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TECHNICAL BASES FOR T-DAB SERVICES NETWORK PLANNING AND COMPATIBILITY WITH EXISTING BROADCASTING SERVICES

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TECHNICAL BASES FOR T-DAB SERVICES NETWORK PLANNING AND COMPATIBILITY WITH EXISTING BROADCASTING SERVICES

LIST OF ANNEXES

DEDICATION

In memory of

Jørn Andersen

through whose resolute and unfaltering efforts

the present volume emerged.

1. Introduction

The digital broadcasting system developed by the Eureka 147 (DAB) consortium, is known as the Eureka DAB system and is referred to throughout this document as “the DAB system”. It is actively supported by the European Broadcasting Union (EBU) for digital sound broadcasting services in Europe. The full system specification is available as a European Telecommunications Standard ETS EN 300 401.

The DAB system is primarily designed to provide a rugged, high-quality, multi-service digital sound broadcasting for reception by mobile, portable and fixed receivers. It is designed to operate at any frequency up to 3 000 MHz for terrestrial, satellite, hybrid (satellite and terrestrial) and cable broadcast delivery.

The DAB system is also designed as a flexible, general-purpose digital broadcasting system which can support a wide range of source and channel coding options in conformity with Recommendation ITU-R BO.789 and Recommendation ITU-R BS.774. The DAB system is furthermore covered by Recommendation ITU-R BS.1114.

This document deals with the planning of Terrestrial DAB (T-DAB), and sets out the planning methods and parameters that have to be applied in relation to its co-existence with other broadcasting services.

2. DAB system aspects

There are two aspects of the DAB system which combine to form this rugged, high-quality transmission system; the mechanism by which the digital content is encoded and the method by which these encoded data are transmitted.

The system uses advanced digital source encoding techniques to remove perceptually irrelevant information from the source signals. Controlled redundancy is then applied to each of the digital source signals in the form of error correcting code that can be used by the receiver. Several such signals are combined into a single "multiplex". Further robustness is obtained by employing time interleaving.

The transmitted information is spread in the frequency domain using a multi-carrier modulation scheme (COFDM, see § 2.1). COFDM lets the T-DAB system take advantage of multiple received signals by means of a "guard interval" which allows for reception in a multipath environment and the implementation of Single Frequency Networks (SFNs).

By employing these techniques, high quality mobile, portable and fixed reception can be obtained even in conditions of severe multipath propagation. Furthermore, efficient spectrum utilisation is achieved by the implementation of SFNs.

The following sections summarise those system characteristics that are important for planning.

2.1 Coded Orthogonal Frequency Division Multiplexing (COFDM)

The T-DAB system is designed to provide rugged digital sound broadcasting using bit rates between 8 and 320 kbits /sec. Under severe multipath conditions such as in the mobile and portable receiving environment, selective fading occurs; a wideband system is used to minimise the problems caused by this fading. In the case of T-DAB, the required bandwidth is about 1.5 MHz, as can be seen from the spectrum diagram in Figure 2.1 below. The useful capacity of the T-DAB channel is about 1.2 Mbits/sec based on protection level 3, as used for planning. This capacity is utilised to carry a multiplex containing several services.

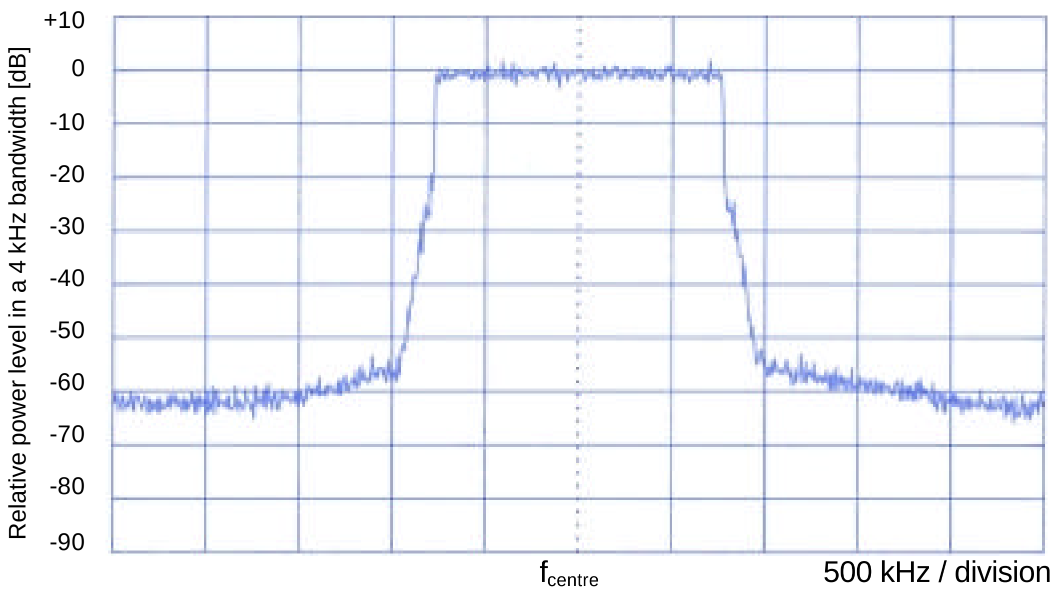


Figure 2.1: Typical RF-spectrum of a DAB signal

One way to provide rugged transmission is to use a multi-carrier system such as COFDM. The key features which make COFDM work in a manner that is well suited to terrestrial channels include:

- The use of ***time and frequency interleaving*** and ***error correction codes*** (the "C" of COFDM);
- ***Carrier orthogonality*** (the "O" of COFDM, see Figure 2.2 below) achieved by the mathematical linking of carrier separation ?f and useful symbol duration T_U, namely ?f?= 1/ T_U;
- The addition of a ***guard interval*** to reduce inter-symbol interference (ISI).

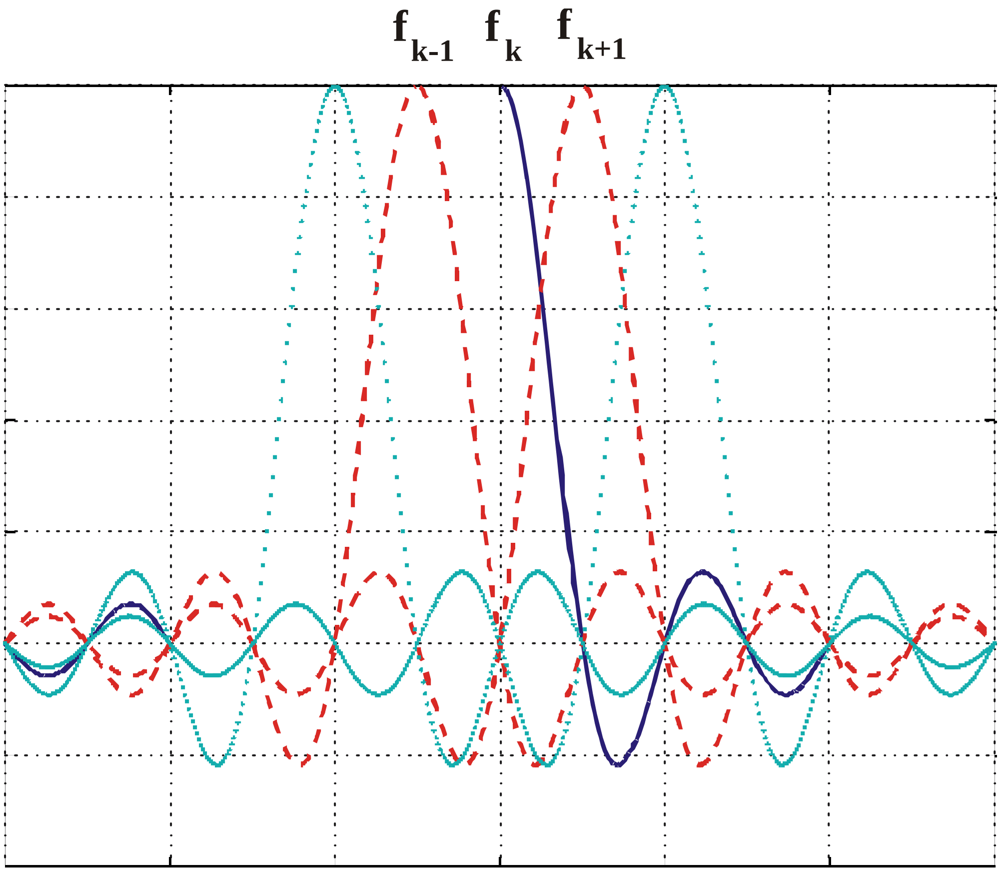


Figure 2.2: Schematic presentation of carrier orthogonality in a COFDM signal

T-DAB uses QPSK[1] modulation of the individual carriers followed by differential demodulation at the receiver. Modulation and demodulation are accomplished by IFFT[1] and FFT[1], respectively.

Further details can be found in [1].

2.2 Transmission modes

The DAB system has four alternative modes which allow for the use of a wide range of transmitting frequencies up to 3 GHz. These transmission modes have been designed to cope with Doppler spread and delay spread, for mobile reception in presence of multipath (passive) echoes and active echoes created by co-channel gap-fillers or transmitters in a single frequency network.

[1] See Definitions in Section 8.

Table 2.1 contain some main characteristics for the four DAB transmission modes.

Mode I is most suitable for a terrestrial single-frequency-network (SFN) in the VHF range, because it allows the largest distances between transmitters as it has the longest guard interval.

Mode II is most suitable for local radio applications requiring one terrestrial transmitter and hybrid satellite/terrestrial transmission up to 1.5 GHz. Mode II can also be used for a small-to-medium SFN at 1.5 GHz.

Mode III is most appropriate for satellite and complementary terrestrial transmission at all frequencies up to 3 GHz. Mode III is also the preferred mode for cable transmission up to 3 GHz.

Mode IV, a new mode, bridging the gap between Modes I and II, which is also optimized for operation at 1.5 GHz has been added with key values in a binary relationship to the previously developed modes. This mode provides for a longer constructive echo delay for easier SFN implementation, while keeping the effect of the Doppler spread at high vehicle speed within reasonable bounds.

		Mode I	**Mode IV***	**Mode II**	**Mode III**
Typical use		Terrestrial VHF	Terrestrial Urban L-Band	Terrestrial L-Band	Satellite L-Band
Number of carriers	n	1536	768	384	192
Approximate Carrier spacing	Δf	1 kHz	2 kHz	4 kHz	8 kHz
Useful symbol duration	T_U	1 msec	500 µsec	250 µsec	125 µsec
Guard Interval	Δ	246 µsec	123 µsec	62 µsec	31 µsec
Total symbol duration	$T_S = T_U + \Delta$	1246 µsec	623 µsec	312 µsec	156 µsec
Max. speed (mobile) VHF	v_{max}	260 / 390 km/h	520 / 780 km/h	n.a.	n.a.
Max. speed (mobile) L-Band	v_{max}	40 / 60 km/h	80 / 120 km/h	160 / 240 km/h	320 / 480 km/h

* Mode 4 is an extension of the original ETSI standard specification [2] to improve multipath performance of L-Band SFNs in urban areas, hence the table does not follow a natural sequence.

Table 2.1: Main characteristics for the four DAB transmission modes

For the maximum speed two values are given: The first figure applies to urban / suburban areas, and the second applies to rural areas [3].

2.3 Protection levels

Convolutional encoding is applied to each of the data sources feeding the multiplex to ensure reliable reception. The encoding process involves adding deliberate redundancy to the source data bursts. In the ETSI standard specification for the DAB system [2], five protection levels are available for audio (forward error correction (code rate) ranges from 1/3 to 3/4) and eight protection levels are available for data services through using punctured convolutional coding.

In the case of an audio signal, greater protection is given to some source-encoded bits than others, following a pre-selected pattern known as the unequal error protection (UEP) profile. The average code rate, defined as the ratio of the number of source-encoded bits to the number of encoded bits after convolutional encoding, may take a value from 1/3 (the highest protection level, giving the lowest useful data capacity) to 3/4 (the lowest protection level which provides the highest data capacity). Different average code rates can be applied to different audio sources, subject to the protection level required and the bit rate of the source-encoded data. For example, the protection level of audio services carried by cable networks may be lower than that of services transmitted in radio-frequency channels.

General data services are convolutionally encoded using one of a selection of uniform rates. Data in the Fast Information Channel (FIC) are encoded at a constant 1/3 rate. Figure 2.3 gives a simplified block diagram of the encoding process.

Because different segments of the data stream for each programme service have different protection levels and therefore require different code rates, it is not possible to precisely specify the overall code rate for each programme service or for the overall multiplex of programme services and data. The code rate thus depends slightly on the data rate used for each programme service (or data service).

Conceptual diagram of the transmission part of DAB

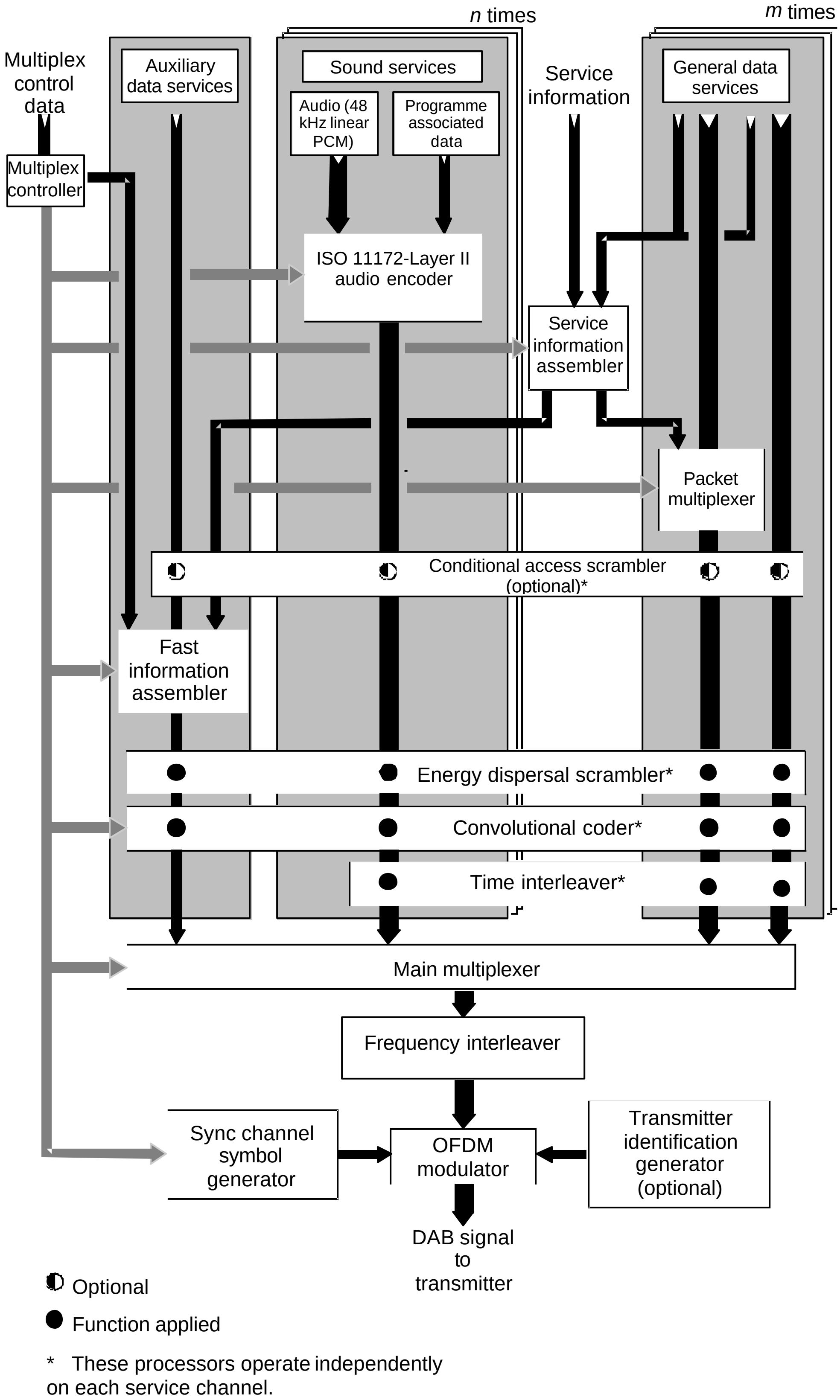


Figure 2.3: Simplified block diagram of DAB encoder.

2.4 C/N values and approximate useful bit rates.

For a Gaussian channel a C/N value of 7.4 dB is required for all four transmission modes to achieve a Bit Error Ratio (BER) of 1 x 10^{-4} after Viterbi. This C/N value for protection level 3 is used in § 2.5 to derive the minimum receiver input signal level.

In order to provide an overview of C/N values for different protection levels in different transmission channels the values shown in Table 2.2 have been established on the basis of corresponding values used for planning of DVB-T (see Annex 1).

Protection Level	Corresponding approximate Code Rate	C/N (dB) for BER of $1*10^{-4}$ after Viterbi			Approximate Bit-Rate (MBit/s)
		Gauss Channel	Rice Channel	Rayleigh Channel	
1	0.34	5.9	7.1	12.1	0.78
2	0.43	6.7	8.0	12.6	0.99
3	**0.50**	**7.4**	**8.8**	**13.3**	**1.15**
4	0.60	8.4	10.0	14.9	1.38
5	0.75	10.2	12.0	18.6	1.73

Table 2.2 : Estimated Band III C/N ratios based on DVB-T data and a variable implementation margin

It should, however, be stressed that the differences between the C/N values of the various protection levels are not constant. They become larger when the transmission channel becomes more difficult. For example, protection level 5 does not work for the mobile high-speed worst-case reception situation mentioned above.

It can be seen from Table 2.2 that there is little advantage in choosing a lower protection level (higher protection) than 3. However, the required C/N ratio increases considerably if a higher protection level (lower protection) is chosen.

Although DAB was primarily designed to operate in a mobile environment (Rayleigh channel) increasing use is being made of fixed antenna reception for which the Ricean channel is more appropriate. Consequently the required C/N is lower in the case of fixed antenna reception than for portable / mobile reception. (See § 8).

2.5 Minimum receiver input voltage

The minimum receiver input voltage is determined by the bandwidth of the receiver and its noise figure. The bandwidth is taken to be equal to the bandwidth of the signal, that is 1.536 MHz.

In Table 2.3 below the minimum receiver input voltage is derived for two frequencies, representative for Band III and the 1.5 GHz range. These values are used in § 5 and § 6 to derive the minimum power flux densities and corresponding minimum median equivalent field strength values for the two frequency bands.

Definitions:

- B : Receiver noise bandwidth [Hz]
- C/N : RF signal to noise ratio required by the system [dB]
- f : RF frequency [MHz]
- F : Receiver noise figure [dB]
- P_n : Receiver noise input power [dBW]
- $P_{s\,min}$: Minimum receiver signal input power [dBW]
- $U_{s\,min}$: Minimum equivalent receiver input voltage into Z_i [dBμV]
- Z_i : Receiver input impedance (75Ω)

Constants:

- k : Boltzmann's Constant = 1.38×10^{-23} Ws/K
- T_0 : Absolute temperature = 290 K

Formulas used:

$$P_n = F + 10 \log (k*T_0*B)$$
$$P_{s\,min} = P_n + C/N$$
$$U_{s\,min} = P_{s\,min} + 120 + 10 \log (Z_i)$$

Derivation of the minimum equivalent receiver input voltage			
Frequency (Band III and 1.5 GHz range)	f (MHz)	200	1470
Equivalent noise band width	B [Hz]	$1.536 * 10^6$	$1.536 * 10^6$
Receiver noise figure	F [dB]	7	6
Corresponding receiver noise input power	P_n [dBW]	-135.1	-136.1
RF signal/noise ratio (Gaussian channel)	C/N [dB]	7.4	7.4
Min. receiver signal input power	$P_{s\,min}$ [dBW]	-127.4	-128.4
Min. equivalent receiver input voltage, 75 ohm	$U_{s\,min}$ [dBμV]	11	10

Table 2.3: Derivation of minimum equivalent receiver input voltage.

2.6 Multipath capability, guard interval and inter-symbol interference

T-DAB is designed to cope with delayed signals in a multipath environment. From the viewpoint of signal processing within the receiver, a multipath signal is indistinguishable from another suitably delayed transmission carrying exactly the same information. The ability of the DAB system to accommodate delayed signals is largely achieved by the incorporation of a Guard Interval of duration Δ μs within the time domain. Provided that the longest multipath delay time does not significantly exceed the guard interval, then all the signal components add constructively (see Figure 2.4).

The Guard Interval is part of the transmitted signal. It is defined as being the first part of a Symbol and does not contain information different from the Symbol which it is a part of. On the transmitter side the Guard Interval includes the time needed by the individual QPSK modulated carriers to stabilise on the phase which corresponds to the new Symbol transmitted.

On the receiver side the Guard Interval is used to prevent (or reduce) inter-symbol interference (ISI) when more than one signal is received.

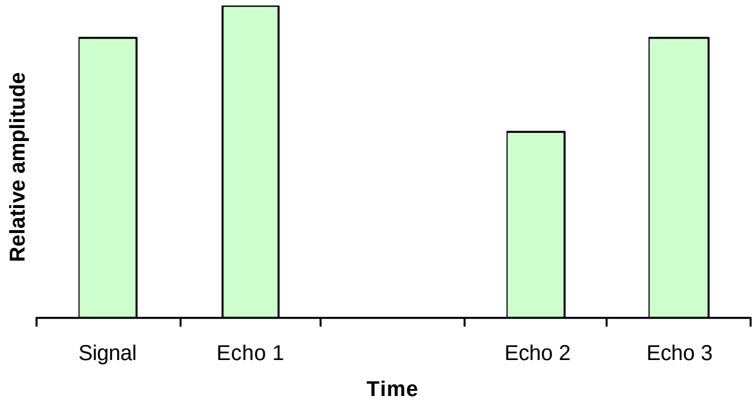


Figure 2.4a: Relative time and amplitude of signals used in Figure 2.4b

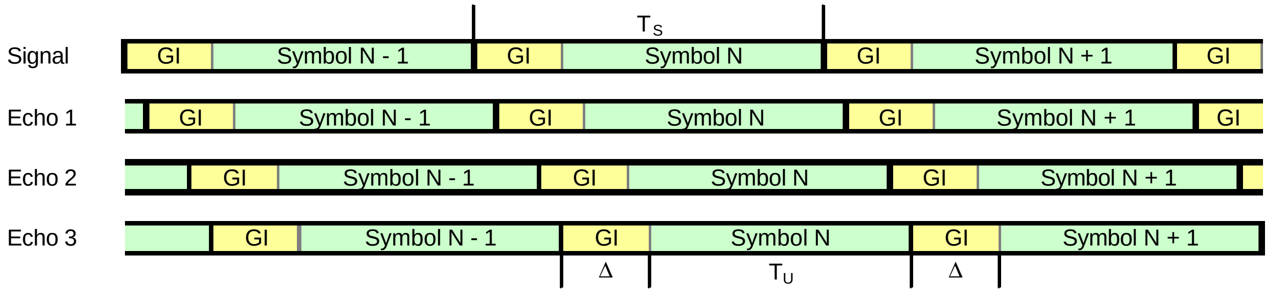


Figure 2.4b: Constructive contribution of signals in a multipath or SFN environment

Figure 2.4 shows the situation where a main signal and three echoes are received. In this example the signal has a lower level than the first echo. The duration of an OFDM symbol T_S , the useful symbol length T_U as well as the guard interval ? are shown in the Figure.

As delay times increase above the guard interval, the constructive effect of multipath signals decreases, and the interference effect increases. In practice, signals arriving at the DAB receiver will contribute to or detract from the overall system performance to an extent determined by their amplitude and their delay (positive or negative) relative to the start of the receiver FFT window position. (See Figure 2.5 below).

Figure 2.5 shows the weighting functions for the wanted and interfering components of the signal. The effect of the interfering contribution is similar to the effect of noise, or of interference from a co-block T-DAB transmitter carrying different information.

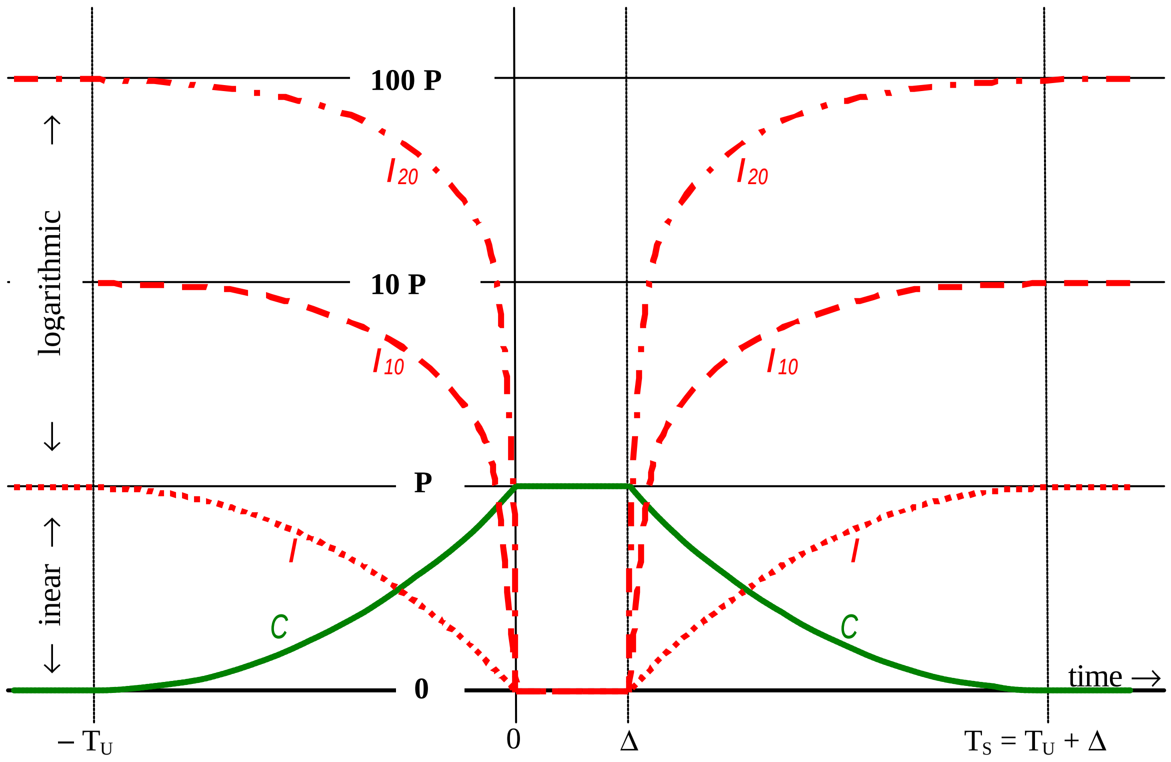


Figure 2.5: The two components of the wanted received power P
C is the useful (contributing) power, I is the self-interfering power
I_{10} (I_{20}) is the equivalent self-interference potential of I with a 10 dB (20 dB) protection ratio

$$-\infty < t < -T_U : \quad f(t) = 0$$
$$-T_U < t < 0 : \quad f(t) = \{(T_U + t) / T_U\}^2$$
$$0 < t < ? : \quad f(t) = 1$$
$$? < t < T_S : \quad f(t) = \{(T_S - t) / T_U\}^2$$
$$T_S < t < \infty : \quad f(t) = 0$$
$$C = P \bullet f(t)$$
$$I = P - C$$
$$I_{10} = 10 \bullet I \quad \text{(i.e. 10 dB increase due to 10 dB protection ratio)}$$
$$I_{20} = 100 \bullet I \quad \text{(i.e. 20 dB increase due to 20 dB protection ratio)}$$

where

t	:	Time of arrival of a signal
T_U	:	Useful symbol time
T_S	:	Total Symbol duration
?	:	Guard Interval
P	:	Power of the received signal

It should be noted that the two curves (I_{10} and I_{20}) in Figure 2.5 indicate, as a function of protection ratio, the 'prompt', and severe, self-interference consequences of exceeding the guard interval in an SFN.

2.7 FFT window synchronisation

2.7.1 General

The DAB signal provides two main mechanisms for synchronisation – a null symbol for coarse synchronisation, and a phase reference symbol (PRS) for fine frequency and time synchronisation. The PRS allows a channel impulse response to be calculated within the receiver. This impulse response will show a number of peaks corresponding to the contributing transmitters and echoes, at a number of different levels and times (illustrated in Figure 2.4a). The strategies employed by the receiver determine which peak in the impulse response the receiver uses for synchronisation, and where the receiver sets the FFT window relative to this peak.

Details concerning methods and strategies for positioning of the FFT window are considered to be beyond the scope of this document but can be found in [2] and [3].

Single signal environment

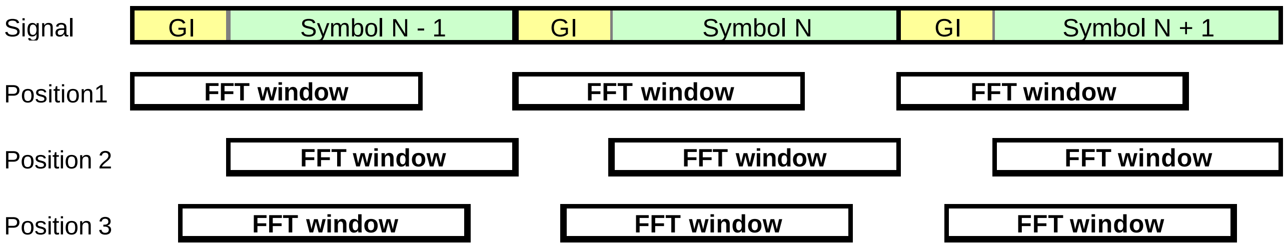


Figure 2.6 DAB symbols and possible FFT window positions in a single signal environment

The FFT window can be positioned adjacent to the preceding symbol (1), or
adjacent to the following symbol (2) or
inside the symbol (3).
In the case of 1 and 3, some signal components sampled by the FFT window come from the guard interval.
In the case of 2, no signal components come from the guard interval. However, there is no discernible difference between these strategies for a single signal, in an undistorted environment.

In a multi-signal environment, the receiver receives signals via a number of different paths, arriving at different times. Such situations are found in SFNs, but also occur with a single transmitter.

In a multiple signal environment, the strategy for where to place the FFT window is important due to the need to avoid inter-symbol interference for successful decoding.

FFT window synchronisation is of particular importance for mobile and portable reception, when the receiver will need to be able to synchronise in a rapidly changing environment and in the presence of pre- and post- echoes.

There are several possible strategies for synchronisation of the receiver FFT window. However, the actual strategy employed in any one receiver is in practice decided by the particular manufacturer. Some of the potential strategies for FFT window positioning are discussed below.

2.7.2 Strongest Signal

One possible approach for the FFT window positioning is a synchronisation to the strongest signal, in a similar way as is shown in Figure 2.6 for a single signal. The strongest signal may, and will in many cases, be the first signal in the impulse response. However, in a complex multipath environment it may happen that the first signal is weaker than one of the echoes and the position of the FFT window needs to make allowance for this (See Figure 2.7).

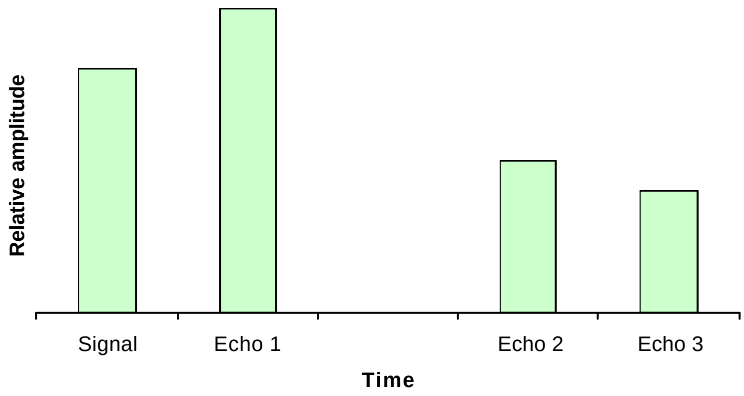


Figure 2.7: Channel response where the first echo is stronger than the signal

2.7.3 First signal with a level above a certain value

With this method, the receiver will synchronise to the earliest received signal within a range of, say 6 to 10 dB, below the strongest received signal, assuming this level is above the minimum receiver input level.

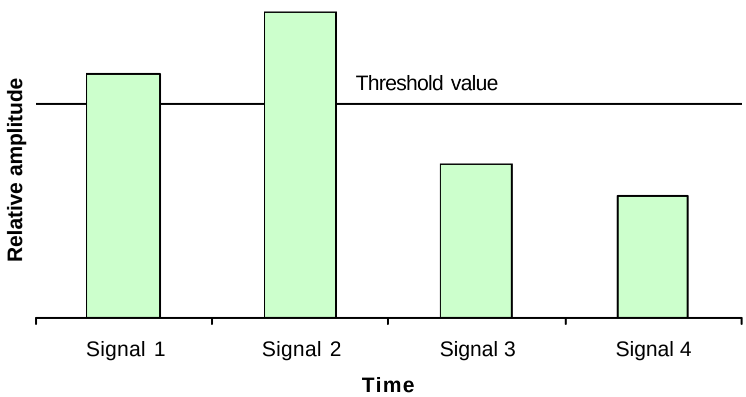


Figure 2.8: Channel response and threshold

In this example it is assumed that the multi-signal configuration is found in an SFN with several transmitters. Considering the first two signals only, Signal 1, the first to arrive, is likely to be from the nearest transmitter. It may be lower in amplitude due to a poor propagation path. Signal 2 may correspond to a more distant transmitter with a better propagation path or a larger ERP. Signals 3 and 4 may correspond to more distant transmitters.

2.7.4 Centre of gravity

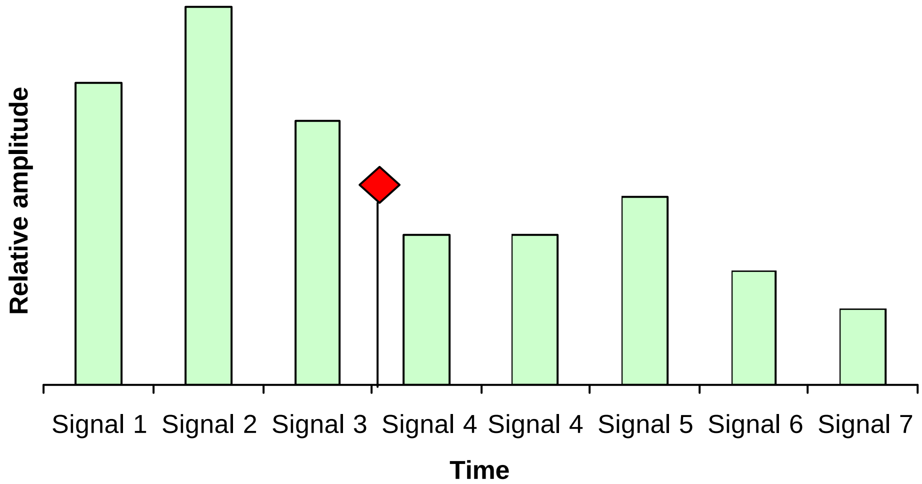


Figure 2.9: Channel Impulse response and the Centre of Gravity FFT window positioning

In this case the receiver looks at the channel impulse response to find all the peaks corresponding to contributing transmitters and echoes. Based on the entire channel response, the receiver calculates the 'Centre of gravity', and centres the FFT window on that point. The centre of gravity approach responds well to pre-echoes and delayed signals of similar amplitude to the synchronised signal.

It is likely that the latest generation of receivers will adopt an approach based on this concept; however, no information has been published to date, since it is considered commercially sensitive.

2.7.5 Optimal position

Whereas the previously discussed strategies all give methods how to find quickly a good FFT window position, an optimal choice would obviously be a position where the effective C/I ratio is maximal. This position, however, is not easily found and would in general take too much time to be calculated. Therefore, normally one of the above simpler strategies, or a combination of them, is applied. Such simpler approaches are additionally justified by the fact that the optimum C/I shows a relatively flat maximum, i.e. errors introduced by sub-optimal synchronisation are small.

3 T-DAB Network Concepts

3.1 Introduction

FM radio and analogue television planning has traditionally been done on the basis of Multi-Frequency Networks (MFNs), where adjacent service areas (centred on a main transmitter) use different frequencies to broadcast the same programme. Because of its ability to make constructive use of delayed signals (provided the delay is within certain limits), T-DAB gives an extra dimension to MFN planning.

In planning T-DAB networks, each service area in an MFN can consist of either a single transmitter (the "traditional" case) or a network of transmitters operating on the same frequency – a Single Frequency Network (SFN). The combination of an MFN consisting of a number of SFNs (a Multi-SFN) allows the planner and the programme maker to take advantage of the benefits that each type of network can provide. These are:

- The MFN concept allows for regionalisation of programmes. This cannot be achieved within an SFN, where all of the transmitters comprising the SFN have to carry precisely the same programme content and data. Regional or local programme variations cannot be accommodated on individual transmitters within an SFN.
- Each SFN comprising the MFN benefits from the network gain that is a feature of the SFN (see § 4.5).

3.2 Types of networks used for the implementation of T-DAB

Basically two types of networks can be used for the implementation of T-DAB. One is called an "open" and the other a "closed" network.

It is assumed that both types of networks are designed to provide the minimum wanted field strength at the boundary of the coverage area.

In an **open network** no measures are taken to minimise the level of radiation towards areas outside of the coverage area. In the limiting case an open network can consist of only a single transmitter.

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

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

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

It follows from the above that for relatively large coverage area, the separation distance between co-block areas will generally be less for closed networks than for open ones. For smaller coverage areas the separation distance for closed networks approaches that for open networks. This indicates that spectrum utilisation efficiency is lower in this case.

3.3 Single Frequency Networks (SFNs)

To date, SFNs have been widely used in implementing T-DAB networks, and therefore it is important to understand the benefits that they give and the limitations to their use. In an SFN, all transmitters within the network are both frequency and time synchronised. They possess a common coverage area and cannot be operated independently.

3.3.1 Performance in a multipath environment.

As discussed in § 2 the T-DAB system is designed to perform well in a multipath environment, typical of portable and mobile reception.

From the viewpoint of signal processing within the receiver, a multipath signal is indistinguishable from another delayed transmission carrying exactly the same information. The ability of the T-DAB system to accommodate delayed signals is achieved by the incorporation of a guard interval within the time domain. Provided that the longest multipath delay time does not significantly exceed the guard interval, then all the signal components add constructively.

It follows therefore that several transmitters forming a T-DAB network over an extensive area can employ a single frequency block without mutual interference. This is the general principle of the SFN. Figure 3.1 shows an example of nationwide coverages by means of SFNs in the British Isles.

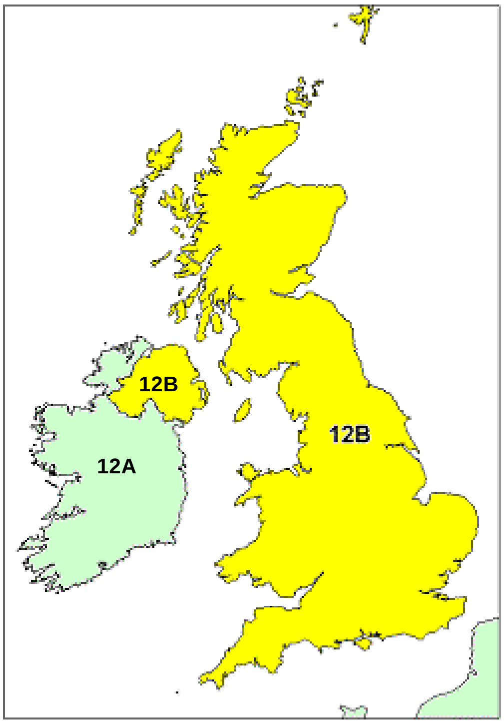


Figure 3.1: National Single Frequency Networks in the British Isles

3.3.2 Network gain

In an SFN, many receiving locations within the coverage area will be served by more than one transmitter. This introduces a certain level of redundancy to signal reception and improves the service availability. The field strength from a single transmitter shows statistical variations due to the presence of obstacles on the propagation path, particularly for portable and mobile reception. This field strength variation can be reduced by the presence of several transmitters, located at different bearings as seen from the receiver, since when one source is shadowed, others may be easily receivable. This aspect of an SFN gives rise to "network gain" which, is explored in more detail in § 4.5.1. An SFN can be designed to provide a more homogeneous field strength distribution throughout its coverage area than a single transmitter covering the same area.

3.3.3 Limitations of SFNs.

In a large SFN, it may be difficult to plan the network so that signals from transmitters a long distance from the receiver are always of an insignificant level compared to those from nearby transmitters.

This difficulty is increased because
- the signal levels from distant transmitters have to be calculated for small percentages of the time (typically 1%) to ensure that reception is protected for high percentages of the time (typically 99%) and
- the receiving aerial for portable and mobile receivers is non-directional.

Signals from distant transmitters within the SFN are delayed with respect to the signals arriving at the receiver from transmitters closer to it. These delayed signals may lie outside the time range where they contribute positively. Any signal arriving at the receiver with a relative delay greater than this will appear as an interferer. This is called self-interference.

3.4 Multi-Frequency Networks (MFNs)

3.4.1 Conventional MFNs

In a conventional MFN, each transmitter is a stand-alone object with regard to frequency and coverage area. This applies also to very small T-DAB allotment areas where the benefit of a closed network structure (see § 3.2 and § 4.7) is either small or non-existent because the level of outgoing interference is determined by the transmitters on the opposite side of the network.

3.4.2 Multi-SFN

Within a given geographical area, it may be desirable to integrate a number of smaller SFNs into a wider area network - a Multiple Single Frequency Network (Multi-SFN) - in order to meet requirements for regional and local programmes. Each SFN gets the benefit of network gain and a more homogeneous field strength distribution throughout its coverage area and the Multi-SFN gives the possibility for programme diversity.

In a Multi-SFN, the total coverage area is divided into a number of smaller areas which are each served by a different frequency block. An example for the UK is shown in Figure 3.2.   The Digital One network is made up of five SFNs using four different frequency blocks to cover the entire area, and allows for regional programming.

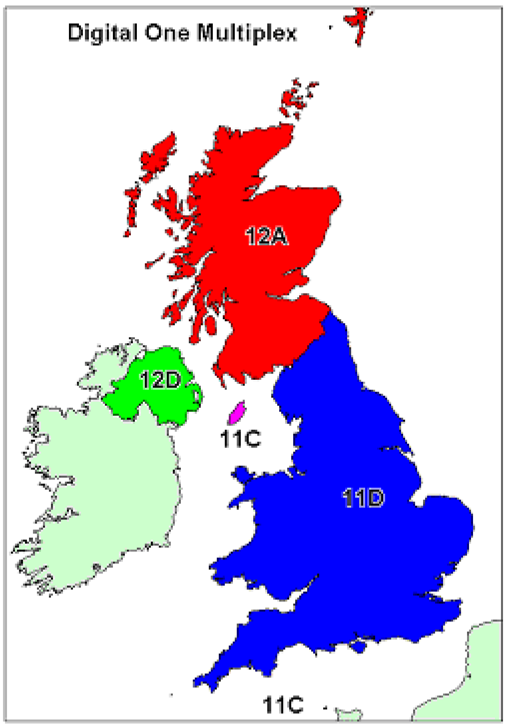


Figure 3.2: A National Network consisting of a Multi-SFN

In a Multi-SFN environment several layers of programme service can be provided to meet the requirements for individual programmes to different regional and local areas. An example is:

Layer 1: a national network with regional services,
Layer 2: a regional network with local services,
Layer 3: a local network with community services, and so on, proceeding as far down the layer structure as is required by the programme makers or is commercially viable.

Using the layered approach, one of the disadvantages of DAB – its inflexibility from the point of view of the programme maker – is overcome. Figure 3.3 illustrates the concept. The Multi-SFN concept also allows the coverage of areas where, due to the constraints of existing services in part of the coverage area, it would not be possible to operate an SFN over the whole coverage area.

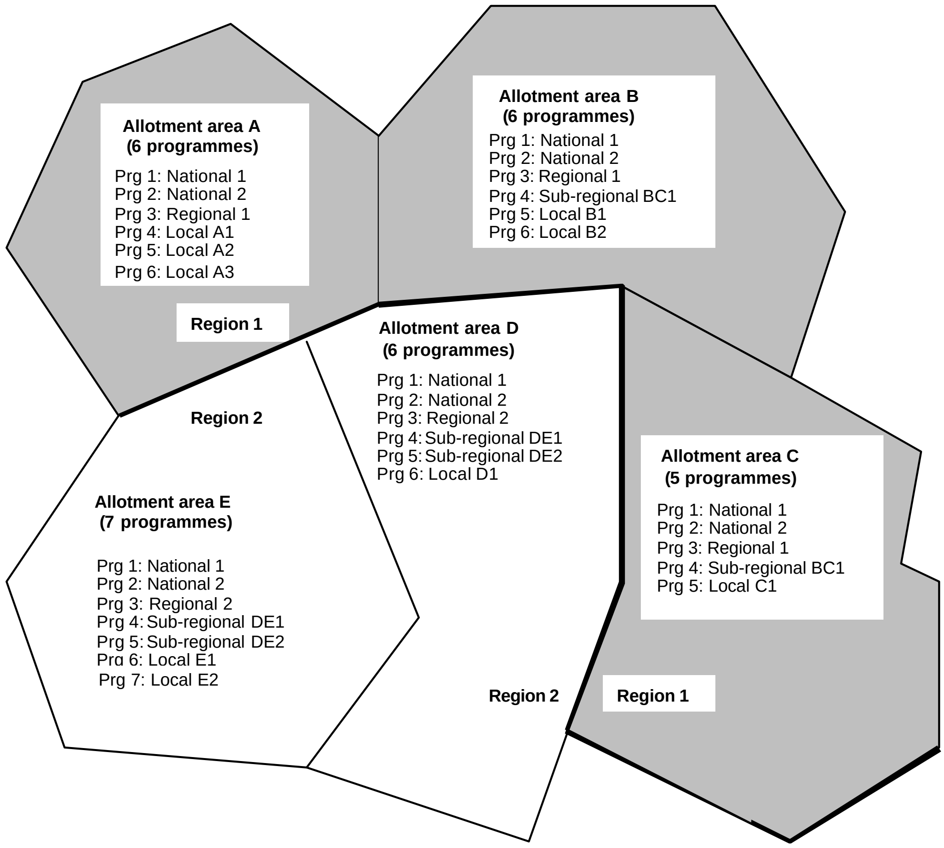


Figure 3.3: Programme flexibility using a plan based on a Multi-SFN.

The penalty for using a Multi-SFN to cover a number of small areas is reduced spectrum utilisation efficiency whilst its advantage is the ability to provide individual programmes to the different regional and local areas.

3.5 The Planning Process: Assignment Planning

The *assignment* of a radio frequency or radio frequency channel is defined in the Radio Regulations (S1.16):

"*Authorisation given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions.*"

In the past, terrestrial television planning (and most other broadcast planning) in Europe has been by way of assignment conferences. In assignment planning, a significant amount of individual station planning is needed to prepare for a planning conference. Stockholm 1952 and Stockholm 1961 were two such conferences related to terrestrial analogue broadcasting and European broadcasters have gained much experience in assignment planning, particularly since the planning methods and criteria of the ST61 conference are still applied to analogue television planning, although they have been developed and updated. This is not to say that station characteristics are fixed for all times. For example the ST61 Agreement allows for some flexibility and indeed there have subsequently been many modifications and additions to the Plan drawn up by this Conference – even for high power stations.

Assignment planning for terrestrial digital broadcasting is also appropriate where all the transmitter sites are known and have known characteristics. As with analogue television it is possible to modify the station characteristics, subject to co-ordination.

An assignment plan provides a frequency or a set of frequencies for each station and at the completion of the assignment planning process the locations and characteristics of the transmitters in the planning area are known. **The transmitters can be brought into service without further co-ordination**.

For practical reasons a lower limit for the radiated power is sometimes defined for stations to be dealt with in the planning process. Stations with a radiated power below the limit are then included in the plan subsequently. For example in 1961 the lower limit was set to 1 kW for VHF stations and to 10 kW for UHF stations. At the ITU FM Planning Conference in 1984 stations down to and below 30 Watts e.r.p. were entered into the Plan.

3.6 The Planning Process: Allotment Planning

The *allotment* of a radio frequency or radio frequency channel is defined in the Radio Regulations (S1.17):

"*Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radiocommunication service in one or more identified countries or geographical areas and under specified conditions*."

The possibility of obtaining allotments at a broadcasting conference has received considerable attention in recent years, particularly because of the opportunities offered by SFNs. However, it should be noted that in the context of terrestrial broadcasting the definition is taken to mean:

Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by administrations for a terrestrial broadcast service within their own country, or geographical areas within their country, and under specified conditions.

Allotment planning for SFNs may be appropriate where spectrum is available, or can be made available, throughout a country or in regions of a country.

The use of allotments in MFN planning may give the Plan a better chance of enduring for a long period in a time of rapid technological development. Allotments will give a country flexibility for the future with respect to the location of its transmitting stations and the type of coverage to be provided.

At the allotment planning stage, in general nothing is known of the actual location of the transmitter sites, or of the specific transmitting stations characteristics to be used. The only parameters available are a definition of the area to be covered and the block to be used and an upper limit for the outgoing interference. In order to carry out the planning and to assess the outgoing interference it is necessary to define some agreed realistic reference transmission conditions so that any necessary compatibility calculations can be made. See § 4.7.2 for examples of reference networks.

The resulting Allotment Plan contains the T-DAB frequency blocks to be used in particular areas without specifying the technical data for the transmitting stations. **Each allotment in the Plan has to be converted into a transmitter assignment or set of transmitter assignments before the service can be brought on air**.

Provided the network plan for an allotment area does not produce field strengths above a limit defined in the plan at the calculation test points surrounding the allotment area then the network can be implemented without co-ordination If this condition can not be met, the full set of stations forming the network must be co-ordinated with the neighbouring countries concerned.

3.7 The connection between assignment and allotment concepts

An assignment Plan contains the detailed transmitter data from the day it is established and therefore allows for implementation as soon as the Plan comes into force. However, any subsequent change to the network will probably have to be coordinated with the concerned neighbours.

The benefit of an allotment plan is flexibility. The detailed technical characteristics of the transmitters are normally planned subsequent to the Conference, but can be established during the Conference, if required.

The definition of an allotment allows the transmitter network, associated with that allotment,

- to be implemented or
- later modified

without co-ordination, providing that the data for the allotment (its boundary points, field strength at each calculation test point, etc.) are not changed.

Moreover, the coverage area of an assignment (in an assignment plan) can be considered as an allotment (area) by specifying its coverage area according to a method to be adopted by the Conference. The Conference can then deal with both allotments and assignments in an equivalent way.

An allotment can be associated with national, regional or local coverage. Furthermore, allotments can be implemented as single transmitters or SFNs, as has been demonstrated in recent T-DAB planning.

If the allotment planning concept is adopted by the Conference, assignments can be treated as allotments in order to facilitate the planning analyses and syntheses.

4. Planning Considerations

4.1 General

When planning a transmitter network four field strengths are important.

- One is, of course, the field strength of the wanted signals inside the coverage area – the wanted field strength.
- The second results from the power radiated by the wanted transmitters towards areas outside of the coverage area and is usually called outgoing interference or outgoing interfering field strength.
- The third is the field strength inside the wanted coverage area due to radiation from interfering transmitters outside the wanted coverage area – incoming interference or incoming interfering field strength.
- The fourth field strength arises in SFNs. It is the self-interference that may be found in SFNs when inter-symbol interference of wanted signals occurs.

The outgoing interference from one network will, in most cases, be a component of the incoming interference of another network.

4.2 The influence of propagation

4.2.1 Variation of field strength with time (time probability)

Field strength propagated over a distance varies with time. For shorter distances, i.e. inside the coverage area of a transmitter or an SFN, the variation is smaller and is usually neglected in the calculations. For longer distances, i.e. relevant for interference to other networks, the variation is important.

4.2.1.1 Wanted field strength

Calculation of the wanted field strength inside the coverage area can be done by means of any appropriate prediction method depending on the choice of the network designer, and is normally calculated for 50% of the time.

4.2.1.2 Interfering field strength

Calculation of the outgoing and incoming interfering field strengths will usually have to be done using a commonly agreed prediction method like Rec. ITU-R P.1546 [4], and is normally calculated for 1% of the time. This is necessary because of the abrupt failure characteristic which is typical for digital broadcasting systems as the C/(N+I) ratio falls below the required minimum value. This ensures that protection of the wanted signal inside the coverage area is achieved for a high percentage (about 99%) of the time.

4.2.2 Variation of field strength with location for fixed, mobile and portable outdoor reception (location probability)

Within a small area, say 100 m x 100 m, there will be a random variation of signal level with location which is due to local terrain irregularities. The statistics of this type of variation are generally characterised by a log-normal distribution of the signal levels. The variation of field strength with location is assumed to apply to the wanted and the interfering fields. The variation of the interfering field is also assumed to be un-correlated with that of the wanted field.

For a digital broadcasting system, like T-DAB, the public expects reception to be at least as good as for analogue systems such as FM. Due to the abrupt failure characteristic of digital broadcasting systems, networks must be designed so that reception is possible almost everywhere in the coverage area. This implies that the location probability for successful reception inside the coverage area should be high, normally taken to be 99%, because T-DAB is specified for operation with a mobile receiver.

For digital wide band signals the standard deviation (σ) of the field strength is assumed to be 5.5 dB which has been confirmed by a number of measurements. In some cases the standard deviation has been measured to be even lower, down to 3.5 dB for Band III.

Measurements have shown that a standard deviation of 5.5 dB is also applicable for the 1.5 GHz frequency range.

In statistical field strength prediction methods, like Rec.ITU-R P.1546 [4], field strength values are given for 50% of locations (the median value). In order to secure reception at greater percentages of locations (e.g. 99% of locations) a higher median value of the field strength is needed. This is done by adding a figure – the **location correction figure** – to the minimum median equivalent field strength.

The wanted T-DAB signals have to be protected at more than 50% of locations (e.g. 99% of locations) against interference from other transmissions. Because it is assumed that the variations of wanted and interfering field strengths are un-correlated, a margin – the **location correction margin** – must be included (in addition to the system protection ratio) in the calculation of the permissible interfering field strength.

4.2.2.1 Location Correction Figure.

In § 5.3 and 6.2, the minimum median equivalent field strengths for T-DAB are calculated. These field strengths are valid for 50% of locations. To obtain the minimum median equivalent field strength needed to provide reception at a higher percentage of locations, a location correction figure C has to be added.

In calculating the location correction figure C_l, a log-normal distribution of the received signal with location is assumed.

The location correction figure, C_l, (dB) can be calculated by the formula:

$$C_l = \mu * \sigma$$

where:

σ is the standard deviation of the field strength (5.5 dB) for shadow fading and μ is the log-normal distribution factor. Values for some often used cases are given below

0.00 for 50% of locations,

0.52 for 70% of locations,

1.28 for 90% of locations,

1.64 for 95% of locations and

2.33 for 99% of locations.

values of μ for other percentages of locations can be found from the normal distribution table in Rec. ITU-R P.1546 [4].

4.2.2.2 Calculation of Location Correction Figure.

Table 4.1 gives the location correction figure which has to be added to the minimum median equivalent field strength to provide reception at the desired percentage of locations (location probability). The value for the recommended location probability for mobile reception (99%) is shown in **bold** print.

Reception Mode	Location Probability (%)	Normal Distribution Factor	Aggregate Standard Deviation (dB)	Location Correction Figure (dB)
Mobile and portable outdoor	50	0.00	5.5	0.0
	70	0.52		2.9
	90	1.28		7.0
	95	1.64		9.0
	99	**2.33**		**12.8**

Table 4.1: Location correction figures for fixed, mobile and portable outdoor reception.

The location corrections for indoor reception can be found in § 4.4, taking account of the building penetration loss.

4.2.2.3 Location Correction Margin.

The amount of protection achieved for a given wanted signal with respect to a given interfering signal is related to the difference of the wanted and interfering field strengths. This difference is a statistical variable that depends on

a) the median values of the two fields, and on
b) their location standard deviations,

and that has a standard deviation which is calculated as follows:

$$s_{res} = \sqrt{(s_{wanted})^2 - 2r \times s_{wanted} \times s_{interferer} + (s_{interferer})^2}$$

It is assumed that the wanted and interfering signals are both log-normally distributed, are uncorrelated, and have identical standard deviations.

since $s_{wanted} = s_{interferer}$ and $\rho = 0$,

$$s_{res} = (s_{wanted}) \times \sqrt{2}$$

In the case of fixed, mobile or portable outdoor reception of T-DAB, the standard deviation, s is assumed to be 5.5 dB, which makes the resultant standard deviation,

$$s_{res} \approx 5.5 \times \sqrt{2} = 7.8 \text{ dB.}$$

The location correction margin is a factor which takes account of the statistically-varying difference between the wanted and interfering signals. The location correction margin and the system protection ratio are added to give the amount (in dB) by which the median value of the wanted signal must exceed the median value of the interfering signal in order to provide adequate protection other than at 50% of locations.

4.2.2.4 Calculation of Location Correction Margin.

Table 4.2 gives the location correction margin which has to be added to the system protection ratios to determine if the wanted signal is protected at the desired percentage of locations (location probability). The value for the recommended location probability for mobile reception (99%) is shown in **bold**.

Reception Mode	Location Probability (%)	Normal Distribution Factor	Resultant Standard Deviation (dB)	Location Correction Margin (dB)
Mobile and portable outdoor	50	0.00	7.8	0.0
	70	0.52		4.1
	90	1.28		10.0
	95	1.64		12.8
	99	**2.33**		**18.2**

Table 4.2: Location correction margins for fixed, mobile and portable outdoor reception.

The location correction margins for indoor reception can be found in § 4.3 on building penetration loss.

4.3 Building Penetration Loss

T-DAB services are primarily planned for mobile reception but they are also required to provide satisfactory reception on portable receivers in the home without relying on fixed antennas. It follows therefore that an allowance to overcome building penetration losses will be required in the implementation process.

The mean building penetration loss is the difference in dB between the mean field strength inside a building at a given height above ground level and the mean field strength outside the same building at the same height above ground level. Therefore the height of the receiver within the building also needs to be considered. Within any particular building, reception on the ground floor would be expected to be worse than on higher floors but better than in basement levels.

Building penetration loss will vary as a function of the construction materials, the number of windows and their size. Metalised window coatings may also significantly reduce the field strength levels inside buildings.

In addition, the effective building penetration loss will be reduced if the coverage is provided by a single frequency network because a number of transmitters are contributing and their signal arrive from different directions.

A limited number of studies have been carried out to quantify domestic building penetration loss. For VHF, the values ranged from 7 dB to 8 dB, with a standard deviation of 3 dB. For the 1.5 GHz range, the values ranged from 7 dB to 17 dB, with a standard deviation of about 6 dB. Building penetration loss in commercial buildings can be even higher. To derive the minimum median equivalent field strengths in this document, the following values have been used:

Frequency band	Building penetration loss (dB)	Standard deviation (dB)
VHF (Band III)	8	3
1.5 GHz	10	6

Table 4.3: Building penetration loss

4.4 Location correction for indoor reception

For vehicular reception a percentage location coverage figure in the order of 99% is used. This high location value may not be necessary within buildings; a relaxation to about 95% is anticipated to be acceptable. This will reduce the adverse effect of building penetration loss.

As a consequence, the location variation of the field strength is increased for indoor reception. If no correlation between shadow fading and building penetration loss is assumed, the resulting standard deviation of the field strength is given by

$$s_{res} = \sqrt{(s_{\text{shadow fading}})^2 + (s_{building penetration\ loss})^2}$$

which yields for the VHF band

$$s_{res} = \sqrt{5.5^2 + 3^2} = 6.3\, dB$$

and for the 1.5 GHz band

$$s_{res} = \sqrt{5.5^2 + 6^2} = 8.1\, dB.$$

This also changes the location correction figures and the location correction margins for indoor reception. These figures are given in tables 4.4 and 4.5. The value for the recommended location probability for portable indoor reception (95%) is shown in **bold** print.

Reception Mode	Location Probability (%)	Normal Distribu-tion Factor	VHF band		1.5 GHz Band	
			Aggregate Standard Deviation (dB)	Location Correction Figure (dB)	Aggregate Standard Deviation (dB)	Location Correction Figure (dB)
Portable indoor	50	0.00	6.3	0.0	8.1	0.0
	70	0.52		3.3		4.2
	90	1.28		8.0		10.4
	95	**1.64**		**10.3**		**13.3**
	99	2.33		14.6		19.0

Table 4.4: Location correction figures for indoor reception.

Reception Mode	Location Probability (%)	Normal Distribu-tion Factor	VHF band		1.5 GHz band	
			Resultant Standard Deviation (dB)	Location Correction Margin (dB)	Resultant Standard Deviation (dB)	Location Correction Margin (dB)
Portable indoor	50	0.00	8.9	0.0	11.5	0.0
	70	0.52		4.6		6.0
	90	1.28		11.3		14.7
	95	**1.64**		**14.5**		**18.9**
	99	2.33		20.6		26.8

Table 4.5: Location correction margins for indoor reception.

4.5 Man-made noise

Man-made noise appears in two ways in relation to T-DAB: one being man-made noise present outdoor either originating from sources located outdoor or radiated from sources in houses, or else due to electrical equipment used inside buildings.

A further factor, which is not considered in planning, is that strong interferers in a room, such as badly shielded electrical equipment or radiating cables, may increase the field strength required within a building.

In the derivation of the minimum median equivalent field strength for planning in § 5.3 and § 6.2 an allowance for man made noise of 1 dB in the VHF range and 0 dB in the 1.5 GHz range is made.

4.6 Spectrum masks

Outside of the 1.5 MHz wide COFDM spectrum the signal contains natural sidebands, attenuated relatively to the main signal by some 40 - 50 dB. Although a high degree of linearity is employed, commonly used power amplifiers produce intermodulation products which increase the level of the sidebands, in some cases to only 30 dB below the main signal. These sidebands are unwanted, are considered as spurious signals and should be suppressed as far as possible to allow optimum usage of the frequency spectrum. This attenuation (also called shoulder attenuation) is of importance because it allows adjacent T-DAB frequency blocks to be used in adjacent service areas.

The T-DAB signal spectrum is measured in a 4 kHz bandwidth. Inside the 1.5 MHz block the power level therefore reduces by $(10 \times \log_{10}(4 / 1534))$ dB = -25.8 dB relative to the total power of the signal. The (shoulder) attenuation of the sidebands (out-of-band signals) is expressed in dB relative to this value.

The out-of-band radiated signal spectrum in any 4 kHz band shall be constrained by one of the masks defined in Figure 4.1 and Table 4.5. The solid line mask shall apply to VHF transmitters in critical areas for adjacent channel interference. The dotted line mask shall apply to VHF transmitters in other circumstances and to 1.5 GHz transmitters in general cases for suppression of adjacent channel interference.

Note: with increasing frequency difference, the attenuation will further increase. However it is difficult to measure such high values of attenuation. If necessary, special notch filters (e.g. at the distress frequency 243 MHz) may be foreseen.

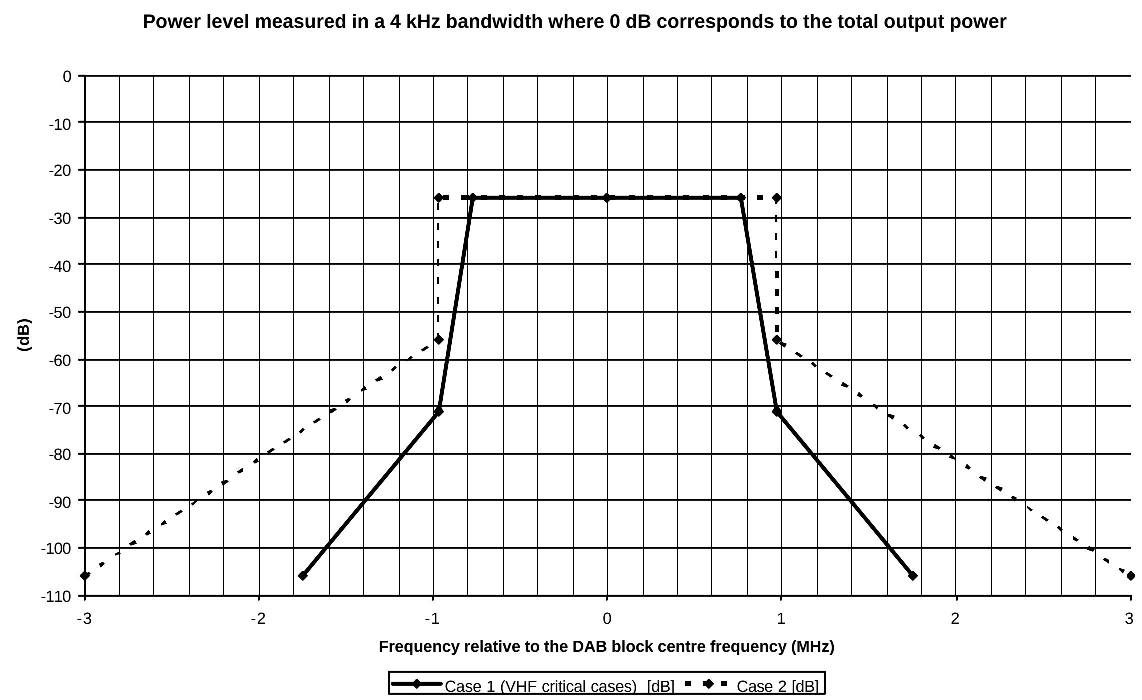


Figure 4.1: Spectrum masks for T-DAB out of band radiation

Frequency relative to the block centre frequency [MHz]	Case 1 (VHF critical cases) relative level [dB]	Case 2 relative level [dB]
-3.0	n.a.	-106
-1.75	-106	n.a.
-0.97	-71	-56
-0.97	n.a.	-25.8
-0.77	-25.8	n.a.
0	-25.8	-25.8
0.77	-25.8	n.a.
0.97	n.a.	-25.8
0.97	-71	-56
1.75	-106	n.a.
3	n.a.	-106

Table 4.6: Break points for spectrum masks in Figure 4.1

4.7 Test Points

An allotment area (coverage area) is described by a set of geographical points (normally up to 36) called **allotment boundary test points** (see § 7 for a description of the data format).

The **allotment boundary test points** are defined by the administration responsible for the area in which the allotment is to be located.

As a part of a requirement for an allotment area the administration also must specify which reference network (see § 4.10) should be used in the planning process to represent the real transmitter network that will be established in this allotment area. There are three reference networks for the VHF range and three for the 1.5 GHz range. In order to ensure efficient use of the spectrum the appropriate reference network should be chosen in accordance with the size of the allotment area, corresponding to a real network to be implemented in the respective allotment.

By means of the allotment boundary test points and the appropriate reference network the locations of the **calculation test points** are calculated (see Annex 2 for details about the calculations). Due to the shape and size of the allotment area the number of calculation test points can amount to more than 100. The locations of the **calculation test points** are calculated by the plan management body when an allotment has been successfully coordinated. This calculation can, in principle, also be done by the requesting administration assuming that suitable software is generally available. The set of **calculation test points** is not a part of the Plan but a tool for subsequent conversion of the allotment into a set of assignments.

The **calculation test points** are located where the transmitters of the reference network produce a given commonly agreed field strength. This field strength must not be exceeded by the subsequent conversion of the allotment into a set of assignments. In special cases it may be an advantage to agree a slightly higher field strength at some calculation test points, but in general this does not solve any compatibility problems between two co-block allotment areas.

4.8 SFN issues

When Single Frequency Networks are being planned some special planning parameters should be taken into consideration. These are:

- Transmitter synchronisation
- Maximum transmitter distance
- Self-interference
- Summation of field strengths
- Network gain

4.8.1 Network synchronisation and timing

In order to make SFN operation possible all transmitters in the network must be synchronised in frequency and time.

4.8.1.1 Time synchronisation

In principle all transmitters in an SFN should radiate the same symbol at the same time.

The programme feed path (transmission lines, satellite, microwave links etc.) will impose different delays to different transmitters because of their different locations relative to the origin of the programme. Furthermore switching in the programme feed paths may change the transmission delay to a given transmitter.

Time stamps are inserted by the multiplexer into the data stream distributed to the transmitters. These stamps make it possible to control the time at which a given symbol is radiated from the transmitters. The data signal is delayed as appropriate in buffers whose length is dynamically controlled by a time reference with a repetition rate of 1 PPS (Pulse per Second). This requires, however, that a time reference is also supplied to the transmitter which can be done by means of a GPS based time reference source.

The total delay from the time when the programme signal is sent from its origin until it is transmitted simultaneously from all transmitters is set to the maximum possible delay in the programme feed paths plus an additional safety margin.

4.8.1.2 Time offset

In an SFN it is an advantage if several transmitters serve the same geographical area and thereby contribute to the network gain. This requires that the signals arrive within a given time-window - in principle equal to the guard interval. In practice the time-window can be taken as 1.2 - 1.3 times the guard interval. If signals arrive too early or too late they cause interference to reception, causing self interference (see § 4.8.3).

Time offset is the (small) adjustment of the time delay of the programme signal at the input to each individual transmitter in an SFN. The purpose of this is to ensure that signals arrive at most receivers within the optimal time window.

4.8.1.3 Frequency coherence

The carrier frequency precision in an SFN should be better than $1x10^{-8}$ at VHF and in the 1.5 GHz range for optimum performance of the network.

This can be achieved in a similar way as precision offset to analogue TV transmitters, i.e. by locking the local oscillators to a reference frequency like a Rubidium standard frequency source. A more convenient way to ensure synchronisation between transmitters is to lock them to a GPS reference frequency source.

4.8.2 Maximum transmitter distance

The distance between adjacent transmitters in an SFN is limited by the length of the guard interval for the T-DAB mode used. This is to ensure that signals from adjacent transmitters arrive at receiving locations within the guard interval. Due to the smooth degradation of reception when signals are received outside of the guard interval (see § 2.6) the maximum distance should not be considered as a hard limitation but be used as a guideline when a transmitter network is designed.

A shorter inter-transmitter distance implies more transmitters to cover a given area and thereby higher network costs. On the other hand the resulting denser network generally provides a more homogeneous field strength distribution over the coverage area.

The maximum transmitter distance can be calculated from the guard interval as follows:

$$D_{max}\ [km] = \nu\ [km/sec] \times t_{guard}\ [\mu sec] / 10^6$$

where ν is the velocity of light (3×10^5 km / sec).

		Mode I	Mode IV	Mode II	Mode III
Max. transmitter distance	D_{max}	73.8 km	36.9 km	18.6 km	9.3 km

Table 4.7: Maximum distances between adjacent transmitters for the four modes

4.8.3 Self-Interference

Other transmitters in the same SFN (or echoes) may cause interference if the delay limits are exceeded (see § 2.6). This depends on the structure of the network (e.g. transmitter separation distances) and network parameters (e.g. guard interval). This effect is termed **self-interference**. For example, a strong signal arriving at a receiving antenna could be rendered useless by a weaker signal from the same SFN if the weaker signal is sufficiently time delayed. In addition, a 'secondary' signal with some delay may provide additive network gain as well as causing self-interference to the 'primary' signal.

Calculation of the self-interference field strength is done in parallel with the calculation of the wanted signals and includes a proper evaluation of inter-symbol interference according to the principles described in § 2.6 and § 2.7.

4.8.4 Summation of field strengths

In the course of planning a network, it is necessary to predict the level of interference field strength, both outgoing from and incoming to the network, i.e. to predict the interference field strength produced by one network in the service area of another.

For international co-ordination, in order to assess compatibility, it is necessary to quantify the sum of the outgoing field strengths from each transmitter in the wanted network into the service area of other networks using the same frequency block.

In order to predict the coverage of a network, it is necessary to estimate the mean value and standard deviation of the wanted field strength and unwanted field strength in a large number of test locations and with these values, calculate the percentage of locations served within the area. The unwanted field strength will be a combination of self-interference from the network itself, and interference from other networks on co and adjacent blocks.

Outgoing interference to non-broadcast services is considered to be outside the scope of this document.

4.8.4.1 Summation of outgoing interference

Coverage areas to be protected in the Allotment Plan are described by means of a series of allotment boundary test points (see § 4.7 and § 7.4) where the incoming interfering field strength must remain at or below a specified threshold. For each relevant frequency Band the threshold value for the equivalent field strength is decided by the planning conference. The value is normally taken as the maximum co-block interfering field strength. For the planning of VHF T-DAB in Europe a value of 27 dBµV/m has been used at the Wiesbaden '95 Planning Meeting. For the 1.5 GHz range, the value of 38 dBµV/m has been used at the Maastricht '02 Planning Meeting. In planning for indoor reception (for 95% location probability) an increased value would need to be used.

A set of calculation test points is derived for each allotment from the allotment boundary test points (see § 4.7 and Annex 2). For each relevant frequency Band the threshold value for the equivalent field strength is decided by the planning conference. The value is normally taken as the maximum co-block interfering field strength increased by an adequate margin to facilitate network implementation. At the Wiesbaden '95 Planning Meeting a value of 33 dBµV/m was used for VHF and at the Maastricht '02 Planning Meeting, the value of 41 dBµV/m was used for the 1.5 GHz range. In planning for indoor reception an increased value would need to be used.

A T-DAB allotment will normally be implemented as a set of transmitting stations operating as a single frequency network. The "total" field strength occuring at each of the calculation test points are calculated in order to ensure that it is below the threshold level agreed for acceptable levels of interference. In T-DAB planning in Europe this "total" field strength calculation is made by means of the summation detailed below.

The individual field strength produced by each transmitter of the real network at each calculation test point of the allotment should be determined using the field strength prediction method specified in the Plan, e.g. Rec. ITU-R P.1546 [4]. The value of the determined individual field strength can be modified, if relevant, by taking account of any receiving antenna discrimination. In general receiving antenna discrimination is not considered for T-DAB.

Only the interference from the T-DAB allotment being converted into assignments is taken into account.

The individual field strengths obtained at each calculation test point from each transmitting station of the T-DAB allotment are added using a variant of the Power Sum Method as described below. The signals are processed in decreasing order.

The power sum is obtained as follows:

– starting from the highest, the power values equivalent to the interfering field strengths are added, one after the other;

– at each summation, the result is compared to the previous one;

– if the increase in power is greater than or equal to 0.5 dB, the summation process continues;

– if the increase in power is less than 0.5 dB, the summation process is stopped and 0.5 dB is added, giving the result of the power sum.

Example:

For a single calculation test point, with a T-DAB allotment converted into a network of 5 assignments, Transmitters 1 to 5, the power summation process would be as detailed below:

Note: The first stage of the summation process is to sort the transmitters in order of decreasing equivalent field strength

The corresponding power factor, power summation and conversion back to the resulting equivalent field strength are calculated according to the formulae below:

Formulae used:

Corresponding Power Factor[1]	$P_f = 10$ ^ $^{(En\ /\ 10)}$
Power Summation	$\sum_p = P_{fn} + P_{fn+1}$
Corresponding Equivalent Field Strength	$E_{ps} = 10 \log (\sum_p)$

[1] This is proportional to power density (linear units), but the constants have been omitted for clarity, since these constants will cancel in the process of the full calculation. See Annex 4 for further information.

Transmitter	Equivalent Field strength E_n (dBµV/m)	Corresponding Power Factor P_f	Progressive Power Sum $\sum_p$	Corresponding Equivalent Field Strength E_{ps} (dBµV/m)	Increase (dB)	Comment	Resulting Equivalent Field Strength (dBµV/m)
Tx 3	13.55	22.65	22.65	13.55		Continue summation	13.55
Tx 4	12.73	18.75	41.40	16.17	2.62	Increase due to this Tx will be more than 0.5 dB, so continue.	16.17
Tx 2	11.88	15.42	56.81	17.54	1.37	Increase due to this Tx will be more than 0.5 dB, so continue.	17.54
Tx 5	11.21	13.21	70.03	18.45	0.91	Increase due to this Tx will be more than 0.5 dB, so continue.	18.95
Tx 1	8.31	6.78	76.80	18.85	0.40	Increase due to this Tx will be less than 0.5 dB, so add 0.5 dB and stop summation.	19.45

Table 4.8: Worked example of the summation for a single calculation test point

4.8.4.2 Assessment of sum field strengths and coverage probabilities

The basic principle when evaluating a service area is to estimate mean value and standard deviation of wanted field strength and unwanted field strength in a large number of test locations in the assumed service area and with these values, to calculate the percentage of locations served.

The calculation of the coverage probability is split into three parts:

- Calculation of the useful sum field strength,
- Calculation of the interfering sum field strength, including self-interference
- Evaluation of the coverage probability.

One of the questions to be answered is how to combine interfering signals when there is more than one and how to take into account the effect of noise. Some of the calculation methods to deal with this question are presented below. They are all statistical methods which require computer processing and they use models of the real situation. In all the methods, except the power sum method which does not make use of statistics at all, it is assumed that field strengths have a log normal distribution with location.

The first method is a numerical approach which is capable of providing the required accuracy but at the expense of a large amount of computer time. The remaining methods are approximations which are presented in order of growing complexity and this increasing complexity corresponds to an increasing computer processing time.

It should be noted that though there may exist some correlation between the individual signals, wanted as well as unwanted signals, none of the methods described below include the treatment of correlation in their original form. However some of them can be extended to include correlation. The effect of correlation varies with the reception situation. It can produce either an increase or a decrease of coverage depending upon the particular correlation situation.

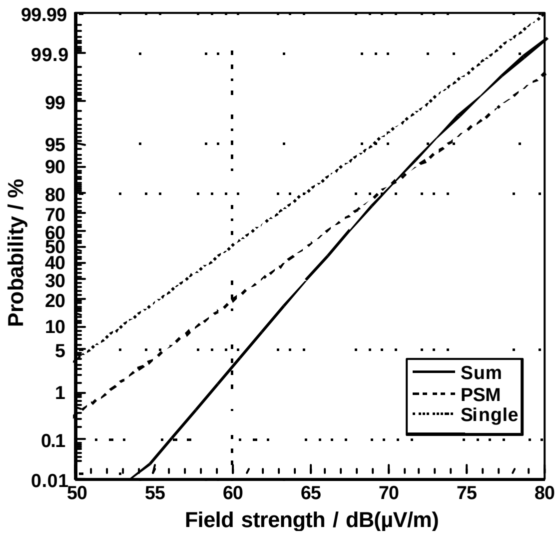
Due to the incomplete knowledge about the propagation path of an RF signal, field strength prediction is afflicted with inaccuracies. The incomplete knowledge can be quantified using location statistics. That is, field strengths are described by means of statistical variables, characterised by probability distributions with mean values and standard deviations. Individual fields show a log-normal distribution for the powers, which corresponds to a Gaussian distribution for the logarithm of the field strengths.

In general, the reception of a digital service occurs in a multi-signal environment. In order to predict of the coverage probability at a given location, the actual C / (N+I) ratio has to be calculated. C and I are derived from the sum of the useful signals and from the sum of the interfering signals, respectively. Being functions of statistical variables, C and I themselves show statistical properties.

With respect to the useful signals the difference between the largest contributing wanted signal and the statistical sum of the powers of all wanted contributors is called the total network gain of the system. Its physical origin is the multi-signal reception situation characterised by location diversity.

As a consequence, proper treatment of field strength statistics automatically yields the pertinent values of C and N+I, including network gain. In particular, no extra effort for the calculation of network gain is necessary. However, the (100%) correlation between the wanted and interfering components of a given delayed wanted signal is not taken into account using this procedure and, depending on the overall configuration, can lead to an over-estimation of the interference potential.

It should be noted that the power sum method yields a good approximation only for a limited range of probability. Figure 4.2 gives an example of this in the case of three equal, non-correlated log-normal fields. The solid line represents the sum distribution (exact result). Its non-constant slope indicates the deviation from log-normal behaviour. For comparison, the dotted line represents the distribution of each one of the equal contributing fields. The third, dashed line, denoted by PSM, represents the result calculated by the power sum method; it is a good approximation between about 70-90% outage, which is generally of little interest for coverage purposes.



F_i = 60 dBµV/m, σ_i = 5.5 dB, i = 1, 2, 3

Figure 4.2: Sum distribution of 3 fields

If the fields represent useful signals, Figure 4.2 gives the outage probability - which is the complement of the coverage probability - with regard to a threshold field strength, e.g. minimum field strength.

The determination of statistically summed field strengths and, further, the evaluation of coverage probabilities, can be performed using numerical methods, numerical integration, Monte Carlo simulation, or by means of approximations. The latter considerably reduces computational effort. Some of the possible approaches are described in the following. More detailed mathematical descriptions are given in Annex 3. For simplicity it is assumed that the fields are not correlated.

The Monte-Carlo method

Apart from a deterministic (numerical integration) method, the Monte-Carlo approach is the most accurate method available to evaluate the coverage probability. Given the mean value and the standard deviation of the distribution of each signal it is possible to simulate the situation for a large number of reception locations in a small area (say, 100m x 100m). This is done by generating one random value of the wanted field and one random value of each interferer. For each combination it is possible to check if the reception location is served or not served by comparing the power of the useful signal with the sum of the powers of the noise and the nuisance fields. By repeating this simulation for a large number of combinations of wanted and unwanted signals, the coverage probability for a given small area may be derived. The larger the number of combinations, the more accurate the method becomes but this can lead to very lengthy computer processing times. In addition, the process must be repeated for a large number of small areas in order to represent the overall coverage area. See Annex 3 for further details.

Power sum method

A description of the power sum method as applied to analogue television is given in EBU doc. Tech 3254 [5]. This method has been used for the assessment of multiple interference at several ITU conferences. The sum of the signal levels is calculated by a non statistical summation of the individual signal powers.

The method gives acceptable results for a 50% locations target but shows a poor behaviour for higher percentages due to its non-statistical character. Detailed formulas are given in Annex 3, Section 2.1.

Simplified multiplication method

The simplified multiplication method is a statistical computation procedure which has also been used for the assessment of multiple interference, for instance at the Regional VHF/FM Broadcasting Conference (Geneva, 1984). See Annex 3, Section 2.2 for more details.

Log-normal method

The log-normal method is an approximation method for the statistical computation of the sum distribution of several log-normally distributed variables. In a coverage calculation it gives the coverage probability of the small area under consideration. See Annex 3, Section 2.3 for more details.

The k-LNM method

To improve the accuracy of the LNM method in the high probability region (that is, a high coverage value) a correction factor can be introduced. This version of the LNM is called k-LNM and is discussed in more detail in Annex 3, Section 2.4.1.

The t-LNM method

The t-LNM method is a numerical approximation method for the statistical computation of the sum distribution of several log-normally distributed variables. Its structure is similar to that of the standard LNM and it is based on the same idea, i.e. that the sum distribution of two log-normal variables is also log-normal. However, the parameters of the sum distribution are calculated in a different way and, as a consequence, are different from those of the standard LNM.

This approach leads to a higher accuracy in the high probability region (that is, a high coverage value) compared to the standard and k-LNM approaches but this must be paid for with higher mathematical complexity. The t-LNM method is able to process different standard deviations of the single fields with few restrictions. The specific case of noise may be regarded as an interference signal with a standard deviation of 0 dB.

A description of the method is given in Annex 3,Section 2.4.2.

A comparison of k- and t-LNM results with Monte Carlo simulation results for the 3-field example of Figure 4.2 is given in Table 4.9.

	Field strength [dB]		Difference [dB] to Monte Carlo	
	for 50%-fractile	For 1%-fractile	For 50%-fractile	for 1%-fractile
Monte Carlo	66.6	58.5	-	-
k-LNM (k=0.5)	67.2	59.9	-0.6	-1.4
k-LNM (k=0.7)	66.8	58.6	-0.2	-0.1
t-LNM	66.7	58.2	-0.1	0.3

Table 4.9: 50%-fractiles and 1%-fractiles of Monte Carlo simulation and approximate approaches for the 3-field example ($\overline{F_i}$ = 60dBµV/m, s_i=5.5dB, i=1,2,3)

Schwartz and Yeh method

The Schwartz and Yeh method is an iterative method for calculation of the characteristics of the resultant of N interferers. It make the assumption that the combination of two log normal variables also has a log normal distribution (this is a common approximation) and it gives the formulas to calculate the resultant of two variables. For more than two signals an iterative process is applied. Its general approach is very similar to that of t-LNM and the accuracy of both methods is comparably high; for this reason, no further details are given here.

4.8.4.3 Evaluation of coverage probability

After one of the above summation approaches has been applied to both the useful and the interfering fields the coverage probability CP can be calculated by the method given in Annex 3, Section 3.

4.8.5 Network Gain

In a single frequency network (SFN) two or more transmitters provide coverage to the same area using a single frequency. With a properly designed network an advantage loosely termed **network gain** can result. In this case the transmitters cannot operate independently and require a high degree of synchronicity:

- The emitted signals from different transmitters must be identical in content;
- Signal emissions must take place at the same time (or with precisely controlled delays);
- The RF carriers must comply with stringent frequency precision requirements.

4.8.5.1 Propagation prediction and its statistical background

Terrestrial broadcasting signals are ‘propagated’ through the atmosphere between the transmitter and the receiver. The characteristics of the propagation channel gives rise to a statistical time variation and a statistical location variation of the transmitted field. The time variation of a wanted field is in general very small compared to its location variation and it is therefore usually ignored in coverage considerations. These statistical variations are incorporated in well known propagation models such as ITU-R Recs. 370 and 1546.

When discussing the statistics of received field strength, the variation of the wanted signal is determined over an area where the signal has an average value and a log-normal type of variation around this median value, with a known standard deviation. The value of standard deviation used when planning (outdoor) digital broadcasting services is 5.5 dB, and the areas over which this value has validity must have a suitable size. In other words, the area cannot be ‘too large’ or ‘too small’. A suitably sized area will be termed an ‘*Area*’. As an illustrative counterexample, measurements of the field strength over an area stretching from the transmitter site outward to a concentric circle 100 km away will certainly have a standard deviation more than 5.5 dB. This would not be an *Area*. Likewise, if the area consists of one point, the location standard variation will be less than 5.5 dB. This would also not be an *Area*.

It must be remembered that field strength values provided by statistical propagation models do not give information about specific points, only about *Areas*. For example, a field strength level, X, may be achieved (or exceeded) at 50% of the locations at a given distance from a transmitter with a given effective antenna height and erp; another (lower) field strength level, Y, may be achieved (or exceeded) at, for example, 99% of those same locations for the same transmitting conditions. The difference, X-Y, is proportional to the standard deviation, and represents the (±) spread within which most field strength values will lie when measured at the points within the *Area*. No information is given as to which individual locations/points within the *Area* receive a field strength equal to a specified field strength level, or which individual locations/points receive a field strength that exceeds the specified field strength level.

If the transmitter power is now increased by a fixed amount (3 dB say), then the received field strength will be increased at each location/point by the same amount (3 dB) and the field strength at more locations/points than before will equal or exceed the specified field strength level (X or Y). But there is still no knowledge of those specific locations/points where this happens. Nevertheless it makes sense to say that the field strength has been raised by 3 dB at all of the locations/points under consideration or, equivalently, that the specified field strength level (X, or Y, respectively in the example) is reached or exceeded at a higher percentage of locations/points (higher than 50%, or 99%, respectively).

When discussing network gain it is necessary to consider an *Area* where two (or more) signals are present and the necessary conditions (i.e., well-defined median value with appropriate standard deviation and a log-normal distribution) apply for both (or all) wanted signals individually. In different *Areas*, the specifics of these conditions may well differ, and this will give rise to differing values of the network gain. Just as the median value of field strength varies throughout the *Areas* of a coverage area, the network gain will also vary throughout the *Areas* of an SFN.

Sometimes the term ‘network gain’ is used to define a single number which is applicable to the entire SFN (or reference network) and this can lead to confusion[2]. To avoid this confusion the term ‘Effective network gain’ will be introduced below to refer to network gain in such large ‘non-*Areas*’.

4.8.5.2 Definitions related to Network Gain

In order to clarify further the concept of network gain, the following set of definitions will be given. In each case the network gain involved is a function of the location probability concerned: in gen-

[2] For example, in more familiar terms, we never talk about the average field strength over the entire coverage area, but rather about the average field strength at the edge of the coverage area.

eral the network gain for a given *Area* will increase as the location probability for which it is determined increases. This will be seen in numerical detail in Table 4.10. Although not usually explicitly stated in the following, the dependence of network gain on location probability must always be kept in mind.

- The **total network gain** (**T**) refers to the total increase of received power, for a specific location probability in the reception *Area* as compared to the power received from one (the strongest) transmitter serving that *Area* for the same location probability. Actually care must be taken in using this definition. It must be recalled that, throughout the *Area*, the field strength due to the (strongest) transmitter itself varies. What is really meant is that over an extended, though small, *Area* the received power will be increased by **at least** the 'total network gain' at the specified location probability throughout the specified small *Area*.

  Several computer methods have been developed to calculate total network gain[3].

The total network gain is sometimes considered to be composed of two contributions: a statistical part and an additive part.

- The **statistical network gain** (**S**) arises due to the purely statistical nature of the individual signals without taking into account their (potential) combination within the receiver. In determining the statistical network gain the location variation of the field strength is the dominant contributing factor: the time variation of the field strength is generally not taken into account because the time standard deviation is relatively small at the short distances involved in providing coverage[4].

  Statistical network gain can be understood in at least two equivalent ways:

  a) Area coverage: To overcome the statistical location variation in field strength, that is in order to ensure that with a single transmitter the minimum equivalent field strength value is achieved at a high percentage of a given area, it is necessary to transmit with more power. If, on the other hand, two (or more) transmitters can be used to cover the same area the percentage of coverage will also be increased without the need to increase the power. For example, if one signal covers an (overlapping) area with 60% probability and a second signal covers, independently, the same area with 55% probability, that area will be covered at $\{1 – (1 – .6) \times (1 – .55)\} = .82$, that is 82% combined probability.

  The statistical network gain, in terms of coverage probability, would be: 82 – 60 = 22%. A third signal covering the same area with 45% probability would increase the combined probability to 90.1%, and this increase of coverage probability is achieved with no increase of power (of the individual transmitters).

  In situations where, in a given *Area*, one transmitter delivers the minimum field strength for a significantly higher percentage of locations than the other transmitters in the network (for example, sufficiently near any given transmitter) the statistical network gain will tend to zero.

  b) Mobile reception: In mobile reception the field strength from a single transmitter shows statistical variations due to the continual variation of obstacles on the propagation path. This field strength variation can be reduced by the presence of several transmitters (or echoes), located in different directions, since when one source is shadowed, others may be more easily receivable.

  Knowing the type of distribution (log normal) and the value of the standard deviation, it is relatively easy to calculate the amount of statistical network gain to be expected (see Annex 5 for examples).

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[3] Examples are the LNM, k-LNM, t-LNM approximations, the Monte Carlo method, etc.

[4] A complete calculation of statistical gain would also take the time variation statistics into account.

- The **<u>additive</u> network gain** (**A**) is manifested as an effective increase in signal strength (or power) in an *Area* due to the incidence of two or more signals at the receiver antenna (i.e., the 'additive point gain') at each point in the *Area*. It is due to the ability of the receiver to add the signal powers delivered by the wanted signals (or echoes) arriving from the transmitters in the SFN and would arise even if there were no statistical variations in the propagation channel[5]. For example, two (three, four,…) signals with the same field strength level and no relative delay arriving at a receiving antenna (located at a point) from two (three, four,…) different transmitters in the SFN would result in a 3 dB (4.8 dB, 6 dB,…) increase of useful signal strength at that point ('additive point gain'). However, because it is not possible (or practical) to determine field strength levels at individual points, it is necessary to define additive network gain over an *Area*, as was done above in the definitions for the total network gain and for the statistical network gain.

  But, taking into account the statistical variation of the fields, the levels of two or more fields are very rarely the same at any given point in a reception *Area*, even if the median values of the signals are the same in that *Area*. Thus it is <u>not</u> correct to say that the additive network gain is 3 dB (4.8 dB, 6 dB,…)[6] if the two (three, four,…) median values of the contributing signals are equal. The 'additive point gain' at a particular location/point will depend on the relative field strengths received at the location/point which in turn are related to, but not explicitly determined by, the means and the location[7] variations of the contributing signals. And the final distribution of the 'additive point gains' throughout the *Area* will define the additive network gain.

  Because the additive network gain is connected to the 'interaction' of signals at a point as well as the variation statistics of the signals at the points over an *Area*, it is not a simple matter to calculate it directly. The additive network gain can, however, be calculated indirectly by subtracting the statistical network gain from the total network gain: **A = T – S**.

- The **<u>effective</u> network gain** (**E**) is defined as follows for an SFN. An SFN coverage area consists of many *Areas*, each *Area* of which, A_i say, benefits from its own individual total network gain, T_i. Recall that this means that throughout each *Area* A_i the received power will be effectively increased by its individual total network gain T_i. In principle, it would be possible to reduce the powers of all the transmitters in the SFN by this amount and still maintain the same location probability in the *Area* as would be attained by the strongest received transmitter operating by itself (at its original power). As a result of network gain, the transmitters in an SFN can be operated at lower powers compared to those in an MFN. Moreover the field strength distribution in the coverage area of the SFN will be more homogeneous. The temptation is to reduce the powers in an SFN by the maximum of the T_i for all the *Areas* in the SFN[8]. But this could lead to a reduction which is too large for certain *Areas* (see § 4.8.5.3 below). The effective network gain is that amount by which each transmitter power in an SFN may be reduced and still provide the required coverage probability throughout the SFN and, as just indicated, this may be less than the maximum T_i. Great care is needed to determine a suitable value for effective network gain.

[5] In a very simple case, two <u>constant</u> (i.e., non-varying) signals of the same level, if added, would result in a 3 dB increase of useful signal strength.
[6] Although it is a crude approximation.
[7] And also, in principle, the time variations.
[8] We are assuming that, in the design of the SFN, the minimum possible transmitter powers are used, while still ensuring that the minimum reference field strength is met or exceeded in all Areas of the SFN.

4.8.5.3 Examples of Network Gain

Table 4.10 below gives the relevant values calculated for various numbers of contributing sources (2, 3 or 4) and for various percentages of location coverage (0.1 to 99.9). It is assumed in each case that all sources are equal contributors (leading to the greatest resulting network gains), uncorrelated, with a log-normal distribution, a 5.5 dB standard deviation. The sum distributions for 2, 3, and 4 equal contributors is given pictorially in the Figures 4.3, 4.4 and 4.5[9] for the entire range of location percentages 0.1 to 99.9, indicating total, statistical, and additive network gain components. Figure 4.6 shows a comparison between the total sum distributions for two, three, and four equal contributors. It can be seen that:

- the additive network gain is <u>not</u> constant[10] and is in fact an increasing function of the percentage location probability of interest;
- the amount of total network gain that can be achieved depends in the same way on the location percentage coverage that is being planned for;
- the overall standard deviation of the composite received signal is less than that of a single signal; hence the extra power margin needed to achieve, for example, a 95% or 99% location coverage can be reduced relative to the single transmitter case.

# Tx	NETWORK GAIN (dB)														
	99.9%			99%			95%			90%			70%		
	Stat	Add	Tot	Stat	Add	Tot	Stat	Add	Tot	Stat	Add	Tot	Stat	Add	Tot
2	6.7	2.0	8.7	5.8	1.8	7.6	4.9	1.7	6.6	4.4	1.7	6.1	3.5	1.5	5.0
3	9.9	3.2	13.1	8.5	3.0	11.5	7.2	2.8	10.0	6.6	2.6	9.2	5.3	2.3	7.6
4	12.2	3.7	15.9	10.3	3.7	14.0	8.7	3.5	12.2	7.9	3.3	11.2	6.4	3.0	9.4

Table 4.10a: Network Gain

# Tx	NETWORK GAIN (dB)														
	50%			30%			10%			1%			0.1%		
	Stat	Add	Tot	Stat	Add	Tot	Stat	Add	Tot	Stat	Add	Tot	Stat	Add	Tot
2	3.0	1.3	4.3	2.5	1.1	3.6	1.9	0.8	2.7	1.3	0.4	1.7	1.2	0.2	1.4
3	4.5	2.1	6.6	3.8	1.8	5.6	3.0	1.3	4.3	2.1	0.7	2.8	1.9	0.3	2.2
4	5.5	2.6	8.1	4.6	2.3	6.9	3.6	1.7	5.3	2.6	0.8	3.4	2.2	0.4	2.6

Table 4.10b: Network Gain

In the more general case signal levels will differ at a specific location. Figure 4.7 shows how the total network gain varies as the relative levels of two contributing signals vary from 0 to 6 dB.

[9] The calculations were carried out using Monte Carlo simulation.
[10] In particular, the values are not generally 3.0, 4.8, 6.0 dB for 2, 3, 4 equal contributors.

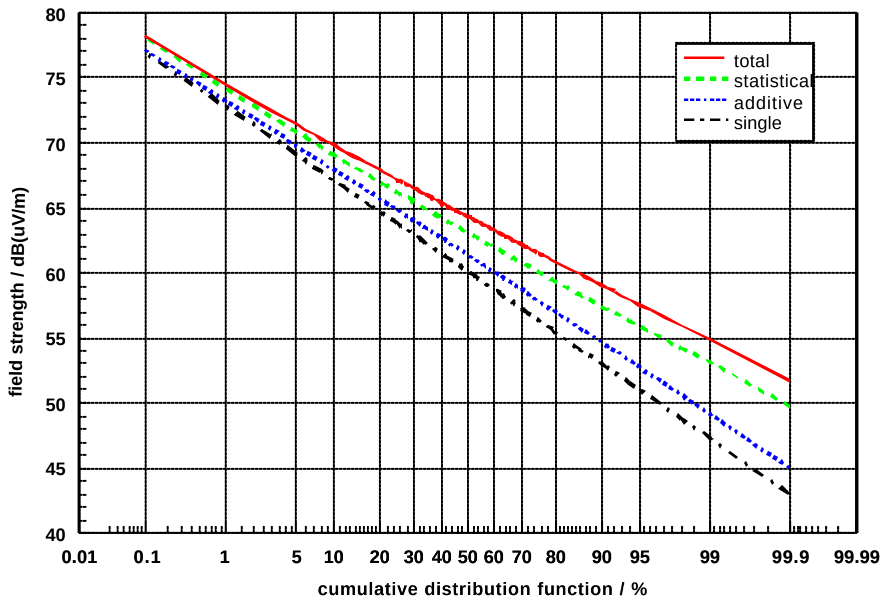


Figure 4.3: Sum distributions for 2 equal contributing signals

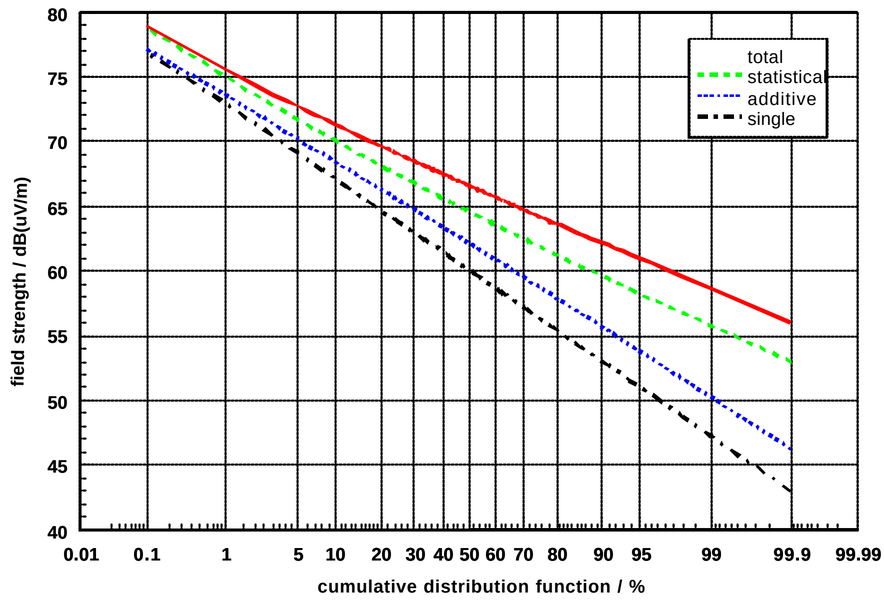


Figure 4.4: Sum distributions for 3 equal contributing signals

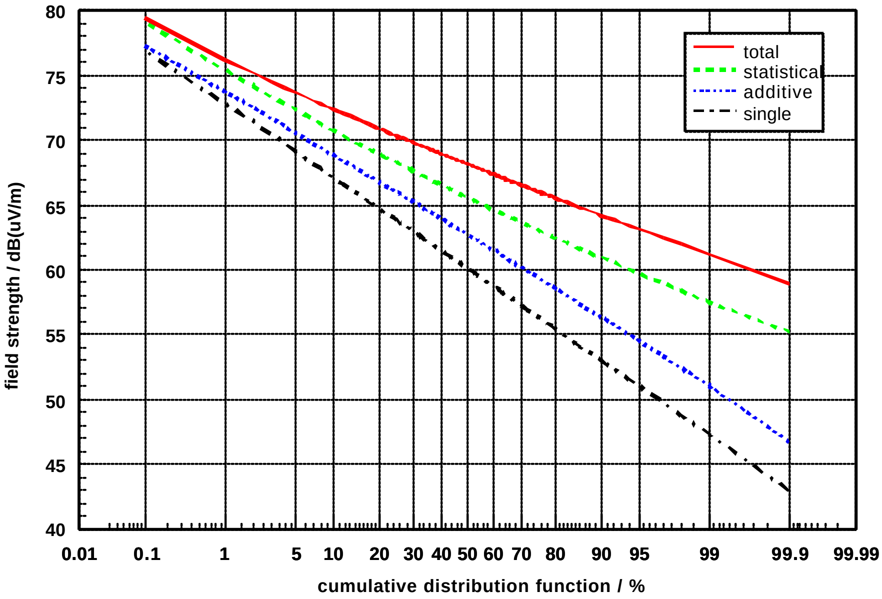


Figure 4.5: Sum distributions for 4 equal contributing signals

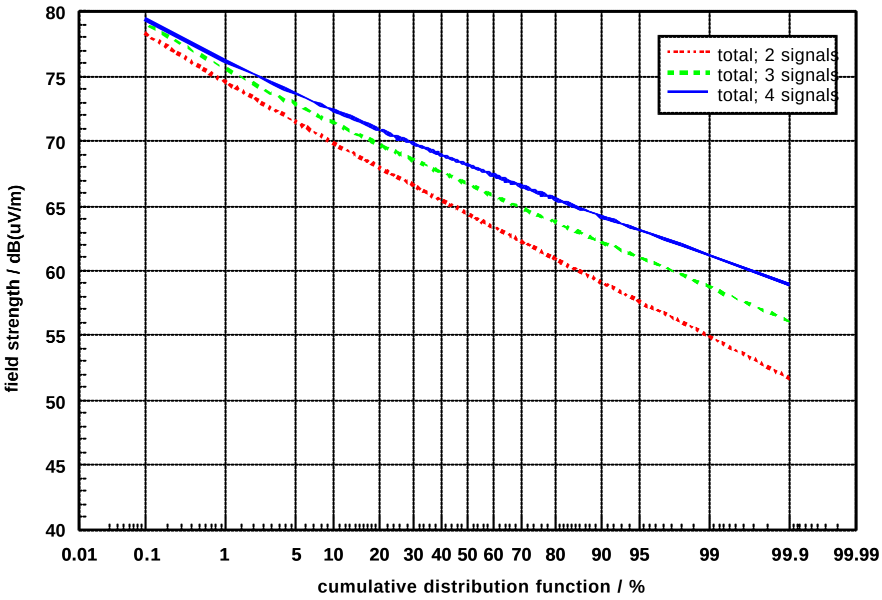


Figure 4.6: Comparison between the total sum distributions for 2, 3 and 4 equal contributing signals

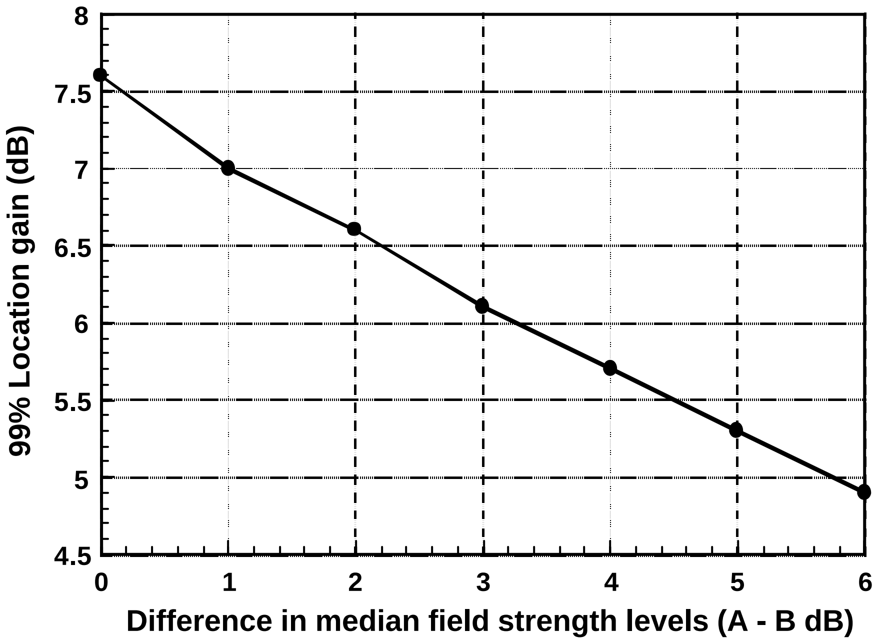


Figure 4.7: Theoretical total SFN Network Gain for two contributing sources A and B (Standard deviation σ = 5.5 dB)

4.8.5.4 Total network gain and the design of an SFN

It is sometimes stated that the total network gain is the amount by which the power in an SFN can be reduced and still attain a given percentage of location coverage. This is true in certain (symmetric) cases but not necessarily true in cases where the contributors are not 'the same'.

In Figures 4.8 and 4.9, the two lowest curves sloping downward to the left and right, respectively, represent the individual field strength levels attained along a line separating two transmitters. In Figure 4.8, the two transmitters both have an effective antenna height equal to 37.5 m and are separated by 40 km. In Figure 4.9, the two transmitters have an effective antenna height equal to 37.5 m (at the left) and 1200 m (at the right), respectively, and are separated by 140 km. In both cases, Figure 4.8 and 4.9, the field strengths from the two transmitters are equal (giving the largest total network gain) at a distance 20 km from the transmitter on the left.

An example of a 'symmetric' case of network gain is shown in Figure 4.8. If the power is reduced by the total network gain the reference field strength level will still be reached elsewhere.

An example of an asymmetric case of network gain is given in Figure 4.9. It can be seen[11] that the reference field strength level will not be achieved everywhere if the power is reduced by the maximum total power gain.

Thus it can be concluded that care must be taken with the simple 'recipe' which would allow the transmitters in a SFN to have their powers reduced by the maximum total network gain with the intent to maintain the desired minimum field strength achieved everywhere.

[11] See the horizontal line.

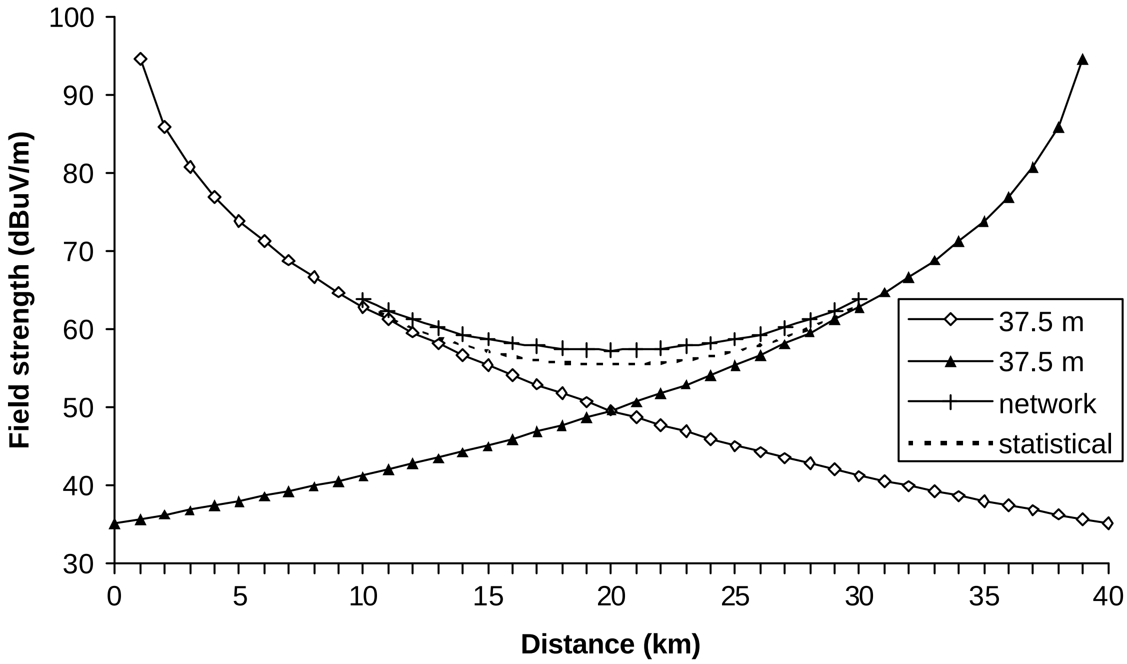


Figure 4.8: Symmetric situation

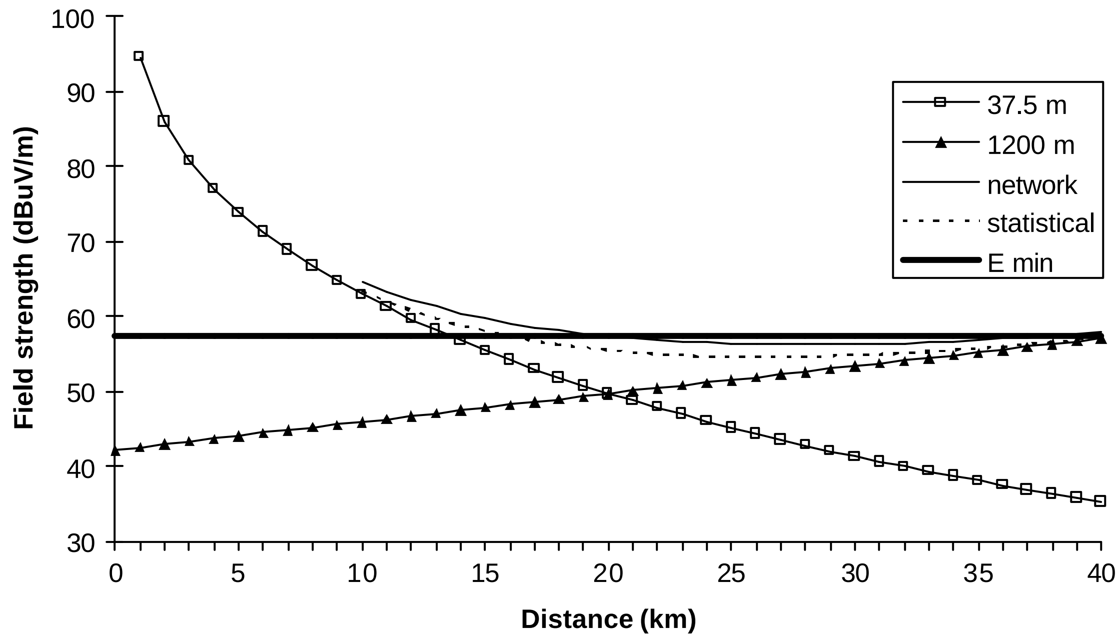


Figure 4.9: Asymmetric situation

4.8.5.5 Influence of the network gain on the minimum median equivalent field strength

In § 5.3 and § 6.2 the minimum median equivalent field strength to be used for planning is derived for the case of a single transmitter (MFN). For the case of SFN coverage the following must be observed.

Because of its higher complexity, a multiple signal configuration no longer allows the identification of a single, unique value of a field strength that must be exceeded in order to achieve proper reception (such as the “minimum median equivalent field strength for planning” in the single transmitter case). Since usually a large variety of signal configurations is encountered throughout the coverage area of an SFN a correspondingly large number of different minimum requirements for proper reception are found across the SFN area. The concept of the “minimum median equivalent field strength for planning” can therefore no longer be applied in a precise sense to SFN planning.

The alternative concept for SFN planning is based on the “minimum equivalent field strength at receiving place” and the envisaged location coverage probability as minimum requirements. The statistical treatment of a given signal configuration and a comparison with the new minimum requirements then provides the answer whether proper reception is possible at the location under consideration. For the case of a single transmitter this approach is identical with the “minimum median equivalent field strength for planning” concept. The appropriate statistical methods to deal with the alternative concept are described in detail in Annex 3.

4.9 MFN issues

In special cases where the area to be covered is very small, say only a few km in diameter, it may not be economically feasible to establish several transmitters forming a single frequency network. In such cases coverage by a single transmitter may be considered.

If several contiguous small areas, each having their own frequency allotted, are all served by single transmitters, they can be said to form a Multi-Frequency Network (MFN).

In an MFN where all transmitters radiate individual multiplexes there is no network gain.

In an MFN with overlapping coverages for a given programme, many receiving locations may be covered by more than one transmitter, thus introducing a certain level of redundancy in the signal sources and improving the service availability. In other words, in a situation of fixed reception the (statistical) probability of receiving at least one of the covering transmitters will increase. In a mobile-reception situation, for example, FM sound broadcasting with RDS provides the possibility of increased coverage for a given programme by ‘frequency switching’ in areas where the field strength from one source becomes insufficient while that from another source, using a different frequency, has increased. Of course there is no **additive** network gain in this type of situation (MFN): the advantage here arises solely from the **statistical** network gain.

For coverage of larger areas there is no advantage in the use of MFNs, in particular because of the increased spectrum needed compared to an SFN. This assumes, of course, that the area is not too large for an SFN. Furthermore the level of outgoing interference from a single transmitter (MFN) is a direct function of the power needed to provide the intended coverage of a given area. In a properly designed SFN the same area can be covered while producing less outgoing interference.

4.10 Reference networks

4.10.1 General

The primary objective of allotment planning is to provide administrations the right to provide service within the allotment area using specified frequencies or channels and the right to cause interference within the agreed limits. An advantage of allotment planning is that there is need for detailed knowledge of the assignments which would be used in practice. It is assumed that an allotment will be implemented as a set of transmitting stations operating as a single frequency network at a later stage after planning is finished. The latter is referred to below as a ‘real network’.

Planning is normally done for a specific system (such as T-DAB or DVB-T) for which the required minimum field strengths and protection ratios are known. The only additional parameters needed at the beginning in allotment planning are a definition of the area to be covered and a list of channels that could be used. An allotment plan, i.e. a correspondence between each allotment area and a specific channel (or channels), can be developed on the basis of permissible signal levels radiated towards the outside of the allotment area, i.e. on the basis of interference potential. In this way, with an adequate number of available channels and ‘good’ planning, it is possible to establish a ‘compatible’ plan, i.e. one that is ‘interference free’, at the same time being spectrum efficient.

A convenient method for doing this is to define a ‘Reference Transmitter’ (for MFN planning) or a ‘Reference Network’ (for SFN planning). Reference Networks are discussed below but the concept and usage of Reference Transmitters is analogous.

4.10.2 Reference networks

A **Reference Network** is a basic tool used in allotment planning to assess the outgoing interference from a given allotment while achieving full coverage of the allotment area. It is a theoretical construct which usually consists of a set of reference transmitters geometrically arranged in a regular polygon, for example a square or a hexagon, etc. The dimensions of the reference polygon can be large (e.g. 100 km side length or more) or small (e.g. 20 km side length or less) or anywhere in between.

At the vertices (and also perhaps at the centre) of the reference polygon, reference transmitter characteristics are specified which will ensure adequate coverage over the entire Reference Network area: that is, the minimum field strength will be achieved (or exceeded) everywhere within the Reference Network using the characteristics of the reference transmitters. These characteristics include effective antenna height, erp, antenna pattern, and perhaps other parameters. (See Tables 4.11 and 4.12)

Once the coverage within the Reference Network is ensured, the outgoing interference produced by the Reference Network can be calculated (See § 4.8.4.1). This is usually done on a power sum basis using the individual field strength contributions from the reference transmitters situated at the vertices (and centre) of the Reference Network. A point called the **reference point** is defined (on the boundary of the Reference Network) from which outgoing interference from the Reference Network is calculated (See Figures 4.11, 4.12, 4.13, 4.14 and 4.15).

A convenient measure of the Reference Network size is called the **coverage radius** which is, roughly, half the distance between a pair of vertices (of the reference polygon) with the largest separation (1.5 GHz Reference Network 1 used at Maastricht 2002 is an “open” network and the definition of the coverage radius is somewhat different).

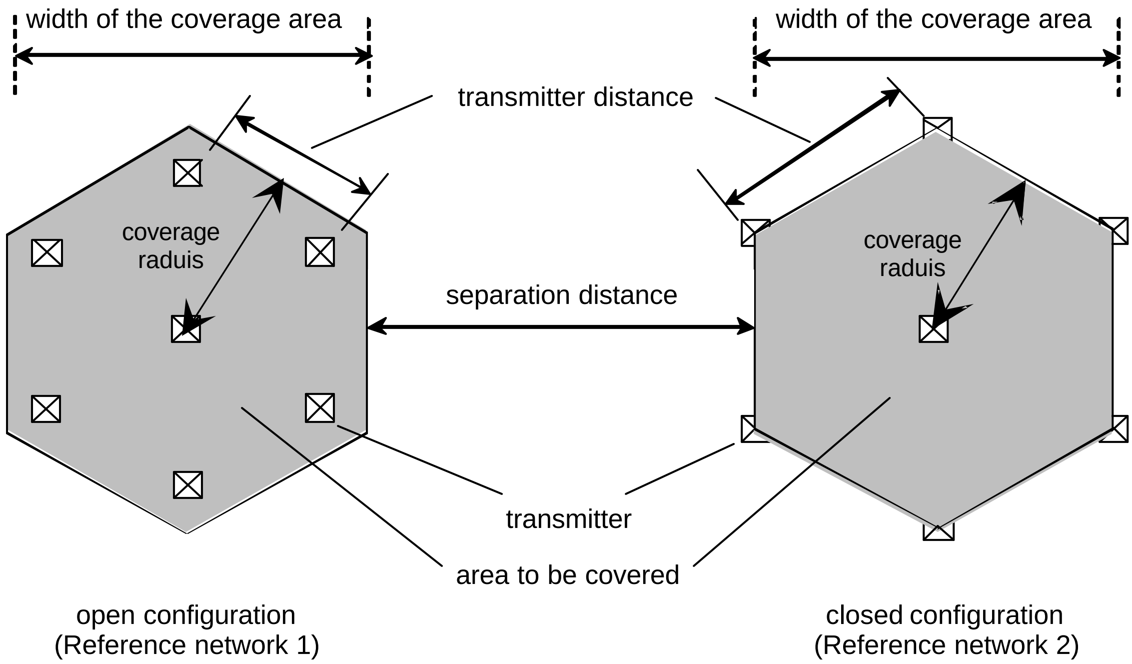
In order to optimise the Reference Network, combinations of relevant parameters are chosen which minimise the ratio of co-block separation distance to coverage radius as much as possible, while at the same time ensuring that other network design requirements are met.

One or more different reference networks can be used simultaneously in the allotment planning, while only one Reference Network is specified for each allotment. The size of the Reference Network chosen will depend to a large extent on the type of service desired.

It is often convenient to develop Reference Network interference curves based on the total combined interference issuing from the Reference Network itself. These derived curves, though based upon, will not be the same as the propagation curves defining the agreed propagation model (e.g. Rec. ITU-R P.1546 [4]). There will be, however, a superficial resemblance between the two. Graphs and Tables showing the interference potential of the reference networks dealt with in this document can be found in Annex 6.

The VHF Reference Network used at Wiesbaden 1995 is shown in Figure 4.11. For the VHF range two new Reference Networks have been developed for cases where the radius of the allotment area is significantly smaller than 52 km, these are shown in Figures 4.12 and 4.13. Technical data for the three Reference Networks are given in Table 4.11.

The three Reference Networks for 1.5 GHz, as used for T-DAB planning at Maastricht 2002 are shown below in figures 4.14, 4.15 and 4.13. Technical data for these Reference Networks are given in Table 4.12.



Note: For this example two different 7 transmitter networks have been used. Other network configurations are possible.

Figure 4.10: Example of T-DAB network structures and distances – co-block case

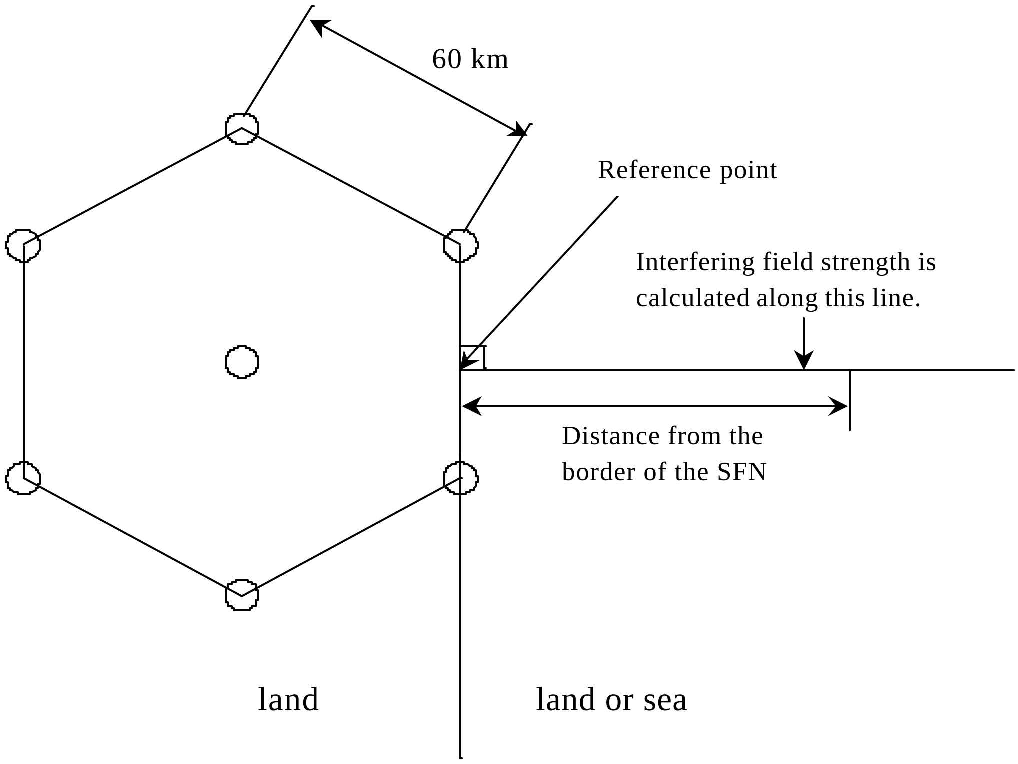


Figure 4.11: Layout diagram of VHF Reference Network 1, closed network

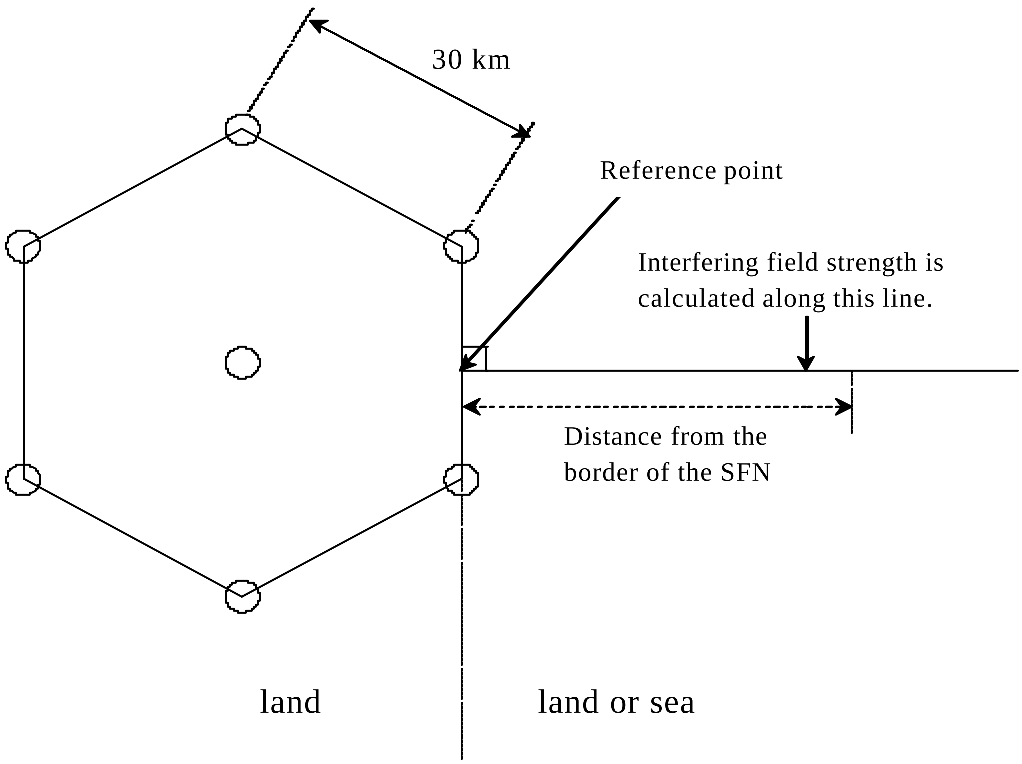


Figure 4.12: Layout diagram of VHF Reference Network 2, closed network

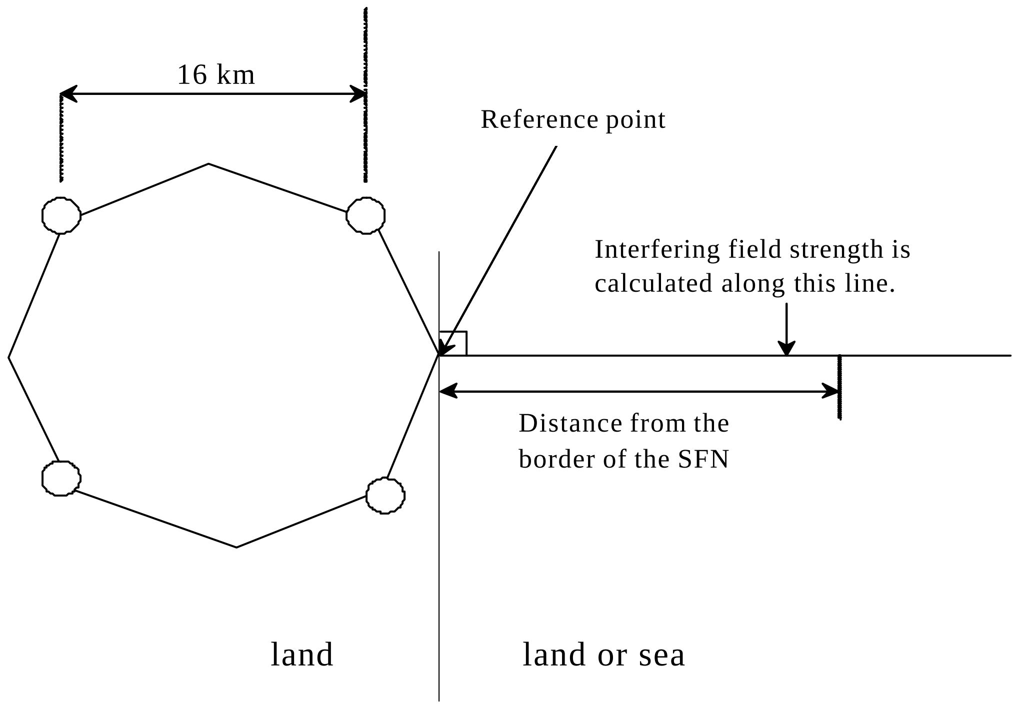


Figure 4.13: Layout diagram of VHF and 1.5 GHz Reference Network 3, closed network

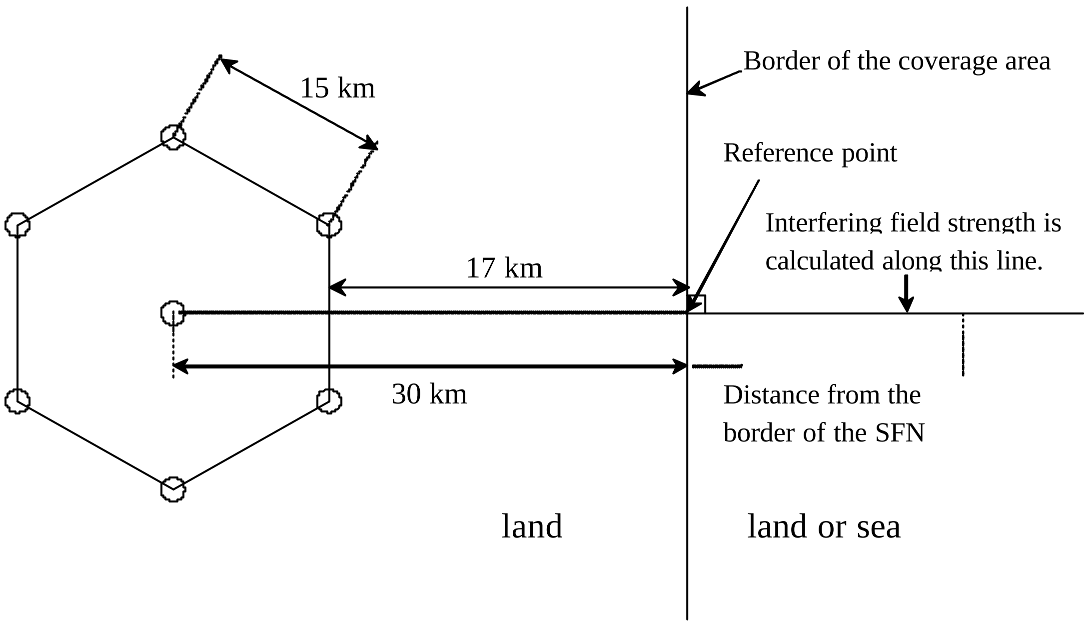


Figure 4.14: Layout diagram of 1.5 GHz Reference Network 1, open network

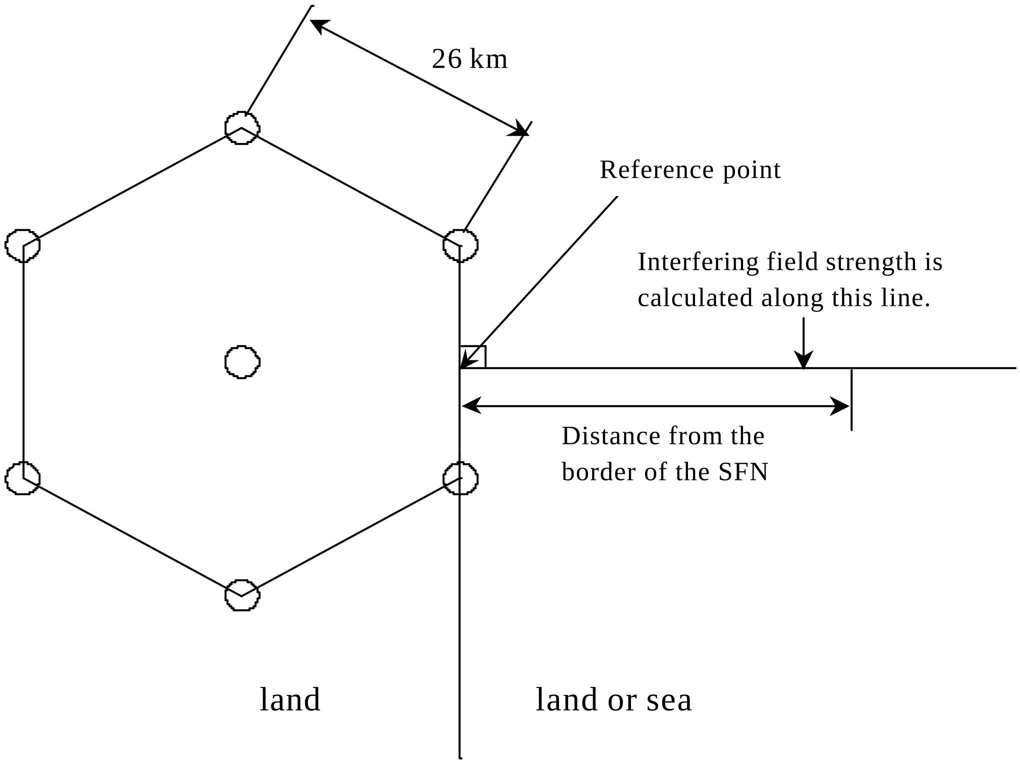


Figure 4.15: Layout diagram of 1.5 GHz Reference Network 2, closed network

As can be seen from the results of the derivations of minimum median field strengths in § 5.3 and § 6.2 higher field strength values are needed when planning is done explicitly for portable indoor reception.

This requirement can be covered by increasing the radiated powers of the transmitters in the reference networks correspondingly or by careful design of the real network to be established in the allotment area.

Reference network number:	**VHF RN 1**	**VHF RN 2**	**VHF RN 3**
Number of transmitters:	7	7	4
Type of network:	Closed	Closed	Closed
Network geometry:	hexagonal	hexagonal	square (octagonal)
Effective antenna height			
Peripheral transmitters:	150 m	50 m	50 m
Central transmitter:	150 m	150 m	n.a.
Transmitter distance:	60 km	30 km	16 km
Radiated power			
Peripheral transmitters:	1 kW / 30 dBW	316 W / 25 dBW	56 W / 12.5 dBW
Central transmitter:	0.1 kW / 20 dBW	80 W / 19 dBW	n.a.
Antenna directivity			
Peripheral transmitters:	-12 dB (over 240°)	-12 dB (over 240°)	-12 dB (over 225°)
Central transmitter:	non-directional	non-directional	n.a.
Coverage radius:	52 km	26 km	12.5 km

Table 4.11: Main characteristics for the Reference Networks applicable to planning in the VHF range.

Reference network number:	**1.5 GHz RN 1**	**1.5 GHz RN 2**	**1.5 GHz RN 3**
Number of transmitters:	7	7	4
Type of network:	Open	Closed	Closed
Network geometry:	hexagonal	hexagonal	square(octagonal)
Effective antenna height			
Peripheral transmitters:	150 m	50 m	50 m
Central transmitter:	150 m	150 m	n.a.
Transmitter distance:	15 km	26 km	16 km
Radiated power			
Peripheral transmitters:	1 kW / 30 dBW	5 kW / 37 dBW	1 kW / 30 dBW
Central transmitter:	0.5 kW / 27 dBW	1.25 kW / 31 dBW	n.a.
Antenna directivity			
Peripheral transmitters:	non-directional	-12 dB (over 240°)	-12 dB (over 225°)
Central transmitter:	non-directional	non-directional	-
Coverage radius:	30 km	22.5 km	12.5 km

Table 4.12: Main characteristics for 3 Reference Networks used for planning in the 1.5 GHz range

4.10.3 Purpose and use

Warning: *It must be emphasized that the purpose of a Reference Network is to ease and facilitate allotment planning in the initial stages and to serve as a loose guidance for implementation of assignments within the allotment area at a later stage.*

In general, an allotment which has been implemented, i.e. one in which assignments have been introduced, will not necessarily resemble the theoretical Reference Network upon which the allotment was based.

Briefly: a Reference Network is a tool for developing appropriate values for allotment separation distances and for estimating how much interference a typical SFN might produce at a given distance.

For simplicity, an allotment area can be defined as a polygon by using a series of geographical boundary test points. As the name implies, the boundary test points should lie on the boundary of the intended coverage area and be situated sufficiently close to one another (usually around 20-50 km separation) so that the resulting polygon is a good approximation to the intended coverage area.

It is good practice to use a Reference Network of a similar size or smaller than the allotment area. To calculate outgoing interference when determining compatibility between allotments (or between the allotment and an Other Service), the reference point of the Reference Network is placed at each allotment boundary test point (and also at points midway between consecutive allotment boundary test points) of the wanted allotment area and the appropriate interference field strength calculations are performed (or the derived interference curves are used). The resulting interference level is calculated at each of the boundary test points of the other allotments (or Other Services) which may be affected. In some sense, this leads to a separation/re-use distance required between co-channel allotments. This separation/re-use distance is a function of the geography separating the two allotments (for example, all-land paths vs. all-sea paths vs. mixed-land-sea paths).

In complex planning scenarios (e.g. Maastricht 2002) several Reference Networks may be used in order to cater to a multiplicity of service needs. This can give rise to asymmetries in the required separation distances with respect to the type of Reference Networks interacting.

In order to provide flexibility for the development of services, it is necessary to provide an overall limit for the interference which could be created by a set of **assignments** introduced when implementing/converting an allotment. In order to do this, **calculation test points** surrounding each allotment area are introduced (See § 4.7). Calculation test points are defined with the help of the Reference Network: they are located outside the allotment area at a distance (generally) at which the interference from a Reference Network achieves a specified reference value. Then, if no other conditions prevail, an allotment can be converted into assignments without restrictions provided the cumulative interfering field strength of the real network (i.e. using the agreed field strength prediction model, e.g. Rec. ITU-R P.1546 [4]) does not exceed the specified reference value at the calculation test points.

4.11 Conversion of an allotment into a set of assignments

When a transmitter network is being designed to cover an allotment area the allotment is converted into a set of assignments. A step by step procedure is given below.

The starting point is the defined allotment area, described by its allotment boundary test points and the calculation test points.

a. Identify relevant possible transmitter sites. In order to provide the best achievable indoor reception in urban areas it is recommended to consider transmitter sites located near such areas as part of the entire network.

b. Define initial values for antenna height, antenna pattern and erp for each station.

c. Calculate the coverage of the allotment area, taking into account all interfering signals from other co-block T-DAB networks and, at VHF, also from television transmitters. If specific data are not available for a co-block T-DAB allotment area, then it should be represented by the reference network defined for the area.

d. Calculate the field strengths at the calculation test points and check whether the threshold value is exceeded (See § 4.8.4.1).

e. Make appropriate changes to the initial network plan and repeat steps c and d until satisfactory coverage is achieved and the threshold value at the calculation test points is not exceeded.

f. There are cases where both criteria can not be met at reasonable costs. In such cases the network should be optimised to exceed the threshold value at the calculation test points as little as possible while still providing acceptable coverage.

g. It is advisable to design the full network, also in cases where only parts of it are intended to be implemented (i.e. in the near future).

h. The procedure for conversion of an allotment into a set of assignments given in the relevant Agreement shall be applied. Article 6 of the WI95/02 and of the MA02 states that:

   - If the network does not exceed the threshold values at any calculation test point co-ordination is not required.

   - If the threshold value is exceeded at one or more calculation test points then co-ordination must be undertaken with the administration(s) responsible for the area(s) where the calculation test point(s) is located. The procedure for co-ordination is given in the relevant Plan. The co-ordination may result in agreements with the administrations involved allowing a higher field strength at some calculation test points.

5. VHF Network Planning

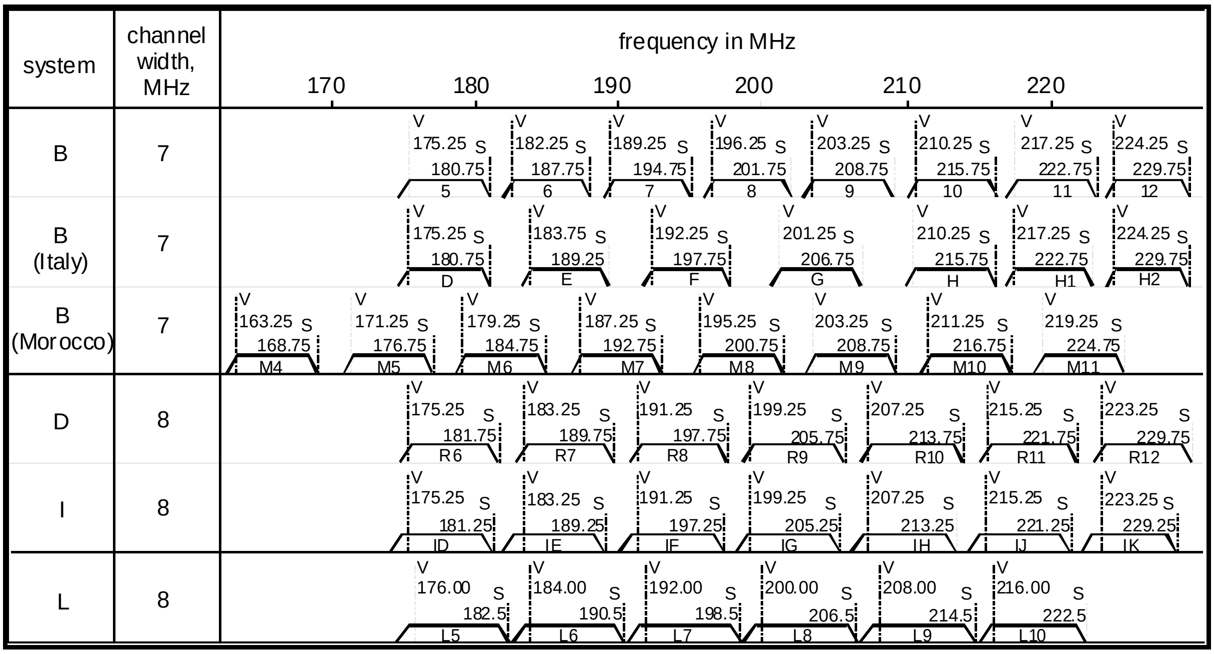
The information contained in this section is generally in line with the technical bases used at Wiesbaden '95. This plan was primarily made for mobile reception, however, in order to facilitate indoor reception additional aspects have to be considered, resulting in modified planning parameters.

This section details planning elements relevant to network planning in VHF Band III for mobile and portable outdoor as well as indoor reception.

5.1 Co-existence with television

In most countries Band III is used for TV services employing various systems with different channel width and therefore differing vision and sound carrier frequencies; see Figure 5.1. T-DAB uses a block bandwidth of 1.534 MHz. The block centre frequencies have been chosen so that within each 7 MHz television channel of system B, four T-DAB frequency blocks can be accommodated, including guard bands.

The presence of 7 different channel rasters in Europe leads to overlaps between T-DAB blocks and television channels where the television service does not use System B.



Note 1: System B1 uses the same channel numbers and vision carrier frequencies as System D but the video bandwidth and the sound carrier frequency is 1 MHz lower than for System D.
Note 2: System I1 uses a 0.75 MHz wide lower sideband.

Figure 5.1: Channel allocations in Band III in Europe

5.2 Position of the T-DAB frequency blocks

Table 5.1 shows the harmonised T-DAB channelling scheme for Band III. This is based on tuning increments of 16 kHz and, typically, guard bands of 176 kHz between adjacent T-DAB frequency blocks within a given TV channel.

To enhance compatibility with the TV sound, the guard bands for DAB frequency blocks A (Channel N) and D (Channel N-1) are either 320 kHz or 336 kHz. The position of T-DAB frequency blocks within Channel 12 is shown in Figure 5.2. The Figure is representative for all television channels from 5 to 12 except for the small variations in the width of the guard bands between channels.

The Band 230 - 240 MHz is called "Channel 13" and has been divided into 6 T-DAB blocks as shown in Figure 5.3. The guard band between blocks 13C and 13D is only 32 kHz which makes it very difficult to use these two blocks in adjacent service areas.

T-DAB block number	Centre frequency (MHz)	Frequency range (MHz)
5A	174.928	174.160 - 175.696
5B	176.640	175.872 - 177.408
5C	178.352	177.584 - 179.120
5D	180.064	179.296 - 180.832
6A	181.936	181.168 - 182.704
6B	183.648	182.880 - 184.416
6C	185.360	184.592 - 186.128
6D	187.072	186.304 - 187.840
7A	188.928	188.160 - 189.696
7B	190.640	189.872 - 191.408
7C	192.352	191.584 - 193.120
7D	194.064	193.296 - 194.832
8A	195.936	195.168 - 196.704
8B	197.648	196.880 - 198.416
8C	199.360	198.592 - 200.128
8D	201.072	200.304 - 201.840
9A	202.928	202.160 - 203.696
9B	204.640	203.872 - 205.408
9C	206.352	205.584 - 207.120
9D	208.064	207.296 - 208.832
10A	209.936	209.168 - 210.704
10B	211.648	210.880 - 212.416
10C	213.360	212.592 - 214.128
10D	215.072	214.304 - 215.840
11A	216.928	216.160 - 217.696
11B	218.640	217.872 - 219.408
11C	220.352	219.584 - 221.120
11D	222.064	221.296 - 222.832
12A	223.936	223.168 - 224.704
12B	225.648	224.880 - 226.416
12C	227.360	226.592 - 228.128
12D	229.072	228.304 - 229.840
13A	230.784	230.016 - 231.552
13B	232.496	231.728 - 233.264
13C	234.208	233.440 - 234.976
13D	235.776	235.008 - 236.544
13E	237.488	236.720 - 238.256
13F	239.200	238.432 - 239.968

Table 5.1: VHF Band III T-DAB frequency blocks

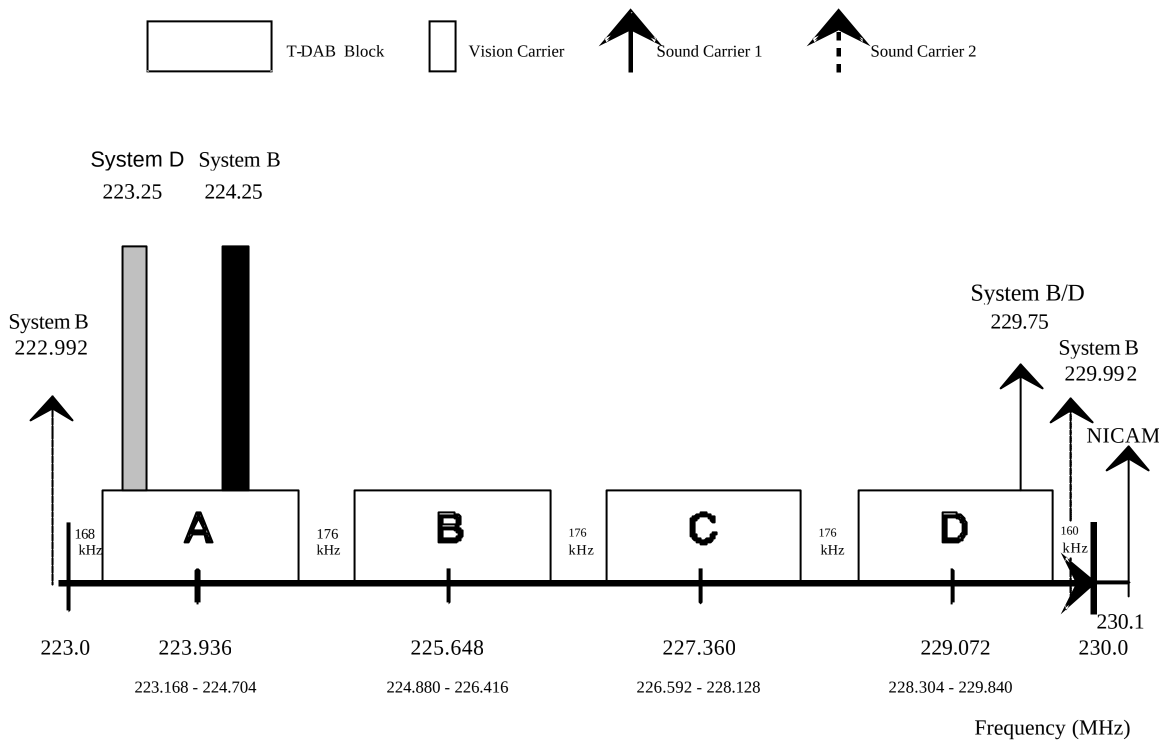


Figure 5.2: Position of T-DAB-blocks in Channel 12.

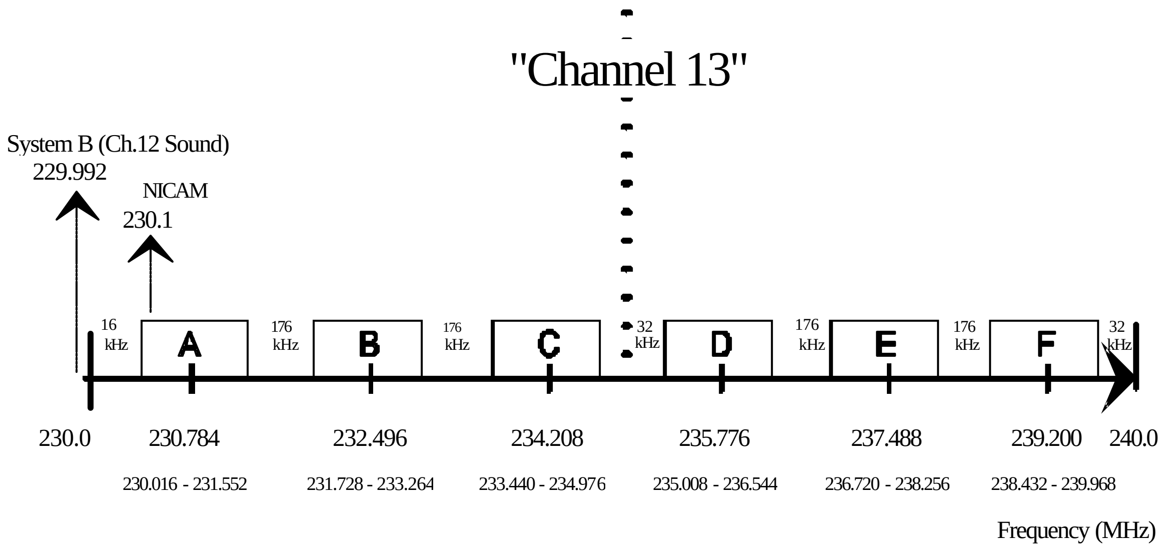


Figure 5.3: Position of T-DAB-blocks in “Channel 13”

5.3 Minimum median equivalent field strength

In § 2.5 the minimum signal levels to overcome receiver noise are given as the minimum receiver input power and the corresponding minimum equivalent receiver input voltage, assuming a receiver noise figure of 7.0 dB for VHF.

In § 2.5, no account is taken of any propagation effects. However, it is necessary to take account of these effects when considering T-DAB reception in a practical environment.

The C/N ratio for the Gauss channel, used in § 2.5 to calculate the minimum receiver input level is 7.4 dB. Under mobile reception conditions this value increases, depending on the multipath conditions and the speed at which the receiver is moving. A C/N value of 13 dB is considered to be representative for mobile reception. When calculating the minimum median equivalent field strength to be used for planning a corresponding correction (13 - 7.4 = 5.6) must be made to the C/N ratio.

The receiving antenna, which is believed to be representative for mobile and portable reception, is omni-directional, having a gain slightly lower than a dipole and an antenna height of 1.5 m. For the purpose of the calculations leading to the results presented in Table 5.2 the gain of an isotropic antenna has been used.

For the height loss from 10 m to 1.5 m a value of 13 dB is assumed to represent realistic situations.

All minimum median equivalent field strength values presented in this chapter are for coverage by a single transmitter only, not for single transmitter networks. In SFNs usually more than one wanted signal is available. This situation changes the signal statistics. The sum signal shows a smaller variance than the individual signals have, and this results in a smaller location correction factor. Since this effect depends on the number and the strength of the signals, the amount by which the minimum median equivalent field strength is lowered varies from location to location. It is approximately given by the amount of the total network gain (See § 4.8.5). For SFN planning, the values given in tables 5.2 and 5.3 can be regarded as an upper limit for the minimum median equivalent field strength for planning.

Due to the very rapid transition from near perfect to no reception at all, it is necessary that the minimum required signal level is achieved at a high percentage of locations. This percentage is normally taken to be 99% for mobile and portable outdoor reception, leading to a location correction figure of 12.8 dB as described in § 4.2.2.

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

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

$\phi_{min} = P_{s\,min\,corr} - A_a$ (in Tables 5.2 and 5.3)

$E_{min} = \phi_{min} + P_{mmn} + 120 + 10 \log_{10} (120\pi) = \phi_{min} + 145.8$

$\phi_{med} = \phi_{min} + P_{mmn} + C_l + L_h$ (in Table 5.2)

$\phi_{med} = \phi_{min} + P_{mmn} + C_l + L_h + L_b$ (in Table 5.3)

$\phi_{med} = \phi_{min} + P_{mmn} + C_l + L_f$ (in Table 5.7)

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

where:

C_l : Location correction factor [dB]

E_{med} : Minimum median equivalent field strength, planning value [dBμV/m]
E_{min} : Equivalent minimum field strength at receiving place [dBμV/m]
G_D : Antenna gain relative to half wave dipole
L_b : Building penetration loss [dB]
L_h : Height loss (10 m. a.g.l. to 1.5 m. a.g.l.) [dB]
L_f : Feeder penetration loss [dB]
P_{mmn} : Allowance for man made noise [dB]
ϕ_{min} : Minimum power flux density at receiving place [dBW/m^2]
ϕ_{med} : Minimum median power flux density, planning value [dBW/m^2]
λ : Wavelength [m]

Minimum median equivalent field strength for planning Mobile and portable outdoor reception		
Frequency (Band III)	f [MHz]	200
Minimum receiver signal input power (from Table 2.3)	$P_{s\,min}$ [dBW]	-127.7
C/N correction for mobile reception condition	[dB]	5.6
Minimum receiver signal input power with C/N correction	$P_{s\,min\,corr}$ [dBW]	-122.1
Antenna gain relative to half wave dipole	G_D [dB]	-2.2
Effective antenna aperture	A_a [dBm^2]	-7.5
Minimum power flux density at receiving place	Φ_{min} [dBW/m^2]	-114.6
Allowance for man made noise	P_{mmn} [dB]	1
Minimum equivalent field strength at receiving place	E_{min} [dBμV/m]	31
Height loss (10 metres to 1.5 metres)	Lh [dB]	13
Location correction for 99% location probability	Cl [dB]	12.8
Minimum median power flux density required at 10m a.g.l. for 50% of the time and 50% of locations to achieve coverage at 99% of locations at 1.5 m a.g.l.	Φ_{med} [dBW/m^2]	-87.8
Minimum median equivalent field strength required at 10m a.g.l. for 50% of the time and 50% of locations to achieve coverage at 99% of locations at 1.5 m a.g.l.	E_{med} [dBμV/m]	**58**

Table 5.2: Derivation of minimum block power flux density and the corresponding minimum median equivalent field strength for mobile and portable outdoor reception.

For the case of indoor reception, the effect of building penetration loss also has to be taken account of as described in § 4.3 and § 4.4. On the other hand, a slightly lower location probability of 95% is usually acceptable. The C/N correction can be assumed to be same as in case of mobile reception.

Minimum median equivalent field strength for planning Portable indoor reception		
Frequency (Band III)	f [MHz]	200
Minimum receiver signal input power (from Table 2.3)	$P_{s\,min}$ [dBW]	-127.7
C/N correction for portable indoor reception condition	[dB]	5.6
Minimum receiver signal input power with C/N correction	$P_{s\,min\,corr}$ [dBW]	-122.1
Antenna gain relative to half wave dipole	G_D [dB]	-2.2
Effective antenna aperture	A_a [dBm^2]	-7.5
Minimum power flux density at receiving place	Φ_{min} [dBW/m^2]	-114.6
Allowance for man made noise	P_{mmn} [dB]	1
Minimum equivalent field strength at receiving place	E_{min} [dBµV/m]	31
Height loss (10 metres to 1.5 metres)	Lh [dB]	13
Building penetration loss	Lb [dB]	8
Location correction for 95% location probability	Cl [dB]	10.3
Minimum median power flux density required at 10m a.g.l. outdoor for 50% of the time and at 50% of locations to achieve coverage at 95% of indoor locations at 1.5 m a.g.l.	Φ_{med} [dBW/m^2]	-82.3
Minimum median equivalent field strength at 10m a.g.l. outdoor for 50% of the time and at 50% of locations to achieve coverage at 95% of indoor locations at 1.5 m a.g.l.	E_{med} [dBµV/m]	**63**

Table 5.3: Derivation of minimum block power flux density and the corresponding minimum median equivalent field strength for portable indoor reception.

5.4 Protection ratios

5.4.1 Protection ratios for analogue television interfered with by T-DAB

T-DAB is sharing with analogue television in Band III and will continue to do so until the end of the transition period. Sharing between T-DAB and television is therefore very important. Systems B1, B-Italy, D, I and L use overlapping channels relative to system B on which the T-DAB frequency block raster is based. Detailed information is given in Annex 7.

5.4.2 Protection ratios for DVB-T interfered with by T-DAB

T-DAB is in operation in Europe in Band III and DVB-T will also be planned to operate in this Band. Due to the different channel rasters in use for television (7 MHz and 8 MHz) and the different bandwidths of the two digital broadcasting services several interference scenarios are possible.

The simplest case is where a DVB-T channel is interfered with by a single T-DAB signal providing an overlap between 0 and the full bandwidth of the T-DAB signal.

The worst (and most complex) case is where a DVB-T channel is interfered with by several T-DAB signals using contiguous frequency blocks, all inside the DVB-T channel.

Protection ratios for DVB-T interfered with by T-DAB are given in Annex 8.

5.4.3 Protection ratios for VHF/FM sound broadcasting in Band II interfered with by T-DAB

Figure 9 and Table 9, Annex 7 show the required protection ratios for continuous and tropospheric interference for VHF/FM stereo and monophonic services interfered with by T-DAB.

The quality criteria used for continuous interference was an audio frequency signal-to-interference ratio of 50 dB measured as described in Rec. ITU-R BS.641 [6]. The protection ratios for tropospheric interference are obtained by subtraction of 8 dB from the corresponding values for continuous interference.

5.4.4 Protection ratios for T-DAB interfered with by analogue television

Figures 1 and 2, Annex 9 show the protection ratios required for T-DAB interfered with by I/PAL and B/PAL, respectively. Since the wanted signal is a digital signal only one set of protection ratios is given which is applicable to both continuous and tropospheric interference.

Figures 3 and 4, Annex 9 show the corresponding protection ratios for D/SECAM or D/PAL and L/SECAM interference to T-DAB, respectively.

5.4.5 Protection ratios for T-DAB interfered with by DVB-T

Annex 10 contains protection ratios for T-DAB interfered with by an overlapping DVB-T signal.

5.4.6 Protection ratios for T-DAB interfered with by wide-band VHF/FM sound broadcasting

Figure 5, Annex 9 shows the required protection ratios for T-DAB interfered with by wide-band VHF/FM. These are shown for the no noise case, i.e. where signal levels are such that the effects of noise can be ignored.

5.4.7 Protection ratios for T-DAB interfered with by CW

The required protection ratio for T-DAB interfered with by a CW signal coincident in frequency with one of the DAB carriers is -6 dB. If the CW carrier is between two COFDM carriers, the degradation in C/N may be higher and the required protection ratio would also be increased (exact values are not available).

5.4.8 Protection ratios for T-DAB interfered with by T-DAB

For the minimum field strengths derived in § 5.3, a C/N ratio of 13 dB is used in order to cover practically all reception situations in terms of the wanted signal level. For protection against interference from other T-DAB services and from self-interference, both of which are less frequently a problem in T-DAB coverage than insufficient wanted field strength, a C/N value of 12 dB, representing an average reception situation can be assumed. The protection ratio for co-block interference is therefore taken also to be 12 dB.

The protection ratio for adjacent block interference is -30 dB.

5.5 Polarisation

When interference into a T-DAB allotment is considered no account is taken of polarisation discrimination.

When the protection of an analogue broadcasting service requiring fixed antenna reception is considered, the relevant antenna polarisation discrimination is used. For Band III a value of 16 dB is used (See Rec. ITU-R BT.419 [7]).

Most main stations of the analogue television service use horizontal polarisation. In order to take advantage of receiving antenna polarisation discrimination T-DAB is planned for transmission with vertical polarisation.

5.6 Maximum co-block interference field strength

	Mobile and portable outdoor reception (99% of locations)	Indoor reception (95% of locations)
Minimum median equivalent field strength at 10 m	58 dBµV/m	63 dBµV/m
Co-block protection ratio	12 dB	12 dB
Location correction margin (see § 4.2.2.4)	18 dB	14 dB
Maximum permissible interfering equivalent field strength at 10 m	28 dBµV/m	37 dBµV/m

Table 5.4: Maximum permissible interfering equivalent field strength at 10 m for co-block interference

Note: In case of an SFN this value can be increased by 3 dB, since it is assumed that an SFN provides a more rugged coverage than a single transmitter, for which the above calculation has been made.

Furthermore the wanted field strength at the periphery of the areas covered by the reference networks is higher than the minimum and thus a further increase of the interfering field strength can be accepted from digital co-block broadcasting services.

These increases are taken into account in the separation distances given in § 5.8.

5.7 Maximum adjacent block interference field strength

	Mobile and portable outdoor reception (99% of locations)	Indoor reception (95% of locations)
Minimum median equivalent field strength at 10 m	58 dBµV/m	63 dBµV/m
Adjacent protection ratio	-30 dB	-30 dB
Location correction margin (see § 4.2.2.4)	18 dB	14 dB
Maximum permissible interfering equivalent field strength at 10 m	70 dBµV/m	79 dBµV/m

Table 5.5: Maximum permissible interfering equivalent field strength at 10 m for adjacent block interference

Note: Due to the negative protection ratio between adjacent block transmissions this interference will only occur when an adjacent block transmitter is located within, or at the periphery of, a service using the adjacent block. Therefore, this type of interference can be minimised by co-siting, or near-siting, the transmitters for each block, even if there is significant difference between the radiated powers or aerial systems used for each service.

5.8 Separation distance between co-block allotments

The separation distance between co-block allotments is determined from the interference potential tables for 1% of the time given in Annex 6 for the relevant reference networks.

In cases where two different reference networks are used for the two allotment areas for which the separation distance is considered, there will be two separation distances of which the larger shall be used.

The separation distances are given in Table 5.6 below:

VHF Reference Networks		**Reference network 1 receiving interference**	**Reference network 2 receiving interference**	**Reference network 3 receiving interference**
Maximum permissible co-block interfering field strength at the edge of the coverage area (dBµV/m)		32 dBµV/m	34 dBµV/m	36 dBµV/m
Reference network 1 as interferer	Land	76 km	66 km	54 km
	Cold sea	143 km	122 km	104 km
	Warm sea	175 km	151 km	127 km
Reference network 2 as interferer	Land	56 km	46 km	36 km
	Cold sea	115 km	94 km	76 km
	Warm sea	135 km	110 km	87 km
Reference network 3 as interferer	Land	29 km	22 km	18 km
	Cold sea	66 km	50 km	37 km
	Warm sea	73 km	55 km	41 km

Table 5.6: Co-block separation distances for the VHF range

The separation distances for VHF reference network 1 can be reduced if the reference network is modified to provide sufficient field strength for portable indoor reception everywhere inside the coverage area by increasing the radiated powers by 5 dB (see § 5.3) because the maximum allowable co-block interfering field strength is increased by 9 dB (see § 5.6). However, if a smaller separation distance is used then the protection for portable outdoor and mobile reception is not protected because of the increased interference level.

VHF reference networks 2 and 3 already provide sufficient field strength for portable indoor reception inside the coverage area.

5.9 Fixed antenna reception

T-DAB networks are designed for mobile and portable reception, including indoor. However, if a fixed rooftop antenna is used, reception can be achieved beyond the normal coverage area. In practice, an antenna located at an elevated position, such as a loft or on an external wall is also likely to be beneficial.

In Table 5.7 below, the minimum median equivalent field strength for fixed antenna reception at rooftop level is derived for information. For fixed antenna reception, a location probability of 95% and the C/N for a Ricean channel (see Table 2.2) have been used.

Minimum median equivalent field strength for planning Fixed antenna reception		
Frequency	f [MHz]	200
Minimum receiver signal input power (from Table 2.3)	$P_{s\,min}$ [dBW]	-127.7
C/N correction for fixed antenna reception condition	[dB]	1.4
Minimum receiver signal input power with C/N correction	$P_{s\,min\,corr}$ [dBW]	-126.3
Antenna gain relative to half wave dipole	G_D [dB]	0
Effective antenna aperture	A_a [dBm^2]	-5.3
Minimum power flux density at receiving place	Φ_{min} [dBW/m^2]	-121.0
Allowance for man made noise	P_{mmn} [dB]	1
Minimum equivalent field strength at receiving place	E_{min} [dBµV/m]	25
Feeder loss	Lf [dB]	2
Location correction for 95% location probability	Cl [dB]	9.0
Minimum median power flux density required at 10m a.g.l. for 50% of the time and 50% of locations to achieve coverage at 95% of locations	Φ_{med} [dBW/m^2]	-109.0
Minimum median equivalent field strength required at 10m a.g.l. for 50% of the time and 50% of locations to achieve coverage at 95% of locations	E_{med} [dBµV/m]	**37**

Table 5.7: Derivation of minimum block power flux density and the corresponding minimum median equivalent field strength for fixed antenna reception.

6. 1.5 GHz Network Planning

The Maastricht plan defines the constraints for the implementation of 1.5 GHz networks across the CEPT area. This plan has been designed for portable outdoor and mobile reception, and as a result a network designed on this basis may not satisfy all the requirements for indoor portable reception. This could be provided by implementing a denser network.

The following section details planning elements relevant to network planning in the 1.5 GHz range.

6.1 Position of the frequency blocks

Table 6.1 shows the adopted harmonized channelling plan. This is based on tuning increments of 16 kHz and guard bands of 176 kHz between adjacent T-DAB frequency blocks.

T-DAB block number	Centre frequency (MHz)	Frequency range (MHz)
LA[1]	1452.960	1452.192 - 1453.728
LB	1454.672	1453.904 - 1455.440
LC	1456.384	1455.616 - 1457.152
LD	1458.096	1457.328 - 1458.864
LE	1459.808	1459.040 - 1460.576
LF	1461.520	1460.752 - 1462.288
LG	1463.232	1462.464 - 1464.000
LH	1464.944	1464.176 - 1465.712
LI	1466.656	1465.888 - 1467.424
LJ	1468.368	1467.600 - 1469.136
LK	1470.080	1469.312 - 1470.848
LL	1471.792	1471.024 - 1472.560
LM	1473.504	1472.736 - 1474.272
LN	1475.216	1474.448 - 1475.984
LO	1476.928	1476.160 - 1477.696
LP[2]	1478.640	1477.872 - 1479.408

Table 6.1: T-DAB frequency blocks

6.2 Minimum median equivalent field strength

In § 2.5 the minimum signal levels to overcome receiver noise are given as the minimum receiver input power and the corresponding minimum equivalent receiver input voltage, assuming a receiver noise figure of 6.0 dB for the 1.5 GHz range.

In § 2.5, no account is taken of any propagation effects. However, it is necessary to take account of these effects when considering T-DAB reception in a practical environment.

The C/N ratio for the Gauss channel, used in § 2.5 to calculate the minimum receiver input level is 7.4 dB. Under mobile reception conditions this value increases, depending on the multipath conditions and the speed at which the receiver is moving. A C/N value of 13 dB is considered to be rep-

[1] the lower guard band for block LA is 192 kHz.
[2] guard band between the blocks LP and LQ is 176 kHz, block LQ is reserved in Europe for S-DAB use.

resentative for mobile reception. When calculating the minimum median equivalent field strength to be used for planning a corresponding correction (13 - 7.4 = 5.6) must be made to the C/N ratio.

The receiving antenna, which is believed to be representative for mobile and portable reception, is omni-directional, having a gain equal to that of a $\lambda/2$ dipole and an antenna height of 1.5 m.

For the height loss from 10 m to 1.5 m a value of 13 dB is assumed to represent realistic situations.

All minimum median equivalent field strength values presented in this chapter are suited for coverage by a single transmitter only, not for single transmitter networks. In SFNs usually more than one wanted signal is available. This fact changes the signal statistics. The sum signal shows a smaller variance than the individual signals have, and this results in a smaller location correction figure. Since this effect depends on the number and the strength of the signals, the amount by which the minimum median equivalent field strength is lowered varies from location to location. It is approximately given by the amount of the total network gain which is described in more detail in § 4.8.5. For SFN planning, the values given in Tables 6.2 and 6.3 can be regarded as an upper limit for the minimum median equivalent field strength for planning.

Due to the very rapid transition from near perfect to no reception at all, it is necessary that the minimum required signal level is achieved at a high percentage of locations. This percentage is normally taken to be 99% for mobile and portable outdoor reception, leading to a location correction figure of 12.8 dB as described in § 4.2.2.

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

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

$\phi_{min} = P_{s\ min\ corr} - A_a$ (in Tables 6.2 and 6.3)

$E_{min} = \phi_{min} + P_{mmn} + 120 + 10 \log_{10} (120\pi) = \phi_{min} + 145.8$

$\phi_{med} = \phi_{min} + P_{mmn} + C_l + L_h$ (in Table 6.2)

$\phi_{med} = \phi_{min} + P_{mmn} + C_l + L_h + L_b$ (in Table 6.3)

$\phi_{med} = \phi_{min} + P_{mmn} + C_l + L_f$ (in Table 6.7)

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

where:

C_l : Location correction factor [dB]
E_{med} : Minimum median equivalent field strength, planning value [dBµV/m]
E_{min} : Equivalent minimum field strength at receiving place [dBµV/m]
G_D : Antenna gain relative to half wave dipole
L_b : Building penetration loss [dB]
L_h : Height loss (10 m. a.g.l. to 1.5 m. a.g.l.) [dB]
L_f : Feeder loss [dB]
P_{mmn} : Allowance for man made noise [dB]
ϕ_{min} : Minimum power flux density at receiving place [dBW/m^2]
ϕ_{med} : Minimum median power flux density, planning value [dBW/m^2]
λ : Wavelength [m]

Minimum median equivalent field strength for planning Portable outdoor and mobile reception		
Frequency	f [MHz]	1470
Minimum receiver signal input power (from Table 2.3)	$P_{s\,min}$ [dBW]	-128.7
C/N correction for mobile reception condition	[dB]	5.6
Minimum receiver signal input power with C/N correction	$P_{s\,min\,corr}$ [dBW]	-123.1
Antenna gain relative to half wave dipole	G_D [dB]	0
Effective antenna aperture	A_a [dBm^2]	-22.6
Minimum power flux density at receiving place	Φ_{min} [dBW/m^2]	-100.5
Allowance for man made noise	P_{mmn} [dB]	0
Minimum equivalent field strength at receiving place	E_{min} [dBμV/m]	45
Height loss (10 metres to 1.5 metres)	Lh [dB]	13
Location correction for 99% location probability	Cl [dB]	12.8
Minimum median power flux density required at 10m a.g.l. for 50% of the time and 50% of locations to achieve coverage at 99% of locations at 1.5 m a.g.l.	Φ_{med} [dBW/m^2]	-74.7
Minimum median equivalent field strength required at 10m a.g.l. for 50% of the time and 50% of locations to achieve coverage at 99% of locations at 1.5 m a.g.l.	E_{med} [dBμV/m]	**71**

Table 6.2: Derivation of minimum block power flux density and the corresponding minimum median equivalent field strength for portable outdoor and mobile reception.

For planning purposes in Europe a minimum median equivalent field strength of 69 dBμV/m has been used for mobile and outdoor portable reception. This field strength is based on different values for C/N, antenna gain and height loss.

For the case of indoor reception, the effect of building penetration loss also has to be taken account of as described in § 4.3 and § 4.4. On the other hand, usually a slightly lower location probability of 95% is taken. The C/N correction can be assumed to be same as for mobile and portable outdoor reception.

Minimum median equivalent field strength for planning Portable indoor reception		
Frequency	f [MHz]	1470
Minimum receiver signal input power (from Table 2.3)	$P_{s\,min}$ [dBW]	-128.7
C/N correction for mobile reception condition	[dB]	5.6
Minimum receiver signal input power with C/N correction	$P_{s\,min\,corr}$ [dBW]	-123.1
Antenna gain relative to half wave dipole	G_D [dB]	0
Effective antenna aperture	A_a [dBm^2]	-22.6
Minimum power flux density at receiving place	Φ_{min} [dBW/m^2]	-100.5
Allowance for man made noise	P_{mmn} [dB]	0
Minimum equivalent field strength at receiving place	E_{min} [dBµV/m]	45
Height loss (10 metres to 1.5 metres)	Lh [dB]	13
Building penetration loss	Lb [dB]	10
Location correction for 95% location probability	Cl [dB]	13.3
Minimum median power flux density required at 10m a.g.l. outdoor for 50% of the time and at 50% of locations to achieve coverage at 95% of indoor locations at 1.5 m a.g.l.	Φ_{med} [dBW/m^2]	-64.2
Minimum median equivalent field strength at 10m a.g.l. outdoor for 50% of the time and at 50% of locations to achieve coverage at 95% of indoor locations at 1.5 m a.g.l.	E_{med} [dBµV/m]	**82**

Table 6.3: Derivation of minimum block power flux density and the corresponding minimum median equivalent field strength for portable indoor reception.

6.3 Protection ratios

There are no other broadcast services in this Band. Therefore only protection ratio for T-DAB interfered with by T-DAB is relevant to this document.

For the minimum field strengths derived in § 6.2, a C/N ratio of 13 dB is used in order to cover practically all reception situations in terms of the wanted signal level. For protection against interference from other T-DAB services and from self-interference, both of which are less frequently a problem in T-DAB coverage than insufficient wanted field strength, a C/N value of 12 dB, representing an average reception situation can be assumed. The protection ratio for co-block interference is therefore taken also to be 12 dB.

The protection ratio for adjacent block interference is -30 dB.

6.4 Polarisation

When interference into a T-DAB allotment is considered no account is taken of polarisation discrimination.

6.5 Maximum co-block interference field strength

	Mobile and portable outdoor reception (99% of locations)	Indoor reception (95% of locations)
Minimum median equivalent field strength at 10 m	71 dBµV/m	82 dBµV/m
Co-block protection ratio	12 dB	12 dB
Location correction margin (see § 4.2.2.4)	18 dB	14 dB
Maximum permissible interfering equivalent field strength at 10 m	41 dBµV/m	56 dBµV/m

Table 6.4: Maximum permissible interfering equivalent field strength at 10 m for co-block interference

Note: The value derived above is valid for allotment areas represented by 1.5 GHz Reference network 1. In the case of Reference Network 2 and Reference Network 3 for the 1.5 GHz range this value can be increased by 2 and 4 dB respectively.

6.6 Maximum adjacent block interference field strength

	Mobile and portable outdoor reception (99% of locations)	Indoor reception (95% of locations)
Minimum median equivalent field strength at 10 m	71 dBµV/m	82 dBµV/m
Adjacent protection ratio	-30 dB	-30 dB
Location correction margin (see § 4.2.2.4)	18 dB	14 dB
Maximum permissible interfering equivalent field strength at 10 m	83 dBµV/m	98 dBµV/m

Table 6.5: Maximum permissible interfering equivalent field strength at 10 m for adjacent block interference

Notes: 1. The value derived above is valid for allotment areas represented by 1.5 GHz Reference network 1. In the case of Reference Network 2 and Reference Network 3 for the 1.5 GHz range this value can be increased by 2 and 4 dB respectively.

2. Due to the negative protection ratio between adjacent block transmissions this interference will only occur when an adjacent block transmitter is located within or at the periphery of a service using the adjacent block. Therefore, this interference can be minimised by co-siting, or near-siting, the transmitters for each block, even if there is significant difference between the radiated powers or aerial systems used for each service.

6.7 Separation distances between co-block allotments

The separation distance between co-block allotments is determined from the interference potential tables for 1% of the time given in Annex 2 for the relevant reference networks.

In cases where two different reference networks are used for the two allotment areas for which the separation distance is considered, there will be two separation distances of which the larger shall be used.

The separation distances for portable outdoor and mobile reception are given in Table 6.6 below. The planning parameters used in Maastricht give the same values.

1.5 GHz Reference Networks		**Reference network 1 receiving interference**	**Reference network 2 receiving interference**	**Reference network 3 receiving interference**
Maximum permissible co-block interfering field strength (dBμV/m)		41 dBμV/m	43 dBμV/m	45 dBμV/m
Reference network 1 as interferer	Land	50 km	44 km	38 km
	Cold sea	314 km	290 km	269 km
	Warm sea	434 km	392 km	350 km
Reference network 2 as interferer	Land	39 km	34 km	30 km
	Cold sea	341 km	318 km	297 km
	Warm sea	466 km	426 km	386 km
Reference network 3 as interferer	Land	23 km	20 km	17 km
	Cold sea	292 km	272 km	255 km
	Warm sea	388 km	348 km	313 km

Table 6.6: Co-block separation distances for the three 1.5 GHz Reference networks for portable outdoor and mobile reception.

6.8 Fixed antenna reception

T-DAB networks are designed for mobile and portable reception. However, if a fixed rooftop antenna is used, reception can be achieved beyond the normal coverage area. In practice, an antenna located at an elevated position, such as a loft or on an external wall is also likely to be beneficial.

In Table 6.7 below, the minimum median equivalent field strength for fixed antenna reception at rooftop level is derived for information. For fixed antenna reception, a location probability of 95% and the C/N for a Ricean channel (see Table 2.2) have been used.

Minimum median equivalent field strength for planning Fixed antenna reception		
Frequency	f [MHz]	1470
Minimum receiver signal input power (from Table 2.3)	$P_{s\,min}$ [dBW]	-128.7
C/N correction for fixed antenna reception condition	[dB]	1.4
Minimum receiver signal input power with C/N correction	$P_{s\,min\,corr}$ [dBW]	-127.3
Antenna gain relative to half wave dipole	G_D [dB]	0
Effective antenna aperture	A_a [dBm^2]	-22.6
Minimum power flux density at receiving place	Φ_{min} [dBW/m^2]	-104.7
Allowance for man made noise	P_{mmn} [dB]	0
Minimum equivalent field strength at receiving place	E_{min} [dBμV/m]	41
Feeder loss	Lf [dB]	7
Location correction for 95% location probability	Cl [dB]	9
Minimum median power flux density required at 10m a.g.l. for 50% of the time and 50% of locations to achieve coverage at 95% of locations	Φ_{med} [dBW/m^2]	-88.7
Minimum median equivalent field strength required at 10m a.g.l. for 50% of the time and 50% of locations to achieve coverage at 95% of locations	E_{med} [dBμV/m]	**57**

Table 6.7: Derivation of minimum block power flux density and the corresponding minimum median equivalent field strength for fixed antenna reception.

7. Data Formats

To facilitate exchange of technical data and calculations of coverage and interference a set of data formats have been developed in co-operation between the EBU and the CEPT.

Each data file consists of the fixed length records separated by the "Carriage return - Line feed" (CrLf) pair of characters. Each record consists of a number of fields containing ASCII characters. An interpretation of any record is unambiguously defined by the field "Record identifier" (field 1). Each field is uniquely defined by its position within the record.

Common for all data formats is that the file name consists of eight characters followed by an extension (three characters) which should be as specified for each format. For exchange of data files it is recommended that the first three characters contain the ITU code for the relevant country, for one letter codes the letter comes first followed by two underscores (_).

7.1 Requirement files

The requirement files are used for co-ordination in accordance with the Wiesbaden Special Arrangement (1995), as revised in Maastricht 2002 and Maastricht Special Arrangement (2002).

7.1.1. T-DAB Allotment requirement

Basic characteristics of a T-DAB allotment to be communicated for a modification to the Allotment Plan are defined in Annex 3A, whilst a data structure for electronic submission is given in Appendix 1 to Annex 3 of both Arrangements (see Table 7.1 below):

Field	Item	Start Column	Width	Type
1	Record identifier (must be '**ALL1**' in the case of Wi95 Rev. Ma02 procedure (VHF) and '**ALL2**' in the case of Ma02 procedure (1.5 GHz))	1	4	A4
2	ITU code for administration responsible (padded by underscores to 3 characters)	5	3	A3
3	T-DAB identifier (5digits identifying number)	8	5	A5
4	ADD/MOD/SUP	13	3	A3
5	Year in which this submission is intended to be converted into one or more assignments	16	4	I4
6	Name of the allotment (up to 20 alphanumeric characters)	20	20	A20
7	T-DAB frequency block	40	3	A3
8	Type of the reference network (must be '**1**' for VHF; the standard reference models **1**, **2** and **3** are used for 1.5 GHz; see Section 5.3 of Annex2 to Ma02).	43	1	I1
9	Centre frequency offset in Hz - defined as: (centre frequency to be used) - (nominal centre frequency)	44	8	I8
10	Enter "**B**" if test points on the country boundary for the allotment are to be used. Otherwise leave blank	52	1	A1
11	If previous field is blank, enter Number of test points (up to 36)	53	2	I2
12	Test points. Up to 36 co-ordinates (longitude and latitude) in degrees and minutes. Example: 017E164346N2731 is co-ordinate 17 deg, 16 min, 43 sec East and 46 deg, 27 min, 31 sec North	55	540	36(I3,A1,I2, I2, I2,A1,I2, I2)
13	Date of submission (DDMMYYYY)	595	8	2I2,I4
14	Remarks	603	165	A165
99	Reserved for housekeeping purposes	768	32	A32

Record length: 799 characters

File name extension: .ALL

Sample file names: G__12345.ALL or DNKDAB99.ALL

7.1.2. T-DAB Assignment requirement

Basic characteristics of a T-DAB assignment to be communicated for the conversion of a T-DAB allotment into one or more assignments are defined in Annex 3B, whilst a data structure for electronic submission is given in Appendix 2 to Annex 3 of both Arrangements (see Table 7.2 below):

Field	Item	Start Column	Width	Type
1	Record identifier, must be '**ASS1**' in the case of Wi95 Rev. Ma02 procedure (VHF) and '**ALL2**' in the case of Ma02 procedure (1.5 GHz)	1	4	A4
2	ITU code for administration responsible (padded by underscores to 3 characters)	5	3	A3
3	T-DAB identifier (5-digits identifying number)	8	5	I5
4	ADD/MOD/SUP	13	3	A3
5	Identification code of the assignment used by the administration	16	9	A9
6	Date of entry into operation (DDMMYYYY)	25	8	2I2, I4
7	ITU code for country in which transmitter is sited (padded by underscores to 3 characters)	33	3	A3
8	Name of the allotment	36	20	A20
9	Name of the transmitter station	56	20	A20
10	Transmitter site - latitude (in degrees, minutes and seconds). Example: 46N2731 is co-ordinate 46 degrees, 27 minutes and 31 seconds North	76	7	I3, A1, 2I2
11	Transmitter site - longitude (in degrees, minutes and seconds). Example: 017E1643 is co-ordinate 17 degrees, 16 minutes and 43 seconds East	83	8	I2, A1, 2I2,
12	Altitude of site (meters above sea level; as sign followed by number)	91	5	I5
13	T-DAB frequency block	96	3	A3
14	Nominal centre frequency in MHz (including decimal point)	99	9	F9.3
15	Centre frequency offset in Hz - defined as: (centre frequency to be used) - (nominal centre frequency)	108	8	I8
16	Maximum e.r.p. of horizontally polarised component (in dBW; as sign followed by a number including a decimal point)	116	5	F5.1
17	Maximum e.r.p. of vertically polarised component (in dBW; as sign followed by a number including a decimal point)	121	5	F5.1
18	Polarisation (**H**/**V**/**M**)	126	1	A1
19	Height of transmitting antenna (meters above ground level.)	127	3	I3
20	**D**irectional/**N**on-directional	130	1	A1
21	Antenna attenuation - horizontal. 36 values of e.r.p. reduction (in dB) of the horizontally polarised component in the horizontal plane relative to the maximum e.r.p. component as given in field 16 (at 10 degrees intervals, starting at North, clockwise)	131	72	36I2
22	Antenna attenuation - vertical. 36 values of e.r.p. reduction (in dB) of the vertically polarised component in the horizontal plane relative to the maximum e.r.p. as given in field 17 (at 10 degree intervals, starting at North, clockwise)	203	72	36I2
23	Effective antenna height. Put '**U**' if the effective height of the antenna is the same in all directions. Otherwise put '**N**'	275	1	A1
24	If the preceding field contains '**U**' give the effective height. Otherwise give 36 values of effective antenna height (in meters, at 10 degree intervals, starting at North, clockwise)	276	180	36I5
25	Spectrum mask (used only in the Wi95 Rev Ma02 procedure)	456	1	I1
26	Date of submission (DDMMYYYY)	457	8	2I2, I4
27	Agreement numbers of the Plan	465	100	20A5
28	Remarks	565	203	A203
99	Reserved for database housekeeping purposes	768	32	A32

Record length: 799 characters

File name extension: .ASS

Sample file names: G__12345.ASS or DNKDAB99.ASS

7.2 T-DAB Transmitter record

The data format for T-DAB transmitters has been developed from the corresponding data formats for analogue and digital television transmitters and has the same structure, i.e. one transmitter in one record with a length of 799 characters.

The format specification is shown in Table 7.3 below:

Field	Field name	Item	Start Column	Width	Type
1	Record type	Record type identifier, must be '**TAD1**'	1	4	A4
2	Administration ID	ITU code for administration responsible (padded by underscores to 3 characters)	5	3	A3
3	Transmitter ID	Identification code of the transmitter used by organisation (Identical to the 'Assignment ID' - field 5 in the *T-DAB assignment requirement* file)	8	9	A9
4	Update code	Update code used by organisation	17	1	A1
5	Serial number	Space reserved for serial number (e.g. ITU No.)	18	9	A9
6	Status code	Status code (**O**perating/**N**ot operating)	27	1	A1
7	Date – operation	Date of entry into operation (DDMMYYYY)	28	8	2I2, I4
8	Country – location	ITU code for country in which transmitter is sited	36	3	A3
9	Transmitter name	Name of the transmitter	39	20	A20
10	Latitude	Latitude (in degrees, N, min., sec.)	59	7	I2,A1,2I2
11	Longitude	Longitude (in degrees, E/W, min., sec.)	66	8	I3,A1,2I2
12	Altitude of site	Altitude of site (meters above sea level; as sign followed by a number)	74	5	I5
13	Unused 1	Unused	79	1	
14	Protection level	T-DAB protection level (1, 2, 3, 4, or 5)	80	1	I1
15	T-DAB mode	T-DAB mode (1, 2, 3, or 4)	81	1	I1
16	Frequency block	T-DAB frequency block	82	3	A3
17	Spectrum mask	Spectrum mask	85	1	A1
18	Unused 2	Unused	86	3	
19	Centre frequency	Block centre frequency in MHz (including decimal point)	89	9	F9.3
20	Block offset in Hz	Block centre frequency offset in Hz – defined as: (block centre frequency to be used) - (nominal block centre frequency) - as sign followed by a number	98	8	I8
21	Unused 3	Unused	106	1	
22	ERP max - hor	Maximum e.r.p. of horizontally polarised component (in dBW; as sign followed by a number including decimal point)	107	5	F5.1
23	ERP max – vert	Maximum e.r.p. of vertically polarised component (in dBW; as sign followed by a number including a decimal point)	112	5	F5.1
24	SFN ID	Identifier for SFN	117	5	A5
25	Relative timing	Relative timing of transmitter within an SFN (micro sec)	122	6	I6
26	Allotment ID	T-DAB allotment identifier (ITU code for administration padded by underscores to 3 characters, followed by 5-digit identification number)	128	8	A8
27	Sub-area ID	Identifier for national sub-area where allotment is located	136	1	A1
28	Unused 4	Unused	137	8	
29	Polarisation	Polarisation (**H**/**V**/**M**)	145	1	A1
30	Height of antenna	Height of antenna (meters above ground level)	146	3	I3
31	Directivity	Directivity (**D**irectional/**N**on-directional)	149	1	A1
32	Ant. pattern-hor	36 values of e.r.p. reduction (in dB) of the horizontally polarised component in the horizontal plane relative to the maximum e.r.p. of the horizontally polarised component as given in field 20 (at 10 degrees intervals, starting at North)	150	72	36I2
33	Ant. pattern-vert	36 values of e.r.p. reduction (in dB) of the vertically polarised component in the horizontal plane relative to the maximum e.r.p. of the vertically polarised component as given in field 21 (at 10 degree intervals, starting at North)	222	72	36I2
34	Beam tilt – hor	Beam tilt angle of the horizontally polarised component (in degrees, negative if above the horizontal)	294	4	F4.1
35	Unused 5	Unused	298	2	
36	Beam tilt – vert	Beam tilt angle of the vertically polarised component (in degrees, negative if above the horizontal)	300	4	F4.1

Field	Field name	Item	Start Column	Width	Type
37	Heff 1	Effective antenna height. Put '**U**' if the effective height of the antenna is the same in all directions. Otherwise put '**N**'.	304	1	A1
38	Unused 6	Unused	305	2	
39	Heff max	Maximum effective antenna height (m)	307	5	I5
40	Heff values	If the field 37 contains 'N', give 36 values of effective antenna height (in meters, at 10 degree intervals, starting at North)	312	180	36I5
41	Tx provider	Transmission provider	492	5	A5
42	Service provider	Service provider	497	5	A5
43	Design. of emiss.	Designation of emission	502	9	A9
44	Date–last change	Date of last change to data in this record (DDMMYYYY)	511	8	2I2, I4
45	Agreement numbers	Agreement numbers of the Plan (5 digits each)	519	100	20(A5)
46	Remarks	Unused or remarks	619	139	A139
47	GEO datum	Designation of a geographical co-ordination system used for geographical co-ordinates in fields 10 and 11 (Examples: WGS84, EURef89, …). If blank, WGS84 is assumed.	758	10	A10
99	Housekeeping	Reserved for database housekeeping purposes	768	32	A32

Record length: 799 characters

File name extension: .TAD

Sample file names: G__12345.TAD or DNKDABTX.TAD

7.3 T-DAB Allotment record

The data format for T-DAB allotment has a length of 249 characters. It is linked with two following data files containing allotment boundary points and calculation test points. This relation is uniquely defined by the field 2 (Administration ID) and field 3 (Allotment ID), which appear in all three data formats, taken together. One record in the allotment file corresponds to a set of records (at least three) in the allotment boundary file and a set of records in the calculation test points file.

The format specification is shown in Table 7.4 below:

Field	Field name	Item	Start Column	Width	Type
1	Record type	Record type identifier, must be '**AAD1**'	1	4	A4
2	Administration ID	ITU code for administration responsible	5	3	A3
3	Allotment ID	T-DAB allotment identifier (5-digits identification number)	8	5	I5
4	ID code	Identification code used by administration	13	9	A9
5	Update code	Update code used by administration	22	1	A1
6	Serial number	Space reserved for serial number (e.g. ITU No.)	23	9	A9
7	Status code	Status code (**O**perating/**N**ot operating)	32	1	A1
8	Date – operation	Date of entry into operation of first transmitter (DDMMYYYY)	33	8	2I2, I4
9	Allotment name	Allotment name	41	20	A20
10	Frequency block	T-DAB frequency block	61	3	A3
11	Centre frequency	Block centre frequency in MHz (including decimal point)	64	9	F9.3
12	Reference network	Type of the reference network (the standard reference models 1, 2 and 3; see Section 5.3 of Annex2 of the Maastricht final acts)	73	1	I1

Field	Field name	Item	Start Column	Width	Type
13	Block offset in Hz	Block centre frequency offset in Hz - defined as: (block centre frequency to be used) - (nominal block centre frequency) - as sign followed by a number	74	8	I8
14	Polarisation	Polarisation (**H**/**V**/**M**)	82	1	A1
15	Sub-area ID	Identifier for national sub-area where allotment is located	83	1	A1
16	Number of TPs	Number of the allotment boundary test points (up to 36)	84	2	I2
17	Agreement numbers	Agreement numbers of the Plan (5 digits each)	86	100	20(A5)
18	Remarks	Unused or remarks	186	24	A24
19	Date – last change	Date of last change to data in this record (DDMMYYYY)	210	8	2I2, I4
99	Housekeeping	Reserved for database housekeeping purposes	218	32	A32

Record length: 249 characters

File name extension: .AAD

Sample file names: G__50001.AAD or DNK50001.AAD

7.4 Allotment boundary test point data

The data format for T-DAB allotment areas has a length of 149 characters. It contains a set of geographical points representing the area of a given allotment. Linear interpolation between adjacent points is assumed for construction of the allotment area.

A set of records (minimum three) in this file corresponds to a single record in the allotment file (AAD1). This relation is uniquely defined by the field 2 (Administration ID) and field 3 (Allotment ID) which appear in both data formats, taken together.

The format specification is shown in Table 7.5 below:

Field	Field name	Item	Start Column	Width	Type
1	Record type	Record type identifier, must be '**BTP1**'	1	4	A4
2	Administration ID	ITU code for administration responsible	5	3	A3
3	Allotment ID	T-DAB allotment identifier (5-digits identification number)	8	5	I5
4	Allotment name	Allotment name	13	20	A20
5	TP serial number	Serial number of test point (001 – 999)	33	3	I3
6	Latitude	Latitude (in degrees, N, min., sec.)	36	7	I2,A1,2I2
7	Longitude	Longitude (in degrees, E/W, min., sec.)	43	8	I3,A1,2I2
8	Unused	Unused	51	4	
9	Date – last change	Date of last change to data in this record (DDMMYYYY)	55	8	2I2, I4
10	Remarks	Unused or remarks	63	45	A45
11	GEO datum	Designation of a geographical co-ordination system used for geographical co-ordinates in fields 6 and 7 (Examples: WGS84, EURef89,). If blank, WGS84 is assumed.	108	10	A10
99	Housekeeping	Reserved for database housekeeping purposes	118	32	A32

Record length: 149 characters

File name extension: .BTP

Sample file names: G__50001.BTP or DNK10001.BTP

7.5 Calculation test point data

The data format for the calculation test points of a T-DAB allotment area has a length of 149 characters. It contains a set of geographical points to be used for interference calculation in accordance with Annex 4 of the Wiesbaden Special Arrangement (1995), as revised in Maastricht 2002 and Maastricht Special Arrangement (2002), respectively.

A set of records in this file corresponds to a single record in the allotment file (AAD1). This relation is uniquely defined by the field 2 (Administration ID) and field 3 (Allotment ID) which appear in both data formats, taken together.

This record also contains a field called "Agreed field strength at the test point" (field 8). The default value is as given in the relevant frequency plan. Where appropriate this field can hold the value of the field strength at the particular test point as agreed between two countries.

The format specification is shown in Table 7.6 below:

Field	Field name	Item	Start Column	Width	Type
1	Record type	Record type identifier, must be '**CTP1**'	1	4	A4
2	Administration ID	ITU code for administration responsible	5	3	A3
3	Allotment ID	T-DAB allotment identifier (5-digits identification number)	8	5	I5
4	Allotment name	Allotment name	13	20	A20
5	TP serial number	Serial number of test point (001 - 999)	33	3	I3
6	Latitude	Latitude (in degrees, N, min., sec.)	36	7	I2,A1,2I2
7	Longitude	Longitude (in degrees, E/W, min., sec.)	43	8	I3,A1,2I2
8	Agreed field str.	Agreed field strength at the test point in dB(μV/m) (a number including a decimal point)	51	4	F4.1
9	Date – last change	Date of last change to data in this record (DDMMYYYY)	55	8	2I2, I4
10	Remarks	Unused or remarks	63	45	A45
11	GEO datum	Designation of a geographical co-ordination system used for geographical co-ordinates in fields 6 and 7 (Examples: WGS84, EURef89,). If blank, WGS84 is assumed.	108	10	A10
99	Housekeeping	Reserved for database housekeeping purposes	118	32	A32

Record length: 149 characters

File name extension: .CTP

Sample file names: G__50001.CTP or DNK10001.CTP

7.6 Country boundary data

A set of geographical points describing the boundaries of European countries has been defined and used in T-DAB planning. Linear interpolation between adjacent boundary points is assumed for construction of country borderlines. The country boundary test points were originally defined on the basis of the ITU digital world map and later agreed by the CEPT countries in the process of implementation of the Chester '97 Agreement.

A continuous section of a borderline is represented by a sub-set of points which is called *segment*. The whole country boundary of any given country consists of one or more such segments. A segment may represent the border of one country only or a common border between the neighbouring countries. Where the latter is the case, identical boundary points are used as a borderline segment for both countries. An advantage of this concept is that overlaps between two countries can not occur. The number identifying the segment is kept in field 4 and the number of the point in that segment is held in field 5. Together fields 4 and 5 form a unique five-digit number for a point on a country boundary. Contiguous segments of the boundary overlap so that the first point in one segment is identical to the last point in the previous segment. The link between such points is specified in field 8.

Country boundary points shared between two (or more) countries are linked by the information which can be contained in the fields 9, 10 and 11.

Some countries contain areas that are geographically separated (i.e. by a considerably large distance or by a territory of other country) and can not be described by a single encircling line (made up of one or more segments). An example is the Danish island of Bornholm in the Baltic sea. In order to make it possible also to cover such cases the idea of sub-areas is introduced. Each geographically separate area forming part of the same country is given an identification letter which is kept in field 3. Country boundary points belonging to different sub-areas of a country can not be connected and have no mutual relation.

The format specification is shown in Table 7.7 below:

Field	Field name	Item	Start Column	Width	Type
1	Record type	Record type identifier, must be '**CBP1**'	1	4	A4
2	Country code	ITU code for country	5	3	A3
3	Sub-area ID	Identifier for national sub-area encircled by a closed contour of country boundary test points (Must be a letter, A ... Z)	8	1	A1
4	Segment ID	Segment identifier (number between 01 and 99)	9	2	I2
5	TP serial number	Test point serial number in segment (number between 001 and 999)	11	3	I3
6	Latitude	Latitude (in degrees, N, min., sec.) of test point	14	7	I2, A1, 2I2
7	Longitude	Longitude (in degrees, E/W, min., sec.) of test point	21	8	I3, A1, 2I2
8	Co-located TP1	Identifier for a co-located boundary point, belonging to the same national sub-area but to an adjacent boundary segment. The identifier is composed in using the fields 1 to 5 (see above) of the co-located test point. If there is no co-located test point fulfilling this criterion, this field is left blank.	29	13	A4, A3, A1, I2, I3
9	Co-located TP2	Identifier for a co-located point, belonging to a neighbouring country (No 1). The identifier is composed in using the fields 1 to 5 (see above) of the co-located boundary point of the neighbouring country. If there is no co-located test point fulfilling this criterion, this field is left blank.	42	13	A4, A3, A1, I2, I3
10	Co-located TP3	Identifier for a co-located test point, belonging to a neighbouring country (No 2). The identifier is composed in using the fields 1 to 5 (see above) of the co-located boundary point of the neighbouring country. If there is no co-located test point fulfilling this criterion, this field is left blank.	55	13	A4, A3, A1, I2, I3

Field	Field name	Item	Start Column	Width	Type
11	Co-located TP3	Identifier for a co-located test point, belonging to a neighbouring country (No 3). The identifier is composed in using the fields 1 to 5 (see above) of the co-located boundary point of the neighbouring country. If there is no co-located test point fulfilling this criterion, this field is left blank.	68	13	A4, A3, A1, I2, I3
12	Date – last change	Date of last change to data in this record (DDMMYYYY)	81	8	2I2, I4
13	Remarks	Unused or remarks	89	19	A28
14	GEO datum	Designation of a geographical co-ordination system used for geographical co-ordinates in fields 6 and 7 (Examples: WGS84, EURef89,). If blank, WGS84 is assumed.	108	10	A10
99	Housekeeping	Reserved for database housekeeping purposes	118	32	A32

Record length: 149 characters

File name extension: .CBP

Sample file names: DNKbound.CBP

8 References and definitions

8.1 References

[1]: “*The how and why of COFDM”, EBU Technical Review, Winter 1998.*

[2]: ETSI standard specification ETS EN 300 401

[3]: ITU-R, DSB Handbook, Terrestrial and satellite sound broadcasting to vihicular, portable and fixed receivers in the VHF/UHF bands.

[4]: Recommendation ITU-R P.1546

[5]: EBU Doc. Tech 3254

[6]: Recommendation ITU-R BS.641

[7]: Recommendation ITU-R BT.419

[8]: Recommendation ITU-R BT.1368

8.2 Definitions

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

Equivalent field strength: The field strength of a single CW (un-modulated RF-carrier) radiated with the same power as the total radiated power of the DAB signal.

FFT: Fast Fourier Transform.

IFFT: Inverse Fast Fourier Transform.

Multiplex: Data stream containing all digitally encoded audio and other data to be transmitted.

Network gain: The improvement of the coverage of a given small area served by more than one transmitter, carrying the same multiplex. Network gain consists of an additive part due to simple addition of the received signals and of a statistical part due to the increased location probability.

PRS: Phase Reference Symbol. Used by the DAB receiver for fine synchronisation in time and frequency.

Self interference: Interference caused by signals from transmitters of the same single frequency network, arriving either too early or too late to add constructively to the reception.

Time offset: A relatively small individual adjustment of the time at which a given DAB symbol is radiated from a given transmitter.

Derivation of T- DAB C/N for Different Protection Levels

1 Introduction

In the Wiesbaden Arrangement (WI95), the carrier to noise (C/N) ratio for T-DAB is given for protection level 3 only. Protection level 3 corresponds to a code rate of about 0.5. The T-DAB specification allows for other code rates to be used, ranging from about 0.34 to about 0.75, with ensuing differences in ruggedness and useful data capacity. It is not possible to precisely link a particular code rate to a protection level as the code rate depends slightly on the bit-rate used for the individual programme services in the T-DAB multiplex. This Annex gives a possible way of deriving T-DAB C/N ratios for code rates other than 0.5, by initially comparing T-DAB with DVB-T, for which C/N ratios are available for several code rates. This method is then modified to take account of the difference in the specification of the T-DAB receiver in Gauss, Rice and Rayleigh channels.

2 Derivation of T-DAB C/N ratios from those of DVB-T

T-DAB uses QPSK modulation, which is also one of the modulation options for DVB-T. The DVB-T set of system variants for QPSK is used as a starting point for the derivation of T-DAB C/N ratios for code rates other than 0.5. However, it must be borne in mind that T-DAB uses differential demodulation whereas DVB-T uses coherent demodulation. In theory, coherent demodulation requires 3 dB lower C/N than differential demodulation for the same bit error rate (BER). In addition, DVB-T employs channel estimation techniques whereas DAB does not. The derivation of C/N ratios for T-DAB code rates other than 0.5 is made in five stages.

The DVB-T C/N ratios are specified for a BER of $2*10^{-4}$, whereas T-DAB is specified for a BER of $1*10^{-4}$. It has been assumed that the differences in C/N ratio between the various code rates are the same for DVB-T and T-DAB, in spite of the differences in BER.

2.1 Stage 1 - Derive C/N ratios for DVB-T QPSK for an extended set of system variants

The theoretical C/N values for the non-hierarchical QPSK set of system variants of DVB-T are given in Table A1.1. These C/N ratios do not include any implementation margin.

Three additional data rows for code rates of 0.34, 0.43 and 0.6 relevant to T-DAB (shown in italics) have been added to the Table. The values for these code rates have been calculated from the data plotted in Figure A1.1 by using a curve-fitting algorithm. The formulae used for the curves for the different channel types are

Gauss $C/N = -0.47 + 4.48x + 5.31x^2$

Rice $C/N = -0.46 + 4.99x + 6.27x^2$

Rayleigh $C/N = 7.44 – 20.73x + 33.25x^2$

Modulation	Code Rate	Required C/N (dB) for BER of $2*10^{-4}$ after Viterbi		
		Gauss Channel	Rice Channel	Rayleigh Channel
QPSK	*0.34*	*1.6*	*1.9*	*4.2*
	0.43	*2.4*	*2.8*	*4.7*
	0.5	**3.1**	**3.6**	**5.4**
	0.6	*4.1*	*4.8*	*7.0*
	0.667	**4.9**	**5.7**	**8.4**
	0.75	**5.9**	**6.8**	**10.7**
	0.833	**6.9**	**8.0**	**13.1**

Table A1.1: Theoretical C/N for DVB-T (excluding implementation margin).

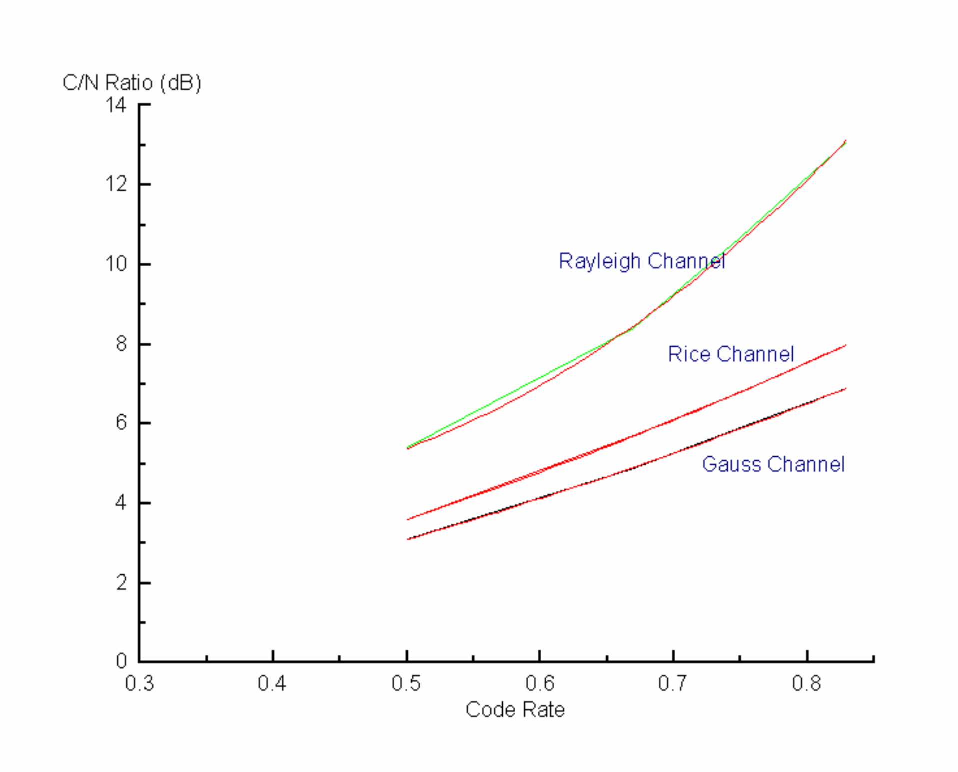


Figure A1.1: Actual and fitted C/N ratios

2.2 Stage 2 – Adjust C/N ratios for differential demodulation

In Table A1.2, the theoretical values of C/N ratio for T-DAB are derived from those of DVB-T by adding 3 dB to each of the DVB-T values. This is to allow for the difference in theoretical C/N performance between coherent (DVB-T) and differential (T-DAB) demodulation. The C/N ratios for code rates not in the DVB-T specification are estimated by extrapolation or interpolation, from the values calculated in Table A1.1.

Modulation	Code Rate	Required C/N (dB) for BER of $1*10^{-4}$ after Viterbi		
		Gauss Channel	Rice Channel	Rayleigh Channel
QPSK	0.34	4.6*	4.9*	7.2*
	0.43	5.4*	5.8*	7.7*
	0.5	6.1	6.6	8.4
	0.6	7.1*	7.8*	10.0*
	0.75	8.9	9.8	13.7

Table A1.2: Derived theoretical C/N for DAB (excluding implementation margin, but adjusted by 3 dB for the difference between differential and coherent demodulation).

* estimated values, extrapolated / interpolated from the DVB-T data.

2.3 Stage 3 – add the T-DAB implementation margin for the Gauss channel

In deriving the C/N values in Table A1.2, it has been assumed that the same protection level is used on all programme services in the multiplex. The C/N value for the Gauss channel and protection level 3 is 7.4 dB (taken from Rec. ITU-R BS.1114, Section 10.1). In "DVB-T" terms, this implies that an implementation margin of 1.3 dB is required. It is the difference between the 6.1 dB theoretical value for the Gauss channel and the 7.4 dB that is needed to adjust the theoretical C/N values to practical ones. The derived C/N values in Table A1.3 have been calculated by adding the 1.3 dB implementation margin for the Gauss channel to all of the values in Table A1.2.

Protection Level	Corresponding approximate Code Rate	C/N (dB) for BER of $1*10^{-4}$ after Viterbi		
		Gauss Channel	Rice Channel	Rayleigh Channel
1	0.34	5.9	6.2	8.5
2	0.43	6.7	7.1	9.0
3	**0.50**	**7.4**	**7.9**	**9.7**
4	0.60	8.4	9.1	11.3
5	0.75	10.2	11.1	15.0

Table A1.3: Derived C/N, including an implementation margin of 1.3 dB for the five protection levels and three transmission channels.

However, the values presented in Table A1.3 for protection level 3 in a Rayleigh channel are significantly lower than the values used in § 5.3 and § 6.2 to derive the minimum median equivalent field strength. This is because of the worst case mobile reception environment chosen for the field strength derivation in § 5.3 and § 6.2. The derived C/N values in Table A1.3 should therefore be used with caution, particularly for the Rayleigh channel. The values for the Rayleigh channel in this table may be assumed to represent portable reception where the receiver is not moved during use.

3 Results of simulations.

3.1 Gauss channel

Section 10.1 of Rec. ITU-R BS.1114 contains data on the performance of DAB in a Gauss channel.

For Band III, a C/N ratio of 7.4 dB is required for a BER of $1*10^{-4}$, assuming protection level 3. Table A1.3 contains the C/N ratios based on the Band III, Transmission Mode I, adjusted for an implementation margin that is constant irrespective of the channel type.

3.2 Rayleigh channel.

Section 10.2 of Rec. ITU-R BS.1114 contains data on the simulated performance of T-DAB in one out several possible Rayleigh channel profiles.

For Band III, Rec. ITU-R BS.1114 gives the required C/N ratio for the channel profile chosen as 14.8 dB for a BER of $1*10^{-4}$ and protection level 3. This is 5.1 dB greater than the value derived in Table A1.3. However, experience with operational T-DAB networks has shown that a C/N value between 13 dB and 13.5 dB seems more appropriate, reducing the difference of 5.1 dB to about 3.6 dB. If the implementation margin of 3.6 dB is applied to the Rayleigh channel, then the process used in Table A1.3 can be used to derive C/N ratios for other code rates by varying the implementation margin according to the type of channel.

3.3 Stage 4 – Calculate implementation margin for Gauss, Rice and Rayleigh channels in Band III.

Table A1.4 gives the implementation margins for the Gauss and Rayleigh channels, based on the C/N ratios derived from DVB-T (Table A1.2) at a code rate of 0.5 and the measurements contained in Rec. ITU-R BS.1114. The Rice channel is intermediate between the Gauss and Rayleigh channels and an implementation margin is estimated for it.

Channel Type	Implementation Margin (dB)
Gauss	1.3
Rice	2.2
Rayleigh	4.9

Table A1.4: Estimated Band III implementation margins for the different channel types.

4 Stage 5 – estimate Band III C/N ratio for the different protection levels and channel types.

If a constant value of implementation margin based on that required for the Gauss channel is used for all channel types, then the C/N ratio derivation procedure given in Table A1.3 underestimates the C/N needed for the Rayleigh channel (and probably for the Rice channel as well). Combining the C/N ratios in Table A1.2 with the implementation margins in Table A1.4 may give a reasonable estimate of the C/N ratios needed for the different protection levels and channel types. Table A1.5 contains the set of estimated C/N ratios, and also includes the approximate net bit-rate for each protection level.

Protection Level	Corresponding approximate Code Rate	C/N (dB) for BER of $1*10^{-4}$ after Viterbi			Approximate Net Bit-Rate (MBit/s)
		Gauss Channel	Rice Channel	Rayleigh Channel	
1	0.34	5.9*	7.1	12.1	0.78
2	0.43	6.7*	8.0	12.6	0.99
3	**0.50**	**7.4**	**8.8**	**13.3**	**1.15**
4	0.60	8.4	10.0	14.9	1.38
5	0.75	10.2	12.0	18.6	1.73

Table A1.5: Estimated Band III C/N ratios based on DVB-T data and a variable implementation margin

It can be seen from Table A1.5 that there is little advantage in choosing a lower protection level (higher protection) than protection level 3. However, the required C/N increases considerably if a higher protection level (lower protection) is chosen.

Construction of calculation test points for T- DAB allotments

The locations of the calculation test points could be determined using the following procedure.

1 For each relevant frequency Band a threshold value for the equivalent field strength is decided by the planning conference, normally taken as the maximum co-block interfering field strength. This threshold value is designated as "***F*** dBµV/m" in the following text. For the planning of VHF T-DAB in Europe a value of 27 dBµV/m has been used at the Wiesbaden '95 Planning Meeting. For the 1.5 GHz range the value 38 dBµV/m has been used at the Maastricht '02 Planning Meeting.

2 Perpendicular bisectors:

- calculation test points are located outside the allotment area, along the perpendicular bisector of each of the lines joining adjacent boundary test points, where the field strength from the appropriate reference network would be ***F*** dBµV/m when it is located as shown in Figures A2.1, A2.3 or A2.5 for Band III or in Figures A2.7, A2.9 or A2.11 for the 1.5 GHz range.
  Examples are point P in Figure A2.1, points 2, 4, 6, 8, and 14 in Figure A2.13 and points 1b and 1c in Figure A2.14.

3 Angular bisectors:

- further calculation test points are located outside the allotment area, along the bisector of the angle formed by the lines joining each boundary test point with its two adjacent boundary test points, where the field strength from the appropriate reference network would be ***F*** dBµV/m when it is located as shown in Figures A2.2, A2.4 or A2.6 for Band III or in Figures A2.8, A2.10 or A2.12 for the 1.5 GHz range.
  Examples are point P in Figure A2.2, points 1, 3, 5, 7, 10 and 13 in Figure A2.13, points 1a, 2a and 3a in Figure A2.14 and point 2e in Figure A2.15.

4 Additional calculation test points

- Taking account of the allotment boundary geometry shown in Figures A2.14 and A2.15, the following procedures are to be applied:

4.1 In the case where $\alpha < 180°$ (see Figure A2.14):

- additional calculation test points are located outside the allotment area, along the perpendiculars to the lines joining point A to B, and point C to B, where the field strength from the reference network situated at point B would be ***F*** dBµV/m. Test points 1e and 1d are the result.

- If the distance between the constructed additional calculation test points 1e and 1d to calculation test point 1a is larger than 75 km (Band III) or 45 km (1.5 GHz range), additional test points are constructed by subdividing, equally, the sectors from test point 1a to test point 1e and/or test point 1a to test point 1d, to produce additional test points until:

  $\beta < 2 \arcsin(d/2D)$

  where: d is 75 km (Band III) and 45 km (1.5 GHz range), and

D is either the larger of the distances from point B to test point 1e and point B to test point 1a in the case of the sector from test points 1e to 1a or, the larger of the distances from point B to test point 1d and point B to test point 1a in the case of the sector from test points 1a to 1d.

- The calculation test point on each of these additional lines is at the location where a field strength of ***F*** dBµV/m is produced from the appropriate reference network situated at point B. This leads to calculation test points 1f and 1g in the case of the geometry of Figure A2.14.

4.2 In the case where $\alpha \geq 180°$ (see Figure A2.15):

- additional calculation test points are located along the bisector of the angle formed by the lines joining the allotment test points A - B and B - C outside the allotment area, where the field strength from the reference network would be ***F*** dBµV/m.

- If the field strength of a reference network at any of the other test points of the allotment produces a higher field strength than that given above, the calculation test point must be moved further outside the allotment area, along the bisector of the angle, until the field strength from the appropriate reference network at all test points of the allotment is equal to or less than ***F*** dBµV/m; this gives calculation test point 2e in Figure A2.15.

5 All calculation test points that lie within the allotment area are to be disregarded, for example point 12 in Figure A2.13.

6 Calculation test points that lie too close to the boundary of the allotment area, such that the field strength from the reference network would be greater than ***F*** dBµV/m are to be disregarded, for example points 9 and 11 in Figure A2.13.

7 If the length of a line drawn between adjacent calculation test points is more than 75 km (Band III) or more than 45 km (1.5 GHz range), additional calculation test points are to be constructed by subdividing the line in equal parts until the distance between adjacent calculation test points is less than the values given above.

8 The distance between the allotment boundary and the relevant calculation test point could be approximately as shown in the table below:

Frequency range	Type of path	Reference Network 1	Reference Network 2	Reference Network 3
VHF (***F*** = *28* dBµV/m)	All land path	105 km	82 km	45 km
	All cold sea path	190 km	164 km	101 km
	All warm sea path	234 km	194 km	114 km
1.5 GHz (***F*** = 41 dBµV/m)	All land path	50 km	38 km	23 km
	All cold sea path	314 km	341 km	292 km
	All warm sea path	434 km	466 km	388 km

Table A2.1: Distances from allotment boundaries to calculation test points for the three VHF reference networks and the three 1.5 GHz reference networks based on the max. co-block interference levels as given in § 5.6 and § 6.4

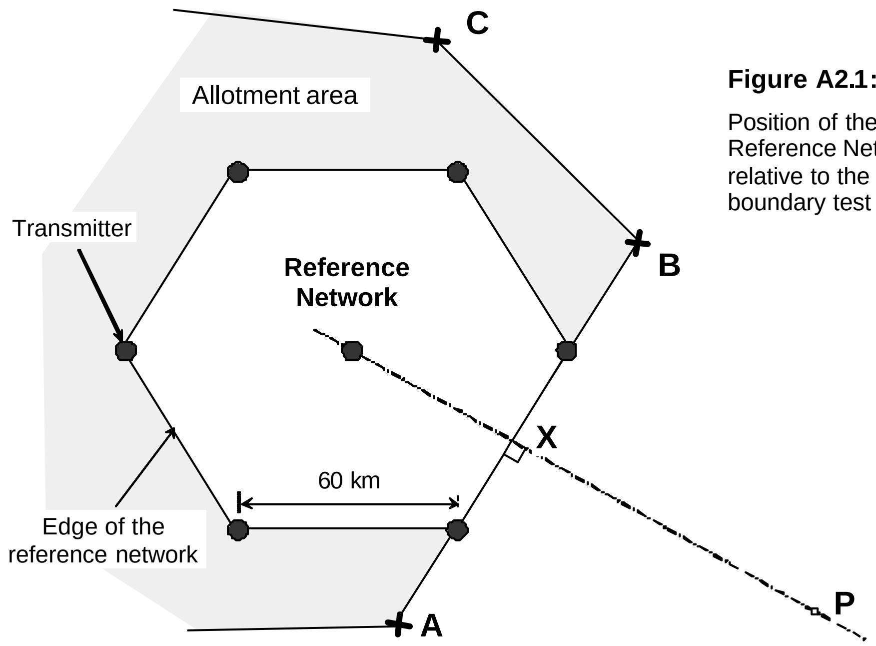


Figure A2.1:

Position of the VHF Reference Network One relative to the line joining boundary test points A and B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point X is the midpoint of the line A-B and is also the reference point of the reference network.
- The line defined by the points X and P is the perpendicular bisector of the line A-B and is also the line along which the interfering field strength is calculated.

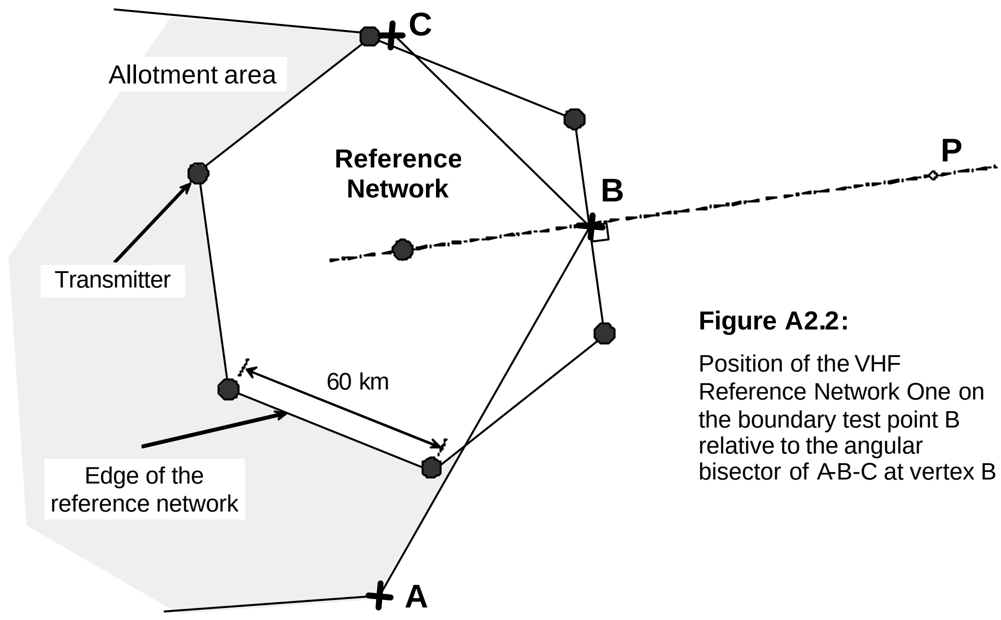


Figure A2.2:

Position of the VHF Reference Network One on the boundary test point B relative to the angular bisector of A-B-C at vertex B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point B is the vertex of the angle A-B-C and is also the reference point of the reference network.
- The line defined by the points B and P is the angle bisector of angle A-B-C and is also the line along which the interfering field strength is calculated.

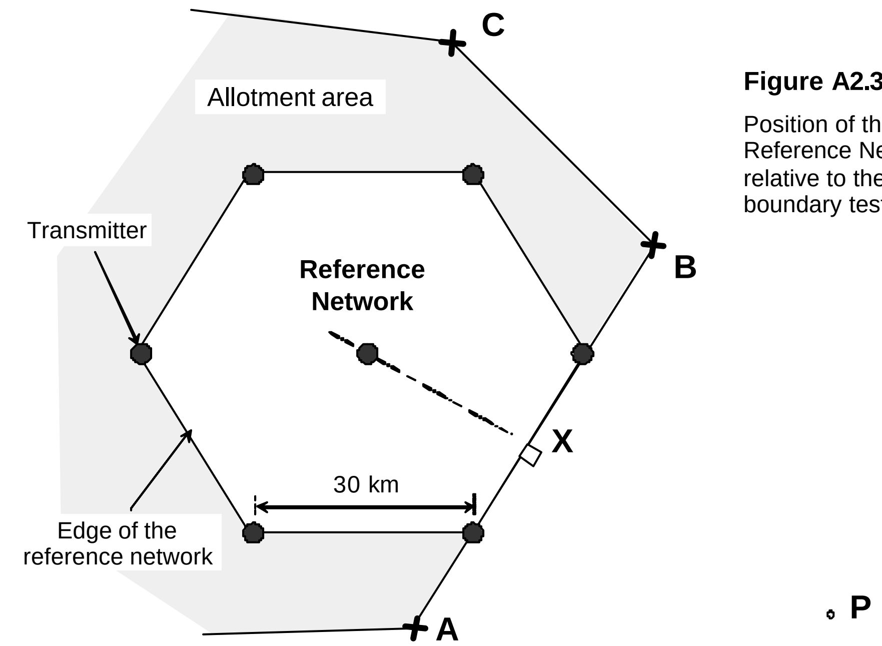


Figure A2.3:

Position of the VHF Reference Network Two relative to the line joining boundary test points A and B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point X is the midpoint of the line A-B and is also the reference point of the reference network.
- The line defined by the points X and P is the perpendicular bisector of the line A-B and is also the line along which the interfering field strength is calculated.

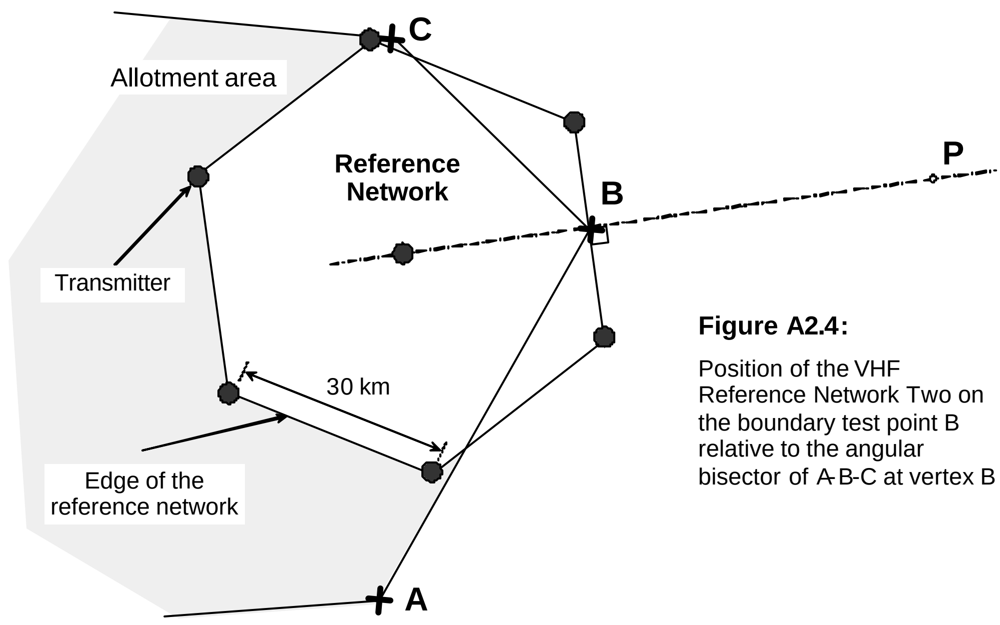


Figure A2.4:

Position of the VHF Reference Network Two on the boundary test point B relative to the angular bisector of A-B-C at vertex B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point B is the vertex of the angle A-B-C and is also the reference point of the reference network.
- The line defined by the points B and P is the angle bisector of angle A-B-C and is also the line along which the interfering field strength is calculated.

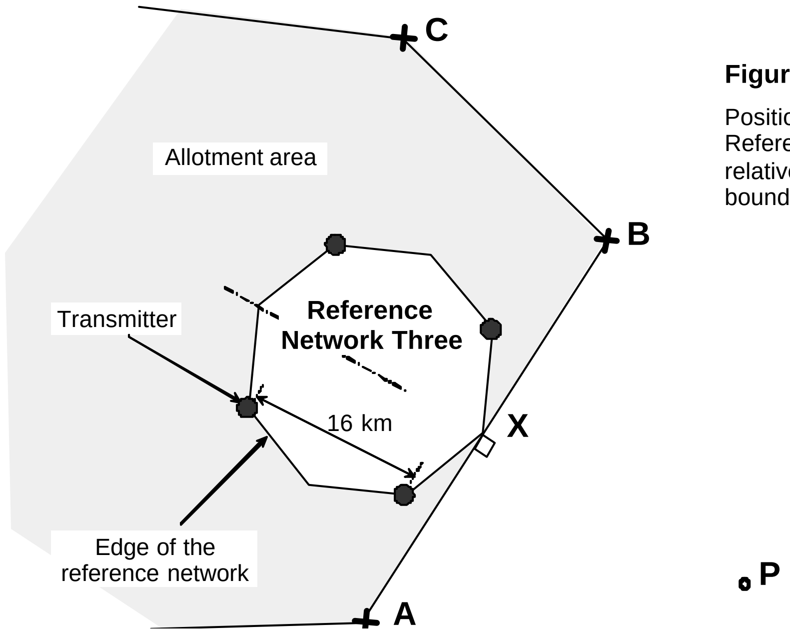


Figure A2.5:

Position of the VHF Reference Network Three relative to the line joining boundary test points A and B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point X is the midpoint of the line A-B and is also the reference point of the reference network.
- The line defined by the points X and P is the perpendicular bisector of the line A-B and is also the line along which the interfering field strength is calculated.

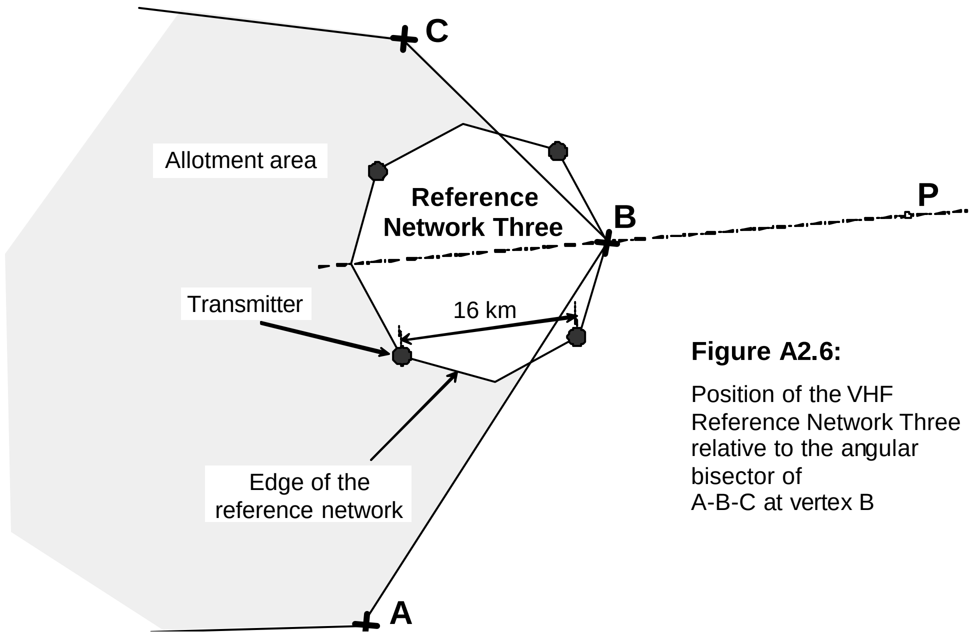


Figure A2.6:

Position of the VHF Reference Network Three relative to the angular bisector of A-B-C at vertex B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point B is the vertex of the angle A-B-C and is also the reference point of the reference network.
- The line defined by the points B and P is the angle bisector of the line A-B and is also the line along which the interfering field strength is calculated.

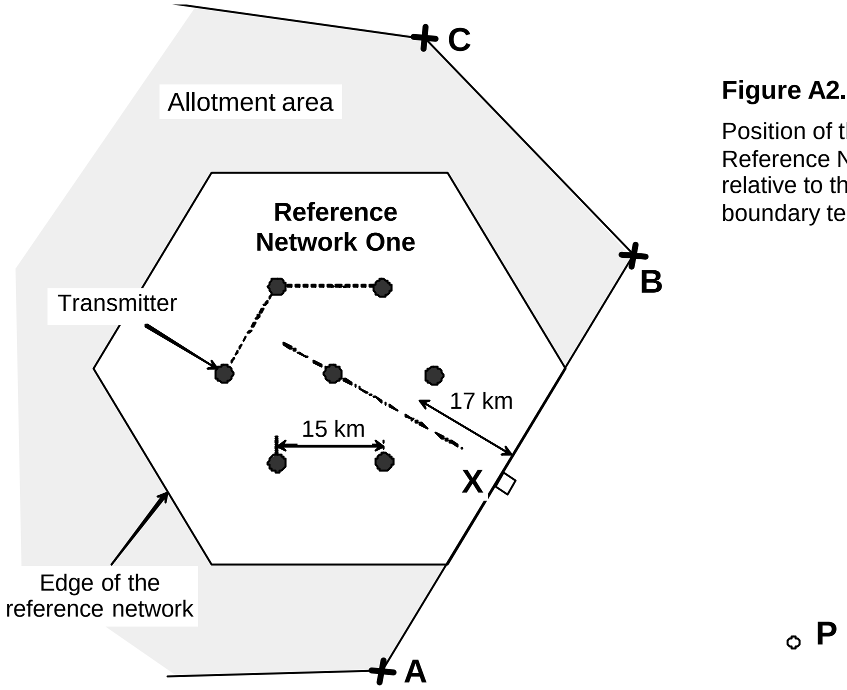


Figure A2.7:

Position of the 1.5 GHz Reference Network One relative to the line joining boundary test points A and B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point X is the midpoint of the line A-B and is also the reference point of the reference network.
- The line defined by the points X and P is the perpendicular bisector of the line A-B and is also the line along which the interfering field strength is calculated.

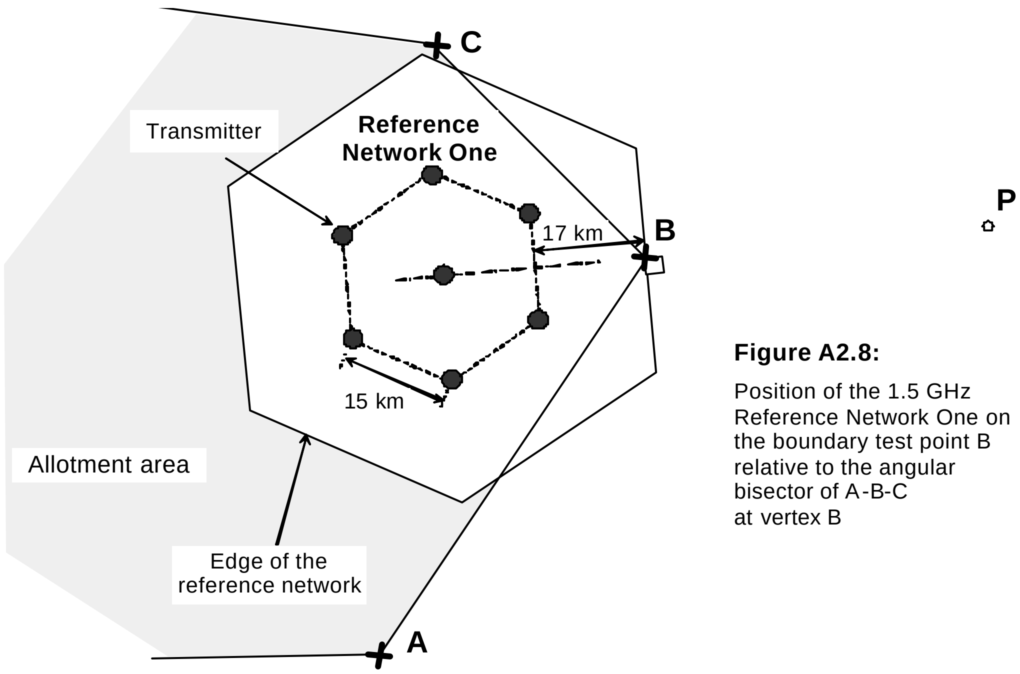


Figure A2.8:

Position of the 1.5 GHz Reference Network One on the boundary test point B relative to the angular bisector of A-B-C at vertex B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point B is the vertex of the angle A-B-C and is also the reference point of the reference network.
- The line defined by the points B and P is the angle bisector of angle A-B-C and is also the line along which the interfering field strength is calculated.

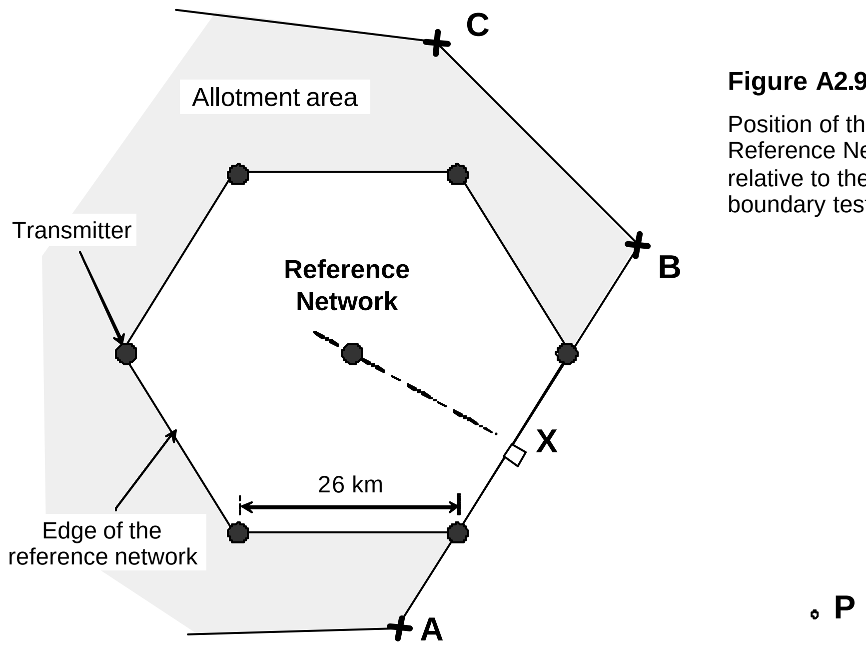


Figure A2.9:

Position of the 1.5 GHz Reference Network Two relative to the line joining boundary test points A and B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point X is the midpoint of the line A-B and is also the reference point of the reference network.
- The line defined by the points X and P is the perpendicular bisector of the line A-B and is also the line along which the interfering field strength is calculated.

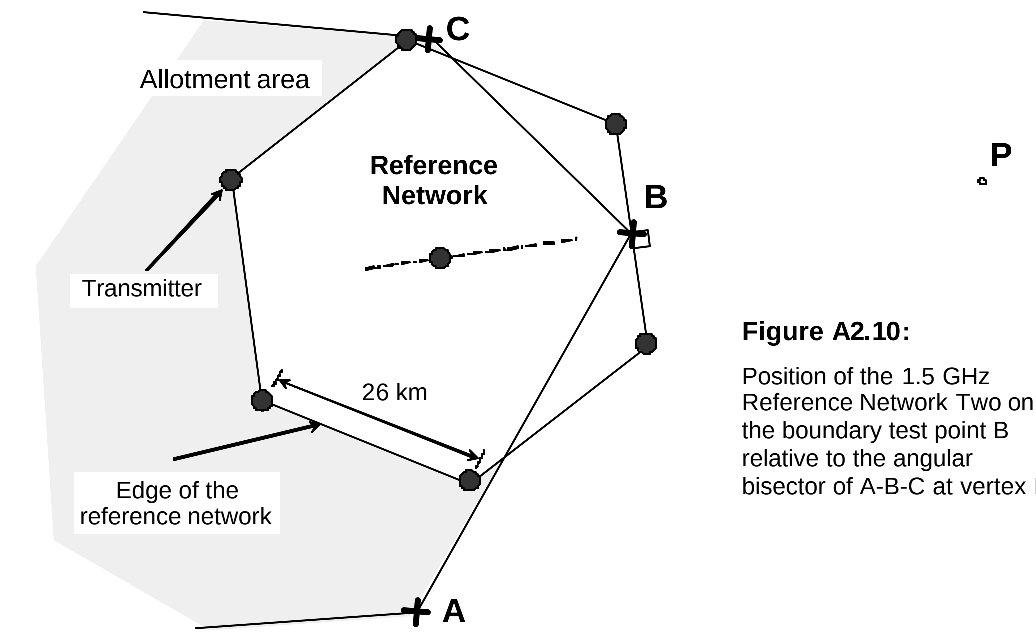


Figure A2.10:

Position of the 1.5 GHz Reference Network Two on the boundary test point B relative to the angular bisector of A-B-C at vertex B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point B is the vertex of the angle A-B-C and is also the reference point of the reference network.
- The line defined by the points B and P is the angle bisector of angle A-B-C and is also the line along which the interfering field strength is calculated.

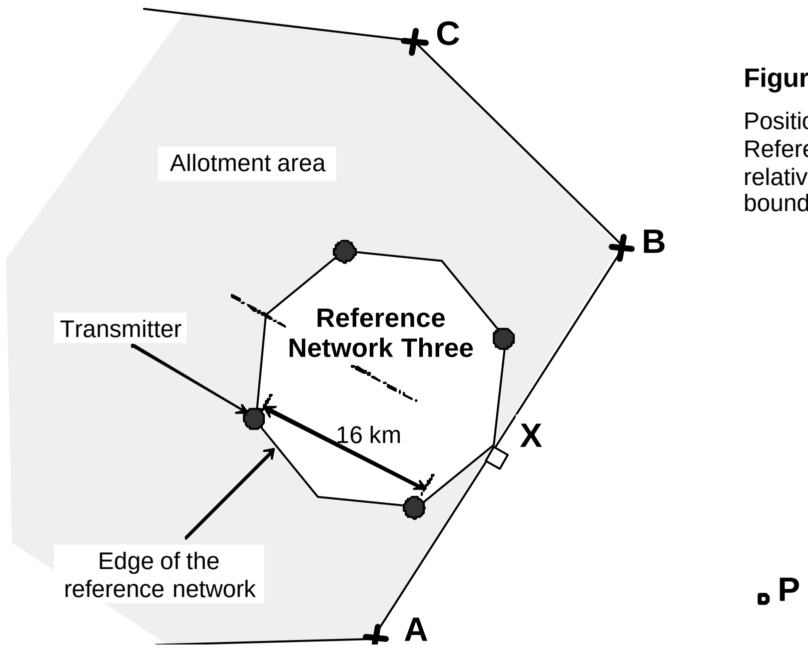


Figure A2.11:

Position of the 1.5 GHz Reference Network Three relative to the line joining boundary test points A and B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point X is the midpoint of the line A-B and is also the reference point of the reference network.
- The line defined by the points X and P is the perpendicular bisector of the line A-B and is also the line along which the interfering field strength is calculated.

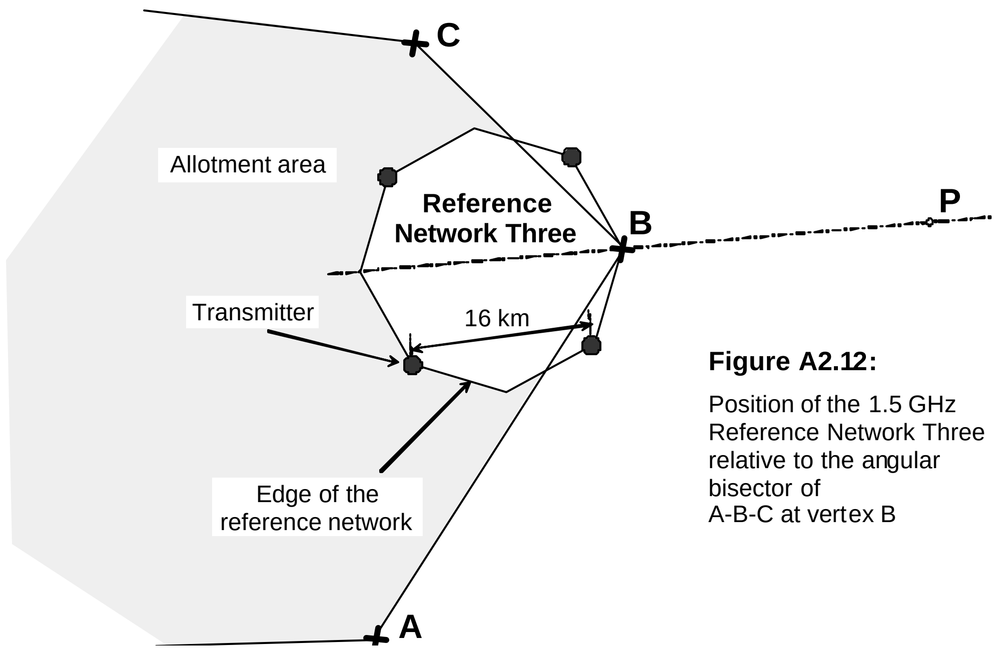


Figure A2.12:

Position of the 1.5 GHz Reference Network Three relative to the angular bisector of A-B-C at vertex B

Note:

- Points A, B and C are boundary points of the allotment area.
- The point B is the vertex of the angle A-B-C and is also the reference point of the reference network.
- The line defined by the points B and P is the angle bisector of the line A-B and is also the line along which the interfering field strength is calculated.

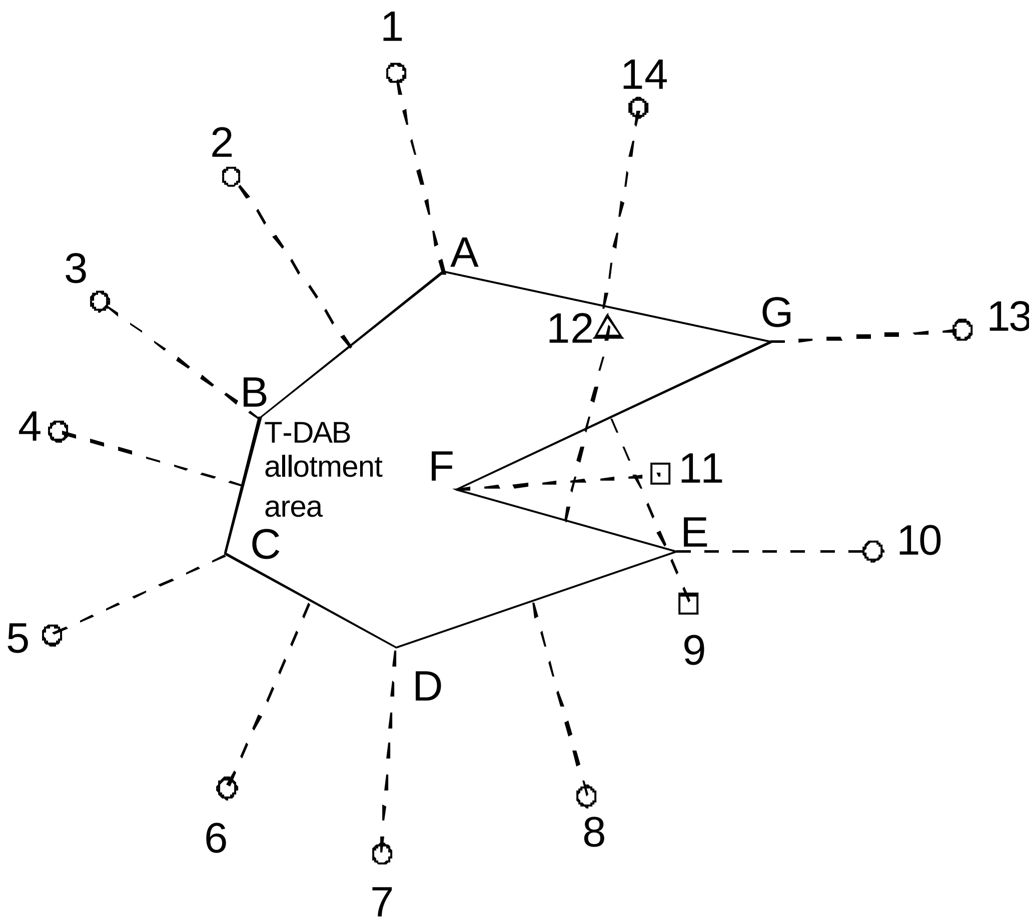


Figure A2.13: Location of the calculation test points

Note 1: Points A to G are the boundary test points of the allotment

Note 2: Points 1 to 14, excluding points 9, 11 and 12, are calculation test points

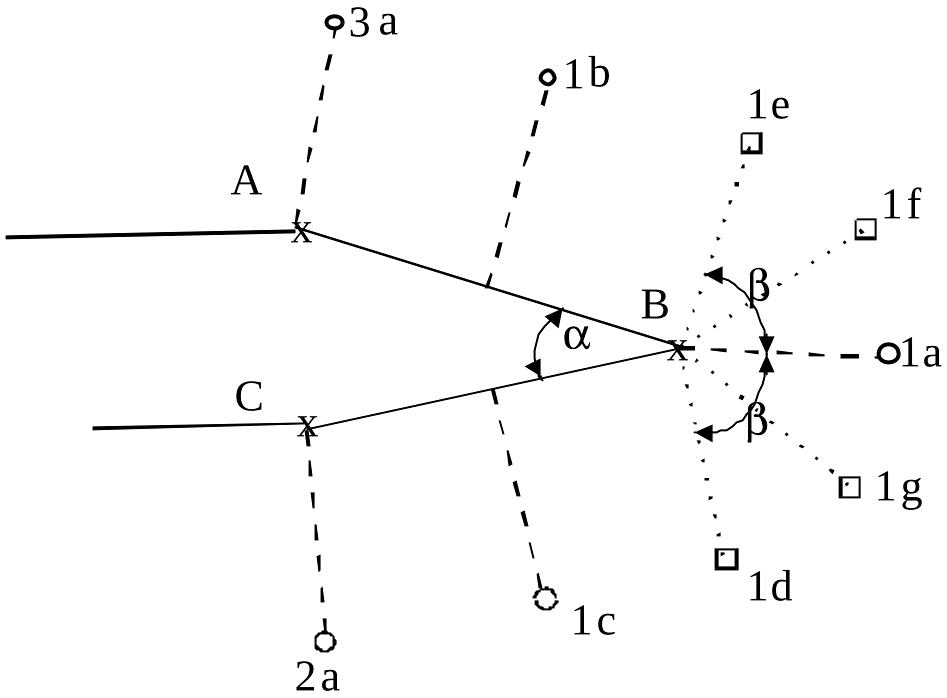


Figure A2.14: Construction of additional calculation test points if a < 180° (see Note below)

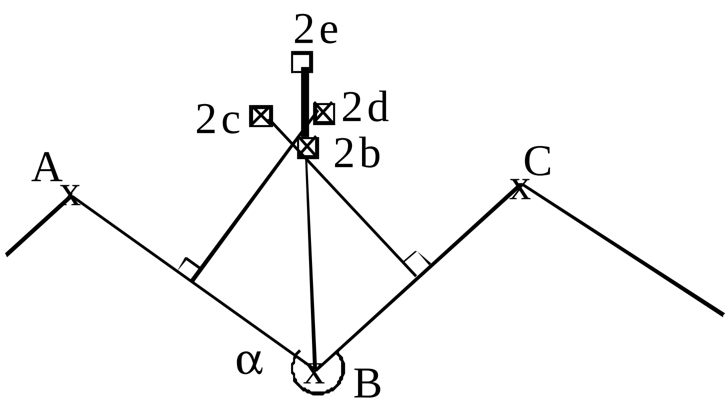


Figure A2.15: Construction of additional calculation test points if a ³ 180° (see Note below)

Note:	A, B, C	Boundary test points of allotment
○	1a, 1b, 1c, 2a, 3a	Calculation test points
□	1d, 1e, 1f, 1g, 2e	Additional calculation test points
☒	2b, 2c, 2d	Calculation test points disregarded because the field strength exceeds the specified threshold

Mathematical treatment of combining multiple field strengths

Evaluation of Sum Field Strengths, Coverage Probabilities and Network Gain
in Single Frequency Networks for Digital Broadcasting Services

1. Numerical methods

Numerical methods in general provide a better accuracy than the analytical methods described in Section 2, however they take more time. On the other hand, reference situations could preferably done by numerical methods such as the Monte Carlo Simulation without leading to a time problem, because they can be carried out in advance of the planning conference.

It should be noted that in the case of fields having greatly different standard deviations, it may lead to incorrect results if 'low' fields are omitted from the calculations if they have a 'high' standard deviation. This situation could give rise to the largest field values at small % of locations.

1.1 Numerical Integration

Numerical integration can be performed with the help of standard quadrature routines which are contained in commonly available mathematical libraries (for instance, the NAG or IMSL libraries).

1.2 Monte Carlo Simulation

An alternative approach is the treatment by means of a Monte Carlo (MC) simulation, which will be described in more detail. A sample of some 10,000 to 50,000 reception situations, for each small area calculation within the coverage area, yields reliable statistics.

Suppose there are given:

- n useful logarithmic fields F_i^{use} with Gaussian distribution (parameters $\overline{F}_i^{use}$, s_i^{use}, $i = 1 \ldots n$),
- m logarithmic interfering fields F_k^{int} with Gaussian distribution (parameters $\overline{F}_k^{int}$, s_k^{int}, $k = 1 \ldots m$),
- a protection ratio PR and noise N;

all quantities are given in dBs and represent system values, i.e. don't include probability margins.

The task is then to find the corresponding protection margin or coverage probability:

1. Using a random number generator, produce n sets:
$$\{F_{ij}^{use},\ j = 1 \ldots s\},\ i = 1 \ldots n,$$
with Gaussian distribution (parameters $\overline{F}_i^{use}$, s_i^{use}) for the n useful fields,
where s is the number of field strength values contained in each set.
2. Using a random number generator, produce m sets:
$$\{F_{kj}^{int},\ j = 1 \ldots s\},\ k = 1 \ldots m,$$
with Gaussian distribution (parameters $\overline{F}_k^{int}$, s_k^{int}) for the m interfering fields.
3. Transform the field strengths F_{ij}^{use} and F_{kj}^{int} to powers P_{ij}^{use} and P_{kj}^{int}:
$$P_{ij}^{use} = 10^{F_{ij}^{use}/10}, \quad P_{kj}^{int} = 10^{F_{kj}^{int}/10}.$$
4. Calculate the power sum of the useful signals:

$$P_j^{use} = \sum_{i=1}^{n} P_{ij}^{use}, \; j = 1 \ldots s.$$

5. Calculate the power sum of the interfering signals and add noise, where noise, N (absolute value) is derived from the difference between the minimum field strength, F_{min} (logarithmic value) and the required carrier to noise ratio, R (logarithmic value):

$$P_j^{int} = N + \sum_{k=1}^{m} P_{kj}^{int}, \; j = 1 \ldots s.$$

where $N = 10^{\frac{(F_{min} - R)}{10}}$

6. Evaluate the signal-to-(noise + interference) ratio:

$$\frac{P_j^{use}}{P_j^{int}}, \; j = 1 \ldots s.$$

7. Transform the signal/(noise + interference) ratio to logarithmic scale:

$$\left(\frac{C}{I+N}\right)_j = 10 \log_{10} \left\{ \frac{P_j^{use}}{P_j^{int}} \right\}, \; j = 1 \ldots s.$$

8. Sort the set $\left\{ \left(\frac{C}{I+N}\right)_j, \; j = 1 \ldots s \right\}$ and extract the distribution density $g\left(\frac{C}{I+N}\right)$ by normalisation.

9. Derive from $g\left(\frac{C}{I+N}\right)$ the probability distribution $P\left(\frac{C}{I+N}\right)$.

10. The value of P at $\frac{C}{I+N} = PR$ gives the coverage probability CP at the location under consideration.

If only the margin for a given percentage of locations is wanted, then it is not necessary to carry out the last three steps (8, 9 and 10). Instead, after step No 6 above, perform the following:

6.1 Sort the set $\left\{ \frac{P_j^{use}}{P_j^{int}}, \; j = 1 \ldots s \right\}$ and extract the value for the wanted location probability.

6.2 Transform the signal/(noise + interference) ratio to logarithmic scale:

$$\text{Margin}\,_{\textit{(\%location)}}\,(\text{dB}) = 10 \log_{10} \left\{ \frac{P^{use}}{P^{int}} \right\}_{\textit{(\%location)}}.$$

1.3 Computation aspects

Both approaches, numerical integration (see 1.1) as well as the Monte Carlo simulation (see 1.2), need a considerable computational effort which is inconvenient for practical coverage calculation purposes. Therefore, it is desirable to have approximations allowing for an analytical or at least a fast numerical treatment.

2. Analytic approximations

Many analytic approximations to the solution of the summation of statistical field strengths have been developed. Details of some of these are given below.

It should be noted that in the case of fields having greatly different standard deviations, it may lead to incorrect results if 'low' fields are omitted from the calculations if they have a 'high' standard deviation. This situation could give rise to the largest field values at small % of locations. This does not apply to the power sum method.

2.1 Power sum method

The power sum method is a procedure for the approximate calculation of the mean value of a sum field. If the mean value of the (logarithmic) field strength of a single signal is denoted by $\bar{F}$ and is expressed in dBµV/m, its power P (in absolute units) is given by

$$P = 10^{\frac{\bar{F}}{10}}.$$

For n individual fields, the respective powers are added:

$$P_S = \sum_{i=1}^{n} P_i .$$

and the mean value $\bar{F}_S$ of the (logarithmic) sum field strength is calculated as:

$$\bar{F}_S = 10 \times \log_{10}(P_S)$$

For the unwanted signal, the powers of the mean values of the individual nuisance fields are added to the power of the minimum field strength (representing the noise contribution). For the wanted signal in an SFN, the powers of the individual useful fields are added. A 50%-location coverage is obtained if the sum of the unwanted-signal levels equals the sum of the wanted-signal levels.

For T-DAB, a margin must be added to the resulting nuisance field in order to cover more than 50% of the locations. This margin is related to the target percentage of locations. Its value is not derived by the power sum method. Usually a value derived from the standard deviation of a single signal is used.

2.2 Simplified multiplication method

The simplified multiplication method gives the coverage probability in the presence of several interfering signals which are assumed to be log-normally distributed with known mean values and standard deviations. The coverage area can be determined by calculating the probability for different locations. The contour of the coverage area is made up of the set of locations where the coverage probability achieves the required value.

As the effect of noise is not taken into account in the statistical treatment, over-estimation of the coverage can be expected when the levels of the interferers are low. However, it is possible to add the effect of noise at the end of the calculation process.

This method is explained in detail in EBU doc. Tech 3254 [5], **but it must be noted that it is not applicable to SFNs since it cannot deal with (the power addition of) multiple useful signals.**

2.3 The LNM method

The log-normal method is an approximation method for the statistical computation of the sum distribution of several log-normally distributed variables. The method is based on the assumption that the resulting sum distributions of the wanted and unwanted fields are also log-normal. To some extent, the LNM is able to cope with different standard deviations of the single field distributions.

To improve the accuracy of the LNM, a correction factor can be introduced. This version of the LNM is called k-LNM. As can be seen from step 4 in § 2.4.1 below, k-LNM is identical to the standard LNM if the factor k is equal to 1.

2.4 LNM related methods

In the following sections, two approximations, k-LNM and t-LNM, are described. k-LNM differs only slightly from the standard LNM approach by the additional use of a correction factor k, enabling more accurate results to be obtained for the distributions of the summed fields in the probability range of interest for coverage calculations (eg 99% locations). The t-LNM method offers greater accuracy, at the expense of increased calculation time and complexity.

2.4.1 k-LNM

The approach assumes that the distribution of the sum of two log-normally distributed statistical variables can be described by a new log-normal distribution, the mean value and standard deviation of which are taken to be identical with those of the true sum distribution:

$$M_{power}^{approx.} = M_{power}^{true} \,,\; S_{power}^{approx.} = S_{power}^{true} \;,$$

where M and S denote mean value and standard deviation of the respective log-normal power distribution.

Since the resulting approximate sum distribution is log-normal, it can be combined again with a third log-normal distribution, and so on, thus enabling the construction of an approximate distribution of n log-normally distributed statistical variables. This procedure can be performed analytically.

k-LNM suffers from the drawback that the appropriate correction factor k depends on the number, the powers and the variances of the fields being summed, as well as the location percentage for which the calculation is being done. To obtain optimal results, an interpolation table for the derivation of the value of k would be necessary, which is not suitable for a heuristic approach like k-LNM. Therefore, to keep the simple and analytic character of the approximation, an average value of k is chosen, derived from a sample of representative field configurations. This simplification still results in an inaccuracy for a few, none the less typical, configurations which amount to some dBs for 99% locations. For the summation of fields with standard deviations between 6 and 10 dB the value k = 0.5 seems to represent a fair compromise. For smaller values of standard deviations a higher value for k should be used, e.g. k = 0.7. If k is set to 1.0, k-LNM is identical to the standard LNM approach.

The summation can be performed either by taking the individual contributions "one-by-one" or "all-at-once".

"ALL-AT-ONCE"

Suppose there are given:
n logarithmic fields F_i with Gaussian distribution (parameters $\overline{F}_i$, s_i, $i = 1 \dots n$), i.e., the corresponding powers are log-normally distributed.

The task is to determine the approximate log-normal distribution of the power sum, or, equivalently, to find the parameters of the Gaussian distribution of the corresponding logarithmic sum field:

1. Transform $\overline{F}_i$, s_i, $i = 1 \dots n$, from dB scale to Neper scale (this avoids nasty constants in the calculation):

$$X_{Neper} = \frac{1}{10 \times \log_{10}(e)} * X_{dB} \ .$$

2. Evaluate the mean values M_i and the variances S_i^2 of the n power distributions:

$$M_i = e^{\overline{F}_i + \frac{s_i^2}{2}}, \quad S_i^2 = e^{2\overline{F}_i + s_i^2} \times \left(e^{s_i^2} - 1\right), \quad i = 1 \dots n, \qquad \text{(Neper scale)}$$

3. Determine mean value M and variance S^2 of the sum power distribution:

$$M = \sum_{i=1}^{n} M_i, \quad S^2 = \sum_{i=1}^{n} S_i^2, \qquad \text{(Neper Scale)}$$

4. Determine the distribution parameters $\overline{F}_S$ and s_S of the approximate log-normal sum distribution:

$$s_S^2 = \log_e\left(k\frac{S^2}{M^2} + 1\right), \quad \overline{F}_S = \log_e(M) - \frac{s_S^2}{2}, \qquad \text{(Neper Scale)}$$

5. Transform $\overline{F}_S$ and s_Σ from Neper scale to dB scale:

$$X_{dB} = 10 \times \log_{10}(e) * X_{Neper} \ .$$

$\overline{F}_S$ and s_S are the mean value and the standard deviation, respectively, of the Gaussian distribution of the logarithmic sum field.

"ONE-BY-ONE" (OR "ONE-BY MANY" OR "MANY-BY MANY")

If some of the fields have already been determined by combining two or more fields using the k-LNM method, more care is needed to avoid multiplication with the k-factor more than once per field.
Assume the physical fields are denoted by F_i as before, and the 'composite' fields (i.e., those that have been determined previously using the k-LNM) are denoted by G_j with Gaussian distribution (parameters $\overline{G}_j$, $?_j$, $j = 1 \dots m$),

2'. Then in addition to step 2 above evaluate also the mean values A_j and the variances T_j^2 of the m 'composite' power distributions:

$$A_j = e^{\overline{G}_j + \frac{?_j^2}{2}}, \quad T_i^2 = e^{2\overline{G}_j + ?_j^2} \times \left(e^{?_j^2} - 1 \right), \quad j = 1..m,$$

and modify step 3 to:

3'. Determine mean value M and variance S^2 of the sum power distribution:

$$M = \sum_{i=1}^{n} M_i + \sum_{j=1}^{m} A_j, \quad S^2 = \sum_{i=1}^{n} S_i^2 + \frac{1}{k} \sum_{j=1}^{m} T_j^2 .$$

This last factor, 1/k, 'undoes' the effect of the previous k-LNM 'composition', preparing for the new, extended, 'composition'; otherwise the k-factor for this part will be taken into account twice.
Steps 4 and 5 are the same as before.

EXAMPLE ("ALL-AT-ONCE")

In the following example the evaluation of the parameters of the sum distribution of three identical fields is demonstrated and the numerical values of the intermediate results of steps 1 to 5 are given. The parameters are chosen to be 60 dBµV/m for the mean values of the distributions of the logarithmic fields and 5.5 dB for the standard deviations. The k-factor is set to k = 0.7.

1.1	$\overline{F}_i^{(dB)} = 60.000, \quad s_i^{(dB)} = 5.500,$	i = 1,2,3	(dB scale)
1.2	$\overline{F}_i^{(Neper)} = 13.816, \quad s_i^{(Neper)} = 1.266,$	i = 1,2,3	(Neper scale)
2.	$M_i = 2.230 \times 10^6, \quad S_i^2 = 1.975 \times 10^{13},$	i = 1,2,3	(Neper scale)
3.	$M = 6.689 \times 10^6, \quad S^2 = 5.925 \times 10^{13},$		(Neper scale)
4.	$\overline{F}_S^{(Neper)} = 15.388, \quad s_S^{2(Neper)} = 0.656, \quad s_S^{(Neper)} = 0.810,$		(Neper scale)
5.	$\overline{F}_S^{(dB)} = 66.830, \quad s_S^{(dB)} = 3.517,$		(dB scale)

2.4.2 t-LNM

More accuracy within the framework of the LNM can be obtained with the t-LNM approach. It approximates the distribution of the logarithmic sum field strength by a Gaussian distribution which possesses the same mean value and the same variance as the true distribution:

$$M^{approx.}_{fieldsstrength} = M^{true}_{fieldstrength}, \quad S^{approx}_{fieldstrength} = S^{true}_{fieldstrength} .$$

This approach gives a better description of the true sum distribution, in particular, of its lower tail.

Since the resulting approximate distribution is Gaussian, as are the distributions of the individual fields, the method allows for the successive construction of the distribution of the logarithmic sum field strength built from n single fields.

A difficulty for the approach arises from the fact that M and S cannot be calculated analytically. As a consequence, an extensive interpolation table (some 1000 values) has to be prepared by means of numerical integration or Monte Carlo simulation for a reasonable range of possible field strength values and standard deviation values. The basic evaluation for two fields can then be performed by trilinear interpolation.

Once the interpolation table has been set up, the method is easily applied with a computational effort similar to that of the analytical standard LNM. The benefits of the approach are given by its high accuracy (1 - 2 dB for the 1%-fractile) and its applicability to a large variety of field configurations.

2.4.3 t-LNM (V2)

This method of computing the sum field from component field parameters (mean, variance) which provides a reduction of computational load compared to earlier versions of t-LNM. The principal structure of computing the sum field by combining the n-th component field with the sum of the fields 1 to n-1 by means of interpolation tables has been retained. By exploiting the properties of a suitably chosen analytical approximation of the expression for the sum of two fields it has become possible to compute the interpolation tables at run time and to replace the two trilinear interpolation steps by three bilinear interpolations, which cuts down the number of necessary operations to almost ½ of the double trilinear version t-LNM (V1).

2.4.3.1 The t-LNM(V2) Algorithm

Let f_1 and f_2 be the (uncorrelated and normally distributed) intensity levels of the two fields to be combined. The corresponding sum field level is given by:

$$f = \log_e(e^{f_1} + e^{f_2}), \qquad (1)$$

which can be written in the form

$$f = \frac{1}{2}(f_1 + f_2) + \log_e\left(e^{x/2} + e^{-x/2}\right) \qquad (2)$$

where

$$x = f_1 - f_2 \ . \qquad (3)$$

From (2) it follows that the mean value <f> of the sum field level f has the form

$$\langle f \rangle = \frac{1}{2}\left(\langle f_1 \rangle + \langle f_2 \rangle\right) + U\left(\bar{x}, s_x\right), \qquad (4)$$

where $<f_1>$ and $<f_2>$ are the mean values of f_1 and f_2, respectively and

$$U(\bar{x}, s_x) := \langle \log_e(e^{x/2} + e^{-x/2}) \rangle . \qquad (5)$$

For convenience, $\bar{f}$ is used in place of <f> in some of the following equations.

Clearly $U(\bar{x}, s_x)$ depends on the parameters of the distribution of x only; by proposition, x is normally distributed with mean $\bar{x} = \bar{f}_1 - \bar{f}_2$ and variance $s_x^2 = s_1^2 + s_2^2$. The variance of f can be written in the form

$$\langle f^2\rangle - \langle f\rangle^2 = \frac{1}{4}s_x^2 + V(\bar{x},s_x) - [U(\bar{x},s_x)]^2 + \tilde{W}(\bar{x},s_1,s_2), \qquad (6)$$

where

$$V(\bar{x},s_x) = \langle \left[\log_e(e^{x/2}+e^{-x/2})\right]^2 \rangle \qquad (7)$$

and

$$\tilde{W}(s_1,s_2) = \langle (f_1-\bar{f}_1+f_2-\bar{f}_2)\times\log_e(e^{x/2}+e^{-x/2}) \rangle\ . \qquad (8)$$

The term $\log_e(e^{x/2}+e^{-x/2})$ can be approximated by:

$$\log_e(e^{x/2}+e^{-x/2}) = \frac{1}{2}|x| + Ce^{-A|x|-Bx^2}\ . \qquad (9)$$

Using the coefficients A = 0.685437037
B = 0.08198801
C = 0.686850632

The maximum error in equation 9 is less than 7×10^{-3}, occurring for x in the interval [-4, 4]. When the approximation (9) is inserted into the expressions (5), (7) and (8) the mean values can be evaluated. It turns out that

$$U(\bar{x},s_x) = \bar{x}\left[F\left(\frac{\bar{x}}{s_x}\right)-\frac{1}{2}\right] + \frac{s_x}{\sqrt{2p}}e^{-\frac{\bar{x}^2}{2s_x^2}} + \frac{Ce^{-\frac{\bar{x}^2}{2s_x^2}}}{\sqrt{1+2Bs_x^2}}\left[e^{\frac{K_+^2}{2}}F(-K_+) + e^{\frac{K_-^2}{2}}F(K_-)\right], \qquad (10)$$

where

$$K_\pm = \frac{\bar{x}/s_x \pm As_x}{\sqrt{1+2Bs_x^2}} \qquad (11)$$

and where $F(y) = \frac{1}{\sqrt{2p}}\int_{-\infty}^{y} e^{-\frac{m^2}{2}}\,dm$ is the cumulative normalized normal distribution.

V is given by

$$V(\bar{x},s_x) = \frac{1}{4}(\bar{x}^2+s_x^2) + \frac{Cs_x}{1+2Bs_x^2}e^{-\frac{\bar{x}^2}{2s_x^2}} \bullet \left[\sqrt{\frac{2}{p}} - K_+e^{\frac{K_+^2}{2}}F(-K_+) + K_-e^{\frac{K_-^2}{2}}F(K_-)\right]$$

$$+\frac{C^2}{\sqrt{1+4Bs_x^2}}e^{\frac{-2B\bar{x}^2+2A^2s_x^2}{1+4Bs_x^2}} \bullet \left[e^{\frac{2A\bar{x}}{1+4Bs_x^2}} \bullet F\left(-\frac{\bar{x}/s_x+2As_x}{\sqrt{1+4Bs_x^2}}\right) + e^{\frac{-2A\bar{x}}{1+4Bs_x^2}} \bullet F\left(\frac{\bar{x}/s_x-2As_x}{\sqrt{1+4Bs_x^2}}\right)\right]. \qquad (12)$$

$\tilde{W}$ finally can be written as

$$\tilde{W} = (s_1^2 - s_2^2) \bullet W(\overline{x}, s_x) \ , \qquad (13)$$

where

$$W(\overline{x}, s_x) = F\left(\frac{\overline{x}}{s_x}\right) - \frac{1}{2} + Ce^{-\frac{\overline{x}^2}{2s_x^2}} \bullet \left\{ \frac{1}{s_x(1+2Bs_x^2)} \left[K_+ e^{\frac{k_+^2}{2}} F(-K_+) + K_- e^{\frac{k_-^2}{2}} F(K_-) \right] - \right.$$

$$\left. \frac{\overline{x}}{s_x^2 \sqrt{1+2Bs_x^2}} \left[\left[e^{\frac{k_+^2}{2}} F(-K_+) + e^{\frac{k_-^2}{2}} F(K_-) \right] \right] \right\} . \qquad (14)$$

Once the functions U, V and W have been tabulated (which due to the many similarities of the terms appearing in (10), (12) and (14) consumes only a moderate amount of computing time) the combination of two fields can very simply be accomplished by first computing $\overline{x}$ and s_x, then finding the corresponding values of the functions U, V and W by bilinear interpolation in the respective tables, and finally computing the mean sum field level by formula (4) and the variance as:

$$\left\langle f^2 \right\rangle - \left\langle f \right\rangle^2 = \frac{1}{4} s_x^2 + V(\overline{x}, s_x) - [U(\overline{x}, s_x)]^2 + \left(s_1^2 - s_2^2\right) W(\overline{x}, s_x) . \qquad (15)$$

The error involved in this approximation depends on the detail of the tables constructed for U, V and W.

3. Applications for the LNM Methods

3.1 Evaluation of protection margin

In order to determine the protection margin, the following procedure can be carried out using the formula for determining the field strength exceeded for p% of locations in terms of the median field strength and the standard deviation:

$$F(p\%) = F_{med} + f(p\%) \cdot \sigma \ ,$$

where

$F(p\%)$ is the field strength exceeded for p% of locations
F_{med} is the median field strength
$f(p\%)$ is the probability correction factor for p% of locations
σ is the standard deviation.

Then, using the parameters in the example "All at Once" (§ 2.4.1 of this Annex):

1. F^1_{med} = 60.000 , σ = 5.500 dB , $f(99\%)$ = -2.33
2. $F^1(99\%)$ = 47.185 dB,

and for the sum of 3 identical fields:

3. F^3_{med} = 66.830 , σ = 3.517 dB , $f(99\%)$ = -2.33
4. $F^3(99\%)$ = 58.635 dB,
5. Protection Margin = $F^3(99\%) - F_{min}$ = 58.635 - 58 = 0.635 dB

3.2 Evaluation of network gain

Continuing with the above example, the network gain can be calculated as follows:

6. Network Gain = $F^3(99\%) - F^1(99\%)$
   Network Gain = 58.635 - 47.185 = 11.450 dB

3.3 Evaluation of coverage probability

The calculation of the coverage probability is split into three parts:

- Calculation of the useful sum field strength,
- Calculation of the interfering sum field strength,
- Evaluation of the coverage probability.

For the first two parts, the LNM approximations are needed to perform the summation of field strengths.

After one of the LNM approaches has been applied to both the useful and the interfering fields, yielding the distribution parameters $\overline{F}_S^{use}$, s_S^{use} and $\overline{F}_S^{int}$, s_S^{int}, respectively, the coverage probability CP can be calculated by simple error function evaluations as shown in the following equation. PR and F_{min} denote protection ratio and minimum field strength, respectively. The further approximation, which goes along with the split of the probability expression for CP into the product of two separate probability expressions, does not introduce a significant additional error.

$$CP = P(F_S^{use} - F_S^{int} > PR) * P(F_S^{use} - F_{min} > 0)$$

where

$$P(F_S^{use} - F_S^{int} > PR) = I\{\bar{F}_S^{use} - (\bar{F}_S^{int} + PR), \sqrt{(s_S^{use})^2 + (s_S^{int})^2}\},$$

$$P(F_S^{use} - F_{min} > 0) = I\{\bar{F}_S^{use} - F_{min}, s_S^{use}\},$$

and the function I is given by

$$I(F,\ s) = \frac{1}{2}\left(1 + \mathrm{erf}\left(\frac{-F}{\sqrt{2}s}\right)\right)$$

The error function erf is evaluated with the help of tables or parametrisations. These can be found in mathematical handbooks.

Derivation of simplified formulae for use in outgoing interference summation

$$\text{Equivalent FS } E_c \text{ in dB}\mu\text{V/m} = E_c$$

$$\text{Equivalent FS of the } n^{th} \text{ Tx in V/m} = E = 10^{\frac{(En-120)}{20}}$$

$$\text{Power Density } P_{dn}(\text{W/m}^2) = \frac{E^2}{R} = \frac{10^{\left(\frac{(E_1-120)}{20}\right)^2}}{120p} \qquad \text{Where } R = 120p$$

$$P_{dn} = \frac{10^{\left(\frac{(E_1-120)}{10}\right)}}{120p}$$

$$\text{Power Sum } P_s = P_{d1} + P_{d2}$$

$$P_s = 10^{\frac{\left(\frac{(E_1-120)}{10}\right)}{120 \cdot p}} + 10^{\frac{\left(\frac{(E_2-120)}{10}\right)}{120 \cdot p}}$$

$$P_s = \frac{\left(10^{\left(\frac{(E_1-120)}{10}\right)} + 10^{\left(\frac{(E_2-120)}{10}\right)}\right)}{120 \bullet p}$$

$$\text{Equivalent Field Strength } E_{ps} \text{ V/m} = \sqrt{P_s \cdot R}$$

$$E_{ps} = \sqrt{\frac{\left(10^{\left(\frac{(E_1-120)}{10}\right)} + 10^{\left(\frac{(E_2-120)}{10}\right)}\right) \cdot 120 \cdot p}{120 \cdot p}}$$

$$E_{ps}((\mu\text{V/m}) = 10^6 \times \sqrt{\left(10^{\left(\frac{(E_1-120)}{10}\right)} + 10^{\left(\frac{(E_2-120)}{10}\right)}\right)}$$

$$E_{ps}(\text{dB}\mu\text{V/m}) = 20\log 10^6 + 20\log\left(\sqrt{\left(10^{\left(\frac{(E_1-120)}{10}\right)} + 10^{\left(\frac{(E_2-120)}{10}\right)}\right)}\right)$$

$$E_{ps}(\text{dB}\mu\text{V/m}) = 120 + 10\log\left(10^{\left(\frac{(E_1-120)}{10}\right)} + 10^{\left(\frac{(E_2-120)}{10}\right)}\right)$$

$$\text{Equivalent Field Strength } \mathrm{E_{ps}}\,(\mathrm{dB\mu V/m}) = 120 + 10\log\left(10^{\left(\frac{(E_1-120)}{10}\right)} + 10^{\left(\frac{(E_2-120)}{10}\right)}\right)$$

$$= 120 + 10\log\left(10^{\left(\frac{\mathrm{E_1}}{10}\right)} \times 10^{\left(\frac{-120}{10}\right)} + 10^{\left(\frac{\mathrm{E_2}}{10}\right)} \times 10^{\left(\frac{-120}{10}\right)}\right)$$

$$= 120 + 10\log\left(\left(10^{\left(\frac{\mathrm{E_1}}{10}\right)} + 10^{\left(\frac{\mathrm{E_2}}{10}\right)}\right) \times 10^{-12}\right)$$

$$= 10\log\left(10^{\left(\frac{\mathrm{E_1}}{10}\right)} + 10^{\left(\frac{\mathrm{E_2}}{10}\right)}\right) + 10\log 10^{-12} + 120$$

$$= 10\log\left(10^{\left(\frac{\mathrm{E_1}}{10}\right)} + 10^{\left(\frac{\mathrm{E_2}}{10}\right)}\right)$$

$$= 10\log\left(\mathrm{P}_{f1} + P_{f2}\right)$$

$$\text{Equivalent Field Strength } \mathrm{E_{ps}}\,(\mathrm{dB\mu V/m}) = 10\log\sum \mathrm{P}$$

Calculating the statistical network gain

1. Examples

Consider the case where a collection of n wanted signals covers a particular small area of the coverage zone. Reception is adequate if the received signal exceeds a given reference level. The signals are assumed to be independent, have median values L_1, …, L_n, and have the same standard deviation. The task is to calculate the statistical network gain of the collection in the small area.

Assume the strongest signal reaches the desired reference level at p_1 percent of the locations and the other signals reach the desired level at p_2, … , p_n percent of the locations. Then the reference level will be exceeded by at least one of the signals at P = $\{1-(1- p_1) \times (1-p_2) \times \ldots \times (1-p_n)\}$ percent of the locations. The standard deviation multiplied by the difference between the Gaussian distribution factors for p_1 percent and P percent, yields the statistical network gain for the collection of signals in the small area.

Example 1

Two signals reach the reference level at 90% of the locations; the standard deviation is 5.5 dB.

The strongest signal reaches the reference level at 90% of the locations (they both do).

Then at least one of the signals reaches the reference level at

$$P = (1 - (1 - .9)) \times (1 - .9) = .99 = 99\% \text{ of the locations.}$$

The Gaussian distribution for 99% is 2.33 and that for 90% is 1.28.

The statistical network gain is 5.5 × (2.33 - 1.28) = 5.77 dB[1].

Example 2

Two signals reach the reference level at 90% of the locations and 50% of the locations, respectively; the standard deviation is 5.5 dB.

The strongest signal reaches the reference level at 90% of the locations.

Then at least one of the signals reaches the reference level at

$$P = (1 - (1 - .9)) \times (1 - .5) = .95 = 95\% \text{ of the locations.}$$

The Gaussian distribution for 95% is 1.64 and that for 90% is 1.28.

The statistical network gain is 5.5 × (1.64 - 1.28) = 1.98 dB.

Example 3

Three signals reach the reference level at 90% of the locations, 70% of the locations, and 66? % of the locations, respectively; the standard deviation is 5.5 dB.

The strongest signal reaches the reference level at 90% of the locations.

Then at least one of the signals reaches the reference level at

[1] The statistical network gain is specified here are a precise number. Actually, as in the case of total network gain, the value 5.77 in this example means that at 90% of the locations the single contributor value has been exceeded by at least 5.77 dB.

P = (1 - (1 - .9)) × (1 - .7) × (1 - .666) = .99 = 99% of the locations.

The Gaussian distribution for 99% is 2.33 and that for 90% is 1.28.

The statistical network gain is 5.5 × (1.64 - 1.28) = 5.77 dB.

Example 4

Three signals reach the reference level at 70% of the locations, 66? % of the locations, and 50% of the locations, respectively; the standard deviation is 5.5 dB.

The strongest signal reaches the reference level at 70% of the locations.

Then at least one of the signals reaches the reference level at

P = (1 - (1 - .7)) × (1 - .666) × (1 - .5) = .95 = 95% of the locations.

The Gaussian distribution for 95% is 1.64 and that for 70% is 0.52.

The statistical network gain is 5.5 × (1.64 - 0.52) = 6.16 dB.

2. Network gain

2.1. Heuristic Mathematical Description

In order to get a feeling for the meaning of 'additive network gain' arising with a set of statistically-varying fields the following simplistic description may help.

Take the case of two wanted fields, having field strengths A and B=A-X. Assuming for the moment that the fields are static, the power sum of the two fields yields

$$P = 10\log\left(10^{A/10} + 10^{(A-X)/10}\right) = 10\log\left[10^{A/10}\left(1+10^{-X/10}\right)\right] = A + 10\log\left(1+10^{-X/10}\right)$$

The term 'A' represents the field strength of the stronger of the two signals. The second term,

$$c = 10\log\left(1+10^{-X/10}\right) = P - A,$$

represents the additive part (the additive network gain) of the combination, the part which arises due to the presence of the second field.

In fact, the two fields A and B both exhibit location variation. Therefore the quantities X = A - B and c = P - A, both of which depend on A and B, also vary with location, i.e. are not constant. If we are interested in the value of the combined field strength which is exceeded at a certain percentage of locations, the term 'c' must be included, even when the median value of A is larger than that of B.

The value of c varies between 0 and 3 dB as X runs through ∞ to 0 for two contributing field strengths. Similar but more complicated considerations could be made for three, four, … contributing field strengths, giving rise to values of c varying between 0 and 4.8 dB, 0 and 6 dB, …, respectively. Furthermore X runs through ∞ to 0, even when the median values of the field strengths A and B are equal because of their statistical variations. In short, the amount of additive network gain that may be expected is not constant and is limited. If X varies from x_1 to x_2, then c will vary from χ_1 to χ_2, say, and the < c > valid for this range will be some sort of 'average' between χ_1 and χ_2. For example, if we are interested in 1% levels, X will be large at most locations, and χ will be close to 0 dB; if we are interested in the 99% levels, X (being the difference between the larger and smaller signal) will more often be close to 0, and thus χ can be expected to be closer to 3 dB.

It should be noted that the above 'derivation' was simplified in the following manner. Field strengths A and B are varying, usually with little or no correlation. This means that the value of the field strength A is larger than field strength B at some places and smaller at others. Thus the statistics of the term χ' become more complicated than discussed above. The larger the number of contributing fields, the more complex this situation becomes.

2.2 Graphical Description

We can get a feeling for the location percentage dependency of the statistical, additive and total network gain by considering the simple, but special case of (nearly) equal median values[2] for two wanted field strengths. In the Figure the variations of two independent field strengths are indicated at 100 points (100 is chosen to be able to identify the 1% and 99% values easily):

- The median value of the ‘main’ field is 60 dB and that of the ‘second’ field is 59.5 dB.
- The standard deviations are about 5.5 dB.
- The values for the maximum (‘max’) of the two field strengths and the power sum (‘total’) are also indicated at each point.
- A set of horizontal lines (‘m99’, ‘mx99’, and ‘t99’) indicate the 99% levels[3] of the ‘main’, ‘max’ and ‘total’ distributions and a second set (‘m01’, ‘mx01’, and ‘t01’) indicate the 1% levels[4].

It is seen that the ‘spread’ between the 99% levels is much more than that between the 1% levels. This can be understood in the following way:

- From the Figure it is seen that, in the 99% case, there are many values of the ‘other’ field which are much ‘higher’ than the 99% ‘main’ level. Thus there is much chance for increasing the 99% ‘main’ level by a ‘high’ amount, by maximising or by power summing. In the 1% case there are many values of the ‘other’ field which are much ‘lower’ than the 1% ‘main’ level. Thus there is not much chance for increasing the 1% ‘main’ level by a ‘high’ amount by maximising or by power summing: we must be content with a ‘small’ increase.
- Thus the likelihood in each case is that the 99% ‘main’ level will be raised by more to reach the 99% ‘max’ level and the 99% ‘total’ level, respectively, than the 1% ‘main’ level will be raised to the 1% ‘max’ level and the 1% ‘main’ level, respectively.
- From the Figure it is seen that the 99% ‘max’ level for the maximum of two fields occurring at a point is about 6 dB higher than the 99% ‘main’ level. Also, the 99% ‘total’ level is about 8 dB higher than the 99% ‘main’ level. The difference, about 2 dB, is the ‘additive network gain’.
- It is also seen that the 1% ‘max’ level for the maximum of two fields occurring at a point is about 1.5 dB higher than the 1% ‘main’ level. Also, the 1% ‘total’ level is about 2 dB higher than the 1% ‘main’ level. The difference, about 0.5 dB, is the ‘additive network gain’.

[2] We make a small difference between the fields to be able to distinguish clearly between the ‘stronger’ and the ‘weaker’ field.
[3] The 99% level means that 99 values are above that level.
[4] The 1% level means that 1 value is above that level.

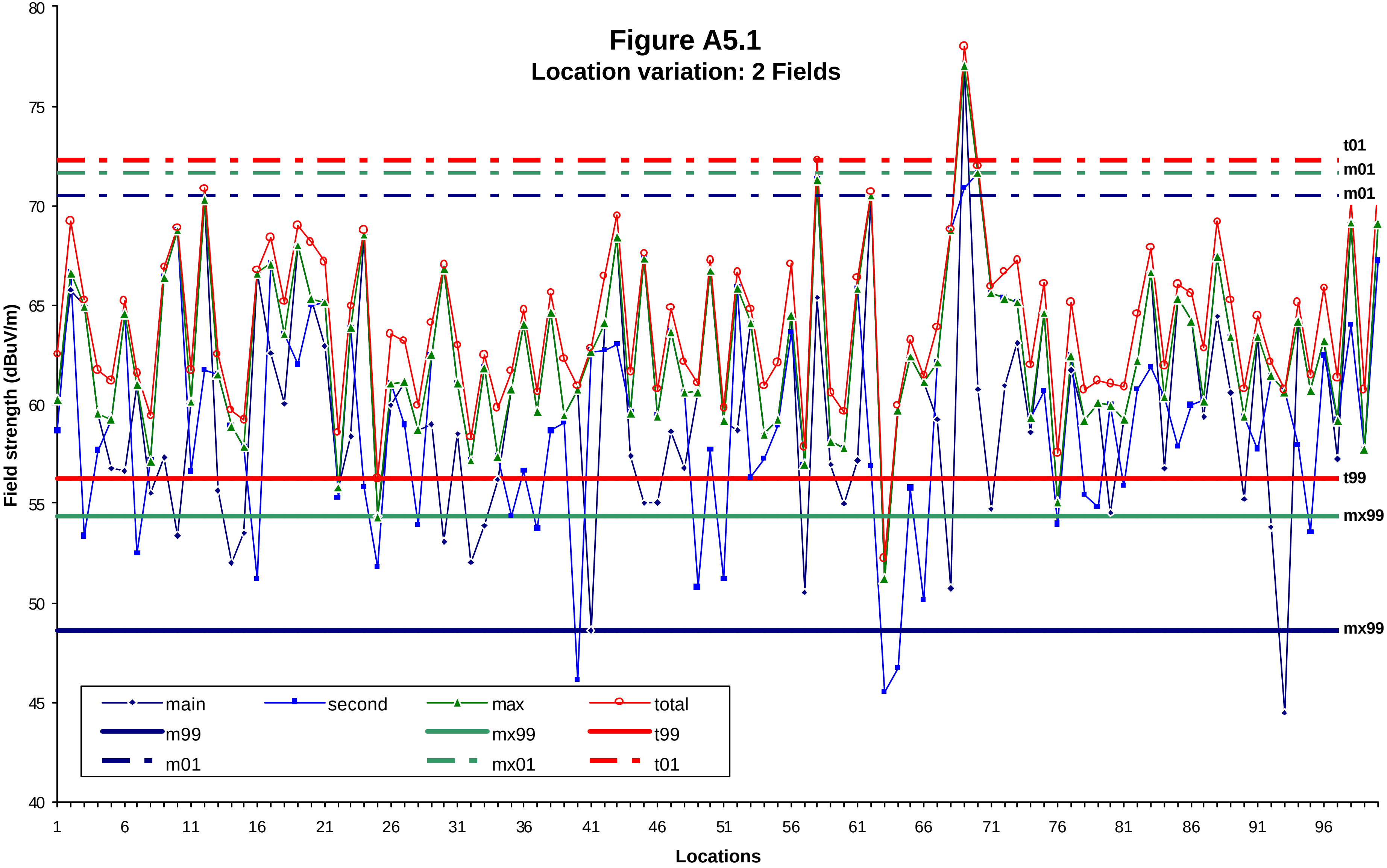


Figure A5.1
Location variation: 2 Fields
Field strength (dBuV/m)
Locations
80
75
70
65
60
55
50
45
40
1
6
11
16
21
26
31
36
41
46
51
56
61
66
71
76
81
86
91
96
t01
m01
m01
t99
mx99
mx99
main
second
max
total
m99
mx99
t99
m01
mx01
t01

Interference potential of T-DAB Reference networks

This annex contains graphs and tables showing the interference potential for the Reference networks described in § 4.

For the sea paths the transmitters of the Reference Network are assumed to be located on land with the sea path starting at the reference point of the network.

Note: In the figures A6.1b, A6.2a, A6.2b and A6.5b a rather sudden change in the interference potential can be seen at a distance between 20 km and 50 km. The figures all show interference potential from closed hexagonnally shaped reference networks. The reason for the sudden change is that the contributions from two of the seven transmitters change from high level to reduced level at this distance because of the shape of the radiation pattern (See § 4.10.2).

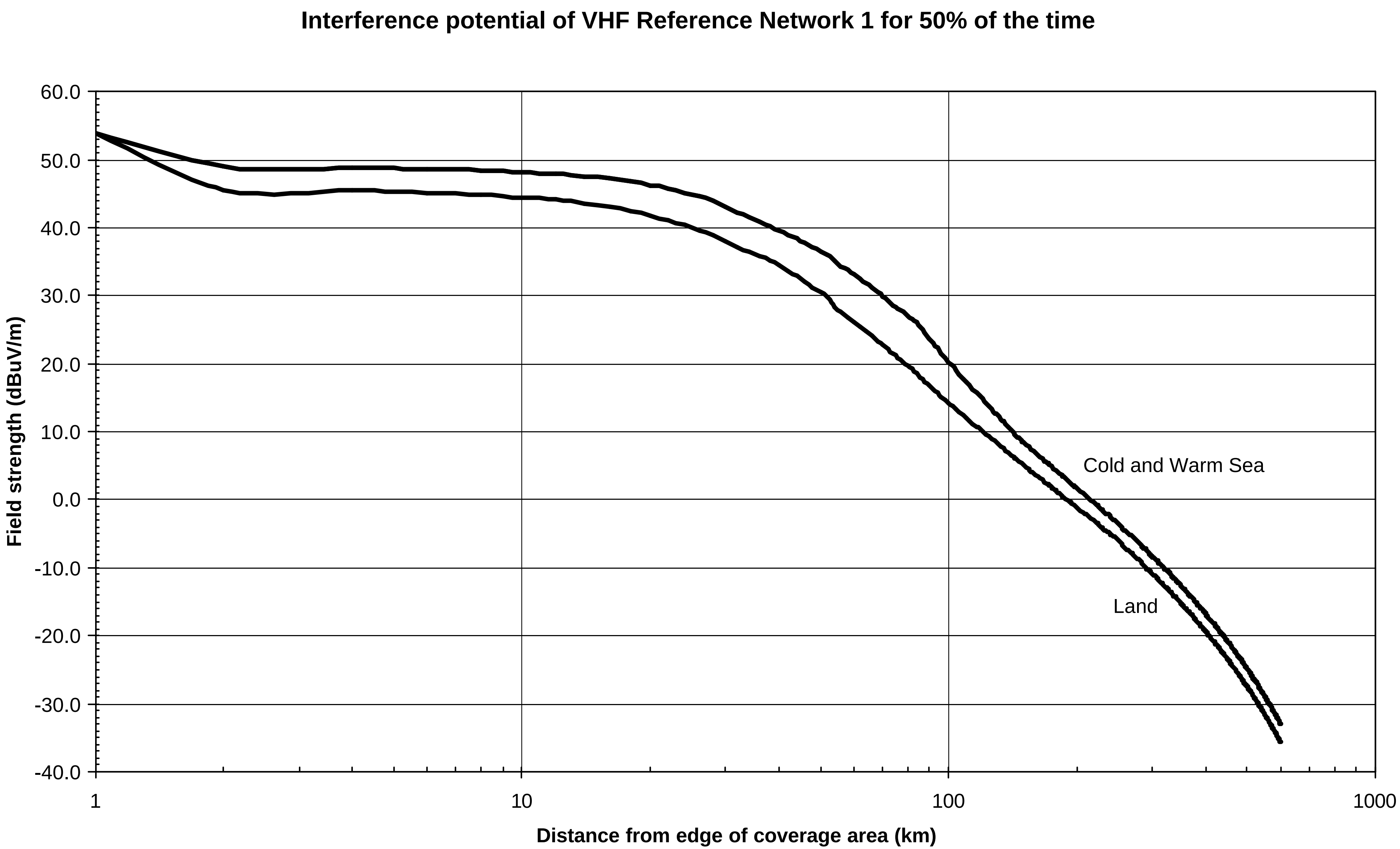


Figure A6.1a: Interference potential of VHF Reference Network One for 50% of time

Table A6.1a: Tabulated values for the interference potential of VHF Reference Network 1 for 50% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	57.3	57.3	57.3	60	26.2	33.1	33.1	120	10.1	14.8	14.8	180	1.1	4.1	4.1	240	-5.1	-2.6	-2.6
2	45.6	49.0	49.0	62	25.5	32.5	32.5	122	9.7	14.3	14.3	182	0.9	3.8	3.8	242	-5.3	-2.8	-2.8
4	45.5	48.8	48.8	64	24.8	31.9	31.9	124	9.3	13.8	13.8	184	0.6	3.6	3.6	244	-5.5	-3.0	-3.0
6	45.2	48.7	48.7	66	24.1	31.2	31.2	126	9.0	13.3	13.3	186	0.4	3.3	3.3	246	-5.7	-3.2	-3.2
8	44.9	48.5	48.5	68	23.4	30.6	30.6	128	8.6	12.8	12.8	188	0.1	3.1	3.1	248	-5.9	-3.4	-3.4
10	44.5	48.2	48.2	70	22.8	29.9	29.9	130	8.2	12.4	12.4	190	-0.1	2.8	2.8	250	-6.1	-3.6	-3.6
12	44.1	47.9	47.9	72	22.2	29.3	29.3	132	7.9	11.9	11.9	192	-0.3	2.5	2.5	252	-6.3	-3.8	-3.8
14	43.6	47.6	47.6	74	21.5	28.7	28.7	134	7.6	11.5	11.5	194	-0.6	2.3	2.3	254	-6.5	-4.0	-4.0
16	43.1	47.2	47.2	76	20.9	28.2	28.2	136	7.2	11.1	11.1	196	-0.8	2.1	2.1	256	-6.7	-4.2	-4.2
18	42.5	46.8	46.8	78	20.3	27.6	27.6	138	6.9	10.7	10.7	198	-1.0	1.8	1.8	258	-6.9	-4.4	-4.4
20	41.8	46.3	46.3	80	19.8	27.1	27.1	140	6.6	10.2	10.2	200	-1.2	1.6	1.6	260	-7.1	-4.6	-4.6
22	41.1	45.8	45.8	82	19.2	26.6	26.6	142	6.3	9.8	9.8	202	-1.4	1.4	1.4	262	-7.3	-4.8	-4.8
24	40.4	45.2	45.2	84	18.6	26.1	26.1	144	6.0	9.4	9.4	204	-1.6	1.2	1.2	264	-7.5	-5.0	-5.0
26	39.7	44.7	44.7	86	18.0	25.4	25.4	146	5.7	9.1	9.1	206	-1.8	1.0	1.0	266	-7.7	-5.2	-5.2
28	38.9	44.0	44.0	88	17.4	24.6	24.6	148	5.4	8.7	8.7	208	-2.0	0.8	0.8	268	-7.8	-5.3	-5.3
30	38.0	43.1	43.1	90	16.9	23.8	23.8	150	5.1	8.4	8.4	210	-2.2	0.5	0.5	270	-8.0	-5.5	-5.5
32	37.2	42.3	42.3	92	16.3	23.0	23.0	152	4.8	8.1	8.1	212	-2.4	0.3	0.3	272	-8.2	-5.7	-5.7
34	36.4	41.6	41.6	94	15.7	22.3	22.3	154	4.5	7.8	7.8	214	-2.6	0.1	0.1	274	-8.4	-5.9	-5.9
36	35.8	40.9	40.9	96	15.2	21.6	21.6	156	4.2	7.5	7.5	216	-2.8	-0.1	-0.1	276	-8.6	-6.1	-6.1
38	35.2	40.2	40.2	98	14.7	20.9	20.9	158	4.0	7.2	7.2	218	-3.0	-0.3	-0.3	278	-8.8	-6.3	-6.3
40	34.6	39.6	39.6	100	14.3	20.3	20.3	160	3.7	6.9	6.9	220	-3.2	-0.5	-0.5	280	-9.0	-6.5	-6.5
42	33.7	39.0	39.0	102	13.8	19.7	19.7	162	3.4	6.6	6.6	222	-3.4	-0.7	-0.7	282	-9.2	-6.7	-6.7
44	32.9	38.4	38.4	104	13.4	19.1	19.1	164	3.2	6.3	6.3	224	-3.6	-0.9	-0.9	284	-9.4	-6.9	-6.9
46	32.1	37.8	37.8	106	12.9	18.5	18.5	166	2.9	6.0	6.0	226	-3.8	-1.1	-1.1	286	-9.6	-7.1	-7.1
48	31.3	37.2	37.2	108	12.5	17.9	17.9	168	2.6	5.7	5.7	228	-4.0	-1.3	-1.3	288	-9.8	-7.2	-7.2
50	30.5	36.6	36.6	110	12.1	17.4	17.4	170	2.4	5.5	5.5	230	-4.2	-1.6	-1.6	290	-10.0	-7.4	-7.4
52	29.8	36.0	36.0	112	11.6	16.8	16.8	172	2.1	5.2	5.2	232	-4.4	-1.8	-1.8	292	-10.2	-7.6	-7.6
54	28.4	35.1	35.1	114	11.2	16.3	16.3	174	1.9	4.9	4.9	234	-4.6	-2.0	-2.0	294	-10.3	-7.8	-7.8
56	27.7	34.4	34.4	116	10.8	15.8	15.8	176	1.6	4.6	4.6	236	-4.8	-2.2	-2.2	296	-10.5	-8.0	-8.0
58	26.9	33.8	33.8	118	10.4	15.3	15.3	178	1.4	4.4	4.4	238	-4.9	-2.4	-2.4	298	-10.7	-8.2	-8.2

Table A6.1a: Tabulated values for the interference potential of VHF Reference Network 1 for 50% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	-10.9	-8.4	-8.4	360	-16.0	-13.5	-13.5	420	-21.0	-18.4	-18.4	480	-25.8	-23.2	-23.2	540	-30.7	-28.1	-28.1
302	-11.1	-8.5	-8.5	362	-16.2	-13.6	-13.6	422	-21.2	-18.6	-18.6	482	-26.0	-23.4	-23.4	542	-30.9	-28.2	-28.2
304	-11.2	-8.7	-8.7	364	-16.4	-13.8	-13.8	424	-21.3	-18.7	-18.7	484	-26.2	-23.5	-23.5	544	-31.1	-28.4	-28.4
306	-11.4	-8.9	-8.9	366	-16.5	-14.0	-14.0	426	-21.5	-18.9	-18.9	486	-26.3	-23.7	-23.7	546	-31.2	-28.6	-28.6
308	-11.6	-9.0	-9.0	368	-16.7	-14.1	-14.1	428	-21.7	-19.0	-19.0	488	-26.5	-23.8	-23.8	548	-31.4	-28.7	-28.7
310	-11.7	-9.2	-9.2	370	-16.9	-14.3	-14.3	430	-21.8	-19.2	-19.2	490	-26.6	-24.0	-24.0	550	-31.6	-28.9	-28.9
312	-11.9	-9.4	-9.4	372	-17.0	-14.5	-14.5	432	-22.0	-19.4	-19.4	492	-26.8	-24.2	-24.2	552	-31.7	-29.0	-29.0
314	-12.1	-9.6	-9.6	374	-17.2	-14.6	-14.6	434	-22.1	-19.5	-19.5	494	-27.0	-24.3	-24.3	554	-31.9	-29.2	-29.2
316	-12.3	-9.7	-9.7	376	-17.4	-14.8	-14.8	436	-22.3	-19.7	-19.7	496	-27.1	-24.5	-24.5	556	-32.1	-29.4	-29.4
318	-12.4	-9.9	-9.9	378	-17.5	-15.0	-15.0	438	-22.5	-19.8	-19.8	498	-27.3	-24.6	-24.6	558	-32.2	-29.5	-29.5
320	-12.6	-10.1	-10.1	380	-17.7	-15.1	-15.1	440	-22.6	-20.0	-20.0	500	-27.5	-24.8	-24.8	560	-32.4	-29.7	-29.7
322	-12.8	-10.2	-10.2	382	-17.9	-15.3	-15.3	442	-22.8	-20.2	-20.2	502	-27.6	-25.0	-25.0	562	-32.6	-29.9	-29.9
324	-13.0	-10.4	-10.4	384	-18.1	-15.5	-15.5	444	-22.9	-20.3	-20.3	504	-27.8	-25.1	-25.1	564	-32.7	-30.0	-30.0
326	-13.1	-10.6	-10.6	386	-18.2	-15.6	-15.6	446	-23.1	-20.5	-20.5	506	-27.9	-25.3	-25.3	566	-32.9	-30.2	-30.2
328	-13.3	-10.7	-10.7	388	-18.4	-15.8	-15.8	448	-23.3	-20.6	-20.6	508	-28.1	-25.5	-25.5	568	-33.1	-30.4	-30.4
330	-13.5	-10.9	-10.9	390	-18.6	-16.0	-16.0	450	-23.4	-20.8	-20.8	510	-28.3	-25.6	-25.6	570	-33.2	-30.5	-30.5
332	-13.6	-11.1	-11.1	392	-18.7	-16.1	-16.1	452	-23.6	-21.0	-21.0	512	-28.4	-25.8	-25.8	572	-33.4	-30.7	-30.7
334	-13.8	-11.3	-11.3	394	-18.9	-16.3	-16.3	454	-23.7	-21.1	-21.1	514	-28.6	-25.9	-25.9	574	-33.6	-30.9	-30.9
336	-14.0	-11.4	-11.4	396	-19.1	-16.5	-16.5	456	-23.9	-21.3	-21.3	516	-28.8	-26.1	-26.1	576	-33.7	-31.0	-31.0
338	-14.2	-11.6	-11.6	398	-19.2	-16.6	-16.6	458	-24.1	-21.4	-21.4	518	-28.9	-26.3	-26.3	578	-33.9	-31.2	-31.2
340	-14.3	-11.8	-11.8	400	-19.4	-16.8	-16.8	460	-24.2	-21.6	-21.6	520	-29.1	-26.4	-26.4	580	-34.1	-31.4	-31.4
342	-14.5	-11.9	-11.9	402	-19.6	-17.0	-17.0	462	-24.4	-21.8	-21.8	522	-29.3	-26.6	-26.6	582	-34.2	-31.5	-31.5
344	-14.7	-12.1	-12.1	404	-19.7	-17.1	-17.1	464	-24.6	-21.9	-21.9	524	-29.4	-26.8	-26.8	584	-34.4	-31.7	-31.7
346	-14.8	-12.3	-12.3	406	-19.9	-17.3	-17.3	466	-24.7	-22.1	-22.1	526	-29.6	-26.9	-26.9	586	-34.6	-31.8	-31.8
348	-15.0	-12.4	-12.4	408	-20.0	-17.4	-17.4	468	-24.9	-22.2	-22.2	528	-29.8	-27.1	-27.1	588	-34.7	-32.0	-32.0
350	-15.2	-12.6	-12.6	410	-20.2	-17.6	-17.6	470	-25.0	-22.4	-22.4	530	-29.9	-27.2	-27.2	590	-34.9	-32.2	-32.2
352	-15.3	-12.8	-12.8	412	-20.4	-17.8	-17.8	472	-25.2	-22.6	-22.6	532	-30.1	-27.4	-27.4	592	-35.0	-32.3	-32.3
354	-15.5	-13.0	-13.0	414	-20.5	-17.9	-17.9	474	-25.4	-22.7	-22.7	534	-30.3	-27.6	-27.6	594	-35.2	-32.5	-32.5
356	-15.7	-13.1	-13.1	416	-20.7	-18.1	-18.1	476	-25.5	-22.9	-22.9	536	-30.4	-27.7	-27.7	596	-35.4	-32.7	-32.7
358	-15.9	-13.3	-13.3	418	-20.8	-18.2	-18.2	478	-25.7	-23.0	-23.0	538	-30.6	-27.9	-27.9	598	-35.5	-32.8	-32.8
																600	-35.7	-33.0	-33.0

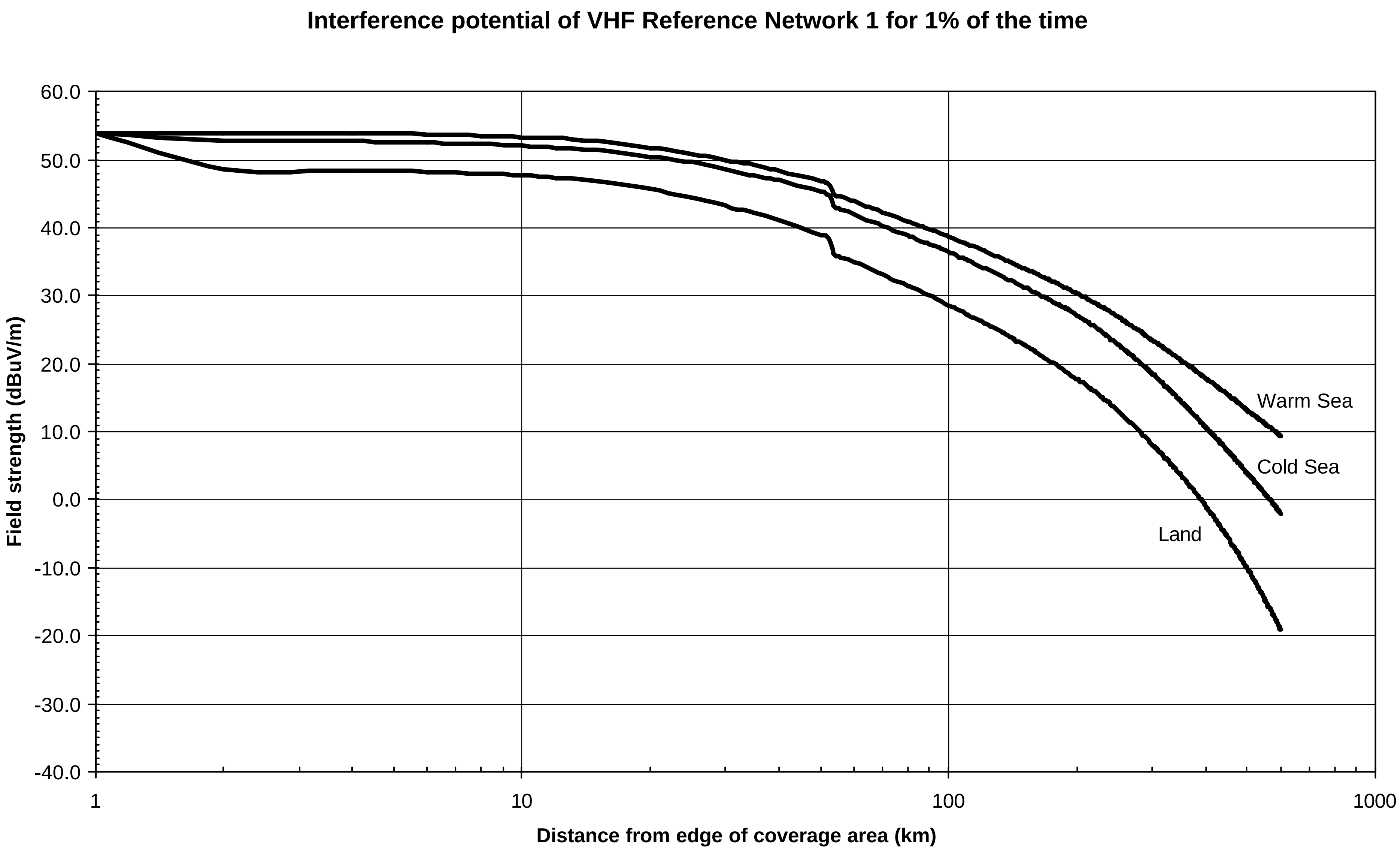


Figure A6.1b: Interference potential of VHF Reference Network One for 1% of time (See note page A6-1)

Table A6.1b: Tabulated values for the interference potential of VHF Reference Network 1 for 1% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	59.2	59.2	59.2	60	35.0	42.0	43.9	120	26.1	34.2	36.7	180	19.7	28.8	31.8	240	14.0	23.6	27.6
2	48.7	52.8	54.0	62	34.7	41.6	43.6	122	25.9	34.0	36.5	182	19.5	28.6	31.6	242	13.8	23.5	27.4
4	48.5	52.7	53.9	64	34.3	41.2	43.2	124	25.7	33.8	36.3	184	19.3	28.4	31.5	244	13.6	23.3	27.3
6	48.3	52.5	53.8	66	33.9	40.9	42.9	126	25.4	33.6	36.1	186	19.1	28.3	31.3	246	13.4	23.1	27.1
8	48.0	52.4	53.6	68	33.5	40.6	42.6	128	25.2	33.4	35.9	188	18.9	28.1	31.2	248	13.2	22.9	27.0
10	47.7	52.1	53.4	70	33.1	40.3	42.3	130	25.0	33.2	35.8	190	18.7	28.0	31.0	250	13.0	22.8	26.9
12	47.4	51.8	53.2	72	32.7	40.0	42.0	132	24.8	33.0	35.6	192	18.5	27.8	30.9	252	12.8	22.6	26.7
14	47.0	51.5	52.9	74	32.4	39.7	41.7	134	24.5	32.8	35.4	194	18.3	27.6	30.8	254	12.6	22.4	26.6
16	46.6	51.2	52.5	76	32.1	39.4	41.5	136	24.3	32.6	35.2	196	18.1	27.5	30.6	256	12.4	22.3	26.4
18	46.2	50.8	52.2	78	31.8	39.1	41.2	138	24.1	32.4	35.1	198	17.9	27.3	30.5	258	12.2	22.1	26.3
20	45.7	50.5	51.8	80	31.5	38.9	41.0	140	23.9	32.3	34.9	200	17.8	27.1	30.3	260	12.0	21.9	26.2
22	45.2	50.2	51.5	82	31.2	38.6	40.7	142	23.7	32.1	34.7	202	17.6	27.0	30.2	262	11.8	21.8	26.0
24	44.7	49.8	51.1	84	31.0	38.3	40.5	144	23.4	31.9	34.6	204	17.4	26.8	30.1	264	11.6	21.6	25.9
26	44.2	49.4	50.7	86	30.7	38.1	40.3	146	23.2	31.7	34.4	206	17.2	26.6	29.9	266	11.4	21.4	25.8
28	43.7	49.0	50.4	88	30.4	37.9	40.0	148	23.0	31.5	34.2	208	17.0	26.4	29.8	268	11.3	21.2	25.6
30	43.3	48.6	50.0	90	30.1	37.6	39.8	150	22.8	31.3	34.1	210	16.8	26.3	29.7	270	11.1	21.1	25.5
32	42.8	48.2	49.7	92	29.8	37.4	39.6	152	22.6	31.2	33.9	212	16.6	26.1	29.5	272	10.9	20.9	25.3
34	42.4	47.8	49.4	94	29.5	37.2	39.4	154	22.4	31.0	33.7	214	16.4	25.9	29.4	274	10.7	20.7	25.2
36	41.9	47.5	49.1	96	29.2	36.9	39.2	156	22.2	30.8	33.6	216	16.3	25.8	29.2	276	10.5	20.6	25.1
38	41.5	47.2	48.7	98	28.9	36.7	39.0	158	22.0	30.6	33.4	218	16.1	25.6	29.1	278	10.3	20.4	24.9
40	41.1	47.0	48.4	100	28.6	36.5	38.7	160	21.7	30.5	33.3	220	15.9	25.4	29.0	280	10.1	20.2	24.8
42	40.6	46.6	48.1	102	28.4	36.2	38.5	162	21.5	30.3	33.1	222	15.7	25.2	28.8	282	9.9	20.0	24.7
44	40.2	46.3	47.8	104	28.1	36.0	38.3	164	21.3	30.1	33.0	224	15.5	25.1	28.7	284	9.7	19.9	24.5
46	39.8	46.0	47.5	106	27.9	35.7	38.1	166	21.1	29.9	32.8	226	15.3	24.9	28.5	286	9.5	19.7	24.4
48	39.4	45.7	47.2	108	27.6	35.5	37.9	168	20.9	29.8	32.7	228	15.1	24.7	28.4	288	9.3	19.5	24.2
50	39.0	45.3	46.9	110	27.3	35.3	37.7	170	20.7	29.6	32.5	230	14.9	24.5	28.3	290	9.1	19.4	24.1
52	38.6	45.0	46.6	112	27.1	35.1	37.5	172	20.5	29.4	32.4	232	14.7	24.3	28.1	292	8.9	19.2	24.0
54	36.1	43.2	44.9	114	26.9	34.9	37.3	174	20.3	29.3	32.2	234	14.6	24.2	28.0	294	8.7	19.0	23.8
56	35.7	42.8	44.6	116	26.6	34.6	37.1	176	20.1	29.1	32.1	236	14.4	24.0	27.8	296	8.5	18.9	23.7
58	35.4	42.4	44.2	118	26.4	34.4	36.9	178	19.9	28.9	31.9	238	14.2	23.8	27.7	298	8.3	18.7	23.6

Table A6.1b: Tabulated values for the interference potential of VHF Reference Network 1 for 1% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	8.1	18.5	23.5	360	2.7	13.7	20.0	420	-2.8	9.3	16.9	480	-8.2	5.3	14.1	540	-13.7	1.5	11.6
302	7.9	18.4	23.3	362	2.5	13.6	19.9	422	-2.9	9.2	16.8	482	-8.4	5.1	14.0	542	-13.8	1.4	11.6
304	7.8	18.2	23.2	364	2.3	13.4	19.8	424	-3.1	9.0	16.7	484	-8.6	5.0	13.9	544	-14.0	1.3	11.5
306	7.6	18.0	23.1	366	2.1	13.3	19.7	426	-3.3	8.9	16.6	486	-8.7	4.9	13.8	546	-14.2	1.2	11.4
308	7.4	17.9	23.0	368	2.0	13.1	19.6	428	-3.5	8.7	16.5	488	-8.9	4.7	13.7	548	-14.4	1.1	11.3
310	7.2	17.7	22.9	370	1.8	12.9	19.5	430	-3.7	8.6	16.4	490	-9.1	4.6	13.6	550	-14.6	0.9	11.2
312	7.0	17.6	22.8	372	1.6	12.8	19.4	432	-3.8	8.5	16.3	492	-9.3	4.5	13.5	552	-14.8	0.8	11.2
314	6.9	17.4	22.6	374	1.4	12.6	19.2	434	-4.0	8.3	16.2	494	-9.5	4.3	13.5	554	-14.9	0.7	11.1
316	6.7	17.2	22.5	376	1.2	12.5	19.1	436	-4.2	8.2	16.2	496	-9.7	4.2	13.4	556	-15.1	0.6	11.0
318	6.5	17.1	22.4	378	1.1	12.3	19.0	438	-4.4	8.1	16.1	498	-9.8	4.1	13.3	558	-15.3	0.5	10.9
320	6.3	16.9	22.3	380	0.9	12.2	18.9	440	-4.6	7.9	16.0	500	-10.0	3.9	13.2	560	-15.5	0.4	10.9
322	6.1	16.7	22.2	382	0.7	12.0	18.8	442	-4.7	7.8	15.9	502	-10.2	3.8	13.1	562	-15.7	0.2	10.8
324	6.0	16.6	22.0	384	0.5	11.9	18.7	444	-4.9	7.7	15.8	504	-10.4	3.7	13.0	564	-15.8	0.1	10.7
326	5.8	16.4	21.9	386	0.3	11.7	18.6	446	-5.1	7.5	15.7	506	-10.6	3.6	13.0	566	-16.0	0.0	10.6
328	5.6	16.3	21.8	388	0.1	11.6	18.5	448	-5.3	7.4	15.6	508	-10.7	3.5	12.9	568	-16.2	-0.1	10.6
330	5.4	16.1	21.7	390	0.0	11.4	18.4	450	-5.5	7.3	15.5	510	-10.9	3.3	12.8	570	-16.4	-0.2	10.5
332	5.2	15.9	21.6	392	-0.2	11.3	18.3	452	-5.7	7.1	15.4	512	-11.1	3.2	12.7	572	-16.6	-0.4	10.4
334	5.1	15.8	21.5	394	-0.4	11.1	18.2	454	-5.8	7.0	15.3	514	-11.3	3.1	12.7	574	-16.8	-0.5	10.3
336	4.9	15.6	21.3	396	-0.6	10.9	18.1	456	-6.0	6.9	15.2	516	-11.5	3.0	12.6	576	-16.9	-0.6	10.3
338	4.7	15.5	21.2	398	-0.8	10.8	18.0	458	-6.2	6.7	15.1	518	-11.7	2.9	12.5	578	-17.1	-0.7	10.2
340	4.5	15.3	21.1	400	-1.0	10.7	17.9	460	-6.4	6.6	15.0	520	-11.8	2.7	12.4	580	-17.3	-0.8	10.1
342	4.3	15.1	21.0	402	-1.1	10.5	17.8	462	-6.6	6.5	14.9	522	-12.0	2.6	12.3	582	-17.5	-0.9	10.0
344	4.1	15.0	20.9	404	-1.3	10.4	17.7	464	-6.7	6.3	14.8	524	-12.2	2.5	12.3	584	-17.7	-1.1	10.0
346	4.0	14.8	20.8	406	-1.5	10.2	17.6	466	-6.9	6.2	14.8	526	-12.4	2.4	12.2	586	-17.8	-1.2	9.9
348	3.8	14.6	20.7	408	-1.7	10.1	17.5	468	-7.1	6.1	14.7	528	-12.6	2.3	12.1	588	-18.0	-1.3	9.8
350	3.6	14.5	20.5	410	-1.9	10.0	17.4	470	-7.3	5.9	14.6	530	-12.8	2.1	12.0	590	-18.2	-1.4	9.7
352	3.4	14.3	20.4	412	-2.0	9.8	17.3	472	-7.5	5.8	14.5	532	-12.9	2.0	11.9	592	-18.4	-1.5	9.7
354	3.2	14.2	20.3	414	-2.2	9.7	17.2	474	-7.7	5.7	14.4	534	-13.1	1.9	11.9	594	-18.6	-1.7	9.6
356	3.1	14.0	20.2	416	-2.4	9.6	17.1	476	-7.8	5.5	14.3	536	-13.3	1.8	11.8	596	-18.8	-1.8	9.5
358	2.9	13.9	20.1	418	-2.6	9.4	17.0	478	-8.0	5.4	14.2	538	-13.5	1.7	11.7	598	-18.9	-1.9	9.5
																600	-19.1	-2.0	9.4

Interference potential of VHF Reference Network 2 for 50% of the time

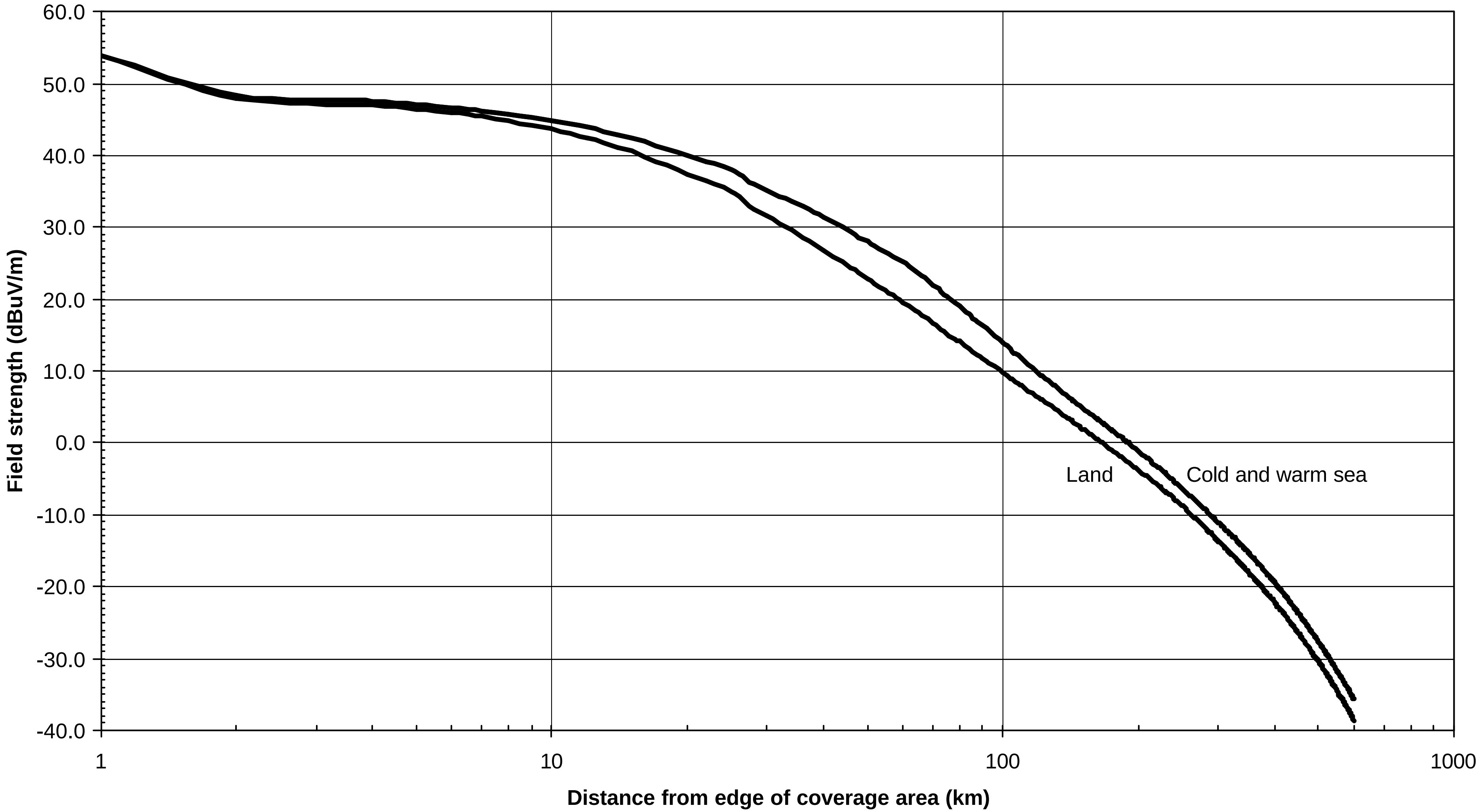


Figure A6.2a: Interference potential of VHF Reference Network Two for 50% of time (See note page A6-1)

Table A6.2a: Tabulated values for the interference potential of VHF Reference Network 2 for 50% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	57.2	57.2	57.2	60	19.6	25.2	25.2	120	6.3	9.7	9.7	180	-1.6	1.1	1.1	240	-7.8	-5.4	-5.4
2	48.0	48.4	48.4	62	19.0	24.6	24.6	122	6.0	9.3	9.3	182	-1.8	0.9	0.9	242	-8.0	-5.6	-5.6
4	47.0	47.6	47.6	64	18.4	24.0	24.0	124	5.7	9.0	9.0	184	-2.1	0.7	0.7	244	-8.2	-5.8	-5.8
6	46.0	46.7	46.7	66	17.8	23.4	23.4	126	5.4	8.6	8.6	186	-2.3	0.4	0.4	246	-8.4	-6.0	-6.0
8	44.8	45.8	45.8	68	17.2	22.7	22.7	128	5.1	8.3	8.3	188	-2.5	0.2	0.2	248	-8.6	-6.2	-6.2
10	43.7	44.9	44.9	70	16.6	22.0	22.0	130	4.8	8.0	8.0	190	-2.7	0.0	0.0	250	-8.8	-6.4	-6.4
12	42.4	43.9	43.9	72	16.1	21.4	21.4	132	4.5	7.6	7.6	192	-2.9	-0.3	-0.3	252	-9.0	-6.6	-6.6
14	41.2	42.9	42.9	74	15.5	20.7	20.7	134	4.2	7.3	7.3	194	-3.2	-0.5	-0.5	254	-9.2	-6.8	-6.8
16	39.9	41.9	41.9	76	15.0	20.2	20.2	136	3.9	7.0	7.0	196	-3.4	-0.7	-0.7	256	-9.4	-7.0	-7.0
18	38.6	40.9	40.9	78	14.5	19.6	19.6	138	3.6	6.7	6.7	198	-3.6	-0.9	-0.9	258	-9.6	-7.2	-7.2
20	37.5	40.0	40.0	80	14.1	19.1	19.1	140	3.3	6.4	6.4	200	-3.8	-1.2	-1.2	260	-9.8	-7.4	-7.4
22	36.5	39.2	39.2	82	13.6	18.5	18.5	142	3.1	6.1	6.1	202	-4.0	-1.4	-1.4	262	-10.0	-7.5	-7.5
24	35.5	38.4	38.4	84	13.2	18.0	18.0	144	2.8	5.8	5.8	204	-4.2	-1.6	-1.6	264	-10.2	-7.7	-7.7
26	34.4	37.5	37.5	86	12.7	17.4	17.4	146	2.5	5.5	5.5	206	-4.4	-1.8	-1.8	266	-10.4	-7.9	-7.9
28	32.6	36.0	36.0	88	12.3	16.9	16.9	148	2.3	5.2	5.2	208	-4.6	-2.0	-2.0	268	-10.6	-8.1	-8.1
30	31.6	35.2	35.2	90	11.8	16.4	16.4	150	2.0	4.9	4.9	210	-4.8	-2.2	-2.2	270	-10.8	-8.3	-8.3
32	30.6	34.4	34.4	92	11.4	15.9	15.9	152	1.8	4.6	4.6	212	-5.0	-2.4	-2.4	272	-11.0	-8.5	-8.5
34	29.6	33.7	33.7	94	11.0	15.4	15.4	154	1.5	4.4	4.4	214	-5.2	-2.7	-2.7	274	-11.2	-8.7	-8.7
36	28.6	32.9	32.9	96	10.6	14.9	14.9	156	1.3	4.1	4.1	216	-5.4	-2.9	-2.9	276	-11.4	-8.9	-8.9
38	27.7	32.2	32.2	98	10.2	14.4	14.4	158	1.0	3.8	3.8	218	-5.6	-3.1	-3.1	278	-11.6	-9.1	-9.1
40	26.8	31.5	31.5	100	9.8	14.0	14.0	160	0.8	3.6	3.6	220	-5.8	-3.3	-3.3	280	-11.8	-9.2	-9.2
42	26.0	30.8	30.8	102	9.4	13.5	13.5	162	0.5	3.3	3.3	222	-6.0	-3.5	-3.5	282	-12.0	-9.4	-9.4
44	25.2	30.1	30.1	104	9.0	13.1	13.1	164	0.3	3.1	3.1	224	-6.2	-3.7	-3.7	284	-12.2	-9.6	-9.6
46	24.4	29.4	29.4	106	8.7	12.6	12.6	166	0.0	2.8	2.8	226	-6.4	-3.9	-3.9	286	-12.4	-9.8	-9.8
48	23.7	28.7	28.7	108	8.3	12.2	12.2	168	-0.2	2.6	2.6	228	-6.6	-4.1	-4.1	288	-12.5	-10.0	-10.0
50	22.9	28.1	28.1	110	8.0	11.8	11.8	170	-0.5	2.3	2.3	230	-6.8	-4.3	-4.3	290	-12.7	-10.2	-10.2
52	22.2	27.4	27.4	112	7.6	11.3	11.3	172	-0.7	2.1	2.1	232	-7.0	-4.6	-4.6	292	-12.9	-10.3	-10.3
54	21.5	26.9	26.9	114	7.3	10.9	10.9	174	-0.9	1.8	1.8	234	-7.2	-4.8	-4.8	294	-13.1	-10.5	-10.5
56	20.9	26.3	26.3	116	6.9	10.5	10.5	176	-1.2	1.6	1.6	236	-7.4	-5.0	-5.0	296	-13.3	-10.7	-10.7
58	20.2	25.8	25.8	118	6.6	10.1	10.1	178	-1.4	1.3	1.3	238	-7.6	-5.2	-5.2	298	-13.5	-10.9	-10.9

Table A6.2a: Tabulated values for the interference potential of VHF Reference Network 2 for 50% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	-13.7	-11.1	-11.1	360	-18.8	-16.1	-16.1	420	-23.8	-21.1	-21.1	480	-28.8	-26.0	-26.0	540	-33.6	-30.8	-30.8
302	-13.8	-11.2	-11.2	362	-19.0	-16.3	-16.3	422	-24.0	-21.2	-21.2	482	-28.9	-26.2	-26.2	542	-33.8	-31.0	-31.0
304	-14.0	-11.4	-11.4	364	-19.2	-16.4	-16.4	424	-24.2	-21.4	-21.4	484	-29.1	-26.3	-26.3	544	-33.9	-31.1	-31.1
306	-14.2	-11.6	-11.6	366	-19.3	-16.6	-16.6	426	-24.3	-21.6	-21.6	486	-29.3	-26.5	-26.5	546	-34.1	-31.3	-31.3
308	-14.4	-11.7	-11.7	368	-19.5	-16.8	-16.8	428	-24.5	-21.7	-21.7	488	-29.4	-26.6	-26.6	548	-34.3	-31.5	-31.5
310	-14.5	-11.9	-11.9	370	-19.7	-16.9	-16.9	430	-24.7	-21.9	-21.9	490	-29.6	-26.8	-26.8	550	-34.4	-31.6	-31.6
312	-14.7	-12.1	-12.1	372	-19.8	-17.1	-17.1	432	-24.8	-22.1	-22.1	492	-29.7	-27.0	-27.0	552	-34.6	-31.8	-31.8
314	-14.9	-12.2	-12.2	374	-20.0	-17.3	-17.3	434	-25.0	-22.2	-22.2	494	-29.9	-27.1	-27.1	554	-34.8	-32.0	-32.0
316	-15.1	-12.4	-12.4	376	-20.2	-17.4	-17.4	436	-25.2	-22.4	-22.4	496	-30.1	-27.3	-27.3	556	-34.9	-32.1	-32.1
318	-15.2	-12.6	-12.6	378	-20.3	-17.6	-17.6	438	-25.3	-22.6	-22.6	498	-30.2	-27.4	-27.4	558	-35.1	-32.3	-32.3
320	-15.4	-12.7	-12.7	380	-20.5	-17.8	-17.8	440	-25.5	-22.7	-22.7	500	-30.4	-27.6	-27.6	560	-35.2	-32.4	-32.4
322	-15.6	-12.9	-12.9	382	-20.7	-17.9	-17.9	442	-25.7	-22.9	-22.9	502	-30.5	-27.8	-27.8	562	-35.4	-32.6	-32.6
324	-15.7	-13.1	-13.1	384	-20.8	-18.1	-18.1	444	-25.8	-23.1	-23.1	504	-30.7	-27.9	-27.9	564	-35.6	-32.8	-32.8
326	-15.9	-13.2	-13.2	386	-21.0	-18.3	-18.3	446	-26.0	-23.2	-23.2	506	-30.9	-28.1	-28.1	566	-35.7	-32.9	-32.9
328	-16.1	-13.4	-13.4	388	-21.2	-18.4	-18.4	448	-26.2	-23.4	-23.4	508	-31.0	-28.2	-28.2	568	-35.9	-33.1	-33.1
330	-16.3	-13.6	-13.6	390	-21.3	-18.6	-18.6	450	-26.3	-23.6	-23.6	510	-31.2	-28.4	-28.4	570	-36.1	-33.3	-33.3
332	-16.4	-13.8	-13.8	392	-21.5	-18.8	-18.8	452	-26.5	-23.7	-23.7	512	-31.4	-28.6	-28.6	572	-36.2	-33.4	-33.4
334	-16.6	-13.9	-13.9	394	-21.7	-18.9	-18.9	454	-26.6	-23.9	-23.9	514	-31.5	-28.7	-28.7	574	-36.4	-33.6	-33.6
336	-16.8	-14.1	-14.1	396	-21.8	-19.1	-19.1	456	-26.8	-24.0	-24.0	516	-31.7	-28.9	-28.9	576	-36.6	-33.8	-33.8
338	-16.9	-14.3	-14.3	398	-22.0	-19.3	-19.3	458	-27.0	-24.2	-24.2	518	-31.8	-29.0	-29.0	578	-36.7	-33.9	-33.9
340	-17.1	-14.4	-14.4	400	-22.2	-19.4	-19.4	460	-27.1	-24.4	-24.4	520	-32.0	-29.2	-29.2	580	-36.9	-34.1	-34.1
342	-17.3	-14.6	-14.6	402	-22.3	-19.6	-19.6	462	-27.3	-24.5	-24.5	522	-32.2	-29.4	-29.4	582	-37.1	-34.2	-34.2
344	-17.5	-14.8	-14.8	404	-22.5	-19.8	-19.8	464	-27.5	-24.7	-24.7	524	-32.3	-29.5	-29.5	584	-37.2	-34.4	-34.4
346	-17.6	-14.9	-14.9	406	-22.7	-19.9	-19.9	466	-27.6	-24.9	-24.9	526	-32.5	-29.7	-29.7	586	-37.4	-34.6	-34.6
348	-17.8	-15.1	-15.1	408	-22.8	-20.1	-20.1	468	-27.8	-25.0	-25.0	528	-32.6	-29.9	-29.9	588	-37.6	-34.7	-34.7
350	-18.0	-15.3	-15.3	410	-23.0	-20.3	-20.3	470	-28.0	-25.2	-25.2	530	-32.8	-30.0	-30.0	590	-37.7	-34.9	-34.9
352	-18.1	-15.4	-15.4	412	-23.2	-20.4	-20.4	472	-28.1	-25.3	-25.3	532	-33.0	-30.2	-30.2	592	-37.9	-35.1	-35.1
354	-18.3	-15.6	-15.6	414	-23.3	-20.6	-20.6	474	-28.3	-25.5	-25.5	534	-33.1	-30.3	-30.3	594	-38.1	-35.2	-35.2
356	-18.5	-15.8	-15.8	416	-23.5	-20.7	-20.7	476	-28.4	-25.7	-25.7	536	-33.3	-30.5	-30.5	596	-38.2	-35.4	-35.4
358	-18.6	-15.9	-15.9	418	-23.7	-20.9	-20.9	478	-28.6	-25.8	-25.8	538	-33.5	-30.7	-30.7	598	-38.4	-35.6	-35.6
																600	-38.6	-35.7	-35.7

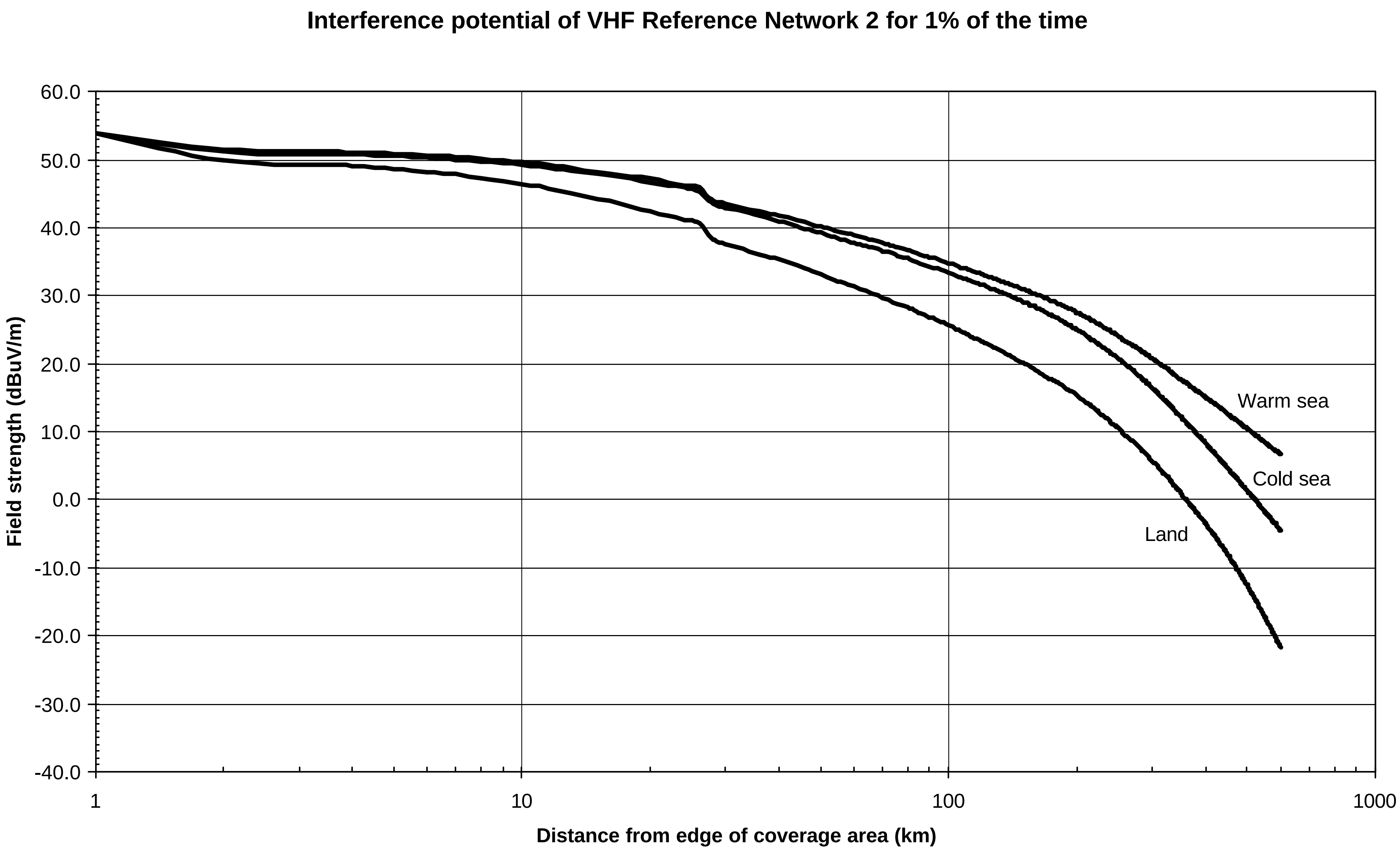


Figure A6.2b: Interference potential of VHF Reference Network Two for 1% of time (See note page A6-1)

Table A6.2b: Tabulated values for the interference potential of VHF Reference Network 2 for 1% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	58.3	58.3	58.3	60	31.4	37.8	38.9	120	23.2	31.6	33.1	180	17.2	26.7	28.9	240	11.4	21.6	24.7
2	49.9	51.2	51.5	62	31.1	37.6	38.7	122	23.0	31.4	33.0	182	17.0	26.5	28.8	242	11.2	21.4	24.6
4	49.1	50.8	51.1	64	30.7	37.3	38.5	124	22.8	31.2	32.8	184	16.8	26.3	28.6	244	11.0	21.2	24.5
6	48.3	50.3	50.7	66	30.4	37.1	38.2	126	22.6	31.0	32.7	186	16.6	26.2	28.5	246	10.9	21.1	24.3
8	47.4	49.8	50.2	68	30.1	36.9	38.0	128	22.3	30.9	32.5	188	16.4	26.0	28.4	248	10.7	20.9	24.2
10	46.5	49.3	49.6	70	29.7	36.6	37.8	130	22.1	30.7	32.4	190	16.2	25.8	28.2	250	10.5	20.7	24.0
12	45.6	48.7	49.1	72	29.4	36.4	37.6	132	21.9	30.5	32.2	192	16.1	25.7	28.1	252	10.3	20.6	23.9
14	44.7	48.2	48.5	74	29.1	36.2	37.3	134	21.7	30.4	32.1	194	15.9	25.5	28.0	254	10.1	20.4	23.8
16	43.9	47.7	48.0	76	28.8	35.9	37.1	136	21.5	30.2	31.9	196	15.7	25.3	27.8	256	9.9	20.2	23.6
18	43.1	47.2	47.6	78	28.6	35.7	36.9	138	21.3	30.1	31.8	198	15.5	25.2	27.7	258	9.7	20.1	23.5
20	42.4	46.7	47.2	80	28.3	35.5	36.7	140	21.1	29.9	31.6	200	15.3	25.0	27.5	260	9.5	19.9	23.4
22	41.8	46.3	46.7	82	28.0	35.2	36.5	142	20.9	29.7	31.5	202	15.1	24.8	27.4	262	9.3	19.7	23.2
24	41.2	45.9	46.3	84	27.7	35.0	36.3	144	20.7	29.6	31.4	204	14.9	24.7	27.3	264	9.1	19.5	23.1
26	40.7	45.4	45.9	86	27.5	34.8	36.1	146	20.5	29.4	31.2	206	14.7	24.5	27.1	266	8.9	19.4	23.0
28	38.3	43.5	44.0	88	27.2	34.6	35.9	148	20.3	29.3	31.1	208	14.5	24.3	27.0	268	8.8	19.2	22.9
30	37.7	43.0	43.6	90	26.9	34.4	35.7	150	20.1	29.1	31.0	210	14.3	24.1	26.8	270	8.6	19.0	22.7
32	37.1	42.6	43.2	92	26.7	34.2	35.6	152	19.9	29.0	30.8	212	14.1	24.0	26.7	272	8.4	18.9	22.6
34	36.6	42.2	42.8	94	26.4	34.0	35.4	154	19.7	28.8	30.7	214	14.0	23.8	26.6	274	8.2	18.7	22.5
36	36.1	41.7	42.4	96	26.2	33.8	35.2	156	19.5	28.6	30.5	216	13.8	23.6	26.4	276	8.0	18.5	22.3
38	35.7	41.3	42.1	98	25.9	33.6	35.0	158	19.3	28.5	30.4	218	13.6	23.5	26.3	278	7.8	18.3	22.2
40	35.3	41.0	41.8	100	25.7	33.4	34.8	160	19.1	28.3	30.3	220	13.4	23.3	26.1	280	7.6	18.2	22.1
42	34.9	40.6	41.5	102	25.4	33.2	34.7	162	18.9	28.1	30.1	222	13.2	23.1	26.0	282	7.4	18.0	21.9
44	34.5	40.3	41.2	104	25.1	33.0	34.5	164	18.7	28.0	30.0	224	13.0	22.9	25.9	284	7.2	17.8	21.8
46	34.1	39.9	40.9	106	24.9	32.8	34.3	166	18.5	27.8	29.9	226	12.8	22.8	25.7	286	7.1	17.6	21.7
48	33.6	39.6	40.5	108	24.6	32.6	34.1	168	18.3	27.6	29.7	228	12.6	22.6	25.6	288	6.9	17.5	21.6
50	33.2	39.3	40.2	110	24.4	32.5	34.0	170	18.1	27.5	29.6	230	12.4	22.4	25.4	290	6.7	17.3	21.4
52	32.8	38.9	40.0	112	24.2	32.3	33.8	172	17.9	27.3	29.4	232	12.2	22.3	25.3	292	6.5	17.1	21.3
54	32.4	38.6	39.7	114	23.9	32.1	33.6	174	17.7	27.2	29.3	234	12.0	22.1	25.2	294	6.3	17.0	21.2
56	32.0	38.3	39.4	116	23.7	31.9	33.5	176	17.6	27.0	29.2	236	11.8	21.9	25.0	296	6.1	16.8	21.0
58	31.7	38.1	39.2	118	23.5	31.7	33.3	178	17.4	26.8	29.0	238	11.6	21.8	24.9	298	5.9	16.6	20.9

Table A6.2b: Tabulated values for the interference potential of VHF Reference Network 2 for 1% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	5.7	16.4	20.8	360	0.1	11.4	17.2	420	-5.3	6.9	14.1	480	-10.7	2.7	11.4	540	-16.2	-1.1	8.8
302	5.5	16.3	20.7	362	-0.1	11.2	17.1	422	-5.5	6.7	14.0	482	-10.9	2.5	11.3	542	-16.4	-1.2	8.8
304	5.4	16.1	20.5	364	-0.3	11.1	17.0	424	-5.7	6.6	13.9	484	-11.1	2.4	11.2	544	-16.6	-1.3	8.7
306	5.2	15.9	20.4	366	-0.5	10.9	16.9	426	-5.9	6.4	13.8	486	-11.3	2.3	11.1	546	-16.8	-1.5	8.6
308	5.0	15.7	20.3	368	-0.7	10.8	16.7	428	-6.0	6.3	13.7	488	-11.4	2.2	11.0	548	-17.0	-1.6	8.5
310	4.8	15.6	20.2	370	-0.9	10.6	16.6	430	-6.2	6.1	13.6	490	-11.6	2.0	10.9	550	-17.2	-1.7	8.4
312	4.6	15.4	20.0	372	-1.1	10.4	16.5	432	-6.4	6.0	13.6	492	-11.8	1.9	10.8	552	-17.3	-1.8	8.4
314	4.4	15.2	19.9	374	-1.2	10.3	16.4	434	-6.6	5.8	13.5	494	-12.0	1.8	10.8	554	-17.5	-1.9	8.3
316	4.2	15.1	19.8	376	-1.4	10.1	16.3	436	-6.7	5.7	13.4	496	-12.2	1.6	10.7	556	-17.7	-2.0	8.2
318	4.0	14.9	19.7	378	-1.6	10.0	16.2	438	-6.9	5.5	13.3	498	-12.4	1.5	10.6	558	-17.9	-2.2	8.2
320	3.9	14.7	19.5	380	-1.8	9.8	16.1	440	-7.1	5.4	13.2	500	-12.5	1.4	10.5	560	-18.1	-2.3	8.1
322	3.7	14.6	19.4	382	-1.9	9.7	16.0	442	-7.3	5.2	13.1	502	-12.7	1.3	10.4	562	-18.3	-2.4	8.0
324	3.5	14.4	19.3	384	-2.1	9.5	15.9	444	-7.5	5.1	13.0	504	-12.9	1.1	10.3	564	-18.5	-2.5	7.9
326	3.3	14.2	19.2	386	-2.3	9.4	15.8	446	-7.6	4.9	12.9	506	-13.1	1.0	10.3	566	-18.6	-2.6	7.9
328	3.1	14.0	19.0	388	-2.5	9.2	15.7	448	-7.8	4.8	12.8	508	-13.3	0.9	10.2	568	-18.8	-2.7	7.8
330	2.9	13.9	18.9	390	-2.7	9.1	15.6	450	-8.0	4.7	12.7	510	-13.5	0.8	10.1	570	-19.0	-2.9	7.7
332	2.7	13.7	18.8	392	-2.8	8.9	15.5	452	-8.2	4.5	12.6	512	-13.7	0.6	10.0	572	-19.2	-3.0	7.7
334	2.5	13.5	18.7	394	-3.0	8.8	15.4	454	-8.3	4.4	12.5	514	-13.8	0.5	9.9	574	-19.4	-3.1	7.6
336	2.3	13.4	18.6	396	-3.2	8.6	15.3	456	-8.5	4.3	12.4	516	-14.0	0.4	9.8	576	-19.6	-3.2	7.5
338	2.1	13.2	18.4	398	-3.4	8.5	15.2	458	-8.7	4.1	12.3	518	-14.2	0.3	9.8	578	-19.7	-3.3	7.5
340	1.9	13.0	18.3	400	-3.6	8.3	15.1	460	-8.9	4.0	12.2	520	-14.4	0.2	9.7	580	-19.9	-3.4	7.4
342	1.7	12.8	18.2	402	-3.7	8.2	15.0	462	-9.1	3.9	12.1	522	-14.6	0.0	9.6	582	-20.1	-3.5	7.3
344	1.6	12.7	18.1	404	-3.9	8.0	14.9	464	-9.3	3.7	12.1	524	-14.8	-0.1	9.5	584	-20.3	-3.6	7.3
346	1.4	12.5	17.9	406	-4.1	7.9	14.8	466	-9.4	3.6	12.0	526	-14.9	-0.2	9.4	586	-20.5	-3.8	7.2
348	1.2	12.3	17.8	408	-4.3	7.7	14.7	468	-9.6	3.4	11.9	528	-15.1	-0.3	9.3	588	-20.7	-3.9	7.1
350	1.0	12.2	17.7	410	-4.4	7.6	14.6	470	-9.8	3.3	11.8	530	-15.3	-0.5	9.3	590	-20.8	-4.0	7.1
352	0.8	12.0	17.6	412	-4.6	7.4	14.5	472	-10.0	3.2	11.7	532	-15.5	-0.6	9.2	592	-21.0	-4.1	7.0
354	0.6	11.9	17.5	414	-4.8	7.3	14.4	474	-10.2	3.1	11.6	534	-15.7	-0.7	9.1	594	-21.2	-4.2	6.9
356	0.4	11.7	17.4	416	-5.0	7.2	14.3	476	-10.3	2.9	11.5	536	-15.9	-0.8	9.0	596	-21.4	-4.3	6.9
358	0.2	11.6	17.3	418	-5.1	7.0	14.2	478	-10.5	2.8	11.4	538	-16.1	-1.0	8.9	598	-21.6	-4.4	6.8
																600	-21.8	-4.5	6.7

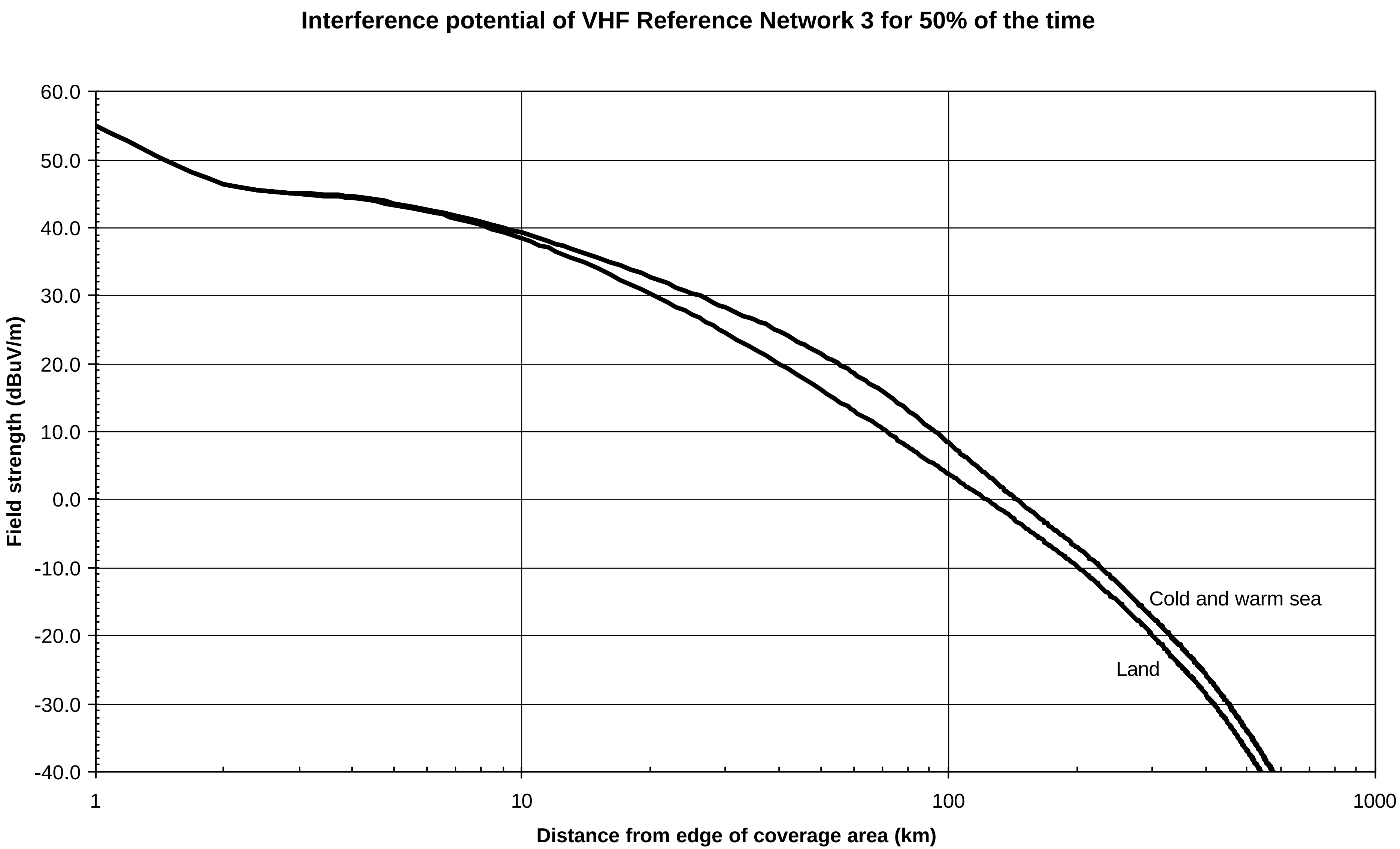


Figure A6.3a: Interference potential of VHF Reference Network Three for 50% of time

Table A6.3a: Tabulated values for the interference potential of VHF Reference Network 3 for 50% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	59.2	59.2	59.2	60	13.1	18.6	18.6	120	0.4	4.2	4.2	180	-7.6	-4.8	-4.8	240	-14.1	-11.3	-11.3
2	46.5	46.5	46.5	62	12.6	18.1	18.1	122	0.1	3.8	3.8	182	-7.8	-5.0	-5.0	242	-14.3	-11.5	-11.5
4	44.4	44.6	44.6	64	12.0	17.5	17.5	124	-0.2	3.4	3.4	184	-8.0	-5.3	-5.3	244	-14.5	-11.7	-11.7
6	42.4	42.7	42.7	66	11.5	16.9	16.9	126	-0.5	3.1	3.1	186	-8.2	-5.5	-5.5	246	-14.7	-12.0	-12.0
8	40.4	40.9	40.9	68	11.0	16.4	16.4	128	-0.8	2.7	2.7	188	-8.5	-5.7	-5.7	248	-14.9	-12.2	-12.2
10	38.5	39.3	39.3	70	10.5	15.9	15.9	130	-1.1	2.3	2.3	190	-8.7	-5.9	-5.9	250	-15.0	-12.4	-12.4
12	36.6	37.7	37.7	72	9.9	15.3	15.3	132	-1.4	2.0	2.0	192	-8.9	-6.1	-6.1	252	-15.2	-12.6	-12.6
14	34.9	36.3	36.3	74	9.4	14.8	14.8	134	-1.6	1.7	1.7	194	-9.1	-6.4	-6.4	254	-15.4	-12.8	-12.8
16	33.2	35.0	35.0	76	8.8	14.3	14.3	136	-1.9	1.3	1.3	196	-9.3	-6.6	-6.6	256	-15.6	-13.0	-13.0
18	31.7	33.9	33.9	78	8.3	13.7	13.7	138	-2.2	1.0	1.0	198	-9.6	-6.8	-6.8	258	-15.8	-13.2	-13.2
20	30.3	32.8	32.8	80	7.8	13.2	13.2	140	-2.5	0.7	0.7	200	-9.8	-7.0	-7.0	260	-16.0	-13.4	-13.4
22	29.0	31.8	31.8	82	7.4	12.7	12.7	142	-2.8	0.4	0.4	202	-10.0	-7.2	-7.2	262	-16.2	-13.6	-13.6
24	27.8	30.8	30.8	84	6.9	12.2	12.2	144	-3.1	0.1	0.1	204	-10.2	-7.5	-7.5	264	-16.4	-13.8	-13.8
26	26.7	30.0	30.0	86	6.5	11.7	11.7	146	-3.3	-0.2	-0.2	206	-10.4	-7.7	-7.7	266	-16.6	-14.0	-14.0
28	25.6	29.1	29.1	88	6.1	11.2	11.2	148	-3.6	-0.5	-0.5	208	-10.7	-7.9	-7.9	268	-16.8	-14.2	-14.2
30	24.6	28.3	28.3	90	5.7	10.7	10.7	150	-3.9	-0.8	-0.8	210	-10.9	-8.1	-8.1	270	-17.0	-14.4	-14.4
32	23.6	27.5	27.5	92	5.3	10.2	10.2	152	-4.2	-1.1	-1.1	212	-11.1	-8.3	-8.3	272	-17.2	-14.6	-14.6
34	22.6	26.8	26.8	94	4.9	9.8	9.8	154	-4.4	-1.4	-1.4	214	-11.3	-8.6	-8.6	274	-17.4	-14.8	-14.8
36	21.7	26.1	26.1	96	4.5	9.3	9.3	156	-4.7	-1.7	-1.7	216	-11.5	-8.8	-8.8	276	-17.6	-15.0	-15.0
38	20.8	25.5	25.5	98	4.1	8.8	8.8	158	-4.9	-1.9	-1.9	218	-11.8	-9.0	-9.0	278	-17.8	-15.3	-15.3
40	20.0	24.8	24.8	100	3.8	8.4	8.4	160	-5.2	-2.2	-2.2	220	-12.0	-9.2	-9.2	280	-18.0	-15.5	-15.5
42	19.2	24.1	24.1	102	3.4	7.9	7.9	162	-5.4	-2.5	-2.5	222	-12.2	-9.4	-9.4	282	-18.2	-15.6	-15.6
44	18.4	23.4	23.4	104	3.1	7.5	7.5	164	-5.7	-2.8	-2.8	224	-12.4	-9.6	-9.6	284	-18.3	-15.8	-15.8
46	17.7	22.8	22.8	106	2.7	7.1	7.1	166	-5.9	-3.0	-3.0	226	-12.6	-9.9	-9.9	286	-18.5	-16.0	-16.0
48	17.0	22.1	22.1	108	2.4	6.6	6.6	168	-6.2	-3.3	-3.3	228	-12.9	-10.1	-10.1	288	-18.7	-16.2	-16.2
50	16.3	21.5	21.5	110	2.0	6.2	6.2	170	-6.4	-3.5	-3.5	230	-13.1	-10.3	-10.3	290	-18.9	-16.4	-16.4
52	15.6	20.9	20.9	112	1.7	5.8	5.8	172	-6.6	-3.8	-3.8	232	-13.3	-10.5	-10.5	292	-19.1	-16.6	-16.6
54	14.9	20.4	20.4	114	1.4	5.4	5.4	174	-6.9	-4.1	-4.1	234	-13.5	-10.7	-10.7	294	-19.3	-16.7	-16.7
56	14.3	19.8	19.8	116	1.1	5.0	5.0	176	-7.1	-4.3	-4.3	236	-13.7	-10.9	-10.9	296	-19.5	-16.9	-16.9
58	13.7	19.2	19.2	118	0.7	4.6	4.6	178	-7.3	-4.6	-4.6	238	-13.9	-11.1	-11.1	298	-19.7	-17.1	-17.1

Table A6.3a: Tabulated values for the interference potential of VHF Reference Network 3 for 50% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	-19.9	-17.3	-17.3	360	-25.3	-22.4	-22.4	420	-30.2	-27.4	-27.4	480	-35.2	-32.4	-32.4	540	-40.1	-37.2	-37.2
302	-20.1	-17.5	-17.5	362	-25.4	-22.6	-22.6	422	-30.4	-27.5	-27.5	482	-35.4	-32.5	-32.5	542	-40.3	-37.4	-37.4
304	-20.3	-17.6	-17.6	364	-25.6	-22.7	-22.7	424	-30.6	-27.7	-27.7	484	-35.6	-32.7	-32.7	544	-40.4	-37.5	-37.5
306	-20.5	-17.8	-17.8	366	-25.8	-22.9	-22.9	426	-30.7	-27.9	-27.9	486	-35.7	-32.8	-32.8	546	-40.6	-37.7	-37.7
308	-20.7	-18.0	-18.0	368	-25.9	-23.1	-23.1	428	-30.9	-28.0	-28.0	488	-35.9	-33.0	-33.0	548	-40.8	-37.9	-37.9
310	-20.9	-18.2	-18.2	370	-26.1	-23.2	-23.2	430	-31.1	-28.2	-28.2	490	-36.1	-33.2	-33.2	550	-40.9	-38.0	-38.0
312	-21.0	-18.3	-18.3	372	-26.2	-23.4	-23.4	432	-31.2	-28.4	-28.4	492	-36.2	-33.3	-33.3	552	-41.1	-38.2	-38.2
314	-21.2	-18.5	-18.5	374	-26.4	-23.5	-23.5	434	-31.4	-28.5	-28.5	494	-36.4	-33.5	-33.5	554	-41.2	-38.3	-38.3
316	-21.4	-18.7	-18.7	376	-26.6	-23.7	-23.7	436	-31.6	-28.7	-28.7	496	-36.5	-33.7	-33.7	556	-41.4	-38.5	-38.5
318	-21.6	-18.9	-18.9	378	-26.7	-23.9	-23.9	438	-31.7	-28.9	-28.9	498	-36.7	-33.8	-33.8	558	-41.6	-38.7	-38.7
320	-21.8	-19.1	-19.1	380	-26.9	-24.0	-24.0	440	-31.9	-29.0	-29.0	500	-36.9	-34.0	-34.0	560	-41.7	-38.8	-38.8
322	-22.0	-19.2	-19.2	382	-27.1	-24.2	-24.2	442	-32.1	-29.2	-29.2	502	-37.0	-34.1	-34.1	562	-41.9	-39.0	-39.0
324	-22.2	-19.4	-19.4	384	-27.2	-24.4	-24.4	444	-32.2	-29.4	-29.4	504	-37.2	-34.3	-34.3	564	-42.1	-39.1	-39.1
326	-22.4	-19.6	-19.6	386	-27.4	-24.5	-24.5	446	-32.4	-29.5	-29.5	506	-37.4	-34.5	-34.5	566	-42.2	-39.3	-39.3
328	-22.6	-19.8	-19.8	388	-27.6	-24.7	-24.7	448	-32.6	-29.7	-29.7	508	-37.5	-34.6	-34.6	568	-42.4	-39.5	-39.5
330	-22.8	-20.0	-20.0	390	-27.7	-24.9	-24.9	450	-32.7	-29.9	-29.9	510	-37.7	-34.8	-34.8	570	-42.5	-39.6	-39.6
332	-23.0	-20.1	-20.1	392	-27.9	-25.0	-25.0	452	-32.9	-30.0	-30.0	512	-37.8	-34.9	-34.9	572	-42.7	-39.8	-39.8
334	-23.1	-20.3	-20.3	394	-28.1	-25.2	-25.2	454	-33.1	-30.2	-30.2	514	-38.0	-35.1	-35.1	574	-42.9	-40.0	-40.0
336	-23.3	-20.4	-20.4	396	-28.2	-25.4	-25.4	456	-33.2	-30.4	-30.4	516	-38.2	-35.3	-35.3	576	-43.0	-40.1	-40.1
338	-23.5	-20.6	-20.6	398	-28.4	-25.5	-25.5	458	-33.4	-30.5	-30.5	518	-38.3	-35.4	-35.4	578	-43.2	-40.3	-40.3
340	-23.6	-20.8	-20.8	400	-28.6	-25.7	-25.7	460	-33.6	-30.7	-30.7	520	-38.5	-35.6	-35.6	580	-43.4	-40.4	-40.4
342	-23.8	-20.9	-20.9	402	-28.7	-25.9	-25.9	462	-33.7	-30.9	-30.9	522	-38.7	-35.8	-35.8	582	-43.5	-40.6	-40.6
344	-24.0	-21.1	-21.1	404	-28.9	-26.0	-26.0	464	-33.9	-31.0	-31.0	524	-38.8	-35.9	-35.9	584	-43.7	-40.8	-40.8
346	-24.1	-21.3	-21.3	406	-29.1	-26.2	-26.2	466	-34.1	-31.2	-31.2	526	-39.0	-36.1	-36.1	586	-43.8	-40.9	-40.9
348	-24.3	-21.4	-21.4	408	-29.2	-26.4	-26.4	468	-34.2	-31.4	-31.4	528	-39.1	-36.2	-36.2	588	-44.0	-41.1	-41.1
350	-24.4	-21.6	-21.6	410	-29.4	-26.5	-26.5	470	-34.4	-31.5	-31.5	530	-39.3	-36.4	-36.4	590	-44.2	-41.3	-41.3
352	-24.6	-21.8	-21.8	412	-29.6	-26.7	-26.7	472	-34.6	-31.7	-31.7	532	-39.5	-36.6	-36.6	592	-44.3	-41.4	-41.4
354	-24.8	-21.9	-21.9	414	-29.7	-26.9	-26.9	474	-34.7	-31.9	-31.9	534	-39.6	-36.7	-36.7	594	-44.5	-41.6	-41.6
356	-24.9	-22.1	-22.1	416	-29.9	-27.0	-27.0	476	-34.9	-32.0	-32.0	536	-39.8	-36.9	-36.9	596	-44.7	-41.8	-41.8
358	-25.1	-22.2	-22.2	418	-30.1	-27.2	-27.2	478	-35.1	-32.2	-32.2	538	-40.0	-37.0	-37.0	598	-44.8	-41.9	-41.9
																600	-45.0	-42.1	-42.1

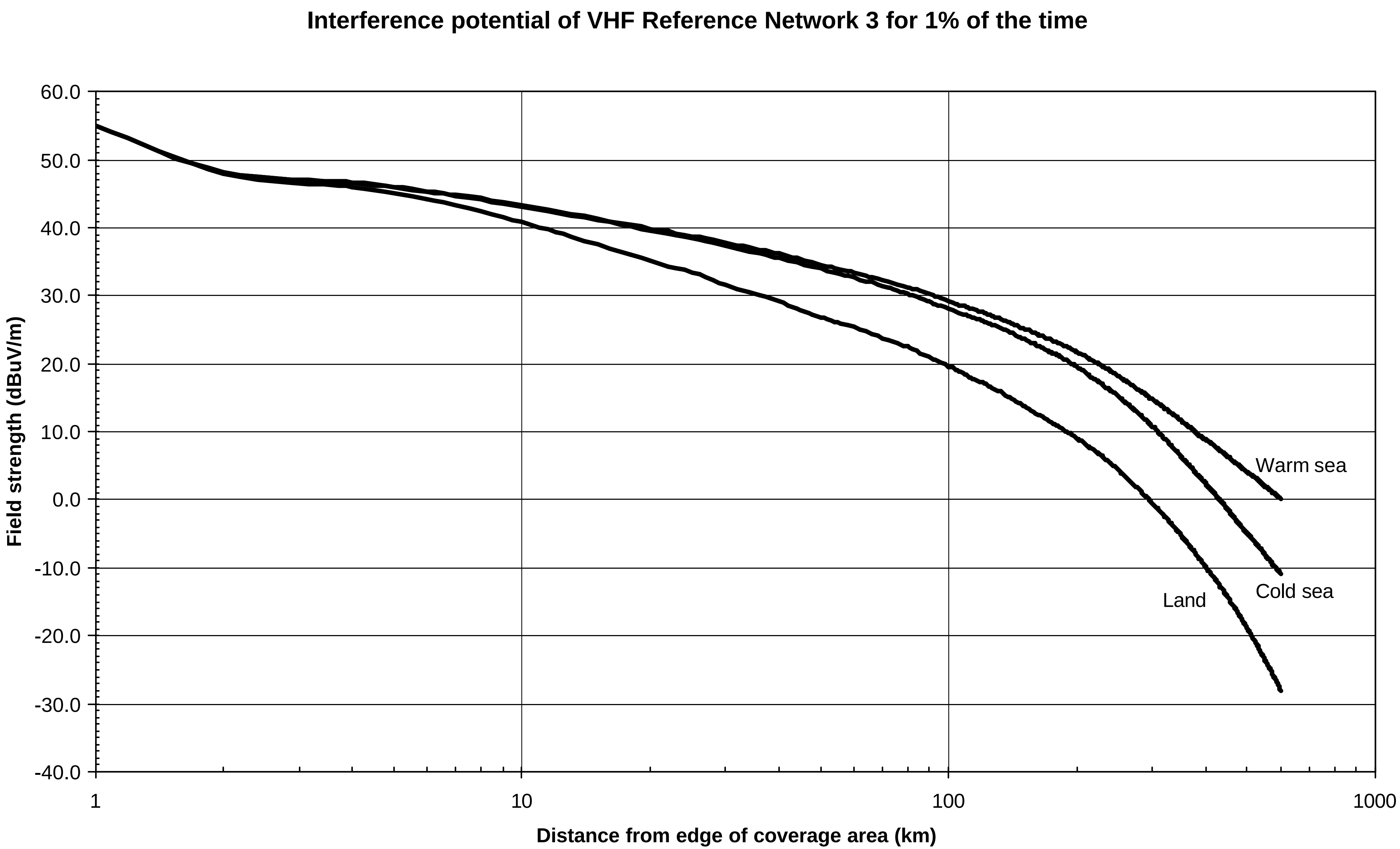


Figure A6.3b: Interference potential of VHF Reference Network Three for 1% of time

Table A6.3b: Tabulated values for the interference potential of VHF Reference Network 3 for 1% of time - (1)																			
Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	60.5	60.5	60.5	60	25.4	32.7	33.4	120	17.2	26.3	27.6	180	10.9	21.2	23.1	240	5.3	16.0	18.9
2	48.0	48.2	48.2	62	25.1	32.4	33.2	122	17.0	26.1	27.4	182	10.7	21.1	23.0	242	5.1	15.9	18.8
4	46.0	46.6	46.7	64	24.7	32.2	33.0	124	16.7	26.0	27.2	184	10.5	20.9	22.9	244	4.9	15.7	18.6
6	44.1	45.3	45.4	66	24.4	32.0	32.7	126	16.5	25.8	27.1	186	10.3	20.7	22.7	246	4.7	15.5	18.5
8	42.4	44.1	44.3	68	24.1	31.7	32.5	128	16.3	25.6	26.9	188	10.1	20.6	22.6	248	4.5	15.3	18.3
10	40.8	43.1	43.3	70	23.8	31.5	32.3	130	16.1	25.5	26.8	190	9.9	20.4	22.4	250	4.3	15.2	18.2
12	39.4	42.3	42.5	72	23.6	31.3	32.1	132	15.9	25.3	26.6	192	9.8	20.2	22.3	252	4.1	15.0	18.1
14	38.1	41.5	41.7	74	23.3	31.0	31.9	134	15.6	25.1	26.4	194	9.6	20.0	22.2	254	3.9	14.8	17.9
16	37.0	40.8	41.0	76	23.0	30.8	31.7	136	15.4	24.9	26.3	196	9.4	19.9	22.0	256	3.8	14.6	17.8
18	36.0	40.2	40.5	78	22.7	30.5	31.5	138	15.2	24.7	26.1	198	9.2	19.7	21.9	258	3.6	14.5	17.6
20	35.1	39.6	39.9	80	22.5	30.3	31.3	140	14.9	24.5	26.0	200	9.0	19.5	21.7	260	3.4	14.3	17.5
22	34.4	39.2	39.5	82	22.2	30.0	31.1	142	14.7	24.4	25.8	202	8.8	19.3	21.6	262	3.2	14.1	17.3
24	33.8	38.7	39.0	84	21.9	29.8	30.9	144	14.5	24.2	25.7	204	8.7	19.2	21.5	264	3.0	14.0	17.2
26	33.1	38.3	38.6	86	21.6	29.6	30.7	146	14.3	24.0	25.5	206	8.5	19.0	21.3	266	2.8	13.8	17.1
28	32.3	37.8	38.2	88	21.3	29.4	30.5	148	14.0	23.8	25.3	208	8.3	18.8	21.2	268	2.6	13.6	16.9
30	31.6	37.4	37.8	90	21.0	29.2	30.3	150	13.8	23.7	25.2	210	8.1	18.6	21.0	270	2.4	13.4	16.8
32	31.1	37.0	37.4	92	20.7	28.9	30.1	152	13.6	23.5	25.1	212	7.9	18.5	20.9	272	2.2	13.3	16.6
34	30.6	36.6	37.1	94	20.4	28.7	29.9	154	13.4	23.3	24.9	214	7.7	18.3	20.7	274	2.0	13.1	16.5
36	30.1	36.2	36.8	96	20.2	28.5	29.7	156	13.2	23.1	24.8	216	7.6	18.1	20.6	276	1.8	12.9	16.3
38	29.6	35.8	36.5	98	19.9	28.3	29.5	158	13.0	23.0	24.6	218	7.4	17.9	20.5	278	1.6	12.7	16.2
40	29.2	35.5	36.2	100	19.6	28.1	29.3	160	12.8	22.8	24.5	220	7.2	17.8	20.3	280	1.4	12.6	16.1
42	28.7	35.2	35.8	102	19.4	27.9	29.1	162	12.6	22.6	24.3	222	7.0	17.6	20.2	282	1.2	12.4	15.9
44	28.2	34.9	35.5	104	19.1	27.7	28.9	164	12.4	22.5	24.2	224	6.8	17.4	20.0	284	1.0	12.2	15.8
46	27.7	34.6	35.2	106	18.9	27.5	28.7	166	12.2	22.3	24.1	226	6.7	17.2	19.9	286	0.8	12.0	15.7
48	27.3	34.3	34.9	108	18.6	27.3	28.6	168	12.0	22.2	23.9	228	6.5	17.1	19.8	288	0.6	11.9	15.6
50	26.9	34.0	34.6	110	18.4	27.2	28.4	170	11.8	22.0	23.8	230	6.3	16.9	19.6	290	0.5	11.7	15.4
52	26.6	33.7	34.4	112	18.1	27.0	28.2	172	11.6	21.8	23.7	232	6.1	16.7	19.5	292	0.3	11.5	15.3
54	26.2	33.4	34.1	114	17.9	26.8	28.0	174	11.4	21.7	23.5	234	5.9	16.5	19.3	294	0.1	11.3	15.2
56	26.0	33.2	33.9	116	17.6	26.6	27.9	176	11.2	21.5	23.4	236	5.7	16.4	19.2	296	-0.1	11.2	15.0
58	25.7	32.9	33.7	118	17.4	26.5	27.7	178	11.0	21.4	23.3	238	5.5	16.2	19.0	298	-0.3	11.0	14.9

Table A6.3b: Tabulated values for the interference potential of VHF Reference Network 3 for 1% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	-0.5	10.8	14.8	360	-6.1	5.6	11.1	420	-11.6	0.9	7.9	480	-17.0	-3.6	5.0	540	-22.5	-7.4	2.5
302	-0.7	10.6	14.7	362	-6.3	5.4	11.0	422	-11.8	0.7	7.8	482	-17.1	-3.8	4.9	542	-22.7	-7.5	2.4
304	-0.9	10.5	14.5	364	-6.5	5.2	10.8	424	-12.0	0.6	7.7	484	-17.3	-3.9	4.8	544	-22.8	-7.6	2.3
306	-1.1	10.3	14.4	366	-6.7	5.1	10.7	426	-12.1	0.4	7.6	486	-17.5	-4.0	4.7	546	-23.0	-7.7	2.2
308	-1.2	10.1	14.3	368	-6.9	4.9	10.6	428	-12.3	0.3	7.5	488	-17.7	-4.1	4.6	548	-23.2	-7.9	2.2
310	-1.4	9.9	14.2	370	-7.1	4.7	10.5	430	-12.5	0.1	7.4	490	-17.9	-4.3	4.5	550	-23.4	-8.0	2.1
312	-1.6	9.7	14.0	372	-7.3	4.6	10.3	432	-12.7	0.0	7.3	492	-18.1	-4.4	4.5	552	-23.6	-8.1	2.0
314	-1.8	9.6	13.9	374	-7.5	4.4	10.2	434	-12.9	-0.2	7.2	494	-18.2	-4.5	4.4	554	-23.8	-8.2	1.9
316	-2.0	9.4	13.8	376	-7.7	4.2	10.1	436	-13.0	-0.3	7.1	496	-18.4	-4.6	4.3	556	-24.0	-8.3	1.8
318	-2.2	9.2	13.7	378	-7.9	4.1	10.0	438	-13.2	-0.5	7.0	498	-18.6	-4.8	4.2	558	-24.1	-8.5	1.8
320	-2.4	9.0	13.5	380	-8.0	3.9	9.9	440	-13.4	-0.6	6.9	500	-18.8	-4.9	4.1	560	-24.3	-8.6	1.7
322	-2.6	8.9	13.4	382	-8.2	3.7	9.7	442	-13.6	-0.8	6.8	502	-19.0	-5.0	4.0	562	-24.5	-8.7	1.6
324	-2.7	8.7	13.3	384	-8.4	3.6	9.6	444	-13.8	-0.9	6.7	504	-19.2	-5.1	4.0	564	-24.7	-8.8	1.5
326	-2.9	8.5	13.2	386	-8.6	3.4	9.5	446	-13.9	-1.1	6.6	506	-19.3	-5.3	3.9	566	-24.9	-9.0	1.4
328	-3.1	8.3	13.0	388	-8.8	3.3	9.4	448	-14.1	-1.2	6.5	508	-19.5	-5.4	3.8	568	-25.1	-9.1	1.4
330	-3.3	8.1	12.9	390	-8.9	3.1	9.3	450	-14.3	-1.4	6.4	510	-19.7	-5.5	3.7	570	-25.2	-9.2	1.3
332	-3.5	8.0	12.8	392	-9.1	3.0	9.2	452	-14.5	-1.5	6.3	512	-19.9	-5.6	3.6	572	-25.4	-9.3	1.2
334	-3.7	7.8	12.7	394	-9.3	2.8	9.1	454	-14.6	-1.7	6.2	514	-20.1	-5.8	3.6	574	-25.6	-9.5	1.1
336	-3.9	7.6	12.5	396	-9.5	2.7	9.0	456	-14.8	-1.8	6.1	516	-20.3	-5.9	3.5	576	-25.8	-9.6	1.0
338	-4.1	7.5	12.4	398	-9.7	2.5	9.0	458	-15.0	-2.0	6.0	518	-20.5	-6.0	3.4	578	-26.0	-9.7	0.9
340	-4.3	7.3	12.3	400	-9.8	2.4	8.9	460	-15.2	-2.1	5.9	520	-20.6	-6.1	3.3	580	-26.2	-9.8	0.9
342	-4.4	7.1	12.2	402	-10.0	2.2	8.8	462	-15.4	-2.3	5.8	522	-20.8	-6.3	3.2	582	-26.3	-9.9	0.8
344	-4.6	7.0	12.0	404	-10.2	2.1	8.7	464	-15.5	-2.4	5.7	524	-21.0	-6.4	3.1	584	-26.5	-10.1	0.7
346	-4.8	6.8	11.9	406	-10.4	1.9	8.6	466	-15.7	-2.6	5.6	526	-21.2	-6.5	3.1	586	-26.7	-10.2	0.7
348	-5.0	6.6	11.8	408	-10.5	1.8	8.5	468	-15.9	-2.7	5.5	528	-21.4	-6.6	3.0	588	-26.9	-10.3	0.6
350	-5.2	6.4	11.7	410	-10.7	1.6	8.4	470	-16.1	-2.9	5.4	530	-21.6	-6.7	2.9	590	-27.1	-10.4	0.5
352	-5.4	6.3	11.6	412	-10.9	1.5	8.3	472	-16.2	-3.0	5.3	532	-21.7	-6.9	2.8	592	-27.3	-10.5	0.5
354	-5.6	6.1	11.4	414	-11.1	1.3	8.2	474	-16.4	-3.2	5.2	534	-21.9	-7.0	2.7	594	-27.4	-10.6	0.4
356	-5.8	5.9	11.3	416	-11.3	1.2	8.1	476	-16.6	-3.3	5.1	536	-22.1	-7.1	2.7	596	-27.6	-10.7	0.4
358	-6.0	5.8	11.2	418	-11.4	1.0	8.0	478	-16.8	-3.5	5.1	538	-22.3	-7.2	2.6	598	-27.8	-10.8	0.3
																600	-28.0	-10.9	0.2

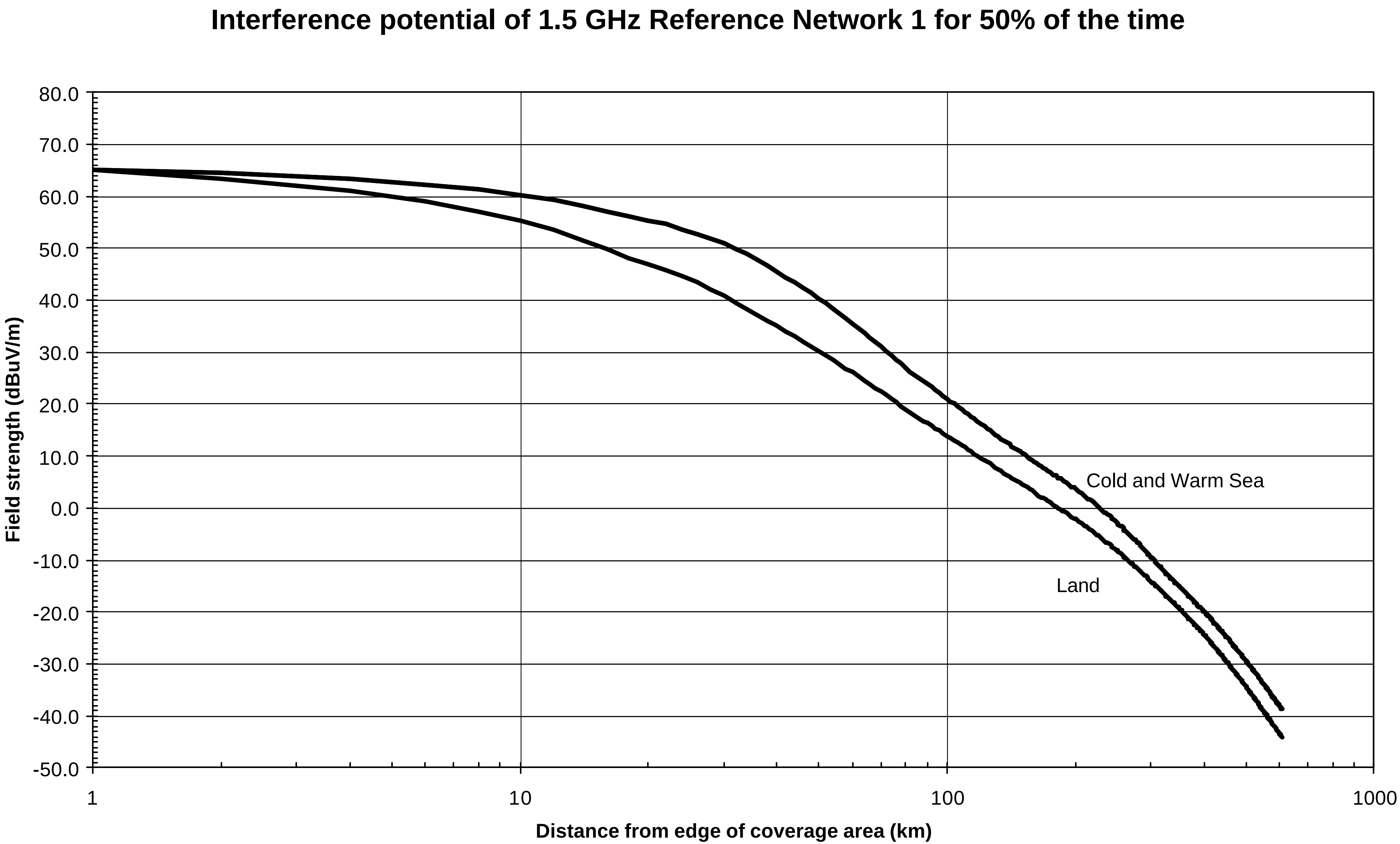


Figure A6.4a: Interference potential of 1.5 GHz Reference Network One for 50% of time

Table A6.4a: Tabulated values for the interference potential of 1.5 GHz Reference Network 1 for 50% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	65.5	65.5	65.5	60	26.1	35.5	35.5	120	9.6	16.2	16.2	180	0.3	6.2	6.2	240	-7.0	-1.6	-1.6
2	63.3	64.4	64.4	62	25.3	34.5	34.5	122	9.3	15.7	15.7	182	0.0	5.9	5.9	242	-7.2	-1.8	-1.8
4	61.1	63.3	63.3	64	24.6	33.6	33.6	124	8.9	15.3	15.3	184	-0.2	5.6	5.6	244	-7.5	-2.1	-2.1
6	59.0	62.3	62.3	66	23.8	32.7	32.7	126	8.5	14.9	14.9	186	-0.5	5.4	5.4	246	-7.7	-2.3	-2.3
8	57.1	61.3	61.3	68	23.1	31.8	31.8	128	8.1	14.5	14.5	188	-0.7	5.1	5.1	248	-8.0	-2.6	-2.6
10	55.3	60.3	60.3	70	22.4	31.0	31.0	130	7.8	14.1	14.1	190	-0.9	4.9	4.9	250	-8.2	-2.9	-2.9
12	53.6	59.4	59.4	72	21.8	30.1	30.1	132	7.4	13.7	13.7	192	-1.2	4.6	4.6	252	-8.4	-3.1	-3.1
14	51.6	58.2	58.2	74	21.1	29.3	29.3	134	7.1	13.3	13.3	194	-1.4	4.4	4.4	254	-8.7	-3.4	-3.4
16	49.7	57.1	57.1	76	20.4	28.5	28.5	136	6.7	13.0	13.0	196	-1.7	4.1	4.1	256	-8.9	-3.6	-3.6
18	48.1	56.1	56.1	78	19.7	27.8	27.8	138	6.4	12.6	12.6	198	-1.9	3.9	3.9	258	-9.2	-3.9	-3.9
20	46.9	55.3	55.3	80	19.1	27.0	27.0	140	6.1	12.3	12.3	200	-2.2	3.6	3.6	260	-9.4	-4.2	-4.2
22	45.8	54.6	54.6	82	18.4	26.2	26.2	142	5.7	11.9	11.9	202	-2.4	3.3	3.3	262	-9.6	-4.4	-4.4
24	44.6	53.7	53.7	84	17.9	25.6	25.6	144	5.4	11.6	11.6	204	-2.6	3.1	3.1	264	-9.9	-4.7	-4.7
26	43.4	52.8	52.8	86	17.3	25.0	25.0	146	5.1	11.2	11.2	206	-2.9	2.8	2.8	266	-10.1	-4.9	-4.9
28	42.1	51.9	51.9	88	16.8	24.4	24.4	148	4.8	10.9	10.9	208	-3.1	2.6	2.6	268	-10.4	-5.2	-5.2
30	40.8	50.9	50.9	90	16.3	23.8	23.8	150	4.5	10.6	10.6	210	-3.4	2.3	2.3	270	-10.6	-5.5	-5.5
32	39.4	49.9	49.9	92	15.8	23.3	23.3	152	4.2	10.3	10.3	212	-3.6	2.1	2.1	272	-10.8	-5.7	-5.7
34	38.2	48.8	48.8	94	15.3	22.7	22.7	154	3.9	9.9	9.9	214	-3.8	1.8	1.8	274	-11.1	-6.0	-6.0
36	37.1	47.7	47.7	96	14.8	22.1	22.1	156	3.6	9.6	9.6	216	-4.1	1.6	1.6	276	-11.3	-6.2	-6.2
38	36.0	46.6	46.6	98	14.4	21.6	21.6	158	3.3	9.3	9.3	218	-4.3	1.3	1.3	278	-11.5	-6.5	-6.5
40	35.0	45.5	45.5	100	13.9	21.1	21.1	160	3.0	9.0	9.0	220	-4.6	1.0	1.0	280	-11.8	-6.8	-6.8
42	34.0	44.5	44.5	102	13.4	20.5	20.5	162	2.7	8.7	8.7	222	-4.8	0.8	0.8	282	-12.0	-7.0	-7.0
44	33.0	43.4	43.4	104	13.0	20.0	20.0	164	2.4	8.4	8.4	224	-5.1	0.5	0.5	284	-12.2	-7.3	-7.3
46	32.0	42.4	42.4	106	12.5	19.5	19.5	166	2.1	8.1	8.1	226	-5.3	0.3	0.3	286	-12.4	-7.5	-7.5
48	31.1	41.4	41.4	108	12.1	19.0	19.0	168	1.9	7.8	7.8	228	-5.5	0.0	0.0	288	-12.7	-7.8	-7.8
50	30.2	40.4	40.4	110	11.7	18.5	18.5	170	1.6	7.5	7.5	230	-5.8	-0.3	-0.3	290	-12.9	-8.1	-8.1
52	29.3	39.4	39.4	112	11.3	18.0	18.0	172	1.3	7.3	7.3	232	-6.0	-0.5	-0.5	292	-13.1	-8.3	-8.3
54	28.4	38.4	38.4	114	10.8	17.6	17.6	174	1.1	7.0	7.0	234	-6.3	-0.8	-0.8	294	-13.3	-8.6	-8.6
56	27.6	37.4	37.4	116	10.4	17.1	17.1	176	0.8	6.7	6.7	236	-6.5	-1.0	-1.0	296	-13.6	-8.8	-8.8
58	26.8	36.4	36.4	118	10.0	16.6	16.6	178	0.5	6.4	6.4	238	-6.7	-1.3	-1.3	298	-13.8	-9.1	-9.1

Table A6.4a: Tabulated values for the interference potential of 1.5 GHz Reference Network 1 for 50% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	-14.0	-9.4	-9.4	360	-20.4	-16.1	-16.1	420	-26.4	-21.9	-21.9	480	-32.3	-27.5	-27.5	540	-38.0	-32.8	-32.8
302	-14.3	-9.6	-9.6	362	-20.6	-16.3	-16.3	422	-26.6	-22.1	-22.1	482	-32.5	-27.6	-27.6	542	-38.2	-33.0	-33.0
304	-14.5	-9.9	-9.9	364	-20.8	-16.5	-16.5	424	-26.8	-22.2	-22.2	484	-32.7	-27.8	-27.8	544	-38.4	-33.2	-33.2
306	-14.7	-10.1	-10.1	366	-21.0	-16.7	-16.7	426	-27.0	-22.4	-22.4	486	-32.9	-28.0	-28.0	546	-38.6	-33.4	-33.4
308	-14.9	-10.4	-10.4	368	-21.2	-16.9	-16.9	428	-27.2	-22.6	-22.6	488	-33.1	-28.2	-28.2	548	-38.8	-33.6	-33.6
310	-15.1	-10.6	-10.6	370	-21.4	-17.1	-17.1	430	-27.4	-22.8	-22.8	490	-33.3	-28.4	-28.4	550	-39.0	-33.7	-33.7
312	-15.4	-10.9	-10.9	372	-21.6	-17.3	-17.3	432	-27.6	-23.0	-23.0	492	-33.5	-28.5	-28.5	552	-39.2	-33.9	-33.9
314	-15.6	-11.1	-11.1	374	-21.8	-17.5	-17.5	434	-27.8	-23.2	-23.2	494	-33.7	-28.7	-28.7	554	-39.4	-34.1	-34.1
316	-15.8	-11.4	-11.4	376	-22.0	-17.7	-17.7	436	-28.0	-23.4	-23.4	496	-33.8	-28.9	-28.9	556	-39.5	-34.3	-34.3
318	-16.0	-11.6	-11.6	378	-22.2	-17.9	-17.9	438	-28.2	-23.6	-23.6	498	-34.0	-29.1	-29.1	558	-39.7	-34.5	-34.5
320	-16.3	-11.9	-11.9	380	-22.4	-18.1	-18.1	440	-28.4	-23.7	-23.7	500	-34.2	-29.3	-29.3	560	-39.9	-34.6	-34.6
322	-16.5	-12.1	-12.1	382	-22.6	-18.3	-18.3	442	-28.6	-23.9	-23.9	502	-34.4	-29.4	-29.4	562	-40.1	-34.8	-34.8
324	-16.7	-12.3	-12.3	384	-22.8	-18.5	-18.5	444	-28.8	-24.1	-24.1	504	-34.6	-29.6	-29.6	564	-40.3	-35.0	-35.0
326	-16.9	-12.6	-12.6	386	-23.0	-18.7	-18.7	446	-29.0	-24.3	-24.3	506	-34.8	-29.8	-29.8	566	-40.5	-35.2	-35.2
328	-17.1	-12.8	-12.8	388	-23.2	-18.9	-18.9	448	-29.2	-24.5	-24.5	508	-35.0	-30.0	-30.0	568	-40.7	-35.3	-35.3
330	-17.3	-13.0	-13.0	390	-23.4	-19.1	-19.1	450	-29.4	-24.7	-24.7	510	-35.2	-30.2	-30.2	570	-40.8	-35.5	-35.5
332	-17.5	-13.2	-13.2	392	-23.6	-19.2	-19.2	452	-29.6	-24.9	-24.9	512	-35.4	-30.3	-30.3	572	-41.0	-35.7	-35.7
334	-17.7	-13.5	-13.5	394	-23.8	-19.4	-19.4	454	-29.8	-25.1	-25.1	514	-35.6	-30.5	-30.5	574	-41.2	-35.9	-35.9
336	-17.9	-13.7	-13.7	396	-24.0	-19.6	-19.6	456	-30.0	-25.2	-25.2	516	-35.7	-30.7	-30.7	576	-41.4	-36.0	-36.0
338	-18.1	-13.9	-13.9	398	-24.2	-19.8	-19.8	458	-30.2	-25.4	-25.4	518	-35.9	-30.9	-30.9	578	-41.5	-36.2	-36.2
340	-18.3	-14.1	-14.1	400	-24.4	-20.0	-20.0	460	-30.4	-25.6	-25.6	520	-36.1	-31.1	-31.1	580	-41.7	-36.4	-36.4
342	-18.5	-14.3	-14.3	402	-24.6	-20.2	-20.2	462	-30.6	-25.8	-25.8	522	-36.3	-31.2	-31.2	582	-41.9	-36.6	-36.6
344	-18.7	-14.5	-14.5	404	-24.8	-20.4	-20.4	464	-30.8	-26.0	-26.0	524	-36.5	-31.4	-31.4	584	-42.1	-36.7	-36.7
346	-18.9	-14.7	-14.7	406	-25.0	-20.6	-20.6	466	-31.0	-26.2	-26.2	526	-36.7	-31.6	-31.6	586	-42.2	-36.9	-36.9
348	-19.1	-14.9	-14.9	408	-25.2	-20.7	-20.7	468	-31.1	-26.4	-26.4	528	-36.9	-31.8	-31.8	588	-42.4	-37.1	-37.1
350	-19.3	-15.1	-15.1	410	-25.4	-20.9	-20.9	470	-31.3	-26.5	-26.5	530	-37.1	-31.9	-31.9	590	-42.6	-37.2	-37.2
352	-19.5	-15.3	-15.3	412	-25.6	-21.1	-21.1	472	-31.5	-26.7	-26.7	532	-37.3	-32.1	-32.1	592	-42.7	-37.4	-37.4
354	-19.7	-15.5	-15.5	414	-25.8	-21.3	-21.3	474	-31.7	-26.9	-26.9	534	-37.5	-32.3	-32.3	594	-42.9	-37.6	-37.6
356	-19.9	-15.7	-15.7	416	-26.0	-21.5	-21.5	476	-31.9	-27.1	-27.1	536	-37.6	-32.5	-32.5	596	-43.1	-37.7	-37.7
358	-20.2	-15.9	-15.9	418	-26.2	-21.7	-21.7	478	-32.1	-27.3	-27.3	538	-37.8	-32.7	-32.7	598	-43.2	-37.9	-37.9
																600	-43.4	-38.1	-38.1

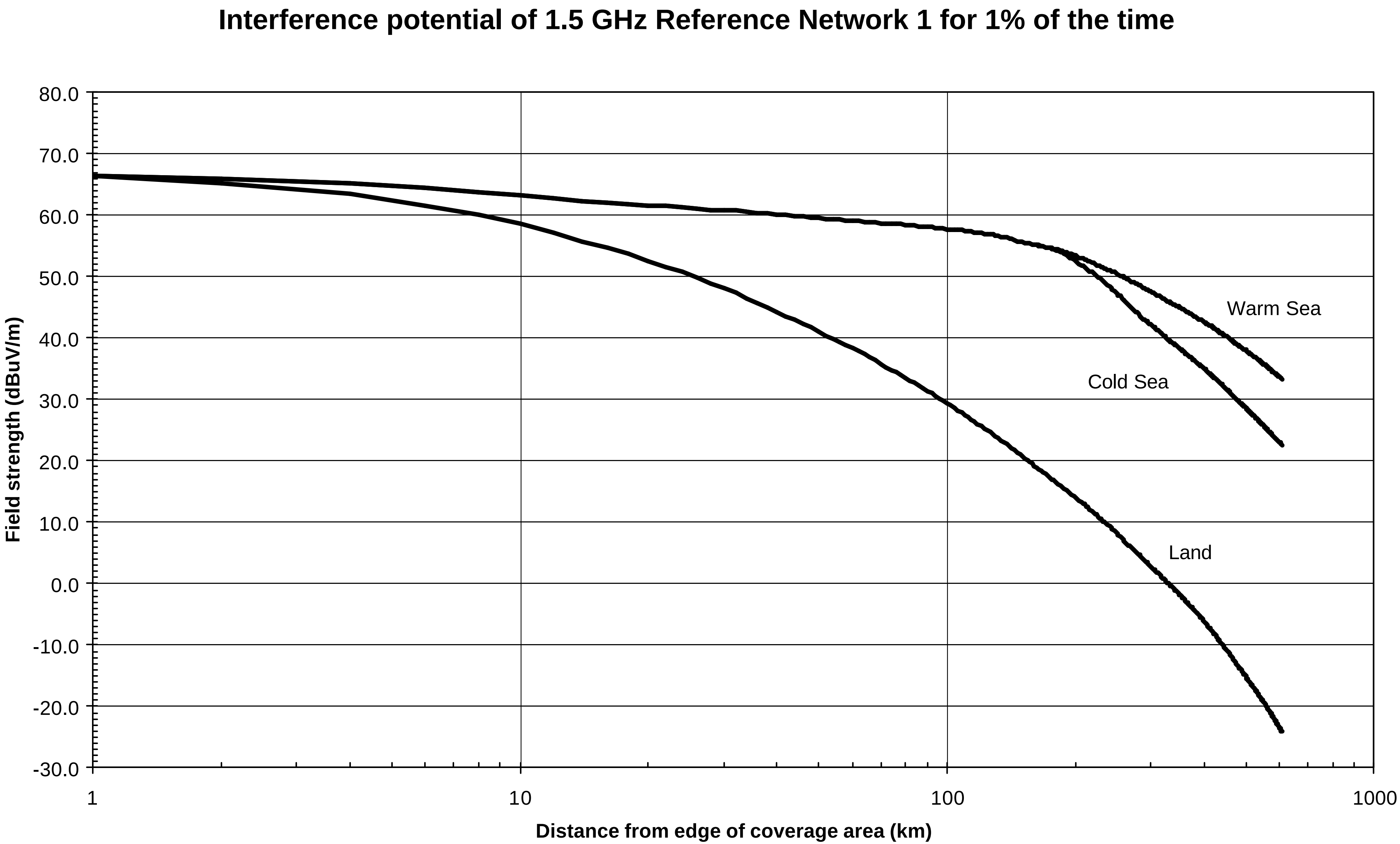


Figure A6.4b: Interference potential of 1.5 GHz Reference Network One for 1% of time

Table A6.4b: Tabulated values for the interference potential of 1.5 GHz Reference Network 1 for 1% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	67.1	67.1	67.1	60	38.3	59.1	59.1	120	25.7	57.1	57.1	180	16.5	54.3	54.4	240	9.3	48.4	51.0
2	65.2	66.0	66.0	62	37.9	59.0	59.0	122	25.3	57.0	57.0	182	16.3	54.2	54.4	242	9.1	48.1	50.9
4	63.4	65.1	65.1	64	37.4	58.9	58.9	124	25.0	56.9	56.9	184	16.0	54.0	54.3	244	8.8	47.9	50.8
6	61.6	64.4	64.4	66	36.8	58.8	58.8	126	24.7	56.8	56.8	186	15.8	53.9	54.2	246	8.6	47.7	50.7
8	60.0	63.7	63.7	68	36.3	58.8	58.8	128	24.3	56.8	56.8	188	15.5	53.7	54.0	248	8.4	47.4	50.5
10	58.5	63.2	63.2	70	35.8	58.7	58.7	130	24.0	56.7	56.7	190	15.3	53.5	53.9	250	8.1	47.2	50.4
12	57.1	62.7	62.7	72	35.3	58.6	58.6	132	23.7	56.6	56.6	192	15.0	53.3	53.8	252	7.9	47.0	50.3
14	55.8	62.3	62.3	74	34.8	58.5	58.5	134	23.3	56.5	56.5	194	14.8	53.1	53.7	254	7.7	46.8	50.2
16	54.6	62.1	62.1	76	34.4	58.5	58.5	136	23.0	56.4	56.4	196	14.6	52.9	53.6	256	7.4	46.5	50.1
18	53.6	61.8	61.8	78	34.0	58.5	58.5	138	22.7	56.3	56.3	198	14.3	52.7	53.5	258	7.2	46.3	50.0
20	52.6	61.6	61.6	80	33.5	58.4	58.4	140	22.3	56.2	56.2	200	14.1	52.5	53.4	260	7.0	46.1	49.8
22	51.6	61.5	61.5	82	33.1	58.4	58.4	142	22.0	56.1	56.1	202	13.8	52.3	53.3	262	6.8	45.8	49.7
24	50.7	61.3	61.3	84	32.7	58.3	58.3	144	21.7	56.0	56.0	204	13.6	52.1	53.1	264	6.5	45.6	49.6
26	49.8	61.1	61.1	86	32.2	58.2	58.2	146	21.4	55.8	55.8	206	13.3	51.9	53.0	266	6.3	45.4	49.5
28	48.9	60.9	60.9	88	31.8	58.2	58.2	148	21.0	55.7	55.7	208	13.1	51.7	52.9	268	6.1	45.1	49.4
30	48.1	60.8	60.8	90	31.4	58.1	58.1	150	20.7	55.6	55.6	210	12.9	51.5	52.8	270	5.9	44.9	49.2
32	47.3	60.7	60.7	92	31.0	58.0	58.0	152	20.4	55.5	55.5	212	12.6	51.3	52.7	272	5.7	44.7	49.1
34	46.5	60.6	60.6	94	30.5	57.9	57.9	154	20.1	55.4	55.4	214	12.4	51.1	52.6	274	5.5	44.5	49.0
36	45.7	60.4	60.4	96	30.1	57.9	57.9	156	19.8	55.4	55.4	216	12.1	50.9	52.4	276	5.2	44.3	48.9
38	45.0	60.3	60.3	98	29.7	57.8	57.8	158	19.5	55.3	55.3	218	11.9	50.7	52.3	278	5.0	44.1	48.8
40	44.3	60.1	60.1	100	29.3	57.7	57.7	160	19.2	55.2	55.2	220	11.6	50.5	52.2	280	4.8	43.9	48.7
42	43.6	60.0	60.0	102	29.0	57.7	57.7	162	18.9	55.1	55.1	222	11.4	50.3	52.1	282	4.6	43.6	48.6
44	42.9	59.9	59.9	104	28.6	57.6	57.6	164	18.7	55.0	55.1	224	11.2	50.1	51.9	284	4.4	43.5	48.5
46	42.3	59.8	59.8	106	28.2	57.5	57.5	166	18.4	55.0	55.0	226	10.9	49.9	51.8	286	4.2	43.3	48.3
48	41.7	59.7	59.7	108	27.8	57.5	57.5	168	18.1	54.9	54.9	228	10.7	49.7	51.7	288	4.0	43.1	48.2
50	41.0	59.5	59.5	110	27.5	57.4	57.4	170	17.8	54.8	54.8	230	10.5	49.5	51.6	290	3.8	43.0	48.1
52	40.4	59.4	59.4	112	27.1	57.3	57.3	172	17.6	54.7	54.8	232	10.2	49.3	51.5	292	3.6	42.8	48.0
54	39.9	59.3	59.3	114	26.7	57.3	57.3	174	17.3	54.6	54.7	234	10.0	49.0	51.3	294	3.4	42.7	47.9
56	39.3	59.3	59.3	116	26.4	57.2	57.2	176	17.0	54.5	54.6	236	9.8	48.8	51.2	296	3.2	42.5	47.8
58	38.8	59.2	59.2	118	26.0	57.1	57.1	178	16.8	54.4	54.5	238	9.5	48.6	51.1	298	3.0	42.3	47.7

Table A6.4b: Tabulated values for the interference potential of 1.5 GHz Reference Network 1 for 1% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	2.8	42.2	47.6	360	-2.6	37.6	44.5	420	-8.0	33.7	41.7	480	-13.3	29.8	38.8	540	-18.4	26.4	36.3
302	2.6	42.0	47.5	362	-2.8	37.5	44.4	422	-8.2	33.6	41.6	482	-13.5	29.7	38.8	542	-18.5	26.2	36.2
304	2.4	41.8	47.4	364	-3.0	37.4	44.3	424	-8.3	33.4	41.5	484	-13.7	29.6	38.7	544	-18.7	26.1	36.1
306	2.3	41.7	47.2	366	-3.1	37.2	44.2	426	-8.5	33.3	41.4	486	-13.8	29.4	38.6	546	-18.9	26.0	36.0
308	2.1	41.5	47.1	368	-3.3	37.1	44.1	428	-8.7	33.2	41.3	488	-14.0	29.3	38.5	548	-19.0	25.9	35.9
310	1.9	41.3	47.0	370	-3.5	37.0	44.0	430	-8.9	33.0	41.2	490	-14.2	29.2	38.4	550	-19.2	25.8	35.8
312	1.7	41.2	46.9	372	-3.7	36.8	43.9	432	-9.1	32.9	41.1	492	-14.3	29.1	38.3	552	-19.4	25.7	35.7
314	1.5	41.0	46.8	374	-3.9	36.7	43.8	434	-9.2	32.8	41.0	494	-14.5	29.0	38.2	554	-19.5	25.5	35.7
316	1.3	40.9	46.7	376	-4.0	36.5	43.7	436	-9.4	32.7	40.9	496	-14.7	28.9	38.2	556	-19.7	25.4	35.6
318	1.1	40.7	46.6	378	-4.2	36.4	43.6	438	-9.6	32.5	40.8	498	-14.8	28.8	38.1	558	-19.9	25.3	35.5
320	0.9	40.5	46.5	380	-4.4	36.3	43.5	440	-9.8	32.4	40.7	500	-15.0	28.6	38.0	560	-20.1	25.2	35.4
322	0.7	40.4	46.4	382	-4.6	36.1	43.4	442	-10.0	32.3	40.6	502	-15.2	28.5	37.9	562	-20.2	25.1	35.3
324	0.5	40.2	46.3	384	-4.7	36.0	43.3	444	-10.1	32.1	40.5	504	-15.4	28.4	37.8	564	-20.4	25.0	35.2
326	0.4	40.1	46.2	386	-4.9	35.9	43.2	446	-10.3	32.0	40.4	506	-15.5	28.3	37.7	566	-20.6	24.8	35.1
328	0.2	39.9	46.0	388	-5.1	35.7	43.1	448	-10.5	31.9	40.4	508	-15.7	28.2	37.6	568	-20.7	24.7	35.0
330	0.0	39.7	45.9	390	-5.3	35.6	43.1	450	-10.7	31.7	40.3	510	-15.9	28.1	37.6	570	-20.9	24.6	35.0
332	-0.2	39.6	45.8	392	-5.5	35.5	43.0	452	-10.9	31.6	40.2	512	-16.0	28.0	37.5	572	-21.1	24.5	34.9
334	-0.4	39.4	45.7	394	-5.6	35.4	42.9	454	-11.0	31.5	40.1	514	-16.2	27.8	37.4	574	-21.2	24.4	34.8
336	-0.5	39.3	45.6	396	-5.8	35.2	42.8	456	-11.2	31.3	40.0	516	-16.4	27.7	37.3	576	-21.4	24.3	34.7
338	-0.7	39.2	45.5	398	-6.0	35.1	42.7	458	-11.4	31.2	39.9	518	-16.5	27.6	37.2	578	-21.6	24.2	34.6
340	-0.9	39.0	45.4	400	-6.2	35.0	42.6	460	-11.6	31.1	39.8	520	-16.7	27.5	37.1	580	-21.7	24.1	34.5
342	-1.1	38.9	45.4	402	-6.4	34.9	42.5	462	-11.8	30.9	39.7	522	-16.9	27.4	37.0	582	-21.9	23.9	34.4
344	-1.2	38.8	45.3	404	-6.5	34.7	42.4	464	-11.9	30.8	39.6	524	-17.0	27.3	37.0	584	-22.1	23.8	34.3
346	-1.4	38.6	45.2	406	-6.7	34.6	42.3	466	-12.1	30.7	39.5	526	-17.2	27.2	36.9	586	-22.3	23.7	34.3
348	-1.6	38.5	45.1	408	-6.9	34.5	42.2	468	-12.3	30.6	39.4	528	-17.4	27.0	36.8	588	-22.4	23.6	34.2
350	-1.8	38.3	45.0	410	-7.1	34.3	42.1	470	-12.5	30.4	39.3	530	-17.5	26.9	36.7	590	-22.6	23.5	34.1
352	-1.9	38.2	44.9	412	-7.3	34.2	42.0	472	-12.6	30.3	39.2	532	-17.7	26.8	36.6	592	-22.8	23.4	34.0
354	-2.1	38.1	44.8	414	-7.4	34.1	42.0	474	-12.8	30.2	39.1	534	-17.9	26.7	36.5	594	-22.9	23.3	33.9
356	-2.3	37.9	44.7	416	-7.6	34.0	41.9	476	-13.0	30.0	39.0	536	-18.0	26.6	36.4	596	-23.1	23.2	33.8
358	-2.4	37.8	44.6	418	-7.8	33.8	41.8	478	-13.2	29.9	38.9	538	-18.2	26.5	36.4	598	-23.3	23.1	33.7
																600	-23.5	23.0	33.7

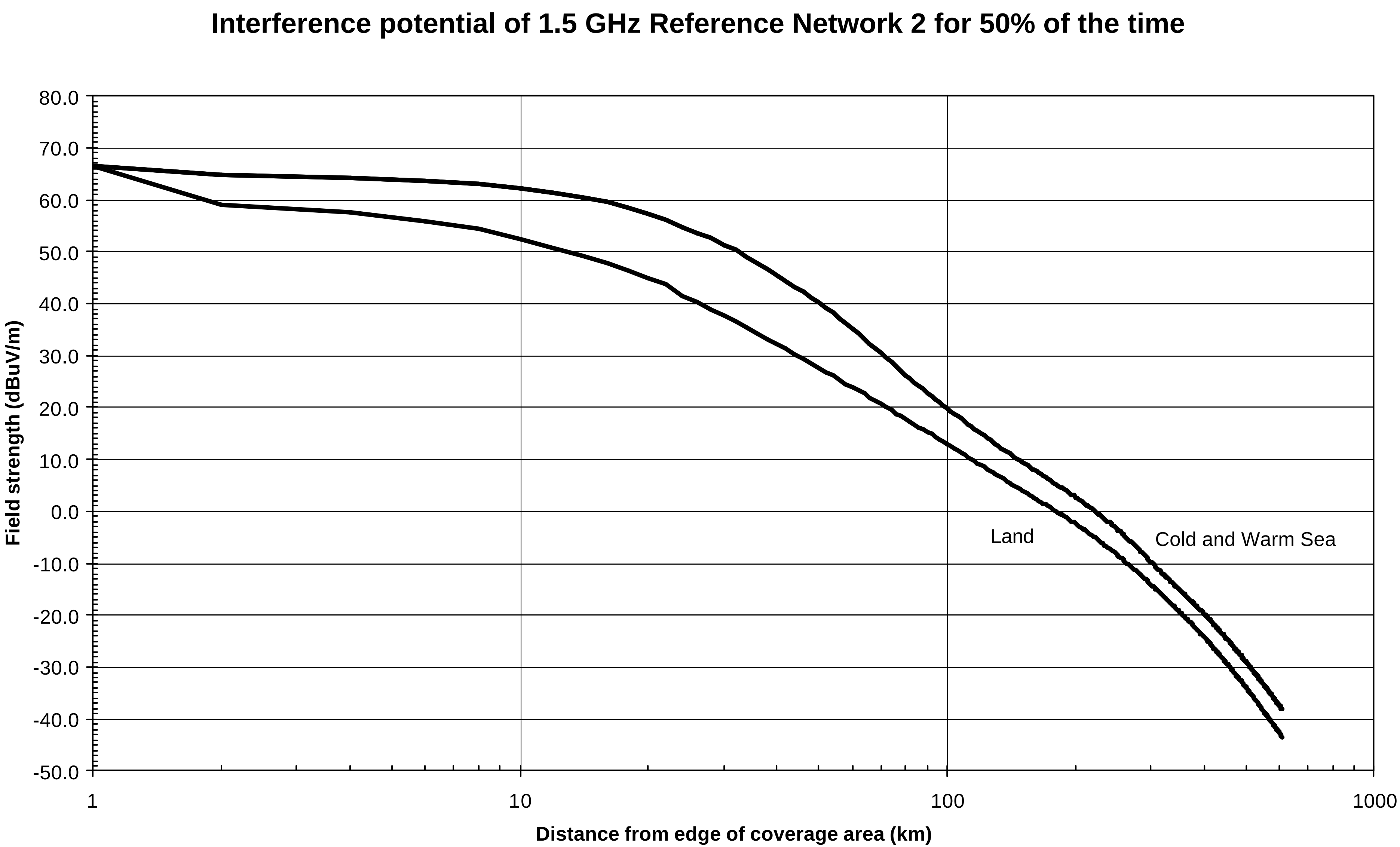


Figure A6.5a: Interference potential of 1.5 GHz Reference Network Two for 50% of time

Table A6.5a: Tabulated values for the interference potential of 1.5 GHz Reference Network 2 for 50% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	68.1	68.1	68.1	60	23.9	35.2	35.2	120	8.9	15.0	15.0	180	0.0	5.2	5.2	240	-7.2	-2.2	-2.2
2	59.0	64.7	64.7	62	23.3	34.2	34.2	122	8.6	14.6	14.6	182	-0.3	5.0	5.0	242	-7.4	-2.4	-2.4
4	57.6	64.3	64.3	64	22.6	33.2	33.2	124	8.2	14.1	14.1	184	-0.5	4.7	4.7	244	-7.6	-2.7	-2.7
6	56.0	63.8	63.8	66	22.0	32.3	32.3	126	7.8	13.7	13.7	186	-0.7	4.5	4.5	246	-7.9	-2.9	-2.9
8	54.4	63.2	63.2	68	21.4	31.4	31.4	128	7.5	13.3	13.3	188	-1.0	4.2	4.2	248	-8.1	-3.2	-3.2
10	52.5	62.3	62.3	70	20.7	30.5	30.5	130	7.2	12.9	12.9	190	-1.2	4.0	4.0	250	-8.4	-3.4	-3.4
12	50.7	61.3	61.3	72	20.1	29.6	29.6	132	6.8	12.6	12.6	192	-1.5	3.7	3.7	252	-8.6	-3.7	-3.7
14	49.2	60.4	60.4	74	19.5	28.7	28.7	134	6.5	12.2	12.2	194	-1.7	3.5	3.5	254	-8.8	-3.9	-3.9
16	47.7	59.5	59.5	76	18.8	27.8	27.8	136	6.2	11.8	11.8	196	-2.0	3.2	3.2	256	-9.1	-4.2	-4.2
18	46.3	58.4	58.4	78	18.3	27.0	27.0	138	5.8	11.5	11.5	198	-2.2	3.0	3.0	258	-9.3	-4.4	-4.4
20	45.0	57.3	57.3	80	17.8	26.2	26.2	140	5.5	11.1	11.1	200	-2.4	2.7	2.7	260	-9.5	-4.7	-4.7
22	43.7	56.2	56.2	82	17.2	25.5	25.5	142	5.2	10.8	10.8	202	-2.7	2.5	2.5	262	-9.7	-4.9	-4.9
24	41.6	54.8	54.8	84	16.7	24.8	24.8	144	4.9	10.4	10.4	204	-2.9	2.2	2.2	264	-10.0	-5.2	-5.2
26	40.2	53.7	53.7	86	16.2	24.1	24.1	146	4.6	10.1	10.1	206	-3.1	2.0	2.0	266	-10.2	-5.4	-5.4
28	38.8	52.6	52.6	88	15.8	23.5	23.5	148	4.3	9.8	9.8	208	-3.4	1.7	1.7	268	-10.4	-5.7	-5.7
30	37.6	51.4	51.4	90	15.3	22.8	22.8	150	4.0	9.5	9.5	210	-3.6	1.5	1.5	270	-10.7	-5.9	-5.9
32	36.5	50.3	50.3	92	14.8	22.2	22.2	152	3.7	9.1	9.1	212	-3.9	1.2	1.2	272	-10.9	-6.2	-6.2
34	35.4	49.1	49.1	94	14.3	21.6	21.6	154	3.4	8.8	8.8	214	-4.1	1.0	1.0	274	-11.1	-6.4	-6.4
36	34.3	47.9	47.9	96	13.9	21.0	21.0	156	3.1	8.5	8.5	216	-4.3	0.8	0.8	276	-11.3	-6.7	-6.7
38	33.2	46.7	46.7	98	13.4	20.4	20.4	158	2.8	8.2	8.2	218	-4.6	0.5	0.5	278	-11.6	-6.9	-6.9
40	32.2	45.6	45.6	100	13.0	19.8	19.8	160	2.6	8.0	8.0	220	-4.8	0.3	0.3	280	-11.8	-7.2	-7.2
42	31.3	44.4	44.4	102	12.6	19.3	19.3	162	2.3	7.7	7.7	222	-5.0	0.0	0.0	282	-12.0	-7.4	-7.4
44	30.3	43.3	43.3	104	12.1	18.8	18.8	164	2.0	7.4	7.4	224	-5.3	-0.2	-0.2	284	-12.2	-7.7	-7.7
46	29.4	42.3	42.3	106	11.7	18.3	18.3	166	1.8	7.1	7.1	226	-5.5	-0.5	-0.5	286	-12.5	-7.9	-7.9
48	28.6	41.3	41.3	108	11.3	17.8	17.8	168	1.5	6.8	6.8	228	-5.7	-0.7	-0.7	288	-12.7	-8.2	-8.2
50	27.7	40.2	40.2	110	10.9	17.3	17.3	170	1.3	6.6	6.6	230	-6.0	-1.0	-1.0	290	-12.9	-8.4	-8.4
52	26.9	39.2	39.2	112	10.5	16.8	16.8	172	1.0	6.3	6.3	232	-6.2	-1.2	-1.2	292	-13.1	-8.7	-8.7
54	26.1	38.2	38.2	114	10.1	16.3	16.3	174	0.7	6.0	6.0	234	-6.5	-1.5	-1.5	294	-13.4	-8.9	-8.9
56	25.4	37.2	37.2	116	9.7	15.9	15.9	176	0.5	5.7	5.7	236	-6.7	-1.7	-1.7	296	-13.6	-9.2	-9.2
58	24.6	36.2	36.2	118	9.3	15.4	15.4	178	0.2	5.5	5.5	238	-6.9	-2.0	-2.0	298	-13.8	-9.4	-9.4

Table A6.5a: Tabulated values for the interference potential of 1.5 GHz Reference Network 2 for 50% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	-14.0	-9.7	-9.7	360	-20.3	-16.0	-16.0	420	-26.2	-21.6	-21.6	480	-31.9	-27.1	-27.1	540	-37.5	-32.4	-32.4
302	-14.3	-9.9	-9.9	362	-20.5	-16.2	-16.2	422	-26.4	-21.8	-21.8	482	-32.1	-27.2	-27.2	542	-37.6	-32.5	-32.5
304	-14.5	-10.2	-10.2	364	-20.7	-16.4	-16.4	424	-26.6	-22.0	-22.0	484	-32.3	-27.4	-27.4	544	-37.8	-32.7	-32.7
306	-14.7	-10.4	-10.4	366	-20.9	-16.6	-16.6	426	-26.8	-22.2	-22.2	486	-32.5	-27.6	-27.6	546	-38.0	-32.9	-32.9
308	-14.9	-10.6	-10.6	368	-21.1	-16.8	-16.8	428	-27.0	-22.4	-22.4	488	-32.7	-27.8	-27.8	548	-38.2	-33.1	-33.1
310	-15.1	-10.9	-10.9	370	-21.3	-17.0	-17.0	430	-27.2	-22.5	-22.5	490	-32.9	-28.0	-28.0	550	-38.4	-33.2	-33.2
312	-15.3	-11.1	-11.1	372	-21.5	-17.2	-17.2	432	-27.3	-22.7	-22.7	492	-33.0	-28.1	-28.1	552	-38.6	-33.4	-33.4
314	-15.6	-11.3	-11.3	374	-21.7	-17.4	-17.4	434	-27.5	-22.9	-22.9	494	-33.2	-28.3	-28.3	554	-38.8	-33.6	-33.6
316	-15.8	-11.5	-11.5	376	-21.9	-17.6	-17.6	436	-27.7	-23.1	-23.1	496	-33.4	-28.5	-28.5	556	-38.9	-33.8	-33.8
318	-16.0	-11.8	-11.8	378	-22.1	-17.7	-17.7	438	-27.9	-23.3	-23.3	498	-33.6	-28.7	-28.7	558	-39.1	-33.9	-33.9
320	-16.2	-12.0	-12.0	380	-22.3	-17.9	-17.9	440	-28.1	-23.5	-23.5	500	-33.8	-28.8	-28.8	560	-39.3	-34.1	-34.1
322	-16.4	-12.2	-12.2	382	-22.5	-18.1	-18.1	442	-28.3	-23.6	-23.6	502	-34.0	-29.0	-29.0	562	-39.5	-34.3	-34.3
324	-16.6	-12.4	-12.4	384	-22.7	-18.3	-18.3	444	-28.5	-23.8	-23.8	504	-34.1	-29.2	-29.2	564	-39.6	-34.4	-34.4
326	-16.8	-12.6	-12.6	386	-22.9	-18.5	-18.5	446	-28.7	-24.0	-24.0	506	-34.3	-29.4	-29.4	566	-39.8	-34.6	-34.6
328	-17.0	-12.8	-12.8	388	-23.1	-18.7	-18.7	448	-28.9	-24.2	-24.2	508	-34.5	-29.5	-29.5	568	-40.0	-34.8	-34.8
330	-17.2	-13.1	-13.1	390	-23.3	-18.9	-18.9	450	-29.1	-24.4	-24.4	510	-34.7	-29.7	-29.7	570	-40.1	-35.0	-35.0
332	-17.5	-13.3	-13.3	392	-23.5	-19.0	-19.0	452	-29.3	-24.6	-24.6	512	-34.9	-29.9	-29.9	572	-40.3	-35.1	-35.1
334	-17.7	-13.5	-13.5	394	-23.7	-19.2	-19.2	454	-29.5	-24.7	-24.7	514	-35.1	-30.1	-30.1	574	-40.5	-35.3	-35.3
336	-17.9	-13.7	-13.7	396	-23.9	-19.4	-19.4	456	-29.7	-24.9	-24.9	516	-35.3	-30.2	-30.2	576	-40.7	-35.5	-35.5
338	-18.1	-13.9	-13.9	398	-24.0	-19.6	-19.6	458	-29.9	-25.1	-25.1	518	-35.4	-30.4	-30.4	578	-40.8	-35.6	-35.6
340	-18.3	-14.1	-14.1	400	-24.2	-19.8	-19.8	460	-30.0	-25.3	-25.3	520	-35.6	-30.6	-30.6	580	-41.0	-35.8	-35.8
342	-18.5	-14.3	-14.3	402	-24.4	-20.0	-20.0	462	-30.2	-25.5	-25.5	522	-35.8	-30.8	-30.8	582	-41.2	-36.0	-36.0
344	-18.7	-14.5	-14.5	404	-24.6	-20.1	-20.1	464	-30.4	-25.6	-25.6	524	-36.0	-31.0	-31.0	584	-41.3	-36.1	-36.1
346	-18.9	-14.7	-14.7	406	-24.8	-20.3	-20.3	466	-30.6	-25.8	-25.8	526	-36.2	-31.1	-31.1	586	-41.5	-36.3	-36.3
348	-19.1	-14.9	-14.9	408	-25.0	-20.5	-20.5	468	-30.8	-26.0	-26.0	528	-36.4	-31.3	-31.3	588	-41.7	-36.5	-36.5
350	-19.3	-15.1	-15.1	410	-25.2	-20.7	-20.7	470	-31.0	-26.2	-26.2	530	-36.5	-31.5	-31.5	590	-41.8	-36.6	-36.6
352	-19.5	-15.3	-15.3	412	-25.4	-20.9	-20.9	472	-31.2	-26.4	-26.4	532	-36.7	-31.7	-31.7	592	-42.0	-36.8	-36.8
354	-19.7	-15.5	-15.5	414	-25.6	-21.1	-21.1	474	-31.4	-26.5	-26.5	534	-36.9	-31.8	-31.8	594	-42.2	-37.0	-37.0
356	-19.9	-15.7	-15.7	416	-25.8	-21.3	-21.3	476	-31.6	-26.7	-26.7	536	-37.1	-32.0	-32.0	596	-42.3	-37.1	-37.1
358	-20.1	-15.9	-15.9	418	-26.0	-21.4	-21.4	478	-31.7	-26.9	-26.9	538	-37.3	-32.2	-32.2	598	-42.5	-37.3	-37.3
																600	-42.7	-37.5	-37.5

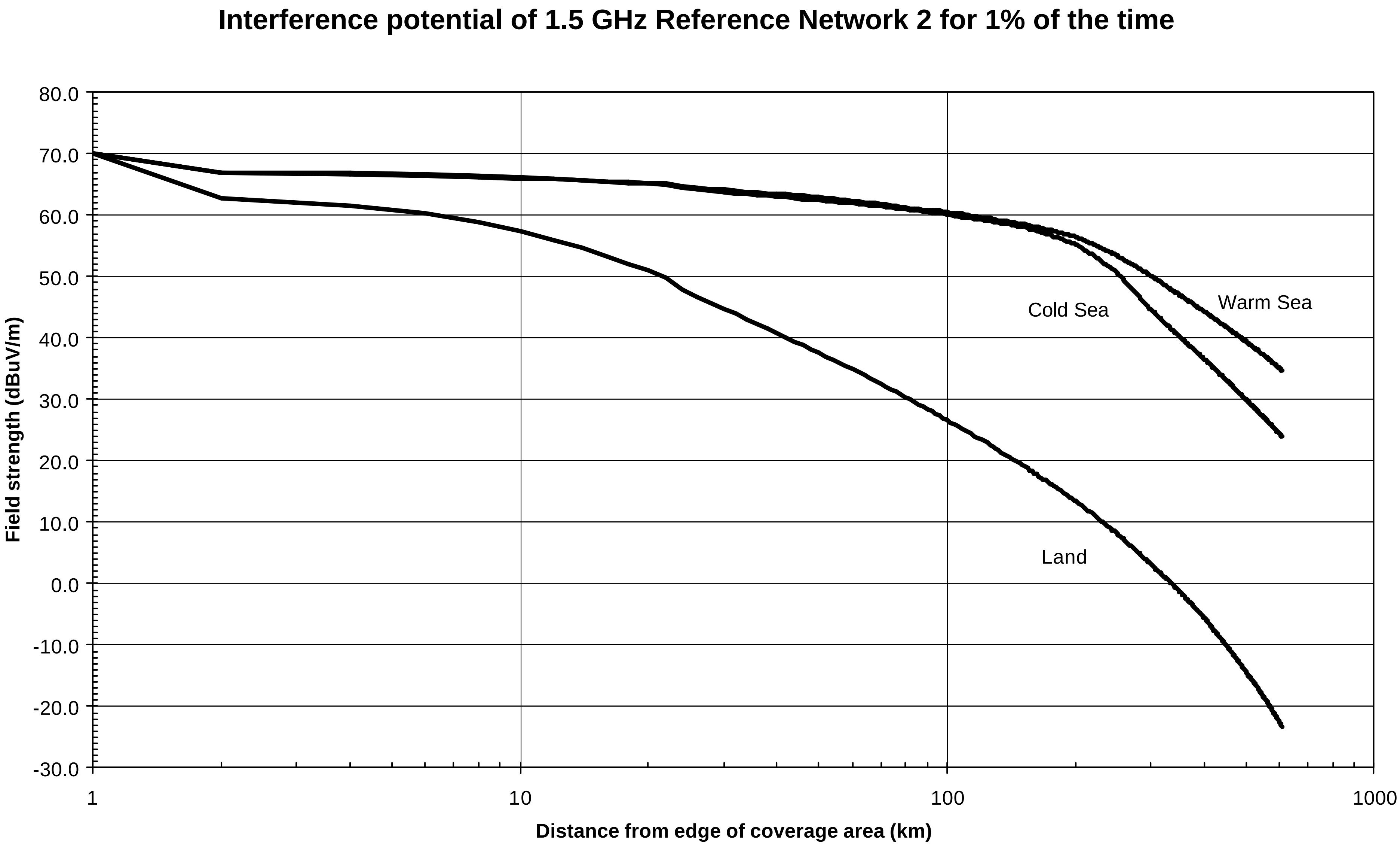


Figure A6.5b: Interference potential of 1.5 GHz Reference Network Two for 1% of time (See note page A6-1)

Table A6.5b: Tabulated values for the interference potential of 1.5 GHz Reference Network 2 for 1% of time - (1)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	72.5	72.5	72.5	60	34.9	61.9	62.3	120	23.4	59.3	59.7	180	15.6	56.4	57.3	240	9.1	51.6	54.0
2	62.7	66.8	67.0	62	34.4	61.8	62.2	122	23.2	59.2	59.6	182	15.4	56.3	57.2	242	8.9	51.4	53.9
4	61.5	66.6	66.8	64	33.9	61.7	62.1	124	22.9	59.1	59.5	184	15.2	56.2	57.2	244	8.7	51.2	53.7
6	60.2	66.4	66.6	66	33.4	61.6	62.0	126	22.6	59.0	59.5	186	15.0	56.1	57.1	246	8.5	51.0	53.6
8	58.8	66.2	66.3	68	32.9	61.5	61.9	128	22.3	58.9	59.4	188	14.7	55.9	57.0	248	8.3	50.8	53.5
10	57.4	66.0	66.1	70	32.5	61.4	61.8	130	22.0	58.9	59.3	190	14.5	55.8	56.9	250	8.1	50.6	53.4
12	56.0	65.8	65.9	72	32.1	61.3	61.7	132	21.7	58.8	59.2	192	14.3	55.7	56.8	252	7.9	50.4	53.2
14	54.6	65.6	65.7	74	31.6	61.2	61.6	134	21.4	58.7	59.2	194	14.1	55.6	56.7	254	7.7	50.1	53.1
16	53.3	65.5	65.5	76	31.2	61.1	61.4	136	21.1	58.6	59.1	196	13.9	55.5	56.7	256	7.5	49.9	53.0
18	52.1	65.3	65.4	78	30.8	61.1	61.3	138	20.9	58.5	59.0	198	13.6	55.4	56.6	258	7.3	49.6	52.8
20	51.0	65.2	65.3	80	30.4	61.0	61.2	140	20.6	58.5	58.9	200	13.4	55.2	56.5	260	7.1	49.4	52.7
22	49.9	65.0	65.2	82	30.0	60.9	61.1	142	20.3	58.4	58.9	202	13.2	55.1	56.4	262	6.9	49.1	52.6
24	47.8	64.5	64.6	84	29.6	60.8	61.1	144	20.0	58.3	58.8	204	13.0	54.9	56.2	264	6.7	48.9	52.5
26	46.7	64.3	64.4	86	29.2	60.7	61.0	146	19.8	58.2	58.7	206	12.8	54.7	56.1	266	6.5	48.6	52.3
28	45.7	64.0	64.2	88	28.8	60.6	60.9	148	19.5	58.2	58.6	208	12.5	54.5	56.0	268	6.3	48.4	52.2
30	44.8	63.8	64.1	90	28.4	60.5	60.8	150	19.3	58.1	58.6	210	12.3	54.3	55.9	270	6.1	48.1	52.1
32	43.9	63.6	64.0	92	28.1	60.4	60.8	152	19.0	58.0	58.5	212	12.1	54.2	55.7	272	5.9	47.9	52.0
34	43.1	63.5	63.8	94	27.7	60.3	60.7	154	18.8	57.9	58.4	214	11.9	54.0	55.6	274	5.7	47.6	51.8
36	42.3	63.3	63.7	96	27.3	60.3	60.7	156	18.5	57.7	58.3	216	11.7	53.8	55.5	276	5.5	47.4	51.7
38	41.5	63.2	63.6	98	27.0	60.2	60.6	158	18.3	57.6	58.2	218	11.5	53.6	55.4	278	5.3	47.1	51.6
40	40.8	63.0	63.5	100	26.6	60.1	60.5	160	18.0	57.5	58.1	220	11.3	53.4	55.2	280	5.1	46.9	51.4
42	40.1	62.9	63.4	102	26.3	60.0	60.4	162	17.8	57.4	58.1	222	11.0	53.3	55.1	282	4.9	46.7	51.3
44	39.4	62.8	63.3	104	26.0	59.9	60.4	164	17.5	57.3	58.0	224	10.8	53.1	55.0	284	4.7	46.4	51.2
46	38.8	62.6	63.2	106	25.6	59.8	60.3	166	17.3	57.2	57.9	226	10.6	52.9	54.9	286	4.5	46.2	51.1
48	38.1	62.5	63.0	108	25.3	59.7	60.2	168	17.0	57.1	57.8	228	10.4	52.7	54.7	288	4.3	46.0	50.9
50	37.6	62.4	62.9	110	25.0	59.7	60.1	170	16.8	57.0	57.7	230	10.2	52.5	54.6	290	4.1	45.7	50.8
52	37.0	62.3	62.8	112	24.7	59.6	60.0	172	16.6	56.9	57.6	232	10.0	52.3	54.5	292	3.9	45.5	50.7
54	36.5	62.2	62.7	114	24.4	59.5	59.9	174	16.3	56.8	57.6	234	9.8	52.1	54.4	294	3.8	45.3	50.5
56	36.0	62.1	62.6	116	24.0	59.4	59.9	176	16.1	56.7	57.5	236	9.6	52.0	54.2	296	3.6	45.1	50.4
58	35.5	62.0	62.5	118	23.7	59.3	59.8	178	15.9	56.5	57.4	238	9.4	51.8	54.1	298	3.4	44.8	50.3

Table A6.5b: Tabulated values for the interference potential of 1.5 GHz Reference Network 2 for 1% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	3.2	44.6	50.2	360	-2.1	39.5	46.5	420	-7.4	35.2	43.3	480	-12.6	31.3	40.4	540	-17.5	27.7	37.7
302	3.0	44.4	50.0	362	-2.3	39.3	46.4	422	-7.6	35.1	43.2	482	-12.7	31.1	40.3	542	-17.6	27.6	37.6
304	2.8	44.2	49.9	364	-2.5	39.2	46.2	424	-7.7	34.9	43.1	484	-12.9	31.0	40.2	544	-17.8	27.5	37.5
306	2.6	44.1	49.8	366	-2.6	39.0	46.1	426	-7.9	34.8	43.0	486	-13.0	30.9	40.1	546	-18.0	27.4	37.4
308	2.4	43.9	49.6	368	-2.8	38.9	46.0	428	-8.1	34.7	42.9	488	-13.2	30.8	40.0	548	-18.1	27.3	37.4
310	2.3	43.7	49.5	370	-3.0	38.7	45.9	430	-8.3	34.5	42.8	490	-13.4	30.7	39.9	550	-18.3	27.2	37.3
312	2.1	43.5	49.4	372	-3.2	38.6	45.8	432	-8.4	34.4	42.7	492	-13.5	30.5	39.8	552	-18.5	27.1	37.2
314	1.9	43.3	49.3	374	-3.3	38.4	45.7	434	-8.6	34.3	42.6	494	-13.7	30.4	39.7	554	-18.6	26.9	37.1
316	1.7	43.2	49.1	376	-3.5	38.3	45.6	436	-8.8	34.1	42.5	496	-13.9	30.3	39.6	556	-18.8	26.8	37.0
318	1.5	43.0	49.0	378	-3.7	38.1	45.5	438	-9.0	34.0	42.4	498	-14.0	30.2	39.5	558	-19.0	26.7	36.9
320	1.4	42.8	48.9	380	-3.9	38.0	45.4	440	-9.1	33.9	42.3	500	-14.2	30.0	39.5	560	-19.1	26.6	36.8
322	1.2	42.6	48.7	382	-4.0	37.8	45.3	442	-9.3	33.7	42.2	502	-14.4	29.9	39.4	562	-19.3	26.5	36.7
324	1.0	42.4	48.6	384	-4.2	37.7	45.2	444	-9.5	33.6	42.1	504	-14.5	29.8	39.3	564	-19.5	26.4	36.6
326	0.8	42.3	48.5	386	-4.4	37.6	45.0	446	-9.7	33.5	42.0	506	-14.7	29.7	39.2	566	-19.6	26.3	36.6
328	0.7	42.1	48.4	388	-4.6	37.4	44.9	448	-9.8	33.3	41.9	508	-14.9	29.6	39.1	568	-19.8	26.1	36.5
330	0.5	41.9	48.2	390	-4.7	37.3	44.8	450	-10.0	33.2	41.8	510	-15.0	29.5	39.0	570	-20.0	26.0	36.4
332	0.3	41.8	48.1	392	-4.9	37.1	44.7	452	-10.2	33.1	41.7	512	-15.2	29.4	38.9	572	-20.1	25.9	36.3
334	0.1	41.6	48.0	394	-5.1	37.0	44.6	454	-10.4	32.9	41.6	514	-15.3	29.2	38.8	574	-20.3	25.8	36.2
336	0.0	41.4	47.9	396	-5.3	36.8	44.5	456	-10.5	32.8	41.5	516	-15.5	29.1	38.8	576	-20.5	25.7	36.1
338	-0.2	41.2	47.7	398	-5.4	36.7	44.4	458	-10.7	32.7	41.4	518	-15.7	29.0	38.7	578	-20.6	25.6	36.0
340	-0.4	41.1	47.6	400	-5.6	36.5	44.3	460	-10.9	32.5	41.3	520	-15.8	28.9	38.6	580	-20.8	25.5	35.9
342	-0.6	40.9	47.5	402	-5.8	36.4	44.2	462	-11.0	32.4	41.2	522	-16.0	28.8	38.5	582	-21.0	25.4	35.9
344	-0.7	40.7	47.4	404	-6.0	36.3	44.1	464	-11.2	32.3	41.1	524	-16.2	28.7	38.4	584	-21.1	25.3	35.8
346	-0.9	40.6	47.3	406	-6.1	36.1	44.0	466	-11.4	32.2	41.0	526	-16.3	28.6	38.3	586	-21.3	25.1	35.7
348	-1.1	40.4	47.1	408	-6.3	36.0	43.9	468	-11.5	32.0	40.9	528	-16.5	28.4	38.2	588	-21.5	25.0	35.6
350	-1.3	40.2	47.0	410	-6.5	35.9	43.8	470	-11.7	31.9	40.9	530	-16.7	28.3	38.1	590	-21.6	24.9	35.5
352	-1.4	40.1	46.9	412	-6.7	35.7	43.7	472	-11.9	31.8	40.8	532	-16.8	28.2	38.1	592	-21.8	24.8	35.4
354	-1.6	39.9	46.8	414	-6.9	35.6	43.6	474	-12.1	31.6	40.7	534	-17.0	28.1	38.0	594	-22.0	24.7	35.3
356	-1.8	39.8	46.7	416	-7.0	35.5	43.5	476	-12.2	31.5	40.6	536	-17.1	28.0	37.9	596	-22.2	24.6	35.2
358	-1.9	39.6	46.6	418	-7.2	35.3	43.4	478	-12.4	31.4	40.5	538	-17.3	27.9	37.8	598	-22.3	24.5	35.2
																600	-22.5	24.4	35.1

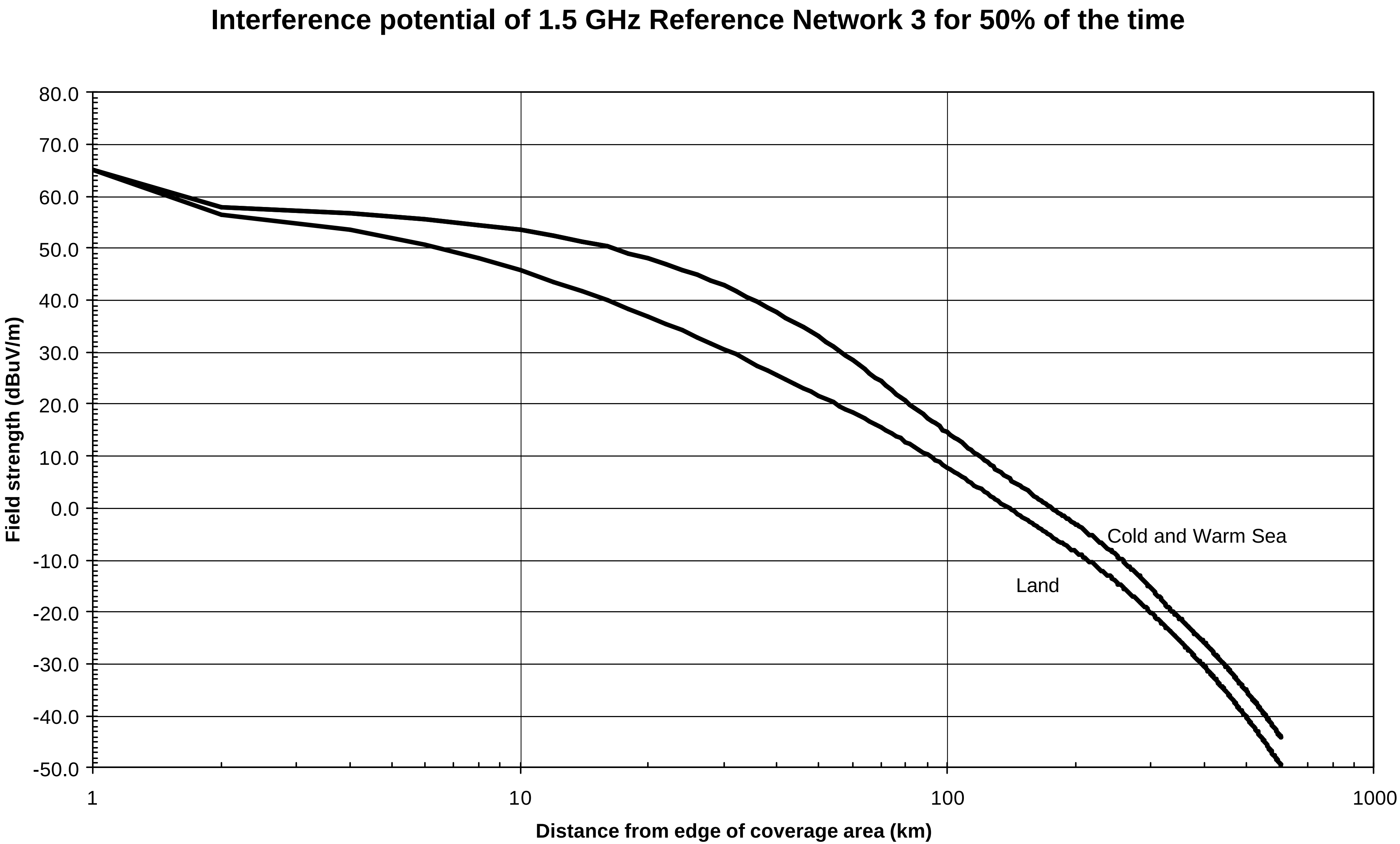


Figure A6.6a: Interference potential of 1.5 GHz Reference Network Three for 50% of time

Table A6.6a: Tabulated values for the interference potential of 1.5 GHz Reference Network 3 for 50% of time - (1)																			
Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	70.4	70.4	70.4	60	18.4	28.5	28.5	120	3.6	9.7	9.7	180	-6.0	-0.6	-0.6	240	-13.1	-8.0	-8.0
2	56.4	57.8	57.8	62	17.8	27.6	27.6	122	3.2	9.3	9.3	182	-6.3	-0.9	-0.9	242	-13.4	-8.2	-8.2
4	53.6	56.6	56.6	64	17.2	26.8	26.8	124	2.8	8.8	8.8	184	-6.5	-1.1	-1.1	244	-13.6	-8.5	-8.5
6	50.8	55.5	55.5	66	16.7	26.0	26.0	126	2.4	8.4	8.4	186	-6.8	-1.4	-1.4	246	-13.8	-8.7	-8.7
8	48.2	54.4	54.4	68	16.1	25.2	25.2	128	2.0	8.0	8.0	188	-7.0	-1.6	-1.6	248	-14.1	-9.0	-9.0
10	45.8	53.4	53.4	70	15.6	24.4	24.4	130	1.7	7.5	7.5	190	-7.2	-1.9	-1.9	250	-14.3	-9.2	-9.2
12	43.6	52.3	52.3	72	15.0	23.6	23.6	132	1.3	7.1	7.1	192	-7.5	-2.1	-2.1	252	-14.6	-9.5	-9.5
14	41.7	51.3	51.3	74	14.4	22.8	22.8	134	0.9	6.8	6.8	194	-7.7	-2.4	-2.4	254	-14.8	-9.7	-9.7
16	39.9	50.3	50.3	76	13.9	22.0	22.0	136	0.6	6.4	6.4	196	-8.0	-2.6	-2.6	256	-15.0	-9.9	-9.9
18	38.3	49.1	49.1	78	13.4	21.3	21.3	138	0.3	6.0	6.0	198	-8.2	-2.9	-2.9	258	-15.3	-10.2	-10.2
20	36.8	48.1	48.1	80	12.8	20.6	20.6	140	-0.1	5.7	5.7	200	-8.4	-3.1	-3.1	260	-15.5	-10.4	-10.4
22	35.4	47.0	47.0	82	12.3	19.9	19.9	142	-0.4	5.3	5.3	202	-8.7	-3.3	-3.3	262	-15.7	-10.7	-10.7
24	34.1	45.9	45.9	84	11.8	19.3	19.3	144	-0.7	5.0	5.0	204	-8.9	-3.6	-3.6	264	-16.0	-10.9	-10.9
26	32.8	44.9	44.9	86	11.3	18.7	18.7	146	-1.1	4.6	4.6	206	-9.1	-3.8	-3.8	266	-16.2	-11.2	-11.2
28	31.7	43.8	43.8	88	10.7	18.0	18.0	148	-1.4	4.3	4.3	208	-9.4	-4.1	-4.1	268	-16.4	-11.4	-11.4
30	30.6	42.9	42.9	90	10.2	17.4	17.4	150	-1.7	3.9	3.9	210	-9.6	-4.3	-4.3	270	-16.7	-11.7	-11.7
32	29.5	41.8	41.8	92	9.7	16.8	16.8	152	-2.0	3.6	3.6	212	-9.8	-4.6	-4.6	272	-16.9	-11.9	-11.9
34	28.4	40.7	40.7	94	9.3	16.3	16.3	154	-2.3	3.3	3.3	214	-10.1	-4.8	-4.8	274	-17.1	-12.1	-12.1
36	27.4	39.7	39.7	96	8.8	15.7	15.7	156	-2.6	3.0	3.0	216	-10.3	-5.1	-5.1	276	-17.4	-12.4	-12.4
38	26.5	38.7	38.7	98	8.3	15.1	15.1	158	-2.9	2.7	2.7	218	-10.5	-5.3	-5.3	278	-17.6	-12.6	-12.6
40	25.5	37.7	37.7	100	7.8	14.6	14.6	160	-3.2	2.3	2.3	220	-10.8	-5.5	-5.5	280	-17.8	-12.9	-12.9
42	24.7	36.7	36.7	102	7.4	14.1	14.1	162	-3.5	2.0	2.0	222	-11.0	-5.8	-5.8	282	-18.1	-13.1	-13.1
44	23.9	35.8	35.8	104	6.9	13.6	13.6	164	-3.8	1.7	1.7	224	-11.3	-6.0	-6.0	284	-18.3	-13.4	-13.4
46	23.1	34.9	34.9	106	6.5	13.1	13.1	166	-4.1	1.4	1.4	226	-11.5	-6.3	-6.3	286	-18.5	-13.6	-13.6
48	22.4	33.9	33.9	108	6.0	12.6	12.6	168	-4.4	1.1	1.1	228	-11.7	-6.5	-6.5	288	-18.7	-13.9	-13.9
50	21.7	33.0	33.0	110	5.6	12.1	12.1	170	-4.7	0.8	0.8	230	-12.0	-6.8	-6.8	290	-19.0	-14.1	-14.1
52	21.0	32.1	32.1	112	5.2	11.6	11.6	172	-4.9	0.5	0.5	232	-12.2	-7.0	-7.0	292	-19.2	-14.4	-14.4
54	20.3	31.1	31.1	114	4.8	11.1	11.1	174	-5.2	0.2	0.2	234	-12.4	-7.3	-7.3	294	-19.4	-14.6	-14.6
56	19.6	30.3	30.3	116	4.4	10.6	10.6	176	-5.5	-0.1	-0.1	236	-12.7	-7.5	-7.5	296	-19.6	-14.9	-14.9
58	19.0	29.3	29.3	118	4.0	10.2	10.2	178	-5.8	-0.3	-0.3	238	-12.9	-7.7	-7.7	298	-19.9	-15.1	-15.1

Table A6.6a: Tabulated values for the interference potential of 1.5 GHz Reference Network 3 for 50% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	-20.1	-15.4	-15.4	360	-26.5	-22.1	-22.1	420	-32.4	-27.7	-27.7	480	-38.2	-33.2	-33.2	540	-43.7	-38.5	-38.5
302	-20.3	-15.6	-15.6	362	-26.7	-22.3	-22.3	422	-32.6	-27.9	-27.9	482	-38.4	-33.4	-33.4	542	-43.9	-38.7	-38.7
304	-20.5	-15.9	-15.9	364	-26.9	-22.5	-22.5	424	-32.8	-28.1	-28.1	484	-38.6	-33.6	-33.6	544	-44.1	-38.9	-38.9
306	-20.7	-16.1	-16.1	366	-27.1	-22.7	-22.7	426	-33.0	-28.3	-28.3	486	-38.8	-33.8	-33.8	546	-44.2	-39.0	-39.0
308	-21.0	-16.4	-16.4	368	-27.3	-22.9	-22.9	428	-33.2	-28.5	-28.5	488	-38.9	-33.9	-33.9	548	-44.4	-39.2	-39.2
310	-21.2	-16.6	-16.6	370	-27.5	-23.1	-23.1	430	-33.4	-28.6	-28.6	490	-39.1	-34.1	-34.1	550	-44.6	-39.4	-39.4
312	-21.4	-16.9	-16.9	372	-27.7	-23.3	-23.3	432	-33.6	-28.8	-28.8	492	-39.3	-34.3	-34.3	552	-44.8	-39.6	-39.6
314	-21.6	-17.1	-17.1	374	-27.9	-23.5	-23.5	434	-33.8	-29.0	-29.0	494	-39.5	-34.5	-34.5	554	-45.0	-39.7	-39.7
316	-21.8	-17.4	-17.4	376	-28.2	-23.7	-23.7	436	-34.0	-29.2	-29.2	496	-39.7	-34.6	-34.6	556	-45.2	-39.9	-39.9
318	-22.1	-17.7	-17.7	378	-28.4	-23.9	-23.9	438	-34.2	-29.4	-29.4	498	-39.9	-34.8	-34.8	558	-45.3	-40.1	-40.1
320	-22.3	-17.9	-17.9	380	-28.6	-24.1	-24.1	440	-34.4	-29.6	-29.6	500	-40.0	-35.0	-35.0	560	-45.5	-40.3	-40.3
322	-22.5	-18.2	-18.2	382	-28.8	-24.2	-24.2	442	-34.5	-29.7	-29.7	502	-40.2	-35.2	-35.2	562	-45.7	-40.4	-40.4
324	-22.7	-18.4	-18.4	384	-29.0	-24.4	-24.4	444	-34.7	-29.9	-29.9	504	-40.4	-35.3	-35.3	564	-45.9	-40.6	-40.6
326	-23.0	-18.7	-18.7	386	-29.2	-24.6	-24.6	446	-34.9	-30.1	-30.1	506	-40.6	-35.5	-35.5	566	-46.1	-40.8	-40.8
328	-23.2	-18.9	-18.9	388	-29.3	-24.8	-24.8	448	-35.1	-30.3	-30.3	508	-40.8	-35.7	-35.7	568	-46.3	-41.0	-41.0
330	-23.4	-19.2	-19.2	390	-29.5	-25.0	-25.0	450	-35.3	-30.5	-30.5	510	-41.0	-35.9	-35.9	570	-46.4	-41.1	-41.1
332	-23.6	-19.4	-19.4	392	-29.7	-25.2	-25.2	452	-35.5	-30.7	-30.7	512	-41.1	-36.1	-36.1	572	-46.6	-41.3	-41.3
334	-23.8	-19.6	-19.6	394	-29.9	-25.3	-25.3	454	-35.7	-30.8	-30.8	514	-41.3	-36.2	-36.2	574	-46.8	-41.5	-41.5
336	-24.0	-19.8	-19.8	396	-30.1	-25.5	-25.5	456	-35.9	-31.0	-31.0	516	-41.5	-36.4	-36.4	576	-47.0	-41.7	-41.7
338	-24.2	-20.0	-20.0	398	-30.3	-25.7	-25.7	458	-36.1	-31.2	-31.2	518	-41.7	-36.6	-36.6	578	-47.2	-41.8	-41.8
340	-24.4	-20.2	-20.2	400	-30.5	-25.9	-25.9	460	-36.3	-31.4	-31.4	520	-41.9	-36.8	-36.8	580	-47.4	-42.0	-42.0
342	-24.6	-20.4	-20.4	402	-30.7	-26.1	-26.1	462	-36.5	-31.6	-31.6	522	-42.1	-36.9	-36.9	582	-47.5	-42.2	-42.2
344	-24.9	-20.6	-20.6	404	-30.9	-26.3	-26.3	464	-36.7	-31.8	-31.8	524	-42.2	-37.1	-37.1	584	-47.7	-42.4	-42.4
346	-25.1	-20.8	-20.8	406	-31.1	-26.4	-26.4	466	-36.9	-32.0	-32.0	526	-42.4	-37.3	-37.3	586	-47.9	-42.5	-42.5
348	-25.3	-21.0	-21.0	408	-31.3	-26.6	-26.6	468	-37.0	-32.1	-32.1	528	-42.6	-37.5	-37.5	588	-48.0	-42.7	-42.7
350	-25.5	-21.2	-21.2	410	-31.5	-26.8	-26.8	470	-37.2	-32.3	-32.3	530	-42.8	-37.6	-37.6	590	-48.2	-42.9	-42.9
352	-25.7	-21.4	-21.4	412	-31.7	-27.0	-27.0	472	-37.4	-32.5	-32.5	532	-43.0	-37.8	-37.8	592	-48.4	-43.0	-43.0
354	-25.9	-21.5	-21.5	414	-31.9	-27.2	-27.2	474	-37.6	-32.7	-32.7	534	-43.1	-38.0	-38.0	594	-48.5	-43.2	-43.2
356	-26.1	-21.7	-21.7	416	-32.0	-27.4	-27.4	476	-37.8	-32.9	-32.9	536	-43.3	-38.2	-38.2	596	-48.7	-43.4	-43.4
358	-26.3	-21.9	-21.9	418	-32.2	-27.5	-27.5	478	-38.0	-33.1	-33.1	538	-43.5	-38.3	-38.3	598	-48.9	-43.5	-43.5
																600	-49.0	-43.7	-43.7

Interference potential of 1.5 GHz Reference Network 3 for 1% of the time

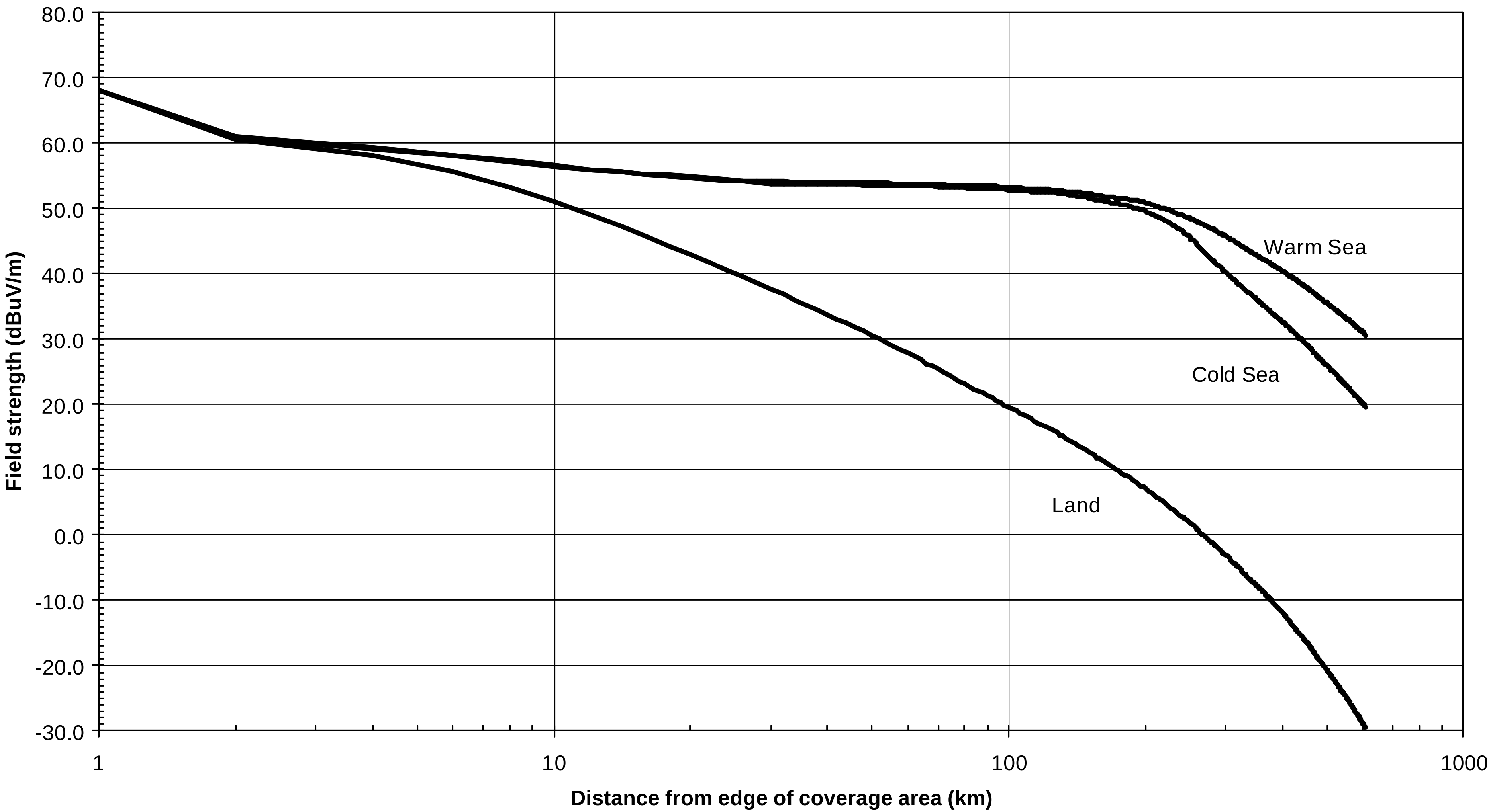


Figure A6.6b: Interference potential of 1.5 GHz Reference Network Three for 1% of time

Table A6.6b: Tabulated values for the interference potential of 1.5 GHz Reference Network 3 for 1% of time - (1)																			
Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
0	74.4	74.4	74.4	60	27.8	53.5	53.8	120	16.7	52.5	52.9	180	9.2	50.5	51.5	240	2.9	46.6	49.0
2	60.6	60.9	61.0	62	27.3	53.4	53.7	122	16.4	52.4	52.9	182	9.0	50.5	51.5	242	2.7	46.4	48.9
4	58.1	59.2	59.4	64	26.8	53.4	53.7	124	16.1	52.4	52.8	184	8.8	50.4	51.4	244	2.5	46.2	48.8
6	55.6	58.1	58.2	66	26.3	53.4	53.7	126	15.9	52.4	52.8	186	8.6	50.3	51.4	246	2.3	46.0	48.7
8	53.2	57.2	57.3	68	25.9	53.4	53.7	128	15.6	52.3	52.8	188	8.4	50.2	51.3	248	2.1	45.8	48.6
10	51.0	56.5	56.6	70	25.4	53.3	53.6	130	15.3	52.3	52.7	190	8.1	50.1	51.2	250	1.9	45.6	48.5
12	49.1	56.0	56.0	72	25.0	53.3	53.6	132	15.1	52.2	52.7	192	7.9	50.0	51.2	252	1.7	45.3	48.4
14	47.3	55.6	55.6	74	24.5	53.3	53.5	134	14.8	52.2	52.6	194	7.7	49.9	51.1	254	1.5	45.1	48.3
16	45.7	55.2	55.3	76	24.0	53.2	53.5	136	14.5	52.1	52.6	196	7.5	49.8	51.1	256	1.3	44.9	48.2
18	44.3	55.0	55.1	78	23.6	53.2	53.5	138	14.2	52.0	52.5	198	7.3	49.7	51.0	258	1.1	44.7	48.1
20	43.0	54.7	54.9	80	23.2	53.2	53.5	140	14.0	52.0	52.5	200	7.1	49.6	50.9	260	0.9	44.4	48.0
22	41.7	54.5	54.7	82	22.8	53.1	53.5	142	13.7	51.9	52.4	202	6.9	49.4	50.8	262	0.7	44.2	47.9
24	40.6	54.3	54.4	84	22.4	53.1	53.4	144	13.5	51.8	52.4	204	6.7	49.3	50.7	264	0.4	44.0	47.8
26	39.5	54.1	54.3	86	22.0	53.1	53.4	146	13.2	51.8	52.3	206	6.4	49.2	50.6	266	0.2	43.7	47.7
28	38.6	53.9	54.2	88	21.7	53.0	53.4	148	12.9	51.7	52.3	208	6.2	49.0	50.5	268	0.0	43.5	47.6
30	37.7	53.8	54.1	90	21.3	53.0	53.4	150	12.7	51.6	52.2	210	6.0	48.9	50.4	270	-0.2	43.3	47.4
32	36.8	53.7	54.1	92	21.0	53.0	53.4	152	12.4	51.5	52.2	212	5.8	48.8	50.4	272	-0.4	43.0	47.3
34	36.0	53.7	54.0	94	20.6	53.0	53.4	154	12.2	51.4	52.1	214	5.6	48.6	50.3	274	-0.6	42.8	47.2
36	35.2	53.7	54.0	96	20.3	52.9	53.3	156	11.9	51.4	52.1	216	5.4	48.5	50.2	276	-0.8	42.6	47.1
38	34.4	53.6	54.0	98	19.9	52.9	53.3	158	11.7	51.3	52.0	218	5.2	48.4	50.1	278	-1.0	42.3	47.0
40	33.7	53.6	54.0	100	19.6	52.8	53.3	160	11.5	51.2	52.0	220	4.9	48.2	50.0	280	-1.2	42.1	46.9
42	33.0	53.6	54.0	102	19.3	52.8	53.2	162	11.2	51.1	51.9	222	4.7	48.1	49.9	282	-1.4	41.9	46.8
44	32.4	53.6	54.0	104	19.0	52.8	53.2	164	11.0	51.0	51.8	224	4.5	48.0	49.8	284	-1.5	41.7	46.7
46	31.8	53.6	54.0	106	18.7	52.7	53.2	166	10.8	51.0	51.8	226	4.3	47.8	49.7	286	-1.7	41.5	46.6
48	31.2	53.5	53.9	108	18.4	52.7	53.1	168	10.5	50.9	51.7	228	4.1	47.7	49.6	288	-1.9	41.4	46.5
50	30.6	53.5	53.9	110	18.1	52.7	53.1	170	10.3	50.8	51.7	230	3.9	47.5	49.5	290	-2.1	41.2	46.3
52	30.0	53.5	53.9	112	17.8	52.6	53.0	172	10.1	50.7	51.6	232	3.7	47.4	49.4	292	-2.3	41.0	46.2
54	29.4	53.5	53.9	114	17.5	52.6	53.0	174	9.9	50.7	51.6	234	3.5	47.2	49.3	294	-2.5	40.8	46.1
56	28.8	53.5	53.8	116	17.2	52.5	53.0	176	9.7	50.6	51.6	236	3.3	47.0	49.2	296	-2.7	40.6	46.0
58	28.3	53.5	53.8	118	16.9	52.5	52.9	178	9.4	50.6	51.5	238	3.1	46.8	49.1	298	-2.9	40.4	45.9

Table A6.6b: Tabulated values for the interference potential of 1.5 GHz Reference Network 3 for 1% of time - (2)

Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea	Distance (km)	Land	Cold sea	Warm sea
300	-3.0	40.3	45.8	360	-8.5	35.4	42.4	420	-13.7	31.3	39.5	480	-18.9	27.2	36.5	540	-23.8	23.7	33.8
302	-3.2	40.1	45.6	362	-8.6	35.3	42.3	422	-13.8	31.2	39.4	482	-19.1	27.1	36.4	542	-24.0	23.6	33.7
304	-3.4	39.9	45.5	364	-8.8	35.2	42.2	424	-14.0	31.0	39.3	484	-19.3	27.0	36.3	544	-24.1	23.4	33.6
306	-3.6	39.7	45.4	366	-9.0	35.0	42.1	426	-14.2	30.9	39.2	486	-19.4	26.9	36.2	546	-24.3	23.3	33.5
308	-3.8	39.6	45.3	368	-9.1	34.9	42.0	428	-14.4	30.8	39.1	488	-19.6	26.7	36.1	548	-24.5	23.2	33.4
310	-4.0	39.4	45.2	370	-9.3	34.7	41.9	430	-14.5	30.6	39.0	490	-19.7	26.6	36.0	550	-24.6	23.1	33.3
312	-4.2	39.2	45.1	372	-9.5	34.6	41.8	432	-14.7	30.5	38.9	492	-19.9	26.5	35.9	552	-24.8	23.0	33.2
314	-4.4	39.1	44.9	374	-9.7	34.4	41.7	434	-14.9	30.4	38.8	494	-20.1	26.4	35.8	554	-25.0	22.8	33.1
316	-4.6	38.9	44.8	376	-9.8	34.3	41.6	436	-15.1	30.2	38.7	496	-20.2	26.3	35.7	556	-25.1	22.7	33.1
318	-4.7	38.7	44.7	378	-10.0	34.1	41.5	438	-15.2	30.1	38.6	498	-20.4	26.1	35.6	558	-25.3	22.6	33.0
320	-4.9	38.5	44.6	380	-10.2	34.0	41.4	440	-15.4	30.0	38.5	500	-20.6	26.0	35.6	560	-25.4	22.5	32.9
322	-5.1	38.4	44.5	382	-10.3	33.8	41.3	442	-15.6	29.8	38.4	502	-20.7	25.9	35.5	562	-25.6	22.4	32.8
324	-5.3	38.2	44.3	384	-10.5	33.7	41.2	444	-15.8	29.7	38.3	504	-20.9	25.8	35.4	564	-25.8	22.2	32.7
326	-5.5	38.0	44.2	386	-10.7	33.6	41.1	446	-15.9	29.5	38.2	506	-21.0	25.7	35.3	566	-25.9	22.1	32.6
328	-5.7	37.8	44.1	388	-10.9	33.4	41.0	448	-16.1	29.4	38.1	508	-21.2	25.6	35.2	568	-26.1	22.0	32.5
330	-5.9	37.7	44.0	390	-11.0	33.3	40.9	450	-16.3	29.3	38.0	510	-21.4	25.4	35.1	570	-26.3	21.9	32.4
332	-6.0	37.5	43.9	392	-11.2	33.2	40.8	452	-16.5	29.1	37.9	512	-21.5	25.3	35.0	572	-26.4	21.8	32.3
334	-6.2	37.4	43.8	394	-11.4	33.0	40.7	454	-16.6	29.0	37.8	514	-21.7	25.2	34.9	574	-26.6	21.6	32.2
336	-6.4	37.2	43.7	396	-11.6	32.9	40.6	456	-16.8	28.9	37.7	516	-21.9	25.1	34.9	576	-26.7	21.5	32.1
338	-6.6	37.1	43.6	398	-11.7	32.8	40.5	458	-17.0	28.7	37.6	518	-22.0	25.0	34.8	578	-26.9	21.4	32.1
340	-6.7	36.9	43.4	400	-11.9	32.6	40.4	460	-17.2	28.6	37.5	520	-22.2	24.9	34.7	580	-27.1	21.3	32.0
342	-6.9	36.8	43.3	402	-12.1	32.5	40.3	462	-17.3	28.5	37.4	522	-22.4	24.7	34.6	582	-27.2	21.2	31.9
344	-7.1	36.6	43.2	404	-12.3	32.4	40.2	464	-17.5	28.3	37.3	524	-22.5	24.6	34.5	584	-27.4	21.1	31.8
346	-7.3	36.5	43.1	406	-12.4	32.2	40.1	466	-17.7	28.2	37.2	526	-22.7	24.5	34.4	586	-27.6	21.0	31.7
348	-7.4	36.3	43.0	408	-12.6	32.1	40.0	468	-17.9	28.0	37.1	528	-22.8	24.4	34.3	588	-27.7	20.8	31.6
350	-7.6	36.2	42.9	410	-12.8	32.0	39.9	470	-18.0	27.9	37.0	530	-23.0	24.3	34.2	590	-27.9	20.7	31.5
352	-7.8	36.0	42.8	412	-13.0	31.8	39.8	472	-18.2	27.8	36.9	532	-23.2	24.1	34.1	592	-28.1	20.6	31.4
354	-7.9	35.9	42.7	414	-13.1	31.7	39.7	474	-18.4	27.6	36.8	534	-23.3	24.0	34.0	594	-28.3	20.5	31.3
356	-8.1	35.7	42.6	416	-13.3	31.6	39.7	476	-18.6	27.5	36.7	536	-23.5	23.9	34.0	596	-28.4	20.4	31.3
358	-8.3	35.6	42.5	418	-13.5	31.4	39.6	478	-18.7	27.4	36.6	538	-23.7	23.8	33.9	598	-28.6	20.3	31.2
																600	-28.8	20.2	31.1

Protection ratios for analogue television and VHF/FM sound broadcasting interfered with by T-DAB

1. General

Composite protection ratios have been established for various television systems (both vision and sound) as well as for FM Sound Broadcasting.

These protection ratios cover both tropospheric interference (ITU-R impairment grade 3) and continuous interference (ITU-R impairment grade 4). The protection ratios given for systems B and D have been measured for tropospheric interference (impairment grade 3) only. The ITU-R recommends that, for the television service, the Grade 3 co-channel protection ratio should be increased by 7 dB to give protection for Grade 4 (just perceptible) interference. For the adjacent channel situations an increase of 10 dB is recommended. During the series of measurements carried out, no specific attempt was made to establish protection ratios for Grade 4, but a brief look at the situation suggested that, for interfering COFDM, an overall increase of 7 dB is required in the co-channel case.

Protection ratios are presented in the form of curves as well as tables. In the Figures as well as in the Tables two thick lines have been entered. Only the values between these lines have been included in the EBU software for compatibility calculations during the Wiesbaden Planning Meeting. Values outside of the thick lines can be used in case by case treatments of specific problems.

As the derivation of the protection ratios in Band III is rather difficult because of the overlapping channels and different standards the protection ratios for all possible frequency blocks in Band III are given in separate tableaux at the end of this annex.

2. Protection ratios

The following protection ratios can be found in this Annex:

B/PAL, single FM-sound -10 dB:	Figure A7-1,	Table A7-1 [1)]	
B/PAL, single FM-sound -13 dB:	Figure A7-2,	Table A7-2,	Tableau A7-2 [1)]
B/PAL/A2, two FM-carriers:	Figure A7-3,	Table A7-3,	Tableau A7-3
B/PAL/NICAM:	Figure A7-4,	Table A7-4,	Tableau A7-4
D/SECAM, single FM-sound -10 dB:	Figure A7-5,	Table A7-5,	Tableaux A7-5a, 5b [2)]
D/SECAM, single FM-sound -13 dB:	Figure A7-6,	Table A7-6 [2)]	
I/PAL/NICAM:	Figure A7-7,	Table A7-7,	Tableau A7-7
L/SECAM/NICAM:	Figure A7-8,	Table A7-8,	Tableau A7-8
FM Sound Broadcasting:	Figure A7-9,	Table A7-9	

[1)] can also be used for B/SECAM
[2)] can also be used for D/PAL

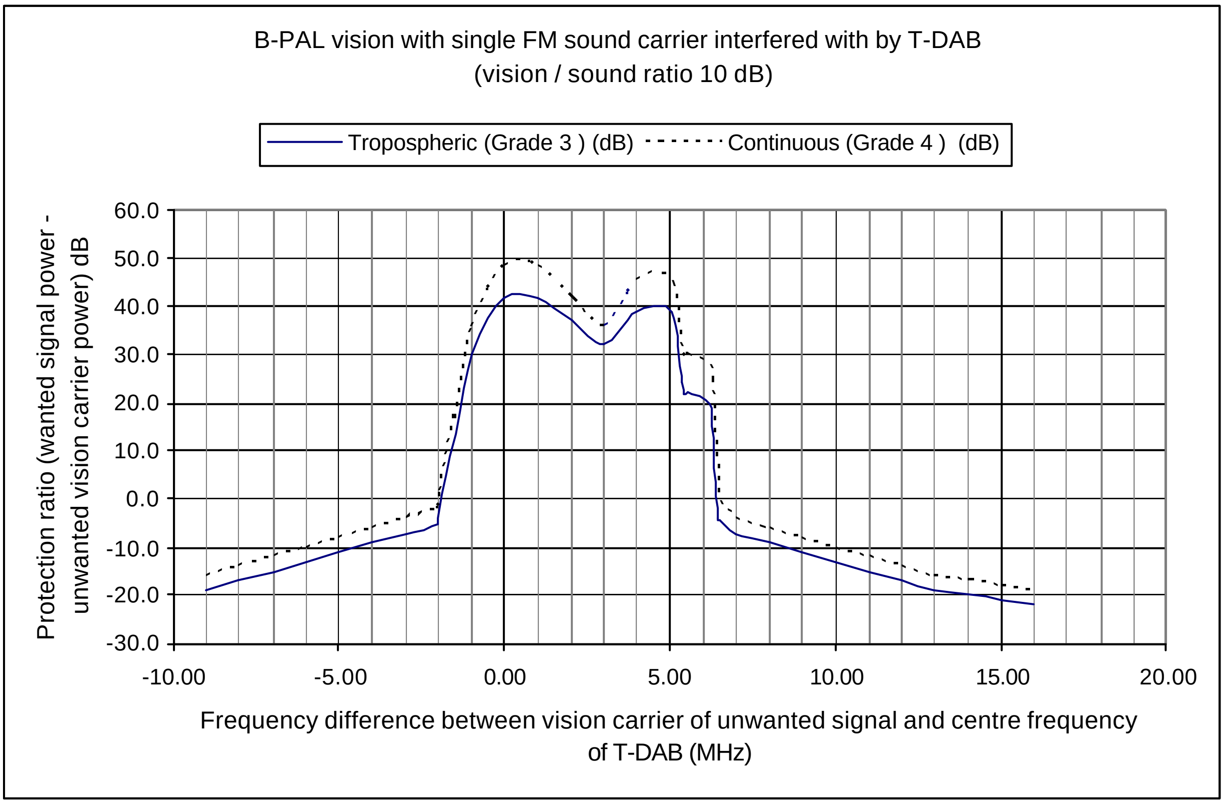


Figure A7 - 1

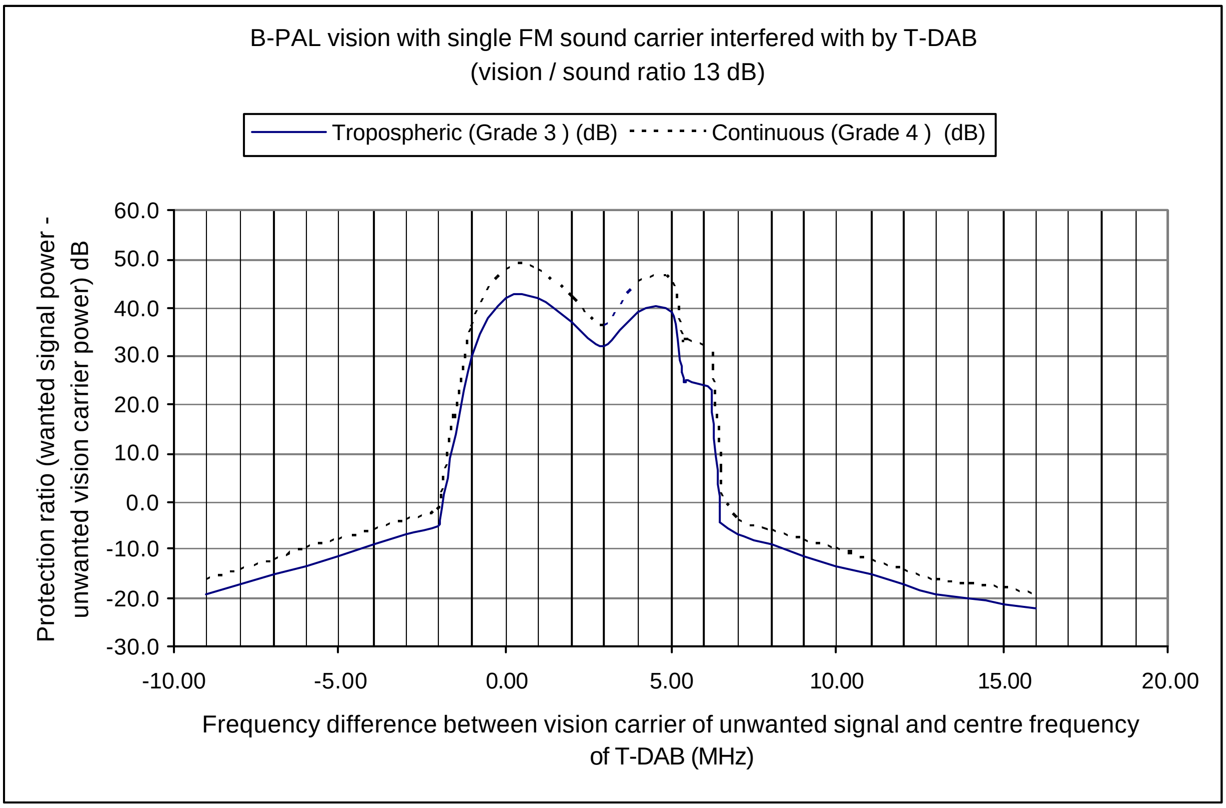


Figure A7 - 2

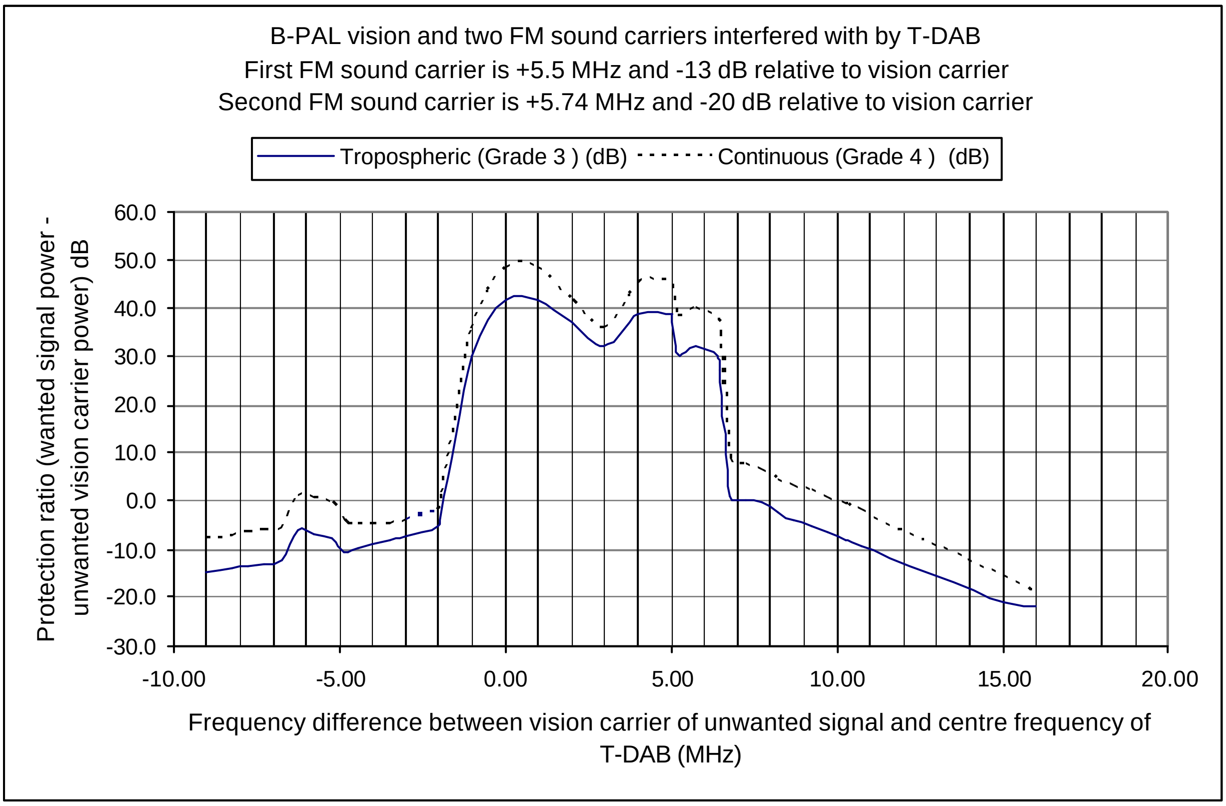


Figure A7 - 3

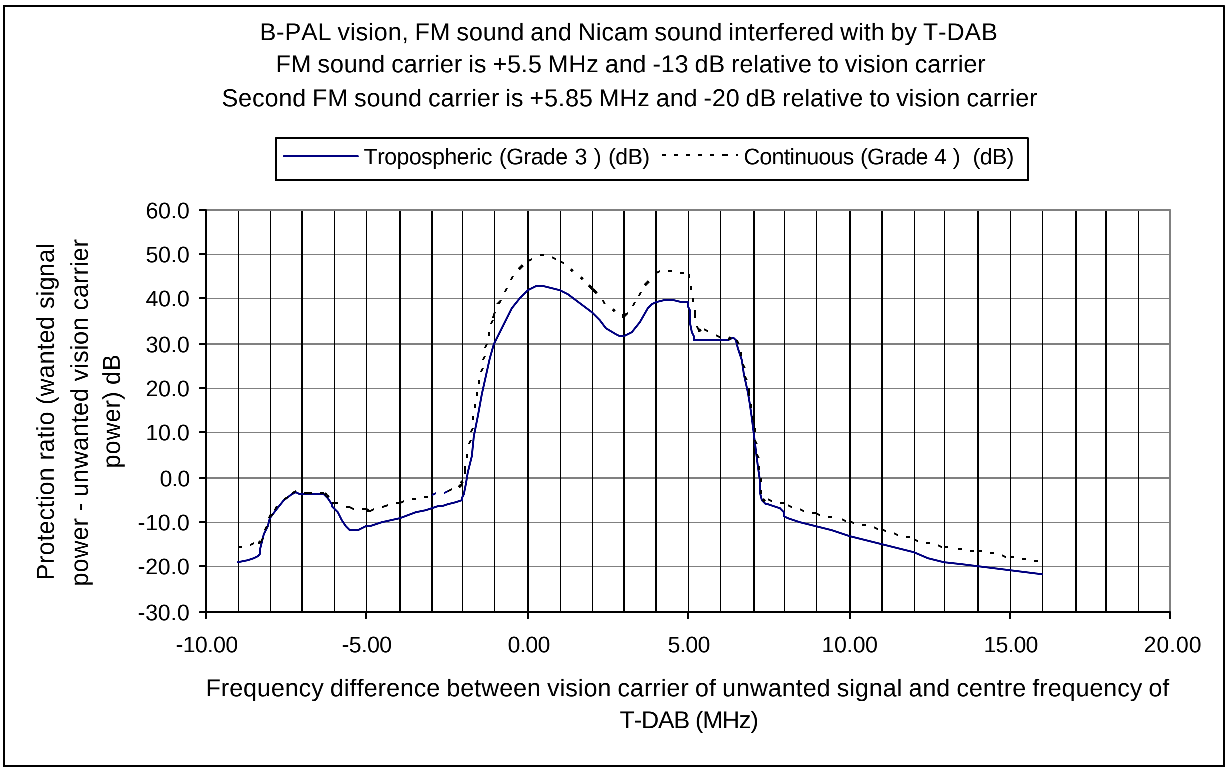


Figure A7 - 4

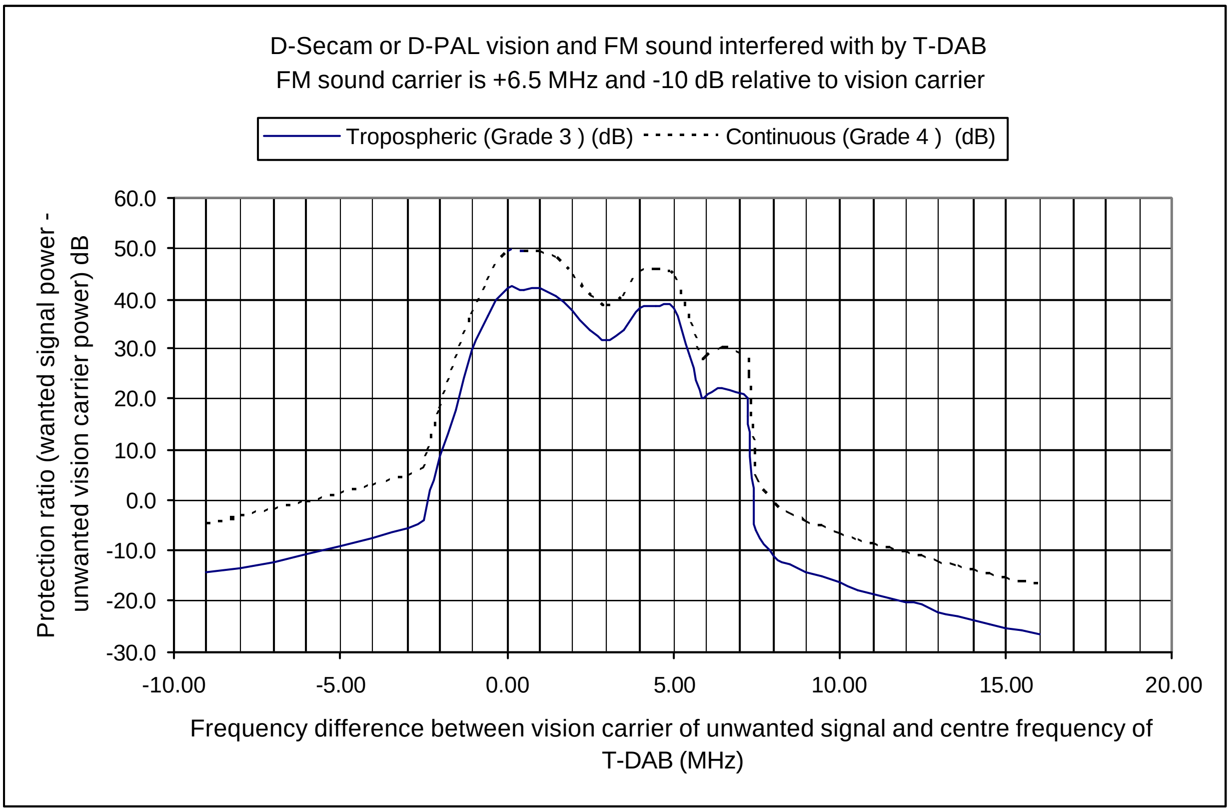


Figure A7 - 5

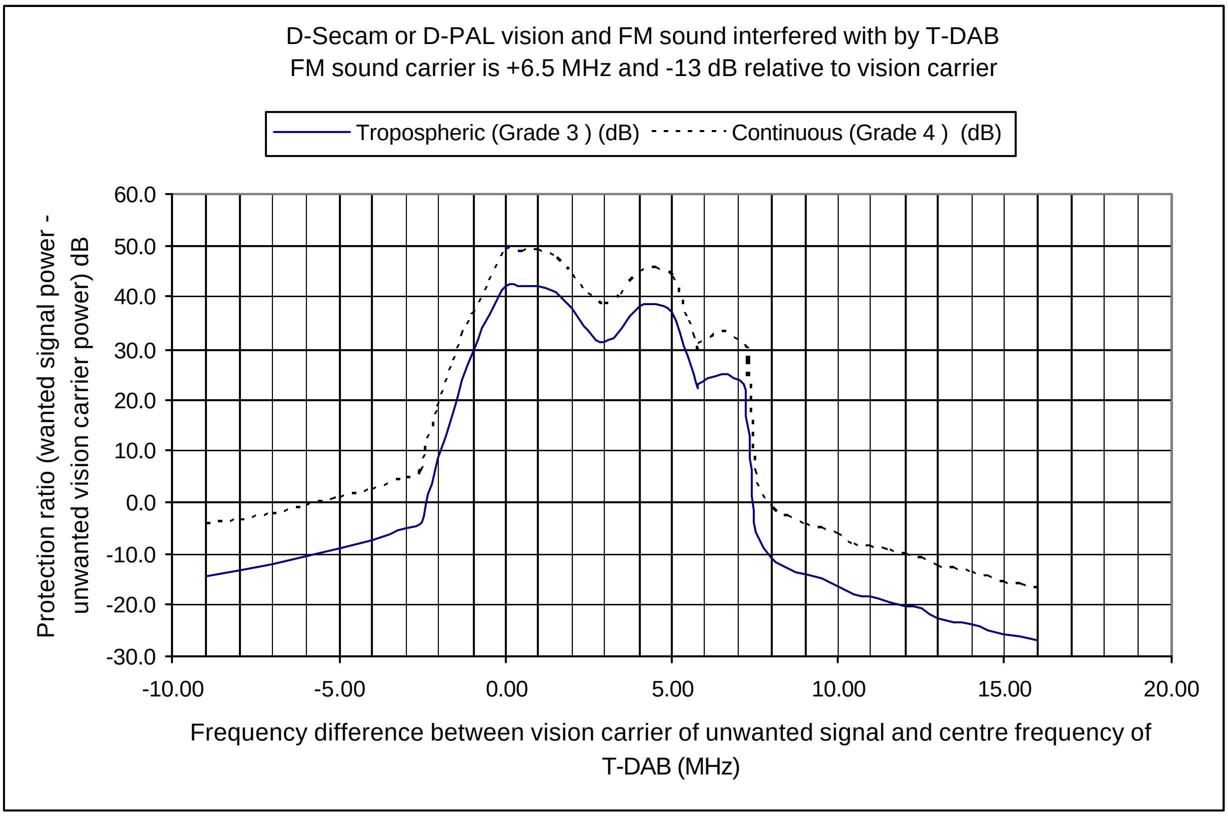


Figure A7 - 6

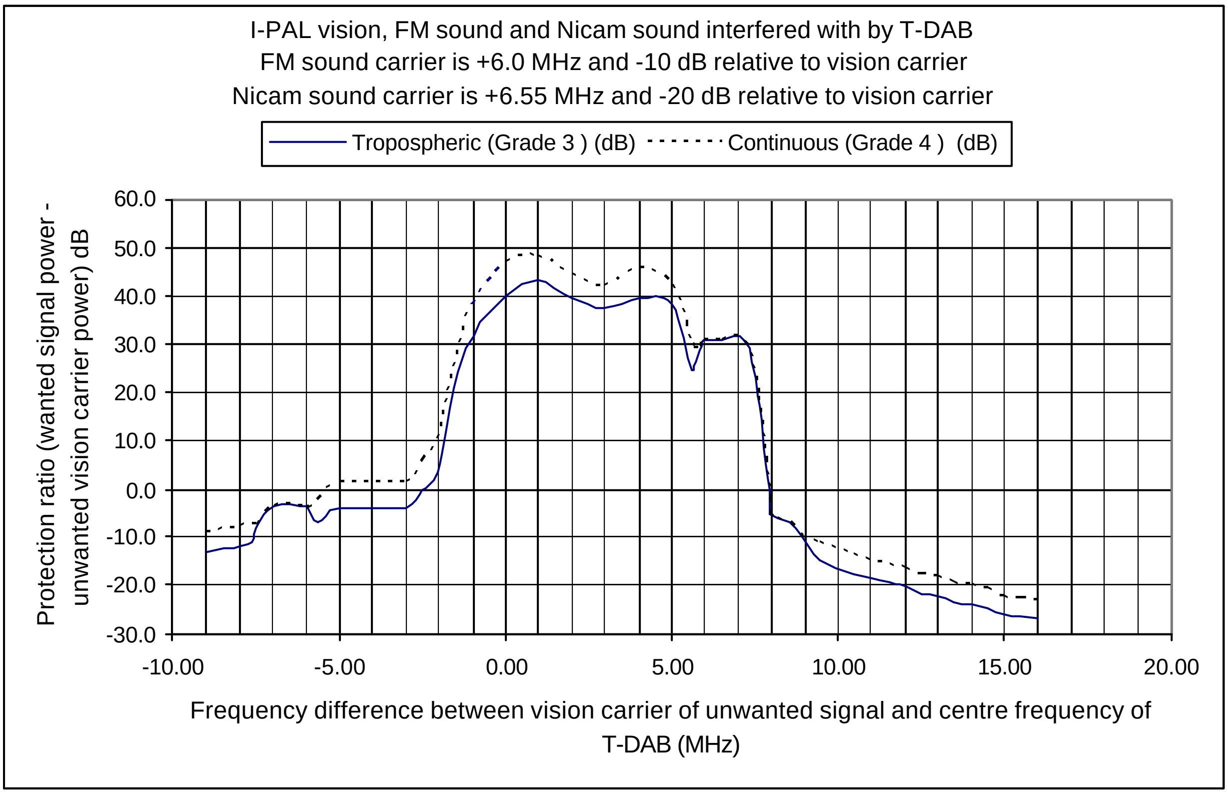


Figure A7 - 7

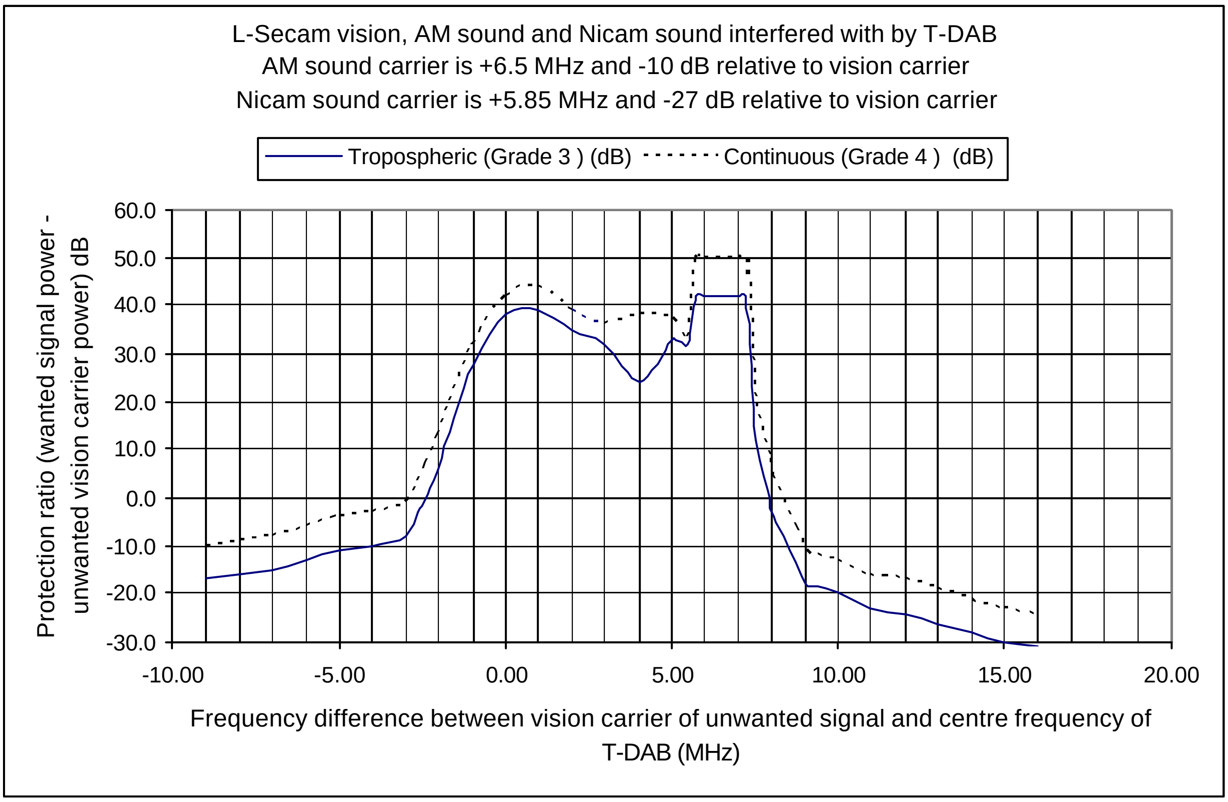


Figure A7 - 8

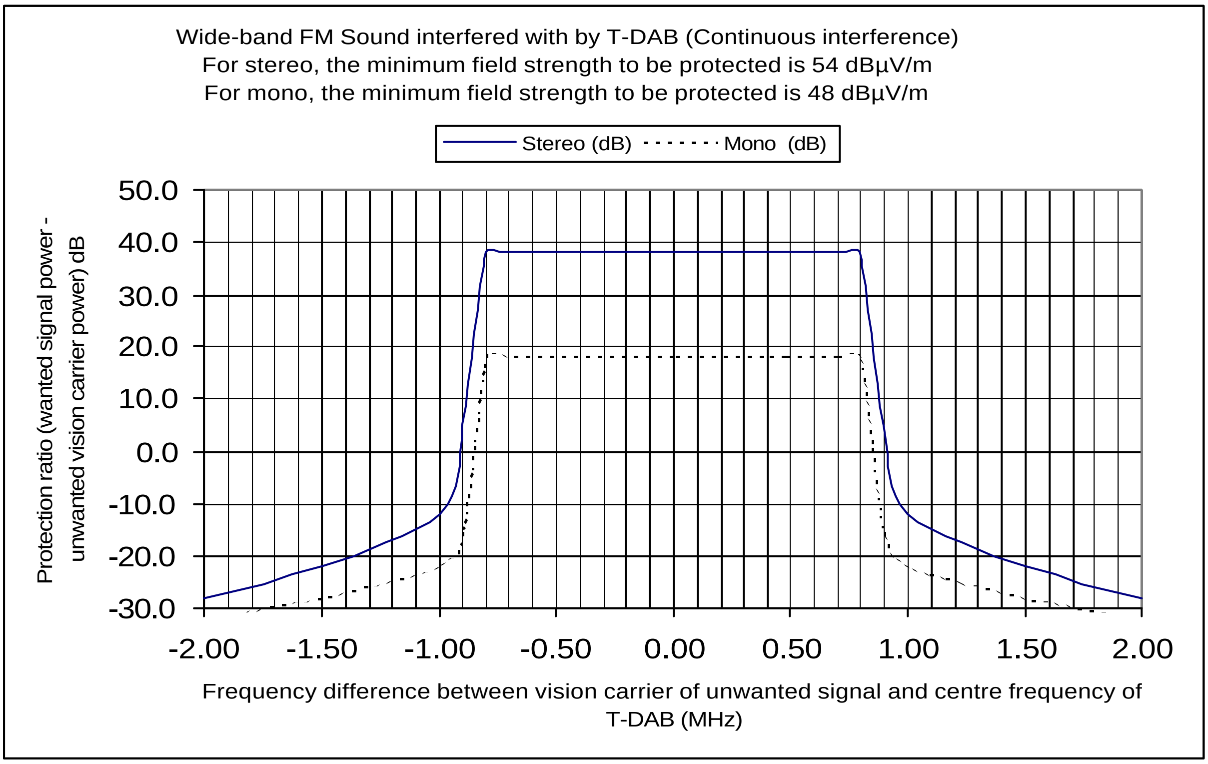

Wide-band FM Sound interfered with by T-DAB (Continuous interference)
For stereo, the minimum field strength to be protected is 54 dBµV/m
For mono, the minimum field strength to be protected is 48 dBµV/m
Stereo (dB)
Mono (dB)
Protection ratio (wanted signal power - unwanted vision carrier power) dB
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0
-30.0
-2.00
-1.50
-1.00
-0.50
0.00
0.50
1.00
1.50
2.00
Frequency difference between vision carrier of unwanted signal and centre frequency of T-DAB (MHz)

Figure A7 - 9

B-PAL vision, FM sound and Nicam sound interfered with by T-DAB		
FM sound carrier is +5.5 MHz and -13 dB relative to vision carrier		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Tropospheric (Grade 3) (dB)	Continuous (Grade 4) (dB)
-9.00	-19.0	-16.0
-8.35	-17.6	-14.8
-8.20	-14.5	-14.5
-7.85	-7.2	-7.2
-7.35	-3.7	-3.7
-6.85	-3.7	-3.7
-6.35	-3.7	-3.7
-6.10	-6.0	-6.0
-6.00	-7.0	-6.1
-5.50	-11.9	-6.7
-5.00	-11.0	-7.4
-4.90	-10.8	-7.8
-4.00	-9.0	-6.0
-3.00	-7.0	-4.0
-2.50	-6.0	-3.0
-2.00	-5.0	-2.0
-1.90	-1.5	1.8
-1.00	30.0	36.0
0.00	42.0	48.0
1.00	42.0	48.0
2.00	37.0	42.0
3.00	32.0	36.0
4.00	39.0	45.3
5.00	39.0	45.3
5.00	39.0	45.3
5.20	31.0	36.8
5.30	31.0	32.6
5.50	31.0	33.0
6.20	31.0	31.0
6.45	31.0	31.0
6.85	19.0	19.0
7.25	-5.0	-5.0
7.45	-6.0	-5.0
7.85	-7.0	-5.8
8.10	-9.2	-6.2
9.00	-11.0	-8.0
10.00	-13.0	-10.0
11.00	-15.0	-12.0
12.00	-17.0	-14.0
13.00	-19.0	-16.0
14.00	-20.0	-17.0
15.00	-21.0	-18.0
16.00	-22.0	-19.0

Table A7 - 1

B-PAL vision with single FM sound carrier interfered with by T-DAB		
Single FM sound carrier is +5.5MHz and –13 dB relative to vision carrier		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Tropospheric (Grade 3) (dB)	Continuous (Grade 4) (dB)
-9.00	-19.0	-16.0
-8.00	-17.0	-14.0
-7.00	-15.0	-12.0
-6.00	-13.0	-10.0
-5.00	-11.0	-8.0
-4.00	-9.0	-6.0
-3.00	-7.0	-4.0
-2.00	-5.0	-2.0
-1.90	-1.5	1.8
-1.00	30.0	36.0
0.00	42.0	48.0
1.00	42.0	48.0
2.00	37.0	42.0
3.00	32.0	36.0
4.00	39.0	45.3
5.00	39.0	45.3
5.30	26.7	32.6
5.35	24.7	32.9
5.40	24.8	32.9
5.50	25.0	33.0
6.20	23.0	31.0
6.25	20.0	28.0
6.45	-0.8	7.2
6.50	-4.5	2.0
7.00	-7.0	-4.0
8.00	-9.0	-6.0
9.00	-11.0	-8.0
10.00	-13.0	-10.0
11.00	-15.0	-12.0
12.00	-17.0	-14.0
13.00	-19.0	-16.0
14.00	-20.0	-17.0
15.00	-21.0	-18.0
16.00	-22.0	-19.0

Table A7 - 2

B-PAL vision and two FM sound carriers interfered with by T-DAB		
First FM sound carrier is +5.5 MHz and –13 dB relative to vision carrier		
Second FM sound carrier is +5.74 MHz and –20 dB relative to sound carrier		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Tropospheric (Grade 3) (dB)	Continuous (Grade 4) (dB)
-9.00	-14.8	-7.8
-8.24	-14.1	-7.1
-7.74	-13.5	-6.5
-7.24	-13.0	-6.0
-6.74	-12.4	-5.4
-6.24	-6.1	0.9
-5.74	-6.7	0.3
-5.24	-7.4	-0.4
-4.85	-10.7	-3.6
-4.74	-10.5	-4.5
-4.40	-9.8	-4.5
-4.00	-9.0	-4.5
-3.50	-8.0	-4.5
-3.00	-7.0	-4.0
-2.00	-5.0	-2.0
-1.90	-1.5	1.8
-1.00	30.0	36.0
0.00	42.0	48.0
1.00	42.0	48.0
2.00	37.0	42.0
3.00	32.0	36.0
4.00	39.0	45.3
5.00	39.0	45.3
5.00	39.0	45.3
5.20	30.5	38.3
5.74	32.0	40.0
6.44	30.0	38.0
6.49	27.0	35.0
6.74	1.0	9.0
7.24	0.2	7.7
7.74	-0.6	6.4
8.24	-2.7	4.3
8.74	-3.9	3.1
9.24	-5.0	2.0
9.74	-6.4	0.6
10.24	-7.9	-0.9
10.74	-9.1	-2.1
15.00	-21.0	-15.8
16.00	-22.0	-19.0

Table A7 - 3

B-PAL vision, FM and Nicam sound carriers interfered with by T-DAB		
First FM sound carrier is +5.5 MHz and –13 dB relative to vision carrier		
Nicam sound carrier is +5.85 MHz and –20 dB relative to sound carrier		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Tropospheric (Grade 3) (dB)	Continuous (Grade 4) (dB)
-9.00	-19.0	-16.0
-8.35	-17.6	-14.8
-8.20	-14.5	-14.5
-7.85	-7.2	-7.2
-7.35	-3.7	-3.7
-6.85	-3.7	-3.7
-6.35	-3.7	-3.7
-6.10	-6.0	-6.0
-6.00	-7.0	-6.1
-5.50	-11.9	-6.7
-5.00	-11.0	-7.4
-4.90	-10.8	-7.8
-4.00	-9.0	-6.0
-3.00	-7.0	-4.0
-2.50	-6.0	-3.0
-2.00	-5.0	-2.0
-1.90	-1.5	1.8
-1.00	30.0	36.0
0.00	42.0	48.0
1.00	42.0	48.0
2.00	37.0	42.0
3.00	32.0	36.0
4.00	39.0	45.3
5.00	39.0	45.3
5.00	39.0	45.3
5.20	31.0	36.8
5.30	31.0	32.6
5.50	31.0	33.0
6.20	31.0	31.0
6.45	31.0	31.0
6.85	19.0	19.0
7.25	-5.0	-5.0
7.45	-6.0	-5.0
7.85	-7.0	-5.8
8.10	-9.2	-6.2
9.00	-11.0	-8.0
10.00	-13.0	-10.0
11.00	-15.0	-12.0
12.00	-17.0	-14.0
13.00	-19.0	-16.0
14.00	-20.0	-17.0
15.00	-21.0	-18.0
16.00	-22.0	-19.0

Table A7 - 4

D-Secam or D-PAL vision and FM sound interfered with by T-DAB		
FM sound carrier is +6.5 MHz and –10 dB relative to vision carrier		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Tropospheric (Grade 3) (dB)	Continuous (Grade 4) (dB)
-9.00	-14.4	-4.4
-8.00	-13.3	-3.3
-7.00	-12.2	-2.2
-6.00	-10.7	-0.7
-5.00	-8.9	1.1
-4.00	-7.4	2.6
-3.00	-5.2	4.8
-2.50	-3.8	6.2
-2.35	-0.1	9.9
-2.00	8.6	18.6
-1.50	18.0	28.0
-1.00	29.8	36.8
-0.50	36.5	43.5
0.00	42.3	49.3
0.50	42.0	49.0
1.00	42.1	49.1
1.50	40.8	47.8
2.00	37.7	44.7
2.50	33.6	40.6
3.00	31.6	38.6
3.50	33.7	40.7
4.00	38.1	45.1
4.50	38.6	45.6
5.00	38.2	44.2
5.50	28.5	35.5
5.88	20.0	27.9
6.00	20.4	28.3
6.50	22.0	30.0
7.20	20.0	28.0
7.25	17.0	25.0
7.43	0.6	10.0
7.50	-5.8	4.2
8.00	-10.9	-0.9
8.50	-12.8	-2.8
9.00	-14.1	-4.1
9.50	-15.1	-5.1
10.00	-16.4	-6.4
10.50	-18.0	-8.0
11.00	-18.6	-8.6
11.50	-19.5	-9.5
12.00	-20.3	-10.3
12.50	-20.9	-10.9
13.00	-22.4	-12.4
13.50	-23.1	-13.1
14.00	-23.8	-13.8
14.50	-24.7	-14.7
15.00	-25.6	-15.6
15.50	-26.1	-16.1
16.00	-26.8	-16.8

Table A7 - 5

D-Secam or D-PAL vision and FM sound interfered with by T-DAB		
FM sound carrier is +6.5 MHz and –13 dB relative to vision carrier		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Tropospheric (Grade 3) (dB)	Continuous (Grade 4) (dB)
-9.00	-14.4	-4.4
-8.00	-13.3	-3.3
-7.00	-12.2	-2.2
-6.00	-10.7	-0.7
-5.00	-8.9	1.1
-4.00	-7.4	2.6
-3.00	-5.2	4.8
-2.50	-3.8	6.2
-2.35	-0.1	9.9
-2.00	8.6	18.6
-1.50	18.0	28.0
-1.00	29.8	36.8
-0.50	36.5	43.5
0.00	42.3	49.3
0.50	42.0	49.0
1.00	42.1	49.1
1.50	40.8	47.8
2.00	37.7	44.7
2.50	33.6	40.6
3.00	31.6	38.6
3.50	33.7	40.7
4.00	38.1	45.1
4.50	38.6	45.6
5.00	37.2	44.2
5.50	28.5	35.5
5.78	22.3	29.9
5.80	23.0	31.0
6.50	25.0	33.0
7.20	23.0	31.0
7.25	20.0	28.0
7.40	4.4	13.7
7.50	-6.0	4.2
8.00	-10.9	-0.9
8.50	-12.8	-2.8
9.00	-14.1	-4.1
9.50	-15.1	-5.1
10.00	-16.4	-6.4
10.50	-18.0	-8.0
11.00	-18.6	-8.6
11.50	-19.5	-9.5
12.00	-20.3	-10.3
12.50	-20.9	-10.9
13.00	-22.4	-12.4
13.50	-23.1	-13.1
14.00	-23.8	-13.8
14.50	-24.7	-14.7
15.00	-25.6	-15.6
15.50	-26.1	-16.1
16.00	-26.8	-16.8

Table A7 - 6

I-PAL vision, FM sound and Nicam sound interfered with by T-DAB		
First FM sound carrier is +6.0 MHz and –10 dB relative to vision carrier		
Nicam sound carrier is +6.55 MHz and –20 dB relative to sound carrier		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Tropospheric (Grade 3) (dB)	Continuous (Grade 4) (dB)
-9.00	-13.0	-9.0
-8.00	-11.8	-7.8
-7.64	-11.0	-7.4
-7.45	-7.2	-7.2
-6.95	-3.7	-3.7
-5.95	-3.7	-3.7
-5.92	-4.0	-4.0
-5.61	-6.8	-2.1
-5.00	-4.0	1.5
-3.00	-4.0	1.5
-2.50	-0.1	5.9
-2.00	3.8	10.3
-1.50	21.0	25.5
-1.00	32.0	38.0
0.00	39.8	46.8
1.00	43.0	48.3
2.00	39.5	44.3
3.00	37.3	41.8
4.00	39.3	45.5
5.00	38.0	42.5
5.63	24.5	30.0
5.67	25.5	29.1
5.89	29.7	29.7
5.95	31.0	31.0
6.55	31.0	31.0
7.20	31.0	31.0
7.55	19.0	19.0
7.90	-2.0	-2.0
7.95	-5.0	-5.0
8.15	-6.0	-6.0
8.55	-7.0	-7.0
8.90	-10.0	-10.0
9.46	-15.0	-11.2
10.50	-17.6	-13.8
11.50	-19.5	-15.7
12.00	-20.3	-16.5
12.50	-21.4	-17.6
13.00	-22.2	-18.4
13.50	-23.1	-19.3
14.00	-23.8	-20.0
14.50	-24.7	20.9
15.00	-25.6	-21.8
15.50	-26.1	-22.3
16.00	-26.8	-23.0

Table A7 - 7

L-Secam vision, AM sound and Nicam sound interfered with by T-DAB		
AM sound carrier is +6.5 MHz and –10 dB relative to vision carrier		
Nicam sound carrier is +5.85 MHz and –27 dB relative to vision carrier		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Tropospheric (Grade 3) (dB)	Continuous (Grade 4) (dB)
-9.00	-17.0	-10.0
-8.00	-16.0	-9.0
-7.00	-15.0	-8.0
-6.00	-13.0	6.0
-5.00	-11.0	-4.0
-4.00	-10.0	-3.0
-3.00	-8.0	-1.0
-2.60	-3.0	4.0
-2.40	0.0	7.0
-2.00	6.0	13.0
-1.00	28.0	32.0
0.00	38.0	42.0
1.00	39.0	44.0
2.00	35.0	39.0
3.00	32.0	36.0
4.00	24.0	38.0
5.00	33.0	37.0
5.50	32.0	34.0
5.75	42.0	50.0
6.00	42.0	50.0
7.00	42.0	50.0
7.25	42.0	50.0
7.50	12.0	20.0
7.90	0.0	8.0
8.00	-3.0	5.0
8.70	-13.4	-6.0
9.00	-18.0	-11.0
9.40	-18.8	-11.8
10.00	-20.0	-13.0
11.00	-23.0	-16.0
12.00	-24.0	-17.0
13.00	-26.0	-19.0
14.00	-28.0	-21.0
15.00	-30.0	-23.0
16.00	-31.0	-24.0

Table A7 - 8

Wide-band FM sound interfered with by T-DAB (Continuous interference)		
For stereo, the minimum field strength to be protected is 54 dBμV/m)		
For mono, the minimum field strength to be protected is 48dBμV/m)		
Frequency difference between DAB centre frequency and Vision frequency (MHz)	Protection Ratio (wanted vision power - unwanted signal power)	
	Stereo (dB)	Mono (dB)
2.00	-28.0	-32.0
1.50	-22.0	-28.0
1.00	-12.0	-22.0
0.90	5.0	-16.0
0.80	38.0	18.0
0.70	38.0	18.0
0.00	38.0	18.0
-0.70	38.0	18.0
-0.80	38.0	18.0
-0.90	5.0	-16.0
-1.00	-12.0	-22.0
-1.50	-22.0	-28.0
-2.00	-28.0	-32.0

Table A7 - 9

B-SECAM vision and two FM sound carriers interfered with by T-DAB
protection ratio (tropospheric and continuous), values of B-PAL used. **2**

TV	TV-ch.	12		11		10		9		8		7		6		5		
DAB	f_{vision} MHz	224.25		217.25		210.25		203.25		196.25		189.25		182.25		175.25		
TV-ch. block	f_C	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	Cont	tropo	cont	tropo	cont	tropo	cont	
13 F	239.200																	dB
13 E	237.488																	dB
13 D	235.776					First FM sound carrier is +5.5 MHz and -13 dB relative to vision carrier.												dB
13 C	234.208					Second FM sound carrier is +5.74 MHz and -20 dB relative to vision carrier.												dB
13 B	232.496					Minimum field strength to be protected is 55 dBµV/m.												dB
13 A	230.784	22	30															dB
12 D	229.072	39	45															dB
12 C	227.360	33	37															dB
12 B	225.648	40	46															dB
12 A	223.936	38	44	7	15													dB
11 D	222.064			39	45													dB
11 C	220.352			33	37													dB
11 B	218.640			40	46													dB
11 A	216.928			38	44	7	15											dB
10 D	215.072					39	45											dB
10 C	213.360					33	37											dB
10 B	211.648					40	46											dB
10 A	209.936					38	44	7	15									dB
9 D	208.064							39	45									dB
9 C	206.352							33	37									dB
9 B	204.640							40	46									dB
9 A	202.928							38	44	7	15							dB
8 D	201.072									39	45							dB
8 C	199.360									33	37							dB
8 B	197.648									40	46							dB
8 A	195.936									38	44	7	15					dB
7 D	194.064											39	45					dB
7 C	192.352											33	37					dB
7 B	190.640											40	46					dB
7 A	188.928											38	44	7	15			dB
6 D	187.072													39	45			dB
6 C	185.360													33	37			dB
6 B	183.648													40	46			dB
6 A	181.936													38	44	7	15	dB
5 D	180.064															39	45	dB
5 C	178.352															33	37	dB
5 B	176.640															40	46	dB
5 A	174.928															38	44	dB

Tableau A7 - 2

B-PAL vision and two FM sound carriers interfered with by T-DAB Protection ratio (tropospheric and continuous)																		3
TV	TV-ch.	12		11		10		9		8		7		6		5		
DAB	f_{vision} MHz	224.25		217.25		210.25		203.25		196.25		189.25		182.25		175.25		
TV-ch. block	f_C	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	
13 F	239.200																	dB
13 E	237.488																	dB
13 D	235.776																	dB
13 C	234.208																	dB
13 B	232.496																	dB
13 A	230.784	22	30															dB
12 D	229.072	39	45															dB
12 C	227.360	33	37															dB
12 B	225.648	40	46															dB
12 A	223.936	38	44	7	15													dB
11 D	222.064			39	45													dB
11 C	220.352			33	37													dB
11 B	218.640			40	46													dB
11 A	216.928			38	44	7	15											dB
10 D	215.072					39	45											dB
10 C	213.360					33	37											dB
10 B	211.648					40	46											dB
10 A	209.936					38	44	7	15									dB
9 D	208.064							39	45									dB
9 C	206.352							33	37									dB
9 B	204.640							40	46									dB
9 A	202.928							38	44	7	15							dB
8 D	201.072									39	45							dB
8 C	199.360									33	37							dB
8 B	197.648									40	46							dB
8 A	195.936									38	44	7	15					dB
7 D	194.064											39	45					dB
7 C	192.352											33	37					dB
7 B	190.640											40	46					dB
7 A	188.928											38	44	7	15			dB
6 D	187.072													39	45			dB
6 C	185.360													33	37			dB
6 B	183.648													40	46			dB
6 A	181.936													38	44	7	15	dB
5 D	180.064															39	45	dB
5 C	178.352															33	37	dB
5 B	176.640															40	46	dB
5 A	174.928															38	44	dB

First FM sound carrier is +5.5 MHz and -13 dB relative to vision carrier.
Second FM sound carrier is +5.74 MHz and -20 dB relative to vision carrier.
Minimum field strength to be protected is 55 dBμV/m.

Tableau A7 - 3

B-PAL vision, FM sound and Nicam sound interfered with by T-DAB — Protection ratio (tropospheric and continuous) **4**

TV / DAB	TV-ch.	12		11		10		9		8		7		6		5		
	f_{vision} MHz	224.25		217.25		210.25		203.25		196.25		189.25		182.25		175.25		
TV-ch. block	f_C	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	
13 F	239.200																	dB
13 E	237.488																	dB
13 D	235.776																	dB
13 C	234.208																	dB
13 B	232.496																	dB
13 A	230.784	28	28															dB
12 D	229.072	39	45															dB
12 C	227.360	33	37															dB
12 B	225.648	40	46															dB
12 A	223.936	38	44	24	24													dB
11 D	222.064			39	45													dB
11 C	220.352			33	37													dB
11 B	218.640			40	46													dB
11 A	216.928			38	44	24	24											dB
10 D	215.072					39	45											dB
10 C	213.360					33	37											dB
10 B	211.648					40	46											dB
10 A	209.936					38	44	24	24									dB
9 D	208.064							39	45									dB
9 C	206.352							33	37									dB
9 B	204.640							40	46									dB
9 A	202.928							38	44	24	24							dB
8 D	201.072									39	45							dB
8 C	199.360									33	37							dB
8 B	197.648									40	46							dB
8 A	195.936									38	44	24	24					dB
7 D	194.064											39	45					dB
7 C	192.352											33	37					dB
7 B	190.640											40	46					dB
7 A	188.928											38	44	24	24			dB
6 D	187.072													39	45			dB
6 C	185.360													33	37			dB
6 B	183.648													40	46			dB
6 A	181.936													38	44	24	24	dB
5 D	180.064															39	45	dB
5 C	178.352															33	37	dB
5 B	176.640															40	46	dB
5 A	174.928															38	44	dB

FM sound carrier is +5.5 MHz and -13 dB relative to vision carrier.
NICAM sound carrier is +5.85 MHz and -20 dB relative to vision carrier.
Minimum field strength to be protected is 55 dBµV/m.

Tableau A7 - 4

D-PAL vision and FM sound interfered with by T-DAB
protection ratio (tropospheric and continuous) **5a**

TV TV-ch. / **DAB** TV-ch. Block	f_{vision} MHz / f_C	R12 223.25 tropo	cont	R11 215.25 tropo	cont	R10 207.25 tropo	cont	R9 199.25 tropo	cont	R8 191.25 tropo	cont	R7 183.25 tropo	cont	R6 175.25 tropo	cont	
13 F	239.200															dB
13 E	237.488															dB
13 D	235.776					FM sound carrier is +6.5 MHz and -10 dB relative to vision carrier.										dB
13 C	234.208					Minimum field strenght to be protected is 55 dBµV/m.										dB
13 B	232.496															dB
13 A	230.784															dB
12 D	229.072	21	29													dB
12 C	227.360	38	45													dB
12 B	225.648	34	41													dB
12 A	223.936	42	49													dB
11 D	222.064	25	34	21	29											dB
11 C	220.352			35	42											dB
11 B	218.640			33	40											dB
11 A	216.928			40	47											dB
10 D	215.072			40	47											dB
10 C	213.360			11	21	21	29									dB
10 B	211.648					38	45									dB
10 A	209.936					33	40									dB
9 D	208.064					42	49									dB
9 C	206.352					31	38	20	28							dB
9 B	204.640							30	37							dB
9 A	202.928							35	42							dB
8 D	201.072							39	46							dB
8 C	199.360							42	49							dB
8 B	197.648							16	26	22	30					dB
8 A	195.936									38	45					dB
7 D	194.064									32	39					dB
7 C	192.352									42	49					dB
7 B	190.640									35	42	4	13			dB
7 A	188.928									1	11	24	32			dB
6 D	187.072											37	44			dB
6 C	185.360											37	44			dB
6 B	183.648											42	49			dB
6 A	181.936											22	31	21	29	dB
5 D	180.064													38	45	dB
5 C	178.352													32	39	dB
5 B	176.640													41	48	dB
5 A	174.928													39	46	dB

Tableau A7 – 5a

D-SECAM vision and FM sound interfered with by T-DAB protection ratio (tropospheric and continuous)																5b
TV TV-ch.		R12		R11		R10		R9		R8		R7		R6		
DAB f_{vision}	MHz	223.25		215.25		207.25		199.25		191.25		183.25		175.25		
TV-ch. Block	f_C	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	
13 F	239.200															dB
13 E	237.488															dB
13 D	235.776					FM sound carrier is +6.5 MHz and -10 dB relative to vision carrier.										dB
13 C	234.208					Minimum field strength to be protected is 55 dBµV/m.										dB
13 B	232.496															dB
13 A	230.784															dB
12 D	229.072	21	29													dB
12 C	227.360	38	45													dB
12 B	225.648	34	41													dB
12 A	223.936	42	49													dB
11 D	222.064	25	34	21	29											dB
11 C	220.352			35	42											dB
11 B	218.640			33	40											dB
11 A	216.928			40	47											dB
10 D	215.072			40	47											dB
10 C	213.360			11	21	21	29									dB
10 B	211.648					38	45									dB
10 A	209.936					33	40									dB
9 D	208.064					42	49									dB
9 C	206.352					31	38	20	28							dB
9 B	204.640							30	37							dB
9 A	202.928							35	42							dB
8 D	201.072							39	46							dB
8 C	199.360							42	49							dB
8 B	197.648							16	26	22	30					dB
8 A	195.936									38	45					dB
7 D	194.064									32	39					dB
7 C	192.352									42	49					dB
7 B	190.640									35	42	4	13			dB
7 A	188.928									1	11	24	32			dB
6 D	187.072											37	44			dB
6 C	185.360											37	44			dB
6 B	183.648											42	49			dB
6 A	181.936											22	31	21	29	dB
5 D	180.064													38	45	dB
5 C	178.352													32	39	dB
5 B	176.640													41	48	dB
5 A	174.928													39	46	dB

Tableau A7 – 5b

I-PAL vision, FM sound and Nicam sound interfered with by T-DAB protection ratio (tropospheric and continuous)																	7
TV TV-ch.		IK		IJ		IH		IG		IF		IE		ID			
DAB f_{vision}	MHz	223.25		215.25		207.25		199.25		191.25		183.25		175.25			
TV-ch. Block	f_C	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont		
13 F	239.200															dB	
13 E	237.488															dB	
13 D	235.776					FM sound carrier is +6.0 MHz and -10 dB relative to vision carrier.										dB	
13 C	234.208					NICAM sound carrier is +6.55 MHz and - 20 dB relative to vision carrier.										dB	
13 B	232.496					Minimum field strength to be protected is 55 dBµV/m.										dB	
13 A	230.784	20	20													dB	
12 D	229.072	28	30													dB	
12 C	227.360	39	45													dB	
12 B	225.648	39	43													dB	
12 A	223.936	42	48													dB	
11 D	222.064	28	33	31	31											dB	
11 C	220.352			36	40											dB	
11 B	218.640			38	43											dB	
11 A	216.928			41	46											dB	
10 D	215.072			38	45	3	3									dB	
10 C	213.360			8	14	31	31									dB	
10 B	211.648					39	44									dB	
10 A	209.936					38	43									dB	
9 D	208.064					42	48									dB	
9 C	206.352					33	39	31	31							dB	
9 B	204.640							30	35							dB	
9 A	202.928							39	44							dB	
8 D	201.072							40	45							dB	
8 C	199.360							40	47							dB	
8 B	197.648							17	22	31	31					dB	
8 A	195.936									38	43					dB	
7 D	194.064									38	42					dB	
7 C	192.352									43	48					dB	
7 B	190.640									35	41	24	24			dB	
7 A	188.928									1	7	26	29			dB	
6 D	187.072											39	45			dB	
6 C	185.360											39	44			dB	
6 B	183.648											41	47			dB	
6 A	181.936											25	30	31	31	dB	
5 D	180.064													38	43	dB	
5 C	178.352													38	42	dB	
5 B	176.640													42	47	dB	
5 A	174.928													37	44	dB	

Tableau A7 - 7

L-SECAM vision, AM sound and Nicam sound interfered with by T-DAB protection ratio (tropospheric and continuous)														8
TV TV-ch.		L10		L9		L8		L7		L6		L5		
DAB f_{vision}	MHz	216.00		208.00		200.00		192.00		184.00		176.00		
TV-ch. block	f_C	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	tropo	cont	
13 F	239.200													dB
13 E	237.488													dB
13 D	235.776			AM sound carrier is +6.5 MHz and -10 dB relative to vision carrier.										dB
13 C	234.208			NICAM sound carrier is +5.85 MHz and -27 dB relative to vision carrier.										dB
13 B	232.496			Minimum field strength to be protected is 55 dBµV/m.										dB
13 A	230.784													dB
12 D	229.072													dB
12 C	227.360													dB
12 B	225.648													dB
12 A	223.936													dB
11 D	222.064	42	50											dB
11 C	220.352	34	38											dB
11 B	218.640	33	37											dB
11 A	216.928	39	44											dB
10 D	215.072	29	33	42	50									dB
10 C	213.360			32	35									dB
10 B	211.648			33	37									dB
10 A	209.936			35	39									dB
9 D	208.064			38	42									dB
9 C	206.352			14	20	42	50							dB
9 B	204.640					33	37							dB
9 A	202.928					32	36							dB
8 D	201.072					39	44							dB
8 C	199.360					32	36	35	43					dB
8 B	197.648					1	8	38	43					dB
8 A	195.936							34	38					dB
7 D	194.064							35	39					dB
7 C	192.352							38	43					dB
7 B	190.640							20	25	42	50			dB
7 A	188.928									33	37			dB
6 D	187.072									32	36			dB
6 C	185.360									38	42			dB
6 B	183.648									34	38	16	24	dB
6 A	181.936									5	12	42	50	dB
5 D	180.064											34	38	dB
5 C	178.352											34	38	dB
5 B	176.640											39	43	dB
5 A	174.928											26	31	dB

Tableau A7 - 8

Protection ratios for DVB-T interfered with by T-DAB

1. General

When DVB-T is interfered with by T-DAB three aspects should be borne in mind:

1. The protection ratio is a power ratio between the wanted DVB-T signal and the unwanted T-DAB signal and that these two signals have different bandwidths. Four T-DAB frequency blocks are accommodated within a 7 MHz television channel.

2. The bandwidth of the T-DAB signal is 1.536 MHz which is significantly less than that of the DVB-T signal. Therefore only a (smaller) part of the carriers of the DVB-T signal is affected by interference from a single T-DAB signal.

   In the special case where four contiguous T-DAB frequency blocks, all using frequencies within the same television channel and all providing the same field strength, interferes with a DVB-T signal, using the same channel, the situation becomes comparable to the case of co-channel interference between two DVB-T signals.

3. In the “Real World” it is unlikely that a DVB-T signal will be interfered with by only one T-DAB signal. It is more likely that a DVB-T signal will be interfered with by more than one T-DAB signal. Although possible, it is not expected to the typical case that all four T-DAB blocks of a given television channel are used to serve the same coverage area and thereby all cause equal interference to a given co-channel DVB-T coverage area.

   A more realistic situation is supposed to be where all four T-DAB frequency blocks cause co-channel interference to a DVB-T service in such a way that, say two T-DAB signals dominate the interference in any part of the DVB-T coverage area while the other two T-DAB signals provide lower levels of interference.

2. Co-channel interference

Measurements in Sweden have shown that there is a non-linear relation between the protection ratios needed for the DVB-T signal as a function of the number of interfering T-DAB blocks (out of four) if the DVB-T signal uses a low code rate like 1/2, i.e. a robust mode. For a high code rate like 7/8, i.e. a less robust DVB-T mode, the protection ratio increases more proportionally for each additional interfering T-DAB block. The reason for this is that in the case of a low code rate and only a single T-DAB interferer the forward error correction in the DVB-T signal can correct most of the errors caused by the interfering T-DAB signal.

Measurements of protection ratios for DVB-T interfered with by a single T-DAB signal have also been carried out in Germany.

All protection ratios presented in this annex have been measured for a Gauss channel and the subjective failure point has been used as criterion to determine the value. The subjective failure point is defined as the point where visible error occurs at average intervals of 20 seconds.

Several types of DVB-T receivers have been measured and, in particular for a single T-DAB interferer, significant differences between the protection ratios needed have been observed. The protection ratios presented here have been derived as pessimistic compromise values between the results available. They are, however, all characterised as being lower than the values given in Rec. ITU-R BT.1368-2.

DVB-T modulation	Code rate	Protection ratio (dB)			
		Number of equal interfering T-DAB signals			
		1	2	3	4
QPSK	1/2	2	6	8	10
	2/3	3	7	10	12
	3/4	7	10	12	13
16 QAM	1/2	3	9	13	16
	2/3	4	10	15	18
	3/4	13	17	19	20
64 QAM	1/2	3	12	18	21
	2/3	10	18	22	24
	3/4	18	22	24	25
	7/8	24	27	29	30

Note: The protection ratios for cases with more than one interfering T-DAB signal are the power ratios between the DVB-T signal and a single T-DAB signal.

Table A8.1: Protection ratios for 8 MHz DVB-T interfered with by T-DAB

Protection ratios for 7 MHz DVB-T interfered with by T-DAB are assumed to be about 0.5 dB lower than the values given in Table A8.1 and Figure 8.1.

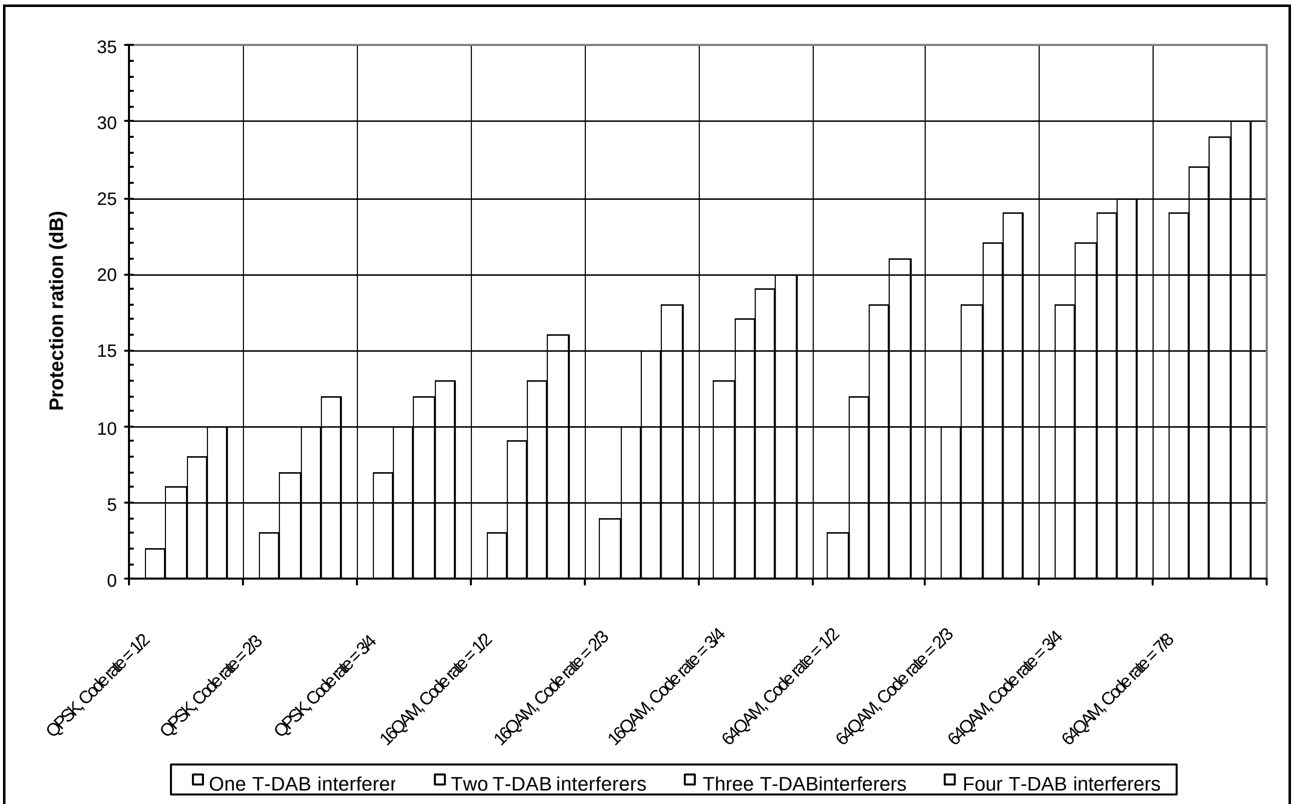


Figure A8.1: Graphical presentation of the protection ratios for 8 MHz DVB-T interfered with by one or more T-DAB signals as given in Table A8.1

3. Overlapping channel interference

The protection ratio for DVB-T interfered with by a single T-DAB signal as a function of the difference Δf between the centre frequencies of the two signals are given in Table A8.2 and Figure A8.2 for a Gauss channel.

The values are given for a 2K, 16QAM, 8 MHz DVB-T signal using a code rate of 2/3. It is assumed that these protection ratios are also valid for the corresponding 8K variant.

The spectrum mask for the interfering T-DAB signal becomes important when the difference between the centre frequencies exceeds the half of the sum of the effective bandwidth of the two signals.

	Protection ratio (dB)												
Centre frequency difference Δf (MHz)	-4.2	-4.0	-3.8	-3.0	-2.0	-1.0	0	1.0	2.0	3.0	3.8	4.0	4.2
Protection ratio (dB)	-11	-9	-5	4	4	4	4	4	4	4	-5	-9	-11

Table A8.2: Protection ratio for 16QAM, code rate 2/3, 8 MHz DVB-T as a function of the difference Δf between the centre frequencies of the wanted DVB-T signal and the interfering T-DAB signal in a Gauss channel

Figure A8.2: Protection ratio for 16QAM, code rate 2/3, 8 MHz DVB-T as a function of the difference Δf between the centre frequencies of the wanted DVB-T signal and the interfering T-DAB signal in a Gauss channel

The protection ratios for 7 MHz DVB-T interfered with by T-DAB have been derived from the values given for 8 MHz DVB-T in Table A8.2.

	Protection ratio (dB)												
Centre frequency difference Δf (MHz)	-3.7	-3.5	-3.3	-3.0	-2.0	-1.0	0	1.0	2.0	3.0	3.3	3.5	3.7
Protection ratio (dB)	-11	-9	-5	4	4	4	4	4	4	4	-5	-9	-11

Note: Protection ratios for 7 MHz DVB-T interfered with by T-DAB are assumed to be about 0.5 dB lower than the values given in Table A8.2 for 8 MHz DVB-T.

Table A8.3: Protection ratio for 16QAM, code rate 2/3, 7 MHz DVB-T as a function of the difference Δf between the centre frequencies of the wanted DVB-T signal and the interfering T-DAB signal in a Gauss channel

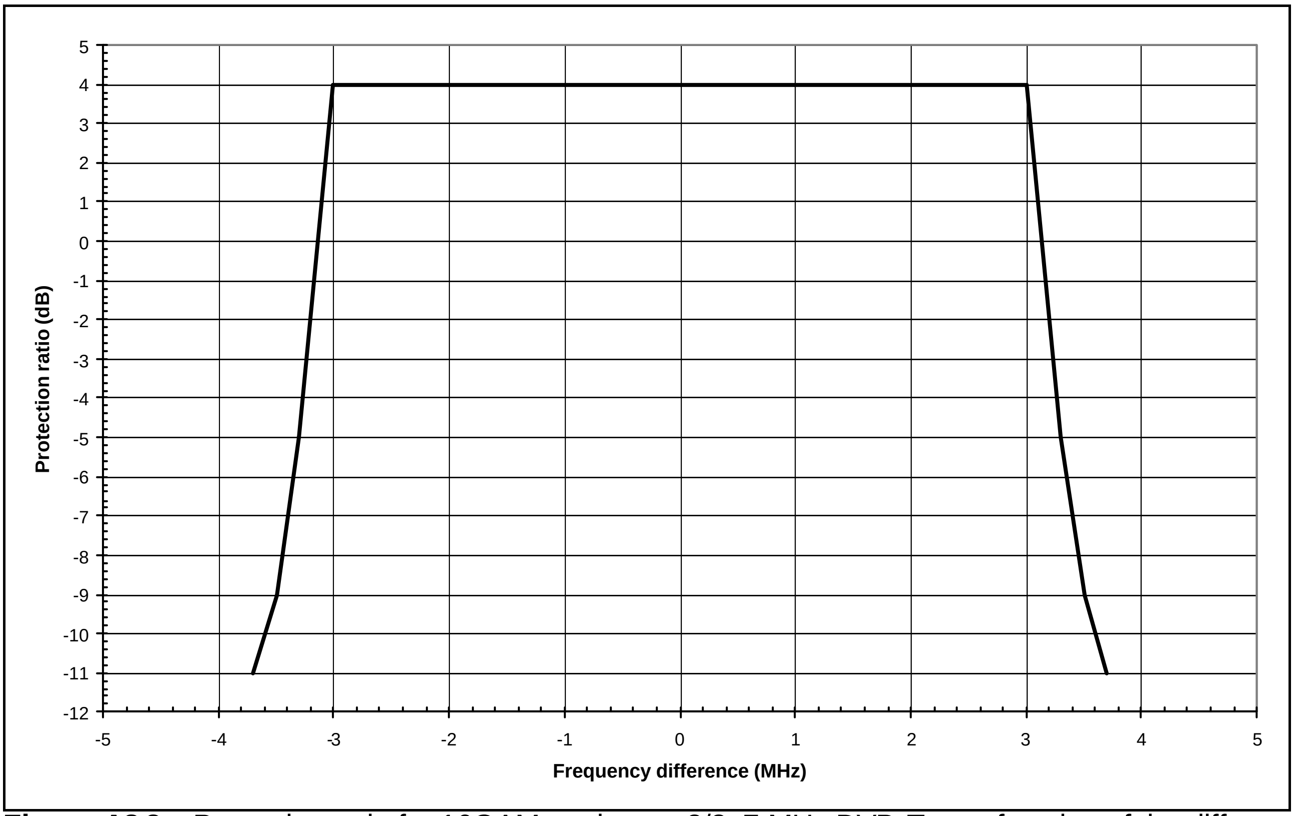


Figure A8.3: Protection ratio for 16QAM, code rate 2/3, 7 MHz DVB-T as a function of the difference Δf between the centre frequencies of the wanted DVB-T signal and the interfering T-DAB signal in a Gauss channel

Protection ratios for T-DAB interfered with by analogue television and VHF/FM Sound Broadcasting

1. General

Protection ratios for various television systems are presented in the form of curves as well as tables.

In the Figures the "Frequency difference between vision carrier of unwanted signal and centre frequency of T-DAB" is defined as: $f_{vision} - f_{c\ T\text{-}DAB}$

As the derivation of the protection ratios in Band III is rather difficult because of the overlapping channels and different standards the protection ratios for all possible frequency blocks in Band III are given in separate tableaux at the end of this annex.

2. Protection ratios

The following protection ratios for T-DAB, when interfered with by Television or FM Sound Broadcasting, can be found in this Annex:

I/PAL/NICAM:	Figure A9-1,	Table A9-1,	Tableau A9-1
B/PAL/A2, two FM-sound carriers:	Figure A9-2,	Table A9-2,	Tableau A9-2a
B/PAL/NICAM:			Tableau A9-2b
B/SECAM/A2, two FM-sound carriers:			Tableau A9-2c
D/SECAM, single FM-sound -7 dB:	Figure A9-3a,	Table A9-3,	Tableau A9-3a
D/PAL, single FM-sound -7 dB:	Figure A9-3b,	Table A9-3,	Tableau A9-3b
L/SECAM:	Figure A9-4,	Table A9-4,	Tableau A9-4
FM Sound Broadcasting:	Figure A9-5,	Table A9-5	

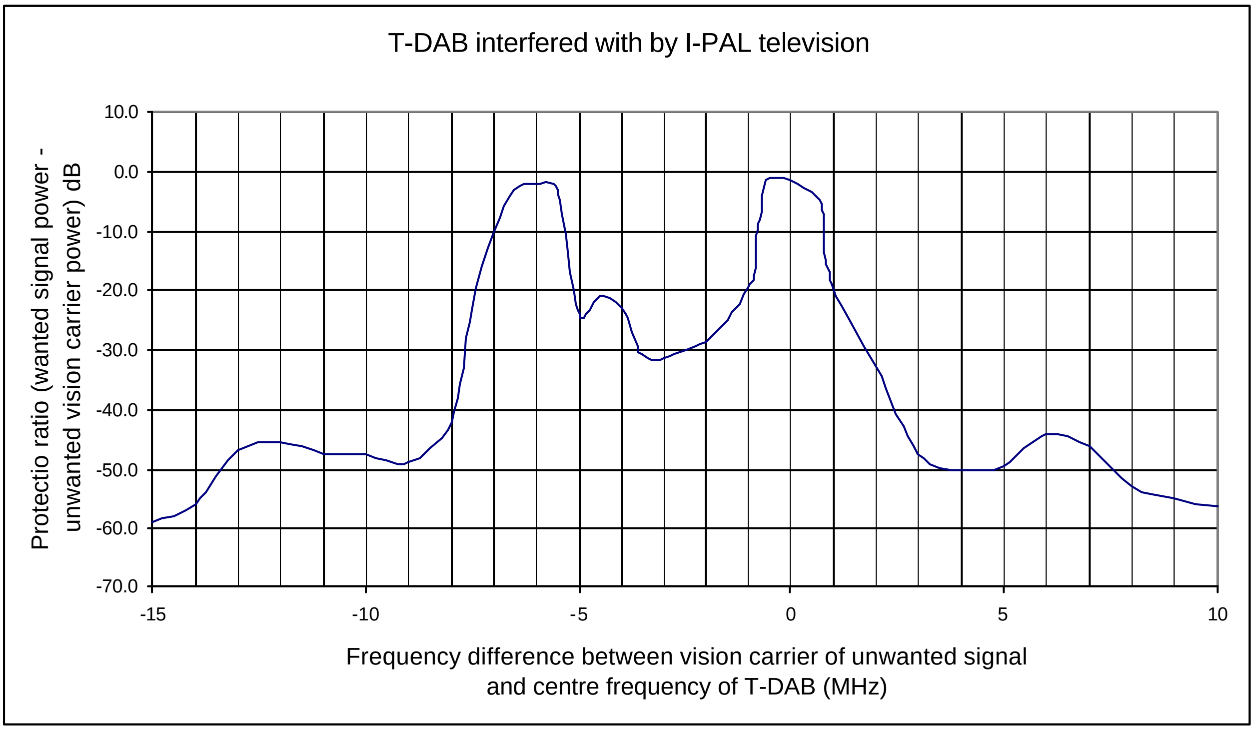


Figure A9 - 1

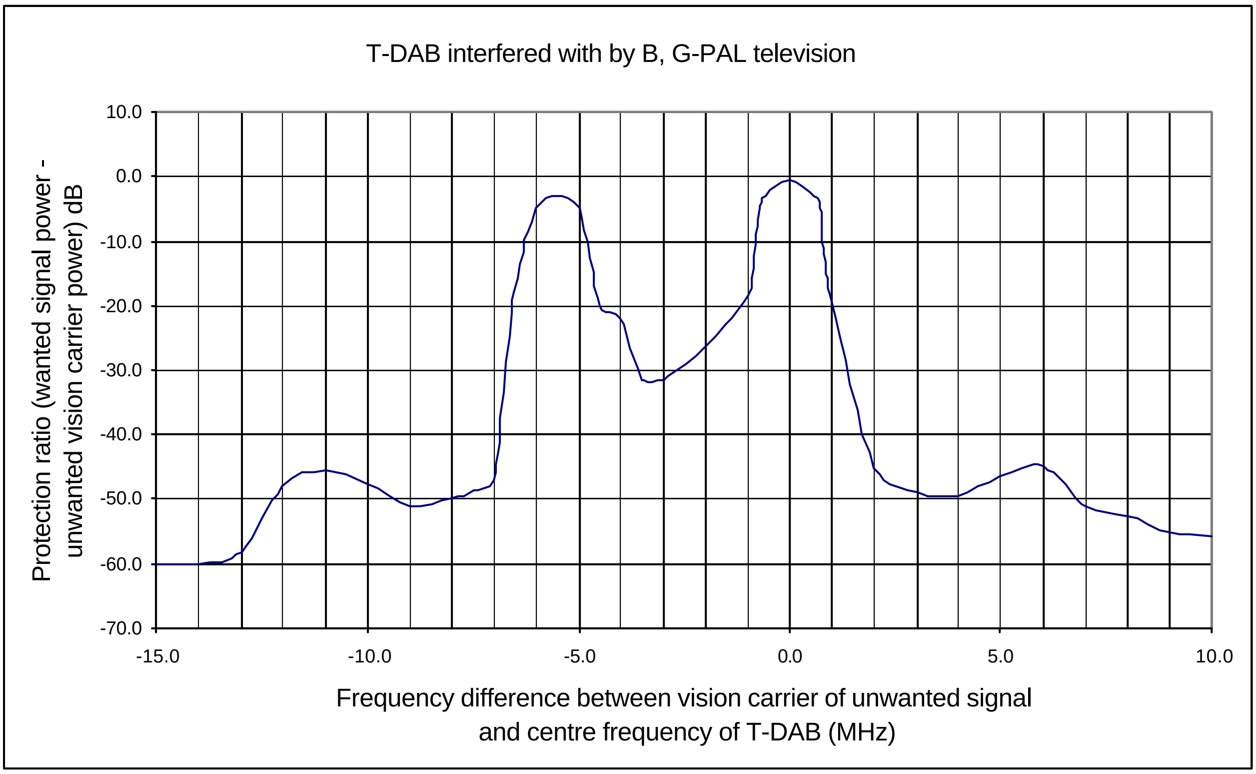


Figure A9 - 2

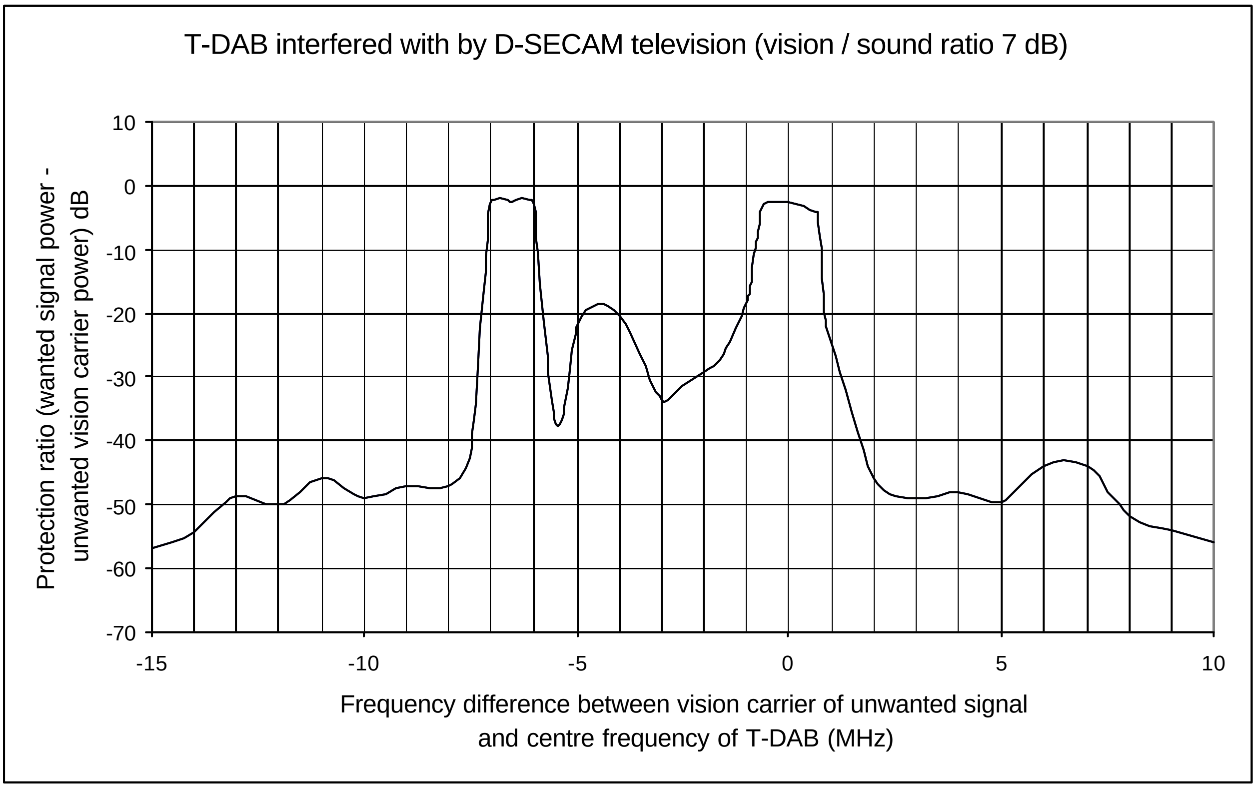


Figure A9 - 3a

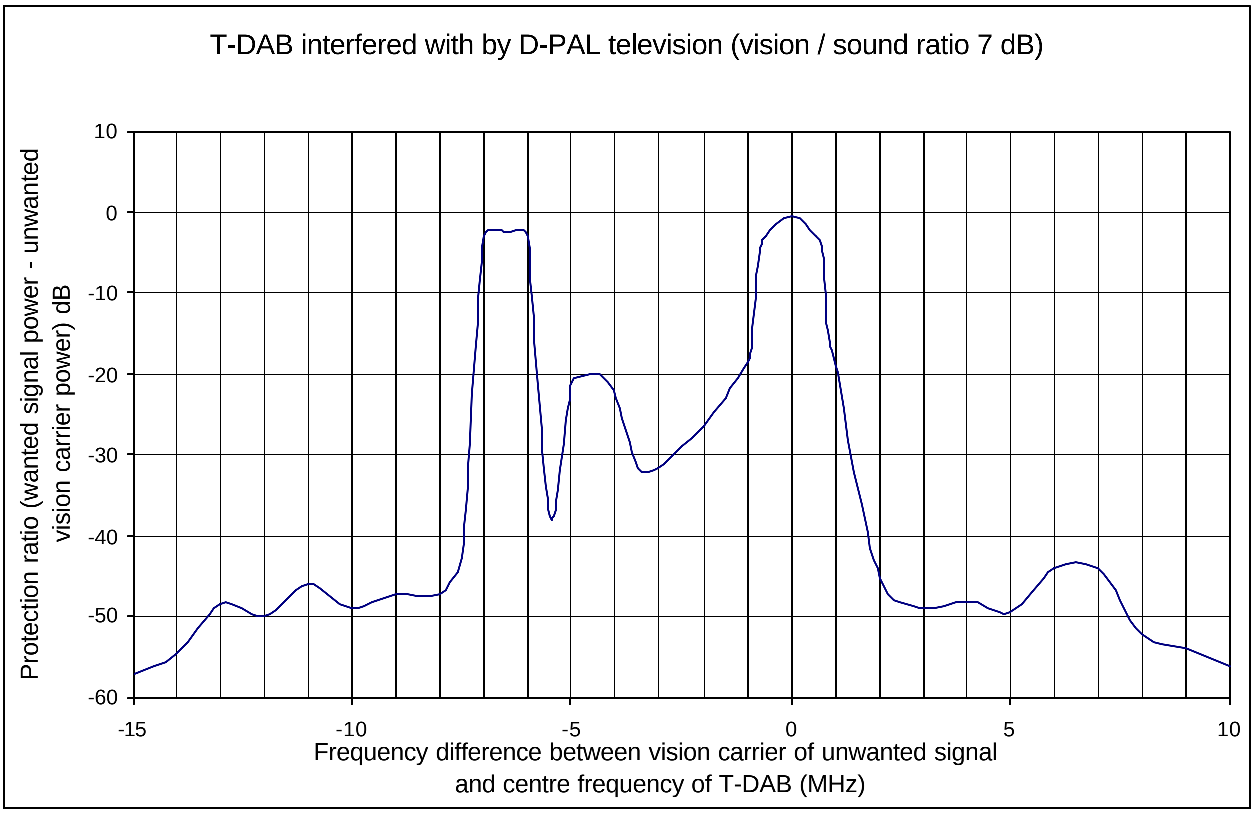


Figure A9 – 3b

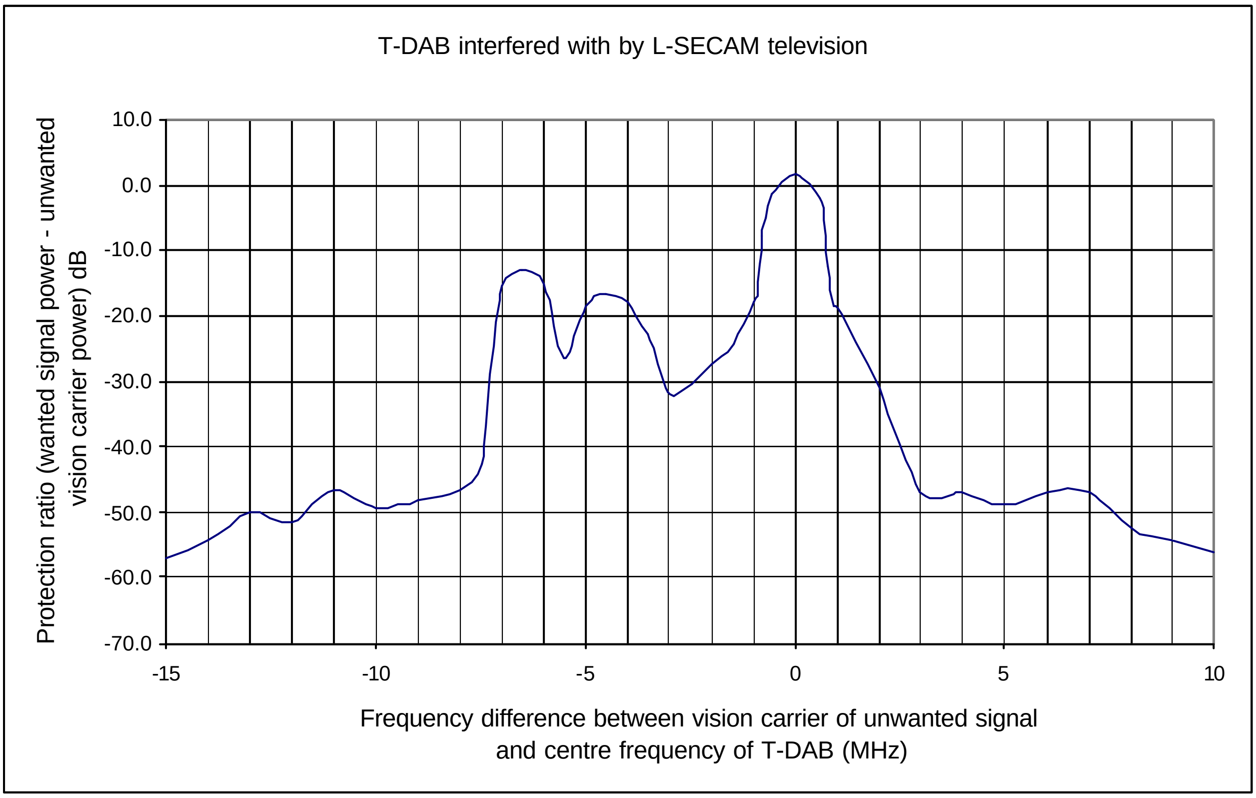


Figure A9 – 4

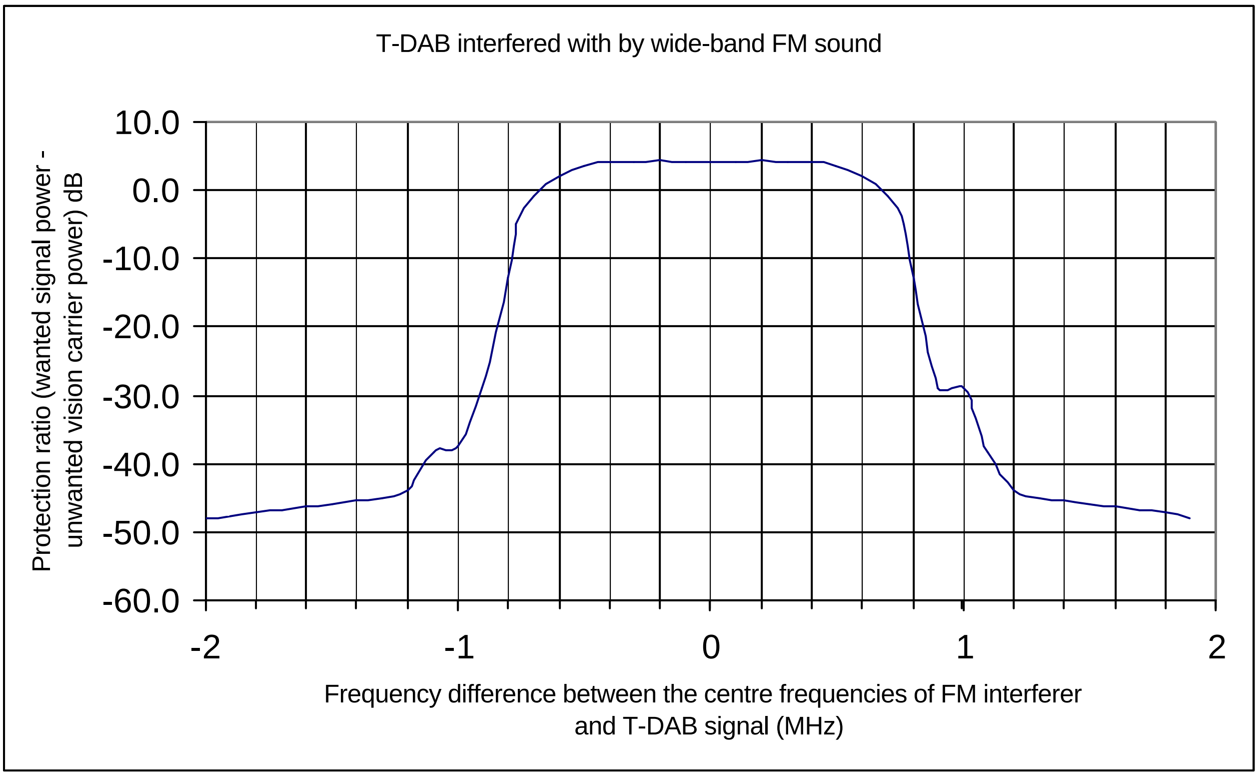


Figure A9 - 5

T-DAB interfered with by I-PAL	
Frequency Difference (Vision - DAB) (MHz)	Protection Ratio (dB)
-15	-59.0
-14.0	-56.0
-13.0	-47.0
-12.0	-45.5
-11.0	-47.5
-10.0	-47.5
-9.0	-49.0
-8.0	-42.0
-7.5	-23.5
-7.0	-10.0
-6.5	-3.0
-6.0	-2.0
-5.5	-3.0
-5.0	-24.0
-4.5	-21.0
-4.0	-23.0
-3.5	-31.0
-3.0	-31.5
-2.5	-30.0
-2.0	-28.5
-1.5	-25.0
-1.0	-19.5
-0.9	-17.5
-0.8	-11.0
-0.7	-7.0
-0.6	-1.5
0.0	-1.5
0.6	-4.0
0.7	-5.5
0.8	-13.5
0.9	-17.0
1.0	-20.0
2.0	-33.0
3.0	-47.5
4.0	-50.5
5.0	-49.5
6.0	-44.5
7.0	-46.5
8.0	-53.0
9.0	-55.0
10.0	-56.5

Table A9 – 1

T-DAB interfered with by B-PAL	
Frequency Difference (Vision - DAB) (MHz)	Protection Ratio (dB)
-15.0	-60.0
-14.0	-60.0
-13.0	-58.0
-12.0	-48.0
-11.0	-45.5
-10.0	-47.5
-9.0	-51.0
-8.0	-50.0
-7.5	-48.5
-7.0	-47.0
-6.5	-18.0
-6.0	-5.0
-5.5	-3.0
-5.0	-5.0
-4.5	-20.0
-4.0	-22.0
-3.5	-31.5
-3.0	-31.5
-2.5	-29.0
-2.0	-26.5
-1.5	-23.0
-1.0	-18.5
-0.9	-16.0
-0.8	-9.0
-0.7	-5.0
-0.6	-3.0
0.0	-0.5
0.6	-3.0
0.7	-4.0
0.8	-12.0
0.9	-16.0
1.0	-19.5
2.0	-45.3
3.0	-49.0
4.0	-49.5
5.0	-46.5
6.0	-45.0
7.0	-51.3
8.0	-52.5
9.0	-55.3
10.0	-55.8

Table A9 – 2

T-DAB interfered with by D-SECAM or D-PAL		
Frequency difference (Vision - DAB) (MHz)	Protection ratio (dB)	
	D-SECAM	D-PAL
-15.0	-57.0	-57.0
-14.0	-54.5	-54.5
-13.0	-48.5	-48.5
-12.0	-50.0	-50.0
-11.0	-46.0	-46.0
-10.0	-49.0	-49.0
-9.0	-47.0	-47.0
-8.0	-47.0	-47.0
-7.5	-42.5	-42.5
-7.0	-3.0	-3.0
-6.5	-2.5	-2.5
-6.0	-3.0	-3.0
-5.5	-37.5	-37.5
-5.0	-21.5	-21.5
-4.5	-18.5	-20.0
-4.0	-20.5	-22.0
-3.5	-26.5	-31.5
-3.0	-33.5	-31.5
-2.5	-31.5	-29.0
-2.0	-29.0	-26.5
-1.5	-26.5	-23.0
-1.0	-18.5	-18.5
-0.9	-16.5	-16.0
-0.8	-9.0	-9.0
-0.7	-6.0	-5.0
-0.6	-3.0	-3.0
0	-2.5	-0.5
0.6	-4.0	-3.0
0.7	-4.5	-4.0
0.8	-12.0	-12.0
0.9	-22.0	-16.0
1.0	-25.0	-19.0
2.0	-46.0	-45.3
3.0	-49.0	-49.0
4.0	-48.0	-48.0
5.0	-49.5	-49.5
6.0	-44.0	-44.0
7.0	-44.0	-44.0
8.0	-52.0	-52.0
9.0	-54.0	-54.0
10.0	-56.0	-56.0

Table A9 – 3

T-DAB interfered with by L-SECAM	
Freq Difference (Vision - DAB) (MHz)	Protection ratios (dB)
-15	-57.0
-14.0	-54.4
-13.0	-50.0
-12.0	-51.5
-11.0	-46.5
-10.0	-49.5
-9.0	-48.0
-8.0	-46.5
-7.5	-42.5
-7.0	-15.5
-6.5	-13.0
-6.0	-15.0
-5.5	-26.5
-5.0	-18.5
-4.5	-17.0
-4.0	-18.0
-3.5	-23.0
-3.0	-31.5
-2.5	-30.5
-2.0	-27.5
-1.5	-24.5
-1.0	-18.0
-0.9	-16.5
-0.8	-8.0
-0.7	-5.0
-0.6	-1.5
0.0	1.5
0.6	-2.0
0.7	-3.5
0.8	-12.5
0.9	-18.5
1.0	-19.0
2.0	-31.0
3.0	-46.8
4.0	-47.0
5.0	-49.0
6.0	-47.0
7.0	-47.0
8.0	-52.5
9.0	-54.5
10.0	-56.0

Table A9 – 4

T-DAB interfered with by wide-band FM sound	
Freq Difference (FM Sound - DAB) (MHz)	Protection ratios (dB)
-2	-48.0
-1.9	-47.9
-1.8	-47.1
-1.7	-46.7
-1.6	-46.4
-1.5	-46.0
-1.4	-45.4
-1.3	-45.1
-1.2	-43.9
-1.1	-38.4
-1.0	-37.4
-0.9	-28.9
-0.8	-12.9
-0.8	-4.9
-0.7	-1.0
-0.6	2.1
-0.5	3.5
-0.4	4.3
-0.3	4.1
-0.2	4.4
-0.1	4.1
0.0	4.0
0.1	4.1
0.2	4.4
0.3	4.1
0.4	4.3
0.5	3.5
0.6	2.1
0.7	-1.0
0.77	-4.9
0.8	-12.9
0.9	-28.9
1.0	-28.9
1.1	-38.4
1.2	-43.9
1.3	-45.1
1.4	-45.4
1.5	-46.0
1.6	-46.4
1.7	-46.7
1.8	-47.1
1.9	-48.0

Table A9 – 5

T-DAB interfered with by I-PAL vision and FM sound carrier
protection ratio (continuous and tropospheric) 1

TV / DAB TV-ch. block	TV-ch. f_{vision} MHz / f_C	IK 223.25	IJ 215.25	IH 207.25	IG 199.25	IF 191.25	IE 183.25	ID 175.25	
13 F	239.200								dB
13 E	237.488								dB
13 D	235.776		FM sound carrier is +6.0 MHz and -10 dB relative to vision carrier.						dB
13 C	234.208		NICAM sound carrier is +6.55 MHz and - 20 dB relative to vision carrier.						dB
13 B	232.496								dB
13 A	230.784	-25							dB
12 D	229.072	-2							dB
12 C	227.360	-23							dB
12 B	225.648	-30							dB
12 A	223.936	-6							dB
11 D	222.064	-22	-7						dB
11 C	220.352	-46	-20						dB
11 B	218.640		-31						dB
11 A	216.928		-26						dB
10 D	215.072		-2	-35					dB
10 C	213.360		-32	-2					dB
10 B	211.648			-21					dB
10 A	209.936			-31					dB
9 D	208.064			-12					dB
9 C	206.352			-17	-13				dB
9 B	204.640			-42	-8				dB
9 A	202.928				-28				dB
8 D	201.072				-27				dB
8 C	199.360				-2				dB
8 B	197.648				-28	-3			dB
8 A	195.936					-22			dB
7 D	194.064					-31			dB
7 C	192.352					-21			dB
7 B	190.640					-4	-21		dB
7 A	188.928					-38	-3		dB
6 D	187.072						-26		dB
6 C	185.360						-29		dB
6 B	183.648						-2		dB
6 A	181.936						-24	-6	dB
5 D	180.064							-23	dB
5 C	178.352							-31	dB
5 B	176.640							-24	dB
5 A	174.928							-3	dB

Tableau A9 – 1

T-DAB interfered with by B-PAL vision and two FM sound carriers
protection ratio (continuous and tropospheric) — **2a**

TV TV-ch.		12	11	10	9	8	7	6	5	
DAB f_{vision}	MHz	224.25	217.25	210.25	203.25	196.25	189.25	182.25	175.25	
TV-ch. block	f_C									
13 F	239.200									dB
13 E	237.488									dB
13 D	235.776			First FM sound carrier is +5.5 MHz and -13 dB relative to vision carrier.						dB
13 C	234.208			Second FM sound carrier is +5.74 MHz and -20 dB relative to vision carrier.						dB
13 B	232.496									dB
13 A	230.784	-20								dB
12 D	229.072	-10								dB
12 C	227.360	-32								dB
12 B	225.648	-22								dB
12 A	223.936	-2	-29							dB
11 D	222.064		-11							dB
11 C	220.352		-32							dB
11 B	218.640		-22							dB
11 A	216.928		-2	-28						dB
10 D	215.072			-10						dB
10 C	213.360			-32						dB
10 B	211.648			-22						dB
10 A	209.936			-2	-29					dB
9 D	208.064				-11					dB
9 C	206.352				-32					dB
9 B	204.640				-22					dB
9 A	202.928				-2	-28				dB
8 D	201.072					-10				dB
8 C	199.360					-32				dB
8 B	197.648					-22				dB
8 A	195.936					-2	-29			dB
7 D	194.064						-11			dB
7 C	192.352						-32			dB
7 B	190.640						-22			dB
7 A	188.928						-2	-28		dB
6 D	187.072							-10		dB
6 C	185.360							-32		dB
6 B	183.648							-22		dB
6 A	181.936							-2	-29	dB
5 D	180.064								-11	dB
5 C	178.352								-32	dB
5 B	176.640								-22	dB
5 A	174.928								-2	dB

Tableau A9 – 2a

T-DAB interfered with by B-PAL vision, FM sound and Nicam sound protection ratio (continuous and tropospheric) **2b**

TV TV-ch. / **DAB** f_{vision}	MHz	12	11	10	9	8	7	6	5	
		224.25	217.25	210.25	203.25	196.25	189.25	182.25	175.25	
TV-ch. block	f_C									
13 F	239.200									dB
13 E	237.488									dB
13 D	235.776			FM sound carrier is +5.5 MHz and -13 dB relative to vision carrier.						dB
13 C	234.208			NICAM sound carrier is +5.85 MHz and -20 dB relative to vision carrier.						dB
13 B	232.496									dB
13 A	230.784	-20								dB
12 D	229.072	-10								dB
12 C	227.360	-32								dB
12 B	225.648	-22								dB
12 A	223.936	-2	-29							dB
11 D	222.064		-11							dB
11 C	220.352		-32							dB
11 B	218.640		-22							dB
11 A	216.928		-2	-28						dB
10 D	215.072			-10						dB
10 C	213.360			-32						dB
10 B	211.648			-22						dB
10 A	209.936			-2	-29					dB
9 D	208.064				-11					dB
9 C	206.352				-32					dB
9 B	204.640				-22					dB
9 A	202.928				-2	-28				dB
8 D	201.072					-10				dB
8 C	199.360					-32				dB
8 B	197.648					-22				dB
8 A	195.936					-2	-29			dB
7 D	194.064						-11			dB
7 C	192.352						-32			dB
7 B	190.640						-22			dB
7 A	188.928						-2	-28		dB
6 D	187.072							-10		dB
6 C	185.360							-32		dB
6 B	183.648							-22		dB
6 A	181.936							-2	-29	dB
5 D	180.064								-11	dB
5 C	178.352								-32	dB
5 B	176.640								-22	dB
5 A	174.928								-2	dB

Tableau A9 – 2b

T-DAB interfered with by B-SECAM vision and two FM sound carriers
protection ratio (continuous and tropospheric), values of B-PAL used (T2) — **2c**

TV / DAB	TV-ch. / f_{vision} MHz	12	11	10	9	8	7	6	5	
TV-ch. block	f_C	224.25	217.25	210.25	203.25	196.25	189.25	182.25	175.25	
13 F	239.200									dB
13 E	237.488									dB
13 D	235.776			First FM sound carrier is +5.5 MHz and -13 dB relative to vision carrier.						dB
13 C	234.208			Second FM sound carrier is +5.74 MHz and -20 dB relative to vision carrier.						dB
13 B	232.496									dB
13 A	230.784	-20								dB
12 D	229.072	-10								dB
12 C	227.360	-32								dB
12 B	225.648	-22								dB
12 A	223.936	-2	-29							dB
11 D	222.064		-11							dB
11 C	220.352		-32							dB
11 B	218.640		-22							dB
11 A	216.928		-2	-28						dB
10 D	215.072			-10						dB
10 C	213.360			-32						dB
10 B	211.648			-22						dB
10 A	209.936			-2	-29					dB
9 D	208.064				-11					dB
9 C	206.352				-32					dB
9 B	204.640				-22					dB
9 A	202.928				-2	-28				dB
8 D	201.072					-10				dB
8 C	199.360					-32				dB
8 B	197.648					-22				dB
8 A	195.936					-2	-29			dB
7 D	194.064						-11			dB
7 C	192.352						-32			dB
7 B	190.640						-22			dB
7 A	188.928						-2	-28		dB
6 D	187.072							-10		dB
6 C	185.360							-32		dB
6 B	183.648							-22		dB
6 A	181.936							-2	-29	dB
5 D	180.064								-11	dB
5 C	178.352								-32	dB
5 B	176.640								-22	dB
5 A	174.928								-2	dB

Tableau A9 – 2c

T-DAB interfered with by D-SECAM vision and FM sound carrier protection ratio (continuous and tropospheric)									3a
TV / **DAB**	TV-ch. / f_{vision} MHz	R12	R11	R10	R9	R8	R7	R6	
		223.25	215.25	207.25	199.25	191.25	183.25	175.25	
TV-ch. block	f_C								
13 F	239.200								dB
13 E	237.488								dB
13 D	235.776		FM sound carrier is +6.5 MHz and -10 dB relative to vision carrier.						dB
13 C	234.208								dB
13 B	232.496								dB
13 A	230.784	-43							dB
12 D	229.072	-15							dB
12 C	227.360	-20							dB
12 B	225.648	-31							dB
12 A	223.936	-6							dB
11 D	222.064	-29	-3						dB
11 C	220.352		-25						dB
11 B	218.640		-28						dB
11 A	216.928		-27						dB
10 D	215.072		-3	-45					dB
10 C	213.360		-44	-3					dB
10 B	211.648			-19					dB
10 A	209.936			-32					dB
9 D	208.064			-10					dB
9 C	206.352			-22	-11				dB
9 B	204.640				-34				dB
9 A	202.928				-24				dB
8 D	201.072				-28				dB
8 C	199.360				-3				dB
8 B	197.648				-38	-3			dB
8 A	195.936					-20			dB
7 D	194.064					-33			dB
7 C	192.352					-20			dB
7 B	190.640					-4	-34		dB
7 A	188.928						-25		dB
6 D	187.072						-23		dB
6 C	185.360						-30		dB
6 B	183.648						-3		dB
6 A	181.936						-32	-3	dB
5 D	180.064							-20	dB
5 C	178.352							-32	dB
5 B	176.640							-25	dB
5 A	174.928							-3	dB

Tableau A9 – 3a

T-DAB interfered with by D-PAL vision and FM sound carrier protection ratio (continuous and tropospheric)									3b
TV TV-ch.		R12	R11	R10	R9	R8	R7	R6	
DAB	f_{vision} MHz	223.25	215.25	207.25	199.25	191.25	183.25	175.25	
TV-ch. block	f_C								
13 F	239.200								dB
13 E	237.488		FM sound carrier is +6.5 MHz and -10 dB relative to vision carrier.						dB
13 D	235.776								dB
13 C	234.208								dB
13 B	232.496								dB
13 A	230.784	-43							dB
12 D	229.072	-15							dB
12 C	227.360	-22							dB
12 B	225.648	-28							dB
12 A	223.936	-5							dB
11 D	222.064	-24	-3						dB
11 C	220.352		-25						dB
11 B	218.640		-32						dB
11 A	216.928		-24						dB
10 D	215.072		-1	-45					dB
10 C	213.360		-42	-3					dB
10 B	211.648			-20					dB
10 A	209.936			-30					dB
9 D	208.064			-10					dB
9 C	206.352			-16	-11				dB
9 B	204.640				-34				dB
9 A	202.928				-28				dB
8 D	201.072				-25				dB
8 C	199.360				-1				dB
8 B	197.648				-35	-3			dB
8 A	195.936					-21			dB
7 D	194.064					-31			dB
7 C	192.352					-19			dB
7 B	190.640					-3	-34		dB
7 A	188.928						-25		dB
6 D	187.072						-25		dB
6 C	185.360						-27		dB
6 B	183.648						-2		dB
6 A	181.936						-27	-3	dB
5 D	180.064							-21	dB
5 C	178.352							-32	dB
5 B	176.640							-22	dB
5 A	174.928							-2	dB

Tableau A9 – 3b

T-DAB interfered with by L-SECAM vision and AM sound carrier protection ratio (continuous and tropospheric)								**4**
TV / **DAB**	TV-ch. f_{vision} MHz	L10 216.00	L9 208.00	L8 200.00	L7 192.00	L6 184.00	L5 176.00	
TV-ch. block	f_C							
13 F	239.200							dB
13 E	237.488							dB
13 D	235.776		AM sound carrier is +6.5 MHz and -10 dB relative to vision carrier.					dB
13 C	234.208		NICAM sound carrier is +5.85 MHz and -27 dB relative to vision carrier.					dB
13 B	232.496							dB
13 A	230.784							dB
12 D	229.072							dB
12 C	227.360							dB
12 B	225.648							dB
12 A	223.936	-46						dB
11 D	222.064	-15						dB
11 C	220.352	-17						dB
11 B	218.640	-31						dB
11 A	216.928	-17						dB
10 D	215.072	-19	-19					dB
10 C	213.360	-41	-24					dB
10 B	211.648		-22					dB
10 A	209.936		-27					dB
9 D	208.064		1					dB
9 C	206.352		-27	-14				dB
9 B	204.640			-17				dB
9 A	202.928			-31				dB
8 D	201.072			-19				dB
8 C	199.360			-3	-35			dB
8 B	197.648			-37	-23			dB
8 A	195.936				-19			dB
7 D	194.064				-28			dB
7 C	192.352				0			dB
7 B	190.640				-23	-14		dB
7 A	188.928					-18		dB
6 D	187.072					-30		dB
6 C	185.360					-23		dB
6 B	183.648					-1	-44	dB
6 A	181.936					-32	-16	dB
5 D	180.064						-18	dB
5 C	178.352						-30	dB
5 B	176.640						-3	dB
5 A	174.928						-20	dB

Tableau A9 – 4

Protection ratios for T-DAB interfered with by DVB-T

General

Protection ratios for T-DAB interfered with by DVB-T are given in Rec. ITU-R BT.1368. They are valid for the cases where the DVB-T signal has a bandwidth of 8 MHz (7.61 MHz effectivel bandwidth) and 7 MHz (6.71 MHz effective bandwidth) respectively.

Based on the assumption that, seen from an interference point of view, the only difference between a 6 MHz DVB-T signal and an 8 MHz DVB-T signal is the bandwidth over which the DVB-T power is distributed the corresponding protection ratios for interference from 6 MHz DVB-T have been derived.

The protection ratios given in Rec. ITU-R BT.1368 are assumed to be applicable for the Gauss channel. The protection ratios are given for interference from a 64QAM, Code rate 2/3 DVB-T signal. It is, however, assumed that the modulation scheme used for the interfering DVB-T signal is of no significance to the protection ratio and that the protection ratios consequently apply to all DVB-T variants. It is further assumed that the protection ratios apply to both 2k and 8k DVB-T variants.

In the Tables and Figures the "Frequency difference" is defined as:

$$\Delta f = f_{\text{centre DVB-T}} - f_{\text{centre T-DAB}}$$

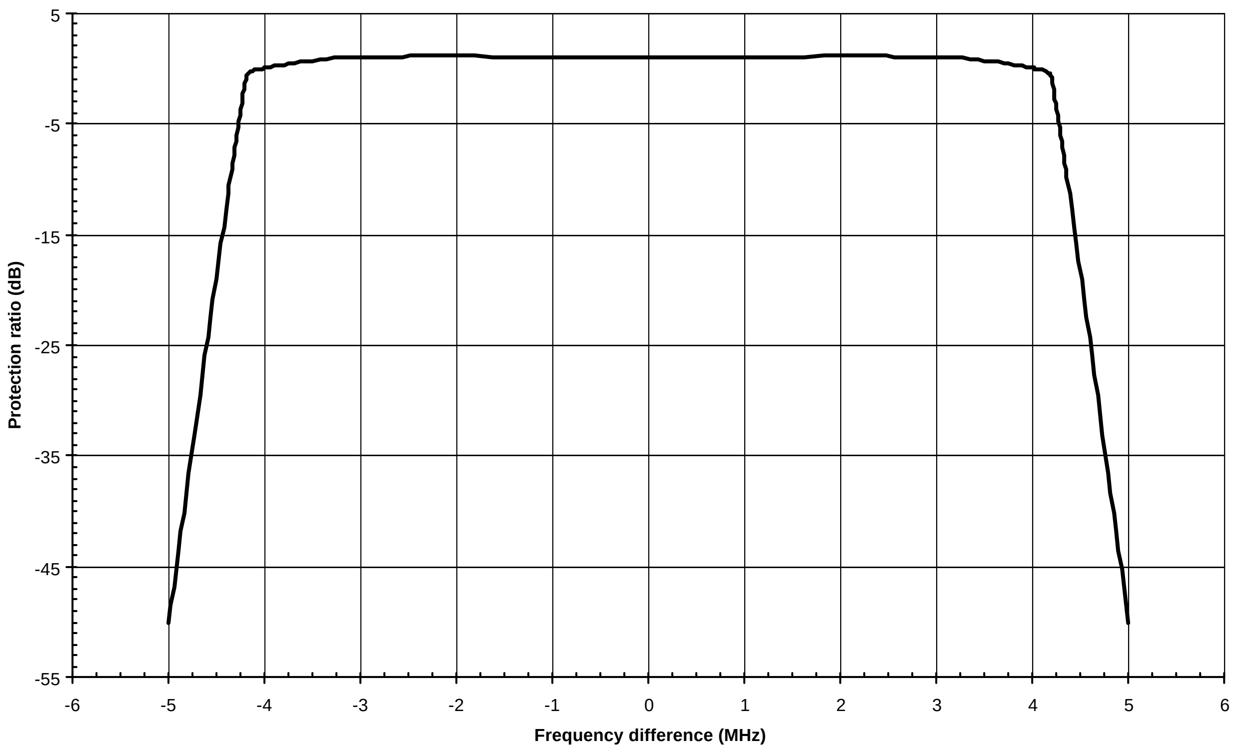


Figure A10.1: Protection ratio for T-DAB interfered with by 8 MHz DVB-T using 64QAM, CR = 2/3

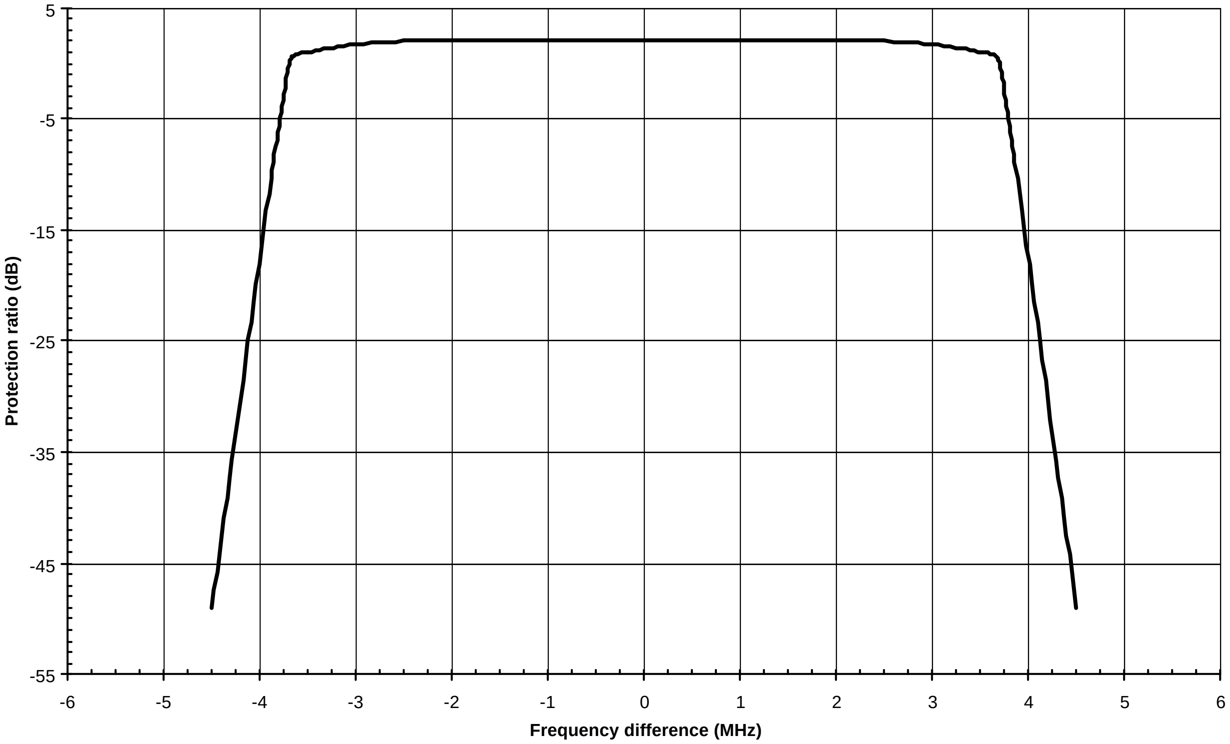


Figure A10.2: Protection ratio for T-DAB interfered with by 7 MHz DVB-T using 64QAM, CR = 2/3

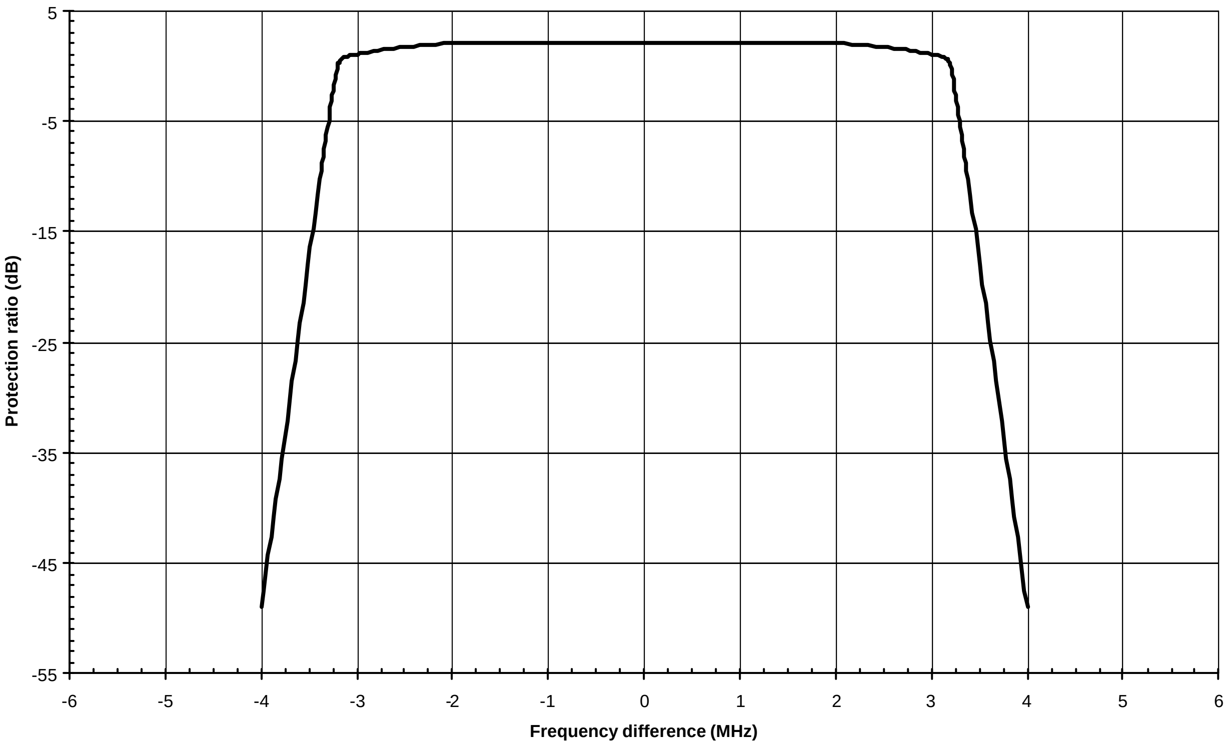


Figure A10.3: Protection ratio for T-DAB interfered with by 6 MHz DVB-T using 64QAM, CR = 2/3

Δf (MHz)	Protection ratio (dB)
-5.0	-50
-4.2	-1
-4.0	0
-3.0	1
0	1
3.0	1
4.0	0
4.2	-1
5.0	-50

Table A10.1: Protection ratios for T-DAB interfered with by 8 MHz DVB-T using 64QAM, CR = 2/3

Δf (MHz)	Protection ratio (dB)
-4.5	-49
-3.7	0
-3.5	1
-2.5	2
0	2
2.5	2
3.5	1
3.7	0
4.5	-49

Table A10.2: Protection ratios for T-DAB interfered with by 7 MHz DVB-T using 64QAM, CR = 2/3

Δf (MHz)	Protection ratio (dB)
-4.0	-49
-3.2	0
-3.0	1
-2.0	2
0	2
2.0	2
3.0	1
3.2	0
4.0	-49

Table A10.3: Protection ratios for T-DAB interfered with by 6 MHz DVB-T using 64QAM, CR = 2/3

Note: The protection ratios for interference from 6 MHz DVB-T seem identical to those for interference from 7 MHz DVB-T. This is due to rounding of decimals. Theoretically the protection ratios for interference from 7 MHz DVB-T are approximately 0.4 dB lower than shown in Table A10.2 whereas the values in Table A10.3 are approximately 0.25 dB higher than shown.