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EUROPEAN COMMON PROPOSALS

PART 2

Agenda Item 1.2 - New modulation techniques in HFBC

Introduction

This item is directed towards the introduction of digital modulation techniques for broadcasting in the HF bands. ITU-R Study Group 6, has determined that the modulation techniques to be considered under this agenda item may be limited to just the digital modulation techniques recommended in Recommendation ITU-R **BS.1514**. WRC-2003 is therefore fully competent to establish the necessary conditions for introducing digitally modulated emissions to the HF bands allocated to broadcasting using those techniques.

The following changes to the Radio Regulations will serve to satisfy the agenda item:

Proposals

ARTICLE 5

MOD EUR/1.2/1

5.134 The bands 5 900-5 950 kHz, [7 300-7 350 kHz]*, 9 400-9 500 kHz, 11 600-11 650 kHz, 12 050-12 100 kHz, 13 570-13 600 kHz, 13 800-13 870 kHz, 15 600-15 800 kHz, 17 480-17 550 kHz and 18 900-19 020 kHz shall be used by the broadcasting service only as from 1 April 2007, and subject to the application of the procedure of Article 12. Administrations are urged to use these bands to facilitate the introduction of digitally modulated emissions in accordance with the provisions of Resolution **517 (Rev. WRC-2003)**.

Reasons:

The purpose of the modification is to promote the use of digital modulation techniques for broadcasting and to clarify the conditions of access to the bands by the broadcasting service.

*1. suitable modulation techniques are now defined in Recommendation ITU-R **BS.1514**;*

*2. Appendix **11**, as proposed for revision in **EUR/1.2/3**, **EUR/1.2/4**, **EUR/1.2/5** and **EUR/1.2/6**, includes the appropriate system specifications; and*

*3. Resolution **517 (Rev. WRC-2003)**, as proposed in **EUR /1.2/10,** provides the necessary technical parameters allowing the introduction of digital modulation techniques.*

*However, in order to protect existing use of these bands by the fixed and certain mobile services until the envisaged implementation date for the WARC-92 extension bands for HF broadcasting, the bands will only become available to the broadcasting service from 1 April 2007. The access date of 1 April 2007 date corresponds to the end of the primary allocation of these bands to fixed or mobile services, as mentioned in Nos **5.136**, **5.143**, **5.146**, and **5.151**. And this provides the reasonably smooth transition necessary for these current services to find other bands which to move to in accordance with Resolution **21 (Rev.WRC-95)**.*

Because the only conferences currently planned prior to the 2007 implementation date are WRC-03 and WRC-07, this revision deletes reference to the decisions of a future competent conference. WRC-03 is fully competent to determine the implementation date as it chooses, in accordance with agenda item 1.2. Any other changes that might be considered at WRC-07 would be unlikely to come into force before 1 April 2007.

** This band may be affected by proposals under agenda item 1.23*

MOD EUR/1.2/2

ARTICLE 23

23.12 Double-sideband, single-sideband and digitally transmitting stations operating in the HF bands allocated to the broadcasting service shall meet the system specifications contained in Appendix **11**.

MOD EUR/1.2/3

APPENDIX 11

System specifications for Double-Sideband (DSB), Single-Sideband (SSB) and Digitally Modulated Emissions in the HF Broadcasting Service

NOC EUR/1.2/4

PART A – Double-sideband (DSB) system

MOD EUR/1.2/5

PART B – Single-sideband (SSB) system

1 System parameters

1.1 Channel spacing

In a mixed DSB, SSB and Digital environment (see Resolution **517 (Rev. WRC-03)**), the channel spacing shall be 10 kHz. In the interest of spectrum conservation, it is also permissible to interleave SSB emissions midway between two adjacent DSB channels, i.e., with 5 kHz separation between carrier frequencies, provided that the interleaved emission is not to the same geographical area as either of the emissions between which it is interleaved.

In an all inclusive SSB environment, the channel spacing and carrier frequency separation shall be 5 kHz.

1.2 Equivalent sideband power

When the carrier reduction relative to peak envelope power is 6 dB, an equivalent SSB emission is one giving the same audio-frequency signal-to-noise ratio at the receiver output as the corresponding DSB emission, when it is received by a DSB receiver with envelope detection. This is achieved when the sideband power of the SSB emission is 3 dB larger than the total sideband power of the DSB emission. (The peak envelope power of the equivalent SSB emission and the carrier power are the same as that of the DSB emission.)

2 Emission characteristics

2.1 Nominal carrier frequencies

Nominal carrier frequencies shall be integral multiples of 5 kHz.

2.2 Frequency tolerance

The frequency tolerance shall be 10 Hz.[1]

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[1] See Note *21)* of Appendix **2**.

2.3 Audio-frequency band

The upper limit of the audio-frequency band (at – 3 dB) of the transmitter shall not exceed 4.5 kHz with a further slope of attenuation of 35 dB/kHz and the lower limit shall be 150 Hz with lower frequencies attenuated at a slope of 6 dB per octave.

2.4 Modulation processing

If audio-frequency signal processing is used, the dynamic range of the modulating signal shall be not less than 20 dB.

2.5 Necessary bandwidth

The necessary bandwidth shall not exceed 4.5 kHz.

2.6 Carrier reduction (relative to peak envelope power)

In a mixed DSB, SSB and digital environment the carrier reduction shall be 6 dB to allow SSB emissions to be received by conventional DSB receivers with envelope detection without significant deterioration of the reception quality.

2.7 Sideband to be emitted

Only the upper sideband shall be used.

2.8 Attenuation of the unwanted sideband

The attenuation of the unwanted sideband (lower sideband) and of intermodulation products in that part of the emission spectrum shall be at least 35 dB relative to the wanted sideband signal level. However, since there is in practice a large difference between signal amplitudes in adjacent channels, a greater attenuation is recommended.

3 Characteristics of the reference receiver

The reference receiver has the main characteristics as given below. For more detailed characteristics see the relevant ITU-R Recommendations.

3.1 Noise limited sensitivity

The value of the noise limited sensitivity is equal to or less than 40 dB(μV/m).

3.2 Demodulator and carrier acquisition

The reference receiver is equipped with a synchronous demodulator, using for the carrier acquisition a device which regenerates a carrier by means of a suitable control loop which locks the receiver to the incoming carrier. The reference receiver should work as well with DSB emissions as with SSB emissions having a carrier reduced to 6 dB below peak envelope power.

3.3 Overall selectivity

The reference receiver has an overall bandwidth (at – 3 dB) of 4 kHz, with a slope of attenuation of 35 dB/kHz.

NOTE - Other combinations of bandwidth and slope of attenuation are possible, as given below, and will provide the same performance at 5 kHz carrier difference.

Slope of attenuation	Overall bandwidth (– 3 dB)
25 dB/kHz	3 300 Hz
15 dB/kHz	2 700 Hz

ADD EUR/1.2/6

PART C – Digital system

1 System parameters

1.1 Channel spacing

The initial spacing for digitally modulated emissions use shall be 10 kHz. However, interleaved channels with a separation of 5 kHz may be used in accordance with the appropriate protection criteria appearing in Recommendation **[EUR/1.2/YYY] (WRC-03)**, provided that the interleaved emission is not to the same geographical area as either of the emissions between which it is interleaved.

1.2 Channel utilisation

Channels using digitally modulated emissions may share the same spectrum or be interleaved with analogue emissions in the same HFBC band provided the protection to the analogue emissions is at least as great as that which currently is in force with analogue-to-analogue protection. To accomplish this may require that the digital spectral power density (and total power) be lower by several dB than is currently used for the same emission circuit using either DSB or SSB emissions.

2 Emission characteristics

2.1 Bandwidth and centre frequency

A full digitally modulated emission will have a 10 kHz bandwidth with its centre frequency at any of the 5 kHz centre frequency locations in the channel raster within the HFBC bands.

Among several possible “simulcast” modes are those having a combination of analogue and digital emissions of the same programme in the same channel, that may use a digital emission of 5 kHz or 10 kHz bandwidth, next to either a 5 kHz or 10 kHz analogue emission. In all cases of this type, the 5 kHz interleaved raster used in HFBC shall be adhered to in placing the emission within the HFBC bands.

2.2 Frequency tolerance

The frequency tolerance shall be 10 Hz.

2.3 Audio frequency band

Digital source coding within a 10 kHz bandwidth, taking account of the need for various levels of error avoidance, detection and correction coding emission mitigation, can range from the equivalent of monophonic FM (approximately 15 kHz) to low level speech codec performance of the order of 3 kHz. The choice of audio quality is connected to the needs of the broadcaster/listener, and includes such characteristics to consider as the propagation channel conditions expected. There is no single specification, only the upper and lower bounds noted in this paragraph.

2.4 Modulation

Quadrature amplitude modulation (QAM) with Orthogonal frequency division multiplexing (OFDM) shall be used. 64 QAM is feasible under many propagation conditions; factors of ½, ¼ and perhaps 1/8 of this are specified for use when needed.

SUP EUR/1.2/7

RESOLUTION 537 (WRC-97)

SURVEY OF HF BROADCASTING TRANSMITTER AND RECEIVER STATISTICS AS CALLED FOR IN RESOLUTION 517 (REV.WRC-97)

Reasons: *The information from this Resolution was submitted by the Director to WRC-2000. This has assisted in formulating the approach taken in developing proposals relating to Agenda 1.2 of WRC-03. It is felt that there would be no added benefit in continuing this survey and accordingly this Resolution should be suppressed. The associated Recommendation **515 (Rev.WRC-97)** is also proposed for suppression as detailed below.*

SUP EUR/1.2/8

RECOMMENDATION 515 (REV.WRC-97)

Introduction of high-frequency broadcasting transmitters and receivers capable of operation with spectrum-efficient modulation techniques

Reasons: *This Recommendation was updated at WRC-97 to reflect the interests in developing digital systems for HF broadcasting. The development of such a system has moved on apace since then and in February 2001, the Radiocommunication Sector adopted a new Recommendation ITU-R **BS.1514** "System for Digital Sound Broadcasting in the Broadcasting Bands below 30 MHz". With the adoption of this Recommendation and the fact that IEC has been informed of this development, Recommendation **515 (Rev.WRC-97)** can be suppressed.*

SUP EUR/1.2/9

RECOMMENDATION 519 (WARC-92)

Introduction of single-sideband (SSB) emissions and possible advancement of the date for cessation of the use of double-sideband (DSB) emissions in the HF bands allocated to the broadcasting service

Reasons: *There is concern within many Administrations, expressed on many occasions at WRC-97, that the introduction of SSB into HF Broadcasting should not restrict the ability of administrations to continue with their existing DSB transmissions for the foreseeable future and that at this point in time it is inappropriate to specify a cessation of DSB in favour of SSB in the year 2015. It is also evident from information presented at WRC-2000 by the Director that the interest in SSB within HF Broadcasting is virtually non-existent. This Recommendation should therefore be suppressed.*

MOD EUR/1.2/10

RESOLUTION 517 (REV.WRC-03)

INTRODUCTION OF DIGITALLY MODULATED AND SINGLE-SIDEBAND EMISSIONS IN THE HIGH-FREQUENCY BANDS BETWEEN 5 900 KHZ AND 26 100 KHZ ALLOCATED TO THE BROADCASTING SERVICE

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that digital techniques are being introduced into many existing services;*b)* that digital and single-sideband (SSB) techniques allow more effective utilization of the frequency spectrum than double-sideband (DSB) techniques;

c) that digital and SSB techniques enable reception quality to be improved;

d) Appendix **11** concerning the Digital and SSB system specifications in the HF broadcasting services;

e) that ITU-R in its Recommendation ITU-R **BS.1514** has recommended system characteristics for digital sound broadcasts in the broadcast bands below 30 MHz;

f) that digital modulation techniques are expected to provide the means to achieve the optimum balance between sound quality, circuit reliability and bandwidth;

g) that digitally modulated emissions can, in general, provide more efficient coverage than amplitude-modulated transmissions by using fewer simultaneous frequencies and less power;

h) that it may be economically attractive, using current technology, to convert modern conventional DSB broadcasting systems to digital operation in accordance with *considering d)* above;

j) that ITU-R is carrying out further studies on the development of broadcasting using digitally modulated emissions in the bands allocated to the broadcasting service below 30 MHz,

)

resolves

1 that the early introduction of digitally modulated emissions as recommended by ITU-R in the HF bands between 5 900 kHz and 26 100 kHz allocated to the broadcasting service is to be encouraged;

2 that digitally modulated and SSB emissions shall comply with the characteristics specified in Appendix **11**;

3 that whenever an administration replaces a DSB emission by an emission using digital or SSB modulation techniques, it shall ensure that the level of interference is not greater than that caused by the original DSB emission, and shall use RF Protection values specified in Recommendations **[EUR/1.2/YYY]** (WRC-03) and 517 (Rev. WRC-03);

urges administrations

to encourage the development of HF broadcasting transmitters that include the capability to offer digital modulation in all new transmitters put into service after 1 January 2004.

invites ITU-R

to continue its studies on digital techniques in HF broadcasting with a view to assist in the development of this technology for future use,

invites administrations

1 to assist the Director of the Radiocommunication Bureau by providing the relevant statistical data and to participate in ITU-R studies on matters relating to the development and introduction of digitally modulated emissions in the HF bands between 5 900 kHz and 26 100 kHz allocated to the broadcasting service;

2 to bring to the notice of transmitter and receiver manufacturers the most recent results of relevant ITU-R studies on spectrum-efficient modulation techniques suitable for use at HF as well as the information referred to in considerings *d)* and *e)*.

MOD EUR/1.2/11

RESOLUTION 535 (Rev.WRC-03)

2 Software modules

DESCRIPTION 1

Methodology and data

MOD

The software should calculate the field strength values and the fading margins at each test point inside the required service area for each of the frequency bands declared to be available, taking account of the relevant transmitting antenna characteristics for each frequency band. The desired RF signal-to-noise ratio should be user selectable with a default value of 34 dB in the case of DSB and as provided in the current ITU-R Recommendation[1] in the case of digital emissions.

DESCRIPTION 3

Specifications of input data for a requirement

MOD

- modulation choice, to specify if the requirement is to use double-side band (DSB), single-side band (SSB) (see Recommendation ITU-R BS.640) or digital emission (see Recommendation ITU-R BS.1514). This field may be used to identify any other type of modulation when this has been defined for use by HFBC in an ITU-R Recommendation;

DESCRIPTION 4

Methodology and data

MOD

The desired RF signal-to-noise and RF protection ratios should be user selectable, the default values being 34 dB and 17 dB (DSB-to-DSB co-channel case), respectively. In the case of digital emissions, the corresponding values are as provided in the current ITU-R Recommendation[1]. The values for RF protection ratios should be used by the Bureau for its compatibility analyses.

ADD EUR/1.2/12

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1 TG 6/7 draft new Recommendation ITU-R BS.[6/324 Rev1].

DRAFT RECOMMENDATION **[EUR/1.2/YYY]** (WRC-03)

RF protection ratios associated with digitally modulated emissions in the HF bands allocated to the broadcasting service

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that this Conference has resolved to encourage the introduction of digitally modulated emissions in the high frequency broadcast bands allocated to the broadcasting service and has revised Resolution **517** accordingly;

b) that the current use of the spectrum is based on the use of double-sideband (DSB) emissions;

c) that RF co-channel and adjacent channel protection ratios are among the fundamental parameters when determining compatibility;

d) that Recommendation ITU-R **BS.1514,** Annex1 describes a digital system suitable for broadcasting in the bands below 30 MHz

f) that Part C of Appendix **11** contains digital system specifications that refer to this Recommendation for matters dealing with appropriate protection ratios,

recommends

that in the application of Article **12**, the protection ratios specified in the Annex to this Recommendation be used for all those cases where digitally modulated emissions operate in the same bands as double-sideband analogue emissions.

ANNEX TO RECOMMENDATION [EUR/1.2/YYY] (WRC-03)

RF protection ratio values

1. In accordance with Resolution **517 (Rev. WRC-03)** digital modulation may be used in any of the HF bands allocated to the broadcasting service. This accommodation has to be made with the appropriate amounts of protection given to both analogue and digital emissions. RF protection ratios are part of the overall regulation of these emissions. Their values appear in the table in this annex.
2. The table consists of relative RF protection ratios for co-channel and adjacent channel conditions. The independent variable in the table is the centre frequency separation in kHz of any pair of emissions, wanted vs. unwanted. The table provides the required relative protection ratios for the DRM mode (Mode B3) that will be used extensively for HF skywave broadcasting in 10 kHz channels. The ratio data are in decibels.
3. The absolute RF protection ratios can be calculated by adding the required audio S/I ratio to the values of relative RF protection ratios.[2]

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2 Examples:

a) Row <AM interfered with by DRM_B3>: if S/I = 17 dB is required for HF (see WARC ’87) all values of relative protection ratios entered in that row of the table must be increased by 17 dB in order to determine the absolute value of the RF protection ratio (RF PR). As examples:

At 0 kHz the RF PR would be 6 + 17 = 23 dB;

4. The digital modulation governing these protection ratios is that which appears in summary in Part C of Appendix **11** and the analogue modulation is double-sideband modulation as summarized in Part A of the same Appendix.

TABLE

Relative RF protection ratios (dB) between broadcasting systems below 30 MHz, and Digital (64-QAM, protection level No. 1) interfered with by Digital (identical robustness modes and spectrum occupancy types)

Wanted signal	Unwanted signal	Frequency separation $f_{unwanted}$-f_{wanted} (kHz)									Parameters	
		–20	–15	–10	–5	0	5	10	15	20	B_{DRM} (kHz)	S/I (dB)
AM	DRM_B3	–47	–42	–32	3	6	3	–32	–42	–47	10	–
DRM_B3	AM	–54	–48	–40	–3	0	–3	–40	–48	–54	10	7
DRM_B3	DRM_B3	–53	–47	–38	–3	0	–3	–38	–47	–53	10	16

AM: DSB AM signal

DRM_B3: DRM signal, robustness mode B, spectrum occupancy type 3

B_{DRM}: Nominal bandwidth of DRM signal

S/I for analogue reception : Audio signal-to-noise ratio in the case ‘wanted AM’ against ‘unwanted DRM’

S/I for digital reception : Signal-to-interference ratio for a BER of 10^{-4} in the cases ‘wanted DRM’ against ‘unwanted AM’ and ‘unwanted DRM’

NOTE - For more complete and accurate information draft new Recommendation ITU-R BS.[Doc.6/324] should be used. In particular, for other DRM modulation schemes and protection levels, the correction factors that appear in Table 19 of the Annex 2 or in Tables 27, 28 and 29 of the Appendix 1 to that Annex 2 should be applied.

At +/- 10 kHz the RF PR would be -32 + 17 = -15 dB.

b) Row <DRM_B3 interfered with by AM>: all values of relative protection ratios entered in that row of the table must be increased by 7 dB in order to determine the absolute value of the RF PR. As examples:

At 0 kHz the RF PR would be 0 + 7 = 7 dB;

At +/- 10 kHz the RF PR would be -40 + 7 = -33 dB.

c) Row <DRM_B3 interfered with by DRM_B3>: All values of relative protection ratios entered in that row of the table must be increased by 16 dB in order to determine the absolute value of the RF protection ratio. As examples:

At 0 kHz the RF PR would be 0 + 16 = 16 dB;

At +/- 10 kHz the RF PR would be -38 + 16 = -22 dB.

MOD EUR/1.2/13

RECOMMENDATION 517 (REV.WRC-03)

RF protection ratio values for single-sideband (SSB) emissions in the HF bands allocated to the broadcasting service

The World Radiocommunication Conference (Geneva 2003,),

considering

a) that WRC-97 adopted Article **12** as the seasonal planning procedure for the HF bands allocated to the broadcasting service;

b) that this procedure is based principally on the use of double-sideband (DSB) emissions;

c) that the RF co-channel protection ratio is one of the fundamental planning parameters;

d) that this Conference has adopted Resolution **517 (Rev. WRC-03)** relating to the introduction of digitally modulated and SSB emissions in the HF bands allocated to the broadcasting service

e) that the SSB system characteristics for HF broadcasting are contained in Appendix **11**;

g) that studies have shown that SSB emissions may require a lower RF co-channel protection ratio for the same reception quality;

recommends

that, the values of RF protection ratio given in the Annex to this Recommendation be used by the Bureau in its application of Article **12** relating to SSB and DSB emissions in the HF bands allocated to the broadcasting service,

ANNEX TO RECOMMENDATION 517 (REV.WRC-03)

RF protection ratio values

1 The values of RF protection ratio given in the table should be used whenever SSB emissions in conformity with the specification in Appendix **11** are involved in the use of the HF bands allocated to the broadcasting service.

2 The values given refer to the case of co-channel DSB wanted and unwanted signals for the same reception quality.

3 For the reception of DSB and SSB (6 dB carrier reduction relative to peak envelope power) wanted signals, a conventional DSB receiver with envelope detection designed for a channel spacing of 10 kHz is assumed.

4 SSB signals with 6 dB carrier reduction relative to peak envelope power assume equivalent sideband power as specified in Appendix **11**, Part B, § 1.2.

5 The figures for case 2 in the following table relate to a situation where the centre frequency of the intermediate frequency pass-band of the DSB receiver is tuned to the carrier frequency of the

wanted SSB signal. If this is not the case, the value for a difference of +5 kHz may increase to –1 dB.

RF protection ratio values with reference to the co-channel RF protection ratio for DSB wanted and unwanted signals (dB)[1] for use in the HF bands allocated to the broadcasting service

	Wanted signal	Unwanted signal	Carrier frequency separation *f* unwanted – *f* wanted, Δ*f* (kHz)								
			–20	**–15**	**–10**	**–5**	**0**	**+5**	**+10**	**+15**	**+20**
1	DSB	SSB (6 dB carrier reduction relative to p.e.p.)	–51	–46	–32	+1	3	–2	–32	–46	–51
2	SSB (6 dB carrier reduction relative to p.e.p.)	DSB	–54	–49	–35	–3	0	–3	–35	–49	–54
3	SSB (6 dB carrier reduction relative to p.e.p.)	SSB (6 dB carrier reduction relative to p.e.p.)	–51	–46	–32	+1	0	–2	–32	–46	–51

[1] Frequency separation Δf (kHz) less than –20 kHz, as well as Δf (kHz) greater than 20 kHz, need not be considered.