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

BT Series

Broadcasting service (television)

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RECOMMENDATION ITU-R BT.2052-0

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

(2014)

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,

recommends

that the relevant planning criteria, including protection ratios (PRs) and the minimum field strength values given in Annexes 1 and 2 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.

General

The RF protection ratio is the minimum required value of the wanted-to-unwanted signal ratio, we can call it *C*/*I*, usually expressed in decibels at receiver input. For the purpose of this Recommendation in annexes, we will also use *D*/*U* 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 dBμV/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 λ/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.

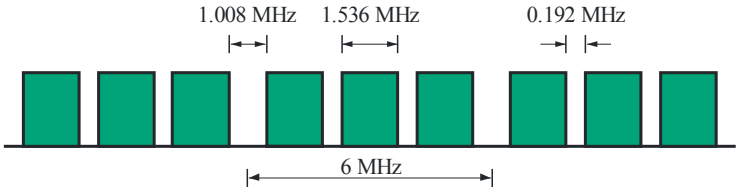
Annex 1

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.

FIGURE 1

Channel arrangement of Multimedia System A in VHF band



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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

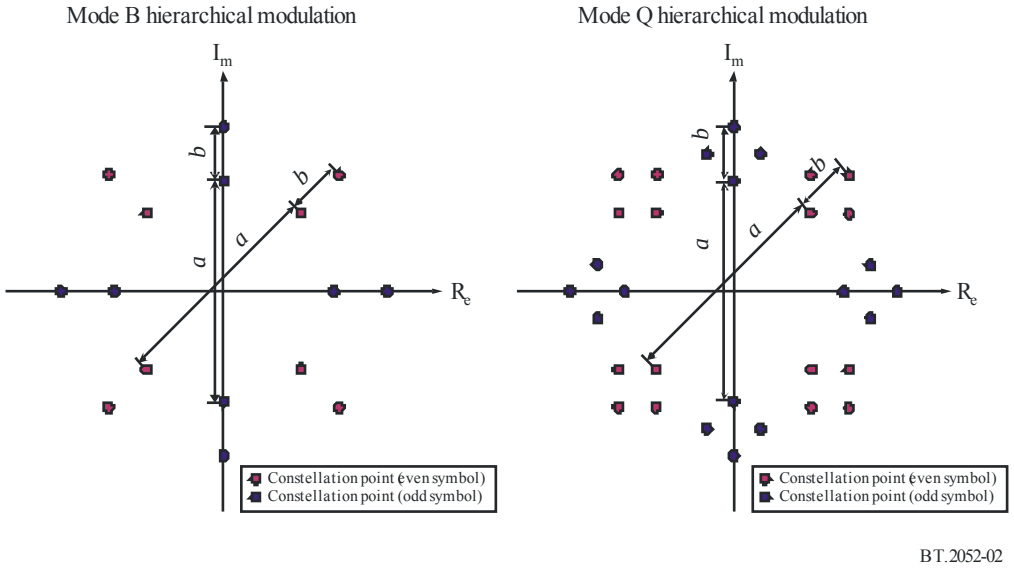
b: maximum distance between constellation points in a quadrant.

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



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 outside the pre-assigned T-DMB frequency, there is no commercial channel filter which meets the spectrum mask operating in critical cases defined in Fig. 1 of Annex 1 of Recommendation ITU-R BS.1660-6. 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 T-DMB/AT-DMB wanted signal changes from 213.008 MHz up to ± 2.0 MHz with 200 kHz frequency spacing;
– 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

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

Table 3 shows the required *D*/*U* for a T-DMB wanted signal against co-channel T-DMB and AT-DMB unwanted signals.

TABLE 3

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)
T-DMB/AT-DMB	6

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

TABLE 4

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)	Base layer	Enhancement layer
T-DMB/ AT-DMB	1.5	1/2	8	7
	1.5	2/5	8	6
	1.5	1/3	8	5
	1.5	1/4	8	3
	2.0	1/2	7	8
	2.0	2/5	7	7
	2.0	1/3	7	6
	2.0	1/4	7	5
	2.5	1/2	6	9
	2.5	2/5	6	8
	2.5	1/3	6	7
	2.5	1/4	6	6
	3.0	1/2	6	10
	3.0	2/5	6	9
	3.0	1/3	6	8
	3.0	1/4	6	7

The required *D*/*U* ratio of AT-DMB depends on constellation ratio and Turbo code rate of AT-DMB wanted signal. As constellation ratio of AT-DMB wanted signal increases, the required *D*/*U* ratio of the base layer decreases, whereas the required *D*/*U* ratio of the enhancement layer increases.

When the value of Turbo code rate of the enhancement layer of AT-DMB wanted signal decreases, the required *D*/*U* ratio of the enhancement layer decreases. But it does not affect the required *D*/*U* ratio of the base layer.

2.3 Protection ratios of a T-DMB signal interfered with by adjacent T-DMB/AT-DMB signals

Table 5 shows the required *D*/*U* for a T-DMB wanted signal against adjacent T-DMB and AT-DMB unwanted signals.

TABLE 5

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

Unwanted signal	Adjacent T-DMB/AT-DMB Frequency (MHz)	*D*/*U* ratio required by the T-DMB wanted signal (dB)
T-DMB/AT-DMB	211.280	–51
T-DMB/AT-DMB	214.736	–51

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

3 Minimum field strength for T-DMB/AT-DMB

Tables 6 and 7 show the minimum field strength measured by T-DMB and AT-DMB test receiver respectively. Because AT-DMB test receiver has the functionality of T-DMB, it was used for testing protection ratios required by T-DMB and AT-DMB. Field strength for T-DMB/AT-DMB was calculated by the following formulas.

$$\text{Field strength}(\text{dBuV/m}) = \text{Power}(\text{dBm}) + 107 + \text{Receiver antenna factor}$$

$$\text{Receiver antenna factor} = 20\log f(\text{MHz}) - \text{antenna gain} - 29.8$$

TABLE 6

Minimum field strength required by T-DMB receiver

Minimum field strength required by T-DMB receiver (dBuV/m)
17.6

TABLE 7

Minimum field strength required by AT-DMB receiver

AT-DMB			Minimum field strength required by AT-DMB receiver (dBuV/m)	
Constellation ratio	**Convolutional code rate (Base layer)**	**Turbo code rate (Enhancement layer)**	**Base layer**	**Enhancement layer**
1.5	1/2	1/2	20.6	20.6
1.5	1/2	2/5	20.6	19.6
1.5	1/2	1/3	20.6	18.6
1.5	1/2	1/4	20.6	17.6
2.0	1/2	1/2	20.6	22.6
2.0	1/2	2/5	20.6	20.6
2.0	1/2	1/3	20.6	19.6
2.0	1/2	1/4	20.6	18.6
2.5	1/2	1/2	19.6	23.6
2.5	1/2	2/5	19.6	21.6
2.5	1/2	1/3	19.6	20.6
2.5	1/2	1/4	19.6	19.6
3.0	1/2	1/2	19.6	24.6
3.0	1/2	2/5	19.6	23.6
3.0	1/2	1/3	19.6	22.6
3.0	1/2	1/4	19.6	20.6

Minimum field strength of T-DMB is slightly less than those of AT-DMB base layer and enhancement layer. As constellation ratio increases, the minimum field strength of the AT-DMB base layer decreases, whereas the minimum field strength of the AT-DMB enhancement layer increases. As Turbo code rate in the AT-DMB enhancement layer decreases, the minimum field strength of the AT-DMB enhancement layer decreases.

Annex 2

Planning criteria for Multimedia System F (ISDB-T multimedia broadcasting) terrestrial multimedia broadcasting systems in VHF/UHF bands

This Annex describes planning criteria for Multimedia System F (ISDB-T multimedia broadcasting) in the VHF/UHF bands. System F can be assigned to a 6-MHz, 7-MHz, or 8-MHz television channel raster. Segment bandwidth is defined to be a fourteenth of the channel bandwidth, therefore 429 kHz (6/14 MHz), 500 kHz (7/14 MHz) or 571 kHz (8/14 MHz). However, the segment bandwidth should be selected in compliance with the frequency situation in each country.

The number of segments of ISDB-T multimedia broadcasting signals can be chosen in accordance with the application and available bandwidth. The spectrum is formed by combining 1-segment, 3-segment, and/or 13-segment blocks without a guard band, as shown in Fig. A2-1 of Recommendation ITU-R BT.2016-1.

Figure 3 shows example combinations of the segment blocks. A receiver can partially demodulate a 1-, 3- or 13-segment part of the ISDB-T multimedia broadcasting system.

FIGURE 3

Example combinations of segment blocks of ISDB-T multimedia broadcasting

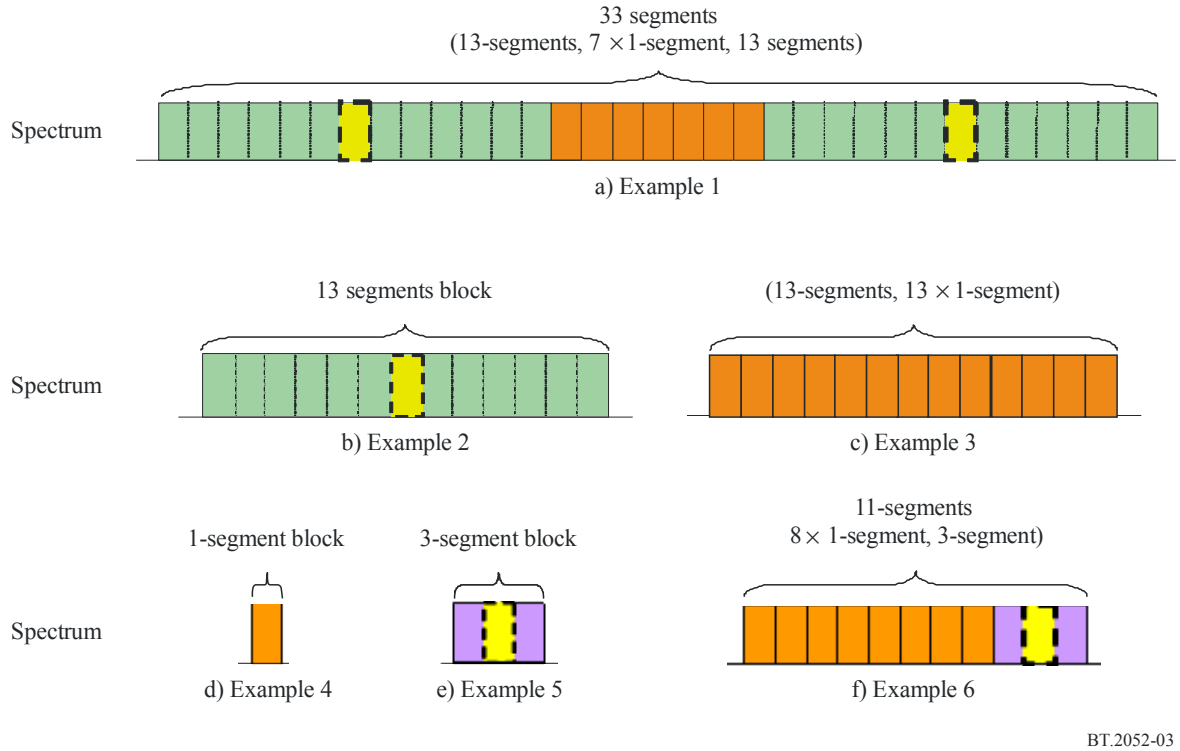


Figure 3 (b), (d) and (e) are three basic component blocks, i.e. 13-, 1- and 3-segment blocks. Figure 3 (a), (c) and (f) are three examples of spectra, which show the composition of two 13-segment block signals with seven 1-segment block signals, the composition of thirteen 1-segment block signals, and the composition of eight 1-segment block signals with one 3-segment block signal.

The spectrum masks defined in Figs. 18, 24 and 25 of Annex 6 of Recommendation ITU-R SM.1541-4 are used for the protection ratio measurement.

1 Characteristics of reference receiver

The parameter values of the ISDB-T multimedia reference receiver operating in the Bands II, III, IV and V are given in Table 8.

TABLE 8

Characteristics of reference receiver for ISDB-T multimedia broadcasting planning

Parameters	Values		
Equivalent noise bandwidth b (MHz)(1)	5.57	6.5	7.43
Receiver noise figure F (dB)	7	7	7
Receiver noise input power P_n (dBm)(2) for 75 Ω and 290 K	–99.2	–98.5	–97.9
Reference threshold C/N (dB)(3)	10	10	10
Minimum receiver input power P_{min} (dBm)(3), (4)	–89.2	–88.5	–87.9
Receiver overload threshold (dBm)(5)	–15	–15	–15
Adjacent channel selectivity (dB)(5),(6)	–39	–39	–39

NOTE 1 – The values are defined as 13 times the segment bandwidths for 13-segment block signals. The segment bandwidths take respective values of 429 kHz (6/14 MHz), 500 kHz (7/14 MHz) and 571 kHz (8/14 MHz) for 6 MHz, 7 MHz and 8 MHz systems. The bandwidth for a 1-segment block or a 3-segment block signal takes the value of one segment bandwidth or a triple of one segment bandwidth.

NOTE 2 – The values are defined for 13-segment block signals. The value for a 1-segment block or a 3-segment block signal can respectively be obtained by subtracting 10 log (13) = 11.1 (dB) or 10 log (13/3) = 6.4 (dB) from the value given in this Table.

NOTE 3 – The values are defined for 5% ESR and correspond to a system variant of 16-QAM-FEC 1/2, and a reception environment with fixed reception. The values are different for other system variants or reception environments. The value for portable outdoor (PO) reception is 16 dB or 14.5 dB for mobile (TU6). See Recommendation ITU-R BT.1368-10 for the other system variants and reception environments.

NOTE 4 – The value varies with the change in reference threshold C/N. The values correspond to system variants of 16-QAM-FEC 1/2, and a reception environment with fixed reception.

NOTE 5 – The values are for battery-powered handheld receivers.

NOTE 6 – The values are defined under no single frequency network (SFN) environment. In an actual SFN environment, the values are –36 dB.

2 Protection ratios for wanted ISDB-T multimedia broadcasting signals

2.1 Protection of ISDB-T multimedia broadcasting signal interfered with by ISDB-T multimedia broadcasting signal

The protection ratio is described as the required desired-to-undesired power ratio (D/U), i.e. power ratio between wanted and unwanted signals. The D/U for 1-segment and 13-segment ISDB-T multimedia broadcasting signals interfered with by ISDB-T multimedia broadcasting signals are measured at a quality criterion of 5% ESR. The difference in the value of D/U between the QEF and SFP of 5% ESR methods is empirically assumed to be around 1.5 dB.

For planning criteria, a propagation correction factor (fading margin) should be considered together with the protection ratios. The protection ratios given in the tables in § 2 are obtained in a Gaussian channel.

The value of the fading margin should be determined by the relevant administration of the territory in which the transmitting stations are located to calculate the protection ratios for all conditions of ISDB-T multimedia broadcasting reception in the actual implementation.

2.1.1 Protection from co-channel interference

Table 9 summarizes the protection ratios of a Gaussian channel for wanted signals of a 6-MHz ISDB-T multimedia broadcasting system interfered with by a co-channel unwanted 13-segment signal of a 6-MHz ISDB-T multimedia broadcasting system.

The ratios in Table 9 can be applied to a 7-MHz or an 8-MHz ISDB-T multimedia broadcasting system.

TABLE 9

Protection ratio (dB) for 6-MHz ISDB-T multimedia broadcasting signal interfered with by co-channel 13-segment 6-MHz ISDB-T multimedia broadcasting signal

Modulation	Coding rate	Wanted signal block		
		1-segment	3-segment	13-segment
QPSK	1/2	–7	–2	4
QPSK	2/3	–5	0	6
16-QAM	1/2	–1	4	10

NOTE 1 – The values for typical modulations and coding rates are defined for 5% ESR.

NOTE 2 − The value in this Table can be converted according to the numbers M and N of segments respectively included in wanted and unwanted signals, in connected-segment transmission. A factor (10 log (M/13) –10 log (N/13)) is added to the ratios in the table.

NOTE 3 − The values are for battery-powered handheld receivers.

2.1.2 Protection from lower or upper adjacent interference

Table 10 lists the protection ratios of a Gaussian channel for a wanted 13-segment block signal of a 6-MHz ISDB-T multimedia broadcasting system interfered with by an unwanted 13-segment signal of a 6-MHz ISDB-T multimedia broadcasting system spaced with a certain extent of frequency offset. The frequency offset between ISDB-T multimedia broadcasting signals is defined as the centre frequency difference between the wanted and unwanted signals to be used to avoid mutual interference, as shown in Fig. 4. The extent of the frequency offset is expressed in segments, whose bandwidth is defined as a fourteenth of the channel bandwidth: 429 kHz (6/14 MHz).

The protection ratio for a 13-segment block signal interfered with by a 13-segment signal at a frequency offset of 14 segments (i.e. 6 MHz for a 6-MHz ISDB-T multimedia broadcasting system) is the same as the protection ratio from the upper or lower adjacent channel. The ratios in Table 10 can be applied to a 7-MHz or an 8-MHz ISDB-T multimedia broadcasting system, where the segment bandwidths are 500 kHz (7/14 MHz) and 571 kHz (8/14 MHz), respectively for a 7-MHz and an 8-MHz channel raster.

FIGURE 4

Frequency offset Δf and arrangement of signals

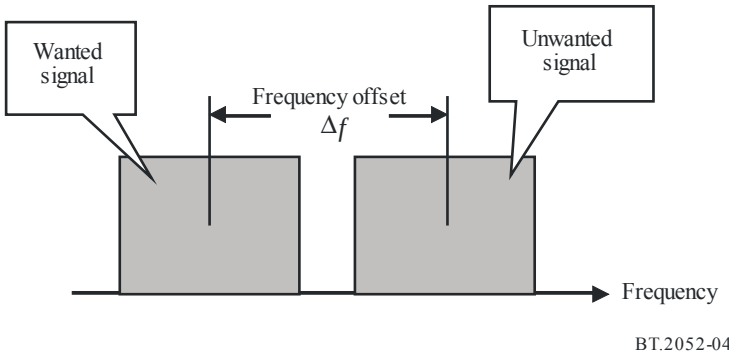


TABLE 10

Protection ratio (dB) for 6-MHz ISDB-T multimedia broadcasting signal interfered with by 13-segment 6-MHz ISDB-T multimedia broadcasting signal with different sized frequency offsets

Wanted signal block	Modulation	Coding rate	Frequency offset Δf (segments)						
			14	14+1/3	14+2/3	14+3/3	14+4/3	14+5/3	14+6/3
13-segment	16-QAM	1/2	–39	–42	–43	–44	–44	–45	–46

NOTE 1 – The values for typical modulations and coding rates are defined for 5% ESR.

NOTE 2 − The values in this Table can be converted according to the numbers M (≥13) and N of segments respectively included in wanted and unwanted signals in connected-segment transmission. A factor (10 log (M/13) – 10 log (N/13)) is added to the ratios in the table.

NOTE 3 – The values are for battery-powered handheld receivers.

2.2 Protection of ISDB-T multimedia broadcasting signal interfered with by ISDB-T digital terrestrial television signal

A 13-segment ISDB-T multimedia broadcasting signal behaves as an ISDB-T digital terrestrial television signal when it acts as an unwanted signal interfering with other signals because the physical-layer format of the 13-segment ISDB-T multimedia broadcasting system is the same as that of the ISDB-T digital terrestrial television broadcasting system.

The protection ratios in Tables 9 and 10 can be applied to the protection ratios to protect a wanted ISDB-T multimedia broadcasting signal from an ISDB-T digital terrestrial television signal.

2.3 Protection of ISDB-T multimedia broadcasting signal interfered with by DVB-T digital terrestrial television signal

2.3.1 Protection from co-channel interference

Table 11 summarizes the protection ratios of a Gaussian channel for a wanted 13-segment block signal of an 8-MHz ISDB-T multimedia broadcasting system interfered with by a co-channel unwanted 8-MHz DVB-T digital terrestrial television signal.

The ratios in Table 11 can be applied to a 6-MHz or a 7-MHz ISDB-T multimedia broadcasting system.

TABLE 11

Protection ratio (dB) for 8-MHz ISDB-T multimedia broadcasting signal interfered with by co-channel 8-MHz DVB-T digital terrestrial television signal

Modulation	Coding rate	Wanted signal block
		13-segment
QPSK	1/2	4
QPSK	2/3	6
16-QAM	1/2	10

NOTE 1 – The values for typical modulations and coding rates are defined for 5% ESR.

NOTE 2 − The values in this Table can be converted according to the number M (≥13) of segments included in a wanted signal in connected-segment transmission. A factor (10 log (M/13)) is added to the ratio in the table.

NOTE 3 − The values are for battery-powered handheld receivers.

2.3.2 Protection from lower or upper adjacent interference

Table 12 lists the protection ratios of a Gaussian channel for a wanted 13-segment block signal of an 8-MHz ISDB-T multimedia broadcasting system interfered with by an unwanted 8-MHz DVB-T digital terrestrial television signal spaced with a certain extent of frequency offsets.

The ratios in Table 12 can be applied to a 6-MHz or a 7-MHz ISDB-T multimedia broadcasting system.

TABLE 12

Protection ratio (dB) for 8-MHz ISDB-T multimedia broadcasting signal interfered with by 8-MHz DVB-T digital terrestrial television signal with different sized frequency offsets

Wanted signal block	Modulation	Coding rate	Frequency offset Δf (segments)						
			14	14+1/3	14+2/3	14+3/3	14+4/3	14+5/3	14+6/3
13-segment	16-QAM	1/2	–39	–42	–43	–44	–44	–45	–46

NOTE 1 – The values for typical modulations and coding rates are defined for 5% ESR.

NOTE 2 − The values in this Table can be converted according to the number M (≥13) of segments included in a wanted signal in connected-segment transmission. A factor (10 log (M/13)) is added to the ratios in the table.

NOTE 3 – The values are for battery-powered handheld receivers.

3 Protection ratios for other broadcasting systems interfered with by ISDB-T multimedia broadcasting signal

3.1 Protection ratios for wanted ISDB-T digital terrestrial television broadcasting signals interfered with by ISDB-T multimedia broadcasting signal

A 13-segment ISDB-T multimedia broadcasting signal behaves as an ISDB-T digital terrestrial television signal when it acts as an unwanted signal interfering with other signals because the physical-layer format of the 13-segment ISDB-T multimedia broadcasting system is the same as that of the ISDB-T digital terrestrial television broadcasting system.

The protection ratios in § 1.1 of Annex 3 to Recommendation ITU-R BT.1368-10 can be applied to the values to protect a wanted ISDB-T digital terrestrial television signal from an ISDB-T multimedia broadcasting signal.

4 Minimum field strength for ISDB-T multimedia broadcasting

4.1 Minimum power flux-density at receiving location φ_{min}

$$\varphi_{min}\ (\mathrm{dBm/m^2}) = P_{min}\ (\mathrm{dBm}) - A_a\ (\mathrm{dB\ m^2}) + L_f\ (\mathrm{dB})$$

with:

P_{min}: minimum receiver input power as given in Table 8

A_a: effective antenna aperture ($\mathrm{dBm^2}$)

L_f: feeder loss (dB).

$$A_a\ (\mathrm{dB\,m^2}) = 10 \cdot \log\left(\frac{1.64}{4\pi}\left(\frac{300}{f\ (\mathrm{MHz})}\right)^2\right) + G_a$$

with:

G_a: antenna gain relative to a half-wavelength dipole (dBd).

4.2 Minimum RMS field-strength level at location of receiving antenna E_{min}

$$E_{min}\ (\mathrm{dB(\mu V/m)}) = \varphi_{min}\ (\mathrm{dBm/m^2}) + 10\log_{10}(Z_{F0})\,(\mathrm{dB\Omega}) + 20\log_{10}\left(\frac{1V}{1\mu V}\right)$$

with:

$$Z_{F0} = \sqrt{\frac{\mu_0}{\varepsilon_0}} \approx 120\pi\ (\Omega):$$ characteristic impedance in free space,

resulting in:

$$E_{min}\,(\mathrm{dB\mu\,V/m}) = \varphi_{min}\,(\mathrm{dBm/m^2}) + 115.8\ \ (\mathrm{dB\,\Omega})$$

Appendix 1 to Annex 1

Protection ratios of an AT-DMB signal interfered with by adjacent T-DMB/AT-DMB signals with regular frequency spacing in VHF band

Tables 13 to 29 show the required *D*/*U* for an AT-DMB wanted signal against adjacent T-DMB and AT-DMB unwanted signals with regular frequency spacing. The graphs of their required *D*/*U* are depicted from Figs. 5 to 21.

TABLE 13

Required *D*/*U* ratio for the T-DMB wanted signal interfered with by T-DMB/AT-DMB unwanted signal

T-DMB/ AT-DMB Unwanted signal	T-DMB wanted signal		*D*/*U* ratio required by T-DMB wanted signal (dB)
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	
213.008	211.008	–2.0	–52
	211.208	–1.8	–52
	211.408	–1.6	–44
	211.608	–1.4	–18
	211.808	–1.2	–1
	212.008	–1.0	2
	212.208	–0.8	3
	212.408	–0.6	4
	212.608	–0.4	4
	212.808	–0.2	5
	213.008	0	6
	213.208	0.2	5
	213.408	0.4	4
	213.608	0.6	4
	213.808	0.8	3
	214.008	1.0	2
	214.208	1.2	–1
	214.408	1.4	–18
	214.608	1.6	–40
	214.808	1.8	–52
	215.008	2.0	–52

FIGURE 5

Required *D*/*U* ratio graph for the T-DMB wanted signal interfered with by T-DMB/AT-DMB unwanted signal

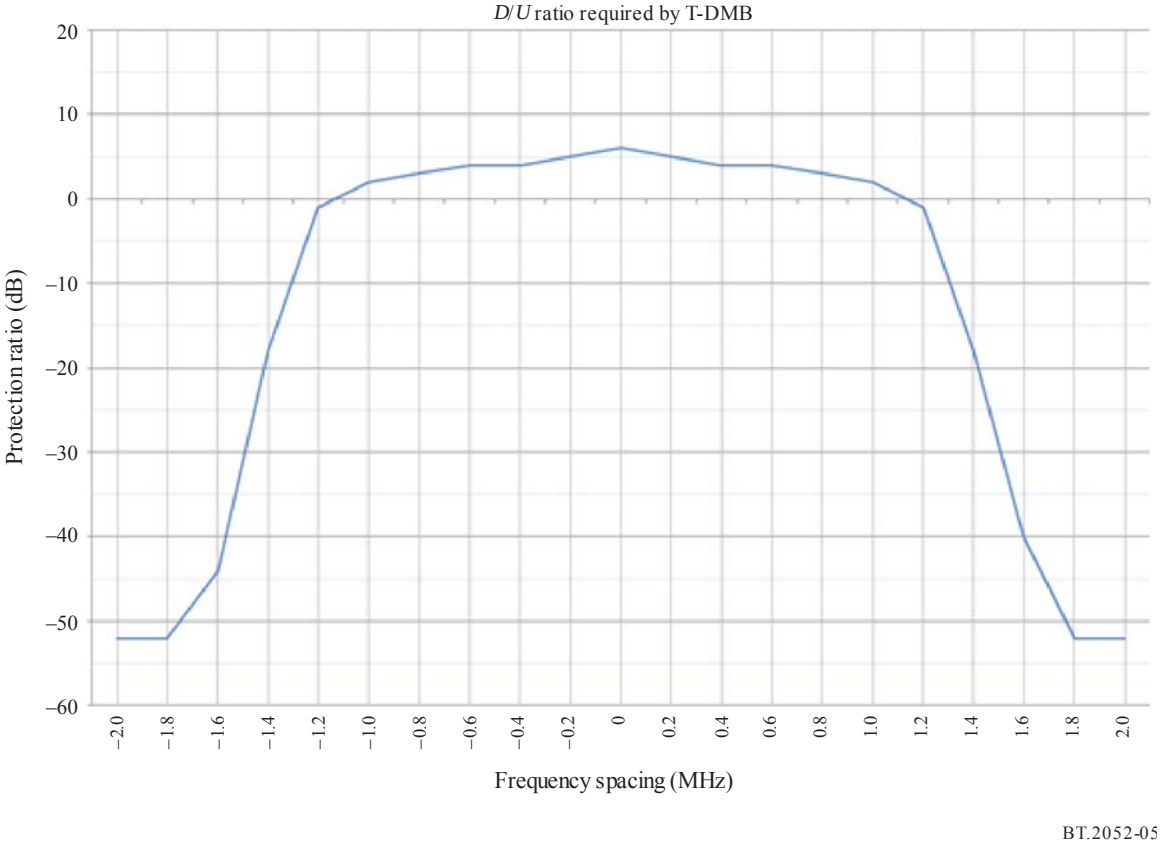


TABLE 14

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/2)

T-DMB/ AT-DMB Unwanted signal	**AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/2)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
213.008	211.008	–2.0	–50	–51
	211.208	–1.8	–50	–51
	211.408	–1.6	–44	–43
	211.608	–1.4	–12	–11
	211.808	–1.2	1	0
	212.008	–1.0	3	2
	212.208	–0.8	5	4
	212.408	–0.6	6	5
	212.608	–0.4	7	6
	212.808	–0.2	7	6
	213.008	0	8	7

TABLE 14 (*end*)

T-DMB/ AT-DMB Unwanted signal	**AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/2)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
	213.208	0.2	7	6
	213.408	0.4	7	6
	213.608	0.6	6	5
	213.808	0.8	5	4
	214.008	1.0	4	2
	214.208	1.2	1	0
	214.408	1.4	–10	–12
	214.608	1.6	–39	–42
	214.808	1.8	–51	–52
	215.008	2.0	–51	–52

FIGURE 6

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/2)

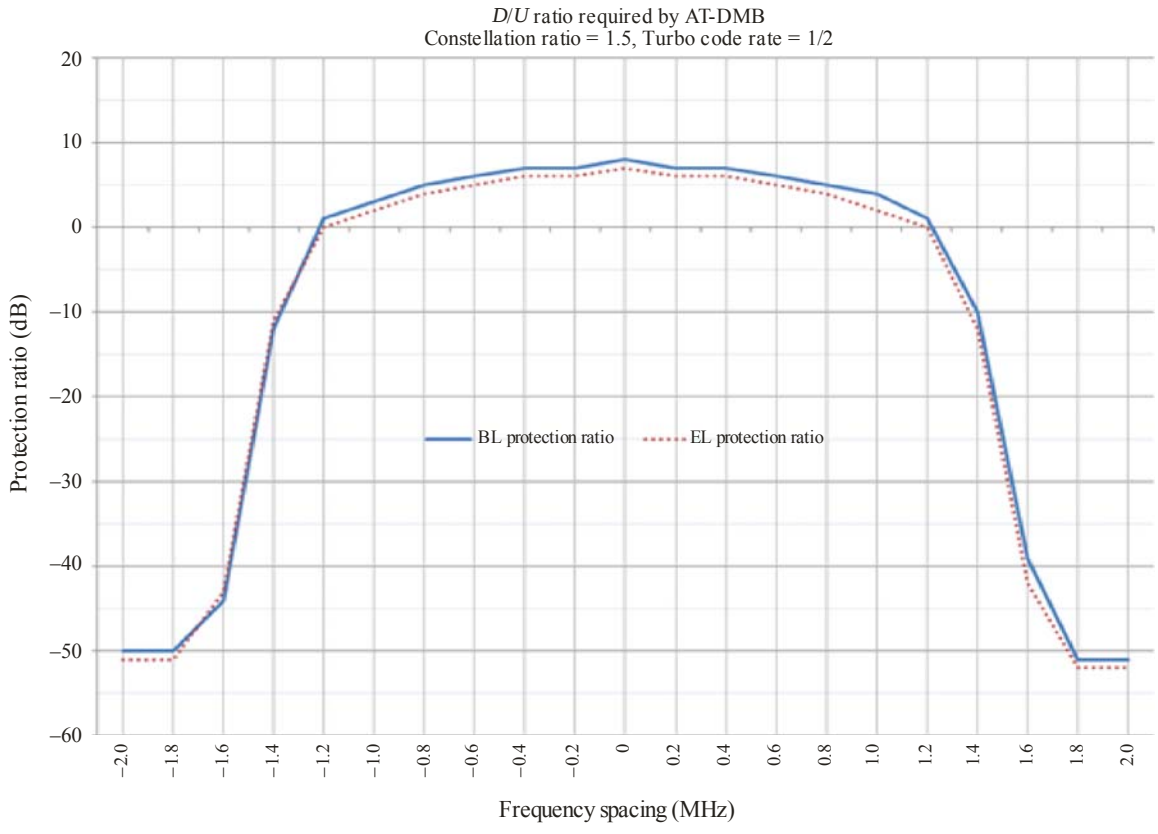


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TABLE 15

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 2/5)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 2/5)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–50	–52
	211.208	–1.8	–50	–52
	211.408	–1.6	–44	–43
	211.608	–1.4	–12	–13
	211.808	–1.2	1	–3
	212.008	–1.0	3	1
	212.208	–0.8	5	3
	212.408	–0.6	6	4
	212.608	–0.4	7	4
	212.808	–0.2	7	5
	213.008	0	8	6
	213.208	0.2	7	5
	213.408	0.4	7	4
	213.608	0.6	6	4
	213.808	0.8	5	2
	214.008	1.0	4	1
	214.208	1.2	1	–3
	214.408	1.4	–10	–17
	214.608	1.6	–39	–44
	214.808	1.8	–51	–52
	215.008	2.0	–51	–52

FIGURE 7

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 2/5)

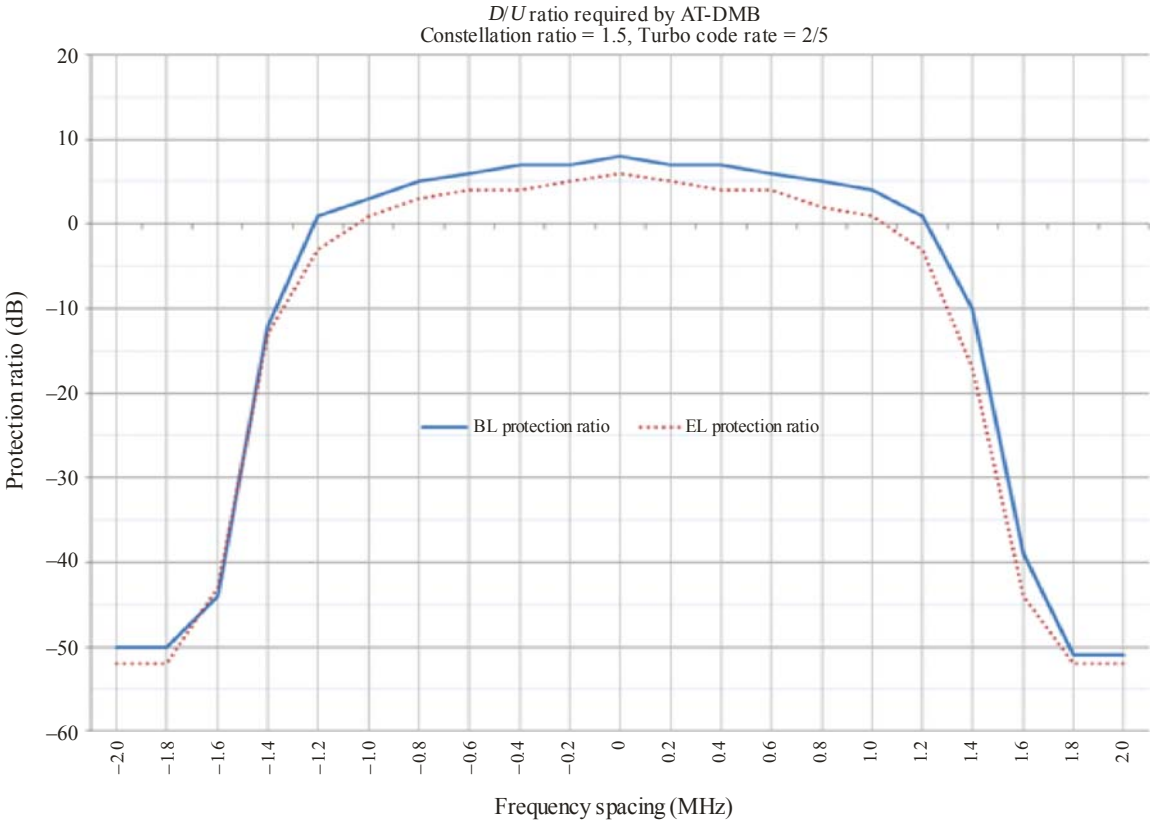

TABLE 16

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/3)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/3)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–50	–52
	211.208	–1.8	–50	–52
	211.408	–1.6	–44	–43
	211.608	–1.4	–12	–21
	211.808	–1.2	1	–4
	212.008	–1.0	3	0
	212.208	–0.8	5	2
	212.408	–0.6	6	3
	212.608	–0.4	7	4
	212.808	–0.2	7	4

TABLE 16 (*end*)

T-DMB/ AT-DMB Unwanted signal	**AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/3)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
	213.008	0	8	5
	213.208	0.2	7	4
	213.408	0.4	7	4
	213.608	0.6	6	3
	213.808	0.8	5	2
	214.008	1.0	4	0
	214.208	1.2	1	–2
	214.408	1.4	–10	–21
	214.608	1.6	–39	–47
	214.808	1.8	–51	–53
	215.008	2.0	–51	–53

FIGURE 8

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/3)

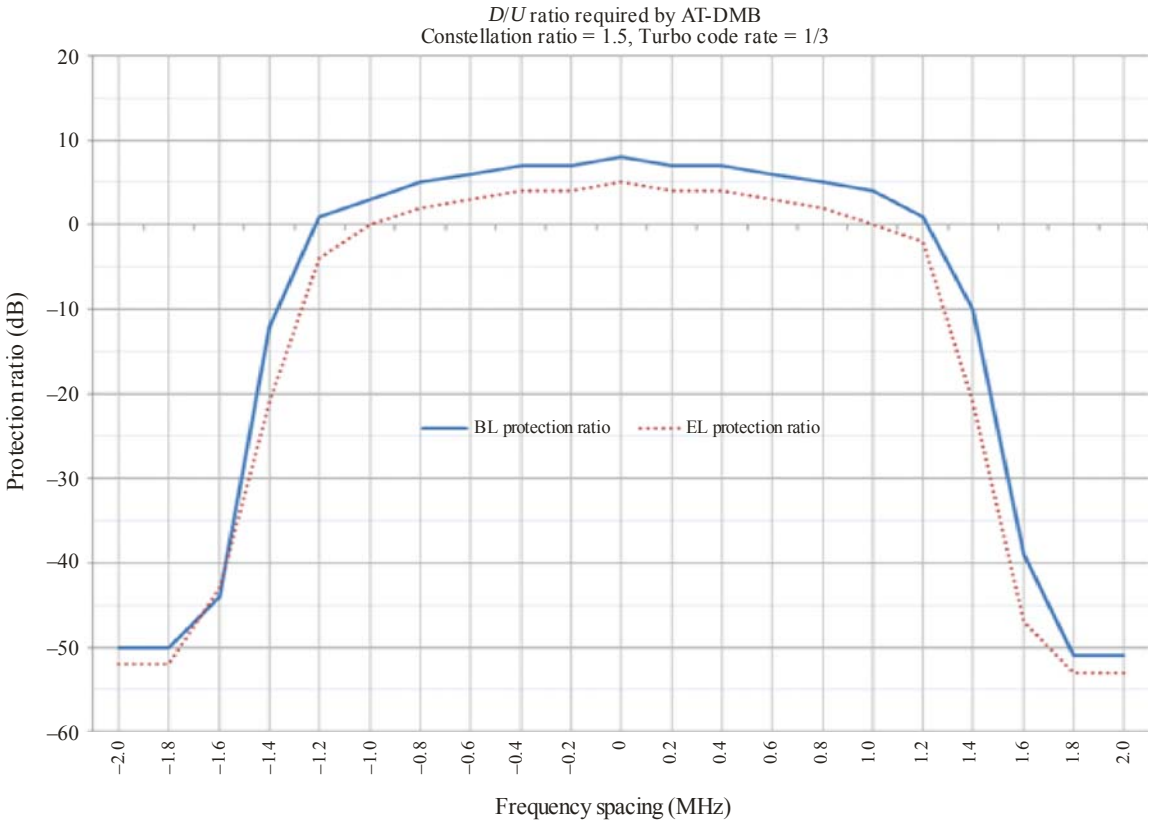

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TABLE 17

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/4)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/4)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–50	–53
	211.208	–1.8	–50	–53
	211.408	–1.6	–44	–43
	211.608	–1.4	–12	–21
	211.808	–1.2	1	–7
	212.008	–1.0	3	–3
	212.208	–0.8	5	0
	212.408	–0.6	6	1
	212.608	–0.4	7	2
	212.808	–0.2	7	3
	213.008	0	8	3
	213.208	0.2	7	3
	213.408	0.4	7	2
	213.608	0.6	6	1
	213.808	0.8	5	–1
	214.008	1.0	4	–3
	214.208	1.2	1	–7
	214.408	1.4	–10	–21
	214.608	1.6	–39	–47
	214.808	1.8	–51	–53
	215.008	2.0	–51	–53

FIGURE 9

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 1.5, Turbo code rate 1/4)

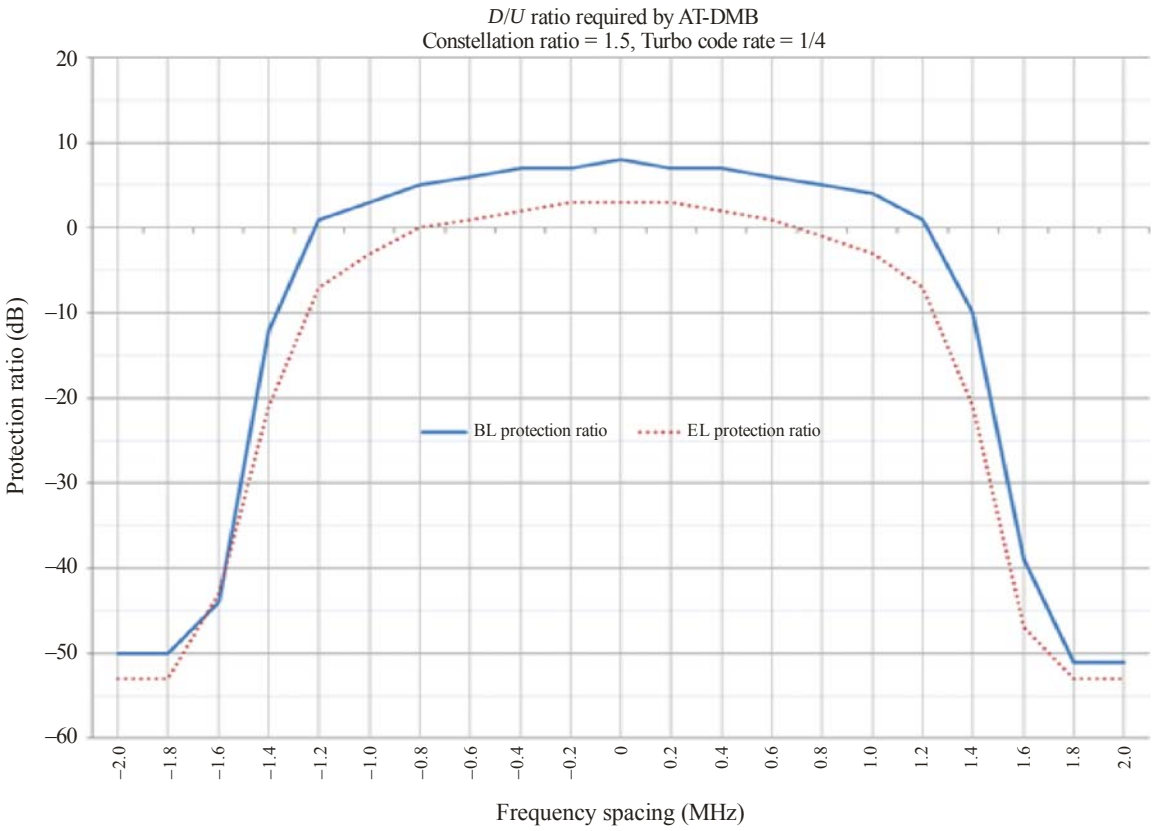

TABLE 18

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/2)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/2)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
213.008	211.008	–2.0	–51	–50
	211.208	–1.8	–51	–50
	211.408	–1.6	–44	–42
	211.608	–1.4	–13	–11
	211.808	–1.2	0	1
	212.008	–1.0	3	4
	212.208	–0.8	4	5
	212.408	–0.6	5	6
	212.608	–0.4	6	7
	212.808	–0.2	6	8

TABLE 18 (*end*)

T-DMB/ AT-DMB Unwanted signal	**AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/2)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
	213.008	0	7	8
	213.208	0.2	6	8
	213.408	0.4	6	7
	213.608	0.6	5	6
	213.808	0.8	4	5
	214.008	1.0	3	4
	214.208	1.2	0	1
	214.408	1.4	–12	–9
	214.608	1.6	–39	–39
	214.808	1.8	–51	–51
	215.008	2.0	–52	–51

FIGURE 10

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/2)

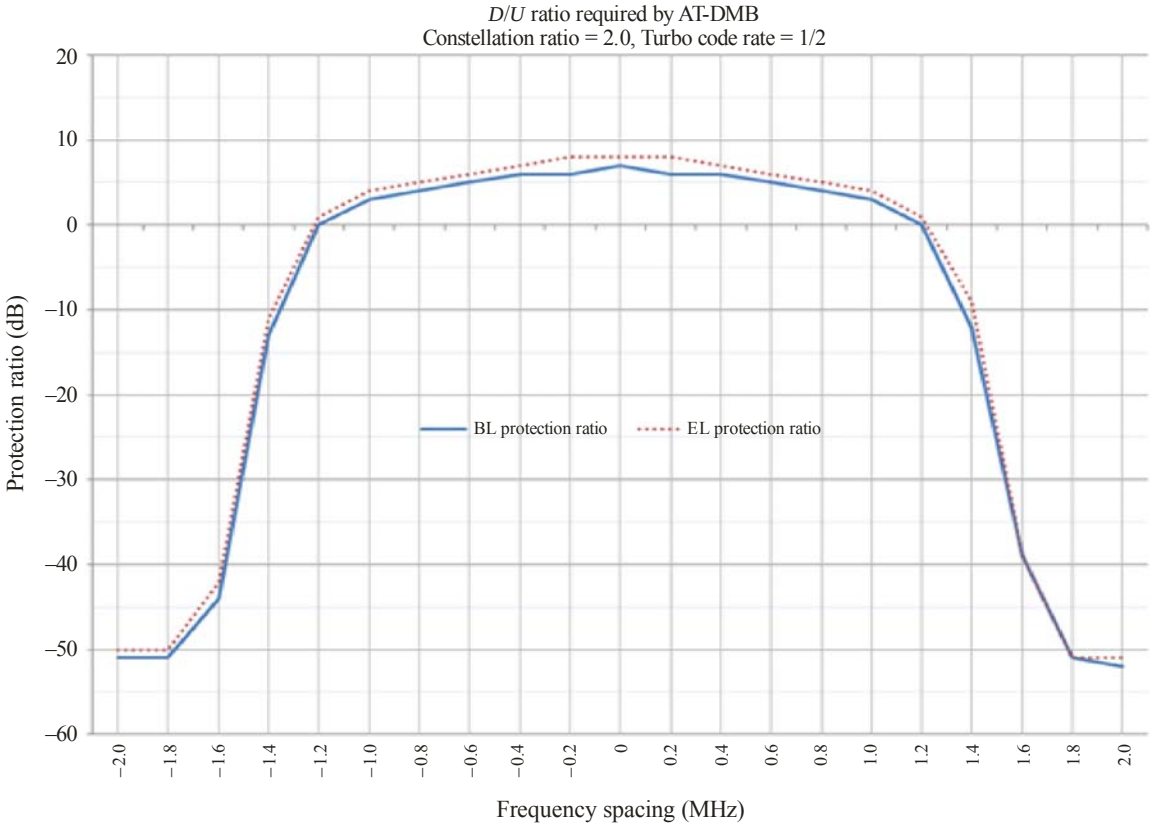

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TABLE 19

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 2/5)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 2/5)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–51
	211.208	–1.8	–51	–51
	211.408	–1.6	–44	–42
	211.608	–1.4	–13	–17
	211.808	–1.2	0	–2
	212.008	–1.0	3	2
	212.208	–0.8	4	4
	212.408	–0.6	5	5
	212.608	–0.4	6	6
	212.808	–0.2	6	6
	213.008	0	7	7
	213.208	0.2	6	6
	213.408	0.4	6	6
	213.608	0.6	5	5
	213.808	0.8	4	4
	214.008	1.0	3	2
	214.208	1.2	0	–1
	214.408	1.4	–12	–17
	214.608	1.6	–39	–43
	214.808	1.8	–51	–52
	215.008	2.0	–52	–52

FIGURE 11

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 2/5)

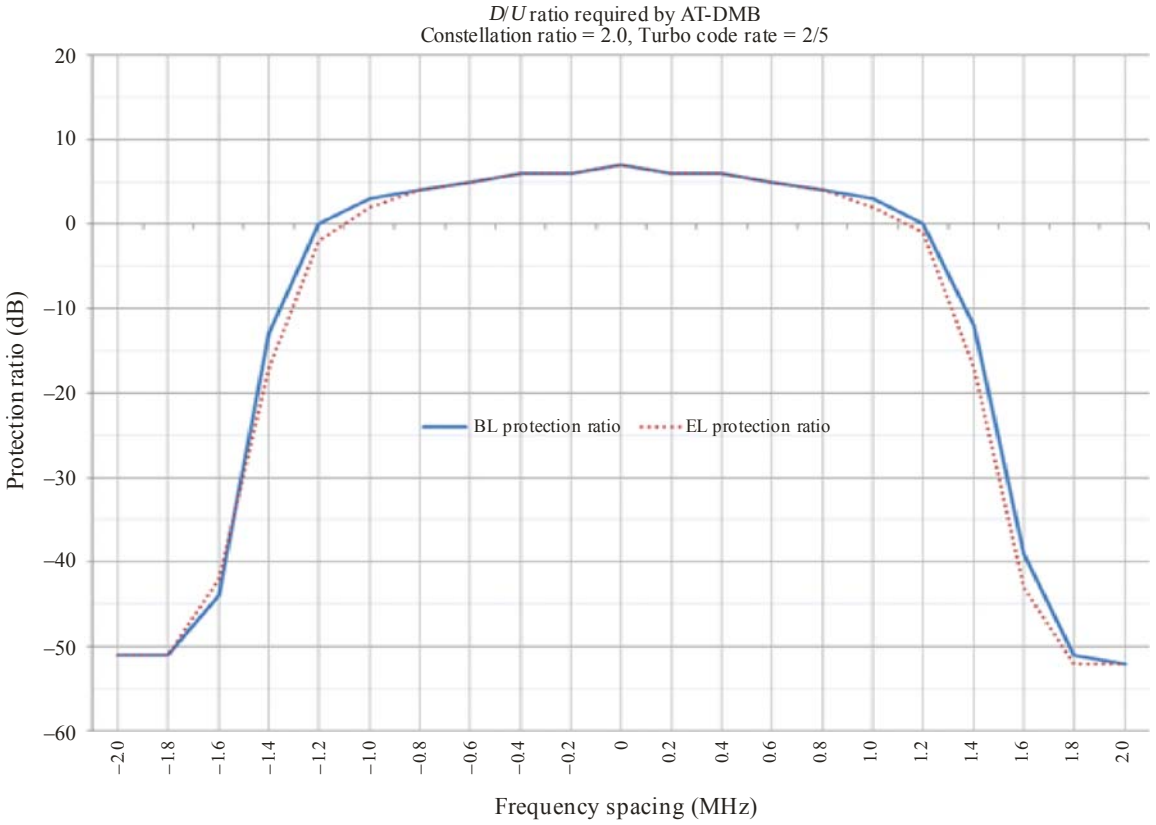

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TABLE 20

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/3)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/3)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–51
	211.208	–1.8	–51	–51
	211.408	–1.6	–44	–43
	211.608	–1.4	–13	–20
	211.808	–1.2	0	–3
	212.008	–1.0	3	1
	212.208	–0.8	4	3
	212.408	–0.6	5	4
	212.608	–0.4	6	5
	212.808	–0.2	6	6
	213.008	0	7	6

TABLE 20 (*end*)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/3)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
	213.208	0.2	6	6
	213.408	0.4	6	5
	213.608	0.6	5	4
	213.808	0.8	4	3
	214.008	1.0	3	1
	214.208	1.2	0	–3
	214.408	1.4	–12	–18
	214.608	1.6	–39	–46
	214.808	1.8	–51	–52
	215.008	2.0	–52	–53

FIGURE 12

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/3)

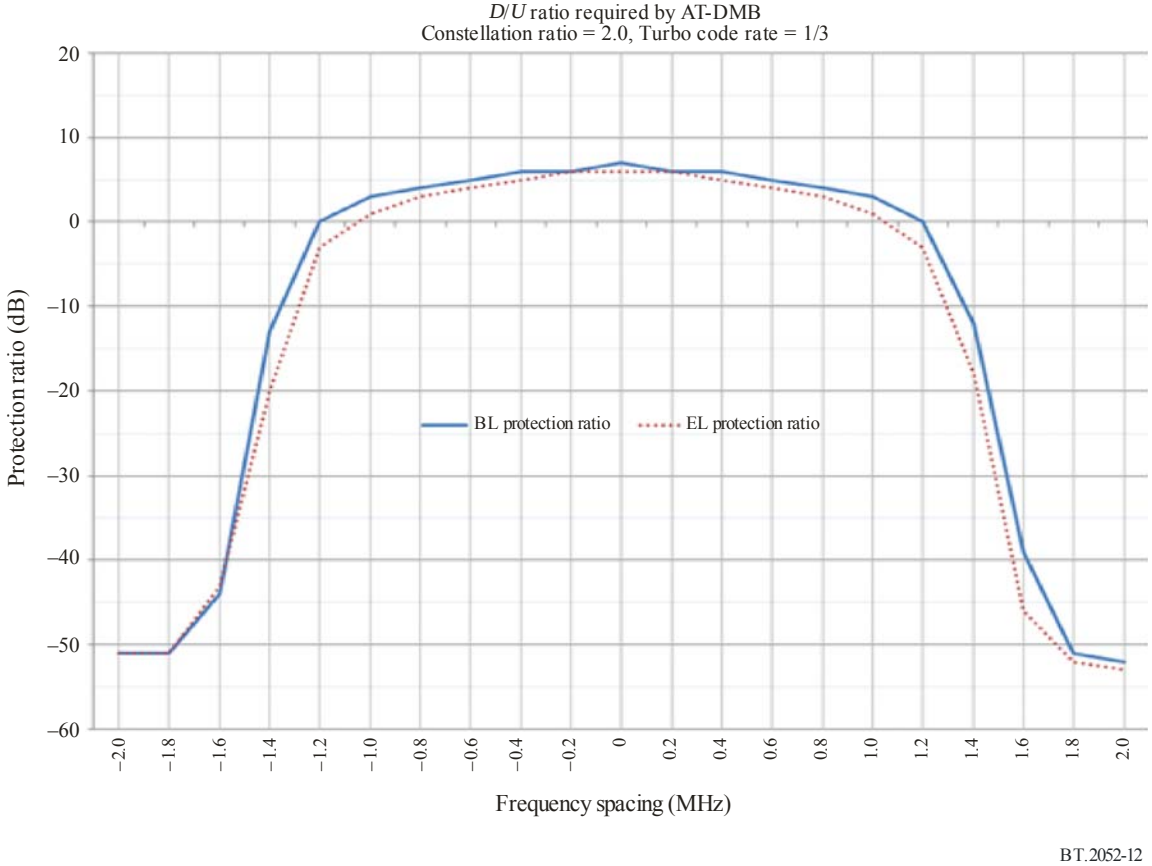

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TABLE 21

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/4)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/4)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–52
	211.208	–1.8	–51	–52
	211.408	–1.6	–44	–43
	211.608	–1.4	–13	–24
	211.808	–1.2	0	–7
	212.008	–1.0	3	–2
	212.208	–0.8	4	1
	212.408	–0.6	5	2
	212.608	–0.4	6	3
	212.808	–0.2	6	4
	213.008	0	7	5
	213.208	0.2	6	4
	213.408	0.4	6	3
	213.608	0.6	5	2
	213.808	0.8	4	0
	214.008	1.0	3	–2
	214.208	1.2	0	–6
	214.408	1.4	–12	–21
	214.608	1.6	–39	–47
	214.808	1.8	–51	–53
	215.008	2.0	–52	–53

FIGURE 13

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 2.0, Turbo code rate 1/4)

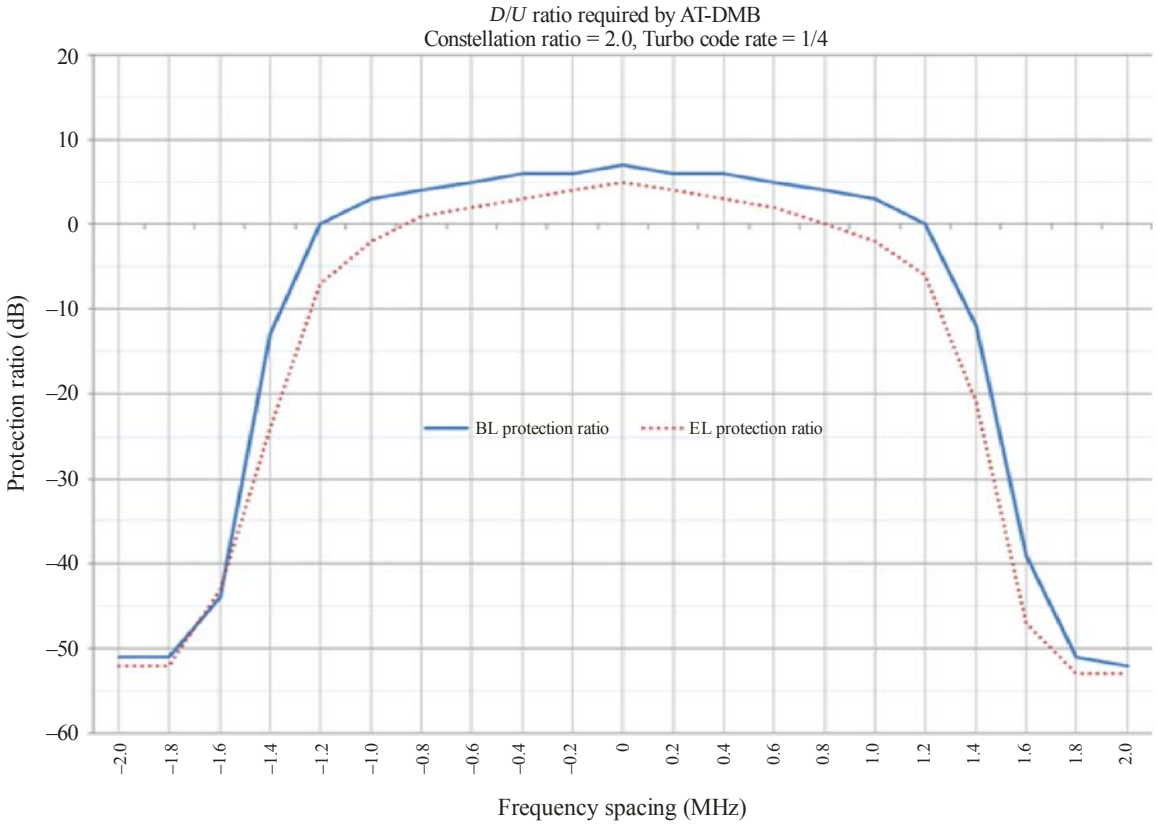

TABLE 22

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/2)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/2)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–49
	211.208	–1.8	–51	–49
	211.408	–1.6	–44	–43
	211.608	–1.4	–16	–10
	211.808	–1.2	0	2
	212.008	–1.0	2	5
	212.208	–0.8	4	7
	212.408	–0.6	5	8
	212.608	–0.4	5	9
	212.808	–0.2	6	9

TABLE 22 (*end*)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/2)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
	213.008	0	6	9
	213.208	0.2	6	9
	213.408	0.4	5	8
	213.608	0.6	5	7
	213.808	0.8	4	6
	214.008	1.0	2	5
	214.208	1.2	0	2
	214.408	1.4	–15	–9
	214.608	1.6	–39	–39
	214.808	1.8	–51	–50
	215.008	2.0	–52	–51

FIGURE 14

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/2)

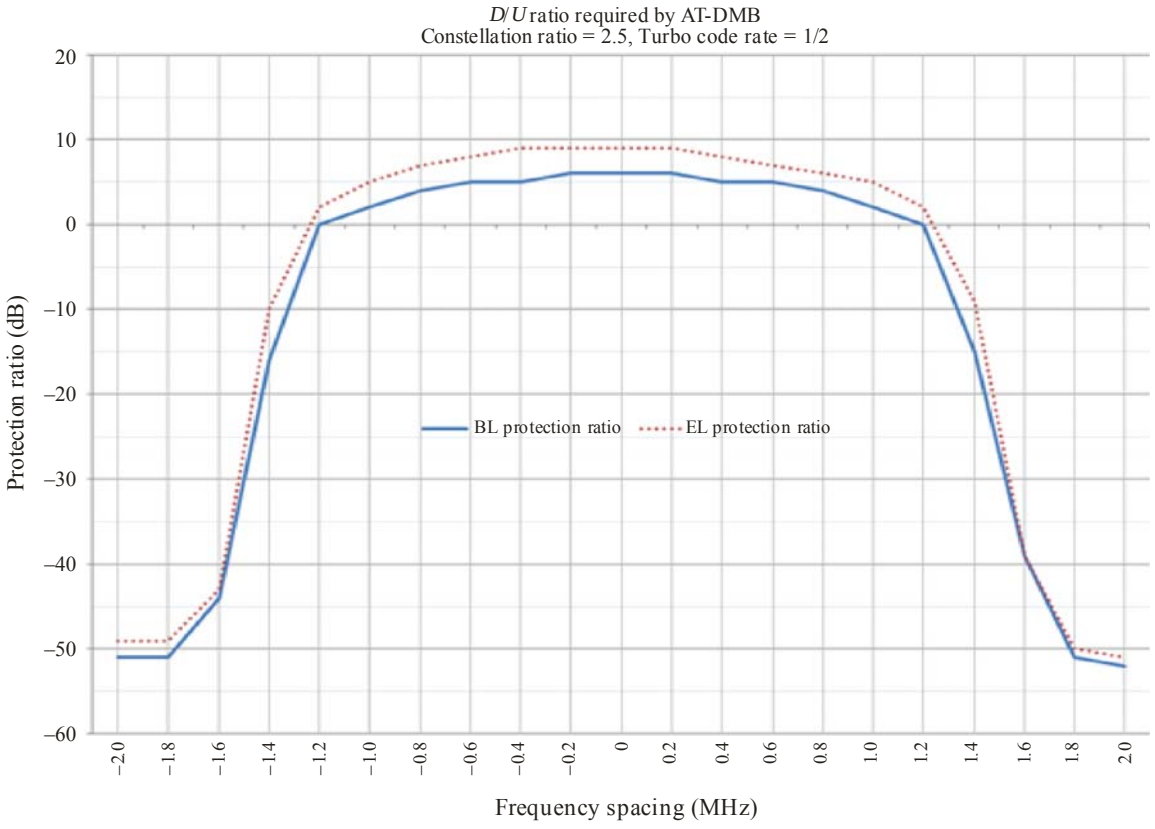

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TABLE 23

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 2/5)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 2/5)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing	BL	EL
213.008	211.008	–2.0	–51	–50
	211.208	–1.8	–51	–50
	211.408	–1.6	–44	–43
	211.608	–1.4	–16	–17
	211.808	–1.2	0	–1
	212.008	–1.0	2	3
	212.208	–0.8	4	5
	212.408	–0.6	5	6
	212.608	–0.4	5	7
	212.808	–0.2	6	8
	213.008	0	6	8
	213.208	0.2	6	8
	213.408	0.4	5	7
	213.608	0.6	5	6
	213.808	0.8	4	5
	214.008	1.0	2	3
	214.208	1.2	0	–1
	214.408	1.4	–15	–16
	214.608	1.6	–39	–39
	214.808	1.8	–51	–50
	215.008	2.0	–52	–51

FIGURE 15

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 2/5)

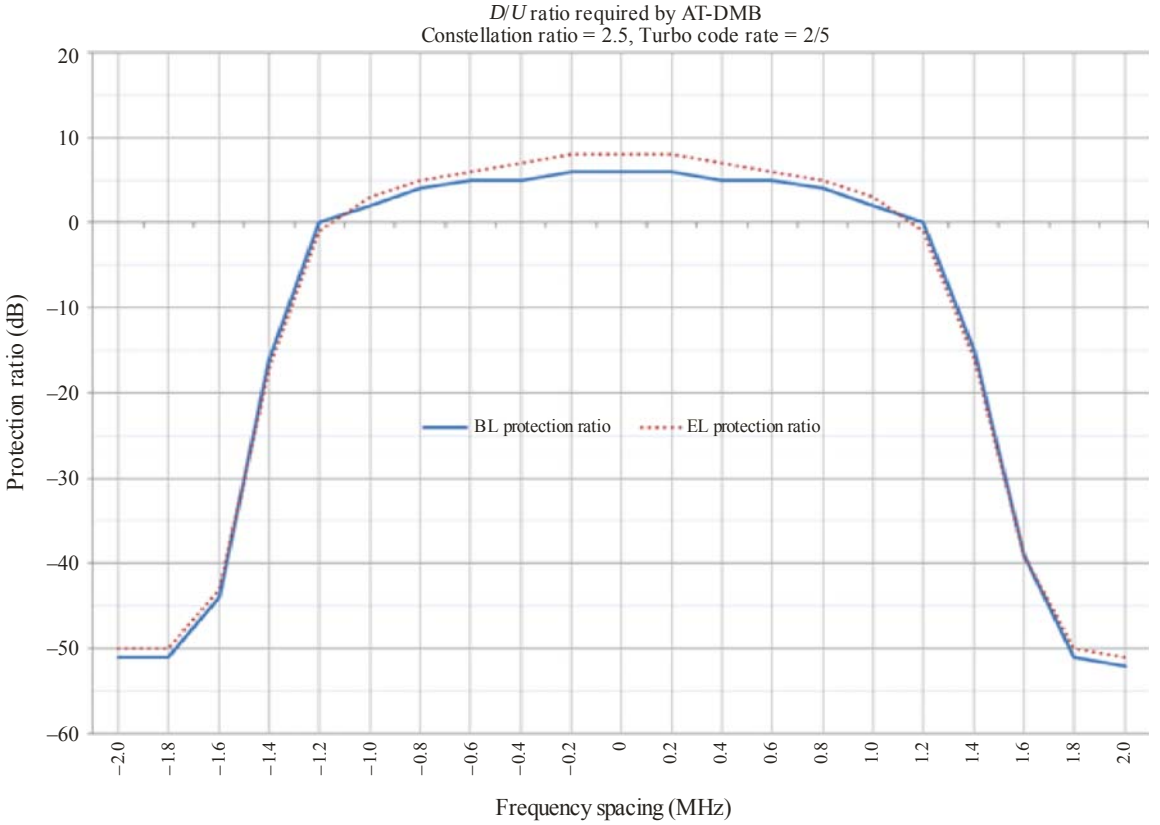

TABLE 24

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/3)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/3)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–51
	211.208	–1.8	–51	–51
	211.408	–1.6	–44	–44
	211.608	–1.4	–16	–19
	211.808	–1.2	0	–2
	212.008	–1.0	2	3
	212.208	–0.8	4	4
	212.408	–0.6	5	5
	212.608	–0.4	5	6
	212.808	–0.2	6	7

TABLE 24 (*end*)

T-DMB/ AT-DMB Unwanted signal	**AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/3)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
	213.008	0	6	7
	213.208	0.2	6	7
	213.408	0.4	5	6
	213.608	0.6	5	5
	213.808	0.8	4	4
	214.008	1.0	2	3
	214.208	1.2	0	–2
	214.408	1.4	–15	–16
	214.608	1.6	–39	–44
	214.808	1.8	–51	–52
	215.008	2.0	–52	–52

FIGURE 16

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/3)

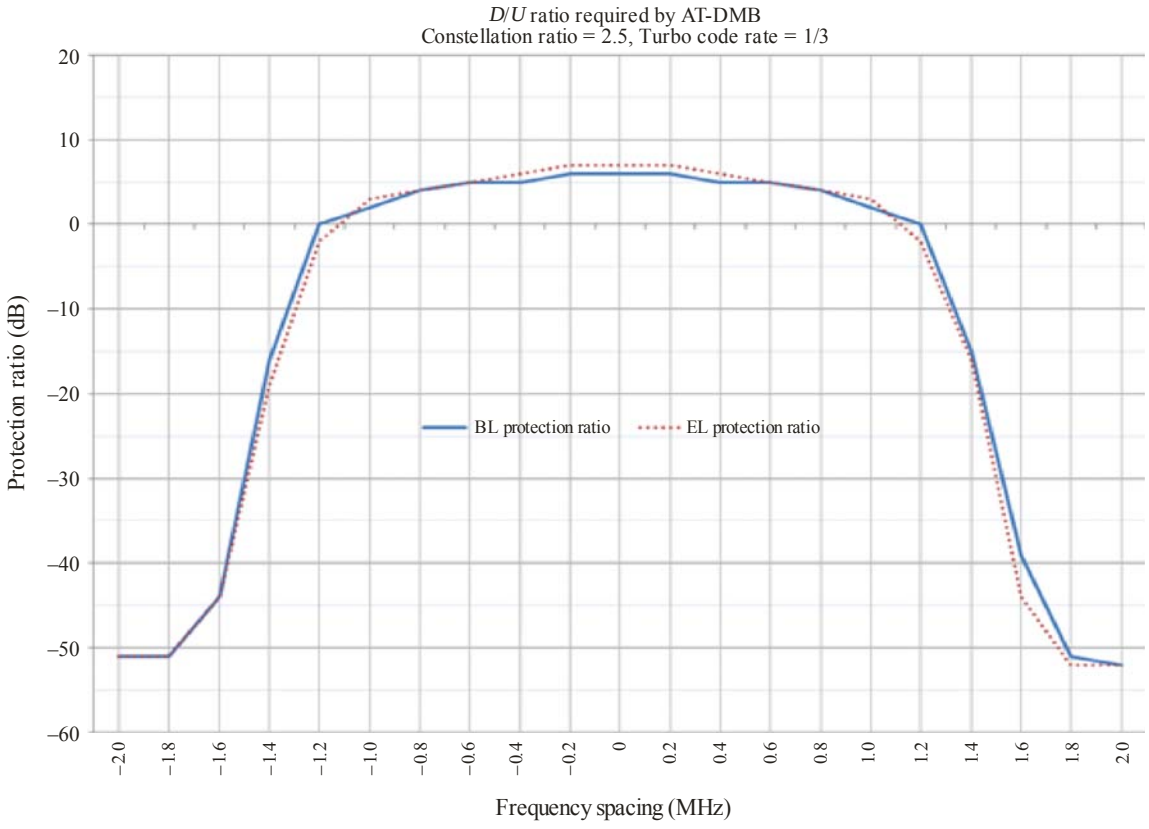

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TABLE 25

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/4)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/4)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–52
	211.208	–1.8	–51	–52
	211.408	–1.6	–44	–44
	211.608	–1.4	–16	–23
	211.808	–1.2	0	–6
	212.008	–1.0	2	–1
	212.208	–0.8	4	2
	212.408	–0.6	5	3
	212.608	–0.4	5	4
	212.808	–0.2	6	5
	213.008	0	6	6
	213.208	0.2	6	5
	213.408	0.4	5	4
	213.608	0.6	5	3
	213.808	0.8	4	2
	214.008	1.0	2	–1
	214.208	1.2	0	–6
	214.408	1.4	–15	–22
	214.608	1.6	–39	–46
	214.808	1.8	–51	–52
	215.008	2.0	–52	–52

FIGURE 17

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 2.5, Turbo code rate 1/4)

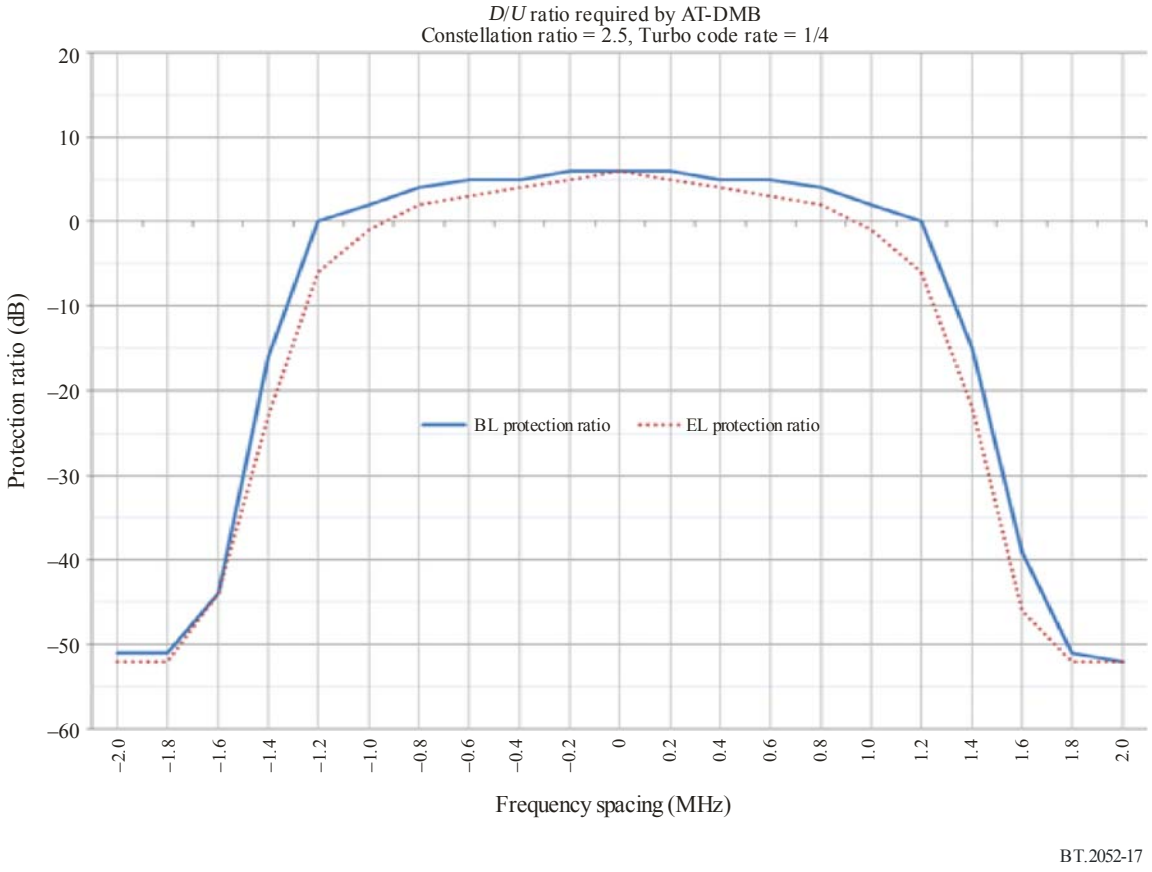

TABLE 26

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/2)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/2)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–48
	211.208	–1.8	–51	–48
	211.408	–1.6	–44	–43
	211.608	–1.4	–17	–9
	211.808	–1.2	–1	3
	212.008	–1.0	2	6
	212.208	–0.8	3	8
	212.408	–0.6	4	9
	212.608	–0.4	5	9
	212.808	–0.2	5	10

TABLE 26 (*end*)

T-DMB/ AT-DMB Unwanted signal	**AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/2)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
	213.008	0	6	10
	213.208	0.2	5	10
	213.408	0.4	5	9
	213.608	0.6	4	8
	213.808	0.8	3	7
	214.008	1.0	2	6
	214.208	1.2	–1	3
	214.408	1.4	–16	–8
	214.608	1.6	–40	–39
	214.808	1.8	–51	–48
	215.008	2.0	–52	–49

FIGURE 18

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/2)

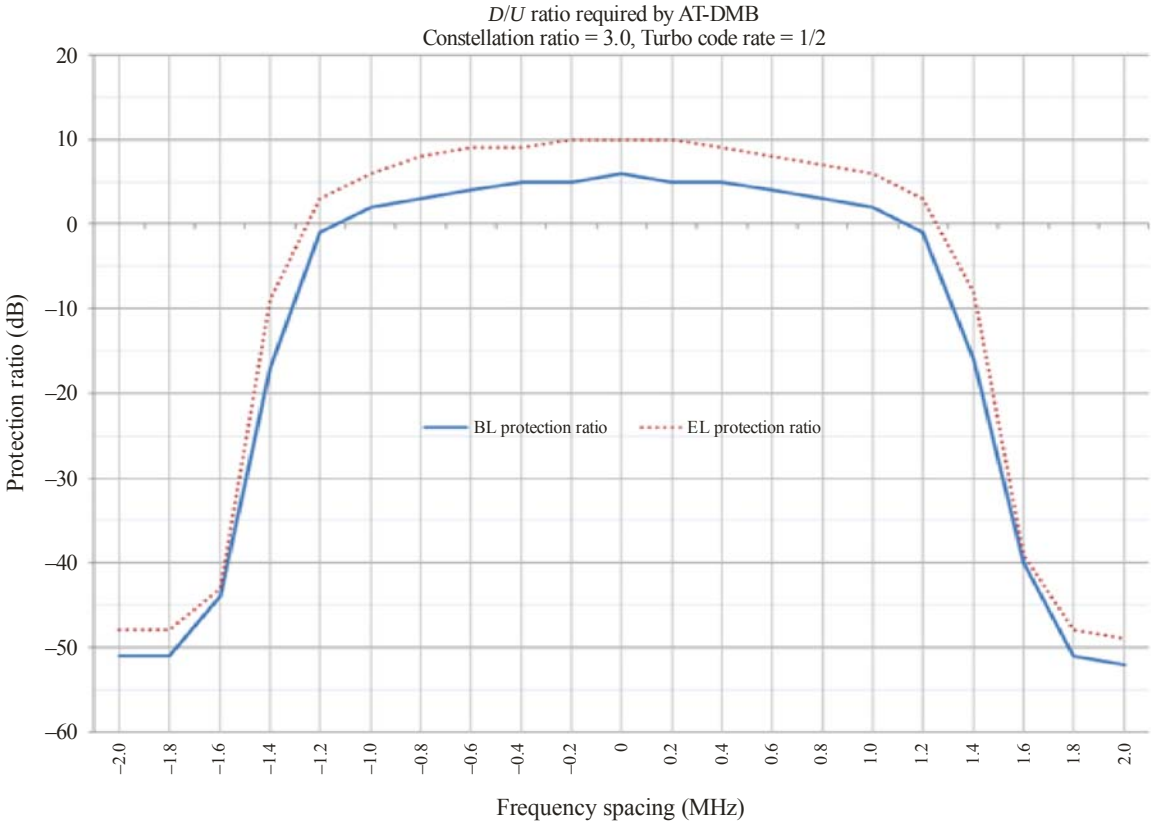

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TABLE 27

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 2/5)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 2/5)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–49
	211.208	–1.8	–51	–49
	211.408	–1.6	–44	–43
	211.608	–1.4	–17	–16
	211.808	–1.2	–1	0
	212.008	–1.0	2	4
	212.208	–0.8	3	6
	212.408	–0.6	4	7
	212.608	–0.4	5	8
	212.808	–0.2	5	9
	213.008	0	6	9
	213.208	0.2	5	9
	213.408	0.4	5	8
	213.608	0.6	4	7
	213.808	0.8	3	6
	214.008	1.0	2	4
	214.208	1.2	–1	0
	214.408	1.4	–16	–15
	214.608	1.6	–40	–39
	214.808	1.8	–51	–49
	215.008	2.0	–52	–51

FIGURE 19

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 2/5)

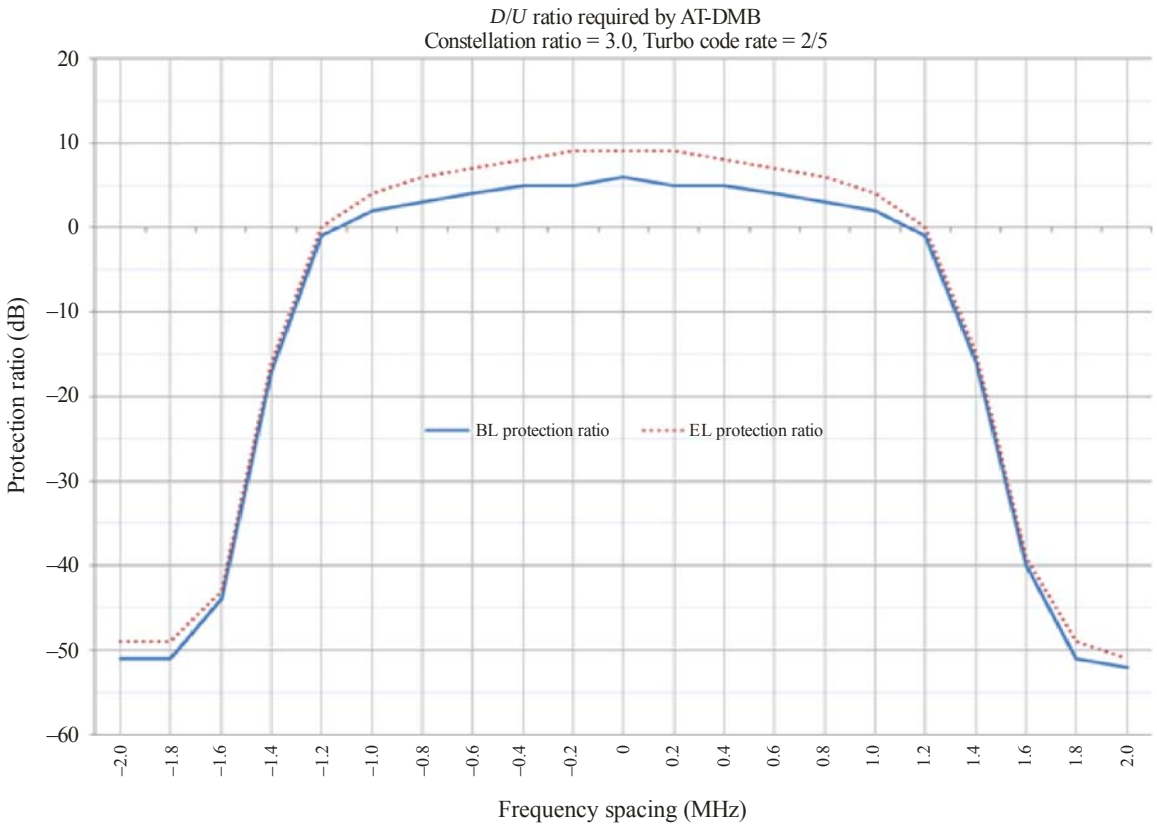

TABLE 28

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/3)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/3)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–50
	211.208	–1.8	–51	–50
	211.408	–1.6	–44	–44
	211.608	–1.4	–17	–17
	211.808	–1.2	–1	–1
	212.008	–1.0	2	3
	212.208	–0.8	3	5
	212.408	–0.6	4	6
	212.608	–0.4	5	7
	212.808	–0.2	5	8

TABLE 28 (*end*)

T-DMB/ AT-DMB Unwanted signal	**AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/3)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**	
Frequency (MHz)	**Frequency (MHz)**	**Frequency spacing (MHz)**	**BL**	**EL**
	213.008	0	6	8
	213.208	0.2	5	8
	213.408	0.4	5	7
	213.608	0.6	4	6
	213.808	0.8	3	5
	214.008	1.0	2	3
	214.208	1.2	–1	–1
	214.408	1.4	–16	–17
	214.608	1.6	–40	–41
	214.808	1.8	–51	–49
	215.008	2.0	–52	–52

FIGURE 20

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/3)

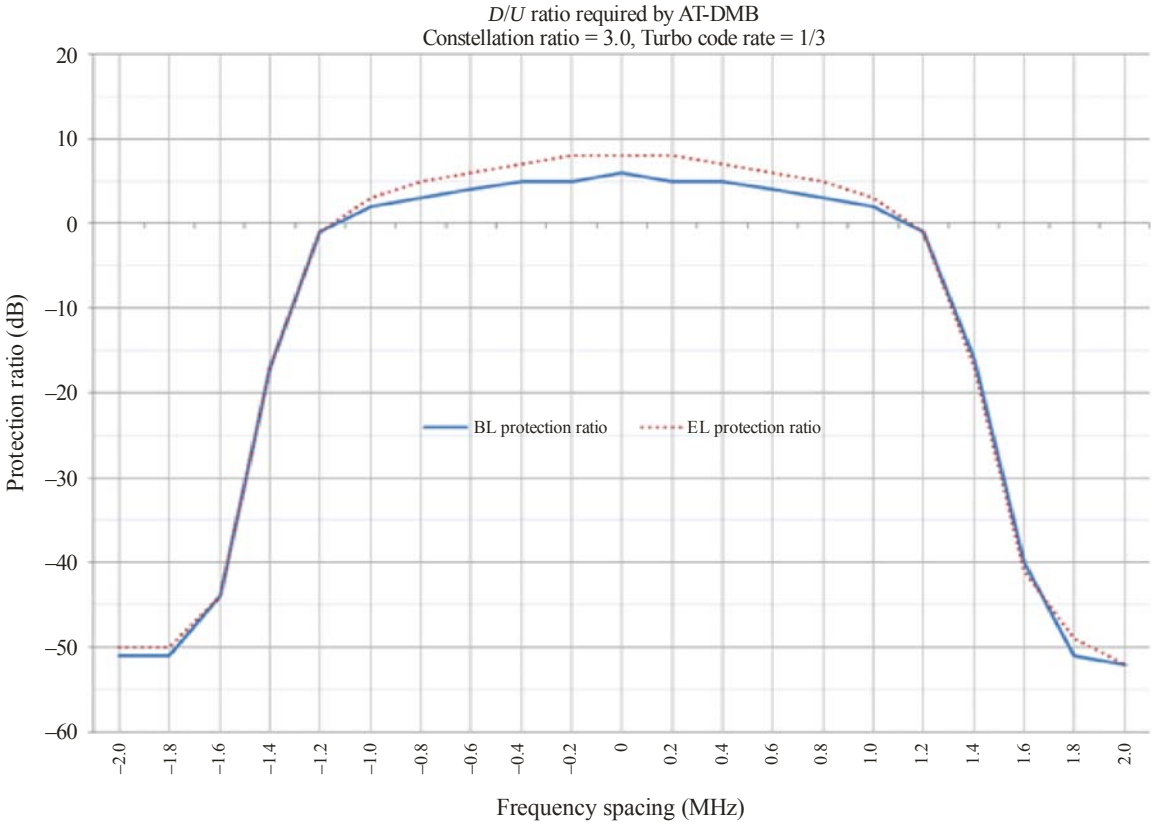

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TABLE 29

Required *D*/*U* ratio for the AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/4)

T-DMB/ AT-DMB Unwanted signal	AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/4)		*D*/*U* ratio required by AT-DMB wanted signal (dB)	
Frequency (MHz)	Frequency (MHz)	Frequency spacing (MHz)	BL	EL
213.008	211.008	–2.0	–51	–51
	211.208	–1.8	–51	–51
	211.408	–1.6	–44	–44
	211.608	–1.4	–17	–22
	211.808	–1.2	–1	–5
	212.008	–1.0	2	0
	212.208	–0.8	3	3
	212.408	–0.6	4	4
	212.608	–0.4	5	5
	212.808	–0.2	5	6
	213.008	0	6	7
	213.208	0.2	5	6
	213.408	0.4	5	5
	213.608	0.6	4	4
	213.808	0.8	3	3
	214.008	1.0	2	0
	214.208	1.2	–1	–5
	214.408	1.4	–16	–22
	214.608	1.6	–40	–44
	214.808	1.8	–51	–52
	215.008	2.0	–52	–52

FIGURE 21

Required *D*/*U* ratio graph for the AT-DMB wanted signal (Constellation ratio 3.0, Turbo code rate 1/4)