**Cover note for the Public Consultation on Draft ECC Report 297**

**Cover note for the Public Consultation on Draft ECC Report 297**

**Analysis of the suitability and update of the regulatory technical conditions  
for 5G MFCN and AAS operation in the 900 MHz and 1800 MHz bands**

This draft ECC Report 297 provides analysis of the changes needed to the technical conditions in ECC Decision (06)13 to enable the use of 5G and AAS in the 900 MHz and 1800 MHz MFCN bands. This first step in a two-part process follows the current approach to reference the 5G NR standard in order to enable a timely update to the technical conditions. The second step, planned for completion in June 2020, will introduce a technology neutral block edge mask to replace the existing technology references.

ECC decided in its meeting #47 on a work item for PT1 concerning the need for updating the technical conditions in ECC Decision (06)13 to enable a timely introduction of 5G and AAS, while ensuring adequate protection of other services and applications.

In line with the timeline defined by ECC, aiming at final approval of the revised Decision in March 2019, ECC PT1 finalised at its 60th meeting in Dublin, 17-21 September 2018, the draft revision of the ECC Decision (06)13, which has been submitted to ECC #49 for approval for public consultation.

In addition to updating the ECC Decision (06)13 ECC PT1 submitted to ECC #49 this draft ECC Report on the same topic for public consultation. Whereas the deliverable defined by ECC in the work item did not contain any specification of such a report, ECC believes that a companion report for the ECC Decision will be useful in explaining the modifications introduced in that document. It will also serve as an important basis for the future work on a CEPT report on the same topic in response to the new Commission mandate on this subject.

Views on the text of the ECC Report are requested during the public consultation.

Analysis of the suitability and update of the regulatory technical conditions for 5G MFCN and AAS operation in the 900 MHz and 1800 MHz bands

approved DD Month YYYY

ECC Report 297

# Executive summary

In its 5G roadmap, the CEPT highlights the need to assess the technical conditions for the 900 MHz and 1800 MHz, with the goal to ensure their suitability for 5G use and when applicable Active Antenna Systems (AAS).

This Report assessed the suitability of the current ECC Decision (06)13 [1] regulatory framework for the possible future usage of:

* 900 MHz band for 5G non-AAS technology including SUL mode of operation. AAS technology is not considered for the 900MHz band in this Report;
* 1800 MHz band for 5G (AAS and non AAS) including SUL mode of operation;
* 1800 MHz band for LTE-AAS.

The compatibility of such new technologies with current systems listed in the annexes 1 and 2 of the ECC Decision (06) 13 (GSM, UMTS, LTE, WiMAX and IoT cellular technologies) and adjacent band systems in 900/1800MHz bands have been evaluated in this Report and confirmed to be possible on similar basis as those concluded for LTE non-AAS in CEPT Report 40 [2], 41 [3] and 42 [4] and in ECC Report 266 [5]. The development of this Report followed the methodology used in previous ECC and CEPT reports and in particular CEPT Reports 40 and41.

It also accounted for the development of Active antenna systems support for both LTE and 5G NR BSs.

For the purpose of this report, Active Antenna System Technology for the BS will be referred to as AAS (LTE/NR) provided this technology is defined for LTE and for NR BSs and the related characteristics of both systems are generally aligned. AAS technology applies only to the BS side and not to the UE.

This report does not consider or propose a Block Edge Mask (BEM) approach to technical harmonisation for 900/1800MHz band.

In light with the results of the compatibility analyses, the report recommended updated ECC regulatory framework based on reference to ETSI harmonised standard of 5G (AAS and non-AAS) including SUL mode of operation and ETSI harmonised standard of LTE-AAS.

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LIST OF ABBREVIATIONS

|  |  |
| --- | --- |
| Abbreviation | Explanation |
| 3GPP | 3rd Generation Partnership Project |
| AAS | Active Antenna System |
| ACIR | Adjacent Channel Interference Ratio |
| ACLR | Adjacent Channel Leakage Ratio |
| ACS | Adjacent Channel Selectivity |
| ALD | Assistive Listening Device |
| BEM | Block Edge Mask |
| BS | Base Station |
| CBW | Channel Bandwidth |
| CDF | Cumulative Distribution Function |
| CEPT | European Conference of Postal and Telecommunications Administrations |
| DCA | Dynamic Channel Allocation |
| DCS | Dynamic Channel Selection |
| DECT | Digital Enhanced Cordless Telecommunications |
| DL | Downlink |
| DME | Distance Measuring Equipment |
| e.i.r.p. | Equivalent Isotropically Radiated Power |
| EC | European Commission |
| ECA | European Common Allocation |
| ECC | Electronic Communications Committee |
| E-GSM-R | Extended GSM-R |
| E-UTRA | Evolved Universal Terrestrial Radio Access |
| FDD | Frequency Division Duplex |
| FS | Fixed Service |
| GB | Guard Band |
| GSM | Global System for Mobile Communications |
| GSM-R | GSM - Railway |
| IMT | International Mobile Telecommunications |
| IoT | Internet of Things |
| ISD | Inter-Site Distance |
| L-DACS | L-band Digital Aeronautical Communication System |
| LRTC | Least Restrictive Technical Conditions |
| LTE | Long Term Evolution |
| LTE-eMTC | LTE evolved Machine Type Communications |
| LTE-MTC | LTE Machine Type Communications |
| M2M | Machine to Machine |
| MCL | Minimum Coupling Loss |
| MFCN | Mobile/Fixed Communications Network |
| MFCN | Mobile/Fixed Communications Networks |
| MIDS | Multifunctional Information Distribution System |
| MIMO | Multiple Input Multiple Output |
| MNO | Mobile Network Operator |
| MS | Mobile Station |
| MSR | Multi-Standard Radio |
| MTC | Machine Type Communications |
| NB-IoT | Narrowband IoT |
| NBN | Narrow Band Network |
| NR | New Radio |
| OBUE | Operating Band Unwanted Emissions |
| OOB | Out of Band |
| OOBE | Out of band emission |
| OTA | Over The Air |
| PAMR | Public Access Mobile Radio |
| PMR | Private Mobile Radio |
| PP | Portable Part |
| PRB | Physical Resource Block |
| RAN | Radio Access Network |
| RAT | Radio Access Technology |
| RB | Resource Block |
| RF | Radio Frequency |
| RFID | Radio Frequency Identification |
| RFP | Radio Fixed Part |
| RR | Radio Regulations |
| SA | Stand Alone |
| SCS | Sub-Carrier Spacing |
| SCS | Sub-Carrier Spacing |
| SDO | Standards Developing Organisation |
| SEM | Spectrum Emission Mask |
| SRD | Short Range Device |
| SUL | Supplemental Uplink |
| TRP | Total Radiated Power |
| TSG | Technical Specification Group |
| UE | User Equipment |
| UEM | Unwanted Emission Mask |
| UL | Uplink |
| UMTS | Universal Mobile Telecommunications System |
| UTRA | Universal Terrestrial Radio Access |
| WAN | Wide Area Network |
| WiMAX | Worldwide Interoperability for Microwave Access |

# Introduction

In this Report we have evaluated the suitability of 900 and 1800 MHz for the following technologies and systems support:

* Suitability of 900/1800MHz bands for 5G NR assuming non-active antenna systems;
* Suitability of 1800MHz band for Active antenna systems whether deployed with LTE BS or NR BS.

The development of this Report accounted for the development of the new radio interfaces (5G NR) that supports the new capabilities of IMT-2020 along with the enhancement of IMT-2000 and IMT-Advanced systems. It also accounted for the development of Active antenna systems support for both LTE and 5G NR BS.

The compatibility of such new technologies with in-band systems and adjacent band systems in 900/1800MHz bands has been evaluated. The development of this Report followed the methodology used in previous ECC and CEPT report and in particular CEPT Reports 40 [2] and41 [3].

# Existing Regulatory framework

## Existing Regulatory Framework for MFCN systems

### Band plan

The ‘900 MHz band’ means the 880-915 MHz and 925-960 MHz bands;

The ‘1800 MHz band’ means the 1710-1785 MHz and 1805-1880 MHz bands.

### Applicable technical conditions

The table below lists the relevant CEPT/ECC/EU documents for 900/1800MHz MFCN frequency bands.

Table : Band specific regulatory framework

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Band | Report | ECC Decision | EC Decision based on CEPT reports | Cross-border coordination |
| 900 (B8) | ECC Report 229 [6]  ECC Report 146 [7]  ECC Report 82 [8]  ECC Report 96 [9]  CEPT Report 40 [1]  CEPT Report 41 [3]  CEPT Report 42 [4]  ECC Report 266 [5] | ERC/DEC/(94)01 [10]ERC/DEC/(97)02 [11]  ECC/DEC(06)13 [1] | EC Decision 2011/251/EU [12]  EC Decision 2009/766/EC [13] | ECC/REC(05)08 [14]  ECC/REC(08)02 [15] |
| 1800 (B3) | ECC Report 146 [7]  ECC Report 82 [8]  ECC Report 96 [9]  ECC Report 146 [7]  CEPT Report 40 [1]  CEPT Report 41 [3]  CEPT Report 42 [4]  ECC Report 266 [5] | ERC/DEC/(95)03 [16]ECC/DEC(06)13 [1] | EC Decision 2011/251/EU [12]  EC Decision 2009/766/EC [13] | ECC/REC(05)08 [14]  ECC/REC(08)02 [15] |

The harmonised technical conditions from ECC and EC decisions applicable to 1800 and 900MHz MFCN band are summarised in table below:

Table 2: Overview of technical conditions in MFCN bands

|  |  |  |
| --- | --- | --- |
| Band | In-band | Adjacent bands |
| 900 MHz + 1800 MHz | EC Decision 2009/766/EC [13]  EC Decision 2011/251/EU [12]  Carrier separation of 5 MHz or more between two neighbouring UMTS networks  Carrier separation of 2.8 MHz or more between a neighbouring UMTS network and a GSM network  Frequency separation of 200 kHz or more between the LTE channel edge and the GSM carrier's channel edge.  No frequency separation between LTE channel edge and the UMTS carrier's channel edge.  No frequency separation between LTE channel edges between two neighbouring LTE networks.  ECC/DEC/(06)13 [1]  LTE MTC/eMTC: No specific requirements in addition to LTE and the applicable harmonised standards  NB-IoT Standalone mode: frequency separation of 200 kHz or more between the standalone NB-IoT channel edge of one network and the UMTS/LTE channel edge of the neighbouring network.  A frequency separation of 200 kHz or more between the standalone NB-IoT channel edge of one network and the GSM channel edge of the neighbouring network.  NB-IoT In band mode: No specific requirements in addition to LTE and the applicable harmonised standards  NB-IoT Guard band mode: A frequency separation of 200 kHz or more between the NB-IoT channel edge and the edge of the operator’s block, taking into account existing guard bands between operators’ block edges or the edge of the operating band (adjacent to other services). | No specific emission limits but recommendations on coordination, with the following systems, are available in various ECC/CEPT Reports as listed in the previous table:  -PMR/PAMR above 915 MHz,  -GSM-R in 876-880/921-925 MHz,  -Aeronautical systems above 960 MHz,  -Fixed Service operating above 1805 MHz |

## Adjacent band allocation and use

The coexistence between LTE and relevant adjacent services was analysed in CEPT Report 41 based on an analogy with UMTS systems. Detailed description systems adjacent to 900 and 1800 MHz bands can be found in CEPT Report 41 [3]:

* 900MHz adjacent systems: GSM-R/E-GSM-R, PMR/PAMR, Aeronautical Radionavigation (DME/L-DACS), Aeronautical Mobile Service Communication systems, MIDS (Military NATO);
* 1800 MHz adjacent systems: DECT, MetSat/Fixed-Telemetry (Weather Satellite, Defence) , radio microphones, fixed services.

# Suitability of the current technical framework for 5G

## Suitability of the current framework for 5G non-AAS systems

The 900 MHz and 1800 MHz bands are regulated for GSM/UMTS/LTE/WiMAX/IoT through reference to the respective ETSI harmonised standards.

As detailed in Annex 1, 3GPP generally defined for NR non AAS system transmit and receive characteristics (UE TS38.101-1 [17] and BS TS 38.104 [18]) that are generally comparable to those defined for LTE (UE TS36.101 [20] and BS TS 36.104 [21]) and used in compatibility analyses performed previously in CEPT e.g. CEPT Reports 40 and41 and ECC report 266. The only relevant difference identified is the NR higher spectrum utilisation for channel bandwidth (CBW) larger than 5MHz.

Since the in-band and out-of-band EIRP of the NR signal transmitted by the NR non-AAS base station does not exceed the limits which apply to LTE carrier, the NR signal does not create more interference, to other services in the same band or to adjacent band services, than an LTE signal occupying the same bandwidth and transmitting at the same power.

Regarding other adjacent services, some studies within the ECC framework already considered the fact that the mobile service does not occupy fully its bandwidth. Therefore, although the overall in-band and out-of-band powers of the signal may not change for NR compared to LTE assuming the same CBW, the higher spectrum utilisation of NR in CBW greater than 5MHz may be seen as additional source of interference by the victim receiver based on its ACS, in particular if the ACS of the victim receiver is not flat within the whole NR bandwidth. However, we show in the annex that the NR higher spectrum utilisation of NR channels larger than 5MHz fulfils by far the required 200 kHz channel edge frequency separation. Comparing the impact of LTE 5 MHz with NR 5/10/15/20/25/30 MHz on adjacent services, it is concluded that the impact of NR is not greater than the one of LTE 5 MHz and LTE 1.4 MHz, 3MHz. The available minimum guard band for each NR BS/UE CBW and sub-carrier spacing (SCS) is always larger than 200 KHz. This minimum guard band increases with the CBW and with SCS[[1]](#footnote-2).

A review of relevant existing adjacent band compatibility studies is described in the following section following similar logic used in ECC Report 266 for the evaluation of 900/1800 MHz MFCN bands suitability for IoT.

## Introduction of AAS BSs and TRP-based Emission requirements

The analyses in this section apply to 1800MHz but not to 900MHz as non-AAS is considered in the foreseeable future in 900MHz.

CEPT recently published CEPT Report 67 [19]. Studies have been performed to understand and better quantify the behaviour of AAS systems.

It was concluded that 4G and 5G AAS BSs are similar from a compatibility standpoint.

As already stated in CEPT Report 67, considerable efforts have been made by 3GPP to assess the effects of the AAS unwanted emissions on other mobile networks and to identify the appropriate metric for their characterisation. The different characteristics of the AAS systems in comparison with traditional sector or omnidirectional antennas were analysed in detail. 3GPP RAN4 technical group has therefore been considering the following approaches for AAS:

* In case of AAS In the context of E-UTRA, the existing single transceiver conducted unwanted emission masks in TS 37.104 [17] are scaled for the multi transceiver AAS in accordance with a value N, where N is a function of the number of active transmitter units per cell/sector and is capped at the value of 8. This approach is to align the AAS requirements to be equivalent to a multi-transceiver 8 way MIMO non-AAS system and is described in Section 6.6.5 of TS 37.105 [26].
* In case of AAS in the context of 5G-New Radio and LTE evolution, the unwanted emission masks are specified in TS38.104 as over-the-air (OTA). Furthermore, the OTA emission limits are specified as TRP. This is because 3GPP studies have indicated that harmful interference to adjacent mobile systems is primarily dictated by the TRP (rather than the e.i.r.p.) of a base station in any given cell or sector.

The AAS work in 3GPP has been captured in the technical report TR 37.842 [29]. Analysis was done assuming fully correlated interference (same case as non-AAS), completely de-correlated interference and half way in between.

The throughput impact of emissions from an AAS network to a legacy (non-AAS) victim network was analysed using simulations for the specific class of antenna arrays with specific elements spacing (that is described in section 5.4 of 3GPP TR 37.842). Different correlation properties between transmitters were simulated and the level of the AAS unwanted emissions were varied in order to observe the effect of correlation and emissions level of an AAS on a legacy (non-AAS) victim network. With the simulation assumptions used for the studies, 100% correlation implies that the unwanted emissions are beam-formed in the same manner as the wanted signal. Such correlation is likely only in very basic AAS systems and was included to ensure all cases were studied. 0% correlation implies that the unwanted emissions are not beam-formed but are radiated with the individual antenna element pattern.

It was found that the aggressor (AAS BS) total radiated unwanted emissions power was directly proportional to the victim network throughput degradation, independently of the correlation and hence the spatial pattern of the unwanted emissions. The results of these studies showed that, the level of correlation (and hence the spatial pattern of the emissions) does not impact the coexistence performance. Simulations have shown that the TRP would be an appropriate metric in assessing harmful interference since it would be independent of the effect of correlation level.

In other words, different BS implementations may lead to the same impact on a given victim system, meaning that limiting the BS implementation would not bring any benefit to the victim system and would only lead to less flexible and less efficient antenna solutions. Hence, the requirements should be independent of the correlation level of the unwanted emissions.

Based on the above it could be concluded that the introduction of AAS in 1800 MHz band impact should be analyses only for BS to other systems compatibility. No impact on UE to other systems compatibility.

## Outline of target regulatory framework

### 5G non-AAS system

3GPP generally defined for NR non-AAS system transmit and receive characteristics (UE TS 38.101-1 [17] and BS TS 38.104 [18]) that are generally comparable to those defined for LTE (UE TS 36.101 [20] and BS TS 36.104 [21]) and used in compatibility analyses performed previously in CEPT e.g. CEPT reports 40 [2], 41 [3] and ECC Report 266 [5]. The 5G non-AAS system characteristics are detailed in ANNEX 1: of this Report.

NR system will be covered by the NR Harmonised Standards: EN 301 908 part 24 [22] (NR BS) and EN 301 908 part 25 [23] (NR UE).

The only relevant difference identified between non-AAS LTE and NR is the NR higher spectrum utilisation for CBW larger than 5 MHz. There is also some apparent difference in BS reference sensitivity levels between NR and LTE. However, we explain in detail in ANNEX 1 that:

* The difference in sensitivity between NR and LTE is justified mainly by the difference in the Fixed Reference Channel definition used (Noise BW). However, the receiver performance could be considered roughly the same since for the same modulated BW, NR and E-UTRA sensitivity requirements are comparable (0.2 dB better performance for NR compared to LTE);
* The BS Noise figure used for both NR and E-UTRA is 5 dB.

Since the in-band and out-of-band EIRP of the NR signal transmitted by the base station does not exceed the limits which apply to LTE carrier, the NR signal does not create more interference, to other services in the same band or to adjacent band services, than an LTE signal occupying the same bandwidth and transmitting at the same power.

The only relevant difference is the NR higher spectrum utilisation for CBW larger than 5 MHz. However for these CBWs, the NR last in-band resources block edge to the NR channel edge is larger than the last in-band resource block of LTE 1.4, 3 and 5 MHz channels and always higher than 300 kHz. Therefore, the impact of NR due to adjacent receiver blocking capabilities is expected not to be larger than LTE 1.4, 3 and 5 MHz channels.

Therefore, the results from CEPT Reports 40 and 41 and ECC Report 266 for LTE and LTE + Guard-Band NB-IoT can be extended to NR non-AAS system and the same technical conditions as defined today for LTE non-AAS system in ECC Decision (06) 13 [1] should apply to NR non AAS-system in 900/1800 MHz bands.

### LTE AAS and 5G AAS systems

AAS functionality as defined in 3GPP for lower bands apply to the BS side only. The same UE conducted parameters/requirements defined by 3GPP apply whether the BS is AAS or non-AAS.

Therefore, the conclusions of CEPT Report 40 [2] and ECC Report 266 [5] regarding compatibility of LTE UE with other systems in the 1800 MHz band still apply to AAS (LTE/NR) 1800 MHz system's UE.

5G NR AAS BS parameters are specified in TS 38.104 [18] for single RAT NR operation and are also reflected in TS 37.105 [26] for MSR NR BS. The LTE-AAS (LTE evolutions AAS) BS parameters are specified in TS 37.105.

NR AAS system will be covered by the NR Harmonised Standards: EN 301 908 part 24 [22] (NR BS) and EN 301 908 part 25 (NR UE) [23].

LTE AAS system will be covered by the NR Harmonised Standards EN 301 908 part 23 (NR BS) [24]. The UE part of LTE is covered by ETSI EN 301 908-13 [25] which is the same as for non-AAS system.

As can be seen from ANNEX 2: below (where both NR-AAS and LTE-AAS parameters are detailed), the AAS RF requirements are comparable for both 5G NR AAS BS and LTE evolutions AAS BS. Therefore in the rest of the document we will refer to those as AAS (LTE/NR) system.

TS 37.105 provides the background for defining OTA AAS BS requirements. It states that for OTA AAS BS there are no conducted requirements. The radiated requirements have been derived in 3GPP based on the principle that they offer the same level of performance and protection as the hybrid AAS BS requirements.

The radiated requirements, therefore use the same equivalence as hybrid AAS BS. The non-AAS BS RF requirements have therefore been further adapted to apply to OTA metrics in the far field.

For AAS NR BS, the main OTA absolute Tx/Rx limits are defined over the air (OTA). These are derived based on scaling of existing basic (conducted) limits defined in NR TS 38.104 with a value X, where X = 9 dB, unless stated differently in regional regulation. This approach is described in sections 4.3.3 and 9.7 of TS 38.104.

TS38.104 states that for AAS BS the transceiver unit array must contain at least 8 transmitter units and at least 8 receiver units. Transmitter units and receiver units may be combined into transceiver units. The transmitter/receiver units have the ability to transmit/receive parallel independent modulated symbol streams.

3GPP uses for AAS the assumption of equivalence with a non-AAS system with the same number of TRX’s (capped to 8TRX). The scaling factor of 8 corresponding to 9dB (9dB=10log10(8)) comes originally from the maximum number of MIMO TRX achievable in the LTE RAN1 requirements and transmission modes. Hence, as non-AAS requirements are all defined per TRX then AAS is equivalent to 8 non AAS TRX. This is mainly the basis of the scaling for main OTA absolute power requirements.

Some "relative" requirements are direct references to the non-AAS BS RF specifications e.g. 3GPP TS 36.104 [21] and 3GPP TS 37.104 [27]. Some co-location requirements which have been developed from assumptions on BS-to-BS coupling do not have direct OTA equivalents.

For LTE AAS BS the scaling factor used is a function of the number of active transmitter units for the whole antenna panel and is capped at the value of 8. This approach is described in Section 6.6.5 of TS 37.105 [26].

# coexistence studies

This section discusses the technical compatibility of NR technology and provides an overview of compatibility requirements in terms of:

* Compatibility with other in-band applications;
* Compatibility with other radio systems operating in adjacent bands.

## In-band coexistence

### In-band coexistence for 5G non-AAS system in 900 and 1800MHz bands

The coexistence between LTE and WiMAX/UMTS/GSM systems was analysed in CEPT Report 40 [2]based on an analogy with UMTS systems. This was completed by the analyses in ECC Report 266 regarding IoT systems compatibility with the systems above. Considering the case when LTE is used in combination with Guard-band NB-IoT, the final conclusion was frequency separation of 200 KHz between the NB-IoT transmitted bandwidth and the edge of the LTE channel.

For the non AAS case 3GPP defined for NR BS and UE similar RF requirements as those defined for LTE non AAS.

Regarding the higher spectrum utilisation of NR compared to LTE for CBW >5MHz, the edge of the transmitted BW is always placed more than 300 kHz away from the NR channel edge. This fulfils the 200 KHz criteria that were set up for LTE in previous studies. NR is not using 1.4 or 3MHz bandwidth.

LTE + Guard band NB-IoT operation could be compared to NR operation due to the higher spectrum utilisation for CBW >5MHz.

Considering the fact that the same RF requirements (TX and RX) as for LTE were reused generally for NR and the fact that the frequency spacing between the NR transmitted BW and the edge of the NR channel is always >200 kHz, the results of CEPT report 40 and ECC Report 266 [5] on the compatibility of LTE and LTE + Guard-Band IoT systems with other systems in the same band (namely GSM, UMTS, LTE, WiMAX and IoT systems) can be extended to NR and the same technical regulatory conditions applicable to LTE should apply to ensure coexistence between NR non-AAS system and other systems in the same band.

### In-band coexistence for 5G AAS system in 1800MHz bands

#### Co-existence between AAS (LTE/NR) system and GSM/UMTS

The coexistence between LTE-non-AAS and GSM systems was analysed in CEPT Report 40 [2] based on an analogy with UMTS systems.

Similar methodology is followed here for AAS (LTE/NR) systems based on an analogy between AAS (LTE/NR) and LTE-non-AAS and taking into account the assumption of equivalence based on 8TRX considered in 3GPP to derive the main absolute OTA RF requirements (AAS BS) based on conducted RF requirements (non-AAS BS).

Downlink ACIR from AAS (LTE/NR) to GSM/UMTS DL

AAS (LTE/NR) ACLR/200 kHz at 300 kHz frequency separation from the channel edge are calculated from the BS spectrum mask, assuming the principle of equivalence with a non-AAS-BS with 8TRX used in 3GPP to derive both BS Transmit power and OBUE for AAS(LTE/NR) BS.

The calculation of GSM ACS values at different frequency offsets is described in Annex 3 of CEPT Report 40. These ACS values are considered to be applicable here for coexistence with LTE/NR system.

Then ACIR was calculated in CEPT Report 40 [2] with the formula below:

ACIR = 1/{1/ BS ACLR + 1/GSM MS ACS }

This formula is reused here:

ACIR = 1/{1/AAS BS ACLR + 1/GSM MS ACS }

The ACLR of the AAS (LTE/NR) BS is calculated based on the AAS(LTE/NR) OTA TX power (A2.2) and the AAS(LTE/NR) OTA OOBE (A2.4).

As detailed in 4.1.2.2, 3GPP conducted simulations in TR 37.840 [28] and TR 37.842 [29], that show that Cell average and 5% CDF throughput loss caused by aggressor AAS Legacy victim are consistent with that caused by legacy LTE-non-AAS BS to Legacy BS with the same ACLR.

It is further explained in 3.3.2 and detailed in ANNEX 2: of this report, for AAS NR BS, the main OTA absolute TX/RX limits including OTA TX power and OTA OOBE are defined over the air (OTA). These are derived based on scaling of existing basic (conducted limits for non-AAS BS with 1 TRX) limits defined in NR TS 38.104 [18] with a value X, where X = 9 dB, unless stated differently in regional regulation. This approach is described in section 4.3.3 and 9.7 of TS 38.104.

Since the same scaling factor of 9dB applied to both the AAS (LTE/NR) BS Transmit power and to its OBUE the ACLR/200KHz at 300KHz can be considered as equivalent to the ACLR for LTE-non-AAS BS and is equal to 50dB (43dBm+9dB -7 (OOBE integrated over 200KHz)+9dB)).

Table 3: AAS (LTE/NR) BS ACLR/200 kHz at 300 kHz frequency separation from channel edge

|  |  |  |  |
| --- | --- | --- | --- |
|  | BS ACLR  (dB/200 kHz) | GSM MS ACSn (dB) | ACIR (dB) |
| AAS (LTE/NR) (5 MHz) | 50 | 68.7 | 49.9 |
| AAS (LTE/NR) (10 MHz) | 50 | 78.7 | 50.0 |
| AAS (LTE/NR) (15 MHz) | 50 | 78.7 | 50.0 |
| AAS (LTE/NR) (20 MHz) | 50 | 78.7 | 50.0 |

It can be seen from the table above that the ACIR from AAS (LTE/NR) BS to GSM DL is dominated by AAS (LTE/NR) BS ACLR, the contribution from GSM ACS to ACIR is negligible.

Similar analyses are provided here for UMTS

Table 4: BS ACLR/3.84 MHz at 2.5 MHz frequency separation from channel edge

|  |  |  |  |
| --- | --- | --- | --- |
|  | BS ACLR  (dB/3.84 MHz) | UMTS UE ACS  (dB/3.84 MHz) | ACIR (dB/3.84 MHz) |
| LTE (5 MHz) | 48.6 | 33 | 32.9 |
| LTE (10 MHz) | 48.6 | 33 | 32.9 |
| LTE (15 MHz) | 48.6 | 33 | 32.9 |
| LTE (20 MHz) | 48.6 | 33 | 32.9 |

The ACLR of AAS(LTE/NR) BS have been calculated from the OTA related spectrum mask, GSM/UMTS ACS.

The derived ACIR from AAS (LTE/NR) to GSM and UMTS DL are similar to those calculated for LTE-Non-AAS. Therefore we assume that the conclusions from CEPT Report 40 [2] apply regarding the necessary frequency separation between LTE and GSM/UMTS.

Uplink ACIR from AAS (LTE/NR) UE to GSM/UMTS

The UE ACLR/200 kHz at 300 kHz frequency offset from the channel edge for AAS(LTE/NR) system is the same as for LTE-non-AAS system. Indeed, the AAS feature is only applicable to the BS. Therefore, the same conclusions from CEPT Report 40 [2] apply for compatibility between AAS (LTE/NR) Uplink and GSM/UMTS.

Interference from GSM to AAS (LTE/NR)

The coexistence between LTE-non-AAS and GSM systems was analysed in CEPT Report 40 [2] based on an analogy with UMTS systems. However, the UMTS and GSM co-existence study results given in 3GPP Report TR 25.816 [30] and ECC Report 82 [8] show that the dominant factor of interference from GSM to UMTS is the UMTS BS and UE receiver blocking performance.

Comparison between AAS(LTE/NR) system and LTE systems narrowband blocking for BS and UE :

As could be seen from Annex 2 the OTA narrow band blocking of AAS LTE BS is defined as:

Table 5: OTA narrow band blocking of AAS LTE BS

|  |  |  |  |
| --- | --- | --- | --- |
|  | Wanted signal mean power [dBm]  (NOTE) | Interfering signal mean power [dBm] | Type of interfering signal |
| Wide Area BS | EISREFSENS + 6dB | -49 – ΔOTAREFSENS | See table 10.5.4.2-2 of TS38.104 [18] |
| EISminSENS + 6dB | -49 – ΔminSENS |
| Medium Range BS | EISREFSENS + 6dB | -44 – ΔOTAREFSENS | See table 10.5.4.2-2  of TS38.104 [18] |
| EISminSENS + 6dB | -44 – ΔminSENS |
| Local Area BS | EISREFSENS + 6dB | -41 – ΔOTAREFSENS | See table 10.5.4.2-2  of TS38.104 [18] |
| EISminSENS + 6dB | -41 – ΔminSENS |
| NOTE: EISREFSENS and EISminSENS depend on the RAT, the BS class and on the channel bandwidth, see subclauses 10.3 and 10.2 of TS38.104 [18]. | | | |

TS37.105 [26] provides the following definitions for these Δ:

* ΔminSENS = PREFSENS – EISminSENS
* ΔOTAREFSENS = PREFSENS -EISREFSENS

As we can see, the interference signal mean power is tested over 2 points. One that is shifted by ΔOTAREFSENS and the second shifted by ΔminSENS compared to LTE non AAS Interfering signal mean power.

The relative wanted signal mean power defined for LTE AAS BS is respectively a function of EISREFSENS and EISminSENS and is also shifted by the same ΔOTAREFSENS and ΔminSENS compared to LTE non AAS relative wanted signal mean power.

Therefore, provided the following comparison between Narrowband blocking definition for LTE-AAS and LTE non-AAS BS:

* The testing wanted and interfering signals power for LTE-AAS BS narrow band blocking are shifted by the same Δ compared to LTE-non-AAS case (relative value is the same);
* the same desensitisation value (6dB) is used for AAS and non-AAS;
* generally comparable Interfering RB centre frequency offset to the lower/upper Base Station RF Bandwidth edge and types of interfering signals are used for AAS and non-AAS.

We conclude that the rejections (ACS relative) of the AAS LTE BS receiver at 300 kHz frequency offset derived from narrow band blocking is the same as for LTE-non-AAS BS.

Regarding NR AAS BS as explained in detail in Annex 2, there are some apparent differences in the absolute value for the Reference sensitivity level defined for NR AAS BS in TS38.104 [18] compared to LTE in TS37.104 [27] for CBW >15 MHz. However, the AAS NR BS receiver performance could be considered to be essentially the same as for AAS LTE since for the same modulated BW, AAS NR and AAS LTE sensitivity requirements are comparable (0.2dB better performance for NR compared to LTE).The difference is only due to:

* Different Fixed Reference Channels defined for NR and for LTE in particular the noise bandwidth of the FRC changes as explained below.
* Small differences in the required SNR for demodulation – this is a minor effect 0.2dB better NR performance compared to LTE for same FRC BW

The AAS (LTE/NR) and LTE non-AAS BS receiver rejections derived from the narrow band blocking characteristics defined in 3GPP technical specifications were compared above. Based on that the AAS LTE, AAS NR and receiver rejection could be considered as equivalent for the same modulated Bandwidth at 300 kHz frequency offset from LTE/NR channel edge.

The narrow band blocking levels and related receiver rejection for the UE in AAS (LTE/NR) system is comparable to LTE UE.

Therefore, based on the above UE and BS narrowband blocking analyses, we can conclude that, similar to LTE-non-AAS, a recommended frequency separation of 300 kHz between GSM carrier frequency and AAS (NR/LTE) channel edge can be proposed, or alternatively 200 kHz separation between GSM and AAS (LTE/NR) channel edges.

Interference from GSM to AAS (LTE/NR)

3GPP TR 37.840 does not contain any results on interference from UMTS to AAS (LTE/NR). However, UMTS is not a worse interferer than LTE-non-AAS itself, so the results of interference between LTE-non-AAS and AAS (LTE/NR), in the section below, are sufficient to show that UMTS will not cause excessive interference to AAS (LTE/NR).

Conclusion

Following the observations above, and considering:

* that OOBE requirements and Narrow band blocking requirements of AAS (LTE/NR) were derived based on the principle of equivalence between AAS system with non-AAS system with the same number or TRX’s (capped at 8);
* that based the above analyses of ACLR and blocking, we understand the same technical conditions should apply for coexistence between AAS (LTE/NR) and UMTS/LTE systems;
* that for NR system the minimum CBW is 5 MHz and the minimum guard band between the last transmitted RB and the edge of the operating channel is always higher than 200 kHz.

As a consequence there is a need for a frequency separation of 200 kHz or more between the NR/LTE AAS channel edge and the GSM carrier's channel edge. This requirement is already fulfilled by the NR AAS specification due the channel characteristics of NR (5 MHz or above channel bandwidth) and related minimum guard band as defined in 3GPP specifications.

Similarly to LTE non-AAS, there also no need for frequency separation between NR/LTE AAS channel edge and the UMTS carrier's channel edge

#### Co-existence between AAS (LTE/NR) systems and between AAS (LTE/NR) system and LTE/NR-non-AAS systems at 1800 MHz

The co-existence between AAS (LTE/NR) system and LTE/NR-non-AAS (Legacy passive Antenna System) systems has been studied at 2 GHz. The simulations assumptions and results are reported in AAS study item TR 37.840 [28] and AAS work item TR 37.842 [29].

These simulations results are based on the assumption of a 10 MHz aggressor system, and 10 MHz victim system, 2 GHz frequency band was used in the simulations and macro cells (cell range 750 m) in an urban area with uncoordinated deployment.

To define ACLR value for AAS BS system simulations evaluated the downlink average and 5% CDF throughput loss of the victim system while coexisting with the adjacent system by varying ACLR value.

Simulation cases as shown in the table below were applied for evaluating in-band blocking and ACLR for AAS BS:

Table 6: Simulation cases for in-band blocking in TR 37.840 [28]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Case | Aggressor | Victim | Simulated link | Statistics |
| 1-a | Legacy E-UTRA  Macro system | AAS E-UTRA Macro system | Uplink | Interferer levels at victim BS |
| 1-b | AAS E-UTRA  Macro system | AAS E-UTRA Macro system | Uplink | Interferer levels at victim BS |
| 1-c(Baseline) | Legacy E-UTRA  Macro system | Legacy E-UTRA Macro system | Uplink | Interferer levels at victim BS |

Table 7: Simulation cases for ACLR in TR 37.840 [28]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Case | Aggressor | Victim | Simulated link | Statistics |
| 1-a | AAS E-UTRA Macro system | Legacy E-UTRA  Macro system | Downlink | Throughput loss |
| 1-b | AAS E-UTRA  Macro system | AAS E-UTRA Macro system | Downlink | Throughput loss |
| 1-c(Baseline) | Legacy E-UTRA  Macro system | Legacy E-UTRA Macro system | Downlink | Throughput loss |

Based on the above simulation in TR37.840, 3GPP concluded that Cell average and 5% CDF throughput loss caused by aggressor AAS Legacy victim are consistent with that caused by legacy non-AAS BS to Legacy non-AAS BS with the same ACLR (per connector) assumption of 45 dB.

3GPP also concluded based on the preliminary simulations above for a single column AAS system that the blocking power level for each individual receiver channel of the AAS system was similar to the in-band blocking level for a legacy BS installed with an assumed typical reference passive antenna array.

On top of the above simulations, a downlink co-existence simulation campaign was performed by 3GPP in TR37.842 [29] with the objective of establishing whether the radiated adjacent channel emissions pattern for an AAS BS aggressor system, which differs from a non-AAS BS aggressor system, impact co-existence KPIs such as mean and 5th percentile throughput losses in the context of the co-existence simulation framework of 3GPP TR 25.942 [31].

Co-existence characteristics were studied in a macro scenario in which cell specific beamforming was performed. This scenario is directly comparable with the simulations performed when deriving the existing LTE-non-AAS ACLR and ACS requirements as outlined in 3GPP TR 36.942 [32].

Cell specific beamforming creates static patterns of interference that differ between AAS BS and non-AAS BS. Other types of beamforming, such as user specific beamforming create patterns which are time varying and are composed of intermodulation between multiple beams. Cell specific beamforming thus represents a worst-case spatial interference behaviour, since its radiated pattern is not averaged across multiple beams or in time.

Besides, an uplink simulation was performed by 3GPP with the objective of establishing blocking levels that are likely to be encountered by an AAS BS victim system within the context of the 3GPP TR 36.942 framework. The blocking simulations were performed using the same system scenario as that used to derive the legacy LTE-non-AAS blocking requirements.

Table 8: Simulation cases for ACLR in TR 37.842 assuming Horizontal/vertical cell splitting

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Case | Aggressor | Victim | Simulated link | Statistics | Target RF requirement |
| 1a\_1 | AAS E-UTRA Macro system: Horizontal cell splitting; | Legacy E-UTRA Macro system: no cell splitting; | Downlink | Throughput loss | ACLR |
| 1a\_2 | AAS E-UTRA Macro system: Vertical cell splitting; | Legacy E-UTRA Macro system: no cell splitting; | Downlink | Throughput loss | ACLR |
| 1b\_1 | AAS E-UTRA Macro system: Horizontal cell splitting; | AAS E-UTRA Macro system: Horizontal cell splitting; | Downlink | Throughput loss | ACLR |
| 1b\_2 | AAS E-UTRA Macro system: Vertical cell splitting; | AAS E-UTRA Macro system: Vertical cell splitting; | Downlink | Throughput loss | ACLR |
| 1c(Baseline) | Legacy  E-UTRA Macro system | Legacy  E-UTRA Macro system | Downlink | Throughput loss | ACLR |

Table 9:Simulation cases for In-band Blocking in TR37.842 [29] assuming Horizontal/vertical cell splitting

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Case | Aggressor | Victim | Simulated link | Statistics | Target RF requirement |
| 2a | Legacy E-UTRA Macro system | AAS E-UTRA Macro system: Horizontal cell splitting | Uplink | Interferer levels at victim BS | In-band blocking |
| 2b(Baseline) | Legacy  E-UTRA Macro system | Legacy  E-UTRA Macro system | Uplink | Interferer levels at victim BS | In-band blocking |

Table 10: Simulation cases for ACLR in TR37.842 [29] assuming UE beamforming

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Case | Aggressor | Victim | Simulated link | Statistics | Target RF requirement |
| 3a | AAS E-UTRA Macro system: UE beamforming | AAS E-UTRA Macro system: UE beamforming | Downlink | Throughput loss | ACLR |
| 3b | AAS E-UTRA Macro system: UE beamforming | Legacy  E-UTRA Macro system | Downlink | Throughput loss | ACLR |
| 3c | Legacy  E-UTRA Macro system | AAS E-UTRA Macro system: UE beamforming | Downlink | Throughput loss | ACLR |
| 3d(Baseline) | Legacy  E-UTRA Macro system | Legacy  E-UTRA Macro system | Downlink | Throughput loss | ACLR |

Based on these simulations it was concluded that in all of the cell and user specific scenarios that were modelled, the spatial pattern of an AAS BS aggressor system did not increase the mean or 5th percentile throughput loss in the victim system beyond what is experienced with a passive system. Therefore it is concluded that the existence of a different spatial distribution of adjacent channel interference that arises from an AAS BS compared to non-AAS BS does not necessitate any additional type of requirement.

Furthermore, the simulations indicated that the existing relative ACLR requirement of 45 dB can be applied per transceiver or across all transceivers for an AAS BS.

Therefore, for AAS (LTE/NR) BS in single RAT E-UTRA operation in TS 37.105 [26], the OTA ACLR limits were defined by 3GPP as ratio of the total wanted signal power at all TAB connectors to the total power at all connectors of adjacent channel power and correspond to 45 dBc which is the same as the requirement specified in 3GPP TS 36.104 [21] for LTE-non-AAS and TS 38.104 [18] for NR-non-AAS per antenna connector.

For AAS (LTE/NR) the ACLR absolute limits from LTE-non-AAS and NR-non-AAS were replaced by OTA values that are scaled with a factor of 9 dB (considering 8TRX for AAS BS). Indeed the non-AAS requirement forms a basic limit, which is scaled up to an AAS BS requirement according to the number of active transceiver units, up to a maximum 8 for AAS BS. This is detailed below in ANNEX 2 of this report.

Besides it was concluded based on the above simulations that the minimum ACS requirements for the AAS BS are specified to correspond to the wanted signal power and adjacent channel signal power at the transceiver array boundary using the same: adjacent channel signal types, interfering signal power levels, wanted signal power levels, and test configuration for target throughputs as the non AAS BS adjacent channel selectivity requirements in 3GPP.

Based on the above compatibility results from 3GPP there is no need for frequency separation between NR/LTE AAS system and NR/LTE non-AAS neighbouring network in 900/1800MHz frequency bands. The same applies for NR/LTE 1800 MHz AAS coexistence with neighbouring LTE/NR 1800 MHz whether it is AAS or non AAS.

#### Co-existence between AAS (LTE/NR) systems and IoT systems

Generally speaking for In-band coexistence it is the systems relative ACLR performance which dominates interference to adjacent systems.

This can be seen if we take the unwanted emission mask (UEM) for LTE (ref: TS 37.104 [27], Table 6.6.4.1-1)

Table 11: Unwanted emission mask (UEM) for LTE (ref: TS 37.104 [27], Table 6.6.4.1-1)

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency offset of measurement filter ‑3dB point, Δf** | **Frequency offset of measurement filter centre frequency, f\_offset** | **Minimum requirement (Note 1, 2)** | **Measurement bandwidth (Note 7)** |
| 0 MHz ≤ Δf < 0.2 MHz | 0.015MHz ≤ f\_offset < 0.215MHz | -14 dBm | 30 kHz |
| 0.2 MHz ≤ Δf < 1 MHz | 0.215MHz ≤ f\_offset < 1.015MHz | (Note 4) | 30 kHz |
| (Note 6) | 1.015MHz ≤ f\_offset < 1.5 MHz | -26 dBm (Note 4) | 30 kHz |
| 1 MHz ≤ Δf ≤  min(Δfmax, 10 MHz) | 1.5 MHz ≤ f\_offset < min(f\_offsetmax, 10.5 MHz) | -13 dBm (Note 4) | 1 MHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.5 MHz ≤ f\_offset < f\_offsetmax | -15 dBm (Note 4, 8) | 1 MHz |

If this is normalised to 30 kHz we get the following

Figure : Wide area UEM

For a 10 MHz channel the average power in the adjacent channel is approximatively -26.5dBm/(30 kHz) or -11.3 dBm/MHz in 1 MHz.

This is higher than the ACLR requirement of 45 dBc (or -13 dBm/MHz), and hence the ACLR dominates.

The purpose of the UEM mask is to ensure that the distribution of the adjacent channel power is appropriate across the adjacent channel.

An AAS BS with for example 43dBm output power will therefore emit exactly the same adjacent channel emissions as a non-AAS system of the same output power. This is irrespective of the number of non-AAS transceivers as the dominant requirement is the relative requirement.

It has been shown in 3GPP compatibility studies that the effect on adjacent network throughput for an AAS system is the same as that for a non-AAS system with the same ACLR performance.

It is also important to note that for NR the minimum channel bandwidth is 5MHz and that the guard band between NR transmission bandwidth and the operating channel edge is always higher than 200MHz.

It can therefore be concluded that the NR/LTE AAS system will provide the same level of co-existence with NB-IoT, LTE MTC/eMTC and EC-GSM-IoT, as for an LTE non-AAS system. In particular:

For NB-IoT:

* Standalone mode: A frequency separation of 200 kHz or more between the standalone NB-IoT channel edge of one network and the NR/LTE AAS channel edge of the neighbouring network;
* In band mode: No specific requirements for NR/LTE AAS system in addition to LTE non AAS system (Note 2) and the applicable harmonised standards;
* Guard band mode: A frequency separation of 200 kHz or more between the NB-IoT channel edge and the edge of the operator’s block, taking into account existing guard bands between operators’ block edges or the edge of the operating band (adjacent to other services);

For LTE MTC/eMTC: No specific requirements for NR/LTE AAS system in addition to LTE non AAS system and the applicable harmonised standards.

For EC-GSM-IoT: No specific requirements for NR/LTE AAS system in addition to GSM (note 1) and the applicable harmonised standards[[2]](#footnote-3)

## Adjacent band coexistence

### Adjacent band coexistence for 5G non-AAS system in 900 and 1800MHz bands

The sections below address compatibility studies between NR systems and adjacent services/applications in particular in the 900 MHz band, however the same justification and rational applies to compatibility for 1800MHz band with adjacent systems.

#### Interference of 5G non-AAS system into adjacent services in 900 and 1800MHz bands

The coexistence between LTE and relevant adjacent services was analysed in CEPT Report 41 [3] based on an analogy with UMTS systems. The report covers the following systems

900MHz adjacent systems: GSM-R/E-GSM-R, PMR/PAMR, Aeronautical Radionavigation (DME/L-DACS), Aeronautical Mobile Service Communication systems, MIDS (Military NATO)

1800 MHz adjacent systems: DECT, MetSat/Fixed-Telemetry (Weather Satellite, Defence), radio microphones, fixed services

This was completed by the analyses in ECC Report 266 [5] regarding IoT systems. Considering the case when LTE is used in combination with Guard-band NB-IoT, the final conclusion was a frequency separation of 200 kHz between the NB-IoT Transmitted bandwidth and the edge of the LTE channel.

3GPP defined for NR BS and UE similar TX and RX requirements as those defined for LTE and used in CEPT Report 41.

Regarding the higher spectrum utilisation of NR compared to LTE for CBW >5MHz, the edge of the transmitted BW is always placed more than 300 kHz away from the NR channel edge. This fulfils the 200 kHz criteria that were set up for LTE in previous studies. NR does not use 1.4 or 3MHz bandwidth.

Therefore, the results of CEPT Report 41 and ECC Report 266 for compatibility between LTE and LTE + Guard-Band IoT and adjacent systems can be extended to the NR system operation in 900/1800 MHz MFCN bands.

More particularly regarding 900 MHz, as shown in the figure below:

* MFCN band: UL occupies 880-915 MHz and DL occupies 925-960 MHz
* GSM-R DL occupies 921-925 MHz

Unlicensed SRDs occupy the 915-921 MHz band.



Figure : Frequency arrangement in 880-960 MHz

915-921 MHz is regulated as unlicensed band, used by multiple applications: RFID, SRDs 100 mW, SRDs 25 mW, ALD, etc. [33]

Based on the addendum report [34] to CEPT Report 59, it is clearly stated that:

“Article 3 of Commission Implementing Decision (2006/771/EC [35] latest amended by 2013/752/EU [36]) on harmonisation of the radio spectrum for use by short-range devices requires that “Member States shall designate and make available, on a non-exclusive, non-interference and non-protected basis, the frequency bands for the categories of short-range devices, …”.

Article 2 of this Decision defines that “ ’non-interference and non-protected basis’ means that no harmful interference may be caused to any radio communications service and that no claim may be made for protection of these devices against harmful interference originating from radio communications services.”

In addition, it is highlighted in recital-3 of EC Decision 2006/771/EC that “… radiocommunications services, as defined in the International Telecommunications Union Radio Regulations, have priority over short-range devices and are not required to ensure protection of particular types of short-range devices against interference.”

Based on this principle, ECC Report 246 has not studied the interference from the 900 MHz cellular systems (GSM/UMTS/LTE) to SRDs (RFID, WAN NBN, etc.), but studied only the interference from SRDs (RFID, WAN NBN, etc.) to the cellular systems uplink. In the ECC Report 246 on the interference from SRDs to cellular system, LPWAN was not considered.

In the particular case of LTE/WiMAX DL and GSM-R DL coexistence at 925 MHz, according to CEPT Report 41 [3], the frequency separation between the nearest GSM-R channel centre frequency and LTE/WiMAX channel edge should be at least 300 kHz (200 kHz between channel edges).

In order to analyse the impact of NR on adjacent services, interference from NR out-of-band emissions and blocking impact of the victim receiver in adjacent bands should be considered.

Regarding the impact of out-of-band emissions of NR, as stated previously, the out of band emission of NR are generally similar to OOB emission of LTE thus there is no additional impact on adjacent services from NR system.

With respect to the blocking impact of the victim receiver, we have highlighted previously that the distance (offset) from the last NR RB edge and edge of the NR CBW >5 MHz is larger than the last in-band resource block of LTE 1.4, 3, 5 MHz channels ( and is at least 242.5 kHz for the 5MHz channel). Therefore, the impact of NR due to adjacent receiver blocking capabilities is not larger than LTE 1.4, 3, 5 MHz channels.

Based on the above analyses the results of CEPT report 41 and ECC report 266 on the compatibility of LTE and LTE + Guard Band IoT systems with adjacent systems in 1800/900 MHz bands can be extended to NR non-AAS systems and the same technical regulatory conditions applicable to LTE should apply to ensure compatibility with NR non-AAS.

#### Interference of adjacent services into 5G non-AAS system in 900 and 1800MHz bands

The co-existence between LTE 900 and GSM-R at 925 MHz was described in CEPT Report 41 [3]. CEPT Report 41 concludes that there is no need for additional guard-band between LTE 900 and GSM-R, whatever the channelisation or bandwidth considered for LTE 900. Therefore a frequency separation of 200 kHz between channel edges was considered to be sufficient for the compatibility between LTE 900 and GSM-R.

Given that the receiver characteristics of NR are similar to those of regular LTE receivers, it is expected that the behaviour of both receivers is the same. Therefore the conditions of operation of NR are expected to be similar to those of LTE.

In ECC Report 246 [33], the interference from all SRDs (Wideband IoT 802.11ah, RFID, ALD, generic SRDs 25 mW) operation in 915-921 MHz to cellular system (GSM/UMTS/LTE) uplink below 915 MHz was studied with Monte-Carlo simulations. But NR system was not specified at that stage.

The simulation results show that the cellular system data service capacity/throughput loss caused by SRDs/IoT operations above 915 MHz depends on the SRD/IoT devices density and duty cycle. Under the assumption that SRDs operate at their regulatory duty cycle limits and high density as assumed, cellular system uplink capacity/throughput loss can be more than 20%.

Given that the receiver characteristics of NR are similar to those of LTE receivers (See Annex 1), it is expected that the behaviour of both receivers is the same and therefore the results of CEPT Report 41 for LTE should apply to NR non-AAS system and potential interference from adjacent systems to 900/1800MHz NR would be similar to LTE.

### Adjacent band coexistence for 5G AAS system in 1800MHz bands

In this section we have used generally similar methodology as the one used in CEPT Report 41 to evaluate compatibility between LTE-non-AAS systems and adjacent systems.

#### Compatibility study between LTE/WiMAX1800 and DECT

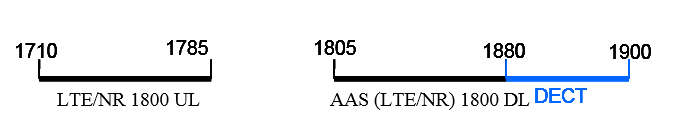


Figure 3: DECT frequency band is adjacent to 1800 DL

As shown in the figure above, the DECT frequency band 1880-1900 MHz is adjacent to the AAS (LTE/NR) 1800 downlink block 1805-1880 MHz band. The adjacent band compatibility study was intensively studied between DECT and LTE-non-AAS in CEPT Report 41 [3]. The adjacent band compatibility study between DECT and DCS1800 is described in ERC Report 31 [37], ERC Report 100 [38] and ECC Report 146 [7]

In order to evaluate the interference from the mobile system onto the DECT system, all previous studies assumed 5 MHz channel;

Similar methodology as the one used in CEPT Report 41 [3] for LTE/DECT compatibility will be followed here for AAS (LTE/NR).

The upper AAS (LTE/NR) carrier centred onto 1877.5 MHz and the lowest DECT channels are considered, since this configuration represents the worst case in terms of coexistence, in line with the previous simulations.



Figure 4: Channels under consideration

The interference is evaluated by calculating ACS and ACLR figures in a similar manner to the methodology used in CEPT Report 41 to analyse compatibility between LTE/WiMAX non AAS and DECT systems

In the following, the evaluation of the DECT blocking response and the AAS (LTE/NR) 1800 unwanted emissions will be assessed through respectively the DECT ACS and AAS (LTE/NR) OTA ACLR figures.

ACS figures for DECT derived from CEPT Report 41

CEPT Report 41 [3] derived approximate DECT ACS figures for a 5 MHz LTE interferer at 1877.5 MHz. The DECT adjacent channel closest to the LTE block is at 1880.064 MHz. The first DECT adjacent channel within the LTE block is at 1878.236 MHz (see Figure 1). This adjacent channel was used to derive the ACS figures in the following table:

Table 12: DECT ACS figures related to an LTE interferer

|  |  |
| --- | --- |
| DECT carrier | ACS figures (dB) related to 5 MHz LTE at 1877.5 MHz |
| F9 | 45 |
| F8 | 51 |
| F7 – F0 | 58 |

These figures same ACS figures can be reused and are valid for AAS (LTE/NR) 5MHz channel.

ACLR figures for AAS (LTE/NR) derived from TS 37.105:

The ACLR figures for AAS (LTE/NR) related to a 1 MHz wide DECT receiver are shown in the following table. The AAS BS OTA TX power of 52dBm was derived based on scaling of the LTE-non-AAS BS Transmit power of 43dBm from CEPT Report 40 [2]scaled by a factor of 9 dB to account for the equivalence with a non-AAS system of 8TRX as explained in sections 3.3.2 and A2.2 of this Report based on 3GPP:

Table 13: AAS (LTE/NR) OTA ACLR related to a DECT 1 MHz receiver

|  |  |  |
| --- | --- | --- |
| DECT carrier | AAS (LTE/NR) OTA Out of band/block interference level | AAS (LTE/NR) OTA ACLR figures (dB) related to a 1 MHz DECT receiver and BS  OTA/Radiated Tx power 52 dBm |
| F9 (1881.792MHz) | -4 dBm/MHz | 56 |
| F8 (1883.52 MHz) | -4 dBm/MHz | 56 |
| F7 (1885.248 MHz) | -4 dBm/MHz | 56 |
| F6-F5 | -4 dBm/MHz | 56 |
| F4 (1890.432 MHz) | -21/-30 dBm/MHz | 73/82 |
| F3-F0 | -21/-30 dBm/MHz | 73/82 |

For AAS (LTE/NR) BS 5 MHz option the ACLRs for F9-F5 is derived from TS37.105 [26], Table 9.7.5.2.3-1"Wide Area operating band unwanted emission mask (UEM) for BC2 for BS not supporting NR or BS supporting NR in Band n3 or n8. For F4-F0 the OOBE and ACLR are derived from TS37.105, Table 9.7.6.4.1.2-1: "AAS BS OTA Spurious emissions limits, Category B" representing requirements for single RAT E-UTRA operation. The same values are defined for AAS NR BS in TS38.104 [18] in section 9.7.5.2.2. However we have also considered here the second case where the regional regulatory limit for TRP spurious limit for AAS systems in 1800 MHz is different from 3GPP default value (considering 9 dB scaling factor).

Comparing DECT ACS and AAS (LTE/NR) OTA ACLR figures

The table below compares DECT ACS and AAS (LTE/NR) OTA ACLR:

Table : Comparing ACLR and ACS

|  |  |  |  |
| --- | --- | --- | --- |
| DECT carrier | DECT ACS  (dB) | LTE non AAS ACLR  (dB) | AAS (LTE/NR) OTA ACLR  (dB) |
| F9 | 45 | 56 | 56 |
| F8 | 51 | 56 | 56 |
| F7-F5 | 58 | 56 | 56 |
| F4-F0 | 58 | 73/82 | 73/82 |

Conclusions for DECT:

AAS (LTE/NR) and LTE-non-AAS interferers effect is similar in the sense that blocking of DECT dominates except for three DECT carriers F7-F5.

In previous GSM studies in ERC Report 100 [38] and ECC Report 146 [7] this was not considered to be a problem as it has been assumed that DECT by its DCS provision is able to detect possible harmful interference on carriers close to the band edge and escape to a less interfered carrier. Similar conclusions were made for compatibility with LTE non-AAS in CEPT Report 41.

Therefore the following relevant conclusions from previous studies (CEPT Report 41 [3], ERC Report 100 [38] and ECC Report 146 [7]) are considered applicable to AAS (LTE/NR) systems operating in 1800 MHz:

* No guard band is required between AAS/5G NR 1800 and DECT allocations, provided that DECT is able to properly detect interference on closest DECT carriers and escape to more distant carriers.
* AAS/5G NR macro-cells can be deployed in the same geographical area in co-existence with DECT which is deployed inside of the buildings, as the interference between DECT RFP and PP and macro-cellular LTE/WiMAX1800 BS and UE is not a problem;
* When pico-cellular AAS/5G NR 1800 BS is deployed inside of the building in co-existence with DECT RFP and PP deployed in the same building indoor area, some potential interference is likely to exist from indoor pico-cellular BS to DECT if they are placed too close and they are operating in the adjacent channel at 1880 MHz;
* The following interference mitigation techniques could be used to address the potential interference from indoor pico-cellular BS to indoor DECT RFP and PP when they are operating at the adjacent frequency point of 1880 MHz (ECC Report 96):

Space separation between indoor pico-cell AAS/5G NR BS and DECT RFP or PP of 65 m or more;

Avoiding the adjacent frequencies of 1880 MHz for indoor pico-cellular AAS/5G NR 1800 BS and DECT or operate with reduced transmitting power if necessary.

In term of interference analysis, the DECT system has the DCA (Dynamic Channel Allocation) mechanism which allows it to avoid efficiently an interfered channel, except if both systems are deployed indoors.

#### Compatibility consideration between AAS (LTE/NR) 1800 and MetSat

Meteorological satellite service (Space to earth) system characteristics are described in ITU-R Recommendation SA.1158 [16]. The main system parameters of the meteorological satellite system operating in the frequency range 1698-1710 MHz are summarised in Table 32 of CEPT report 41.

The MetSat operating frequency range of 1700-1710 MHz is adjacent to the AAS (LTE/NR) 1800 uplink frequency block at 1710-1785 MHz.

From the frequency arrangement between MetSat and AAS (LTE/NR) systems, the possible interference scenario is the interference from AAS (LTE/NR) system UE into MetSat Earth Station receivers.

CEPT Report 41 concluded that the interference from LTE/WiMAX1800 UE to MetSat Earth Stations operating in adjacent frequency band is unlikely to be a problem.

The potential interference from MetSat DL to LTE/WiMAX1800 UE was not covered in past studies and was left for future further study if it appears necessary.

Conclusions

AAS technology applies to BS side only and does not impact the UE characteristics. Besides the adjacent channel leakage power of 5G NR UE is in the same range as for legacy LTE UE.

The MetSat Earth stations have been adjacent to GSM 1800 and LTE 1800 MHz for many years, and have not experienced interference from GSM MS or LTE UE transmissions therefore the interference from AAS (LTE/NR) systems UE to MetSat Earth Stations operating in adjacent frequency band is unlikely to be a problem.

#### Compatibility consideration between AAS (LTE/NR) and Radio microphones

Radio microphone system characteristics are described in ERC Report 063 [39], ERC/REC 70-03 [40], ETSI standard EN 300 422 [41] and CEPT Report 41 (Table 33) [3].

Interference analysis between GSM1800 and Radio Microphones operating in adjacent frequency bands was described in ERC Report 063. Interference analyses between LTE/WiMAX 1800 and Radio Microphones was described in CEPT Report 41.

Similar interference analysis methodology can be re-used for AAS (LTE/NR) 1800 and Radio Microphones compatibility. The conclusion of the interference analysis between LTE/WiMAX (non AAS) 1800 and Radio Microphones was that the 700 kHz guard band in ERC Report 63 and ERC/REC 70-03 for the protection of GSM1800 is sufficient for protecting LTE/WiMAX 1800 BS receivers. This assumes that the radio microphone maximum transmitting power is limited to 13 dBm (20 mW) for hand held microphones and 17 dBm (50 mW) for body worn microphones, as recommended in ERC Report 063 and ERC/REC 70-03.

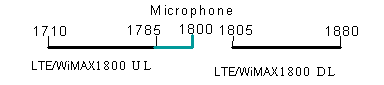


Figure 5: Radio Microphone frequency band is adjacent to AAS (LTE/NR) 1800 UL

For the compatibility between radio microphones and AAS (LTE/NR) 1800 system, there is a need to verify through analysis whether the recommended guard band of 700 kHz in ERC Report 063 [39] is sufficient for ensuring compatibility between AAS (LTE/NR) 1800 and radio microphones operating in the adjacent band.

AAS (LTE/NR) 1800 BS radiated (OTA) narrowband blocking is defined in Table 10.5.2.2-2 and Table 10.5.2.2-3 of 3GPP TS 38.104 [18] and is reflected in Annex 2 of this report.

For NR the narrow band blocking was defined to ensure that adjacent NR 1800 UE transmitting 1RB with maximum power of 23 dBm is able to co-exist with AAS (LTE/NR) when positioned with a much smaller frequency separation/guard band than 700 kHz. Therefore, by considering that radio microphones transmit at a maximum power of 13 dBm (smaller than the NR UE), the interference from radio microphones to AAS (LTE/NR) BS should not be a problem with a guard band of 700 kHz.

Conclusions for Radio Microphones

It can be considered that the proposed guard band of 700 kHz in ERC Report 063 [39] and ERC/REC 70-03 [40] for the protection of GSM1800 and legacy LTE/WiMAX 1800 MHz is sufficient for protecting AAS (LTE/NR) 1800 BS receivers. This assumes that the radio microphone maximum transmitting power is limited to 13 dBm (20 mW) for hand held microphones and 17 dBm (50 mW) for body worn microphones, as recommended in ERC Report 063 and ERC/REC 70-03.

#### Compatibility study between AAS (LTE/NR) 1800 and Fixed Services

Compatibility between UMTS and Fixed Services operating in co-frequency and adjacent bands was studied and reported in ERC Report 65, [[42]ERC Report 64 [43] and ECC Report 96 [9] (based on the 2 previous ERC reports). As described in these two ERC Reports, the critical interference scenarios are between UMTS BS and Fixed Service stations, the interference between UMTS UE and Fixed Services was not considered.

CEPT Report 41 [3] considers that the conclusions relating to Fixed services compatibility with UMTS within the above mentioned reports are considered applicable to LTE/WiMAX 1800MHz (non-AAS).

Similar to what has been concluded for UMTS, the sharing situation between AAS (LTE/NR) system and existing fixed services will depend on the exact operational parameters of the AAS (LTE/NR) system and fixed service systems as well as factors such as the terrain features at the particular geographical location under consideration.

The Fixed Service frequency range is adjacent to AAS (LTE/NR) system UL at 1710 MHz and 1785 MHz. The potential interference, if any, will be between Fixed Service and AAS (LTE/NR) 1800 BS at 1805 MHz. A similar interference analysis method as the one used in the two ERC Reports 064 and 065, can be used by administrations planning deployment or coordination of AAS (LTE/NR) with existing fixed services to derive the separation/coordination distance as a function of frequency separations between AAS (LTE/NR) base station and Fixed service station similarly to what has been described in ERC Reports 64 [43] and 65 [42].

ECC report 173 “Fixed Service in Europe Current use and future trends post 2016” updated on 27 April 2018 [44] confirms the intention from several administrations to decrease the use of frequencies below 2 GHz, similarly to possible allocation to other services / applications.

### Conclusions

This analysis is based mainly on CEPT Report 41 [3] which was developed for the introduction of LTE at 1800 MHz. The main conclusions from CEPT Report 041 for LTE-non-AAS 1800 system and ECC Report 96 [9] for UMTS 1800 MHz compatibility with adjacent systems are considered here to be also applicable to AAS (LTE/NR) 1800 MHz systems. Based on the above, the following conclusions can be made:

* For DECT: No guard band is required between AAS/5G NR 1800 and DECT allocations and AAS/5G NR macro-cells can be deployed in the same geographical area in co-existence with DECT which is deployed inside of the buildings. Potential interference between AAS (LTE/NR) and DECT does not appear to be an obstacle, except for the case where an AAS (LTE/NR) 1800 pico BS is installed in indoor environment close to DECT PP or RFP in which case different interference mitigation techniques could be used. In practice, DECT system has a DCA (Dynamic Channel Allocation) mechanism which allows it to avoid interference. GSM1800 deployment has demonstrated that no additional interference mitigation techniques with DECT are really needed in practice;
* For MetSat: Similar to LTE non-AAS, our analysis indicate that the potential interference between (LTE/NR) 1800 UE and MetSat Earth Stations is not expected to be a problem provided the fact that AAS functionality applies only to the BS side. The UE NR/LTE characteristics remain the same whether the BS uses AAS or not;
* For Radio Microphones: The interference analysis leads to the conclusion that with the existing guard band of 700 kHz from the radio microphones frequency band the potential interference from radio microphones to AAS (LTE/NR) 1800 MHz BS should not be a problem, if the radio microphone maximum transmit power is limited to 13 dBm (20 mW) for hand held microphones and 17 dBm (50 mW) for body worn microphones, as recommended in ERC Report 63 [39]and ERC/REC 70-03E [40];
* For Fixed services: The Fixed Service frequency range is adjacent to AAS (LTE/NR) system UL at 1710 MHz and 1785 MHz. Similar to what has been concluded for UMTS and LTE, the sharing situation between AAS (LTE/NR) system and existing fixed services will depend on the exact operational parameters of the AAS (LTE/NR) system and fixed service systems as well as factors such as the terrain features at the particular geographical location under consideration. A comparable interference analysis method as the one used in the two ERC Reports 64 [43] and 65 [42], can be used by administrations planning deployment or coordination of AAS (LTE/NR) with existing fixed services to derive the separation/coordination distance.

# Recommended Framework

## Band plan

The following bands relevant to 900/1800MHz frequency bands are defined for NR systems in 3GPP:

Table 15: NR operating bands in 900/1800MHz

|  |  |  |  |
| --- | --- | --- | --- |
| NR operating band | Uplink (UL) operating band BS receive / UE transmit  FUL\_low – FUL\_high | Downlink (DL) operating band BS transmit / UE receive  FDL\_low – FDL\_high | Duplex Mode |
| n3 | 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| n8 | 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |
| n81 | 880 MHz – 915 MHz |  | SUL |
| n80 | 1710 MHz – 1785 MHz |  | SUL |

NR systems in frequency bands 880 MHz – 915 MHz and 1710 MHz – 1785 MHz may operate in Supplemental uplink mode (SUL), i.e. NR Uplink operation without paired downlink NR spectrum. SUL bands are meant to be aggregated to another NR band e.g. TDD band (3400-3800 MHz, see ECC Decision (11)06 [45]) that includes a DL direction.

For the update of ECC Decision (06)13 [1], the same consideration regarding 900/1800MHz band plan used for LTE should be extended to NR systems (whether AAS or not) and there is no need to [update] change the ECC decision with that regard. However there is a need to add reference in the updated ECC Decision (06) 13 to the possibility that NR systems in frequency bands 880 MHz – 915 MHz and 1710 MHz – 1785 MHz may operate in Supplemental uplink mode (SUL), i.e. NR Uplink operation without paired downlink NR spectrum.

## Applicable technical conditions for 5G non-AAS system in 900 and 1800MHz bands

The compatibility results from CEPT Reports 40 [2] and 41 [3] and ECC Report 266 [5] for LTE in 900/1800MHz bands can be extended to NR non-AAS system.

The same technical conditions defined in ECC Decision (06)13 [1] for LTE can be extended for 5G NR non-AAS system in 900/1800MHz bands including SUL mode of operation.

To ensure coexistence with other systems operating in the 900/1800MHz bands, the following requirements apply to 5G NR non-AAS system similarly for LTE (non AAS):

* Frequency separation of 200 kHz or more between the 5G NR channel edge and the GSM carrier's channel edge. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5MHz or above channel bandwidth). The same applies to coexistence between NR system and EC-GSM-IoT systems.
* No frequency separation is required between 5G NR channel edge and the UMTS carrier's channel edge.
* No frequency separation is required between 5G NR channel edge and the LTE carrier's channel edge. The same applies to coexistence with LTE MTC/eMTC system
* No frequency separation is required between 5G NR channel edges between two neighbouring 5G NR networks.
* A frequency separation of 200 kHz or more is needed between the standalone NB-IoT channel edge of one network and the NR channel edge of the neighbouring network. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5MHz or above channel bandwidth).

CEPT analysis confirms that the conclusions from CEPT Report 41 [3], CEPT Report 42 [4] and ECC Report 96 [9] for LTE-non-AAS 900/1800 MHz systems compatibility with adjacent systems are considered to be also applicable to NR non-AAS 900/1800 MHz systems. In consequence, reference to 5G ETSI harmonised standard could be added to Annex 1 of the revised ECC Decision (06)13 [1].

## Applicable technical conditions for AAS (LTE/5G) system in 1800MHz bands

To ensure coexistence with other systems operating in the bands, the following requirements apply to AAS (LTE/NR) 1800MHz system similarly for LTE non-AAS:

* Frequency separation of 200 kHz or more between the 5G NR channel edge and the GSM carrier's channel edge. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5MHz or above channel bandwidth). The same applies to coexistence between NR system and EC-GSM-IoT systems;
* No frequency separation is required between 5G NR channel edge and the UMTS carrier's channel edge;
* No frequency separation is required between 5G NR channel edge and the LTE carrier's channel edge. The same applies to coexistence with LTE MTC/eMTC system;
* No frequency separation is required between 5G NR channel edges between two neighbouring 5G NR networks;
* A frequency separation of 200 kHz or more is needed between the standalone NB-IoT channel edge of one network and the NR channel edge of the neighbouring network. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5MHz or above channel bandwidth).

CEPT analysis confirms that the conclusions from CEPT Report 41 [3], CEPT Report 42 [4] and ECC Report 96 [9] for LTE-non-AAS 1800 MHz systems compatibility with adjacent systems are considered to be also applicable to AAS (LTE/NR) 1800 MHz systems.

In consequence, reference to NR and AAS ETSI harmonised standard could be added to Annex 1 of the ECC Decision (06)13 [1].

CEPT confirms that the spurious emissions limit of ERC Recommendation 74-01 [46] are applicable. CEPT noted that AAS issue is relevant for BS only (AAS will not be applicable to UE).

## Summary of updated framework for suitability to 5G (900/1800MHz) and AAS (1800MHz)

Based on the above, we propose the following update to ECC Decision (06)13 Annex 1. No changes are necessary to Annex 2 of the ECC Decision:

Table 16: Description of GSM, UMTS, LTE, NR and WiMAX

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Technology | Terminology in ITU-R Recommendations (e.g. Recommendation ITU-R M.1457 [47] | | Standards Development Organisations (SDO) | Terms used by SDO | Applicable  ETSI standards | Other terms commonly used | |
| GSM | |  | 3GPP  ETSI | GSM  GSM/EDGE | EN 301 502 [48]  EN 301 511 [49]  EN 301 908-18 [50] | | GPRS, EDGE |
| UMTS | | IMT-2000 CDMA Direct Spread | 3GPP  ETSI | UMTS  UTRA | EN 301 908-1 [51]  EN 301 908-2 [52]  EN 301 908-3 [53]  EN 301 908-11 [54]  EN 301 908-18 [50] | | IMT-2000/UMTS; W-CDMA; HSPA |
| LTE | | IMT-2000 CDMA Direct Spread  (E UTRAN)(1) | 3GPP  ETSI | LTE  E-UTRA  E-UTRA AAS | EN 301 908-1 [51]  EN 301 908-13 [25]  EN 301 908-14 [55]  EN 301 908-15 [56]  EN 301 908-18 [50]  EN 301 908-23 [24] | |  |
| WiMAX | | IMT-2000 OFDMA TDD WMAN(2) | IEEE | WiMAX | EN 301 908-1 [51]  EN 301 908-21 [57]  EN 301 908-22 [58] | |  |
| NR | | IMT-2020(3) | 3GPP  ETSI | NR | EN 301 908-24 [22]  EN 301 908-25 [23] | |  |
| (1) This radio interface now includes an option using OFDM modulation.  (2) This radio interface now supports FDD.  (3) This radio interface supports both FDD and SUL. | | | | | | | |

# Conclusions

This Report assesses the suitability of the current ECC Decision (06)13 [1] regulatory framework for the possible future usage of:

* 900 MHz band for 5G non-AAS technology including SUL mode of operation. AAS technology is not considered for the 900MHz band in this report;
* 1800 MHz band for 5G (AAS and non AAS) including SUL mode of operation;
* 1800 MHz band for LTE-AAS.

ECC analysed and confirmed that the in-band compatibility conclusions from CEPT Report 40 [2] applicable to LTE non-AAS systems in 900/1800 MHz bands are also applicable to both LTE/5G NR AAS systems in 1800 MHz frequency band and to 5G NR non-AAS systems in 900/1800 MHz frequency bands.

ECC also concluded that the adjacent bands compatibility conclusions from CEPT Report 41 [3] and CEPT Report 42 [4] applicable to LTE non-AAS systems in 900/1800 MHz band are also applicable to both 5GNR non-AAS 900/1800 MHz systems and to LTE/5GNR AAS 1800 MHz systems.

This Report does not consider or propose a Block Edge Mask (BEM) approach to technical harmonisation for 900/1800MHz band.

Based on the above the following updated framework is recommended based on reference to relevant ETSI harmonised standard:

Updated Band plan:

According to the analyses performed in this Report, the same sharing conditions used for LTE could be extended to LTE AAS systems and to NR systems (whether AAS or not) including NR SUL mode of operation. There is a need to refer in the annex listing the relevant applicable ETSI harmonised standards to LTE AAS and to 5G including SUL mode of operation.

Applicable technical conditions for 5G and AAS:

The same technical conditions defined in ECC Decision (06)13 for LTE can be extended for 5G NR non-AAS system in 900/1800MHz bands including SUL mode of operation. The same applies for AAS (LTE/NR) in 1800MHz band.

To ensure coexistence with other systems operating in the 900/1800MHz bands, the following requirements apply to 5G NR (AAS or non-AAS) and for LTE-AAS:

* Frequency separation of 200 kHz or more between the 5G NR channel edge and the GSM carrier's channel edge. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5MHz or above channel bandwidth). The same applies to coexistence between NR system and EC-GSM-IoT systems;
* No frequency separation is required between 5G NR channel edge and the UMTS carrier's channel edge;
* No frequency separation is required between 5G NR channel edge and the LTE carrier's channel edge. The same applies to coexistence with LTE MTC/eMTC system;
* No frequency separation is required between 5G NR channel edges between two neighbouring 5G NR networks;
* A frequency separation of 200 kHz or more is needed between the standalone NB-IoT channel edge of one network and the NR channel edge of the neighbouring network. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5MHz or above channel bandwidth).

CEPT confirms that the spurious emissions limit of ECC Recommendation 74-01 [46] are applicable. CEPT noted that AAS issue is relevant for BS only (AAS will not be applicable to UE).

Based on the above, ECC decided that reference to NR (AAS and non-AAS) and to LTE-AAS ETSI harmonised standard could be added to Annex 1 of the ECC Decision (06)13 decision as follows:

Table 17: Description of GSM, UMTS, LTE, NR and WiMAX

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Technology | Terminology in ITU-R Recommendations (e.g. Recommendation ITU-R M.1457 [47]) | Standards Develop-ment Organisations (SDO) | Terms used by SDO | Applicable  ETSI standards | Other terms commonly used |
| GSM |  | 3GPP  ETSI | GSM  GSM/EDGE | EN 301 502 [48]  EN 301 511 [49]  EN 301 908-18 [50] | GPRS, EDGE |
| UMTS | IMT-2000 CDMA Direct Spread | 3GPP  ETSI | UMTS  UTRA | EN 301 908-1 [51]  EN 301 908-2 [52]  EN 301 908-3 [53]  EN 301 908-11 [54]  EN 301 908-18 [50] | IMT-2000/UMTS; W-CDMA; HSPA |
| LTE | IMT-2000 CDMA Direct Spread  (E UTRAN)(1) | 3GPP  ETSI | LTE  E-UTRA  E-UTRA AAS | EN 301 908-1 [51]  EN 301 908-13 [25]  EN 301 908-14 [55]  EN 301 908-15 [56]  EN 301 908-18 [50]  EN 301 908-23 [24] |  |
| WiMAX | IMT-2000 OFDMA TDD WMAN(2) | IEEE | WiMAX | EN 301 908-1 [51]  EN 301 908-21 [57]  EN 301 908-22 [58] |  |
| NR | IMT-2020(3) | 3GPP  ETSI | NR | EN 301 908-24 [22]  EN 301 908-25 [23] |  |
| (1) This radio interface now includes an option using OFDM modulation.  (2) This radio interface now supports FDD.  (3) This radio interface supports both FDD and SUL. | | | | | |

1. Main technical parameters of 5G non-AAS system for coexistence studies in 900 and 1800 MHz bands
   * 1. Bands definition

NR technology is standardised in 3GPP starting from NR release 15.The main transmitter and receiver technical characteristics for lower bands are described in TS 38.101-1[17] for UE and TS 38.104 [18] for the BS. The NR non-AAS BS requirements are called conducted requirements and can be found under section 6 of TS38.104 for the transmitter side and section 7 for the receiver side.

Table 18: NR operating bands in 900/1800MHz

|  |  |  |  |
| --- | --- | --- | --- |
| NR operating band | Uplink (UL) operating band BS receive / UE transmit  FUL\_low – FUL\_high | Downlink (DL) operating band BS transmit / UE receive  FDL\_low – FDL\_high | Duplex Mode |
| n3 | 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| n8 | 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |
| n81 | 880 MHz – 915 MHz |  | SUL |
| n80 | 1710 MHz – 1785 MHz |  | SUL |

As we can see from the table above, NR systems in frequency bands 880 MHz – 915 MHz and 1710 MHz – 1785 MHz may operate in Supplemental uplink mode (SUL), i.e. NR Uplink operation without paired downlink NR spectrum. SUL bands are meant to be aggregated to another NR band e.g. TDD band (3400-3800 MHz, see ECC Decision (11)06) that includes a DL direction.

* + 1. conducted Maximum output power

For NR 900 and 1800MHz bands UE, 3GPP define power class 3 which has 23 dBm maximum output power. This is the same requirement defined for LTE UE

Regarding the NR BS, 3GPP defines 3 BS power classes for NR (Table 6.2.1-1 of TS38.104): Wide Area BS, Medium Range BS and Local Area BS with the same BS rated output power and BS Maximum output power limits as for the LTE.

Table 19: BS type 1-C rated output power limits for BS classes

|  |  |
| --- | --- |
| BS class | Prated,c,AC |
| Wide Area BS | (Note) |
| Medium Range BS | ≤ 38 dBm |
| Local Area BS | ≤ 24 dBm |
| NOTE: There is no upper limit for the Prated,c, AC rated output power of the Wide Area Base Station | |

* + 1. Channel bandwidth

The channel bandwidth requirement corresponds to The requirements in this specification apply to the combination of BS channel bandwidths, SCS and operating bands for NR is defined as follows:

Table 20: NR channel bandwidth and SCS per operating band

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band | SCS  kHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz |
| n3 FDD band (1710– 1785 /1805 – 1880 MHz)  and  n80 SUL band (1710 MHz – 1785 MHz) | 15 | Yes | Yes | Yes | Yes | Yes | Yes |
| 30 |  | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes | Yes | Yes |
| n8 FDD band (880– 915 /925– 960 MHz)  n81 SUL band (880 MHz – 915 MHz) | 15 | Yes | Yes | Yes | Yes |  |  |
| 30 |  | Yes | Yes | Yes |  |  |
| 60 |  |  |  |  |  |  |

For NR in band 1800MHz (FDD band n3 and SUL band n80), in addition to the 5, 10, 15 and 20MHz CBW that were defined as for LTE (case of SCS 15KHz), 2 additional CBW were added: 25MHz and 30MHz. The NR TX requirements for these channel bandwidths are similar to the requirements defined in 3GPP for LTE intra-band contiguous carrier aggregation of respectively 5MHz +20MHz and 15MHz+15MHz carriers already deployed in the market.

Unlike LTE, CBW of 1.4MGHz and 3MHz are not defined for NR.

* + 1. Maximum transmission bandwidth configuration and corresponding Minimum guard-band

The maximum transmission bandwidth configuration NRB for each UE channel bandwidth and subcarrier spacing is specified in the following Table (extract from Table 5.3.2-1 of TS 38.101-1), this corresponds to the BS Transmission bandwidth configuration (defined in Table 5.3.2-1 of TS 38.104):

Table 21: Maximum transmission bandwidth configuration NRB

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | 5MHz | 10MHz | 15MHz | 20 MHz | 25 MHz | 30 MHz |
| NRB | NRB | NRB | NRB | NRB | NRB |
| 15 | 25 | 52 | 79 | 106 | 133 | 160 |
| 30 | 11 | 24 | 38 | 51 | 65 | 78 |
| 60 | N/A | 11 | 18 | 24 | 31 | 38 |

The minimum guardband for each BS/UE channel bandwidth and SCS is specified in the following table (extract from Table 5.3.3-1 of TS38.104 and Table 5.3.3-1 of TS36.101-1):

Table 22: Minimum guard-band for each BS/UE channel bandwidth and SCS (kHz)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SCS (kHz) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz |
| 15 | 242.5 | 312.5 | 382.5 | 452.5 | 522.5 | 592.5 |
| 30 | 505 | 665 | 645 | 805 | 785 | 945 |
| 60 | N/A | 1010 | 990 | 1330 | 1310 | 1290 |
| NOTE: The minimum guard-bands have been calculated using the following equation: (CHBW x 1000 (kHz) - RB value x SCS x 12) / 2 - SCS/2. | | | | | | |

Please note that 'Guardband' does not refer to any potential guard-band between bands of operation but to the spectrum on the side of an NR channel, where the emission masks rolls out in order to meet the out of block requirement.

We can see from the tables above that for NR operating in 5MHz CBW, the NR requirement in terms of maximum transmission Bandwidth configuration and related minimum guard band is defined for NR in identical manner as for LTE (for Subcarrier spacing of 15KHz).

For CBW higher than 5MHz, NR has higher spectrum utilisation compared to LTE. However for these larger CBWs, the related minimum guard band (distance between the NR last in-band resources block edge to the NR channel edge) is larger than LTE 1.4, 3 and 5 MHz channels and always higher than 300KHz.

* + 1. conducted BS and UE Emission mask

3GPP defined for NR the following conducted/basic Category B requirements (Option 2) (in Table 6.6.4.2.2.2-1) intended for Europe and that may be applied regionally for BS operating in bands n1 (2100MHz), n3 (1800MHz), n8 (900MHz).

Table 23: Regional Wide Area BS operating band unwanted emission limits for Category B

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | Basic limit (Note 1, 2) | Measurement bandwidth |
| 0 MHz ≤ Δf < 0.2 MHz | 0.015 MHz ≤ f\_offset < 0.215 MHz | -14 dBm | 30 kHz |
| 0.2 MHz ≤ Δf < 1 MHz | 0.215 MHz ≤ f\_offset < 1.015 MHz |  | 30 kHz |
| (Note 4) | 1.015 MHz ≤ f\_offset < 1.5 MHz | -26 dBm | 30 kHz |
| 1 MHz ≤ Δf ≤  min( 10 MHz, Δfmax) | 1.5 MHz ≤ f\_offset <  min(10.5 MHz, f\_offsetmax) | -13 dBm | 1 MHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.5 MHz ≤ f\_offset < f\_offsetmax | -15 dBm (Note 3) | 1 MHz |
| NOTE 1: For a BS supporting non-contiguous spectrum operation within any operating band, the minimum requirement within sub-block gaps is calculated as a cumulative sum of contributions from adjacent sub blocks on each side of the sub block gap, where the contribution from the far-end sub-block shall be scaled according to the measurement bandwidth of the near-end sub-block. Exception is f ≥ 10MHz from both adjacent sub blocks on each side of the sub-block gap, where the minimum requirement within sub-block gaps shall be -15dBm/1MHz.  NOTE 2: For a multi-band connector with Inter RF Bandwidth gap < 20MHz the minimum requirement within the Inter RF Bandwidth gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks or RF Bandwidth on each side of the Inter RF Bandwidth gap, where the contribution from the far-end sub-block or RF Bandwidth shall be scaled according to the measurement bandwidth of the near-end sub-block or RF Bandwidth.  NOTE 3: The requirement is not applicable when Δfmax < 10 MHz.  NOTE 4: This frequency range ensures that the range of values of f\_offset is continuous. | | | |

The NR BS OOBE specified above for NR non AAS systems are the same as the LTE Category B option 2 requirements used in CEPT Reports 40, 41 and 42 for LTE compatibility analysis in band 900 and 1800MHz.

* + 1. UE spectrum emission Mask

The NR general spectrum emission mask of the NR UE is provided in the table below:

Table 24: NR General spectrum emission mask

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Spectrum emission limit (dBm) / Channel bandwidth | | | | | | | |
| ΔfOOB  (MHz) | 5  MHz | 10  MHz | 15  MHz | 20  MHz | 25  MHz | 30 MHz | Measurement bandwidth |
| ± 0-1 | -15 | -18 | -20 | -21 | -22 | -23 | 30 kHz |
| ± 1-5 | -10 | -10 | -10 | -10 | -10 | -10 | 1 MHz |
| ± 5-6 | -13 | -13 | -13 | -13 | -13 | -13 |
| ± 6-10 | -25 |
| ± 10-15 |  | -25 |
| ± 15-20 |  |  | -25 |
| ± 20-25 |  |  |  | -25 |
| ± 25-30 |  |  |  |  | -25 |
| ± 30-35 |  |  |  |  |  | -25 |

For the same CBW as that for LTE, i.e. 5MHz, 10MHz, 15MHz and 20MHz, the NR SEM requirement is the same as the SEM defined for LTE.

For NR CBW of 25 and 30MHz (applicable to the 1800MHz/band 3) the NR SEM requirement is the same as the SEM used for LTE intra-band contiguous carrier aggregation of respectively 5MHz +20MHz and 15MHz+15MHz carriers.

* + 1. conducted BS Adjacent Channel Leakage Ratio (ACLR)

3GPP defined in TS38.104 section 6.6.3.2 for NR BS ACLR (relative) limit of 45dB.

The ACLR for NR is defined with a square filter of bandwidth equal to the transmission bandwidth configuration of the transmitted signal (BWConfig) centred on the assigned channel frequency and a filter centred on the adjacent channel frequency according to the tables below.

For operation in paired and unpaired spectrum, the ACLR shall be higher than the value specified in the following table:

Table 25: Base station ACLR limit (Table 6.6.3.2-1 of TS38.104)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel bandwidth of NR lowest/highest carrier transmitted BWChannel [MHz] | BS adjacent channel centre frequency offset below the lowest or above the highest carrier centre frequency transmitted | Assumed adjacent channel carrier (informative) | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit |
| 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80,90, 100 | BWChannel | NR of same BW (Note 2) | Square (BWConfig) | 45 dB |
| 2 x BWChannel | NR of same BW (Note 2) | Square (BWConfig) | 45 dB |
| BWChannel /2 + 2.5 MHz | 5 MHz E-UTRA | Square (4.5 MHz) | 45 dB  (NOTE 3) |
| BWChannel /2 + 7.5 MHz | 5 MHz E-UTRA | Square (4.5 MHz) | 45 dB  (NOTE 3) |
| NOTE 1: BWChannel and BWConfig are the BS channel bandwidth and transmission bandwidth configuration of the lowest/highest NR carrier transmitted on the assigned channel frequency.  NOTE 2: With SCS that provides largest transmission bandwidth configuration (BWConfig).  NOTE 3: The requirements are applicable when the band is also defined for E-UTRA or UTRA. | | | | |

This is the same value defined by 3GPP for LTE and considered for LTE compatibility analyses performed previously in CEPT e.g. CEPT Reports 40 and 41.

3GPP also defined absolute basic limits for ACLR corresponding to the following:

Table 26: Base station ACLR absolute limit (Table 6.6.3.2-2 of TS38104)

|  |  |
| --- | --- |
| BS category / BS class | ACLR absolute limit |
| Category A Wide Area BS | -13 dBm/MHz |
| Category B Wide Area BS | -15 dBm/MHz |
| Medium Range BS | -25 dBm/MHz |
| Local Area BS | -32 dBm/MHz |

Either the “relative” ACLR limits or the absolute limit shall apply for each antenna connector, whichever is less stringent.

* + 1. UE NRACLR

NR adjacent channel leakage power ratio (NRACLR) is the ratio of the filtered mean power centred on the assigned NR channel frequency to the filtered mean power centred on an adjacent NR channel frequency at nominal channel spacing.

The assigned NR channel power and adjacent NR channel power are measured with rectangular filters with measurement bandwidths specified below.

If the measured adjacent channel power is greater than –50dBm then the NRACLR shall be higher than the value specified in Table below:

Table : NR ACLR measurement bandwidth

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| NR channel bandwidth / NRACLR measurement bandwidth | | | | | | |
|  | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz |
| NRACLR measurement bandwidth | 4.515 | 9.375 | 14.235 | 19.095 | 23.955 | 28.815 |

Table :NRACLR requirement

|  |  |
| --- | --- |
|  | Power class 3 |
| NRACLR | 30 dB |

For the same CBW as that for LTE, i.e. 5MHz, 10MHz, 15MHz and 20MHz, the ACLR requirement is similar to the one defined for LTE.

For NR CBW of 25 and 30MHz (applicable to the 1800MHz: FDD band n3 and SUL band n80) the NR ACLR requirement is the same as the ACLR used for LTE intra-band contiguous carrier aggregation of respectively 5MHz +20MHz and 15MHz+15MHz carriers.

* + 1. UE UTRA ACLR

UTRA adjacent channel leakage power ratio (UTRAACLR) is the ratio of the filtered mean power centred on the assigned NR channel frequency to the filtered mean power centred on an adjacent(s) UTRA channel frequency.

UTRAACLR is specified for the first adjacent UTRA channel (UTRAACLR1) which center frequency is ± 2.5 MHz from NR channel edge and for the 2nd adjacent UTRA channel (UTRAACLR2) which center frequency is ± 7.5 MHz from NR channel edge.

If the measured adjacent channel power is greater than –50dBm then the UTRAACLR1 and UTRAACLR2 shall be higher than the value specified in the following Table:

Table : UTRA ACLR requirement

|  |  |
| --- | --- |
|  | Power class 3 |
| UTRAACLR1 | 33 dB |
| UTRAACLR2 | 36 dB |

* + 1. Conducted BS spurious emissions

3GPP defined the following limits applicable to category B NR Base stations in 900/1800MHz.

This are identical to ones defined by 3GPP for LTE and considered for LTE compatibility analyses performed previously in CEPT e.g. CEPT Reports 40 and 41..

Table 30: NR BS Spurious emissions limits in FR1 (Lower bands), Category B (table Table 6.6.5.2.1-2 from TS38.104)

|  |  |  |  |
| --- | --- | --- | --- |
| Spurious frequency range | Basic limit | Measurement bandwidth | Notes |
| 9 kHz – 150 kHz | -36 dBm | 1 kHz | Note 1, Note 4 |
| 150 kHz – 30 MHz | 10 kHz | Note 1, Note 4 |
| 30 MHz – 1 GHz | 100 kHz | Note 1 |
| 1 GHz – 12.75 GHz | -30 dBm | 1 MHz | Note 1, Note 2 |
| 12.75 GHz – 5th harmonic of the upper frequency edge of the operating band in GHz | 1 MHz | Note 1, Note 2, Note 3 |
| NOTE 1: Measurement bandwidths as in ITU-R SM.329 [2], s4.1.  NOTE 2: Upper frequency as in ITU-R SM.329 [2], s2.5 table 1.  NOTE 3: Applies only for operating bands for which the 5th harmonic of the upper frequency edge is reaching beyond 12.75 GHz.  NOTE 4: This spurious frequency range applies only to BS type 1-C and BS type 1-H. | | | |

In addition 3GPP defined the following limits for the protection of the BS receiver of own or different BS: This requirement shall be applied for NR FDD operation in order to prevent the receivers of the BSs from being desensitised by emissions from a BS transmitter.

The power of any spurious emission shall not exceed the limits in the table below:

Table 31: NR BS Spurious emissions limits for protection of the BS receiver

(Table 6.6.5.2.2-1 of TS38.104)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| BS class | Frequency range | Basic limit | Measurement bandwidth | Note |
| Wide Area BS | FUL\_low – FUL\_high | -96 dBm | 100 kHz |  |
| Medium Range BS | FUL\_low – FUL\_high | -91 dBm | 100 kHz |  |
| Local Area BS | FUL\_low – FUL\_high | -88 dBm | 100 kHz |  |

3GPP also defined the following optional Additional spurious emissions requirements. These may apply for the protection of specific equipment (UE, MS and/or BS) or equipment operating in specific systems (GSM, CDMA, UTRA, E-UTRA, etc.) as listed in the extract table below:

Table 32: BS Spurious emissions limits for BS for co-existence with systems operating in other frequency bands (Extract from Table 6.6.5.2.3-1 of TS38.104)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| System type for NR to co-exist with | Frequency range for co-existence requirement | Basic limit | Measurement bandwidth | Note |
| GSM900 | 921 – 960 MHz | -57 dBm | 100 kHz | This requirement does not apply to BS operating in band n8 |
| 876 – 915 MHz | -61 dBm | 100 kHz | For the frequency range 880-915 MHz, this requirement does not apply to BS operating in band n8, since it is already covered by the requirement in subclause 6.6.5.1.3. |
| DCS1800 | 1805 – 1880 MHz | -47 dBm | 100 kHz | This requirement does not apply to BS operating in band n3. |
| 1710 – 1785 MHz | -61 dBm | 100 kHz | This requirement does not apply to BS operating in band n3, since it is already covered by the requirement in subclause 6.6.5.1.3. |
| PCS1900 | 1930 1990 MHz | -47 dBm | 100 kHz | This requirement does not apply to BS operating in band n2 or band n70. |
| 1850 – 1910 MHz | -61 dBm | 100 kHz | This requirement does not apply to BS operating in band n2, since it is already covered by the requirement in subclause 6.6.5.1.3. |
| GSM850 or CDMA850 | 869 – 894 MHz | -57 dBm | 100 kHz | This requirement does not apply to BS operating in band n5. |
| 824 – 849 MHz | -61 dBm | 100 kHz | This requirement does not apply to BS operating in band n5, since it is already covered by the requirement in subclause 6.6.5.1.3. |
| UTRA FDD Band I or  E-UTRA Band 1 or NR Band n1 | 2110 – 2170 MHz | -52 dBm | 1 MHz | This requirement does not apply to BS operating in band n1 |
| 1920 – 1980 MHz | -49 dBm | 1 MHz | This requirement does not apply to BS operating in band n1, since it is already covered by the requirement in subclause 6.6.5.1.3. |
| UTRA FDD Band III or  E-UTRA Band 3 or NR Band n3 | 1805 – 1880 MHz | -52 dBm | 1 MHz | This requirement does not apply to BS operating in band n3. |
| 1710 – 1785 MHz | -49 dBm | 1 MHz | This requirement does not apply to BS operating in band n3, since it is already covered by the requirement in subclause 6.6.5.1.3. |
| UTRA FDD Band VII or  E-UTRA Band 7 or NR Band n7 | 2620 – 2690 MHz | -52 dBm | 1 MHz | This requirement does not apply to BS operating in band n7. |
| 2500 – 2570 MHz | -49 dBm | 1 MHz | This requirement does not apply to BS operating in band n7, since it is already covered by the requirement in subclause 6.6.5.1.3. |
| UTRA FDD Band VIII or  E-UTRA Band 8 or NR Band n8 | 925 – 960 MHz | -52 dBm | 1 MHz | This requirement does not apply to BS operating in band n8. |
| 880 – 915 MHz | -49 dBm | 1 MHz | This requirement does not apply to BS operating in band n8, since it is already covered by the requirement in subclause 6.6.5.1.3. |

The limits above are all identical to those defined by 3GPP for LTE and considered for LTE compatibility analyses performed previously in CEPT e.g. CEPT Reports 40 and 41..

* + 1. UE spurious emissions

Table 33: Boundary between NR out of band and general spurious emission domain

(Table 6.5.3.1-1 of TS38.101-1)

|  |  |
| --- | --- |
| Channel bandwidth | OOB boundary FOOB (MHz) |
| BWChannel | BWChannel + 5 |

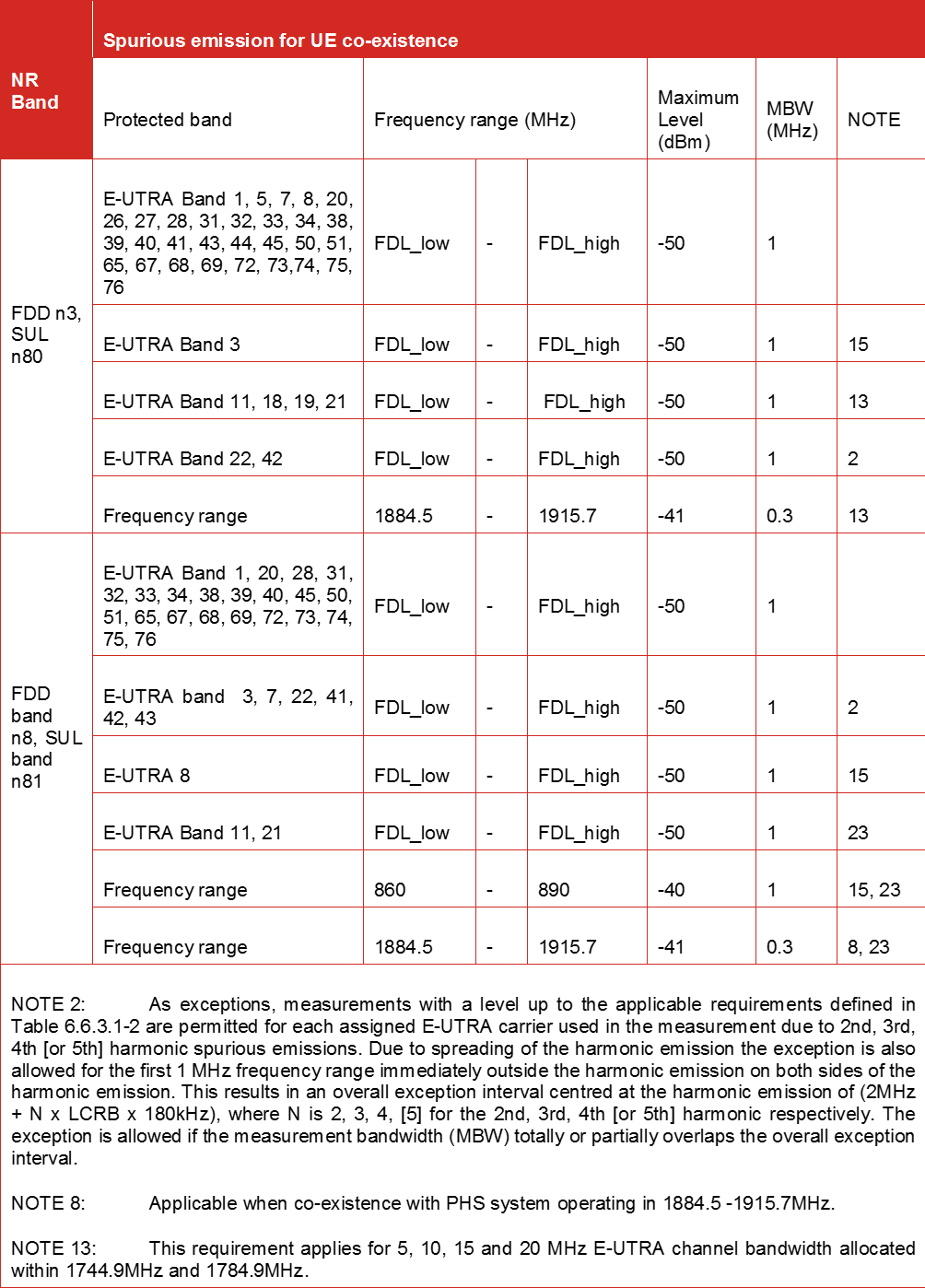
Table 34: Requirement for general spurious emissions limits (Table 6.5.3.1-2 of TS38.101-1)

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | Maximum Level | Measurement bandwidth | NOTE |
| 9 kHz ≤ f < 150 kHz | -36 dBm | 1 kHz |  |
| 150 kHz ≤ f < 30 MHz | -36 dBm | 10 kHz |  |
| 30 MHz ≤ f < 1000 MHz | -36 dBm | 100 kHz |  |
| 1 GHz ≤ f < 12.75 GHz | -30 dBm | 1 MHz |  |
| 12.75 GHz ≤ f < 5th harmonic of the upper frequency edge of the UL operating band in GHz | -30 dBm | 1 MHz | 1 |
| 12.75 GHz < f < 26 GHz | -30 dBm | 1 MHz | 2 |
| NOTE 1: Applies for Band that the upper frequency edge of the UL Band more than 2.69 GHz  NOTE 2: Applies for Band that the upper frequency edge of the UL Band more than 5.2 GHz | | | |

The table below specifies the requirements for NR bands for coexistence with protected bands.

Table 35: Requirements for spurious emissions for UE co-existence relevant to 900/1800MHz

(extract from Table 6.5.3.2-1 of TS38.101-1)



Note: To simplify the Table above, E-UTRA band numbers were listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.

The NR UE spurious emissions limits above are generally aligned with those defined for LTE

* + 1. UE Inband blocking

For NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 in-band blocking (IBB) 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.

Table 36: In-band blocking parameters for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz (extract from Table 7.6.2-1 of TS38.101-1)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5 MHz/10MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | 7 | 9 | 10 | 11 |
| BWinterferer | MHz | 5 | | | | |
| FIoffset, case 1 | MHz | 7.5 | | | | |
| FIoffset, case 2 | MHz | 12.5 | | | | |

Table 37: In-band blocking for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Case 1 | Case 2 | Case 3 |
| Pinterferer | dBm | -56 | -44 | -15 |
| n1, n2, n3, n5, n7, n8, n20, n28, n38, n41, n50, n51, n66, n70, n71, n74, n75, n76 | Finterferer (offset) | MHz | -CBW/2 –  FIoffset, case 1  and  CBW/2 +  FIoffset, case 1 | ≤ -CBW/2 –  FIoffset, case 2  and  ≥ CBW/2 +  FIoffset, case 2 |  |
| Finterferer | MHz | NOTE 2 | FDL\_low – 15  to  FDL\_high + 15 |  |
| NOTE 1: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.  NOTE 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: -CBW/2 – FIoffset, case 1; b: CBW/2 + FIoffset, case 1 | | | | | |

In band blocking for NR UE is similar to LTE for Case 1 and 2. Case 3 requires further confirmation

* + 1. UE Out-of-band blocking

For NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz out-of-band band blocking is defined for an unwanted CW interfering signal falling outside a frequency range 15 MHz below or above the UE receive band.

Table 38: Out-of-band blocking parameters for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz (extract from Table 7.6.3-1 of TS38.101-1)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5 – 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz |
| Power in transmission bandwidth configuration | dBm | REFSENS + channel specific value below | | | | |
| dB | 6 | 7 | 9 | 10 | 11 |
| NOTE : The transmitter shall be set to 4dB below …. | | | | | | |

Table 39: Out of-band blocking for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz (extract from Table 7.6.3-2 of TS38.101-1)



Out of band blocking for NR UE is similar to LTE.

* + 1. UE Narrow band blocking

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

The relative throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.6.2-1. For operating bands with an unpaired DL part (as noted in Table 5.5-1), the requirements only apply for carriers assigned in the paired part.

The following table summarises the 3GPP NR requirement for some relevant lower bands including Band 3 (1800MHz) and 8 (900MHz):

Table 40: Narrow Band Blocking (extract from Table 7.6.4-1 of TS38.101-1)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Channel Bandwidth | | | | |
| 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz |
| n1, n3, n7, n8,  n38 | Pw | dBm | PREFSENS + channel-bandwidth specific value below | | | | |
| 16 | 13 | 14 | 16 | 16 |
| Puw (CW) | dBm | -55 | -55 | -55 | -55 | -55 |
| Fuw (offset SCS= 15 kHz) | MHz | 2.7075 | 5.2125 | 7.7025 | 10.2075 | 13.0275 |
| Fuw (offset SCS= 30 kHz) | MHz | NA | NA | NA | NA |  |
| NOTE 1: The transmitter shall be set a 4 dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3.1-2 with PCMAX\_L as defined in subclause 6.2.5.  NOTE 2: Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.  NOTE 3: The PREFSENS power level is specified in Table 7.3.1-1 and Table 7.3.1-1a for two and four antenna ports, respectively. | | | | | | | |

Narrow band blocking for NR UE is similar to LTE.

* + 1. UE Reference sensitivity power level

UE Reference sensitivity for NR can be found in Section 7.3 of TS38.101-1. However, for NR more CBW's (for 1800MHz) and SCS are defined and some new configurations are considered compared to LTE e.g. supplemental Uplink (SUL). NR reference Sensitivity level is comparable to LTE for the common CBWs and SCS with very minor differences fractions of dB (0.2dB) which should not have major impact on compatibility studies in this report.

* + 1. Conducted BS Reference sensitivity level

For NR, the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in Annex A of TS38.104 with parameters specified as in the table below for Wide Area BS (Table 7.2.2-1 of TS38.104):

Table 41: NR Wide Area BS reference sensitivity levels

|  |  |  |  |
| --- | --- | --- | --- |
| BS channel bandwidth [MHz] | Sub-carrier spacing [kHz] | Reference measurement channel | Reference sensitivity power level, PREFSENS  [dBm] |
| 5, 10, 15 | 15 | G-FR1-A1-1 | -101.7 |
| 10, 15 | 30 | G- FR1-A1-2 | -101.8 |
| 10, 15 | 60 | G- FR1-A1-3 | -98.9 |
| 20, 25, 30, 40, 50 | 15 | G- FR1-A1-4 | -95.3 |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | 30 | G- FR1-A1-5 | -95.6 |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | 60 | G- FR1-A1-6 | -95.7 |
| NOTE: PREFSENS 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 the reference measurement channel mapped to disjoint frequency ranges with a width corresponding to the number of resource blocks of the reference measurement channel each, except for one instance that might overlap one other instance to cover the full BS channel bandwidth. | | | |

The parameters for the reference measurement channels are specified the following table (table A.1-1 of TS38.104):

Table 42: NR FRC parameters for FR1 receiver sensitivity and in-channel selectivity

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | G-FR1-A1-1 | G-FR1-A1-2 | G-FR1-A1-3 | G-FR1-A1-4 | G-FR1-A1-5 | G-FR1-A1-6 | G-FR1-A1-7 | G-FR1-A1-8 | G-FR1-A1-9 |
| Subcarrier spacing[kHz] | 15 | 30 | 60 | 15 | 30 | 60 | 15 | 30 | 60 |
| Allocated resource blocks | 25 | 11 | 11 | 106 | 51 | 24 | 15 | 6 | 6 |
| CP-OFDM Symbols per slot (Note 1) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Code rate (Note 2) | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Payload size (bits) | 2152 | 984 | 984 | 9224 | 4352 | 2088 | 1320 | 528 | 528 |
| Transport block CRC (bits) | 16 | 16 | 16 | 24 | 24 | 16 | 16 | 16 | 16 |
| Code block CRC size (bits) | - | - | - | 24 | - | - | - | - | - |
| Number of code blocks - C | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| Coded block size (bits) | 2168 | 1000 | 1000 | 4648 | 4376 | 2104 | 1336 | 544 | 544 |
| Total number of bits per slot | 7200 | 3168 | 3168 | 30528 | 14688 | 6912 | 4320 | 1728 | 1728 |
| Total symbols per slot | 3600 | 1584 | 1584 | 15264 | 7344 | 3456 | 2160 | 864 | 864 |
| NOTE 1: UL-DMRS-config-type = 1 with UL-DMRS-max-len = 1, UL-DMRS-add-pos = 1 with = 2, = 11 as per Table 6.4.1.1.3-3 of TS 38.211 [5].  NOTE 2: MCS index 4 and target coding rate = 308/1024 are adopted to calculate payload size for receiver sensitivity and in-channel selectivity | | | | | | | | | |

There are some apparent differences in the absolute value for the conducted Reference sensitivity defined for NR in TS38.104 compared to LTE in TS36.104. The difference is due only to

* Different Fixed Reference Channels defined for NR and for LTE in particular the noise bandwidth of the FRC changes as explained below.
* Small differences in the required SNR for demodulation – this is a minor effect 0.2dB better NR performance compared to LTE for same FRC BW

Table 43: E-UTRA Wide Area BS reference sensitivity levels

|  |  |  |
| --- | --- | --- |
| E-UTRA  channel bandwidth [MHz] | Reference measurement channel | Reference sensitivity power level, PREFSENS  [dBm] |
| 1.4 | FRC A1-1 in Annex A.1 | -106.8 |
| 3 | FRC A1-2 in Annex A.1 | -103.0 |
| 3 | FRC A1-6 in Annex A.1 for E-UTRA with NB-IoT in-band operation (Note 3) | -103.0 (Note 2) |
| 5 | FRC A1-3 in Annex A.1 | -101.5 |
| 5 | FRC A1-7 in Annex A.1 for E-UTRA with NB-IoT in-band operation | -101.5 (Note 2) |
| 10 | FRC A1-3 in Annex A.1 (Note 1) | -101.5 |
| 10 | FRC A1-7 in Annex A.1 for E-UTRA with NB-IoT in-band operation (Note 4) | -101.5 (Note 2) |
| 15 | FRC A1-3 in Annex A.1 (Note 1) | -101.5 |
| 15 | FRC A1-7 in Annex A.1 for E-UTRA with NB-IoT in-band operation (Note 4) | -101.5 (Note 2) |
| 20 | FRC A1-3 in Annex A.1 (Note 1) | -101.5 |
| 20 | FRC A1-7 in Annex A.1 for E-UTRA with NB-IoT in-band operation (Note 4) | -101.5 (Note 2) |
| Note 1: PREFSENS 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.  Note 2: The requirements apply to BS that supports E-UTRA with NB-IoT in-band operation.  Note 3: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of FRC A1-6 mapped to the 12 E-UTRA resource blocks adjacent to the NB-IoT PRB.  Note 4: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of FRC A1-7 mapped to the 24 E-UTRA resource blocks adjacent to the NB-IoT PRB, and 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. | | |

The parameters for the LTE BS reference measurement channels are specified in Table A.1-1 of TS36.104:

Table 44: E-UTRA FRC parameters for reference sensitivity and in-channel selectivity

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference channel | A1-1 | A1-2 | A1-3 | A1-4 | A1-5 | A1-6 | A1-7 | A1-8 | A1-9 |
| Allocated resource blocks | 6 | 15 | 25 | 3 | 9 | 12 | 24 | 101 | 102 |
| DFT-OFDM Symbols per subframe | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Modulation | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Code rate | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 | 1/3 |
| Payload size (bits) | 600 | 1544 | 2216 | 256 | 936 | 1224 | 2088 | 1032 | 1032 |
| Transport block CRC (bits) | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Code block CRC size (bits) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Number of code blocks - C | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Coded block size including 12bits trellis termination (bits) | 1884 | 4716 | 6732 | 852 | 2892 | 3756 | 6348 | 3180 | 3180 |
| Total number of bits per sub-frame | 1728 | 4320 | 7200 | 864 | 2592 | 3456 | 6912 | 2880 | 2880 |
| Total symbols per sub-frame | 864 | 2160 | 3600 | 432 | 1296 | 1728 | 3456 | 1440 | 1440 |
| NOTE 1: For reference channel A1-8, the allocated RB’s are uniformly spaced over the channel bandwidth at RB index N, N+5, N+10, ..., N+45 where N = {0, 1, 2, 3, 4}.  NOTE 2: For reference channel A1-9, the allocated RB’s are uniformly spaced over the channel bandwidth at RB index N, N+10, N+20, ..., N+90 where N = {0, 1, 2, … 9}. | | | | | | | | | |

Reference sensitivity level is calculated for both NR and LTE as follows:



Where:

* kT is Boltzmann's constant and T is temperature in degrees Kelvin (-174dBm at nominal temp)
* B is the noise/modulated BW of the signal which is – 4.5MHz in the case of LTE FRC A1-3
* SNR is the power to noise ratio required for demodulation of the signal –1dB for E-UTRA, (this is based on simulation of the demodulation of the FRC A1-3 measurement channel from RAN4)
* NF is the BS noise figure and is assumed to be - 5dB for both NR and LTE
* IM is the implementation margin, 2dB is used for both NR and LTE

It is important to note that for PREFSENS is based on the noise BW of the FRC not the Channel Band Width (CBW)

For E-UTRA 5,10,15,20 MHz channels BWs that all use E-UTRA FRC A1-3:

The noise modulated BW is:



The reference E-UTRA sensitivity level is:



For NR, the following table compares the Reference Sensitivity Level specified in TS 38.104 and the calculation based on the above formula:

Table 45: Comparison of Reference Sensitivity Level specified in TS 38.104 and the calculation value

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TS 38.104 Table 7.2.2-1: NR Wide Area BS reference sensitivity levels | | | | Calculation by formula | | | | | |
| BS channel bandwidth [MHz] | Sub-carrier spacing [kHz] | Reference measurement channel | Reference sensitivity power level, PREFSENS | No RBs | Noise BW | NF | SNR | IM | PREFSENS |
| [dBm] | MHz | dB | dB | dB | dBm |
| 5, 10, 15 | 15 | G-FR1-A1-1 | -101.7 | 25 | 4.5 | 5 | -1.2 | 2 | -101.7 |
| 10, 15 | 30 | G- FR1-A1-2 | -101.8 | 11 | 3.96 | 5 | -0.8 | 2 | -101.8 |
| 10, 15 | 60 | G- FR1-A1-3 | -98.9 | 11 | 7.92 | 5 | -0.9 | 2 | -98.9 |
| 20, 25, 30, 40, 50 | 15 | G- FR1-A1-4 | -95.3 | 106 | 19.08 | 5 | -1.1 | 2 | -95.3 |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | 30 | G- FR1-A1-5 | -95.6 | 51 | 18.36 | 5 | -1.2 | 2 | -95.6 |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | 60 | G- FR1-A1-6 | -95.7 | 24 | 17.28 | 5 | -1.1 | 2 | -95.7 |

The following can be noted:

* The calculation gives the same result as the specified value;
* The BS RF NF is the same for all cases – and the same as E-UTRA i.e. 5dB;
* The SNR is based on the average result from simulations submitted to RAN4, details in TR 38.817-2 Annex B.3.

Based on the above we can conclude that:

* The difference in sensitivity between NR and LTE is explained mainly by the difference in the Fixed Reference Channel definition used (Noise BW). the receiver performance could be considered to be essentially the same since for the same modulated BW, NR and E-UTRA sensitivity requirements are comparable (0.2dB better performance for NR compared to LTE);
* The BS Noise figure used for both NR and E-UTRA is 5dB.
  + 1. Conducted BS blocking

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel.

The blocking requirements are applicable outside the Base Station RF Bandwidth or Radio Bandwidth. The interfering signal offset is defined relative to the Base Station RF Bandwidth edges or Radio Bandwidth edges. The blocking requirements apply in the in-band blocking frequency range, which is from 20 MHz below the lowest frequency of the uplink operating band up to 20 MHz above the highest frequency of the uplink operating band for BS type 1-C in an operating band less than 200 MHz wide or BS type 1-H in an operating band less than 100 MHz wide, or is from 60 MHz below the lowest frequency of the uplink operating band up to 60 MHz above the highest frequency of the uplink operating band for BS type 1-C in an operating band more than or equal to 200 MHz wide or BS type 1-H in an operating band more than or equal to 100 MHz wide, but excludes the downlink frequency range of the operating band.

Table 46: Base station general blocking requirement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR channel bandwidth of the lowest/highest carrier received [MHz] | Wanted signal mean power [dBm] | Interfering signal mean power [dBm] | Interfering signal centre frequency offset to the band edge of the wanted carrier [MHz] | Type of interfering signal |
| 5, 10, 15, 20 | PREFSENS + 6dB | Wide Area: -43  Medium Range: -38  Local Area: -35 | 7.5 | 5MHz NR signal  SCS: 15kHz |
| [25, 30, 40, 50, 60, 70, 80,90, 100] | PREFSENS + 6dB | Wide Area: -43  Medium Range: -38  Local Area: -35 | 30 | 20MHz NR signal  SCS: 15kHz |

Table 47: Base station narrowband blocking requirement

|  |  |  |
| --- | --- | --- |
| NR channel bandwidth of the lowest/highest carrier received [MHz] | Wanted signal mean power [dBm] | Interfering signal mean power [dBm] |
| 5, 10, 15, 20 (NOTE 1) | PREFSENS + 6dB | Wide Area: -49  Medium Range: -44  Local Area: -41 |
| 25, 30, 40, 50, 60, 70, 80,90, 100 (NOTE 1) | PREFSENS + 6dB | Wide Area: -49  Medium Range: -44  Local Area: -41 |
| NOTE: The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth | | |

Table 48: Base Station narrowband blocking interferer frequency offsets

|  |  |  |
| --- | --- | --- |
| NR channel bandwidth of the lowest/highest carrier received [MHz] | Interfering signal centre frequency offset to the band edge of the wanted carrier [kHz] | Type of interfering signal |
| 5 | [342,5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5MHz NR signal, 1 RB  SCS: 15kHz |
| 10 | [347.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5MHz NR signal, 1 RB  SCS: 15kHz |
| 15 | [352.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5MHz NR signal, 1 RB  SCS: 15kHz |
| 20 | [342.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5MHz NR signal, 1 RB  SCS: 15kHz |
| 25 | [557.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |
| 30 | [562.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |
| 40 | [557.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |
| 50 | [552.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |
| 60 | [562.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |
| 70 | [557.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |
| 80 | [552.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |
| 90 | [562.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |
| 100 | [557.5]+m\*180,  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 20MHz NR signal, 1 RB  SCS: 15kHz |

The out-of-band blocking characteristics is a measure of the receiver ability to receive a wanted signal at its assigned channel in the presence of an unwanted interferer out of the operating band, which is a CW signal for out-of-band blocking.

Table 49: Out-of-band blocking performance requirement for NR

|  |  |  |
| --- | --- | --- |
| Interfering Signal mean power [dBm] | Wanted Signal mean power [dBm] | Type of Interfering Signal |
| -15 | PREFSENS +6dB | CW carrier |

The blocking performance requirements defined for NR BS are similar to those defined for LTE.

* + 1. UE Adjacent channel selectivity

Adjacent channel selectivity (ACS) is a measure of a receiver's ability to receive an NR 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 requirements specified in the table below for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz.

These limits are similar to LTE limits.

Table 50: ACS for NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RX parameter | Units | Channel bandwidth | | | | |
| 5-10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz |
| ACS | dB | [33] | [30] | [27] | [26] | [25.5] |

* + 1. Conducted BS Adjacent channel selectivity

The ACS requirement is applicable outside the Base Station RF Bandwidth or Radio Bandwidth. The interfering signal offset is defined relative to the Base station RF Bandwidth edges or Radio Bandwidth edges.

Table : Base station ACS requirement

|  |  |  |
| --- | --- | --- |
| NR channel bandwidth of the lowest/highest carrier received [MHz] | Wanted signal mean power [dBm] | Interfering signal mean power [dBm] |
| 5, 10, 15, 20 (NOTE 1) | PREFSENS + 6dB | Wide Area: -52  Medium Range: -47  Local Area: -44 |
| [25, 30, 40, 50, 60, 70, 80, 90, 100] (NOTE 1) | PREFSENS + 6dB | Wide Area: -52  Medium Range: -47  Local Area: -44 |
| NOTE: The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth | | |

These limits are similar to LTE limits.

1. Main technical parameters of AAS (LTE/NR) system for coexistence studies in 1800 MHz band
   * 1. AAS LTE and AAS NR Radiated (OTA) limits

For lower bands AAS functionality is a feature that applied to the BS side only not to the UE. The NR and LTE UE requirements are defined in TS38.101-1 and TS36.101 respectively as conducted requirements they remain the same whether the BS is AAS or non-AAS.

LTE AAS BS requirements are defined in 3GPP TS37.105 Section-9 for the BS transmitter side and Section-10 for the Receiver side. LTE AAS system will be covered by the NR Harmonised Standards EN 301 908 part 23 (NR BS). The UE part of LTE is covered by ETSI EN 301 908-13 which is the same as for non-AAS system.

NR AAS BS requirements are defined in 3GPP TS 38.104 Section-9 for the BS transmitter side and Section-10 for the receiver side for the receiver side, starting from NR release 15. NR AAS system will be covered by the NR Harmonised Standards: EN 301 908 part 24 (NR BS) and EN 301 908 part 25 (NR UE).

TS 37.105 provides the background for defining OTA AAS BS requirements. It states that for OTA AAS BS there are no conducted requirements. The radiated requirements have been derived in 3GPP based on the principle that they offer the same level of performance and protection as the hybrid AAS BS requirements. The radiated requirements therefore use the same equivalence as hybrid AAS BS to the non-AAS requirements assuming a scaling factor based on 8TRX compared to non-AAS BS.

Some "relative" requirements are direct references to the non-AAS BS RF specifications e.g. 3GPP TS 36.104 and 3GPP TS 37.104. Some co-location requirements which have been developed from assumptions on BS-to-BS coupling do not have direct OTA equivalents. The radiated co-location requirements use the same scenarios used to develop the non-AAS RF requirements.

Table 52: NR operating bands in 900/1800MHz

|  |  |  |  |
| --- | --- | --- | --- |
| NR operating band | Uplink (UL) operating band BS receive / UE transmit  FUL\_low – FUL\_high | Downlink (DL) operating band BS transmit / UE receive  FDL\_low – FDL\_high | Duplex Mode |
| n3 | 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| n8 | 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |
| n81 | 880 MHz – 915 MHz |  | SUL |
| n80 | 1710 MHz – 1785 MHz |  | SUL |

* + 1. OTA BS output power

3GPP defines the same 3 BS power classes for LTE OTA AAS BS and NR OTA AAS BS (Table 9.3.2.1-2 of TS37.105): Wide Area BS, Medium Range BS and Local Area BS.

Table 53: E-UTRA and NR OTA AAS Base Station rated output power limits for BS classes

|  |  |  |
| --- | --- | --- |
| OTA AAS BS class | | PRated,c,TRP |
| Wide Area BS | (NOTE) | |
| Medium Range BS | ≤ 47 dBm | |
| Local Area BS | ≤ 33 dBm | |
| NOTE: There is no upper limit for the PRated,c,TRP of the Wide Area Base Station. | | |

TR37.843 (Release 15) provides explanation in section 5.2.4 on how the AAS BS output power was derived from non-AAS BS specifications. These are important to apprehend some if the compatibility analyses in this Report.

The AAS BS output power limits in existing requirements are based on the values derived for the non-AAS BS specifications. These power levels are specified as the rated output power per carrier at the antenna connector, i.e. per non-AAS transceiver.

The equivalent output power limit for the OTA AAS BS specification is TRP. The AAS BS TRP is equivalent to the system output power (i.e. not the transceiver unit output power) by the following relationship:

PRated,c,TRP = PRated,c,sys – LTX

The OTA AAS BS output power limit can therefore be defined as:

PRated,c,TRP ≤ Non-AAS Power limit – LTX + 10log(NTXU)

Where NTXU is the minimum number of active transceiver units, for an OTA AAS BS has ≥8 TRXU’s for E-UTRA or ≥4 TRXU’s for UTRA. This number is fixed. As both LTX and NTXU have fixed values, the values in the power limit tables do not need to include variables and the adjusted fixed number can be used.

For example for medium range E-UTRA

PRated,c,TRP ≤ 38 dBm – 0 +10LOG10(8) ≤ 47 dBm

* + 1. OTA BS Channel bandwidth and Maximum transmission bandwidth configuration and corresponding Minimum guard-band

The channel bandwidth and Maximum transmission bandwidth configuration requirements in 3GPP are defined independently from whether the BS is AAS or non-AAS.

The same BW applies to LTE-AAS and LTE-non AAS BS.

The same BW and Maximum transmission bandwidth configuration applies to NR-AAS and NR-non-AAS BS.

Similar to the conclusion derived in ANNEX1 for NR-non-AAS, for CBW higher than 5MHz, NR-AAS BS has higher spectrum utilisation compared to LTE BS. However for these larger CBWs, the related minimum guard band (distance between the NR-AAS BS last in-band resources block edge to the NR channel edge) is larger than LTE 1.4, 3 and 5 MHz channels and always higher than 300KHz. This is consistent with the coexistence conditions with GSM.

* + 1. OTA Operating band unwanted emission

3GPP defines in TS37.105 (section 9.7.5.2.3) the same OTA Operating band unwanted emission requirements for NR-AAS and LTE-AAS BS in bands n3 (1800Hz) and n8 (900MHz).

Table 54: Wide Area operating band unwanted emission mask (UEM) for BC2 for BS not supporting NR or BS supporting NR in Band n3 or n8

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | Minimum requirement (NOTE 2, 3) | Measurement bandwidth (NOTE 10) |
| 0 MHz ≤ Δf < 0.2 MHz  (NOTE 1) | 0.015 MHz ≤ f\_offset < 0.215 MHz | -5 dBm | 30 kHz |
| 0.2 MHz ≤ Δf < 1 MHz | 0.215 MHz ≤ f\_offset < 1.015 MHz |  | 30 kHz |
| (NOTE 9) | 1.015 MHz ≤ f\_offset < 1.5 MHz | -17 dBm | 30 kHz |
| 1 MHz ≤ Δf ≤  min(Δfmax, 10 MHz) | 1.5 MHz ≤ f\_offset < min(f\_offsetmax, 10.5 MHz) | -4 dBm | 1 MHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.5 MHz ≤ f\_offset < f\_offsetmax | -6 dBm (NOTE 11) | 1 MHz |
| NOTE 1: For operation with an E-UTRA 1.4 or 3 MHz carrier adjacent to the Base Station RF Bandwidth edge, the limits in table 9.7.5.2.3-2 apply for 0 MHz ≤ Δf < 0.15 MHz.  NOTE 2: For MSR RIB supporting non-contiguous spectrum operation within any operating band the minimum requirement within sub-block gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks on each side of the sub-block gap, where the contribution from the far-end sub-block shall be scaled according to the measurement bandwidth of the near-end sub-block. Exception is f ≥ 10MHz from both adjacent sub-blocks on each side of the sub-block gap, where the minimum requirement within sub-block gaps shall be -6dBm/MHz.  NOTE 3: For a MSR multi-band RIB with Inter RF Bandwidth gap < 2×ΔfOBUE operation the minimum requirement within the Inter RF Bandwidth gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks or Base Station RF Bandwidth on each side of the Inter RF Bandwidth gap, where the contribution from the far-end sub-block or Base Station RF Bandwidth shall be scaled according to the measurement bandwidth of the near-end sub-block or Base Station RF Bandwidth. | | | |

TR37.843 (Release 15) provides explanation in section 5.6.1.2 on how the unwanted emissions for AAS BS were derived based on basic limits that are conducted requirements corresponding to non-AAS BS unwanted emissions and by applying a fixed scaling factor FSF that is based on minimum number of 8 transceiver units for E-UTRA.

The OTA AAS BS emissions limits for E-UTRA therefore are applied per cell and are based on the basic limits used in the Rel-13 AAS BS requirements multiplied by the FSF equal to 8 (or plus 9dB).

Besides, TR37.843 provides some elements on how the existing EIRP regulations were interpreted to TRP e.g.:

* E-UTRA: OTA AAS BS emissions limits = EIRP – [17] dBi + 9 dB

A fixed assumption was made of the gain of a passive antenna system [17]dBi in order that an OTA TRP requirement can be provided for AAS BS

* + 1. OTA Adjacent Channel Leakage power Ratio (ACLR)

3GPP defined in TS37.105 section 9.7.3, OTA ACLR requirements (Relative and Absolute) for LTE AAS BS. These correspond to the same values defined in TS38.104 for NR.

OTA Adjacent Channel Leakage power Ratio (ACLR) is defined as 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 measured power is TRP.

In these specifications, the (relative) OTA ACLR limits for AAS BS are the same as those specified in 3GPP TS 37.104 for LTE-non-AAS BS (which is the same as for NR-non-AAS) i.e. 45dB.

The ACLR absolute limits are defined as follows:

* For E-UTRA or NR Category A AAS BS of Wide Area BS class the OTA ACLR absolute limit of -4dBm/MHz shall apply;
* For E-UTRA or NR Category B AAS BS Wide Area BS class the OTA ACLR absolute limit of -6dBm/MHz shall apply;
* For E-UTRA or NR AAS BS of Medium Range BS class the OTA ACLR absolute limit of -16 dBm/MHz shall apply;
* For E-UTRA or NR AAS BS of Local Area BS class the OTA ACLR absolute limit of -23dBm/MHz shall apply.

The OTA ACLR limit or the ACLR absolute limit of AAS BS, whichever is less stringent, shall apply outside the Base Station RF Bandwidth or Radio Bandwidth.

For 900/1800MHz bands in Europe the requirements for Category B BS applies.

Similar to the principle for operating band unwanted emissions definition, the ACLR absolute limits are defined based on the requirements from non-AAS-BS scaled by a fixed Scaling Factor FSF equal to 8 (or plus 9dB):

* + 1. OTA BS spurious emissions

For NR AAS BS (type 1-O) 3GPP defined in TS38.104 section 9.7.5.2 requirements consisting of OTA transmitter spurious emission requirements based on TRP and co-location requirements not based on TRP.

The TRP Tx spurious emissions requirements for NR AAS BS (type 1-O) shall not exceed an OTA limit specified as the basic limit + X, where X = 9 dB, unless stated differently in regional regulation.

The basic limit corresponds to the conducted requirement for NR-non-AAS BS that is detailed in Annex 1 above.

Regarding the OTA NR requirement for Protection of the BS receiver of own or different BS, it shall be applied for NR FDD operation in order to prevent the receivers of own or a different BS of the same band being desensitised by emissions from a type 1-O BS.

This requirement is a co-location requirement as defined in subclause 4.9 of TS38.104, the power levels are specified at the co-location reference antenna output.

The total power of any spurious emission from both polarisations of the co-location reference antenna connector output shall not exceed the basic (conducted) limits defined in subclause 6.6.5.2.2 of TS38.104 for NR-non-AAS BS + X dB, where X = -21 dB. This corresponds to -30dB coupling + 9dB scaling factor.

For LTE-AAS BS, 3GPP defines in TS37.105 section the same values as per NR-AAS BS.

* + 1. OTA BS Adjacent channel selectivity, general blocking, and narrowband blocking

3GPP defines in TS 37.105 section 10.5.4 OTA BS ACS and NB Blocking for single E-UTRA BS operation. The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel.

The NR ACS, general blocking and NB-Blocking are defined in TS38.104 in section 10.5.

Table 55: OTA Narrowband blocking requirement for E-UTRA BS

|  |  |  |  |
| --- | --- | --- | --- |
|  | Wanted signal mean power [dBm]  (NOTE) | Interfering signal mean power [dBm] | Type of interfering signal |
| Wide Area BS | EISREFSENS + 6dB | -49 – ΔOTAREFSENS | See table 10.5.4.2-2 |
| EISminSENS + 6dB | -49 – ΔminSENS |
| Medium Range BS | EISREFSENS + 6dB | -44 – ΔOTAREFSENS | See table 10.5.4.2-2 |
| EISminSENS + 6dB | -44 – ΔminSENS |
| Local Area BS | EISREFSENS + 6dB | -41 – ΔOTAREFSENS | See table 10.5.4.2-2 |
| EISminSENS + 6dB | -41 – ΔminSENS |
| NOTE: EISREFSENS and EISminSENS depend on the RAT, the BS class and on the channel bandwidth, see subclauses 10.3 and 10.2. | | | |

Table 56: Interfering signal for OTA Narrowband blocking requirement for E-UTRA BS (Table 10.5.4.2-2 of TS37.105)

|  |  |  |
| --- | --- | --- |
| E-UTRA channel  BW of the lowest/highest carrier received [MHz] | Interfering RB centre frequency offset to the lower/upper Base Station RF Bandwdith edge or sub-block edge inside a sub-block gap [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 (NOTE) |
| 3 | ±(247.5+m\*180),  m=0, 1, 2, 3, 4, 7, 10, 13 | 3 MHz E-UTRA signal, 1 RB (NOTE) |
| 5 | ±(342.5+m\*180),  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5 MHz E-UTRA signal, 1 RB (NOTE) |
| 10 | ±(347.5+m\*180),  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5 MHz E-UTRA signal, 1 RB (NOTE) |
| 15 | ±(352.5+m\*180),  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5 MHz E-UTRA signal, 1 RB (NOTE) |
| 20 | ±(342.5+m\*180),  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5 MHz E-UTRA signal, 1 RB (NOTE) |
| NOTE: Interfering signal consisting of one resource block is positioned at the stated offset, the channel bandwidth of the interfering signal is located adjacently to the lower/upper Base Station RF Bandwidth edge. | | |

Table 57: OTA Adjacent channel selectivity for E-UTRA Wide Area BS (Table 10.5.4.2-3 of TS37.105)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| E-UTRA  channel bandwidth of the lowesthighest carrier received [MHz] | Wanted signal mean power [dBm]  (NOTE) | Interfering signal mean power [dBm] | Interfering signal centre frequency offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [MHz] | Type of interfering signal |
| 1.4 | EISminSENS + 11dB | -52 – ΔminSENS | ±0.7025 | 1.4MHz E-UTRA signal |
| 3 | EISminSENS + 8dB | -52 – ΔminSENS | ±1.5075 | 3MHz E-UTRA signal |
| 5 | EISminSENS + 6dB | -52 – ΔminSENS | ±2.5025 | 5MHz E-UTRA signal |
| 10 | EISminSENS + 6dB | -52 – ΔminSENS | ±2.5075 | 5MHz E-UTRA signal |
| 15 | EISminSENS + 6dB | -52 – ΔminSENS | ±2.5125 | 5MHz E-UTRA signal |
| 20 | EISminSENS + 6dB | -52 – ΔminSENS | ±2.5025 | 5MHz E-UTRA signal |
| NOTE: EISminSENS depends on the channel bandwidth as specified see subclause 10.2. | | | | |

Table 58: OTA ACS requirement for NR AAS BS type 1-O (Table 10.5.1.2-1o of TS38.104)

|  |  |  |
| --- | --- | --- |
| BS channel bandwidth of the lowest/highest carrier received [MHz] | Wanted signal mean power [dBm]  (Note 2) | Interfering signal mean power [dBm] |
| 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80,90, 100 (Note 1) | EISminSENS + 6dB | Wide Area: -52 – ΔminSENS  Medium Range: -47– ΔminSENS  Local Area: -44– ΔminSENS |
| NOTE 1:The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth  NOTE 2:EISminSENS depends on the BS channel bandwidth | | |

Table 59: OTA ACS interferer frequency offset for NR AAS BS type 1-O (Table 10.5.1.2-2 of TS38.104)

|  |  |  |
| --- | --- | --- |
| BS channel bandwidth of the lowest/highest carrier received [MHz] | Interfering signal centre frequency offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [MHz] | Type of interfering signal |
| 5 | ±2.5025 | 5 MHz DFT-s-OFDM NR signal  SCS: 15kHz, 25 RB |
| 10 | ±2.5075 | 5 MHz DFT-s-OFDM NR signal  SCS: 15kHz, 25 RB |
| 15 | ±2.5125 | 5 MHz DFT-s-OFDM NR signal  SCS: 15kHz, 25 RB |
| 20 | ±2.5025 | 5 MHz DFT-s-OFDM NR signal  SCS: 15kHz, 25 RB |
| 25 | ±9.535 | 20 MHz DFT-s-OFDM NR signal  SCS: 15kHz, 100 RB |
| 30 | ±9.585 | 20 MHz DFT-s-OFDM NR signal  SCS: 15kHz, 100 RB |
| … |  |  |

Table 60: General OTA blocking requirement for NR AAS BS type 1-O (Table 10.5.2.2-1 of TS38.104)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| BS channel bandwidth of the lowest/highest carrier received [MHz] | Wanted signal mean power [dBm] | Interfering signal mean power [dBm] | Interfering signal centre frequency minimum offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [MHz][MHz] | Type of interfering signal |
| 5, 10, 15, 20 | EISREFSENS + 6 dB | Wide Area: -43 - ΔOTAREFSENS  Medium Range: -38 - ΔOTAREFSENS  Local Area: -35 - ΔOTAREFSENS | ±7.5 | 5 MHz DFT-s-OFDM NR signal  SCS: 15 kHz, 25 RB |
| EISminSENS + 6 dB | Wide Area: -43 – ΔminSENS  Medium Range: -38 – ΔminSENS  Local Area: -35 – ΔminSENS | ±7.5 | 5 MHz DFT-s-OFDM NR signal  SCS: 15 kHz, 25 RB |
| 25 ,30, 40, 50, 60, 70, 80, 90, 100 | EISREFSENS + 6 dB | Wide Area: -43 - ΔOTAREFSENS  Medium Range: -38 - ΔOTAREFSENS  Local Area: -35 - ΔOTAREFSENS | ±30 | 20 MHz DFT-s-OFDM NR signal  SCS: 15 kHz, 100 RB |
| EISminSENS + 6 dB | Wide Area: -43 – ΔminSENS  Medium Range: -38 – ΔminSENS  Local Area: -35 – ΔminSENS | ±30 | 20 MHz DFT-s-OFDM NR signal  SCS: 15 kHz, 100 RB |

Table 61: OTA narrowband blocking requirement for AAS NR BS type 1-O

(Table 10.5.2.2-2 of TS38.104)

|  |  |  |
| --- | --- | --- |
| BS channel bandwidth of the lowest/highest carrier received [MHz] | OTA Wanted signal mean power [dBm] | OTA Interfering signal mean power [dBm] |
| 5, 10, 15, 20 | EISREFSENS + 6 dB | Wide Area: -49 - ΔOTAREFSENS  Medium Range: -44 - ΔOTAREFSENS  Local Area: -41 - ΔOTAREFSENS |
| EISminSENS + 6 dB | Wide Area: -49 – ΔminSENS  Medium Range: -44 – ΔminSENS  Local Area: -41 – ΔminSENS |
| 25, 30, 40, 50, 60, 70, 80, 90, 100 | EISREFSENS + 6 dB | Wide Area: -49 - ΔOTAREFSENS  Medium Range: -44 - ΔOTAREFSENS  Local Area: -41 - ΔOTAREFSENS |
| EISminSENS + 6 dB | Wide Area: -49 – ΔminSENS  Medium Range: -44 – ΔminSENS  Local Area: -41 – ΔminSENS |
| NOTE: The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth | | |

Table 62: OTA narrowband blocking interferer frequency offsets for BS type 1-O (Table 10.5.2.2-3 from TS38.104)

|  |  |  |
| --- | --- | --- |
| BS channel bandwidth of the lowest/highest carrier received [MHz] | Interfering RB centre frequency offset to the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [kHz] | Type of interfering signal |
| 5 | ±([342.5] + m\*180),  m=0, 1, 2, 3, 4, 9, 14, 19, 24 | 5 MHz DFT-s-OFDM NR signal, 1 RB  SCS: 15 kHz |
| 10 | ±([347.5] + m\*180),  m=0, 1, 2, 3, 4, 9, 14, 19, 24 |
| 15 | ±([352.5] + m\*180),  m=0, 1, 2, 3, 4, 9, 14, 19, 24 |
| 20 | ±([342.5] + m\*180),  m=0, 1, 2, 3, 4, 9, 14, 19, 24 |
| 25 | ±([557.5] + m\*180),  m=0, 1, 2, 3, 4, 29, 54, 79, 104 | 20 MHz DFT-s-OFDM NR signal, 1 RB  SCS: 15 kHz |
| 30 | ±([562.5] + m\*180),  m=0, 1, 2, 3, 4, 29, 54, 79, 104 |

The blocking performance requirements defined for AAS NR BS and those defined for AAS LTE BS are comparable.

OTA wanted signal mean power and OTA interfering signal mean power used in the above requirements' definition are shifted by Δ (ΔminSENS and ΔOTAREFSENS ) compared to LTE-non-AAS requirements definition.

TS37.105 provides the following definitions for the Δ:

* ΔminSENS = PREFSENS – EISminSENS
* ΔOTAREFSENS = PREFSENS -EISREFSENS

As we can see, the interference signal mean power is tested over 2 points: one that is scaled by ΔOTAREFSENS and by ΔminSENS compared to LTE non AAS Interfering signal mean power.

The relative wanted signal mean power defined for LTE AAS BS is respectively is a function of EISREFSENS and EISminSENS and is also scaled by the same ΔOTAREFSENS and by ΔminSENS compared to LTE non AAS relative wanted signal mean power.

This means that the rejections of the AAS LTE BS receiver derived from narrow band blocking is the same as for LTE-non-AAS BS.

* + 1. OTA BS Reference sensitivity level

For AAS NR BS, the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in the corresponding table and annex A of TS38.104 when the OTA test signal is at the corresponding EISREFSENS level and arrives from any direction within the FR1 OTA REFSENS RoAoA.

Table 63: NR AAS Wide Area BS OTA reference sensitivity levels (Table 10.3.2-1 of TS38.104)

|  |  |  |  |
| --- | --- | --- | --- |
| BS channel bandwidth [MHz] | Sub-carrier spacing [kHz] | Reference measurement channel | OTA Reference sensitivity level, EISREFSENS  [dBm] |
| 5, 10, 15 | 15 | G- FR1-A1-1 | -101.7 - ΔOTAREFSENS |
| 10, 15 | 30 | G- FR1-A1-2 | -101.8 - ΔOTAREFSENS |
| 10, 15 | 60 | G- FR1-A1-3 | -98.9 - ΔOTAREFSENS |
| 20, 25, 30, 40, 50 | 15 | G- FR1-A1-4 | -95.3 - ΔOTAREFSENS |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | 30 | G- FR1-A1-5 | -95.6 - ΔOTAREFSENS |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | 60 | G- FR1-A1-6 | -95.7 - ΔOTAREFSENS |
| NOTE: EISREFSENS 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 the reference measurement channel mapped to disjoint frequency ranges with a width corresponding to the number of resource blocks of the reference measurement channel each, except for one instance that might overlap one other instance to cover the full BS channel bandwidth. | | | |

For OTA AAS LTE BS, the reference sensitivity level is defined in TS37.105 in section 10.3.4 "Minimum requirement for single RAT E-UTRA operation" as follows:

Table 64: E-UTRA Wide area AAS BS OTA reference measurement channel (Table 10.3.4-1 from TS37.105)

|  |  |  |
| --- | --- | --- |
| E-UTRA  channel bandwidth [MHz] | Reference measurement channel | EISREFSENS  [dBm] |
| 1.4 | FRC A1-1 in 3GPP TS 36.104 [8], annex A.1 | -106.8 - ΔOTAREFSENS |
| 3 | FRC A1-2 in 3GPP TS 36.104 [8], annex A.1 | -103.0 - ΔOTAREFSENS |
| 5 | FRC A1-3 in 3GPP TS 36.104 [8], annex A.1 | -101.5 - ΔOTAREFSENS |
| 10 | FRC A1-3 in 3GPP TS 36.104 [8], annex A.1 (NOTE) | -101.5 - ΔOTAREFSENS |
| 15 | FRC A1-1 in 3GPP TS 36.104 [8], annex A.1(NOTE) | -101.5 - ΔOTAREFSENS |
| 20 | FRC A1-2 in 3GPP TS 36.104 [8], annex A.1(NOTE) | -101.5 - ΔOTAREFSENS |
| NOTE: EISREFSENS 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. | | |

As could be seen from the table above the OTA requirements of NR and LTE are defined in very similar way by applying a - ΔOTAREFSENS to the reference sensitivity levels defined respectively for NR-non-AAS and LTE-non-AAS BS.

We have already analysed in Annex 1 those apparent differences between LTE non-AAS and NR-Non AAS Reference sensitivity levels and concluded the following:

* The difference in sensitivity between NR and LTE is explained mainly by the difference in the Fixed Reference Channel definition used (Noise BW). However, for the same modulated BW, NR and E-UTRA requirements are comparable (0.2 dB better performance for NR compared to LTE).
* The BS Noise figure used for both NR-non-AAS and E-UTRA-non-AAS is 5 dB

Based on the above we can conclude that for the same modulated BW, AAS-NR and AAS-LTE receiver reference sensitivity requirement is comparable ((0.2dB better performance for AAS-NR compared to AAS-LTE).

1. List of References
2. to be finalised during public consultation
3. ECC Decision (06)13 - Designation of the bands 880-915 MHz, 925-960 MHz, 1710-1785 MHz and 1805-1880 MHz for terrestrial UMTS, LTE, WiMAX and IoT cellular systems. Amended March 2018
4. CEPT Report 40 - Compatibility study for LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands), November 2010
5. CEPT Report 41 - Compatibility between LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands) and systems operating in adjacent bands, November 2010
6. CEPT Report 42 - Compatibility between UMTS and existing and planned aeronautical systems above 960 MHz, November 2010
7. ECC Report 266 – The suitability of the current ECC regulatory framework for the usage of Wideband and Narrowband M2M in the frequency bands 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz. June 2017
8. ECC Report 229 - Guidance for improving coexistence between GSM-R and MFCN in the 900 MHz band, May 2015
9. ECC Report 146 - Compatibility between GSM MCBTS and other services (TRR, RSBN/PRMG, HC-SDMA, GSM-R, DME, MIDS, DECT) operating in the 900 and 1800 MHz frequency bands, July 2010
10. ECC Report 82 - Compatibility study for UMTS operating within the GSM 900 and GSM 1800 frequency bands, June 2006
11. ECC Report 96 - Compatibility between UMTS 900/1800 and systems operating in adjacent bands, April 2007
12. ERC Decision (94)01 - ERC Decision of 24th October 1994 on the frequency bands to be designated for the coordinated introduction of the GSM digital pan-European communications system
13. ERC Decision (97)02 - ERC Decision of 21 March 1997 on the extended frequency bands to be used for the GSM Digital Pan-European Communications System
14. EC Decision 2011/251/EU - Commission Implementing Decision of 18 April 2011 amending Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community
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17. ECC Recommendation (08)02 - Frequency planning and frequency coordination for GSM / UMTS / LTE / WiMAX Land Mobile systems operating within the 900 and 1800 MHz bands. April 2012
18. ERC Decision (95)03 - ERC Decision of 1 December 1995 on the frequency bands to be designated for the introduction of DCS 1800
19. 3GPP TS 38.101-1: Technical Specification Group Radio Access Network; NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone (Release 15)
20. 3GPP TS 38.104: Technical Specification Group Radio Access Network; NR; Base Station (BS) radio transmission and reception; (Release 15)
21. CEPT Report 67: Report A from CEPT to the European Commission in response to the Mandate “to develop harmonised technical conditions for spectrum use in support of the introduction of next-generation (5G) terrestrial wireless systems in the Union” Review of the harmonised technical conditions applicable to the 3.4-3.8 GHz ('3.6 GHz') frequency band, July 2018
22. 3GPP TS 36.101
23. 3GPP TS 36.104
24. ETSI EN 301 908-24 - IMT cellular networks; Harmonised Standard for access to radio spectrum Part 24: New Radio (NR) Base Stations (BS) [NR BS V15.1.1]
25. ETSI EN 301 908-25 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Radio Equipment Directive 2014/53/EU; Part 25: New Radio (NR) User Equipments (UE)
26. ETSI EN 301 908-23 - IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 23: Active Antenna System (AAS) Base Station (BS); Conducted conformance testing [AAS BS V13.1.1]  
    [Editor’s Note: Check status of publication of these last three ETSI Harmonised Standards during Public Consultation]
27. ETSI EN 301 908-13 V11.1.2 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 13: Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE)
28. 3GPP TS 37.105 Technical Specification Group Radio Access Network: "Active Antenna System (AAS) Base Station (BS) transmission and reception (Release 14)"
29. 3GPP TS 37.104 Technical Specification Group Radio Access Network: "E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception (Release 15)"
30. 3GPP TR 37.840
31. 3GPP TR 37.842: Evolved Universal Terrestrial Radio Access (E-UTRA) and Universal Terrestrial Radio Access (UTRA; Radio Frequency (RF) requirement background for Active Antenna System (AAS) Base Station (BS)
32. 3GPP TR 25.816
33. 3GPP TR 25.942
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36. Addendum to CEPT Report 59 – Addendum to the CEPT Report 59 in response to the EC Permanent Mandate on the ”Annual update of the technical annex of the Commission Decision on the technical harmonisation of radio spectrum for use by short range devices”, Possibilities for a harmonisation approach for the bands 870-876 MHz and 915-921 MHz also taking into account new opportunities in the band 862-868 MHz
37. EC Decision 2006/771/EC
38. EC Decision 2013/752/EU
39. ERC Report 31
40. ERC Report 100
41. ERC Report 063
42. ERC/REC 70-03
43. ETSI EN 300 422
44. ERC Report 65
45. ERC Report 64
46. ECC Report 173
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48. ERC Recommendation 74-01
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50. ETSI EN 301 502 V11.1.1 - Global System for Mobile communications (GSM); Harmonised EN for Base Station Equipment covering the essential requirements of article 3.2 of the R&TTE Directive
51. ETSI EN 301 511 V 12.5.1 - Global System for Mobile communications (GSM); Mobile Stations (MS) equipment; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
52. ETSI EN 301 908-18 V5.2.1 - IMT cellular networks; Harmonised EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 18: E-UTRA, UTRA and GSM/EDGE Multi-Standard Radio (MSR) Base Station (BS)
53. ETSI EN 301 908-1 V11.1.1 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Introduction and common requirements
54. ETSI EN 301 908-2 V11.1.2 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 2: CDMA Direct Spread (UTRA FDD) User Equipment (UE)
55. ETSI EN 301 908-3 V11.1.3 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 3: CDMA Direct Spread (UTRA FDD) Base Stations (BS)
56. ETSI EN 301 908-11 V11.1.2 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 11: CDMA Direct Spread (UTRA FDD) Repeaters
57. ETSI EN 301 908-14 V11.1.2 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 14: Evolved Universal Terrestrial Radio Access (E-UTRA) Base Stations (BS)
58. ETSI EN 301 908-15 V11.1.2 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 15: Evolved Universal Terrestrial Radio Access (E-UTRA FDD) Repeaters
59. ETSI EN 301 908-21 V6.1.1 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 21: OFDMA TDD WMAN (Mobile WiMAX) FDD User Equipment (UE)
60. ETSI EN 301 908-22 V6.1.1 - IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 22: OFDMA TDD WMAN (Mobile WiMAX) FDD Base Stations (BS)
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    <http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=7493>
64. CEPT Report 19 - Least restrictive technical conditions for frequency bands addressed in the context of WAPECS, October 2008
65. ECC Recommendation (11)06 - Block Edge Mask Compliance Measurements for Base Stations
66. ECO Report 03 - The licensing of 'Mobile bands' in CEPT

1. See Annex 1 section ‎A1.4 for the detailed table of minimum guard band for each NR BS/UE CBW and sub-carrier spacing (SCS) [↑](#footnote-ref-2)
2. Note 1: Frequency separation requirements on GSM as defined in ECC Report 266

   Note 2: Frequency separation requirements on LTE as defined in ECC Report 266 [↑](#footnote-ref-3)