R&S®Axx / R&S®SMx Signal Generators

IEEE 802.11n: all signals for development, production, service

WLAN-n (IEEE 802.11n), the standardized "pre n draft" expansion of the IEEE 802.11a / g Wi-Fi mobile radio standards, is going to ensure a net data throughput of up to 100 Mbit/s in wireless LANs. The R&S®SMU 200 A, R&S®SMJ 100 A, R&S®SMATE 200 A, R&S®AMU 200 A and R&S®AFQ 100 A generators with their new -K54 and -K254 options generate the signals required for testing.

Complete solution for WLAN-n

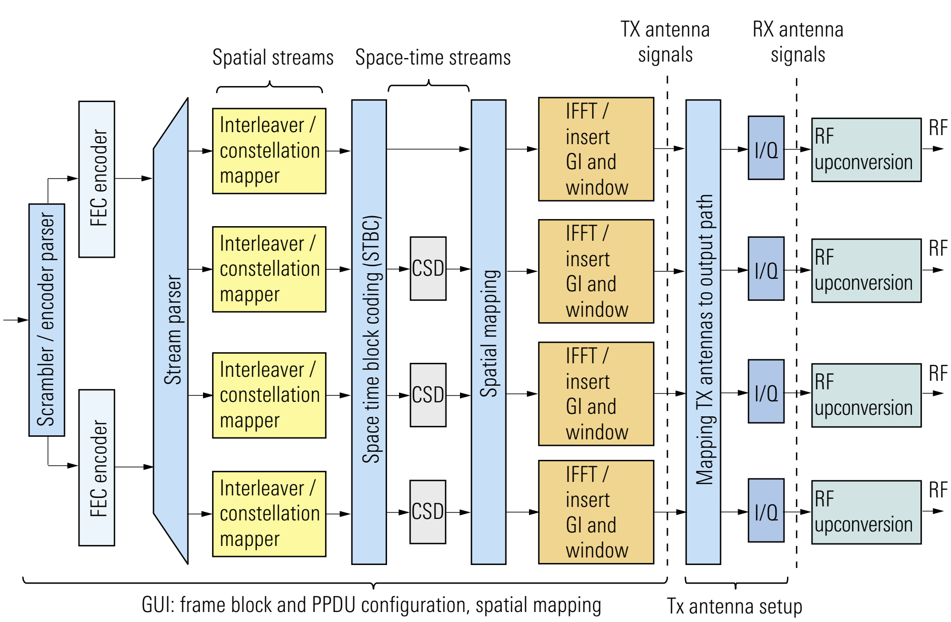
IEEE 802.11n is the expansion of the WLAN IEEE 802.11a / g standards for peak data rates up to 600 Mbit/s. 802.11n – like 802.11a / g – uses OFDM modulation. In addition, the MIMO technology and also a special coding method are employed up to a bandwidth of 40 MHz to increase the data rate. This expansion providing higher data rates is also known as *High Throughput Mode* (HT mode). Correspondingly, the non-HT mode ensures backward compatibility with IEEE 802.11a / g.

IEEE 802.11n signals are generated in several steps. In the HT mode, the user data to be transmitted is specifically encoded and subsequently radiated via up to four transmitting antennas (FIG 1):

In the first step, the data is scrambled, encoded and split into a maximum of four spatial streams. Each spatial stream is interleaved and then separately modulated by means of the BPSK, QPSK, 16QAM or 64QAM method. Subsequently, space time block coding (STBC) may optionally be used to provide redundancy and an increased immunity of transmissions to interference. A cyclic shift to decorrelate the space-time streams is followed by spatial mapping, i.e. the distribution of the pre-encoded data to the respective OFDM carriers. The transmitter tries to optimize the spatial mapping with respect to the current transmission conditions, i.e. MIMO channel. To this end, channel sounding is first performed on the transmission channel. Now an inverse fast Fourier transform (IFFT) follows to convert the signal from the frequency domain back into the time domain, and a guard interval (GI) is added to protect the signal from inter symbol interference (ISI) in case of multipath propagation. Finally, the signals are allocated to the different transmitting antennas.

The development and test of modules and equipment for compliance with IEEE 802.11n therefore requires, on the one hand, that all new functions provided in addition to the conventional WLAN are tested in detail while, on the other, the correct implementation of backward compatibility must be ensured. The new IEEE 802.11n option for the signal generators has precisely been designed for this purpose. Special attention has been devoted to keeping the signal generation of this complex standard simple and clear for the user.

FIG 1 Signal flow during the generation of IEEE 802.11n signals.



Only a few operating steps are necessary to prepare the generators for receiver tests – irrespective of whether frames with HT mode (up to 600 Mbit/s) or without HT mode (up to 54 Mbit/s) are to be generated. The information data to be transmitted (PPDU) may be voice or data, possible physical modes include *Legacy* (backward compatibility with 802.11a/g), *High Throughput Mixed* (HT MM) and *High Throughput Greenfield* (HT GF). Available transmission modes include *20 MHz*, *40 MHz*, *Duplicate*, *Upper* and *Lower*. In the *Duplicate* mode, the same carriers (with 90° phase shift) are transmitted on the two upper and lower 20 MHz channels. All important PPDU parameters can be set separately for each frame (FIG 2). Spatial streams, space-time and extended spatial streams may be varied. Conventional PPDUs have a maximum length of 4095 bytes and HT PPDUs 65535 bytes. The raw data rate can be set between 6 Mbit/s and 600 Mbit/s depending on the spatial stream setup and data settings such as modulation, guard and channel coding. PLCP preamble, interleaver and time domain windowing may be enabled or disabled. In addition, the MAC settings (HT and Legacy) and the spatial mapping mode of the current frame can be set (direct or spatial expansion). So the flexible signal generator solution of Rohde & Schwarz allows the verification of all functions of the standard in both physical layer and MAC layer.

Considering the backward compatibility of IEEE 802.11n and this standard's manifold options for variation, the capability of generating signals that reflect this variety is of paramount importance. The frame block configuration provides this capability. The user may cascade up to 100 frame blocks, i.e. groups of equally configured frames, that will be continuously transmitted in sequence (FIG 3). This makes it possible to combine different configurations such as the HT mode and the conventional modes of 802.11a/g in order to scrutinize the receiver under any aspect.

The R&S®SMU200A, R&S®SMJ100A, R&S®SMATE200A, R&S®AFQ100A and R&S®AMU200A signal generators with their new software options generate signals in accordance with IEEE 802.11n Draft 3.00. Moreover, the weighted signals of the up to four antennas can be added to enable simple diversity and MIMO tests also in the absence of a channel simulator.

For even more realistic channel simulations, the R&S®SMU200A and R&S®AMU200A generators may be equipped with an internal R&S®SMU-/R&S®AMU-B14/-B15 fading simulator and the R&S®SMU-K74 / R&S®AMU-K74 2×2 MIMO fading option. The optional R&S®SMU-K62 / R&S®AMU-K62 AWGN module adds noise. In summary, a solution scalable according to application and test requirements is now available to test receivers for the IEEE 802.11n standard under realistic conditions.

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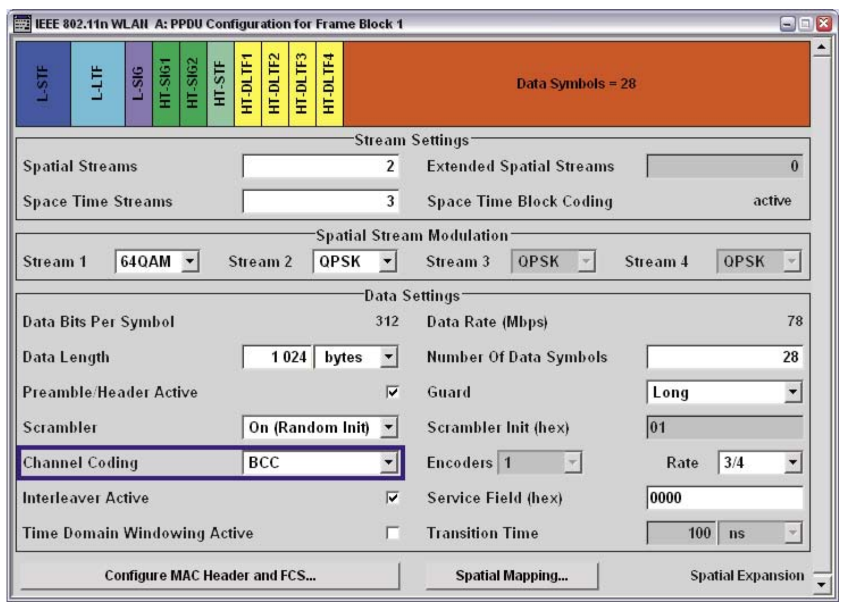

FIG 2 PPDU configuration menu of a frame block.

FIG 3 Configuration menu for the frame blocks.