IEEE P802.11
Wireless LANs

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| Draft Spec Text for Section 33.3.10 (Transmit specification) |
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Abstract

This submission contains spec text for Sec. 33.3.10 (Transmit specification) to be incorporated in P802.11bd D0.1. The text reflects the related passed motions recorded in 11-19/0514r10.

Revisions:

* Rev 0: Initial version of the document.

33. Next Generation V2X (NGV) PHY specification

* + 1. NGV transmit specification

33.3.10.1 Transmit spectrum mask

The transmit spectrum mask by regulatory domain is defined in Annex D and Annex E.

NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause.

NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale.

NOTE 3—For rules regarding TX center frequency leakage levels, see 33.3.10.4.2 (Transmit center frequency leakage). The spectral mask requirements in this subclause do not apply to the RF LO.

For operation using 10 MHz channel spacing and 20MHz channel spacing, the transmitted spectrum masks are defined in 17.3.9.3 (Transmit spectrum mask).

33.3.10.2 Spectral flatness

Spectral flatness measurements shall be conducted using BPSK modulated PPDUs. Demodulate the PPDUs according to the following (or equivalent) procedure:

* Start of PPDU shall be detected.
* Transition from L-STF to L-LTF shall be detected and fine timing shall be established.
* Coarse and fine frequency offsets shall be estimated.
* Symbols in a PPDU shall be derotated according to estimated frequency offset.
* For each NGV-LTF symbol, transform the symbol into subcarrier received values, estimate the phase from the pilot subcarriers, and derotate the subcarrier values according to the estimated phase.
* For each of the data OFDM symbols: transform the symbol into subcarrier received values.

The spectral flatness test shall be performed over at least 20 PPDUs. The PPDUs under test shall be at least 16 data OFDM symbols long.

Evaluate spectral flatness using the subcarrier received values or the magnitude of the channel estimation.

Let $E\_{i,avg}$ denote the magnitude of the channel estimation on subcarrier *i* or the average constellation energy of a BPSK modulated subcarrier *i* in a NGV data symbol.

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| Table 33-x1 Maximum transmit spectral flatness deviations  |
| Format | Bandwidth of transmission (MHz) | Averaging subcarrier indices (inclusive) | Tested subcarrier indices (inclusive) | Maximum deviation (dB) |
| NGV | 10 | –16 to –1 and +1 to +16 | –16 to –1 and +1 to +16 | ±4 |
| –28 to –17 and +17 to +28 | +4/–6 |
| 20 | –42 to –2 and +2 to +42 | –42 to –2 and +2 to +42 | ±4 |
| –58 to –43 and +43 to +58 | +4/–6 |

For the spectral flatness test, the transmitting STA shall be configured to use a spatial mapping matrix *Qk* (see 33.3.9.8 (OFDM modulation)) with flat frequency response. Each output port under test of the transmitting STA shall be connected through a cable to one input port of the testing instrumentation. The requirements apply to both 10 MHz and 20 MHz transmissions.

33.3.10.3 Transmit center frequency and symbol clock frequency tolerance

The symbol clock frequency and transmit center frequency tolerance shall be ±20 ppm maximum. The transmit center frequency and the symbol clock frequency for all transmit antennas and frequency segments shall be derived from the same reference oscillator.

33.3.10.4 Modulation accuracy

33.3.10.4.1 Introduction to modulation accuracy tests

Transmit modulation accuracy specifications are described in 21.3.17.4.2 (Transmit center frequency leakage) and 21.3.17.4.3 (Transmitter constellation error). The test method is described in 21.3.17.4.4 (Transmitter modulation accuracy (EVM) test).

33.3.10.4.2 Transmit center frequency leakage

TX LO leakage shall meet the following requirements for all bandwidths:

* When the RF LO is in the center of the transmitted PPDU BW, the power measured at the center of transmission BW using resolution BW 156.25 kHz shall not exceed the average power per-subcarrier of the transmitted PPDU, or equivalently, ($P-10log\_{10}(N\_{ST})$), where *P* is the transmit power per antenna in dBm, and *NST* is defined in Table 33-x1 (Timing-related constants).
* When the RF LO is not at the center of the transmitted PPDU BW, the power measured at the location of the RF LO using resolution BW 156.25 kHz shall not exceed the maximum of –32 dB relative to the total transmit power and –20 dBm, or equivalently $max⁡(P-32, -20)$, where *P* is the transmit power per antenna in dBm, and *NST* is defined in Table 33-x1 (Timing-related constants).

The transmit center frequency leakage is specified per antenna.

33.3.10.4.3 Transmitter constellation error

The relative constellation RMS error, calculated by first averaging over subcarriers, NGV PPDUs, and spatial streams (see Equation (19-89)) shall not exceed a data-rate dependent value according to Table 21-24 (Allowed relative constellation error versus constellation size and coding rate). The number of spatial streams under test shall be equal to the number of utilized transmitting STA antenna (output) ports and also equal to the number of utilized testing instrumentation input ports. In the test, *NSS = NSTS* (no STBC) shall be used and no beamforming steering matrix shall be used. Each output port of the transmitting STA shall be connected through a cable to one input port of the testing instrumentation. The requirements apply to both 10 MHz and 20 MHz transmissions.

33.3.10.4.4 Transmitter modulation accuracy (EVM) test

The transmit modulation accuracy test shall be performed by instrumentation capable of converting the transmitted signals into a stream of complex samples at sampling rate greater than or equal to the bandwidth of the signal being transmitted.

In this case, transmit modulation accuracy of each segment shall meet the required value in Table 21-24 (Allowed relative constellation error versus constellation size and coding rate) using only the subcarriers within the corresponding segment.

The instrument shall have sufficient accuracy in terms of I/Q arm amplitude and phase balance, DC offsets, phase noise, and analog to digital quantization noise. A possible embodiment of such a setup is converting the signals to a low IF frequency with a microwave synthesizer, sampling the signal with a digital oscilloscope and decomposing it digitally into quadrature components. The sampled signal shall be processed in a manner similar to an actual receiver, according to the following steps, or equivalent procedure:

* Start of PPDU shall be detected.
* Transition from L-STF to L-LTF shall be detected and fine timing shall be established.
* Coarse and fine frequency offsets shall be estimated.
* Symbols in a PPDU shall be derotated according to estimated frequency offset.
* For each NGV-LTF symbol, transform the symbol into subcarrier received values, estimate the phase from the pilot subcarriers, and derotate the subcarrier values according to the estimated phase.
* Estimate the complex channel response coefficient for each of the subcarriers and each of the transmit streams.
* For each of the data OFDM symbols: transform the symbol into subcarrier received values, estimate the phase from the pilot subcarriers, derotate the subcarrier values according to the estimated phase, group the results from all of the receiver chains in each subcarrier to a vector, and multiply the vector by a zero-forcing equalization matrix generated from the estimated channel.
* For each data-carrying subcarrier in each spatial stream, find the closest constellation point and compute the Euclidean distance from it.
* Compute the average across PPDUs of the RMS of all errors per PPDU as given by Equation (19-89).

NOTE—In the case the transmit modulation accuracy test is performed simultaneously for the two frequency segments of the 80+80 MHz transmissions, *NST* in Equation (19-89) represents the total number of subcarriers of both 80 MHz frequency segments.

The test shall be performed over at least 20 PPDUs $N\_{f}$ as defined in Equation (19-89)). The PPDUs under test shall be at least 16 data OFDM symbols long. Random data shall be used for the symbols.

33.3.10.5 Time of Departure accuracy

The Time of Departure accuracy test evaluates TIME\_OF\_DEPARTURE against aTxPHYTxStartRMS and aTxPHYTxStartRMS against TIME\_OF\_DEPARTURE\_ACCURACY\_TEST\_THRESH as defined in Annex P with the following test parameters:

* MULTICHANNEL\_SAMPLING\_RATE is $20×10^{6}\left(1+\left⌈\frac{f\_{H}-f\_{L}}{20 MHz}\right⌉\right)$ sample/s, where

*fH* is the nominal center frequency in Hz of the highest channel in the channel set

*fL* is the nominal center frequency in Hz of the lowest channel in the channel set, the channel set is the set of channels upon which frames providing measurements are transmitted, the channel set comprises channels uniformly spaced across $f\_{H}-f\_{L}\leq 50 MHz$.

* FIRST\_TRANSITION\_FIELD is L-STF.
* SECOND\_TRANSITION\_FIELD is L-LTF.
* TRAINING\_FIELD is the Long symbols windowed in a manner which should approximate the windowing described in 17.3.2.5 (Mathematical conventions in the signal descriptions) with *T*TR = 100 ns for 20 MHz channel spacing, *T*TR = 200 ns for 10 MHz channel spacing.
* TIME\_OF\_DEPARTURE\_ACCURACY\_TEST\_THRESH is 80 ns.

NOTE—The indicated windowing applies to the time of departure accuracy test equipment, and not the transmitter or receiver.