1.1 Downstream Transmit and Receive

1.1.1 OFDM Downstream Transmit Fidelity Requirements

1.1.1.1 OFDM Channel Power and Bandwidth

Comment [JS1]: CM-SP-PHYv3.1-I01-131029 Section 7.5.9

New Content

For the purposes of this specification, the number of occupied CEA channels of an OFDM channel is the occupied bandwidth of the OFDM channel divided by 6 MHz.

CLTs capable of generating N_{OFDM}-channels of OFDM per RF port, for purposes of the output electrical requirements, are said to be capable of generating N_{eq} equivalent 6 MHz CEA channels per RF port, where N_{eq} = 32*N_{OFDM}.

An N_{eq}-channel per RF port CLT MUST comply with all requirements operating with all N_{eq} channels on the RF port, and MUST comply with all requirements for an N_{eq}'-channel per RF port device operating with N_{eq}' active channels on the RF port for all values of N_{eq}' less than N_{eq}, where N_{eq}' is the full set of modulated or active channels.

For an OFDM channel there is a) the occupied bandwidth, b) the encompassed spectrum, c) the modulated spectrum, and d) the number of equivalent 6 MHz CEA channels.

The encompassed spectrum in MHz is 204.8 MHz, minus the number of subcarriers in the band edge exclusion sub-band for the upper and lower band edges (combined), multiplied by the subcarrier spacing in MHz. For example, with subcarrier spacing of 50 kHz and 150 lower band edge subcarriers and 152 upper band edge subcarriers (for a total of 302 subcarriers in the two band edge exclusion sub-bands), the encompassed spectrum = 204.8 – 302*(0.05) = 189.7 MHz. The encompassed spectrum is also equal to the center frequency of the highest frequency modulated subcarrier minus the center frequency of the lowest frequency modulated subcarrier in an OFDM channel, plus the subcarrier spacing.

The occupied bandwidth is a multiple of 6 MHz, with a minimum of 24 MHz, and consists of all CEA channels that include the encompassed spectrum, plus the taper region shaped by the OFDM channels' transmit windowing; the out-of-band spurious emissions requirements (except for gap channel spurious emissions requirements) apply outside the occupied spectrum. With a 1 MHz taper region on each band edge of the OFDM channel, shaped by the transmit windowing function, encompassed spectrum of 189.7 MHz may provide 192 MHz of occupied bandwidth.

The modulated spectrum of an OFDM channel is the encompassed spectrum minus the total spectrum in the internal excluded sub-bands of the channel, where the total spectrum in the internal excluded sub-bands is equal to the number of subcarriers in all of the internal excluded sub-bands of the OFDM channel multiplied by the subcarrier spacing of the OFDM channel. In the previous example, if there are 188 subcarriers total in three internal exclusion sub-bands, then the total spectrum in the internal excluded sub-bands (in MHz) is 188*0.05 = 9.4 MHz, and the modulated spectrum is 189.7 MHz – 9.4 MHz = 180.3 MHz.

For an N_{eq}-channel per RF port CLT, the applicable maximum power per channel and spurious emissions requirements are defined using a value of N^* = minimum(4N_{eq}', ceiling[N_{eq}/4]) for N_{eq}' < N_{eq}/4, and N^* = N_{eq}' otherwise.

These specifications assume that the CLT will be terminated with a 75 Ohm load.

1.1.1.2 CLT Output Electrical Requirements

Comment [JS2]: CM-SP-PHYv3.1-I01-131029 Sections 7.5.9.1 and 7.5.10

New content and motioned items

For OFDM, all modulated subcarriers in an OFDM channel are set to the same average power (except pilots which are boosted by 6 dB). For purposes of spurious emissions requirements, the "commanded transmit power per channel" for an equivalent 6 MHz CEA channel is computed as follows:

- CLT power is configured by power per CEA channel and number of occupied CEA channels for each OFDM channel.
- For each OFDM channel, the total power is Power per CEA channel + 10log10(Number of occupied CEA channels) for that OFDM channel.
- CLT calculates power for data subcarrier and pilots (using total number of non-zero valued (non-excluded) subcarriers).

- CLT calculates power in 400 kHz containing PLC.
- For the spurious emissions requirements, power calculated for the 400 kHz containing the PLC is the commanded average power of an equivalent 6 MHz CEA channel for that OFDM channel.

A CLT shall output an OFDM RF modulated signal with the characteristics defined in Table 2 and Table 3.

A CLT shall output an RF modulated OFDM signal with the characteristics defined in **Error! Reference source not found.**. The condition for these requirements is the entire OFDM block commanded to a constant power spectral density, except for Phase Noise, Diagnostic Carrier Suppression, and power difference requirements (Table 2), and except as described previously in this section.

The CLT shall provide for independent selection of center frequency when the ratio of active bandwidth to excluded bandwidth in the encompassed spectrum is at least 2:1, and with each channel independently meeting the requirements of **Error! Reference source not found.** except for spurious emissions requirements defined in Section 1.1.1.2.2.

The condition for these requirements is all N_{eq}' commanded to the same average power, except for the Single Channel Active Phase Noise, Diagnostic Carrier Suppression, OFDM Phase Noise, OFDM Diagnostic Suppression, and power difference requirements, and except as described for Out-of-Band Noise and Spurious Requirements.

Table 1 - CLT RF Output Requirements

Parameter	Value
FDD Mode Frequency Band	CLT shall support 54 MHz – 1212 MHz
TDD Mode Frequency Bands	CLT shall support the following frequency bands, either separately or together: 5 MHz – 277 MHz (low band) 750 MHz – 1800 MHz (high band)
Signal Type	OFDM
Single FFT Block Bandwidth	192 MHz
Minimum Active Signal Bandwidth	24 MHz
Subcarrier Spacing / OFDM Symbol Rate FFT duration	25 kHz / 40 µsec 50 kHz / 20 µsusec
FFT Size	50 kHz: 4096 (4K FFT) 25 kHz: 8192 (8K FFT)
Maximum Number of Subcarriers per FFT	4K: 3840 8K: 7680
Number of Data Subcarriers per FFT	4K: 3801 – number of continuous pilot tones 8K: 7601– number of continuous pilot tones
Level	Adjustable. See Table 2.
Modulation Type	CLT shall support: QPSK, 16-QAM, 64-QAM, 128-QAM, 256-QAM, 512-QAM, 1024-QAM, 2048-QAM, 4096-QAM CLT may support 8192-QAM, 16384-QAM

Comment [JS3]: CM-SP-PHYv3.1-I01-131029 Table 7-36 and Table 7 – 39

New content and motioned items

Parameter	Value
Inband Spurious, Distortion, and Noise 528 MHz total occupied bandwidth, 6 MHz gap (Internal Excluded subcarriers) 88 equivalent 6 MHz CEA channels. See Notes 4,6	Allowable degradation: 1.5 dB
For measurements below 600 MHz	≤ -50 dBr Average over center 400 kHz subcarriers within gap
For measurements from 600 MHz to 1002 MHz	≤ -47 dBr Average over center 400 kHz subcarriers within gap
For measurements 1002 MHz to 1212 MHz	≤ -45 dBr Average over center 400 kHz subcarriers within gap
MER in 192 MHz OFDM channel occupied bandwidth 528 MHz total occupied bandwidth, 88 equivalent 6 MHz CEA channels. See Notes 2, 4, 5, 6	
For measurements below 600 MHz	≥ 48 dB Any single subcarrier. See Note 1 ≥ 50 dB Average over the complete OFDM channel. See Note 1
For measurements from 600 MHz to 1002 MHz	≥ 45 dB Any single subcarrier. See Note 1 ≥ 47 dB Average over the complete OFDM channel. See Note 1
For measurements 1002 MHz to 1212 MHz	≥ 43 dB Any single subcarrier. See Note 1 ≥ 45 dB Average over the complete OFDM channel. See Note 1 Minimal test receiver equalization: See note 7 2 dB relief for above requirements (e.g., MER > 48 dB becomes MER > 46 dB)
MER in 24 MHz OFDM channel occupied bandwidth, single OFDM channel only, 24 MHz total occupied spectrum: See notes 1, 2, 4, 8	
For measurements below 600 MHz	≥ 48 dB Average over the complete OFDM channel.
For measurements from 600 MHz to 1002 MHz	≥ 45 dB Average over the complete OFDM channel.
For measurements 1002 MHz to 1218 MHz	≥ 43 dB Average over the complete OFDM channel.

Parameter	Value
Phase noise, double sided maximum, Full power CW signal 1002 MHz or lower	1 kHz - 10 kHz: -48 dBc 10 kHz - 100 kHz: -56 dBc 100 kHz - 1 MHz: -60 dBc 1 MHz - 10 MHz: -54 dBc 10 MHz - 100 MHz: -60 dBc
Full power 192 MHz OFDM channel block with 6 MHz in center as Internal Exclusion subband + 0 dBc CW in center, with block not extending beyond 1002 MHz [CW not processed via FFT]	1 kHz - 10 kHz: -48 dBc 10 kHz - 100 kHz: -56 dBc
Full power 192 MHz OFDM channel block with 24 MHz in center as Internal Exclusion subband + 0 dBc CW in center, with block not extending beyond 1002 MHz [CW not processed via FFT]	100 kHz - 1 MHz: -60 dBc
Full power 192 MHz OFDM channel block with 30 MHz in center as Internal Exclusion subband + 7 dBc CW in center, with block not extending beyond 1002 MHz [CW not processed via FFT]	1 MHz - 10 MHz: -53dBc
Output Impedance	75 ohms
Output Return Loss (Note 3)	> 14 dB within an active output channel from 54 MHz to 750 MHz > 13 dB within an active output channel from 750 MHz to 870 MHz > 12 dB within an active output channel from 870 MHz to 1218 MHz > 12 dB in every inactive channel from 54 MHz to 870 MHz > 10 dB in every inactive channel from 870 MHz to 1218 MHz

Parameter	Value
Table Notes: 1. Receiver channel estimation is applied in the test receiver; test receiver does best estimation possible. Transmit windowing is applied to potentially interfering channel and selected to be sufficient to suppress cross channel interference 2. MER (modulation error ratio) is determined by the cluster variance caused by the transmit waveform at the output of the ideal receive matched filter. MER includes all discrete spurious, noise, subcarrier leakage, clock lines, synthesizer products, distortion, and other undesired transmitter products. Phase noise up to ±50 kHz of the subcarrier is excluded from inband specification, to separate the phase noise and inband spurious requirements as much as possible. In measuring MER, record length or carrier tracking loop bandwidth may be adjusted to exclude low frequency phase noise from the measurement. MER requirements assume measuring with a calibrated test instrument with its residual MER contribution removed. 3. Frequency ranges are edge-to-edge. 4. Phase noise up to 10 MHz offset is mitigated in test receiver processing or by test equipment (latter using hardline carrier from modulator, which requires special modulator test port and functionality). 5. Up to 5 subcarriers in one OFDM channel can be excluded from this requirement 6. The measured OFDM channel is allocated 204.8 MHz of spectrum which is free from the other OFDM channels which together comprise 528 MHz of occupied spectrum. 7. The estimated channel impulse response used by the test receiver is limited to half of length of smallest transmit cyclic prefix 8. A single subcarrier in the OFDM channel can be excluded from this requirement, no windowing is applied and minimum CP is selected.	

1.1.1.2.1 Power per Channel for CLT

Comment [JS4]: CM-SP-PHYv3.1-I01-131029 Section 7.5.9.1.1

New content

A CLT shall generate an RF output with power capabilities as defined in Table 2.

The CLT shall be capable of adjusting channel RF power on a per channel basis as stated in Table 2.

Table 2 - CLT Output Power

Comment [JS5]: CM-SP-PHYv3.1-I01-131029 Table 7-37

New content

Parameter	Value
Required power per channel for N_{eq}' channels combined onto a single RF port for $N_{eq}' \geq N_{eq}/4$:	Required power in dBmV per channel $60 - \text{ceil}\,[3.6*\log_2(N_{eq}')]$ dBmV
Required power per channel for $\boldsymbol{N_{eq}'}$ channels combined onto a single RF port for $4 \leq \boldsymbol{N_{eq}' < N_{eq}}/4$:	Required power in dBmV per channel $60 - \text{ceil}\,[3.6*\log2(N_{eq}'')]$ dBmV
Range of commanded transmit power per channel	≥ 8 dB below required power level specified below maintaining full fidelity over the 8 dB range
Range of commanded power per channel; adjusted on a per channel basis	CLT shall: 0 dBc to -2 dBc relative to the highest commanded transmit power per channel, within an 8 dB absolute window below the highest commanded power. May: *required power* (in table below) to *required power - 8 dB*, independently on each channel.
Commanded power per channel step size	≤ 0.2 dB Strictly monotonic
Power difference between any two adjacent channels in the 108-1212 MHz downstream spectrum (with commanded power difference removed if channel power is independently adjustable)	≤ 0.5 dB
Power difference between any two non-adjacent channels in a 48 MHz contiguous bandwidth block (with commanded power difference removed if channel power is independently adjustable)	≤ 1 dB

Parameter	Value
Power difference (normalized for bandwidth) between any two channels OFDM channel blocks in the 108 - 1212 MHz downstream spectrum (with commanded power difference removed if channel power is independently adjustable)	≤ 2 dB
Power per channel absolute accuracy	±2 dB
Diagnostic carrier suppression (3 modes) Mode 1: One channel suppressed Mode 2: All channels suppressed except one Mode 3: All channels suppressed	Mode 1: ≥ 50 dB carrier suppression within the occupied spectrum in any one active channel. CLT shall accomplish this without service impacting discontinuity or detriment to the unsuppressed channels. Mode 2: 50 dB carrier suppression within the occupied spectrum in every active channel except one. The suppression is not required to be glitchless, and the remaining unsuppressed active channel is allowed to operate with increased power such as the total power of the N' active channels combined. Mode 3: 50 dB carrier suppression within the occupied spectrum in every active channel. In all three modes the output return loss of the suppressed channel(s) shall comply with the Output Return Loss requirements for active channels given in Table 1. The total noise and spur requirement is the combination of noise power from the 50 dBc suppressed channel and the normal noise and spur requirement for the CLT output when operating with all channels unsuppressed.
RF output port muting	≥ 73 dB below the unmuted aggregate power of the RF modulated signal, in every 6 MHz CEA channel from 54 MHz to 1218 MHz. The specified limit applies with all active channels commanded to the same transmit power level. Commanding a reduction in the transmit level of any, or all but one, of the active channels does not change the specified limit for measured muted power in 6 MHz. The output return loss of the output port of the muted device shall comply with the Output Return Loss requirements for inactive channels given in Table 1.
Required power per channel for N_{eq}' channels combined onto a single RF port for $N_{eq}' \geq N_{eq}/4$:	Required power in dBmV per channel $60 - \text{ceil}\,[3.6*\log_2(N_{eq}')]$ dBmV
Required power per channel for $\boldsymbol{N_{eq}'}$ channels combined onto a single RF port for $4 \leq \boldsymbol{N_{eq}'} < \boldsymbol{N_{eq}}/4$:	Required power in dBmV per channel, $60 - \text{ceil}\,[3.6*\log2(N_{eq}'')]$ dBmV

1.1.1.2.2 Out-of-Band Noise and Spurious Requirements for the CLT

Comment [JS6]: CM-SP-PHYv3.1-I01-131029 Section 7.5.9.1.2

New content

Table 1 lists the out-of-band spurious requirements. In cases where the *N'* combined channels are not commanded to the same power level, "dBc" denotes decibels relative to the strongest channel among the active channels. When commanded to the same power level, "dBc" should be interpreted as the average channel power, averaged over the active channels, to mitigate the variation in channel power across the active channels (see Table 2), which is allowed with all channels commanded to the same power.

The CLT modulator shall satisfy the out-of-band spurious emissions requirements of Table 3 in measurements below 600 MHz and outside the encompassed spectrum when the active channels are contiguous or when the ratio of modulated spectrum to gap spectrum within the encompassed spectrum is 4:1 or greater.

The CLT modulator shall satisfy the out-of-band spurious emissions requirements of Table 3, with 1 dB relaxation, in measurements within gaps in modulated spectrum below 600 MHz and within the encompassed spectrum when the ratio of modulated spectrum to gap spectrum within the encompassed spectrum is 4:1 or greater.

The CLT modulator shall satisfy the out-of-band spurious emissions requirements of Table 3, with 3 dB relaxation, when the ratio of modulated spectrum to gap spectrum within the encompassed spectrum is 4:1 or greater, in measurements with 603 MHz ≤ center frequency ≤ 999 MHz, outside the encompassed spectrum or in gap channels within the encompassed spectrum.

The CLT modulator shall satisfy the out-of-band spurious emissions requirements of Table 3, with 5 dB relaxation, when the ratio of modulated spectrum to gap spectrum within the encompassed spectrum is 4:1 or greater, in measurements with 999 MHz < center frequency ≤ 1209 MHz, outside the encompassed spectrum or in gap channels within the encompassed spectrum.

The CLT modulator shall satisfy the out-of –band spurious emissions requirements of Table 3, in addition to contributions from theoretical transmit windowing, with permissible configurations of lower edge and upper edge subband exclusions of at least 1 MHz each, FFT Size, cyclic prefix length (N_{cp}) and windowing roll-off period (N_{rp}) values. The test limit for determining compliance to the spurious emissions requirements is the power sum of the spurious emissions requirements taken in accordance with Table 3; and the contributions from the theoretical transmit windowing for the configured transmissions.

When the N_{eq}' combined active channels are not contiguous, and the ratio of modulated spectrum to gap spectrum within the encompassed spectrum is 4:1 or greater, the spurious emissions requirements are determined by summing the spurious emissions power allowed in a given measurement bandwidth by each of the contiguous sub-blocks among the occupied spectrum. In the gap channels within the encompassed spectrum and below 600 MHz there is a 1 dB relaxation in the spurious emissions requirements, so that within the encompassed spectrum the spurious emissions requirements (in absolute power) are 26% higher power in the measurement band determined by the summing of the contiguous sub-blocks' spurious emissions requirements. In all channels above 600 MHz there is a 3 dB relaxation in the spurious emissions requirements, so that the spurious emissions requirements (in absolute power) are double the power in the measurement band determined by the summing of the contiguous sub-blocks' spurious emissions requirements. The following three paragraphs provide the details of the spurious emissions requirements for non-contiguous channel operation outside the encompassed spectrum; within the encompassed spectrum the same details apply except there is an additional 1 dB allowance below 600 MHz; and 3 dB allowance is applied above 600 MHz for all channels.

The full set of N_{eq}' channels is referred to throughout this specification as the modulated channels or the active channels. However, for purposes of determining the spurious emissions requirements for non-contiguous transmitted channels, each separate contiguous sub-block of channels within the active channels is identified, and the number of channels in each contiguous sub-block is denoted as N_{eqi}, for i = 1 to K, where K is the number of contiguous sub-blocks. Therefore, $N_{eq}' = \sum_{i=1 \text{ to } k} N_{eqi}$. Note that K = 1 when and only when the entire set of active channels is contiguous. Also note that an isolated transmit channel, i.e., a transmit channel with empty adjacent channels, is described by $N_i = 1$ and constitutes a sub-block of one contiguous channel. Any number of the "contiguous sub-blocks" may have such an isolated transmit channel; if each active channel was an isolated channel, then K = N'.

When $N_{eq}' \geq N_{eq}/4$, Table 3 is used for determining the noise and spurious power requirements for each contiguous sub-block, even if the sub-block contains fewer than $N_{eq}/4$ active channels. When $N_{eq}' < N_{eq}/4$, Table 3 is used for determining the noise and spurious power requirements for each contiguous sub-block. Thus, the noise and spurious power requirements for all contiguous sub-blocks of transmitted channels are determined from Table 3, where the

applicable table is determined by N_{eq}' being greater than or equal to $N_{eq}/4$, or not. The noise and spurious power requirements for the i[th] contiguous sub-block of transmitted channels is determined from Table 3 using the value N_i for the "number of active channels combined per RF port", and using "dBc" relative to the highest commanded power level of a 6 MHz equivalent channel among all the active channels, and not just the highest commanded power level in the i[th] contiguous sub-block, in cases where the N_{eq}' combined channels are not commanded to the same power. The noise and spurious emissions power in each measurement band, including harmonics, from all K contiguous sub-blocks, is summed (absolute power, NOT in dB) to determine the composite noise floor for the non-contiguous channel transmission condition.

For the measurement channels adjacent to a contiguous sub-block of channels, the spurious emissions requirements from the non-adjacent sub-blocks are divided on an equal "per Hz" basis for the narrow and wide adjacent measurement bands. For a measurement channel wedged between two contiguous sub-blocks, adjacent to each, the measurement channel is divided into three measurement bands, one wider in the middle and two narrower bands each abutting one of the adjacent transmit channels. The wideband spurious and noise requirement is split into two parts, on an equal "per Hz" basis, to generate the allowed contribution of power to the middle band and to the farthest narrowband. The ceiling function is applied to the resulting sum of noise and spurious emissions, per Note 1 of Table 3 to produce a requirement of ½ dB resolution.

Items 1 through 4 list the requirements in channels adjacent to the commanded channels.

Item 5 lists the requirements in all other channels further from the commanded channels. Some of these "other" channels are allowed to be excluded from meeting the Item 5 specification. All the exclusions, such as 2[nd] and 3[rd] harmonics of the commanded channel, are fully identified in the table.

Item 6 lists the requirements on the $2N'$ 2[nd] harmonic channels and the $3N'$ 3[rd] harmonic channels.

Table 3 - CLT Output Out-of-Band Noise and Spurious Emissions Requirements

Comment [JS7]: CM-SP-PHYv3.1-I01-131029 Table 7-38

New content

for $N^* \equiv \begin{cases} minimum[4N_{eq}', ceiling\left[\frac{N_{eq}'}{4}\right]], & N_{eq}' < N_{eq}/4 \\ N_{eq}', & N_{eq}' \geq N_{eq}/4 \end{cases}$, Adjusted Number of Active Channels Combined per RF Port		
	Band	**Requirement (in dBc)**
1	Adjacent channel up to 750 kHz from channel block edge	For N* = 1, 2, 3, 4: ≤ -58; For N* ≥ 5: ≤ $10*\log_{10}[10^{-58/10}+(0.75/6)*(10^{-65/10}+(N*-2)*10^{-73/10})]$
2	Adjacent channel (750 kHz from channel block edge to 6 MHz from channel block edge)	For N* = 1: ≤ -62; For N* ≥ 2: ≤ $10*\log_{10}[10^{-62/10}+(5.25/6)*(10^{-65/10}+(N*-2)*10^{-73/10})]$
3	Next-adjacent channel (6 MHz from channel block edge to 12 MHz from channel block edge)	≤ $10*\log_{10}[10^{-65/10}+(N*-1)*10^{-73/10}]$
4	Third-adjacent channel (12 MHz from channel block edge to 18 MHz from channel block edge)	For $N*$ = 1: ≤ -73; For $N*$ = 2: ≤ -70; For $N*$ = 3: ≤ -67; For $N*$ = 4: ≤ -65; For $N*$ = 5: ≤ -64.5; For $N*$ = 6, 7: ≤ -64; For $N*$ ≥ 8: ≤ $-73 + 10*\log_{10}(N*)$

for $N^* \equiv \begin{cases} minimum[4N_{eq}', ceiling\left[\frac{N_{eq}'}{4}\right]], & N_{eq}' < N_{eq}/4 \\ N_{eq}', & N_{eq}' \geq N_{eq}/4 \end{cases}$, Adjusted Number of Active Channels Combined per RF Port		
	Band	**Requirement (in dBc)**
5	Noise in other channels (47 MHz to 1218 MHz) Measured in each 6 MHz channel excluding the following: a) Desired channel(s) b) 1st, 2nd, and 3rd adjacent channels (see Items 1, 2, 3, 4 in this table) c) Channels coinciding with 2nd and 3rd harmonics (see Item 6 in this table)	For *N** = 1: ≤ -73; For *N** = 2: ≤ -70; For *N** = 3: ≤ -68; For *N** = 4: ≤ -67; For *N** ≥ 5: ≤ -73 + 10*log$_{10}$ (*N**)
6	In each of 2N' contiguous 6 MHz channels or in each of 3N' contiguous 6 MHz channels coinciding with 2nd harmonic and with 3rd harmonic components respectively (up to 1218 MHz)	≤ -73 + 10*log$_{10}$(*N**) dBc, or -63, whichever is greater
7	Lower out of band noise in the band of 5 MHz to 47 MHz Measured in 6 MHz channel bandwidth	≤ -50 + 10*log$_{10}$(*N**)
8	Higher out of band noise in the band of 1218 MHz to 3000 MHz Measured in 6 MHz channel bandwidth	For *N** ≤ 8: ≤ -55 + 10*log$_{10}$(*N**) For *N** > 8: ≤ -60 + 10*log$_{10}$(*N**)

Table Notes

1. All equations are Ceiling(Power, 0.5) dBc. Use "Ceiling(2*Power) / 2" to get 0.5 steps from ceiling functions that return only integer values. For example Ceiling(-63.9, 0.5) = -63.5 dBc.
2. Add 3 dB relaxation to the values specified above for noise and spurious emissions requirements in all channels with 603 MHz ≤ center frequency ≤ 999 MHz. For example -73 dBc becomes -70 dBc.
   Add 5 dB relaxation to the values specified above for noise and spurious emissions requirements in all channels with 999 MHz < center frequency ≤ 1209 MHz . For example -73 dBc becomes -68 dBc.
3. Add 1 dB relaxation to the values specified above for noise and spurious emissions requirements in gap channels with center frequency below 600 MHz. For example -73 dBc becomes -72 dBc.

1.1.1.2.3 Independence of individual channel within the multiple channels on a single RF port

TBD

1.1.2 CNU Receiver Input Requirements

The CNU shall be able to accept any range of OFDM subcarriers defined for the CLT transmitter in Table 1 - CLT RF Output Requirements. Active subcarrier frequencies, loading, and other OFDM characteristics are described by OFDM configuration settings and CNU exclusion bands and profile definition. The OFDM signals and CNU interfaces will have the characteristics and limitations defined in Table 4.

Table 4 - Electrical Input to CNU

Parameter	Value
Variable Bit Loading	MUST support with subcarrier granularity MUST support zero bit loaded and zero valued subcarriers
Total Input Power	< 40 dBmV, 54 MHz – 1.794 GHz ** Assuming negligible power outside this range*
Level Range (24 MHz min occupied BW)	-9 dBmV/24 MHz -21 dBmV/24 MHz

Comment [JS8]: CM-SP-PHYv3.1-I01-131029 Section 7.5.10.1.1

See the D3.1 PHY specification; need to determine what we would like to include for EPoC

Comment [JS9]: CM-SP-PHYv3.1-I01-131029 7.5.11

New and motioned itesm

Comment [JS10]: CM-SP-PHYv3.1-I01-131029 Table 7-40

New and motioned items

Parameter	Value
Maximum average power of any 24 MHz input to the CNU from 54 MHz to 1218 MHz OR From 258 MHz to 1.794 GHz	Let **X** = Average power of lowest power 24 MHz BW for demodulation Additional Demodulated Bandwidth, B_{remond} : ≤ Min [**X** + 10 + 10*log(**B**$_{remond}$/24) ; 21+ 10*log(**B**$_{remond}$/24)] Additional Non-Demodulated Bandwidth, $B_{no\text{-}demod}$: ≤ Min [**X** + 10 + 10*log(**B**$_{no\text{-}demod}$/24) ; 26+ 10*log(**B**$_{no\text{-}demod}$/24)] For up to 12 MHz of occupied bandwidth (analog, OOB, QAM, OFDM) ≤ Min [**X** + 10 + 10*log(**B**$_{no\text{-}demod}$/24) ; 21+ 10*log(**B**$_{no\text{-}demod}$/24)] for all remaining bandwidth Level range does not imply anything about BER performance or capability vs. QAM. CM BER performance is separately described.
Input Impedance	75 ohms
Input Return Loss	> 6 dB (258 MHz – 1218 MHz) > 6 dB (108 MHz – 1218 MHz) Note: Applies when lower frequency boundary is 108 MHz > 6 dB (258 MHz – 1.794 GHz) Note: Applies when upper frequency boundary is 1.794 GHz

1.1.3 CNU Receiver Capabilities

Comment [JS11]: CM-SP-PHYv3.1-I01-131029 Section 7.5.12

New content

The required level for CNU downstream post-FEC error rate is defined as less than or equal to 10-6 PER (packet error ratio) with 1500 byte Ethernet packets. This section describes the conditions at which the CNU is required to meet this error rate.

1.1.3.1 CNU Error Rate Performance in AWGN Channel

Comment [JS12]: CM-SP-PHYv3.1-I01-131029 Section 7.5.12.1

New content

Implementation loss of the CNU shall be such that the CNU achieves the required error rate when operating at a CNR as shown in Table 5, under input load and channel conditions as follows:

- Any valid transmit combination (frequency, subcarrier clock frequency, transmit window, cyclic prefix, pilot, PLC, subcarrier exclusions, interleaving depth, multiple modulation profile configuration, etc.) as defined in this spec.
- P6AVG (the measured channel power divided by number of occupied CEA channels) ≤ 15 dBmV.
- Up to fully loaded spectrum of 54 - 1212 MHz for FDD and 10 – 1800 MHz for TDD.
- Power in (both above and below) 4 adjacent 6 MHz channels ≤ P6AVG+3 dB.
- Power in any 6 MHz channel over the spectrum ≤ P6AVG+6 dB.
- Peak envelope power in any analog channel over the spectrum ≤ P6AVG+6 dB
- Average power per channel across spectrum ≤ P6AVG+3 dB.
- OFDM channel phase noise as in CLT spec.
- No other artifacts (reflections, burst noise, tilt, etc.).

Table 5 - CM Minimum CNR Performance in AWGN Channel

Comment [JS13]: CM-SP-PHYv3.1-I01-131029 Table 7-41

Constellation	CNR[1,2] (dB) Up to 1 GHz	CNR[1,2] (dB) 1 GHz to 1.2 GHz	Min P_{6AVG} dBmV
4096	41.0	41.5	-6
2048	37.0	37.5	-9
1024	34.0	34.0	-12
512	30.5	30.5	-12
256	27.0	27.0	-15
128	24.0	24.0	-15
64	21.0	21.0	-15
16	15.0	15.0	-15

Table Notes:

1. CNR is defined here as total signal power in occupied bandwidth divided by total noise in occupied bandwidth
2. Channel CNR is adjusted to the required level by measuring the source inband noise including phase noise component and adding the required delta noise from an external AWGN generator
3. Applicable to an OFDM channel with 192 MHz of occupied spectrum