Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

THE TECHNICAL IMPACT OF INTRODUCING CDMA-PAMR ON 12.5 / 25 kHz PMR/PAMR TECHNOLOGIES IN THE 410-430 and 450-470 MHz BANDS

Granada, February 2004

EXECUTIVE SUMMARY

This report considers the technical impact of introducing CDMA-PAMR on the existing PMR/PAMR radio systems/services in the bands 410-430 and 450-470 MHz. In this report, the term PMR/PAMR radio systems/services refers to 12.5 kHz and 25 kHz analogue systems and other systems compliant with EN 300 086-2 and EN 300 113, including NMT-450, Mobitex, Tetrapol and EN 300 392 (TETRA). The report establishes the level of interference, which can be expected to affect analogue PMR/PAMR, NMT-450, TETRA, Mobitex or Tetrapol systems in the harmonised CEPT bands between 410-430 and 450-470 MHz when CDMA-PAMR is deployed adjacent to them. The impact of CDMA-PAMR on NMT-450 used in Fixed Wireless Access applications has also been studied. This study is included in Annex 3.

Monte Carlo simulations have been performed using the CEPT's SEAMCAT modelling tool in order to establish the level of interference from CDMA-PAMR to PMR/PAMR systems. The simulations have considered four scenarios, namely:

- Scenario 1, CDMA-PAMR Mobile Stations (MS) into PMR/PAMR MS (at frequencies around the duplex transition frequency)
- Scenario 2, CDMA-PAMR MS into PMR/PAMR Base Stations (BS) (at frequencies in the uplink band)
- Scenario 3, CDMA-PAMR BS into PMR/PAMR MS (at frequencies in the downlink band)
- Scenario 4, CDMA-PAMR BS into PMR/PAMR BS (at frequencies around the duplex transition frequency)

In the last of these four scenarios, the use of SEAMCAT alone to calculate the level of interference is not sufficient to establish compatibility between CDMA-PAMR BS transmitters and PMR/PAMR BS receivers when they are operating at frequencies close to each other (e.g. close to the duplex transition frequencies at 420 or 460 MHz). For such cases, MCL modelling has been performed in order to establish the conditions under which the two systems can co-exist, and the mitigation measures that may be necessary in order to ensure that interference is avoided. The report establishes that co-ordination between CDMA-PAMR and incumbent PMR/PAMR services is required in some circumstances in order to avoid interference to PMR/PAMR BS receivers from CDMA-PAMR BS transmitters. The report further establishes the separation distances and/or other mitigation measures necessary to avoid interference.

The report concludes that the CEPT PMR/PAMR bands between 410-430 and 450-470 MHz can be utilised for CDMA-PAMR with negligible risk of interference to PMR/PAMR, including TETRA, NMT-450, Mobitex and Tetrapol systems provided the following constraints (guard bands or frequency separation around the duplex transition frequency between the uplink and downlink bands[1]) are applied:

- A guard band of 200 kHz in the uplink-to-uplink band (MS to BS) and downlink-to-downlink band (BS to MS) interference scenarios,
- A frequency separation of 125 kHz or less at the duplex transition frequency between the uplink and downlink bands (MS to MS) interference scenarios,
- A frequency separation of 1875 kHz at the duplex transition frequency between the uplink and downlink bands (BS to BS) interference will limit necessary mitigation to between 0.5% of BSs (using duplex filter type 1) to around 20% of BSs (using frequency duplex filter type 2) for a CDMA-PAMR BS density of 0.03142/sq.km[2]. If additional frequency separation is used, the need for co-ordination and/or mitigation reduces. In reality this frequency separation is expected to be larger than 1.875 MHz (ECC Report 25),

The additional mitigation measures that may be required have been calculated using MCL. These are:

To avoid desensitisation due to blocking or 3rd order intermodulation (IMD3) of PMR/TETRA BS receivers, additional filtering at the PMR/TETRA BS receiver may be required when a PMR/TETRA BS receiver is located within a certain distance (around 100 m for PMR and 500 m for TETRA using filter type 1; filter type 2 will require very large separation distances and therefore may be inappropriate for urban areas without additional filtering under these conditions) from a CDMA-PAMR BS transmitter. The amount of filtering required is dependent on the actual

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[1] In this report the term guard band is considered to be the minimum frequency separation between the channel edges of the two systems. Similarly, frequency separation around the duplex transition frequency between the uplink and downlink bands refers to the frequency separation between the channel edges of the two systems.

[2] The values quoted exclude the effect of intermodulation because at present SEAMCAT is unable to simulate this correctly. Manual simulations indicate that an increase in the values of around 50 % to 0.75 and 30 % respectively may be expected.

frequency, the number of carriers, the separation distance, type of antennas deployed, the transmitter power of the CDMA-PAMR BS and the duplex filter attenuation of the PMR/TETRA receiver.
In the case of wide band noise, the results again indicate that filtering is required at the CDMA-PAMR BS transmitter when it is located within a certain distance (around 100 m for PMR and 500 m for TETRA) of a PMR/TETRA BS receiver. The amount of filtering required is dependent on the actual frequency, the number of carriers, the type of antennas deployed, the transmitter power, the separation distance and the duplex filter attenuation of the CDMA-PAMR transmitter.

It should be noted that this report did not consider interference from existing PMR/PAMR radio systems into CDMA-PAMR deployed in adjacent bands, since the effect from the new systems on the incumbent ones is the most important part to deal with.

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The technical impact of introducing CDMA-PAMR on 12.5 / 25 kHz PMR/PAMR technologies in the 410-430 and 450-470 MHz bands

1 INTRODUCTION

This report considers the technical impact of introducing CDMA-PAMR on the existing PMR/PAMR radio systems/services in the bands 410-430 and 450-470 MHz. In this report, the term PMR/PAMR radio systems/services refers to 12.5 kHz and 25 kHz frequency modulated (FM) PMR/PAMR systems and other systems compliant to EN 300 086-2, EN 300 113-2 and EN 300 392 (TETRA), including NMT-450, Mobitex and Tetrapol. The impact of CDMA-PAMR on NMT-450 used in Fixed Wireless Access applications has also been considered, as given in Annex 3.

Part of the calculations in this report have been performed using the specifications from EN 300 113. This is because this specification is representative for a large number of systems and by applying the specification for 12.5 kHz this will also cover 25 kHz. Again, the reason is that the blocking figures remain the same for 12.5 and 25 kHz and that whilst the receiver bandwidth is slightly wider than double for 25 kHz, this is countered by a 4 dB reduction in a co-channel rejection ratio. It is therefore considered that using the 12.5 kHz requirements is representative for the purpose of this study.

The report also contains calculations according to EN 300 392 to cover the interference from CDMA-PAMR to TETRA V+D.

The report considers in particular the interference from CDMA-PAMR, as specified in the Lucent SRDoc, into existing PMR/PAMR systems including TETRA in the 400 MHz bands. Monte Carlo modelling has been performed using SEAMCAT in order to investigate the interference to a PMR/PAMR system caused by the introduction of a CDMA-PAMR network in adjacent spectrum with a guard band between them. The simulations focus on a 1.25 MHz band for CDMA-PAMR because the impact of a second or a third carrier is insignificant. This is because of the steep roll-off of the wide band noise through the duplex filter and the carrier frequency separation of 1.25 MHz. The modelling has investigated the effects of interference from both CDMA-PAMR BS and MS to both PMR/PAMR BS and MS.

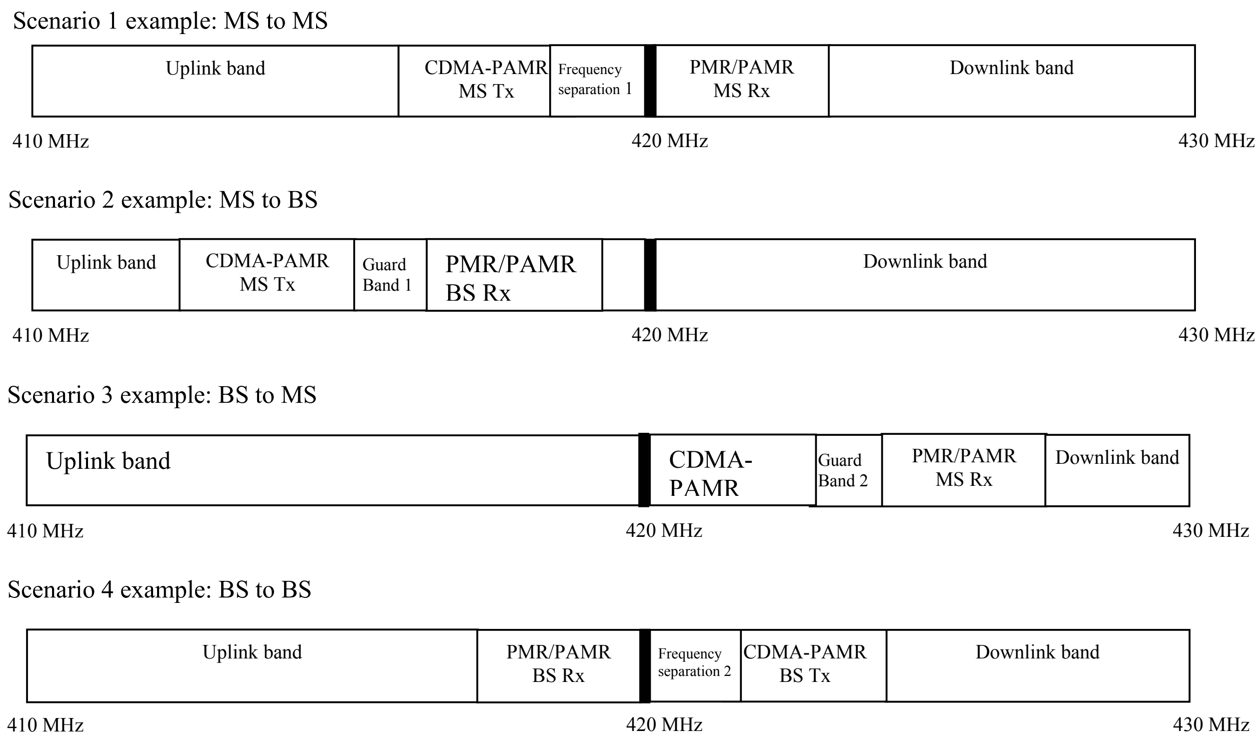


Figure 1: Examples of different scenarios of PMR/PAMR vs. CDMA-PAMR systems in the 410-430 MHz band, similar figures apply to the 450-470 MHz band

In addition to the Monte Carlo modelling, the report also focused in more detail on adjacent band compatibility at the duplex frequency boundaries (see Fig.1), in particular on interference from CDMA-PAMR BS transmissions into PMR/PAMR BS receivers. The report specifically studied different scenarios of PMR/PAMR and CDMA-PAMR systems in the 410-430 MHz bands, as shown in Fig. 1. However, similar results would apply to the 450-470 MHz bands.

It should be noted that the report did not consider interference from existing PMR/PAMR radio systems into CDMA-PAMR deployed in adjacent bands, since the effect from the new systems on the incumbent ones is the most important part to deal with.

2 METHODOLOGY

2.1 Monte Carlo

Monte Carlo (MC) modelling using SEAMCAT® (Spectrum Engineering Advanced Monte Carlo Analysis Tool) was undertaken for following scenarios:

- Scenario 1, CDMA-PAMR MS into PMR/PAMR MS (at frequencies around the duplex transition frequency)
- Scenario 2, CDMA-PAMR MS into PMR/PAMR BS (at frequencies in the uplink band)
- Scenario 3, CDMA-PAMR BS into PMR/PAMR MS (at frequencies in the downlink band)
- Scenario 4, CDMA-PAMR BS into PMR/PAMR BS (at frequencies around the duplex transition frequency).

These scenarios were modelled for a CDMA-PAMR single channel of 1250 kHz interfering with a block of 2 MHz of PMR/PAMR (160x12.5 kHz channels) where the geographical position of the systems and frequencies of the PMR/PAMR systems were randomised. In addition, a scenario was modelled where a PMR/PAMR system was operating on a single adjacent channel to provide more precise information about the impact of the guard band (all other parameters remaining as described above).

In the scenarios where MSs are involved, the SEAMCAT® was used exclusively. This is because of the statistical distribution of the MSs, for which reason MCL was deemed inappropriate. SEAMCAT has been used to simulate the effect of blocking, spurious emissions and wide band noise upon PMR/PAMR.

In the special case of the CDMA-PAMR BS to PMR/PAMR BS scenario the SEAMCAT® tool was used to determine the actual size of the problem of interference between two BSs randomly positioned within a given area and with random selected frequency from within their respective sub bands.

2.2 MCL

Minimum Coupling Loss (MCL) is a method that involves calculating a static link budget. It was used in addition to the MC SEAMCAT tool for the BS-to-BS scenarios (see Fig. 4), where CDMA-PAMR is the interferer and PMR/PAMR is the victim. This approach was used because both the interferer and victim are stationary both in frequency and geographical position (static interference scenario). MCL provided a means to address the worst case scenario, which can determine how much additional attenuation is required for interference-free operation.

MCL was used in the frequency range where uplink meets downlink (e.g. around 419-421 MHz), for the case CDMA-PAMR downlink -> PMR/PAMR uplink. The PMR/PAMR system and CDMA-PAMR uses a single channel for the blocking, spurious and wide band noise calculations. For the IMD3 calculations two CDMA-PAMR carriers were used, as well as the case of one CDMA-PAMR carrier and the TX leakage from the PMR/PAMR BS. MCL has been used to simulate the effect of blocking, IMD3, spurious emissions and wide band noise upon PMR/PAMR.

3 INTERFERENCE MODELLING

This section presents results from the interference modelling, firstly using SEAMCAT and then using MCL for the BS-to-BS case.

The study investigated the interference that occurs from a CDMA-PAMR transmitter into a PMR/PAMR receiver. In the following it is assumed that the separation between the edge of the PMR/TETRA BS RX band and the edge of the CDMA-PAMR BS TX band is at least 1.875 MHz.

The following mechanisms have been identified that need to be considered when introducing CDMA-PAMR services in the band:

1) Blocking will occur where the incoming power from the CDMA-PAMR transmitter is above the specified PMR/PAMR blocking level; this will desensitise the PMR/PAMR base receiver, so that the reference sensitivity performance may not be maintained.

2) The Unwanted Emission (Spurious Emission and Wide Band Noise) from the CDMA-PAMR transmitter that is above the receiver sensitivity will desensitise the PMR/PAMR base receiver, so that low level signals may not be received.

3) Desensitisation of the PMR/PAMR BS receiver because of IMD3 will occur if two or more RF signals exceed the specified levels and if the mixed frequencies contain a frequency component at the PMR/PAMR BS receiver frequency. The following mechanisms of IMD3 have been investigated and it was concluded that the predominant sources would be adequately covered by the cases (a) where two CDMA carriers are received by the PMR/PAMR BS receiver and (b) in which the leakage of the PMR transmitter forms IMD3 products in the presence of a CDMA carrier:
   a) IMD3 due to mixing of three received CDMA-PAMR carriers operating in the adjacent frequency range between 2.5-5 MHz above the transition frequency. This case may happen only when the lowest of the CDMA-PAMR carriers are deployed simultaneously with one or both of the others. The effect of the IMD3 product will be limited to the frequencies between 417.1875 or, for the upper band, 457.1875 MHz and the duplex transition frequency. Because of the slope of the duplex filter, the IMD3 product will peak at the duplex transition frequency. The calculations for this case have been made around this peak. The IMD3 product decreases it's amplitude at frequencies below the transition frequency. Please note that under normal conditions the blocking will be the dominant interference mechanism.
   b) IMD3 due to mixing of leakage from TETRA's "own" TX within the downlink band and a received CDMA-PAMR carrier operating in the downlink band. To create maximum interference for a single carrier system, the TETRA transmitter frequency must be 6.875 MHz above the duplex transition frequency. This may cause IMD3 to occur at the frequencies between 416,875 or, for the upper band, 456.875 MHz and the transition frequency. The calculations for this case have been made around this peak. For a single carrier system, the IMD3 product will disappear below this frequency and will decrease above this frequency with the steepness of the slope of the duplex filter, i.e. 21–31 dB/MHz. This can be seen in Figure 6d, which also indicates where blocking becomes dominant. For multi-carrier systems, one or more IMD products can occur anywhere within the TETRA receive band, depending on the particulars of the frequency plan. Please note that the mitigation (if required) should take account of the actual TETRA transmitter power (see Annex 2).
   c) IMD3 due to mixing of a TETRA in-band blocker and a received CDMA-PAMR carrier operating in the down link band.
   d) IMD3 due to a single CDMA-PAMR carrier in immediate adjacency to the TETRA BS RX band
   e) Cross-modulation (XMD) due to mixing of a TETRA in-band blocker and a received CDMA-PAMR carrier operating in the down link band.

It should be noted, that IMD3 cases, in general, are very sensitive to the filter function of the duplex filters.

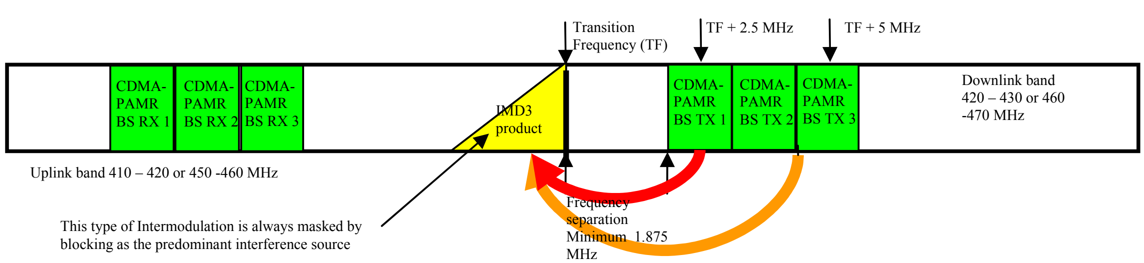


Figure 2: Example of Intermodulation case a)

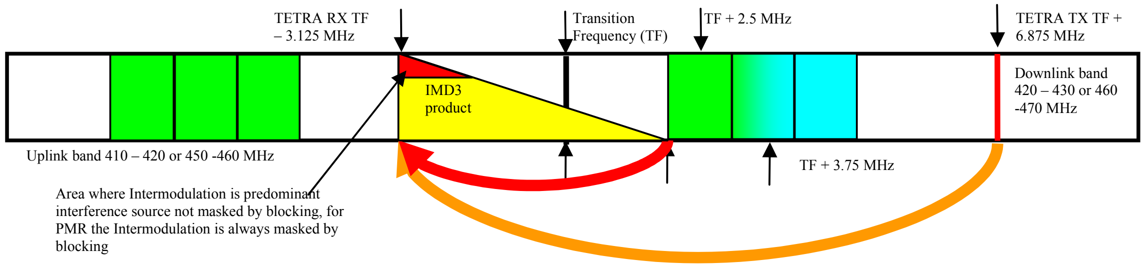


Figure 3: Example of Intermodulation case b) for a single carrier system

Where available, the values used in the calculations have been derived using standard specification values as these represent the minimum requirements even though it is recognised that in practice real equipment performance may be better. With respect to the parameters required for the MCL and MC methods used in this report it was decided to use the requirements of EN 300 113, EN 300 392, TIA/EIA 97/98E and the Lucent SRDoc.

3.1 Propagation models and Active Interferer Densities

The propagation models were selected so as to be appropriate for the task.

3.1.1 Monte Carlo models

All MC studies were undertaken using the Extended Hata propagation model as defined by WGPT SE21.

3.1.2 Minimum Coupling Loss

ITU recommends that for distances up to 1 km ITU Rec. P.1411 is appropriate. However, for this distance and for antenna heights above 9 m, P.1411 and the Free Space propagation model delivers the same mean value of propagation loss. In the MCL study scenario, CDMA-PAMR BS TX into PMR/PAMR BS RX the Free Space propagation model has been used to calculate the loss.

3.1.3 Active Interferer Densities

Active Interferer Density (AID) was calculated on the assumption that a limited amount of spectrum would be available. This report focused on a 1.25 MHz band for CDMA-PAMR because the impact of a second and third carrier is considered insignificant. This is because of the steep roll-off of the CDMA-PAMR wide band noise through the duplex filter and the carrier separation of 1.25 MHz. Hence, this report is valid for more than one CDMA carrier. The maximum and typical AID figures in Table 1 are quoted per carrier.

Environment	Cell Radius (km)	Cell Area (km^2)	AID (max) per carrier ($1/km^2$)	Max number of Users per carrier at 0.015 Erlang	AID (typical) per carrier ($1/km^2$)	Typical number of Users per carrier at 0.015 Erlang
Urban	3.5	32	0.25	534	0.1	213
Suburban	7	127	0.05	423	0.02	169
Rural	20	1039	0.01	693	0.004	277

Table 1: Description of CDMA-PAMR Cell Radii and Active Interferer Density

The maximum urban AID has been assumed to be 0.5 per sq.km (representing hot spots). Assuming that two carriers are likely to be provided in dense urban areas, an AID of 0.25 per sq.km per carrier is expected.
The BS densities are calculated as 1/cell area in sq.km.

When the SEAMCAT study was undertaken the possibility was considered that the interference from the victim system might raise the power control threshold of the CDMA system. This would have resulted in an increase of the interference potential of CDMA-PAMR. Facilities were therefore included in the power control models to simulate this form of interference. It was found that, at the AIDs that were under consideration, a difference of 1 dB was found in no more than 1% of the simulations. It was concluded that this effect was not significant for these simulations.

This effect, however, should be considered for systems which have higher AID than considered here.

3.2 Monte Carlo modelling results

Monte Carlo simulations were performed using the SEAMCAT tool in order to establish the level of interference from CDMA-PAMR into PMR/PAMR 12.5kHz systems. The simulations considered four scenarios, namely:

- Scenario 1, CDMA-PAMR MS into PMR/PAMR MS (at frequencies around the duplex transition frequency)
- Scenario 2, CDMA-PAMR MS into PMR/PAMR BS (at frequencies in the uplink band)
- Scenario 3, CDMA-PAMR BS into PMR/PAMR MS (at frequencies in the downlink band)
- Scenario 4, CDMA-PAMR BS into PMR/PAMR BS (at frequencies around the duplex transition frequency).

The effect of a CDMA-PAMR 1.25 MHz band into PMR/PAMR is considered representative for one or more carriers. This is because of the roll-off of the wide band noise compared to the very wide channel, which leads to that a second carrier's contribution to the wide band noise is 1.25 MHz further away. This allows for simplified SEAMCAT simulations using a single carrier for CDMA-PAMR.

In each results table the typical values of interference are highlighted.

The frequencies used for the guard bands and frequency separation around the duplex transition frequency were selected from specified points on the roll-off of the wide band noise of the CDMA-PAMR transmitter mask. However, in the case of the frequency separation, it is expected that these will be equal to or greater than 1.875 MHz. This is consistent with the approach of ECC Report 25 and is also used in the MCL calculations in this report.

3.2.1 Scenario 1 Results: MS to MS

The following tables contain results of SEAMCAT modelling of the interference from CDMA-PAMR MS into PMR/PAMR MS for a variety of different guard bands.

		Urban		**Suburban**		**Rural**	
Frequency separation ⇩	**AI D⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
125k		0.036%	0.006%	0.005%	0.001%	0.001%	0.000%
200k		0.014%	0.011%	0.004%	0.001%	0.000%	0.000%
260k		0.012%	0.007%	0.001%	0.001%	0.000%	0.000%
500k		0.008%	0.006%	0.004%	0.000%	0.001%	0.000%
1355k		0.006%	0.000%	0.000%	0.000%	0.000%	0.000%
3375k		0.001%	0.000%	0.000%	0.000%	0.000%	0.000%

Table 2.1: Interference probability (%) from a CDMA-PAMR MS single channel into PMR/PAMR MS 2 MHz band

Frequency separation ⇩	AID⇨	Urban		Suburban		Rural	
		0.25	0.10	0.05	0.02	0.01	0.004
125k		0.058%	0.027%	0.009%	0.004%	0.003%	0.000%
200k		0.048%	0.016%	0.013%	0.004%	0.002%	0.000%
260k		0.045%	0.016%	0.012%	0.003%	0.000%	0.000%
500k		0.028%	0.010%	0.009%	0.004%	0.001%	0.000%
1355k		0.024%	0.008%	0.002%	0.001%	0.000%	0.000%
3375k		0.008%	0.003%	0.002%	0.000%	0.000%	0.000%

Table 2.2: Interference probability (%) from a CDMA-PAMR MS single channel into TETRA MS 2 MHz band

Frequency separation ⇩	AID⇨	Urban		Suburban		Rural	
		0.25	0.10	0.05	0.02	0.01	0.004
125k		0.070%	0.018%	0.016%	0.003%	0.001%	0.000%
200k		0.063%	0.014%	0.015%	0.004%	0.002%	0.000%
260k		0.061%	0.024%	0.019%	0.007%	0.003%	0.000%
500k		0.029%	0.014%	0.006%	0.000%	0.000%	0.000%
1355k		0.004%	0.002%	0.000%	0.000%	0.000%	0.000%
3375k		0.004%	0.000%	0.000%	0.000%	0.000%	0.000%

Table 2.3: Interference probability (%) from a CDMA-PAMR MS single channel into PMR/PAMR MS single adjacent channel

		Urban		Suburban		Rural	
Frequency separation ⇩	**AID⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
125k		0.152%	0.063%	0.024%	0.004%	0.014%	0.005%
200k		0.122%	0.041%	0.030%	0.008%	0.013%	0.005%
260k		0.110%	0.037%	0.029%	0.010%	0.011%	0.002%
500k		0.087%	0.023%	0.013%	0.006%	0.000%	0.000%
1355k		0.029%	0.009%	0.009%	0.004%	0.000%	0.000%
3375k		0.014%	0.003%	0.002%	0.001%	0.000%	0.000%

Table 2.4: Interference probability (%) from a CDMA-PAMR MS single channel into TETRA MS single adjacent channel

The results indicate that, even for AID values that are very high, the probability of interference is very low.

3.2.2 Scenario 2 Results: MS to BS

The following tables contain results of SEAMCAT modelling of interference from CDMA-PAMR MS into PMR/PAMR BS for a variety of different guard bands.

		Urban		Suburban		Rural	
Guard Band⇩	**AID ⇨**	**0.25**	**0.1**	**0.05**	**0.02**	**0.01**	**0.004**
125k		0.110%	0.031%	0.052%	0.003%	0.043%	0.014%
200k		0.078%	0.024%	0.032%	0.011%	0.028%	0.005%
260k		0.074%	0.029%	0.039%	0.012%	0.032%	0.007%
500k		0.043%	0.022%	0.024%	0.006%	0.017%	0.001%
1355k		0.017%	0.002%	0.005%	0.001%	0.004%	0.002%
3375k		0.004%	0.000%	0.001%	0.000%	0.000%	0.000%

Table 3.1: Interference probability (%) from a CDMA-PAMR MS single channel into PMR/PAMR BS 2 MHz band

		Urban		Suburban		Rural	
Guard Band⇩	**AID ⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
125k		0.859%	0.319%	0.312%	0.123%	0.282%	0.087%
200k		0.737%	0.273%	0.290%	0.110%	0.224%	0.081%
260k		0.693%	0.247%	0.230%	0.093%	0.208%	0.061%
500k		0.434%	0.140%	0.149%	0.055%	0.120%	0.041%
1355k		0.171%	0.065%	0.054%	0.013%	0.041%	0.016%
3375k		0.111%	0.030%	0.030%	0.013%	0.023%	0.008%

Table 3.2: Interference probability (%) from a CDMA-PAMR MS single channel into TETRA BS 2 MHz band

		Urban		Suburban		Rural	
Guard Band⇩	**AID ⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
125k		0.365%	0.116%	0.175%	0.058%	0.170%	0.053%
200k		0.406%	0.143%	0.191%	0.050%	0.193%	0.067%
260k		0.351%	0.141%	0.178%	0.061%	0.180%	0.041%
500k		0.150%	0.051%	0.072%	0.026%	0.080%	0.020%
1355k		0.018%	0.007%	0.008%	0.000%	0.017%	0.002%
3375k		0.001%	0.005%	0.004%	0.001%	0.001%	0.000%

Table 3.3: Interference probability (%) from a CDMA-PAMR MS single channel into PMR/PAMR BS single adjacent channel

		Urban		Suburban		Rural	
Guard Band⇩	**AID ⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
125k		2.851%	1.058%	1.174%	0.413%	1.129%	0.373%
200k		2.763%	0.989%	1.132%	0.395%	1.128%	0.400%
260k		2.742%	1.007%	1.079%	0.388%	1.066%	0.365%
500k		1.223%	0.470%	0.501%	0.184%	0.439%	0.144%
1355k		0.295%	0.110%	0.101%	0.041%	0.087%	0.030%
3375k		0.113%	0.041%	0.037%	0.013%	0.023%	0.011%

Table 3.4: Interference probability (%) from a CDMA-PAMR MS single channel into TETRA BS single adjacent channel

3.2.3 Scenario 3 Results: BS to MS

The following tables contain results of SEAMCAT modelling of interference from CDMA-PAMR BS into PMR/PAMR MS for a variety of different guard bands.

		Urban		Suburban		Rural	
BS AID⇨		**0.03142**		**0.007855**		**0.0009623**	
Guard Band⇩	**MS AID ⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
125k		0.15%	0.13%	0.14%	0.11%	0.11%	0.11%
200k		0.10%	0.083%	0.062%	0.068%	0.070%	0.068%
260k		0.076%	0.068%	0.052%	0.060%	0.050%	0.042%
500k		0.066%	0.056%	0.049%	0.054%	0.038%	0.035%
1355k		0.055%	0.054%	0.047%	0.049%	0.035%	0.035%
3375k		0.050%	0.050%	0.045%	0.045%	0.035%	0.034%

Table 4.1: Interference probability (%) from a CDMA-PAMR BS single channel into PMR/PAMR MS 2 MHz band

		Urban		Suburban		Rural	
BS AID⇨		0.03142		0.007855		0.0009623	
Guard Band⇩	MS AID ⇨	0.25	0.10	0.05	0.02	0.01	0.004
125k		0.516%	0.441%	0.343%	0.302%	0.260%	0.248%
200k		0.306%	0.271%	0.178%	0.171%	0.157%	0.154%
260k		0.275%	0.261%	0.163%	0.159%	0.146%	0.144%
500k		0.282%	0.226%	0.145%	0.145%	0.122%	0.111%
1355k		0.232%	0.203%	0.130%	0.139%	0.126%	0.105%
3375k		0.241%	0.221%	0.153%	0.148%	0.129%	0.102%

Table 4.2: Interference probability (%) from a CDMA-PAMR BS single channel into TETRA MS 2 MHz band

		Urban		Suburban		Rural	
BS AID⇨		0.03142		0.007855		0.0009623	
Guard Band⇩	MS AID ⇨	0.25	0.10	0.05	0.02	0.01	0.004
125k		2.5%	2.3%	2.3%	2.4%	2.5%	2.4%
200k		0.63%	0.56%	0.52%	0.52%	0.55%	0.54%
260k		0.34%	0.32%	0.27%	0.28%	0.27%	0.25%
500k		0.073%	0.072%	0.059%	0.060%	0.055%	0.055%
1355k		0.069	0.052%	0.041%	0.038%	0.028	0.025%
3375k		0.046	0.049%	0.039%	0.036%	0.025%	0.023%

Table 4.3: Interference probability (%) from a CDMA-PAMR BS single channel into PMR/PAMR MS single adjacent channel

		Urban		Suburban		Rural	
BS AID⇨		**0.03142**		**0.007855**		**0.0009623**	
Guard Band⇩	**MS AID ⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
125k		7.778%	7.194%	5.832%	5.477%	5.169%	4.851%
200k		1.474%	1.373%	1.027%	0.968%	0.920%	0.855%
260k		0.557%	0.511%	0.380%	0.357%	0.341%	0.319%
500k		0.300%	0.275%	0.187%	0.178%	0.171%	0.164%
1355k		0.263%	0.242%	0.150%	0.146%	0.121%	0.111%
3375k		0.253%	0.240%	0.139%	0.132%	0.114%	0.107%

Table 4.4: Interference probability (%) from a CDMA-PAMR BS single channel into TETRA MS single adjacent channel

3.2.4 Scenario 4 Results: BS to BS

The following tables contain results of SEAMCAT modelling of interference from CDMA-PAMR BS into PMR/PAMR BS for a variety of different frequency separations, including the minimum frequency separation used for the MCL calculations. The results are expressing a percentage of BSs where additional mitigation is needed. It should be noted that the simulations do not reflect the duplex filter/combiner of the victim system. The values are therefore expected to be reduced. Examples of this can be seen in tables 5.2a and 5.4a where two different typical duplex filters has been taken into account using the same minimum frequency separation as has been used for the MCL calculations. The values quoted exclude the effect of Intermodulation because at present SEAMCAT is unable to simulate this correctly. Manual simulations indicate that an increase in the values of around 50% to 0.75 and 30% respectively may be expected.

For the special case where downlink interferes with uplink around the transition frequencies, i.e. at 420 and 460 MHz, although the probabilities of interference are reasonably low for the suburban and rural cases, the results for the urban case suggest that co-ordination is required.

		Urban		Suburban		Rural	
BS AID⇨		0.03142		0.007855		0.0009623	
Frequency separation⇩	MS AID⇨	0.25	0.10	0.05	0.02	0.01	0.004
125k		7.9%	7.5%	7.3%	7.1%	4.4%	4.0%
200k		5.9%	5.4%	5.4%	5.1%	2.7%	2.4%
260k		5.1%	4.6%	4.6%	4.2%	2.0%	1.9%
500k		3.8%	3.4%	3.3%	3.0%	1.2%	1.1%
1355k		3.5%	3.2%	3.1%	2.8%	1.1%	1.0%
1875k		3.3%	3.2%	3.1%	2.7%	1.1%	0.9%
3375k		3.4%	3.0%	3.0%	2.7%	1.1%	1.0%

Table 5.1: Interference probability (%) from a CDMA-PAMR BS single channel into PMR/PAMR BS 2 MHz band (PMR without duplex filter)

		Urban		Suburban		Rural	
BS AID⇨		0.03142		0.007855		0.0009623	
Frequency separation ⇩	MS AID⇨	0.25	0.10	0.05	0.02	0.01	0.004
125k		29.4%	27.9%	23.7%	22.8%	15.2%	14.3%
200k		27.2%	25.8%	21.7%	20.8	12.8%	12.0%
260k		26.3%	24.8%	20.7%	19.8%	11.9%	11.1%
500k		24.7%	23.3%	19.5%	18.7%	11.1%	10.3%
1355k		22.6%	21.1%	17.8%	17.0%	9.8%	9.1%
1875k		22.3%	21.1%	17.5%	16.7%	10.0%	9.0%
3375k		22.4%	21.0%	17.6%	16.8%	9.8%	9.2%

Table 5.2: Interference probability (%) from a CDMA-PAMR BS single channel into TETRA BS 2 MHz band (TETRA without duplex filter)

		Urban		Suburban		Rural	
BS AID⇨		**0.03142**		**0.007855**		**0.0009623**	
Frequency separation ⇩	**MS AID⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
1875k (Duplex filter type 1)		0.53%	0.40%	0.23%	0.22%	0.03%	0.03%
1875k (Duplex filter type 2)		20.17%	19.03%	15.54%	14.72%	8.31%	7.81%

Table 5.2a: Interference probability (%) from a CDMA-PAMR BS single channel into TETRA BS 2 MHz band (with TETRA Duplex filters type 1 and 2)

		Urban		Suburban		Rural	
BS AID⇨		**0.03142**		**0.007855**		**0.0009623**	
Frequency separation ⇩	**MS AID⇨**	**0.25**	**0.10**	**0.05**	**0.02**	**0.01**	**0.004**
125k		66%	64%	66%	64%	59%	57%
200k		34%	32%	33%	32%	25%	23%
260k		21%	20%	21%	20%	13%	13%
500k		5.3%	4.8%	4.8%	4.4%	1.9%	1.6%
1355k		3.6%	3.4%	3.2%	3.0%	1.1%	1.0%
1875k		3.3%	3.1%	3.0%	2.7%	1.1%	0.9%
3375k		3.3%	3.1%	3.1%	2.8%	1.1%	1.0%

Table 5.3: Interference probability (%) from a CDMA-PAMR BS single channel into PMR/PAMR BS single adjacent channel (PMR without duplex filter)

		Urban		Suburban		Rural	
BS AID⇨		0.03142		0.007855		0.0009623	
Frequency separation ⇩	MS AI D⇨	0.25	0.10	0.05	0.02	0.01	0.004
125k		91.9%	91.1%	89.3%	88.5%	85.4%	84.4%
200k		69.6%	67.9%	63.0%	61.8%	53.1%	51.5%
260k		47.4%	45.4%	40.1%	38.5%	28.5%	27.3%
500k		32.0%	30.5%	25.3%	24.6%	15.5%	14.7%
1355k		23.0%	21.4%	17.7%	17.0%	10.0%	9.2%
1875k		22.6%	21.4%	17.4%	16.6%	10.0%	9.4%
3375k		22.7%	21.2%	17.4%	16.7%	9.7%	9.1%

Table 5.4: Interference probability (%) from a CDMA-PAMR BS single channel into TETRA BS single adjacent channel (TETRA without duplex filter)

		Urban		Suburban		Rural	
BS AID⇨		0.03142		0.007855		0.0009623	
Frequency separation ⇩	MS AI D⇨	0.25	0.10	0.05	0.02	0.01	0.004
1875k (Duplex filter type 1)		1.7%	1.5%	0.80%	0.75%	0.16%	0.11%
1875k (Duplex filter type 2)		22.71%	21.25%	17.66%	17.00%	10.04%	9.30%

Table 5.4a: Interference probability (%) from a CDMA-PAMR BS single channel into TETRA BS single adjacent channel (with TETRA Duplex filters type 1 and 2)

3.3 MCL modelling for the BS-to-BS case (Scenario 4)

The scenario used for the BS-to-BS interference includes the urban and suburban cases where antennas of BSs are mounted on rooftops. This will lead to a worst case situation where the antennas of the CDMA-PAMR and PMR/PAMR BSs are facing each other and have a direct line-of-sight. For this scenario a separation distance of 20 m was selected to form the basis for the calculations. This scenario reflects a situation where a PMR/PAMR antenna is at a rooftop on one side of a road and an CDMA-PAMR antenna on the other. It was considered that at a distance separation of 20 m the antennas had reached their specified gain.

Another scenario for BS-to-BS case is where antennas are co-sited, for this a coupling loss of 30 dB between the antennas has been introduced because this is a recognised standard value. An alternative coupling loss of 40 dB has been also considered, recognising that site engineering is able to provide additional coupling loss. In the calculations the 30 dB value is incorporated as a 1 m point not shown in the figure. This provides for somewhat peculiar curve form that is depicted between the 10 m point and the 20 m point. At distance separations below 20 m, it is considered that antenna gain is very unpredictable and will be depending on the actual antennas deployed. This part of the curve should therefore not be used for co-ordination purposes without checking the actual coupling loss.

In the following figures 5 to 8, the attenuation required to avoid interference as a function of separation distance is depicted. The MCL method was used to calculate the interference that may occur. The figures make use of the worst case scenario from the calculations of interference and add a free space propagation to extrapolate the required attenuation as a function of the physical separation distance.

The calculations were made for 20 m separation distance for the rooftop-to-rooftop scenario. For the close proximity of antennas scenario there are calculations for 30 dB and 40 dB isolation between the antennas.

A graphic representation is provided for desensitisation from blocking and IMD3 in the PMR/PAMR BS receiver by a CDMA-PAMR transmitter as a function of separation distance for different power levels (figures 5 and 6). Also the influence of the spurious emission from CDMA-PAMR is provided as a function of separation distance (figure 7). Further the influence of the wide band noise from CDMA-PAMR is provided as a function of separation distance for different frequency separations (figure 8).

The frequencies used in these calculations are examples only. The lowest frequency used for the MCL calculation is the closest carrier that is ever expected to be allocated. According to ECC Report 25, the frequencies for wide band services should be allocated up and down from around the middle of the band (415/425 or 455/465 MHz) according to national existing services in these bands. By using a carrier at 2.5 MHz above the transition frequency between up- and down-link the effect is that only 1.675 MHz will be available to existing narrow band services at the low end of the band. This is unlikely to be realistic and it must be expected that the lowest CDMA-PAMR carrier therefore will be at a higher frequency than used in this report. Consequently the calculations in this report will represent a worst case. However, should lower frequencies be used than the lowest carrier used in this report, a re-calculation must be performed to identify the required attenuation to avoid harmful interference to the services just below the transition frequency. The calculation method can be found in Annex 1. It should also be noted that the duplex filters used for PMR, TETRA and CDMA-PAMR, as specified in Annex 2, are a critical part of the required attenuation. Attention should therefore be drawn to this effect when selecting duplex filters and any additional attenuation and if required, must be taken into account.

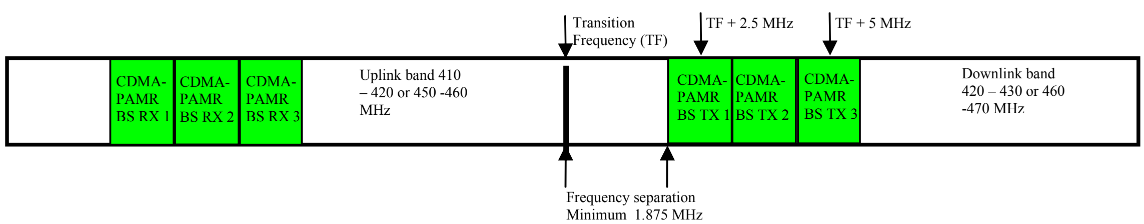


Figure 4: Worst case location of CDMA-PAMR carriers for the purpose of the MCL calculations

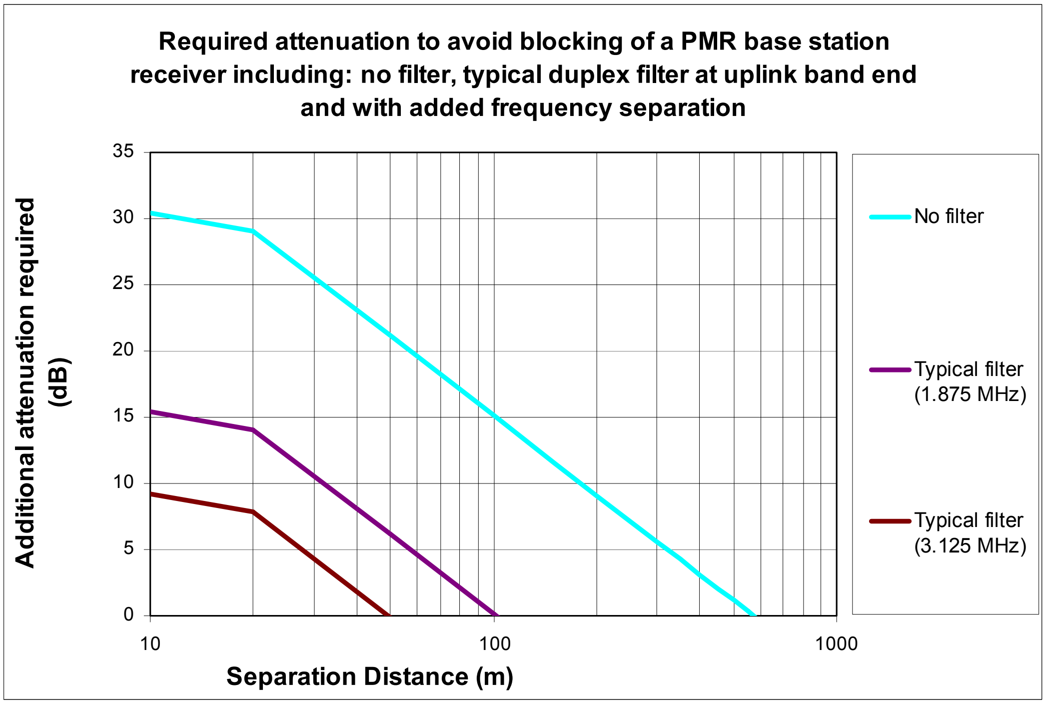


Figure 5a: Required attenuation to avoid blocking of a PMR BS receiver

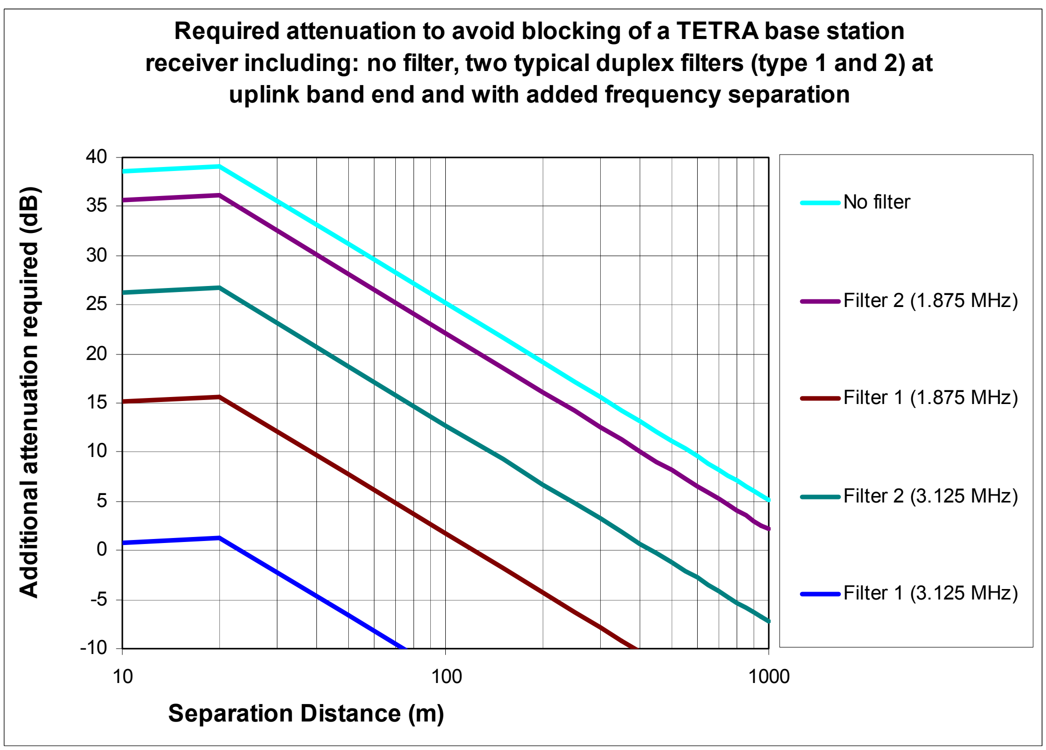


Figure 5b: Required attenuation to avoid blocking of a TETRA BS receiver

For tables 3a and b reference is made to tables 6 (a) to (g) “Required attenuation for blocking” for antennas facing on adjacent buildings (20 m) scenario at an ERP of 53 dBm for a frequency being 2.5 MHz above the transition frequency. The calculation includes typical PMR/TETRA duplex filters at the uplink band end and at a frequency separation of 3.125 MHz. The additional separation distances have been derived by extrapolation.

It should be noted that the impact of blocking is only transmitter output power dependent. The required filter must be located at the PMR/TETRA BS receiver input. The affected PMR/TETRA BS Receivers could be at one or more sites in the area surrounding the CDMA-PAMR Transmitter.

Required attenuation for two carriers = 10*LOG10(10^(attenuation 1st carrier/10)+10^(attenuation 2nd carrier /10)).

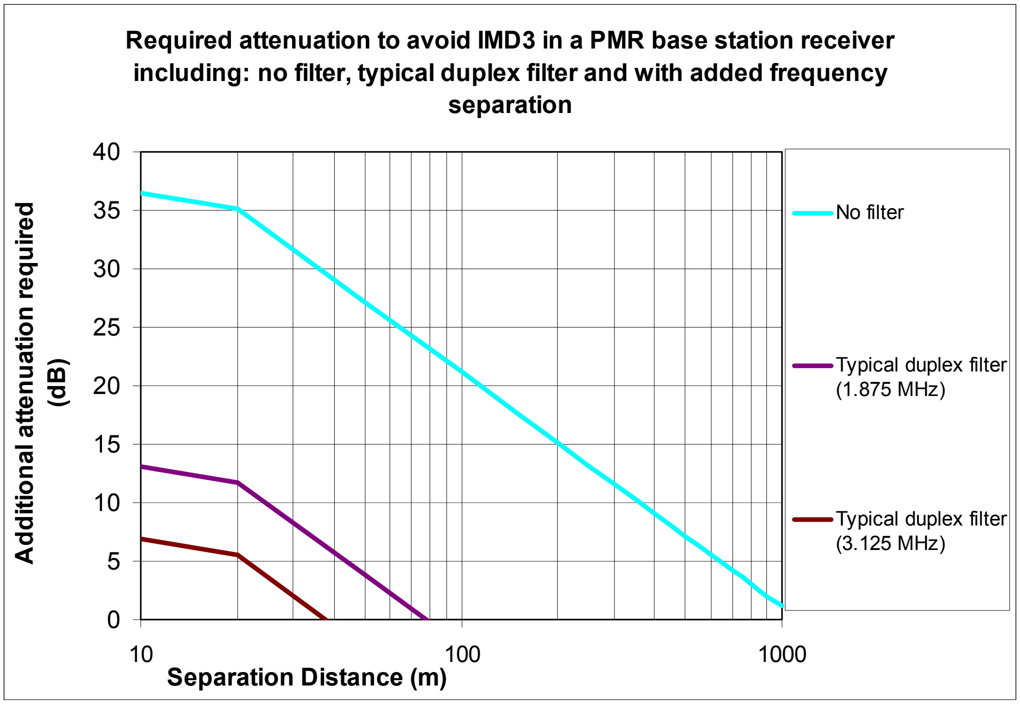


Figure 6 a: Filter requirement for IMD3 improvement of PMR receivers

No further investigation of this type of IMD3 has been made because the required attenuation to avoid blocking of the PMR BS receiver is always predominant.

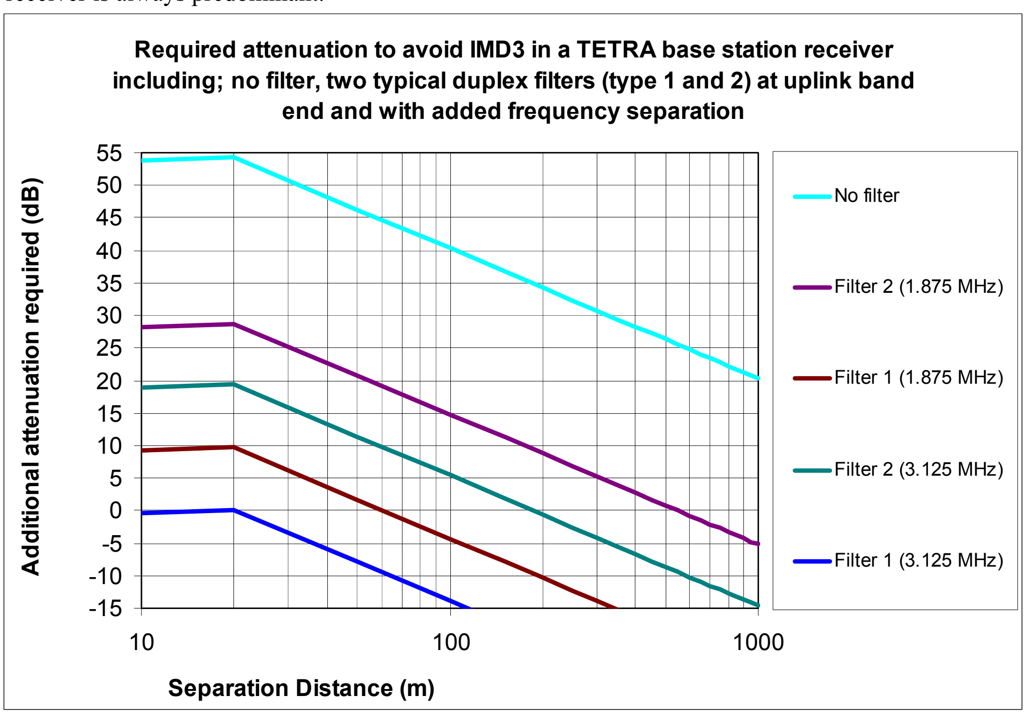


Figure 6b: Filter requirement for IMD3 improvement of TETRA receivers

No further investigation of this type of IMD3 has been made because the required attenuation to avoid blocking of the TETRA BS receiver is always predominant.

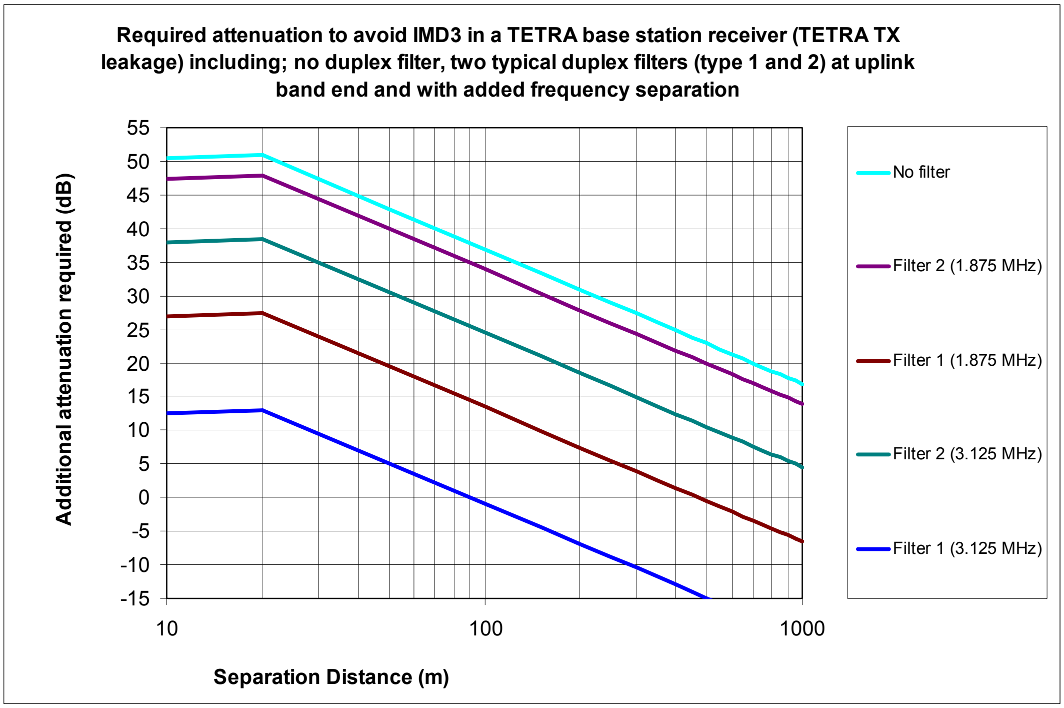


Figure 6c: Filter requirement for IMD3 improvement of TETRA receivers (TETRA TX leakage case)

Further investigation of this type of IMD3 has been made because the required attenuation to avoid IMD3 exceeds the required attenuation for blocking. In Figure 6d the detailed area where IMD3 can occur at its maximum is described for the example case of a single carrier TETRA system.

It should be noted that the attenuation calculated is only true for the assumptions described in Annex 2. If a lower gain antenna is used, the IMD3 of this type will be attenuated by two times the reduction of the antenna gain. If the output power is increased, the IMD of this type will increase linear to the power.

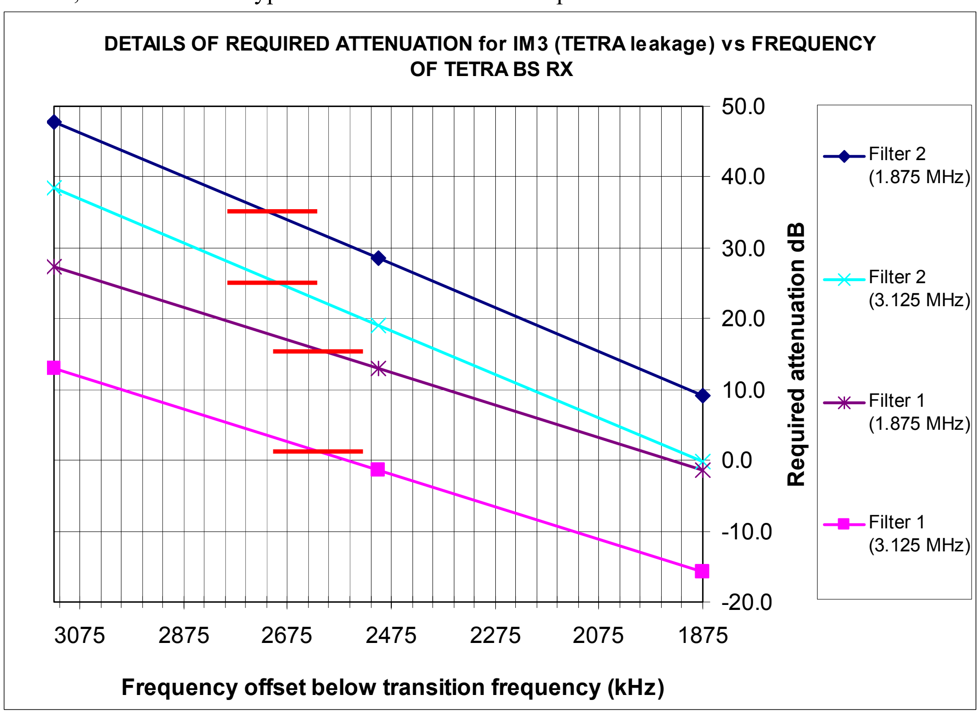


Figure 6d: Filter requirement for IMD3 improvement of TETRA receivers (TETRA TX leakage case for a single carrier TETRA system)

Figure 6d pictures the case where a CDMA-PAMR carrier is present at 2.5 MHz above the duplex transition frequency and a single TETRA BS transmitter between 6.875 MHz and 8.125 MHz above the duplex transition frequency. With the above frequencies the TETRA BS receiver will be between 3.125 MHz and 1.875 MHz below the duplex transition frequency. The results are for the 20 m rooftop-to-rooftop case as in Figure 6c. In Figure 6d the red crossing lines indicate that below these blocking is the dominant source of interference. This also indicates that IMD3 is the dominant source of interference for a TETRA BS RX frequency between 3.125 and 2.6 to 2.7 MHz below the transition band for a single carrier TETRA system. For multi-carrier systems, one or more IMD3 products can occur anywhere within the TETRA receive band and hence the frequency range across which IMD3 dominates over blocking may be correspondingly larger, depending on the particulars of the frequency plan.

Reference is made to tables 7 (a) to (l) “Required attenuation for IMD3” for antennas facing on adjacent buildings (20 m) scenario covering carriers at 2.5 MHz and 5 MHz above the transition frequency at an ERP of 53 dBm. The calculations include typical PMR/PAMR duplex filters. The additional output power ranges and separation distances have been derived by extrapolation. The steep slopes of the duplex filters have been compensated for.

It should be noted that the impact of IMD3 is frequency and transmitter output power dependent. Any additional filter required must be located at the PMR/TETRA BS receiver input. The impacted PMR/TETRA BS receivers could be at one or more sites in the area surrounding the CDMA-PAMR transmitter.

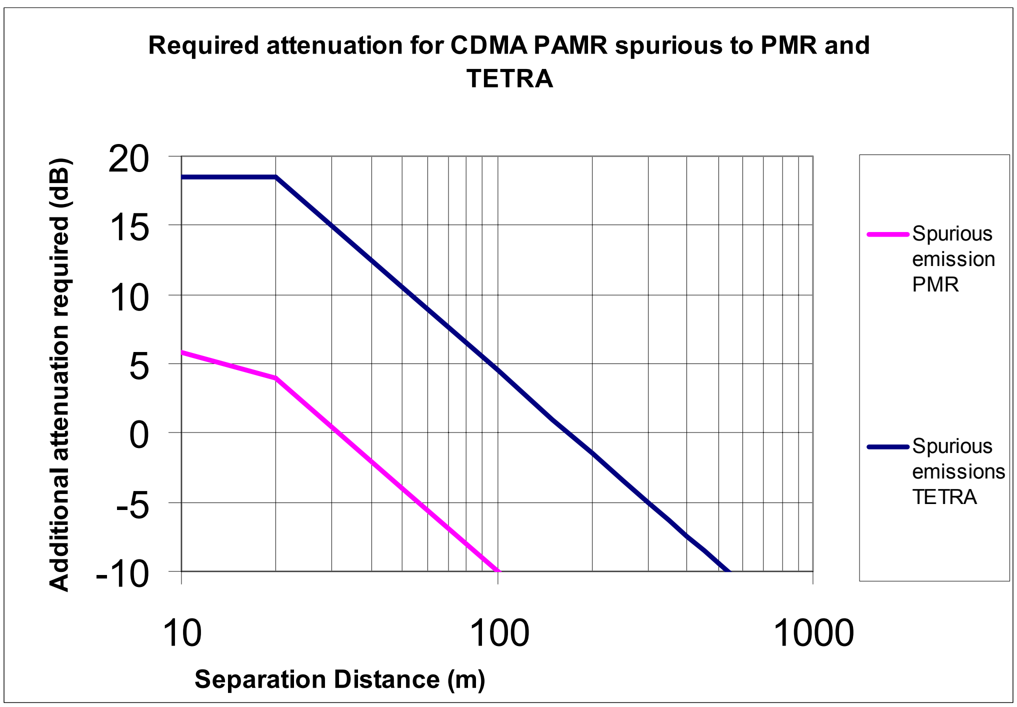


Figure 7: Required attenuation for CDMA-PAMR spurious

Reference is made to table 8 “Required attenuation for spurious” for the antennas facing on adjacent buildings (20 m). The additional separation distances have been derived by extrapolation.
Required attenuation for two carriers = 10*LOG10(10^(attenuation 1st carrier/10)+10^(attenuation 2nd carrier /10)).
Any required filter must be located at the transmitter's output of the CDMA-PAMR BS.
Note: Because of the low probability that a spurious will occur at its limit and at the frequency of the adjacent PMR/PAMR BS receiver this should be considered a special case. The attenuation required for suppression of wide band noise (below) will, with a high probability, also remove any spurious products. In the unlikely event where spurious emission proves to be the predominant source of interference additional attenuation must be provided according to the values above.

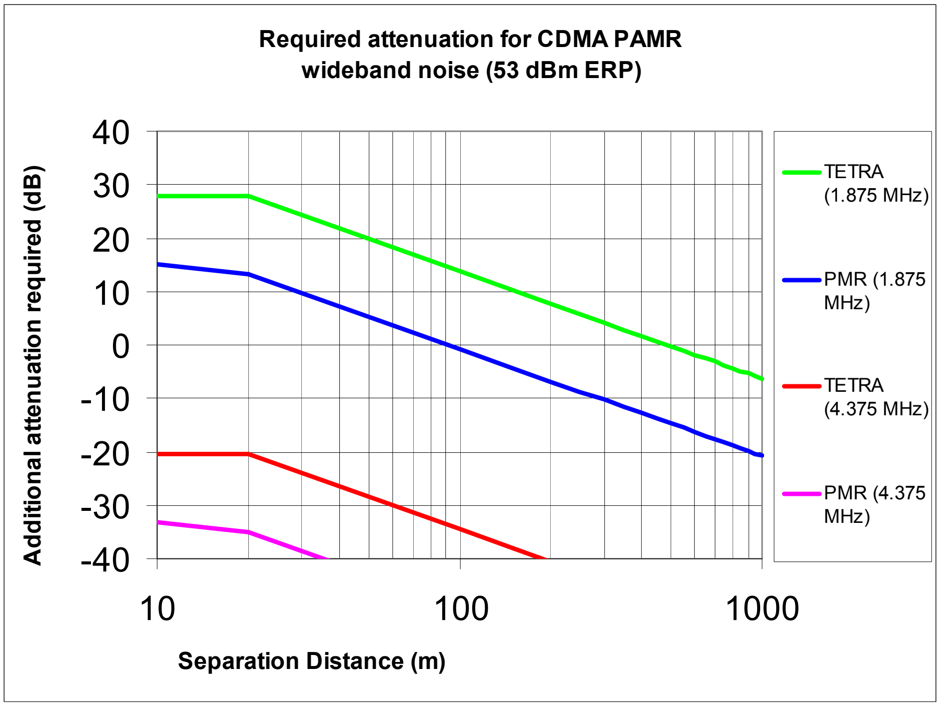


Figure 8: Required attenuation for CDMA-PAMR wideband noise

Reference is made to tables 9 (c) and (d) "Required attenuation for CDMA-PAMR wide band noise" for the antennas facing on adjacent buildings (20 m) scenario. The additional separation distances have been derived by extrapolation.

The victim is located at the channel immediately below 420 or 460 MHz.

Any filter required must be located at the transmitter output of a CDMA-PAMR BS. The effect of wide band noise has to be considered for PMR/PAMR BS receivers that are operating at frequencies below 420 and 460 MHz. The affected PMR/TETRA receivers could be at one or more sites in the area surrounding the CDMA-PAMR transmitter.

Required attenuation for two carriers = 10*LOG10(10^(attenuation 1st carrier/10)+10^(attenuation 2nd carrier /10)).
Add 3 dB if adjacent system is TETRA because the bandwidth is double of the 12.5 kHz calculated in the figure.

4 OBSERVATIONS

From the results of the simulations it is clear that a very low level of interference may be expected in the normal uplink-to-uplink and downlink-to-downlink scenarios. This is also the case around the transition frequency in the uplink-to-downlink scenario (MS-to-MS). However, for the downlink to uplink scenario (BS-to-BS) it is also clear from the probability of interference and the level of the attenuation required to avoid interference that co-ordination between CDMA-PAMR and PMR/TETRA systems is required. This is required for the frequency region around the transition from downlink to uplink. If an uncoordinated approach were taken, this would most likely result in interference to some PMR/PAMR BS receivers in the vicinity of a CDMA-PAMR BS transmitter.

The results also show that to avoid desensitisation due to blocking or IMD3 of PMR/TETRA BS receivers, additional filtering at the PMR/TETRA BS receiver may be required when a PMR/TETRA BS receiver is located within a certain distance (around 100 m for PMR and 500 m for TETRA using filter type 1; filter type 2 will require very large separation distances and therefore may be inappropriate for urban areas without additional filtering under these conditions) from a CDMA-PAMR BS transmitter. The amount of filtering required is dependent on the actual frequency, the number of carriers, the separation distance, type of antennas deployed, the transmitter power of the CDMA-PAMR BS and the duplex filter attenuation of the PMR/TETRA receiver. Please note that the mitigation (if required) should take account of the actual TETRA transmitter power (see Annex 2).

In the case of wide band noise the results again show that filtering is required at the CDMA-PAMR BS transmitter when it is located within a certain distance (around 100 m for PMR and 500 m for TETRA) from a PMR/TETRA BS receiver. The amount of filtering required is dependent on the actual frequency, the number of carriers, the type of antennas deployed, the transmitter power, the separation distance and the duplex filter attenuation of the CDMA-PAMR transmitter.

5 MITIGATION FACTORS (BS-TO-BS SCENARIO ONLY)

As can be seen from the results in section 3, CDMA-PAMR will be able to operate in the 400 MHz bands without causing harmful interference to adjacent PMR/PAMR services, provided that the geographic and/or frequency separation between CDMA-PAMR BS and PMR/PAMR BS is sufficiently large and additional filtering will be provided at some PMR/PAMR BS when necessary. A number of possible mitigation measures are available that can be used to decrease the possibility of harmful interference even further.

In this section, different techniques are discussed that will enable CDMA-PAMR BS to operate without producing harmful interference into the PMR/PAMR BS receivers. The different techniques required to ensure that the PMR/PAMR BS receiver can operate as intended are: frequency separation, physical separation distance, improved performance (filters) and any combination of these.

From the SEAMCAT modelling it may be seen that at a CDMA-PAMR BS density of 0.03142/km^2 between 0.5% of BSs (using duplex filter type 1) to around 20% of BSs (using duplex filter type 2) will require mitigation at a frequency separation of 1.875 MHz of the transition band edge. The SEAMCAT simulations did not include the effect of IMD3 because SEAMCAT at present is unable to perform these simulations correctly. Manual check simulations of the effect of Intermodulation indicate that the above proportions of BSs may increase around 50%. The selected frequency separation of 1.875 MHz is a fairly conservative figure and a more realistic frequency separation would be larger than 1.875 MHz (ECC Report 25). This would obviously reduce further the percentage of BSs requiring mitigation.

5.1 Frequency planning and co-ordination

It is necessary that the use of the frequencies around the transition between uplink and downlink at 420 and 460 MHz is co-ordinated between the operators of existing systems and the new operator of CDMA-PAMR system.

5.2 Separation distance

The use of physical separation is expected to be the normal way of achieving the majority of the necessary attenuation. It is the most cost effective way of establishing the required coupling loss between the CDMA-PAMR BS transmitter and the PMR/PAMR BS receiver.

Physical separation is feasible in rural and suburban areas. Physical separation in urban areas may only be possible as a partial solution.

5.3 Frequency separation

Use of frequency separation as a single solution to achieve the necessary attenuation of both the power and wide band noise from CDMA-PAMR may be difficult. This is because of the limited amount of contiguous spectrum. This fact combined with the difficulties in network planning and especially re-planning for optimisation of the network makes frequency separation unattractive as a stand alone solution. However, the frequency separation required around the transition frequencies (420 and 460 MHz) between up- and downlink may well be achieved by frequency management. If frequencies for CDMA-PAMR are allocated according to ECC Report 25 (i.e. allocations around the middle of the bands) the minimum requirement for the transition separation will automatically be met and coordination may not be required. In this report frequency separations of 1.875 and 3.125 MHz have been investigated as examples. The frequency separation can be achieved by either the CDMA-PAMR system or the PMR/TETRA system being closer to the centre of the up-/down-link bands.

5.4 Filters

Performance of both the CDMA-PAMR transmitter and the PMR/PAMR receiver can be improved using filters. The need for filters is limited to the BS-to-BS interference and will in most cases be covered by the duplex and combining filters. To allow the filters to operate, a guard band is considered necessary. The requirements of the filters needed for improving the PMR/PAMR receiver blocking and IMD3 performance are dependant on the scenario and the duplex filter deployed. This report has incorporated typical duplex filters for PMR and TETRA as specified in Annex 2. There are several ways to increase the attenuation where the duplex filter does not provide sufficient protection. To mention a couple: one solution is to replace the duplex filter with the one having a more aggressive cut-off; another solution is to add a stop band filter to deal with the actual frequencies providing RF level exceeding the protection of the receiver through the already deployed duplex filter.

The filters necessary to improve the CDMA-PAMR transmitter wide band noise attenuation in the PMR/PAMR receiver frequency range are more demanding. These filters will also need to be able to handle the necessary transmit power.

6 CONCLUSIONS

The report has identified the interference potential for the PMR/PAMR services in the 400 MHz bands, when CDMA-PAMR is deployed adjacent to them. The report has estimated interference that can be experienced for different cases of guard bands and transition bands. The SEAMCAT calculations indicate that the risk of harmful interference from CDMA-PAMR interfering with PMR/PAMR 12.5, 25 kHz and related systems in the 400 MHz bands is very low for the MS-to-MS, MS-to-BS ad BS-to-MS cases.

The report has identified the necessary mitigation to protect the existing PMR/PAMR BS receivers against interference from CDMA-PAMR BS transmissions.

Mitigation in form of filters will be required in some cases. To allow the filters to operate, a guard band or frequency separation around the duplex transition frequency is considered necessary.

The modelling has demonstrated that the following guard bands and frequency separation should be applied:

- A guard band of 200 kHz in the uplink to uplink band (MS-to-BS) and downlink to downlink band (BS-to-MS) interference,
- A frequency separation of 125 kHz or less at the duplex transition frequency between the uplink and downlink bands (MS-to-MS) interference,
- A frequency separation of 1875 kHz (based on the MCL results) at the duplex transition frequency between the uplink and downlink bands (BS-to-BS) interference. This will limit necessary mitigation to between 0.5% of BSs (using duplex filter type 1) to around 20% of BSs (using duplex filter type 2) for a CDMA-PAMR BS density of 0.03142/km^2. If additional frequency separation is used, the need for co-ordination and/or mitigation reduces. In reality this frequency separation is expected to be larger than 1875 kHz (ECC Report 25). The values quoted exclude the effect of IMD3 because at present SEAMCAT is unable to simulate this correctly. Manual simulations indicate that an increase in the values of around 50% may be expected.

The additional mitigation measures that may be required have been calculated using MCL. These are:

- To avoid desensitisation due to blocking or IMD3 of PMR/TETRA BS receivers, additional filtering at the PMR/TETRA BS receiver may be required when a PMR/TETRA BS receiver is located within a certain distance (around 100 m for PMR and 500 m for TETRA using filter type 1; filter type 2 will require very large separation distances and therefore may be inappropriate for urban areas without additional filtering under these conditions) from a CDMA-PAMR BS transmitter. The amount of filtering required is dependent on the actual frequency, the number of carriers, the separation distance, type of antennas deployed, the transmitter power of the CDMA-PAMR BS and the duplex filter attenuation of the PMR/TETRA receiver.
- In the case of wide band noise, the results again indicate that filtering is required at the CDMA-PAMR BS transmitter when it is located within a certain distance (around 100 m for PMR and 500 m for TETRA) from a PMR/TETRA BS receiver. The amount of filtering required is dependent on the actual frequency, the number of carriers, the type of antennas deployed, the transmitter power, the separation distance and the duplex filter attenuation of the CDMA-PAMR transmitter.

It is clear from the findings that the utilisation of CDMA-PAMR requires co-ordination between the existing operator of the PMR/PAMR systems and the new operator of the CDMA-PAMR system at the frequencies around the transition between uplink and downlink at 420 and 460 MHz.

It should be noted that the report did not consider the interference from existing PMR/PAMR Radio systems into CDMA-PAMR deployed in adjacent bands, since the effect from the new systems on the incumbent ones is the most important part to deal with.

7 BIBLIOGRAPHY

[1] CDMA-PAMR SRDoc V0.1.1 (2002-8), “System Reference Document, CDMA-PAMR”, SE(02)114.
[2] ETSI TR 102 260 v1.1.1: CDMA-PAMR System Reference Document.
[3] TIA/EIA/IS-2000.1-C, “Introduction to cdma2000 Standards for Spread Spectrum Systems”.
[4] TIA/EIA/IS-2000.2-C, “Physical Layer Standard for cdma2000 Spread Spectrum Systems”.
[5] TIA/EIA/IS-2000.3-C, “Medium Access Control (MAC) Standard for cdma2000 Spread Spectrum Systems”.
[6] TIA/EIA/IS-2000.4-C, “Signalling Link Access Control (LAC) Standard for cdma2000 Spread Spectrum Systems”.
[7] TIA/EIA/IS-2000.5-C, “Upper Layer (Layer 3) Signalling Standard for cdma2000 Spread Spectrum Systems”.
[8] TIA/EIA-97-E, “Recommended Minimum Performance Standard for cdma2000 Spread Spectrum Base Stations”.
[9] TIA/EIA-98-E, “Recommended Minimum Performance Standard for cdma2000 Spread Spectrum Mobile Stations”.
[10] Recommendation ITU-R P.372-7
[11] Recommendation ITU Rec. P.1411.
[12] EN 300 086-2, Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive
[13] EN 300 113-2, Electromagnetic compatibility and Radio spectrum Matters (ERM); Land MS service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive
[14] EN 300 392, Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D).

ANNEX 1: MCL CALCULATIONS OF THE CDMA-PAMR BS INTO PMR/PAMR BS SCENARIO (SCENARIO 4)

In the following the results of MCL calculations for Scenario 4 are provided.

By considerations of blocking, CDMA PAMR to PMR without duplex filter	CDMA-PAMR centre frequency separation from transition frequency MHz	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Interference power dBm	specified blocking (EN 300 113 (5.2.8)) dBm	**Required attenuation for blocking** dB
	2.5												
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	52.8	1.0	20.0	50.9	3.0	1.0	6.1	-23.0	29.1
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	12.0	-23.0	35.0
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	2.0	-23.0	25.0

Table 6a: Calculation of the required attenuation to avoid blocking of a PMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of blocking, CDMA PAMR to TETRA without duplex filter	CDMA-PAMR centre frequency separation from transition frequency MHz	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Interference power dBm	specified blocking (EN 300 392) dBm	**Required attenuation for blocking** dB
	2.5												
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	14.1	-25.0	39.1
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	12.0	-25.0	37.0
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	2.0	-25.0	27.0

Table 6b: Calculation of the required attenuation to avoid blocking of a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of blocking, CDMA PAMR to PMR with duplex filter at uplink band end	CDMA-PAMR centre frequency separation from transition frequency	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Impact of typical duplex filter	Interference power	specified blocking (EN 300 113 (5.2.8))	Required attenuation for blocking
	MHz	Watts	dB	dBi	dBm		m	dB	dBi	dB	dB	dBm	dBm	dB
	2.5													
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	52.8	1.0	20.0	50.9	3.0	1.0	15.0	-8.9	-23.0	14.1
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	15.0	-3.0	-23.0	20.0
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	15.0	-13.0	-23.0	10.0

Table 6c: Calculation of the required attenuation to avoid blocking of a PMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of blocking, CDMA PAMR to PMR with duplex filter and added separation	Frequency separation between PMR RX band edge and CDMA-PAMR carrier edge	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Impact of typical duplex filter	Interference power	specified blocking (EN 300 113 (5.2.8))	Required attenuation for blocking
	MHz	Watts	dB	dBi	dBm		m	dB	dBi	dB	dB	dBm	dBm	dB
	3.125													
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	52.8	1.0	20.0	50.9	3.0	1.0	21.3	-15.2	-23.0	7.8
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	21.3	-9.3	-23.0	13.7
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	21.3	-19.3	-23.0	3.7

Table 6d: Calculation of the required attenuation to avoid blocking of a PMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of blocking, CDMA PAMR to TETRA with frequency duplex filter type 2 at uplink band edge	CDMA-PAMR centre frequency separation from transition frequency	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Impact of typical duplex filter	Interference power	specified blocking (EN 300 392)	**Required attenuation for blocking**
	MHz	Watts	dB	dBi	dBm		m	dB	dBi	dB	dB	dBm	dBm	dB
	2.5													
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	3.0	11.1	-25.0	36.1
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	3.0	9.0	-25.0	34.0
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	3.0	-1.0	-25.0	24.0

Table 6e: Calculation of the required attenuation to avoid blocking of a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of blocking, CDMA PAMR to TETRA with frequency duplex filter type 1 at uplink band edge	CDMA-PAMR centre frequency separation from transition frequency	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Impact of typical duplex filter	Interference power	specified blocking (EN 300 392)	**Required attenuation for blocking**
	MHz	Watts	dB	dBi	dBm		m	dB	dBi	dB	dB	dBm	dBm	dB
	2.5													
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	23.4	-9.3	-25.0	15.7
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	23.4	-11.5	-25.0	13.5
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	23.4	-21.5	-25.0	3.5

Table 6f: Calculation of the required attenuation to avoid blocking of a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of blocking, CDMA PAMR to TETRA with duplex filter type 2 and added frequency separation	Frequency separation between TETRA RX band edge and CDMA-PAMR carrier edge	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Impact of typical duplex filter	Interference power	specified blocking (EN 300 392)	**Required attenuation for blocking**
	MHz	Watts	dB	dBi	dBm		m	dB	dBi	dB	dB	dBm	dBm	dB
	3.125													
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	12.4	1.7	-25.0	26.7
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	12.4	-0.4	-25.0	24.6
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	12.4	-10.4	-25.0	14.6

Table 6g: Calculation of the required attenuation to avoid blocking of a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of blocking, CDMA PAMR to TETRA with duplex filter type 1 and added frequency separation	Frequency separation between TETRA RX band edge and CDMA-PAMR carrier edge	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Impact of typical duplex filter	Interference power	specified blocking (EN 300 392)	**Required attenuation for blocking**
	MHz	Watts	dB	dBi	dBm		m	dB	dBi	dB	dB	dBm	dBm	dB
	3.125													
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	37.8	-23.7	-25.0	1.3
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	37.8	-25.8	-25.0	-0.8
Antennas in close proximity		25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	37.8	-35.8	-25.0	-10.8

Table 6h: Calculation of the required attenuation to avoid blocking of a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

For the tables 6(a) to (h) the following conditions apply:
Propagation model used is free space loss for antenna distances of 20m and over.
The antenna gain of the victim (PMR/TETRA) and interferer (CDMA-PAMR) BS is assumed to be 3/11 dBi and 12 dBi respectively.
It has been agreed that a figure of 30 dB is used between two antennas in close proximity because it is considered a standard value. 40 dB is also included because improved attenuation can be achieved with high gain antennas by site engineering.
the effect of the duplex filter in tables 6 has been reduced by 6 dB for filter 1 and by 10 dB for filter 2 where the point of interest is on the the steep slope, no reduction has been made where the point of interest is on a level part of the curve.
Other duplex filters have been considered but found to fall between the values of those included.

By considerations of IM3, CDMA PAMR to PMR without duplex filter	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Interference power in 2000 kHz	specified IM3 (EN 300 113 (5.2.7))	Protected sensitivity; C/I (12 dB) below neg 107 dBm	IIP3	IMD3 in 2000 kHz	Bandwidth conversion 2000 to 8 kHz	IMD3 in 8 kHz	Required attenuation for IM3
	Watts	dB	dBi	dBm		m	dB	dBi	dB	dBm	dBm	dBm	dBm	dB	dB	dB	dB
Antennas on adjacent buildings, rooftop to rooftop	25.0	1.0	12.0	52.8	1.0	20.0	50.9	3.0	1.0	6.1	-37.0	-119.0	4	10.3	24.0	-13.7	35.1
Antennas in close proximity	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	12.0	-37.0	-119.0	4	27.9	24.0	4.0	41.0
Antennas in close proximity	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	2.0	-37.0	-119.0	4	-2.1	24.0	-26.0	31.0

Table 7a: Calculation of the required attenuation to avoid IMD3 in a PMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA without duplex filter	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Interference power in 2000 kHz	specified IM3 (EN 300 392)	Protected sensitivity; C/I (19 dB) below neg 103 dBm	IIP3	IMD3 in 2000 kHz	Bandwidth conversion 2000 to 18 kHz	IMD3 in 18 kHz	Required attenuation for IM3
	Watts	dB	dBi	dBm		m	dB	dBi	dB	dBm	dBm	dBm	dBm	dB	dB	dB	dB
Antennas on adjacent buildings, rooftop to rooftop	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	14.1	-47.0	-122.0	-9.5	61.3	20.5	40.8	54.3
Antennas in close proximity	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	12.0	-47.0	-122.0	-9.5	54.9	20.5	34.5	52.2
Antennas in close proximity	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	2.0	-47.0	-122.0	-9.5	24.9	20.5	4.5	42.2

Table 7b: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to PMR with duplex filter at uplink band end	CDMA-PAMR centre frequency separation from transition frequency	CDMA PAMR Tx power	losses	Tx ant gain	CDMA PAMR Tx ERP - dBm	No of Tx	Distance	Free space propagation	RX antenna gain	feeders etc	Impact of typical duplex filter	Interference power in 2000 kHz	specified IM3 (EN 300 113 (5.2.7))	Protected sensitivity; C/I (12 dB) below neg 107 dBm	IIP3	IMD3 in 2000 kHz	Bandwidth conversion 2000 to 8 kHz	IMD3 in 8 kHz	Required attenuation for IM3
	MHz	Watts	dB	dBi	dBm		m	dB	dBi	dB		dBm	dBm	dBm	dBm	dB	dB	dB	dB
Antennas on adjacent buildings, rooftop to rooftop	2.50	25.0	1.0	12.0	52.8	1.0	20.0	50.9	3.0	1.0	15.0	-8.9	-37.0	-119.0	4	-59.7	24.0	-83.7	11.8
	5.00										40.0	-33.9	-37.0	-119.0	4	-59.7	24.0	-83.7	11.8
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	15.0	-3.0	-37.0	-119.0	4	-42.1	24.0	-66.0	17.7
	5.00										40.0	-28.0	-37.0	-119.0	4	-42.1	24.0	-66.0	17.7
	2.50	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	15.0	-13.0	-37.0	-119.0	4	-72.1	24.0	-96.0	7.7
Antennas in close proximity	5.00										40.0	-38.0	-37.0	-119.0	4	-72.1	24.0	-96.0	7.7

Table 7c: Calculation of the required attenuation to avoid IMD3 in a PMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to PMR with duplex filter and added frequency separation	Frequency separation between PMR RX band edge and CDMA-PAMR carrier edge (1 & 3) MHz	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2000 kHz dBm	specified IM3 (EN 300 113 (5.2.7)) dBm	Protected sensitivity; C/I (12 dB) below neg 107 dBm dBm	IIP3 dBm	IMD3 in 2000 kHz dB	Bandwidth conversion 2000 to 8 kHz dB	IMD3 in 8 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	3.125	25.0	1.0	12.0	52.8	1.0	20.0	50.9	3.0	1.0	21.3	-15.2	-37.0	-119.0	4	-78.5	24.0	-102.4	5.5
	5.625										46.3	-40.2	-37.0	-119.0	4	-78.5	24.0	-102.4	5.5
Antennas in close proximity	3.125	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	21.3	-9.3	-37.0	-119.0	4	-60.8	24.0	-84.8	11.4
	5.625										46.3	-34.3	-37.0	-119.0	4	-60.8	24.0	-84.8	11.4
	3.125	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	21.3	-19.3	-37.0	-119.0	4	-90.8	24.0	-114.8	1.4
Antennas in close proximity	5.625										46.3	-44.3	-37.0	-119.0	4	-90.8	24.0	-114.8	1.4

Table 7d: Calculation of the required attenuation to avoid IMD3 in a PMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA with duplex filter type 2 at uplink band end	CDMA-PAMR centre frequency separation from MHz	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2000 kHz dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 1250 kHz dB	Bandwidth conversion 2000 to 18 kHz dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	2.50	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	3.0	11.1	-47.0	-122.0	-9.5	-15.2	20.5	-35.7	28.8
	5.00										70.5	-56.4	-47.0	-122.0	-9.5	-15.2	20.5	-35.7	28.8
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	3.0	9.0	-47.0	-122.0	-9.5	-21.6	20.5	-42.0	26.7
	5.00										70.5	-58.5	-47.0	-122.0	-9.5	-21.6	20.5	-42.0	26.7
	2.50	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	3.0	-1.0	-47.0	-122.0	-9.5	-51.6	20.5	-72.0	16.7
Antennas in close proximity	5.00										70.5	-68.5	-47.0	-122.0	-9.5	-51.6	20.5	-72.0	16.7

Table 7e: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA with duplex filter type 1 at uplink band end	CDMA-PAMR centre frequency separation from MHz	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2000 kHz dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 2000 kHz dB	Bandwidth conversion 2000 to 18 kHz dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	2.50	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	23.4	-9.3	-47.0	-122.0	-9.5	-72.5	20.5	-93.0	9.7
	5.00										86.9	-72.8	-47.0	-122.0	-9.5	-72.5	20.5	-93.0	9.7
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	23.4	-11.5	-47.0	-122.0	-9.5	-78.9	20.5	-99.3	7.6
	5.00										86.9	-75.0	-47.0	-122.0	-9.5	-78.9	20.5	-99.3	7.6
	2.50	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	23.4	-21.5	-47.0	-122.0	-9.5	-108.9	20.5	-129.3	-2.4
Antennas in close proximity	5.00										86.9	-85.0	-47.0	-122.0	-9.5	-108.9	20.5	-129.3	-2.4

Table 7f: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA with duplex filter type 2 and added frequency separation	Frequency separation between TETRA RX band edge and CDMA-PAMR carrier edge MHz	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2000 kHz dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 2000 kHz dB	Bandwidth conversion 2000 to 18 kHz dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	3.125	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	12.4	1.7	-47.0	-122.0	-9.5	-43.5	20.5	-63.9	19.4
	5.625										80.0	-65.9	-47.0	-122.0	-9.5	-43.5	20.5	-63.9	19.4
Antennas in close proximity	3.125	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	12.4	-0.4	-47.0	-122.0	-9.5	-49.8	20.5	-70.3	17.2
	5.625										80.0	-68.0	-47.0	-122.0	-9.5	-49.8	20.5	-70.3	17.2
	3.125	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	12.4	-10.4	-47.0	-122.0	-9.5	-79.8	20.5	-100.3	7.2
Antennas in close proximity	5.625										80.0	-78.0	-47.0	-122.0	-9.5	-79.8	20.5	-100.3	7.2

Table 7g: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA with duplex filter type 1 and added frequency separation	Frequency separation between TETRA RX band edge and CDMA-PAMR carrier edge MHz	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2000 kHz dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 1250 kHz dB	Bandwidth conversion 2000 to 18 kHz dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	3.125	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	37.8	-23.7	-47.0	-122.0	-9.5	-101.3	20.5	-121.8	0.1
	5.625										87.0	-72.9	-47.0	-122.0	-9.5	-101.3	20.5	-121.8	0.1
Antennas in close proximity	3.125	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	37.8	-25.8	-47.0	-122.0	-9.5	-107.7	20.5	-128.1	-2.0
	5.625										87.0	-75.0	-47.0	-122.0	-9.5	-107.7	20.5	-128.1	-2.0
	3.125	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	37.8	-35.8	-47.0	-122.0	-9.5	-137.7	20.5	-158.1	-12.0
Antennas in close proximity	5.625										87.0	-85.0	-47.0	-122.0	-9.5	-137.7	20.5	-158.1	-12.0

Table 7h: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to PMR without duplex filter (TX leakage case)	CDMA-PAMR centre frequency separation from transition frequency MHz	Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2500 kHz dBm	specified IM3 (EN 300 113 (5.2.7)) dBm	Protected sensitivity; C/I (12 dB) below neg 107 dBm dBm	IIP3 dBm	IMD3 in 2500 kHz dB	Bandwidth conversion 2500 to 8 kHz and spreadning loss dB	IMD3 in 8 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	2.50	25.0	1.0	12.0	52.8	1.0	20.0	50.9	3.0	1.0	0.0	6.1	-37.0	-119.0	4	-41.8	24.9	-66.8	26.1
PMR TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	0.0	12.0	-37.0	-119.0	4	-30.1	24.9	-55.0	32.0
PMR TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	0.0	2.0	-37.0	-119.0	4	-50.1	24.9	-75.0	22.0
PMR TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0

Table 7i: Calculation of the required attenuation to avoid IMD3 in a PMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA without duplex filter (TX leakage case)	CDMA-PAMR centre frequency separation from transition frequency MHz	Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2500 kHz dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 2500 kHz dB	Bandwidth conversion 2500 to 18 kHz and spreadning loss dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	2.50	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	0.0	14.1	-47.0	-122.0	-9.5	1.2	21.4	-20.3	50.9
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	0.0	12.0	-47.0	-122.0	-9.5	-3.1	21.4	-24.5	48.8
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	0.0	2.0	-47.0	-122.0	-9.5	-23.1	21.4	-44.5	38.8
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0

Table 7j: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA with duplex filter type 2 at uplink band edge (TX leakage case)	CDMA-PAMR centre frequency separation from transition frequency MHz	Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2500 kHz dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 2500 kHz dB	Bandwidth conversion 2500 to 18 kHz and spreadning loss dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	2.50	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	3.0	11.1	-47.0	-122.0	-9.5	-4.8	21.4	-26.3	47.9
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	3.0	9.0	-47.0	-122.0	-9.5	-9.1	21.4	-30.5	45.8
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	3.0	-1.0	-47.0	-122.0	-9.5	-29.1	21.4	-50.5	35.8
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0

Table 7k: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA with duplex filter type 1 at uplink band edge (TX leakage case)	CDMA-PAMR centre frequency separation from transition frequency MHz	Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2500 kHz reduced for power spread dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 2500 kHz dB	Bandwidth conversion 2500 to 18 kHz and spreadning loss dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	2.50	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	23.4	-9.3	-47.0	-122.0	-9.5	-45.7	21.4	-67.1	27.4
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	23.4	-11.5	-47.0	-122.0	-9.5	-49.9	21.4	-71.4	25.3
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0
Antennas in close proximity	2.50	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	23.4	-21.5	-47.0	-122.0	-9.5	-69.9	21.4	-91.4	15.3
TETRA TX leakage, fixed attenuation	7.50	2.5									80.0	-46.0							0.0

Table 7l: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA with duplex filter type 2 and more frequency separation (TX leakage case)	Frequency separation between TETRA RX band edge and CDMA-PAMR carrier edge MHz	Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2500 kHz dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 2500 kHz dB	Bandwidth conversion 2500 to 18 kHz and spreadning loss dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	3.125	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	12.4	1.7	-47.0	-122.0	-9.5	-23.6	21.4	-45.0	38.5
TETRA TX leakage, fixed attenuation	8.750	2.5									80.0	-46.0							0.0
Antennas in close proximity	3.125	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	12.4	-0.4	-47.0	-122.0	-9.5	-27.8	21.4	-49.2	36.4
TETRA TX leakage, fixed attenuation	8.750	2.5									80.0	-46.0							0.0
Antennas in close proximity	3.125	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	12.4	-10.4	-47.0	-122.0	-9.5	-47.8	21.4	-69.2	26.4
TETRA TX leakage, fixed attenuation	8.750	2.5									80.0	-46.0							0.0

Table 7m: Calculation of the required attenuation to avoid IMD3 in a TETRA Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

By considerations of IM3, CDMA PAMR to TETRA with duplex filter type 1 and more frequency separation (TX leakage case)	Frequency separation between TETRA RX band edge and CDMA-PAMR carrier edge MHz	Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR Tx ERP - dBm dBm	No of Tx	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Impact of typical duplex filter	Interference power in 2500 kHz reduced for power spread dBm	specified IM3 (EN 300 392) dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	IIP3 dBm	IMD3 in 2500 kHz dB	Bandwidth conversion 2500 to 18 kHz and spreadning loss dB	IMD3 in 18 kHz dB	**Required attenuation for IM3** dB
Antennas on adjacent buildings, rooftop to rooftop	3.125	25.0	1.0	12.0	52.8	1.0	20.0	50.9	11.0	1.0	37.8	-23.7	-47.0	-122.0	-9.5	-74.5	21.4	-95.9	13.1
TETRA TX leakage, fixed attenuation	8.750	2.5									80.0	-46.0							0.0
Antennas in close proximity	3.125	25.0	1.0	0.0	N/A	1.0	N/A	30.0	0.0	1.0	37.8	-25.8	-47.0	-122.0	-9.5	-78.7	21.4	-100.1	10.9
TETRA TX leakage, fixed attenuation	8.750	2.5									80.0	-46.0							0.0
Antennas in close proximity	3.125	25.0	1.0	0.0	N/A	1.0	N/A	40.0	0.0	1.0	37.8	-35.8	-47.0	-122.0	-9.5	-98.7	21.4	-120.1	0.9
TETRA TX leakage, fixed attenuation	8.750	2.5									80.0	-46.0							0.0

Table 7o: Calculation of the required attenuation to avoid IMD3 in a PMR/PAMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power

CDMA-PAMR modulation kHz	Relative freq kHz	TETRA RX offset from Transition Frequency	Impact of duplex filter 2	Required attenuation IM3 b)	Required attenuation over filter slope
-625	0	3125	0.0	47.9	47.9
0	625	2500	19.4	47.9	28.5
625	1250	1875	38.8	47.9	9.1

Table 7p: Calculation of the required attenuation to avoid IMD3 in a PMR/PAMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power over a narrow frequency range

CDMA-PAMR modulation kHz	Relative freq kHz	TETRA RX offset from Transition Frequency	Impact of duplex filter 1	Required attenuation IM3 b)	Required attenuation over filter slope
-625	0	3125	0.0	27.4	27.4
0	625	2500	14.4	27.4	13.1
625	1250	1875	28.8	27.4	-1.3

Table 7q: Calculation of the required attenuation to avoid IMD3 in a PMR/PAMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power over a narrow frequency range

CDMA-PAMR modulation kHz	Relative freq kHz	TETRA RX offset from Transition Frequency	Impact of duplex filter 2 + more separation	Required attenuation IM3 b)	Required attenuation over filter slope
-625	0	3125	0.0	38.5	38.5
0	625	2500	19.4	38.5	19.1
625	1250	1875	38.8	38.5	-0.3

Table 7r: Calculation of the required attenuation to avoid IMD3 in a PMR/PAMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power over a narrow frequency range

CDMA-PAMR modulation kHz	Relative freq kHz	TETRA RX offset from Transition Frequency	Impact of duplex filter 1 + more separation	Required attenuation IM3 b)	Required attenuation over filter slope
-625	0	3125	0.0	13.1	13.1
0	625	2500	14.4	13.1	-1.3
625	1250	1875	28.8	13.1	-15.7

Table 7s: Calculation of the required attenuation to avoid IMD3 in a PMR/PAMR Base Station Receiver from the CDMA-PAMR Base Station transmitter output power over a narrow frequency range

For the tables 7(a) to (l) the following conditions apply:
The effect of the duplex filter 1 in tables 7 has been reduced by 6 dB where the point of interest is on the the steep slope, no reduction has been made where the point of interest is on a level part of the curve.
The effect of the duplex filter 2 in tables 7 has been reduced by 10 dB where the point of interest is on the the steep slope, no reduction has been made where the point of interest is on a level part of the curve.
Other duplex filters have been considered but found to fall between the values of those included.

In tables 7 the IMD3 product of the two CDMA-PAMR carrier has been found to produce its main power in a 2 MHz band, in the “TX leakage” case the main power is in a 2.5 MHz band.
In tables 7 h to l the transmitter output power of TETRA has been selected to 34 dBm. This assumption may not constitute a worst case if the regulator allows a higher ERP than 44 dBm for narrow band PMR.

By consideration of CDMA-PAMR spurious for PMR (spurious domain starts at 3125 kHz Rec. 74-01)	CDMA-PAMR centre frequency separation from transition frequency	Spurious spec. + effect of Duplex Filter	losses	Tx ant gain	Radiated spurious dBm	no of spurious	Distance	Free space propagation	RX antenna gain	feeders etc	Interference power in 8 kHz	Protected sensitivity; C/I (12 dB) below neg 107 dBm	**Required attenuation for spurious emission**
	MHz	dBm	dB	dBi	dBm		m	dB	dBi	dB	dBm	dBm	dB
Antennas on adjacent buildings, rooftop to rooftop	3.1	-64.0	1.0	12.0	-55.2	1.0	20.0	50.9	3.0	1.0	-115.0	-119.0	4.0
Antennas in close proximity		-64.0	1.0	0.0	-65.0	1.0	N/A	30.0	0.0	1.0	-107.0	-119.0	12.0
Antennas in close proximity		-64.0	1.0	0.0	-65.0	1.0	N/A	40.0	0.0	1.0	-117.0	-119.0	2.0

Table 8a: Calculation of the required attenuation to avoid desensitisation of a PMR Base Station Receiver from the CDMA-PAMR Base Station Transmitter spurious emission

By consideration of CDMA-PAMR spurious for TETRA (spurious domain starts at 3125 kHz Rec. 74-01)	CDMA-PAMR centre frequency separation from transition frequency	Spurious spec. + effect of Duplex Filter	losses	Tx ant gain	Radiated spurious dBm	no of spurious	Distance	Free space propagation	RX antenna gain	feeders etc	Interference power in 18 kHz	Protected sensitivity; C/I (19 dB) below neg 103 dBm	**Required attenuation for spurious emission**
	MHz	dBm	dB	dBi	dBm		m	dB	dBi	dB	dBm	dBm	dB
Antennas on adjacent buildings, rooftop to rooftop	3.1	-64.0	1.0	12.0	-55.2	1.0	20.0	50.9	11.0	1.0	-103.5	-122.0	18.5
Antennas in close proximity		-64.0	1.0	0.0	-65.0	1.0	N/A	30.0	0.0	1.0	-103.4	-122.0	18.6
Antennas in close proximity		-64.0	1.0	0.0	-65.0	1.0	N/A	40.0	0.0	1.0	-113.4	-122.0	8.6

Table 8b: Calculation of the required attenuation to avoid desensitisation of a TETRA Base Station Receiver from the CDMA-PAMR Base Station Transmitter spurious emission

Propagation model used is free space loss for antenna distances of 20m and over
For antenna separation distances below 20m a fixed coupling of 30 and 40 dB has been used.
The antenna gain of the victim (PMR/PAMR) and interferer (CDMA-PAMR) BS is assumed to be 3/11 dBi and 12 dBi respectively.
Bandwidth adjustment is required because the spurious emissions of CDMA-PAMR are measured in 100 kHz bandwidth and PMR/PAMR is an 8/18 kHz carrier.
The value of -119 dBm for protection of PMR is from EN 300 113.

The value of -122 dBm for protection of TETRA is from EN 300 392.
Spurious emissions have been included because of the potential of a spurious to be of wider band width than normal discrete spurious.

Note: Because of the low probability that a spurious will occur at its limit and at the frequency of the adjacent PMR/PAMR BS receiver this should be considered a special case. The attenuation required for suppression of wide band noise will, with a high probability, also remove any spurious products. In the unlikely event where spurious emission proves to be the predominant source of interference additional attenuation must be provided.

By consideration of wide band noise CDMA PAMR to PMR	CDMA-PAMR centre frequency separation from transition frequency MHz 2.5	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR WBN spec + effect of Duplex Filter dBc	Bandwidth gain (ref. 30 kHz. Victim bw. 8 kHz) dB	Radiated noise dBm in 8 kHz dBm	No	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Interference power dBm	Protected sensitivity; C/I (12 dB) below neg 107 dBm dBm	**Required attenuation for wide band noise** dB
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	-104.0	-5.7	-56.9	1.0	20.0	50.9	3.0	1.0	-105.8	-119.0	13.2
Antennas in close proximity		25.0	1.0	0.0	-104.0	-5.7	-66.8	1.0	N/A	30.0	0.0	1.0	-97.8	-119.0	21.2
Antennas in close proximity		25.0	1.0	0.0	-104.0	-5.7	-66.8	1.0	N/A	40.0	0.0	1.0	-107.8	-119.0	11.2

Table 9a: Calculation of the required attenuation to avoid desensitisation of a PMR Base Station Receiver from the CDMA-PAMR Base Station Transmitter wide band noise

By consideration of wide band noise CDMA PAMR to TETRA	CDMA-PAMR centre frequency separation from transition frequency MHz 2.5	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR WBN spec + effect of Duplex Filter dBc	Bandwidth gain (ref. 30 kHz. Victim bw. 18 kHz) dB	Radiated noise dBm in 18 kHz dBm	No	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Interference power dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	**Required attenuation for wide band noise** dB
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	-104.0	-2.2	-53.4	1.0	20.0	50.9	11.0	1.0	-94.3	-122.0	27.7
Antennas in close proximity		25.0	1.0	0.0	-104.0	-2.2	-63.2	1.0	N/A	30.0	0.0	1.0	-94.2	-122.0	27.8
Antennas in close proximity		25.0	1.0	0.0	-104.0	-2.2	-63.2	1.0	N/A	40.0	0.0	1.0	-104.2	-122.0	17.8

Table 9b: Calculation of the required attenuation to avoid desensitisation of a TETRA Base Station Receiver from the CDMA-PAMR Base Station Transmitter wide band noise

By consideration of wide band noise CDMA PAMR to PMR	CDMA-PAMR centre frequency separation from transition MHz 5.0	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR WBN spec + effect of Duplex Filter dBc	Bandwidth gain (ref. 100 kHz. Victim bw. 8 kHz) dB	Radiated noise dBm in 8 kHz dBm	No	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Interference power dBm	Protected sensitivity; C/I (12 dB) below neg 107 dBm dBm	**Required attenuation for wide band noise** dB
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	-147.0	-11.0	-105.1	1.0	20.0	50.9	3.0	1.0	-154.0	-119.0	-35.0
Antennas in close proximity		25.0	1.0	0.0	-147.0	-11.0	-115.0	1.0	N/A	30.0	0.0	1.0	-146.0	-119.0	-27.0
Antennas in close proximity		25.0	1.0	0.0	-147.0	-11.0	-115.0	1.0	N/A	40.0	0.0	1.0	-156.0	-119.0	-37.0

Table 9c: Calculation of the required attenuation to avoid desensitisation of a PMR Base Station Receiver from the CDMA-PAMR Base Station Transmitter wide band noise

By consideration of wide band noise CDMA PAMR to TETRA	CDMA-PAMR centre frequency separation from transition frequency MHz 5.0	CDMA PAMR Tx power Watts	losses dB	Tx ant gain dBi	CDMA PAMR WBN spec + effect of Duplex Filter dBc	Bandwidth gain (ref. 100 kHz. Victim bw. 18 kHz) dB	Radiated noise dBm in 18 kHz dBm	No	Distance m	Free space propagation dB	RX antenna gain dBi	feeders etc dB	Interference power dBm	Protected sensitivity; C/I (19 dB) below neg 103 dBm dBm	**Required attenuation for wide band noise** dB
Antennas on adjacent buildings, rooftop to rooftop		25.0	1.0	12.0	-147.0	-7.4	-101.6	1.0	20.0	50.9	11.0	1.0	-142.5	-122.0	-20.5
Antennas in close proximity		25.0	1.0	0.0	-147.0	-7.4	-111.5	1.0	N/A	30.0	0.0	1.0	-142.5	-122.0	-20.5
Antennas in close proximity		25.0	1.0	0.0	-147.0	-7.4	-111.5	1.0	N/A	40.0	0.0	1.0	-152.5	-122.0	-30.5

Table 9d: Calculation of the required attenuation to avoid desensitisation of a TETRA Base Station Receiver from the CDMA-PAMR Base Station Transmitter wide band noise

These results are based on the following assumptions:
Propagation model used is free space loss for antenna distances of 20m and over.
For antenna separation distances below 20m a fixed coupling of 30 and 40 dB has been used.
The antenna gain of the victim (PMR/TETRA) and interferer (CDMA-PAMR) BS is assumed to be 3/11 dBi and 12 dBi respectively.
Bandwidth adjustment is required because the wide band noise of CDMA-PAMR is measured in 30 and 100 kHz bandwidth and PMR/TETRA is an 8/18 kHz carrier.

ANNEX 2: TECHNICAL PARAMETERS USED FOR SEAMCAT® MODELLING AND MCL CALCULATIONS

Parameter			CDMA-PAMR		FM		NMT450		TETRA	
			MS	BS	MS	BS	MS	BS	MS	BS
Channel Spacing		kHz	1250	1250	12.5	12.5	25	25	25	25
Cell Radius – Urban		km	3.5		3.5		3.5		3.5	
– Suburban		km	7		7		7		6	
– Rural		km	20		20		20		16	
Transmit Power		dBm	23	44	37	41	41.8/ 31.8	47	30	34”
Receiver Bandwidth		kHz	1250	1250	8	8	18	18	18	18
Antenna Height		m	1.5	30	1.5	30	1.5	30	1.5	30
Antenna Gain		dBi	0	11	0	3	0	?	0	10*
Receiver Sensitivity		dBm	-117	-124	-104	-104	-107	-109	-103	-106
Receiver Protection Ratio		dB			12	12	8	8	19	19
Power Control Characteristics	Step	dB	1	1	N/A	N/A	10	N/A	N/A	N/A
	Range	dB	60	PC sim	N/A	N/A	20	N/A	N/A	N/A
	Threshold	dBm	see table below	see table below	N/A	N/A		N/A	N/A	N/A

The cell size has been determined by calculation of the link budget. Values are taken from specifications wherever possible. Although the TIA/EIA-98-E standard specifies values up to 38 dBm for CDMA mobiles output power, in practice, the maximum output power from existing CDMA-PAMR mobile is 23 dBm in accordance with the ETSI and Lucent SRDocs. This is the value for the maximum output power that is designed into CDMA-PAMR mobiles, and is the same value as the maximum output power for CDMA-1X MSs (on which CDMA-PANR mobiles are based). The value is suitable for balancing of uplink and downlink link budgets (with CDMA-PAMR BSs having maximum output power of up to 44 dBm). Note that CDMA-PAMR employs fast power control on both the uplink and the downlink, with a particularly large dynamic range on the downlink (typically 60 dB). Hence, both BSs and MSs in a CDMA-PAMR network will usually be transmitting at output powers that are significantly below the maximum values. For example, the typical output power from a CDMA-PAMR MS operating on a typical CDMA-PAMR network can be expected to be at least 10-20 dB below the maximum value.
*For the purpose of this study a high gain antenna was assumed for the TETRA BS receiver because this would increase the interference into the receiver itself.
“This study has assumed a power of 34 dBm it should however be noted that in real deployment a power level of up to 48 dBm may be used. Increasing the power of the BS will in general lower or maintain the total interference experienced by the MSs because of a higher wanted signal level. One exception to this is the Intermodulation product that arises from the transmitter's leakage into its own receiver. For this type of Intermodulation the mitigation should take the actual deployed power into account.

Unwanted Emissions CDMA-PAMR:
For Band Class 11
The emission levels for frequency offsets between the specified points are derived by linear interpolation.
a) Base Station limits from the Lucent CDMA-PAMR SRDoc

Separation from centre frequency (| Δf |)	Emission limit
750 kHz	-45 dBc / 30kHz
885 kHz	-60 dBc / 30kHz
1.125 to 1.98 MHz	-65 dBc / 30kHz
1.98 to 4.00 MHz	-75 dBc / 30kHz
4.00 to 6.00 MHz	-36 dBm / 100 kHz
> 6.00 MHz	-45 dBm / 100 kHz

b) Mobile Station limits from the Lucent CDMA-PAMR SRDoc

Separation from centre frequency (| Δf |)	Emission limit
885 kHz	-47 dBc / 30kHz
1.125 MHz	-54 dBc / 30kHz
1.98 MHz	-67 dBc / 30kHz
4.00 MHz	-82 dBc / 30kHz
4.00 to 10.0 MHz	-51 dBm / 100kHz

Note In the TIA/EIA 98E standard the figure given is 1.120MHz due to a typographical error (Table 4.5.1.3-5, Sub class 1)

CDMA BS spectrum mask including a 1 carrier duplex filter
Note 1: this specification for duplex filter performance is proprietary and not included as part of the TIA specifications as referenced in Lucent SRDoc.

	CDMA - PAMR BS	CDMA - PAMR 44 dBm	CDMA-PAMR BS Normalised to 30 kHz bw		
Offset kHz 1 Channel	Spec.	BS Spec. dBc	1 carrier dBc	Duplex Spec dBc	1 carrier incl Duplexer
-30000	-45.0	-89.0	-94.2	-75.0	-169
-15000	-45.0	-89.0	-94.2	-85.0	-179
-6000	-45.0	-89.0	-94.2	-85.0	-179
-5999	-36.0	-80.0	-85.2	-85.0	-170
-4000	-36.0	-80.0	-85.2	-40.0	-125
-3999	-75.0	-75.0	-75.0	-40.0	-115
-1980	-75.0	-75.0	-75.0	-25.0	-100
-1979	-65.0	-65.0	-65.0	-25.0	-90
-1125	-65.0	-65.0	-65.0	-15.0	-80
-1000	-62.5	-62.5	-62.5	-15.0	-78
-885	-60.0	-60.0	-60.0	-10.0	-70
-750	-45.0	-45.0	-45.0	0.0	-45
-625	0	0.0	-16.2	0.0	-16
625	0	0.0	-16.2	0.0	-16
750	-45.0	-45.0	-45.0	0.0	-45
885	-60.0	-60.0	-60.0	-10.0	-70
1000	-62.5	-62.5	-62.5	-15.0	-78
1125	-65.0	-65.0	-65.0	-15.0	-80
1979	-65.0	-65.0	-65.0	-25.0	-90
1980	-75.0	-75.0	-75.0	-25.0	-100
3999	-75.0	-75.0	-75.0	-40.0	-115
4000	-36.0	-80.0	-85.2	-40.0	-125
5999	-36.0	-80.0	-85.2	-50.0	-135
6000	-45.0	-89.0	-94.2	-50.0	-144
30000	-45.0	-89.0	-94.2	-75.0	-169

The values included for the duplex filter is from a typical single carrier filter.

Receiver Blocking Characteristics

Frequency Offset			FM	
			MS	BS
4	kHz	dBc	0	0
6.25	kHz	dBc	60+3	60+3
18.75	kHz	dBc	60+3	60+3
18.76	kHz	dBc	70+3	70+3
1000	kHz	dBc	70+3	70+3
1000.01	kHz	dBc	84+3	84+3
20000	kHz	dBc	84+3	84+3

Reference for blocking/adjacent selectivity is 84/70 dB above 6dB/µV EMF, sensitivity however is 3dB/µV EMF

PMR Duplex filter assumptions (RX branch)		
offset for start of slope	1	MHz
slope	10	dB/MHz
att on own TX (stopband att)	80	dB

TETRA duplex filter type 1	RX Filter assumptions assumes 5 MHz duplex gap
offset for start of slope	1.22 MHz
Slope	23 dB/MHz
att on own TX (stopband att)	87 dB

when a CDMA-PAMR carrier is located on the steep slope of the above filter the filter function has been reduced by 6 dB because of the bandwidth of CDMA-PAMR and the integration of power over this bandwidth

Typical TETRA duplex filter RX branch type 2	
Offset MHz	Attenuation DB
-30	-60
-20	-60
-15	-60
-12.5	-55
-10	-50
-7.5	-30
-5	-3
-2.5	0
0	0
2.5	0
5	-3
7.5	-80
10	-80
12.5	-80
15	-70
20	-70
30	-70

when a CDMA-PAMR carrier is located on the steep slope of the above filter the filter function has been reduced by 10 dB because of the bandwidth of CDMA-PAMR and the integration of power over this bandwidth.

Analogue Receiver IM3 Characteristics
70 dB above 6dB/ųV EMF ~ -37 dBm

TETRA Receiver IM3 Characteristics
- 47 dBm at 3 dB above reference sensitivity

TETRA Blocking levels of the receiver

Offset from nominal Rx freq.	Level of interfering signal
50 kHz to 100 kHz	-40 dBm
100 kHz to 200 kHz	-35 dBm
200 kHz to 500 kHz	-30 dBm
> 500 kHz	-25 dBm

Active Interferer Densities

Environment	CDMA-PAMR		
	MS Max. per carrier	MS Typical per carrier	BS per carrier/cell
Urban	0.25	0.1	0.03142
Suburban	0.05	0.02	0.007855
Rural	0.01	0.004	0.0009623

Information in this table is based on assumption of hexagonal cells. The BS densities are calculated as 1/cell area in km^2.

This report is valid for one or more CDMA-PAMR carrier even though the simulated cases only use one CDMA-PAMR carrier. Because of the steep roll-off of the wide band noise through the duplex filter and the carrier frequency separation of 1.25 MHz the impact of a second or a third carrier becomes insignificant. This has been verified with the following control calculations:

CDMA-PAMR MS to TETRA BS Urban Comparison between 1 and 2 CDMA-PAMR carriers interference					
Victim Band⇨		2 MHz TETRA Band		Single Channel TETRA	
Guard Band⇩	CDMA channels⇨	1	2	1	2
125k		0.45%	0.49%	5.4%	5.5%
200k		0.25	0.32%	2.0%	2.0%
260k		0.21%	0.27%	1.0%	1.0%
500k		0.16%	0.21%	0.47%	0.49%
1355k		0.05%	0.1%	0.01%	0.17%
3375k		0.04%	0.08%	0.02%	0.09%

Table 2.2 CDMA-PAMR MS single channel into TETRA MS 2 MHz band

CDMA-PAMR TX power distribution and related Rx threshold values for urban, sub-urban and rural

Environment	CDMA-PAMR BS Power distribution (cumulative probability for SEAMCAT)				Related BS Rx threshold values
	37 dBm	38 dBm	39 dBm	40 dBm	dBm
Urban max MS aid 0.25, r = 3.5 km, N =-106.1 dBm	0.07	0.63	0.96	1	-116.87
Urban typ MS aid 0.1, r = 3.5 km, N, =-106.1 dBm	0.37	0.95	1		-117.85
Suburban max MS aid 0.05, r = 7 km, N, =-111.1 dBm	0.09	0.74	1		-122.26
Suburban typ MS aid 0.02, r = 7 km, N, =-111.1 dBm	0.34	0.96	1		-123.04
Rural max MS aid 0.01, r = 20 km, N, =-113.1 dBm	0.04	0.53	0.97	1	-123.32
Rural typ MS aid 0.004, r = 20 km, N, =-113.1 dBm	0.17	0.91	1		-124.67

Frequencies for the SEAMCAT simulations
Frequency Ranges for Various Scenarios

CDMA MS to FM MS (Scenario 1)
CDMA Range (Carrier Centres):

GB (kHz)	125	260	500	1355	3375
CDMA Carrier 3	416.75	416.615	416.375	415.52	413.5
CDMA Carrier 2	418	417.865	417.625	416.77	414.75
CDMA Carrier 1	419.25	419.115	418.875	418.02	416

FM Range (Carrier Centres): 420.00625 to 421.99375 MHz.

CDMA MS to FM BS (Scenario 2)

CDMA Range (Carrier Centres):

GB (kHz)	125	260	500	1355	3375
CDMA Carrier 3	414	413.865	413.625	412.77	410.75
CDMA Carrier 2	415.25	415.115	414.875	414.02	412
CDMA Carrier 1	416.5	416.365	416.125	415.27	413.25

FM Range (Carrier Centres): 417.25625 to 419.24375 MHz.

CDMA BS to FM MS (Scenario 3)
CDMA Range (Carrier Centres):

GB (kHz)	125	260	500	1355	3375
CDMA Carrier 3	424	423.865	423.625	422.77	420.75
CDMA Carrier 2	425.25	425.115	424.875	424.02	422
CDMA Carrier 1	426.5	426.365	426.125	425.27	423.25

FM Range (Carrier Centres): 427.25625 to 429.24375 MHz.

CDMA BS to FM BS (Scenario 4)
CDMA Range (Carrier Centres):

GB (kHz)	125	260	500	1355	3375
CDMA Carrier 1	420.75	420.885	421.125	421.98	424
CDMA Carrier 2	422	422.135	422.375	423.23	425.25
CDMA Carrier 3	423.25	423.385	423.625	424.48	426.5

FM Range (Carrier Centres): 418.00625 to 419.99375 MHz.

ANNEX 3: STUDY OF THE IMPACT OF CDMA-PAMR INTO NMT-450 USED IN FIXED WIRELESS ACCESS APPLICATIONS

A3.1 INTRODUCTION

This Annex considers the impact of introducing CDMA-PAMR in the frequency range 450-470 MHz taking into account the existing Fixed Service Point-to-Multipoint links (Fixed Wireless Access) based on NMT-450 with 16 kHz bandwidth (25 kHz channel spacing).

This annex considers in particular the interference arising from CDMA-PAMR as specified in the Lucent SRDoc into existing P-MP in the 450-470 MHz band. Monte Carlo modelling has been performed using SEAMCAT® in order to investigate the interference to the P-MP system caused by the introduction of a CDMA-PAMR network in adjacent spectrum with a guard band between them.

The simulations focused on a 1.25 MHz band for CDMA-PAMR because the impact of a second or a third carrier is insignificant. This is because of the steep roll-off of the wide band noise through the duplex filter and the carrier frequency separation of 1.25 MHz. The modelling has investigated the effects of interference from both CDMA-PAMR BSs and MSs to both BSs and Terminal Equipment (TE) of the P-MP system.

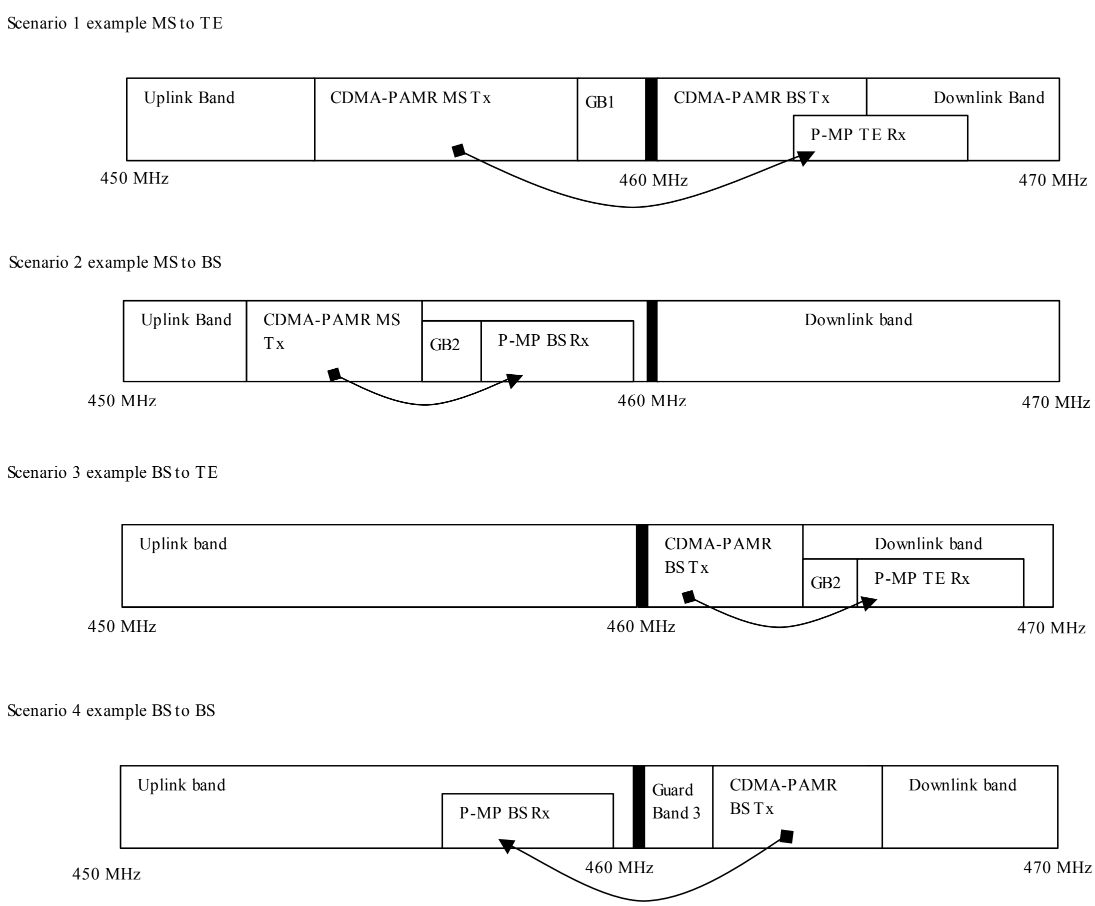


Figure A3.1. Modelled scenarios of interference from CDMA-PAMR to NMT-450 FWA

A3.2. METHODOLOGY

A3.2.1 Monte Carlo

Monte Carlo modelling using SEAMCAT® was carried out for the following scenarios (see Fig. A3.1):

- Scenario 1: CDMA-PAMR MS into NMT-450 TE (at frequencies near the duplex transition).
- Scenario 2, CDMA-PAMR MS into NMT-450 BS (at frequencies near at the uplink band).
- Scenario 3, CDMA-PAMR BS into NMT-450 TE (at frequencies near at the downlink band).
- Scenario 4, CDMA-PAMR BS into NMT-450 BS (at frequencies near the duplex transition).

The simulations focused on a 1.25 MHz band for CDMA-PAMR because the impact of a second or a third carrier is insignificant. This is because of the steep roll-off of the wide band noise through the duplex filter and the carrier frequency separation of 1.25 MHz. The modelling has investigated the effects of interference from both CDMA-PAMR BSs and MSs to both NMT-450 BSs and TE.

In the scenarios where NMT-450 TE are involved some "sub-scenarios" were performed: *indoor* and *outdoor*.

A3.2.2 MCL

Minimum Coupling Loss (MCL) is a method that involves calculating a static link budget. It is used in addition to the MC SEAMCAT® Tool for the BS to TE and BS scenarios (see Figures 5 and Figure 7.) where CDMA-PAMR is the interferer and NMT-450 is the victim. This approach is used because both the interferer and victim are stationary both in frequency and geographical position (static interference scenario). MCL is a means to address the worst-case scenario that can determine how much additional attenuation is required for interference free operation.

For cases related to Scenarios 3 and 4 above, MCL modelling has been performed in order to establish the conditions under which the two systems can co-exist, and the mitigation measures that may be necessary in order to ensure that interference is avoided.

A3.3. INTERFERENCE MODELLING

The following study investigated the interference that occurs from the CDMA-PAMR MS and BS transmitters into a NMT-450 BS and TE receivers:

1- The Unwanted Emission (Spurious Emission and Wide Band Noise) from the CDMA-PAMR transmitter that is above the receiver sensitivity will desensitise the NMT-450 BS and TE receivers, so that low-level signals may not be received.
2- Blocking will occur where the incoming power from the CDMA-PAMR transmitters is above the specified NMT-450 blocking level; this will desensitise the NMT450 receiver, so that the reference sensitivity performance may not be maintained.

A3.3.1 Propagation models and AIDs

The propagation models were selected so as to be appropriate for the task.

A3.3.1.1 Monte Carlo simulation models

All SEAMCAT MC simulations were undertaken using the Extended Hata propagation model as defined by WGPT SE21.

A3.3.1.2 Minimum Coupling Loss:

ITU recommends that for distances up to 1 km ITU Rec. P.1411 is appropriate. However, for this distance and for antenna heights above 9 m, P 1411 and the Free Space propagation model delivers the same mean value of propagation loss. In the MCL scenario 4, CDMA-PAMR BS into NMT-450 BS, the Free Space propagation model has been used to calculate the loss. In the scenario 3 -CDMA-PAMR BS into NMT-450 TE- and considering the range of distances up to 30 km and the environment, the Okumura-Hata model were used instead of the Free Space propagation.

A3.3.1.3 Active Interferer Densities

Active Interferer Densities (AIDs) were calculated on the assumption that a limited amount of spectrum would be available. The simulations focused on a 1.25 MHz band for CDMA-PAMR because the impact of a second or a third carrier is insignificant. This is because of the steep roll-off of the wide band noise through the duplex filter and the carrier frequency separation of 1.25 MHz. This has been verified with control calculations. Consequently this annex is valid for more than one CDMA-PAMR carrier. Any necessary guard bands will be additional to the above bands and will be depending on the technology used adjacent to CDMA-PAMR.

Environment	Cell Radius (km)	Cell Area (km2)	AID (max) per carrier (1/km2)	Max number of Users per carrier at 0.015 Erlang	AID (typical) per carrier (1/km2)	Typical number of Users per carrier at 0.015 Erlang
Suburban	7	127	0.05	423	0.02	169
Rural	20	1039	0.01	693	0.004	277

Table A3.1. Description of Cell Radii and Active Interferer Density

The AID figures used are consistent with those used in the study between CDMA-PAMR and PMR/PAMR technologies. The BS densities are calculated as 1/cell area in km^2.

A3.4 MONTE CARLO MODELLING RESULTS

Monte Carlo modelling using SEAMCAT® was undertaken for the following scenarios (see Fig. A3.1):

- Scenario 1: CDMA-PAMR MS into NMT-450 TE (at frequencies near the duplex transition).
- Scenario 2, CDMA-PAMR MS into NMT-450 BS (at frequencies near at the uplink band).
- Scenario 3, CDMA-PAMR BS into NMT-450 TE (at frequencies near at the downlink band).
- Scenario 4, CDMA-PAMR BS into NMT-450 BS (at frequencies near the duplex transition).

The simulations focused on a 1.25 MHz band for CDMA-PAMR because the impact of a second or a third carrier is insignificant. This is because of the steep roll-off of the wide band noise through the duplex filter and the carrier frequency separation of 1.25 MHz. The modelling has investigated the effects of interference from both CDMA-PAMR BSs and MSs to both NMT-450 BSs and TE.

A3.4.1 Scenario 1

Scenario 1 assessed the level of interference from CDMA-PMAR MSs into NMT-450 TE.

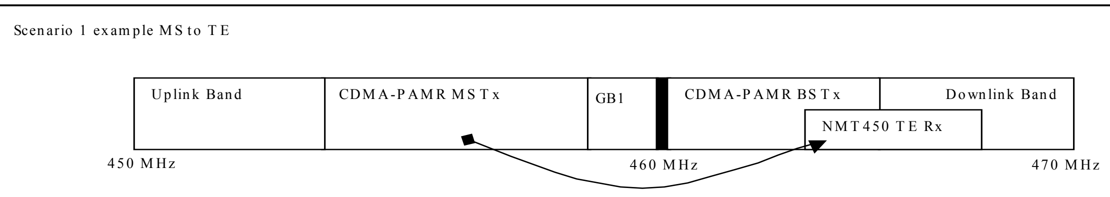


Figure A3.2. Scenario 1

In this scenario the resulting interference probability obtained was zero. Both RF carriers are separated sufficiently to avoid any desensitisation of the NMT-450 receiver due to spurious emissions and wide band noise from CDMA–PAMR MSs.

A3.4.2 Scenario 2

Scenario 2 assessed the level of interference from CDMA-PAMR MS into NMT-450 BS.

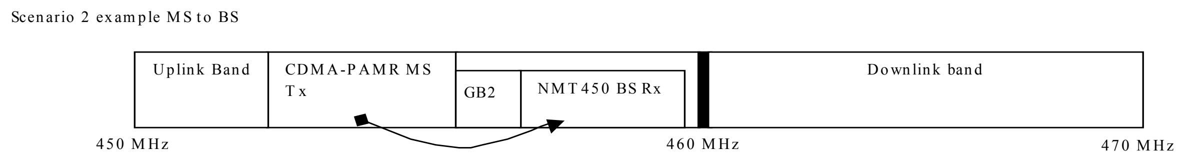


Figure A3.3. Scenario 2

Sub-scenarios were performed with the aim to assess the importance of the NMT-450 TE location in the scenario.

The TE are installed in two scenarios: *indoor* and *outdoor*. In the *outdoor* scenario simulations were performed with different coverage radius, since that the desired signal level will be modified and therefore affect the interference probability.

A3.4.2.1 Results for the scenario 2

The following tables contain results of SEAMCAT® modelling of the interference from CDMA-PAMR MS into NMT-450 BS for a variety of different guard bands.

		Suburban		Rural	
Guard Band⇩	AID⇨	0.05	0.02	0.01	0.004
62.5		1.3876%	0.6675%	0.4652%	0.2101%
262.5		0.5792%	0.2783%	0.1551%	0.1010%
512.5		0.2627%	0.1788%	0.0500%	0.0450%
1362.5		0.0997%	0.0421%	0.0050%	0.0200%
3362.5		0.0053%	0.0000%	0.0000%	0.0000%

Table A3.2a. NMT-450 TE Indoor and Coverage Radius: 5 km

		Suburban		Rural	
Guard Band⇩	AID⇨	0.05	0.02	0.01	0.004
62.5		0.5107%	0.2352%	0.1200%	0.0650%
262.5		0.2253%	0.1602%	0.0200%	0.0100%
512.5		0.1202%	0.0801%	0.0150%	0.0980%
1362.5		0.0100%	0.0050%	0.0000%	0.0000%
3362.5		0.0000%	0.0000%	0.0000%	0.0000%

Table A3.2b. NMT-450 TE Outdoor and Coverage Radius: 10 km

		Suburban		Rural	
Guard Band⇩	AID⇨	0.05	0.02	0.01	0.004
62.5		0.9531%	0.4290%	0.1900%	0.1400%
262.5		0.3328%	0.1970%	0.0900%	0.0350%
512.5		0.2069%	0.1414%	0.0250%	0.0200%
1362.5		0.0656%	0.0202%	0.0200%	0.0050%
3362.5		0.0000%	0.0000%	0.0000%	0.0000%

Table A3.2a. NMT-450 TE Outdoor and Coverage Radius: 15 km

		Suburban		Rural	
Guard Band⇩	AID⇨	0.05	0.02	0.01	0.004
62.5		Note 2	Note 2	0.7911%	0.3155%
262.5		“	“	0.2453%	0.1551%
512.5		“	“	0.1652%	0.0751%
1362.5		“	“	0.0400%	0.0200%
3362.5		“	“	0.0000%	0.0000%

Table A3.2a. NMT-450 TE Outdoor and Coverage Radius: 30 km

Note 2: These scenarios were not considered since they do not represent practical implementation.

A3.4.3 Simulations for the Scenario 3

Scenario 3 assesses the level of interference from CDMA-PAMR BSs into NMT-450 TE.

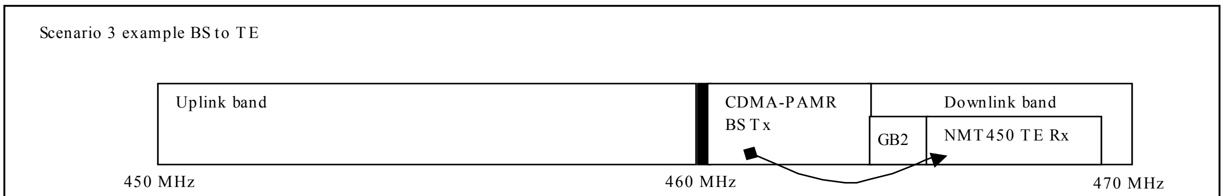


Figure A3.4. Scenario 3

Sub-scenarios were performed with the aim to assess the importance of the NMT-450 TE location in the scenario.

The TE is installed in two scenarios: *indoor* and *outdoor*. In the *outdoor* scenario simulations were performed with different coverage radius, since that the desired signal level will be modified and therefore affect the interference probability.

A3.4.3.1 Results for the scenario 3

The following tables contain results of SEAMCAT® modelling of the interference from CDMA-PAMR BS into NMT-450 TE for a variety of different guard bands.

		Suburban		Rural	
BS AID⇨		**0.007855**		**0.0009623**	
Guard Band⇩	MS AID⇨	0.05	0.02	0.01	0.004
62.5		1.9090%	1.4520%	0.4302%	0.4050%
262.5		0.0672%	0.0363%	0.0050%	0.0050%
512.5		0.0362%	0.0104%	0.0000%	0.0000%
1362.5		0.0000%	0.0000%	0.0000%	0.0000%
3362.5		0.0000%	0.0000%	0.0000%	0.0000%

Table A3.3a. NMT-450 TE Indoor and Coverage Radius: 5 km

		Suburban		Rural	
BS AID⇨		**0.007855**		**0.0009623**	
Guard Band⇩	MS AID⇨	0.05	0.02	0.01	0.004
62.5		6.9060%	5.1460%	1.1300%	0.9750%
262.5		0.1503%	0.0902%	0.0350%	0.0150%
512.5		0.0552%	0.0301%	0.0000%	0.0000%
1362.5		0.0000%	0.0050%	0.0000%	0.0000%
3362.5		0.0000%	0.0000%	0.0000%	0.0000%

Table A3.3b. NMT-450 TE Outdoor and Coverage Radius: 10 km

		Suburban		Rural	
BS AID⇨		**0.007855**		**0.0009623**	
Guard Band⇩	MS AID⇨	0.05	0.02	0.01	0.004
62.5		12.9100%	9.5450%	2.3400%	1.9700%
262.5		0.2082%	0.1373%	0.0300%	0.0300%
512.5		0.0915%	0.0508%	0.0300%	0.0050%
1362.5		0.0050%	0.0102%	0.0000%	0.0000%
3362.5		0.0000%	0.0000%	0.0000%	0.0000%

Table A3.3c. NMT-450 TE Outdoor and Coverage Radius: 15 km

		Suburban		Rural	
BS AID⇨		**0.007855**		**0.0009623**	
Guard Band⇩	MS AID⇨	0.05	0.02	0.01	0.004
62.5		Note2	Note 2	8.6020%	7.3830%
262.5		"	"	0.1453%	0.1153%
512.5		"	"	0.0602%	0.0251%
1362.5		"	"	0.0000%	0.0050%
3362.5		"	"	0.0000%	0.0000%

Table A3.3d. NMT-450 TE Outdoor and Coverage Radius: 30 km

A3.4.3.2 MCL modelling for the BS-to-TE case (Scenario 3)

The scenario used for the BS-to-TE included the suburban and rural environment cases where antennas of BSs are mounted on rooftops. This will lead to a worst-case situation where the antennas of the CDMA-PAMR and NMT-450 TE are facing each other and have a direct line of sight. For this scenario a separation distance of 20 m was selected to form the basis for the calculations.

The MCL method was used to calculate the interference that may occur. The figures make use of the worst-case scenario from the calculations of interference and considering the range of distances up to 30 km and the environment, the Okumura-Hata model were used instead of the Free Space propagation model to extrapolate the required attenuation as a function of the physical separation distance.

A graphic representation is provided for the influence of the wide band noise from CDMA-PAMR as a function of separation distance (Figure A3.5).

A3.4.3.3 MCL studies for the scenario 3

Calculation of the required attenuation to avoid Blocking of a NMT-450 TE Rx from CDMA-PAMR BS

CDMA BTS	Power [dBm]	Losses [dB]	Tx Ant Gain [dBi]	Tx EIRP [dBm]	Distance [m]	Free Space Loss [dB]	NMT-450 TE Rx Ant Gain [dBi]	Feeders Loss [dB]	Interference power [dBm]	Blocking [dBc]	Blocking [dBm]	Required Atten [dB]
NMT: 465.2 MHz	38.00	1.00	12.00	49.00	20.00	51.77	15.00	3.00	9.23	-70.00	-34.00	43.23
NMT: other RF	38.00	1.00	12.00	49.00	20.00	51.77	15.00	3.00	9.23	-84.00	-20.00	29.23

Table A3.4.: Scenario considering CDMA BS emitting at 465.2 MHz and TE Rx NMT-450 receiving at 465.2 MHz and others RF carriers

Calculation of the required attenuation to avoid Desensitisation of a NMT-450 TE Rx from CDMA-PAMR BS wide band noise

CDMA BTS / NMT RF⇩	Guard Band [kHz]	Power [dBm]	Ant Gain [dBi]	Spurious [dBc]	B ref	G 16/Bref [dBi]	Radiated noise	Distance [m]	Okumura Losses [dB]	NMT-450 TE Rx Ant Gain [dBi]	Interference power [dBm]	Prot Sens -104-8	Required Atten [dB]
465.9	62.50	38.00	11.00	-16.00	30.00	-2.73	30.27	20.00	58.90	12.00	-9.50	-112.00	95.37
466.1	262.50	38.00	11.00	-16.00	30.00	-2.73	30.27	20.00	58.90	12.00	-9.50	-112.00	41.37
466.35	512.50	38.00	11.00	-16.00	30.00	-2.73	30.27	20.00	58.90	12.00	-9.50	-112.00	31.37
467.2	1362.50	38.00	11.00	-80.00	30.00	-2.73	-33.73	20.00	58.90	12.00	-73.50	-112.00	-8.63
469.2	3362.50	38.00	11.00	-125.00	30.00	-2.73	-78.73	20.00	58.90	12.00	-118.50	-112.00	-23.63

Table a3.5: Scenario considering CDMA BS emitting at 465.2 MHz and TE Rx NMT-450 receiving at different RF carriers, near the duplex transition

Note: 38 dBm of power is the average power that CDMA BS transmits under normal conditions (see Power Distribution Table in Appendix 1).

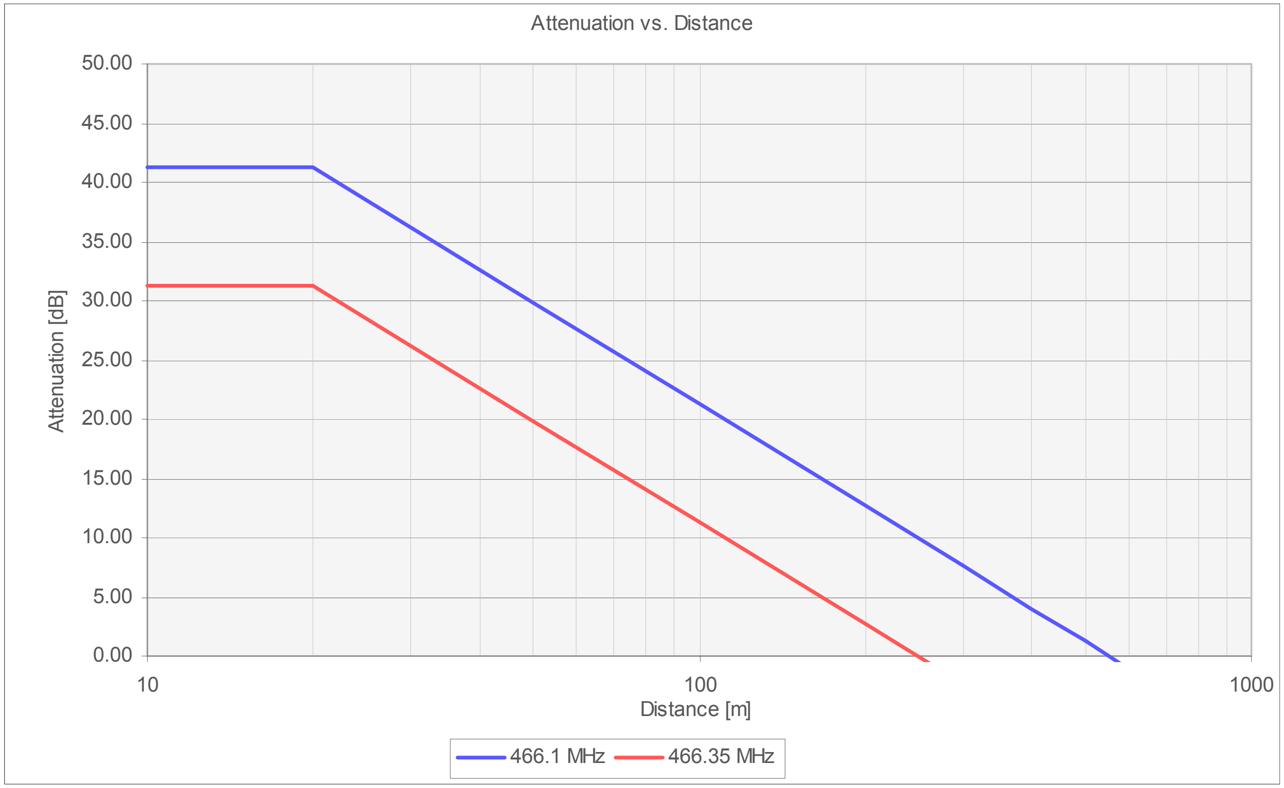


Figure A3.5. Attenuation *versus* Distance required due to wide band noise.

A3.4.4 Simulations for the Scenario 4

Scenario 4 assessed the level of interference from CDMA-PMAR BSs into NMT-450 TE when NMT-450 is operating near the duplex transition frequency.

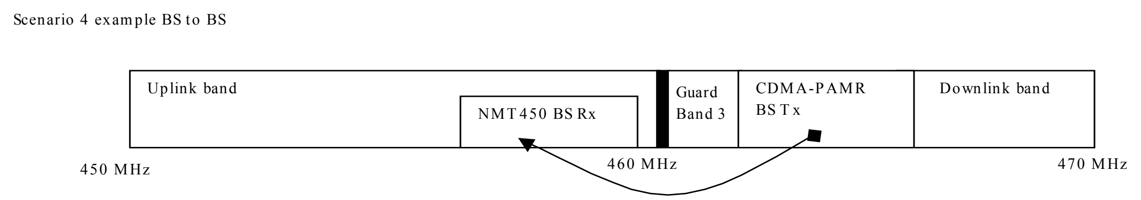


Figure A3.6. Scenario 4

Operating near the duplex transition frequency and considering the CDMA-PAMR frequency carrier of 465.2 MHz means that a minimum of transition band (3325 kHz) already exists. In this scenario the resulting interference probability obtained was zero. Both RF carriers are separated sufficiently to avoid any desensitisation of the NMT-450 receiver due to spurious emissions and wide band noise from CDMA–PAMR system.

Other simulations were also performed to obtain the transition band in this frequency range. The results indicate that a 375 kHz transition band is adequate to avoid interference.

A3.4.4.1 Results for scenario 4

The following tables contain results of SEAMCAT® modelling of the interference from CDMA-PAMR BS into NMT-450 BS for a variety of different transition bands.

		Suburban		Rural	
BS AID⇨		**0.007855**		**0.0009623**	
Transition Band⇩	MS AID⇨	0.05	0.02	0.01	0.004
75		70.3357%	61.0468%	24.9775%	22.1330%
375		1.0551%	0.8793%	0.0400%	0.0450%
1375		0.0631%	0.0474%	0.0000%	0.0000%
3325		0.0000%	0.0000%	0.0000%	0.0000%

Table A3.6a. NMT-450 TE Indoor and Coverage Radius: 5 km

		Suburban		Rural	
BS AID⇨		**0.007855**		**0.0009623**	
Transition Band⇩	MS AID⇨	0.05	0.02	0.01	0.004
75		43.3864%	34.7680%	5.7150%	4.8550%
375		0.2654%	0.1852%	0.0000%	0.0050%
1375		0.0050%	0.0000%	0.0000%	0.0000%
3325		0.0000%	0.0000%	0.0000%	0.0000%

Table A3.6b. NMT-450 TE Outdoor and Coverage Radius: 10 km

		Suburban		Rural	
BS AID⇨		**0.007855**		**0.0009623**	
Transition Band⇩	MS AID⇨	0.05	0.02	0.01	0.004
75		59.9798%	50.0707%	13.3800%	11.6000%
375		0.6056%	0.4345%	0.0100%	0.0150%
525		0.4038%	0.3686%	0.0050%	0.0100%
1375		0.0353%	0.0151%	0.0000%	0.0000%
3325		0.0000%	0.0000%	0.0000%	0.0000%

Table A3.6c. NMT-450 TE Outdoor and Coverage Radius: 15 km

		Suburban		Rural	
BS AID⇨		**0.007855**		**0.0009623**	
Transition Band⇩	MS AID⇨	0.05	0.02	0.01	0.004
75		Note 2	Note 2	39.7167%	35.3359%
375		“	“	14.1605%	11.6442%
525		“	“	0.2002%	0.2252%
1375		“	“	0.0701%	0.0801%
3325		“	“	0.0451%	0.0551%

Table A3.6d. NMT-450 TE Outdoor and Coverage Radius: 30 km

A3.4.4.2 MCL modelling for the BS-to-BS case (Scenario 4)

The scenario used for the BSt-to-BS included the suburban and rural environment case, where antennas of BSs are mounted on rooftops. This will lead to a worst-case situation where the antennas of the CDMA-PAMR and NMT-450 BSs are facing each other and have a direct line-of-sight. For this scenario a separation distance of 20 m was selected to form the basis for the calculations.

Another scenario for BS-to-BS is where the antennas are co-sited, for this a coupling loss of 30 dB between the antennas has been introduced because this is a recognised standard value. An alternative coupling loss of 40 dB has been also considered, recognising that site engineering is able to provide additional coupling loss.

In the following figure A3.7, the attenuation required to avoid interference as a function of separation distance is depicted. The MCL method is used to calculate the interference that may occur. The figures make use of the worst-case scenario from the calculations of interference and add a free space propagation to extrapolate the required attenuation as a function of the physical separation distance.

The calculations were made for 20 m separation distance for the rooftop-to-rooftop scenario. For the close proximity of antennas scenario there are calculations for 30 dB and 40 dB isolation between the antennas.

A graphic representation is provided to show the influence of the spurious emission from CDMA-PAMR as a function of separation distance (FigureA3.7).

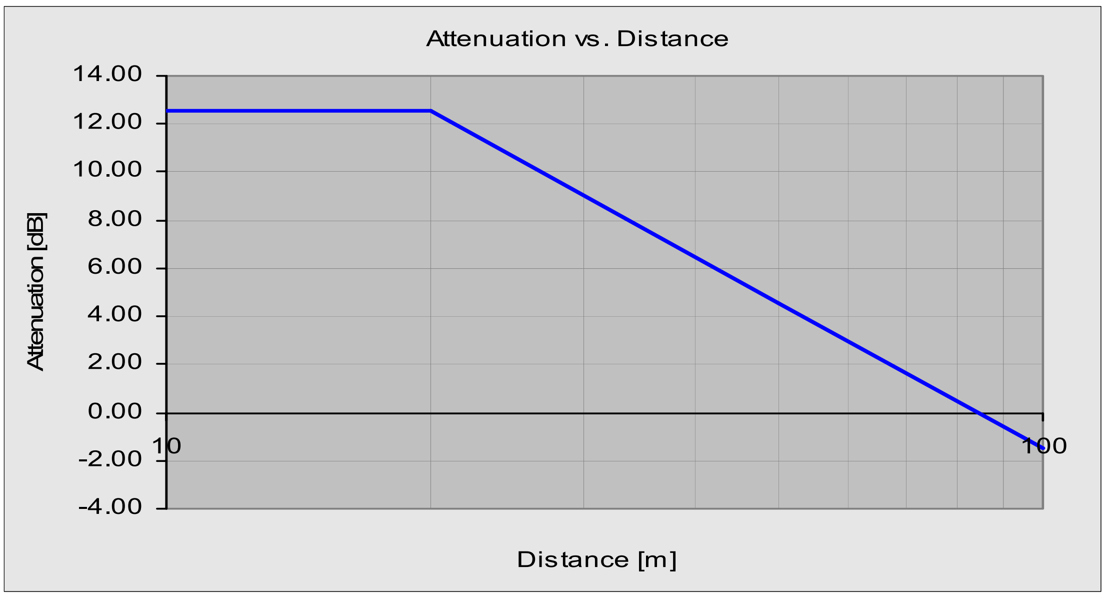


Figure A3.7. Attenuation *versus* Distance required due to wide band noise

A3.4.4.3 MCL studies for the scenario 4

Calculation of the required attenuation to avoid Blocking of a NMT-450 BS Rx from CDMA-PAMR BS

CDMA BTS	Power [dBm]	Losses [dB]	Tx Ant Gain [dBi]	Tx EIRP [dBm]	Distance [m]	Free Space Loss [dB]	NMT BS Rx Ant Gain [dBi]	Interference power [dBm]	Blocking [dBc]	Blocking [dBm]	Required Atten [dB]
Shared site	38.00	1.00	12.00	49.00	20.00	51.75	5.00	2.25	-84.00	-23.00	25.25
Close Proximity	38.00	1.00		37.00		30.00	5.00	7.00	-84.00	-23.00	30.00
Close Proximity	38.00	1.00		37.00		40.00	5.00	-3.00	-84.00	-23.00	20.00

Table A3.7. Scenario considering CDMA BS emitting at 463.95 MHz and BS Rx NMT-450 receiving at 457.475 MHz and others RF carriers

Calculation of the required attenuation to avoid Desensitisation of a NMT-450 BS Rx from CDMA-PAMR BS wide band noise

CDMA BTS	Conducted spurious [dBm]	Ant Gain [dBi]	Losses [dB]	Radiated Spurious [dBm]	Distance [m]	Free Space Loss [dB]	NMT BS Rx Ant Gain [dBi]	B ref	G 16/Bef [dBi]	Interference power [dBm]	Prot Sens -107-8	Required Atten [dB]
Shared site	-64.00	12.00	1.00	-53.00	20.00	51.75	5.00	30.00	-2.73	-102.48	-115.00	12.52
Close Proximity	-64.00	0.00	1.00	-65.00		30.00	0.00	30.00	-2.73	-97.73	-115.00	17.27
Close Proximity	-64.00	0.00	1.00	-65.00		40.00	0.00	30.00	-2.73	-107.73	-115.00	7.27

Table A3.8. Scenario considering CDMA BS emitting at 463.95 MHz and BS Rx NMT-450 receiving at different RF carriers, near the duplex transition

A3.5 CALCULATION OF INTERFERENCE

In the previous sections of this annex, calculations are provided in Tables A3.1-8 and Figures A3.5,7 concerning the interference that may occur in different scenarios. Calculations are provided for blocking of the NMT-450 TE and BS receivers from CDMA-PAMR base and MS transmitters.

Blocking occurs as a result of the power being present and is not related to the transmitter system type.

Also, the influence of the wide band noise from CDMA-PAMR into the NMT-450 TE and BS receivers were calculated. The calculations for the CDMA-PAMR wide band noise influence were separated into sections because of changing requirement and measuring method as a function of frequency separation from the carrier. The presented results (e.g. required attenuation) depend on the assumed duplexer filter. The used CDMA-PAMR duplexer filter characteristics are detailed in Appendix 1 to this Annex.

This annex considered in particular the interference from CDMA-PAMR, as specified in the Lucent SRDoc, into existing NMT-450 P-MP FS in the 450-470 MHz band. Monte Carlo modelling has been performed using SEAMCAT® to investigate the interference into a NMT-450 P-MP system caused by the introduction of a CDMA-PAMR network in adjacent spectrum with a guard or transition band between them. The simulations focus on a single 1.25 MHz carrier for CDMA-PAMR because the impact of a second or a third carrier is insignificant. This is because of the steep roll-off of the wide band noise through the duplex filter and the carrier frequency separation of 1.25 MHz. The modelling has investigated the effects of interference from both CDMA-PAMR BS and MS to both NMT-450 BS and TE.

A3.6 OBSERVATIONS

From the calculations of the attenuation required to avoid interference it can be seen that co-ordination between NMT-450 and CDMA-PAMR is required. From the figures derived from SEAMCAT® simulations it can be deduced that of 1000 TE deployed it can be expected that only 2 to 3 will suffer interference.

The results show that to avoid blocking of NMT-450 receivers additional filtering may be required when CDMA-PAMR transmitters are located within a vicinity of the (victim) NMT-450 Point-to-Multipoint system. The amount of filtering required is dependent on the frequency, the number of carriers, the separation distance and the transmitter power for the CDMA-PAMR BS.

A3.7 CO-ORDINATION PROCESS AND MITIGATION FACTORS

Care must be taken when assessing the interference by blocking in the scenario 3. In that scenario the potentially affected terminals may be identified by analytical means (e.g. C/I calculations) in case the required source data regarding the NMT-450 system is available, or if this is not possible then they may be identified on a case-by-case basis. However, the different techniques required to ensure that the NMT-450 receivers can operate without interference are: frequency separation, physical separation distance, improved performance (filters) and any combination of these.

Because mitigation is needed, co-ordination between the operators of NMT-450 P-MP networks and the CDMA-PAMR network is advised. Whilst it is recognised that the following technical solutions will assist co-ordination between operators, further detailed investigation is recommended into the practicality of implementing any of the following techniques.

A3.7.1 Separation Distance

The use of physical separation may be one way of achieving most cases of necessary attenuation.

Physical separation may be feasible in rural areas. Because the NMT-450 network is well established in those areas, the task of finding suitable locations, meeting the physical separation criteria, will be predominantly on the new CDMA-PAMR operator.

However it should be noted that relying solely on physical separation distance is not commonly used as a mitigation technique for the most popular cellular standards deployed around the world. This is due to the fact that cellular systems in urban areas are deployed with high site densities and often undergo changes. Relying on additional physical separation for interference control will require co-ordination to identify and track mutually interfering BS sites for resolving possible interference situations.

By using appropriate RF specifications and by avoiding difficult interference scenarios similar to those considered in this study, where the TX is spectrally and geographically in close proximity to the RX there is commonly not any need for considering additional physical separation.

A3.7.2 Frequency Separation

Use of frequency separation as a single solution to achieve the necessary attenuation of wide band noise from CDMA-PAMR requires a frequency separation extending outside the allocated band. This is because the wide band noise roll-off of CDMA-PAMR is fairly slow and also the blocking performance of NMT-450 receivers only improves marginally with frequency. This fact, combined with the difficulties in network planning and especially re-planning for optimisation of the network makes frequency separation a very unattractive solution. This study shows that a guard band of 262.5 kHz guarantees that no significant degradation happens to NMT-450 Point-to-Multipoint system.

A3.7.3 Filters

The performance of both the CDMA-PAMR transmitter and the NMT-450 receivers can be improved using filters. To allow the filters to operate a guard band is considered necessary. The requirements of the filter needed for improving the blocking performance of NMT-450 receivers in the CDMA-PAMR transmitter frequency range may not require any power handling capability, but the effect on both it's performance and that of the network needs to be evaluated. However it is important to maintain low insertion loss (IL) in NMT-450 RX filters in order to prevent desensitisation of the receiver.

A3.7.4 Separation Distance and Filters

Where it is impossible to establish sufficient physical separation to eliminate blocking and desensitisation of the NMT-450 receivers by wide band noise, additional filters could be used, subject to evaluation of impact on the receiver's performance. The filters may be selected to produce the desired attenuation, taking into account the physical separation distance loss, for the NMT-450 receivers to operate as intended.

A3.8 CONCLUSIONS

The study in this annex has identified the interference potential for NMT-450 system used as Fixed Wireless Access in the 450 MHz band when CDMA-PAMR is deployed adjacent to it. The annex has provided estimation of interference that can be experienced for different cases of guard bands and transition bands. The SEAMCAT calculations indicate that the risk of harmful interference from CDMA-PAMR interfering with NMT-450 used as Fixed Wireless Access in the 450 MHz bands is very low for the MS-to-MS, MS-to-BS ad BS-to-MS cases.
The annex has identified the necessary mitigation to protect the existing NMT-450 receivers against interference from CDMA-PAMR BS transmissions.
Mitigation in the form of filters will be required in some cases. To allow the filters to operate, a guard band or transition band is considered necessary.

The report concludes that the 450-470 MHz band can be utilised for CDMA-PAMR with negligible risk of interference to Fixed Wireless Access (P-MP) services provided the following guard bands/transition bands[3] are applied:
260 kHz guard band in the uplink to uplink band (MS-to-BS) and downlink to downlink band (BS-to-MS interference),
the transition band between the uplink and downlink bands (MS-to-MS interference) could not be determined by this study because the separation from the actual frequency allocations are such that no interference occur,
375 kHz transition band at the duplex transition frequency between the uplink and downlink bands (BS-to-BS interference) will limit necessary mitigation to around 1% of BSs in a suburban area.
The actual frequency allocations are such that a minimum transition band of 3325 kHz exist in the BS-to-BS scenario, no interference was recorded at this transition band.

The requirements on the CDMA-PAMR operator are such that it should be encouraged to use the physical separation whenever possible.

It is clear that the utilisation requires co-ordination between any NMT-450 P-MP operator and the new CDMA-PAMR operator. An uncoordinated approach could result in interference to some of the NMT-450 BS or TE receivers.

It should be noted that the annex did not consider interference from existing NMT-450 FWA P-MP system into CDMA-PAMR deployed in adjacent bands, since the effect from the new systems on the incumbent ones is the most important part to deal with. Since this direction of interference would address interference from narrow band 16/25 kHz to wider band systems, it has been considered that under the conditions presented above CDMA-PAMR systems would not be interfered.

[3] In this report the term guard band is considered to be the minimum frequency separation between the channel edges of the two systems. The term transition band is considered to be the minimum frequency separation between the channel edge of the CDMA-PAMR transmitters and the transition frequency between up and downlink.

APPENDIX 1 TO ANNEX 3: DESCRIPTION OF NMT-450 USED AS FWA, TECHNICAL PARAMETERS FOR THE SEAMCAT® MODELLING AND MCL CALCULATIONS

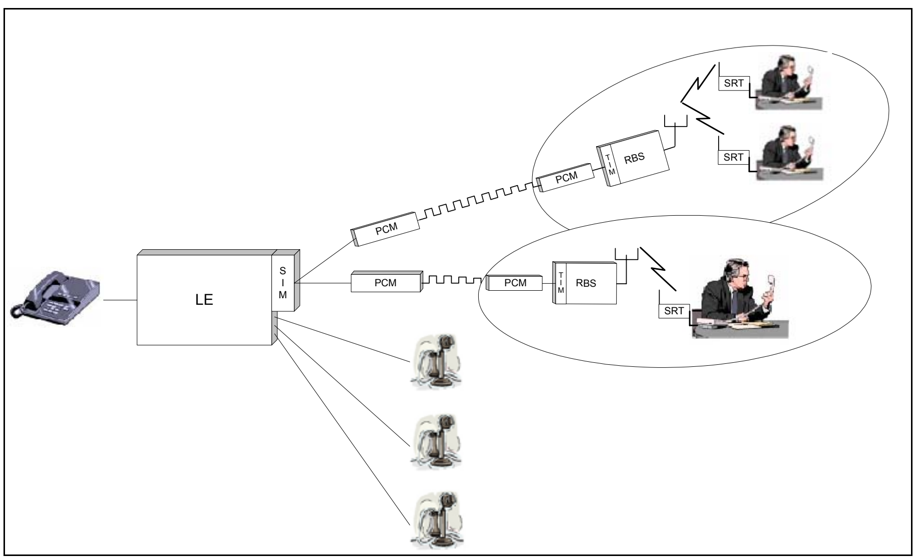
Description of the P-MP FIXED SERVICE System[4]

Due to the rough ground existing in Portugal some fixed operators have difficulties to provide their services in medium density areas especially those with scattered subscribers, e.g. rural areas.

An alternative way is connecting normal Plain Old Telephone Service (POTS) subscribers by using radio access, providing the same service level to end users as ordinary wired subscribers have. The TE (SRT) is fixed and is operated with a normal POTS telephone set (see Figure A3.8 below).

From the Local Exchange point of view the radio access subscriber is identical to an ordinary subscriber, i.e., charging of subscriber calls, handling of subscriber services and subscriber administration are done in the same way.

Note 1: Since the actual implementation of this Point-Multipoint is based on specifications of NMT (Nordic Mobile Telephone system) operating in 450 MHz, the Annex 3 describes Base Stations and Terminal (Mobile) Station as used in NMT-450 description, i.e. NMT-450 BS or Terminal Equipment (TE), respectively.



LE: Local Exchange SIM: Switching Interface Module
TIM: Translator Interface Module RBS: RadElectronic
Communications Committee (ECC)
s FWA

Switching Interface Module (SIM)

The SIM interfaces with the Local Exchange. It carries the signalling towards the Local Exchange, switch functions to select radio channels and holds a subscriber register. The translation of the PSTN subscriber number to a MS number is also handled, undetectable to the subscriber, by the SIM. The SIM is located at the Local Exchange.

Traffic is concentrated in the SIM, which economizes the transmission.

[4] Technology Schematic based on RAS1000 from Ericsson

Translator Interface Module (TIM)

The TIM "translates" the line-access-based signalling at the Local Exchange into NMT-450 signalling used for radio access. The TIM performs all the NMT-450 specific signalling, ciphering and control of the BS. The TIM is co-located with the RBS.

Point-to-Multipoint System

The radio subsystem is composed of a transmitter, the RBS, connected to an omnidirectional (*indoor* or *outdoor*) or Yagi (*outdoor*) antenna. The scenario depends on the quality of the received signal.

In the case of *indoor* antennas it is not expected that the coverage radius will be more than 5 km and for the *outdoor* scenarios the coverage radius will not be more than 30 km.

For those scenarios the TE antenna heights considered was 3 m and for BS - 30 m.

Parameters		CDMA-PAMR		NMT*	
		MS	BS	TE	BS
Channel Spacing	kHz	1250	1250	25	25
Coverage Radius – Urban	km	3.5		5** 10/15/30***	
– Suburban	km	7			
– Rural	km	30			
Emitted Power	dBm	23	44	42	47
Receiver Bandwidth	kHz	1250	1250	25	25
Antenna Height	m	1.5	30	1.5	30
Antenna Gain	dBi	0	11	0-9-15	8
Receiver Sensitivity	dBm	-117	-124	-104	-107
C/I	dB			8	8

* Data provided from ETS 300113 standard

** Simulations performed considering *indoor* scenario

*** Simulations performed considering *outdoor* scenario

Power distribution of the CDMA-PAMR system

CDMA MS Power Control		CDMA BS Power Mask	
Power Control	2	Power	Cum Prob
Min Threshold	-123	37 dBm	0.17
Range	6	38 dBm	0.91
		39 dBm	1

Spurious Emissions of the CDMA-PAMR system:

a) Base Station, from SRDoc - Lucent

Frequency shift RF (| Δf |)	Limits
750 kHz	-45 dBc / 30kHz
885 kHz	-60 dBc / 30kHz
1.125 to 1.98 MHz	-65 dBc / 30kHz
1.98 to 4.00 MHz	-75 dBc / 30kHz
4.00 to 6.00 MHz	-36 dBm / 100 kHz
> 6.00 MHz	-45 dBm / 100 kHz

b) Mobile Stations, from SRDoc - Lucent

Frequency shift RF (| Δf |)	Limits
885 kHz	-47 dBc / 30kHz
1.125 MHz	-54 dBc / 30kHz
1.98 MHz	-67 dBc / 30kHz
4.00 MHz	-82 dBc / 30kHz
4.00 to 10.0 MHz	-51 dBm / 100kHz

Blocking Characteristics of NMT*

Frequency Shift		NMT	
25	kHz	70	dBc
50-10000	kHz	84	dBc

Data provided from ETS 300113 standard

Frequency Ranges for the Scenarios

1. CDMA MS to NMT-450 TE (Scenario 1)

NMT Range (Carrier Centres):

GB (kHz)	3500
NMT-450 Carriers [MHz]	464.825

CDMA Range (Carrier Centres): 455.2 MHz.

2. CDMA MS to NMT-450 BS (Scenario 2)

NMT Range (Carrier Centres):

GB (kHz)	62.5	262.5	512.5	1362.5	3362.5
NMT-450 Carriers [MHz]	455.9	456.1	456.35	457.2	459.2

CDMA Range (Carrier Centres): 455.2 MHz.

3. CDMA BS to NMT-450 TE (Scenario 3)

NMT Range (Carrier Centres):

GB (kHz)	62.5	262.5	512.5	1362.5	3362.5
NMT-450 Carriers [MHz]	465.9	466.1	466.35	467.2	469.2

CDMA Range (Carrier Centres): 465.2 MHz.

4. CDMA BS to NMT-450 BS (Scenario 4)

CDMA Range (Carrier Centres):

GB (kHz)	75	375	1375	3325
CDMA Carriers [MHz]	460.7	460.9	462	463.95

NMT-450 Range (Carrier Centres): 459.9875 MHz.

CDMA BS spectrum mask including a 1 carrier duplex filter

Note 1: this specification for duplex filter performance is proprietary and not included as part of the TIA specifications as referenced in Lucent SRDoc.

	CDMA - PAMR BS	CDMA - PAMR 44 dBm BS	CDMA-PAMR BS Normalised to 30 kHz bw		
Offset kHz 1 Channel	Spec.	Spec. dBc	1 carrier dBc	Duplex Spec dBc	1 carrier incl Duplexer
-40000	-45.0	-89.0	-94.2	-85.0	-179
-6000	-45.0	-89.0	-94.2	-60.0	-154
-5999	-36.0	-80.0	-85.2	-60.0	-145
-4000	-36.0	-80.0	-85.2	-50.0	-135
-3999	-75.0	-75.0	-75.0	-50.0	-125
-1980	-75.0	-75.0	-75.0	-45.0	-120
-1979	-65.0	-65.0	-65.0	-45.0	-110
-1637.5	-65.0	-65.0	-65.0	-40.0	-105
-1125	-65.0	-65.0	-65.0	-15.0	-80
-1000	-62.5	-62.5	-62.5	-15.0	-78
-885	-60.0	-60.0	-60.0	-10.0	-70
-750	-45.0	-45.0	-45.0	0.0	-45
-625	0	0.0	-16.2	0.0	-16
625	0	0.0	-16.2	0.0	-16
750	-45.0	-45.0	-45.0	0.0	-45
885	-60.0	-60.0	-60.0	-10.0	-70
1000	-62.5	-62.5	-62.5	-15.0	-78
1125	-65.0	-65.0	-65.0	-15.0	-80
1979	-65.0	-65.0	-65.0	-20.0	-85
1980	-75.0	-75.0	-75.0	-20.0	-95
3999	-75.0	-75.0	-75.0	-30.0	-105
4000	-36.0	-80.0	-85.2	-30.0	-115
5999	-36.0	-80.0	-85.2	-50.0	-135
6000	-45.0	-89.0	-94.2	-50.0	-144
45000	-45.0	-89.0	-94.2	-85.0	-179