# Introduction

This sharing study describes the interference scenarios between wireless broadband low and medium power base station (WBB LMP BS) transmitters and the Fixed Service (FS) receivers in the band 3800-4200 MHz. While identifying key parameters, interference scenarios, the propagation model and the protection criteria, the needed separation distances for the protection of FS from WBB LMP BS are calculated via MCL and these results are analysed.

These Minimum Coupling Loss (MCL) simulation results are analysed to determinate needed conditions for the co-channel coexistence while ensuring the protection of the FS. For this, the interference from the WBB LMP BS into the FS stations is studied. Interference from FS into WBB LMP was not considered in this study.

# INterference Scenario

Several scenarios are considered in this study:

* Outdoor to outdoor
* Indoor to outdoor for the low power WBB BS

UK/NOR approach with 12 dB building loss

Traditional building loss

Thermally efficient building loss

* Outdoor to outdoor with real deployment FS parameters

## Fixed Service Parameters

Fixed Service in this band is usually used for long distance links. For example about 50% of all FS links in Germany have a length of 50 km to 130 km. To enable such long distances for the FS links, there is a need for very high antenna heights (see Figure 1).

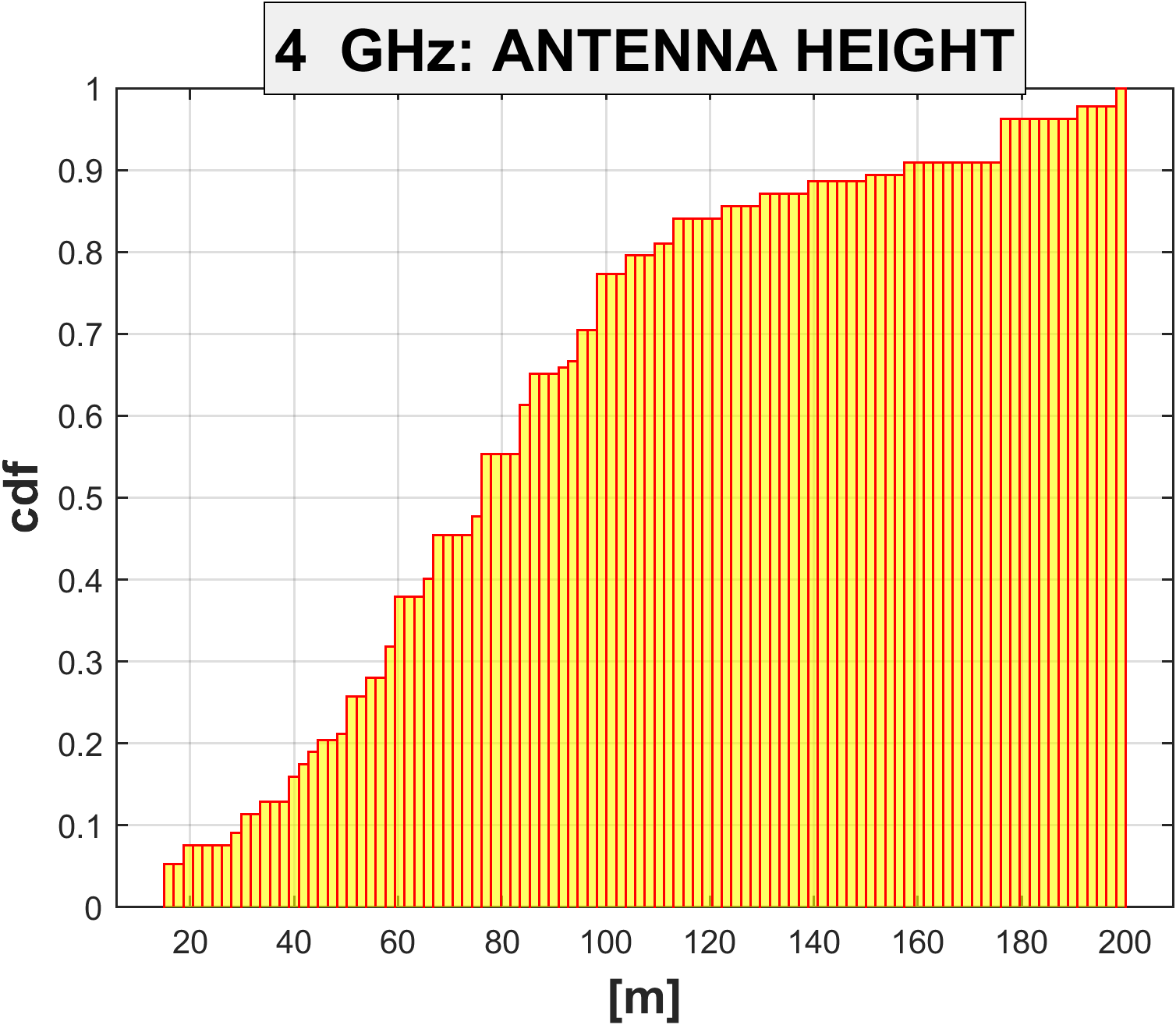


Figure 1: Real deployment of FS antenna heights in Germany

The study looks into two different sets of parameters for comparison. Generic parameters from ITU-R Recommendations and real FS deployment parameters based on the situation in Germany. The current use of FS links in the band is assumed to decrease, possibly stagnating. These links are often stationed in a rural environment or height above the clutter.

Recommendation ITU-R F.758 provides a generic set of FS parameters that are commonly used in sharing and compatibility studies and referred by the expert group WG SE19 for a number of other studies (e.g. CEPT Report 75). An FS antenna height of 50 m is assumed for the generic study, as it is not defined in ITU-R F.758.

ITU-R F.699-8 is used to calculate the gain of the FS antenna (see Figure 2), with the parameters given in ITU-R F.758-7 for the relevant frequency band (the detailed FS parameters are listed in ANNEX 2:).

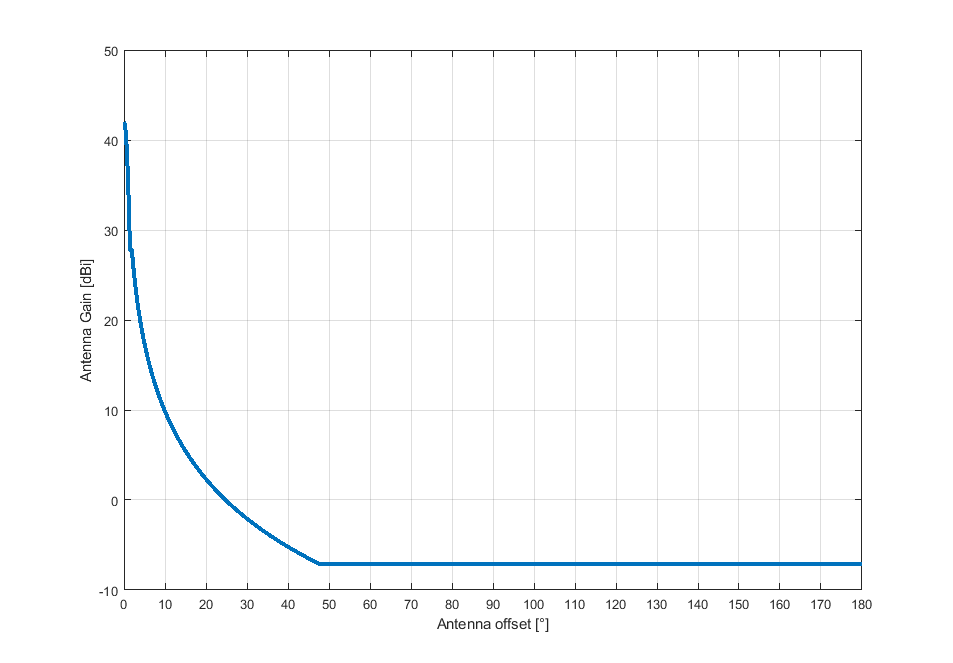


Figure 2: point-to-point FS antenna pattern with 42 dBi max gain (Recommendation ITU-R F.699)

Table 1: Main differences between generic and real deployment parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Generic case | Real deployment  (average height) | Real deployment 2  (worst case) |
| Antenna height (h\_FS) | 50 m | 80 m | 180 m |
| Antenna gain (G\_FS) | 42 dBi | 38 dBi | 38 dBi |

## WBB LMP Parameters for 3800-4200 MHz

Parameters for the WBB LMP 3800-4200 MHz based on the UK/NOR approach (detailed WBB LMP parameters are listed in ANNEX 1:).

Table 2: Scenario parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Value |  |
| f | 3800 MHz | worst case frequency |
| hBS,LP | 10 m | Base station height **low power BS** scenario |
| hBS,MP | 25 m | Base station height **medium power BS** scenario |

## Propagation model

Recommendation ITU-R P.452-16 is used to calculate the path loss (PL) between FS and WBB LMP with a time percentage of 20% to match the FS long-term protection criteria. The study assumes non-time variant assumptions, e.g. both victim services and interfering services are static.

Clutter is applied on the WBB side for the **low power** BS scenario, as the maximum antenna height is limited to 10m. ITU-R P.2108-1, with 50 percentage of locations is used to calculate the average clutter loss.

L\_Clutter = 31 dB

No clutter is applied for the **medium power** BS scenario, as the antenna height for both services is considered above the average clutter level.

Building entry loss (L\_BEL) is considered for the **indoor** WBB **low power** BS scenario. Buildings fall into two distinct classes when characterised in terms of entry loss. Recommendation ITU-R P.2109-1 states that the classification of ‘thermally-efficient buildings’ and ‘traditional buildings’ refers purely to the thermal efficiency of construction materials of the complete building (or the overall thermal efficiency). Where modern, thermally-efficient building methods are used building entry loss is generally significantly higher compared to traditional buildings without such materials.

Recommendation ITU-R P.2109-1 suggests for f = 4 GHz a loss of 16 dB for a traditional building and a loss of 31 dB for a thermally-efficient building. Both cases are considered in the study (see section 3.2).

The indoor WBB low power BS scenario is also calculated with L\_BEL = 12 dB. This value is based on the UK/NOR approach (see Table 6 for comparison).

## protection criteria

The protection criteria used in the simulations is I/N = -10 dB. This is the long term interference protection criteria suggested by Recommendation ITU-R F.758, Table 5 and should be used with a time percentage of pt = 20%.

The resulting maximum allowed interference level in the FS receiver is:

Imax = N + NF + I/N = -114 dBm/MHz +3 dB -10 dB = -121 dBm/MHz

# MCL – worst case Analysis

Calculating the maximum allowed interference power:

Imax <= P\_WBB + G\_FS – PL – L\_Clutter – L\_BEL

## Results for the outdoor scenario

The initial scenario analyses the resulting path losses and the necessary separation distances to protect the FS receiver from harmful interference of the outdoor WBB LMP BS.

The results show that coordination may be required to protect the FS receivers from interferences of WBB LMP BS, as the required separation distances can go up to 40 km for the low power BS and 90 km for the medium power BS. The required separation distances are reduced significantly when the BS is placed in the side lobe of the FS receiver for the low power WBB BS.

Table 3: Results for the outdoor scenario (h\_FS = 50m)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Low power BS (P\_WBB\_LP = 11 dBm/MHz) | | Medium power BS  (P\_WBB\_MP = 29 dBm/MHz) | |
| **Calculated path loss (PL)** | **Required separation distance** | **Calculated path loss (PL)** | **Required separation distance** |
| FS main lobe (G\_FS = 42 dBi) | 143 dB | 38.5 km | 192 dB | 90 km |
| FS side lobe (G\_FS = -7.15 dBi) | 94 dB | 0.3 km | 143 dB | 46 km |

Although the necessary path loss for low power BS main lobe and medium power BS side lobe is the same, the difference in the required separation distance results from different antenna heights for both scenarios (LP = 10m height, MP = 25m height).

Figure 3 and Figure 4 show the keyhole plots for the low and medium power outdoor scenarios.

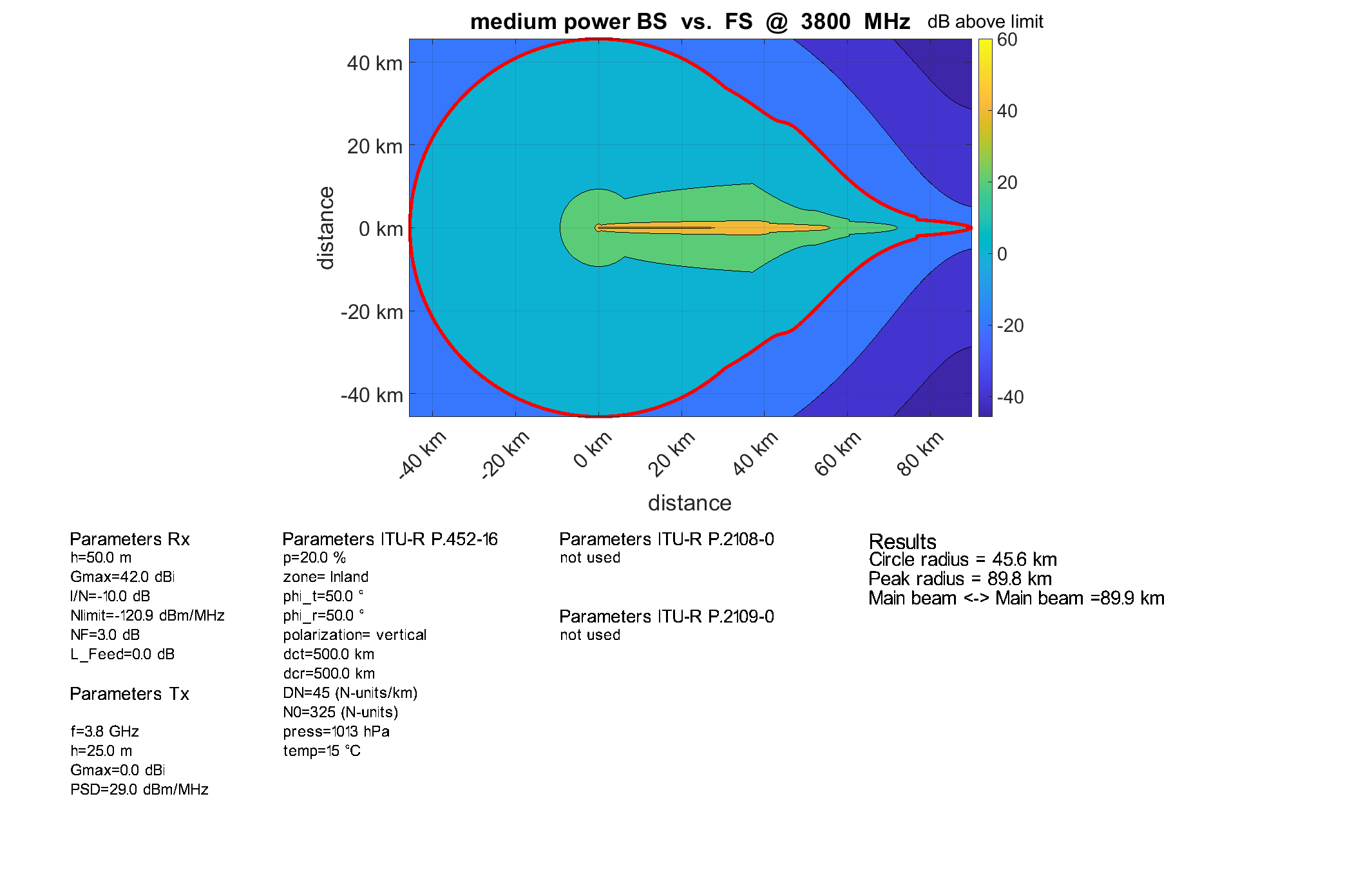


Figure 3: Outdoor medium power BS generic scenario

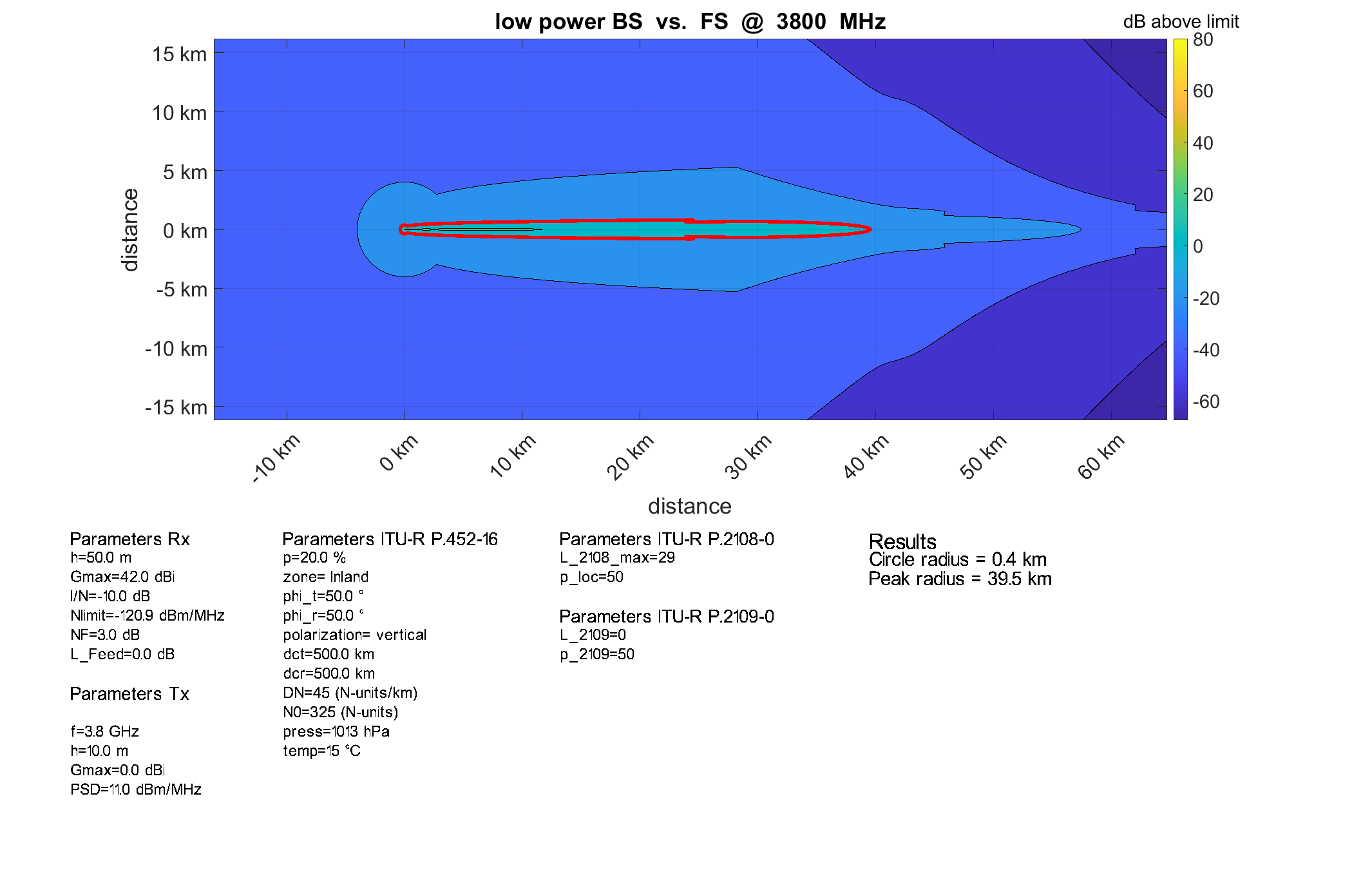


Figure 4: Outdoor low power BS generic scenario, BS inside of clutter

## Results for the indoor scenario

The results for three different building loss attenuations ranging between 12 dB and 31 dB are shown in Table 4 and Table 5. Only the low power WBB BS is studied.

Table 4: Results for the indoor scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Low power BS traditional building L\_BEL = 16 dB | | Low power BS thermally-efficient building L\_BEL = 31 dB | |
| **Calculated path loss (PL)** | **Required separation distance** | **Calculated path loss (PL)** | **Required separation distance** |
| FS main lobe (G\_FS = 42 dBi) | 127 dB | 15.5 km | 112 dB | 2.6 km |
| FS side lobe (G\_FS = -7.15 dBi) | 78 dB | < 0.1 km | 63 dB | < 0.1 km |

Table 5: Results for the indoor scenario with the building entry loss value from the UK/NOR approach

|  |  |  |
| --- | --- | --- |
|  | Low power BS UK/NOR approach L\_BEL = 12 dB | |
| **Calculated path loss (PL)** | **Required separation distance** |
| FS main lobe (G\_FS = 42 dBi) | 131 dB | 25.5 km |
| FS side lobe (G\_FS = -7.15 dBi) | 82 dB | < 0.1 km |

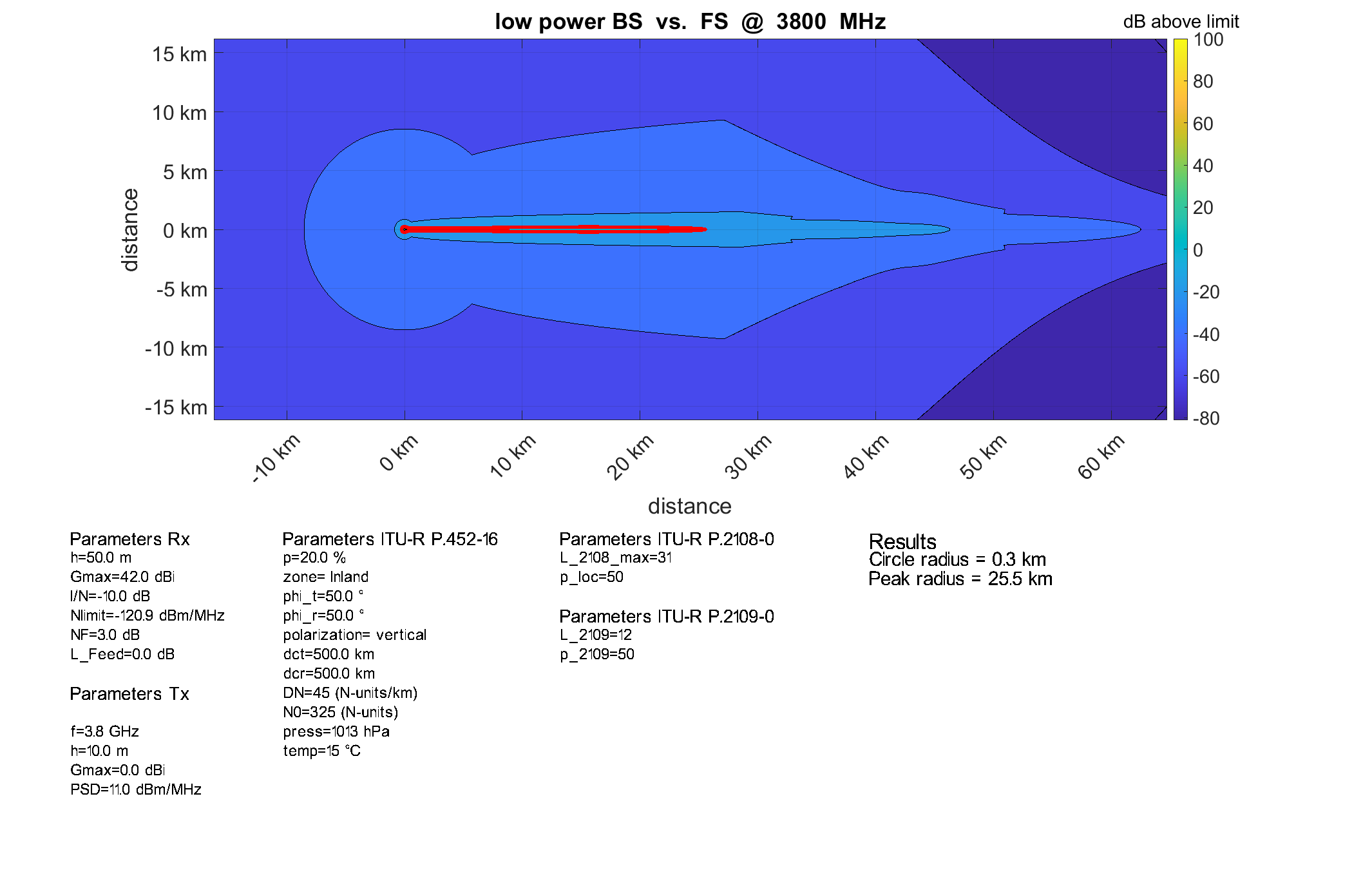


Figure 5: indoor low power BS, BEL = 12 dB

The keyhole plot in Figure 5 shows that placing the low power WBB in the side lobe of the FS receiver would significantly reduce the necessary separation distances.

## Results for real deployment FS parameters

Table 1 shows that the real deployment in Germany focuses on very high FS antennas in comparison to the assumed height in the generic scenario. The calculations lead to bigger interference distances, although the maximum FS antenna gain is 3 dB lower than suggested in Recommendation ITU-R F.758 for this frequency band.

Table 6: Results for real deployment FS antenna height of 180 m

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Low power BS (P\_WBB\_LP = 11 dBm/MHz) | | Medium power BS  (P\_WBB\_MP = 29 dBm/MHz) | |
| **Calculated path loss (PL)** | **Required separation distance** | **Calculated path loss (PL)** | **Required separation distance** |
| FS main lobe (G\_FS = 38 dBi) | 139 dB | 56.5 km | 188 dB | 113 km |
| FS side lobe (G\_FS = -7.15 dBi) | 94 dB | < 0.1 km | 143 dB | 69 km |

Table 7: Results for the scenario with the average real deployment FS antenna height of 80 m

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Low power BS (P\_WBB\_LP = 11 dBm/MHz) | | Medium power BS  (P\_WBB\_MP = 29 dBm/MHz) | |
| **Calculated path loss (PL)** | **Required separation distance** | **Calculated path loss (PL)** | **Required separation distance** |
| FS main lobe (G\_FS = 38 dBi) | 139 dB | 41.1 km | 188 dB | 93 km |
| FS side lobe (G\_FS = -7.15 dBi) | 94 dB | 0.3 km | 143 dB | 52 km |

The calculations with real deployment parameters show that the WBB medium power BS can induce interferences into the Fixed Service for very large distances and even into the FS antenna side lobe. The possible interference distance increases even more when using worst case real deployment parameters from the German deployment.

# Summary

The results in this sharing study indicate that the required separation distances to protect FS from WBB LMP may go up to **90.5 km for medium power** WBB BS and up to **38.5 km for low power** WBB BS for a worst case scenario. This distance reduces to about 300 m for the WBB low power BS, if the BS is placed in the side lobe of the Fixed Service antenna.

The results for the medium power WBB BS show also very large interference distances (46 – 69 km) for the FS side lobe. Coordination with a medium power WBB BS would therefore be quite challenging. No clutter is applied for the medium power BS scenario, as the antenna height for both services is considered above the average clutter level.

1. WBB LMP PARAMETERS

Table 8: Parameters of the WBB LMP providing local area network connectivity in 3.8-4.2 GHz from UK/NOR approach

|  |  |  |
| --- | --- | --- |
| Parameter | Low Power BS | Medium Power BS |
| Bandwidth | 10 MHz to 100 MHz | 10 MHz to 100 MHz |
| Antenna height | Outdoor: Limited to a maximum of 10 m above ground  Indoor: Any height within building | No limit |
| Deployment scenario | Outdoor/indoor  or  Indoor-only | Rural areas only |
| BS Tx EIRP limit  (for AAS & non-AAS) | 24 dBm / carrier for carriers ≤ 20 MHz; or  18 dBm / 5 MHz for carriers > 20 MHz | 42 dBm / carrier for carriers ≤ 20 MHz; or  36 dBm / 5 MHz for carriers > 20 MHz |

1. FS Parameters

Table 9: System parameters for PP FS systems in allocated bands between 3 and 12 GHz

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range (MHz) | 3600-4200 MHz | | 3700-4200 MHz |
| Reference ITU-R Recommendation | F.635 | | F.382 |
| Modulation | 64-QAM | 512-QAM | QPSK (Note 3) |
| Channel spacing and receiver noise bandwidth (MHz) | **10**, **30**, 40, 60, 80, 90 | 10, 30, **40**, 60, 80, 90 | 28, **29** |
| Maximum Tx output power range (dBW) | −1 | 7 | 0 |
| Maximum Tx output power density range (dBW/MHz)(1) | −16…−11 | −9.0 | −15 |
| Minimum feeder/multiplexer loss range (dB) | 0 | 3 | 3 |
| Maximum antenna gain range (dBi) | 42 | 40 | 37 |
| Maximum e.i.r.p. range (dBW) | 41 | 44 | 38 |
| Maximum e.i.r.p. density range (dBW/MHz) (Note 1) | 26…31 | 28 | 23 |
| Receiver noise figure (dB) | 3 | 2 | 4 |
| Receiver noise power density typical (=*NRX*) (dBW/MHz) | −141 | −142 | −140 |
| Normalized Rx input level for 1 × 10–6 BER (dBW/MHz) | −114.5 | −106.5 | −126.5 |
| Nominal long-term interference power density (dBW/MHz) (Note 2) | −141 + *I*/*N* | −142 + *I*/*N* | −140 + *I*/*N* |
| Note 1: To calculate the values for the Tx/e.i.r.p. densities, channel spacing/bandwidth needs to be identified. In these Tables, the channel spacing indicated in **bold text** is used.  Note 2: Nominal long-term interference power density is defined by “Receiver noise power density + (required *I*/*N*)” as described in § 4.13 in Annex 2 (see also § 4.1 in Annex 1).  Note 3: There are two modulations (QPSK and 4FSK) described and QPSK is selected. | | | |

Table 10: Long term interference criteria

|  |  |  |  |
| --- | --- | --- | --- |
| I/N  (Note 1) | Frequency range | Sharing/compatibility conditions (Note 2) | Comments and relevant ITU-R Recommendations |
| ≤ –10 dB | Above 3 GHz | Sharing with more than one co-primary service | Apportionment of ITU-R F.1094 objectives (see § 2 in Annex 1 of this Recommendation)  −6 dB or –10 dB, as appropriate, may be applicable where the risk of simultaneous interference from the stations of the other co-primary allocations is negligible. In other cases, a more stringent criterion may be required to account for aggregate interference from all interfering co-primary services (i.e. −6 dB or −10 dB should be intended as maximum aggregate *I*/*N* from all other co-primary services). |
| Note 1: These values of I/N apply to the aggregate interference from the operations of the shared service.  Note 2: For purposes of this Recommendation, compatibility studies refer to those studies performed between FWS and:  – systems in services having allocation on a secondary basis in bands allocated to the fixed service on a primary basis;  – systems in services having allocation in other bands (e.g. in adjacent bands); or  – sources of emissions other than radio services. | | | |