European Radiocommunications Committee (ERC)
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ADJACENT BAND COMPATIBILITY BETWEEN UMTS AND OTHER SERVICES IN THE 2 GHz BAND

Menton, May 1999
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ADJACENT BAND COMPATIBILITY BETWEEN UMTS AND OTHER SERVICES IN THE 2 GHz BAND

1 INTRODUCTION

Decision ERC/DEC/(97)07 designated the frequency bands 1900-1980 MHz, 2010-2025 MHz and 2110-2170 MHz to terrestrial UMTS applications. It decided to accommodate UMTS satellite component applications within the bands 1980-2010 MHz and 2170-2200 MHz. The frequency bands identified in ERC/DEC/(97)07 have co-primary allocations for fixed service. Co-channel (but not adjacent channel) compatibility studies between the fixed service in the band 2025-2110 MHz and the terrestrial component of UMTS have been studied in ERC Report 64. In this study HAPS is not included.

The band 1880-1900 MHz is currently used by DECT (ERC/DEC/(94)03). The bands 2025-2110 MHz (and 2200-2290 MHz) are currently allocated to several space services, the fixed service and the mobile service (see Figure 1).

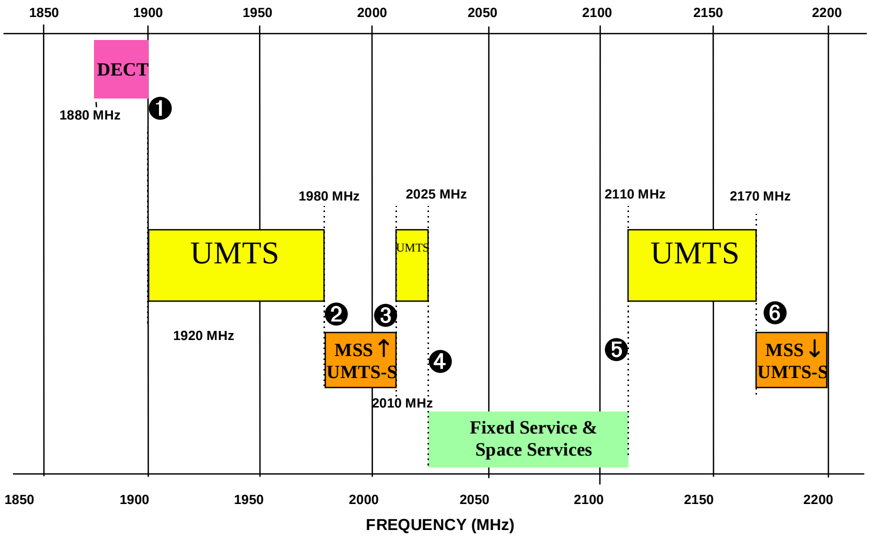


Figure 1 - European frequency plan for the 2 GHz band

This report gives the relevant parameters needed in interference studies for the systems identified in figure 1, at the date of publication. N.B. the parameters assumed in this report are those of UMTS; no other terrestrial IMT2000 radio interface has been considered in this report in terms of adjacent band interference. The interference problems are investigated by both deterministic and statistical approaches, for the different scenarios. This report gives initial recommendations on the necessary guard bands between UMTS and other services to use when introducing UMTS. Since these recommendations are based on parameters correct at the date of publication, it should be noted that any changes in parameters, for example, in the terrestrial UMTS emission masks, would require the recommendation of this report to be re-considered.

Because the UMTS carrier spacing can vary from 4.4 MHz up to more than 5 MHz, depending on the intra-system configuration, the results will be given in terms of “required carrier frequency separation”. This enables the derivation of the “extreme acceptable position of the UMTS carrier centre frequency”.

2 COMPATIBILITY STUDY METHODS

The parameters for terrestrial UMTS, MSS, DECT and space services are provided in **Annex A**. The parameters for fixed service are provided in **Annex D**.

2.1 Scenarios for consideration

Based on the number of systems under consideration, a number of scenarios have to be considered. Table 1 lists these scenarios, which have been considered and makes reference to the relevant paragraphs in this report.

Bands	**Below 1900 MHz**	**1900-1920 MHz**	**1920-1980 MHz**	**1980-2010 MHz**	**2010-2025 MHz**	**2025-2110 MHz**	**2110-2170 MHz**	**2170-2200 MHz**	**Above 2200 MHz**
Assigned to ...	DECT	Terrestrial UMTS TDD	Terrestrial UMTS FDD/TDD	MSS/UMTS-S	Terrestrial UMTS TDD	Fixed service, space services (E-S/s-s)	Terrestrial UMTS FDD	MSS/UMTS-S	Fixed service, space services (s-E/s-s)
Co-channel band sharing		Fixed service [C]	Fixed service [C]	Fixed service [E]	Fixed service [C]		Fixed service	Fixed service [E]	
Adjacent band sharing (lower band edge)		DECT [A]	Terrestrial UMTS TDD fixed service	Terrestrial UMTS FDD/TDD fixed service	Fixed service[F] MSS/UMTS-S[D]		Fixed service space services (uplink) [B]	Terrestrial UMTS FDD fixed service	
Adjacent band sharing (upper band edge)		Terrestrial UMTS FDD/TDD fixed service	MSS/UMTS-S [D] fixed service	Terrestrial UMTS TDD fixed service	Fixed service[F] space services (E-s/s-s) [B]		Fixed service MSS/UMTS-S[D]	Fixed service space services (downlink)	

Table 1 - UMTS sharing matrix

[A] See section 3.1
[B] See section 3.3.2
[C] See ERC Report 64
[D] See section 3.2.1
[E] ITU-R Recommendation M.1141, M.1142, M.1143.
[F] See section 3.4

2.2 Minimum Coupling Loss (MCL) and Monte Carlo (MC) approaches

Within CEPT, two approaches have been used so far to assess interference between two systems.

The first one, the Minimum Coupling Loss (MCL), is now well-known, and gives for a given system the relationship between the separation distance and the guard band for a given set of transmitter and receiver parameters. The second and more recent one, Monte Carlo (MC) simulation, [3], is becoming more usual and gives a probability of interference for the given set of parameters and a deployment and power control model.

It is understood that only one of the approaches described above is not sufficient alone to describe in detail the interference problem, and to conclude on the problem of guard bands. The following points are relevant to the comparison of deterministic and statistical approaches :

- The MCL method is useful for an initial assessment of frequency sharing, and is suitable for fairly “static” interference situations (e.g. fixed links vs mobile base stations). It can however be pessimistic in some cases.

- The Monte-Carlo probabilistic method will generally give more realistic results. It is however complex to implement and will only give accurate results if the probability distributions of all the input parameters are well known.

- Because of the lack of agreed parameters for IMT-2000/UMTS in ETSI ETSs / TBRs and knowledge of deployment scenarios at the moment, the calculations must be done with approximate parameters for the transmitters and receivers. If the Monte-Carlo simulations are made with those approximate parameters, it is difficult to interpret the interference probability determined by the simulation to verify that the results are accurate.

2.3 Propagation models

When the distances considered in the MCL approach are small the free space propagation model can be used. For Monte Carlo simulations, the propagation model described in [3] is used.

It should be noted that Recommendation ITU-R M.1225 (REVAL) and UMTS 30.03 [1] give a set of propagation models that were used in the selection of the transmission technologies. These models differ slightly from the one in [3], but the results are expected to be similar.

2.4 Minimum Coupling Loss

The coupling loss between two interfering systems depends on the scenarios under study.

The separation distance between the interferer and the victim is not the same if they are mobile or base stations.
The MCL between an interfering transmitter (Tx) and a victim receiver (Rx) is defined as
MCL = Tx Power (dBm/ref. BW) + Tx Out-of-band attenuation (dB) + Tx antenna gain (dBi) + Rx antenna gain (dBi) - Rx interference threshold (dBm/ref. BW)

2.5 Impact of interference

In UMTS the interference results in loss of capacity and/or of coverage, and the MCL may not be the best method to investigate this loss.

The acceptable interference probability used in Monte-Carlo studies will depend on the scenario under consideration. For example, in the case of interference between DECT and UMTS, the maximum acceptable interference probability is considered to be 2%.

Furthermore, the impact of interference on the loss of capacity needs to be the subject of further study.

2.6 Monte Carlo assumptions

The assumptions used in the Monte Carlo simulations are detailed in **Annex C**, and are based on work in ITU-R [5]. Additional information is also included alongside the reported compatibility studies.

2.7 Interference mechanisms

This report has considered the effect of out-of-band emissions from one system falling into the receiver of another, and where the necessary technical information is available, the effects of receiver blocking have also been considered. Where the necessary receiver performance data is not available, blocking has not been considered and receivers will need to be designed taking into account the adjacent band systems and the guard bands available.

3 COMPATIBILITY STUDY RESULTS

3.1 DECT

The interference between DECT and UMTS has been evaluated for the UMTS TDD mode only, because it is expected that the band immediately above 1900 MHz will not be paired and therefore will be available for the TDD mode only.

3.1.1 Mutual Interference Cases

In the following sections, RFP means “Radio Fixed Part”, equivalent to a DECT base station; CTA means “cordless terminal adaptor”, i.e. fixed subscriber unit; PP means “Portable Part”.

All possible scenarios are numbered 1 to 30 in table 2 below:

UMTS **DECT**	**Above roof-top macro BTS**	**Below roof-top micro BTS**	**Indoor micro BTS**	**Outdoor MS**	**Indoor MS**
Above roof-top WLL RFP	**1**	2	3	4	5
Above roof-top WLL CTA	**6**	7	8	9	10
Below roof-top CTM RFP	11	12	13	14	15
Indoor RFP	16	17	18	19	**20**
Outdoor PP	21	22	23	24	25
Indoor PP	26	27	28	29	**30**

The cases in bold are the most important

Table 2 – Possible interference scenarios

Since both DECT and UMTS are TDD technologies, all the above mutual interference cases exist, although many are not very likely to occur, and only some are critical. In order to estimate the probabilities for harmful interference, it is important to know how common different types of systems are, and to know their geographical distribution.

Above roof-top WLL RFPs and **Above roof-top WLL CTAs** installations are for the time being mainly found in Eastern Europe, Asia, Latin America and Africa.

Below roof-top CTM RFPs and **Outdoor PPs** for public use in large numbers are only found in Italy, where streets, shopping centres and public buildings are covered in 31 cities. Total number of subscribers is about 130.000. Outdoor RFPs (and PPs) also exist as outdoor coverage extensions (parking places etc.) of office systems. The largest is the Volvo Torslanda plant with 2 sqkm area complete indoor/outdoor coverage for about 5000 subscribers.

Indoor RFPs with **Indoor PPs** (office and residential applications) are the most common DECT installations. They represent the vast majority of the shipments of DECT equipment. These systems are spread world wide, but the most of them are in Western Europe.

UMTS TDD Systems are not deployed. The standard is not finalised. Which will be the most common application is not known, but the following system types are provided for:

Above roof-top macro BTS. Where DECT WLL is installed, cases 1 and 6 are critical.

Below roof-top micro BTS. Cases 12 and 22 are important for Italy.

Indoor micro BTS with Indoor MS. Is not very critical. Indoor UMTS and Indoor DECT systems will very seldom be installed in the same location, since they give the same service. It could happen in a few large shopping centres and large exhibition halls. In these few cases the coexistence will be solved by installing the systems with a proper large margin on the wanted signal level (smaller cells). Indoor sites are not expensive.

Outdoor MSs. Cases 14 and 24 are important for Italy. (Same parameters as for 20 and 30, but different propagation model).

Indoor MSs. Where the MS belongs to an outdoor UMTS system (micro or macro BTS), and this MS visits an indoor location where an indoor DECT system is installed, it is obvious that cases 20 and 30 will be important frequent cases.

3.1.2 Summary table with Minimum Separation Distances for the most important cases.

In table 3 below are shown the Minimum Separation Distances for the critical scenarios 1, 6, 20 and 30.
The dominating interference mechanism to UMTS is blocking due to limited UMTS receiver interference rejection of the power of the (closest) DECT carriers.
The dominating interference mechanism to DECT from UMTS MS is Out-Of-Band emissions. Interference to DECT from UMTS BTS is a combination of Out-Of-Band emissions from UMTS and interference through DECT blocking.

In order to make this study as realistic as possible, average values for typical DECT equipment have been used, as explained in Annex A. UMTS equipment is not available, but for UMTS Out-Of-Band emissions and blocking, values about 5 dB better than the specification have been used.

UMTS Carrier	Relative level of interfering signal [B]	Indoor UMTS MS and indoor DECT system. Cases 20 and 30.		UMTS Macro BTS and DECT WLL system. Cases 1 and 6.	
		Victim UMTS indoor 21 dBm MS connected to outdoor BTS (due to blocking)	Victim DECT [A] 24 dBm RFP and PP (due to out-of-band emissions)	Victim UMTS 55.5 dBm Macro BTS (due to blocking)	Victim DECT 36 dBm RFP and CTA (due to out-of-band)
1902.5 MHz	0 dB	47 m	18 m	1680 m	1 500 m
	10 dB	27 m	10 m	530 m	470 m
1907.5 MHz	0 dB	27 m	10 m	420 m	470 m
	10 dB	15 m	3 m	130 m	150 m
1912.5 MHz	0 dB	13 m	-	130 m	470 m
	10 dB	5.6 m	-	42 m	150 m

A - DECT will easily escape interference from a UMTS up-link time slot through instant dynamic channel selection,DCS.
B - For UMTS, this value is relative to –99 dBm for MS, -103 dBm for BTS. For DECT 0 dB is related to –80 dBm wanted signal, and 10 dB is relative to –70 dBm wanted signal.

Table 3 – Minimum separation distances beetween DECT and UMTS equipment

3.1.3 Interference to UMTS

One critical scenario is interference between DECT WLL and UMTS Macro BTS, Cases 1 and 6. If co-ordination distances down to 100 to 200 m are required, macro TDD BTSs on carrier 1902.5 MHz is not recommended to be used in areas where DECT WLL systems are installed. TDD macro BTS on carrier 1907.5 MHz use is feasible if local interference power up to 10 dB above the UMTS BTS noise floor is accepted, which means that the UMTS link budget may locally be reduced by 10 dB. For carrier 1912.5 MHz the situation is better. Mitigation techniques can be considered on a national basis where Administrations intend to licence DECT WLL and UMTS macro-cell applications in close vicinity (see example in section 3.1.6).

Another critical scenario for UMTS, is interference from DECT indoor office and residential systems to an UMTS MS, where the MS belongs to an outdoor UMTS system (micro or macro BTS), and this MS visits an indoor location where the indoor DECT system is installed, cases 20 and 30. It is obvious that cases 20 and 30 will be the most frequent of all cases. Indoor systems are the main market for DECT and UMTS MSs used indoors and outdoors, belonging to some outdoor BTS (micro/macro) system, are a likely use of the TDD band.

Separation distances down to 3-5 m occur for cases 20 and 30. The MSD for carrier 1902.5 MHz is 47 m and for 1907.5 MHz 27 m. With an interference level 10 dB above the noise floor, the distances become 27 and 15 m. This is still far from 3-5 m. Furthermore, a UMTS MS may most of the time have a DECT BS and/or an active DECT MS within 15 m, when visiting a home or an office with a DECT installation. With interference levels 30 dB above the noise floor for carrier 1902.5 MHz and 20 dB above the noise floor for carrier 1907.5 MHz, MSD becomes 5 m. Carrier 1912.5 MHz with interference level 10 dB above noise floor will meet this criterion.

10 dB wanted signal margin means a reduction of the indoor coverage area down to ½ or 1/3 of the original area for propagation decay index –6 or –4 respectively. Thus 10 dB (but not higher) wanted signal margin could be used as reference for which the minimum separation distances have to be acceptable.

Thus the two UMTS/TDD channels 1900 – 1905 and 1905 – 1910 MHz could be difficult to utilise by an operator, who wants to use them for outdoor macro- or micro cells. It should be noted that, although the scenarios are different, similar interference occurs between adjacent UMTS TDD carriers used indoor/outdoors.

In scenarios 20 and 30 UMTS MS, unless close to the own BTS, will have difficulties to operate properly (especially for carrier 1902.5 MHz), unless the MS can make intra-cell handover to a “free” time slot when interfered. Such an escape is possible, because the closest DECT BS or MS will not occupy all timeslots at the same time. Both DECT and UMTS TDD have 10 ms frame cycle time, therefore interference between the two systems will be synchronous, and therefore intra-cell handover and instant Dynamic Channel Selection, iDCS, in the time domain will be efficient. A successful connection to a UMTS MS requires that neither the down-link broadcast and control channel nor the down-link traffic channel are interfered. Neither call set-up nor handover will not be possible if the down-link broadcast or control channel is interfered. This will require dynamic allocation on multiple time slots of the down-link broadcast and control channel for TDD UMTS. DECT has this property built in through its iDCS procedures.

3.1.4 Interference to DECT

The only critical scenario for DECT is interference to DECT WLL from UMTS Macro BTS, Cases 1 and 6, if coordination distances down to 100 or 200m are required. These cases 1 and 6 should be avoided unless proper measures are taken.
Mitigation techniques need to be determined on a national basis where Administrations intend to licence DECT WLL and UMTS macro-cell applications in close vicinity (see example in section 3.1.6).

DECT indoor systems do not suffer harmful interference from UMTS indoor applications using the 1902.5 MHz carrier. This is due to a combination of DECT iDCS and proper DECT blocking performance and wanted signal margin for indoor systems.

3.1.5 Discussion on the less important scenarios

Discussions and conclusions for the less frequent or less critical scenarios are found in Annex E section A.3. Generally the carrier 1902.5 MHz has higher probability (although mostly small) for interference than the other carriers.
It could be noted that where private DECT systems are locally extended to cover outdoor areas, or in Italy where a DECT CTM systems are implemented, cases 14 and 24, UMTS MS will encounter the same problems outdoors, as indoor cases 20 and 30 discussed above.

3.1.6 Means to improve compatibility

3.1.6.1 DECT FWA and above roof-top macro BS

The critical case occurs when the DECT RFP and/or subscriber units, CTAs are in proximity of a UMTS TDD BS and the antennas are in direct alignment.

Site coordination and system planning has to be done properly. Above roof-top DECT FWA BS and above roof-top UMTS TDD BSs should be geographically separated as much as possible. Wherever possible the UMTS TDD BS sites should occur at the intersection of the DECT FWA cells. This is important to minimise interference probability between the UMTS BS and the DECT BSs and the DECT CTA subscriber units which have a directional antenna.

Furthermore the coordination distances could be brought down to about 300m for carrier 1902.5 MHz and to about 200m for carrier 1907.5 MHz with interfering power equal to the noise floor level, if for example the following precautions are taken :

- the last DECT carrier F0 is disabled
- the UMTS TDD BS adjacent channel selectivity ACS is improved to 55 dB (external filter or improved specification)
- if the UMTS TDD system is installed first, plan the DECT FWA installation for –70 dBm minimum wanted signal instead of –80 dBm, and if the DECT FWA is installed first limit the UMTS TDD BS eirp to 45 dBm

Note that below roof-top TDD UMTS BS will not cause a critical scenario with DECT FWA systems.

3.1.6.2 DECT indoor BS system and UMTS TDD outdoor BS system

For protection of the indoor systems the typical short cell radius will provide a wanted signal level margin relevant for self-protection and no further measures are required.

The outdoor TDD BS system however should implement an efficient instant dynamic channel selection procedure, including multiple instances of the broadcast channel to reduce the interference probability to the outdoor system MS when the MS enters a location with an indoor system.

3.1.7 Conclusions

- No additional guard bands are needed between DECT and UMTS TDD if UMTS TDD is deployed indoors.
- UMTS TDD Macro BTS systems should not be applied on the band 1900 –1910 MHz in areas where DECT WLL systems are installed (Eastern Europe), unless special measures are taken.
- UMTS TDD outdoor BTS systems used in the band 1900 –1910 MHz should use interference avoidance techniques (such as intra-cell handover and instant Dynamic Channel Selection, iDCS, in the time domain) to reduce the probability of interference to Mobile Stations entering a location with DECT. Similar considerations arise between adjacent UMTS TDD carriers operating with indoors and outdoors base stations, within the whole 1900-1920MHz band.

- Introduce instant Dynamic Channel Selection to the UMTS/TDD standard, which would facilitate the application of UMTS/TDD outdoor micro-cell infrastructures.

3.2 Mobile satellite service

3.2.1 Interference to MSS satellites

The methodology employed to assess interference in to MSS satellites is given in **Annex B**. The input parameters required by this methodology are given in **Annex A**.

These calculations examine the interference due to the unwanted emissions from the terrestrial component of UMTS into the mobile satellite service (MSS) operating in an adjacent allocation. The general principle in radio design, and in relevant ITU-R documentation, is that, in establishing the overall interference budget, the interference from unwanted emissions of adjacent band radio systems is a small fraction of that from in-band, co-primary interference sources, e.g. 1%, 6%. The satellite systems are designed to tolerate typically a 20% increase of the thermal noise level. This 20% is then divided in an appropriate way between adjacent channel (and co-channel) systems and services.

There is no agreed ITU-R Recommendation on the percentage of increase of noise that is acceptable to a satellite, although it is noted that Working Parties 8D and 4A are currently working on this and related issues.

For the purpose of evaluation of the carrier separation between terrestrial UMTS and MSS in this report, two criteria are considered: 3% and 6% of increase of noise. The 6% criterion applies at the edge of the band allocated to MSS, while the 3% criterion is applied 100 kHz within the MSS band. The results below show that these two criteria result in the same value of the extreme position of the UMTS carrier.

3.2.1.1 FDD Mode of terrestrial UMTS at 1980 MHz

In this case the band below 1980 MHz is the transmitter frequency band for the FDD terrestrial UMTS MSs. Application of the methodology in **Annex B** with the parameters for the FDD mode given in **Annex A** (table A3) gives the intermediate results listed in table 4. The parameters assume that the FDD mode is used to provide wide area outdoor coverage.

Satellite beam:		Sub-Satellite	Edge-of-coverage
Cell radius:	Average [A]	6.8 km	
EIRP per cell:	Average [B]	13.3 dBm	
Interference power from Cells lying in 3 dB beamwidth (0 Hz offset from the carrier)		-166.3 dBmHz^{-1}	-161.3 dBmHz^{-1}
Number of Cells in 3 dB beamwidth		4,219	23,927
⇒ Approximate area on Earth's surface of 3 dB beamwidth		500,000 km^2	2,870,000 km^2
Field-of-view correction [C]		-3.0 dB	
C_{FOV} (see §B2)		+6.7 dB	+4.0 dB
Design margin (dB)[D]		-3 dB	-3 dB

A - Calculated using radii assumed typical for terrestrial FDD UMTS.
B - Calculated using average MS EIRP for each environment and traffic predictions.
C - The entire satellite's field-of-view will not be uniformly covered as implied by other assumptions. This factor takes into account, for example, that the terrestrial busy hour may extend across time zones over the visible area and there may be portions of the satellite beam over ocean.
D- The design margin applies for frequency offsets greater than 2.5 MHz

Table 4 - Calculation of aggregate interference at satellite receiver from the FDD mode MSs of terrestrial UMTS

Figure 2 plots aggregate interference power at the satellite receiver from the FDD mode MSs of terrestrial UMTS against frequency offset from the terrestrial UMTS MS carrier frequency. The values in this figure are calculated using the information given in table 2. Note that only the outermost terrestrial UMTS carrier has been considered in this interference power calculation. Also the typical minimum wanted signal power from Mobile Earth Stations is shown in figure 2, to aid the comparison and discussion.

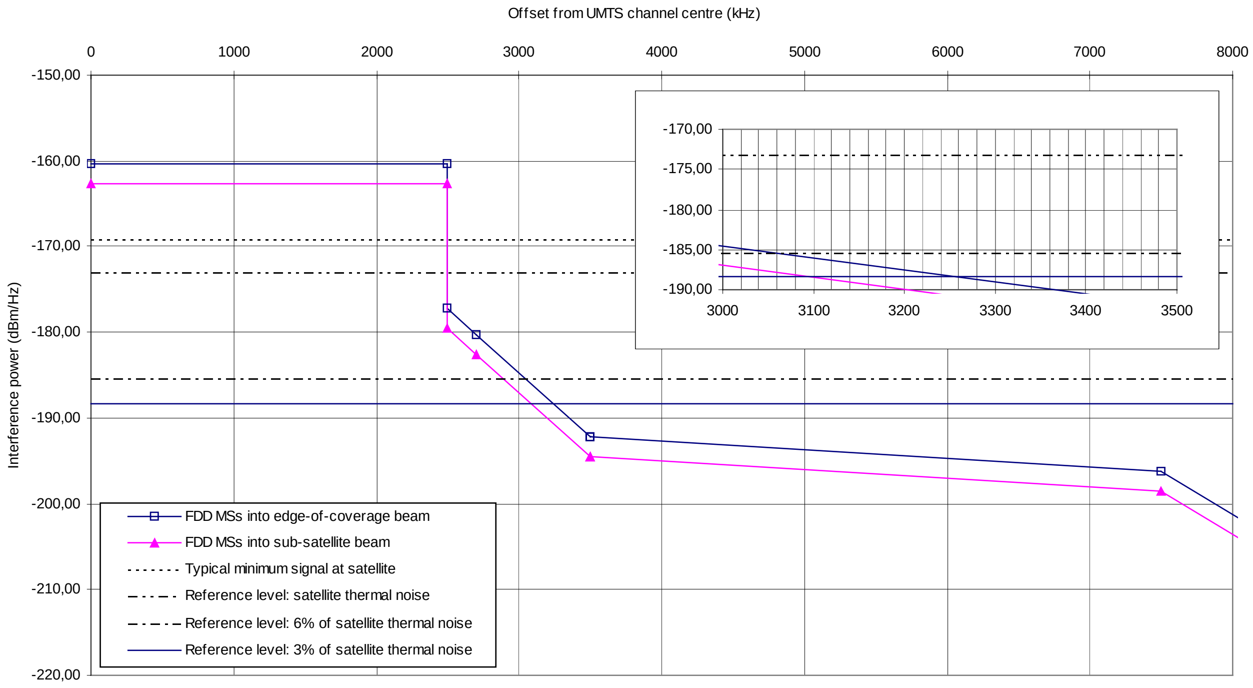


Figure 2 – Calculation of aggregate interference at satellite receiver from the FDD mode MSs of terrestrial UMTS

3.2.1.2 TDD Mode of terrestrial UMTS at 1980 MHz and 2010 MHz, used to provide limited area indoor coverage

In this case the bands below 1980 MHz and above 2010 MHz are the transmitter frequency bands for the TDD terrestrial UMTS BSs and MSs. Application of the methodology in **Annex B** with the parameters for the TDD mode given in **Annex A** (table A4) gives the intermediate results listed in table 5. The parameters assume that the TDD mode is used to provide limited area indoor coverage (the type of coverage associated with, for example, license-exempt applications operating in self-coordinating mode).

Satellite beam:		Sub-Satellite	Edge-of-coverage
Cell radius:	Average	0.2 km	
Power into antenna per cell:	Average	MS: 15.8 dBm BS: 13.3 dBm	
Interference power from Cells lying in 3 dB beamwidth (at 0 Hz offset from the carrier)		MS: -133.2 $dBmHz^{-1}$ BS: -135.7 $dBmHz^{-1}$	MS: -129.4 $dBmHz^{-1}$ BS: -126.9 $dBmHz^{-1}$
Coverage correction [A]		-20.5 dB	
Indoor use		-12.0 dB [B]	-10 dB
Multiple floors [C]		+2.0 dB	
C_{FOV} (see §B2)		+6.7 dB	+4.0 dB
Design margin (dB)[D]		-3 dB	-3 dB

A - $10\log_{10}$(30% of potential implementation area of 3%).
B - $10\log_{10}$(((30% of potential implementation area $\times 10^{14.7\,dB/10}$)+(70% of potential implementation area $\times 10^{10\,dB/10}$))/ total potential implementation area of 3%)).
C - $10\log_{10}$((3 floors over 30% of potential implementation area + 1 floor over 70% of potential implementation area)/(total potential implementation area of 3%)).
D- The design margin applies for frequency offsets greater than 2.5 MHz

Table 5 - Calculation of aggregate interference at satellite receiver from the TDD mode of terrestrial UMTS below 1980 MHz and above 2010 MHz, with limited area indoor TDD coverage

The actual average power received the satellite is an average depending on the uplink ratio R_{UL} (defined as the percentage of cells where the mobiles are transmitting over the total number of cells).

$$P_{Average} = 10\,.\log_{10}\left(10^{P_{BS}/10}.(1 - R_{UL}) + 10^{P_{MS}/10}.R_{UL}\right) \qquad (1)$$

As the TDD mode of UMTS will be used mainly to handle asymmetric traffic, it is expected that R_{UL} will be much smaller than 50%. Actually, as most of the symmetric traffic will be carried by the FDD mode of UMTS, a good estimate of R_{UL} is 20%.

Figure 3 plots aggregate interference power at the satellite receiver from the TDD mode of terrestrial UMTS against the frequency offset from the terrestrial UMTS carrier frequency.

It plots the interference coming from terrestrial UMTS for three scenarios:
1. Base Stations are transmitting simultaneously in all cells;
2. Mobile Stations are transmitting simultaneously in all cells;
3. Mobile Stations are transmitting in 20% of cells and Base Stations are transmitting in 80% of cells.

The values in this figure are calculated using the information given in table 3. Note that only the outermost terrestrial UMTS carrier has been considered when calculating interference power. Also the typical minimum wanted signal power from Mobile Earth Stations is shown in the figure, to aid the comparison and discussion.

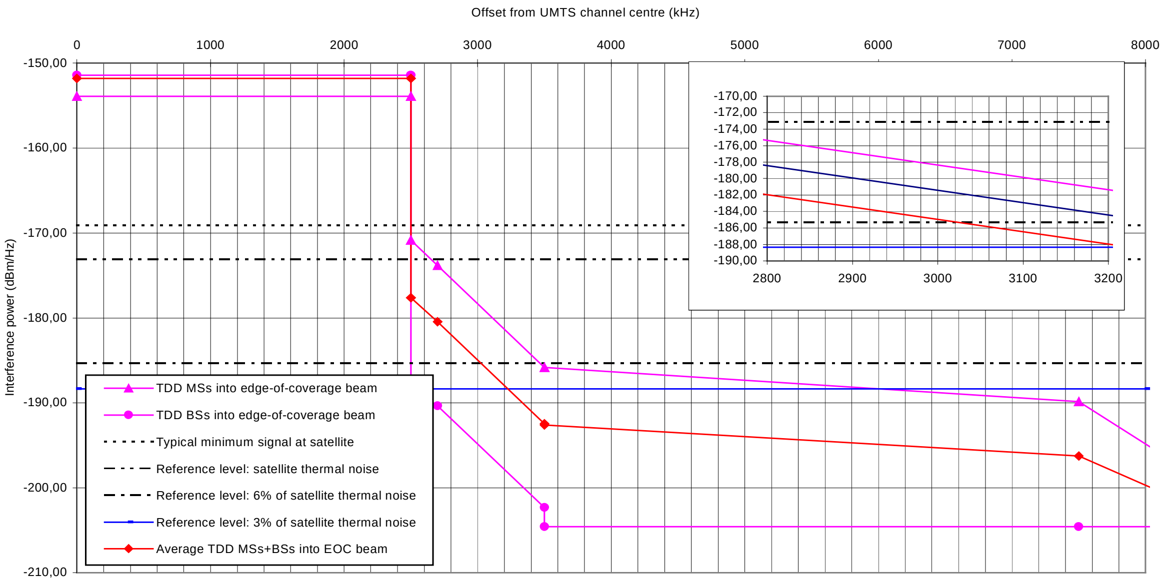


Figure 3 - Interference power at a satellite receiver from the TDD mode of terrestrial UMTS used to provide limited area indoor coverage

3.2.1.3 TDD Mode of terrestrial UMTS at 1980 MHz and 2010 MHz, used to provide outdoor coverage

In this case the bands below 1980 MHz and above 2010 MHz are the transmitter frequency bands for the TDD terrestrial UMTS BSs and MSs. Application of the methodology in **Annex B** with the parameters for the TDD mode given in **Annex A** (table A4) gives the intermediate results listed in table 6. The parameters assume that the TDD mode is used to outdoor coverage (the type of coverage associated with, for example, licensed public applications).

Satellite beam:	Sub-Satellite	Edge-of-coverage
Cell radius: Average	6.8 km	
Power into antenna per cell: Average	MS: 13.3 dBm[A] BS: 35 dBm[B]	
Interference power from Cells lying in 3 dB beamwidth (at 0 Hz offset from the carrier)	MS: -166.2 $dBmHz^{-1}$ BS: -152.1 $dBmHz^{-1}$	MS: -161.2 $dBmHz^{-1}$ BS: -132.9 $dBmHz^{-1}$
Field of view correction[C]	-3.0 dB	
C_{FOV} (see §B2) using: – Omnidirectional antenna pattern (MS) – Figure A2b antenna pattern (BS)	MS: +6.7 dB BS: +20.2 dB	MS: +4.0 dB BS: +5.3 dB
Design margin (dB)[D]	-3 dB	-3 dB

A - Same as for FDD mode. The power per user should be approximately 15 times more, but for a given time slot, about 1/15th of the mobiles are transmitting.

B - Source : TG1(99)68. This may be overestimated, a maximum power of 41 dBm is assumed with a 6 dB allowance for power control

C - The entire satellite's field-of-view will not be uniformly covered as implied by other assumptions. This factor takes into account, for example, that the terrestrial busy hour may extend across time zones over the visible area and there may be portions of the satellite beam over ocean.

D- The design margin applies for frequency offsets greater than 2.5 MHz

Table 6 - Calculation of aggregate interference at satellite receiver from the TDD mode of terrestrial UMTS below 1980 MHz and above 2010 MHz, with outdoor TDD coverage

Figure 4 plots aggregate interference power at the satellite receiver from the TDD mode of terrestrial UMTS against the frequency offset from the terrestrial UMTS carrier frequency. The values in this figure are calculated using the information given in table 4. Note that only the outermost terrestrial UMTS carrier has been considered when calculating interference power. Also the typical minimum wanted signal power from Mobile Earth Stations is shown in the figure, to aid the comparison and discussion.

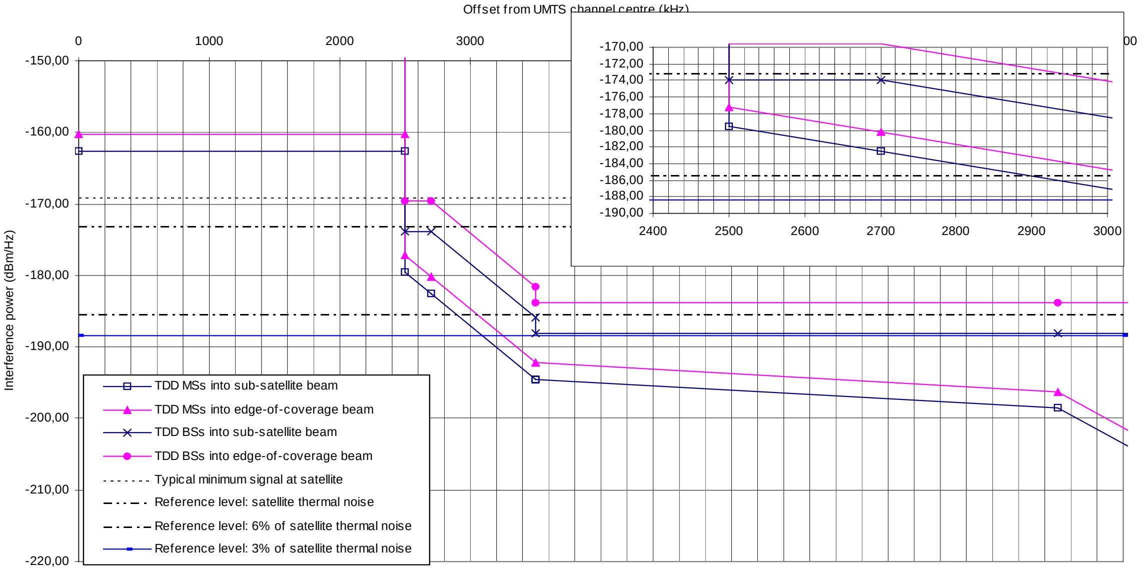


Figure 4 - Interference power at a satellite receiver from the TDD mode of terrestrial UMTS used to provide outdoor coverage

3.2.1.4 Interpretation of results

Examination of the results presented above shows that, even though an edge-of-coverage spot beam covers a considerably larger area than the sub-satellite spot beam, the aggregate interference into both beams is generally similar. This is not the case for interference from TDD BSs though, where, amongst other things, the smaller BS antenna gain used when considering a sub-satellite beam results in a significantly reduced interference level.

Figures 2, 3 and 4 show the interference power at the satellite receiver, as well as the reference levels of 6% and 3% increase of satellite thermal noise. Comparing these values in the figures, it can be seen that:

(i) for interference from FDD MSs, the interference power is less than the reference level beyond 3.04 MHz offset from carrier for the 6% reference and beyond 3.26 MHz offset from the 3% reference;

(ii) for interference from TDD used to provide limited area indoor coverage, the interference power is less than the reference level beyond around 3.0 MHz offset from carrier for the 6% reference and beyond around 3.2 MHz offset from the 3% reference;

(iii) for interference from TDD used to provide outdoor coverage, the interference power is not less than the reference level below 12.5 MHz offset from carrier for both the 6% reference and the 3% reference. At 3.5 MHz, the increase of noise is 8.4%, and it is noted that with the mask assumed, the compatibility does not improve further even with much larger guard bands. The required attenuation for the BS out-of-band power level to meet the 6% reference is 54.7 dB, or -35 dBm/30 kHz for a 41 dBm BS.

3.2.1.5 Comments on the results

For the FDD calculation, it may be noted that if smaller cells had been assumed the interference would be lower since the power per mobile would be reduced (the total number of active mobiles remains fixed based on the given predicted amount of traffic per user).

For the TDD calculation, if the cell size is smaller than the 0.2 km currently assumed (the Forum report mentions an example of 0.075 km), the impact on the calculated interference to the satellite would depend on the degree to which the average BS/MS power correspondingly reduces. There is currently insufficient information about the typical TDD power to make this assessment precisely, however consideration of the propagation model indicates that the effect of reduced BS/MS Tx power will dominate over the increase in the number of visible cells.

It should be noted that the calculations are highly sensitive to certain assumptions made when examining indoor/outdoor use (for example, EIRP and building attenuation). Figure 5 below shows how the effective average building attenuation varies with the percentage of transmitting stations indoors.

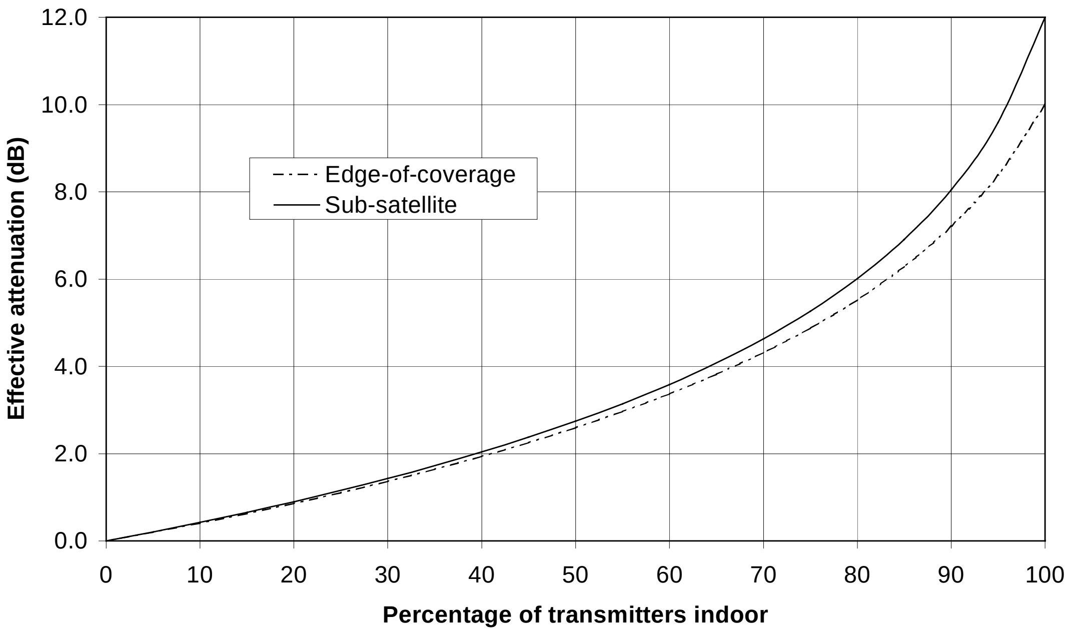


Figure 5 - Variation of effective attenuation with percentage of transmitters indoor

From Figure 5, it can be seen that:

(i) as the percentage of transmitters indoors is reduced from 100%, the effective attenuation falls quite quickly. For example, for the EOC case a reduction in the number of transmitters indoors from 100% to 90% implies a fall in effective attenuation of more than 3 dB.

(ii) as the percentage of transmitters is increased from 0%, the effective attenuation rises slowly. For example, an increase in the number of transmitters indoors from 0% to 20% implies an increase in effective attenuation of less than 1 dB.

Noting that the masks assumed result from simulation of the modulation only, filtering may reduce the interference effects, however the practical considerations of filter roll-off may still require guard-bands to adequately reduce interference into the adjacent satellite band. Examination of the results in §3.3.1.1 and §3.3.1.2 shows that, even though an edge-of-coverage spot beam covers a considerably larger area than the sub-satellite spot beam, the aggregate interference into both beams is generally similar.

3.2.2 Interference from MSS satellites to terrestrial UMTS

[8] and [9], which provide information on the MSS satellite systems expected to be operated in these bands, are examined.

[8] and [9] describe various systems that employ a variety of constellations (e.g. LEO, MEO, GEO) and access schemes (e.g. TDMA, CDMA). Based on this it was possible to calculate the maximum in-band spectral power flux densities (spfds) of these systems on the Earth's surface. These maximum spfds are in the range -162.3 to -168.6 $dBWm^{-2}Hz^{-1}$. The level of -162.3 $dBWm^{-2}Hz^{-1}$ is used here, noting that this level is the highest in a range of maximum spfd values.

It is noted that ITU-R Task Group 1/5 is currently examining generic OOB emission limits for all services and the Chairman's report of the 4th meeting (document 1-5/158, in its annex 8) contains the current working proposals building up to the development of such limits. TG1-5 is far from concluding its work on these generic limits (the work is needed for WRC'03) and so considerable further work is expected.

Document 1-5/158 includes proposals for masks from ITU-R WP4A based on worst-case OOB emission measurements Ku-band (which are expected to apply in C-band as well). These masks are currently being examined by various Study Groups, manufacturers and operators to check/ensure their validity with other systems and in other bands. It has not been possible to locate any other generic masks and so these masks have been used here on the assumption that they can be considered as relatively generic. At the point defined closest to the in-band emission (0.7 x the transponder bandwidth, measured from the centre of the transponder bandwidth) these masks indicate maximum OOB emission levels of -27 dBs (NB. dBs is defined as dB relative to the in-band spectral power density). The maximum interference at the UMTS MS receiver is calculated in table 7.

Max in-band satellite spfd (on Earth's surface) equivalent to	-162.3 dBWm^{-2}Hz^{-1} -132.3 dBm(m^{-2}Hz^{-1})
OOB emission level	-27 dBs
UMTS Receiver bandwidth	+66.1 dBHz
UMTS MS effective antenna area	-26.3 dB(m²)
Max interference power at UMTS MS receiver	-119.5 dBm

Table 7 - Interference from an MSS satellite to a terrestrial UMTS mobile station

The calculated value of maximum interference power at the MS receiver is -119.5 dBm. This is 20.6 dB below the receiver noise floor. It should be noted that the actual level of interference is expected to be less than this value since:

(i) maximum spfds, from the literature, are used; satellites are a power limited and will mostly operate at lower spfds than these maximums;

(ii) the OOB emission levels used assume the worst case scenario (i.e. fully loaded transponders); OOB emission levels in practical operation will generally be lower than this.

Terrestrial UMTS does therefore not require any guard band from the satellite downlink segment.

3.2.3 MSS Earth station interference

Interference from and to satellite UMTS Mobile Earth Stations has been investigated using a Monte Carlo analysis [6], updated here with a new UMTS emissions mask. The results of the study are summarised in the following paragraphs.

The UMTS and MES technical parameters used in the study are given in **Annex A** (sections A1 and A2 respectively).

3.2.3.1 UMTS BS into MSS MES at 2170 MHz

The results of a Monte Carlo analysis of interference into the MSS MES from the UMTS Base Stations for three different environments are shown in figure 6.

The method of calculation was to choose an MES location randomly and, assuming a given density of surrounding UMTS base stations (see legend), the distance to the nearest base station and the corresponding propagation loss is determined. Taking into account the interferer UMTS BS transmit power and antenna gains, the sampled interference power is determined and compared to the maximum permitted level of an MSS MES. The permitted level could either be fixed, or if appropriate, set according to a probability distribution (eg. taking into account the probability of fading on the wanted link). The trial is then repeated a large number of times (over 1000 in the studies presented here) and the proportion of cases where the interference exceeds the permitted level is determined (i.e. the probability of interference occurring). It was assumed that the MES is operating on the carrier nearest to the UMTS band. The UMTS Base Station is assumed to transmit 3 dB below maximum power, and a 3 dB design margin in the UMTS mask is included.

The assumptions used in the Monte Carlo analysis (propagation model, antenna heights, UMTS BS density and MES interference criterion) are all indicated on the legend of the figure. In the results in figure 6 the criterion of 0.5 dB loss in MSS fade margin is used.

The results were calculated assuming transmitting UMTS base stations (FDD) which are located outdoors.

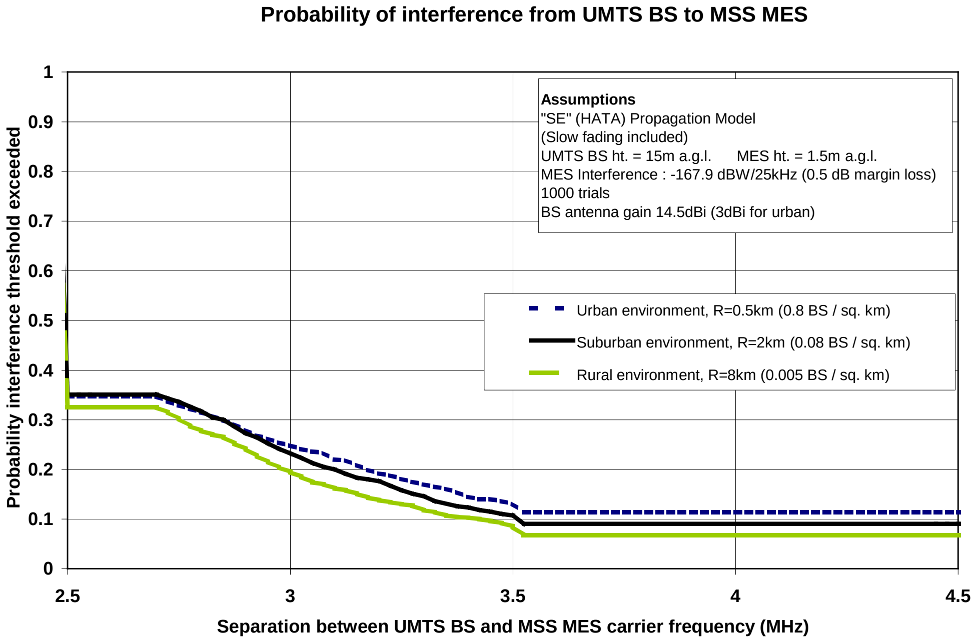


Figure 6 – Probability of MES receiver interference as a function of carrier frequency separation

3.2.3.2 MSS MES into UMTS BS at 1980MHz and 2010 MHz

The results of a Monte Carlo analysis of interference from the MSS MES into the UMTS BS is shown in figure 7.

For a Monte Carlo analysis of interference from an MES to a UMTS BS a single UMTS base station could be considered with an MES located randomly. Such an analysis would however yield very low interference probability simply by virtue of the fact that the expected density of active MESs is very low. Instead it is considered more meaningful to study the probability that an MES would cause interference to any UMTS base station since these will probably be deployed to give ubiquitous coverage. The simulation process is basically then as for the previous case (UMTS BS to MES). Because the allowed interference level used for the UMTS base station already assumes a 3 dB loss in margin, and since uplink power control for MES is likely to be used the permitted interference level at the base station is fixed in this case. The only variable in the simulation is the variable separation distance between interferer and victim defined by the random MES deployment. The study assumes that MES is in operation and using the channel closest to the UMTS band, which in themselves represent a low probability. Results for the different propagation environments (and assumed corresponding UMTS cell sizes and antenna gains) are presented.

The assumptions used in the Monte Carlo analysis (propagation model, antenna heights, UMTS BS density) are all indicated on the legend of the figures.

The results were calculated for receiving UMTS base stations (FDD) which are located outdoors. For the case of the MES interfering with UMTS TDD, the result below is also valid since the key parameters are the same. If the TDD base station were located indoors the required carrier separation would be even less. Since the dominant interference scenario will then almost certainly be the UMTS to the satellite anyway (see §3.3.1), this has not been studied in detail.

Similarly, interference from the MES to the UMTS TDD MS has not been studied since it is assumed that the UMTS mobile would be indoors and the MES outdoors and significant building attenuation would generally be available. If TDD were used extensively outdoors further study may be necessary to assess potential interference from the transmitting MES's.

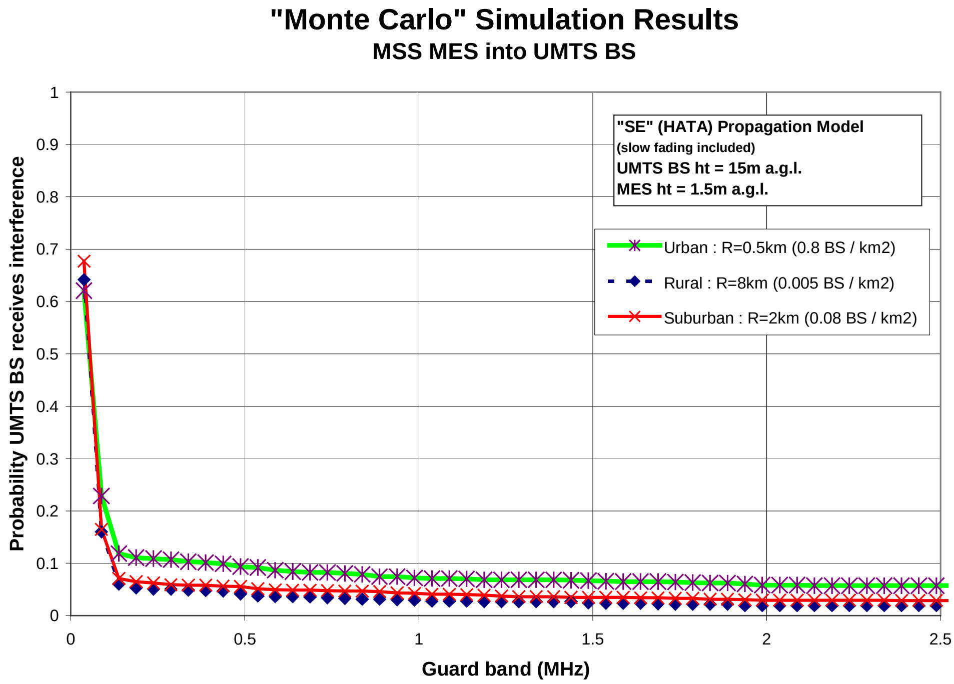


Figure 7

The “guard band” shown in the above figure is measured between the 3 dB bandwidth of the UMTS and MSS channels, assuming these to be 4.1 MHz and 25 kHz respectively. Thus, the “Carrier frequency separation” will correspond to the “guard band” + 2.06 MHz.

3.2.3.3 Discussion and conclusions

This study has focused on the analysis of unwanted emissions to determine the guard band requirements between UMTS BS and MSS MESs. Receiver blocking effects may require further investigation when more details of the receivers become available.

The Monte Carlo interference analysis results reveal that in this study the carrier frequency separation requirements are similar for the different environments considered (urban, sub-urban and rural). This is because the effect of the greater propagation losses at a given distance in the urban environment are offset by the fact that the interference path lengths are shorter because of the higher density of base stations.

In carrying out the analysis it was noticed that the results are strongly affected by the standard deviation of the normal distribution which is added to the median propagation loss to model slow fading effects. The results obtained are of course dependent on the various input assumptions (e.g. cell size, powers, Tx masks) and would need to be recalculated if any of these change significantly.

In Figure 6 the probability of interference is plotted for a 0.5 dB criterion for the loss in the MSS margin. **Annex A** mentions an 8 dB fade margin on the downlink, and therefore a 0.5 dB loss in the margin is seen as an acceptable criterion for interference, when coupled with the interference probability given below. In order to achieve carrier spacings as indicated in the first published version of this Report, the MSS would need to tolerate a 3 dB loss in the fade margin. Considering that typical MSS systems have an 8 dB margin, this may mean that the MSS operation would be unfeasable on the affected channels.

The interference probability plotted in figure 6 decreases with the carrier separation up to 3.5 MHz. Beyond this the compatibility does not improve (as expected from the shape of the UMTS emission mask). The threshold for acceptable interference for both a mobile Earth station and a terrestrial UMTS terminal is set to 10% because the scenarios in consideration themselves have low probability to occur (the number of available satellite channels within the MSS satellite coverage mean that active MES will be sparsely distributed compared with terrestrial UMTS stations).

The required carrier frequency separation for the BS into MSS MES scenario is therefore approximately 3.5 MHz for 10% probability of 0.5 dB or less degradation in MSS fade margin for the sub-urban environment. For the rural environment

the required spacing is less (see figure 6). Although not plotted in the figure, it has been calculated that a 2.8 MHz carrier separation (recommended in the first version of Report 65) corresponds to 3 dB loss in margin. It is noted that the existing ERC Decisions 97(03) and (97)04 relating to satellite-PCS indicate that utilisation of the bottom of the 2 GHz MSS band is foreseen at a later stage after initial implementation of systems in the top half of the band. The impact of dual mode terrestrial/satellite UMTS terminals may also be relevant in determining the protection required by MSS terminals operating within areas of terrestrial coverage.
For the MSS MES interference into the UMTS BS the loss in margin is particularly detrimental in rural areas, where the coverage will be a limiting factor, and in particular in the up link budget. Taking into account the very low probability that an MES is indeed located in a cell area due to the low expected densities of active MESs, this 10% probability of interference is however considered to be acceptable and a 2.5 MHz carrier frequency separation requirement can be deduced from figure 7.Since the victim station is here a base station operating with CDMA, interference can cause not only a loss of coverage but also a loss of part of or all the uplink capacity. A 3 dB increase of noise is however not considered to cause a detrimental loss of capacity. More detailed simulations, taking into account both the wanted received signal and the interfering signal levels, would be necessary to study the loss of capacity and blocking effects. This is a topic for further study.

3.3 Space services

Annex 1 to ITU-R Recommendation SA.1154 [7] provides a compatibility study of space services and high-density land mobile systems. The conclusion of this study is that high density mobile systems should not be introduced in the 2025-2110 MHz and 2200-2290 MHz bands (i.e. these bands cannot be identified as potential IMT-2000 extension bands).

3.3.1 At 2025 MHz

The band 2010-2025 MHz is unpaired and it is expected to be used in TDD mode. Therefore interference from both mobile and base stations needs to be investigated.
The methodology employed to assess interference into SSS spacecraft is the same as for MSS satellites and is given in **Annex B**. The input parameters required by this methodology are given in **Annex A**.

The UMTS parameters are the same as for the MSS and are listed below. They are differentiated according to two possibilities :

- If the band adjacent to SSS is used for self-provided applications operating in self-coordinated mode, the scenario is entitled «micro»
- If the band is used for licensed public applications outdoors, the scenario is entitled «macro»

	TDD «micro» MS	TDD «macro» MS	TDD «micro» BS
Average power per cell (dBm)	15.8	13.3[A]	13.3
Antenna gain (dBi)	0	0	0
Field-of-view and coverage correction (dB)	-20.5[B]	-3.0[C]	-20.5[B]
Indoor use (dB)	-12.0[D]	0.0	-12.0[D]
Multiple floors (dB)	2.0[E]	0.0	2.0[E]
Frequency (MHz)	2025[F]		

A - Same as for FDD mode, source TG1(98)152. The power per user should be approximately 15 times more, but for a given time slot, about 1/15th of the mobiles are transmitting
B - $10\log_{10}$(30% of potential implementation area of 3%)
C - The entire satellite's field-of-view will not be uniformly covered as implied by other assumptions. This factor takes into account, for example, that the terrestrial busy hour may extend across time zones over the visible area and there may be portions of the satellite beam over ocean
D - $10\log_{10}$((30% of potential implementation area $\times 10^{14.7\ dB/10}$)+(70% of potential implementation area $\times 10^{10\ dB/10}$))/ (total potential implementation area of 3%))
E - $10\log_{10}$((3 floors over 30% of potential implementation area + 1 floor over 70% of potential implementation area)/(total potential implementation area of 3%))
F - The path loss at 2110 MHz is increased by 0.2 dB

Table 8 – Parameters assumed for interference to a spacecraft from the TDD mode of terrestrial UMTS

The interference coming from TDD base stations used in public outdoor applications is the same as the scenario with FDD base stations considered in section 3.4.2.

The methodology is applied assuming an omnidirectional antenna on the spacecraft, at a orbital height is 250 km.

The figure below compares the aggregated received power at the spacecraft antenna as a function of the frequency offset.

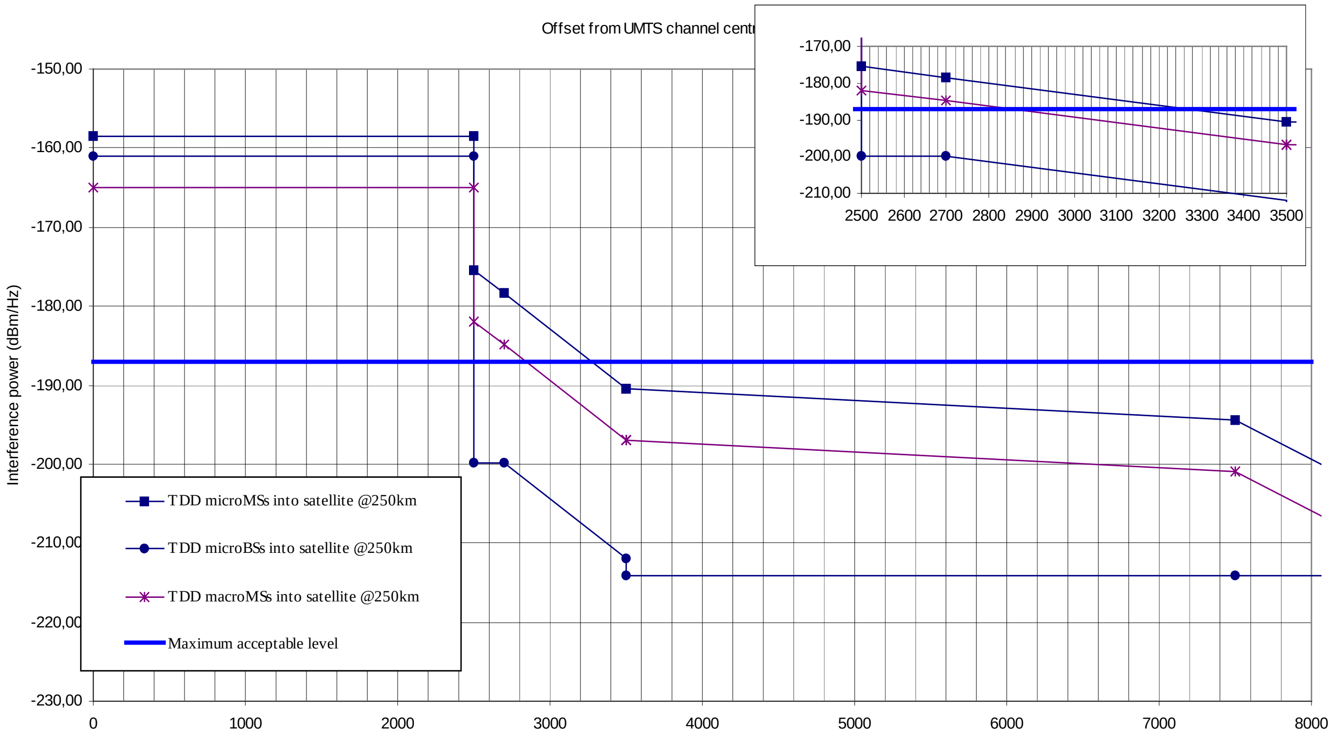


Figure 8 – Aggregated interference power at a spacecraft coming from the TDD mode of terrestrial UMTS

The required frequency offsets are as follows:

	TDD «micro» MS	TDD «macro» MS	TDD «micro» BS	TDD «macro» BS
Required frequency separation (kHz)	3260	2800	2500	(see 3.4.2)

Table 9 – Required separation distances between UMTS and SSS at 2025 MHz

3.3.2 At 2110 MHz

The aggregate interference to the space science service satellite receiver from all the visible UMTS base stations can be calculated as shown in table 10 below.

Space craft height (km)	250
Average transmission loss (dB)	154.2
Polarisation loss (dB)	2
Max received (dBW/Hz) (including in-band/out-band ratio of 3 dB)[A]	-217
Max acceptable transmitted power density (dBW/Hz)	-60.8
Average cell radius (km)	6.8
Visible Earth (km²)	9689313
No. of simultaneous Txs	66700
BS power (dBm)	41
Power control/remote areas (dB)	-6
Bandwidth (Hz)	$3.84\ 10^{6}$
BS e.i.r.p. (dBW/Hz)	-61
Downtilt (2.5°)	-2
Total BS Tx (dBW/Hz)	-13
Average design tolerance on the mask (dB)	-3
Required attenuation including design tolerance (dB)	**43**

A - For Earth to space links, the protection criterion is 4 dB less stringent (-213 dBW/Hz)

Table 10 - Interference scenario around 2110 MHz

The assumptions made in the calculation are :

- The average transmission loss is defined as the average of the BS antenna gain in the direction of the satellite and the free space path loss for all visible cells.
- A polarisation loss of 2 dB can be considered applicable between vertically polarised UMTS and circularly polarised space systems.
- An average down-tilt of 2.5° is assumed which reduces the antenna gain by 2 dB.
- Half of the interference budget is allowed for out-of-band interference from UMTS.
- Base stations are assumed to transmit at a power of 41 dBm, an estimated allowance of 6 dB is incorporated for power control and the low base station density in remote and sea areas.

The necessary carrier frequency offset corresponding to the attenuation required depends to a major extent on the UMTS BS transmitter mask. According to figure A3, the required attenuation would be met at a frequency offset of **3.3 MHz** from the UMTS carrier centre. For the 4 dB less stringent criteria applicable to space links, a frequency separation of 3.0 MHz can be deduced from the mask.
It should be noted that there is an internationally agreed multiple access frequency at 2106.4 MHz with a bandwidth of ±2.5 MHz for sensitive space to space links.

3.3.3 Conclusions

Table 11 lists the frequency offsets necessary for compliance with ITU-R Rec. SA.1154.

	At 2025 MHz				At 2110 MHz	
	Used indoors		Used outdoors		Used outdoors	
Space link	Earth to space	Space to space	Earth to space	Space to space	Earth to space	Space to space
Frequency offset from the carrier (MHz)	2.96	3.26	3.0	3.3	3.0	3.3

N.B. The Earth to space results are derived using a satellite interference criterion 4 dB less stringent than that used for space to space links

Table 11 - guard bands to protect the space services

The above carrier separations are needed to protect narrow band reception on spacecraft. It is understood that only few narrow band systems are operated near to 2110 MHz. These are Earth to space links, and it may be possible to increase the Earth station power to overcome the excessive interference with respect to ITU-R Recommendation SA.1154. The majority of systems found near to 2110 MHz use space to space links with typical receiver bandwidths of several MHz. It appears therefore acceptable to take into account the cumulative interference within a bandwidth of approximately 5 MHz. Based on the above reasons a carrier separation of **2.8 MHz** appears to be sufficient.

At 2025 MHz, current systems use Earth to space links, and consequently it may be possible to increase the Earth station power to an extent that 2.8 MHz carrier separation may be sufficient.

3.4 Fixed service

This section addresses the adjacent band compatibility between the Fixed Service in the band 2025-2110 MHz paired with 2200-2290. The co-channel frequency sharing between UMTS and FS in the designated UMTS-bands is studied in ERC Report 64 [10]

The detailed compatibility study including blocking and out-of-band emission situations is investigated in Annex D. Only the FDD component has been considered in detail. In particular, the analysis focuses on the critical case in terms of the adjacent sharing between the FS-channels in the upper part of the band 2025-2110 MHz and the UMTS-channels (FDD mode) in the lower part of the band 2110-2170 MHz.
However the results can be extrapolated to TDD in the band 2010-2025 MHz under the assumption that the TDD parameters for compatibility studies are similar to the FDD.

Scenario	**MCL (dB)**	**Min separation distance (km) –worst case**	**Min separation distance (km) – typical**
BS FDD→FS P-P (1.75 MHz, Carrier separation ≥5.75 MHz) (The outermost channel not used)	148	273	2.7
BS FDD→FS P-MP (Carrier sep ≥ 4.0 MHz)	128	27	2.7
BS FDD→FS P-P (Carrier separation ≥8.3 MHz)	145	200	2.0
BS FDD→FS P-MP (Carrier separation ≥ 8.3 MHz)	125	20	2.0
FS P-P→User Equipment/Blocking (7 MHz, Carrier separation ≥ 7.5 MHz)	97	0.8	< 0.01
FS P-P→User Equipment/OOB (1.75 MHz, Carrier separation ≥ 5.75 MHz) (The outermost channel. not used)	126	23	0.23
FS P-P→User Equipment/OOB (7.0 MHz, Carrier separation ≥ 7.5 MHz)	140	116	0.12 (not outermost ch.)
FS P-P→User Equipment/Adjacent channel (7.0 MHz, Carrier separation ≥7.5 MHz)	138	92	<0.1 (not outermost ch.)
FS P-P→User Equipment/Adjacent channel (1.75 MHz, Carrier separation ≥5.75 MHz) (The outermost channel not used)	113	5	<0.05
FS P-P→Base station/Blocking/	101	1.4	<0.001.4
FS P-P→Base station/OOB (1.75 MHz)	145	211	0.2

Table 12 - Minimum Coupling Loss (MCL) and corresponding separation distances for different propagation conditions

The conclusions drawn from the calculations and summarised in table 12 above, are:

- that, in order to facilitate the adjacent sharing approximately 2 km separation distance and 8.3 MHz carrier separation is required. The 8.3 MHz carrier separation corresponds to not utilising the 3 outermost FS.channels (1.75 MHz ch. spacing) or the outermost FS-channel (3.5 and 7 MHz channel spacings) in the upper part of 2025-2110 MHz (ERC Rec T/R 13-01). All FS channels with 14 MHz channel spacing can be utilised. This is consistent, with the exception of 14MHz channel spacing, with a footnote in the same Rec: *"the outermost channels should be utilised last, to provide further time for detailed study of compatibility with future mobile services in the adjacent bands"*. UMTS is one of these mobile services. Taking the required carrier separation into account (8.3 MHz at a minimum distance of approximately 2 km), ERC Recommendation T/R 13-01 should be revised.

- that the outermost UMTS channel (2020-2025 MHz and 2110-2115 MHz) preferably is used in pico- and microcell applications. In this case, the adjacent sharing is improved due to increased clutter loss and increased antenna discrimination. In addition, the increase in carrier separation of 5 MHz (first Macro-channel) will increase the out-of-band attenuation significantly

- that, due to the large separation distances about 2 km required to protect stations in the Fixed Service (table 10), fixed service deployment in urban areas is not recommended.

In summary, considering that P-P as well as P-MP applications in the 2 GHz band, due to the propagation conditions, mainly will operate in rural areas where long paths are necessary, the necessary co-ordination of stations in UMTS and the Fixed Service should be feasible.
Consequently, careful planning of UMTS base stations and stations (P-P, P-MP CS) in the Fixed Service should avoid harmful interference to the UMTS BS from the fixed service as well as harmful interference to the FS receivers exceeding the long-term criteria.

4 CONCLUSIONS AND DISCUSSION

The compatibility studies in section 3 have resulted in either guard bands or carrier separations necessary to protect UMTS from other systems and other systems from UMTS. They are summarised in table 13 below.

This guard band can be taken either totally inside the UMTS band or be accommodated with the guard band provided by the particular spectrum utilisation of adjacent services and systems. Therefore table 13 summarises as well the "extreme position of the UMTS carrier centre frequency". This is calculated based on the following information :

- The last DECT channel centre frequency is 1897.344 MHz

- TBR 42 limits the operation of mobile Earth stations to the bands 1980.1-2109.9 MHz.

- The space science services operate in the whole band 2025-2110 MHz. In particular, there is an internationally agreed carrier frequency at 2106.4 MHz ± 2.5 MHz.

- A minimum carrier separation of 8.3 MHz, corresponding to a separation distance of approximately 2 km, is required between stations in fixed service and UMTS in urban areas. This separation distance can be implemented by not utilising the 3 outermost fixed service channels (1.75 MHz channel spacing) or the outermost fixed service channel (3.5 and 7 MHz channel spacings) in the upper part of 2025-2110 MHz (ERC Rec T/R 13-01). In the case of 14 MHz channel spacing (T/R 13-01) use of the outermost channel will provider sufficient separation in frequency.

  Thus, in urban areas co-ordination of stations is required in order to meet required separation distances (<2 km) between stations in FS (P-P, P-MP CS) and UMTS. Consequently, taking into account required separations in frequency and distance, should avoid harmful interference to the UMTS BS from the fixed service as well as harmful interference to the FS receivers exceeding the long-term criteria. In summary, considering that P-P as well as P-MP applications in the 2 GHz band, due to the propagation conditions, mainly will operate in rural areas where long paths are necessary, the necessary co-ordination of stations in UMTS and the Fixed Service should be feasible.

Adjacent services	Minimum carrier separation	Calculated Extreme position of the UMTS carrier centre	"Additional" guard band[C]	Comments
❶ **1900 MHz: DECT** UMTS (TDD) (see section 3.1)	5.2 MHz	1902.5 MHz	-	Indoor TDD base stations require no special measures. TDD outdoor BS systems may require special measures, e.g. Dynamic Channel Selection, see section 3.1.6. and 3.1.7 In the case of DECT WLL *vs* UMTS TDD Base Stations above rooftops, mitigation techniques are needed, see section 3.1.6. and 3.1.7 .
❷ **1980 MHz MSS (E-s)** UMTS (FDD) (section 3.2.1.1)	3.04 MHz	1976.96 MHz	0.54 MHz	Based on dominant interference mode of UMTS to satellite
UMTS (TDD used outdoors) (see section 3.2.1.3)	>3.5 MHz[E]	<1976.5 MHz	>1.0 MHz	A 54.7 dB attenuation is required to meet a 6% increase of noise interference threshold
UMTS (TDD used indoor) (see section 3.2.1.2)	3.5 MHz	1976.52 MHz	0.98 MHz	
❸ **2010 MHz MSS (E-s)** UMTS (TDD used outdoors) (see section 3.2.1.3)	>3.5 MHz[E]	>2013.5 MHz	>1.0 MHz	Based on dominant interference mode of UMTS to satellite. A 54.7 dB attenuation is required to meet a 6% increase of noise interference threshold
UMTS (TDD used indoor) (see section 3.2.1.2)	3.0 MHz	2013.0 MHz	0.5 MHz	
❹ **2025 MHz SSS** UMTS (TDD used outdoors) UMTS (TDD used indoors) (see sections 3.3.1)	3.0-3.3[A] MHz 2.96-3.26[A] MHz	2022.2 MHz 2022.2 MHz	0.3 MHz 0.3 MHz	
2025 MHz FS[B] (see section 3.4)	8.3	2022.5 MHz	-	Coordination of stations required in urban areas in order to meet required separation distances (<2 km).
❺ **2110 MHz SSS** SSS/UMTS (FDD) (section 3.3.2)	3.0- 3.3[A] MHz	2112.8 MHz	0.3 MHz	
2110 MHz FS[B] UMTS(FDD) (see section 3.4)	8.3 MHz	2112.5 MHz	-	Coordination of stations required in urban areas in order to meet required separation distances (<2 km)
❻ **2170 MHz MSS (s-E)** UMTS (FDD) (see section 3.2.3.1)	<3.5 MHz[D]	2166.6 MHz	0.9 MHz	Dominated by UMTS BS into MES considerations and dependant on the UMTS deployment scenario.

A *These carrier separations would be required for compliance with recommendation ITU-R SA.1154. In view of the specific use of the border regions by the space science services, a separation of 2.8 MHz appears to be sufficient.*

B *This separation distance can be implemented by not utilising the 3 outermost FS.channels (1.75 MHz ch. spacing) or the outermost FS-channel (3.5 and 7 MHz ch spacing) in the upper part of 2025-2110 MHz (ERC Rec T/R 13-01). For the lower part of 2025-2110 MHz all 7 MHz channels can be used. At both edges all FS channels with 14 MHz ch. spacing can be utilised. It is further recommended to use the 2020-2025 MHz and 2110-2115 MHz UMTS channel preferably in micro and pico-cells.*

C *This is the difference between the calculated and nominal extreme UMTS carrier position. The nominal extreme UMTS carrier position is taken to be 2.5 MHz from the UMTS band edge.*

D *This value is applicable for the sub-urban environment for 10% probability and 0.5 dB loss in MSS fade margin. A smaller carrier separation would impact to the ability to operate MSS on the affected channels due to degradation in the fade margin (see section 3.2.3.3). For the rural environment the required spacing is less, see figure 6.*

E *The compatibility does not significantly improve with further increase in carrier spacing because of the shape of the emission mask.*

Table 13 - Summary of the required carrier separations (❶,❷, …, ❻ refer to figure 1)

A working assumption for the UMTS channel frequencies is that it is based on a 200 kHz raster. This channel raster has not been taken into account in the figures for the extreme position.

If the adjacent systems' assumed bandwidth changes, the carrier separation would be modified accordingly, but the extreme position of the UMTS carrier would not change. If the unwanted emission mask changes the extreme position of the UMTS carrier may need to be revised.

The studies in this Report have been based on the information available as of September 1999, which are detailed in Annexes A and D. In the case that this information is modified at a later stage, a careful investigation of the impact on the guard band would be necessary.

5 GLOSSARY

MINIMUM CARRIER SEPARATION :

The minimum separation required between the nearest carriers of two adjacent band systems for them to co-exist.

MINIMUM FREQUENCY SEPARATION :

The minimum separation required between the band edges of two adjacent band systems for them to co-exist.

Minimum Frequency Separation is less than the Minimum Carrier Separation.

The difference is of the order of one half of the sum of the two systems channel spacings.

e.g. for two systems with channel spacings 200 kHz and 25 kHz a minimum frequency separation of x kHz equates to a minimum carrier separation of x + 112.5 kHz

CO-EXIST :

The systems will operate satisfactorily in adjacent bands.

i.e. the magnitude of the interference anticipated is considered acceptable.

CTS Cordless Telephone System

6 REFERENCES

[1] ETSI TR 101 112, Universal Mobile Telecommunications System (UMTS); Selection procedures for the choice of radio transmission technologies of the UMTS (UMTS 30.03 version 3.1.0)

[2] ETS 300 175-2, Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical layer (PHL)

[3] ERC Report 68, Monte Carlo Radio Simulation Methodology, http://www.ero.dk/eroweb/seamcat/ERC Report 68

[4] UMTS Forum, Spectrum for UMTS/IMT 2000, December 1998

[5] Document 8-1/45-E, Study period 1997-2000, Report of the expert meeting

[6] Compatibility between terrestrial UMTS and mobile-satellite services, Doc. ERC TG1 WG1 02, London 21 July 1998.

[7] Recommendation ITU-R SA.1154, 1995, Provisions to protect the space research (SR), space operations (SO) and Earth-exploration satellite services (EES) and to facilitate sharing with the mobile service in the 2025-2110 MHz and 2200-2290 MHz bands

[8] the IMT-2000 Satellite RTT Descriptions (as posted on the ITU web site http://www.itu.int/imt);

[9] ITU-R Recommendation M.1184 "Technical Characteristics of Mobile Satellite Systems in the 1-3 GHz Range for Use in Developing Countries for Sharing between the Mobile-Satellite Service (MSS) and other Services using Common Frequencies".

[10] CEPT ERC Report 64, ”Frequency sharing between UMTS and existing fixed services”, May 1999

[11] CEPT ERC Recommendation T/R 13-01 E, ”Preferred channel arrangements for fixed services in the range 1-3 GHz”, 1993

[12] 3GPP TSG RAN, TS 25.101 v 3.0.0, October 1999, “UE Radio transmission and reception (FDD)”

[13] 3GPP TSG RAN, TS 25.104 v 3.0.0, October 1999, “UTRA (BS) FDD; Radio transmission and reception”

ANNEX A - SYSTEM PARAMETERS

A1 Terrestrial UMTS Parameters

The values of the basic parameters are generally consistent with those defined in [1].

A1.1 Antenna gain characteristics

The antenna gain will be very dependent on the deployment of UMTS by individual operators. For typical deployments using 3 sectors, the value defined in [1] is a reasonable assumption :

13 dBi - 2 dB typical cable loss = 11 dBi

For deployments designed for maximum range, cellular antennas with a gain of up to 17 dBi are available for GSM 1800.

For most scenarios, a value of 14.5 dBi (including feeder loss) will be used.

A1.2 Receiver blocking

The blocking characteristics is a measure of the receiver ability to receive a wanted signal at is assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels; without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occur.
The static reference performance as specified in [13] clause 7.3.1 should be met with a wanted and an interfering signal coupled to BS antenna input using the following parameters.

Center Frequency of Interfering Signal	Interfering Signal Level	Wanted Signal Level	Minimum Offset of Interfering Signal	Type of Interfering Signal
1920 – 1980 MHz	-40 dBm	<REFSENS> + 6 dB	10 MHz	WCDMA signal with one code
1900 – 1920 MHz 1980 – 2000 MHz	-40 dBm	<REFSENS> + 6 dB	10 MHz	WCDMA signal with one code
<1900, > 2000 MHz	-15 dBm	<REFSENS> + 6 dB	—	CW carrier (preferred)

Table A1 - UMTS BS blocking specification

Parameter	**Unit**	**Offset**	**Offset**
$\hat{I}_{or}$	dBm/3.84 MHz	-107	-107
$I_{blocking}$ (modulated)	dBm/3.84 MHz	-56	-44
Blocking offset	MHz	10<|f-fo|<15	|f-fo| ≥15

Table A2 – UMTS UE blocking speacification

Parameter	**Unit**	**Band 1**	**Band 2**	**Band 3**
$\hat{I}_{or}$	dBm/3.84 MHz	-107	-107	-107
$I_{blocking}$ (CW)	dBm	-44	-30	-15
Blocking offset	MHz	2050<f <2095 2185<f <2230	2025 <f <2050 2230 <f <2255	1< f <2025 2255<f<12750

Note: On frequency regions 2095 <f< 2110 MHz and 2170<f< 2185 MHz, the appropriate in-band blocking or adjacent channel selectivity in [12] section 7.5.1 shall be applied.

Figure A3 – UMTS UE blocking specification

A1.3 Other parameters

The following parameters have been used in interference calculations.

		BS	MS	
Rx noise floor (or Rx interference level)	dBm	-102.9	-98.9	
Rx sensitivity	dBm	-125.5	-118	
Rx bandwidth	MHz	3.84	3.84	
Peak Tx power	dBm	41	21	
Antenna gain + feeder loss	dBi	14.5 3 in microcells	0	
Tx spectrum mask		see figures below		
Channel spacing	MHz	5		
Power control		not used	FDD Rx Power + Tx Power = -83.5 dBm	TDD Rx Power + Tx Power = -66 dBm

Table A4 - Parameters used in interference evaluation

Power control should be applied on the downlink as well, in both systems. However, it is applied individually on each channel, and the total reduction of transmitting power is effective only when the cell is lightly loaded. Therefore power control is not generally applied in this report.

A1.4 Emission masks

The masks below apply for FDD UE and BS. It is assumed that TDD equipment will comply with the same masks.
In the calculation, a 3 dB factor has been taken into account to represent variations of spectra for a large number of equipment, as an design margin.

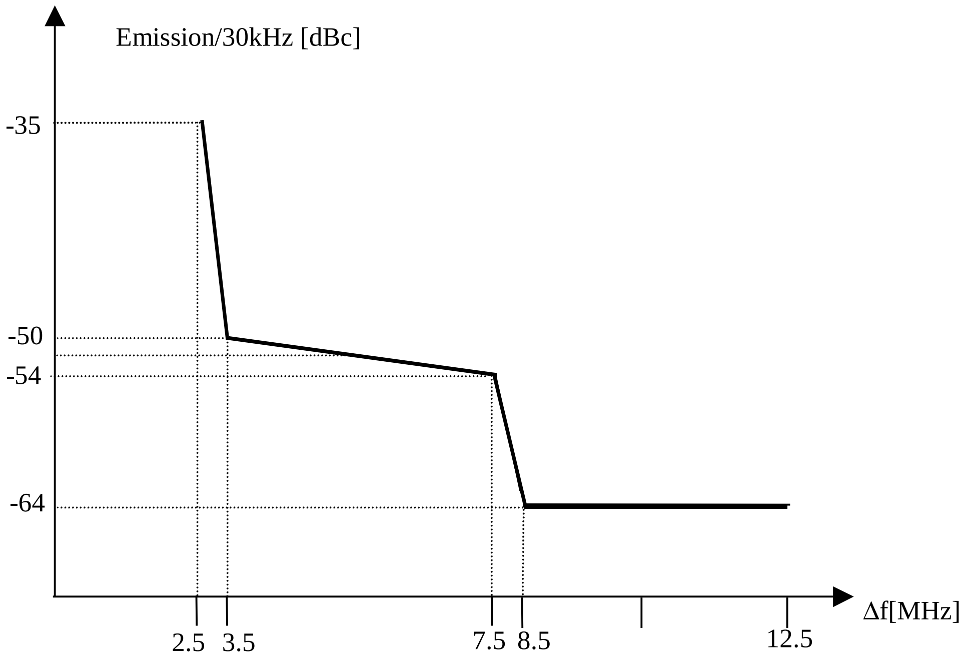


Figure A1 - UMTS Mobile Station (or UE : User Equipment) spectrum mask

The UE spectrum emission mask shall apply for out of band frequencies which are between 2.5 and 12.5 MHz away from a carrier frequency. The out of band frequencies are specified relative to the measured maximum output power of the UE.

The power of any UE emission shall not exceed the levels specified in table A5

Frequency offset from carrier Δf	**Minimum requirement**	**Measurement bandwidth**
2.5 - 3.5 MHz	-35 -15*(Δf – 2.5) dBc	30 kHz *
3.5 - 7.5 MHz	-35- 1*(Δf-3.5) dBc	1 MHz *
7.5 - 8.5 MHz	-39 - 10*(Δf – 7.5) dBc	1 MHz *
8.5 - 12.5 MHz	-49 dBc	1 MHz *

* The first and last measurement position with a 30 kHz filter is 2.515 MHz 3.485 MHz
* The first and last measurement position with a 1 MHz filter is 4 MHz and 12 MHz

Table A5 Spectrum Emission Mask Requirement

The BS emission mask requirement shall be met by a base station transmitting on a single RF carrier configured in accordance with the manufacturer's specification.

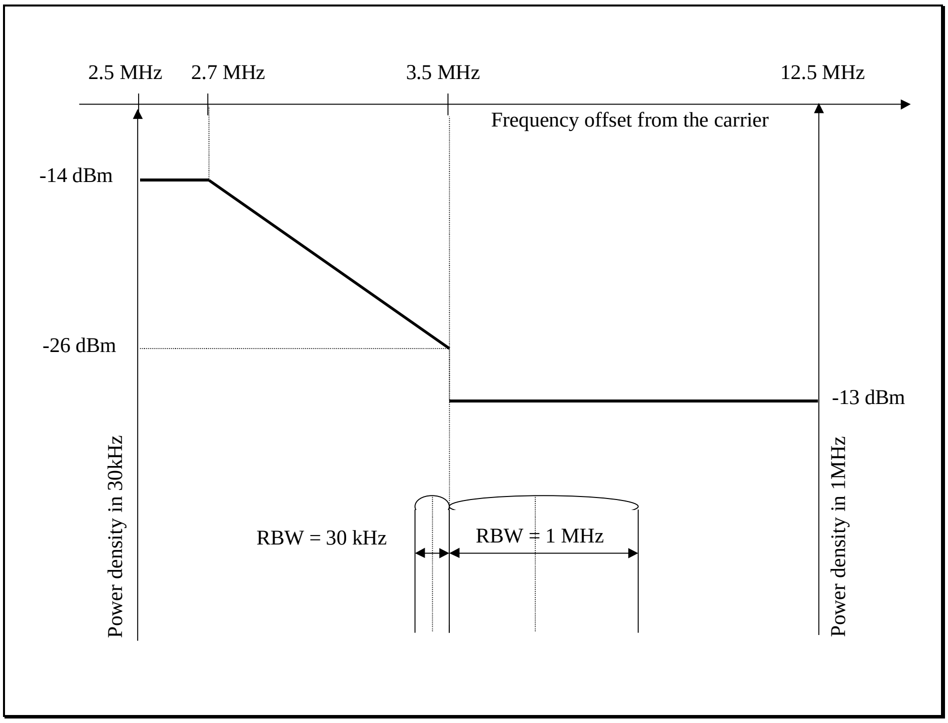


Figure A2 – BS Spectrum emission mask measured in 30 kHz bandwidth

Frequency offset Δf	Minimum requirement	Measurement bandwidth
2.5-2.7 MHz	-14 dBm	30 kHz
2.7-3.5 MHz	-14-15(Δf-2.7) dBm	30 kHz
3.5-12.5 MHz	-13 dBm	1 MHz

Table A6 : Spectrum emission mask values

The above mask is derived from [13] for a BS transmitting 43 dBm.

The BS Output power in the following figure is 41 dBm.

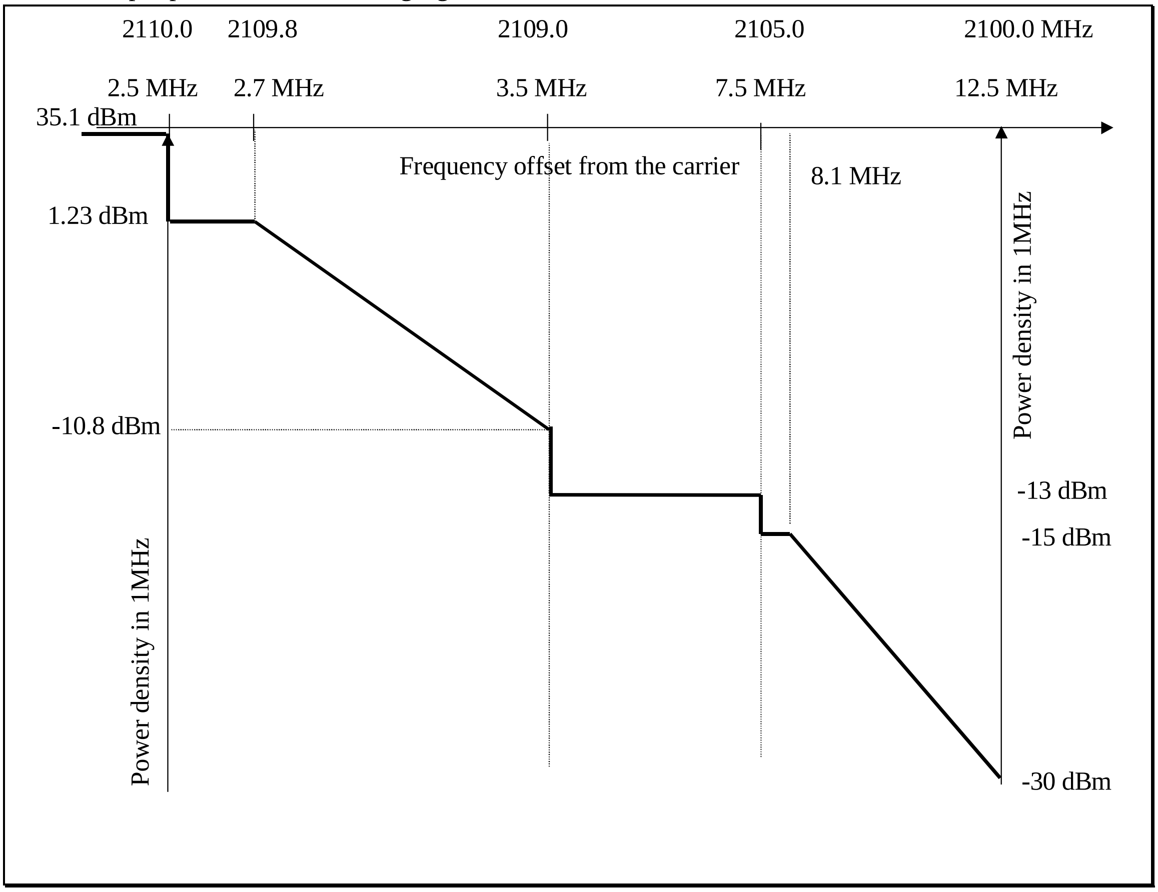


Figure A3 - Equivalent BS emission mask for a BS with 41 dBm output used in the compatibility studies at 2110 MHz.

A1.5 Parameters used in the study of interference to the satellites

The parameters in table A7 and A8 have been used in addition in the study of interference to the satellites of the MSS and SSS.

The population density figures are based on the report Spectrum for IMT-2000, UMTS Forum, December 1998. It provides figures for High-density In-building (CBD), Urban Pedestrian and Urban Vehicular; here these have been assumed equivalent to Urban/CBD, Urban/Suburban and Rural. The cell sizes assumed below for FDD outdoor use are consistent with the information in the UMTS Forum report for the year 2010.

Percentage of land area [A]	No coverage	10 %
	Rural	87 %
	Urban/Suburban	2.98%
	Urban/CBD	0.02%
Typical cell radius [B]	Rural	8 km
	Urban/Suburban	2 km
	Urban/CBD	0.5 km
Average BS Tx power	All environments	38 dBm
Average MS EIRP [C]	Rural	8.3 dBm
	Urban/Suburban	6.6 dBm
	Urban/CBD	-2.5 dBm
Active users per cell per channel [D]	Rural	0.3
	Urban/Suburban	12.5
	Urban/CBD	23.7

A - Considered to be representative of land use in Europe (e.g. UK).
B - Assumed typical of terrestrial FDD UMTS cell radii
C - See ERC TG1 document (98) 152, Ericsson, October 1998
D - Calculated using figures for Population Density, Penetration, Traffic (summed over all services) and Total Spectrum Requirement from the UMTS Forum report and assuming a 50% activity factor.

Table A7 - FDD mode parameters and traffic figures used in interference to the satellite

Typical cell radius		0.2 km
Coverage		30% of Urban/Suburban and Urban/CBD areas [A]
Multiple floors	In 70% of the coverage	1 floor
	In 30% of the coverage	3 floors
Indoor use		100%
Building Attenuation	Sub-satellite beam; single floor	10 dB
	Sub-satellite beam; aggregate over 3 floors	14.7 dB
	Edge-of-coverage beam	10 dB
Average power[B] (into antenna)per cell	MS indoor	15.8 dBm
	BS indoor (average with traffic per cell)	13.3 dBm
	BS outdoor (average with traffic per cell)	35 dBm
Antenna gain	MS	0 dBi
	BS (in sub-satellite beam)	0 dBi
	BS (in edge-of-coverage beam)	5 dBi

A - Areas as defined in FDD parameters above.
B See ERC TG1 document (99)138, France Télécom, September 1999

Table A4 - TDD mode parameters and traffic figures used in interference to the satellite

Base Station Antenna
The antenna pattern shown in Figure A4 is assumed for UMTS base stations. It is assumed that base stations are sectored and that antennas are downtilted by 2.5°.

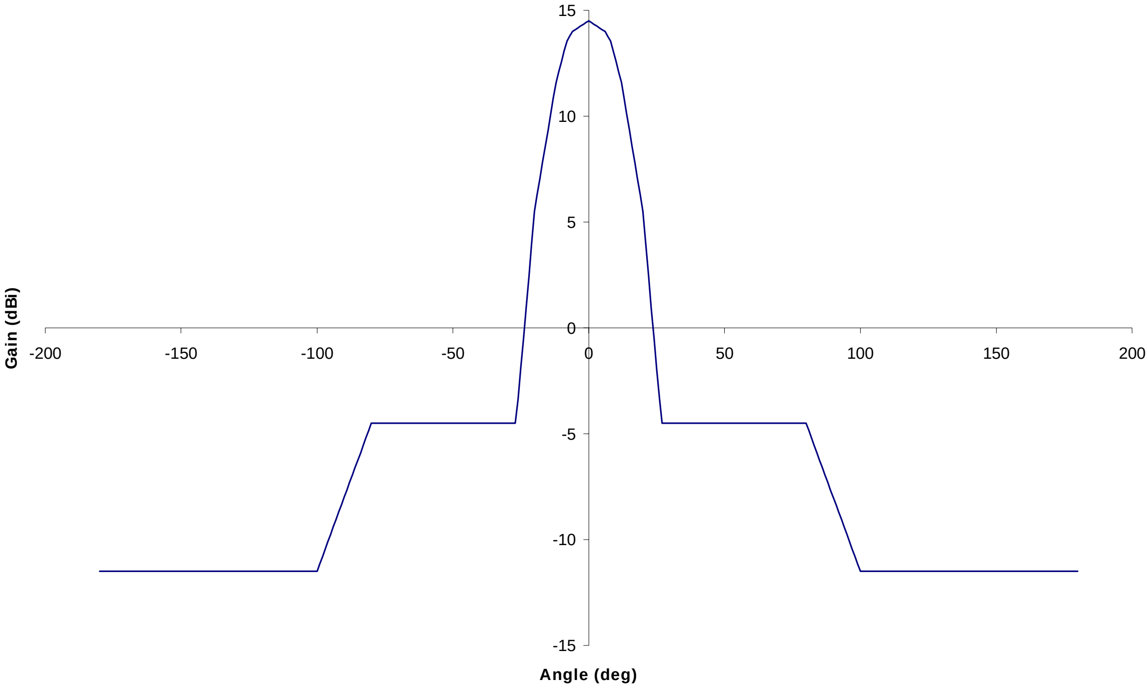


Figure A4 – Base Station antenna pattern

A2 Satellite UMTS

A2.1 Mobile Earth Station

Transmitter characteristics for MSS in the 2 GHz band can be found in ETSI TBR 042. The unwanted emission mask, for the final carrier into an adjacent band, is plotted in figure A5.

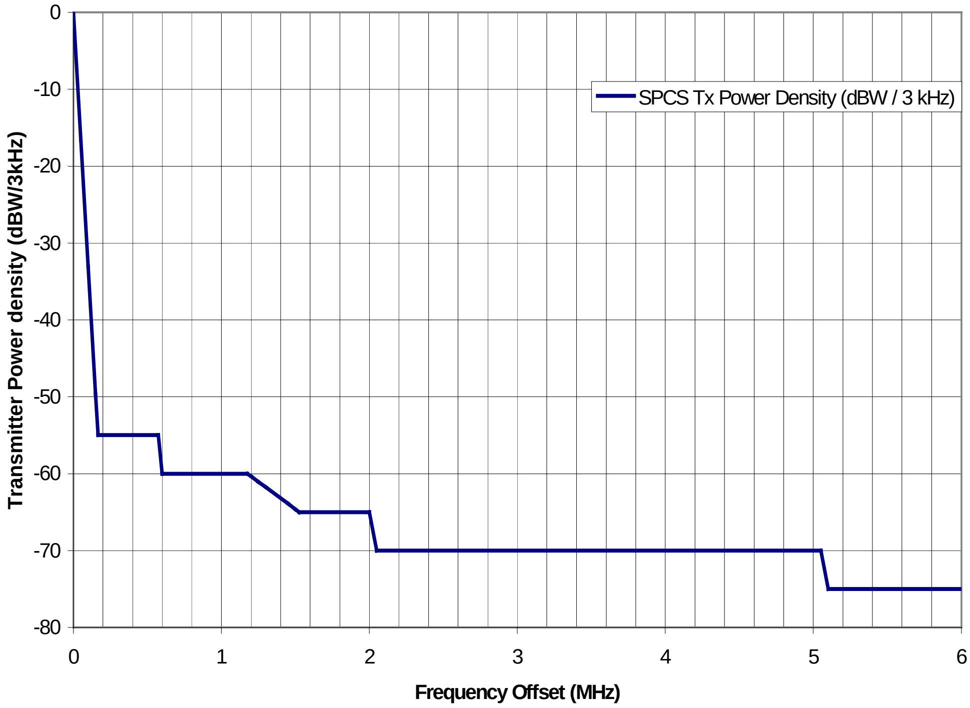


Figure A5 - 2 GHz S-PCN out-of-band mask

ETSI TBR 42 furthermore details that an MESs nominated bandwidth shall not fall in the 100 kHz bands located at either end of the allocated band.

One satellite system that intends to form part of the UMTS satellite component has [5]:

- 8 dB fade margin on the downlink
- 25 kHz channel bandwidth
- -154.8 dBW typical minimum signal level at MES receiver
- threshold C/N+I of 4 dB.

These values have been used for reference.

A2.2 Satellite (Space station)

Parameters below are representative of one satellite system which intends to form part of the UMTS satellite component. For the purposes of the interference studies of this Report, these parameters can be considered generically representative of any UMTS satellite system, since the key parameters are:

- the permissible interference level, which is calculated directly from the satellite noise level. However, the majority of noise captured by satellite antenna is due to the Earth and therefore satellite noise will not differ much between satellite systems;
- the spot beam size. However, spot beam sizes will generally be very similar since they are determined by, amongst other things, antenna diameter, satellite cost and hand-over signalling limitations. It should also be noted that differing orbit heights have very little effect on the study since, for the same spot beam size, any increase in path loss with increasing orbit altitude is directly cancelled by the increase in antenna gain required to develop the spot beam.

Satellite altitude		10,390 km
Beam nadir angle	Sub-satellite beam	0°
	Edge-of-coverage beam	20.2°
Receive antenna	Gain	30 dBi
	Pattern	See Figure A4
Typical minimum wanted signal level		-169 $dBmHz^{-1}$
Satellite G/T		4.5 dBK^{-1}
⇒ Satellite receiver noise power		-173 $dBmHz^{-1}$
Co-channel interference allowance (increase in noise due to adjacent band unwanted emissions)		1% [A]
⇒ Permissible interference level		-193.1 $dBmHz^{-1}$

A – See paragraph 3.2.1 for discussion of this requirement

Table A9 - Space station parameters

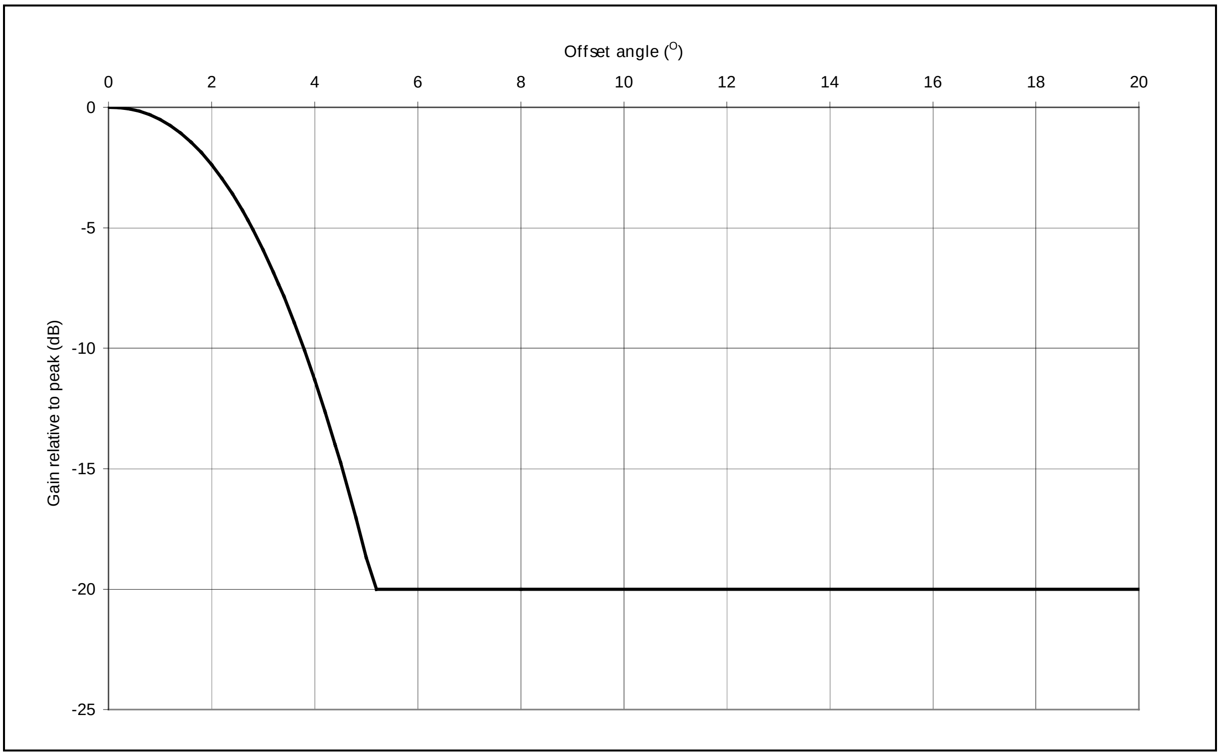


Figure A6 - Satellite Beam Antenna Gain

A3 DECT

A3.1 General aspects

DECT is operating in the band 1880-1900 MHz, and the RF part complies with ETS 300 175-2 [2].

DECT systems are today gaining recognition as much more than only a system offering limited mobility at the customer premises level (home cordless telephone, wireless PBX, FWA).

One important condition for the acceptance and growth of DECT systems is a high service quality and availability. This is only guaranteed when the capacity in the DECT frequency band is not reduced by unwanted emissions from adjacent services, e.g. broad band noise of UMTS. Therefore Directive 91/287/EEC requires and CEPT Recommendation T/R22-02 recommends that : "DECT shall have priority over other services in the same band, and be protected in the designated band".

The relevant parameters for the study are given in table A10.

		Portable Part (PP) or Radio Fixed Part (RFP)
Tx power	mW	250
Tx antenna gain [A]	dBi	0 / 12
Rx bandwidth	kHz	1728
Rx sensitivity	dBm	-83
Rx C/I co-channel	dB	10
Last DECT channel centre frequency	MHz	1897.344
Blocking : 1900-1905 MHz [B]	dBm	-46
Blocking : 1905-2000 MHz	dBm	-33

Table A10 - DECT transmitter and receiver parameters

A - A 0 dBi antenna is applicable in most of the cases. However, for wireless local loop application, a 12 dBi antenna gain should be used instead, and both sets of results should be presented.

B - The blocking level is not specified in [2] for frequency offsets smaller than 6 MHz, but the interference level for the second adjacent DECT channel has been used.This value is –39 dBm related to –73 dBm wanted signal level and becomes –46 dBm related to –80 dBm wanted signal level, which is taken as blocking level.

DECT is a TDD system, operating with 24 slots in a frame of duration 10 ms. The effect of this active/passive rate is difficult to investigate, but some mitigating factor can be found from this phenomenon.
DECT uses Dynamic Channel Allocation (DCA) to combat interference. In case interference occurs on one channel, DECT has the ability to select another one, without loss of communication. This must also be taken into account in evaluating interference to the last DECT channel.

A3.2 Out-of-band emissions

With transmissions on physical channel "M" in successive frames, the power in physical channel "Y" shall be less than the values in table A11.

Emissions on RF channel "Y"	Maximum power level
Y = M ± 1	160 µW
Y = M ± 2	1 µW
Y = M ± 3	40 nW
Y = any other DECT channel	20 nW

Table A11 - DECT emissions due to modulation

NOTE: For Y = "any other DECT channel", the maximum power level shall be less than 20 nW except for one instance of a 500 nW signal.

The power in RF channel Y is defined by integration over a bandwidth of 1 MHz centred on the nominal centre frequency, Fy, averaged over at least 60 % but less than 80 % of the physical packet, and starting before 25 % of the physical packet has been transmitted but after the synchronisation word.

A3.3 Application to interference between DECT and UMTS TDD

Parameters used in a specification are not always directly applicable for compatibility studies. For instance, interpolation and other adjustments are required when distinct steps (does not happen in real equipment) and (for the adjacent system) non-relevant bandwidths occur in the specification. In the review below, we use UMTS carriers on nominal frequencies (fixed 5 MHz carrier separation); 1902.5 MHz, 1907.5 MHz etc.

For some parameters, where relevant information is available, we estimate typical parameter values to be expected for real equipment. This will make the results more realistic.

The following documents have been used to derive the proper parameters:

UMTS draft specifications (values from FDD have been used if not found for TDD)
[1] TS 25.101 v3.0.0 (MS FDD)
[2] TS 25.102 v3.0.0 (MS TDD)
[3] TS 25.104 v3.3.0 (BS FDD)
[4] TS 25.105 v3.0.0 (BS TDD)

For DECT
[5] ETSI TBR06
[6] CEPT SE7 draft report on “DECT/GSM1800 compatibility” SE7(99)28final or later revision.

Carrier position	UMTS (2 closest carriers): 1902.5 MHz, 1907.5 MHz DECT (2 closest carriers): 1897.344 MHz, 1895.616 MHz
Carrier separation	UMTS at 1902.5 MHz: 5.2 and 7.9 MHz to closest DECT carriers UMTS at 1907.5 MHz: 10.2 and 12.9 MHz to closest DECT carriers (Note that the closest DECT receive carrier falls in the middle of the first and second UMTS adjacent channel)
Bandwidth	UMTS(TDD): 4 MHz (3.84 MHz) for transmission and reception DECT: 1 MHz for transmission and reception
Separation between DECT TX carrier and UMTS receive channel	This separation is 1.5 MHz less than the carrier separation due to the wide UMTS bandwidth, whereby the DECT carrier power just falls within the UMTS bandwidth. UMTS at 1902.5 MHz: 3.7 and 6.4 MHz to closest DECT carriers UMTS at 1907.5 MHz: 8.7 and 11.4 MHz to closest DECT carriers
Reduction of 4 MHz UMTS Tx power into a 1 MHz DECT receiver	6 dB (Using the exact bandwidth 3.84 MHz for UMTS, will give 5,84 dBm. This is abbreviated to 6 dB, which is accurate enough)
Transmit power EIRP	UMTS Macro BTS: 55.5 dBm (41 dBm + 14.5 dBi antenna) UMTS indoor BTS: 30 dBm (30 dBm + 0 dBi antenna) UMTS MS: 21 dBm (21 dBm + 0 dBi antenna gain) DECT WLL (RFP and CTA): 36 dBm (24 dBm + 12 dBi ant.) DECT RFP (indoor) and MS: 24 dBm (24 dBm + 0 dBi ant.)
Acceptable interference power at receiver input	UMTS BTS: -103 dBm (= the Rx noise floor) into 4MHz UMTS MS: -99 dBm (= the Rx noise floor) into 4MHz DECT: -90 dBm into 1 MHz (10 dB below minimum installed wanted signal level –80 dBm)
Out-of-band emissions (Note 1)	DECT to UMTS 1902.5 MHz carrier: -61 dB relative total DECT power (Note 2) DECT to UMTS 1907.5 MHz carrier: -65 dB relative total DECT power (Note 3) UMTS BTS/MS1902.5 MHz carrier to DECT closest carrier 1 MHz receiver: -56/-43 dB relative total UMTS power (Note 4). UMTS BTS/MS1907.5 MHz carrier to DECT (all carriers): -66/-53 dB relative total UMTS power (Note 4).
Maximum blocking interfering levels into receiver	UMTS 1902.5 MHz to DECT (closest carrier): -33 dBm related to the UMTS power in 4 MHz bandwidth (Note 5) UMTS 1907.5 MHz to DECT (all carriers): -23 dBm related to the UMTS power in 4 MHz bandwidth (Note 6) DECT to UMTS 1902.5 MHz BTS/MS: -52/-61 dBm (Note 7) DECT to UMTS 1907.5 MHz BTS/MS: -40/-51 dBm (Note 7) DECT to UMTS 1912.5 MHz BTS/MS: -30/-39 dBm (Note 7)

Note 1: Out-of-band emissions are emissions due to modulation, due to the short frequency separation distances. 0 dBi antenna gain is applied at both ends.

Note 2: Emissions from the closest DECT carrier dominate. Relevant for 0 dBi DECT antenna. The maximum emitted power into the second adjacent DECT channel (3.4 MHz separation, steep emission curve) is specified to –30 dBm. Not all this power falls inside the 4 MHz UMTS receive filter for the 5 MHz carrier separation case. The power emission value for the DECT second adjacent channel is anyhow relevant due to a combination of the steep curve and integration over 4 MHz. Average emitted power into the second adjacent is about -37 dBm for typical DECT equipment. This typical value will be used here. *Relative 24 dBm DECT Tx power, this equals – 61 dB.*

Note 3: Emissions from the closest DECT carrier dominate –47 dBm power level is specified for the fourth adjacent DECT channel (6.9 MHz separation, here the emission curve is very flat). Typical DECT equipment is not much better. *By adding 6 dB for integration over 4 MHz, we get –41 dBm which will be used here.) Related to 24 dBm Tx power, this equals – 65 dB.*

Note 4: The Adjacent Channel Leakage power Ratio, ACLR, is for, BTS/MS 45/33 dB at 5 MHz separation and 55/43 dB at 10 MHz separation [2],[4]. The closest DECT receive carrier is at 5.2 MHz separation for UMTS carrier 1902.5 MHz and at 10.2 MHz separation for UMTS carrier 1907.5 MHz. The out-of band emissions in dBm into a 1 MHz DECT receiver filter are calculated by increasing the attenuation figures of the specified ACLR by 6 dB due to bandwidth differences. This gives BTS/MS 51/39 dB for UMTS carrier 1902.5 MHz and 61/49 dB for UMTS carrier 1907.5 MHz. Furthermore, to reflect average performance of real equipment, and to adjust for the fact that the DECT 1 MHz wide receiver will not receive as much power from the slopes as the 4 MHz wide UMTS receiver does, another 5 dB attenuation have been added to the BS emissions and 4 dB to the MS emissions. This finally gives BTS/MS 56/43 dB for UMTS carrier 1902.5 MHz and 66/53 dB for UMTS carrier 1907.5 MHz. ([2] also has a Spectrum Emission Mask requirement, but this requirement is less stringent than the ACLR requirements.)

Note 5: The blocking figure is related to the total UMTS carrier power over 4 MHz bandwidth. Due too the short frequency separation distances, the blocking levels have to be related to the IF-filter attenuation (for first, second etc. adjacent channel). The specification for DECT is –46 dBm. Typical DECT equipment is 10 dB better than the specification, which gives –36 dBm. *We are here relating this blocking figure to the total UMTS power (4 MHz bandwidth). Therefore, the figure should be reduced about 3 dB to about –33 dBm, due to the slope of the DECT blocking curve.*

Note 6: The blocking figure is related to the total UMTS carrier power over 4 MHz bandwidth. The specification for DECT in Table A6 for Blocking: 1905 - 2000 MHz is –33 dBm . Typical DECT equipment is 10 dB better than the specification, which gives –23 dBm. *We are here relating this blocking figure to the total UMTS power (4 MHz bandwidth). But since the blocking curve here is rather flat, no correction is needed as in Note 5.*

Note 7. Due to the small frequency separation, a combination of the Adjacent Channel Selectivity, ACS, requirements, and blocking requirements are to be used, as for DECT, Note 5. The ACS values are found in [2] and [4], partly through backwards calculations of the ACS and blocking requirements. MS ACS [2] is 33 dB for 5 MHz carrier separation (section 7.5.1). The noise floor –99 dB, and thus the maximum interfering power for 5 MHz separation becomes –99 + 33 dBm = -66 dBm. From the MS blocking requirements (section 7.6.1), the maximum interfering power is –56 dBm for 10 MHz carrier separation, and –44 dBm for 15 MHz carrier separation. (This corresponds to ACS values of 43 and 55 dB respectively.)
ACS is not defined for 5 MHz carrier separation in [4]. Therefore the requirement from [3] section 7.5.1 (ACS for FDD BS) are used instead. In this section the wanted signal is "reference sensitivity level" + 6 dB, which is –122 dBm + 6 dBm = 116 dBm. The permitted interfering signal is –52 dBm on the adjacent channel. At the "reference sensitivity level" (-122 dBm), the interference is the co-channel noise floor level, –103 dBm. Thus at –116 dBm wanted signal the co-channel interference is to be increased to –103 + 6 = -97 dBm. Of these –97 dBm 1/4th of the power (-6dB) comes from the noise floor and the rest from the externally applied interfering signal. Thus the co-channel power from the external interference corresponds to –98 dBm (75% of –97 dBm). Thus the BS ACS becomes 98 – 52 dB = 46 dB at 5MHz carrier offset. For blocking requirements [4] section 7.5 , the interfering signal level has been increased by 12 dB compared to section 7.5.1 above in [3]. This gives BS ACS = 58 dB for 10 MHz carrier offset. In this report we define unacceptable interference when the interfering co-channel power equals the noise floor –103 dBm. Thus the maximum allowed interfering signal for 5 MHz separation will be –103 + 46 dBm = -57 dBm and –45 dBm for 10 MHz separation. For 15 MHz separation we estimate -35 dBm.
Furthermore, to reflect average performance of real equipment, and to adjust for the fact that the DECT 1 MHz wide receiver will not receive as much power from the slopes as the 4 MHz wide UMTS receiver does, the permitted interference levels have been increased by 5 dB.

Therefore the above allowed interference levels have been increased by 5 dB to BS/MS –52/-61 dBm for 5 MHz separation, BS/MS –40/-51 dBm for 10 MHz separation and BS/MS –30/-39 dBm for 15 MHz separation.

A4 Space Operation (SO), Space Research (SR) and Earth-Exploration Satellite (EES) services

The bands 2025-2110 MHz and 2200-2290 MHz are currently allocated on a primary basis to three of the space science services : space research, space operation, earth exploration-satellite (SR, SO, EES); the fixed service (FS) and the mobile service (MS), subject to footnote S5.391 of the RR.

The band 2025-2110 MHz is allocated to Earth-to-space and space-to-space links.

The band 2200-2290 MHz is allocated to space-to-Earth and space-to-space links.

The footnote S5.391 refers to ITU-R Recommendation SA.1154 (Provisions to protect the SR, SO and EES and to facilitate sharing with the mobile service in the 2025-2110 MHz and 2200-2290 MHz band), which recommends, *inter alia* :

1 that the following provisions are suitable to protect the SR, SO and EES services from aggregate interference from emissions of mobile systems in the 2 025-2 110 MHz band:

1.1 that the aggregate interference at the input terminals of the spacecraft receiver, except in the case of a space-to-space link, should not exceed –210 dB(W/Hz) for more than 0.1% of the time;

1.2 that in the case of space-to-space links the aggregate interference at the input terminals of the spacecraft receiver should not exceed –214 dB(W/Hz) for more than 0.1% of the time;

2 that the following provisions are suitable to protect the SR, SO and EES services from aggregate interference from emissions of mobile systems in the 2 200-2 290 MHz band:

2.1 that the aggregate interference at the input terminals of the receiver in the earth station should not exceed –16 dB(W/Hz) for more than 0.1% of the time;

2.2 that the aggregate interference at the input terminals of the DRS spacecraft receiver should not exceed –214 dB(W/Hz) for more than 0.1% of the time.

ANNEX B - METHODOLOGY AND PARAMETERS FOR ASSESSING INTERFERENCE TO THE MSS SPACE SEGMENT

B1 Methodology

As shown in Figure B1, the centres of the terrestrial UMTS cells are modelled as lying on concentric rings centred on the sub-satellite point. This assumption simplifies the interference calculations since the elevation angle, the range and the Free Space Path Loss (FSPL) to the satellite are constant for each ring of cells. The radius of each ring of cells is a multiple of the single cell radius and is measured along the Earth's surface. The number of cells in a ring is calculated assuming a hexagonal cell pattern (i.e. 6 cells in the first ring, 12 in the next, 18 in the next, etc.).

The satellite forms a number of spot beams on the Earth, with a sub-satellite spot beam diameter, for current designs, of typically 600 - 700 km. It is therefore a requirement, in order to determine the worst case, to be able to undertake the interference calculations for any particular spot beam. A satellite spot beam is defined by its beam nadir angle and changing the value of this angle allows examination of any satellite beam (e.g. a sub-satellite or edge of coverage beam). Before any calculations are undertaken the spot beam to be examined, and its nadir angle, must be determined.

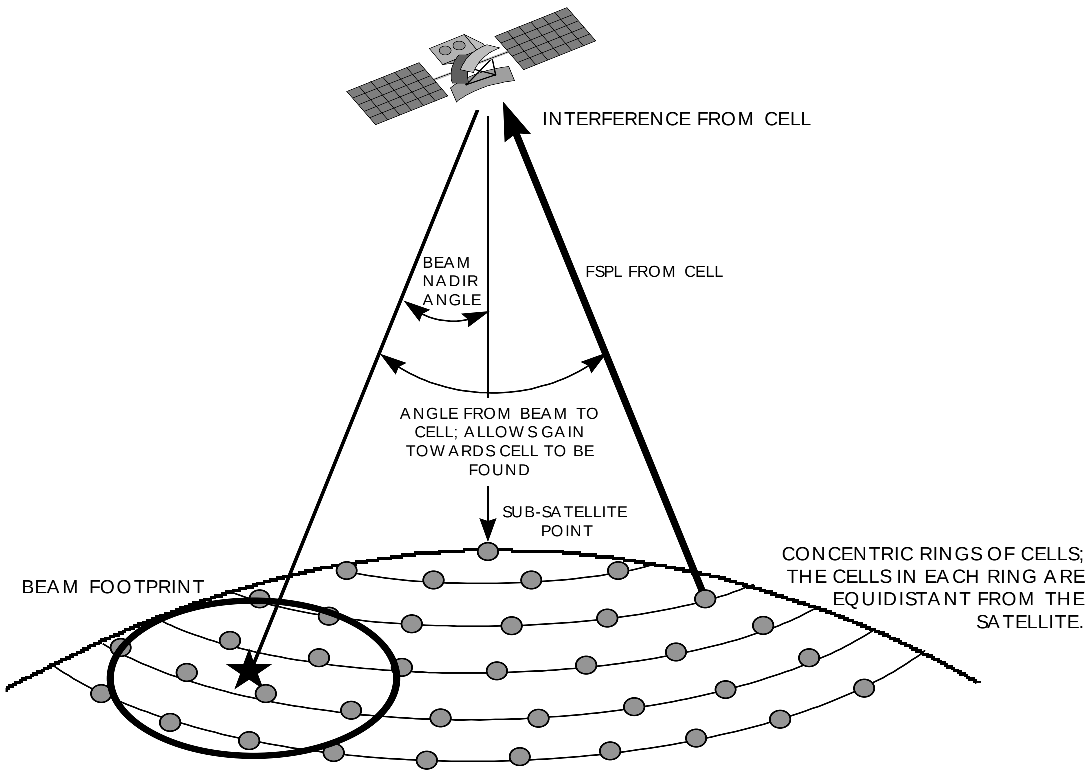


Figure B1 : Interference Calculation Methodology

For the n[th] terrestrial cell, CELL-n, the interference contribution at the satellite is calculated from:

1. The cell's total interference power, $I_{CELL\text{-}n}$. This is calculated using transmit spectrum masks and making assumptions on the number of channels in use, the number of RF carriers in use, the use of power control, etc.;

2. The Free Space Path Loss, $FSPL_{CELL\text{-}n}$, to the satellite for the ring containing CELL-n. This is calculated using the distance between the cell and the satellite;

3. The receive gain, $G_{Rx\ CELL\text{-}N}$, of the satellite beam towards CELL-n. This is calculated using:

   i) the angle between the centre of the beam and the cell (calculated using the beam nadir angle and the CELL-n nadir angle);
   ii) a model of the satellite receive antenna gain pattern.

The total interference at the satellite is then calculated by summing up the contributions from each visible cell (i.e. cells on rings with an elevation angle to the satellite greater than 0°):

$$I = \sum_{All\ Cells} (Contribution\ from\ each\ cell) = \sum_{All\ Cells} (I_{CELL-n} - FSPL_{CELL-n} + G_{Rx\ CELL-n})$$

The interference from only those cells lying within the 3 dB beamwidth of the satellite spot beam can also be calculated using the same methodology by limiting the interference summation appropriately.

Calculation of Average Terrestrial Cell Size and Average EIRP per cell

Assuming:

1. land with an area, A, which is many orders of magnitude greater than the area of a terrestrial cell

2. that the area of land can be divided into four types of terrestrial UMTS coverage:

- No coverage
- Rural coverage
- Suburban coverage
- Urban coverage

3. that each type of coverage covers a proportion of the area, A:

- No coverage; P_N
- Rural coverage; P_R
- Suburban coverage; P_S
- Urban coverage; P_U

4. that these coverages do not overlap (i.e. $P_N + P_R + P_S + P_U = 1$);

5. that each of these coverage areas can be characterised by a typical hexagonal cell radius, an average MS EIRP and an average number of active users per cell:

	Cell radius (m)	Average MS EIRP (W)	Average number of active users per cell
No coverage	N/A	N/A	N/A
Rural	R_R	E_R	U_R
Suburban	R_S	E_S	U_S
Urban	R_U	E_U	U_U

and given:

1. that the area, A_{CELL}, of a hexagonal cell of radius R is given by:

$$A_{CELL} = F(R) = \frac{3\sqrt{3}}{2} R^2$$

then:

1. the total number of terrestrial cells of coverage type i in area A, N_i, can be found:

$$N_i = \frac{P_i A}{F(R_i)}$$

2. the total number of terrestrial cells in area A, $N_{CELLS-TOTAL}$, can be found:

$$N_{CELLS-TOTAL} = N_R + N_S + N_U$$

3. the average cell area, A_{AV}, can be found:

$$A_{AV} = \frac{A}{N_{CELLS-TOTAL}}$$

4. the corresponding ***average cell radius***, R_{AV}, can be found:

$$R_{AV} = F^{-1}(A_{AV})$$

5. the total EIRP from the MSs operating at the average EIRP in the cells of coverage type i can be found:

$$E_{Ti} = N_i E_i U_i$$

6. the ***average EIRP per cell*** (across all coverage types) can be found:

$$E_{AV} = \frac{\sum_i E_{Ti}}{\sum_i N_i}$$

B2 Simplifying the use of the methodology by examining the effect of interference outside the satellite beam

The methodology aggregates the interference power falling in to a satellite beam from all the terrestrial cells in the satellite's field-of-view. Noting that a key assumption of the methodology is uniform terrestrial cellular coverage over the satellite field-of-view, the calculations can be simplified considerably by examining only interference from terrestrial cells in the 3 dB beamwidth of the satellite's spot beam and adding a 'field-of-view correction factor', C_{FOV}. This correction factor accounts for the interference contribution from all terrestrial cells outside the 3 dB beamwidth of the satellite's spot beam. For the spot beams examined in this document, the full methodology has been employed to calculate this field-of-view correction factor, C_{FOV}:

- for the sub-satellite spot beam, C_{FOV} = 6.7 dB;
- for an edge-of-coverage spot beam, C_{FOV} = 4.0 dB.

Note that this factor would change with the inclusion of a more representative antenna pattern for BSs and with the use of different satellite system parameters (although any change here would be offset elsewhere in the calculations to provide similar interference results).

ANNEX C -ASSUMPTIONS FOR MONTE-CARLO SIMULATIONS

The following assumptions were agreed for use in Monte Carlo simulations :

Interference mechanisms :

- Unwanted emissions and blocking : normally included
- Spurious emissions : not included

Path loss models :

- Propagation above roofs for BS->BS, BS->MS, MS->BS
- Propagation below roofs for MS-> MS

Victim system :

- Circular cells
- MS density depends on BS density and considered system spectrum efficiency
- Omnidirectionnal antennae
- Voice link
- Single (closest to interfering signal) or multiple channels to be considered
- Unwanted emissions integrated over receiver bandwidth

Interfering system :

- Circular cells
- Omnidirectionnal antennae
- Voice link
- For an interfering base station, multiple channels are transmitted (see presentation of results)
- Uniform distribution of interferers
- Power control may be used even for base station
- 100 interferers are considered

ANNEX D: FIXED SERVICE COMPATIBILITY STUDIES

D1 FIXED LINK DEPLOYMENT AND SHARING PARAMETERS

The ERO Study “Fixed Service trends post-1998” details the current and future fixed link deployment within Europe. The band 2025-2110/2200-2290 MHz is used in Europe for Point-to-Point- (currently Tactical radio relay in many European countries) as well as for future Point-to-MultiPoint applications in the fixed service, mainly in rural areas (wireless local loop/fixed wireless access).
The band is harmonised according to the channel plan in Annex C, ERC Rec T/R 13-01 [A]
The sharing parameters of typical 2 GHz fixed links are given in ITU-R Recommendation F.759 [B], in the ongoing revision (April 1999) of ITU-R Recommendation F.758 [C] and in ERC Rep 40 [D].

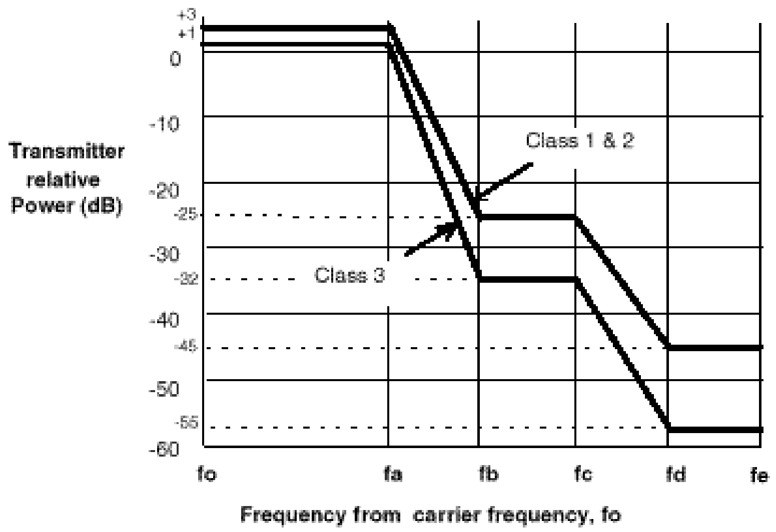
With reference to the Recommendations above, the parameters in Table D1 represents typical (i.e. not worst-case) Point-to-Point- and Point-to-Multi Point systems in the 2 GHz-band.

Parameter	**P-P (Digital)**	**P-MP Central Station**	**P-MP Terminal Station**
Antenna type	Dish/Horn	Omni/Sector	Dish/Horn
Antenna gain (dBi)	33	10/13	20 (Analogue) 27 (Digital)
Eirp (max) (dBW)	32-42	12 (Analogue) 24 (Digital	21 (Analogue) 34 (Digital)
Receiver IF Bandwidth (MHz)	0.7-21	3.5	3.5
Maximum permissible long-term interference power (20 % of time) (dBW/MHz)	-146	-147	-147

Table D1 - Typical Fixed service system parameters for frequency sharing between Point-to-Point (P-P), Point-to-MultiPoint (P-MP) and other services in the 2 GHz band

Concerning spectral characteristics (unwanted emission) for the fixed service, general guidelines is proposed in the recent revision of ITU-R Rec F.1191, april 1999, [G]. In this draft revision, the need of a bandwidth-dependent boundary between spurious and Out-Of-Band (OOB) emission is pointed out (currently 2.5×Necessary bandwidth, where the limit 250% is independent of bandwidth. A boundary of 50-250 % is proposed).

Equipment in the 2 GHz-band shall comply with the RF power spectrum mask given in ETS 300 633 [E], plotted in Figure D1. It should be pointed out that this mask is unduly pessimistic in comparison with real spectrum masks where the Out of band attenuation typically exceeds 80 dB for frequency offsets more than about 30 MHz from the channel centre frequency.



Channel Spacing	fa	fb	fc	fd	fe
500 kHz	210 kHz	325 kHz	450 kHz	800 kHz	1 250 kHz
1 MHz	420 kHz	650 kHz	900 kHz	1 600 kHz	2 500 kHz
1,75 MHz	750 kHz	1 150 kHz	1 600 kHz	2 800 kHz	4 375 kHz
2 MHz	840 kHz	1 300 kHz	1 800 kHz	3 200 kHz	5 000 kHz
3,5 MHz	1 500 kHz	2 400 kHz	3 500 kHz	6 000 kHz	8 750 kHz
7 MHz	3 000 kHz	4 800 kHz	7 000 kHz	12 000 kHz	17 500 kHz
14 MHz	6 000 kHz	9 600 kHz	14 000 kHz	24 000 kHz	35 000 kHz

Figure D1 - RF spectrum mask for FS-equipment in the 2 GHz band

D2 MODEL AND METHODOLOGY

D2.1 Propagation model

ITU-R Recommendation P.452-8 (Revised June 1999) is the agreed model in the ITU-R and CEPT for terrestrial interference assessment, and includes use of the recommended additional attenuation due to clutter in various environments.

For the considered scenarios the transmission loss L is modelled by the attenuation due to LOS-propagation (short term effects excluded, i.e., median loss) and additional diffraction due to buildings and vegetation:

$$L = 32.5 + 20\log(f) + 20\log(d) + Ah$$

Where

d is distance in km
f is frequency in MHz
Ah is ”average” clutter loss [F] in dB

$$A_h = 10.25 \times e^{-d_k} \left(1 - \tanh \left[6 \left(\frac{h}{h_a} - 0.625 \right) \right] \right) - 0.33$$

where:

d_k : distance (km) from nominal clutter point to the antenna (the interferer and interfered-with stations respectively)
h : antenna height (m) above local ground level
h_a : nominal clutter height (m) above local ground level.

Guidance is given in Rec 452-8 [F] for different categories of clutter (Dense urban, urban, industrial, sub-urban, village, etc) with corresponding nominal clutter height h_a and clutter distance d_k.

The clutter loss can be significant in scenarios where the antennas are imbedded in local ground clutter. However, in the case where the antennas are mounted on roofs etc, the clutter loss is limited. In figure D2 the average loss vs. antenna height is shown for an urban environment. It´s worth noting that the maximum loss (<20 dB) is conservative and represent the average loss for an »average» urban environment. In cases where the clutter parameters are known, they can replace the recommended parameters.

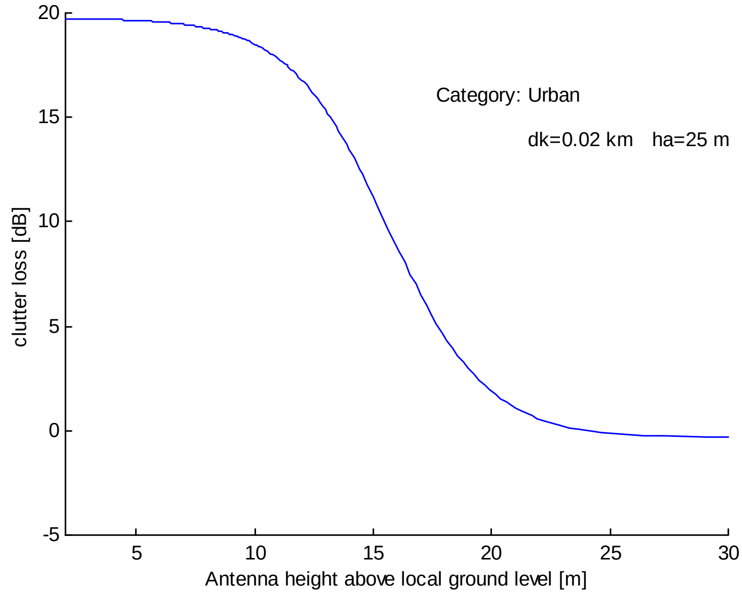


Figure D2 – Average loss due to clutter loss vs antenna height

D.2.2 Methodology for calculation of Interference

The MCL method is considered to be sufficient for examining the static case in terms of the adjacent channel sharing between stations in the fixed service and UMTS-base stations. MCL is defined as the minimum transmission loss in dB required to meet the performance objective:

MCL= Tx power – Out Of Band attenuation + Tx antenna gain + Rx antenna gain – Rx interference threshold

In the calculations below, transmit power and receiver interference threshold is expressed in the same reference bandwidth (1MHz).

D.3 CALCULATIONS

D.3.1 Fixed service interfered with UMTS

D.3.1.1 Point – to- Point systems

Due to the propagation conditions and guardbands the interference in terms of Out of Band emission from the transmitting BS (FDD) in the centre gap 2110-2170 MHz (Rec. T/R 13-01) to the FS-receiver in the upper part of the band 2025-2110 MHz is the limiting case.

Four different cases are studied with reference to the channel plan T/R 13-01 (figure D3):

a. Channel spacing 14 MHz
b. Channel spacing 7 MHz
c. Channel spacing 3.5 MHz
d. Channel spacing 1.75 MHz

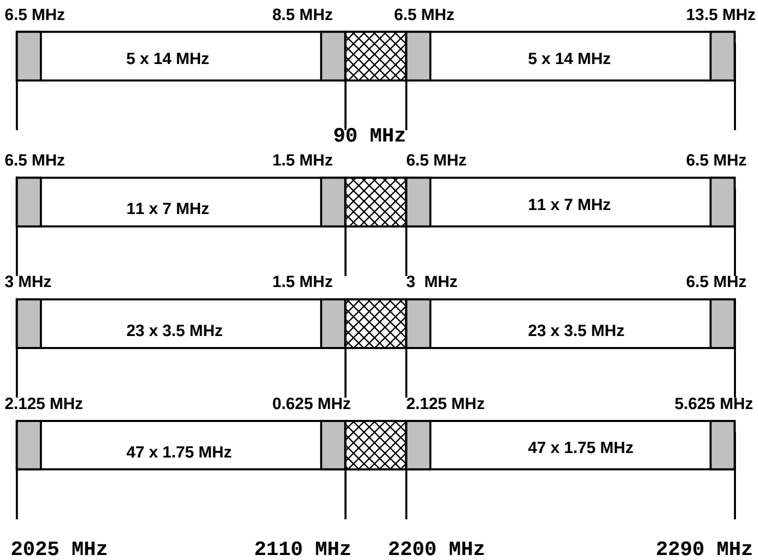


Figure D3 - Channel arrangement for the Fixed service in the band 2025-2110 MHz paired with 2200-2290 MHz

In the calculations of Minimum Coupling Loss (MCL), transmitter power and receiver threshold are expressed in a reference bandwidth of 1 MHz. The BS transmitter power is thus equal to 41-30-5.8 = 5.2 dBW/MHz. The BS emission mask is given in figure A1.[3]. In the calculation, a 3 dB factor has been taken into account to represent variations of spectra for a large number of equipment, as an design margin. The MCL calculated below represent beam-to-beam in direct line of sight interference scenarios.

Channel spacing 1.75 MHz
The outermost FS channel, carrier frequency f= 2155-128.75+47×1.75= 2108.5 MHz corresponds to a carrier separation of 2.5+0.625+1.75/2=4 MHz between BS-transmitter and FS-receiver resulting in an out of band attenuation, see figure A1.[3], of (35.1+13)+3=51 dB:

MCL=5.2-51+14.5+33- (-146)=147.7 dB

Channel spacing 3.5 MHz
The outermost FS channel, carrier frequency f= 2155-128.75+23×3.5= 2106.75 MHz corresponds to a carrier separation of 2.5+1.5+3.5/2 = 5.75 MHz between BS-transmitter and FS-receiver resulting in an out of band attenuation of (35.1+13)+3=51 dB:

MCL=5.2-51+14.5+33 - (-146)=147.7 dB

Channel spacing 7 MHz
The outermost FS channel, carrier frequency f= 2155-127.0+11×7= 2105 MHz corresponds to a carrier separation of 2.5+1.5+7/2 = 7.5 MHz between BS-transmitter and FS-receiver resulting in an out of band attenuation of roughly (35.1+13)+3=51 dB:

MCL=5.2-51+14.5+33 - (-146)=147.7 dB

Channel spacing 14 MHz

The outermost FS channel, carrier frequency f= 2155-130.5+5×14= 2094.5 MHz corresponds to a carrier separation of 2.5+8.5+14/2 = 18 MHz between BS-transmitter and FS-receiver resulting in an out of band attenuation of roughly (35.1+30)+3=68 dB:

MCL=5.2-68+14.5+33 - (-146) = 130.7 dB

Required minimum separation distance *d* is determined from the requirement L>MCL.
In the worst case (ch. Separation 1.75 MHz , beam-to-beam) and assuming that the outermost channel is <u>not</u> utilised:

$$32.5 + 20\log(2106{,}75) + 20\log(d) + Ah > 147.7$$

For the worst-case scenario with roof mounted UMTS BS (FDD) and P-P systems where the antenna heights typically are high, Line-Of-Sight transmission (Ah=0) is not unrealistic but may not be typical. In this case, assuming beam-to-beam the minimum required separation distance d is 273 km for the case 1.75 MHz ch. spacing..
Assuming additional loss of 20 dB due to Clutter (buildings, vegetations etc), transmission loss equal to 127 dB, corresponding distance is reduced to 27 km, (figure D4).

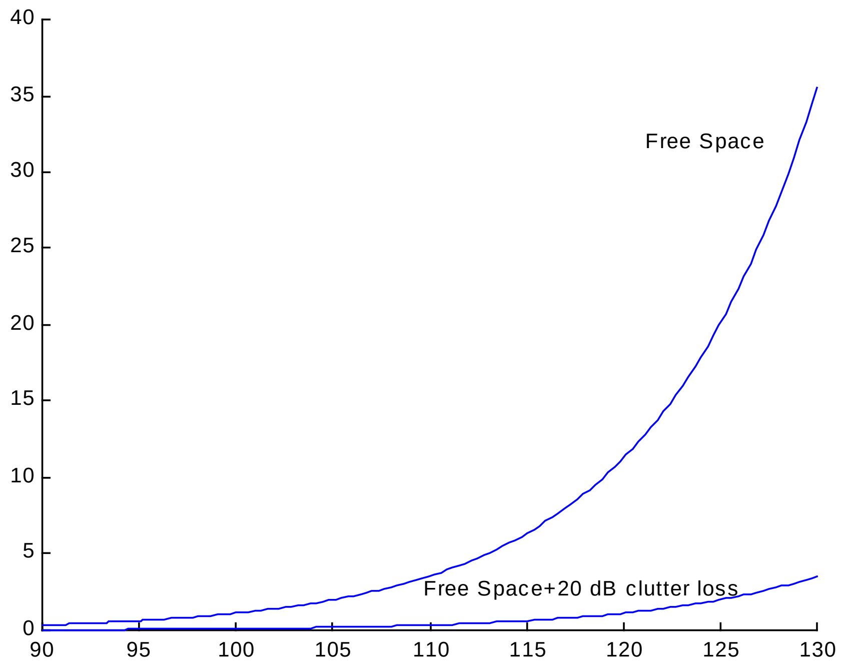


Figure D4 – Separation distance vs transmission loss

Taking into account careful planning of stations in both FS and UMTS, the FS-antenna discrimination (3 dB lobe width typically equal to ±1 degree) provides typically 20 dB attenuation. In this case, the required separation distance *d* is reduced by a factor of 10, thus 2.7 km.
Assuming careful planning of stations in both UMTS and FS, a minimum separation distance *d* of 1-2 km (MCL = 139 - 145 dB) between UMTS BS and FS stations should facilitate sharing in adjacent bands under practical conditions, with minimum carrier separation, for both the FS and UMTS operator.. The minimum carrier separation should thus be at least 8.3 (2 km) - 10.0 (1 km) MHz. T/R 13.01 [A] indicates that the outermost fixed channel should be utilised last. The most interesting is however the achieved carrier separation with the outermost fixed channel not utilised. This corresponds to 5.75 MHz (for 1.75 MHz channel spacing), 9.25 MHz (for 3.5 MHz ch. spacing), 14.5 MHz (for 7.0 MHz ch. spacing) and 32 MHz (for 14 MHz ch. spacing).

Due to the BS emission mask, fig A1.[3], MCL is reduced considerably if the carrier separation is more than 7.5 MHz. The outermost channels not utilised for the fixed service result in the following:

Rec T/R 13.01	One channel not utilised			Two channels not utilised			Three channels not utilised		
Channel spacing (MHz)	Carrier separation (MHz)	OOB attenuation (dBW/MHz)	MCL (dB)	Carrier separation (MHz)	OOB attenuation (dBW/MHz)	MCL (dB)	Carrier separation (MHz)	OOB attenuation (dBW/MHz)	MCL (dB)
1.75	5.75	51	147.7	7.5	51	147.7	9.25	57	141.7
3.5	9.25	57	141.7	---	---	---	---	--	----
7.0	14.5	68	130.7	---	---	---	---	--	----
14	---	---	---	---	---	---	---	--	---

Table D2 - MCL, carrier separation and OOB attenuation for the one, two and three outermost fixed channels not utilised.

D3.1.2 Point – to- MultiPoint systems

The receiver threshold (-147 dBW/MHz, Table D1) for both Central Station (CS) and Terminal Station (TS) is, compared to receivers in P-P systems, equivalent.
However, the antenna gain is typically 20 dB lower for the CS and at least 6 dB lower for the TS.
Consequently, in relation to the MCL applicable for P-P corresponding MCL is reduced by 20 dB (CS) and more than 6 dB (TS) respectively.

Thus, assuming a carrier separation of at least 4 MHz (dependent on channel plan):

$$MCL \approx 147.7\text{-}20 = 127.7 \text{ dB } (CS)$$
$$MCL \approx 147.7.5\text{-}6 = 141.7 \text{ dB } (TS)$$

Taking into account that TS antenna height is typically a few meters above local ground, the clutter loss will be significant in a majority of cases.
In the case of CS, the clutter loss will be limited due to the high antenna heights.

Concerning the sharing improvement due to antenna discrimination, the directional TS-antennas will provide significant reduction of the required separation distance, typically 20 dB discrimination corresponding to a factor of 10 in the reduction of distance.

The use of sector antennas in the CS will require careful planning of stations in order to achieve any significant antenna discrimination. The required separation distance will thus be 2.7 km (MCL *≈ 128, Clutter loss = 10 dB, Antenna discrimination = 10 dB).*

Assuming careful planning of stations in both UMTS and FS, a minimum separation distance *d* of 1-2 km (MCL = 139 - 145 dB) between UMTS BS and FS stations should facilitate sharing in adjacent bands under practical conditions, with minimum carrier separation, for both the FS and UMTS operator.. The minimum carrier separation should thus be at least 8.3 (2 km) - 10.0 (1 km) MHz. T/R 13.01 [A] indicates that the outermost fixed channel should be utilised last. The most interesting is however the achieved carrier separation with the outermost fixed channel not utilised. This corresponds to 5.75 MHz (for 1.75 MHz channel spacing), 9.25 MHz (for 3.5 MHz channel spacing), 14.5 MHz (for 7.0 MHz channel spacing) and 32 MHz (for 14 MHz channel spacing).

D3.2UMTS

The fixed service systems have different channel plans and channel bandwidths for the band 2025-2110 MHz according to ref. [A]. See figure D3. Four different cases are studied with focus on the worst of them.

a) 14.0 MHz channel
b) 7.00 MHz channel
c) 3.50 MHz channel
d) 1.75 MHz channel

This will result in different interference situation especially for the FS - UMTS (UE) situation. The studied scenarios are the same for the FS (P-P)-UMTS case as for the UMTS-FS (P-P).

The fixed system parameters are described in table D1 and the maximum value of 42 dBW for the Eirp will be used.

D.3.2.1 Base Station For UMTS

The scenario for interference from the fixed service system into the receiver band for UMTS is around 1980 MHz--2025 MHz for the FDD mode of UMTS. Thus at least 45 MHz separation between the systems. Blocking and out-of-band are studied.

Blocking

The value used in the blocking calculations is -15 dBm, see table A1.

The four cases a)-d) will give the same result concerning blocking.

$MCL = Tx_{Eirp} + Rx_{Antenna\ gain} - Rx_{interference\ threshold}$

MCL = 72 +14.5 - (-15) = 101.5 dB

Required minimum separation distance *d* is determined from the requirement L>MCL.

L = 32.5 + 20 log(f) + 20 log d, f = 2025 MHz

MCL<L gives the distance to be, d >1.4 km.

Out of band emissions from the fixed system

The four cases a)-d) will for these calculations only differ in the output power spectral density. The 42 dBW would be:

a)	14.0 MHz	42 dBW 30.5 dBW/MHz	60.5 dBm/MHz
b)	7.00 MHz	42 dBW 33.5 dBW/MHz	63.5 dBm/MHz
c)	3.50 MHz	42 dBW 36.6 dBW/MHz	66.6 dBm/MHz
d)	1.75 MHz	42 dBW 39.6 dBW/MHz	69.6 dBm/MHz

Case d) will be studied since it corresponds to the worst case.

$MCL = Tx_{Eirp} + Rx_{Antenna\ gain} - Rx_{interference\ threshold} + Tx$ Out of band attenuation

MCL = 69.6 + 14.5 -(-109) - 48 = 145.1 dB

Required minimum separation distance *d* is determined from the requirement L>MCL.

L = 32.5 + 20 log(f) + 20 log d, f = 2025 MHz

MCL<L gives the distance to be, d >211 km.

Thus considering the distances the out of band case is more severe than the blocking for the base station.

D.3.2.2 User equipment for UMTS

The scenario for interference from the fixed service system into the user equipment receiver band for UMTS is around 2110 MHz for the FDD mode of UMTS. The two services are adjacent concerning frequency allocations. There are therefore three cases that need investigation, blocking, adjacent channel selectivity and the effect of the transmission mask into the used UMTS channel.. For the UE input parameters see appendix A.

<u>Blocking</u>

For the blocking part it is interpreted that the blocking offset should be 10<|f-fo|<15 MHz and closer channels should be studied as adjacent. But these are only for +5 or -5 MHz. So there seems to be some discrepancies in this area, at least for studies with other system than 5 MHz channels.

The lowest attenuation for the fixed TX channels, according to the ETSI mask, figure D1, at 10-15 MHz away from the closest UMTS carrier frequency at 2010 MHz is:

	Channel spacing	Carrier separation	attenuation	attenuation at 10-15 MHz carrier separation
a)	14.0 MHz	18.0 MHz	-28 -- -48	----
b)	7.00 MHz	7.5 MHz	-28 -- -48	-28 -- -48
c)	3.50 MHz	5.75 MHz	-48	-48
d)	1.75 MHz	4.0 MHz	-48	-48

Case b) will be studied since it corresponds to the worst case.

MCL = Tx_{Eirp} + $Rx_{Antenna\ gain}$ - $Rx_{interference\ threshold}$ +Tx Out of band attenuation

MCL = 63.5 + 0 - (-56 -5.8) - 28 = 97.3 dB

Required minimum separation distance *d* is determined from the requirement L>MCL.

L = 32.5 + 20 log(f) + 20 log d, f = 2110 MHz

MCL<L gives the distance to be, <u>d >0.8 km</u>.

<u>Out of band emissions from the fixed system</u>

The out-of-band emission from the fixed into the UMTS is split into two part, the emission from the fixed channel into the main UMTS channel at 2110+2.5 MHz (position for this calculations)(RX noise floor) and signals into the adjacent channel for UMTS (Adjacent channel selectivity).

RX noise floor, emissions into the UMTS channel

Sharing would be possible if the interference from the fixed station is less than the RX noise floor for the UE, that is -98.9 dBm., i.e. -104.7 dBm/MHz for a 3.84 MHz channel

	Channel spacing	Carrier separation	Attenuation	Attenuation with outermost fixed channel not utilised
a)	14.0 MHz	18.0 MHz	-28 -- -48	-48
b)	7.00 MHz	7.5 MHz	-28 -- -48	-48
c)	3.50 MHz	5.75 MHz	-48	-48
d)	1.75 MHz	4.0 MHz	-48	-48

Case b) will be studied since it corresponds to the worst case.

MCL = Tx_{Eirp} + $Rx_{Antenna\ gain}$ - $Rx_{interference\ threshold}$ +Tx Out of band attenuation

MCL = 63.6 + 0 - (-104.7) - 28 = 140.3 dB)

Required minimum separation distance *d* is determined from the requirement L>MCL.

L = 32.5 + 20 log(f) + 20 log d, f = 2110 MHz

MCL<L gives the distance to be, <u>d >116 km</u>.

If the outermost fixed channel is not utilised case d) will be studied since it corresponds to the worst case.

MCL = 69.6 + 0 - (-104.7) - 48 = 126.3 dB)

MCL<L gives the distance to be, d >23.2 km.

Adjacent channel selectivity
The description of adjacent channel selectivity for UMTS User Equipment and extract from tables are from ref [H].

"Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive a W-CDMA signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the center frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

Minimum requirement
The ACS shall be better than the value indicated in Table 13a for the test parameters specified in Table 13b where the BER shall not exceed 0.001

Table 13a: Adjacent Channel Selectivity

Power Class	Unit	ACS
4	dB	33 "

The same method as in section RX noise floor, emissions into the UMTS channel will be used with the different that the TX out of band attenuation will be much lower but the receiver performance is improved.

Sharing would be possible if the interference from the fixed station is less than the RX noise floor for the UE, that is -98.9 dBm., i.e -104.7 dBm/MHz for 3.84 MHz channel compensated for the adjacent channel with 33 dB, i.e -104.7+33 = -71.7 dBm/MHz.

	Channel spacing	Carrier separation	Attenuation with outermost fixed channel not utilised
a)	14.0 MHz	13.0 MHz	-28
b)	7.00 MHz	2.5 MHz	+3
c)	3.50 MHz	0.75 MHz	+3
d)	1.75 MHz	(-)1.0 MHz	+3

Case b) will be studied since it corresponds to the worst case.

$MCL = Tx_{Eirp} + Rx_{Antenna\ gain} - Rx_{interference\ threshold} + Tx_{Out\ of\ band\ attenuation}$

MCL = 63.5 + 0 - (-71.7) + 3 = 138.2 dB
Required minimum separation distance *d* is determined from the requirement L>MCL.
L = 32.5 + 20 log(f) + 20 log d, f = 2110 MHz

MCL<L gives the distance to be, d >92 km.

If the outermost fixed channel is not utilised:
Case d) will be studied since it corresponds to the worst case.

MCL = 69.6 + 0 - (-71.7) - 28 = 113.3 dB
MCL<L gives the distance to be, d >5.2 km.

Thus the effects of the interference in the adjacent channel is less severe than the emission into the UMTS channel.

D4 SUMMARY AND CONCLUSIONS

In table D3 below where the calculations are summarised, the »worst case» is equivalent to beam-to-beam, Line-of-sight propagation and »typical» takes into account real transmitter filter characteristics, typical clutter attenuation as well as antenna discrimination assuming careful planning of both UMTS BS as well as P-P stations and P-MP stations (CS) in the fixed service.

The following additional attenuation is included in the »typical» separation distances (table D3):
FS, P-P↔UMTS BS: Clutter Loss 20 dB, Antenna discrimination 20 dB
(careful planning assumed)
FS, P-MP,CS←UMTS BS: Clutter Loss 10 dB, Antenna discrimination 10 dB
(extremely careful planning assumed)
FS→UMTS UE: Clutter Loss 20 dB, Antenna discrimination 20 dB

Compared to the pessimistic eirp 42 dBW for the fixed service used in the calculations, eirp is expected to be typically 10 dB lower for P-MP (CDMA) utilising ATPC.
In addition, in the case of UMTS- blocking and OOB respectively with a carrier separation of 45 MHz between the centre frequencies of FS and UMTS, real transmitter filter characteristics will add about 30 dB to the attenuation given by the ETSI-emission mask which provides no more than 48 dB out of band attenuation.
Taking these assumptions into account, the worst-case distances reduces to the typical distances, where the outermost channel (centre frequency 2108.5 MHz) in the FS channel plan with 1.75 ch. spacing is not utilised in the calculations.

Scenario	**MCL (dB)**	**Min separation distance (km) –worst case**	**Min separation distance (km) – Typical**
BS FDD→FS P-P (1.75 MHz, Carrier separation ≥5.75 MHz) (The outermost channel not used)	148	273	2.7
BS FDD→FS P-MP (Carrier separation ≥ 4.0 MHz)	128	27	2.7
BS FDD→FS P-P (Carrier separation ≥8.3 MHz)	145	200	2.0
BS FDD→FS P-MP (Carrier sep ≥ 8.3 MHz)	125	20	2.0
FS P-P→User Equipment/Blocking (7 MHz, Carrier separation ≥ 7.5 MHz)	97	0.8	<0.01
FS P-P→User Equipment/OOB (1.75 MHz, Carrier separation ≥ 5.75 MHz) (The outermost channel not used)	126	23	0.23
FS P-P→User Equipment/OOB (7.0 MHz, Carrier separation ≥ 7.5 MHz)	140	116	0.12 (not outermost channel)
FS P-P→User Equipment/Adjacent channel (7.0 MHz, Carrier separation. ≥7.5 MHz)	138	92	<0.1 (not outermost channel)
FS P-P→User Equipment/Adjacent channel (1.75 MHz, Carrier separation ≥5.75 MHz) (The outermost channel not used)	113	5	<0.05
FS P-P→Base station/Blocking/	101	1.4	<0.002
FS P-P→Base station/OOB (1.75 MHz)	145	211	0.2

Table D3 - Minimum Coupling Loss (MCL) and corresponding separation distances for different propagation conditions

The conclusions drawn from the calculations and summarised in table D3 above are:

- that, in order to facilitate the adjacent sharing approximately 2 km separation distance and 8.3 MHz carrier separation is required. The 8.3 MHz carrier separation corresponds to not utilising the 3 outermost FS.channels (1.75 MHz channel spacing) or the outermost FS-channel (3.5 and 7 MHz channel spacing) in the upper part of 2025-

2110 MHz (ERC Rec T/R 13-01). All FS channels with 14 MHz channel spacing can be utilised. This is consistent with a footnote in the same Rec: *"the outermost channels should be utilised last, to provide further time for detailed study of compatibility with future mobile services in the adjacent bands"*. UMTS is one of these mobile services. Taking the required carrier separation into account(8.3 MHz at a minimum distance of approximately 2km), ERC Recommendation T/R 13-01 should be revised.

- that the outermost UMTS channel (2020-2025 MHz and 2110-2115 MHz) preferably is used in pico- and microcell applications. In this case, the adjacent sharing is improved due to increased clutter loss and increased antenna discrimination. In addition, the increase in carrier separation of 5 MHz (first Macro-channel) will increase the out-of-band attenuation significantly

- that, due to the large separation distances of approximately 2 km required to protect stations in the Fixed Service (table D3),FS deployment in urban areas is not recommended.

In summary, considering that P-P as well as P-MP applications in the 2 GHz band, due to the propagation conditions, mainly will operate in rural areas where long paths are necessary, the necessary co-ordination of stations in UMTS and the Fixed Service should be feasible.
Consequently, careful planning of UMTS base stations and stations (P-P, P-MP CS) in the Fixed Service should avoid harmful interference to the UMTS BS from the fixed service as well as harmful interference to the FS receivers exceeding the long-term criteria.

D.5 REFERENCES

[A] CEPT ERC Recommendation T/R 13-01 E, ”Preferred channel arrangements for fixed services in the range 1-3 GHz”, 1993

[B] Recommendation UIT-R F.759, ”Use of frequencies in the band 500 to 3000 MHz for radio-relay systems”, 1992

[C] Recommendation ITU-R F.758-1, ”Considerations in the development of criteria for sharing between the terrestrial fixed service and other services”, October 1998

[D] CEPT ERC Report 40, ”Fixed service system parameters for frequency sharing”, October 1996

[E] ETSI, ETS 300 633, ”Transmission and Multiplexing; Digital Radio Relay Systems, Low and medium capacity point-to-point DRRS operating in the frequency range 2.1 -2.6 GHz”, June 1997

[F] Recommendation ITU-R P.452-8, ”Prediction procedure for the evaluation of microwave interference between stations on the surface of the earth at frequencies above about 0.7 GHz”, June 1999

[G] Recommendation ITU-R F.1191, ”Bandwidth and unwanted emissions of digital radio-relay systems”, April 1999

[H] 3GPP, ”Technical Specification, UE Radio transmission and reception (FDD)”, 1999-06, TS 25.101 V2.0.0

ANNEX E – DECT/UMTS COMPATIBILITY ANALYSIS

Calculation of Minimum Coupling Loss, MCL, and corresponding Minimum Separation Distance, MSD

The tables below shows the calculated Minimum Coupling Loss, MCL (dB), and corresponding Minimum Separation Distance, MSD (m), using parameters from section1 of this document.

Note that the bandwidth conversion factors are already included in the parameters of the table in section 1.

The free space attenuation is L(dB) = 38 + 20 log d, d is in (m).

The indoor propagation model is L (dB) = 38 + 20logd for d < 10 m,
and L (dB) = 18 + 40logd for d > 10 m.

E.1. Interference to DECT

Case	**EIRP (dBm)**	**UMTS Tx carrier (MHz)**	**Receiver antenna gain (dB)**	**Receiver BLO interference (4 MHz wide) level (dBm) . (Margin N)**	**MCL (dB)**	**Propagation Model**	**MSD (m)**
1a, 6a	55.5	1902.5	12	-33	100.5	Free space	1 330
1b, 6b	55.5	1902.5	12	-23 (N=10 dB)	90.5	Free space	420
1c, 6c	55.5	1907.5	12	-23	90.5	Free space	420
1d, 6d	**55.5**	**1907.5**	**12**	**-13 (N=10 dB)**	**80.5**	**Free space**	**130**
1e, 6e	**55.5**	**1912.5**	**12**	**-23**	**90.5**	**Free space**	**420**
26a	55.5	1902.5	0	-23 (N=10 dB)	78.5	Fr. sp.+15 dB	19
26b	**55.5**	**1907.5**	**0**	**-13 (N=10 dB)**	**68.5**	**Fr. sp.+15 dB**	**6**
12a,22a	30	1902.5	0	-33	63	Free space	18
12b,22b	**30**	**1907.5**	**0**	**-23**	**53**	**Free space**	**6**
18b,28b	**30**	**1907.5**	**0**	**-13 (N=10 dB)**	**43**	**Indoor mod.**	**2**
4, 9	**21**	**1907.5**	**12**	**-23**	**56**	**Free space**	**8**
20a,30a	21	1902.5	0	-33	54	Indoor mod.	6
20b,30b	**21**	1902.5	0	-23 (N=10 dB)	44	Indoor mod.	2
20c,30c	21	**1907.5**	**0**	**-23**	**44**	**Indoor mod.**	**2**
20d,30d	**21**	**1907.5**	**0**	**-13 (N=10 dB)**	**34**	**Indoor mod.**	**1**

Table E1 - MSD calculations, DECT is the victim due to blocking (BLO)

Example of calculation: For the first row in the table above we get: MCL = 55.5 (Interferer EIRP) + 33 (Max 4 MHz wide interference level at victim receiver) + 12 (DECT victim antenna gain) = 100.5 dB.

Case	**OOB EIRP (dBm) in 1 MHz**	**UMTS Tx carrier (MHz)**	**Receiver antenna gain (dB)**	**Receiver co-ch. interference level (dB). (Margin N)**	**MCL (dB)**	**Propagation Model**	**MSD (m)**
1a, 6a	55.5-56	1902.5	12	-90	101.5	Free space	1 500
1b, 6b	55.5-56	1902.5	12	-80 (N=10 dB)	91.5	Free space	470
1c, 6c	55.5-66	1907.5	12	-90	91.5	Free space	470
1d, 6d	**55.5-66**	**1907.5**	**12**	**-80 (N=10 dB)**	**81.5**	**Free space**	**150**
26a	55.5-56	1902.5	0	-80 (N=10 dB)	79.5	Fr. sp.+15 dB	21
26b	**55.5-66**	**1907.5**	**0**	**-80 (N=10 dB)**	**69.5**	**Fr. sp.+15 dB**	**7**
12a,22a	30-56	1902.5	0	-90	64	Free space	20
12b,22b	**30-66**	**1907.5**	**0**	**-90**	**54**	**Free space**	**6**
18b,28b	**30-66**	**1907.5**	**0**	**-80(N=10 dB)**	**44**	**Indoor mod.**	**2**
4, 9	**21-53**	**1907.5**	**12**	**-90**	**70**	**Free space**	**40**
20a,30a	21-43	1902.5	0	-90	68	Indoor mod.	18
20b,30b	21-43	1902.5	0	-80(N=10 dB)	58	Indoor mod.	10
20c,30c	**21-53**	**1907.5**	**0**	**-90**	**58**	**Indoor mod.**	**10**
20d,30d	**21-53**	**1907.5**	**0**	**-80(N=10 dB)**	**48**	**Indoor mod.**	**3**

Table E2 - MSD calculations, DECT is the victim due to out-of-band (OOB) emissions

Example of calculation: For the first row in the table above we get : MCL = 55.5 (Interferer EIRP) - 56 (Attenuation relative interferer EIRP at victim receiver frequency after 1 MHz bandwidth limitation) + 90 (Max interference co-channel level at victim receiver) + 12 (DECT victim antenna gain) = 101.5 dB.

We conclude that the dominating interference mechanism to DECT is Out-Of-Band emissions from UMTS.

E.2. Interference to UMTS

Case	**OOB EIRP (dBm) in 4 MHz**	**UMTS Tx carrier (MHz)**	**Receiver antenna gain (dB)**	**Receiver co-ch. interference level (dB). (Margin N)**	**MCL (dB)**	**Propagation Model**	**MSD (m)**
1a, 6a	36-61	1902.5	14.5	-103	92.5	Free space	530
1b, 6b	36-61	**1902.5**	**14.5**	**-93 (N=10 dB)**	**82.5**	**Free space**	**170**
1c, 6c	36-65	1907.5	14.5	-103	88.5	Free space	330
1d, 6d	36-65	**1907.5**	**14.5**	**-93 (N=10 dB)**	**78.5**	**Free space**	**106**
21a	24-61	1902.5	14.5	-103	80.5	Free space	130
21b	24-65	1907.5	14.5	-103	76.5	Free space	84
12a,22a	24-61	1902.5	0	-103	66	Free space	25
12b,22b	24-65	**1907.5**	**0**	**-103**	**62**	**Free space**	**16**
18a,28a	24-61	**1902.5**	**0**	**-93 (N=10 dB)**	**56**	**Indoor mod.**	**8**
18a,28b	24-65	**1907.5**	**0**	**-93 (N=10 dB)**	**52**	**Indoor mod.**	**5**
4, 9	36-61	1902.5	0	-89(N=10 dB)	64	**Free space**	20
20a,30a	24-61	1902.5	0	-99	62	Indoor mod.	13
20b,30b	24-61	1902.5	0	-89(N=10 dB)	52	Indoor mod.	5
20c,30c	24-65	**1907.5**	**0**	**-99**	**58**	**Indoor mod.**	**10**
20d,30d	24-65	**1907.5**	**0**	**-89(N=10 dB)**	**45**	**Indoor mod.**	**2**
14a,24a	24-61	1902.5	**0**	**-99**	**62**	**Free space**	**16**
14b,24b	24-65	**1907.5**	**0**	**-99**	**58**	**Free space**	**10**

Table E3 - MSD calculations, UMTS is the victim due to out-of-band (OOB) emissions

Case	EIRP (dBm)	UMTS Tx carrier (MHz)	Receiver antenna gain (dB)	Receiver BLO interference level (dB). (Margin N)	MCL (dB)	Propagation Model	MSD (m)
1a, 6a	36	1902.5	14.5	-52	102.5	Free space	1 680
1b, 6b	**36**	**1902.5**	**14.5**	**-42 (N=10 dB)**	**92.5**	**Free space**	**530**
1c, 6c	36	1907.5	14.5	-40	90.5	Free space	420
1d, 6d	**36**	**1907.5**	**14.5**	**-30 (N=10 dB)**	**80.5**	**Free space**	**130**
1e, 6e	**36**	**1912.5**	**14.5**	**-30**	**80.5**	**Free space**	**130**
1f, 6f	36	1912.5	14.5	-20 (N=10 dB)	70.5	Free space	42
21a	24	1902.5	14.5	-52	90.5	Free space	420
21b	24	1907.5	14.5	-40	78.5	Free space	106
12a,22a	24	1902.5	0	-52	76	Free space	80
12b,22b	**24**	**1907.5**	**0**	**-40**	**66**	**Free space**	**25**
18a,28a	**24**	**1902.5**	**0**	**-42 (N=10 dB)**	**66**	**Indoor mod.**	**16**
18b,28b	**24**	**1907.5**	**0**	**-30 (N=10 dB)**	**54**	**Indoor mod.**	**6**
4, 9	36	1902.5	0	-51(N=10 dB)	87	**Free space**	280
20a,30a	24	1902.5	0	-61	85	Indoor mod.	47
20b,30b	**24**	1902.5	0	-51 (N=10 dB)	75	Indoor mod.	27
20c,30c	24	**1907.5**	**0**	**-51**	**75**	**Indoor mod.**	**27**
20d,30d	**24**	**1907.5**	**0**	**-41 (N=10 dB)**	**65**	**Indoor mod.**	**15**
20e,30e	**24**	**1912.5**	**0**	**-39**	**63**	**Indoor mod.**	**13**
20f,30f	**24**	**1912.5**	**0**	**-29 (N=10 dB)**	**53**	**Indoor mod.**	**5.6**
14a,24a	**24**	1902.5	**0**	**-61**	**85**	**Free space**	**220**
14b,24b	**24**	**1907.5**	**0**	**-51**	**75**	**Free space**	**71**

Table E4 - MSD calculations, UMTS is the victim due to blocking (BLO)

We conclude that the dominating interference mechanism to UMTS in Blocking due to limited interference rejection of the power of the (closest) DECT carriers.

E3. Discussions and conclusions for the different cases

E3.1 Mutual interference between UMTS Macro BTS and DECT WLL system, RFPs and CTAs. Cases 1 and 6.

For Cases 1 and 6 see discussions in section E.3.1.

E3.2 Interference between a DECT indoor system and an MS from a (macro cell or outdoor micro cell) UMTS TDD system being at the same location as the DECT system . Cases 20 and 30.

For Cases 20 and 30 see discussions in section 3.1.

E3.3 Interference between Outdoor UMTS MS and DECT WLL system , RFPs and CTAs. Cases 4 and 9.

UMTS MS and are typically not in line of sight of DECT WLL equipment. The calculations are made for free space propagation, which will very seldom occur.

UMTS MSs will have 34.5 dB less EIRP than UMTS macro BTSs. Further more, a close by DECT RFPs or CTAs can easily escape to a other time slot if required. **Therefore interference from UMTS MS to DECT WLL is not critical.**

There is some probability that interference will occur to UMTS MS, especially on carrier 1902.5 MHz. **Interference from DECT WLL to UMTS MS, is not very critical, but could occasionally occur on carrier 1902.5 MHz.**

E3.4 Interference between Out door UMTS below roof-top (micro) BTS and DECT WLL system , RFPs and CTAs. Cases 2 and 7.

Cases 2 and 7 have not been calculated in the above tables, but cases 4 and 9 could be used as reference, although the MCL for interference to UMTS will be 5.5 dB higher and for interference to DECT 9 dB higher. The BTSs are however not mobile, and since they are installed below roof-top it is possible to avoid LOS to DECT RFPs and the separation distance is no longer critical. Special site engineering may be required for a very limited number of above roof-top CTAs so that they do not point directly at the UMTS BTS. A close by DECT CTAs can easily by iDCS escape to a other time slot if required. **Mutual interference can be avoided with proper site engineering, not critical.**

E3.5 Interference between Outdoor UMTS below roof-top (micro) BTS and Outdoor DECT below roof-top RFP and outdoor DECT MS. Cases 12 and 22.

This case 12 and 22 will occur in one country (DECT CTM) and when private DECT systems are locally extended to cover outdoor areas. The probability for these cases are low except for 31 cities in that country. **Interference to DECT is not critical due to iDCS**.

There is some probability that interference will occur to UMTS micro-cell BTS, especially on carrier 1902.5 MHz (80 m). An UMTS MS outdoors in a city with CTM, will almost always be within 80 m from a CTM DECT RFP. But the traffic load on the CTM is very low and the UMTS connections are not always at range limit.**Interference from DECT (CTM Italy) to UMTS micro cell BTS could occasionally occur on carrier 1902.5 MHz.**

E3.6 Interference between Outdoor MS and Outdoor DECT below roof-top RFP and outdoor DECT MS. Cases 14 and 24.

This case 14 and 24 will occur in Italy (DECT CTM) and when private DECT systems are locally extended to cover outdoor areas. The probability for these cases are low except for 31 cities in Italy. **Interference to DECT is not critical due to iDCS**.

Interference could occur to UMTS MS, especially on carrier 1902.5 MHz (220 m). 71 m for 1907.5 MHz. An UMTS MS outdoors in a city with CTM, will always be within 220 m, and often within 56m, from a CTM DECT RFP. But the traffic load on the CTM is very low (1 slot) and the UMTS connections are not always at range limit. **Interference from DECT (CTM Italy) to UMTS MS will occasionally occur on carrier 1902.5 MHz, and could occur to lesser extent at 1907.5 MHz.** The problem for the UMTS MS is exactly the same as for the MS indoor cases 20 and 30. If these cases are improved by proper dynamic channel selection procedures for UMTS TDD, also cases 14 and 24 (and other cases) would improve considerably for UMTS.

E4 Instant Dynamic Channel Selection, iDCS, application to UMTS TDD

If UMTS TDD is provided with a DECT compatible instant Dynamic Channel Selection procedure, iDCS, the coexistence would dramatically improve for many of the mutual interference cases.

DECT instantaneous Dynamic Channel Selection (iDCS) provides co-existence between systems with different carrier spacing, different carrier bandwidth and different slot length, as long as the TDMA frame cycle is a 10 ms or a sub-multiple of 10 ms. Efficient or compatible co-existence with DECT requires however both 10 ms frame cycle time, and duplex (or double simplex) bearers defined as two equal length time slots on the same carrier with 5 ms separation between the time slots. The difference in carrier bandwidth/spacing and in slot length should not be very large.

Introduction of instant Dynamic Channel Selection, iDCS, to the UMTS/TDD standard, would facilitate the application of UMTS/TDD outdoor micro-cell infrastructures, both in relation to DECT indoor systems, UMTS/TDD indoor systems and to interference between two UMTS/TDD outdoor micro-cell infrastructures in the same local area (street). Such iDCS has to include application of multiple instances of the access channels and of the down-link broadcast and synchronisation channels. Furthermore, the efficiency of the iDCS increases when a system has access to more than one carrier.