Draft CEPT Report 53

Draft Report from CEPT to the European Commission in response to the Mandate

“to develop harmonised technical conditions for the 694[[1]](#footnote-1)-790 MHz ('700 MHz') frequency band in the EU for the provision of wireless broadband and other uses in support of EU spectrum policy objectives”

**date**

# Executive summary

This CEPT Report has been developed within European Conference of Postal and Telecommunications Administrations (CEPT) in the framework of the EC Mandate on the 700 MHz (see ANNEX 1:).

CEPT was mandated to undertake the following tasks:

1. Develop a *preferred technical (including channelling) arrangement* and identify *common* and *minimal (least restrictive) technical conditions[[2]](#footnote-2)* for wireless broadband use in the 694[[3]](#footnote-3)-790 MHz frequency band for the provision of electronic communications services, subject later to a precise definition of the lower band edge under task (3), as well as PPDR services that can make use of such technical conditions. These conditions should be sufficient:
2. to avoid interference between wireless broadband use and other services in the 6943-790 MHz band and in adjacent bands, and in particular to ensure the appropriate protection of broadcasting and PMSE services below the lower band edge, as well as compliance with EU harmonised conditions for the 790-862 MHz band[[4]](#footnote-4);
3. to facilitate cross-border coordination, including at the EU external borders;
4. In performing (1), study the possibility of identifying *suitable spectrum to accommodate* incumbent uses in the 6943-790 MHz band such as PMSE (in particular wireless microphones)[[5]](#footnote-5), and develop *common technical conditions* for the coexistence of such uses with wireless broadband use in the band, taking into account spectrum sharing requirements and efficient spectrum use;
5. In addition to and based on (1) and taking utmost account of the possibility of international harmonisation[[6]](#footnote-6), assess the need to refine the conditions developed under (1), in particular *the common and minimal (least restrictive) technical conditions*, in order to ensure that they are sufficiently precise for the development of EU-wide equipment. The overall aim of a coordinated European approach should be considered, as implemented through detailed national decisions on frequency rearrangements in line with international frequency coordination obligations;

Task 3 will be addressed further to WRC-15.

CEPT considered the various tasks (1 and 2) as described in the EC Mandate on 700 MHz (see ANNEX 1:) and studied the following issues:

1. **Preferred channelling arrangement in 694 -790 MHz**

CEPT confirmed the lower edge at 694 MHz as the only option to be studied in the WRC-15 preparation and discussed possible channelling arrangements on that basis.

* **Preferred channelling arrangement considering MFCN**

Maximum inter-regional harmonisation is achieved by basing the preferred channelling arrangement on the lower duplexer of the APT 700 MHz band plan allowing for economies of scale. As this would only provide for 63% utilisation of the band by MFCN, placing up to 4 blocks of 5 MHz MFCN SDL in the duplex gap would result in a utilisation of 83% by MFCN. This arrangement is described in ANNEX 2:.

* **Options considering PMSE, PPDR and other services on a national basis**

PMSE could use the guard band and the duplex gap of the paired 2x30 MHz block according to the technical conditions developed in this report.

PPDR (2x5 MHz) could use the guard band (698-703 MHz) and the duplex gap (e.g. 753-758 MHz) of the paired 2x30 MHz block, subject to the compatibility with DTT below 694 MHz. It is assumed that those PPDR systems use a conventional FDD band plan. Nevertheless, studies on the technical conditions for the usage of the band need to be finalised by CEPT. Besides, PPDR could be provided in part of the MFCN blocks. The amount of spectrum to be used for broadband PPDR needs to be flexible to fit the individual requirements of CEPT countries.

Other services could use parts of the duplex gap with the same BEM as for MFCN SDL (see section 3.3 of this report).

These options could be combined together with the usage of a number of MFCN SDL blocks in order to provide flexibility for administrations depending on their requirements.

Additional considerations are described in chapter 2 of this report.

1. **Common least restrictive technical conditions (BEM)**

The technical conditions derived below for the frequency range 694-790 MHz are optimised for, but not limited to, fixed/mobile communications networks (two-way). Therefore, they are derived both for base stations (BS) and terminal stations (TS). The BEMs have been developed to protect other MFCN blocks, as well as other services and applications in adjacent bands and in the spectrum between the MFCN uplink and downlink. The BS BEM also applies if the spectrum in the duplex gap is used to provide a supplemental downlink (SDL). BEMs for BS and TS are developed for equipment used in commercial mobile networks, as well as for PPDR applications operating in the MFCN spectrum.

The Base Station (BS) BEM consists of several elements. The in-block power limit is applied to a block licensed to an operator. The out-of-block elements consist of a baseline level, designed to protect the spectrum of other MFCN operators as well as adjacent services, and transitional levels enabling filter roll-off from in-block to baseline levels. Additionally, elements are provided for guard bands between MFCN and other services and between the MFCN up- and downlink. The BEM is based on minimum coupling loss (MCL) analysis and simulations.

Table 1: contains the different elements of the BS BEM, and Table 2: to Table 6: contain the power limits for the different BEM elements.

To obtain a BS BEM for a specific block, the BEM elements that are defined in Table 1: are used as follows:

* In-block power limit is used for the block assigned to the operator.
* Transitional regions are determined, and corresponding power limits are used. The transitional regions may overlap with guard bands and adjacent bands, in which case transitional power limits are used.
* For remaining spectrum assigned to MFCN UL and DL (including SDL spectrum, if applicable), for DTT spectrum and for spectrum allocated to MFCN above 790 MHz, baseline power limits are used.
* For remaining guard band spectrum (i.e. not covered by transitional regions) guard band power limits are used.

Less stringent technical parameters may be agreed on a bilateral or multilateral basis for the operation of mobile/fixed communications networks (MFCN) in the 694-790 MHz band, providing that they continue to comply with the technical conditions applicable for the protection of other services, applications or networks and with cross-border obligations.

1. BS BEM elements

|  |  |
| --- | --- |
| In-block | Block for which the BEM is derived |
| Baseline | Spectrum used for MFCN UL and DL (including SDL, if applicable), for DTT and for MFCN above 790 MHz (UL and DL)  |
| Transitional region | The transitional region applies 0 to 10 MHz below and above the block assigned to the operator |
| Guard bands | Spectrum between the DTT allocation and the lower edge of the MFCN uplink, spectrum between the MFCN up- and downlink (including SDL, if applicable), and spectrum between the MFCN downlink and the MFCN downlink above 790 MHz (if applicable). In case of overlap between transitional regions and guard bands, transitional power limits are used |

1. BS in-block power limit

| **Frequency range**  | **Maximum mean** **e.i.r.p. power**  | **Measurement** **bandwidth** |
| --- | --- | --- |
| Block assigned to the operator  | Not mandatory. In case an upper bound is desired by an administration, a value of 64 dBm/5 MHz per antenna may be applied. | 5 MHz |

1. BS baseline requirements

| **Frequency range**  | **Maximum mean** **e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| MFCN uplink frequencies and 832- 862 MHz (uplink of 800 MHz band) | -50.4 dBm per cell  | 5 MHz |
| MFCN downlink frequencies and 791-821 MHz (downlink of 800 MHz band) | 16 dBm per antenna | 5 MHz |
| For DTT frequencies wherebroadcasting is protected | -23 dBm per cell | 8 MHz |

1. BS transition requirements below the upper FDD downlink band edge

| **Frequency range**  | **Maximum mean e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| –10 to –5 MHz from lower block edge | 18 dBm per antenna | 5 MHz |
| –5 to 0 MHz from lower block edge | 22 dBm per antenna | 5 MHz |
| 0 to +5 MHz from upper block edge | 22 dBm per antenna | 5 MHz |
| +5 to +10 MHz from upper block edge | 18 dBm per antenna | 5 MHz |

1. BS transition requirements above the upper FDD downlink band edge

| **Frequency range**  | **Maximum mean e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| 788-791 MHz for block with upper edge at 788 MHz | 20.8 dBm per antenna | 3 MHz |
| 788-791 MHz for block with upper edge at 783 MHz | 15.8 dBm per antenna | 3 MHz |
| 791-796 MHz for block with upper edge at 788 MHz | 18.6 dBm per antenna | 5 MHz  |
| 791-796 MHz for block with upper edge at 783 MHz | 16.9 dBm per antenna | 5 MHz  |
| 796-801 MHz for block with upper edge at 788 MHz | 16.9 dBm per antenna | 5 MHz |

1. BS requirements for guard bands and duplex gap

| **Frequency range**  | **Maximum mean** **e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| -10 to 0 MHz offset from downlink lower band edge, but above uplink upper band edge | 16 dBm per antenna | 5 MHz |
| More than 10 MHz offset from downlink lower band edge, but above uplink upper band edge | -11 dBm per antenna | 1 MHz |
| Spectrum between broadcasting band edge and FDD uplink lower band edge  | -32 dBm per antenna | 1 MHz |
| Spectrum between downlink upper band edge and 791 MHz  | 13.8 dBm per antenna | 3 MHz  |

The TS BEM consists of an in-block level, elements for the spectrum between the MFCN UL and DL (including SDL, if applicable), requirements for the guard band between DTT and the MFCN UL, and a baseline level for DTT spectrum, see Table 7: to Table 9:. Further requirements will have to be taken into account by ETSI in the harmonised standards, which may require close cooperation between ETSI, CEPT and Standard Developing Organisations.

The power limits are specified as e.i.r.p. for terminal stations designed to be fixed or installed and as TRP for terminal stations designed to be mobile or nomadic.

Administrations may relax the in-block power limit in certain situations, for example fixed TS in rural areas, providing that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.

1. TS in-block emission limit

| **Maximum mean in-block power**  |
| --- |
|  23 dBm  |

Note: It is recognised that this value is subject to a tolerance of up to +2 dB, to take account of operation under extreme environmental conditions and production spread.

1. TS requirements for guard bands

| **Frequency range of** **out-of-block emissions** | **Maximum mean** **out-of-block e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| More than -5 MHz offset from uplink lower band edge |  -7 dBm  | 4 MHz |
| -5 to 0 MHz offset from uplink lower band edge |  1.6 dBm  | 5 MHz |
| 0 to 5 MHz offset from downlink upper band edge (duplex gap) | 1.6 dBm  | 5 MHz |
| 5 to 20 offset from downlink upper band edge (duplex gap)  | -6 dBm | 5 MHz |
| More than 20 MHz offset from downlink upper band edge (duplex gap)  | -18 dBm | 5 MHz |

1. Out-of-band requirements for TS over frequencies occupied by broadcasting

| **Frequency range of** **out-of-band emissions**  | **Maximum mean out-of-band power (see Notes)** | **Measurement****bandwidth** |
| --- | --- | --- |
| 470-694 MHz | -42 dBm | 8 MHz |

Note 1: Out-of-band emission limit was derived for an MFCN system with a bandwidth of 10 MHz for a DTT-MFCN centre frequency separation of 18 MHz (assuming an 8 MHz TV channel, 9 MHz guard band and a 10 MHz MFCN bandwidth). Should administrations wish to deploy MFCN on a national basis with a bandwidth greater than 10 MHz starting at 703 MHz, the levels of out-of-band emissions may be higher than the limit given in the table. This may result in greater risk of interference to DTT. In that case, administrations may consider:

* either implementing the greater MFCN bandwidth starting at a higher frequency so that the required level of out-of-band emission is still achieved;
* or applying mitigation techniques (see Note 3).

Note 2: This value has been derived with regard to fixed DTT reception. Administrations who wish to consider portable-indoor DTT reception may need, on a case-by-case basis, to implement further measures at a national/local level (see Note 3).

Note 3: For information purpose only, examples of potential mitigation techniques which may be considered by administrations include using additional DTT filtering, reducing the in-band power of the TS, reducing the bandwidth of the TS transmissions, or using techniques contained in the non-exhaustive list of potential mitigation techniques given in CEPT Report 30.

**Additional considerations on the coexistence between MFCN and broadcasting below 694 MHz**

To mitigate DTT receiver blocking due to MFCN BS transmissions, additional external filtering could be required at the input of the DTT receiver chain, in particular to avoid overload saturation in antenna amplifiers.

**Interference from broadcasting to MFCN**

Interference from broadcasting transmitters to MFCN BS receivers either due to transmitter in band power or out of band emissions may arise. In such cases, appropriate mitigation techniques can be applied on a case-by-case basis at national level.

**PMSE in 700 MHz**

PMSE usage of spectrum in the MFCN duplex gap has been studied. Based on simulations of PMSE interference to MFCN UL and DL, power restrictions have been derived. Note that these power restrictions do not cover out-of-block spectrum in the MFCN duplex gap. A spectrum emission mask may be applied for that spectrum on a national basis.

The compatibility situation at the boundary between PMSE and MFCN around the MFCN uplink upper band edge also applies at the MFCN uplink lower band edge, if PMSE is used immediately below the MFCN UL, due to the fact that the equipment is the same.

1. PMSE power restrictions for handheld microphone

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Range** | **E.i.r.p.** | **Measurement bandwidth** | **Reasoning** |
| MFCN uplink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |
| More than -4.2 MHz offset from MFCN downlink lower band edge  | 19 dBm | 200 kHz | Annex 2 in ECC Report XYW [8] |
| -4.2 to - 2.8 MHz offset from MFCN downlink lower band edge | 13 dBm | 200 kHz |
| - 2.8 to 0 MHz offset from MFCN downlink lower band edge (guard band) | -- | -- |
| MFCN downlink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |

1. PMSE power restrictions for body worn microphone

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Range** | **E.i.r.p.** | **Measurement bandwidth** | **Reasoning** |
| MFCN uplink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |
| More than -1.2 MHz offset from MFCN downlink lower band edge  | 19 dBm | 200 kHz | Annex 2 in ECC Report XYW [8] |
| - 1.2 to 0 MHz offset from MFCN downlink lower band edge (guard band) | -- | -- |
| MFCN downlink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |

The ECC Report XYW [8] contains the study of the interference from commercial mobile network to PMSE equipment. The results of the studies indicate that that for PMSE operation a frequency separation of approximately 1 MHz from MFCN downlink and 1 to 10 MHz from MFCN uplink (depending on spatial distance between MFCN TS and PMSE receiver) are needed.

It can be concluded that audio PMSE equipment will not be able to operate in all the compatibility scenarios. However PMSE is able to find an operational channel with sufficient Quality of Service (QoS) with the assumption of certain spatial distances between the PMSE equipment and the MFCN equipment. The most critical case is if the PMSE is close to a MFCN UE. If this separation distance is increased, the probability of interference decreases accordingly.

PMSE should be operated only if a check of quality of service in the radio environment is performed before use and resulted in sufficient quality. The PMSE setup indicates whether enough PMSE channels with no interference are available to guarantee the needed quality of service. This procedure is described in Annex 5 of the ECC Report 191 [9].

**Protection of PMSE below 694 MHz**

Simulations carried out show that given the requirements on MFCN TSs and BSs to protect broadcasting below 694 MHz, PMSE will also be protected.

**Compatibility with harmonized conditions of wireless broadband at 790-862 MHz**

The preferred channeling arrangement in the 694-790 MHz band identified by CEPT (see ANNEX 2:) uses a conventional duplex arrangement (uplink in the lower part of the band and downlink in the upper part of the band). The 790-862 MHz band uses a reversed duplex arrangement (downlink in the lower part of the band and uplink in the upper part of the band), starting at 791 MHz.

As a consequence, the 700 MHz base station transmit band is adjacent to the 800 MHz base station transmit band. This avoids adjacency between base stations and terminal stations and therefore provides compatibility between the existing 790-862 MHz channeling arrangement and the preferred channeling arrangement the for 694-790 MHz band.

**Non-radio issues**

The Mandate from the European Commission states that CEPT should indicate the potential impact on non-radio end-user equipment for fixed broadcasting and broadband electronic communication services in support of standardisation work relating to interference mitigation.

The CEPT report in response to the EC Mandate covers radio-communication issues. In accordance with the Terms of Reference of ECC, the assessment of potential impact to non-radio systems has been limited to identification of potential frequency ranges (CEPT is not responsible for addressing the impact on non-radio equipment). CEPT describes the evolution of the spectrum usage in this band and the resulting new radio environment in this report, and will inform ETSI and CENELEC so that they may take this into account in their work.

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**LIST OF ABBREVIATIONS**

|  |  |
| --- | --- |
| **Abbreviation** | **Explanation** |
| **BEM****CEPT** | Block Edge MaskEuropean Conference of Postal and Telecommunications Administrations |
| **DL****EC****ECC****e.i.r.p.****FDDIMT****LRTC****MFCN****M2M****PMSE****PPDR****QoS****SEM****SDL****TRP****TS****UE****UL****WBB****WRC-15** | DownlinkEuropean CommissionElectronic Communications Committeeequivalent isotropically radiated powerFrequency Duplex DivisionInternational Mobile TelecommunicationsLeast Restrictive Technical ConditionsMobile/Fixed Communication NetworkMachine-to-machineProgramme Making and Special EventsPublic Protection and Disaster ReliefQuality of ServiceSpectrum Emission MaskSupplemental DownlinkTotal Radiated PowerTerminal StationUser EquipmentUplinkWireless broadbandWorld Radiocommunications Conference 2015 |

# introduction

The CEPT considered the various tasks (1 and 2) as described in the EC Mandate on 700 MHz, see ANNEX 1: with the results delivered in this report on the following topics:

* preferred channelling arrangement in the 694-790 MHz band for MFCN;
* options considering PMSE, PPDR and other services on a national basis;
* relevant LRTC (BEM) for commercial MFCN, as well as for PPDR in the frequency bands identified for MFCN;
* compatibility with harmonized conditions of MFCN in the 790-862 MHz band;
* coexistence between MFCN in the 694-790 MHz band and Broadcasting below 694 MHz;
* coexistence between MFCN in the 694-790 MHz band and PMSE below 694 MHz;
* PMSE in the 700 MHz band;
* considerations on Machine-to-Machine (M2M) communications.

The Mandate from the European Commission states that CEPT should indicate the potential impact on non-radio end-user equipment for fixed broadcasting and broadband electronic communication services in support of standardisation work relating to interference mitigation.

The CEPT Report in response to tasks 1, 2, and 3 of the EC Mandate covers radio-communication issues. In accordance with the Terms of Reference of ECC, the assessment of potential impact to non-radio systems has been limited to identification of potential frequency ranges (CEPT is not responsible for addressing the impact on non-radio equipment). CEPT describes the evolution of the spectrum usage in this band and the resulting new radio environment in this report, and will inform ETSI and CENELEC so that they may take this into account in their work.

# Preferred channelling arrangement in 694 -790 MHz

CEPT confirmed the lower edge at 694 MHz as the only option to be studied in the WRC-15 preparation and discussed possible channelling arrangements on that basis.

**Preferred channelling arrangement considering MFCN**

Maximum inter-regional harmonisation is achieved by basing the preferred channelling arrangement on the lower duplexer of the APT 700 MHz band plan allowing for economies of scale. As this would only provide for 63% utilisation of the band by MFCN, placing up to 4 blocks of 5 MHz MFCN SDL in the duplex gap would result in a utilisation of 83% by MFCN. This arrangement is described in ANNEX 2:.

**Options considering PMSE, PPDR and other services on a national basis**

PMSE could use the guard band and the duplex gap of the paired 2x30 MHz block according to the technical conditions developed in this report.

PPDR (2x5 MHz) could use the guard band (698-703 MHz) and the duplex gap (e.g. 753-758 MHz) of the paired 2x30 MHz block, subject to the compatibility with DTT below 694 MHz. It is assumed that those PPDR systems use a conventional FDD band plan. Nevertheless, studies on the technical conditions for the usage of the band need to be finalised by CEPT. Besides, PPDR could be provided in part of the MFCN blocks. The amount of spectrum to be used for broadband PPDR needs to be flexible to fit the individual requirements of CEPT countries.

Other services could use parts of the duplex gap with the same BEM as for MFCN SDL (see section 3.3 of this report).

These options could be combined together with the usage of a number of MFCN SDL blocks in order to provide flexibility for administrations depending on their requirements.

**Additional considerations**

CEPT noted that LTE technology is expected to be the future technology to meet broadband PPDR needs. The work is in progress with standardization organisations defining functionality enhancements for PPDR operators. The CEPT is considering the options for accommodating 2x10 MHz for PPDR LTE equipment within the frequency range 694 to 790 MHz, subject to national decision at a later stage. At the same time the CEPT is also considering the 410-430 MHz and 450-470 MHz sub-bands for PPDR LTE. The CEPT also assumes that any decision on the allocation of either dedicated or shared with commercial MFCN operators spectrum to PPDR users will be taken at a national level[[7]](#footnote-7).

These options may result in several scenarios of cross-border coexistence between two CEPT administrations.

It is assumed that PPDR systems use a conventional FDD band plan (as for the IMT band plan in the considered band) and may be subject to further harmonisation measure in CEPT. This conventional duplex approach ensures that cross border coordination between PPDR networks and MFCN SDL systems would be manageable at the border with appropriate field-strength levels.

In addition, CEPT may develop cross-border coordination measures so as to ensure the appropriate field-strength levels at borders between PPDR networks at both sides of the border.

Further to the ongoing CEPT work, it appears that the measures that CEPT may have to adopt to take into account several options are usual and would not create specific difficulties. In particular, the development of a harmonised ECC framework for PPDR ensuring that PPDR systems use a conventional FDD band plan and of one (or two) ECC Recommendation(s) on cross border coordination for downlink only systems and for PPDR to ensure appropriate field-strength levels at cross-border, would ensure the possibility for any administration to choose its most appropriate option.

# least restrictive technical conditions (BEM)

## Method for defining least restrictive technical conditions

The definition of the least restrictive technical conditions is based on the block edge mask (BEM) approach, in line with previous work in CEPT, e.g. on the 790-862 MHz [1], the 2.5-2.69 GHz [2] [3], the 2 GHz [4] and the 3.4-3.8 GHz bands [5].

A BEM is an emission mask that is defined as a limit on the average e.i.r.p. or TRP (total radiated power)[[8]](#footnote-8) inside and outside of the block of spectrum licensed to an operator, and is defined for a certain measurement bandwidth. The out-of-block component of the BEM may consist of a baseline level and intermediate (transition) levels which describe the transition from the in-block level to the baseline level as a function of off-set from the block edge.

The BEMs are presented as upper limits on the mean e.i.r.p. or TRP over an averaging time interval. and over a measurement frequency bandwidth. In the time domain, the e.i.r.p. or TRP is averaged over the active portions of signal bursts and corresponds to a single power control setting. In the frequency domain, the e.i.r.p. or TRP is determined over the measurement bandwidth (e.g. MFCN block or TV channel) specified in the tables derived below. It should be noted that the actual measurement bandwidth of the measurement equipment used for purposes of compliance testing may be smaller than the measurement bandwidth provided in the tables. For requirements with a measurement bandwidth of 5 MHz, the measurement bandwidth is aligned within a block.

Figure 1: describes a general BEM.



1. Illustration of a general block-edge mask

The technical conditions derived below for the frequency range 694-790 MHz are optimised for, but not limited to, fixed/mobile communications networks (two-way). Therefore, they are derived both for base stations (BS) and terminal stations (TS). In addition appropriate technical conditions have also been derived for SDL in the FDD duplex gap.

BEMs for BS and TS are developed for equipment used in commercial mobile networks, as well as for PPDR applications operating in the MFCN spectrum.

A BEM may also be defined in order to protect the radio systems in adjacent bands. It is also possible to define technical conditions for such protection, which are not in the form of a BEM.

The BEM is a ‘regulatory mask’ and should not be confused with Spectrum Emission Masks (SEM) for base stations and user equipment.

The BEM concept does not in itself define the means by which the equipment in an operator’s network meets the BEM. This may be achieved in different ways such as by employing equipment inherently meeting the requirements, by adding filters, by creating an internal (in-block) guard band or by decreasing the in-block power.

BEMs shall be applied as an essential component of the technical conditions necessary to ensure coexistence between services at a national level. However it should be understood that the derived BEMs do not always provide the required level of protection of victim services and additional mitigation techniques would need to be applied in order to resolve any remaining cases of interference. Possible mitigation techniques are described in Annex 4 of CEPT Report 30 [1].

Less stringent technical parameters may be agreed on a bilateral or multilateral basis for the operation of MFCN in the 694-790 MHz band, providing that they continue to comply with the technical conditions applicable for the protection of other services, applications or networks and with cross-border obligations.

## Considerations of coexistence parameters for BEM derivation

As broadband PPDR will use LTE technology, BS and TS parameters can be assumed to be the same as commercial MFCN in the co-existence analysis.

As indicated in chapter 2, some MFCN spectrum may be used for Supplemental DownLink (SDL), i.e. downlink without paired uplink spectrum. Such SDL spectrum would be located just below the paired DL spectrum. In terms of co-existence analysis and derivation of BEM, there is no reason to distinguish between SDL blocks and paired DL blocks since the in-block power and antenna characteristics will be the same and since the SDL and paired DL are surrounded by and need to protect the same services and systems. In particular, SDL equipment will need to protect the FDD UL and thus to employ a filter similar to the duplex filter of BSs for paired frequency arrangements.

## Technical conditions for base stations

The BEM elements derived below apply to base stations for MFCN. The BS BEM also applies if the spectrum in the duplex gap is used to provide a supplemental downlink (SDL). The BEM has been designed to protect the adjacent band services, including MFCN above 791 MHz. Other requirements can be applied subject to bi- or multilateral agreements.

### In-block e.i.r.p. limits

Table 12: contains information regarding in-block power. The adoption of in-block power limits is not mandatory. In case an upper bound is desired by an administration, a value of 64 dBm/5 MHz per antenna may be applied. Administrations may consider authorising higher in-block e.i.r.p. in specific circumstances, e.g. in rural deployments.

1. In-block power limit

| **Frequency range**  | **Maximum mean  e.i.r.p.**  | **Measurement** **bandwidth** |
| --- | --- | --- |
| Block assigned to the operator  | Not mandatory. In case an upper bound is desired by an administration, a value of 64 dBm/5 MHz, per antenna may be applied. | 5 MHz |

### Out-of-block e.i.r.p. limits

Table 13: defines the out-of-block BEM baseline requirements. The details of calculation and the coexistence parameter used for BEM element for FDD uplink spectrum are provided in ANNEX 3:

The BEM element for FDD downlink frequencies has been obtained from the Spectrum Emission Mask (SEM) in [6] for frequencies below 1 GHz and carrier bandwidths of 5 MHz and more, for a frequency offset of more than 10 MHz, and by adding an antenna gain of 15 dBi, including feeder loss, to convert it into an e.i.r.p. value.

The applicability of the baseline elements to the 800 MHz up- and downlink spectrum follows from the fact that the channelling arrangement at 694-790 MHz uses a conventional duplex arrangement (uplink in the lower part of the band and downlink in the upper part of the band), whereas the 790-862 MHz band uses a reversed duplex arrangement (downlink in the lower part of the band, 791-831 MHz, and uplink in the upper part of the band, 832-862 MHz).

As a consequence, the 700 MHz base station transmit (downlink) band is adjacent to the 800 MHz base station transmit (downlink) band. The 800 MHz downlink can thus be seen as an extension of the 700 MHz downlink band, from a co-existence perspective. Applying the BS BEM elements beyond 790 MHz thus guarantees sufficiently low interference to the 800 MHz downlink band, as the interference situation for two adjacent downlinks will be the same regardless if they are in the same band or not. Similarly, applying the BS uplink BEM in the 800 MHz uplink frequency range guarantees sufficiently low interference there as well.

1. Baseline requirements

| **Frequency range**  | **Maxim e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| MFCN uplink frequencies and 832-862 MHz (uplink of 800 MHz band) | -50.4 dBm per cell  | 5 MHz |
| MFCN downlink frequencies and 791-821 MHz (downlink of 800 MHz band) | 16 dBm per antenna | 5 MHz |
| Frequencies between downlink upper band edge and 791 MHz | 13.8 dBm per antenna | 3 MHz  |

Table 14: shows the requirements in transitional regions below 788 MHz. The transitional regions for some of the DL blocks overlap with the duplex gap, in which case transitional power limits are used.

The levels proposed for the transitional regions have been calculated by integration of the SEM in [7] for frequencies below 1 GHz and carrier bandwidths of 5 MHz and above assuming an antenna gain of 15 dBi including feeder loss.

1. Transition requirements below the upper FDD downlink band edge

| **Frequency range**  | **Maximum mean e.i.r.p.**  | **Measurement** **bandwidth** |
| --- | --- | --- |
| –10 to –5 MHz from lower block edge | 18 dBm per antenna | 5 MHz |
| –5 to 0 MHz from lower block edge | 22 dBm per antenna | 5 MHz |
| 0 to +5 MHz from upper block edge | 22 dBm per antenna | 5 MHz |
| +5 to +10 MHz from upper block edge | 18 dBm per antenna | 5 MHz |

Table 15: shows the requirements in transitional regions above 788 MHz. These requirements need to be treated separately due to the frequency separation of 3 MHz between the 700 MHz DL and the 800 MHz DL. The elements in Table 15: have also been obtained by integration of the spectrum mask in [7] (§6.6.2.1.1.), and adding antenna gain.

1. Transition requirements above the upper FDD downlink band edge

| **Frequency range**  | **Maximum mean e.i.r.p.**  | **Measurement** **bandwidth** |
| --- | --- | --- |
| 788-791 MHz. for block with upper edge at 788 MHz | 20.8 dBm per antenna | 3 MHz |
| 788-791 MHz. for block with upper edge at 783 MHz | 15.8 dBm per antenna | 3 MHz |
| 791-796 MHz. for block with upper edge at 788 MHz | 18.6 dBm per antenna | 5 MHz  |
| 791-796 MHz. for block with upper edge at 783 MHz | 16.9 dBm per antenna | 5 MHz  |
| 796-801 MHz. for block with upper edge at 788 MHz | 16.9 dBm per antenna | 5 MHz |



1. Qualitative description on transitional requirements above the upper downlink band edge for different MFCN blocks

Table 16: contains BEM elements for the spectrum between MFCN uplink and downlink (including possible SDL spectrum). The BEM element in Table 16: for an offset of more than 10 MHz has been derived from the spurious requirement of -36 dBm/100 kHz. The measurement bandwidth for this element is 1 MHz instead of 5 MHz, as the size of the spurious emission region may be smaller
than 5 MHz.

1. Requirements for spectrum between MFCN uplink and downlink
(including possible SDL spectrum)

| **Frequency range**  | **Maximum mean** **e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| -10 to 0 MHz offset from downlink lower band edge but above uplink upper band edge | 16 dBm per antenna | 5 MHz |
| More than 10 MHz offset from lower downlink lower band edge, but above uplink upper band edge  | -11 dBm per antenna | 1 MHz |

Table 17: shows the requirement for base stations over frequencies used as guard band between the MFCN UL and spectrum used for DTT, which has been obtained by converting the baseline for DTT spectrum (see below) from 8 MHz to 1 MHz measurement bandwidth.

1. Requirements for guard band between broadcasting and FDD uplink

| **Frequency range**  | **Maximum mean** **out-of-block e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| Spectrum between broadcasting band edge and FDD uplink lower band edge  | -32 dBm per antenna | 1 MHz |

Table 18: shows the BEM baseline requirement for MFCN base stations within the spectrum used by the broadcasting (DTT) service. The baseline requirement for broadcasting spectrum is based on the strictest level specified in CEPT Report 30 [1] where it was shown that this level would allow coexistence with broadcasting services. In a typical BS implementation there will be a duplex filter for attenuating the emissions in the receive band and the design of the duplex filters will also result in significant attenuation adjacent to the receive band, e.g. in the broadcasting band. However, it should be noted that these strict limits are feasible due to the special situation of downlink frequencies in this band and may not be feasible in other situations.

1. Baseline requirements for DTT spectrum

| **Frequency range**  | **Maximum mean e.i.r.p.** | **Measurement bandwidth** |
| --- | --- | --- |
| For DTT frequencies wherebroadcasting is protected | -23 dBm per cell | 8 MHz |

## Technical conditions for terminal stations

The tables below contain BEM elements for commercial networks as well as for PPDR defining in-block power and BEMs for protecting services in adjacent bands and in the duplex gap. As additional requirements on TS are not included in the relevant EC Decisions, any further requirements will have to be taken into account by ETSI in the harmonised standards, which may require close cooperation between ETSI, CEPT and Standard Developing Organisations. CEPT Report 39 [4] contains a more detailed discussion about responsibilities of different organizations regarding TS BEMs.

The power limits are specified as e.i.r.p. for terminal stations designed to be fixed or installed and as TRP for terminal stations designed to be mobile or nomadic.

Table 19: defines the maximum value of the in-block emission level for terminal stations. Administrations may relax this limit in certain situations, for example fixed TS in rural areas, providing that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.

1. TS in-block emission limit

| **Maximum mean in-block power**  |
| --- |
|  23 dBm  |

Note: It is recognised that this value is subject to a tolerance of up to +2 dB, to take account of operation under extreme environmental conditions and production spread.

Table 20: shows the requirements for terminal stations over frequencies used as guard band. The following BEM have been obtained by integrating the SEM in [7] as reported in ANNEX 4:. BEM values are based on the consideration that support for 1.4 and 3 MHz terminals is not required in this band.

1. Requirements for guard bands

| **Frequency range of** **out-of-block emissions** | **Maximum mean** **out-of-block e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| More than -5 MHz offset from uplink lower band edge |  -7 dBm  | 4 MHz |
| -5 to 0 MHz offset from uplink lower band edge |  1.6 dBm  | 5 MHz |
| 0 to 5 MHz offset from downlink upper band edge (duplex gap) | 1.6 dBm  | 5 MHz |
| 5 to 20 offset from downlink upper band edge (WBB duplex gap)  | -6 dBm | 5 MHz |
| More than 20 MHz offset from downlink upper band edge (duplex gap)  | -18 dBm | 5 MHz |

Table 21: shows the out-of-band emission requirements for MFCN terminal stations within the spectrum allocated to the broadcasting (DTT) service.

1. Out-of-band requirements for TS over frequencies occupied by broadcasting

| **Frequency range of** **out-of-band emissions**  | **Maximum mean out-of-band power (see Notes)** | **Measurement****bandwidth** |
| --- | --- | --- |
| 470-694 MHz | -42 dBm | 8 MHz |

Note 1: Out-of-band emission limit was derived for an MFCN system with a bandwidth of 10 MHz for a DTT-MFCN centre frequency separation of 18 MHz (assuming an 8 MHz TV channel, 9 MHz guard band and a 10 MHz MFCN bandwidth). Should administrations wish to deploy MFCN on a national basis with a bandwidth greater than 10 MHz starting at 703 MHz, the levels of out-of-band emissions may be higher than the limit given in the table.

This may result in greater risk of interference to DTT. In that case, administrations may consider:

* either implementing the greater MFCN bandwidth starting at a higher frequency so that the required level of out-of-band emission is still achieved;
* or applying mitigation techniques (see Note 3).

Note 2: This value has been derived with regard to fixed DTT reception. Administrations who wish to consider portable-indoor DTT reception may need, on a case-by-case basis, to implement further measures at a national/local level (see Note 3).

Note 3: For information purpose only, examples of potential mitigation techniques which may be considered by administrations include using additional DTT filtering, reducing the in-band power of the TS, reducing the bandwidth of the TS transmissions, or using techniques contained in the non-exhaustive list of potential mitigation techniques given in CEPT Report 30.

# Additional considerations on the Coexistence between MFCN and Broadcasting below 694 MHz

## DTT receiver blocking

With regard to blocking[[9]](#footnote-9) of DTT receiver by MFCN BS, additional isolation could be required between the MFCN base station and the DTT Receiver. The actual impact should be determined on a case-by-case basis since this type of interference usually depends on the first component of receiver chain (pre-amplifier of the receiver or amplifier of the antenna assumed to increase the received signal). One way to address this issue would be to improve the DTT adjacent channel rejection capability through enhancing receiving chains (e.g. by adding at the beginning of the receiver system a filter which reduces the unwanted emissions) where needed.

# INTERFERENCE FROM broadcasting to MFCN

## Interference from broadcasting transmitters to MFCN BS receivers

In some cases, interference from broadcasting transmitters to MFCN BS receivers due to transmitter in band power may arise. In practice, there are mitigation techniques, which can be applied in such cases. For example, improved receiver performance (receiver blocking levels) of the MFCN BS can be done through better BS design or additional filter.

In some other cases, interference to MFCN BS due to out of band emissions from high power broadcasting transmitters, transmitting on channel 48, may appear. Other mitigation techniques can be applied. Such mitigation measures could be performed in a case-by-case basis at the national level. It is expected that in real life the number of interference cases would be limited.

A case study reported in ANNEX 6: on the potential interference from broadcasting transmitters to MFCN BS receivers leads to the following conclusions:

* MFCN BS receiver out of band blocking level as defined in 3GPP Specification TS 36.104 [6] may not be sufficient; an additional isolation of up to 40 dB may be required. With the assumptions used in the study of a guard band of 9 MHz, this additional isolation can be achieved with an external filter or improved IMT BS design.
* Non-critical DTT mask may not be sufficient for protecting the MFCN uplink for MFCN BS near the high tower / high power DTT transmitters transmitting on channel 48. Several dB of additional isolation may be needed. Nevertheless, the real DTT transmitter masks are always better than the minimum technical requirement of non-critical mask. Consequently, the interference from high tower / high power DTT transmitters should not be a real problem.

# SPecial application / MACHINE-TO-MACHINE COMMUNICATIONS

Machine-to-Machine (M2M) communications domain covers a wide variety of applications, including utility provisioning, transportation, healthcare, energy, retail, public safety, building and many others.

Special applications, such as Machine-to-Machine communications may be considered in the guard bands and/or part of the duplex gap. The usage of the spectrum blocks for M2M, as well as the associated technical conditions can be studied and decided at national level.

# PMSE Issues

## Technical conditions for PMSE

PMSE usage of spectrum in the MFCN duplex gap has been studied. Based on simulations of PMSE interference to MFCN UL and DL, power restrictions as presented in Table 22: and Table 23: have been derived. Note that these power restrictions do not cover out-of-block spectrum in the duplex gap. A spectrum emission mask may be applied for that spectrum on a national basis. For additional details, see [8].

The compatibility situation at the boundary between PMSE and MFCN around the uplink upper band edge, also applies at the uplink lower band edge, if PMSE is used immediately below the MFCN UL, due to the fact that the equipment is the same.

1. Power restrictions for handheld microphone

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Range** | **E.i.r.p.** | **Measurement bandwidth** | **Reasoning** |
| MFCN uplink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |
| More than -4.2 MHz offset from MFCN downlink lower band edge  | 19 dBm | 200 kHz | Annex 2 of ECC Report XYW [8] |
| -4.2 to - 2.8 MHz offset from MFCN downlink lower band edge | 13 dBm | 200 kHz |
| - 2.8 to 0 MHz offset from MFCN downlink lower band edge (guard band) | -- | -- |
| MFCN downlink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |

1. Power restrictions for body worn microphone

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Range** | **E.i.r.p.** | **Measurement bandwidth** | **Reasoning** |
| MFCN uplink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |
| More than -1.2 MHz offset from MFCN downlink lower band edge  | 19 dBm | 200 kHz | Annex 2 of ECC Report XYW [8] |
| - 1.2 to 0 MHz offset from MFCN downlink lower band edge (guard band) | -- | -- |
| MFCN downlink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |

The ECC Report XYW [8] also considers interference from commercial mobile network to PMSE equipment. The results of the studies are illustrated in Table 24:. These results indicate that for PMSE operation a frequency separation of approximately 1 MHz from MFCN downlink and 1 to 10 MHz from MFCN uplink (depending on spatial distance between MFCN TS and PMSE receiver) are needed.

It can be concluded that audio PMSE equipment will not be able to operate in all the compatibility scenarios. However PMSE is able to find an operational channel with sufficient Quality of Service with the assumption of certain spatial distances between the PMSE equipment and the MFCN equipment. The most critical case is if the PMSE is close to a MFCN UE. If this separation distance is increased, the probability of interference decreases accordingly.

PMSE should be operated only if a check of quality of service in the radio environment is performed before use and resulted in sufficient quality. The PMSE setup indicates whether enough PMSE channels with no interference are available to guarantee the needed quality of service. This procedure is described in Annex 5 of the ECC Report 191 [9].

1. SEAMCAT simulation results: MFCN interfering PMSE receiver

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | **Separation****distance** | **Interferer** | **PMSE Frequency [MHz]****Unwanted / Blocking propability [%]** |
|  | 733.1 | 734.1 | 742.9 | 743.9 | 754.9 | 755.2 | 756.9 | 757.9 |
| 2:Outdoor | 15 – 100m | LTE UE | 6.87 / 0 | 3.06 / 0 | 0 / 0 | 0 / 0 | 0 / 0 |
| 4:Outdoor | 100 – 350m | LTE BS | 0 / 0.12 | 0 / 0.12 | 0 / 0.12 | 0 / 0.10 | 4.80 / 0.13 | 18.35 / 0.13 |
| 5:Mixed | 100 - 350 m | LTE BS | 0 / 0.03 | 0 / 0.03 | 0 / 0.03 | 0 / 0.03 | 1.73 / 0.03 | 8.11 / 0.04 |
| 7:Indoor | 5 - 50m | LTE UE | 64.25 / 0 | 47.11 / 0 | 3.16 / 0 | 0.35/ 0 | 0.13 / 0 |

## Protection of PMSE below 694 MHz

The CEPT noted that the 470-694 MHz band is currently available and will continue to be available for PMSE equipment on a sharing basis with the broadcasting service and that it is used on a daily basis.

In order to assess the impact of MFCN UE on PMSE below 694 MHz, two studies have been carried out:

* Monte-Carlo simulation using the SEAMCAT tool. The simulation results show that with a MFCN UE OOB emission level of -28 dBm/MHz, the probability of interference from a MFCN UE to a PMSE receiver is very low.
* a coexistence study based on Monte-Carlo simulation providing the distance separation necessary to ensure the coexistence between PMSE and MFCN UE.

The details of the above studies are available in ANNEX 5:.

Based on those results and also with consideration of requirements on MFCN TS OOB emissions to protect the broadcasting service below 694 MHz as specified in section 3.4, it can be concluded that MFCN TS above 703 MHz and PMSE below 694 MHz can coexist.

# Compatibility with harmonized conditions of wireless broadband at 790- 862 MHz

The preferred channeling arrangement in the 694-790 MHz band identified by CEPT (see ANNEX 2:) uses a conventional duplex arrangement (uplink in the lower part of the band and downlink in the upper part of the band). The 790-862 MHz band uses a reversed duplex arrangement (downlink in the lower part of the band and uplink in the upper part of the band), starting at 791 MHz.

As a consequence, the 700 MHz base station transmit band is adjacent to the 800 MHz base station transmit band. This avoids adjacency between base stations and terminal stations and therefore provides compatibility between the existing 790-862 MHz channeling arrangement and the preferred channeling arrangement the for 694-790 MHz band.

# CONClusions

ECC considered the various tasks (1 and 2) as described in the EC Mandate on 700 MHz (see ANNEX 1:) and studied the following issues:

**Preferred channelling arrangement in 694 -790 MHz**

1. **Preferred channelling arrangement in 694 -790 MHz**

CEPT confirmed the lower edge at 694 MHz as the only option to be studied in the WRC-15 preparation and discussed possible channelling arrangements on that basis.

* **Preferred channelling arrangement considering MFCN**

Maximum inter-regional harmonisation is achieved by basing the preferred channelling arrangement on the lower duplexer of the APT 700 MHz band plan allowing for economies of scale. As this would only provide for 63% utilisation of the band by MFCN, placing up to 4 blocks of 5 MHz MFCN SDL in the duplex gap would result in a utilisation of 83% by MFCN. This arrangement is described in ANNEX 2:.

* **Options considering PMSE. PPDR and other services on a national basis**

PMSE could use the guard band and the duplex gap of the paired 2x30 MHz block according to the technical conditions developed in this report.

PPDR (2x5 MHz) could use the guard band (698-703 MHz) and the duplex gap (e.g. 753-758 MHz) of the paired 2x30 MHz block, subject to the compatibility with DTT below 694 MHz. It is assumed that those PPDR systems use a conventional FDD band plan. Nevertheless, studies on the technical conditions for the usage of the band need to be finalised by CEPT. Besides, PPDR could be provided in part of the MFCN blocks. The amount of spectrum to be used for broadband PPDR needs to be flexible to fit the individual requirements of CEPT countries.

Other services could use parts of the duplex gap with the same BEM as for MFCN SDL (see section 3.3 of this report).

These options could be combined together with the usage of a number of MFCN SDL blocks in order to provide flexibility for administrations depending on their requirements.

1. **Common least restrictive technical conditions (BEM)**

The technical conditions derived below for the frequency range 694-790 MHz are optimised for but not limited to fixed/mobile communications networks (two-way). Therefore, they are derived both for base stations (BS) and terminal stations (TS). The BEMs have been developed to protect other MFCN blocks, as well as other services and applications in adjacent bands and in the spectrum between the MFCN uplink and downlink. The BS BEM also applies if the spectrum in the duplex gap is used to provide a supplemental downlink (SDL). BEMs for BS and TS are developed for equipment used in commercial mobile networks, as well as for PPDR applications operating in the MFCN spectrum.

The Base Station (BS) BEM consists of several elements. The in-block power limit is applied to a block licensed to an operator. The out-of-block elements consist of a baseline level, designed to protect the spectrum of other MFCN operators as well as adjacent services, and transitional levels enabling filter roll-off from in-block to baseline levels. Additionally, elements are provided for guard bands between MFCN and other services and between the MFCN up- and downlink. The BEM is based on minimum coupling loss (MCL) analysis and simulations.

Table 25: contains the different elements of the BS BEM, and Table 26: to Table 30: contain the power limits for the different BEM elements.

To obtain a BS BEM for a specific block, the BEM elements that are defined in Table 25: are used as follows:

* In-block power limit is used for the block assigned to the operator.
* Transitional regions are determined, and corresponding power limits are used. The transitional regions may overlap with guard bands and adjacent bands, in which case transitional power limits are used.
* For remaining spectrum assigned to MFCN UL and DL (including SDL spectrum, if applicable), for DTT spectrum and for spectrum allocated to MFCN above 790 MHz, baseline power limits are used.
* For remaining guard band spectrum (i.e. not covered by transitional regions) guard band power limits are used.

Less stringent technical parameters may be agreed on a bilateral or multilateral basis for the operation of mobile/fixed communications networks (MFCN) in the 694-790 MHz band, providing that they continue to comply with the technical conditions applicable for the protection of other services, applications or networks and with cross-border obligations.

1. BS BEM elements

|  |  |
| --- | --- |
| In-block | Block for which the BEM is derived |
| Baseline | Spectrum used for MFCN UL and DL (including SDL, if applicable), for DTT and for MFCN above 790 MHz (UL and DL).  |
| Transitional region | The transitional region applies 0 to 10 MHz below and above the block assigned to the operator. |
| Guard bands | Spectrum between the DTT allocation and the lower edge of the MFCN uplink, spectrum between the MFCN up- and downlink (including SDL, if applicable), and spectrum between the MFCN downlink and the MFCN downlink above 790 MHz (if applicable). In case of overlap between transitional regions and guard bands, transitional power limits are used. |

1. BS in-block power limit

| **Frequency range**  | **Maximum mean** **e.i.r.p. power**  | **Measurement** **bandwidth** |
| --- | --- | --- |
| Block assigned to the operator  | Not mandatory. In case an upper bound is desired by an administration, a value of 64 dBm/5 MHz per antenna may be applied. | 5 MHz |

1. BS baseline requirements

| **Frequency range**  | **Maximum mean** **e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| MFCN uplink frequencies and 832-862 MHz (uplink of 800 MHz band) | -50.4 dBm per cell  | 5 MHz |
| MFCN downlink frequencies and 791-821 (downlink of 800 MHz band) | 16 dBm per antenna | 5 MHz |
| For DTT frequencies wherebroadcasting is protected | -23 dBm per cell | 8 MHz |

1. BS transition requirements below the upper FDD downlink band edge

| **Frequency range**  | **Maximum mean e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| –10 to –5 MHz from lower block edge | 18 dBm per antenna | 5 MHz |
| –5 to 0 MHz from lower block edge | 22 dBm per antenna | 5 MHz |
| 0 to +5 MHz from upper block edge | 22 dBm per antenna | 5 MHz |
| +5 to +10 MHz from upper block edge | 18 dBm per antenna | 5 MHz |

1. BS transition requirements above the upper FDD downlink band edge

| **Frequency range**  | **Maximum mean e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| 788-791 MHz for block with upper edge at 788 MHz | 20.8 dBm per antenna | 3 MHz |
| 788-791 MHz for block with upper edge at 783 MHz | 15.8 dBm per antenna | 3 MHz |
| 791-796 MHz for block with upper edge at 788 MHz | 18.6 dBm per antenna | 5 MHz  |
| 791-796 MHz for block with upper edge at 783 MHz | 16.9 dBm per antenna | 5 MHz  |
| 796-801 MHz for block with upper edge at 788 MHz | 16.9 dBm per antenna | 5 MHz |

1. BS requirements for guard bands and duplex gap

| **Frequency range**  | **Maximum mean** **e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| -10 to 0 MHz offset from downlink lower band edge, but above uplink upper band edge | 16 dBm per antenna | 5 MHz |
| More than 10 MHz offset from downlink lower band edge, but above uplink upper band edge | -11 dBm per antenna | 1 MHz |
| Spectrum between broadcasting band edge and FDD uplink lower band edge  | -32 dBm per antenna | 1 MHz |
| Spectrum between downlink upper band edge and 791 MHz  | 13.8 dBm per antenna | 3 MHz  |

The TS BEM consists of an in-block level, elements for the spectrum between the MFCN UL and DL (including SDL, if applicable), requirements for the guard band between DTT and the MFCN UL, and a baseline level for DTT spectrum, see Table 31: to Table 33:. Further requirements will have to be taken into account by ETSI in the harmonised standards, which may require close cooperation between ETSI, CEPT and Standard Developing Organisations.

The power limits are specified as e.i.r.p. for terminal stations designed to be fixed or installed and as TRP for terminal stations designed to be mobile or nomadic.

Administrations may relax the in-block power limit in certain situations, for example fixed TS in rural areas, providing that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.

1. TS in-block emission limit

| **Maximum mean in-block power**  |
| --- |
|  23 dBm  |

Note: It is recognised that this value is subject to a tolerance of up to +2 dB, to take account of operation under extreme environmental conditions and production spread.

1. TS requirements for guard bands

| **Frequency range of** **out-of-block emissions** | **Maximum mean** **out-of-block e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| More than -5 MHz offset from uplink lower band edge |  -7 dBm  | 4 MHz |
| -5 to 0 MHz offset from uplink lower band edge |  1.6 dBm  | 5 MHz |
| 0 to 5 MHz offset from downlink upper band edge (duplex gap) | 1.6 dBm  | 5 MHz |
| 5 to 20 offset from downlink upper band edge (duplex gap)  | -6 dBm | 5 MHz |
| More than 20 MHz offset from downlink upper band edge (duplex gap)  | -18 dBm | 5 MHz |

1. Out-of-band requirements for TS over frequencies occupied by broadcasting

| **Frequency range of** **out-of-band emissions**  | **Maximum mean out-of-band power (see Notes)** | **Measurement****bandwidth** |
| --- | --- | --- |
| 470-694 MHz | -42 dBm | 8 MHz |

Note 1: Out-of-band emission power was derived for an MFCN system with a bandwidth of 10 MHz for a DTT-MFCN centre frequency separation of 18 MHz (assuming an 8 MHz TV channel, 9 MHz guard band and a 10 MHz MFCN bandwidth). Should administrations wish to deploy MFCN on a national basis with a bandwidth greater than 10 MHz starting at 703 MHz, the levels of out-of-band power may be higher than the limit given in the table.

This may result in greater risk of interference to DTT. In that case, administrations may consider:

* either implementing the greater MFCN bandwidth starting at a higher frequency so that the required level of out-of-band emission is still achieved;
* or applying mitigation techniques (see Note 3).

Note 2: This value has been derived with regard to fixed DTT reception. Administrations who wish to consider portable-indoor DTT reception may need, on a case-by-case basis, to implement further measures at a national/local level (see Note 3).

Note 3: For information purpose only, examples of potential mitigation techniques which may be considered by administrations include using additional DTT filtering, reducing the in-band power of the TS, reducing the bandwidth of the TS transmissions, or using techniques contained in the non-exhaustive list of potential mitigation techniques given in CEPT Report 30.

**Additional considerations on the coexistence between MFCN and broadcasting below 694 MHz**

To mitigate DTT receiver blocking due to MFCN BS transmissions, additional external filtering could be required at the input of the DTT receiver chain, in particular to avoid overload saturation in antenna amplifiers.

 **Interference from broadcasting to MFCN**

Interference from broadcasting transmitters to MFCN BS receivers either due to transmitter in band power or out of band emissions may arise. In such cases, appropriate mitigation techniques can be applied on a case-by-case basis at national level.

**PMSE in 700 MHz**

PMSE usage of spectrum in the MFCN duplex gap has been studied. Based on simulations of PMSE interference to MFCN UL and DL, power restrictions have been derived. Note that these power restrictions do not cover out-of-block spectrum in the MFCN duplex gap. A spectrum emission mask may be applied for that spectrum on a national basis.

The compatibility situation at the boundary between PMSE and MFCN around the MFCN uplink upper band edge, also applies at the MFCN uplink lower band edge, if PMSE is used immediately below the MFCN UL, due to the fact that the equipment is the same.

1. PMSE Power restrictions for handheld microphone

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Range** | **E.i.r.p.** | **Measurement bandwidth** | **Reasoning** |
| MFCN uplink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |
| More than -4.2 MHz offset from MFCN downlink lower band edge  | 19 dBm | 200 kHz | Annex 2 in ECC Report XYW [8] |
| -4.2 to - 2.8 MHz offset from MFCN downlink lower band edge | 13 dBm | 200 kHz |
| - 2.8 to 0 MHz offset from MFCN downlink lower band edge (guard band) | -- | -- |
| MFCN downlink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |

1. PMSE Power restrictions for body worn microphone

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Range** | **E.i.r.p.** | **Measurement bandwidth** | **Reasoning** |
| MFCN uplink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |
| More than -1.2 MHz offset from MFCN downlink lower band edge  | 19 dBm | 200 kHz | Annex 2 in ECC Report XYW [8] |
| -1.2 to 0 MHz offset from MFCN downlink lower band edge (guard band) | -- |  |
| MFCN downlink frequencies | -45 dBm | 200 kHz | ETSI EN 300 422 |

The ECC Report XYW [8] contains the study of the interference from commercial mobile network to PMSE equipment. The results of the studies indicate that that for PMSE operation a frequency separation of approximately 1 MHz from MFCN downlink and 1 to 10 MHz from MFCN uplink (depending on spatial distance between MFCN TS and PMSE receiver) are needed.

It can be concluded that audio PMSE equipment will not be able to operate in all the compatibility scenarios. However PMSE is able to find an operational channel with sufficient Quality of Service (QoS) with the assumption of certain spatial distances between the PMSE equipment and the MFCN equipment. The most critical case is if the PMSE is close to a MFCN UE. If this separation distance is increased, the probability of interference decreases accordingly.

PMSE should be operated only if a check of quality of service in the radio environment is performed before use and resulted in sufficient quality. The PMSE setup indicates whether enough PMSE channels with no interference are available to guarantee the needed quality of service. This procedure is described in Annex 5 of the ECC Report 191 [9].

**Protection of PMSE below 694 MHz**

Simulations carried out show that given the requirements on MFCN TSs and BSs to protect broadcasting below 694 MHz, PMSE will also be protected.

**Compatibility with harmonized conditions of wireless broadband at 790-862 MHz**

The preferred channeling arrangement in the 694-790 MHz band identified by CEPT (see ANNEX 2:) uses a conventional duplex arrangement (uplink in the lower part of the band and downlink in the upper part of the band). The 790-862 MHz band uses a reversed duplex arrangement (downlink in the lower part of the band and uplink in the upper part of the band), starting at 791 MHz.

As a consequence, the 700 MHz base station transmit band is adjacent to the 800 MHz base station transmit band. This avoids adjacency between base stations and terminal stations and therefore provides compatibility between the existing 790-862 MHz channeling arrangement and the preferred channeling arrangement the for 694-790 MHz band.

**Non-radio issues**

The Mandate from the European Commission states that CEPT should indicate the potential impact on non-radio end-user equipment for fixed broadcasting and broadband electronic communication services in support of standardisation work relating to interference mitigation.

The CEPT Report in response to the EC Mandate covers radio-communication issues. In accordance with the Terms of Reference of ECC, the assessment of potential impact to non-radio systems has been limited to identification of potential frequency ranges (CEPT is not responsible for addressing the impact on non-radio equipment). CEPT describes the evolution of the spectrum usage in this band and the resulting new radio environment in this report, and will inform ETSI and CENELEC so that they may take this into account in their work.

1. EC Mandate on 700 MHz



1. technical parameters for electronic communications services

Based on the result of studies in response to the EC Mandate 700 MHz, the following elements are considered by CEPT to be relevant in the context of potential future EU harmonization:

* Preferred channelling arrangement for electronic communications services
* Common least restrictive technical conditions (BEM) for MFCN (for electronic communications services)
* Coexistence between MFCN and Broadcasting below 694MHz
* Coexistence between MFCN above 790 MHz
* Coexistence with PMSE below 694 MHz

In response to the task 2 of the EC Mandate, the possible spectrum to accommodate PMSE, on national basis, in the 694-790 MHz band and the relevant Common technical conditions (BEM) for PMSE are described in chapter 2 (possible spectrum) and section 7.1 (BEM) of this CEPT Report.

The implementation of PPDR in the 700 MHz band is a national decision and not suitable for the EU harmonization. The technical parameters (channelling arrangement and Common least restrictive technical conditions (BEM)) in this Annex are also applicable for PPDR above 703 MHz.

1. **Preferred channelling arrangement for electronic communications services**

Within the band 694-790 MHz the channelling arrangement shall be as follows:

* The block sizes shall be in multiples of 5 MHz, which does not preclude smaller channel bandwidths within a block
* Paired frequency arrangement (FDD):
* terminal station transmitter: 703-733 MHz
* base station transmitter: 758-788 MHz
* Unpaired frequency arrangement:
* supplemental downlink[[10]](#footnote-10) using up to 4 contiguous channels in the following frequency blocks: 738-743 MHz, 743-748 MHz, 748-753 MHz and 753-758 MHz.

CEPT identified also options considering PMSE, PPDR and other services on a national basis. These options may offer some flexibility according to the demand of EU member states.

1. **Common least restrictive technical conditions for electronic communications services**

The technical conditions presented in this section are in the form of block edge masks (BEMs).

A BEM is an emission mask that is defined as a limit on the average e.i.r.p. or TRP (total radiated power) inside and outside of the block of spectrum licensed to an operator.

A BEM consists of several elements which are defined for certain measurement bandwidths. The in-block power limit may be applied to a block licensed to an operator. The out-of-block elements consist of a baseline level, designed to protect the spectrum of other MFCN operators as well as services in adjacent spectrum, and transitional levels enabling filter roll-off from in-block to baseline levels.

BEMs shall be applied as an essential component of the technical conditions necessary to ensure coexistence between services at a national level. However, it should be understood that the derived BEMs do not always provide the required level of protection of victim services and additional mitigation techniques may need to be applied in order to resolve remaining cases of interference.

Less stringent technical parameters may be agreed on a national, bilateral or multilateral basis for the operation of mobile/fixed communications networks (MFCN) in the 694-790 MHz band, providing that they continue to comply with the technical conditions applicable for the protection of other services, applications or networks and with cross-border obligations.

The term block edge refers to the frequency boundary of an authorised right of use. The term band edge refers to the boundary of a range of frequencies designated for a certain use.

* 1. Technical conditions for base stations (BS)

Table 36: contains the different elements of the BS BEM, and Table 37: to Table 40: contain the power limits for the different BEM elements.

To obtain a BS BEM for a specific block, the BEM elements that are defined in Table 36: are used as follows:

* In-block power limit is used for the block assigned to the operator.
* Transitional regions are determined, and corresponding power limits are used. The transitional regions may overlap with guard bands and adjacent bands. in which case transitional power limits are used.
* For remaining spectrum assigned to MFCN UL and DL (including SDL spectrum, if applicable), for DTT spectrum and for spectrum allocated to MFCN above 790 MHz, baseline power limits are used.
* For remaining guard band spectrum (i.e. not covered by transitional regions), guard band power limits are used.
1. BS BEM elements

|  |  |
| --- | --- |
| In-block | Block for which the BEM is derived |
| Baseline | Spectrum used for MFCN UL and DL (including SDL, if applicable), for DTT and for MFCN above 790 MHz (UL and DL)  |
| Transitional region | The transitional region applies 0 to 10 MHz below and above the block assigned to the operator |
| Guard bands | Spectrum between the DTT allocation and the lower edge of the MFCN uplink, spectrum between the MFCN up- and downlink (including SDL, if applicable), and spectrum between the MFCN downlink and the MFCN downlink above 790 MHz (if applicable). In case of overlap between transitional regions and guard bands, transitional power limits are used |

1. In-block limits:
The adoption of in-block power limits is not mandatory. In case an upper bound is desired by an administration, a value of 64 dBm/5 MHz per antenna may be applied.
2. Out-of-block limits:
3. BS baseline requirements

| **Frequency range**  | **Maximum mean e.i.r.p.** | **Measurement bandwidth** |
| --- | --- | --- |
| MFCN uplink frequencies and 832-862 MHz (uplink of 800 MHz band) | -50.4 dBm per cell  | 5 MHz |
| MFCN downlink frequencies and 791-821 MHz (downlink of 800 MHz band) | 16 dBm per antenna | 5 MHz |
| For DTT frequencies wherebroadcasting is protected | -23 dBm per cell | 8 MHz |

1. BS transition requirements below the upper FDD downlink band edge

| **Frequency range**  | **Maximum mean e.i.r.p.**  | **Measurement bandwidth** |
| --- | --- | --- |
| -10 to -5 MHz from lower block edge | 18 dBm per antenna | 5 MHz |
| -5 to 0 MHz from lower block edge | 22 dBm per antenna | 5 MHz |
| 0 to +5 MHz from upper block edge | 22 dBm per antenna | 5 MHz |
| +5 to +10 MHz from upper block edge | 18 dBm per antenna | 5 MHz |

1. BS transition requirements above the upper FDD downlink band edge

| **Frequency range**  | **Maximum mean e.i.r.p.** | **Measurement bandwidth** |
| --- | --- | --- |
| 788-791 MHz for block with upper edge at 788 MHz | 20.8 dBm per antenna | 3 MHz |
| 788-791 MHz for block with upper edge at 783 MHz | 15.8 dBm per antenna | 3 MHz |
| 791-796 MHz for block with upper edge at 788 MHz | 18.6 dBm per antenna | 5 MHz  |
| 791-796 MHz for block with upper edge at 783 MHz | 16.9 dBm per antenna | 5 MHz  |
| 796-801 MHz for block with upper edge at 788 MHz | 16.9 dBm per antenna | 5 MHz |

1. BS requirements for guard bands and duplex gap

| **Frequency range**  | **Maximum mean** **e.i.r.p.** | **Measurement** **bandwidth** |
| --- | --- | --- |
| -10 to 0 MHz offset from downlink lower band edge, but above uplink upper band edge | 16 dBm per antenna | 5 MHz |
| More than 10 MHz offset from downlink lower band edge, but above uplink upper band edge | -11 dBm per antenna | 1 MHz |
| Spectrum between broadcasting band edge and FDD uplink lower band edge  | -32 dBm per antenna | 1 MHz |
| Spectrum between downlink upper band edge and 791 MHz  | 13.8 dBm per antenna | 3 MHz  |

* 1. Technical conditions for terminal stations

The power limits are specified as e.i.r.p. for terminal stations designed to be fixed or installed and as TRP for terminal stations designed to be mobile or nomadic.

1. TS in-block emission limit

| **Maximum mean in-block power**  |
| --- |
|  23 dBm  |

Note: It is recognised that this value is subject to a tolerance of up to +2 dB, to take account of operation under extreme environmental conditions and production spread.

1. TS requirements for guard bands

| **Frequency range of out-of-block emissions** | **Maximum mean out-of-block e.i.r.p.** | **Measurement bandwidth** |
| --- | --- | --- |
| More than -5 MHz offset from uplink lower band edge |  -7 dBm  | 4 MHz |
| -5 to 0 MHz offset from uplink lower band edge |  1.6 dBm  | 5 MHz |
| 0 to 5 MHz offset from downlink upper band edge (duplex gap) | 1.6 dBm  | 5 MHz |
| 5 to 20 offset from downlink upper band edge (duplex gap)  | -6 dBm | 5 MHz |
| More than 20 MHz offset from downlink upper band edge (duplex gap)  | -18 dBm | 5 MHz |

1. Out-of-band requirements for TS over frequencies occupied by broadcasting

| **Frequency range of out-of-band emissions**  | **Maximum mean out-of-band power (see Notes)** | **Measurementbandwidth** |
| --- | --- | --- |
| 470-694 MHz | -42 dBm | 8 MHz |

Note 1: Out-of-band emission limit was derived for an MFCN system with a bandwidth of 10 MHz for a DTT-MFCN centre frequency separation of 18 MHz (assuming an 8 MHz TV channel, 9 MHz guard band and a 10 MHz MFCN bandwidth). Should administrations wish to deploy MFCN on a national basis with a bandwidth greater than 10 MHz starting at 703 MHz, the levels of out-of-band emissions may be higher than the limit given in the table. This may result in greater risk of interference to DTT. In that case, administrations may consider:

* either implementing the greater MFCN bandwidth starting at a higher frequency so that the required level of out-of-band emission is still achieved;
* or applying mitigation techniques (see Note 3).

Note 2: This value has been derived with regard to fixed DTT reception. Administrations who wish to consider portable-indoor DTT reception may need, on a case-by-case basis, to implement further measures at a national/local level (see Note 3).

Note 3: For information purpose only, examples of potential mitigation techniques which may be considered by administrations include using additional DTT filtering, reducing the in-band power of the TS, reducing the bandwidth of the TS transmissions, or using techniques contained in the non-exhaustive list of potential mitigation techniques given in CEPT Report 30.

1. **Coexistence with PMSE below 694 MHz**

BEM requirements for TSs and BSs to protect broadcasting below 694 MHz are also sufficient for the protection of PMSE.

1. Derivation of BS baseline requirements for FDD UPLINK frequencies

In CEPT Report 30 [1] the baseline requirements for FDD uplink frequencies are based on the MCL approach for a base-to-base line-of-sight interference scenarios between a transmitting BS and a receiving from another operator separated by 100 m.

Table 44: summarises the MCL calculation based on the principles in CEPT Report 30, where the 800 MHz BEMs are derived, although the frequency is changed here to reflect the studied band. The main difference with ECC Report 30 is the propagation loss which is 69.9 dB (instead of 71 dB); the feeder link loss it is not considered as measurements are made at the antenna connector.

1. Parameters for MCL calculation of BS to BS interference

| **Parameters**  | **Value** |
| --- | --- |
| Receiver bandwidth(nominal for 5 MHz channel BW) | 4.5 MHz |
| Receiver noise figure | 5 dB |
| Receiver noise floor | -102.5 dBm/5 MHz |
| Protection ratio (INR) |  -5.8 dB |
| Maximum received interference | -108.3 dBm |
| Pathloss(freespace, 750MHz, 100m) | 69.9 dB |
| Receiver antenna gain [including feeder loss] | 15 dBi |
| Receiver tilt loss | 3 dB |
| Transmitter tilt loss | 3 dB |

The BS baseline requirements for uplink frequencies is obtained with the assumptions in Table 44:.

Considering the following notations:

E.I.R.P.tx Base station in-block e.i.r.p.

GArx Receiver Antenna Gain

Gtxtilt Tilting Gain of the TX antenna

Rtxtilt Tilting Gain of the RX antenna

PL Path-Loss

NF Noise Floor

INR Interference over Noise Ratio

It is obtained:

ACIR = E.I.R.P.tx +Gtxtilt +PL+GArx+ Grxtilt – (NF+ INR)

ACIR= E.I.R.P.tx -3 -69.9+15 -3 – (-102.5 –5.8) = E.I.R.P.tx + 47.4 dB

Considering ACS=ACLR, then ACLR = ACIR+3 = E.I.R.P.tx + 47.4 +3 = E.I.R.P.tx + 50.4 dB

The BS baseline requirements can be therefore derived as:

**BS baseline requirement** = E.I.R.P.tx – ACLR = E.I.R.P.tx – (E.I.R.P.tx + 50.4) = -**50.4 dBm/ 5MHz**

1. Derivation of the requirements for terminal stations over frequencies used as guard band

To meet the coexistence requirements between MFCN and DTT in terms of OOBE limits for terminal stations, the optimisation of duplexers is needed.

To this aim, in the frequencies used as guard band, emission limits in line with the LTE standards have been considered, in particular Table 6.6.2.1.1-1 of 3GPP 36.101 [7] (see Table 45:).

1. General E-UTRA spectrum emission mask [7]

| **Spectrum emission limit (dBm) / Channel bandwidth** |
| --- |
| ΔfOOB (MHz) | 1.4 MHz | 3.0 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | **Measurement bandwidth** |
| ± 0-1 | -10 | -13 | -15  | -18 | -20 | -21 | 30 kHz  |
| ± 1-2.5 | -10 | -10 | -10 | -10 | -10 | -10  | 1 MHz |
| ± 2.5-2.8 | -25 | -10 | -10 | -10 | -10 | -10  | 1 MHz |
| ± 2.8-5 |  | -10 | -10 | -10 | -10 | -10 | 1 MHz |
| ± 5-6 |  | -25 | -13 | -13 | -13 | -13 | 1 MHz |
| ± 6-10 |  |  | -25 | -13 | -13  | -13  | 1 MHz |
| ± 10-15 |  |  |  | -25 | -13  | -13  | 1 MHz |
| ± 15-20 |  |  |  |  | -25  | -13  | 1 MHz |
| ± 20-25 |  |  |  |  |  | -25  | 1 MHz |

Considering the frequency ranges 703-733 MHz and 758-788 MHz as uplink and downlink respectively, values in the table above correspond to the following emission levels over larger bandwidth:

1. Derived emission levels

| Frequency range | **LTE BW** |
| --- | --- |
| 1.4 MHz | 3.0 MHz | 5 MHz | 10 MHz | 15 MHz | **20 MHz** |
| 694-698 MHz | -19.0 dBm | -19.0 dBm | -12.2 dBm | -7.0 dBm | -7.0 dBm | -7.0 dBm |
| 698-703 MHz | 5.4 dBm | 3.2 dBm | 1.6 dBm | -0.3 dBm | -1.3 dBm | -1.8 dBm |
| 733-738 MHz | 5.4 dBm | 3.2 dBm | 1.6 dBm | -0.3 dBm | -1.3 dBm | -1.8 dBm |
| 738-743 MHz | -18.0 dBm | -18.0 dBm | -12.0 dBm | -6.0 dBm | -6.0 dBm | -6.0 dBm |
| 743-748 MHz | -18.0 dBm | -18.0 dBm | -18.0 dBm | -18.0 dBm | -6.0 dBm | -6.0 dBm |
| 748-753 MHz | -18.0 dBm | -18.0 dBm | -18.0 dBm | -18.0 dBm | -18.0 dBm | -6.0 dBm |
| 753-758 MHz | -18.0 dBm | -18.0 dBm | -18.0 dBm | -18.0 dBm | -18.0 dBm | -18.0 dBm |

In order for a range of terminals to be supported in the band, it is necessary to adopt emission requirements as the envelope of the terminals emissions. Assuming that support for 1.4 and 3 MHz terminals is not required in this band, the requirements for terminal stations in the table below can be derived.

1. Requirements over frequencies used as guard band

| **Frequency range** | **Requirement** | **Measurement Bandwidth** |
| --- | --- | --- |
| 694-698 MHz | -7.0 dBm | 4 MHz |
| 698-703 MHz | 1.6 dBm | 5 MHz |
| 733-738 MHz | 1.6 dBm | 5 MHz |
| 738-753 MHz | -6.0 dBm | 5 MHz |
| 753-758 MHz | -18 dBm | 5 MHz |

1. impact of the introduction of MFCN in the 700 MHz on PMSE
	1. Monte-Carlo Simulation with SEAMCAT

In order to assess the impact of MFCN terminal on PMSE receiver below 694 MHz, a Monte-Carlo simulation has been performed. The scenario and parameters are taken from ECC report 191 [9].

In ECC Report 191, several scenarios are considered, but the most critical and relevant in this study is Scenario 12 (see Table 48:).

1. Coexistence scenario between PMSE and LTE UE [9]

| **Outdoor/Indoor** | **Interferer** | **Victim** | **Distance (MCL)** | **Distance range(Monte-Carlo Simulations)** | **Propagation model** |
| --- | --- | --- | --- | --- | --- |
| Indoor | LTE UE | PMSE | 5 m | 5…50 m | IEEE 802.11 Model C, break-point at 5m |

Simulation parameters are summarised in Table 49:

1. Parameters for MFCN UE

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | **Comment** |
| Channel bandwidth | MHz | 10 |  |
| Transmission bandwidth (BW) | MHz | 9  | ETSI TS 136 101, Table 7.3.1-2 |
| Antenna height | m | 1.5 |  |
| Body loss | dB | 3 |  |
| Antenna gain | dBi | -4 | Average valueOmni directional |
| Maximum transmit power | dBm | 23 | ETSI TS 136 101, Table 6.2.2-1 |
| Cell size | m | 350 | Urban environment is considered. |

In this simulation MFCN UE power control is considered and the values in Table 50: below are used.

1. MFCN UE power control values

| **Parameter** | **Unit** | **Value** | **Comment** |
| --- | --- | --- | --- |
| Power control step size | dB | 1 |  |
| Minimum threshold | dBm | -101.5 | Sensitivity of the MFCN BS |
| Dynamic range | dB | 63 |  |

This means that if the received power at the base station is higher than the minimum threshold, the UE will reduce the transmitted power in 1 dBm steps, until the minimum threshold is reached. Depending on the frequency separation between block edge of the MFCN UE and PMSE channel edge, and the filter characteristics of the UE in questions. PMSE can experience different levels of MFCN UE OOB emissions as illustrated in Table 51:. These values correspond to a maximum Transmit power of 23 dBm and for lower transmitted power due to power control the OOB emission will be lower as well.

The results of the simulation are illustrated in Table 51:.

1. Monte-Carlo Simulation Results

|  |
| --- |
| **Interference probability: Unwanted [%]** |
| Maximum MFCN UE OOB emission level [dBm/MHz] | -13 | -25 | -28 | -30 | -35 | -37 |
| % interference unwanted | 17.6  | 5.95 | 4.06 | 3.35 | 1.35 | 0.85 |

The simulation results indicate that with a MFCN UE OOB emission level lower than -28 dBm/MHz, the probability of interference from MFCN UE to PMSE receiver is below 4%, which is in line with protection criteria used in ECC report 191 [9].

* 1. Coexistence study based on “scenario 12” from ECC Report 191

In this study, we consider MFCN UE randomly dispatched (uniform distribution) from 0 to 10 metres around the PMSE receiver.

The different parameters used in the simulations are taken from ECC Report 191 [9]:

1. MFCN UE parameters

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| Channel bandwidth | MHz | 10  |
| Antenna height | m | 1.5 |
| Body loss | dB | 3 |
| Antenna gain | dBi | -2 |
| Maximum transmit power | dBm | 23 |

1. PMSE receiver parameters

| **Parameter** | **Unit** | **Value** |
| --- | --- | --- |
| Bandwidth (BW) | MHz | 0.2 |
| Reference sensitivity | dBm | -90 |
| Noise figure (NF) | dB | 6 |
| Noise floor (N) | dBm | -115 |
| Standard desensitization DSTANDARD | dB | 3 |
| Antenna height | m | 3 |
| Antenna gain | dBi | 0 |
| C/(N+I) | dB | 25 |

In the simulation 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. The distribution of the wanted signal is described in Annex 1, section A1.3.1, of ECC Report 191 [9].

Free space loss was used as propagation model.

We then look at the probability of interference depending on the distance for an OOBE of -51 dBm/MHz (corresponding to -42 dBm/8MHz), in Figure 3:.



1. Probability of Interference as a function of the distance

It can be concluded that for a distance separation above 3 metres, the probability of interference is negligible for a OOBE of -51 dBm/MHz (corresponding to -42 dBm/8MHz), even though power control was not implemented and the signal strength of the PMSE link was very low.

* 1. Conclusion

Considering the results of the presented studies it can be concluded that MFCN TS and PMSE below 694 MHz can coexist.

1. analysis of potential interference from broadcasting transmitters to MFCN BS receivers
	1. Co-existence scenario and simulation assumptions

The frequency arrangement considered in the simulation of potential interference from DTT to MFCN uplink is plotted in Figure 4:. It can be seen that the analysis and simulations are focused on the potential interference from DTT channel 48 (686-694 MHz) to MFCN UL lower block (703-713 MHz).

DTT

470

694

686

**690**

MFCN UL

703

713

733

**708**

1. Frequency arrangement considered in the analysis of interference from DTT
to MFCN Uplink

The coexistence scenario for the analysis of potential interference from DTT transmitter to MFCN uplink is illustrated in Figure 5:.

D

1. Co-existence scenario

As shown in Figure 5:, a LTE network clutter (7 tri-sector sites composed of 21 cells) is placed at separation distance D (between the DTT transmitter and LTE cluster centre reference cell site). The DTT parameters and LTE network parameters are summarised in the following tables. In particular DTT parameters are given in Table 54:, DTT transmitter non critical mask and critical mask are given in Table 55:, and MFCN UL system parameters are summarised in Table 56:.

1. DVB-T link budget for fixed roof top reception

|  |
| --- |
| **DVB-T link budget for fixed roof top reception at 10 m****Single transmitter case (Assignments)** |
| **DVB-T parameters** |   | **Downlink all environments (Medium power transmitter)** | **Downlink all environments (High power transmitter)** | **Notes** |
| **Center frequency** | MHz | 690.00 | 690.00 | Channel 48 |
| **Channel BW** | **MHz** | **8.00** | **8.00** |  |
| **Effective BW** | **MHz** | **7.61** | **7.61** |  |
| **Noise figure (F)** | **dB** | **7** | **7** |  |
| **Boltzmann's constant (k)** | Ws/K | 1.38E-23 | 1.38E-23 |   |
| **Absolute temperature (T)** | K | 290 | 290 |   |
| **Noise power (Pn)** | dBm | -98.16 | -98.16 | Pn(dBm) = F+10log(k\*T\*B\*106)+30 |
| **SNR at cell-edge** | dB | 21 | 21 |  |
| **Receiver sensitivity (Pmin)** | **dBm** | **-77.16** | **-77.16** | Pmin = Pn(dBm) +SNR(dB) |
| **Cell-edge coverage probability** | **%** | **95** | **95** |  |
| **Gaussian confidence factor for cell-edge coverage probability of 95% (995%)** | % | 1.645 | 1.645 |   |
| **Shadowing loss****standard deviation ()** | dB | 5.50 | 5.50 |  |
| **Building entry loss****standard deviation (w )** | dB | 0.00 | 0.00 |   |
| **Total loss****standard deviation (T)** | dB | 5.50 | 5.50 | sT = SQRT(2 + w2) |
| **Loss margin (Lm)** | 95% | 9.05 | 9.05 | Lm = 95%\* T  |
| **Pmean (95%)** | **dBm** | **-68.11** | **-68.11** | Pmean = Pmin + Lm |
| **Minimum median field strength** | **dBµV/m** | **56.72** | **56.72** |  |
| **E.i.r.p.** | **dBm** | **69.15** | **85.15** | 5 and 200 kW ERP respectively. |
| **Antenna height** | m | 150.00 | 300.00 |  |
| **Cable loss (Lcable)** | dB | 4.00 | 4.00 |  |
| **Antenna gain (Giso)** | dBi | 13.15 | 13.15 |  |
| **Giso-Lcable** | dBi | 9.15 | 9.15 |   |
| **Average building entry loss****(Lwall)** | dB | 0.00 | 0.00 |   |
| **Max allowed path loss (Lpmax)** | **dB** | **146.42** | **162.42** | Lpmax = e.i.r.p. + (Giso-Lcable)- Lwall -Lbody -Pmean |
| **DVB-T coverage radius calculated by JTG 5-6 model** | **km** | **12.62** | **39.5** | Urban |
|  | **km** | **32.11** | **70.53** | Suburban |
|  | **km** | **32.11** | **70.53** | Rural |

1. DTT Tx mask (GE06) [10]

|  |
| --- |
| DTT Tx mask for 8 MHz Channel |
|  | Non critical | Critical |
| Frequency relative(MHz) | Relative level (dB) | Relative level(dB) |
| –12 | –110 | –120 |
| –6 | –85 | –95 |
| –4.2 | –73 | –83 |
| –3.9 | –32.8 | –32.8 |
| +3.9 | –32.8 | –32.8 |
| +4.2 | –73 | –83 |
| +6 | –85 | –95 |
| +12 | –110 | –120 |

1. MFCN UL system parameters

|  |
| --- |
| MFCN UL system parameters |
| Channel bandwidth | 10 MHz |
| BS antenna height | 30 m |
| BS antenna gain | 15 dBi including feeder loss |
| BS antenna patterns | ITU-R F1336 with k=0.7 |
| BS antenna downtilt | 6° (urban) |
| UE Tx maximum power | 23 dBm |
| UE antenna gain | -3 dB  |
| Body/hand loss | -4 dB |
| MCL UE to BS | 70 dB |
| Number of active users per cell | 3 UEs/cell |
| Cell range | 1 km (urban) |

In the simulation of potential interference from DTT to MFCN UL, DTT transmitter antenna used has an omnidirectional pattern on horizontal plan, and a vertical antenna pattern taken from a real DTT transmitter antenna.

In the simulation, 3 outdoor LTE UEs are generated per cell. LTE network cluster throughput loss due to interference from DTT is simulated. LTE BS receiver mask is taken from 3GPP TS36.104 [6], as given in Table 57:.

|  |
| --- |
| LTE 10 MHz BS receiver mask (5 dB noise figure) |
| Frequency offset (MHz) | Rejection (dB) |
| <-25  | 79.7 |
| -25 to -10 | 51.7 |
| -10 to -5  | 42.7 |
| -4.5 to 4.5 | 0 |
| 5 to 10 | 42.7 |
| 10 to 25  | 51.7 |
| -25 | 79.7 |

1. LTE 10 MHz BS receiver mask [6]

In the simulation, a variable additional isolation for LTE700 BS receiver blocking below 694 MHz is assumed; the objective is to find the appropriate LTE700 BS blocking level to keep the throughput loss below 5%.

The propagation models used in the simulations are summarised in Table 58:.

1. Propagation models used in the simulation

|  |
| --- |
| Propagation models used in the simulation |
| Link | Propagation model |
| DTT Tx to Rx  | ITU-R P.1546 |
| LTE UE to BS | Extended Hata (Urban) |
| DTT Tx to LTE BS | ITU-R P.1546 |

* 1. Interference simulation and analysis

**Urban area DTT high site (H=300 m, Tx e.i.r.p.=85.15 dBm)**

The simulation results for DTT transmitter antenna at 300 m and e.i.r.p. 85.15 dBm in urban area with critical DTT Tx mask and non-critical DTT Tx mask are given in Table 59: and Table 60: respectively, for a separation distance between DTT transmitter and LTE cluster reference cell BS of D=300 m.

1. Simulation results for D=300 m (DTT Tx e.i.r.p.=85.15 dBm at H=300 m)
(DTT Critical Tx mask)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Add isolation to LTE BS Rx (dB)** | **0** | **20** | **30** | **40** |
| iRSS\_unwanted (dBm) | -118.55 | -118.96 | -118.93 | -118.68 |
| iRSS\_Blocking (dBm) | -78.82 | -98.97 | -109.2 | -118.95 |
| Ref\_Cell TP Loss (%) | 94.071 | 27.846 | 6.24 | 1.333 |
| Net average TP Loss (%) | 95.324 | 34.596 | 9.18 | 2.32 |

1. Simulation results for D=300 m (DTT Tx e.i.r.p.=85.15 dBm at H=300 m)
(DTT Non Critical Tx mask)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Add isolation to LTE BS Rx (dB)** | **0** | **20** | **30** | **40** |
| iRSS\_unwanted | -108.89 | -109.01 | -108.81 | -108.85 |
| iRSS\_Blocking | -79.16 | -99.88 | -109.08 | -119.13 |
| Ref\_Cell TP Loss (%) | 93.337 | 26.995 | 9.658 | 6.309 |
| Net average TP Loss (%) | 95.262 | 35.668 | 14.232 | 9.439 |

The simulation results in Table 59: and Table 60: show that when the LTE700 network cluster is placed at D=300 m from DTT transmitter:

1. When 40 dB of additional isolation is added to LTE700 BS blocking level, with the DTT transmitter using the critical mask, LTE700 uplink throughput loss is about 2%, that is well below 5%.
2. When 40 dB of additional isolation is added to LTE700 BS blocking level, with the DTT transmitter using the non-critical mask, LTE700 uplink throughput loss is about 9%.

The simulation results are given in Table 61: and Table 62: respectively for DTT transmitter with critical Tx mask and non-critical Tx mask for a separation distance between DTT transmitter and LTE cluster reference cell BS of D=19.75 km.

1. Simulation results for D=19.75km (DTT Tx e.i.r.p.=85.15 dBm at H=300m)
(DTT Critical Tx mask)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Add isolation to LTE BS Rx (dB)** | **0** | **20** | **30** | **40** |
| iRSS\_unwanted | -126.9 | -126.63 | -126.43 | -126.56 |
| iRSS\_Blocking | -87.17 | -106.91 | -116.7 | -126.83 |
| Ref\_Cell TP Loss (%) | 73.608 | 8.632 | 1.378 | 0.235 |
| Net average TP Loss (%) | 57.396 | 5.078 | 0.763 | 0.155 |

1. Simulation results for D=19.75km (DTT Tx e.i.r.p.=85.15 dBm at H=300m)
(DTT Non Critical Tx mask)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Add isolation to LTE BS Rx (dB)** | **0** | **20** | **30** | **40** |
| iRSS\_unwanted | -116.58 | -116.55 | -117.01 | -116.21 |
| iRSS\_Blocking | -86.86 | -106.82 | -117.28 | -126.48 |
| Ref\_Cell TP Loss (%) | 74.619 | 9.237 | 2.114 | 1.511 |
| Net average TP Loss (%) | 58.129 | 5.530 | 1.333 | 0.818 |

The simulation results in Table 61: and Table 62: show that when the LTE700 network cluster is placed at D=19.75 km from DTT transmitter, which is the middle point of the DTT coverage range:

1. When 30 dB of additional isolation is added to LTE700 BS blocking level, with the DTT transmitter using the critical mask, LTE700 uplink throughput loss is about 1%, that is well below 5%.
2. When 30 dB of additional isolation is added to LTE700 BS blocking level, with the DTT transmitter using the non-critical mask, LTE700 uplink throughput loss is about 2%, that is below 5%.

**Urban area DTT Low site (H=150 m, Tx e.i.r.p.=69.15 dBm)**

The simulation results for DTT transmitter at 150 m and e.i.r.p. 69.15 dBm in urban area with critical DTT Tx mask and non-critical DTT Tx mask are given in Table 63: and Table 64: respectively for aseparation distance between DTT transmitter and LTE cluster reference cell BS of D=300 m.

1. Simulation results for D=300 m (DTT Tx e.i.r.p.=69.15 dBm at H=150 m)
(DTT Critical Tx mask)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Add isolation to LTE BS Rx (dB)** | **0** | **20** | **30** | **40** |
| iRSS\_unwanted (dBm) | -132.07 | -131.78 | -131.65 | -131.39 |
| iRSS\_Blocking (dBm) | -92.34 | -112.05 | -121.93 | -131.66 |
| Ref\_Cell TP Loss (%) | 54.172 | 3.257 | 0.409 | 0.073 |
| Net average TP Loss (%) | 65.206 | 7.545 | 1.264 | 0.254 |

1. Simulation results for D=300 m (DTT Tx e.i.r.p.=69.15 dBm at H=150 m)
(DTT Non Critical Tx mask)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Add isolation to LTE BS Rx (dB)** | **0** | **20** | **30** | **40** |
| iRSS\_unwanted | -121.46 | -121.94 | -121.9 | -121.82 |
| iRSS\_Blocking | -91.73 | -112.21 | -122.18 | -132.1 |
| Ref\_Cell TP Loss (%) | 56.349 | 3.231 | 0.666 | 0.445 |
| Net average TP Loss (%) | 65.866 | 8.224 | 2.093 | 1.271 |

The simulation results given in Table 63: and Table 64: show that:

1. When 30 dB of additional isolation is added to LTE700 BS blocking level, with the DTT transmitter using the critical mask, LTE700 uplink throughput loss is about 1%, that is well below 5%.
2. When 30 dB of additional isolation is added to LTE700 BS blocking level, with the DTT transmitter using the non-critical mask, LTE700 uplink throughput loss is about 2%, that is below 5%.

The simulation results for DTT with critical Tx mask and non-critical Tx mask are given in Table 65: and Table 66: respectively for a separation distance between DTT transmitter and LTE cluster reference cell BS of D=6.3 km.

1. Simulation results for D=6.3km (DTT Tx e.i.r.p.=69.15 dBm at H=150m)
(DTT Critical Tx mask)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Add isolation to LTE BS Rx (dB)** | **0** | **20** | **30** | **40** |
| iRSS\_unwanted | -132.51 | -132.69 | -132.87 | -132.54 |
| iRSS\_Blocking | -92.79 | -112.97 | -123.15 | -132.81 |
| Ref\_Cell TP Loss (%) | 50.494 | 2.461 | 0.364 | 0.06 |
| Net average TP Loss (%) | 36.361 | 1.745 | 0.223 | 0.041 |

1. Simulation results for D=6.3km (DTT Tx e.i.r.p.=69.15 dBm at H=150m)
(DTT Non Critical Tx mask)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Add isolation to LTE BS Rx (dB)** | **0** | **20** | **30** | **40** |
| iRSS\_unwanted | -122.39 | -122.64 | -122.67 | -122.61 |
| iRSS\_Blocking | -92.66 | -112.91 | -122.94 | -132.88 |
| Ref\_Cell TP Loss (%) | 51.984 | 3.068 | 0.612 | 0.356 |
| Net average TP Loss (%) | 36.681 | 1.929 | 0.403 | 0.235 |

The simulation results given in Table 65: and Table 66: for LTE network cluster at D=6.3 km from DTT transmitter show that:

1. When 20 dB of additional isolation is added to LTE700 BS blocking level, with the DTT transmitter using the critical mask, LTE700 uplink throughput loss is about 2.5%, which is below 5%.
2. When 20 dB of additional isolation is added to LTE700 BS blocking level, when the DTT transmitter using the non-critical mask, LTE700 uplink throughput loss is about 3%, which is below 5%.
	1. Analysis of the simulation results

The simulation results described above show the LTE700 uplink throughput loss caused by interference from DTT transmitter (DTT channel 48 (686-694 MHz) to LTE700 lower block (703-713 MHz)), due to two mechanisms:

* + 1. out of band emission of DTT transmitter
		2. out of band blocking of LTE700 BS receiver

Based on the 5% throughput loss criterion, the simulation results show that:

1. DTT transmitter non-critical mask is sufficient for protecting the LTE700 uplink when the DTT transmit power (e.i.r.p.) is below 69 dBm.
2. For the DTT transmitter at transmit power of 85 dBm, the non-critical mask may not appear to be sufficient for protecting the LTE700 uplink for LTE700 BS near the DTT transmitter and several dB (<10 dB) additional improvement is needed. Considering that the real DTT transmitter mask is always better than the minimum requirement of the non-critical mask, it may not be a problem in the field.
3. For DTT transmitting power e.i.r.p. of 69 dBm, an additional isolation up to 30 dB is required to improve the LTE700 BS receiver out of band blocking level.
4. For DTT transmitting power e.i.r.p. of 85 dBm, an additional isolation of 40 dB is required to improve the LTE700 BS receiver out of band blocking level.
	1. Conclusions

Based on the simulation results and analysis of the potential interference from DTT transmitter to LTE700 uplink using frequencies above 703 MHz, the following conclusions can be drawn:

1. LTE MHz BS receiver blocking level defined in 3GPP TS36.104 is not sufficient, and an additional isolation of 40 dB is required. With 9 MHz guard band, a filter can be designed with 40 dB rejection and an acceptable insertion loss (<0.5 dB).
2. DTT non-critical mask is sufficient for protecting LTE700 uplink reception for DTT transmit power e.i.r.p. up to 69 dBm.
3. For high power (e.i.r.p. 85 dBm) DTT transmitter transmitting on the channel 48, several dB (<10 dB) improvement above the non-critical mask might be needed for protecting LTE700 uplink based on the protection criterion of 5% throughput loss.

Since the situation of high power DTT transmitting on the channel 48 varies country by country, DTT transmitter out of band emissions may be dealt with at national level.

1. LIST of REFERENCEs
2. CEPT Report 30: The identification of common and minimal (least restrictive) technical conditions for 790 - 862 MHz for the digital dividend in the European Union
3. CEPT Report 19: Least restrictive technical conditions for WAPECS frequency bands
4. ECC Report 131: The derivation of a Block Edge Mask (BEM) for terminal stations in the 2.6 GHz frequency band (2500-2690 MHz)
5. CEPT Report 39: To develop least restrictive technical conditions for 2 GHz bands
6. CEPT Report 49: Technical conditions regarding spectrum harmonisation for terrestrial wireless systems
7. 3GPP TS 36.104 Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception
8. 3GPP TS 36.101 Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception
9. ECC Report 221: Adjacent band compatibility between MFCN and PMSE audio applications in the 700 MHz frequency band (*under public consultation)*
10. ECC Report 191: Adjacent band compatibility between MFCN and PMSE audio applications in 1785 to 1805 MHz
11. ETSI EN302 296-2 v1.2.1
12. Decision No. 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme
13. EU Council Recommendation No. 10141/09 “on improving radio communication between operational units in border areas”
14. RSPG Report on Strategic Sectoral Spectrum Needs, November 2013 (doc RSPG13-521(rev2)).
1. Provisional lower band edge subject to precise definition within the scope of this Mandate [↑](#footnote-ref-1)
2. Such as the definition of appropriate BEMs (Block Edge Masks) [↑](#footnote-ref-2)
3. This provisional lower band edge is subject to a precise definition within the scope of this Mandate. It is identical with the provisional lower limit stipulated in WRC-12 Resolution 232 which is subject to additional refinement at the WRC-15 [↑](#footnote-ref-3)
4. Subject to Commission Decision 2010/267/EU [↑](#footnote-ref-4)
5. For example in unused parts of the band such as a center gap of a potential FDD arrangement [↑](#footnote-ref-5)
6. Such as resolutions at the ITU WRC-15 [↑](#footnote-ref-6)
7. See also: [11] ( Article 8.3), [12], [13] [↑](#footnote-ref-7)
8. TRP is a measure of how much power the antenna actually radiates. The TRP is defined as the integral of the power transmitted in different directions over the entire radiation sphere. For an isotropic antenna radiation pattern, e.i.r.p. and TRP are equivalent. For a directional antenna radiation pattern, e.i.r.p. in the direction of the main beam is (by definition) greater than the TRP. [↑](#footnote-ref-8)
9. Blocking interference is generated by a strong interference signal out of the receiver band that makes the receiver work in saturation state and then reduces the gains and generally affects the performance of the receiver chain. [↑](#footnote-ref-9)
10. MFCN SDL could aggregate the usual downlink channel of a MFCN paired (FDD) band with a supplemental downlink channel(s) in the unpaired spectrum to increase the downlink capacity [↑](#footnote-ref-10)