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| **Title\*:** | Interference scenarios for receiver blocking values |
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| input for **Committee**\***:** | BRAN |
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**ABSTRACT:***This document provides relevant information for the discussion on the appropriate values for receiver blocking performance. It is broken into two parts: Possible interference scenarios; and a summary of relevant previous input contributions and standards.*

1. **INTRODUCTION**

Ofcom believe that the receiver blocking values in current draft versions of some of the ENs being prepared by ETSI BRAN are not appropriate to ensure receivers have sufficient resilience to signals from adjacent systems. Most of the current values were taken from the draft of EN 300 328 compiled by TG11. These values are currently being reviewed and updated by TG11 for the subsequent version of EN 300 328. We have included the current discussions within TG11 for information and reference purposes. We believe the final values used for each of the ENs should be based on a general principle that they should be fit for purpose but also be finalised after taking cognisance of, on a case by case basis, the typical interference scenarios for the systems and bands covered by the EN.

This document sets out some of the back history regarding possible interference scenarios discussed and presented in ERM TG11 that were relevant for the 2.4 GHz band discussions. Some of these scenarios may also be relevant to the 5 GHz Wi-Fi and TVWS sharing scenarios and could be used to define the minimum values for receiver blocking within the relevant standards.

BRAN is requested to take note and discuss the analysis set out below and to commit to bringing receiver characteristics in-line with the spirit of the analysis set out below.

1. **POSSIBLE INTERFERENCE SCENARIOS**

Ofcom considers that the receiver blocking values in the ENs covering devices using the 5GHz bands and TVWS bands should be set at appropriate levels to ensure sufficient resilience to interference in the likely interference scenarios that devices will operate in. The following scenarios were considered by TG11 as a starting point:

1. Femto cell in close proximity to Wi-Fi router in a domestic scenario (0.5 or 1m separation may be typical).
2. LTE handset at typical powers in close proximity to a Wi-Fi access point or client device in a coffee shop or public transport (1m or 2m separation in a coffee shop but 0.5m might be relevant on public transport).
3. LTE outdoor base station to outdoor Wi-Fi Access point (10, 20 or 50m separation might be relevant).

These scenarios are analysed below, where a simple minimum coupling loss method is used based on the following parameters.

* Transmit power:
	+ Femtocells are typically 20 to 24 dBm e.i.r.p.
	+ LTE handsets may be up to 23dBm but typical powers of 9 dBm e.i.r.p.
	+ Micro / Macro base stations are typically 35dBm / 60 dBm e.i.r.p.
* Minimum coupling losses at 2400 MHz are:

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| --- | --- | --- | --- | --- | --- | --- |
| **Distance** | **0.5m** | **1m** | **2m** | **10m** | **50m** | **100m** |
| Free space | 34 dB | 40 dB | 46 dB | 60 dB | 74 dB | 80 dB |
| Suburban Hata | - | - | - | 64 dB | 77 dB | 96 dB |
| Note:at 5.8 GHzat 650 MHz | + 8dB loss in free space, (Hata not applicable)-11 dB loss in free space, -11 to -13dB for Hata |

* Which leads to the following maximum wideband signal levels for the various scenarios[[1]](#footnote-1). We note however that the blocking signal specified in EN 300 328 V2.2.20 is CW and some increase in these levels may be required in order to account for this signal type (see section 3 below for further discussion on this point): :

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| --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | **0.5m** | **1m** | **2m** | **10m** | **50m** | **100m** |
| a) Femtocells to Wi-Fi Aps | -10 to -14 dBm | -16 to-20 dBm | -22 to-26 dBm | - | - | - |
| b) LTE handset power into Wi-Fi (typical) (max) | -25 dBm-11 dBm | -31 dBm-17 dBm | -37 dBm-23 dBm | - | - | - |
| c) Micro Base stations to Wi-Fi APs (FSL)d) Macro base stations\* to Wi-Fi Aps (Hata) | - | - | - | -25 dBm-4 dBm | -39 dBm-17 dBm | -45 dBm-36 dBm |

\* It should be noted that at close distances macro cell antenna patterns will become significant and the effective power in the direction of the Wi-Fi AP might be significantly reduced, therefore reducing the blocking requirement

At ERM TG11#47 on 04.07 – 07.07.2016 these scenarios were discussed and narrowed down to what was felt by TG11 to be more relevant scenarios. The output of which was :

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| --- | --- | --- | --- | --- | --- | --- |
| ***Scenario*** | ***0.5m*** | ***1m*** | ***2m*** | ***10m*** | ***50m*** | ***100m*** |
| *a) Femtocells to Wi-Fi Aps* | *~~-10 to~~* *~~-14 dBm~~* | *~~-16 to~~**~~-20 dBm~~* | *-22 to**-26 dBm* | *-* | *-* | *-* |
| *b) LTE handset power into Wi-Fi (typical)* *~~(max)~~* | *-25 dBm**~~-11 dBm~~* | *-31 dBm**~~-17 dBm~~* | *-37 dBm**~~-23 dBm~~* | *-* | *-* | *-* |
| *c) Micro Base stations to Wi-Fi APs (FSL)**d) Macro base stations to Wi-Fi Aps (Hata)* | *-* | *-* | *-* | *-25 dBm**~~-4 dBm~~* | *-39 dBm**~~-17 dBm~~* | *-45 dBm**-36 dBm* |

***TG11 Comments / observations on the various scenarios***

***Scenario a)*** *Separation distance of 0.5 m and 1 m is not considered as realistic. User instructions could provide guidance to respect a minimum separation distance of 2m.*

***Scenario b)*** *We will only consider typical output power for LTE handsets ( 9 dBm eirp)*

*LTE handsets are assumed to operate at a reduced duty cycle. That should be taken into account in the analysis.*

*In addition, a separation distance of 0,5 m between LTE and WIFI UE, seems to indicated both devices belong to the same user.*

***Scenario c)***  *Focus is on scenario d) as that is more challenging.*

***Scenario d)*** *A separation distance of 10 m between a (60 dBm eirp) macro base station and WiFi APs is not realistic. In addition, the AP is not assumed to be in the main beam of the LTE base station.*

 *For the case of a 50 m separation distance, still the AP most likely is not within the antenna beam of the macro basestation. Outdoor APs are assumed to be professional installed.*

This resulted in blocking levels for category 1 receivers being proposed for further discussion as -26dBm / -32dBm rather than the current levels of -47dBm / -53dBm

A suggestion was made that other categories of equipment should be tested against the same levels of blocking signal (as the interference environments were likely to be the same) but that it may be appropriate to raise the wanted signal. This essentially has the effect of reducing the range of the transmission in the presence of blocking but ensures that the system remains operational. Ofcom supports this approach.

It was also agreed that further consideration is needed over CW versus wideband blocking signals

1. **OTHER RELEVANT INPUTS provided to TG11**

The following input contributions are relevant to the discussion on appropriate values for receiver blocking performance in order to ensure that devices have sufficient resilience to interference. We note that in some cases the discussion has moved on since these contributions were made. Previous contributions related to the performance of current equipment have in general not been considered as these relate to equipment intended to operate in the current, not future interference environment and this is not the basis on which minimum performance criteria should be set in the subsequent standard.

 [**ERMTG11(14)000037**](https://docbox.etsi.org/ERM/ERMTG11/05-CONTRIBUTIONS/2014/ERMTG11%2814%29000037_Liaison_statement_to_ETSI_ERM_on_2_4_GHz.docx) **- Liaison statement to ETSI ERM on 2.4 GHz**

WG FM informed ERM that it had assuming a wideband blocking value of -40 dBm / 10 MHz for WLAN access points when modifying the technical parameters in the draft ECC Decision *‘Harmonised technical and regulatory conditions for the use of the band 2300-2400 MHz for MFCN’*. The updated technical conditions were derived from calculations on the coexistence with WLAN above 2.4 GHz and the blocking value is the same as that specified for Home BS from the 3GPP TS 36.104, Table 7.5.1-5.

[**ERMTG11(15)000058**](https://docbox.etsi.org/ERM/ERMTG11/05-CONTRIBUTIONS/2015/ERMTG11%2815%29000058_Proposal_for_Receiver_Blocking_Levels.docx) **and** [**ERMTG11(15)000004**](https://docbox.etsi.org/ERM/ERMTG11/05-CONTRIBUTIONS/2015/ERMTG11%2815%29000004_Proposal_for_Receiver_Blocking_Level.docx) **– Proposal for Receiver blocking Level contribution from Orange**

ERMTG11(15)000004 presented lab results that showed that the difference between a wideband LTE signal and CW signal was 16 to 21 dB at 2380 MHz (average of 18.7dB) and 9 to 18 dB at 2390 MHz (average of 13.7dB).

Applying this to the assumptions made by WG FM would imply that a CW blocking value of -22dBm would be necessary at 2380 MHz. However Orange proposed in ERMTG11(15)000058 that For category 1 receiver, the CW blocking signal level were as follows, although a clear reasoning was not provided in that paper

* -40 dBm at 20 MHz frequency offset (2380 MHz and 2503,5 MHz)
* -20 dBm at and below 2360 MHz and at and above 2523,5 MHz.

However [**ERMTG11(16)000005**](https://docbox.etsi.org/ERM/ERMTG11/05-CONTRIBUTIONS/2016/ERMTG11%2816%29000005_On_the_selection_of_minimum_performance_criteria.docx) **- On the selection of minimum performance criteria** from Ofcom showed that there was a degree of variation between how a Wi-Fi device responded to a wideband TD-LTE signal and a CW signal. This varied by signal strength above Pmin and also by device. Annex 1 of ERMTG11(16)000005 shows that one device was more resilient to the wideband TDD signal than CW and that another device showed a 5dB difference at 6dB above Pmin and concluded that there was insufficient evidence to suggest a single offset between Ofcom’s previous measurements and CW at Pmin + 6dB. By extension this also applies to the difference between TD-LTE and CW at Pmin + 6 dB.

[**ERMTG11(15)000052**](https://docbox.etsi.org/ERM/ERMTG11/05-CONTRIBUTIONS/2015/ERMTG11%2815%29000052_Proposal_for_Blocking_Test_Signal_specifications.docx) **– Proposal for Blocking Test Specifications** from Greenpeak bases some proposed CW blocking levels based on possible interference scenarios from an LTE femtocell and LTE client device of:

* -45 dBm at [approximately] 20 MHz frequency offset (2380 MHz and 2520 MHz)
* -35 dBm below 2380 MHz and above 2520 MHz.

[**ERMTG11(15)000060**](https://docbox.etsi.org/ERM/ERMTG11/05-CONTRIBUTIONS/2015/ERMTG11%2815%29000060_Ofcom_analysis_of_Wi-Fi_blocking_levels.docx) **– Ofcom analysis of Wi-Fi blocking levels** presented some of the key elements on Ofcom’s analysis of the interference risk between LTE in 2350 – 2390 MHz and Wi-Fi and other technologies in the 2.4 GHz band. The Ofcom analysis was predominantly based around a median blocking value of -39 dBm for a wideband signal. Whilst the interference risk was judged to be low it was suggested that if Wi-Fi devices had a better performance, then the risk would be reduced, suggesting a blocking value of higher than -39 dBm for a wideband signal would be required.

[**ES 202 131 v1.2.1**](http://www.etsi.org/deliver/etsi_es/202100_202199/202131/01.02.01_60/es_202131v010201p.pdf) **- Specification of Reference Receiver Performance Parameters for Spectrum Planning**

This standard, published in 2003, presents some minimum performance parameters for receivers for wideband data systems operating in the 2.4 GHz band. Performance parameter values are provided for Receiver sensitivity, blocking/desensitization and adjacent channel selectivity. Example blocking values (in absolute level) are summarised as:

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| **System** | **Blocking value based on wanted signal 6dB above Rx sensitivity** | **Comments** |
| 802.11 – FH systems | 1 Mbit/s: -34 dBm2 Mbit/s: -39 dBm | Value for FER ≤ 3%  |
| 802.11 – DS and 802.11b systems | 2 Mbit/s: -24 dBm11 Mbit/s: -20 dBm | Value for FER ≤ 8% |
| 802.11g - ERP OFDM systems | 6 Mbit/s: -29 dBm54 Mbit/s: -29 dBm | Value for FER ≤ 10% |
| 802.11 a/h systems | 6 Mbit/s: -31 dBm54 Mbit/s: -32 dBm | Value for FER ≤ 10% |
| Bluetooth | -24 dBm | Value for BER ≤ 0.1% |

1. **Conclusions**

Depending on the likely interference scenario the blocking values required may vary from -10dBm to -45 dBm. This is consistent with many of the other inputs and ES 202 131 which suggests that in most cases the standard reference is around -24 to -34 dBm. Please also note that we have addressed receiver parameters for the 5.8GHz band in a separate input.

1. The probability of these scenarios occurring will depend on the 2.4 GHz equipment, use cases and operating scenarios. [↑](#footnote-ref-1)