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Contents

Foreword

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shall not indicates an interdiction (prohibition) to do something

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should indicates a recommendation to do something

should not indicates a recommendation not to do something

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can indicates that something is possible

cannot indicates that something is impossible

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will indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

will not indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

might indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document is a technical report for LTE IoT NTN operating bands.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 38.741: “Non-Terrestrial Networks (NTN) L-/S-band for NR”.

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

4 Background

In 3GPP RAN#99 meeting, for fulfilling market demand, the new spectrum WI to add support for a new IoT NTN band with the DL part on the S-band (2500MHz) and the UL part on the L-band (1600MHz) was agreed. Additionally, another new IoT NTN spectrum WI for the Extended L-band (DL 1518-1525 MHz, UL 1668-1675 MHz) was agreed as well. Introduction and specification of requirements for more NTN IoT bands is expected and can be requested if necessary.

5 Common band agnostic aspects

5.1 System parameters

5.1.1 Operating bands

IoT NTN operation is designed in the operating bands defined in Table 5.1.1-1.

Table 5.1.1-1 E-UTRA operating bands for IoT NTN operation

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit	Downlink (DL) operating band BS transmit UE receive	Duplex Mode
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	
254	1610 MHz - 1626.5 MHz	2483.5 MHz - 2500 MHz	FDD
253	1668 MHz - 1675 MHz	1518 MHz - 1525MHz	FDD
NOTE: Satellite bands are numbered in descending order from 256			

5.1.2 Channel arrangements

5.1.2.1 Channel arrangement for category M1

Table 5.1.2.1-1: E-UTRA channel numbers

E-UTRA Operating Band	ΔF_{Raster} (kHz)	Downlink			Uplink		
		F_{DL_low} (MHz)	$N_{Offs-DL}$	Range of N_{DL} (First – <Step size> – Last)	F_{UL_low} (MHz)	$N_{Offs-UL}$	Range of N_{UL} (First – <Step size> – Last)
254	100	2483.5	228571	228571 –<1>- 228735	1610	261339	261339 –<1>- 261503
253	100	1668	228501	228501-<1>- 228570	1518	261269	261269 -<1>- 261338

NOTE: In addition to the above, the following was agreed during RAN4#108-bis:

- The need for additional flexibility in channel raster for IoT NTN LTE bands has been identified, especially to accommodate future deployments of NB-IoT NTN and eMTC NTN together with NR NTN around existing services, taking into account possible guard bands for protection of other services, Doppler, and for deployment within the same SAN (i.e. same FFT). This issue could be further discussed independently of band 253, with more general applicability to all IoT NTN LTE bands.
  - Capture this aspect in the TR.
  - FFS whether to capture a note in the specification

Table 5.1.2.1-2: Default UE TX-RX frequency separation

E-UTRA Operating Band	TX – RX carrier centre frequency separation
254	873.5 MHz
253	-150 MHz

NOTE: As highlighted in RAN4#108-bis, based on operator input, there is a strong desire to consider flexible TX-RX separation for the band itself, and moreover for NTN FR1 bands, provided the frequency separation is sufficiently large.

The following conclusion was reached during RAN4#109:

Conclusion: Stop discussion on this issue in this WI.

6 FDD band B254 (L+S band)

6.1 Regulation

Existing regulatory information concerning regulatory rules applicable to this NTN L-/S-band can be found in Clause 5 in [2].

6.2 UE requirements

6.2.1 UE transmitter characteristics

6.2.1.1 Maximum output power for category M1 and NB1/NB2

Table 6.2.1.1-1: UE Power Class for category M1

EUTRA band	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 5 (dBm)	Tolerance (dB)
254			23	+/-2	20	+/-2
NOTE 1: $P_{PowerClass}$ is the maximum UE power specified without taking into account the tolerance.						

Table 6.2.1.1-2: UE Power Class for category NB1/NB2

EUTRA band	Class 3 (dBm)	Tolerance (dB)	Class 5 (dBm)	Tolerance (dB)
254	23	+/-2	20	+/-2

6.2.1.2 Emission requirements and NS values

6.2.1.2.1 Spurious emission for category M1

Table 6.2.1.2.1-1: Requirements for spurious emissions for UE co-existence

E-UTRA Band	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
254	E-UTRA Band 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 31, 41, 48, 54, 66, 70, 71, 72, 85, 87, 88, 103 NR Band n1, n3, n7, n8, n18, n20, n28, n34, n38, n39, n40, n50, n51, n53, n54, n65, n67, n74, n75, n76, n77, n78, n90, n91, n92, n93, n94, n105	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	2

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.1.1-1
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5A.4.2-2 are permitted for each assigned E-UTRA carrier used in the measurement due to 2nd, 3rd, 4th [or 5th] harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x L_{CRB} x 180kHz), where N is 2, 3, 4, [5] for the 2nd, 3rd, 4th [or 5th] harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.

6.2.1.3 Configured TX power

It is agreed the current TS 36.102 requirements can be re-used for band n254.

6.2.1.4 Power control

It is agreed the current TS 36.102 requirements can be re-used for band n254.

6.2.1.5 Frequency error

It is agreed the current TS 36.102 requirements can be re-used for band n254.

6.2.1.6 Transmit modulation quality

It is agreed the current TS 36.102 requirements can be re-used for band n254.

6.2.2 UE receiver characteristics

6.2.2.1 Reference sensitivity for category M1 and NB1/NB2

Table 6.2.2.1-1: Reference sensitivity for FDD UE category M1 QPSK $P_{REFSENS}$

NTN Band	REFSENS (dBm)	Duplex Mode
254	-102.2	FDD
255	-102.7	FDD
256	-102.2	FDD
NOTE 1: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.5- in TS 36.101 [7].		

Table 6.2.2.1-2: Reference sensitivity for HD-FDD UE category M1 QPSK $P_{REFSENS}$

NTN Band	REFSENS (dBm)	Duplex Mode
254	-103.1	HD-FDD
255	-103.5	HD-FDD
256	-103	HD-FDD
NOTE 1: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.5 in TS 36.101 [7].		

Table 6.2.2.1-3: FDD UE category M1 Uplink configuration for reference sensitivity

E-UTRA Band	N_{RB}	Duplex Mode
254	6[1]	FDD and HD-FDD
255	6[1]	FDD and HD-FDD
256	6[1]	FDD and HD-FDD
NOTE 1: [1] refers to the UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.3A-1).		

Table 6.2.2.1-4: Reference sensitivity for UE category NB1 and NB2

Operating band	REFSENS [dBm]
According to subclause 5.2B	- 108.2

6.2.2.2 Blocking requirements

For Out-of-Band Blocking requirement, it is agreed to reuse the general requirements for NR bands with FDL_high < 2700 MHz and FUL_high < 2700 MHz, for band b254 category M1 and NB1/NB2.

6.2.3 Evaluation and simulation

6.2.3.1 Evaluation and simulation on Cat. M1

The 3GPP emission mask for the 1.4MHz channel is generally either the same or stricter comparing to the ETSI or FCC requirements, and there is one case for the ETSI in-band emission mask for the 1618.25-1626.5MHz range where the ETSI mask is stricter. To check whether existing MPR requirements still apply, we conduct a set of simulation cases with the 1.4MHz LTE channel placed in different locations. The common simulation parameters are as follows:

- Tx power: PC3 +23dBm
- Modulation: DFT-s-OFDM QPSK
- LO placement: always in the centre of the carrier
- Regulations: ETSI and FCC

As for the actual channel configurations, Figure 6.2.3-1 below shows three 1.4MHz channel with centre frequencies of 1610.7MHz, 1618.95MHz and 1625.8MHz.

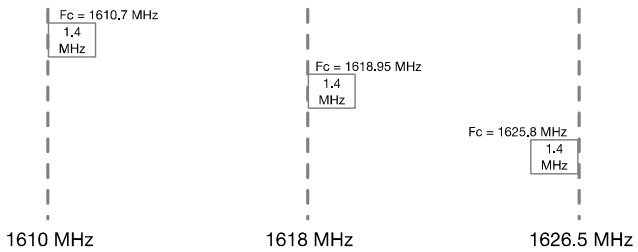


Figure 6.2.3.1-1: Considered channels for power back-off simulations.

Figure 6.2.3.1-2 below captures summary of the power back-off needed for the LTE MTC 1.4MHz channel placed right at the lower edge of the NTN L-/S-band:

- For most cases no power back-off is needed at all. Even when a single RB is scheduled at the lower-most edge of the channel resulting in the highest PSD, still no power back-off is required.
- There are only two cases when power back-off is applied, when 5 and 6 RBs are scheduled. Still power back-off values are quite marginal, 0.2dB, and are within the existing MPR allowances (see Appendix A).

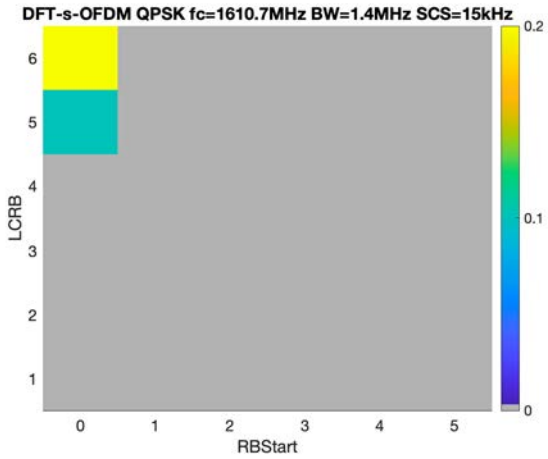


Figure 6.2.3.1-2: Power back-off values for the 1.4MHz channel at Fc=1610.7MHz.

Figure 6.2.3.1-3 below captures summary of the power back-off needed for the LTE MTC 1.4MHz channel placed in the second ETSI sub-range of 1618.25-1626.5MHz:

- The main conclusion is that while a UE might need some power back-off to meet emission requirements, it is needed only for 5-6 RBs and the maximum value does not exceed 0.3dB, which is still within existing MPR requirements (see Appendix A).
- It does not matter much whether the 1.4MHz channel is at the lower or the upper edge of the second ETSI sub-range. While there are out-of-band emission requirements for frequencies above 1628.5MHz, they do not have any discernible impact on the power back-off values.

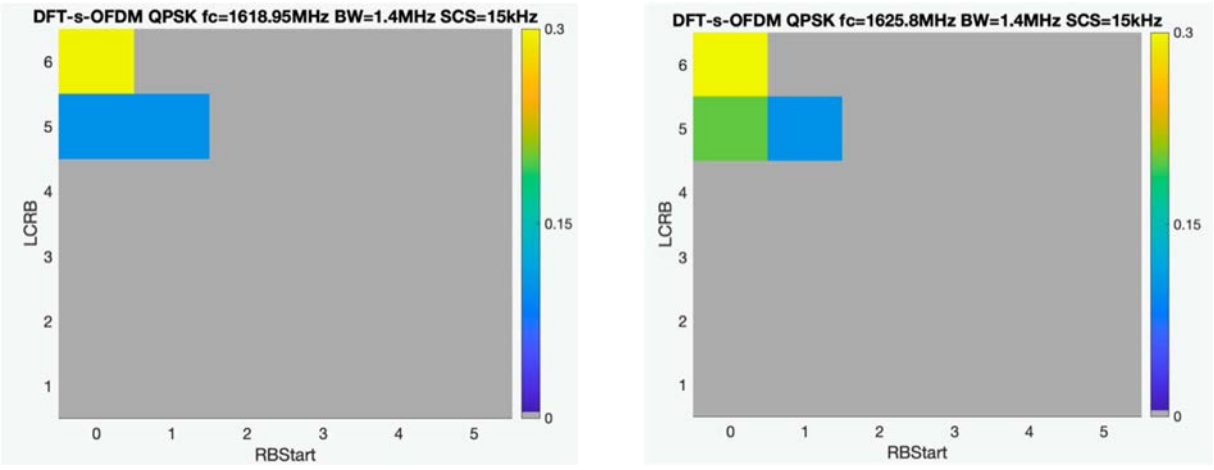
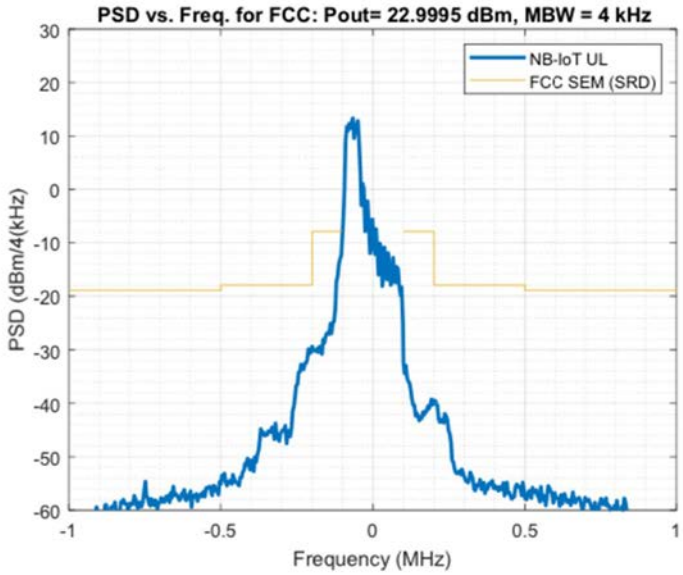


Figure 6.2.3.1-3: Power back-off values for the 1.4MHz channel at Fc=1618.95 and Fc=1625.8MHz.

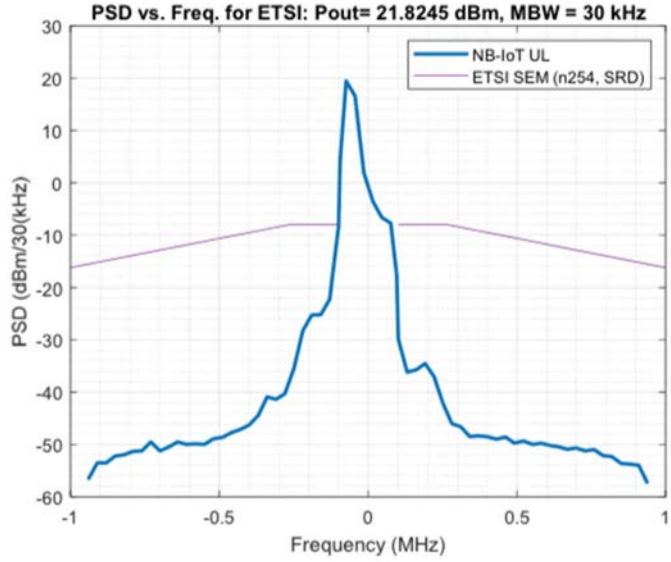
Based on these observations our preliminary view is that no additional maximum power reduction requirements are needed to meet existing FCC and ETSI requirements.

6.2.3.2 Evaluation and simulation on Cat. NB1/NB2

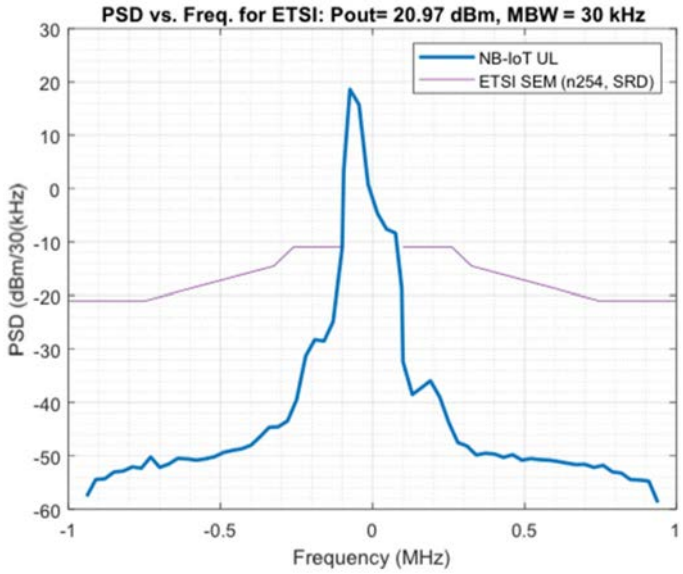
For A-MPR for category NB1/NB2, simulations where a QPSK signal with different allocations including 3 tones, 6 tones and 12 tones is generated and passed to a typical PC3 power amplifier. And LO is set to the center of the carrier. The simulation results are shown in the following figures from R4-2317572 and R4-2318708.



a. 3-tone [0-2] allocation, FCC → No A-MPR is required

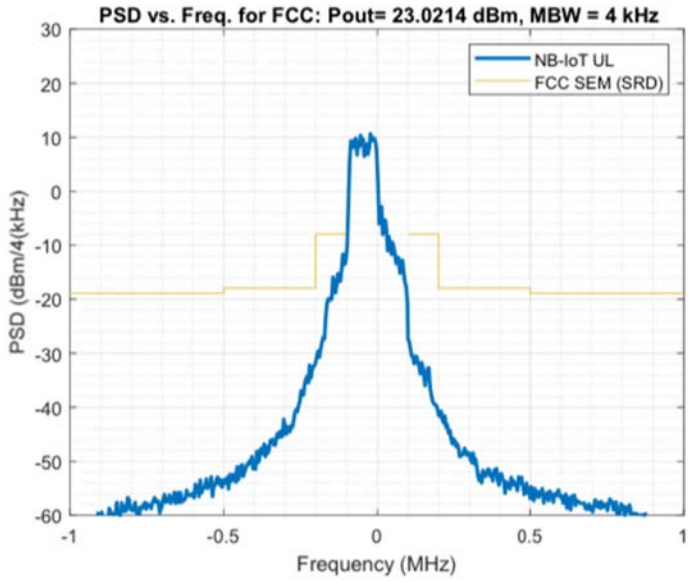


b. 3-tone [0-2] allocation, ETSI, Fc = 1610 – 1618.25 MHz → A-MPR = 0.7dB

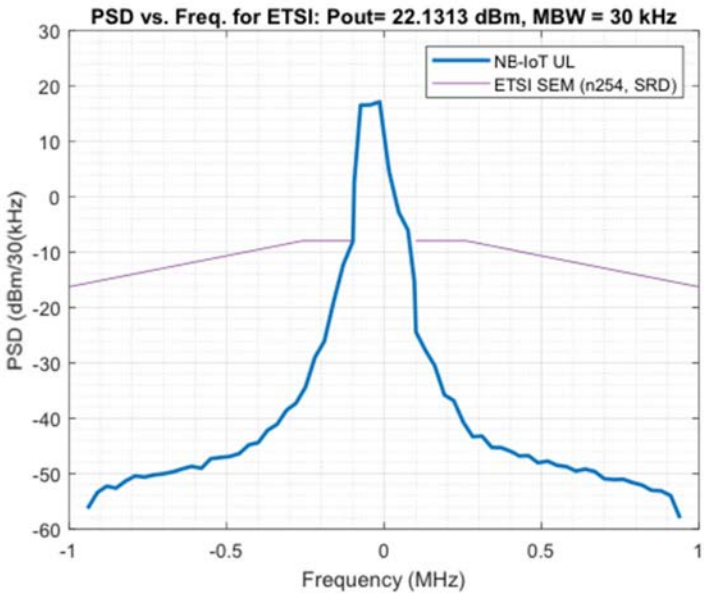


c. 3-tone [0-2] allocation, ETSI, Fc = 1618.25 – 1626.5 MHz → A-MPR = 1.5 dB

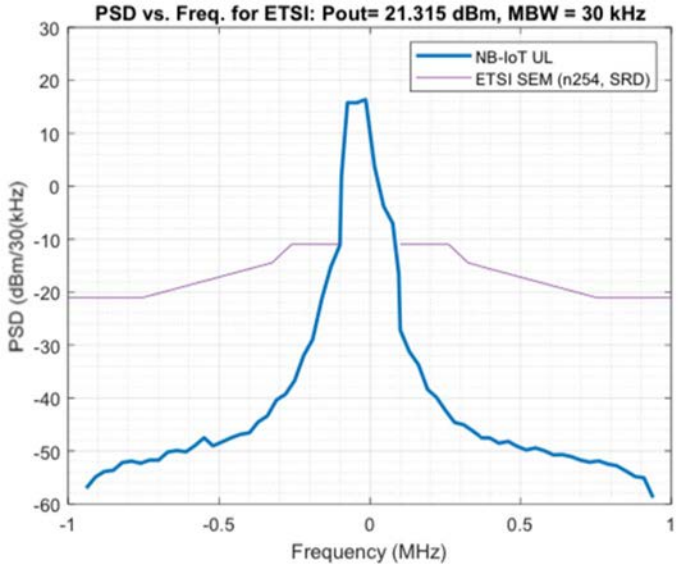
Fig. 6.2.3.2-1, MPR simulation results wth 3-tone allocation for FCC and ETSI requirements.



d. 6-tone [0-6] allocation, FCC → No A-MPR is required

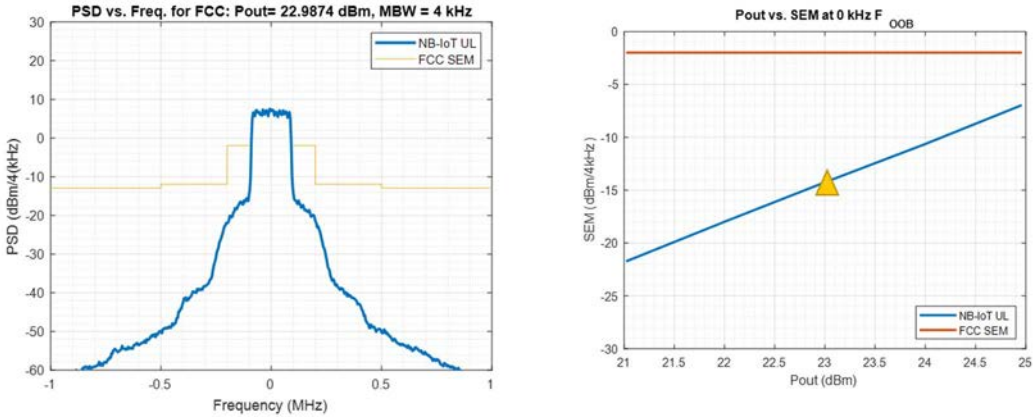


e. 6-tone [0-5] allocation, ETSI, Fc = 1610 – 1618.25 MHz → A-MPR = 0

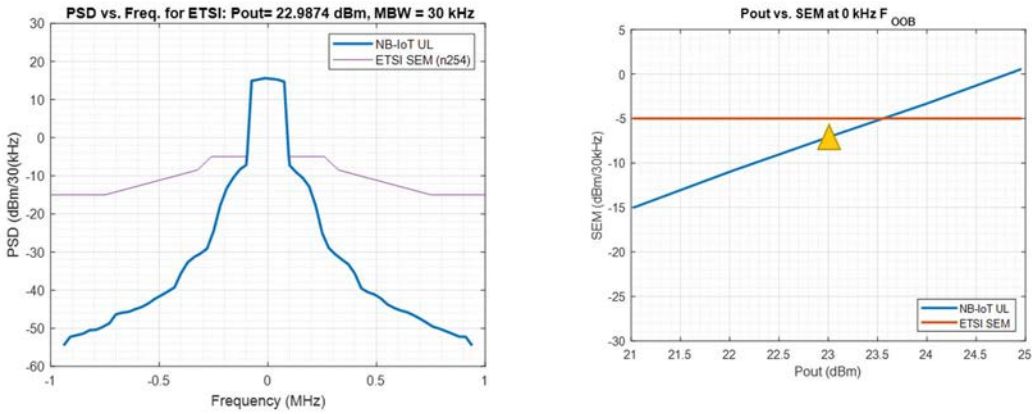


f. 6-tone [0-5] allocation, ETSI, Fc = 1618.25 – 1626.5 MHz → A-MPR = 0.7dB

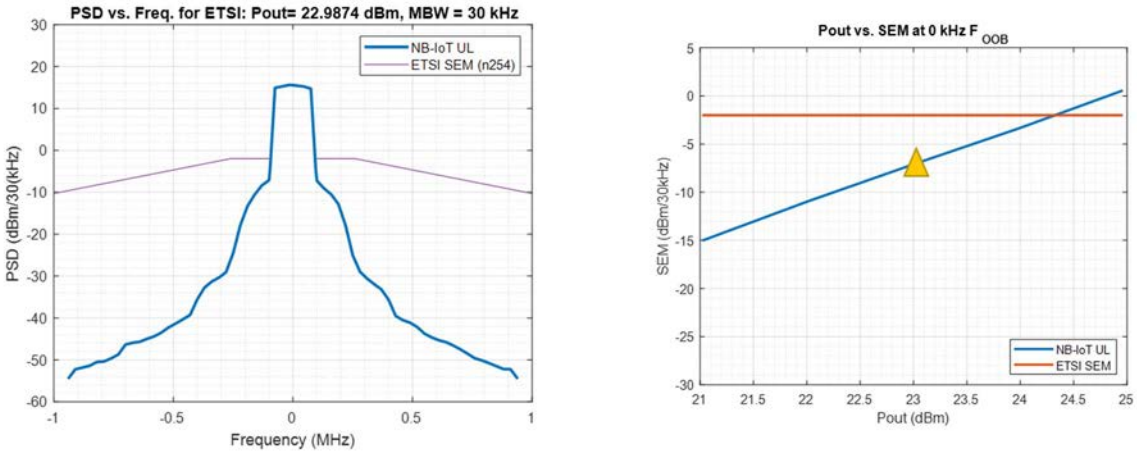
Fig. 6.2.3.2-2, MPR simulation results wth 6-tone allocation for FCC and ETSI requirements.



g. FCC



h. ETSI, Fc = 1618.25 MHz – 1626.5 MHz



i. ETSI, Fc = 1610 MHz – 1618.25 MHz

Fig. 6.2.3.2-3, MPR simulation results wth 12-tone allocation for FCC and ETSI requirements.

The additional MPR is not required for FCC regulations.

The additional MPR are summarized in the tables below for ETSI regulations.

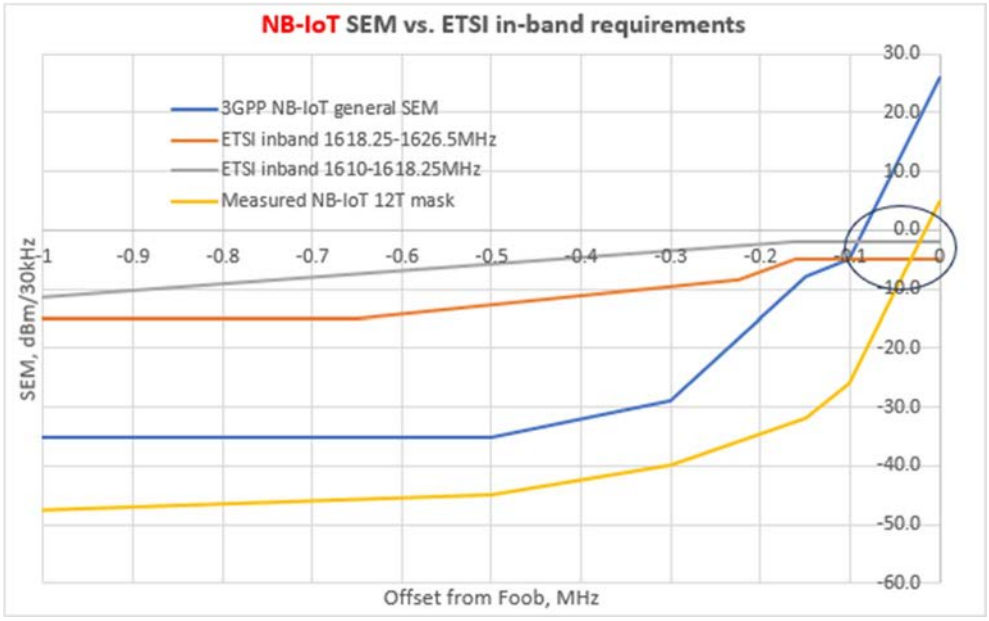
Table 6.2.3.2-1: A-MPR for NS_04N

Modulation	QPSK		
Tone positions for 3 Tones allocation	0-2	3-5 and 6-8	9-11
A-MPR	≤ 0.7 dB	0.2 dB	≤ 0.7 dB
Tone positions for 6 Tones allocation	0-5 and 6-11		
A-MPR	0 dB	0 dB	
Tone positions for 12 Tones allocation	0-11		
A-MPR	0 dB		

Table 6.2.3.2-2: A-MPR for NS_05N

Modulation	QPSK		
Tone positions for 3 Tones allocation	0-2	3-5 and 6-8	9-11
A-MPR	≤ 1.5 dB	0.5 dB	≤ 1.5 dB
Tone positions for 6 Tones allocation	0-5 and 6-11		
A-MPR	≤ 0.7 dB	≤ 0.7 dB	
Tone positions for 12 Tones allocation	0-11		
A-MPR	0 dB		

For 12-tone allocation, the below results are based on the measurements from R4-2321798.



6.3 BS requirements

7 FDD band 253 (Extended L-band)

7.1 Regulation

NOTE1: The purpose of this section is to collect information from existing regulatory documents concerning regulatory rules applicable to this NTN extended L band.

NOTE2: As per agreement in RAN4#108, the following assumption is captured:

For the time being, re-use TN-NTN coexistence assumptions from TR 38.863, which would yield a total separation distance of 5250 m from TN BS site and NTN UE, at least for low-gain land-based NTN UE, compatible with smartphone and IoT use cases.

NOTE3: At RAN#108-bis Xiamen, an LS Reply was received from ETSI SES SCN (R4-2317932), with the following content:

"ETSI TC SES would like to thank 3GPP RAN4 for its LS on the 3GPP NTN requirements and the potential impact on the specification work in ETSI TC SES.

ETSI TC SES want to clarify that the requirements in the ETSI harmonised standards for earth stations are defined based on and referenced in CEPT regulatory framework or in accordance with ITU recommendations. Current TC-SES ETSI harmonised standards have not yet considered 3GPP NTN access technology and updates may be needed.

Therefore, it is proposed to create a new work item (NWI) in ETSI in order to accommodate NTN requirements in harmonised standards. There are already ongoing discussions between ETSI TC SES and ETSI TC MSG groups to find a way forward to capture the 3GPP NTN specifications in ETSI standards.

ETSI TC SES would remain at the disposal of 3GPP RAN4 for any additional information."

NOTE4: ETSI requirements from EN 301 681 and ECC requirements from ECC Report 263 are captured for information, but have not presently been included in the specification.
As per the agreement raised in RAN4#109 below, the introduction of additional blocking requirements from ETSI EN 301 681 and recommendations from ECC Report 263 has been put on hold. Any ETSI- or ECC-specific requirements will be addressed after further feedback from ETSI is received.

7.1.1 ETSI EN 301 681

7.1.1.2 Overview

The following section includes excerpts from ETSI EN 301 681.

7.1.2.2 Excerpts from EN 301 681

ETSI EN 301 681 is applicable to Mobile Earth Stations (SES) with both transmit and receive capabilities for operation in Satellite Personal Communications Networks (S-PCN) in any combination of all or any part of the Mobile Satellite Service (MSS) frequency bands sub-band 1 and sub-band 2 defined in table 7.1.2.2-1.

Table 7.1.2.2-1: Mobile Satellite Service (MSS) frequency band

Sub-band	Transmission path	MSS frequency band
1	MESs transmit 1	1 626,5 MHz to 1 660,5 MHz
	MESs receive 1	1 525 MHz to 1 559 MHz
2	MESs transmit 2	1 668,0 MHz to 1 675,0 MHz
	MESs receive 2	1 518,0 MHz to 1 525,0 MHz

Unwanted emissions from Mobile Earth Stations (LMESs) outside the band 1 626,5 MHz to 1 660,5 MHz and outside the band 1 668 MHz to 1 675 MHz shall be below the following limits.

Unless otherwise stated the specification in this clause shall apply to all types of MESs notwithstanding their transmitting capabilities within the frequency bands as defined in table 7.1.2.2-1:

- For MES that are capable of transmitting within only the sub-band 1 frequency band as defined in table 7.1.2.2-1, the maximum EIRP spectral density of the unwanted emissions from the MES outside the band 1 626,5 MHz to 1 660,5 MHz shall not exceed the limits in either table 7.1.2.2-2 or table 7.1.2.2-3. The applicant shall declare which alternative shall be used.

- For MES that are capable of transmitting within only sub-band 2 frequency band or within both the sub-band 1 and sub-band 2 frequency bands, the maximum EIRP spectral density of the unwanted emissions from the MES

outside the bands 1 626,5 MHz to 1 660,5 MHz and 1 668,0 MHz to 1 675,0 MHz shall not exceed the limits in table 7.1.2.2-3.

Table 7.1.2.2-2: Unwanted emissions outside the band 1 626,5 MHz to 1 660,5 MHz for MES only capable of transmitting within sub-band 1 frequency band as defined in table 7.1.2.2-1

Frequency (MHz)	Carrier - on state		
	EIRP (dBW)	Measurement bandwidth	Measurement method (see note 6)
30 to 1 000	-66	100 kHz	Peak Hold
1 000 to 1 559	-61	1 MHz	Average
1 559 to 1 605,0	-70	1 MHz (see note 3)	Average (see note 2)
1 605,0 to 1 612,5	-70 to -58,5 (see note 4)	1 MHz (see note 3)	Average
1 612,5 to 1 616,5	-55 to -50 (see note 4)	1 MHz	Average
1 616,5 to 1 621,5	-50 to -46 (see note 4)	1 MHz	Average
1 621,5 to 1 624,5	-60	30 kHz	Average
1 624,5 to 1 625,0	-60 to -57,5 (see notes 4, 5, 7)	30 kHz	Average
1 625,0 to 1 625,125	-57,5 to -57,2 (see notes 4, 5, 7)	30 kHz	Average
1 625,125 to 1 625,8	-57,2 to -50 (see notes 4, 5, 7)	30 kHz	Average
1 625,8 to 1 626,0	-50 to -47 (see notes 4, 5, 7)	30 kHz	Average
1 626,0 to 1 626,2	-47 to -40 (see notes 4, 5, 7)	30 kHz	Average
1 626,2 to 1 626,5	-40 (see notes 5, 7)	30 kHz	Average
1 626,5 to 1 660,5	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
1 660,5 to 1 662,5	The levels in table 4a shall apply from 1 660,5 MHz to 1 662,5 MHz		
1 662,5 to 1 665,5	-60	30 kHz	Average
1 665,5 to 1 670,5	-60	100 kHz	Average
1 670,5 to 1 680,5	-60	300 kHz	Average
1 680,5 to 1 690,5	-60	1 MHz	Average
1 690,5 to 2 250	-60	3 MHz	Average
2 250 to 12 750 (see note 1)	-60	3 MHz	Peak Hold

NOTE 1: In the band 3 253,0 MHz to 3 321,0 MHz the maximum EIRP in one, and only one, 3 MHz measurement bandwidth shall not exceed -38 dBW. Elsewhere in this band the power limit in table 3 shall be applied.
In each of the bands 4 879,5 MHz to 4 981,5 MHz, 6 506,0 MHz to 6 642,0 MHz and 8 132,5 MHz to 8 302,5 MHz the maximum EIRP in one, and only one, 3 MHz measurement bandwidth shall not exceed -48 dBW. Elsewhere in this band the power limit in table 3 shall be applied.
NOTE 2: The average measurement method defined in clause 5.2.2.3 shall apply except that an averaging period of 20 ms shall be used in the sub-band 1 573,42 MHz to 1 580,42 MHz.
NOTE 3: Measurement bandwidths less than 1 MHz are allowable provided the power in the narrower bandwidth is integrated over 1 MHz.
NOTE 4: Linearly interpolated in dBW vs. Frequency.
NOTE 5: The power limits specified in the band 1 624,5 MHz to 1 626,5 MHz require further study. This study is important to determine whether less stringent limits may enhance spectrum efficiency and utilization immediately above 1 626,5 MHz.
NOTE 6: Peak Hold and Average measurements shall be performed as specified in clauses 5.2.2.2 and 5.2.2.3.
NOTE 7: For systems employing CDMA, the EIRP limits shall be decreased by 10 log (N) dB, where N is the maximum number of MESs in the receive beam of the satellite to which these MESs are communicating and which are expected to transmit simultaneously in the same frequency band within that same beam. This number shall be declared by the manufacturer (N = 1 in a TDMA system).

Table 7.1.2.2-3: Unwanted emissions outside the bands 1 626,5 MHz to 1 660,5 MHz and 1 668,0 MHz to 1 675,0 MHz for MES capable of transmitting within all or any part of sub-band 1 and sub-band 2 frequency bands as defined in table 7.1.2.2-1

Frequency (MHz)	Carrier - on state		
	EIRP (dBW)	Measurement bandwidth	Measurement method (see note 8)
30 to 1 000	-66	100 kHz	Peak Hold
1 000 to 1 559	-61	1 MHz	Average
1 559 to 1 605,0	-70	1 MHz (see note 5)	Average (see note 2)
1 605,0 to 1 612,5	-70 to -58,5 (see note 6)	1 MHz (see note 5)	Average
1 612,5 to 1 616,5	-55 to -50 (see note 6)	1 MHz	Average
1 616,5 to 1 621,5	-50 to -46 (see note 6)	1 MHz	Average
1 621,5 to 1 624,5	-60	30 kHz	Average
1 624,5 to 1 625,0	-60 to -57,5 (see notes 6, 7, 9)	30 kHz	Average
1 625,0 to 1 625,125	-57,5 to -57,2 (see notes 6, 7, 9)	30 kHz	Average
1 625,125 to 1 625,8	-57,2 to -50 (see notes 6, 7, 9)	30 kHz	Average
1 625,8 to 1 626,0	-50 to -47 (see notes 6, 7, 9)	30 kHz	Average
1 626,0 to 1 626,2	-47 to -40 (see notes 6, 7, 9)	30 kHz	Average
1 626,2 to 1 626,5	-40 (see notes 7, 9)	30 kHz	Average
1 626,5 to 1 660,5	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
1 660,5 to 1 662,5	note 1	note 1	note 1
1 662,5 to 1 666,0	-55	30 kHz	Average
1 666,0 to 1 668,0	note 2	note 2	note 2
1 668,0 to 1 675,0	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
1 675,0 to 1 677,0	note 2	note 2	note 2
1 677,0 to 1 680,0	-60	30 kHz	Average
1 680,0 to 1 685,0	-60	100 kHz	Average
1 685,0 to 1 695,0	-60	300 kHz	Average
1 695,0 to 1 705,0	-60	1 MHz	Average
1 705,0 to 2 250	-60	3 MHz	Average
2 250 to 12 750 (see note 3)	-60	3 MHz	Peak Hold

NOTE 1: For an MES transmitting in sub-band 1 (as defined in table 1) the limits defined in table 4a shall apply for the band 1 660,5 MHz to 1 662,5 MHz. For an MES transmitting in sub-band 2 (as defined in table 1) a limit of -55 dBW in 30 kHz shall apply for the band 1 660,5 MHz to 1 662,5 MHz.
NOTE 2: For an MES transmitting in sub-band 2 (as defined in table 1) the limits defined in table 4a shall apply for the bands 1 666,0 MHz to 1 668,0 MHz and 1 675,0 MHz to 1 677,0 MHz. For an MES transmitting in sub-band 1 (as defined in table 1) a limit of -55 dBW in 30 kHz shall apply for the bands 1 666,0 MHz to 1 668,0 MHz and 1 675,0 MHz to 1 677,0 MHz.
NOTE 3: In the bands 3 253,0 MHz to 3 321,0 MHz and 3 336,0 MHz to 3 350,0 MHz the maximum EIRP in one, and only one, 3 MHz measurement bandwidth shall not exceed -38 dBW. Elsewhere in this band the power limit in table 3a shall be applied.
In the bands 4 879,5 MHz to 4 981,5 MHz and 5 004,0 MHz to 5 025,0 MHz the maximum EIRP in one, and only one, 3 MHz measurement bandwidth shall not exceed -48 dBW. Elsewhere in this band the power limit in table 3a shall be applied.
In the bands 6 506,0 MHz to 6 642,0 MHz and 6 672,0 MHz to 6 700,0 MHz the maximum EIRP in one, and only one, 3 MHz measurement bandwidth shall not exceed -48 dBW. Elsewhere in this band the power limit in table 3a shall be applied.
In the bands 8 132,5 MHz to 8 302,5 MHz and 8 340,0 MHz to 8 375,0 MHz the maximum EIRP in one, and only one, 3 MHz measurement bandwidth shall not exceed -48 dBW. Elsewhere in this band the power limit in table 3a shall be applied.
NOTE 4: The average measurement method defined in clause 5.2.2.3 shall apply except that an averaging period of 20 ms shall be used in the sub-band 1 573,42 MHz to 1 580,42 MHz.
NOTE 5: Measurement bandwidths less than 1 MHz are allowable provided the power in the narrower bandwidth is integrated over 1 MHz.
NOTE 6: Linearly interpolated in dBW vs. Frequency.
NOTE 7: The power limits specified in the band 1 624,5 MHz to 1 626,5 MHz require further study. This study is important to determine whether less stringent limits may enhance spectrum efficiency and utilization immediately above 1 626,5 MHz.
NOTE 8: Peak Hold and Average measurements shall be performed as specified in clauses 5.2.2.2 and 5.2.2.3.
NOTE 9: For systems employing CDMA, the EIRP limits shall be decreased by 10 log (N) dB, where N is the maximum number of MESs in the receive beam of the satellite to which these MESs are communicating and which are expected to transmit simultaneously in the same frequency band within that same beam. This number shall be declared by the manufacturer (N = 1 in a TDMA system).

Table 7.1.2.2-4: Maximum unwanted emissions in the bands 1 626,5 MHz to 1 660,5 MHz and 1 660,5 MHz to 1 662,5 MHz caused by S-PCN MESs transmitting in the band 1 626,5 MHz to 1 660,5 MHz; and maximum unwanted emissions in the bands 1 666,0 MHz to 1 668,0 MHz, 1 668,0 MHz to 1 675,0 MHz and 1 675,0 MHz to 1 677,0 MHz caused by S-PCN MESs transmitting in the band 1 668,0 MHz to 1 675,0 MHz

Frequency offset (kHz) (see note 1)	Carrier-on state		
	EIRP (dBW) (see note 2)	Measurement bandwidth (kHz)	Measurement method
0 to 25	0 to -15	3	Average
25 to 125	-15 to -50	3	Average
125 to 425	-50	3	Average
425 to 1 500	-50 to -65	3	Average
1 500 to 36 000	-55	30	Average

NOTE 1: Frequency offset is determined from the edge of the nominated bandwidth. NOTE 2: Linearly interpolated in dBW vs. Frequency offset.

Table 7.1.2.2-5: Maximum unwanted emissions in the bands 1 626,5 MHz to 1 660,5 MHz caused by S-PCN MESs transmitting in the band 1 626,5 MHz to 1 660,5 MHz; and maximum unwanted emissions in the bands 1 668,0 MHz to 1 675,0 MHz caused by S-PCN MESs transmitting in the band 1 668,0 MHz to 1 675,0 MHz

Frequency offset (kHz) (see notes 1 and 3)	Carrier-on state		
	EIRP (dBW) (see note 2)	Measurement bandwidth (kHz)	Measurement method
0 to 25	0 to -15	3	Average
25 to 55	-15 to -25 (see note 4)	3	Average
55 to AB	-25 (see note 4)	3	Average
AB to (AB + 0,35 x B3dB)	-25 to -40 (see note 4)	3	Average
(AB + 0,35 x B3dB) to CD	-40	3	Average
CD to (CD + 0,25 x B3dB)	-40 to -50	3	Average
(CD + 0,25 x B3dB) to EF	-50	3	Average
EF to 1 500	-50 to -65	3	Average
1 500 to 36 000	-55	30	Average

NOTE 1: Frequency offset is determined from the edge of the nominated bandwidth.
NOTE 2: Linearly interpolated in dBW vs. Frequency offset.
NOTE 3: The parameters AB, CD, EF are defined below.
NOTE 4: The limit of -25 dBW in this table is determined on the assumption that the adjacent channel interference results from a single interferer. This limit shall apply to MESs that are designed for operation in a network where the occurrence of two (or more) interferers, all transmitting with the maximum permitted level of unwanted emissions, does not exceed 0,1 % of the time; otherwise a limit of -30 dBW shall apply.

The parameters AB, CD and EF are defined as a proportion of the 3 dB Bandwidth as follows:

AB = (55) or (100 % of the B3dB), whichever is the greater; • CD = (95) or (200 % of the B3dB), whichever is the greater;

EF = (125) or (300 % of the B3dB), whichever is the greater.

To protect the radio astronomy service in the 1 660 MHz to 1 660,5 MHz band and the 1 668,0 MHz to 1 670,0 MHz band from emissions produced by MESs the transmissions in these frequency bands shall be capable of being disabled in the vicinity of RA stations recorded in the ITU Master International Frequency Register.

7.1.2 ECC Report 263

7.1.2.1 Overview

NOTE: The coexistence assumptions used in ECC Report 263 are different compared to the assumptions used by 3GPP in the TN-NTN coexistence analysis captured in TR 38.863.

The following section contains some excerpts from ECC Report 263.

7.1.2.2 Excerpts from ECC Report 263

The report has established the technical characteristics of the IMT and the MSS system and determined the relevant scenarios. It has also determined the appropriate propagation models for these scenarios according to the environment where the equipment is used and further the protection criteria has been established.

The report has, from these characteristics and parameters, developed an MCL analysis with the resulting required separation distances for the 3 different frequency separations (1 MHz, 3 MHz and 6 MHz frequency separations).

The frequency separation allocation is not addressed by this report.

Further the report makes use of the MCL to establish interference arising in the first MES channel above the 3 different frequency separations investigated for an area with IMT coverage.

The results of the simulations show that there will be some interference irrespective of the selected frequency separation.

MES terminals currently on the market which have characteristics similar to those selected for this study, may experience interference problems because of the susceptibility of the MES receiver to the wanted signals from the IMT systems. As there are currently no available technical characteristics which outline at what frequency this effect starts to occur, blocking may also be experienced from IMT transmitters more than 6 MHz away into the IMT band below 1518 MHz.

Based on the findings of this report, the following mitigation techniques could further improve the compatibility between IMT and MSS around 1518 MHz:

- The interference due to IMT OOB emissions can be reduced by improved filtering on the IMT base station.
- The interference due to blocking can be reduced by improving the MES resilience to LTE blocking signals in the adjacent band.
- Either adding location based frequency allocation to MSS to avoid the use the lower couple of MHz and/or, implementing interference avoidance which would in addition allow for a better frequency utilisation of the lower part of the 1518-1559 MHz frequency band for MSS. The feasibility and impact of these techniques have not been assessed.

The following values have been used to examine the impact of enhanced MES receiver performance.

Table 7.1.2.2-1: Assumed blocking level for enhanced MES receivers

Frequency separation between channel edges	Interference level (at output of receiving antenna)
1 MHz	–55 to –45 dBm
3 MHz	–35 to –30 dBm
6 MHz	–30 to –25 dBm

Based on the final results of its compatibility studies, it is concluded that:

- the minimum in-band blocking characteristic for land mobile earth stations receivers from a 5 MHz broadband signal interferer (LTE) operating below 1518 MHz shall be −30dBm above 1520 MHz (Note: when the MES operates above 1520 MHz),
- the base station unwanted emission limits EIRP for a broadband signal interferer (LTE) operating below 1518 MHz shall be −30dBm/MHz above 1520 MHz. This figure is 10 dB more stringent than ECC Decision (13)03 due to a different service in the adjacent band.

It is noted that the IMT block ends at 1517 MHz.

7.2 UE requirements

7.2.1 UE transmitter characteristics

7.2.1.1 Maximum output power for category M1 and NB1/NB2

Table 7.2.1.1-1: UE Power Class for category M1

EUTRA band	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 5 (dBm)	Tolerance (dB)
253			23	+/-2	20	+/-2
NOTE 1: $P_{PowerClass}$ is the maximum UE power specified without taking into account the tolerance.						

Table 7.2.1.1-2: UE Power Class for category NB1 and NB2

EUTRA band	Class 3 (dBm)	Tolerance (dB)	Class 5 (dBm)	Tolerance (dB)
[253]	23	+/-2	20	+/-2

7.2.1.2 Emission requirements and NS values

7.2.1.2.1 Spurious emission for category M1

Table 7.2.1.2.1-1: Requirements for spurious emissions for UE co-existence

E-UTRA Band	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
253	E-UTRA Band 5, 26, 41, 48 NR Band n1, n3, n7, n8, n18, n20, n28, n34, n38, n39, n40, n50, n51, n65, n67, n74, n75, n76, n79, n91, n92, n93, n94	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	2
NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.4A.2-1 NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5A.4.2-2 are permitted for each assigned E-UTRA carrier used in the measurement due to 2nd, 3rd, 4th [or 5th] harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x L_{CRB} x 180kHz), where N is 2, 3, 4, [5] for the 2nd, 3rd, 4th [or 5th] harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval. NOTE 3: The co-existence between 256 and band 2, 25 and 70 is subject to regional/national regulation.						

7.2.1.3 Configured TX power

It is agreed the current TS 36.102 requirements can be re-used for band n253.

7.2.1.4 Power control

It is agreed the current TS 36.102 requirements can be re-used for band n253.

7.2.1.5 Frequency error

It is agreed the current TS 36.102 requirements can be re-used for band n253.

7.2.1.6 Transmit modulation quality

It is agreed the current TS 36.102 requirements can be re-used for band n253.

7.2.2 UE receiver characteristics

7.2.2.1 Reference sensitivity for category M1 and NB1/NB2

Table 7.2.2.1-1: Reference sensitivity for FDD UE category M1 QPSK $P_{REFSENS}$

NTN Band	REFSENS (dBm)	Duplex Mode
253	-102.7	FDD
NOTE 1: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.5- in TS 36.101 [7].		

Table 7.2.2.1-2: Reference sensitivity for HD-FDD UE category M1 QPSK $P_{REFSENS}$

NTN Band	REFSENS (dBm)	Duplex Mode
253	-103.5	HD-FDD
NOTE 1: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.5 in TS 36.101 [7].		

Table 7.2.2.1-3: FDD UE category M1 Uplink configuration for reference sensitivity

E-UTRA Band	N_{RB}	Duplex Mode
253	6[1]	FDD and HD-FDD
255	6[1]	FDD and HD-FDD
256	6[1]	FDD and HD-FDD
NOTE 1: [1] refers to the UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.3A-1).		

7.2.2.2 Blocking requirements

7.2.2.2.1 In Band blocking requirements for category M1

Table 7.2.2.2.1-1: In band blocking parameters

Rx parameter	Units	Channel bandwidth
		1.4 MHz
Power in Transmission Bandwidth Configuration	dBm	REFSENS + channel bandwidth specific value below
		6

$BW_{Interferer}$	MHz	1.4
$F_{Ioffset, case\ 1}$	MHz	2.1+0.0125
$F_{Ioffset, case\ 2}$	MHz	3.5+0.0075
NOTE 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3A-3 with P_{CMAX_L} as defined in subclause 6.2.5 of TS 36.101 [7].		
NOTE 2: The interferer consists of the Reference measurement channel specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 and set-up according to Annex C.3.1.		
NOTE 3: For DL category M1 UE, the reference sensitivity for category M1 in table 7.3A-1 should be used as REFSENS for the power in Transmission Bandwidth Configuration.		
NOTE 4: For DL category M1 UE, the parameters for the applicable channel bandwidth apply.		

Table 7.2.2.2.1-2: In-band blocking

E-UTRA band	Parameter	Unit	Case 1	Case 2
	$P_{Interferer}$	dBm	-56	-44
	$F_{Interferer}$ (offset)	MHz	$=-BW/2 - F_{Ioffset,case\ 1}$ & $=+BW/2 + F_{Ioffset,case\ 1}$	$\leq -BW/2 - F_{Ioffset,case\ 2}$ & $\geq +BW/2 + F_{Ioffset,case\ 2}$
256, 255, 253	$F_{Interferer}$	MHz	(NOTE 2)	$F_{DL\_low} - 15$ to $F_{DL\_high} + 15$
NOTE 1: For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive band, but within the first 15 MHz below or above the UE receive band				
NOTE 2: For each carrier frequency the requirement is valid for two frequencies: a. the carrier frequency -BW/2 - $F_{Ioffset, case\ 1}$ and b. the carrier frequency +BW/2 + $F_{Ioffset, case\ 1}$				
NOTE 3: $F_{Interferer}$ range values for unwanted modulated interfering signal are interferer center frequencies				

7.2.2.2.2 Out-of-band blocking requirements for category M1

Table 7.2.2.2.2-1: Out-of-band blocking parameters for category M1 UE

RX parameter	Units	Channel bandwidth (MHz)
		1.4
Power in transmission bandwidth configuration	dBm	REFSENS + 6 dB
NOTE 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 in TS 36.101 [7] with P_{CMAX_L} as defined in subclause 6.2.5.		

Table 7.2.2.2.2-2: Out of-band blocking for category M1 UE

Operating Band	Parameter	Unit	Range 1	Range 2	Range 3
	$P_{interferer}$	dBm	-44	-30	-15
253, 255	$F_{interferer}$ (C`W)	MHz	$-60 < f - F_{DL\_low} < -15$ or $15 < f - F_{DL\_high} < 60$	$-85 < f - F_{DL\_low} \leq -60$ or $60 \leq f - F_{DL\_high} < 85$	$1 \leq f \leq F_{DL\_low} - 85$ or $F_{DL\_high} + 85 \leq f \leq 12750$
256[1]	$F_{interferer}$ (CW)	MHz	$-100 < f - F_{DL\_low} < -15$ or $15 < f - F_{DL\_high} < 60$	$-145 < f - F_{DL\_low} \leq -100$ or $60 \leq f - F_{DL\_high} < 85$	$1 \leq f \leq F_{DL\_low} - 145$ or $F_{DL\_high} + 85 \leq f \leq 12750$
NOTE 1: Band 256 lower frequency ranges are modified to enable specific implementations.					

7.2.2.2.3 Narrow band blocking for category M1

Table 7.2.2.2.3-1: Narrow-band blocking

Parameter	Unit	Channel Bandwidth
		1.4 MHz
P_w	dBm	$P_{REFSENS}$ + channel-bandwidth specific value below
		22
P_{uw} (CW)	dBm	-55
F_{uw} (offset for Δf = 15 kHz)	MHz	0.9075
F_{uw} (offset for Δf = 7.5 kHz)	MHz	
NOTE 1: The transmitter shall be set a 4 dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3A-3 with P_{CMAX_L} as defined in subclause 6.2.5 of TS 36.101 [7]. NOTE 2: Reference measurement channel is specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 of TS 36.101 [7]. NOTE 3: For DL category M1 UE, the reference sensitivity for category M1 in table 7.3A-1 should be used as $P_{REFSENS}$ for P_w. NOTE 4: For DL category M1 UE, the parameters for the applicable channel bandwidth apply. NOTE 5: For DL category M1 UE, the parameter, P_w, for all the channel bandwidth will be $P_{REFSENS}$ +22 dBm.		

7.2.2.2.4 Out-of-band blocking requirements for category NB1 and NB2

Table 7.2.2.2.4-1: Out-of-band blocking parameters for category NB1 and NB2 UE

Operating Band	Parameter	Unit	Range 1	Range 2	Range 3
	P_w	dBm	REFSENS + 6 dB		
	$P_{interferer}$	dBm	-44	-30	-15[3]
253, 255	$F_{interferer}$ (CW)	MHz	$-60 < f - F_{DL\_low} < -15$ or $15 < f - F_{DL\_high} < 60$	$-85 < f - F_{DL\_low} \leq -60$ or $60 \leq f - F_{DL\_high} < 85$	$1 \leq f \leq F_{DL\_low} - 85$ or $F_{DL\_high} + 85 \leq f \leq 12750$
256[2]	$F_{interferer}$ (CW)	MHz	$-100 < f - F_{DL\_low} < -15$ or $15 < f - F_{DL\_high} < 60$	$-145 < f - F_{DL\_low} \leq -100$ or $60 \leq f - F_{DL\_high} < 85$	$1 \leq f \leq F_{DL\_low} - 145$ or $F_{DL\_high} + 85 \leq f \leq 12750$
NOTE 1: Void. NOTE 2: Band 256 lower frequency ranges are modified to enable specific implementations. NOTE 3: For operating bands which downlink band frequency range is between 1475.9 MHz < f < 2690 MHz the power level of the interferer ($P_{Interferer}$) for Range 3 shall be modified to: -20 dBm for the frequency range which is bounded by F_{DL_low}- 200 MHz of the lowest band that UE supports in frequency range 1475.9 MHz < f < 2690 MHz and F_{DL_high} + 200 MHz of the highest band that UE supports in frequency range 1475.9 MHz < f < 2690 MHz." NOTE 4: The power level of the interferer ($P_{Interferer}$) for Range 3 shall be modified to -20 dBm for $F_{Interferer}$ > 2800 MHz and $F_{Interferer}$ < 4400 MHz.					

NOTE: As per the agreement raised in RAN4#109 below, the introduction of additional blocking requirements from ETSI EN 301 681 and recommendations from ECC Report 263 has been put on hold. Any ETSI- or ECC-specific requirements will be addressed after further feedback from ETSI is received.

Issue 1-2-1: In-Band Blocking Requirements for Cat M1 + Issue 1-2-2: In-Band Blocking Requirements for Cat NB1 NB2

Agreement:

- Put the action on capturing the additional blocking requirements from EN 301 681 and ECC Report 263 on hold until further information from ETSI, considering the UE implementation difficulty and the ongoing discussion in ETSI.
  - Send LS to ETSI to show the discrepancy and applicability to device types
  - Add the note in the TS and TR that the requirements would be defined after the feedback of ETSI is received.

Issue 1-2-2: Out-of-Band Blocking Requirements for Cat M1 + Issue 1-2-2: In-Band Blocking Requirements for Cat NB1 NB2

Agreement:

- Do not define the additional out-of-band blocking requirements in Rel-18
  - Further discuss it, if needed, in the future release in TEI or WI

Annex A (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2023-04	RAN4#106 bis-e	R4-2304497				TR skeleton	0.0.1
2023-08	RAN4#108	R4-2314712				System parameters/MOP/Spurious emission/REFSENS and some simulation results are added	0.0.2
2023-10	RAN4#108 -bis	R4-2316133				TP to Draft TR for IoT NTN bands	0.0.4
2023-11	RAN4#109	R4-2321815				TP to draft TR for B254	0.0.5
2023-12	RAN#102	RP-233282				Provide endorsed TR to RAN plenary for one step approval	1.0.0

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2023-12	RAN#102					Approved by plenary – Rel-18 spec under change control	18.0.0
2024-03	RAN#103	RP-240578	0001	1	B	CR to TR 36.764 to introduce IoT NTN Extended L-band	18.1.0

History

Document history		
V18.1.0	May 2024	Publication