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Digitalna videoradiodifuzija (DVB) - Struktura okvirov, kodiranje kanalov in modulacija za drugo generacijo sistema digitalne prizemne televizijske radiodifuzije (DVB-T2)

Digital Video Broadcasting (DVB) - Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2)

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Foreword

This European Standard (EN) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation 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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The Digital Video Broadcasting Project (DVB) is an industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulatory bodies, content owners and others committed to designing global standards for the delivery of digital television and data services. DVB fosters market driven solutions that meet the needs and economic circumstances of broadcast industry stakeholders and consumers. DVB standards cover all aspects of digital television from transmission through interfacing, conditional access and interactivity for digital video, audio and data. The consortium came together in 1993 to provide global standardisation, interoperability and future proof specifications.

National transposition dates	
Date of adoption of this EN:	19 March 2012
Date of latest announcement of this EN (doa):	30 June 2012
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 December 2012
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1 Scope

The present document describes a second generation baseline transmission system for digital terrestrial television broadcasting. It specifies the channel coding/modulation system intended for digital television services and generic data streams.

The scope is as follows:

- it gives a general description of the Baseline System for digital terrestrial TV;
- it specifies the digitally modulated signal in order to allow compatibility between pieces of equipment developed by different manufacturers. This is achieved by describing in detail the signal processing at the modulator side, while the processing at the receiver side is left open to different implementation solutions. However, it is necessary in this text to refer to certain aspects of reception.

Versions 1.1.1 and 1.2.1 of this specification defined a single profile which incorporates time-slicing but not time-frequency-slicing (TFS). Features which would allow a possible future implementation of TFS (for receivers with two tuners/front-ends) can be found in annex E. It is not intended that a receiver with a single tuner should support TFS.

The present document (version 1.3.1 of this specification) adds a T2-Lite profile. This profile is intended to allow simpler receiver implementations for very low capacity applications such as mobile broadcasting, although it may also be received by conventional stationary receivers. The details of this T2-Lite profile are described in annex I. Version 1.3.1 also introduces a name, which is 'T2-base profile', for the previous single profile.

2 References

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References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 101 162: "Digital Video Broadcasting (DVB); Allocation of identifiers and codes for Digital Video Broadcasting (DVB) systems".

[2] ETSI TS 102 992: "Digital Video Broadcasting (DVB); Structure and modulation of optional transmitter signatures (T2-TX-SIG) for use with the DVB-T2 second generation digital terrestrial television broadcasting system".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ISO/IEC 13818-1: "Information technology - Generic coding of moving pictures and associated audio information: Systems".

[i.2] ETSI TS 102 606: "Digital Video Broadcasting (DVB); Generic Stream Encapsulation (GSE) Protocol".

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[i.3] ETSI EN 302 307: "Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications (DVB-S2)".

[i.4] ETSI EN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

[i.5] ETSI EN 300 744: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

0xkk: digits 'kk' should be interpreted as a hexadecimal number

active cell: OFDM cell carrying a constellation point for L1 signalling or a PLP

auxiliary stream: sequence of cells carrying data of as yet undefined modulation and coding, which may be used for future extensions or as required by broadcasters or network operators

BBFRAME: set of K_{bch} bits which form the input to one FEC encoding process (BCH and LDPC endcoding)

bias balancing cells: special cells inserted into the P2 symbols to reduce the effect of the bias in the L1 signalling

common PLP: PLP having one slice per T2-frame, transmitted after the L1 signalling and any bias balancing cells, which may contain data shared by multiple PLPs

configurable L1-signalling: L1 signalling consisting of parameters which remain the same for the duration of one super-frame

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data cell: OFDM cell which is not a pilot or tone reservation cell (may be an unmodulated cell in the Frame Closing Symbol)

data PLP: PLP of Type 1 or Type 2

data symbol: OFDM symbol in a T2-frame which is not a P1 or P2 symbol

div: integer division operator, defined as:

$$x \text{ div } y = \left\lfloor \frac{x}{y} \right\rfloor$$

dummy cell: OFDM cell carrying a pseudo-random value used to fill the remaining capacity not used for L1 signalling, PLPs or Auxiliary Streams

dynamic L1-signalling: L1 signalling consisting of parameters which may change from one T2-frame to the next

elementary period: time period which depends on the system bandwidth and is used to define the other time periods in the T2 system

FEC Block: set of N_{cells} OFDM cells carrying all the bits of one LDPC FECFRAME

FECFRAME: set of N_{ldpc} (16 200 or 64 800) bits from one LDPC encoding operation

FEF part: part of the super-frame between two T2-frames which contains FEFs

NOTE: A FEF part always starts with a P1 symbol. The remaining contents of the FEF part should be ignored by a DVB-T2 receiver and may contain further P1 symbols.

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FFT size: nominal FFT size used for a particular mode, equal to the active symbol period T_s expressed in cycles of the elementary period T

for i=0..xxx-1: the corresponding signalling loop is repeated as many times as there are elements of the loop

NOTE: If there are no elements, the whole loop is omitted.

frame closing symbol: OFDM symbol with higher pilot density used at the end of a T2-frame in certain combinations of FFT size, guard interval and scattered pilot pattern

Im(x): imaginary part of x

interleaving frame: unit over which dynamic capacity allocation for a particular PLP is carried out, made up of an integer, dynamically varying number of FEC blocks and having a fixed relationship to the T2-frames

NOTE: The Interleaving Frame may be mapped directly to one T2-frame or may be mapped to multiple T2-frames. It may contain one or more TI-blocks.

L1 bias balancing bits: unused bits within the L1 signalling fields which are nominated to be set so as to reduce the overall bias in the L1 signalling

L1-post signalling: signalling carried in the P2 symbol carrying more detailed L1 information about the T2 system and the PLPs

L1-pre signalling: signalling carried in the P2 symbols having a fixed size, coding and modulation, including basic information about the T2 system as well as information needed to decode the L1-post signalling

NOTE: L1-pre signalling remains the same for the duration of a super-frame.

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MISO group: group (1 or 2) to which a particular transmitter in a MISO network belongs, determining the type of processing which is performed to the data cells and the pilots

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NOTE: Signals from transmitters in different groups will combine in an optimal manner at the receiver.

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mod: modulo operator, defined as:

$$x \bmod y = x - y\left\lfloor \frac{x}{y} \right\rfloor$$

nn_D: digits 'nn' should be interpreted as a decimal number

normal symbol: OFDM symbol in a T2-frame which is not a P1, P2 or Frame Closing symbol

OFDM cell: modulation value for one OFDM carrier during one OFDM symbol, e.g. a single constellation point

OFDM symbol: waveform Ts in duration comprising all the active carriers modulated with their corresponding modulation values and including the guard interval

P1 signalling: signalling carried by the P1 symbol and used to identify the basic mode of the DVB-T2 symbol

P1 symbol: fixed pilot symbol that carries S1 and S2 signalling fields and is located in the beginning of the frame within each RF-channel

NOTE: The P1 symbol is mainly used for fast initial band scan to detect the T2 signal, its timing, frequency offset, and FFT-size.

P2 symbol: pilot symbol located right after P1 with the same FFT-size and guard interval as the data symbols

NOTE: The number of P2 symbols depends on the FFT-size. The P2 symbols are used for fine frequency and timing synchronization as well as for initial channel estimate. P2 symbols carry L1 and L2 signalling information and may also carry data.

physical layer pipe: physical layer TDM channel that is carried by the specified sub-slices

NOTE: A PLP may carry one or multiple services.

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PLP_ID: this 8-bit field identifies uniquely a PLP within the T2 system, identified with the T2_system_id

NOTE: The same PLP_ID may occur in one or more frames of the super-frame.

Re(x): real part of x

reserved for future use: not defined by the present document but may be defined in future revisions of the present document

NOTE: Further requirements concerning the use of fields indicated as "reserved for future use" are given in clause 7.1.

slice: set of all cells of a PLP which are mapped to a particular T2-frame

NOTE: A slice may be divided into sub-slices.

sub-slice: group of cells from a single PLP, which before frequency interleaving, are transmitted on active OFDM cells with consecutive addresses over a single RF channel

T2-base signal: T2 signal using the T2-base profile

T2-frame: fixed physical layer TDM frame that is further divided into variable size sub-slices. T2-frame starts with one P1 and one or multiple P2 symbols

T2-Lite signal: T2 signal using the T2-Lite profile

T2 profile: subset of all configurations allowed by the present document

NOTE: The present document defines a T2-base profile and a T2-Lite profile.

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T2 signal: signal consisting of the waveform using a particular profile of the present document (T2-base profile or T2-Lite profile), including any FEF parts.

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NOTE: A composite RF signal may be formed comprising two or more T2 signals, where each T2 signal has the others in its FEF parts.

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T2 Super-frame: set of T2-frames consisting of a particular number of consecutive T2-frames

NOTE: A super-frame may in addition include FEF parts.

T2 system: second generation terrestrial broadcast system whose input is one or more TS or GSE streams and whose output is an RF signal

NOTE: The T2 system:

- means an entity where one or more PLPs are carried, in a particular way, within a DVB-T2 signal on one or more frequencies;
- is unique within the T2 network and it is identified with T2_system_id. Two T2 systems with the same T2_system_id and network_id have identical physical layer structure and configuration, except for the cell_id which may differ;
- is transparent to the data that it carries (including transport streams and services).

T2_SYSTEM_ID: this 16-bit field identifies uniquely the T2 system within the DVB network (identified by NETWORK_ID)

time interleaving block (TI-block): set of cells within which time interleaving is carried out, corresponding to one use of the time interleaver memory

type 1 PLP: PLP having one slice per T2-frame, transmitted before any Type 2 PLPs

type 2 PLP: PLP having two or more sub-slices per T2-frame, transmitted after any Type 1 PLPs

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3.2 Symbols

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

$\oplus$	Exclusive OR / modulo-2 addition operation
Δ	Guard interval duration
λ_i	LDPC codeword bits
η_{MOD}, $\eta_{MOD}(i)$	number of transmitted bits per constellation symbol (for PLP i)
$\mathbf{1}_{TR}$	Vector containing ones at positions corresponding to reserved carriers and zeros elsewhere
$a_{m,l,p}$	Frequency-Interleaved cell value, cell index p of symbol l of T2-frame m
A_{CP}	Amplitude of the continual pilot cells
A_{P2}	Amplitude of the P2 pilot cells
A_{SP}	Amplitude of the scattered pilot cells
$b_{BS,j}$	Bit j of the BB scrambling sequence
$b_{e,do}$	Output bit of index do from substream e from the bit-to-sub-stream demultiplexer
$c(x)$	BCH codeword polynomial
C/N	Carrier-to-noise power ratio
C/N+I	Carrier-to-(Noise+Interference) ratio
$C_{bal}(m)$	Value to which bias balancing cells are set for T2-frame m
$C'_{bal}(m)$	Desired value for the bias balancing cells in T2-frame m to approximately balance the bias
$C_{bias}(m)$	Bias in coded and modulated L1 signalling for T2-frame m before applying the L1-ACE algorithm
$C_{bias\_L1\_ACE}(m)$	Value of $C_{bias}(m)$ after being reduced by the correction to be applied by the bias balancing cells
$C'_{bias}(m)$	Residual bias in the modulated cells of the L1 signalling for T2-frame m after correction by the L1-ACE algorithm
C_{data}	Number of active cells in one normal symbol
C_{FC}	Number of active cells in one frame closing symbol
$C_{im}(m)$	Imaginary part of $C_{bias}(m)$
$C_{L1\_ACE\_MAX}$	Maximum correction applied by L1-ACE algorithm
$c_{m,l,k}$	Cell value for carrier k of symbol l of T2-frame m
C_{P2}	Number of active cells in one P2 symbol
$c\_post_{m,i}$	Correction applied to cell i of coded and modulated L1-post signalling in T2-frame m by L1-ACE algorithm
$c\_pre_{m,i}$	Correction applied to cell i of coded and modulated L1-pre signalling in T2-frame m by L1-ACE algorithm
$C_{re}(m)$	Real part of $C_{bias}(m)$
$CSS_{S1,i}$	Bit i of the S1 modulation sequence
$CSS_{S2,i}$	Bit i of the S2 modulation sequence
C_{tot}	Number of active cells in one T2-frame
D_{BC}	Number of cells occupied by the bias balancing cells and the associated dummy cells
D_i	Number of cells mapped to each T2-frame of the Interleaving Frame for PLP i
$D_{i,aux}$	Number of cells carrying auxiliary stream i in the T2-frame
$D_{i,common}$	Number of cells mapped to each T2-frame for common PLP i
$D_{i,j}$	Number of cells mapped to each T2-frame for PLP i of type j
D_{L1}	Number of OFDM cells in each T2-frame carrying L1 signalling
D_{L1post}	Number of OFDM cells in each T2-frame carrying L1-post signalling
D_{L1pre}	Number of OFDM cells in each T2-frame carrying L1-pre signalling

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$d_{n,s,r,q}$	Time Interleaver input / Cell interleaver output for cell *q* of FEC block *r* of TI-block *s* of Interleaving Frame *n*
D_{PLP}	Number of OFDM cells in each T2-frame available to carry PLPs
$d_{r,q}$	Cell interleaver output for cell *q* of FEC block *r*
D_x	Difference in carrier index between adjacent scattered-pilot-bearing carriers
D_y	Difference in symbol number between successive scattered pilots on a given carrier
$e_{m,l,p}$	Cell value for cell index *p* of symbol *l* of T2-frame *m* following MISO processing
f_c	Centre frequency of the RF signal
$f\_post_{m,i}$	Cell *i* of coded and modulated L1-post signalling for T2-frame *m*
$f'\_post_{m,i}$	Cell *i* of L1-post signalling for T2-frame *m* after modification by the L1-ACE algorithm
$f\_pre_{m,i}$	Cell *i* of coded and modulated L1-pre signalling for T2-frame *m*
$f'\_pre_{m,i}$	Cell *i* of L1-post signalling for T2-frame *m* after modification by the L1-ACE algorithm
f_q	Constellation point normalized to mean energy of 1
f_{SH}	Frequency shift for parts 'B' and 'C' of the P1 signal
$g(x)$	BCH generator polynomial
$g_1(x), g_2(x), \ldots, g_{12}(x)$	polynomials to obtain BCH code generator polynomial
g_q	OFDM cell value after constellation rotation and cyclic Q delay
$H(p)$	Frequency interleaver permutation function, element *p*
$H_0(p)$	Frequency interleaver permutation function, element *p*, for even symbols
$H_1(p)$	Frequency interleaver permutation function, element *p*, for odd symbols
I_{FEF}	Value signalled by FEF_INTERVAL
$I_{JUMP}, I_{JUMP}(i)$	Frame interval: difference in frame index between successive T2-frames to which a particular PLP is mapped (for PLP *i*)
i_j	BCH codeword bits which form the LDPC information bits
j	$\sqrt{-1}$
k'	Carrier index relative to the centre frequency
k	OFDM carrier index
K_{bch}	number of bits of BCH uncoded Block
Kbit	1 024 bits
K_{ext}	Number of carriers added on each side of the spectrum in extended carrier mode
$K_{L1\_PADDING}$	Length of L1_PADDING field
K_{ldpc}	number of bits of LDPC uncoded Block
K_{max}	Carrier index of last (highest frequency) active carrier
K_{min}	Carrier index of first (lowest frequency) active carrier
K_{mod}	Modulo value used to calculate continual pilot locations
$k_{p1}(i)$	Carrier index *k* for active carrier *i* of the P1 symbol
K_{post}	Length of L1-post signalling field including the padding field
$K_{post\_ex\_pad}$	Number of information bits in L1-post signalling excluding the padding field
K_{pre}	Information length of the L1-pre signalling
K_{sig}	Number of signalling bits per FEC block for L1-pre- or L1-post signalling
K_{total}	Number of OFDM carriers
l	Index of OFDM symbol within the T2-frame
L	Maximum value of real or imaginary part of the L1-post constellation
L_{data}	Number of data symbols per T2-frame including any frame closing symbol but excluding P1 and P2
L_F	Number of OFDM symbols per T2-frame excluding P1
$L_{im}(m)$	Correction level for the imaginary part of the L1-post used in the L1-ACE algorithm

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