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**LTE;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Radio Frequency (RF) requirements for LTE Pico Node B
(3GPP TR 36.931 version 9.0.0 Release 9)**

Reference

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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00   Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Contents

Foreword

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1   Scope

This document is a Technical Report on Release 9 work item "RF requirements for LTE Pico NodeB".

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.

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

[2]   3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".

[3]   3GPP TS 36.141: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing".

[4]   3GPP TR 25.951: "FDD Base Station (BS) classification".

[5]   3GPP TR 36.942: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios".

[6]   3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[7]   ITU-R Reccommendation P.1238: "Propagation data and prediction methods for the planning of indoor radiocommunication systems and radio local area networks in the frequency range 900 MHz to 100 GHz".

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

3   Definitions, symbols and abbreviations

3.1   Definitions

For the purposes of the present document, the terms and definitions given in 3GPP 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 3GPP TR 21.905 [1].

(Void)

3.2   Symbols

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

(void)

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

(void)

4 General

4.1 Work item objective

The objective is to define LTE Pico BS and then specify the corresponding RF requirements according to the followings:

- definition of LTE Pico BS class

- the RF requirements for LTE Pico BS class

- introduction of BS transmission and reception requirements, but no baseband performance requirements

- update of conformance test specifications

5 System scenarios

This clause describes the system scenarios for LTE operation that are considered when defining LTE Pico BS class.   It also includes typical radio parameters that are used to derive requirements.

5.1 Pico NodeB class

Pico Base Stations are characterised by requirements derived from Pico Cell scenarios with a BS to UE minimum coupling loss (MCL) equal to 45 dB.

Note: This value was derived from 2GHz Band.

[Editor's Note: The impact on the MCL values due to different frequency bands is for FFS.]

5.2 Radio scenario

Pico radio scenarios have these characteristics: relatively large coverage, dense user population, easy and flexible installation, and large capacity data service. Pico BS is typically used in indoor offices, indoor hotspots, outdoor hotspots, or dense blocks, and is located on walls, ceilings, or masts.

5.3 Simulation assumptions

5.3.1 Deployment modelling

5.3.1.1   f General blocking requirement Pico deployment

This modelling is referenced to the Pico scenario described in 3GPP TR 25.951 [4]. A model indoor environment is specified below and consists of a large office building with an open floor plan layout. Figure1 shows a diagram of the environment. The parameters of the Pico environment are the following:

- building size = 100 x 100 metres

- room size = 23 x 20 metres

- corridor width = 4 metres
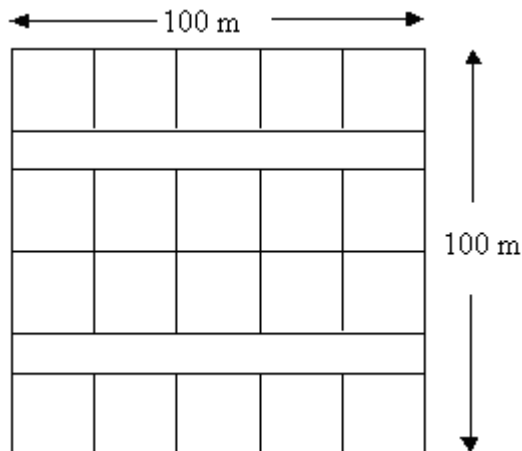
Figure 5.3.1.1-1 Pico deployment

5.3.1.2   Macro-Pico deployment

The hexagonal cells represent the macro cells and the indoor systems have been mapped onto the macro cells. The indoor layout has been adopted from clause 5.3.1.1. A certain number of indoor systems are dropped within the macro coverage area with a random uniform distribution.
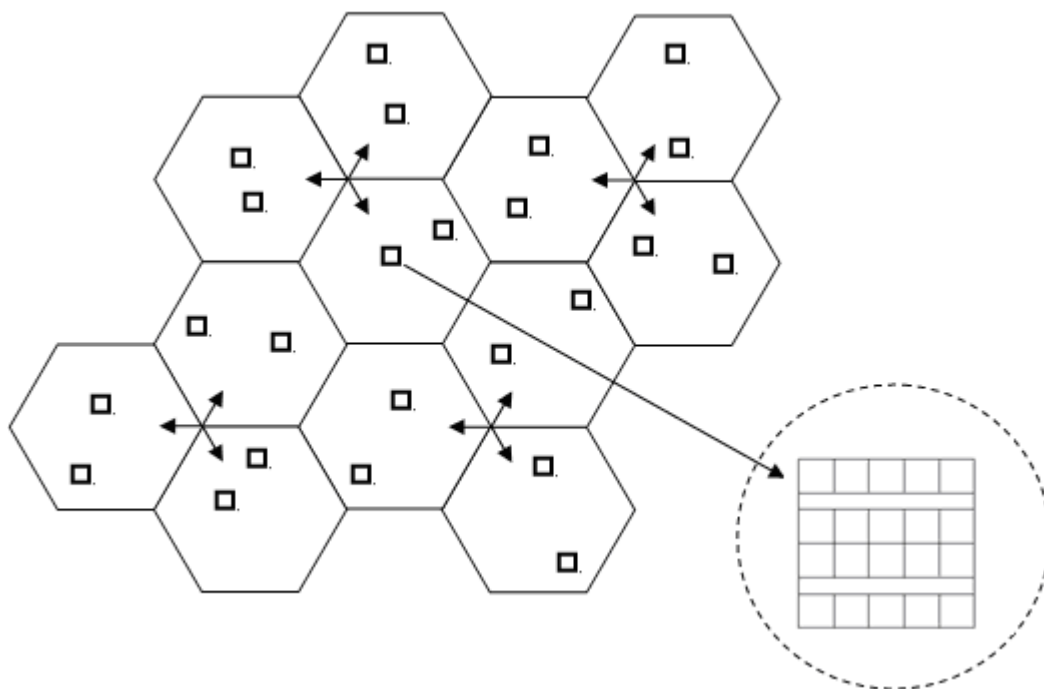
Figure 5.3.1.2-1. Macro-Pico deployment

5.3.2   Channel models

5.3.2.1   Antenna patterns

The macro BS antenna radiation pattern to be used for each sector in 3-sector cell sites is plotted in Figure 3. The pattern is identical to those defined in 3GPP TR 36.942 [5].

$$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, \ A_m\right] \quad \text{where} \quad -180 \leq \theta \leq 180,$$

θ_{3dB} is the 3dB beam width which corresponds to 65 degrees, and $A_m = 20dB$ is the maximum attenuation
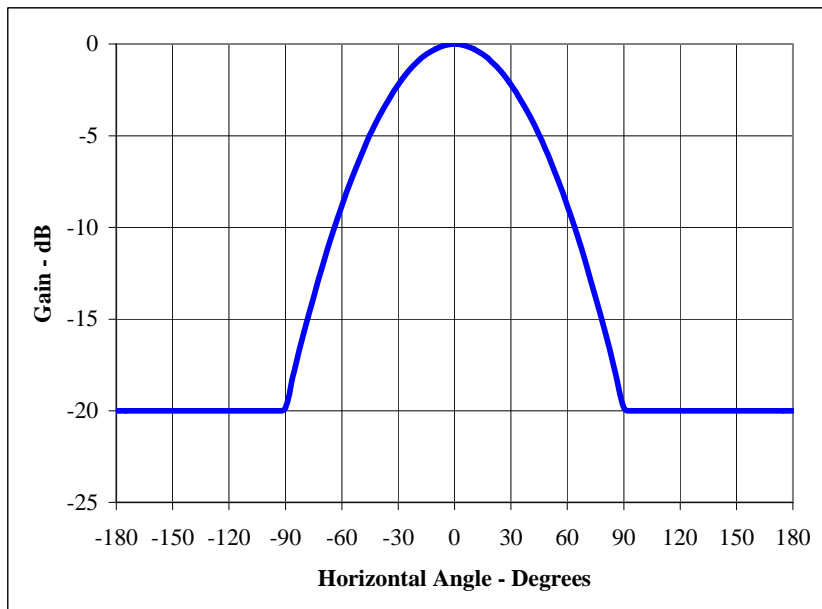
Figure 5.3.2.1-1 Antenna Pattern for 3-Sector Cells

For initial coexistence simulations, the azimuth antenna patterns for Pico BS are assumed to be omnidirectional.

5.3.2.2 Propagation model

5.3.2.2.1 Indoor path loss model

According to Keenan-Motley and ITU-R P.1238 [7] indoor models, the indoor propagation model expressed in dB is in the following form, which gives the similar results with the indoor model in 3GPP TR 25.951 [4] when a carrier frequency of 2000MHz is used.

$$PL(dB) = 20 \times \log(f) + 20 \times \log(R) - 28dB + \sum_{i=0}^{n} P_i$$

Where:

- R transmitter-receiver separation given in metres

- f the carrier frequency given in MHz

- n number of penetrated walls

- Pi loss of wall number i

To be convenient for simulation, according to the parameters given for office environment in ITU-R P.1238 [7], the indoor path loss model is represented by the following formula when considering a carrier frequency of 2000 MHz.

$$PL(dB) = 38 + 30 \times \log(R)$$

where:

R = transmitter-receiver separation given in metres

Slow fading deviation in Pico environment is assumed to be 6 dB.

5.3.2.2.2 Macro cell propagation model

Macro cell propagation model for urban area is applicable for scenarios in urban and suburban areas outside the high rise core where buildings are of nearly uniform height (3GPP TR 36.942 [5]). Assuming that the base station antenna height is fixed at 15 m above the rooftop, and a carrier frequency of 2 GHz is used, the path loss L can be expressed as below:

$$L = 128.1 + 37.6 \log_{10}(R)$$

Where:

R is the transmitter-receiver separation in kilometers

Slow fading deviation in Macro environment is assumed to be 10 dB.

5.3.3 Macro cell parameters

The macro cell parameters are proposed as follows:

Table 5.3.3-1: Macro system assumptions

Parameters	Assumptions	
Carrier frequency	2000 MHz	
System bandwidth	10 MHz(aggressor), 10 MHz(victim)	
Cellular layout	Hexagonal grid, 19 cell sites, with BTS in the corner of the cell , 65-degree sectored beam.	
Wrap around	Employed	
Inter-site distance	750 m	
Traffic model	Full buffer	
UE distribution	UEs dropped with uniform density within the macro coverage area, Indoor UEs ratio is a parameter depending on the simulation scenario.	
Path loss model	L = 128.1 + 37.6 log10 (R), R in kilometers	
Lognormal shadowing	Log Normal Fading with 10 dB standard deviation	
LTE BS Antenna gain after cable loss	15 dBi	
UE Antenna gain	0 dBi	
Outdoor wall penetration loss	10 dB	
White noise power density	-174 dBm/Hz	
BS noise figure	5 dB	
UE noise figure	9 dB	
Maximum BS TX power	46dBm	
Maximum UE TX power	23dBm	
Minimum UE TX power	-30dBm	
MCL	70 dB	
Scheduling algorithm	Round Robin	
RB width	180 kHz, total 50 RBs	
RB numbers per user	Downlink:1	Uplink:16

5.3.4 Pico cell parameters

The Pico cell parameters are proposed as follows:

Table 5.3.4-1: Pico system assumptions

Parameters	Assumptions	
Carrier frequency	2000 MHz	
System bandwidth	10 MHz(aggressor), 10 MHz(victim)	
Path loss model	L = 38 + 30 log10 (R), R in metres	
Lognormal shadowing	Log Normal Fading with 6 dB standard deviation	
Antenna gain	0 dBi or 2 dBi	
Outdoor wall penetration loss	10 dB	
Pico BS noise figure	6 dB	
Maximum Pico TX power	24dBm	
Min separation UE to Pico BS	2 m	
Scheduling algorithm	Round Robin	
RB width	180 kHz, total 50 RBs	
RB numbers per user	Downlink:1	Uplink:16

5.3.5 Scheduler

For initial coexistence simulations, Round Robin scheduler shall be used.

5.3.6 Power control modelling

No power control in downlink, fixed power per frequency resource block is assumed.

The fractional power control described in 3GPP TR 36.942 [5] shall be used for the initial uplink coexistence simulations.

6 Changes for the Release 9 in addition to Release 8

6.1 Changes in 36.104

This clause describes the necessary changes to requirements on BS minimum RF characteristics, with respect to Release 8 requirements in 3GPP TS 36.104 [2].

6.1.1 Changes to transmitter characteristics

6.1.1.1 Frequency error

The frequency error requirement may be specified separately for different base station classes. In Pico cells, the Doppler shift of the mobile should be lower than that in general cells. For that reason we consider that the requirement of frequency error for Pico BS may be relaxed without performance degradation. Meanwhile, the demodulation performance with high order modulation which is sensitive to the frequency error should be considered.

It is agreed to set the frequency error requirement for Pico eNodeB to ±[0.1] ppm.

6.1.1.2 Base station maximum output power

Maximum output power, Pmax, of the base station is the mean power level per carrier measured at the antenna connector during the transmitter ON period in a specified reference condition.

Base Station maximum output power for Pico NodeB shall be as specified in table 6.1.1.2-1.

Table 6.1.1.2-1: Base Station maximum output power

BS Class	Maximum output power
Pico NodeB	$\leq$ + 24 dBm (for one transmit antenna port)
	$\leq$ + 21 dBm (for two transmit antenna ports)
	$\leq$ + 18 dBm (for four transmit antenna ports)

6.1.1.3 Adjacent Channel Leakage power Ratio (ACLR)

6.1.1.3.1 Relative value

Downlink interference between Macro cell and Pico cell was evaluated in R4-093591, from the simulation results, average downlink throughput loss for LTE Macro is less than 0.5% and capacity loss for UTRA Macro is less than 2.5% when LTE Macro or UTRA Macro and Pico cells are deployed on adjacent frequencies (ACIR = 33 dB).

ACIR defines the protection against adjacent channel interference. In the downlink, ACIR is the function of Pico BS ACLR and UE ACS as follows:

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

ACS1 of MUE is assumed to be 33 dB 3GPP TS 36.101 [6], the relationship between ACIR and ACLR1 is provided in Table 6.1.1.3.1-1. It is observed that the ACIR is mainly dominated by the UE ACS1 performance and tightening the BS ACLR1 only would insignificantly improve the overall ACIR.

Table 6.1.1.3.1-1 Relationship between ACIR and ACLR

BS ACLR (dB)	UE ACS (dB)	ACIR (dB)
45	33	32.73
50	33	32.91
55	33	32.97

Based on the above investigation, a relative ACLR1 value of 45 dB could ensure Macro downlink performance degradation to an acceptable level. Due to the fact that ACS2 of UE is better than ACS1, the requirement of ACLR2 would be lower than ACLR1 for Pico BS to get the same ACIR. The same requirements for ACLR1 and ACLR2 are appropriate. So there is no need to tighten the relative ACLR requirements for the Pico BS from requirements used for general purpose BS.

6.1.1.3.2 Absolute value

For wide area base stations, absolute limits of -15 dBm/MHz for Category B and -13dBm/MHz for Category A are specified in 3GPP TS 36.104 [2]. Assuming these limits are applicable to Pico NB and taking 10 MHz bandwidth as an example, the corresponding relative ACLR is 29 dB for Category B and 27 dB for Category A. It may influence co-existence performance under these absolute limits. It is proposed to use a level of -32 dBm/MHz as the absolute limit, which is 5 dB below SEM mask level in spurious domain inside the operating band.

6.1.1.4 Operating band unwanted emissions

For LTE Pico NodeB, emissions shall not exceed the maximum levels specified in tables 6.1.1.4-1 to 6.1.1.4-3.

Table 6.1.1.4-1: Pico eNodeB operating band unwanted emission limits for 1.4 MHz channel bandwidth

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth (Note 1)
0 MHz ≤ Δf < 1.4 MHz	0.05 MHz ≤ f_offset < 1.45 MHz	$-21dBm - \dfrac{10}{1.4}\left(\dfrac{f\_offset}{MHz} - 0.05\right)dB$	100 kHz
1.4 MHz ≤ Δf < 2.8 MHz	1.45 MHz ≤ f_offset < 2.85 MHz	-31 dBm	100 kHz
2.8 MHz ≤ Δf ≤ Δf$_{max}$	2.85 MHz ≤ f_offset < f_offset$_{max}$	-31 dBm	100 kHz

Table 6.1.1.4-2: Pico eNodeB operating band unwanted emission limits for 3 MHz channel bandwidth

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth (Note 1)
0 MHz ≤ Δf < 3 MHz	0.05 MHz ≤ f_offset < 3.05 MHz	$-25dBm - \dfrac{10}{3}\left(\dfrac{f\_offset}{MHz} - 0.05\right)dB$	100 kHz
3 MHz ≤ Δf < 6 MHz	3.05 MHz ≤ f_offset < 6.05 MHz	-35 dBm	100 kHz
6 MHz ≤ Δf ≤ Δf$_{max}$	6.05 MHz ≤ f_offset < f_offset$_{max}$	-35 dBm	100 kHz

Table 6.1.1.4-3: Pico eNodeB operating band unwanted emission limits for 5, 10, 15 and 20 MHz channel bandwidth

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth (Note 1)
0 MHz ≤ Δf < 5 MHz	0.05 MHz ≤ f_offset < 5.05 MHz	$-30dBm - \dfrac{7}{5}\left(\dfrac{f\_offset}{MHz} - 0.05\right)dB$	100 kHz
5 MHz ≤ Δf < 10 MHz	5.05 MHz ≤ f_offset < 10.05 MHz	-37 dBm	100 kHz
10 MHz ≤ Δf ≤ Δf$_{max}$	10.05 MHz ≤ f_offset < f_offset$_{max}$	-37 dBm	100 kHz

6.1.1.5 Transmitter spurious

6.1.1.5.1 Mandatory requirement

The mandatory requirements of spurious emission are defined according to the ITU-R Recommendation SM.329 [8] and are independent of BS classes. It shall also be applied for Pico eNode B.

6.1.1.5.2 Protection of the BS receiver of own or different BS

This requirement is to protect the receivers of the BSs that may be desensitised by emissions from a BS transmitter. Assuming 30 dB coupling loss between the Tx and Rx antenna ports, 5 dB noise figure and 0.8 dB desensitization (interferer 7 dB below noise floor), the maximum allowed level of Macro eNodeB is -96 dBm with 100kHz bandwidth. For Pico eNodeB the noise figure is agreed as 13dB, so for the Pico eNode B any spurious emissions for protection of the own or other Pico eNode B receiver shall not exceed the limits in table 6.1.1.5.2-1.

Table6.1.1.5.2-1: Pico eNodeB spurious emissions limits for protection of the BS receiver

	Frequency range	Maximum Level	Measurement Bandwidth	Note
	F_{UL_low} – F_{UL_high}	-88dBm	100 kHz	

6.1.1.5.3   Additional spurious emissions requirements

These requirements are applied for the protection of specific equipment operating in specific systems (GSM, UTRA, E-UTRA, etc.). The requirements are used for protection of E-UTRA system in other band or other systems which are not belong to LTE and are independent of the BS classifications. The requirement in clause 6.6.4.3 of TS36.104 shall also be applied for Pico eNode B.

6.1.1.5.4   Co-location with other base stations

These requirements are applied to the BSs of the same classification. Similar to UTRA it is reasonable to reuse the co-location scenarios that defined for GSM Base stations, which also involves in 30 dB coupling loss between the Tx and Rx antenna ports. Considering that both the UTRA and E-UTRA system are may operate within the same band, both the two systems should be protected. The spurious emission limit is determined by the E-UTRA and UTRA spurious requirement whichever is more stringent.

The power of any spurious emission shall not exceed the limits of table 6.1.1.5.4-1 for a Pico eNodeB where requirements for co-location with a BS type listed in the first column apply.

Table 6.1.1.5.4-1: BS Spurious emissions limits for Pico eNodeB co-located with another BS

Type of co-located BS	Frequency range for co-location requirement	Maximum Level	Measurement Bandwidth	Note
Pico GSM900	876-915 MHz	-70 dBm	100 kHz	
Pico DCS1800	1710 - 1785 MHz	-80 dBm	100 kHz	
Pico PCS1900	1850 - 1910 MHz	-80 dBm	100 kHz	
Pico GSM850	824 - 849 MHz	-70 dBm	100 kHz	
LA UTRA FDD Band I or E-UTRA Band 1	1920 - 1980 MHz	-88dBm	100 kHz	
LA UTRA FDD Band II or E-UTRA Band 2	1850 - 1910 MHz	-88dBm	100 kHz	
LA UTRA FDD Band III or E-UTRA Band 3	1710 - 1785 MHz	-88dBm	100 kHz	
LA UTRA FDD Band IV or E-UTRA Band 4	1710 - 1755 MHz	-88dBm	100 kHz	
LA UTRA FDD Band V or E-UTRA Band 5	824 - 849 MHz	-88dBm	100 kHz	
LA UTRA FDD Band VI or E-UTRA Band 6	815 - 850 MHz	-88dBm	100 kHz	
LA UTRA FDD Band VII or E-UTRA Band 7	2500 - 2570 MHz	-88dBm	100 KHz	
LA UTRA FDD Band VIII or E-UTRA Band 8	880 - 915 MHz	-88dBm	100 KHz	
LA UTRA FDD Band IX or E-UTRA Band 9	1749.9 - 1784.9 MHz	-88dBm	100 KHz	
LA UTRA FDD Band X or E-UTRA Band 10	1710 - 1770 MHz	-88dBm	100 kHz	
LA UTRA FDD Band XI or E-UTRA Band 11	1427.9 - 1452.9 MHz	-88dBm	100 kHz	
LA UTRA FDD Band XII or E-UTRA Band 12	698 - 716 MHz	-88dBm	100 kHz	
LA UTRA FDD Band XIII or E-UTRA Band 13	777 - 787 MHz	-88dBm	100 kHz	
LA UTRA FDD Band XIV or E-UTRA Band 14	788 - 798 MHz	-88dBm	100 kHz	
E-UTRA Band 17	704 - 716 MHz	-88dBm	100 kHz	
LA UTRA TDD in Band a) or E-UTRA Band 33	1900 - 1920 MHz	-88dBm	100 kHz	This is not applicable to E-UTRA BS operating in Band 33
LA UTRA TDD in Band a) or E-UTRA Band 34	2010 - 2025 MHz	-88dBm	100 kHz	This is not applicable to E-UTRA BS operating in Band 34
LA UTRA TDD in Band b) or E-UTRA Band 35	1850 – 1910 MHz	-88dBm	100 kHz	This is not applicable to E-UTRA BS operating in Band 35
LA UTRA TDD in Band b) or E-UTRA Band 36	1930 - 1990 MHz	-88dBm	100 kHz	This is not applicable to E-UTRA BS operating in Band 2 and 36
LA UTRA TDD in Band c) or E-UTRA Band 37	1910 - 1930 MHz	-88dBm	100 kHz	This is not applicable to E-UTRA BS operating in Band 37. This unpaired band is defined in ITU-R M.1036, but is pending any future deployment.

LA UTRA TDD in Band d) or E-UTRA Band 38	2570 – 2620 MHz	-88dBm	100 kHz	This is not applicable to E-UTRA BS operating in Band 38.
LA E-UTRA Band 39	1880 – 1920MHz	-88dBm	100 kHz	This is not applicable to E-UTRA BS operating in Band 33 and 39
LA E-UTRA Band 40	2300 – 2400MHz	-88dBm	100 kHz	This is not applicable to E-UTRA BS operating in Band 40

6.1.2 Changes to receiver characteristics

6.1.2.1 Receiver reference sensitivity

6.1.2.1.1 Discussion

Two contributions were presented during the RAN4 #52bis proposing the receiver reference sensitivity requirement for the LTE Pico NodeB in R4-093588 and R4-093987. This two contributions both provided simulation results on uplink performance degradation of Macro cell and Noise rise at Pico NB. From these simulation results, 2 aspects were identified:

1) Pico Node B operating on adjacent channel will not cause noticeable throughput loss of Macro NodeB.

2) Due to the different setting on probability of Pico NodeB suffering from the highest interference, 10 dB noise rise is proposed in R4-093588 and 4~6 dB is proposed in R4-093987.

Considering both system performance and implementation cost, it is proposed that the receiver sensitivity for Pico BS is relaxed by 8dB compared to that for Macro BS.

The receiver reference sensitivity for Pico NodeB can be specified as below:

6.1.2.1.2 Minimum requirement

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in annex A in 3GPP TS 36.104 [2] with parameters specified in table 6.1.2.1.2-1.

Table 6.1.2.1.2-1: BS reference sensitivity levels

E-UTRA channel bandwidth [MHz]	Reference measurement channel	Reference sensitivity power level, $P_{REFSENS}$ [dBm]
1.4	FRC A1-1 in annex A.1	-98.8
3	FRC A1-2 in annex A.1	-95.0
5	FRC A1-3 in annex A.1	-93.5
10	FRC A1-3 in annex A.1*	-93.5
15	FRC A1-3 in annex A.1*	-93.5
20	FRC A1-3 in annex A.1*	-93.5
Note*: $P_{REFSENS}$ is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of FRC A1-3 mapped to disjoint frequency ranges with a width of 25 resource blocks each.		

6.1.2.2 Blocking characteristics

6.1.2.2.1   General blocking requirement

The blocking characteristic is a measure of the receiver ability to receive a wanted signal at its assigned channel in the presence of an unwanted interferer, which is either a 1.4 MHz, 3 MHz or 5 MHz E-UTRA signal for in-band blocking or a CW signal for out-of-band blocking. For the out-of-band blocking, the same requirement which is a -15 dBm CW signal as for general purpose BS may apply to the Pico BS. Meanwhile, due to the fact that separation between UE and Pico BS may be relatively close, the in-band blocking requirements for Pico BS may be more stringent than that for general purpose BS.

The deployment scenario and simulation assumptions are the same as in clause 5.3. The Macro and Pico layers are deployed on different frequencies. One block is located in each Macro sector. Number of Pico NB per block is 4. Indoor UE ratio of Macro cell is set to 20%. The total received power level at Pico NodeB in 10 MHz bandwidth in Macro operating frequency from MUEs is calculated.

Figure 6.1.2.2.1-1 and figure 6.1.2.2.1-2 show the CDF curves of the total received blocking power level at Pico NB from Macro UEs. It is observed that the interfering level of -35 dBm corresponds to the case that 99.8% probability of the blocking levels at the receivers is below this level.

In reality, macro UEs will be blocked due to the strong signal from Pico NB, before they can cause significant interference to Pico BS. A blocking threshold of –39 dBm for UE is assumed (assuming 5dB higher than the blocking level of –44 dBm in 3GPP TS 36.101 [6]). Figure 6.1.2.2.1-3 shows the CDF with DL UE blocking. It is observed that all the interference levels will less than -37 dBm.
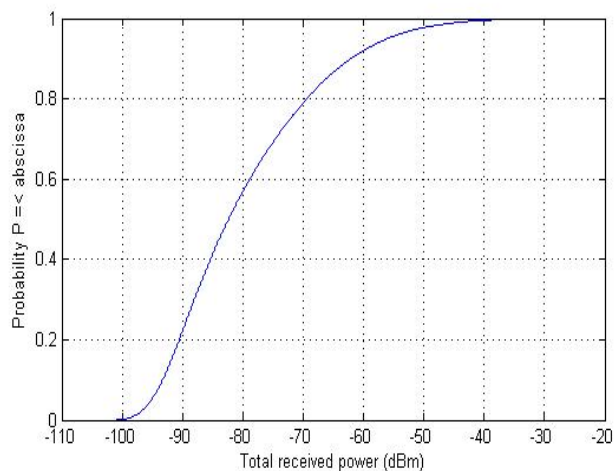
Figure 6.1.2.2.1-1 CDF of the total received blocking power, no UE blocking
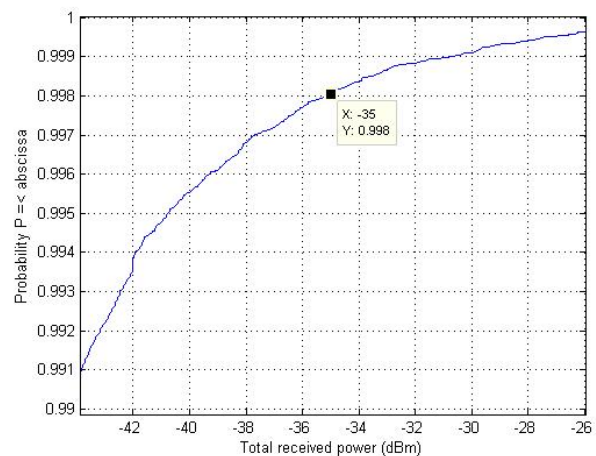
Figure 6.1.2.2.1-2 CDF of the total received blocking power (zoomed version), no UE blocking
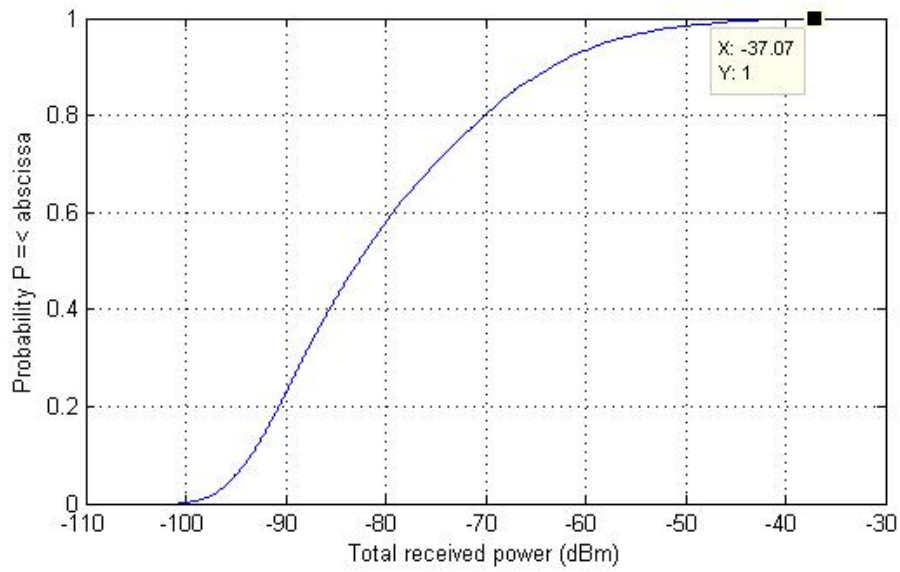
Figure 6.1.2.2.1-3 CDF of the total received blocking power, with UE blocking

Based on these findings, it is proposed that a blocking level of -35 dBm for in-band blocking is sufficient for Pico NB.

It is expected that the receiver blocking should be tested with a wanted signal 6 dB above sensitivity as for a general purpose BS. The receiver blocking for Pico NodeB can be specified as below:

6.1.2.2.1.1 Minimum requirement

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel, with a wanted and an interfering signal coupled to BS antenna input using the parameters in tables 6.1.2.2.1.1-1 and 6.1.2.2.1.1-2. The reference measurement channel for the wanted signal is identified in table 6.1.2.1.2-1 for each channel bandwidth and further specified in annex A of 3GPP TS 36.104 [2].

Table 6.1.2.2.1.1-1: Blocking performance requirement

| Operating Band	Centre Frequency of Interfering Signal [MHz]			Interfering Signal mean power [dBm]	Wanted Signal mean power [dBm]	Interfering signal centre frequency minimum frequency offset from the channel edge of the wanted signal [MHz]	Type of Interfering Signal
1-7, 9-11, 13-14, 18,19, 33-40	(F_{UL_low} -20)	to	(F_{UL_high} +20)	-35	$P_{REFSENS}$ +6dB*	See table6.1.2.2.1.1-2	See table 6.1.2.2.1.1-2
	1 (F_{UL_high} +20)	to to	(F_{UL_low} -20) 12750	-15	$P_{REFSENS}$ +6dB*	—	CW carrier
8	(F_{UL_low} -20)	to	(F_{UL_high} +10)	-35	$P_{REFSENS}$ +6dB*	See table6.1.2.2.1.1-2	See table 6.1.2.2.1.1-2
	1 (F_{UL_high} +10)	to to	(F_{UL_low} -20) 12750	-15	$P_{REFSENS}$ +6dB*	—	CW carrier
12	(F_{UL_low} -20)	to	(F_{UL_high} +12)	-35	$P_{REFSENS}$ +6dB*	See table 6.1.2.2.1.1-2	See table 6.1.2.2.1.1-2
	1 (F_{UL_high} +12)	to to	(F_{UL_low} -20) 12750	-15	$P_{REFSENS}$ +6dB*	—	CW carrier
17	(F_{UL_low} -20)	to	(F_{UL_high} +18)	-35	$P_{REFSENS}$ +6dB*	See table 6.1.2.2.1.1-2	See table 6.1.2.2.1.1-2
	1 (F_{UL_high} +18)	to to	(F_{UL_low} -20) 12750	-15	$P_{REFSENS}$ +6dB*	—	CW carrier
Note*: $P_{REFSENS}$ depends on the channel bandwidth as specified in v table 6.1.2.1.4-1.							

Table 6.1.2.2.1.1-2: Interfering signals for blocking performance requirement for

E-UTRA channel BW [MHz]	Interfering signal centre frequency minimum offset to the channel edge of the wanted signal [MHz]	Type of interfering signal
1.4	2.1	1.4MHz E-UTRA signal
3	4.5	3MHz E-UTRA signal
5	7.5	5MHz E-UTRA signal
10	7.5	5MHz E-UTRA signal
15	7.5	5MHz E-UTRA signal
20	7.5	5MHz E-UTRA signal

6.1.2.2.2 Collocation with other base stations

This additional blocking requirement may be applied for the protection of Pico E-UTRA BS receivers when GSM, UTRA or E-UTRA Pico BS operating in a different frequency band are collocated with an LTE Pico BS.

The requirements are applied to the BSs of the same classification. The requirements in this clause assume a 30 dB coupling loss between interfering transmitter and Pico BS receiver. For the maximum output power of UTRA or LTE Pico BS is 24 dBm, the interfering Signal mean power equals to -6 dBm.

6.1.2.2.2.1 Minimum requirement

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel, with a wanted and an interfering signal coupled to BS antenna input using the parameters in table 6.1.2.2.2.1.-1. The reference

measurement channel for the wanted signal is identified in table 6.1.2.1.2-1 for each channel bandwidth and further specified in annex A in 3GPP TS 36.104 [2].

Table 6.1.2.2.2.1-1: Blocking performance requirement for LTE Pico BS when co-located with BS in other frequency bands

Co-located BS type	Centre Frequency of Interfering Signal (MHz)	Interfering Signal mean power (dBm)	Wanted Signal mean power (dBm)	Type of Interfering Signal
Pico GSM850	869 – 894	-7	$P_{REFSENS}$ + 6dB*	CW carrier
Pico GSM900	921 – 960	-7	$P_{REFSENS}$ + 6dB*	CW carrier
Pico DCS1800	1805 – 1880	-4	$P_{REFSENS}$ + 6dB*	CW carrier
Pico PCS1900	1930 – 1990	-4	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band I or E-UTRA Band 1	2110 – 2170	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band II or E-UTRA Band 2	1930 – 1990	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band III or E-UTRA Band 3	1805 – 1880	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band IV or E-UTRA Band 4	2110 – 2155	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band V or E-UTRA Band 5	869 – 894	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band VI or E-UTRA Band 6	875 – 885	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band VII or E-UTRA Band 7	2620 – 2690	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band VIII or E-UTRA Band 8	925 – 960	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band IX or E-UTRA Band 9	1844.9 – 1879.9	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band X or E-UTRA Band 10	2110 – 2170	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band XI or E-UTRA Band 11	1475.9 - 1500.9	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band XII or E-UTRA Band 12	728 - 746	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band XIIII or E-UTRA Band 13	746 - 756	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band XIV or E-UTRA Band 14	758 - 768	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA E-UTRA Band 17	734 - 746	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA E-UTRA Band 18	860 - 875	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA FDD Band XIX or E-UTRA Band 19	875 - 890	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA TDD in Band a)	1900-1920 2010-2025	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA E-UTRA TDD in Band 33	1900-1920	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA E-UTRA TDD in Band 34	2010-2025	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA TDD in Band b)	1850-1910 1930-1990	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA E-UTRA TDD in Band 35	1850-1910	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA E-UTRA TDD in Band 36	1930-1990	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA TDD in Band c) or E-UTRA TDD in Band 37	1910-1930	-6	$P_{REFSENS}$ + 6dB*	CW carrier
LA UTRA TDD in Band d) or E-UTRA in Band 38	2570-2620	-6	$P_{REFSENS}$ + 6dB*	CW carrier
Pico E-UTRA in Band 39	1880-1920	-6	$P_{REFSENS}$ + 6dB*	CW carrier
Pico E-UTRA in Band 40	2300-2400	-6	$P_{REFSENS}$ + 6dB*	CW carrier
Note*: $P_{REFSENS}$ depends on the channel bandwidth as specified in table 6.1.2.1.2-1				

6.1.2.3 Dynamic range

The dynamic range is specified as a measure of the capability of the receiver to receive a wanted signal in the presence of an interfering signal inside the received channel bandwidth. In this condition a throughput requirement shall be met for a specified reference measurement channel. The interfering signal for the dynamic range requirement is an AWGN signal.

6.1.2.3.1 Analysis

The evaluation of the Macro eNodeB receiver dynamic range is shown as the following equations.

[Interfering signal mean power]= [noise floor] + [20 dB interference-over-thermal]

[Wanted signal mean power]= [Interfering signal mean power] + [SNR at 95% throughput] + [implement margin]

In the formulas above the additional noise of 20 dB and SNR point are proposed based on simulations, and the implement margin which is due to receiver chain imperfections is chosen as 2.5 dB. The simulation assumptions for Pico eNB are the same as clause 5.3. There are 10 pico eNBs per sector and 80% MUE indoor. The Macro and Pico layers are deployed on adjacent frequencies, Adjacent Channel Interference Ratio (ACIR) is set to 30 dB and the Pico eNodeB building block is located in the cell border.

.I
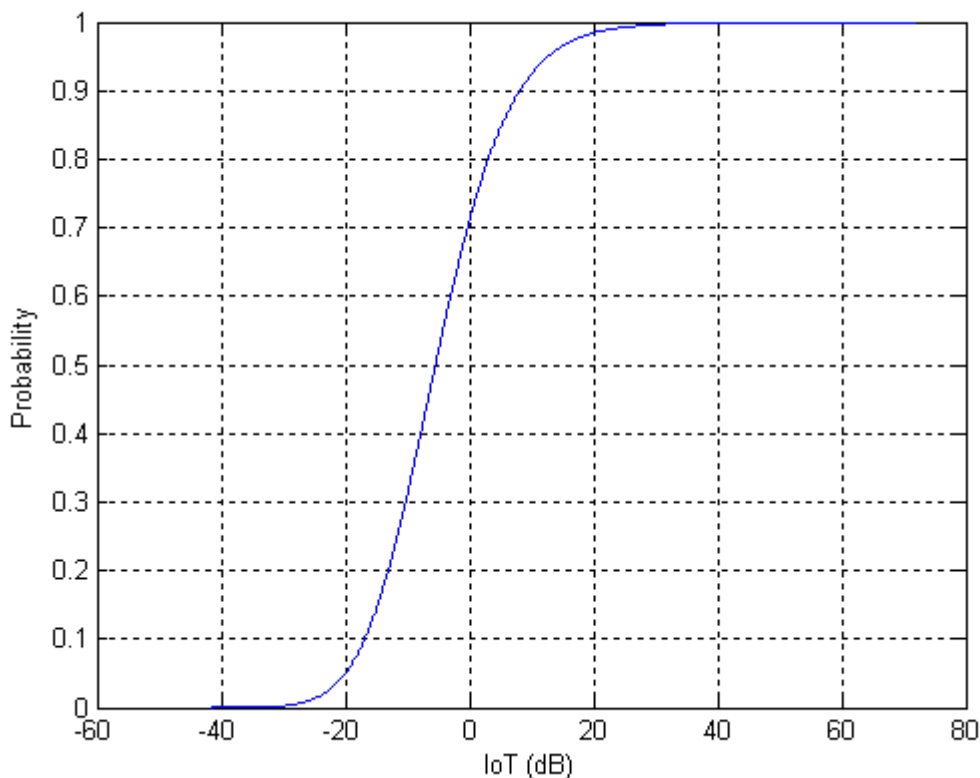
Figure 6.1.2.3.1-1: probability of IoT

Figure 6.1.2.3.1-1 gives the IoT caused by uncoordinated macro UE, and the IoT of 20dB is corresponding to 98.4% probability, so it is reasonable to reuse the 20dB IoT which is proposed above.

Figure 6.1.2.3.1-2 shows the CDF of interfering signal level based on another deployment scenario. In the simulation, one block is randomly located in each Macro sector. Number of Pico NB per block is 4. Indoor UEs ratio of Macro cell is set to 20%. The total received interference power from uncoordinated macro UEs is calculated.

In Figure 6.1.2.3.1-2, we can see the distribution of the interference from uncoordinated macro UEs. The simulations show that the interfering level of -76.5 dBm corresponds to the case that 99% probability of the interference levels to

the receivers are below this level. This corresponds to a level 14.5 dB above the noise floor for Pico BS, which is -91 dBm according to R4-094034.
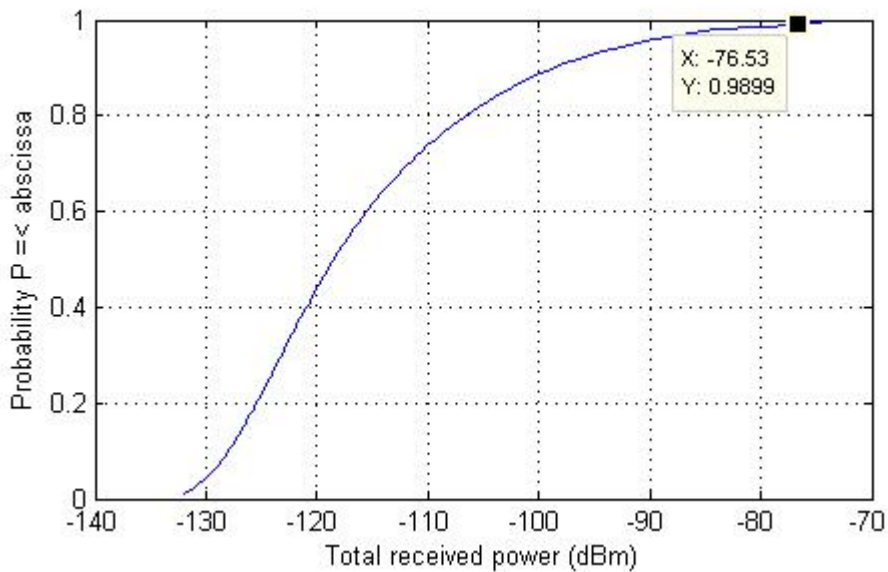
Figure 6.1.2.3.1-2 Interfering signal power CDF

Based on these findings, the conclusion is that the receiver dynamic range of 20 dB as for macro BS is sufficient for Pico NB.

The dynamic range for Pico Node B can be specified as below:

6.1.2.3.2   Minimum requirement

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in annex A with parameters specified in table 6.1.2.3.2-1.

Table 6.1.2.3.2-1: Dynamic range

E-UTRA channel bandwidth [MHz]	Reference measurement channel	Wanted signal mean power [dBm]	Interfering signal mean power [dBm] /channel BW	Type of interfering signal
1.4	FRC A2-1 in annex A.2	-68.3	-80.7	AWGN
3	FRC A2-2 in annex A.2	-64.4	-76.7	AWGN
5	FRC A2-3 in annex A.2	-62.2	-74.5	AWGN
10	FRC A2-3 in annex A.2*	-62.2	-71.5	AWGN
15	FRC A2-3 in annex A.2*	-62.2	-69.7	AWGN
20	FRC A2-3 in annex A.2*	-62.2	-68.4	AWGN

6.1.2.4 In-channel selectivity

Receiver in-channel selectivity requirement is a measure of the receiver ability to receive a wanted signal at its assigned resource block locations in the presence of an interfering signal received at a larger power spectral density.

6.1.2.4.1   Analysis

For Pico eNode B, the same method as that for Macro eNB can be used for defining this requirement. The UL signals are just defined for 2 users, one being the "wanted" signal and the other one being the "interfering" signal at elevated power as following:

[Wanted signal mean power]= [RBs noise floor] + [wanted signal C/I] + [implement margin] + [desensitization of 3 dB]

[Interfering signal mean power]= [RBs noise floor] + [16dB interference-over-thermal] + [assumption of 9 dB C/I]

Regarding the interferer level, a 16QAM "interfering" signal is proposed 25 dB above its noise floor to mask the impact of receiver's own noise floor. The "wanted" signal was defined as a QPSK modulated FRC, for which ≥95% T-put should be achieved in the presence of the interfering signal. The only difference between Macro eNB and Pico eNB is the RBs noise floor. Since the noise figure has been agreed as 13 dB (8 dB degradation compared to Macro eNB), the wanted signal and interfering signal levels for Pico eNode B is shown as following:

6.1.2.4.2   Minimum requirement

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in annex A of 3GPP TS 36.104 [2] with parameters specified in table 6.1.2.4.2-1 for Pico eNode B.

Table 6.1.2.4.2-1 E-UTRA Pico BS in-channel selectivity

E-UTRA channel bandwidth (MHz)	Reference measurement channel	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Type of interfering signal
1.4	A1-4 in annex A.1	-98.9	-79	1.4 MHz E-UTRA signal, 3 RBs
3	A1-5 in annex A.1	-94.1	-76	3 MHz E-UTRA signal, 6 RBs
5	A1-2 in annex A.1	-92.0	-73	5 MHz E-UTRA signal, 10 RBs
10	A1-3 in annex A.1	-90.5	-69	10 MHz E-UTRA signal, 25 RBs
15	A1-3 in annex A.1*	-90.5	-69	15 MHz E-UTRA signal, 25 RBs*
20	A1-3 in annex A.1*	-90.5	-69	20 MHz E-UTRA signal, 25 RBs*
Note*: Wanted and interfering signal are placed adjacently around Fc				

6.1.2.5 Adjacent Channel Selectivity (ACS) and narrow-band blocking

Adjacent channel selectivity (ACS) is a measure of the receiver ability to receive a wanted signal at its assigned channel frequency in the presence of an adjacent channel signal with a specified centre frequency offset of the interfering signal to the band edge of a victim system.

6.1.2.5.1   Analysis

In UTRA the ACS of Local Area BS was not changed from the requirement used for a general purpose BS, as the ACIR in the up-link is dominated by the ACLR performance of the terminals. For Pico eNodeB the similar criteria may also be taken.

Based on these assumptions, it is recommended to change the wanted signal mean power level and the interferer signal mean power of Pico eNode B ACS requirement linearly with the rise of noise figure.

6.1.2.5.2   Minimum requirement

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel, with a wanted and an interfering signal coupled to the BS antenna input as specified in tables 6.1.2.5.2-1 and 6.1.2.5.2-2 for narrowband blocking and in table 6.1.2.5.2-3 for ACS. The reference measurement channel for the wanted signal is identified in clause 6.1.2 for each channel bandwidth and further specified in annex A of 3GPP TS 36.104 [2].

Table 6.1.2.5.2-1: Narrowband blocking requirement

Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Type of interfering signal
$P_{REFSENS}$ + 6dB*	-41	See table 6.1.2.5.2-2
Note*:　$P_{REFSENS}$ depends on the channel bandwidth as specified in table 6.1.2.1.2-1		

Table 6.1.2.5.2-2: Interfering signal for Narrowband blocking requirement

E-UTRA Assigned BW [MHz]	Interfering RB centre frequency offset to the channel edge of the wanted signal [kHz]	Type of interfering signal
1.4	252.5+m*180, m=0, 1, 2, 3, 4, 5	1.4 MHz E-UTRA signal, 1 RB*
3	247.5+m*180, m=0, 1, 2, 3, 4, 7, 10, 13	3 MHz E-UTRA signal, 1 RB*
5	342.5+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB*
10	347.5+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB*
15	352.5+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB*
20	342.5+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB*
Note*:　Interfering signal consisting of one resource block adjacent to the wanted signal		

Table 6.1.2.5.2-3: Adjacent channel selectivity

E-UTRA channel bandwidth [MHz]	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal centre frequency offset from the channel edge of the wanted signal [MHz]	Type of interfering signal
1.4	$P_{REFSENS}$ + 11dB*	-44	0.7025	1.4MHz E-UTRA signal
3	$P_{REFSENS}$ + 8dB*	-44	1.5075	3MHz E-UTRA signal
5	$P_{REFSENS}$ + 6dB*	-44	2.5025	5MHz E-UTRA signal
10	$P_{REFSENS}$ + 6dB*	-44	2.5075	5MHz E-UTRA signal
15	$P_{REFSENS}$ + 6dB*	-44	2.5125	5MHz E-UTRA signal
20	$P_{REFSENS}$ + 6dB*	-44	2.5025	5MHz E-UTRA signal
Note*:　$P_{REFSENS}$ depends on the channel bandwidth as specified in table 6.1.2.1.2-1.				

6.1.2.6　Receiver Intermodulation

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

6.1.2.6.1　Analysis

For the UTRA Wide area BS, the level of IM interfering signals are 8 dB lower compared to Blocking requirement. It used the same relative values for the UTRA Local area BS. The reason is described in [4]: the receiver intermodulation can occur when two interfering signals with a particular relationship are applied to a BS receiver. Two large interfering

signals at the same time occur less frequently than a single interfering signal. Due to lower probability of two large interfering signals, the power level of the interfering signals for the Intermodulation requirement should be lower compared to Blocking requirement.

For the E-UTRA eNodeB, the level of IM interfering signals are 9dB lower compared to Blocking requirement. It is proposed that the same relative values also could be used for the Pico eNode B.

Following signals for Intermodulation is proposed:

[Wanted signal mean power]=Reference sensitivity level +6 dB

[IM Interfering signals mean power]= -44 dBm.

6.1.2.6.2   Minimum requirement

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel, with a wanted signal at the assigned channel frequency and two interfering signals coupled to the BS antenna input, with the conditions specified in tables 6.1.2.6.2-1 and 6.1.2.6.2-2 for intermodulation performance and in table 6.1.2.6.2-3 for narrowband intermodulation performance. The reference measurement channel for the wanted signal is identified in clause 6.1.2.1 for each channel bandwidth and further specified in annex A of 3GPP TS 36.104 [2].

Table 6.1.2.6.2-1: Intermodulation performance requirement

Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Type of interfering signal
$P_{REFSENS}$ + 6dB*	-44	See table 6.1.6.2-2
Note*: $P_{REFSENS}$ depends on the channel bandwidth as specified in clause 6.1.2.1.		

Table 6.1.2.6.2-2: Interfering signal for Intermodulation performance requirement

E-UTRA channel bandwidth [MHz]	Interfering signal centre frequency offset from the channel edge of the wanted signal [MHz]	Type of interfering signal
1.4	2.1	CW
	4.9	1.4MHz E-UTRA signal
3	4.5	CW
	10.5	3MHz E-UTRA signal
5	7.5	CW
	17.5	5MHz E-UTRA signal
10	7.5	CW
	17.7	5MHz E-UTRA signal
15	7.5	CW
	18	5MHz E-UTRA signal
20	7.5	CW
	18.2	5MHz E-UTRA signal

Table 6.1.2.6.2-3: Narrowband intermodulation performance requirement

E-UTRA channel bandwidth [MHz]	Wanted signal mean power [dBm]	Interfering signal mean power[dBm]	Interfering RB centre frequency offset from the channel edge of the wanted signal [kHz]	Type of interfering signal
1.4	P$_{REFSENS}$ + 6dB*	-44	270	CW
		-44	790	1.4 MHz E-UTRA signal, 1 RB**
3	P$_{REFSENS}$ + 6dB*	-44	275	CW
		-44	790	3.0 MHz E-UTRA signal, 1 RB**
5	P$_{REFSENS}$ + 6dB*	-44	360	CW
		-44	1060	5 MHz E-UTRA signal, 1 RB**
10	P$_{REFSENS}$ + 6dB* (***)	-44	415	CW
		-44	1420	5 MHz E-UTRA signal, 1 RB**
15	P$_{REFSENS}$ + 6dB* (***)	-44	380	CW
		-44	1600	5MHz E-UTRA signal, 1 RB**
20	P$_{REFSENS}$ + 6dB* (***)	-44	345	CW
		-44	1780	5MHz E-UTRA signal, 1 RB**
Note*: P$_{REFSENS}$ is related to the channel bandwidth as specified in clause 6.1.2.1. Note**: Interfering signal consisting of one resource block positioned at the stated offset. Note***: This requirement shall apply only for a FRC A1-3 in [2] mapped to the frequency range at the channel edge adjacent to the interfering signals				

6.1.3 Clarification on performance requirements

The typical deployment scenarios for Pico eNodeB are indoor environments, outdoor hotspots areas, and outdoor dense blocks etc. All these scenarios correspond to low UE speeds and small delay spreads environments. Among the 4 types of propagation conditions defined for Macro eNB, Static propagation condition and EVA /EPA mode of Multi-path fading propagation conditions are applicable for Pico eNB.

Considering the assumption that the speed of UE served by Pico eNB is no more than 50km/h, it is suggested to focus on the maximum Doppler frequencies of 5Hz and 70Hz for Pico eNB performance requirement of multi-path fading propagation condition.

As the performance requirement is independent of classification of BS, it is suggested to use the same requirement for Pico eNB and Macro eNB under the same reference measurement channel and propagation conditions.

6.2 Changes in 36.141

This clause describes the necessary changes to base station conformance testing, with respect to Release 8 requirements in 3GPP TS 36.141 [3].

Editor's note: For further study.

7 Impacts to other WGs

Editor's note: For further study.

Annex A:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2009-03	R4#50bis	R4-091371			Skeleton		0.0.1
2009-10	R4#52bis	R4-093586			Agreed TPs in RAN4#51bis: R4-092299, "Radio scenarios for LTE Pico BS", Huawei R4-092590, "TP on MCL for Pico eNodeB", Huawei, CATT Agreed TPs in RAN4#52: R4-092809, "Text proposal on frequency error for Pico eNodeB", Huawei, CATT R4-093441, "TP on maximum output power for LTE pico NodeB", Huawei, CATT R4-093442, "TP on simulation assumptions for pico NodeB RF requirements", Huawei	0.0.1	0.1.0
2009-11	R4#53	R4-094611			Agreed TPs in RAN4#52bis: R4-094034, "Text proposal on receiver reference sensitivity for LTE Pico NodeB", Huawei, CATT R4-094035, "Text proposal on Unwanted emissions for LTE Pico NodeB" Huawei, CATT R4-094036, "Text proposal on blocking requirements for LTE Pico NodeB", Huawei	0.1.0	0.2.0
2009-11	R4#53	R4-094954			Agreed TPs in RAN4#53: R4-094304, "Pico eNode B transmitter spurious requirement", CATT R4-094613, "Co-location with other base stations for LTE Pico NodeB", Huawei R4-094856, "Text proposal for Pico eNode B performance requirement", CATT, Huawei R4-094308, "Pico eNode B receiver Inter-modulation requirement", CATT R4-094855, "Text proposal for Pico eNode B receiver dynamic range requirement", CATT, Huawei R4-094873, "Pico eNodeB receiver in channel selectivity requirement",CATT R4-094874, "Pico eNode B receiver ACS requirement", CATT, Huawei	0.2.0	0.3.0
2009-12	RAN#46	RP-091145			Presentation to TSG RAN for approval	0.3.0	2.0.0
2009-12	RAN#46				Approved version Note: Late delivery (2011-04) due to MCC oversight.	2.0.0	9.0.0

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