PLANNING PARAMETERS FOR

TERRESTRIAL DIGITAL SOUND

BROASDCASTING SYSTEMS IN VHF

BANDS

HD RADIO SYSTEM

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# Introduction

This document describes some parameters that will be very important to close the planning parameters for terrestrial digital sound broadcasting systems in HDRadio.

## Receiver noise input power level

The thermal noise level for HDRadio can be calculated with the formula:

$$P\_{n}=F+10\*log\_{10}(k\*T\*B)$$

Where,

Pn -> Receiver noise input power level.

F -> Noise Figure.

k -> Boltzmann constant: k = 1.3806504\* 10-23 Ws/K.

T -> Temperature in Kelvin, T= 290◦.

B -> Bandwidth in Hz.

 Considering the information[[1]](#footnote-1) at Tabela 1, it is possible to calculate the Receiver noise input power level for each kind of the receiver. For example, the calculation for Portable Indoor Handset receiver:

$$P\_{n}=F+10\*log\_{10}(k\*T\*B)$$

$$P\_{n}=25+10\*log\_{10}(1.3806504\*10^{-23}\*290\*100000)$$

$$P\_{n}=-128,98 dBW$$

Tabela – Receiver Noise Figure.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Reception Mode | FX | MO | PO | PI | PO-H | PI-H |
| Antenna type | External fixed | Adapted | External telescopic / ear bud | External telescopic / ear bud | Internal | Internal |
| Receiver System Noise Figure, [dB] | 7 | 7 | 8 | 8 | 25 | 25 |

## Minimum receiver input power level

To determine the Minimum receiver input power level for HDRadio can be use the following formula:

$$P\_{s,min}\left(dBW\right)=\left(\frac{C}{N}\right)\_{min}+P\_{n}+L\_{i}\begin{matrix}&&\left(2\right)\end{matrix}$$

Where,

Ps,min -> Minimum receiver input power level.

C/N -> Carrier / Noise.

Pn -> Receiver noise input power level.

Li -> Implementation loss factor.

**RUSS:** in this point I have doubt about the values for C/N in HD Radio. In page 22 until 24, referent to tables 4-3 to 4-7, there are the values in Cd/No [dB-Hz]. In my point of view this parameters are different in relation to C/N. On the other hand, in page 30 Appendix C, we have IBOC FM Conversion of Cd/No to Digital CNR or SNR Example. In this way am I right to say that C/N is like SNRdB for HDRadio? If not, please could you tell me how can calculate it? Below I am sending you an example, if I am right.

**Example:** considering the table 4-1 in reception mode MO for service MP1, we could calcite the C/N as:

$$\frac{C}{N}\_{dB}=SNR=\left(\frac{C\_{d}}{N\_{0}}\right)\_{dB}-48.45 dB$$

$$\frac{C}{N}\_{dB}=SNR=57.2-48.45=8.75 dB$$

Does it correct?

## Effective antenna aperture

To determine the Effective antenna aperture for HDRadio, considering the central operate frequency at 100 MHz, it can be use the following formula:

$$A\_{a}\left(dBm^{2}\right)=10\*log\_{10}\left(\frac{1.64}{4π}\left(\frac{300}{f\_{MHz}}\right)^{2}\right)+G\_{D}\begin{matrix}\left(dB\right)&&\left(4\right)\end{matrix}$$

Where,

Aa -> Effective antenna aperture (dBm2).

GD -> Antenna gain in dBd.

**Example:** considering the table 3.10 in reception mode MO, the antenna gain correction is 0 dB, then the effective antenna aperture is:

$$A\_{a}\left(dBm^{2}\right)=10\*log\_{10}\left(\frac{1.64}{4π}\left(\frac{300}{100}\right)^{2}\right)+0$$

$$A\_{a}\left(dBm^{2}\right)=0.698765$$

## Minimum power flux-density

Minimum power flux density is the magnitude of the Poynting vector at receiving place. To determine the Minimum power flux density for HDRadio can be use the following formula:

$$φ\_{min}\left(dBW/m^{2}\right)=P\_{s,min}\left(dBW\right)-A\_{a}\left(dBm^{2}\right)+L\_{f}\begin{matrix}\left(dB\right)&&\left(3\right)\end{matrix}$$

Where,

ϕmin -> Minimum power flux density.

Ps,min -> Minimum receiver input power level.

Aa -> Effective antenna aperture (dBm2).

Lf -> feeder loss (dB).

**Example:** considering a reception mode MO, the minimum power flux density is:

$$φ\_{min}\left(dBW/m^{2}\right)=-135.23-0.698765+0.3$$

$$φ\_{min}\left(dBW/m^{2}\right)=-135.63$$

## Calculation of minimum RMS

To determine the minimum RMS field-strength level at the location of the receiving antenna, it is possible to use the following equation:

$$E\_{min}\left(dB\left(μV/m\right)\right)=φ\_{min}\left(dBW/m^{2}\right)+10log\_{10}\left(Z\_{F0}\right)\left(dBΩ\right)+20log\_{10}\left(\frac{1V}{1μ}\right)$$

With:

$$Z\_{F0}=\sqrt[2]{\frac{μ\_{0}}{ε\_{0}}}≅120π, the characteristic impedance in free space$$

Resulting in:

$$E\_{min}\left(dB\left(μV/m\right)\right)=φ\_{min}\left(dBW/m^{2}\right)+145.8\left(dBΩ\right)$$

**Example:** considering a reception mode MO, the minimum RMS is:

$$E\_{min}\left(dB\left(μV/m\right)\right)=-135.63 +145.8$$

$$E\_{min}\left(dB\left(μV/m\right)\right)=10.17$$

## Calculation of minimum median RMS field-strength level

For the different receiving scenarios the minimum median RMS field strength is calculated as follows:

* For fixed reception:
	+ $E\_{med}=E\_{min}+P\_{mm}+C\_{l}$

Where:

Emin -> Minimum RMS.

Pm,m -> Allowance for manmade noise.

Cl -> Location correction factor.

* For portable outdoor and mobile reception:
	+ $E\_{med}=E\_{min}+P\_{mm}+C\_{l}+L\_{h}$

Where:

Emin -> Minimum RMS.

Pm,m -> Allowance for manmade noise.

Cl -> Location correction factor.

Lh -> Antenna height loss.

* For portable indoor reception:
	+ $E\_{med}=E\_{min}+P\_{mm}+C\_{l}+L\_{h}+L\_{b}$

Where:

Emin -> Minimum RMS.

Pm,m -> Allowance for manmade noise.

Cl -> Location correction factor.

Lh -> Antenna height loss.

Lb -> Building penetration loss.

## Referências

[1] Recommendation ITU-R BS.1660-6, “Technical basis for planning of terrestrial digital sound broadcasting in the VHF band”, 2012.

[2] EBU-TECH 3317, “Planning parameters for hand held reception concerning the use of DVB-H and T-DMB in Bands III, IV, V and the 1.5 GHz band”, 2007.

[3] GE06 , “Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06) Annex3: Technical basis and characteristics”.

[4] Recommendation ITU-R BS.599, “Directivity of antennas for the reception of sound broadcasting in band 8 (VHF)”, 1982.

[5] ETSI TR 101 190, “Digital Video Broadcasting (DVB); Implementation guidelines for DVB terrestrial services; Transmission aspects”.

1. Document: HD RadioTM System Planning Parameters for VHF Band II, table 4.4 at page 20. [↑](#footnote-ref-1)