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Typical frequency sharing characteristics for digital terrestrial television broadcasting systems in the frequency band 470-862 MHz

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REPORT ITU-R BT.2383-5

Typical frequency sharing characteristics for digital terrestrial television broadcasting systems in the frequency band 470-862 MHz

(2015-2016-2019-2021-2022-2023)

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1 Introduction

This Report contains a summary of the frequency sharing characteristics for digital terrestrial television broadcasting (DTTB) broadcast systems, operating in the frequency range 470-862 MHz, required for relevant compatibility studies[1].

In many places in this Report, material was extracted from the Final Acts of the RRC 2006 in Geneva. For these cases, the following symbol is added to illustrate the reference: (GE06)

Quotes from existing text in ITU-R are highlighted though the use of *Italics*.

It should be noted that for Band I, II, III, IV and V systems broadcasters quote antenna gains and effective radiated power (ERP) relative to a dipole. So, for example, a DTTB receiving antenna with a quoted gain of 7 dB has a gain of 9.15 dBi when referenced to an isotropic source. Also, a broadcast station with a quoted ERP of 200 kW (53 dBW) has an e.i.r.p. of 85.15 dBm.

2 Broadcasting coverage area and service area planning

Recommendation ITU-R V.573-5 No. A51b defines *coverage area* as the *area associated with a transmitting station for a given service and a specified frequency within which, under specified technical conditions, radiocommunications may be established with one or several receiving stations*.

Note 4 of No. A51b explains that *the term "service area" should have the same technical basis as for "coverage area", but also include administrative aspects*.

Reference to the administrative aspects in the definition of service area is understood to mean that in that service area protection is required.

For the case of broadcast services which are usually planned with multiple overlapping transmissions from different transmitter sites, it is usual to protect only the best coverage. Furthermore, spill-over coverage into international neighbours or adjacent regions of a country do not usually form part of the intended service area and may not require protection.

3 Definition of reception location probability

Reception location probability is defined in Report ITU-R BT.2265, § 2 as *the percentage of locations within a small area, referred in this Report as "pixel"*[2]*, where the wanted signal is high enough to overcome noise and interference for a given percentage of time taking into account the temporal and spatial statistical variations of the relevant fields.*

In digital terrestrial broadcasting the *coverage area* is defined in Report ITU-R BT.2265 Annex 2 as *the area that comprises all pixels, where a given reference reception location probability (e.g. 95%) is reached or exceeded for a predetermined percentage of the time*.

4 Broadcasting protection criteria

Broadcasting protection criteria are based on local interference considerations such as reception location probability, degradation to reception location probability in the presence of additional interference, I/N limitation and degradation to C/N.

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[1] Characteristics of Band III broadcast systems can be found in Report ITU-R BT.2469 – Typical frequency sharing characteristics of digital terrestrial broadcasting systems in the frequency band 174-230 MHz.

[2] Pixel is a small area of typically about 100 m × 100 m where the percentage of covered receiving locations is indicated.

Details about the protection requirements for the broadcasting service can be found in particular in Recommendation ITU-R BT.1895 – Protection criteria for terrestrial broadcasting systems, and Report ITU-R BT.2265 – Guidelines for the assessment of interference into the broadcasting service. Further references are listed in Annex 1.

Interference to DTTB in sharing and compatibility studies should initially be based on an assessment of the increase in interference (I/N) as described in Recommendation ITU-R BT.1895.

5 Quality of service requirements

Planning of terrestrial television broadcasting services is required by many administrations to cover a high percentage of the population/households (e.g. 98%) or geographic regions (e.g. the entire country), in accordance with statutory requirements or commercial agreements, with all reception in the area defined by this coverage requirement essentially stipulated for continuous use to a specified time availability, within the hours of transmission. This coverage requirement (as distinct from the coverage area of the broadcast transmission) applies within the service area that is licenced and to be protected.

Within the broadcast service area, interference effects can be assessed in many ways, but the overriding issue is how they may translate in terms of reducing the capacity to meet the coverage requirement of the broadcasting service. A reduction in capacity to meet the coverage requirement effectively translates to a loss of access to broadcast receiving stations at the specified time availability. Broadcast service planning methods are based on meeting a prescribed coverage requirement.

Specifically, the broadcast service delivery to the target population within the broadcast service area has been based on the expectation of a signal quality with minimum interruption[3].

6 Assessment of interference impact on the broadcast coverage

6.1 Introduction

In order to assess the impact of interference into broadcast networks, it is necessary to apply the broadcast planning criteria with the new level of interference and compare the relative change in quality-of-service requirement before and after the introduction of the new source of interference. The issues that arise from the combination of this process and sharing studies are highlighted in § 6.2.

6.2 Standard Broadcast Planning Practise

Planning of the digital terrestrial television broadcasting service is based on specified parameters and requirements and providing a service that is quasi-error-free (QEF). These form the basis for the protection of the existing digital terrestrial broadcast networks.

A Quasi Error Free (QEF) condition of a digital television broadcasting signal means less than one uncorrected error event per hour and a corresponding bit error rate (BER) can be calculated for an assumed transmission bit rate. For example, for a DTTB transmission with a bit rate of about 28 Mbit/s, QEF corresponds to BER less than 10^{-11} after the whole error correction process.

In the case of DVB-T, ATSC 1.0 and ISDB-T, this corresponds to BER less than 2×10^{-4} after Viterbi decoder or BER less than 10^{-11} after Reed-Solomon decoder.

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[3] Refer to Recommendations ITU-R BT.500 and ITU-R BT.1735.

In the case of DVB-T2, ATSC 3.0, DTMB and DTMB-A, this corresponds to BER less than 10^{-7} before BCH decoder or BER less than 10^{-11} after BCH decoder.[4]

Any study of interference into a DTTB system must take account of QEF and the hour time window. Information on the use of Monte Carlo simulation to model interference to DTTB and application of a time window can be found in Recommendation ITU-R BT.2136 and Report ITU-R BT.2470.

For planning terrestrial television broadcasting services, it is important to take into consideration the different elements of interference and the implications of temporal variations to separately identify when interference into the broadcast service arises from protection ratio failure and blocking due to overloading.

Spectrum planners are aware that a relaxation in the value or exclusion of certain interference assessment factors would reduce the ability to meet the television broadcast coverage quality requirement. A relaxation of more than one of these parameters could result in a significant cumulative reduction in the extent to which a service area can be covered.

In the simple conceptual example below of planning the broadcasting service, it is assumed that the area covered by the broadcast transmission is circular and that up to four of the above interference assessment factors have been relaxed. Each reduction in the level of protection afforded by one of the broadcast interference assessment factors is represented by a ring identifying the potential percentage of the existing population or country that can no longer be reached under the television broadcast coverage requirement, as a result of interference arising from the relaxation in the interference assessment factor(s).

A simplification of the spectrum planning process[5] is provided for illustrative purposes in the diagram below. A service area with an existing broadcast provision that has been planned in accordance with the broadcast planning criteria and meets or exceeds the prescribed coverage requirement is represented in Fig. 1A by the dotted circle. That part of the service area in Fig. 1A, where the planned broadcast coverage has been reduced or lost due to the level of the interfering signal arising from the relaxation in one of the interference assessment factor(s) is shown in Fig.1B.

In Fig. 1C the relaxation of multiple (in this case 4) interference assessment factors is aggregated to show the consequential impact on the planned broadcast service area, with the dotted area the only part of the planned broadcast service area in Fig. 1A, that remains covered by the planned broadcast transmission parameters. Not only is the effective broadcast service area significantly reduced but the target population within the planned service area is no longer served.

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[4] For ATSC 3.0, this is achieved using 256-QAM Non-Uniform Constellation and rate 10/15, 64K-LDPC.

[5] Refer to Report ITU-R BT.2248.

FIGURE 1A

Original area covered

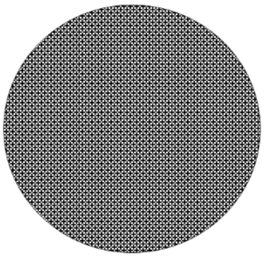


FIGURE 1B

Reduction in area covered (relaxation of one factor)

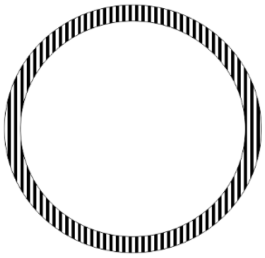
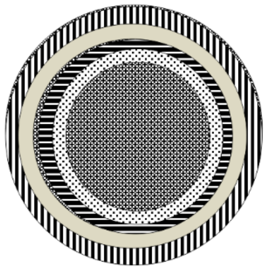


FIGURE 1C

Resulting area covered (relaxation of four factors)



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In practise, a television broadcast service area is unlikely to be circular and the population lost to broadcast coverage will not be located in convenient rings around the edge of that service area. Both areas will be influenced by topographical factors, population distribution and the respective locations of the wanted and interfering transmitters.

Transmissions in adjacent bands/channels may also cause interference. Recommendations ITU- R BT.1368 and ITU-R BT.2033, as well as Reports ITU-R BT.2215 and ITU-R BT.2248, contain additional information on this case.

7 DVB-T and DVB-T2 reference broadcasting networks

Reference broadcast transmitter configurations are provided that are representative of actual deployments in the case of assignments or are the reference configurations used in the GE06 Agreement for allotment planning.

7.1 Single transmitter case (assignments)

- High power
  - ERP: 200 kW
  - Effective antenna height: 300 m
  - Antenna height a.g.l.: 200 m
  - Antenna pattern:
    - Horizontal: Omnidirectional
    - Vertical antenna aperture: based on 24λ aperture with 1° beam tilt
- Medium power
  - ERP: 5 kW
  - Effective antenna height: 150 m
  - Antenna height a.g.l.: 75 m
  - Antenna pattern:
    - Horizontal: Omnidirectional
    - Vertical: based on 16λ aperture with 1.6° beam tilt
- Low power

- ERP: 250 W
- Effective antenna height: 75 m
- Antenna height a.g.l.: 30 m
- Antenna pattern:
  - Horizontal: Directional (cardioid)
  - Vertical: based on 4λ aperture with 3° beam tilt

The attenuation (A_ϑ) of the horizontal radiation pattern with azimuth angle (ϑ) is given by:

$$A_\vartheta = 20\log_{10}(2B - B^2)\ \text{dB}$$

where:

$$B = \frac{1+k+\cos(\vartheta)}{2+k}$$

where:

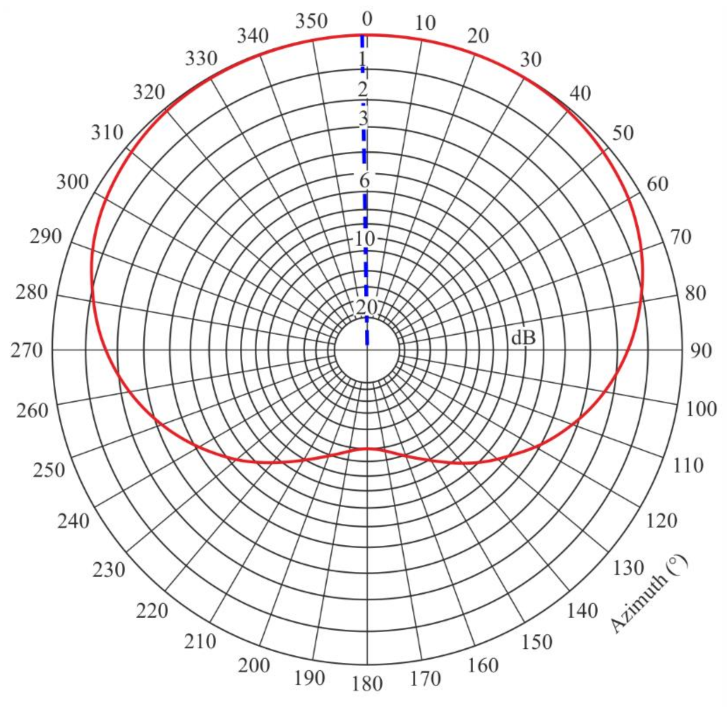
ϑ : azimuth angle

k : 0.4187 for 10 dB pattern minima.

The resulting pattern is shown in Fig. 2:

FIGURE 2

Low power DTTB



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Unlike high and medium power antennas which are usually omnidirectional, very few low power DTTB antenna are omnidirectional. Low power DTTB antennas typically have a directional horizontal radiation pattern usually of a type cardioid (dipoles mounted on a pole) or consisting of one or more panel, Yagi or log-periodic elements. These antennas typically have minima in the HRP that are 10 dB or more below the maximum and may have lobes that occur at various azimuth angles, lobes typically being aligned with the desired service area.

As patterns of low power antenna vary considerably modelling all combinations of pattern in generic compatibility studies is usually not practical. Therefore, to better represent the horizontal radiation pattern of low power DTTB it is proposed to base the generic model on the pattern of a cardioid antenna with a 10 dB minimum. Depending on the compatibility study being undertaken the orientation of the pattern (angle of azimuth) can be varied as required.

The overall gain of the low power DTTB antenna is unchanged given that the gain of the proposed 4λ cardioid is approximately the same as that of an 8λ omnidirectional antenna. The decrease in vertical aperture of a 4λ cardioid relative to an 8λ cardioid (reduction in gain of 3 dB) is offset by the directivity of the cardioid's horizontal radiation pattern (nominal gain of 3 dB).

7.1.1 Vertical radiation patterns

The normalised field strength in the vicinity of the broadcast transmitting station is a function of the vertical radiation pattern of the transmitting antenna. The equation below is an approximation to be used for sharing studies at angles of θ above and below the horizon.

$$E(\theta) = abs\left(\frac{\sin\psi}{\psi}\right)$$

where:

$$\psi = \pi A \sin(\theta - \beta)$$

and

A : the antenna vertical aperture in wavelengths

β : the beam tilt radians below the horizontal.

To allow for null fill the value of $E(\theta)$ should not go below the value shown in Table 1.

TABLE 1

Null fill values to be applied to vertical radiation patterns

	Limit on $E(\theta)$
First null	0.15
Second null	0.1

For the third null and at all angles of θ beyond the third null the value of $E(\theta)$ should not fall below 0.05.

$E(\theta)$ given above are linear values, to convert them to reduction values in dB the following equation is used:

$$Reduction\ in\ dB = 20 * \log10\{E(\theta)\}$$

7.2 Out of band mask

Information on transmitter spectrum masks to be used in compatibility studies is provided in Recommendation ITU-R BT.1206.

7.3 Single frequency networks (Allotments) (GE06)

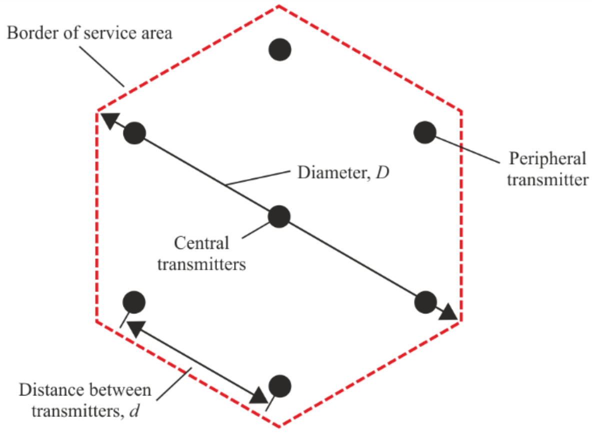
Three reference networks (RN) for DTTB services in Region 1 will be used as described in Appendix 3.6 of Chapter 3 of the GE06 Agreement. This information is reproduced in part below.

For sharing studies within the service area of an SFN the same vertical diagrams as provided in § 7.1 above should be applied for each transmitter.

7.3.1 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. 3. This reference network (RN 1) is applied to different cases: fixed (RPC 1), outdoor/mobile (RPC 2) and indoor (RPC 3) reception, for Bands IV and V. RN 1 is intended for large service area SFN coverage. It is assumed that main transmitter sites with an appropriate 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 is 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 3



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For the guard interval length, the maximum value 1/4 T_u of the 8k FFT mode is assumed. The distance between transmitters in an SFN should not significantly 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 RPC 2 and RPC 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.

The parameters and the power budgets of RN 1 given in Table 2 should be used.

TABLE 2

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 effective antenna height (m)	150	150	150
Tx antenna pattern	Non-directional	Non-directional	Non-directional
e.r.p.* dB(W) Band IV/V	42.8	49.7	52.4

* The e.r.p. values indicated in this Table incorporate an additional power margin of 3 dB.

The e.r.p. is given for 650 MHz in Bands IV/V; for other frequencies (*f* in MHz) the frequency correction factor added is: $20 \log_{10}(f/650)$ for RPC 1 and $30 \log_{10}(f/650)$ for RPC 2 and RPC 3.

7.3.2 Reference network 2 (small service area SFN, dense SFN)

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. 4.

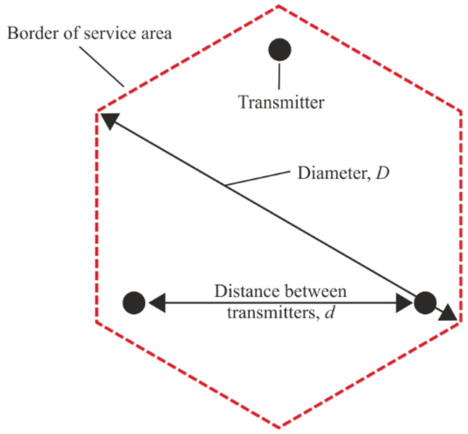
This reference network 2 (RN 2) is applied to different cases: fixed (RPC 1), outdoor/mobile (RPC 2) and indoor (RPC 3) reception, for both Bands IV and V.

RN 2 is intended for small service area SFN coverage. Transmitter sites with appropriate 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 have large service areas being represented by RN 1, even if a dense network structure is envisaged.

FIGURE 4

RN 2 (small service area SFN)



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In RN 2 the inter-transmitter distance is 40 km for RPC 1 and 25 km in the case of RPCs 2 and 3. The parameters and the power budgets of the RN 2 given in Table 3 should be used.

TABLE 3

Parameters of RN 2 (small 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		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 effective antenna height (m)		150	150	150
Tx antenna pattern		Non-directional	Non-directional	Non-directional
e.r.p.* (dBW)	Band IV/V	31.8	39.0	46.3

* The e.r.p. values indicated in this Table incorporate an additional power margin of 3 dB.

The e.r.p. is given for 650 MHz in Bands IV/V; for other frequencies (f in MHz) the frequency correction factor added is: 20 $\log_{10}(f/650)$ for RPC 1 and 30 $\log_{10}(f/650)$ for RPC 2 and RPC 3.

7.3.3 Reference network 3 (small service area SFN for urban environment)

The geometry of the transmitter lattice of reference network 3 (RN 3) and the service area are identical to those of RN 2 (see Fig. 4 above).

RN 3 is applied to different cases: fixed (RPC 1), outdoor/mobile (RPC 2) and indoor (RPC 3) reception, for both Bands IV and 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. This increases the required power of the SFN transmitters by about 5 dB for RPC 2 and RPC 3.

The parameters and the power budgets of the RN 3 given in Table 4 should be used.

TABLE 4

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

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		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 effective antenna height (m)		150	150	150
Tx antenna pattern		Non-directional	Non-directional	Non-directional
e.r.p.* (dBW)	Band IV/V	31.8	44.9	52.2

* The e.r.p. values indicated in this table incorporate an additional power margin of 3 dB.

The e.r.p. is given for 650 MHz in Bands IV/V; for other frequencies (f in MHz) the frequency correction factor added is: $20 \log_{10}(f/650)$ for RPC 1 and $30 \log_{10}(f/650)$ for RPC 2 and RPC 3.

8 ATSC Reference broadcasting networks

Reference broadcast transmitter configurations are provided that are representative of actual deployments of DTTB System A (ATSC) or ATSC 3.0[6] in the cases of the assignments or the reference configurations used for allotment planning.[7] The configurations depend on both the 'system-independent' planning factors and the 'system dependent' planning factors, that were used in regulatory allotments by those countries adopting the system. Included are such factors as the maximum power permitted in a 6 MHz channel, the maximum height (HAAT) at which that power level can be used, threshold signal levels for reception in the several television broadcast frequency bands, and so forth. There is only a single operating point with respect to the required signal-to-noise ratio for the threshold of reception at a specific bitrate.

Countries adopting DTTB System A or ATSC 3.0 should use the broadcast transmitter configurations and planning factors provided here.

[6] DTTB System A, also known as "ATSC 1.0," is defined in Recommendation ITU-R BT.1306. ATSC 3.0 is defined in Recommendation ITU-R BT.1877.

[7] Values were derived from the Consolidated Data Base System (CDBS) of the U.S. Federal Communications Commission (FCC). This system was the predecessor to the Licensing and Management System (LMS) of the FCC currently in use and available at: https://enterpriseefiling.fcc.gov/dataentry/login.html.

8.1 DTTB System A (ATSC 1.0) or System S (ATSC 3.0) single transmitter

– High power
  - ERP: 1 000 kW
  - Antenna Height Above Average Terrain (HAAT): 365 m
  - Antenna pattern: Omnidirectional
– Medium power
  - ERP: 400 kW
  - Antenna Height Above Average Terrain (HAAT): 550 m
  - Antenna pattern: Omnidirectional
– Low power
  - ERP: 50 kW
  - Antenna Height Above Average Terrain (HAAT): 1 800 m
  - Antenna pattern: Omnidirectional

8.1.1 Vertical radiation pattern

The field strength in the vicinity of the broadcast UHF transmitting station is a function of the vertical radiation pattern of the transmitting antenna. Table 5 is to be used for sharing studies.[8]

TABLE 5

Vertical UHF radiation pattern

Angle from horizon (degrees)	Relative field strength
0.75	1.000
1.50	0.880
2.00	0.690
2.50	0.460
3.00	0.260
3.50	0.235
4.00	0.210
5.00	0.200
6.00	0.150
7.00	0.150
8.00	0.150
9.00	0.150
10.00	0.150

To allow for null fill the value of the relative field strength should not go below 0.150 at all angles.

Relative Field Strength given above are linear values; to convert them to reduction values in dB the following equations is used:

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[8] See: http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet69/oet69.pdf.

$$Reduction\ in\ dB = 20 * \log10(Relative\ Field\ Strength)$$

9 ISDB-T reference broadcasting networks

9.1 DTTB System C (ISDB-T) single transmitter

– Main station
  - ERP: 30 kW
  - Antenna Height Above Average Terrain (HAAT): 100 m
  - Antenna pattern: Omnidirectional

– Relay station
  - ERP: 50 W
  - Antenna Height Above Average Terrain (HAAT): 20 m
  - Antenna pattern: Omnidirectional

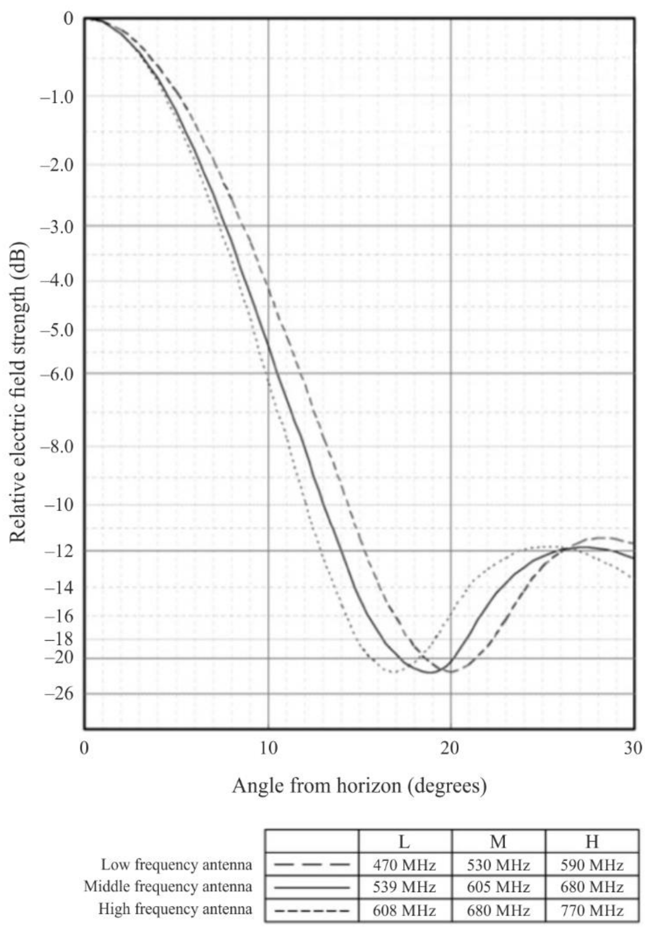
– Repeater
  - ERP: 50 mW
  - Antenna Height Above Average Terrain (HAAT): 10 m
  - Antenna pattern: Omnidirectional

9.2 Vertical radiation pattern

The field strength in the vicinity of the broadcast UHF transmitting station is a function of the vertical radiation pattern of the transmitting antenna. The middle frequency antenna from Fig. 5 below is to be used for sharing studies for main and relay stations.

FIGURE 5

Vertical UHF radiation pattern for main and relay station



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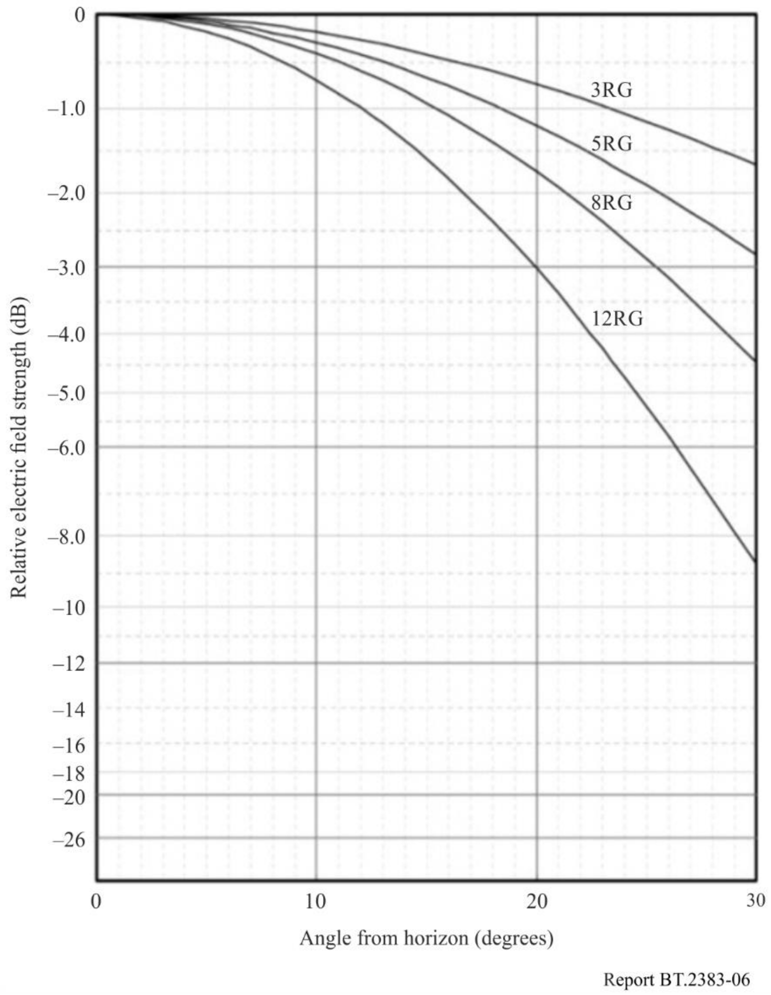
For repeater stations, the 3RG vertical pattern in Fig. 6 should be used.

FIGURE 6

Vertical UHF radiation pattern for repeater



10 DTMB Reference broadcasting networks

Reference broadcast transmitter configurations are provided that are representative of actual deployments in the case of assignments.

10.1 Single transmitter case (Assignments)

– High power
  - ERP: 200 kW
  - Effective antenna height: 300 m
  - Antenna height a.g.l.: 200 m
  - Antenna pattern:
    – Horizontal: Omnidirectional
    – Vertical: 24λ aperture with 1° beam tilt (see formula in § 7.1.1)

– Medium power
  - ERP: 5 kW
  - Effective antenna height: 150 m
  - Antenna height a.g.l.: 75 m

- Antenna pattern:
  – Horizontal: Omnidirectional
  – Vertical: 16λ aperture with 1.6° beam tilt (see formula in § 7.1.1)

– Low power
- ERP: 250 W
- Effective antenna height: 75 m
- Antenna height a.g.l.: 30 m
- Antenna pattern:
  – Horizontal: Omnidirectional
  – Vertical: 8λ aperture with 3° beam tilt (see formula in § 7.1.1)

11 DTTB reception modes

11.1 Fixed DTTB reception

Fixed reception is defined as reception where a directional receiving antenna mounted at roof level is used.

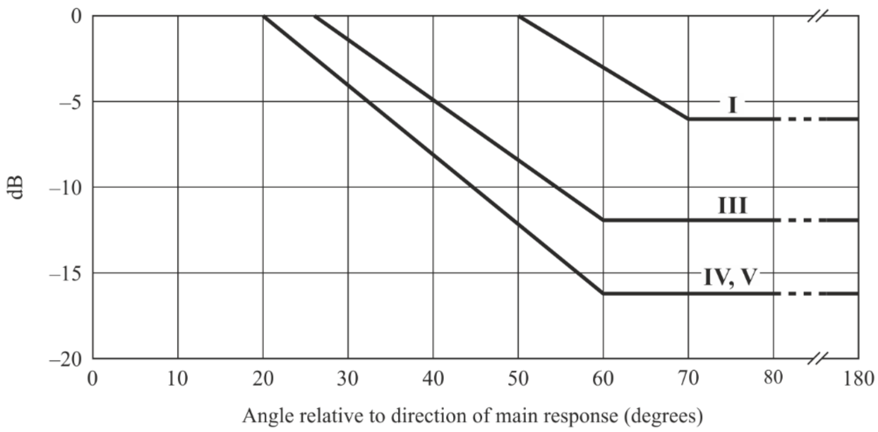
The reference receiving antenna height considered to be representative in calculating the field strength for fixed reception is 10 m above ground level or the height of the surrounding clutter if it is greater than 10 m, for example in an urban environment. In order to derive the minimum median field-strength levels, the receiving antenna gain and feeder-loss values are given in §§ 12.1.2 and 12.1.3 for reference frequencies. Minimum median field strength levels for other frequencies are derived by interpolation as described in § 11.5.

11.1.1 Fixed antenna radiation pattern

Standard radiation patterns for receiving antennas for Bands I, III, IV and V, Fig. 7, are given in Recommendation ITU-R BT.419. The curves in Fig. 7 are valid for signals of vertical or horizontal polarization, when both the wanted and the unwanted signals have the same polarization. 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. The tilt angle for fixed reception of terrestrial television services in hilly environments needs to be taken into account when the angle of arrival above the horizontal plane is considered.

FIGURE 7

Discrimination obtained by the use of directional receiving antennas in broadcasting (The number of the broadcasting band is shown on the curve)



Report BT.2383-07

Additional information on radiation pattern characteristics of UHF television receiving antennas reported in Report ITU-R BT.2138 should be considered, where applicable.

11.1.2 Antenna gain

11.1.2.1 DVB-T / DVB-T2 / ATSC 1.0 / ATSC 3.0 / ISDB-T

The antenna gain values (relative to a half-wave dipole) used in the derivation of the minimum median equivalent field-strength values are given in Table 6.

TABLE 6

Antenna gain (relative to a half-wave dipole) in Bands IV and V (GE06)

Band	IV	V
Reference frequency (MHz)	500	800
Antenna gain (dBd)	10	12

The value of the antenna gain for other frequencies can be calculated by linear inter/extrapolation.

11.1.2.2 DTMB

The antenna gains used in the derivation of the minimum median field strength are given in Table 7.

Antenna gain used in the derivation of the minimum median field strength.

TABLE 7

Antenna gain used in the derivation of the minimum median field strength

Band	IV	V
Reference frequency (MHz)	500	700
Antenna gain (dBd)	10	12

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

$$Corr = 10 \log F_A / F_R$$

where:

- $Corr$: correction term
- F_A : actual working frequency being considered
- F_R : reference frequency quoted above.

11.1.3 Feeder loss

The feeder-loss values used in the derivation of the minimum median wanted signal levels are given in Table 8.

TABLE 8

Feeder loss in Bands IV and V (GE06)

Band	IV	V
Frequency (MHz)	500	800
Feeder loss (dB)	3	5

The value of the antenna gain for other frequencies can be calculated by linear inter/extrapolation using the values for 500 MHz and 800 MHz.

11.1.4 Location probability for fixed reception

For fixed reception, the location probability is a target value used in spectrum allocations and allotments, as well as channel assignments and facility designs. In certain cases, appropriate location probability varies due to regulatory decisions and/or use case requirements, which also can vary by country.

Table 9 presents location probabilities as mentioned in the GE06 Agreement, Recommendations ITU-R BT.1368 and ITU-R BT.2033, to be used in sharing and compatibility studies.

TABLE 9

Location probability for fixed reception

System	DVB-T/DVB-T2 (GE06)	ATSC 1.0, ATSC 3.0 (FCC)	ISDB-T	DTMB
Location probability (%) [9]	95	50/95	95	95

11.1.5 Polarization discrimination for fixed reception

11.1.5.1 DVB-T and DVB-T2

For calculation of interference:

– For terminal station (UE) polarization discrimination must not be applied.

[9] For ATSC 1.0/ATSC 3.0, the 50% figure has been used by several administrations for allotments and assignments; the 95% figure can be used to support expanded use cases and/or service requirements.

– For base station (BS) polarization discrimination may be applied. The combined value of polarization discrimination and discrimination offered by receive aerial directivity must not be more than 16 dB[10].

11.1.5.2 ATSC 1.0/ATSC 3.0

Polarization discrimination should not be taken into account in frequency planning for fixed reception due to the possibility of multipath interference.

11.1.5.3 ISDB-T

Polarization discrimination should not be taken into account in frequency planning for fixed reception due to the possibility of multipath interference.

11.1.5.4 DTMB

Polarization discrimination should not be taken into account in frequency planning for fixed reception.

11.2 Portable DTTB reception[(GE06)]

Portable reception is defined as:

– outdoor – which means reception by a portable receiver with an attached or built-in antenna is used outdoors at no less than 1.5 m above ground level;

– indoor – which means reception by a portable receiver with an attached or built-in antenna is used indoors at no less than 1.5 m above floor level in rooms with a window in an external wall.

In both cases, it is assumed that optimal receiving conditions will be found by moving the antenna up to 0.5 m in any direction and extreme cases, such as reception in completely shielded rooms, are disregarded.

11.2.1 Considerations on height loss

For portable (indoor and outdoor) reception, a receiving antenna height of 1.5 m above ground level is used. The same receiving antenna height is also used for mobile reception.

However, in broadcasting, it is common practice for fixed reception to calculate the field strength at 10 m, or at the height of the surrounding clutter if it is greater than 10 m, for example in an urban environment[11]. In some cases, a 10 m reference height is also used as the starting point in calculations for portable and mobile reception with an appropriate height loss taken into account to derive the required value at 1.5 m.

Hence a height loss correction factor for an antenna height of 1.5 m should be used in the calculation of signal levels. The height-loss values for portable and for mobile reception for reference frequencies are given in Tables 10 and 11. Appropriate values for the height loss for other frequencies in the UHF broadcast band can be obtained by linear interpolation/extrapolation of the values given in Tables 10 and 11 for 500 MHz and 800 MHz.

---

[10] Refer to Recommendation ITU-R BT.419.

[11] Recommendation ITU-R P.1546, Annex 5 § 9.

TABLE 10

Rural/suburban height loss in Bands IV and V[12]

	Band IV	Band V
Frequency (MHz)	500	800
Height loss (dB) (10 m terminal and clutter height to 1.5 m receiver height)	16	18

NOTE – These values are those obtained for rural/suburban coverage. In urban and dense-urban areas, higher values are to be applied (see Table 11).

TABLE 11

Urban/dense urban height loss in Bands IV and V[13]

	Band IV	Band V
Frequency (MHz)	500	800
Urban height loss (dB) (20 m terminal and clutter height to 1.5 m receiver height)	23	25
Dense urban height loss (dB) (30 m terminal and clutter height to 1.5 m receiver height)	26	28

11.2.2 Building entry loss

The methodology described in Recommendation ITU-R P.2109 for calculating building loss should be used in sharing and compatibility studies involving broadcast systems.

Recommendation ITU-R P.2109 covers a full range of building types of traditional and thermally efficient construction. For sharing and compatibility studies involving broadcast systems using Recommendation ITU-R P.2109, whenever a single representative value is required (for example, in an MCL analysis), the parameters provided in Table 12 should be used. This is independent of coverage planning. For dynamic or statistical analysis (for example, in a Monte Carlo simulation), the full distribution function of Recommendation ITU-R P.2109 should be used.

TABLE 12

P.2109 broadcast building entry loss parameters to use in sharing and compatibility studies

Building type	Environment	Probability building entry loss not exceeded
Traditional	Suburban	50%
Traditional	Urban	70%

NOTE – Studies of building entry loss have meant figures have changed over time with the current version of Recommendation ITU-R P.2109 representing the latest work. The parameters specified in Table 12 provide a building entry loss aligned with values derived using parameters supplied in older documents, for example Recommendation ITU-R P.1812 and the low building class in Recommendation ITU-R BT.2033.

[12] Refer to Recommendation ITU-R P.1546. They are equivalent to the values provided in GE06.

[13] Refer to Recommendation ITU-R P.1546.

11.2.3 Antenna gain for portable reception

Recommendation ITU-R BT.1368 gives in its Annex 6, § 4.1, information on antennas for portable reception. For portable reception, an omnidirectional antenna should be applied. The antenna gain (relative to a half-wave dipole) is as given in Table 13.

TABLE 13

Antenna gain (dBd) for portable reception

Band	Gain (dBd)
Band IV (470-582 MHz)	0
Band V (582-960 MHz)	0

Note: This is equivalent to 2.15 dBi.

11.2.4 Location probability for portable reception

For portable indoor and outdoor reception, the location probability is a target value used in spectrum allocations and allotments, as well as channel assignments and facility designs. In certain cases, appropriate location probability varies due to regulatory decisions and/or use case requirements, which also can vary by country.

Table 14 presents location probabilities as mentioned in the GE06 Agreement, Recommendations ITU-R BT.1368 and ITU-R BT.2033, to be used in sharing and compatibility studies.

TABLE 14

Location probability for portable reception

System	DVB-T/DVB-T2 (GE06)	ATSC 1.0 ATSC 3.0	ISDB-T	DTMB
Location probability (%)[14]	95	50/95	95	95

11.2.5 Polarization discrimination for portable reception

Polarization discrimination should not be taken into account in frequency planning for portable reception.[15]

11.3 Mobile DTTB reception

Mobile reception is defined as reception by a receiver in motion with an antenna (external or integrated one) situated at no less than 1.5 m above ground level. This could for example be a car receiver or handheld equipment.

The dominant factor with regard to local reception effects is fading in a Rayleigh channel. Fade margins are intended to offset these effects. Fade margins depend on the frequency and the velocity.

[14] For ATSC 1.0/ATSC 3.0, the 50% figure has been used by several administrations for allotments and assignments; the 95% figure can be used to support expanded use cases and/or service requirements.

[15] Recommendation ITU-R BT.1368.

11.3.1 Considerations on height loss

For mobile reception, height loss as given in Tables 10 and 11 should be used.

11.3.2 Antenna gain for Mobile DTTB reception

Recommendation ITU-R BT.1368 gives in its Annex 6, § 4.3, information on antennas for mobile reception. For mobile reception, practical standard 1/4 monopole antenna for vehicle reception, which uses the metallic roof as a ground plane, should be applied. The antenna gain for conventional incident wave angles depends on the position of the antenna on the roof. For passive antenna systems, the antenna gain (relative to a half-wave dipole) is as given in Table 15.

TABLE 15

Antenna gain (dBd) for mobile reception

Band	Gain (dBd)
Band IV	−2
Band V	−1

Note: This is equivalent to 2.15 dBi.

11.3.3 Location probability for mobile reception

For mobile reception, the location probability is a target value used in spectrum allocations and allotments, as well as channel assignments and facility designs. In certain cases, appropriate location probability varies due to regulatory decisions and/or use case requirements, which also can vary by country.

Table 16 presents location probabilities as mentioned in the GE06 Agreement, Recommendations ITU-R BT.1368 and ITU-R BT.2033, to be used in sharing and compatibility studies.

TABLE 16

Location probability for mobile reception

System	DVB-T/DVB-T2	ATSC 1.0/ ATSC 3.0	ISDB-T	DTMB
Location probability (%) [16]	99	50/99	99	99

11.3.4 Polarization discrimination for mobile reception

For mobile reception, the polarization discrimination is between about 4 to 10 dB depending on the roof position of the antenna when mounted on top of a vehicle.[17] The polarization discrimination for integrated antennas, i.e. antennas within the housing of portable devices, is assumed to be 0 dB.

[16] For ATSC 1.0/ATSC 3.0, the 50% figure has been used by several administrations for allotments and assignments; the 99% figure can be used to support expanded use cases and/or service requirements.

[17] Recommendation ITU-R BT.1368.

11.4 Reference planning configurations for DVB-T and DVB-T2 (GE06)

A planning configuration describes relevant technical aspects of a broadcasting service implementation. Three planning configurations are used in assessing DTTB coverage in Region 1 as described in Appendix 3.5 of Chapter 3 of the GE06 Agreement. The three reference planning configurations are:

1) RPC1 – Fixed
2) RPC2 – Portable Outdoor/Mobile
3) RPC3 – Portable Indoor.

11.5 Interpolation of reference field strength values (GE06)

For frequencies other than those quoted in tables, as described in Appendix 3.5 of Chapter 3 of the Final Acts of RRC06, the reference field-strength values should be adjusted by adding the correction factor defined according to the following rule:

– $(E_{med})_{ref}(f) = (E_{med})_{ref}(f_r)$ + Corr;

– for fixed reception, Corr = 20 $\log_{10}(f/f_r)$, where f is the actual frequency and f_r the reference frequency in the table;

– for portable reception and mobile reception, Corr = 30 $\log_{10}(f/f_r)$ where f is the actual frequency and f_r the reference frequency in the Table.

12 System parameters for DTTB Systems

12.1 System parameters related to DVB-T (8 MHz)

12.1.1 General parameters

TABLE 17

General DVB-T parameters

Parameter	Fixed reception Portable reception (outdoor/mobile or indoor)
Signal bandwidth (MHz)	7.60
Thermal noise density (kT_0) (dBm/Hz)	−173.98
Receiver noise figure[18] (dB)	7

The studies should consider two reception modes, one mode for fixed reception and one mode for portable reception.

[18] Refer to Recommendation ITU-R BT.1368 Annex 2.

12.1.2 Carrier-to-noise ratio

Within Recommendations ITU-R BT.1368 for DVB-T and in ITU-R BT.2033 for DVB-T2, carrier to noise figures are provided. For compatibility and sharing studies the values in Table 18 should be used for both systems.

TABLE 18

Carrier-to-noise ratio

Fixed reception	Portable reception
20 dB	18 dB

12.1.3 Minimum field strength at 650 MHz

TABLE 19

Minimum field strength at f_r = 650 MHz

Fixed reception at 10 m for 95% location probability	Portable outdoor suburban reception at 1.5 m for 95% location probability
55.2 dB(µV/m)	60.2 dB(µV/m)

Minimum median field-strength levels for other frequencies than 650 MHz are derived by the correction described in § 11.5.

12.1.4 Link budgets

Example link budgets for DVB-T for fixed rooftop, portable outdoor and portable indoor reception are provided in Annex 2.

12.1.5 Protection ratios and overload threshold for interference from other services

Recommended values for protection ratios (PR) and overloading thresholds for DVB-T systems to be used in sharing studies can be found Recommendation ITU-R BT.1368, Annex 2, § 1.5 "Protection of DVB-T from wideband signals other than terrestrial broadcasting".

For other ACLR values than those in used in the referenced table, the PR figures should be corrected using the formula referenced in § 12.6.

12.2 System parameters related to DVB-T2 (8 MHz)

12.2.1 General parameters

TABLE 20

General DVB-T2 parameters

Parameter	Fixed reception Portable reception (outdoor/Mobile or indoor)
Signal bandwidth (MHz)	7.77
Thermal noise density (kT_0) (dBm/Hz)	−173.98
Receiver noise figure[19] (dB)	6

The studies should consider two reception modes, one mode for fixed reception and one mode for portable reception.

12.2.2 Carrier-to-noise ratio

Within GE06, Recommendations ITU-R BT.1368 for DVB-T and in ITU-R BT.2033 for DVB-T2, carrier-to-noise figures are provided. For compatibility and sharing studies the values in Table 21 should be used for both systems.

TABLE 21

Carrier-to-noise ratio

Fixed reception	Portable reception
20 dB	18 dB

12.2.3 Minimum field strength at 650 MHz

TABLE 22

Minimum field strength at f_r=650 MHz

Fixed reception at 10 m for 95% location probability	Portable outdoor suburban reception at 1.5 m for 95% location probability
54.3 dB(µV/m)	59.3 dB(µV/m)

Minimum median field-strength levels for other frequencies than 650 MHz are derived by the correction described in § 11.5.

12.2.4 Link budgets

Example link budgets for DVB-T2 for fixed rooftop, portable outdoor and portable indoor reception are provided in Annex 2.

[19] Refer to Recommendation ITU-R BT.2033.

12.2.5 Protection ratios and overload threshold for interference from other services

Recommended values for protection ratios and overloading threshold for DVB-T2 receivers can be found Annex 1 of Recommendation ITU-R BT.2033. For other ACLR values than those in used in the referenced table, the PR figures should be corrected using the formula referenced in § 12.6.

12.3 System parameters related to ATSC 1.0 and ATSC 3.0 (both 6 MHz)

12.3.1 General UHF parameters

TABLE 23

General UHF parameters

Parameter	
Channel bandwidth (MHz)	6
Thermal noise density (kT_0) (dBm/Hz)	−173.20
Receiver noise figure[20] (dB)	7

The studies should consider two reception modes, one mode for fixed reception and one mode for portable reception.

12.3.2 Carrier-to-noise ratio

TABLE 24

Carrier-to-noise ratio

Fixed reception	Portable reception
15.0 dB	15.0 dB

12.3.3 Minimum UHF field strength

TABLE 25

Minimum field strength at f_r = 650 MHz[21]

Fixed reception at 10 m for 50% location probability	Portable outdoor reception at 1.5 m for 50% location probability
41 dB(μV/m)	48 dB(μV/m)

Minimum median field-strength levels for other frequencies than 650 MHz are derived by the correction described in § 11.5.

[20] Refer to Recommendation ITU-R BT.1368.

[21] ATSC 3.0 can operate over a wide range of field strengths and *S*/*N* thresholds based on radiated power and particular modulation and coding parameters.

12.3.4 Link budgets

Example link budgets for ATSC 3.0 for fixed rooftop, portable outdoor and portable indoor reception are provided in Annex 2.

12.3.5 Protection ratios

Co-channel, first adjacent-channel, and multiple adjacent-channel values for protection ratio to be used in sharing studies can be found Tables 3, 4 and 5 in Annex 1 of Recommendation ITU- R BT.1368.

12.4 System parameters and protection requirements related to ISDB-T (6 MHz/8 MHz)

12.4.1 General parameters

TABLE 26

General ISDB-T parameters

Parameter	Fixed reception / Portable reception
Signal bandwidth (6 MHz system / 8 MHz system) (MHz)	5.6 / 7.4
Thermal noise density (kT_0) (dBm/Hz)	−173.98
Receiver noise figure (dB)	7

12.4.2 Carrier-to-noise ratio

TABLE 27

Carrier-to-noise ratio

Fixed reception
21 dB[22]

12.4.3 Minimum field strength at 600 MHz

TABLE 28

Minimum field strength at f_r = 600 MHz

Bandwidth	Fixed reception at 10 m for 95% location probability[23]
6 MHz system	55.0 dB(μV/m)
8 MHz system	56.2 dB(μV/m)

[22] This value is for 64-QAM 3/4 which is the typical parameter used in many countries.

[23] This value is calculated with adding 9 dB as the location correction factor to the minimum field strength value required for 50% location probability.

Minimum median field-strength levels for other frequencies than 600 MHz are derived by the correction described in § 11.5.

12.4.4 Link budget

An example link budget for ISDB-T for fixed rooftop reception is provided in Annex 2.

12.4.5 Protection ratios and overload threshold for interference from other services

Recommended values for protection ratios (PR) and overloading thresholds for ISDB-T systems to be used in sharing studies can be found in Annex 3 to Recommendation ITU-R BT.1368.

12.5 System parameters and protection requirements related to DTMB (8 MHz)

12.5.1 General parameters

TABLE 29

General DTMB parameters

Parameter	Fixed reception Portable reception (outdoor/Mobile or indoor)
Signal bandwidth (MHz)	7.56
Thermal noise density (kT_0) (dBm/Hz)	−173.98
Receiver noise figure[24] (dB)	7

12.5.2 Carrier-to-noise ratio

TABLE 30

Carrier-to-noise ratio

Fixed reception	Portable reception
19 dB	14 dB

12.5.3 Minimum field strength at 700 MHz

TABLE 31

Minimum field strength at f_r = 700 MHz

Fixed reception at 10 m for 95% location probability	Portable outdoor reception at 1.5 m for 95% location probability
50 dB(μV/m)	67 dB(μV/m)

Minimum median field-strength levels for other frequencies than 700 MHz are derived by the correction described in § 11.5.

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[24] Refer to Recommendation ITU-R BT.1368, Annex 2.

12.5.4 Protection ratios and overload threshold for interference from other services

Recommended values for protection ratios (PR) and overloading thresholds for DTMB systems to be used in sharing studies can be found in Annex 4 to Recommendation ITU-R BT.1368.

12.6 Correction of protection ratio figures for different ACLR values

Recommendation ITU-R BT.1368 Attachment 3 to Annex 2 describes calculation to derive protection ratios for all DTTB systems for different ACLR values.

13 Propagation considerations

Broadcast planning is based on the service being subject to occasional very limited outages during the year. Indeed, many administrations have followed this and other principles established in the DTTB Handbook – Digital terrestrial television broadcasting in the VHF/UHF bands[25], in achieving global harmonisation of terrestrial television broadcasting systems. The protection criteria established in Recommendations ITU-R BT.1368 and ITU-R BT.2033 for protecting DTTB services have been developed on the assumption that Recommendation ITU-R P.1546 is used in interference assessment and it is essential to take this into consideration.

As Recommendation ITU-R P.1546 is applicable where terminals are below 3 000 metres, for compatibility studies when a terminal is above 3 000 metres Recommendation ITU-R P.528 (up to 20 000 metres) or Recommendation ITU-R P.619 should be used for computation of the interfering signal strengths at the required quantile.

It should be noted that Recommendation ITU-R P.1546 has been the recommended propagation model for terrestrial television broadcast planning for many decades. Application of a different propagation model for DTTB coverage/interference assessment may not necessarily be compatible with the planning criteria and protection ratios applied by administrations towards maintaining the required quality of coverage.

Administrations which currently have planned digital terrestrial television broadcasting services are aware that, like several other radiocommunication services, interference assessment is based on an interfering signal exceeding an annual 1% of time limit based upon a methodology that includes Recommendation ITU-R P.1546.

The values in Table 32 are normally applied (standard broadcast planning practice and the GE06 Agreement):

TABLE 32

Time percentages used for planning and sharing studies

System	Wanted field strength	Interfering field strength
DVB-T / DVB-T2	50%	1%
ATSC 1.0/ATSC 3.0 / ISDB-T	90%[26]	1%
DTMB	50%	1%

[25] Refer to http://www.itu.int/pub/R-HDB-39

[26] $Field\ strength\ (90\%) = field\ strength\ (50\%) - \{field\ strength(10\%) - field\ strength\ (50\%)\}$

14 Aggregation of interference

Attachment 3 to Annex 2 to Report ITU-R BT.2265 describes the methods for the aggregation of short-term interfering signals.

Two methods for the computation of aggregate interference from multiple transmitters where individual path losses are temporally variable are recommended.

The first approach ("general method") is based on a rigorous mathematical treatment of the joint variability of multiple paths, and can be used to estimate the aggregate received power at any percentage-time. The method uses Monte Carlo simulation involving multiple calculations for each path of interest, and would be appropriate for use in a situation where numerically-intensive computer simulation is already envisaged.

Recognizing that this approach may not always be appropriate (e.g. where a quick estimate is required without an iterative computer simulation), a simple alternative is also proposed ("simple method"). This method is currently only defined for the case where the aggregate power is to be estimated at 1% time, although it could be readily extended for use at other percentage-times.

15 Comparative evaluations

When calculations are carried out with certain reference parameters and comparison calculations are to be carried out, the relevant reference parameters must be the same. For example, if single-entry field strength values are calculated at a 10 m DTTB receive antenna height, then comparison multiple-entry field values should also be calculated at the same 10 m DTTB receive antenna height.

16 Inclusion of noise in interference assessments

An important factor in terrestrial television broadcast service planning has been to take into consideration an allowance for the noise environment in which the television broadcast service is to be planned – these are rural, urban and suburban. It should also be noted that television broadcast services are planned based upon the calculation of C/N prior to the introduction and deployment of other services which has the potential to increase the noise allowance calculation required in many environments.

A wanted television broadcast signal must be sufficient to overcome noise for it to be receivable and in this respect thermal noise and noise figure are an essential part of any calculations. These are the fundamentals upon which the television receivers deployed globally have been designed.

Annex 1

List of relevant ITU-R texts

Additional information on the characteristics which are referred to in this Report can be found in the following ITU documents:

– Recommendation ITU-R BT.419 – Directivity and polarization discrimination of antennas in the reception of television broadcasting
– Recommendation ITU-R BT.500 – Methodology for the subjective assessment of the quality of television pictures
– Recommendation ITU-R BT.1206 – Spectrum limit masks for Digital Terrestrial Television Broadcasting
– Recommendation ITU-R BT.1306 – Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting
– Recommendation ITU-R BT.1368 – Planning criteria, including protection ratios, for digital terrestrial television services in the VHF/UHF bands
– Recommendation ITU-R BT.1877 – Error-correction, data framing, modulation and emission methods for second generation of digital terrestrial television broadcasting systems
– Report ITU-R BT.2138 – Radiation pattern characteristics of UHF television receiving antennas
– Final Acts of RRC06 – The GE06 Agreement[27]
– ITU-R DTTB Handbook.

Additional information on the protection requirements which are referred to in this Report can be found in the following ITU documents:

– Recommendation ITU-R BT.1368 – Planning criteria, including protection ratios, for digital terrestrial television services in the VHF/UHF bands
– Recommendation ITU-R BT.1735 – Methods for objective reception quality assessment of digital terrestrial television broadcasting signals of System B specified in Recommendation ITU-R BT.1306 – Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting
– Recommendation ITU-R BT.1895 – Protection criteria for terrestrial broadcasting systems
– Final Acts of RRC06 – The GE06 Agreement[23]
– Recommendation ITU-R BT.2033 – Planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands
– Recommendation ITU-R BT.2036 – Characteristics of a reference receiving system for frequency planning of digital terrestrial television systems.
– Report ITU-R BT.2215 – Measurements of Protection Ratios and Overload Thresholds for Broadcast TV Receivers
– Report ITU-R BT.2265 – Guidelines for the assessment of interference into the broadcasting service

[27] For Region 1 and the Islamic republic of Iran except the territory of Mongolia the use of the band 470-694 MHz is subject to the GE06 agreement.

Information on sharing and compatibility studies involving DTTB can be found in the following ITU documents:

– Recommendation ITU-R BT.2136 – Assessing interference into digital terrestrial television broadcasting from other services by means of Monte Carlo simulation
– Report ITU-R BT.2247 – Field measurement and analysis of compatibility between DTTB and IMT
– Report ITU-R BT.2248 – A conceptual method for the representation of loss of broadcast coverage
– Report ITU-R BT.2337 – Sharing and compatibility studies between digital terrestrial television broadcasting and terrestrial mobile broadband applications, including IMT, in the frequency band 470-694/698 MHz
– Report ITU-R BT.2339 – Co-channel sharing and compatibility studies between digital terrestrial television broadcasting and international mobile telecommunication in the frequency band 694-790 MHz in the GE06 planning area
– Report ITU-R BT.2470 – Use of Monte Carlo simulation to model interference to DTTB.

Information on propagation matters referred to in this Report can be found in the following ITU documents:

– Recommendation ITU-R P.528 – A propagation prediction method for aeronautical mobile and radio navigation services using the VHF, UHF and SHF bands
– Recommendation ITU-R P.619 – Propagation data required for the evaluation of interference between stations in space and those on the surface of the earth
– Recommendation ITU-R P.1546 – Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz
– Recommendation ITU-R P.1812 – A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands
– Recommendation ITU-R P.2109 – Prediction of building entry loss.

Annex 2

DTTB link budgets

A2.1 DVB-T

A2.1.1 DVB-T fixed

DVB-T link budget for fixed roof top reception					
DVB-T transmitter parameters					
	Unit	**High power transmitter**	**Medium power transmitter**	**Low power transmitter**	**Notes**
e.i.r.p.	dBm	85.16	69.14	56.13	For 200 kW, 5 kW and 0.25 kW ERP transmitters respectively
Tx antenna effective height	m	300.00	150.00	75.00	
DVB-T receiver parameters					
Rx antenna height	m	10.00	10.00	10.00	ITU-R BT.2036-2
Centre frequency	MHz	650.00	650.00	650.00	Table 19
Channel BW	MHz	8.00	8.00	8.00	ITU-R BT.1368-13
Effective BW	MHz	7.6	7.6	7.6	ITU-R BT.2036-2
Noise figure (F)	dB	7	7	7	ITU-R BT.1368-13
Boltzmann's constant (k)	J/K	1.38E-23	1.38E-23	1.38E-23	
Absolute temperature (T)	K	290	290	290	
Allowance for man-made noise	dB	0	0	0	
Noise power (P_n)	dBm	−98.17	−98.17	−98.17	P_n(dBm) = $F + 10\log(k * T * B * 10^6) + 30$
SNR at cell edge	dB	20	20	20	Table 18
Receiver sensitivity (P_{min})	dBm	−78.17	−78.17	−78.17	$P_{min} = P_n(\text{dBm}) + SNR(\text{dB})$
DVB-T link budget for fixed roof top reception					
Cell edge coverage probability	%	95	95	95	Table 9
Gaussian confidence factor for cell edge coverage probability of 95% ($\mu_{95\%}$)	%	1.64	1.64	1.64	
Shadowing loss standard deviation (σ)	dB	5.50	5.50	5.50	ITU-R P.1546-6
Loss margin (L_m) 95%	dB	9.02	9.02	9.02	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−69.15	−69.15	−69.15	$P_{mean} = P_{min} + L_m$
Minimum field strength at 10 m	dB(µV/m)	55.16	55.16	55.16	
Feeder loss (L_{cable})	dB	4.00	4.00	4.00	Table 8
Antenna gain (G_{iso})	dBi	13.15	13.15	13.15	Table 6
G_{iso}-L_{cable}	dBi	9.15	9.15	9.15	
Max allowed path loss (L_p)	dB	163.43	147.41	134.40	$L_p = EIRP+(G_{iso}-L_{cable}) - P_{mean}$

A2.1.2 DVB-T portable outdoor

DVB-T link budget for portable outdoor reception					
DVB-T transmitter parameters					
	Unit	**High power transmitter**	**Medium power transmitter**	**Low power transmitter**	**Notes**
e.i.r.p.	dBm	85.16	69.14	56.13	For 200 kW, 5 kW and 0.25 kW ERP transmitters respectively
Tx antenna effective height	m	300.00	150.00	75.00	
DVB-T receiver parameters					
Rx antenna height	m	1.50	1.50	1.50	ITU-R BT.2036-2
Centre frequency	MHz	650.00	650.00	650.00	Table 19
Channel BW	MHz	8.00	8.00	8.00	ITU-R BT.1368-13
Effective BW	MHz	7.6	7.6	7.6	ITU-R BT.2036-2
Noise figure (F)	dB	7	7	7	ITU-R BT.1368-13
Boltzmann's constant (k)	J/K	1.38E-23	1.38E-23	1.38E-23	
Absolute temperature (T)	K	290	290	290	
Allowance for man-made noise	dB	0	0	0	
Noise power (P_n)	dBm	−98.17	−98.17	−98.17	P_n(dBm) = $F + 10\log(k * T * B * 10^6) + 30$
SNR at cell edge	dB	18	18	18	Table 18
Receiver sensitivity (P_{min})	dBm	−80.17	−80.17	−80.17	$P_{min} = P_n(\text{dBm}) + SNR(\text{dB})$
DVB-T link budget for portable outdoor reception					
Cell edge coverage probability	%	95	95	95	Table 14
Gaussian confidence factor for cell edge coverage probability of 95% ($\mu_{95\%}$)	%	1.64	1.64	1.64	
Shadowing loss standard deviation (σ)	dB	5.50	5.50	5.50	ITU-R P.1546-6
Loss margin (L_m) 95%	dB	9.02	9.02	9.02	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−71.15	−71.15	−71.15	$P_{mean} = P_{min} + L_m$
Minimum field strength at 20 m	dB(μV/m)	84.16	84.16	84.16	Urban
Minimum field strength at 10 m	dB(μV/m)	77.16	77.16	77.16	Suburban
Feeder loss (L_{cable})	dB	0.00	0.00	0.00	
Antenna gain (G_{iso})	dBi	2.15	2.15	2.15	Table 13
G_{iso}-L_{cable}	dBi	2.15	2.15	2.15	
Urban height loss 20 m to 1.5 m (L_{height})	dB	24	24	24	ITU-R P.1546-6
Suburban height loss 10 m to 1.5 m (L_{height})	dB	17	17	17	ITU-R P.1546-6
Urban 20 m max path loss (L_p)	dB	134	118	105	$L_p = EIRP + (G_{iso}\text{-}L_{cable}) - L_{height} - P_{mean}$
Suburban 10 m max path loss (L_p)	dB	141	125	112	$L_p = EIRP + (G_{iso}\text{-}L_{cable}) - L_{height} - P_{mean}$

A2.1.3 DVB-T portable indoor

DVB-T link budget for portable indoor reception					
DVB-T transmitter parameters					
	Unit	**High power transmitter**	**Medium power transmitter**	**Low power transmitter**	**Notes**
e.i.r.p.	dBm	85.16	69.14	56.13	For 200 kW, 5 kW and 0.25 kW ERP transmitters respectively
Tx antenna effective height	m	300.00	150.00	75.00	
DVB-T receiver parameters					
Rx antenna height	m	1.50	1.50	1.50	ITU-R BT.2036-2
Centre frequency	MHz	650.00	650.00	650.00	Table 19
Channel BW	MHz	8.00	8.00	8.00	ITU-R BT.1368-13
Effective BW	MHz	7.6	7.6	7.6	ITU-R BT.2036-2
Noise figure (F)	dB	7	7	7	ITU-R BT.1368-13
Boltzmann's constant (k)	J/K	1.38E-23	1.38E-23	1.38E-23	
Absolute temperature (T)	K	290	290	290	
Allowance for man-made noise	dB	0	0	0	
Noise power (P_n)	dBm	−98.17	−98.17	−98.17	P_n(dBm) = $F + 10\log(k * T * B * 10^6) + 30$
SNR at cell edge	dB	18	18	18	Table 18
Receiver sensitivity (P_{min})	dBm	−80.17	−80.17	−80.17	$P_{min} = P_n(\text{dBm}) + SNR(\text{dB})$
DVB-T link budget for portable indoor reception					
Cell edge coverage probability	%	95	95	95	Table 14
Gaussian confidence factor for cell edge coverage probability of 95% ($\mu_{95\%}$)	%	1.64	1.64	1.64	
Shadowing loss standard deviation (σ)	dB	5.50	5.50	5.50	ITU-R P.1546-6
Loss margin (L_m) 95%	dB	9.02	9.02	9.02	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−71.15	−71.15	−71.15	$P_{mean} = P_{min} + L_m$
Minimum field strength at 20 m	dB(μV/m)	102.3	102.3	102.3	Urban
Minimum field strength at 10 m	dB(μV/m)	91.23	91.23	91.23	Suburban
Feeder loss (L_{cable})	dB	0.00	0.00	0.00	
Antenna gain (G_{iso})	dBi	2.15	2.15	2.15	Table 13
G_{iso}-L_{cable}	dBi	2.15	2.15	2.15	
Urban height loss 20 m to 1.5 m (L_{height})	dB	24	24	24	ITU-R P.1546-6
Suburban height loss 10 m to 1.5 m (L_{height})	dB	17	17	17	ITU-R P.1546-6
Urban building entry loss (p=70%) (L_{wall})	dB	18.14	18.14	18.14	Table 13
Suburban building entry loss (p=50%) (L_{wall})	dB	14.07	14.07	14.07	Table 12
Urban 20 m max path loss (L_p)	dB	116	100	87	$L_p = EIRP+(G_{iso} - L_{cable}) - L_{wall} - L_{height} - P_{mean}$
Suburban 10 m max path loss (L_p)	dB	127	111	98	$L_p = EIRP+(G_{iso} - L_{cable}) - L_{wall} - L_{height} - P_{mean}$

A2.2 DVB-T2

A2.2.1 DVB-T2 fixed

DVB-T2 link budget for fixed roof top reception					
DVB-T2 transmitter parameters					
	Unit	**High power transmitter**	**Medium power transmitter**	**Low power transmitter**	**Notes**
e.i.r.p.	dBm	85.16	69.14	56.13	For 200 kW, 5 kW and 0.25 kW ERP transmitters respectively
Tx antenna effective height	m	300.00	150.00	75.00	
DVB-T2 receiver parameters					
Rx antenna height	m	10.00	10.00	10.00	ITU-R BT.2036-2
Centre frequency	MHz	650.00	650.00	650.00	Table 22
Channel BW	MHz	8.00	8.00	8.00	ITU-R BT.2033-1
Effective BW	MHz	7.77	7.77	7.77	ITU-R BT.2036-2
Noise figure (F)	dB	6	6	6	ITU-R BT.2033-1
Boltzmann's constant (k)	J/K	1.38E-23	1.38E-23	1.38E-23	
Absolute temperature (T)	K	290	290	290	
Allowance for man made noise	dB	0	0	0	
Noise power (P_n)	dBm	−99.07	−99.07	−99.07	P_n(dBm) = $F + 10\log(k * T * B * 10^6) + 30$
SNR at cell edge	dB	20	20	20	Table 23
Receiver sensitivity (P_{min})	dBm	−79.07	−79.07	−79.07	$P_{min} = P_n$(dBm) + SNR(dB)
DVB-T link budget for fixed roof top reception					
Cell edge coverage probability	%	95	95	95	Table 9
Gaussian confidence factor for cell edge coverage probability of 95% ($\mu_{95\%}$)	%	1.64	1.64	1.64	
Shadowing loss standard deviation (σ)	dB	5.50	5.50	5.50	ITU-R P.1546-6
Building entry loss standard deviation (σ_w)	dB	0.00	0.00	0.00	
Total loss standard deviation (σ_T)	dB	5.50	5.50	5.50	$s_T = \text{SQRT}(\sigma^2 + \sigma_w^2)$
Loss margin (L_m) 95%	dB	9.02	9.02	9.02	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−70.05	−70.05	−70.05	$P_{mean} = P_{min} + L_m$
Minimum field strength at 10 m	dB(μV/m)	54.26	54.26	54.26	
Feeder loss (L_{cable})	dB	4.00	4.00	4.00	Table 8
Antenna gain (G_{iso})	dBi	13.15	13.15	13.15	Table 6
G_{iso}-L_{cable}	dBi	9.15	9.15	9.15	
Max allowed path loss (L_p)	dB	164	148	135	$L_p = EIRP + (G_{iso} - L_{cable}) - P_{mean}$

A2.2.2 DVB-T2 portable outdoor

DVB-T2 link budget for portable outdoor reception					
DVB-T2 transmitter parameters					
	Unit	**High power transmitter**	**Medium power transmitter**	**Low power transmitter**	**Notes**
e.i.r.p.	dBm	85.16	69.14	56.13	For 200 kW, 5 kW and 0.25 kW ERP transmitters respectively
Tx antenna effective height	m	300.00	150.00	75.00	
DVB-T2 receiver parameters					
Rx antenna height	m	1.50	1.50	1.50	ITU-R BT.2036-2
Centre frequency	MHz	650.00	650.00	650.00	Table 22
Channel BW	MHz	8.00	8.00	8.00	ITU-R BT.2033-1
Effective BW	MHz	7.77	7.77	7.77	ITU-R BT.2036-2
Noise figure (*F*)	dB	6	6	6	ITU-R BT.2033-1
Boltzmann's constant (k)	J/K	1.38E-23	1.38E-23	1.38E-23	
Absolute temperature (*T*)	K	290	290	290	
Allowance for man made noise	dB	0	0	0	
Noise power (P_n)	dBm	−99.07	−99.07	−99.07	P_n(dBm) = $F + 10\log(k * T * B * 10^6)+30$
SNR at cell edge	dB	18	18	18	Table 21
Receiver sensitivity (P_{min})	dBm	−81.07	−81.07	−81.07	$P_{min} = P_n$(dBm) + SNR(dB)
DVB-T2 link budget for portable outdoor reception					
Cell edge coverage probability	%	95	95	95	Table 15
Gaussian confidence factor for cell edge coverage probability of 95% ($\mu_{95\%}$)	%	1.64	1.64	1.64	
Shadowing loss standard deviation (σ)	dB	5.50	5.50	5.50	ITU-R P.1546-6
Loss margin (L_m) 95%	dB	9.02	9.02	9.02	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−72.05	−72.05	−72.05	$P_{mean} = P_{min} + L_m$
Minimum field strength at 20 m	dB(μV/m)	83.26	83.26	83.26	Urban
Minimum field strength at 10 m	dB(μV/m)	76.26	76.26	76.26	Suburban
Feeder loss (L_{cable})	dB	0.00	0.00	0.00	
Antenna gain (G_{iso})	dBi	2.15	2.15	2.15	Table 13
G_{iso}-L_{cable}	dBi	2.15	2.15	2.15	
Urban height loss 20 m to 1.5 m (L_{height})	dB	24	24	24	ITU-R P.1546-6
Suburban height loss 10 m to 1.5 m (L_{height})	dB	17	17	17	ITU-R P.1546-6
Urban 20 m max path loss (L_p)	dB	135	119	106	$L_p = EIRP + (G_{iso} - L_{cable}) - L_{height} - P_{mean}$
Suburban 10 m max path loss (L_p)	dB	142	126	113	$L_p = EIRP + (G_{iso}$-$L_{cable}) - L_{height} - P_{mean}$

A2.2.3 DVB-T2 portable indoor

DVB-T2 link budget for portable indoor reception					
DVB-T2 transmitter parameters					
	Unit	**High power transmitter**	**Medium power transmitter**	**Low power transmitter**	**Notes**
e.i.r.p.	dBm	85.16	69.14	56.13	For 200 kW, 5 kW and 0.25 kW ERP transmitters respectively
Tx antenna effective height	m	300.00	150.00	75.00	
DVB-T2 receiver parameters					
Rx antenna height	m	1.50	1.50	1.50	ITU-R BT.2036-2
Centre frequency	MHz	650.00	650.00	650.00	Table 22
Channel BW	MHz	8.00	8.00	8.00	ITU-R BT.2033-1
Effective BW	MHz	7.77	7.77	7.77	ITU-R BT.2036-2
Noise figure (*F*)	dB	6	6	6	ITU-R BT.2033-1
Boltzmann's constant (k)	J/K	1.38E-23	1.38E-23	1.38E-23	
Absolute temperature (*T*)	K	290	290	290	
Allowance for man made noise	dB	0	0	0	
Noise power (P_n)	dBm	−99.07	−99.07	−99.07	P_n(dBm) = $F + 10\log(k * T * B * 10^6) + 30$
SNR at cell edge	dB	18	18	18	Table 21
Receiver sensitivity (P_{min})	dBm	−81.07	−81.07	−81.07	$P_{min} = P_n$(dBm) +*SNR*(dB)
DVB-T2 link budget for portable indoor reception					
Cell edge coverage probability	%	95	95	95	Table 14
Gaussian confidence factor for cell edge coverage probability of 95% ($\mu_{95\%}$)	%	1.64	1.64	1.64	
Shadowing loss standard deviation (σ)	dB	5.50	5.50	5.50	ITU-R P.1546-6
Loss margin (L_m) 95%	dB	9.02	9.02	9.02	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	-72.05	-72.05	-72.05	$P_{mean} = P_{min} + L_m$
Minimum field strength at 20 m	dB(µV/m)	101.4	101.4	101.4	Urban
Minimum field strength at 10 m	dB(µV/m)	90.33	90.33	90.33	Suburban
Feeder loss (L_{cable})	dB	0.00	0.00	0.00	
Antenna gain (G_{iso})	dBi	2.15	2.15	2.15	
G_{iso}-L_{cable}	dBi	2.15	2.15	2.15	Table 13
Urban height loss 20 m to 1.5 m (L_{height})	dB	24	24	24	ITU-R P.1546-6
Suburban height loss 10 m to 1.5 m (L_{height})	dB	17	17	17	ITU-R P.1546-6
Urban building entry loss (P=70%) (L_{wall})	dB	18.14	18.14	18.14	Table 12
Suburban building entry loss (P=50%) (L_{wall})	dB	14.07	14.07	14.07	Table 12
Urban 20 m max path loss (L_p)	dB	117	101	88	$L_p = EIRP+(G_{iso} - L_{cable}) - L_{wall} - L_{height} - P_{mean}$
Suburban 10 m max path loss (L_p)	dB	128	112	99	$L_p = EIRP+(G_{iso} - L_{cable}) - L_{wall} - L_{height} - P_{mean}$

A2.3 ISDB-T

A2.3.1 ISDB-T fixed

ISDB-T link budget for fixed roof top reception					
ISDB-T transmitter parameters					
	Unit	**Main station**	**Relay station**	**Repeater**	**Notes**
e.i.r.p.	dBm	77	49	19	For 30 kW, 50W and 50mW ERP transmitters respectively
Antenna height above average terrain	m	100	20	10	
ISDB-T receiver parameters					
Rx antenna height	m	10	10	10	ITU-R BT.2036-2
Centre frequency	MHz	600	600	600	ITU-R BT.1368-13
Channel BW	MHz	6	6	6	ITU-R BT.1368-13
Effective BW	MHz	5.6	5.6	5.6	ITU-R BT.1368-13
Noise figure (F)	dB	7	7	7	ITU-R BT.1368-13
Boltzmann's constant (k)	J/K	1.38E-23	1.38E-23	1.38E-23	
Absolute temperature (T)	K	290	290	290	
Allowance for man-made noise	dB	0	0	0	ITU-R BT.1368-13
Noise power (P_n)	dBm	−99	−99	−99	P_n(dBm) = $F + 10\log(k * T * B * 10^6) + 30$
SNR at cell edge	dB	22	22	22	ITU-R BT.1368-13
Receiver sensitivity (P_{min})	dBm	−77	−77	−77	$P_{min} = P_n$(dBm) +SNR(dB)
ISDB-T link budget for fixed roof top reception					
Cell edge coverage probability	%	95	95	95	
Gaussian confidence factor for cell edge coverage probability of 95% ($\mu_{95\%}$)	%	1.64	1.64	1.64	
Shadowing loss standard deviation (σ)	dB	5.5	5.5	5.5	ITU-R P.1546-6
Loss margin (L_m) 95%	dB	9	9	9	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−68	−68	−68	$P_{mean} = P_{min} + L_m$
Minimum field strength at 10 m	dB(μV/m)	55	55	55	
Feeder loss (L_{cable})	dB	3	3	3	ITU-R BT.1368-13
Antenna gain (G_{iso})	dBi	12.15	12.15	12.15	ITU-R BT.1368-13
G_{iso}-L_{cable}	dBi	9.15	9.15	9.15	
Max allowed path loss (L_p)	dB	155	127	97	$L_p = EIRP + (G_{iso} - L_{cable}) - P_{mean}$

A2.4 ATSC 3.0

A2.4.1 ATSC 3.0 fixed

Table 33 provides an example ATSC 3.0 link budget scenario for the use of an external outdoor antenna mounted at a height of 10 metres.

There are several relevant features for this link budget. Since the antenna has some directivity, the channel model used for this case is the Rice model. Using the parameters selected for this use case, a minimum C/N value of 16.9 dB is used. This C/N threshold includes the channel model effects as well as margin for other real-world effects such as channel estimation errors. The ATSC 3.0

parameters are as follows: 64-QAM, 11/15 LDPC code, 32K FFT, pilot mode SP8_4. The downlead is assumed to be 75 feet (22.9 m) of RG-59 coaxial cable.

TABLE 33

ATSC 3.0 link budget for fixed roof top reception			
Channel centre frequency (MHz)	69	195	605
Channel bandwidth (MHz)	6	6	6
Antenna gain (dB)	4.0	6.0	10.0
Downlead loss (dB)	1.4	2.0	4.0
Receiver noise figure (dB)	7.0	7.0	7.0
Receiver generated noise (dB)	−99.2	−99.2	−99.2
Sky noise (dBm)	−90.0	−102.4	−106.2
Equivalent noise at the antenna input (dBm)	−89.7	−99.8	−102.6
Channel model	Rice	Rice	Rice
Minimum C/N (dB)	16.9	16.9	16.9
Minimum antenna input power (dBm)	−72.8	−82.9	−85.7
Dipole factor (dB)	111.8	120.8	130.7
Minimum required field strength at antenna (dB(μV/m))	39.0	38.0	44.9
ATSC 3.0 fixed roof top coverage scenario 1			
Required area coverage (%)	70.0	70.0	70.0
Distribution factor	0.5	0.5	0.5
Standard deviation (dB)	5.5	5.5	5.5
Location correction factor (dB)	2.9	2.9	2.9
Minimum required field strength at antenna with margin (dB(μV/m))	41.9	40.8	47.8
ATSC 3.0 fixed roof top coverage scenario 2			
Required area coverage (%)	95.0	95.0	95.0
Distribution factor	1.6	1.6	1.6
Standard deviation (dB)	5.5	5.5	5.5
Location correction factor (dB)	9.0	9.0	9.0
Minimum required field strength at antenna with margin (dB(μV/m))	48.0	47.0	54.0

A2.4.2 ATSC 3.0 portable outdoor

Table 34 provides an example ATSC 3.0 link budget scenario for automotive reception. The antenna has no directivity so the Rayleigh channel model is used. The ATSC 3.0 parameters are as follows: 16-QAM, 5/15 LDPC code, 16K FFT, pilot mode SP4_2. The downlead loss is assumed to be that of 10 feet (3.0 m) of RG-59 coaxial cable.

TABLE 34

ATSC 3.0 link budget for portable outdoor reception			
Channel centre frequency (MHz)	69	195	605
Channel bandwidth (MHz)	6	6	6
Antenna gain (dB)	−4.0	−2.0	0.0
Downlead loss (dB)	0.2	0.3	0.6
Receiver noise figure (dB)	7.0	7.0	7.0
Receiver generated noise (dB)	−99.2	−99.2	−99.2
Sky noise (dBm)	−90.0	−102.4	−106.2
Equivalent noise at the antenna input (dBm)	−88.8	−95.8	−97.9
Channel model	Rayleigh	Rayleigh	Rayleigh
Minimum C/N (dB)	7.8	7.8	7.8
Minimum antenna input power (dBm)	−81.0	−88.0	−90.1
Dipole factor (dB)	111.8	120.8	130.7
Minimum required field strength at antenna (dB(μV/m))	30.8	32.8	40.6
ATSC 3.0 portable outdoor coverage Scenario 1			
Required area coverage (%)	90.0	90.0	90.0
Distribution factor	1.3	1.3	1.3
Standard deviation (dB)	5.9	5.9	5.9
Location correction factor (dB)	7.7	7.7	7.7
Minimum required field strength at antenna with margin (dB(μV/m))	38.5	40.5	48.2
ATSC 3.0 portable outdoor coverage Scenario 2			
Required area coverage (%)	99.0	99.0	99.0
Distribution factor	2.3	2.3	2.3
Standard deviation (dB)	5.9	5.9	5.9
Location correction factor (dB)	13.6	13.6	13.6
Minimum required field strength at antenna with margin (dB(μV/m))	44.4	46.4	54.1

A2.4.3 ATSC 3.0 portable indoor

ATSC 3.0 link budget for portable indoor reception			
ATSC 3.0 transmitter parameters			
ATSC 3.0	**Urban indoor**	**Suburban indoor**	**Quasi open /rural**
Channel BW (MHz)	8	8	8
Transmission BW (MHz)	7.78	7.78	7.78
Transmitter/Base station			
Transmitter antenna height (m)	30	30	30
Frequency (MHz)	700	700	700

ATSC 3.0 link budget for portable indoor reception			
ATSC 3.0 transmitter parameters			
ATSC 3.0	**Urban indoor**	**Suburban indoor**	**Quasi open /rural**
Wavelength (m)	0.43	0.43	0.43
Transmitter power (W)	40	40	40
Transmitter power (dBm)	46.0	46.0	46.0
Transmitter antenna gain (dBd)	8	8	8
Cable loss (dB)	2	2	2
Equivalent radiated power (ERP) (dBm)	52.0	52.0	52.0
Receiver (Tablet)			
Diversity	No	No	No
ATSC 3 FFT	8k	8k	8k
Total capacity of mode (Mbit/s)	3.68	3.68	3.68
Modulation	16-QAM	16-QAM	16-QAM
Code rate	2/15	2/15	2/15
C/*N* required (Rayleigh) static	0.50	0.50	0.50
ATSC 3.0 Guard interval	GI1_192	GI1_192	GI1_192
Receiver noise bandwidth (MHz)	7.78	7.78	7.78
Receiver noise figure (dB)	7	7	7
Receiver noise input power (dBW)	−128.0	−128.0	−128.0
C/*N* Signal to noise ratio (dB)	1.0	1.0	1.0
Minimum receiver input power (dBW)	−127.0	−127.0	−127.0
Antenna gain **(**dBd**)** [GdBi = GdBd + 2.15]	−9.2	−9.2	−9.2
Body loss	−2.0	−2.0	−2.0
Effective antenna aperture (dBm^2)	−27.4	−25.4	−25.4
Feeder loss (dB)	0.0	0.0	0.0
Minimum power flux-density (dBW/m^2)	−99.7	−101.7	−101.7
Equivalent minimum field strength (dB(μV/m))	46.1	44.1	44.1
ATSC 3.0 Portable indoor coverage scenario			
Location probability (%)	95	95	95
Outdoor standard deviation (dB)	5.5	5.5	5.5
Indoor standard deviation (dB)	6.0	6.0	0.0
Combined standard deviation (dB)	8.1	8.1	5.5
Location correction factor (dB)	13.4	13.4	9.0
Interference Allowance (Reuse 1)	0.0	0.0	0.0
Height loss (dB)	0.0	0.0	0.0
Building penetration loss (dB)	17.0	17.0	17.0
Minimum median equivalent field strength (dB(μV/m))	76.5	74.5	70.1

ATSC 3.0 link budget for portable indoor reception			
ATSC 3.0 transmitter parameters			
ATSC 3.0	**Urban indoor**	**Suburban indoor**	**Quasi open /rural**
Minimum required power level at rec_antenna (dBm), no location correction	−88.0	−97.0	−97.0
Allowed/Planned propagation loss for cell range (dB)	109.7	111.7	116.0
Coverage radius (km)	0.40	0.84	2.65
Circle cell area (km^2)	0.51	2.24	22.09
Approx. SFN cell radius (km)	0.65	1.30	3.97
SFN circle cell area (km^2)	1.34	5.30	49.54

Annex 3

List of abbreviations

Abbreviation	Description
ACLR	Adjacent channel leakage ratio
a.g.l.	Above ground level
ATSC 1.0	Advanced Television Systems Committee standard
ATSC 3.0	Advanced Television Systems Committee standard
BCH	Bose-Chaudhuri-Hocquenghem code
BER	Bit error rate
BS	Base station
CDBS	Consolidated data base system
C/N	Carrier to noise ratio
CRC	Cyclic redundancy check
dB	Decibel
dBd	Decibel relative to a dipole
dBi	Decibel relative to an isotropic radiator
dBm	Decibel relative to a milliwatt
dBW	Decibel relative to a watt
dB(μV/m)	Decibel relative to a micro-volt per metre
DAB	Digital audio broadcasting
DSB	Digital sound broadcasting
DTTB	Digital terrestrial television broadcasting
DTMB	Digital terrestrial multimedia broadcast
DTMB-A	Digital terrestrial multimedia broadcast – 2nd Generation
DVB-T	Digital video broadcasting – Terrestrial

Abbreviation	Description
DVB-T2	Digital video broadcasting – Second generation terrestrial
ERP	Effective radiated power
FCC	U.S. Federal Communications Commission
FEC	Forward error correction
FFT	Fast Fourier transform
GE06	Geneva 06 Radio Regional Conference
HAAT	Height above average terrain
HRP	Horizontal radiation pattern
Hz	Hertz
I/N	Interference to noise ratio
IMT	International Mobile Telecommunications
ISDB-T	Integrated Services Digital Broadcasting - Terrestrial
k	Boltzmann's constant
km	Kilometre
kW	Kilowatt
LDPC	Low density parity check code
LMS	Licensing and management system
MBit/s	Megabits per second
MHz	Megahertz
NTIA	National Telecommunications and Information Administration
QAM	Quadrature amplitude modulation
QEF	quasi-error-free
RN	Reference network
RPC	Reference planning configuration
RRC	Regional Radio Conference
SFN	Single frequency network
SNR	Signal-to-noise ratio
T	Temperature degrees Kelvin
VHF	Very high frequency
VRP	Vertical radiation pattern
UE	User equipment
UHF	Ultra-high frequency