CHAPTER 3

Technical basis and characteristics

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3.1 Frequency bands, channel spacing, channel distribution

3.1.1 General

In Band III (174-230 MHz), the new digital plan should accommodate DVB-T and T-DAB.

Furthermore, the whole of Band III should be available for DVB-T and T-DAB planning.

Both DVB-T and T-DAB services should coexist in Band III. There should not be a rigid splitting of Band III between DVB-T and T-DAB, unless this is proposed on a national basis and only depending on national requirements. However, administrations should note that the efficient use of Band III may be facilitated by the separation of T-DAB and DVB-T services, as well as a harmonized 7 MHz bandwidth for all of Band III.

In Bands IV and V (470-862 MHz), the new digital plan should accommodate DVB-T. Also, in Bands IV and V, the new digital plan should be based upon an 8 MHz channel bandwidth associated with an identical 8 MHz channel spacing.

For T-DAB, the channelling plan in Band III as given in Recommendation ITU-R BS.1660 – Technical basis for planning of terrestrial digital sound broadcasting in the VHF band, should be inserted into the new digital plan.

Information concerning the frequencies for analogue and DVB-T television channels and for T-DAB frequency blocks in Bands III, IV and V is given in Annex 3.1, Tables A.3.1-1 to A.3.1-10. DVB-T channels have the same channel reference and channel boundaries as for the analogue channels given in the Annex 3.1, Tables A.3.1-1 to A.3.1-9. However, for DVB-T channels the assigned frequency is the centre frequency.

For channel bandwidths and channel spacing in Band III, each administration may retain its own arrangement (channel spacing and bandwidth defined previously for analogue TV).

3.1.2 Details of frequency bands

In Band III, different television channel spacings are used across the planning area. In Eastern Europe, France, Ireland and some African countries, channels are 8 MHz wide but they are aligned differently. In other countries the channel width is 7 MHz, also with different channel alignments. In some countries using a 7 MHz channel width (e.g. Italy and Morocco), there are also different channel spacings. This means that in the VHF bands there are many cases where channels overlap.

Within Bands IV and V, there is a single channel spacing of 8 MHz, with the upper and lower edges, and vision carrier, of each channel being the same for all countries in the planning area.

Annex 3.1 shows a list of television systems as notified by administrations with territories located in the planning area. The frequencies for these television channels in Bands III, IV and V are given in Annex 3.1, Tables A.3.1-1 to A.3.1-9, as provided by administrations.

It should be noted that while the frequency band 174-216 MHz is primarily used for terrestrial analogue television, there are also some T-DAB allotments in this band in Europe. The frequency band 216-230 MHz is mainly allocated to T-DAB in European countries; nevertheless there is still widespread use of part of this band for television.

3.1.3 Future Band III sharing options

Three ways in which Band III can be shared between T-DAB and DVB-T have been identified and these are considered in this chapter, namely:

– Option 1 single service usage of the band;

– Option 2 partitioning of the band;

– Option 3 mixed T-DAB/DVB-T.

Descriptions of these options are given in Annex 3.2.

3.2 Planning considerations

It must be recognized that digital broadcasting frequency planning is a multidimensional subject requiring many technical inputs: criteria such as minimum signal levels and protection ratios and parameters such as distance between transmitters, transmitting antenna heights and type of reception. There is no single and universal solution. In planning the initial introduction of digital television, it may be necessary to restrict the planning studies to a representative subset of criteria and parameters (see § 3.6).

For frequency planning, three field strengths are important:

– the first is the field strength of the wanted signals inside the coverage area, known as the wanted field strength;

– the second results from the power radiated by the wanted transmitters towards areas outside of the coverage area and is usually called outgoing interference or outgoing interfering field strength;

– the third is the field strength inside the wanted coverage area due to radiation from interfering transmitters outside the wanted coverage area, known as incoming interference or nuisance field strength.

The network configurations and reception modes can evolve from one configuration to another due to the flexibility of the digital systems. Frequency planning should provide flexibility in order to cope with future demands (e.g. a conversion from fixed reception to portable and mobile reception may require an evolution from a multifrequency network (MFN) to a single frequency network (SFN) configuration).

A digital frequency plan should also include the possibility of introducing a number of network configurations for different reception modes which result in different reference usable field strengths.

The usable field strength is calculated by combining the individual nuisance field strengths and the combined location correction factor.

3.3 Reception modes

DVB-T planning should be able to deal with different reception modes, namely, fixed reception, portable (outdoor and indoor) reception and mobile reception, using a limited number of appropriate system variants and location probabilities (see § 3.6).

T-DAB planning should be able to deal with mobile reception and with portable indoor reception.

3.3.1 Fixed reception

The reference antenna height considered to be representative in calculating the field strength for fixed reception is 10 m above ground level. The derivation of the minimum median wanted signal levels for Bands III, IV and V requires standard radiation patterns (as given in Recommendation ITU-R BT.419), reference antenna gains (relative to half-wave dipole) and feeder loss from the receiving antenna.

3.3.1.1 Radiation patterns for receiving fixed antennas at roof level

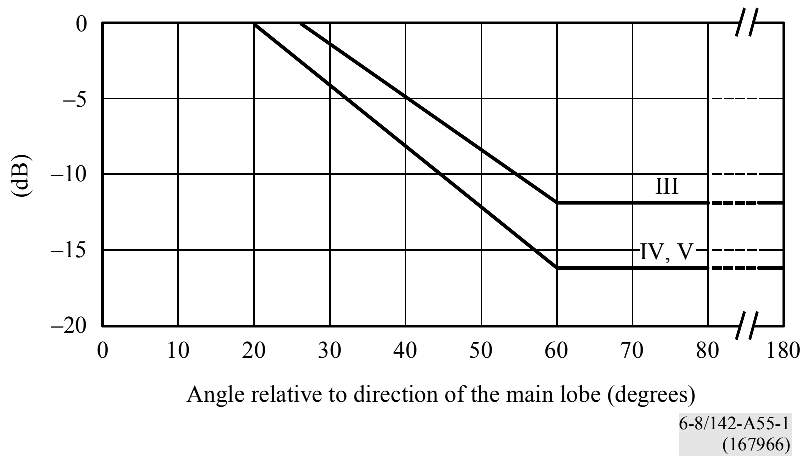
Standard radiation patterns for receiving antennas for Bands III, IV and V are given in Recommendation ITU-R BT.419 (see Fig. 3.3-1).

FIGURE 3.3-1

Directivity of receiving antennas for Bands III, IV and V

(Band I is not covered by this report)

(The number of the broadcasting band is shown on the curve)



3.3.1.2 Antenna gain

The antenna gain values (relative to a half-wave dipole) used in the derivation of the minimum median wanted signal levels are given in Table 3.3-1:

TABLE 3.3-1

Antenna gain (relative to a half-wave dipole) in Bands III, IV and V

Frequency (MHz)	200	500	800
Antenna gain (dB)	7	10	12

These values are considered as realistic minimum values.

Within any frequency band, the variation of antenna gain with frequency may be taken into account by the addition of a correction factor:

$$\text{Corr} = 10 \log (F_A/F_R)$$

where:

F_A: actual frequency being considered

F_R: relevant reference frequency quoted above.

3.3.1.3 Feeder loss

The feeder loss values used in the derivation of the minimum median wanted signal levels are given in Table 3.3-2.

TABLE 3.3-2

Feeder loss in Bands III, IV and V

Frequency (MHz)	200	500	800
Feeder loss (dB)	2	3	5

Measurements were carried out at the indicated frequencies.

The variation of feeder loss values with frequency in Bands IV and V is made by linear interpolation between the two extreme values.

3.3.1.4 Location probability for fixed reception

For fixed reception, a location probability of 95% should be used.

3.3.1.5 Polarization discrimination for fixed reception

It is possible to take advantage of polarization discrimination for fixed reception.

Referring to Note 3 in Recommendation ITU-R BT.419, in the case of orthogonal polarization the combined discrimination provided by directivity and orthogonality cannot be calculated by adding together the separate discrimination values. However, it has been found in practice that a combined discrimination value of 16 dB may be applied for all angles of azimuth in the terrestrial television Bands I to V.

3.3.2 Portable reception

Portable reception is defined in Chapter 1, § 1.6.11.

For planning purposes, it has been assumed that the antenna of a portable receiver is omnidirectional and that the gain (relative to a half-wave dipole) is 0 dB for a UHF antenna and −2.2 dB for a VHF antenna. A portable receiver can be assumed to have 0 dB feeder loss.

3.3.2.1 Considerations on height loss

For portable reception, the antenna height of 10 m above ground level generally used for planning purposes is not realistic and a correction factor needs to be introduced based on a receiving antenna near ground level. For this reason a receiving antenna height of 1.5 m above ground level (outdoor) or above floor level (indoor) has been assumed.

The field-strength values given by the land curves in Recommendation ITU-R P.1546-1 are for a reference receiving antenna at a height representative of the height of the ground cover surrounding the receiving antenna, subject to a minimum height value of 10 m. For planning purposes, the ground cover at the receiver location is generally not known and, hence, a receiving antenna at a height of 10 m in an open area is assumed. To correct the predicted values for a receiving height of 1.5 m above ground level, a factor called "height loss correction factor" has been introduced.

For planning purposes, the height loss values given in Table 3.3-3 should be used for portable and for mobile reception.

TABLE 3.3-3

Height loss in Bands III, IV and V

200 MHz	12 dB
500 MHz	16 dB
800 MHz	18 dB

These values are those obtained for suburban coverages and are used for the calculation of the portable and mobile reception cases. They are used in calculations of reference planning configurations (see § 3.6).

For other frequencies, linear interpolation should be used.

3.3.2.2 Considerations on building penetration loss

Portable reception can take place at outdoor and indoor locations. The field strength at indoor locations will be attenuated significantly by an amount depending on the materials and the construction of the building. A wide range of building penetration losses is to be expected.

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

TABLE 3.3-4

Building penetration loss in Bands III, IV and V

	Building penetration loss	Standard deviation
VHF	9 dB	3 dB
UHF	8 dB	5.5 dB

However, existing evidence that the loss could be even higher suggests that these values should be seen as lower limits.

Reception improvement may be achieved by means of active devices and/or more sophisticated solutions such as the antenna diversity proposed for digital terrestrial television. For frequency planning purposes, antenna diversity is not taken into account.

3.3.2.3 Location probability for portable reception

The location probability for T-DAB for indoor reception should be taken as 95%.

For DVB-T, a lower percentage of location probability may be used (from 70% to 95%).

3.3.2.4 Polarization discrimination for portable reception

Polarization discrimination is not taken into account in frequency planning for portable reception.

3.3.3 Mobile reception

Mobile reception is defined in Chapter 1, § 1.6.12.

The reference situation is defined as being reception of a digital signal while in motion, using an antenna situated at no less than 1.5 m above ground level.

A mobile receiver can be assumed to have a low feeder loss in all bands. The values for antenna gains (relative to a half-wave dipole) are initially assumed to be –2.2 dB in Band III and 0 dB in Bands IV and V. However, improvements may be achieved by means of active devices and/or more sophisticated solutions. Antenna diversity is a key technique for future mobile DVB-T compliant broadband multimedia receivers. The potential advantages of using antenna diversity for mobile reception are considerable, since for low-speed mobile reception a 6 to 8 dB gain in C/N values is expected. This should lead to improved robustness against variations in reception conditions.

For planning purposes, antenna diversity is not taken into account.

3.3.3.1 Location probability for mobile reception

For mobile reception, a location probability of 99% should be used.

3.3.3.2 Polarization discrimination for mobile reception

Polarization discrimination is not taken into account in planning for mobile reception.

3.3.4 T-DAB and DVB-T receiver noise figure

It is assumed that the noise figure of the receiver is the same for all reception modes, namely 7 dB.

3.4 Planning criteria

This section concerns the different criteria for planning digital terrestrial television systems (DVB-T) in Bands III, IV and V, with the addition of a digital terrestrial sound system (T-DAB) in Band III only.

The planning criteria consist of the following:

– *C*/*N* values;

– protection ratios;

– location correction factors and the percentage of time.

For planning the introduction of digital terrestrial broadcasting, it is usually necessary to restrict the interim planning studies to a representative subset of variants corresponding to particular *C*/*N* values.

3.4.1 *C*/*N* values for planning

For DVB-T the *C*/*N* values for the non-hierarchical mode should be taken from Table 3.4-1 below. The *C*/*N* values given for the Ricean channel should be used for the fixed reception case, and those for the Rayleigh channel should be used for the portable and mobile reception cases. For hierarchical modes, the *C*/*N* values can be found in Annex 3.4.

However, for the planning process, the possible DVB-T variants will be limited in number (see § 3.6).

TABLE 3.4-1

Required *C/N* for non-hierarchical transmission to achieve a BER = 2×10^{-4} after Viterbi decoding and net bit rate values (Mbit/s)

			Required *C/N* for BER = 2×10^{-4} after Viterbi decoding (quasi error-free after Reed-Solomon decoding)(1)			Net bit rate (Mbit/s) For different guard intervals (GI)			
System variant(2)	Modulation	Code rate	Gaussian channel	Ricean channel	Rayleigh channel	GI = 1/4	GI = 1/8	GI = 1/16	GI = 1/32
8 MHz variants									
A1	QPSK	1/2	3.1	3.6	5.4	4.98	5.53	5.85	6.03
A2	QPSK	2/3	4.9	5.7	8.4	6.64	7.37	7.81	8.04
A3	QPSK	3/4	5.9	6.8	10.7	7.46	8.29	8.78	9.05
A5	QPSK	5/6	6.9	8.0	13.1	8.29	9.22	9.76	10.05
A7	QPSK	7/8	7.7	8.7	16.3	8.71	9.68	10.25	10.56
B1	16-QAM (M1(1))	1/2	8.8	9.6	11.2	9.95	11.06	11.71	12.06
B2	16-QAM	2/3	11.1	11.6	14.2	13.27	14.75	15.61	16.09
B3	16-QAM	3/4	12.5	13.0	16.7	14.93	16.59	17.56	18.10
B5	16-QAM	5/6	13.5	14.4	19.3	16.59	18.43	19.52	20.11
B7	16-QAM	7/8	13.9	15.0	22.8	17.42	19.35	20.49	21.11
C1	64-QAM (M2(1))	1/2	14.4	14.7	16.0	14.93	16.59	17.56	18.10
C2	64-QAM (M3(1))	2/3	16.5	17.1	19.3	19.91	22.12	23.42	24.13
C3	64-QAM	3/4	18.0	18.6	21.7	22.39	24.88	26.35	27.14
C5	64-QAM	5/6	19.3	20.0	25.3	24.88	27.65	29.27	30.16
C7	64-QAM	7/8	20.1	21.0	27.9	26.13	29.03	30.74	31.67
7 MHz variants									
D1	QPSK	1/2	3.1	3.6	5.4	4.35	4.84	5.12	5.28
D2	QPSK	2/3	4.9	5.7	8.4	5.81	6.45	6.83	7.04
D3	QPSK	3/4	5.9	6.8	10.7	6.53	7.26	7.68	7.92
D5	QPSK	5/6	6.9	8.0	13.1	7.26	8.06	8.54	8.80
D7	QPSK	7/8	7.7	8.7	16.3	7.62	8.47	8.97	9.24
E1	16-QAM	1/2	8.8	9.6	11.2	8.71	9.68	10.25	10.56
E2	16-QAM	2/3	11.1	11.6	14.2	11.61	12.90	13.66	14.08
E3	16-QAM	3/4	12.5	13.0	16.7	13.06	14.52	15.37	15.83
E5	16-QAM	5/6	13.5	14.4	19.3	14.52	16.13	17.08	17.59
E7	16-QAM	7/8	13.9	15.0	22.8	15.24	16.93	17.93	18.47
F1	64-QAM	1/2	14.4	14.7	16.0	13.06	14.51	15.37	15.83
F2	64-QAM	2/3	16.5	17.1	19.3	17.42	19.35	20.49	21.11
F3	64-QAM	3/4	18.0	18.6	21.7	19.60	21.77	23.05	23.75
F5	64-QAM	5/6	19.3	20.0	25.3	21.77	24.19	25.61	26.39
F7	64-QAM	7/8	20.1	21.0	27.9	22.86	25.40	26.90	27.71

(1) ITU-R reference system variants (Recommendation ITU-R BT.1368).

(2) Identifiers of DVB-T variant used for non-hierarchical transmission.

For T-DAB, a *C*/*N* value of 15 dB is implicitly given in Recommendation ITU-R BS.1660 – Technical basis for planning of terrestrial digital sound broadcasting in the VHF band.

In the case of T-DAB, only portable indoor and mobile reception modes are relevant for planning purposes, and consequently, only the Rayleigh channel should be used. As already observed, the *C*/*N* values given are based on theoretical considerations.

3.4.2 Protection ratios

For DVB-T (vis-à-vis DVB-T, T-DAB and analogue television, and conversely), the protection ratios given in Recommendation ITU-R BT.1368 – Planning criteria for digital terrestrial television services in the VHF/UHF bands should be used.

For T-DAB vis-à-vis T-DAB, a value of 15 dB should be used.

For wanted T-DAB vis-à-vis DVB-T or analogue television, the protection ratios given in Recommendation ITU-R BS.1660 – Technical basis for planning of terrestrial digital sound broadcasting in the VHF band, should be used.

For wanted analogue television vis-à-vis T-DAB, the protection ratios given in Recommendation ITU-R BT.655 – Radio-frequency protection ratios for AM vestigial sideband terrestrial television systems interfered with by unwanted analogue vision signals and their associated sound signals, should be used.

3.4.3 Location correction factors and percentage of time

Due to the sharp degradation of quality that occurs when the required *C*/*I* is not attained, calculations involving high percentages of time and locations are required for the wanted field (and low percentages for the interfering signals). Therefore, an extra correction to the value derived from Recommendation ITU-R P.1546-1 curves is required.

Field-strength variations can be divided into macro-scale and micro-scale variations. The macro-scale variations relate to areas with linear dimensions of 10 m to 100 m or more and are mainly caused by shadowing and by multipath reflections from distant objects. The micro-scale variations relate to areas with dimensions of the order of a wavelength and are mainly caused by multipath reflections from nearby objects. As it may be assumed that, for portable reception, the position of the antenna can be optimized within the order of a wavelength, micro-scale variations will not be too significant for planning purposes. Another way to overcome these variations is the possibility of using a receiver with antenna diversity.

Macro-scale variations of the field strength are very important for coverage assessment. In general, a high target percentage for coverage will be required to compensate for the rapid failure rate of digital television and sound signals.

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

3.4.3.1 Signal variations at outdoor locations

Recommendation ITU-R P.1546-1 gives a standard deviation of 5.5 dB for wideband signals. This value is used for determining the field-strength variation at outdoor locations, as represented by the "location correction factor".

This location correction factor for macro-scale variations is therefore:

TABLE 3.4-2

Coverage target (location probability) (%)	Location correction factor (VHF and UHF) (dB)
99	13
95	9
70	3

For mobile reception it may be necessary to plan for a location probability of 99%. There is no need to take into account building penetration losses, but the specification of the channel model is more stringent than for portable reception.

3.4.3.2 Signal variations at indoor locations

The field-strength variation at indoor locations is the combined result of the outdoor variation and the variation due to building attenuation. These variations are likely to be uncorrelated. The standard deviation of the indoor field strength distribution can therefore be calculated by taking the square root of the sum of the squares of the individual standard deviations. At VHF, where the signal standard deviations are 5.5 dB and 3 dB respectively, the combined value is 6.3 dB. At UHF, where the signal standard deviations are both 5.5 dB, the combined value is 7.8 dB.

The location correction factor for macro-scale variations at indoor locations is given in Table 3.4-3:

TABLE 3.4-3

Coverage target (location probability) (%)	Location correction factor (VHF) (dB)	Location correction factor (UHF) (dB)
95	10	13
70	3	4

The overall field-strength prediction process must take account of the location variation.

3.4.4 Considerations regarding the minimum signal levels for planning

This section presents general considerations regarding the minimum signal levels for planning. Nevertheless § 3.6 presents reference planning configurations to enable administrations to reduce the number of variants to be taken into consideration.

When trying to build new digital terrestrial networks, the main questions are the evaluation of the service area and of the population served. These evaluations are made by estimating the level of the useful signals and the level of the interfering signals.

The minimum signal levels needed to overcome noise, usually expressed as the minimum receiver input power or the corresponding minimum equivalent receiver input voltage, do not take any propagation effects into account. However, it is necessary to take account of these effects when considering television or sound reception in a real environment.

Due to the very rapid transition from near perfect reception to no reception at all, it is necessary that the minimum required signal level be achieved at a high percentage of locations. For fixed or portable reception of digital television, these percentages have been set at 70% for "acceptable" and 95% for "good" reception. The latter value applies also if portable indoor digital sound reception is considered. The value of 99% has to be used for mobile reception of digital broadcasting signals. Minimum median signal levels may be derived, taking account of propagation factors, in order to ensure that the minimum values are achieved at the specified percentage of locations.

An example is given in Annex 3.5 (see Tables A.3.5-1 to A.3.5-3). The minimum median signal levels are calculated for:

– four different digital television receiving modes (fixed, portable outdoor, portable indoor at ground floor and mobile reception);
– different frequency bands;
– different representative *C*/*N* ratios;
– digital sound broadcasting for mobile and portable indoor receiving modes.

Representative *C*/*N* values are used for these examples. Results for any given system variant may be obtained by interpolation between the relevant representative values.

When evaluating the coverage area of an analogue television service using typical prediction tools, the value of the field strength specified at the edge of the coverage area is a mean value. It represents the average value of all the actual values of the field strength that could be measured within a small area, usually taken to be 100 m × 100 m. This means that in this small area, about half of the actual values of the field strength are below this mean value and about half are above this value. For analogue television, if the value of, say, 67 dB(μV/m) is specified as the lower limit of the mean value, that implies that lower-than-average values of the field strength can be found inside the small area. However, if 67 dB(μV/m) corresponds to grade 4 for the picture quality according to the ITU scale, a lower value of field strength will give a somewhat lower quality because of the smooth degradation of analogue reception in the presence of noise or interference. A reduction of about 6 dB for the *C*/*N* or *C*/*I* will lead to a loss of one grade of picture quality. Thus, at the edge of the service area, even if the actual value of the wanted field strength is below the specified limit value, a picture will still be received but with a lower quality. We can say that the inherent assumption for analogue television is that the “average” quality is grade 4 at the edge of the service area.

For digital broadcasting, it is known that the behaviour of the receiver is completely different. When the signal level decreases and the *C*/*N* or *C*/*I* falls below a given “minimum” value, the television or sound programme disappears completely if there is a further signal level reduction of less than about 1 dB. This behaviour is generally referred to as the rapid failure characteristic of the digital system and the limit value of the field strength is designated as the minimum field strength. This is due to the fact that there is no smooth degradation for digital receivers; the picture quality changes rapidly from grade 5 to grade 0, without any intermediate levels of quality. If the same coverage definition as for analogue systems were used for digital systems, this would mean that 50% of the locations would not be served at or near the edge of the service area or in any other areas of reduced signal caused by local obstructions. This value of only 50% of locations receiving a programme is clearly unacceptable, and higher values of the percentage of locations have to be selected in order to allow reception in a larger number of households with a standard receiving installation, or in other receiving situations. The exact value chosen depends on the target level of service quality, and that is why values can be different from one country to another, or even from one service provider to another within a given country.

Nevertheless, values of 70%, 95% and 99% of locations have been chosen for digital television, depending on the reception conditions. For digital sound broadcasting, values of 95% and 99% of locations are recommended for planning.

3.4.5 Minimum median power flux-density and minimum median field strength values

The minimum median power flux-density values and the corresponding minimum median field strength values are calculated for different frequency bands and for different conditions of percentage of location and for representative *C*/*N* ratios.

Illustrations of calculations for minimum median power flux-density values and minimum median field strength values are given in Annex 3.5 for DVB-T and T-DAB.

3.4.6 Reference parameters for field strength representation

For the different reception modes, the field strengths required to provide the desired location probability for reception of the wanted signal can best be compared by using a reference receiving antenna height, location probability and percentage of time, as follows:

– Receiving antenna height: 10 m above ground level
– Location probability: 50%
– Percentage of time: 50%.

The field strengths corresponding to these conditions are termed the “minimum median field strengths”.

3.5 Spectrum mask

The spectrum mask is inherent to digital broadcasting systems and must be taken into account for efficient frequency planning.

In order to avoid excessive out-of-band emissions and to allow implementations adjacent to broadcasting channels or to other services, a technical description of spectrum masks is given below.

3.5.1 Spectrum mask for digital sound broadcasting (T-DAB)

Recommendation ITU-R BS.1114-5 – Systems for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz, gives the spectrum mask for T-DAB.

3.5.2 Spectrum mask for digital television (DVB-T)

3.5.2.1 Symmetrical spectrum mask for DVB-T in 8 MHz and 7 MHz channels

For digital television transmitters using the channels adjacent to other services (low power or receive only), the spectrum mask may not give enough attenuation on the side of the digital television channel falling in the frequency band where the other service operates (see Chapter 4 – Compatibility with other primary services).

In such cases, special spectrum masks have to be defined, based on the characteristics of the other service and the distance between the digital television transmitter and the service area (or receiving installation) of the other service. It must be borne in mind, however, that spectrum mask filters showing a higher attenuation close to the digital television channel will be very expensive and imply a higher insertion loss.

Two symmetrical spectrum masks are shown in Fig. 3.5-1 and the associated Table 3.5-1. The mask having a shoulder attenuation of 40 dB is intended for non-critical cases, and the mask with a shoulder attenuation of 50 dB is intended for sensitive cases.

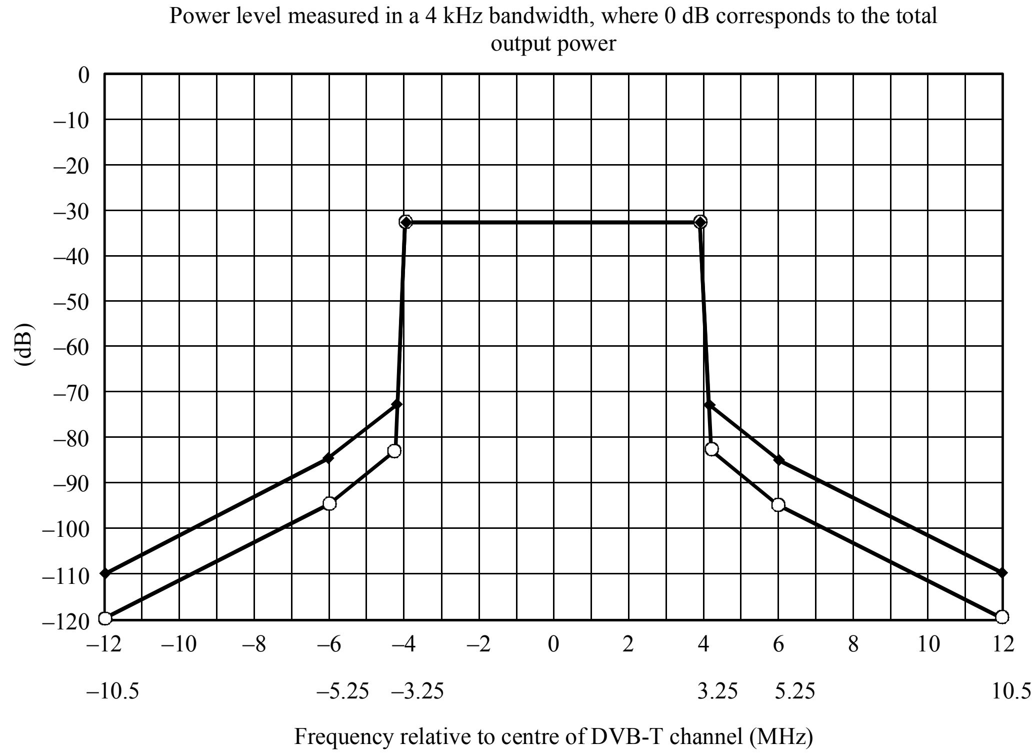
The mask for non-critical cases should also be used for measurements of protection ratios for analogue television interfered with by DVB-T.

The shape of the masks has been established on the following basis:

- the natural spectrum of a 7.6 MHz OFDM signal (for 8 MHz channels) and a 6.7 MHz OFDM signal (for 7 MHz channels);
- the amplitude response of an IF SAW-filter;
- the power amplifier of the transmitter produces intermodulation outside the channel at a level limited by the amount of intermodulation acceptable inside the channel;
- the mask for sensitive cases also includes the amplitude response of a six-cavity band pass filter at the output of the transmitter.

FIGURE 3.5-1

Symmetrical spectrum masks for non-critical and sensitive cases



Upper scale = 8 MHz channel; lower scale = 7 MHz channel
Upper curve: non-critical cases; lower curve: sensitive cases

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(180229)

TABLE 3.5-1

Symmetrical spectrum masks for non-critical and sensitive cases

Breakpoints					
8 MHz channels			**7 MHz channels**		
	Non-critical cases	**Sensitive cases**		**Non-critical cases**	**Sensitive cases**
Relative frequency (MHz)	**Relative level (dB)**	**Relative level (dB)**	**Relative frequency (MHz)**	**Relative level (dB)**	**Relative level (dB)**
–12	–110	–120	–10.5	–110	–120
–6	–85	–95	–5.25	–85	–95
–4.2	–73	–83	–3.7	–73	–83
–3.9	–32.8	–32.8	–3.35	–32.8	–32.8
+3.9	–32.8	–32.8	+3.35	–32.8	–32.8
+4.2	–73	–83	+3.7	–73	–83
+6	–85	–95	+5.25	–85	–95
+12	–110	–120	+10.5	–110	–120

3.5.2.2 Asymmetrical spectrum mask for DVB-T in 8 MHz and 7 MHz channels

In the starting phase of terrestrial digital television, channels will have to be found mainly between those already in use for analogue television. In some cases, it will be necessary to use channels adjacent to existing analogue television channels. To avoid interference into the analogue television services, it is considered important to limit the out-of-channel emissions from digital television transmitters as much as possible. This leads to a need for defined spectrum masks for digital television transmitters.

Examples of asymmetrical DVB-T masks for 8 and 7 MHz systems appropriate for ensuring compatibility between broadcasting services are given in Annex 3.6. They allow for a digital transmitter to use an adjacent channel of an analogue TV transmitter with the assumption that they are co-sited and radiating the same power.

3.6 Network structure and configurations

3.6.1 General considerations

3.6.1.1 Typical digital terrestrial broadcasting configurations: MFN, SFN or mixed MFN-SFN

In digital terrestrial broadcasting planning there are many more criteria and parameters to be considered than in analogue planning. The planning criteria and parameters should be limited to a number of essential reference configurations in order to enable planning exercises to be conducted in a limited time-frame.

For digital terrestrial broadcasting systems such as DVB-T and T-DAB, there are many possible options for implementing networks. For example, there is a choice of criteria: digital terrestrial broadcasting variants in the case of television, or transmission modes in the case of sound. Also, there is a choice of parameters for the infrastructure: MFNs, SFNs or mixed MFN-SFN.

SFNs can be implemented by one of two types of structure. One is called an “open” and the other a “closed” network. It is assumed that both types of network are designed to provide the minimum wanted field strength at the boundary of the coverage area.

– In an open network, no measures are taken to minimize the level of radiation towards areas outside the coverage area. In the limiting case, an open network can consist of just a single transmitter.

– In a closed network, the level of radiation towards areas outside the coverage area is deliberately reduced without reduction of the coverage of the intended area. This can be achieved by using directional antennas at transmitting stations near the periphery of the coverage area.

In a real network covering a large area, there will be considerable distances between the transmitters. If such a network is designed as a closed network, it will cause less interference at a given distance outside its coverage area than if it had been designed as an open network. The reason for this is that the level of interference is mainly determined by the radiated power from the transmitters closest to the boundary of the coverage area in the direction considered.

However, in a closed network covering a small area, the radiated power from transmitters on the side of the coverage area opposite to the direction considered contributes relatively more to the outgoing interference level than in a closed network covering a large area. Thus, the use of directional transmitting antennas at transmitters near the boundary of the coverage area brings less advantage than in the case of networks covering larger areas.

It follows from the above that, for relatively large coverage areas, the separation distance between co-channel areas will generally be less for closed networks than for open ones. For smaller coverage areas, the separation distance for closed networks approaches that for open networks.

To date, SFN structures have been used in implementing T-DAB and some DVB-T networks.

3.6.1.2 Transmitting sites (distance between sites and effective radiated power)

Digital terrestrial broadcasting can use existing sites, new sites, or alternative network architectures. These parameters thus affect the choice of digital terrestrial broadcasting variant and the frequency requirements. In some countries, it is intended to use the same sites for digital as for analogue (with the possibility of establishing local high-density SFN).

The number of transmitter sites deployed and the separation distances will vary significantly from country to country and will depend on the system variant, the reception mode (fixed, portable or mobile), the size of the country and boundary situations. For digital terrestrial broadcasting, the distance between transmitter sites may vary between 30 and 50 km in the most populated areas or in hilly areas, and between 75 and 125 km in less populated areas or less hilly areas.

In an SFN using appropriate digital terrestrial broadcasting standards, the separation distance between transmitters influences the choice of guard interval, which in turn limits the size of the network. The separation distance and the effective height influence the e.r.p.

In the case of SFNs, the use of “dense networks” can offer some advantages over networks based on high-power transmitters separated by large distances (sixty to several hundred kilometres).

Particularly in the case of regional SFNs, but also for national SFNs, it is possible to consider various forms of dense networks, with all of the transmitters using the same channel, but having significantly lower e.r.p. than that required by a single transmitter serving the same area. For digital terrestrial broadcasting, the concept of “distributed emission” can provide the needed field strength over the entire service area with a number of low-power, synchronized SFN transmitters located on a more-or-less regular lattice. It is also possible to use on-channel repeaters receiving their signal off-air from the main transmitter, to improve the coverage of the main transmitter. In the latter case, the repeaters need not be synchronized in time, and no parallel transmission infrastructure is needed to bring the signal to them.

Furthermore, local high-density SFNs could be used to supplement large SFNs in areas where the coverage would otherwise be inadequate, due to the orography. Finally, they offer a reduction of the impact of co-channel interference at the border of the service area, by introducing a sharper field strength roll-off. This can be further improved by suitable use of transmitting antenna directivity.

For example, it is possible to envisage transmitter topologies in which the central part of the service area is covered by a large SFN (with high-power transmitters separated by large distances), but near the border a dense transmitter network is installed (with low e.r.p. and with low-height and directive antennas). This allows the e.r.p. to be "tailored" according to the service area contour, reducing the interference to adjacent areas and maintaining a high level of service availability inside the service area. This technique can also be useful on the borders of national SFNs.

3.6.1.3 Transmitting antenna types and radiation patterns

Transmitting antennas will have an omnidirectional or directional pattern. For the stations located along or close to country borders or sea borders, directional antennas should preferably be used to reduce interference outside service areas. This will reduce the re-use distance for the frequencies in question, and protect coverage areas of existing television stations. This is especially true for high-power and medium-power stations and will in general result in a more efficient use of the frequency spectrum.

Beam-tilt, applied to antennas with an effective height of more than 100 m, is an efficient tool to target the radiated power of high-power stations to the inner part of the coverage area and, at the same time, reduces the interference potential at large distances and to the aeronautical service.

Recommendation ITU-R BS.1195 – Transmitting antenna characteristics at VHF and UHF, might be used as a source of comprehensive information on the characteristics of VHF and UHF transmitting antenna systems for frequency planning. The transmitting antenna radiation patterns are normalized to 0 dB.

3.6.1.4 Factors influencing the distance between transmitters

There are several factors that influence the distance between transmitters, for example radiated power, antenna height, reception mode, system variant and propagation path. It must be noted that these may be different for different reference networks. In SFNs, the distance between adjacent transmitters is limited by the length of the guard interval.

3.6.1.5 Factors influencing the separation distance between transmitters

The separation distance between transmitters has a significant influence on the number of frequency blocks or channels needed to establish coverage of a larger area encompassing several countries or regions, each having its own programmes transmitted in one frequency block or channel.

Coverage areas served by transmitters located along the periphery and using directive antennas pointing inwards (i.e., a closed network) will result in somewhat shorter separation distances compared to equivalent coverage achieved by the use of non-directional antennas (i.e., an open network). In the case of propagation paths with a significant amount of sea, separation distances will be larger than for land-only paths.

3.6.2 Reference planning configurations

3.6.2.1 General

T-DAB and DVB-T offer the freedom to implement a large variety of broadcast service options. For DVB-T in particular, several thousand planning configurations could be thought of by combining the various possible modulation schemes, code rates, fast Fourier transform (FFT) modes, guard intervals, reception modes, coverage quality classes, network approaches, etc. Thus, a planning configuration describes the sum of all relevant technical aspects of a broadcasting service implementation. The various aspects of a planning configuration, for the example of DVB-T, are summarized in Table 3.6-1.

TABLE 3.6-1

Aspects of DVB-T planning configurations

Aspect	Element
Reception mode	Fixed roof-level Portable outdoor Portable indoor Mobile
Coverage quality (in terms of percentage of locations)	70% 95% 99%
Network structure	MFN (single transmitter) SFN Dense SFN
DVB-T system variant	from QPSK-1/2 to 64-QAM-7/8
Frequency band	Band III (200 MHz) Band IV (500 MHz) Band V (800 MHz)

However, a large number of these theoretically possible combinations make little or no sense, from an economic, a technical or a frequency-management point of view.

Moreover, seen from the point of view of compatibility analysis, which is the major issue in producing a frequency plan, a large number of the realistic and meaningful planning configurations can be treated as equivalent, since they differ little or not at all in terms of compatibility aspects.

For frequency planning purposes, a reduction to a very small number of so-called reference planning configurations (RPCs) is possible, which then are abstract in the sense that they no longer correspond to specific real planning configurations. Thus, a reference planning configuration represents a T-DAB or a DVB-T implementation with the parameters of a typical planning configuration.

3.6.2.2 Reference planning configurations for DVB-T

For DVB-T, a grouping of planning configurations can be found which are governed by the reception mode aspect and the frequency band aspect:

– fixed reception;

– portable outdoor reception, mobile reception and lower coverage quality portable indoor reception;

– higher coverage quality portable indoor reception.

For reference frequencies:

– 200 MHz (VHF);

– 650 MHz (UHF).

The grouping assumes that, for fixed reception, less rugged DVB-T variants with a high data capacity are used. This is possible since the transmission channel is less difficult in this case than for portable or mobile reception. In the latter case, more rugged DVB-T variants are assumed, this being necessary in order to overcome the adverse effects of the portable or mobile transmission channel. However, this higher ruggedness has to be paid for with less data capacity.

In this way, for DVB-T, a reduction of the large number of possible planning configurations to three RPCs for each of the two reference frequencies is achieved, which facilitates the establishment of the frequency plan and the definition of coordination procedures.

The reference planning configurations are summarized in Table 3.6-2.

TABLE 3.6-2

RPCs for DVB-T

RPC	RPC 1	RPC 2	RPC 3
Reference location probability	95%	95%	95%
Reference *C/N* (dB)	21	19	17
Reference $(E_{med})_{ref}$ (dB(μV/m)) at 200 MHz	50	67	76
Reference $(E_{med})_{ref}$ (dB(μV/m)) at 650 MHz	56	78	88

$(E_{med})_{ref}$: minimum median equivalent field strength

RPC 1: RPC for fixed roof-level reception

RPC 2: RPC for portable outdoor reception or lower coverage quality portable indoor reception or mobile reception

RPC 3: RPC for higher coverage quality for portable indoor reception.

For other frequencies, interpolation of the previous proposed reference field-strength values should follow the following rules: For other frequencies, interpolation of the previous proposed reference field-strength values should follow the following rules:

– for fixed reception, Corr = 20 log (f/f_r), where f is the actual frequency and f_r the reference frequency of the relevant band quoted above;

– for portable reception and mobile reception, Corr = 30 log (f/f_r) where f is the actual frequency and f_r the reference frequency of the relevant band quoted above.

The reference parameters of the RPC that are given in Table 3.6-2 (location probability, *C*/*N*, minimum median field strength) are not associated with a particular DVB-T system variant or a real DVB-T network implementation; rather, they stand for a large number of different real implementations. For instance, a DVB-T service for mobile reception might use as real implementation parameters a location probability of 99% and a rugged DVB-T variant with a *C*/*N* of 14 dB. Nevertheless, this service will be represented by RPC 2 with a reference location probability of 95% and a reference *C*/*N* of 19 dB without restricting the possibilities for the implementation of the “real” service for mobile DVB-T reception.

Typically, a data capacity of about 20-27 Mbit/s is associated with RPC 1, about 8-24 Mbit/s with RPC 2, and about 13-16 Mbit/s with RPC 3. However, it is to be emphasized that there is a trade-off between coverage and data capacity. An increase of the coverage area can be achieved within an RPC when a more rugged DVB-T variant is chosen which is accompanied by a reduction of the data capacity, and vice versa.

For a compatibility analysis, protection ratios for the concerned services are needed. Since the RPCs represent artificial configurations, there do not exist measurements for the appropriate protection ratios. Instead, it is recommended to use the following values:

– for DVB-T against DVB-T analysis, the respective value of the reference *C*/*N* in Table 3.6-2 as the protection ratio;

– in other cases:
  – for RPC 1, protection ratio values for DVB-T variant 64-QAM 3/4, to be found in Recommendation ITU-R BT.1368;
  – for RPC 2, protection ratio values for DVB-T variant 16-QAM 3/4, to be found in Recommendation ITU-R BT.1368;
  – for RPC 3, protection ratio values for DVB-T variant 16-QAM 2/3, to be found in Recommendation ITU-R BT.1368.

3.6.2.3 Reference planning configurations for T-DAB

For T-DAB, the situation is simpler, since there is not a large variety of possible planning configurations. Frequency planning will be performed for mobile or portable indoor reception and an average channel code rate $R = 0.5$ (see Recommendation ITU-R BS.1114).

Two RPCs are available for T-DAB in Band III:

TABLE 3.6-3

RPCs for T-DAB

Reference planning configuration	RPC 4	RPC 5
Location probability	99%	95%
Reference *C/N* (dB)	15	15
Reference $(E_{med})_{ref}$ (dB(μV/m)) at 200 MHz	60	66

$(E_{med})_{ref}$: minimum median equivalent field strength

RPC 4: RPC for mobile reception

RPC 5: RPC for portable indoor reception

The relevant protection ratios for compatibility calculations are given in § 3.4.2.

3.6.3 Reference networks

3.6.3.1 General considerations

A basic task when establishing a frequency plan is to perform compatibility analyses between transmitters and/or networks. For such calculations, the characteristics of the transmitters have to be known. If a requirement is given in assignment form, these characteristics are available.

However, there will be cases where the exact transmitter characteristics of a network will not be known at the time when a frequency plan is to be established. This will in particular be true for the case of SFN implementations where the service area may already be known, but not yet the exact number, locations and powers of the SFN transmitters. Despite this lack of such information, it is necessary to perform the compatibility calculations in order to establish the plan. For this purpose, it is useful to define generic network structures which may represent the as yet unknown real networks in a compatibility analysis. Such generic networks are called reference networks.

Three RPCs have been selected for Bands III and IV/V for DVB-T and two for T-DAB in Band III. For each of them, reference networks have been developed, and the properties of these reference networks will be different according to the characteristics of the associated RPCs.

Reference networks are regarded as idealized approximations of real network implementations. They exhibit a high degree of geometrical symmetry and homogeneity with regard to transmitter characteristics. They can be characterized by the following parameters:

– Number of transmitters
– Distance between transmitters
– Transmitter network geometry
– Transmitter power
– Transmitter antenna height
– Transmitter antenna pattern
– Service area (area to be covered).

Reference networks facilitate the compatibility analysis and plan synthesis in frequency planning. Their main purpose is to determine interference potentials and interference susceptibilities of typical DVB-T or T-DAB, which are the basic input for a compatibility calculation between service areas and hence fundamental to the production of a frequency plan.

It has to be emphasized that real networks, as implemented, by no means need to have the same characteristics as the reference network– whether in terms of the number of transmitters, of transmitter locations, of transmitter powers, or of any other property of the reference network – as long as the real network implementation complies with the interference potential restriction that is associated with the relevant reference network.

3.6.3.2 Single reference transmitter

A single artificial reference transmitter, in the case of the MFN approach, would be the simplest representative of a reference "network". However, in the majority of cases of a single-transmitter requirement, the characteristics of the transmitter are already known – and if not, they can easily be calculated from the intended service area properties. Therefore, in the single-transmitter case, there is no need to define an artificial "reference transmitter"; rather, the "real" transmitter properties can be used in the compatibility analysis. Thus, if a requirement is given in assignment form, the compatibility analysis will be made on the basis of the required transmitter properties.

3.6.3.3 Reference SFN

SFNs are intended to cover larger service areas than those of single transmitters, and in general not all of the SFN transmitters and their characteristics will be known at the stage of the establishment of the frequency plan. Moreover, these transmitter characteristics are not necessarily needed in an allotment planning approach at the stage of the establishment of the frequency plan. Compatibility calculations may be performed by means of reference networks as described above. Where the real transmitter locations and other characteristics are known, these should be used in compatibility calculations in the SFN case. A detailed description of reference networks is given in Annex 3.7.

3.6.3.4 Interference potential

The interference potential of a transmitter or a transmitter network is the outgoing interference that is produced by the transmitter or the transmitter network. If, in the planning process, the real interference potential of a network is not known, the interference potential of a reference network may be taken as representative of the real interference potential.

The interference potential of a reference network may be represented by a field-strength curve which is calculated by summing the interfering field strengths of the transmitters of the reference network along a line directed outwards from the reference network and starting at the border of the service area of that reference network. The summation can be performed by means of the power sum method or a statistical summation method.

In a compatibility analysis, the interference potential curve may be used to calculate the hypothetical interference at a certain location, by assuming that the test points on the border of the service area of the network under consideration are – one by one – the source of interference. The highest interfering field-strength value is then taken as representative of the interference at that location. Of course, a direct evaluation of the interference produced by the reference network transmitters at that location is also possible in a compatibility analysis, after having defined the exact position of the reference network with regard to the boundary test point.

ANNEX 3.1

List of terrestrial broadcasting systems in the VHF and UHF bands

TABLE A.3.1-1

VHF System B

Used in the following geographical areas:

ALB, ALG, ARS, AUT, BEL, BHR, BIH, CME, CNR, CVA, CYP, D, DJI, DNK, E, EGY, ERI, ETH, FIN, FRO, GHA, GIB, GNB, GNE, GRC, HOL, HRV, IRN, IRQ, ISL, ISR, JOR, KEN, KWT, LBN, LBR, LBY, LIE, LUX, MAU, MDR, MKD, MLI, MLT, MTN, NIG, NOR, OMA, POR, QAT, RRW, S, SCG, SDN, SEY, SOM, SRL, STP, SUI, SVN, SYR, TCD, TUN, TUR, UAE, UGA, YEM, ZMB

Channel	Channel boundaries (MHz)		Assigned frequency (MHz)	Vision carrier (MHz)	Sound carrier (MHz)	Dual FM second sound carrier (MHz)	NICAM carrier (MHz)
5	174	181	177.50	175.25	180.75	180.99	181.1
6	181	188	184.50	182.25	187.75	187.99	188.1
7	188	195	191.50	189.25	194.75	194.99	195.1
8	195	202	198.50	196.25	201.75	201.99	202.1
9	202	209	205.50	203.25	208.75	208.99	209.1
10	209	216	212.50	210.25	215.75	215.99	216.1
11	216	223	219.50	217.25	222.75	222.99	223.1
12	223	230	226.50	224.25	229.75	229.99	230.1
13*	230	237	233.50	231.25	236.75	236.99	237.1
14*	246.18	253.18	249.68	247.43	252.63	252.87	252.98

* Used in ZMB only (outside the planned bands for RRC).

TABLE A.3.1-2

VHF System B

Used in the following geographical areas:

I, SMR

Channel	Channel boundaries (MHz)		Assigned frequency (MHz)	Vision carrier (MHz)	Sound carrier (MHz)	Dual FM second sound carrier (MHz)
D	174.00	181.00	177.50	175.25	180.75	180.99
E	182.50	189.50	186.00	183.75	189.25	188.49
F	191.00	198.00	194.50	192.25	197.75	197.99
G	200.00	207.00	203.50	201.25	206.75	206.99
H	209.00	216.00	212.50	210.25	215.75	215.99
H1	216.00	223.00	219.50	217.25	222.75	222.99
H2	223.00	230.00	226.50	224.25	229.75	229.99

TABLE A.3.1-3

VHF System B

Used in the following geographical area:

MRC

Channel	Channel boundaries (MHz)		Assigned frequency (MHz)	Vision carrier (MHz)	Sound carrier (MHz)
4*	162	169	165.50	163.25	168.75
5*	170	177	173.50	171.25	176.75
6	178	185	181.50	179.25	184.75
7	186	193	189.50	187.25	192.75
8	194	201	197.50	195.25	200.75
9	202	209	205.50	203.25	208.75
10	210	217	213.50	211.25	216.75
11	216	223	219.50	217.25	222.75
12	223	230	226.50	224.25	229.75

* Outside the planned bands (or partially outside) for RRC.

TABLE A.3.1-4

VHF System B1

Used in the following geographical areas:

EST, SVK

Channel	Channel boundaries (MHz)		Assigned frequency (MHz)	Vision carrier (MHz)	Sound carrier (MHz)	Dual FM second sound carrier (MHz)	NICAM carrier (MHz)
6	174	182	178.00	175.25	180.75	180.99	181.1
7	182	190	186.00	183.25	188.75	188.99	189.1
8	190	198	194.00	191.25	196.75	196.99	197.1
9	198	206	202.00	199.25	204.75	204.99	205.1
10	206	214	210.00	207.25	212.75	212.99	213.1
11	214	222	218.00	215.25	220.75	220.99	221.1
12	222	230	226.00	223.25	228.75	228.99	229.1

TABLE A.3.1-5

VHF System D

Used in the following geographical areas:

ARM, AZE, BLR, BUL, CZE, GEO, HNG, KAZ, KGZ, LTU, LVA, MDA, ROU, RUS, SVK, TJK, TKM, UKR, UZB

VHF System D1

Used in the following geographical areas:

LTU, LVA, POL

VHF System K1

Used in the following geographical areas:

BDI, BEN, BFA, CAF, COD, COG, COM, CPV, CTI, GAB, GUI, MDG, MYT, NGR, REU, SEN, TGO

Channel System K1	Channel Systems D and D1	Channel boundaries (MHz)		Assigned frequency (MHz)	Vision carrier (MHz)	Sound carrier (MHz)	NICAM carrier (MHz)
	6A*	173	181	177.00	174.25	180.75	180.10
5	6	174	182	178.00	175.25	181.75	181.10
6	7	182	190	186.00	183.25	189.75	189.10
7	8	190	198	194.00	191.25	197.75	197.10
8	9	198	206	202.00	199.25	205.75	205.10
9	10	206	214	210.00	207.25	213.75	213.10
10	11	214	222	218.00	215.25	221.75	221.10
11	12	222	230	226.00	223.25	229.75	229.10

* System D only.

TABLE A.3.1-6

VHF System I

Used in the following geographical areas:

AFS, AGL, ASC, BOT, G, GMB, IRL, LSO, MWI, NMB, SHN, TRC, TZA

Channel GE89	Channel ST61	Channel boundaries (MHz)		Assigned frequency (MHz)	Vision carrier (MHz)	Sound carrier (MHz)	NICAM carrier (MHz)
5	D	174	182	178.00	175.25	181.25	181.80
6	E	182	190	186.00	183.25	189.25	189.80
7	F	190	198	194.00	191.25	197.25	197.80
8	G	198	206	202.00	199.25	205.25	205.80
9	H	206	214	210.00	207.25	213.25	213.80
10	J	214	222	218.00	215.25	221.25	221.80
11	K	222	230	226.00	223.25	229.25	229.80
12*	-	230	238	234.00	231.25	237.25	237.80
13*	-	246.18	254.18	250.18	247.43	253.43	253.98

* Used in AFS, BOT, MWI, NMB only (outside the planned bands for RRC).

TABLE A.3.1-7

VHF System L

Used in the following geographical area:

F

Channel	Channel boundaries (MHz)		Assigned frequency (MHz)	Vision carrier (MHz)	Sound carrier (MHz)	NICAM carrier (MHz)
5	174.75	182.75	178.75	176.00	182.50	181.85
6	182.75	190.75	186.75	184.00	190.50	189.85
7	190.75	198.75	194.75	192.00	198.50	197.85
8	198.75	206.75	202.75	200.00	206.50	205.85
9	206.75	214.75	210.75	208.00	214.50	213.85
10	214.75	222.75	218.75	216.00	222.50	221.85

TABLE A.3.1-8

VHF System G

Used in the following geographical areas:

MOZ, SWZ, ZWE

Channel	Channel boundaries (MHz)		Assigned frequency (MHz)	Vision carrier (MHz)	Sound carrier (MHz)
5	174.00	182.00	178.00	175.25	180.75
6	182.00	190.00	186.00	183.25	188.75
7	190.00	198.00	194.00	191.25	196.75
8	198.00	206.00	202.00	199.25	204.75
9	206.00	214.00	210.00	207.25	212.75
10	214.00	222.00	218.00	215.25	220.75
11	222.00	230.00	226.00	223.25	228.75
12*	230.00	238.00	234.00	231.25	236.75
13*	246.18	254.18	250.18	247.43	252.93

* Used in MOZ and ZWE only (outside the planned bands for RRC).

TABLE A.3.1-9

UHF Systems D1, G, H, I, I1, K, K1 and L

Channel	Channel boundaries (MHz)		Vision carrier (MHz)	System G, H sound carrier (MHz)	System G dual FM second sound carrier (MHz)	System G System L System D1 NICAM carrier (MHz)	System I System I1 sound carrier (MHz)	System K System K1 System L System D1 sound carrier (MHz)	System I System I1 NICAM carrier (MHz)
21	470	478	471.25	476.75	476.99	477.1	477.25	477.75	477.8
22	478	486	479.25	484.75	484.99	485.1	485.25	485.75	485.8
23	486	494	487.25	492.75	492.99	493.1	493.25	493.75	493.8
24	494	502	495.25	500.75	500.99	501.1	501.25	501.75	501.8
25	502	510	503.25	508.75	508.99	509.1	509.25	509.75	509.8
26	510	518	511.25	516.75	516.99	517.1	517.25	517.75	517.8
27	518	526	519.25	524.75	524.99	525.1	525.25	525.75	525.8
28	526	534	527.25	532.75	532.99	533.1	533.25	533.75	533.8
29	534	542	535.25	540.75	540.99	541.1	541.25	541.75	541.8
30	542	550	543.25	548.75	548.99	549.1	549.25	549.75	549.8
31	550	558	551.25	556.75	556.99	557.1	557.25	557.75	557.8
32	558	566	559.25	564.75	564.99	565.1	565.25	565.75	565.8
33	566	574	567.25	572.75	572.99	573.1	573.25	573.75	573.8
34	574	582	575.25	580.75	580.99	581.1	581.25	581.75	581.8
35	582	590	583.25	588.75	588.99	589.1	589.25	589.75	589.8
36	590	598	591.25	596.75	596.99	597.1	597.25	597.75	597.8
37	598	606	599.25	604.75	604.99	605.1	605.25	605.75	605.8
38	606	614	607.25	612.75	612.99	613.1	613.25	613.75	613.8
39	614	622	615.25	620.75	620.99	621.1	621.25	621.75	621.8
40	622	630	623.25	628.75	628.99	629.1	629.25	629.75	629.8
41	630	638	631.25	636.75	636.99	637.1	637.25	637.75	637.8
42	638	646	639.25	644.75	644.99	645.1	645.25	645.75	645.8
43	646	654	647.25	652.75	652.99	653.1	653.25	653.75	653.8
44	654	662	655.25	660.75	660.99	661.1	661.25	661.75	661.8
45	662	670	663.25	668.75	668.99	669.1	669.25	669.75	669.8
46	670	678	671.25	676.75	676.99	677.1	677.25	677.75	677.8
47	678	686	679.25	684.75	684.99	685.1	685.25	685.75	685.8
48	686	694	687.25	692.75	692.99	693.1	693.25	693.75	693.8
49	694	702	695.25	700.75	700.99	701.1	701.25	701.75	701.8
50	702	710	703.25	708.75	708.99	709.1	709.25	709.75	709.8
51	710	718	711.25	716.75	716.99	717.1	717.25	717.75	717.8
52	718	726	719.25	724.75	724.99	725.1	725.25	725.75	725.8
53	726	734	727.25	732.75	732.99	733.1	733.25	733.75	733.8

TABLE A.3.1-9 (*end*)

Channel	**Channel boundaries (MHz)**		**Vision carrier (MHz)**	**System G, H sound carrier (MHz)**	**System G dual FM second sound carrier (MHz)**	**System G System L System D1 NICAM carrier (MHz)**	**System I System I1 sound carrier (MHz)**	**System K System K1 System L System D1 sound carrier (MHz)**	**System I System I1 NICAM carrier (MHz)**
54	734	742	735.25	740.75	740.99	741.1	741.25	741.75	741.8
55	742	750	743.25	748.75	748.99	749.1	749.25	749.75	749.8
56	750	758	751.25	756.75	756.99	757.1	757.25	757.75	757.8
57	758	766	759.25	764.75	764.99	765.1	765.25	765.75	765.8
58	766	774	767.25	772.75	772.99	773.1	773.25	773.75	773.8
59	774	782	775.25	780.75	780.99	781.1	781.25	781.75	781.8
60	782	790	783.25	788.75	788.99	789.1	789.25	789.75	789.8
61	790	798	791.25	796.75	796.99	797.1	797.25	797.75	797.8
62	798	806	799.25	804.75	804.99	805.1	805.25	805.75	805.8
63	806	814	807.25	812.75	812.99	813.1	813.25	813.75	813.8
64	814	822	815.25	820.75	820.99	821.1	821.25	821.75	821.8
65	822	830	823.25	828.75	828.99	829.1	829.25	829.75	829.8
66	830	838	831.25	836.75	836.99	837.1	837.25	837.75	837.8
67	838	846	839.25	844.75	844.99	845.1	845.25	845.75	845.8
68	846	854	847.25	852.75	852.99	853.1	853.25	853.75	853.8
69	854	862	855.25	860.75	860.99	861.1	861.25	861.75	861.8

TABLE A.3.1-10

T-DAB frequency blocks in Band III

T-DAB block number	Centre frequency (MHz)	Block bandwidth (MHz)	Lower guardband (kHz)	Upper guardband (kHz)	Frequency range* (MHz)
5A	174.928	174.160-175.696	–	176	174.0-181.0
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	181.0-188.0
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	188.0-195.0
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	195.0-202.0
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	202.0-209.0
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	209.0-216.0
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	216.0-223.0
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	223.0-230.0
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	–	

* The frequency ranges given are the channels for System B/PAL, which are 7 MHz wide. They have no other significance.

TABLE A.3.1-11

Overview of digital broadcast systems intended for or already in use in the Bands III, IV and V

(as of 16 September 2003)

Administration/geographical area symbol	Band III		Band IV/V
	Digital systems		Digital television
	Sound	Television	
AFS			
AGL			
ALB			
ALG	Not available	Not available*	DVB-T
AND			
AOE			
ARM			
ARS	Not available	Not available*	DVB-T
ASC			
AUT	T-DAB	DVB-T	DVB-T
AZE			
AZR			
BDI			
BEL	T-DAB	DVB-T	DVB-T
BEN			
BFA			
BHR	T-DAB	DVB-T	DVB-T
BIH			
BLR			
BOT	T-DAB	DVB-T	
BUL	T-DAB	DVB-T	DVB-T
CAF			
CME	T-DAB	DVB-T	DVB-T
CNR	T-DAB	DVB-T	DVB-T
COD			
COG			
COM			
CPV			
CTI			
CVA	T-DAB	DVB-T	DVB-T
CYP			
CZE	T-DAB	DVB-T	DVB-T
D	T-DAB	DVB-T	DVB-T
DJI	Not available	Not available*	DVB-T
DNK	T-DAB	DVB-T	DVB-T
E	T-DAB	DVB-T	DVB-T
EGY	Not available	Not available*	DVB-T
ERI			
EST	T-DAB	DVB-T	DVB-T
ETH			
F	T-DAB	DVB-T	DVB-T
FIN	T-DAB	DVB-T	DVB-T
FRO			
G	T-DAB	Not available	DVB-T
GAB			

TABLE A.3.1-11 (*continued*)

Administration/geographical area symbol	**Band III**		**Band IV/V**
	Digital systems		**Digital television**
	Sound	**Television**	
GEO			
GHA			
GIB			
GMB			
GNB			
GNE			
GRC	T-DAB	DVB-T	DVB-T
GUI			
HNG	T-DAB	DVB-T	DVB-T
HOL	T-DAB	DVB-T	DVB-T
HRV	T-DAB	DVB-T	DVB-T
I	T-DAB	DVB-T	DVB-T
IRL	T-DAB	DVB-T	DVB-T
IRN	Not available	Not available*	DVB-T
IRQ			
ISL			
ISR	T-DAB	DVB-T	DVB-T
JOR	Not available	Not available*	DVB-T
KAZ			
KEN			
KGZ			
KWT			
LBN			
LBR			
LBY			
LIE	T-DAB	DVB-T	DVB-T
LSO			
LTU	T-DAB	DVB-T	DVB-T
LUX			
LVA	T-DAB	DVB-T	DVB-T
MAU			
MCO			
MDA	T-DAB	DVB-T	DVB-T
MDG			
MDR			
MKD	T-DAB	DVB-T	DVB-T
MLI			
MLT			
MOZ			
MRC	Not available	DVB-T	DVB-T
MTN			
MWI			
MYT			
NGR			
NIG			
NMB			
NOR	T-DAB	DVB-T	DVB-T
OMA	T-DAB	DVB-T	DVB-T
POL	T-DAB	DVB-T	DVB-T
POR	T-DAB	DVB-T	DVB-T
PSE		DVB-T	DVB-T
QAT	Not available	Not available*	DVB-T
REU			

TABLE A.3.1-11 (*end*)

Administration/geographical area symbol	Band III		Band IV/V
	Digital systems		Digital television
	Sound	Television	
ROU	T-DAB	DVB-T	DVB-T
RRW			
RUS	T-DAB	DVB-T	DVB-T
S	T-DAB	DVB-T	DVB-T
SCG	T-DAB	DVB-T	DVB-T
SDN	Not available	Not available*	DVB-T
SEN	T-DAB	DVB-T	DVB-T
SEY			
SHN			
SMR	T-DAB	DVB-T	DVB-T
SOM			
SRL			
STP			
SUI	T-DAB	DVB-T	DVB-T
SVK	T-DAB	DVB-T	DVB-T
SVN	T-DAB	DVB-T	DVB-T
SWZ			
SYR	Not available	*	DVB-T
TCD			
TGO			
TJK			
TKM			
TRC			
TUN	–	*	DVB-T
TUR	T-DAB	DVB-T	DVB-T
TZA			
UAE	–	*	DVB-T
UGA			
UKR	T-DAB	DVB-T	DVB-T
UZB			
YEM	–	*	DVB-T
ZMB			
ZWE			

* DVB-T system will be introduced in VHF Band III in the very long-term future, after its successful implementation in the UHF Bands IV and V.

Information on television systems as notified by administrations with territories located in the planning area of RRC

A.3.1.1 Television systems

Recommendation ITU-R BT.470 contains detailed technical information on conventional television systems. Table A.3.1-12 contains the information on television systems as recorded in the master copies of the ST61 and GE89 Plans, which the Bureau maintains in accordance with the relevant provisions of the ST61 and GE89 Regional Agreements. Systems are grouped by geographical areas, which are located within or partly within the planning area of RRC.

The Table also lists the band of operation, the vision and colour systems, the nominal RF channel bandwidth, the class of emission of the vision component, the separation of the vision carrier frequency relative to the assigned frequency, the separation of the first sound carrier frequency relative to the vision carrier, and the line frequency.

Note that the power ratio of the vision carrier to the first sound carrier is not listed, although it is notified and recorded in the database, because such an inclusion would generate an unpractical, long list for all the different combinations of power ratios notified.

Administrations are encouraged to review and update, where necessary, the information as notified and recorded[1].

[1] It should also be noted that some administrations indicated their intention to change the television system in their countries, but did not formalize this intention by notifying modifications to the ST61 Plan or to the Master Register.

TABLE A.3.1-12[1]

Television systems recorded in the GE89 and ST61 Plans and in the Master Register

(as at September 2003)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
AFS	South Africa (Republic of)	UHF	I		8 000	C3F--	2.75	5.9996	15.625
		UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I		8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
AGL	Angola (Republic of)	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		UHF	K1	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
ALB	Albania (Republic of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
ALG	Algeria (People's Democratic Republic of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
AND	Andorra (Principality of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	L		8 000	C3F--	2.75	6.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
AOE	Western Sahara	VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
ARM	Armenia (Republic of)	UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
ARS	Saudi Arabia (Kingdom of) ***	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		UHF	H		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
ASC	Ascension	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
AUT	Austria	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
AZE	Azerbaijani Republic	UHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
AZR	Azores	VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
		UHF	G	PAL	8 000	C3F	2.75	5.5	15.625
BDI	Burundi (Republic of)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
BEL	Belgium	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	H		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625

[1] This Table is for information only.

TABLE A.3.1-12 (*continued*)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
BEN	Benin (Republic of)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
BFA	Burkina Faso	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
BHR	Bahrain (State of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
BIH	Bosnia and Herzegovina (Republic of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
BLR	Belarus (Republic of)	UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
BOT	Botswana (Republic of)	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
BUL	Bulgaria (Republic of)	UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	PAL	8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
CAF	Central African Republic	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
CME	Cameroon (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
CNR	Canary Islands	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	T1**		8 000	X7FXF			
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
COD	Democratic Republic of the Congo	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
COG	Congo (Republic of the)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1		8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
COM	Comoros (Union of the)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
CPV	Cape Verde (Republic of)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
CTI	Côte d'Ivoire (Republic of)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1		8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
CVA	Vatican City State	UHF	H		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
CYP	Cyprus (Republic of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	H		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
CZE	Czech Republic ***	UHF	K		8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625

TABLE A.3.1-12 (*continued*)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
D	Germany (Federal Republic of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		UHF	I		8 000	C3F--	2.75	5.9996	15.625
		UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		UHF	M		6 000	C3F--	1.75	4.5	15.750
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
DJI	Djibouti (Republic of)	UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
DNK	Denmark	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
E	Spain	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	T1**		8 000	X7FXF			
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
EGY	Egypt (Arab Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
ERI	Eritrea	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
EST	Estonia (Republic of) ***	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	B1	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
ETH	Ethiopia (Federal Democratic Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
F	France	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	L		8 000	C3F--	2.75	6.5	15.625
		UHF	L	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	L		8 000	C3F--	2.75	6.5	15.625
		VHF	L	SECAM	8 000	C3F--	2.75	6.5	15.625
FIN	Finland	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
FRO	Faroe Islands	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
G	United Kingdom of Great Britain and Northern Ireland	UHF	I		8 000	C3F--	2.75	5.9996	15.625
		UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		UHF	T1**		8 000	X7FXF			

TABLE A.3.1-12 (*continued*)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
GAB	Gabonese Republic	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1		8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
GEO	Georgia	UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
GHA	Ghana	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
GIB	Gibraltar	UHF	G		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
GMB	Gambia (Republic of the)	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
GNB	Guinea-Bissau (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
GNE	Equatorial Guinea (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
GRC	Greece ***	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		UHF	H		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
GUI	Guinea (Republic of)	UHF	K1	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	PAL	8 000	C3F--	2.75	6.5	15.625
HNG	Hungary (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	PAL	8 000	C3F--	2.75	6.5	15.625
HOL	Netherlands (Kingdom of the) ***	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	M		6 000	C3F--	1.75	4.5	15.750
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
HRV	Croatia (Republic of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
I	Italy ***	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	H		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
IRL	Ireland	UHF	I		8 000	C3F--	2.75	5.9996	15.625
		UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I		8 000	C3F--	2.75	5.9996	15.625
IRN	Iran (Islamic Republic of) ***	UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
IRQ	Iraq (Republic of)	UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625

TABLE A.3.1-12 (*continued*)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
ISL	Iceland	VHF	B		7 000	C3F--	2.25	5.5	15.625
ISR	Israel (State of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
JOR	Jordan (Hashemite Kingdom of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
KAZ	Kazakhstan (Republic of)	UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
KEN	Kenya (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
KGZ	Kyrgyz Republic	UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
KWT	Kuwait (State of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
LBN	Lebanon	UHF	G		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
LBR	Liberia (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
LBY	Libya (Socialist People's Libyan Arab Jamahiriya)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
LIE	Liechtenstein (Principality of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
LSO	Lesotho (Kingdom of)	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
LTU	Lithuania (Republic of) ***	UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	PAL	8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
LUX	Luxembourg	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
LVA	Latvia (Republic of)	UHF	K	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	D	PAL	8 000	C3F--	2.75	6.5	15.625
MAU	Mauritius (Republic of)	UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
MCO	Monaco (Principality of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	L		8 000	C3F--	2.75	6.5	15.625
MDA	Moldova (Republic of)	UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625

TABLE A.3.1-12 (*continued*)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
MDG	Madagascar (Republic of)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
MDR	Madeira	VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
MKD	The Former Yugoslav Republic of Macedonia	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
MLI	Mali (Republic of)	UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
MLT	Malta	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
MOZ	Mozambique (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
MRC	Morocco (Kingdom of)	UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		UHF	K		8 000	C3F--	2.75	6.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
MTN	Mauritania (Islamic Republic of)	UHF	G	SECAM	8 000	C3F--	2.75	5.5	15.625
		VHF	B	SECAM	7 000	C3F--	2.25	5.5	15.625
MWI	Malawi	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
MYT	Mayotte (Territorial Collectivity of)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
NGR	Niger (Republic of the)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
NIG	Nigeria (Federal Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
NMB	Namibia (Republic of)	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I		8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
NOR	Norway	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
OMA	Oman (Sultanate of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
POL	Poland (Republic of)	UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	PAL	8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D*		8 000	C3F--	2.75	6.5	15.625
		VHF	D*	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	D*	SECAM	8 000	C3F--	2.75	6.5	15.625

TABLE A.3.1-12 (*continued*)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
POR	Portugal	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
QAT	Qatar (State of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
REU	Reunion (French Department of)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
ROU	Romania	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	PAL	8 000	C3F--	2.75	6.5	15.625
RRW	Rwandese Republic	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
RUS	Russian Federation	UHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
		UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		UHF	T1**		8 000	X7FXF			
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
S	Sweden	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
SCG	Serbia and Montenegro	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
SDN	Sudan (Republic of the)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
SEN	Senegal (Republic of)	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
SEY	Seychelles (Republic of)	VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
SHN	Saint Helena	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
SMR	San Marino (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
SOM	Somali Democratic Republic	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
SRL	Sierra Leone	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
STP	Sao Tome and Principe (Democratic Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625

TABLE A.3.1-12 (*continued*)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
SUI	Switzerland (Confederation of) ***	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
SVK	Slovak Republic ***	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
SVN	Slovenia (Republic of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
SWZ	Swaziland (Kingdom of)	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
		VHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
SYR	Syrian Arab Republic	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	H		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
TCD	Chad (Republic of) ***	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
TGO	Togolese Republic	UHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	K1	SECAM	8 000	C3F--	2.75	6.5	15.625
TJK	Tajikistan (Republic of)	UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
TKM	Turkmenistan	UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
TRC	Tristan da Cunha	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
TUN	Tunisia ***	UHF	G		8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
TUR	Turkey	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	H		8 000	C3F--	2.75	5.5	15.625
		UHF	H	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
TZA	Tanzania (United Republic of)	UHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
		UHF	K1	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	I	PAL	8 000	C3F--	2.75	5.9996	15.625
UAE	United Arab Emirates	UHF	G		8 000	C3F--	2.75	5.5	15.625
		UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625

TABLE A.3.1-12 (*end*)

Symbol	Designation	Band	Vision system	Colour system	TV channel bandwidth (kHz)	Class of emission	Assigned frequency relative to vision carrier frequency (MHz)	Sound carrier frequency relative to vision carrier frequency (MHz)	Line frequency (kHz)
UGA	Uganda (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		UHF	K1	PAL	8 000	C3F--	2.75	6.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
UKR	Ukraine	UHF	K		8 000	C3F--	2.75	6.5	15.625
		UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
UZB	Uzbekistan (Republic of)	UHF	K	SECAM	8 000	C3F--	2.75	6.5	15.625
		VHF	D		8 000	C3F--	2.75	6.5	15.625
		VHF	D	SECAM	8 000	C3F--	2.75	6.5	15.625
YEM	Yemen (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
ZMB	Zambia (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	B	PAL	7 000	C3F--	2.25	5.5	15.625
ZWE	Zimbabwe (Republic of)	UHF	G	PAL	8 000	C3F--	2.75	5.5	15.625
		VHF	B		7 000	C3F--	2.25	5.5	15.625
		VHF	G	PAL	8 000	C3F--	2.75	5.5	15.625

* The Administration of Poland has informed the Bureau that it intends to replace system D/K with system D1.

** T1 is used for an 8 MHz digital television system.

*** These administrations have indicated modifications to their information, as summarized below:

– Saudi Arabia (Kingdom of): replace SECAM by PAL
– Estonia (Republic of): delete UHF System K, UHF System K SECAM and VHF D
– Italy: add PAL
– Iran (Islamic Republic of): replace SECAM by PAL
– Lithuania (Republic of): replace SECAM by PAL
– Slovak Republic: delete UHF System K; add VHF System B1 PAL with sound carrier at 5.5 MHz
– Chad (Republic of): delete UHF System K1; replace VHF K1 by VHF System B with sound carrier at 5.5 MHz
– Tunisia: add PAL in UHF and VHF
– Czech Republic: add PAL in UHF and VHF
– Greece: delete UHF System G SECAM and UHF System H; add PAL in UHF and VHF
– Netherlands (Kingdom of the): delete UHF System G without colour system, UHF System M and VHF System B without colour system
– Switzerland (Confederation of): delete UHF System G and VHF System B, add T1, colour PAL to UHF System G
– Russian Federation: delete UHF D SECAM
– Senegal: add System B for VHF and UHF.

ANNEX 3.2

Future Band III sharing options

A.3.2.1 Option 1 – Single service usage of Band III

Single service usage of T-DAB or DVB-T throughout Band III leaves only sharing with analogue television to be considered during the transition period from analogue to digital transmission.

A.3.2.1.1 All T-DAB

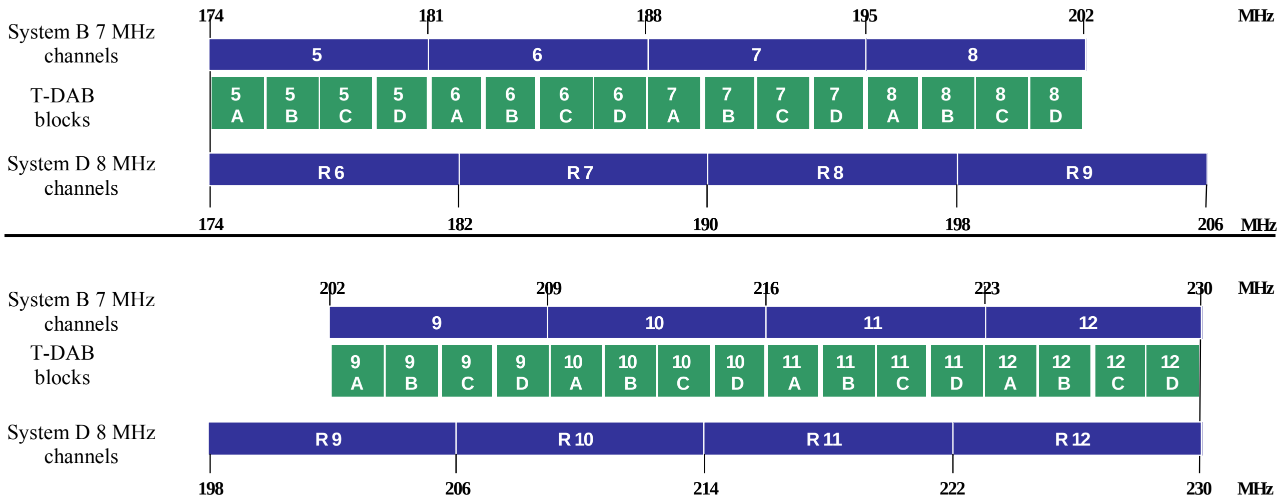
In this scenario, the maximum available spectrum (of 56 MHz) in Band III is divided into 32 T-DAB blocks, 5A, 5B, etc., through to 12D, identified by the System B channel number (5 to 12) and a T-DAB block letter (A to D), as shown in Fig. A.3.2-1.

A.3.2.1.2 All DVB-T

The 56 MHz of spectrum in Band III could be divided into seven 8 MHz or eight 7 MHz DVB-T channels (see Fig. A.3.2-1). This scenario excludes the use of Band III by T-DAB, and is not likely to be of interest in most European countries, as T-DAB is either planned or has been already implemented in this band. However, the all-DVB-T scenario may be of interest in other parts of the planning area.

FIGURE A.3.2-1

Relative positions of 7 MHz System B and 8 MHz System D television channel spacings with respect to T-DAB blocks



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A.3.2.2 Option 2 – Partitioning of Band III

A.3.2.2.1 Partitioning of the band

Partitioning of the band means that Band III is split into two or more parts, each of which is designated for exclusive use by either T-DAB or DVB-T. The partitioning of Band III may differ from country to country according to the needs of each. It is likely that better spectral utilization would be achieved if groups of neighbouring countries used common band partitioning.

If a different channel raster is used in neighbouring countries, the partitioning scenarios will be complicated. This aspect is not considered in this chapter, as it will have to be dealt with through bilateral or multilateral agreements. Thus, only a limited set of television channel spacings is considered – System D (8 MHz) and System B (7 MHz) (see Fig. A.3.2-1).

In band partitioning, it is assumed that the T-DAB blocks are grouped in one or more television channels and not scattered throughout the band. The channel spacing of the television service influences how effectively multiple partitions can be implemented in Band III. Tables A.3.2-1 and A.3.2-2 give the most effective sharing possibilities for T-DAB, 8 MHz System D and 7 MHz System B.

A.3.2.2.1.1 Partitioning between T-DAB and the 8 MHz System D television channel spacing

For the 8 MHz System D television channels, examination of Fig. A.3.2-1 shows that the sharing possibilities in Table A.3.2-1 (assuming contiguous 8 MHz television channels and a contiguous allocation of channels to T-DAB) give good spectrum usage. As the T-DAB blocks are based on the System B 7 MHz channel spacing, they cannot always be in perfect alignment with any 8 MHz channel spacing. Therefore, only a limited range of options leads to effective spectrum usage, although in principle any number of television channels (between 0 and 7) could be used for T-DAB, and the remaining spectrum allocated to television.

TABLE A.3.2-1

Effective usage of Band III between T-DAB and 8 MHz System D television channels

Number of contiguous 8 MHz television channels allocated to T-DAB	Number of T-DAB blocks	Number of television channels
0	0	7
2	9	5
4	18	3
7	32	0

The allocation of two contiguous 8 MHz System D television channels to T-DAB leaves only five Band III television channels for DVB-T.

A.3.2.2.1.2 Partitioning between T-DAB and the 7 MHz System B television channel spacing

Table A.3.2-2 gives the sharing possibilities between T-DAB and television for the System B 7 MHz channel spacing. There is perfect alignment between the T-DAB blocks and the System B channel spacing throughout Band III. Therefore, a country using this channel spacing can designate any number of television channels (between 0 and 8) for T-DAB and use the remaining spectrum for television. Neither the channels containing the T-DAB blocks nor the channels used for television have to be contiguous, and Band III can be partitioned into two or more segments, each being used exclusively for either T-DAB or DVB-T.

TABLE A.3.2-2

Effective usage of Band III between T-DAB and 7 MHz System B television channels

Number of 7 MHz television channels allocated to T-DAB	Number of T-DAB blocks	Number of television channels
0	0	8
1	4	7
2	8	6
3	12	5
4	16	4
5	20	3
6	24	2
7	28	1
8	32	0

The situation for the 7 MHz System B television channels is somewhat better than in the 8 MHz case, as the allocation of two 7 MHz television channels to T-DAB leaves an additional channel for DVB-T.

A.3.2.3 Option 3 – Mixed T-DAB/DVB-T

In parts of Europe, it is likely that there will be extended areas in which several coverage layers of T-DAB and one DVB-T coverage will be in operation at the same time in Band III. It is likely that additional demand for T-DAB coverage will arise in the future. The individual requirements might differ dramatically, as might the constraints to be taken into account for each of them.

Partitioning the VHF spectrum to accommodate both services may no longer be a successful strategy in such circumstances. It may turn out that T-DAB blocks have to be accommodated in any VHF channel in order to minimize mutual interaction between services. The price to pay is a more complex sharing scenario than in the straightforward partitioning schemes described in § A.3.2.2.

In general, there will be overlapping areas in which co-spectrum usage is forbidden, and adjacent channel or block restrictions may also apply. Furthermore, the interference potential between two service areas depends on the services in operation.

The formation of coverage areas that combine to build several nationwide layers of coverage gives rise to two principle types of interference which can be labelled by the term "overlap". These two types of overlap are spectral overlap and geographical overlap.

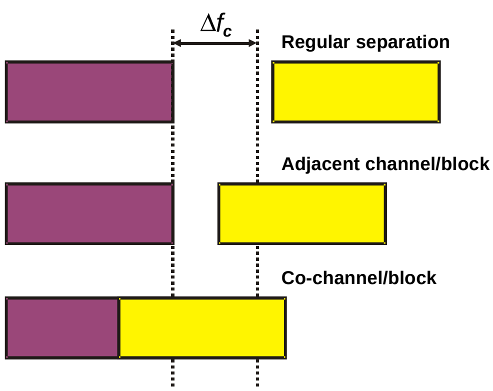
Spectral overlap is due to the different channel spacings currently used in the VHF range across Europe (see § 3.1). Contiguous coverage areas belonging to regions in which different channel spacings are used must fully take into account partially overlapping channels. This can occur, for example, in border areas.

The second type of overlap is overlap of geographical areas. This is inevitably linked to the existence of more than one nationwide coverage layer. In general, there will be different network providers both for T-DAB and for DVB-T. In addition, different layers of T-DAB coverage could be established by different network providers. Co-sited transmission of the signals cannot always be guaranteed in view of the probable involvement of different network providers. Therefore, it may be necessary to impose constraints on the frequency plan in order to avoid adjacent channel/block usage in overlapping areas.

The term "adjacent" needs some clarification in the context of two digital transmission systems employing different bandwidths. In a DVB-T/DVB-T sharing situation, adjacent means consecutive channels, for example channel 5 and channel 6. The term is applicable in a T-DAB-only context where the word "channels" is substituted by "blocks". However, when considering a T-DAB/DVB-T case, more care has to be taken. A reasonable approach that includes all possible cases is given by introducing a critical spectral distance by which two frequencies need to be separated if the corresponding coverage areas overlap. Figure A.3.2-2 sketches the definition of the critical spectral distance, Δf_C. It has to be noted that this definition of spectral overlap clearly can be applied to problems arising from different channel spacings as well.

FIGURE A.3.2-2

Definition of the critical spectral distance between two spectral blocks to be obeyed for overlapping coverage areas



Usually, the concept of a geographical separation distance for co-channel/block usage is employed as a first indicator to determine if interference beyond the acceptable limits is to be expected. Since the Wiesbaden 1995 Plan, the separation distance between two T-DAB allotment areas is fixed at 81 km for Band III for an all-land path. For the DVB-T/DVB-T interaction, no separation distance has been finally agreed. The same holds for the T-DAB/DVB-T case. If propagation paths above cold or warm sea have also to be taken into account, the geographic distance between two areas must be replaced by an effective distance appropriately defined to represent the impact of mixed paths.

However, previous experience shows that the simple approach of determining the mutual interference of two allotment areas based only on their separation distance does not lead to satisfying results in cases where particular topographic profiles have to be taken into account. The calculation of field strengths to be expected at properly chosen test points based on wave propagation models like Recommendation ITU-R P.1546-1 or terrain models might lead to a more refined image of the interference potential.

Sharing spectrum of Band III between T-DAB and DVB-T means the assignment of TV channels or T-DAB blocks to any area requiring them. This requires that many different types of constraint on the accessibility to spectrum be taken into account in practice.

Basically, there are three system-based interaction cases, namely T-DAB to T-DAB, DVB-T to DVB-T or the mixed interaction T-DAB to DVB-T. Due to the large number of system variants of DVB-T, these cases may require completely different mutual protection demands. In some cases, particularly in the transition period, the interactions between analogue television and T-DAB and DVB-T may also have to be considered.

The experience of previous frequency planning conferences demonstrates that last-minute changes could occur, and that flexible planning methods are needed. This rules out the application of highly sophisticated mathematical algorithms that are perfectly adapted to special sets of constraints.

A.3.2.4 Tabulated comparison of sharing options

Table A.3.2-3 shows a comparison of the three options described above.

TABLE A.3.2-3

Comparison of options for sharing of Band III

Sharing options in Band III	Option 1	Option 2	Option 3
Method	Single-service usage of T-DAB or DVB-T throughout a whole region	Partitioning of Band III for use by both T-DAB and DVB-T services	Mixed T-DAB/DVB-T
T-DAB blocks grouping	Required	Required	Not required
Efficient spectrum use	Not very satisfactory overall	– Frequency efficiency can be achieved if groups of neighbouring countries use common band partitioning – In some cases, only a limited number of television channel spacings can be considered – The channel spacing used by the television service influences how effectively multiple partitions can be implemented	The most efficient
Ease of sharing	Very easy	Not easy – complicated if different channel spacings are used by neighbouring countries	Complicated – requires the use of sophisticated planning methods
Coordination with neighbouring countries after the conference (Article 4)	Business as usual	Will be laborious in many cases, where different services and channel spacings are used by neighbouring countries	Will be laborious and complicated
Flexibility	None	Very restricted	Most flexible
Comments	The exclusive use of DVB-T in Band III is not of interest for Europe since T-DAB is already planned or has been already implemented in this band in most European countries		There will be overlapping areas in which co-spectrum usage is forbidden and where adjacent channel or block channel restrictions may also apply

ANNEX 3.3

Mobile reception

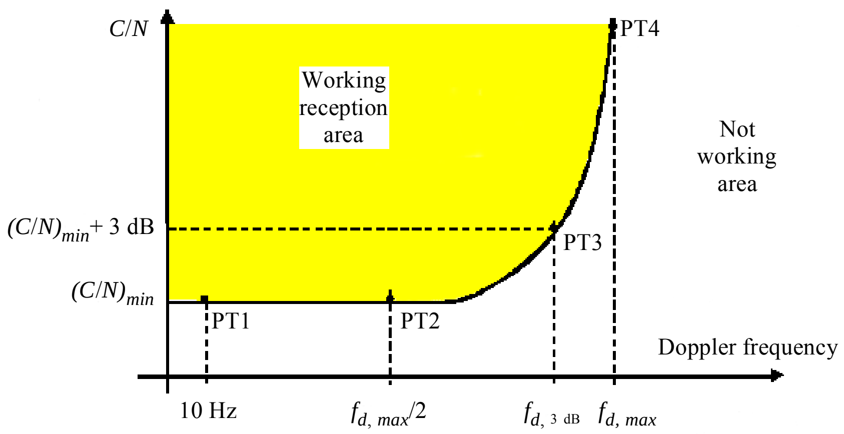
In general, the required C/N over a mobile channel is defined as the average C/N over a sufficiently long time to obtain a stable value, and a sufficiently short time to avoid any influence of shadow fading. This means that fast fading signal variations are included in the C/N values given but not the shadow (log-normal) fading.

For OFDM systems (T-DAB and DVB-T), and for a given mode and a given channel profile, the required C/N for a certain quality level is a function of Doppler frequency only, and a curve like the one presented in Fig. A.3.3-1 can be drawn. Similar receiver behaviour can also be observed for T-DAB.

The curve is characterized by a C/N floor, C/N_{min}, which gives information about the minimum signal requirement for good reception when in motion. For low speeds, the required C/N value is relatively independent of the specific Doppler frequency. However, the slope of the C/N curve at low Doppler (between points PT1 and PT2 in Fig. A.3.3-1) varies, in the case of DVB-T with the DVB-T variants used and the quality of service requirements. For higher speeds (or Doppler frequencies) the required C/N value increases gradually until a maximum acceptable Doppler frequency is reached.

FIGURE A.3.3-1

DVB-T receiver behaviour in a mobile propagation channel



$f_{d,\ max}/2$, $f_{d,\ 3\ dB}$, $f_{d,\ max}$ represent the values of Doppler frequency for 10 Hz, half of the maximum Doppler frequency, the Doppler frequency for C/N_{min} + 3 dB and the maximum Doppler frequency. PT1, PT2, PT3 and PT4 are the corresponding points of C/N for different Doppler frequency values

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To characterize the C/N versus Doppler curve in a given DVB-T variant, using a given channel profile, four measurement points are used:

– PT1: C/N at very low Doppler frequency (for example 10 Hz);
– PT2: C/N_{min} which characterizes the noise floor acceptable by the mobile receiver;
– PT3: C/N_{min} + 3 dB which gives an indication of the speed limit;
– PT4: maximum Doppler limit which characterizes the maximum speed when no noise is added. This corresponds to an infinite C/N loss.

As the impairments occurring in the mobile environment are related to the Doppler characteristics of the propagation channel, and because the "Doppler distortion" evolves proportionally both with the speed of the vehicle and the signal centre-frequency, the RF channel used to deliver a digital service to mobiles is of major importance for the service reception performance. Better performance is obtained when lower frequencies are used, whilst worse performance will occur when higher frequencies are used.

Values for DVB-T mobile reception are given in Tables A.3.3-1 and A.3.3-2 for the typical channel profile – Typical urban. Table A.3.3-1 shows values for the minimum C/N ratio and the speed limits (corresponding to a Doppler frequency for a C/N equal to C/N_{min} + 3 dB) in the non-diversity case. Table A.3.3-2 contains the corresponding values for the antenna diversity case. The speed limits are given for three frequencies (200 MHz, 500 MHz and 800 MHz).

The figures apply to the case of single transmitter coverage. Simulations show that in the SFN case, where large echo delays reduce the probability of flat fading, smaller values for C/N are needed. Improvements may be achieved with receivers particularly designed for mobile reception.

The figures for C/N as well as for the Doppler frequencies are to be considered as preliminary.

In the absence of these values for DVB-T, Tables A.3.3-1 and A.3.3-2 provide the values in use in the CEPT countries.

Higher code rates than 1/2 and 2/3 are less suitable for mobile reception. The usage of 64-QAM modulation will be power limited due to the very high C/N requirement in the non-diversity case.

The values for the bit rate correspond to the shortest guard interval of 1/32, which is the least critical case in terms of Doppler; with a 1/4 guard interval, about 85% of this performance is to be expected. In SFN networks, a shorter guard interval may increase the risk of self-interference.

It can be seen from Tables A.3.3-1 and A.3.3-2 that lower frequencies allow for a higher speed of the vehicle and also that 2k variants allow for higher speed than 8k variants. For UHF, the lower part of the band is better suited for mobile reception.

TABLE A.3.3-1

***C/N*, speed limits for mobile reception with the "Typical urban" profile for the antenna non-diversity case**

Guard interval = 1/32			2k			Speed at f_d, 3 dB (km/h)			8k			Speed at f_d, 3 dB (km/h)		
Modulation	**Bit rate (Mbit/s)**	**Code rate**	**C/N_{min} (dB)**	**$f_{d,\ max}$ (Hz)**	**f_d @ C/N_{min} + 3 dB**	**200 MHz**	**500 MHz**	**800 MHz**	**C/N_{min} (dB)**	**$f_{d,\ max}$ (Hz)**	**f_d @ C/N_{min} + 3 dB**	**200 MHz**	**500 MHz**	**800 MHz**
QPSK	6.03	1/2	13.0	318	259	1398	559	349	13.0	76	65	349	140	87
QPSK	8.04	2/3	16.0	247	224	1207	483	302	16.0	65	53	286	114	71
16-QAM	12.06	1/2	18.5	224	182	985	394	246	18.5	59	47	254	102	64
16-QAM	16.09	2/3	21.5	176	147	794	318	199	21.5	41	35	191	76	48
64-QAM	18.10	1/2	23.5	141	118	635	254	159	23.5	35	29	159	64	40
64-QAM	24.13	2/3	27.0	82	65	349	140	87	27.0	24	18	95	38	24

TABLE A.3.3-2

***C/N*, speed limits for mobile reception with the "Typical urban" profile for the antenna diversity case**

Guard interval = 1/32			2k			Speed at f_d, 3 dB (km/h)			8k			Speed at f_d, 3 dB (km/h)		
Modulation	**Bit rate (Mbit/s)**	**Code rate**	**C/N_{min} (dB)**	**$f_{d,\ max}$ (Hz)**	**f_d @ C/N_{min} + 3 dB**	**200 MHz**	**500 MHz**	**800 MHz**	**C/N_{min} (dB)**	**$f_{d,\ max}$ (Hz)**	**f_d @ C/N_{min} + 3 dB**	**200 MHz**	**500 MHz**	**800 MHz**
QPSK	6.03	1/2	7.0	560	518	2795	1118	699	7.0	140	129	699	280	175
QPSK	8.04	2/3	10.0	494	447	2414	966	604	10.0	129	106	572	229	143
16-QAM	12.06	1/2	12.5	447	365	1969	788	492	12.5	118	94	508	203	127
16-QAM	16.09	2/3	15.5	353	294	1588	635	397	15.5	82	71	381	152	95
64-QAM	18.10	1/2	17.5	282	235	1271	508	318	17.5	71	59	318	127	79
64-QAM	24.13	2/3	21.0	165	129	699	280	175	21.0	47	35	191	76	48

ANNEX 3.4
C/*N* values for hierarchical transmissions

TABLE A.3.4-1

Required *C*/*N* for hierarchical transmission to achieve a BER = 2×10^{-4} after Viterbi decoding and net bit rate (Mbit/s)

			Required *C*/*N* for BER = 2×10^{-4} after Viterbi (quasi error-free after Reed-Solomon)			Net bit rate (Mbit/s) For different guard intervals (GI)			
Modulation	**Code rate**	α[(1)]	**Gaussian channel**	**Ricean channel (F_1)**	**Rayleigh channel (P_1)**	**GI = 1/4**	**GI = 1/8**	**GI = 1/16**	**GI = 1/32**
8 MHz variants									
QPSK	1/2		4.8	5.4	6.9	4.98	5.53	5.85	6.03
in	2/3		7.1	7.7	9.8	6.64	7.37	7.81	8.04
non-uniform	3/4		8.4	9.0	11.8	7.46	8.29	8.78	9.05
16-QAM		2				+			
	1/2		13.0	13.3	14.9	4.98	5.53	5.85	6.03
	2/3		15.1	15.3	17.9	6.64	7.37	7.81	8.04
	3/4		16.3	16.9	20.0	7.46	8.29	8.78	9.05
	5/6		16.9	17.8	22.4	8.29	9.22	9.76	10.05
	7/8		17.9	18.7	24.1	8.71	9.68	10.25	10.56
QPSK	1/2		3.8	4.4	6.0	4.98	5.53	5.85	6.03
in	2/3		5.9	6.6	8.6	6.64	7.37	7.81	8.04
non-uniform	3/4		7.1	7.9	10.7	7.46	8.29	8.78	9.05
16-QAM		4				+			
	1/2		17.3	17.8	19.6	4.98	5.53	5.85	6.03
	2/3		19.1	19.6	22.3	6.64	7.37	7.81	8.04
	3/4		20.1	20.8	24.2	7.46	8.29	8.78	9.05
	5/6		21.1	22.0	26.0	8.29	9.22	9.76	10.05
	7/8		21.9	22.8	28.5	8.71	9.68	10.25	10.56
7 MHz variants									
QPSK	1/2		4.8	5.4	6.9	4.35	4.84	5.12	5.28
in	2/3		7.1	7.7	9.8	5.81	6.45	6.83	7.04
non-uniform	3/4		8.4	9.0	11.8	6.53	7.26	7.68	7.92
16-QAM		2				+			
	1/2		13.0	13.3	14.9	4.35	4.84	5.12	5.28
	2/3		15.1	15.3	17.9	5.81	6.45	6.83	7.04
	3/4		16.3	16.9	20.0	6.53	7.26	7.68	7.92
	5/6		16.9	17.8	22.4	7.26	8.06	8.54	8.80
	7/8		17.9	18.7	24.1	7.62	8.47	8.97	9.24
QPSK	1/2		3.8	4.4	6.0	4.35	4.84	5.12	5.28
in	2/3		5.9	6.6	8.6	5.81	6.45	6.83	7.04
non-uniform	3/4		7.1	7.9	10.7	6.53	7.26	7.68	7.92
16-QAM		4				+			
	1/2		17.3	17.8	19.6	4.35	4.84	5.12	5.28
	2/3		19.1	19.6	22.3	5.81	6.45	6.83	7.04
	3/4		20.1	20.8	24.2	6.53	7.26	7.68	7.92
	5/6		21.1	22.0	26.0	7.26	8.06	8.54	8.80
	7/8		21.9	22.8	28.5	7.62	8.47	8.97	9.24

[(1)] α: Value corresponding to constellation diagrams used in hierarchical transmission.

TABLE A.3.4-2

Required *C/N* for hierarchical transmission to achieve a BER = 2×10^{-4} after Viterbi decoding. Results for QPSK in non-uniform 64-QAM with α = 4 is not included due to the poor performance of the 64-QAM signal

			Required *C/N* for BER = 2×10^{-4} after Viterbi (quasi error-free after Reed-Solomon)			Net bit rate (Mbit/s) For different guard intervals (GI)			
Modulation	**Code rate**	α[(1)]	**Gaussian channel**	**Ricean channel (F_1)**	**Rayleigh channel (P_1)**	**GI = 1/4**	**GI = 1/8**	**GI = 1/16**	**GI = 1/32**
8 MHz variants									
QPSK in uniform 64-QAM	1/2	1	8.9	9.5	11.4	4.98	5.53	5.85	6.03
	2/3		12.1	12.7	14.8	6.64	7.37	7.81	8.04
	3/4		13.7	14.3	17.5	7.46	8.29	8.78	9.05
	1/2		14.6	14.9	16.4	9.95	11.06	11.71	12.06
	2/3		16.9	17.6	19.4	13.27	14.75	15.61	16.09
	3/4		18.6	19.1	22.2	14.93	16.59	17.56	18.10
	5/6		20.1	20.8	25.8	16.59	18.43	19.52	20.11
	7/8		21.1	22.2	27.6	17.42	19.35	20.49	21.11
QPSK in non-uniform 64-QAM	1/2	2	6.5	7.1	8.7	4.98	5.53	5.85	6.03
	2/3		9.0	9.9	11.7	6.64	7.37	7.81	8.04
	3/4		10.8	11.5	14.5	7.46	8.29	8.78	9.05
	1/2		16.3	16.7	18.2	9.95	11.06	11.71	12.06
	2/3		18.9	19.5	21.7	13.27	14.75	15.61	16.09
	3/4		21.0	21.6	24.5	14.93	16.59	17.56	18.10
	5/6		21.9	22.7	27.3	16.59	18.43	19.52	20.11
	7/8		22.9	23.8	29.6	17.42	19.35	20.49	21.11
7 MHz variants									
QPSK in uniform 64-QAM	1/2	1	8.9	9.5	11.4	4.35	4.84	5.12	5.28
	2/3		12.1	12.7	14.8	5.81	6.45	6.83	7.04
	3/4		13.7	14.3	17.5	6.53	7.26	7.68	7.92
						+			
	1/2		14.6	14.9	16.4	8.71	9.68	10.25	10.56
	2/3		16.9	17.6	19.4	11.61	12.90	13.66	14.08
	3/4		18.6	19.1	22.2	13.06	14.52	15.37	15.83
	5/6		20.1	20.8	25.8	14.52	16.13	17.08	17.59
	7/8		21.1	22.2	27.6	15.24	16.93	17.93	18.47
QPSK in non-uniform 64-QAM	1/2	2	6.5	7.1	8.7	4.35	4.84	5.12	5.28
	2/3		9.0	9.9	11.7	5.81	6.45	6.83	7.04
	3/4		10.8	11.5	14.5	6.53	7.26	7.68	7.92
	1/2		16.3	16.7	18.2	8.71	9.68	10.25	10.56
	2/3		18.9	19.5	21.7	11.61	12.90	13.66	14.08
	3/4		21.0	21.6	24.5	13.06	14.52	15.37	15.83
	5/6		21.9	22.7	27.3	14.52	16.13	17.08	17.59
	7/8		22.9	23.8	29.6	15.24	16.93	17.93	18.47

[(1)] α: Value corresponding to constellation diagrams used in hierarchical transmission.

ANNEX 3.5

Illustration of minimum median power flux-density and minimum median field strength for digital terrestrial television broadcasting (DVB-T) and digital terrestrial sound broadcasting (T-DAB)

A.3.5.1 Calculation of minimum signal levels for digital terrestrial broadcasting

The minimum signal levels to overcome receiver noise are given by the minimum receiver input power and the corresponding minimum equivalent receiver input voltage, assuming a receiver noise figure of 7 dB. No account is taken of any location variation effects. However, it is necessary to take account of these effects when considering television reception in a practical environment.

In defining coverage it is indicated that due to the very rapid transition from near perfect to no reception at all, it is necessary that the minimum required signal level is achieved at a high percentage of locations. This defines the "quality" of the coverage.

The minimum median power-flux densities for DVB-T are calculated for:

- 8 MHz channels. For 7 MHz channels, 0.6 dB should be subtracted from the relevant results given in Tables A.3.5-1 to A.3.5-12;
- three different receiving conditions:
  - fixed reception;
  - portable reception:
    - portable outdoor reception;
    - portable indoor reception at ground floor;
  - mobile;
- three frequencies representing Band III, Band IV and Band V:
  - 200 MHz;
  - 500 MHz;
  - 800 MHz;
- representative *C*/*N* ratios.

The minimum median power-flux densities for T-DAB (Table A.3.5-13) are calculated for:

- bandwidth of 1.536 MHz;
- two different receiving conditions:
  - portable indoor reception;
  - mobile;
- frequency of 200 MHz representing Band III;
- representative *C*/*N* ratio of 15 dB.

Representative C/N values are used for these examples. Results for any chosen system and system variant may be obtained by interpolation between relevant representative values.

All minimum median field-strength values presented in this Chapter are for coverage by a single transmitter only, not for single frequency networks.

To calculate the minimum median power flux-density and the minimum median field strength needed to ensure that the minimum values of signal level can be achieved at the required percentage of locations, the following formulas are used:

$$P_n = F + 10 \log_{10} (k\, T_0\, B)$$

$$P_{s\,min} = C/N + P_n$$

$$A_a = G_D + 10 \log_{10} (1.64 \cdot \lambda^2/4\pi)$$

$$\varphi_{min} = P_{s\,min} - A_a + L_f \quad \text{for fixed reception}$$

$$\varphi_{min} = P_{s\,min} - A_a \quad \text{for portable/mobile reception}$$

$$E_{min} = \varphi_{min} + 120 + 10 \log_{10} (120\pi) = \varphi_{min} + 145.8$$

$$\varphi_{med} = \varphi_{min} + P_{mmn} + C_l \quad \text{for fixed reception}$$

$$\varphi_{med} = \varphi_{min} + P_{mmn} + C_l + L_h \quad \text{for outdoor portable/mobile reception}$$

$$\varphi_{med} = \varphi_{min} + P_{mmn} + C_l + L_h + L_b \quad \text{for indoor reception}$$

$$E_{med} = \varphi_{med} + 120 + 10 \log_{10} (120\pi) = \varphi_{med} + 145.8$$

where:

- A_a: effective antenna aperture (dBm^2)
- C/N: RF signal-to-noise ratio required by the system (dB)
- C_l: location correction factor (dB)
- E_{med}: minimum median field strength, planning value (dB(μV/m))
- E_{min}: minimum field strength at receiving place (dB(μV/m))
- G_D: antenna gain relative to half-wave dipole (dB)
- L_b: building penetration loss (dB)
- L_f: feeder loss (dB)
- L_h: height loss (between 10 m and 1.5 m above ground level) (dB)
- P_{mmn}: allowance for man-made noise (dB)
- φ_{min}: minimum power flux-density at receiving location (dB(W/m^2))
- φ_{med}: minimum median power flux-density, planning value (dB(W/m^2))
- λ: wavelength (m)
- P_n: receiver noise input power (dBW)

F: receiver noise figure (dB)

k: Boltzmann's constant ($k = 1.38 \times 10^{-23}$) J/K

T_0: absolute temperature ($T_0 = 290$ K)

B: receiver noise bandwidth (6.66×10^6 Hz for a 7 MHz channel, 7.61×10^6 Hz for a 8 MHz channel and 1.54×10^6 Hz for T-DAB)

$P_{s\,min}$: minimum receiver signal input power (dBW).

Additionally, the following formula is presented, for information only:

$$U_{s\,min} = P_{s\,min} + 120 + 10 \log_{10} R$$

$U_{s\,min}$: minimum equivalent receiver input voltage, for 75 Ω (dBμV)

R: input impedance of receiver ($R = 75$ Ω).

For calculating the location correction factor C_l (see definition in Chapter 1), a log-normal distribution of the received signal is assumed. It should be noted that this standard deviation only relates to location statistics and the inherent inaccuracies of the propagation prediction method are not taken into account. The location correction factor will need to be re-assessed as more information becomes available.

The location correction factor can be calculated by the formula:

$$C_l = \mu \cdot \sigma$$

where:

μ: distribution factor, being 0.52 for 70%, 1.64 for 95% and 2.32 for 99%

σ: standard deviation, taken as 5.5 dB for outdoor reception.

Other appropriate values of σ are used in the case of indoor reception.

The tables below give the minimum median power flux-density and the minimum median field strength for 70% and 95% of location probability in Bands III, IV and V, as well as for 99% of location probability in the case of mobile reception in Bands III, IV and V only. These values are related to the minimum power flux-density and minimum field strength at the receiving location. For Band III, an allowance for man-made noise has been included.

A.3.5.2 Digital terrestrial television broadcasting (DVB-T)

The results for the different DVB-T antenna reception modes are given in Tables A.3.5-1 to A.3.5-12.

TABLE A.3.5-1

Minimum median power flux-density and minimum median field strength in Band III for 70% and 95% location probability, fixed reception

Receiving condition: fixed, Band III

Frequency	f (MHz)	200				
Minimum C/N required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\ min}$ (dBW)	−126.2	−120.2	−114.2	−108.2	−102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\ min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Feeder loss	L_f (dB)	2				
Antenna gain relative to half wave dipole	G_D (dB)	7				
Effective antenna aperture	A_a (dBm^2)	1.7				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	−125.9	−119.9	−113.9	−107.9	−101.9
Minimum field strength at receiving location	E_{min} (dB(μV/m))	20	26	32	38	44
Allowance for man-made noise	P_{mmn} (dB)	2				

Location probability: 70%

Location correction factor	C_l (dB)	3				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−121	−115	−109	−103	−97
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	25	31	37	43	49

Location probability: 95%

Location correction factor	C_l (dB)	9				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−115	−109	−103	−97	−91
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	31	37	43	49	55

a.g.l.: above ground level.

TABLE A.3.5-2

Minimum median power flux-density and minimum median field strength in Band IV for 70% and 95% location probability, fixed reception

Receiving condition: fixed, Band IV

Frequency	f (MHz)	500				
Minimum C/N required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\,min}$ (dBW)	−126.2	−120.2	−114.2	−108.2	−102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\,min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Feeder loss	L_f (dB)	3				
Antenna gain relative to half wave dipole	G_D (dB)	10				
Effective antenna aperture	A_a (dBm^2)	−3.3				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	−119.9	−113.9	−107.9	−101.9	−95.9
Minimum field strength at receiving location	E_{min} (dB(μV/m))	26	32	38	44	50
Allowance for man-made noise	P_{mmn} (dB)	0				

Location probability: 70%

Location correction factor	C_l (dB)	3				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−117	−111	−105	−99	−93
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	29	35	41	47	53

Location probability: 95%

Location correction factor	C_l (dB)	9				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−111	−105	−99	−93	−87
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	35	41	47	53	59

TABLE A.3.5-3

Minimum median power flux-density and minimum median field strength in Band V for 70% and 95% location probability, fixed reception

Receiving condition: fixed, Band V

Frequency	f (MHz)	800				
Minimum C/N required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\ min}$ (dBW)	–126.2	–120.2	–114.2	–108.2	–102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\ min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Feeder loss	L_f (dB)	5				
Antenna gain relative to half wave dipole	G_D (dB)	12				
Effective antenna aperture	A_a (dBm^2)	–5.4				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	–115.8	–109.8	–103.8	–97.8	–91.8
Minimum field strength at receiving location	E_{min} (dB(μV/m))	30	36	42	48	54
Allowance for man-made noise	P_{mmn} (dB)	0				

Location probability: 70%

Location correction factor	C_l (dB)	3				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–113	–107	–101	–95	–89
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	33	39	45	51	57

Location probability: 95%

Location correction factor	C_l (dB)	9				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–107	–101	–95	–89	–83
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	39	45	51	57	63

TABLE A.3.5-4

Minimum median power flux-density and minimum median field strength in Band III for 70% and 95% location probability, portable outdoor reception

Receiving condition: portable outdoor (Class A), Band III

Frequency	f (MHz)	200				
Minimum C/N required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\,min}$ (dBW)	−126.2	−120.2	−114.2	−108.2	−102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\,min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Antenna gain relative to half wave dipole	G_D (dB)	−2.2				
Effective antenna aperture	A_a (dBm^2)	−7.5				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	−118.7	−112.7	−106.7	−100.7	−94.7
Minimum field strength at receiving location	E_{min} (dB(μV/m))	27	33	39	45	51
Allowance for man-made noise	P_{mmn} (dB)	2				
Height loss	L_h (dB)	12				

Location probability: 70%

Location correction factor	C_l (dB)	3				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2)	−102	−96	−90	−84	−78
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m)	44	50	56	62	68

Location probability: 95%

Location correction factor	C_l (dB)	9				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−96	−90	−84	−78	−72
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	50	56	62	68	74

TABLE A.3.5-5

Minimum median power flux-density and minimum median field strength in Band IV for 70% and 95% location probability, portable outdoor reception

Receiving condition: portable outdoor (Class A), Band IV

Frequency	f (MHz)	500				
Minimum *C*/*N* required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\,min}$ (dBW)	−126.2	−120.2	−114.2	−108.2	−102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\,min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Antenna gain relative to half wave dipole	G_D (dB)	0				
Effective antenna aperture	A_a (dBm^2)	−13,3				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	−112.9	−106.9	−100.9	−94.9	−88.9
Minimum field strength at receiving location	E_{min} (dB(μV/m))	33	39	45	51	57
Allowance for man-made noise	P_{mmn} (dB)	0				
Height loss	L_h (dB)	16				

Location probability: 70%

Location correction factor	C_l (dB)	3				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−94	−88	−82	−76	−70
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	52	58	64	70	76

Location probability: 95%

Location correction factor	C_l (dB)	9				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−88	−82	−76	−70	−64
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	58	64	70	76	82

TABLE A.3.5-6

Minimum median power flux-density and minimum median field strength in Band V for 70% and 95% location probability, portable outdoor reception

Receiving condition: portable outdoor (Class A), Band V

Frequency	f (MHz)	800				
Minimum C/N required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\,min}$ (dBW)	–126.2	–120.2	–114.2	–108.2	–102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\,min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Antenna gain relative to half wave dipole	G_D (dB)	0				
Effective antenna aperture	A_a (dBm^2)	–17.4				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	–108.8	–102.8	–96.8	–90.8	–84.8
Minimum field strength at receiving location	E_{min} (dB(μV/m))	37	43	49	55	61
Allowance for man-made noise	P_{mmn} (dB)	0				
Height loss	L_h (dB)	18				

Location probability: 70%

Location correction factor	C_l (dB)	3				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–88	–82	–76	–70	–64
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	58	64	70	76	82

Location probability: 95%

Location correction factor	C_l (dB)	9				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–82	–76	–70	–64	–58
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	64	70	76	82	88

TABLE A.3.5-7

Minimum median power flux-density and minimum median field strength in Band III for 70% and 95% location probability, portable indoor reception at ground floor

Receiving condition: portable indoor ground floor (Class B), Band III

Frequency	f (MHz)	200				
Minimum C/N required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\,min}$ (dBW)	–126.2	–120.2	–114.2	–108.2	–102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\,min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Antenna gain relative to half wave dipole	G_D (dB)	–2.2				
Effective antenna aperture	A_a (dBm^2)	–7.5				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	–118.7	–112.7	–106.7	–100.7	–94.7
Minimum field strength at receiving location	E_{min} (dB(μV/m))	27	33	39	45	51
Allowance for man-made noise	P_{mmn} (dB)	2				
Height loss	L_h (dB)	12				
Building penetration loss	L_b (dB)	9				

Location probability: 70%

Indoor location correction factor	C_l (dB)	3				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–93	–87	–81	–75	–69
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	53	59	65	71	77

Location probability: 95%

Indoor location correction factor	C_l (dB)	10				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–86	–80	–74	–68	–62
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	60	66	72	78	84

NOTE 1 – Minimum median field-strength values at 10 m a.g.l. for 50% of the time and 50% of the locations are expected to be:

– 5 dB lower than the values shown if reception is required in rooms at the first floor;

– 10 dB lower than the values shown if reception is required in rooms higher than the first floor.

TABLE A.3.5-8

Minimum median power flux-density and minimum median field strength in Band IV for 70% and 95% location probability, portable indoor reception at ground floor

Receiving condition: portable indoor ground floor (Class B), Band IV

Frequency	f (MHz)	500				
Minimum C/N required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\,min}$ (dBW)	−126.2	−120.2	−114.2	−108.2	−102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\,min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Antenna gain relative to half wave dipole	G_D (dB)	0				
Effective antenna aperture	A_a (dBm^2)	−13.3				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	−112.9	−106.9	−100.9	−94.9	−88.9
Minimum field strength at receiving location	E_{min} (dB(μV/m))	33	39	45	51	57
Allowance for man-made noise	P_{mmn} (dB)	0				
Height loss	L_h (dB)	16				
Building penetration loss	L_b (dB)	8				

Location probability: 70%

Indoor location correction factor	C_l (dB)	4				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−85	−78	−73	−67	−61
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	61	67	73	79	85

Location probability: 95%

Indoor location correction factor	C_l (dB)	13				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−76	−70	−64	−58	−52
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	70	76	82	88	94

NOTE 1 – Minimum median field-strength values at 10 m a.g.l. for 50% of the time and 50% of the locations are expected to be:

– 6 dB lower than the values shown if reception is required in rooms at the first floor;

– 12 dB lower than the values shown if reception is required in rooms higher than the first floor.

TABLE A.3.5-9

Minimum median power flux-density and minimum median field strength in Band V for 70% and 95% location probability, portable indoor reception at ground floor

Receiving condition: portable indoor ground floor (Class B), Band V

Frequency	f (MHz)	800				
Minimum C/N required by system	**(dB)**	**2**	**8**	**14**	**20**	**26**
Minimum receiver signal input power	$P_{s\ min}$ (dBW)	−126.2	−120.2	−114.2	−108.2	−102.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\ min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6
Antenna gain relative to half wave dipole	G_D (dB)	0				
Effective antenna aperture	A_a (dBm^2)	−17.4				
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	−108.8	−102.8	−96.8	−90.8	−84.8
Minimum field strength at receiving location	E_{min} (dB(μV/m))	37	43	49	55	61
Allowance for man-made noise	P_{mmn} (dB)	0				
Height loss	L_h (dB)	18				
Building penetration loss	L_b (dB)	8				

Location probability: 70%

Indoor location correction factor	C_l (dB)	4				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−79	−73	−67	−61	−55
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	67	73	79	85	91

Location probability: 95%

Indoor location correction factor	C_l (dB)	13				
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	−70	−64	−58	−52	−46
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	76	82	88	94	100

NOTE 1 – Minimum median field-strength values at 10 m a.g.l. for 50% of the time and 50% of the locations are expected to be:

– 6 dB lower than the values shown if reception is required in rooms at the first floor;

– 12 dB lower than the values shown if reception is required in rooms higher than the first floor.

TABLE A.3.5-10

Minimum median power flux-density and minimum median field strength for 70%, 95% and 99% location probability

Receiving condition: mobile reception, Band III

Frequency	f (MHz)	200					
Representative minimum C/N ratio	**(dB)**	**2**	**8**	**14**	**20**	**26**	**32**
Minimum receiver signal input power	$P_{s\,min}$ (dBW)	–126.2	–120.2	–114.2	–108.2	–102.2	–96.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\,min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6	42.6
Antenna gain relative to half wave dipole	G_D (dB)	–2.2					
Effective antenna aperture	A_a (dBm^2)	–7.5					
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	–118.7	–112.7	–106.7	–100.7	–94.7	–88.7
Minimum field strength at receiving location	E_{min}(dB(μV/m))	27	33	39	45	51	57
Allowance for man-made noise	P_{mmn} (dB)	2					
Height loss	L_h (dB)	12					

Location probability: 70%

Location correction factor	C_l (dB)	3					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–102	–96	–90	–84	–78	–72
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	44	50	56	62	68	74

Location probability: 95%

Location correction factor	C_l (dB)	9					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–96	–90	–84	–78	–72	–66
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	50	56	62	68	74	80

Location probability: 99%

Location correction factor	C_l (dB)	13					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–92	–86	–80	–74	–68	–62
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	54	60	66	72	78	84

TABLE A.3.5-11

Minimum median power flux-density and minimum median field strength for 70%, 95% and 99% location probability

Receiving condition: mobile reception, Band IV

Frequency	f (MHz)	500					
Representative minimum C/N ratio	**(dB)**	**2**	**8**	**14**	**20**	**26**	**32**
Minimum receiver signal input power	$P_{s\ min}$ (dBW)	–126.2	–120.2	–114.2	–108.2	–102.2	–96.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\ min}$ (dBμV)	12.6	18.6	24.6	30.4	36.6	42.6
Antenna gain relative to half wave dipole	G_D (dB)	0					
Effective antenna aperture	A_a (dBm^2)	–13.3					
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	–112.9	–106.9	–100.9	–94.9	–88.9	–82.9
Minimum field strength at receiving location	E_{min} (dB(μV/m))	33	39	45	51	57	63
Allowance for man-made noise	P_{mmn} (dB)	0					
Height loss	L_h (dB)	16					

Location probability: 70%

Location correction factor	C_l (dB)	3					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–94	–88	–82	–76	–70	–64
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	52	58	64	70	76	82

Location probability: 95%

Location correction factor	C_l (dB)	9					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–88	–82	–76	–70	–64	–58
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	58	64	70	76	82	88

Location probability: 99%

Location correction factor	C_l (dB)	13					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–84	–78	–72	–66	–60	–54
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	62	68	74	80	86	92

TABLE A.3.5-12

Minimum median power flux-density and minimum median field strength for 70%, 95% and 99% location probability

Receiving condition: mobile reception, Band V

Frequency	f (MHz)	800					
Representative minimum C/N ratio	**(dB)**		**8**	**14**	**20**	**26**	**32**
Minimum receiver signal input power	$P_{s\ min}$ (dBW)		–120.2	–114.2	–108.2	–102.2	–96.2
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\ min}$ (dBμV)		18.6	24.6	30.4	36.6	42.6
Antenna gain relative to half wave dipole	G_D (dB)	0					
Effective antenna aperture	A_a (dBm^2)	–17.4					
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))		–102.8	–96.8	–90.8	–84.8	–78.8
Minimum field strength at receiving location	E_{min} (dB(μV/m))		43	49	55	61	67
Allowance for man-made noise	P_{mmn} (dB)	0					
Height loss	L_h (dB)	18					

Location probability: 70%

Location correction factor	C_l (dB)	3					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))		–82	–76	–70	–64	–58
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))		64	70	76	82	88

Location probability: 95%

Location correction factor	C_l (dB)	9					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))		–76	–70	–64	–58	–52
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))		70	76	82	88	94

Location probability: 99%

Location correction factor	C_l (dB)	13					
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))		–72	–66	–60	–54	–48
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))		74	80	86	92	98

A.3.5.3 Digital terrestrial sound broadcasting (T-DAB)

As for DVB-T, Table A.3.5-13 gives an example for T-DAB outdoor and indoor reception modes.

TABLE A.3.5-13

Minimum median power flux-density and minimum median field strength for 95% and 99% location probability

Receiving condition: T-DAB mobile and portable indoor reception, Band III

Frequency	f (MHz)	200	
Reception mode		**Mobile**	**Portable indoor**
Representative minimum *C*/*N* ratio	**(dB)**	**15**	
Minimum receiver signal input power	$P_{s\,min}$ (dBW)	–120.1	
Minimum equivalent receiver input voltage, 75 Ω	$U_{s\,min}$ (dBμV)	18.6	
Antenna gain relative to half wave dipole	G_D (dB)	–2.2	
Effective antenna aperture	A_a (dBm^2)	–7.5	
Minimum power flux-density at receiving location	φ_{min} (dB(W/m^2))	–112.6	
Minimum field strength at receiving location	E_{min} (dB(μV/m))	33.2	
Allowance for man-made noise	P_{mmn} (dB)	2	
Height loss	L_h (dB)	12	
Building penetration loss	L_b (dB)	0	9
Location probability: 95%			
Location correction factor	C_l (dB)	Not applicable	10
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	Not applicable	–80
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	Not applicable	66
Location probability: 99%			
Location correction factor	C_l (dB)	13	Not applicable
Minimum median power flux-density at 10 m a.g.l. 50% of time and 50% of locations	φ_{med} (dB(W/m^2))	–86	Not applicable
Minimum median field strength at 10 m a.g.l. 50% of time and 50% of locations	E_{med} (dB(μV/m))	60	Not applicable

ANNEX 3.6

Asymmetrical spectrum mask for DVB-T in 8 MHz and 7 MHz channels

Examples of asymmetrical DVB-T masks for 8 and 7 MHz systems appropriate for ensuring compatibility between broadcasting services are given below in Figs. A.3.6-1 and A.3.6-2 and the associated Tables A.3.6-1 and A.3.6-2. They allow for a digital transmitter to use an adjacent channel of an analogue TV transmitter with the assumption that they are co-sited and radiating the same power. If the radiated powers are not identical, proportional correction could be applied.

FIGURE A.3.6-1

Asymmetrical spectrum masks for a digital terrestrial television transmitter operating in a channel adjacent to a co-sited analogue television transmitter, 8 MHz

Power level measured in a 4 kHz bandwidth, where 0 dB corresponds to the total output power

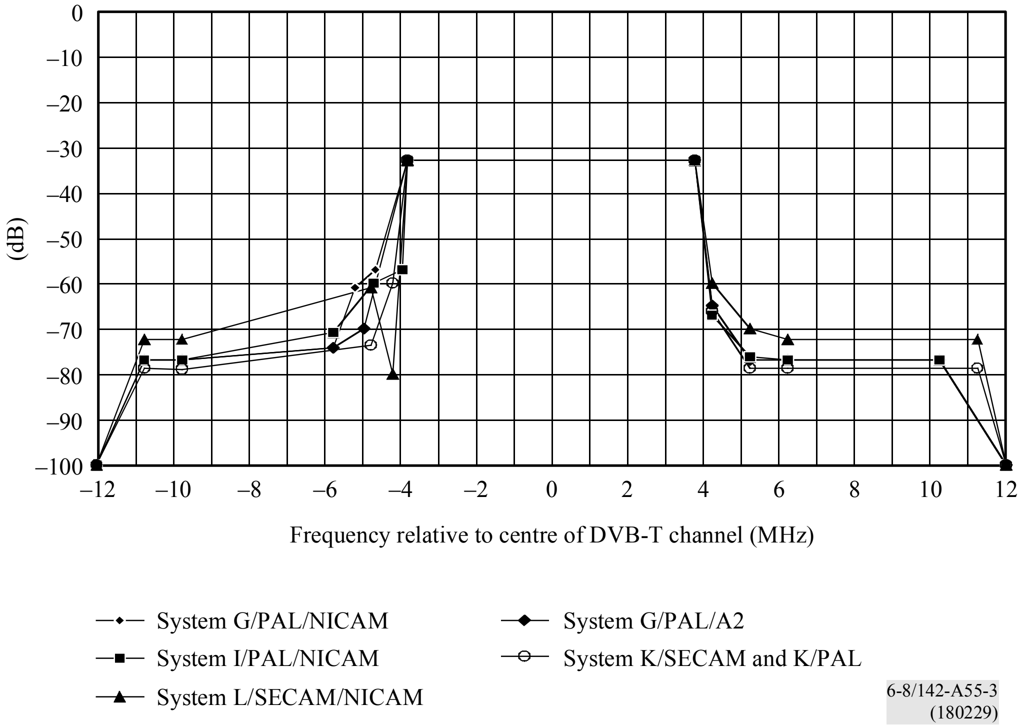


TABLE A.3.6-1

Asymmetrical spectrum masks for a digital terrestrial television transmitter operating in a channel adjacent to a co-sited analogue television transmitter, 8 MHz

Breakpoints										
	G/PAL/NICAM		**G/PAL/A2**		**I/PAL/NICAM**		**K/SECAM, K/PAL**		**L/SECAM/NICAM**	
	Relative frequency (MHz)	**Relative level (dB)**	**Relative frequency (MHz)**	**Relative level (dB)**	**Relative frequency (MHz)**	**Relative level (dB)**	**Relative frequency (MHz)**	**Relative level (dB**	**Relative frequency (MHz)**	**Relative level (dB)**
1	–12	–100	–12	–100	–12	–100	–12	–100	–12	–100
4	–5.75	–74.2	–5.75	–74.2	–5.75	–70.9	–4.75	–73.6	–4.75	–60.9
5	–5.185	–60.9	–5.185	Not available	–4.685	–59.9	–4.185	–59.9	–4.185	–79.9
6	Not available	Not available	–4.94	–69.9	Not available	Not available	Not available	Not available	Not available	Not available
7	–4.65	–56.9	Not available	Not available	–3.925	–56.9	Not available	Not available	Not available	Not available
8	–3.8	–32.8	–3.8	–32.8	–3.8	–32.8	–3.8	–32.8	–3.8	–32.8
9	+3.8	–32.8	+3.8	–32.8	+3.8	–32.8	+3.8	–32.8	+3.8	–32.8
10	+4.25	–64.9	+4.25	–64.9	+4.25	–66.9	+4.25	–66.1	+4.25	–59.9
11	+5.25	–76.9	+5.25	–76.9	+5.25	–76.2	+5.25	–78.7	+5.25	–69.9
12	+6.25	–76.9	+6.25	–76.9	+6.25	–76.9	+6.25	–78.7	+6.25	–72.4
14	+12	–100	+12	–100	+12	–100	+12	–100	+12	–100

FIGURE A.3.6-2

Asymmetrical spectrum masks for a digital terrestrial television transmitter operating in a channel adjacent to a co-sited analogue System B television transmitter, 7 MHz

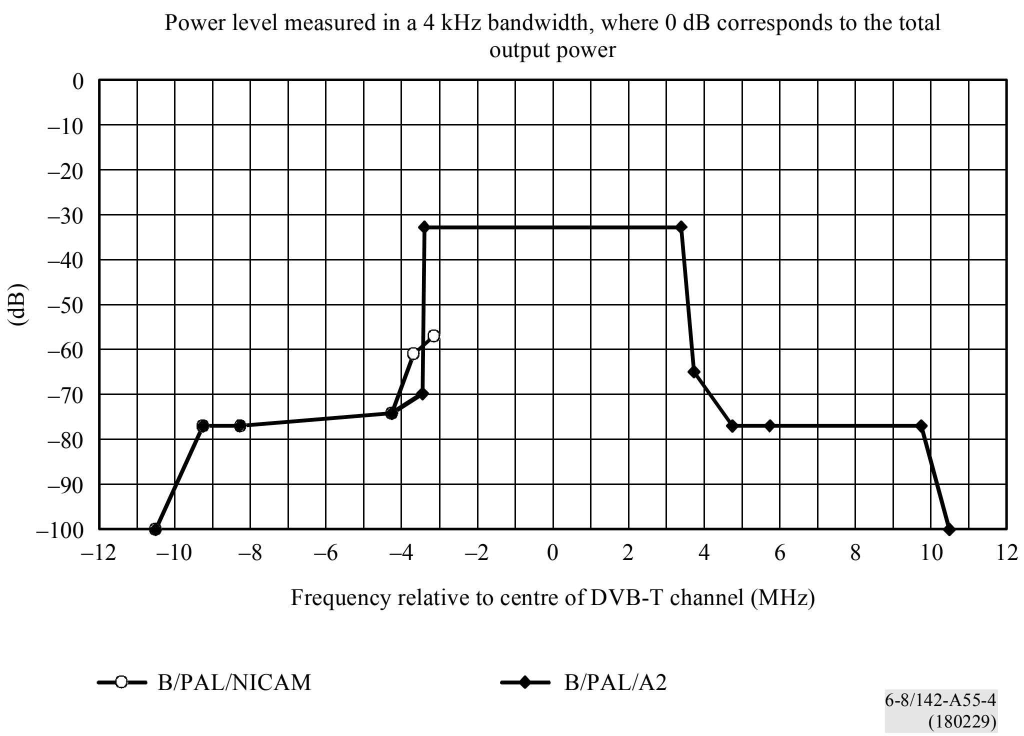


TABLE A.3.6-2

Asymmetrical spectrum masks for a digital terrestrial television transmitter operating in a channel adjacent to a co-sited analogue System B television transmitter, 7 MHz

Breakpoints				
	B/PAL/NICAM		**B/PAL/A2**	
	Relative frequency (MHz)	**Relative level (dB)**	**Relative frequency (MHz)**	**Relative level (dB)**
1	–10.5	–100	–10.5	–100
2	–9.25	–76.9	–9.25	–76.9
3	–8.25	–76.9	–8.25	–76.9
4	–4.25	–74.2	–4.25	–74.2
5	–3.685	–60.9	–3.685	Not available
6	Not available	Not available	–3.44	–69.9
7	–3.15[(1)]	–56.9	Not available	Not available
8	–3.35	–32.8	–3.4	–32.8
9	+3.35	–32.8	+3.4	–32.8
10	+3.75	–64.9	+3.75	–64.9
11	+4.75	–76.9	+4.75	–76.9
12	+5.75	–76.9	+5.75	–76.9
13	+9.75	–76.9	+9.75	–76.9
14	+10.5	–100	+10.5	–100

(1) The NICAM signal overlaps with the DVB-T signal if relative offset is less than 200 kHz.

ANNEX 3.7

Reference networks

A.3.7.1 Reference networks for DVB-T

A.3.7.1.1 General considerations

Four reference networks have been designed in order to cover the different implementation requirements for DVB-T networks.

For the determination of the power budget of the reference networks, antenna heights and powers are adjusted in such a way that the desired coverage probability is achieved at each location of the service area. Full account is taken of network gain and self-interference aspects in the calculation of the coverage probability within the service area. Recommendation ITU-R P.1546-1 is used as the field-strength prediction model. Statistical field-strength summation is performed by means of the *k*-LNM method.

The approach of adjusting the power budget of the network described above uses a noise-limited basis, which is known to be not very frequency efficient. To overcome this drawback, the powers of the transmitters in the reference networks have to be increased by a value of 3 dB. This additional power is indicated in the relevant tables by the symbol Δ to ensure that there is no confusion regarding the various elements which enter into the power budget.

For the effective antenna heights of the transmitter in the reference networks, 150 m has been used as a reasonable average value. It is clear that in real network implementations, effective antenna heights may differ considerably from this average value. However, it should be kept in mind that there is a trade-off between effective antenna heights and transmitter powers. If, in an SFN, a transmitter has a significantly larger effective antenna height than the other transmitters, its power will normally be reduced, since in an SFN it is not desirable to have strong inhomogeneities with regard to transmitter characteristics, because self-interference would then become dominant.

An open network structure has been chosen for the reference networks, since it is assumed that real network implementations will more often resemble this network type. The service area is defined as a hexagon about 15% larger than the hexagon formed by the peripheral transmitters. However, in order to allow for network implementations with very low interference potentials, a reference network with a semi-closed network structure is also introduced.

A.3.7.1.2 Reference network 1 (large service area SFN)

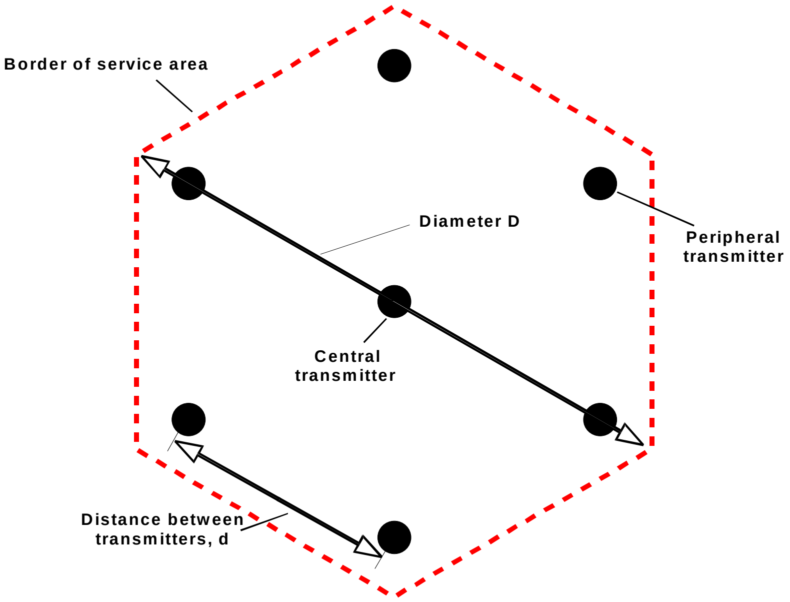
The network consists of seven transmitters situated at the centre and at the vertices of a hexagonal lattice. An open network type has been chosen, i.e. the transmitters have non-directional antenna patterns and the service area is assumed to exceed the transmitter hexagon by about 15%. The geometry of the network is given in Fig. A.3.7-1.

This reference network (RN 1) is applied to different cases: fixed (RPC 1), outdoor/mobile (RPC 2) and indoor (RPC 3) reception, for both Band III and Band IV/V.

RN 1 is intended for large service area SFN coverage. It is assumed that main transmitter sites with a reasonable effective antenna height are used as a backbone for this type of network. For portable and mobile reception, the size of the real service areas for this type of SFN coverage will be restricted to 150 to 200 km in diameter because of self-interference degradation, unless very rugged DVB-T system variants are used or the concept of dense networks is employed.

FIGURE A.3.7-1

RN 1 (large service area SFN)



For the guard interval length, the maximum value 1/4 T_u of the 8k FFT mode has been chosen. The distance between transmitters in an SFN should not overly exceed the distance equivalent to the guard interval duration. In this case, the guard interval duration is 224 µs, which corresponds to a distance of 67 km. The distance between transmitters for RPC 1 is taken as 70 km. For the RPC 2 and 3, 70 km is too large a distance from a power budget point of view. Therefore, smaller values for the distance between transmitters have been selected, 50 km for RPC 2 and 40 km for RPC 3.

Table A.3.7-1 gives the parameters and the power budgets of RN 1.

TABLE A.3.7-1

Parameters of RN 1 (large service area SFN)

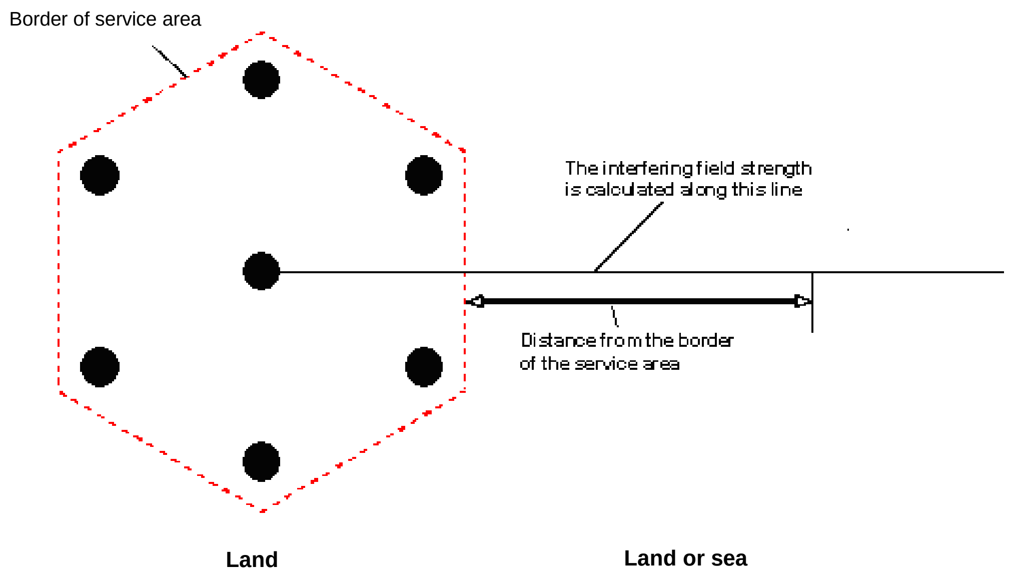
RPC and reception type		RPC 1 Fixed antenna	RPC 2 Portable outdoor and mobile	RPC 3 Portable indoor
Type of network		Open	Open	Open
Geometry of service area		Hexagon	Hexagon	Hexagon
Number of transmitters		7	7	7
Geometry of transmitter lattice		Hexagon	Hexagon	Hexagon
Distance between transmitters *d* (km)		70	50	40
Service area diameter *D* (km)		161	115	92
Tx antenna height (m)		150	150	150
Tx antenna pattern		Non-directional	Non-directional	Non-directional
e.r.p. (dBW)	Band III	31.1 + Δ	33.2 + Δ	37.0 + Δ
	Band IV/V	39.8 + Δ	46.7 + Δ	49.4 + Δ

The power margin Δ is 3 dB.

Figure A.3.7-2 shows the geometry for the interference potential calculation.

FIGURE A.3.7-2

Geometry used in the calculation of interference potential, RN 1



A.3.7.1.3 Reference network 2 (small service area SFNs, dense SFNs)

The network consists of three transmitters situated at the vertices of an equilateral triangle. An open network type has been chosen, i.e. the transmitters have non-directional antenna patterns. The service area is assumed to be hexagonal, as indicated in Fig. A.3.7-3.

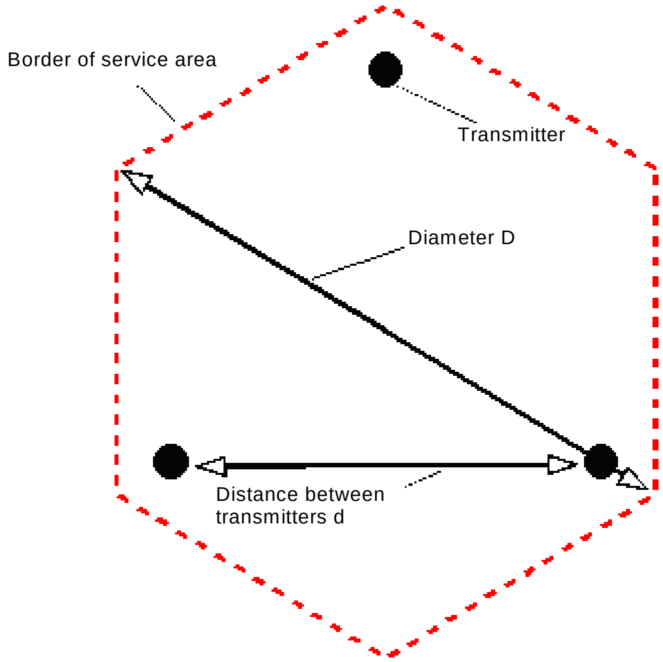
This reference network (RN 2) is applied to different cases: fixed (RPC 1), outdoor/mobile (RPC 2) and indoor (RPC 3) reception, for both Band III and Band IV/V.

RN 2 is intended for small service area SFN coverage. Transmitter sites with reasonable effective antenna heights are assumed to be available for this type of network and self-interference restrictions are expected to be small. Typical service area diameters may be from 30 to 50 km.

It is also possible to cover large service areas with this kind of dense SFN. However, a very large number of transmitters is then necessary. It therefore seems reasonable to choose RN 1 for large service areas, even if a dense network structure is envisaged.

FIGURE A.3.7-3

RN 2 (small service area SFN)



In RN 2 the inter-transmitter distance is 25 km in the case of RPCs 2 and 3. It is therefore possible to use a value of 1/8 T_u (8k FFT) for the guard interval, which would increase the available data capacity as compared to RN 1. The same guard interval value might also be feasible for the RPC 1, with its greater distance between transmitters of 40 km, since fixed roof-level reception is less sensitive to self-interference because of the directional properties of the receiving antenna.

Table A.3.7-2 gives the parameters and the power budgets of the RN 2.

TABLE A.3.7-2

Parameters of RN 2 (small service area SFN)

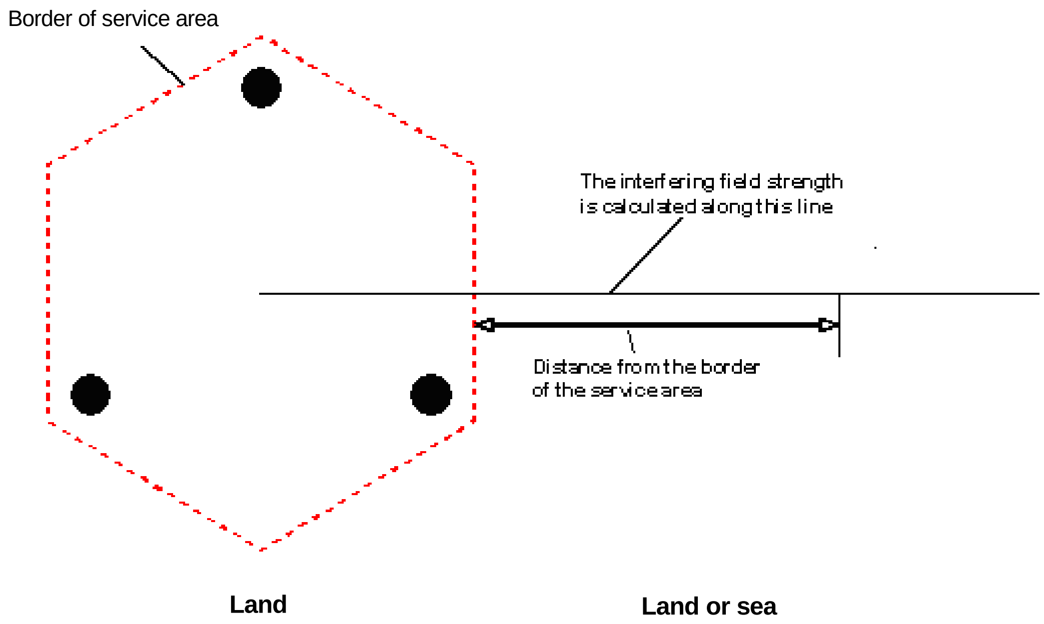
Reference planning configuration and reception type		**RPC 1 Fixed antenna**	**RPC 2 Portable outdoor and mobile**	**RPC 3 Portable indoor**
Type of network		Open	Open	Open
Geometry of service area		Hexagon	Hexagon	Hexagon
Number of transmitters		3	3	3
Geometry of transmitter lattice		Triangle	Triangle	Triangle
Distance between transmitters *d* (km)		40	25	25
Service area diameter *D* (km)		53	33	33
Tx antenna height (m)		150	150	150
Tx antenna pattern		Non-directional	Non-directional	Non-directional
e.r.p. (dBW)	Band III	21.1 + Δ	23.6 + Δ	31.1 + Δ
	Band IV/V	28.8 + Δ	36.0 + Δ	43.3 + Δ

The power margin Δ is 3 dB.

Figure A.3.7-4 shows the geometry for the interference potential calculation.

FIGURE A.3.7-4

Geometry for the calculation of interference potential, RN 2



A.3.7.1.4 Reference network 3 (RN 3) (small service area SFNs for urban environment)

The geometry of the transmitter lattice of RN 3 and the service area is identical with that of RN 2; it is therefore not necessary to repeat the figures.

RN 3 is applied to different cases: fixed (RPC 1), outdoor/mobile (RPC 2) and indoor (RPC 3) reception, for both Band III and Band IV/V.

RN 3 is intended for small service area SFN coverage in an urban environment. It is identical to RN 2, apart from the fact that urban type height loss figures are used (see Table A.3.7-3). This increases the required power of the SFN transmitters by about 5 dB.

TABLE A.3.7-3

Parameters of RN 3 (small service area SFN for urban environment)

Reference planning configuration and reception type		RPC 1 Fixed antenna	RPC 2 Portable outdoor and mobile	RPC 3 Portable indoor
Type of network		Open	Open	Open
Geometry of service area		Hexagon	Hexagon	hexagon
Number of transmitters		3	3	3
Geometry of transmitter lattice		Triangle	Triangle	Triangle
Distance *d* (km)		40	25	25
Service area diameter *D* (km)		53	33	33
Tx antenna height (m)		150	150	150
Tx antenna pattern		Non-directional	Non-directional	Non-directional
e.r.p. (dBW)	Band III	21.1 + Δ	29.5 + Δ	37.1 + Δ
	Band IV/V	28.8 + Δ	41.9 + Δ	49.2 + Δ

The power margin Δ is 3 dB.

A.3.7.1.5 Reference network 4 (RN 4) (semi-closed small service area SFN)

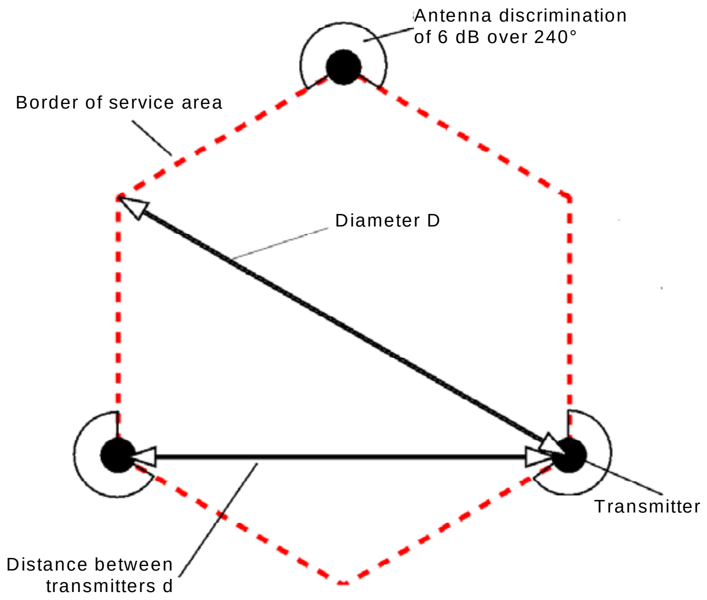
This reference network is intended for cases in which increased implementation efforts regarding transmitter locations and antenna patterns are undertaken in order to reduce the outgoing interference of the network.

The geometry for RN 4 is identical to that for RN 2, except for the antenna patterns of the transmitters, which have a reduction of the outgoing field strength of 6 dB over 240° (i.e. it is a semi-closed RN). The service area of this RN is shown in Fig. A.3.7-5.

RN 4 is applied to different cases: fixed (RPC 1), outdoor/mobile (RPC 2) and indoor (RPC 3) reception, for both Band III and Band IV/V.

FIGURE A.3.7-5

RN 4 (semi-closed small service area SFN)



The difference between RN 4 and RN 2 is the outgoing interference (interference potential). RN 4 has a lower interference potential compared to the other RNs. Because of this, the distance at which the same frequency can be re-used is smaller when two allotments are both planned with RN 4.

There is a trade-off between this lower interference potential and the increased implementation costs to achieve the directional antennas. This should be kept in mind when choosing this RN for planning. There is also a reduction in the diameters of the service areas compared with those for RN 2.

Table A.3.7-4 gives the parameters and the power budgets of the reference networks RN 4.

TABLE A.3.7-4

Parameters of RN 4 (semi-closed small service area SFN)

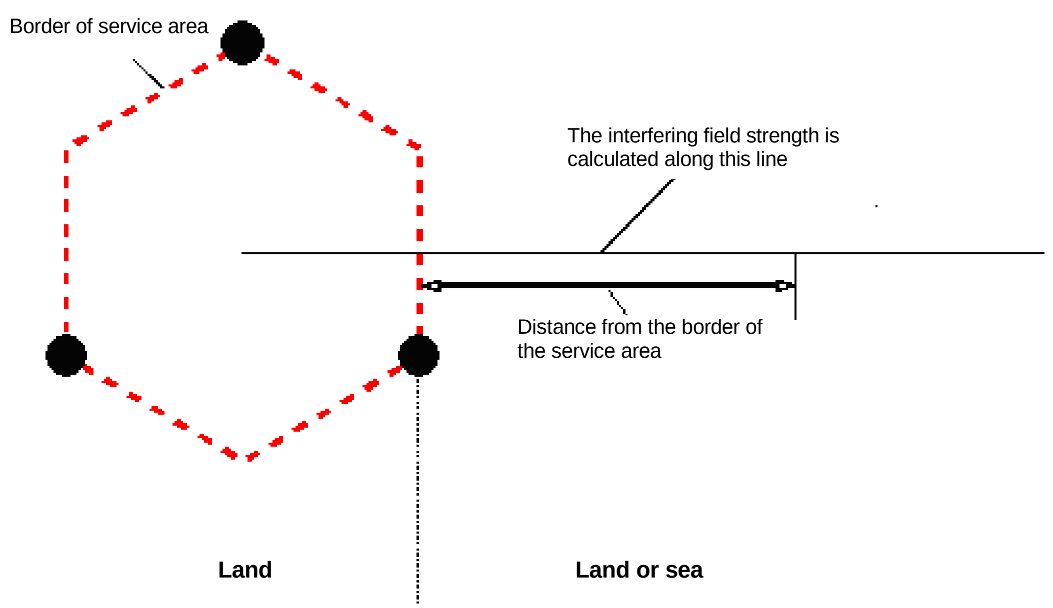
RPC		RPC 1	RPC 2	RPC 3
Type of network and reception type		Semi-closed Fixed antenna	Semi-closed Portable outdoor and mobile	Semi-closed Portable indoor
Geometry of service area		Hexagon	Hexagon	Hexagon
Number of transmitters		3	3	3
Geometry of transmitter lattice		Triangle	Triangle	Triangle
Distance between transmitters *d* (km)		40	25	25
Service area diameter *D* (km)		46	29	29
Tx antenna height (m)		150	150	150
Tx antenna pattern		Directional 6 dB reduction over 240°	Directional 6 dB reduction over 240°	Directional 6 dB reduction over 240°
e.r.p. (dBW)	Band III	19.0 + Δ	21.0 + Δ	29.5 + Δ
	Band IV/V	26.4 + Δ	34.2 + Δ	41.8 + Δ

The power margin Δ is 3 dB.

Figure A.3.7-6 shows the geometry for the interference potential calculation.

FIGURE A.3.7-6

Geometry for the calculation of interference potential, RN 4



A.3.7.2 Reference networks for T-DAB

Two reference networks for T-DAB have been designed, respectively, for RPC 4 and RPC 5.

For RPC 4, the mobile reception case, the reference network consists of seven transmitters located at the centre and the vertices of a hexagon and is of the closed network type. The power of the central transmitter is reduced by 10 dB with respect to the peripheral transmitters, which have a power of 1 kW.

For RPC 5, the portable indoor reception case, the same reference network geometry is used as for RPC 4, and the transmitter powers are increased by 9 dB, corresponding to the higher minimum field strength needed for this reception mode.

Table A.3.7-5 gives the parameters and the power budgets of the RN for RPC 4 and RPC 5; Fig. A.3.7-7 shows the geometry of the RN, and Fig. A.3.7-8 provides information relating to the geometry used in the calculation of the interference potential.

TABLE A.3.7-5

Parameters of the RN for RPC 4 and RPC 5

RPC	**RPC 4**	**RPC 5**
Reception type	Mobile	Portable indoor
Type of network	Closed	closed
Geometry of service area	Hexagon	Hexagon
Number of transmitters	7	7
Geometry of transmitter lattice	Hexagon	Hexagon
Distance between transmitters *d* (km)	60	60
Service area diameter *D* (km)	120	120
Tx antenna height (m)	150	150
Peripheral Tx antenna pattern	Directional 12 dB reduction over 240°	Directional 12 dB reduction over 240°
Central Tx antenna pattern	Non-directional	Non-directional
Peripheral Tx e.r.p. (dBW)	30.0	39.0
Central Tx e.r.p. (dBW)	20.0	29.0

FIGURE A.3.7-7

Geometry of the RN

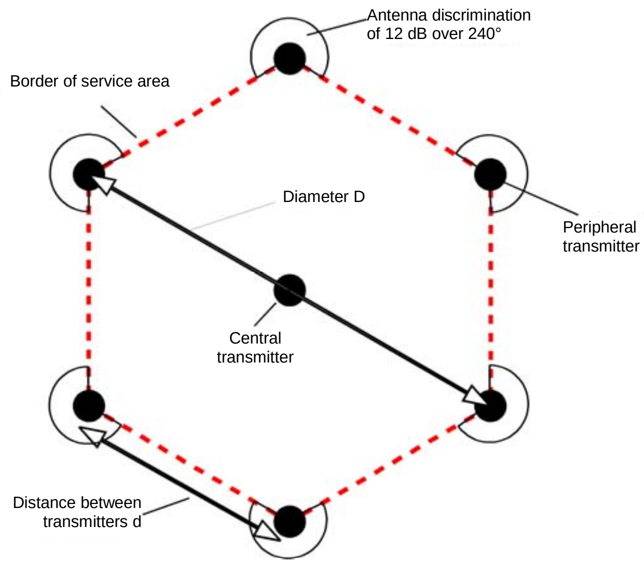


FIGURE A.3.7-8

Geometry used in the calculation of interference potential