Draft ETSI EN 301 775 V1.1.1 (2000-07)

European Standard (Telecommunications series)

Digital Video Broadcasting (DVB); Specification for the carriage of Vertical Blanking Information (VBI) data in DVB bitstreams

Reference
DEN/JTC-DVB-106

Keywords
broadcasting, digital, DVB, SNG, TV, video

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

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Foreword

This European Standard (Telecommunications series) 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), and is now submitted for the ETSI standards One-step Approval Procedure.

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.

European Broadcasting Union
CH-1218 GRAND SACONNEX (Geneva)
Switzerland
Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

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 latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

1 Scope

The present document specifies a new VBI standard to be added to MPEG-2 and DVB to handle the transmission of data intended to be transcoded into the VBI of MPEG-2 decoded video. The definitions given by the present document are an extension of the format specified by ETSI EN 300 472 [2].

The extensions include inverted teletext, VPS (ETSI ETS 300 231 [4]) and WSS (ETSI EN 300 294 [5]) data to be used for 625-line systems and Closed-Captioning (EIA-608 Revision A [6]) data to be used for 525-line systems. Also, a generic format for transmitting luminance-only VBI data is defined to have a means of coping with other standard or non-standard VBI systems.

The present document allows for conveying VBI data units and EBU teletext data units using the same elementary stream. Backwards compliance with the ETSI EN 300 472 [2] is guaranteed, as the EBU teletext as specified in ETSI EN 300 472 [2] and VBI data as specified in the present document can co-exist in the same service on separate PIDs. To cater for this, some extensions to the SI, ETSI EN 300 468 [9] have been defined.

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, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, 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 (1996): "Generic coding of moving pictures and associated audio information: Systems (also referred to as MPEG-2 Systems)".

[2] ETSI EN 300 472 (V1.2): "Digital Video Broadcasting (DVB); Specification for conveying ITU-R System B Teletext in DVB bitstreams".

[3] ETSI ETS 300 706: "Enhanced Teletext specification".

[4] ETSI ETS 300 231 (1998): "Television systems; Specification of the domestic video Programme Delivery Control system (PDC)".

[5] ETSI EN 300 294 (V1.3): "Television systems; 625-line television Wide Screen Signalling (WSS)".

[6] EIA-608 Revision A (1999): "Recommended practice for Line 21 data service".

[7] CCIR Recommendation 601-1 (1982-1986): "Encoding parameters of digital television for studios".

[8] CCIR Recommendation 656 (1986): "Interfaces for digital component video signals in 525-line and 625-line television systems".

[9] ETSI EN 300 468 (V1.3): "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

3 Abbreviations

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

CC	Closed-Captioning
DVB	Digital Video Broadcasting
EACEM	European Association of Consumer Electronics Manufacturers
EBU	European Broadcasting Union
EIA	Electronic Industries Association
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
IEC	International Electrotechnical Commission
ISO	International Standards Organization
ITU	International Telecommunications Union
MPEG	Moving Pictures Experts Group
PES	Packetized Elementary Stream
PID	Packet Identifier
PMT	Program Map Table
PSI	Program Specific Information
PTS	Presentation Time Stamp
SI	Service Information
VBI	Vertical Blanking Interval
VPS	Video Programme System
WSS	Wide Screen Signalling

4 Coding of VBI Signals in MPEG-2 Transport Streams

4.1 General issues

The VBI data transferred through the mechanism described in this clause is intended to be transcoded into the VBI of a companion video channel of an MPEG-2 programme. However, it also is possible to transmit and transcode a VBI data stream on its own, without a companion video channel. In addition it is possible for a decoder to interpret the data directly, without any intermediate transcoding into the VBI.

The transmission means is generally based on ETSI EN 300 472 [2]. The data transfer uses the private PES packet mechanism of type private_stream_1 as defined by ISO/IEC 13818-1 [1]. The VBI encoding and decoding should be synchronized with the companion video channel, if one is present.

The VBI data stream associated with a service is identified in the Program Map Table (PMT) of the Program Specific Information (PSI) for that service. This mechanism is described in subclause 4.2.

The following restrictions apply to the coding of VBI data as described in the present document:

- a VBI PES packet contains data of one and only one video frame and always carries a PTS;
- the decoding of VBI data does not require a frame memory (i.e. a memory that stores VBI data for display in a frame other than the current). This means that VBI data present for a certain line within a certain frame never will appear in the next frame unless it is specifically coded as such again;
- the VBI decoding does not require a line memory (i.e. a memory that stores one or more lines of VBI data for display in the current frame). This means that lines shall appear in the bitstream in the same order, as they will appear in the VBI;
- VBI lines that are not coded will either be set to "black" or will have another default value defined by the decoder;
- a certain VBI line may never be coded twice within a frame. A line is coded using one and only one data field with the exception of lines containing monochrome 4:2:2 samples (see subclause 4.8). These may be spread over several data fields adjacently coded;

- whenever a VBI stream is coded, the VBI_data_descriptor defined in subclause 4.2 shall be used in the PMT to identify the VBI stream. If teletext is coded in the same stream, then at the same time a VBI teletext descriptor shall be associated with the VBI stream;

- the data_identifier defined in subclause 4.3 shall be set to either 0 x 10 to 0 x 1F or 0 x 99 to 0 x 9B. For data_identifier values between 0 x 10 to 0 x 1F, it may be possible that decoders compliant only to ETSI EN 300 472 [2] are able to decode the teletext data. They have to be robust against the non-teletext data; i.e. robust against data units other than 0 x 02, 0 x 03, and 0 x FF;

- the standard teletext buffer model is used, as is defined by ETSI EN 300 472 [2].

4.2 Definition of SI for VBI data streams

The Packet Identifier (PID) of a VBI data stream associated with a service is identified in the Program Map Table (PMT) of the Program Specific Information (PSI) for that service. The VBI data stream is given stream_type value 0 x 06, which indicates a PES stream carrying private data. If the VBI data stream contains any of the extensions defined by the present document, the appropriate ES_info_field of the program map section describing VBI data streams shall contain one and only one VBI_data_descriptor as defined in ETSI EN 300 468 [9]. A service may include more than one VBI data stream, provided that the streams are distinguishable by their respective descriptors in the PSI. In addition a VBI teletext descriptor shall be used if and only if the VBI stream contains amongst others EBU teletext data. The descriptor is needed to use languages for selecting magazines or subtitles.

For the component descriptor, VBI data transported using the VBI standard is represented by stream_content and component_type values defined in ETSI EN 300 468 [9].

4.3 Definition of PES data field

The teletext PES packet syntax from ETSI EN 300 472 [2] is followed, as defined by PES_data_field () in Table 1 of ETSI EN 300 472 [2], with the extension of the data field to other types of data.

4.3.1 Syntax for PES data field

Table 1: Syntax for PES data field

Syntax	No. of bits	Mnem.	Valid Range
PES_data_field () {			
data_identifier	**8**	**uimsbf**	See Table 2
for (I = 0; i < N; i++) {			
data_unit_id	**8**	**uimsbf**	See Table 3
data_unit_length	**8**	**uimsbf**	0 x 00 .. 0 x FF
if (data_unit_id == 0 x 02 ||			
data_unit_id == 0 x 03 ||			
data_unit_id == 0 x C0 ||			
data_unit_id == 0 x C1) {			
txt_data_field ();			
} else if (data_unit_id == 0 x C3) {			
vps_data_field();			
} else if (data_unit_id == 0 x C4) {			
wss_data_field ();			
} else if (data_unit_id == 0 x C5) {			
closed_captioning_data_field ();			
} else if (data_unit_id == 0 x C6) {			
monochrome_data_field ();			
} else if (data_unit_id == 0 x FF) {			
/* No data field */			
}			
for (i = 0; i < N; i++) {			
stuffing_byte	**8**	**bslbf**	'11111111'
}			
}			
}			

4.3.2 Semantics for PES data field

The semantics for PES data field from ETSI EN 300 472 [2] are followed, noting the following additions and constraints:

data_identifier: this 8-bit field identifies the type of data carried in the PES packet. It is coded as in Table 2.

data_unit_id: this 8-bit field identifies the type of this data unit. The coding is based on Table 4 in ETSI EN 300 472 [2], with the addition of a number of reserved values. Coding as defined by the present document is given by Table 3.

data_unit_length: this 8-bit field indicates the number of bytes in this data unit immediately following the length field. If the data_identifier has a value between 0 x 10 and 0 x 1F inclusive, this field shall always be set to 0 x 2C.

stuffing_byte: this 8-bit field shall in any case be discarded by the decoder.

Table 2: data_identifier for PES data field

data_identifier	Value	Action decoders (see note)
0 x 00 to 0 x 0F	reserved for future use	discard
0 x 10 to 0 x 1F	EBU teletext only or EBU teletext combined with VPS and/or WSS and/or closed captioning and/or VBI sample data	transcode EBU teletext, VPS, WSS, closed captioning, VBI sample data
0 x 20 to 0 x 7F	reserved for future use	discard
0 x 80 to 0 x 98	user defined	discard
0 x 99 to 0 x 9B	EBU teletext and/or VPS and/or WSS and/or closed captioning and/or VBI sample data	transcode EBU teletext, VPS, WSS, closed captioning, VBI sample data
0 x 9C to 0 x FF	user defined	discard
NOTE: If a decoder is not capable of decoding the data or if the specific decoding option is switched off, the data shall be discarded.		

Table 3: data_unit_id for data_identifier equal to 0 x 10 up to 0 x 1F or 0 x 99 up to 0 x 9B

data_unit_id	Value	Action of decoders (see note)
0 x 00 to 0 x 01	reserved for future use	discard
0 x 02	EBU teletext non-subtitle data	transcode as EBU teletext
0 x 03	EBU teletext subtitle data	transcode as EBU teletext
0 x 04 to 0 x 7F	reserved for future use	discard
0 x 80 to 0 x BF	user defined	discard
0 x C0	inverted teletext	transcode as EBU teletext with an inverted framing code
0 x C1	reserved	discard
0 x C2	reserved	discard
0 x C3	VPS	transcode as VPS
0 x C4	WSS	transcode as WSS
0 x C5	closed captioning	transcode as closed captioning
0 x C6	monochrome 4:2:2 samples	transcode as raw VBI data
0 x C7 to 0 x FE	user defined	discard
0 x FF	stuffing	discard
NOTE: If a decoder is not capable of decoding the data or if the specific decoding option is switched off, the data shall be discarded.		

4.4 Data field for EBU and inverted teletext

EBU teletext is encoded in a data field similar to that specified as data_field () in ETSI EN 300 472 [2]. The data is intended to be transcoded into the VBI of 625-line video, but may also be interpreted directly by a decoder.

4.4.1 Syntax for EBU and inverted teletext data field

For clarity and for syntactical consistency with the encoding of other VBI signals Table 4 is a slightly rewritten version of Table 2 of ETSI EN 300 472 [2]. The txt_data_block in this definition is a combination of magazine_and_packet_address and data_block. Inverted teletext is coded using the same definition as EBU teletext.

Table 4: Syntax of data field for EBU and inverted teletext

Syntax	No. of bits	Mnem.	Valid Range
txt_data_field () {			
reserved_future_use	**2**	**bslbf**	'11'
field_parity	**1**	**bslbf**	'0', '1'
line_offset	**5**	**uimsbf**	0, 7 .. 22
framing_code	**8**	**bslbf**	'11100100', '00011011'
txt_data_block	**336**	**bslbf**	see [3]
}			

4.4.2 Semantics for EBU and inverted teletext data field

For most fields the semantics for the EBU teletext data field from ETSI EN 300 472 [2] are followed. For clarity, all fields are defined in the present document again.

field_parity: this 1-bit flag specifies the field for which the data is intended. The value '1' indicates the first field of a frame; the value '0' indicates the second field of a frame.

line_offset: this 5-bit field specifies the line number on which the teletext data packet is intended to be presented if it is transcoded into the VBI. Within a field, the line_offset numbering shall follow a progressive incremental order except for the undefined line_offset value 0. The toggling of the field_parity flag indicates a new field.

The line offset is coded as in the following table:

Table 5: line_offset for EBU and inverted teletext

line_offset	Meaning	
	field_parity == '1'	**field_parity == '0'**
0	line number undefined	line number undefined
1 to 6	reserved for future use	reserved for future use
7	line number = 7	line number = 320
8	line number = 8	line number = 321
:	:	:
22	line number = 22	line number = 335
23 to 31	reserved for future use	reserved for future use

Only values 0 and 7 to 22 are permitted for EBU and inverted teletext data units.

framing_code: this 8-bit field specifies the framing code to be used if the teletext line is transcoded into the VBI. For EBU teletext the framing_code field shall be '11100100'. For inverted teletext the framing_code field shall be '00011011'.

txt_data_block: this 336-bit field corresponds to the 42 bytes following the clock-run-in and framing-code sequence of an EBU or inverted teletext data packet as defined in ETSI ETS 300 706 [3]. Data packets are inserted in the same order, as they are intended to arrive at the teletext decoder or to be transcoded into the VBI. Data bits are inserted in the same order, as they would appear in the VBI.

4.5 Data field for VPS

Video Programme System (VPS) ETSI ETS 300 231 [4] data packets are encoded in a data field in a way similar to the encoding of EBU teletext. The data is intended to be transcoded into the VBI of 625-line video, but may also be interpreted directly by a decoder. Its syntax is defined by Table 6.

4.5.1 Syntax for VPS data field

Table 6: Syntax of data field for VPS

Syntax	No. of bits	Mnem.	Valid Range
vps_data_field () {			
reserved_future_use	**2**	**bslbf**	'11'
field_parity	**1**	**bslbf**	'1'
line_offset	**5**	**uimsbf**	16
vps_data_block	**104**	**bslbf**	see [4]
}			

4.5.2 Semantics for VPS data field

For some fields the semantics for the EBU teletext data field from subclause 4.4 are followed, noting the following additions and constraints:

field_parity: coding equipment will only generate VPS data fields with field_parity set to '1'. Decoders need only implement field_parity equal to '1', they may ignore packets with field_parity set to '0'.

line_offset: coding equipment will only generate VPS data fields with line_offset equal to 16. Decoders need only implement line_offset equal to 16, they may ignore other lines.

The line offset for VPS is coded as in the following table:

Table 7: line_offset for VPS

line_offset	Meaning	
	field_parity == '1'	field_parity == '0'
0 to 15	reserved for future use	reserved for future use
16	line number = 16	reserved for future use
17 to 31	reserved for future use	reserved for future use

vps_data_block: this field corresponds to the 13 data bytes of a VPS line as described in subclause 8.2.2.2 of ETSI ETS 300 231 [4], excluding the run-in and start code byte. So, byte 3 up to and including 15 are coded. Data bits are inserted in the PES packet in the same order, as they would appear in the VBI.

4.6 Data field for WSS

Wide Screen Signalling (WSS) ETSI EN 300 294 [5] data packets are encoded in a data field in a way similar to the encoding of EBU teletext. The data is intended to be transcoded into the VBI of 625-line video, but may also be interpreted directly by a decoder. Its syntax is defined by Table 8.

4.6.1 Syntax for WSS data field

Table 8: Syntax of data_field for WSS

Syntax	No. of bits	Mnem.	Valid Range
wss_data_field () {			
reserved_future_use	**2**	**bslbf**	'11'
field_parity	**1**	**bslbf**	'1'
line_offset	**5**	**uimsbf**	23
wss_data_block	**14**	**bslbf**	see [5]
reserved_future_use	**2**	**bslbf**	'11'
}			

4.6.2 Semantics for WSS data field

For some fields the semantics for the EBU teletext data field from subclause 4.4 are followed, noting the following additions and constraints:

field_parity: coding equipment will only generate WSS data fields with field_parity set to '1'. Decoders need only implement field_parity equal to '1', they may ignore packets with field_parity set to '0'.

line_offset: coding equipment will only generate WSS data fields with line_offset equal to 23. Decoders need only implement line_offset equal to 23, they may ignore other lines.
Decoders shall generate Wide Screen Signalling bits only in the first half of the line, as defined in subclause 4.1 of ETSI EN 300 294 [5].

The line offset for WSS is coded as in the following table:

Table 9: line_offset for WSS

line_offset	Meaning	
	field_parity == '1'	**field_parity == '0'**
0 to 22	reserved for future use	reserved for future use
23	line number = 23	reserved for future use
24 to 31	reserved for future use	reserved for future use

wss_data_block: this field corresponds to the 14 wide-screen-signalling bits defined in Table 1 of ETSI EN 300 294 [5]. WSS bit 0 corresponds to the left-most bit of wss_data_block, such that the data bits are inserted in the PES packet in the same order, as they would appear in the VBI.

4.7 Data field for closed-captioning

Closed-captioning data packets EIA-608 Revision A [6] are encoded in a data field in a way similar to the encoding of EBU teletext. The data is intended to be transcoded into the VBI of 525-line video, but may also be interpreted directly by a decoder. Its syntax is defined by Table 10.

4.7.1 Syntax for closed-captioning data field

Table 10: Syntax of data_field for closed-captioning

Syntax	No. of bits	Mnem.	Valid Range
closed_captioning_data_field () {			
reserved_future_use	**2**	**bslbf**	'11'
field_parity	**1**	**bslbf**	'0', '1'
line_offset	**5**	**uimsbf**	21
closed_captioning_data_block	**16**	**bslbf**	see [6]
}			

4.7.2 Semantics for closed-captioning data field

For some fields the semantics for the EBU teletext data field from subclause 4.4 are followed, noting the following additions and constraints:

line_offset: coding equipment will only generate closed-captioning data fields with line_offset equal to 21. Decoders need only implement line_offset equal to 21, they may ignore other lines.

The line offset for closed-captioning is coded as in the following table:

Table 11: line_offset for closed-captioning

line_offset	Meaning	
	field_parity == '1'	field_parity == '0'
0 to 20	reserved for future use	reserved for future use
21	line number = 21, first field	line number = 21, second field
22 to 31	reserved for future use	reserved for future use

closed_captioning_data_block: this field corresponds to the 16 closed-captioning data bits defined in EIA-608 Revision A [6]. Closed-captioning bit b0 of character one corresponds to the left-most bit of closed_captioning_data_block, such that the data bits are inserted in the PES packet in the same order, as they would appear in the VBI.

4.8 Data field for monochrome 4:2:2 samples

Monochrome sample data coding is included in order to cope with VBI data transfer and signalling standards not covered by the present document. An encoder might use the monochrome 4:2:2 samples mechanism to encode any single VBI line as long as no chrominance information is involved.

Monochrome 4:2:2 samples are coded using the conventions of CCIR Recommendation 601-1 [7] and CCIR Recommendation 656 [8]. In the present definition a video line contains 720 luminance samples and 360 samples for each colour difference signal. A pixel corresponds to a luminance sample. A decoder shall re-insert the coded VBI data into the video according to CCIR Recommendation 656 [8]. The data is intended to be transcoded into the VBI of either 525 or 625-line video.

For monochrome 4:2:2 data, only luminance samples are coded. All co-sited chrominance samples of pixels for which luminance samples are coded have the value 0 x 80 (zero chrominance) by definition. Samples that are not coded (either at the start or at the end of a line, or both) will have a value defined by the decoder.

Monochrome data may be split into several segments. The segments shall be contiguously coded into adjacent data units within the PES packet.

To be compliant with standard DVB teletext decoders the encoded data stream has to comply to the standard teletext buffer model, as is defined by ETSI EN 300 472 [2]. For the present purpose the present document defines that an encoder shall generate at most one single monochrome VBI data line per field if any other VBI data is encoded in this field. If no other VBI data is encoded in a specific field, the encoder may generate up to two monochrome VBI data lines in this field.

4.8.1 Syntax for monochrome data field

Table 12: Syntax of data_field for monochrome 4:2:2 samples

Syntax	No. of bits	Mnem.	Valid Range
monochrome_data_field () {			
first_segment_flag	**1**	**bslbf**	'0', '1'
last_segment_flag	**1**	**bslbf**	'0', '1'
field_parity	**1**	**bslbf**	'0', '1'
line_offset	**5**	**uimsbf**	7 .. 23
first_pixel_position	**16**	**uimsbf**	0 .. 719
n_pixels	**8**	**uimsbf**	1 .. 251
for (i = 0; i < n_pixels; i++) {			
Y_value	**8**	**uimsbf**	0 x 10 .. 0 x EB
}			
}			

4.8.2 Semantics for monochrome data field

For some fields the semantics for the EBU teletext data field from subclause 4.4 are followed, noting the following additions and constraints:

first_segment_flag: this is a one-bit flag indicating the first segment of a line containing monochrome 4:2:2 samples. It shall be set to '1' for the first segment of a line, and '0' for all others.

last_segment_flag: this is a one-bit flag indicating the last segment of a line containing monochrome 4:2:2 samples. It shall be set to '1' for the last segment of a line, and '0' for all others.

line_offset: this 5-bit field specifies the line number on which the monochrome 4:2:2 samples packet is intended to be presented if it is transcoded into the VBI. Within a field, the line_offset numbering shall follow a progressive incremental order. The toggling of the field_parity flag indicates a new field.

The line offset is coded as in the following table:

Table 13: line_offset for monochrome 4:2:2 samples

line_offset	Meaning	
	field_parity == '1'	**field_parity == '0'**
0 to 6	reserved for future use	reserved for future use
7	line number = 7, first field	line number = 7, second field
8	line number = 8, first field	line number = 8, second field
:	:	:
23	line number = 23, first field	line number = 23, second field
24 to 31	reserved for future use	reserved for future use

first_pixel_position: this is the position of the first coded luminance sample of this segment. It is in units of one pixel, so it may have any value between 0 and 719 inclusive. If this segment is followed by another (i.e. last_segment_flag equals '0'), the value of first_pixel_position of the next segment shall equal the sum of the current values of first_pixel_position and n_pixels.

n_pixels: this is the number of luminance samples coded in this segment. It shall be greater than 0.

Y_value: this is the value of a single luminance sample. Its value is defined according to CCIR Recommendation 601-1 [7].

4.9 Combining VBI data with ETSI EN 300 472 teletext data

This VBI standard allows for conveying VBI data units and EBU teletext data units using the same elementary stream. This is especially useful in areas where minimization of the number of synchronized PID streams is important. For example, in primary distribution, existing head-end receivers may only be capable of receiving one stream for both VBI and teletext data.

In other areas a wide variety of IRDs might occur. Some IRDs might only support the ETSI EN 300 472 [2] teletext standard, others just the VBI standard, and there might even be IRDs supporting both standards. As re-multiplexing becomes more and more common practice, all variants are likely to co-exist in the field. Backwards compliance with ETSI EN 300 472 [2] is guaranteed since the EBU teletext as specified in ETSI EN 300 472 [2] and VBI data as specified in the VBI standard can co-exist in the same service on *separate* PIDs.

Therefore, in areas where supporting a mixed variety of IRDs is a major concern, it will be necessary to broadcast VBI on two or more PIDs. A viable strategy is to use one PID for the ETSI EN 300 472 [2] teletext standard and another PID for the VBI standard. Teletext data is then to be broadcast on both PIDs.

Bibliography

- ETSI TR 101 233 (V1.1): "Television systems; Code of practice for allocation of services in the Vertical Blanking Interval (VBI)".

History

Document history		
V1.1.1	July 2000	One-step Approval Procedure OAP 20001124: 2000-07-26 to 2000-11-24