R&S®SMW200A vector signal generator: testing WLAN 802.11ad up to 65 GHz

Generating wideband signals up to 65 GHz for testing WLAN 802.11ad receivers is a major challenge. The R&S®SMW200A vector signal generator in combination with the new R&S®SZU100A IQ upconverter masters this task and allows objective evaluation of the receivers' performance.

Modern wireless communications scenarios require ever higher information data rates up to the Gbit range. Large amounts of data are managed in cloud storage and must be available quickly at any time. Wireless devices are the future: mobile phones that are quickly synchronized with multimedia libraries or laptops that exchange high video data volumes in 4K quality using wireless docks with external hard disks, servers, TV sets or projectors.

Signal generators for developing such applications must reach beyond conventional modulation bandwidths and frequency ranges. Requirement specifications include generating wideband signals up to the 60 GHz range as well as an RF bandwidth of 2 GHz – with high output power and excellent signal quality. This article describes how the new R&S®SZU100A IQ upconverter now expands the capabilities of the R&S®SMW200A vector signal generator up to 65 GHz, especially for WLAN 802.11ad applications.

65 GHz – a T&M challenge

Up to now, reproducible tests on millimeterwave receivers have been very complex. For some time, wideband test signals up to the 40 GHz range have been easily generated directly with vector signal generators such as the R&S®SMW200A. Signals up to the 60 GHz range (e.g. for receiver tests for WLAN 802.11ad) however, required an additional RF mixer in order to achieve the target frequencies from 57.32 GHz to 65.80 GHz. But these conventional mixer setups have some disadvantages. For example, for practical reasons, upconversion into the 60 GHz band often takes place in several stages. This typically results in local oscillator (LO) mixing products that lie in the operating band. Moreover, additional filters must be used to suppress unwanted sidebands that occur during mixing.

Conventional mixing concepts are also subject to fluctuating RF characteristics. Depending on frequency and level, the setup typically has a different frequency response. To cope with this, the actual frequency response must be recorded and tediously corrected using external measuring equipment. However, this compensation is only valid for one level and one frequency, which in practice requires a recalibration before each measurement, resulting in considerably longer measurement times.

The significantly stronger attenuation of the propagation of millimeterwaves compared to frequencies below 6 GHz complicates matters even more. In a conducted test setup, an attenuation of 7 dB to 10 dB per meter can be expected. However, due to the tight integration of the antenna array and RF frontend, WLAN 802.11ad receivers usually do not allow a wired connection. Consequently, tests for WLAN 802.11ad are generally only possible via the air interface.

In a typical over-the-air test setup, the generator signal is passed on to a transmitting horn antenna (e.g. with 23 dBi gain), and the receiver under test is placed at a distance of one meter, for example. At 60 GHz the free-field attenuation is 68 dB/m which means that these tests require a relatively high output power of the signal generator. To meet the WLAN 802.11ad receiver sensitivity limit of –53 dBm for an MCS 12 signal, the signal generator must produce a signal with at least –8 dBm transmit power. Losses in the test setup caused by switches, adapters or feed cables increase the required power to 0 dBm or more. If a WLAN receiver is to be tested up to its limits, very low levels with the same modulation quality and, in particular, good signal-to-noise ratio must also be generated – a major challenge for conventional test setups.

Vector signal generator for 65 GHz

A unique solution for these measurements is the new R&S®SZU100A IQ upconverter, which expands the R&S®SMW200A vector signal generator to the range of 57.32 GHz to 65.80 GHz (Figs. 1 and 2). The generator's wideband baseband option (R&S®SMW-B9) creates internal WLAN 802.11ad signals with the required symbol rates of 1.76 GHz. All WLAN-specific parameters such as modulation, coding, packet size and MAC header can be configured as required. This approx. 2 GHz baseband signal is fed to the R&S®SZU100A via the analog I/Q input, where it is upconverted to the 60 GHz band using an LO signal from the high-performance RF synthesis module of the R&S®SMW200A. The IQ upconverter is controlled via USB and integrates

seamlessly into the R&S®SMW200A operating concept. Frequency and level are adjusted, as usual, via the signal generator's graphical user interface. Users can easily and conveniently operate the setup as with standalone vector signal generators from Rohde&Schwarz.

High output power

The R&S®SZU100A is designed as a remote millimeterwave head. It can be placed close to the DUT and flexibly positioned with its adjustable feet and variety of mounting points. A horn antenna can be directly mounted to its waveguide output (WR15) without requiring an additional adapter. The I/Q upconverter features its own output amplifier, an attenuator and, directly on the waveguide output, an integrated level detector. This makes it possible to precisely set levels from –80 dBm to +5 dBm with excellent linearity over the entire dynamic range as well as with virtually constant signal-to-noise ratio. Typically, an output level of even more than +10 dBm is available. The sophisticated synthesis concept ensures that spurs and mirror images are suppressed, eliminating the need for external filters with their undesired insertion losses. All of these measures minimize loss in the test setup and ensure high output power to test the DUT.

Test setup for WLAN 802.11ad measurements

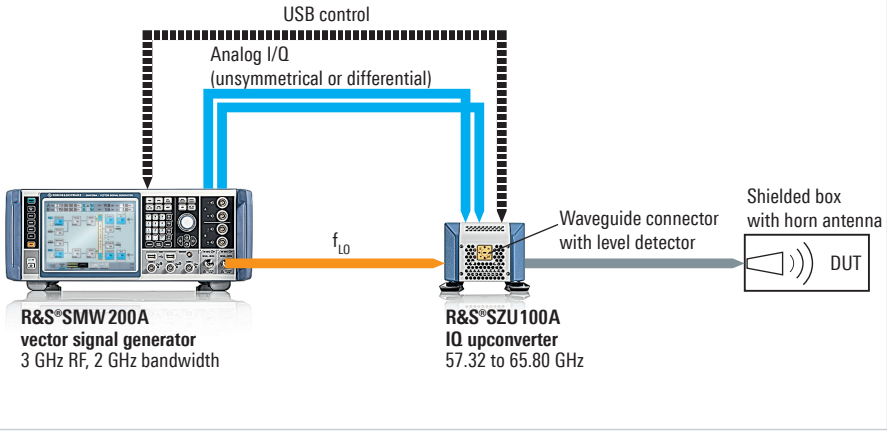

Fig. 1: The R&S®SZU100A IQ upconverter expands the R&S®SMW200A to the range of 57.32 GHz to 65.80 GHz for WLAN 802.11ad receiver measurements.

Frequency response correction in real time

Rohde&Schwarz fully characterizes the IQ upconverter in production and stores the frequency response correction data in its EEPROM. The R&S®SMW200A uses these values during operation to

correct the frequency response in real time (Fig. 3). This ensures a flat frequency response independent of the level, frequency and signal type, making it unnecessary to correct the setup before each measurement using expensive external calibration hardware. This not only reduces the cost of hardware, but also saves additional calibration cycles during operation and considerably shortens overall measurement time. Because the frequency response correction is independent of the transmit signal, maintaining a variety of predistorted waveforms for each individual test setup is unnecessary. It is possible to work with identical signals at different measurement stations. This reduces the effort required to manage waveform libraries and provides transparent results. Thanks to real time correction of the frequency response, the combination of R&S®SMW200A and R&S®SZU100A can achieve excellent EVM values of specified –31 dB; usually even –32 dB or better is reached (Fig. 4).

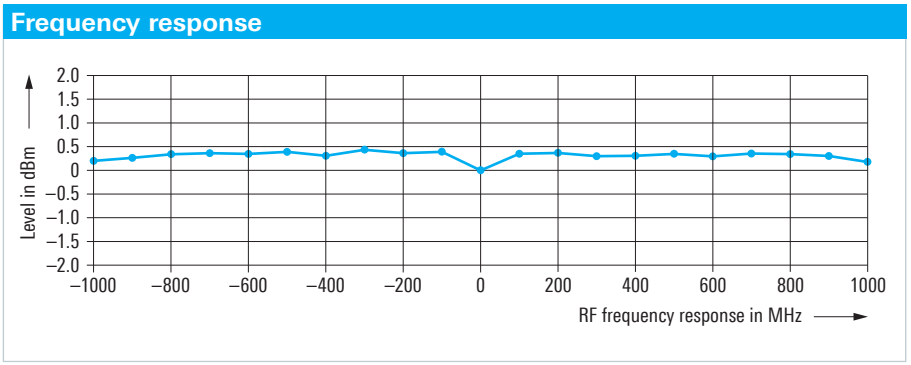

Fig. 3: Measured frequency response of the R&S®SMW200A in combination with the R&S®SZU100A at a carrier frequency of 64.80 GHz and output level of +0 dBm.

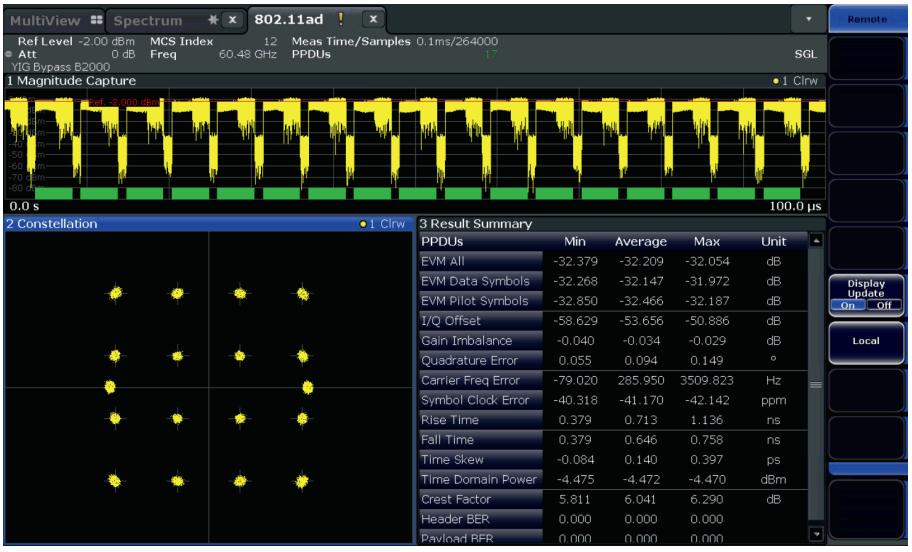

Fig. 4: Measured EVM of a WLAN 802.11ad signal (MCS 12) generated by the R&S®SZU100A and the R&S®SMW200A at 60.48 GHz.

Fig. 2: The R&S®SZU100A IQ upconverter fits seamlessly into the R&S®SMW200A operating concept.

Summary

The R&S®SZU100A IQ upconverter and the R&S®SMW200A vector signal generator are a powerful duo for WLAN 802.11ad measurements in the 60 GHz band. The setup generates standard-compliant PHY signals for testing components, modules and wireless devices with excellent signal quality and with impressive dynamic range. Thanks to the internal real-time frequency response correction, the signal is always correct. Special calibration with additional equipment before each measurement is not necessary. The setup is operated exclusively via the generator: make the necessary configuration and start measuring right away. This ensures a fast and uncomplicated workflow and enables users to successfully carry out their measurement tasks in the shortest possible time.

Simon Ache