19.3.16 Slot time

The slot time shall follow 17.3.8.6 for 5 GHz bands and 18.5.4 for 2.4 GHz bands.

The slot time for 40 MHz channel spacing shall be the same as that for 20 MHz channel spacing.

19.3.17 Transmit and receive impedance at the antenna connector

The impedance at the transmit antenna connector and receive antenna connector for each transmit and receive antenna shall follow 17.3.8.7.

19.3.18 PHY transmit specification

19.3.18.1 Transmit spectrum mask

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, i.e., its emissions can be no higher at any frequency offset than the minimum of the values specified in the regulatory and default masks.

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

For rules regarding TX center frequency leakage levels by VHT STAs, see 21.3.17.4.2.

For the 2.4 GHz band, when transmitting in a 20 MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset, and the maximum of –45 dBr and –53 dBm/MHz at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 19-17. The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

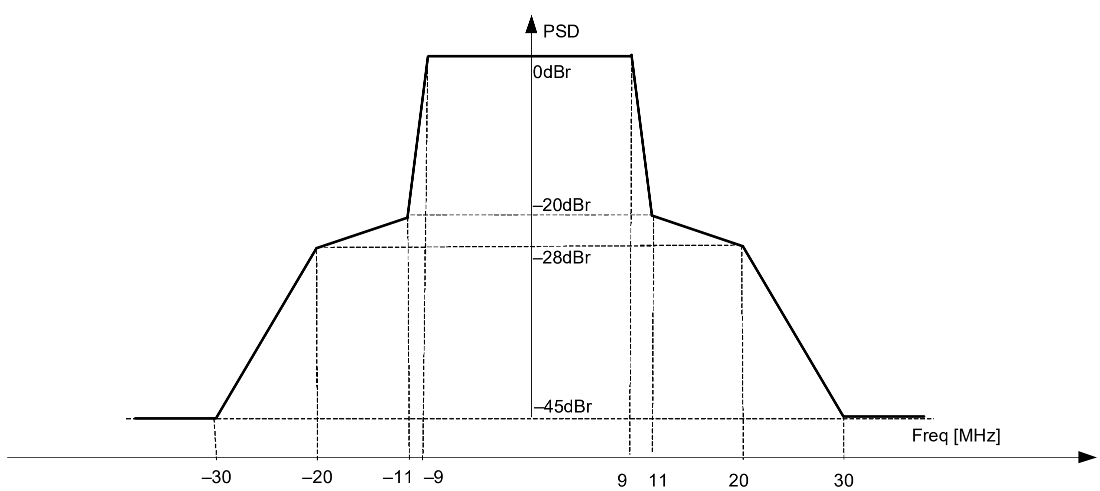

Figure 19-17—Transmit spectral mask for 20 MHz transmission in the 2.4 GHz band

For the 2.4 GHz band, when transmitting in a 40 MHz channel, the transmitted spectrum shall have a 0 dBr bandwidth not exceeding 38 MHz, –20 dBr at 21 MHz frequency offset, –28 dBr at 40 MHz offset, and the maximum of –45 dBr and –56 dBm/MHz at 60 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 19-18.

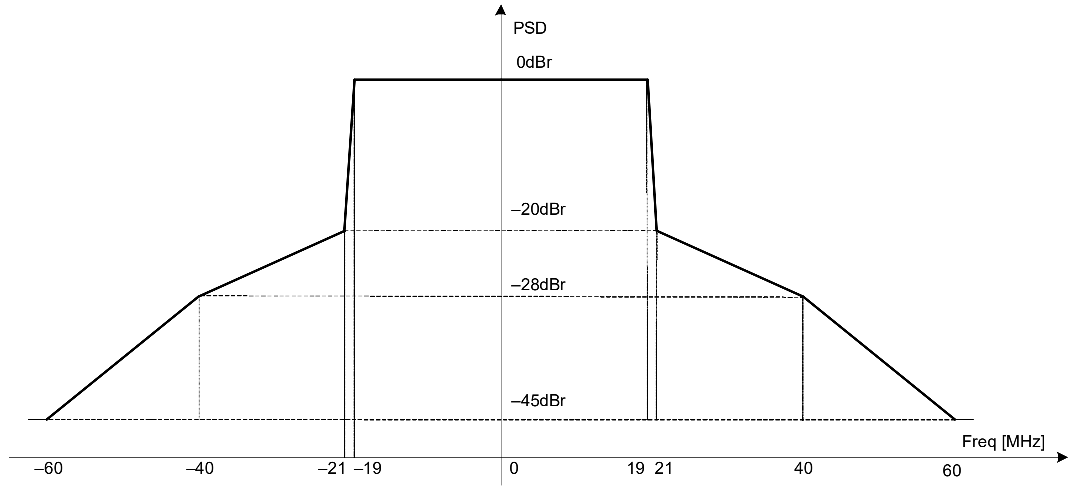

Figure 19-18—Transmit spectral mask for a 40 MHz channel in the 2.4 GHz band

For the 5 GHz band, when transmitting in a 20 MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset, and the maximum of –40 dBr and –53 dBm/MHz at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 19-19. The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

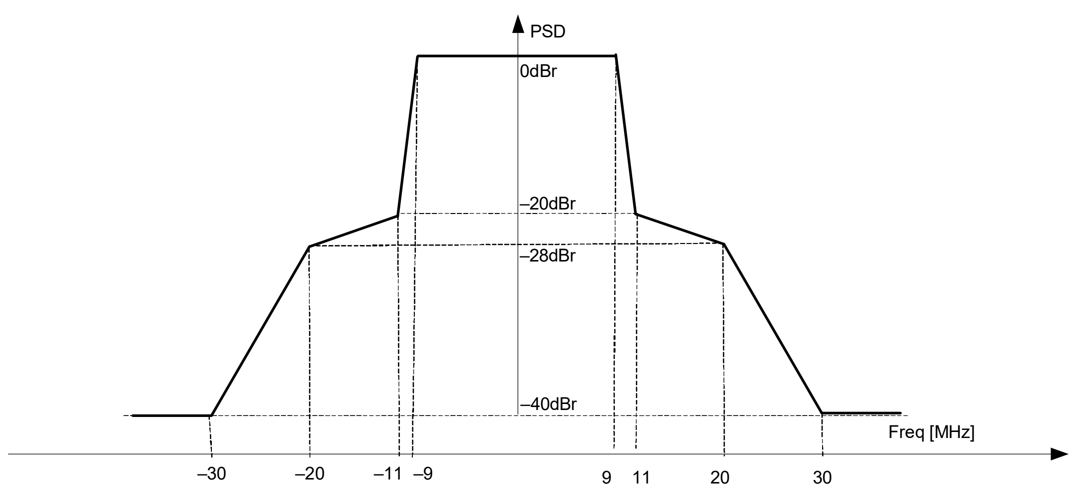

Figure 19-19—Transmit spectral mask for 20 MHz transmission in the 5 GHz band

For the 5 GHz band, when transmitting in a 40 MHz channel, the transmitted spectrum shall have a 0 dBr bandwidth not exceeding 38 MHz, –20 dBr at 21 MHz frequency offset, –28 dBr at 40 MHz offset, and the maximum of –40 dBr and –56 dBm/MHz at 60 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure 19-20.

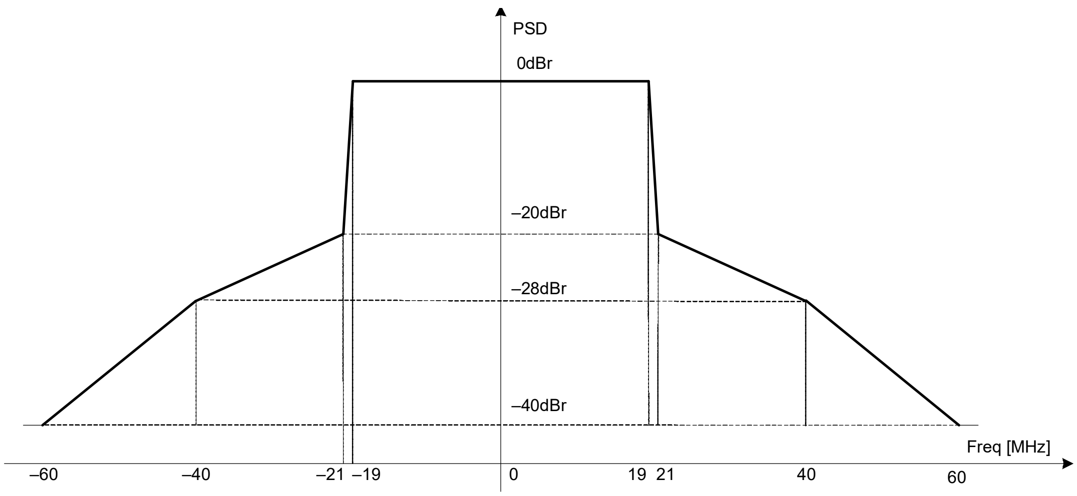

Figure 19-20—Transmit spectral mask for a 40 MHz channel in the 5 GHz band

Transmission with CH_OFF_20U, CH_OFF_20L, or CH_OFF_40 shall comply with the same mask that is used for the 40 MHz channel.

19.3.18.2 Spectral flatness

In a 20 MHz channel and in corresponding 20 MHz transmission in a 40 MHz channel, the average energy of the constellations in each of the subcarriers with indices –16 to –1 and +1 to +16 shall deviate no more than ± 4 dB from their average energy. The average energy of the constellations in each of the subcarriers with indices –28 to –17 and +17 to +28 shall deviate no more than +4/–6 dB from the average energy of subcarriers with indices –16 to –1 and +1 to +16.

In a 40 MHz transmission (excluding PPDUs in MCS 32 format and non-HT duplicate format), the average energy of the constellations in each of the subcarriers with indices –42 to –2 and +2 to +42 shall deviate no more than ± 4 dB from their average energy. The average energy of the constellations in each of the subcarriers with indices –43 to –58 and +43 to +58 shall deviate no more than +4/–6 dB from the average energy of subcarriers with indices –42 to –2 and +2 to +42.

In MCS 32 format and non-HT duplicate format, the average energy of the constellations in each of the subcarriers with indices –42 to –33, –31 to –6, +6 to +31, and +33 to +42 shall deviate no more than ± 4 dB from their average energy. The average energy of the constellations in each of the subcarriers with indices –43 to –58 and +43 to +58 shall deviate no more than +4/–6 dB from the average energy of subcarriers with indices –42 to –33, –31 to –6, +6 to +31, and +33 to +42.

The tests for the spectral flatness requirements may be performed with spatial mapping $Q_k = \mathbf{I}$ (see 19.3.11.11.2).

19.3.18.3 Transmit power

The maximum allowable output power is measured in accordance with practices specified by the appropriate regulatory bodies.

19.3.18.4 Transmit center frequency tolerance

The transmitter center frequency tolerance shall be ± 20 ppm for the 5 GHz band and ± 25 ppm for the 2.4 GHz band. The different transmit chain center frequencies (LO) and each transmit chain symbol clock frequency shall all be derived from the same reference oscillator.

19.3.18.5 Packet alignment

If no signal extension is required (see 19.3.2), the receiver shall emit a PHY-CCA.indication(IDLE) primitive (see 8.3.5.12) at the 4 µs boundary following the reception of the last symbol of the packet. If a signal extension is required, the receiver shall emit a PHY-CCA.indication(IDLE) primitive a duration of aSignalExtension after the 4 µs boundary following the reception of the last symbol of the packet. This situation is illustrated for an HT-greenfield format packet using short GI in Figure 19-21.

If no signal extension is required, the transmitter shall emit a PHY-TXEND.confirm primitive (see 8.3.5.8) at the 4 µs boundary following the trailing boundary of the last symbol of the PPDU on the WM. If a signal extension is required, the transmitter shall emit a PHY-TXEND.confirm primitive (see 8.3.5.8) a duration of aSignalExtension after the 4 µs boundary following the trailing boundary of the last symbol of the PPDU on the WM. This situation is illustrated in Figure 19-21.

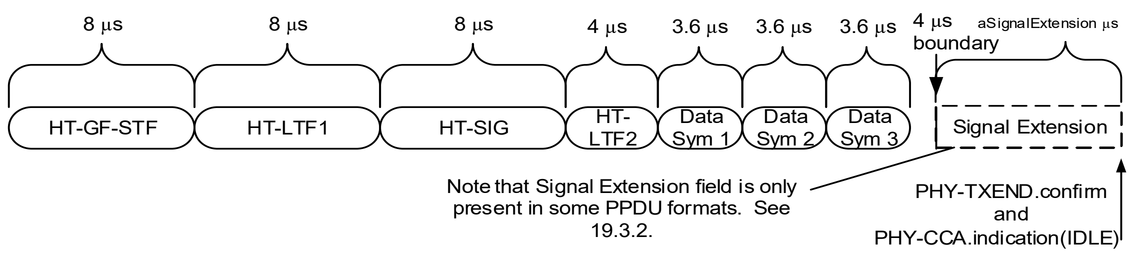

Figure 19-21—PHY-TXEND.confirm alignment (HT-greenfield format with short GI)

19.3.18.6 Symbol clock frequency tolerance

The symbol clock frequency tolerance shall be ± 20 ppm for 5 GHz bands and ± 25 ppm for 2.4 GHz bands. The transmit center frequency and the symbol clock frequency for all transmit antennas shall be derived from the same reference oscillator.

19.3.18.7 Modulation accuracy

19.3.18.7.1 Introduction to modulation accuracy tests

Transmit modulation accuracy specifications are described in 19.3.18.7.2 and 19.3.18.7.3. The test method is described in 19.3.18.7.4.

19.3.18.7.2 Transmit center frequency leakage

For VHT STAs the requirements on transmitter center frequency leakage are defined in 21.3.17.4.2; otherwise, the requirements are defined in this subclause.

The transmitter center frequency leakage shall follow 17.3.9.7.2 for all transmissions in a 20 MHz channel width. For transmissions in a 40 MHz channel width, the center frequency leakage shall not exceed $max(P - 20, -20)$ dBm, or, equivalently, 0 dB relative to the average energy of the rest of the subcarriers. For upper or lower 20 MHz transmissions in a 40 MHz channel, the center frequency leakage (center of a 40 MHz channel) shall not exceed $max(P - 17, -20)$ dBm. The transmit center frequency leakage is specified per antenna.

19.3.18.7.3 Transmitter constellation error

The relative constellation frame-averaged RMS error, calculated first by averaging over subcarriers, OFDM frames, and spatial streams, shall not exceed a data-rate-dependent value according to Table 19-22. 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, $N_{SS} = N_{STS}$ with EQM MCSs 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 same requirement applies both to 20 MHz channels and 40 MHz channels.

Table 19-22—Allowed relative constellation error versus constellation size and coding rate

Modulation	Coding rate	Relative constellation error (dB)
BPSK	1/2	–5
QPSK	1/2	–10
QPSK	3/4	–13
16-QAM	1/2	–16
16-QAM	3/4	–19
64-QAM	2/3	–22
64-QAM	3/4	–25
64-QAM	5/6	–27

19.3.18.7.4 Transmitter modulation accuracy (EVM) test

The transmit modulation accuracy test shall be performed by instrumentation capable of converting the transmitted signals into a streams of complex samples at 40 Msample/s or more, with sufficient accuracy in terms of I/Q arm amplitude and phase balance, dc offsets, phase noise, and analog-to-digital quantization noise. Each transmit chain is connected directly through a cable to the setup input port. A possible embodiment of such a setup is converting the signals to a low intermediate 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 an equivalent procedure:

a) Detect the start of frame.
b) Detect the transition from short sequences to channel estimation sequences, and establish fine timing (with one sample resolution).
c) Estimate the coarse and fine frequency offsets.

d) Derotate the frame according to estimated frequency offset.
e) Estimate the complex channel response coefficients for each of the subcarriers and each of the transmit chains.
f) For each of the data OFDM symbols, transform the symbol into subcarrier received values, estimate the phase from the pilot subcarriers in all spatial streams, derotate the subcarrier values according to estimated phase, group the results from all of the receiver chains in each subcarrier to a vector, multiply the vector by a zero-forcing equalization matrix generated from the channel estimated during the channel estimation phase.
g) For each data-carrying subcarrier in each spatial stream, find the closest constellation point and compute the Euclidean distance from it.
h) Compute the average of the RMS of all errors in a frame. It is given by Equation (19-89).

$$Error_{RMS} = \frac{\sum_{i_f=1}^{N_f} \sqrt{\frac{\sum_{i_s=1}^{N_{SYM}} \left[\sum_{i_{ss}=1}^{N_{SS}} \left(\sum_{i_{sc}=1}^{N_{ST}} \left((I(i_f, i_s, i_{ss}, i_{sc}) - I_0(i_f, i_s, i_{ss}, i_{sc}))^2 + (Q(i_f, i_s, i_{ss}, i_{sc}) - Q_0(i_f, i_s, i_{ss}, i_{sc}))^2 \right) \right) \right]}{N_{SYM} \times N_{SS} \times N_{ST} \times P_0}}}{N_f} \tag{19-89}$$

where

N_f	is the number of frames for the measurement
$I_0(i_f, i_s, i_{ss}, i_{sc}), Q_0(i_f, i_s, i_{ss}, i_{sc})$	denotes the ideal symbol point in the complex plane in subcarrier i_{sc}, spatial stream i_{ss}, and OFDM symbol i_s of frame i_f
$I(i_f, i_s, i_{ss}, i_{sc}), Q(i_f, i_s, i_{ss}, i_{sc})$	denotes the observed symbol point in the complex plane in subcarrier i_{sc}, spatial stream i_{ss}, and OFDM symbol i_s of frame i_f
P_0	is the average power of the constellation

The vector error on a phase plane is shown in Figure 17-16.

The test shall be performed over at least 20 frames (N_f), and the average of the RMS shall be taken. The frames under test shall be at least 16 OFDM symbols long. Random data shall be used for the symbols.

19.3.18.8 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

$20 \times 10^6\left(1 + \left\lceil \frac{f_H - f_L}{20 \text{ MHz}} \right\rceil\right)$ sample/s, for a CH_BANDWIDTH parameter equal to HT_CBW20

$40 \times 10^6\left(1 + \left\lceil \frac{f_H - f_L}{40 \text{ MHz}} \right\rceil\right)$ sample/s, for a CH_BANDWIDTH parameter equal to HT_CBW40

where

f_H	is the nominal center frequency in Hz of the highest channel in the channel set
f_L	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 $f_H - f_L \geq 50$ MHz

- FIRST_TRANSITION_FIELD is L-STF (for HT-mixed format) or HT-GF-STF (for HT-greenfield format)
- SECOND_TRANSITION_FIELD is L-LTF (for HT-mixed format) or HT-GF-LTF1 (for HT-greenfield format)
- TRAINING_FIELD is L-LTF (for HT-mixed format) or HT-LTF1 (for HT-greenfield format) windowed in a manner which should approximate the windowing described in 17.3.2.5 with T_{TR} = 100 ns.
- TIME_OF_DEPARTURE_ACCURACY_TEST_THRESH is 80 ns (for a CH_BANDWIDTH parameter equal to HT_CBW20) or 80 ns (for a CH_BANDWIDTH parameter equal to HT_CBW40).

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

19.3.19 HT PHY receiver specification

19.3.19.1 Receiver minimum input sensitivity

The packet error ratio (PER) shall be less than 10% for a PSDU length of 4096 octets with the rate-dependent input levels listed in Table 19-23 or less. The minimum input levels are measured at the antenna connector and are referenced as the average power per receive antenna. 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 device under test input ports. Each output port of the transmitting STA shall be connected through a cable to one input port of the device under test. The test in this subclause and the minimum sensitivity levels specified in Table 19-23 apply only to non-STBC modes, MCSs 0–31, 800 ns GI, and BCC.

Table 19-23—Receiver minimum input level sensitivity

Modulation	Rate (R)	Adjacent channel rejection (dB)	Nonadjacent channel rejection (dB)	Minimum sensitivity (20 MHz channel spacing) (dBm)	Minimum sensitivity (40 MHz channel spacing) (dBm)
BPSK	1/2	16	32	–82	–79
QPSK	1/2	13	29	–79	–76
QPSK	3/4	11	27	–77	–74
16-QAM	1/2	8	24	–74	–71
16-QAM	3/4	4	20	–70	–67
64-QAM	2/3	0	16	–66	–63
64-QAM	3/4	–1	15	–65	–62
64-QAM	5/6	–2	14	–64	–61

19.3.19.2 Adjacent channel rejection

For all transmissions in a 20 MHz channel width, the adjacent channel rejection shall be measured by setting the desired signal's strength 3 dB above the rate-dependent sensitivity specified in Table 19-23 and raising the power of an interfering signal of 20 MHz bandwidth until 10% PER is caused for a PSDU length of 4096 octets. The difference in power between the signals in the interfering channel and the desired channel is the corresponding adjacent channel rejection. The adjacent channel center frequencies shall be separated by 20 MHz when operating in the 5 GHz band, and the adjacent channel center frequencies shall be separated by 25 MHz when operating in the 2.4 GHz band.

For all transmissions in a 40 MHz channel width, the adjacent channel rejection shall be measured by setting the desired signal's strength 3 dB above the rate-dependent sensitivity specified in Table 19-23 and raising the power of an interfering signal of 40 MHz bandwidth until 10% PER is caused for a PSDU length of 4096 octets. The difference in power between the signals in the interfering channel and the desired channel is the corresponding adjacent channel rejection. The adjacent channel center frequencies shall be separated by 40 MHz.

The interfering signal in the adjacent channel shall be a signal compliant with the HT PHY, unsynchronized with the signal in the channel under test. The corresponding rejection shall be no less than specified in Table 19-23. The interference signal shall have a minimum duty cycle of 50%.

The test in this subclause and the adjacent channel rejection levels specified in Table 19-23 apply only to non-STBC modes, MCSs 0–31, 800 ns GI, and BCC.

19.3.19.3 Nonadjacent channel rejection

For all transmissions in a 20 MHz channel width in the 5 GHz band, the nonadjacent channel rejection shall be measured by setting the desired signal's strength 3 dB above the rate-dependent sensitivity specified in Table 19-23 and raising the power of an interfering signal of 20 MHz bandwidth until a 10% PER occurs for a PSDU length of 4096 octets. The difference in power between the signals in the interfering channel and the desired channel is the corresponding nonadjacent channel rejection. The nonadjacent channel center frequencies shall be separated by 40 MHz or more.

For all transmissions in a 40 MHz channel width in the 5 GHz band, the nonadjacent channel rejection shall be measured by setting the desired signal's strength 3 dB above the rate-dependent sensitivity specified in Table 19-23 and raising the power of an interfering signal of 40 MHz bandwidth until a 10% PER occurs for a PSDU length of 4096 octets. The difference in power between the signals in the interfering channel and the desired channel is the corresponding nonadjacent channel rejection. The nonadjacent channel center frequencies shall be separated by 80 MHz or more.

The interfering signal in the nonadjacent channel shall be a signal compliant with the HT PHY, unsynchronized with the signal in the channel under test. The corresponding rejection shall be no less than specified in Table 19-23. The interference signal shall have a minimum duty cycle of 50%. The nonadjacent channel rejection for transmissions in a 20 MHz or 40 MHz channel width is applicable only to 5 GHz band.

The test in this subclause and the nonadjacent channel rejection level specified in Table 19-23 apply only to non-STBC modes, MCSs 0–31, 800 ns GI, and BCC.

19.3.19.4 Receiver maximum input level

The receiver shall provide a maximum PER of 10% at a PSDU length of 4096 octets, for a maximum input level of –30 dBm in the 5 GHz band and –20 dBm in the 2.4 GHz band, measured at each antenna for any baseband modulation.

19.3.19.5 CCA sensitivity

19.3.19.5.1 General

The thresholds in this subclause are compared with the signal level at each receiving antenna.

19.3.19.5.2 CCA-Energy Detect (CCA-ED)

For the operating classes requiring CCA-Energy Detect (CCA-ED), the PHY shall also indicate a medium busy condition when CCA-ED detects a channel busy condition.

For improved spectrum sharing, CCA-ED is required in some bands. The behavior class indicating CCA-ED is given in Table D-2. The operating classes requiring the corresponding CCA-ED behavior class are given in E.1. The PHY of a STA that is operating within an operating class that requires CCA-ED shall operate with CCA-ED.

CCA-ED shall detect a channel busy condition when the received signal strength exceeds the CCA-ED threshold as given by dot11OFDMEDThreshold for the primary channel and dot11OFDMEDThreshold for the secondary channel (if present). The CCA-ED thresholds for the operating classes requiring CCA-ED are subject to the criteria in D.2.5.

NOTE—The requirement to detect a channel busy condition as stated in 19.3.19.5.3, 19.3.19.5.4, and 19.3.19.5.5 is a mandatory energy detection requirement on all Clause 19 receivers. Support for CCA-ED is an additional requirement that relates specifically to the sensitivities described in D.2.5.

19.3.19.5.3 CCA sensitivity for non-HT PPDUs

CCA sensitivity requirements for non-HT PPDUs in the primary channel are described in 17.3.10.6 and 18.4.6.

19.3.19.5.4 CCA sensitivity in 20 MHz

For an HT STA with the operating channel width equal to 20 MHz, the start of a 20 MHz HT signal at a receive level greater than or equal to the minimum modulation and coding rate sensitivity of –82 dBm shall cause the PHY to set PHY-CCA.indication(BUSY) with a probability > 90% within 4 μs. The receiver shall indicate a channel busy condition for any signal 20 dB or more above the minimum modulation and coding rate sensitivity (–82 + 20 = –62 dBm) in the 20 MHz channel.

An HT STA that does not support the reception of HT_GF PPDUs shall indicate a channel busy condition [PHY-CCA.indication(BUSY)] for any valid HT_GF signal in the 20 MHz channel at a receive level greater than or equal to –72 dBm.

19.3.19.5.5 CCA sensitivity in 40 MHz

This subclause describes the CCA sensitivity requirements for an HT STA with the operating channel width equal to 40 MHz.

The receiver of a 20/40 MHz STA with the operating channel width equal to 40 MHz shall provide CCA on both the primary and secondary channels.

When the secondary channel is idle, the start of a 20 MHz HT signal in the primary channel at a receive level greater than or equal to the minimum modulation and coding rate sensitivity of –82 dBm shall cause the PHY to generate a PHY-CCA.indication(BUSY, {primary}) primitive with a probability > 90% within 4 μs. The start of a 40 MHz HT signal that occupies both the primary and secondary channels at a receive level greater than or equal to the minimum modulation and coding rate sensitivity of –79 dBm shall cause the PHY to generate a PHY-CCA.indication(BUSY, {primary, secondary}) primitive for both the primary and secondary channels with a probability per channel > 90% within 4 μs.

An HT STA that does not support the reception of HT_GF PPDUs shall indicate a {primary} channel busy condition (PHY-CCA.indication(BUSY, {primary}) primitive) for any valid HT_GF signal in the primary channel at a receive level greater than or equal to –72 dBm when the secondary channel is idle. An HT STA that does not support the reception of HT_GF PPDUs shall indicate a {primary, secondary} channel busy condition (PHY-CCA.indication(BUSY, {primary, secondary}) primitive) for any valid 40 MHz HT_GF signal in both the primary and secondary channels at a receive level greater than or equal to –69 dBm.

The receiver shall indicate a {primary} channel busy condition for any signal at or above –62 dBm in the 20 MHz primary channel. This level is 20 dB above the minimum modulation and coding rate sensitivity for a 20 MHz PPDU. When the primary channel is idle, the receiver indicate a {secondary} channel busy condition for any signal at or above –62 dBm in the 20 MHz secondary channel. The receiver shall indicate a {primary, secondary} channel busy condition for any signal present in both the primary and secondary channels that is at or above –62 dBm in the primary channel and at or above –62 dBm in the secondary channel.

19.3.19.6 Received channel power indicator (RCPI) measurement

The RCPI is a measure of the received RF power in the selected channel for a received frame. This parameter shall be a measure by the PHY of the received RF power in the channel measured over the data portion of the received frame. The received power shall be the average of the power in all active receive chains.

The RCPI encoding is defined in 9.4.2.37.

RCPI shall equal the received RF power within an accuracy of ± 5 dB (95% confidence interval) within the specified dynamic range of the receiver. The received RF power shall be determined assuming a receiver noise equivalent bandwidth equal to the channel width multiplied by 1.1.

19.3.19.7 Reduced interframe space (RIFS)

The receiver shall be able to decode a PPDU that was transmitted with a RIFS separation from the previous PPDU.

19.3.20 PHY transmit procedure

There are three options for the transmit PHY procedure. The first two options, for which typical transmit procedures are shown in Figure 19-22 and Figure 19-23, are selected if the FORMAT field of the PHY-TXSTART.request(TXVECTOR) primitive is equal to HT_MF or HT_GF, respectively. These transmit procedures do not describe the operation of optional features, such as LDPC or STBC. The third option is to follow the transmit procedure in Clause 17 or Clause 18 if the FORMAT field is equal to NON_HT. Additionally, if the FORMAT field is equal to NON_HT, CH_BANDWIDTH indicates NON_HT_CBW20, and NON_HT_MODULATION indicates OFDM, follow the transmit procedure in Clause 17. If the FORMAT field is equal to NON_HT, CH_BANDWIDTH indicates NON_HT_CBW20, and NON_HT_MODULATION indicates other than OFDM, follow the transmit procedure in Clause 18. And furthermore, if the FORMAT field is equal to NON_HT and CH_BANDWIDTH indicates NON_HT_CBW40, follow the transmit procedure in Clause 17, except that the signal in Clause 17 is generated simultaneously on each of the upper and lower 20 MHz channels that constitute the 40 MHz channel as defined in 19.3.8 and 19.3.11.12. In all these options, in order to transmit data, the PHY-TXSTART.request primitive shall be enabled so that the PHY entity shall be in the transmit state. Further, the PHY shall be set to operate at the appropriate frequency through station management via the PLME, as specified in 19.4. Other transmit parameters, such as MCS coding types and transmit power, are set via the PHY SAP with the PHY-TXSTART.request(TXVECTOR) primitive, as described in 19.2.2.