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

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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 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 $\lambda/4$ 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.

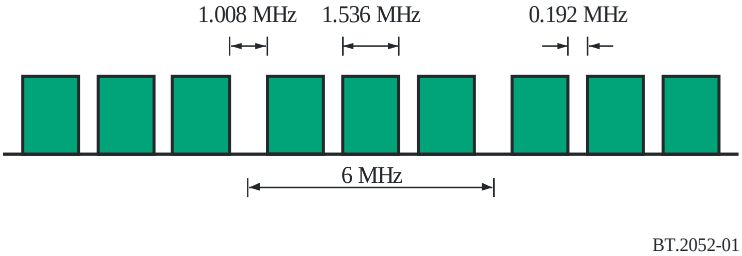
Annex 1

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.

FIGURE 1

Channel arrangement of Multimedia System A in VHF band



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:

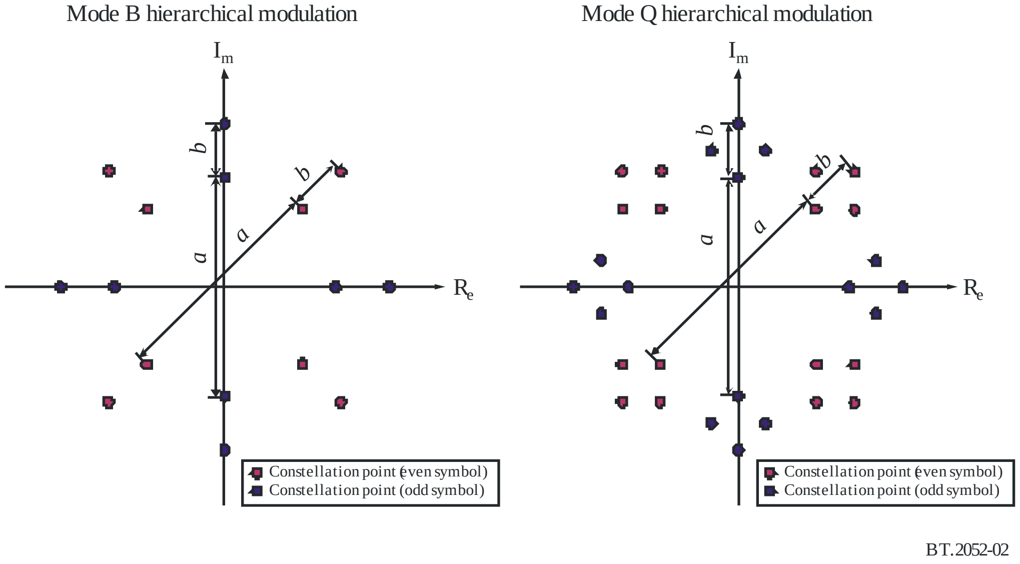
- a: maximum distance between two neighbouring quadrants
- b: maximum distance between constellation points in a quadrant.

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 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 (μs)	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 (μs)	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 (μs)	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	½	Gaussian	8	7
	1.5	2/5		8	6
	1.5	1/3		8	5
	1.5	¼		8	3
	2.0	½		7	8
	2.0	2/5		7	7
	2.0	1/3		7	6
	2.0	¼		7	5
	2.5	½		6	9
	2.5	2/5		6	8
	2.5	1/3		6	7
	2.5	¼		6	6
	3.0	½		6	10
	3.0	2/5		6	9
	3.0	1/3		6	8
	3.0	¼		6	7

TABLE 7 (*continued*)

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	½	Ricean	12	11
	1.5	2/5		12	9
	1.5	1/3		12	8
	1.5	¼		12	6
	2.0	½		11	14
	2.0	2/5		11	11
	2.0	1/3		11	10
	2.0	¼		11	8
	2.5	½		10	15
	2.5	2/5		10	13
	2.5	1/3		10	11
	2.5	¼		10	9
	3.0	½		9	16
	3.0	2/5		9	14
	3.0	1/3		9	12
	3.0	¼		9	10
T-DMB/ AT-DMB	1.5	½	Rayleigh	13	13
	1.5	2/5		13	12
	1.5	1/3		13	10
	1.5	¼		13	7
	2.0	½		12	15
	2.0	2/5		12	12
	2.0	1/3		12	11
	2.0	¼		12	9
	2.5	½		11	16
	2.5	2/5		11	14
	2.5	1/3		11	12
	2.5	¼		11	10
	3.0	½		10	17
	3.0	2/5		10	15
	3.0	1/3		10	13
	3.0	¼		10	11

TABLE 7 (*end*)

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	½	TU6	15	15
	1.5	2/5		15	13
	1.5	1/3		15	11
	1.5	¼		15	9
	2.0	½		14	17
	2.0	2/5		14	14
	2.0	1/3		14	12
	2.0	¼		14	10
	2.5	½		13	17
	2.5	2/5		13	15
	2.5	1/3		13	13
	2.5	¼		13	11
	3.0	½		12	19
	3.0	2/5		12	16
	3.0	1/3		12	14
	3.0	¼		12	12

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

TABLE 8

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 assigned frequency (MHz)	*D*/*U* ratio required by the T-DMB wanted signal (dB)	
		Channel	***D*/*U* ratio**
T-DMB/AT-DMB	211.280	Gaussian	–51
		Ricean	–46
		Rayleigh	–44
		TU6	–42
T-DMB/AT-DMB	214.736	Gaussian	–51
		Ricean	–46
		Rayleigh	–44
		TU6	–42

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.

2.4 Protection ratios of an AT-DMB signal interfered with by adjacent T-DMB/AT-DMB signals

Tables 9 and 10 show the required *D*/*U* for an AT-DMB wanted signal against an adjacent T-DMB/AT-DMB unwanted signals.

TABLE 9

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

Unwanted signal	**AT-DMB wanted signal (211.280 MHz)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**		
Frequency(MHz)	**Constellation ratio**	**Turbo code rate (enhancement layer)**	**Channel**	**Base layer**	**Enhancement layer**
213.008	1.5	½	Gaussian	–48	–49
	1.5	2/5		–48	–50
	1.5	1/3		–48	–50
	1.5	¼		–48	–51
	2.0	½		–48	–48
	2.0	2/5		–48	–49
	2.0	1/3		–48	–49
	2.0	¼		–48	–50
	2.5	½		–49	–47
	2.5	2/5		–49	–48
	2.5	1/3		–49	–49
	2.5	¼		–49	–50
	3.0	½		–49	–46
	3.0	2/5		–49	–47
	3.0	1/3		–49	–48
	3.0	¼		–49	–49
213.008	1.5	½	Ricean	–42	–42
	1.5	2/5		–42	–43
	1.5	1/3		–42	–45
	1.5	¼		–42	–47
	2.0	½		–43	–40
	2.0	2/5		–43	–41
	2.0	1/3		–43	–43
	2.0	¼		–43	–45
	2.5	½		–44	–38
	2.5	2/5		–44	–40
	2.5	1/3		–44	–41
	2.5	¼		–44	–44
	3.0	½		–45	–38
	3.0	2/5		–45	–49
	3.0	1/3		–45	–41
	3.0	¼		–45	–43

TABLE 9 (*end*)

Unwanted signal	AT-DMB wanted signal (211.280 MHz)		*D*/*U* ratio required by AT-DMB wanted signal (dB)		
Frequency(MHz)	**Constellation ratio**	**Turbo code rate (enhancement layer)**	**Channel**	**Base layer**	**Enhancement layer**
213.008	1.5	½	Rayleigh	–40	–40
	1.5	2/5		–40	–42
	1.5	1/3		–40	–44
	1.5	¼		–40	–47
	2.0	½		–41	–38
	2.0	2/5		–41	–40
	2.0	1/3		–41	–42
	2.0	¼		–41	–45
	2.5	½		–42	–37
	2.5	2/5		–42	–39
	2.5	1/3		–42	–41
	2.5	¼		–42	–44
	3.0	½		–43	–35
	3.0	2/5		–43	–37
	3.0	1/3		–43	–39
	3.0	¼		–43	–42
213.008	1.5	½	TU6	–38	–37
	1.5	2/5		–38	–40
	1.5	1/3		–38	–43
	1.5	¼		–38	–46
	2.0	½		–39	–35
	2.0	2/5		–39	–38
	2.0	1/3		–39	–40
	2.0	¼		–39	–44
	2.5	½		–40	–33
	2.5	2/5		–40	–36
	2.5	1/3		–40	–38
	2.5	¼		–40	–42
	3.0	½		–41	–32
	3.0	2/5		–41	–34
	3.0	1/3		–41	–36
	3.0	¼		–41	–40

TABLE 10

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

Unwanted signal	AT-DMB wanted signal (214.736 MHz)		*D/U* ratio required by AT-DMB wanted signal (dB)		
Frequency(MHz)	**Constellation ratio**	**Turbo code rate (enhancement layer)**	**Channel**	**Base layer**	**Enhancement layer**
213.008	1.5	½	Gaussian	–48	–50
	1.5	2/5		–48	–50
	1.5	1/3		–48	–51
	1.5	¼		–48	–51
	2.0	½		–48	–49
	2.0	2/5		–48	–50
	2.0	1/3		–48	–50
	2.0	¼		–48	–51
	2.5	½		–49	–48
	2.5	2/5		–49	–48
	2.5	1/3		–49	–59
	2.5	¼		–49	–50
	3.0	½		–49	–46
	3.0	2/5		–49	–47
	3.0	1/3		–49	–48
	3.0	¼		–49	–50
213.008	1.5	½	Ricean	–42	–41
	1.5	2/5		–42	–43
	1.5	1/3		–42	–45
	1.5	¼		–42	–47
	2.0	½		–43	–39
	2.0	2/5		–43	–41
	2.0	1/3		–43	–43
	2.0	¼		–43	–45
	2.5	½		–44	–38
	2.5	2/5		–44	–40
	2.5	1/3		–44	–41
	2.5	¼		–44	–44
	3.0	½		–45	–37
	3.0	2/5		–45	–39
	3.0	1/3		–45	–40
	3.0	¼		–45	–42

TABLE 10 (*end*)

Unwanted signal	**AT-DMB wanted signal (214.736 MHz)**		***D*/*U* ratio required by AT-DMB wanted signal (dB)**		
Frequency(MHz)	**Constellation ratio**	**Turbo code rate (enhancement layer)**	**Channel**	**Base layer**	**Enhancement layer**
213.008	1.5	½	Rayleigh	–40	–40
	1.5	2/5		–40	–42
	1.5	1/3		–40	–44
	1.5	¼		–40	–47
	2.0	½		–41	–38
	2.0	2/5		–41	–40
	2.0	1/3		–41	–42
	2.0	¼		–41	–45
	2.5	½		–42	–37
	2.5	2/5		–42	–39
	2.5	1/3		–42	–41
	2.5	¼		–42	–44
	3.0	½		–43	–35
	3.0	2/5		–43	–37
	3.0	1/3		–43	–40
	3.0	¼		–43	–42
213.008	1.5	½	TU6	–38	–38
	1.5	2/5		–38	–40
	1.5	1/3		–38	–42
	1.5	¼		–38	–44
	2.0	½		–39	–36
	2.0	2/5		–39	–38
	2.0	1/3		–39	–40
	2.0	¼		–39	–42
	2.5	½		–40	–35
	2.5	2/5		–40	–37
	2.5	1/3		–40	–39
	2.5	¼		–40	–41
	3.0	½		–41	–34
	3.0	2/5		–41	–36
	3.0	1/3		–41	–38
	3.0	¼		–41	–40

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

Tables 11 and 12 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.

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

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

TABLE 11

Minimum field strength required by T-DMB receiver

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

TABLE 12

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	½	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	¼	20.6	17.6
2.0	1/2	½	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	¼	20.6	18.6
2.5	1/2	½	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	¼	19.6	19.6
3.0	1/2	½	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	¼	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

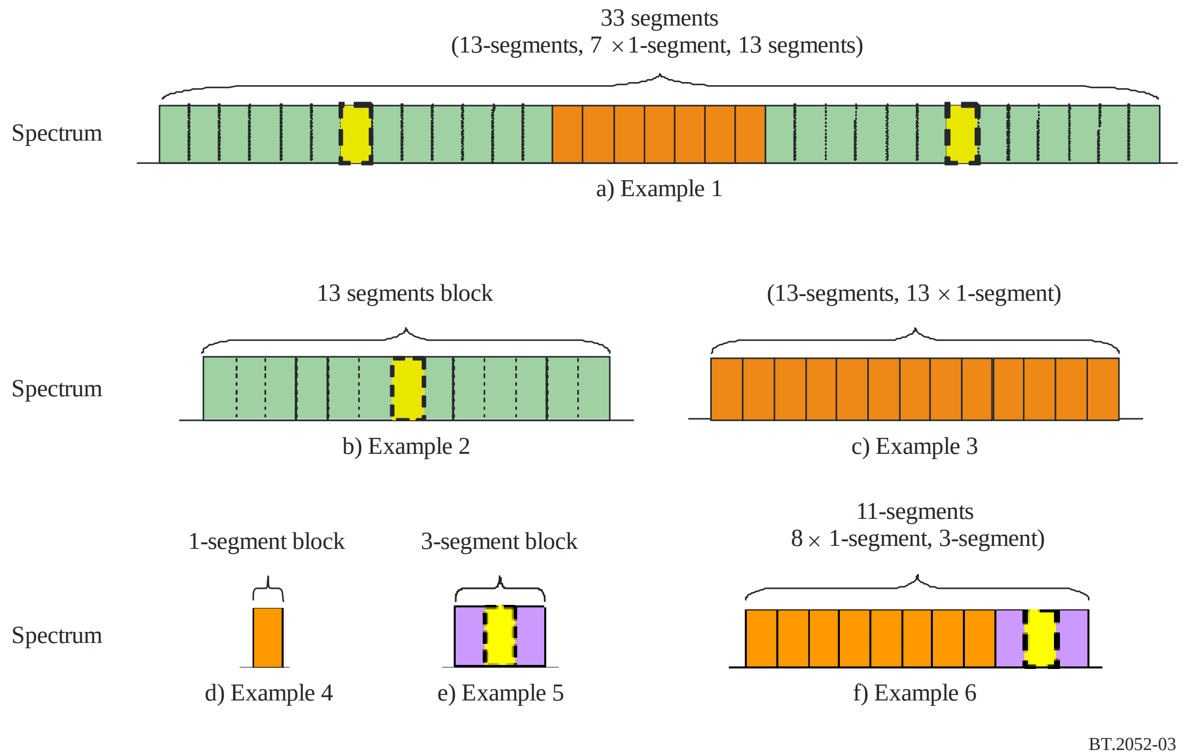


Figure 3 (b), (d) and (e) are three basic component blocks, i.e. 13-, 1- and 3-segment blocks. Figure 3 (a), (c) and (f) are three examples of spectra, which show the composition of two 13-segment block signals with seven 1-segment block signals, the composition of thirteen 1-segment block signals, and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

TABLE 13

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 14 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 14 can be applied to a 7-MHz or an 8-MHz ISDB-T multimedia broadcasting system.

TABLE 14

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 15 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 15 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 Δ*f* and arrangement of signals

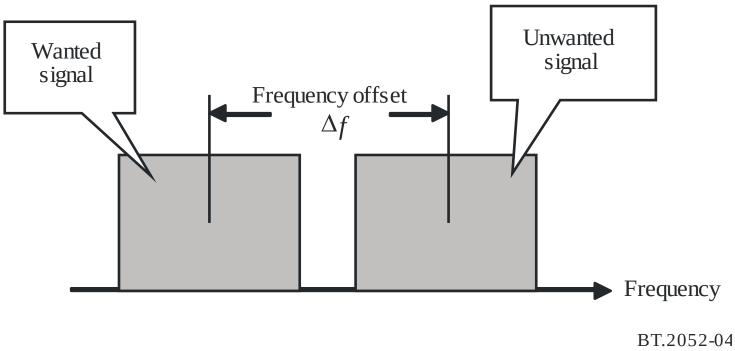


TABLE 15

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 Δ*f* (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 14 and 15 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 16 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 16 can be applied to a 6-MHz or a 7-MHz ISDB-T multimedia broadcasting system.

TABLE 16

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	½	4
QPSK	2/3	6
16-QAM	½	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 17 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 17 can be applied to a 6-MHz or a 7-MHz ISDB-T multimedia broadcasting system.

TABLE 17

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 (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}

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

with:

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

resulting in:

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

Annex 3

Planning criteria for Multimedia System T2 (T2-Lite profile of DVB-T2) terrestrial multimedia broadcasting systems in VHF/UHF bands

1 Introduction

DVB-T2-Lite is a system profile which was added in an annex of version 1.3.1 of the DVB-T2 specification in November 2011 [1]. It is particularly designed for mobile and handheld reception. With T2-Lite the set of possible system configurations is restricted as compared to the full range of options provided by DVB-T2 as described in the main part of the standard. In order to distinguish T2-Lite from this full range of options the latter profile is called T2-Base. However, T2-Lite also adds some new options that are not available in T2-Base. Thus T2-Base does not describe the full superset of DVB-T2 options that now exist.

In general, T2-Lite reduces the complexity that is required for the reception of only T2-Lite services, serving to reduce the cost and power consumption for receivers designed for handheld and mobile reception.

In § 2 the differences between T2-Base and T2-Lite are listed as far as they are relevant for frequency and network planning. Section 3 describes how the T2-Lite data stream can be integrated in the DVB-T2 multiplex. Sections 4 and 5 give details of system and planning parameters.

2 Differences between T2-Base and T2-Lite

Differences between DVB-T2-Lite and DVB-T2-Base relevant for planning are:

– Additional, more robust code rates 1/3 and 2/5 are available
– Sensitive code rates 4/5 and 5/6 are omitted
– 256-QAM modulation is possible, but not with code rates 2/3 and 3/4, and no rotated constellation is possible with 256-QAM
– The maximum data rate is restricted to 4 Mbit/s per service
– FFT sizes 1k and 32k are omitted
– Pilot pattern PP8 is not possible
– Long FEC (64k) is omitted
– Only a reduced time interleaving memory is available
– The number of combinations of FFT size, guard interval GI and pilot pattern PP is restricted
– Additional optional error protection is available (scrambling of L1 post signalling)
– Longer FEF blocks are possible (up to 1 000 ms).

3 DVB-T2-Lite signal structure

In principle, a combination of T2-Lite and T2-Base services is achieved by means of the future extension frame (FEF). The T2-Lite profile is signalled to the receiver via the P1 preamble.

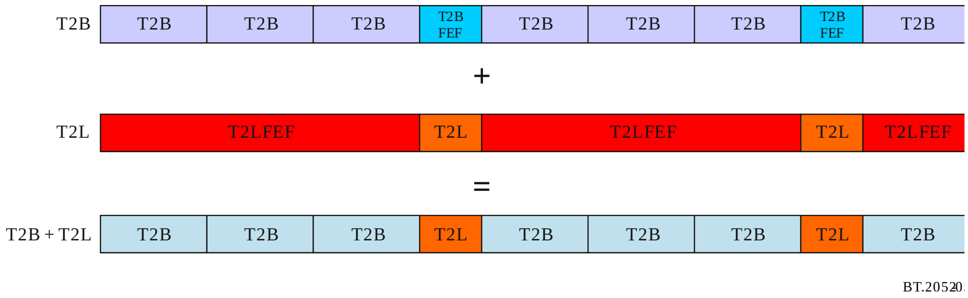
There are several possibilities for a T2-Lite transmission.

The simplest case is that the T2-Lite signal is transmitted as a stand-alone signal, i.e., no combination with T2-Base is required.

For the combination of T2-Lite (T2L) and T2-Base (T2B), T2-Base is transmitted in the FEF of T2-Lite and vice versa. This is shown in Fig. 5.

FIGURE 5

T2-Lite in T2-Base FEFs and vice versa



In the example of Fig. 1 the increase of the FEF block length in T2-Lite is employed in order to accommodate the long T2-Base blocks.

It is also possible to indicate, in L1-pre signalling ('T2_BASE_LITE' bit), that the current T2-Base profile signal is compatible with the T2-Lite profile, which should allow an appropriately designed T2-Lite receiver to demodulate this signal. In this way one can address, with the same signal, legacy DVB-T2 receivers that do not understand T2-Lite, and at the same time T2-Lite receivers.

4 DVB-T2-Lite system parameters

As described in § 2, T2-Lite allows for a slightly different set of possible combination of DVB-T2 parameters. It is to be recalled that these possible combinations are not simply a subset of the T2-Base options but also provide additional options.

Table 18 gives an overview of the possible combinations of modulation scheme and code rate. For 256-QAM some combinations are possible, but not with a simultaneous use of the rotated constellation mode.

TABLE 18

Possible combination of modulation and code rate for DVB-T2-Lite (from [1])

Code rate	QPSK	16-QAM	64-QAM	256-QAM
1/3	Yes	Yes	Yes	Yes, but no rotated constellation
2/5	Yes	Yes	Yes	Yes, but no rotated constellation
1/2	Yes	Yes	Yes	Yes, but no rotated constellation
3/5	Yes	Yes	Yes	Yes, but no rotated constellation
2/3	Yes	Yes	Yes	No
3/4	Yes	Yes	Yes	No

Tables 19 and 20 give the possible combinations of FFT size, guard interval and scattered pilot pattern for the SISO and the MISO mode.

TABLE 19

Scattered pilot pattern to be used for T2-Lite for each allowed combination of FFT size and guard interval in SISO mode (from [1])

FFT size	Guard interval						
	1/128	**1/32**	**1/16**	**19/256**	**1/8**	**19/128**	**1/4**
16k	PP7	PP7 PP6	PP4 PP5	PP2 PP4 PP5	PP2 PP3	PP2 PP3	PP1
8k	PP7	PP7 PP4	PP4 PP5	PP4 PP5	PP2 PP3	PP2 PP3	PP1
4k, 2k	n/a	PP7 PP4	PP4 PP5	n/a	PP2 PP3	n/a	PP1

TABLE 20

Scattered pilot pattern to be used for T2-Lite for each allowed combination of FFT size and guard interval in MISO mode (from [1])

FFT size	Guard interval						
	1/128	**1/32**	**1/16**	**19/256**	**1/8**	**19/128**	**1/4**
16k	PP4 PP5	PP4	PP3	PP3	PP1	PP1	n/a
8k	PP4 PP5	PP4 PP5	PP3	PP3	PP1	PP1	n/a
4k, 2k	n/a	PP4 PP5	PP3	n/a	PP1	n/a	n/a

5 DVB-T2-Lite planning parameters

5.1 *C/N* values

Other than for T2-Base, for T2-Lite only an LDPC block length of 16200 bits is available. *C/N* values for this block length differ slightly from those for 64800 bits block length. For details see Tables 44 and 45 in the DVB-T2 Implementation Guidelines [2].

In addition, to date no simulation or measurement results are publicly available for the additional T2-Lite code rates 1/3 and 2/5. However, preliminary measurement results of these modes by Rai/RaiWay, which are not yet public, allow for an extrapolation to gain also raw values for T2-Lite modes with code rates 1/3 and 2/5. These raw *C/N* figures for an AWGN channel together with the raw *C/N* figures from the Implementation Guidelines for a LDPC block length of 16200 bits cover all T2-Lite modes and are given in Table 21.

C/N values and protection ratios for frequency and network planning may then be calculated as described in § 2.5 and § 3.4 of Report ITU-R BT.2254 ‘Frequency and network planning aspects of DVB-T2’ [3]. Further information on planning criteria, including protection ratios, can be found in Recommendation ITU-R BT.2033 ‘Planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands’.

For Ricean and (static) Rayleigh channels further correction factors for T2-Lite modes with code rates 1/3 and 2/5 are required, beyond those already available for T2-Base in Table 2.13 in Report ITU-R BT.2254 [3]. They are derived by extrapolation of the correction factors in this table and are given in Table 22.

TABLE 21

Raw *C/N* values for DVB-T2-Lite for a Gaussian Channel (AWGN channel)
(from Table 45 in [2] and extrapolation by means of measurement results from Rai/RaiWay)

Constellation	Code rate	Gaussian Channel $C/N_{Gauss\text{-}raw}$ (dB)
QPSK	1/3	–0.9
QPSK	2/5	0.1
QPSK	1/2	0.7
QPSK	3/5	2.5
QPSK	2/3	3.4
QPSK	3/4	4.3
16-QAM	1/3	3.7
16-QAM	2/5	4.9
16-QAM	1/2	5.5
16-QAM	3/5	7.9
16-QAM	2/3	9.1
16-QAM	3/4	10.3
64-QAM	1/3	7.2
64-QAM	2/5	8.6
64-QAM	1/2	9.2
64-QAM	3/5	12.3
64-QAM	2/3	13.8
64-QAM	3/4	15.5
256-QAM	1/3	10.3
256-QAM	2/5	11.9
256-QAM	1/2	12.6
256-QAM	3/5	16.9

TABLE 22

Increase DELTA [dB] of *C/N* for Rice and static Rayleigh channels with regard to a Gaussian channel for DVB-T2-Lite modes with code rates 1/3 and 2/5

Constellation	Code Rate	$DELTA_{Rice}$ (dB)	$DELTA_{Rayleigh}$ (dB)
QPSK	1/3	0.2	0.7
QPSK	2/5	0.2	0.8
16-QAM	1/3	0.2	1.2
16-QAM	2/5	0.2	1.3
64-QAM	1/3	0.3	1.8
64-QAM	2/5	0.3	1.9
256-QAM	1/3	0.3	2.3
256-QAM	2/5	0.3	2.3

5.2 Protection ratios DVB-T2-Lite vs. DVB-T2-Lite/DVB-T2-Base//DVB-T

5.2.1 Co-channel

As usual for OFDM systems, it is expected that DVB-T2 intra-protection ratios (T2-Lite vs. T2-Lite and T2-Base) for co-channel interference are identical to the respective *C/N* values. The same holds for the protection ratios DVB-T vs. DVB-T2-Lite.

It is therefore assumed that for planning purposes the co-channel protection ratios can be derived according to the methodology for *C/N* described in § 5.1.

Also for the protection ratios the receiving environment has to be taken into account, i.e. for a Rice or a Rayleigh channel environment the corresponding *C/N* values should be used for the protection ratios.

5.3 Minimum receiver input levels and signal levels for planning

Sections 3.1 and 3.2 of Report ITU-R BT.2254 [3] describe how minimum receiver input levels and signal levels for planning for T2-Base can be derived. The same methodology can be applied to T2-Lite, too, while using the information of Tables 21 and 22 in § 5.1.

In Tables 23 and 24 examples of signal levels for planning are given. They are derived according to Report ITU-R BT.2254 [3] and they correspond to the respective examples for T2-Base given in § 3.3 of Report ITU-R BT.2254 [3].

Table 23 describes examples of Band III scenarios with a bandwidth of 1.7 MHz and 7 MHz. Table 24 gives examples of Band IV/V scenarios with a bandwidth of 8 MHz. If combined, the distribution of the multiplex capacity to T2-Base and T2-Lite is left to the network operator. In the tables the totally available data rate is given.

TABLE 23

Signal levels for planning for DVB-T2-Lite
Examples of Band III scenarios with 1.7 MHz and 7 MHz bandwidth

DVB-T2-Lite in Band III			**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Typical receiving situation			**Portable indoor/urban (robust)**	**Mobile/rural**	**Handheld portable outdoor integrated antenna**	**Handheld mobile integrated antenna**
Frequency	Freq	MHz	200	200	200	200
Minimum *C/N* required by system	*C/N*	dB	7.4	9.5	9.1	9.5
System variant (example)			QPSK FEC 2/3, 16k, PP2 Normal	16-QAM FEC 1/2, 8k, PP1 Normal	16-QAM FEC 1/2, 16k, PP3 Normal	16-QAM FEC 1/2, 8k, PP2 Normal
Bit rate (indicative values)		Mbit/s	7.0-7.4	2.2	10.9-11.2	2.5-2.7
Receiver noise figure	F	dB	6	6	6	6
Equivalent noise bandwidth	B	MHz	6.66	1.54	6.66	1.54
Receiver noise input power	Pn	dBW	-129.7	-136.1	-129.7	-136.1
Min. receiver signal input power	Ps min	dBW	-122.3	-126.6	-120.6	-126.6
Min. equivalent receiver input voltage, 75Ω	Umin	dBμV	16.4	12.1	18.1	12.1
Feeder loss	Lf	dB	0	0	0	0
Antenna gain relative to half dipole	Gd	dB	-2.2	-2.2	-17	-17
Effective antenna aperture	Aa	dBm^2	-7.5	-7.5	-22.3	-22.3
Min Power flux density at receiving location	□min	$dB(W)/m^2$	-114.8	-119.1	-98.3	-104.3
Min equivalent field strength at receiving location	Emin	dBμV/m	31.0	26.7	47.5	41.5
Allowance for man-made noise	Pmmn	dB	8	5	0	0
Penetration loss (building or vehicle)	Lb, Lv	dB	9	0	0	8
Standard deviation of the penetration loss		dB	3	0	0	2
Diversity gain	Div	dB	0	0	0	0
Location probability		%	70	90	70	90
Distribution factor			0.5244	1.28	0.5244	1.28
Standard deviation			6.3	5.5	5.5	5.9
Location correction factor	Cl	dB	3.30	7.04	2.88	7.55
Minimum median power flux density at reception height[1]; 50% time and 50% locations	□med	$dB(W)/m^2$	-94.5	-107.1	-95.4	-88.7
Minimum median equivalent field strength at reception height[1]; 50% time and 50% locations	Emed	dBμV/m	51.3	38.7	50.4	57.1
Location probability		%	95	99	95	99
Distribution factor			1.6449	2.3263	1.6449	2.3263
Standard deviation			6.3	5.5	5.5	5.9
Location correction factor	Cl	dB	10.36	12.79	9.05	13.73
Minimum median power flux density at reception height[1]; 50% time and 50% locations	□med	$dB(W)/m^2$	-87.4	-101.3	-89.3	-82.6
Minimum median equivalent field strength at reception height[1]; 50% time and 50% locations	Emed	dBμV/m	58.4	44.5	56.5	63.2

[1] 1.5 m for all reception modes

TABLE 24

Signal levels for planning for DVB-T2-Lite
Examples of Band IV/V scenarios with 8 MHz bandwidth

DVB-T2-Lite in Band IV/V			**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Typical receiving situation			**Portable indoor/urban (robust)**	**Mobile/rural**	**Handheld portable outdoor integrated antenna**	**Handheld mobile integrated antenna**
Frequency	Freq	MHz	650	650	650	650
Minimum *C/N* required by system	*C/N*	dB	7.4	9.5	9.1	9.5
System variant (example)			QPSK FEC 2/3, 16k, PP2 Extended	16-QAM FEC 1/2, 8k, PP1 Extended	16-QAM FEC 1/2, 16k, PP3 Extended	16-QAM FEC 1/2, 8k, PP2 Extended
Bit rate (indicative values)		Mbit/s	8.2-8.7	11.2	12.8-13.1	12.2-13.0
Receiver noise figure	F	dB	6	6	6	6
Equivalent noise band width	B	MHz	7.77	7.71	7.77	7.71
Receiver noise input power	Pn	dBW	-129.1	-129.1	-129.1	-129.1
Min. receiver signal input power	Ps min	dBW	-121.7	-119.6	-120.0	-119.6
Min. equivalent receiver input voltage, 75 ohm	Umin	dBμV	17.0	19.1	18.7	19.1
Feeder loss	Lf	dB	0	0	0	0
Antenna gain relative to half dipole	Gd	dB	0	0	-9.5	-9.5
Effective antenna aperture	Aa	dBm^2	-15.6	-15.6	-25.1	-25.1
Min Power flux density at receiving location	□min	$dB(W)/m^2$	-106.1	-104.0	-94.9	-94.5
Min equivalent field strength at receiving location	Emin	dBμV/m	39.7	41.8	50.9	51.3
Allowance for man-made noise	Pmmn	dB	1	0	0	0
Penetration loss (building or vehicle)	Lb, Lv	dB	11	0	0	8
Standard deviation of the penetration loss		dB	6	0	0	2
Diversity gain	Div	dB	0	0	0	0
Location probability		%	70	90	70	90
Distribution factor			0.5244	1.28	0.5244	1.28
Standard deviation			8.1	5.5	5.5	5.9
Location correction factor	Cl	dB	4.25	7.04	2.88	7.55
Minimum median power flux density at reception height[1]; 50% time and 50% locations	□med	$dB(W)/m^2$	-89.9	-97.0	-92.0	-78.9
Minimum median equivalent field strength at reception height[1]; 50% time and 50% locations	Emed	dBμV/m	55.9	48.8	53.8	66.9
Location probability		%	95	99	95	99
Distribution factor			1.6449	2.3263	1.6449	2.3263
Standard deviation			8.1	5.5	5.5	5.9
Location correction factor	Cl	dB	13.32	12.79	9.05	13.73
Minimum median power flux density at reception height[1]; 50% time and 50% locations	□med	$dB(W)/m^2$	-80.8	-91.2	-85.9	-72.8
Minimum median equivalent field strength at reception height[1]; 50% time and 50% locations	Emed	dBμV/m	65.0	54.6	59.9	73.0

[1] 1.5 m for all reception modes

6 References

[1] ETSI EN 302 755 V1.3.1 (2011-11), "Digital Video Broadcasting (DVB); Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2)", ETSI, Sophia Antipolis, 2011.

[2] ETSI TS 102 831 V1.2.1 (2012-08), “Digital Video Broadcasting (DVB); Implementation guidelines for a second generation digital terrestrial television broadcasting system (DVB-T2)”, ETSI, Sophia Antipolis, 2012.

[3] Report ITU-R BT.2254-1 – Frequency and network planning aspects of DVB-T2.