

PMA Exclusion Rules

Technical decisions made

TD	US/DS	Text of motion	Notes	Disp
TD#5	B	Support exclusion of one or more OFDM subcarriers.	Included in Proposal	P
TD#14	B	Exclusion sub-bands can be on the lower portion of the OFDM channel, the upper OFDM channel, or within the OFDM channel.	Included in Proposal	P
Td#24	US	The supported RF bandwidth of an upstream channel shall be 192 MHz. The definition of exclusion bands shall allow for smaller channels when there is not 192 MHz of spectrum available.	Included in Proposal	P
TD#55	B	Move to define Exclusion Sub-band as a set of k adjacent subcarriers indexed [m, m+1,... m+k-1], which are configured to have zero amplitude.	Included in Proposal without individual excluded subcarriers	P
TD#56	B	Move to define two different types of exclusion sub-bands: - Internal exclusion sub-bands - Band edge exclusion sub-bands [and] to define two different types of individual exclusion subcarriers: - individual exclusion subcarriers which have zero amplitude - individual exclusion subcarriers which are pilots	Included in Proposal Except "individual exclusion subcarriers which are pilots". Pilots are well defined and should be separate from Exclusion bands (imho)	PA
TD#57	B	Move that the standard will support support 2 separate downstream band-edge exclusion sub-bands, in a single 192 MHz OFDM Channel, in the transmitted signal.	Included in Proposal	P
TD#58	B	Move that the minimum width of a downstream internal exclusion sub-band is 1 MHz.	Included in Proposal without individual excluded subcarriers	P
TD#59	B	Move that the standard shall support a fixed integer number of internal exclusion sub-bands, in a single 192 MHz OFDM channel, in the transmitted signal.	Included in Proposal without individual excluded subcarriers (2 "Band Edge" and 14 internal for a total of 16)	P
TD#69	B	An exclusion sub-band is characterized by a start sub-carrier index and an integer number of sub-carriers.	Not included, All subcarriers are configured via the 10GPASS-XR US/DS profile descriptor registers	E
TD#70	DS	In the downstream an exclusion sub-band shall be mappable onto any of the OFDM subcarriers within an OFDM channel, with the restriction that there is at least one modulated subcarrier between exclusion sub-bands.	Included in Proposal except 1 SC between exclusion bands. Is this useful?	PA
TD#71	DS	In the downstream, there shall be at most 16 exclusion sub-bands in a single 192-MHz OFDM channel.	Included in Proposal without individual excluded subcarriers	P
TD#110	DS	Adopt laubach_3bn_04c_1113.pdf as a baseline starting point for EPoC downstream.	Included in Proposal Applicable rules copied below	P

Disposition codes:

E Excluded

P Proposed
PA Partially Proposed

Excerpt from Laubach_3bn_04c_1113

1.2.1.6 Downstream Exclusion Band Rules

<ul style="list-style-type: none">There has to be at least one contiguous modulated OFDM bandwidth of 22 MHz or greater, which will enable an OFDM channel bandwidth of 24 MHz including guardbands.	Included
<ul style="list-style-type: none">Exclusion bands separate contiguous modulation bands.	Excluded (definition)
<ul style="list-style-type: none">The minimum contiguous modulation band has to be 2 MHz.	Included
<ul style="list-style-type: none">Exclusion bands and individually excluded subcarriers are common to all downstream profiles.	Included
<ul style="list-style-type: none">Exclusion bands are a minimum of 1 MHz but increment above 1 MHz by granularity of individual subcarrier (25 kHz for 8k FFT and 50 kHz for 4K FFT).	Included
<ul style="list-style-type: none">Exclusion bands plus individually excluded subcarriers are limited to 20% or less of spanned modulation spectrum, where the spanned modulation spectrum is defined as: frequency of maximum active subcarrier – frequency of minimum active subcarrier.	Included
<ul style="list-style-type: none">The number of individually excluded subcarriers is limited by the following:	
<ul style="list-style-type: none"><ul style="list-style-type: none">The total spectrum of individually excluded subcarriers cannot exceed 5% of any contiguous modulation spectrum.	Conflicts with 1 MHz rule
<ul style="list-style-type: none"><ul style="list-style-type: none">The total spectrum of individually excluded subcarriers cannot exceed 5% of a 6 MHz moving window across the contiguous modulation spectrum.	Included
<ul style="list-style-type: none"><ul style="list-style-type: none">The total spectrum of individually excluded subcarriers cannot exceed 20% of a 1 MHz moving window across the contiguous modulation spectrum.	Included
<ul style="list-style-type: none">The 6 MHz of contiguous spectrum reserved for the PLC cannot have any exclusion bands or excluded subcarrier.	See 102.2.1.1

Proposed Text based on all TD's

Definition of terms may be added to CI 1.4.x

active subcarrier: any subcarrier that is not excluded.

contiguous spectrum: a group of subcarriers that all; a) have an assigned modulation order of QPSK or (2^N) QAM, where $4 \leq n \leq 16$, b) are all null, or c) are all excluded.

Note that this definition precludes use of the term to refer to a band or window that has one or more excluded subcarriers.

Here is a dictionary definition of contiguous (<http://www.merriam-webster.com/dictionary/contiguous>):

- 1 : being in actual contact : touching along a boundary or at a point*
- 2 of angles : adjacent*
- 3 : next or near in time or sequence*
- 4 : touching or connected throughout in an unbroken sequence*

exclusion band: a portion of spectrum, 1 MHz (20 subcarriers) or more in width, that contains only excluded subcarriers

encompassed spectrum: the frequency difference between the highest frequency active subcarrier and the lowest frequency active subcarrier in a single 192 MHz RF Channel

This is defined well in 100.2.8.1

Insert new text and sub-sections in 101.4.2.3 as below.

101.4.2 Downstream PMA transmit function

101.4.2.3 Subcarrier configuration and bit loading

Each subcarrier in an OFDM channel is configured using the DS_ModTypeSCn variables (where $0 \leq n \leq 4095$). These variables allow the Phy to configure each subcarrier to be nulled, to be a continuous pilot, to have a specific bit loading (such as 512-QAM or 1024-QAM), or to be Excluded. Subcarriers that are not configured as excluded are active subcarriers. Subcarrier configuration in an EPoC RF Channel of 192 MHz shall conform to the rules outlined in Table 101-x.

All devices in an EPoC network share the same downstream subcarrier configuration and bit loading including nulled subcarriers, continuous pilots, bit loaded subcarriers and excluded subcarriers.

Table 101-x Downstream subcarrier configuration rules

Parameter	Limit	Unit
Minimum number of active subcarriers in a contiguous group	40	SC
Minimum number of contiguous active subcarrier bands of 22 MHz or greater in width (1)	1	
Minimum OFDM channel guard band (3)	1	MHz
Maximum excluded spectrum in the encompassed spectrum	20	%
Total individually excluded spectrum in any window, 6 MHz or greater in width, not	5	%

including any portion of an exclusion band (2)		
Total individually excluded spectrum in any window 1 MHz in width not including any portion of an exclusion band (2)	20	%
Max OFDM channel encompassed spectrum (3)	TBD	MHz

Notes:

1) this is also specified in Table 100–1—CLT RF output requirements as Minimum Active Signal Bandwidth, do we need both definitions???

2) the last two rules regarding individually excluded spectrum would not be included if disallowing individually excluded subcarriers.

3) not sure this is needed, may be better elsewhere (CI 100?)

101.4.2.3.1 Nulled subcarriers

Nulled subcarriers do not carry MAC or PHY Link data but may be used as pilots. Nulled subcarriers are not modulated except when being used as a scattered pilot in the downstream direction (see 101.4.2.5.1).

101.4.2.3.2 Continuous pilots

In the downstream direction continuous pilots are used to help delineate the downstream PHY Link (see 101.4.2.5.2).

101.4.2.3.3 Bit loaded subcarriers

When a subcarrier is used to carry MAC data it uses the modulation type of QPSK or 2^n -QAM, where $4 \leq n \leq 16$, assigned via the DS_ModTypeSCn or US_ModTypeSCn variables except when used as:

- a downstream scattered Pilot (see 101.4.2.5.1),
- *any other cases?*

There is at least one contiguous 22 MHz or greater band of subcarriers with an assigned bit loading in any single 192 MHz RF Channel. This may include subcarriers intended as Pilots and PHY Link subcarriers. A 1 MHz guardband of excluded subcarriers above and below this 22 MHz creates a minimum width OFDM channel of 24 MHz encompassed spectrum.

Note this prohibits nulled SCs in this 24 MHz band. An alternative would be: “There is at least one contiguous 22 MHz or greater band of active subcarriers in any single 192 MHz RF Channel”.

The text below does not include individually excluded carriers as this concept was never discussed in the TF that I can recall.

101.4.2.3.4 Excluded subcarriers

EPoC devices shall not transmit energy into a subcarrier that has been excluded from the RF Channel (i.e, excluded subcarriers have zero amplitude). Typically there is a Band Edge Exclusion Band at both the top and bottom of the RF channel and there may be up to 14 exclusion bands internal to a single 192 MHz RF channel.

Exclusion bands are limited to 20% or less of encompassed spectrum (see Table 101-x).

Suggested text for 101.4.2.3.4 if we wish to include individually excluded subcarriers (included in Table 101-x).

101.4.2.3.4 Excluded subcarriers

EPoC devices shall not transmit energy into a subcarrier that has been excluded from the RF Channel (i.e, excluded subcarriers have zero amplitude). Typically there is a contiguous group of excluded subcarriers at both the top and bottom of a single 192 MHz RF channel. The percent of excluded spectrum in the encompassed spectrum is limited per Table 101-x.

101.4.3 Upstream PMA transmit function

Modify title of 101.4.3.3 as shown below

101.4.3.3 OFDMA frame configuration and ~~bit loading~~ burst transmission

Replace 101.4.3.4 Frame timing with title and text as shown below.

101.4.3.4 Subcarrier configuration and bit loading

Each subcarrier in the OFDMA channel is configured using the US_ModTypeSCn (where $0 \leq n \leq 4095$) or TBD (variable for pilot pattern definition) variables. These variables allow the Phy to configure each subcarrier to be nulled, to have a specific bit loading (such as 512-QAM or 1024-QAM), or to be Excluded and to define the pilot pattern to be used in upstream transmissions. Subcarriers that are not configured as excluded are active subcarriers. Subcarrier configuration in an EPoC RF Channel of 192 MHz shall conform to the rules outlined in Table 101-y.

All devices in an EPoC network share the same upstream subcarrier configuration and bit loading including nulled subcarriers, pilot pattern, bit loaded subcarriers and excluded subcarriers.

Table 201-y Upstream subcarrier configuration rules

Parameter	Limit	Unit
Minimum number of active subcarriers in a contiguous group	40	SC
Minimum number of contiguous active subcarrier bands of TBD MHz or greater in width (1)	1	
Minimum OFDM channel guard band (3)	1	MHz
Maximum excluded spectrum in the encompassed spectrum	TBD	%
Total individually excluded spectrum in any window, 6 MHz or greater in width, not including any portion of an exclusion band (2)	TBD	%
Total individually excluded spectrum in any window 1 MHz in width not including any portion of an exclusion band (2)	TBD	%
Max OFDM channel encompassed spectrum (3)	TBD	MHz

Notes:

1) this is also specified in Table 100–1—CLT RF output requirements as Minimum Active Signal Bandwidth, do we need both definitions???

2) the last two rules regarding individually excluded spectrum would not be included if disallowing individually excluded subcarriers.

3) not sure this is needed, may be better elsewhere (CI 100?)

101.4.3.4.1 Nulled subcarriers

Nulled subcarriers do not carry MAC or PHY Link data but may be used as pilots or probes. Nulled subcarriers are not modulated except when being used as a pilot or Probe symbol in the upstream direction (see 102.4.3).

In the above para I used the term Probe symbol although we've decided in San Diego that the Probe is a 5-6 symbol period. Do we want to change Probe symbol to something else?

101.4.3.4.2 Bit loaded subcarriers

When a subcarrier is used to carry MAC data it uses the modulation type of QPSK or 2^n -QAM, where $4 \leq n \leq 16$, assigned via the US_ModTypeSCn variables except when used as:

- an upstream pilot (see 101.4.3.7),
- an upstream Probe, PHY Discovery Response, or Fine Ranging Response (see 102.4), or
- an upstream burst marker (see 101.4.3.8).
- *any other cases?*

There is at least one contiguous TBD MHz or greater band of subcarriers with an assigned bit loading in any single 192 MHz RF Channel. This may include subcarriers intended as Pilots and PHY Link subcarriers. A 1 MHz guardband of excluded subcarriers above and below this TBD MHz creates a minimum width OFDM channel of TBD MHz encompassed spectrum.

Note this prohibits nulled SCs in this band. An alternative would be: "There is at least one contiguous 22 MHz or greater band of active subcarriers in any single 192 MHz RF Channel".

The text below does not include individually excluded carriers as this concept was never discussed in the TF that I can recall.

101.4.2.3.4 Excluded subcarriers

EPoC devices shall not transmit energy into a subcarrier that has been excluded from the RF Channel (i.e, excluded subcarriers have zero amplitude). Typically there is a Band Edge Exclusion Band at both the top and bottom of the RF channel and there may be up to 14 exclusion bands internal to a single 192 MHz RF channel.

Exclusion bands are limited to TBD% or less of encompassed spectrum (see Table 101-y).

Suggested text for 101.4.2.3.4 if we wish to include individually excluded subcarriers (included in Table 101-x).

101.4.2.3.4 Excluded subcarriers

EPoC devices shall not transmit energy into a subcarrier that has been excluded from the RF Channel (i.e, excluded subcarriers have zero amplitude). Typically there is a contiguous group of excluded subcarriers at both the top and bottom of a single 192 MHz RF channel. The percent of excluded spectrum in the encompassed spectrum is limited per Table 101-x.