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| **Report ITU-R BS.2214-2**  **(10/2016)** |
| **Planning parameters for terrestrial  digital sound broadcasting  systems in VHF bands** |
| **BS Series**  **Broadcasting service (sound)** |

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REPORT ITU-R BS.2214-2

Planning parameters for terrestrial digital sound  
broadcasting systems in VHF bands

(2011-2015-2016)

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# 1 Introduction

This Report provides planning parameters for digital terrestrial broadcasting systems G (also known as DRM+) and RAVIS in VHF Bands. DRM+ is designed for use in VHF Bands I, II and III, RAVIS is designed for use in VHF Bands I and II.

The report defines a framework for calculating all relevant network planning parameters that are very similar for both systems.

The system characteristics of digital System G are included in Recommendation ITU‑R BS.1114 and the description of RAVIS is contained in Report ITU‑R BT.2049.

Framework for evaluation of planning parameters is given in Parts 2 to 5.

Part 6 gives planning parameter for DRM+.

Part 7 gives planning parameter for RAVIS.

Normative and technical references are given in Attachments 1 and 2 respectively.

To calculate the relevant planning parameters minimum median field strength and protection ratios, firstly receiver and transmitter characteristics, system parameters as well as transmission aspects as common basis for concrete digital broadcasting transmission network planning are determined. All parameters are either derived or the reference to the source of origin is given. Various typical reception scenarios are taken into account to match as much as possible planning and prediction scenarios.

# 2 Reception modes

## 2.1 Fixed reception

Fixed reception (FX) is defined as reception where a receiving antenna mounted at roof level is used. It is assumed that near-optimal reception conditions (within a relatively small volume on the roof) are found when the antenna is installed. In calculating the field-strength levels for fixed antenna reception, a receiving antenna height of 10 m above ground level is considered to be representative for the broadcasting service [1].

A location probability of 70% is assumed to obtain a good reception situation.

## 2.2 Portable reception

In general, portable reception means a reception where a portable receiver with an attached or built‑in antenna is used outdoors or indoors at no less than 1.5 m above ground level.

A location probability of 95% is assumed to obtain a good reception situation.

Two receiving locations will be distinguished:

– **Indoor reception** with a reception place in a building.

– **Outdoor reception** with a reception place outside a building.

Within these receiving locations two opposed receiving conditions will be distinguished additionally due to the great variability of portable reception situations with different receiver‑/antenna-types and also different reception conditions:

– **Portable reception**:This situation models the reception situation with good reception conditions for both situations indoor and outdoor, resp., and a receiver with an omnidirectional VHF antenna pattern as given in GE06 [1].

– **Portable handheld reception**: This situation models the reception situation with bad reception conditions and a receiver with an external antenna (for example telescopic antennas or the cable of wired headsets) as given in EBU-3317 [2].

### 2.2.1 Portable indoor reception

Portableindoor(PI) reception is defined by a portable receiver with stationary power supply and a built-in (folded)-antenna or with a plug for an external antenna. The receiver is used indoors at no less than 1.5 m above floor level in rooms on the ground floor and with a window in an external wall. It is assumed that optimal receiving conditions will be found by moving the antenna up to 0.5 m in any direction and the portable receiver is not moved during reception and large objects near the receiver are also not moved [1]. A suburban area is assumed.

### 2.2.2 Portable outdoor reception

Portable outdoor (PO) reception is defined as reception by a portable receiver with battery supply and an attached or built-in antenna which is used outdoors at no less than 1.5 m above ground level [1]. A suburban area is assumed in this case.

### 2.2.3 Portable handheld reception (PI-H, PO-H)

Portable reception is defined as reception by a portable handheld receiver with battery supply and an external antenna as given in EBU-3317 [2] for both reception situations indoor and outdoor, respectively. An urban area is assumed in this case.

## 2.3 Mobile reception

Mobile reception (MO) is defined as reception by a receiver in motion also at high speed with a matched antenna situated at no less than 1.5 m above ground level or floor level [1]. A rural area with hilly terrain is assumed in this case.

# 3 Correction factors for field-strength predictions

Recommendation ITU-R P.1546 forms the basis of a field-strength prediction method applicable for the broadcasting services amongst other services. Predictions can be made from 30 MHz up to 3 000 MHz within a path distance of 1 to 1 000 km, percentage of time of 1 to 50%, and for various transmitting antenna heights. The method draws a distinction between paths over land, cold seas and warm seas, makes due allowance for location variability for land area-service predictions and takes account of local clutter surrounding the receiving location. It also provides procedures for handling negative effective transmitting antenna heights and mixed-path propagation (i.e. with combinations of land and sea).

The wanted field-strength level values predicted (see Recommendation ITU-R P.1546) refer always to the median value at a receiving location with a receiving antenna in 10 m height above ground level. This antenna height is a generic value, used as stated only in rural or suburban areas, with constructions or vegetation below 10 m height. Otherwise the wanted field-strength values are predicted at the average construction or vegetation height at the receiving location. The true receiving antenna height influences the height loss correction factor (see § ‎3.4).

To take into account different receiving modes and circumstances into network planning correction factors have to be included to carry the minimum receiver input power level or the minimum field-strength level over to the median minimum field-strength level for predictions (see Recommendation ITU-R P.1546).

## 3.1 Reference frequencies

The planning parameters and correction factors in this document are calculated for the reference frequencies given in Table 1.

TABLE 1

Reference frequencies for calculations

|  |  |  |  |
| --- | --- | --- | --- |
| VHF band (frequency range) | I (47-68 MHz) | II (87.5-108 MHz) | III (174-230 MHz) |
| Reference frequency (MHz) | 65 | 100 | 200 |

## 3.2 Antenna gain

The antenna gain *GD* (dBd) references to a half-wave dipole.

### 3.2.1 Antenna gain for fixed reception

In Recommendation ITU-R BS.599 and GE06 [1], the antenna pattern for fixed reception are given for both VHF Band II (4 dB) and VHF Band III (7 dB). In ETSI-DVB [3] the antenna pattern for fixed reception is given for VHF Band I (3 dB).

Taking into account the current use of roof-top antenna systems with omnidirectional dipole antennas or ground plane antennas for future planning it is recommended that an omnidirectional antenna pattern with a gain of 0 dBd is used (see Table 2).

TABLE 2

Antenna gain *GD* for fixed reception

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Antenna gain *GD* (dBd) | 0 | 0 | 0 |

### 3.2.2 Antenna gain for portable reception

GE06 [1] assumes an omnidirectional VHF antenna pattern with an antenna gain of –2.2 dBd for standard portable receiver planning, e.g. for DAB reception. From this reference, the antenna gains *GD* for portable reception are assumed to –2.2 dBd as given in Table 3.

TABLE 3

Antenna gain *GD* for portable reception

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Antenna gain *GD* (dBd) | –2.2 | –2.2 | –2.2 |

### 3.2.3 Antenna gain for portable handheld reception

Antenna gains *GD* for portable handheld reception in VHF Band III (200 MHz) are given by EBU‑3317[2]:

– Receiver integrated antenna: *GD* = −17 dBd

– External antenna (telescopic or wired headsets): *GD =*−13 dBd

– Adapted antenna (for mobile reception): *GD* = −2.2 dBd

The antenna gain for portable handheld reception in VHF Band I and VHF Band II can be calculate by the computation given in Annex 2, section ‎0 [4]. From it the antenna gains *GD* (dB) for portable handheld reception modes with an external antenna are given in Table 4.

TABLE 4

Antenna gains *GD* for portable handheld reception

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Gain variation Δ*G* referenced to 200 MHz (dB) | –9.76 | –6.02 | 0.00 |
| Antenna gain *GD* for receiver integrated antenna (dBd) | –26.76 | –23.02 | –17.00 |
| **Antenna gain *GD* for portable handheld reception** (external antenna, telescopic or wired headsets) (dBd) | –**22.76** | –**19.02** | –**13.00** |

### 3.2.4 Antenna gain for mobile reception

For mobile reception an omnidirectional VHF antenna pattern with an antenna gain *GD* of −2.2 dBd [1] is assumed, see Table 5.

TABLE 5

Antenna gains *GD* for mobile reception

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Antenna gain *GD* for adapted antenna (mobile reception) (dBd) | –2.2 | –2.2 | –2.2 |

## 3.3 Feeder loss

The feeder loss *Lf* expresses the signal attenuation from the receiving antenna to the receiver’s RF input. The feeder loss *Lf* for fixed reception at 200 MHz is given in GE06 [1] with 2 dB for 10 m cable length. The frequency dependent cable attenuation per unit length *L′f* is assumed to be equal to:

 (1)

with *f* the frequency (MHz). The feeder loss values per unit length *L′f* are given in Table 6.

TABLE 6

Feeder loss *L′f* per unit length

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Feeder loss *L*′*f* (dB/m) | 0.11 | 0.14 | 0.2 |

The feeder loss *Lf* is given by:

 (2)

with *l* the length of the feeder cable (m).

The cable length *l* for the different reception modes are given in Table 7, and the feeder losses *Lf*for different frequencies and reception modes are given in Table 8.

TABLE 7

Cable length *l* for reception modes

|  |  |  |  |
| --- | --- | --- | --- |
| Reception mode | Fixed reception (FX) | Portable reception  (PO, PI, PO-H, PI-H) | Mobile reception (MO) |
| Cable length *l* (m) | 10 | 0 | 2 |

TABLE 8

Feeder loss *Lf* for different reception modes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency (MHz) | | 65 | 100 | 200 |
| Feeder loss *Lf* | for fixed reception (FX) (dB) | 1.1 | 1.4 | 2.0 |
|  | for portable reception (PO, PI, PO-H, PI-H) (dB) | 0.0 | 0.0 | 0.0 |
|  | for mobile reception (MO) (dB) | 0.22 | 0.28 | 0.4 |

## 3.4 Height loss correction factor

For portable reception a receiving antenna height of 1.5 m above ground level (outdoor and mobile) or above floor level (indoor) is assumed. The propagation prediction method usually provides field‑strength values at 10 m. To correct the predicted value from 10 m to 1.5 m above ground level a height loss factor *Lh* (dB) has to be applied.

The height loss correction factor *Lh* for an antenna height of 1.5 m is given in GE06 [1] as follows:

*Lh =*12 dB at 200 MHz

*Lh* = 16 dB at 500 MHz

*Lh* = 18 dB at 800 MHz

Therefore, the height loss correction factor *Lh* (dB) at 100 MHz is assumed to 10 dB, and at 65 MHz to 8 dB, for portable and mobile reception modes The height loss correction factor *Lh* for handheld reception with external antenna is given in EBU-3317 [2] for VHF Band III as 19 dB in urban areas and is assumed to 17 dB at 100 MHz and to 15 dB at 65 MHz.

The height loss correction factor *Lh* for different reception modes is given in Table 9.

TABLE 9

Height loss correction factor *Lh* for different reception modes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency (MHz) | | 65 | 100 | 200 |
| Height loss correction factor *Lh* | for fixed reception (FX) (dB) | 0 | 0 | 0 |
| for portable and mobile reception (PO, PI, MO) (dB) | 8 | 10 | 12 |
| for portable handheld reception (PO-H, PI-H) (dB) | 15 | 17 | 19 |

## 3.5 Building penetration loss

The ratio between the mean field strength inside a building at a given height above ground level and the mean field strength outside the same building at the same height above ground level expressed in (dB) is the mean building penetration loss.

The mean building penetration loss *Lb* in VHF Band III is given in GE06 [1] and EBU-3317 [2] as 9 dB which is proposed to be used for VHF Band II, too. The mean building penetration loss for VHF Band I is given in ETSI-DVB [3] as 8 dB. The standard deviation of the building penetration loss σ*b* is always given by 3 dB.

The mean building penetration losses *Lb* and standard deviations σ*b* are given in Table 10.

TABLE 10

Building penetration loss *Lb* and standard deviation σ*b*

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Mean building penetration loss *Lb* (dB) | 8 | 9 | 9 |
| Standard deviation of the building penetration loss σ*b* (dB) | 3 | 3 | 3 |

## 3.6 Allowance for man-made noise

The allowance for man-made noise (MMN) (dB), takes into account the effect of the MMN received by the antenna on the system performance. The system equivalent noise figure *Fs* (dB) to be used for coverage calculations is calculated from the receiver noise figure *Fr* (dB) and MMN (dB) (for details see Attachment 2, § 2.2):

 (3)

The allowance for man-made noise is calculated from an antenna noise factor *fa*, which takes into account the man-made noise received by the antenna:

 (4)

where:

*fr* : the receiver noise factor:

 (5)

*fa* : the antenna noise factor:

 (6)

where:

*Fa* : the antenna noise figure.

### 3.6.1 Allowance for man-made noise for fixed, portable and mobile reception

Recommendation ITU-R P.372 gives the legal values to calculate the allowance of man-man noise in different areas and frequencies with the definitions of the antenna noise figure, its mean values *Fa,med* and the values of decile variations (10% and 90%) measured in different regions as a function of the frequency. The equation to calculate the antenna noise figure is given in Recommendation ITU‑R P.372 by:

 (7)

For all reception modes the residential area (Curve B in Recommendation ITU-R P.372) is assumed. In this case the values for the variables *c* and *d* are given by:

*c =*72.5                *d =*27.7

Herewith the values of the medium antenna noise figure *Fa,med* (dB) can be computed. The results are shown in Table 11.

TABLE 11

Medium antenna noise figure *Fa,med*

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Medium antenna noise figure *Fa,med* for residential area (curve B) (dB) | 22.28 | 17.10 | 8.76 |

Herewith the MMN (dB), taking into account a receiver noise figure *Fr* of 7 dB, can be computed. The results are shown in Table 12.

TABLE 12

Allowance for man-made noise (MMN) for fixed, portable and mobile reception

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Allowance for man-made noise for fixed, portable and mobile reception (*Fr*= 7 dB) (dB) | 15.38 | 10.43 | 3.62 |

Recommendation ITU-R P.372 gives the value of decile location variations (10% and 90%) in residential area by 5.8 dB. For 90% location probability the distribution factor μ = 1.28. Therefore the standard deviation of MMN for fixed, portable and mobile reception σ*MMN* = 4.53 dB, see Table 13.

TABLE 13

Standard deviation of MMN σ*MMN*for fixed, portable and mobile reception

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Standard deviation of MMN σ*MMN* (dB) | 4.53 | 4.53 | 4.53 |

The standard deviation of MMN has to be considered in the calculation of the combined standard deviation for the wanted field-strength level (see § 3.8.2).

### 3.6.2 Allowance for man-made noise for portable handheld reception

The antenna gain is the product of directivity and efficiency. The lowest realistic directivity is the one of a short dipole (length l << λ) and it has the value 1.5 (1.8 dBi). Any gain lower than 1.8 dBi (−0.4 dBd) is due to an antenna efficiency η lower than 1. The interference power at the receiver input is reduced accordingly and the MMN equation is (see Attachment 2, § 2.2):

 (8)

The efficiency η can be calculated from the antenna gain *GD* (dB) for gains lower than –0.4 dBd:

 (9)

The MMN for portable handheld reception, taking the receiver noise figure as 7 dB, are given in Table 14.

TABLE 14

Allowance for man-made noise for portable handheld reception (external antenna)

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Handheld antenna gain *GD* (dBd) | −22.8 | −19 | −13 |
| Efficiency η | 0.0058 | 0.0138 | 0.055 |
| Calculated MMN allowance (dB) | 0.42 | 0.30 | 0.14 |
| **Allowance for man-made noise for portable handheld reception (dB)** | **0.0** | **0.0** | **0.0** |

In the further calculations the allowance for man-made noise is specified to 0 dB due to the very low calculated values.

## 3.7 Implementation loss factor

Implementation loss of the non-ideal receiver is considered in the calculation of the minimum receiver input power level with an additional implementation loss factor *Li* of 3 dB, see Table 15.

TABLE 15

Implementation loss factor *Li*

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Implementation loss factor *Li* (dB) | 3 | 3 | 3 |

## 3.8 Correction factors for location variability

The random variation of the received signal field strength with location due to terrain irregularities and the effect of obstacles in the near vicinity of the receiver location is modelled by a statistical distribution (typically log normal) over a specified macro-scale area (typically a square with edge lengths of 100 m to 500 m). Considering the received signal field-strength level *E* (dB(μV/m)), the lognormal distribution is transformed in a Gaussian distribution with mean (and median) *Emed* (dB) and standard deviation σ (dB).

The field-strength level *E*(*p*)(dB(μV/m)), used for coverage and interference predictions in the different reception modes, which will be exceeded for *p*(%) of locations for a land receiving/mobile antenna location, is given by:

 for 50% ≤ *p* ≤ 99% (10)

with:

*C*1(*p*) (dB) : location correction factor;

*Emed* (dB(μV/m) : field-strength value for 50% of locations and 50% of time.

The location correction factor *C*l(*p*) (dB) depends on the so called combined standard deviation σ*c* (dB) of the wanted field-strength level that sums the single standard deviations of all relevant signal parts that have to be taken into account and the so-called distribution factor μ(*p*), namely:

 (11)

with:

: the distribution factor and  (standard normal Gaussian CDF)

σ*C* : the combined standard deviation of the wanted field-strength level (dB).

### 3.8.1 Distribution factor

The distribution factors μ(*p*) of the different location probabilities taking into account the different receiving modes (see § 2) are given in Table 16.

TABLE 16

Distribution factor μ

|  |  |  |  |
| --- | --- | --- | --- |
| Percentage of receiving locations *p* (%) | 70 | 95 | 99 |
| Reception mode | fixed | portable | mobile |
| Distribution factor μ | 0.524 | 1.645 | 2.326 |

### 3.8.2 Combined standard deviation

The combined standard deviation σ*c* (dB) takes into account the standard deviation of the wanted field-strength level σ*m* (dB), the standard deviation of the MMNσ*MMN* (dB), and, in the case of indoor reception, the standard deviation of the building penetration loss, σ*b*(dB), respectively.

Since the statistics of the received wanted field-strength level for macro-scale, the statistics of the MMNσ*MMN* (dB), and the statistics of the building attenuation can be assumed to be statistically uncorrelated, the combined standard deviation σ*c* (dB) is calculated by:

 (12)

The values of the standard deviations of the building penetration loss σ*b*(dB) and of the MMNσ*MMN* (dB) are given in §§ 3.5 and ‎3.6, respectively.

The values of standard deviation σ*m* (dB) of the wanted field-strength level *E* are dependent on frequency and environment, and empirical studies have shown a considerable spread. Representative values for areas of 500 m × 500 m are given by Recommendation ITU-R P.1546 as well as the expression to calculate the standard deviation σ*m* (dB):

 (13)

where:

*K* = 1.2, for receivers with antennas below clutter height in urban or suburban environments for mobile systems with omnidirectional antennas at car-roof height

*K*  1.0, for receivers with rooftop antennas near the clutter height

*K*  0.5, for receivers in rural areas

*f*: required frequency (MHz).

Furthermore, the following fixed values are given:

σ*m* = 8.3 dB for broadcasting, analogue at 100 MHz (i.e. FM)

σ*m* = 5.5 dB for broadcasting, digital (more than 1 MHz bandwidth, i.e. DAB)

The standard deviations σ*m* (dB) for FM and DAB are given in Table 17 whereas those for DRM and RAVIS in urban and suburban areas as well as in rural areas are given in Table 18.

TABLE 17

Standard deviation for DAB σ*m,DAB* and FM σ*m,FM*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency (MHz) | | 65 | 100 | 200 |
| Standard deviation | for FM σ*m,FM* (dB) | – | 8.3 | – |
| for DAB σ*m,DAB* (dB) | – | – | 5.5 |

TABLE 18

Standard deviation for DRM and RAVIS σ*m*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency (MHz) | | 65 | 100 | 200 |
| Standard deviation for DRM and RAVIS σ*m* | in urban and suburban areas (dB) | 3.56 | 3.80 | 4.19 |
| in rural areas (dB) | 2.86 | 3.10 | 3.49 |

These values of the standard deviation take into account only the effects of slow fading, but not the effects of fast fading. Therefore it must be ensured that the determination of the minimum *C*/*N* value consider the effects of the fast fading. Otherwise a margin depending to the bandwidth of the signal of 1.6 dB at 8 MHz, 2.3 dB at 1.5 MHz and 4.6 dB at 120 kHz has to be added.

For DRM and RAVIS the effects of fast fading are included into the measurement method and therefore they do not have to be added.

For the different reception modes more or less parts of the given particular standard deviations have to be taken into account, see Table 19.

Due to these differences the combined standard deviation σ*c* (dB) for the respective reception modes are given in Table 20.

TABLE 19

Allowance for the particular standard deviations for the different reception modes

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Particular standard deviations | | σ*m* | σ*m* | σ*m* | σ*MMN* | σ*b* |
| Frequency (MHz) | | 65 | 100 | 200 | all | all |
| Reception modes | fixed (FX) and portable outdoor (PO) (dB) | 3.56 | 3.80 | 4.19 | 4.53 | 0.00 |
| portable handheld outdoor (PO‑H) (dB) | 3.56 | 3.80 | 4.19 | 0.00 | 0.00 |
| mobile (MO) (dB) | 2.86 | 3.10 | 3.49 | 4.53 | 0.00 |
| portable indoor (PI) (dB) | 3.56 | 3.80 | 4.19 | 4.53 | 3.00 |
| portable handheld indoor (PI-H) (dB) | 3.56 | 3.80 | 4.19 | 0.00 | 3.00 |

TABLE 20

Combined standard deviation σ*c* for the different reception modes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency (MHz) | | 65 | 100 | 200 |
| Combined standard deviation σ*c*for reception mode | fixed (FX) and portable outdoor (PO) (dB) | 5.76 | 5.91 | 6.17 |
| portable handheld outdoor (PO-H) (dB) | 3.56 | 3.80 | 4.19 |
| mobile (MO) (dB) | 5.36 | 5.49 | 5.72 |
| portable indoor (PI) (dB) | 6.49 | 6.63 | 6.86 |
| portable handheld indoor (PI‑H) (dB) | 4.65 | 4.84 | 5.15 |

### 3.8.3 Combined location correction factor for protection ratios

The needed protection of a wanted signal against an interfering signal is given as the basic protection ratio *PRbasic* (dB) for 50% of location probability.

In the case of higher location probability as given for all reception modes a so called combined location correction factor *CF* (dB) is used as a margin that has to be added to the basic protection ratio *PRbasic*, valid for the wanted field-strength level and the nuisance field-strength level, to the protection ratio *PR*(*p*) corresponding to the needed percentage *p* (%) of locations for the wanted service [1].

 for 50% ≤ *p* ≤ 99% (14)

with:

 (15)

where σ*w* and σ*n*, both in (dB), denote the standard deviation of location variation for the wanted signal for the nuisance signal, respectively. The values for σ*w* and σ*n*are given in § 3.8.2 for the different broadcasting systems as σ*m*.

## 3.9 Polarization discrimination

In principal it is possible to take advantage of polarization discrimination for fixed reception. GE84 [5] does not take into account polarization discrimination in the planning procedure for VHF Band II, except in specific cases with the agreement of administrations concerned. In such cases, a value of 10 dB was used for orthogonal polarization discrimination.

GE06 [1] gives that in VHF Band III polarization discrimination shall not be taken into account in the DAB planning procedures.

For the planning procedures of digital sound broadcasting systems in the VHF bands no polarization discrimination will be taken into account for all reception modes.

### 3.10 Calculation of minimum median field-strength level

The calculation of the minimum median field-strength level at 10 m above ground level for 50% of time and for 50% of locations is given in GE06 [1] by the following steps:

*Step 1*:Determine the receiver noise input power level *Pn*:

 (16)

where:

*F* : receiver noise figure (dB);

*k* : Boltzmann’s constant, *k* = 1.38 10–23 (J/K);

*T*0 : absolute temperature (K);

*B* : receiver noise bandwidth (Hz).

*Step 2*:Determine the minimum receiver input power level *Ps,min*:

 (17)

where:

(*C*/*N*)*min* : minimum carrier-to-noise ratio at the digital broadcasting decoder input (dB).

*Step 3*: Determine the minimum power flux-density (i.e. the magnitude of the Poynting vector) at receiving place ϕ*min*:

 (18)

where:

*Lf* : feeder loss (dB);

*Aa* : effective antenna aperture (dBm2).

 (19)

*Step* *4*: Determine the minimum RMS field-strength level at the location of the receiving antenna *Emin*:

 (20)

with:

 , the characteristic impedance in free space (21)

resulting in:

 (22)

*Step 5*: Determine the minimum median RMS field-strength level *Emed*:

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

– for fixed reception:

*Emed* = *Emin* + *Pmmn* + *Cl*(23)

– for portable outdoor and mobile reception:

*Emed* = *Emin* + *Pmmn* + *Cl* + *Lh*(24)

– for portable indoor reception:

*Emed* = *Emin* + *Pmmn* + *Cl* + *Lh* + *Lb*(25)

# 4 Planning parameters for digital terrestrial broadcasting system DRM robustness mode E in VHF Bands I, II and III

Digital Radio MondialeTM (DRM) was originally designed by the DRM Consortium as a digital broadcasting system for the radio bands below 30 MHz and it is standardized as ETSI ES 201 980 [6]. In 2009, DRM was extended by a mode E – called “DRM+” – to use DRM in radio bands up to 174 MHz.

The University of Applied Sciences in Kaiserslautern[[1]](#footnote-1) (Germany) and the University of Hannover[[2]](#footnote-2) (Germany) successfully conducted laboratory measurements and field trials with DRM in VHF Band II and in VHF Band III, respectively. Demonstrations were also given successfully in Paris in VHF Band I by the University of Applied Sciences in Kaiserslautern. Other field trials all over the world, especially in Brazil, Italy, Sri Lanka, the United Kingdom and in the Republic of Korea, have completed the tests.

The measurements and field trials have confirmed the technical parameters, and comparisons of coverage area have been performed between FM in VHF Band II and DRM also as with DAB in VHF Band III and DRM. In addition, protection ratio measurements have been performed and planning models have been used to predict coverage. The results from both German sites show that DRM works well in all VHF bands including VHF Band III.

From these results and based on relevant ITU Recommendations, this Report defines a framework for calculating all relevant DRM network planning parameters in all VHF bands. The focus lies on VHF Band II (87.5-108 MHz) and VHF Band III (174-230 MHz) in ITU Region 1, however where the values for the VHF Band I (47-68 MHz) are available, they are given.

Other frequency allocations in VHF bands assigned to broadcasting services are not exhaustively covered yet, e.g. areas in ITU Region 1 where allocations of the Wiesbaden T-DAB Agreement 1995 are still used (230-240 MHz) or in some Southern African countries, where the VHF Band III is allocated to the broadcasting services up to 254 MHz, or the broadcasting bands in ITU Regions 2 and 3, perhaps the OIRT FM band (65.8-74 MHz) or the Japanese FM band (76‑90 MHz), respectively, that can later be adapted. Planning parameters for these unconsidered cases can be derived or taken from the given values, considering 254 MHz as the international top boundary of the VHF broadcasting spectrum[[3]](#footnote-3).

## 4.1 DRM system parameters

The description of the DRM system parameters refers to Mode E of the DRM system [6].

### 4.1.1 Modes and code rates

#### 4.1.1.1 Overview of SDC and MSC code rates

ETSI-DRM [6] defines the SDC code rates summarized in Table 21 and the MSC modes with code rates *R* given in Table 22.

TABLE 21

SDC code rates

|  |  |  |  |
| --- | --- | --- | --- |
| MSC-mode 11  (4-QAM) | | MSC-mode 00  (16-QAM) | |
| SDC-mode | Code rate *R* | SDC-mode | Code rate *R* |
| 0 | 0.5 | 0 | 0.5 |
| 1 | 0.25 | 1 | 0.25 |

TABLE 22

MSC code rates

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Protection level | Code rate R for  MSC mode 11: 4-QAM | | Code rate R combinations for  MSC mode 00: 16-QAM | | | |
| *Rall* | *R*0 | *Rall* | *R*0 | *R*1 | *RYlcm* |
| 0 | 0.25 | 1/4 | 0.33 | 1/6 | 1/2 | 6 |
| 1 | 0.33 | 1/3 | 0.41 | 1/4 | 4/7 | 28 |
| 2 | 0.4 | 2/5 | 0.5 | 1/3 | 2/3 | 3 |
| 3 | 0.5 | 1/2 | 0.62 | 1/2 | 3/4 | 4 |

The net bit rate of the MSC varies from 37 kbit/s to 186 kbit/s depending of the used parameter set.

#### 4.1.1.2 SDC and MSC code rates for calculations

Several of the derived parameters depend on the characteristic of the transmitted DRM signal. To limit the amount of tests two typical parameters sets were chosen as basic sets, see Table 23:

– **DRM with 4-QAM** as a high protected signal with a lower data rate which is suited for a robust audio signal with a low data rate data service.

– **DRM with 16-QAM** as a low protected signal with a high data rate which is suited for several audio signals or for an audio signal with a high data rate data service.

TABLE 23

MSC code rates for calculations

|  |  |  |
| --- | --- | --- |
| MSC mode | 11-4-QAM | 00-16-QAM |
| MSC protection level | 1 | 2 |
| MSC code rate *R* | 1/3 | 1/2 |
| SDC mode | 1 | 1 |
| SDC code rate *R* | 0.25 | 0.25 |
| Bit rate approx. | 49.7 kbit/s | 149.1 kbit/s |

### 4.1.2 Propagation-related OFDM parameters

The propagation-related OFDM parameters of DRM are given in Table 24.

TABLE 24

OFDM parameters

|  |  |
| --- | --- |
| Elementary time period *T* | 83 1/3 μs |
| Duration of useful (orthogonal) part *Tu*= 27 · *T* | 2.25 ms |
| Duration of guard interval *Tg*= 3 · *T* | 0.25 ms |
| Duration of symbol *Ts = Tu + Tg* | 2.5 ms |
| *Tg*/*Tu* | 1/9 |
| Duration of transmission frame *Tf* | 100 ms |
| Number of symbols per frame *Ns* | 40 |
| Channel bandwidth *B* | 96 kHz |
| Carrier spacing 1/*Tu* | 444 4/9 Hz |
| Carrier number space | *Kmin* = −106;  *Kmax*= 106 |
| Unused carriers | none |

### 4.1.3 Single frequency operation capability

DRM transmitter can be operating in single frequency networks (SFN). The maximum transmitter distance that has to go below to prevent self-interferences depends on the length of the OFDM guard interval.

The maximum transmitter distance is calculated with the maximum echo delay which is given by:

*Decho*(*max*) (km) = *Tg* · *c*0 (26)

where:

*c*0 = 300 · 103 (km/s);

*Tg* = 0.25 (s).

Since the length *Tg* of the DRM guard interval is 0.25 ms, see Table 24, the maximum echo delay, and, therefore, the maximum transmitter distance, yields 75 km.

### 4.1.4 Channel models

Radio wave propagation in VHF bands is characterized by diffraction, scattering and reflection of the electromagnetic waves on their way between the transmitter and the receiver. Typically the waves arrive at different times and different angles at the receiver (multipath propagation) resulting in more or less strong frequency-selective fading (dependent on system bandwidth). In addition movements of the receiver or surrounding objects cause a time variation of the channel characteristic and can result in Doppler shift.

For calculation of the different reception modes the channel models are given in Table 25 [6] have been assumed and investigated. These channel models are considering the fading characteristics for different reception environments. For receivers with higher frequencies the fading in time direction is normally short, so the interleaving and error correction algorithms can work. With slow receiver velocities flat fading over a time, longer than the interleaver (600 ms) can result in signal drop outs.

TABLE 25

Channel models in the ETSI standard for DRM

|  |  |  |
| --- | --- | --- |
| Channel model (name) | Velocity | Remark |
| Channel 7 (AWGN) | 0 km/h | no time variation |
| Channel 8 (urban) | 2 km/h and 60 km/h | pedestrian and vehicle speed |
| Channel 9 (rural) | 150 km/h | vehicle speed on highways |
| Channel 10 (terrain obstructed) | 60 km/h | vehicle speed within built-in areas |
| Channel 11 (hilly terrain) | 100 km/h | vehicle speed along country roads |
| Channel 12 (SFN) | 150 km/h | vehicle speed on highways |

## 4.2 DRM receiver parameters

### 4.2.1 General characteristics

A DRM receiver is intended to receive and decode programmes transmitted according to the DRM system specification Mode E (DRM+) [6].

The parameters relevant for determining the required minimum field-strength levels are:

–noise figure *Fr* (dB), measured from the antenna input to the I/Q base band DRM decoder input (including down conversion and A/D conversion);

–receiver noise input power *Pn* (dBW);

–minimum carrier-to-noise ratio (*C*/*N*)*min* (dB) at the DRM decoder input;

–minimum receiver input power level *Ps,min* (dBW).

### 4.2.2 Receiver noise figure

In GE06 a receiver noise figure of 7 dB is been used for both DVB-T and T-DAB. For having cost effective DRM receiver solutions the receiver noise figure *F* is assumed to be *Fr* = 7 dB too for all VHF bands, see Table 26.

TABLE 26

Receiver noise figure *Fr*

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency (MHz) | 65 | 100 | 200 |
| Receiver noise figure *Fr* (dB) | 7 | 7 | 7 |

### 4.2.3 Receiver noise input power

With *B* = 100 kHz and *T* = 290 K, the thermal receiver noise input power level *Pn* for DRM Mode E yields:

 (27)

### 4.2.4 Minimum carrier to noise ratio

On basis of the channel models in the respective reception mode the required minimum values of the (*C*/*N*)*min* had been calculated. Therefore effects of the narrow-band system like fast fading are included in the calculated values of the (*C*/*N*)*min*.

ETSI-DRM [6] gives a required (*C*/*N*)*min* for a transmission in VHF Band II to achieve an average coded bit error ratio BER = 1 ⋅ 10–4 (bit) after the channel decoder for different channel models, see Table 27.

TABLE 27

(*C*/*N*)*min* with different channel models

|  |  |  |  |
| --- | --- | --- | --- |
|  | | (*C*/*N*)*min* (dB) for | |
| Reception mode | Channel model | 4-QAM, *R* = 1/3 | 16-QAM, *R* = 1/2 |
| Fixed reception | Channel 7 (AWGN) | 1.3 | 7.9 |
| Portable reception | Channel 8 (urban@60 km/h) | 7.3 | 15.4 |
|  | Channel 9 (rural) | 5.6 | 13.1 |
|  | Channel 10 (terrain obstructed) | 5.4 | 12.6 |
| Mobile reception | Channel 11 (hilly terrain) | 5.5 | 12.8 |
|  | Channel 12 (SFN) | 5.4 | 12.3 |

### 4.2.5 Minimum receiver input power level

Based on the above equations and including the implementation loss factor, the minimum receiver input power level at the receiving location can be calculated for both 16-QAM and 4‑QAM, see Table 28 and Table 29.

TABLE 28

Minimum receiver input power level *Ps,min* for 4-QAM, R = 1/3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reception mode | | Fixed | Portable | Mobile |
| Receiver noise figure | *Fr* (dB) | 7 | 7 | 7 |
| Receiver noise input power level | *Pn* (dBW) | −146.98 | −146.98 | −146.98 |
| Representative minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | 1.3 | 7.3 | 5.5 |
| Implementation loss factor | *Li* (dB) | 3 | 3 | 3 |
| **Minimum receiver input power level** | ***Ps*,*min*** (**dBW**) | **−142.68** | **−136.68** | **−138.48** |

TABLE 29

Minimum receiver input power level *Ps,min* for 16-QAM, *R* = 1/2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reception mode | | Fixed | Portable | Mobile |
| Receiver noise figure | *Fr* (dB) | 7 | 7 | 7 |
| Receiver noise input power level | *Pn* (dBW) | −146.98 | −146.98 | −146.98 |
| Representative minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | 7.9 | 15.4 | 12.8 |
| Implementation loss factor | *Li* (dB) | 3 | 3 | 3 |
| **Minimum receiver input power level** | ***Ps*,*min*** (**dBW**) | **−136.08** | **−128.58** | **−131.18** |

## 4.3 DRM planning parameters

### 4.3.1 Minimum median field-strength level

Based on the equations in § 3, the minimum median field-strength level for the respective reception modes had been calculated for both 16-QAM and 4-QAM, for VHF Bands I, II and III, see Table 30 to Table 35.

#### 4.3.1.1 VHF Band I

TABLE 30

Minimum median field-strength level *Emed* for 4-QAM, *R =*1/3 in VHF Band I

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| DRM modulation | | | 4-QAM. *R* = 1/3 | | | | |
| Receiving situation | | FX | PI | PI-H | PO | PO-H | MO |
| Minimum receiver input power level | *Ps,min* (dBW) | −142.68 | −136.68 | −136.68 | −136.68 | −136.68 | −138.48 |
| Antenna gain | *GD* (dBd) | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lc* dB | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux‑density at receiving place | φ*min* (dBW/m2) | −146.02 | −138.92 | −118.36 | −138.92 | −118.36 | −140.50 |
| Minimum field‑strength level at receiving antenna | *Emin* (dB(μV/m)) | −0.25 | 6.85 | 27.41 | 6.85 | 27.41 | 5.27 |
| Allowance for man‑made noise | *Pmmn* (dB) | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |

TABLE 30 (*end*)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna height loss | *Lh* (dB) | 0.00 | 8.00 | 15.00 | 8.00 | 15.00 | 8.00 |
| Building penetration loss | *Lb* (dB) | 0.00 | 8.00 | 8.00 | 0.00 | 0.00 | 0.00 |
| Location probability |  | 70% | 95% | 95% | 95% | 95% | 99% |
| Distribution factor | μ | 0.52 | 1.64 | 1.64 | 1.64 | 1.64 | 2.33 |
| Standard deviation of DRM field strength | σ*m* (dB) | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of MMN | σ*MMN* (dB) | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Location correction factor | *Cl* (dB) | 3.02 | 10.68 | 7.65 | 9.47 | 5.85 | 12.46 |
| **Minimum median field‑strength level** | ***Emed* (dB(μV/m))** | **18.15** | **48.91** | **58.06** | **39.71** | **48.26** | **41.11** |

TABLE 31

Minimum median field-strength level *Emed* for 16 QAM, *R* = 1/2 in VHF Band I

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| DRM modulation | | 16-QAM. *R* = 1/2 | | | | | |
| Receiving situation | | FX | PI | PI-H | PO | PO-H | MO |
| Minimum receiver input power level | *Ps,min* (dBW) | −136.08 | −128.58 | −128.58 | −128.58 | −128.58 | −131.18 |
| Antenna gain | *GD* (dBd) | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lc* (dB) | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux-density at receiving place | ϕ*min* (dBW/m2) | −139.42 | −130.82 | −110.26 | −130.82 | −110.26 | −133.20 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | 6.35 | 14.95 | 35.51 | 14.95 | 35.51 | 12.57 |
| Allowance for man-made noise | *Pmmn* (dB) | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Antenna height loss | *Lh* (dB) | 0.00 | 8.00 | 15.00 | 8.00 | 15.00 | 8.00 |
| Building penetration loss | *Lb* (dB) | 0.00 | 8.00 | 8.00 | 0.00 | 0.00 | 0.00 |
| Location probability |  | 70% | 95% | 95% | 95% | 95% | 99% |
| Distribution factor | μ | 0.52 | 1.64 | 1.64 | 1.64 | 1.64 | 2.33 |
| Standard deviation of DRM field strength | σ*m* (dB) | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of MMN | σ*MMN* (dB) | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Location correction factor | *Cl*(dB) | 3.02 | 10.68 | 7.65 | 9.47 | 5.85 | 12.46 |
| **Minimum median field-strength level** | ***Emed*** (**dB(μV/m))** | **24.75** | **57.01** | **66.16** | **47.81** | **56.36** | **48.41** |

#### 4.3.1.2 VHF Band II

TABLE 32

Minimum median field-strength level *Emed* for 4-QAM, *R* = 1/3 in VHF Band II

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| DRM modulation | | 4-QAM. *R* = 1/3 | | | | | |
| Receiving situation | | FX | PI | PI-H | PO | PO-H | MO |
| Minimum receiver input power level | *Ps*,*min* (dBW) | −142.68 | −136.68 | −136.68 | −136.68 | −136.68 | −138.48 |
| Antenna gain | *GD* (dBd) | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lc* (dB) | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | φ*min* (dBW/m2) | −141.97 | −135.17 | −118.35 | −135.17 | −118.35 | −136.69 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | 3.79 | 10.59 | 27.41 | 10.59 | 27.41 | 9.07 |
| Allowance for man-made noise | *Pmmn* (dB) | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Antenna height loss | *Lh* (dB) | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Location probability |  | 70% | 95% | 95% | 95% | 95% | 99% |
| Distribution factor | μ | 0.52 | 1.64 | 1.64 | 1.64 | 1.64 | 2.33 |
| Standard deviation of DRM field strength | σ*m* (dB) | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of MMN | σ*MMN* (dB) | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Location correction factor | *Cl*(dB) | 3.10 | 10.91 | 7.96 | 9.73 | 6.25 | 12.77 |
| **Minimum median field‑strength level** | ***Emed*** (**dB(μV/m))** | **17.32** | **50.92** | **61.37** | **40.74** | **50.66** | **42.27** |

TABLE 33

Minimum median field-strength level *Emed* for 16-QAM, *R* = 1/2 in VHF Band II

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| DRM modulation | | 16-QAM *R* = 1/2 | | | | | |
| Receiving situation | | FX | PI | PI-H | PO | PO-H | MO |
| Minimum receiver input power level | *Ps,min* (dBW) | −136.08 | −128.58 | −128.58 | −128.58 | −128.58 | −131.18 |
| Antenna gain | *GD* (dBd) | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lc* (dB) | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | φ*min* (dBW/m2) | −135.37 | −127.07 | −110.25 | −127.07 | −110.25 | −129.39 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | 10.39 | 18.69 | 35.51 | 18.69 | 35.51 | 16.37 |
| Allowance for man-made noise | *Pmmn* (dB) | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Antenna height loss | *Lh* (dB) | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Location probability |  | 70% | 95% | 95% | 95% | 95% | 99% |
| Distribution factor | μ | 0.52 | 1.64 | 1.64 | 1.64 | 1.64 | 2.33 |
| Standard deviation of DRM field strength | σ*m* (dB) | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of MMN | σ*MMN* (dB) | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Location correction factor | *Cl*(dB) | 3.10 | 10.91 | 7.96 | 9.73 | 6.25 | 12.77 |
| **Minimum median field‑strength level** | ***Emed* (dB(μV/m))** | **23.92** | **59.02** | **69.47** | **48.84** | **58.76** | **49.57** |

#### 4.3.1.3 VHF Band III

TABLE 34

Minimum median field-strength level *Emed* for 4-QAM, *R* = 1/3 in VHF Band III

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| DRM modulation | | 4-QAM. *R* = 1/3 | | | | | |
| Receiving situation | | FX | PI | PI-H | PO | PO-H | MO |
| Minimum receiver input power level | *Ps,min* (dBW) | −142.68 | −136.68 | −136.68 | −136.68 | −136.68 | −138.48 |
| Antenna gain | *GD* (dBd) | 0.00 | −2.20 | −13.00 | −2.20 | −13.00 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) | −5.32 | −7.52 | −18.32 | −7.52 | −18.32 | −7.52 |
| Feeder-loss | *Lc* (dB) | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 |
| Minimum power flux‑density at receiving place | ϕ*min* (dBW/m2) | −135.35 | −129.15 | −118.35 | −129.15 | −118.35 | −130.55 |

TABLE 34 (*end*)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | 10.41 | 16.61 | 27.41 | 16.61 | 27.41 | 15.21 |
| Allowance for man-made noise | *Pmmn* (dB) | 3.62 | 3.62 | 0.00 | 3.62 | 0.00 | 3.62 |
| Antenna height loss | *Lh* (dB) | 0.00 | 12.00 | 19.00 | 12.00 | 19.00 | 12.00 |
| Building penetration loss | *Lb* (dB) | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Location probability |  | 70% | 95% | 95% | 95% | 95% | 99% |
| Distribution factor | μ | 0.52 | 1.64 | 1.64 | 1.64 | 1.64 | 2.33 |
| Standard deviation of DRM field strength | σ*m* (dB) | 4.19 | 4.19 | 4.19 | 4.19 | 4.19 | 3.49 |
| Standard deviation of MMN | σ*MMN* (dB) | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Location correction factor | *Cl*(dB) | 3.24 | 11.29 | 8.48 | 10.15 | 6.89 | 13.31 |
| **Minimum median field‑strength level** | ***Emed* (dB(μV/m))** | **17.26** | **52.52** | **63.89** | **42.38** | **53.30** | **44.13** |

TABLE 35

Minimum median field-strength level *Emed* for 16-QAM, *R* = 1/2 in VHF Band III

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| DRM modulation | | 16-QAM. R = ½ | | | | | |
| Receiving situation | | FX | PI | PI-H | PO | PO-H | MO |
| Minimum receiver input power level | *Ps*,*min* (dBW) | −136.08 | −128.58 | −128.58 | −128.58 | −128.58 | −131.18 |
| Antenna gain | *GD* (dBd) | 0.00 | −2.20 | −13.00 | −2.20 | −13.00 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) | −5.32 | −7.52 | −18.32 | −7.52 | −18.32 | −7.52 |
| Feeder-loss | *Lc* (dB) | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 |
| Minimum power flux‑density at receiving place | φ*min* (dBW/m2) | −128.75 | −121.05 | −110.25 | −121.05 | −110.25 | −123.25 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | 17.01 | 24.71 | 35.51 | 24.71 | 35.51 | 22.51 |
| Allowance for man-made noise | *Pmmn* (dB) | 3.62 | 3.62 | 0.00 | 3.62 | 0.00 | 3.62 |
| Antenna height loss | *Lh* (dB) | 0.00 | 12.00 | 19.00 | 12.00 | 19.00 | 12.00 |
| Building penetration loss | *Lb* (dB) | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Location probability |  | 70% | 95% | 95% | 95% | 95% | 99% |
| Distribution factor | μ | 0.52 | 1.64 | 1.64 | 1.64 | 1.64 | 2.33 |
| Standard deviation of DRM field strength | σ*m* (dB) | 4.19 | 4.19 | 4.19 | 4.19 | 4.19 | 3.49 |
| Standard deviation of MMN | σ*MMN*(dB) | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Location correction factor | *Cl* (dB) | 3.24 | 11.29 | 8.48 | 10.15 | 6.89 | 13.31 |
| **Minimum median field-strength level** | ***Emed* (dB(μV/m))** | **23.86** | **60.62** | **71.99** | **50.48** | **61.40** | **51.43** |

### 4.3.2 Position of DRM frequencies

The DRM system is designed to be used at any frequency with variable channelization constraints and propagation conditions throughout these bands [6].

Referring to the legal frequency plans in ITU Region 1 this Report covers DRM:

–in VHF Band I as well as in VHF Band II regarding to GE84 [5];

–in VHF Band III regarding to GE06 [1].

Other areas in the VHF bands assigned for sound broadcasting services, e.g. areas in ITU Region 1 where allocations of the Wiesbaden T-DAB Agreement 1995 are still used (230-240 MHz) or in southern Africa, where the VHF Band III is allocated to the broadcasting services up to 254 MHz, or the broadcasting bands in ITU Region 2 and 3, perhaps the OIRT FM band (65.8-74 MHz) or the Japanese FM band (76-90 MHz), respectively, are not yet covered in this section and can be adapted later.

#### 4.3.2.1 VHF Band I and VHF Band II

The DRM centre frequencies are positioned in 100 kHz distance according to the FM frequency grid in VHF Band II. The nominal carrier frequencies are, in principle, integral multiples of 100 kHz [5]. The DRM system is designed to be used with this raster [6].

The table of centre frequencies of DRM in VHF Band II is given in Attachment 2.

On the other hand it has to be considered to allow a spacing of 50 kHz in VHF Band II to achieve the full potential of the DRM hybrid mode and to alleviate the deployment of new DRM transmitters in the overcrowded FM band.

#### 4.3.2.2 VHF Band III

The frequency band of a DAB block has a bandwidth of 1.536 MHz [1] with lower and upper guard channels to fit into the 7 MHz channels of VHF Band III.

The DRM centre frequencies are positioned in 100 kHz distance beginning by 174.05 MHz and integral multiples of 100 kHz up to the end of VHF Band III.

The table of the centre frequencies of DRM in VHF Band III in the range from 174 to 230 MHz is given in Attachment 2.

### 4.3.3 Out-of-band spectrum mask

The power density spectrum at the transmitter output is important to determine the adjacent channel interference.

The spectrum characteristics of an OFDM system are given in Recommendation ITU-R SM.328, Annex 6, Chapter 5.

#### 4.3.3.1 VHF Band I and VHF Band II

An out-of-band spectrum mask for DRM in VHF Band I and VHF Band II, respectively, as minimum transmitter requirement is proposed in Fig. 1 and Table 36. The vertices of the symmetric out-of-band spectrum mask for FM transmitters are given in ETSI-FM [7].

Note that the out-of-band spectrum masks are defined for a resolution bandwidth (RBW) of 1 kHz.

Figure 1

Out-of-band spectrum masks for FM in VHF Band II and DRM in VHF Bands I and II

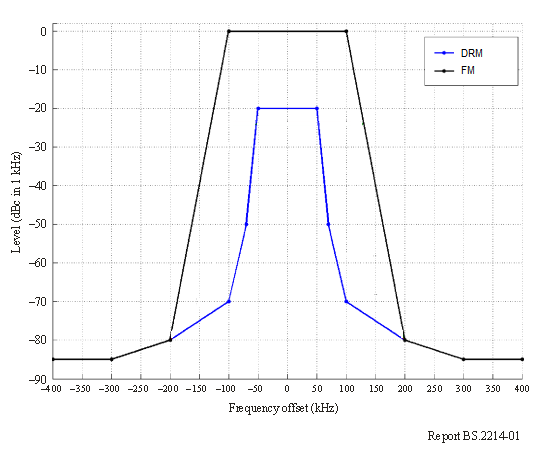


TABLE 36

Out-of-band spectrum masks for FM in VHF Band II and DRM in VHF Bands I and II

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Spectrum mask  (100 kHz channel)/ relative level for FM | |  | Spectrum mask  (100 kHz channel)/ relative level for DRM | |
| Frequency offset (kHz) | Level  (dBc)/ (1 kHz) |  | Frequency offset (kHz) | Level  (dBc)/ (1 kHz) |
| **0** | 0 |  | **0** | −20 |
| **±50** | 0 |  | **±50** | −20 |
| **±70** | 0 |  | **±70** | −50 |
| **±100** | 0 |  | **±100** | −70 |
| **±200** | −80 |  | **±200** | −80 |
| **±300** | −85 |  | **±300** | −85 |
| **±400** | −85 |  | **±400** | −85 |

#### 4.3.3.2 VHF Band III

The vertices of the symmetric out-of-band spectrum masks for DAB transmitters are given in Recommendation ITU‑R BS.1660. An out-of-band spectrum mask for DRM is proposed that fits into the DAB masks, see Fig. 2 and Table 37.

Note that the out-of-band spectrum masks are defined for a resolution bandwidth (RBW) of 4 kHz. Thus the value of –14 dBr results for DRM.

Figure 2

Out-of-band spectrum masks for DAB and DRM in VHF Band III



TABLE 37

Out-of-band spectrum masks for DAB and DRM in VHF Band III

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Spectrum mask  (1.54 MHz channel)/ relative level for DAB | | | |  | Spectrum mask  (100 kHz channel)  relative level for DRM | |
| Frequency offset (MHz) | Level (dBc) (non-critical cases) | Level (dBc) (critical cases) | Level (dBc) (critical cases/12D) |  | Frequency offset (kHz) | Level (dBc) |
| ±0.77 | – | −26 | −26 |  | **0** | −14 |
| < ±0.97 | −26 | – | – |  | **±50** | −14 |
| ±0.97 | −56 | −71 | −78 |  | **±60** | −44 |
| ±1.75 | – | −106 | – |  | **±181.25** | −59 |
| ±2.2 | – | – | −126 |  | **±200** | −74 |
| ±3.0 | −106 | −106 | −126 |  | **±300** | −79 |
|  |  |  |  |  | **±500** | −84 |

### 4.3.4 Protection ratios

The minimum acceptable ratio between a wanted signal and interfering signals to protect the reception of the wanted signal is defined as the protection ratio *PR* (dB). The values of protection ratios are given as:

– **Basic protection ratio** *PRbasic* for a wanted signal interfered with by an unwanted signal at 50% location probability. These values are determined in accordance with Recommendation ITU‑R BS.641.

– **Combined location correction factor** *CF* (dB) as a margin that has to be added to the basic protection ratio for a wanted signal interfered with by an unwanted signal for the calculation of protection ratios at location probability greater as 50%. The equation for the calculation is given in § 3.8.3.

– **Corresponding protection ratio** *PR*(*p*) for a wanted digital signal interfered with by an unwanted signal at location probability greater than 50% taking into account the respective location probability of the corresponding reception modes that have higher protection requirements due to the higher location probability to be protected.

**4.3.4.1 Protection ratios for DRM**

The DRM signal parameters are given in § 4.1.

**4.3.4.1.1 DRM interfered with by DRM**

The basic protection ratio *PRbasic* for DRM is valid for all VHF bands, see Table 38. For the standard deviation of DRM differs in the respective VHF bands the combined location correction factors CF, see Table 39, are different in the respective VHF bands as well as the corresponding protection ratios *PR*(*p*), see Table 40 for 4-QAM and Table 41 for 16-QAM.

TABLE 38

Basic protection ratios *PRbasic* for DRM interfered with by DRM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| DRM (4-QAM, *R* = 1/3) | *PRbasic* (dB) | 4 | −16 | −40 |
| DRM (16-QAM, *R* = 1/2) | *PRbasic* (dB) | 10 | −10 | −34 |

TABLE 39

Combined location correction factor *CF* for DRM interfered with by DRM

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Reference frequency band (MHz) | | 65 MHz VHF Band I | | | 100 MHz VHF Band II | | | 200 MHz VHF Band III | | |
| Location probability *p* (%) | | 70 | 95 | 99 | 70 | 95 | 99 | 70 | 95 | 99 |
| Combined location correction factor **in urban and suburban area for fixed and portable reception** | *CF* (dB) | 2.64 | 8.27 | 11.70 | 2.82 | 8.84 | 12.50 | 3.11 | 9.75 | 13.79 |
| Combined location correction factor **in rural area for mobile reception** | *CF* (dB) | 2.12 | 6.65 | 9.40 | 2.30 | 7.21 | 10.20 | 2.59 | 8.12 | 11.49 |

TABLE 40

Corresponding protection ratios *PR*(*p*) to reception modes for DRM (4-QAM. *R* = 1/3) interfered with by DRM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference frequency band (MHz) | | 65 MHz VHF Band I | | |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 6.64 | −13.36 | −37.36 |
| Portable reception (PO, PI, PO-H, PI-H) | *PR*(*p*) (dB) | 12.27 | −7.73 | −31.73 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 13.40 | −6.60 | −30.60 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference frequency band (MHz) | | 100 MHz  VHF Band II | | |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 6.82 | −13.18 | −37.18 |
| Portable reception (PO, PI, PO-H, PI-H) | *PR*(*p*) (dB) | 12.84 | −7.16 | −31.16 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 14.20 | −5.80 | −29.80 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference frequency band (MHz) | | 200 MHz VHF Band III | | |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 7.11 | −12.89 | −36.89 |
| Portable reception (PO. PI. PO-H. PI-H) | *PR*(*p*) (dB) | 13.75 | −6.25 | −30.25 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 15.49 | −4.51 | −28.51 |

TABLE 41

Corresponding protection ratios *PR*(*p*) to reception modes for DRM (16-QAM. *R* = 1/2) interfered with by DRM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference frequency band (MHz) | | 65 MHz VHF Band I | | |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 12.64 | −7.36 | −31.36 |
| Portable reception (PO. PI. PO-H. PI-H) | *PR*(*p*) (dB) | 18.27 | −1.73 | −25.73 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 19.40 | −0.60 | −24.60 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference frequency band (MHz) | | 100 MHz  VHF Band II | | |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 12.82 | −7.18 | −31.18 |
| Portable reception (PO, PI, PO-H, PI-H) | *PR*(*p*) (dB) | 18.84 | −1.16 | −25.16 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 20.20 | 0.20 | −23.80 |

TABLE 41 (*end*)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reference frequency band (MHz) | | 200 MHz VHF Band III | | |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 13.11 | −6.89 | −30.89 |
| Portable reception (PO, PI, PO-H, PI-H) | *PR*(*p*) (dB) | 19.75 | −0.25 | −24.25 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 21.49 | 1.49 | −22.51 |

##### 4.3.4.1.2 DRM interfered with by FM in VHF Band II

The basic protection ratio *PRbasic* for DRM interfered with by FM in VHF Band II is given in Table 42. The values for the combined location correction factors *CF* are given in Table 43, and for the corresponding protection ratios *PR*(*p*), are given in Table 44 for 4-QAM and in Table 45 for 16‑QAM, respectively.

TABLE 42

Basic protection ratios *PRbasic* for DRM interfered with by FM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| DRM (4-QAM. *R* = 1/3) interfered with by FM (stereo) | *PRbasic* (dB) | 11 | −13 | −54 |
| DRM (16-QAM. *R* = 1/2) interfered with by FM (stereo) | *PRbasic* (dB) | 18 | −9 | −49 |

TABLE 43

Combined location correction *CF* factor for DRM interfered with by FM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Location probability *p* (%) | | 70 | 95 | 99 |
| Combined location correction factor **in urban and suburban area for fixed and portable reception** | *CF* (dB) | 4.79 | 15.02 | 21.24 |
| Combined location correction factor **in rural area for mobile reception** | *CF* (dB) | 4.65 | 14.57 | 20.61 |

TABLE 44

Corresponding protection ratios *PR*(*p*) to reception modes   
for DRM (4-QAM. *R* = 1/3) interfered with by FM stereo

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 15.79 | −8.21 | −49.21 |
| Portable reception (PO, PI, PO-H, PI-H) | *PR*(*p*) (dB) | 26.02 | 2.02 | −38.98 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 31.61 | 7.61 | −33.39 |

TABLE 45

Corresponding protection ratios *PR*(*p*) to reception modes   
for DRM (16-QAM. *R* = 1/2) interfered with by FM stereo

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 22.79 | −4.21 | −44.21 |
| Portable reception (PO, PI, PO-H, PI-H) | *PR*(*p*) (dB) | 33.02 | 6.02 | −33.98 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 38.61 | 11.61 | −28.39 |

##### 4.3.4.1.3 DRM interfered with by DAB in VHF Band III

The basic protection ratio *PRbasic* for DRM interfered with by DAB in VHF Band III is given in Table 46. The values for the combined location correction factors CF are given in Table 47, and for the corresponding protection ratios *PR*(*p*)*,* are given in Table 48 for 4-QAM and in Table 49 for 16‑QAM, respectively.

TABLE 46

Basic protection ratios *PRbasic* of DRM interfered with by DAB

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Basic protection ratio for DRM (4-QAM. *R* = 1/3) | *PRbasic* (dB) | −7 | −36 | −40 |
| Basic protection ratio for DRM (16-QAM. *R* = 1/2) | *PRbasic* (dB) | −2 | −18 | −40 |

TABLE 47

Combined location correction factor *CF* of DRM interfered with by DAB

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Location probability *p* (%) | | 70 | 95 | 99 |
| Combined location correction factor  **in urban and suburban area for fixed and portable reception** | *CF* (dB) | 3.63 | 11.37 | 16.09 |
| Combined location correction factor  i**n rural area for mobile reception** | *CF* (dB) | 3.42 | 10.72 | 15.16 |

TABLE 48

Corresponding protection ratios *PR*(*p*) to reception modes   
for DRM (4-QAM. *R* = 1/3) interfered with by DAB

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | −3.37 | −32.37 | −50.37 |
| Portable reception (PO, PI, PO-H, PI‑H) | *PR*(*p*) (dB) | 4.37 | −24.63 | −42.63 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 8.16 | −20.84 | −38.84 |

TABLE 49

Corresponding protection ratios *PR*(*p*) to reception modes   
for DRM (16-QAM. *R* = 1/2) interfered with by DAB

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Fixed reception (FX) | *PR*(*p*) (dB) | 1.63 | −14.37 | −45.37 |
| Portable reception (PO, PI, PO-H, PI-H) | *PR*(*p*) (dB) | 9.37 | −6.63 | −37.63 |
| Mobile reception (MO) | *PR*(*p*) (dB) | 13.16 | −2.84 | −33.84 |

##### 4.3.4.1.4 DRM interfered with by DVB-T in VHF Band III

Since the impact mechanisms of DAB into DRM is the same as that of DVB-T it is proposed that the same protection ratios for DRM interfered with by DVB-T in VHF Band III can be assumed as for DRM interfered with by DAB in VHF Band III.

#### 4.3.4.2 Protection ratios for broadcasting systems interfered with by DRM

##### 4.3.4.2.1 Protection ratios for FM in VHF Band II

The FM signal parameters are given in Recommendation ITU‑R BS.412.

Recommendation ITU‑R BS.412, Annex 5 states that interferences can be caused by intermodulation of strong FM signals in a frequency offset greater than 400 kHz. This cross modulation effect from a high interfering signal level in a range up to 1 MHz offset has also to be taken into account when planning OFDM systems into the VHF Band II. Therefore not only the protection ratios *PRbasic* are given in the range 0 kHz to ±400 kHz, and for ±500 kHz and ±1 000 MHz, see Table 50. The values for ±600 kHz to ±900 kHz can be found by linear interpolation.

TABLE 50

Basic protection ratios *PRbasic* for FM interfered with by DRM

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 | ±300 | ±400 | ±500 | ±1 000 |
| Basic protection ratio for FM (stereo) | *PRbasic* (dB) | 49 | 30 | 3 | −8 | −11 | −13 | −21 |

**4.3.4.2.2 Protection ratios for DAB in VHF Band III**

The DAB signal parameters are given in Recommendation ITU-R BS.1660. In GE06 [1] it is given that the T-DAB planning should be able to deal with mobile reception with a location probability of 99%, and with portable indoor reception with a location probability of 95%, respectively. In addition the values for fixed reception with a location probability of 70% are given.

The basic protection ratios for DAB interfered with by DRM are given in Table 51, the related combined location correction factors are given in Table 52, and the corresponding protection ratios *PR*(*p*) are given in Table 53, respectively.

TABLE 51

Basic protection ratios *PRbasic* for DAB interfered with by DRM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| Basic protection ratio for T‑DAB | *PRbasic* (dB) | 10 | −40 | −40 |

TABLE 52

Combined location correction factor *CF* for DAB interfered with by DRM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Location probability *p* (%) | | 70 | 95 | 99 |
| Combined location correction factor  **in urban and suburban area for fixed and portable reception** | *CF* (dB) | 3.63 | 11.37 | 16.09 |
| Combined location correction factor  **in rural area for mobile reception** | *CF* (dB) | 3.42 | 10.72 | 15.16 |

TABLE 53

Corresponding protection ratios *PR*(*p*) to reception   
modes for DAB interfered with by DRM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 |
| DAB fixed reception | *PR*(*p*) (dB) | 13.63 | −36.37 | −36.37 |
| DAB portable reception | *PR*(*p*) (dB) | 21.37 | −28.63 | −28.63 |
| DAB mobile reception | *PR*(*p*) (dB) | 25.16 | −24.84 | −24.84 |

##### 4.3.4.2.3 Protection ratios for DVB-T in VHF Band III

The DVB-T signal parameters are given in Recommendation ITU-R BT.1368.

In VHF Band III not only DAB but also may be DVB-T operated additionally as an interferer into DRM or to be interfered with by DRM.

DRM as an interferer against a DAB wanted signal has the same impact as a DAB interferer under the assumption that more than one DRM interferer with different frequencies in a DAB block has to be included, see Table 51.

The same proposal can be assumed if DVB-T is the wanted signal. If there is more than one DRM interferer with different frequencies in a DVB-T channel the impact may be the same as it is caused by a DAB signal. Therefore, it is proposed that the protection ratios of DVB-T interfered with by DRM are the same as DVB-T is interfered with by DAB.

In Recommendation ITU-R BT.1368 the basic protection ratios for DVB-T interfered with DAB are given, see Table 54. These protection rations are proposed for the interferences by a DRM signal also. In the adjacent channels no impact is proposed.

TABLE 54

Co-channel basic protection ratios *PRbasic* for DVB-T interfered   
with by DAB (Recommendation ITU-R BT.1368) and by DRM

|  |  |
| --- | --- |
| Wanted signal DVB-T constellation-code rate | *PR*  (dB) |
| QPSK-1/2 | 10 |
| QPSK-2/3 | 12 |
| QPSK-3/4 | 14 |
| 16-QAM-1/2 | 15 |
| 16-QAM-2/3 | 18 |
| 16-QAM-3/4 | 20 |
| 64-QAM-1/2 | 20 |
| 64-QAM-2/3 | 24 |
| 64-QAM-3/4 | 26 |
| 64-QAM-7/8 | 31 |

#### 4.3.4.3 Protection ratios for other services interfered with by DRM

##### 4.3.4.3.1 Other services below the radio broadcasting VHF Band II

Below the VHF Band II broadcasting band, land mobile services with security tasks are located. The interference potential of DRM into these services is not higher as the one of FM signals. Provided sufficient additional band-pass filtering of the output of the transmitter is applied, the interference potential of DRM into narrow-band FM (BOS) reception is not substantially higher than that of a standard FM broadcast signal [8].

##### 4.3.4.3.2 Other services above the radio broadcasting VHF Band II

Above the VHF Band II broadcasting band, aeronautical radio navigation services are located. The interference potential of DRM into these services is not higher as the one of FM signals. For frequency offsets of less than 200 kHz, the interference potential of DRM into VOR and ILS localizer reception is much less than of a standard FM broadcast signal (up to 30 dB less). For larger frequency offsets, both signals produce roughly the same interference, provided sufficient additional band-pass filtering of the output of the transmitter is deployed [8].

##### 4.3.4.3.3 Other services in the radio broadcasting VHF Band III

The values and the procedures to take into account other services in VHF Band III is given in GE06. For DRM the same values as for DAB shall be applied.

### 4.3.5 Calculation of the resulting sum field strength of interferers

To calculate the resulting interfering sum field-strength level from several signal sources *Esum*

– **in VHF Band I and VHF Band II** the simplified multiplication method (see Report ITU‑R BS.945) shall be applied according to GE84 [5];

– **in VHF Band III** the log-normal methods (see Report ITU-R BS.945) according to the planning procedures of T-DAB and DVB-T [1] shall be applied.

# 5 Planning parameters for digital terrestrial broadcasting system RAVIS in VHF Bands I and II

The RAVIS system is designed for digital sound and multimedia broadcasting in VHF Bands I and II. The system is nationally standardized in the Russian Federation [9-13]. Main characteristics and features of RAVIS can be found in Report ITU‑R BT.2049 – Broadcasting of multimedia and data applications for mobile reception.

## 5.1 System parameters of RAVIS

### 5.1.1 RAVIS signal parameters

RAVIS supports three types of radio channel bandwidth: 100, 200 and 250 kHz.

RAVIS supports three different coding rates for logical channel of main service: 1/2, 2/3 and 3/4.

RAVIS supports three different modulation types for logical channel of main service: QPSK, 16‑QAM and 64-QAM.

Rounded bit rates for different combinations of system parameters are given in Table 55.

TABLE 55

Bit rates for RAVIS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation type | Code rate | Bit rate (kbit/s) | | |
| 100 kHz channel | 200 kHz channel | 250 kHz channel |
| QPSK | 1/2 | 80 | 160 | 200 |
| 2/3 | 100 | 210 | 270 |
| 3/4 | 120 | 240 | 300 |
| 16-QAM | 1/2 | 150 | 320 | 400 |
| 2/3 | 210 | 420 | 530 |
| 3/4 | 230 | 470 | 600 |
| 64-QAM | 1/2 | 230 | 470 | 600 |
| 2/3 | 310 | 630 | 800 |
| 3/4 | 350 | 710 | 900 |

Main OFDM parameters of RAVIS signal are given in Table 56.

TABLE 56

OFDM parameters of RAVIS

|  |  |  |  |
| --- | --- | --- | --- |
| Channel bandwidth *B* | 100 kHz | 200 kHz | 250 kHz |
| Number of curriers | 215 | 439 | 553 |
| Number of information curriers | 196 | 400 | 504 |
| Distance between first and last curriers | 95.1 kHz | 194.7 kHz | 245.3 kHz |
| Carrier spacing 1/*Tu* | 4 000/9 Hz = 444 4/9 Hz | | |
| Duration of useful part of symbol *Tu* | 2.25 ms | | |

TABLE 56 (*end*)

|  |  |
| --- | --- |
| Duration of guard interval *Tg* | 281.25 ms |
| Duration of symbol *Ts = Tu + Tg* | 2.53125 ms |
| *Tg/Tu* | 1/8 |
| Duration of transmission frame *Tf* | 103.8 ms |
| Number of symbols per frame *Ns* | 41 |

### 5.1.2 SFN operation capabilities

RAVIS can operate in single frequency networks (SFN). The maximum transmitter distance that has to go below to prevent self-interferences depends on the length of the OFDM guard interval. The maximum transmitter distance defined by (26) is calculated through the multiplication of velocity of light (3 · 105 km/s) by guard interval duration (~0.28 ms for RAVIS). So maximum transmitter distance is about 84 km.

### 5.1.3 Channel models

Channel models used for simulation of RAVIS operation corresponds to the models defined in DRM standard [6] and used for DRM operation simulation (see Table 25).

## 5.2 RAVIS radio receiver related parameters

RAVIS receiver is intended to receive and decode programmes transmitted according to the RAVIS system standard [9].

The parameters relevant for determining the required minimum field-strength levels are:

–noise figure *Fr* (dB), measured from the antenna input to the I/Q base band RAVIS decoder input (including down conversion and A/D conversion);

–receiver noise input power *Pn* (dBW);

–minimum carrier-to-noise ratio (*C*/*N*)*min* (dB) at the RAVIS decoder input;

–minimum receiver input power level *Ps,min* (dBW).

For having cost effective RAVIS receiver solutions the receiver noise figure *F* is assumed to be *Fr* = 7 dB as for DRM receiver for all VHF bands, see Table 26.

Receiver noise input power *Pn* is calculated according to (16) and depends on input signal bandwidth (*T* = 290 K):

*Pn* (dBW) = –146.98 (dBW) for 100 kHz signal bandwidth;

*Pn* (dBW) = –143.97 (dBW) for 200 kHz signal bandwidth;

*Pn* (dBW) = –143.00 (dBW) for 250 kHz signal bandwidth.

Required (*C*/*N*)*min* for a transmission in VHF Band II to achieve an average coded bit error ratio BER = 1 ⋅ 10−4 (bit) after the channel decoder for system parameters and different channel models are given in Tables 57 to 59. Channel models correspond to the models from [6], Annex B.2. Channel 7 (AWGN) models fixed reception mode, channel 8 (Urban) models portable reception mode, channel 11 (Hilly terrain) models mobile reception mode.

TABLE 57

(*C*/*N*)*min* for RAVIS with 100 kHz channel bandwidth

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Channel model/ reception mode | (*C*/*N*)*min* (dB) | | | | | | | | |
| QPSK | | | 16-QAM | | | 64-QAM | | |
| *R*= 1/2 | *R*= 2/3 | *R* = 3/4 | *R =* 1/2 | *R* = 2/3 | *R* = 3/4 | *R*= 1/2 | *R* = 2/3 | *R* = 3/4 |
| Channel 7 (AWGN)/fixed reception | 5 1.2 | 6 3.4 | 6 4.3 | 8 6.6 | 1 9.2 | 1 10.3 | 1 10.9 | 1 14.2 | 1 15.6 |
| Channel 8 (urban)/ portable reception | 1 6.5 | 1 9.5 | 1 11.7 | 1 12.6 | 1 15.1 | 1 17.2 | 2 16.3 | 2 19.6 | 2 22.2 |
| Channel 11 (hilly terrain)/mobile reception | 9 5.6 | 1 8.7 | 1 10.0 | 1 10.5 | 1 13.3 | 1 15.8 | 1 14.8 | 2 18.1 | 2 20.7 |

TABLE 58

(*C*/*N*)*min* for RAVIS with 200 kHz channel bandwidth

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Channel model/ reception mode | (*C*/*N*)*min* (dB) | | | | | | | | |
| QPSK | | | 16-QAM | | | 64-QAM | | |
| *R*= 1/2 | *R*= 2/3 | *R* = 3/4 | *R =* 1/2 | *R* = 2/3 | *R* = 3/4 | *R*= 1/2 | *R* = 2/3 | *R* = 3/4 |
| Channel 7 (AWGN)/fixed reception | 4 1.1 | 5 3.3 | 6 4.2 | 8 6.4 | 1 9.1 | 1 10.2 | 1 10.8 | 1 14.0 | 1 15.4 |
| Channel 8 (urban)/ portable reception | 1 6.4 | 1 9.4 | 1 11.5 | 1 12.5 | 1 14.9 | 1 17.0 | 2 16.2 | 2 19.4 | 2 22.0 |
| Channel 11 (hilly terrain)/mobile reception | 1 5.5 | 1 8.6 | 1 9.8 | 1 10.4 | 1 13.2 | 1 15.6 | 1 14.7 | 2 17.9 | 2 20.5 |

TABLE 59

(*C*/*N*)*min* for RAVIS with 250 kHz channel bandwidth

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Channel model /reception mode | (*C*/*N*)*min* (dB) | | | | | | | | |
| QPSK | | | 16-QAM | | | 64-QAM | | |
| *R*= 1/2 | *R*= 2/3 | *R* = 3/4 | *R =* 1/2 | *R* = 2/3 | *R* = 3/4 | *R*= 1/2 | *R* = 2/3 | *R* = 3/4 |
| Channel 7 (AWGN) /fixed reception | 5 1.1 | 5 3.2 | 6 4.2 | 8 6.3 | 1 9.1 | 1 10.2 | 1 10.6 | 1 14.0 | 1 15.4 |
| Channel 8 (urban) /portable reception | 1 6.4 | 1 9.4 | 1 11.5 | 1 12.4 | 2 14.9 | 2 17.0 | 2 16.1 | 2 19.4 | 2 22.0 |
| Channel 11 (hilly terrain)/mobile reception | 1 5.5 | 1 8.5 | 1 9.8 | 1 10.3 | 1 13.2 | 1 15.6 | 2 14.6 | 2 17.9 | 2 20.5 |

## 5.3 RAVIS planning parameters

### 5.3.1 Minimum median field-strength

Based on the parameters and equations set above, the minimum median field-strength level for different reception modes and frequency Bands I and II can be calculated for all sets of RAVIS system parameters, as shown in Tables 60 to 77.

TABLE 60

Minimum median field-strength level *Emed* for 100 kHz channel   
bandwidth and QPSK modulation in Band I

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R* = 1/2 | 51.2 | 16.5 | 16.5 | 16.5 | 16.5 | 95.6 |
| *R* = 2/3 | 63.4 | 19.5 | 19.5 | 19.5 | 19.5 | 18.7 |
| *R* = 3/4 | 64.3 | 111.7 | 111.7 | 111.7 | 111.7 | 110.0 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R*= 1/2 | −142.78 | −137.48 | −137.48 | −137.48 | −137.48 | −138.38 |
| *R* = 2/3 | −140.58 | −134.48 | −134.48 | −134.48 | −134.48 | −135.28 |
| *R* = 3/4 | −139.68 | −132.28 | −132.28 | −132.28 | −132.28 | −133.98 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux‑density at receiving place | ϕ*min* (dBW/m2) | *R* = 1/2 | −146.12 | −139.72 | −119.16 | −139.72 | −119.16 | −140.40 |
| *R* = 2/3 | −143.92 | −136.72 | −116.16 | −136.72 | −116.16 | −137.30 |
| *R*= 3/4 | −143.02 | −134.52 | −113.96 | −134.52 | −113.96 | −136.00 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(µV/m)) | *R* = 1/2 | −0.32 | 6.08 | 26.64 | 6.08 | 26.64 | 5.40 |
| *R* = 2/3 | 1.88 | 9.08 | 29.64 | 9.08 | 29.64 | 8.50 |
| *R* = 3/4 | 2.78 | 11.28 | 31.84 | 11.28 | 31.84 | 9.80 |
| Allowance for man‑made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 83.56 | 83.56 | 82.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl* (dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |

TABLE 60 (*end*)

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 8.00 | 815.00 | 8.00 | 815.00 | 8.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dB(µV/m)) | *R* = 1/2 | 18.06 | 48.18 | 57.32 | 38.97 | 47.51 | 41.26 |
| *R* = 2/3 | 20.26 | 51.18 | 60.32 | 41.97 | 50.51 | 44.36 |
| *R* = 3/4 | 21.16 | 53.38 | 62.52 | 44.17 | 52.71 | 45.66 |

TABLE 61

Minimum median field-strength level *Emed* for 100 kHz channel   
bandwidth and QPSK modulation in Band II

| Reception mode |  |  | FX | PI | PI−H | PO | PO−H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R* = 1/2 | 1.20 | 6.50 | 6.50 | 6.50 | 6.50 | 5.60 |
| *R* = 2/3 | 3.40 | 9.50 | 9.50 | 9.50 | 9.50 | 8.70 |
| *R* = 3/4 | 4.30 | 11.70 | 11.70 | 11.70 | 11.70 | 10.00 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −142.78 | −137.48 | −137.48 | −137.48 | −137.48 | −138.38 |
| *R* = 2/3 | −140.58 | −134.48 | −134.48 | −134.48 | −134.48 | −135.28 |
| *R* = 3/4 | −139.68 | −132.28 | −132.28 | −132.28 | −132.28 | −133.98 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | ϕ*min* (dBW/m2) | *R*= 1/2 | −142.08 | −135.98 | −119.16 | −135.98 | −119.16 | −136.60 |
| *R*= 2/3 | −139.88 | −132.98 | −116.16 | −132.98 | −116.16 | −133.50 |
| *R* = 3/4 | −138.98 | −130.78 | −113.96 | −130.78 | −113.96 | −132.20 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(µV/m)) | *R* = 1/2 | 3.72 | 9.82 | 26.64 | 9.82 | 26.64 | 9.20 |
| *R*= 2/3 | 5.92 | 12.82 | 29.64 | 12.82 | 29.64 | 12.30 |
| *R*= 3/4 | 6.82 | 15.02 | 31.84 | 15.02 | 31.84 | 13.60 |
| Allowance for man‑made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |

TABLE 61 (*end*)

| Reception mode |  |  | FX | PI | PI−H | PO | PO−H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl* (dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dB(µV/m)) | *R*= 1/2 | 17.23 | 50.19 | 60.63 | 40.01 | 49.91 | 42.42 |
| *R* = 2/3 | 19.43 | 53.19 | 63.63 | 43.01 | 52.91 | 45.52 |
| *R*= 3/4 | 20.33 | 55.39 | 65.83 | 45.21 | 55.11 | 46.82 |

TABLE 62

Minimum median field-strength level *Emed* for 100 kHz channel   
bandwidth and 16‑QAM modulation in Band I

| Reception mode |  |  | FX | PI | PI−H | PO | PO−H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R* = 1/2 | 6.60 | 12.60 | 12.60 | 12.60 | 12.60 | 10.50 |
| *R*= 2/3 | 9.20 | 15.10 | 15.10 | 15.10 | 15.10 | 13.30 |
| *R*= 3/4 | 10.30 | 17.20 | 17.20 | 17.20 | 17.20 | 15.80 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R*= 1/2 | −137.38 | −131.38 | −131.38 | −131.38 | −131.38 | −133.48 |
| *R* = 2/3 | −134.78 | −128.88 | −128.88 | −128.88 | −128.88 | −130.68 |
| *R* = 3/4 | −133.68 | −126.78 | −126.78 | −126.78 | −126.78 | −128.18 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux‑density at receiving place | ϕ*min* (dBW/m2) | *R*= 1/2 | −140.72 | −133.62 | −113.06 | −133.62 | −113.06 | −135.50 |
| *R*= 2/3 | −138.12 | −131.12 | −110.56 | −131.12 | −110.56 | −132.70 |
| *R* = 3/4 | −137.02 | −129.02 | −108.46 | −129.02 | −108.46 | −130.20 |
| Minimum field‑strength level at receiving antenna | *Emin*(dB(μV/m)) | *R* = 1/2 | 5.08 | 12.18 | 32.74 | 12.18 | 32.74 | 10.30 |
| *R* = 2/3 | 7.68 | 14.68 | 35.24 | 14.68 | 35.24 | 13.10 |
| *R*= 3/4 | 8.78 | 16.78 | 37.34 | 16.78 | 37.34 | 15.60 |
| Allowance for man-made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |

TABLE 62 (*end*)

| Reception mode |  |  | FX | PI | PI−H | PO | PO−H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl* (dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 8.00 | 815.00 | 8.00 | 815.00 | 8.00 |
| Building penetration loss | *Lb* |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dB(μV/m)) | *R* = 1/2 | 23.46 | 54.28 | 63.42 | 45.07 | 53.61 | 46.16 |
| *R*= 2/3 | 26.06 | 56.78 | 65.92 | 47.57 | 56.11 | 48.96 |
| *R*= 3/4 | 27.16 | 58.88 | 68.02 | 49.67 | 58.21 | 51.46 |

TABLE 63

Minimum median field-strength level *Emed* for 100 kHz channel   
bandwidth and 16‑QAM modulation in Band II

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*  (dB) | *R* = 1/2 | 6.60 | 12.60 | 12.60 | 12.60 | 12.60 | 10.50 |
| *R* = 2/3 | 9.20 | 15.10 | 15.10 | 15.10 | 15.10 | 13.30 |
| *R* = 3/4 | 10.30 | 17.20 | 17.20 | 17.20 | 17.20 | 15.80 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −137.38 | −131.38 | −131.38 | −131.38 | −131.38 | −133.48 |
| *R* = 2/3 | −134.78 | −128.88 | −128.88 | −128.88 | −128.88 | −130.68 |
| *R* = 3/4 | −133.68 | −126.78 | −126.78 | −126.78 | −126.78 | −128.18 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | ϕ*min* (dBW/m2) | *R* = 1/2 | −136.68 | −129.88 | −113.06 | −129.88 | −113.06 | −131.70 |
| *R*= 2/3 | −134.08 | −127.38 | −110.56 | −127.38 | −110.56 | −128.90 |
| *R*= 3/4 | −132.98 | −125.28 | −108.46 | −125.28 | −108.46 | −126.40 |

TABLE 63 (*end*)

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 9.12 | 15.92 | 32.74 | 15.92 | 32.74 | 14.10 |
| *R* = 2/3 | 11.72 | 18.42 | 35.24 | 18.42 | 35.24 | 16.90 |
| *R* = 3/4 | 12.82 | 20.52 | 37.34 | 20.52 | 37.34 | 19.40 |
| Allowance for man-made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl* (dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dB(μV/m)) | *R* = 1/2 | 22.63 | 56.29 | 66.73 | 46.11 | 56.01 | 47.32 |
| *R* = 2/3 | 25.23 | 58.79 | 69.23 | 48.61 | 58.51 | 50.12 |
| *R*= 3/4 | 26.33 | 60.89 | 71.33 | 50.71 | 60.61 | 52.62 |

TABLE 64

Minimum median field-strength level *Emed* for 100 kHz channel   
bandwidth and 64‑QAM modulation in Band I

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R* = 1/2 | 10.90 | 16.30 | 16.30 | 16.30 | 16.30 | 14.80 |
| *R* = 2/3 | 14.20 | 19.60 | 19.60 | 19.60 | 19.60 | 18.10 |
| *R* = 3/4 | 15.60 | 22.20 | 22.20 | 22.20 | 22.20 | 20.70 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −133.08 | −127.68 | −127.68 | −127.68 | −127.68 | −129.18 |
| *R* = 2/3 | −129.78 | −124.38 | −124.38 | −124.38 | −124.38 | −125.88 |
| *R* = 3/4 | −128.38 | −121.78 | −121.78 | −121.78 | −121.78 | −123.28 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |

TABLE 64 (*end*)

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Minimum power flux‑density at receiving place | ϕ*min* (dBW/m2) | *R* = 1/2 | −136.42 | −129.92 | −109.36 | −129.92 | −109.36 | −131.20 |
| *R* = 2/3 | −133.12 | −126.62 | −106.06 | −126.62 | −106.06 | −127.90 |
| *R* = 3/4 | −131.72 | −124.02 | −103.46 | −124.02 | −103.46 | −125.30 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 9.38 | 15.88 | 36.44 | 15.88 | 36.44 | 14.60 |
| *R* = 2/3 | 12.68 | 19.18 | 39.74 | 19.18 | 39.74 | 17.90 |
| *R* = 3/4 | 14.08 | 21.78 | 42.34 | 21.78 | 42.34 | 20.50 |
| Allowance for man-made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl* (dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 8.00 | 815.00 | 8.00 | 815.00 | 8.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field-strength level | *Emed*(dB(μV/m)) | *R* = 1/2 | 27.76 | 57.98 | 67.12 | 48.77 | 57.31 | 50.46 |
| *R*= 2/3 | 31.06 | 61.28 | 70.42 | 52.07 | 60.61 | 53.76 |
| *R* = 3/4 | 32.46 | 63.88 | 73.02 | 54.67 | 63.21 | 56.36 |

TABLE 65

Minimum median field-strength level *Emed* for 100 kHz channel   
bandwidth and 64‑QAM modulation in Band II

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 | −146.98 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*  (dB) | *R* = 1/2 | 10.90 | 16.30 | 16.30 | 16.30 | 16.30 | 14.80 |
| *R* = 2/3 | 14.20 | 19.60 | 19.60 | 19.60 | 19.60 | 18.10 |
| *R* = 3/4 | 15.60 | 22.20 | 22.20 | 22.20 | 22.20 | 20.70 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |

TABLE 65 (*end*)

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −133.08 | −127.68 | −127.68 | −127.68 | −127.68 | −129.18 |
| *R* = 2/3 | −129.78 | −124.38 | −124.38 | −124.38 | −124.38 | −125.88 |
| *R* = 3/4 | −128.38 | −121.78 | −121.78 | −121.78 | −121.78 | −123.28 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux-density at receiving place | ϕ*min*(dBW/m2) | *R* = 1/2 | −132.38 | −126.18 | −109.36 | −126.18 | −109.36 | −127.40 |
| *R*= 2/3 | −129.08 | −122.88 | −106.06 | −122.88 | −106.06 | −124.10 |
| *R* = 3/4 | −127.68 | −120.28 | −103.46 | −120.28 | −103.46 | −121.50 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(µV/m)) | *R* = 1/2 | 13.42 | 19.62 | 36.44 | 19.62 | 36.44 | 18.40 |
| *R* = 2/3 | 16.72 | 22.92 | 39.74 | 22.92 | 39.74 | 21.70 |
| *R*= 3/4 | 18.12 | 25.52 | 42.34 | 25.52 | 42.34 | 24.30 |
| Allowance for man‑made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl*(dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dB(μV/m)) | *R* = 1/2 | 26.93 | 59.99 | 70.43 | 49.81 | 59.71 | 51.62 |
| *R* = 2/3 | 30.23 | 63.29 | 73.73 | 53.11 | 63.01 | 54.92 |
| *R* = 3/4 | 31.63 | 65.89 | 76.33 | 55.71 | 65.61 | 57.52 |

TABLE 66

Minimum median field-strength level *Emed* for 200 kHz channel   
bandwidth and QPSK modulation in Band I

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*(dB) | *R* = 1/2 | 1.10 | 6.40 | 6.40 | 6.40 | 6.40 | 5.50 |
| *R* = 2/3 | 3.30 | 9.40 | 9.40 | 9.40 | 9.40 | 8.60 |
| *R* = 3/4 | 4.20 | 11.50 | 11.50 | 11.50 | 11.50 | 9.80 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −139.87 | −134.57 | −134.57 | −134.57 | −134.57 | −135.47 |
| *R*= 2/3 | −137.67 | −131.57 | −131.57 | −131.57 | −131.57 | −132.37 |
| *R*= 3/4 | −136.77 | −129.47 | −129.47 | −129.47 | −129.47 | −131.17 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux‑density at receiving place | φ*min* (dBW/m2) | *R*= 1/2 | −143.21 | −136.81 | −116.25 | −136.81 | −116.25 | −137.49 |
| *R*= 2/3 | −141.01 | −133.81 | −113.25 | −133.81 | −113.25 | −134.39 |
| *R* = 3/4 | −140.11 | −131.71 | −111.15 | −131.71 | −111.15 | −133.19 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 2.59 | 8.99 | 29.55 | 8.99 | 29.55 | 8.31 |
| *R* = 2/3 | 4.79 | 11.99 | 32.55 | 11.99 | 32.55 | 11.41 |
| *R*= 3/4 | 5.69 | 14.09 | 34.65 | 14.09 | 34.65 | 12.61 |
| Allowance for man-made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl*(dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 8.00 | 815.00 | 8.00 | 815.00 | 8.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field-strength level | *Emed* (dB(μV/m)) | *R* = 1/2 | 20.97 | 51.09 | 60.23 | 41.88 | 50.42 | 44.17 |
| *R* = 2/3 | 23.17 | 54.09 | 63.23 | 44.88 | 53.42 | 47.27 |
| *R*= 3/4 | 24.07 | 56.19 | 65.33 | 46.98 | 55.52 | 48.47 |

TABLE 67

Minimum median field-strength level *Emed* for 200 kHz channel   
bandwidth and QPSK modulation in Band II

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R* = 1/2 | 1.10 | 6.40 | 6.40 | 6.40 | 6.40 | 5.50 |
| *R* = 2/3 | 3.30 | 9.40 | 9.40 | 9.40 | 9.40 | 8.60 |
| *R*= 3/4 | 4.20 | 11.50 | 11.50 | 11.50 | 11.50 | 9.80 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R*= 1/2 | −139.87 | −134.57 | −134.57 | −134.57 | −134.57 | −135.47 |
| *R* = 2/3 | −137.67 | −131.57 | −131.57 | −131.57 | −131.57 | −132.37 |
| *R* = 3/4 | −136.77 | −129.47 | −129.47 | −129.47 | −129.47 | −131.17 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | φ*min*(dBW/m2) | *R*= 1/2 | −139.17 | −133.07 | −116.25 | −133.07 | −116.25 | −133.69 |
| *R* = 2/3 | −136.97 | −130.07 | −113.25 | −130.07 | −113.25 | −130.59 |
| *R* = 3/4 | −136.07 | −127.97 | −111.15 | −127.97 | −111.15 | −129.39 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 6.63 | 12.73 | 29.55 | 12.73 | 29.55 | 12.11 |
| *R* = 2/3 | 8.83 | 15.73 | 32.55 | 15.73 | 32.55 | 15.21 |
| *R*= 3/4 | 9.73 | 17.83 | 34.65 | 17.83 | 34.65 | 16.41 |
| Allowance for man‑made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl*(dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed*(dB(µV/m)) | *R*= 1/2 | 20.14 | 53.10 | 63.54 | 42.92 | 52.82 | 45.33 |
| *R* = 2/3 | 22.34 | 56.10 | 66.54 | 45.92 | 55.82 | 48.43 |
| *R* = 3/4 | 23.24 | 58.20 | 68.64 | 48.02 | 57.92 | 49.63 |

TABLE 68

Minimum median field-strength level *Emed* for 200 kHz channel   
bandwidth and 16‑QAM modulation in Band I

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*  (dB) | *R* = 1/2 | 6.40 | 12.50 | 12.50 | 12.50 | 12.50 | 10.40 |
| *R*= 2/3 | 9.10 | 14.90 | 14.90 | 14.90 | 14.90 | 13.20 |
| *R* = 3/4 | 10.20 | 17.00 | 17.00 | 17.00 | 17.00 | 15.60 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −134.57 | −128.47 | −128.47 | −128.47 | −128.47 | −130.57 |
| *R* = 2/3 | −131.87 | −126.07 | −126.07 | −126.07 | −126.07 | −127.77 |
| *R* = 3/4 | −130.77 | −123.97 | −123.97 | −123.97 | −123.97 | −125.37 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux-density at receiving place | ϕ*min* (dBW/m2) | *R* = 1/2 | −137.91 | −130.71 | −110.15 | −130.71 | −110.15 | −132.59 |
| *R* = 2/3 | −135.21 | −128.31 | −107.75 | −128.31 | −107.75 | −129.79 |
| *R* = 3/4 | −134.11 | −126.21 | −105.65 | −126.21 | −105.65 | −127.39 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 7.89 | 15.09 | 35.65 | 15.09 | 35.65 | 13.21 |
| *R* = 2/3 | 10.59 | 17.49 | 38.05 | 17.49 | 38.05 | 16.01 |
| *R* = 3/4 | 11.69 | 19.59 | 40.15 | 19.59 | 40.15 | 18.41 |
| Allowance for man‑made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b*(dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl*(dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |
| Antenna height loss | *Lh*(dB) |  | 0.00 | 8.00 | 815.00 | 8.00 | 815.00 | 8.00 |
| Building penetration loss | *Lb*(dB) |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed*(dB(μV/m)) | *R* = 1/2 | 26.27 | 57.19 | 66.33 | 47.98 | 56.52 | 49.07 |
| *R* = 2/3 | 28.97 | 59.59 | 68.73 | 50.38 | 58.92 | 51.87 |
| *R* = 3/4 | 30.07 | 61.69 | 70.83 | 52.48 | 61.02 | 54.27 |

TABLE 69

Minimum median field-strength level *Emed* for 200 kHz channel   
bandwidth and 16‑QAM modulation in Band II

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R* = 1/2 | 6.40 | 12.50 | 12.50 | 12.50 | 12.50 | 10.40 |
| *R* = 2/3 | 9.10 | 14.90 | 14.90 | 14.90 | 14.90 | 13.20 |
| *R* = 3/4 | 10.20 | 17.00 | 17.00 | 17.00 | 17.00 | 15.60 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps min* (dBW) | *R* = 1/2 | −134.57 | −128.47 | −128.47 | −128.47 | −128.47 | −130.57 |
| *R* = 2/3 | −131.87 | −126.07 | −126.07 | −126.07 | −126.07 | −127.77 |
| *R* = 3/4 | −130.77 | −123.97 | −123.97 | −123.97 | −123.97 | −125.37 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | φ*min* (dBW/m2) | *R* = 1/2 | −133.87 | −126.97 | −110.15 | −126.97 | −110.15 | −128.79 |
| *R*= 2/3 | −131.17 | −124.57 | −107.75 | −124.57 | −107.75 | −125.99 |
| *R* = 3/4 | −130.07 | −122.47 | −105.65 | −122.47 | −105.65 | −123.59 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 11.93 | 18.83 | 35.65 | 18.83 | 35.65 | 17.01 |
| *R* = 2/3 | 14.63 | 21.23 | 38.05 | 21.23 | 38.05 | 19.81 |
| *R* = 3/4 | 15.73 | 23.33 | 40.15 | 23.33 | 40.15 | 22.21 |
| Allowance for man-made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl*(dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed*(dB(μV/m)) | *R* = 1/2 | 25.44 | 59.20 | 69.64 | 49.02 | 58.92 | 50.23 |
| *R* = 2/3 | 28.14 | 61.60 | 72.04 | 51.42 | 61.32 | 53.03 |
| *R* = 3/4 | 29.24 | 63.70 | 74.14 | 53.52 | 63.42 | 55.43 |

TABLE 70

Minimum median field-strength level *Emed* for 200 kHz channel   
bandwidth and 64‑QAM modulation in Band I

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R* = 1/2 | 10.80 | 16.20 | 16.20 | 16.20 | 16.20 | 14.70 |
| *R* = 2/3 | 14.00 | 19.40 | 19.40 | 19.40 | 19.40 | 17.90 |
| *R* = 3/4 | 15.40 | 22.00 | 22.00 | 22.00 | 22.00 | 20.50 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −130.17 | −124.77 | −124.77 | −124.77 | −124.77 | −126.27 |
| *R*= 2/3 | −126.97 | −121.57 | −121.57 | −121.57 | −121.57 | −123.07 |
| *R*= 3/4 | −125.57 | −118.97 | −118.97 | −118.97 | −118.97 | −120.47 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux‑density at receiving place | ϕ*min*(dBW/m2) | *R* = 1/2 | −133.51 | −127.01 | −106.45 | −127.01 | −106.45 | −128.29 |
| *R* = 2/3 | −130.31 | −123.81 | −103.25 | −123.81 | −103.25 | −125.09 |
| *R* = 3/4 | −128.91 | −121.21 | −100.65 | −121.21 | −100.65 | −122.49 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 12.29 | 18.79 | 39.35 | 18.79 | 39.35 | 17.51 |
| *R* = 2/3 | 15.49 | 21.99 | 42.55 | 21.99 | 42.55 | 20.71 |
| *R* = 3/4 | 16.89 | 24.59 | 45.15 | 24.59 | 45.15 | 23.31 |
| Allowance for man‑made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl*(dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 8.00 | 815.00 | 815.00 | 8.00 | 8.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dB(μV/m)) | *R* = 1/2 | 30.67 | 60.89 | 70.03 | 51.68 | 60.22 | 53.37 |
| *R* = 2/3 | 33.87 | 64.09 | 73.23 | 54.88 | 63.42 | 56.57 |
| *R*= 3/4 | 35.27 | 66.69 | 75.83 | 57.48 | 66.02 | 59.17 |

TABLE 71

Minimum median field-strength level *Emed* for 200 kHz channel   
bandwidth and 64‑QAM modulation in Band II

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 | −143.97 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R*= 1/2 | 10.80 | 16.20 | 16.20 | 16.20 | 16.20 | 14.70 |
| *R* = 2/3 | 14.00 | 19.40 | 19.40 | 19.40 | 19.40 | 17.90 |
| *R* = 3/4 | 15.40 | 22.00 | 22.00 | 22.00 | 22.00 | 20.50 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −130.17 | −124.77 | −124.77 | −124.77 | −124.77 | −126.27 |
| *R*= 2/3 | −126.97 | −121.57 | −121.57 | −121.57 | −121.57 | −123.07 |
| *R* = 3/4 | −125.57 | −118.97 | −118.97 | −118.97 | −118.97 | −120.47 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | φ*min* (dBW/m2) | *R* = 1/2 | −129.47 | −123.27 | −106.45 | −123.27 | −106.45 | −124.49 |
| *R* = 2/3 | −126.27 | −120.07 | −103.25 | −120.07 | −103.25 | −121.29 |
| *R* = 3/4 | −124.87 | −117.47 | −100.65 | −117.47 | −100.65 | −118.69 |
| Minimum field-strength level at receiving antenna | *Emin*(dB(µV/m)) | *R* = 1/2 | 16.33 | 22.53 | 39.35 | 22.53 | 39.35 | 21.31 |
| *R* = 2/3 | 19.53 | 25.73 | 42.55 | 25.73 | 42.55 | 24.51 |
| *R* = 3/4 | 20.93 | 28.33 | 45.15 | 28.33 | 45.15 | 27.11 |
| Allowance for man-made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | µ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl*(dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dBµV/m) | *R* = 1/2 | 29.84 | 62.90 | 73.34 | 52.72 | 62.62 | 54.53 |
| *R*= 2/3 | 33.04 | 66.10 | 76.54 | 55.92 | 65.82 | 57.73 |
| *R* = 3/4 | 34.44 | 68.70 | 79.14 | 58.52 | 68.42 | 60.33 |

TABLE 72

Minimum median field-strength level *Emed* for 250 kHz channel   
bandwidth and QPSK modulation in Band I

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*  (dB) | *R* = 1/2 | 1.10 | 6.40 | 6.40 | 6.40 | 6.40 | 5.50 |
| *R =* 2/3 | 3.20 | 9.40 | 9.40 | 9.40 | 9.40 | 8.50 |
| *R* = 3/4 | 4.20 | 11.50 | 11.50 | 11.50 | 11.50 | 9.80 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min*  (dBW) | *R* = 1/2 | −138.90 | −133.60 | −133.60 | −133.60 | −133.60 | −134.50 |
| *R* = 2/3 | −136.80 | −130.60 | −130.60 | −130.60 | −130.60 | −131.50 |
| *R* = 3/4 | −135.80 | −128.50 | −128.50 | −128.50 | −128.50 | −130.20 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux‑density at receiving place | ϕ*min*(dBW/m2) | *R* = 1/2 | −142.24 | −135.84 | −115.28 | −135.84 | −115.28 | −136.52 |
| *R* = 2/3 | −140.14 | −132.84 | −112.28 | −132.84 | −112.28 | −133.52 |
| *R* = 3/4 | −139.14 | −130.74 | −110.18 | −130.74 | −110.18 | −132.22 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 3.56 | 9.96 | 30.52 | 9.96 | 30.52 | 9.28 |
| *R* = 2/3 | 5.66 | 12.96 | 33.52 | 12.96 | 33.52 | 12.28 |
| *R* = 3/4 | 6.66 | 15.06 | 35.62 | 15.06 | 35.62 | 13.58 |
| Allowance for man-made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl* (dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 8.00 | 815.00 | 8.00 | 815.00 | 8.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed*(dB(μV/m)) | *R* = 1/2 | 21.93 | 52.06 | 61.20 | 42.85 | 51.39 | 45.14 |
| *R* = 2/3 | 24.03 | 55.06 | 64.20 | 45.85 | 54.39 | 48.14 |
| *R* = 3/4 | 25.03 | 57.16 | 66.30 | 47.95 | 56.49 | 49.44 |

TABLE 73

Minimum median field-strength level *Emed* for 250 kHz channel   
bandwidth and QPSK modulation in Band II

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min* (dB) | *R* = 1/2 | 1.10 | 6.40 | 6.40 | 6.40 | 6.40 | 5.50 |
| *R* = 2/3 | 3.20 | 9.40 | 9.40 | 9.40 | 9.40 | 8.50 |
| *R* = 3/4 | 4.20 | 11.50 | 11.50 | 11.50 | 11.50 | 9.80 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min*  (dBW) | *R* = 1/2 | −138.90 | −133.60 | −133.60 | −133.60 | −133.60 | −134.50 |
| *R* = 2/3 | −136.80 | −130.60 | −130.60 | −130.60 | −130.60 | −131.50 |
| *R* = 3/4 | −135.80 | −128.50 | −128.50 | −128.50 | −128.50 | −130.20 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | ϕ*min*(dBW/m2) | *R* = 1/2 | −138.20 | −132.10 | −115.28 | −132.10 | −115.28 | −132.72 |
| *R* = 2/3 | −136.10 | −129.10 | −112.28 | −129.10 | −112.28 | −129.72 |
| *R* = 3/4 | −135.10 | −127.00 | −110.18 | −127.00 | −110.18 | −128.42 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 7.60 | 13.70 | 30.52 | 13.70 | 30.52 | 13.08 |
| *R* = 2/3 | 9.70 | 16.70 | 33.52 | 16.70 | 33.52 | 16.08 |
| *R*= 3/4 | 10.70 | 18.80 | 35.62 | 18.80 | 35.62 | 17.38 |
| Allowance for man-made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl* (dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 10.00 | 17.00 | 10.00 | 170.00 | 10.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed*(dB(μV/m)) | *R* = 1/2 | 21.11 | 54.07 | 64.51 | 43.89 | 53.79 | 46.30 |
| *R* = 2/3 | 23.21 | 57.07 | 67.51 | 46.89 | 56.79 | 49.30 |
| *R* = 3/4 | 24.21 | 59.17 | 69.61 | 48.99 | 58.89 | 50.60 |

TABLE 74

Minimum median field-strength level *Emed* for 250 kHz channel   
bandwidth and 16‑QAM modulation in Band I

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*  (dB) | *R* = 1/2 | 6.30 | 12.40 | 12.40 | 12.40 | 12.40 | 10.30 |
| *R* = 2/3 | 9.10 | 14.90 | 14.90 | 14.90 | 14.90 | 13.20 |
| *R* = 3/4 | 10.20 | 17.00 | 17.00 | 17.00 | 17.00 | 15.60 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min* (dBW) | *R* = 1/2 | −133.70 | −127.60 | −127.60 | −127.60 | −127.60 | −129.70 |
| *R* = 2/3 | −130.90 | −125.10 | −125.10 | −125.10 | −125.10 | −126.80 |
| *R* = 3/4 | −129.80 | −123.00 | −123.00 | −123.00 | −123.00 | −124.40 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux‑density at receiving place | ϕ*min*(dBW/m2) | *R* = 1/2 | −137.04 | −129.84 | −109.28 | −129.84 | −109.28 | −131.72 |
| *R* = 2/3 | −134.24 | −127.34 | −106.78 | −127.34 | −106.78 | −128.82 |
| *R* = 3/4 | −133.14 | −125.24 | −104.68 | −125.24 | −104.68 | −126.42 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 8.76 | 15.96 | 36.52 | 15.96 | 36.52 | 14.08 |
| *R* = 2/3 | 11.56 | 18.46 | 39.02 | 18.46 | 39.02 | 16.98 |
| *R* = 3/4 | 12.66 | 20.56 | 41.12 | 20.56 | 41.12 | 19.38 |
| Allowance for man-made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl*(dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 8.00 | 815.00 | 8.00 | 815.00 | 8.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed*(dB(μV/m)) | *R* = 1/2 | 27.13 | 58.06 | 67.20 | 48.85 | 57.39 | 49.94 |
| *R* = 2/3 | 29.93 | 60.56 | 69.70 | 51.35 | 59.89 | 52.84 |
| *R* = 3/4 | 31.03 | 62.66 | 71.80 | 53.45 | 61.99 | 55.24 |

TABLE 75

Minimum median field-strength level *Emed* for 250 kHz channel   
bandwidth and 16‑QAM modulation in Band II

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*(dB) | *R* = 1/2 | 6.30 | 12.40 | 12.40 | 12.40 | 12.40 | 10.30 |
| *R* = 2/3 | 9.10 | 14.90 | 14.90 | 14.90 | 14.90 | 13.20 |
| *R* = 3/4 | 10.20 | 17.00 | 17.00 | 17.00 | 17.00 | 15.60 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min*  (dBW) | *R* = 1/2 | −133.70 | −127.60 | −127.60 | −127.60 | −127.60 | −129.70 |
| *R* = 2/3 | −130.90 | −125.10 | −125.10 | −125.10 | −125.10 | −126.80 |
| *R* = 3/4 | −129.80 | −123.00 | −123.00 | −123.00 | −123.00 | −124.40 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | φ*min*(dBW/m2) | *R* = 1/2 | −133.00 | −126.10 | −109.28 | −126.10 | −109.28 | −127.92 |
| *R* = 2/3 | −130.20 | −123.60 | −106.78 | −123.60 | −106.78 | −125.02 |
| *R* = 3/4 | −129.10 | −121.50 | −104.68 | −121.50 | −104.68 | −122.62 |
| Minimum field-strength level at receiving antenna | *Emin*(dB(µV/m)) | *R* = 1/2 | 12.80 | 19.70 | 36.52 | 19.70 | 36.52 | 17.88 |
| *R* = 2/3 | 15.60 | 22.20 | 39.02 | 22.20 | 39.02 | 20.78 |
| *R*= 3/4 | 16.70 | 24.30 | 41.12 | 24.30 | 41.12 | 23.18 |
| Allowance for man-made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl*(dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed*  (dB(µV/m)) | *R* = 1/2 | 26.31 | 60.07 | 70.51 | 49.89 | 59.79 | 51.10 |
| *R* = 2/3 | 29.11 | 62.57 | 73.01 | 52.39 | 62.29 | 54.00 |
| *R* = 3/4 | 30.21 | 64.67 | 75.11 | 54.49 | 64.39 | 56.40 |

TABLE 76

Minimum median field-strength level *Emed* for 250 kHz channel   
bandwidth and 64‑QAM modulation in Band I

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*  (dB) | *R* = 1/2 | 10.60 | 16.10 | 16.10 | 16.10 | 16.10 | 14.60 |
| *R* = 2/3 | 14.00 | 19.40 | 19.40 | 19.40 | 19.40 | 17.90 |
| *R* = 3/4 | 15.40 | 22.00 | 22.00 | 22.00 | 22.00 | 20.50 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min*  (dBW) | *R*= 1/2 | −129.40 | −123.90 | −123.90 | −123.90 | −123.90 | −125.40 |
| *R* = 2/3 | −126.00 | −120.60 | −120.60 | −120.60 | −120.60 | −122.10 |
| *R* = 3/4 | −124.60 | −118.00 | −118.00 | −118.00 | −118.00 | −119.50 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −22.76 | −2.20 | −22.76 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 4.44 | 2.24 | −18.32 | 2.24 | −18.32 | 2.24 |
| Feeder-loss | *Lf* (dB) |  | 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 |
| Minimum power flux‑density at receiving place | ϕ*min* (dBW/m2) | *R*= 1/2 | −132.74 | −126.14 | −105.58 | −126.14 | −105.58 | −127.42 |
| *R*= 2/3 | −129.34 | −122.84 | −102.28 | −122.84 | −102.28 | −124.12 |
| *R* = 3/4 | −127.94 | −120.24 | −99.68 | −120.24 | −99.68 | −121.52 |
| Minimum field-strength level at receiving antenna | *Emin* (dB(μV/m)) | *R* = 1/2 | 13.06 | 19.66 | 40.22 | 19.66 | 40.22 | 18.38 |
| *R* = 2/3 | 16.46 | 22.96 | 43.52 | 22.96 | 43.52 | 21.68 |
| *R*= 3/4 | 17.86 | 25.56 | 46.12 | 25.56 | 46.12 | 24.28 |
| Allowance for man-made noise | *PMMN* (dB) |  | 15.38 | 15.38 | 0.00 | 15.38 | 0.00 | 15.38 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.56 | 3.56 | 3.56 | 3.56 | 3.56 | 2.86 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b* (dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.76 | 6.50 | 4.66 | 5.76 | 3.56 | 5.36 |
| Location correction factor | *Cl*(dB) |  | 3.00 | 10.72 | 7.68 | 9.51 | 5.87 | 12.48 |
| Antenna height loss | *Lh* (dB) |  | 0.00 | 8.00 | 815.00 | 8.00 | 815.00 | 8.00 |
| Building penetration loss | *Lb* (dB) |  | 0.00 | 98.00 | 98.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dB(μV/m)) | *R* = 1/2 | 31.43 | 61.76 | 70.90 | 52.55 | 61.09 | 54.24 |
| *R* = 2/3 | 34.83 | 65.06 | 74.20 | 55.85 | 64.39 | 57.54 |
| *R* = 3/4 | 36.23 | 67.66 | 76.80 | 58.45 | 66.99 | 60.14 |

TABLE 77

Minimum median field-strength level *Emed* for 250 kHz channel   
bandwidth and 64‑QAM modulation in Band II

| Reception mode |  |  | FX | PI | PI-H | PO | PO-H | MO |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Receiver noise figure | *F* (dB) |  | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Receiver noise input power | *Pn* (dBW) |  | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 | −143.00 |
| Minimum *C*/*N* ratio | (*C*/*N*)*min*  (dB) | *R* = 1/2 | 10.60 | 16.10 | 16.10 | 16.10 | 16.10 | 14.60 |
| *R*= 2/3 | 14.00 | 19.40 | 19.40 | 19.40 | 19.40 | 17.90 |
| *R* = 3/4 | 15.40 | 22.00 | 22.00 | 22.00 | 22.00 | 20.50 |
| Implementation loss | *Li* (dB) |  | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Minimum receiver input power level | *Ps,min*  (dBW) | *R* = 1/2 | −129.40 | −123.90 | −123.90 | −123.90 | −123.90 | −125.40 |
| *R* = 2/3 | −126.00 | −120.60 | −120.60 | −120.60 | −120.60 | −122.10 |
| *R* = 3/4 | −124.60 | −118.00 | −118.00 | −118.00 | −118.00 | −119.50 |
| Antenna gain | *Gd* (dBd) |  | 0.00 | −2.20 | −19.02 | −2.20 | −19.02 | −2.20 |
| Effective antenna aperture | *Aa* (dBm2) |  | 0.70 | −1.50 | −18.32 | −1.50 | −18.32 | −1.50 |
| Feeder-loss | *Lf* (dB) |  | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |
| Minimum power flux‑density at receiving place | ϕ*min*(dBW/m2) | *R* = 1/2 | −128.70 | −122.40 | −105.58 | −122.40 | −105.58 | −123.62 |
| *R* = 2/3 | −125.30 | −119.10 | −102.28 | −119.10 | −102.28 | −120.32 |
| *R* = 3/4 | −123.90 | −116.50 | −99.68 | −116.50 | −99.68 | −117.72 |
| Minimum field-strength level at receiving antenna | *Emin*(dB(μV/m)) | *R* = 1/2 | 17.10 | 23.40 | 40.22 | 23.40 | 40.22 | 22.18 |
| *R* = 2/3 | 20.50 | 26.70 | 43.52 | 26.70 | 43.52 | 25.48 |
| *R* = 3/4 | 21.90 | 29.30 | 46.12 | 29.30 | 46.12 | 28.08 |
| Allowance for man-made noise | *PMMN* (dB) |  | 10.43 | 10.43 | 0.00 | 10.43 | 0.00 | 10.43 |
| Location probability | *p* (%) |  | 70.00 | 95.00 | 95.00 | 95.00 | 95.00 | 99.00 |
| Distribution factor | μ |  | 0.52 | 1.65 | 1.65 | 1.65 | 1.65 | 2.33 |
| Standard deviation of field strength | σ*m* (dB) |  | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.10 |
| Standard deviation of man-made noise | σ*MMN* (dB) |  | 4.53 | 4.53 | 0.00 | 4.53 | 0.00 | 4.53 |
| Standard deviation of building penetration loss | σ*b*(dB) |  | 0.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| Combined standard deviation of field strength | σ*c* (dB) |  | 5.91 | 6.63 | 4.84 | 5.91 | 3.80 | 5.49 |
| Location correction factor | *Cl* (dB) |  | 3.07 | 10.94 | 7.99 | 9.76 | 6.27 | 12.79 |
| Antenna height loss | *Lh* |  | 0.00 | 10.00 | 17.00 | 10.00 | 17.00 | 10.00 |
| Building penetration loss | *Lb* |  | 0.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 |
| Minimum median field‑strength level | *Emed* (dB(μV/m)) | *R* = 1/2 | 30.61 | 63.77 | 74.21 | 53.59 | 63.49 | 55.40 |
| *R* = 2/3 | 34.01 | 67.07 | 77.51 | 56.89 | 66.79 | 58.70 |
| *R*= 3/4 | 35.41 | 69.67 | 80.11 | 59.49 | 69.39 | 61.30 |

### 5.3.2 Out-of-band emissions

The spectrum masks for RAVIS transmission (for three types of channel bandwidth) [10] compared to spectrum mask for analogue FM (according to ETSI EN 302 018-2 [7]) are given in Tables 78‑81 and Fig. 3. RAVIS spectrum masks are fitting into analogue FM spectrum mask.

TABLE 78

Spectrum mask for FM transmission

|  |  |
| --- | --- |
| Frequency offset (kHz) | Level (dBc)/(1 kHz) |
| 0 | 0 |
| ±100 | 0 |
| ±200 | −80 |
| ±300 | −85 |
| ±400 | −85 |

TABLE 79

Spectrum mask for RAVIS transmission, 100 kHz channel bandwidth

|  |  |
| --- | --- |
| Frequency offset (kHz) | Level (dBc)/(1 kHz) |
| 0 | −20 |
| ±50 | −20 |
| ±70 | −50 |
| ±100 | −70 |
| ±200 | −80 |
| ±300 | −85 |
| ±400 | −85 |

TABLE 80

Spectrum mask for RAVIS transmission, 200 kHz channel bandwidth

|  |  |
| --- | --- |
| Frequency offset (kHz) | Level (dBc)/(1 kHz) |
| 0 | −23 |
| ±100 | −23 |
| ±120 | −50 |
| ±150 | −70 |
| ±200 | −80 |
| ±300 | −85 |
| ±400 | −85 |

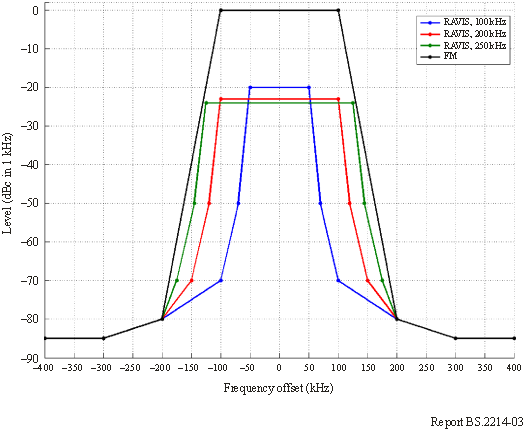
TABLE 81

Spectrum mask for RAVIS transmission, 250 kHz channel bandwidth

|  |  |
| --- | --- |
| Frequency offset (kHz) | Level (dBc)/(1 kHz) |
| 0 | −24 |
| ±125 | −24 |
| ±145 | −50 |
| ±175 | −70 |
| ±200 | −80 |
| ±300 | −85 |
| ±400 | −85 |

Figure 3

Spectrum mask for RAVIS and FM transmission



### 5.3.3 Protection ratios

#### 5.3.3.1 Protection ratios for FM

Basic protection ratios for FM interfered with by RAVIS are given in Table 82.

TABLE 82

Basic protection ratios *PRbasic* for FM interfered with by RAVIS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 | ±300 | ±400 |
| Basic protection ratio, channel bandwidth *B* = 100 kHz | *PRbasic* (dB) | 50 | 35 | 5 | −5 | −10 |
| Basic protection ratio, channel bandwidth *B* = 200 kHz | *PRbasic* (dB) | 50 |  |  |  |  |
| Basic protection ratio, channel bandwidth *B* = 250 kHz | *PRbasic* (dB) | 50 |  |  |  |  |

#### 5.3.3.2 Protection ratios for RAVIS

Basic protection ratios for RAVIS interfered with by RAVIS are given in Table 83.

TABLE 83

Basic protection ratios *PRbasic* for RAVIS interfered with by RAVIS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 | ±300 | ±400 |
| B = 100 kHz, QPSK, R = 1/2 | *PRbasic* (dB) | 8 | 0 | −48 | −55 | −56 |
| B = 100 kHz, QPSK, R = 2/3 | *PRbasic* (dB) | 9 | 2 | −47 | −54 | −55 |
| B = 100 kHz, QPSK, R = 3/4 | *PRbasic* (dB) | 10 | 3 | −46 | −53 | −54 |
| B = 100 kHz, 16-QAM, R = 1/2 | *PRbasic* (dB) | 12 | 6 | −43 | −51 | −52 |
| B = 100 kHz, 16-QAM, R = 2/3 | *PRbasic* (dB) | 14 | 8 | −41 | −49 | −50 |
| B = 100 kHz, 16-QAM, R = 3/4 | *PRbasic* (dB) | 15 | 9 | −40 | −48 | −49 |
| B = 100 kHz, 64-QAM, R = 1/2 | *PRbasic* (dB) | 16 | 10 | −39 | −47 | −48 |
| B = 100 kHz, 64-QAM, R = 2/3 | *PRbasic* (dB) | 19 | 13 | −36 | −44 | −45 |
| B = 100 kHz, 64-QAM, R = 3/4 | *PRbasic* (dB) | 20 | 14 | −35 | −43 | −44 |
| B = 200 kHz, QPSK, R = 1/2 | *PRbasic* (dB) | 8 | 6 | −22 | −51 | −54 |
| B = 200 kHz, QPSK, R = 2/3 | *PRbasic* (dB) | 9 | 7 | −6 | −50 | −53 |
| B = 200 kHz, QPSK, R = 3/4 | *PRbasic* (dB) | 10 | 8 | −1 | −49 | −52 |
| B = 200 kHz, 16-QAM, R = 1/2 | *PRbasic* (dB) | 12 | 10 | 2 | −47 | −49 |
| B = 200 kHz, 16-QAM, R = 2/3 | *PRbasic* (dB) | 14 | 12 | 5 | −45 | −48 |
| B = 200 kHz, 16-QAM, R = 3/4 | *PRbasic* (dB) | 15 | 13 | 6 | −44 | −47 |
| B = 200 kHz, 64-QAM, R = 1/2 | *PRbasic* (dB) | 16 | 14 | 7 | −42 | −46 |
| B = 200 kHz, 64-QAM, R = 2/3 | *PRbasic* (dB) | 19 | 17 | 10 | −39 | −43 |
| B = 200 kHz, 64-QAM, R = 3/4 | *PRbasic* (dB) | 20 | 18 | 11 | −38 | −41 |
| B = 250 kHz, QPSK, R = 1/2 | *PRbasic* (dB) | 8 | 6 | 2 | −47 | −52 |
| B = 250 kHz, QPSK, R = 2/3 | *PR*basic (dB) | 9 | 7 | 3 | −46 | −51 |
| B = 250 kHz, QPSK, R = 3/4 | *PRbasic* (dB) | 10 | 8 | 5 | −44 | −50 |
| B = 250 kHz, 16-QAM, R = 1/2 | *PRbasic* (dB) | 12 | 10 | 7 | −41 | −48 |
| B = 250 kHz, 16-QAM, R = 2/3 | *PRbasic* (dB) | 14 | 12 | 9 | −35 | −46 |
| B = 250 kHz, 16-QAM, R = 3/4 | *PRbasic* (dB) | 15 | 13 | 10 | −32 | −45 |
| B = 250 kHz, 64-QAM, R = 1/2 | *PRbasic* (dB) | 16 | 14 | 11 | −30 | −44 |
| B = 250 kHz, 64-QAM, R = 2/3 | *PRbasic* (dB) | 19 | 17 | 14 | −24 | −41 |
| B = 250 kHz, 64-QAM, R = 3/4 | *PRbasic* (dB) | 20 | 18 | 15 | −23 | −40 |

Basic protection ratios for RAVIS interfered with by FM are given in Table 84.

TABLE 84

Basic protection ratios *PRbasic* for RAVIS interfered with by RAVIS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Frequency offset (kHz) | | 0 | ±100 | ±200 | ±300 | ±400 |
| B = 100 kHz, QPSK, R = 1/2 | *PRbasic* (dB) | 8 | 28 | 20 | −55 | −56 |
| B = 100 kHz, QPSK, R = 2/3 | *PRbasic* (dB) | 9 | 29 | 22 | −54 | −55 |
| B = 100 kHz, QPSK, R = 3/4 | *PRbasic* (dB) | 10 | 30 | 23 | −53 | −54 |
| B = 100 kHz, 16-QAM, R = 1/2 | *PRbasic* (dB) | 12 | 29 | 25 | −51 | −52 |
| B = 100 kHz, 16-QAM, R = 2/3 | *PRbasic* (dB) | 14 | 26 | 27 | −49 | −50 |
| B = 100 kHz, 16-QAM, R = 3/4 | *PRbasic* (dB) | 15 | 25 | 28 | −48 | −49 |
| B = 100 kHz, 64-QAM, R = 1/2 | *PRbasic* (dB) | 16 | 24 | 29 | −47 | −48 |
| B = 100 kHz, 64-QAM, R = 2/3 | *PRbasic* (dB) | 19 | 21 | 32 | −44 | −45 |
| B = 100 kHz, 64-QAM, R = 3/4 | *PRbasic* (dB) | 20 | 20 | 33 | −43 | −44 |
| B = 200 kHz, QPSK, R = 1/2 | *PRbasic* (dB) | 8 | 30 | 26 | −51 | −54 |
| B = 200 kHz, QPSK, R = 2/3 | *PRbasic* (dB) | 9 | 31 | 27 | −49 | −53 |
| B = 200 kHz, QPSK, R = 3/4 | *PRbasic* (dB) | 10 | 32 | 28 | −48 | −51 |
| B = 200 kHz, 16-QAM, R = 1/2 | *PRbasic* (dB) | 12 | 34 | 30 | −46 | −49 |
| B = 200 kHz, 16-QAM, R = 2/3 | *PRbasic* (dB) | 14 | 36 | 32 | −45 | −47 |
| B = 200 kHz, 16-QAM, R = 3/4 | *PRbasic* (dB) | 15 | 37 | 33 | −44 | −46 |
| B = 200 kHz, 64-QAM, R = 1/2 | *PRbasic* (dB) | 16 | 38 | 34 | −43 | −45 |
| B = 200 kHz, 64-QAM, R = 2/3 | *PRbasic* (dB) | 19 | 41 | 37 | −40 | −42 |
| B = 200 kHz, 64-QAM, R = 3/4 | *PRbasic* (dB) | 20 | 42 | 38 | −39 | −39 |
| B = 250 kHz, QPSK, R = 1/2 | *PRbasic* (dB) | 8 | 30 | 27 | −45 | −52 |
| B = 250 kHz, QPSK, R = 2/3 | *PRbasic* (dB) | 9 | 31 | 28 | 7 | −51 |
| B = 250 kHz, QPSK, R = 3/4 | *PRbasic* (dB) | 10 | 32 | 29 | 16 | −50 |
| B = 250 kHz, 16-QAM, R = 1/2 | *PRbasic* (dB) | 12 | 34 | 31 | 20 | −48 |
| B = 250 kHz, 16-QAM, R = 2/3 | *PRbasic* (dB) | 14 | 36 | 33 | 23 | −46 |
| B = 250 kHz, 16-QAM, R = 3/4 | *PRbasic* (dB) | 15 | 37 | 34 | 24 | −45 |
| B = 250 kHz, 64-QAM, R = 1/2 | *PRbasic* (dB) | 16 | 38 | 35 | 25 | −44 |
| B = 250 kHz, 64-QAM, R = 2/3 | *PRbasic* (dB) | 19 | 41 | 38 | 28 | −41 |
| B = 250 kHz, 64-QAM, R = 3/4 | *PRbasic* (dB) | 20 | 42 | 39 | 30 | −40 |

### 5.3.4 Sharing criteria with other services

The potential interference from RAVIS to the services in adjacent frequency ranges (for example, to aeronautical radionavigation service in the band above 108.0 MHz) is not higher as the one of analogue FM service.

Attachment 1   
  
Normative references

# 1 Symbols and abbreviations

For the purposes of the present Report, the following symbols and abbreviations apply:

φ*min* minimum power flux-density at receiving place (dBW/m2)

*Aa* effective antenna aperture (dBm2)

*B* receiver noise bandwidth (Hz)

*CF* combined location correction factor (dB)

*C*l location correction factor (dB)

*c*0 velocity of light in free space (km/s)

*d* antenna directivity

DAB Digital audio broadcasting

*Decho(max)* Maximum echo delay distance (km)

DRM+ DRM mode E

*E* RMS field-strength level (dB)

*Emin* equivalent minimum RMS field-strength level at receiving place (dB(μV/m))

*Emed* equivalent median RMS field-strength level, planning value (dB(μV/m))

*Fa* antenna noise figure (dB)

*Fa,med* antenna noise figure mean value (dB)

*Fr* receiver noise figure (dB)

*Fs* system equivalent noise figure (dB)

FM frequency modulation

*fa* antenna noise factor

*fr* receiver noise factor

*g* linear antenna gain (dB)

*G* antenna gain (dB)

*GD* antenna gain with reference to half-wave dipole (dBd)

Δ*G* antenna gain variation (dB)

η antenna efficiency

*k* Boltzmann’s constant (J/K)

*K* correction factor for the macro-scale standard deviation σ*m* (dB)

*l* cable length (m)

λ wavelength (m)

*Lb* mean building penetration loss (dB)

*Lf* feeder loss (dB)

*L′f*  feeder loss per unit length (dB/m)

*Lh* height loss correction factor (10 m a.g.l. to 1.5 m. a.g.l.) (dB)

μ distribution factor

MMN allowance for man-made noise

MSC main service channel

*Ns* number of symbols per frame in DRM mode E (ms)

OFDM Orthogonal Frequency Division Multiplexing

*p* percentage of receiving locations (location probability) (%)

*PL* protection level in DRM mode E

*Pmmn* man-made noise level (dB)

*Pn*  receiver noise input power (dBW)

*PR* protection ratio (dB)

*PRbasic* basic protection ratio (dB)

*Ps*,*min* minimum receiver signal input power (dBW)

QAM quadrature amplitude modulation

*R* code rate

*RL* antenna loss resistance (Ω)

*Rr* antenna radiation resistance (Ω)

σ*b* building penetration loss standard deviation (dB)

σ*c* combined standard deviation (dB)

σ*m* macro-scale standard deviation (dB)

σ*m,DRM* macro-scale standard deviation for DRM (dB)

σ*m*,DAB macro-scale standard deviation for DAB (dB)

σ*m*,FM macro-scale standard deviation for FM (dB)

σMMN man-made noise standard deviation (dB)

SDC service description channel

SFN single frequency network

*T* elementary time period of DRM mode E (ms)

*Tf* duration of transmission frame of DRM mode E (ms)

*Tg* duration of guard interval of DRM mode E (ms)

*Ts* duration of OFDM symbol of DRM mode E (ms)

*Tu* duration of useful (orthogonal) part of DRM mode E (ms)

*T*0 absolute temperature (K)

VHF very high frequency

*ZF*0 characteristic impedance in free space (Ω).

**2 References**

[1] 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) Annex 3: Technical basis and characteristics.

[2] EBU-TECH 3317 [July, 2007] 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.

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

[4] KRAUS, J.D. [December, 2001] Antennas, Mc Graw Hill College; 3rd revised edition.

[5] GE84 – Final Acts of the Regional Administrative Conference for the Planning of VHF Sound Broadcasting (Region 1 and Part of Region 3); Geneva 1984.

[6] ETSI EN 201 980; Digital Radio Mondiale (DRM); System Specification.

[7] ETSI EN 302 018-2; Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Frequency Modulated (FM) sound broadcasting service.

[8] Documentation G531/00328/07 [September, 2007] Compatibility Measurements DRM120, DRM and HD Radio interfering with FM Broadcast, Narrowband FM (BOS) and Aeronautical Radionavigation, German Network Agency and University of Applied Science of Kaiserslautern.

[9] Russian Federation national standard GOST R 54309-2011 “Realtime audiovisual information system (RAVIS). Framing structure, channel coding and modulating for digital terrestrial narrowband broadcasting system for the VHF band. Technical specification”

[10] Russian Federation national standard GOST R 55686-2013 “Realtime audiovisual information system (RAVIS). Digital modulator. Main parameters and technical requirements”

[11] Russian Federation national standard GOST R 55687-2013 “Realtime audiovisual information system (RAVIS). Test radio receiver. General technical requirements”

[12] Russian Federation national standard GOST R 55688-2013 “Realtime audiovisual information system (RAVIS). Content creator. Structure and protocols of data transmission”

[13] Russian Federation national standard GOST R 55689-2013 “Realtime audiovisual information system (RAVIS). Norms and methods of metrology support”

Recommendations and Reports ITU-R

Recommendation ITU‑R BS.412-9 – Planning standards for terrestrial FM sound broadcasting at VHF.

Recommendation ITU‑R BS.599 – Directivity of antennas for the reception of sound broadcasting in band 8 (VHF).

Recommendation ITU‑R BS.641 – Determination of radio-frequency protection ratios for frequency-modulated sound broadcasting.

Recommendation ITU‑R BS.1660-3 – Technical basis for planning of terrestrial digital sound broadcasting in the VHF band.

Recommendation ITU‑R BT.1368-8 – Planning criteria for digital terrestrial television services in the VHF/UHF bands.

Recommendation ITU‑R P.372-8 – Radio Noise.

Recommendation ITU‑R P.1546-4 – Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz.

Recommendation ITU‑R SM.328-11 – Spectra and bandwidth of emissions.

Report ITU‑R BS.945-2 – Methods for the assessment of multiple interference.

Attachment 2   
  
Technical references

# 1 Position of DRM frequencies

## 1.1 VHF Band II

he DRM centre frequencies are positioned in 100 kHz distance according to the FM frequency grid and ETSI-DRM [6]. The nominal carrier frequencies are, in principle, integral multiples of 100 kHz [5], see Table 85. A 50 kHz channel spacing is considered.

TABLE 85

Position of DRM frequencies in VHF Band II (87.5-108 MHz)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DRM channel centre frequency *fC* (MHz) | DRM channel number |  | DRM channel centre frequency *fC* (MHz) | DRM channel number |  | DRM channel centre frequency *fC* (MHz) | DRM channel number |  | DRM channel centre frequency *fC* (MHz) | DRM channel number |
| 87.6 | 1 |  | 92.7 | 52 |  | 97.8 | 103 |  | 102.9 | 154 |
| 87.7 | 2 |  | 92.8 | 53 |  | 97.9 | 104 |  | 103.0 | 155 |
| 87.8 | 3 |  | 92.9 | 54 |  | 98.0 | 105 |  | 103.1 | 156 |
| 87.9 | 4 |  | 93.0 | 55 |  | 98.1 | 106 |  | 103.2 | 157 |
| 88.0 | 5 |  | 93.1 | 56 |  | 98.2 | 107 |  | 103.3 | 158 |
| 88.1 | 6 |  | 93.2 | 57 |  | 98.3 | 108 |  | 103.4 | 159 |
| 88.2 | 7 |  | 93.3 | 58 |  | 98.4 | 109 |  | 103.5 | 160 |
| 88.3 | 8 |  | 93.4 | 59 |  | 98.5 | 110 |  | 103.6 | 161 |
| 88.4 | 9 |  | 93.5 | 60 |  | 98.6 | 111 |  | 103.7 | 162 |
| 88.5 | 10 |  | 93.6 | 61 |  | 98.7 | 112 |  | 103.8 | 163 |
| 88.6 | 11 |  | 93.7 | 62 |  | 98.8 | 113 |  | 103.9 | 164 |
| 88.7 | 12 |  | 93.8 | 63 |  | 98.9 | 114 |  | 104.0 | 165 |
| 88.8 | 13 |  | 93.9 | 64 |  | 99.0 | 115 |  | 104.1 | 166 |
| 88.9 | 14 |  | 94.0 | 65 |  | 99.1 | 116 |  | 104.2 | 167 |
| 89.0 | 15 |  | 94.1 | 66 |  | 99.2 | 117 |  | 104.3 | 168 |
| 89.1 | 16 |  | 94.2 | 67 |  | 99.3 | 118 |  | 104.4 | 169 |
| 89.2 | 17 |  | 94.3 | 68 |  | 99.4 | 119 |  | 104.5 | 170 |
| 89.3 | 18 |  | 94.4 | 69 |  | 99.5 | 120 |  | 104.6 | 171 |
| 89.4 | 19 |  | 94.5 | 70 |  | 99.6 | 121 |  | 104.7 | 172 |
| 89.5 | 20 |  | 94.6 | 71 |  | 99.7 | 122 |  | 104.8 | 173 |
| 89.6 | 21 |  | 94.7 | 72 |  | 99.8 | 123 |  | 104.9 | 174 |
| 89.7 | 22 |  | 94.8 | 73 |  | 99.9 | 124 |  | 105.0 | 175 |

TABLE 85 (*end*)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DRM channel centre frequency *fC* (MHz) | DRM channel number |  | DRM channel centre frequency *fC* (MHz) | DRM channel number |  | DRM channel centre frequency *fC* (MHz) | DRM channel number |  | DRM channel centre frequency *fC* (MHz) | DRM channel number |
| 89.8 | 23 |  | 94.9 | 74 |  | 100.0 | 125 |  | 105.1 | 176 |
| 89.9 | 24 |  | 95.0 | 75 |  | 100.1 | 126 |  | 105.2 | 177 |
| 90.0 | 25 |  | 95.1 | 76 |  | 100.2 | 127 |  | 105.3 | 178 |
| 90.1 | 26 |  | 95.2 | 77 |  | 100.3 | 128 |  | 105.4 | 179 |
| 90.2 | 27 |  | 95.3 | 78 |  | 100.4 | 129 |  | 105.5 | 180 |
| 90.3 | 28 |  | 95.4 | 79 |  | 100.5 | 130 |  | 105.6 | 181 |
| 90.4 | 29 |  | 95.5 | 80 |  | 100.6 | 131 |  | 105.7 | 182 |
| 90.5 | 30 |  | 95.6 | 81 |  | 100.7 | 132 |  | 105.8 | 183 |
| 90.6 | 31 |  | 95.7 | 82 |  | 100.8 | 133 |  | 105.9 | 184 |
| 90.7 | 32 |  | 95.8 | 83 |  | 100.9 | 134 |  | 106.0 | 185 |
| 90.8 | 33 |  | 95.9 | 84 |  | 101.0 | 135 |  | 106.1 | 186 |
| 90.9 | 34 |  | 96.0 | 85 |  | 101.1 | 136 |  | 106.2 | 187 |
| 91.0 | 35 |  | 96.1 | 86 |  | 101.2 | 137 |  | 106.3 | 188 |
| 91.1 | 36 |  | 96.2 | 87 |  | 101.3 | 138 |  | 106.4 | 189 |
| 91.2 | 37 |  | 96.3 | 88 |  | 101.4 | 139 |  | 106.5 | 190 |
| 91.3 | 38 |  | 96.4 | 89 |  | 101.5 | 140 |  | 106.6 | 191 |
| 91.4 | 39 |  | 96.5 | 90 |  | 101.6 | 141 |  | 106.7 | 192 |
| 91.5 | 40 |  | 96.6 | 91 |  | 101.7 | 142 |  | 106.8 | 193 |
| 91.6 | 41 |  | 96.7 | 92 |  | 101.8 | 143 |  | 106.9 | 194 |
| 91.7 | 42 |  | 96.8 | 93 |  | 101.9 | 144 |  | 107.0 | 195 |
| 91.8 | 43 |  | 96.9 | 94 |  | 102.0 | 145 |  | 107.1 | 196 |
| 91.9 | 44 |  | 97.0 | 95 |  | 102.1 | 146 |  | 107.2 | 197 |
| 92.0 | 45 |  | 97.1 | 96 |  | 102.2 | 147 |  | 107.3 | 198 |
| 92.1 | 46 |  | 97.2 | 97 |  | 102.3 | 148 |  | 107.4 | 199 |
| 92.2 | 47 |  | 97.3 | 98 |  | 102.4 | 149 |  | 107.5 | 200 |
| 92.3 | 48 |  | 97.4 | 99 |  | 102.5 | 150 |  | 107.6 | 201 |
| 92.4 | 49 |  | 97.5 | 100 |  | 102.6 | 151 |  | 107.7 | 202 |
| 92.5 | 50 |  | 97.6 | 101 |  | 102.7 | 152 |  | 107.8 | 203 |
| 92.6 | 51 |  | 97.7 | 102 |  | 102.8 | 153 |  | 107.9 | 204 |

## 1.2 VHF Band III

The frequency band of a DAB block has a bandwidth of 1.536 MHz with lower and upper guard channels to fit into the 7 MHz channels of VHF Band III. The DRM centre frequencies are positioned in 100 kHz distance beginning by 174.05 MHz and integral multiples of 100 kHz up to 229.95 MHz, see Table 86.

The nomenclature of the DRM channel identifier is given by:

(No. of the VHF channel) – (No. of the DRM channel suffix in the VHF channel),

e.g. for the first DRM channel in this table the identifier is “5‑1”.

TABLE 86

Position of DRM frequencies in VHF Band III (174-230 MHz)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DRM channel suffix | DRM channel centre frequency *fC* (MHz) in VHF channel (number) | | | | | | | |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | 174.050 | 181.050 | 188.050 | 195.050 | 202.050 | 209.050 | 216.050 | 223.050 |
| 2 | 174.150 | 181.150 | 188.150 | 195.150 | 202.150 | 209.150 | 216.150 | 223.150 |
| 3 | 174.250 | 181.250 | 188.250 | 195.250 | 202.250 | 209.250 | 216.250 | 223.250 |
| 4 | 174.350 | 181.350 | 188.350 | 195.350 | 202.350 | 209.350 | 216.350 | 223.350 |
| 5 | 174.450 | 181.450 | 188.450 | 195.450 | 202.450 | 209.450 | 216.450 | 223.450 |
| 6 | 174.550 | 181.550 | 188.550 | 195.550 | 202.550 | 209.550 | 216.550 | 223.550 |
| 7 | 174.650 | 181.650 | 188.650 | 195.650 | 202.650 | 209.650 | 216.650 | 223.650 |
| 8 | 174.750 | 181.750 | 188.750 | 195.750 | 202.750 | 209.750 | 216.750 | 223.750 |
| 9 | 174.850 | 181.850 | 188.850 | 195.850 | 202.850 | 209.850 | 216.850 | 223.850 |
| 10 | 174.950 | 181.950 | 188.950 | 195.950 | 202.950 | 209.950 | 216.950 | 223.950 |
| 11 | 175.050 | 182.050 | 189.050 | 196.050 | 203.050 | 210.050 | 217.050 | 224.050 |
| 12 | 175.150 | 182.150 | 189.150 | 196.150 | 203.150 | 210.150 | 217.150 | 224.150 |
| 13 | 175.250 | 182.250 | 189.250 | 196.250 | 203.250 | 210.250 | 217.250 | 224.250 |
| 14 | 175.350 | 182.350 | 189.350 | 196.350 | 203.350 | 210.350 | 217.350 | 224.350 |
| 15 | 175.450 | 182.450 | 189.450 | 196.450 | 203.450 | 210.450 | 217.450 | 224.450 |
| 16 | 175.550 | 182.550 | 189.550 | 196.550 | 203.550 | 210.550 | 217.550 | 224.550 |
| 17 | 175.650 | 182.650 | 189.650 | 196.650 | 203.650 | 210.650 | 217.650 | 224.650 |
| 18 | 175.750 | 182.750 | 189.750 | 196.750 | 203.750 | 210.750 | 217.750 | 224.750 |
| 19 | 175.850 | 182.850 | 189.850 | 196.850 | 203.850 | 210.850 | 217.850 | 224.850 |
| 20 | 175.950 | 182.950 | 189.950 | 196.950 | 203.950 | 210.950 | 217.950 | 224.950 |
| 21 | 176.050 | 183.050 | 190.050 | 197.050 | 204.050 | 211.050 | 218.050 | 225.050 |
| 22 | 176.150 | 183.150 | 190.150 | 197.150 | 204.150 | 211.150 | 218.150 | 225.150 |
| 23 | 176.250 | 183.250 | 190.250 | 197.250 | 204.250 | 211.250 | 218.250 | 225.250 |
| 24 | 176.350 | 183.350 | 190.350 | 197.350 | 204.350 | 211.350 | 218.350 | 225.350 |
| 25 | 176.450 | 183.450 | 190.450 | 197.450 | 204.450 | 211.450 | 218.450 | 225.450 |
| 26 | 176.550 | 183.550 | 190.550 | 197.550 | 204.550 | 211.550 | 218.550 | 225.550 |
| 27 | 176.650 | 183.650 | 190.650 | 197.650 | 204.650 | 211.650 | 218.650 | 225.650 |
| 28 | 176.750 | 183.750 | 190.750 | 197.750 | 204.750 | 211.750 | 218.750 | 225.750 |
| 29 | 176.850 | 183.850 | 190.850 | 197.850 | 204.850 | 211.850 | 218.850 | 225.850 |
| 30 | 176.950 | 183.950 | 190.950 | 197.950 | 204.950 | 211.950 | 218.950 | 225.950 |
| 31 | 177.050 | 184.050 | 191.050 | 198.050 | 205.050 | 212.050 | 219.050 | 226.050 |
| 32 | 177.150 | 184.150 | 191.150 | 198.150 | 205.150 | 212.150 | 219.150 | 226.150 |

TABLE 86 (*end*)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DRM channel suffix | DRM channel centre frequency *fC* (MHz) in VHF channel (number) | | | | | | | |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 33 | 177.250 | 184.250 | 191.250 | 198.250 | 205.250 | 212.250 | 219.250 | 226.250 |
| 34 | 177.350 | 184.350 | 191.350 | 198.350 | 205.350 | 212.350 | 219.350 | 226.350 |
| 35 | 177.450 | 184.450 | 191.450 | 198.450 | 205.450 | 212.450 | 219.450 | 226.450 |
| 36 | 177.550 | 184.550 | 191.550 | 198.550 | 205.550 | 212.550 | 219.550 | 226.550 |
| 37 | 177.650 | 184.650 | 191.650 | 198.650 | 205.650 | 212.650 | 219.650 | 226.650 |
| 38 | 177.750 | 184.750 | 191.750 | 198.750 | 205.750 | 212.750 | 219.750 | 226.750 |
| 39 | 177.850 | 184.850 | 191.850 | 198.850 | 205.850 | 212.850 | 219.850 | 226.850 |
| 40 | 177.950 | 184.950 | 191.950 | 198.950 | 205.950 | 212.950 | 219.950 | 226.950 |
| 41 | 178.050 | 185.050 | 192.050 | 199.050 | 206.050 | 213.050 | 220.050 | 227.050 |
| 42 | 178.150 | 185.150 | 192.150 | 199.150 | 206.150 | 213.150 | 220.150 | 227.150 |
| 43 | 178.250 | 185.250 | 192.250 | 199.250 | 206.250 | 213.250 | 220.250 | 227.250 |
| 44 | 178.350 | 185.350 | 192.350 | 199.350 | 206.350 | 213.350 | 220.350 | 227.350 |
| 45 | 178.450 | 185.450 | 192.450 | 199.450 | 206.450 | 213.450 | 220.450 | 227.450 |
| 46 | 178.550 | 185.550 | 192.550 | 199.550 | 206.550 | 213.550 | 220.550 | 227.550 |
| 47 | 178.650 | 185.650 | 192.650 | 199.650 | 206.650 | 213.650 | 220.650 | 227.650 |
| 48 | 178.750 | 185.750 | 192.750 | 199.750 | 206.750 | 213.750 | 220.750 | 227.750 |
| 49 | 178.850 | 185.850 | 192.850 | 199.850 | 206.850 | 213.850 | 220.850 | 227.850 |
| 50 | 178.950 | 185.950 | 192.950 | 199.950 | 206.950 | 213.950 | 220.950 | 227.950 |
| 51 | 179.050 | 186.050 | 193.050 | 200.050 | 207.050 | 214.050 | 221.050 | 228.050 |
| 52 | 179.150 | 186.150 | 193.150 | 200.150 | 207.150 | 214.150 | 221.150 | 228.150 |
| 53 | 179.250 | 186.250 | 193.250 | 200.250 | 207.250 | 214.250 | 221.250 | 228.250 |
| 54 | 179.350 | 186.350 | 193.350 | 200.350 | 207.350 | 214.350 | 221.350 | 228.350 |
| 55 | 179.450 | 186.450 | 193.450 | 200.450 | 207.450 | 214.450 | 221.450 | 228.450 |
| 56 | 179.550 | 186.550 | 193.550 | 200.550 | 207.550 | 214.550 | 221.550 | 228.550 |
| 57 | 179.650 | 186.650 | 193.650 | 200.650 | 207.650 | 214.650 | 221.650 | 228.650 |
| 58 | 179.750 | 186.750 | 193.750 | 200.750 | 207.750 | 214.750 | 221.750 | 228.750 |
| 59 | 179.850 | 186.850 | 193.850 | 200.850 | 207.850 | 214.850 | 221.850 | 228.850 |
| 60 | 179.950 | 186.950 | 193.950 | 200.950 | 207.950 | 214.950 | 221.950 | 228.950 |
| 61 | 180.050 | 187.050 | 194.050 | 201.050 | 208.050 | 215.050 | 222.050 | 229.050 |
| 62 | 180.150 | 187.150 | 194.150 | 201.150 | 208.150 | 215.150 | 222.150 | 229.150 |
| 63 | 180.250 | 187.250 | 194.250 | 201.250 | 208.250 | 215.250 | 222.250 | 229.250 |
| 64 | 180.350 | 187.350 | 194.350 | 201.350 | 208.350 | 215.350 | 222.350 | 229.350 |
| 65 | 180.450 | 187.450 | 194.450 | 201.450 | 208.450 | 215.450 | 222.450 | 229.450 |
| 66 | 180.550 | 187.550 | 194.550 | 201.550 | 208.550 | 215.550 | 222.550 | 229.550 |
| 67 | 180.650 | 187.650 | 194.650 | 201.650 | 208.650 | 215.650 | 222.650 | 229.650 |
| 68 | 180.750 | 187.750 | 194.750 | 201.750 | 208.750 | 215.750 | 222.750 | 229.750 |
| 69 | 180.850 | 187.850 | 194.850 | 201.850 | 208.850 | 215.850 | 222.850 | 229.850 |
| 70 | 180.950 | 187.950 | 194.950 | 201.950 | 208.950 | 215.950 | 222.950 | 229.950 |

# 2 Computations of correction factors

## 2.1 Computation of the antenna gain for portable handheld reception

The antenna (linear) gain *g* is the product of directivity *d* and efficiency η [4].

 (28)

For lossless antennas the efficiency equals one and the gain equals the directivity.

Portable handheld reception antennas are very lossy, and therefore the gain is much lower than directivity. They are also short linear antennas, with small dimensions compared to wavelength, and have a constant directivity of about 1.5 (1.8 dBi or –0.4 dBd). The gain changes with frequency only due to efficiency.

To estimate the efficiency change with frequency a transmitting antenna is considered. That leads to the values for a receiving antenna also, because antennas are reciprocal; their directivity, efficiency and gain are the same as receiving or transmitting antenna [4].

To transfer the maximum energy from a port to an antenna or vice versa the antenna has to be matched to the port impedance. A matched antenna has an equivalent series circuit with radiation resistance *Rr*, antenna loss resistance and a matching circuit loss resistance. We consider the reactive part of the serial impedance as zero. The radiation resistance is small and the transmitted energy is dissipated mostly in the antenna loss resistance and the matching circuit. Only the energy in *Rr* is radiated. Combining all losses in *RL* the antenna efficiency:

 (29)

*Rr* can be neglected in the denominator, because *Rr* is much lower than *RL*.

For the antenna length l << λ the radiation resistance magnitude is proportional to the square of the antenna length l relative to wavelength λ [4]:

 (30)

where λ was substituted by *c*/*f*, with *c* the light velocity.

If the antenna dimension is not changed, and it is considered that the losses in the antenna and the matching circuit does not change significantly in the frequency range of interest, the efficiency η2 at a frequency *f*2, compared to the efficiency η1 at a frequency *f*1, changes as follows:

 (31)

The same is true for the gain *G* (dB), since the directivity does not change.

Changing the frequency from *f*1 to *f*2 the gain changes with:

 (32)

## 2.2 Computation of man-made noise allowance from the antenna noise factor

Definition of the antenna noise factor

An antenna for terrestrial communications with efficiency one receives from its environment, no matter what shape its receiving diagram has, thermal noise with a power *n*:



where:

*k* : Boltzmann’s constant (J/K)

*T* : environment temperature (K)

*B* : bandwidth (Hz).

If the antenna receives in the same bandwidth B Gaussian noise like man-made noise with a power *i*, the total power received is:



We can define an antenna noise factor *fa* as:



and an antenna noise figure *Fa* given in dB [4]:



The man-made noise allowance for coverage calculations

In a link budget used for coverage calculations, the receiver is taken into account by its noise figure *Fr*. It can be shown, that the effect of the man-made noise *i* received by the antenna is equivalent to an increase of the receiver noise figure *Fr* by an amount MMN in dB, called man-made noise allowance.

If the antenna does not receive man-made noise, the total equivalent noise at a receiver input is:



with:

*p* : power sum (W)

*pr* : receiver noise corresponding to the noise figure and the bandwidth (W)

*n* : thermal noise (*kTB*) (W)

*fr* :receiver noise factor calculated from the noise figure .

The receiver noise factor is defined as:



If man-made noise *i* is received, the power at the receiver input is:



The interference power is increased by a factor *mmn*:



but:



and



The factor *mmn* can be expressed as a function of *fr* and *fa*:



or in dB, the allowance for man-made noise *MMN*:



The system equivalent noise figure to be used for coverage calculations is increased to:



Special case with antenna gain below 1.8 dBi

The antenna gain is the product of directivity and efficiency. The lowest realistic directivity is the one of a short dipole (length << λ) and it has the value 1.5 (1.8 dBi). Any gain lower than 1.8 dBi (−0.4 dBd) is due to an antenna efficiency η lower than 1.

If the antenna efficiency is η, from the received wanted signal *w* only η*\*w* reaches the receiver, but the Gaussian noise and the man-made noise getting into the receiver are also reduced to η*\*n* and η*\*i*.

The interference power at the receiver input is increased due to man-made noise interference *i* by the factor *mmn*:





The efficiency η can be calculated from the antenna gain *GD*, for gains lower than −0.4 dBd:



1. <http://www.fh-kl.de>; <http://www.drm-radio-kl.eu>. [↑](#footnote-ref-1)
2. <http://www.ikt.uni-hannover.de/>. [↑](#footnote-ref-2)
3. Radio Regulations No. **5.252**: in Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe, the bands 230-238 MHz and 246-254 MHz are allocated to the broadcasting service on a primary basis, subject to agreement obtained under No. **9.21**. [↑](#footnote-ref-3)