EBU

OPERATING EUROVISION AND EURORADIO

TR 025

REPORT ON FREQUENCY AND NETWORK PLANNING PARAMETERS RELATED TO DAB+

VERSION 1.1

SOURCE: SM-EDP

THIS TR SUPERSEDES
BPN 101 (DEC. 2012)

Geneva
October 2013

* Page intentionally left blank. This document is paginated for two sided printing

Contents

Page intentionally left blank. This document is paginated for two sided printing

Report on Frequency and Network Planning Parameters Related to DAB+

EBU Committee	*First Issued*	*Revised*	*Re-issued*
SM-EDP	Dec. 2012		

Keywords: DAB, DAB+, HE-AAC, Frequency, Network Planning, Parameter.

1. Introduction

The DAB+ standard offers high potential for future digital broadcast. Therefore the rollout of DAB+ is strongly favoured by many operators. For planning purposes, parameters and assumptions have to be defined. DAB+ uses a more efficient audio codec (HE-AAC v2), but in principle DAB and DAB+ do not differ substantially from a planning point of view. The majority of planning parameters is identical for both systems and can be taken from well-known planning documents such as the GE06 agreement [1], ITU-R Rec. BS.1660 [2] or EBU BPN 003, 3rd edition [3].

With regard to error protection, DAB+ is designed differently from DAB. DAB+ uses Equal Error Protection (EEP) for which four different Protection Levels are defined. This is described in § 2 together with the associated code rates and net bit rates.

§ 3 characterizes the robustness of the different protection classes by means of C/N values for fixed reception (Rice channel) and for portable and mobile reception (Rayleigh channel). Results from simulations and laboratory measurements are given, together with values for the noise figure of DAB+ receivers.

2. Protection classes and net bit rates

DAB+ is protected by Equal Error Protection EEP. Four different Protection Levels are defined for EEP. Level 1 represents the strongest and Level 4 the lowest error protection, the most frequently used is Level 3. Beyond that there are two feasible options for using EEP, leading to a total of eight possible combinations of DAB+ error protection; the most common EEP option is Option A, which has sub-channels in multiples of 8 kbit/s and offers a maximum flexibility for segmentation for the service providers. In contrast, the rarely used Option B has sub-channels in multiples of 32 kbit/s. Table 1 shows the corresponding code rates for EEP Option A:

Table 1: Code rates for EEP Option A

Protection Level	**1A**	**2A**	**3A**	**4A**
Code rate	1/4	3/8	1/2	3/4

The total capacity of the Main Service Channel (MSC) can be partitioned into several sub-channels. Depending on the number of sub-channels the net bit rate is calculable. Some net bit rates using the example of 6, 12 and 18 sub-channels are given in Table 2:

Table 2: Net bit rates per sub-channel for DAB+

Protection Level	Net bit rate in kbit/s		
	6 sub-channels	12 sub-channels	18 sub-channels
1A	96	48	32
2A	144	72	48
3A	192	96	64
4A	288*	144	96

* *not allowed for DAB+, since the audio bit rates are restricted to fit within a maximum sub-channel size of 192 kbit/s [4]*

DAB+ requires lower bit rates than DAB to achieve comparable audio quality, although opinions vary as to what bitrates actually correspond to an equivalent audio quality [5]. Without entering into detail on this, it may be summarized that for an equivalent audio quality it would be possible to operate twice as many DAB+ programmes than DAB programmes in a given bandwidth. (For example, to achieve a quality better than FM would require about 160 kbit/s for DAB and about 80 kbit/s for DAB+).

3. C/N and receiver noise figures

A fundamental planning parameter for DAB+ that differs from DAB is the C/N value, according to measurements that have been carried out by the IRT for the evaluation of C/N values for DAB+ [6].

In these measurements, a Gaussian type channel was assumed for fixed reception, whereas for mobile and portable reception a Rayleigh channel (profile TU12 at 25 km/h and 178 MHz) was assumed. The measurements result in the following proposal for C/N values:

Table 3: C/N values for DAB+ (IRT measurements)

Protection Level	Fixed Reception (C/N, dB)	Mobile and Portable Reception (C/N, dB)
1A	3.8	7.0
2A	4.4	9.3
3A	5.7	11.8
4A	8.6	17.3

The measurements are based on two arbitrarily chosen DAB+ receivers. The measured receiver noise figures are 4.7dB and 6.7dB. Measurements with more receivers would be required to achieve higher accuracy regarding C/N values and receiver noise figures.

Table 4 shows a comparison of C/N values for DAB and DAB+ for the case of mobile reception.

Table 4: Comparison of C/N values for DAB and DAB+

	Mobile Reception (C/N, dB)
DAB GE06	15.0
DAB measurements (IRT), PL 3	13.3
DAB+ measurements (IRT), PL 3A	11.8

The first row gives the C/N value for DAB from the GE06 agreement [1]. The second C/N value is the result of DAB measurements [7] in a mobile TU channel (50 km/h and 226 MHz), based on the most commonly used DAB mode I with UEP Protection Level 3 (code rate 1/2). The third row corresponds to the C/N value for DAB+ from Table 3 (Protection Level 3A). The improvement of

DAB+ compared to DAB is quite obvious.

Similar results for C/N for mobile reception were achieved in simulations performed by the Communications Research Centre of Canada (CRC) [8], probably for Protection Level 3A. They describe two typical profiles, Urban and Rural, for three different velocities. The results are given in Table 5, which is adapted from [8] *Figure 10 "C/N for threshold of audibility"*.

Table 5: C/N values for DAB+ (CRC simulations)

System	4.2 km/h		84 km/h		251 km/h	
	Urban	Rural	Urban	Rural	Urban	Rural
Layer II, 192 kbit/s [DAB]	15.7	19.2	12.2	13.2	16.7	15.7
HE AAC v2, 40 kbit/s [DAB+]	12.5	17.0	9.0	10.0	10.0	10.9
HE AAC v2, 96 kbit/s [DAB+]	14.0	17.0	9.5	10.0	10.2	11.0

Comparing the C/N values from Table 3 and Table 5, a slight difference is noted, e.g. approximately 2 dB difference between the respective mobile cases:

(*Table 3, PL 3A mobile = 11.8 dB* and *Table 5, Urban, HE AAC v2, 96 kbit/s, 84 km/h = 9.5 dB*).

The C/N values from Table 3 are based on laboratory measurements whereas the values from Table 5 are simulations. An exact match between theory and practice is rarely possible due to implementation aspects. C/N values based on measurements are usually slightly higher than those arising from simulations, as may also be noted for the DAB C/N values in the mobile case:

(*Table 4, DAB, = 13.3 dB* and *Table 5, Urban, Layer II, 192 kbit/s, 84 km/h = 12.2 dB*).

4. References

[1] GE06 Final Acts, ITU-R, Geneva, 2006

[2] ITU-R Rec. BS.1660-4, Technical basis for planning of terrestrial digital sound broadcast in the VHF band, 05/2011

[3] EBU BPN 003, 3rd edition, Technical bases for the T-DAB services network planning and compatibility with existing broadcasting services, 02/2003

[5] Der Systemstandard DAB+, BLM, 10/2008 (in German)

[4] ETSI TS 102 563 (V1.1.1), Digital Audio Broadcasting (DAB); Transport of Advanced Audio Coding (AAC) audio, 2/2007

[6] Labormessungen zur Ermittlung der C/N-Werte bei DAB+ und der Rauschzahl der Empfänger, Raul Schramm, IRT, 11/2011 (in German)

[7] Comparison of C/N values for mobile and portable T-DAB reception, Raul Schramm, IRT, 06/2007

[8] F. Herrmann, L. Erismann and M. Prosch, The evolution of DAB, EBU TECHNICAL REVIEW – 311 - July 2007 1/18