ECC REPORT 5

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

ADJACENT BAND COMPATIBILITY BETWEEN GSM AND TETRA MOBILE SERVICES AT 915 MHz

Baden, June 2002

EXECUTIVE SUMMARY

This report has established the level of interference that can impact GSM base station receivers below 915 MHz when TETRA or TAPS is deployed in the band 915 – 921 MHz. The report also establishes that co-ordination between GSM and TETRA/TAPS is required. An uncoordinated approach would most likely result in severe interference to the GSM base station receivers.

The report further establishes the separation distances necessary to avoid interference. The resulting distances are such that it is likely that further mitigation is needed to allow for the utilisation of the 915 – 921 MHz band. The report also provides the required additional mitigation, as a function of distance, needed to avoid interference.

The report has determined that interference can occur as a result of the transmitter power from a TETRA or TAPS system in the band 915 – 921 MHz. This would result in Blocking of the GSM base station receiver. To avoid blocking of GSM base station receivers additional filtering would be required at the input of the GSM receiver.

Another type of interference that can occur is the unwanted emission from a TETRA or TAPS system desensitising the GSM base station receiver. The unwanted emission can be spurious emission or wide band noise. To avoid unwanted emission desensitising the GSM base station receiver additional filtering is required in the TETRA and TAPS transmitter.

The band 915 – 921 MHz can be utilised without any risk of interference to the GSM base station receivers if co-ordinated between the operators below and above 915 MHz and with the use of mitigation according to the actual separation distances.

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ADJACENT BAND COMPATIBILITY BETWEEN GSM AND TETRA MOBILE SERVICES AT 915 MHz

1 INTRODUCTION

This report is concerned with adjacent band compatibility issues relating to TETRA and GSM at the frequency boundary at 915 MHz. The primary focus is on the use of so-called “TETRA 2” High Speed Data in the band, and in particular the TETRA Enhanced Packet Service (TAPS) that has recently been standardised by ETSI.

The report also considers the possibility that the original TETRA V+D standards TETRA Release 1 may be utilised alongside TETRA Release 2 TAPS at the lower end of the band. In this report TETRA refers to TETRA 1 (V+D) and TAPS refers to TETRA Release 2 TAPS

This report complements the earlier studies on TETRA by SE7 within DSI Phase II & III. The report specifically studies the situation when TETRA/TAPS base stations in the downlink band 915-921MHz band are deployed close to the GSM base stations in the uplink band just below 915 MHz. In order to reduce the amount of interference from TETRA/TAPS base stations leaking into the GSM band, a guard band is required between the two bands. This is shown in Figure 1.

The following study and the mitigation factors are only valid for TETRA or TAPS operating in the frequency range 915.6 – 921 MHz. This is because the blocking requirement of GSM base station receivers is 10 dB more relaxed at a frequency separation below 800 kHz.

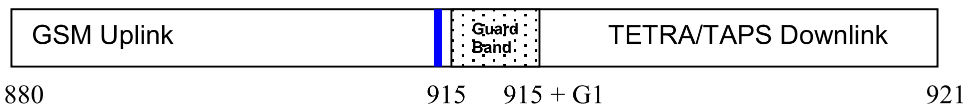

Figure 1 : GSM and TETRA/TAPS systems around 915MHz

2 METHODOLOGY

A link budget methodology approach has used for the scenario where TETRA/TAPS is the interferer and GSM is the victim. This approach is termed Minimum Coupling Loss (MCL) and is used instead of the statistically based Monte Carlo (MC) methodology because both the interferer and the victim are fixed base stations.

The following two interference scenarios are investigated at the low end of the TETRA downlink band (i.e. around 915/916 MHz):

- TAPS (downlink) > GSM (uplink)
- TETRA V+D (downlink) > GSM (uplink).

3 INTERFERENCE SCENARIOS

The following study investigates the interference that occurs from a TETRA/TAPS base station transmitter into a GSM base station receiver.

Two mechanisms have been identified that need to be considered when introducing TETRA/TAPS services in the band 915-921 MHz

1) Blocking will occur where the incoming power from the TETRA/TAPS transmitters is above the specified GSM blocking level; this will desensitise the GSM base receiver such that the reference sensitivity performance may not be maintained.

2) The Unwanted Emission (Spurious Emission and Wide Band Noise) from the TETRA/TAPS transmitters that is above the receiver sensitivity will desensitise the GSM base station receiver such that low level signals may not be received.

All specifications used in the calculations have been derived using standard ETSI specification values as these represent the worst case values even though it is recognised that in practice real equipment performance may be better.

3.1 Scenarios

In urban areas antennas of base stations are often mounted on rooftops. This will lead to a worst case situation where the antennas of the GSM and TETRA/TAPS base stations are facing each other and have a direct line of sight. For this scenario a separation distance of 20 meters was selected to form the basis for the calculation.

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

Micro – micro is a special case not covered by the figures in the mitigation section of this report. The separation distance selected was 25 meters and the calculation for this distance is provided. It was however felt that the micro – micro case is very dependent on the actual installation that the propagation model used to calculate the loss would vary considerably. Actual measurements are therefore recommended for this case.

3.2 Propagation model

The basis for the Path Loss Calculation was the Line of Sight process, which is defined in ITU Rec. P.1411. This is applicable for distances less than 1 kilometre.

If the effective antenna height exceeds 9 metres the path loss for distances of up to 1 kilometre is considered to be less than a breakpoint. The process for distances less than this breakpoint develops a greatest and least loss. The mean loss approximates to the Free Space Loss propagation. This has provided the basis for these calculations.

The rooftop – rooftop and the micro – micro scenarios have been calculated using the Free Space Propagation model.

3.3 Calculation of interference

In the following Tables 1-7 the calculations of the interference that occur in different scenarios are provided. Calculations are provided for blocking of the GSM base station receiver combined for TETRA and TAPS. This is because the blocking occurs as a result of the power being present and is not related to the type of system producing the power.

Also the influence of the spurious emission from TETRA/TAPS combined are calculated. The combination is possible because the requirements for spurious emission are the same for TETRA and TAPS. Further the calculations of the influence of the wide band noise in the GSM base station receiver is provided. These calculations are separated between TETRA and TAPS because of the different emission characteristics. The calculations for TAPS is further separated into three because of changing requirement and measuring method as a function of frequency separation from the carrier.

The frequency range, for which the calculations are valid, is limited by the GSM base station receiver-blocking requirement, which is relaxed at frequency separations below 800 kHz.

The calculations are based on the GSM base station receiver operating on its highest frequency channel in uplink at 914.8 MHz, the valid frequency range for TETRA/TAPS is therefore limited to 915.6 – 921 MHz.

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By considerations of blocking, TETRA/TAPS at 915.6 - 917.6 MHz	TETRA Tx power	Losses	Tx Ant Gain 0=n/a	TETRA Tx EIRP - dBm	No of Tx	Distance	Propagation loss	GSM RX antenna gain 0=n/a	feeders etc	Interference power	Specified blocking	Required attenuation for blocking
	Watts	*dB*	*dBi*	*dBmi*		*m*	*dB*	*dB*	*dB*	*dBm*	*dBm*	*dB*
Shared site antennas facing or antennas on adjacent buildings	39.8	3.0	15.0	58.0	1.0	20.0	57.7	15.0	3.0	12.3	-16.0	28.3
Antennas in close proximity	39.8	3.0	0.0	N/A	1.0	N/A	30.0	0.0	3.0	10.0	-16.0	26.0
Antennas in close proximity	39.8	3.0	0.0	N/A	1.0	N/A	40.0	0.0	3.0	0.0	-16.0	16.0
Micro to micro	1.0	3.0	7.2	34.2	1.0	25.0	59.6	7.2	3.0	-21.3	-16.0	-5.3

By considerations of blocking, TETRA/TAPS at 917.8 - 921 MHz	TETRA Tx power	Losses	Tx Ant Gain 0=n/a	TAPS Tx EIRP - dBm	No of Tx	Distance	Propagation loss	GSM RX antenna gain 0=n/a	Feeders etc	Interference power	Specified blocking	Required attenuation for blocking
	Watts	*dB*	*dBi*	*dBmi*		*m*	*dB*	*dB*	*dB*	*dBm*	*dBm*	*dB*
Shared site antennas facing or antennas on adjacent buildings	39.8	3.0	15.0	58.0	1.0	20.0	57.7	15.0	3.0	12.3	-13.0	25.3
Antennas in close proximity	39.8	3.0	0.0	N/A	1.0	N/A	30.0	0.0	3.0	10.0	-13.0	23.0
Antennas in close proximity	39.8	3.0	0.0	N/A	1.0	N/A	40.0	0.0	3.0	0.0	-13.0	13.0
Micro to micro	1.0	3.0	7.2	34.2	1.0	25.0	59.6	7.2	3.0	-21.3	-13.0	-8.3

Tables 1 & 2: Calculation of the required attenuation to avoid blocking of a GSM Base Station Receiver from TETRA/TAPS Base Station output power

I) Propagation model used is free space loss for antenna distances of 20m and over.
II) The antenna gain and cable loss of both the victim (GSM) and interferer (TAPS) base station is assumed to be 15 dBi and 3 dB respectively.
III) 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.

By consideration of TETRA/TAPS spurious emission	Spurious requirement TETRA and TAPS	losses	Tx side ant gain 0=n/a	Radiated spurious dBmi	No of spurious	Distance	Propagation loss	GSM RX antenna gain 0=n/a	Feeders etc	Interference power in 200 kHz	Protected sensitivity; C/I (9 dB) below neg 101 dBm	**Required attenuation for spurious emission**
	dBm	*dB*	*dB*	*dBmi*		*m*	*dB*	*dB*	*dB*	*dBm*	*dBm*	*dB*
Shared site antennas facing or antennas on adjacent buildings	-36.0	3.0	15.0	-24.0	1.0	20.0	57.7	15.0	3.0	-66.7	-110.0	43.3
Antennas in close proximity	-36.0	3.0	0.0	-39.0	1.0	N/A	30.0	0.0	3.0	-69.0	-110.0	41.0
Antennas in close proximity	-36.0	3.0	0.0	-39.0	1.0	N/A	40.0	0.0	3.0	-79.0	-110.0	31.0
Micro to micro	-36.0	3.0	7.2	-31.9	1.0	25.0	59.6	7.2	3.0	-84.3	-110.0	25.7

Table 3: Calculation of the required attenuation to avoid desensitisation of a GSM Base Station Receiver from TETRA/TAPS Base Station Transmitter spurious emission

I) Propagation model used is free space loss for antenna distances of 20m and over.
II) For antenna separation distances below 20m a fixed coupling of 30 and 40 dB has been used.
III) The antenna gain and cable loss of both the victim (GSM) and interferer (TAPS) base station is assumed to be 15 dBi and 3 dB respectively.
IV) The value of -110 dBm for protection of GSM has been selected because it provides the same protection as required for blocking.
V) The valid frequency range is limited to 915.6 – 921 MHz by the GSM base station receiver-blocking requirement.

Note: Because of the statistical nature of spurious emission and the low probability for a spurious to occur at its limit and at the frequency of the adjacent GSM base station 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 TETRA wide band noise 915.3 – 921 MHz	TETRA Tx power	Losses	Tx Ant Gain 0=n/a	TETRA spec par 6.4.2.3 table 6	Bandwidth gain (200 kHz /18*kHz)	Radiated noise dBmi in 200 kHz	No	Distance	Propagation loss	GSM RX antenna gain 0=n/a	Feeders etc	Interference power	Protected sensitivity; C/I (9 dB) below neg101dBm	**Required attenuation for wide band noise**
	Watts	*dB*	*dBi*	*dBc*	*dB*	*dBmi*		*m*	*dB*	*dB*	*dB*	*dBm*	*dBm*	*dB*
Shared site antennas facing or antennas on adjacent buildings	39.8	3.0	15.0	-90.0	10.5	-21.5	1.0	20.0	57.7	15.0	3.0	-67.2	-110.0	42.8
Antennas in close proximity	39.8	3.0	0.0	-90.0	10.5	-36.5	1.0	N/A	30.0	0.0	3.0	-69.5	-110.0	40.5
Antennas in close proximity	39.8	3.0	0.0	-90.0	10.5	-36.5	1.0	N/A	40.0	0.0	3.0	-79.5	-110.0	30.5
Micro to micro	1.0	3.0	7.2	-90.0	10.5	-45.4	1.0	25.0	59.6	7.2	3.0	-100.8	-110.0	9.2

Table 4: Calculation of the required attenuation to avoid desensitisation of a GSM Base Station Receiver from TETRA Base Station Transmitter wide band noise

I) Propagation model used is free space loss for antenna distances of 20m and over.
II) For antenna separation distances below 20m a fixed coupling of 30 and 40 dB has been used.
III) The antenna gain and cable loss of both the victim (GSM) and interferer (TETRA) base station is assumed to be 15 dBi and 3 dB respectively
IV) Bandwidth adjustment is required as TETRA is measured in an 18 kHz bandwidth and GSM is a 200 kHz carrier.
V) The value of -110 dBm for protection of GSM has been selected because it provides the same protection as required for blocking.
VI) The valid frequency range is limited to 915.6 – 921 MHz by the GSM base station receiver-blocking requirement.
* TETRA bandwidth is specified in EN 300 392-2 Section 2, Modulation.

By consideration of wide band noise TAPS at 915.4 - 915.8 MHz	TAPS Tx power	losses	Tx Ant Gain 0=n/a	TAPS WBN	Bandwidth gain (ref. 30 kHz. Measuring bw. 30 kHz)	Radiated noise dBmi in 200 kHz	No	Distance	Propagation loss	GSM RX antenna gain 0=n/a	feeders etc	Interference power	Protected sensitivity; C/I (9 dB) below neg101dBm	**Required attenuation for wide band noise**
	Watts	*dB*	*dBi*	*dBc*	*dB*	*dBmi*		*m*	*dB*	*dB*	*dB*	*dBm*	*dBm*	*dB*
Shared site antennas facing or antennas on adjacent buildings	39.8	3.0	15.0	-70.0	0.0	-12.0	1.0	20.0	57.7	15.0	3.0	-57.7	-110.0	52.3
Antennas in close proximity	39.8	3.0	0.0	-70.0	0.0	-27.0	1.0	N/A	30.0	0.0	3.0	-60.0	-110.0	50.0
Antennas in close proximity	39.8	3.0	0.0	-70.0	0.0	-27.0	1.0	N/A	40.0	0.0	3.0	-70.0	-110.0	40.0
Micro to micro	1.0	3.0	7.2	-60.0	0.0	-25.9	1.0	25.0	59.6	7.2	3.0	-81.3	-110.0	28.7

Table 5: Calculation of the required attenuation to avoid desensitisation of a GSM Base Station Receiver from TAPS Base Station Transmitter wide band noise

These results are based on the following assumptions:

I) Propagation model used is free space loss for antenna distances of 20m and over.
II) For antenna separation distances below 20m a fixed coupling of 30 and 40 dB has been used.
III) The antenna gain and cable loss of both the victim (GSM) and interferer (TAPS) base station is assumed to be 15 dBi and 3 dB respectively.
IV) No bandwidth adjustment is required because both TAPS and GSM are 200 kHz carriers.
VI) The value of -110 dBm for protection of GSM has been selected because it provides the same protection as required for blocking.
VII) The valid frequency range is limited at the lower end to 915.6 MHz by the GSM base station receiver-blocking requirement.

By consideration of wide band noise TAPS at 916 - 916.4 MHz	TAPS Tx power	Losses	Tx Ant Gain 0=n/a	TAPS WBN	Bandwidth gain (ref. 30 kHz. Measuring bw. 30 kHz)	Radiated noise dBmi in 200 kHz	No	Distance	Propagation loss	GSM Rx antenna gain 0=n/a	feeders, etc.	Interference power	Protected sensitivity; C/I (9 dB) below neg101dBm	**Required attenuation for wide band noise**
	Watts	*dB*	*dBi*	*dBc*	*dB*	*dBmi*		*m*	*dB*	*dB*	*dB*	*dBm*	*dBm*	*dB*
Shared site antennas facing or antennas on adjacent buildings	39.8	3.0	15.0	-73.0	0.0	-15.0	1.0	20.0	57.7	15.0	3.0	-60.7	-110.0	49.3
Antennas in close proximity	39.8	3.0	0.0	-73.0	0.0	-30.0	1.0	N/A	30.0	0.0	3.0	-63.0	-110.0	47.0
Antennas in close proximity	39.8	3.0	0.0	-73.0	0.0	-30.0	1.0	N/A	40.0	0.0	3.0	-73.0	-110.0	37.0
Micro to micro	1.0	3.0	7.2	-63.0	0.0	-28.9	1.0	25.0	59.6	7.2	3.0	-84.3	-110.0	25.7

Table 6: Calculation of the required attenuation to avoid desensitisation of a GSM Base Station Receiver from TAPS Base Station Transmitter wide band noise

These results are based on the following assumptions:

I) Propagation model used is free space loss for antenna distances of 20m and over.

II) For antenna separation distances below 20m a fixed coupling of 30 and 40 dB has been used.

III) The antenna gain and cable loss of both the victim (GSM) and interferer (TAPS) base station is assumed to be 15 dBi and 3 dB respectively.

IV) No bandwidth adjustment is required because both TAPS and GSM are 200 kHz carriers.

V) The value of -110 dBm for protection of GSM has been selected because it provides the same protection as required for blocking.

By consideration of wide band noise TAPS at 916.6 - 921 MHz	TAPS Tx power	Losses	Tx Ant Gain 0=n/a	TAPS WBN	Bandwidth gain (ref. 30 kHz. Measuring bw. 100 kHz)	Radiated noise dBmi in 200 kHz	No	Distance	Propagation loss	GSM Rx antenna gain 0=n/a	feeders, etc.	Interference power	Protected sensitivity; C/I (9 dB) below neg101dBm	**Required attenuation for wide band noise**
	Watts	dB	dBi	dBc	dB	dBmi		m	dB	dB	dB	dBm	dBm	dB
Shared site antennas facing or antennas on adjacent buildings	39.8	3.0	15.0	-75.0	-5.2	-22.2	1.0	20.0	57.7	15.0	3.0	-67.9	-110.0	42.1
Antennas in close proximity	39.8	3.0	0.0	-75.0	-5.2	-37.2	1.0	N/A	30.0	0.0	3.0	-70.2	-110.0	39.8
Antennas in close proximity	39.8	3.0	0.0	-75.0	-5.2	-37.2	1.0	N/A	40.0	0.0	3.0	-80.2	-110.0	29.8
Micro to micro	1.0	3.0	7.2	-65.0	-5.2	-36.1	1.0	25.0	59.6	7.2	3.0	-91.5	-110.0	18.5

Table 7. Calculation of the required attenuation to avoid desensitisation of a GSM Base Station Receiver from TAPS Base Station Transmitter wide band noise

These results are based on the following assumptions:

I) Propagation model used is free space loss for antenna distances of 20m and over.

II) For antenna separation distances below 20m a fixed coupling of 30 and 40 dB has been used.

III) The antenna gain and cable loss of both the victim (GSM) and interferer (TAPS) base station is assumed to be 15 dBi and 3 dB respectively.

IV) No bandwidth adjustment is required because both TAPS and GSM are 200 kHz carriers.

V) For frequency separation above 1.8 MHz, 5.2 dB has been compensated because of the change of measuring bandwidth in the TAPS specification.

VI) The value of -110 dBm for protection of GSM has been selected because it provides the same protection as required for blocking.

4 OBSERVATIONS

From the calculations of the attenuation required to avoid interference it can be seen that co-ordination between GSM and TETRA/TAPS is required. If an uncoordinated approach were taken this would most likely result in severe interference to the GSM base station receivers.

The results show that to avoid blocking of GSM BS receivers additional filtering at the GSM BS receiver will be required when TETRA or TAPS transmitters are located within a considerable distance of a GSM receiver. The amount of filtering required is dependent on the frequency, the number of carriers, the separation distance and the transmitter power of the TETRA or TAPS BS.

In the case of wideband noise the results again show that filtering is required at the TETRA and TAPS BS transmitter when located within a considerable distance of a GSM receiver. The amount of filtering required is dependent on the frequency, the number of carriers and the separation distance of the TAPS BS and also the transmitter power for the TETRA BS.

5 MITIGATION FACTORS

In this section different techniques are discussed that will enable TETRA/TAPS to operate without producing harmful interference into the GSM base station receivers. The different techniques required to ensure the GSM base station receiver can operate as intended are; frequency separation, physical separation distance, improved performance (filters) and any combination of these.

Because mitigation is needed co-ordination between the operators of GSM networks at the top end of the GSM band and the TETRA/TAPS network is always required. 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.

5.1 Frequency planning and co-ordination

It is necessary that the use of the frequencies just above 915 MHz is co-ordinated between the GSM network that operates on the frequencies just below 915 MHz and the TETRA/TAPS operator.

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 TETRA/TAPS base station transmitter and the GSM base station receiver.

Physical separation is feasible in rural and suburban areas. It is also possible to use physical separation in urban areas either as a partial solution. Because the GSM networks are well established the task of finding suitable locations, meeting the physical separation criteria, will be on the new TETRA/TAPS operator.

5.3 Frequency Separation

Use of frequency separation as a single solution to achieve the necessary attenuation of both the Power and WBN from TETRA/TAPS requires a frequency separation outside the allocated band. This is because the WBN roll off of TETRA/TAPS is fairly slow and also the blocking performance of GSM receiver only improves marginally with frequency. This combined with the difficulties in network planning and especially re-planning for optimisation of the network makes frequency separation a very unattractive solution.

5.4 Filters

The performance of both the TETRA/TAPS transmitter and the GSM receiver 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 GSM receiver blocking performance in the TETRA/TAPS transmitter frequency range may not require any power handling capability but the effect on both its performance, and the networks, needs to be evaluated.

This mitigation technique has been used in the UK for a similar scenario when introducing GSM services adjacent to the existing TACS services, therefore further investigation into the feasibility of using this approach is warranted. The filter needed for improving the TETRA/TAPS transmitter WBN attenuation in the GSM receiver frequency range is more demanding also because of the requirements to power handling.

5.5 Separation Distance and Filters

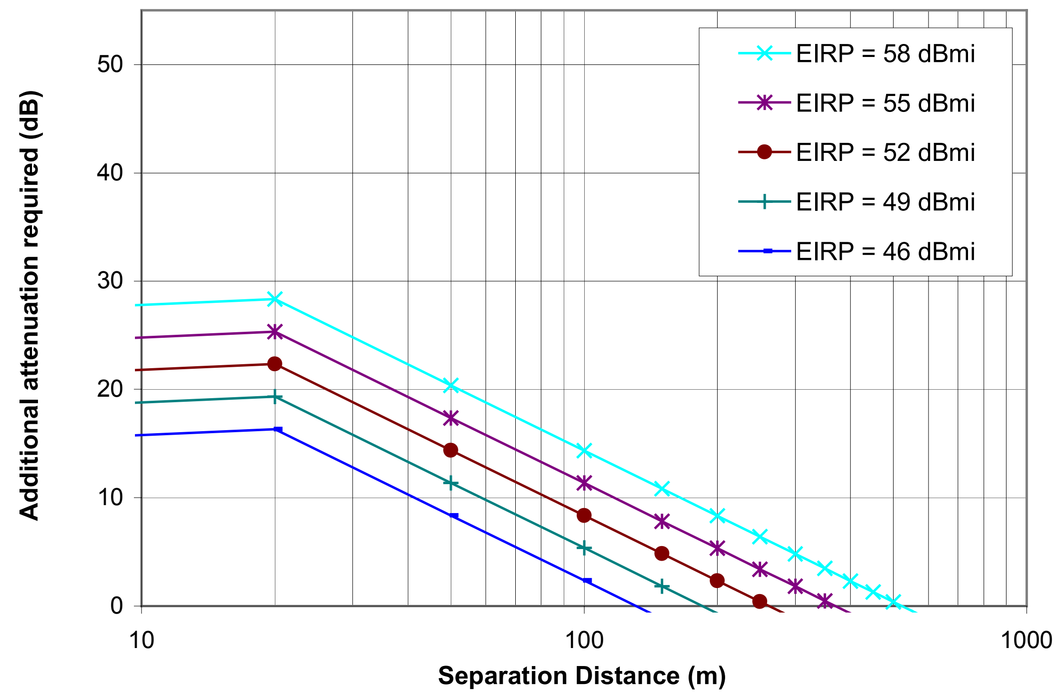
Where it is impossible to establish sufficient physical separation to eliminate blocking and desensitisation by WBN of the GSM base station receiver additional filters could be used, subject to evaluation on the receiver's performance. The filters are selected to produce the desired attenuation, taking into account the physical separation distance loss, for the GSM base station receiver to operate as intended.

6 FILTER REQUIREMENTS VS. SEPARATION DISTANCE

In the following figures 2-5, the attenuation required to avoid interference as a function of separation distance is depicted. The figures are based on the calculations of interference included in this document. 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-roof top scenario. For the close proximity of antennas scenario there are calculations for 30 dB and 40 dB isolation between the antennas. The calculations for the micro–micro scenario is at a separation distance of 25 m.

The rooftop–rooftop and the micro–micro scenarios have been calculated using the Free Space Propagation model. The frequency range, for which the calculations are valid, is limited by the GSM base station receiver-blocking requirement, which is relaxed at frequency separations below 800 kHz. Because the GSM base station receiver's highest operating frequency channel in uplink is at 914.8 MHz, the valid frequency range for TETRA/TAPS is limited to 915.6 – 921 MHz.



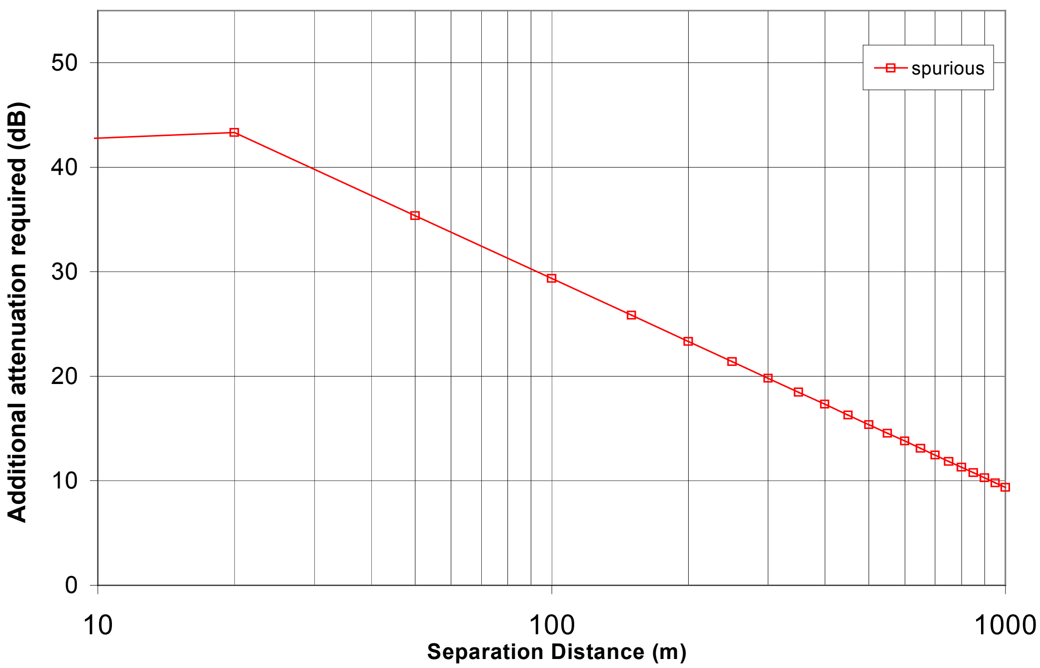
For dual carrier operation add according to formula in the following text.
For operation at or above 917.8 MHz deduct 3 dB

Figure 2: Filter requirement for blocking improvement of GSM

Reference is made to tables 1&2 “Required attenuation for blocking” for the antennas facing on adjacent buildings (20 m) scenario covering the frequency range 915.6 - 917.6 MHz at an EIRP of 58 dBmi. The additional output power ranges and separation distances have been derived by extrapolation. To assess impact in the frequency range 917.6 – 921 a deduction of 3 dB the depicted values must be made.

It should be noted that the impact of blocking is both frequency and transmitter output power dependent. The filter must be located at the GSM base station receiver input terminal.

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



For dual carrier operation add according to formula in the text below.

Figure 3: Filter requirement for TETRA/TAPS spurious emission

Reference is made to table 3 “Required attenuation for spurious” for the antennas facing on adjacent buildings (20 m) at an EIRP of 58 dBmi. The additional separation distances have been derived by extrapolation.

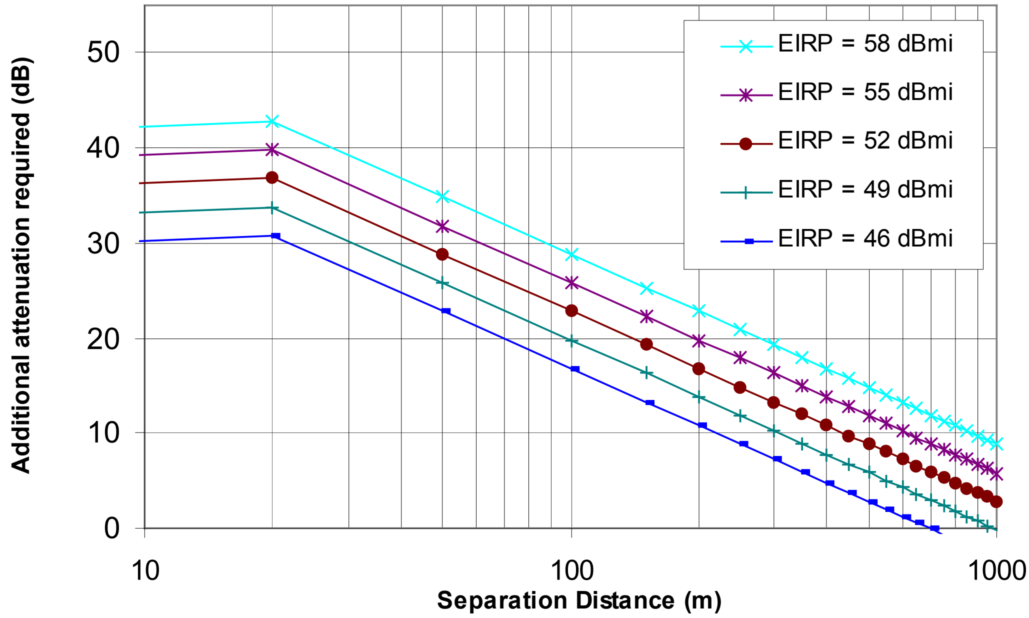
It should be noted that the impact of spurious emission is frequency and transmitter output power independent.

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

The requirement to the attenuation of wide band noise will also effectively suppress any spurious emission except in the micro to micro case.

Any filter must be located at the transmitter's output terminal of a TETRA/TAPS base station.

Note: Because of the statistical nature of spurious emission and the low probability for a spurious to occur at its limit and at the frequency of the adjacent GSM base station 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 according to the values above.



For dual carrier operation add according to formula in the text below.

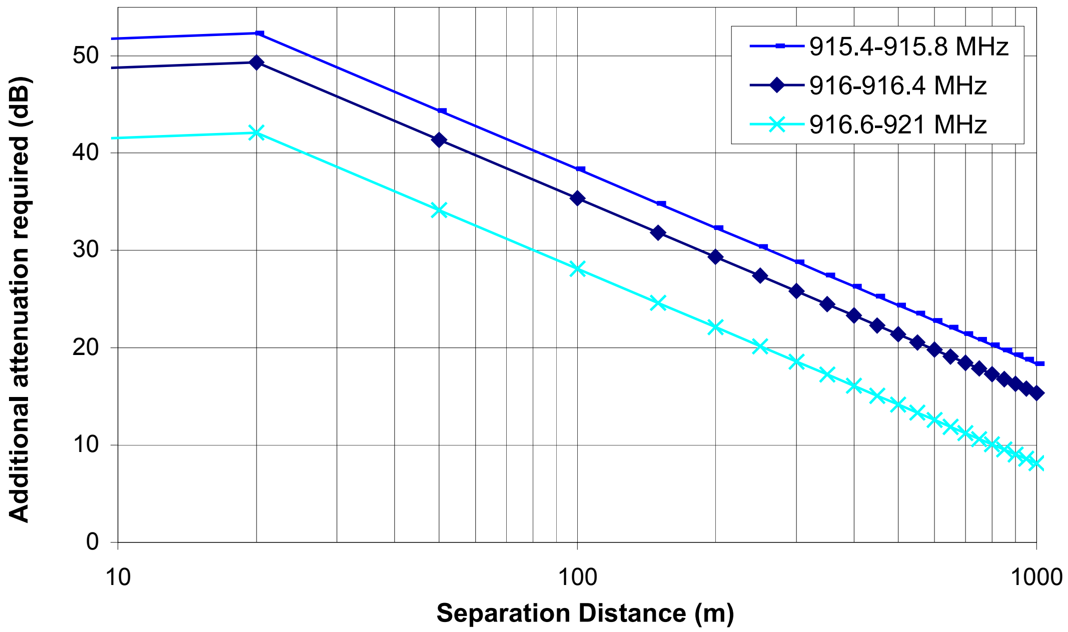
Figure 4. Filter requirement for TETRA Wide Band Noise

Reference is made to table 4 “Required attenuation for TETRA wide band noise” for the antennas facing on adjacent buildings (20 m) scenario covering the frequency range 915.6-921 MHz at an EIRP of 58 dBmi. The additional separation distances have been derived by extrapolation.

It should be noted that for TETRA the impact of Wide Band Noise is output power dependent but is independent of the TETRA transmitter frequency.

The filter must be located at the transmitter's output terminal of a TETRA base station.

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



For dual carrier operation add according to formula in the text below.

Figure 5. Filter Requirement for TAPS Wide Band Noise

Reference is made to tables 5, 6 and 7 “Required attenuation for TAPS wide band noise” for the antennas facing on adjacent buildings (20 m) scenario covering the frequency range 915.4 - 921 MHz at an EIRP of 58 dBmi. The additional separation distances have been derived by extrapolation.

It should be noted that for TAPS the impact of Wide Band Noise is frequency dependent but is independent of the TAPS transmitter output power.

The filter must be located at the transmitter's output terminal of a TAPS base station.

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

7 CONCLUSIONS

From the above calculations, concerning the protection of the existing GSM base station receivers against interference from TETRA or TAPS, the technical requirements for the utilisation of the band 915 to 921 MHz can be found.

Mitigation in the form of filters will be required in some cases. To allow the filters to operate, a guard band is considered as necessary.

The requirements on the TETRA or TAPS operator are such that it encourages the use of physical separation distance whenever possible.

It is clear that the utilisation requires co-ordination between the GSM operator at the frequency just below 915 MHz and the new TETRA or TAPS operator.