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Technical Specification

**3rd Generation Partnership Project;
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Evolved Universal Terrestrial Radio Access (E-UTRA);
User Equipment (UE) radio transmission and reception;
(Release 8)**

Keywords

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Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

Contents

Foreword

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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1 Scope

The purpose of this TR is to summarize the study of radio requirements for the User Equipment (UE) radio transmission and reception as part of the work item on Evolved Universal Terrestrial Radio Access (E-UTRA).

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] TD RP-040461: "Proposed Study Item on Evolved UTRA and UTRAN".

[2] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[3] 3GPP TR 25.913: "Requirements for Evolved UTRA and UTRAN".

[4] 3GPP TR 25.912; "Feasibility Study for Evolved UTRA and UTRAN".

[5] 3GPP TR 25.813: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Radio interface protocol aspects".

[5] 3GPP TR 25.814: "Physical Layer Aspects for Evolved UTRA".

[6] ETSI ETR 273: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement of radiated methods of measurement (using test sites) and evaluation of the corresponding measurement uncertainties; Part 1: Uncertainties in the measurement of mobile radio equipment characteristics; Sub-part 2: Examples and annexes".

[7] 3GPP TS 25.101 V7.3.0 (2006-03), "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; User Equipment (UE) radio transmission and reception (FDD) (Release 7)".

[8] Recommendation ITU-R M.1581-1, "Generic unwanted emission characteristics of mobile stations using the terrestrial radio interfaces of IMT-2000".

[9] Recommendation ITU-R SM.328-10, "Spectra and Bandwidth of Emissions".

[10] Recommendation ITU-R SM.329-10, "Unwanted emissions in the spurious domain"

[11] "International Telecommunications Union Radio Regulations", Edition 2004, Volume 1 – Articles, ITU, December 2004.

[12] "Title 47 of the Code of Federal Regulations (CFR)", Federal Communications Commission.

[13] "Adjacent Band Compatibility between UMTS and Other Services in the 2 GHz Band", ERC Report 65, Menton, May 1999, revised in Helsinki, November 1999.

[14] "Sharing and Adjacent Band Compatibility between UMTS/IMT-2000 in the Band 2500-2690 MHz and Other Services", ECC Report 045, Granada, February 2004.

[15] "Compatibility Study For UMTS Operating within the GSM 900 And GSM 1800 Frequency Bands"), Draft ECC Report 082, ECC PT1(05)053 ANNEX 22.

[16] Report ITU-R M.2039, "Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses".

[17] ETSI EN 301 908-2 V2.2.1 (2003-10), "Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive".

[18] Recommendation ITU-R SM.1541, “Unwanted emissions in the out-of-band domain”.

[19] 3GPP TR 25.942 V6.4.0 (2005-03), “3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; Radio Frequency (RF) system scenarios (Release 6)”.

[20] R4-070263, “Proposal on LTE ACLR requirements for UE”, NTT DoCoMo et.al,.

[21] 3GPP TS 25.102 V7.2.0 (2006-03), “3rd Generation Partnership Project; Technical Specification Group Radio Access Network; User Equipment (UE) radio transmission and reception (TDD) (Release 7)”.

[22] Recommendation ITU-R M.1225, “Guidelines for Evaluation of Radio Transmission Technologies for IMT-2000”, ITU-R, 1997.

[23] 3GPP TS 45.005 V7.8.0 (2006-11), “3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Radio transmission and reception (Release 7)”.

[24] R4-070752, “Proposal for LTE channel models”, Ericsson, et al.

[25] 3GPP TR 25.943 V6.0.0 (2004-12), “Deployment aspects (Release 6)”.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

<defined term> : <definition>.

For the purposes of the present document, the terms and definitions given in TR 21.905 [x] 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 [x].

Channel bandwidth: The RF bandwidth supporting a single E-UTRA RF carrier with the transmission bandwidth configured in the uplink or downlink of a cell. The channel bandwidth is measured in MHz and is used as a reference for transmitter and receiver RF requirements.

Maximum Output Power: The mean power level per carrier of UE measured at the antenna connector in a specified reference condition.

Mean power: When applied to E-UTRA transmission this is the power measured in the operating system bandwidth of the carrier. The period of measurement shall be at least one subframe (1ms) for frame structure type 1 and one subframe (0.675ms) for frame structure type 2 excluding the guard interval, unless otherwise stated.

Occupied bandwidth: The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage β/2 of the total mean power of a given emission.

Output power: The mean power of one carrier of the UE, delivered to a load with resistance equal to the nominal load impedance of the transmitter.

Reference bandwidth: The bandwidth in which an emission level is specified.

Transmission bandwidth: Bandwidth of an instantaneous transmission from a UE or BS, measured in Resource Block units.

Transmission bandwidth configuration: The highest transmission bandwidth allowed for uplink or downlink in a given channel bandwidth, measured in Resource Block units.

3.2 Symbols

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

$BW_{Channel}$	Channel bandwidth
F	Frequency
$F_{Interferer}$ (offset)	Frequency offset of the interferer
$F_{Interferer}$	Frequency of the interferer
F_C	Frequency of the carrier centre frequency
F_{DL_low}	The lowest frequency of the downlink operating band
F_{DL_high}	The highest frequency of the downlink operating band
F_{UL_low}	The lowest frequency of the uplink operating band
F_{UL_high}	The highest frequency of the uplink operating band
R_{av}	Minimum average throughput per RB
REFSENS	Reference Sensitivity power level
$P_{Interferer}$	Modulated mean power of the interferer
Δf_{OOB}	Δ Frequency of the Out Of Band emission

3.3 Abbreviations

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

ACLR	Adjacent Channel Leakage Ratio

ACS	Adjacent Channel Selectivity
A-MPR	Additional Maximum Power Reduction
AWGN	Additive White Gaussian Noise
BS	Base Station
CW	Continuous Wave
DL	Downlink
E-UTRA	Evolved UMTS Terrestrial Radio Access
EUTRAN	Evolved UMTS Terrestrial Radio Access Network
EVM	Error Vector Magnitude
FDD	Frequency Division Duplex
FRC	Fixed Reference Channel
HD-FDD	Half- Duplex FDD
LA	Local Area (base station class)
MOP	Maximum Output Power
MCS	Modulation and Coding Scheme
MPR	Maximum Power Reduction
MSR	Maximum Sensitivity Reduction
OOB	Out-of-band
PA	Power Amplifier
REFSENS	Reference Sensitivity power level
SNR	Signal-to-Noise Ratio
TDD	Time Division Duplex
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

Other abbreviations used in the present document are listed in 3GPP TR 21.905 [2].

4 General

4.1 Relationship between Minimum Requirements and Test Requirements

The Minimum Requirements given in this specification make no allowance for measurement uncertainty. The test specification 34.121 Annex F defines Test Tolerances. These Test Tolerances are individually calculated for each test. The Test Tolerances are used to relax the Minimum Requirements in this specification to create Test Requirements.

The measurement results returned by the test system are compared – without any modification - against the Test Requirements as defined by the shared risk principle.

The Shared Risk principle is defined in ETR 273 Part 1 sub-part 2 section 6.5.

5 Frequency bands and channel arrangement

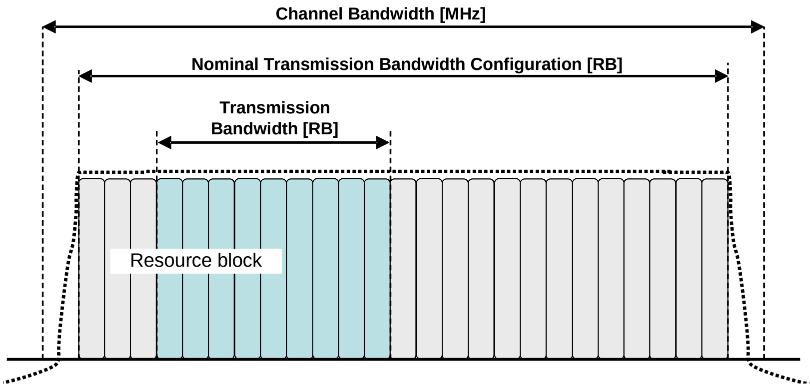
5.1 General

Table 5.1-1 specifies number of resource blocks in an operating system bandwidth

Table 5.1-1 Number of resource blocks in an operating system bandwidth

Channel bandwidth [MHz]	1.4	1.6*	3	3.2*	5	10	15	20
FDD mode	6	n/a	15	n/a	25	50	75	100
TDD mode FS1	6	n/a	15	n/a	25	50	75	100
TDD mode FS2	n/a	7	n/a	16	25	50	75	100

Figure 5.1-1: Definition of Channel Bandwidth and Transmission Bandwidth Configuration



5.2 Frequency bands

Table 5.2-1: TX-RX frequency / channel bandwidth / Duplex mode

E-UTRA Band	Uplink (UL) eNode B receive UE transmit	Downlink (DL) eNode B transmit UE receive	UL-DL Band gap	Duplex Mode
	F_{UL_low} - F_{UL_high}	F_{DL_low} - F_{DL_high}	F_{DL_ow} - F_{UL_high}	
1	1920 MHz - 1980 MHz	2110 MHz - 2170 MHz	130 MHz	FDD
2	1850 MHz - 1910 MHz	1930 MHz - 1990 MHz	20 MHz	FDD
3	1710 MHz - 1785 MHz	1805 MHz - 1880 MHz	20 MHz	FDD
4	1710 MHz - 1755 MHz	2110 MHz - 2155 MHz	355 MHz	FDD
5	824 MHz - 849 MHz	869 MHz - 894MHz	20 MHz	FDD
6	830 MHz - 840 MHz	875 MHz - 885 MHz	35 MHz	FDD
7	2500 MHz - 2570 MHz	2620 MHz - 2690 MHz	50 MHz	FDD
8	880 MHz - 915 MHz	925 MHz - 960 MHz	10 MHz	FDD
9	1749.9 MHz - 1784.9 MHz	1844.9 MHz - 1879.9 MHz	60 MHz	FDD
10	1710 MHz - 1770 MHz	2110 MHz - 2170 MHz	340 MHz	FDD
11	1427.9 MHz - 1452.9 MHz	1475.9 MHz - 1500.9 MHz	23 MHz	FDD
12	[TBD] - [TBD]	[TBD] - [TBD]	[TBD]	FDD
13	[TBD] - [TBD]	[TBD] - [TBD]	[TBD]	FDD
14	[TBD] - [TBD]	[TBD] - [TBD]	[TBD]	FDD
...				
33	1900 MHz - 1920 MHz	1900 MHz - 1920 MHz	N/A	TDD
34	2010 MHz - 2025 MHz	2010 MHz - 2025 MHz	N/A	TDD
35	1850 MHz - 1910 MHz	1850 MHz - 1910 MHz	N/A	TDD
36	1930 MHz - 1990 MHz	1930 MHz - 1990 MHz	N/A	TDD
37	1910 MHz 1930 MHz	1910 MHz 1930 MHz	N/A	TDD
38	2570 MHz - 2620 MHz	2570 MHz - 2620 MHz	N/A	TDD
39	1880MHz - 1920MHz	1880MHz - 1920MHz	N/A	TDD
40	2300MHz - 2400MHz	2300MHz - 2400MHz	N/A	TDD

5.3 TX–RX frequency separation

<Text will be added>

5.4 Channel arrangement

<Text will be added>

5.4.1 Channel spacing

The spacing between carriers will depend on the deployment scenario, the size of the frequency block available and the channel bandwidth.

5.4.2 Channel bandwidth

The supported channel bandwidth is a function of the E-UTRA band characteristics as specified in Table 5.2.1 and the required RF parameters as specified in section 6 (Transmitter Characteristic) and section 7 (Receiver Characteristics) .

5.4.2.1 Nominal channel bandwidth

Table 5.4.2-1 specifies the nominal channel bandwidth which are supported for the E-UTRA band

Table 5.4.2-1: E-UTRA channel bandwidth

E-UTRA band / channel bandwidth								
E-UTRA Band	**1.4 MHz**	**1.6 MHz**	**3 MHz**	**3.2 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
1					√	√	√	√
2	√		√		√	√		
3	√		√		√	√		
4	√		√		√	√	√	√
5	√		√		√	[√]		
6					√	[√]		
7					√	√	[√]	
8	√		√		√	[√]		
9					√	√	[√]	[√]
10					√	√	√	√
11					√			
12								
13								
14								
...								
33					FFS	FFS		
34					FFS	FFS		
3435	FFS	FFS	FFS	FFS	FFS	FFS	FFS	FFS
36	FFS	FFS	FFS	FFS	FFS	FFS	FFS	FFS
37	FFS	FFS	FFS	FFS	FFS	FFS	FFS	FFS
38					FFS	FFS		

5.4.2.2 Additional channel bandwidth

The following additional channel bandwidth can be supporting for the following operating bands depending on;

a) TDD or HD-FDD operating. In this case a higher channel bandwidth can be supported

b) The network assigns the maximum transmit configuration (Resource Blocks). In this case the network would ensure the REFSENS (clause 7.3.2) would not be degraded based on the allocated UE transmit power, RB location and channel bandwidth.

c) Maximum Reduction in Sensitivity (MRS) is specified (clause 7.3.3)

d) No solutions might be needed when additional MPR is applied.

Table 5.4.4.2-1: Additional E-UTRA channel bandwidth

E-UTRA band / channel bandwidth								
E-UTRA Band	**1.4 MHz**	**1.6 MHz**	**3 MHz**	**3.2 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
1								
2							√	√
3							√	√
4							√	√
5						[√]	√	√
6						[√]		
7							[√]	√
8						[√]		
9							[√]	[√]
10						√	√	√
11						√	√	√
12								
13								
14								
...								
33								
34								
35								
36								
37								
38								

5.4.3 Channel raster

The channel raster is 100 kHz for all bands, which means that the carrier centre frequency must

5.4.5 EARFCN

<Text will be added>

6 Transmitter characteristics

6.1 General

Unless otherwise stated, the transmitter characteristics are specified at the antenna connector of the UE with a single transmit antenna. For UE with integral antenna only, a reference antenna with a gain of 0 dBi is assumed.

6.2 Transmit power

6.2.1 Maximum Output Power (MOP)

The Maximum Output Power (MOP) defined in Table 6.2.1-1is the broadband transmit power of the UE, i.e. the power in a bandwidth of at least (1+x) times the channel bandwidth for all the Transmit bandwidth configurations (Resources Block)

Table 6.2.1-1: Maximum Output Power (MOP)

Class	Power (dBm)	Tolerance (dB)
1	[+30]	
2	[+27]	
3	+23	+/-2 dB
4	[+21]	

6.2.2 UE Power class

The following Power Classes defines the Nominal Maximum Output power. The nominal Maximum Output Power defined is the broadband transmit power of the UE, i.e. the power in a bandwidth of at least (1+x) times the channel bandwidth of the radio access mode. The period of measurement shall be at least one [timeslot/ frame/TTI].

Table 6.2.2-1: UE Power Class

E-UTRA Band	Class 1 (dBm)	Tol. (dB)	Class 2 (dBm)	Tol. (dB)	Class 3 (dBm)	Tol. (dB)	Class 4 (dBm)	Tol. (dB)
1					23	± 2		
2					[23]	[+/-2]		
3					[23]	[+/-2]		
4					[23]	[+/-2]		
5					[23]	[+/-2]		
6					[23]	[+/-2]		
7					[23]	[+/-2]		
8					[23]	[+/-2]		
9					[23]	[+/-2]		
10					[23]	[+/-2]		
11					[23]	[+/-2]		
12					[23]	[+/-2]		
13					[23]	[+/-2]		
14					[23]	[+/-2]		
...								
33					[23]	[+/-2]		
34					[23]	[+/-2]		
35					[23]	[+/-2]		
36					[23]	[+/-2]		
37					[23]	[+/-2]		
38					[23]	[+/-2]		

The transmission bandwidth configuration (Resources Blocks) for maximum output power specified in Table 6.2.2-1 is defined in Table 6.2.2-2 below for QPSK modulation

Table 6.2.2-2: UE Power Class / channel bandwidth / transmission configuration

UE Power Class	Channel bandwidth / Transmission bandwidth configuration [RB]							
	1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
1								
2								
3	≤ [TBD]	≤ [TBD]	≤ [TBD]	≤ [TBD]	≤ 8	≤ [16]	≤ [24]	≤ [32]
4								

6.2.3 Maximum Power Reduction (MPR)

Background

The number of RB identified in Table 6.2.3-1 and 6.2.3-2 is based on meeting the E-UTRA $_{ACLR1}$ and UTRA$_{ACLR1}$ requirements as specified in clause 6.6.2.2 and requires MPR reduction due to CM. In which case simple scaling can be used to derive the requirement for other bandwidth based on the previously agreed value for 5MHz channel bandwidth [R4-06XX]

E-UTRA requirements

For the UE Power Class 3, the Maximum Power Reduction (MPR) due to higher modulation and transmit bandwidth configuration (resource block) is specified in Table 6.2.3-1

Table 6.2.3-1: Maximum Power Reduction (MPR)

Modulation	Channel bandwidth / Transmission bandwidth configuration [RB]								MPR (dB)
	1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
QPSK	-	> [TBD]	> [TBD]	> [TBD]	> 8	> [16]	> [24]	> [32]	≤ 1
16 QAM	≤ [TBD]	≤ [TBD]	≤ [TBD]	≤ [TBD]	≤ [8]	≤ [16]	≤ [24]	≤ [32]	≤ [1]
16 QAM	> [TBD]	> [TBD]	> [TBD]	> [TBD]	> [8]	> [16]	> [24]	> [32]	≤ 2

6.2.4 Additional MPR allowed for "Additional spectrum emission" requirements

Background

1. It is proposed that some "additional spectrum emission" requirements are signalled to the UE by the network as part of the cell handover/broadcast information, to indicate to the UE that it is required to meet the indicated "additional spectrum emission" requirement for a particular cell to address a specific regulatory or deployment scenario.
2. The benefit of signalling the "additional spectrum emission" requirement is that is can be specified on case by case basis. For example a "sandwich" deployment in the same operator block would not need an "additional spectrum emission" requirement compared with a channel assignment next to an adjacent operator block where regulatory requirements may be applicable.
3. Some cell specific scenarios are identified in table 6.2.3.4-1 For example;
   i. NS_02 can be used to support an UTRA ACLR2 value of 43dB/3,84MHz value if needed
   ii. NS_03 can be used to address FCC requirement
   iii. NS_04 is used when a 10 MHz channel bandwidth (50 RB allocation need to meet the same OOB and spurious emission mask as a 5MHz channel bandwidth OOB requirement.
   iv. NS-06 for PHS protection for larger channel bandwidths (15, 20 MHz)
4. The need to meet an "additional spectrum emission" requirement will require improved transmitter linearity. This will result in lower transmitter efficiency, increased thermal dissipation and worse battery life. Hence some additional MPR may be required for the UE in this case. Hence it is important to minimise the scenario where it is needed to meet "additional spectrum emission" requirements.
5. For the cases where "additional spectrum emission" requirements need an additional MPR, then an upper limit for A-MPR should be specified.
6. "Additional spectrum emission" requirements should only be used in a restricted set of transmission bandwidth configurations and deployment scenarios

E-UTRA Requirements

"Additional spectrum emission" requirements are signalled by the network to indicate that the UE shall meet an "additional spectrum emission" requirement in a specific deployment scenario as part of the cell handover/broadcast message. To meet these additional spectrum emission requirements the concept of A-MPR is introduced.

For UE Power Class 3 the specific requirements and identified sub-clauses are specified in table 6.2.3.4-1, along with the proposed allowed A-MPR values that may be needed to meet these requirements. The A-MPR values specified below are in addition to allowed MPR requirements specified in clause 6.2.3

Table 6.2.3.4-1: Additional Spectrum Emission requirements (showing Additional Maximum Power Reduction (A-MPR))

Network Signalling value	Requirement (sub-clause)	Transmission bandwidth (RB)	A-MPR (dB)	Description [Informative – refer to requirement sub-clause for band and channel applicability]		
				Comment	E-UTRA Band	Channel bandwidth (MHz
NS_01	-	-	0	No Additional requirement	-	-
NS_02	6.6.2.2.1	>[30]	≤ [3]	UTRA$_{ACLR2bis}$ value	1, 6, 9,10,11	10
NS_03	6.6.2.1.2	>[5]	≤ [1.5]	FCC Part 22	2, 4,10	3
	6.6.2.1.2	>[5]	≤ [1.5]	FCC Part 22	2, 4,10	5
	6.6.2.1.2	>[7]	≤ [1.5]	FCC Part 22	2, 4,10	10
	6.6.2.1.2	TBD	TBD	FCC Part 22	2, 4,10	15
	6.6.2.1.2	TBD	TBD	FCC Part 22	2, 4,10	20
NS_04	6.6.2.1.2.3	>[30]	≤ [2]	5MHz channel OOB	1,3,7,8	10
	6.6.3.2.1			5 MHz spurious		
NS_05	6.6.2.1.2.2	TBD		FCC Part 27	TBD	TBD
NS_06	6.6.3.2.3	>[60]	≤ 1	PHS Protection	1	15
	6.6.3.2.3	>[60]	≤ 2	PHS Protection	1	20

Note: 0 ≤A-MPR ≤ [3],

6.3 Frequency Error

The UE modulated carrier frequency shall be accurate to within ±0.1 PPM observed over a period of one subframe (1ms) for generic frame structure type 1 and one subframe (0.675ms) for frame structure type 2 excluding the guard period (Cyclic prefix).

6.4 Output power dynamics

<Text will be added>

6.4.1 Power control

<Text will be added>

6.4.2 Minimum output power

The minimum controlled output power of the UE is defined as the broadband transmit power of the UE, i.e. the power in the channel bandwidth (clause 5.2) for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value.

6.4.2.1 Minimum requirement

The minimum output power is defined as the mean power in one sub-frame (1ms). The minimum output power shall be less than [-30] dBm. This value was derived from the macro cell scenario. The impacts in the micro cell scenario should be investigated further.

6.4.3 Transmit ON/OFF power

6.4.4 Out-of-synchronization handling of output power

<Text will be added>

6.5 Control and monitoring functions

<Text will be added>

6.6 Output RF spectrum emissions

Unwanted emissions are divided into "Out-of-band emission" and "Spurious emissions" in 3GPP RF specifications. This notation is in line with ITU-R recommendations such as SM.329 [10] and the Radio Regulations [11]. ITU defines:

Out-of-band emission = Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

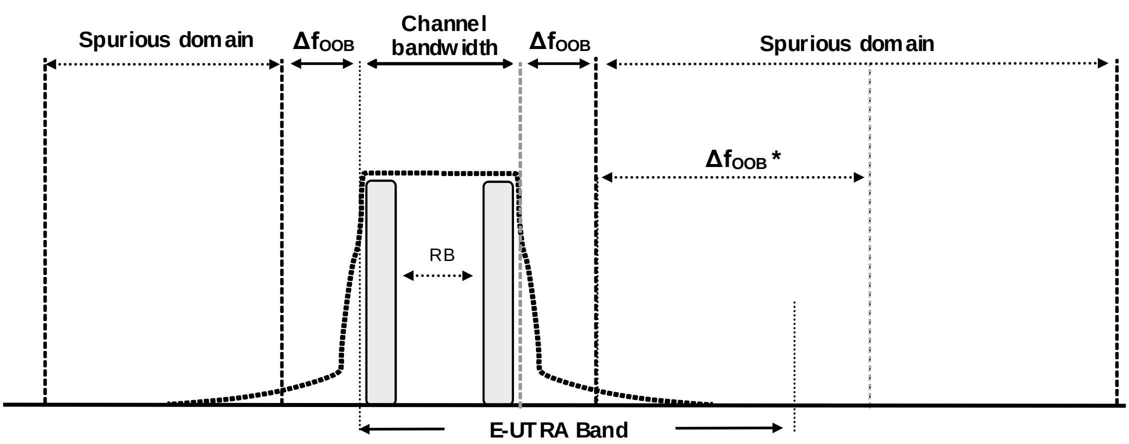
Spurious emission = Emission on a frequency, or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

Unwanted emissions = Consist of spurious emissions and out-of-band emissions.

E-UTRA requirement

The UE transmitter spectrum emission consists of the three components; the occupied bandwidth (channel bandwidth), the Out Of Band (OOB) emissions and the far out spurious emission domain.

Figure 6.6-1: Transmitter RF spectrum



6.6.1 Occupied bandwidth

UTRA Background

The occupied bandwidth is defined in ITU-R SM.328 [9] and ITU-R Radio Regulations [11]:

Occupied bandwidth = The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage β/2 of the total mean power of a given emission. Unless otherwise specified by the Radiocommunication Assembly for the appropriate class of emission, the value of β/2 should be taken as 0.5%. [9] [11]

Occupied bandwidth is used in some regions as a regulatory requirement. It is not defined as a regulatory requirement by the FCC or CEPT/ECC and it is not used as input to any compatibility studies. It is today a mandatory requirement for the UE in RAN4 specifications.

E-UTRA requirements

Occupied bandwidth is a measure of the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel

The occupied channel bandwidth for all transmission bandwidth configurations (Resources Blocks) should be less than the channel bandwidth specified in Table 6.6.1.1-1

Table 6.6.1.1-1: Occupied channel bandwidth

Occupied channel bandwidth / channel bandwidth								
Channel bandwidth [MHz]	1.4	1.6	3	3.2	5	10	15	20
Nominal Transmission bandwidth configuration [Resource Blocks]	**6**	**7**	**15**	**16**	**25**	**50**	**75**	**100**

6.6.2 Out of band emission

Out of band emissions are unwanted emissions immediately outside the nominal channel resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. This out of band emission limit is specified in terms of a spectrum emission mask and Adjacent Channel Leakage power Ratio.

UTRA Background

The core requirements for out-of band emissions are specified for the UE in TS 25.101[7] and TS25.102[21]. The corresponding test requirements are in TS 34.121. There are several ways of specifying Out-of-band emissions. Three ways are used in RAN4 specifications, namely Occupied Bandwidth, Spectrum emission mask and Adjacent Channel Leakage Ratio (ACLR).

References for the Out-of-band requirements are summarised in Table 6.6.2-1 for the UE. The tables give references to RAN4 core specs, to where the term is defined and to some relevant regulatory references. These regulatory references have either defined the limit value in 3GPP or they have used it as a basis for studies or recommendations.

Table 6.6.2-1 Summary of regulatory references for UE requirements

Requirement	**RAN4** TS 25.101 [7]	**Definition**	**Some relevant regulatory references**
Occupied bandwidth	6.6.1	ITU-R SM.328 (1.13) [9]	ITU Radio Regulations No. S1.153 [11]

Spectrum emission mask	6.6.2.1	ITU-R SM.1541 [18] Limits fined in 3GPP [7]	ITU-R M.1581 (Annex 1.2) [8]: Band I limits included. FCC Title 47 part 24.238 [12]: Band II limits. FCC Title 47 part 27.53 [12] Band IV limits. FCC Title 47 part 22.917 [12]: Band V limits. ERC Report 65 [13]: Based on Band I limits. ECC Report 045 [14]: Based on Band VII limits. ECC Report 082 [15]: Based on Band III and VIII limits. ETSI EN 301 908-2 [17]: Limits included.
ACLR	6.6.2.2	ITU-R SM.1541 [18] Limits defined in 3GPP [7]	ITU-R M.1581 (Annex 1.3) [8]: Band I limits included. ITU-R M.2039 [16]: ACLR limits included. ERC Report 65 [13]: Based on Band I limits. ECC Report 045 [14]: Based on Band VII limits. ECC Report 082 [15]: Based on Band III and VIII limits. ETSI EN 301 908-2 [17]: Limits included.

ITU-R SM.328 [9] and SM.1541 [18] define "Permissible out-of-band spectrum (of an emission)" as the power density of emissions above and below the necessary bandwidth. The spectrum emission masks defined for the UE in RAN4 specifications specify such limits of emissions, based on a necessary bandwidth of 5 MHz (+/-l 2.5 MHz from the carrier centre frequency). No limits are specified inside the necessary bandwidth.

For Band I the masks are also included in the ITU-R recommendation M.1581 [8] on IMT-2000 unwanted emissions. The spectrum masks were mostly based on studies of the spectrum shape of UTRA emissions in early stages of RAN4 work. The masks are also limited by FCC regulations [12] for Bands II, IV and V.

The masks were used for several 3GPP co-existence studies as input parameters. In regulatory bodies, CEPT/ECC used the masks as input to several reports studying co-existence and adjacent channel compatibility for IMT-2000 [13] [14] [15]. These reports were partly developed in co-operation with 3GPP.

The UTRA UE mask [7] is defined from 2.5 MHz to 12.5 MHz from the UE carrier centre frequency. 12.5 MHz is selected as 250% of the necessary bandwidth, as recommended in ITU-R SM.329 [10]. The mask is defined with a 30 kHz resolution in the first MHz and with a 1 MHz resolution beyond that point. The mask is expressed in dBc, with an additional absolute limit.

The UE spectrum mask for the UE is mandatory in RAN4 specifications, to allow for global circulation of terminals.

E-UTRA Background

E-UTRA should have a spectrum emissions mask requirements (SEM) defined for the UE, based on the following prerequisites.

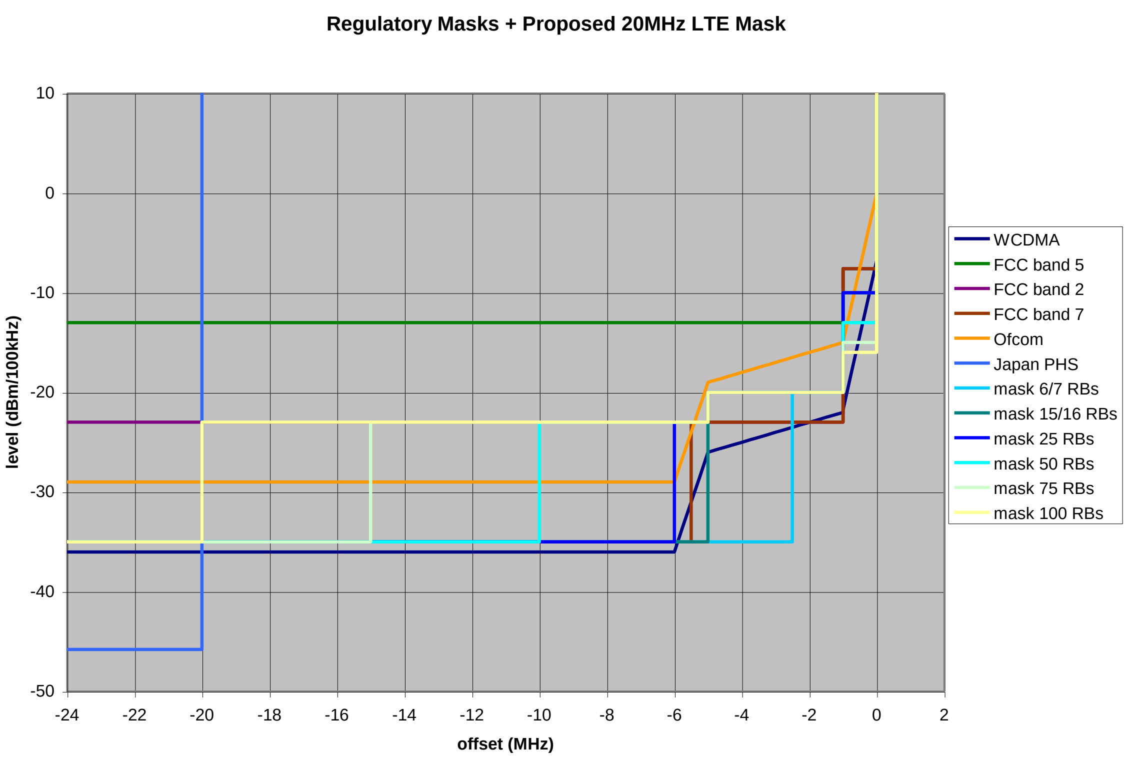
- SEM should be defined with a reference bandwidth of [100 kHz]. It would have to be verified if this number will be suitable also for matching the mask in the first adjacent MHz as defined in ERC Report 65.
- The SEM limit should also be set to allow some variations due to varying power allocation between resource blocks.
- For the larger carrier bandwidths, the OOB domain will stretch outside the operating band. Emission limits must then be set carefully considering co-existence with adjacent band systems.
- Separate spectrum emission mask definitions are needed for each LTE RF carrier bandwidth.
- The masks should be illustrated with a common figure illustrating the shape and the break points of the mask, with each break point identified A, B, etc. These break points can then easily be referenced the tables.
- The spectrum emission mask applies to frequencies (Δf_{OOB}) starting from the edge of the assigned E-UTRA channel bandwidth. For frequencies greater than (Δf_{OOB}) for each channel bandwidth the spurious requirements are applicable.

- In the proposed spectrum mask no attempt is made to tailor the shape of the spectrum mask to the transmitter emission for two reasons. A shaped mask would have difficulty in support the different channel bandwidth and RB locations. The "shaped aspect" would be addressed by the ALCR requirement. In this case we avoid the need to integrate the area under the mask to derive the ACLR as this is specified separately

- The proposed general mask figure 6.6.2.1-1 is based on the following;

  - The spectrum emission scales with number of resources blocks.
  - The emission offset of the 1st RB and subsequent RB change with the different channel bandwidth. This is due to the difference in necessary bandwidth and range from 160 KHz for the 1.4 MHz channel bandwidth to 1 MHz for the 20MHz channel bandwidth. This affect would be of significant for regulatory requirements in the 0- 1 MHz region (FCC requirements).
  - A worst case scenario i.e. RB is allocated from edge of channel bandwidth is assumed. This worst case assumption is based on a non-intelligent network scheduler. If a scheduler can allocate RB based on spectrum mask, then it possible for mid range RB allocations (25-75) to be scheduled from the centre of the channel bandwidth to minimize the spectrum emission into the adjacent channels. This has a profound impact in addressing some regulatory requirements. So in this case we need the mask should support both a non intelligent scheduler (assuming RB start from channel edge) and an intelligence scheduler (RB start from centre of channel) which would could provide better system performance as the MPR/A-MPR could be reduced. Note, the analysis assumes a non-intelligent scheduler which is based on worst case (RB start from channel edge)
  - The Δf_{OOB} boundary between the out of band and spurious emission domain scale with channel bandwidth

Figure 6.6.2.1 -1: Regulatory mask and proposed E-UTRA masks



- For those cases where the regulatory requirements are not met with the general mask (OOB and spurious emission) this is addressed in terms of new requirement and will need an "Additional spectrum emission requirement" which is not the case for the proposed general mask.
- RACH emission requirements are FFS

6.6.2.1 E-UTRA Spectrum emission mask

The spectrum emission mask of the UE applies to frequencies (Δf_{OOB}) starting from the edge of the assigned E-UTRA channel bandwidth. For frequencies greater than (Δf_{OOB}) as specified in Table 6.6.2.1-1 the spurious requirements in clause 6.6.3 are applicable

Table 6.6.2.1 -1: Δf_{OOB} boundary between E-UTRA out of band and spurious emission domain

Channel bandwidth	1.4 [MHz]	1.6 [MHz]	3 [MHz]	3.2 [MHz]	5 [MHz]	10 [MHz]	15 [MHz]	20 [MHz]
Δf_{OOB} (MHz)	[tbd]	[tbd]	[tbd]	[tbd]	10	15	20	25

6.6.2.1.1 General requirement

The power of any UE emission shall not exceed the levels specified in Table 6.6.2.1.1-1 for the specified channel bandwidth

Table 6.6.2.1.1-1: General E-UTRA spectrum emission mask

Δf_{OOB} (MHz)	Spectrum emission limit (dBm)/ Channel bandwidth								Measurement bandwidth **
	1.4 MHz	1.6 MHz	3.0 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
± 0-1	[TBD]	[TBD]	[TBD]	[TBD]	-15	-20	-25	-30	30 kHz
± 1-2.5	[-10]	[-10]	[-10]	[TBD]	-10	-10	-10	-10	1 MHz
± 2.5-5	[-25]	[-25]	[-10]	[-10]	-10	-10	-10	-10	1 MHz
± 5-6			[-25]	[-25]	-13	-13	-13	-13	1 MHz
± 6-10					-25	-13	-13	-13	1 MHz
± 10-15						-25	-13	-13	1 MHz
± 15-20							-25	-13	1 MHz
± 20-25								-25	1 MHz

Note**: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

6.6.2.1.2 Additional requirement

E-UTRA Background

Currently 3 additional requirements are suggested. These are for spectrum emission mask A (FCC E-UTRA band 2), spectrum emission mask B (FCC band X) and spectrum mask C (10MHz channel need to meet a 5 MHz channel OOB and spurious emission limit). This requirement can be specified in terms of an “additional spectrum emission” requirement.

6.6.2.1.2.1 Spectrum emission mask A

E-UTRA requirements

This clause specifies the additional requirements signalled by the network for E-UTRA band {2, 4, and 10}.

The power of any UE emission shall not exceed the levels specified in Table 6.6.2.1.2-1.

Table 6.6.2.1.2.1-1: Additional requirements (FCC Part 22)

Δf_{OOB} (MHz)	Spectrum emission limit (dBm)/ Channel bandwidth								Measurement bandwidth **
	1.4 MHz	1.6 MHz	3.0 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
± 0-1	[TBD]	[TBD]	[TBD]	[TBD]	-15	-20	-25	-30	30 kHz
± 1-2.5	[TBD]	[TBD]	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 2.5-5	[TBD]	[TBD]	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 5-6	[TBD]	[TBD]	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 6-10	[TBD]	[TBD]	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 10-15	[TBD]	[TBD]	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 15-20	[TBD]	[TBD]	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 10-25	[TBD]	[TBD]	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz

Note** : As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth

6.6.2.1.2.2 Spectrum emission mask B

E-UTRA requirements

This clause specifies the additional requirements signalled by the network for E-UTRA band {TBD}.

The power of any UE emission shall not exceed the levels specified in Table 6.6.2.1.2.2-1.

Table 6.6.2.1.2.2-1: Additional requirements (FCC Part 27)

Δf_{OOB} (MHz)	Spectrum emission limit (dBm)/ Channel bandwidth								Measurement bandwidth **
	1.4 MHz	1.6 MHz	3.0 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
± 0-1	[TBD]	[TBD]	[TBD]	[TBD]	-15	-20	-25	-30	30 kHz
± 1-2.5	[TBD]	[TBD]	[TBD]	[TBD]	-15	-15	-15	-15	1 MHz
± 2.5-5.5	[TBD]	[TBD]	[TBD]	[TBD]	-15	-15	-15	-15	1 MHz
± 5.5-6	[TBD]	[TBD]	[TBD]	[TBD]	-25	-25	-25	-25	1 MHz
± 6-10	[TBD]	[TBD]	[TBD]	[TBD]	-25	-25	-25	-25	1 MHz
± 10-15	[TBD]	[TBD]	[TBD]	[TBD]	-25	-25	-25	-25	1 MHz
± 15-20	[TBD]	[TBD]	[TBD]	[TBD]	-25	-25	-25	-25	1 MHz
± 10-25	[TBD]	[TBD]	[TBD]	[TBD]	-25	-25	-25	-25	1 MHz

Note** : As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth,

6.6.2.1.2.3 Spectrum emission mask C

E-UTRA requirements

This clause specifies the additional requirements signalled by the network when the nominal transmission bandwidth configuration (50 RB) for a 10 MHz channel bandwidth is required to meet the requirements for a transmission bandwidth configuration (25RB) for a 5 MHz channel bandwidth for E-UTRA band {TBD}.

The power of any UE emission shall not exceed the levels specified in Table 6.6.2.1.2.3-1.

Table 6.6.2.1.2.3-1: Additional requirements (10MHz » 5MHz OOB)

Δf_{OOB} (MHz)	Spectrum emission limit (dBm)/ Channel bandwidth								Measurement bandwidth **
	1.4 MHz	1.6 MHz	3.0 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
6-10	-	-	-	-	-	25	-	-	1 MHz

Note** : As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth

6.6.2.2 Adjacent Channel Leakage Ratio

UTRA Background

ITU-R SM.1541 [18] defines Adjacent Channel Power as one way of defining limits on Out-of-band emissions. The term ACLR was defined by RAN4, to avoid confusion regarding related terms such as ACI, ACP and ACL:

Adjacent Channel Leakage power Ratio (ACLR) = The ratio of the RRC filtered mean power centred on the assigned channel frequency to the RRC filtered mean power centred on an adjacent channel frequency.

In combination with the corresponding receiver requirement on Adjacent Channel Selectivity (ACS), ACLR has been an extremely useful tool in co-existence and co-existence studies, both in 3GPP and in CEPT/ECC [13] [14] [15]. For Band I, ACLR is also included in the ITU-R recommendations M.1581 [8] on IMT-2000 unwanted emissions. It is also included in ITU-R report M.2039 [16] that defines parameters to be used in co-existence studies for all IMT-2000 systems.

Together with ACS, the ACLR defines the Adjacent Channel Interference Ratio (ACIR) as

$$ACIR = \frac{1}{\frac{1}{ACLR} + \frac{1}{ACS}}$$

This relation and its application rely on identical assumed bandwidths in the ACLR and ACS definitions. If aggressor and victim have different bandwidths, both ACLR and ACS definitions have to account for exactly those bandwidths. This is not a problem for co-existence between two 5 MHz WCDMA system, but it becomes more complex when there are different systems involved or the bandwidth of a system is flexible as in E-UTRA.

E-UTRA Background

If there is to be both an ACLR-type requirement with carrier-wide reference bandwidth and a mask (SEM) with much narrower reference bandwidth, the ACLR limit should be somewhat stricter than the integrated SEM. In this way, the

ACLR can capture the "average" behaviour over a carrier, while the SEM can take into account the variations in the spectrum emissions resulting from variations in Resource block allocations.

Since it is important to assess sharing properties both with adjacent UTRA systems and with LTE carriers the ACLR is defined with different bandwidths:

- ACLR/UTRA in a 1st adjacent channel with 5 MHz and/or 1.6 MHz reference bandwidth depending on paired or unpaired spectrum.
- ACLR/E-UTRA (reference bandwidth equal to E-UTRA carrier bandwidth) in a 1st adjacent channel.
- For carriers with bandwidth larger than 5 MHz positioned close to or adjacent to the band edge, the 1st or 2nd adjacent channel that define the ACLR/ E-UTRA may fall partly or fully outside the operating band edge. If it is fully outside, it should not be defined. If it is partly outside it can still be defined, but may not be limiting compared to the unwanted emission limits defined by SEM and spurious emissions.

The current working assumptions for UE ACLR are captured in the table 6.6.2.3-1 for E-UTRA operating in paired spectrum and in Table 6.6.2.3-2 in unpaired spectrum. The numbers are based on the co-existence simulations outlined in TR 36.942.

Table 6.6.2.2-1: Working assumption for UE ACLR for adjacent E-UTRA carriers (paired spectrum)

E-UTRA Assigned BW (MHz)	ALCR limit for 1st Adjacent channel relative to assigned channel frequency [dB]							
		UTRA[1] 5.0 MHz	E-UTRA[2] X MHz	E-UTRA[2] Y MHz	E-UTRA[2] 5.0 MHz	E-UTRA[2] 10 MHz	E-UTRA[2] 15 MHz	E-UTRA[2] 20 MHz
X	ACLR 1	[33]	[30]	-	-	-	-	-
	ACLR 2	[36-43]	[TBD]	-	-	-	-	-
Y	ACLR 1	[33]	-	[30]	-	-	-	-
	ACLR 2	[36-43]	-	[TBD]	-	-	-	-
5	ACLR 1	[33]	-	-	[30]	-	-	-
	ACLR 2	[36-43]	-	-	[TBD]	-	-	-
10	ACLR 1	[33]	-	-	-	[30]	-	-
	ACLR 2	[36-43]	-	-	-	[TBD]	-	-
15	ACLR 1	[33]	-	-	-	-	[30]	-
	ACLR 2	[36-43]	-	-	-	-	[TBD]	-
20	ACLR 1	[33]	-	-	-	-	-	[30]
	ACLR 2	[36-43]	-	-	-	-	-	[TBD]

NOTES: [1] Measured with a 3.84 MHz bandwidth RRC filter with roll-off factor α =0.22 centered on the adjacent channel.

[2] Measured with a [TBD] filter centered on the 1st or 2nd adjacent channel

Table 6.6.2.2-2: Working assumption for UE ACLR for adjacent E-UTRA carriers (unpaired spectrum assuming a synchronized operation)

E-UTRA Assigned BW (MHz)	ALCR limit for 1st Adjacent channel relative to assigned channel frequency [dB]								
		UTRA[1] 7.68 Mcps	UTRA[1] 3.84 Mcps	UTRA[1] 1.28 Mcps	E-UTRA[2] [1.6 MHz]	E-UTRA[2] 5.0 MHz	E-UTRA[2] 10 MHz	E-UTRA[2] 15 MHz	E-UTRA[2] 20 MHz
[1.6]	ACLR1	- [3]	- [3]	[33]	[30]	-	-	-	-
	ACLR2				[TBD]	-	-	-	-
5	ACLR1	[33]	[33]	[33]	-	[30]	-	-	-
	ACLR2				-	[TBD]	-	-	-
10	ACLR1	[33]	[33]	[33]	-	-	[30]	-	-
	ACLR2				-	-	[TBD]	-	-
15	ACLR1	[33]	[33]	[33]	-	-	-	[30]	-
	ACLR2				-	-	-	[TBD]	-
20	ACLR1	[33]	[33]	[33]	-	-	-	-	[30]
	ACLR2				-	-	-	-	[TBD]

NOTES: [1] Measured with a 7.68 MHz, 3.84 MHz or 1.28 MHz bandwidth RRC filter respectively, with roll-off factor α =0.22 centered on the adjacent channel.

[2] Measured with a [TBD] filter centered on the 1st or 2nd adjacent channel

[3] Operation in adjacent channels not possible with synchronized operation in unpaired spectrum due to different time slot structures.

. It was pointed out in [20] that an E-UTRA UEs must not cause larger interference (in terms of absolute power) to the co-existing UTRA system than the one allowed in the current 3GPP requirements, irrespective of its operating system bandwidth. Maximum power reduction should be applied to a UE, in case the E-UTRA UE cannot meet the current UTRA absolute adjacent power limit effectively.

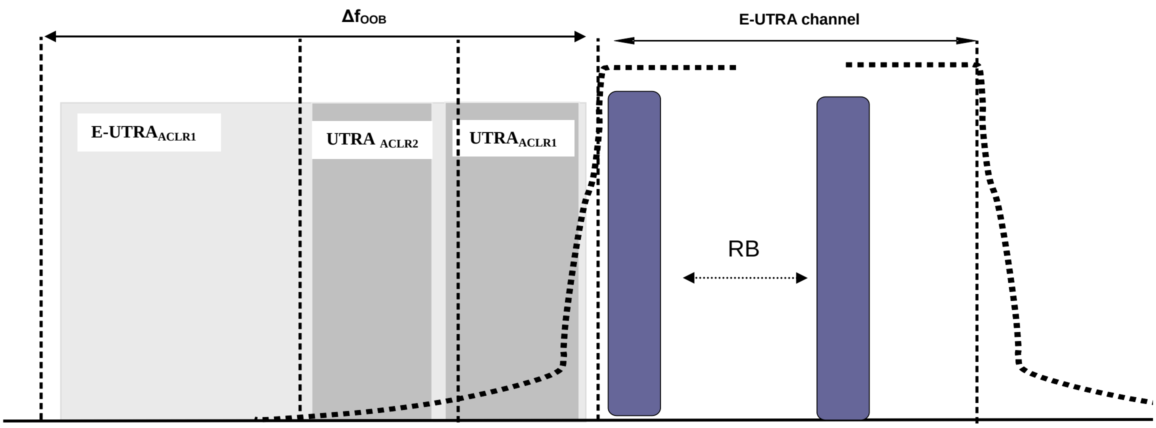
The measurement filter for the transmitted E-UTRA carrier and the adjacent E-UTRA carrier is for further study. It should be a filter that models a typical E-UTRA receiver of the specified RF carrier bandwidth.

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the [TBD] filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

E-UTRA requirements

ACLR requirements are specified for two scenarios. E-UTRA$_{ACLR}$ and UTRA$_{ACLR1/2}$ as shown in Figure 6.6.2.2 -1:

Figure 6.6.2.2 -1: Adjacent Channel Leakage requirements



6.6.2.2.1 General requirements

The general requirements are applicable for E-UTRA deployment where the ACLR requirements are defined as E-UTRA Adjacent Channel Leakage power Ratio (E-UTRA$_{ACLR}$) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency. The E-UTRA channel is measured with a [rectangular measurement bandwidth filter.]

Table 6.6.2.2.1-1: General requirements for E-UTRA$_{ACLR}$

	Channel bandwidth / E-UTRA$_{ACLR1}$ / measurement bandwidth							
	1.4 MHz	**1.6 MHz**	**3 MHz**	**3.2 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
E-UTRA$_{ACLR1}$	30 dB	30 dB	30 dB	30 dB	30 dB	30 dB	30 dB	30 dB
E-UTRA channel Measurement bandwidth					[4.5] MHz	[9.0] MHz	[13.5] MHz	[18] MHz

6.6.2.2.2 Additional requirements

Additional ACLR requirements are specified for adjacent UTRA channels where the UTRA Adjacent Channel Leakage power Ratio ($UTRA_{ACLR}$) is the ratio of the filtered mean power centred on the assigned E-UTRA channel frequency to the filtered mean power centred on an adjacent(s) UTRA channel frequency.

UTRA Adjacent Channel Leakage power Ratio is specified for both the first UTRA 5 MHz adjacent channel ($UTRA_{ACLR1}$) and the 2nd UTRA 5MHz adjacent channel ($UTRA_{ACLR2}$) .The UTRA channel is measured with a 3.84 MHz RRC bandwidth filter with roll-off factor α =0.22.

For some scenarios a 2nd UTRA 5MHz adjacent channel bis requirement ($UTRA_{ACLR2bis}$) is specified where the "additional spectrum emission" requirement as defined in Table 6.2.3.4-1 is applicable

Table 6.6.2.2.2-1: Additional requirements

	Channel bandwidth / $UTRA_{ACLR1/2}$ / measurement bandwidth							
	1.4 MHz	**1.6 MHz**	**3 MHz**	**3.2 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
$UTRA_{ACLR1}$	33 dB	33 dB	33 dB	33 dB	33 dB	33 dB	33 dB	33 dB
$UTRA_{ACLR2}$	-	-	-	-	36 dB	36 dB	36 dB	36 dB
$UTRA_{ACLR2bis}$	-	-	-	-	43 dB	43 dB	-	-
E-UTRA channel Measurement bandwidth		-	-	-	[4.5] MHz	[9.0] MHz	[13.5] MHz	[18] MHz
UTRAchannel Measurement bandwidth	-	-	-	-	3.84 MHz	3.84 MHz	3.84 MHz	3.84 MHz

6.6.3 Spurious emissions

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

UTRA background

The core requirements for spurious emissions are specified for the UE in TS 25.101 [7] and TS25.102[21]. The corresponding test requirements are in TS 34.121 and TS 34.122.

References for the spurious emissions requirements are summarised in Table 6.6.3-1 for the UE. The tables give references to RAN4 core specs, to where the term is defined and to some relevant regulatory references. These regulatory references have either defined the limit value in 3GPP or they have used it as a basis for studies or recommendations.

Table 6.6.3-1 Summary of regulatory references for UE spurious emissions limits

Spurious emissions requirement	**RAN4** TS 25.101 [7]	**Definition**	**Some relevant regulatory references**
General	6.6.3.1 Table 6.12	ITU-R SM.329 [10]	ITU-R M.1581 (Annex 1.4) [8]: Band I limits included. ITU-R SM.329 [10]: 1.4 Necessary bandwidth 4.1 Reference bandwidths 4.3 Category B limits ITU-R M.2039 [16]: Limits included by reference. ETSI EN 301 908-2 [17]: Limits included.

Co-existence with other bands	6.6.3.1 Table 6.13	Developed and defined in 3GPP [7]	ITU-R. M.1581 (Annex 1.4) [8]: Band I limits included. ITU-R M.2039 [16]: Limits included by reference. ETSI EN 301 908-2 [17]: Limits to protect GSM900 and GSM1800 are included.

The general spurious emissions requirements and the corresponding reference bandwidths are taken from ITU-R recommendation SM.329 [10] for both the UE and the BS. The stricter Category B requirements were selected for the UE, to allow for global circulation of terminals.

The requirements are only applicable for frequencies, which are separated more than 250% of the necessary bandwidth from the carrier, as recommended in ITU-R SM.329 [10].

The spurious emissions requirements are included in ITU-R recommendations M.1581 [8] on IMT-2000 unwanted emissions. They are also included in ETSI harmonised standards [17] and referenced from ITU-R report M.2039 [16] that defines parameters to be used in co-existence studies for all IMT-2000 systems.

The RAN4 specifications define specific UE spurious emission limits for co-existence with a number of systems, including UTRA and GSM in the same and different bands, PHS, TDD and other services in adjacent bands. These are defined in terms of additional spurious emission requirements. Some of the co-existence requirements are referenced or included by external bodies such as ITU-R [8] [16] and ETSI [17] as shown in Table 6.6.3-1

E-UTRA background

In the same way as was described for UTRA, general spurious emission requirements based on ITU-R SM.329 [10] will be needed. Spurious emission limits as defined in [10] are divided into several Categories, where Category A and B are taken into 3GPP requirements. Since UEs are intended for global circulation, there cannot be any regional requirement and the stricter Category B limits will apply.

The requirements will apply for frequencies that are separated from the carrier frequency F_c by more than 250% of the necessary bandwidth of E-UTRA. Frequencies that are closer to F_c than 250% of the necessary bandwidth are part of the Out-of-band domain, where the out-of-band limits apply as described in Clause 6.6.2. The necessary bandwidth is taken to be equal to the RF bandwidth of the E-UTRA carrier. This approach is however FFS

In terms of additional requirements, fundamentally, the requirements to co-exist with systems in other bands are the same for E-UTRA as for UTRA. The additional spurious emissions limits in Table 6.13 of TS 25.101 [7] can therefore be re-used for E-UTRA to a large extent. The limits for band VIII (900 MHz) do however have two exceptions for the 2nd and 3rd order harmonics that may fall into band III (1800 MHz) and VII (2600 MHz). These exceptions may be modified taking the wider bandwidth E-UTRA carriers into account. The spurious emission limit for co-existence with other bands in the UE-to-UE interference scenario should also be reviewed. [Detailed requirements TBD]

6.6.3.1 E-UTRA General requirements

The spurious emission limits apply for the frequency ranges that are more than Δf_{OOB} (MHz) from the edge of the channel bandwidth.

Table 6.6.3.1 -1: Δf_{OOB} boundary between E-UTRA channel and spurious emission domain

Channel bandwidth	1.4 [MHz]	1.6 [MHz]	3 [MHz]	3.2 [MHz]	5 [MHz]	10 [MHz]	15 [MHz]	20 [MHz]
Δf_{OOB} (MHz)	[tbd]	[tbd]	[tbd]	[tbd]	10	15	20	25

The spurious emission limits in Table 6.6-3.1-2 apply for all transmitter band configurations (RB) and channel bandwidths

Table 6.6-3.1-2: Spurious emissions limits

Frequency Range	Maximum Level	Measurement Bandwidth
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz

6.6.3.2 Additional requirements

6.6.3.2.1 Spurious emission (co-existence)

This clause specifies the additional requirements for the specified E-UTRA band

Table 6.6.3.2-1: requirements

E-UTRA Band	Frequency Range			Maximum Level	Measurement Bandwidth	Channel bandwidth
	fstart	-	*fend*			
1	1884.5 MHz	-	1919.6 MHz	-41 dBm	300 kHz	1.4,1.6,3. 3.2, 5, 10
	860 MHz	-	895 MHz	-[60] dBm	3.84 MHz	
2		-				
3		-				
4		-				
5		-				
6	1884.5 MHz	-	1919.6 MHz	-41 dBm	300 kHz	5
	860 MHz	-	895 MHz	-[60] dBm	3.84 MHz	
7		-				
8		-				
9	1884.5 MHz	-	1919.6 MHz	-41 dBm	300 kHz	5
	860 MHz	-	895 MHz	-[60] dBm	3.84 MHz	
10		-				
11	1884.5 MHz	-	1919.6 MHz	-41 dBm	300 kHz	5
	860 MHz	-	895 MHz	-[60] dBm	3.84 MHz	
12		-				
13		-				
14		-				
...						
33		-				
34	1884.5 MHz	-	1919.6 MHz	-41 dBm	300 kHz	
35		-				
36		-				
37						
38		-				

6.6.3.2.2 Spurious emission (OOB reduction)

This clause specifies the additional requirements signalled by the network when the nominal transmission bandwidth configuration (50 RB) for a 10 MHz channel bandwidth is required to meet the requirements for a transmission bandwidth configuration (25RB) for a 5 MHz channel bandwidth for E-UTRA band {TBD}.

The power of any UE emission shall not exceed the levels specified in Table 6.6.3.1.2-1.

Table 6.6.3.2.2-1: Δf_{OOB} boundary between E-UTRA out of band and spurious emission domain

Channel bandwidth	1.4 [MHz]	1.6 [MHz]	3 [MHz]	3.2 [MHz]	5 [MHz]	10 [MHz]	15 [MHz]	20 [MHz]	Measurement bandwidth
Δf_{OOB} (MHz)	-	-	-	-	-	10	-	-	1 MHz

6.6.3.2.3 Spurious emission (PHS protection)

E-UTRA background

The additional spurious emission requirement for PHS coexistence (1884.5~1919.6MHz) -41dBm/300kHz (Equivalent to -46dBm/100kHz.) at [20] MHz offset for E-UTRA band 1. This additional Requirement will only need to be specified for the 15MHz and 20 MHz channel bandwidth (PHS requirement for other channel bandwidth are covered in the general requirement). Note that requirements are specified from edge of channel closest to PHS band. A-MPR can be mitigated by starting from edge furthest from PHS band

E-UTRA requirement

This clause specifies the additional requirements signalled by the network for E-UTRA band 1.

The power of any UE emission shall not exceed the levels specified in Table 6.6.3.2.3-1.

Table 6.6.3.2.3-1: Additional requirements (PHS)

Δf_{OOB} (MHz)	Channel bandwidth / Spectrum emission limit (dBm)								Measurement bandwidth
	1.4 MHz	1.6 MHz	3.0 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
[TBD]	-	-	-	-	-	-	-41	-41	300 KHz

6.7 Transmit intermodulation

The transmit intermodulation performance is a measure of the capability of the transmitter to inhibit the generation of signals in its non linear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna.

6.8 Transmit modulation

E-UTRA Background

Transmit modulation defines the modulation quality for expected in-channel RF transmissions from the UE

Transmit modulation defines the modulation quality for expected in-channel RF transmissions from the UE. This transmit modulation limit is specified in terms of an Error Vector Magnitude (EVM) for the allocated resources blocks (RBs) and in terms of in-band emissions for the non-allocated RBs.

E-UTRA requirements

Measurement point

The unwanted emission falling into non-allocated RB(s) is calculated directly after the FFT as described below. In contrast to this, the EVM for the allocated RB(s) is calculated after the IDFT.

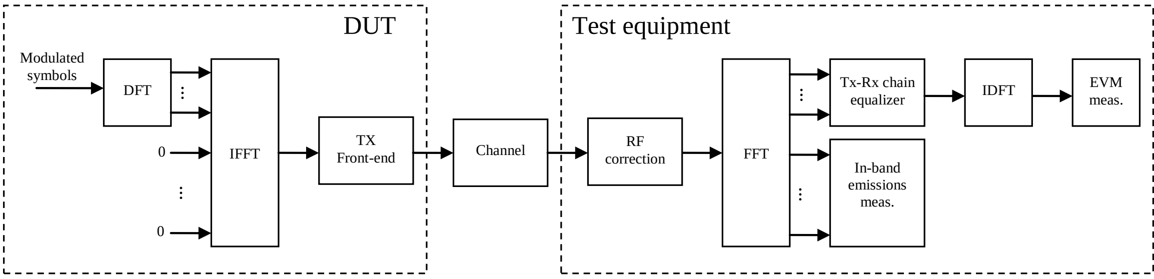


Figure 6.8.1-1: EVM measurement points

Basic Error Vector Magnitude measurement

The EVM is the difference between the ideal waveform and the measured waveform for the allocated RB(s)

$$EVM = \sqrt{\frac{\sum_{v \in T_m} \left| z'(v) - i(v) \right|^2}{\left| T_m \right| \cdot P_0}} ,$$

where

T_m is a set of $\left|T_m\right|$ modulation symbols with the considered modulation scheme being active within the measurement period,

$z'(v)$ are the samples of the signal evaluated for the EVM as defined in the subsection 6.8.4(ii),,

$i(v)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

The basic EVM measurement interval is defined over one [slot] in the time domain except when the mean power between [slot] is expected to change due to power control

i. Basic in-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks

For the non-allocated RBs below the allocated frequency block the in-band emissions would be measured as follows

$$Emissions_{absolute}(\Delta_{RB}) = \frac{1}{\left|T_s\right|} \sum_{t \in T_s} \sum_{\max(f_{\min}, c-12\cdot\Delta_{RB})}^{\min(f_{\max}, c-12\cdot\Delta_{RB}+11)} \left| Y(t, f) \right|^2 ,$$

where

T_s is a set of $\left|T_s\right|$ SC-FDMA symbols with the considered modulation scheme being active within the measurement period,

Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. $\Delta_{RB} = 1$ or $\Delta_{RB} = -1$ for the first adjacent RB),

$f_{\min}$ (resp. $f_{\max}$) is the lower (resp. upper) edge of the UL system BW,

c is the lower edge of the allocated BW, and

$Y(t,f)$ is the frequency domain signal evaluated for in-band emissions as defined in the subsection (ii)

The relative in-band emissions are, given by

$$Emissions_{relative}(\Delta_{RB}) = \frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_s| \cdot N_{RB}} \sum_{t \in T_s} \sum_{c}^{c+12 \cdot N_{RB}-1} |Y(t,f)|^2}$$

where

N_{RB} is the number of allocated RBs

The basic in-band emissions measurement interval is defined over one [slot] in the time domain except when the mean power between [slot] is expected to change due to power control

ii. Modified signal under test

To minimize the error, the signal under test should be modified with respect to a set of parameters following the procedure explained below.

Notation:

$\Delta\tilde{t}$ is the sample timing difference between the FFT processing window in relation to nominal timing of the ideal signal.

$\Delta\tilde{f}$ is the RF frequency offset.

$\tilde{\varphi}(t,f)$ is the phase response of the TX chain.

$\tilde{a}(t,f)$ is the amplitude response of the TX chain.

In the following $\Delta\tilde{c}$ represents the middle sample of the EVM window of length W (defined in the next subsections) or the last sample of the first window half if W is even.

The EVM analyser shall

- detect the start of each subframe and estimate $\Delta\tilde{t}$ and $\Delta\tilde{f}$,
- determine $\Delta\tilde{c}$ so that the EVM window of length W is centred on the measured cyclic prefix of the considered OFDM symbol.

To determine the other parameters a sample timing offset equal to $\Delta\tilde{c}$ is corrected from the signal under test. The EVM analyser shall then

- correct the RF frequency offset $\Delta\tilde{f}$ for each subframe, and
- apply an FFT of appropriate size.

The IQ origin offset shall be removed from the evaluated signal before calculating the EVM and the in-band emissions; however, the removed relative IQ origin offset power (relative carrier leakage power) also has to satisfy the applicable requirement.

At this stage the allocated RBs shall be separated from the non-allocated RBs. The signal on the non-allocated RB(s), $Y(t,f)$, is used to evaluate the in-band emissions.

Moreover, the following procedure applies only to the signal on the allocated RB(s). The UL EVM analyzer shall then estimate the TX chain equalizer coefficients $\tilde{a}(t,f)$ and $\tilde{\varphi}(t,f)$ used by the ZF equalizer for all subcarriers by

1. time averaging at each reference signal subcarrier of the amplitude and phase of the reference symbols, the time-averaging length is [1] subframe. This process creates an average amplitude and phase for each reference signal subcarrier.

At this stage estimates of $\Delta\tilde{f}$, $\tilde{a}(t,f)$, $\tilde{\varphi}(t,f)$ and $\Delta\tilde{c}$ are available. $\Delta\tilde{t}$ is one of the extremities of the window W , i.e. $\Delta\tilde{t}$ can be $\Delta\tilde{c}+\alpha-\left\lfloor\frac{W}{2}\right\rfloor$ or $\Delta\tilde{c}+\left\lfloor\frac{W}{2}\right\rfloor$, where $\alpha=0$ if W is odd and $\alpha=1$ if W is even. The EVM analyser shall then

- calculate EVM_l with $\Delta\tilde{t}$ set to $\Delta\tilde{c}+\alpha-\left\lfloor\frac{W}{2}\right\rfloor$,
- calculate EVM_h with $\Delta\tilde{t}$ set to $\Delta\tilde{c}+\left\lfloor\frac{W}{2}\right\rfloor$.

a. Timing offset

As a result of using a cyclic prefix, there is a range of $\Delta\tilde{t}$, which, at least in the case of perfect Tx signal quality, would give close to minimum error vector magnitude. As a first order approximation, that range should be equal to the length of the cyclic prefix. Any time domain windowing or FIR pulse shaping applied by the transmitter reduces the $\Delta\tilde{t}$ range within which the error vector is close to its minimum.

b. Window length

The window length W affects EVM, and could be expressed as a certain percentage of the configured cyclic prefix length. In the case where equalization is present, as with frequency domain EVM computation, the effect of FIR is reduced. This is because the equalization can correct most of the linear distortion introduced by the FIR. However, the time domain windowing effect can't be removed.

c. Window length for normal CP

[FFS]

d. Window length for Extended CP

[FFS]

iii. Minimum requirement for the allocated resources blocks

The EVM requirement is a measure of difference the reference waveform and the measured waveform for the allocated resources blocks. The EVM for the wanted resource block allocation is a measure of the modulation accuracy for the wanted signal.

The RMS average of the basic EVM measurements for [10] consecutive sub-frames for the different modulations schemes shall not exceed the values specified in Table 6.8.5-1 for the test parameters defined in Table 6.8.5-2

Table 6.8.5-1: Minimum requirements for allocated resource blocks

Parameter	Unit	Level
QPSK	%	[17.5-20]
16QAM	%	[10-14]
64QAM	%	[tbd]

Table 6.8.5-2: Test parameters

Parameter	Unit	Level
UE Output Power	dBm	≥ -30
Operating conditions		Normal conditions
Power control step size	dB	[tbd]
Basic measurement period (Note 1,2)	[slot]	[] ms
Note 1: Less any [ ]µs transient periods Note 2: [ ]ms for generic frame structure type 1 and [ ] ms for frame structure type 2		

iv. Minimum requirement for the LO leakage

One possible way of addressing LO leakage is to define a corresponding parameter that is matched as part of the EVM optimization process. This means measuring the carrier leakage coefficient and subtracting the corresponding signal even before the FFT operation. In other words, the error minimization step also includes selecting a carrier coefficient offset besides selecting the frequency, time offset and equalizer coefficients to minimize the error vector. The carrier coefficient offset is the phase and amplitude of an additive sinusoid waveform that has the same frequency as the reference waveform carrier frequency. The estimated carrier coefficient offset shall be removed from the evaluated signal before further processing; however, the removed carrier coefficient offset amplitude also has to satisfy the applicable requirements.

Due to the half tone offset defined for the E-UTRA UL, measuring the DC value after the front-end FFT is not more accurate than measuring the carrier coefficients before the front-end FFT. But both implementations would give identical results.

Note also that the LO leakage measurement can be carried out irrespective of whether the allocated UL RBs contain the DC tone or not.

The proposed requirement for the LO leakage would be as shown in the following table:

Table 6.8.6-1: Minimum requirements for LO-leakage (IQ origin offset)

	Relative Limit (dBc)	Absolute Limit (dBm)
LO Leakage	[TBD]	[TBD]

v. Minimum requirement for non-allocated resources blocks

The in-band emission is defined as an average across 12 tones and as a function of the RB offset from the edge of the allocated UL block.

The in-band emission is measured as dB value comparing the PSD in the allocated RB(s) and s non-allocated RB

The in band emissions are determined directly from the front-end FFT output, therefore there is no need to consider any impact of frequency domain equalization.

The measured in-band emissions would be compared to the requirements shown in the following table:

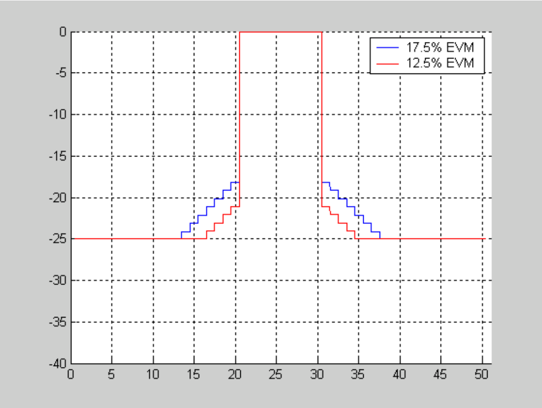
Table 6.8.7-1: Minimum requirements for in-band emissions

Relative emissions (non-allocated PSD / allocated PSD in dB)	Absolute emissions (dBm/180kHz)

$\max\left[-25,(20\cdot\log_{10}EVM)-3-10\cdot(\Delta_{RB}-1)/N_{RB})\right]$	TBD

Few examples are provided below:

10MHz, 10RBs allocated in the center of the band



5MHz, 5RBs allocated in the left of the band

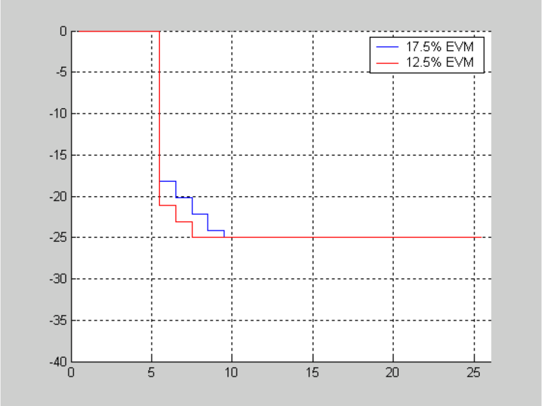


Figure 6.8.7-2: Examples of in-band emission requirements

vi. Minimum requirement for Spectrum Flatness

The spectrum flatness is defined as a relative power variation across the subcarrier of all RB of the allocated UL block. The spectrum flatness is measured as a dB value comparing the output power of a subcarrier and the average power per subcarrier.

The data for the subcarrier output power shall be taken from the equaliser estimation step.

The measured spectrum flatness would be compared to the requirements shown in the following table:

Table 6.8.x-x: Minimum requirements for spectrum flatness

	Relative output power (in dB)
Spectrum Flatness	Tbd.

The spectrum flatness requirement could be expressed by a formula such as $\pm\left[X+Y*(N_{RB}-1)/100)\right]$. The definition for modified requirements for RB allocations at the band edges is ffs.

7 Receiver characteristics

7.1 General

Unless otherwise stated the receiver characteristics are specified at the antenna connector(s) of the UE. For UE(s) with an integral antenna only, a reference antenna(s) with a gain of 0 dBi is assumed for each antenna port(s). UE with an integral antenna(s) may be taken into account by converting these power levels into field strength requirements, assuming a 0 dBi gain antenna. The levels of the test signal applied to each of the antenna connectors shall be as defined in the respective sections below

All the parameters in clause 7 are defined using the DL reference measurement channel specified in Annex C and fixed power allocation for the RB(s). As a first phase the same channel bandwidth for DL and UL should be assumed when requirements for the receiver are defined. Later on the impacts of unequal RX and TX channel band widths could be included.

ACS, blocking, spurious emissions and intermodulation requirements in sections 7.5, 7.6, 7.7 and 7.8 are defined for full band width signals i.e. for signals where all resource blocks are allocated for specific user. The requirements for sub-band signals with low number of resource blocks located in the middle or at the edge of the channel are FFS.

7.2 Diversity characteristics

The requirements in Section 7 assume that the receiver is equipped with two Rx port as a baseline. Requirements for 4 ports are FFS

7.3 Reference sensitivity level

E-UTRA requirements

The reference sensitivity power level REFSENS is the minimum mean power applied to both the UE antenna ports at which the mean throughput R_{av} shall meet or exceed the requirements for the specified reference measurement channel

The throughput R_{av} shall meet or exceed the minimum requirements specified in table 7.3.1-1 for the specified REFSENS

Table 7.3-1: Reference sensitivity QPSK

E-UTRA BAND	Channel bandwidth															
	1.4 MHz		1.6 MHz		3 MHz		3.2 MHz		5 MHz		10 MHz		15 MHz		20 MHz	
	REFSENS / R_{av}		REFSENS / R_{av}		REFSENS / R_{av}		REFSENS / R_{av}		REFSENS / R_{av}		REFSENS / R_{av}		REFSENS / R_{av}		REFSENS / R_{av}	
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NOTE

1. For FDD the transmitter shall be set to maximum output power level
2. Reference measurement channel is [Annex C QPSK R=1/3]
3. For UE(s) which support a maximum sub-set of N_{BW}^{RB} sub-carriers, R_{av} should be the average measured across the full number of N_{BW}^{RB} specified for that channel bandwidth

7.3.1 Maximum Sensitivity Reduction (MSR)

For some operating bands, it is anticipated that the transmitter noise falling in the receive band will be dependant on the channel bandwidth and will degrade the reference sensitivity depending on the operating bandwidth, Tx power and FDD or TDD operation configured by the scheduler. This section is for FFS

7.4 Maximum input level

Background
The maximum input level requirement could be defined for both low and high SNR reference channels as done in UTRA. For High SNR requirement it's likely that higher IM needs to be used. Initial analysis shows that four (4) dB could be used as working assumption. Due to similarities between UTRA and E-UTRA in down link equal maximum input level should be defined for LTE UE. As high SNR case is expected to be the more challenging one for the UE receiver it's proposed that requirements is defined only for that.

E-UTRA requirements

The throughput R_{av} shall meet or exceed the minimum requirements specified in table 7.4.1-1 for the specified wanted signal mean power

Table 7.4-1: Maximum input level

Rx Parameter	Units	Channel bandwidth							
		1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Wanted signal mean power	dBm	-25							
R_{av}	kbps								
NOTE 1. For FDD the transmitter shall be set to 4dB below the supported maximum output power. 2. Reference measurement channel is [Annex C 64QAM R=3/4] 3. For UE(s) which support a maximum sub-set of N_{BW}^{RB} sub-carriers, R_{av} should be the average measured across the full number of N_{BW}^{RB} specified for that channel bandwidth									

7.5 Adjacent Channel Selectivity (ACS)

UTRA Background

The Adjacent Channel Selectivity (ACS) for the UE was specified in 3GPP together with the ACLR, based on extensive simulations documented in TR 25.942 [19]. As explained in clause 6.6.2.1.1, the parameters are closely linked from a system performance point of view and have been an effective tool in co-existence studies.

Adjacent Channel Selectivity (ACS) = A measure of the receiver ability to receive a wanted signal at is assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the center frequency of the assigned channel. ACS is the ratio of the receiver filter attenuation on the assigned channel frequency to the receiver filter attenuation on the adjacent channel(s).

ACS cannot be directly measured, but is defined by stating a certain receiver performance (BER = 0.001) at a specified DPCH_Ec, Îor and Ioac, where Ioac is the power of a UTRA interfering signal located on the adjacent channel. The wanted signal mean power is 14 dB and 41 dB above the reference sensitivity. This does not mean that 14 dB or 41 dB degradation is allowed, those are simply selected test parameters in order to make the interference impact measurable. The reason that both a set of lower and higher input level parameters are selected for the requirement is to capture the dynamic range requirements of the receiver. Further details of how the requirement is derived can be found in clause 8.1.5 of TR 25.942 [19].

The selected set of parameters for UTRA FDD UE in TS 25.101 [7] and for UTRA TDD UE in TS 25.102 [21] corresponds to an ACS value of 33 dB, assuming a 9 dB noise figure of the UE receiver.

E-UTRA Background

The adjacent channel selectivity is defined following the same principles as used in UTRA using modulated E-UTRA carrier as interfering technology. ACS performance of E-UTRA UE should be equal to UTRA UE up to 10MHz bandwidth, but in order to avoid very stringent selectivity requirements for 15 and 20MHz E-UTRA UEs the ACS requirement should be relaxed. For 15MHz option [3dB] and for 20MHz option [6dB] relaxation is proposed. ACS requirement should be defined for low SNR reference channel only.

The UE shall fulfill the specified average throughput requirement R_{av} for low SNR reference channel for all values of an adjacent channel interferer up to –25 dBm.

The performance should be verified with two different cases as in UTRA today.

It's assumed that 0dB SNR is required to demodulate the signal with required TP performance and 2dB IM is used.

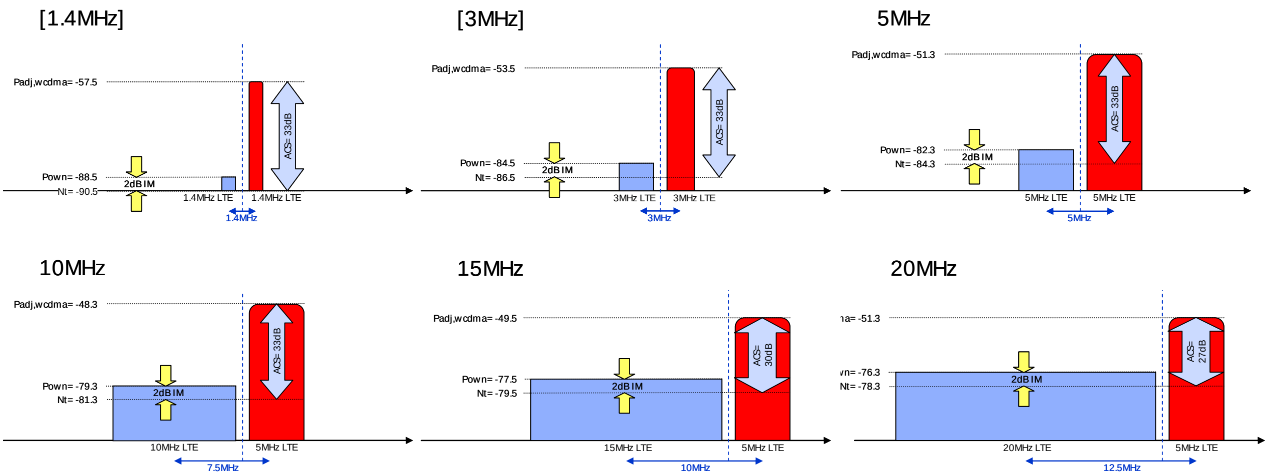

Figure 7.5.1-1: ACS channel selectivity, Case 1

E-UTRA Requirements

Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive a E-UTRA signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

The UE shall fulfil the minimum requirement specified in Table 7.5.1 for all values of an adjacent channel interferer up to -25 dBm. However it is not possible to directly measure the ACS, instead the lower and upper range of test parameters are chosen in Table 7.5.1.-2 and Table 7.5.1.3 where the throughput R_{av} shall meet or exceed the values specified in Table 7.5.1-1

Table 7.5.2.1: Adjacent channel selectivity

Rx Parameter	Units	Channel bandwidth							
		1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
ACS	dB	33.0	33.0	33.0	33.0	33.0	33.0	30	[27]
R_{av}	kbps								

Table 7.5.2-2: Test parameters for Adjacent channel selectivity, Case 1

Rx Parameter	Units	Channel bandwidth							
		1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Wanted signal mean power	dBm	REFSENS + 14 dB							
$P_{Interferer}$	dBm	[-57.5]		[-53.5]		[-51.3*]	[-48.3*]	[49.5*]	[51.2*]
$BW_{Interferer}$	MHz	1.4	1.6	3	3.2	5	5	5	5
$F_{Interferer}$ (offset)	MHz	1.4	1.6	3	3.2	5	7.5	10	12.5

NOTE
1. For FDD the transmitter shall be set to 4dB below the supported maximum output power.
2. Reference measurement channel is [Annex C QPSK R=1/3]
3. For UE(s) which support a maximum sub-set of N_{BW}^{RB} sub-carriers, R_{av} should be the average measured across the full number of N_{BW}^{RB} specified for that channel bandwidth
4. *FDD only

Table 7.5.2-3: Test parameters for Adjacent channel selectivity, Case 2

Rx Parameter	Units	Channel bandwidth							
		1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Wanted signal mean power	dBm	[-56.0]	[-56.0]	[-56.0]	[-56.0]	[-56.0]	[-56.0]	[-53.0]	[-50.0]
$P_{Interferer}$	dBm	-25							
$BW_{Interferer}$	MHz	1.4	1.6	3	3.2	5	5	5	5
$F_{Interferer}$ (offset)	MHz	1.4	1.6	3	3.2	5	7.5	10	12.5

NOTE
1. Foe FDD the transmitter shall be set to 24dB below the supported maximum output power.
2. Reference measurement channel is [Annex C QPSK R=1/3]
3. For UE(s) which support a maximum sub-set of N_{BW}^{RB} sub-carriers, R_{av} should be the average measured across the full number of N_{BW}^{RB} specified for that channel bandwidth

7.6 Blocking characteristics

E-UTRA Background

The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occur.

The blocking requirements should be defined for low SNR reference channel only.

7.6.1 In-band blocking

The UE shall fulfill the specified average throughput requirement R_{av} for low SNR reference channel with weak own signal power in presence of modulated E-UTRA blockers at defined offsets. The blocking signal levels of -56dBm and -44dBm should be used as in UTRA.

E-UTRA requirements

In-band blocking is defined for an unwanted interfering signal falling into the UE receive band or into the first 15 MHz below or above the UE receive band at which the specified throughput R_{av} shall meet or exceed the minimum requirements.

The requirements are specified in terms of a minimum information bit throughput R_{av} for the parameters specified in Table 7.6.1.1-1. Using this configuration the throughput shall meet or exceed the minimum requirements specified in Table 7.6.1.1-2

Table 7.6.1.1-1: In band blocking parameters

Rx Parameter	Units	Channel bandwidth							
		1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Wanted signal mean power	dBm	REFSENS + channel bandwidth specific value below							
		3		3		3	3	[4]	[6]
$BW_{Interferer}$	MHz	1.4		3		5	5	5	5
$F_{Interferer}$ (offset) case 1	MHz	2.1		4.5		7.5	7.5	7.5	7.5
$F_{Interferer}$ (offset) Case 2	MHz	3.5		7.5		12.5	12.5	12.5	12.5
R_{av}	kbps								

NOTE

1. For FDD the transmitter shall be set to 4dB below the supported maximum output power.
2. Reference measurement channel is [Annex C QPSK R=1/3]
3. For UE(s) which support a maximum sub-set of N_{BW}^{RB} sub-carriers, R_{av} should be the average measured across the full number of N_{BW}^{RB} specified for that channel bandwidth

Table 7.6.1.1-2: In-band blocking

E-UTRA band	Parameter	Units	Case 1	Case 2
	$P_{Interferer}$	dBm	-56	-44
	$F_{Interferer}$ (offset)	MHz	$=-BW/2 - F_{Ioffset, case 1}$ & $=+BW/2 + F_{Ioffset, case 1}$	$\leq -BW/2- F_{Ioffset, case 2}$ & $\geq +BW/2 + F_{Ioffset, case 2}$
1, 2, 3, 4, 5 7, 8, 9, 10	$F_{Interferer}$	MHz	F_{DL_low} -7.5 to F_{DL_high} +7.5 (Note 3)	F_{DL_low} -15 to F_{DL_high} +15
6	$F_{Interferer}$	MHz	F_{DL_low} - 7.5 to F_{DL_high} +7.5 (Note 2 & 3)	F_{DL_low} -15 to F_{DL_high} +15 (Note 3)

NOTE

1. The interfering modulated signal is 5MHz E-UTRA signal as described in Annex D for channel bandwidths ≥5 MHz
2. For each carrier frequency the requirement is valid for two frequencies, the carrier frequencies $-BW/2 - F_{Ioffset, case 1}$ & $+ BW/2 + F_{Ioffset, case 1}$.
3. For Band 6, the unwanted modulated interfering signal does not fall inside the UE receive band, but within the first 15 MHz below or above the UE receive band

7.6.2 Out of-band blocking

Background

The UE shall fulfill the specified average throughput requirement R_{av} for low SNR reference channel with weak own signal power in presence unwanted interfering signal falling more than 15 MHz below or above the UE receive band.

E-UTRA requirement

Out-of-band band blocking is defined for an unwanted CW interfering signal falling more than 15 MHz below or above the UE receive band. For the first 15 MHz below or above the UE receive band the appropriate in-band blocking or adjacent channel selectivity in sub-clause 7.5.1 and sub-clause 7.6.1 shall be applied

The requirements are specified in terms of a minimum information bit throughput R_{av} for the parameters specified in Table 7.6.2.1-1. Using this configuration the throughput shall meet or exceed the minimum requirements specified in Table 7.6.2.1-2

For Table 7.6.2.1-2 in frequency range 1, 2 and 3, up to [24] exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1MHz step size. For these exceptions the requirements of clause 7.7 Spurious response are applicable.

For Table 7.6.2.1-2 in frequency range 4, up to [8] exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1MHz step size. For these exceptions the requirements of clause 7.7 Spurious response are applicable.

Table 7.6.2-1: Out-of-band blocking parameters

Rx Parameter	Units	Channel bandwidth							
		1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Wanted signal mean power	dBm	REFSENS + channel bandwidth specific value below							
		3	3	3	3	3	3	[4]	[6]
R_{av}	kbps								

NOTE

1. For FDD the transmitter shall be set to 4dB below the supported maximum output power.
2. Reference measurement channel is [Annex C QPSK R=1/3]
3. For UE(s) which support a maximum sub-set of N_{BW}^{RB} sub-carriers, R_{av} should be the average measured across the full number of N_{BW}^{RB} specified for that channel bandwidth

Table 7.6.2-2: Out of band blocking

E-UTRA band	Parameter	Units	Frequency			
			range 1	range 2	range 3	range 4
	$P_{Interferer}$	dBm	[-44]	[-30]	[-15]	[-15]
1, 2, 3, 4, 5 6,7, 8, 9, 10	$F_{Interferer}$ (CW)	MHz	F_{DL_low} -15 to F_{DL_low} -60	F_{DL_low} -60 to F_{DL_low} -85	F_{DL_low} -85 to 1 MHz	-
			F_{DL_high} +15 to F_{DL_high} + 60	F_{DL_high} +60 to F_{DL_high} +85	F_{DL_high} +85 to +1275 MHz	-
2, 5	$F_{Interferer}$	MHz	-	-	-	F_{UL_low} - F_{UL_high}

NOTE

7.6.3 Narrow band blocking

E-UTRA Background

This requirement is measure of a receiver's ability to receive a E-UTRA signal at its assigned channel frequency in the presence of an unwanted narrow band interferer at a frequency, which is less than the nominal channel spacing. The UE shall fulfill the specified average throughput requirement R_{av} for low SNR reference channel in presence of CW adjacent channel signal.

It's assumed that 0dB SNR is required to demodulate the signal with required TP performance and 2dB IM is used.

E-UTRA Requirements

This requirement is measure of a receiver's ability to receive a E-UTRA signal at its assigned channel frequency in the presence of an unwanted narrow band CW interferer at a frequency, which is less than the nominal channel spacing.

The requirements are specified in terms of a minimum information bit throughput R_{av} for the parameters specified in Table 7.6.3.1-1. Using this configuration the throughput shall meet or exceed the minimum requirements specified in table 7.6.3.1-2

Table 7.6.3.1: Narrow-band blocking

Rx Parameter	Units	Channel bandwidth							
		1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Wanted signal mean power	dBm	REFSENS + channel bandwidth specific value below							
		[19]	[19]	[15]	[15]	[13]	[10]	[11]	[13]
$P_{Interferer}$ (CW)	dBm	[-55.5]		[-55.5]		[-55.3] [4]	[-55.3 [4]]	[-55.5] [4]	[-55.2] [4]
$F_{Interferer}$ (offset)	MHz	[0.9+d]	[1.0+d]	[1.7+d]	[1.8+d]	[2.7+d]	[5.2~+d]	[7.7+d]	[10.2+d]
R_{av}	Kbps								

NOTE

1. For FDD the transmitter shall be set to 4dB below the supported maximum output power.
2. Reference measurement channel is [Annex C QPSK R=1/3]
3. For UE(s) which support a maximum sub-set of N_{BW}^{RB} sub-carriers, R_{av} should be the average measured across the full number of N_{BW}^{RB} specified for that channel bandwidth
4. FDD only >5 MHz
5. d= frequency off set tbd

7.7 Spurious response

E-UTRA Background

Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency at which a response is obtained i.e. for which the out of band blocking limit as specified in subclause 7.6.2 is not met.

The UE shall fulfill the specified average throughput requirement R_{av} for low SNR reference channel.

E-UTRA Requirements

Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency at which a response is obtained i.e. for which the out of band blocking limit as specified in sub-clause 7.6.2 is not met.

The requirements are specified in terms of a minimum information bit throughput R_{av} for the parameters specified in Table 7.7.1-1. Using this configuration the throughput shall meet or exceed the minimum requirements specified in table 7.7.1-2

Table 7.7-1: Spurious response parameters

Rx Parameter	Units	Channel bandwidth							
		1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Wanted signal mean power	dBm	REFSENS + channel bandwidth specific value below							
		3	3	3	3	3	3	[4]	[6]
R_{av}	kbps								
NOTE 1. For FDD the transmitter shall be set to 4dB below the supported maximum output power. 2. Reference measurement channel is [Annex C QPSK R=1/3]									

Table 7.7-2: Spurious Response

Parameter	Unit	Level
$P_{Interferer}$ (CW)	dBm	-44
$F_{Interferer}$	MHz	Spurious response frequencies

7.8 Intermodulation characteristics

Third and higher order mixing of the two interfering RF signals can produce an interfering signal in the band of the desired channel. Intermodulation response rejection is a measure of the capability of the receiver to receiver a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal.

7.8.1 Wide band Intermodulation

E-UTRA Background

The wide band intermodulation requirement should be defined following the same principles as in WCDMA using modulated E-UTRA carrier and CW signal as interferer. The wide-band intermodulation requirement should be defined for low SNR reference channel only.

The UE shall fulfill the specified average throughput requirement R_{av} for low SNR reference channel with weak own signal power in presence of two interfering signals producing an IMD3 product that falls on top of the received signal.

it's assumed that 0dB SNR is required to demodulate the signal with required TP performance and 2dB IM is used.

The required IIP3 for each BW is calculated below. The requirement is quite well in line with UTRA where about -20dBm IIP3 is required.

Table 7.8.1.1: IIP 3 analysis

BW

	1.4	3	5	10	15	20	
RBs	6	15	25	50	75	100	
Pin	-93.5	-93.5	-93.3	-90.3	-87.5	-84.2	dBm
C/I including IM	2	2	2	2	2	2	dB
BW delta	0	0	0	-3.0	-4.8	-6.0	dB
Input referred IMD power [Pin-C/I-BW delta-3]	-98.5	-98.5	-98.3	-98.3	-97.3	-95.3	dBm
Ptest	-46	-46	-46	-46	-46	-46	dBm
IIP3	**-19.8**	**-19.8**	**-19.9**	**-19.9**	**-20.4**	**-21.4**	dBm

The wide band intermodulation requirement is defined following the same principles using modulated E-UTRA carrier and CW signal as interferer.

E-UTRA Requirement

The throughput R_{av} shall meet or exceed the minimum requirements specified in table 7.8.1-1 for the specified wanted signal mean power in the presence of two interfering signals

Table 7.8.1.1-2: Wide band Intermodulation

Rx Parameter	**Units**	**Channel bandwidth**							
		1.4 MHz	**1.6 MHz**	**3 MHz**	**3.2 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Wanted signal mean power	dBm	REFSENS + channel bandwidth specific value below							
		[9]	[8]	[5]	[5]	3	3	[4]	[6]
$P_{Interferer\ 1}$ (CW)	dBm	-46							
$P_{Interferer}$ 2	dBm	-46							
$BW_{Interferer}$ 2		1.4	1.6	3	3.2	5			
$F_{Interferer}$ 1 (offset)	MHz	-BW/2 – 2.1 / +BW/2+ 2.1	-BW/2 –2.4 / +BW/2 +2.4	-BW/2 – 4.5 / +BW/2 + 4.5	BW/2 – 4.8 / +BW/2+ 4.8	-BW/2 – 7.5 / +BW/2 + 7.5			
$F_{Interferer}$ 2 (offset)	MHz	2*$F_{Interferer\ 1}$							
R_{av}	kbps								

NOTE

7. For FDD the transmitter shall be set to 4dB below the supported maximum output power.
8. Reference measurement channel is [Annex C QPSK R=1/3]
9. The interfering modulated signal is 5MHz E-UTRA signal as described in Annex D for channel bandwidth ≥5MHz
10. For UE(s) which support a maximum sub-set of N_{BW}^{RB} sub-carriers, R_{av} should be the average measured across the full number of N_{BW}^{RB} specified for that channel bandwidth

7.8.2 Narrow band Intermodulation

<Text will be added>

7.9 Spurious emissions

The spurious emissions power is the power of emissions generated or amplified in a receiver that appear at the UE antenna connector

E-UTRA requirements

The power of any narrow band CW spurious emission shall not exceed the maximum level specified in Table 7.9

Table 7.9-1: General receiver spurious emission requirements

Frequency Band	Measurement Bandwidth	Maximum level	Note
30MHz ≤ f < 1GHz	100 kHz		
1GHz ≤ f ≤ 12.75 GHz	1 MHz		

8 Performance requirement

8.1 General

<Text will be added>

8.1.1 Dual-antenna receiver capability

The requirements are based on UE(s) which utilise dual-antenna receiver.

8.1.1.2 Antenna correlation and gain imbalance

Dual-antenna receiver would provide lower performance gain at lower frequency (e.g. less than 1 GHz) than at higher frequency, due to the increase in antenna correlation and gain imbalance at lower frequency This need to be accounted in terms of performance requirements

8.1.1.3 Simultaneous unicast and MBMS operations

Simultaneous support of 2Rx unicast + 2Rx dedicated carrier MBMS would not be desirable from the terminal implementation perspective [R4-0706610]. One solution is that UE demodulation performance requirements could be developed based on 2Rx assumption separately for unicast and MBMS, and additional performance requirements for simultaneous unicast and MBMS operations would be developed assuming 1 Rx unicast + 1 Rx MBMS reception. Another is time-multiplexing solution. However, the final solution would be FFS.

8.1.1.4 Dual-antenna receiver capability in idle mode

Dual-antenna operation in idle mode would impact the UE battery life, while it could reduce the overhead of the common channels, such as P-BCH, D-BCH, PICHand PCH. The UE requirements in idle mode will be developed based on the assumptions listed below

Table 8.1.1.4 Assumptions for developing UE requirements in idle mode

Event	Dual-antenna baseline receiver assumption
P-BCH reception	Mandatory
D-BCH reception	Mandatory
PICH and PCH reception	Mandatory
Measurements for Cell re-selection	[tbd]

Annex A (normative): Measurement channels

A.1 General

<Text will be added>

A.2 UL reference measurement channels

<Text will be added>

A.3 DL reference measurement channels

<Text will be added>

Annex B (normative): Propagation conditions

B.1 General

<Text will be added>

B.2 Propagation channels

<Text will be added>

B.2.1 Static propagation condition

<Text will be added>

B.2.2 Multi-path fading propagation conditions

The multipath propagation conditions consist of several parts:

- A delay profile in the form of a "tapped delay-line", characterized by a number of taps at fixed positions on a sampling grid. The profile can be further characterized by the r.m.s. delay spread and the maximum delay spanned by the taps.
- A Doppler spectrum, characterized by a spectrum shape and a maximum Doppler frequency that is determined from the mobile speed
- A set of correlation matrices defining the correlation between the UE and BS antennas in case of multi-antenna systems.

In this clause, a limited set of conditions is defined for each of the parts listed above. Channel models used in performance evaluation are then formed by combining delay profile with a Doppler spectrum, with the addition of correlation properties in case of a multi-antenna scenario.

B.2.2.1 Delay profiles

The delay profiles are selected to be representative of *low*, *medium* and *high* delay spread environments. The profiles for *low* and *medium* delay spread are based on the ITU Pedestrian A and Vehicular A channel models respectively, originally defined for the ITU-R evaluation of IMT-2000 [22]. The high delay spread model is based on the Typical Urban model used for GSM [23] and in some of the evaluation work for LTE.

The resulting model parameters are summarized in Table B.2.2.1 and the tapped delay line models are shown in Tables B.2.2.2, B.2.2.3 and B.2.2.4.

The models are defined on a [10 ns] sampling grid. They can be adapted to any desired sampling grid used in a simulation or test setup using the procedure defined to align sampling grids shown in Annex B of TR 25.943 [25].

Table B.2.2.1-1 Summary of delay profiles for LTE channel models

Model	Number of channel taps	Delay spread (r.m.s.)	Maximum excess tap delay (span)
Extended Pedestrian A (EPA)	7	45 ns	410 ns
Extended Vehicular A model (EVA)	9	357 ns	2510 ns
Extended Typical Urban model (ETU)	9	991 ns	5000 ns

Table B.2.2.1-2 Extended Pedestrian A model (EPA)

Excess tap delay [ns]	Relative power [dB]
0	0.0
30	-1.0
70	-2.0
[0	-3.0
110	-8.0
190	-17.2
410	-20.8

Table B.2.2.1-3 Extended Vehicular A model (EVA)

Excess tap delay [ns]	Relative power [dB]
[0	0.0
30	-1.5
150	-1.4
310	-3.6
370	-0.6
710	-9.1
1090	-7.0
1730	-12.0
2510	-16.9

Table B.2.2.1-4 Extended Typical Urban model (ETU)

Excess tap delay [ns]	Relative power [dB]
0	-1.0
50	-1.0
120	-1.0
200	0.0
230	0.0
500	0.0
1600	-3.0
2300	-5.0
5000	-7.0

B.2.2.2 Doppler spectrum

The Doppler spectrum is modelled using the well known *Clarke* or *Classical Doppler spectrum* [23]. This is the same as the one used for the UTRA performance requirements:

$$p(f) = \begin{cases} \dfrac{P}{\pi f_{d,\max}\sqrt{1-\left(\dfrac{f}{f_{d,\max}}\right)^2}} & if\ |f| < f_{d,\max} \\ 0 & if\ |f| \geq f_{d,\max} \end{cases} \quad (1)$$

where P is the net power, and $f_{d,\max}$ denotes the maximum Doppler frequency, and

$$f_{d,\max} = f_c \frac{v}{c} \quad (2)$$

where v is the speed of the mobile, f_c is the carrier frequency and c is the speed of light.

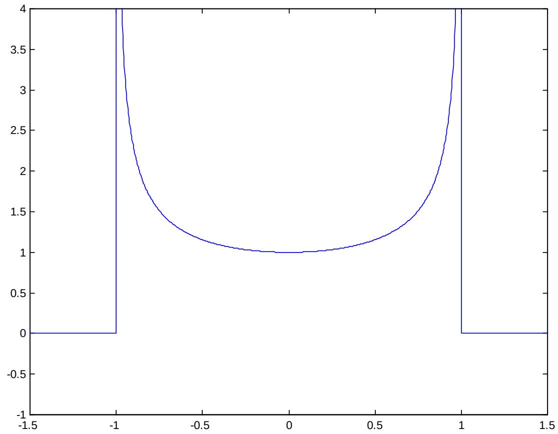

Figure B.2.2.1 The *Clarke* or *Classical Doppler spectrum* as a function of normalised Doppler frequency.

When defining the Doppler frequency $f_{d,\max}$ to use for E-UTRA performance requirements, a principle similar to what was used for UTRA can be implemented. Each propagation condition is based on a max Doppler frequency and not on a specific UE speed. A set of three Doppler frequencies spanning the requirement range as *high*, *middle* and *low* Doppler frequencies is selected:

- The LTE requirements for mobility in TR 25.913 [3] state that "Mobility across the cellular network shall be maintained at speeds from 120 km/h to 350 km/h (or even up to 500 km/h depending on the frequency band)." It is also stated that this "…represents a special case such as high speed train environment." This special case is specified in Appendix B.2.3, based on a High speed train scenario..

- There are more common high speed scenarios for moderately high mobile speeds. It is stated in TR 25.913 [3] that high performance should be maintained up to mobile speeds of 120 km/h. The corresponding maximum Doppler frequency for f_c =2690 km/h is f_D =299 Hz. Based on this, the ***high Doppler frequency*** is selected as ***300 Hz***.

- TR 25.913 [3] also state that "The E-UTRAN shall support mobility across the cellular network and should be optimized for low mobile speed from 0 to 15 km/h." For testing purposes, too low mobile speeds are not attractive, since testing times may be very long. The lowest Doppler frequency in UTRA propagation conditions is 5.4 Hz, corresponding to between 2.3 and 7 km/h in the existing frequency bands. Based on this, the ***low Doppler frequency*** is selected as ***5 Hz.***

- An intermediate Doppler frequency can be set at the "logarithmic" average of the 5 and 900 Hz, being 67 Hz. Based on this, the ***medium Doppler frequency*** is selected as ***70 Hz***.

The UE speed that the Doppler frequencies will correspond to will vary between the Operating bands, as shown in Tables B.2.2.5 and B.2.2.6 (informative), where the carrier frequencies at the centre of each uplink and downlink band are used to derive the corresponding UE speeds.

Table B.2.2.5 Uplink Doppler frequencies and corresponding UE speeds (informative).

Operating Band	UL Frequencies UE transmit, Node B receive	Propagation condition (Doppler) Corresponding UE speed [km/h]		
		Low (5 Hz)	*Mid (70 Hz)*	*High (300 Hz)*
1	1920 - 1980 MHz	2.8	39	166
2	1850 - 1910 MHz	2.9	40	172
3	1710 - 1785 MHz	3.1	43	185
4	1710 - 1755 MHz	3.1	44	187
5	824 - 849 MHz	6.5	90	387
6	830 - 840 MHz	6.5	91	388
7	2500 - 2570 MHz	2.1	30	128
8	880 - 915 MHz	6.0	84	361
9	1749.9 - 1784.9 MHz	3.1	43	183
10	1710 - 1770 MHz	3.1	43	186

Table B.2.2.6 Downlink Doppler frequencies and corresponding UE speeds (informative).

Operating Band	UL Frequencies UE transmit, Node B receive	Propagation condition (Doppler) Corresponding UE speed [km/h]		
		Low (5 Hz)	*Mid (70 Hz)*	*High (300 Hz)*
1	2110 - 2170 MHz	2.5	35	151
2	1930 - 1990 MHz	2.8	39	165
3	1805 - 1880 MHz	2.9	41	176
4	2110 - 2155 MHz	2.5	35	152
5	869 - 894 MHz	6.1	86	368
6	875 - 885 MHz	6.1	86	368
7	2620 - 2690 MHz	2.0	28	122
8	925 - 960 MHz	5.7	80	344
9	1844.9 - 1879.9 MHz	2.9	41	174
10	2110 - 2170 MHz	2.5	35	151

Table B.2.2.7 Doppler frequencies and corresponding UE speeds for TDD operating band (informative).

Operating Band	UL Frequencies UE transmit, Node B receive	Propagation condition (Doppler) Corresponding UE speed [km/h]		
		Low (5 Hz)	*Mid (70 Hz)*	*High (300 Hz)*
33	1900 – 1920 MHz	2.8	40	170
	2010 – 2025 MHz	2.7	37	161
34	1850 – 1910 MHz	2.9	40	172
	1930 – 1990 MHz	2.8	39	165
36	1910 – 1930 MHz	2.8	39	169
37	2570 – 2620 MHz	2.1	29	125

B.2.2.3 Multi-Antenna channel models

B.2.2.3.1 Background

The LTE MIMO channel model is defined by applying the same correlation matrix to the multipaths defined in Section B.2.2.1. Three types of correlations are defined namely high, medium and low correlation. The low correlation matrix will have no correlation and simply becomes the identity matrix. The following discussion then concentrates on the high and medium correlation types. No particular antenna configurations are provided although it is implicitly assumed that linear spatial arrays of 1, 2, or 4 elements are used at eNB and UE. The correlation matrices are specified via an eNB spatial correlation between adjacent antennas α and a UE spatial correlation between adjacent antennas β.

There are many different physical realisations that can lead to the definition of the correlation matrices. Therefore no specific antenna configuration is specified here so that it is not implied that only one antenna configuration can lead to the definition of these correlation matrices.

The correlation matrix for the eNB with two antennas is represented as follows:

$$R_{eNB} = \begin{pmatrix} 1 & \alpha \\ \alpha^* & \mathbf{1} \end{pmatrix}$$

and with one antenna, the correlation matrix for the eNB reduces to:

$$R_{eNB} = 1$$

The correlation matrix for UE is represented as follows:

$$R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & \mathbf{1} \end{pmatrix}$$

The parameters α and β are defined in Table B.2.2.1 and define the spatial correlation between the antennas at the eNB and UE.

We define the channel spatial correlation matrix for 2x2 case, R_{spat}, as:

$$R_{spat} = R_{eNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix} = \begin{bmatrix} 1 & \beta & \alpha & \alpha\beta \\ \beta^* & 1 & \alpha\beta^* & \alpha \\ \alpha^* & \alpha^*\beta & 1 & \beta \\ \alpha^*\beta^* & \alpha^* & \beta^* & 1 \end{bmatrix}$$

and for the 1x2 case:

$$R_{spat} = R_{UE} = \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix}$$

For cases with more antennas at either eNB or UE or both, the channel spatial correlation matrix can still be expressed as the Kronecker product of R_{eNB} and R_{UE} according to $R_{spat} = R_{eNB} \otimes R_{UE}$. Due to the size of R_{spat} for these cases the explicit elements have not be given here.

The α and β for different correlation types are given in Table B.2.2.1.

Table B.2.2.1

Low correlation		Medium Correlation		High Correlation	
α	β	α	β	α	β
0	0	0.3	0.9	0.9	0.9

B.2.2.3.2 Correlation Matrix Defintions

The correlation matrices for high correlation for 1x2 and 2x2 respectively are:

$$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$$

$$R_{high} = \begin{pmatrix} 1 & 0.9 & 0.9 & 0.81 \\ 0.9 & 1 & 0.81 & 0.9 \\ 0.9 & 0.81 & 1 & 0.9 \\ 0.81 & 0.9 & 0.9 & 1 \end{pmatrix}$$

The correlation matrix for medium correlation for 2x2 is:

$$R_{medium} = \begin{pmatrix} 1 & 0.9 & 0.3 & 0.27 \\ 0.9 & 1 & 0.27 & 0.3 \\ 0.3 & 0.27 & 1 & 0.9 \\ 0.27 & 0.3 & 0.9 & 1 \end{pmatrix}$$

The correlation matrices for low correlation is (no correlation) for 1x2 and 2x2 respectively are:

$$R_{low} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$R_{low} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

B.2.2.3.3 Correlation Matrix Application

[This section is to be completed with a clear definition of the application of these correlation matrices, see for example R4-070141]

B.2.2.4 Combinations of channel model parameters

A set of baseline combinations of channel model parameters are introduced. These offer a selection from the range of parameters, in order to reduce the total number of channel models to be used in simulating and defining the LTE receiver performance.

Delay spread	Doppler frequency	Model	Comment
[Low]	[Low]	**[EPA 5Hz]**	[Low delay spread model representing small cell and indoor cases.]
[Medium]	[Low]	**[EVA 5Hz]**	
[Medium]	[Medium]	**[EVA 70Hz]**	
[High]	[Medium]	**[ETU 70Hz]**	[Represents high delay spread environments, with a delay span of the same order as the cyclic prefix.]
[High]	[High]	**[ETU 300Hz]**	
TBD	[High]	**TBD**	[A high speed train scenerio is for further study.]

B.2.3 High speed train scenario

The high speed train condition for the test of the baseband performance is a non fading propagation channel with one tap. Doppler shift is given by

$$f_s(t) = f_d \cos\theta(t) \qquad \text{(B.2.3.1)}$$

where $f_s(t)$ is the Doppler shift and f_d is the maximum Doppler frequency. The cosine of angle $\theta(t)$ is given by

$$\cos\theta(t) = \frac{D_s/2 - vt}{\sqrt{D_{\min}{}^2 + (D_s/2 - vt)^2}}\ ,\ 0 \le t \le D_s/v \qquad \text{(B.2.3.2)}$$

where $D_s/2$ is the initial distance of the train from BS, and $D_{\min}$ is BS-Railway track distance, both in meters; v is the velocity of the train in m/s, t is time in seconds. The parameters in the equation are shown in Table B.2.3-1 assuming a carrier frequency f_C = 2690 MHz. The resulting Doppler shift is shown in Figure B.2.3-1.

Table B.2.3-1

Parameter	Value
D_s	300 m
$D_{\min}$	2 m
v	300 km/h
f_d	750 Hz

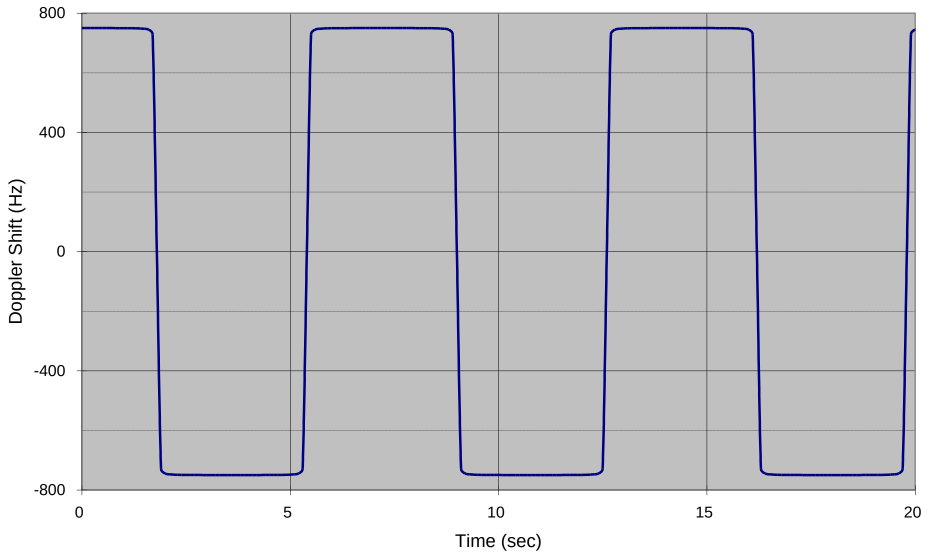

Figure B.2.3-1: Doppler shift trajectory

Annex C (normative): Downlink Physical Channels

C.1 General

As the purpose of the section 7 requirements is to guarantee that the analog parts of the receiver have good performance (noise figure, selectivity, linearity etc.) it's proposed that one or two different "down link reference channels" are defined with fixed modulation and coding. One of the channels should represent low SNR and the other possibly high SNR case.

The section 7 requirement can also be defined without HARQ, which will simplify and also speed up the testing of the UE. QPSK modulated signal with [1/3] coding could be used as low SNR channel 64QAM modulated signal with [3/4] coding as high SNR channel. The relative throughput versus SNR of these two channels in AWGN channel with 1 TX / 1 RX, no HARQ, and true channel estimation is shown in figure 1. With high number of sub-carriers the maximum throughput of 1/3 coded QPSK channel is achieved with SNR of 0dB and about 17.5dB is needed for 3/4 coded 64 QAM channel.

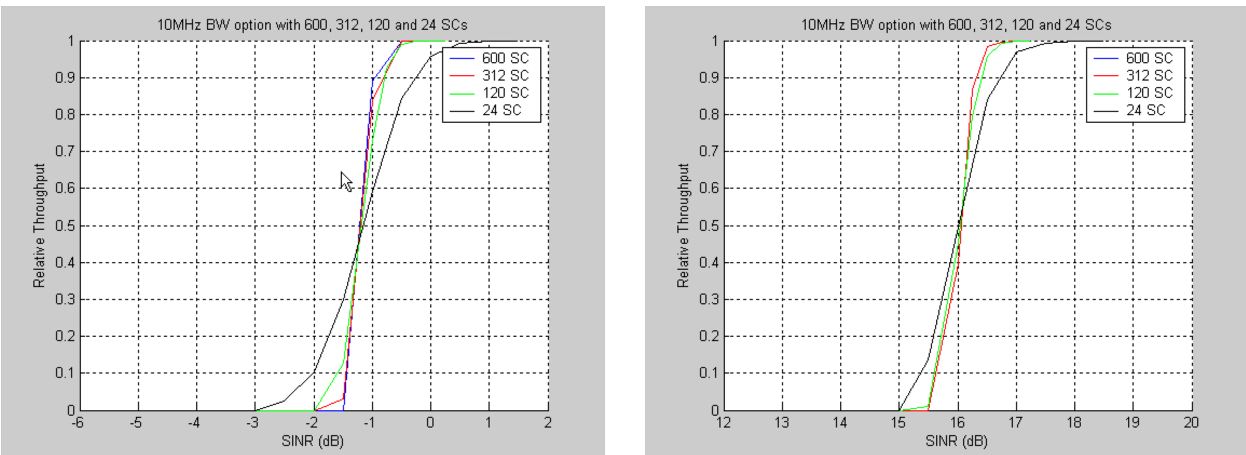

Figure C.1.1. Relative throughput of 1/3 coded QPSK and 3/4 coded 64QAM signals

As can be seen from the figures above the throughput without HARQ reacts strongly to changes in SNR close to switching point and therefore throughput could be used as performance metric in all receiver RF requirements.

Table C.1.1: Description of low and high SNR DL reference channels

Parameter	Low SNR channel	High SNR channel	Unit
Channel Band width	Requirement dependent	Requirement dependent	MHz
Allocated Resource blocks	Requirement dependent	Requirement dependent	
Modulation	QPSK	64QAM	
Coding	[1/3]	[3/4]	
SNR requirement	[0]	[18]	dB

C.2 Set-up

<Text will be added>

C.3 Connection

<Text will be added>

Annex D (normative): Characteristics of the interfering signal

D.1 General

The following interfering signals are used in 3GPP TS 25.101 section 7 when performance requirements for WCDMA UE are defined.

- Wide band interferer
    - Modulated WCDMA down link signal as specified in ANNEX C 4 of [2]
- Narrow band interferers
    - CW interferer
    - GMSK modulated interfering signal as defined in TS 45.004 [4]

As there are many similarities in LTE DL to WCDMA DL it would seem reasonable to use same set of interfering signals when the receiver RF performance requirements for LTE UE are set. On the other hand it would be good to use as few interfering signals to keep both specification and test systems as simple as possible.

The RX requirements for LTE UE must guarantee that the performance is maintained in the presence of both wide band and narrow band interfering technologies. 5MHz full band width LTE down link signal would be a good choice as wide band interfering signal as wider band width down link signals (10, 15 and 20MHz) are expected to be more lenient from receiver perspective due to lower power spectral density. The performance in presence of narrow band width options could be guaranteed by setting a narrow band ACS or blocking requirements. However, as it will be very challenging to define appropriate requirements for narrow band width signals with wide band interfering signal it is proposed that band width of the interferer should never be wider than channel band width of received signal.

Based on the learning in WCDMA, using a GMSK modulated interferer in narrow band blocking and IMD test cases does not add value to the existing requirement. It’s true that in real networks the interfering signals are often GMSK modulated, but also other technologies are used on adjacent frequency blocks. The GMSK modulated signal does not have any amplitude variation and the power is concentrated on very narrow area in frequency domain and therefore the differences to CW signal are after all are very small.

Based on the findings above it’s proposed that when the channel band width is wider or equal to 5MHz, a 5MHz full band width LTE down link signal and CW signal are used as interfering signals when RF performance requirements for LTE UE receiver are defined. For channels narrower than 5MHz, the band width of interferer should be equal to band width of the received signal.

D.2 E-UTRA Requirements

When the channel band width is wider or equal to 5MHz, a 5MHz full band width E-UTRA down link signal and CW signal are used as interfering signals when RF performance requirements for E-UTRA UE receiver are defined. For channels narrower than 5MHz, the band width of interferer should be equal to band width of the received signal.

Table D.2.1 describes the modulated interferers

Table D.2-1: Description of modulated E-UTRA interferer

	Channel bandwidth							
	1.4 MHz	**1.6 MHz**	**3 MHz**	**3.2 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
RB	6	7	15	16	**25**	**50**	**75**	**100**
$BW_{Interferer}$	1.4 MHz	1.6 MHz	3 MHz	3.2 MHz	5 MHz	5 MHz	5 MHz	5 MHz

Annex E (informative): EARFCN numbers

E.1 General

<Text will be added>

E.2 List of EARFCN

Annex F (normative): Environmental conditions

F.1 General

This normative annex specifies the environmental requirements of the UE. Within these limits the requirements of the present documents shall be fulfilled.

F.2 Environmental

The requirements in this clause apply to all types of UE(s).

F.2.1 Temperature

The UE shall fulfil all the requirements in the full temperature range of:

Table F2.1-1

+15°C to +35°C	for normal conditions (with relative humidity of 25 % to 75 %)
-10°C to +55°C	for extreme conditions (see IEC publications 68-2-1 and 68-2-2)

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 for extreme operation.

F.2.2 Voltage

The UE shall fulfil all the requirements in the full voltage range, i.e. the voltage range between the extreme voltages.

The manufacturer shall declare the lower and higher extreme voltages and the approximate shutdown voltage. For the equipment that can be operated from one or more of the power sources listed below, the lower extreme voltage shall not be higher, and the higher extreme voltage shall not be lower than that specified below.

Table F2.2-1

Power source	Lower extreme voltage	Higher extreme voltage	Normal conditions voltage
AC mains	0,9 * nominal	1,1 * nominal	nominal
Regulated lead acid battery	0,9 * nominal	1,3 * nominal	1,1 * nominal
Non regulated batteries: Leclanché Lithium Mercury/nickel & cadmium	 0,85 * nominal 0,95 * nominal 0,90 * nominal	 Nominal 1,1 * Nominal	 Nominal 1,1 * Nominal Nominal

Outside this voltage range the UE if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

F.2.3 Vibration

The UE shall fulfil all the requirements when vibrated at the following frequency/amplitudes.

Table F2.3-1

Frequency	ASD (Acceleration Spectral Density) random vibration
5 Hz to 20 Hz	0,96 m^2/s^3
20 Hz to 500 Hz	0,96 m^2/s^3 at 20 Hz, thereafter –3 dB/Octave

Outside the specified frequency range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 25.101 for extreme operation

Annex G (informative): Change history

Date	TSG#	TSG Doc.	CR	Subject	Old	New
Feb 2006				Report (TR36.803) based on (R4-06158 + R4-060631)		0.0.1
16-02-2007				Revised during RAN4#42 to include R4-070298, R4-070299, R4-070300 and R4-070301		0.1.0
04-04-2007				Text from; R4-070415, R4-070454, R4-070340		0.2.0
07-04-2007				Proposal from Vodafone to define tolerance in [] and band III /8 as 23 dBm		0.2.1
11-05-2007	R4#43	R4-070872		Revised during RAN4#43 to include R4-070682, R4-070810 and R4-070573		0.3.0
2007-07	R4#43bis	R4		Revised after RAN4#43bis to add the following **R4-071085**: Text proposal to TR36.803 – Section 7.1 General **R4-071086**: Text proposal to TR36.803 – Annex C Downlink Physical channels **R4-071087**: Text proposal to TR36.803 – Annex D Interference signals **R4-071088**: Text proposal to TR36.803 – Section 7.4 Maximum input level **R4-071089**: Text proposal to TR36.803 – Section 7.5 ACS **R4-071090**: Text proposal to TR36.803 – Section 7.6 Blocking **R4-071091**: Text proposal to TR36.803 – Section 7.7 Spurious emission **R4-071092**: Text proposal to TR36.803 – Section 7.8 Intermodulation **R4-071096**: LTE Band numbering text proposal for TR36.803 **R4-071099**: Text proposal to TR36.803 on dual antenna receiver **R4-071132**: Text proposal for frequency error in section 6.3 in TR36.803		0.4.0
2007-08	R4#44	R4-071515		Revised after RAN4#44 to add the following **R4-071236:** TP for TR36.803 section 5 channel arrangement **R4-071442:** TP to section 8 of TR36.803 on dual antenna reception **R4-071444:** TP to 36.803 for MIMO correlation matrices **R4-071500:** Update of R4-071237 **R4-071508:** TP to TR 36.803 – Section 6.8 Transmit modulation		0.5.0
2007-09	R4#44bis	R4-071779		**R4-071602: update of R4-071515 + meeting approved changes**		0.6.0
2007-09	R4#44bis	R4-071788		**R4-071738:** TP for TR36.804 on channel numbering **R4-071733:** TP 36.803 High speed scenario **R4-071780:** TP to TR36.803 on the LTE UE modulation accuracy measurements R4-071789: MPR ad-hoc		0.7.0
2007-11	R4#45	R4-072057		Revised after R4#44bis to address editorial correction		0.7.1
2007-11	R4#45	R4-072233		R4-071958: TR 36.803: TP for High speed train model (UE) R4-072113: TP to UE TR on frequency band for E-UTRA TDD R4-072146: TP to TR36.803 on the EVM window R4-072209: Text proposal for TR 36.803: Minimum output power R4-072223: TP for 36.803 for MIMO correlation matrices for LTE R4-072225: TP for E-UTRA UE channel bandwidth for TR36.803		0.8.0
2007-12	R#38	RP-071008		Document presented to RAN as version 1.0.0		1.0.0