



Recommendation ITU-R BT.1306-7
(06/2015)

**Error-correction, data framing, modulation
and emission methods for digital
terrestrial television broadcasting**

BT Series
Broadcasting service
(television)



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SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
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V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R BT.1306-7

**Error-correction, data framing, modulation and emission methods
for digital terrestrial television broadcasting**

(Question ITU-R 132-2/6)

(1997-2000-2005-2006-2009-03/2011-12/2011-2015)

Scope

This Recommendation defines error-correction, data framing, modulation and emission methods for the existing digital terrestrial television broadcasting systems.

The ITU Radiocommunication Assembly,

considering

- a) that digital terrestrial television broadcasting (DTTB) is being introduced in the VHF/UHF bands by some administrations from 1997;
- b) that DTTB should fit into existing 6, 7, 8 MHz channels intended for analogue television transmission;
- c) that it may be desirable to support the simultaneous transmission of a hierarchy of nested quality levels (including high definition television (HDTV)), standard definition TV (SDTV) and low definition TV (LDTV) within a single channel;
- d) that it may be necessary for DTTB services to coexist with existing analogue television transmissions for a temporary period;
- e) that many types of interference, including co-channel and adjacent channel, ignition noise, multipath and other signal distortions exist in the VHF/UHF bands;
- f) that commonalities with alternative media, such as cable and satellite, could be advantageous at the level of outer coding scheme;
- g) that it is necessary that the frame synchronization be capable of robustness in channels subject to transmission errors;
- h) that it is desirable that the frame structure be adapted to different bit rate channels;
- j) that both single carrier and multi-carrier modulation methods may be introduced;
- k) that it is desirable that there be maximum commonality of characteristics between systems;
- l) that it is desirable that there be maximum commonality between digital terrestrial television transmissions that are required to coexist with existing analogue television transmissions and those that are not;
- m) that with the rapid evolution of digital technologies, digital terrestrial TV systems, proposed at different times, open new attractive possibilities and services;
- n) that the selection of a modulation option needs to be based on specific conditions such as spectrum resource, policy, coverage requirements, existing network structure, reception conditions, type of service required, cost to the consumer and broadcasters,

recommends

- 1 that administrations wishing to introduce DTTB should use one of the families of error correction, framing, modulation and emission methods outlined in Annex 1.

Annex 1

Table 1a) provides data for single carrier systems, Table 1b) provides data about multi-carrier systems, and Table 1c) provides data about multi-carrier systems with RF band segmentation, Table 1d) provides data about the combined single- and multi-carrier systems, and Table 1e) provides data about Time-domain synchronized multi-carrier system or TDS multi-carrier systems. Specifications for Systems A, B, C, D and E are found in Attachments 1, 2, 3, 4 and 5.

Selection guidelines for Systems A, B, C, D and E are described in Attachment 6 to Annex 1.

TABLE 1
Parameters for DTTB transmission systems
a) Single carrier systems

	Parameters	6 MHz	7 MHz	8 MHz
1	Used bandwidth	5.38 MHz (−3 dB)	6.00 MHz (−3 dB)	7.00 MHz (−3 dB)
2	Number of radiated carriers	1	1	1
3	Modulation method	8-VSB	8-VSB	8-VSB
4	Spectrum shaping function	Root raised cosine roll-off $R = 5.8\%$	Root raised cosine roll-off $R = 8.3\%$	Root raised cosine roll-off $R = 7.1\%$
5	Channel occupancy ⁽¹⁷⁾	See Recommendation ITU-R BT.1206	–	–
6	Active symbol duration	92.9 ns	83.3 ns	71.4 ns
7	Overall symbol or segment duration	77.3 μs (segment)	69.3 μs (segment)	59.4 μs (segment)
8	Transmission frame duration	48.4 ms	43.4 ms	37.2 ms
9	Channel equalization			
10	Inner interleaving	12 (independently encoded streams interleaved in time)	24 (independently encoded streams interleaved in time)	28 (independently encoded streams interleaved in time)
	Inner channel	$R = 2/3$ trellis, concatenated $R = 1/2$ or $R = 1/4$ trellis	$R = 2/3$ trellis, concatenated $R = 1/2$ or $R = 1/4$ trellis	$R = 2/3$ trellis, concatenated $R = 1/2$ or $R = 1/4$ trellis
11	Outer channel Reed-Solomon (RS) code	RS (207,187, $T = 10$), concatenated RS (184,164, $T = 10$)	RS (207,187, $T = 10$), concatenated RS (184,164, $T = 10$)	RS (207,187, $T = 10$), concatenated RS (184,164, $T = 10$)
12	Outer interleaving	52 segment convolutional byte interleaved, concatenated 46 segment byte interleaved	52 segment convolutional byte interleaved, concatenated 46 segment byte interleaved	52 segment convolutional byte interleaved, concatenated 46 segment byte interleaved
13	Data randomization/ Energy dispersal	16 bit PRBS	16 bit PRBS	16 bit PRBS

TABLE 1 (continued)

a) Single carrier systems (end)

	Parameters	6 MHz	7 MHz	8 MHz
14	Time/frequency synchronization	Segment sync, pilot carrier	Segment sync, pilot carrier	Segment sync, pilot carrier
15	Frame synchronization	Frame sync	Frame sync	Frame sync
16	Data equalization	Frame sync, PN.511 and $3 \times$ PN.63	Frame sync, PN.511 and $3 \times$ PN.63	Frame sync, PN.511 and $3 \times$ PN.63
17	Transmission mode identification	Mode symbols in frame sync	Mode symbols in frame sync	Mode symbols in frame sync
18	Net data rate	Depending on modulation code rate 4.23-19.39 Mbit/s	Depending on modulation code rate 4.72-21.62 Mbit/s	Depending on modulation code rate 5.99-27.48 Mbit/s
19	Carrier-to-noise ratio in an additive white Gaussian noise (AWGN) channel	Depending on channel code, 15.19 dB, 9.2 dB, 6.2 dB ^{(1), (2)}	Depending on channel code, 15.19 dB, 9.2 dB, 6.2 dB ⁽²⁾	Depending on channel code, 15.19 dB, 9.2 dB, 6.2 dB ⁽²⁾

b) Multi-carrier systems

	Parameters	6 MHz multi-carrier (OFDM)	7 MHz multi-carrier (OFDM)	8 MHz multi-carrier (OFDM)
1	Used bandwidth	5.71 MHz	6.66 MHz	7.61 MHz
2	Number of radiated carriers	1 705 (2k mode) ⁽³⁾ 3 409 (4k mode) 6 817 (8k mode)	1 705 (2k mode) ⁽³⁾ 3 409 (4k mode) 6 817 (8k mode)	1 705 (2k mode) ⁽³⁾ 3 409 (4k mode) 6 817 (8k mode)
3	Modulation mode	Constant coding and modulation (CCM)	Constant coding and modulation (CCM)	Constant coding and modulation (CCM)
4	Modulation method	QPSK, 16-QAM, 64-QAM, MR-16-QAM, MR-64-QAM ⁽⁴⁾	QPSK, 16-QAM, 64-QAM, MR-16-QAM, MR-64-QAM ⁽⁴⁾	QPSK, 16-QAM, 64-QAM, MR-16-QAM, MR-64-QAM ⁽⁴⁾
5	Channel occupancy ⁽¹⁷⁾	See Recommendation ITU-R SM.1541	See Recommendations ITU-R BT.1206 or ITU-R SM.1541	See Recommendations ITU-R BT.1206 or ITU-R SM.1541
6	Active symbol duration	298.67 µs (2k mode) 597.33 µs (4k mode) 1 194.67 µs (8k mode)	256 µs (2k mode) 512 µs (4k mode) 1 024 µs (8k mode)	224 µs (2k mode) 448 µs (4k mode) 896 µs (8k mode)
7	Carrier spacing	3 348.21 Hz (2k mode) 1 674.11 Hz (4k mode) 837.05 Hz (8k mode)	3 906 Hz (2k mode) 1 953 Hz (4k mode) 976 Hz (8k mode)	4 464 Hz (2k mode) 2 232 Hz (4k mode) 1 116 Hz (8k mode)

TABLE 1 (continued)

b) Multi-carrier systems (continued)

	Parameters	6 MHz multi-carrier (OFDM)	7 MHz multi-carrier (OFDM)	8 MHz multi-carrier (OFDM)
8	Guard interval duration	1/32, 1/16, 1/8, 1/4 of active symbol duration 9.33, 18.67, 37.33, 74.67 μ s (2k mode) 18.67, 37.33, 74.67, 149.33 (4k mode) 37.33, 74.67, 149.33, 298.67 μ s (8k mode)	1/32, 1/16, 1/8, 1/4 of active symbol duration 8, 16, 32, 64 μ s (2k mode) 16, 32, 64, 128 μ s (4k mode) 32, 64, 128, 256 μ s (8k mode)	1/32, 1/16, 1/8, 1/4 of active symbol duration 7, 14, 28, 56 μ s (2k mode) 14, 28, 56, 112 μ s (4k mode) 28, 56, 112, 224 μ s (8k mode)
9	Overall symbol duration	308.00, 317.33, 336.00, 373.33 μ s (2k mode) 616.00, 634.67, 672.00, 746.67 μ s (4k mode) 1 232.00, 1 269.33, 1 344.00, 1 493.33 μ s (8k mode)	264, 272, 288, 320 μ s (2k mode) 528, 544, 576, 640 μ s (4k mode) 1 048, 1 088, 1 152, 1 280 μ s (8k mode)	231, 238, 252, 280 μ s (2k mode) 462, 476, 504, 560 μ s (4k mode) 924, 952, 1 008, 1 120 μ s (8k mode)
10	Transmission frame duration	68 OFDM symbols. One super frame consists of 4 frames	68 OFDM symbols. One super-frame consists of 4 frames	68 OFDM symbols. One super-frame consists of 4 frames
11	Inner channel code	Convolutional code, mother rate 1/2 with 64 states. Puncturing to rate 2/3, 3/4, 5/6, 7/8	Convolutional code, mother rate 1/2 with 64 states. Puncturing to rate 2/3, 3/4, 5/6, 7/8	Convolutional code, mother rate 1/2 with 64 states. Puncturing to rate 2/3, 3/4, 5/6, 7/8
12	Inner interleaving	Bit interleaving, combined with native or in-depth ⁽⁵⁾ symbol interleaving	Bit interleaving, combined with native or in-depth ⁽⁵⁾ symbol interleaving	Bit interleaving, combined with native or in-depth ⁽⁵⁾ symbol interleaving
13	Outer channel Reed-Solomon (RS) code	RS (204,188, $T = 8$)	RS (204,188, $T = 8$)	RS (204,188, $T = 8$)
14	Outer interleaving	Byte-wise convolutional interleaving, $I = 12$	Byte-wise convolutional interleaving, $I = 12$	Byte-wise convolutional interleaving, $I = 12$
15	Data randomization/energy dispersal	PRBS	PRBS	PRBS
16	Time/frequency synchronization	Pilot carriers ⁽⁶⁾	Pilot carriers ⁽⁶⁾	Pilot carriers ⁽⁶⁾
17	IP outer channel code Reed-Solomon (RS) code	MPE-FEC RS (255,191) ⁽⁷⁾	MPE-FEC RS (255,191) ⁽⁷⁾	MPE-FEC RS (255,191) ⁽⁷⁾
18	Receiver power consumption reduction	Time-slicing ⁽⁸⁾	Time-slicing ⁽⁸⁾	Time-slicing ⁽⁸⁾