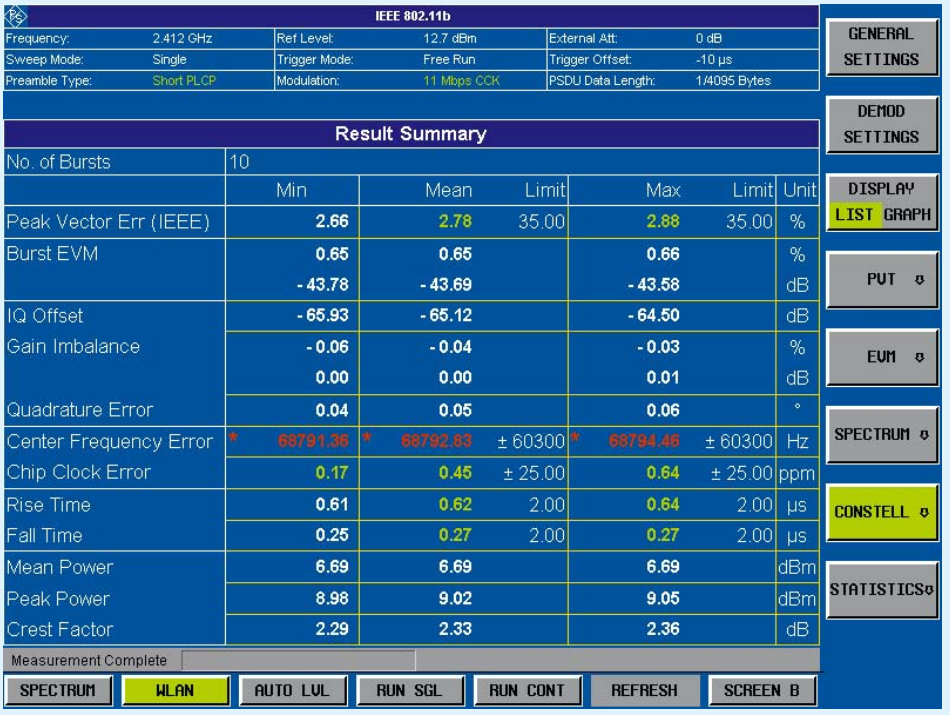

FIG 3 Overview of the most important measurement results for standard 802.11b. The frequency error has exceeded the permissible absolute limit and is shown in red.

Convenient measurements

A detailed result list provides the most important parameters at a glance (FIG 3). The limit values specified in the standard are checked, and deviations are marked in red. Moreover, you can edit all limit values. The measurement results are statistically evaluated over a definable number of bursts, which enables you to spot any outliers by displaying the average, minimum and maximum.

For more accurate spectrum analysis, graphical evaluations for any type of measurement are available. Variations in transmission frequency that occur at start of burst, for example, cause compatibility problems with the receivers. Since the frequency error and phase error in the preamble are displayed, such transients are immediately visible (FIG 4).

Although the single-carrier methods of standards 802.11b and 802.11g do not specify any special transmit filters, the transmit signal must comply with the standard-conforming spectral mask. Merely by pressing a button, you can instruct the spectral measurements of the WLAN option to display the signal spectrum and the associated mask on the screen and automatically check whether the mask limits have been exceeded. The gating function enables you to select and analyze specific areas of a burst. You can use either a level-adjustable power trigger or an external trigger as a time reference.

Constellation diagram or error vector magnitude (EVM) over all symbols plus numerous other measurements meet almost every requirement. Additional OFDM subcarrier evaluations complement the range of measurements for multicarrier methods.

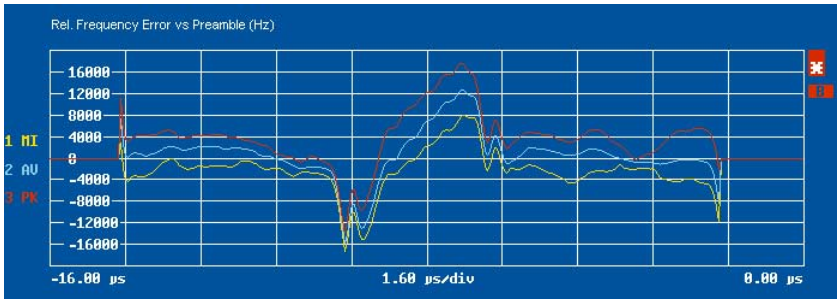

FIG 4 Unwanted frequency variations in the preamble of an OFDM signal.

Ready for the future

An expanded setting menu in standard 802.11a enables you to change the sampling rate and thus the OFDM carrier spacing. This allows you to develop customer-specific WLAN systems with flexible data rates. Even today, WLAN modules are already in use that make data rates of up to 108 Mbit/s possible by doubling the carrier spacing from 312.5 kHz to 625 kHz. These modules also occupy a bandwidth of 32 MHz. With the optional Bandwidth Extension R&S®FSQ-B72, the R&S®FSQ analyzes signals with bandwidths of up to 60 MHz ($f_c \leq 3.6$ GHz) or 120 MHz (fc > 3.6 GHz). Therefore, it is ready to handle future expansions of the standard, such as 802.11n.

The OFDM method with double carrier spacing is already integrated in the WLAN option as “turbo mode”. It is just as simple to choose the 10 MHz mode of standard 802.11j, which reduces the carrier spacing by half. Both modes offer the same full measurement convenience available for the standard 802.11a. Time and frequency specifications are adapted to the standard-specific carrier spacing.

Summary

By offering a large number of convenient measurement functions, the combination of the R&S®FSQ and the option R&S®FSQ-K91 is a must in every WLAN development project. With its flexible sampling rates and bandwidths of up to 120 MHz (when equipped with the option R&S®FSQ-B72), the signal analyzer is ready today for the future expansions of the standard.

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More information and data sheet at www.rohde-schwarz.com (search term: FSQ)

REFERENCES
See box on page 28.