Radiocommunication Study Groups

Received: 12 April 2010

Source: Annex 7 to Document 6A/285

Document 6A/347-E
15 April 2010
English only

Digital Radio Mondiale (DRM)

COMMENTS ON PRELIMINARY DRAFT REVISION TO RECOMMENDATION ITU-R BS.1114-6

Systems for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz

At its November 2009 meeting, the Working Party developed Annex 7 to Document 6A/285, a preliminary draft revision to Recommendation ITU-R BS.1114-6. The preliminary draft revision is intended to add the characteristics and features of proposed Digital System G to the recommendation.

The United States noted during the November 2009 meeting of the Working Party that Recommendation ITU-R BS.1114-6 had been developed over a number of years and sought additional evidence that Digital System G had been thoroughly tested.

Digital Radio Mondiale would like to offer reassurance that extensive testing of the system has been performed over a number of years. Digital System G is a part of the Digital Radio Mondiale standard for digital broadcasting. It is an extension to higher frequencies but is fundamentally based on the below 30 MHz system (DRM30) recommended in ITU-R BS.1514. It shares a common modulation, coding and signalling basis with DRM30 enhanced by the provision of a new robustness mode (E) which takes account of the propagation conditions and regulatory environment of the higher frequency bands. Digital System G utilises the industry standard HE AAC v2 audio coding system, in common with other digital broadcasting systems.

Digital System G was developed after the DRM Consortium voted unanimously in 2005 to extend DRM to cover higher frequencies and to therefore address the calls for a digital broadcasting system designed to fit the way that spectrum allocated to analogue radio broadcasting was used throughout the world. Therefore the spectrum targeted includes not only the international FM band of 87.5 to 108 MHz, but also the Japanese FM band of 76 to 90 MHz, the OIRT FM band of 65.8 to 74 MHz and in addition the system may be used in the 47 to 68 MHz band where analogue television has been closed and administrations wish to provide new use.

The design, development and testing has been supported by a wide range of companies and organisations in different parts of the world, including broadcasters (both public and private; local, national and international), network operators, receiver and transmitter manufacturers, research institutes, and others. Major equipment vendors from North America and Europe have developed products which support Digital System G.

The testing began with extensive mathematical modelling of the performance of the system when used in the industry standard channel models developed from the processes that led to Digital Systems A and C. Following these mathematical simulations, laboratory testing using fading channel simulators was performed to determine and verify the capability in all conditions - six channel models were used providing confidence that whether the situation be urban, rural, obstructed terrain, hilly terrain, or a single frequency network that the system would provide reliable and robust reception at field strengths that were lower than the equivalent requirement for analogue FM broadcasting. Tests were also performed for an AWGN channel.

Since 2007, field testing has been performed, principally based at the Universities of Hanover and Kaiserslautern, through the collaborative efforts of many well established and newly emerging companies, such as the Fraunhofer Institute, Robert Bosch, Dolby, RFMondiale, and the media authorities LMK and NLM. The major focus of these tests has been in band II (87.5 to 108 MHz) but testing in other bands has also been performed. Annex 1 reproduces a paper delivered to the IEEE International Symposium on Broadband Multimedia and Broadcasting Systems in Bilbao May 2009. It summarises and discusses findings on compatibility of Digital System G with FM broadcasting with the results based on theoretical studies, laboratory and field measurements and planning exercises. A vast amount of additional material is available from the University of Kaiserslautern web site - http://drm-radio-kl.eu/berichte_vortraege.htm.

Annex 2 provides the most recent report into the field testing of Digital System G in band II by the University of Hanover. The work describes two test cases in which the first case is for horizontal polarization of the transmitted signal, and the second case is for vertical polarization. In both cases the receive antenna is vertically polarised. As expected, matching the polarization of the transmit and receive antennas provides the best result.

In June and July 2009, Paris saw demonstrations of Digital System G in band I. No formal measurements of these demonstration were made, however the event is documented - see Annex 3.

Annex 4 describes the Technical Elements and Parameters for Digital Terrestrial Broadcasting in Band II for Digital System G (DRM+) in line with the current process within CEPT PT FM45 considering the future digital use of Band II in Europe.

In the Annexes to this document, DRM is providing a small sample of the available test materials that establish the suitability of Digital System G to provide broadcast services that satisfy the requirements set out in BS.779.

Annexes: 4

ANNEX 1

Paper summarizing and discussing findings on compatibility of Digital System G with FM broadcasting with the results based on theoretical studies, laboratory and field measurements and planning exercises

R07-WP6A-C-0347!!
MSW-E-Annex1.pdf

ANNEX 2

Report on field testing of Digital System G in Band II by the University of Hanover

R07-WP6A-C-0347!!
MSW-E-Annex2.pdf

ANNEX 3

DRM+ successfully trialled in Paris

The Digital Radio Mondiale (DRM) technology for broadcast at higher frequencies was successfully trialled in Paris on Thursday. The DRM+ signal was broadcast on 64.5 MHz from Tour Pleyel, North of Paris, and was received at the office of Conseil Supérieur de l'Audiovisuel (CSA) which regulates the various electronic media in France. The CSA is located 10 km away from the transmitter but the signal strength was good with only 400 watts of radiating power.

This positions DRM+ as a perfect solution for stations not able to join multiplexes, even in places where the FM band is full.

DRM+ extends the DRM standard which is the open, universal, digital radio standard for broadcast bands, to frequencies up to 174MHz including the FM spectrum from 87.5MHz to 108 MHz. DRM+ offers a range of features and benefits for radio stations' around the world and can lead to a cost-effective migration to digital. It was first successfully tested on the FM Band in Kaiserslautern, Germany last year, but this is the first time DRM+ has been used in Band 1.

DRM+ has distinct advantages over conventional FM, it needs lower transmission power for same coverage, opens up new audio possibilities like 5.1 surround sound, increases spectrum efficiency and offers electronic data services such as programme guide and supporting information.

David Blanc, SNRL (Syndicat National des Radios Libres) says: “Professor Dr Andreas Steil and his team (Mr. Schad and Mr. Köhler) from the University of Applied Sciences, Kaiserslautern, was able to put together a complete DRM+ broadcast system on Band 1 and agreed to test it in Paris. SNRL, which gathers over 300 local stations in France, has been trying to find a technical solution for the many stations which cannot join multiplexes for various reasons, including coverage area, cost and desire to remain in control of their broadcast operations. “

“DRM+ seems to be an excellent choice, offering over 100 kbps of usable bit rate, enabling CD audio quality, slideshow and other data to be broadcast from a simple privately-owned transmitter. We now recommend integrating DRM+ in all digital radio receivers, from 60 to 108 Mhz.”, he added.

This test was performed by the help of University of Applied Sciences, Kaiserslautern and Fraunhofer IIS, Erlangen.

Ruxandra Obreja, Chairman, DRM Consortium says: “Through this trial in France, we have yet another proof that the DRM standard can offer a most versatile, economical range of options for big and small operators for the benefit of audiences that want good quality radio. We hope that the trial in France will be positively noted and actioned by the French radio authorities. It is an excellent extra step that will preface the expected all- band extension of the DRM global standard.”

DRM+ in Band I promoted as a most suitable technology to complement other digital radio standards in countries like France successfully trialled in Paris

Paris, France – DRM+ (the DRM technology for radio broadcasts at frequencies up to 174 MHz) has been successfully demonstrated in Paris on Thursday, July 16th 2009. A DRM+ signal was broadcast in band I on 64.5 MHz from Tour Pleyel, in the North of Paris. The stereo and 5.1 Surround sound audio accompanied by DRM Dynamic Labels, Journaline text information, and SlideShow graphics images, were presented with live indoor reception to an audience of over fifty broadcasters and radio specialists. Following the event participants had the opportunity to experience live DRM+ reception with the 5.1 surround sound touring in a car.

This demonstration was organized by the Syndicat National des Radios Libres (SNRL) and was performed with the help of University of Applied Sciences, Kaiserslautern and Fraunhofer IIS, Erlangen. The aim of this event was to prove that the DRM system is the perfect solution for local and smaller radio stations unable to join multiplexes, even in places where the FM band is full thanks to the use of available frequencies below 87 MHz.

David Blanc, SNRL said: “DRM+ is a perfect complement to multiplexes in band 3, it is an efficient and simple solution for hundreds of isolated local radio stations, especially in rural or mountainous areas. The near-CD audio is superb and the data is as rich as with T-DMB or DAB+, with nice slideshow picture quality and useful textual information sent alongside the audio. We really hope this technology can get government approval in France and Europe and be integrated in radio receivers.”

Ruxandra Obreja, DRM Consortium chair said: “It was great to experience for the first time DRM+ in band I. The DRM+ demo in Paris proved that there is already the cutting edge technology available to provide all the benefits of digital radio meeting the needs of smaller stations and of the listeners wherever they are.”

For more information and DRM updates please visit www.drm.org or subscribe to DRM news by writing to pressoffice@drm.org.

Please find and read here the presentations of Mrs. Ruxandra Obreja, DRM Chairman, M. Alexander Zink, Chairman DRM Distribution Interfaces and Vice Chairman DRM Technical Committee, M. Prof. Andreas Steil (presentation in French), University of Applied Sciences, FH Kaiserslautern and M. David Blanc (presentation in French), SNRL.

Contact: Fanny Podworny, pressoffice@drm.org

Telephone: +44 7523518341

ANNEX 4

Initial first draft for a supplement to the ECC Report [xxx] on future possibilities for the digitalisation of Band II

Technical elements and parameters for digital terrestrial broadcasting in Band II

1 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.

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 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.

2 Network planning parameters

2.1 DRM+

Several of the derived parameters depend on the characteristic of the transmitted DRM signal. To limit the amount of tests two parameters sets were chosen as basic sets. One signal has a high data rate but a lower protection, the other signal has a lower data rate but a high protection. The first signal is suited for several audio signals or for an audio signal with a high data rate data service. The second signal is suited for an audio signal with a low data rate data service.

Low protected signal

Robustness Mode E, MSC Mode 00 (16-QAM), SDC Mode 0, Protection level 2 (code rate = 1/2), MSC equal error protection, bit rate 149.1 kbit/s.

High protected signal

Robustness Mode E, MSC Mode 11 (4-QAM), SDC Mode 0, Protection level 1 (code rate = 1/3), MSC equal error protection, bit rate 49.7 kbit/s.

Reception modes

The following reception modes are defined for the planning parameters:

Six different receiving scenarios:

1) Fixed reception (FX);
2) Portable indoor reception (PI);
3) Portable outdoor reception (PO);
4) Mobile reception (MO).
5) Portable indoor reception with handheld devices (PI-H)
6) Portable outdoor reception with handheld devices (PO-H)

OFDM-subcarriers: 4-QAM and 16-QAM.

A description of the receiving scenarios is given in the following subchapters:

Fixed reception (FX)

Fixed reception is defined as reception where a directional receiving antenna mounted at roof level is used. It is assumed that near-optimal reception conditions (within a relatively small volume on the roof) are found when the antenna is installed. In calculating the field strength levels for fixed antenna reception, a receiving antenna height of 10 m above ground level is considered to be representative for the broadcasting service (RRC06).

Portable reception indoor (PI)

Portable indoor reception is defined by a portable receiver with stationary power supply and a build-in (folded)-antenna or with a plug for an external antenna. The receiver is used indoors at no less than 1.5 m above floor level in rooms with on the ground floor, or with a window in an external wall. The location of the receiver is fixed (RRC06)

Portable reception outdoor (PO)

Portable outdoor reception is defined as reception by a portable receiver with battery supply and an attached or built-in antenna is used outdoors at no less than 1.5 m above ground level at a speed of 0-5 km/h.

Mobile reception (MO)

Mobile reception is defined as reception by a receiver in motion also at high speed with a matched antenna situated at no less than 1.5 m above ground level or floor level (RRC06).

Portable reception indoor with handheld devices (PI-H)

Hand-held devices (‘handhelds’ for short) are personal wireless devices, normally of a very small size, similar to that of a mobile phone or PDA (Personal Digital Assistant), with the capability of receiving audiovisual streams and data services, often with facilities for bidirectional voice/data communication, as defined in (EBU-TECH-3317). The hand-held reception requirements are different from those of fixed reception (using a roof top antenna) or portable and mobile reception, in terms of its use and with respect to planning. This means that higher field strengths are needed in order to compensate the low antenna gain, lower receiving antenna height and building penetration loss, real mobility, etc, associated with the use of hand-held devices. These negative aspects can in part be compensated by improvements of the link layer.

The receiver is a handheld with an integrated antenna at no less than 1.5 m over ground level, at very low speed or rest in a room with a window in an external wall.

Portable reception outdoor with handheld devices (PO-H)

Reception with a handheld device as defined in (EBU-TECH-3317), above

2.1.2 Receiving parameter

General characteristics

For every kind of reception the parameters of a here defined reference receiving configuration are assumed. Differing parameters of a receiving configuration and receiving scenarios have to be taken into account.

Receiver noise figure

The receiver noise figure is here defined to F=7dB allowing to have cost effective DRM+ receiver solutions.

Receiver noise input power

The thermal noise level for DRM Mode E with a bandwidth B=100 kHz, T=290° and the Boltzmann constant: $k = 1.3806504 * 10^{-23}$ Ws/K can be calculated with the formula:

$$P_n = F + 10\log(kTB) = -146.98 dBW$$

Minimum receiver input power

The minimum receiver input power level is calculated as follows:

$$P_{S\min} = P_n + C/N$$

C/N is the Carrier to Noise ratio (see below).

Definition and relationship of BER, C/N and sound quality

The bit error ratio (BER) shall be measured at the receiver's channel decoder output. During the measurement, the receiver should remain synchronised. Unless otherwise noted, BER measurements shall be performed in the MSC with the defined signals. If the BER output is not available audio tests could be performed and stated in the test. For tests with Gaussian interferences at the receiver and a BER of 10^-4 approximately 1-2 dB more SNR is needed at the point of failure for the audio output.

C/N values

For the fixed reception (FX) the C/N values for the AWGN channel from (ETSI ES 201 980) are taken. For the portable reception (PI, PO, PI-H, PO-H) the values of the rural channel (channel 9), and for mobile reception (MO) the C/N values of the terrain obstructed (channel 10) are taken from (ETSI ES 201 980).

As the simulations in the DRM system specification are made with ideal channel estimation and receiver, additional implementation losses are considered as 3 dB in Chapter 7.1.

TABLE 2

C/N values in [dB] for the different receiving scenarios and modulations

Scenario	FX	PI	PO	MO	PI-H	PO-H
4-QAM	1.3	5.6	5.6	5.4	5.6	5.6
16-QAM	7.9	13.1	13.1	12.6	13.1	13.1

Antenna parameter

The effective antenna aperture $A_a[dBm^2]$ for a dipole is proportional to the antenna gain G_d and given by:

$$A_a[dBm^2] = G_d + 10\log_{10}(1.64 \cdot \lambda^2 / 4\pi)$$

Antenna properties fixed reception (FX)

For fixed reception a directional receiving antenna mounted at roof level is used. The values in Table 3 are given as antenna gain in the corresponding documents and the antenna aperture calculated with the formula given above.

TABLE 3

Antenna gain and aperture for fixed reception

Frequency	100 MHz
Gain [dBd]	4 (RRC06)
Effective antenna aperture	4.69

Portable and mobile receiving antenna properties (PI, PO, MO)

For portable and mobile reception, an adapted antenna shall be applied. The gain and calculated antenna aperture are given in Table 4.

TABLE 4

Antenna gain and aperture for portable and mobile reception

Frequency	100 MHz
Gain [dBd]	-2.2 (EBU-TECH-3317)
Effective antenna aperture	-1.51

Reception with handheld devices (PI-H, PO-H)

For reception with handheld devices as worst case the antenna gain of an integrated antenna for band III are given in (EBU-TECH, 2007) as -17 dBd. The gain values for the other frequencies in Table 5 are calculated assuming the same antenna aperture.

TABLE 5

Antenna gain and aperture for portable and mobile reception with handheld devices

Frequency	100 MHz
Gain [dBd]	-23.02
Effective antenna aperture	-22.33

Man made Noise

The Man made noise values P_{mmn} for Band I and for Band III in Table 6 are given in (ETSI TR 101 190), the value for Band II is interpolated.

TABLE 6

Antenna gain and aperture for portable and mobile reception

	P_{mmn} **[dB]**
Band I	6
Band II	4
Band III	2

2.1.3 Minimum wanted field strength used for planning

The minimum median equivalent field strength planning value in dBµV/m is calculated as follow:

$$E_{med} = \phi_{med} + 120 + 10\log(120\pi)$$

The minimum median power flux density at the receiving place is calculated as follows:

$$\phi_{med} = (P_{S\min} - A_a) + P_{mmn} + C_l + L_h + L_b + L_C + L_i$$

C_l is the location correction factor, L_h is the height loss correction factor, L_C is the feeder loss, L_i is the implementation loss and L_b is the building penetration loss. In some scenarios particular values are neglected. The detailed values of the correction factors are given in the following sections.

Correction factors

Location correction factor

The location correction factor can be calculated by the formula:

$$C_l = \mu \sigma_c ,$$

μ and σ_c are the distribution factor and the combined standard deviation, respectively.

$$\sigma_c = \sqrt{\sigma_b^2 + \sigma_m^2} ,$$

σ_b and σ_m are the standard deviation of building penetration loss and the standard deviation, respectively.

In defining coverage it is indicated that due to the very rapid transition from near perfect to no reception at all, it is necessary that the minimum required signal level is achieved at a high percentage of locations. These percentages have been set as in (ITU-R P.1546-3) at 70% for stationary reception and potable indoor reception, at 95% for "good" indoor reception and outdoor reception and 99% for "good" mobile reception. The corresponding distribution factors are given in Table 7.

TABLE 7

Distribution factors for different percentages of locations.

Percentage of locations	70%	95%	99%
Szenarios	FX, PI, PI-H	PO, PO-H	MO
μ	0.52	1.64	2.33

Height loss

For portable reception, the antenna height of 10 m above ground level generally used for planning purposes is not realistic and a correction factor needs to be introduced based on a receiving antenna near ground or floor level. For this reason a receiving antenna height of 1,5 m above ground level (outdoor and mobile) or above floor level (indoor) has been assumed.

The propagation prediction method uses often a receiving height of 10 m. To correct the predicted values for a receiving antenna height of 1,5 m above ground level a factor called "height loss" has been introduced.

The formula for the calculation is given by (Recommendation ITU-R P.1546-3). The calculated values are given in Table 8.

TABLE 8

Height loss for different frequencies.

Receiving height	10 m
Antenna height	**1.5 m**
L_h @100 MHz	9.78

Building penetration loss

The building penetration loss for band II is given in (EBU-TECH-3317) and (Digital Radio Coverage and Interference Analysis (DRCIA)), the values are given in Table 9.

TABLE 9

Building penetration loss and standard deviation

Frequency	100 MHz
L_B	9
σ_b	3

The building penetration loss correction factor L_b is calculating as follows:

$$L_b = L_B + \sigma_b \mu.$$

σb: standard deviation of building penetration

μ: distribution factor

Feeder loss

The feeder loss expresses the signal attenuation from the receiving antenna to the receiver's RF input. The feeder loss can be calculated by the following formula from (RRC06).

$$L_C = 0.2l\sqrt{f / f_0},$$

l is the length of the antenna cable in m, *f* is the receiving frequency and $f_0 = 200$ MHz. Tab. 10 gives the values of L_C for the representative frequency.

TABLE 10

Feeder loss correction factor.

Frequency	100 MHz
L_C	0.141 dB / meter

Implementation loss

Implementation loss of the non ideal receiver is considered in the link budget with an additional implementation loss factor (L_i) of 3dB.

Standard deviation

The standard deviation σ_L for digital systems having a bandwidth less than 1 MHz are given as a function of frequency by (ITU-R P.1546-3):

σ_L [dB] =□*K* □□1.6·log(*f*) *f* [MHz]

with: K= 2.1 for mobile systems in urban locations
K= 3.8 for mobile systems in suburban locations or amongst rolling hills
K= 5.1 for analogue broadcasting systems

For DRM+ the worst case mobile surrounding in suburban locations was chosen. The standard deviations σ_L calculated for DRM+ are given in Table 11.

TABLE 11

Standard deviation for DRM+

Frequency	100 MHz
Standard deviation	7 dB

Field strength levels for DRM+

The complete calculations of the field strength levels for DRM+ are given in the following tables.

DRM+ 4QAM			FX	PI	PO	MO	PI-H	PO-H
Frequency	f	MHz	100	100	100	100	100	100
Modulation			4	4	4	4	4	4
Code rate			0.33	0.33	0.33	0.33	0.33	0.33
Data rate		kbit/s	49,7	49,7	49,7	49,7	49,7	49,7
Minimum C/N	C/N	dB	1,3	5,6	5,6	5,5	5,6	5,6
Receiver noise figure	F	dB	7	7	7	7	7	7
Receiver noise input power	P_n	dBW	-146,98	-146,98	-146,98	-146,98	-146,98	-146,98
Minimum receiver signal input power	$P_{S\,min}$	dbW	-145.68	-141.38	-141.38	-141.38	-141.48	-141.38
Effective Antenna Aperture	A_a	dBm^2	4,69	-1,51	-1,51	-1,51	-22,33	-22,33
Antenna gain	G_d	dB	4,0	-2,2	-2,2	-2,2	-23,02 -	-23,02
Minimum power flux density at receiving place	ϕ_{min}	dBW / m^2	-150.37	-139.87	-139.87	-139.97	-119.05	-119.05
Equivalent minimum field strength at receiving place	E_{min}	dBµV/m	-4.57	5.93	5.93	5.83	26.75	26.75
Allowance for man made noise	P_{mmn}	dB	4	4	4	4	4	4
Percentage of locations		%	70	70	95	99	70	95
Distribution factor	µ		0,52	0,52	1,64	2,33	0,52	1,64
Standard deviation of building penetration loss	σ_b			0	3,0	0	0	3,0
Standard deviation	σ_m		7,00	7,00	7,00	7,00	7,00	7,00
Combined standard deviation	σ_c		7,00	7,62	7,00	7,00	7,62	7,00
Location correction factor	C_l	dB	3,64	3,96	11,48	16,31	3,96	11,48
Hight loss	L_h	dB	0	9,78	9,78	9,78	9,78	9,78
Building penetration loss	L_b	dB	0	9	0	0	9	0
Building penetration loss correction factor	L_B	dB	0	10,56	0	0	10,56	0
Feeder loss	L_C	dB	1,41	0	0	0	0	0
Implementation loss	L_i	dB	3	3	3	3	3	3
Minimum median equivalent field strength, planning value	E_{med}	dBµV/m	7.48	37.23	34.19	38.92	58.05	55.01

DRM+ 16QAM			FX	PI	PO	MO	PI-H	PO-H
Frequency	f	MHz	100	100	100	100	100	100
Modulation			16	16	16	16	16	16
Code rate			0,50	0,50	0,50	0,50	0,50	0,50
Data rate		kbit/s	149,1	149,1	149,1	149,1	149,1	149,1
Minimum C/N	C/N	dB	7,9	13,1	13,1	12,6	13,1	13,1
Receiver noise figure	F	dB	7	7	7	7	7	7
Receiver noise input power	P_n	dBW	-146,98	-146,98	-146,98	-146,98	-146,98	-146,98
Minimum receiver signal input power	$P_{S\,\min}$	dbW	-139,08	-133,88	-133,88	-134,38	-133,88	-133,88
Effective Antenna Aperture	A_a	dBm^2	4,69	-1,51	-1,51	-1,51	-22,33	-22,33
Antenna gain	G_d	dB	4,0	-2,2	-2,2	-2,2	-23,02	-23,02
Minimum power flux density at receiving place	$\phi_{\min}$	dBW / m^2	-143,77	-132,37	-132,37	-132,87	-111,55	-111,55
Equivalent minimum field strength at receiving place	$E_{\min}$	dBµV/m	2,03	13,43	13,43	12,93	34,25	34,25
Allowance for man made noise	P_{mmn}	dB	4	4	4	4	4	4
Percentage of locations		%	70	70	95	99	70	95
Distribution factor	µ		0,52	0,52	1,64	2,33	0,52	1,64
Standard deviation of building penetration loss	σ_b			0	3,0	0	0	3,0
Standard deviation	σ_m		7,00	7,00	7,00	7,00	7,00	7,00
Combined standard deviation	σ_c		7,00	7,62	7,00	7,00	7,62	7,00
Location correction factor	C_l	dB	3,64	3,96	11,48	16,31	3,96	11,48
Hight loss	L_h	dB	0	9,78	9,78	9,78	9,78	9,78
Building penetration loss	L_b	dB	0	9	0	0	9	0
Building penetration loss correction factor	L_B	dB	0	10,56	0	0	10,56	0
Feeder loss	L_C	dB	1,41	0	0	0	0	0
Implementation loss	L_i	dB	3	3	3	3	3	3
Minimum median equivalent field strength, planning value	E_{med}	dBµV/m	14.08	44.73	41.69	46.02	65.55	62.51

2.1.3 Out-of-band emissions

(in discussion)

The out-of-band radiated signal in band I and II should fulfill the mask defined in Table 1 and Fig. 1. The vertices of the symmetric out-of-band spectrum mask for FM transmitters are given in (ETSI EN 302 018-2). The out-of-band spectrum mask for DRM+ fitting into the FM mask is proposed as given by Tab. 1. Note that the out-of-band spectrum masks are defined for a resolution bandwidth (RBW) of 1 kHz.

Die Eckwerte wurden immer noch nicht so übernommen, dass sie richtig wären und von mir bereits korrigiert vorliegen, daher die überarbeitete Tabelle nochmals:

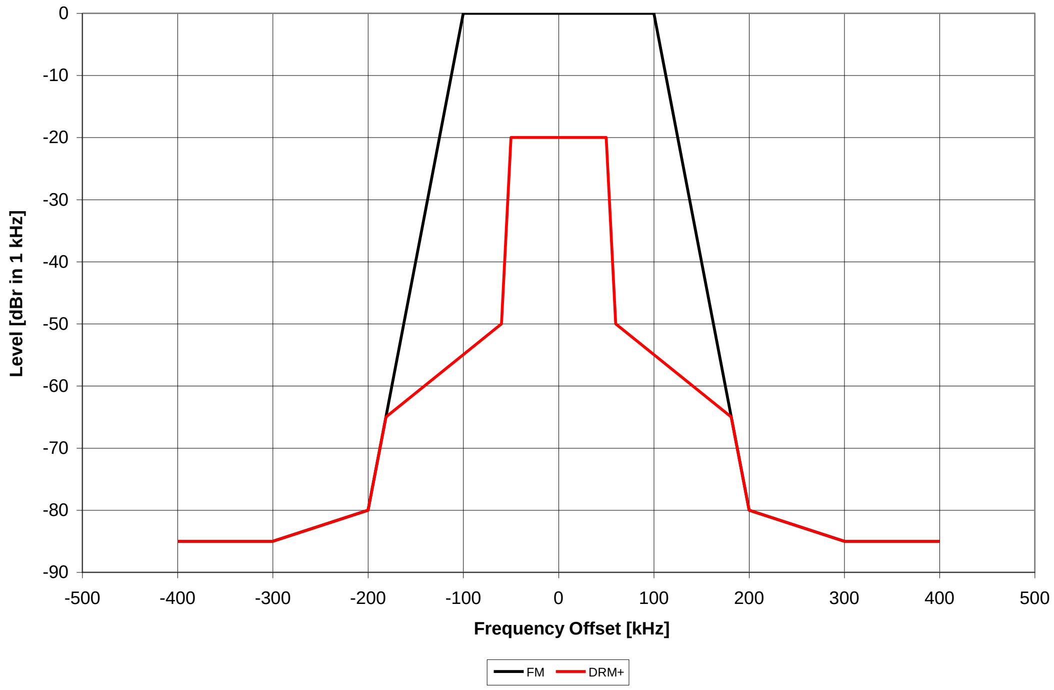
TABLE 1

Out-of-band spectrum masks for FM and DRM+ in VHF band II

Spectrum mask (100 kHz channel) / relative level for FM		Spectrum mask (100 kHz channel) / relative level for DRM+	
Frequency offset [kHz]	**Level [dBr]/[1 kHz]**	**Frequency offset [kHz]**	**Level [dBr]/[1 kHz]**
0	0	0	-20
± 50	0	± 50	-20
± 100	0	± 60	-50
± 181.25	-65	± 181,25	-65
± 200	-80	± 200	-80
± 300	-85	± 300	-85
± 400	-85	± 400	-85

FIGURE 1

Spectrum mask for DRM+ and FM



3 Sharing criteria between FM and digital terrestrial broadcasting

3.1 DRM+

3.1.1 DRM+ interfering DRM+

Frequency offset	[kHz]	0	± 100	± 200	± 300	± 400
DRM+ (16-QAM, PL=0) interfered with by DRM+	[dB]	14	-6	-34	-65	-67
DRM+ (4-QAM, PL=2) interfered with by DRM+	[dB]	6	-14	-40	-72	-74

3.1.2 DRM+ interfering FM and vice versa)

Frequency offset	[kHz]	0	± 100	± 200	± 300	± 400
DRM+ (16-QAM, PL=0) interfered with by FM (stereo)	[dB]	18	-9	-49	-68	-69
DRM+ (16-QAM, PL=0) interfered with by FM (norm signal)	[dB]	17	-20	-65	-68	-69
DRM+ (4-QAM, PL=2) interfered with by FM (stereo)	[dB]	11	-13	-54	-76	-77
DRM+ (4-QAM, PL=2) interfered with by FM (norm signal)	[dB]	12	-26	-73	-76	-76
FM (stereo) interfered with by DRM+	[dB]	)*	)*	)*	)*	)*

)* These values are evaluated at the moment

4 Sharing criteria between digital terrestrial croadcasting and aeronautical radionavigation services above 108.0 MHz

4.1 DRM+

Above the VHF band II broadcasting band, aeronautical radio navigation services are located. The interference potential of DRM+ into these services is not higher as the one of FM signals.

5 Sharing criteria between digital terrestrial broadcasting and land mobile services below 87.5 MHz

5.1 DRM+

Below the VHF band II broadcasting band, land mobile services with security tasks are located. The interference potential of DRM+ into these services is not higher as the one of FM signals.

6 Network planning parameters

6.1 DRM+

6.1.1 Position of DRM+ frequencies

The DRM+ frequencies in band I and band II are positioned in 100 kHz distance according to the FM frequency grid of the former OIRT in band I and of the Geneva Plan 1984 in band II. The nominal carrier frequencies are, in principle, integral multiples of 100 kHz.

6.1.2 SFN operating capability

The maximum echo delay can be calculated from

$D_{echo(max)}$ [km] = $T_g \cdot c_0$ with $c_0 = 300 \cdot 10^3$ [km/s], T_g [s]

Since the length T_g of the DRM+ guard interval is 0.25 ms, the maximum echo delay, and, therefore, the maximum transmitter distance, yields 75 km.

In this calculation cliff edge behavior of DRM+ in the SFN is assumed which still has to be proved.