International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R BS.1660-4
(05/2011)

Technical basis for planning of terrestrial digital sound broadcasting in the VHF band

BS Series

Broadcasting service (sound)

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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 BS.1660-4*

Technical basis for planning of terrestrial digital sound broadcasting in the VHF band

(Question ITU-R 56/6)

(2003-2005-2005-2006-2011)

Scope

This Recommendation describes the planning criteria, which could be used for planning of terrestrial digital sound broadcasting in the VHF band, for Digital Systems A and F of Recommendation ITU-R BS.1114.

The ITU Radiocommunication Assembly,

considering

a) Recommendations ITU-R BS.774 and ITU-R BS.1114;

b) ITU-R Digital Sound Broadcasting Handbook – Terrestrial and satellite digital sound broadcasting to vehicular, portable and fixed receivers in the VHF/UHF bands,

recommends

1 that the planning criteria as described in Annex 1 for Digital System A and Annex 2 for Digital System F could be used for planning of terrestrial digital sound broadcasting in the VHF band.

Annex 1

Technical basis for planning of terrestrial digital sound broadcasting System A (T-DAB) in the VHF band

1 General

This Recommendation contains relevant T-DAB system parameters and network concepts, including a description of single frequency networks (SFNs).

The receiving antenna, which is assumed to be representative for mobile and portable reception, has a height of 1.5 m above ground level, omnidirectional with a gain slightly lower than a dipole.

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* The Administration of the Syrian Arab Republic is not in a position to accept the content of this Recommendation, nor for it to be used as a technical basis for the planning of sound broadcasting in the VHF band, at the forthcoming Regional Radiocommunication Conferences planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3.

The field strength prediction method relies on curves for 50% locations, 50% time for the wanted signal and 50% locations, 1% time for the unwanted signal.

For the calculation of tropospheric (1% time) and continuous (50% time) interference, see Recommendation ITU-R BT.655.

The required location percentage for T-DAB services is 99%. Therefore, taking a standard deviation of 5.5 dB, an increase of 13 dB (2.33 × 5.5 dB) shall be applied to the field strength values (50% locations) in order to obtain the 99% location values required for planning a T-DAB service.

The propagation curves used for planning relate to a receiving antenna height of 10 m above ground, whereas a T-DAB service will be planned primarily for mobile reception, i.e., with an effective receiving antenna height of about 1.5 m. An allowance of 10 dB is necessary to convert the minimum required T-DAB field strength at a vehicle antenna height of 1.5 m to the equivalent value at 10 m.

2 Minimum wanted field strength used for planning

Table 1 contains values for VHF Band III with the inclusion of a correction of 13 dB for location percentage and of 10 dB for height gain. The below given minimum median equivalent field strength represents the minimum wanted field strength used for planning.

The values shown in Table 1 are applied to mobile reception.

TABLE 1

Minimum median equivalent field strength (dB(μV/m)) at an antenna height of 10 m

Frequency band	Band III
Minimum equivalent field strength (dB(μV/m))	35
Location percentage correction factor (50% to 99%) (dB)	+13
Antenna height gain correction (dB)	+10
Minimum median equivalent field strength for planning (dB(μV/m))	58

3 Unwanted emissions

3.1 Spectrum masks for T-DAB out-of-band emissions

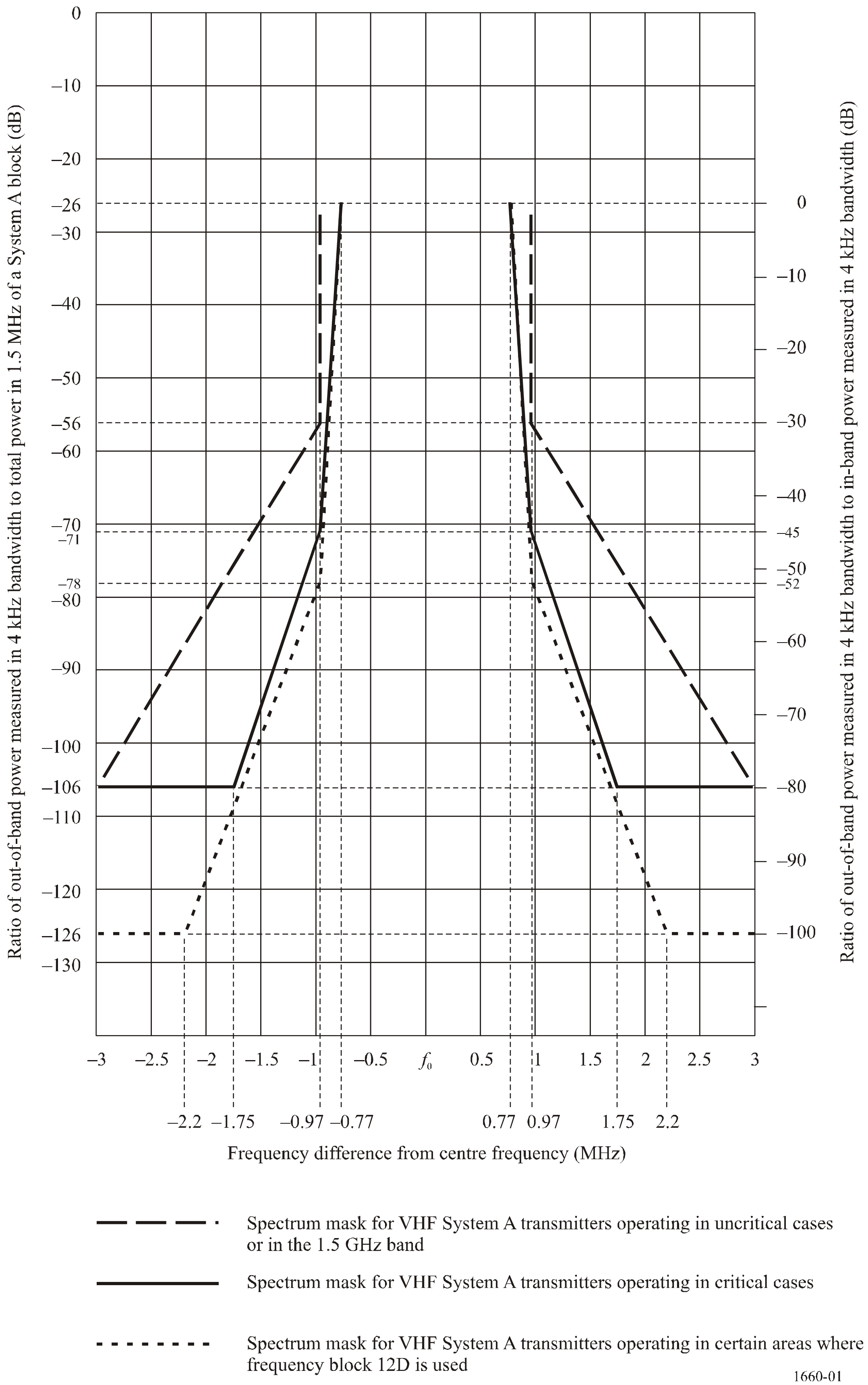
The out-of-band radiated signal in any 4 kHz band should be constrained by one of the masks defined in Fig. 1.

The solid line mask should apply to VHF transmitters operating in critical cases. The dashed line mask should apply to VHF transmitters operating in uncritical cases or in the 1.5 GHz band and the dotted line mask should apply to VHF transmitters operating in certain areas where frequency block 12D is used.

The level of the signal at frequencies outside the normal 1.536 MHz bandwidth can be reduced by applying an appropriate filtering.

FIGURE 1

Out-of-band spectrum masks for a transmission signal of System A



Out-of-band spectrum table for a transmission signal of System A

	Frequency relative to the centre of the 1.54 MHz channel (MHz)	Relative level (dB)
Spectrum mask for VHF System A transmitters operating in uncritical cases or in the 1.5 GHz band	± 0.97	–26
	± 0.97	–56
	± 3.0	–106
Spectrum mask for VHF System A transmitters operating in critical cases	± 0.77	–26
	± 0.97	–71
	± 1.75	–106
	± 3.0	–106
Spectrum mask for VHF System A transmitters operating in certain areas where frequency block 12D is used	± 0.77	–26
	± 0.97	–78
	± 2.2	–126
	± 3.0	–126

Appendix 1
to Annex 1

Planning criteria as used by a group of countries in the Wiesbaden 1995 Special Arrangement

1 Position of frequency blocks in Band III

Table 2 shows a harmonized channelling plan. This is based on tuning increments of 16 kHz and guardbands of 176 kHz between adjacent T-DAB frequency blocks.

Within each 7 MHz television channel, four T-DAB frequency blocks are accommodated.

In order to enhance compatibility with the sound carrier(s) in 7 MHz TV systems, the guardbands for T-DAB frequency blocks A in Channel N and D in Channel N-1 are 320 kHz or 336 kHz. The position of T-DAB frequency blocks within Channel 12 is shown as an example in Fig. 2.

TABLE 2

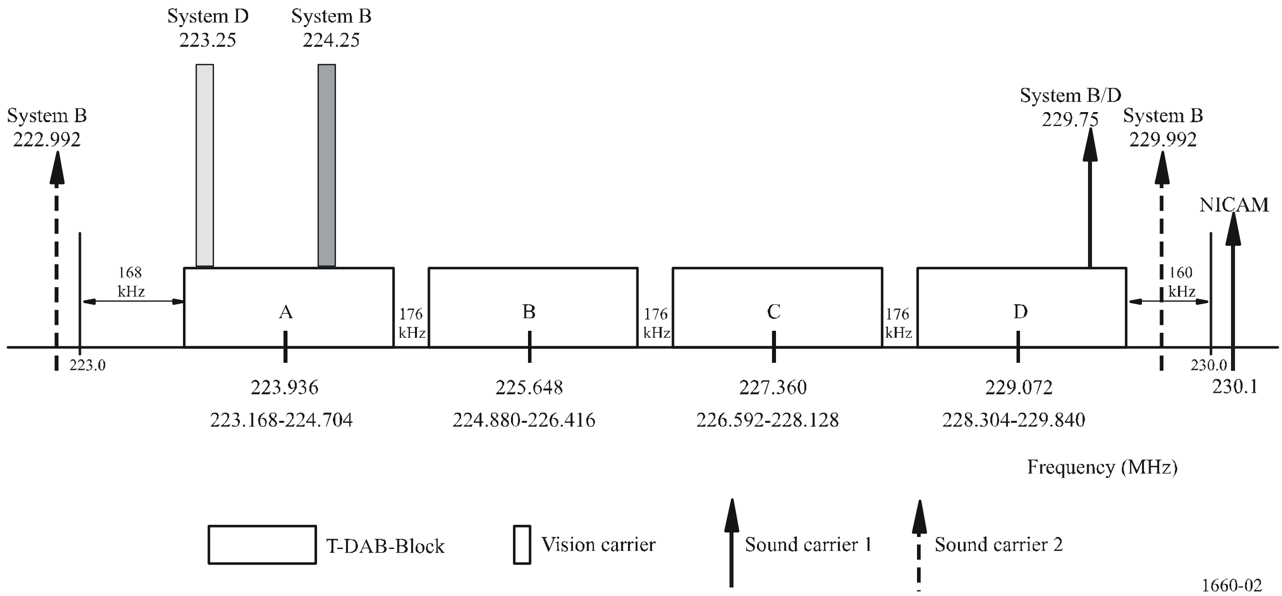
T-DAB frequency blocks

T-DAB block number	Centre frequency (MHz)	Frequency range (MHz)	Lower guardband[(1)] (kHz)	Upper guardband[(1)] (kHz)
5A	174.928	174.160-175.696	–	176
5B	176.640	175.872-177.408	176	176
5C	178.352	177.584-179.120	176	176
5D	180.064	179.296-180.832	176	336
6A	181.936	181.168-182.704	336	176
6B	183.648	182.880-184.416	176	176
6C	185.360	184.592-186.128	176	176
6D	187.072	186.304-187.840	176	320
7A	188.928	188.160-189.696	320	176
7B	190.640	189.872-191.408	176	176
7C	192.352	191.584-193.120	176	176
7D	194.064	193.296-194.832	176	336
8A	195.936	195.168-196.704	336	176
8B	197.648	196.880-198.416	176	176
8C	199.360	198.592-200.128	176	176
8D	201.072	200.304-201.840	176	320
9A	202.928	202.160-203.696	320	176
9B	204.640	203.872-205.408	176	176
9C	206.352	205.584-207.120	176	176
9D	208.064	207.296-208.832	176	336
10A	209.936	209.168-210.704	336	176
10B	211.648	210.880-212.416	176	176
10C	213.360	212.592-214.128	176	176
10D	215.072	214.304-215.840	176	320
11A	216.928	216.160-217.696	320	176
11B	218.640	217.872-219.408	176	176
11C	220.352	219.584-221.120	176	176
11D	222.064	221.296-222.832	176	336
12A	223.936	223.168-224.704	336	176
12B	225.648	224.880-226.416	176	176
12C	227.360	226.592-228.128	176	176
12D	229.072	228.304-229.840	176	–

(1) In arriving at these values, it has been assumed that the T-DAB transmitting and receiving equipment must allow for the use of adjacent T-DAB frequency blocks in adjacent areas, i.e., using a 176 kHz guardband.

FIGURE 2

Position of T-DAB blocks in channel 12



2 T-DAB reference network

Reference networks are used for the planning of allotments.

The characteristics of the reference networks represent a reasonable compromise between the density of the transmitters required to support the desired coverage and the potential to reuse the same frequency block with other programme content in other areas.

A reference network is a tool for developing appropriate values for separation distances and for estimating how much interference a typical SFN might produce at a given distance.

2.1 T-DAB transmitter network structures

T-DAB stations or networks consist of one of three basic models or combinations thereof:

– a single transmitter;

– an SFN using non-directional transmitting antennas, also referred to as an "open network";

– an SFN using directional transmitting antennas along the periphery of the coverage area, also referred to as a "closed network".

2.2 Definitions

The reference point is the point on the boundary of a reference network from which outgoing interference is calculated, see also Fig. 4. Incoming interference is calculated at the same point.

In the following text, two distances are defined; see also Fig. 3.

– The separation distance is the distance required between the borders (or peripheries) of two coverage areas served by either T-DAB services or by two different services. There will often be two separation distances, one for each service, because of different field strengths to be protected or because of different protection ratios for the two services. In such cases the longer of these two distances shall be used.

– The transmitter distance is the distance between adjacent transmitter sites in an SFN.

FIGURE 3

Definition of distances for different network structures (SFN, single transmitter)

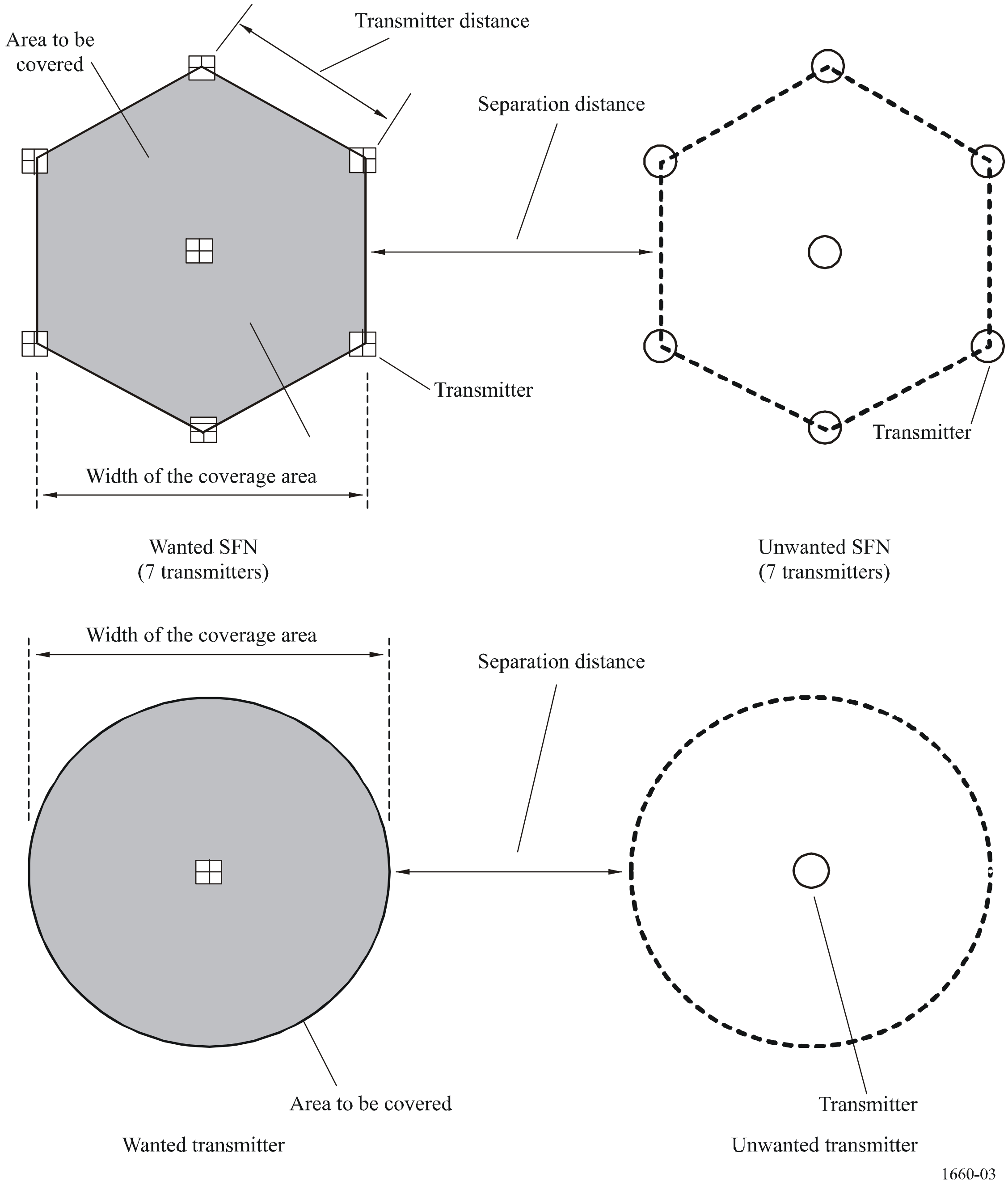
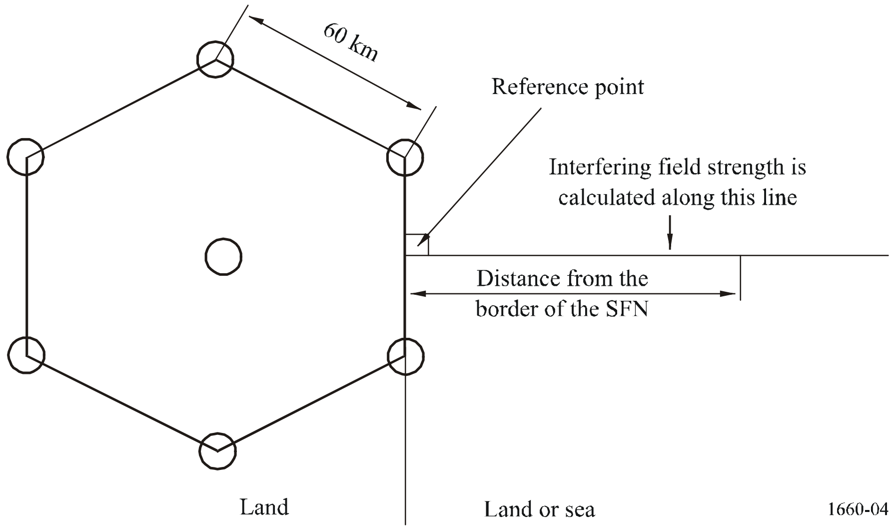


FIGURE 4

Information related to the interfering field strength calculation for the reference network



2.3 T-DAB reference SFN

In interfering field strength calculations the contributions from all transmitters of the reference network are added using the power sum method. In the case of mixed land-sea paths, field strengths are first calculated individually for an all-land path and an all-sea path, each of the same distance as the mixed path concerned. A linear interpolation is then performed between the field strengths for all-land and all-sea paths at the required distance from the border of the SFN according to the following formula:

$$E_M = E_L + \frac{d_S}{d_T}(E_S - E_L)$$

where:

E_M: field strength for a mixed land-sea path

E_L: field strength for an all-land path

E_S: field strength for an all-sea path

d_S: length of the sea path

d_T: length of the total path.

All field strengths are in dB(µV/m).

In all-sea path calculations it is assumed that the reference network and its coverage area are on land and that the sea starts from the edge of the coverage area. For land paths a terrain roughness of 50 m is assumed.

2.3.1 Reference network structure

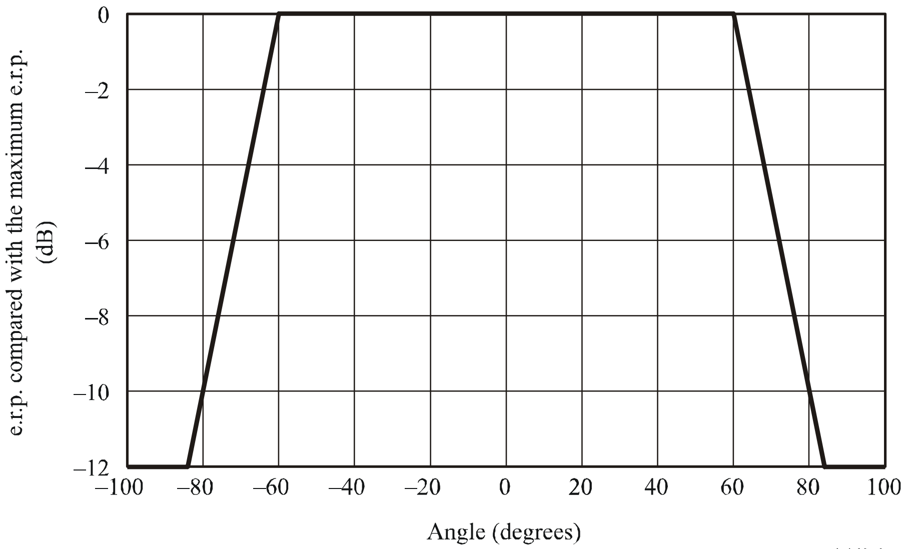
The reference network suitable for the frequency allotment process is defined as follows (see also Fig. 4):

–	Hexagonal structure:	closed
–	Transmitter distance:	60 km
–	Transmitting antenna height:	150 m
–	Central transmitter effective radiated power (e.r.p.):	100 W

– Radiation pattern of the central transmitter: omnidirectional
– Peripheral transmitter e.r.p.: 1 kW
– Radiation pattern of peripheral transmitters: see Fig. 5
– Main lobe of directional antennas: in the direction of the central transmitter.

FIGURE 5

Radiation pattern of the peripheral transmitters



When using the field strength prediction method described in this Appendix, the reference network produces the required coverage inside the network. The effective wanted field strength on the border of the reference network is about 3 dB higher than the minimum field strength for planning. This makes it possible to allow 3 dB more interference at the edge of the network.

Thus the maximum interfering field strength from another co-channel T-DAB service on the border of the reference network is:

$$E_I^{Max} = E_W^{Min} - PR - PC + 3$$

where:

E_I^{Max}: maximum interfering field strength on the border of the reference network

E_W^{Min}: minimum median wanted field strength for planning

PR: protection ratio, in this case 10 dB

PC: propagation correction 18 dB (50% to 99% location correction factor).

The additional 3 dB margin is not allowed for the other services because during the frequency block allotment procedure each source of interference is considered separately and their power sum is not calculated.

Thus the maximum interfering field strength from any other service on the border of the reference network is:

$$E_I^{Max} = E_W^{Min} - PR - PC$$

where:

E_I^{Max}: maximum interfering field strength on the border of the reference network

E_W^{Min}: minimum median wanted field strength for planning

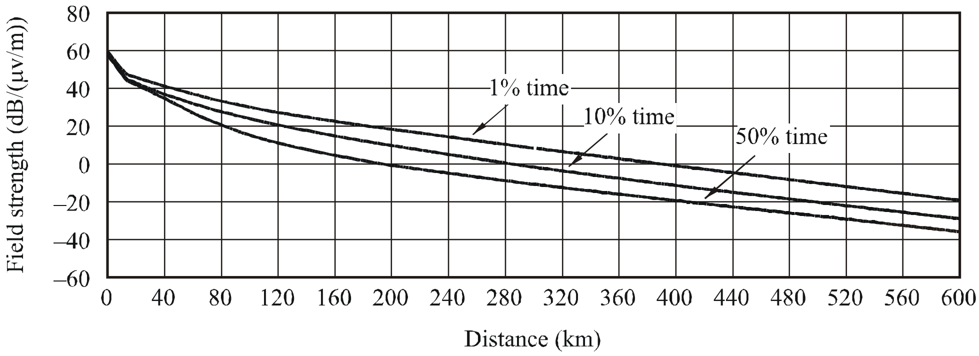
PR: protection ratio, depending on service under consideration

PC: propagation correction 18 dB.

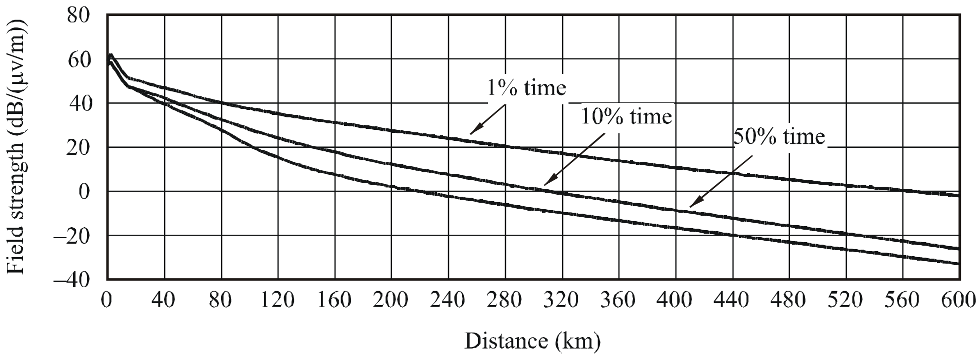
The interfering field strengths for land, cold sea and warm sea paths produced by a reference network are shown in Figs. 6a, 6b and 6c. Separation distances for Band III are 81, 142 and 173 km for land, cold sea and warm sea paths respectively.

FIGURE 6

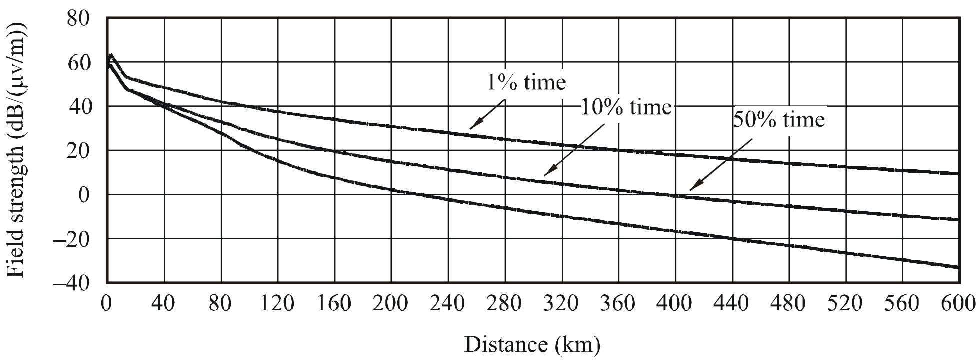
Interfering field strength produced by the reference network



a) Field strength variation with distance: land



b) Field strength variation with distance: cold sea



c) Field strength variation with distance: warm sea

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Where the field strength is calculated within 1 km of the transmitter site location, receiving antenna discrimination should not be taken into account.

2.3.2 Nominal transmitter location for the calculation of potential T-DAB interference to the aeronautical mobile service

The centre of the reference network shall be used as the nominal location for the network to calculate interference to an aeronautical reception test point. In this case the power used for calculations is 33.8 dBW in Band III.

3 Protection of T-DAB

3.1 T-DAB interfered with by T-DAB

The T-DAB co-block protection ratio is 10 dB.

Table 3 shows the values for the maximum permissible interfering field strength used for planning.

TABLE 3

Maximum permissible interfering field strength (T-DAB to T-DAB)

Frequency band	Minimum wanted field strength (dB(μV/m)) (50% locations, 10 m height)	Protection ratio T-DAB interfered with by T-DAB (dB)	Propagation correction (dB)	Maximum permissible interfering field strength (dB(μV/m))
BAND III	58	10	18	30[(1)]

(1) In the case of an SFN, this figure shall be increased by 3 dB.

The standard deviation of a location variation of T-DAB signal is 5.5 dB. The field strength values for wanted and unwanted signals are assumed to be uncorrelated. To protect wanted T-DAB signals for 99% of locations against interference from another T-DAB transmission, a propagation correction of $2.33 \times 5.5 \times \sqrt{2} = 18$ dB as well as the T-DAB protection ratio (T-DAB to T-DAB) of 10 dB shall be taken into account.

$$E_I^{Max} = E_W^{Min} - PR - PC + 3$$

where:

E_I^{Max}: maximum permissible interfering field strength

E_W^{Min}: minimum median equivalent field strength

PR: protection ratio

PC: propagation correction.

3.2 T-DAB interfered with by analogue sound broadcasting

Wideband FM sound mono		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
S1	58.0	10.0

Δ*f* (MHz)	–1.3	–1.2	–1.1	–1.0	–0.9	–0.8	–0.8	–0.7	–0.6	–0.5	–0.4
PR (dB)	–45.1	–43.9	–38.4	–37.5	–28.9	–12.9	–4.9	–1.0	2.1	3.5	4.3
Δ*f* (MHz)	–0.3	–0.2	–0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
PR (dB)	4.1	4.4	4.1	4.0	4.1	4.4	4.1	4.3	3.5	2.1	–1.0
Δ*f* (MHz)	0.8	0.8	0.9	1.0	1.1	1.2	1.3				
PR (dB)	–4.9	–12.9	–28.9	–37.5	–38.4	–43.9	–45.1				

Wideband FM sound stereo		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
S2	58.0	10.0

Δ*f* (MHz)	–1.3	–1.2	–1.1	–1.0	–0.9	–0.8	–0.8	–0.7	–0.6	–0.5	–0.4
PR (dB)	–45.1	–43.9	–38.4	–37.5	–28.9	–12.9	–4.9	–1.0	2.1	3.5	4.3
Δ*f* (MHz)	–0.3	–0.2	–0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
PR (dB)	4.1	4.4	4.1	4.0	4.1	4.4	4.1	4.3	3.5	2.1	–1.0
Δ*f* (MHz)	0.8	0.8	0.9	1.0	1.1	1.2	1.3				
PR (dB)	–4.9	–12.9	–28.9	–37.5	–38.4	–43.9	–45.1				

3.3 T-DAB interfered with by digital terrestrial television broadcasting

Protection ratios for a T-DAB system interfered with by a DVB-T 8 MHz system									
Δ*f* [(1)] (MHz)	–5	–4.2	–4	–3	0	3	4	4.2	5
PR (dB) mobile and portable receiving environment	–43	6	7	8	8	8	7	6	–43
PR (dB) Gaussian channel	–50	–1	0	1	1	1	0	–1	–50

(1) Δ*f*: centre frequency of the DVB-T signal minus centre frequency of the T-DAB signal.

Protection ratios for a T-DAB system interfered with by a DVB-T 7 MHz system									
Δ*f* [(1)] (MHz)	–4.5	–3.7	–3.5	–2.5	0	2.5	3.5	3.7	4.5
PR (dB) mobile and portable receiving environment	–42	7	8	9	9	9	8	7	–42
PR (dB) Gaussian channel	–49	0	1	2	2	2	1	0	–49

(1) Δ*f*: centre frequency of the DVB-T signal minus centre frequency of the T-DAB signal.

3.4 T-DAB interfered with by analogue terrestrial television broadcasting

I/PAL (Band III)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
T1	58.0	10.0

Δ*f* (MHz)	–8.0	–7.5	–7.0	–6.5	–6.0	–5.5	–5.0	–4.5	–4.0	–3.5	–3.0
PR (dB)	–42.0	–23.5	–10.0	–3.0	–2.0	–3.0	–24.0	–21.0	–23.0	–31.0	–31.5
Δ*f* (MHz)	–2.5	–2.0	–1.5	–1.0	–0.9	–0.8	–0.7	–0.6	0.0	0.6	0.7
PR (dB)	–30.0	–28.5	–25.0	–19.5	–17.5	–11.0	–7.0	–1.5	–1.5	–4.0	–5.5
Δ*f* (MHz)	0.8	0.9	1.0	2.0	3.0						
PR (dB)	–13.5	–17.0	–20.0	–33.0	–47.5						

B/PAL (Band III)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
T2	58.0	10.0

Δ*f* (MHz)	–7.0	–6.5	–6.0	–5.5	–5.0	–4.5	–4.0	–3.5	–3.0	–2.5	–2.0
PR (dB)	–47.0	–18.0	–5.0	–3.0	–5.0	–20.0	–22.0	–31.5	–31.5	–29.0	–26.5
Δ*f* (MHz)	–1.5	–1.0	–0.9	–0.8	–0.7	–0.6	0.0	0.6	0.7	0.8	0.9
PR (dB)	–23.0	–18.5	–16.0	–9.0	–5.0	–3.0	–0.5	–3.0	–4.0	–12.0	–16.0
Δ*f* (MHz)	1.0	2.0									
PR (dB)	–19.5	–45.3									

D/SECAM, K/SECAM (Band III)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
T3	58.0	10.0

Δ*f* (MHz)	–8.0	–7.5	–7.0	–6.5	–6.0	–5.5	–5.0	–4.5	–4.0	–3.5	–3.0
PR (dB)	–47.0	–42.5	–3.0	–2.5	–3.0	–37.5	–21.5	–18.5	–20.5	–26.5	–33.5
Δ*f* (MHz)	–2.5	–2.0	–1.5	–1.0	–0.9	–0.8	–0.7	–0.6	0.0	0.6	0.7
PR (dB)	–31.5	–29.0	–26.5	–18.5	–16.5	–9.0	–6.0	–3.0	–2.5	–4.0	–4.5
Δ*f* (MHz)	0.8	0.9	1.0	2.0							
PR (dB)	–12.0	–22.0	–25.0	–46.0							

L/SECAM (Band III)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
T4	58.0	10.0

Δ*f* (MHz)	–8.0	–7.5	–7.0	–6.5	–6.0	–5.5	–5.0	–4.5	–4.0	–3.5	–3.0
PR (dB)	–46.5	–42.5	–15.5	–13.0	–15.0	–26.5	–18.5	–17.0	–18.0	–23.0	–31.5
Δ*f* (MHz)	–2.5	–2.0	–1.5	–1.0	–0.9	–0.8	–0.7	–0.6	0.0	0.6	0.7
PR (dB)	–30.5	–27.5	–24.5	–18.0	–16.5	–8.0	–5.0	–1.5	1.5	–2.0	–3.5
Δ*f* (MHz)	0.8	0.9	1.0	2.0	3.0						
PR (dB)	–12.5	–18.5	–19.0	–31.0	–46.8						

B/SECAM (Band III). B/PAL (T2) data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
T5	58.0	10.0

Δ*f* (MHz)	–7.0	–6.5	–6.0	–5.5	–5.0	–4.5	–4.0	–3.5	–3.0	–2.5	–2.0
PR (dB)	–47.0	–18.0	–5.0	–3.0	–5.0	–20.0	–22.0	–31.5	–31.5	–29.0	–26.5
Δ*f* (MHz)	–1.5	–1.0	–0.9	–0.8	–0.7	–0.6	0.0	0.6	0.7	0.8	0.9
PR (dB)	–23.0	–18.5	–16.0	–9.0	–5.0	–3.0	–0.5	–3.0	–4.0	–12.0	–16.0
Δ*f* (MHz)	1.0	2.0									
PR (dB)	–19.5	–45.3									

D/PAL (Band III)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
T6	58.0	10.0

Δ*f* (MHz)	–8.0	–7.5	–7.0	–6.5	–6.0	–5.5	–5.0	–4.5	–4.0	–3.5	–3.0
PR (dB)	–47.0	–42.5	–3.0	–2.5	–3.0	–37.5	–21.5	–20.0	–22.0	–31.5	–31.5
Δ*f* (MHz)	–2.5	–2.0	–1.5	–1.0	–0.9	–0.8	–0.7	–0.6	0.0	0.6	0.7
PR (dB)	–29.0	–26.5	–23.0	–18.5	–16.0	–9.0	–5.0	–3.0	–0.5	–3.0	–4.0
Δ*f* (MHz)	0.8	0.9	1.0	2.0							
PR (dB)	–12.0	–16.0	–19.0	–45.3							

B/PAL (FM+Nicam) (Band III)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
T7	58.0	10.0

Δ*f* (MHz)	–7.0	–6.5	–6.0	–5.5	–5.0	–4.5	–4.0	–3.5	–3.0	–2.5	–2.0
PR (dB)	–47.0	–18.0	–5.0	–3.0	–5.0	–20.0	–22.0	–31.5	–31.5	–29.0	–26.5
Δ*f* (MHz)	–1.5	–1.0	–0.9	–0.8	–0.7	–0.6	0.0	0.6	0.7	0.8	0.9
PR (dB)	–23.0	–18.5	–16.0	–9.0	–5.0	–3.0	–0.5	–3.0	–4.0	–12.0	–16.0
Δ*f* (MHz)	1.0	2.0									
PR (dB)	–19.5	–45.3									

3.5 T-DAB interfered with by services other than broadcasting

The maximum interfering field strength (FS) to avoid interference is calculated as follows:

$$Maximum\ allowable\ FS = (FS_{T\text{-}DAB} - PR - 18) \qquad \text{dB}(\mu\text{V/m})$$

As examples the following Table (non-exhaustive list) contains the protection ratio values used for calculations.

The service information is shown as follows, for example:

Aeronautical safety service 1		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
AL	58.0	10 000

where:

AL: service identifier

58.0: T-DAB field strength to be protected (dB(μV/m)) for Band III

10 000: other service transmit antenna height (m).

The columns in the Table relating to the above example have the following meaning:

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–66.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–66.0

where:

Δ*f*: frequency difference (MHz), i.e., interfering other service centre frequency minus centre frequency of interfered-with T-DAB block (in the case of an interfering TV signal the vision carrier frequency has to be taken instead of the centre frequency of the TV channel)

PR: required protection ratio (dB).

Table 4 serves to identify services other than broadcasting:

TABLE 4

Service identifier	Radio Regulations provision No.	Service
AL	1.34	aeronautical mobile (OR)
CA	1.20	fixed
DA	1.34	aeronautical mobile (OR)
DB	1.34	aeronautical mobile (OR)
IA	1.20	fixed
MA	1.26	land mobile
ME	1.34	aeronautical mobile (OR)
MF	1.34	aeronautical mobile (OR)
MG	1.34	aeronautical mobile (OR)
MI	1.28	maritime mobile
MJ	1.28	maritime mobile
MK	1.28	maritime mobile
ML	1.20	fixed
MT	1.20	fixed
MU	1.24	mobile
M1	1.24	mobile
M2	1.24	mobile
RA	1.24	mobile
R1	1.26	land mobile
R3	1.24	mobile
R4	1.24	mobile
XA	1.26	land mobile
XB	1.20	fixed
XE	1.34	aeronautical mobile (OR)
XM	1.26	land mobile
YB	1.26	land mobile
YC	1.34	aeronautical mobile (OR)
YD	1.34	aeronautical mobile (OR)
YE	1.28	maritime mobile
YH	1.26	land mobile
YT	1.34	aeronautical mobile (OR)
YW	1.34	aeronautical mobile (OR)

Aeronautical safety service 1		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
AL	58.0	10 000

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–66.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–66.0

Service used in Czech Republic. No information, continuous wave (CW) interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
CA	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Aeronautical safety service 2		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
DA	58.0	10 000

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–66.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–66.0

Aeronautical safety service (Germany), DB. The centre frequency is 235 MHz and the first channel is at 231 MHz. The values used are the same as those for the ME service		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
DB	58.0	10 000

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Italian service. No information, CW interference data used (224.25 MHz)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
IA	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Land mobile service (173-174 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
MA	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Military air-ground-air system, analogue minimum separation distance is 1 km. Frequency range is 230 MHz to just above 240 MHz, but channel frequencies are not identical in all countries. No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
ME	58.0	10 000

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Military air-ground-air system, digital (230-243 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
MF	58.0	10 000

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Military air-ground-air system, frequency hopping (230-243 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
MG	58.0	10 000

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Mobile navy service, analogue (230-243 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
MI	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Mobile navy service, digital (230-243 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
MJ	58.0	10.0

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Mobile navy service, frequency hopping (230-243 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
MK	58.0	10.0

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Military fixed services (230-243 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
ML	58.0	10.0

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Military mobile and fixed (tactical) services. No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
MT	58.0	10.0

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Mobile radio – low power devices S2 data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
MU	58.0	10.0

Δ*f* (MHz)	–2.0	–1.9	–1.8	–1.7	–1.6	–1.5	–1.4	–1.3	–1.2	–1.1	–1.0
PR (dB)	–48.0	–47.9	–47.1	–46.7	–46.4	–46.0	–45.4	–45.1	–43.9	–38.4	–37.5
Δ*f* (MHz)	–0.9	–0.8	–0.8	–0.7	–0.6	–0.5	–0.4	–0.3	–0.2	–0.1	0.0
PR (dB)	–28.9	–12.9	–4.9	–1.0	2.1	3.5	4.3	4.1	4.4	4.1	4.0
Δ*f* (MHz)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1.0
PR (dB)	4.1	4.4	4.1	4.3	3.5	2.1	–1.0	–4.9	–12.9	–28.9	–37.5
Δ*f* (MHz)	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	
PR (dB)	–38.4	–43.9	–45.1	–45.4	–46.0	–46.4	–46.7	–47.1	–47.9	–48.0	

Mobile services – narrow-band (12.5 kHz) FM system. No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
M1	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Mobile services – narrow-band (12.5 kHz) FM system. No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
M2	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Mobile services – narrow-band (12.5 kHz) FM system. No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
RA	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Medical telemetry in Denmark (223-225 MHz). No interference to T-DAB (10 mW e.r.p.)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
R1	58.0	10.0

Δ*f* (MHz)	–0.8	0.0	0.8								
PR (dB)	–66.0	–66.0	–66.0								

Mobile service – remote control (223-225 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
R3	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.94
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Mobile service – remote control (223-225 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
R4	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Professional mobile radio (PMR) (5 kHz channel spacing). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
XA	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Finnish alarm system (230-231 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
XB	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Military air-ground-air system (aeronautical frequencies). No information		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
XE	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Radio microphones (VHF). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
XM	58.0	10.0

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Video link		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
YB	58.0	10.0

Δ*f* (MHz)	–8.0	–7.5	–7.0	–6.5	–6.0	–5.5	–5.0	–4.5	–4.0	–3.5	–3.0
PR (dB)	–42.0	–23.5	–10.0	–3.0	–2.0	–3.0	–24.0	–21.0	–23.0	–31.0	–31.5
Δ*f* (MHz)	–2.5	–2.0	–1.5	–1.0	–0.9	–0.8	–0.7	–0.6	0.0	0.6	0.7
PR (dB)	–30.0	–28.5	–25.0	–19.5	–17.5	–11.0	–7.0	–1.5	–1.5	–4.0	–5.5
Δ*f* (MHz)	0.8	0.9	1.0	2.0	3.0						
PR (dB)	–13.5	–17.0	–20.0	–33.0	–47.5						

Military air-ground-air system, frequency hopping (230-243 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
YC	58.0	10 000

Δ*f* (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Military air-ground-air system, frequency hopping (230-243 MHz). No information, CW interference data used		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
YD	58.0	10 000

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Mobile navy (aircraft) service (230-243 MHz). New type		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
YE	58.0	10 000

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–66.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–66.0

Audio link special		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
YH	58.0	10 000

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–66.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–66.0

Military air-ground-air system, frequency hopping (230-243 MHz). No information, CW interference data used (as YC)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
YT	58.0	10 000

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Military air-ground-air system, frequency hopping (230-243 MHz). No information, CW interference data used (as YC)		
Service identifier	**Field strength to be protected for Band III (dB(μV/m))**	**Transmit antenna height (m)**
YW	58.0	10 000

Δf (MHz)	–0.9	–0.8	–0.6	–0.4	–0.2	0.0	0.2	0.4	0.6	0.8	0.9
PR (dB)	–60.0	–6.6	2.7	3.2	4.1	6.5	4.1	3.2	2.7	–6.6	–60.0

Where no information concerning protection ratios for T-DAB interfered with by other services has been supplied to the Planning Meeting, the administrations concerned should develop appropriate sharing criteria by mutual agreement or use the relevant ITU-R Recommendations when available.

Bibliography

ETSI Specification EN 300 401 – Radio broadcasting systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers.

Annex 2

Technical basis for planning of terrestrial digital sound broadcasting System F (ISDB-T_{SB}) in the VHF band

1 General

This Annex describes planning criteria for Digital System F (ISDB-T_{SB}) in the VHF band. 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 that is 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.

2 Spectrum masks for out-of-band emissions

The radiated signal spectrum should be constrained by the spectrum mask. Table 5 defines the breakpoints of the spectrum mask for *n*-segment transmission for 6/14 MHz, 7/14 MHz, and 8/14 MHz segment system. The spectrum mask is defined as the relative value to the mean power of each frequency. Figure 7 shows the spectrum mask for 3-segment transmission in 6/14 MHz segment system.

TABLE 5

Breakpoints of the spectrum mask (segment bandwidth (BW) = 6/14, 7/14, or 8/14 MHz)

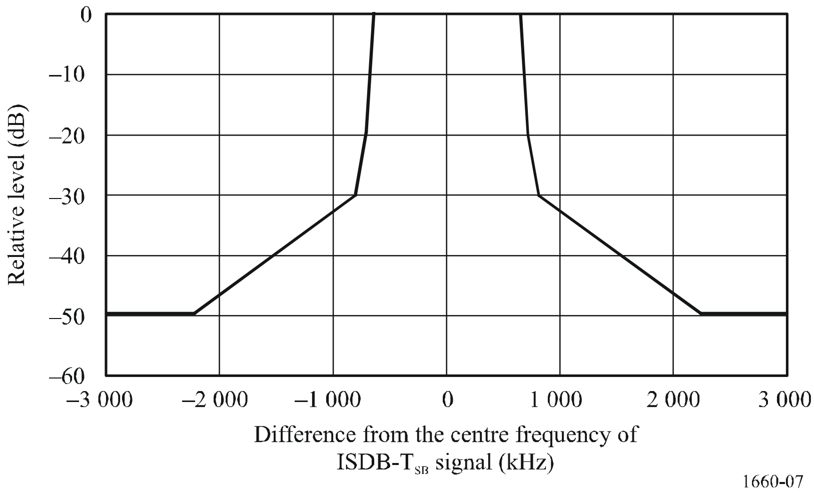
Difference from the centre frequency of the terrestrial digital sound signal	Relative level (dB)
$\pm\left(\frac{\mathrm{BW}\times n}{2}+\frac{\mathrm{BW}}{216}\right)$ MHz	0
$\pm\left(\frac{\mathrm{BW}\times n}{2}+\frac{\mathrm{BW}}{216}+\frac{\mathrm{BW}}{6}\right)$ MHz	–20
$\pm\left(\frac{\mathrm{BW}\times n}{2}+\frac{\mathrm{BW}}{216}+\frac{\mathrm{BW}}{3}\right)$ MHz	–30
$\pm\left(\frac{\mathrm{BW}\times n}{2}+\frac{\mathrm{BW}}{216}+\frac{11\times\mathrm{BW}}{3}\right)$ MHz	–50

n: Number of consecutive segments.

FIGURE 7

Spectrum mask for ISDB-T_{SB} transmission signal

(BW = 6/14 MHz, *n* = 3)



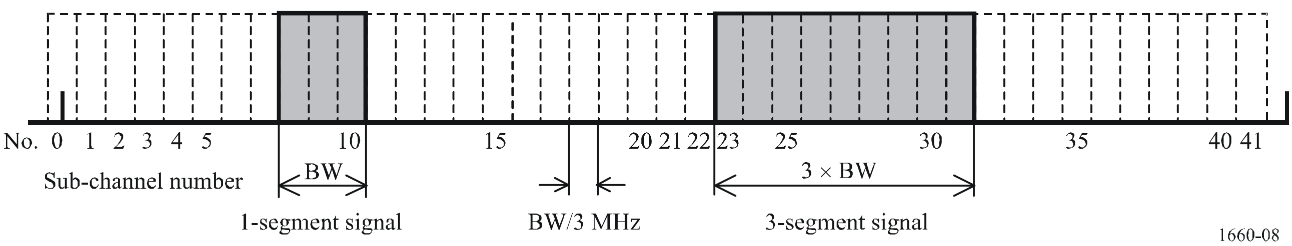
3 Frequency condition

3.1 Definition of sub-channel

In order to indicate the frequency position of the ISDB-T_{SB} signal each segment is numbered using a sub-channel number 0 through 41. The sub-channel is defined as one third of the BW (see Fig. 8). For example, the frequency positions of 1-segment and 3-segment signal shown in Fig. 8 are defined as the 9th and 27th sub-channels respectively in the analogue television channel.

FIGURE 8

Definition of sub-channel

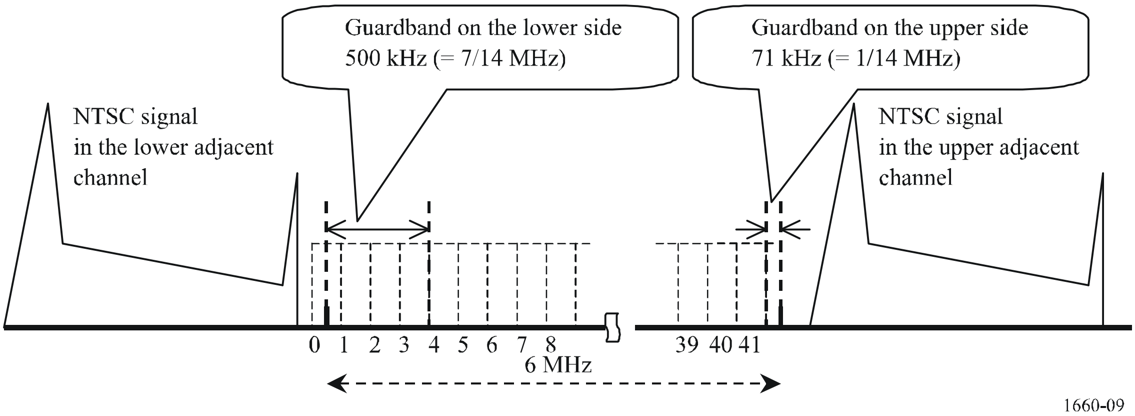


3.2 Guardbands

From the results of subjective evaluation on NTSC interfered with by ISDB-T_{SB}, guardbands are determined at both sides of the NTSC signal. As shown in Fig. 9, the guardbands are 500 kHz (= 7/14 MHz) on the lower side within the channel and 71 kHz (= 1/14 MHz) on the upper side. Accordingly, the sub-channels that can be used for digital sound broadcasting are from sub-channel Nos. 4 to 41. Within a 6 MHz television channel, a maximum of 12 segments can be allocated, excluding the guardbands.

FIGURE 9

Guardbands to coexist with adjacent analogue television signal



4 Minimum usable field strength

Link budgets for the three cases of fixed reception, portable reception and mobile reception at the frequencies of 100 MHz and 200 MHz are presented in Table 6. Required field strengths for the 1-segment and the 3-segment are described in the 22nd row and the 24th row respectively. The values are for the case of 6/14 MHz segment system, and can be converted for the case of 7/14 MHz or 8/14 MHz segment system according to the bandwidth.

TABLE 6

Link budgets for ISDB-T$_{SB}$

(a) 100 MHz

	Element	**Mobile reception**			**Portable reception**			**Fixed reception**		
	Frequency (MHz)	100			100			100		
	Modulation scheme	QPSK	QPSK	16-QAM	QPSK	QPSK	16-QAM	QPSK	QPSK	16-QAM
	Coding rate of the inner code	1/2	2/3	1/2	1/2	2/3	1/2	1/2	2/3	1/2
1	Required *C/N* (QEF after error correction) (dB)	4.9	6.6	11.5	4.9	6.6	11.5	4.9	6.6	11.5
2	Implementation degradation (dB)	2	2	2	2	2	2	2	2	2
3	Interference margin (dB)	2	2	2	2	2	2	2	2	2
4	Multipath margin (dB)	–	–	–	1	1	1	1	1	1
5	Fading margin (temporary fluctuation correction) (dB)	9.4	9.4	8.1	–	–	–	–	–	–
6	Receiver required *C/N* (dB)	18.3	20	23.6	9.9	11.6	16.5	9.9	11.6	16.5
7	Receiver noise figure, *NF* (dB)	5	5	5	5	5	5	5	5	5

TABLE 6 (*continued*)

	Element	Mobile reception			Portable reception			Fixed reception		
8	Noise bandwidth (1-segment), *B* (kHz)	429	429	429	429	429	429	429	429	429
9	Receiver intrinsic noise power, N_r (dBm)	–112.7	–112.7	–112.7	–112.7	–112.7	–112.7	–112.7	–112.7	–112.7
10	External noise power at the receiver input terminal, N_0 (dBm)	–98.1	–98.1	–98.1	–98.1	–98.1	–98.1	–99.1	–99.1	–99.1
11	Total receiver noise power N_t (dBm)	–98.0	–98.0	–98.0	–98.0	–98.0	–98.0	–98.9	–98.9	–98.9
12	Feeder loss, *L* (dB)	1	1	1	1	1	1	2	2	2
13	Minimum usable receiver input power (dBm)	–79.7	–78.0	–74.4	–88.1	–86.4	–81.5	–89.0	–87.3	–82.4
14	Receiver antenna gain, G_r (dBi)	–0.85	–0.85	–0.85	–0.85	–0.85	–0.85	–0.85	–0.85	–0.85
15	Effective antenna aperture (dB/m^2)	–2.3	–2.3	–2.3	–2.3	–2.3	–2.3	–2.3	–2.3	–2.3
16	Minimum usable field strength, E_{min} (dB (μV/m))	39.4	41.1	44.7	31.0	32.7	37.6	31.1	32.8	37.7
17	Time-rate correction (dB)	0.0	0.0	0.0	0.0	0.0	0.0	4.3	4.3	4.3
18	Location rate correction (dB)	12.8	12.8	12.8	2.9	2.9	2.9	–	–	–
19	Wall penetration loss value (dB)	–	–	–	10.1	10.1	10.1	–	–	–
20	Required field strength (1-segment) at antenna, *E*(dB(μV/m))	52.2	53.9	57.5	44.0	45.7	50.6	35.4	37.1	42.0
	Assumed antenna height, h_2 (m)	1.5	1.5	1.5	1.5	1.5	1.5	4.0	4.0	4.0
21	Height correction to 10 m (dB)	10.0	10.0	10.0	10.0	10.0	10.0	7.0	7.0	7.0
22	Required field strength (1-segment, h_2 = 10 m), *E*(dB(μV/m))	62.2	63.9	67.5	54.0	55.7	60.6	42.4	44.1	49.0
23	Conversion from 1-segment to 3-segment (dB)	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
24	Required field strength (3-segment, h_2 = 10 m), *E*(dB(μV/m))	67.0	68.7	72.3	58.8	60.5	65.4	47.2	48.9	53.8

TABLE 6 (*continued*)

(b) 200 MHz

	Element	**Mobile reception**			**Portable reception**			**Fixed reception**		
	Frequency (MHz)	200			200			200		
	Modulation scheme	DQPSK	16-QAM	64-QAM	DQPSK	16-QAM	64-QAM	DQPSK	16-QAM	64-QAM
	Coding rate of the inner code	1/2	1/2	7/8	1/2	1/2	7/8	1/2	1/2	7/8
1	Required *C*/*N* (QEF after error correction) (dB)	6.2	11.5	22.0	6.2	11.5	22.0	6.2	11.5	22.0
2	Implementation degradation (dB)	2.0	2.0	3.0	2.0	2.0	3.0	2.0	2.0	3.0
3	Interference margin (dB)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
4	Multipath margin (dB)	–	–	–	1.0	1.0	1.0	1.0	1.0	1.0
5	Fading margin (temporary fluctuation correction) (dB)	9.5	8.1	(1)	–	–	–	–	–	–
6	Receiver required *C*/*N* (dB)	19.7	23.6	(1)	11.2	16.5	28.0	11.2	16.5	28.0
7	Receiver noise figure, *NF* (dB)	5	5	–	5	5	5	5	5	5
8	Noise bandwidth (1-segment), *B* (kHz)	429	429	–	429	429	429	429	429	429
9	Receiver intrinsic noise power, N_r (dBm)	–112.7	–112.7	–	–112.7	–112.7	–112.7	–112.7	–112.7	–112.7
10	External noise power at the receiver input terminal, N_0 (dBm)	–107.4	–107.4	–	–107.4	–107.4	–107.4	–107.4	–107.4	–107.4
11	Total receiver noise power, N_t (dBm)	–106.3	–106.3	–	–106.3	–106.3	–106.3	–106.3	–106.3	–106.3
12	Feeder loss, *L* (dB)	2.0	2.0	–	2.0	2.0	2.0	2.0	2.0	2.0
13	Minimum usable receiver input power (dBm)	–86.6	–82.7	–	–95.1	–89.8	–78.3	–95.1	–89.8	–78.3
14	Receiver antenna gain, G_r (dBi)	–0.85	–0.85	–	–0.85	–0.85	–0.85	–0.85	–0.85	–0.85
15	Effective antenna aperture (dB/m^2)	–8.3	–8.3	–	–8.3	–8.3	–8.3	–8.3	–8.3	–8.3

TABLE 6 (*end*)

	Element	Mobile reception			Portable reception			Fixed reception		
16	Minimum usable field strength, E_{min} (dB(μV/m))	39.5	43.4		31.0	36.3	47.8	31.0	36.3	47.8
17	Time-rate correction (dB)	0.0	0.0	–	0.0	0.0	0.0	6.2	6.2	6.2
18	Location rate correction (dB)	12.8	12.8	–	2.9	2.9	2.9	–	–	–
19	Wall penetration loss value (dB)	–	–	–	10.1	10.1	10.1	–	–	–
20	Required field strength (1-segment) at antenna, E(dB(μV/m))	52.3	56.2		44.0	49.3	60.8	37.2	42.5	54.0
	Assumed antenna height, h_2 (m)	1.5	1.5	–	1.5	1.5	1.5	4	4	4
21	Height correction to 10 m (dB)	12	12	–	12	12	12	10	10	10
22	Required field strength (1-segment, $h_2 = 10$ m), E(dB(μV/m))	64.3	68.2	–	56.0	61.3	72.8	47.2	52.5	64.0
23	Conversion from 1-segment to 3-segment (dB)	4.8	4.8	–	4.8	4.8	4.8	4.8	4.8	4.8
24	Required field strength (3-segment, $h_2 = 10$ m), E(dB(μV/m))	69.1	73.0		60.8	66.1	77.6	52.0	57.3	68.8

(1) Not usable in fading environment.

1) Required *C*/*N*

The required *C*/*N* for modulation schemes and coding rates are shown in Table 7.

TABLE 7

Required *C*/*N*

Modulation	Coding rate for convolutional coding				
	1/2	2/3	3/4	5/6	7/8
DQPSK	6.2 dB	7.7 dB	8.7 dB	9.6 dB	10.4 dB
QPSK	4.9 dB	6.6 dB	7.5 dB	8.5 dB	9.1 dB
16-QAM	11.5 dB	13.5 dB	14.6 dB	15.6 dB	16.2 dB
64-QAM	16.5 dB	18.7 dB	20.1 dB	21.3 dB	22.0 dB

2) Implementation degradation

The amount of equivalent *C*/*N* degradation expected in equipment implementation.

3) Interference margin

The margin for the equivalent *C*/*N* degradation caused by interference from analogue broadcasting, etc.

NOTE 1 – Long-distance propagation over sea paths or other environments may cause interference in some circumstances. Although it is not practical to include such special cases in the calculation of link budgets, attention should be paid to this type of interference.

4) Multipath margin for portable reception or fixed reception

The margin for the equivalent *C*/*N* degradation caused by multipath interference.

5) Fading margin for mobile reception

The margin for the equivalent *C*/*N* degradation caused by temporary fluctuation in the field strength.

The *C*/*N* required in the fading channel is shown in Table 8. Fading margins are shown in Table 9.

TABLE 8

Required *C*/*N*
(Mode 3, Guard 1/16, and GSM typical urban fading model)

			Maximum Doppler frequency (f_D)[1]		
Modulation	**Coding rate**	**Gaussian noise (dB)**	2 Hz	7 Hz	20 Hz
DQPSK	1/2	6.2	15.7 dB	11.4 dB	9.9 dB
QPSK	1/2	4.9	14.3 dB	10.8 dB	10.4 dB
16-QAM	1/2	11.5	19.6 dB	17.4 dB	19.1 dB
64-QAM	1/2	16.5	24.9 dB	22.9 dB	>35 dB

(1) When velocity of vehicle is 100 km/h, maximum Doppler frequency is up to 20 Hz in the VHF high channel (170-220 MHz).

TABLE 9

Fading margins
(Temporary field-strength fluctuation margin)

Modulation	**Coding rate**	**VHF (up to f_D = 20 Hz) (dB)**
DQPSK	1/2	9.5
QPSK	1/2	9.4
16-QAM	1/2	8.1
64-QAM	1/2	–

6) Receiver required *C/N*

= (1: required *C/N*) + (2: implementation degradation) + (3: interference margin) + (4: multipath margin) + (5: fading margin).

7) Receiver noise figure, *NF*

= 5 dB.

8) Noise bandwidth, *B*

= 1-segment signal transmission bandwidth.

9) Receiver thermal noise power, N_r

$= 10 \times \log (k\,T\,B) + NF$

$k = 1.38 \times 10^{-23}$ (the Boltzmann constant), $T = 290$ K.

10) External noise power, N_0

The external noise power (lossless antenna) in the 1-segment bandwidth based on the median values of man-made noise power for business (curve A) category in Recommendation ITU-R P.372 at each of the frequencies of 100 MHz and 200 MHz is as follows:

$N_0 = –96.3$ dBm – (12: feeder loss) + G_{cor} for 100 MHz,

$N_0 = –104.6$ dBm – (12: feeder loss) + G_{cor} for 200 MHz,

$G_{cor} = G_r\ (G_r < 0),\ 0\ (G_r > 0).$

NOTE 1 – G_{cor} is a correction factor for the received external noise power by a receiving antenna. A receiving antenna with a minus gain ($G_r < 0$) receives both desired signals and external noise with the minus gain ($G_{cor} = G_r$). On the other hand, a receiving antenna with a plus gain ($G_r > 0$) receives desired signals in the direction of the main beam with the plus gain but receives external noise omnidirectionally without a gain ($G_{cor} = 0$).

11) Total received noise power, N_t

= the power sum of (9: receiver intrinsic noise power) and (10: external noise power at the receiver input terminal)

$= 10 \times \log (10^{(N_r/10)} + 10^{(N_0/10)})$.

12) Feeder loss, *L*

$L = 1$ dB at 100 MHz for mobile and portable reception

$L = 2$ dB at 100 MHz for fixed reception

$L = 2$ dB at 200 MHz for mobile, portable and fixed reception.

13) Minimum usable receiver input power

= (6: receiver required *C/N*) + (11: total receiver noise power)

$= C/N + N_t$

14) Receiving antenna gain, G_r

= –0.85 dBi, assuming a λ/4 monopole antenna.

15) Effective antenna aperture

$= 10 \times \log (\lambda^2/4\pi)$ + (14: receiving antenna gain) (dBi).

16) Minimum usable field strength, E_{min}

= (12: feeder loss) + (13: minimum receiver input power) – (15: effective antenna aperture) + 115.8 (power flux-density (dBm/m^2) to field strength (dB(μV/m)) conversion).

17) Time-rate correction

For fixed reception, the time-rate correction value is determined by Recommendation ITU-R P.1546. The value from 50% to 1% is 4.3 dB at 100 MHz and 6.2 dB at 200 MHz, respectively. The propagation condition is as follows:

Path:	Land paths
Transmitting/base antenna height:	250 m
Distance:	70 km.

18) Location rate correction

According to Recommendation ITU-R P.1546, standard deviation of location variation σ is 5.5 dB for digital broadcasting signal.

In the case of mobile reception, the location correction value from 50% to 99%[1] is 12.9 dB (2.33 σ).

In the case of portable reception, the location correction value from 50% to 70%[1] is 2.9 dB (0.53 σ).

19) Wall penetration loss

For indoor reception, the signal loss due to passing through walls is considered. The average penetration loss is 8 dB with a standard deviation of 4 dB. Assuming the location rate of 70% (0.53 σ) for portable receivers, the value is as follows.

= 8 dB + 0.53 × 4 dB = 10.1 dB.

20) Required field strength at antenna

= (16: minimum field strength, E_{min}) + (17: time rate correction) + (18: location rate correction) + (19: wall penetration loss).

21) Height correction

According to Recommendation ITU-R P.1546, the height correction values are derived as shown in Table 10.

TABLE 10

Height correction values

(a) Suburban, 100 MHz

	4 m above ground level (dB)	**1.5 m above ground level (dB)**
Difference in field strength from height of 10 m above ground level	–7	–10

[1] Different percentages may be used according to the service criteria in each country.

TABLE 10 (*end*)

(b) Suburban, 200 MHz

	4 m above ground level (dB)	1.5 m above ground level (dB)
Difference in field strength from height of 10 m above ground level	–10	–12

22) Required field strength at receiving height of 10 m above ground level

= (20: required field strength at antenna) + (21: reception height correction).

23) Conversion from 1-segment signal to 3-segment signal

noise bandwidth conversion value

= $10 \times \log(3/1) = 4.8$ dB.

24) Required field strength (h_2 = 10 m) for 3-segment signal

= (22: required field strength (h_2 = 10 m)) + (23: conversion from 1-segment signal to 3-segment signal).

5 Protection of ISDB-T_{SB}

5.1 ISDB-T_{SB} interfered with by ISDB-T_{SB}

5.1.1 Required *D*/*U* in fixed reception

The *D*/*U* between 1-segment ISDB-T_{SB} signals are measured at a BER of 2×10^{-4} after decoding the inner code, and are shown for each guardband in Table 11. The guardband means a frequency spacing between spectrum edges.

In the case where the spectra overlap each other, interference is considered as co-channel interference.

TABLE 11

Required *D*/*U* (dB) between 1-segment ISDB-T_{SB} signals (fixed reception)

Modulation	Coding rate	Co-channel	Guardband (MHz)							
			0/7	1/7	2/7	3/7	4/7	5/7	6/7	7/7 or above
DQPSK	1/2	4	–15	–21	–25	–28	–29	–36	–41	–42
16-QAM	1/2	11	–6	–12	–21	–24	–26	–33	–38	–39
64-QAM	7/8	22	–4	–10	–10	–11	–13	–19	–23	–24

5.1.2 Required *D*/*U* in mobile reception

In mobile reception, the standard deviation of a location variation of digital broadcasting signal is 5.5 dB according to Recommendation ITU-R P.1546. The field-strength values for wanted and unwanted signals are assumed to be uncorrelated. To protect wanted ISDB-T_{SB} signals for 99% of locations against interference from other ISDB-T_{SB} transmissions, a propagation correction is 18 dB ($\approx 2.33 \times 5.5 \times 1.414$). The *D*/*U* including the total margins are listed in Table 12.

TABLE 12

Required *D*/*U* (dB) between 1-segment ISDB-T_{SB} signals (mobile reception)

Modulation	**Coding rate**	**Co-channel**	**Guardband (MHz)**							
			0/7	1/7	2/7	3/7	4/7	5/7	6/7	7/7 or above
DQPSK	1/2	22	3	–3	–7	–10	–11	–18	–23	–24
16-QAM	1/2	29	12	6	–3	–6	–8	–15	–20	–21

5.1.3 Resultant protection ratios for ISDB-T_{SB} interfered with by ISDB-T_{SB}

The protection ratios are defined as the highest values taken from Table 11 and Table 12 to apply to every reception condition. The resultant protection ratios are shown in Table 13.

TABLE 13

Protection ratios for ISDB-T_{SB} interfered with by ISDB-T_{SB}

Desired signal	**Interference**		**Protection ratio**
	Interference signal	**Frequency difference**	
ISDB-T_{SB} (1-segment)	ISDB-T_{SB} (1-segment)	Co-channel	29 dB
		Adjacent	Table 14
	ISDB-T_{SB} (3-segment)	Co-channel	24 dB
		Adjacent	Table 14
ISDB-T_{SB} (3-segment)	ISDB-T_{SB} (1-segment)	Co-channel	34 dB
		Adjacent	Table 14
	ISDB-T_{SB} (3-segment)	Co-channel	29 dB
		Adjacent	Table 14

NOTE 1 – For protection ratios for ISDB-T_{SB}, fading margin for mobile reception is taken into account. The values in the Table include the fading margin of 18 dB.

TABLE 14

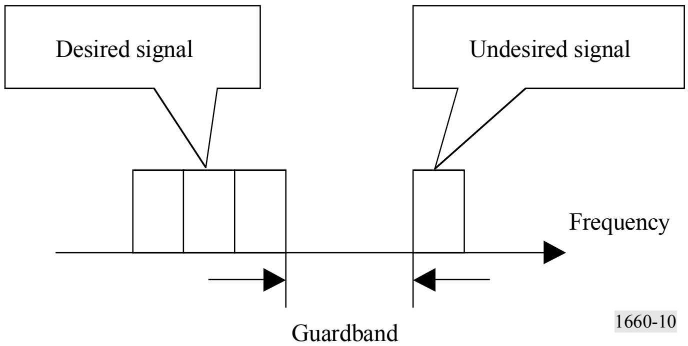
Protection ratios (dB) depending on guardbands

Desired signal	Interference signal	Guardband (MHz)							
		0/7	1/7	2/7	3/7	4/7	5/7	6/7	7/7 or above
ISDB-T_{SB} (1-segment)	ISDB-T_{SB} (1-segment)	12	6	–3	–6	–8	–15	–20	–21
	ISDB-T_{SB} (3-segment)	7	1	–8	–11	–13	–20	–25	–26
ISDB-T_{SB} (3-segment)	ISDB-T_{SB} (1-segment)	17	11	2	–1	–3	–10	–15	–16
	ISDB-T_{SB} (3-segment)	12	6	–3	–6	–8	–15	–20	–21

NOTE 1 – The values in the Table include the fading margin of 18 dB. The guardband between ISDB-T_{SB} signals is as shown in Fig. 10.

FIGURE 10

Guardband and arrangement of the signals



5.2 ISDB-T_{SB} interfered with by analogue television (NTSC)

5.2.1 Required *D*/*U* in fixed reception

The *D*/*U* required for 1-segment ISDB-T_{SB} signal interfered with by NTSC are listed in Table 15. The *D*/*U* are measured at the BER of 2×10^{-4} after decoding the inner code. The guardbands between ISDB-T_{SB} signal and NTSC signal in adjacent channel interference are as shown in Fig. 9.

TABLE 15

Required *D*/*U* for 1-segment ISDB-T_{SB} interfered with by analogue television (NTSC) (fixed reception)

Modulation	Coding rate	Interference		
		Co-channel (dB)	Lower-adjacent channel (dB)	Upper-adjacent channel (dB)
DQPSK	1/2	2	–57	–60
16-QAM	1/2	5	–54	–56
64-QAM	7/8	29	–38	–38

5.2.2 Required *D*/*U* in mobile reception

In mobile reception, both the desired signal and interference signal experience field-strength fluctuation due to Rayleigh fading. The standard deviation of a location variation of digital broadcasting signal is 5.5 dB and that of analogue broadcasting signal is 8.3 dB according to Recommendation ITU-R P.1546. The field-strength values for wanted and unwanted signals are assumed to be uncorrelated. To protect wanted ISDB-T_{SB} signals for 99% of locations against interference from NTSC signals, the propagation correction is 23 dB.

The *D*/*U* including a margin required for mobile reception are listed in Table 16.

TABLE 16

Required *D*/*U* for 1-segment ISDB-T_{SB} interfered with by analogue television (NTSC) (mobile reception)

Modulation	Coding rate	Interference		
		Co-channel (dB)	Lower-adjacent channel (dB)	Upper-adjacent channel (dB)
DQPSK	1/2	25	–34	–37
16-QAM	1/2	28	–31	–33

5.2.3 Resultant protection ratios for ISDB-T_{SB} interfered with by analogue television (NTSC)

The protection ratios are defined as the highest values taken from Table 15 and Table 16 to apply to every reception condition. For the 3-segment transmission, it is necessary to correct the protection ratios by 5 dB ($\approx$ 4.8 dB = 10 $\times$ log (3/1)). The resultant protection ratios are shown in Table 17.

TABLE 17

Protection ratios for ISDB-T_{SB} interfered with by analogue television (NTSC)

Desired signal	Interference		Protection ratio (dB)
	Interference signal	Frequency difference	
ISDB-T_{SB} (1-segment)	NTSC	Co-channel	29
		Lower-adjacent	–31
		Upper-adjacent	–33
ISDB-T_{SB} (3-segment)		Co-channel	34
		Lower-adjacent	–26
		Upper-adjacent	–28

NOTE 1 – For protection ratios for ISDB-T_{SB}, fading margin for mobile reception is taken into account. The values in the Table include the fading margin of 23 dB.

5.3 Analogue television (NTSC) interfered with by ISDB-T_{SB}

Protection ratios are defined as *D*/*U* at which subjective evaluations resulted in an impairment score of 4 (5-grade impairment scale). The evaluation experiments were conducted according to the double-stimulus impairment scale method described in Recommendation ITU-R BT.500.

In the case of adjacent interference, the guardbands between NTSC signal and ISDB-T_{SB} signal are as shown in Fig. 9. For the 3-segment transmission, it is necessary to correct the protection ratios by 5 dB (≈ 4.8 dB = 10 × log (3/1)). The resultant protection ratios are shown in Table 18.

TABLE 18

Protection ratios for analogue television (NTSC) interfered with by ISDB-T_{SB}

Desired signal	Interference		Protection ratio (dB)
	Interference signal	Frequency difference	
NTSC	ISDB-T_{SB} (1-segment)	Co-channel	57
		Lower-adjacent	11
		Upper-adjacent	11
		Image channel	–9
	ISDB-T_{SB} (3-segment)	Co-channel	52
		Lower-adjacent	6
		Upper-adjacent	6
		Image channel	–14

5.4 ISDB-T_{SB} interfered with by services other than broadcasting

The maximum interfering field-strength density below 108 MHz to avoid interference by services other than broadcasting is shown as follows:

TABLE 19

Maximum interfering field strength density interfered with by services other than broadcasting

Parameter	Value	Unit
Maximum interfering field-strength density	4.6	dB(μV/(m • 100 kHz))

NOTE 1 – For derivation, see Appendix 1 to Annex 2.

Appendix 1
to Annex 2

Derivation of maximum interfering field strength density interfered with by services other than broadcasting

Parameter	Symbol	Value	Unit
Frequency	f	108	MHz
Bandwidth	B	429×10^3	Hz
Receiver antenna gain	Gr	–0.85	dBi
Feeder loss	L	1	dB
NF	NF	5	dB
Receiver intrinsic noise power	Nr	–112.7	dBm
Median value of man-made noise power as described in § 5 of Recommendation ITU-R P.372-10	F_{am}	20.5	dB
External noise power to the receiver input power	N_0	–99.0	dBm
Total receiver noise power	N_t	–98.8	dBm
Effective antenna aperture	A_{eff}	–3.0	dB • m^2
Total noise field strength	E_t	21.0	dB(μV/m)
Maximum interfering field strength (in 429 kHz)	E_i	11.0	dB(μV/m)
Maximum interfering field strength density	E_{is}	4.6	dB(μV/(m • 100 kHz))

Receiver intrinsic noise power

$$N_r = 10 \times \log (k\,T\,B) + NF + 30 \qquad \text{(dBm)}$$

Median value of man-made noise power as described in § 5 of Recommendation ITU-R P.372-9

$$F_{am} = c - d \times \log f \qquad \text{(dB)}$$

(c = 76.8 and d =27.7 for the city area)

External noise power to the receiver input power

$$N_o = 10 \times \log (k\,T\,B) - L + 30 + F_{am} + G_{cor} \qquad \text{(dBm)}$$

$$G_{cor} = G_r\,(G_r < 0),\ 0\ (G_r > 0)^2$$

2 G_{cor} is a correction factor for the received external noise power by a receiving antenna. A receiving antenna with a minus gain ($G_r < 0$) receives both desired signals and external noise with the minus gain ($G_{cor} = G_r$). On the other hand, a receiving antenna with a plus gain ($G_r > 0$) receives desired signals in the direction of the main beam with the plus gain but receives external noise omnidirectionally without a gain ($G_{cor} = 0$).

Total receiver noise power

$$N_t = 10 \times \log\left(10^{(N_r/10)} + 10^{(N_0/10)}\right) \qquad \text{(dBm)}$$

Effective antenna aperture

$$A_{eff} = 10 \times \log(\lambda^2/4\pi) + G_r \text{ (dB} \cdot \text{m}^2\text{)}$$

Total noise field strength

$$E_t = L + N_t - A_{eff} + 115.8 \text{ (dB(μV/m))}$$

Maximu interfering field strength

$$E_i = E_t + I/N \text{ (dB(μV/m))}$$

Data

k: Boltzmann's constant = 1.38×10^{-23} J/K

T: Absolute temperature = 290 K

I/*N*: *I*/*N* for inter-service sharing = –10 (dB).