International Telecommunication Union

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(07/2019)

Characteristics of digital terrestrial television broadcasting systems in the frequency band 470-862 MHz

BT Series

Broadcasting service (television)

International Telecommunication Union

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***Note**: This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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REPORT ITU-R BT.2383-2

Characteristics of digital terrestrial television broadcasting systems in the frequency band 470-862 MHz

(2015-2016-2019)

TABLE OF CONTENTS

Page

1 Introduction

This Report contains a summary of the technical and operational characteristics of digital terrestrial television broadcasting (DTTB) broadcast systems required for relevant sharing studies.

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*.

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, section 2 as "*the percentage of locations within a small area, referred in this document as 'pixel'*[1]*, 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.2265-2 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.

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.

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

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[2].

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 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, ATSC1.0 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.

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

Any study of interference into a DTTB system must take account of QEF and the hour time window.

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.

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

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[3] 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.

FIGURE 1A

Original area covered

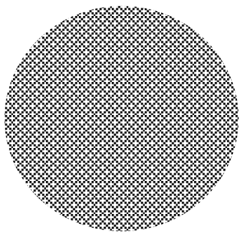


FIGURE 1B

Reduction in area covered (relaxation of one factor)

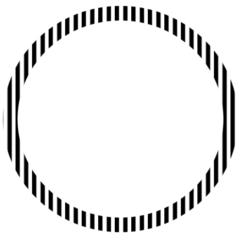
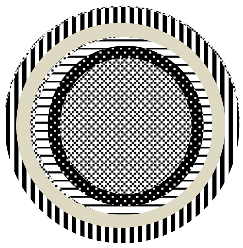


FIGURE 1C

Resulting area covered (relaxation of four factors)



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.

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3 Refer to Report ITU-R BT.2248.

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:

$$A_\vartheta = 20\mathrm{Log}_{10}(2B - B^2)\ \mathrm{dB}$$

where:

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

where:

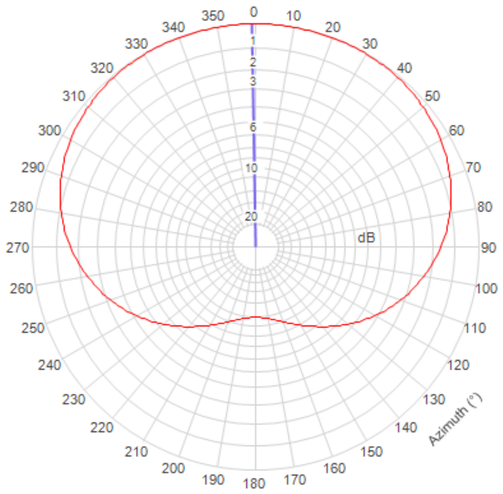
ϑ : azimuth angle

k : 0.4187 for 10 dB pattern minima.

The resulting pattern is shown in Fig. 2:

FIGURE 2

Low power DTT



Unlike high and medium power antennas which are usually omnidirectional, very few low power DTT antenna are omnidirectional. Low power DTT 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 DTT 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 DTT 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.

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

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 Single frequency networks (Allotments) (GE06)

Three reference networks (RN) for DTT 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.

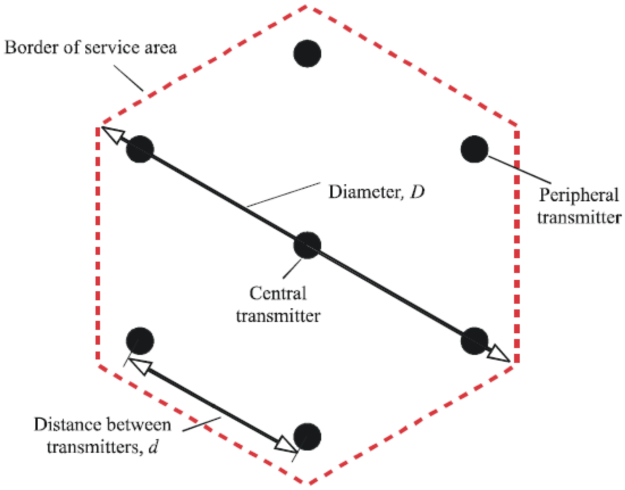
For sharing studies within the service area of an SFN the same vertical diagrams as provided in § 7.1 above should be applied for each transmitter.

7.2.1 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

RN 1 (large service area SFN)



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.

7.2.2 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.

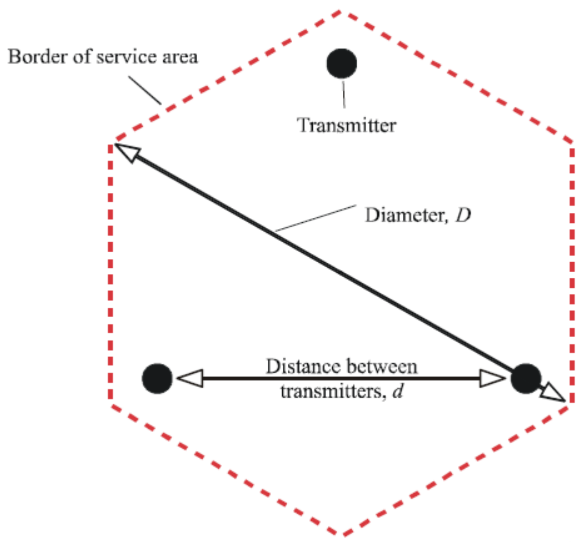
This reference network (RN 2) is applied to different cases: fixed (RPC 1), outdoor/mobile (RPC 2) and indoor (RPC 3) reception, for both Bands IV & V.

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)



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.

7.2.3 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 in the case of assignments or are the reference configurations used for allotment planning.[4]

8.1 DTTB System A (ATSC) 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

[4] Values are derived from the Consolidated Data Base System (CDBS) found at: http://transition.fcc.gov/ftp/Bureaus/MB/Databases/cdbs/index.html

- 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. The table below is to be used for sharing studies.[5]

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:

$$Reduction\ in\ dB = 20 * \log 10(Relative\ Field\ Strength)$$

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

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

- Antenna Height Above Average Terrain (HAAT): 20 m
- Antenna pattern: Omnidirectional

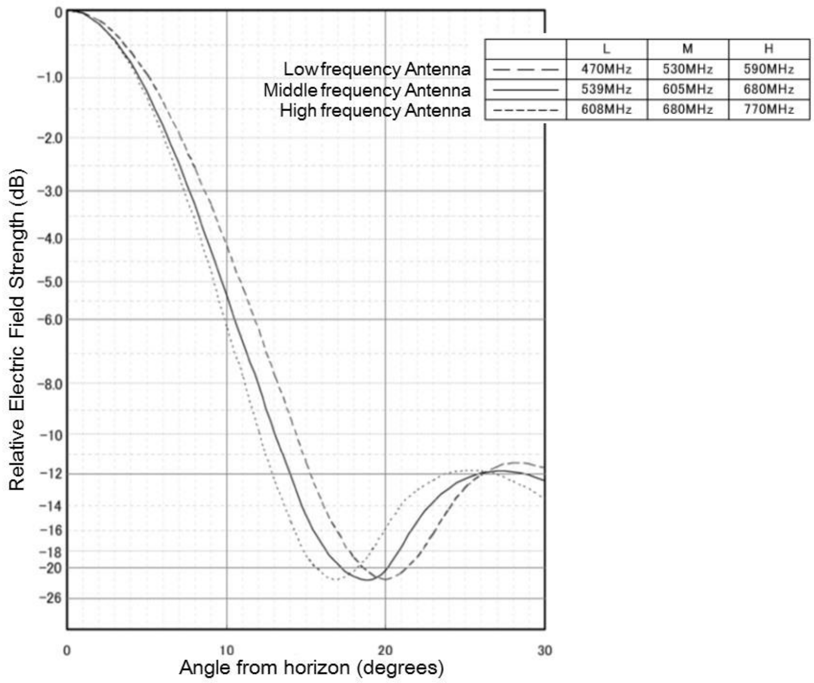
– Repeater
  - ERP: 50 mW
  - Antenna Height Above Average Terrain (HAAT): 10 m
  - Antenna pattern: Omnidirectional

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

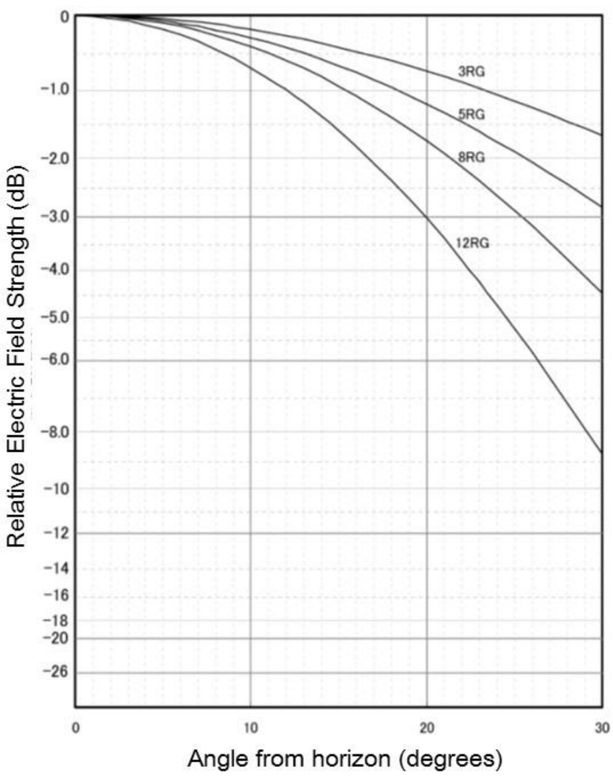
Vertical UHF radiation pattern for Main and Relay station



For repeater stations use the 3RG vertical pattern in Fig. 6.

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 reception

The reference receiving antenna height considered to be representative in calculating the field strength for fixed reception is 10 m above ground level. 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 § 11.4.

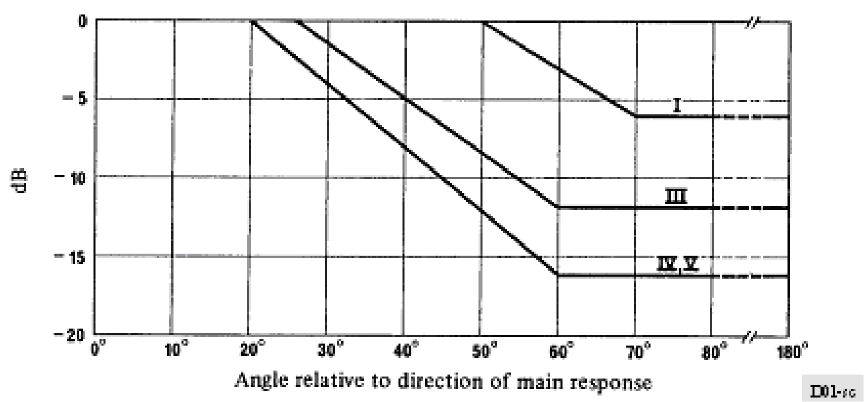
11.1.1 Fixed antenna radiation pattern

Standard radiation patterns for receiving antennas for Bands I, III, IV and V, Fig. 7, are given in Recommendation ITU-R BT.419-3.

FIGURE 7

Discrimination obtained by the use of directional receiving antennas in broadcasting

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



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 / 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)

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:

$$\mathrm{Corr} = 10\log\left(\mathrm{F}_A / \mathrm{F}_\mathrm{R}\right)$$

where:

- Corr is the correction term
- F_A is the actual working frequency being considered
- F_R is the 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)

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 as given in Table 9 should be used.

TABLE 9

Location Probability for fixed Reception

System	DVB-T/DVB-T2 (GE06)	ATSC	ISDB-T	DTMB
Location Probability (%)	95	50	95[6]	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.

– 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[7].

11.1.5.2 ATSC

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.

11.1.6 For fixed indoor reception (DTMB only)

Indoor fixed reception is defined as: reception where a receiving antenna mounted inside room is used.

In calculating the equivalent field strength required for indoor fixed reception, the building penetration loss should be considered.

The field strength at indoor locations will be attenuated significantly depending on the incident angle and the frequency of the radio wave, and the construction material of the house. The building penetration loss is defined as the difference (in dB) between the median field strength of a given height at indoor location and the median field strength of the same height at outdoor location. However, there is no unique formula to calculate the building penetration loss. This value has been confirmed by measurements as shown in Table 10.

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6 Appropriate location probability may vary by country.

7 Refer to Recommendation ITU-R BT.419-3.

TABLE 10

Building penetration loss in UHF band IV/V

Indoor reception success rate	Average building penetration loss dB	Mean square deviation (σ_b) dB
High	7	5
Median	11	6
Low	15	7

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. Since all field-strength calculations are for a receiving antenna height of 10 m, a height loss correction factor for an antenna height of 1.5 m should be used in the calculation of minimum median field-strength levels. For planning purposes, the height-loss values for portable and for mobile reception for reference frequencies are given in Table 11. Minimum median field-strength levels for other frequencies are derived by interpolation as described in § 11.4.

TABLE 11

Suburban height loss in Bands IV and V[8]

Frequency (MHz)	500	800
Height loss (dB)	16	18

Note: Appropriate values for the height loss for frequencies between 500 MHz and 800 MHz can be obtained by linear interpolation between the values given in the Table for 500 MHz and 800 MHz.

These values are those obtained for suburban coverage. In urban and dense-urban areas higher values are to be applied, Table 12.

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

TABLE 12

Urban/Dense urban height loss in Bands IV and V[9]

Frequency (MHz)	500	800
Urban height loss (dB)	23	25
Dense urban height loss (dB)	26	28

Note: Appropriate values for the height loss for frequencies between 500 MHz and 800 MHz can be obtained by linear interpolation between the values given in the Table for 500 MHz and 800 MHz.

11.2.2 Building entry loss

Table 13 contains the mean values for building entry loss and the corresponding standard deviation at UHF taken from Table 6 in Recommendation ITU-R P.1812-2.

TABLE 13

Building entry loss in bands IV and V

	Building entry loss (dB)	**Standard deviation (dB)**
470 MHz	10.4	5
≥ 600 MHz	11	6

Note: Appropriate values for the building entry loss and the standard deviation for frequencies between 470 MHz and 600 MHz can be obtained by linear interpolation between the values given in the Table for 470 MHz and 600 MHz

11.2.3 Antenna gain for portable reception

Recommendation ITU-R BT.1368-13 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 14.

TABLE 14

Antenna gain (dBd) for portable reception

Band	**Gain (dBd)**
Band IV	0
Band V	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 as given in Table 15 should be used.

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

TABLE 15

Location probability for portable reception

System	DVB-T/DVB-T2 (GE06)	ATSC	ISDB-T	DTMB
Location Probability (%)	95	50	95[10]	95

11.2.5 Polarization discrimination for portable reception

Polarization discrimination should not be taken into account in frequency planning for portable reception.[11]

11.3 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 DTT 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.

11.4 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.

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[10] Appropriate location probability may vary by country.

[11] Recommendation ITU-R BT.1368-13.

12 System parameters for DTTB Systems

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

12.1.1 General parameters

TABLE 16

General DVB-T Parameters

Parameter	Fixed reception Portable reception (outdoor/Mobile or indoor)
Signal band width (MHz)	7.60
Thermal noise density (kT_0) (dBm/Hz)	−173.98
Receiver noise figure[12] (dB)	7

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

12.1.2 Carrier-to-noise ratio

Within Recommendations ITU-R BT.1368-13 for DVB-T and in ITU-R BT.2033-1 for DVB-T2, carrier to noise figures are provided. For compatibility and sharing studies the values in Table 17 should be used for both systems.

TABLE 17

Carrier-to-noise ratio

Fixed reception	Portable reception
20 dB	18 dB

12.1.3 Minimum field strength at 650 MHz

TABLE 18

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 dBµV/m	60.2 dBµV/m

Minimum median field-strength levels for other frequencies than 650 MHz are derived by the correction described in § 11.4.

[12] Refer to Recommendation ITU-R BT.1368-13 Annex 2.

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.1368-13 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 19

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[13] (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 GE-06, Recommendations ITU-R BT.1368-13 for DVB-T and in ITU-R BT.2033-1 for DVB-T2, carrier to noise figures are provided. For compatibility and sharing studies the values in Table 20 should be used for both systems.

TABLE 20

Carrier-to-noise ratio

Fixed reception	Portable reception
20 dB	18 dB

[13] Refer to Recommendation ITU-R BT.2033-1.

12.2.3 Minimum field strength at 650 MHz

TABLE 21

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 dBμV/m	59.3 dBμV/m

Minimum median field-strength levels for other frequencies than 650 MHz are derived by the correction described in § 11.4.

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.

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.2033-1. 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 (6 MHz)

12.3.1 General UHF parameters

TABLE 22

General UHF Parameters

Parameter	
Channel bandwidth (MHz)	6
Thermal noise density (kT_0) (dBm/Hz)	−173.20
Receiver noise figure[14] (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 23

Carrier-to-noise ratio

Fixed reception	Portable reception
15.0 dB	15.0 dB

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

12.3.3 Minimum UHF field strength

TABLE 24

Minimum field strength at f_r=650 MHz

Fixed reception at 10 m for 50% location probability	Portable outdoor reception at 1.5 m for 50% location probability
41 dBµV/m	48 dBµV/m

Minimum median field-strength levels for other frequencies than 650 MHz are derived by the correction described in § 11.4.

12.3.4 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.1368-13.

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

12.4.1 General parameters

TABLE 25

General ISDB-T Parameters

Parameter	Units	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 26

Carrier-to-noise ratio

Fixed reception
21 dB[15]

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

12.4.3 Minimum field strength at 600 MHz

TABLE 27

Minimum field strength at f_r=600 MHz

Bandwidth	Fixed reception at 10 m for 95% location probability[16]
6 MHz system	55.0 dBμV/m
8 MHz system	56.2 dBμV/m

Minimum median field-strength levels for other frequencies than 600 MHz are derived by the correction described in § 11.4.

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 of Recommendation ITU-R BT.1368-13.

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

12.5.1 General parameters

TABLE 28

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[17] (dB)	7

12.5.2 Carrier-to-noise ratio

TABLE 29

Carrier-to-noise ratio

Fixed reception	Portable reception
19 dB	14 dB

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

[17] Refer to Recommendation ITU-R BT.1368-13 Annex 2.

12.5.3 Minimum field strength at 700 MHz

TABLE 30

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 dBμV/m	67 dBμV/m

Minimum median field-strength levels for other frequencies than 700 MHz are derived by the correction described in § 11.4.

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 Recommendation ITU-R BT.1368-13.

12.6 Correction of protection ratio figures for different ACLR values

Recommendation ITU-R BT.1368-13 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*[18] – 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. 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 31 are normally applied (standard broadcast planning practice and the GE06 Agreement):

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

TABLE 31

Time percentages used for planning and sharing studies

System	Wanted field strength	Interfering field strength
DVB-T / DVB-T2	50%	1%
ATSC / ISDB-T	90%[19]	1%
DTMB	50%	1%

14 Aggregation of interference

Appendix 3 to Annex 2 to Report ITU-R BT.2265-2 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.

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

Annex 1

List of relevant ITU-R Reports and Recommendations

Additional information on the characteristics which are referred to in this Report can be found in 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.1368 – Planning criteria, including protection ratios, for digital terrestrial television services in the VHF/UHF bands.
- Report ITU-R BT.2138 – Radiation pattern characteristics of UHF television receiving antennas.
- Final Acts of RRC06 – The GE06 Agreement[20].
- ITU-R DTTB Handbook.

Additional information on the characteristics which are not referred to in this Report can be found in ITU documents:

- Recommendation ITU-R BT.1206 – Spectrum limit masks for digital terrestrial television broadcasting.
- Recommendation ITU-R BT.1877 – Error-correction, data framing, modulation and emission methods for second generation of digital terrestrial television broadcasting systems.
- Recommendation ITU-R BT.1306 – Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting.

Additional information on the protection requirements which are referred to in this Report can be found in 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.
- Recommendation ITU-R BT.1895 – Protection criteria for terrestrial broadcasting systems.
- Final Acts of RRC06 – The GE06 Agreement.[24]
- Recommendation ITU-R BT.2033 – Planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands.
- 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.

[20] 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.

– Recommendation ITU-R BT.2036 – Characteristics of a reference receiving system for frequency planning of digital terrestrial television systems.

Additional information on the protection requirements which are not referred to in this Report can be found in ITU documents:

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

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

– 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.

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

– 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.

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**
EIRP	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
Center frequency	MHz	650.00	650.00	650.00	Table 18
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

DVB-T link budget for fixed roof top reception					
Noise figure (F)	dB	7	7	7	ITU-R BT.1368-13
Boltzmann's constant (k)	Ws/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+10log(k*T*B*10^6)+30
SNR at cell edge	dB	20	20	20	Table 17
Receiver sensitivity (P_{min})	dBm	−78.17	−78.17	−78.17	$P_{min} = P_n$(dBm) +SNR(dB)
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 1546-5
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	$s_T = SQRT(\sigma^2 + \sigma_w^2)$
Loss margin (L_m) 95%	dB	9.05	9.05	9.05	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−69.12	−69.12	−69.12	$P_{mean} = P_{min} + L_m$
Minimum field strength @ 10 m	dBµV/m	55.20	55.20	55.20	
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	
Height Loss 10 m to 1.5 m	dB	NA	NA	NA	
Height Loss 10 m to 1.5 m		NA	NA	NA	
Building Entry Loss	dB	NA	NA	NA	
Max allowed path loss (L_p)	dB	163.43	147.41	134.40	L_p = EIRP+(G_{iso}-L_{cable}) - L_{wall} - L_{body} - 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**
EIRP	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
Center frequency	MHz	650.00	650.00	650.00	Table 18
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)	Ws/K	1.38E-23	1.38E-23	1.38E-23	
Absolute temperature (T)	K	290	290	290	

DVB-T link budget for portable outdoor reception					
Allowance for man made noise	dB	0	0	0	
Noise power (P_n)	dBm	−98.17	−98.17	−98.17	P_n(dBm) = F+10log(k*T*B*10^6)+30
SNR at cell edge	dB	18	18	18	Table 17
Receiver sensitivity (P_{min})	dBm	−80.17	−80.17	−80.17	P_{min} = P_n(dBm) +SNR(dB)
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 1546-5
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 = SQRT($\sigma^2 + \sigma_w^2$)
Loss margin (L_m) 95%	dB	9.05	9.05	9.05	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−71.12	−71.12	−71.12	$P_{mean} = P_{min} + L_m$
Minimum field strength @ 10 m	dBµV/m	84.20	84.20	84.20	Urban
Minimum field strength @ 10 m	dBµV/m	77.20	77.20	77.20	Suburban
Feeder loss (L_{cable})	dB	0.00	0.00	0.00	
Antenna gain (G_{iso})	dBi	2.15	2.15	2.15	Table 14
G_{iso}-L_{cable}	dBi	2.15	2.15	2.15	
Urban Height Loss 10 m to 1.5 m	dB	24	24	24	ITU-R P.1546-5
Suburban Height Loss 10 m to 1.5 m	dB	17	17	17	ITU-R P.1546-5
Building Entry Loss	dB	NA	NA	NA	
Max allowed path loss (L_p)	dB	158.43	142.41	129.40	L_p = EIRP+(G_{iso}-L_{cable}) - L_{wall} - L_{body} - 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**
EIRP	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
Center frequency	MHz	650.00	650.00	650.00	Table 18
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)	Ws/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+10log(k*T*B*10^6)+30

DVB-T link budget for portable indoor reception					
SNR at cell edge	dB	18	18	18	Table 17
Receiver sensitivity (P_{min})	dBm	−80.17	−80.17	−80.17	$P_{min} = P_n$(dBm) +SNR(dB)
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.1546-5
Building entry loss standard deviation (σ_w)	dB	6.00	6.00	6.00	Table 13
Total loss standard deviation (σ_T)	dB	8.14	8.14	8.14	s_T = SQRT($\sigma^2 + \sigma_w^2$)
Loss margin (L_m) 95%	dB	13.39	13.39	13.39	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−66.78	−66.78	−66.78	$P_{mean} = P_{min} + L_m$
Minimum field strength @ 10 m	dBμV/m	99.54	99.54	99.54	Urban
Minimum field strength @ 10 m	dBμV/m	92.54	92.54	92.54	Suburban
Feeder loss (L_{cable})	dB	0.00	0.00	0.00	
Antenna gain (G_{iso})	dBi	2.15	2.15	2.15	Table 14
G_{iso}-L_{cable}	dBi	2.15	2.15	2.15	
Urban Height Loss 10 m to 1.5 m	dB	24	24	24	ITU-R P.1546-5
Suburban Height Loss 10 m to 1.5 m	dB	17	17	17	ITU-R P.1546-5
Building Entry Loss	dB	11.00	11.00	11.00	Table 13
Max allowed path loss (L_p)	dB	154.09	138.07	125.06	L_p = EIRP+(G_{iso}-L_{cable}) - L_{wall} - L_{body} - 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**
EIRP	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
Center frequency	MHz	650.00	650.00	650.00	Table 21
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)	Ws/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+10log(k*T*B*10^6)+30

DVB-T2 link budget for fixed roof top reception					
SNR at cell edge	dB	20	20	20	Table 20
Receiver sensitivity (P_{min})	dBm	−79.07	−79.07	−79.07	$P_{min} = P_n$(dBm) +SNR(dB)
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.1546-5
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 = SQRT($\sigma^2 + \sigma_w^2$)
Loss margin (L_m) 95%	dB	9.05	9.05	9.05	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−70.02	−70.02	−70.02	$P_{mean} = P_{min} + L_m$
Minimum field strength @ 10 m	dBµV/m	54.30	54.30	54.30	
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	
Urban Height Loss 10 m to 1.5 m	dB	NA	NA	NA	
Suburban Height Loss 10 m to 1.5 m		NA	NA	NA	
Building Entry Loss	dB	NA	NA	NA	
Max allowed path loss (L_p)	dB	164.33	148.31	135.30	L_p = EIRP+(G_{iso}-L_{cable}) - L_{wall} - L_{body} - 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**
EIRP	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
Center frequency	MHz	650.00	650.00	650.00	Table 21
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)	Ws/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+10log(k*T*B*10^6)+30
SNR at cell edge	dB	18	18	18	Table 20

DVB-T2 link budget for portable outdoor reception					
Receiver sensitivity (P_{min})	dBm	−81.07	−81.07	−81.07	$P_{min} = P_n$(dBm) +SNR(dB)
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.1546-5
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 = SQRT($\sigma^2 + \sigma_w^2$)
Loss margin (L_m) 95%	dB	9.05	9.05	9.05	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−72.02	−72.02	−72.02	$P_{mean} = P_{min} + L_m$
Minimum field strength @ 10 m	dBµV/m	83.30	83.30	83.30	Urban
Minimum field strength @ 10 m	dBµV/m	76.30	76.30	76.30	Suburban
Feeder loss (L_{cable})	dB	0.00	0.00	0.00	
Antenna gain (G_{iso})	dBi	2.15	2.15	2.15	Table 14
G_{iso}-L_{cable}	dBi	2.15	2.15	2.15	
Urban Height Loss 10 m to 1.5 m	dB	24	24	24	ITU-R P.1546-5
Suburban Height Loss 10 m to 1.5 m	dB	17	17	17	ITU-R P.1546-5
Building Entry Loss	dB	NA	NA	NA	
Max allowed path loss (L_p)	dB	159.33	143.31	130.30	L_p = EIRP+(G_{iso}-L_{cable}) - L_{wall} - L_{body} - 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**
EIRP	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
Center frequency	MHz	650.00	650.00	650.00	
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)	Ws/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+10log(k*T*B*10^6)+30
SNR at cell edge	dB	18	18	18	Table 17

DVB-T2 link budget for portable indoor reception					
Receiver sensitivity (P_{min})	dBm	−81.07	−81.07	−81.07	$P_{min} = P_n$(dBm) +SNR(dB)
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.1546-5
Building entry loss standard deviation (σ_w)	dB	6.00	6.00	6.00	Table 13
Total loss standard deviation (σ_T)	dB	8.14	8.14	8.14	s_T = SQRT($\sigma^2 + \sigma_w^2$)
Loss margin (L_m) 95%	dB	13.39	13.39	13.39	$L_m = \mu_{95\%} * \sigma$
P_{mean} (95%)	dBm	−67.68	−67.68	−67.68	$P_{mean} = P_{min} + L_m$
Minimum field strength @ 10 m	dBμV/m	98.64	98.64	98.64	Urban
Minimum field strength @ 10 m	dBμV/m	91.64	91.64	91.64	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 14
Urban Height Loss 10 m to 1.5 m	dB	24	24	24	ITU-R P.1546-5
Suburban Height Loss 10 m to 1.5 m	dB	17	17	17	ITU-R P.1546-5
Building Entry Loss	dB	11.00	11.00	11.00	Table 13
Max allowed path loss (L_p)	dB	154.99	138.97	125.96	L_p = EIRP+(G_{iso}-L_{cable}) - L_{wall} - L_{body} - 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**
EIRP	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
Center 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)	Ws/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+10log(k*T*B*10^6)+30

ISDB-T link budget for fixed roof top reception					
SNR at cell edge	dB	22	22	22	ITU-R BT.1368-13
Receiver sensitivity (P_{min})	dBm	−77	−77	−77	$P_{min} = P_n(dBm) + SNR(dB)$
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.1546-5
Building entry loss standard deviation (σ_w)	dB	0	0	0	
Total loss standard deviation (σ_T)	dB	5.5	5.5	5.5	$\sigma_T = SQRT(\sigma^2 + \sigma_w^2)$
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 @ 10 m	dBµV/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	
Urban Height Loss 10 m to 1.5 m	dB	NA	NA	NA	
Suburban Height Loss 10 m to 1.5 m		NA	NA	NA	
Building Entry Loss	dB	NA	NA	NA	
Max allowed path loss (L_p)	dB	155	127	97	$L_p = EIRP + (G_{iso} - L_{cable}) - L_{wall} - L_{body} - P_{mean}$