

International Telecommunication Union



**Report ITU-R BT.2295-4**  
(09/2022)

# **Digital terrestrial broadcasting systems**

**BT Series**  
**Broadcasting service**  
**(television)**



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## Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

## Policy on Intellectual Property Right (IPR)

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### Series of ITU-R Reports

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| Series    | Title                                                                                |
|-----------|--------------------------------------------------------------------------------------|
| <b>BO</b> | Satellite delivery                                                                   |
| <b>BR</b> | Recording for production, archival and play-out; film for television                 |
| <b>BS</b> | Broadcasting service (sound)                                                         |
| <b>BT</b> | <b>Broadcasting service (television)</b>                                             |
| <b>F</b>  | Fixed service                                                                        |
| <b>M</b>  | Mobile, radiodetermination, amateur and related satellite services                   |
| <b>P</b>  | Radiowave propagation                                                                |
| <b>RA</b> | Radio astronomy                                                                      |
| <b>RS</b> | Remote sensing systems                                                               |
| <b>S</b>  | Fixed-satellite service                                                              |
| <b>SA</b> | Space applications and meteorology                                                   |
| <b>SF</b> | Frequency sharing and coordination between fixed-satellite and fixed service systems |
| <b>SM</b> | Spectrum management                                                                  |

***Note:** This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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## REPORT ITU-R BT.2295-4

**Digital terrestrial broadcasting systems**

(2013-2015-2017-2020-2022)

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## 1 Introduction

This Report reviews the general characteristics of the systems for digital terrestrial sound, multimedia and TV broadcasting for fixed, portable and mobile reception. The Report deals with the systems included into ITU-R Recommendations and Reports.

There is an increasing worldwide demand for suitable means of broadcasting high-quality sound, multimedia and TV programmes to vehicular, portable and fixed receivers.

Digital terrestrial broadcasting offers the potential for new and improved services to consumers. Digital terrestrial broadcasting has such advantages as high reliability of service for practically unlimited number of users, free-to-air access, possibility of fixed and mobile reception, etc.

Digital terrestrial broadcasting systems have been implemented in many countries or they are planned to be introduced. It may be necessary for digital terrestrial broadcasting services to coexist with analogue transmissions for a temporary period.

ITU-R Study Group 6 has developed and adopted a set of Recommendations comprising description of various digital terrestrial broadcasting systems – sound, multimedia, TV – that may be used in different frequency bands. These Recommendations are aimed to supply the Administrations with the guidance for the choice of national and regional broadcasting systems providing technical and service requirements to various possible systems.

Recommendation ITU-R BS.1514 describes systems for digital terrestrial sound broadcasting in frequency bands below 30 MHz. Recommendation ITU-R BS.1114 describes systems for digital terrestrial sound broadcasting in frequency range 30-3 000 MHz (VHF and UHF bands). Recommendations ITU-R BT.1833 and ITU-R BT.2016 describe the systems for digital terrestrial multimedia broadcasting in VHF/UHF frequency bands. Recommendations ITU-R BT.1306 and ITU-R BT.1877 describe first and second generation systems for digital terrestrial TV broadcasting.

Recommendations ITU-R BS.1615 and ITU-R BS.1660 provide the technical basis for planning of terrestrial sound broadcasting at frequencies below 30 MHz and in VHF band respectively. Planning criteria for digital terrestrial multimedia broadcasting are given in Recommendation ITU-R BT.2052. Recommendation ITU-R BT.1368 defines planning criteria for various methods of providing digital terrestrial television services in the VHF/UHF bands. Planning criteria for second generation digital television broadcasting systems are given in Recommendation ITU-R BT.2033. Recommendation ITU-R BT.2036 establishes characteristics of a reference television receiving system used as a basis for frequency planning.

The interoperability between digital TV, multimedia and sound broadcasting systems may be desired.

The division of broadcasting systems into sound, multimedia and TV becomes more and more relative in present-day conditions. For example, even digital narrowband sound broadcasting systems are able to transmit video information in frequency bands below 30 MHz. Additionally, digital TV broadcasting systems are used for sound programmes also. Some digital broadcasting systems (for example, ISDB-T, DVB-T2, ATSC 3.0) may be used for TV, multimedia and sound broadcasting, depending on different operating modes.

Availability of receivers in the market, that are capable of receiving all or multiple digital radio systems that are used currently or will be offered in the future, would meet the interests of users at best, in particular for reception during travelling. Availability of such receivers will allow intersystem interoperability of information services in disaster and emergency situations, navigation, safety, etc. This issue is under study of ITU-R Study Group 6 according to ITU-R Question 136-2/6 – Worldwide broadcasting roaming. Recommendation ITU-R BT.2072 provides the requirements for main functionality of consumer receivers for worldwide broadcasting roaming.

Service requirements for digital terrestrial sound broadcasting systems in frequency bands below 30 MHz are outlined in Recommendation ITU-R BS.1348. Service requirements for digital terrestrial sound broadcasting systems in VHF/UHF frequency bands are outlined in Recommendation ITU-R BS.774. Requirements for enhanced multimedia services for digital terrestrial broadcasting in VHF bands are outlined in Recommendation ITU-R BS.1892.

Report ITU-R BS/BT.2384 considers aspects of practice implementation of digital terrestrial sound and multimedia broadcasting.

Digital terrestrial TV broadcasting should fit into existing 6, 7, 8 MHz channels intended for analogue television transmission.

Report ITU-R BT.2382 describes the interference into a digital terrestrial television receiver in general and specifically for such systems as ATSC, DVB-T, DVB-T2.

Report ITU-R BT.2383 analyses characteristics of digital terrestrial television broadcasting systems in frequency bands 470-862 MHz for frequency sharing/interference.

Report ITU-R BT.2389 provides guidelines on measurements for digital terrestrial broadcasting systems.

Report ITU-R BT.2386 discusses various aspects of design and implementation of single frequency networks (SFN) for TV and sound broadcasting.

Report ITU-R BT.2343 describes UHDTV field trials using digital terrestrial television networks.

Modern digital terrestrial broadcasting receivers implement interactivity, broadband access, content delivery from Internet, record of content for further presentation, playback of local content (so-called smart receivers). Modern digital terrestrial broadcasting receivers have programmable functions and allow for software update.

The choice of broadcasting system should depend on specific conditions such as spectrum availability, regulation policy, coverage requirements, structure of existing network, reception conditions, types of required services and cost for customers and broadcasters.

This Report reviews the following systems:

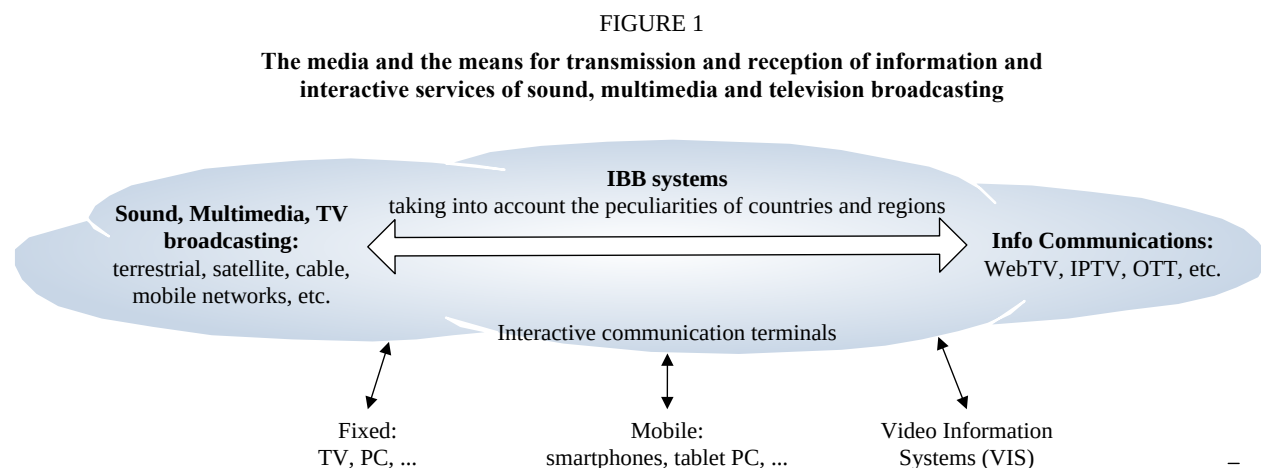
- ATSC, ATSC Mobile DTV, ATSC 3.0 (Recommendations ITU-R BT.1306, ITU-R BT.1368, ITU-R BT.1833, ITU-R BT.2036, ITU-R BT.1877, Reports ITU-R BT.2049, ITU-R BT.2382, ITU-R BT.2383, ITU-R BT.2389);
- DAB (Recommendations ITU-R BS.1114, ITU-R BS.1660, Reports ITU-R BS.1203, ITU-R BT/BS.2384);
- DRM (Recommendations ITU-R BS.1114, ITU-R BS.1514, ITU-R BS.1615, ITU-R BS.1660, ITU-R BS.1661, Reports ITU-R BS.2144, ITU-R BS.2208, ITU-R BS.2214, ITU-R BS.2251, ITU-R BT/BS.2384);
- DTMB, DTMB-A (Recommendations ITU-R BT.1306, ITU-R BT.1368, ITU-R BT.1877, Reports ITU-R BT.2383, ITU-R BT.2386, ITU-R BT.2389);
- DVB-T, DVB-H, DVB-SH (Recommendations ITU-R BT.1306, ITU-R BT.1368, ITU-R BT.1833, ITU-R BT.2016, ITU-R BT.2036, Reports ITU-R BT.2049, ITU-R BT.2382, ITU-R BT.2383, ITU-R BT.2386, ITU-R BT.2389);
- DVB-T2 (Recommendations ITU-R BT.1833, ITU-R BT.1877, ITU-R BT.2016, ITU-R BT.2033, ITU-R BT.2036, Reports ITU-R BT.2049, ITU-R BT.2254, ITU-R BT.2343, ITU-R BT.2382, ITU-R BT.2383, ITU-R BT.2386, ITU-R BT.2389);
- IBOC (Recommendations ITU-R BS.1114, ITU-R BS.1514, ITU-R BS.1615, Reports ITU-R BS.1203, ITU-R BT/BS.2384);

- ISDB-T, ISDB-TSB, ISDB-T multimedia systems (Recommendations ITU-R BS.1114, ITU-R BT.1306, ITU-R BT.1368, ITU-R BS.1660, ITU-R BT.1833, ITU-R BT.2016, ITU-R BT.2052, ITU-R BT.2036, Report ITU-R BT.2049, ITU-R BT.2209, ITU-R BT.2294, ITU-R BT.2343, ITU-R BT.2383, ITU-R BT/BS.2384, ITU-R BT.2389);
- RAVIS (Recommendation ITU-R BS.1114, Reports ITU-R BS.2214, ITU-R BT.2049, ITU-R BS/BT.2384);
- T-DMB, AT-DMB (Recommendations ITU-R BT.1833, ITU-R BT.2016, ITU-R BT.2052, Report ITU-R BT.2049).
- CDR (Recommendation ITU-R BS.1114, Report ITU-R BS.2214);
- System L<sup>1</sup> (Recommendation ITU-R BT.2016, Report ITU-R BT.2049);
- System N (Recommendation ITU-R BT.2016, Report ITU-R BT.2049).

Mobile telecommunication systems with advanced information technologies are under implementation in many countries. In many cases there is a need for interoperability between the mobile telecommunication services and interactive digital broadcasting services.

There are telecommunication systems not explicitly dedicated to broadcasting services, such as Multimedia Broadcast/Multicast Services (MBMS), as shown in Attachment 1, that fulfil the requirements for interoperability between mobile telecommunication services and interactive digital broadcasting services (Report ITU-R BT.2049).

Study Group 6 is carrying out the study of Integrated Broadcast-Broadband (IBB) systems: Report ITU-R BT.2267, Recommendations ITU-R BT.2037, ITU-R BT.2053, ITU-R BT.2075. Such systems integrates both traditional broadcasting (terrestrial, satellite, cable) and broadcasting in mobile networks as well as other types of broadcasting taking into account the peculiarities of countries and regions (see Fig. 1).



Digital terrestrial broadcasting systems may be efficiently used for public warning, disaster mitigation and relief. These issues and the examples of practical usage of broadcasting for these purposes are considered in the Report ITU-R BT.2299.

<sup>1</sup> This system was developed by 3GPP including the proposal “5G, Release 15 and beyond – LTE+NR SRIT” which is included as Annex 1 of Recommendation ITU-R M.2150-1 – Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020), and has been standardised by ETSI as TS 103 720 – 5G Broadcast System for linear TV and radio services; LTE-based 5G terrestrial broadcast system.

The advances in sound system development reflected in the Reports ITU-R BS.2159 and ITU-R BS.2266 have been led to the principal possibility of the immersive sound usage not only in specially equipped placements but in domestic and even mobile environment by transmission of object-oriented audio content with the aid of digital terrestrial broadcasting systems.

A new Handbook on Digital Terrestrial Television Broadcasting Networks and Systems Implementation was developed by Study Group 6 in 2016.

The aim of the Handbook is to provide assistance in technical and service issues such as networks and systems, audiovisual quality and quality of transmission as well as on other issues of interest for the introduction of digital terrestrial TV broadcasting (from multimedia systems to UHD TV) in different countries. The Handbook takes into account progress and convergence of technologies, different environments for production, primary and secondary distribution of broadcast programs as well as experiences in providing quality of service for Digital Terrestrial Television Broadcasting (DTTB).

In more detail, the Handbook considers:

- 1) Technical aspects on the introduction of digital terrestrial and multimedia broadcasting.
- 2) Information on standardized broadcasting systems in digital terrestrial and multimedia broadcasting networks, and some guidance on their implementation.
- 3) References to normative documents (standards, technical specifications, reports, recommendations and other documents) that are important with respect to baseband (audio, video data) and transmission quality, as well as to DTTB services including interactive TV and access services.
- 4) The use of DTTB systems in electronic news gathering and contribution of audio-visual content.

The Handbook includes all the digital terrestrial television and multimedia broadcasting systems.

## **2 General characteristics of digital terrestrial broadcasting systems**

Key characteristics of digital terrestrial broadcasting systems are represented in Table 1.

Table 1 can be used for the evaluation of the respective characteristics of the systems and selecting a specific system.

TABLE 1A

## Key characteristics of digital terrestrial broadcasting systems

| Characteristics                                                              | ATSC                                                                                                       | ATSC 3.0                                                                                                   | CDR                                                                                           | DAB                   | DRM                                                                                                                                       | DTMB                                                                                                                          | DTMB-A                                                                                                             | DVB-T, DVB-H, DVB-SH                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reception modes:<br>– Fixed<br>– Portable<br>– Portable handheld<br>– Mobile | +<br>+<br>+<br>+                                                                                           | +<br>+<br>+<br>+                                                                                           | +<br>+<br>+<br>+                                                                              | +<br>+<br>+<br>+      | +<br>+<br>+<br>+                                                                                                                          | +<br>+<br>+<br>+                                                                                                              | +<br>+<br>+<br>+                                                                                                   | +<br>+<br>+<br>+                                                                                                                                                                                                                                                                                                                                          |
| Net data rates                                                               | Depending on modulation code rate:<br>a) 4.23-19.39 Mbit/s<br>b) 4.72-21.62 Mbit/s<br>c) 5.99-27.48 Mbit/s | Depending on modulation and code rate<br>a) 0.93-57.9 Mbit/s<br>b) 1.08-67.5 Mbit/s<br>c) 1.24-77.2 Mbit/s | Depending on modulation, code rate, robustness mode, channel bandwidth:<br>36 to 712.8 kbit/s | 0.576 to 1.728 Mbit/s | Depending on modulation, code rate, robustness mode, channel bandwidth:<br>1) Modes A, B, C, D – 5-72 kbit/s<br>2) Mode E – 37-186 kbit/s | Depending on modulation, code and frame header:<br>a) 3.610-24.436 Mbit/s<br>b) 4.211-28.426 Mbit/s<br>c) 4.813-32.486 Mbit/s | Depending on modulation, code and frame header:<br>a) 3.75-38 Mbit/s<br>b) 4.38-44.4 Mbit/s<br>c) 5.0-50.73 Mbit/s | a) 0.42 to 3.447 Mbit/s <sup>3</sup><br>b) 1.332 to 10.772 Mbit/s <sup>3</sup> ; 2.33 to 14.89 Mbit/s <sup>4</sup><br>c) 1.60 to 12.95 Mbit/s <sup>3</sup> ; 2.80 to 23.5 Mbit/s <sup>4</sup><br>d) 1.868 to 15.103 Mbit/s <sup>3</sup> ; 3.27 to 27.71 Mbit/s <sup>4</sup><br>e) 2.135 to 17.257 Mbit/s <sup>3</sup> ; 3.74 to 31.67 Mbit/s <sup>4</sup> |
| Spectrum efficiency (bit/s/Hz)                                               | 0.55-1.48                                                                                                  | 0.26-10.36                                                                                                 | 0.37-3.62                                                                                     | 0.38-1.1              | 1) Modes A, B, C, D – 1.1-3.73 kbit/s<br>2) Mode E – 0.39-1.9 kbit/s                                                                      | 0.64-4.30                                                                                                                     | 0.66-6.52                                                                                                          | 0.28-2.44 <sup>3</sup><br>0.46-1.86 <sup>4</sup>                                                                                                                                                                                                                                                                                                          |
| Single frequency networks                                                    |                                                                                                            | Supported                                                                                                  | Supported                                                                                     | Supported             | Supported                                                                                                                                 | Supported                                                                                                                     | Supported                                                                                                          | Supported                                                                                                                                                                                                                                                                                                                                                 |

TABLE 1A (continued)

| Characteristics                                        | ATSC                                                   | ATSC 3.0                                                                                                                                                                                                                  | CDR                                                                                | DAB         | DRM                                                                    | DTMB                                      | DTMB-A                                    | DVB-T, DVB-H,<br>DVB-SH                                                                                                                                                                 |
|--------------------------------------------------------|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------|-------------------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Broadcasting types:<br>– sound<br>– multimedia<br>– TV | +<br>+<br>+                                            | +<br>+<br>+                                                                                                                                                                                                               | +<br>+                                                                             | +<br>+      | +<br>+                                                                 | +<br>+                                    | +<br>+                                    | +<br>+                                                                                                                                                                                  |
| Transmission data/service types                        | Video, audio, data                                     | Video, audio, data                                                                                                                                                                                                        | Video, audio, data                                                                 | Audio, data | Audio, data                                                            | Video, audio, data                        | Video, audio, data                        | Video, audio, data                                                                                                                                                                      |
| Frequency bands                                        | VHF, UHF                                               | VHF, UHF                                                                                                                                                                                                                  | VHF                                                                                | VHF, UHF    | LF, MF, HF (Modes A, B, C, D), VHF (Mode E)                            | VHF, UHF                                  | VHF, UHF                                  | VHF, UHF                                                                                                                                                                                |
| Channel bandwidth                                      | a) 6 MHz<br>b) 7 MHz<br>c) 8 MHz                       | Signalled in 'bootstrap':<br>a) bsr_coefficient=2 for 6 MHz<br>b) bsr_coefficient=5 for 7 MHz<br>c) bsr_coefficient=8 for 8 MHz<br>When channel bonding is used, the channel bandwidth is doubled (e.g., 12, 14, 16 MHz). | a) 100 kHz<br>b) 200 kHz                                                           | 1.712 MHz   | 4.5, 5, 9, 10, 18, 20 kHz (Modes A, B, C, D); 100 kHz (Mode E)         | a) 6 MHz<br>b) 7 MHz<br>c) 8 MHz          | a) 6 MHz<br>b) 7 MHz<br>c) 8 MHz          | a) 1.7 MHz <sup>3</sup><br>b) 5 MHz<br>c) 6 MHz<br>d) 7 MHz<br>e) 8 MHz                                                                                                                 |
| Used bandwidth                                         | At –3 dB:<br>a) 5.38 MHz<br>b) 6.00 MHz<br>c) 7.00 MHz | a) 5.508 ~ 5.832 MHz<br>b) 6.426 ~ 6.804 MHz<br>c) 7.345 ~ 7.777 MHz                                                                                                                                                      | a) 96.42 kHz<br>97.22 kHz<br>96.42 kHz<br>b) 196.8 kHz<br>196.03 kHz;<br>196.8 kHz | 1.536 MHz   | 4.4, 4.8, 8.7, 9.8, 17.3, 19.4 kHz (Modes A, B, C, D); 96 kHz (Mode E) | a) 5.67 MHz<br>b) 6.62 MHz<br>c) 7.56 MHz | a) 5.67 MHz<br>b) 6.62 MHz<br>c) 7.56 MHz | a) 1.52 MHz <sup>3</sup><br>b) 4.75 MHz<br>c) 5.71 MHz<br>d) 6.66 MHz<br>e) 7.61 MHz<br>TDM <sup>3</sup> :<br>a) 1.368 MHz<br>b) 4.27 MHz<br>c) 5.13 MHz<br>d) 5.18 MHz<br>e) 6.838 MHz |

TABLE 1A (continued)

| Characteristics                   | ATSC | ATSC 3.0                                                                      | CDR                                          | DAB                        | DRM                                                                                                                                                                                                                                                                             | DTMB                                                  | DTMB-A                                                  | DVB-T, DVB-H, DVB-SH                                                     |
|-----------------------------------|------|-------------------------------------------------------------------------------|----------------------------------------------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|---------------------------------------------------------|--------------------------------------------------------------------------|
| Number of segments                | 1    | Configurable                                                                  | 1                                            | 1                          | 1                                                                                                                                                                                                                                                                               | 1                                                     | 1                                                       | Configurable number of time slices per bandwidth <sup>3</sup>            |
| Number of subcarriers per segment | 1    | 6 529-6 913 (8k mode)<br>13 057-13 825 (16k mode)<br>26 113-27 649 (32k mode) | a) 242<br>122<br>242<br>b) 494<br>246<br>494 | 192<br>384<br>768<br>1 536 | Mode A: 101 (4.5 kHz), 113 (5 kHz), 205 (9 kHz), 229 (10 kHz), 413 (18 kHz), 461 (20 kHz)<br>Mode B: 91 (4.5 kHz), 103 (5 kHz), 183 (9 kHz), 207 (10 kHz), 367 (18 kHz), 411 (20 kHz)<br>Mode C: 139 (10 kHz), 281 (20 kHz)<br>Mode D: 89 (10 kHz), 179 (20 kHz)<br>Mode E: 213 | 1 (single-carrier mode)<br>3 780 (multi-carrier mode) | 4 096 (4k mode)<br>8 192 (8k mode)<br>32 678 (32k mode) | 853 (1k mode) 3<br>1 705 (2k mode)<br>3 409 (4k mode)<br>6 817 (8k mode) |

TABLE 1A (continued)

| Characteristics    | ATSC | ATSC 3.0                                                                                                                                                                                                                        | CDR                                       | DAB                                          | DRM                                                                                                  | DTMB                                                           | DTMB-A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | DVB-T, DVB-H,<br>DVB-SH                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Subcarrier spacing | –    | a) 843.75 Hz (8k mode)<br>421.875 Hz (16k mode)<br>210.9375 Hz (32k mode)<br>b) 984.375 Hz (8k mode)<br>492.1875 Hz (16k mode)<br>246.0938 Hz (32k mode)<br>c) 1125 Hz (8k mode)<br>562.5 Hz (16k mode)<br>281.25 Hz (32k mode) | 398.4375 Hz<br>796.8750 Hz<br>398.4375 Hz | a) 8 kHz<br>b) 4 kHz<br>c) 2 kHz<br>d) 1 kHz | 750/18 Hz (Mode A), 750/16 Hz (Mode B),<br>750/11 Hz (Mode C), 750/7 Hz (Mode D), 4000/9 Hz (Mode E) | Multi-carrier mode:<br>a) 1.5 kHz<br>b) 1.75 kHz<br>c) 2.0 kHz | a) 6 MHz bandwidth<br>4k mode –<br>1 384 Hz, $\alpha = 0.05$ <sup>8</sup><br>1 424 Hz, $\alpha = 0.025$<br>8k mode –<br>692 Hz, $\alpha = 0.05$ ,<br>712 Hz, $\alpha = 0.025$<br>32k mode –<br>173 Hz, $\alpha = 0.05$ ,<br>178 Hz, $\alpha = 0.025$<br>b) 7 MHz bandwidth<br>4k mode –<br>1 615 Hz, $\alpha = 0.05$ ,<br>1 662 Hz, $\alpha = 0.025$<br>8k mode –<br>807 Hz, $\alpha = 0.05$ ,<br>831 Hz, $\alpha = 0.025$<br>32k mode –<br>202 Hz, $\alpha = 0.05$ ,<br>208 Hz, $\alpha = 0.025$<br>c) 8MHz bandwidth<br>4k mode –<br>1 846 Hz, $\alpha = 0.05$ ,<br>1 899 Hz, $\alpha = 0.025$<br>8k mode –<br>923 Hz, $\alpha = 0.05$ ,<br>949 Hz, $\alpha = 0.025$<br>32k mode –<br>231 Hz, $\alpha = 0.05$ ,<br>237 Hz, $\alpha = 0.025$ | a) 1 786 kHz (1k) <sup>3</sup><br>b) 5 580.322 Hz (1k) <sup>3</sup> ,<br>2 790.179 Hz (2k),<br>1 395.089 Hz (4k),<br>697.545 Hz (8k)<br>c) 6 696.42 Hz (1k) <sup>3</sup> ,<br>3 348.21 Hz (2k),<br>1 674.11 Hz (4k),<br>837.05 Hz (8k)<br>d) 7 812 Hz (1k) <sup>3</sup> ,<br>3 906 Hz (2k),<br>1 953 Hz (4k),<br>976 Hz (8k)<br>e) 8 929 Hz (1k) <sup>3</sup> ,<br>4 464 Hz (2k),<br>2 232 Hz (4k),<br>1 116 Hz (8k) |

TABLE 1A (continued)

| Characteristics        | ATSC                                   | ATSC 3.0                                                                                                                                                                                                                                                                                         | CDR                               | DAB                                                                    | DRM                                                                                                  | DTMB                                                                                                                                                                                                                                         | DTMB-A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | DVB-T, DVB-H,<br>DVB-SH                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Active symbol duration | a) 92.9 ns<br>b) 83.3 ns<br>c) 71.4 ns | a) 1 185.185 $\mu$ s (8k mode)<br>2 370.370 $\mu$ s (16k mode)<br>4 740.741 $\mu$ s (32k mode)<br>b) 1015.873 $\mu$ s (8k mode)<br>2 031.746 $\mu$ s (16k mode)<br>4 063.492 $\mu$ s (32k mode)<br>c) 888.8889 $\mu$ s (8k mode)<br>1 777.778 $\mu$ s (16k mode)<br>3 555.556 $\mu$ s (32k mode) | 2.804 ms<br>1.426 ms<br>2.5786 ms | a) 156 $\mu$ s<br>b) 312 $\mu$ s<br>c) 623 $\mu$ s<br>d) 1 246 $\mu$ s | 24 ms (Mode A),<br>21.33 ms (Mode B),<br>14.66 ms (Mode C),<br>9.33 ms (Mode D),<br>2.25 ms (Mode E) | a) 0.176 $\mu$ s (single-carrier mode)<br>666.67 $\mu$ s (multi-carrier mode)<br>b) 0.151 $\mu$ s (single-carrier mode)<br>571.43 $\mu$ s (multi-carrier mode)<br>c) 0.132 $\mu$ s (single-carrier mode)<br>500 $\mu$ s (multi-carrier mode) | a) 6 MHz bandwidth<br>4k mode -<br>722.4 $\mu$ s, $\alpha = 0.05$ <sup>8</sup><br>702.17 $\mu$ s, $\alpha = 0.025$<br>8k mode -<br>1 444.8 $\mu$ s, $\alpha = 0.05$ ,<br>1 404.34 $\mu$ s, $\alpha = 0.025$<br>32k mode -<br>5 779.19 $\mu$ s, $\alpha = 0.05$ ,<br>5 617.37 $\mu$ s, $\alpha = 0.025$<br>b) 7 MHz bandwidth<br>4k mode -<br>619.2 $\mu$ s, $\alpha = 0.05$ ,<br>601.86 $\mu$ s, $\alpha = 0.025$<br>8k mode -<br>1 238.4 $\mu$ s, $\alpha = 0.05$ ,<br>1 203.72 $\mu$ s, $\alpha = 0.025$<br>32k mode -<br>4 953.6 $\mu$ s, $\alpha = 0.05$ ,<br>4 814.89 $\mu$ s, $\alpha = 0.025$<br>c) 8 MHz bandwidth<br>4k mode -<br>541.8 $\mu$ s, $\alpha = 0.05$ ,<br>526.63 $\mu$ s, $\alpha = 0.025$<br>8k mode -<br>1 083.6 $\mu$ s, $\alpha = 0.05$ ,<br>1 053.26 $\mu$ s, $\alpha = 0.025$<br>32k mode -<br>4 334.4 $\mu$ s, $\alpha = 0.05$ ,<br>4 213.03 $\mu$ s, $\alpha = 0.025$ | a) 560 $\mu$ s (1k) <sup>3</sup><br>b) 179.2 $\mu$ s (1k) <sup>3</sup> ,<br>358.40 $\mu$ s (2k),<br>716.80 $\mu$ s (4k),<br>1 433.60 $\mu$ s (8k)<br>c) 149.33 $\mu$ s (1k) <sup>3</sup> ,<br>298.67 $\mu$ s (2k),<br>597.33 $\mu$ s (4k),<br>1 194.67 $\mu$ s (8k)<br>d) 2 128 $\mu$ s (1k) <sup>3</sup> ,<br>256 $\mu$ s (2k),<br>512 $\mu$ s (4k),<br>1 024 $\mu$ s (8k)<br>e) 112 $\mu$ s (1k) <sup>3</sup> ,<br>224 $\mu$ s (2k),<br>448 $\mu$ s (4k),<br>896 $\mu$ s (8k) |