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Technical Specification

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User Equipment (UE) radio transmission and reception
(3GPP TS 36.101 version 8.3.0 Release 8)

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Contents

Foreword

This Technical Specification (TS) has been produced by the 3rd Generation Partnership Project (3GPP).

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1 Scope

. The present document establishes the minimum RF characteristics and minimum performance requirements for E-UTRA User Equipment (UE).

2 References

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

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

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

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

[3] ITU-R Recommendation M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications-2000".

[4] 3GPP TS 36.211: "Physical Channels and Modulation".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Channel edge: The lowest and highest frequency of the carrier, separated by the channel bandwidth.

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) 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 $\beta/2$ 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
E_{RS}	Transmitted energy per RE for reference symbols during the useful part of the symbol, i.e. excluding the cyclic prefix, (average power normalized to the subcarrier spacing) at the eNode B transmit antenna connector
$\hat{E}_s$	The received energy per RE during the useful part of the symbol, i.e. excluding the cyclic prefix, averaged across the allocated RB(s) (average power within the allocated RB(s), divided by the number of RE within this allocation, and normalized to the subcarrier spacing) at the UE antenna connector
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

Editor''s note : one of the two following definitions for Io will be used (TBD)

I_o	The power spectral density of the total input signal (power averaged over the useful part of the symbols within the transmission bandwidth configuration, divided by the total number of RE for this configuration and normalised to the subcarrier spacing) at the UE antenna connector, including the own-cell downlink signal
I_o	The power spectral density of the total input signal at the UE antenna connector (power averaged over the useful part of the symbols within a given bandwidth and normalised to the said bandwidth), including the own-cell downlink signal
I_{or}	The total transmitted power spectral density of the own-cell downlink signal (power averaged over the useful part of the symbols within the transmission bandwidth configuration, divided by the total number of RE for this configuration and normalised to the subcarrier spacing) at the eNode B transmit antenna connector
$\hat{I}_{or}$	The total received power spectral density of the own-cell downlink signal (power averaged over the useful part of the symbols within the transmission bandwidth configuration, divided by the total number of RE for this configuration and normalised to the subcarrier spacing) at the UE antenna connector
I_{ot}	The received power spectral density of the total noise and interference for a certain RE (average power obtained within the RE and normalized to the subcarrier spacing) as measured at the UE antenna connector
N_{cp}	Cyclic prefix length
N_{DL}	Downlink EARFCN
N_{oc}	The power spectral density of a white noise source (average power per RE normalised to the subcarrier spacing), simulating interference from cells that are not defined in a test procedure, as measured at the UE antenna connector$N_{Offs-DL}$ Offset used for calculating downlink EARFCN
$N_{Offs-UL}$	Offset used for calculating uplink EARFCN
N_{otx}	The power spectral density of a white noise source (average power per RE normalised to the subcarrier spacing) simulating eNode B transmitter impairments as measured at the eNode B transmit antenna connector
N_{RB}	Transmission bandwidth configuration, expressed in units of resource blocks

N_{UL}	Uplink EARFCN
Rav	Minimum average throughput per RB
$P_{Interferer}$	Modulated mean power of the interferer
ΔF_{OOB}	Δ Frequency of Out Of Band emission

3.3 Abbreviations

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

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
EARFCN	E-UTRA Absolute Radio Frequency Channel Number
EPRE	Energy Per Resource Element
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
MCS	Modulation and Coding Scheme
MOP	Maximum Output Power
MPR	Maximum Power Reduction
MSR	Maximum Sensitivity Reduction
OOB	Out-of-band
PA	Power Amplifier
PSS	Primary Synchronization Signal
PSS_RA	PSS-to-RS EPRE ratio for the channel PSS
RE	Resource Element
REFSENS	Reference Sensitivity power level
r.m.s	Root Mean Square
SNR	Signal-to-Noise Ratio
SSS	Secondary Synchronization Signal
SSS_RA	SSS-to-RS EPRE ratio for the channel SSS
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
xCH_RA	xCH-to-RS EPRE ratio for the channel xCH in all transmitted OFDM symbols not containing RS
xCH_RB	xCH-to-RS EPRE ratio for the channel xCH in all transmitted OFDM symbols containing RS

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 TS 36.xxx section y 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 ITU-R M.1545 [3].

4.2 Applicability of minimum requirements

In this specification the Minimum Requirements are specified as general requirements and additional requirements. Where the Requirement is specified as a general requirement, the requirement is mandated to be met in all scenarios

For specific scenarios for which an additional requirement is specified, in addition to meeting the general requirement, the UE is mandated to meet the additional requirements.

5 Frequency bands and channel arrangement

5.1 General

The channel arrangements presented in this clause are based on the frequency bands and channel bandwidths defined in the present release of specifications.

NOTE: Other frequency bands and channel bandwidths may be considered in future releases.

5.2 Frequency bands

E-UTRA is designed to operate in the frequency bands defined in Table 5.2-1.

Table 5.2-1 E-UTRA frequency bands

E-UTRA Band	Uplink (UL) eNode B receive UE transmit			Downlink (DL) eNode B transmit UE receive				Duplex Mode
	F_{UL_low}	–	F_{UL_high}	F_{DL_low}	–	F_{DL_high}		
1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz		FDD
2	1850 MHz	–	1910 MHz	1930 MHz	–	1990 MHz		FDD
3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz		FDD
4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz		FDD
5	824 MHz	–	849 MHz	869 MHz	–	894MHz		FDD
6	830 MHz	–	840 MHz	875 MHz	–	885 MHz		FDD
7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz		FDD
8	880 MHz	–	915 MHz	925 MHz	–	960 MHz		FDD
9	1749.9 MHz	–	1784.9 MHz	1844.9 MHz	–	1879.9 MHz		FDD
10	1710 MHz	–	1770 MHz	2110 MHz	–	2170 MHz		FDD
11	1427.9 MHz	–	1452.9 MHz	1475.9 MHz	–	1500.9 MHz		FDD
12	698 MHz	–	716 MHz	728 MHz	–	746 MHz		FDD
13	777 MHz	–	787 MHz	746 MHz	–	756 MHz		FDD
14	788 MHz	–	798 MHz	758 MHz	–	768 MHz		FDD
...								
17	704 MHz	–	716 MHz	734 MHz	–	746 MHz		FDD
...								
33	1900 MHz	–	1920 MHz	1900 MHz	–	1920 MHz		TDD
34	2010 MHz	–	2025 MHz	2010 MHz	–	2025 MHz		TDD
35	1850 MHz	–	1910 MHz	1850 MHz	–	1910 MHz		TDD
36	1930 MHz	–	1990 MHz	1930 MHz	–	1990 MHz		TDD
37	1910 MHz	–	1930 MHz	1910 MHz	–	1930 MHz		TDD
38	2570 MHz	–	2620 MHz	2570 MHz	–	2620 MHz		TDD
39	1880 MHz	-	1920 MHz	1880 MHz	-	1920 MHz		TDD
40	2300 MHz	-	2400 MHz	2300 MHz	-	2400 MHz		TDD

5.3 TX–RX frequency separation

5.4 Channel arrangement

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 bandwidths. The nominal channel spacing between two adjacent E-UTRA carriers is defined as following:

$$\text{Nominal Channel spacing} = (BW_{Channel(1)} + BW_{Channel(2)})/2$$

where $BW_{Channel(1)}$ and $BW_{Channel(2)}$ are the channel bandwidths of the two respective E-UTRA carriers. The channel spacing can be adjusted to optimize performance in a particular deployment scenario.

5.4.2 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.4.2-1.

Table 5.4.2-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.4.2-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

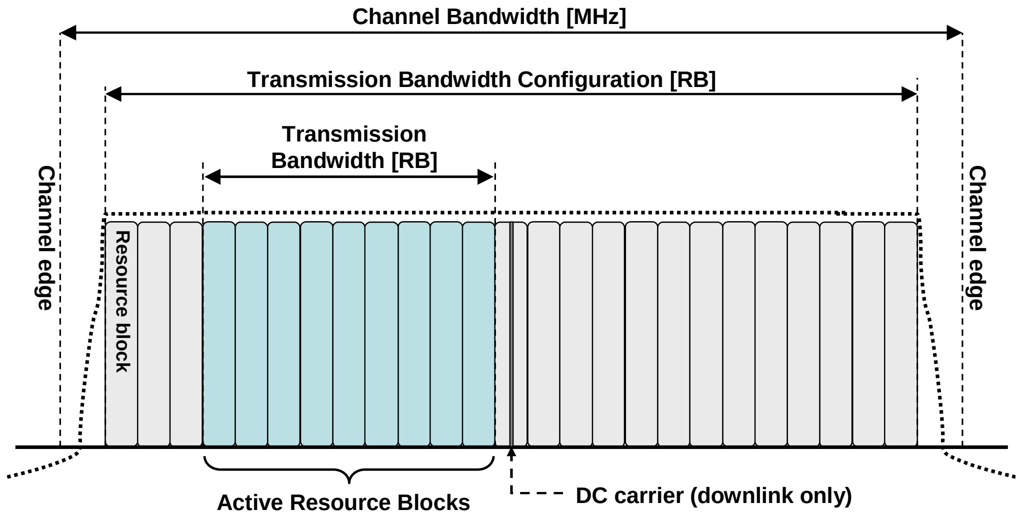

Figure 5.4.2-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier.

5.4.2.1 Channel bandwidths per operating band

The requirements in this specification apply to the combination of channel bandwidths and operating bands shown in Table 5.4.2.1-1. The transmission bandwidth configuration in Table 5.4.2.1-1 shall be supported for each of the specified channel bandwidths.

Table 5.4.2.1-1: E-UTRA channel bandwidth

E-UTRA band / channel bandwidth

E-UTRA Band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
1			Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes[1]	Yes[1]
3	Yes	Yes	Yes	Yes	Yes[1]	Yes[1]
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes[1]		
6			Yes	Yes[1]		
7			Yes	Yes	Yes	Yes[1]
8	Yes	Yes	Yes	Yes[1]		
9			Yes	Yes	Yes[1]	Yes[1]
10			Yes	Yes	Yes	Yes
11			Yes	Yes[1]	Yes[1]	Yes[1]
12						
13	Yes	Yes	Yes[1]	Yes[1]		
14	Yes	Yes	Yes[1]	Yes[1]		
...						
33			Yes	Yes	Yes	Yes
34			Yes	Yes	Yes	
35	Yes	Yes	Yes	Yes	Yes	Yes
36	Yes	Yes	Yes	Yes	Yes	Yes
37			Yes	Yes	Yes	Yes
38			Yes	Yes		
39			Yes	Yes	Yes	Yes
40				Yes	Yes	Yes

NOTE 1: bandwidth for which a relaxation of the specified UE receiver sensitivity requirement (Clause 7.3) is allowed.

5.4.2.2 Void

5.4.3 Channel raster

The channel raster is 100 kHz for all bands, which means that the carrier centre frequency must be an integer multiple of 100 kHz.

5.4.4 Carrier frequency and EARFCN

The carrier frequency in the uplink and downlink is designated by the E-UTRA Absolute Radio Frequency Channel Number (EARFCN). The relation between EARFCN and the carrier frequency in MHz for the downlink is given by the following equation, where F_{DL_low} and $N_{Offs\text{-}DL}$ are given in table 5.4.4-1 and N_{DL} is the downlink EARFCN.

$$F_{DL} = F_{DL\_low} + 0.1(N_{DL} - N_{Offs\text{-}DL})$$

The relation between EARFCN and the carrier frequency in MHz for the uplink is given by the following equation where F_{UL_low} and $N_{Offs\text{-}UL}$ are given in table 5.4.4-1 and N_{UL} is the uplink EARFCN.

$$F_{UL} = F_{UL\_low} + 0.1(N_{UL} - N_{Offs\text{-}UL})$$

Table 5.4.4-1 E-UTRA channel numbers

	Downlink			Uplink		
Band	**F_{DL_low} (MHz)**	**$N_{Offs\text{-}DL}$**	**Range of N_{DL}**	**F_{UL_low} (MHz)**	**$N_{Offs\text{-}UL}$**	**Range of N_{UL}**
1	2110	0	0 – 599	1920	13000	13000 – 13599
2	1930	600	600 – 1199	1850	13600	13600 – 14199
3	1805	1200	1200 – 1949	1710	14200	14200 – 14949
4	2110	1950	1950 – 2399	1710	14950	14950 – 15399
5	869	2400	2400 – 2649	824	15400	15400 – 15649
6	875	2650	2650 – 2749	830	15650	15650 – 15749
7	2620	2750	2750 – 3449	2500	15750	15750 – 16449
8	925	3450	3450 – 3799	880	16450	16450 – 16799
9	1844.9	3800	3800 – 4149	1749.9	16800	16800 – 17149
10	2110	4150	4150 – 4749	1710	17150	17150 – 17749
11	1475.9	4750	4750 – 4999	1427.9	17750	17750 – 17999
12						
13	746	5180	5180 – 5279	777	18180	18180 – 18279
14	758	5280	5280 – 5379	788	18280	18280 – 18379
…						
33	1900	26000	26000 – 26199	1900	26000	26000 – 26199
34	2010	26200	26200 – 26349	2010	26200	26200 – 26349
35	1850	26350	26350 – 26949	1850	26350	26350 – 26949
36	1930	26950	26950 – 27549	1930	26950	26950 – 27549
37	1910	27550	27550 – 27749	1910	27550	27550 – 27749
38	2570	27750	27750 – 28249	2570	27750	27750 – 28249
39	1880	28250	28250-28649	1880	28250	28250-28649
40	2300	28650	28650-29649	2300	28650	28650-29649

5.4.5 Void

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 Void

6.2.2 UE Maximum Output Power

The following UE Power Classes define the nominal maximum output power. The nominal power is defined as the broadband transmit power of the UE, i.e. the power in the channel bandwidth (clause 5.2) 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

ITRA Band	ss 1 3m)	erance dB)	ss 2 3m)	erance dB)	ss 3 3m)	erance dB)	ss 4 3m)	erance 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		
39					23	±2		
40					23	±2		

1. The above tolerances are applicable for UE(s) that support up to 4 E-UTRA operating bands. For UE(s) that support 5 or more E-UTRA bands the maximum output power is expected to decrease with each additional band and is FFS

6.2.3 UE Maximum Output power for modulation / channel bandwidth

For UE Power Class 3, the allowed Maximum Power Reduction (MPR) for the maximum output power in Table 6.2.2-1due to higher order modulation and transmit bandwidth configuration (resource blocks) is specified in Table 6.2.3-1.

Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3

Modulation	Channel bandwidth / Transmission bandwidth configuration [RB]						MPR (dB)
	L.4 MHz	3.0 MHz	MHz	10 MHz	15 MHz	20 MHz	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2

6.2.4 UE Maximum Output Power with additional requirements

Additional ACLR and spectrum emission requirements can be signalled by the network to indicate that the UE shall meet also additional requirements in a specific deployment scenario. To meet these additional requirements the concept of Additional Maximum Power Reduction A-MPR is introduced for the output power in Table 6.2.2-1

For UE Power Class 3 the specific requirements and identified sub-clauses are specified in table 6.2.4-1 along with the allowed A-MPR values that may be used to meet these requirements. The allowed A-MPR values specified below in Table 6.2.4.-1 are in addition to the allowed MPR requirements specified in clause 6.2.3.

Table 6.2.4-1: Additional Maximum Power Reduction (A-MPR) / Spectrum Emission requirements

Network Signalling value	Requirements (sub-clause)	E-UTRA Band	Channel bandwidth (MHz)	Resources Blocks	A-MPR (dB)
NS_01	-	-	-		
NS_02	6.6.2.4.1 6.6.3.3.1	1, 6, 9, 11	10	> 42	≤ 1
			15	> 44	≤ 1
			20	> 48	≤ 1
NS_03	6.6.2.2.1	2, 4,10, 35, 36	3	>5	≤ 1
	6.6.2.2.1	2, 4,10, 35,36	5	>6	≤ 1
	6.6.2.2.1	2, 4,10, 35,36	10	>6	≤ 1
	6.6.2.2.1	2, 4,10,35,36	15	>8	≤ 1
	6.6.2.2.1	2, 4,10,35, 36	20	>10	≤ 1
NS_04	6.6.2.2.2	TBD	TBD	TBD	
NS_05	6.6.3.3.1	1[2]	10,15,20	≥ 50 for QPSK	≤ 1
NS_06	6.6.2.2.3	13, 14	1.4, 3, 5, 10	n/a	n/a
..					
NS_32	-	-	-	-	-
Note: 0 ≤A-MPR ≤ 3 Note2: Applicable when the edge of the assigned E-UTRA UL channel bandwidth frequency is larger than or equal to 1920MHz + the Channel BW assigned. Operations below this point are for further study.					

6.3 Output power dynamics

6.3.1 Power control

Power control is used to limit the interference level and compensate the channel fading. The UE power is defined as the mean power in a subframe or ON power duration, whichever is available.

The UE transmission can be in two contiguity modes, i.e. contiguous transmission and non-contiguous transmission. The former has a transmission gap of 0 and the later has a transmission gap larger than 0. The transmission gap is the time interval between the end of the last UE transmission subframe and the beginning of the next UE transmission subframe or the UpPTS (for TDD).

6.3.1.1 Absolute power tolerance

Absolute power tolerance is the ability of the UE transmitter to set its initial output power to a specific value at the start of a contiguous transmission or non-contiguous transmission with a long transmission gap, i.e. transmission gap is larger than [x] ms. It includes the channel estimation error (the absolute RSRP accuracy requirement specified in clause 9.1 of TS 36.133) and UE power setting error.

6.3.1.1.1 Minimum requirement

The minimum requirement on absolute power tolerance is given in Table 6.3.1.1.1.

Table 6.3.1.1.1: Absolute power tolerance

Conditions	Tolerance
Normal conditions	± 10.5 dB
Extreme conditions	± 13.5 dB

6.3.2 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 for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value.

6.3.2.1 Minimum requirement

The minimum output power is defined as the mean power in one sub-frame (1ms). The minimum output power shall not exceed the values specifed in Table 6.3.2.1-1.

Table 6.3.2.1-1: Minimum output power

	el bandwidth / Minimum output power / measurement bandwidth					
	1.4 MHz	**.0 Hz**	**5 Hz**	**0 Hz**	**15 MHz**	**0 Hz**
um output power			-40 dBm			
rement bandwidth	8 MHz	MHz	MHz	MHz	5 MHz	MHz

6.3.3 Transmit ON/OFF power

6.3.3.1 Transmit OFF power

Transmit OFF power is defined as the mean power when the transmitter is OFF. The transmitter is considered to be OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During measurements gaps, the UE is not considered to be OFF.

6.3.3.1.1 Minimum requirement

The transmit OFF power is defined as the mean power in a duration of at least one sub-frame (1ms) excluding any transient periods. The transmit OFF power shall not exceed the values specified in Table 6.3.3.1-1.

Table 6.3.3.1-1: Transmit OFF power

	el bandwidth / Minimum output power / measurement bandwidth					
	1.4 MHz	**.0 Hz**	**5 Hz**	**0 Hz**	**15 MHz**	**0 Hz**
smit OFF power			-50 dBm			
rement bandwidth	8 MHz	MHz	MHz	MHz	5 MHz	MHz

6.4 Control and monitoring functions

6.4.1 Out-of-synchronization handling of output power

6.5 Transmit signal quality

6.5.1 Frequency error

The UE modulated carrier frequency shall be accurate to within ±0.1 PPM observed over a period of one sub-frame (1ms) compared to the carrier frequency received from the E-UTRA Node B

6.5.2 Transmit modulation

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 (RB), an I/Q component and an in-band emissions for the non-allocated RB.

All the parameters defined in clause 6.5.2 are defined using the measurement methodology specified in Annex F.

6.5.2.1 Error Vector Magnitude

The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. Before calculating the EVM the measured waveform is corrected by the sample timing offset and RF frequency offset. Then the IQ origin offset shall be removed from the measured waveform before calculating the EVM.

The measured waveform is further modified by selecting the absolute phase and absolute amplitude of the Tx chain. The EVM result is defined after the front-end IDFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. The basic EVM measurement interval is one sub-frame in the time domain.

6.5.2.1.1 Minimum requirement

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 6.5.2.1.1-1 for the parameters defined in Table 6.5.2.1.1-2.

Table 6.5.2.1.1-1: Minimum requirements for Error Vector Magnitude

Parameter	Unit	Level
QPSK	%	17.5
16QAM	%	12.5
64QAM	%	[tbd]

Table 6.5.2.1.1-2: Parameters for Error Vector Magnitude

Parameter	Unit	Level
UE Output Power	dBm	≥ -40
Operating conditions		Normal conditions
Basic measurement period		slot

6.5.2.2 IQ-component

The IQ origin offset is the phase and amplitude of an additive sinusoid waveform that has the same frequency as the reference waveform carrier frequency.

6.5.2.2.1 Minimum requirements

The relative carrier leakage power (IQ origin offset power) shall not exceed the values specified in Table 6.5.2.2.1-1.

Table 6.5.2.2.1-1: Minimum requirements for Relative Carrier Leakage Power

LO Leakage	Parameters	Relative Limit (dBc)
	Output power >0 dBm	-25
	-30 dBm ≤ Output power ≤0 dBm	-20
	-40 dBm ≤ Output power < -30 dBm	-10

6.5.2.3 In-band emissions

The in-band emission is defined as the average across 12 sub-carrier and as a function of the RB offset from the edge of the allocated UL transmission bandwidth. The in-band emission is measured as the [relative UE output power] of any non –allocated RB(s) and the [total UE output power] of all the allocated RB(s). The basic in-band emissions measurement interval is defined over one slot in the time domain.

6.5.2.3.1 Minimum requirements

The relative in-band emission shall not exceed the values specified in Table 6.5.2.3.1-1.

Table 6.5.2.3.1-1: Minimum requirements for in-band emissions

In band emission	Relative emissions (dB)
	$\max\left[-25, (20\cdot\log_{10} EVM) - 3 - 10\cdot(\Delta_{RB} - 1)/N_{RB})\right]$

6.5.2.4 Spectrum flatness

The spectrum flatness is defined as a relative power variation across the subcarriers 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.

6.5.2.4.1 Minimum requirements

The spectrum flatness shall not exceed the values specified in Table 6.5.2.4.1-1 for normal conditions and Table 6.5.2.4.1-2 for extreme conditions.

Table 6.5.2.4.1-1: Minimum requirements for spectrum flatness (normal conditions)

Spectrum Flatness	Relative Limit (dB)
If $F_{UL\_measurement} - F_{UL\_low} \geq$ [3MHz] and If $F_{UL\_high} - F_{UL\_measurement} \geq$ [3 MHz]	[+2/-2]
If $F_{UL\_measurement} - F_{UL\_low} <$ [3 MHz] and If $F_{UL\_high} - F_{UL\_measurement} <$ [3 MHz]	[+3/-5]

Note

1. F_{UL_low} and F_{UL_high} refers to each E-UTRA frequency band specified in Table 5.2-1
2. $F_{UL\_measurement}$ refers to frequency tone being evaluated

Table 6.5.2.4.1-2: Minimum requirements for spectrum flatness (extreme conditions)

Spectrum Flatness	Relative Limit (dB)
If $F_{UL\_measurement} - F_{UL\_low} \geq$ [3MHz] and If $F_{UL\_high} - F_{UL\_measurement} \geq$ [3 MHz]	[+2/-2]
If $F_{UL\_measurement} - F_{UL\_low} <$ [3 MHz] and If $F_{UL\_high} - F_{UL\_measurement} <$ [3 MHz]	[+4/-8]

Note

3. F_{UL_low} and F_{UL_high} refers to each E-UTRA frequency band specified in Table 5.2-1
4. $F_{UL\_measurement}$ refers to frequency tone being evaluated

6.6 Output RF spectrum emissions

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

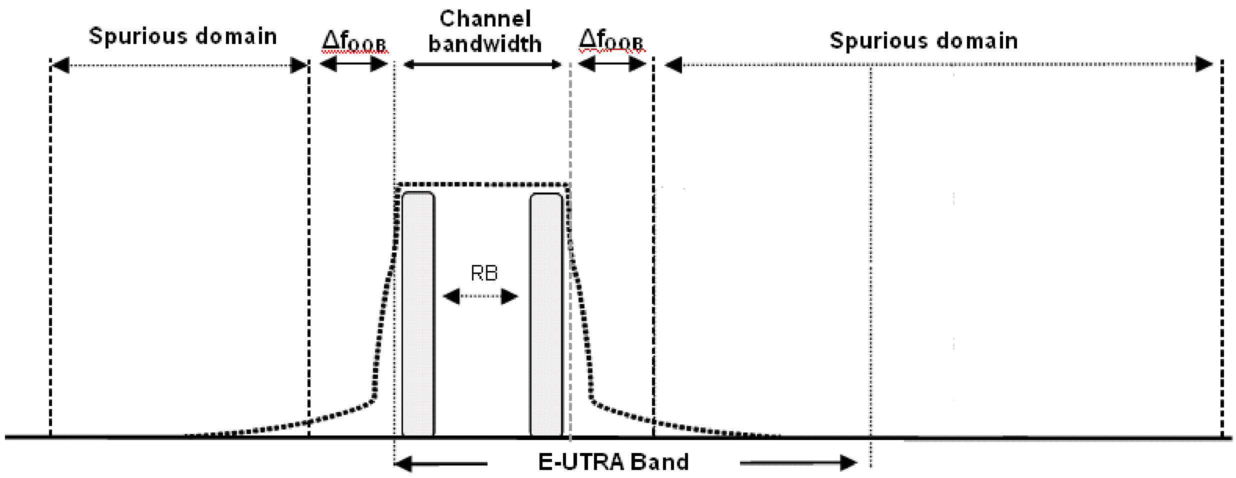

Figure 6.6-1: Transmitter RF spectrum

6.6.1 Occupied bandwidth

Occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel. The occupied bandwidth for all transmission bandwidth configurations (Resources Blocks) shall be less than the channel bandwidth specified in Table 6.6.1-1

Table 6.6.1-1: Occupied channel bandwidth

	cupied channel bandwidth / channel bandwidth					
	1.4	0		)	;	)
	MHz	lz	lz	lz	lz	lz
nel bandwidth [MHz]	1.4			)	;	)

6.6.2 Out of band emission

The Out of band emissions are unwanted emissions immediately outside the assigned channel bandwidth 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 an Adjacent Channel Leakage power Ratio.

6.6.2.1 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 6.6.2.1.1-1 the spurious requirements in clause 6.6.3 are applicable.

6.6.2.1.1 Minimum 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)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Measurement bandwidth
± 0-1	[TBD]	[TBD]	-15	-18	-20	-21	30 kHz
± 1-2.5	[-10]	[-10]	-10	-10	-10	-10	1 MHz
± 2.5-5	[-25]	[-10]	-10	-10	-10	-10	1 MHz
± 5-6		[-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.

6.6.2.2 Additional Spectrum Emission Mask

This requirement is specified in terms of an "additional spectrum emission" requirement.

6.6.2.2.1 Minimum requirement (network signalled value "NS_03")

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS_03" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.2.2.1-1.

Table 6.6.2.2.1-1: Additional requirements

	Spectrum emission limit (dBm)/ Channel bandwidth						
Δf_{OOB} (MHz)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Measurement bandwidth
± 0-1	[TBD]	[TBD]	-15	-18	-20	-21	30 kHz
± 1-2.5	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 2.5-5	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 5-6	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 6-10	[TBD]	[TBD]	-25	-13	-13	-13	1 MHz
± 10-15	[TBD]	[TBD]		-25	-13	-13	1 MHz
± 15-20	[TBD]	[TBD]			-25	-13	1 MHz
± 10-25	[TBD]	[TBD]				-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.

6.6.2.2.2 Minimum requirement (network signalled value "NS_04")

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS_04" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.2.2.2-1.

Table 6.6.2.2.2-1: Additional requirements

	Spectrum emission limit (dBm)/ Channel bandwidth						
Δf_{OOB} (MHz)	**1.4 MHz**	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Measurement bandwidth**
± 0-1	[TBD]	[TBD]	-15	-18	-20	-21	30 kHz
± 1-2.5	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 2.5-5	[TBD]	[TBD]	-13	-13	-13	-13	1 MHz
± 5-6	[TBD]	[TBD]	-25	-25	-25	-25	1 MHz
± 6-10	[TBD]	[TBD]	-25	-25	-25	-25	1 MHz
± 10-15	[TBD]	[TBD]		-25	-25	-25	1 MHz
± 15-20	[TBD]	[TBD]			-25	-25	1 MHz
± 10-25	[TBD]	[TBD]				-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.

6.6.2.2.3 Minimum requirement (network signalled value "NS_06")

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS_06" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.2.2.3-1.

Table 6.6.2.2.3-1: Additional requirements

	Spectrum emission limit (dBm)/ Channel bandwidth				
Δf_{OOB} (MHz)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	Measurement bandwidth
± 0-0.1	[TBD]	[TBD]	-15	-18	30 kHz
± 0.1-1	-13	-13	-13	-13	100 kHz
± 1-2.5	[TBD]	[TBD]	-13	-13	1 MHz
± 2.5-5	[TBD]	[TBD]	-13	-13	1 MHz
± 5-6		[TBD]	-13	-13	1 MHz
± 6-10			-25	-13	1 MHz
± 10-15				-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.

6.6.2.3 Adjacent Channel Leakage Ratio

Adjacent Channel Leakage power Ratio (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. ACLR requirements are specified for two scenarios for an adjacent E -UTRA and /or UTRA channel as shown in Figure 6.6.2.3 -1.

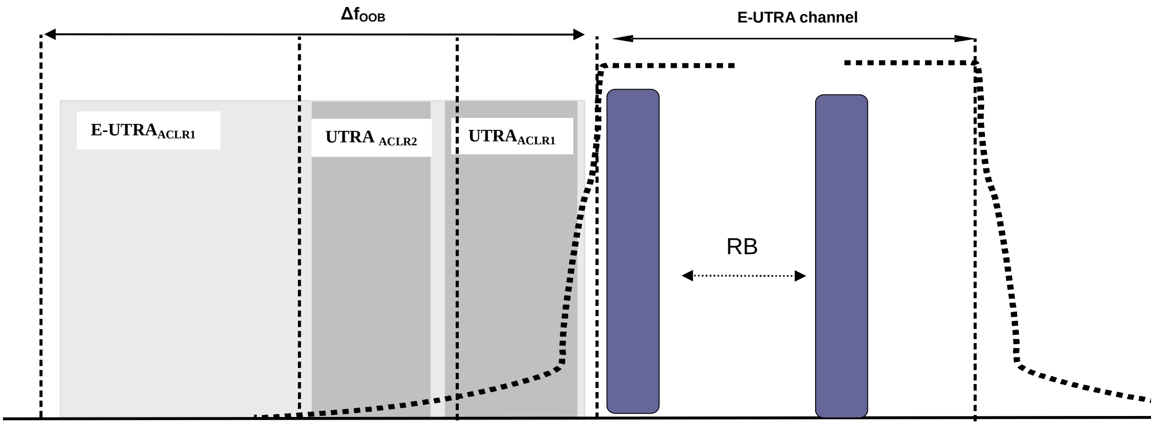

Figure 6.6.2.3-1: Adjacent Channel Leakage requirements

6.6.2.3.1 Minimum requirement E-UTRA

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 assigned E-UTRA channel power and adjacent E-UTRA channel power are measured with rectangular filters with measurement bandwidths specified in Table 6.6.2.3.1-1. If the measured adjacent channel power is greater than –[50]dBm then the E-UTRA$_{ACLR}$ shall be higher than the value specified in Table 6.6.2.3.1-1.

Table 6.6.2.3.1-1: General requirements for E-UTRA$_{ACLR}$

	Channel bandwidth / E-UTRA$_{ACLR1}$ / measurement bandwidth					
	.4 Hz	.0 Hz	5 lHz	10 ⁄lHz	15 MHz	20 MHz
E-UTRA$_{ACLR1}$	dB	dB	) dB	0 dB	:0 dB	:0 dB
UTRA channel Measurement bandwidth			MHz	) MHz	.5 MHz	} MHz

6.6.2.3.2 Minimum requirements UTRA

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 power is measured with a 3.84 MHz RRC bandwidth filter with roll-off factor α =0.22. The assigned E-UTRA channel power is measured with a rectangular filter with measurement bandwidth specified in Table 6.6.2.3.2-1. If the measured UTRA channel power is greater than –[50]dBm then the UTRA$_{ACLR}$ shall be higher than the value specified in Table 6.6.2.3.2-1.

Table 6.6.2.3.2-1: Additional requirements

	Channel bandwidth / $UTRA_{ACLR1/2}$ / measurement bandwidth					
	.4	**.0**	**5**	**10**	**15**	**20**
	Hz	**Hz**	**IHz**	**IHz**	**MHz**	**MHz**
$UTRA_{ACLR1}$	dB	dB	3 dB	3 dB	3 dB	3 dB
$UTRA_{ACLR2}$	-	-	5 dB	5 dB	6 dB	6 dB
UTRA channel Measurement bandwidth		-	MHz	MHz	.5 MHz	3 MHz
hannel Measurement bandwidth	-	-	4 MHz	4 MHz	4 MHz	4 MHz

6.6.2.4 Additional ACLR requirements

This requirement is specified in terms of an additional $UTRA_{ACLR2}$ requirement.

6.6.2.4.1 Minimum requirements (network signalled value "NS_02")

"NS_02" is signalled by the network to indicate that the UE shall meet this additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

The Additional ACLR requirement is specified for the 2[nd] UTRA 5MHz adjacent channel ($UTRA_{ACLR2}$) The UTRA channel power is measured with a 3.84 MHz RRC bandwidth filter with roll-off factor α =0.22. The assigned E-UTRA channel power is measured with a rectangular filter with measurement bandwidth specified in Table 6.6.2.3.2-1. If the UTRA 2[nd] adjacent channel power is greater than –[50]dBm then the $UTRA_{ACLR2}$ shall be higher than the value specified in Table 6.6.2.4.1-1.

Table 6.6.2.4.1-1: Additional requirements ($UTRA_{ACLR2}$)

	hannel bandwidth / $UTRA_{ACLR2}$ / measurement bandwidth					
	.4	**.0**	**5**	**10**	**15**	**20**
	Hz	**Hz**	**IHz**	**IHz**	**IHz**	**IHz**
$TRA_{ACLR2bis}$	-	-	3 dB	3 dB	-	-
TRA channel Measurement bandwidth	-	-	MHz	MHz	-	-
TRA channel Measurement bandwidth	-	-	4 MHz	4 MHz	-	-

6.6.3 Spurious emissions

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions. The spurious emission limits are specified in terms of general requirements inline with SM.329 [2] and E-UTRA operating band requirement to address UE co-existence.

6.6.3.1 Minimum requirements

The spurious emission limits in Table 6.6.3.1-2 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: Boundary between E-UTRA Δf_{OOB} and spurious emission domain

el bandwidth	4 Hz	0 Hz	ı Hz	0 Hz	5 Hz	0 Hz
OB (MHz)	d]	d]	0	5	0	5

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

requency Range	imum Level	surement Bandwidth
kHz ≤ f < 150 kHz	-36 dBm	1 kHz
0 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
MHz ≤ f < 1000 MHz	-36 dBm	100 kHz
Hz ≤ f < 12.75 GHz	-30 dBm	1 MHz

6.6.3.2 Spurious emission band UE co-existence

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

Table 6.6.3.2-1: Requirements

E-UTRA Band	Spurious emission						
	Protected band	Frequency range (MHz)			Level (dBm)	Bandwidth (MHz)	Comment
1	E-UTRA Band 1, 3, 7, 8, 9, 11, 34, 38, 40	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	
	E-UTRA band 33	1900	-	1920	-50	1	Note [3]
	E-UTRA band 39	1880	-	1920	-50	1	Note [3]
2	E-UTRA Band 2, 4, 5, 10, 13, 14	FDL_low	-	FDL_high	-50	1	
3	E-UTRA Band 1, 3, 7, 8, 9, 11, 33, 34, 38	FDL_low	-	FDL_high	-50	1	
4	E-UTRA Band 2, 4, 5, 10, 13, 14	FDL_low	-	FDL_high	-50	1	
5	E-UTRA Band 2, 4, 5, 10, 13, 14	FDL_low	-	FDL_high	-50	1	
6	E-UTRA Band 1, 9, 11, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	875	-37	1	
	Frequency range	875	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	
7	E-UTRA Band 1, 3, 7, 8, 33, 34	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 38	2570	-	2620	-50	1	Note [3]
8	E-UTRA Band 1, 8, 7, 33, 34, 38, 39, 40	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 3	1805	-	1830	-50	1	Note [4]
	E-UTRA band 3	1805	-	1880	-36	0.1	Note [2,4]

	E-UTRA band 3	1830	-	1880	-50	1	Note 4
	E-UTRA band 7	2640	-	2690	-50	1	Note 4
	E-UTRA band 7	2640	-	2690	-36	0.1	Note 2,4
9	E-UTRA Band 1, 9, 11, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	
10	E-UTRA Band 2, 4, 5, 10, 13, 14	FDL_low	-	FDL_high	-50	1	
11	E-UTRA Band 1, 9, 11, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	
13	E-UTRA Band 2, 4, 5, 10, 13, 14	FDL_low	-	FDL_high	-50	1	
	Frequency range	763	-	775	-35	0.00625	
14	E-UTRA Band 2, 4, 5, 10, 13, 14	FDL_low	-	FDL_high	-50	1	
	Frequency range	763	-	775	-35	0.00625	
33	E-UTRA Band 1, 3, 8, 34, 38, 39, 40	FDL_low	-	FDL_high	-50	1	Note 5
34	E-UTRA Band 1, 3, 7, 8, 9, 11, 33, 38,39, 40	FDL_low	-	FDL_high	-50	1	Note 5
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	
35							
36							
37			-				
38	E-UTRA Band 1,3, 33, 34	FDL_low	-	FDL_high	-50	1	
39	E-UTRA Band 34, 40	FDL_low	-	FDL_high	-50	1	
40	E-UTRA Band 1, 3, 33, 34, 39	FDL_low	-	FDL_high	-50	1	

Note

1 FDL_low and FDL_high refer to each E-UTRA frequency band specified in Table 5.2-1

2 A number of exceptions are permitted and is FFS. These exceptions include both spurious due to LO mixing and I/Q imbalance for specific values of N_{RB}. For these exceptions the requirements of Table 6.6.3.1-2 are applicable.

3 To meet these requirements some restriction will be needed for either the operating band or protected band

4 Requirements are specified in terms of E-UTRA sub-bands

5 For non synchronised TDD operation to meet these requirements some restriction will be needed for either the operating band or protected band

6.6.3.3 Additional spurious emissions

These requirements are specified in terms of an additional spectrum emission requirement.

6.6.3.3.1 Minimum requirement (network signalled value 'NS_02' or "NS_05")

Additional spurious emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When 'NS_02' or "NS_05" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.3.3.1-1.

Table 6.6.3.3.1-1: Additional requirements (PHS)

Frequency band (MHz)	Channel bandwidth / Spectrum emission limit (dBm)						Measurement bandwidth
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
$1884.5 \leq f \leq 1919.6$	-41	-41	-41	-41	-41	-41	300 KHz
Note 1. The requirements are applicable when the edge of the assigned E-UTRA UL channel bandwidth frequency is larger than or equal to 1920MHz + the Channel BW assigned. Operations below this point are for further study.							

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.

6.7.1 Minimum requirement

User Equipment(s) transmitting in close vicinity of each other can produce intermodulation products, which can fall into the UE, or eNode B receive band as an unwanted interfering signal. The UE intermodulation attenuation is defined by the ratio of the mean power of the wanted signal to the mean power of the intermodulation product when an interfering CW signal is added at a level below the wanted signal at each of the transmitter antenna port with the other antenna port(s) if any is terminated.

The requirement of transmitting intermodulation is prescribed in Table 6.7.1-1.

Table 6.7.1-1: Transmit Intermodulation

BWChannel (UL)	5MHz		10MHz		15MHz		20MHz	
Interference Signal Frequency Offset	5MHz	10MHz	10MHz	20MHz	15MHz	30MHz	20MHz	40MHz
Interference CW Signal Level	[-40dBc]							
Intermodulation Product	[-31dBc]	[-41dBc]	[t.b.d.]	[t.b.d.]	[t.b.d.]	[t.b.d.]	[t.b.d.]	[t.b.d.]
Measurement bandwidth	4.5MHz	4.5MHz	9.0MHz	9.0MHz	13.5MHz	13.5MHz	18MHz	18MHz

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. . For UEs with more than one receiver antenna connector, identical interfering signals shall be applied to each receiver antenna port if more than one of these is used (diversity).

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 A.3.2 and using the set-up specified in Annex C.3.1

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. With the exception of clause 7.9 all requirements shall be verified by using both (all) antenna ports simultaneously.

7.3 Reference sensitivity power level

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

7.3.1 Minimum requirements (QPSK)

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in Annex A.3.2 with parameters specified in Table 7.3.1-1 and table 7.3.1-2

Table 7.3.1-1: Reference sensitivity QPSK $P_{REFSENS}$

Channel bandwidth							
E-UTRA Band	**1.4 MHz (dBm)**	**3 MHz (dBm)**	**5 MHz (dBm)**	**10 MHz (dBm)**	**15 MHz (dBm)**	**20 MHz (dBm)**	**Duplex Mode**
1	-	-	-100	-97	-95.2	-94	FDD
2	-104.2	-100.2	-98	-95	-93.2	-92	FDD
3	-103.2	-99.2	-97	-94	-92.2	-91	FDD
4	-106.2	-102.2	-100	-97	-95.2	-94	FDD
5	-104.2	-100.2	-98	-95			FDD
6	-	-	-100	-97			FDD
7	-	-	-98	-95	-93.2	-92	FDD
8	-103.2	-99.2	-97	-94			FDD
9	-	-	-99	-96	-94	-93	FDD
10	-	-	-100	-97	-95.2	-94	FDD
11	-	-	-98	-95	-93.2	-92	FDD
12							FDD
13	-103.2	-99.2	-97	-94			FDD
14							FDD
33	-	-	[-100]	[-97]	[-95.2]	[-94]	TDD
34	-	-	[-100]	[-97]	[-95.2]	[-94]	TDD
35	[-106.2]	[-102.2]	[-100]	[-97]	[-95.2]	[-94]	TDD
36	[-106.2]	[-102.2]	[-100]	[-97]	[-95.2]	[-94]	TDD
37	-	-	[-100]	[-97]	[-95.2]	[-94]	TDD
38	-	-	[-100]	[-97]	[-95.2]	[-94]	TDD
39	-	-	[-100]	[-97]	[-95.2]	[-94]	TDD
40	-	-	[-100]	[-97]	[-95.2]	[-94]	TDD
Note 1: The transmitter shall be set to maximum output power level (Table 7.3.1-2) Note 2: Reference measurement channel is A.3.2 Note 3: The signal power is specified per port Note 4: For the UE which supports both Band 3 and Band 9 the reference sensitivity level of Band 3 + 0.5 dB is applicable for band 9							

Note 1: The relation to the received PSD is $\left\langle \mathrm{REF}\,\hat{I}_{or} \right\rangle = P_{REFSENS}\left(N_{sc}^{RB} N_{RB} \Delta f\right)^{-1}$ with N_{RB} is the maximum transmission configuration according to Table 5.4.2-1.

Table 7.3.1-2 specifies the minimum number of allocated uplink resource blocks for which the reference receive sensitivity requirement must be met. For larger transmission configurations a certain relaxation of the UE performance is allowed. Table 7.3.1-3 specifies the maximum output power level for which the reference receive sensitivity requirement must be met when UL resource blocks is the total resource blocks (Table 5.4.2-1) supported by the channel bandwidth.

Table 7.3.1-2: Maximum uplink configuration for reference sensitivity

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode							
E-UTRA Band	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Duplex Mode**
1	-	-	25	50	75	100	FDD
2	6	15	25	50	[50[1]]	[50[1]]	FDD
3	6	15	25	50	[50[1]]	[50[1]]	FDD
4	6	15	25	50	75	100	FDD

5	6	15	25	[25[1]]	-	-	FDD
6	-	-	25	[25[1]]	-	-	FDD
7	-	-	25	50	[75[1]]	[75[1]]	FDD
8	6	15	25	[25[1]]	-	-	FDD
9	-	-	25	50	[50[1]]	[50[1]]	FDD
10	-	-	25	50	75	100	FDD
11	-	-	25	[25[1]]	[25[1]]	[25[1]]	FDD
12							FDD
13	6	15	20[1]	20[1]			FDD
14							FDD
...							
33	-	-	25	50	75	100	TDD
34	-	-	25	50	75	-	TDD
35	6	15	25	50	75	100	TDD
36	6	15	25	50	75	100	TDD
37	-	-	25	50	75	100	TDD
38	-	-	25	50	-	-	TDD
39			25	50	75	100	TDD
40				50	75	100	TDD

Note

1. Maximum number of UL resources blocks allocated is less than the total resources blocks supported by the channel bandwidth

Table 7.3.1-3: Maximum transmission power for reference sensitivity

	Channel bandwidth						
E-UTRA Band	**1.4 MHz (dBm)**	**3 MHz (dBm)**	**5 MHz (dBm)**	**10 MHz (dBm)**	**15 MHz (dBm)**	**20 MHz (dBm)**	**Duplex Mode**
1							FDD
2							FDD
3							FDD
4							FDD
5							FDD
6							FDD
7							FDD
8							FDD
9							FDD
10							FDD
11							FDD
12							FDD
13							FDD
14							FDD
Note 1: UE output power is less than the maximum output power							

7.3.2 (Void)

7.4 Maximum input level

This is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel.

7.4.1 Minimum requirements

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.3.2 with parameters specified in Table 7.4.1.

Table 7.4.1-1: Maximum input level

Rx Parameter	ıits	Channel bandwidth					
		ıHz	MHz	IHz	ıHz	ıHz	ıHz
;ignal mean power		-25					

1. The transmitter shall be set to 4dB below the supported maximum output power.
2. Reference measurement channel is [Annex C 64QAM R=3/4]

7.5 Adjacent Channel Selectivity (ACS)

7.5.1 Minimum 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 7.5.1-1 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 shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.3.2.

Table 7.5.1-1: Adjacent channel selectivity

		Channel bandwidth					
: Parameter	ıits	MHz	IHz	IHz	ıHz	ıHz	ıHz

Table 7.5.1-2: Test parameters for Adjacent channel selectivity, Case 1

Parameter	ts	Channel bandwidth					
		4 MHz	MHz	; MHz	) MHz	; MHz	) MHz
;ignal mean power	m	REFSENS + 14 dB					
	m	S +[45.5]dB	S +[45.5]dB	S +[45.5]dB*	S +[45.5]dB	S +[42.5]dB	S +[39.5]dB
r	Iz	1.4	3	5	5	5	5
offset)	Iz	1.4	3	5	7.5	10	12.5

1. The transmitter shall be set to 4dB below the supported maximum output power.
2. The interferer consists of the Reference measurement channel specified in Annex A.3.2 with set-up according to Annex C.3.1

Table 7.5.1-3: Test parameters for Adjacent channel selectivity, Case 2

Parameter	ts	Channel bandwidth					
		4 MHz	MHz	; MHz	) MHz	; MHz	) MHz
;ignal mean power		56.5]	56.5]	[-56.5]	56.5]	53.5]	50.5]
				-25			
r		1.4	3	5	5	5	5
offset)		1.4	3	5	7.5	10	12.5

1. The transmitter shall be set to 24dB below the supported maximum output power.
2. The interferer consists of the Reference measurement channel specified in Annex 3.2 with set-up according to Annex C.3.1

7.6 Blocking characteristics

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.

7.6.1 In-band blocking

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 relative throughput shall meet or exceed the minimum requirement for the specified measurement channels..

7.6.1.1 Minimum requirements

The throughput shall be $\geq$ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.3.2 with parameters specified in Tables 7.6.1.1-1 and 7.6.1.1-2.

Table 7.6.1.1-1: In band blocking parameters

Parameter	ts	Channel bandwidth					
		4 MHz	MHz	5 MHz	) MHz	5 MHz	) MHz
ignal mean power		REFSENS + channel bandwidth specific value below					
		6	6	6	6	7	9
r		1.4	3	5	5	5	5
$F_{Ioffset, case 1}$	MHz	2.1	4.5	7.5	7.5	7.5	7.5
$F_{Ioffset, case 2}$	MHz	3.5	7.5	12.5	12.5	12.5	12.5

1. The transmitter shall be set to 4dB below the supported maximum output power.
2. The interferer consists of the Reference measurement channel specified in Annex A.3.2 with set-up according to Annex C.3.1

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, 11, 33,34,35,36,37,38 ,39,40	$F_{Interferer}$	MHz	F_{DL_low} -7.5 to F_{DL_high} +7.5 (Note 1)	F_{DL_low} -15 to F_{DL_high} +15
6, 13	$F_{Interferer}$	MHz	F_{DL_low} - 7.5 to F_{DL_high} +7.5 (Note 1 & 2)	F_{DL_low} -15 to F_{DL_high} +15 (Note 2)

Note

1. For each carrier frequency the requirement is valid for two frequencies:
   a. the carrier frequency -BW/2 -FIoffset, case 1 and
   b. the carrier frequency + BW/2 + FIoffset, case 1.
2. For Band 6 and 13 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

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.

7.6.2.1 Minimum requirements

. The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.3.2 with parameters specified in Tables 7.6.2.1-1 and 7.6.2.1-2.

For Table 7.6.2.1-2 in frequency range 1, 2 and 3, up to [TBD] 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 [TBD] 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 7.6.2.1-1: Out-of-band blocking parameters

Rx Parameter	iits	Channel bandwidth					
		IHz	IHz	IHz	IHz	IHz	IHz
ignal mean power		FSENS + channel bandwidth specific value below					
		6	6	6	6	7	9

1. The transmitter shall be set to 4dB below the supported maximum output power.
2. Reference measurement channel is [A.3.2]

Table 7.6.2.1-2: Out of band blocking

band	er	its	Frequency			
			range 1	range 2	range 3	range 4
		m	[-44]	[-30]	[-15]	[-15]
5 , 9, 10,11,13 36,37,38,39,40	CW)		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 60	F_{DL_high} +60 to 85	F_{DL_high} +85 to +12750 MHz	-
2, 5		Hz	-	-	-	F_{UL_low} - F_{UL_high}

7.6.3 Narrow band blocking

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.

7.6.3.1 Minimum requirements

. The relative throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.3.2 with parameters specified in Table 7.6.3.1-1

Table 7.6.3.1-1: Narrow-band blocking

Parameter	Unit	Channel Bandwidth					
		1.4 MHz	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
P_w	dBm	$P_{REFSENS}$ + channel-bandwidth specific value below					
		22	18	16	13	14	16
P_{uw} (CW)	dBm	-55	-55	-55	-55	-55	-55
F_{uw} (offset for Δf = 15 kHz)	MHz	0.9075	1.7025	2.7075	5.2125	7.7025	10.2075
F_{uw} (offset for Δf = 7.5 kHz)	MHz						
Note 1: The transmitter shall be set a 4 dB below the supported maximum power. Note 2: Reference measurement channel is [A.3.2].							

7.7 Spurious response

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.

7.7.1 Minimum requirements

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.3.2 with parameters specified in Tables 7.7.1-1 and 7.7.1-2.

Table 7.7.1-1: Spurious response parameters

Parameter	its	Channel bandwidth					
		MHz	MHz	MHz	MHz	MHz	MHz
ignal mean power		REFSENS + channel bandwidth specific value below					
		6	6	6	6	7	7

1. The transmitter shall be set to 4dB below the supported maximum output power.
2. Reference measurement channel is [A.3.2]

Table 7.7.1-2: Spurious Response

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

7.8 Intermodulation characteristics

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

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

7.8.1.1 Minimum requirements

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.3.2 with parameters specified in Table 7.8.1.1 for the specified wanted signal mean power in the presence of two interfering signals

Table 7.8.1.1-1: Wide band intermodulation

Parameter	**its**	**Channel bandwidth**					
		.4 MHz	**MHz**	**MHz**	**MHz**	**MHz**	**MHz**
ignal mean power		REFSENS + channel bandwidth specific value below					
		[12]	[8]	6	6	7	9
		-46					
ed)		-46					
r 2		1.4	3		5		
		-BW/2 –2.1 / W/2+ 2.1	-BW/2 –4.5 / W/2 + 4.5		-BW/2 – 7.5 / +BW/2 + 7.5		
		$2*F_{Interferer\ 1}$					

1. 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. The modulated interferer consists of the Reference measurement channel specified in Annex A.3.2 with set-up according to Annex C.3.1The interfering modulated signal is 5MHz E-UTRA signal as described in Annex D for channel bandwidth ≥5MHz

7.8.2 Narrow band intermodulation

7.8.2.1 Minimum requirements

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.

7.9.1 Minimum requirements

The power of any narrow band CW spurious emission shall not exceed the maximum level specified in Table 7.9.1-1

Table 7.9.1-1: General receiver spurious emission requirements

Frequency Band	Measurement Bandwidth	Maximum level	Note
30MHz ≤ f < 1GHz	100 kHz	-57 dBm	
1GHz ≤ f ≤ 12.75 GHz	1 MHz	-47 dBm	

8 Performance requirement

This clause contains performance requirements for the physical channels specified in [TS 36.211]. The performance requirements for the UE in this clause are specified for the measurement channels specified in Annex A.3, the propagation conditions in Annex B and the downlink channels in Annex C.3.2.

8.1 General

8.1.1 Dual-antenna receiver capability

The performance requirements are based on UE(s) that utilize a dual-antenna receiver.

8.1.1.1 Simultaneous unicast and MBMS operations

8.1.1.2 Dual-antenna receiver capability in idle mode

8.2 Demodulation of PDSCH (Cell-Specific Reference Symbols)

8.2.1 FDD (Fixed Reference Channel)

The parameters specified in Table 8.2.1-1 are valid for all FDD tests unless otherwise stated.

Table 8.2.1-1: Common Test Parameters (FDD)

Parameter	Unit	Value
Inter-TTI Distance		1
Number of HARQ processes	Processes	8
Maximum number of HARQ transmission		4
Redundancy version coding sequence		{0,1,2,3} for QPSK and 16QAM {0,0,1,2} for 64QAM
Number of OFDM symbols for PDCCH	OFDM symbols	2 [for bandwidths ≥ 10 MHz]
Cyclic Prefix		Normal
Note:		

For all test cases, the SNR is defined as

$$SNR = \frac{\hat{E}_s^{(1)} + \hat{E}_s^{(2)}}{N_{oc}^{(1)} + N_{oc}^{(2)}},$$

where the superscript indicates the receiver antenna connector. The SNR requirement applies for the UE categories given for each test.

8.2.1.1 Single-antenna port performance

The receiver single-antenna performance in a given multi-path fading environments is determined by the SNR for which a certain relative information bit throughput of the reference measurement channels in Annex A.3.2 is achieved.

The purpose of these tests is to verify the single-antenna performance with different channel models and MCS. The QPSK and 64QAM cases are also used to verify the performance for all bandwidths specified in Table 5.4.2.1-1.

8.2.1.1.1 Minimum Requirement QPSK

The requirements are specified in Table 8.2.1.1.1-2, with the addition of the parameters in Table 8.2.1.1.1-1 and the downlink physical channel setup according to table [in Annex C.3.2].

Table 8.2.1.1.1-1: Test Parameters for Testing QPSK

Parameter	Unit	Test [1.1-1.4,2.1]
Reference signal power E_{RS} / I_{or}	dB	0
N_{oc} at antenna port	dBm/15kHz	TBD [-74]
Note: TBD		

Table 8.2.1.1.1-2: Minimum performance QPSK (FRC)

Test number	Bandwidth	Reference Channel	Propagation Condition	Correlation Matrix	Reference value Fraction of Maximum Throughput (%)	Reference value SNR (dB)	UE Category
[1.1]	10 MHz	[R.2 FDD]	EVA5	Low	70	-1.0	
[1.2]	10 MHz	[R.2 FDD]	ETU70	Low	70	-0.4	
[1.3]	10 MHz	[R.2 FDD]	ETU300	Low	70	0.0	
[1.4]	10 MHz	[R.2 FDD]	HST	Low	70	TBD	
[2.1]	1.4 MHz	[R.4 FDD]	EVA5	Low	70	TBD	

8.2.1.1.2 Minimum Requirement 16QAM

The requirements are specified in Table 8.2.1.1.2-1, with the addition of the parameters in Table 8.2.1.1.2-2 and the downlink physical channel setup according to table [in Annex C.3.2].

Table 8.2.1.1.2-1: Test Parameters for Testing 16QAM

Parameter	Unit	Test [1.5-1.7]
Reference signal power E_{RS} / I_{or}	dB	0
N_{oc} at antenna port	dBm/15kHz	TBD
Note: TBD		

Table 8.2.1.1.2-2: Minimum performance 16QAM (FRC)

Test number	Bandwidth	Reference Channel	Propagation Condition	Correlation Matrix	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[1.5]	10 MHz	[R.3 FDD]	EVA5	Low	70	6.7	
[1.6]	10 MHz	[R.3 FDD]	ETU70	Low	30	1.4	
[1.7]	10 MHz	[R.3 FDD]	ETU300	High	70	9.4	

8.2.1.1.3 Minimum Requirement 64QAM

The requirements are specified in Table 8.2.1.1.3-2, with the addition of the parameters in Table 8.2.1.1.3-1 and the downlink physical channel setup according to table [in Annex C.3.2].

Table 8.2.1.1.3-1: Test Parameters for Testing 64QAM

Parameter	Unit	Test [1.8-1.10, 2.2-2.5]
Reference signal power E_{RS}/I_{or}	dB	0
N_{oc} at antenna port	dBm/15kHz	TBD
Note: TBD		

Table 8.2.1.1.3-2: Minimum performance 64QAM (FRC)

Test number	Bandwidth	Reference Channel	Propagation Condition	Correlation Matrix	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[2.2]	3 MHz	[R.5 FDD]	EVA5	Low	70	TBD	
[2.3]	5 MHz	[R.6 FDD]	EVA5	Low	70	TBD	
[1.8]	10 MHz	[R.7 FDD]	EVA5	Low	70	17.7	
[1.9]	10 MHz	[R.7 FDD]	ETU70	Low	70	19.0	
[1.10]	10 MHz	[R.7 FDD]	EVA5	High	70	19.1	
[2.4]	15 MHz	[R.8 FDD]	EVA5	Low	70	17.7	
[2.5]	20 MHz	[R.9 FDD]	EVA5	Low	70	17.6	

8.2.1.1.4 Minimum Requirement 1 PRB allocation

The requirements are specified in Table 8.2.1.1.4-2, with the addition of the parameters in Table 8.2.1.1.4-1 and the downlink physical channel setup according to table [in Annex C.3.2]. The purpose of these tests is to verify the single-antenna performance with a single PRB allocated at the lower band edge.

Table 8.2.1.1.4-1: Test Parameters for Testing 1 PRB allocation

Parameter	Unit	Test [3.1-3.3]
Reference signal power E_{RS}/I_{or}	dB	
N_{oc} at antenna port	dBm/15kHz	TBD
PRB allocation		[Lower channel edge]
Note: TBD		

Table 8.2.1.1.4-2: Minimum performance 1PRB (FRC)

Test number	Bandwidth and MCS	Reference Channel	Propagation Condition	Correlation Matrix	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[3.1]	1.4 MHz 16QAM 1/2	[R.0 FDD]	ETU70	Low	30	TBD	
[3.2]	10 MHz 16QAM 1/2	[R.1 FDD]	ETU70	Low	30	TBD	
[3.3]	20 MHz 16QAM 1/2	[R.1 FDD]	ETU70	Low	30	TBD	

8.2.1.2 Transmit diversity performance

The requirements are specified in Table 8.2.1.2-2, with the addition of the parameters in Table 8.2.1.2-1 and the downlink physical channel setup according to table [in Annex C.3.2]. The purpose is to verify the performance of transmit diversity (SFBC) with 2 and 4 transmitter antennas.

Table 8.2.1.2-1: Test Parameters for Transmit diversity Performance (FRC)

Parameter	Unit	Test [7.1]		
Reference signal power $(E_{RS}/I_{or})^{(p)}$	dB	3		
N_{oc} at antenna port	dBm/15kHz			

Table 8.2.1.2-2: Minimum performance Transmit Diversity (FRC)

Test number	Bandwidth and MCS	Reference Channel	Propagation Condition	Correlation Matrix and Antenna Configuration	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[7.1]	10 MHz 16QAM 1/2	[R.11 FDD]	EVA5	2x2 Medium	70	6.8	
[7.2]	10 MHz QPSK 1/3	[R.10 FDD]	HST	2x2 Low	70	TBD	
[7.3]	1.4 MHz QPSK 1/3	[R.12 FDD]	EPA5	4x2 Medium	70	TBD	

8.2.1.3 Open-loop spatial multiplexing performance

8.2.1.4 Closed-loop spatial multiplexing performance

8.2.1.4.1 Minimum Requirement Single-Layer Spatial Multiplexing

The requirements are specified in Table 8.2.1.4.1-2, with the addition of the parameters in Table 8.2.1.4.1-1 and the downlink physical channel setup according to table [in Annex C.3.2]. The purpose of these tests is to verify the closed loop rank-one performance with wideband and frequency selective precoding.

Table 8.2.1.4.1-1: Test Parameters for Single-Layer Spatial Multiplexing (FRC)

Parameter	Unit	Test [4.1]	Test [4.2]	
Reference signal power $(E_{RS}/I_{or})^{(p)}$	dB	3		
N_{oc} at antenna port	dBm/15kHz			
Precoding granularity	PRB	6	50	

Table 8.2.1.4.1-2: Minimum performance Single-Layer Spatial Multiplexing (FRC)

Test number	Bandwidth and MCS	Reference Channel	Propagation Condition	Correlation Matrix and Antenna Configuration	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[4.1]	10 MHz QPSK 1/3	[R.10]	EVA5	2x2 Low	70	-2.5	
[4.2]	10 MHz QPSK 1/3	[R.10]	EPA5	2x2 High	70	-2.8	
[4.3]	10 MHz QPSK 1/3	[R.13]	EVA5	4x2 Low	70	TBD	

8.2.1.4.2 Minimum Requirement Multi-Layer Spatial Multiplexing

The requirements are specified in Table 8.2.1.4.2-2, with the addition of the parameters in Table 8.2.1.4.2-1 and the downlink physical channel setup according to table [in Annex C.3.2]. The purpose of these tests is to verify the closed loop rank-two performance with wideband and frequency selective precoding.

Table 8.2.1.4.2-1: Test Parameters for Multi-Layer Spatial Multiplexing (FRC)

Parameter	Unit	Test [5.1,5.2]	Test [5.3]	
Reference signal power $(E_{RS}/I_{or})^{(p)}$	dB	3		
N_{oc} at antenna port	dBm/15kHz			
Precoding granularity	PRB	50	6	
PMI delay		6	6	

Table 8.2.1.4.2-2: Minimum performance Multi-Layer Spatial Multiplexing (FRC)

Test number	Bandwidth and MCS	Reference Channel	Propagation Condition	Correlation Matrix and Antenna Configuration	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[5.1]	10 MHz 16QAM 1/2	[R.11 FDD]	EVA5	2x2 Low	70	12.9	
[5.2]	10 MHz 16QAM 1/2	[R.11 FDD]	ETU70	2x2 Low	70	14.3	
[5.3]	10 MHz 16QAM 1/2	[R.14 FDD]	EVA5	4x2 Low	70	TBD	

8.2.1.5 MU-MIMO

8.2.1.6 [Control channel performance: D-BCH and PCH]

8.2.2 TDD (Fixed Reference Channel)

The parameters specified in Table 8.2.2-1 are valid for all TDD tests unless otherwise stated.

Table 8.2.2-1: Common Test Parameters (TDD)

Parameter		Value
Uplink downlink configuration (Note 1)		1
Special subframe configuration (Note 2)		4
Cyclic prefix		Normal
Inter-TTI Distance		1
Number of HARQ processes	Processes	7
Maximum number of HARQ transmission		4
Redundancy version coding sequence		{0,1,2,3} for QPSK and 16QAM {0,0,1,2} for 64QAM
Number of OFDM symbols for PDCCH	OFDM symbols	
Cyclic Prefix		Normal
Note 1: as specified in Table 4.2-2 in [TS 36.211] Note 2: as specified in Table 4.2-1 in [TS 36.211]		

8.2.2.1 Single-antenna port performance

The receiver single-antenna performance in a given multi-path fading environments is determined by the SNR for which a certain relative information bit throughput of the reference measurement channels in Annex A.3.2 is achieved. The purpose of these tests is to verify the single-antenna performance with different channel models and MCS. The QPSK and 64QAM cases are also used to verify the performance for all bandwidths specified in Table 5.4.2.1-1.

8.2.2.1.1 Minimum Requirement QPSK

The requirements are specified in Table 8.2.2.1.1-2, with the addition of the parameters in Table 8.2.2.1.1-1 and the downlink physical channel setup according to table [in Annex C.3.2].

Table 8.2.2.1.1-1: Test Parameters for Testing QPSK

Parameter	Unit	Test [1.1-1.4,2.1]
Reference signal power E_{RS}/I_{or}	dB	0
N_{oc} at antenna port	dBm/15kHz	TBD [-74]
Note: TBD		

Table 8.2.2.1.1-2: Minimum performance QPSK (FRC)

Test number	Bandwidth	Reference Channel	Propagation Condition	Correlation Matrix	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[1.1]	10 MHz	[R.2 TDD]	EVA5	Low	70	TBD	
[1.2]	10 MHz	[R.2 TDD]	ETU70	Low	70	TBD	
[1.3]	10 MHz	[R.2 TDD]	ETU300	Low	70	TBD	
[1.4]	10 MHz	[R.2 TDD]	HST	Low	70	TBD	
[2.1]	1.4 MHz	[R.4 TDD]	EVA5	Low	70	TBD	

8.2.2.1.2 Minimum Requirement 16QAM

The requirements are specified in Table 8.2.2.1.2-1, with the addition of the parameters in Table 8.2.2.1.2-2 and the downlink physical channel setup according to table [in Annex C.3.2].

Table 8.2.2.1.2-1: Test Parameters for Testing 16QAM

Parameter	Unit	Test [1.5-1.7]
Reference signal power E_{RS} / I_{or}	dB	0
N_{oc} at antenna port	dBm/15kHz	TBD
Note: TBD		

Table 8.2.2.1.2-2: Minimum performance 16QAM (FRC)

Test number	Bandwidth	Reference Channel	Propagation Condition	Correlation Matrix	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[1.5]	10 MHz	[R.3 TDD]	EVA5	Low	70	TBD	
[1.6]	10 MHz	[R.3 TDD]	ETU70	Low	30	TBD	
[1.7]	10 MHz	[R.3 TDD]	ETU300	High	70	TBD	

8.2.2.1.3 Minimum Requirement 64QAM

The requirements are specified in Table 8.2.2.1.3-2, with the addition of the parameters in Table 8.2.2.1.3-1 and the downlink physical channel setup according to table [in Annex C.3.2].

Table 8.2.2.1.3-1: Test Parameters for Testing 64QAM

Parameter	Unit	Test [1.8-1.10, 2.2-2.5]
Reference signal power E_{RS}/I_{or}	dB	0
N_{oc} at antenna port	dBm/15kHz	TBD
Note: TBD		

Table 8.2.2.1.3-2: Minimum performance 64QAM (FRC)

Test number	Bandwidth	Reference Channel	Propagation Condition	Correlation Matrix	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[2.2]	3 MHz	[R.5 TDD]	EVA5	Low	70	TBD	
[2.3]	5 MHz	[R.6 TDD]	EVA5	Low	70	TBD	
[1.8]	10 MHz	[R.7 TDD]	EVA5	Low	70	TBD	
[1.9]	10 MHz	[R.7 TDD]	ETU70	Low	70	TBD	
[1.10]	10 MHz	[R.7 TDD]	EVA5	High	70	TBD	
[2.4]	15 MHz	[R.8 TDD]	EVA5	Low	70	TBD	
[2.5]	20 MHz	[R.9 TDD]	EVA5	Low	70	TBD	

8.2.2.1.4 Minimum Requirement 1 PRB allocation

The requirements are specified in Table 8.2.2.1.4-2, with the addition of the parameters in Table 8.2.2.1.1.4-1 and the downlink physical channel setup according to table [in Annex C.3.2]. The purpose of these tests is to verify the single-antenna performance with a single PRB allocated at the lower band edge.

Table 8.2.2.1.4-1: Test Parameters for Testing 1 PRB allocation

Parameter	Unit	Test [3.1-3.3]
Reference signal power E_{RS}/I_{or}	dB	
N_{oc} at antenna port	dBm/15kHz	TBD
PRB allocation		[Lower channel edge]
Note: TBD		

Table 8.2.2.1.4-2: Minimum performance 1PRB (FRC)

Test number	Bandwidth and MCS	Reference Channel	Propagation Condition	Correlation Matrix	Reference value		UE Category
					Fraction of Maximum Throughput (%)	SNR (dB)	
[3.1]	1.4 MHz 16QAM 1/2	[R.0 TDD]	ETU70	Low	30	TBD	
[3.2]	10 MHz 16QAM 1/2	[R.1 TDD]	ETU70	Low	30	TBD	
[3.3]	20 MHz 16QAM 1/2	[R.1 TDD]	ETU70	Low	30	TBD	

8.2.2.2 Transmit diversity performance

8.2.2.3 Open-loop spatial multiplexing performance

8.2.2.4 Closed-loop spatial multiplexing performance

8.2.2.5 MU-MIMO

8.2.2.6 [Control channel performance: D-BCH and PCH]

8.3 Demodulation of PDSCH (User-Specific Reference Symbols)

Requirements for user-specific requirements are TBD. 8.4 Demodulation of PDCCH/PCFICH

8.4 Demodulation of PDCCH/PCFICH

The receiver characteristics of the PDCCH/PCFICH are determined by the probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg). PDCCH and PCFICH are tested jointly, i.e. a miss detection of PCFICH implies a miss detection of PDCCH.

8.4.1 FDD

Table 8.4.1-1: Test Parameters for PDCCH/PCFICH

Parameter	Unit	Test [8.1]		
Number of PDCCH symbols	symbols	2		
PHICH mapping		1 PHICH group, normal PHICH duration		
Cell ID		0		
Reference signal power $(E_{RS}/I_{or})^{(p)}$	dB	0		
Power difference between PCFICH and PDCCH	dB	0		
N_{oc} at antenna port	dBm/15kHz			
Cyclic prefix		Normal		

8.4.1.1 Single-antenna port performance

For the parameters specified in Table 8.4.1-1 the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.4.1.1-1 [The downlink physical setup is in accordance with Annex C.3.2.]

Table 8.4.1.1-1: Minimum performance PDCCH/PCFICH

Test	Bandwidth	Aggregation level	Reference Channel	Propagation Condition	Correlation Matrix	Reference value	
						Pm-dsg (%)	SNR (dB)
[8.1]	10 MHz	8 CCE	[R.15 FDD]	ETU70	Low	1	-1.7

8.4.1.2 Transmit diversity performance

8.4.2 TDD

8.4.2.1 Single-antenna port performance

8.4.2.2 Transmit diversity performance

8.5 Demodulation of PHICH

8.6 Demodulation of PBCH

9 Reporting of [CQI/PMI]

<Text omitted>

Annex A (normative): Measurement channels

A.1 General

A.2 UL reference measurement channels

A.3 DL reference measurement channels

A.3.1 General

The number of available channel bits varies across the sub-frames due to PBCH and PSS/SSS overhead. The payload size per sub-frame is varied in order to keep the code rate constant throughout a frame.

The algorithm for determining the payload size *A* is as follows; given a desired coding rate *R* and radio block allocation N_{RB}

1. Calculate the number of channel bits N_{ch} that can be transmitted during the first transmission of a given sub-frame.

2. Find *A* such that the resulting coding rate is as close to *R* as possible, that is,

$$\min\left|R-(A+24)/N_{ch}\right|,$$

subject to

a) A is a valid TB size (according to section 7.1.7 of 36.213) assuming an allocation of N_{RB} resource blocks.

3. If there is more than one *A* that minimises the equation above, then the larger value is chosen per default.

A.3.2 Reference measurement channel for receiver characteristics

Tables A.3.2-1 and A.3.2-2 are applicable for measurements on the Receiver Characteristics (clause 7) [with the exception of sub-clause 7.4 (Maximum input level)].

Tables A.3.2-1 and A.3.2-2 also apply for the modulated interferer used in Clauses 7.5, 7.6 and 7.8 with test specific bandwidths.

Table A.3.2-1 Fixed Reference Channel for Receiver Requirements (FDD)

Parameter	Unit	Value					
Channel bandwidth	MHz	1.4	3	5	10	15	20
Allocated resource blocks		6	15	25	50	75	100
Subcarriers per resource block		12	12	12	12	12	12
Allocated subframes per Radio Frame		10	10	10	10	10	10
Modulation		QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
Target Coding Rate		1/3	1/3	1/3	1/3	1/3	1/3
Number of HARQ Processes	Processes	8	8	8	8	8	8
Maximum number of HARQ transmissions		1	1	1	1	1	1
Information Bit Payload							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	408	1320	2216	4392	6712	8760
For Sub-Frame 5	Bits	320	1064	1800	4392	6712	8760
For Sub-Frame 0	Bits	152	872	1800	4392	6712	8760
Transport block CRC	Bits	24	24	24	24	24	24
Number of Code Blocks per subframe		1	1	1	1	2	2
Code block CRC size	Bits	0	0	0	0	24	24
Binary Channel Bits Per Sub-Frame							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	1368	3780	6300	13800	20700	27600
For Sub-Frame 5	Bits	1080	3492	6012	13512	20412	27312
For Sub-Frame 0	Bits	528	2940	5460	12960	19860	26760
Max. Throughput averaged over 1 frame	kbps	373.6	1249.6	2132.8	4392	6712	8760

Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW. 3 symbols allocated to PDCCH for 5 MHz and 3 MHz. 4 symbols allocated to PDCCH for 1.4 MHz
Note 2: Reference signal, Synchronization signals and PBCH allocated as per TS 36.211 [4]
Note 3: The RLC should be configured to Unacknowledged Mode

Table A.3.2-2 Fixed Reference Channel for Receiver Requirements (TDD)

Parameter	Unit	Value					
Nominal Avg. Inf. Bit Rate	kbps						
Number of HARQ Processes	Processes	1	1	1	1	1	1
Maximum number of HARQ transmission		1	1	1	1	1	1
Information Bit Payload per Sub-Frame	Bits						
Number of Code Blocks							
Binary Channel Bits Per Sub-Frame	Bits						
Coding Rate							
Bandwidth	MHz	1.4	3	5	10	15	20

Number of OFDM symbols per Sub-Frame							
					11. 5		
Modulation		QP SK	QP SK	QP SK	QP SK	QP SK	QP SK
Note 1: 2 symbols allocated to PDCCH Note 2: The RLC should be configured to Unacknowledged Mode							

A.3.3 Reference measurement channels for PDSCH performance requirements (FDD)

A.3.3.1 Single-antenna transmission (Common Reference Symbols)

Table A.3.3.1-1: Fixed Reference Channel QPSK R=1/3

Parameter	Unit	Value					
Reference channel		[R.4 FDD]			[R.2 FDD]		
Channel bandwidth	MHz	1.4	3	5	10	15	20
Allocated resource blocks		6			50		
Allocated subframes per Radio Frame		10			10		
Modulation		QPSK			QPSK		
Target Coding Rate		1/3			1/3		
Information Bit Payload							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	408			4392		
For Sub-Frame 5	Bits	328			4392		
For Sub-Frame 0	Bits	152			4392		
Number of Code Blocks per subframe		1			1		
Binary Channel Bits Per Sub-Frame							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	1368			13800		
For Sub-Frame 5	Bits	1080			13512		
For Sub-Frame 0	Bits	528			12960		
Max. Throughput averaged over 1 frame	Mbps	0.374			4.39		
Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4]							

Table A.3.3.1-2: Fixed Reference Channel 16QAM R=1/2

Parameter	Unit	Value					
Reference channel					[R.3 FDD]		
Channel bandwidth	MHz	1.4	3	5	10	15	20
Allocated resource blocks					50		
Allocated subframes per Radio Frame					10		
Modulation					16QAM		
Target Coding Rate					1/2		
Information Bit Payload							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits				14112		
For Sub-Frame 5	Bits				12960		
For Sub-Frame 0	Bits				12960		
Number of Code Blocks per subframe					3		

Binary Channel Bits Per Sub-Frame							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits				27600		
For Sub-Frame 5	Bits				27024		
For Sub-Frame 0	Bits				25920		
Max. Throughput averaged over 1 frame	Mbps				13.9		

Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz

Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4]

Table A.3.3.1-3: Fixed Reference Channel 64QAM R=3/4

Parameter	Unit	Value					
Reference channel			[R.5 FDD]	[R.6 FDD]	[R.7 FDD]	[R.8 FDD]	[R.9 FDD]
Channel bandwidth	MHz	1.4	3	5	10	15	20
Allocated resource blocks			15	25	50	75	100
Allocated subframes per Radio Frame			10	10	10	10	10
Modulation		64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Target Coding Rate		3/4	3/4	3/4	3/4	3/4	3/4
Information Bit Payload							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits		8504	14112	30576	46888	61664
For Sub-Frame 5	Bits		7992	13536	30576	45352	61664
For Sub-Frame 0	Bits		6456	12576	28336	45352	61664
Number of Code Blocks per subframe			2	3	5	8	11
Binary Channel Bits Per Sub-Frame							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits		11340	18900	41400	62100	82800
For Sub-Frame 5	Bits		10476	18036	40536	61236	81936
For Sub-Frame 0	Bits		8820	16380	38880	59580	80280
Max. Throughput averaged over 1 frame	Mbps		8.25	13.9	30.4	46.6	61.7

Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz

Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4]

Table A.3.3.1-4: Fixed Reference Channel Single PRB (Channel Edge)

Parameter	Unit	Value					
Reference channel			[R.0 FDD]		[R.1 FDD]		
Channel bandwidth	MHz	1.4	3	5	10/20	15	20
Allocated resource blocks			1		1		
Allocated subframes per Radio Frame			10		10		
Modulation			16QAM		16QAM		
Target Coding Rate			1/2		1/2		
Information Bit Payload							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits		224		256		
For Sub-Frame 5	Bits		224		256		
For Sub-Frame 0	Bits		224		256		
Number of Code Blocks per subframe			1		1		
Binary Channel Bits Per Sub-Frame							

For Sub-Frames 1,2,3,4,6,7,8,9	Bits		504		552		
For Sub-Frame 5	Bits		504		552		
For Sub-Frame 0	Bits		504		552		
Max. Throughput averaged over 1 frame	Mbps		0.224		0.256		
Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4]							

A.3.3.2 Multi-antenna transmission (Common Reference Symbols)

A.3.3.2.1 Two antenna ports

Table A.3.3.2.1-1: Fixed Reference Channel two antenna ports

Parameter	Unit	Value					
Reference channel			[R.10 FDD]	[R.11 FDD]			
Channel bandwidth	MHz		10	10			
Allocated resource blocks			50	50			
Allocated subframes per Radio Frame			10	10			
Modulation			QPSK	16QAM			
Target Coding Rate			1/3	1/2			
Information Bit Payload							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits		4392	12960			
For Sub-Frame 5	Bits		4392	12960			
For Sub-Frame 0	Bits		4392	12960			
Number of Code Blocks per subframe			1	3			
Binary Channel Bits Per Sub-Frame							
For Sub-Frames 1,2,3,4,6,7,8,9	Bits		13200	26400			
For Sub-Frame 5	Bits		12912	25824			
For Sub-Frame 0	Bits		12384	24768			
Max. Throughput averaged over 1 frame	Mbps		4.39	13.0			
Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4]							

A.3.3.2.2 Four antenna ports

Table A.3.3.2.2-1: Fixed Reference Channel four antenna ports

Parameter	Unit	Value						
Reference channel		[R.12 FDD]	[R.13 FDD]	[R.14 FDD]				
Channel bandwidth	MHz	1.4	10	10				
Allocated resource blocks		6	50	50				
Allocated subframes per Radio Frame		10	10	10				
Modulation		QPSK	QPSK	16QAM				
Target Coding Rate		1/3	1/3	1/2				
Information Bit Payload								
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	408	4392	12960				
For Sub-Frame 5	Bits	328	4392	12960				
For Sub-Frame 0	Bits	152	3624	11448				
Number of Code Blocks per subframe								
For Sub-Frames 1,2,3,4,6,7,8,9		1	1	3				
For Sub-Frame 5		1	1	3				
For Sub-Frame 0		1	1	2				
Binary Channel Bits Per Sub-Frame								
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	1248	12800	25600				
For Sub-Frame 5	Bits	960	12512	25024				
	Bits	480	12032	24064				
Max. Throughput averaged over 1 frame	Mbps	0.374	4.32	12.8				

Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz

Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4]

A.3.3.3 [RMC for UE-Specific Reference Symbols]

A.3.4 Reference measurement channels for PDSCH performance requirements (TDD)

A.3.4.1 Single-antenna transmission (Common Reference Symbols)

Table A.3.4.1-1: Fixed Reference Channel QPSK R=1/3

Parameter	Unit	Value					
Reference channel		[R.4 TDD]			[R.2 TDD]		
Channel bandwidth	MHz	1.4	3	5	10	15	20
Allocated resource blocks		6			50		
Uplink-Downlink Configuration (Note 3)		1			1		
Allocated subframes per Radio Frame (D+S)		4+2			4+2		
Modulation		QPSK			QPSK		
Target Coding Rate		1/3			1/3		
Information Bit Payload							
For Sub-Frames 4,9	Bits	TBD			4392		
For Sub-Frames 1,6	Bits	TBD			3624		
For Sub-Frame 5	Bits	TBD			4392		
For Sub-Frame 0	Bits	TBD			4392		
Number of Code Blocks per subframe					1		
Binary Channel Bits Per Sub-Frame							
For Sub-Frames 4,9	Bits	TBD			13800		
For Sub-Frames 1,6	Bits	TBD			11256		
For Sub-Frame 5	Bits	TBD			13656		
For Sub-Frame 0	Bits	TBD			13104		
Max. Throughput averaged over 1 frame	Mbps				2.48		

Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4]
Note 3: as per Table 4.2-2 in TS 36.211 [4]

Table A.3.4.1-2: Fixed Reference Channel 16QAM R=1/2

Parameter	Unit	Value					
Reference channel					[R.3 TDD]		
Channel bandwidth	MHz	1.4	3	5	10	15	20
Allocated resource blocks					50		
Uplink-Downlink Configuration (Note 3)					1		

Allocated subframes per Radio Frame (D+S)					4+2		
Modulation					16QAM		
Target Coding Rate					1/2		
Information Bit Payload							
For Sub-Frames 4,9	Bits				14112		
For Sub-Frames 1,6	Bits				11448		
For Sub-Frame 5	Bits				14112		
For Sub-Frame 0	Bits				12960		
Number of Code Blocks per subframe							
For Sub-Frames 4,9					3		
For Sub-Frames 1,6					2		
For Sub-Frame 5					3		
For Sub-Frame 0					3		
Binary Channel Bits Per Sub-Frame							
For Sub-Frames 4,9	Bits				27600		
For Sub-Frames 1,6	Bits				22512		
For Sub-Frame 5	Bits				27312		
For Sub-Frame 0	Bits				26208		
Max. Throughput averaged over 1 frame	Mbps				7.82		

Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4]
Note 3: as per Table 4.2-2 in TS 36.211 [4]

Table A.3.4.1-3: Fixed Reference Channel 64QAM R=3/4

Parameter	Unit	Value					
Reference channel			[R.5 TDD]	[R.6 TDD]	[R.7 TDD]	[R.8 TDD]	[R.9 TDD]
Channel bandwidth	MHz	1.4	3	5	10	15	20
Allocated resource blocks			15	25	50	75	100
Uplink-Downlink Configuration (Note 3)			1	1	1	1	1
Allocated subframes per Radio Frame (D+S)			4+2	4+2	4+2	4+2	4+2
Modulation		64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
Target Coding Rate			3/4	3/4	3/4	3/4	3/4
Information Bit Payload							
For Sub-Frames 4,9	Bits		TBD	TBD	30576	46888	61664
For Sub-Frames 1,6	Bits		TBD	TBD	25456	37888	51024
For Sub-Frame 5	Bits		TBD	TBD	30576	46888	61664
For Sub-Frame 0	Bits		TBD	TBD	30576	45352	61664
Number of Code Blocks per subframe							
For Sub-Frames 4,9			TBD	TBD	41400	62100	82800
For Sub-Frames 1,6			TBD	TBD	33768	50868	67968
For Sub-Frame 5			TBD	TBD	40968	61668	82368

For Sub-Frame 0			TBD	TBD	39312	60012	80712
Binary Channel Bits Per Sub-Frame							
For Sub-Frames 4,9	Bits		TBD	TBD	5	8	11
For Sub-Frames 1,6	Bits		TBD	TBD	5	7	9
For Sub-Frame 5	Bits		TBD	TBD	5	8	11
For Sub-Frame 0	Bits		TBD	TBD	5	8	11
Max. Throughput averaged over 1 frame	Mbps				17.3	26.2	34.9
Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4] Note 3: as per Table 4.2-2 TS 36.211 [4]							

Table A.3.4.1-4: Fixed Reference Channel Single PRB

Parameter	Unit	Value					
Reference channel			[R.0 TDD]		[R.1 TDD]		
Channel bandwidth	MHz	1.4	3	5	10/20	15	20
Allocated resource blocks			1		1		
Uplink-Downlink Configuration (Note 3)			1		1		
Allocated subframes per Radio Frame (D+S)			4+2		4+2		
Modulation			16QAM		16QAM		
Target Coding Rate			1/2		1/2		
Information Bit Payload							
For Sub-Frames 4,9	Bits		TBD		256		
For Sub-Frames 1,6	Bits		TBD		208		
For Sub-Frame 5	Bits		TBD		256		
For Sub-Frame 0	Bits		TBD		256		
Number of Code Blocks per subframe			TBD		1		
Binary Channel Bits Per Sub-Frame							
For Sub-Frames 4,9	Bits		TBD		552		
For Sub-Frames 1,6	Bits		TBD		456		
For Sub-Frame 5	Bits		TBD		552		
For Sub-Frame 0	Bits		TBD		552		
Max. Throughput averaged over 1 frame	Mbps				0.144		
Note 1: 2 symbols allocated to PDCCH for 20 MHz, 15 MHz and 15 MHz channel BW; 3 symbols allocated to PDCCH for 5 MHz and 3 MHz; 4 symbols allocated to PDCCH for 1.4 MHz Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [4] Note 3: as per Table 4.2-2 in TS 36.211 [4]							

A.3.4.2 Multi-antenna transmission (Common Reference Signals))

A.3.4.3 [RMC for UE-Specific Reference Symbols]

A.3.5 Reference measurement channels for PDCCH/PCFICH performance requirements

A.3.5.1 FDD

Table A.3.5.1-1: Reference Channel FDD

Parameter	Unit	Value		
Reference channel		[R.15 FDD]	[R.16 FDD]	[R.17 FDD]
Number if transmitter antennas		1	2	4
Channel bandwidth	MHz	10	1.4	10
Number of OFDM symbols for PDCCH	symbols	2	2	2
Aggregation level	CCE	8	2	4
DCI Format		Format 1	Format 1	Format 2
Cell ID		0	0	0
Payload (without CRC)	Bits	31	32+1	46

A.3.5.2 TDD

Table A.3.5.1-1: Reference Channel TDD

Parameter	Unit	Value		
Reference channel		[R.15 TDD]	[R.16 TDD]	[R.17 TDD]
Number if transmitter antennas		1	2	4
Channel bandwidth	MHz	10	1.4	10
Number of OFDM symbols for PDCCH	symbols	2	2	2
Aggregation level	CCE	8	2	4
DCI Format		Format 1	Format 1	Format 2
Cell ID		0	0	0
Payload (without CRC)	Bits	34	35	49

Annex B (normative): Propagation conditions

B.1 Static propagation condition

B.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 combination of channel model parameters that include the Delay profile and the Doppler spectrum, that is characterized by a classical spectrum shape and a maximum Doppler frequency
- A set of correlation matrices defining the correlation between the UE and eNodeB antennas in case of multi-antenna systems.

B.2.1 Delay profiles

The delay profiles are selected to be representative of low, medium and high delay spread environments. The resulting model parameters are defined in Table B.2.1-1 and the tapped delay line models are defined in Tables B.2.1-2, B.2.1-3 and B.2.1-4.

Table B.2.1-1 Delay profiles for E-UTRA 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.2.1-2 Extended Pedestrian A model (EPA)

Excess tap delay [ns]	Relative power [dB]
0	0.0
30	-1.0
70	-2.0
90	-3.0
110	-8.0
190	-17.2
410	-20.8

Table B.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.2.1-4 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 Combinations of channel model parameters

Table B.2.2-1 shows propagation conditions that are used for the performance measurements in multi-path fading environment for low, medium and high Doppler frequencies

Table B.2.2-1 Channel model parameters

Model	Maximum Doppler frequency
EPA 5Hz	5 Hz
EVA 5Hz	5 Hz
EVA 70Hz	70 Hz
ETU 70Hz	70 Hz
ETU 300Hz	300 Hz

B.2.3 MIMO Channel Correlation Matrices

B.2.3.1 Definition of MIMO Correlation Matrices

Table B.2.3.1-1 defines the correlation matrix for the eNodeB

Table B.2.3.1-1 eNodeB correlation matrix

	One antenna	Two antennas	Four antennas
eNode B Correlation	$R_{eNB}=1$	$R_{eNB}=\begin{pmatrix}1 & \alpha \\ \alpha^* & \mathbf{1}\end{pmatrix}$	$R_{eNB}=\begin{pmatrix}1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9*} & \alpha^{1/9*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9*} & \alpha^{1/9*} & 1\end{pmatrix}$

Table B.2.3.1-2 defines the correlation matrix for the UE:

Table B.2.3.1-2 UE correlation matrix

	One antenna	Two antennas	Four antennas
UE Correlation	$R_{UE}=1$	$R_{UE}=\begin{pmatrix}1 & \beta \\ \beta^* & \mathbf{1}\end{pmatrix}$	$R_{UE}=\begin{pmatrix}1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9*} & \beta^{1/9*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9*} & \beta^{1/9*} & 1\end{pmatrix}$

Table B.2.3.1-3 defines the channel spatial correlation matrix R_{spat}. The parameters, α and β in Table B.2.3.1-3 defines the spatial correlation between the antennas at the eNodeB and UE.

Table B.2.3.1-3: R_{spat} correlation matrices

1x2 case

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

2x2 case

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

4x2 case

$$R_{spat} = R_{eNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix}$$

4x4 case

$$R_{spat} = R_{eNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{bmatrix} \otimes \begin{pmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{pmatrix}$$

For cases with more antennas at either eNodeB 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 $R_{spat} = R_{eNB} \otimes R_{UE}$.

B.2.3.2 MIMO Correlation Matrices at High, Medium and Low Level

The α and β for different correlation types are given in Table B.2.3.2-1.

Table B.2.3.2-1

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

The correlation matrices for high, medium and low correlation are defined in Table B.2.3.1-2, B.2.3.2-3 and B.2.3.2-4,as below.

Table B.2.3.2-2: MIMO correlation matrices for high correlation

1x2 case

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

2x2 case

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

4x2 case

$$R_{high} = \begin{pmatrix} 1.0000 & 0.9000 & 0.9884 & 0.8895 & 0.9543 & 0.8588 & 0.9000 & 0.8100 \\ 0.9000 & 1.0000 & 0.8895 & 0.9884 & 0.8588 & 0.9543 & 0.8100 & 0.9000 \\ 0.9884 & 0.8895 & 1.0000 & 0.9000 & 0.9884 & 0.8895 & 0.9543 & 0.8588 \\ 0.8895 & 0.9884 & 0.9000 & 1.0000 & 0.8895 & 0.9884 & 0.8588 & 0.9543 \\ 0.9543 & 0.8588 & 0.9884 & 0.8895 & 1.0000 & 0.9000 & 0.9884 & 0.8895 \\ 0.8588 & 0.9543 & 0.8895 & 0.9884 & 0.9000 & 1.0000 & 0.8895 & 0.9884 \\ 0.9000 & 0.8100 & 0.9543 & 0.8588 & 0.9884 & 0.8895 & 1.0000 & 0.9000 \\ 0.8100 & 0.9000 & 0.8588 & 0.9543 & 0.8895 & 0.9884 & 0.9000 & 1.0000 \end{pmatrix}$$

4x4 case

$$R_{high} = \left(\begin{matrix} 1.0000 & 0.9884 & 0.9543 & 0.9000 & 0.9884 & 0.9769 & 0.9431 & 0.8895 & 0.9543 & 0.9431 & 0.9106 & 0.8588 & 0.9000 & 0.8895 \\ 0.9884 & 1.0000 & 0.9884 & 0.9543 & 0.9769 & 0.9884 & 0.9769 & 0.9431 & 0.9431 & 0.9543 & 0.9431 & 0.9106 & 0.8895 & 0.9000 \\ 0.9543 & 0.9884 & 1.0000 & 0.9884 & 0.9431 & 0.9769 & 0.9884 & 0.9769 & 0.9106 & 0.9431 & 0.9543 & 0.9431 & 0.8588 & 0.8895 \\ 0.9000 & 0.9543 & 0.9884 & 1.0000 & 0.8895 & 0.9431 & 0.9769 & 0.9884 & 0.8588 & 0.9106 & 0.9431 & 0.9543 & 0.8100 & 0.8588 \\ 0.9884 & 0.9769 & 0.9431 & 0.8895 & 1.0000 & 0.9884 & 0.9543 & 0.9000 & 0.9884 & 0.9769 & 0.9431 & 0.8895 & 0.9543 & 0.9431 \\ 0.9769 & 0.9884 & 0.9769 & 0.9431 & 0.9884 & 1.0000 & 0.9884 & 0.9543 & 0.9769 & 0.9884 & 0.9769 & 0.9431 & 0.9431 & 0.9543 \\ 0.9431 & 0.9769 & 0.9884 & 0.9769 & 0.9543 & 0.9884 & 1.0000 & 0.9884 & 0.9431 & 0.9769 & 0.9884 & 0.9769 & 0.9106 & 0.9431 \\ 0.8895 & 0.9431 & 0.9769 & 0.9884 & 0.9000 & 0.9543 & 0.9884 & 1.0000 & 0.8895 & 0.9431 & 0.9769 & 0.9884 & 0.8588 & 0.9106 \\ 0.9543 & 0.9431 & 0.9106 & 0.8588 & 0.9884 & 0.9769 & 0.9431 & 0.8895 & 1.0000 & 0.9884 & 0.9543 & 0.9000 & 0.9884 & 0.9769 \\ 0.9431 & 0.9543 & 0.9431 & 0.9106 & 0.9769 & 0.9884 & 0.9769 & 0.9431 & 0.9884 & 1.0000 & 0.9884 & 0.9543 & 0.9769 & 0.9884 \\ 0.9106 & 0.9431 & 0.9543 & 0.9431 & 0.9431 & 0.9769 & 0.9884 & 0.9769 & 0.9543 & 0.9884 & 1.0000 & 0.9884 & 0.9431 & 0.9769 \\ 0.8588 & 0.9106 & 0.9431 & 0.9543 & 0.8895 & 0.9431 & 0.9769 & 0.9884 & 0.9000 & 0.9543 & 0.9884 & 1.0000 & 0.8895 & 0.9431 \\ 0.9000 & 0.8895 & 0.8588 & 0.8100 & 0.9543 & 0.9431 & 0.9106 & 0.8588 & 0.9884 & 0.9769 & 0.9431 & 0.8895 & 1.0000 & 0.9884 \\ 0.8895 & 0.9000 & 0.8895 & 0.8588 & 0.9431 & 0.9543 & 0.9431 & 0.9106 & 0.9769 & 0.9884 & 0.9769 & 0.9431 & 0.9884 & 1.0000 \\ 0.8588 & 0.8895 & 0.9000 & 0.8895 & 0.9106 & 0.9431 & 0.9543 & 0.9431 & 0.9431 & 0.9769 & 0.9884 & 0.9769 & 0.9543 & 0.9884 \\ 0.8100 & 0.8588 & 0.8895 & 0.9000 & 0.8588 & 0.9106 & 0.9431 & 0.9543 & 0.8895 & 0.9431 & 0.9769 & 0.9884 & 0.9000 & 0.9543 \end{matrix}\right.$$

Table B.2.3.2-3: MIMO correlation matrices for medium correlation

case	N/A
case	$R_{medium} = \begin{pmatrix} 1 & 0.9 & 0.3 & 0.27 \\ 0.9 & 1 & 0.27 & 0.3 \\ 0.3 & 0.27 & 1 & 0.9 \\ 0.27 & 0.3 & 0.9 & 1 \end{pmatrix}$
case	$_{dium} = \begin{pmatrix} 1.0000 & 0.9000 & 0.8748 & 0.7873 & 0.5856 & 0.5271 & 0.3000 & 0.2700 \\ 0.9000 & 1.0000 & 0.7873 & 0.8748 & 0.5271 & 0.5856 & 0.2700 & 0.3000 \\ 0.8748 & 0.7873 & 1.0000 & 0.9000 & 0.8748 & 0.7873 & 0.5856 & 0.5271 \\ 0.7873 & 0.8748 & 0.9000 & 1.0000 & 0.7873 & 0.8748 & 0.5271 & 0.5856 \\ 0.5856 & 0.5271 & 0.8748 & 0.7873 & 1.0000 & 0.9000 & 0.8748 & 0.7873 \\ 0.5271 & 0.5856 & 0.7873 & 0.8748 & 0.9000 & 1.0000 & 0.7873 & 0.8748 \\ 0.3000 & 0.2700 & 0.5856 & 0.5271 & 0.8748 & 0.7873 & 1.0000 & 0.9000 \\ 0.2700 & 0.3000 & 0.5271 & 0.5856 & 0.7873 & 0.8748 & 0.9000 & 1.0000 \end{pmatrix}$
case	TBD

Table B.2.3.2-4: MIMO correlation matrices for low correlation

1x2 case	$R_{low} = \mathbf{I}_2$
2x2 case	$R_{low} = \mathbf{I}_4$
4x2 case	$R_{low} = \mathbf{I}_8$
4x4 case	$R_{low} = \mathbf{I}_{16}$

In Table B.2.3.2-4, $\mathbf{I}_d$ is the $d \times d$ identity matrix.

B.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

$$f_s(t) = f_d \cos\theta(t)$$

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

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

$$\cos\theta(t) = \frac{-1.5D_s + vt}{\sqrt{D_{\min}{}^2 + (-1.5D_s + vt)^2}}, \quad D_s/v < t \le 2D_s/v$$

$$\cos\theta(t) = \cos\theta(t \mod (2D_s/v)), \quad t > 2D_s/v$$

where $D_s/2$ is the initial distance of the train from eNodeB, and $D_{\min}$ is eNodeB 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.3-1 assuming a carrier frequency f_C = 2690 MHz. The resulting Doppler shift is shown in Figure.B.3-1.

Table B.3-1: High speed train scenario

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

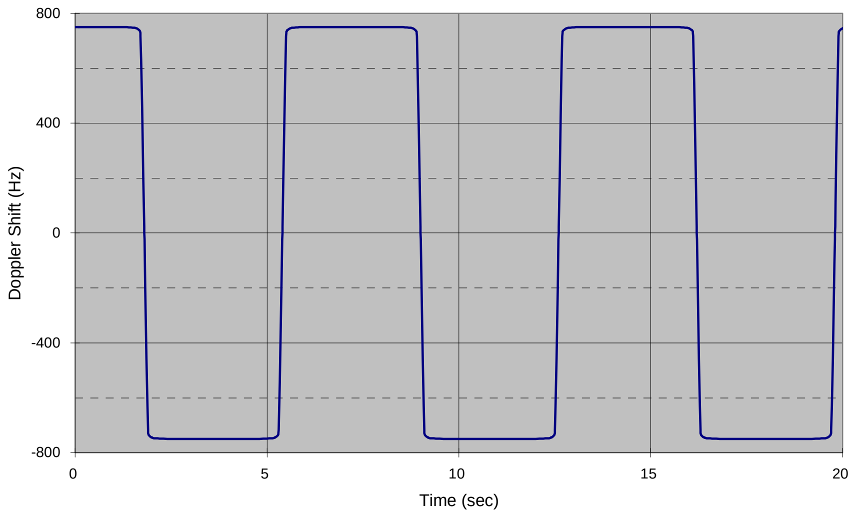

Figure B.3-1: Doppler shift trajectory

Annex C (normative): Downlink Physical Channels

C.1 General

This annex specifies the downlink physical channels that are needed for setting a connection and channels that are needed during a connection.

C.2 Set-up

Table C.2-1 describes the downlink Physical Channels that are required for connection set up.

Table C.2-1: Downlink Physical Channels required for connection set-up

Physical Channel
PBCH
SSS
PSS
PCFICH
PDCCH
PHICH
PDSCH

C.3 Connection

The following clauses, describes the downlink Physical Channels that are transmitted during a connection i.e., when measurements are done.

C.3.1 Measurement of Receiver Characteristics

Table C.3.1-1 is applicable for measurements on the Receiver Characteristics (clause 7).

Table C.3.1-1: Downlink Physical Channels transmitted during a connection (FDD and TDD)

Physical Channel	EPRE Ratio	
PBCH	PBCH_RA = 0 dB	
	PBCH_RB = 0 dB	
PSS	PSS_RA = 0 dB	
SSS	SSS_RA = 0 dB	
PCFICH	PCFICH_RB = 0 dB	
PDCCH	PDCCH_RA = 0 dB	
	PDCCH_RB = 0 dB	
PDSCH	PDSCH_RA = 0 dB	
	PDSCH_RB = 0 dB	

NOTE 1: No boosting is applied.

Table C.3.1-2: Power allocation for OFDM symbols and reference signals

Parameter	Unit	Value	Note
Transmitted power spectral density I_{or}	dBm/15 kHz	Test specific	1. I_{or} shall be kept constant throughout all OFDM symbols
Cell-specific reference signal power ratio E_{RS}/I_{or}		0 dB	

C.3.2 Measurement of Performance requirements

Table C.3.2-1 is applicable for measurements in which uniform RS-to-EPRE boosting for all downlink physical channels.

Table C.3.2-1: Downlink Physical Channels transmitted during a connection (FDD and TDD)

Physical Channel	EPRE Ratio	
PBCH	PBCH_RA = ρ_A	
	PBCH_RB = ρ_B	
PSS	PSS_RA = ρ_A	
SSS	SSS_RA = ρ_A	
PCFICH	PCFICH_RB = ρ_B	
PDCCH	PDCCH_RA = ρ_A	
	PDCCH_RB = ρ_B	
PDSCH	PDSCH_RA = ρ_A	
	PDSCH_RB = ρ_B	

NOTE 1: $\rho_A = \rho_B$ = 0 dB means no RS boosting.

Table C.3.2-2: Power allocation for OFDM symbols and reference signals

Parameter	Unit	Value	Note
Total transmitted power spectral density I_{or}	dBm/15 kHz	Test specific	1. I_{or} shall be kept constant throughout all OFDM symbols
Cell-specific reference signal power ratio E_{RS}/I_{or}		Test specific	1. Applies for antenna port *p*

Annex D (normative): Characteristics of the interfering signal

D.1 General

When the channel band width is wider or equal to 5MHz, a modulated 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 channel band widths below 5MHz, the band width of modulated interferer should be equal to band width of the received signal.

D.2 Interference signals

Table D.2-1 describes the modulated interferer for different channel band width options.

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

	Channel bandwidth					
	MHz	**IHz**	**/IHz**	**MHz**	**MHz**	**MHz**
RB	6	5	25	;0	75	100
$_{Interferer}$	MHz	IHz	/IHz	/IHz	/IHz	MHz

Annex E (normative): Environmental conditions

E.1 General

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

E.2 Environmental

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

E.2.1 Temperature

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

Table E.2.1-1

+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.

E.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 E.2.2-1

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.

E.2.3 Vibration

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

Table E.2.3-1

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 36.101 for extreme operation.

Annex F (normative): Transmit modulation

F.1 Measurement Point

Figure F.1-1 shows the measurement point for the unwanted emission falling into non-allocated RB(s) and the EVM for the allocated RB(s).

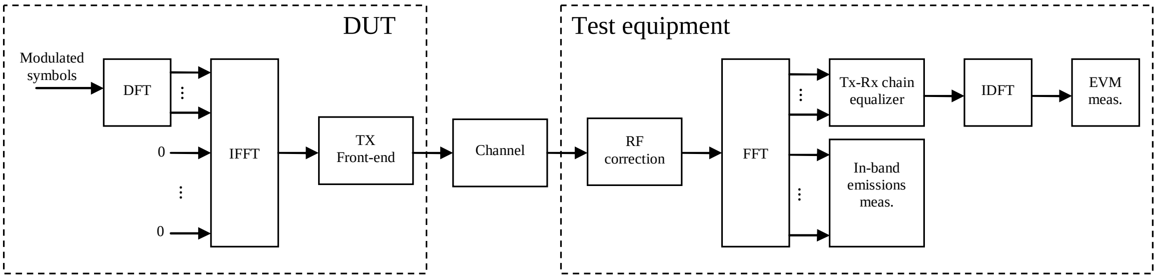

Figure F.1-1: EVM measurement points

F.2 Basic Error Vector Magnitude measurement

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

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

where

T_m is a set of $|T_m|$ 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,

$i(v)$ 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.

F.3 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

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

where

T_s is a set of $|T_s|$ 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.

F.4 Modified signal under test

Implicit in the definition of EVM is an assumption that the receiver is able to compensate a number of transmitter impairments. The signal under test is equalised and decoded according to:

$$Z'(t,f) = IDFT\left\{ \frac{FFT\left\{ z(v-\Delta\tilde{t}) \cdot e^{-j2\pi\Delta\tilde{f}v} \right\} \cdot e^{j2\pi f\Delta\tilde{t}}}{\tilde{a}(t,f) \cdot e^{j\tilde{\varphi}(t,f)}} \right\}$$

where

$z(v)$ is the time domain samples of the 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 slot 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 time interval determined by the measured cyclic prefix minus 16 samples of the considered OFDM symbol for symbol 0 for normal CP, i.e. the first 16 samples of the CP should not be taken into account for this step.
    - on the measured cyclic prefix of the considered OFDM symbol symbol for symbol 1 to 6 for normal CP and for symbol 0 to 5 for extended CP.

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. [tbd]

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 $\Delta\tilde{c} + \left\lfloor \frac{W}{2} \right\rfloor$.

F.5 Window length

F.5.1 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.

F.5.2 Window length

The window length W affects the measured EVM, and is expressed as a function 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.

F.5.3 Window length for normal CP

The table below specifies the EVM window length at channel bandwidths 1.4, 3, 5, 10, 15, 20 MHz, for normal CP. The nominal window length for 3 MHz is rounded down one sample to allow the window to be centered on the symbol.

Table F.5.3-1 EVM window length for normal CP

Channel Bandwidth MHz	Cyclic prefix length N_{cp} for symbol 0	Cyclic prefix length N_{cp} for symbols 1 to 6	Nominal FFT size	Cyclic prefix for symbols 1 to 6 in FFT samples	EVM	Ratio of *W* to CP for symbols 1 to 6*
1.4	160	144	128	9	[5]	[55.6]
3			256	18	[12]	[66.7]
5			512	36	[32]	[88.9]
10			1024	72	[66]	[91.7]
15			1536	108	[102]	[94.4]
20			2048	144	[136]	[94.4]

* Note: These percentages are informative and apply to symbols 1 through 6. Symbol 0 has a longer CP and therefore a lower percentage.

F.5.4 Window length for Extended CP

The table below specifies the EVM window length at channel bandwidths 1.4, 3, 5, 10, 15, 20 MHz, for extended CP. The nominal window lengths for 3 MHz and 15 MHz are rounded down one sample to allow the window to be centered on the symbol.

Table F.5.4-1 EVM window length for extended CP

Channel Bandwidth MHz	Cyclic	Nominal FFT size	Cyclic prefix in FFT samples	EVM window length W	Ratio of
1.4	512	128	32	[28]	[87.5]
3		256	64	[58]	[90.6]
5		512	128	[124]	[96.9]
10		1024	256	[250]	[97.4]
15		1536	384	[374]	[97.4]
20		2048	512	[504]	[98.4]

* Note: These percentages are informative

F.6 Averaged EVM

EVM is averaged over all basic EVM measurements for 20 slots in the time domain.

$$\overline{EVM} = \sqrt{\frac{1}{20}\sum_{i=1}^{20} EVM_i^2}$$

The EVM requirements should be tested against the maximum of the RMS average at the window W extremities of the EVM measurements:

Thus $\overline{\mathrm{EVM}}_l$ is calculated using $\Delta\tilde{t} = \Delta\tilde{t}_l$ in the expressions above and $\overline{\mathrm{EVM}}_h$ is calculated using $\Delta\tilde{t} = \Delta\tilde{t}_h$.

Thus we get:

$$EVM = \max(\overline{\mathrm{EVM}}_l, \overline{\mathrm{EVM}}_h)$$

F.7 Spectrum Flatness

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

Annex G (informative): Change history

Table G.1: Change History

Date	TSG#	TSG Doc.	CR	Subject	Old	New
9-11-2007	R4#45	R4-72206		TS36.101V0.1.0 approved by RAN4	-	
12-2007	RP#38	RP-070979		Approved version at TSG RAN #38	1.0.0	8.0.0
03-2008	RP#39	RP-080123	3	TS36.101 - Combined updates of E-UTRA UE requirements	8.0.0	8.1.0
05-2008	RP#40	RP-080325	4	TS36.101 - Combined updates of E-UTRA UE requirements	8.1.0	8.2.0
09-2008	RP#41	RP-080638	5r1	Addition of Ref Sens figures for 1.4MHz and 3MHz Channel bandwiidths	8.2.0	8.3.0
09-2008	RP#41	RP-080638	7r1	Transmitter intermodulation requirements	8.2.0	8.3.0
09-2008	RP#41	RP-080638	10	CR for clarification of additional spurious emission requirement	8.2.0	8.3.0
09-2008	RP#41	RP-080638	15	Correction of In-band Blocking Requirement	8.2.0	8.3.0
09-2008	RP#41	RP-080638	18r1	TS36.101: CR for section 6: NS_06	8.2.0	8.3.0
09-2008	RP#41	RP-080638	19r1	TS36.101: CR for section 6: Tx modulation	8.2.0	8.3.0
09-2008	RP#41	RP-080638	20r1	TS36.101: CR for UE minimum power	8.2.0	8.3.0
09-2008	RP#41	RP-080638	21r1	TS36.101: CR for UE OFF power	8.2.0	8.3.0
09-2008	RP#41	RP-080638	24r1	TS36.101: CR for section 7: Band 13 Rx sensitivity	8.2.0	8.3.0
09-2008	RP#41	RP-080638	26	UE EVM Windowing	8.2.0	8.3.0
09-2008	RP#41	RP-080638	29	Absolute ACLR limit	8.2.0	8.3.0
09-2008	RP#41	RP-080731	23r2	TS36.101: CR for section 6: UE to UE co-existence	8.2.0	8.3.0
09-2008	RP#41	RP-080731	30	Removal of [ ] for UE Ref Sens figures	8.2.0	8.3.0
09-2008	RP#41	RP-080731	31	Correction of PA, PB definition to align with RAN1 specification	8.2.0	8.3.0
09-2008	RP#41	RP-080731	37r2	UE Spurious emission band UE co-existence	8.2.0	8.3.0
09-2008	RP#41	RP-080731	44	Definition of specified bandwidths	8.2.0	8.3.0
09-2008	RP#41	RP-080731	48r3	Addition of Band 17	8.2.0	8.3.0
09-2008	RP#41	RP-080731	50	Alignment of the UE ACS requirement	8.2.0	8.3.0
09-2008	RP#41	RP-080731	52r1	Frequency range for Band 12	8.2.0	8.3.0
09-2008	RP#41	RP-080731	54r1	Absolute power tolerance for LTE UE power control	8.2.0	8.3.0
09-2008	RP#41	RP-080731	55	TS36.101 section 6: Tx modulation	8.2.0	8.3.0
09-2008	RP#41	RP-080732	6r2	DL FRC definition for UE Receiver tests	8.2.0	8.3.0
09-2008	RP#41	RP-080732	46	Additional UE demodulation test cases	8.2.0	8.3.0
09-2008	RP#41	RP-080732	47	Updated descriptions of FRC	8.2.0	8.3.0
09-2008	RP#41	RP-080732	49	Definition of UE transmission gap	8.2.0	8.3.0
09-2008	RP#41	RP-080732	51	Clarification on High Speed train model in 36.101	8.2.0	8.3.0
09-2008	RP#41	RP-080732	53	Update of symbol and definitions	8.2.0	8.3.0
09-2008	RP#41	Rp-080743	56	Addition of MIMO (4x2) and (4x4) Correlation Matrices	8.2.0	8.3.0

History

Document history		
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