ECC Report 220

Compatibility/sharing studies related to PMSE, DECT and SRD with DA2GC in the 2 GHz unpaired bands and MFCN in the adjacent 2 GHz paired band

Approved September 2014

0 EXECUTIVE SUMMARY

This ECC Reports considers compatibility issues concerning a possible implementation of DA2GC and PMSE within the 2 GHz unpaired bands based on a Commission Mandate to CEPT to undertake studies on the harmonised technical conditions for the 1900-1920 MHz and 2010-2025 MHz frequency bands in the EU with the purpose to assess and identify alternative uses of the unpaired terrestrial 2 GHz band other than for the provision of mobile electronic communications services (as introduced by the UMTS Decision of 1999[1]).

Compatibility studies between DA2GC at 1900-1920 MHz and 2010-2025 MHz and systems in adjacent bands are covered by ECC Report 209 [2].

Applications that were studied:

- Broadband Direct Air-to-Ground Communications, 2 x 10 MHz for FDD or 20 MHz for TDD was studied,
- PMSE, preferably for use by wireless cameras,
- DECT extension to the band 1900-1920 MHz
- SRD

are part of a shortlist of potential harmonised uses of the 1900-1920 MHz and 2010-2025 MHz frequency bands to be given priority in this Mandate.

As spectrum preferably for use by wireless cameras is looked for, the corresponding three PMSE scenarios[2], cordless camera links (CCL), mobile video links (MVL) and portable video links (PVL) are considered. It has to be noted that if DA2GC TDD system is implemented in the band 1900-1920 MHz, it would make the band 2010-2025 MHz available for PMSE use.

DA2GC vs PMSE video links:

Both radio applications PMSE video links and Broadband DA2GC are considered as a potential interferer and as a potential victim.

It is concluded that adjacent-channel operation of DA2GC FL and PMSE video links (CCL, MVL and PVL) is feasible with separation distances and some mitigation techniques depending on the PMSE scenario.

Co-channel operation of DA2GC FL and PMSE CCL would be feasible with appropriate separation distances.

Co-channel and adjacent operation of DA2GC RL and PMSE (CCL, MVL and PVL) is not feasible due to the exceeding of the protection criterion of the PMSE Rx.

DA2GC RL vs PMSE audio links at 2010-2025 MHz:

In the case of interferences from DA2GC AS transmitter to PMSE audio link receivers, by assuming 20 dB wall attenuation and indoor operation of PMSE audio links, the interference threshold of the PMSE receiver is exceeded within a radius of about 18 km below a DA2GC AS Tx at 3000 m altitude. No interference would occur with wall attenuation higher than 26 dB or aircraft altitudes higher than 5100 m.

In the case of interferences from PMSE audio link transmitters to DA2GC ground station receivers, the interference threshold of the DA2GC GS Rx is met with separation distances of:

- about 3.3 km in rural environment with 10 dB wall attenuation
- about 0.9 km in sub-urban environment with 10 dB wall attenuation
- about 0.5 km in urban environment with 10 dB wall attenuation

[1] Decision 128/1999/EC

[2] Studies in ECC Report 172 [11] also consider only these three PMSE scenarios.

DA2GC FL vs SRD at 1900-1920 MHz:

Co-channel operation:

The single entry MCL analysis already demonstrates that one single metropolitan utility device has the potential to interfere severely into a DA2GC AS receiver in the case of co-channel operation. The protection threshold is met by at least 4 dB in the case of adjacent channel operation.

Assuming the same range of SRD technologies, applications, parameters and scenarios as used for the "Compatibility with Unmanned Aircraft Systems (UAS)", the probability of interference from SRDs into a DA2GC AS receiver is 100% for LOS and Non-LOS conditions, respectively.

Even with the assumption that only Home Automation applications with limited power and limited density according to Table 6 (i.e. limitation of power to 10 dBm and reduction of density by the factor 5), the probability of interference into the DA2GC AS receiver is still almost 40% for Non-LOS conditions. With a density reduction of the HA devices to 100/km^2 the probability of interference goes down to 10%.

Therefore, it is concluded that co-channel operation of DA2GC FL and massive indoor SRD deployment is not feasible. Sharing with low power and low density indoor SRD applications would be feasible.

Adjacent channel operation:

Assuming the same range of SRD technologies, applications, parameters and scenarios as used for the "Compatibility with Unmanned Aircraft Systems (UAS)" in [3], the probability of interference from SRD devices into a DA2GC AS receiver is about 40-60% for LOS and Non-LOS conditions, respectively.

With the assumption that only indoor applications (i.e. metropolitan utilities with limited power of 10 dBm and Home Automation applications according to Table 6) are deployed, the probability of interference into the DA2GC AS receiver goes down to about 10% for LOS- and Non-LOS conditions.

Therefore, it is concluded that operation of DA2GC FL and indoor SRD deployment in the adjacent band – with one SRD channel guard separation – would be feasible with a power limitation of 10 dBm for the SRDs. Usage conditions for SRD channels further away from the DA2GC FL would be subject for further evaluations.

DA2GC FL vs DECT at 1900-1920 MHz:

Co-channel operation:

- OUTDOOR DECT STATION/TERMINAL INTERFERED BY DA2GC GS: from the results it can be concluded that the I/N is above the threshold up to more than 20 km, in rural environment, about 14 km in suburban areas and 6.5 km in urban areas. These results are valid for the worst case scenario. For DECT installed bellow rooftop the 0 dB I/N threshold are reached at 1 km distance in urban areas, and at 2 km in suburban areas.
- DA2GC GS INTERFERED BY OUTDOOR DECT STATION: the results show that, for DECT 12 dBi antenna gain, the DA2GC GS protection criteria will be exceeded. For DECT installed bellow rooftop, a separations distance of about 3km will be required.
- DA2GC AS INTERFERED BY DECT OUTDOOR STATION: the results show that, for DECT 12 dBi antenna gain, the DA2GC AS protection criteria will be exceeded, for both 3 km and 10 km of the aircraft altitude. For DECT installed bellow rooftop, I/N becomes maximum 8 dB at 3 km and maximum -2 dB at 10 km.
- DECT STATION/TERMINAL INTERFERED BY DA2GC AS: the results of the studies shows that there is noticeable impact from the DA2GC AS on the reception at the DECT station in the co-channel case, when examined worst case scenario with outdoor reception using the high gain antenna. For DECT installed bellow rooftop, I/N=0 dB threshold is met, requiring additional separation distance. Furthermore, with I/N of 15-20 dB DECT outdoor base stations have no problem to serve with good quality outdoor DECT users, which normally are in LOS well within 100 m from the base station, which reduces the impact of DA2GC AS.

Adjacent channel operation:

For adjacent channel operation, a protection distance up to 3 km is required to mitigate the interference of DA2GC GS in outdoor DECT stations with 12 dBi of antenna gain. For DECT installed bellow rooftop compatibility is achieved, and no protection distance is required.

In opposite direction, a protection distance up to 0.4 km is required to mitigate the interference of outdoor DECT stations with 12 dBi of antenna gain in DA2GC GS. For DECT installed bellow rooftop compatibility is achieved, and no protection distance is required.

PMSE video links in 1900-1920 MHz vs. MFCN above 1920 MHz:

Taking into account the characteristics of PMSE digital video links in ECC Report 219 [33] and based on the studies of the present report, it can be concluded that:

- Cordless Camera Links can be used in the frequency band 1900-1920 MHz without restriction;
- Mobile Video Links should be limited to an e.i.r.p. of 23 dBm in the frequency band 1915-1920 MHz in a urban environment and that they could be used without restriction in a rural environment;
- Portable Video Links may be able to coexist with MFCN if case-by-case coordination is applied through a specific detailed study taking into account the field environment.

Due to very low density of video PMSE using the same channel and the assumption that professional users will co-ordinate at the same place and at the same time, these values may be adjusted at a further stage based on feedback.

DECT in 1900-1920 MHz vs. MFCN above 1920 MHz:

MCL calculation shows that compatibility between DECT in 1900-1920 MHz and MFCN in 1920-1980 MHz is possible in case DECT not using channels F20 and F21.

Coexistence between DECT devices in the 1900-1920 MHz band and MFCN BS above 1920 MHz is possible when the following conditions are met:

Table 1: Summary of compatibility study results between DECT and MFCN

DECT channels	F11 to F19	F20 and F21
DECT stations with omni-directional antenna	no restriction (26 dBm max e.i.r.p. as in ERC/DEC/(98)22)	
DECT stations with directional antenna	30 dBm max e.i.r.p.	not allowed

Different services are actually under study as part of the mandate. The results given in this report give the possible usability of the band depending on the different sharing possibilities. Depending on the option chosen, some additional study might be needed in order to define more precisely the least restrictive technical characteristics for the services that will be introduced in this band.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
ACIR	Adjacent Channel Interference Ratio
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
AS	Aeronautical Station
BS	Base Station
CEPT	European Conference of Postal and Telecommunications Administrations
CCL	Cordless Camera Link
CGC	Complementary Ground Component
DA2GC	Direct Air to Ground Communications
DEC	Decision
DECT	Digital Enhanced Cordless Telecommunications
ECC	Electronic Communications Committee
ECO	European Communications Office
EESS	Earth Exploration Satellite Service
e.i.r.p.	equivalent isotropically radiated power
ENG	Electronic News Gathering
ERM	Electromagnetic compatibility and Radio spectrum Matters
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
FL	Forward Link, communication from ground base station to aircraft
GS	Ground Station
GSM	Global System for Mobile Communications
GUI	Graphical User Interface
I	Interference
I/N	Interference to Noise
ISM	Industrial, Scientific and Medical
ITU-R	International Telecommunication Union - Radiocommunication Sector
LTE	Long Term Evolution
MFCN	Mobile Fixed Communications Network
MSS	Mobile Satellite Service
MVL	Mobile Video Link
OB	Outside Broadcasting
OBU	On-Board Unit
PMSE	Programme Making and Special Events
PP	Portable Part
PPDR	Public Protection and Disaster Relief
PVL	Portable Video Link
RB	Resource Block
RFP	Radio Fixed Part
RL	Return Link, communication from aircraft to ground base station
Rx	Receiver
SAB	Services Ancillary to Broadcasting
SAP	Services Ancillary to Programme making
SEAMCAT	Spectrum Engineering Advanced Monte Carlo Analysis Tool

SEM	Spectrum Emission Mask
SRD	Short Range Device
TDD	Time Domain Duplex
TR	Technical Report
TRR	Tactical Radio Relay
Tx	Transmitter
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
w	with
w/o	without
WiFi	Wireless Fidelity

1 INTRODUCTION

The ECC/DEC/(06)01 which initially entered into force on 24 March 2006 and addressed both paired (1920-1980 MHz and 2110-2170 MHz) and unpaired (1900-1920 MHz and 2010-2025 MHz) frequency bands aimed at providing a common approach for planning and use of spectrum including channel arrangements. The revision of ECC/DEC/(06)01 was preceded by a questionnaire on the use of the unpaired 2 GHz bands in 2010. Further updated information on the current status of individual authorisations in force on the unpaired 2 GHz bands can be found in ECO Report 03.

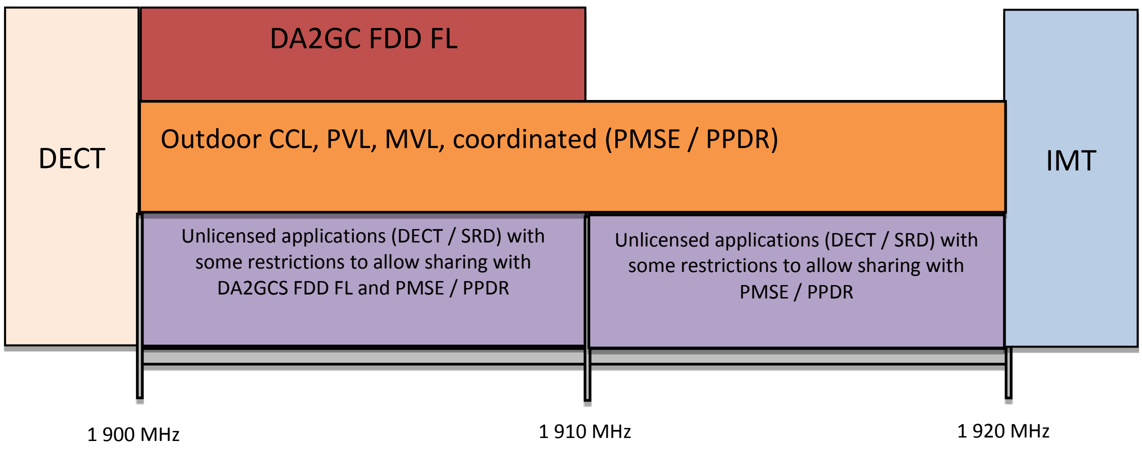
The frequency bands 1900-1920 MHz and 2010-2025 MHz were individually licensed years ago in many countries for UMTS TDD. However, in most of the countries these bands are currently not in use. Frequency arrangements for these frequency bands have been removed from the revision of the ECC Decision (06)01, which entered into force 2nd November 2012.

The following alternative scenarios for the unpaired 2 GHz bands have been proposed:

1.1 SCENARIO 1

DA2GC FDD + DECT / SRD + PMSE / PPDR, as follows:

- 1900-1910 MHz: DA2GC FDD FL;
- 1900-1920 MHz: Outdoor CCL, PVL, MVL, coordinated (PMSE / PPDR); no separation distance required to DA2GC GS;
- 1900-1920 MHz: Unlicensed applications (DECT / SRD); restrictions may be necessary for DECT / SRD, such as duty cycle, indoor restriction and emission limit;
- 2010-2020 MHz: DA2GC FDD RL;
- 2010-2020 MHz: PMSE (restrictions required to allow co-existence with DA2GC);
- 2020-2025 MHz: PMSE.



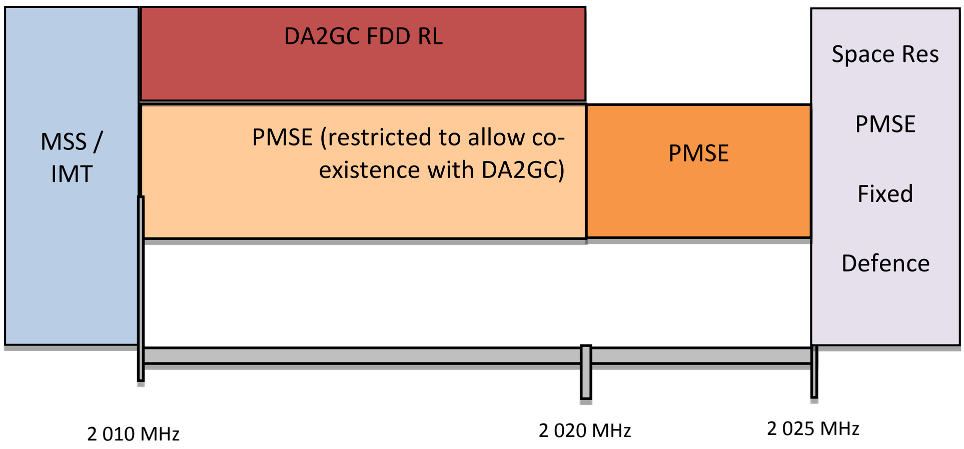
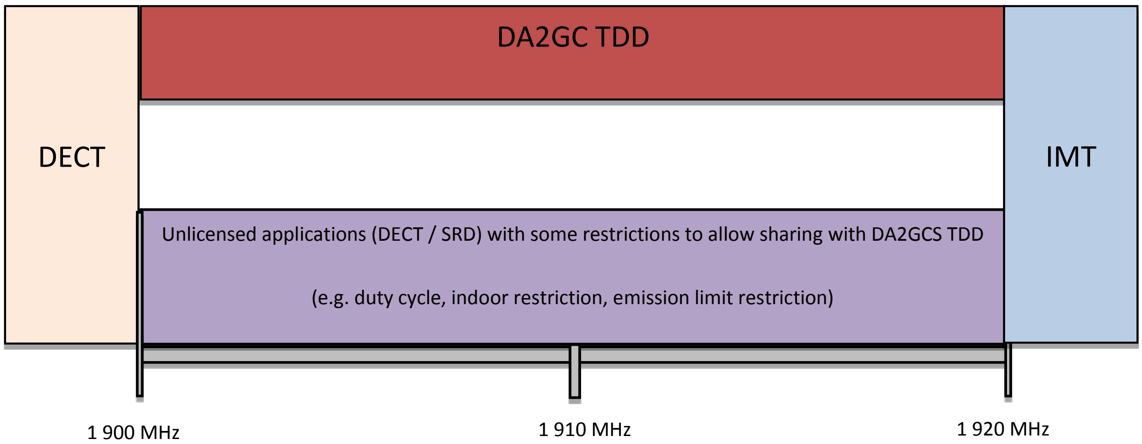


Figure 1: Scenario 1 (DA2GC FDD, DECT / SRD, PMSE / PPDR)

1.2 SCENARIO 2

DA2GC TDD + DECT / SRD + PMSE / PPDR, as follows:

- 1900-1920 MHz: DA2GC TDD; sharing with DECT / SRD should be investigated (indoor restriction, duty cycle, emission limit restriction);
- 2010-2025 MHz: PMSE / PPDR.



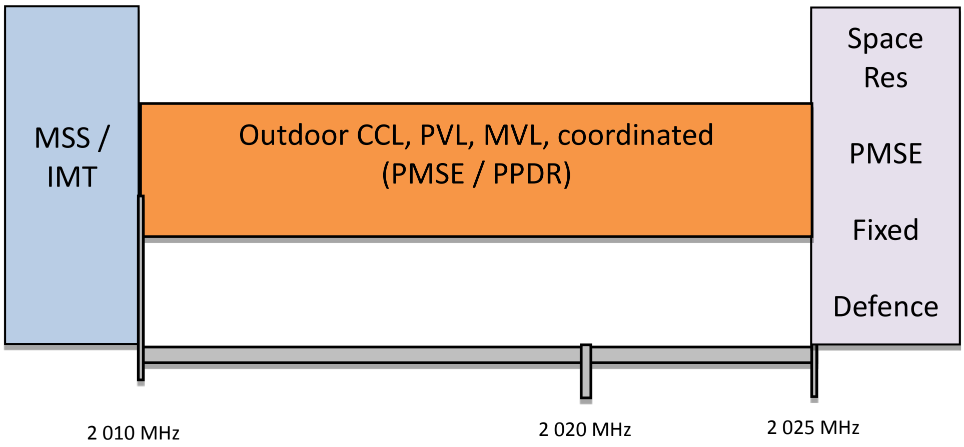


Figure 2: Scenario 2 (DA2GC TDD, DECT / SRD, PMSE / PPDR)

This Report covers Broadband DA2GC system located in the unpaired 2 GHz bands (mainly FDD approach assumed [1], but also TDD systems are considered [18]).

Note that compatibility studies between DA2GC at 1900-1920 MHz and 2010-2025 MHz and systems in adjacent bands are covered by ECC Report 209 [2].

1.3 BROADBAND DA2GC FDD IMPLEMENTATION ALTERNATIVES

This Report considers a Broadband DA2GC system[3] located in the unpaired 2 GHz bands (mainly FDD approach assumed, based on the system described in ETSI TR 103 054 [1] and PMSE which is also a candidate application for the 2 GHz unpaired bands and already in operation above 2025 MHz on a tuning range basis.

Both the transmission and the receiving paths of PMSE links with Broadband DA2GC (both FL (Forward Link) and RL (Reverse Link)) are considered. Both radio applications (PMSE links and Broadband DA2GC) are considered as a potential interferer and as a potential victim. A paired arrangement for Broadband DA2GC is taken into account (FL in one band, RL in the other band at 2 GHz). In case the co-channel usage (PMSE links / Broadband DA2GC) and adjacent channel arrangement for these two applications is investigated.

Two different approaches are considered dependent on the implementation of forward and reverse link of the DA2GC FDD system in each of the 2 GHz unpaired band. A possible sharing between DA2GC FL and PMSE – subject to be proven by the studies – is assumed in the implementation overviews. A spectrum demand of 2 x 10 MHz for FDD DA2GC is assumed.

1.4 DA2GC FL IN THE LOWER BAND, RL IN THE UPPER BAND

Figure 3 gives an overview of the realization alternative 1: the FL is located in the lower frequency band (1900-1920 MHz) and shared with PMSE video links, whereas the RL is located in the upper frequency band (2010 2025 MHz) having guard bands to adjacent services.

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[3] Two alternative Broadband DA2GC systems are also under consideration for operation within these frequency bands, both of which are based on a TDD implementation. Some studies have also been carried out in respect of one of these alternative systems (the system described in ETSI TR 101 599 [18]). These are referred to in Section 6 and detailed results of one study specific to that system are included in Annex 1.

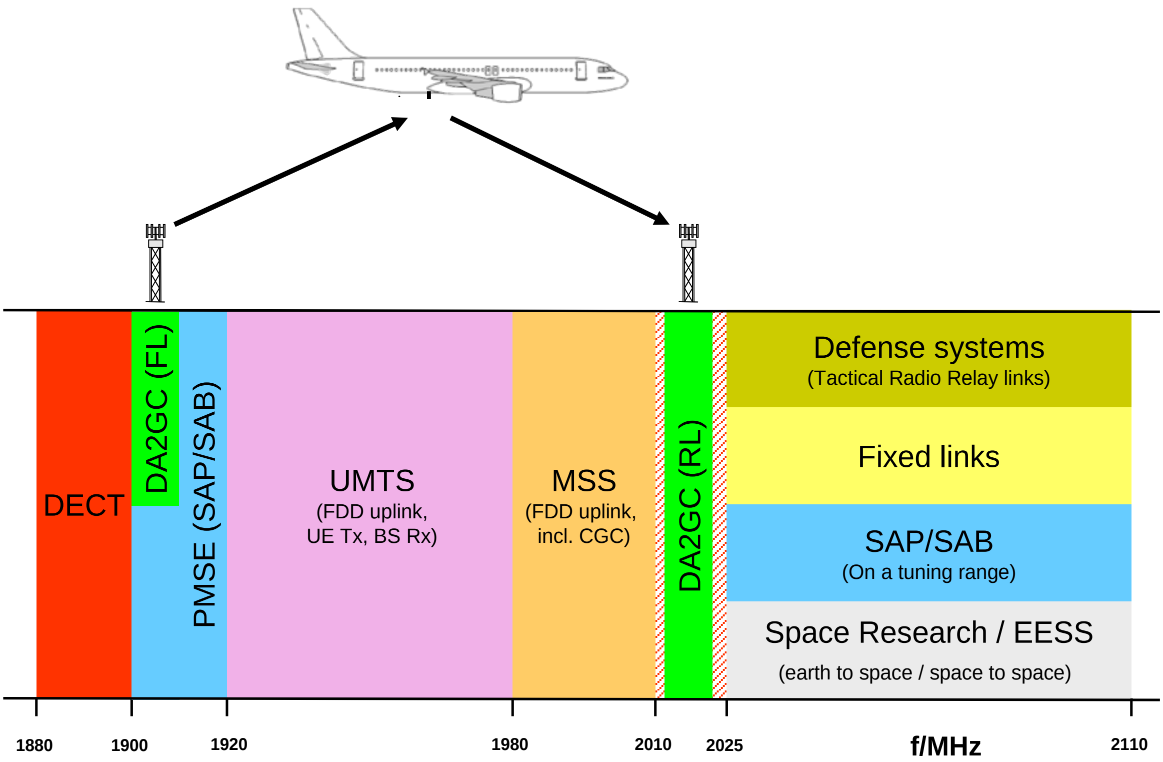


Figure 3: DA2GC with FL in the lower band compatibility/sharing with PMSE

1.4.1 DA2GC RL in the lower band, FL in the upper band

Figure 4 gives an overview of the realization alternative 2: the RL is located in the lower frequency band (1900-1920 MHz), whereas the FL is located in the upper frequency band (2010 -2025 MHz) and shared with PMSE video links.

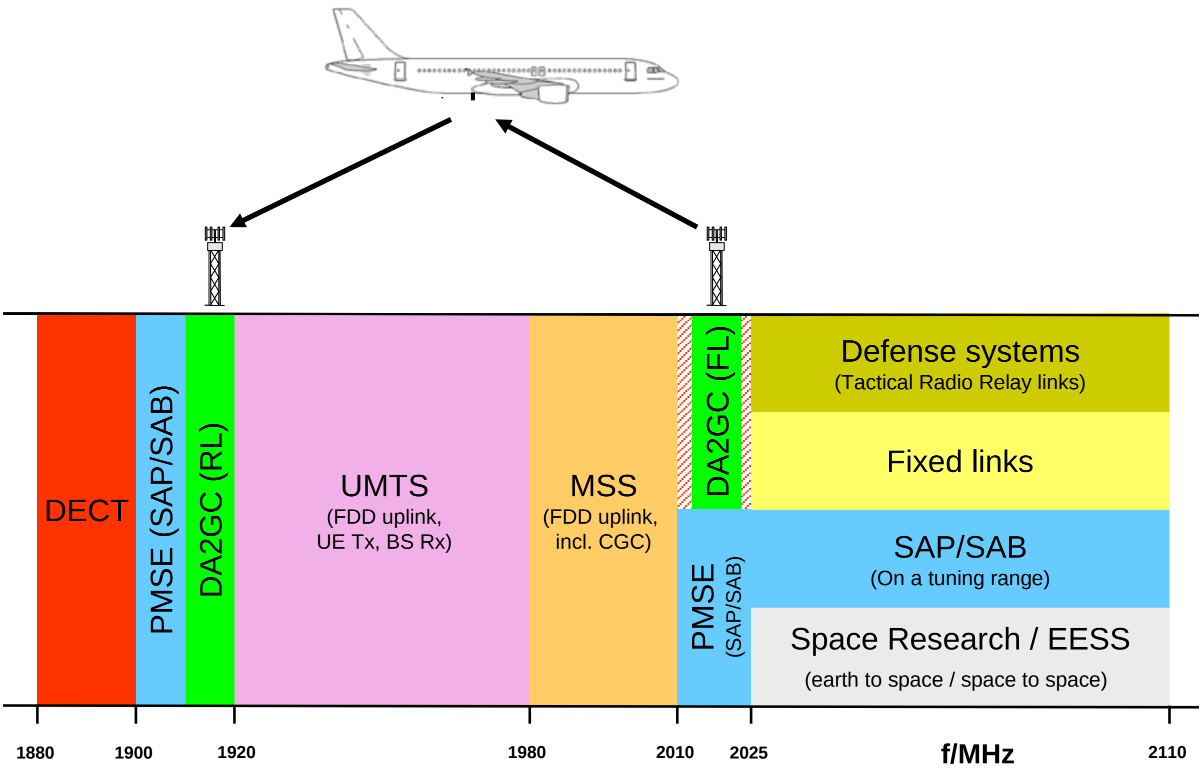


Figure 4: DA2GC with RL in the lower band compatibility/sharing with PMSE

1.4.2 Interference scenarios

Following interference scenarios are evaluated:

1. DA2GC FL in lower and RL in upper band
   a. The reception at a PMSE receiver is interfered with by a DA2GC ground station (GS) transmission (DA2GC FL) in co-channel and adjacent (in-band) channel operation.
   b. The reception at a DA2GC aircraft station (AS), i.e. the DA2GC FL is interfered with by a PMSE transmission in co-channel and adjacent (in-band) channel operation.
   c. The reception at a PMSE receiver is interfered with by the DA2GC AS transmission (DA2GC RL) in adjacent channel operation.
   d. The reception at a DA2GC GS, i.e. the DA2GC RL, is interfered with by a PMSE transmission in adjacent channel operation.
2. DA2GC RL in lower and FL in upper band
   a. The reception at a PMSE receiver is interfered with by a DA2GC AS transmission (DA2GC RL) in adjacent (in-band) channel operation.
   b. The reception at a DA2GC GS, i.e. the DA2GC RL, is interfered with by a PMSE transmission in adjacent (in-band) channel operation.
   c. The reception at a PMSE receiver is interfered with by the DA2GC GS transmission (DA2GC FL) in co-channel and adjacent channel (incl. in-band) operation.
   d. The reception at a DA2GC AS, i.e. the DA2GC FL, is interfered with by a PMSE transmission in co-channel and adjacent channel (incl. in-band) operation.

The evaluation results are based on worst case single link scenarios between the interferer and the victim system.

2 DEFINITIONS

Term	Definition
Forward link (FL)	Downlink direction; communication from ground base station to aircraft.
Return link (RL)	Uplink direction; communication from aircraft to ground base station.

3 TECHNICAL CHARACTERISTICS

Technical characteristics of the broadband DA2GC system, PMSE video links, MFCN systems and DECT system used for the sharing and compatibility studies are given in the following subsections.

3.1 BROADBAND DA2GC SYSTEM

The DA2GC system parameters are primarily based on 3GPP specifications for LTE transmitter and receiver characteristics [14] and [15], but some are modified according to the need of the aeronautical use case, mainly related to antenna characteristics of GS and AS as well as Tx power of the AS [1].

The following tables provide an overview of the main parameters for the DA2GC GS and AS.

Table 2: Main parameters for DA2GC ground stations (TR 103 054) [1]

Parameter	DA2GC ground station
	FDD
Base station type	Macro
Environment	Rural
Cell radius (max.)	Up to 100 km
Tx power	46 dBm
Antenna type	3 x 120° sector antennas
Antenna gain	Up to 17 dBi
Antenna height	50 m
Antenna tilt	10°(up-tilt) (Note 1)
Channel bandwidth	2 x 10 MHz (FDD)
Frequency re-use factor	1
Signal bandwidth (related to number of occupied resource blocks with bandwidth of 180 kHz)	9 MHz (FDD)
Rx thermal noise	-104.5 dBm (FDD)
Rx noise figure	5 dB
Rx noise floor	-99.5 dBm (FDD)
Rx reference sensitivity level	-101.5 dBm (FDD) (Note 2)
Interference protection ratio I/N	-6 dB
Interference protection level	-105.5 dBm (FDD) (Note 2)
Tx spectrum emission mask (SEM) / Spurious emissions	According to [15]
Adjacent channel leakage ratio (ACLR) limit	45 dB (Note 3)
Rx in-band / out-of-band blocking	According to [15]
Rx adjacent channel selectivity (ACS)	43.5 dB (according to [15])

Note 1: The antenna up-tilt is dependent on the final characteristic of the antenna and the cell radius to be covered. The value used here is suitable for large cells; for cells with smaller radius the main lobe should have higher up-tilt.
Note 2: In [15] the sensitivity level of -101.5 dBm is also applied for signal bandwidths above 10 MHz, as only up to 25 resource blocks (RB) are assigned to a single UE link, even if more RBs are feasible.
Note 3: In general the ACLR limit given in the table or the absolute limit of -15 dBm/MHz is valid, whichever is less stringent (macro BS according category B) [15].

Table 3: Main parameters for DA2GC aircraft stations (TR 103 054)

Parameter	DA2GC aircraft station FDD
Tx power (max./min.) (Note 1)	40 dBm / -23 dBm
Antenna type	Azimuth: Omni-directional Elevation: See Figure 6
Antenna gain	6.54 dBi (Note 2)
Antenna height	3000 - 13000 m (Note 3)
Channel bandwidth	2 x 10 MHz
Signal bandwidth (related to number of occupied resource blocks with bandwidth of 180 kHz)	9 MHz
Rx thermal noise	-104.5 dBm
Rx noise figure	9 dB
Rx noise floor	-95.5 dBm
Rx reference sensitivity level	-97.5 dBm
Interference protection ratio I/N	-6 dB
Interference protection level	-101.5 dBm
Tx spectrum emission mask (SEM) / Spurious emissions	According to [14]
Adjacent channel leakage ratio (ACLR) limit	37 dB (Note 4)
Rx in-band / out-of-band blocking	According to [14]
Rx adjacent channel selectivity (ACS)	33 / 30 / 27 dB for channel bandwidths of 10/15/20 MHz (according to [14])

Note 1: The Tx power of the mobile station is dependent on the power control implementation applied by the equipment provider.
Note 2: For former evaluation a simple omni-directional characteristic with 0 dBi gain was assumed. The final diagram incl. the gain will be dependent on further antenna optimization steps as well as on limits set by the regulation. In the range just below the horizontal aircraft plane the antenna gain will normally be higher (up to about 6 dBi) to allow access of the OBU to the BS at the cell edge.
Note 3: The current assumption for a DA2GC OBU is that it will not transmit for altitudes below 3000 m as the GSM/WiFi on-board wireless access networks for the passengers have to be switched off below that threshold. In case the airlines are interested to use the DA2GC also for their operational services (non-safety relevant), it has to be clarified with the regulatory authorities under which conditions DA2GC radio links can kept until the aircraft reaches the airport ground (only wired access in the aircraft below the altitude threshold allowed).
Note 4: A higher ACLR value is required to keep the maximum allowed out-of-band emission level given in [14] in case of higher maximum Tx power of up to 40 dBm for the DA2GC OBU.

In Table 3 the ACLR limit is given according to the LTE UE specifications, but as explained in Note 4 above the same absolute out-of-band spectrum emissions are assumed as for LTE UEs, but the higher AS Tx power requires a more stringent ACLR.

The following Figure 5 and Figure 6 provide antenna patterns for the DA2GC GS and AS used for the evaluations.

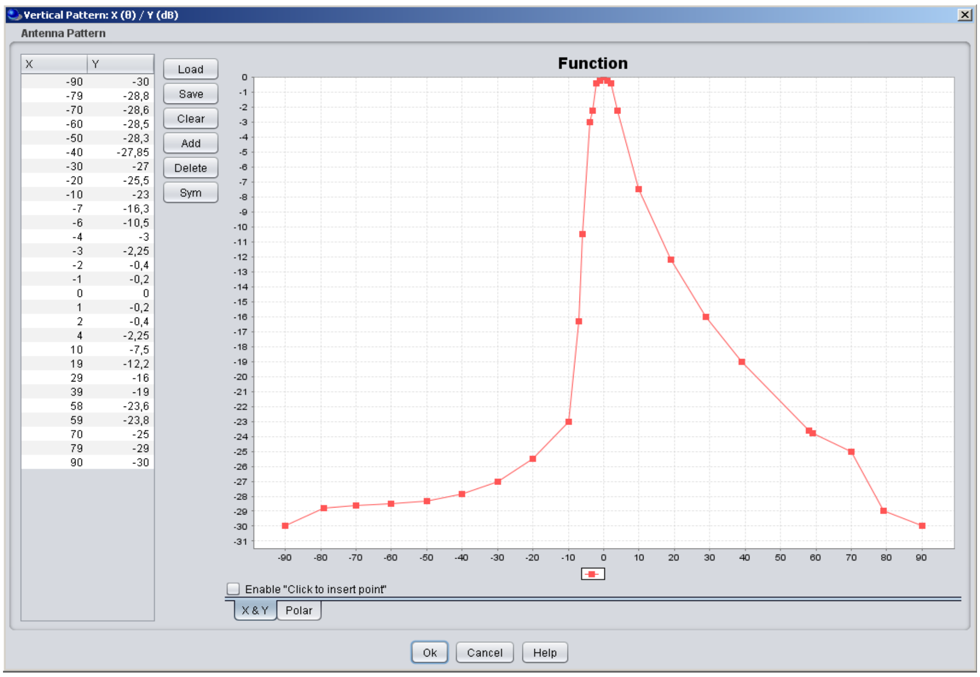


Figure 5: Vertical sector antenna pattern (approximated cosecant-squared) characteristic of the DA2GC GS (screen shot of SEAMCAT GUI; up-tilt not considered in the diagram)

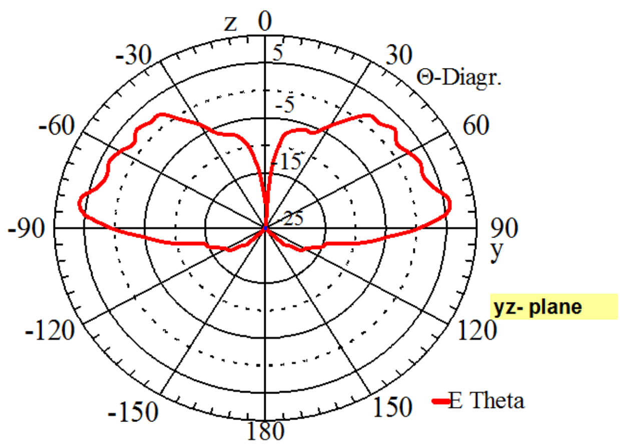


Figure 6: Vertical antenna pattern (monopole) for the DA2GC AS (gain of 6.54 dBi; direction to Earth at 0°, to the horizon at ±90°)

The compatibility evaluations have been performed with the maximum AS Tx power of 40 dBm as a worst case assumption, i.e. the Tx power always corresponds to a value according to a placement of the aircraft at the cell edge. Taking into account, in addition to TX power control in the DA2GC AS, the level of interference from the DA2GC AS will be less in reality, when the aircraft is close to the DA2GC GS.

3.2 PMSE WIRELESS VIDEO LINKS

Based on the outcome of a joint meeting of PTs FM48 and FM51 [9] the priority of first compatibility studies should be on the PMSE use case for SAP/SAB and ENG/OB links, respectively. Those links are typically used only temporarily at different locations and therefore have a long history of spectrum sharing in different frequency bands. Typical application scenarios and technical characteristics of SAP/SAB equipment are described in detail in ERC Report 38 (video links) [10]. In the following subsections characteristics for three different types of links are given. These parameters according to Table 19 and Table 22 in ECC Report 172 [11] have already been used in other compatibility studies.

3.2.1 PMSE wireless video link scenarios selected for the studies

For the present study, three usage scenarios of video links have been selected which are described in the following table and illustrated in Figure 7, Figure 8 and Figure 9.

Table 4: Usage scenarios, antenna types and propagation models for wireless video link coexistence study (according to Table 19 in [11])

#	Name	Transmitter	Tx Ant. Type	Receiver	Rx Ant. Type	Propagation Model [10]
1	Cordless Camera Link	portable hand-held camera	semi-sphere omnidirectional	portable hand-held receiver	directional (e.g. disk Yagi)	Urban, below rooftop
2	Mobile Video Link	portable camera on motorcycle	semi-sphere omnidirectional,	receiver on helicopter	semi-sphere omnidirectional	Free Space (helicopter links); Urban, below rooftop
3	Portable Video Link	two-man radio camera	directional (e.g. disk Yagi)	TV van	1.2 m parabolic dish	Urban, below rooftop

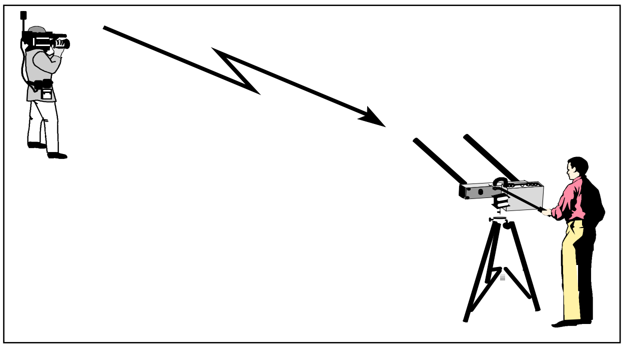


Figure 7: Scenario 1 – Cordless camera link

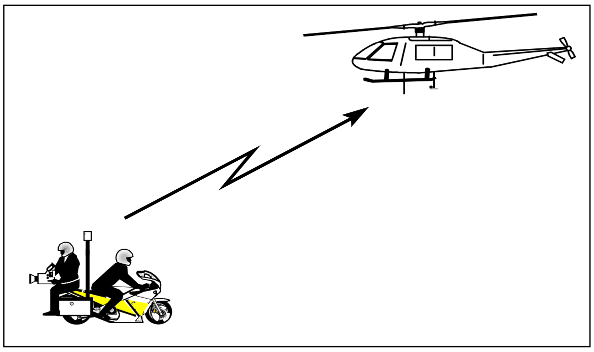


Figure 8: Scenario 2 – Mobile video link

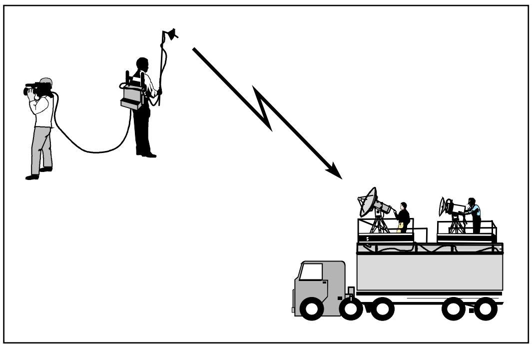


Figure 9: Scenario 3 – Portable video link

3.2.2 PMSE wireless video link antenna characteristics used in the studies

For the worst case single link scenarios considered in this report, only the vertical antenna patterns are relevant. These patterns for the antennas used in the three selected PMSE video link scenarios (see Table 4) are given in Figure 10, Figure 11 and Figure 12.

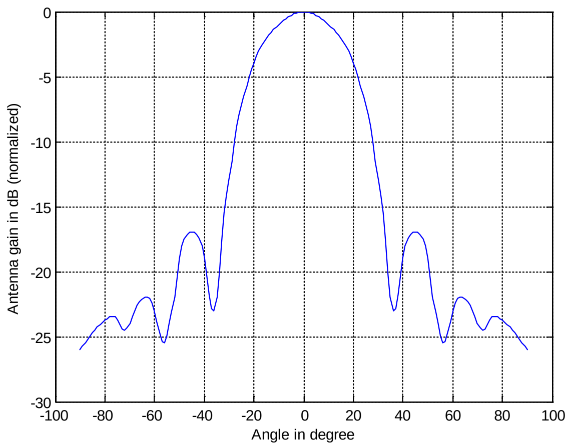


Figure 10: Disc Yagi antenna diagram (normalized) [10]

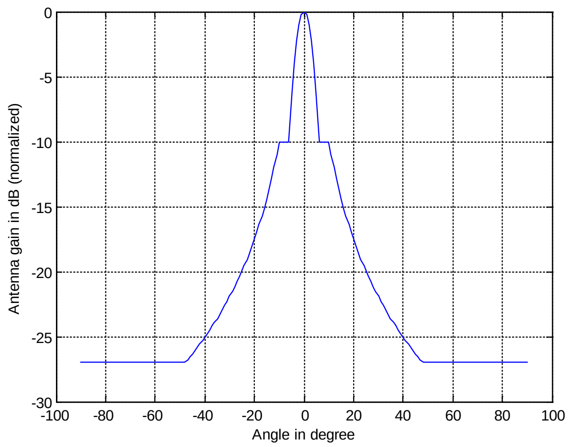


Figure 11: Diagram of parabolic dish antenna (normalized) [10] [17]

3.2.3 PMSE wireless video link transmission mask characteristics used in the studies

According to [12] the transmitter output spectrum shall be considered with respect to the measurement mask in Figure 12 where B is the declared channel bandwidth which is equal to 10 MHz for present study [9]. The power is required to be determined outside the channel bandwidth B within block 2 and block 3 as shown in the figure.

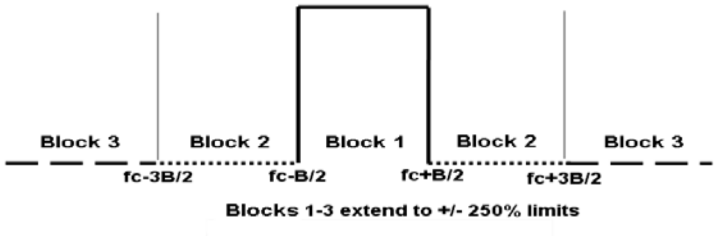


Figure 12: Measurement mask normalized to the channel bandwidth B [12].

The required bandwidth (ACLR) power limits are given in the two following tables taken from [12] with P_{MAX} the mean transmitter output power and P_0 the output power incl. the antenna gain. The impact of any discrete components occurring in the adjacent bands was not considered in the present study.

Table 5: Integrated power limits relative to P_{MAX} for P_0 < 0.3 W e.i.r.p.

Out-of-band block	Each half of the region	Both halves of the region
Block 2	-36 dB	-33 dB
Block 3	-42 dB	-39 dB

Table 6: Integrated power limits relative to P_{MAX} for P_0 > 0.3 W e.i.r.p.

Out-of-band block	Each half of the region	Both halves of the region
Block 2	-36 dB - 10 log (P_0/0.3)	-33 dB - 10 log (P_0/0.3)
Block 3	-42 dB - 10 log (P_0/0.3)	-39 dB - 10 log (P_0/0.3)

For the scenarios the same value for P_{MAX} is used as given in ECC Report 172 [11].

With P_{MAX} equal to 17 dBm and a Tx antenna gain of 5 dBi, the ACLR value corresponds to about 53 dB in Block 2 and 59 dB in Block 3 for each half of the region for the CCL.

With PMAX equal to 30 dBm and a Tx antenna gain of 5 dBi, the ACLR value corresponds to about 46 dB in Block 2 and 52 dB in Block 3 for each half of the region for the MVL.

With PMAX equal to 30 dBm and a Tx antenna gain of 16 dBi, i.e. the ACLR value corresponds to about 57 dB in Block 2 and 63 dB in Block 3 for each half of the region for the PVL.

The level of spurious transmitter emissions, measured as described in the ETSI specification [12], shall not exceed the limits given in Table 6. The measurement bandwidth for carrier frequencies > 1000 MHz is 1 MHz, i.e. for the frequency band considered in present study the spurious emissions should be below -30 dBm/MHz during operation of the video link.

Table 7: Radiated spurious emissions

State	Frequencies <= 1 GHz	Frequencies > 1 GHz
Operating	250 nW	1 µW
Standby	2 nW	20 nW

Further parameters for the video link scenarios applied in the present studies:

- The adjacent channel selectivity (ACS) of a receiver for wireless video equipment operating above 1.3 GHz is specified to be 30 dB [13].
- The same values are used as given in ECC Report 172 [11] for the Rx noise figure (4 dB) and the I/N threshold (-6 dB) for the video link.
- No cable/feeder losses are considered on the transmission and reception side for the wireless video link.

3.2.4 Summary of the parameters for PMSE wireless video link scenarios

Table 8: Summary of parameters for PMSE wireless video link scenarios

Parameter	CCL	MVL	PVL
Tx/Rx Bandwidth	10 MHz	10 MHz	10 MHz
Frequency bands	1900-1920 MHz 2010-2025 MHz	1900-1920 MHz 2010-2025 MHz	1900-1920 MHz 2010-2025 MHz
Tx Max output power	17 dBm (according to Table 22 in [11])	30 dBm (according to Table 22 in [11])	30 dBm (according to Table 22 in [11])
Antenna tilt	0°	Tx: 0°, Rx pointing towards Earth surface	0°
Antenna horizontal direction	Pointed at interferer	Pointed at interferer	Pointed at interferer
Antenna Directivity Loss horizontal	0 dB	0 dB	0 dB
Antenna Directivity Loss vertical	0 dB	0 dB	0 dB
ACLR (dB)	53 (Block 2), 56 (Block 3)	46 (Block 2), 52 (Block 3)	57 (Block 2), 63 (Block 3)
Spurious emissions	-30 dBm/MHz	-30 dBm/MHz	-30 dBm/MHz
ACS	30 dB	30 dB	30 dB
Rx Noise figure	4 dB	4 dB	4 dB
I/N	-6 dB	-6 dB	-6 dB
Rx Antenna height	1.5 m	150 m	5 m
Tx Antenna height	1.5 m	1.5 m	3 m
Rx Antenna gain	16 dBi (according to Table 19 in [11])	5 dBi (according to Table 19 in [11])	27 dBi (according to Table 19 in [11])
Tx Antenna gain	5 dBi (according to Table 19 in [11])	5 dBi (according to Table 19 in [11])	16 dBi (according to Table 19 in [11])

3.3 DECT TECHNICAL CHARACTERISTICS

The DECT system parameters used in the study are based on ETSI EN 300 175-2 [19] and on additional information provided by the DECT Forum.

Table 9: Main parameters for DECT stations/terminals

Parameter	DECT station/terminal
	TDD
Tx power (max./min.)	24 dBm
Antenna type	Directional / Omni-directional
Antenna gain	Up to 6 dBi / Up to 3 dBi (Note 1)
Antenna height	5 m (Note 2)
Channel separation	1.728 MHz
Signal bandwidth	1.152 MHz
Rx thermal noise	-114 dBm
Rx noise figure	11 dB
Rx noise floor	-103 dBm
Rx reference sensitivity level	-93 dBm (Note 3)
Interference protection ratio I/N	0 dB
Interference protection level	-103 dBm (Note 4)
Tx spectrum emission mask (SEM) / Spurious emissions	According to [19]
Adjacent channel leakage ratio (ACLR) limit	See Table 10
Rx in-band / out-of-band blocking	According to [19]
Rx adjacent channel selectivity (ACS)	See Table 11

Note 1: Typically DECT equipment uses omni-directional antennas with 0 dBi (due to asymmetries in the diagram peak gains up to 3 dBi may occur). . The 6 dBi value should be considered as worst case assumption for the interference computation in the present study. In section 5 a value of 12 dBi has been used for historical reasons.
Note 2: Similar to the antenna gain a height of 5 m has been assumed corresponding to an outdoor enterprise or WLL station.
Note 3: The reference sensitivity level given in ETSI EN 300 175-2 [19] is only -83 dBm, but DECT manufacturers very early succeeded to make cost efficient DECT phones with -93 dBm sensitivity, which is the industry standard since then.
Note 4: Interfering signal level to allow a 3 dB desensitization of the DECT receiver.

Twenty two RF carriers are defined for DECT in the frequency band 1880-1920 MHz with centre frequencies Fc given by:

$$F_c = F_0 - c \times 1.728 \text{ MHz where } F_0 = 1897.344 \text{ MHz and } c = 0, 1, 2, ..., 9 \text{ and}$$

$$F_c = F_9 + c \times 1.728 \text{ MHz where } F_9 = 1\,881.792 \text{ MHz; and } c = 10, 11, 12, ..., 21.$$

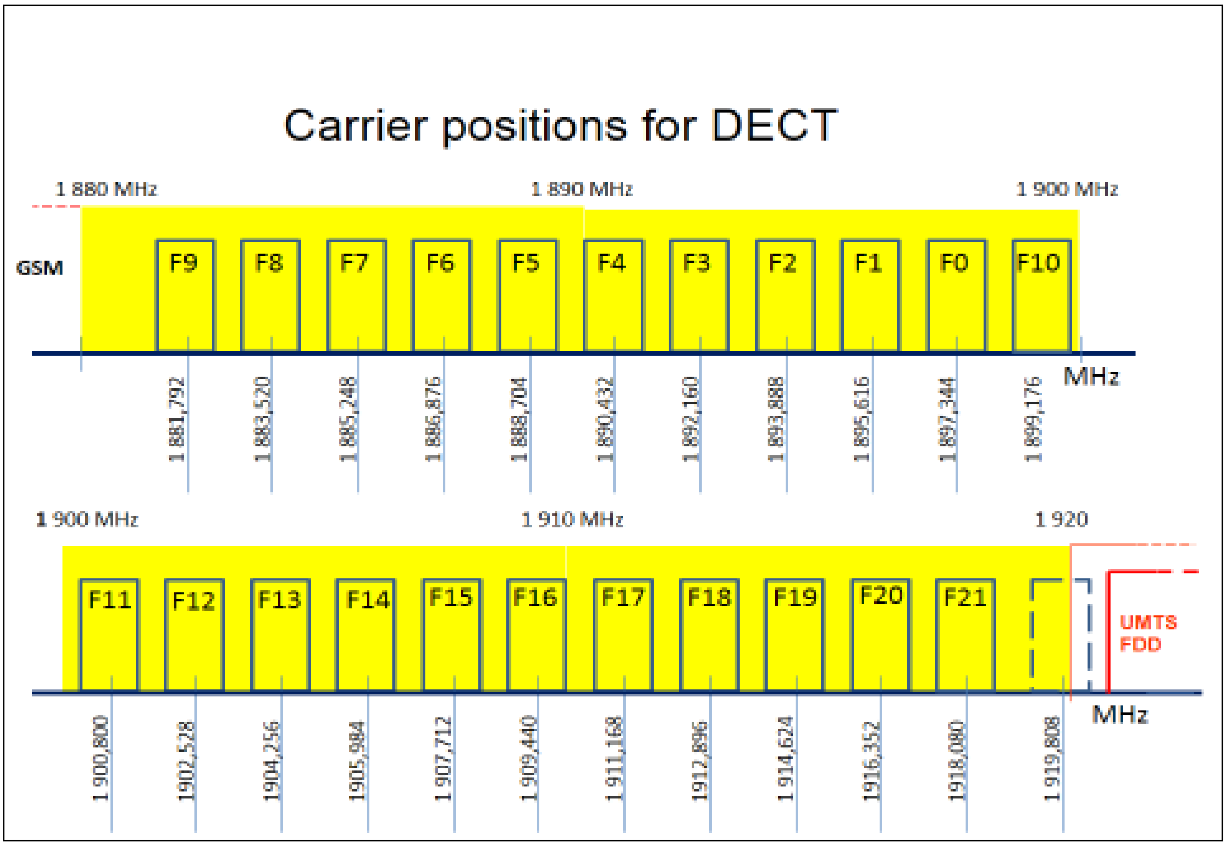


Figure 13: Position of DECT carriers and adjacent channels extended outside the DECT band (related to UMTS TDD channelization)

Table 10: Adjacent channel leakage ratio for DECT channelization (bandwidth of about 1 MHz)

Adjacent channel #	Maximum power level	ACLR
1st adj. channel	-8 dBm	32 dB
2nd adj. channel	-30 dBm	54 dB
3rd adj. channel	-41 dBm	65 dB
4th & higher adj. channel	-44 dBm	68 dB

Table 11: Adjacent channel selectivity for DECT-like interferer

Adjacent channel #	ACS
1st adj. channel	24 dB
2nd adj. channel	45 dB
3rd adj. channel	51 dB
4th adj. channel	55 dB
5th & higher adj. channel	58 dB

3.4 MFCN TECHNICAL CHARACTERISTICS

3.4.1 UMTS BS technical characteristics

Technical characteristics of UMTS macro base stations, receiving in the frequency band 1920-1980 MHz, are given in the following table.

Table 12: UMTS Wide Area BS characteristics from ETSI TS 125 104 [25]

Parameter	Value	Comment
Channel bandwidth	5 MHz	
Transmission bandwidth	3.84 MHz	
Noise figure (NF)	5 dB	
Standard wideband blocking level	-52 dBm (1st adjacent block) -40 dBm (2nd adjacent block and following ones)	Table 7.3 Table 7.4
ACS_1 (1915-1920 MHz)	46 dB	
ACS_2 (1900-1915 MHz)	58 dB	
Desensitization for MCL calculation	1 dB	
Antenna height	30m	
Antenna gain	17 dBi	
Feeder loss	0 dB 2 dB	in studies type #1 in other studies
Vertical antenna discrimination	≥ 12 dB 0 dB	in studies type #1 in other studies

3.4.2 LTE BS technical characteristics

Technical characteristics of LTE macro and pico base stations, receiving in the frequency band 1920-1980 MHz, are given in the following tables.

Table 13: LTE Wide Area BS characteristics from ETSI TS 136 104 [26]

Parameter	Value	Comment
Channel bandwidth	10 MHz / 5 MHz/1.4 MHz	
Transmission bandwidth	9 MHz / 4.5 MHz/1.08 MHz	
Noise figure (NF)	5 dB	
Standard wideband blocking level	-52 dBm (1st adjacent block) -43 dBm (2nd adjacent block and following ones)	
ACS_1 (1915-1920 MHz)	46 dB	In the case of DECT, a weighted ACStotal value is used (see section 11)
ACS_2 (1900-1915 MHz)	55 dB	
Desensitization for MCL calculation	1 dB	
Antenna height	30m	
Antenna gain	17 dBi	
Feeder loss	0 dB 2 dB	in studies type #1 in other studies
Vertical antenna discrimination	≥ 12 dB 0 dB	in studies type #1 in other studies

Table 14: LTE Local area BS characteristics from ETSI TS 136 104 [26]

Parameter	Value	Comment
Channel bandwidth	10 MHz / 5 MHz/1.4 MHz	
Transmission bandwidth	9 MHz / 4.5 MHz/1.08 MHz	
Noise figure (NF)	13 dB	
Standard wideband blocking level	-44 dBm (1st adjacent block) -35 dBm (2nd adjacent block and following ones)	
ACS_1 (1915-1920 MHz)	46 dB	In the case of DECT, a weighted ACStotal value is used (see section 11)
ACS_2 (1900-1915 MHz)	55 dB	
Desensitization for MCL calculation	1 dB	
Antenna height	3 m	
Antenna gain	0 dBi	
Feeder loss	0 dB	
Vertical antenna discrimination	0 dB	

4 COMPATIBILITY EVALUATION BETWEEN DA2GC AND PMSE

4.1 GENERAL REMARKS

The diagrams with evaluation results shown in following subsections show

- the path loss with and without consideration of the vertical antenna characteristics of the involved system components, i.e. the DA2GC GS and AS as well as the PMSE video link Tx and Rx,
- the received interference power at the victim station (always related to the signal bandwidth of the victim system; in present study the bandwidth of both systems is equal to 10 MHz),
- the resulting interference-to-noise ratio (I/N) compared to the threshold of victim system along the ground-based distance (great circle distance) between the involved stations. In case of involvement of a DA2GC AS results are given for aircraft altitudes of 3 km and 10 km, respectively. With respect to interference the worst case assumption is to have line-of-sight propagation between interferer and victim. Therefore, in all cases with involvement of the DA2GC AS and/or MVL Rx (helicopter) free space loss was applied [29]. In the cases where both victim and interferer are placed on the ground the Extended Hata Model for open rural area was applied for the computation of the path loss (see e.g. [30] for information about the model). Where applicable, also suburban and urban area environment were considered.

For the I/N computation the resulting adjacent channel interference ratio (ACIR) was considered which is based on following relationship of the Tx and Rx characteristics of interferer and victim equipment:

$$ACIR = \frac{1}{\frac{1}{ACLR} + \frac{1}{ACS}}$$

The ACLR and ACS values of the involved systems may vary dependent on the frequency separation which is related to the positioning of the DA2GC signal and the PMSE video link signal as mentioned before.

4.2 DA2GC FL IN THE BAND 1900-1920 MHz

4.2.1 Scenario (1a)

This scenario is related to a positioning of the DA2GC FL in the lower unpaired 2 GHz band, i.e. the carrier frequency is selected to 1905 MHz. For the PMSE transmission two cases have to be differentiated. In the first case the PMSE signal is transmitted in co-channel operation to the DA2GC signal (reminder: both signals have the same bandwidth), in the second case the PMSE signal is transmitted in the adjacent channel with a carrier frequency of 1915 MHz, i.e. the transmission is still inside the lower unpaired 2 GHz band (see Figure 3).

4.2.1.1 PMSE CCL Rx interfered by a DA2GC GS

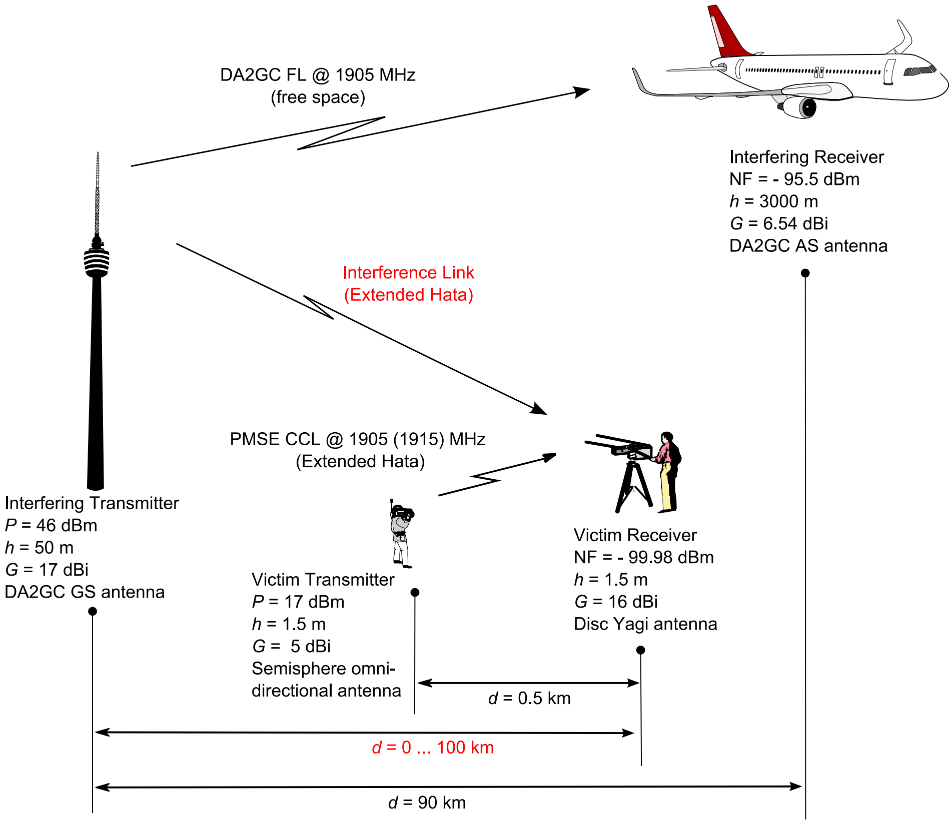


Figure 14: Scenario: PMSE CCL RX interfered by DA2GC GS

Based on the given ACLR and ACS values of the interfering and the victim system, respectively, a final ACIR value of 28.7 dB can be computed, which is dominated by the ACS value of the PMSE Rx.

In Figure 15 to Figure 17 the resulting interference power and I/N at the CCL Rx is shown, taken into account 3 different environments of the Extended Hata propagation model (rural area, suburban (middle), urban (bottom). For the co-channel operation (blue curve) it can be seen that the I/N is above the threshold up to about 36 km, in rural environment, 12 km in suburban areas and 6 km in urban areas. In case of adjacent channel operation the CCL transmission will be disturbed in a radius of about 7.5 km around the DA2GC GS in rural area. The required separation distance is reduced in suburban and urban environment to about 2 km and 1 km, respectively.

It has to be noted that this is really a worst case situation. If the adjustment of high gain dish antenna at the PMSE Rx is only slightly changed, the interference will be drastically reduced due to the small beam characteristic. As the number of DA2GC GS required covering the pan-European area is rather low (about 400 sites), the final interference probability for CCL is also very low.

Extended-Hata Rural: ACLR = 34.59/ ACS =30 / ACIR =28.70 dB

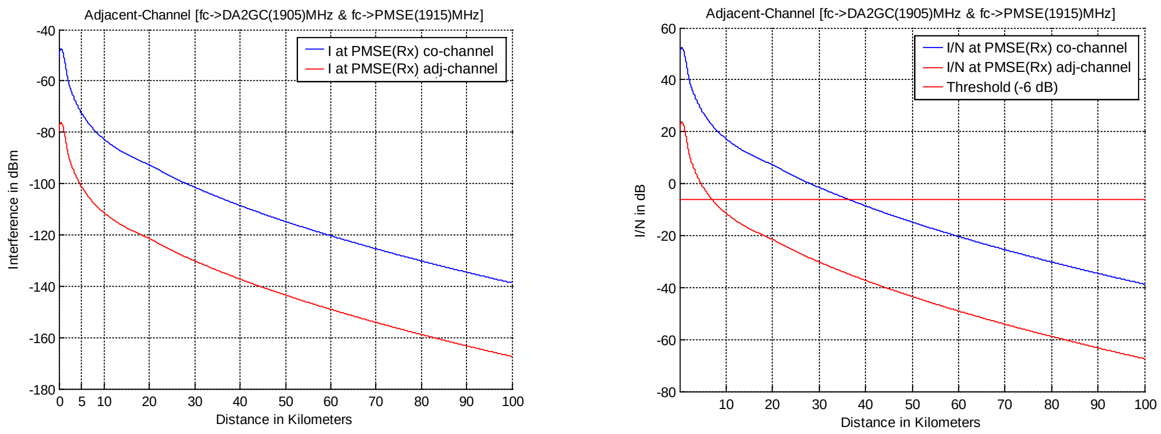


Figure 15: Co- and adjacent channel interference signal power and resulting I/N at CCL Rx (Ext. Hata Model for open rural area)

Extended-Hata Sub Urban: ACLR = 34.59/ ACS =30 / ACIR =28.70 dB

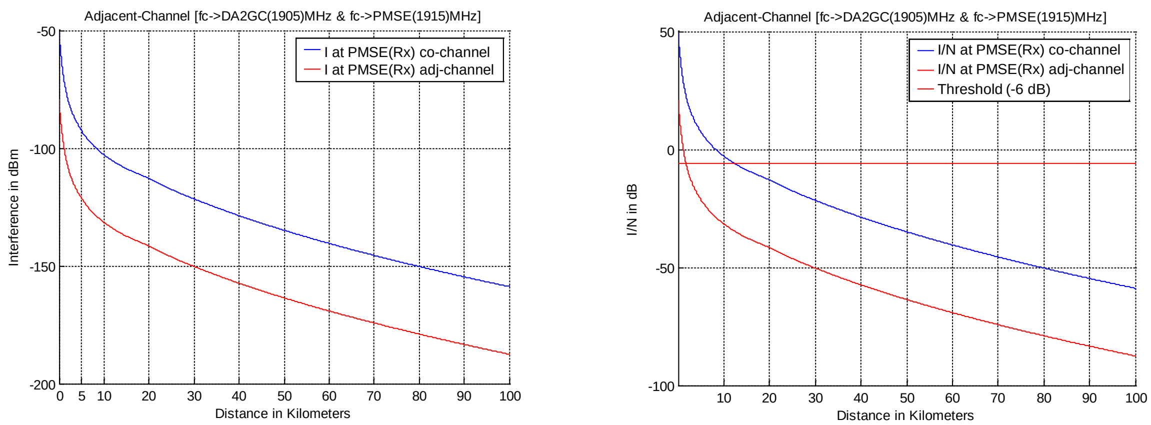


Figure 16: Co- and adjacent channel interference signal power and resulting I/N at CCL Rx (Ext. Hata Model for suburban area)

Extended-Hata Urban: ACLR = 34.59/ ACS =30 / ACIR =28.70 dB

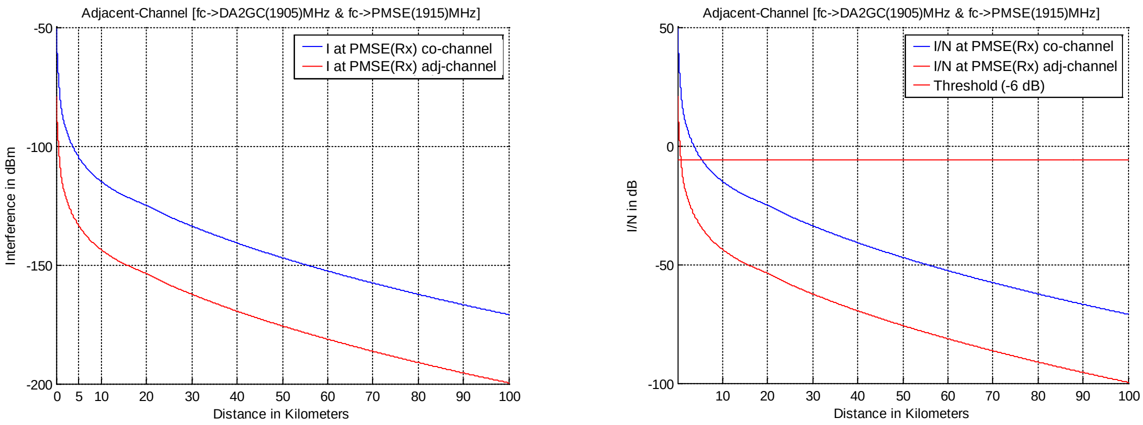


Figure 17: Co- and adjacent channel interference signal power and resulting I/N at CCL Rx (Ext. Hata Model urban area)

4.2.1.2 PMSE MVL Rx at helicopter interfered by a DA2GC GS

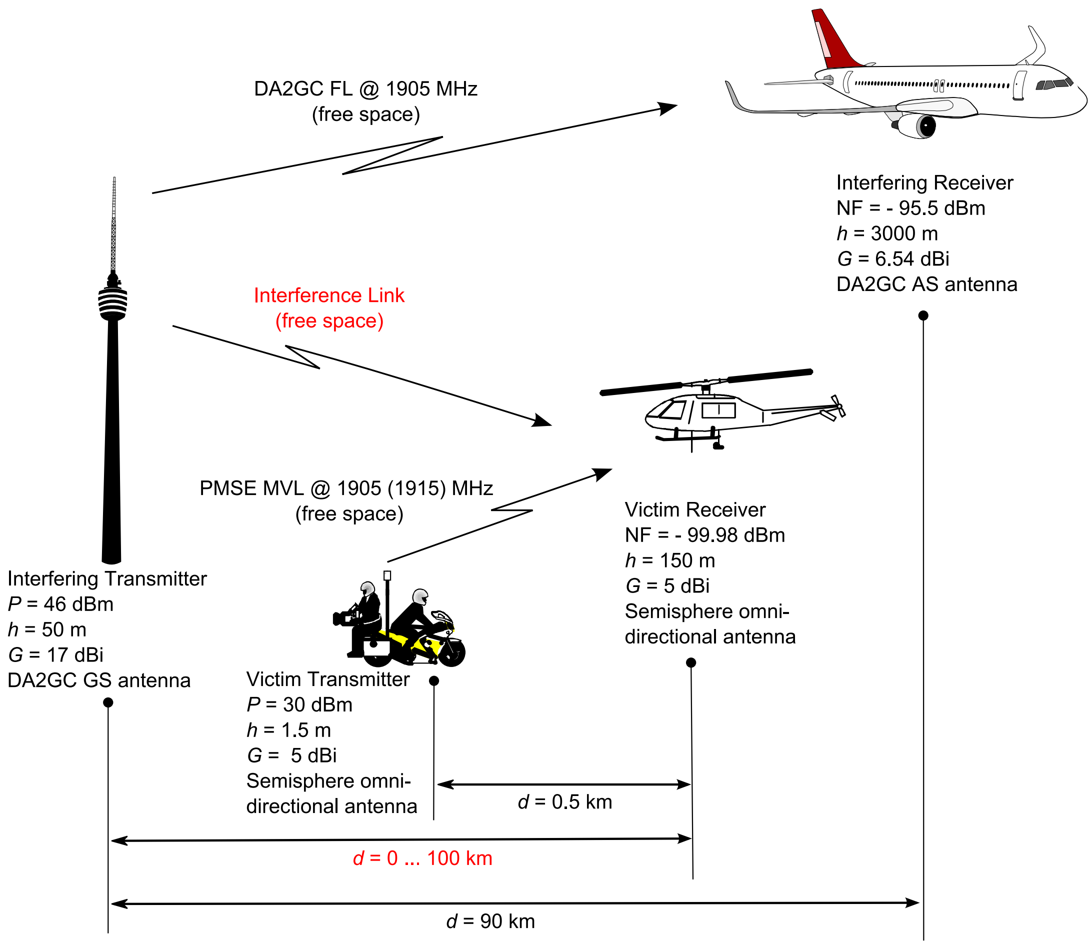


Figure 18: Scenario: PMSE MVL RX at helicopter interfered by DA2GC GS

Based on the given ACLR and ACS values of the interfering and the victim system, respectively, a final ACIR value of 29.9 dB can be computed.

In Figure 19, the path loss between the DA2GC GS and the MVL Rx at the helicopter for free space propagation is shown based on the technical parameters given in section 3.2. Only the vertical antenna diagram characteristics are considered, i.e. it is always assumed that the main lobes of the horizontal antenna diagrams (typically sector antennas for DA2GC GS as well as an omnidirectional antenna at the helicopter) are pointed directly to each other (worst case).

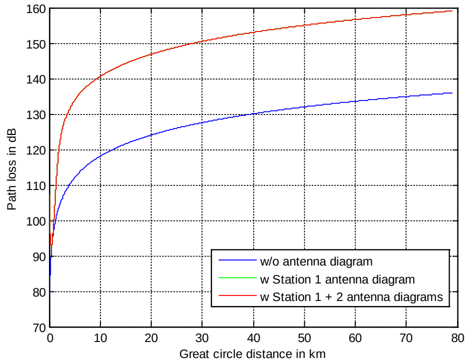


Figure 19: Path loss w & w/o consideration of vertical antenna characteristics (antenna gain not included) at DA2GC GS (Station 1) and MVL Rx (Station 2) at helicopter (free space)

Figure 20 and Figure 21 show the resulting interference power and I/N at the MVL Rx. For the co-channel operation (blue curve) it can be seen that the I/N is distinctly above the threshold. In case of adjacent channel operation the MVL transmission will be disturbed in a radius of about 10.5 km around the DA2GC GS.

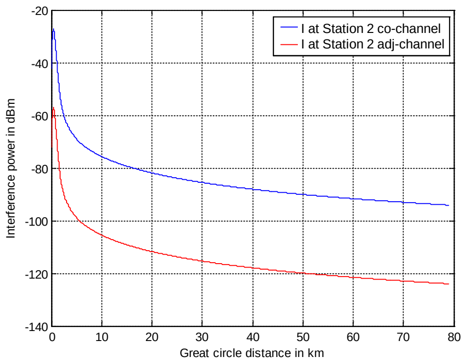


Figure 20: Co- and adjacent channel interference signal power at MVL Rx (Station 2) at helicopter (free space)

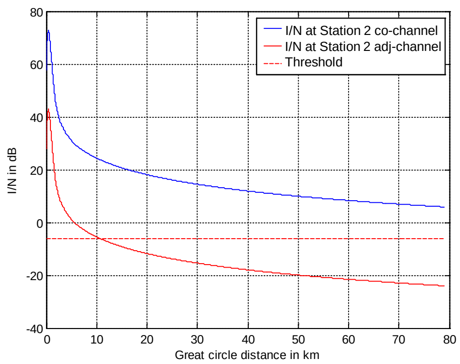


Figure 21: Resulting co- and adjacent channel I/N at MVL Rx (Station 2) at helicopter (free space)

4.2.1.3 PMSE PVL Rx interfered by a DA2GC GS

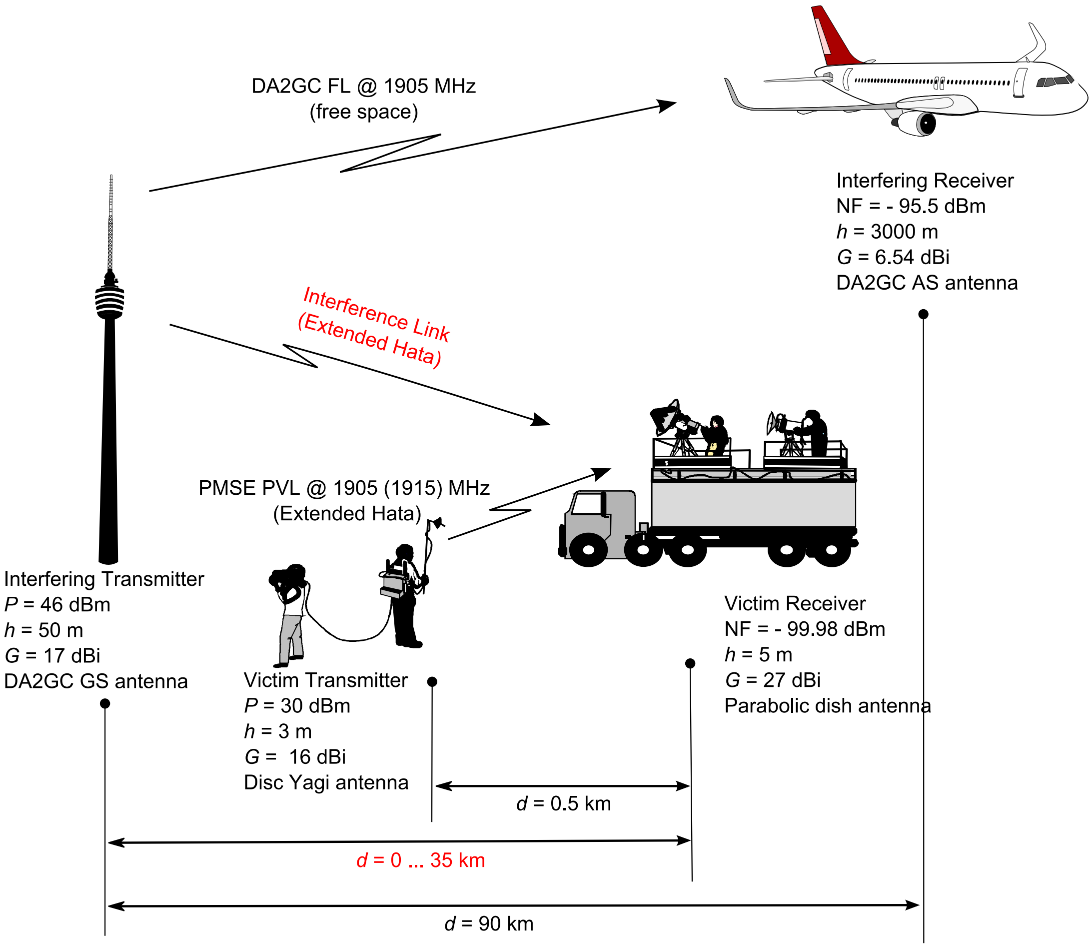


Figure 22: Scenario: PMSE PVL RX interfered by DA2GC GS

Based on the given ACLR and ACS values of the interfering and the victim system, respectively, a final ACIR value of 29.9 dB can be computed, which is dominated by the ACS value of the PMSE Rx.

In Figure 23 the resulting interference power and I/N at the PVL Rx is shown, taken into account 3 different types of the Extended Hata propagation model (open rural area (top), suburban (middle), urban (bottom). For the co-channel operation (blue curve) it can be seen that the I/N is distinctly above the threshold, up to about 55 km in rural environment, 37 km in suburban areas and 22 km in urban areas. In case of adjacent channel operation the PVL transmission will be disturbed in a radius of about 26 km around the DA2GC GS in open area. The required separation distance is reduced in suburban and urban environment to about 7 and 3 km, respectively.

It has to be noted that this is really a worst case situation. If the adjustment of high gain dish antenna at the PMSE RX is only slightly changed, the interference will be drastically reduced due to the small beam characteristic. As the number of DA2GC GS required covering the pan-European area is rather low (about 400 sites), the final interference probability for PVL is also very low.

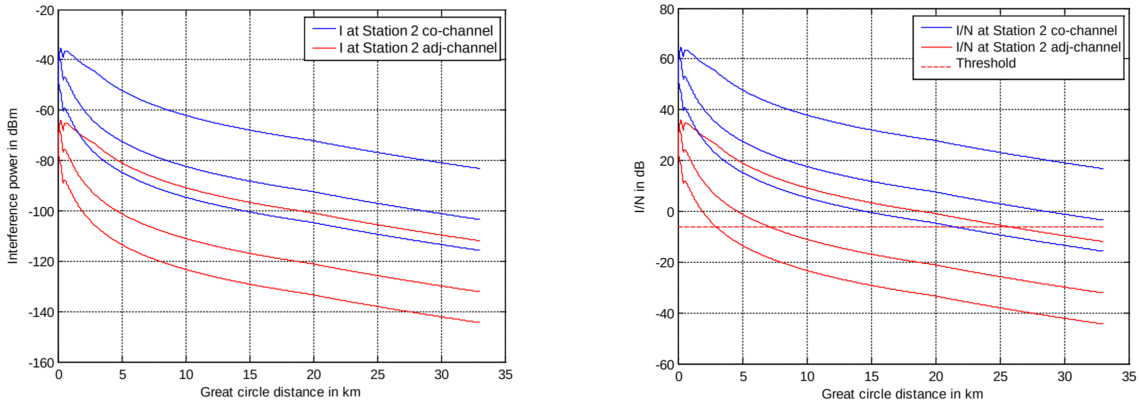


Figure 23: Co- and adjacent channel interference signal power and resulting I/N at PVL Rx (Ext. Hata Models for open rural area (top), suburban and urban)

4.2.2 Scenario (1b)

4.2.2.1 DA2GC AS interfered by a PMSE CCL Tx

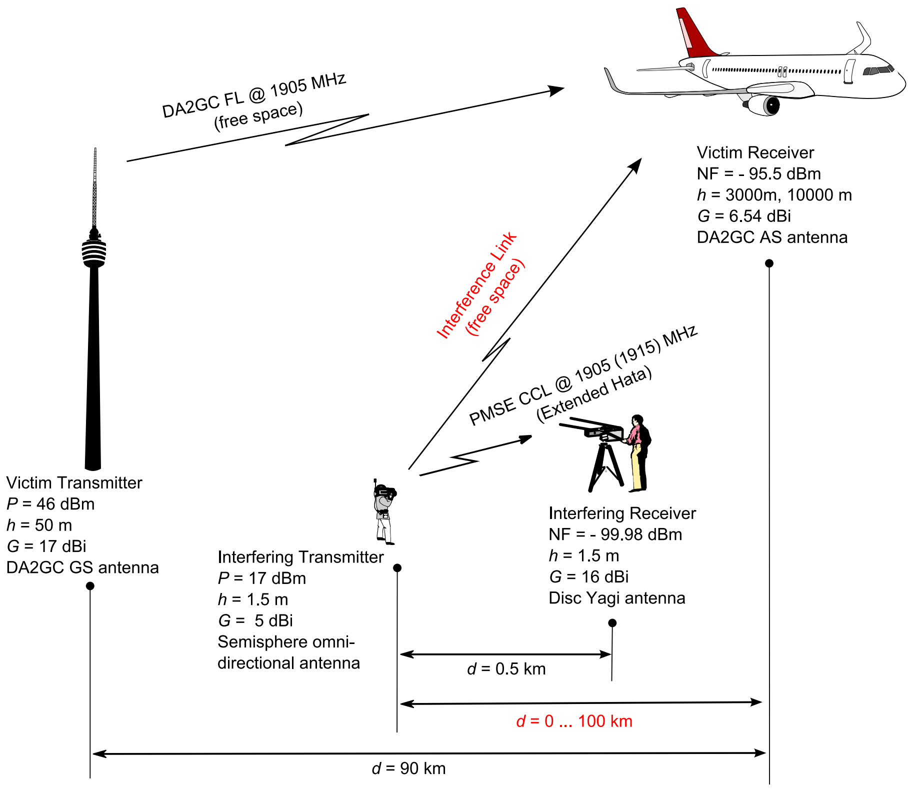


Figure 24: Scenario: DA2GC AS RX interfered by PMSE CCL TX

In this scenario the interference of a CCL Tx signal on the reception at a DA2GC AS is evaluated. In Figure 25results are given for an aircraft altitude of 3 km. The protection threshold is met for an aircraft altitude of 3 km.

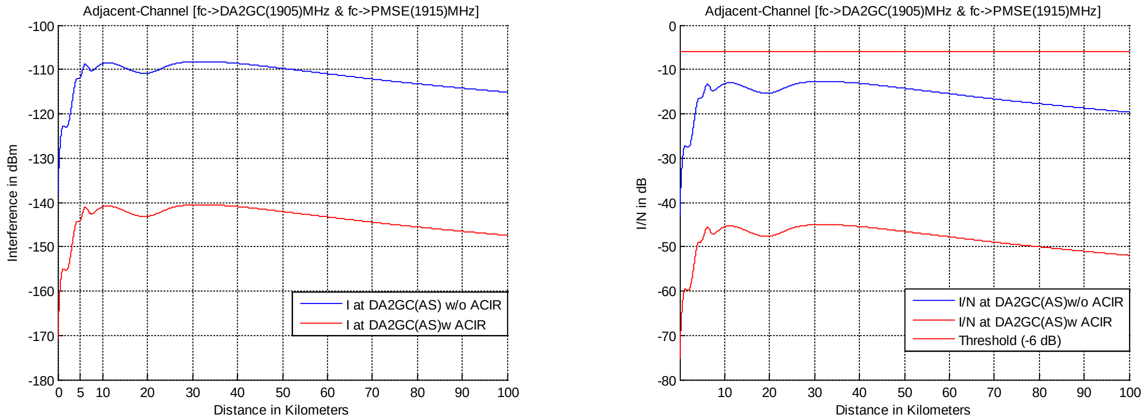


Figure 25: Interference signal power and resulting I/N at DA2GC AS with aircraft altitude of 3 km w/ & w/o consideration of ACIR (free space)

4.2.2.2 DA2GC AS interfered by a PMSE MVL Tx at motorcycle

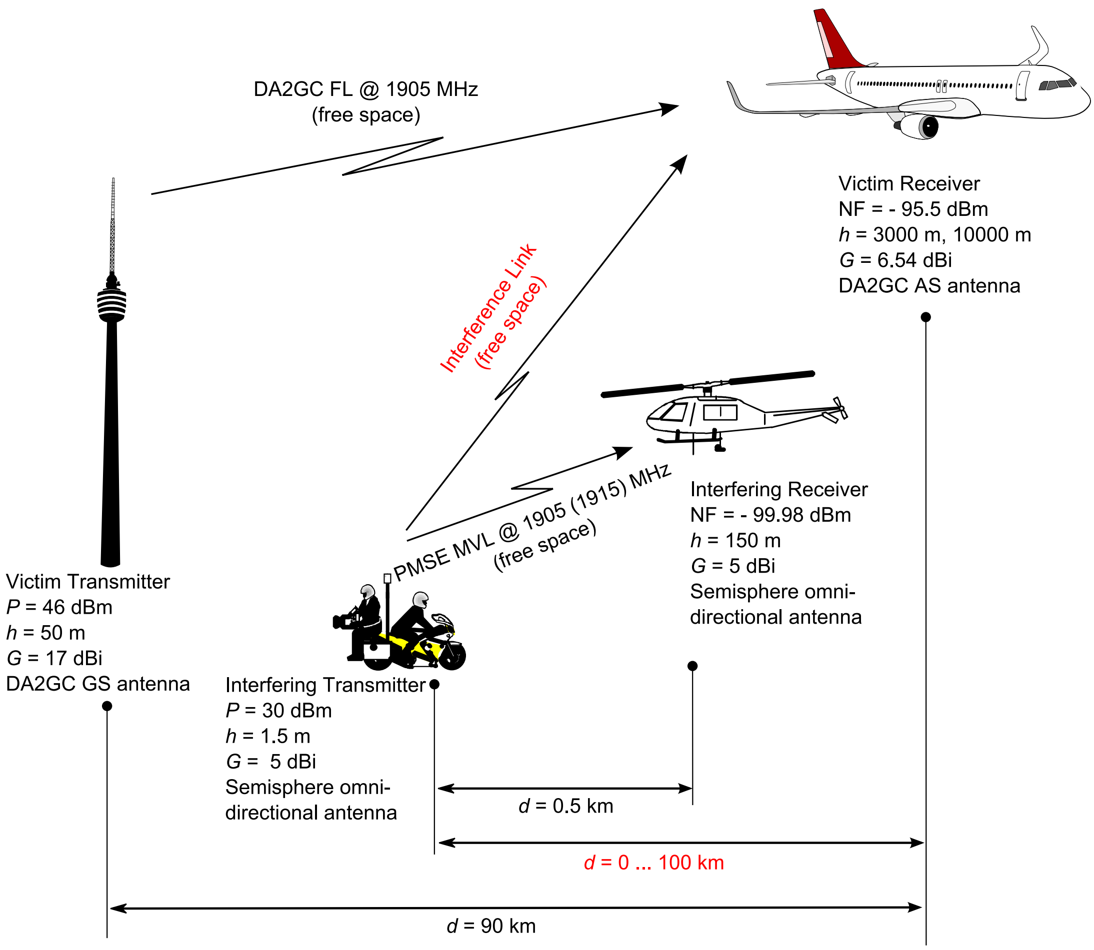


Figure 26: Scenario: DA2GC AS RX interfered by PMSE MVL TX at motorcycle

This scenario has same basic parameter as used in scenario (1a), but now the interference of a MVL Tx signal transmitted from a motorcycle on the reception at a DA2GC AS is evaluated. The resulting ACIR corresponds to 32.8 dB. In Figure 27 to Figure 29 the results are given for an aircraft altitude of 3 km, in Figure 30 to Figure 32 for 10 km.

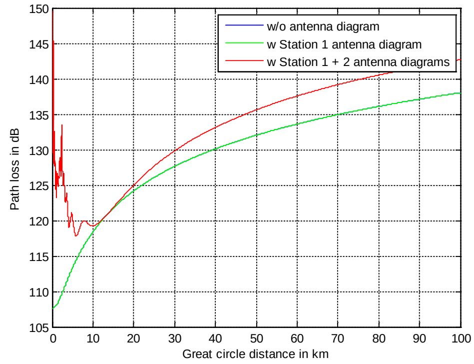


Figure 27: Path loss w & w/o consideration of vertical antenna characteristics (antenna gain not included) at MVL Tx (Station 1) at motorcycle and DA2GC AS (Station 2) with aircraft altitude of 3 km (free space)

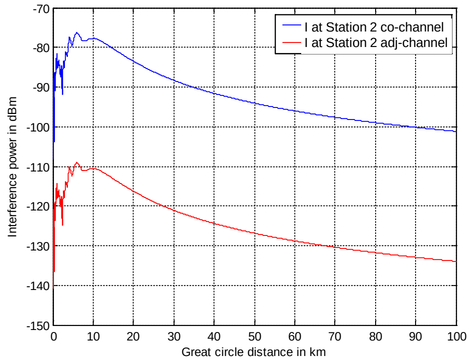


Figure 28: Co- and adjacent channel interference signal power at DA2GC AS (Station 2) with aircraft altitude of 3 km (free space)

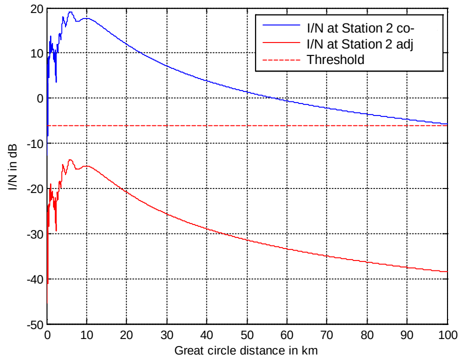


Figure 29: Resulting co- and adjacent channel I/N at DA2GC AS (Station 2) with aircraft altitude of 3 km (free space)

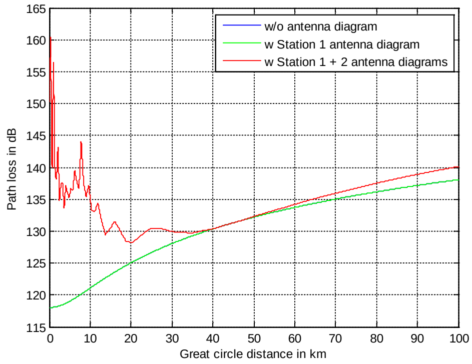


Figure 30: Path loss w & w/o consideration of vertical antenna characteristics (antenna gain not included) at MVL Tx (Station 1) at motorcycle and DA2GC AS (Station 2) with aircraft altitude of 10 km (free space)

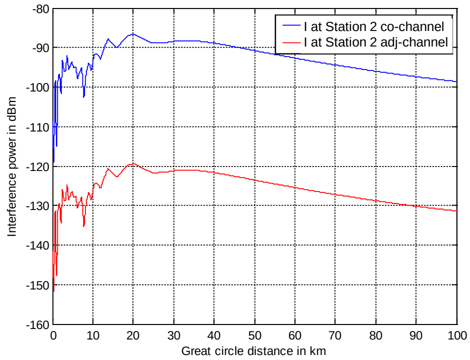


Figure 31: Co- and adjacent channel interference signal power at DA2GC AS (Station 2) with aircraft altitude of 10 km (free space)

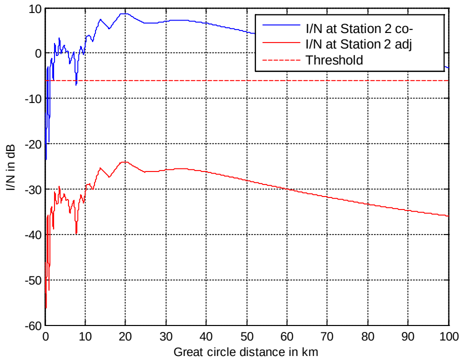


Figure 32: Resulting co- and adjacent channel I/N at DA2GC AS (Station 2) with aircraft altitude of 10 km (free space)

4.2.2.3 DA2GC AS interfered by a PMSE PVL Tx

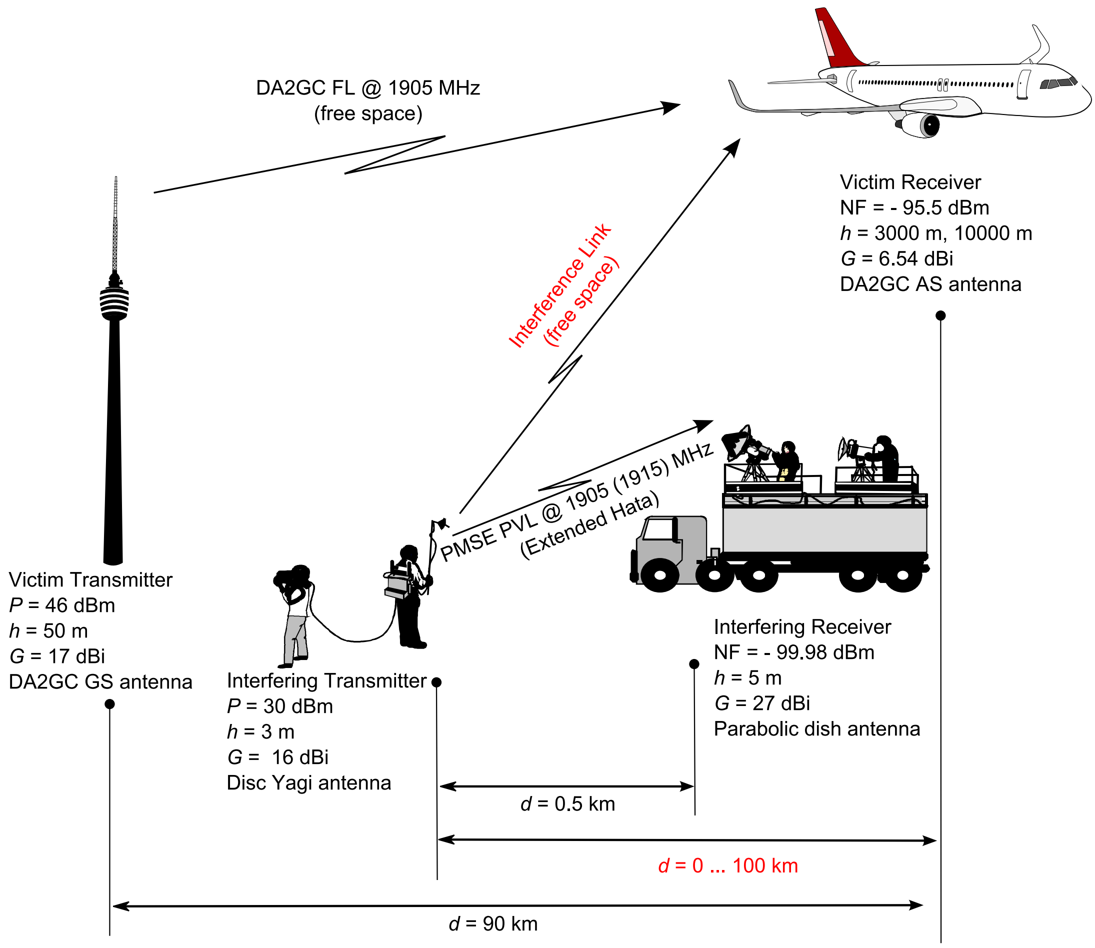


Figure 33: Scenario: DA2GC AS RX interfered by PMSE PVL TX

In this scenario the interference of a PVL Tx signal on the reception at a DA2GC AS is evaluated. The resulting ACIR corresponds to 32.9 dB (dominated by the ACS of the AS). In Figure 34 and Figure 35 the results are given for aircraft altitudes of 3 and 10 km, respectively.

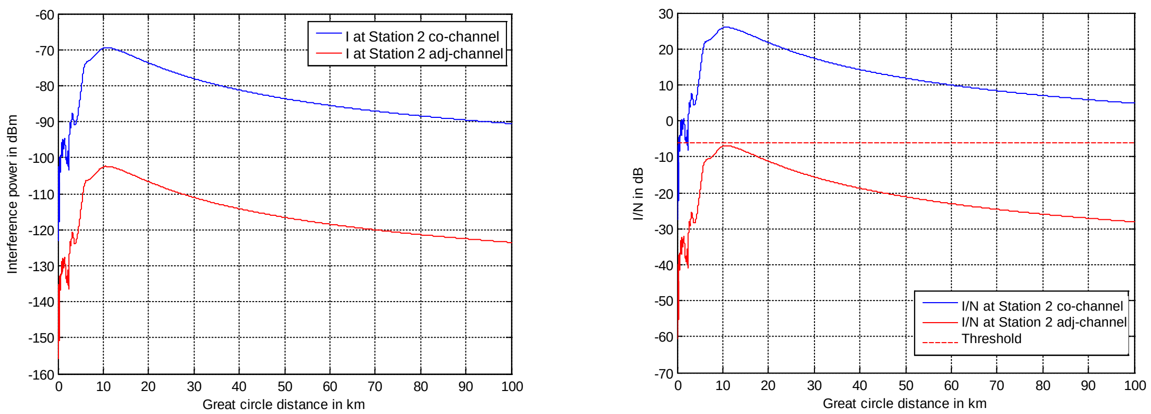


Figure 34: Co- and adjacent channel interference signal power and resulting I/N at DA2GC AS with aircraft altitude of 3 km (free space)

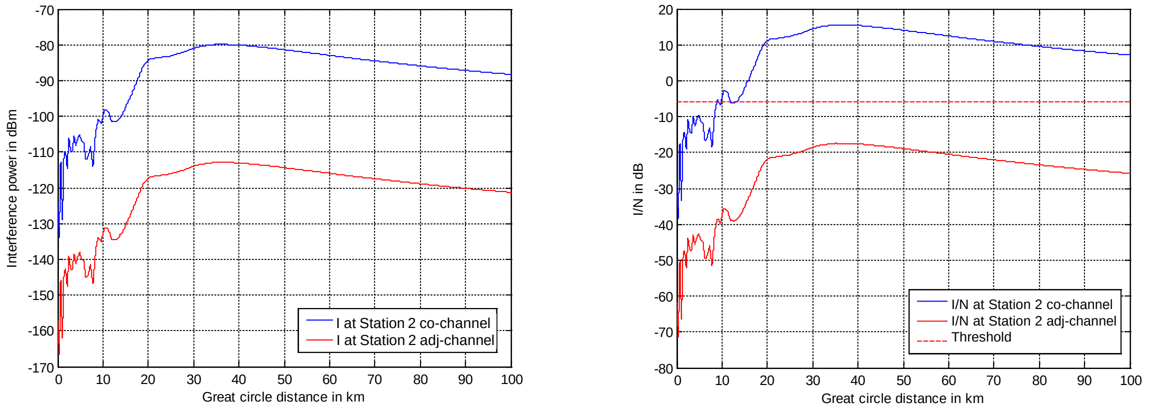


Figure 35: Co- and adjacent channel interference signal power and resulting I/N at DA2GC AS with aircraft altitude of 10 km (free space)

4.3 DA2GC RL IN THE BAND 2010-2025 MHZ

4.3.1 Scenario (1c)

For this scenario a transmission of the DA2GC RL in the upper unpaired 2 GHz band is considered.

4.3.1.1 PMSE CCL Rx interfered by a DA2GC AS

This scenario is similar to scenario (2a). The only difference is in the carrier frequency as now the upper unpaired 2 GHz band is considered. As the change in path loss is less than 0.5 dB no new figures are shown, i.e. the results are comparable to those in Figure 53 and Figure 54.

4.3.1.2 PMSE MVL Rx at helicopter interfered by a DA2GC AS

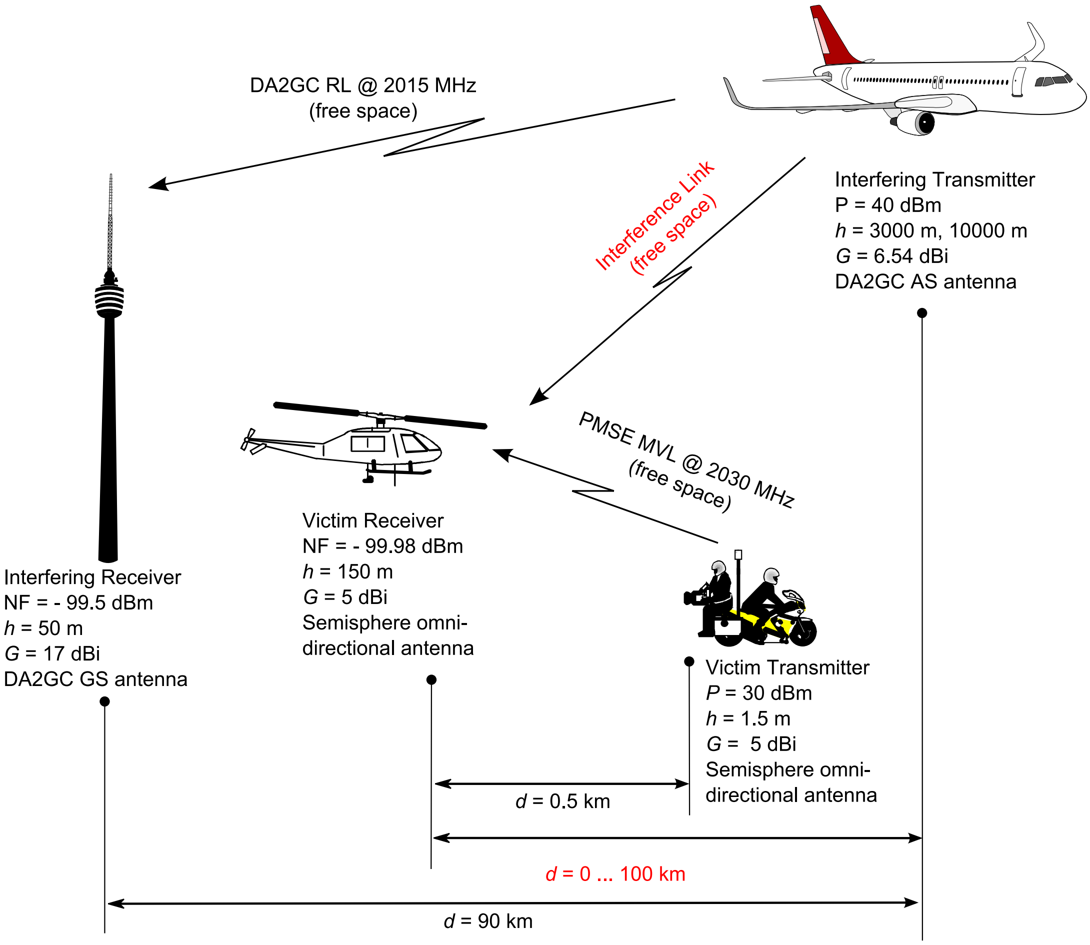


Figure 36: Scenario: PMSE MVL RX at helicopter interfered by DA2GC AS TX

Now the reception of the MVL signal at the helicopter is interfered by a signal transmitted from a DA2GC AS. Again results for 2 aircraft altitudes of 3 and 10 km are given. In case of adjacent channel operation (now above 2015 MHz outside the upper unpaired 2 GHz band) the resulting ACIR of 29.5 dB reduces the interference impact, but for an aircraft altitude of 3 km the I/N threshold is still exceeded for ground distances up to about 25 km between both stations.

It has to be mentioned, that the antenna gain of 5 dBi of the MVL Rx is also assumed to be available above the helicopter in the computation (omnidirectional vertical diagram). In a real environment the antenna diagram will have a strong attenuation up to 10 – 20 dB in the direction to the aircraft. In addition the power control feature of the DA2GC AS was not applied, i.e. the signal is always transmitted with full power of 40 dBm. In a realistic scenario the transmission with maximum power will only happen at cell edge, therefore the interference probability is strongly reduced.

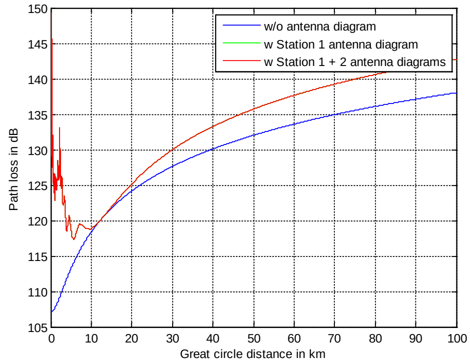


Figure 37: Path loss w & w/o consideration of vertical antenna characteristics (antenna gain not included) at DA2GC AS (Station 1) with aircraft altitude of 3 km and MVL Rx (Station 2) at helicopter (free space)

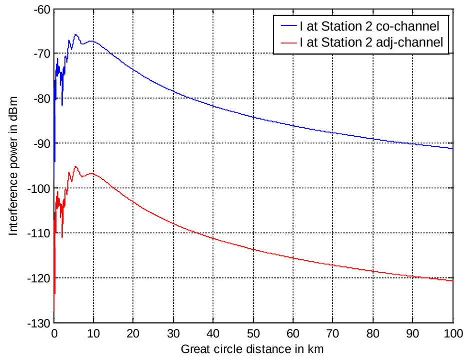


Figure 38: Co- and adjacent channel interference signal power at MVL Rx (Station 2) at helicopter for aircraft altitude of 3 km (free space)

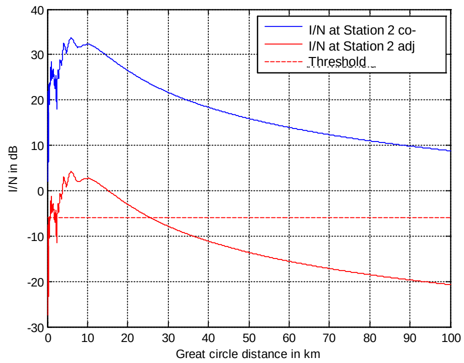


Figure 39: Resulting co- and adjacent channel I/N at MVL Rx (Station 2) at helicopter for aircraft altitude of 3 km (free space)

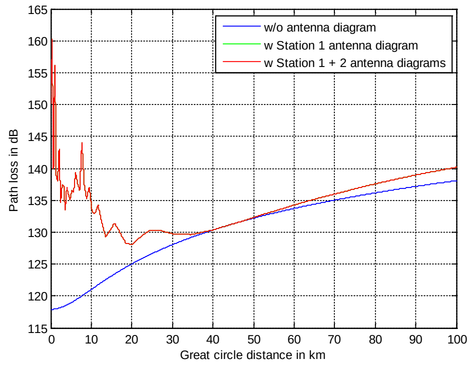


Figure 40: Path loss w & w/o consideration of vertical antenna characteristics (antenna gain not included) at DA2GC AS (Station 1) with aircraft altitude of 10 km and MVL Rx (Station 2) at helicopter (free space)

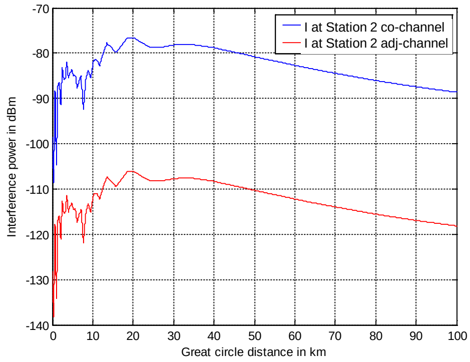


Figure 41: Co- and adjacent channel interference signal power at MVL Rx (Station 2) at helicopter for aircraft altitude of 10 km (free space)

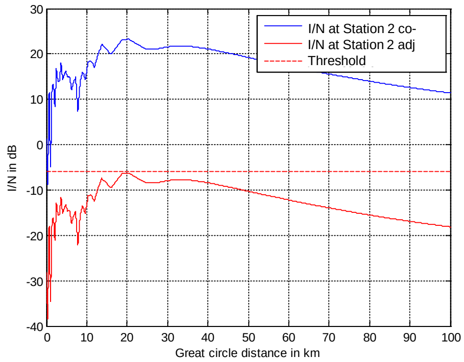


Figure 42: Resulting co- and adjacent channel I/N at MVL Rx (Station 2) at helicopter for aircraft altitude of 10 km (free space)

4.3.1.3 PMSE PVL Rx interfered by a DA2GC AS

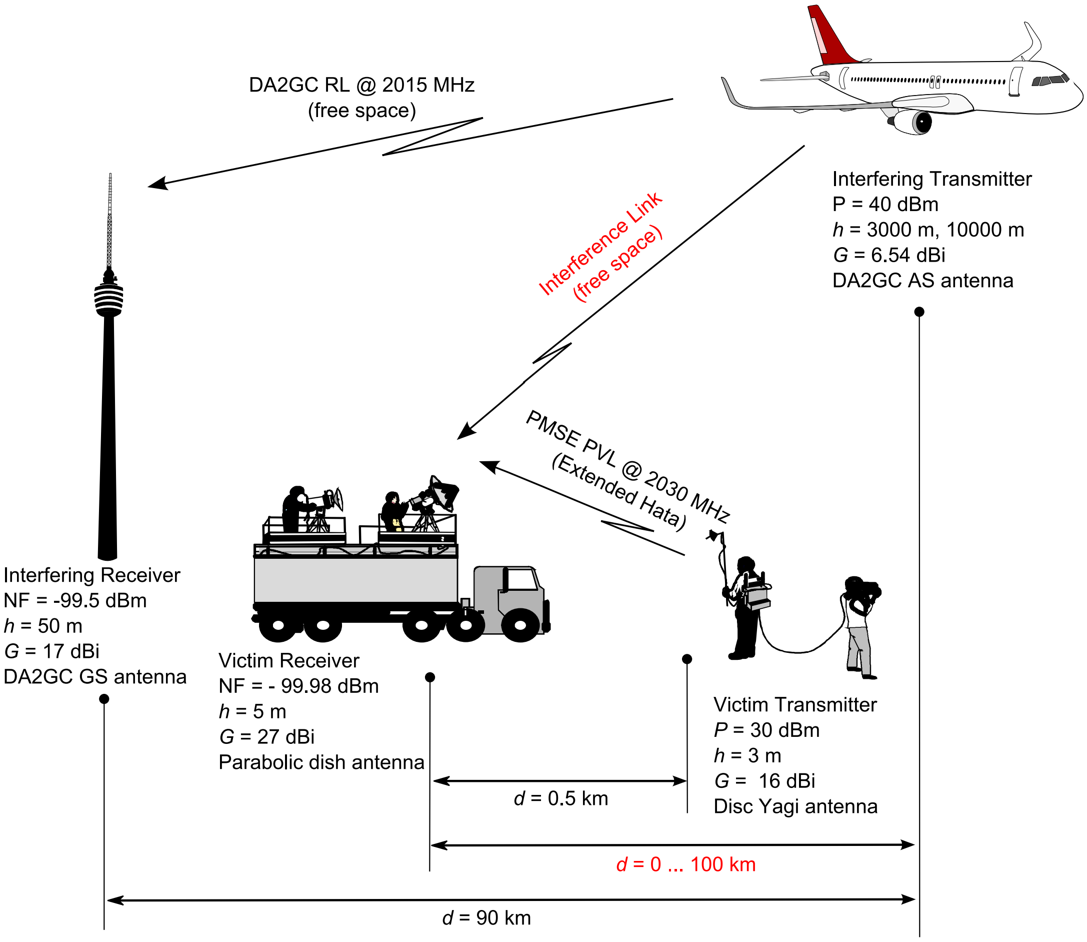


Figure 43: Scenario: PMSE PVL RX interfered by DA2GC AS TX

Now the reception of the PVL signal is interfered by a signal transmitted from a DA2GC AS. Again results for aircraft altitudes of 3 km and 10 km are given in Figure 44 and Figure 45.

In the case of adjacent channel operation (now above 2015 MHz outside the upper unpaired 2 GHz band) the resulting ACIR is not sufficient to reduce the interference impact below the I/N threshold. Similar to scenario (1a) the interference power will be strongly reduced, if the adjustment of the dish antenna is only slightly changed or if the line-of-sight condition (free space propagation assumed) between the dish antenna and the aircraft is affected. In addition the final interference probability will be further reduced by the Tx power control feature of the DA2GC AS.

Further studies in order to demonstrate whether the assumptions provide sufficient mitigation, are postponed for the time being.

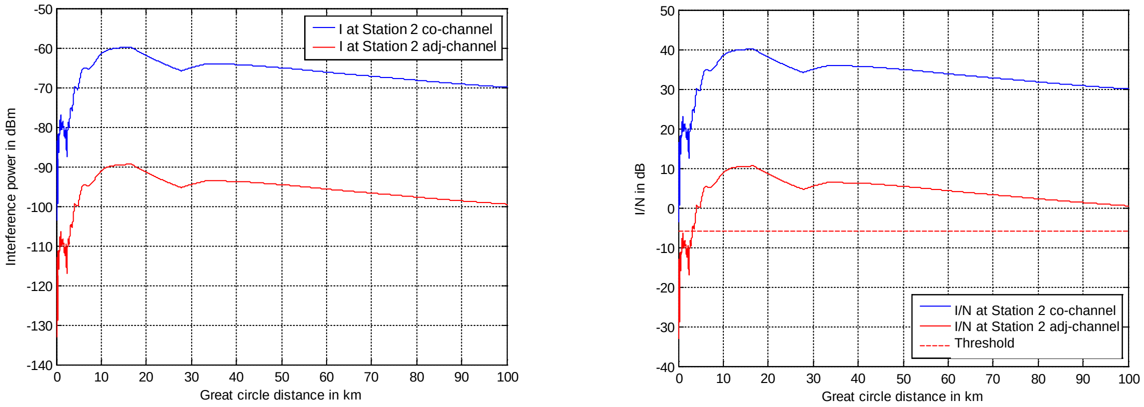


Figure 44: Co- and adjacent channel interference signal power and resulting I/N at PVL Rx for aircraft altitude of 3 km (free space)

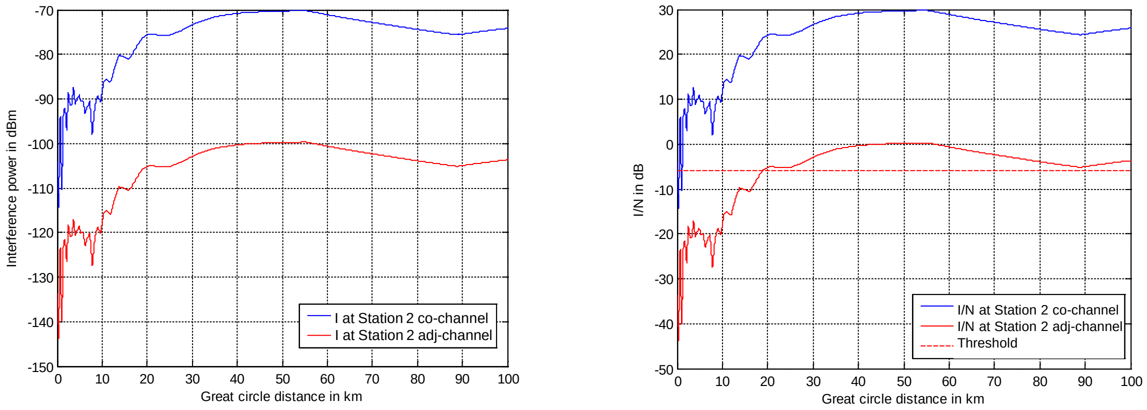


Figure 45: Co- and adjacent channel interference signal power and resulting I/N at PVL Rx for aircraft altitude of 10 km (free space)

4.3.2 Scenario (1d)

4.3.2.1 DA2GC GS interfered by a PMSE CCL Tx

This scenario is comparable with scenario (2b) under consideration of changed carrier frequency with respect to upper and lower unpaired 2 GHz band. As the change in path loss is less than 0.5 dB the results are comparable to those in Figure 55 and Figure 56.

4.3.2.2 DA2GC GS interfered by a PMSE MVL Tx at motorcycle

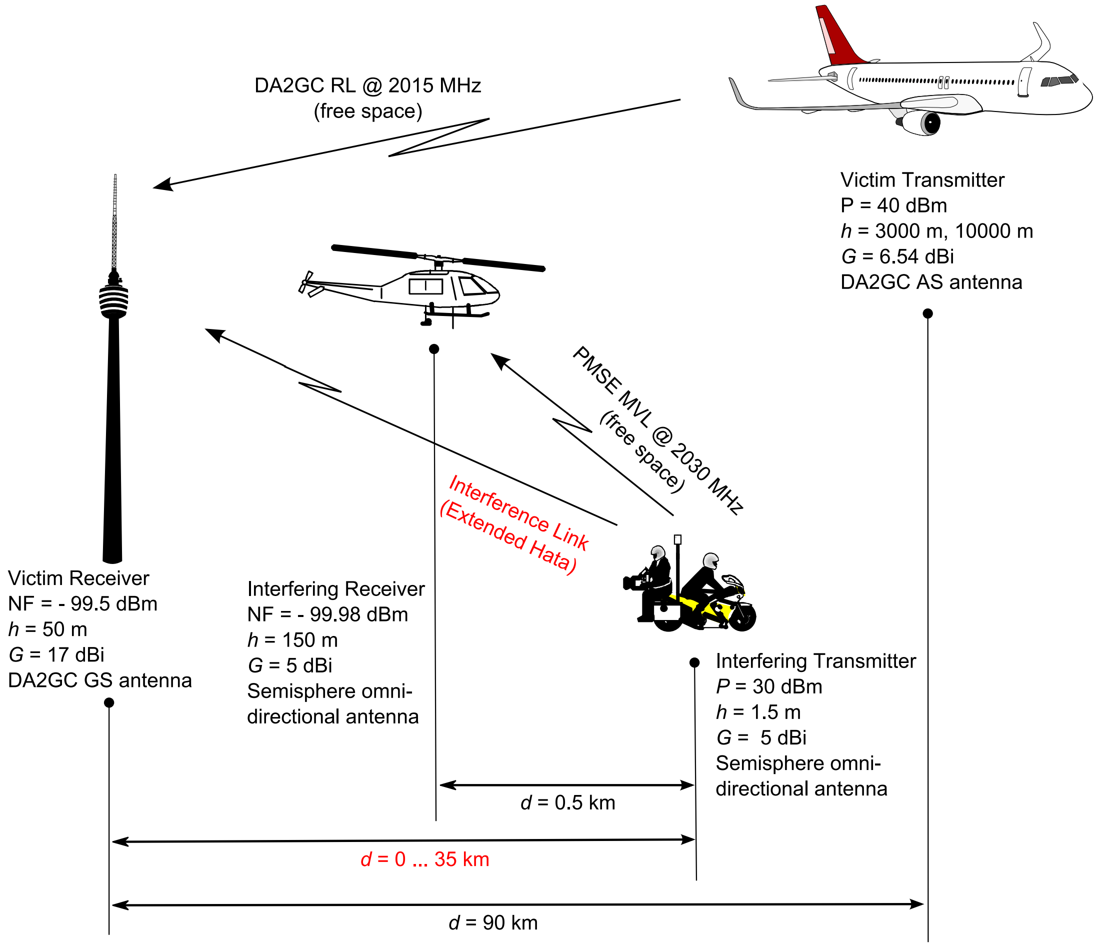


Figure 46: Scenario: DA2GC GS RX interfered by PMSE MVL TX at motorcycle

Similar to scenario (1c) the impact of a MVL Tx from a motorcycle on the reception of the DA2GC RL at a GS has been evaluated in the upper unpaired 2 GHz band. In the case of co-channel operation the MVL transmission would disturb the DA2GC link, if the motorcycle is in a range of about 9 km around the GS.

For adjacent channel operation (resulting ACIR equal to 41.6 dB) the range in which the MVL disturbs the DA2GC RL reception goes down to about 0.4 km. In contrast to the other scenarios the Extended Hata Model for open rural area has been applied for path loss computation instead of the free space model, but due to the high antenna height used for the DA2GC GS the difference is only very small. In a real environment the line-of-sight connection between the motorcycle antenna and the GS antenna may be at least partly disturbed by clutter and vegetation, therefore the interference impact is not seen as very critical. Some dBs can be further gained if an additional frequency guard band is introduced for PMSE MVL in areas near DA2GC GSs, which will have typically large inter-site distances of about 60 – 100 km.

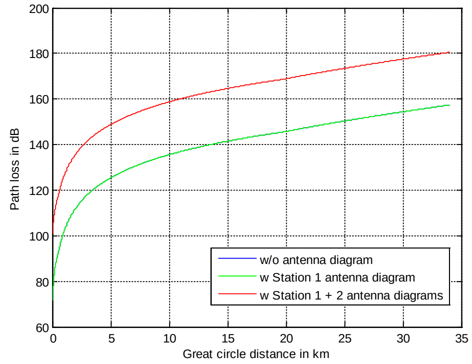


Figure 47: Path loss w & w/o consideration of vertical antenna characteristics (antenna gain not included) at MVL Tx (Station 1) at motorcycle and DA2GC GS (Station 2) (Ext. Hata Model for open rural area)

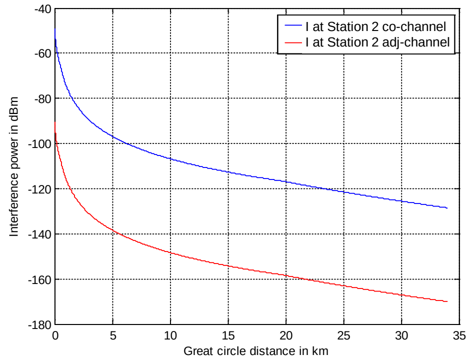


Figure 48: Co- and adjacent channel interference signal power at DA2GC GS (Station 2) (Ext. Hata Model for open rural area)

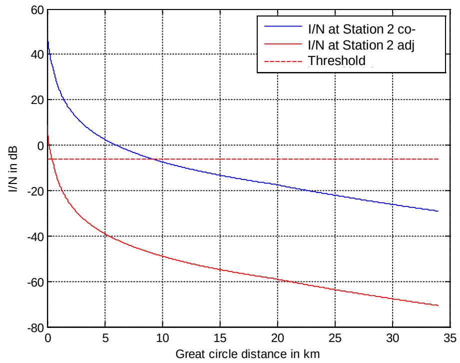


Figure 49: Resulting co- and adjacent channel I/N at DA2GC GS (Station 2) (Ext. Hata Model for open rural area)

4.3.2.3 DA2GC GS interfered by a PMSE PVL Tx

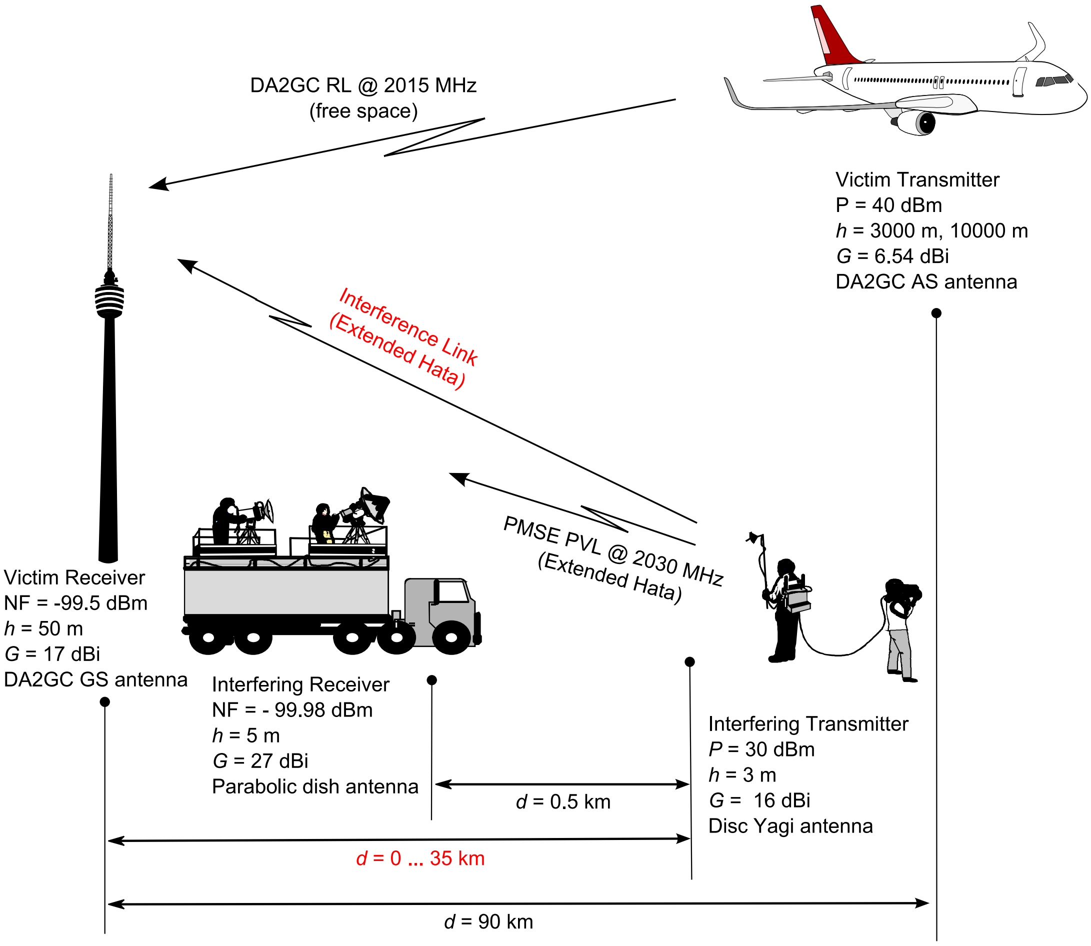


Figure 50: Scenario: DA2GC GS RX interfered by PMSE PVL TX

Similar to scenario (1c) the impact of a PVL Tx on the reception of the DA2GC RL at a GS has been evaluated in the upper unpaired 2 GHz band. Interference signal power and resulting I/N are given in Figure 51 for different propagation models (Ext. Hata Model for open rural area (top), suburban and urban). The PVL transmission would disturb the DA2GC link, if the wireless camera is in a range of about 24 km around the GS (open rural area assumed).

For adjacent channel operation the range in which the PVL disturbs the DA2GC RL reception goes down to about 1.3 km in open rural area. In suburban area it is further reduced to about 0.3 km and tends to zero in urban area. As in real environment the line-of-sight connection between the PVL Tx antenna and the GS antenna may be at least partly disturbed by clutter and vegetation the interference impact is not seen as very critical. In addition also the Yagi antenna used at the PMSE Tx has a strong directivity, so changes in the horizontal adjustment have drastic impact on the final I/N. Some dBs can be further gained if an additional frequency guard band is introduced for PMSE PVL in areas near DA2GC GSs, which will have typically large inter-site distances of about 60 – 100 km compared to usual macro cell grid of mobile radio networks.

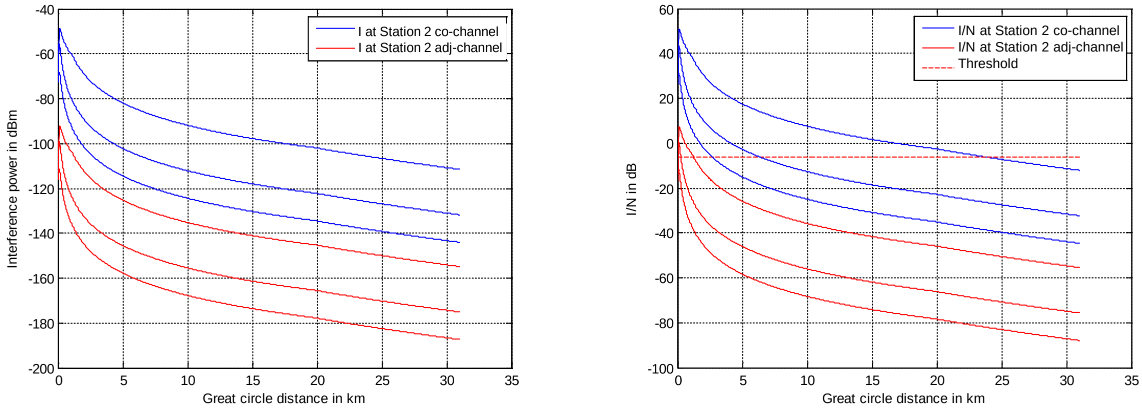


Figure 51: Co- and adjacent channel interference signal power and resulting I/N at DA2GC GS (Ext. Hata Model for open rural area (top), suburban and urban)

4.4 DA2GC RL IN THE BAND 1900-1920 MHz

4.4.1 Scenario (2a)

For this scenario a transmission of the DA2GC RL in the lower unpaired 2 GHz band with a carrier frequency of 1915 MHz is considered.

4.4.1.1 PMSE CCL Rx interfered by a DA2GC AS

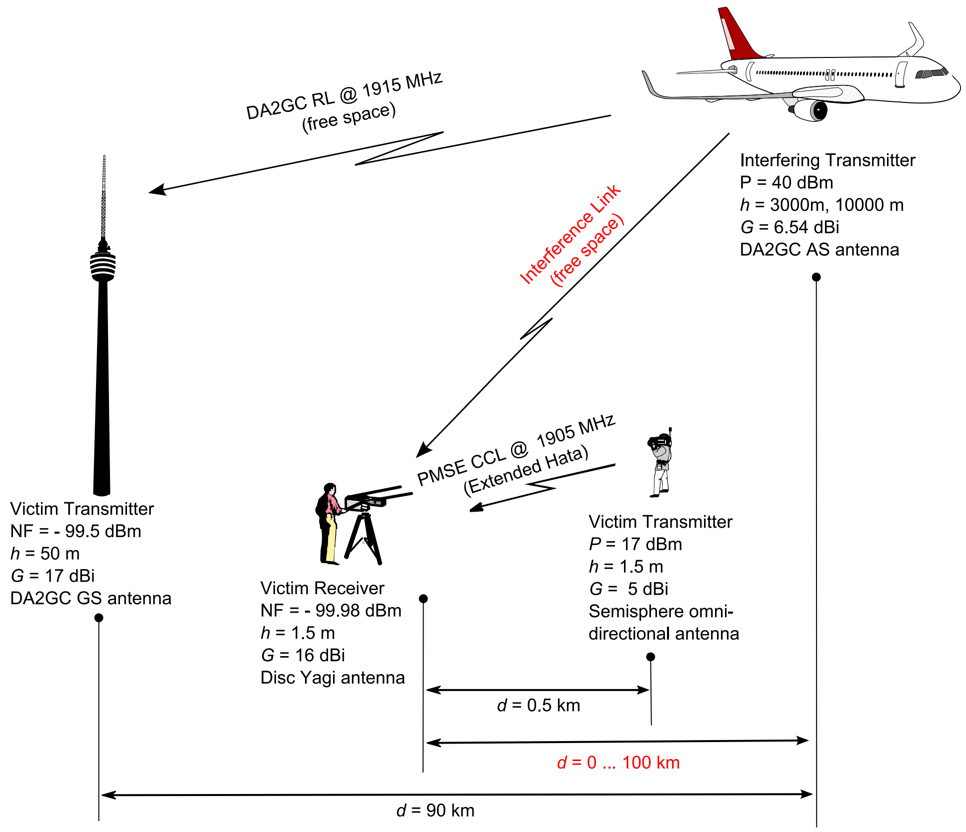


Figure 52: Scenario: PMSE CCL RX interfered by DA2GC AS TX

Now the reception of the CCL signal is interfered by a signal transmitted from a DA2GC AS. Again results for aircraft altitudes of 3 km and 10 km are given in Figure 53 and Figure 54.

In case of adjacent channel operation the resulting ACIR is not sufficient to reduce the interference impact below the I/N threshold.

Similar to scenario (1a) the interference power will be strongly reduced if the adjustment of the dish antenna is only slightly changed or if the line-of-sight condition (free space propagation assumed) between the dish antenna and the aircraft is affected. Further studies in order to demonstrate whether the assumptions provide sufficient mitigation, are postponed for the time being.

ACLR = 39.29 / ACS =30 / ACIR= 29.516

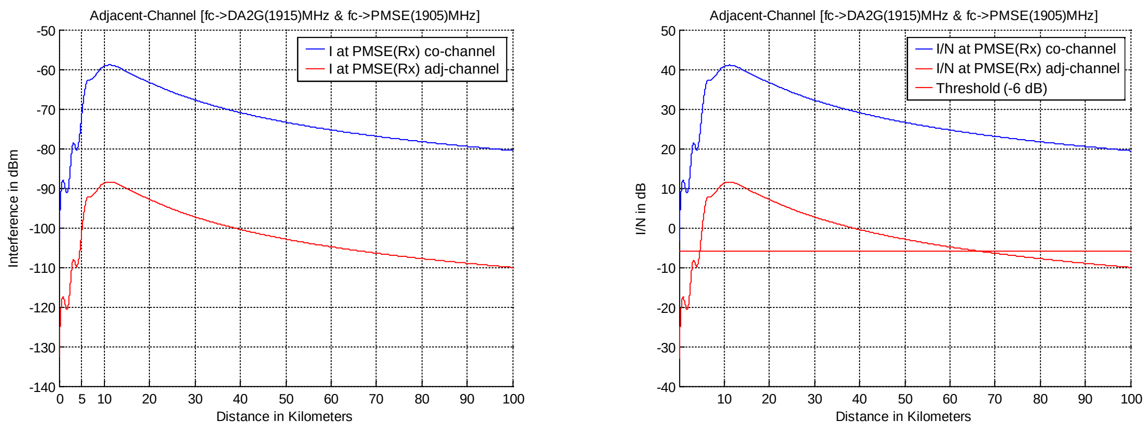


Figure 53: Co- and adjacent channel interference signal power and resulting I/N at CCL Rx for aircraft altitude of 3 km (free space)

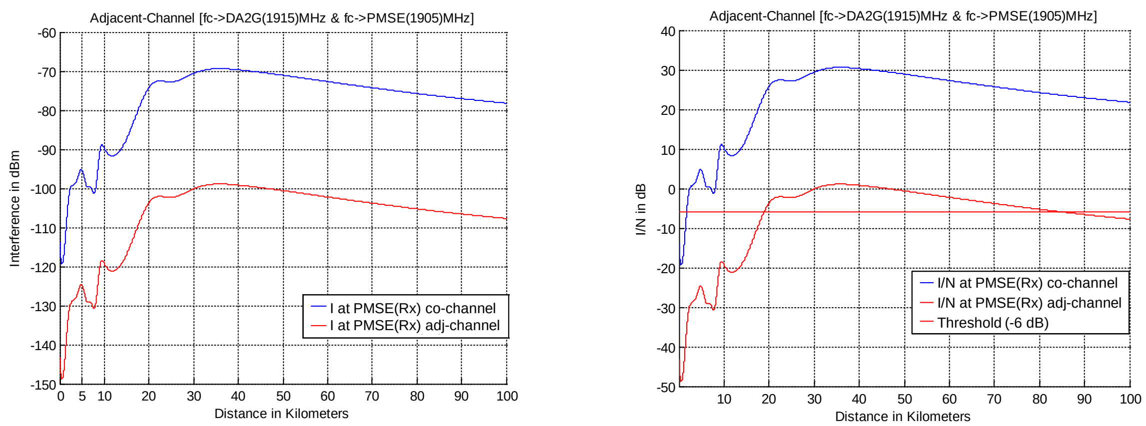


Figure 54: Co- and adjacent channel interference signal power and resulting I/N at CCL Rx for aircraft altitude of 10 km (free space)

4.4.1.2 PMSE MVL Rx at helicopter interfered by a DA2GC AS

This scenario is similar to scenario (1c). The only difference is in the carrier frequency as now the lower unpaired 2 GHz band is considered. As the change in path loss is less than 0.5 dB the results are comparable to those in Figure 38 to Figure 42.

4.4.1.3 PMSE PVL Rx interfered by a DA2GC AS

This scenario is similar to scenario (1c). The only difference is in the carrier frequency as now the lower unpaired 2 GHz band is considered. As the change in path loss is less than 0.5 the results are comparable to those in Figure 44 and Figure 45. Even in-band adjacent channel operation (see Figure 4) might be affected in worst case situations considered in present study, but the probability of occurrence is rather low.

4.4.2 Scenario (2b)

4.4.2.1 DA2GC GS interfered by a PMSE CCL Tx

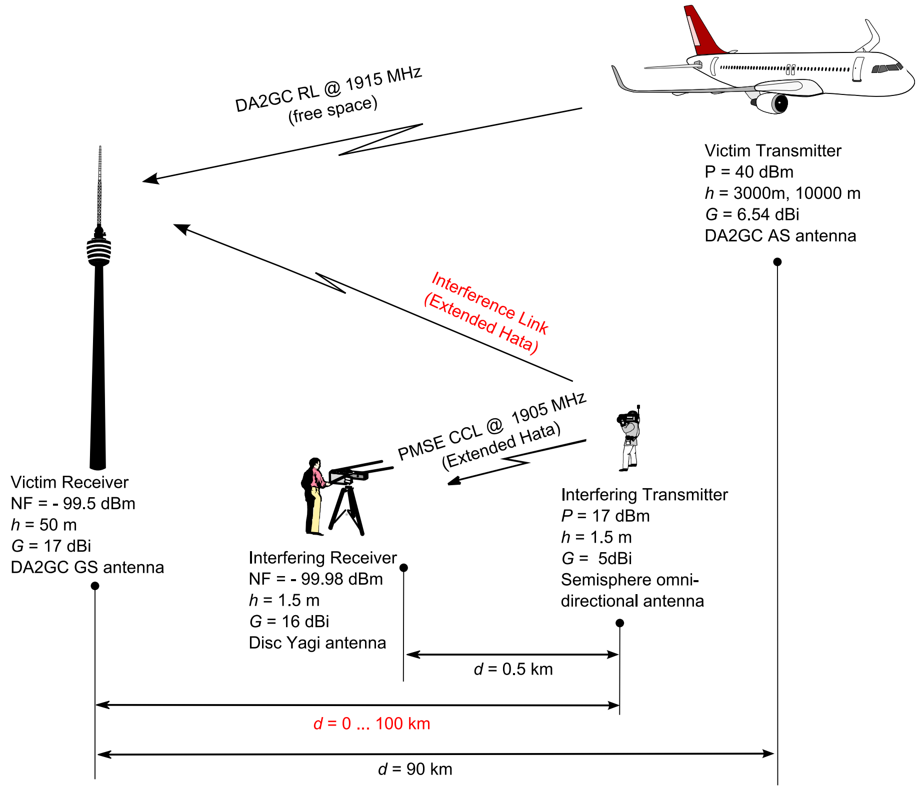


Figure 55: Scenario: DA2GC GS RX interfered by PMSE CCL TX

In this scenario the impact of a CCL Tx on the reception of the DA2GC RL at a GS has been evaluated in the lower unpaired 2 GHz band.

The interference signal power and resulting I/N are given in Figure 56 for the Ext. Hata Model for open rural area.

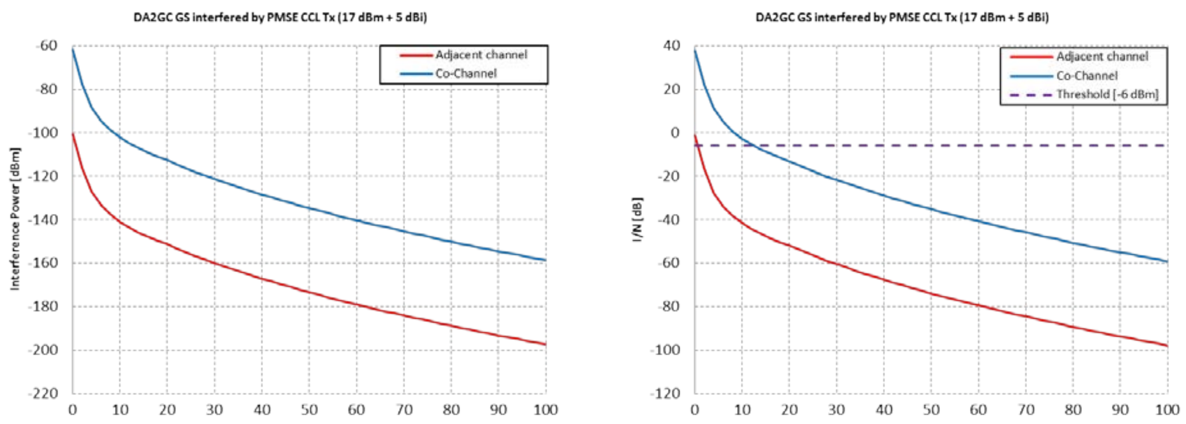


Figure 56: Interference signal power and resulting I/N at DA2GC GS w/ & w/o consideration of ACIR (Ext. Hata Model for open rural area)

4.4.2.2 DA2GC GS interfered by a PMSE MVL Tx at motorcycle

This scenario is comparable with scenario (1d) under consideration of changed carrier frequency with respect to upper and lower unpaired 2 GHz band, i.e. for adjacent channel in-band operation of both systems there will be some disturbance of the DA2GC RL, if a MVL transmitter is near a DA2GC GS (within a range of about 400 m, see Figure 49). Due to expected low number of DA2GC GS across Europe and only temporary use of MVL links near the sites, the impact is rated as rather uncritical.

4.4.2.3 DA2GC GS interfered by a PMSE PVL Tx

This scenario is comparable with scenario (1d) under consideration of changed carrier frequency with respect to upper and lower unpaired 2 GHz band, i.e. for adjacent channel in-band operation of both systems there will be some disturbance of the DA2GC RL, if a PVL transmitter is near a DA2GC GS (within a range of about 1.3 km in open rural areas, see Figure 51). Due to expected low number of DA2GC GS across Europe and only temporary use of PVL links near the sites, the impact is rated as rather uncritical.

4.5 DA2GC FL IN THE BAND 2010-2025 MHZ

4.5.1 Scenario (2c)

This scenario is similar to scenario (1a), only the change in the carrier frequency has to be considered.

4.5.1.1 PMSE CCL Rx interfered by a DA2GC GS

Using Figure 15 as reference for the results it be concluded that even in case of adjacent channel operation using the band above 2025 MHz the CCL link will be disturbed in a range around the DA2GC GS with radius of about 7.5 km in open rural areas. As mentioned already before the interference is strongly reduced in case that the adjustment of the disc Yagi antenna is slightly moved away from the direction to the DA2GC GS.

4.5.1.2 PMSE MVL Rx at helicopter interfered by a DA2GC GS

Using Figure 19 to Figure 21 as reference for the results it be concluded that even in case of adjacent channel operation using the band above 2025 MHz the MVL link will be disturbed in a range around the DA2GC GS with radius of about 10 km. Introducing further frequency guard bands, i.e. shifting the carrier frequency to values above 2030 MHz will hopefully help as the limiting factor is mainly the ACS performance of the MVL Rx at the helicopter (unfortunately no further information is available for higher frequency separations).

4.5.1.3 PMSE PVL Rx interfered by a DA2GC GS

This scenario is similar to scenario (1a), only the change in the carrier frequency has to be considered. Using Figure 23 as reference for the results it be concluded that even in case of adjacent channel operation using the band above 2025 MHz the PVL link will be disturbed in a range around the DA2GC GS with radius of about 25 km in open rural areas. Introducing further frequency guard bands, i.e. shifting the carrier frequency to values above 2030 MHz will hopefully help as the limiting factor is mainly the ACS performance of the PVL Rx on the TV van (unfortunately no further information is available for higher frequency separations). As mentioned already before the interference is strongly reduced in case that the adjustment of the dish antenna is slightly moved away from the direction to the DA2GC GS.

4.5.2 Scenario (2d)

The only difference to scenario (1b) is in the carrier frequency (now in the upper unpaired 2 GHz band).

4.5.2.1 DA2GC AS interfered by a PMSE CCL Tx

Figure 25 can act as reference. The protection threshold is met for an aircraft altitude of 3 km.

4.5.2.2 DA2GC AS interfered by a PMSE MVL Tx at motorcycle

Figure 27 to Figure 32 can be used as reference.

4.5.2.3 DA2GC AS interfered by a PMSE PVL Tx

Figure 34 to Figure 35 can act as reference.

5 COMPATIBILITY EVALUATION BETWEEN DA2GC AND DECT

5.1 COMPATIBILITY SCENARIOS BETWEEN DA2GC AND DECT

Following interference scenarios are evaluated based on the assumption that the DA2GC forward link (FL) is applied in the band 1900-1920 MHz (see Figure 1):

a. The reception at a DECT station is interfered with by the DA2GC ground station (GS) transmission (DA2GC FL).

b. The reception at the DA2GC AS (DA2GC FL) is interfered with by the signal transmission of a DECT station.

Following interference scenarios are evaluated based on the assumption that the DA2GC reverse link (RL) is applied in the band 1900-1920 MHz (see Figure 2):

c. The reception at a DECT station is interfered with by the DA2GC AS (DA2GC RL).

d. The reception at the DA2GC GS (DA2GC RL) is interfered with by the signal transmission of a DECT station.

The evaluation results described later are based on worst case single link scenarios between the interferer and the victim system to get an overview about scenarios which might perhaps require a more deep analysis based on statistical evaluations e.g. by use of the SEAMCAT Monte Carlo simulation functionality [6] [7].

The results of simulations for co-channel and adjacent band[4] are provided on the same figures. Co-channel results are drawn from the blue curves (w/o ACLR) which show interference signal power and resulting I/N for the co-channel case.

5.2 GENERIC REMARKS

The diagrams with evaluation results shown in following subsections show

- the received interference power at the victim station (always related to the signal bandwidth of the victim system);
- the resulting interference-to-noise ratio (I/N) compared to the threshold of victim system;
- in the calculations an antenna gain of 12 dBi was used;

along the ground-based distance (great circle distance) between the involved station. In case of involvement of a DA2GC AS results are given for aircraft altitudes of 3 km and 10 km, respectively.

With respect to interference the worst case assumption is to have line-of-sight propagation between interferer and victim. Therefore, in most cases free space loss was applied. In real scenarios there may be a strong shadowing of the interfering signal resulting in drastically improved system performance compared to the results given in the present document. A first approximation at least for links without involvement of a DA2GC AS (i.e. both stations are placed on the ground with different antenna heights) was given by applying the Extended Hata Model for the computation of the path loss.

5.3 SCENARIO (1): DECT STATION/TERMINAL INTERFERED BY DA2GC GS

For the co-channel operation with an outdoor DECT device, (blue curve) it can be seen that the I/N is above the threshold up to more than 20 km, in rural environment, about 14 km in suburban areas and 6.5 km in urban areas. For the indoor case, these separation distances will be reduced due to additional attenuation (see section 12.1.3.1).

[4] studies in adjacent channel are presented in [2]

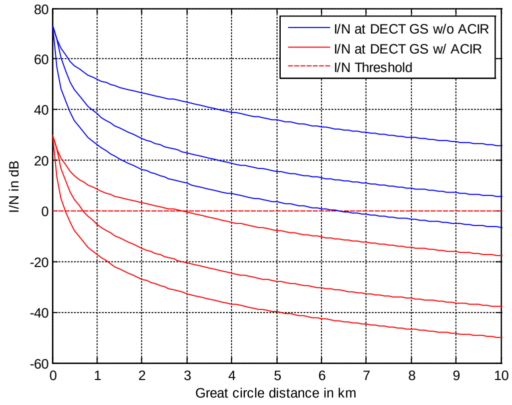


Figure 57: Resulting I/N at DECT station w/ & w/o consideration of ACIR for three propagation cases (Ext. Hata Model for Rural (Open), Suburban and Urban Area)

5.4 SCENARIO (2): DA2GC AS INTERFERED BY DECT STATION

The blue curves of the Figure 58 and Figure 59 show the resulting I/N in the co-channel configuration for a worst case scenario with DECT outdoor transmission at rooftop level (i.e. line-of-sight between both antennas) and applying a directional high gain antenna.

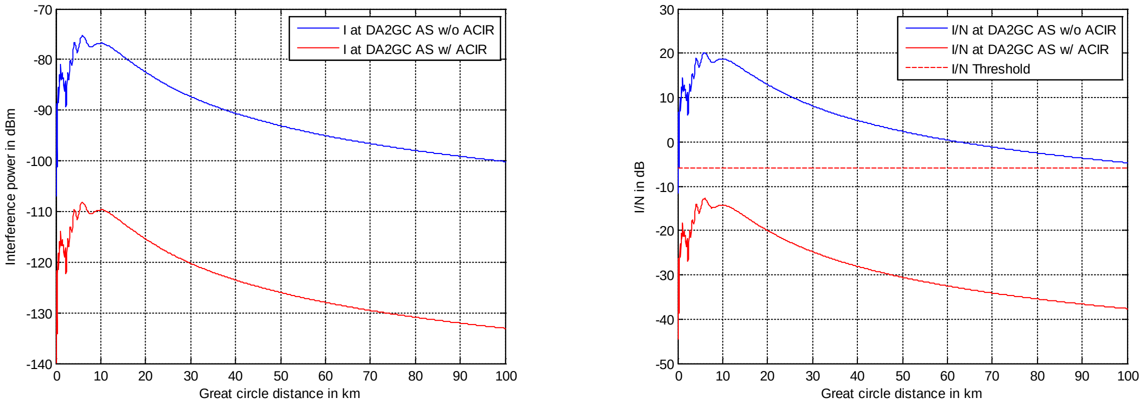


Figure 58: Interference signal power and resulting I/N at DA2GC AS w/ & w/o consideration of ACIR (aircraft altitude of 3 km)

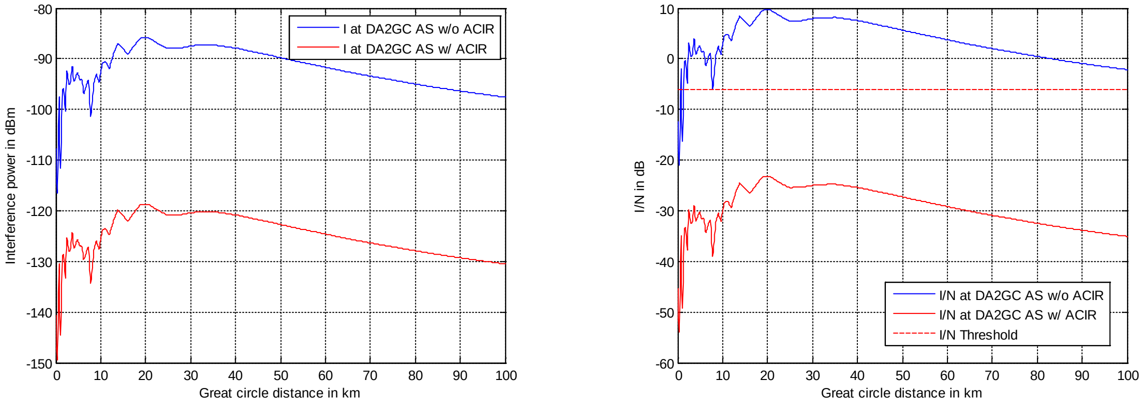


Figure 59: Interference signal power and resulting I/N at DA2GC AS w/ & w/o consideration of ACIR (aircraft altitude of 10 km)

For the DECT indoor case 0 dBi (and 24 dBm transmit power) is relevant. Besides, the indoor to outdoor attenuation is at least 15 dB. Thus for the totally dominating indoor case, at least 27 dB (12 dBi + 15 dB) can be subtracted from the results presented here. (See section 12.1.3.1.)

In order to take into account the aggregated interference from numerous DECT transmissions, statistical Monte-Carlo Simulations would need to be performed.

5.5 SCENARIO (3): DECT STATION/TERMINAL INTERFERED BY DA2GC AS

One of the examinations for a worst case scenario is created with DECT outdoor reception at rooftop level (i.e. line-of-sight between both antennas) and applying a directional high gain antenna.

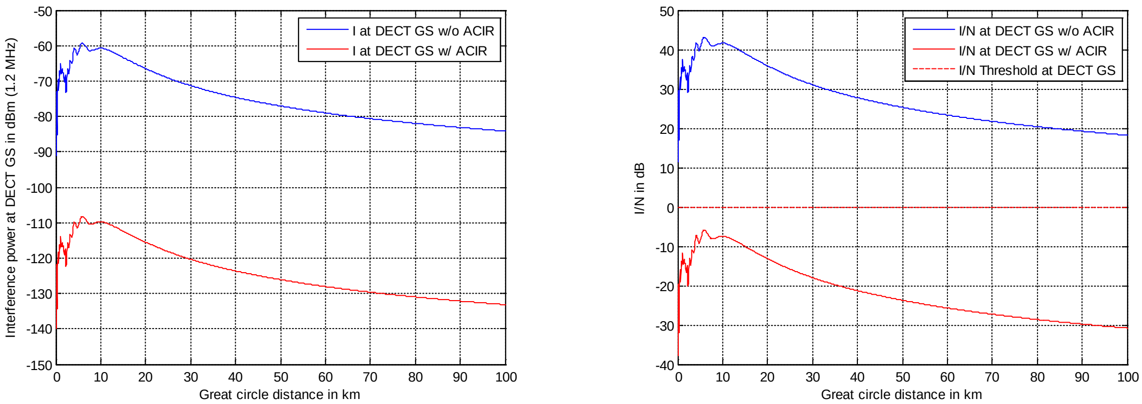


Figure 60: Interference signal power and resulting I/N at DECT station w/ & w/o consideration of ACIR (aircraft altitude of 3 km)

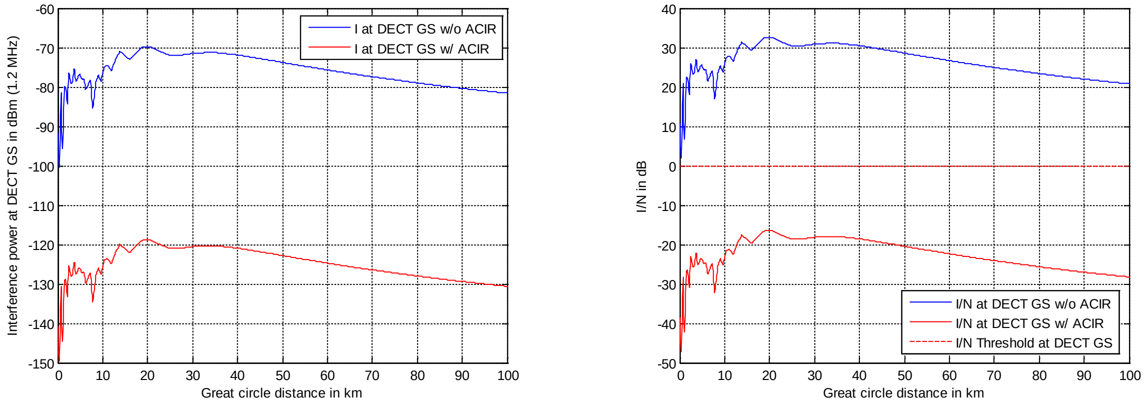


Figure 61: Interference signal power and resulting I/N at DECT station w/ & w/o consideration of ACIR (aircraft altitude of 10 km)

Figure 60 and Figure 61 demonstrate that there is noticeable impact from the DA2GC AS on the reception at the DECT station in the co-channel case (blue curve), when examined worst case scenario with outdoor reception using the high gain antenna.

For the indoor DECT case, at least 27 dB (12 dBi + 15 dB) can be subtracted from the results presented here. (See section 12.1.3.1.)

5.6 SCENARIO (4): DA2GC GS INTERFERED BY DECT STATION

The interference impact of an outdoor DECT station on a DA2GC GS is presented in Figure 62.

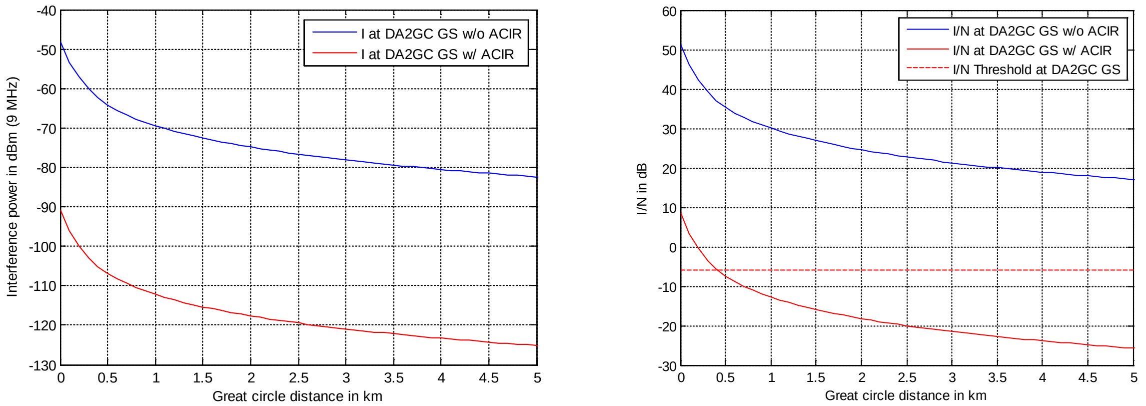


Figure 62: Interference signal power and resulting I/N at DA2GGC GS w/ & w/o consideration of ACIR

For the indoor DECT case, at least 27 dB (12 dBi + 15 dB) can be subtracted from the results presented here (See section 12.1.3.1.)

6 COMPATIBILITY BETWEEN PMSE AND MFCN AT 1920 MHZ (BASED ON CEPT REPORT 39)

CEPT Report 39 [8] provides compatibility studies of TDD base station to FDD base station (uplink) interference scenario with a separation distance of 100m and 1dB desensitisation (see section 4.4.2.3, table 6).

The results shown in the table 6 are "*start quotation*… that an in-block limit is needed in the TDD blocks FDD operation in the block 1920-1925 MHz limits the in-block power of BS to 43 dBm/5MHz in the 1900-1905 MHz block. This limit is 30 dBm/5MHz in the 1905-1910 MHz block TDD block and 20 dBm/5MHz in the last two blocks 1910-1920 MHz. It has to be mentioned that the in-block limits given in this table are derived for the protection of BS receiver.

…

		Interferer:					
		ECN TDD BS	ECN TDD BS 1900-1905 MHz	ECN TDD BS 1905-1910 MHz	ECN TDD BS 1910-1915 MHz	ECN TDD BS 1915-1920 MHz	
		Victim:	Victim:	Victim:	Victim:	Victim:	
Parameter	**Units**	ECN TDD BS	ECN FDD BS 1920-1925 MHz	ECN FDD BS 1920-1925 MHz	ECN FDD BS 1920-1925 MHz	ECN FDD BS 1920-1925 MHz	**Comment**
Frequency	MHz	1900	1905	1910	1915	1920	fo
Target performance							
Target desensitisation	dB	1,00	1,00	1,00	1,00	1,00	Performance criterion: D
INR (IoverN ratio)	dB	-5,87	-5,87	-5,87	-5,87	-5,87	INR = 10log(10^(D/10) - 1)
Receiver NF	dB	5,00	5,00	5,00	5,00	5,00	NF
Thermal noise floor (5 MHz)	dBm	-101,99	-101,99	-101,99	-101,99	-101,99	Pn = 10log(kTB) + NF + 30
Target interference power	dBm	-107,85	-107,85	-107,85	-107,85	-107,85	PI = Pn + INR
Victim's performance							
Receiver selectivity	**dB**	**61,24**	**84,24**	**71,24**	**61,24**	**61,24**	**FDD BS receiver selectivity/in-band blocking are derived from measurements provided by a manufacturer**
Geometry							
Horizontal distance	m	100,00	100,00	100,00	100,00	100,00	
Link budget							
Free space losses	dB	-78,08	-78,10	-78,12	-78,14	-78,17	Gpl
Interferer ant. Elevation pattern	dB	-3,00	-3,00	-3,00	-3,00	-3,00	Gd,i
Victim ant. elevation pattern	dB	-3,00	-3,00	-3,00	-3,00	-3,00	Gd,v
Victim antenna gain	dBi	17,00	17,00	17,00	17,00	17,00	Gv
Coupling loss	**dB**	**-67,08**	**-67,10**	**-67,12**	**-67,14**	**-67,17**	**G = Gpl + Gd,i + Gd,v + Gv**
Interferer out-of-block EIRP within victim wanted channel	**dBm/(5 MHz)**	**-50,00**	**-50,00**	**-50,00**	**-50,00**	**-50,00**	**7dB more stringent than the baseline of -43dBm/5MHz**
Interferer in-block EIRP	**dBm/(5MHz)**	**20**	**43**	**30**	**20**	**20**	**Pib=(PI/G-Poob).ACS**

CEPT Report 039, Table 6: Detailed calculations of in block power limit for TDD ECN base stations

…*end quotation*"

CEPT Report 39 studies interference from a TDD base station to a FDD base station (uplink) with a separation distance of 100 m and 1 dB desensitisation. The conclusion for video link assuming that similar values of TDD base station could be applied, is that the maximum allowed e.i.r.p. would be 20 dBm/5MHz in the frequency range 1910-1920 MHz and 30 dBm/5MHz in the frequency range 1900-1910 MHz.

For shorter separation distances, there is a need to adjust the e.i.r.p. The corresponding maximum allowed e.i.r.p for a separation distance of 50 meters, thus reducing the values by 6 dBm, would be 14/24 dBm/5MHz. For 25 meters separation distance the maximum allowed e.i.r.p would be 8/18 dBm/5MHz.

7 COMPATIBILITY BETWEEN PMSE AND MFCN AT 1920 MHZ (STUDY TYPE #1)

An MCL method is used: it consists in evaluating for each scenario listed in the table below the maximum allowed e.i.r.p. that can be transmitted by the PMSE transmitter when adjacent to the MFCN uplink frequency range 1920-1980 MHz due to MFCN blocking performance.

7.1 PMSE SYSTEMS TO BE CONSIDERED

Table 15: MCL scenarios

Scenario	Type of link	Antenna height	Ground distance with BS	Propagation model
#1	Cordless camera link	1.50 m	30 m 50 m 100 m	Extended Hata, Urban
#2	Mobile video link	1.50 m	30 m 50 m 100 m	Extended Hata, Urban
#3	Portable video link	3 m	30 m 50 m 100 m	Extended Hata, Urban

The maximum e.i.r.p. acceptable from a video transmitter is given by the following formula:

$$VideoTX\_ e.i.r.p._{Max} = Blocking\_Level + Path\_Loss - BS\_Antenna\_Gain - BS\_ Feeder\_Loss + BS\_Antenna\_Discrimination$$

where BS_Feeder_Loss = 0 dB

7.2 MCL RESULTS FOR THE COMPATIBILITY BETWEEN PMSE VIDEO LINKS AND UMTS

Table 16: Results for Cordless Camera Link

Distance	30m		50m		100m	
Frequency range (MHz)	1900-1910	1910-1920	1900-1910	1910-1920	1900-1910	1910-1920
Blocking level (dBm)	-53.7	-62.7	-53.7	-62.7	-53.7	-62.7
Path loss (dB)	71.3		82.7		102.5	
Vertical antenna discrimination (dB)	17		17		12	
Max VL e.i.r.p. (dBm/5MHz)	17.5	8.5	29.0	20.0	43.8	34.8

Table 17: Result for Mobile Video Link

Distance	30m		50m		100m	
Frequency range (MHz)	1900-1910	1910-1920	1900-1910	1910-1920	1900-1910	1910-1920
Blocking level (dBm)	-53.7	-62.7	-53.7	-62.7	-53.7	-62.7
Path loss (dB)	71.3		82.7		102.5	
Vertical antenna discrimination (dB)	17		17		12	
Max VL e.i.r.p. (dBm/5MHz)	17.5	8.5	29.0	20.0	43.8	34.8

Table 18: Result for Portable Video Link

Distance	30m		50m		100m	
Frequency range (MHz)	1900-1910	1910-1920	1900-1910	1910-1920	1900-1910	1910-1920
Blocking level (dBm)	-53.7	-62.7	-53.7	-62.7	-53.7	-62.7
Path loss (dB)	70.4		80.6		98.1	
Vertical antenna discrimination (dB)	17		17		12	
Max VL e.i.r.p. (dBm/5MHz)	16.6	7.6	26.9	17.9	39.4	30.4

7.3 SUMMARY OF THE FINDINGS IN STUDY TYPE #1

An MCL method was used to estimate the maximum allowed e.i.r.p. that can be transmitted by the PMSE transmitter when adjacent to the MFCN uplink due to MFCN blocking performance. The results are presented in the summary table below.

Table 19: Results summary

Distance	30m		50m		100m	
Frequency range (MHz)	1900-1910	1910-1920	1900-1910	1910-1920	1900-1910	1910-1920
Cordless Camera Link Max e.i.r.p. (dBm/5MHz)	17.5	8.5	29.0	20.0	43.8	34.8
Mobile Video Link Max e.i.r.p. (dBm/5MHz)	17.5	8.5	29.0	20.0	43.8	34.8
Portable Video Link Max e.i.r.p. (dBm/5MHz)	16.6	7.6	26.9	17.9	39.4	30.4

The following elements should be considered:

- In a urban environment, the typical distance between two macro BS (which may belong to two different operators) is assumed to be 100 m. Thus results for a separation distance of 50 m should be considered.
- The maximum e.i.r.p. of Cordless Camera Links varies between 20 and 23 dBm/10MHz.
- The maximum e.i.r.p. of Mobile Video Links varies between 34 to 39 dBm/10MHz.
- The maximum e.i.r.p. of Portable Video Links varies between 39 and 47 dBm/10MHz.
- The table above provides the following results:
  - Maximum e.i.r.p. for CCL/MVL: 29 dBm/5MHz in 1900-1910 MHz; 20 dBm/5MHz in 1910-1920 MHz.
  - Maximum e.i.r.p. for PVL: 27 dBm/5MHz in 1900-1910 MHz; 18 dBm/5MHz in 1910-1920 MHz.

Max eirp values are achieved by using the propagation model average values, corresponding to a 50 % probability of interference. A lower probability of interference of e.g. 5 % would require a reduction of the max eirp in the range of 6-11 dB.

8 COMPATIBILITY BETWEEN PMSE AND MFCN AT 1920 MHz (STUDY TYPE #2)

This paragraph provides the e.i.r.p. limits that can be transmitted by the video transmitter when adjacent to the MFCN uplink frequency range 1920-1980 MHz based on a comparison with LTE UE characteristics.

8.1 PATHLOSS CALCULATION

UMTS/LTE base stations network is designed to ensure compatibility with UEs operating in an adjacent channel. Any PMSE device should not create more interference to a base station than a mobile terminal does when used by another operator in an adjacent channel.

Thus it is proposed to apply the required path loss between an LTE UE transmitting in an adjacent 5 MHz channel at its maximum output power of 23 dBm and an LTE base station to any PMSE video device.

This assumption disregards the UE power control which reduces the needed isolation with up to 50 dB and thereby also reduces the allowed PMSE max eirp with up to 50 dB.

5MHz channel bandwidth UMTS

Studies conducted with LTE will lead to a more restrictive e.i.r.p. for the PMSE than the ones with UMTS.

5MHz channel bandwidth LTE

The interference level at the LTE base station receiver should remain below -108.4 dBm. Indeed, the noise level at the LTE base station receiver is -102.4 dBm for a bandwidth of 4.5 MHz, then the noise level plus interference is equal to -101.4 dBm.

Considering LTE UE e.i.r.p. of 23 dBm in the 5 MHz bandwidth channel, and ACS of 46 dB (for the BS) and an ACLR of 30 dB (ETSI TS 136 101 Table 6.6.2.3.1-1), the pathloss used in 3GPP standards between LTE UE and LTE Base station is 116.5 dB using the following calculations:

Unwanted_emissions_LTE_UE= -7 dBm

Blocking_LTE_UE= -23 dBm

Pathloss(dB) = – Interference_LTE_BS (dBm) + (10.log10 (10^(Unwanted_emissions_LTE_UE/10) + 10^(Blocking_LTE_UE /10) + LTE BS Gain (dB) – LTE BS Feeder loss (dB)

8.2 SUMMARY OF THE FINDINGS FOR STUDY TYPE#2

To be compatible with miscellaneous PMSE systems, the maximum e.i.r.p. are provided for different values of PMSE ACLR, assuming a path loss of 116.5 dB towards the LTE BS.

Max_VL_e.i.r.p. = Path_Loss + I_{max} + ACIR - BS_Gain + Feeder_Loss

In the frequency range 1915-1920 MHz:

Table 20: Summary of the findings for study type #2 in the frequency range 1915-1920 MHz

Parameter	Unit	ACLR << ACS	ACLR = ACS	ACLR >> ACS
ACLR	dB	30	46	56
ACIR	dB	29.9	43	45.6
I max	dBm	-107.9	-107.9	-107.9
Max VL e.i.r.p.	dBm	23	36.1	38.7

For any PMSE equipment having the same ACLR as an LTE equipment (30 dB), the maximum e.i.r.p. is equivalent to the maximum e.i.r.p. from an LTE UE (23 dBm).

An improvement of the ACLR leads to an increase of video links' maximum e.i.r.p. The effect of ACLR is significant, as long as the ACLR dominates the ACS in the ACIR calculation.

In the frequency range 1910-1915 MHz:

Table 21: Summary of the findings for study type #2 in the frequency range 1910-1915 MHz

Parameter	Unit	ACLR << ACS	ACLR = ACS	ACLR >> ACS
ACLR	dB	36	55	65
ACIR	dB	35.9	52	54.6
I max	dBm	-107.9	-107.9	-107.9
Max VL e.i.r.p.	dBm	29	45.1	47.7

9 COMPATIBILITY BETWEEN PMSE AND MFCN AT 1920 MHZ (STUDY TYPE #3)

9.1 CHARACTERISTICS

All parameters needed for performing the MCL calculations are available in section 3. ECC Report 172 [11],Tables 13, 19 and 22.

9.2 COEXISTENCE SCENARIO

There are three relevant systems which will be investigated in the present study:

- UMTS macro system;
- LTE macro system;
- LTE pico system (outdoor case[5]).

The scenarios investigated in this section are those described in Table 3 and Table 7.

9.3 METHODOLOGY

The following set of equations is provided to outline the calculation methodology for Minimum Coupling Loss and Minimum Separation Distance in the coexistence scenarios.

9.3.1 General calculation of median Minimum Coupling Loss

The required Minimum Coupling Loss, MCL, can be calculated for different probabilities of interference. For MFCN, the level is set to 5%, therefore MCL_{95} is used. It is calculated as follows:

$$MCL_{95} = MCL_{50} + F_m$$

$$MCL_{50} = P_i - ACIR + G_i + G_v - I - BMF + \; + Fm$$

where, in logarithmic scale (dB or dBm),

P_i: Interfering output power

ACIR: Adjacent Channel Interference Ratio

G_i: Transmit antenna gain

G_v: Receive antenna gain

I: Acceptable interference level

Criterion: Maximum allowable received interference power. I/N = -6 dB is a value commonly used in coexistence studies involving video links as well as MFCN.

$$\mathbf{N = P_{ih}} = -174 + 10 \log(B_r) + F$$

is the effective thermal noise at the receiver, $k \cdot T \cdot B_r$ at T = 300 K, amplified by the receiver noise figure F.

BMF: Bandwidth mitigation factor

BMF = 0 in the alternate channel case

BMF = specific mitigation factor derived from the transmitter's emission mask in the adjacent channel case

BMF = max{0; 10 log (B_t/B_r)} for the co-channel case

where

B_t: Bandwidth of Interferer system. Calculations performed for B_t = 5, 10 MHz

B_r: Bandwidth of Victim system. Calculations performed for B_r = 5, 10, MHz

[5] If the outdoor case is acceptable, then the indoor case does not need to be investigated.

F_m: Fading margin

F_m $= \sigma \cdot \mathrm{sqrt}(2)\, \mathrm{erf}^{-1}(2 \cdot 0.95 - 1)$

9.3.2 Calculation of minimum separation distance

The required coupling losses MCL_{50} or MCL_{95} can be translated into a required separation distance between interfering transmitter and victim receiver. For this purpose, the Extended Hata Propagation model and the line of Sight (LOS) model were used.

In the Extended Hata model, the path loss depends on antenna heights and distances as well as carrier frequency and radio environment. The calculation of the necessary separation distance from a given resulting path loss was performed in an iterative manner, since the required path loss is in turn influenced by distance-dependent parameters such as vertical antenna directivity loss, and the distance-dependent slow fading standard deviation σ.

9.3.3 Using max e.i.r.p or a typical output power value

In the tables in section 10.4-10.6, the max e.i.r.p. values are used (from Table 13 in [11]). In section 10.7, a summary table is given. In 10.7, a summary table using typical values (from Table 22 in [11], section 4 of this document) is also available.

9.4 COMPATIBILITY BETWEEN PMSE AND UMTS AT 1920 MHz

9.4.1 Results for CCL

Table 22: Results for CCL

Victim BS characteristics UMTS			Interferer characteristics (CCL)		
Channel BW (BWv)	MHz	3.84	Frequency Adjacent (Fv)	MHz	1917.5
Noise Figure (NF)	dB	5	Frequency 5 MHz guard	MHz	1907.5
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	5
I/N	dB	-5.87	Tx Power (Pi)	dBm	31
Thermal Noise (Nth)	dBm/BW	-107.99	ACLR_1	dB	47
ACS_1	dB	46	ACLR_2	dB	53
ACS_2	dB	58	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	1,5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	43,46
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-108.85
MCL 95%	**dB**	**131,24**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0,68**			
Results. 5 MHz Guard band					
MCL 95%	**dB**	**122,90**			
Distance (Ex-Hata Urban)	**km**	**0,39**			

9.4.2 Results for MVL

Table 23: Results for MVL

Victim BS characteristics UMTS			Interferer characteristics (MVL)		
Channel BW (BWv)	MHz	3.84	Frequency Adjacent (Fv)	MHz	1917.5
Noise Figure (NF)	dB	5	Frequency 5 MHz guard	MHz	1907.5
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	5
I/N	dB	-5.87	Tx Power (Pi)	dBm	51
Thermal Noise (Nth)	dBm/BW	-107.99	ACLR_1	dB	67
ACS_1	dB	46	ACLR_2	dB	73
ACS_2	dB	58	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	1.5
Feeder Loss (Gvfe)	dB	2	Calculated values		
Antenna height (Hv)	m	30	ACIR	dB	45,97
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-108.85
MCL 95%	**dB**	**148,74**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**2,14**			
Results. 5 MHz Guard band					
MCL 95%	**dB**	**136,84**			
Distance (Ex-Hata Urban)	**km**	**0,98**			

9.4.3 Results for PVL

Table 24: Results for PVL

Victim BS characteristics UMTS			Interferer characteristics (PLV)		
Channel BW (BWv)	MHz	3.84	Frequency Adjacent (Fv)	MHz	1917.5
Noise Figure (NF)	dB	5	Frequency 5 MHz guard	MHz	1907.5
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	5
I/N	dB	-5.87	Tx Power (Pi)	dBm	30
Thermal Noise (Nth)	dBm/BW	-107.99	ACLR_1	dB	57
ACS_1	dB	46	ACLR_2	dB	63
ACS_2	dB	58	Antenna gain (Gi)	dBi	16
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	3
Feeder Loss (Gvfe)	dB	2	Calculated values		
Antenna height (Hv)	m	30	ACIR	dB	45,67
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-108.85
MCL 95%	**dB**	**139,04**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**1,51**			
Results. 5 MHz Guard band					
MCL 95%	**dB**	**127,90**			
Distance (Ex-Hata Urban)	**km**	**0,73**			

9.4.4 Results for point-to-point video link

Table 25: Results for point-to-point video link

Victim BS characteristics UMTS			Interferer characteristics (TP2PL)		
Channel BW (BWv)	MHz	3.84	Frequency Adjacent (Fv)	MHz	1917.5
Noise Figure (NF)	dB	5	Frequency 5 MHz guard	MHz	1907.5
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	5
I/N	dB	-5.87	Tx Power (Pi)	dBm	47
Thermal Noise (Nth)	dBm/BW	-107.99	ACLR_1	dB	81
ACS_1	dB	46	ACLR_2	dB	87
ACS_2	dB	58	Antenna gain (Gi)	dBi	23
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	10
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	46,00
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-108.85
MCL 95%	**dB**	**149,51**	Fading margin (Fm)	dB	1.65
Distance (LOS)	**km**	**369,46**			
Results. 5 MHz Guard band					
MCL 95%	**dB**	**137,51**			
Distance (LOS)	**km**	**92,85**			

9.5 COMPATIBILITY BETWEEN PMSE AND LTE AT 1920 MHZ

9.5.1 Results for CCL vs 10 MHz LTE

Table 26: Results for CCL vs 10 MHz LTE

Victim BS characteristics LTE macro			Interferer characteristics (CCL)		
Channel BW (BWv)	MHz	9	Frequency Adjacent (Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	31
Thermal Noise (Nth)	dBm/BW	-104.29	ACLR_1	dB	47
ACS_1	dB	48.5	ACLR_2	dB	53
ACS_2	dB	55	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	1.5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	44,68
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-105.16
MCL 95%	**dB**	**126,33**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0,49**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**120,13**			
Distance (Ex-Hata Urban)	**km**	**0,33**			

9.5.2 Results for CCL vs 1.4 MHz LTE

Table 27: Results for CCL vs 1.4 MHz LTE

Victim BS characteristics LTE macro			Interferer characteristics (CCL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	31
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	56.2
ACS_1	dB	52	ACLR_2	dB	62.2
ACS_2	dB	55	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	1.5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	50.6
Results. Adjacent channel			Max interference&noise (I)	dBm/BW	-114.36
MCL 95%	**dB**	**129.61**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**0.61**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**125.97**			
Distance (Ex-Hata Urban)	**Km**	**0.48**			

9.5.3 Results for MVL vs. 10 MHz LTE

Table 28: Results for MVL vs. 10 MHz LTE

Victim BS characteristics LTE macro			Interferer characteristics (MVL)		
Channel BW (BWv)	MHz	9	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	51
Thermal Noise (Nth)	dBm/BW	-104.29	ACLR_1	dB	67
ACS_1	dB	48,5	ACLR_2	dB	73
ACS_2	dB	55	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	1.5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	48,44
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-105.16
MCL 95%	**dB**	**142,57**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**1,43**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**136,07**			
Distance (Ex-Hata Urban)	**Km**	**0,93**			

9.5.4 Results for MCL vs 1.4 MHz LTE

Table 29: Results for MCL vs 1.4 MHz LTE

Victim BS characteristics LTE macro			Interferer characteristics (MVL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent (Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	51
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	76,2
ACS_1	dB	52	ACLR_2	dB	82,2
ACS_2	dB	55	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	1,5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	51,98
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-114.36
MCL 95%	**dB**	**148,23**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**2,07**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**145,22**			
Distance (Ex-Hata Urban)	**km**	**1,70**			

9.5.5 Results for PVL vs 10 MHz PVL

Table 30: Results for PVL vs 10 MHz PVL

Victim BS characteristics LTE macro			Interferer characteristics (PLV)		
Channel BW (BWv)	MHz	9	Frequency Adjacent (Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	30
Thermal Noise (Nth)	dBm/BW	-104.29	ACLR_1	dB	57
ACS_1	dB	48.5	ACLR_2	dB	63
ACS_2	dB	55	Antenna gain (Gi)	dBi	16
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	3
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	45,67
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-105.16
MCL 95%	**dB**	**139,04**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**1,51**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**127,90**			
Distance (Ex-Hata Urban)	**km**	**0,73**			

9.5.6 Results for PVL vs. 1.4 MHz LTE

Table 31: Results for PVL vs. 1.4 MHz LTE

Victim BS characteristics LTE macro			Interferer characteristics (PVL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	30
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	66.2
ACS_1	dB	52	ACLR_2	dB	72.2
ACS_2	dB	55	Antenna gain (Gi)	dBi	16
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	3
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	51.84
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-114.36
MCL 95%	**dB**	**138.38**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**1.45**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**135.30**			
Distance (Ex-Hata Urban)	**Km**	**1.18**			

9.5.7 Results for PVL vs. 1.4 MHz LTE

Table 32: Results for PVL vs. 1.4 MHz LTE

Victim BS characteristics LTE macro			Interferer characteristics (PVL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	30
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	66.2
ACS_1	dB	52	ACLR_2	dB	72.2
ACS_2	dB	55	Antenna gain (Gi)	dBi	16
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	3
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	51.84
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-114.36
MCL 95%	**dB**	**138.38**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**1.45**			
Results. 10 MHz Guard band					

9.5.8 Results for Ptp vs. 10 MHz LTE (Annex)

Table 33: Results for Ptp vs. 10 MHz LTE (Annex)

Victim BS characteristics LTE macro			Interferer characteristics (TP2PL)		
Channel BW (BWv)	MHz	9	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	47
Thermal Noise (Nth)	dBm/BW	-104.29	ACLR_1	dB	81
ACS_1	dB	48.5	ACLR_2	dB	87
ACS_2	dB	55	Antenna gain (Gi)	dBi	23
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	10
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	48.50
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-105.16
MCL 95%	**dB**	**143.31**	Fading margin (Fm)	dB	1.65
Distance (LOS)	**Km**	**181.23**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**136.81**			
Distance (LOS)	**Km**	**85.75**			

9.5.9 Results for Ptp vs. 1.4 MHz LTE (Annex)

Table 34: Results for Ptp vs. 1.4 MHz LTE (Annex)

Victim BS characteristics LTE macro			Interferer characteristics (TP2PL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	5	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	47
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	90.2
ACS_1	dB	52	ACLR_2	dB	96.2
ACS_2	dB	55	Antenna gain (Gi)	dBi	23
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	10
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	52.0
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-114.36
MCL 95%	**dB**	**149.01**	Fading margin (Fm)	dB	1.65
Distance (LOS)	**Km**	**349.59**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**146.01**			
Distance (LOS)	**Km**	**247.48**			

9.6 COMPATIBILITY BETWEEN PMSE AND PICO LTE AT 1920 MHZ

9.6.1 Results for CCL vs 10 MHz LTE

Table 35: Results for CCL vs 10 MHz LTE

Victim BS characteristics LTE pico			Interferer characteristics (CCL)		
Channel BW (BWv)	MHz	9	Frequency Adjacent (Fv)	MHz	1915
Noise Figure (NF)	dB	13	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	31
Thermal Noise (Nth)	dBm/BW	-104.29	ACLR_1	dB	47
ACS_1	dB	48.5	ACLR_2	dB	53
ACS_2	dB	55	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	1.5
Feeder Loss (Gvfe)	dB	0	Calculated values		
Antenna height (Hv)	m	3	ACIR	dB	44,68
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-97.16
MCL 95%	**dB**	**103,33**	Fading margin (Fm)	dB	14.85
Distance (ITU P.1411)	**km**	**0,14**			
Results. 10 MHz Guard band					
MCL 95% (ITU P.1411)	**dB**	**97,13**			
Distance (Ex-Hata Urban)	**km**	**0,11**			

9.6.2 Results for CCL vs. 1.4 MHz LTE

Table 36: Results for CCL vs. 1.4 MHz LTE

Victim BS characteristics LTE pico			Interferer characteristics (CCL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	13	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	31
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	56.2
ACS_1	dB	52	ACLR_2	dB	62.2
ACS_2	dB	55	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	1.5
Feeder Loss (Gvfe)	dB	0	Calculated values		
Antenna height (Hv)	m	3	ACIR	dB	50.6
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-106.36
MCL 95%	**dB**	**106.61**	Fading margin (Fm)	dB	14.85
Distance (ITU P.1411)	**Km**	**0.15**			
Results. 10 MHz Guard band					
MCL 95% (ITU P.1411)	**dB**	**102.97**			
Distance (Ex-Hata Urban)	**Km**	**0.13**			

9.6.3 Results for MVL vs 10 MHz LTE

Table 37: Results for MVL vs 10 MHz LTE

Victim BS characteristics LTE pico			Interferer characteristics (MVL)		
Channel BW (BWv)	MHz	9	Frequency Adjacent (Fv)	MHz	1915
Noise Figure (NF)	dB	13	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	67
Thermal Noise (Nth)	dBm/BW	-104.29	ACLR_1	dB	73
ACS_1	dB	48.5	ACLR_2	dB	68
ACS_2	dB	55	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	1.5
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	48,44
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-97.16
MCL 95%	**dB**	**119,57**	Fading margin (Fm)	dB	14.85
Distance (ITU P.1411)	**km**	**0,30**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**113,07**			
Distance (ITU P.1411)	**km**	**0,19**			

9.6.4 Results for MVL vs. 1.4 MHz LTE

Table 38: Results for MVL vs 1.4 MHz LTE

Victim BS characteristics LTE pico			Interferer characteristics (MVL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	13	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	51
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	76.2
ACS_1	dB	52	ACLR_2	dB	82.2
ACS_2	dB	55	Antenna gain (Gi)	dBi	5
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	1.5
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	51.98
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-106.36
MCL 95%	**dB**	**125.23**	Fading margin (Fm)	dB	14.85
Distance (ITU P.1411)	**Km**	**0.53**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**122.22**			
Distance (ITU P.1411)	**Km**	**0.38**			

9.6.5 Results for PVL vs 10 MHz LTE

Table 39: Results for PVL vs 10 MHz LTE

Victim BS characteristics LTE pico			Interferer characteristics (PLV)		
Channel BW (BWv)	MHz	9	Frequency Adjacent (Fv)	MHz	1915
Noise Figure (NF)	dB	13	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	30
Thermal Noise (Nth)	dBm/BW	-104.29	ACLR_1	dB	57
ACS_1	dB	48.5	ACLR_2	dB	63
ACS_2	dB	55	Antenna gain (Gi)	dBi	16
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	3
Feeder Loss (Gvfe)	dB	0	Calculated values		
Antenna height (Hv)	m	3	ACIR	dB	47,93
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-97.16
MCL 95%	**dB**	**110,08**	Fading margin (Fm)	dB	14.85
Distance (ITU P.1411)	**km**	**0,18**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**103,64**			
Distance (Ex-Hata Urban)	**km**	**0,14**			

9.6.6 Results for PVL vs. 1.4 MHz LTE

Table 40: Results for PVL vs 1.4 MHz LTE

Victim BS characteristics LTE pico			Interferer characteristics (PVL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	13	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	30
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	66.2
ACS_1	dB	52	ACLR_2	dB	72.2
ACS_2	dB	55	Antenna gain (Gi)	dBi	16
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	3
Feeder Loss (Gvfe)	dB	0	Calculated values		
Antenna height (Hv)	m	3	ACIR	dB	51.84
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-106.36
MCL 95%	**dB**	**115.38**	Fading margin (Fm)	dB	14.85
Distance (ITU P.1411)	**Km**	**0.22**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**112.30**			
Distance (Ex-Hata Urban)	**Km**	**0.19**			

9.6.7 Results for Point-to-Point Video Link vs 10 MHz LTE (Annex)

Table 41: Results for Point-to-Point Video Link vs 10 MHz LTE (Annex)

Victim BS characteristics LTE pico			Interferer characteristics (TP2PL)		
Channel BW (BWv)	MHz	9	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	13	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5,87	Tx Power (Pi)	dBm	47
Thermal Noise (Nth)	dBm/BW	-104.29	ACLR_1	dB	81
ACS_1	dB	48.5	ACLR_2	dB	87
ACS_2	dB	55	Antenna gain (Gi)	dBi	23
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	10
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	3	ACIR	dB	48.5
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-97.16
MCL 95%	**dB**	**133.51**	Fading margin (Fm)	dB	14.85
Distance (E-Hata)	**Km**	**0.56**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**127.01**			
Distance (E-Hata)	**Km**	**0.37**			

9.6.8 Results for Ptp vs. 1.4 MHz LTE (Annex)

Table 42: Results for Ptp vs. 1.4 MHz LTE (Annex)

Victim BS characteristics LTE pico			Interferer characteristics (TP2PL)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1915
Noise Figure (NF)	dB	13	Frequency 10 MHz guard	MHz	1905
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	10
I/N	dB	-5.87	Tx Power (Pi)	dBm	47
Thermal Noise (Nth)	dBm/BW	-113.50	ACLR_1	dB	90.2
ACS_1	dB	52	ACLR_2	dB	96.2
ACS_2	dB	55	Antenna gain (Gi)	dBi	23
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	10
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	3	ACIR	dB	52.0
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-106.36
MCL 95%	**dB**	**139.21**	Fading margin (Fm)	dB	14.85
Distance (E-Hata)	**Km**	**0.82**			
Results. 10 MHz Guard band					
MCL 95%	**dB**	**136.21**			
Distance (E-Hata)	**Km**	**0.67**			

9.7 SUMMARY OF THE FINDINGS FOR STUDY TYPE#3

In an urban environment with multi-operator networks, the inter-BS distance can be estimated to 100 m, implying a maximum separation distance of 50 meters to an interferer. The LTE inter-pico BS distance can be estimated to be 80-100 m, implying a maximum separation distance of 40-50 meters to an interferer

9.7.1 Using the max e.i.r.p value

Below, all MCL calculations from 9.4-9.6 are available in a summary table.

In the case of 5/10 MHz band width, scenarios 1-3 for the UMTS/LTE BS display a needed separation distance of 0.49-2.14 km for the adjacent channel, and 0.33-0.98 km using a guard band. It is clear that for the investigated cases, even if a guard band is used, additional mitigation techniques concerning for example output power is needed.

In the case of 5/10 MHz band width, the scenarios 4 for the UMTS/LTE BS, which consider the temporary point-to-point link system, display a needed separation distance of 181-369 km for the adjacent channel, and 85-92 km using a guard band. This estimate using LOS does not consider diffraction and the earth curvature, and the model thus over-estimates the distance. However, it is clear that more mitigation techniques than using a guard band are needed. It is noted that the temporary point-to-point link system can transmit at very high power. The case of 1.4 MHz band width for the LTE BS show a need for even larger distances, and thus has an even higher requirement on protection.

In the case of 10 MHz band width, the scenarios 1-3 for the LTE pico BS display a needed separation distance of 0.14-0.56 km for the adjacent channel, and 0.11-0.37 km using a guard band. It is clear that for the investigated cases, even if a guard band is used, additional mitigation techniques concerning for example output power is needed.

The LTE pico BSs can appear both outdoor and indoor. In an indoor situation, shielded by a wall, the results show that a LTE pico BS can be interfered from the outside under the conditions used in these MCL calculations.

Table 43: Minimum coupling loss and separation distance to avoid interference from PMSE video links to UMTS and LTE BS, using max e.i.r.p. values

	Victim	Interf.	Prop. model	Adjacent Channel (10 MHz/1.4 MHz LTE)		5 MHz Guard band for UMTS 10 MHz Guard band for LTE macro and pico (10 MHz/1.4 MHz LTE)	
				MCL (dB)	Distance (Km)	MCL (dB)	Distance (Km)
1	UMTS BS	CCL	E-hata	131,24	0,68	122,90	0,39
2		PVL	E-hata	139,04	1,51	127,90	0,73
3		MVL	E-hata	148,74	2,14	136,84	0,98
4		TP2P	LOS	149,51	369,46	137,51	92,85
1	LTE BS	CCL	E-hata	126,33/129,61	0,49/0,61	120,13/125,97	0,33/0,48
2		PVL	E-hata	133,08/138,38	1,02/1,45	126,64/135,30	0,67/1,18
3		MVL	E-hata	142,57/148,23	1,43/2,07	136,07/145,22	0,93/1,70
4		TP2P	LOS	143,31/149,01	181,23/349,59	136,81/146,01	85,75/247,48
1	LTE Pico BS	CCL	ITU P.1411	103,33/106,61	0,14/0,15	97,13/102,97	0,11/0,13
2		PVL	ITU P.1411	110,08/115,38	0,18/0,22	103,64/112,30	0,14/0,19
3		MVL	ITU P.1411	119,57/125,23	0,30/0,53	113,07/122,22	0,19/0,38
4		TP2P	E-hata	133,51/139,21	0,56/0,82	127,01/136,21	0,37/0,67

9.7.2 Using a typical value

The values in the summary table below were derived using the same method as in sections 10.4-10.6

In the case of 5/10 MHz band width, scenarios 1-3 for the UMTS/LTE BS display a needed separation distance of 0.35-1.51 km for the adjacent channel, and 0.24-0.73 km using a guard band. It is clear that for the investigated cases, even if a guard band is used, additional mitigation techniques concerning for example output power is needed. The case of 1.4 MHz band width for the LTE BS show a need for even larger distances, and thus has an even higher requirement on protection.

In the case of 5/10 MHz band width, the scenarios 4 for the UMTS/LTE BS, which consider the temporary point-to-point link system, display a needed separation distance of 18.62-37.52 km for the adjacent channel, and 8.84-9.85 km using a guard band. This estimate using LOS does not consider diffraction and the earth curvature, and the model thus over-estimates the distance. However, it is clear that more mitigation techniques than using a guard band are needed. It is noted that the temporary point-to-point link system can transmit at very high power. The case of 1.4 MHz band width for the LTE BS show a need for even larger distances, and thus has an even higher requirement on protection.

In the case of 10 MHz band width, the scenarios 1-4 for the LTE pico BS display a needed separation distance of 0.11-0.18 km for the adjacent channel, and 0.09-0.14 km using a guard band. It is clear that for the investigated cases, even if a guard band is used, additional mitigation techniques concerning for example output power is needed. The case of the temporary point-to-point link system and 1.4 MHz band width for the LTE pico BS show a need for even larger distances, and thus has an even higher requirement on protection.

The LTE pico BSs can appear both outdoor and indoor. In an indoor situation, shielded by a wall, the results show that a LTE pico BS can be interfered from the outside under the conditions used in these MCL calculations.

Table 44: Minimum coupling loss and separation distance to avoid interference from PMSE video links to UMTS and LTE BS, using a typical value

	Victim	Interf.	Prop. model	Adjacent Channel (10 MHz/1.4 MHz LTE)		5 MHz Guard band for UMTS 10 MHz Guard band for LTE macro and pico (10 MHz/1.4 MHz LTE)	
				MCL (dB)	Distance (Km)	MCL (dB)	Distance (Km)
1	UMTS BS	CCL	E-hata	125,12	0,46	118,81	0,30
2		PVL	E-hata	139,04	1,51	127,90	0,73
3		MVL	E-hata	130,72	0,66	122,68	0,39
4		TP2P	LOS	129,64	37,52	118,02	9,85
1	LTE BS	CCL	E-hata	121,24/121.84	0,35/0,37	115,22/116.53	0,24/0,26
2		PVL	E-hata	133,08/138,38	1,02/1,45	126,64/135,30	0,67/1,18
3		MVL	E-hata	125,94/128,91	0,48/0,59	119,77/125,15	0,32/0,46
4		TP2P	LOS	123,54/129,08	18,62/35,22	117,07/126,05	8,84/24,84
1	LTE Pico BS	CCL	ITU P.1411	98,24/98.84	0,11/0,15	92,22/93.53	0,09/0,09
2		PVL	ITU P.1411	110,08/115,38	0,18/0,22	103,64/112,30	0,14/0,19
3		MVL	ITU P.1411	102,94/105,91	0,11/0,15	96,77/102,15	0,11/0,13
4		TP2P	E-hata	113,74/119,28	0,15/0,22	107,27/116,25	0,10/0,18

10 COMPATIBILITY BETWEEN DECT AND MFCN AT 1920 MHZ (STUDY TYPE #1)

An MCL method is used: it consists in evaluating for each scenario listed in the table below the maximum allowed e.i.r.p. that can be transmitted by the DECT transmitter when adjacent to the MFCN uplink frequency range 1920-1980 MHz due to MFCN blocking performance.

Table 45: MCL scenarios

Scenario	Description	Antenna height	Ground distance with BS	Propagation model
#1	DECT vs. LTE macro BS	DECT: 5 m LTE: 30 m	30 m 50 m 100 m	Extended Hata, Urban
#2	DECT vs. LTE pico BS	DECT: 5 m LTE: 5 m	30 m 50 m 100 m	Free space

DECT stations and MFCN BS are both supposed to be outdoor. The maximum e.i.r.p. acceptable from a video transmitter is given by the following formula:

$$DectTX\_\,e.i.r.p._{Max} = Blocking\_Level + Path\_Loss - BS\_Antenna\_Gain - BS\_\,Feeder\_Loss + BS\_Antenna\_Discrimination$$

where BS_Feeder_Loss = 0 dB

10.1 MCL RESULTS FOR THE COMPATIBILITY BETWEEN PMSE VIDEO LINKS AND LTE

Table 46: Results for LTE macro BS

Distance	30 m		50 m		100 m	
Frequency range (MHz)	1900-1915	1915-1920	1900-1915	1915-1920	1900-1915	1915-1920
Blocking level (dBm)	-53.7	-62.7	-53.7	-62.7	-53.7	-62.7
Path loss (dB)	69.9		78.0		92.2	
Antenna gain (dB)	17		17		17	
Vertical antenna discrimination (dB)	17		17		12	
Max DECT e.i.r.p.	16.2	7.2	24.3	15.3	33.5	24.5

Table 47: Result for LTE pico BS (Free space)

Distance	30 m		50 m		100 m	
Frequency range (MHz)	1900-1915	1915-1920	1900-1915	1915-1920	1900-1915	1915-1920
Blocking level (dBm)	-45.7	-54.7	-45.7	-54.7	-45.7	-54.7
Path loss (dB)	67.6		72.0		78.1	
Antenna gain (dB)	0		0		0	
Vertical antenna discrimination (dB)	0		0		0	
Max DECT e.i.r.p.	21.9	12.9	26.3	17.3	32.3	23.3

10.2 SUMMARY OF THE FINDINGS IN STUDY TYPE#1

An MCL method was used to estimate the maximum allowed e.i.r.p. that can be transmitted by the DECT transmitter when adjacent to the MFCN uplink due to MFCN blocking performance. For each scenario, three fixed distances were used.

The results are presented in the summary table below.

Table 48: Results summary

Distance		30 m		50 m		100 m	
Frequency range (MHz)		1900-1915	1915-1920	1900-1915	1915-1920	1900-1915	1915-1920
LTE macro BS	Max DECT e.i.r.p.	16.2	7.2	24.3	15.3	33.5	24.5
LTE pico BS		21.9	12.9	26.3	17.3	32.3	23.3

The following elements should be considered:

- In a urban environment, the typical distance between two macro BS (which may belong to two different operators) is assumed to be 100m. Thus results for a separation distance of 50m should be considered.
- Most DECT stations are located indoor. Their maximum e.i.r.p. is 26 dBm, according to ERC/DEC/(98)22 as amended in November 2013.
- Typical wall loss between outdoor and indoor is 18 dB.
- Typical wall loss between two adjacent indoor rooms is 10 dB.
- In specific cases, some DECT stations may be rolled out outside with directive antenna. Their maximum e.i.r.p. is 30 dBm, according to ERC/DEC/(98)22 as amended in November 2013.
- The main scenarios to be considered are:
  - a DECT indoor station interfering a macro LTE BS;
  - a DECT outdoor station with a directive antenna interfering a macro LTE BS;
  - a DECT indoor station interfering a pico LTE BS.

It is thus reasonable, in order to prevent harmful interference to MFCN BS, to apply the following conditions:

- No restriction to stations with omni-directional antenna (intended for indoor use): the 26 dBm e.i.r.p. still applies.
- Stations with directional antenna (intended for outdoor use) are not allowed to use DECT channels F20 and F21 but they can operate on DECT channels F11 to F19 with a maximum e.i.r.p. of 30 dBm.

11 COMPATIBILITY BETWEEN DECT AND MFCN AT 1920 MHZ (STUDY TYPE #3)

11.1 CHARACTERISTICS

All parameters needed for performing the MCL calculations are available in section 3.

11.2 METHODOLOGY

The following set of equations is provided to outline the calculation methodology for Minimum Coupling Loss and Minimum Separation Distance in the coexistence scenarios.

11.2.1 General calculation of median Minimum Coupling Loss

The required Minimum Coupling Loss, MCL, can be calculated for different probabilities of interference. For MFCN, the level is set to 5%, therefore MCL_{95} is used. It is calculated as follows:

$$MCL_{95} = MCL_{50} + F_m$$

$$MCL_{50} = P_i - ACIR + G_i + G_v - I - BMF + +$$

where, in logarithmic scale (dB or dBm),

P_i: Interfering output power

ACIR: Adjacent Channel Interference Ratio

G_i: Transmit antenna gain

G_v: Receive antenna gain

I: Acceptable interference level

Criterion: Maximum allowable received interference power. I/N = -6 dB is a value commonly used in coexistence studies involving video links as well as MFCN

$$\mathbf{N = P_{ih}} = -174 + 10 \log(B_r) + F$$

is the effective thermal noise at the receiver, $k \cdot T \cdot B_r$ at T = 300 K, amplified by the receiver noise figure F.

BMF: Bandwidth mitigation factor

BMF = 0 in the alternate channel case

BMF = specific mitigation factor derived from the transmitter's emission mask in the adjacent channel case

BMF = max{0; 10 log (B_t/B_r)} for the co-channel case

where

B_t: Bandwidth of Interferer system. Calculations performed for B_t = 5, 10 MHz

B_r: Bandwidth of Victim system. Calculations performed for B_r = 5, 10, MHz

F_m: Fading margin,

$$\mathbf{F_m} = \sigma \cdot \text{sqrt}(2)\ \text{erf}^{-1}(2 \cdot 0.95 - 1)$$

11.2.2 Calculation *of* minimum separation distance

The required coupling losses MCL_{50} or MCL_{95} can be translated into a required separation distance between interfering transmitter and victim receiver. For this purpose, the Extended Hata Propagation model and the line of Sight (LOS) model were used.

In the Extended Hata model, the path loss depends on antenna heights and distances as well as carrier frequency and radio environment. The calculation of the necessary separation distance from a given resulting path loss was performed in an iterative manner, since the required path loss is in turn influenced by distance-dependent parameters such as vertical antenna directivity loss, and the distance-dependent slow fading standard deviation σ.

Regarding the ACIR calculation, a weighted total ACS is used for MFCN BS.

11.3 COMPATIBILITY BETWEEN DECT AND UMTS AT 1920 MHz

11.3.1 Results for channel F21

Table 49: Results for channel F21

Victim BS characteristics (UMTS)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	5	Frequency Adjacent (Fv)	MHz	1918.08
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	1.056
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-106.84	Antenna gain (Gi)	dBi	6
ACStotal	dB	46	ACLRtotal	dB	41.8
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	2	Calculated values		
Antenna height (Hv)	m	30	ACIR	dB	40.40
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-107.71
MCL 95%	**dB**	**127.16**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**1.01**			

11.3.2 Results for channel F20

Table 50: Results for channel F20

Victim BS characteristics (UMTS)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	3.84	Frequency Adjacent (Fv)	MHz	1916.352
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	2.784
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-107.99	Antenna gain (Gi)	dBi	6
ACStotal	dB	46	ACLRtotal	dB	59.1
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	2	Calculated values		
Antenna height (Hv)	m	30	ACIR	dB	45.79
Results. Second Adjacent channel			Max interference & noise (I)	dBm/BW	-108.85
MCL 95%	**dB**	**122.91**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0.77**			

11.3.3 Results for channel F19

Table 51: Results for channel F19

Victim BS characteristics (UMTS)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	3.84	Frequency Adjacent (Fv)	MHz	1914.624
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	4.512
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-107.99	Antenna gain (Gi)	dBi	6
ACStotal	dB	50.29	ACLRtotal	dB	62.1
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	50.01
Results. Third Adjacent channel			Max interference & noise (I)	dBm/BW	-108.85
MCL 95%	**dB**	**118.69**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0.58**			

11.4 COMPATIBILITY BETWEEN DECT AT 1900-1920 MHz AND LTE AT 1920-1980 MHz

11.4.1 Results for channel F21 vs 5 MHz LTE

Table 52: Results for channel F21 vs 5 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	4.5	Frequency Adjacent (Fv)	MHz	1918.08
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	1.056
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-107.30	Antenna gain (Gi)	dBi	6
ACStotal	dB	46	ACLRtotal	dB	35.6
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	35.22
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-108.17
MCL 95%	**dB**	**132.79**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**1.47**			

11.4.2 Results for channel F21 vs. 1.4 MHz LTE

Table 53: Results for channel F21 vs 1.4 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1918.08
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	1.056
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-113.50	Antenna gain (Gi)	dBi	6
ACStotal	dB	51.23	ACLRtotal	dB	34.9
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5

Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	34.80
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-114.36
MCL 95%	**dB**	**139.41**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**2.26**			

11.4.3 Results for channel F20 vs 5 MHz LTE

Table 54: Results for channel F20 vs 5 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	4.5	Frequency Adjacent(Fv)	MHz	1916.352
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	2.784
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-107.30	Antenna gain (Gi)	dBi	6
ACStotal	dB	46	ACLRtotal	dB	55.9
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	45.58
Results. Second Adjacent channel			Max interference & noise (I)	dBm/BW	-108.17
MCL 95%	**dB**	**122.44**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0.75**			

11.4.4 Results for channel F20 vs. 1.4 MHz LTE

Table 55: Results for channel F20 vs 1.4 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1916.352
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	2.784
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-113.50	Antenna gain (Gi)	dBi	6
ACS total	dB	55	ACLR total	dB	56.2
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	2	**Calculated values**		
Antenna height (Hv)	m	30	ACIR	dB	52.55
Results.Second Adjacent channel			Max interference & noise (I)	dBm/BW	-114.36
MCL 95%	**dB**	**121.67**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**0.71**			

11.4.5 Results for channel F19 vs 5 Mhz LTE

Table 56: Results for channel F19 vs 5 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	4.5	Frequency Adjacent (Fv)	MHz	1914.624
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	4.512
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-107.30	Antenna gain (Gi)	dBi	6
ACStotal	dB	50.29	ACLRtotal	dB	61.1
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	2	Calculated values		
Antenna height (Hv)	m	30	ACIR	dB	49.94
Results. Third Adjacent channel			Max interference & noise (I)	dBm/BW	-108.17
MCL 95%	**dB**	**118.07**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0.56**			

11.4.6 Results for channel F19 vs. 1.4 MHz LTE

Table 57: Results for channel F19 vs 1.4 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1914.624
Noise Figure (NF)	dB	5	Frequency guard Edge2Edge	MHz	4.512
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-113.50	Antenna gain (Gi)	dBi	6
ACStotal	dB	55	ACLRtotal	dB	64.8
Antenna gain (Gv)	dBi	17	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	2	Calculated values		
Antenna height (Hv)	m	30	ACIR	dB	54.57
Results. Third Adjacent channel			Max interference & noise (I)	dBm/BW	-114.36
MCL 95%	**dB**	**119.65**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**0.62**			

11.5 COMPATIBILITY BETWEEN DECT AND PICO LTE AT 1920 MHZ

11.5.1 Results for channel F21 vs 5 MHz LTE

Table 58: Results for channel F21 vs 5 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	4.5	Frequency Adjacent(Fv)	MHz	1918.08
Noise Figure (NF)	dB	13	Frequency guard Edge2Edge	MHz	1.056
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-107.30	Antenna gain (Gi)	dBi	6
ACStotal	dB	46	ACLRtotal	dB	35.6
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	5

Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	3	ACIR	dB	35.22
Results. Adjacent channel			Max interference & noise (I)	dBm/BW	-100.17
MCL 95%	**dB**	**109.79**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0.08**			

11.5.2 Results for channel F21 vs. 1.4 MHz LTE

Table 59: Results for channel F21 vs 1.4 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1918.08
Noise Figure (NF)	dB	13	Frequency guard Edge2Edge	MHz	1.056
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-113.50	Antenna gain (Gi)	dBi	6
ACStotal	dB	51.23	ACLRtotal	dB	34.9
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	3	ACIR	dB	34.80
Results.Adjacent channel			Max interference & noise (I)	dBm/BW	-106.36
MCL 95%	**dB**	**116.41**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**0.12**			

11.5.3 Results for channel F20 vs 5 MHz LTE

Table 60: Results for channel F20 vs 5 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	4.5	Frequency Adjacent(Fv)	MHz	1916.352
Noise Figure (NF)	dB	13	Frequency guard Edge2Edge	MHz	2.784
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-107.30	Antenna gain (Gi)	dBi	6
ACStotal	dB	46	ACLRtotal	dB	55.9
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	3	ACIR	dB	45.58
Results. Second Adjacent channel			Max interference & noise (I)	dBm/BW	-100.17
MCL 95%	**dB**	**99.44**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0.04**			

11.5.4 Results for channel F20 vs. 1.4 MHz LTE

Table 61: Results for channel F20 vs 1.4 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1916.352
Noise Figure (NF)	dB	13	Frequency guard Edge2Edge	MHz	2.784
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728

I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-113.50	Antenna gain (Gi)	dBi	6
ACS total	dB	55	ACLR total	dB	56.2
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	3	ACIR	dB	52.55
Results. Second Adjacent channel			Max interference & noise (I)	dBm/BW	-106.36
MCL 95%	**dB**	**98.67**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**0.04**			

11.5.5 Results for channel F19 vs 5 MHz LTE

Table 62: Results for channel F19 vs 5 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	4.5	Frequency Adjacent (Fv)	MHz	1914.624
Noise Figure (NF)	dB	13	Frequency guard Edge2Edge	MHz	4.512
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-107.30	Antenna gain (Gi)	dBi	6
ACStotal	dB	50.29	ACLRtotal	dB	61.1
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	3	ACIR	dB	49.94
Results. Third Adjacent channel			Max interference & noise (I)	dBm/BW	-100.17
MCL 95%	**dB**	**95.07**	Fading margin (Fm) (1)	dB	14.85
Distance (Ex-Hata Urban)	**km**	**0.03**			

11.5.6 Results for channel F19 vs. 1.4 MHz LTE

Table 63: Results for channel F19 vs 1.4 MHz LTE

Victim BS characteristics (LTE)			Interferer characteristics (DECT)		
Channel BW (BWv)	MHz	1.08	Frequency Adjacent(Fv)	MHz	1914.624
Noise Figure (NF)	dB	13	Frequency guard Edge2Edge	MHz	4.512
Desensitization (D)	dB	1	Channel BW (BWi)	MHz	1.728
I/N	dB	-5.87	Tx Power (Pi)	dBm	24
Thermal Noise (Nth)	dBm/BW	-113.50	Antenna gain (Gi)	dBi	6
ACStotal	dB	55	ACLRtotal	dB	64.8
Antenna gain (Gv)	dBi	0	Antenna height (Hi)	m	5
Feeder Loss (Gvfe)	dB	0	**Calculated values**		
Antenna height (Hv)	m	3	ACIR	dB	54.57
Results. Third Adjacent channel			Max interference & noise (I)	dBm/BW	-106.36
MCL 95%	**dB**	**96.65**	Fading margin (Fm)	dB	14.85
Distance (Ex-Hata Urban)	**Km**	**0.03**			

11.6 SUMMARY OF STUDY TYPE#3

Below, all MCL calculations are available in a summary table.

In an urban environment with multi-operator networks, the inter-BS distance can be estimated to 100 m, implying a maximum separation distance of 50 meters to an interferer. The LTE inter-pico BS distance can be estimated to be 80-100 m, implying a maximum separation distance of 40-50 meters to an interferer

This MCL study focuses on the outdoor DECT case, since that is the most critical case. In the case of UMTS, a needed separation distance of 0.58-1.01 km is required, depending on the chosen channel. In the case of LTE BS 10 MHz, a needed separation distance of 0.56-1.47 km is required, depending on the chosen channel. A LTE pico BS 10 MHz, needs a separation distance of 0.03-0.08 km, depending on the chosen channel. It is clear that by not using channels near MFCN band, the separation distance can be reduced. However, for co-existence additional mitigation techniques concerning for example output power is needed.

In an indoor case, the interference will be reduced since there is no directional antenna. This will reduce the leakage of emission power, and thus lower the interference with MFCN.

Interference calculations from DECT to MFCN in Annex 4 “DECT radio system parameters in 1880-1920 MHz” are based on a UMTS system with 5 MHz channel bandwidth. The victim bandwidth is considered as 4 MHz centered in 1922.5 MHz (1920.5-1924.5 MHz). The LTE system works with different channel BW from 1.4 MHz up to 20 MHz which can have different centre frequency. LTE is different from UMTS, and no conclusions can be drawn for a LTE system based on UMTS.

MCL calculation shows that compatibility between DECT in 1900-1920 MHz and MFCN in 1920-1980 MHz is possible in case DECT not using channels F20 and F21.

Table 64: Minimum coupling loss and separation distance to avoid interference from DECT to UMTS and LTE BS

Victim	Interferer	Adjacent Channel (F21) (5 MHz LTE)		2nd adjacent channel (F20) (5 MHz LTE)		3rd adjacent channel (F19) (5 MHz LTE)	
		MCL (dB)	Distance (Km)	MCL (dB)	Distance (Km)	MCL (dB)	Distance (Km)
UMTS BS	DECT	127.16	1.01	122.91	0.77	118.69	0.58
LTE BS	DECT	132.79	1.47	122.44	0.75	118.07	0.56
LTE Pico BS	DECT	109.79	0.08	99.44	0.04	95.07/ 96.65	0.03

Note: the parameter of fading margin is not considered relevant for general studies between MFCN and DECT. The present study should be only considered as additional information

12 DECT EXTENSION TO THE BAND TO 1900-1920 MHZ

12.1 IN-BAND SHARING BETWEEN DECT AND OTHER SYSTEMS IN THE BAND 1900-1920 MHZ

It is proposed that DECT will share the band 1900 -1920 MHz with other technologies.

12.1.1 Interferences from other systems to DECT

The sharing and compatibility study for providing DECT extension into the band 1900-1920 MHz has from a DECT perspective two components:

1. Investigate, that the technologies that are proposed to share the band 1900-1920 MHz with DECT, will not cause an unacceptable quality degradation of the DECT service offerings.
2. Study the compatibility with the existing adjacent band cellular UMTS FDD service above 1920 MHz.

A basic reference for studying the coexistence with adjacent band technologies and services, as well as sharing possibilities in the same spectrum, is the ETSI TR 103 089 [31]

The different technology candidates suggested to share the 1900-1920 MHz with DECT can be assumed not to be “DECT-like”. This means that DECT cannot share the time domain with those technologies (as DECT does for interference from DECT systems). DECT will have to share, or escape, only in the frequency domain. This detection is easy for interfering FDD systems that transmit continuously. For non-DECT TDD interference, or intermittent transmissions, an orderly escape from the interference may be more complicated, but can often be solved. See further ETSI TR 103 089 section 6.6 in [31].

12.1.2 Interference from DECT to other systems

The potential interference from DECT to other technology candidates sharing the extension band is found in the documents (sections) for the respective technology.

The DECT system parameters for these assessments are found in section 3.3. See especially Table 98 on ACLR figures for DECT and section A4.4 on DECT transmit power and receiver sensitivity.

A DECT residential base is typically idle. In this case the base is quiet, or transmits a beacon with 1% duty cycle. An enterprise base station in average typically transmits with a duty cycle of 3.7 %. Thus a technology, which repeats lost packets, may have an effective inherent mitigation technique in relation to DECT.

12.1.3 Co-channel interference between DECT and DA2GC (FL) in the band 1900-1920 MHz

Section 5 of the present document analyses the compatibility between DECT and DA2GC relevant for operation at adjacent channels inside and outside the band 1900-1920 MHz. However, in all the diagrams showing I/N margins for adjacent channels, there is also an I/N curve shown w/o ACIR (ACIR 0 dB). That is the result for the co-channel case. Section 5 does however not draw any conclusions on the co-channel case. This section is the complement analysing and discussing the co-channel case based on I/N calculations from section 5.

The assessments made in this section are limited to the case where DA2GC is an FDD system with the FL (GS to AS link) applied in the band 1900-1920 MHz. The figure below shows the DECT/DA2GC FL co-channel case within the band 1900-1920 MHz.

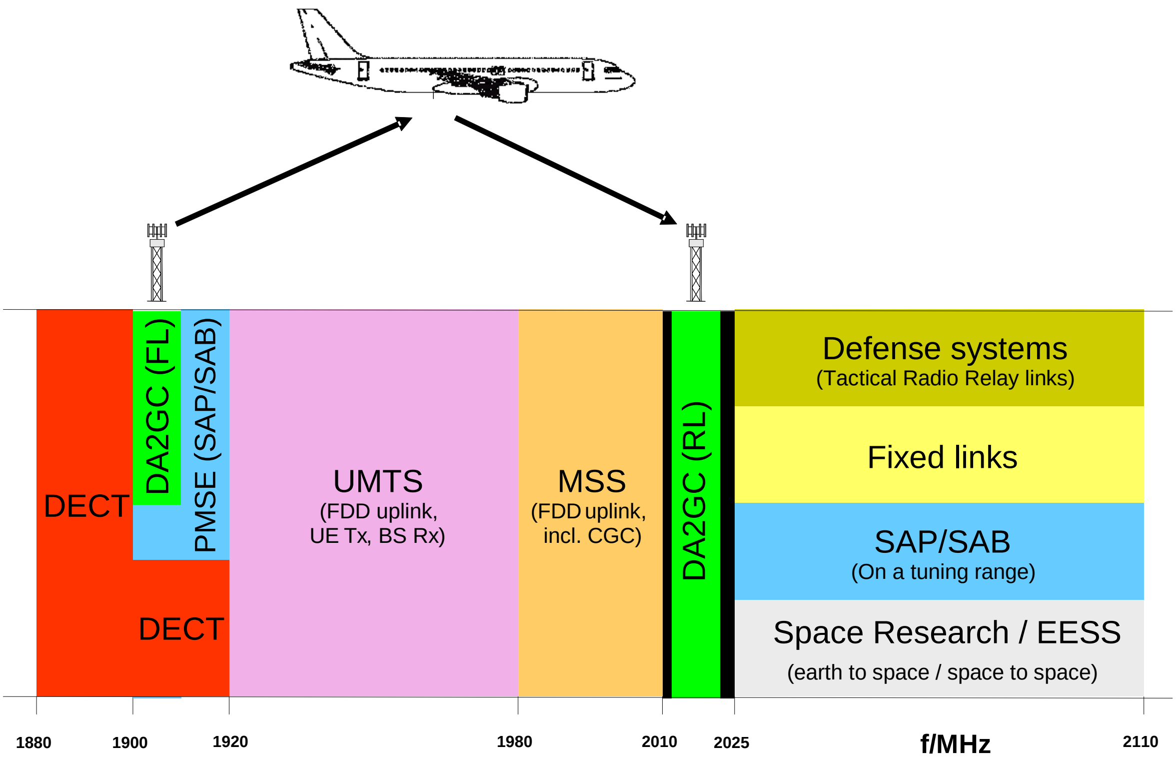


Figure 63: DECT compatibility/sharing with FDD DA2GC having FL in the lower band

12.1.3.1 General considerations

The analysis in section 5 is made for a DECT above rooftop outdoor base station with 12 dBi antenna gain. It is acknowledged in the discussions in section 5 that this is a very worst case. As mentioned above, proper power levels to be used for different DECT scenarios are described in Annex 4 section A4.4.1, from where the following is extracted:

a. More than 99 % of all DECT transmissions occur indoors. For this case 0 dBi (and 24 dBm transmit power) is relevant and shall be used. Besides, the indoor to outdoor attenuation is assumed as 15 dB. Thus for the indoor case, at least 27 dB (12 dBi + 15 dB) can be subtracted from the results of section 5.

b. A DECT outdoor base station is in LOS in relation to DA2GC AS. The Figure 65 shows typical below rooftop installations of DECT base stations.

For the selected (may be most likely DA2GC implementation) case, co-channel interference from DA2GC to DECT (calculated in section 5.3), and from DECT to DA2GC AS (calculated in section 5.4) have to be analysed.

12.1.3.2 Co-channel interference from DA2GC to DECT

In section A4.7 is concluded that DECT will be able to escape harmful interference within the 1900-1920 MHz band by an orderly escape to the DECT base band. The relevant reference is Figure 57 in section 5.3. The co-channel curves in this figure indicate interference levels of 20-50 dB above the DECT noise floor. If these worst case results were relevant, then most of the DECT links would be forced to escape to the DECT base band. Therefore this section complements the worst case analysis, by implementing study results on typical relevant DECT installations and antennas gain.

DECT indoor application

These indoor applications are typically in NLOS in relation to the DA2GC GS, and therefore Figure 57 is relevant in this context. In Figure 57 it is the curves using the suburban and urban models that are relevant for the majority of installations. As stated in section 12.1.3.1 a) at least 27 dB shall be deducted from the co-channel curves of Figure 57. Deducting 27 dB, the 0 dB I/N points are reached at 1 km distance in urban areas, and at 2 km in suburban areas. This will again include almost all DECT indoor installations, and those will benefit for using the proposed extension band, in spite of potential co-channel interference from the DA2GC GSs.

Outdoor DECT base stations

Outdoor base stations are typically in NLOS in relation to the DA2GC GS, and therefore Figure 65 is relevant in this context. In Figure 66 it is the curves using the suburban and urban models that are relevant for the majority of outdoor base stations. Furthermore, with I/N of 15-20 dB DECT outdoor base stations have no problem to serve with good quality outdoor DECT users, which normally are in LOS well within 100 m from the base station. This will include almost all DECT outdoor base stations.

Conclusion

Almost every DECT indoor and outdoor base stations will be able to well utilize the extra capacity of the band 1900-1920 MHz in spite of potential interference from DA2GC GSs.

12.1.3.3 Co-channel interference from DECT to DA2GC AS

Figure 58 (3 km altitude) and Figure 59 (10 km altitude) of section 5.4 are relevant for the co-channel interference from DECT to DA2GC AS for the single link scenario.

DECT indoor application

These indoor applications are typically in NLOS in relation to the DA2GC AS. As stated in section 12.1.3.1 a) at least 27 dB shall be deducted from the co-channel curves of Figure 58 and Figure 59. Deducting 27 dB, the I/N will always be below the required - 6 dBm both at 3 and 10 km AS altitude for the single link scenario.

Outdoor DECT base stations

As stated in section 12.1.3.1.b), those outdoor base stations are installed below rooftop, and DECT outdoor base stations is in LOS in relation to DA2GC AS.See examples in Figure 65. For this case the DECT antenna gain in the, say 100 degree, vertical opening angle should be used. An below roof top DECT antenna with gain in the horizontal plane, will in an vertical angle opening have less gain than an isotropic antenna. Thus a relevant dBi in the relation to the AS is about 0 dBi, or less for most angles. An above roof top antenna with 12 dB gain and LOS for the link to the AS have been used for calculating the co-channel curves in Figure 58 and Figure 59. The above information, makes that the maximum I/N in reality is at least 12 dB lower than indicated in Figure 58 and Figure 59 w/o ACIR. I/N then becomes maximum 8 dB at 3 km and maximum -2 dB at 10 km. It could be expected that a simulation of the DECT antenna pattern in the opening angle of a below rooftop DECT outdoor base station, could further reduce the maximum values of 8 and -2 dB.

Conclusion

Potential co-channel interference *from a single indoor DECT installation* is expected not to degrade the DA2GC service.

Co-channel interference from DECT outdoor base stations may occur in the time domain with a low duty cycle exceed the -6 dB I/N threshold. Also an aggregate effect from numerous of DECT outdoor base stations would need to be taken into account.

12.2 SUMMARY ON THE FINDINGS ON THE IN-BAND SHARING BETWEEN DECT AND OTHER SYSTEMS REGARDING DECT AS VICTIM

The conclusion of the above considerations, is that

- it essential for the effective use of DECT in the band 1900-1920 MHz, that the use of this band is always accessed as an extension to the DECT baseband 1880-1900 MHz;
- Additional functionality (see above) can and may need to be added to the DECT instant dynamic channel selection procedures, to improve coexistence with non-DECT compatible technologies using the band 1900-1920 MHz.

With this the quality mark of the DECT band can be preserved, because escape possibility to the “interference free” 1880-1900 MHz are always available, when or if local and/or temporary severe interference would occur within the extension band 1900-1920 MHz.

Considerations above indicate that severe local and/or temporary interference will occur. But that the probability for severe local interference to DECT will be small, not least because the vast majority of all DECT communication will occur indoors. This means that DECT in average will be able to utilize the capacity of all extended 20 MHz, and during the few occasions (locally and temporary) of severe interference, the equipment automatically limits itself to only use the interference free 10 carriers of the base band 1880-1900 MHz.

12.3 ADJACENT BAND COMPATIBILITY BETWEEN DECT AND OTHER SYSTEMS ABOVE 1920 MHz

The primary study needed, is the compatibility between DECT and UMTS FDD at the 1920 MHz band border. This compatibility analysis is most important, since the UMTS FDD service exists and is well established all over Europe. This analysis is relevant also for the cases when an operator implements LTE, since the radio parameters relevant for the analysis are similar for UMTS and LTE.

The by far most common and most relevant deployment and interference scenario between DECT and a cellular UMTS FDD system operating in the block 1920-1925 MHz is described in figure below.

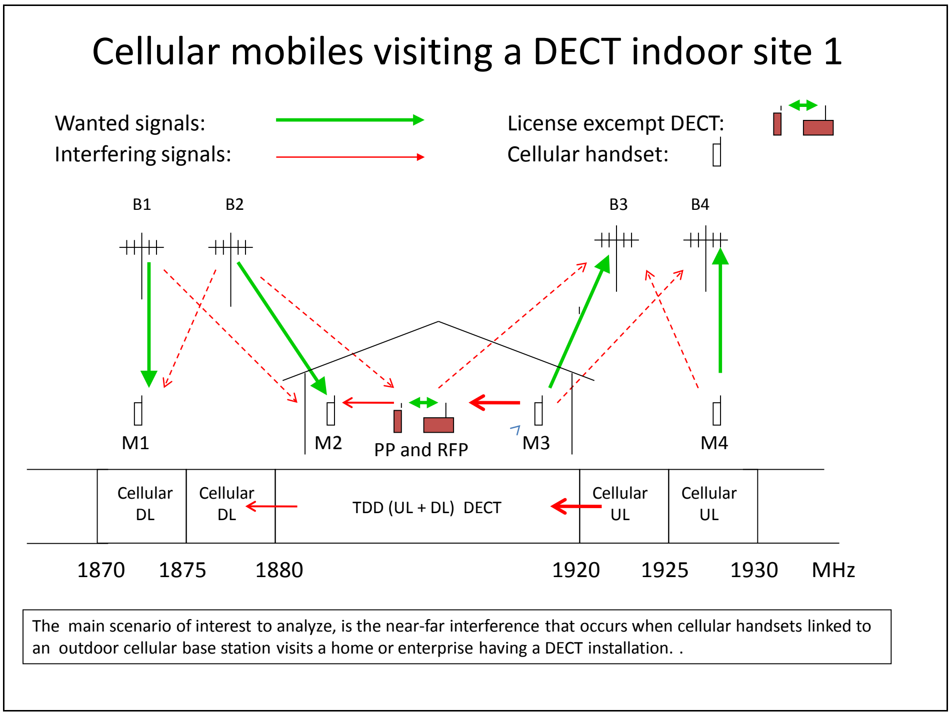


Figure 64: Interference cases between DECT and indoor public mobile station of FDD network

This figure is the same as figure A.2 in Annex A of ETSI TR 103 089 [31], except that the 1900 MHz border has been changed to 1920 MHz. Two interference cases are indicated by the figure:

- Interference from UMTS MS (M3) to DECT RFP and PP;
- Interference from DECT RFP and PP to UMTS BS.

12.3.1 Interference from UMTS handsets to DECT

The figure indicates severe potential interference to DECT from UMTS FDD handsets visiting a DECT site. This is due to the low ACLR (33 dB) of UMTS (and LTE) handsets.
This case has been analysed in the Annex 4 section A4.7.

The conclusion is: The UMTS UE will cause DECT to create a temporary guard band of up to 10 MHz of the extension band 1900-1920 MHz, when an active UE enters a DECT indoor site. This will not cause a quality degeneration of the DECT radio links. There will however be a local temporary capacity loss. This is regarded acceptable, since the band 1900-1920 MHz is an extension band to the DECT base band 1880-1900 MHz, leaving typically 30 MHz free.

12.3.2 Interference from DECT to UMTS base stations

The report ETSI TR 103 089 [31] Annex A sections A1 and A2 conclude that interference from residential and enterprise DECT systems is not a critical scenario. The argument is as follows:

DECT (24 dBm) RFPs and PPs have about the same transmit power as cellular MS, For residential and enterprise systems, the RFPs and PPs are in relation to the cellular base stations geographically used in similar positions as cellular MSs. See M3 and M4 of Figure 64 above. Therefore, principally, the interference probability to cellular base stations from DECT will not exceed the interference probability from cellular MSs on an adjacent cellular block, especially since the ACLR figures for DECT are considerably better than for cellular MSs.

Thus since by real life experience, the UMTS FDD systems work satisfactory in the presence of interference from adjacent block UMTS MSs, then we could conclude that interference from DECT should not be critical.

To verify the statement above, the interference, to UMTS base stations from DECT and from the adjacent block UMTS MSs are compared in the paragraphs below.

12.3.3 Comparing interferences from DECT and UMTS MS to UMTS Base station

In this section, interference to a UMTS BS from DECT and from a UMTS MS transmitting on a 5 MHz block adjacent to the 5 MHz block used by the BS is compared.

The interference at the victim receiver becomes: P_{Tx} [dBm] – ACIR [dB] – L [dB], where P_{Tx} is the transmit power of the interferer, ACIR is the adjacent channel interference ratio (see Annex 4 section A4.6) and L is the link budget or propagation loss, including antenna gain, between interferer and victim.

The following conditions apply when making the comparison of potential interference from DECT and from an UMTS MS:

<u>Main case:</u>

- DECT RFP and PP are located at similar geographical locations as UMTS MSs (L is equal).
- The transmit power is the same, 24 dBm for DECT and 24 dBm for UMTS MS (Class 3) (P_{Tx} is equal)

<u>Special case:</u>

Outdoor base stations with directive antenna.

12.3.3.1 The Main Case:

Only ACIR needs to be compared, since the radio link budget will be similar, and the transmit power is similar. However, the influence of the UMTS MS power control is also addressed.

The table below shows ACIR for the UMTS UE and the DECT carriers F11-F21. The ACIR figures are taken from Table 104.

Table 65: Comparing ACIR for UMTS UE and DECT

Interferer	ACIR
UMTS UE (MS)	33 dB
DECT Carrier F21	50 dB
DECT Carrier F20 – F11	60 dB

The ACIR for DECT is 17 dB (carrier F21) and 27 dB (carriers F20 – F11) higher than for a UMTS UE.

Some compensation for power control of the UMTS UE could be introduced. However, a substantial part of cellular handsets operate close to max power. With a macro cell planning for max power at the cell boarder, in average 50 % of the handsets operate within 6 dB of the max power (COST Hata Model). Many DECT handsets, PPs, also use power control, but not the RFPs. It could anyhow be relevant for the comparison to introduce a 6 dB correction factor to compensate for the advantage of the UMTS UE power control (COST Hata Model).

Conclusion for the main case: Interference levels to a UMTS FDD BS from DECT are typically 11 dB (carrier F21) and 21 dB (carriers F20 – F11) lower than from a UMTS UE.

12.3.3.2 Special case:

The special case discusses the influence of DECT outdoor base stations with directive antenna.

The figure below shows typical implementations of DECT out door directive antennas.

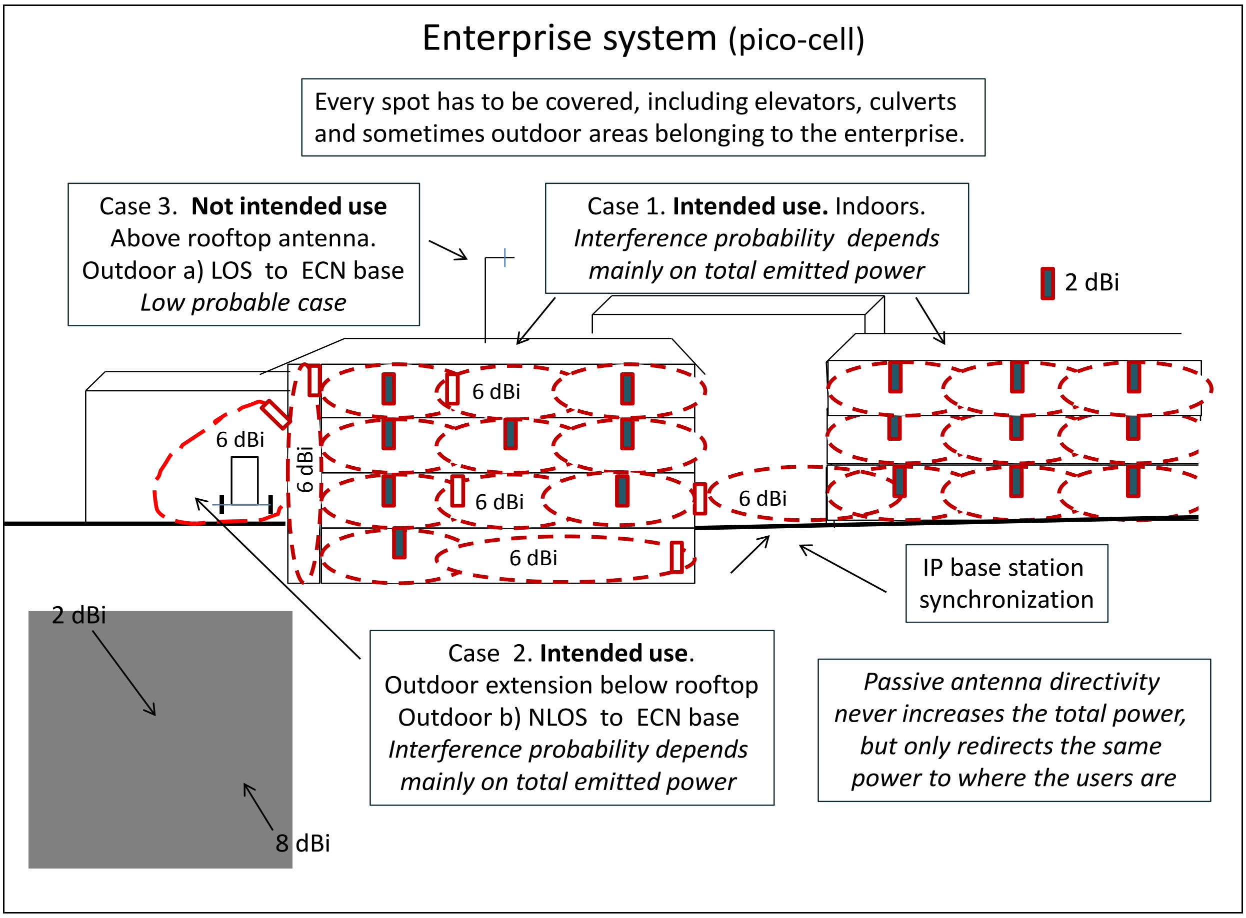


Figure 65: Typical use of DECT outdoor directional antennas

The installations of the DECT outdoor antennas have the following main characteristics:

- They correspond to about 0.01 % of the installed DECT transmitters. They are few, but essential for the performance and service offerings of DECT enterprise systems. See ETSI TR 103 089 [31], section 4.4.1.
- The antennas are passive
- They are installed below roof top (NLOS), typical height between 3-7 m. A 5 m height corresponds to about 10 dB less radio link attenuation compared to normal 1.5 m handset position (COST Hata model).
- The gain of directive antennas is limited to 6 dBi (see ERC Decision (98)22 “Exemption from Individual Licensing for DECT Equipment”, amended 8 November 2013 [22]). The 6 dB figure is thus relevant for this study.
- The coverage or horizontal interfering area of the directive antennas is the same as for a 2 dBi dipole. See the figure above. That means that the interference probability does not increase due to the directivity. In fact, simulations spring 2013 by a PT1 Correspondence Group showed similar interference probability from an isotropic (0 dBi) antenna as from commercial directional antennas of 8 and 11 dBi. See also ETSI TR 103 089 [31], end of section 6.3 and section 6.4.2.

Reviewing the influence of the above characteristics, it is found, that it is not the directivity as such, that might increase the probability for interfering a UMTS BS, but the height may. It could thus be relevant for the comparison to introduce a 10 dB correction factor to compensate for the decrease in link budget (COST Hata Model) of outdoor DECT base stations.

<u>Conclusion for the special case:</u>
For outdoor DECT base stations the interference levels to a UMTS FDD BS from DECT are typically 1 dB (carrier F21) and 11 dB (carriers F20 – F11) lower than from a UMTS UE.

12.3.4 Summary on the findings on the interference from DECT to UMTS base station

The potential interference from DECT to UMTS FDD base stations is not a critical case. In average and typically, the interference levels are about 20 dB lower than the potential interference from UMTS UEs operating on the adjacent 1925 -1930 MHz UMTS block.

More exact, Interference levels from DECT are typically 21 dB lower than from UMTS UEs (11 dB lower for carrier F21). For outdoor DECT base stations (a very small fraction of the DECT transmitters) interference levels from DECT are typically 11 dB lower than from UMTS UEs (1 dB lower for carrier F21).

12.4 SUMMARY ON THE FINDINGS ON THE ADJACENT BAND COMPATIBILITY BETWEEN DECT AND OTHER SYSTEMS

The relevant interference cases are:

- Interference from UMTS UE (M3) to DECT RFP and PP;
- Interference from DECT RFP and PP to UMTS BS.

Conclusion on the potential interference from UMTS handsets (UE) to DECT:

The UMTS UE will cause DECT to create a temporary guard band of up to 10 MHz of the extension band 1900-1920 MHz, when an active UE enters a DECT indoor site. This will not cause a quality degeneration of the DECT radio links. There will however be a local temporary capacity loss. This is regarded acceptable, since the band 1900-1920 MHz is an extension band to the DECT base band 1880-1900 MHz, leaving typically 30 MHz free.

Conclusions on interference from DECT to UMTS base stations:

The potential interference from DECT to UMTS FDD base stations is not a critical case, as indicated in Annex A sections A1 and A2 of ETSI TR 103 089 [31].

The reason is that in average and typically, the interference levels are about 20 dB lower than the potential interference from UMTS UEs operating on the adjacent 1925-1930 MHz UMTS block, and that by real life experience it is known, that the UMTS FDD systems work satisfactory in the presence of interference from adjacent block UMTS MSs.

Note: The considerations above are made for UMTS macro base station. The relation between interference levels from DECT and from UMTS UE will however be about the same if we consider UMTS micro and pico bases. The interference from DECT to UMTS BS is not considered critical, except for UMTS pico/femto cells. UMTS pico/femto cells cannot be used within a DECT site. (Section A.3 and figure A.4 of ETSI EN 301 089) It is up to the site owner to select system. The problem is however not on the DECT side. If an active macro cell UE from the adjacent FDD block (1925-1930 MHz) enters the pico-cell site (1920-1925 MHz), which is very likely, the interference to the pico cell will be considerably worse than from a DECT transmitter. The compatibility problem with pico/femto cells is generic and should not be a reason to bar DECT or any other technology to utilize the extension band.

13 CONCLUSIONS

13.1 CONCLUSION ON THE COMPATIBILITY BETWEEN DA2GC AND PMSE

Worst case link evaluations concerning the compatibility between DA2GC and outdoor PMSE video links have been conducted for the implementation of the DA2GC FDD system [1] in the unpaired 2 GHz bands. For that DA2GC system the two different alternatives for the realization of FL and RL in the lower and upper band were taken into account.

Both the transmission and the receiving paths of PMSE video links and Broadband DA2GC (both FL (Forward Link) and RL (Reverse Link)) have been studied, and both radio applications (PMSE video links and Broadband DA2GC) have been considered as a potential interferer and as a potential victim. Furthermore a paired arrangement for Broadband DA2GC has been taken into account (FL in one, RL in the other unpaired 2 GHz band). Both, co-channel usage of PMSE video links and Broadband DA2GC and adjacent channel arrangement for these two applications have been investigated.

The results of the evaluations from section 4 are summarized in the three following tables for the system described in ETSI TR 103 054 [1]. The scenarios not calculated are considering the same victim-interferer situations, but in the other unpaired 2 GHz band, thus the results are comparable.

Table 66: Summary of compatibility study results between DA2GC FDD system ([1]) and PMSE Cordless Camera Link

Scenario	Victim	Interferer	Adjacent channel operation	Co-channel operation
(1a)	CCL Rx (portable hand-held receiver)	DA2GC GS Tx	Feasible with separation distance[6]	Feasible with mitigation techniques[7] and separation distance.
(1b)	DA2GC AS Rx	CCL Tx (hand-held camera)	Feasible without mitigation techniques	Feasible
(2a)	CCL Rx (portable hand-held receiver)	DA2GC AS Tx	Not feasible[8]	Not feasible.
(2b)	DA2GC GS Rx	CCL Tx (hand-held camera)	Feasible with separation distance[9]	Feasible with separation distance[10]

Co-channel operation of DA2GC FL and PMSE CCL would be feasible with appropriate separation distances. Co-channel operation of DA2GC RL and PMSE CCL is not feasible due to the high exceeding of the protection criterion of the CCL Rx.

Adjacent channel operation between DA2GC FL and PMSE CCL is feasible with limited mitigation for the worst case scenarios. Adjacent channel operation between DA2GC RL and PMSE CCL is not feasible with

[6] of about 7.5 km (rural), 2 km (sub-urban) and 1 km (urban) for the worst case assumption.
[7] The separation distance of about 36 km in rural area is reduced to about 12 km in suburban area and to about 6 km in urban area, i.e. co-channel operation would be feasible in specific areas or with PMSE CCL Rx with less antenna gain.
[8] With the assumption of the worst case scenario.
[9] of about 1.5 km (rural) for the worst case assumption. This distance will be much less for suburban and urban environment.
[10] of about 12 km (rural) for the worst case assumption. This distance will be much less for suburban and urban environment.

the assumption of worst case scenarios. When placing the DA2GC RL into the upper 2 GHz unpaired band, which is also more suitable with regard to the compatibility with the current services in the adjacent bands, the frequency separation would apply as mitigation (ECC Report 209 [2]).

Table 67: Summary of compatibility study results between DA2GC FDD system (ETSI TR 103 054) and PMSE Mobile Video Link

Scenario	Victim	Interferer	Adjacent channel operation	Co-channel operation
(1a)	MVL Rx (helicopter)	DA2GC GS Tx	Feasible with separation distance[11]	Not feasible
(1b)	DA2GC AS Rx	MVL Tx (motorcycle)	Feasible without mitigation techniques	Not feasible
(1c)	MVL Rx (helicopter)	DA2GC AS Tx	Not feasible[12]	Not feasible
(1d)	DA2GC GS Rx	MVL Tx (motorcycle)	Feasible with separation distance[13]	Feasible with separation distance

Co-channel operation of DA2GC FL and PMSE MVL is not feasible. Co-channel operation of DA2GC RL and PMSE MVL is not feasible due to the high exceeding of the protection criterion of the MVL Rx.

Adjacent channel operation of the DA2GC RL and PMSE MVL is not feasible with the assumption of worst case scenarios. When placing the DA2GC RL into the upper 2 GHz unpaired band, which is also more suitable with regard to the compatibility with the current services in the adjacent bands, the frequency separation would apply as mitigation [2]. For adjacent channel operation of the DA2GC FL and PMSE MVL separation distances have to be applied, in particular for the scenario where the DA2GC GS is transmitting adjacent to the reception at the helicopter. However, the necessary separation distance of about 10.5 km compared to inter-site distances of the DA2GC GS of 100-170 km would allow for PMSE MVL operations in wide areas adjacent to the DA2GC GS.

Table 68: Summary of compatibility study results between DA2GC FDD system ([1]) and PMSE Portable Video Link

Scenario	Victim	Interferer	Adjacent channel operation	Co-channel operation
(1a)	PVL Rx (TV van)	DA2GC GS Tx	Feasible with separation distance[14]	Feasible with mitigation techniques[15] and separation distance
(1b)	DA2GC AS Rx	PVL Tx (hand-held camera)	Feasible without mitigation techniques	Not feasible
(1c)	PVL Rx (TV van)	DA2GC AS Tx	Not feasible[16]	Not feasible
(1d)	DA2GC GS Rx	PVL Tx (hand-held camera)	Feasible with separation distance[17]	Feasible with separation distance

[11] of about 10.5 km (rural) for the worst case assumption.
[12] With the assumption of the worst case.
[13] of about 0.4 km (rural) for the worst case assumption.
[14] of about 26 km (rural), 7 km (sub-urban) and 3 km (urban) for the worst case assumption.
[15] The separation distance of about 55 km in rural area is reduced to about 37 km in suburban area and to about 22 km in urban area, i.e. co-channel operation would be feasible in specific areas or with PMSE PVL Rx with less antenna gain.
[16] With the assumption of the worst case scenario (PVL Rx antenna pointing in the direction of an DA2GC AS Tx). Therefore, further studies in order to demonstrate whether the assumption provide sufficient mitigation, are postponed for the time being.
[17] of about 1.3 km (rural), 0.3 km (sub-urban) and none (urban) for the worst case assumption.

Adjacent-channel operation of DA2GC FL and PMSE PVL is considered feasible with separation distances from DA2GC GS. Adjacent channel operation between DA2GC RL and PMSE CCL is not feasible with the assumption of worst case scenarios. When placing the DA2GC RL into the upper 2 GHz unpaired band, which is also more suitable with regard to the compatibility with the current services in the adjacent bands, the frequency separation would apply as mitigation (cf. ECC Report 209 [2]).

Co-channel operation of DA2GC FL and PMSE PVL is not feasible. Co-channel operation of DA2GC RL and PMSE PVL is not feasible due to the high exceeding of the protection criterion of the PVL Rx.

The results of a compatibility study between the Broadband DA2GC system described in ETSI TR 101 599 [18] and PMSE equipment mounted on a helicopter are included in Annex 1. It can be seen from this study that adjacent band operation for this TDD DA2GC system is feasible with a maximum required separation distance of 3.7 km.

No detailed studies have yet been carried out for this TDD Broadband DA2GC system in respect of the other PMSE sharing scenarios listed in the three tables above. However, a simple comparison of the transmit powers and antenna gain patterns of the system, compared to those of the FDD system on which the results in the tables above are based allows for some broad conclusions to be drawn. In the case of ground-based PMSE systems, the likely required separation distances would be no greater than those calculated for the system described in TR 103 054.

12.2 CONCLUSION ON THE COMPATIBILITY BETWEEN DA2GC AND DECT

13.1.1 DA2GC FL in the band 1900-1920 MHz

In order to draw final conclusions on the feasibility of co-channel operation with DECT indoor applications, statistical Monte-Carlo Simulations would need to be performed. The suitability of an inherent mitigation technique to achieve coexistence with DECT outdoor operations is considered difficult as installation below rooftop and a limitation of DECT outdoor stations will not be enforceable by regulation.

13.1.2 DA2GC RL in the band 1900-1920 MHz

Co-channel could be temporary/locally possible for DECT indoor applications assuming a 27 dB deduction (see section 12.1.3.1)

The results of the evaluations are summarised in the following table.

Table 69: Summary of compatibility study results between DA2GC and DECT

Scenario	Victim	Interferer	Adjacent channel operation	Co-channel operation
(1)	DECT Rx	DA2GC GS Tx	[2]	Feasible with sufficient separation distances
(2)	DA2GC AS Rx	DECT Tx	[2]	Subject to further studies taking into account aggregated interference *(see section 12.1.1.* 3).
(3)	DECT Rx	DA2GC AS Tx	[2]	Temporary/locally possible for DECT indoor applications assuming a 27 dB deduction
(4)	DA2GC GS Rx	DECT Tx	[2]	Possible with DECT indoor applications assuming a 27 dB deduction if a separation distance of at least 3.6 km is ensured

13.3 CONCLUSION ON COMPATIBILITY BETWEEN PMSE AND MFCN

Taking into account the characteristics of PMSE digital video links in ECC Report 219 [33] and based on the studies of the present report, it can be concluded that:

- Cordless Camera Links can be used in the frequency band 1900-1920 MHz without restriction;
- Mobile Video Links should be limited to an e.i.r.p. of 23 dBm in the frequency band 1915-1920 MHz in a urban environment and that they could be used without restriction in a rural environment;
- Portable Video Links may be able to coexist with MFCN if case-by-case coordination is applied through a specific detailed study taking into account the field environment.

Due to very low density of video PMSE using the same channel at the same place and at the same time, these values may be adjusted at a further stage based on feedback.

Two separate MCL studies of the compatibility between PMSE and MFCN (UMTS) were performed. The first study produced max allowed e.i.r.p (dBm/5MHz) values for different separation distances (30 m, 60 m, 100 m) and probability of interference (50 %, 5 %). In an urban situation, with around 100 meters between base stations, the 30 m scenario suggests that for 5 - 50 % probability of interference, the max VL e.i.r.p would be in the range 10.9 - 17.5 dBm/5MHz in the1900 - 1910 frequency range. In the 1910 - 1920 frequency range the corresponding numbers are 1.9 - 8.5 dBm/5MHz.

The second study produced minimum required separation distances between PMSE and MFCN (UMTS BS, LTE BS and LTE pico BS) with 5 % probability of interference.

For the case of maximum PMSE output power

- In the six scenarios when 10 MHz Cordless camera link/Portable video link/Mobile video link interfere with 5 MHz UMTS BS/10 MHz LTE BS, MCL calculations showed a needed separation distance of 0.49 - 2.14 km for the adjacent channel, and 0.33 - 0.98 km when using a guard band. For the temporary point-to-point link system, the calculation showed a needed separation distance of 181 - 369 km for the adjacent channel, and 85 - 92 km when using a guard band. It is noted that the temporary point-to-point link system can transmit at very high power. It is clear that for the investigated cases, even if a guard band is used, additional mitigation techniques concerning for example output power is needed. The case of 1.4 MHz band width for the LTE BS showed a need for even larger distances, and thus has an even higher requirement on protection.

- In the scenarios when the four 10 MHz PMSE systems interfere with 10 MHz LTE pico BS, the MCL calculations show a needed separation distance of 0.14 - 0.56 km for the adjacent channel, and 0.11 - 0.37 km using a guard band. It is clear that for the investigated cases, even if a guard band is used, additional mitigation techniques concerning for example output power is needed. The LTE pico BSs can appear both outdoor and indoor. In an indoor situation, shielded by a wall, the LTE pico BS can be interfered from the outside under the conditions used in these MCL calculations.

For the case of typical PMSE output power

- In the six scenarios when 10 MHz Cordless camera link/Portable video link/Mobile video link interfere with 5 MHz UMTS BS/10 MHz LTE BS, MCL calculations showed a needed separation distance of 0.35 - 1.51 km for the adjacent channel, and 0.24 - 0.73 km when using a guard band. For the temporary point-to-point link system, the calculation showed a needed separation distance of 18.62 - 37.52 km for the adjacent channel, and 8.84 - 9.85 km when using a guard band. It is noted that the temporary point-to-point link system can transmit at very high power. It is clear that for the investigated cases, even if a guard band is used, additional mitigation techniques concerning for example output power is needed. The case of 1.4 MHz band width for the LTE BS showed a need for even larger distances, and thus has an even higher requirement on protection.

- In the scenarios when the four 10 MHz PMSE systems interfere with 10 MHz LTE pico BS, the MCL calculations show a needed separation distance of 0.11 - 0.18 km for the adjacent channel, and 0.09 - 0.14 km using a guard band. It is clear that for the investigated cases, even if a guard band is used, additional mitigation techniques concerning for example output power is needed. The LTE pico BSs can appear both outdoor and indoor. In an indoor situation, shielded by a wall, the LTE pico BS can be interfered from the outside under the conditions used in these MCL calculations.

For an urban environment the two studies suggest that power restrictions are required in order to protect MFCN systems

As MFCN studies provide the worst case, the study 2 reflects the typical statistical situation of UE to ensure compatibility between PMSE and MFCN base station.

The proposed conclusion is to ensure compatibility between LTE/UMTS and miscellaneous PMSE systems, the maximum typical e.i.r.p of PMSE depending on ALCR, has to be in accordance with the following tables:

In the frequency band 1915-1920 MHz:

Table 70: Summary of the findings for study type #2 in the frequency range 1915-1920 MHz

Parameter	Unit	ACLR << ACS	ACLR = ACS	ACLR >> ACS
ACLR	dB	30	46	56
e.i.r.p. Max	dBm	23	36.1	38.7

In the frequency band 1910-1915MHz

Table 71: Summary of the findings for study type #2 in the frequency range 1910-1915 MHz

Parameter	Unit	ACLR << ACS	ACLR = ACS	ACLR >> ACS
ACLR	dB	36	55	65
e.i.r.p. Max	dBm	29.05	45.1	47.7

Due to very low density of video PMSE using the same channel at the same place and at the same time, these values may be adjusted based on feedback.

Coexistence between PMSE video links in the 1900-1920 MHz band and MFCN BS above 1920 MHz is possible when the following conditions are met:

Table 72: Summary of compatibility study results between PMSE and MFCN

	1900-1910 MHz	1910-1920 MHz
Cordless Camera Link	no restriction (1) (20 dBm/5MHz max e.i.r.p.)	
Mobile Video Link	31 dBm/5MHz max e.i.r.p.(2)	guard band or 20 dBm/5MHz max e.i.r.p.
Portable Video Link	Not allowed	

Note 1: 23 dBm/10MHz is the typical maximum e.i.r.p. for Cordless Camera Links.
Note 2: 34 dBm/10MHz is the lower typical maximum e.i.r.p. for Mobile Video Links.

This is in-line with CEPT Report 39 that proposed least restrictive technical conditions for the 2 GHz bands.

13.2 CONCLUSION ON COMPATIBILITY BETWEEN DECT AND MFCN ABOVE 1920 MHz

MCL calculation shows that compatibility between outdoor DECT in 1900-1920 MHz and MFCN in 1920-1980 MHz is possible in case DECT not using channels F20 and F21.

In detail, coexistence between DECT devices in the 1900-1920 MHz band and MFCN BS above 1920 MHz is possible when the following conditions are met:

Table 73: Summary of compatibility study results between DECT and MFCN

DECT channels	F11 to F19	F20 and F21
DECT stations with omni-directional antenna	no restriction (26 dBm max e.i.r.p. as in ERC/DEC/(98)22)	
DECT stations with directional antenna	30 dBm max e.i.r.p.	not allowed

ANNEX 1: COMPATIBILITY BETWEEN BEAMFORMING DA2GC SYSTEM AND PMSE

This Annex considers another DA2GC system (as described in ETSI TR 101 599 [18]), which is based on beam-forming antennas, and its compatibility with PMSE systems in the 2 GHz unpaired bands.

A1.1 GROUND STATION E.I.R.P.

The worst-case transmitted power (e.i.r.p.) as a function of elevation (selected points) is shown in the table below:

Table 74: e.i.r.p. for sample elevation angles

Elevation	TR 101 599 ([18])
0° elevation	P = 22 dBm
	G = -10 dBi
	e.i.r.p. = 12 dBm
10° elevation	P = 22 dBm
	G = 23 dBi
	e.i.r.p. = 45 dBm
90° elevation	P = 22 dBm
	G = 15 dBi
	e.i.r.p. = 37 dBm

A1.2 PMSE HELICOPTER PROFILE

The DA2GC ACLR for a 10 MHz receive bandwidth is 43 dB and the PMSE ACS with respect to a 10 MHz transmit bandwidth is 30 dB. The PMSE ACS therefore dominates, giving an overall ACLR of 29.9 dB. Using this value, together with the DA2GC Ground Station power profile reflected in the previous section, the level of interference received by a PMSE helicopter at 150 m altitude (free space path loss) is shown in Figure 66 below. It can be seen from this plot that the necessary ground path separation for the system described in TR 101 599 [18] is 3.7 km.

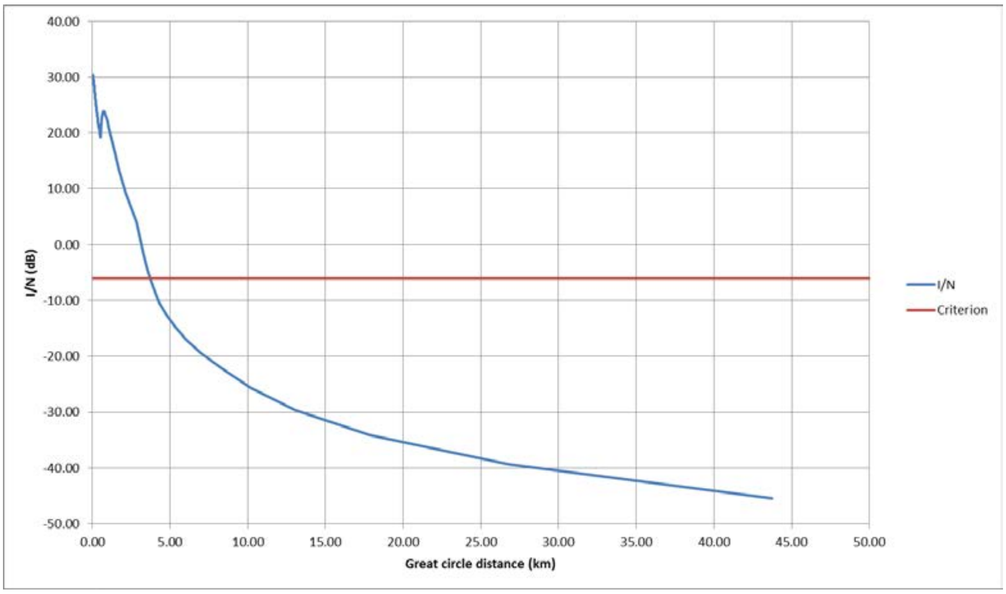


Figure 66: Interference at helicopter (150m altitude) versus separation distance

A1.3 REVERSE DIRECTION

The preceding section has addressed the potential for interference when the DA2GC Ground Station is the potential interferer and the PMSE receiver at a helicopter is the potential victim. The TR 101 599 [18] system however uses TDD so it is also necessary to consider the situation where a PMSE transmitter is the potential interferer and the DA2GC Ground Station is the potential victim.

Taking the helicopter link as an example, it is possible to compare the sum of the e.i.r.p. and receive gain in both directions to see which direction dominates or whether the potential impact is balanced. This is shown in the table below:

Table 75: Comparison of link gains between cases where PMSE (helicopter) & DA2GC Ground Station is the victim

Elevation (degrees)	e.i.r.p. (dBm)	G_{Rx} (dBi)	e.i.r.p. + G_{Rx}
0	12 (DA2GC GS)	5 (PMSE)	17
10	45	5	50
90	37	5	42
0	26 (PMSE)	-10 (DA2GC GS)	16
10	26	23	49
90	26	15	41

It can be seen from the table above that, for the helicopter case, the potential impact of interference is balanced between the two systems.

In the case of other ground based PMSE transmitters it is mainly the 0 degrees elevation case that is of interest. The balance on these links is such that interference into the PMSE system dominates because the PMSE receive gain is generally greater than 5 dBi and the PMSE e.i.r.p. is generally less than the value of 26 dBm used in the helicopter scenario.

A1.4 CONCLUSIONS

It is shown, on the basis a worst case example, that that the necessary ground path separation for the system described in TR 101 599 [18] and a PMSE receiver at a helicopter is 3.7 km.

Furthermore, DA2GC operations in the reverse direction (TDD) will not give rise to a separation distance greater than those estimated for the forward direction.

ANNEX 2: COMPATIBILITY BETWEEN DA2GC RL AND PMSE AUDIO LINKS AT 2010-2020 MHz

The possibilities for DA2GC RL at 2010-2020 MHz sharing with PMSE is investigated, in order to identify if PMSE could possibly be allowed; in this respect, it has to be highlighted that some studies point out that “Co-channel and adjacent operation of DA2GC RL and PMSE (CCL, MVL and PVL) is not feasible due to the exceeding of the protection criterion of the PMSE Rx.”; to overcome this difficulty, it might be necessary to restrict cordless cameras and portable video links use to indoor only;

There may be PMSE applications (video as well as audio) with indoor usage scenario such as intercoms and conference systems that can make use of 2010-2020 MHz in case of a usage restriction. It was noted that ETSI is developing ETSI SRDocs for such applications.

A2.1 SCENARIOS AND SYSTEM CHARACTERISTICS

A2.1.1 Interference scenarios

The purpose of this study is to verify the feasibility to operate PMSE audio equipment (wireless microphones) in the frequency band 2010-2020 MHz, shared with the DA2GC RL.

Interference in both directions is considered, i.e. interference from DA2GC AS transmissions into the PMSE audio link receiver and interference from PMSE audio link transmissions into the DA2GC GS receiver. The Minimum Coupling Loss (MCL) analysis is used for the evaluation of interference.

For the consideration of DA2GC AS transmissions into PMSE audio link reception free space propagation is assumed, for the PMSE audio link transmissions into the DA2GC GS receiver the “Extended-Hata-Model” is chosen.

The diagrams with the evaluation results show

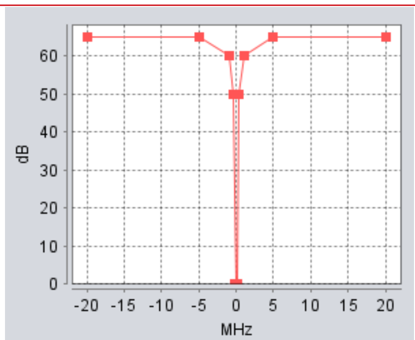
- the received interference power at the victim station related to the signal bandwidth of the victim system,
- the resulting interference-to-noise ratio (I/N) compared to the threshold of the victim system along the ground-based distance between the involved stations.

A2.1.2 Characteristics of studied DA2GC SYSTEM AND PMSE audio links

The DA2GC system considered in the studies is described in [1]. The DA2GC system parameters correspond to [2].

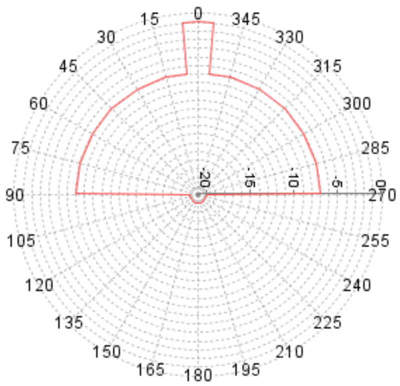
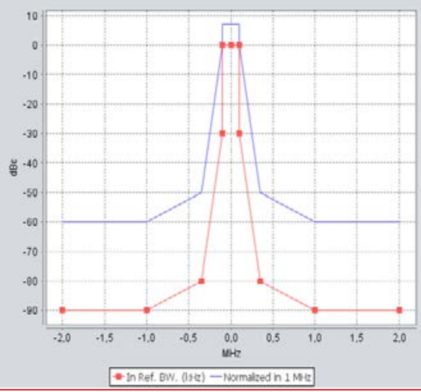
For the PMSE audio link the same parameters as in [4] are used. The relevant parameters copied from [4] are shown in the two following tables.

Table 76: Parameters for PMSE receivers

Parameter	Unit	Value	Comment
Bandwidth (BW)	MHz	0.2	
Reference Sensitivity	dBm	-90	ETSI TR 102 546, Section B.4.1.3
Noise Figure (NF)	dB	6	ETSI TR 102 546, Section B.3.1
Noise Floor (N)	dBm	-115	10·log(k·T·BW·1000) + NF
Standard Desensitization $D_{STANDARD}$	dB	3	$D_{TARGET} = D_{STANDARD}$
Blocking Response	dB		ETSI TR 102 546 Attachment 2, Applicable Receiver Parameter for PWMS below 1 GHz
Antenna height	m	3	
Antenna gain	dBi	0	Omni directional

Note: For the SEAMCAT simulations the minimum required signal of -90 dBm (sensitivity) with a location probability of 95 % has been used. The fading conditions on a stage are simulated with a Gaussian distribution with a standard deviation of 12 dB.

Table 77: Parameters for handheld PMSE

Parameter	Unit	Value	Comment
Bandwidth (BW)	MHz	0.2	
Antenna height	m	1.5	
Body loss	dB	1 around 0° 7 elsewhere 	
Maximum e.i.r.p.	dBm	13	ERC/REC 70-03, Annex 10
Transmitter mask (Monte-Carlo Simulations)	dBm		ETSI EN 300 422 (revised) [5]

A2.2 SHARING OF DA2GC FL AND PMSE AUDIO LINKS

A2.2.1 Interference from DA2GC AS Tx into PMSE audio link reception

For the evaluation of interference from DA2GC AS transmissions into the PMSE audio link the single entry minimum coupling loss (MCL) method is used assuming free space propagation.

The corresponding interference scenario is illustrated in Figure 67.

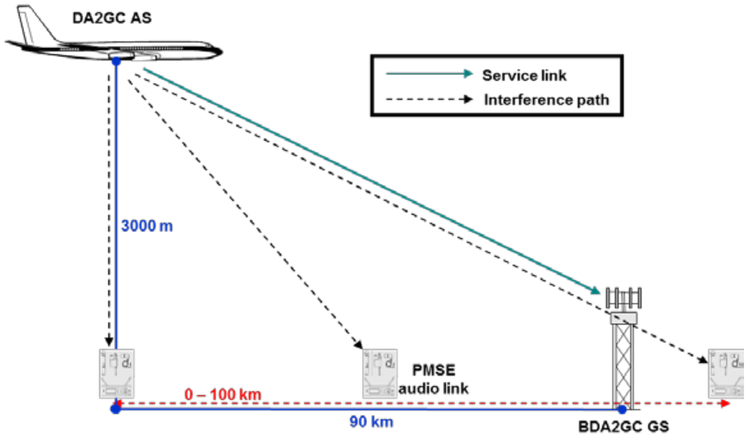


Figure 67: Scenario for interference into the PMSE audio link

For the PMSE audio link operation two scenarios are considered:

1. Outdoor operation with line of sight to the DA2GC AS Tx
2. Indoor operation with 20 dB wall attenuation

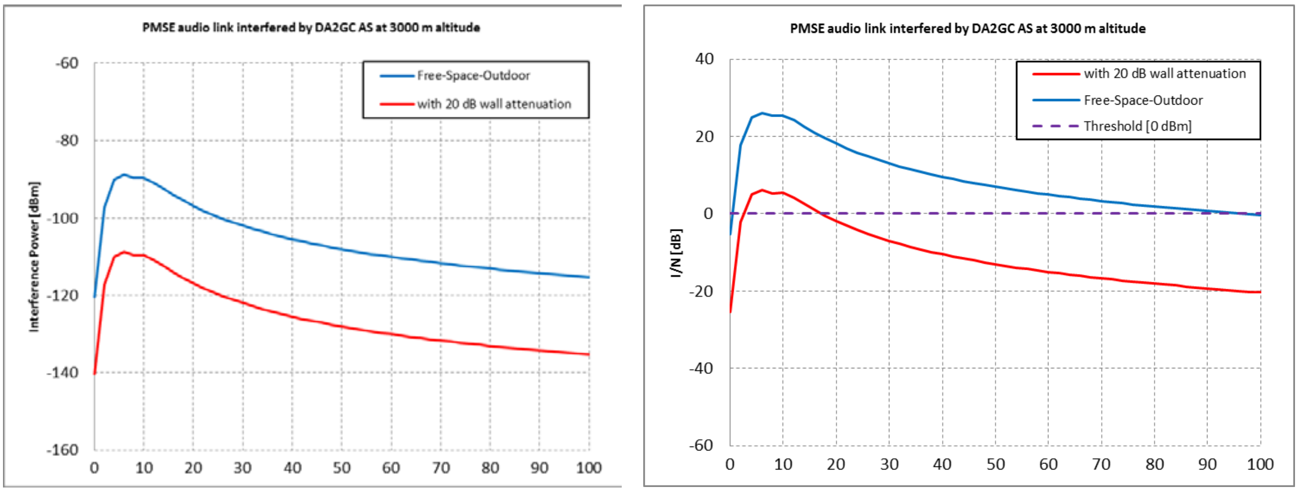


Figure 68: Interference power and resulting I/N at PMSE Rx for single entry analysis

The maximum interference power (iRSS unwanted) occurs at a distance of about 6 km between the DA2GC AS Tx and the PMSE audio link (see curves in Figure 68). Therefore, further calculations are done at this distance with variations of the DA2GC AS Tx altitude. The results presented in the following table are based on the assumption of indoor operation with 20 dB wall attenuation.

Table 78: Interference power and interference probability at 6 km distance between DA2GC AS Tx and PMSE audio link with AS Tx variations

AS altitude [m]	iRSS(unwanted) [dBm]	I/N [dB]	Interference probability [%]	
			I/N	C/I
3000	-108.83	6.17	100	14
3500	-109.62	5.38	100	12
4000	-113.34	1.66	100	6
4500	-113.73	1.27	100	5
5000	-114.45	0.55	100	4
5100	-115.17	-0.17	0	3
5200	-115.88	-0.88	0	2
5300	-116.60	-1.60	0	1
5400	-117.41	-2.41	0	1
5500	-118.21	-3.21	0	0
Uniform distribution 3000-10000	**-120.6**	**-5.6**	**30**	**2.5**

A2.2.2 Interference from PMSE audio link transmissions into DA2GC GS Rx

As the evaluation of interference from the DA2GC AS Tx into the PMSE audio link reception already demonstrate that outdoor operation of PMSE is not feasible, only indoor PMSE audio links are considered.

For the evaluation of interference from the PMSE audio link transmissions into the DA2GC GS receiver the single entry minimum coupling loss (MCL) method is used with the following propagation model settings in SEAMCAT for the “Transmitter to Victim Link Receiver Path”:

DA2GC GS outdoor and PMSE audio link indoor:

- Propagation Model: Extended Hata
- General Environment: Urban / Sub-urban / Rural
- Local Environment (receiver): Outdoor
- Local Environment (transmitter): Indoor
- Propagation Environment: Below Roof

The corresponding interference scenario is illustrated in Figure 69.

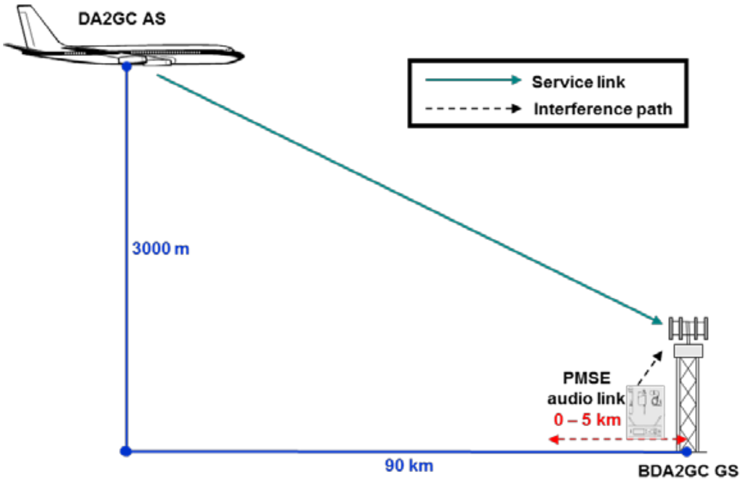


Figure 69: Scenario for interference into the DA2GC GS Rx

For the PMSE audio link operation three scenarios are considered:

1. Rural environment with 10 dB wall attenuation (red curve)
2. Sub-urban environment with 10 dB wall attenuation (blue curve)
3. Urban environment with 10 dB wall attenuation (green curve)

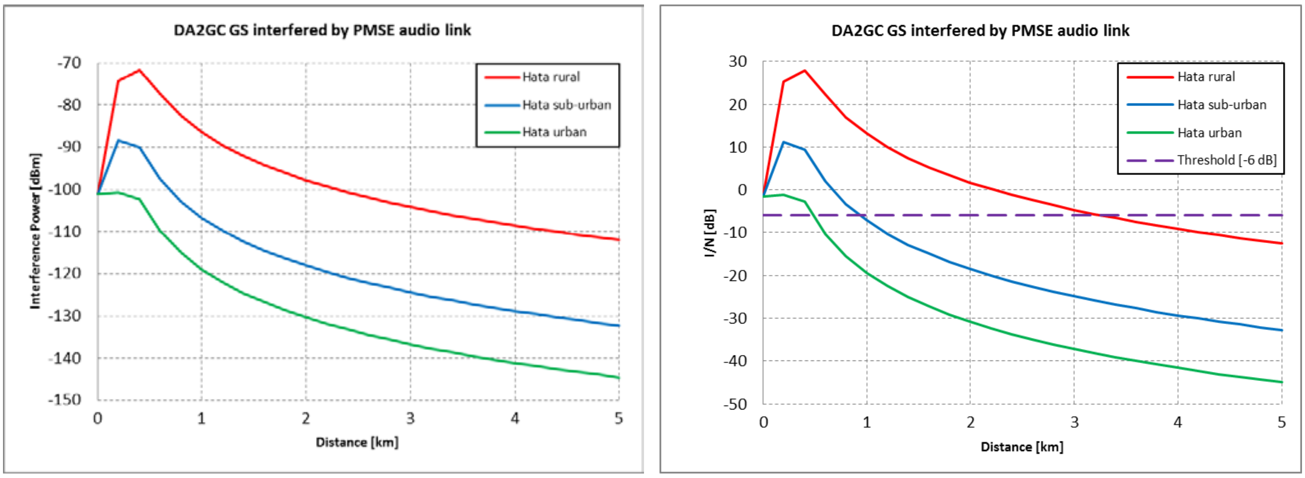


Figure 70: Interference power and resulting I/N at DA2GC GS Rx for single entry analysis

A2.3 CONCLUSIONS

Co-channel operation of the DA2GC RL and outdoor PMSE audio applications is not feasible.

Indoor operation of PMSE audio links could be feasible with a remaining risk of interference.

A2.3.1 Interference from DA2GC AS Tx into PMSE audio link reception

By assuming 20 dB wall attenuation and indoor operation of PMSE audio links, the interference threshold of the PMSE receiver is exceeded within a radius of about 18 km below a DA2GC AS Tx at 3000 m altitude. No interference would occur with wall attenuation higher than 26 dB or aircraft altitudes higher than 5100 m (see Table 36)

A2.3.2 Interference from PMSE audio link transmissions into DA2GC GS Rx

The interference threshold of the DA2GC GS Rx is met with separation distances (see Figure 70) of:

- about 3.3 km in rural environment with 10 dB wall attenuation
- about 0.9 km in sub-urban environment with 10 dB wall attenuation
- about 0.5 km in urban environment with 10 dB wall attenuation

ANNEX 3: COMPATIBILITY BETWEEN DA2GC FL AND SRD AT 1900-1920 MHZ

Non-specific SRD regulation with several medium access options may be implemented (e.g. DCS, SRD LDC); DECT can always use core band for RFP beacons (see remarks below for scenario 2). Considerable SRD information is available from ECC Reports 182, 189 and 200 dealing with UHF SRDs. It is assumed that information in these reports could be taken to investigate SRD spectrum access options concerning parameters such as emission levels, duty cycle restriction. It has been noted that many SRD application fields are actually fixed installed applications such as home automation, many M2M applications, metering applications, alarms installations.

A3.1 CHARACTERISTICS OF STUDIED DA2GC SYSTEM AND SRD APPLICATIONS

The DA2GC system considered in the studies is described in [1]. The DA2GC system parameters correspond to [2].

In the Monte-Carlo analysis the DA2GC AS antenna is assumed to be omni-directional with a constant antenna gain of 0 dBi instead of the specified AS antenna pattern. The specified pattern AS antenna pattern is applied in the MCL analysis.

This study considers a range of SRD technologies and applications. Parameters and scenarios are the same as used for “Compatibility with Unmanned Aircraft Systems (UAS)” in [3].

A3.2 INTERFERENCE FROM SRD’S INTO DA2GC AS

A3.2.1 Single entry MCL analysis

The high altitudes of DA2GC operation mean that the line-of-sight conditions could not be disregarded even at a larger distances. In such situations even a single interfering device could have good power coupling conditions on the interference path and may potentially affect the operation of DA2GC. In order to check what kind of impact distances could be considered for such case, first of all the MCL analysis is applied for the case of a single interferer.

The respective radio parameters of DA2GC and Metropolitan utilities (Smart Metering/M3N) used for this analysis are in accordance with [2] and [3].

The corresponding interference scenario is illustrated in Figure 71.

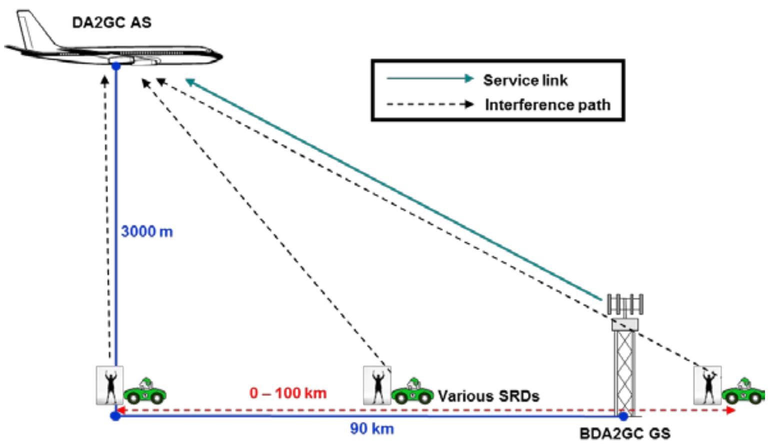


Figure 71: Interference scenario for single entry analysis

The diagrams in Figure 72 with evaluation results show

- the received interference power at the victim station (always related to the signal bandwidth of the victim system,
- the resulting interference-to-noise ratio (I/N) compared to the threshold of victim system along the ground-based distance) between the involved stations. In case of involvement of a DA2GC AS results are given for aircraft altitudes of 3 km and 10 km, respectively. With respect to interference the worst case assumption is to have line-of-sight propagation between interferer and victim. Therefore, free space loss was applied.

For the I/N computation the resulting adjacent channel interference ratio (ACIR) was considered which is based on following relationship of the Tx and Rx characteristics of interferer and victim equipment:

$$ACIR = \frac{1}{\frac{1}{ACLR} + \frac{1}{ACS}}$$

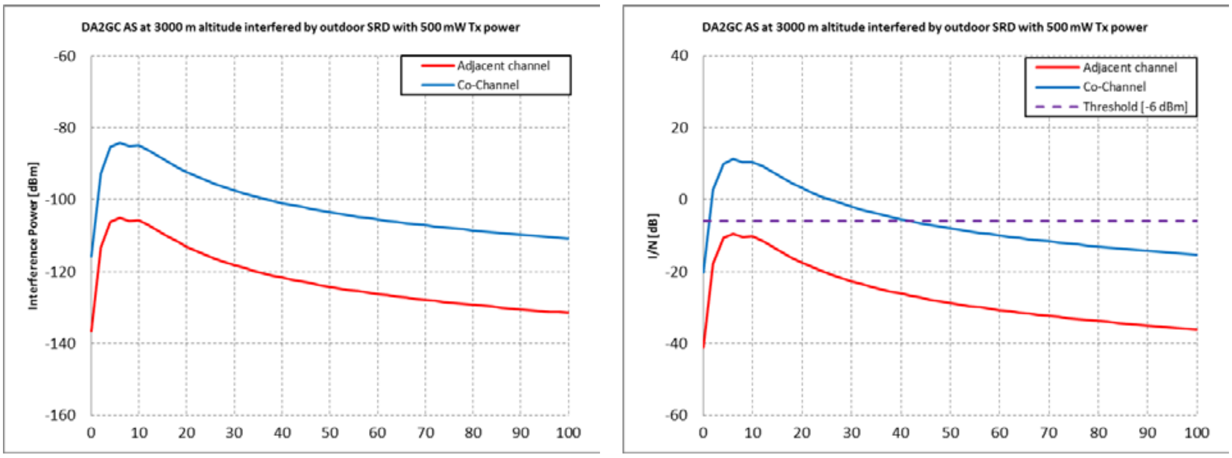


Figure 72: Interference power and resulting I/N at DA2GC AS Rx for single entry analysis

The table below provides the results of calculations for Metropolitan utilities (Smart Metering/M3N). Note that by its nature, the application of MCL analysis may be seen as providing the ultimate theoretical limit on interference for a worst case scenario.

Table 79: Results of single entry MCL analysis for interference to DA2GC AS

Simulation input/output parameters	Settings/Results	
VL: DA2CG FL (AS receiver)		
Frequency	1905.00 MHz	
VL Rx sensitivity	-97.50 dBm / 9 MHz	
VL Rx antenna	According to antenna pattern	
VL Rx height	3000 m (constant)	
VL Tx power e.i.r.p.	43 dBm	
VL Tx → Rx path	Constant (distance/polar angle), R=90 km	
IL1: Metropolitan utilities (Smart Metering/M3N)		
Frequency	1905.00 MHz	1910.10 MHz
IL Tx power e.i.r.p.	27 dBm/200 kHz	
IL Tx → VL Rx interfering path	Free space	

Simulation input/output parameters	Settings/Results	
IL Tx → VL Rx distance	0 … 100 km (max. I/N at 6 km)	
Simulation results		
dRSS	-94.2 dBm	
$iRSS_{unwanted}$	-84.28 … -110.80 dBm	-105.28 … -131.79 dBm
Interference power	-84.28 … -110.80 dBm	-105.02 ... -131.53 dBm
I/N	15.22 ... -11.30 dB	-5.52 ... -32.03 dB

A3.2.2 Statistical (Monte-Carlo) Simulation

In order to complement the static MCL analysis, it is worth also performing the statistical Monte-Carlo simulations. These evaluate the dynamic and random conditions observed in real life, such as the sporadic nature of SRD transmissions and their random scattering in the interference area.

The selected overall scenario outline represents the operation of DA2G in rural area, with geographical extent as illustrated in Figure 73.

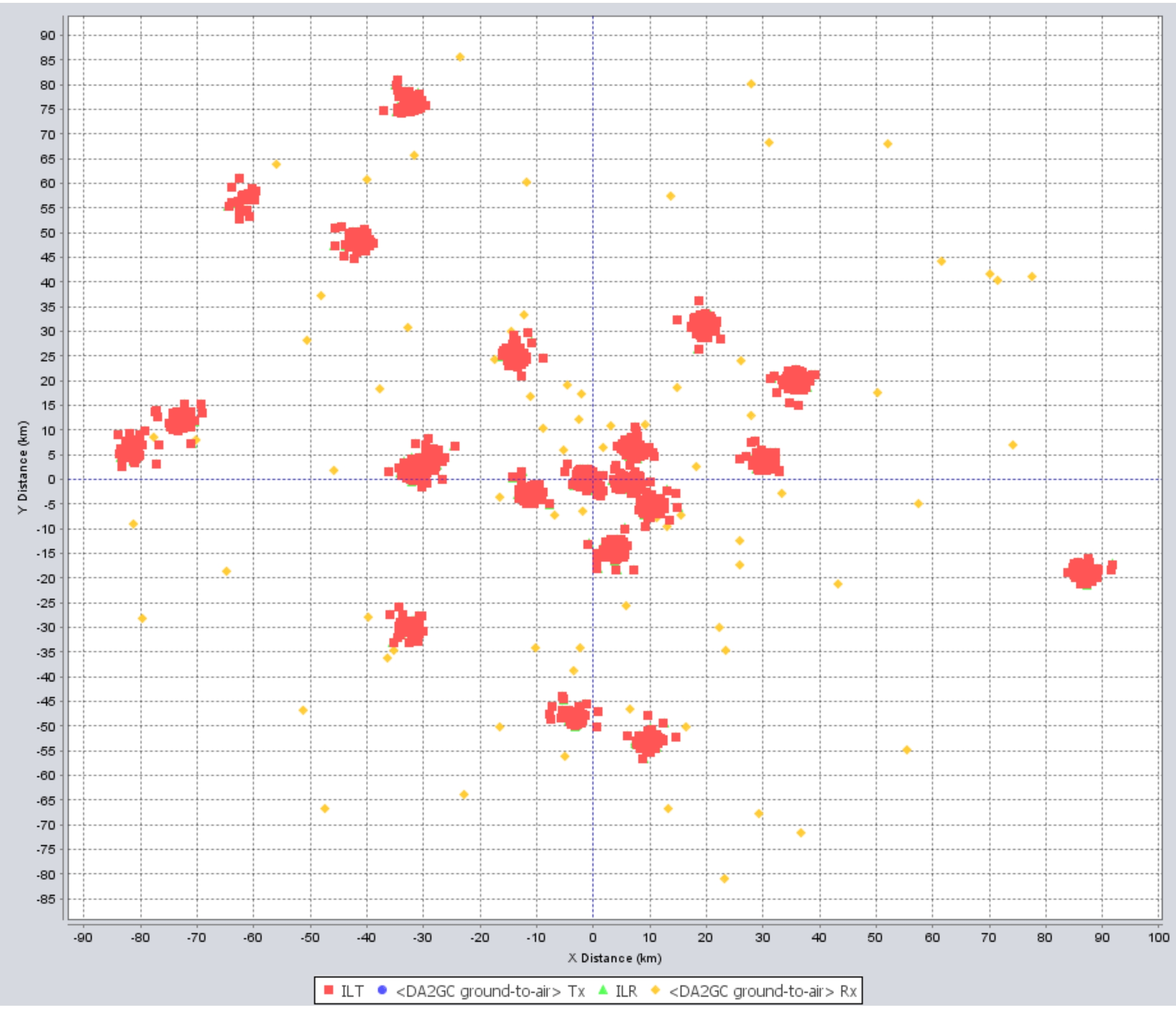


Figure 73: Snapshot of the SEAMCAT scenario outline for the statistical simulation

Two cases are considered with some distinctive specifics:

1. The scenario for SRD outdoor operations vs. DA2GC FL co-existence is characterised by assuming LOS conditions on both wanted and interfering link. The path loss in this case is modelled by Free Space Loss model.
2. The scenario for SRD indoor operations vs. DA2GC FL co-existence is characterised by assuming that Non-LOS condition from SRD to DA2GC AS Rx, with path loss modelled by Hata-Extended model.

A3.2.2.1 Co-channel operation of DA2GC FL and SRD applications assuming LOS conditions

Table 80: Simulation results: mix of SRDs to DA2GC FL (Case 1: LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL1: Metropolitan utilities (Smart Metering/M3N)	
Frequency	1900-1910 MHz, 0.2 MHz steps
ILT power e.i.r.p.	27 dBm/200 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	2000/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	38
IL2: HA	
Frequency	1900-1910 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
IL3: Alarms	
Frequency	1900-1910 MHz, 0.025 MHz steps
ILT power e.i.r.p.	20 dBm/25 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Above Roof
ILT density	12/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	1
IL4: Automotive (high power variety)	
Frequency	1900-1910 MHz, 0.5 MHz steps
ILT power e.i.r.p.	27 dBm/500 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	80/km^2
ILT probability of transmission	0.001

Simulation input/output parameters	Settings/Results
ILT: number of active transmitters	7
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Free Space Loss model (variations 5 dB)
Simulation results	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-68 (2.8)
Probability of interference, C/I = 19 dB, %	**100**
Probability of interference, I/N = -6 dB, %	**100**

A3.2.2.2 Co-channel operation of DA2GC FL and SRD applications assuming urban environment for SRD operation

Table 81: Simulation results: mix of SRDs to DA2GC FL (Case 2: Non-LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL1: Metropolitan utilities (Smart Metering/M3N)	
Frequency	1900-1910 MHz, 0.2 MHz steps
ILT power e.i.r.p.	27 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	2000/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	38
IL2: HA	
Frequency	1900-1910 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
IL3: Alarms	
Frequency	1900-1910 MHz, 0.025 MHz steps
ILT power e.i.r.p.	20 dBm/25 kHz
IL → VL interfering path	Urban/Outdoor-Outdoor/Above Roof
ILT density	12/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	1

Simulation input/output parameters	Settings/Results
IL4: Automotive (high power variety)	
Frequency	1900-1910 MHz, 0.5 MHz steps
ILT power e.i.r.p.	27 dBm/500 kHz
IL → VL interfering path	Urban/Outdoor-Outdoor/Below Roof
ILT density	80/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	7
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Extended Hata Model, urban environment
Simulation results	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-69 (4.2)
Probability of interference, C/I = 15 dB, %	**100**
Probability of interference, I/N = -6 dB, %	**100**

A3.2.2.3 Co-channel operation of DA2GC FL and SRD Home Automation applications assuming urban environment for SRD operation

Table82: Simulation results: only HA SRDs to DA2GC FL (Case 2: Non-LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL2 HA	
Frequency	1900-1910 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Extended Hata Model, urban environment
Simulation results	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-99 (9.3)
Probability of interference, C/I = 15 dB, %	**56**
Probability of interference, I/N = -6 dB, %	**61**

Table 83: Simulation results: only HA SRDs (with max. 10dBm E.I.R.P.) to DA2GC FL (Case 2: Non-LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL2 HA	
Frequency	1900-1910 MHz, 0.2 MHz steps
ILT power e.i.r.p.	**10** dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3

General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Extended Hata Model, urban environment
Simulation results	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
iRSS$_{unwanted}$, dBm (Std.dev., dB)	-103 (9.3)
Probability of interference, C/I = 15 dB, %	**44**
Probability of interference, I/N = -6 dB, %	**42**

Table 84: Simulation results: only HA SRDs (with max. 10 dBm e.i.r.p. and reduced densities of 100-10000/km2) to DA2GC FL (Case 2: Non-LOS)

Simulation input/output parameters	Settings/Results		
VL: DA2CG FL (AS receiver)			
Frequency	1905.00 MHz		
VLR sensitivity	-97.50 dBm / 9 MHz		
VLR antenna	Omni- directional with 0 dBi gain		
VLR height	3000-10000 m (uniformly distributed)		
VL Tx power e.i.r.p.	43 dBm (max.)		
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km		
IL2 HA			
Frequency	1900-1910 MHz, 0.2 MHz steps		
ILT power e.i.r.p.	**10** dBm/200 kHz		
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof		
ILT density	**10000**/km^2	**1000**/km^2	**100**/km^2
ILT probability of transmission	0.000025		
ILT: number of active transmitters	3		

Simulation input/output parameters	Settings/Results		
General settings for all ILs			
ILT → VLR positioning mode	Uniform density around VLR position		
VL Tx → Rx & ILT → VLR path loss	Extended Hata Model, urban environment		
Simulation results			
dRSS, dBm (Std.dev., dB)	-83 (8.9)		
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-104 (8.0)	-108 (7.6)	-116 (8.4)
Probability of interference, C/I = 15 dB, %	**39**	**27**	**10**
Probability of interference, I/N = -6 dB, %	**36**	**19**	**4**

A3.2.2.4 Adjacent-channel operation of DA2GC FL and SRD applications assuming LOS conditions

For the adjacent channel case, 1 SRD channel (i.e. 0.2 MHz for IL1 and IL2, 0.025 MHz for IL3 and 0.5 MHz for IL4) has been taken into account in the simulations.

Table 85: Simulation results: mix of SRDs to DA2GC FL (Case 1: LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL1: Metropolitan utilities (Smart Metering/M3N)	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	27 dBm/200 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	$2000/km^2$
ILT probability of transmission	0.001
ILT: number of active transmitters	38
IL2: HA	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	$50000/km^2$
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
IL3: Alarms	
Frequency	1910.025-1919.075 MHz, 0.025 MHz steps
ILT power e.i.r.p.	20 dBm/25 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Above Roof
ILT density	$12/km^2$
ILT probability of transmission	0.001
ILT: number of active transmitters	1

Simulation input/output parameters	Settings/Results
IL4: Automotive (high power variety)	
Frequency	1910.5-1919.5 MHz, 0.5 MHz steps
ILT power e.i.r.p.	27 dBm/500 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	80/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	7
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Free Space Loss model (variations 5 dB)
Simulation results	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-100 (2.8)
Probability of interference, C/I = 19 dB, %	**49**
Probability of interference, I/N = -6 dB, %	**59**

Table 86: Simulation results: mix of SRDs without IL4 (Automotive) to DA2GC FL (Case 1: LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL1: Metropolitan utilities (Smart Metering/M3N)	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	27 dBm/200 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	2000/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	38
IL2: HA	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
IL3: Alarms	
Frequency	1910.025-1919.075 MHz, 0.025 MHz steps
ILT power e.i.r.p.	20 dBm/25 kHz

Simulation input/output parameters	Settings/Results
IL → VL interfering path	Rural/Outdoor-Outdoor/Above Roof
ILT density	12/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	1
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Free Space Loss model (variations 5 dB)
Simulation results[18]	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
iRSS$_{unwanted}$, dBm (Std.dev., dB)	-101 (2.9)
Probability of interference, C/I = 19 dB, %	**48**
Probability of interference, I/N = -6 dB, %	**55**

Table 87: Simulation results: mix of SRDs without IL3 (Alarms) and IL4 (Automotive) and reduced Tx (from 27dBm to 14 dBm) for IL1 (Metropolitan utilities) to DA2GC FL (Case 1: LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL1: Metropolitan utilities (Smart Metering/M3N)	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	**14** dBm/200 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	2000/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	38
IL2: HA	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Rural/Outdoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Free Space Loss model (variations 5 dB)
Simulation results	

[18] Additional removal of IL3 (Alarms) has almost no impact on the simulation results.

Simulation input/output parameters	Settings/Results
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-113 (2.9)
Probability of interference, C/I = 19 dB, %	**11**
Probability of interference, I/N = -6 dB, %	**0**

A3.2.2.5 Adjacent-channel operation of DA2GC FL and SRD applications assuming urban environment for SRD operation

Table 88: Simulation results: mix of SRDs to DA2GC FL (Case 2: Non-LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL1: Metropolitan utilities (Smart Metering/M3N)	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	27 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	$2000/km^2$
ILT probability of transmission	0.001
ILT: number of active transmitters	38
IL2: HA	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	$50000/km^2$
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
IL3: Alarms	
Frequency	1910.025-1919.075 MHz, 0.025 MHz steps
ILT power e.i.r.p.	20 dBm/25 kHz
IL → VL interfering path	Urban/Outdoor-Outdoor/Above Roof
ILT density	$12/km^2$
ILT probability of transmission	0.001
ILT: number of active transmitters	1
IL4: Automotive (high power variety)	
Frequency	1910.5-1919.5 MHz, 0.5 MHz steps
ILT power e.i.r.p.	27 dBm/500 kHz
IL → VL interfering path	Urban/Outdoor-Outdoor/Below Roof
ILT density	$80/km^2$

Simulation input/output parameters	Settings/Results
ILT probability of transmission	0.001
ILT: number of active transmitters	7
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Extended Hata Model, urban environment
Simulation results	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-102 (4.3)
Probability of interference, C/I = 19 dB, %	**46**
Probability of interference, I/N = -6 dB, %	**41**

Table 89: Simulation results: mix of SRDs (without IL4: Automotive) to DA2GC FL (Case 2: Non-LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL1: Metropolitan utilities (Smart Metering/M3N)	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	27 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	2000/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	38
IL2: HA	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
IL3: Alarms	
Frequency	1910.025-1919.075 MHz, 0.025 MHz steps
ILT power e.i.r.p.	20 dBm/25 kHz
IL → VL interfering path	Urban/Outdoor-Outdoor/Above Roof
ILT density	12/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	1

Simulation input/output parameters	Settings/Results
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Extended Hata Model, urban environment
Simulation results[19]	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-103 (4.6)
Probability of interference, C/I = 19 dB, %	**42**
Probability of interference, I/N = -6 dB, %	**33**

Table 90: Simulation results: mix of SRDs without IL3 (Alarms) and IL4 (Automotive) and reduced Tx (from 27dBm to 14 dBm) for IL1 (Utilities) to DA2GC FL (Case 2: Non-LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL1: Metropolitan utilities (Smart Metering/M3N)	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	**14** dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	2000/km^2
ILT probability of transmission	0.001
ILT: number of active transmitters	38
IL2: HA	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Extended Hata Model, urban environment
Simulation results	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-115 (4.9)
Probability of interference, C/I = 19 dB, %	**7**
Probability of interference, I/N = -6 dB, %	**1**

[19] Additional removal of IL3 (Alarms) has almost no impact on the simulation results.

A3.2.2.6 Adjacent-channel operation of DA2GC FL and SRD Home Automation applications assuming urban environment for SRD operation

Table 91: Simulation results: only HA SRDs to DA2GC FL (Case 2: Non-LOS)

Simulation input/output parameters	Settings/Results
VL: DA2CG FL (AS receiver)	
Frequency	1905.00 MHz
VLR sensitivity	-97.50 dBm / 9 MHz
VLR antenna	Omni- directional with 0 dBi gain
VLR height	3000-10000 m (uniformly distributed)
VL Tx power e.i.r.p.	43 dBm (max.)
VL Tx → Rx path	Uniform (distance/polar angle), R = 0 … 90 km
IL2 HA	
Frequency	1910.2-1919.8 MHz, 0.2 MHz steps
ILT power e.i.r.p.	14 dBm/200 kHz
IL → VL interfering path	Urban/Indoor-Outdoor/Below Roof
ILT density	50000/km^2
ILT probability of transmission	0.000025
ILT: number of active transmitters	3
General settings for all ILs	
ILT → VLR positioning mode	Uniform density around VLR position
VL Tx → Rx & ILT → VLR path loss	Extended Hata Model, urban environment
Simulation results	
dRSS, dBm (Std.dev., dB)	-83 (8.9)
$iRSS_{unwanted}$, dBm (Std.dev., dB)	-131 (9.3)
Probability of interference, C/I = 15 dB, %	**1**
Probability of interference, I/N = -6 dB, %	**1**

A3.3 CONCLUSIONS

The single entry MCL analysis in section A3.2.1 already demonstrate that one single metropolitan utility device has the potential to interfere severely into a DA2GC AS receiver in the case of co-channel operation. The protection threshold is met by at least 4 dB in the case of adjacent channel operation.

A3.3.1 Co-Channel operation of DA2GC FL and SRD applications

Assuming the same range of SRD technologies, applications, parameters and scenarios as used for the “Compatibility with Unmanned Aircraft Systems (UAS)” in [3], the probability of interference from SRDs into a DA2GC AS receiver is 100% for LOS and Non-LOS conditions, respectively.

Even with the assumption that only Home Automation applications with limited power and limited density according to Table 6 (i.e. limitation of power to 10 dBm and reduction of density by the factor 5), the probability of interference into the DA2GC AS receiver is still almost 40% for Non-LOS conditions. With a density reduction of the HA devices to 100/km^2 the probability of interference goes down to 10%.

Therefore, it is concluded that co-channel operation of DA2GC FL and massive indoor SRD deployment is not feasible. Sharing with low power and low density indoor SRD applications would be feasible.

A3.3.2 Adjacent Channel operation of DA2GC FL and SRD applications

Assuming the same range of SRD technologies, applications, parameters and scenarios as used for the "Compatibility with Unmanned Aircraft Systems (UAS)" in [3], the probability of interference from SRD devices into a DA2GC AS receiver is about 40-60% for LOS and Non-LOS conditions, respectively.

With the assumption that only indoor applications (i.e. metropolitan utilities with limited power of 10 dBm and Home Automation applications according to Table 6) are deployed, the probability of interference into the DA2GC AS receiver goes down to about 10% for LOS- and Non-LOS conditions.

Therefore, it is concluded that operation of DA2GC FL and indoor SRD deployment in the adjacent band – with one SRD channel guard separation – would be feasible with a power limitation of 10 dBm for the SRDs. Usage conditions for SRD channels further away from the DA2GC FL would be subject for further evaluations.

ANNEX 4: DECT RADIO SYSTEM PARAMETERS AT 1880-1920 MHZ

Updated radio system parameters for DECT, UMTS, LTE and WiMax are provided in Annex B of ETSI TR 103 089 “DECT properties and radio parameters relevant for studies on compatibility with cellular technologies operating on frequency blocks adjacent to the DECT frequency band”. In this report, ACLR and ACS figures have been calculated and used for the compatibility studies at the boarder 1900 MHz between DECT and above mentioned cellular technologies. The same methodology is used below to develop ACLR and ACS figures between extended DECT and UMTS FDD at the 1920 MHz boarder.

For information on a new simplified statistical analysis to estimate interference from cellular indoor handsets to indoor DECT, see CEPT Report 39 [8] Annex 3 section A.3.2.

CEPT Report 39 [8] does not contain any updated analysis of interference from DECT to UMTS

A4.1 DECT CARRIER POSITIONS

Twenty-two RF carriers are defined in the frequency band 1 880 MHz to 1 920 MHz with centre frequencies F_c given by:

$F_c = F_0 - c \times 1.728$ MHz where: $F_0 = 1\,897.344$ MHz; and c = 0, 1, ..., 9 and

$F_c = F_9 + c \times 1.728$ MHz where: $F_9 = 1\,881.792$ MHz; and c = 10, 11, 12, ..., 21.

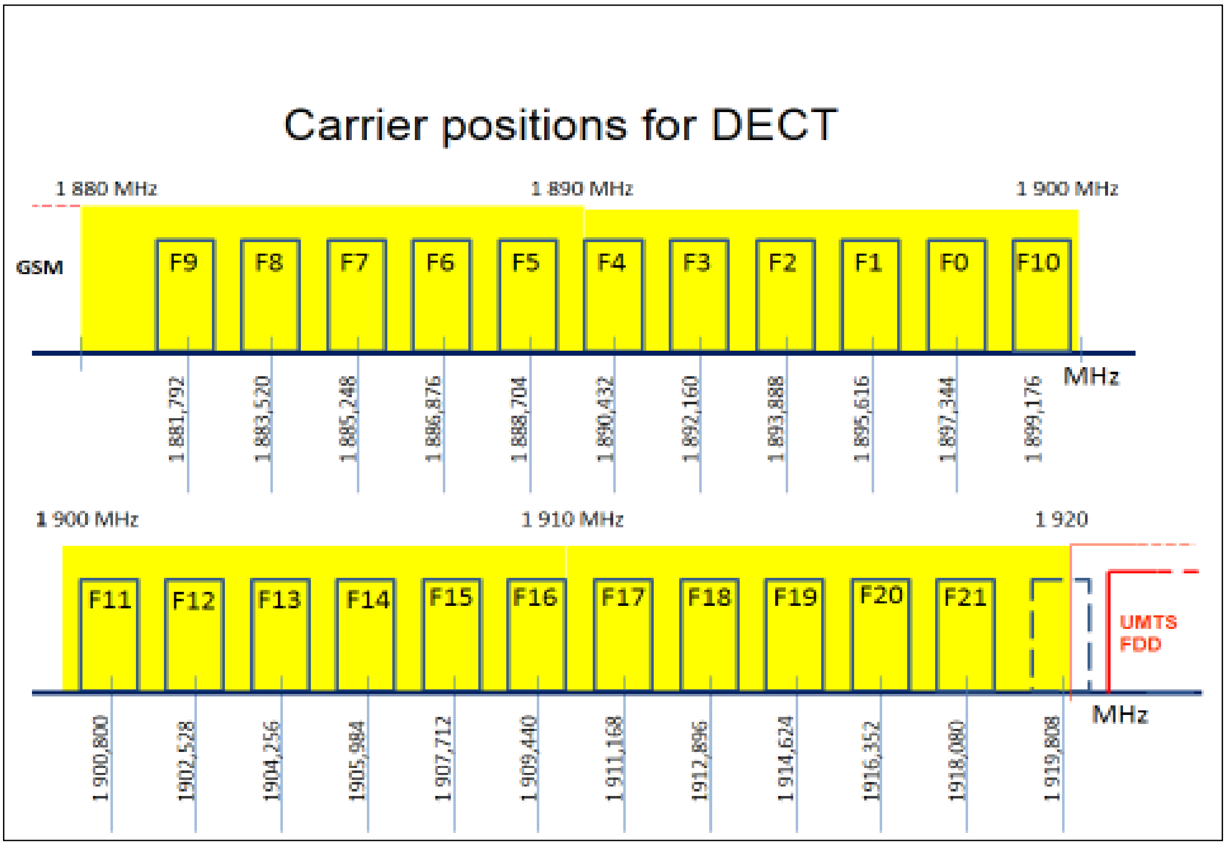


Figure 74: Positions of DECT carriers extended into 1900-1920 MHz

For the purpose of ACS and ACLR calculations, virtual DECT carrier position has been defined also within the adjacent UMTS FDD blocks. See figure below. Definition of DECT carrier frequencies are found in EN 300 175-2 [19].

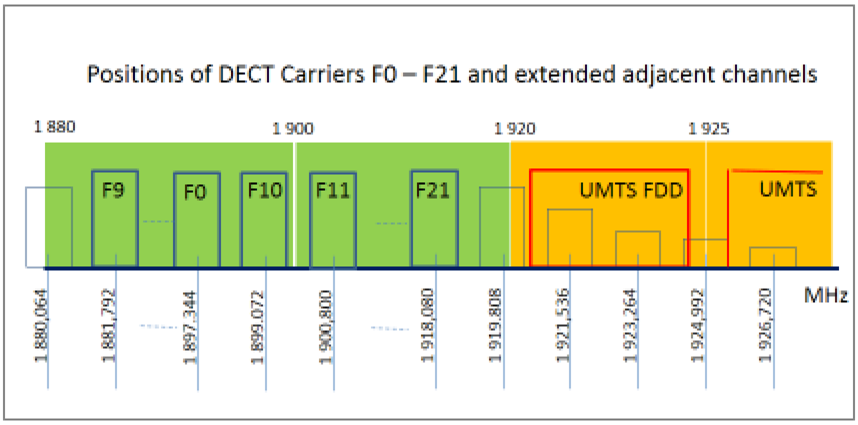


Figure 75: Positions of DECT carriers and adjacent channels extended outside the DECT band

The carrier spacing is 1,752 MHz and the transmit bandwidth about 1 MHz (1.152 Mbps).

The bandwidth of UMTS operating in the FDD band above 1920 is supposed to have a bandwidth of about 4 MHz.

In the calculations below a conversion factor of 6 dB (4 times) is used between the bandwidth of DECT and UMTS. The approximate figure of 6 dB is accurate enough for the purpose of this study.

The calculations below of ACS and ACLR for DECT are based on specification for DECT for the basic DECT frequency band 1880-1900 MHz. The same specification parameters are supposed to apply also for DECT carriers extended into the 1900-1920 MHz.

A4.2 CALCULATION OF ACS FOR DECT

ACS for DECT is derived by combining clause 6.4 “Radio receiver interference performance” and clause 6.5 “Radio receiver blocking” of ref. [19].

> ***6.4 Radio receiver interference performance***
> *With a received signal strength of -73 dBm (i.e. 70 dBμV/m) on RF channel M, the BER in the D-field shall be maintained better than 0,001 when a modulated, reference DECT interferer of the indicated strength is introduced on the DECT RF channels shown in Table A2.1.*

Table 92: Radio interference performance

Interferer on RF channel "Y":	Interferer signal strength (dBμV/m)	Interferer signal strength (dBm)
Y = M	59	-84
Y = M ± 1	83	-60
Y = M ± 2	104	-39
Y = any other DECT channel	110	-33
NOTE: The RF carriers "Y" shall include the three nominal DECT RF carrier positions immediately outside each edge of the DECT band.		

ACS (N^{th} adj. ch.) = Interferer signal strength (Y=M) - Interferer signal strength (Y=M+N).

C/I = Received signal strength - Interferer signal strength (Y=M) = -73 + 84 = 11 dB.

The table below shows the ACS figures for the first 3 adjacent channels.

Table 93: ACS for DECT-like interferer

ACS (1st adj. ch.)	24 dB
ACS (2nd adj. ch.)	45 dB
ACS (3rd adj. ch.)	51 dB
ACS (4th adj. ch.)	See below
ACS (5th adj. ch.)	See below

ACS for the 4th adjacent channels is calculated from the blocking requirements.

6.5 Radio receiver blocking

With the desired signal set at -80 dBm, the BER shall be maintained below 0,001 in the D-field in the presence of any one of the signals shown in table 5.

The receiver shall operate on a frequency band allocation with the low band edge F_L MHz and the high band edge F_U MHz.

Table 94: Radio interference performance

Frequency (f)	Continuous wave interferer level	
	For radiated measurements dB µV/m	For conducted measurements dBm
25 MHz $\le f < F_L$ - 100 MHz	120	-23
F_L - 100 MHz $\le f < F_L$ - 5 MHz	110	-33
$\lvert f - F_C \rvert$ > 6 MHz	100	-43
F_U + 5 MHz $< f \le F_U$ + 100 MHz	110	-33
F_U + 100 MHz $< f \le$ 12.75 GHz	120	-23

For the basic DECT frequency band allocation FL is 1 880 MHz and FU is 1 900 MHz. Receivers may support additional carriers, e.g. up to FU = 1 920 MHz.

Thus for F_U = 1900 MHz the blocking level -33 dBm applies for the frequency range 1905 MHz < f <= 2000 MHz.

The blocking figure -33 dBm can be translated into an ACS figure:

ACS (1905 MHz) = Blocking level – Desired signal + C/I = -33 + 80 + 11 = 58 dB.

Related to the DECT carrier F0, 1905 MHz falls between the 4th and 5th adjacent carrier.

Thus it is possible to complement the ACS above table for the 4th and 5th adjacent carrier, where the figure for the 4th adjacent carrier is derived through best guess interpolation:

Table 95: ACS for DECT-like interferer

Adjacent channel #	ACS
1st adj. ch.	24 dB
2nd adj. ch.	45 dB
3rd adj. ch.	51 dB
4th adj. ch.	55 dB
5th & higher adj. ch.	58 dB

The table above formally applies for DECT carrier F0, but at 1905 MHz, just 5 MHz outside of the DECT band, the main attenuation comes from the IF-filter, and very little from the RF-filter, and thus the table is supposed to be relevant for all DECT carriers F0 to F9.

The ACS figures above, are, as mentioned above, supposed to be relevant also for DECT carriers F10 – F21.

The next step is to relate the DECT ACS table to a broadband adjacent interferer with about 4 MHz bandwidth operating on the block 1920-1925 MHz. As an approximation the ACS related to a 4 MHz interferer is calculated as the sum of the weighted average linear attenuation (times not dB) of the two adjacent channels falling within the 4 MHz interfering channel. (The two channels are given the weight 0.5 each.) The figure below shows which two adjacent channels that shall be used, depending on the interfered DECT carrier FX, X = 18 - 21. The MHz line shows relative distances between a DECT carrier FX and a UMTS interferer centered at 1922.5 MHz.

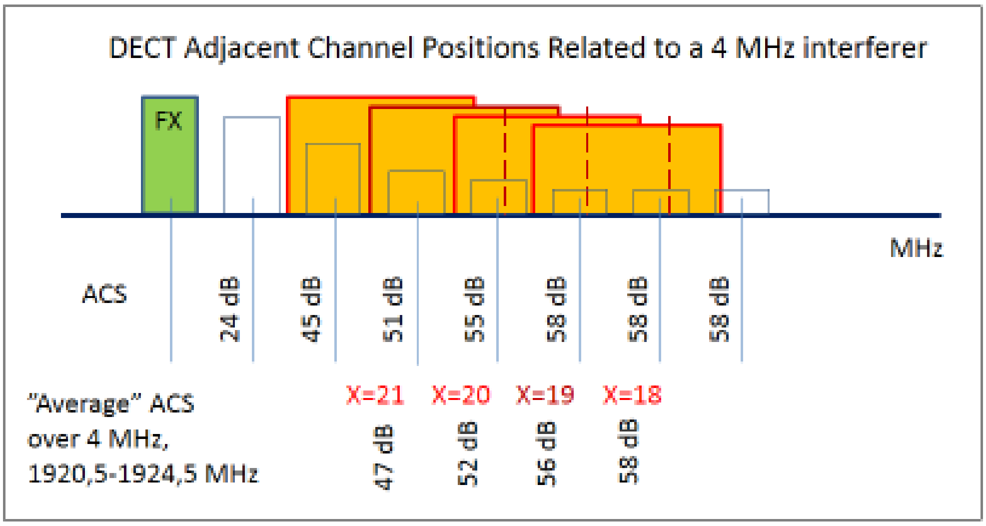


Figure 76: Estimated ACS related to a 4 MHz wide interferer at 1922.5 MHz, for DECT carriers F18 to F21

The DECT ACS related to a 4 MHz interferer in the block 1920-1925 MHz becomes:

Table 96: DECT ACS for a 4 MHz interferer within 1920.5 – 1924.5 MHz

DECT Carrier	ACS	Interference level for 3 dB desensitization
F21	47 dB	-56 dBm
F20	52 dB	-51 dBm
F19	56 dB	-47 dBm
F18 – F0	58 dB	-45 dBm

The power level of the interferer within the band 1920-1925 MHz is related to 3 dB desensitization of the DECT receiver, which corresponds to -103 dBm (= noise level).

A4.3 CALCULATION OF ACLR FOR DECT

ACLR for DECT is derived from clause 5.5.1 “Emissions due to modulation” of ref [19]:

Table 97: Emissions modulation

Emissions on RF channel "Y"	Maximum power level
Y = M ± 1	160 µW
Y = M ± 2	1 µW
Y = M ± 3	80 nW
Y = any other DECT channel	40 nW
NOTE: For Y = "any other DECT channel", the maximum power level shall be less than 40 nW except for one instance of a 500 nW signal.	

The above power level measurements are made with 1 MHz bandwidth.

The DECT transmit power is 250 mW or 24 dBm.

From the table above, we derive the following ACLR figures.

Table 98: ACLR for DECT (in 1 MHz channels)

Adjacent Channel No	Maximum power level	ACLR
1st	160 µW or -8 dBm	32 dB
2nd	1 µW or -30 dBm	54 dB
3rd	80 nW or -41 dBm	65 dB
4th and higher	40 nW or -44 dBm	68 dB

When the victim is UMTS, or any other technology, with a receive filter band approximately 1920.5-1924.5 MHz, an “average” ACLR (times and not dB) should be estimated from the ACLR of the two adjacent DECT channels which, depending on DECT carrier number FX, fall within the band 1920.5-1924.5 MHz. (The “average” is estimated by weighting the two channels by a factor 0.5 each.) The MHz line shows relative distances between a DECT carrier FX and a UMTS 4 MHz receiver centered at 1922.5 MHz.

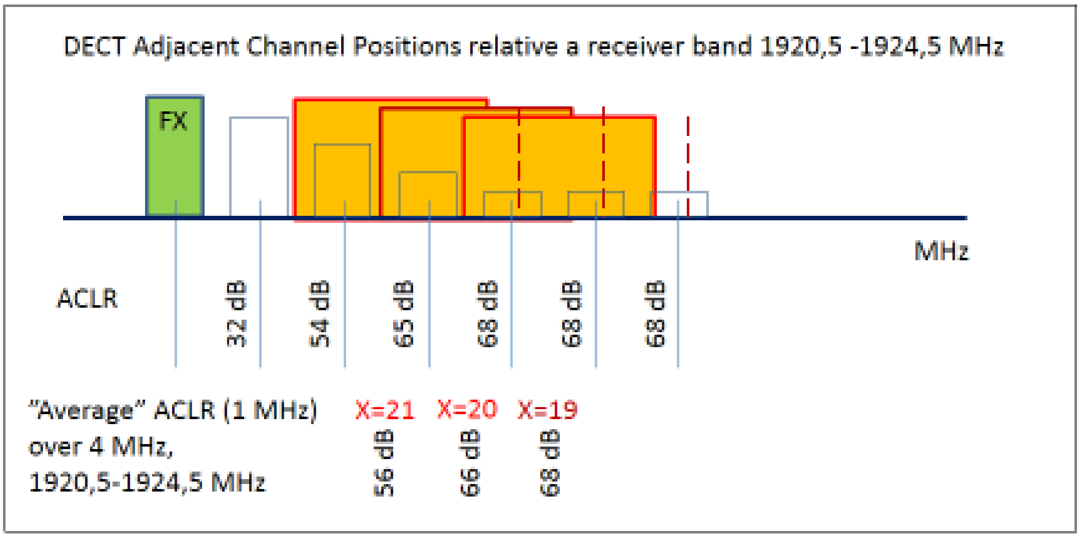


Figure 77: Estimated ACLR (1 MHz) figures for DECT carriers F0 to F9, averaged over a receive channel 1920.5-1924.5 MHz

Thus the ACLR for different DECT carriers F21-F19 averaged over the band 1920.5-1924.5 MHz becomes:

Table 99: DECT ACLR for a victim with a receive filter band 1920.5-1924.5 MHz

DECT Carrier	Average ACLR (1 MHz bandwidth)	ACLR (4 MHz bandwidth)	Maximum power level (4 MHz bandwidth)
F21	56 dB	50 dB	2,5 μW or -26 dBm
F20	66 dB	60 dB	250 nW or -36 dBm
F19 –F0	68 dB	62 dB	160 nW or -38 dBm

A4.4 DECT TRANSMIT POWER LEVELS, RECEIVER SENSITIVITY AND INDOOR PROPAGATION MODEL

A4.4.1 DECT transmit power levels

The nominal transmit power for each DECT transmitter is maximum 24 dBm (250 mW)

Maximum e.i.r.p. levels are 26 dBm for omni-directional antennas and maximum 30 dBm for directional antennas [22]. These new antenna requirements for licence exempted DECT devices were accepted by the ECC in November 2013 [22]. Previous version allowed 12 dBi antenna gain [21].

More than 99 % of the transmitters are handsets (PP) and base stations (RFP) in residential systems, which both have small integrated antennas. For those it is feasible to suppose 24 dBm and a 0 dBi antenna.

For pico-cell enterprise systems as described by Figure 65, assessment of the influence of DECT antenna gain can be summarized as: For portable equipment entering a DECT site, the probability of interference depends primarily on the totally radiated power and is rather independent of the shape of the antenna pattern; and for interference form DECT outdoor base stations to outdoor NLOS cellular base stations, it can be assumed that the antenna directivity may have a limited impact on the probability of interference."

The same conclusion is expressed in Annex A Overview of earlier coexistence studies on DECT of ETSI TR 103 089 [31]:

"It has been concluded in clause 6.4 of the present document, that the usage of 24 dBm total transmit power and an isotropic antenna (0 dBi antenna gain) is a valid approximation for analysing below rooftop and indoor DECT systems complying with the DECT Harmonized Standard EN 301 406 [20], which specifies 24 dBm terminal power and a maximum antenna gain of 12 dBi (new value [22] corresponds to 6 dBi).

Also during the preparation of the revised ERC Decision (98)22 [22], simulations were made of the impact of outdoor DECT below rooftop base stations using 24 dBm transmit power and 8 and 11 dBi antennas.

According to the simulations the impact of antennas directional in the horizontal plane seems limited when compared to the 0 dBi antenna case." The few DECT license exempt outdoor base stations are clearly intended to be installed below roof top. See Considering l) of [22].

A proper power notation to be used for the intended DECT system installations is 24 dBm and 0 dBi. Based on the above referenced studies and investigations performed, this power notation will well reflect the overall impact from DECT to other technologies adjacent to DECT. This conclusion is a proper approximation and also simplifies interference assessments from DECT.

A4.4.2 Maximum allowable interfering signal level for DECT

The thermal noise floor for DECT is -114 dBm.

Noise figure 11 dB gives a receiver noise level of -103 dBm.

DECT requires a C/(N+I) of 21 dB

The maximum allowable interfering signal level for DECT is -103 dBm/MHz for 3 dB desensitization of the DECT receiver.

See CEPT Report 19 [27] section 5.6.3, the last paragraph:

> "*In order to provide an appropriate protection level to DECT system from adjacent band WAPECS systems, it is proposed to use the typical receiver sensitivity of -93 dBm (measured as a maximum total power within any bandwidth of 1.152 MHz) plus a margin of 10 dB (leading to -103 dBm) as the upper limit for out of band emissions for the adjacent frequencies to the band 1880 to 1900 MHz ensuring a sufficient protection level of DECT.*"

Note that the receiver sensitivity requirement of ETSI EN 300 175-2 [19] is only -83 dBm, (which can lead to confusion when deriving ACS figures from e.g. the DECT blocking requirements [19]). The -83 dBm level was many years ago thought relevant to allow cost efficient design of a price sensitive consumer product at 2 GHz. But since the range had to be comparable to analogue cordless phones at 900 MHz, DECT manufacturers very early succeeded to make cost efficient DECT phones with -93 dBm sensitivity, which is the industry standard since then.

A4.4.3 Proper propagation models for DECT indoor scenarios

For the enterprise applications, a model based on measurements in a rather modern multi store office building is proposed. The model taken [28] has the base station in the corridor and the users in surrounding rooms. A correction factor of 8 dB has been used to relate the 5 GHz measurements to 2 GHz. The propagation loss L has for the purpose of this document been approximated to:

$L = 38 + 30 \log(d)$ [dB], where d is the distance in meters.

This formula is relevant for $d >= 4$ m, since some kind of wall is in the path.

For $d < 4$ m "line-of-sight", $L = 38 + 20 \log(d)$ applies.

This model is feasible to be used also for residential systems.

A4.5 RELEVANT ACLR AND ACS FIGURES FOR UMTS FDD 3.84 MCPS OPTION OPERATING ON THE BAND 1920-1925 MHz

Relevant ACLR and ACS for UMTS FDD in relation to DECT is

- ACLR for UMTS UE (MS) and
- ACS for the UMTS BS.

These parameters are calculated below, related to the DECT carriers F0-F21.

Corresponding parameters for LTE are similar to the UMTS figures. Therefore this calculation is relevant also for LTE.

The table below shows the frequency separation between DECT carriers and the broadband centre carrier 1922.5 MHz and the band edge frequency 1920 MHz, respectively.

Table 100: Frequency separation between DECT carriers and the broadband center carrier 1922.5 MHz respectively the band edge frequency 1920 MHz.

DECT Carrier	DECT carrier frequency, MHz	Broadband carrier (1922.5 MHz) to DECT carrier separation, Δf MHz	Band edge (1920 MHz) to DECT carrier separation, Δf_{OOB} MHz
F10	1899.072	23.4	20.9
F11	1900.800	21.7	19.2
F12	1902.528	20.0	17.5
F13	1904.256	18.2	15.7
F14	1905.984	16.5	14.0
F15	1907.712	14.8	12.3
F16	1909.440	13.1	10.6
F17	1911.168	11.3	8.8
F18	1912.896	9.6	7.1
F19	1914.624	7.9	5.4
F20	1916.352	6.1	3.6
F21	1918.080	4.4	1.9

The broadband adjacent channel positions are shown below in relation to the DECT carriers in the band 1900-1920 MHz.

The ACLR and ACS figures have to be calculated for the 1st, 2nd, 3rd and 4th adjacent UMTS channel.

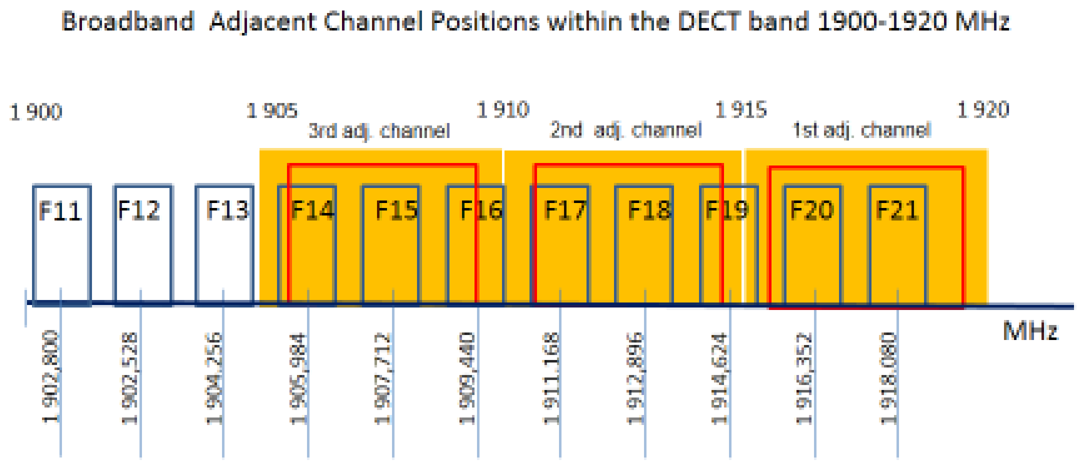


Figure 78: Broadband adjacent channel positions within the DECT band 1900-1920 MHz

A4.5.1 UMTS FDD 3.84 Mcps option - ACLR for UE(MS) and ACS for BS

For UMTS UE transmit power 24 dBm (Power Class 3, see [32]) has been selected. For UMTS BS transmit power 43 dBm has been selected.

For DECT carriers F0-F21, the table below shows the ACLR for UMTS UE (MS) in relation to a DECT receiver (1 MHz) and ACS for the UMTS BS.

Table 101: UMTS FDD 3.84 Mcps Option. ACLR for UE(MS) and ACS for BS

DECT Carriers / # of adj UMTS ch	UMTS UE (24 dBm TX Power)			UMTS BS (Thermal noise level -103 dBm)
	OOBE dBm/MHz	ACLR 4 MHz RX	ACLR 1 MHz RX	ACS
F20 - F21 / 1st		33 dB	39 dB	46 (61)** dB
F19 - F17 / 2nd		43 dB	49 dB	58 (61)** dB
F16 - F11 / 3rd, 4th	-36*	54 dB	60 dB	58 (71)** dB
F10, F0 - F9 / < 1900 MHz				83 (84)** dB

For UMTS UE the ACLRs for the 1st and 2nd adjacent channels are derived from [32] "*Table 6.11:UE ACLR*". ACLR for the 3rd and 4th adjacent channels are derived from "*Table 6.13: Additional spurious emissions requirements*". (*) The requirement is -41 dBm within 300 kHz, which corresponds to -36 dBm/MHz. For the UMTS BS the ACS for the 1st adjacent channel has been derived from [25] *"Table 7.3: Adjacent Channel Selectivity"*. An interference level of -52 dBm is indicated, and this corresponds to an ACS of about 46 dB. (See Report ITU-R M.2039-2 [16], Table 10A). For the 2nd, 3rd, and 4th adjacent channel, the figures have been derived from *"Table 7.4: Blocking requirements for Wide Area BS"*. There the interfering signal is -40 dBm within the band 1900-1920 MHz. This is 12 dB higher than for the 1st adjacent channel, giving ACS = 58 dB. The same table indicates an interfering signal of -15 dBm for frequencies below 1900 MHz, giving ACS = 83 dB. **) Measured performance of real UMTS FDD BS from Table 6 of CEPT Report 39 [8].

A4.6 CALCULATION OF ACIR FIGURES

The adjacent channel leakage power ratio, ACLR of the interferer and adjacent channel selectivity, ACS of the victim, are combined to give an adjacent channel interference ratio, ACIR, according to the following equation:

$$ACIR^{-1} = ACLR^{-1} + ACS^{-1} \qquad \text{(for ACIR, ACLR and ACS as linear ratios)}$$

The interference at the victim receiver becomes: P_{Tx} [dBm] – ACIR [dB] – L [dB], where P_{Tx} is the transmit power of the interferer, and L is the link budget or propagation loss, including antenna gain, between interferer and victim.

A4.6.1 ACIR for UMTS UE (MS) interfering DECT

The ACLR figures of UMTS UE are found in Table 101. The ACS figures for DECT are found in Table 95. The table below indicates the related ACIR figures, which depend on the DECT carrier Fx.

Table 102: ACIR from UMTS UE (MS) FDD 3.84 Mcps Option for a DECT victim

DECT Carriers / # of adj UMTS ch	ACLR of UMTS MS (1 MHz bandwidth)	ACS of DECT	ACIR
F21 / 1st	39 dB	47 dB	39 dB
F20 / 1st	39 dB	52 dB	39 dB
F19 / 2nd	49 dB	56 dB	48 dB
F18 –F17 / 2nd	49 dB	58 dB	48 dB
F16 - F11 / 3rd, 4th	60 dB	58 dB	56 dB
F10, F0 – F9 / < 1900 MHz	60 dB	58 dB	56 dB

The figure indicates severe potential interference to DECT from UMTS FDD handsets visiting a DECT site. This is due to the low ACLR (33 dB) of UMTS (and LTE) handsets.

This case has been analysed in CEPT Report 39 [8] for the boarder 1900 MHz with a UMTS TDD system operating in the block 1900 -1905 MHz.

The result can be derived from the following statement (third last paragraph of section A3.2 of annex 3 of CEPT Report 39 [8]):

“The 1 % (interference probability) limit is also met if the DECT system can orderly escape from interference on carriers F3-F0 to any of the carriers F9-F4. The DECT instant Dynamic Channel Selection (DCS) procedure creates the necessary 5-10 MHz guard band within the DECT band, at the expense of capacity loss.”

A simple traceable statistical analysis has been used in Annex 3. The statement above indicates that when one active UMTS UE enters a DECT site, the probability to cause an inescapable interference is less than 1 %. This low probability has two conditions: 1) that an orderly escape to a “free” channel possible, and 2) that the capacity loss of a temporary guard band of 10 MHz within the extension band is acceptable.

The condition 1) is fulfilled by UMTS FDD. See explanation above and in section 6.6.2 of ETSI TR 103 089 [31].

The condition 2) could be assumed to be fulfilled by the fact that the 1900-1920 MHz is an extension to the base band 1880-1900 MHz, the capacity of which is available.

A4.6.2 ACIR for DECT interfering UMTS BS

The ACLR figures of DECT are found in Table 98. The ACS figures for UMTS BS are found in Table 101. The table below indicates the related ACIR figures, which depend on the DECT carrier Fx.

Table 103: ACIR from DECT for a UMTS BS victim with a receive filter band 1920.5-1924.5 MHz

DECT Carriers / # of adj UMTS ch	ACLR of DECT (4 MHz bandwidth)	ACS of UMTS BS	ACIR (standard ACS)	ACIR (real BS ACS)
F21 / 1st	50 dB	46 / 61* dB	45 dB	50 dB
F20 / 1st	60 dB	46 / 61* dB	46 dB	58 dB
F19 –F17 / 2nd	62 dB	58 / 61* dB	57 dB	59 dB
F16 - F11 / 3rd, 4th	62 dB	58 / 71* dB	57 dB	62 dB
F10, F0 – F9 / < 1900 MHz	62 dB	83 / 84* dB	62 dB	62 dB

*) Measured performance of real UMTS FDD BS from Table 6 of CEPT Report 39 [8].

For the purpose of this study, the ACIR values for ACS from a real BS are used. From the table above it is seen that for transmissions on DECT carrier F21, the ACIR is 50 dB. DECT is randomly using the different carriers F0-F21. ACIR figures are very similar for carriers F11-F20: 1 value 58 dB, 3 values 59 dB and 6 values 62 dB. For the purpose of this study an average ACIR of 60 dB for carriers F11-F20 is a feasible simplification. This is summarized in the table below.

Table 104: Summary table for ACIR from DECT for a real UMTS BS victim

DECT Carriers / # of adj UMTS ch	ACIR (real BS ACS)
F21 / 1st	50 dB
F20 –F11	60 dB
F10, F0 – F9 / < 1900 MHz	62 dB

A4.6.3 ACIR for UMTS UE (MS) interfering UMTS BS operating on adjacent 5 MHz blocks

Parameters for ACIR calculation for the 1st adjacent channel are found in Table 101 first row. ACLR for the UMTS UE is 33 dB and ACS for the real UMTS BS is 61 dB. ACIR becomes 33 dB.

A4.7 INTERFERENCE FROM AN FDD UMTS UE (MS) VISITING AN INDOOR DECT SITE

The most common and critical interference scenario for interference for UMTS UE (MS) to DECT, is when a UMTS UE visits a DECT indoor site, and transmits on a UMTS block adjacent to the DECT band. See Annex A of ETSI TR 103 089 [26].

This case has already been well analysed in Annex 3 of CEPT Report 39 [8]. The only difference is that in [8], the analysis is made for a UMTS TDD UE transmitting on the block 1900-1905 MHz adjacent to the DECT base band 1880-1900 MHz. The ACIR figures of the above Table 102 are very similar to the corresponding Table 27 in [8]. The results from [8] can be directly used for the UMTS FDD case at 1920 MHz, because the ACLR and out-of-band specifications are equal or very similar for UMTS TDD UE and FDD UE.

Therefore, the results of [8] will be used in this report.

The result is derived from the following statement (third last paragraph of section A3.2 of annex 3 of CEPT Report 39 [8]):
"The 1 % (interference probability) limit is also met if the DECT system can orderly escape from interference on carriers F3-F0 to any of the carriers F9-F4. The DECT instant Dynamic Channel Selection (DCS) procedure creates the necessary 5-10 MHz guard band within the DECT band, at the expense of capacity loss."

The statement above indicates two things:

- An active UMTS UE entering a DECT site will typically block 5 up to 10 MHz of the DECT frequency band;

- If the DECT system can orderly escape* from interfered channels, then DECT can use the remaining part of the spectrum, without quality degradation, as long as the traffic capacity loss is acceptable.

*) Depending on the transmit pattern of the interfering signal, it may be easy or difficult for DECT to interpret the nature of the interference, so that DECT can make a correct differentiation between the bad and good DECT access channels. It is easy for DECT to make an orderly escape from a continuous FDD signal. More information on the ability of DECT to be compatible with different classes of transmission patterns, is found in time in section 6.6 of ETSI TR 103 089 [31].

A4.7.1 Conclusion on potential interference from UMTS FDD UE to DECT

The UMTS UE will cause DECT to create a temporary guard band of up to 10 MHz of the extension band 1900-1920 MHz, when an active UE enters a DECT indoor site. This will not cause a quality degeneration of the DECT radio links. There will however be a local temporary capacity loss, but this is regarded acceptable, since the band 1900-1920 MHz is an extension band to the DECT base band 1880-1900 MHz, leaving typically 30 MHz free.

ANNEX 5: LIST OF REFERENCES

[1] ETSI TR 103 054: Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Broadband Direct-Air-to-Ground Communications operating in part of the frequency range from 790 MHz to 5 150 MHz

[2] ECC Report 209: Compatibility/sharing studies related to Broadband Direct-Air-to-Ground Communications (DA2GC) in the frequency bands 1900-1920 MHz / 2010-2025 MHz and services/applications in the adjacent bands

[3] ECC Report 200: Co-existence studies for proposed SRD and RFID applications in the frequency band 870-876 MHz and 915-921 MHz

[4] ECC Report 191: Adjacent band compatibility between MFCN and PMSE audio applications in the 1785-1805 MHz frequency range..

[5] ETSI EN 300 422: Wireless microphones in the 25 MHz to 3 GHz frequency range

[6] ERC Report 68: Monte Carlo Simulation Methodology for use in sharing and compatibility studies between different radio services or systems

[7] SEAMCAT Version 4.0.1 - free download and user manual at: www.seamcat.org

[8] CEPT Report 39: Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for 2 GHz bands.

[9] CEPT FM48/51(13)007 Annex 2: Liaison Statement to SE44 and WG SE / Subject: Broadband DA2GC and PMSE; Frequency bands 1900-1920 MHz and 2010-2025 MHz; January 2013.

[10] ERC Report 38: Handbook on Radio Equipment and Systems Video Links for ENG/OB Use; May 1995.

[11] ECC Report 172: Broadband Wireless Systems Usage in 2300-2400 MHz; March 2012.

[12] ETSI EN 302 064-1: Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless Video Links (WVL) operating in the 1,3 GHz to 50 GHz frequency band; Part 1: Technical characteristics and methods of measurement; V1.1.2, July 2004.

[13] ETSI ES 202 239: Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless digital video links operating above 1,3 GHz; Specification of typical receiver performance parameters for spectrum planning; V1.1.1, October 2003.

[14] 3GPP TS 36.101: User equipment (UE) radio transmission and reception; V10.3.0, June 2011.

[15] 3GPP TS 36.104: Base station (BS) radio transmission and reception.

[16] ITU-R Report M.2039: Characteristics of terrestrial IMT-2000 systems for frequency sharing/ interference analyses; November 2010.

[17] ITU-R Recommendation F.699-7: Reference radiation patterns for fixed wireless system antennas for use in coordination studies and interference assessment in the frequency range from 100 MHz to about 70 GHz; April 2006.

[18] ETSI TR 101 599, System Reference Document on Broadband Direct-Air-to-Ground Communications System employing beamforming antennas, operating in the 2.4 GHz and 5.8 GHz bands; V1.1.3 September 2012.

[19] ETSI EN 300 175-2 “Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical Layer”.

[20] ETSI EN 301 406: “Digital Enhanced Cordless Telecommunications (DECT); Harmonized EN for Digital Enhanced Cordless Telecommunications (DECT) covering the essential requirements under article 3.2 of the R&TTE Directive Generic radio

[21] ERC/DEC/(94)03: ” ERC Decision of 24th October 1994 on the frequency band to be designated for the coordinated introduction of the Digital European Cordless Telecommunications system”

[22] ERC/DEC/(98)22: “Exemption from Individual Licensing of DECT equipment”, Approved 23 November 1998. Amended 8 November 2013.

[23] ETSI TR 101 310: "Digital Enhanced Cordless Telecommunications (DECT); Traffic capacity and spectrum requirements for multi-system and multi-service DECT applications co-existing in a common frequency band".

[24] CEPT WGSE SE(12)040 Annex 16 “Liaison Statement from WG SE to WG FM (cc: ECC-PT1) on Digital Enhanced Cordless Telephony (DECT) studies”.

[25] ETSI EN 125 104 “Universal Mobile Telecommunications System (UMTS); Base Station (BS) radio transmission and reception (FDD)”

[26] ETIS TS 136 104: Base station (BS) radio transmission and reception.

[27] CEPT Report 19 “Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for frequency bands addressed in the context of WAPECS”

[28] IEEE VTC Fall 2000 Boston “Simple and Accurate Path Loss Modelling at 5 GHz in Indoor Environments with Corridors”, Jonas Medebo, Jan-Erik Berg, Ericsson Radio Systems AB.

[29] ITU-R Recommendation P.525-2: Calculation of free-space attenuation; August 1994.
[30] SEAMCAT (Spectrum Engineering Advanced Monte Carlo Analysis Tool) Handbook, January 2010.
[31] ETSI TR 103 089: "Digital Enhanced Cordless Telecommunications (DECT); DECT properties and radio parameters relevant for studies on compatibility with cellular technologies operating on frequency blocks adjacent to the DECT frequency band".
[32] ETSI EN 125 101 “Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (FDD)”
[33] ECC Report 219: “Characteristics of PMSE digital video links to be used in compatibility and sharing studies”