ANNEX 7: CONSIDERATIONS ON RECEIVER BLOCKING RESPONSE AND RECEIVER BLOCKING LEVEL

A7.1 PRELIMINARY

The blocking parameters of a standard are specified for specific values testing parameters which do not always correspond to typical operational values. In particular, blocking values in LTE standards are specified for desensitization values (e.g. 6 dB for BS, 13 dB for MS) which may not correspond to the desired operational value for specific studies (e.g. 1 dB for BS and 3 dB for MS). It is therefore sometimes necessary to translate the Blocking Level defined by the standard for a desensitization $D_{STANDARD}$ into the corresponding Blocking Level for another desensitization D_{TARGET}.

The analysis in Section A7.3 is conducted for a standard that provides a maximum power (Blocking Level) of an interfering signal received outside of the in-band, for a given frequency offset between the wanted signal and the interfering signal. This absolute blocking level is specified in the standard for a specific desensitization $D_{STANDARD}$. This is the case for the narrowband blocking specifications in LTE standards (ETSI TS 136.101 and ETSI TS 136.104). Ii is also the case for the blocking specifications for the 4th adjacent channel and the following ones in GSM (ETSI TS 145.005).

The analysis in Section A7.4 is conducted for a standard that provides a protection ratio. This is the case for the blocking specifications for the first 3 adjacent channels in GSM (ETSI TS 145.005).

A7.2 DEFINITIONS

Abbreviation	Explanation
Blocking Level	Maximum power (Maximum I_{OOB}) of an interfering signal outside of the in-band, for a given frequency offset between the wanted signal and the interfering signal, given in dBm
Blocking Response	Receiver filter attenuation of signals outside of receiver's channel/band, given in dB. It is derived by the following equation: Blocking Response = I_{IB} - I_{OOB}
$C_{STANDARD}$	Wanted signal level defined by the standard for the blocking specification
D	Desensitization of the receiver in the presence of an interfering signal, given in dB. It corresponds to the 'noise rise' due to the interfering signal and is derived by the following equation in dB: D = 10.log10[(10^(N/10) + 10^(I_{IB}/10))] - N
$D_{STANDARD}$	Desensitization defined by the standard for the blocking specification
D_{TARGET}	Target desensitization for a specific interference study
I_{IB}	I_{OOB} in-band equivalent interfering signal
$I_{IB-STANDARD}$	$I_{OOB-STANDARD}$ equivalent in-band interfering signal
$I_{IB-TARGET}$	$I_{OOB-TARGET}$ equivalent in-band interfering signal
I_{OOB}	Interfering signal at the RF input of a receiver, outside of the receiver's bandwidth.
$I_{OOB-STANDARD}$	Allowed power of an interfering blocking signal as specified by the standard (for $D_{STANDARD}$).
$I_{OOB-TARGET}$	Allowed power of an interfering blocking signal for D_{TARGET}.
N	Noise floor, given in dBm. N is derived from the following equation in dB: 10.log10(k.T.BW) + NF, where k = Boltzmann constant, T = 290 K, BW = Bandwidth, NF = Noise figure
SENSITIVITY	Minimum power of the wanted signal defined by the standard for appropriate reception in the absence of interference

$C_{STANDARD}$ is referred to in different standards and documents as:

- *Useful signal* (ETSI TS 145.005 - Chapters 5.1.2 and 5.1.3)
- *Wanted signal mean power* (ETSI TS 136.104 - Table 7.5.1-1)
- *Pw* (ETSI TS 136.101 - Table 7.6.3.1-1)
- *Prefsens + desensitization* (ETSI TS 136.104 - Table 7.5.1-1, ETSI TS 136.101 - Table 7.6.3.1-1)
- "*C*"

$C_{STANDARD}$ is specified for a given sensitivity and a given desensitization.

$I_{OOB-STANDARD}$ is referred to in different standards as:

- *Blocking signal level* (ETSI TS 145.005 - Table 5.1-2a)
- *Puw* (ETSI TS 136.101 - Table 7.6.3.1-1)
- *Interfering signal mean power* (ETSI TS 136.104 - Table 7.5.1-1)

$I_{OOB-STANDARD}$ is specified for a given frequency offset, a given sensitivity and a given desensitization $D_{STANDARD}$.

$I_{OOB-TARGET}$ is derived for a given frequency offset, a given SENSITIVITY and a given desensitization D_{TARGET}.

SENSITIVITY is referred to in different standards as:

- *Reference sensitivity level* (ETSI TS 145.005 - Tables 6.2-1x),
- *Reference sensitivity* (ETSI TS 136.101 - Table 7.3.1-1),
- *Reference sensitivity power level* (ETSI TS 136.104 - Tables 7.2.1-1 and 7.2.1-2),
- *Prefsens* (ETSI TS 136.101 - Table 7.3.1-1, ETSI TS 136.104 - Tables 7.2.1-1 and 7.2.1-2).

A7.3 WHEN THE BLOCKING LEVEL (MAXIMUM I_{OOB}) IS GIVEN BY THE STANDARDS

A7.3.1 Derivation of the Receiver Blocking Response

A7.3.1.1 Goal

When an interfering signal I_{OOB} is applied to the RF input of a receiver outside of the receiver's bandwidth, the receiver will be interfered due to the non-perfect selectivity of the receiver's filter. However, the receiver's filter attenuate the interfering signal I_{OOB} into an 'equivalent in-band interfering signal' I_{IB}. In other words, the performance of the receiver are left unchanged in presence of the interfering signal I_{OOB} at the given frequency offset, or in presence of the interfering signal I_{IB} in the receiver's bandwidth.

The receiver Blocking Response is defined as the receiver filter attenuation of signals outside of receiver's channel/band (in dB):

$$\text{Blocking Response} = I_{IB} - I_{OOB}$$

The present section derives the receiver Blocking Response from the Blocking Level specified in the standard.

A7.3.1.2 Derivation

Starting from:

$$D_{STANDARD} = 10.\log10[10\text{^}(N/10) + 10\text{^}(I_{IB-STANDARD}/10)] - N$$

$I_{IB-STANDARD}$ can be then derived from the following equation in dB:

$$I_{IB-STANDARD} = N + 10.\log10[10\text{^}(D_{STANDARD}/10) - 1]$$

$$I_{IB\text{-}STANDARD} - N = 10.\log10[10\text{^}(D_{STANDARD}/10) - 1]$$

For example,

- For $D_{STANDARD}$ = 16 dB, ($I_{IB\text{-}STANDARD}$ – N) = 15.9 dB (ETSI TS 136.101 - Table 7.6.3.1-1, Channel Bandwidth = 5 MHz).
- For $D_{STANDARD}$ = 13 dB, ($I_{IB\text{-}STANDARD}$ – N) = 12.7 dB (ETSI TS 136.101 - Table 7.6.3.1-1, Channel Bandwidth = 10MHz).
- For $D_{STANDARD}$ = 6 dB, ($I_{IB\text{-}STANDARD}$ – N) = 4.7 dB (ETSI TS 136.104 - Table 7.5.1-1, Wide Area BS and Local Area BS).
- For $D_{STANDARD}$ = 3 dB, ($I_{IB\text{-}STANDARD}$ – N) = 0 dB (ETSI TS 145.005 - Chapters 5.1.2 and 5.1.3).

Blocking Response is then derived by the following equation:

$$\begin{aligned} \text{Blocking Response} &= I_{IB\text{-}STANDARD} - I_{OOB\text{-}STANDARD} \\ &= N + (I_{IB\text{-}STANDARD} - N) - I_{OOB\text{-}STANDARD} \\ &= N + 10.\log10[10\text{^}(D_{STANDARD}/10) - 1] - I_{OOB\text{-}STANDARD} \end{aligned}$$

A7.3.1.3 Graphical representation

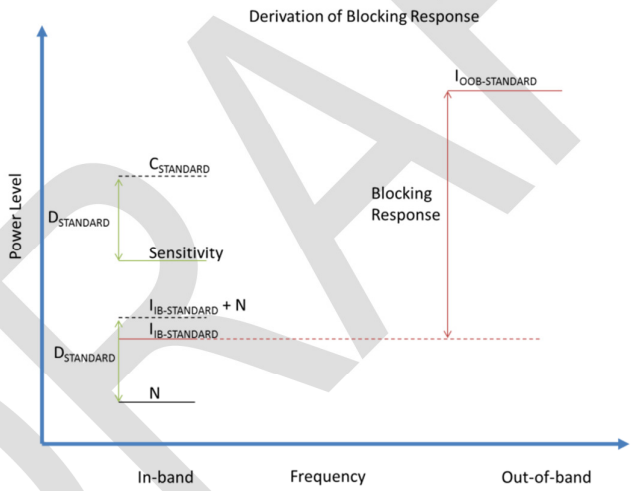

Figure 5: Derivation of the Blocking Response from the Blocking Level specified by the standard

A7.3.2 Derivation of the receiver Blocking Level

A7.3.2.1 Goal

From the Blocking Response, it is possible to derive the receiver Blocking Level for another value of desensitization.

In order to derive this new receiver Blocking Level, we assume that the Blocking Response is constant and fully linear over the complete range of desensitization from 0 to $D_{STANDARD}$.

A7.3.2.2 Derivation

$I_{IB\text{-}TARGET}$ can be derived from the following equation:

$$I_{IB\text{-}TARGET} = N + 10.\log10[10^{\wedge}(D_{TARGET}/10) - 1]$$

$I_{OOB\text{-}TARGET}$ can be derived from the following equation:

$$I_{OOB\text{-}TARGET} = I_{IB\text{-}TARGET} - \text{Blocking Response}$$

A7.3.2.3 Graphical representation

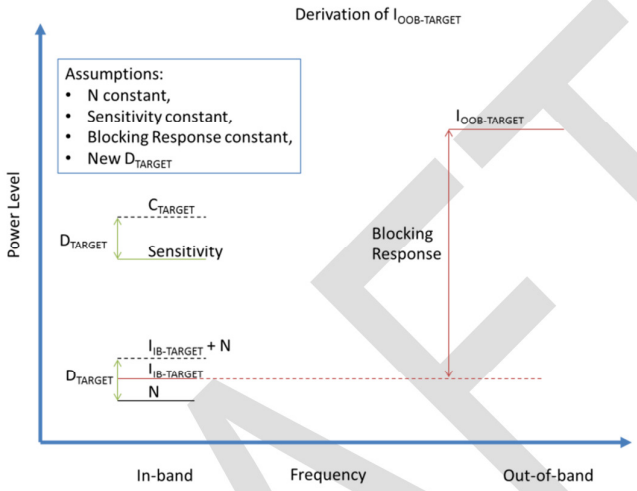

Figure 6: Derivation of the Blocking Level for a desired D_{TARGET}

A7.4 WHEN A PROTECTION RATIO IS GIVEN BY THE STANDARDS

This is the case for GSM, with regards to the 3 first adjacent channels.

In ETSI TS 145.005, Table 6.3-1, the $C_{STANDARD}$ - $I_{OOB\text{-}STANDARD}$ is specified in dB for a desensitization $D_{STANDARD}$ of 3 dB (see chapter 5.1.2 in ETSI TS 145 005).

- First adjacent channel, $[C/Ia1]_{Linear}$[5] = C – Ia1= -9 dB,
- Second adjacent channel, $[C/Ia2]_{Linear}$5 = C –Ia2 = -41 dB,
- Third adjacent channel, $[C/Ia3]_{Linear}$5 = C – Ia3 = -49 dB.

These are the “blocking protection ratios”.

A7.4.1 Derivation

Let’s consider for instance a BS and the first adjacent channel.

$$C_{STANDARD} = SENSITIVITY + D_{STANDARD}$$

$$= -104 \text{ dBm} + 3 \text{ dB}$$

$$= -101 \text{ dBm}$$

[5] It should be noted that the standard refers to C/Ia which is an equation in the linear domain, but specifies the value in dB, i.e. in the logarithmic domain.

$I_{OOB\text{-}STANDARD}$ = $C_{STANDARD}$ - Blocking Protection Ratio

= -101 dBm - (-9 dB)

= -92 dBm

Blocking Response = N + 10.log10[10^($D_{STANDARD}$/10) -1] - $I_{OOB\text{-}STANDARD}$

= -113 + 0 - (-92)

= -21 dB

The Receiver Blocking Level $I_{OOB\text{-}TARGET}$ for a desensitization D_{TARGET} of 1 dB can be derived from the following equation:

$I_{OOB\text{-}TARGET}$ = N + 10.log10[10^(D_{TARGET}/10) -1] - Blocking Response

= -113 - 6 + 21

= -98 dBm