

**Study on the Comparison  
of the Transmitting Power  
between DRM+ and DAB/DAB+ in VHF Band III  
to Cover the same Service Area**

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## Management Summary

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In this report the comparison of the transmitting power between DRM+ and DAB/DAB+ in VHF Band III is given.

The minimum median field strength levels of the radio broadcasting system *Digital Audio Broadcasting* were calculated based on newly results of estimations and measurements. The results comprise different portable and mobile reception modes and all protection levels for both audio signal versions:

- **DAB** with MPEG 1 layer II audio<sup>1</sup> and
- **DAB+** with MPEG 4 AAC audio<sup>2</sup>.

The legal median field strength levels of the radio broadcasting system *Digital Radio Mondiale* in OFDM mode E, so called **DRM+**, were taken into account in its signal configurations **4-QAM** with R=1/3 and **16-QAM** with R=1/2 respectively.

The differences of the transmitting power to provide the same coverage correspond directly with the differences of the minimum median field strength levels of both broadcasting systems. The compared values are slightly different in the particular reception modes. Therefore the results can be shown in a medium value for all estimated portable and mobile reception modes regarding to the particular DAB/DAB+ protection levels. In general DAB/DAB+ is used only with the protection levels 1/1A to 3/3A. Therefore the following results of the comparison with DRM+ refer only to this range of the DAB/DAB+ protection level.

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<sup>1</sup> ETSI EN 300 401: "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers"

<sup>2</sup> ETSI TS 102 563 "Digital Audio Broadcasting (DAB); Transport of Advanced Audio Coding (AAC) audio"

The results of the difference of the transmitting power between DRM+ and DAB/DAB+ in VHF band III to cover the same service area are:

The results of the difference of the transmitting power between DRM+ and DAB/DAB+ in VHF band III to cover the same service area are:

- In any case **DRM+ needs less transmitting power than DAB/DAB+.**
- **Comparing DRM+ (4-QAM) with DAB+,** the difference lies between 9 dB (for DAB+ PL=1A) and 14 dB (for DAB+ PL=3A). Therefore **a medium value of the difference of 12 dB** ( $P_{DAB+} - P_{DRM+}$ ) is estimated.
- **Comparing DRM+ (4-QAM) with DAB,** a medium value of the difference of **15 dB** ( $P_{DAB} - P_{DRM+}$ ) is estimated. This is acceptable due to the fact that the range of the differences regarding to the used DAB protection level is very small and lies between 14 dB and 16 dB.
- **Using DRM+ (16-QAM) instead of DRM+ (4-QAM)** the difference of the transmitting power to DAB/DAB+ is always **about 8 dB lower.** The difference  $P_{DAB/DAB+} - P_{DRM+ 16-QAM}$  lies between 1 dB for DAB+ PL=1A and 6dB for DAB+ PL=3A and at 7 dB for DAB respectively.

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## Details of the Study

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### 1 Objective

DRM+ in VHF band III can provide an opportunity to support the digitalisation of terrestrial radio in addition to large-area DAB/DAB+ coverage, in particular for existing or new local and regional content providers that cannot use DAB efficiently.

In the discussions about the advantages of DAB/DAB+ and DRM+ for local coverages one aspect is the comparison of the distribution costs between DAB/DAB+ and DRM+. These depend notably on the necessary transmitting power of both systems to cover a service area that directly depends on the values of the minimum median field strength levels to reach the coverage.

In this report the minimum median field strength levels of DAB/DAB+ are calculated in different reception modes and signal types and compared with the legal levels of DRM+. Then the differences of the transmitting power are shown.

### 2 Considerations

#### 2.1 References

In the Final Acts of the RRC-06<sup>3</sup> the legal planning parameters for DAB (but not for DAB+) are given only for protection level 3 and only for portable indoor (with a good antenna and receiving equipment) and mobile reception modes. An allowance of man-made noise was not included.

Due to these restrictions newer studies are taken into account to determine the minimum field strength levels for DAB/DAB+ for all protection levels and for all reception modes that are also used for DRM+:

- The EBU Reports TR 025<sup>4</sup> and Report BPN 003<sup>5</sup> give considerations and results of measurements for C/N values for DAB and DAB+ for all protection levels.
- The ITU-Rec. BS.1660-6<sup>6</sup> with the legal planning parameters for DRM+ gives reception modes that comprise handheld reception modes regarding to the EBU Report TECH 3317<sup>7</sup> that are adapted to DAB/DAB+.

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<sup>3</sup> 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)

<sup>4</sup> EBU Report TR 025 "FREQUENCY AND NETWORK PLANNING PARAMETERS RELATED TO DAB+ VERSION" (DEC. 2012)

<sup>5</sup> EBU Report BPN 003 „TECHNICAL BASES FOR T-DAB SERVICES NETWORK PLANNING AND COMPATIBILITY WITH EXISTING BROADCASTING SERVICES" (OKT. 2013)

<sup>6</sup> Recommendation ITU-R BS.1660-6 (08/2012) "Technical basis for planning of terrestrial digital sound broadcasting in the VHF band"

- The ITU-Rec. BS.1660-6 gives the formulas and methods to compute the minimum median field strength levels for DRM+ that are used also for the determination of the values of DAB/DAB+.
- The ITU-Rec. P.372-8/-11<sup>8</sup> gives the values of the allowance for man-made noise.

## 2.2 Basic Values for the Determination of DAB/DAB+

In the named references the following values are given that are basis of the determination of the minimum median field strength levels of DAB/DAB+.

Based on the EBU Reports TR 025 and BPN 003 the following considerations and results of measurements for **C/N values for DAB and DAB+** for all protection levels are taken into account:

Protection Level	C/N (dB)				
	1 / 1A	2 / 2A	3 / 3A	4 / 4A	5 / ---
C/N for DAB (EBU BPN 003)	12.1	12.6	13.3	14.9	18.6
C/N for DAB+ (EBU TR 025)	7.0	9.3	11.8	17.3	

For DAB and DAB+ an **allowance of man-made noise** of 3.62 dB is taken into account. This is the same value that was used in the ITU-Rec. BS.1660-6 for DRM+ that corresponds to the value in the ITU-Rec. P.372-8 for the “residential” reception environment.

**All portable and mobile reception modes** that are described in the ITU-Rec. BS.1660-6 for DRM+ are used for DAB/DAB+:

Reception mode	Probability	Description
Portable indoor (PI)	p=95%	Reception in a building with a good receiver connected with a plug with a non-directional antenna
Portable indoor handheld (PI-H)	p=95%	Reception in a building with a simple receiver with a poor antenna
Portable outdoor (PO)	p=95%	Reception outside a building with a good receiver with battery supply with a non-directional antenna
Portable outdoor handheld (PO-H)	p=95%	Reception outside a building with a simple receiver with battery supply and a poor antenna
Mobile (MO)	p=99%	Reception by a receiver in motion also at high speed with a matched antenna

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<sup>7</sup> 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”

<sup>8</sup> Recommendation ITU-R P.372-8/-11 "Radio noise"

For each reception mode it is estimated that the receiver has a **noise figure** of 7 dB and the receiving antenna has a **gain** of -2.2 dB for the non-directional antenna and of -13 dB for the poor handheld antenna respectively. In the mobile reception mode an antenna **cable loss** of 0.4 dB is taken into account.

With that the minimum field strength levels of DAB/DAB+ at the antenna base were determined.

To calculate the median minimum field strength of DAB/DAB+ in each reception mode the following correction factors were taken into account.

Correction Factors for Reception Mode		PI	PI-H	PO	PO-H	MO
Allowance for man-made noise	$P_{mmn}$ [dB]	3.62	0.00	3.62	0.00	3.62
Antenna height loss	$L_h$ [dB]	12.00	19.00	12.00	19.00	12.00
Building penetration loss	$L_b$ [dB]	9.00	9.00	0.00	0.00	0.00
Location probability	$p$	95%	95%	95%	95%	99%
Distribution factor	$\mu$	1.64	1.64	1.64	1.64	2.33
Standard deviation of DAB field strength	$\sigma_m$ [dB]	5.50	5.50	5.50	5.50	5.50
Standard deviation of building penetration loss	$\sigma_b$ [dB]	3.00	3.00	0.00	0.00	0.00
Location correction factor	$C_l$ [dB]	10.30	10.30	9.05	9.05	12.79
<b>Sum of the Correction Factors</b>	<b>C [dB]</b>	<b>34.92</b>	<b>38.30</b>	<b>24.67</b>	<b>28.05</b>	<b>28.41</b>

### 3 Minimum Median Field Strength Levels

#### 3.1 Minimum Median Field Strength Levels of DAB/DAB+

With the given considerations and computation formulas and methods above the minimum median field strength levels of DAB/DAB+ were calculated with the following results:

Minimum median field strength level of DAB+; $E_{med\ min\ DAB+}$ (dB $\mu$ V/m)				
Reception Mode	DAB+ Protection Level			
	1A	2A	3A	4A
Portable indoor	60.1	62.4	64.9	70.4
Portable indoor handheld	74.3	76.6	79.1	84.6
Portable outdoor	49.8	52.1	54.6	60.1
Portable outdoor handheld	64.0	66.3	68.8	74.3
Mobile	54.0	56.3	58.8	64.3
Difference between the minimum field strength levels for all reception modes referring to PL=1A as 0 dBr	0 dBr	2.3 dBr	4.8 dBr	10.3 dBr

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<b>Minimum median field strength level of DAB; <math>E_{\text{med min DAB}}</math> (dB<math>\mu</math>V/m)</b>					
<b>Reception Mode</b>	<b>DAB Protection Level</b>				
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Portable indoor	65.2	65.7	66.4	68.0	71.7
Portable indoor handheld	79.4	79.9	80.6	82.2	85.9
Portable outdoor	54.9	55.4	56.1	57.7	61.4
Portable outdoor handheld	69.1	69.6	70.3	71.9	75.6
Mobile	59.1	59.6	60.3	61.9	65.6
Difference between the minimum field strength levels for all reception modes referring to PL=1 as 0 dBr	0 dBr	0.5 dBr	1.2 dBr	2.8 dBr	6.5 dBr

Remarks:

- The values of the minimum field strength level of DAB for portable indoor and mobile reception modes for PL=3 fits with the values given in the Final Acts of the RRC-06.
- In every reception mode the difference of the minimum median field strength between two protection levels has a constant value (see last row in the tables above for DAB/DAB+ referring to PL=1A/1 as 0 dBr).

The difference of the minimum median field strength levels between DAB and DAB+ in all the reception modes is always identical for a given protection level and differ only in the particular protection level. Comparing the differences in the protection levels 1/1A to 3/3A it is shown that DAB+ needs less field strength level than DAB, in protection level 4 /4A DAB+ needs more of it.

<b>Difference of the minimum median field strength level between DAB and DAB+ regarding to the protection levels; <math>E_{\text{med min DAB}} - E_{\text{med min DAB+}}</math> (dB)</b>				
<b>DAB / DAB+ Protection Level</b>	<b>1 / 1A</b>	<b>2 / 2A</b>	<b>3 / 3A</b>	<b>4 / 4A</b>
Difference between the minimum median field strength levels of DAB and DAB+	5.1	3.3	1.5	-2.4

### 3.2 Minimum Median Field Strength Levels of DRM+

The minimum median field strength levels of DRM+ are given in the ITU-Rec. BS.1660.6 as following:

<b>Minimum median field strength level of DRM+</b> $E_{\text{med min DRM+}} \text{ (dB}\mu\text{V/m)}$		
	<b>DRM Mode</b>	
<b>Reception Mode</b>	<b>4-QAM</b>	<b>16-QAM</b>
Portable indoor	52.5	60.6
Portable indoor handheld	63.9	72.0
Portable outdoor	42.4	50.5
Portable outdoor handheld	53.3	61.4
Mobile	44.1	51.4

The difference between the minimum median field strength level of DRM+ 16-QAM and DRM+ 4-QAM in all portable reception modes is always 8.1 dB and in the mobile reception it is 7.3 dB.

<b>Difference between the minimum median field strength levels of DRM+ 16-QAM and DRM+ 4-QAM</b> $E_{\text{med min DRM 16-QAM}} - E_{\text{med min DRM 4-QAM}} \text{ (dB)}$	
<b>Reception Mode</b>	
Portable indoor	8.1
Portable indoor handheld	8.1
Portable outdoor	8.1
Portable outdoor handheld	8.1
Mobile	7.3

The medium value of the differences for all reception modes is nearly 8 dB.

#### 4 Comparison between DAB/DAB+ and DRM+

Firstly only DAB+ is compared with DRM+ in 4-QAM mode for these signal variations are most commonly used.

At least a comparison of all signal variations in general is made.

##### 4.1 Comparison between DAB+ and DRM+ (4-QAM)

With the results given above the differences between DAB+ and DRM+ (4-QAM) in the different reception modes were calculated.

<b>Difference between the minimum median field strength levels of DAB+ and DRM+ (4-QAM); <math>E_{\text{med min DAB+}} - E_{\text{med min DRM+4-QAM}}</math> (dB)</b>				
<b>Reception Mode</b>	<b>DAB+ Protection Level</b>			
	<b>1A</b>	<b>2A</b>	<b>3A</b>	<b>4A</b>
Portable indoor	7.6	9.9	12.4	17.9
Portable indoor handheld	10.4	12.7	15.2	20.7
Portable outdoor	7.4	9.7	12.2	17.7
Portable outdoor handheld	10.7	13.0	15.5	21.0
Mobile	9.9	12.2	14.7	20.2

To simplify the results for all reception modes the medium values were calculated for each protection level:

<b>Difference between the minimum median field strength levels of DAB+ and DRM+ 4-QAM; <math>E_{\text{med min DAB+}} - E_{\text{med min DRM+4-QAM}}</math> (dB)</b>				
<b>DAB+ Protection Level</b>	<b>1A</b>	<b>2A</b>	<b>3A</b>	<b>4A</b>
Medium value for all reception modes	9.2	11.5	14.0	19.5

#### 4.2 Comparison between DAB/DAB+ and DRM+ in general

Based on the given results of the comparison between DAB+ and DRM+ in 4-QAM mode all combinations of the comparison between DAB/ DAB+ and DRM in 4-QAM mode and 16-QAM mode respectively were calculated.

The values are slightly different in the particular reception modes. Therefore a summarized presentation is given below.

To simplify the presentation of the results a feasible medium value for all estimated portable and mobile reception modes are shown regarding to the particular DAB/DAB+ protection levels in the following tables:

<b>Difference between the minimum median field strength levels and the transmitting power of DAB+ and DRM+</b> (medium value for all estimated portable and mobile reception modes)				
$E_{\text{med min DAB+}} - E_{\text{med min DRM+}}$ (dB)   $P_{\text{TX DAB+}} - P_{\text{TX DRM+}}$ (dB)				
<b>DAB+ Protection Level</b>	<b>1A</b>	<b>2A</b>	<b>3A</b>	<b>4A</b>
Difference between DAB+ and DRM+ (4-QAM)	9.2	11.5	14.0	19.5
Difference between DAB+ and DRM+ (16-QAM)	1.3	3.6	6.1	11.6

<b>Difference between the minimum median field strength levels and the transmitting power of DAB and DRM+</b> (medium value for all estimated portable and mobile reception modes)					
$E_{\text{med min DAB}} - E_{\text{med min DRM+}}$ (dB)   $P_{\text{TX DAB}} - P_{\text{TX DRM+}}$ (dB)					
<b>DAB Protection Level</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Difference between DAB and DRM+ (4-QAM)	14.3	14.8	15.5	17.1	20.8
Difference between DAB and DRM+ (16-QAM)	6.4	6.9	7.6	9.2	12.9

### 4.3 Summary

In general DAB/DAB+ is used only with the protection levels 1/1A to 3/3A. Therefore the following results of the comparison with DRM+ refer only to this range of the protection level.

**The results of the difference of the transmitting power between DRM+ and DAB/DAB+ in VHF band III to cover the same service area are:**

- In any case **DRM+ needs less transmitting power than DAB/DAB+.**
- **Comparing DRM+ (4-QAM) with DAB+,** the difference that lies between 9 dB (for DAB+ PL=1A) and 14 dB (for DAB+ PL=3A). Therefore **a medium value of the difference of 12 dB** ( $P_{DAB+} - P_{DRM+}$ ) is estimated.
- **Comparing DRM+ (4-QAM) with DAB,** a medium value of the difference of **15 dB** ( $P_{DAB} - P_{DRM+}$ ) is estimated. This is acceptable due to the fact that the range of the differences regarding to the used DAB protection level is very small and lies between 14 dB and 16 dB.
- **Using DRM+ (16-QAM) instead of DRM+ (4-QAM)** the difference of the transmitting power to DAB/DAB+ is always **about 8 dB lower**. The difference  $P_{DAB/DAB+} - P_{DRM+ 16-QAM}$  lies between 1 dB for DAB+ PL=1A and 6dB for DAB+ PL=3A and at 7 dB for DAB respectively.