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Digitalna videoradiodifuzija (DVB) ï Mikrovalovni veļ toļ kovni distribucijski sistemi (MMDS) pod 10 GHz

Digital Video Broadcasting (DVB); Microwave Multipoint Distribution Systems (MMDS) below 10 GHz

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Foreword

This second edition, previously as an ETS now an EN, contains changes of an entirely editorial nature as follows:

1) add the DVB logo to the front page of the deliverable;
2) change the title from: "Digital broadcasting systems for television, sound and data services; etc." to "Digital Video Broadcast (DVB); etc.";
3) add in the foreword the DVB acknowledgement.

This European Standard (Telecommunications series) has been produced by the Joint Technical Committee (JTC) of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE: The EBU/ETSI JTC was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC 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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Digital Video Broadcasting (DVB) Project

Founded in September 1993, the DVB Project is a market-led consortium of public and private sector organizations in the television industry. Its aim is to establish the framework for the introduction of MPEG-2 based digital television services. Now comprising over 200 organizations from more than 25 countries around the world, DVB fosters market-led systems, which meet the real needs, and economic circumstances, of the consumer electronics and the broadcast industry.

Proposed national transposition dates	
Date of adoption of this EN:	4 April 1997
Date of latest announcement of this EN (doa):	31 July 1997
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 January 1998
Date of withdrawal of any conflicting National Standard (dow):	31 January 1998

1 Scope

The present document describes the framing structure, channel coding and modulation (denoted "the System" for the purposes of the present document) for a digital multi-program television distribution by Microwave Multipoint Distribution Systems (MMDS) operating below 10 GHz.

The aim of the present document is to present a harmonized transmission standard for cable, satellite and MMDS, based on the MPEG-2 System Layer ISO/IEC 13818-1 [1], with the addition of appropriate Forward Error Correction (FEC) technique.

This System follows the modulation/channel coding system for digital multi-program television by cable EN 300 429 (see annex C, bibliography) and is based on Quadrature Amplitude Modulation (QAM) with 16, 32, and 64 constellation points.

The System FEC is designed to improve Bit Error Ratio (BER) from 10^{-4} to a range, 10^{-10} to 10^{-11}, ensuring "Quasi Error Free" (QEF) operation with approximately one uncorrected error event per transmission hour.

2 Normative references

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ISO/IEC 13818-1: "Coding of moving pictures and associated audio".

[2] IEEE Trans. Comm. Tech., COM-19, pp. 772-781, (October 1971) Forney, G.D.: "Burst-correcting codes for the classic bursty channel".

3 Symbols and abbreviations

3.1 Symbols

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

α	roll-off factor
A_k, B_k	Most Significant Bits (MSB) at the output of the byte to m-tuple converter
f_0	channel centre frequency
f_N	Nyquist frequency
g(x)	Reed - Solomon (RS) code generator polynomial
HEX	HEXadecimal
I	Interleaving depth (bytes)
I, Q	In-phase, Quadrature phase components of the modulated signal
j	branch index
k	number of bytes mapped into n symbols
m	power of 2^m-level QAM: 4,5,6 for 16-QAM, 32-QAM, 64-QAM, respectively

M	convolutional interleaver branch depth for j = 1, M = N/I
n	number of symbols mapped from k bytes
N	error protected frame length (bytes)
p(x)	RS field generator polynomial
r_m	in-band ripple (dB)
R	Randomized sequence
R_s	symbol Rate corresponding to the bilateral Nyquist bandwidth of the modulated signal
R_u	useful bit Rate after MPEG-2 transport multiplexer
$R_{u'}$	bit Rate after RS outer encoder
q	number of differentially uncoded bits: 2,3,4 for 16-QAM, 32-QAM, 64-QAM, respectively
T	number of bytes which can be corrected in RS error protected packet
T_s	symbol period

3.2 Abbreviations

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

BB	BaseBand
BER	Bit Error Ratio
D/A	Digital-to-Analogue conversion
FEC	Forward Error Correction
FIFO	First In First Out
IF	Intermediate Frequency
IRD	Integrated Receiver Decoder
LSB	Least Significant Bit
MMDS	Microwave Multipoint Distribution Systems
MPEG	Moving Pictures Experts Group
MSB	Most Significant Bit
MUX	MUltipleX
PDH	Plesiochronous Digital Hierarchy
PRBS	Pseudo-Random Binary Sequence
QAM	Quadrature Amplitude Modulation
QEF	Quasi Error Free
RF	Radio Frequency
RS	Reed-Solomon
SMATV	Satellite Master Antenna Television
TDM	Time Division Multiplex
TV	TeleVision

4 MMDS System concept

The MMDS System shall be defined as the functional block of equipment performing the adaptation of the baseband TV signals to the MMDS channel characteristics (see figure 1).

At the transmitter site, the following TV baseband signal sources can be considered:

- satellite signal(s);
- cable signal(s);
- contribution link(s);
- local program source(s).

The processes in the following subclauses shall be applied as shown in figure 1.

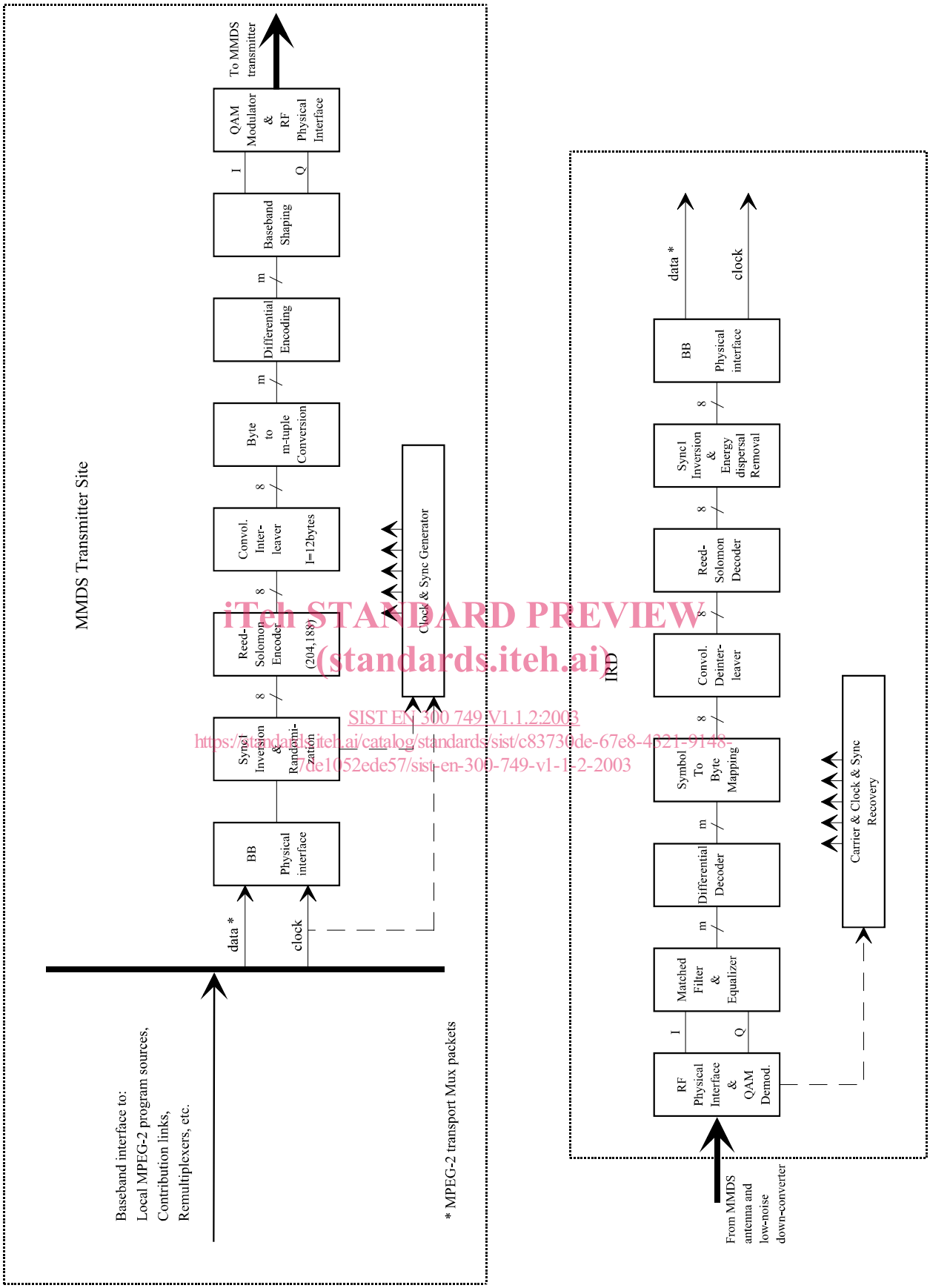

Figure 1: Conceptual block diagram of elements at the transmitting and receiving sites of MMDS systems below 10 GHz

4.1 Baseband interfacing and sync

This unit shall adapt the data structure to the format of the signal source. The framing structure shall be in accordance with MPEG-2 transport layer including sync bytes.

NOTE: Interfaces are not part of the present document.

4.2 Sync 1 inversion and randomization

This unit shall invert the Sync 1 byte according to the MPEG-2 framing structure, and randomizes the data stream for spectrum shaping purposes.

4.3 Reed-Solomon (RS) encoder

This unit shall apply a shortened RS code to each randomized transport packet to generate an error-protected packet. This code shall also be applied to the Sync byte itself.

4.4 Convolutional interleaver

This unit shall perform a depth I = 12 convolutional interleaving of the error-protected packets. The periodicity of the sync bytes shall remain unchanged.

4.5 Byte to m-tuple conversion

This unit shall perform a conversion of the bytes generated by the interleaver into QAM symbols.

4.6 Differential encoding

In order to get a rotationally-invariant constellation, this unit shall apply a differential encoding to the two Most Significant Bits (MSBs) of each symbol.

4.7 Baseband shaping

This unit performs mapping from differentially encoded m-tuples to I and Q signals and a square-root raised cosine filtering of the I and Q signals prior to QAM modulation.

4.8 QAM modulation and physical interface

This unit performs QAM modulation. It is followed by interfacing the QAM modulated signal to the Radio Frequency (RF) MMDS channel.

4.9 MMDS receiver

A System receiver shall perform the inverse signal processing, as described for the modulation process above, in order to recover the baseband signal.

5 MPEG-2 transport layer

The MPEG-2 Transport Layer is defined in ISO/IEC 13818-1 [1]. The Transport Layer for MPEG-2 data is comprised of packets having 188 bytes, with one byte for synchronization purposes, three bytes of header containing service identification, scrambling and control information, followed by 184 bytes of MPEG-2 or auxiliary data.

6 Framing structure

The framing organization shall be based on the MPEG-2 transport packet structure. The System framing structure is shown in figure 2.

Figure 2a) MPEG-2 transport MUX packet

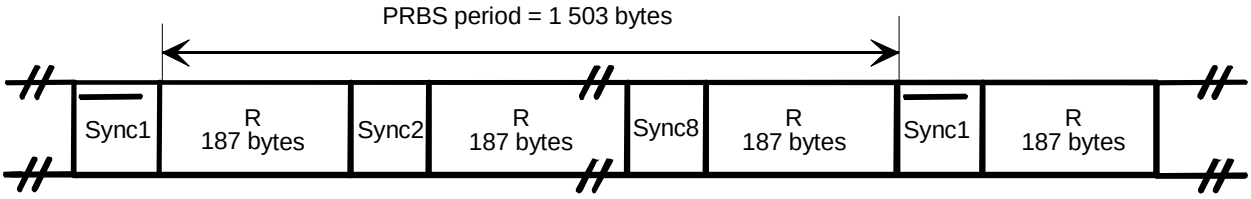

Figure 2b) Randomized transport packets: Sync bytes and Randomized Sequence R

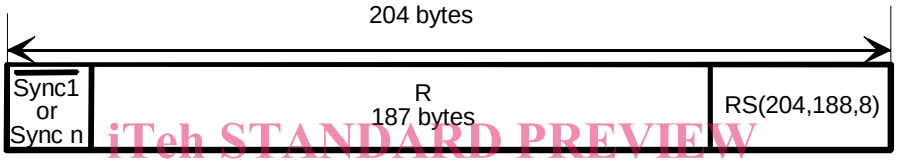

Figure 2c) Reed-Solomon RS(204,188, T = 8) error protected packet

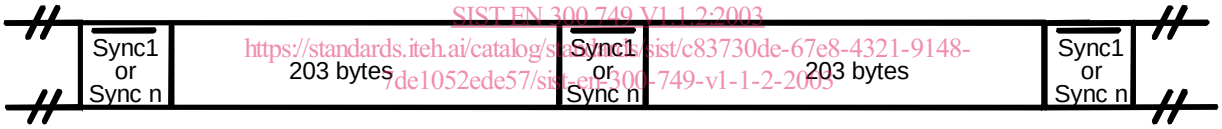

Figure 2d) Interleaved Frames; Interleaving depth I = 12 bytes

$\overline{\text{Sync1}}$ = nonrandomized complemented sync byte
Syncn = nonrandomized sync byte, n = 2, 3, ..., 8

Figure 2: Framing structure

7 Channel coding

To achieve the appropriate level of error protection required for MMDS transmission of digital data, a FEC based on RS encoding shall be used.

In contrast to the baseline system for satellite described in EN 300 421 (see annex C, bibliography), no convolutional coding shall be applied for MMDS transmission.

Protection against burst errors shall be achieved by the use of byte interleaving.