MoCA 2.0/2.5 Specification for Device RF Characteristics

20160808

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1 MoCA 2.0/2.5 Specification - Introduction and Scope

1.1 *Scope*

This document summarizes several technical specifications for operation of Multimedia Over Coax Alliance (MoCA) 2.0 and 2.5 devices ("nodes") using in-home coaxial wiring for transport of multimedia content: MoCA Frequency Plan, Connector and Return Loss, Maximum Total Output Power, MoCA Transmitter Spectral Mask, MoCA 2.0 RF Mode Transmitter Spurious Output, Receiver Minimum Sensitivity, Coexistence with Other Signals, Sensitivity to ATSC Interference, and Non-Transmit Spurious and Noise Emissions.

1.2 *Introduction*

The MoCA system network model creates a coax network which supports communications between a convergence layer in one MoCA node to the corresponding convergence layer in another MoCA node. All MoCA 2.0 and 2.5 devices also comply with all of the specifications for MoCA 1.0 and 1.1 devices. When MoCA 1.0 or 1.1 devices are present in the same network as MoCA 2.0 and 2.5 devices, all communication between MoCA 1 devices and MoCA 2.0 and 2.5 devices uses MoCA 1 protocols. In the same network MoCA 2.0 and 2.5 devices communicate with other MoCA 2 devices using MoCA 2 protocols.

MoCA 2 MAC supersedes MoCA 1.1 with a set of new features. The new features improve MAC efficiency for higher throughput and overall system performance. MoCA 2 offers seamless interoperability with MoCA 1 legacy nodes. MoCA 2.5 adds new management features and PHY rates to MoCA 2.0.

1.3 *Abbreviations*

Table 1-1. Table of Abbreviations

Term	Stands for
ACMT	Adaptive Constellation Multi-tone
ECL	Ethernet Convergence Layer
FSK	Frequency Shift Keying
ISDB-T	Integrated Services Digital Broadcasting Terrestrial
LNB	Low Noise Block down-converter
MAC	Media Access Control
MoCA	Multimedia over Coax Alliance
OSP	Operator-Service Provider
PHY	Physical Layer
RBW	Resolution Bandwidth
SWM	Single Wire Multi-switch
TPC	Transmit Power Control
VBW	Video Bandwidth

1.4 *Definitions*

Bonded-PHY - A transmission mode where two MoCA 2.0 PHYs or two to five MoCA 2.5 PHYs are bonded under control by a single MAC.

Flat Channel – A MoCA channel with power magnitude variation of less than 4.5 dB and group-delay variation of less than 2 ns across any MoCA channel with no added noise, interference, or multipath.

1.5 *Physical Network Model*

Typical in-home coaxial networks are configured as a branching tree topology. The point of connection to the first splitter is called the Root Node. The MoCA nodes inside the home communicate with each other by having their signals traverse across one or more splitters. The signal path transmission between two MoCA nodes is the superposition of several individual paths. Each individual signal path may have a different magnitude and delay resulting in an aggregate signal path with frequency nulls, large attenuation, and significant delay spread. The MoCA Network will operate under these channel conditions.

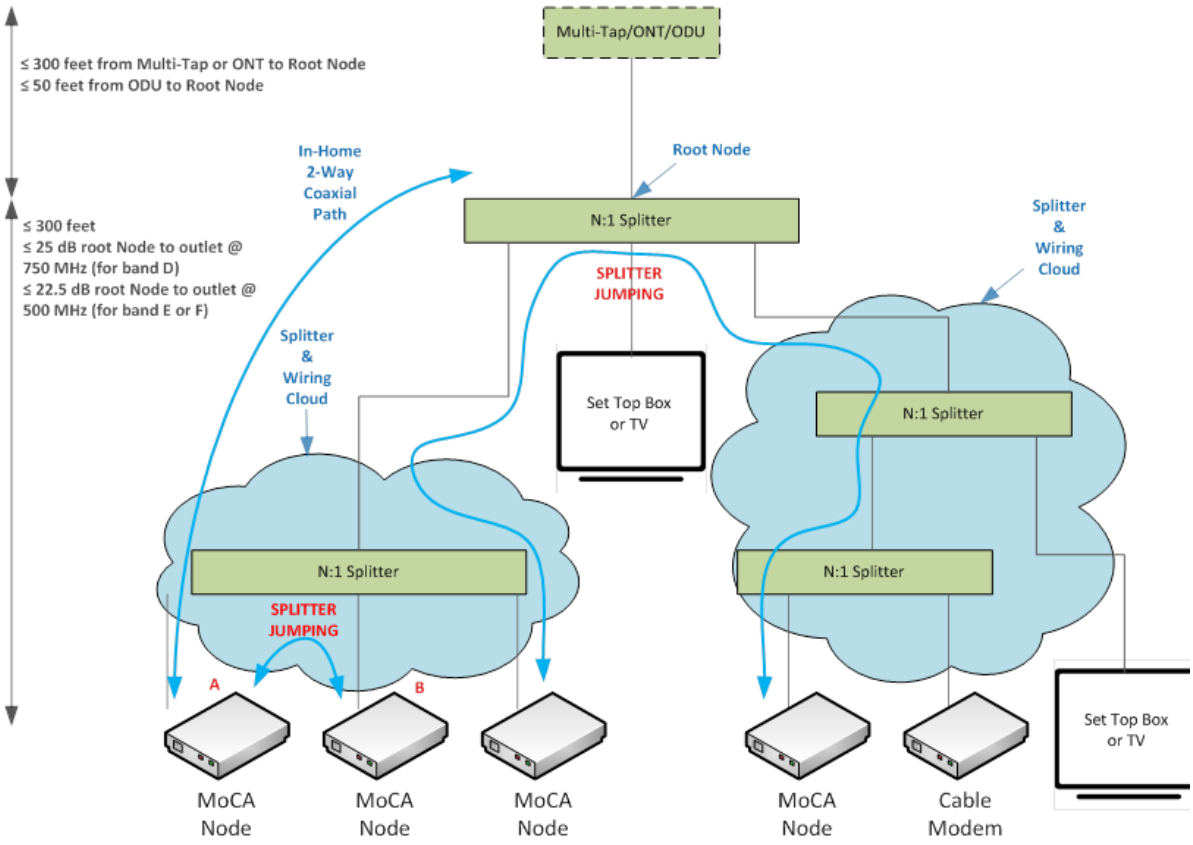

Figure 1-1: A Typical In-home MoCA Network

2 MoCA 2.0 and MoCA 2.5 Reference Specification

2.1 *MoCA Frequency Plan*

The following subsections define the bands of operation supported by the MoCA specification.

The specified requirements are referenced at the F-connector at the output of any filter required by the device for proper operation. A minimum network isolation of 9 dB (5 dB minimum splitter isolation + 4 dB minimum cable loss, representing a worst case condition) is assumed between the F-connector of MoCA 2.0 device and any other device on the network.

2.1.1 MoCA 2.0 Extended Band D Frequency Plan

This section specifies the frequency plan for MoCA 2.0 single and bonded-pair channels operation in extended band D (ExD). The extended band D is defined between 1125 MHz and 1675 MHz (550 MHz wide), and extends the high frequency of the existing MoCA 1 band D by 150 MHz. Primary Channels (100 MHz BW) in extended band D are centered on a 25 MHz grid. Bonded-pair channels (225 MHz BW) have a fixed 25 MHz gap between them and tune together as a block where both the Primary Channel and Secondary Channels are centered on the 25 MHz grid.

The MoCA 2.0 frequency plan defines, within the new extended band D, two sub-bands for independent network operation. These sub-bands comprise the D-low and D-high, as follows:

Sub-band D-Low (DL): 1125 to 1225 MHz edge to edge (100 MHz wide)

Sub-band D-High (DH): 1350 to 1675 MHz edge to edge (325 MHz wide)

Guard-band between sub-bands: 1225 to 1350 MHz (125 MHz wide)

Figure 2-1 illustrates the MoCA 2.0 frequency plan in extended band D when a single network is configured in the band. Figure 2-2 illustrates the MoCA 2.0 frequency plan in extended band D in order to support two MoCA Networks in the band. Table 2-1 specifies the allowed center frequencies of the Primary Channel, Secondary Channel, and Beacon Channel, in the extended band D as well as the center frequencies which apply to sub-bands D-Low and D-High.

This frequency plan provides for:

- Single channel or bonded-pair channels operation in extended band D
- Two independent networks on shared RF medium
    - Network 1: Single (non-bonded-pair) channel operating in sub-band D-Low
    - Network 2: Single channel or 2 bonded-pair channels in sub-band D-High
- Mixed Mode operation anywhere within the extended band D

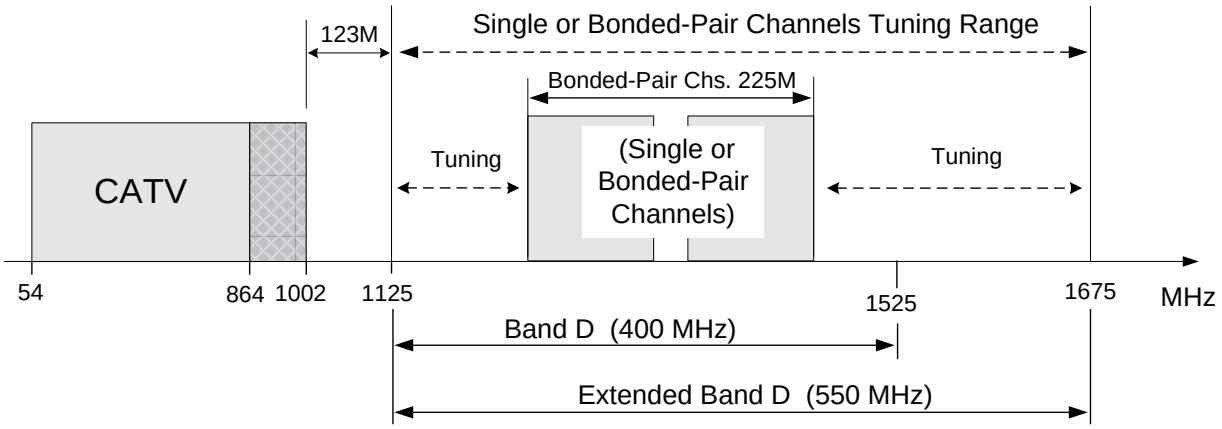

Figure 2-1. MoCA 2.0 Extended Band D Frequency Plan

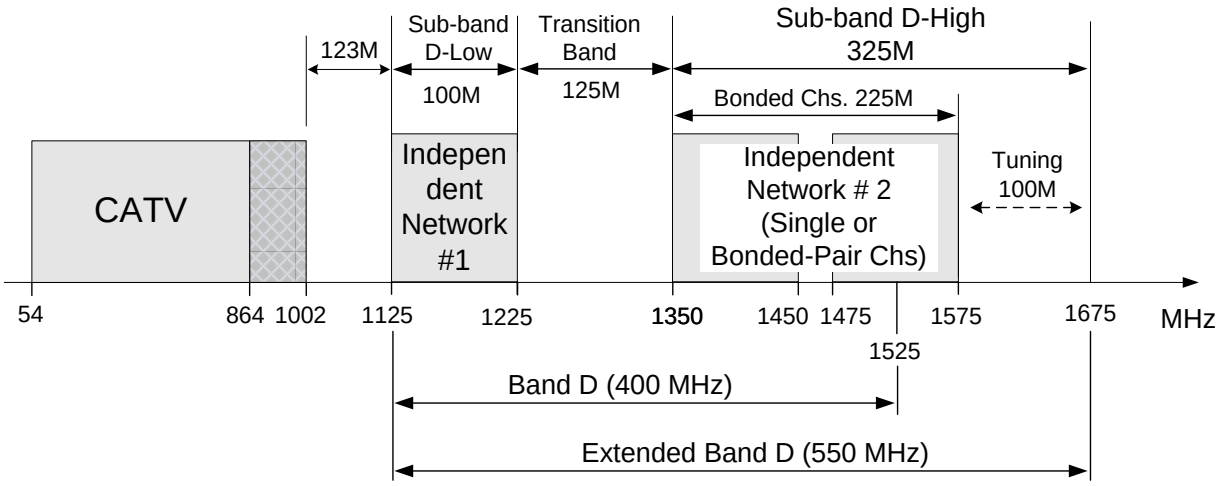

Figure 2-2. MoCA 2.0 Extended Band D Frequency Plan – Independent Networks

Table 2-1. Extended Band D Channel Frequencies

Frequency [MHz]	Channel #	MoCA 1.1 Channels	MoCA 2.0 Primary Channels	MoCA 2.0 Secondary Channels	Beacon Channels	D-Low / D-High
1150	D1	√			√	D-Low
1175	D1a		√	√		D-Low
1200	D2	√	√	√	√	D-Low
1225	D2a		√	√		
1250	D3	√	√	√	√	
1275	D3a		√	√		
1300	D4	√	√	√	√	
1325	D4a		√	√		
1350	D5	√	√	√	√	
1375	D5a		√	√		
1400	D6	√	√	√	√	D-High
1425	D6a		√	√		D-High
1450	D7	√	√	√	√	D-High
1475	D7a		√	√		D-High
1500	D8	√	√	√	√	D-High
1525	D8a		√	√		D-High
1550	D9		√	√	√	D-High
1575	D9a		√	√		D-High
1600	D10		√	√	√	D-High
1625	D10a		√	√		D-High

2.1.2 MoCA 2.0 Band E Frequency Plan

This section specifies the frequency plan for MoCA 2.0 single and bonded-pair channels operation in Band E. Band E is defined between frequencies 400 MHz and 700 MHz (300 MHz wide).

MoCA 2.0 single channels (100 MHz BW) are centered on a 25 MHz grid and can tune in 25 MHz increments. Bonded-pair channels (225 MHz BW) have a fixed 25 MHz gap between them where both the Primary Channel and Secondary Channels are centered on the 25 MHz grid.

This frequency plan enables:

- MoCA 2.0 single channel or bonded-pair channels operation in Band E
- Mixed-mode operation (MoCA 1/MoCA 2.0) in Band E

Figure 2-3 illustrates the MoCA 2.0 frequency plan in Band E with bonded pair channels example. The MoCA 2.0 center channel frequencies (and the MoCA 1.1 channels for reference) are defined in Table 2-2.

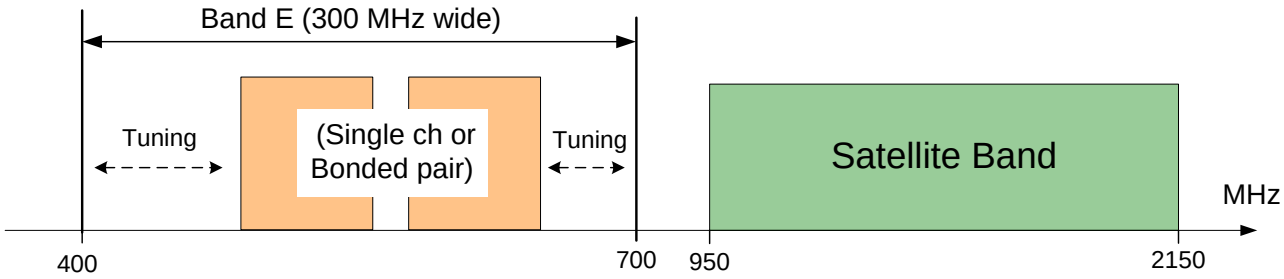

Figure 2-3. MoCA 2.0 Band E Frequency Plan with Single or Bonded-Pair Channels Example

Table 2-2. Band E Channel Frequencies

Center Frequency [MHz]	Channel #	MoCA 1.1 Channels	MoCA 2.0 Primary Channels	MoCA 2.0 Secondary Channels	Beacon Channels
450	EE1			√	
475	EE2			√	
500	E1	√		√	√
525	E2	√	√		√
550	E3	√	√		√
575	E4	√	√		√
600	E5	√	√		√
625	EE3		√		
650	EE4			√	

2.1.3 MoCA 2.0 Band F Frequency Plan

This section specifies the frequency plan for MoCA 2.0 single and bonded-pair channels operation in Band F. The Band F is defined between frequencies 650 MHz and 875 MHz (225 MHz wide). This band comprises of two bands F_{SAT} and F_{CBL}, both having the same channel plan but differ in some of the other requirements. For the purpose of this specification, whenever a requirement refers to band F the requirement applies to both F_{SAT} and F_{CBL}. All requirements which are specific to one of the two bands will indicate the specific band to which they apply.

MoCA 2.0 single channels (100 MHz BW) are centered on a 25 MHz grid and can tune in 25 MHz increments. Bonded-pair channels (225 MHz BW) have a fixed 25 MHz gap between them where both the primary channel and secondary channels are centered on the 25 MHz grid.

This frequency plan enables:

- MoCA 2.0 single channel or bonded-pair channels operation in Band F
- Mixed-mode operation (MoCA 1/MoCA 2.0) in Band F

Figure 2-4 and Figure 2-5 illustrate the MoCA 2.0 frequency plan in bands F_{SAT} and F_{CBL} respectfully with bonded pair channels example. The band F MoCA 2.0 center channel frequencies (and the MoCA 1.1 channels for reference) are defined in Table 2-3.

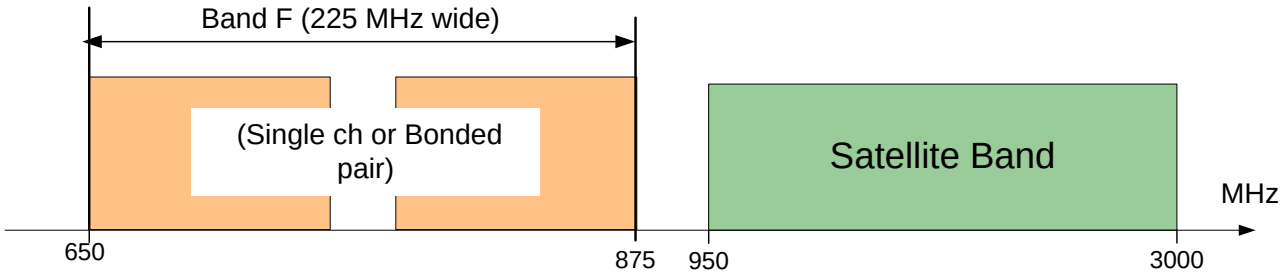

Figure 2-4. MoCA 2.0 Band FSAT Frequency Plan with Bonded-Pair Channels Example

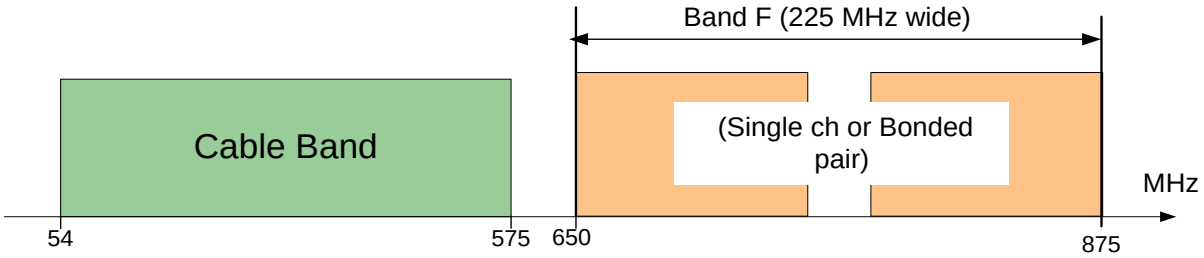

Figure 2-5. MoCA 2.0 Band FCBL Frequency Plan with Bonded-Pair Channels Example

Table 2-3. Band F Channel Frequencies

Center Frequency [MHz]	Channel #	MoCA 1.1 Channels	MoCA 2.0 Primary Channels	MoCA 2.0 Secondary Channels	Beacon Channels
675	F1	√			√
700	F2	√	√	√	√
725	F3	√	√		√
750	F4	√	√		√
775	F5	√	√		√
800	F6	√	√		√
825	F7	√	√	√	√
850	F8	√			√

2.1.4 MoCA 2.5 Extended Band D Frequency Plan

This section specifies the frequency plan for a Node operating with MoCA 2.5 PHY in extended band D (ExD).

Figure 2-6 illustrates the MoCA 2.5 frequency plan in extended band D. Figure 2-7 illustrates an example MoCA 2.5 deployment with a higher frequency DOCSIS signal allowed by DOCSIS 3.1; 1194 MHz is shown with 1218 MHz marking the edge of DOCSIS3.1. Note that the transition band between DOCSIS 3.1 and MoCA 2.5 will require careful engineering and filtering to avoid interference.

Table 2-4 specifies the allowed center frequencies of each 100 MHz bonded channel.

As shown in Table 2-4, three, four or five contiguous 100 MHz bonded channels may be located within the 550 MHz ExD frequency range. When only 4 contiguous channels are used, Channel 5 is not used and when only 3 contiguous channels are used, both Channels 4 and 5 are not used.

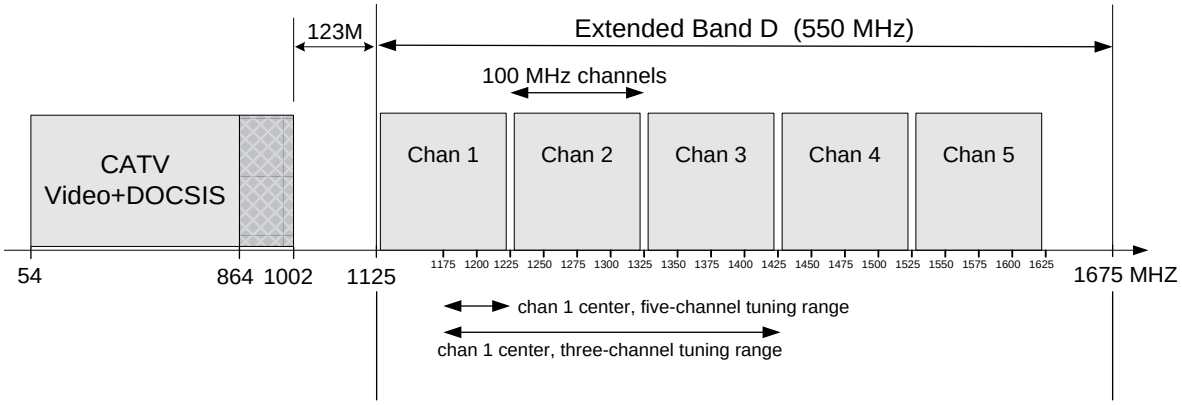

Figure 2-6. MoCA 2.5 Extended Band D Frequency Plan

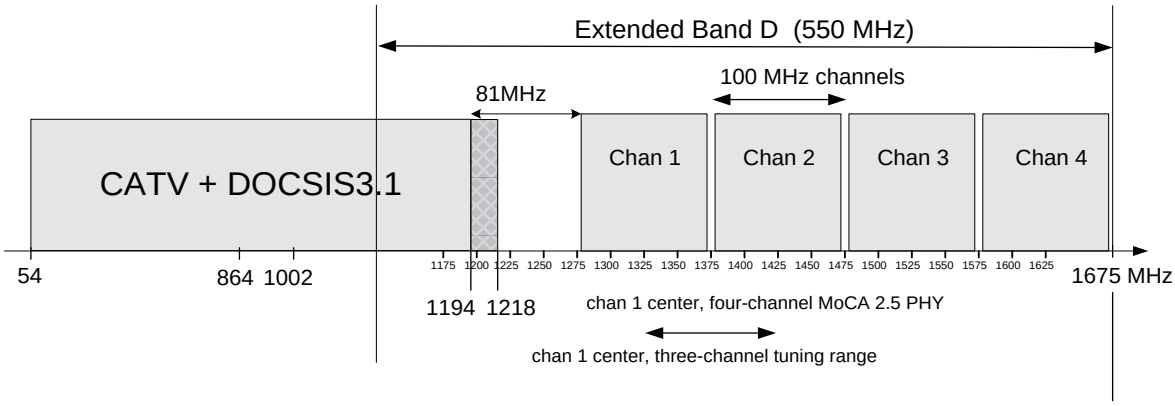

Figure 2-7. MoCA 2.5 Extended Band D With DOCSIS 3.1 Note

Table 2-4. MoCA 2.5 Extended Band D Channel Frequencies

MoCA 2.5 channel	1st Channel center	2nd Channel center	3rd Channel center	4th Channel center (if used)	5th Channel center (if used)
D2p5-1	1175	1275	1375	1475	1575
D2p5-2	1200	1300	1400	1500	1600
D2p5-3	1225	1325	1425	1525	1625
D2p5-4	1250	1350	1450	1550	-
D2p5-5	1275	1375	1475	1575	-
D2p5-6	1300	1400	1500	1600	-
D2p5-7	1325	1425	1525	1625	-
D2p5-8	1350	1450	1550	-	-
D2p5-9	1375	1475	1575	-	-
D2p5-10	1400	1500	1600	-	-
D2p5-11	1425	1525	1625	-	-

2.1.5 MoCA 2.5 Band E Frequency Plan

This section specifies the frequency plan for a Node operating with MoCA 2.5 PHY with 3 bonded channels in Band E.

Figure 2-8 illustrates the MoCA 2.5 frequency plan in Band E. The MoCA 2.5 center channel frequencies are defined in Table 2-5.

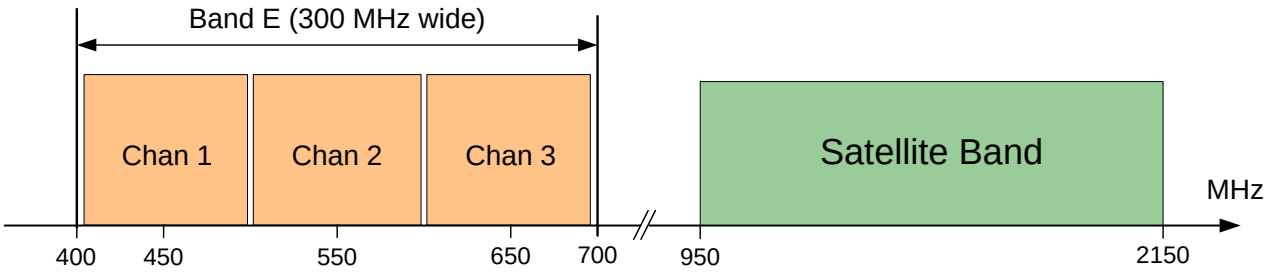

Figure 2-8. MoCA 2.5 Band E Frequency Plan

Table 2-5. Band E Channel Frequencies

MoCA 2.5 channel	Chan. 1 center	Chan. 2 center	Chan. 3 center		
E2p5-1	450	550	650		

2.2 *Connector and Return Loss*

The Transmit Mode return loss, measured at the F connector, MUST be ≥ 5 dB when operating in band ExD or sub-bands D-Low and D-High, and MUST be ≥8 dB when operating in band E or band F, relative to 75 ohm measured across fc ± 47.5 MHz. For bonded-pair channel this requirement applies to both the primary and Secondary Channels. The Transmit Mode return loss of a Node MUST remain within a 4 dB range over any time window of 20 minutes except during times when the return loss is > 15 dB. The Transmit Mode return loss of a Node MUST remain within a 2 dB range for any given Transmit Backoff setting, over any time window of 20 minutes except during times when the return loss is > 15 dB.

2.3 *Maximum Total Output Power*

When transmitting in MoCA 1 PHY, MoCA 2.0 PHY, Bonded-PHY, or MoCA 2.5 PHY, a Node MUST have a maximum per channel output power and maximum total output power as shown in Table 2-6. The maximum output power per channel MUST be supported on every MoCA channel frequency of operation.

Table 2-6. Maximum Total Output

Transmitting Mode	Number Channels Transmitted	BW per channel (MHz)	Maximum Output Power per Channel	Total Output Power of all transmitted channels
MoCA Beacon	1	50	-1 dBm to +7 dBm	-1 dBm to +7 dBm
MoCA 1 PHY	1	50	-1 dBm to +7 dBm	-1 dBm to +7 dBm
MoCA 2.0 PHY	1	100	-1 dBm to +7 dBm	-1 dBm to +7 dBm
MoCA 2.0 Bonded-PHY	2	100	-1 dBm to +7 dBm	+2 dBm to +10 dBm
MoCA 2.5 Bonded-PHY	2	100	-3 dBm to +5 dBm	0 dBm to +8 dBm
MoCA 2.5 PHY	3	100	-4.5 dBm to +3.5 dBm	+0.3 dBm to +8.3 dBm
MoCA 2.5 PHY	4	100	-5.3 dBm to +2.7 dBm	+0.7 dBm to +8.7 dBm
MoCA 2.5 PHY	5	100	-6 dBm to +2 dBm	+1 dBm to +9 dBm

All transmit power is measured into a 75 ohm load.

2.4 *MoCA Transmitter Spectral Mask*

The following subsections define the spectral mask requirements for transmissions using MoCA 2.5 PHY, MoCA 2.0 PHY, Bonded-PHY, and MoCA 1 PHY. The spectral mask requirements stated in the following subsection apply for each MoCA band of operation in the frequency ranges specified in Table 2-7.

Table 2-7. Transmitter Spectral Mask Frequency Ranges

MoCA Band	Frequency Range
ExD, D-Low, D-High	1002 MHz < f < 2150 MHz
E	4 MHz < f < 900 MHz
F_{SAT}	600 MHz < f < 925 MHz
F_{CBL}	600 MHz < f < 2150 MHz

2.4.1 MoCA 2.5 PHY Transmit Spectral Mask and Spurious

All transmitter performance specifications in this section apply at the F-connector. The terms used in this section are as follows:

TPC has a range of 0 to 30 dB for OFDM and -12 to 30 dB for OFDMA.

fc represents the center frequency of a MoCA 2.0 PHY transmission.

fc_0 represents the center frequency of a MoCA 1 PHY transmission Beacon Channel

fc_1 represents the center frequency of the lower of the two MoCA 2.0 PHYs constructing a Bonded-PHY Primary Channel or Secondary Channel

fc_2 represents the center frequency of the higher of the two MoCA 2.0 PHYs constructing a Bonded-PHY Primary Channel or Secondary Channel

Fc_P represents the center frequency of the Bonded-PHY Primary Channel

fc_S represents the center frequency of the Bonded-PHY Secondary Channel

fc_{min} and fc_{max} are defined as follows:

If MoCA 2.5 PHY transmissions are used between any nodes in the MoCA network:

fc_{min} = center frequency of the First Channel

fc_{max} = center frequency of the highest used channel, either Third Channel, Fourth Channel, or Fifth Channel

If MoCA 2.5 PHY transmissions are not used between any nodes and Bonded_PHY transmissions are used between any nodes in the MoCA network:

$fc_{min} = fc_1$

$fc_{max} = fc_2$

If MoCA 2.5 PHY and Bonded_PHY transmissions are not used between any nodes in the network and MoCA 2.0 PHY is used between any nodes in the MoCA network:

$fc_{min} = fc_{max} = fc$

If only MoCA 1 PHY is used between all nodes in the MoCA network:

$fc_{min} = fc_0 + 20$ MHz

$fc_{max} = fc_0 – 20$ MHz

The output spectrum from the Node when transmitting with MoCA 2.5 PHY at any TPC setting MUST conform to the mask per Table 2-9. M_{55} and M_{125} are defined as follows:

$M_{55} \equiv -38$dBr

$M_{125} \equiv -M_{Floor} + 0.25[TPC_{MIN}-20 + |TPC_{MIN}-20|]$ dBr

where TPC_{MIN} is is the lowest TPC setting of any 100 MHz MoCA 2.5 bonded channel in use and M_{Floor} is a function of NUM_OF_CHANNELS as shown in Table 2-8.

Table 2-8. MoCA 2.5 M_{Floor} Values

NUM_OF_CHANNELS	M_{Floor}
3	45.5
4	44.6
5	44.0

Table 2-9. Transmitter Spectral Mask for TPC Settings of 0 to 30

Frequency Range	Output
$fc_{min} - 50$ MHz $\leq f \leq fc_{max} + 50$ MHz	< 0 dBr
$fc_{min} - 55$ MHz $\leq f \leq fc_{min} - 50$ MHz	Linear slope from $M_{55}$to -20 dBr
$fc_{max} + 50$ MHz $\leq f \leq fc_{max} + 55$ MHz	Linear slope from -20 dBr to M_{55}
$fc_{min} - 125$ MHz $\leq f \leq fc_{min} - 55$ MHz	Linear slope from M_{125} to M_{55}
$fc_{max} + 55$ MHz $\leq f \leq fc_{max} + 125$ MHz	Linear slope from M_{55} to M_{125}
$f < fc_{min} - 125$ MHz	$\leq M_{125}$
$f > fc_{max} + 125$ MHz	$\leq M_{125}$

In addition to the requirements in Table 2-9, the output spectrum from the Node when TPC is the same on each channel MUST conform to the mask in Table 2-10.

Table 2-10. Transmitter Spectral Mask with the same TPC on each channel

Frequency Range	Output
$fc_{min} - 47$ MHz $\leq f \leq fc_{max} + 47$ MHz	–5 dBr to 0 dBr *

* For any unused subcarrier, the lower bound is not applicable and the output MUST be ≤ 0 dBr.

Figure 2-9 illustrates the required spectrum when the same TPC is set on each channel, for TPC settings of 0 to 20.

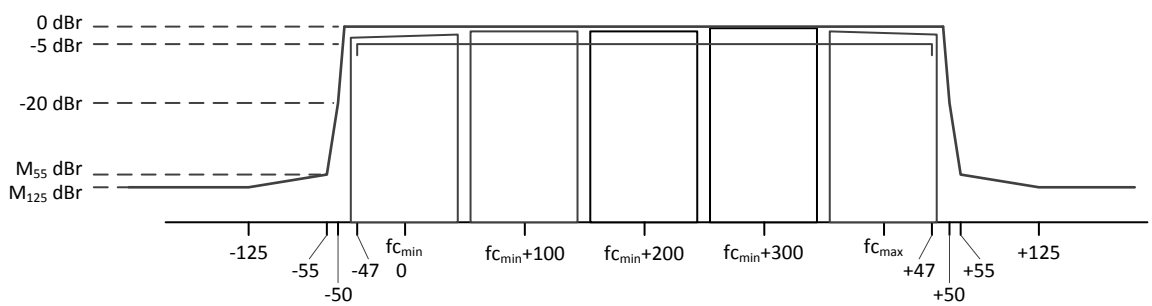

Figure 2-9. MoCA 2.5 Transmit Spectral Mask with the same TPC each channel, (for TPC Settings of 0 to 20)

When a transmitter is turned on for transmission in MoCA 2.5 PHY mode and PHY-frames are not yet being transmitted, in each of the 100 MHz bonded channels the transmitted output power MUST be less than -39 dBc relative to the transmitted power when the ACMT carriers are turned-on except for the allowed spurious in Table 2-11.

When a transmitter is turned on for transmission in MoCA 2.5 PHY mode and PHY-frames are being transmitted the transmitter output MUST not have any spurious output except for the allowed spurious in Table 2-11.

Table 2-11. Allowed Spurious when Transmitting

Frequency Range	Maximum Value	Notes
At all f = k×50MHz Where k is any integer > 1	-80 dBm	Spurious allowed at every frequency

2.4.2 MoCA 2.0 PHY Transmit Spectral Mask and Spurious

The spectrum at the F-connector from the Node when using MoCA 2.0 PHY at any TPC setting in both OFDM and OFDMA transmissions MUST conform to the mask per Table 2-12, where fc represents the center frequency of the transmitted signal and M_{55} and M_{125} are defined as follows:

$$M_{55} \equiv -40 + 0.25[TPC-30 + |TPC-30|] + 0.25[TPC-40 + |TPC-40|] \text{ dBr}$$
$$M_{125} \equiv -50 + 0.25[TPC-20 + |TPC-20|] + 0.25[TPC-30 + |TPC-30|] \text{ dBr}$$

where TPC is the transmitter TPC setting (in dB).

Figure 2-10 illustrates the required spectrum for TPC settings of -12 to 20. The spectral mask from fc–150 MHz to fc+150 MHz SHOULD be measured with the spectrum analyzer set to RBW = 300 kHz, VBW = 3 kHz, Sweep = Cont, Sweep Time = Auto. Video Averaging = On (100 traces), and Span = 300 MHz. The measured peak power of the MoCA transmitter spectral profile on the spectrum analyzer is the 0 dBr value. The spectral mask below fc-150 MHz and above fc+150 MHz SHOULD be measured with the spectrum analyzer set to RBW=2MHz, VBW = 10 kHz, Sweep = Cont, Sweep Time = Auto, Video Averaging = off, and the following start and stop frequencies (where applicable) for the band of operation:

- Start freq = the low edge of the frequency range in Table 2-7, stop freq = fc – 150 MHz
- Start freq = fc + 150 MHz, stop freq = the high edge of the frequency range in Table 2-7

Table 2-12. Transmitter Spectral Mask for TPC Settings of -12 to 45

Frequency Range	Output
fc – 0.931 MHz ≤ f ≤ fc + 0.931 MHz	≤ 0 dBr
fc – 21.5 MHz ≤ f ≤ fc – 0.931 MHz	–3 dBr to 0 dBr *
fc + 0.931 MHz ≤ f ≤ fc + 21.5 MHz	–3 dBr to 0 dBr *
fc – 47 MHz ≤ f ≤ fc – 21.5 MHz	–4 dBr to 0 dBr *
fc + 21.5 MHz ≤ f ≤ fc + 47 MHz	–4 dBr to 0 dBr *
fc – 50 MHz ≤ f ≤ fc – 47 MHz	< 0 dBr
fc + 47 MHz ≤ f ≤ fc + 50 MHz	< 0 dBr
fc - 55 MHz ≤ f ≤ fc - 50 MHz	Linear slope from $M_{55}$to -20 dBr
fc + 50 MHz ≤ f ≤ fc + 55 MHz	Linear slope from -20 dBr to M_{55}
fc - 125 MHz ≤ f ≤ fc - 55 MHz	Linear slope from $M_{125}$to M_{55}
fc + 55 MHz ≤ f ≤ fc + 125 MHz	Linear slope from $M_{55}$to M_{125}
f< fc - 125 MHz	M_{125}
fc + 125 MHz < f	M_{125}

* For any unused subcarrier, the lower bound is not applicable and the output MUST be ≤ 0dBr.

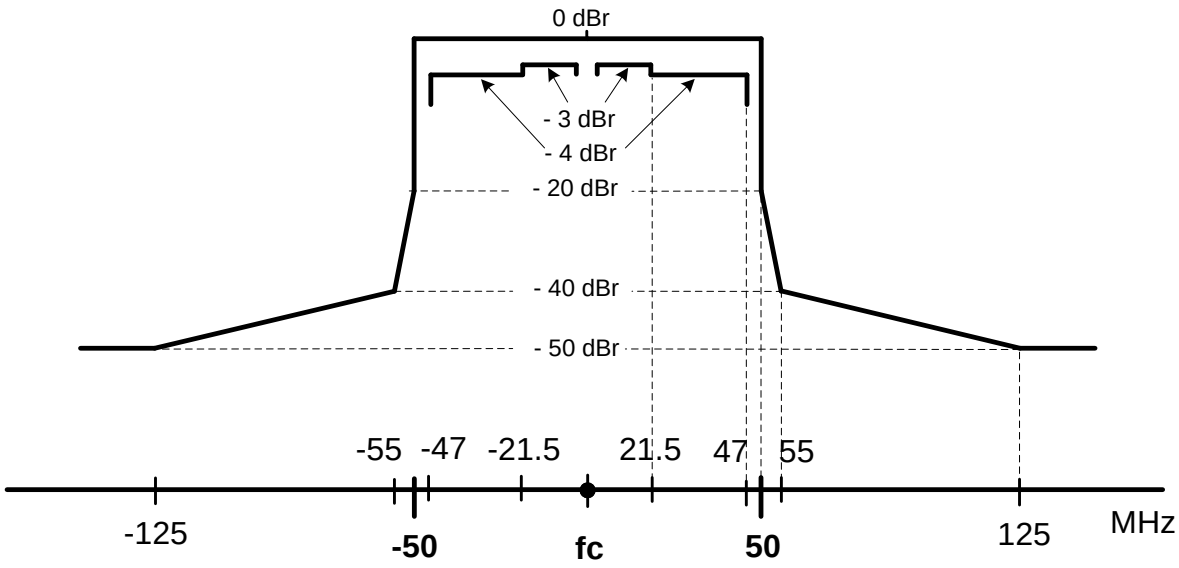

Figure 2-10. MoCA 2 –Transmit Spectral Mask (for TPC Settings of -12 to 20)

At 75 MHz offset from center (i.e. 25 MHz from the edge of the channel), the skirts of the mask are at approximately -43 dBr, sufficiently low to allow the placement of the bonded-pair channel edge at that frequency, as shown in Figure 2-11.

When a transmitter is turned on for transmission in MoCA 2.0 PHY mode and PHY-frames are not yet being transmitted, the transmitted output power MUST be less than -39 dBc relative to the transmitted power when the ACMT carriers are turned-on, excluding one of the following two spurious conditions:

- A spurious at fc with relative power of less than -23 dBc relative to the transmitted power when the ACMT carriers are turned-on
- When SECONDARY_CHANNEL_OFFSET ≠ 0b00: A spurious at fc_1+62.5 MHz with relative power of less than -23 dBc relative to the transmitted power when the ACMT carriers are turned-on

2.4.3 Bonded-PHY Transmit Spectral Mask

The spectrum at the F-connector from the Node when transmitting in Bonded-PHY MUST conform to the specification in Section 2.4.2 as shown in Figure 2-10 for both the Primary Channel and Secondary Channel. The combination of the spectral masks of the two Bonded-PHY channels when transmitting with the same TPC setting is shown in Figure 2-11:

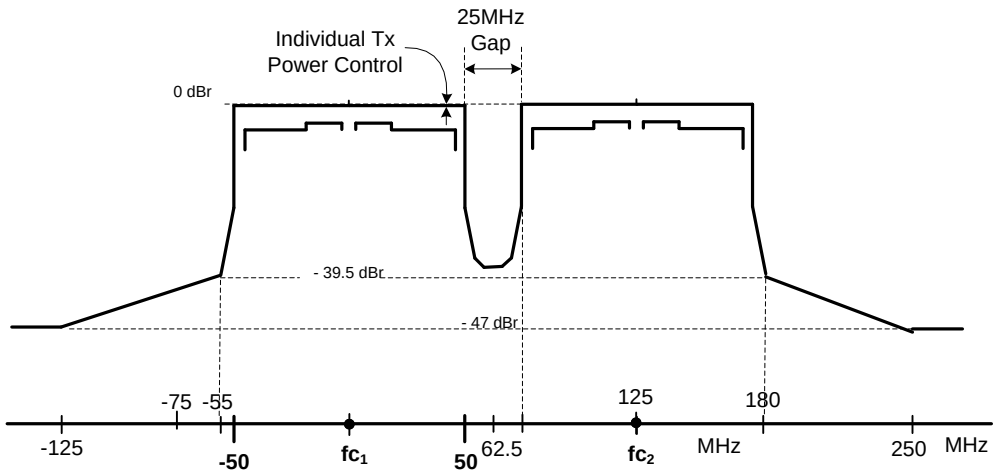

Figure 2-11. MoCA 2 – Bonded-Pair Channels – Tx Transmit Spectral Mask

The separation between the two Bonded-PHY channels MUST be 25 MHz, as shown in Figure 2-11.

When a transmitter is turned on for transmission in Bonded-PHY mode and PHY-frames are not yet being transmitted, the transmitted output power MUST be less than -39 dBc relative to the transmitted power when the sub carriers are turned on excluding one of the following two spurious conditions:

- A spurious at fc_1 with relative power of less than -23 dBc relative to the total power of the channel centered at fc_1 and a spurious at fc_2 with relative power of less than -23 dBc relative to the total power of the channel centered at fc_2
- A single spurious at fc_1+62.5 MHz with relative power of less than -23 dBc relative to the higher of (1) the total power of the channel centered at fc_1 and (2) the total power of the channel centered at fc_2.

A transmit level pre-equalization, or power offset, is required to assist the receiver in handling the effects of the network frequency response profile causing adjacent channel power inequality at the receiver input. By offsetting the transmit levels (e.g. by means of individual transmit power control) at the transmitter side, the received levels of the two channels are equalized, reducing the receiver dynamic range requirement.

Bonded-PHY transmitters MUST be capable of establishing an average output power differential between the primary and Secondary Channels of at least 6dB. This capability MUST be supported anywhere within the supported backoff range of the transmitter.

2.4.4 MoCA 1 PHY Transmit Spectral Mask

The following subsections define the spectral mask requirements for a Node operating in a Mixed Mode network, when transmitting in MoCA 1 PHY. fc_0 is defined as the center frequency of the MoCA 1 PHY transmission.

2.4.4.1 Data and frequency-domain probes

The spectrum at the F-connector from the MoCA transmitter when transmitting in MoCA 1 mode MUST conform to the following spectral mask:

- If the MoCA 1 PHY transmission is at the lower half of the 100 MHz-wide MoCA 2.0 channel then the spectrum MUST conform to the spectral mask per Table 2-13 and Figure 2-12.
- If the MoCA 1 PHY transmission is at the center of the 100 MHz-wide MoCA 2.0 channel then the spectrum MUST conform to the spectral mask per Table 2-14 and Figure 2-13.

- If the MoCA 1 PHY transmission is at the higher half of the 100 MHz-wide MoCA 2.0 channel then the spectrum MUST conform to the spectral mask per Table 2-15 and Figure 2-14.

The spectral mask from fc_0–150 MHz to fc_0+150 MHz SHOULD be measured with the spectrum analyzer set to RBW = 300 kHz, VBW = 3 kHz, Sweep = Continuous, Sweep Time = 300 ms, Video Averaging = On (100 traces), and Span = 100 MHz. The measured peak power of the MoCA transmitter spectral profile on the spectrum analyzer, when transmitting in MoCA 1 PHY mode, is the 0 dBr value. The spectral mask below fc_0-150 MHz and above fc_0+150 MHz SHOULD be measured with the spectrum analyzer set to RBW=2MHz, VBW = 10 kHz, Video Averaging = off, Sweep = Continuous, Sweep Time = 100 ms, and the following start and stop frequencies (where applicable) for the band of operation:

- Start freq = the low edge of the frequency range in Table 2-7, stop freq = fc_0-150 MHz
- Start freq = fc_0+150 MHz, stop freq = the high edge of the frequency range in Table 2-7

Table 2-13. MoCA 1.0 PHY Transmitter Spectral Mask - Signal at Lower Half of MoCA 2.0 Channel

Frequency Range	Output
fc_0 – 21.5 MHz ≤ f ≤ fc_0 – 0.931 MHz	–3 dBr to 0 dBr*
fc_0 + 0.931 MHz ≤ f ≤ fc_0 + 21.5 MHz	–3 dBr to 0 dBr*
fc_0 + 25 MHz ≤ f ≤ fc_0 + 30 MHz	< -20 dBr
fc_0 – 30 MHz ≤ f ≤ fc_0 – 25 MHz	< -20 dBr
fc_0 + 30 MHz<f	< -30 dBr
f< fc_0 – 30 MHz	< -40 dBr
fc_0 + 75 MHz < f	< -45 dBr
f< fc_0 – 50 MHz	< -45 dBr

* For any unused subcarrier, the lower bound is not applicable and the output MUST be ≤ 0dBr

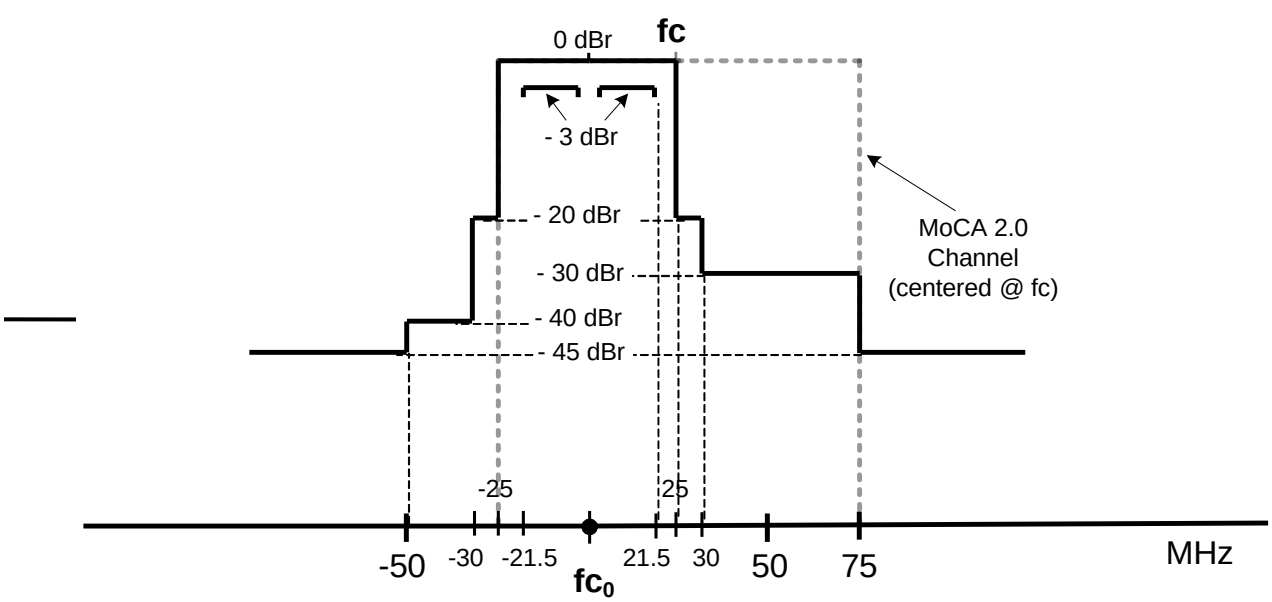

Figure 2-12. MoCA 1 PHY Transmitter Spectral Mask - Signal at Lower Half of MoCA 2.0 Channel

Table 2-14. MoCA 1 PHY Transmitter Spectral Mask - Signal at Center of MoCA 2.0 Channel

Frequency Range	Output
fc_0 – 21.5 MHz to fc_0 – 0.931 MHz	–3 dBr to 0 dBr*
fc_0 + 0.931 MHz to fc_0 + 21.5 MHz	–3 dBr to 0 dBr*
fc_0 + 25 MHz to fc_0 + 30 MHz	< -20 dBr
fc_0 – 30 MHz to fc_0 – 25 MHz	< -20 dBr
> fc_0 + 30 MHz	< -30 dBr
< fc_0 – 30 MHz	< -30 dBr
> fc_0 + 50 MHz	< -45 dBr
< fc_0 – 50 MHz	< -45 dBr

* For any unused subcarrier, the lower bound is not applicable and the output MUST be ≤ 0dBr

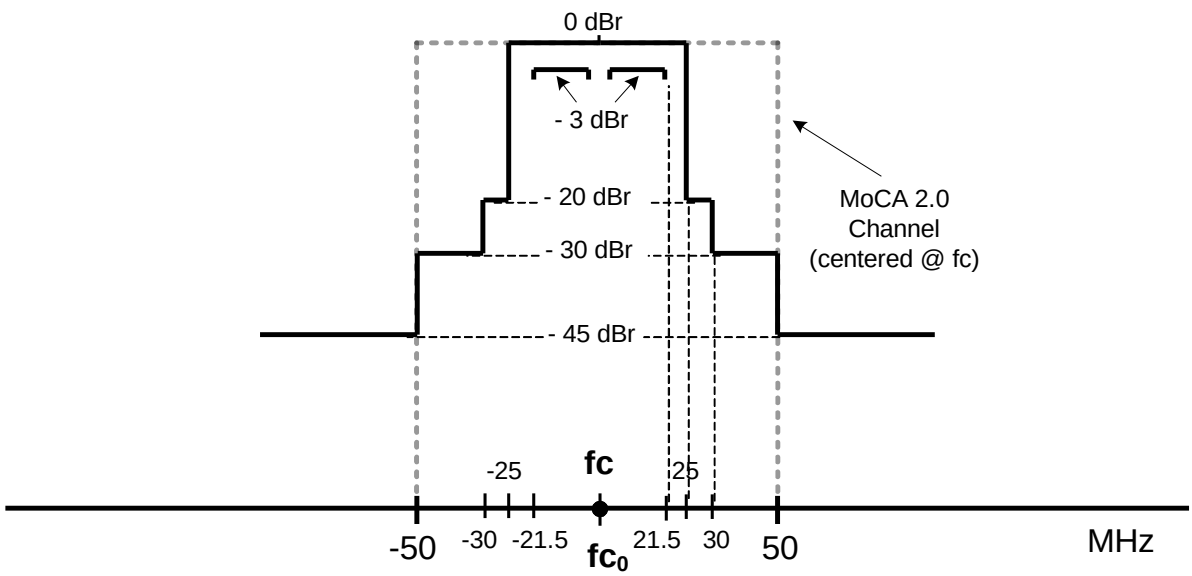

Figure 2-13. MoCA 1 PHY Transmitter Spectral Mask - Signal at Center of MoCA 2.0 Channel

Table 2-15. MoCA 1 PHY Transmitter Spectral Mask - Signal at Higher Half of MoCA 2.0 Channel

Frequency Range	Output
fc_0 – 21.5 MHz ≤ f ≤ fc_0 – 0.931 MHz	–3 dBr to 0 dBr*
fc_0 + 0.931 MHz ≤ f ≤ fc_0 + 21.5 MHz	–3 dBr to 0 dBr*
fc_0 + 25 MHz ≤ f ≤ fc_0 + 30 MHz	< -20 dBr
fc_0 – 30 MHz ≤ f ≤ fc_0 – 25 MHz	< -20 dBr
fc_0 + 30 MHz< f	< -40 dBr
f< fc_0 – 30 MHz	< -30 dBr
fc_0 + 50 MHz < f	< -45 dBr
f< fc_0 – 75 MHz	< -45 dBr

* For any unused subcarrier, the lower bound is not applicable and the output MUST be ≤ 0dBr

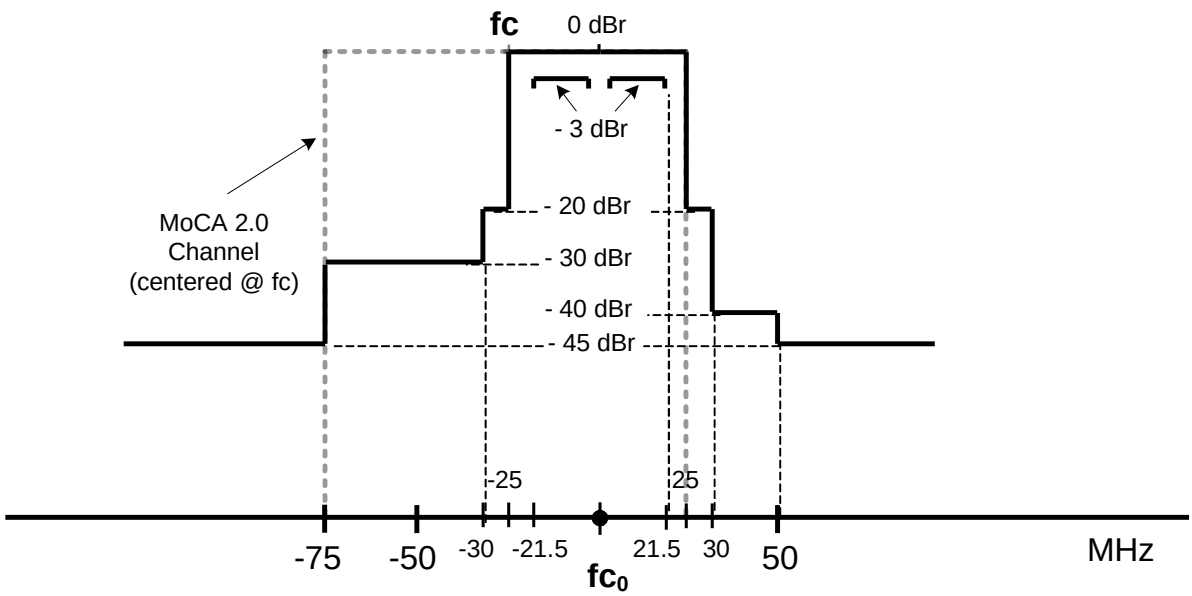

Figure 2-14. MoCA 1 PHY Transmitter Spectral Mask - Signal at Higher Half of MoCA 2.0 Channel

When a MoCA transmitter is turned on for transmission in MoCA 1 PHY mode and PHY-frames are not yet being transmitted, the transmitted output power MUST be less than –39 dBc relative to the transmitted power when the ACMT carriers are turned-on excluding the following two allowed spurious outputs:

- A single spurious at fc_0 with relative power of less than -23 dBc
- A single spurious at either fc_0+25MHz or fc_0-25MHz with relative power of less than -39 dBc appearing not earlier than when the transmitter is turned on and with a relative power of less than -35 dBc not earlier than 1.5 μsec before the first symbol has reached 90% of its final value.

2.4.4.2 Time-domain probes

When MoCA 1 time-domain probes are transmitted, the spectrum at the F-connector from the MoCA transmitter MUST conform to the following spectral mask:

- If the MoCA 1 PHY transmission is at the lower half of the 100 MHz-wide MoCA 2.0 channel then the spectrum MUST conform to the spectral mask per Table 2-16.
- If the MoCA 1 PHY transmission is at the center of the 100 MHz-wide MoCA 2.0 channel then the spectrum MUST conform to the spectral mask per Table 2-17.
- If the MoCA 1 PHY transmission is at the higher half of the 100 MHz-wide MoCA 2.0 channel then the spectrum MUST conform to the spectral mask Table 2-18.

Where the Relative Signal Power is the signal power measured in 300 kHz bandwidth and it is relative to the total integrated signal power (measured using a power meter). The total integrated signal power is equivalent to the 0 dBc value.

Table 2-16. MoCA 1 PHY Transmitter Spectral Mask for Probe Signals - Signal at Lower Half of MoCA 2.0 Channel

Frequency Range	Relative Signal Power
fc_0 + 27 MHz< f	< – 43.8 dBc
f< fc_0 – 27 MHz	< – 43.8 dBc
fc_0 + 28 MHz< f	< – 51.8 dBc
f< fc_0 – 28 MHz	< – 61.8 dBc
fc_0 + 75 MHz< f	< – 66.8 dBc
f< fc_0 – 50 MHz	< – 66.8 dBc

Table 2-17. MoCA 1 PHY Transmitter Spectral Mask for Probe Signals - Signal at Center of MoCA 2.0 Channel

Frequency Range	**Relative Signal Power**
fc_0 + 27 MHz< f	< – 43.8 dBc
f< fc_0 – 27 MHz	< – 43.8 dBc
fc_0 + 28 MHz< f	< – 51.8 dBc
f< fc_0 – 28 MHz	< – 51.8 dBc
fc_0 + 50 MHz< f	< – 66.8 dBc
f< fc_0 – 50 MHz	< – 66.8 dBc

Table 2-18. MoCA 1 PHY Transmitter Spectral Mask for Probe Signals - Signal at Higher Half of MoCA 2.0 Channel

Frequency Range	**Relative Signal Power**
fc_0 + 27 MHz< f	< – 43.8 dBc
f< fc_0 – 27 MHz	< – 43.8 dBc
fc_0 + 28 MHz< f	< – 61.8 dBc
f< fc_0 – 28 MHz	< – 51.8 dBc
fc_0 + 50 MHz< f	< – 68.8 dBc
f< fc_0 – 75 MHz	< – 68.8 dBc

2.5 *MoCA 2.0 RF Mode Transmitter Spurious Output*

2.5.1 Extended Band D Transmit Spurious Emissions

The spurious signals at the output F-connector of a Node operating in extended band D (ExD, D-Low, or D-High) MUST conform to Table 2-19. Unless otherwise stated the requirements in Table 2-16 apply to transmissions in any of the modes (MoCA 2.0 PHY, Bonded-PHY, or MoCA 1 PHY).

Table 2-19. Extended Band D Transmitter Spurious Output

Parameter	Frequency Range	Maximum Value*	Notes
Spurious at fc when transmitting in MoCA 2.0 PHY	fc or fc_1+62.5 MHz	-23 dBc	The spurious at fc_1+62.5 MHz is only allowed when SECONDARY_CHANNEL_OFFSET ≠ 0b00
Spurious at fc when transmitting in Bonded-PHY	(fc_1 and fc_2) or fc_1+62.5 MHz	-23 dBc	When the spurious are at fc_1 and fc_2: A spurious at fc_1 with power relative to the total power of the channel centered at fc_1 and a spurious at fc_2 with power relative to the total power of the channel centered at fc_2 When the spurious is at fc_1+62.5 MHz: the power of the spurious is relative to the higher of (1) the total power of the channel centered at fc_1 and (2) the total power of the channel centered at fc_2.
Spurious at fc_0 when transmitting in MoCA 1 PHY	fc_0 or fc or fc_1+62.5 MHz	-23 dBc	The spurious at fc_1+62.5 MHz is only allowed when SECONDARY_CHANNEL_OFFSET ≠ 0b00
Spurious and noise	54 MHz ≤ f ≤ 1002 MHz	-45dBmV	Measured in 4 MHz BW including discretes
Discrete tones only	54 MHz ≤ f ≤ 1002 MHz	-50 dBmV	

*The dBc value is measured relative to the total transmitted signal power.

2.5.2 Band E Transmit Spurious Emissions

The spurious signals at the output F-connector of a Node operating in Band E MUST conform to Table 2-20. Unless otherwise stated the requirements in Table 2-20 apply to transmissions in any of the modes (MoCA 2.0 PHY, Bonded-PHY, or MoCA 1 PHY).

Table 2-20. Band E Transmitter Spurious Output

Parameter	Frequency Range	Maximum Value*	Notes
Spurious at fc when transmitting in MoCA 2.0 PHY	fc or fc_1+62.5 MHz	-23 dBc	The spurious at fc_1+62.5 MHz is only allowed when SECONDARY_CHANNEL_OFFSET ≠ 0b00
Spurious at fc when transmitting in Bonded-PHY	(fc_1 and fc_2) or fc_1+62.5 MHz	-23 dBc	When the spurious are at fc_1 and fc_2: A spurious at fc_1 with power relative to the total power of the channel centered at fc1 and a spurious at fc_2 with power relative to the total power of the channel centered at fc_2 When the spurious is at fc1+62.5 MHz: the power of the spurious is relative to the higher of (1) the total power of the channel centered at fc_1 and (2) the total power of the channel centered at fc_2.
Spurious at fc_0 when transmitting in MoCA 1 PHY	fc_0 or fc or fc_1+62.5 MHz	-23 dBc	The spurious at fc_1+62.5 MHz is only allowed when SECONDARY_CHANNEL_OFFSET ≠ 0b00
Spurious and Noise	0.5 MHz < f ≤ 2.1 MHz	-50 dBm / 152 kHz	
Spurious and Noise	2.1 MHz < f ≤ 2.5 MHz	-78 dBm / 152 kHz	
Spurious and Noise	2.5 MHz < f ≤ 3 MHz	-40 dBm	Integrated power over the frequency range
Spurious and Noise	3 MHz < f ≤ 4 MHz	-20 dBm	Integrated power over the frequency range
Spurious and Noise	900 MHz < f < 950 MHz	-55 dBm / 20 MHz	
Spurious and Noise	950 MHz ≤ f ≤ 2500 MHz	-94 dBm / 20 MHz	
Spurious and Noise	2500 < f < 3000 MHz	-80 dBm / 20 MHz	

* The dBc value is measured relative to the total transmitted signal power.

2.5.3 Band F Transmit Spurious Emissions

The spurious signals at the output F-connector of a Node MUST conform to Table 2-21 when operating in band F_{SAT} and MUST conform to Table 2-22 when operating in band $F_{CBL.}$ Unless otherwise stated the requirements in both Table 2-21 and Table 2-22 apply to transmissions in any of the modes (MoCA 2.0 PHY, Bonded-PHY, or MoCA 1 PHY).

Table 2-21. Band FSAT Transmitter Spurious Output

Parameter	Frequency Range	Maximum Value*	Notes
Spurious at fc when transmitting in MoCA 2.0 PHY	fc or fc_1+62.5 MHz	-23 dBc	
Spurious at fc when transmitting in Bonded-PHY	(fc_1 and fc_2) or fc_1+62.5 MHz	-23 dBc	When the spurious are at fc1 and fc2: A spurious at fc1 with power relative to the total power of the channel centered at fc1 and a spurious at fc2 with power relative to the total power of the channel centered at fc2 When the spurious is at fc1+62.5 MHz: the power of the spurious is relative to the higher of (1) the total power of the channel centered at fc1 and (2) the total power of the channel centered at fc2.
Spurious at fc_0 when transmitting in MoCA 1 PHY	fc_0 or fc or fc_1+62.5 MHz	-23 dBc	
Spurious and Noise	10 kHz < f ≤ 1 MHz	25 mV p-p at 12 ohm	
Spurious and Noise	1 MHz < f < 500 MHz	-58 dBm / 50 MHz	
Spurious and Noise	500 MHz ≤ f ≤ 575 MHz	-83 dBm / 50 MHz	
Spurious and Noise	575 MHz < f < 600 MHz	-52 dBm	
Spurious and Noise	925 MHz < f < 950MHz	-52 dBm	
Spurious and Noise	950 MHz ≤ f < 3000 MHz	-94 dBm / 27 MHz	

* The dBc value is measured relative to the total transmitted signal power.

Table 2-22. Band FCBL Transmitter Spurious Output

Parameter	Frequency Range	Maximum Value*	Notes
Spurious at fc when transmitting in MoCA 2.0 PHY	fc or fc_1+62.5 MHz	-23 dBc	
Spurious at fc when transmitting in Bonded-PHY	(fc_1 and fc_2) or fc_1+62.5 MHz	-23 dBc	When the spurious are at fc1 and fc2: A spurious at fc1 with power relative to the total power of the channel centered at fc1 and a spurious at fc2 with power relative to the total power of the channel centered at fc2 When the spurious is at fc1+62.5 MHz: the power of the spurious is relative to the higher of (1) the total power of the channel centered at fc1 and (2) the total power of the channel centered at fc2.
Spurious at fc_0 when transmitting in MoCA 1 PHY	fc_0 or fc or fc_1+62.5 MHz	-23 dBc	
Spurious and Noise	1 MHz < f < 54 MHz	-58 dBm / 50 MHz	
Spurious and Noise	54 MHz ≤ f ≤ 575 MHz	-94 dBm / 4 MHz	
Discrete tones only	54 MHz ≤ f ≤ 575 MHz	-99 dBm	
Spurious and Noise	575 MHz < f < 600 MHz	-52 dBm	

* The dBc value is measured relative to the total transmitted signal power.

2.6 *MoCA 2.5 Band Specific Transmit Spurious and Noise Emissions*

In addition to the spurious and noise requirements in this section, a Node MUST also simultaneously comply with the spurious requirements in Section 2.4.

2.6.1 Band ExD Transmit Spurious and Noise Emissions

The spurious and noise at the output of a Node transmitting in band ExD MUST conform to Table 2-23.

Table 2-23. Extended Band D Transmitter Spurious Output

Parameter	Frequency Range	Maximum Value*	Notes
Spurious and noise	54 MHz ≤ f ≤ 1002 MHz	-45dBmV	Measured in 4 MHz BW including discretes
Discrete tones only	54 MHz ≤ f ≤ 1002 MHz	-50 dBmV	

2.6.2 Band E Transmit Spurious Emissions

The spurious and noise at the output of a Node transmitting in Band E MUST conform to Table 2-24.

Table 2-24. Band E Transmitter Spurious Output

Parameter	Frequency Range	Maximum Value*	Notes
Spurious and Noise	0.5 MHz < f ≤ 2.1 MHz	-50 dBm / 152 kHz	
Spurious and Noise	2.1 MHz < f ≤ 2.5 MHz	-78 dBm / 152 kHz	
Spurious and Noise	2.5 MHz < f ≤ 3 MHz	-40 dBm	Integrated power over the frequency range
Spurious and Noise	3 MHz < f ≤ 4 MHz	-20 dBm	Integrated power over the frequency range
Spurious and Noise	900 MHz < f < 950 MHz	-55 dBm / 20 MHz	
Spurious and Noise	950 MHz ≤ f ≤ 2500 MHz	-94 dBm / 20 MHz	
Spurious and Noise	2500 < f < 3000 MHz	-80 dBm / 20 MHz	

2.6.3 Band F Transmit Spurious and Noise Emissions

The spurious and noise at the output of a Node MUST conform to Table 2-25 when transmitting in band F_{SAT} and MUST conform to Table 2-26 when transmitting in band $F_{CBL.}$

Table 2-25. Band F_{SAT} Transmitter Spurious Output

Parameter	Frequency Range	Maximum Value*	Notes
Spurious and Noise	10 kHz < f ≤ 1 MHz	25 mV p-p at 12 ohm	
Spurious and Noise	1 MHz < f < 500 MHz	-58 dBm / 50 MHz	
Spurious and Noise	500 MHz ≤ f ≤ 575 MHz	-83 dBm / 50 MHz	
Spurious and Noise	575 MHz < f < 600 MHz	-52 dBm	
Spurious and Noise	925 MHz < f < 950MHz	-52 dBm	
Spurious and Noise	950 MHz ≤ f < 3000 MHz	-94 dBm / 27 MHz	

Table 2-26. Band F_{CBL} Transmitter Spurious Output

Parameter	Frequency Range	Maximum Value*	Notes
Spurious and Noise	1 MHz < f < 54 MHz	-58 dBm / 50 MHz	
Spurious and Noise	54 MHz ≤ f ≤ 575 MHz	-94 dBm / 4 MHz	
Discrete tones only	54 MHz ≤ f ≤ 575 MHz	-99 dBm	
Spurious and Noise	575 MHz < f < 600 MHz	-52 dBm	

2.7 *Receiver Minimum Sensitivity*

2.7.1 MoCA 2.0 Receiver Minimum Sensitivity

A receiving Node in a MoCA Network operating in MoCA 2.0 Mode MUST achieve on its Primary Channel a minimum PHY Rate per received power level as specified in Table 2-27 when operating in band ExD and as specified in Table 2-28 when operating in bands E or F and under the following conditions:

- The in-home cable plant response is Flat Channel

A receiving Node in a MoCA Network operating in Turbo Mode MUST achieve on its Primary Channel a minimum PHY Rate per received power level as specified in Table 2-29 when operating in band ExD and as specified in Table 2-30 when operating in bands E or F and under the following conditions:

- The in-home cable plant response is Flat Channel

The minimum PHY Rate requirement as a function of the receiver input level in MoCA 2.0 Mode for both MoCA 2.0 Baseline Mode and Turbo Mode are shown in Figure 2-15 for band ExD and in Figure 2-16 for bands E and F.

For bonded-pair Nodes the above requirements apply to both the Primary Channel and the Secondary Channel independently.

Table 2-27. Minimum PHY Rate vs. Receive Power Level in Band ExD

Receive Power Level X [dBm]	Minimum Required PHY Rate [Mbps]
-44 ≤ X ≤ -2	600
-64 ≤ X ≤ -44	600+(580/23)(X+44)

Table 2-28. Minimum PHY Rate vs. Receive Power Level in Bands E and F

Receive Power Level X [dBm]	Minimum Required PHY Rate [Mbps]
-43 ≤ X ≤ -2	600
-63 ≤ X ≤ -43	600+(580/23)(X+43)

Table 2-29. Minimum PHY Rate vs. Receive Power Level for Turbo Mode in Band ExD

Receive Power Level X [dBm]	Minimum Required PHY Rate [Mbps]
-42.41 ≤ X ≤ -2	640
-64 ≤ X ≤ -42.41	640+(580/23)(X+42.41)

Table 2-30. Minimum PHY Rate vs. Receive Power Level for Turbo Mode in Bands E and F

Receive Power Level X [dBm]	Minimum Required PHY Rate [Mbps]
$-41.41 \le X \le -2$	640
$-63 \le X \le -41.41$	640+(580/23)(X+41.41)

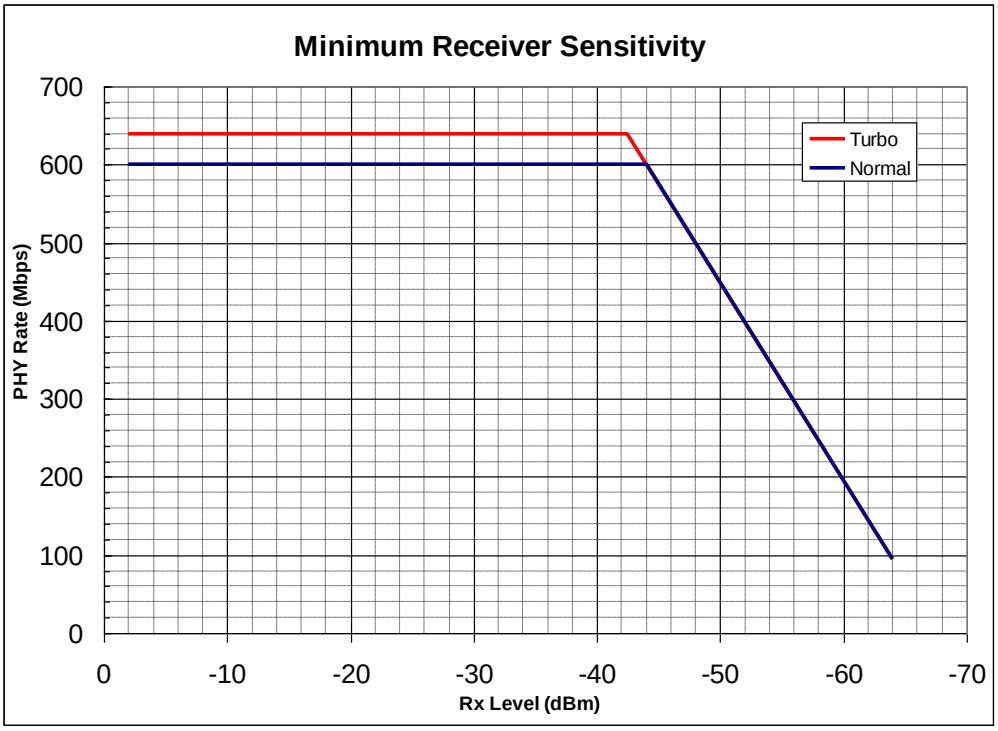

Figure 2-15. Minimum Receiver Sensitivity in Band ExD

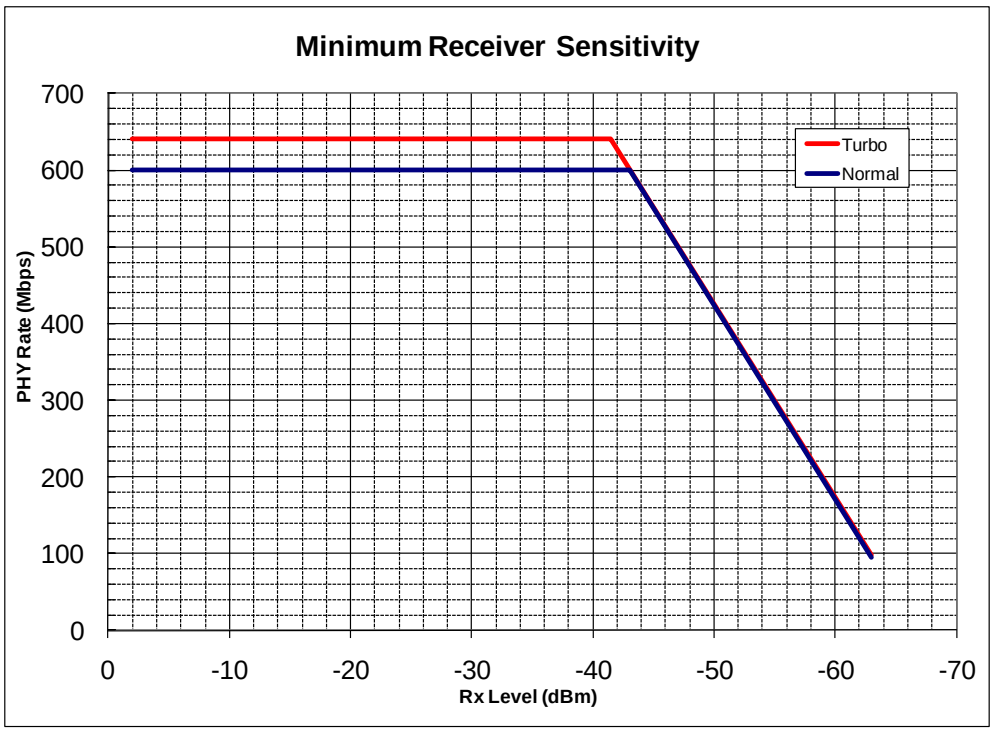

Figure 2-16. Minimum Receiver Sensitivity in Bands E and F

2.7.2 MoCA 2.5 Receiver Minimum Sensitivity

A receiving Node in a MoCA Network operating in MoCA 2.5 PHY Mode MUST achieve on each bonded Channel a minimum PHY Rate per received power level as specified in Table 2-31 and illustrated in Figure 2-17 These requirements apply under the following conditions:

- The in-home cable plant response is Flat Channel

Table 2-31. MoCA 2.5 Minimum PHY Rate vs. Receive Power Level

Receive Power Level X [dBm]	Minimum Required PHY Rate [Mbps]
$-41 \le X \le +1$	650
$-63 \le X \le -41$	650+(580/23)(X+41)

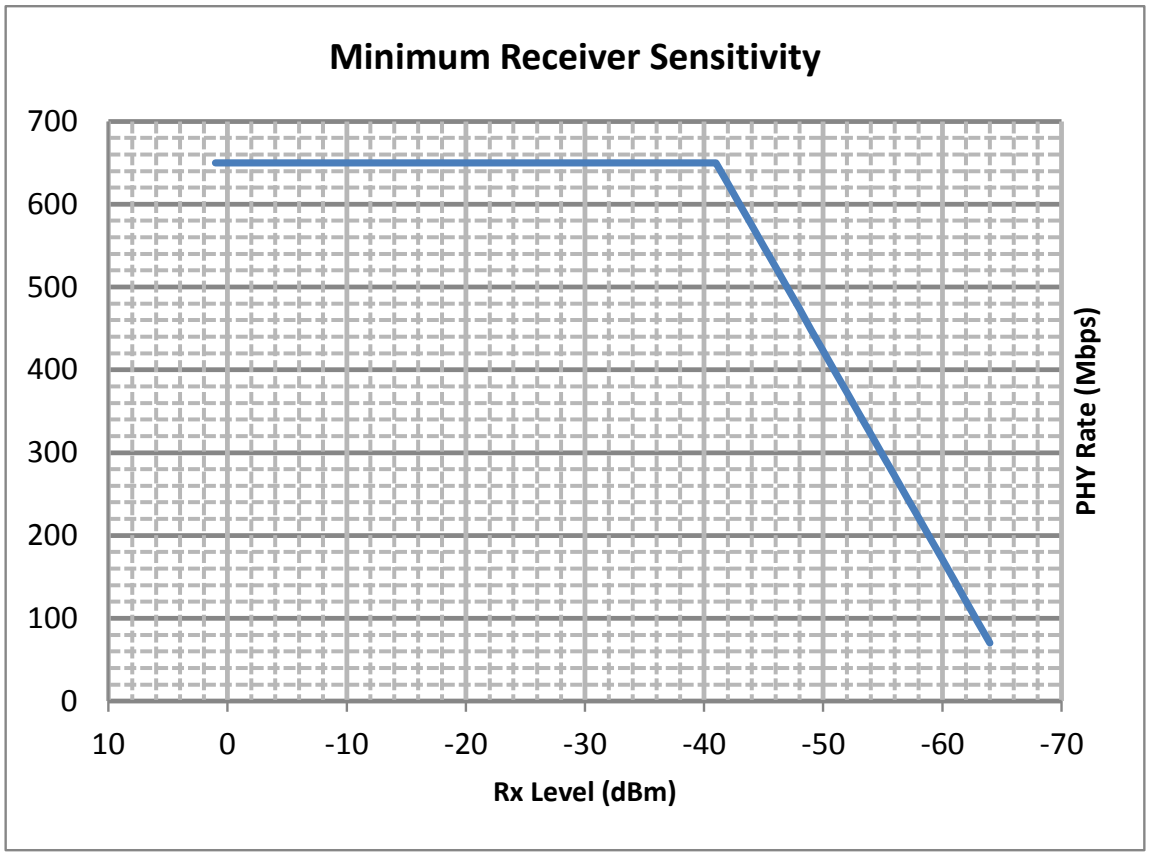

Figure 2-17. MoCA 2.5 Minimum Receiver Sensitivity

2.8 *Coexistence with Other Signals*

2.8.1 CATV and DOCSIS Susceptibility

2.8.1.1 Band ExD

When operating in band ExD or subbands D-Low or D-High, a Node MUST meet all the performance requirements in the presence of simultaneous CATV and DOCSIS signals at the input to the Node as shown in Table 2-32.

Table 2-32. CATV Signals Coexisting with Band ExD

Parameter	Value	Notes
Input Frequency range	54-1002 MHz	
RF channel spacing	6 MHz	
Maximum analog video signal level (per channel)	+15 dBmV	Peak NTSC picture carrier level in 6 MHz bandwidth
Maximum digital signal level (per channel)	+15 dBmV	Average power in 6 MHz bandwidth
Maximum number of carriers	158	Up to 1002 MHz
Maximum number of analog carriers	83	Up to 550 MHz
Maximum aggregate power level	33 dBmV	

2.8.1.2 Band F_{CBL}

When operating in band F_{CBL}, a Node MUST meet all the performance requirements in the presence of simultaneous CATV signals at the input to the Node as shown in Table 2-33.

Table 2-33. CATV Signals Coexisting with Band FCBL

Parameter	Value	Notes
Input frequency range	54 - 575MHz	
RF channel spacing	6 MHz	
Maximum analog video signal level (per channel)	+15 dBmV	Peak NTSC picture carrier level in 6 MHz bandwidth
Maximum digital video signal level (per channel)	+15 dBmV	Average power in 6 MHz bandwidth
Maximum number of carriers	87	
Maximum aggregate power level	30 dBmV	

2.8.2 Satellite Susceptibility

2.8.2.1 Band E

When operating in band E, a Node MUST meet all the performance requirements in the presence of the following simultaneous signals at the F-connector:

- An OSP satellite transponder signal at the input to the Node as specified in Table 2-34
- FSK control signal as specified in Table 2-35
- Maximum intermittent power levels as specified in Table 2-36

Table 2-34. OSP Satellite Transponder Signal Level for Band E Devices

Parameter	Value
Input Frequency range	900-2150 MHz
Signal level (in any 24 MHz bandwidth in the Input Frequency range)	Up to -20 dBm (average power per carrier)
Total aggregated power level (measured at the Node)	-10 dBm

Table 2-35. FSK Control Signal

Parameter	Value
Tx Carrier Frequency	2.3 MHz ± 10 kHz
Tx Frequency shift	± 40 kHz +10/-5 kHz
Asynchronous Serial Bit Rate	39 kbaud ±0.5%
Tx Carrier maximum Power	-1 dBm (75 ohms)

Table 2-36. Maximum Intermittent Power Levels at the Input to the Node

Frequency	Power Level*
0.2 MHz to 0.6 MHz	Increasing linearly from -31dBm/200kHz to -28dBm/200kHz
> 0.6 MHz to 1 MHz	Increasing linearly from -28dBm/200kHz to -25dBm/200kHz
> 1 MHz to 1.8 MHz	Increasing linearly from -25dBm/200kHz to -16dBm/200kHz
> 1.8 MHz to 2 MHz	Increasing linearly from -16dBm/200kHz to -9dBm/200kHz
> 2.0 MHz to 2.1 MHz	Increasing linearly from -9dBm/200kHz to -1dBm/200kHz
> 2.1 MHz to 2.5 MHz	-1 dBm/200 kHz
> 2.5 MHz to 50 MHz	Decreasing linearly from -1 dBm to -30 dBm/200 kHz
> 50 MHz to100 MHz	-35 dBm/200 kHz; -30 dBm Aggregate
> 100 MHz to 200 MHz	-45 dBm/200 kHz; -40 dBm Aggregate
> 200 MHz to 375 MHz	-55 dBm/200 kHz; -50 dBm Aggregate
> 375 MHz to 395 MHz	-65 dBm/200 kHz; -60 dBm Aggregate
> 395 MHz to 400 MHz	-96 dBm/200 kHz
> 400 MHz to 700 MHz	-116 dBm/200 kHz
> 700 MHz to 705 MHz	-96 dBm/200 kHz
> 705 MHz to 725 MHz	-65 dBm/200 kHz; -60 dBm Aggregate
> 725 MHz to 900 MHz	-55 dBm/200 kHz; -50 dBm Aggregate

* The power level is the measured peak power level over any 5 μs time interval.

2.8.2.2 Band F_{SAT}

When operating in band F_{SAT}, a Node MUST meet all the performance requirements in the presence of the following simultaneous signals at the F-connector:

- OSP satellite transponder signal level as shown in Table 2-37
- DiSEqC™ signal as show in Table 2-38
- Maximum intermittent power levels as specified in Table 2-39
- UHF analog video signal as shown in Table 2-40

Table 2-37. OSP Satellite Transponder Signal Level for Band FSAT Devices

Parameter	Value	Notes
Input frequency range	950 - 3000 MHz	
Maximum signal power level	-25 dBm	Per 27MHz transponder
Maximum total aggregated power level	-7 dBm	

Table 2-38. DiSEqC™ Control Signal

Parameter	Value	Notes
Tx carrier frequency	17.6 kHz - 26.4 kHz	
Signal level	200 mVp-p – 1Vp-p	
DiSEqC™ impedance	12 – 18 ohm	Rx mode

Table 2-39. Maximum Intermittent Power Levels at the Input to the Node

Frequency	Power Level*
1 MHz < f ≤ 10 MHz	-30 dBm / 200 kHz, -13 dBm aggregate
10MHz < f ≤ 300MHz	-35 dBm / 200 kHz, -30 dBm aggregate
300 < f ≤ 450MHz	-45 dBm / 200 kHz, -40 dBm aggregate
450 < f ≤ 625MHz	-55 dBm / 200 kHz, -50 dBm aggregate
625 < f ≤ 645MHz	-65 dBm / 200 kHz, -60 dBm aggregate
645 MHz < f ≤ 650 MHz	-96 dBm / 200 kHz
650 MHz < f ≤ 875 MHz	-116 dBm / 200 kHz
875 MHz < f ≤ 880 MHz	-96 dBm / 200 kHz
880 < f ≤ 900MHz	-65 dBm / 200 kHz, -60 dBm aggregate
900 < f ≤ 950 MHz	-55 dBm / 200 kHz, -50 dBm aggregate

* The power level is the measured peak power level over any 5 μs time interval.

Table 2-40. UHF Analog Video Signal

Parameter	Value	Notes
Input frequency range	500 – 575MHz	
Maximum signal power level (per channel)	-27 dBm	Peak NTSC picture carrier level in 6MHz bandwidth
Maximum number of carriers	2	
Maximum aggregate power level	-24 dBm	

2.8.3 Receiver Sensitivity to Gated Noise in Bands E and F

A receiving Node in a MoCA Network operating in MoCA 2.0 Mode MUST achieve on its Primary Channel a minimum PHY Rate per received power level as specified in Table 2-41 in the presence of a gated AWGN noise of any duty cycle, any cycle duration, and any power density levels up to -145 dBm/Hz, at the F-connector input to the Node.

These minimum PHY Rate requirements apply under the following conditions:

- The network is operating in bands E or F.
- The in-home cable plant response is Flat Channel.

For bonded-pair Nodes the requirements specified in this section apply to both the Primary Channel and the Secondary Channel independently.

Table 2-41. Bands E and F Minimum PHY Rate vs. Receive Power Level with Gated Noise

Input Level [dBm]	Minimum Required PHY Rate [Mbps]
-6	600
-25	540
-34	426
-38	330
-44	205

2.9 *Sensitivity to ATSC Interference*

The requirements in this section apply only when a Node is operating in band E or band F.

A receiving Node in a MoCA Network operating in MoCA 2.0 Mode MUST achieve on its Primary Channel a minimum PHY Rate as follows:

When operating in band E:

- 190 Mbps with four to six co-channel ATSC signals
- 330 Mbps with three or less co-channel ATSC signals

- When operating in band F:
  - 330 Mbps with three or less co-channel ATSC signals

The above minimum PHY Rate requirements apply under the following conditions:

- The in-home cable plant response is Flat Channel with the addition of the co-channel ATSC signals meeting the following additional restriction:
  - When operating in band E: Each of the ATSC signals is of power level up to -65 dBm each at the F connector occurring anywhere within band E and:
    - i. When there are four to six co-channel ATSC signals, their center frequencies are no more than 12 MHz apart.
    - ii. When there are three or less co-channel ATSC signals, their center frequencies are no more than 18 MHz apart
  - When operating in band F: Each of the ATSC signals is of power level up to -65 dBm each at the F connector occurring anywhere within band F up to 698 MHz (upper edge of the ATSC signal), and the center frequencies of the ATSC signals are no more than 18 MHz apart.
- All the Nodes in the network have recovered from the appearance of the co-channel ATSC signals (including if necessary rejoining or reforming the network as specified below).

A receiving Node in a MoCA Network operating in band E or band F in MoCA 2.0 Mode MUST achieve on its Primary Channel a minimum PHY Rate of 600 Mbps under the following conditions:

- Three or less adjacent ATSC signals of power up to -65 dBm each at the F connector present:
  - When operating in band E: anywhere in band E outside the MoCA Network channel of operation
  - When operating in band F: anywhere in band F up to 698 MHz (upper edge of ATSC signal) outside the MoCA Network channel of operation

A Node in a MoCA Network MUST be able to reform the existing MoCA Network within the time T_{ATSC_RFRM}, as specified in Table 2-42, following the appearance of the following signals at the input to the Node:

- When operating in band E: up to six ATSC signals each at -65 dBm, appearing anywhere within band E but with no more than 3 ATSC signals in any 50 MHz band.
- When operating in band F: up to three ATSC signals each at -65 dBm, appearing anywhere within band F up to 698 MHz (upper edge of the ATSC signal).

A Node in a MoCA Network MUST be able to rejoin the existing MoCA Network within T_{ATSC_RJOIN}, as specified in Table 2-43, following the appearance of the following signals at the input to the Node:

- When operating in band E: up to six ATSC signals each at -65 dBm, appearing anywhere within band E but with no more than 3 ATSC signals in any 50 MHz band.
- When operating in band F: up to three ATSC signals each at -65 dBm, appearing anywhere within band F up to 698 MHz (upper edge of the ATSC signal).

Table 2-42. ATSC Interference Maximum Time to Reform a Network

Band of Operation	# of Nodes	T_{ATSC_RFRM} [sec]	
		T_{LP_MIN} = T_{LP_MIN1} for at least one Node	T_{LP_MIN} = T_{LP_MIN2} for all Nodes
E	2 to 6	115	235
E	7 to 16	215	335
F	2 to 6	130	250
F	7 to 16	230	350

Table 2-43. ATSC Interference Maximum Time to Rejoin a Network

Band of Operation	T_{ATSC_RJOIN} [sec]	
	Node's LOF = Channel of existing MoCA Network	Node's LOF ≠ Channel of existing MoCA network
E	25	50
F	25	70

2.10 *Non-Transmit Spurious and Noise Emissions*

2.10.1 Extended Band D Non-Transmit Emissions

The spurious signals from a Node, when operating in extended band D and not transmitting, at the output of the MoCA F-connector, MUST conform to Table 2-44. For a Node supporting Channel Bonding this requirement applies to each of the Node's MoCA 2.0 PHY transmitters independently.

Table 2-44. Extended Band D Non-Transmit Emissions Limits

Parameter	Frequency Range	Maximum Value
Spurious at multiples of 25 MHz	1150 to 1650 MHz where: fc – 150 MHz ≤ f ≤ fc + 150 MHz	-90 dBm/200 kHz
Spurious at multiples of 25 MHz	1150 to 1650 MHz where: f ≤ fc – 175 MHz or f ≥ fc + 175 MHz	-72 dBm/200 kHz
Spurious at multiples of 25 MHz	1125 MHz and 1675 to 2150 MHz	-72 dBm/200 kHz
Spurious excluding multiples of 25 MHz	1125 to 2150 MHz	-110 dBm/200 kHz

* fc represents the center frequency of the Node's MoCA 2.0 PHY transmitter

2.10.2 Band E Non-Transmit Emissions

The spurious signals from a MoCA 2.0 Node, when operating in band E and not transmitting, at the output of the F-connector, MUST conform to Table 2-45. For a Node supporting Channel Bonding this requirement applies to each of the Node's MoCA 2.0 PHY transmitters independently.

Table 2-45. Band E Non-Transmit Emissions Limits

Parameter	Frequency Range	Maximum Value
Spurious and Noise	0.5 to ≤ 2.1 MHz	-50 dBm/152kHz
Spurious and Noise	2.1 to ≤ 4.0 MHz	-78dBm/152kHz
Spurious at multiple of 25 MHz	425 MHz to 675 MHz where: fc-150 MHz ≤ f ≤ fc+150 MHz	-90 dBm/200kHz
Spurious at multiple of 25 MHz	425 MHz to 675 MHz where: f ≤ fc-175 MHz or f ≥ fc+175 MHz	-72 dBm/200kHz
Spurious at multiple of 25 MHz	25 MHz to 400 MHz and 700 MHz to 925 MHz	-72 dBm/200kHz
Spurious emissions and Noise excluding multiples of 25 MHz	4 MHz to 400 MHz and 700 MHz to 950 MHz	-96 dBm/200 kHz
Spurious emissions and Noise excluding multiples of 25 MHz	400 MHz to 700 MHz where: f ≤ fc-175 MHz or f ≥ fc+175 MHz	-108 dBm/200 kHz
Spurious emissions and Noise excluding multiples of 25 MHz	400 MHz to 700 MHz where: fc-175 MHz < f < fc+175 MHz	-114 dBm/200 kHz
Up to 3 temporally constant spurs* excluding multiples of 25 MHz	In any 50 MHz band centered at 25n MHz where: n = 17 to 27	-102 dBm/200 kHz
Spurious and Noise	950 to 2500 MHz	-94 dBm/20 MHz
Spurious and Noise	> 2500 to 3000 MHz	-80 dBm/20 MHz

*Temporally constant spur is a constant amplitude spur measured over a 5 minute interval.

2.10.3 Band F Non-Transmit Emissions

The spurious signals from a Node at the output of the F-connector when not transmitting MUST conform to Table 2-46 when operating in band F_{SAT} and MUST conform to Table 2-47 when operating in band F_{CBL}. For a Node supporting Channel Bonding this requirement applies to each of the Node's MoCA 2.0 PHY transmitters independently.

Table 2-46. Band FSAT Non-Transmit Emissions Limits

Parameter	Frequency Range	Maximum Value
Spurious and Noise	10 KHz < f ≤ 1 MHz	25 mV p-p at 12 ohm
Spurious and Noise	1 MHz < f < 500 MHz	-58 dBm / 50 MHz
Spurious and Noise	500 MHz ≤ f ≤ 575MHz	-83 dBm / 50 MHz
Spurious at multiple of 25 MHz	600 MHz ≤ f ≤ 650 MHz	-72 dBm / 200 KHz
Spurious Emissions and Noise excluding multiples of 25 MHz	575MHz < f < 650MHz	-96 dBm / 200 kHz
Spurious at multiple of 25 MHz	675 MHz ≤ f ≤ 850 MHz	-90 dBm / 200 kHz
Spurious Emissions and Noise excluding multiples of 25 MHz	650 MHz ≤ f ≤ 875 MHz	-114 dBm / 200 kHz
Up to 3 temporally constant spurs* excluding multiples of 25 MHz	In any 50 MHz band centered at 25n MHz where: n = 27 to 34	-102 dBm / 200 kHz (each spur)
Spurious at multiple of 25 MHz	875 MHz ≤ f ≤ 925 MHz	-72 dBm / 200 KHz
Spurious Emissions and Noise excluding multiples of 25 MHz	875 MHz < f < 950 MHz	-96 dBm / 200 kHz
Spurious and Noise	950 MHz ≤ f ≤ 3000 MHz	-94 dBm / 27 MHz

*Temporally constant spur is a constant amplitude spur measured over a 5 minute interval.

Table 2-47. Band FCBL Non-Transmit Emissions Limits

Parameter	Frequency Range	Maximum Value
Spurious and Noise	1 MHz < f < 54 MHz	-58 dBm / 50 MHz
Spurious at multiple of 25 MHz	25 MHz ≤ f ≤ 50 MHz	-72 dBm / 200 KHz
Spurious and Noise	54 MHz ≤ f ≤ 575MHz	-94 dBm / 4 MHz
Discrete tones only	54 MHz ≤ f ≤ 575MHz	-99 dBm
Spurious at multiple of 25 MHz	600 MHz ≤ f ≤ 650 MHz	-72 dBm / 200 KHz
Spurious Emissions and Noise excluding multiples of 25 MHz	575MHz < f < 650MHz	-96 dBm / 200 kHz
Spurious at multiple of 25 MHz	675 MHz ≤ f ≤ 850 MHz	-90 dBm / 200 kHz
Spurious Emissions and Noise excluding multiples of 25 MHz	650 MHz ≤ f ≤ 875 MHz	-114 dBm / 200 kHz
Up to 3 temporally constant spurs* excluding multiples of 25 MHz	In any 50 MHz band centered at 25n MHz where: n = 27 to 34	-102 dBm / 200 kHz (each spur)
Spurious at multiple of 25 MHz	875 MHz ≤ f ≤ 2150 MHz	-72 dBm / 200 KHz
Spurious Emissions and Noise excluding multiples of 25 MHz	875 MHz < f < 950 MHz	-96 dBm / 200 kHz
Spurious Emissions and Noise excluding multiples of 25 MHz	950 MHz ≤ f ≤ 2150 MHz	-110 dBm / 200 kHz

*Temporally constant spur is a constant amplitude spur measured over a 5 minute interval.