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|  | ***Working Group Frequency ManagementProject Team FM PT45Digital Broadcasting Issues*** | **Doc. FM45(11)259** |
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|  |
| --- |
| **Summary:** |
| This document contains an updated information about RAVIS system in working document on the draft supplement to ECC Report 141 |
| **Proposal:** |
| It is proposed to include the provided information about system RAVIS into the draft supplement to ECC Report 141 on future possibilities for the digitalization of Band II  |
| **Background:** |
| PT FM45 at its 13th meeting continued the work on the first draft for a supplementary report of ECC Report 141 with “Technical Elements and Parameters for Digital Terrestrial Broadcasting in Band II” and prepared appropriate document, annexed to the Chairman’s report. Participants were invited to submit contributions proposing appropriate information about digital terrestrial broadcasting systems for the individual sections of the document for the next meeting of FM45. |



**FM45(11)255**

**Annex 5**

Electronic Communications Committee (ECC)

within

the European Conference of Postal and Telecommunications Administrations (CEPT)

**DRAFT SUPPLEMENT TO ECC REPORT 141**

**Place, Month, Year**

# Executive summary

**Table of Contents**

[0 Executive summary 2](#_Toc290574611)

[1 Introduction 6](#_Toc290574612)

[2 General Technical CharActeriStics of Candidate Digital Terrestrial Broadcasting Systems for Band II 7](#_Toc290574613)

[2.1 Digital Radio Mondiale (DRM) 7](#_Toc290574614)

[2.1.1 System Parameters of DRM 7](#_Toc290574615)

[2.1.1.1 DRM Signal Parameters 7](#_Toc290574616)

[2.1.1.2 DRM Frequency Rasters 7](#_Toc290574617)

[2.1.1.3 SFN Operation Capability 7](#_Toc290574618)

[2.2 HD Radio 8](#_Toc290574619)

[2.2.1 HD Radio System Parameters 8](#_Toc290574620)

[2.2.1.1 HD Radio Signal Parameters 8](#_Toc290574621)

[2.2.1.2 HD Radio Frequency Rasters 9](#_Toc290574622)

[2.2.1.3 SFN Operation Capability 11](#_Toc290574623)

[2.3 RAVIS 11](#_Toc290574624)

[2.3.1 RAVIS Radio System Parameters 11](#_Toc290574625)

[2.3.1.1 RAVIS Signal Parameters 11](#_Toc290574626)

[2.3.1.2 RAVIS Frequency Rasters 11](#_Toc290574627)

[2.3.1.3 SFN Operation Capabilities 11](#_Toc290574628)

[2.4 T-DAB 11](#_Toc290574629)

[3 Sharing Parameters 12](#_Toc290574630)

[3.1 FM 12](#_Toc290574631)

[3.2 DRM 12](#_Toc290574632)

[3.2.1 Out-of-Band Emissions 12](#_Toc290574633)

[3.3 HD Radio 13](#_Toc290574634)

[3.3.1 Out-of-Band Emissions 13](#_Toc290574636)

[3.4 RAVIS 14](#_Toc290574637)

[3.4.1 Out-of-Band Emissions 14](#_Toc290574638)

[4 Protection Ratios 17](#_Toc290574639)

[4.1 Protection Ratios for FM 17](#_Toc290574640)

[4.1.1 FM interfered with by DRM 17](#_Toc290574641)

[4.1.2 FM interfered with by HD Radio 17](#_Toc290574642)

[4.1.3 FM interfered with by RAVIS 19](#_Toc290574643)

[4.2 Protection Ratios for DRM 20](#_Toc290574644)

[4.2.1 DRM interfered with by DRM 20](#_Toc290574645)

[4.2.2 DRM interfered with by FM 20](#_Toc290574646)

[4.3 Protection Ratios for HD Radio 21](#_Toc290574647)

[4.3.1 HD Radio interfered with by HD Radio 21](#_Toc290574648)

[4.3.2 HD Radio interfered with by FM 21](#_Toc290574649)

[4.4 Protection Ratios for RAVIS 22](#_Toc290574650)

[4.4.1 RAVIS interfered with by RAVIS 22](#_Toc290574651)

[4.4.2 RAVIS interfered with by FM 23](#_Toc290574652)

[5 Sharing Criteria with Other Services 24](#_Toc290574653)

[5.1 Sharing Criteria with Aeronautical Radionavigation Services above 108.0 MHz 24](#_Toc290574654)

[5.1.1 DRM 24](#_Toc290574655)

[5.1.2 HD Radio 24](#_Toc290574656)

[5.1.2.1 HD Radio Signal and VOR Reception 24](#_Toc290574657)

[5.1.2.2 HD Radio Signal and ILS Reception 24](#_Toc290574658)

[5.1.3 RAVIS 25](#_Toc290574659)

[5.2 Sharing Criteria with Land Mobile Services below 87.5 MHz 25](#_Toc290574660)

[5.2.1 DRM 25](#_Toc290574661)

[5.2.2 HD Radio 25](#_Toc290574662)

[5.2.3 RAVIS 25](#_Toc290574663)

[ANNEX 1: List of reference 26](#_Toc290574664)

**LIST OF ABBREVIATIONS**

|  |  |
| --- | --- |
| Abbreviation | Explanation |
| CEPT | European Conference of Postal and Telecommunications Administrations |
| DRM | Digital Radio Mondiale  |
| FM | Frequency Modulation  |
| FX | Fixed Reception |
| ILS | Instrument Landing System |
| IRT | Institut für Rundfunktechnik GmbH (Broadcast Technology Institute), Munich, Germany |
| MMN | Man-Made Noise  |
| PI-H, PO-H | Portable Handheld Reception |
| PI | Portable Indoor Reception |
| PL | Primary Lower |
| PO | Portable Outdoor Reception |
| PR | Protection Ratio |
| PU | Primary Upper |
| QAM | Quadrature amplitude modulation |
| QPSK | Quadrature Phase Shift Keying |
| RAVIS | Realtime AudioVisual Information System |
| T-DAB | Terrestrial-Digital Audio Broadcasting |
| VHF | Very high frequency |

*[to be complete]*

# Introduction

Any conceivable introduction of digital terrestrial broadcasting in Band II can be achieved on the basis of sharing the spectrum with existing FM services only. To this end, appropriate sharing criteria need to be adhered to. Relevant technical parameters in this context are summarized in this supplement to ECC Report 141 [1]. The purpose of this document is NOT to provide a planning handbook for digital terrestrial broadcasting systems in VHF Band II.

FM frequency allocation in Band II may be used for digital terrestrial broadcasting services with characteristics that may be different from those appearing in the GE84 Plan [2] but within the envelope of their Plan entry or aggregate entries under the provisions of GE84, and that their administrations agree that any such use will be afforded protection to the levels defined by the interfering field strengths as arising from their frequency allocations, taking into account any relevant bilateral agreements. This means any such alternative usage of Band II frequencies must not produce more interference nor claim more protection than the corresponding frequency allocation of GE84.

# General Technical CharActeriStics of Candidate Digital Terrestrial Broadcasting Systems for Band II

## Digital Radio Mondiale (DRM)

The DRM standard provides configurations for broadcast frequencies below 30 MHz as well as for broadcast frequencies above 30 MHz in Mode ‘E’ (often referred to as 'DRM+'), including the VHF Band II. The parameters and statements given in this section refer to the latter set of DRM configurations.

### System Parameters of DRM

#### DRM Signal Parameters

Two different modulations in DRM robustness mode E are considered here, cf. .

The first one is a low protected DRM signal which is defined by the set of parameters:

Mode E, MSC Mode 0 (16-QAM), SDC Mode 1 (code rate = 0.25), MSC Protection level 2 (code rate = 1/2), MSC equal error protection, net bit rate 149.1 kbit/s.

The second modulation represents a high protected DRM signal with the parameters:

MSC Mode 4 (4-QAM), SDC Mode 1 (code rate = 0.25), MSC Protection level 1 (code rate = 1/3), MSC equal error protection, net bit rate 49.7 kbit/s.

**Table 16: MSC code rates for DRM**

|  |  |  |
| --- | --- | --- |
| DRM signal | High protected | Low protected |
| MSC mode | 11 - 4-QAM | 00 - 16-QAM |
| MSC protection level | 1  | 2 |
| MSC code rate | 1/3 | 1/2 |
| SDC mode | 1 | 1 |
| SDC code rate | 0.25 | 0.25 |
| Bit rate approx. | 49.7 kbit/s | 149.1 kbit/s |

The propagation-related OFDM parameters as bandwidth of DRM are given in

Table 24.

Table 24 OFDM parameters

|  |  |
| --- | --- |
| Elementary time period T | 83 1/3 s |
| Duration of useful (orthogonal) part Tu = 27·T | 2.25 ms |
| Duration of guard interval Tg=3·T | 0.25 ms |
| Duration of symbol Ts = Tu + Tg | 2.5 ms |
| Tg/Tu | 1/9 |
| Duration of transmission frame Tf | 100 ms |
| Number of symbols per frame Ns | 40 |
| Channel bandwidth B | 96 kHz |
| Carrier spacing 1/Tu | 444 4/9 Hz |
| Carrier number space | K**min**= -106; K**max**= 106 |
| Unused carriers | none |

#### DRM Frequency Rasters

The DRM frequencies can be positioned in a 100 kHz raster in Band II. The nominal centre carrier frequencies are, in principle, integral multiples of 100 kHz [ITU-GE84].

It is to be considered to allow a spacing of 50 kHz to achieve the full potential of the DRM hybrid mode and to alleviate the deployment of new DRM transmitters in the overcrowded FM band. Also the protections ratios of FM interfered with by DRM (see section 4) have to be extended by a 50 kHz grid later.

## HD Radio

[NOTE: following the discussion at the end of the FM45 meeting in Stuttgart HD Radio has to be considered as a single COFDM block of either 70 or 100 kHZ bandwidth with respect to planning, sharing and compatibility issues. The analogue part of the hybrid HD Radio signal may or may not be linked to the digital side-lobe, in any case it is assumed that this signal is not changed. If two digital side-lobes are employed they have to be treated as two independent COFDM signals in a European Band II context. Whether analogue signal and digital side-lobes are linked or not in terms of re-broadcasting the analogue in the digital parts as well is not of relevance for the issues addressed here.

NOTE: text is needed that explains that in this supplement HD Radio is only considered in terms of its digital modes, i.e. either two distinct digital side-lobes or the full digital mode. All values given refer to one of these modes. The analogue part has to dealt with as an independent FM signal according to ITU-R 412-9]

The description of HD Radio is limited to three waveforms as given in ITU-R BS.1114:

* **Hybrid Waveform:** The digital signal is transmitted in primary main (PM) sidebands on either side of the analogue FM signal in the hybrid waveform. The power level of each sideband is approximately 23 dB below the total power in the analogue FM signal. The analogue signal may be monophonic or stereo, and may include subsidiary communications authorization (SCA) channels.
* **Extended Hybrid Waveform:** In the extended hybrid waveform, the bandwidth of the hybrid sidebands can be extended toward the analogue FM signal to increase digital capacity. This additional spectrum, allocated to the inner edge of each primary main sideband, is termed the primary extended (PX) sideband.
* **All Digital Waveform:** The greatest system enhancements are realized with the all digital waveform, in which the analogue signal is removed and the bandwidth of the primary digital sidebands is fully extended as in the extended hybrid waveform. In addition, this waveform allows lower-power digital secondary sidebands to be transmitted in the spectrum vacated by the analogue FM signal.

HD Radio system provides numerous configurations. The configurations allow for different bandwidth settings, frequency positioning, band combining and different throughput. These configurations are captured (or being updated at the present time) in standard documents, such as NRSC-5C and ETSI TR 102 216 [NOTE: check the number and then put to reference]. They are also briefly described in the present document in conjunction with the provided planning parameters and deployment aspects, such as sharing criteria.

It has to be noted that for the purpose of this report only all digital waveforms of HD Radio will be dealt with. This covers one or two digital blocks occupying 70 or 100 kHz each, respectively, and the all-digital waveform with a bandwidth of 400 kHz.

### HD Radio System Parameters

#### HD Radio Signal Parameters

The system can be configured to use a single frequency block that employs 70 kHz digital signal bandwidth or 100 kHz digital signal bandwidth. The configuration is defined by system modes, and provides various combinations of logical channels, bit rates and protection levels.

When configured to use 70 kHz bandwidth, the system may be configured by mode *MP9*. It then employs logical channel *P1* and provides a throughput (net bit rate) of 98.3kbit/s. The employed modulation is QPSK.

When configured to use 100 kHz bandwidth, the system may be configured to mode *MP8* or mode *MP19*. When configured to mode *MP8*, the system employs logical channel *P1* and provides a throughput (net bit rate) of 98.3kbit/s. When configured to mode *MP19*, the system employs logical channels *P1*and *P3*, and provides a throughput (net bit rate) of 122.9kbit/s. The employed modulation is QPSK.

Although it may be treated as two independent signals, in the context of planning for Band II in Europe, the system also supports joint configurations of two digital bands. Such joint configurations provide higher protection and support higher bit rate. When configured to use 2 x 70 kHz bandwidth, the system may be configured by mode *MP1*. It then employs logical channel *P1* and provides a throughput (net bit rate) of 98.3kbit/s. When configured to use 2 x 100 kHz bandwidth, the system may be configured by mode *MP11*. It then employs logical channels *P1*, *P3* and *P4*, and provides a throughput (net bit rate) of 147.5kbit/s.

The general characteristics of HD Radio system configurations (operating modes) are summarized in table 20.

[NOTE: does this table contain information on the digital only waveforms of HD Radio?]

Table 20 General Characteristics of HD Radio System Operating Modes

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| System Mode | Used BW[kHz] | Total1 bit rate | Channel P1 | Channel P3 | Channel P4 | Comments |
| Code rate | Bit1 rate | Code rate | Bit1 rate | Code rate | Bit1 rate | Interleaver span |
| MP9 | 70 | 98.3 | 4/5 | 98.3 | - | - | - | - | P1: ~1.5s  |
| MP8 | 100 | 98.3 | 4/7 | 98.3 | - | - | - | - | P1: ~1.5s; additional diversity delay |
| MP19 | 100 | 122.9 | 4/5 | 98.3 | 1/2 | 24.6 | - | - | P1: ~1.5s;P3: ~3s  |
| MP1 | 2x 70 | 98.3 | 2/5 | 98.3 | - | - | - | - | P1: ~1.5s  |
| MP11 | 2x 100 | 147.5 | 2/5 | 98.3 | 1/2 | 24.6 | 1/2 | 24.6 | P1: ~1.5s;P3/P4: ~3s |

Note 1: the bit rates reflect the throughput (‘net’ bit rate) by the application layer, and do not include the overhead used by the physical layer.

#### HD Radio Frequency Rasters

In Europe, planning is based on a 100 kHz raster in Band II. In the US the fundamental raster is based on a 200 kHz spacing. The HD Radio system presumes that the digital signal blocks are at pre-defined positions. As can be seen from the diagrams in figures 3.2.1 and 3.2.2 these positions are not centred on the 100 kHz (or 200 kHz) raster but in between.

 

Note: PL and PU are used for indicating lower positioning and upper positioning (respectively) of the digital band. The indication is for convenience only, and does not suggest an actual difference in the signal.

Figure 3.2 – 1 HD Radio 70 kHz digital band positioning examples



Note: PL and PU are used for indicating lower positioning and upper positioning (respectively) of the digital band. The indication is for convenience only, and does not suggest an actual difference in the signal.

Figure 3.2 – 2 HD Radio 100 kHz digital band positioning examples

## RAVIS

The RAVIS standard is intended for digital broadcasting in VHF Bands I and II [12].

### RAVIS System Parameters

#### RAVIS Signal Parameters

RAVIS supports three types of radio channel bandwidth: 100, 200 and 250 kHz.

RAVIS supports three different coding rates for logical channel of main service: 1/2, 2/3 and 3/4.

RAVIS supports three different modulation types for logical channel of main service: QPSK, 16-QAM and 64-QAM.

Rounded bit rates for different combinations of system parameters are given in Table 3.1.

**Table 3.1: Bit rates for RAVIS**

|  |  |  |
| --- | --- | --- |
| Modulation type | Code rate | Bit rate [kbps] |
| 100 kHz channel | 200 kHz channel | 250 kHz channel |
| QPSK | 1/2 | 80 | 160 | 200 |
| 2/3 | 100 | 210 | 270 |
| 3/4 | 120 | 240 | 300 |
| 16-QAM | 1/2 | 150 | 320 | 400 |
| 2/3 | 210 | 420 | 530 |
| 3/4 | 230 | 470 | 600 |
| 64-QAM | 1/2 | 230 | 470 | 600 |
| 2/3 | 310 | 630 | 800 |
| 3/4 | 350 | 710 | 900 |

The propagation-related OFDM parameters of RAVIS are given in Table 3.2.

**Table 3.2: OFDM parameters of RAVIS**

|  |  |
| --- | --- |
| Duration of useful (orthogonal) part Tu | 2.25 ms |
| Duration of guard interval Tg | 0.28125 ms |
| Duration of symbol Ts = Tu + Tg | 2.53125 ms |
| Tg/Tu | 1/8 |
| Duration of transmission frame Tf | 103.78125 ms |
| Number of symbols per frame Ns | 41 |
| Carrier spacing 1/Tu | 444 4/9 Hz |
| Channel bandwidth B | 100 kHz | 200 kHz | 250 kHz |
| Number of curriers Ktotal | 215 | 439 | 553 |
| Spacing between boundary curriers (Ktotal - 1)/Tu | 91.5 kHz | 194.7 kHz | 245.3 kHz |

#### RAVIS Frequency Rasters

The RAVIS frequencies can be positioned in a 100 kHz raster in Band II. The nominal centre carrier frequencies are integral multiples of 100 kHz [ITU-GE84].

## T-DAB

Initially, T-DAB was considered as a candidate system for digital terrestrial audio broadcasting in Band II as a successor of FM. However, this option is no longer pursued. Information for the planning of T-DAB is available within the original Wiesbaden 95 documentation and also the GE06 documentation.

# Sharing Parameters

[NOTE: all masks below should be shown taken into account the position relative to their own centre frequency which includes a correction of the level of the spectral density depending on the modulation format bandwidth as well as proper frequency separation. So, we need to have one mask for DRM and five masks for HD Radio, namely single block with 70/100 kHz, two blocks with 70/100kHz and the full digital]

## FM

Spectrum masks for FM in VHF band II as minimum transmitter requirement are given in [ETSI-FM –> reference? ]. Note that the spectrum masks are defined for a resolution bandwidth of 1 kHz. [NOTE: include the mask here]

**Table XX:** FM spectrum mask

|  |
| --- |
| Spectrum mask (100 kHz channel) / relative level for FM |
| Frequency offset[kHz] | Level [dBc]/[1 kHz] |
| 0 | 0 |
|  |  |
| ± 100 | 0 |
|  |  |
| ± 200 | -80 |
| ± 300 | -85 |
| ± 500 | -85 |

## DRM

### Out-of-Band Emissions

Spectrum masks for DRM in VHF band II are given in **Figure 1**and **Table 24**.

**Figure 1: Spectrum masks for FM and DRM in VHF Band II**

**Table 24: Spectrum masks for FM and DRM in VHF Band II**

**[NOTE: the table for FM should be removed here and put under 3.1, only the digital systems to be kept in tables]**

|  |  |
| --- | --- |
|  | Spectrum mask (100 kHz channel) / relative level for DRM |
|  | Frequency offset[kHz] | Level [dBc]/[1 kHz] |
|  | 0 | -20 |
|  | ± 50 | -20 |
|  | ± 60 | -50 |
|  | **± 181.25** | **-65** |
|  | ± 200 | -80 |
|  | ± 300 | -85 |
|  | ± 500 | -90 |

## HD Radio

### Out-of-Band Emissions

The out-of-band spectral emission mask for HD Radio transmissions, using a single digital block, is given in and below, in reference to the FM radio broadcast spectral mask, as indicated in the ETSI EN 302 018-1 [8].

**Table 25: Out-of-band spectrum mask for single block HD Radio transmissions in Band II**

|  |  |
| --- | --- |
| Frequency Offset [kHz] | Level [dBc/1 kHz] |
| ± 50 kHz | -20 |
| ± 57.5 kHz | -53 |
| ± 100 kHz | -62 |
| ± 150 kHz | -90 |
| ± 500 kHz | -90 |

**[NOTE: the figure and the table above has to be replaced by one where the HD Radio mask is shifted to +150kHz or -150 kHz]**

****

**Figure 2: Out-of-band spectrum mask for HD Radio transmissions in Band II**

[NOTE: in the figure “EN …” should be replaced by “FM”]

[NOTE: new text]

The out-of-band spectral emission mask for two digital blocks is given in Table X2 and Figure Y2 [to be provided]

The out-of-band spectral emission mask for HD Radio All Digital Mode is given in Table X3 and Figure Y3 [to be provided]

[NOTE: end of new text]

[NOTE: the whole section needs to be revised in order to provide tables and figures for spectrum masks for all digital waveforms treated in this report]

]

## RAVIS

### Out-of-Band Emissions

The spectrum masks for RAVIS transmission (for three types of channel bandwidth) are given in XX, YY and ZZ. RAVIS spectrum masks are fitting into analogue FM spectrum mask. Figure xxx sketches all three masks together with the FM spectrum mask as a reference.

**Table XX: Spectrum Mask for RAVIS transmission, 100 kHz bandwidth**

|  |  |
| --- | --- |
| Frequency Offset [kHz] | Level [dBc/1 kHz] |
| 0 kHz | -20 |
| ± 50 kHz | -20 |
| ± 70 kHz | -50 |
| ± 100 kHz | -70 |
| ± 200 kHz | -80 |
| ± 300 kHz | -85 |
| ± 500 kHz | -85 |

**Table XX: Spectrum Mask for RAVIS transmission, 200 kHz bandwidth**

|  |  |
| --- | --- |
| Frequency Offset [kHz] | Level [dBc/1 kHz] |
| 0 kHz | -23 |
| ± 100 kHz | -23 |
| ± 120 kHz | -50 |
| ± 150 kHz | -70 |
| ± 200 kHz | -80 |
| ± 300 kHz | -85 |
| ± 500 kHz | -85 |

**Table XX: Spectrum Mask for RAVIS transmission, 250 kHz bandwidth**

|  |  |
| --- | --- |
| Frequency Offset [kHz] | Level [dBc/1 kHz] |
| 0 kHz | -24 |
| ± 125 kHz | -24 |
| ± 145 kHz | -50 |
| ± 175 kHz | -70 |
| ± 200 kHz | -80 |
| ± 300 kHz | -85 |
| ± 500 kHz | -85 |



# Protection Ratios

The minimum acceptable ratio between a wanted signal and interfering signals to protect the reception of the wanted signal defines the protection ratio *PR* [dB]. The values of protection ratios PR given in this section refer to a location probability of 50%. They were determined by application of ITU-Recommendation BS.641.

The assessment of FM being interfered by FM has to be carried out in accordance with ITU-R BS.641. This recommendation shall be applied correspondingly also in those cases where FM is interfered by one of the digital signal types described in this report. The FM interferer has to be replaced by the digital interfering signal. The spectrum of the digital signal should resemble the shape of the corresponding spectrum mask as close as possible.

To date only information about protection ratios for Gaussian channels is available. If further information is provided then it can be added in due course by a revision update.

##  Gaussian Protection Ratios for FM

### FM interfered with by DRM

The protection ratios for FM interfered with by DRM are given in **Table 27**.

**Table 27: Protection ratios PRbasic for FM interfered with by DRM**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency offset | [kHz] | 0 | ± 100 | ± 200 | ± 300 | ± 400 | ± 500 | ± 1000 |
| Basic protection ratio  | PRbasic [dB] | 49 | 30 | 3 | -8 | -11 | -13 | -21 |

###  FM interfered with by HD Radio

[NOTE: the whole text has been put into square brackets in order to indicate that it has to be revised to cover only the digital waveforms of HD Radio]

For the purpose of this report HD Radio is dealt with a digital OFDM signal consisting of one or two digital blocks of 70 or 100 kHz each, respectively, or a digital signal occupying a bandwidth of 400 kHz.

The protection ratios for FM interfered with by [HD-Radio Extended Hybrid Mode] with digital sidebands only (2x 100 kHz OFDM blocks with 200 kHz spacing between them and without an FM carrier) are given in and for HD Radio All Digital Mode (400 kHz OFDM block) are given in **Table 29**.

[NOTE: all five all digital HD Radio configurations have to be included here in terms of independent PR tables and also the terminology (names of these configurations) should be clarified, also in sections above]

**[Table 28: Protection ratios PRbasic for FM interfered with by HD Radio Extended Mode with digital sidebands only**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency offset | [kHz] | 0 | ± 100 | ± 200 | ± 300 | ± 400 | ± 500 | ± 1000 |
| Basic protection ratio  | PRbasic [dB] | 2 dB | 45 dB | 45 dB | -4 dB | -7 dB | -9 dB | -23 dB |

**Table 29: Protection ratios PRbasic for FM interfered with by HD Radio All Digital Mode**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency offset | [kHz] | 0 | ± 100 | ± 200 | ± 300 | ± 400 | ± 500 | ± 1000 |
| Basic protection ratio  | PRbasic [dB] | 30 dB | 43 dB | 43 dB | 2 dB | -5 dB | -11 dB | -26 dB |

]

### FM interfered with by RAVIS

The protection ratios for FM interfered with by RAVIS are given in **Table 30** for 100 kHz bandwidth, in **Table 31** for 200 kHz bandwidth and in **Table 32** for 250 kHz bandwidth.

 [

**Table 30: Protection ratios PRbasic for FM interfered with by RAVIS (100 kHz bandwidth)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency offset | [kHz] | 0 | ± 100 | ± 200 | ± 300 | ± 400 | ± 500 | ± 1000 |
| Basic protection ratio  | PRbasic [dB] | 50 | 32 | -3 | -8 | -10 | -12 | -20 |

**Table 31: Protection ratios PRbasic for FM interfered with by RAVIS (200 kHz bandwidth)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency offset | [kHz] | 0 | ± 100 | ± 200 | ± 300 | ± 400 | ± 500 | ± 1000 |
| Basic protection ratio  | PRbasic [dB] | 49 | 46 | 25 | -8 | -10 | -12 | -20 |

**Table 32: Protection ratios PRbasic for FM interfered with by RAVIS (250 kHz bandwidth)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency offset | [kHz] | 0 | ± 100 | ± 200 | ± 300 | ± 400 | ± 500 | ± 1000 |
| Basic protection ratio  | PRbasic [dB] | 48 | 45 | 26 | -8 | -10 | -12 | -20 |

# Sharing Criteria with Other Services

## Sharing Criteria with Aeronautical Radionavigation Services above 108.0 MHz

The sharing criteria with aeronautical radionavigation services above 108.0 MHz are still objects of investigation, measurements and considerations. ILS/VOR receivers show different sensitivities against and interference by digital broadcasting systems. Furthermore the new aeronautical radionavigation system GBAS needs to be taken into account.

Therefore the section sharing criteria with aeronautical radionavigation services above 108.0 MHz needs further consideration and amendment. [NOTE from BNetzA: The current text of this section is based on results of measurements with one ILS receiver. There are ongoing studies and measurements. Therefore the reader should be made aware, that there might be amendments of changes to this text in the (possibly near) future].

### DRM

Above the VHF band II broadcasting band, aeronautical radio navigation services are located. The interference potential of a DRM signal into these services is not higher than the one of FM signals (see ANNEX 2 and [11]). For frequency offsets of less than 200 kHz, the interference potential of DRM into VOR and ILS localizer reception is much less than of a standard FM broadcast signal (up to 30 dB less). For larger frequency offsets, both signals produce roughly the same interference, provided sufficient additional band pass filtering of the output of the transmitter is deployed.

### HD Radio

[NOTE: the whole text has been put into square brackets in order to indicate that it has to be revised to cover only the digital waveforms of HD Radio 🡪 input to be provided]

[HD Radio signal in VHF band II allows for the co-existence with aeronautical services above VHF band II. Details for co-existence with VOR and ILS services are provided. *see link [11]:* [NOTE: the description is only valid for HD Radio Hybrid Mode that will not be considered in this report] The interference potential of HD-Radio into VOR and ILS reception is generally much higher for frequency offsets up to 500 kHz and little more than from a standard FM broadcast signal for larger offsets, provided the levels of remaining sideband emis­sions are the same. HD-Radio could not be used in the upper FM channels 107.8 and 107.9 MHz, because then even parts of the normal emission fall inside the aeronauti­cal band.

#### HD Radio Signal and VOR Reception

The interference caused by HD Radio signal to VOR reception is assumed to similar to or less than the interference caused by analogue FM signals. [need a link to the evidence] However, there is a potential for some exceptions to that assumption. In order to mitigate these potential exceptions, the following guidelines are proposed [NOTE: the description is only not valid for HD Radio Full Digital Mode, therefore the proposals have to be deleted]:

* In an area of expected reception of VOR signal operated at 108.0 MHz, the use of HD Radio digital band upper frequency positioning, as indicated in the frequency raster (i.e.fc +150 kHz) is not recommended, when the radio signal host frequency is above 107.7 MHz.
* In an area of expected reception of VOR signal operated at 108.2 MHz, the use of HD Radio digital band PU at power level > -21 dBc (relative to the pre-allocated host) is not recommended, when the radio signal host frequency is 107.9 MHz.

#### HD Radio Signal and ILS Reception

The interference caused by HD Radio signal to ILS reception is assumed to be similar to or less than the interference caused by analogue FM signals. However, there is a potential for exceptions to that assumption. In order to mitigate these potential exceptions, the following guidelines are proposed [NOTE: the description is only not valid for HD Radio Full Digital Mode, therefore the proposals have to be deleted]:

* In an area of expected reception of ILS signal operated at 108.1 MHz, the use of HD Radio digital band PU in combination with the analogue host is not recommended, when the radio broadcast host frequency is at 107.9 MHz.
* It is noted that the guidelines above are expected to have minimal affect on planning consideration, due to the ILS operation procedures. These procedures are normally limited to a distance of 30 km from the ILS transmitter, at a radial of 5 degrees.]

### RAVIS

The potential interference from RAVIS service to the aeronautical radionavigation services in the band above 108.0 MHz is expected to be not higher as the one from analogue FM service (according to out-of-band emission masks). 100 kHz bandwidth RAVIS signal is practically the same as DRM signal (see signal parameters and out-of-band emission for DRM and RAVIS above). The potential interference from 200 and 250 kHz bandwidth RAVIS signal need to be proven. Measurements of protection ratios are planned to the second half of 2011.

## Sharing Criteria with Land Mobile Services below 87.5 MHz

### DRM

Below the VHF Band II broadcasting band, land mobile services with security tasks are located. The interference potential of a DRM signal into these services is not higher than the one of FM signals. [NOTE evidence to be provided ]see link [11]

### HD Radio

[NOTE: the whole text has been put into square brackets in order to indicate that it has to be revised to cover only the digital waveforms of HD Radio]

[HD Radio signal in VHF band II allows co-existence with Land Mobile services below VHF band II. The interference caused by HD Radio signal to such services is assumed to be similar to or less than the interference caused by analogue FM signals. However, there is a potential for some exceptions to that assumption. In order to mitigate these potential exceptions, the following guidelines are proposed [NOTE: the description is only not valid for HD Radio Full Digital Mode, therefore the proposals have to be deleted]:

* In an area of expected reception of land mobile services operated at 87.3 MHz to 87.5 MHz, the use of HD Radio digital band PL in combination with the analogue host is not recommended, when the radio signal host frequency is at 87.6 MHz.]

### RAVIS

The potential interference from RAVIS service to the land mobile services in the band below 87.5 MHz is expected to be not higher as the one of analogue FM service (according to out-of-band emission masks). Measurements of protection ratios are planned to the second half of 2011.

1. List of reference
2. ECC Report 141: Future possibilities for the digitalisation of band II (87.5-108 MHz)
3. GE84: Final Acts of the Regional Administrative Conference for the Planning of VHF Sound Broadcasting (Region 1 and Part of Region 3); Geneva 1984
4. EBU-TECH 3317: Planning parameters for hand held reception
5. ITU-R Recommendation P.1546: Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz
6. GE06: Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06) Annex 3: Technical basis and characteristics
7. ITU-R Report 945: Methods for the assessment of multiple interference
8. ETSI ES 201 980: Digital Radio Mondiale (DRM);System Specification)
9. ETSI EN 302 018-1: Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Frequency Modulated (FM) sound broadcasting service
10. Recommendation ITU-R BS.412-9: Planning standards for terrestrial FM sound broadcasting at VHF
11. Recommendation ITU-R P.372-8: Radio Noise
12. FM45(09)114\_DRM and HD Radio interfering with FM Broadcasting and Aeronautical Radionavigation.zip; Documentation G531/00328/07, Compatibility Measurements DRM120, DRM and HD Radio interfering with FM Broadcast, Narrowband FM (BOS) and Aeronautical Radionavigation, German Network Agency and University of Applied science Kaiserslautern, September 2007 [NOTE: include hyper link to this doc here]
13. Russian Federation National Standard GOST R 54309-2011: Realtime audiovisual information system(RAVIS). Framing structure, channel coding and modulation for digital terrestrial narrowband broadcasting system for VHF band. Technical specification.

**ANNEX 2 – Excerpt from a report on a measurement campaign by Bundesnetzagentur and Fachhochschule Kaiserlautern, Germany**

The title page and the executive summary of a report on a measurement campaign carried out by the German regulator Bundesnetzagentur and the University of Applied Sciences of Kaiserslautern.



**Radio Monitoring Station Munich**

Federal Network Agency / Fachhochschule Kaiserslautern - Compatibility Measurements September 07

page 1

**Documentation G531/00328/07**

**Compatibility Measurements**

**DRM120, DRM+ and HD Radio interfering with**

**FM Broadcast, Narrowband FM (BOS) and Aeronautical Radionavigation**

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September 2007

**0 Executive Summary**

Federal Network Agency / Fachhochschule Kaiserslautern -Compatibility Measurements September 07

Page 4

This document describes the results of protection ratio measurements between the following radio services:

* FM stereo reception interfered by DRM+ / DRM120 and HD-Radio
* Narrowband FM reception interfered by DRM+ / DRM120 and HD-Radio
* Aeronautical Radionavigation (VOR and ILS) interfered by DRM+ / DRM120 and HD­Radio

The main motivation for this measurement series was to assess the interference potential of the planned new digital broadcast systems DRM+ and HD-Radio into existing in-band ser­vices and services in adjacent frequency bands. To enable the comparison of these results with the interference potential of the standard FM broadcast signal, the protection ratios with this analogue signal into the services listed above was also measured.

The main results can be summarized as follows:

1. Provided sufficient additional band pass filtering of the output of the transmitter is ap­plied, the interference potential of HD-Radio and DRM+ / DRM120 into narrowband FM (BOS) reception is not substantially higher than that of a standard FM broadcast signal.
2. The interference potential of DRM+ / DRM120 into FM stereo reception is depending on the frequency separation between wanted and interfering signals. For offsets of less than +/-300 kHz, DRM+ / DRM120 produces roughly the same interference than an FM broadcast signal. For offsets above +/- 300 kHz, the interference potential of DRM+ / DRM120 is tentatively higher but strongly depends on the receiver design. Results range from about 30 dB more critical to equal protection ratios.
3. The interference potential of HD-Radio into FM stereo reception also depends on the frequency separation: For separations of more than +/-300 kHz, the same interfer­ence as from a standard FM broadcast signal can be expected. For Offsets between +/-100 and +/-300 kHz, however, the protection ratios are up to 20 dB higher (i. e. more critical). This is not surprising because the digital frequency blocks of the HD­Radio signal cause the spectrum to exceed the current transmitter mask for FM broadcast substantially.
4. For frequency offsets of less than 200 kHz, the interference potential of DRM+ / DRM120 into VOR and ILS localizer reception is much less than of a standard FM broadcast signal (up to 30 dB less). For larger frequency offsets, both signals pro­duce roughly the same interference, provided sufficient additional band pass filtering of the output of the transmitter is deployed.
5. The interference potential of HD-Radio into VOR and ILS reception is generally much higher for frequency offsets up to 500 kHz and little more than from a standard FM broadcast signal for larger offsets, provided the levels of remaining sideband emis­sions are the same. HD-Radio could not be used in the upper FM channels 107.8 and 107.9 MHz, because then even parts of the normal emission fall inside the aeronauti­cal band.