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Digital Radio Mondiale (DRM) –

System specification for digital transmissions in the broadcasting bands below 30 MHz

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Technical Specification

Digital Radio Mondiale (DRM); System Specification

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public and established in an organization operating under given procedures.

IEC-PAS 62272-1 is identical to ETSI specification TS 101980. The ETSI document is the result of a co-operation between Digital Radio Mondiale Consortium (DRM) and the European Telecommunications Standards Institute (ETSI)

Both ETSI and DRM expressed their willingness to have this ETSI document published as an IEC PAS.

IEC-PAS 62272-1 has been processed by IEC technical committee 103: Transmitting equipment for radio-communication.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
103/24/PAS	103/25/RVD

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Foreword

This Technical Specification (TS) has been produced by Joint Technical Committee (JTC) of the European Broadcasting Union (EBU), Comité Européen de Normalization Electrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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Introduction

The frequency bands used for broadcasting below 30 MHz are:

- Low frequency (LF) band - from 148,5 kHz to 283,5 kHz, in ITU Region 1 [1] only;
- Medium frequency (MF) band - from 526,5 kHz to 1 606,5 kHz, in ITU Regions 1 [1] and 3 [1] and from 525 kHz to 1 705 kHz in ITU Region 2 [1];
- High frequency (HF) bands - a set of individual broadcasting bands in the frequency range 2,3 MHz to 27 MHz, generally available on a Worldwide basis.

These bands offer unique propagation capabilities that permit the achievement of:

- Large coverage areas, whose size and location may be dependent upon the time of day, season of the year or period in the (approximately) 11 year sunspot cycle;
- Portable and mobile reception with relatively little impairment caused by the environment surrounding the receiver.

There is thus a desire to continue broadcasting in these bands, perhaps especially in the case of international broadcasting where the HF bands offer the only reception possibilities which do not also involve the use of local repeater stations.

However, broadcasting services in these bands:

- use analogue techniques;
- are subject to limited quality;
- are subject to considerable interference as a result of the long-distance propagation mechanisms which prevail in this part of the frequency spectrum and the large number of users.

As a direct result of the above considerations, there is a desire to effect a transfer to digital transmission and reception techniques in order to provide the increase in quality which is needed to retain listeners who, increasingly, have a wide variety of other programme reception media possibilities, usually already offering higher quality and reliability.

In order to meet the need for a digital transmission system suitable for use in all of the bands below 30 MHz, the Digital Radio Mondiale (DRM) consortium was formed in early 1998. The DRM consortium is a non-profit making body which seeks to develop and promote the use of the DRM system worldwide. Its members include broadcasters, network providers, receiver and transmitter manufacturers and research institutes. More information is available from their website (http://www.drm.org/).

DIGITAL RADIO MONDIALE (DRM) –

System specification for digital transmissions in the broadcasting bands below 30 MHz

1 Scope

The present document gives the specification for the Digital Radio Mondiale (DRM) system for digital transmissions in the broadcasting bands below 30 MHz.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] ITU-R Radio Regulations.

[2] ISO/IEC 14496-3: "Information technology - Coding of audio-visual objects - Part 3: Audio".

[3] ISO/IEC 14496-3/Amd 1: "Audio extensions".

[4] ETSI EN 300 401: "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[5] EN 50067: "Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 to 108,0 MHz".

[6] ISO/IEC 10646-1: "Information technology - Universal Multiple-Octet Coded Character Set (UCS) - Part 1: Architecture and Basic Multilingual Plane".

[7] ISO 639-2: "Codes for the representation of names of languages - Part 2: Alpha-3 code".

[8] ISO 3166 (all parts): "Codes for the representation of names of countries and their subdivisions".

[9] ISO 8859-1: "Information technology - 8-bit single-byte coded graphic character sets - Part 1: Latin alphabet No. 1".

[10] ETSI TS 101 756: "Digital Audio Broadcasting (DAB); Registered Tables".

[11] ITU-R Recommendation BS.559-2: "Objective measurement of radio-frequency protection ratios in LF, MF and HF broadcasting".

[12] ITU-R Recommendation SM.328-10: "Spectra and bandwidth of emissions".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

cell: sine wave portion of duration T_S, transmitted with a given amplitude and phase and corresponding to a carrier position

NOTE 1: Each OFDM symbol is the sum of K such sine wave portions equally spaced in frequency.

energy dispersal: operation involving deterministic selective complementing of bits in the logical frame, intended to reduce the possibility that systematic patterns result in unwanted regularity in the transmitted signal

Fast Access Channel (FAC): channel of the multiplex data stream which contains the information that is necessary to find services and begin to decode the multiplex

Main Service Channel (MSC): channel of the multiplex data stream which occupies the major part of the transmission frame and which carries all the digital audio services, together with possible supporting and additional data services

mod: the modulo operator

NOTE 2: (x mod y) = z, where y > 0, such that x = qy + z, q is an integer, and $0 \leq z < y$.

OFDM symbol: transmitted signal for that portion of time when the modulating amplitude and phase state is held constant on each of the equally-spaced carriers in the signal

reserved for future addition (rfa): bits with this designation shall be set to zero

NOTE 3: Receivers shall ignore these bits.

reserved for future use (rfu): bits with this designation shall be set to zero

NOTE 4: Receivers shall check that these bits are zero in order to determine the valid status of the other fields in the same scope.

Service Description Channel (SDC): channel of the multiplex data stream which gives information to decode the services included in the multiplex

NOTE 5: The SDC also provides additional information to enable a receiver to find alternative sources of the same data.

Single Frequency Network (SFN): network of transmitters sharing the same radio frequency to achieve a large area coverage

transmission frame: a number of consecutive OFDM symbols (duration of 400 ms), whereby the first OFDM symbol contains the time reference cells

transmission super frame: three consecutive transmission frames (duration of 1 200 ms), whereby the first OFDM symbols contain the SDC block

logical frame: contains data of one stream during 400 ms

multiplex frame: logical frames from all streams form a multiplex frame (duration of 400 ms)

NOTE 6: It is the relevant basis for coding and interleaving.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

E[ ]	expectation value of the expression in brackets

f_c	reference frequency of the emitted signal
K	number of active carriers in the OFDM symbol
K_{max}	carrier index of the upper active carrier in the OFDM signal
K_{min}	carrier index of the lower active carrier in the OFDM signal
L_{MUX}	number of input bits per multiplex frame for the multilevel encoding
N_{MUX}	number of MSC cells (QAM symbols) per multiplex frame
T	elementary time period, equal to $83^{1/3}$ µs (1/12 kHz)
T_f	duration of the transmission frame, equal to 400 ms
T_g	duration of the guard interval
T_s	duration of an OFDM symbol
T_{sf}	duration of the transmission super-frame built from three transmission frames
T_u	duration of the useful (orthogonal) part of an OFDM symbol, excluding the guard interval
X^*	complex conjugate of value X
$\lceil\ \rceil$	round towards plus infinity
$\lfloor\ \rfloor$	round towards minus infinity

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAC	Advanced Audio Coding
AFS	Alternative Frequency Switching
BER	Bit Error Ratio
CELP	Code Excited Linear Prediction
CRC	Cyclic Redundancy Check
DFT	Discrete Fourier Transform
EEP	Equal Error Protection
FAC	Fast Access Channel
HF	High Frequency
HVXC	Harmonic Vector eXcitation Coding
IFFT	Inverse Fast Fourier Transform
ISO	International Organization for Standardization
LF	Low Frequency
LPC	Linear Predictive Coding
LSb	Least Significant bit
LSP	Line Spectral Pairs
MF	Medium Frequency
MPEG	Moving Picture Experts Group
MSb	Most Significant bit
MSC	Main Service Channel
OFDM	Orthogonal Frequency Division Multiplexing
PRBS	Pseudo-Random Binary Sequence
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
rfa	reserved for future addition
rfu	reserved for future use
SBR	Spectral Band Replication
SDC	Service Description Channel
SFN	Single Frequency Network
SM	Simple Modulation
SPP	Standard Protected Part
UEP	Unequal Error Protection
uimsbf	unsigned integer most significant bit first
VSPP	Very Strongly Protected Part