



Recommendation ITU-R BT.2052-1
(10/2015)

**Planning criteria for terrestrial multimedia
broadcasting for mobile reception using
handheld receivers in VHF/UHF bands**

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(television)



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Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R BT.2052-1

Planning criteria for terrestrial multimedia broadcasting for mobile reception using handheld receivers in VHF/UHF bands

(2014-2015)

Scope

This Recommendation defines the planning criteria for various methods of providing terrestrial multimedia broadcasting for mobile reception using handheld receivers in VHF/UHF bands.

The ITU Radiocommunication Assembly,

considering

- a) that digital multimedia broadcasting systems have been implemented in many countries or are planned to be introduced, using the inherent capability of digital broadcasting systems;
- b) that many types of interference, including co-channel and adjacent channel, ignition noise, multipath and other signal distortions exist in the VHF/UHF bands;
- c) that the error-correction, data framing, modulation and emission methods for terrestrial multimedia broadcasting systems have been defined in Recommendation ITU-R BT.2016;
- d) that terrestrial emission systems for mobile reception using handheld receivers require specific consideration for determining planning criteria due to peculiar propagation characteristics;
- e) that the availability of consistent sets of planning criteria agreed by administrations will facilitate the introduction of terrestrial multimedia broadcasting services;
- f) that while there is a necessary connection between the receiver characteristics required as limit specifications for manufacturing, efficient spectrum use and frequency planning should take account of the complete receiving system and should be based on a representative reference receiving system rather than “worst-case” limit specifications,

noting

- a) that Recommendation ITU-R BT.1368 defines the planning criteria for various methods of providing digital terrestrial television services in the VHF/UHF bands;
- b) that Recommendation ITU-R BS.1660 defines the planning criteria, which could be used for planning of terrestrial digital sound broadcasting in the VHF band;
- c) that Recommendation ITU-R BT.2033 defines the planning criteria for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands,

recommends

that the relevant planning criteria, including protection ratios (PRs) and the minimum field strength values given in Annexes 1, 2 and 3 should be used as the basis for frequency planning for terrestrial multimedia broadcasting services.

Introduction

This Recommendation contains the following Annexes:

- Annex 1 – Planning criteria for Multimedia System A (T-DMB and AT-DMB) terrestrial multimedia broadcasting systems in VHF/UHF bands.
- Annex 2 – Planning criteria for Multimedia System F (ISDB-T multimedia broadcasting) terrestrial multimedia broadcasting systems in VHF/UHF bands.
- Annex 3 – Planning criteria for Multimedia System T2 (T2 Lite profile of DVB-T2 system) terrestrial multimedia broadcasting systems in VHF/UHF bands.

General

The RF protection ratio is the minimum required value of the wanted-to-unwanted signal ratio, C/I , usually expressed in decibels at receiver input. For the purpose of this Recommendation, D/U will also be used in its Annexes with the identical meaning for the protection ratio.

The reference level of the digital signal is defined as the r.m.s. value of the emitted signal power within the channel bandwidth. The protection ratio values for wanted digital signals were historically measured with a -60 dBm receiver input power. Where possible, protection ratios for terrestrial multimedia broadcasting systems are derived from measurements covering a range of signal levels.

Two methods of measurement can be applied: the subjective failure point (SFP) and quasi-error-free (QEF).

The SFP method can be used for measurements of protection ratios. The quality criterion for measurements of protection ratios is to find a limit for a just error-free picture on the TV screen. The RF protection ratio for the wanted signal is the minimum required value for the wanted-to-unwanted signal ratio at receiver input, e.g. determined with the SFP method.

The SFP method corresponds to the picture quality where no more than one error is visible in the picture for an average observation time of 20 s. The quality criterion for SFP corresponds to a 5% erroneous seconds ratio (ESR).

The QEF method can also be used for measurements of protection ratios. The quality criterion for protection measurements is to find a limit for the prescribed BER (e.g. 10^{-12}), which is usually applied to the evaluation of systems.

1 Reception mode

Three reception modes: portable outdoor, portable indoor and mobile. The relevant administrations should consider which reception modes to be included.

1.1 Portable reception

In general, portable reception refers to a reception where a portable receiver is used outdoors or indoors at no less than 1.5 m above ground level.

Two receiving locations will be distinguished:

- portable outdoor reception is defined as reception outdoors by a portable receiver with a battery supply and an attached or built-in antenna at no less than 1.5 m above ground level;
- portable indoor reception is defined as reception indoors by a portable receiver with an attached or a built-in 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 a maximum of 0.5 m in any direction while the portable receiver and large objects in the near vicinity remain unmoved during reception.

1.2 Mobile reception

Mobile reception is defined as reception by a receiver in motion at the speed of an automobile or train. Vehicle receivers may be used in addition to portable receivers.

2 Planning parameters for terrestrial multimedia broadcasting to be used for planning study

There are many planning parameters to take into account in the planning study of terrestrial multimedia broadcasting services due to a number of combinations of reception modes and other transmission systems to be considered. Planning studies should primarily be conducted using the items listed in §§ 2.1 and 2.2, and then other parameters listed in § 3 could be applied when such parameters are thought to be included.

2.1 Basic planning parameters

Two basic planning parameters are defined as below:

Minimum field strength is defined as the field strength that gives the minimum input voltage of a reference receiver for correct reception, usually expressed in dB μ V/m.

Protection ratio is the minimum value of wanted-to-unwanted signal ratio, usually expressed in decibels at the receiver input.

2.2 Reference receiving conditions

The following conditions should be observed in the planning purpose:

- characteristics of reference receiver: To be provided in each Annex. System dependent characteristics such as C/N are included;
- reference antenna height: 1.5 m above ground level for portable outdoor reception, and 1.5 m above floor level in rooms on the ground floor with a window in an external wall for portable indoor reception;
- reference antenna gain: 0 dBd, such as a $\lambda/4$ monopole antenna.

3 Other parameters to be considered in planning

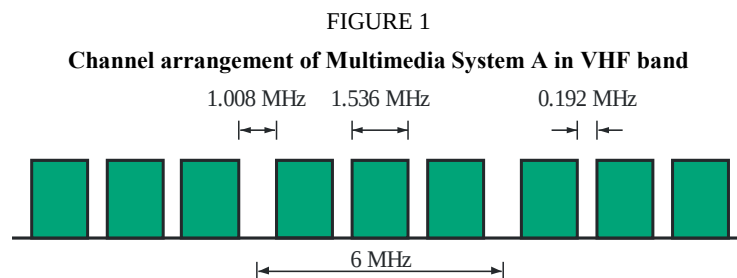
3.1 Location correction factor

The location correction factor is the margin to add to field strength to obtain a certain location probability. The field strength distributions of wanted and unwanted waves can be assumed to exhibit the same statistics, although they come from different directions. Recommendation ITU-R P.1546 states the standard deviation of field strengths for digital broadcasting waves is 5.5 dB and provides correction factor for different location probability.

Annex 1

Planning criteria for Multimedia System A (T-DMB and AT-DMB) terrestrial multimedia broadcasting systems in VHF/UHF bands

This Annex describes the planning criteria for Multimedia System A in VHF band within a 6 MHz TV channel. Channel bandwidth of Multimedia System A is 1.536 MHz. The minimum guard band between two adjacent channels is 0.192 MHz and the maximum guard band is 1.008 MHz by the channel arrangement in Korea for Multimedia System A as shown in Fig. 1. That is, the frequency spacing between the nearest two adjacent channels is 1.728 MHz apart from their central frequencies. The measurement scale of protection ratios is 1 dB.



The spectrum masks operating in critical cases defined in Fig. 1 of Annex 1 of Recommendation ITU-R BS.1660-6 are used for the measurement of protection ratios.

AT-DMB increases channel capacity of T-DMB and guarantees backward compatibility with T-DMB. To guarantee backward compatibility with T-DMB, a hierarchical modulation mechanism is applied. Hierarchical modulation is the technology modulating multiple data streams into one single symbol stream. AT-DMB has two layers by hierarchical modulation: the base layer and the enhancement layer. The base layer is T-DMB channel and the enhancement layer is the additional channel added by AT-DMB.

AT-DMB defines two hierarchical modulation schemes: mode B using BPSK symbol mapping over DQPSK symbol and mode Q using QPSK symbol mapping over DQPSK symbol. The hierarchical modulation schemes are shown in Fig. 2. Mode B hierarchical modulation has better performance in a mobile environment. On the other hand, mode Q hierarchical modulation is more advantageous in a fixed reception environment.

AT-DMB also defines a constellation ratio. The constellation ratio is defined as:

$$\alpha = \frac{a}{b}$$

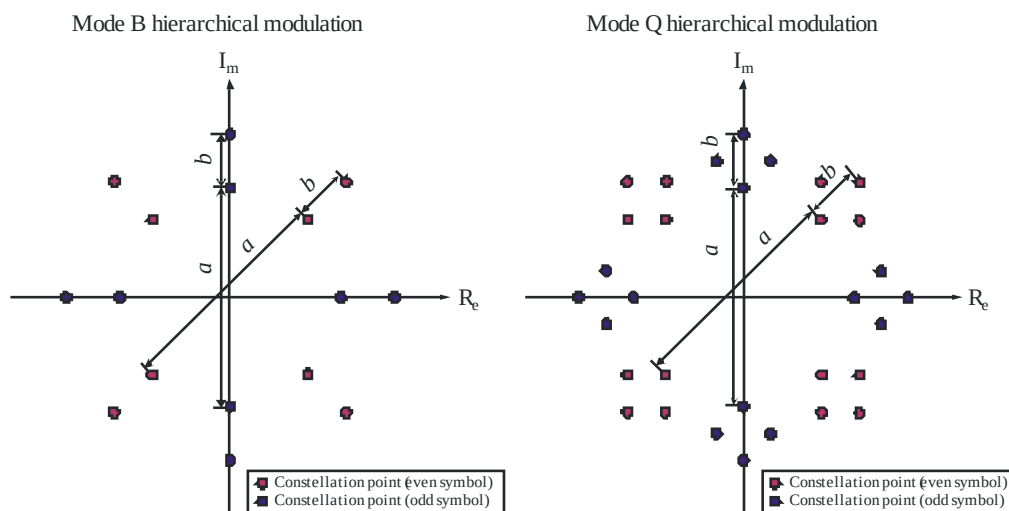
where:

- a*: maximum distance between two neighbouring quadrants
- b*: maximum distance between constellation points in a quadrant.

AT-DMB supports four constellation ratios: 1.5, 2.0, 2.5 and 3.0. By changing the value of the constellation ratio, the performance of the base layer and the enhancement layer of AT-DMB would be changed. AT-DMB adopted Turbo code in the enhancement layer in order to improve its reception performance, whereas Convolutional code is used in the base layer. AT-DMB supports four Turbo code rates: 1/2, 2/5, 1/3, 1/4. The performance of the enhancement layer of AT-DMB would be increased as the value of Turbo code rate decreases.

Refer to Report ITU-R BT.2049-5, Recommendation ITU-R BT.1833-2 and Recommendation ITU-R BT.2016 for more information.

FIGURE 2

AT-DMB hierarchical modulation scheme

BT.2052-02

The effective data rates of T-DMB/AT-DMB depend on its forward error correction (FEC) code rates as shown in Table 1. Since Turbo code rate of AT-DMB enhancement layer can be selected regardless of Convolutional code rate of T-DMB/AT-DMB base layer, the total effective data rate of AT-DMB is to add effective data rates of AT-DMB base layer and AT-DMB enhancement layer.

TABLE 1

Effective data rates of T-DMB/AT-DMB

	T-DMB/AT-DMB base layer	AT-DMB enhancement layer (Mode B)			
FEC code rate	Convolutional code 1/2	Turbo code 1/2	Turbo code 2/5	Turbo code 1/3	Turbo code 1/4
Effective data rate	1.152 Mbit/s	0.576 Mbit/s	0.448 Mbit/s	0.384 Mbit/s	0.288 Mbit/s

The Convolutional code rate 1/2 at T-DMB and at the base layer of AT-DMB is usually used. Mode B at AT-DMB is used for the mobile broadcasting service.

Protection ratios would be different whether its test signal is video or audio. It is because BER for correcting errors of test signal at the receiver side is different from each other.

To measure precise protection ratios, the spectrum mask shall be applied each to the outputs of both wanted and unwanted T-DMB/AT-DMB signals. But whether the spectrum mask is applied to the output of T-DMB/AT-DMB wanted signal or not, the performance of its reception is the same. Taking these into consideration, the spectrum mask was applied to the output of unwanted T-DMB/AT-DMB signal and not applied to the output of T-DMB/AT-DMB wanted signal.

Thus, a protection ratio test had been measured under the following conditions:

- convolutional code rates of T-DMB and the base layer of AT-DMB are set to 1/2;

- hierarchical modulation mode of AT-DMB is set to mode B;
- QVGA quality videos are only used for test;
- frequency of unwanted T-DMB/AT-DMB signal is set to 213.008 MHz;
- constellation ratio of unwanted AT-DMB signal is set to 2.0;
- turbo code rate of unwanted AT-DMB signal is set to 1/2;
- spectrum mask was not applied to the T-DMB/AT-DMB wanted signal;
- spectrum mask was applied to the unwanted T-DMB/AT-DMB signal.

1 Characteristics of reference receiver

The parameter values of the AT-DMB reference receiver operating in the Bands III are given in Table 2.

TABLE 2
Characteristics of the AT-DMB reference receiver

Parameters	Values		
	T-DMB	AT-DMB	
		Base layer	Enhancement layer
Frequency ranges (MHz)	175.280 ~ 214.736		
Equivalent noise bandwidth (MHz)	1.536		
Maximum receiver sensitivity (dBm) ⁽¹⁾	−104	−101	−99
Reference threshold C/N (dB)	6	9	11
Receiver overload threshold (dBm)	0	0	

NOTE 1 – The value of T-DMB was measured at Convolutional code rate ‘1/2’. The values of AT-DMB were measured under the condition of Constellation ratio ‘2.0’, Convolutional code rate of the base layer ‘1/2’, and Turbo code rate of the enhancement layer ‘1/2’.

2 Protection ratios for T-DMB/AT-DMB wanted terrestrial multimedia broadcasting signals

Channel profiles used for measuring protection ratios of T-DMB/AT-DMB are as follows:

- Fixed outdoor reception: Ricean channel profile with 6-Taps;
- Fixed indoor reception: Rayleigh channel profile with 6-Taps in ETSI TS 102 831;
- Mobile outdoor reception: TU6 channel profile defined in COST (European Cooperation in the Field of Scientific and Technical Research) 207 at speed of 100 km/s, at band III frequency.

The details of these selected channel profiles are shown in Table 3 to Table 5.

TABLE 3
Ricean channel profile (Fix outdoor reception)

Tap number	Delay (μ s)	Amplitude	Level (dB)	Phase (rad)
1	0	1	0	0
2	0.475	0.146	-16.71	0.363
3	0.645	0.119	-18.49	2.739
4	1.933	0.117	-18.64	-0.156
5	2.754	0.089	-21.01	-2.239
6	3.216	0.103	-19.74	-0.103

TABLE 4
Rayleigh channel profile (Fix indoor reception)

Tap number	Delay (μ s)	Amplitude	Level (dB)	Phase (rad)
1	0.050	0.360	-8.87	-2.875
2	0.479	1	0.00	0.0
3	0.621	0.787	-2.08	2.182
4	1.907	0.587	-4.63	-0.460
5	2.764	0.482	-6.34	-2.616
6	3.193	0.451	-6.92	-2.863

TABLE 5
Typical Urban (TU6) channel profile (Mobile outdoor reception)

Tap number	Delay (μ s)	Relative Power (dB)	Doppler spectrum
1	0.0	-3	Rayleigh
2	0.2	0	Rayleigh
3	0.5	-2	Rayleigh
4	1.6	-6	Rayleigh
5	2.3	-8	Rayleigh
6	5.0	-10	Rayleigh

2.1 Protection ratios of a T-DMB signal interfered with by co-channel T-DMB/AT-DMB signals

Table 6 shows the required D/U for a T-DMB wanted signal against co-channel T-DMB and AT-DMB unwanted signals.

TABLE 6

Required D/U ratio for a T-DMB wanted signal interfered with by co-channel T-DMB/AT-DMB unwanted signals

Unwanted signal	D/U ratio required by T-DMB wanted signal (dB)	
	Channel	D/U ratio
T-DMB/AT-DMB	Gaussian	6
	Ricean	8
	Rayleigh	9
	TU6	11

Protection ratios required by a T-DMB wanted signal against co-channel T-DMB/AT-DMB unwanted signals are independent from the interferers, because the average power of AT-DMB is the same with T-DMB.

2.2 Protection ratios of an AT-DMB signal interfered with by co-channel T-DMB/AT-DMB signals

Table 7 shows the required D/U for an AT-DMB wanted signal against co-channel T-DMB and AT-DMB unwanted signals.

TABLE 7

Required D/U ratio for an AT-DMB wanted signal interfered with by co-channel T-DMB/AT-DMB unwanted signals

Unwanted signal	AT-DMB wanted signal		D/U ratio required by AT-DMB wanted signal (dB)		
	Constellation ratio	Turbo code rate (enhancement layer)	Channel	Base layer	Enhancement layer
T-DMB/ AT-DMB	1.5	$\frac{1}{2}$	Gaussian	8	7
	1.5	$\frac{2}{5}$		8	6
	1.5	$\frac{1}{3}$		8	5
	1.5	$\frac{1}{4}$		8	3
	2.0	$\frac{1}{2}$		7	8
	2.0	$\frac{2}{5}$		7	7
	2.0	$\frac{1}{3}$		7	6
	2.0	$\frac{1}{4}$		7	5
	2.5	$\frac{1}{2}$		6	9
	2.5	$\frac{2}{5}$		6	8
	2.5	$\frac{1}{3}$		6	7
	2.5	$\frac{1}{4}$		6	6
	3.0	$\frac{1}{2}$		6	10
	3.0	$\frac{2}{5}$		6	9
	3.0	$\frac{1}{3}$		6	8
	3.0	$\frac{1}{4}$		6	7