ENGLISH TRANSLATION

RECEIVER FOR TERRESTRIAL MOBILE MULTIMEDIA BROADCASTING BASED ON CONNECTED SEGMENT TRANSMISSION

ARIB STANDARD (DESIRABLE SPECIFICATIONS)

ARIB STD-B53 Version 1.2

Version 1.0 March 28, 2011
Version 1.1 July 3, 2012
Version 1.2 March 19, 2013

Association of Radio Industries and Businesses

General Notes to the English Translation of ARIB Standards and Technical Reports

1. Notes on Copyright

- The copyright of this document is ascribed to the Association of Radio Industries and Businesses (ARIB).

- All rights reserved. No part of this document may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, without the prior written permission of ARIB.

2. Notes on English Translation

- ARIB Standards and Technical Reports are usually written in Japanese. This document is a translation into English of the original document for the purpose of convenience of users. If there are any discrepancies in the content, expressions, etc. between the original document and this translated document, the original document shall prevail.

- ARIB Standards and Technical Reports, in the original language, are made publicly available through web posting. The original document of this translation may have been further revised and therefore users are encouraged to check the latest version at an appropriate page under the following URL:
http://www.arib.or.jp/english/index.html.

Foreword

The Association of Radio Industries and Businesses (ARIB) investigates and summarizes the basic technical requirements for various radio systems in the form of "ARIB Standards". These standards are developed with the participation of and through discussions amongst radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users, etc.

ARIB Standards include "government technical regulations" (mandatory standard) that are set for the purpose of encouraging effective use of frequency and preventing interference with other spectrum users, and "private technical standards" (voluntary standards) that are defined in order to ensure compatibility and adequate quality of radio equipment and broadcasting equipment as well as to offer greater convenience to radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters, and users, etc.

This ARIB Standard is developed for "RECEIVER FOR TERRESTRIAL MOBILE MULTIMEDIA BROADCASTING BASED ON CONNECTED SEGMENT TRANSMISSION". In order to ensure fairness and transparency in the defining stage, the standard was set by consensus at the ARIB Standard Assembly with the participation of both domestic and foreign interested parties from radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters, and users, etc.

ARIB sincerely hopes that this ARIB Standard will be widely used by radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters, and users etc.

NOTE:

Although this ARIB Standard contains no specific reference to any essential Industrial Property Rights relating thereto, the holders of such essential Industrial Property Rights state to the effect that the rights listed in the Attachment, which are the Industrial Property Rights relating to this standard, are held by the parties also listed therein, and that to the users of this standard, the holders shall grant, under reasonable terms and conditions, a non-exclusive and non-discriminatory license to practice the Industrial Property Rights contained therein. However, this does not apply to anyone who uses this ARIB Standard and also owns and lays claim to any other Essential Industrial Property Rights of which is covered in whole or part in the contents of the provisions of this ARIB Standard.

Annexed table

Patent Applicant/Holder	Name of Invention	Application No., etc.	Remark
Panasonic Corporation (*)	Comprehensive confirmation of ARIB STD-B53 version 1.0 is submitted.		
NHK (*)	Orthogonal frequency division multiplex digital signal transmission and reception device	Patent 2904986	Japan, US, UK, Germany, France
	Coded modulation device and demodulation device	Patent 2883238	Japan
	Digital signal transmission method and receiver	Patent 3457482	Japan
	Digital signal transmission method and digital signal transmission system	Patent 3795183	Japan
	Digital signal transmitter and digital signal receiver	Patent 3691211	Japan
	Orthogonal frequency division multiplex transmission system, transmission equipment and reception equipment	Patent 3083159	Japan, China, Korea Taiwan
	Quadrature frequency division multiplex transmission system, transmission equipment and reception equipment therefor	Patent 4197568	Japan
	Transmission method, reception method, transmitter, and receiver	Patent 4057603	Japan
	Transmitting method, receiving method, transmitting apparatus and receiving apparatus	Patent 4197690	Japan
	Digital signal receiver	Patent 2975932	Japan
	Transmitter and receiver	Patent 3884869	Japan
	Orthogonal frequency division multiplex transmission system, transmission equipment and reception equipment	Patent 3046960	Japan
	Receiver for receiving emergency warning in digital terrestrial television broadcasting and transmission apparatus for transmitting emergency warning	Patent 4555360	Japan

	Receiver and transmitter of early warning in digital terrestrial television broadcasting, and transmission system	Patent 4555393	Japan
	Receiver for receiving emergency prompt report in terrestrial digital television broadcast, transmitter for transmitting emergency prompt report, and transmission system	Patent 4510925	Japan
	Receiver for receiving emergency prompt report in terrestrial digital television broadcasting	Patent 4555391	Japan
	Methods and devices for transmitting and receiving digital signal	Patent 3353264	Japan
	OFDM receiver	Patent 3782233	Japan
	OFDM signal demodulating device	Patent 3782237	Japan
NEC Corp. (*1)	Orthogonal frequency division multiplex demodulator and correction method for phase errors in symbol in orthogonal frequency division multiplex demodulation	Patent 3090137	Japan
Qualcomm Incorporated	Comprehensive confirmation of ARIB STD-B53 Version 1.0 is submitted (*1)		
	Method and apparatus for overhead messaging in a wireless communication system (*2)	JP4773042	JP; US7,349,425; AU; BR; CN; DE; EP; FI; FR; GB; ID; IL; IN; IT; KR; MX; NO; RU; SE; SG; TW; UA
	Adaptive filter (*2)	JP3771275	JP; US6,724,944; US7,242,815; DE; EP; FI; FR; GB; HK; NL

(*) Received on March 15, 2011

(*1) Received on March 18, 2011

(*2) Received on October 3, 2011

CONTENTS

Chapter 1: General Matters

1.1 Objective

This standard is meant to define the basic functions, ratings, and performance of receivers for multimedia broadcasting.

1.2 Scope

This standard applies to receivers for terrestrial mobile multimedia broadcasting based on connected segment transmission that use a frequency of 207.5 MHz or more and 222 MHz or less (hereinafter referred to as “multimedia broadcasting”).

1.3 References

1.3.1 Normative References

(1) ARIB STD-B10, “Service Information for Digital Broadcasting System”
(2) ARIB STD-B24, “Data Coding and Transmission Specification for Digital Broadcasting”
(3) ARIB STD-B25, “Conditional Access System Specifications for Digital Broadcasting”
(4) ARIB STD-B32, “Video Coding, Audio Coding and Multiplexing Specifications for Digital Broadcasting”
(5) ARIB STD-B38, “Coding, Transmission and Storage Specification for Broadcasting System Based on Home Servers”
(6) ARIB STD-B45, “Content Download System for Digital Broadcasting”
(7) ARIB STD-B46, “Transmission System for Terrestrial Mobile Multimedia Broadcasting Based on Connected Segment Transmission”
(8) ARIB STD (RCR)-33, “Low Power Data Communication System/Wireless LAN System”
(9) ARIB STD-T66, “Second Generation Low Power Data Communication System/Wireless LAN System”
(10) ARIB STD-T71, “Broadband Mobile Access Communication System (CSMA) ”
(11) JEITA Standard, CP-4120, “Interface between Digital Tuner and Television Receiver using D-Connector”
(12) JEITA Standard, RC-5237, “D-Connector for Digital Broadcasting Component Video Signal (Y, P_B, P_R) Connection”
(13) JEITA Standard, CP-6101, “Digital Monitor Interface GVIF”
(14) Notification No. 399 of the Ministry of Posts and Telecommunications, 1985, "Regulations of Terminal Equipment,”
(15) ITU-R Rec.BT.1361 (Rec. ITU-R BT.709)
(16) ITU-T Rec. H.222.0 | ISO/IEC 13818-1:2006: Information technology - Generic coding of moving pictures and associated audio information: Systems (MPEG-2 Systems Standard)
(17) ITU-T Rec. H.262 | ISO/IEC 13818-2:2000: Information technology -- Generic coding of moving pictures and associated audio information: Video (MPEG-2 Video Standard)
(18) ITU-T Rec. H.264 | ISO/IEC 14496-10:2012: Advanced video coding for generic audiovisual services (MPEG-4 AVC Standard)
(19) ISO/IEC 13818-7:2006 Information technology -- Generic coding of moving pictures and associated audio information -- Part 7: Advanced Audio Coding (AAC)
(20) ISO/IEC 13818-7:2006/Cor.1:2009 Information technology -- Generic coding of moving pictures and associated audio information -- Part 7: Advanced Audio Coding (AAC), TECHNICAL CORRIGENDUM 1 (in combination with (13), MPEG-2 AAC Standard)
(21) ISO/IEC 14496-3:2001/Amd.1 (MPEG-4 HE-AAC)

(22) ISO/IEC 14496-3:2005/Amd.2:2006 (MPEG-4 HE-AAC v2)
(23) ISO/IEC 13818-3:1998 Information technology -- Generic coding of moving pictures and associated audio information: Audio (MPEG-2 BC Standard)
(24) ISO/IEC 14496-3:2009 Information technology -- Coding of audio-visual objects -- Part 3: Audio
(25) ISO/IEC 13818-1:2007/AMD 1:2007 Transport of MPEG-4 streaming text and MPEG-4 lossless audio over MPEG-2 systems
(26) ISO/IEC 23003-1:2007 Information technology -- MPEG audio technologies – Part 1: MPEG Surround
(27) IEC 61937-6 (2006-01) Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 – Part 6: Non-linear PCM bitstreams according to the MPEG-2 AAC and MPEG-4 AAC audio formats
(28) IEC 61883-1: Consumer audio/video equipment - Digital interface - Part1 : General, Part4: MPEG2-TS data transmission
(29) IEC 61966-2-4: Multimedia systems and equipment - Colour measurement and management - Part 2-4: Colour management - Extended-gamut YCC colour space for video applications - xvYCC
(30) HDMI Licensing LLC: High-Definition Multimedia Interface Specification
(31) DDWG (Digital Display Working Group): Digital Visual Interface (DVI terminal)
(32) Bluetooth SIG standard: Advanced Audio Distribution Profile (A2DP)
(33) IEEE Std 1394-1995 “IEEE Standard for a High Performance Serial Bus”
(34) DLNA Networked Device Interoperability Guidelines expanded: October 2006 (DLNA guidleline), Volume 1: Architectures and Protocols, Volume 2: Media Format Profiles

1.3.2 Informative References

(1) “Ministerial ordinance for amending the entire standard transmission system for digital broadcasting among standard television broadcasting, etc., (Ordinance No. 87 of the Ministry of Internal Affairs and Communications, 2011)” (hereinafter referred to as the “Ordinance”).
(2) “Notification on the arrangement of TMCC and AC symbols as well as the structure of time and frequency interleaving (related to Article 11 and Article 12 of Ordinance),” (Notification No. 303 of the Ministry of Internal Affairs and Communications, 2011)
(3) “Notification on the structure of TMCC information (related to Article 13 of Ordinance),” (Notification No. 304 of the Ministry of Internal Affairs and Communications, 2011)
(4) “Notification on the structure of seismic motion warning information (related to Schedule 18 of Ordinance),” (Notification No. 306 of the Ministry of Internal Affairs and Communications, 2011)
(5) ARIB STD-B21(Desirable Specifications), “Receiver for Digital Broadcasting”
(6) ARIB STD-B29, “Transmission System for Digital Terrestrial Sound Broadcasting”
(7) ARIB STD-B31, “Transmission System for Digital Terrestrial Television Broadcasting”
(8) ARIB STD-B55, “Transmission System for Area Broadcasting,”
(9) IETF RFC 3926, “FLUTE - File Delivery over Unidirectional Transport” http://www.ietf.org/rfc/rfc3926.txt

1.4 Terminology

1.4.1 Definitions

Terrestrial mobile multimedia broadcasting (Multimedia broadcasting)	Multimedia broadcasting carried out with terrestrial basic broadcasting stations defined in Chapter 4, Ministerial Ordinance
Terrestrial mobile multimedia broadcasting based on connected segment transmission	Multimedia broadcasting defined in Section 1 of Chapter 4, Ministerial Ordinance.
Digital terrestrial television broadcasting	Digital broadcasting and high-definition television broadcasting among various types of standard television broadcasting carried out with terrestrial basic broadcasting stations defined in Chapter 3, Ministerial Ordinance.
Digital terrestrial sound broadcasting	Digital broadcasting among various types of ultra-high-frequency wave broadcasting carried out with terrestrial basic broadcasting stations defined in Chapter 2, Ministerial Ordinance.
Bluetooth	A short-range wireless communications technology standardized by Bluetooth SIG for use with portable devices such as mobile phones
DLNA	Digital Living Network Alliance: A group that formulates and promotes guidelines for home network equipment implementation
DVI	Digital Visual Interface: An interface standard specified by the DDWG (Digital Display Working Group: An industry group that promotes the standardization of digital display interfaces)
EPG/ECG	Electronic Program Guide/Electronic Contents Guide: A means to allow the presentation and selection of programs and content information with metadata represented in XML specified by ARIB STD-B38
ES	Elementary Stream: ES is defined as coded video, audio, or independent data in PES packets. One ES is carried in a sequence of PES packets with the same stream ID.
FLUTE	A protocol for file delivery over unidirectional transport (RFC 3926)
INT	Used to specify the transport stream ID, service ID, component tag, and the target IP address of the receiver to the platform ID in a stream constituting a storage-based broadcasting service
IP	Internet protocol (RFC791): Used to define addressing mechanisms of Internet and network layer protocols as well as to process data delivery
MPEG-2	Moving Pictures Expert Group-2: A compression coding technology standardized by the International Organization for Standardization for compressing data such as video and audio (ISO/IEC 13818)
MPEG-4	Moving Pictures Expert Group-4: A compression coding technology standardized by the International Organization for Standardization for compressing data

	such as video and audio (ISO/IEC 14496)
PSI	Program Specific Information: This information is necessary for selecting a specific program, and consists of five tables: PAT, PMT, NIT, CAT, and INT.
SI	Service Information: SI is defined as various information designed to improve the convenience of program selection, defined by the ordinances of the Ministry of Internal Affairs and Communications and specified by the ARIB standard. The information also includes MPEG-2 PSI information in addition to an expansion of the ARIB standard.
TS	Transport Stream: The transport stream defined by the MPEG-2 system standard (ISO/IEC 13818-1); in multimedia broadcasting, one TS can be allocated for both each of the 13 segments and for one segment.
Conditional access	To make contents available only for users who have the rights to access the contents
Conditional access controller	A receiver function that realizes conditional access
Export processor	A processor for utilizing download-based contents outside the functions for the service; this term is not defined in this standard
Complementation of content	Recovery of a content the storage of which was not completed at the end of the broadcasting with complementary data
Reference channel	A channel used to transmit a super segment, having the same bandwidth as digital terrestrial television broadcasting (One super segment is transmitted within the bandwidth of one reference channel. However, it is possible to allocate the one segment at the edge of the bandwidth of the type-B super segment over multiple reference channels. In addition, reference channels can be defined with some part of the bandwidths overlapping each other.)
Product planning	Receiver functions or actions that depend on the hardware design, the software design of the receiver planned by each manufacturer
Super segment	Type-A super segment or type-B super segment
Seismic motion warning information	The information regarding seismic motion warning conducted based on the regulation of Clause 1 of Article 13, *Meteorological Service Act* (Act No. 165 of 1952) Although seismic motion warning is generally called "Earthquake Early Warning," this standard uses the term "Seismic Motion Warning."
Type-A super segment	The 13-segment format OFDM segment based on the "Transmission System for Digital Terrestrial Television Broadcasting" (ARIB STD-B31).
Type-B super segment	The concatenation of 14 or less one-segment format OFDM segments based on "Transmission System for Digital Terrestrial Sound Broadcasting" (ARIB STD-B29).
Terrestrial mobile multimedia broadcasting (Multimedia broadcasting)	Multimedia broadcasting carried out with terrestrial basic broadcasting stations as defined in Chapter 4, Ordinance

Terrestrial mobile multimedia broadcasting based on connected segment transmission	Multimedia broadcasting as defined in Section 1 of Chapter 4, Ordinance
Digital terrestrial television broadcasting	Digital broadcasting and high-definition television broadcasting among various types of standard television broadcasting carried out with terrestrial basic broadcasting stations as defined in Chapter 3, Ordinance
Digital terrestrial sound broadcasting	Digital broadcasting among various types of ultra-high-frequency-wave broadcasting carried out with terrestrial basic broadcasting stations as defined in Chapter 2, Ordinance
Channel information	A broadcaster name or other information displayed after channel selection
Decrypt	Decoding of encrypted download-based contents
Partial reception	Reception of only one OFDM segment at the center of a signal composed of 13 OFDM segments

1.4.2 Abbreviations

AAC	Advanced Audio Coding
AC	Auxiliary Channel
ADTS	Audio Data Transport Stream
CAT	Conditional Access Table
CIF	Common Intermediate Format
ECM	Entitlement Control Message
ES	Elementary Stream
FLUTE	File Delivery over Unidirectional Transport
HHR	Half Horizontal Resolution
INT	IP/MAC Notification Table
IP	Internet Protocol
LC	Low Complexity
MPEG-2	Moving Pictures Expert Group –2
MPEG-4	Moving Pictures Expert Group –4
NIT	Network Information Table
OFDM	Orthogonal Frequency Division Multiplexing
PAT	Program Association Table
PES	Packetized Elementary Stream
PMT	Program Map Table
PSI	Program Specific Information
QAM	Quadrature Amplitude Modulation
QCIF	Quarter Common Intermediate Format
QPSK	Quadrature Phase Shift Keying
QSIF	Quarter Source Input Format
QVGA	Quarter VGA
SI	Service Information
SIF	Source Input Format
SQVGA	Sub Quarter VGA
TS	Transport Stream

VGA	Video Graphics Array
VUI	Video Usability Information

Chapter 2: Configuration of the Receiver

The basic configuration of the “receiver” specified here is shown in Fig. 2-1.
The multimedia broadcasting receiver in a narrow sense is composed of the following units:

1) Built-in antenna, or 2) an external antenna;
3) Connection cable between the external antenna and the receiver; and
4) Receiver.

The multimedia broadcasting receiver in a broad sense is composed of, in addition to the units of the multimedia broadcasting receiver in a narrow sense, the following units:

5) Integrated video output unit; and
6) Integrated audio output unit.

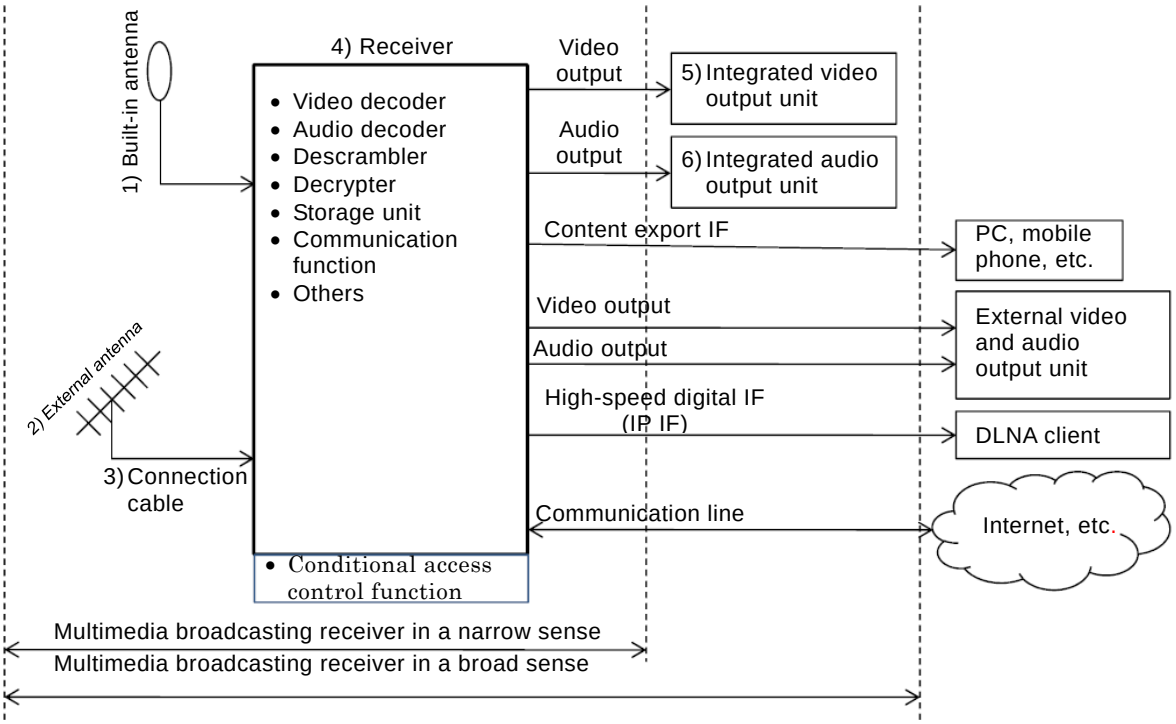


Fig. 2-1 Basic configuration of the receiver

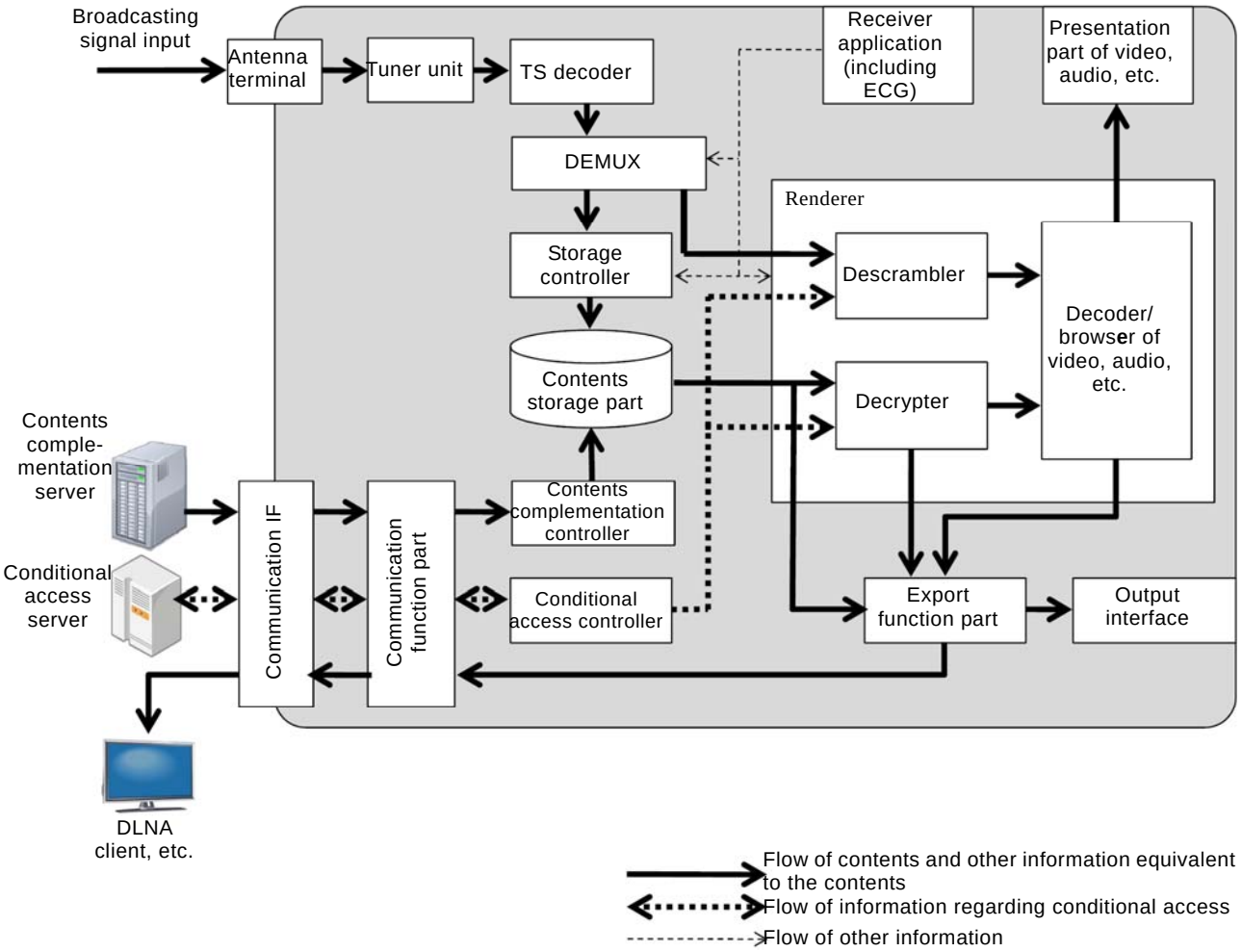


Fig. 2-2 Basic configuration of the receiver

Multimedia broadcasting consists of two broadcasting types: high-quality real-time-based broadcasting (broadcasting with video, audio, data, or a combination of such elements) and download-based broadcasting that allows the receiver to store a wide variety of contents. The contents serviced by download-based broadcasting include video, audio, images, text, data, and contents in combination with those elements. The multimedia broadcasting receiver should be able to receive, process, and output either or both of the two broadcasting types.

Chapter 3: Ambient Conditions

No specific values are specified regarding the ambient temperature and humidity.

Chapter 4: Ratings and Specifications of the Units of the Multimedia Broadcasting Receiver

4.1 Receiving antenna

Table 4-1 Ratings of the receiving antenna

Item	Rating
Frequency range	207.5 MHz to 222 MHz
Reception polarization	Horizontal or vertical
Antenna gain	The antenna gain is not stipulated, as it varies depending on the reception conditions.
Directional pattern	A directional pattern is not stipulated, as it varies depending on the reception conditions.

4.2 Specifications of receiver

The receiver must satisfy the following specifications.

4.2.1 Input

- Input impedance: 75 Ω (for an external antenna)
- Frequency range : 207.5 MHz – 222 MHz
- Center frequency

Super-segment arrangement (A)

13-segment type: 210+3/7 MHz, 219 MHz

One-segment type: 213+3/7 MHz, 213+6/7 MHz, 214+2/7 MHz, 214+5/7 MHz, 215+1/7 MHz, 215+4/7 MHz, 216 MHz

Super-segment arrangement (B)

13-segment type: 213+3/7 MHz, 219 MHz

One-segment type: 207+6/7 MHz, 208+2/7 MHz, 208+5/7 MHz, 209+1/7 MHz, 209+4/7 MHz, 210 MHz, 210+3/7 MHz

Super-segment arrangement (C)

13-segment type: 210 + 3/7 MHz, 216 MHz

One-segment type: 219 MHz, 219+3/7 MHz, 219+6/7 MHz, 220+2/7MHz, 220+5/7 MHz, 221+1/7 MHz, 221+4/7 MHz

The following figure shows the super-segment arrangement (A) to (C).

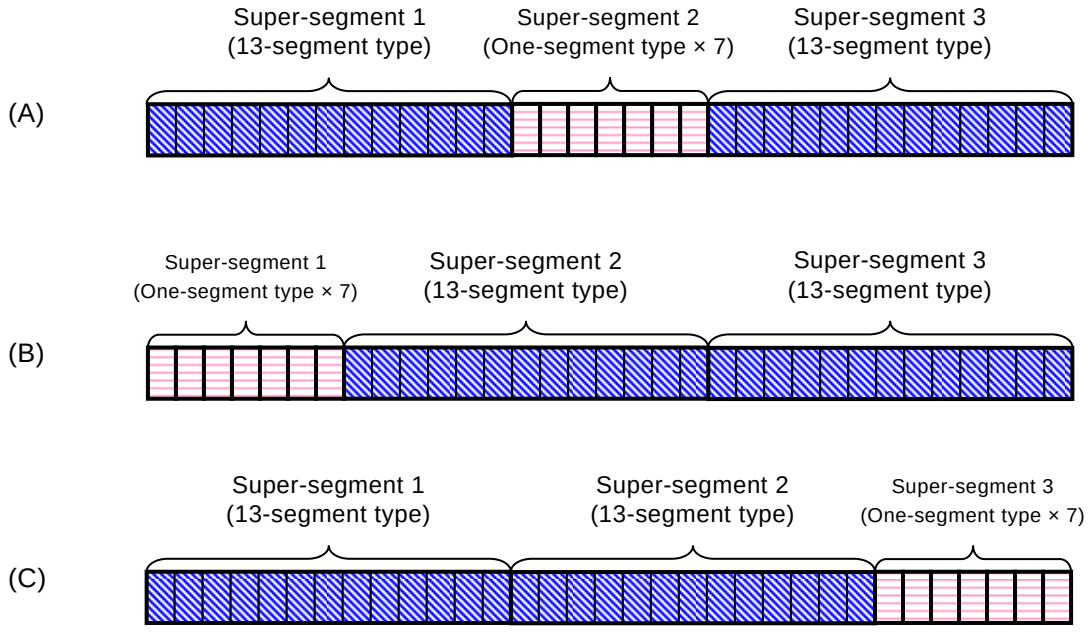


Fig. 4-1 Arrangement of super segments

4.2.2 Intermediate frequency

Not stipulated

4.2.3 Synchronization frequency range of the received signal

- Synchronization frequency range of the received signal: ±30 kHz or wider

4.2.4 Synchronization clock range of the received signal

- Synchronization clock range of the received signal: ±20 ppm or wider

4.2.5 Characteristics of the tuning unit

A tuning unit for receiving multimedia broadcasting in the 13-segment reception mode should satisfy the following specifications:

- Minimum input level: -85.5 dBm or lower (targeted value); and
- Maximum input level: -20 dBm or higher.

However, when the tuning unit is in the one-segment reception mode or partially receiving one segment located in the central part of the 13 segments, the level should be reduced by a factor equivalent to the bandwidth (i.e., $1/13^{th}$ or –11 dB).

Note: The parameters used for the measurement of the input level should be as follows: Mode 3, guard interval ratio of 1/4, time interleaving of 4, modulation of 16 QAM, and an inner-code coding rate of 1/2.

4.2.6 Front-end signal processing

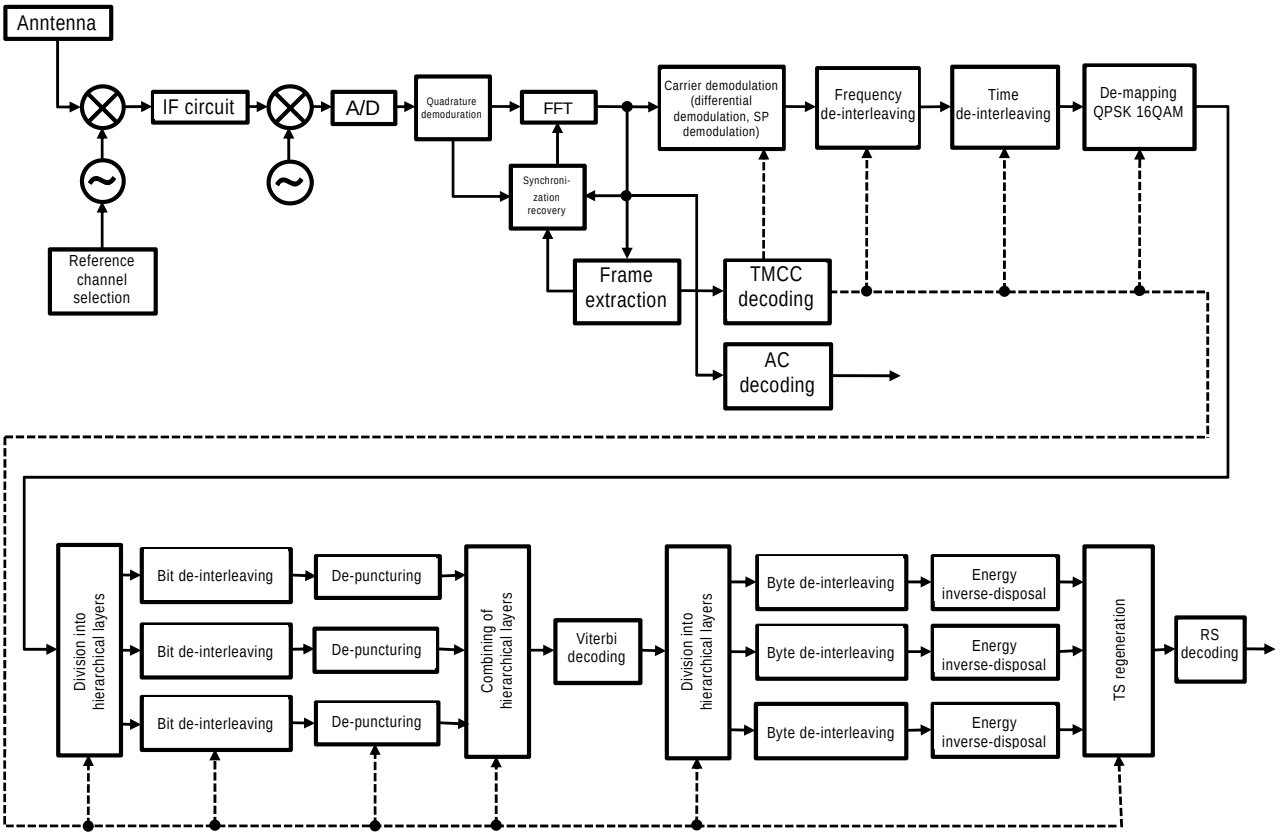


Fig. 4-2 Outline of a receiving block diagram (13-segment reception)

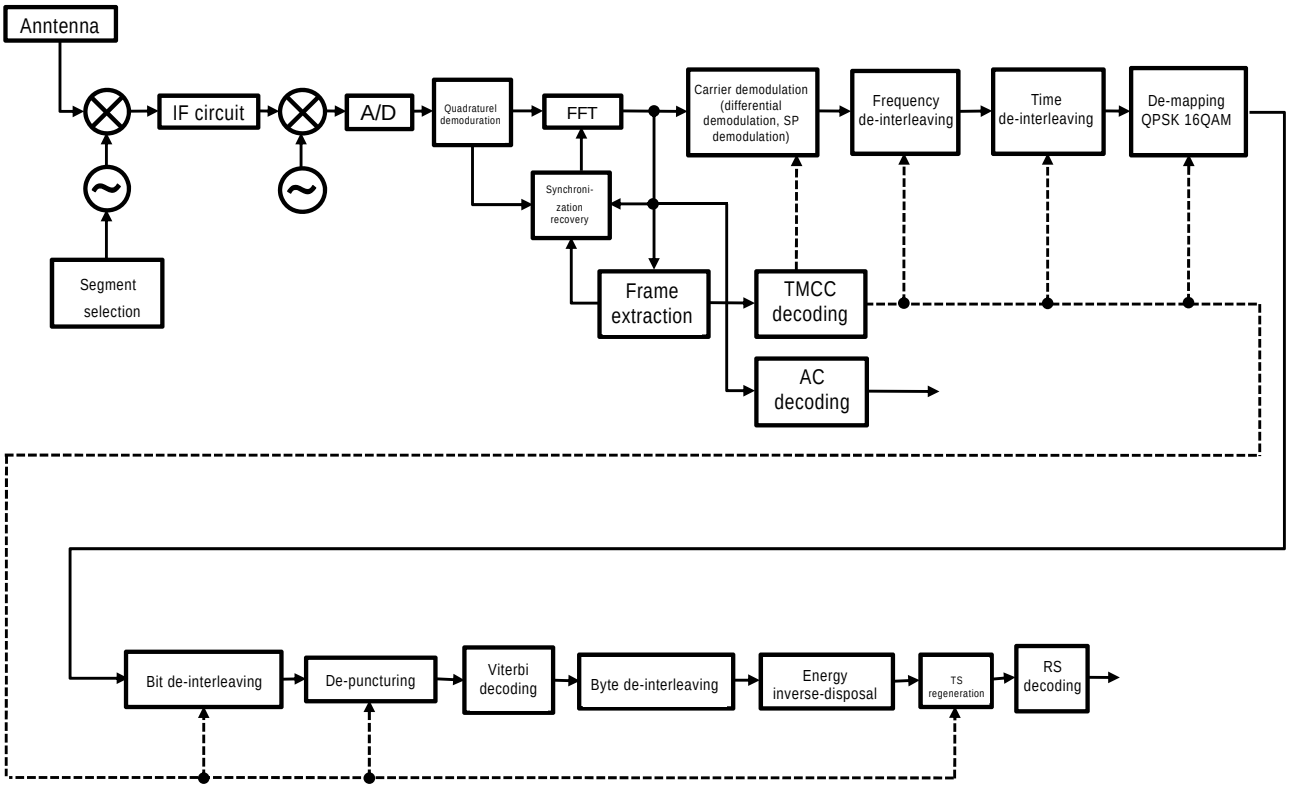


Fig. 4-3 Outline of a receiving block diagram (one-segment reception)

- Reference channel selection, segment selection:
  The reference channel (13-segment reception) or the segment (one-segment reception) of the multimedia broadcasting is selected.
  Refer to Chapter 2, ARIB STD-B46 for the relation between a reference channel and a super segment.
- Synchronization recovery: The signal in a selected reference channel or selected segment is quadrally demodulated, and, through synchronization recovery, OFDM symbol synchronization and an FFT sample frequency are regenerated in accordance with the mode and the guard interval length.
  The Mode and the guard interval length can be judged with the correlation of the guard interval period of the OFDM signal.
- FFT: FFT operation is executed for a period corresponding to an effective OFDM symbol duration. Due to the multipath state of the received signal, FFT processing must be performed for a suitable period. Note that it is preferable to set the number of the FFT size for one-segment reception as 1,024 points (Mode 3).
- Frame extraction: OFDM frame synchronization signal is extracted from the TMCC signal.
- TMCC decoding: TMCC information is extracted from the TMCC signal and used to conduct various controls.
- AC decoding: A receiver equipped with the AC signal reception function should extract seismic motion warning information when the composition ID in the AC signal of the segment No. 0 of the FFT output indicates the transmission of seismic motion warning information (“001” or “110”). The AC signal should not be decoded when the composition ID is another value. Note that seismic motion warning information is defined in “Transmission Systems for Terrestrial Mobile Multimedia Broadcasting Based on Connected Segment Transmission,” ARIB STD-B46.
- Carrier demodulation: In accordance with the TMCC information, coherent demodulation through the use of scattered pilot (SP) for QPSK or 16QAM is conducted to detect amplitude and phase information. Note that, as there is only one layer in the hierarchical transmission in the case of one-segment broadcasting, it is not necessary to demodulate simultaneously for plural layers.
- De-interleaving: Frequency and time de-interleaving is conducted.

- De-mapping:	De-mapping of QPSK or 16QAM is executed in accordance with the amplitude and phase information and bit information is extracted.
-Division into hierarchical layers:	When TMCC information indicates execution of hierarchical transmission, the signal is divided into hierarchical layers. Note that the division is performed of 204 bytes between the byte next to the synchronization byte (47 H) of the TS packet and the synchronization byte of the next TS packet.
- Bit de-interleaving:	Bit de-interleaving is executed in the each layer of hierarchical transmission.
- De-puncturing:	Bit-interpolation is executed for the each layer of hierarchy, in accordance with the convolution coding rate indicated in the TMCC information.
- Viterbi decoding:	Viterbi decoding with a coding rate of 1/2 is executed. In Viterbi decoding, a soft-decision algorithm is employed to improve performance. Further, to avoid error propagation due to the convolutional code, termination processing is conducted based on the fact that the synchronization byte (47 H) of the TS packet is already known.
- Byte de-interleaving:	De-interleaving is executed on a byte-by-byte basis.
- Energy inverse-dispersal:	Inverse dispersal is conducted by means of exclusive ORing with the 15th M-sequence PN signal on a bit-by-bit basis, except for the synchronization byte of the TS packet. Note that during the period of the synchronization byte, a shift register is in operation, and initialized at every OFDM frame.
- TS regeneration:	Processing for regeneration of a transport stream is conducted. On this occasion, the order of the TS packets and the temporal location of the PCR should be the same as they are on the transmitting side.
- RS decoding:	Shortened Reed-Solomon code RS(204,188) is decoded. During RS decoding, if an error is detected following a correction, transport_error_indicator, which is positioned at the 9th bit of the transport stream packet (specifically, MSB in the second byte), is set to "1."

4.2.7 Transport processing

It is mandatory that the receiver has a section filtering function to support the following three types of section formats for data stipulated in ISO/IEC13818-1:

(1) Each section composed of one TS packet

(2) Multiple sections composed of one TS packet (However, the maximum number of sections included in one TS packet is limited to 10).

(3) Each section composed of two or more TS packets

4.2.8 Memories

The receiver should have volatile memory for storing the contents of the data broadcasting. Likewise, the receiver should have non-volatile memory for storing programs and download-based contents. In addition, the storage area for frequency lists and modification information should be secured. See Operational Guidelines for transmission system of Terrestrial Mobile Multimedia Broadcasting Based on Connected Segment transmission for the operational specification.

4.2.9 Decoding process of video of real-time-based broadcasting and output signals

This will be described in Chapter 5.

4.2.10 Decoding process of audio of real-time-based broadcasting and output signals

This will be described in Chapter 5.

4.2.11 Primary data decoder

This will be described in Chapter 6.

4.2.12 Download function

This will be described in Chapter 11.

4.2.13 Decoding process of video, audio, and other information of download-based broadcasting and output signals

Refer to Part 2, ARIB STD-B45 for the processing of contents received as download-based broadcasting.

4.2.14 EPG/ECG function

This will be described in Chapter 7.

4.2.15 High-speed digital interface

This will be described in Chapter 8.

4.2.16 Conditional access controller

This will be described in Chapter 9.

4.2.17 External interfaces

(1) Antenna input

One antenna input terminal should be provided (optional).

(2) Bidirectional communication function

This will be described in Chapter 10.

(3) High-speed digital interface

This will be described in Chapter 8.

(4) Video and audio outputs

This will be described in Chapter 5.

4.2.18 Channel access

No stipulations are made for the operation keys or the channel access method, etc. However, the commonality of the keys used for basic functions (power supply/channel access/system setting, etc.) should be provided wherever possible, in order to increase convenience for the user.

(1) Necessary button functions

It is desirable that at least the following button functions be provided to allow the user to enjoy multimedia broadcast services:

- Power-supply button (a button function that the user operates to switch among full power, the waiting state, and power off);
- Ten keys, a program listing display key, an Enter key, channel up-and-down keys, and a menu key;
- "Move upward," "move downward," "move rightward," and "move leftward" keys.

The concrete implementation method of button functions will be left for product planning.

(2) Channel access

The channel access method is not stipulated, but is left to those involved in product planning. However, a service ID, a channel name, and a logo are designated by the broadcast service provider. The method of accessing a channel, that is, whether it is done by entering the service ID or by operating ten keys, a channel addressing key, or the like, is left to those involved in product planning.

4.2.19 Reception function of seismic motion warning information

A receiver equipped with the AC signal reception function should have a function to receive an AC signal of the segment No. 0 (the central segment among the 13 segments) for

identifying the composition ID in the AC signal. When the result of the identification shows that the value of the composition ID indicates the transmission of seismic motion warning information (“001” and “110”), the AC signal should be decoded.

Note that the bit assignment of the AC signal including composition ID should be based on “Transmission Systems for Terrestrial Mobile Multimedia Broadcasting Based on Connected Segment Transmission,” ARIB STD-B46.

Chapter 5: Decoding Process of the Video and Audio of Real-time-based Broadcasting and Output Signals

This chapter specifies the decoding process of the video and audio of real-time-based broadcasting and output signals.

5.1 Video decoding process and output signals

5.1.1 Video decoding process

The receiver should be able to decode Baseline Profile or Main Profile streams encoded at Level 1, 1.1, 1.2, 1.3, 2, 2.1, 2.2, or 3 as specified in the MPEG-4 AVC standard. Table 5-1 shows the constraints of the coding parameters. The other parameters that are not shown in Table 5-1, such as buffer size, shall be compliant with the specifications of the MPEG-4 AVC standard.

Table 5-3 shows the video formats and corresponding parameters. The 16:9 picture in SQVGA and QVGA has the same pixel aspect ratio as the 4:3 picture, with the picture size reduced in vertical pixels.

The frame rate can be calculated with the variables of VUI Parameters by the following equation to be an integral multiplication of 1000/1001:

frame rate = time_scale / num_units_in_tick

However, the maximum frame rates (Hz) at each level for the video format to be operated are shown in Table 5-4.

Table 5-1 Constrains of coding parameters

Parameter		Constraints
Picture format		YCBCR 4:2:0
Input pixel depth		8-bit
Scanning method		Progressive scan
Maximum frame rate		29.97 Hz
Maximum size of picture		Specified by MPEG-4 AVC (see Table 5-2)
Maximum bit rate		Specified by MPEG-4 AVC (see Table 5-2)
Time interval of pictures		Within 0.7 seconds when video ES is multiplexed to PES
Color description	color_primaries	Rec.ITU-R BT.1361 (Rec.ITU-R BT.709)
	transfer_characteristics	Rec.ITU-R BT.1361 conventional color gamut system (Rec.ITU-R BT.709) or wide color gamut system (IEC61966-2-4)
	matrix_coefficients	Rec.ITU-R BT.1361 (Rec.ITU-R BT.709)

Table 5-2 Maximum picture size and bit rate

Profile	Level	Maximum picture size (number of macro blocks) (specified by MPEG-4 AVC)	Examples of horizontal pixels × vertical lines (luminance signal) and aspect ratio (horizontal : vertical)	Maximum bit rate (specified by MPEG-4 AVC)
Baseline or Main	1	99	160 × 90 (16:9) 160 × 120 (4:3) 176 × 120 (4:3, 16:9) 176 × 144 (4:3)	64 kbit/s
	1.1	396	320 × 180 (16:9) 320 × 240 (4:3) 352 × 240 (4:3, 16:9) 352 × 288 (4:3)	192 kbit/s
	1.2	396		384 kbit/s
	1.3	396		768 kbit/s
	2	396		2 Mbit/s
	2.1	792	352 × 480 (4:3, 16:9)	4 Mbit/s
	2.2	1620	640 × 480 (4:3) 720 × 480 (4:3, 16:9)	4 Mbit/s
	3	1620		10 Mbit/s

Table 5-3 Video formats and parameters

Format	Picture size (horizontal × vertical)	Aspect ratio (horizontal : vertical)	seq_parameter_set_rbsp()		vui_parameters()	
			pic_width_in_mbs_minus1	pic_height_in_map_units_minus1	aspect_ratio_info_present_flag	aspect_ratio_info
SQVGA	160 × 120	4:3	9	7 (Note)	1	1
SQVGA	160 × 90	16:9	9	5 (Note)		1
525QSIF	176 × 120	4:3	10	7 (Note)		3
525QSIF	176 × 120	16:9	10	7 (Note)		5
QCIF	176 × 144	4:3	10	8		2
QVGA	320 × 240	4:3	19	14		1
QVGA	320 × 180	16:9	19	11 (Note)		1
525SIF	352 × 240	4:3	21	14		3
525SIF	352 × 240	16:9	21	14		5
CIF	252 × 288	4:3	21	17		2
525HHR	352 × 480	4:3	21	29		3
525HHR	352 × 480	16:9	21	29		5
VGA	640 × 480	4:3	39	29		1
525SD	720 × 480	4:3	44	29		3
525SD	720 × 480	16:9	44	29		5

Note: In case that the width or the height of pictures are not an integer multiple of 16, dummy data must be added to the right of the active samples or below the active lines to make the value an integer multiple of 16. The result is that coding is processed on the assumption that the number of samples or lines is an integer multiple of 16. A decoder removes the added dummy data to output only the active samples or active lines.

Table 5-4 Maximum frame rate (Hz) at each level

	1	1.1	1.2	1.3	2	2.1
SQVGA (4:3)	15000/1001	30000/1001	30000/1001	30000/1001	30000/1001	30000/1001
SQVGA (16:9)	24000/1001	30000/1001	30000/1001	30000/1001	30000/1001	30000/1001
525QSIF (4:3)	15000/1001	30000/1001	30000/1001	30000/1001	30000/1001	30000/1001
525QSIF (16:9)	15000/1001	30000/1001	30000/1001	30000/1001	30000/1001	30000/1001
QCIF	15000/1001	30000/1001	30000/1001	30000/1001	30000/1001	30000/1001
QVGA (4:3)	-	10000/1001	15000/1001	30000/1001	30000/1001	30000/1001
QVGA (16:9)	-	12000/1001	24000/1001	30000/1001	30000/1001	30000/1001
525SIF (4:3)	-	15000/2002	15000/1001	30000/1001	30000/1001	30000/1001
525SIF (16:9)	-	15000/2002	15000/1001	30000/1001	30000/1001	30000/1001
CIF	-	15000/2002	15000/1001	30000/1001	30000/1001	30000/1001
525HHR (4:3)	-	-	-	-	-	30000/1001
525HHR (16:9)	-	-	-	-	-	30000/1001
VGA	-	-	-	-	-	-
525SD (4:3)	-	-	-	-	-	-
525SD (16:9)	-	-	-	-	-	-

	2.2	3
SQVGA (4:3)	30000/1001	30000/1001
SQVGA (16:9)	30000/1001	30000/1001
525QSIF (4:3)	30000/1001	30000/1001
525QSIF (16:9)	30000/1001	30000/1001
QCIF	30000/1001	30000/1001
QVGA (4:3)	30000/1001	30000/1001
QVGA (16:9)	30000/1001	30000/1001
525SIF (4:3)	30000/1001	30000/1001
525SIF (16:9)	30000/1001	30000/1001
CIF	30000/1001	30000/1001
525HHR (4:3)	30000/1001	30000/1001
525HHR (16:9)	30000/1001	30000/1001
VGA	15000/1001	30000/1001
525SD (4:3)	15000/1001	30000/1001
525SD (16:9)	15000/1001	30000/1001

5.1.2 Video output signals

The receiver should output the video signal in one or more formats selected from among 1080i, 720p, 480p, and 480i signals, regardless of the settings of the video coding parameter values of the stream to be decoded.

The receiver should have a function for changing the video-signal format in accordance with the video-signal formats that can be handled by the display to be connected in a switchable manner. When the format is 480i, the receiver should have a further function for changing the aspect ratio in accordance with the aspect ratio (4:3 or 16:9) of the display to be connected.

The relation between the video format of the stream to be decoded and the video signal output is not specified. When upconversion or another conversion is required, its method will be left for the product planning of the receiver. Similarly, the display of data broadcasting or EPG/ECG will also be left for the product planning of the receiver.

5.1.3 Video-signal output

5.1.3.1 Analog output

The receiver should be equipped with at least one video output terminal. In cases in which the receiver is equipped with an output terminal for the component signals (Y, P_B, P_R), it is preferred that at least one D terminal be provided (which is optional for the all-in-one-type receiver). Digital broadcasting receivers equipped with a D terminal should conform to the following standard of the Japan Electronics and Information Technology Industries Association (the former Electronic Industries Association of Japan; EIAJ).

JEITA standard: EIAJ CP-4120

"Interface between a Digital Tuner and Television Receiver using D-Connector"

JEITA standard: EIAJ RC-5237

"D Connector for Digital Broadcasting Component Video Signal (Y, P_B, P_R) connection"
The assumed formats of the output signal are given in the following tables.

(1) 1080i component output

Signal format	Luminance (Y)/color difference signal	Red/green/blue signal
Output level	Y: +700 mV P_B, P_R: ±350 mV Sync signal: ±300 mV, superposed on Y	700 mV_{p-p} Sync signal (VD, HD): -300 mV, not superposed on G, B, or R
Colorimetry parameter	See Table 5-5.	
Impedance	75 Ω	75 Ω
Connector	The use of D terminal is desirable.	RCA pin x 3 Sync-signal pin x 2

(2) 720p component output

Signal format	Luminance (Y)/color difference signal	Red/green/blue signal
Output level	Y: +700 mV P_B, P_R: ±350 mV Sync signal: ±300 mV, superposed on Y	700 mV_{p-p} Sync signal (VD, HD): -300 mV, not superposed on G, B, or R
Colorimetry parameter	See Table 5-5.	
Impedance	75 Ω	75 Ω
Connector	The use of D terminal is desirable.	RCA pin x 3 Sync-signal pin x 2

(3) 480p component output

Signal format	Luminance (Y)/color difference signal	Red/green/blue signal
Output level	Y: +700 mV P_B, P_R: ±350 mV Sync signal: ±300 mV, superposed on Y	700 mV_{p-p} Sync signal (VD, HD): -300 mV, not superposed on G, B, or R
Colorimetry parameter	See Table 5-5.	
Impedance	75 Ω	75 Ω
Connector	The use of D terminal is desirable.	RCA pin x 3 Sync-signal pin x 2

(4) 480i component output

Signal format	Luminance (Y)/color difference signal	Red/green/blue signal
Output level	Y: +700 mV PB, PR: ±350 mV Sync signal: -300 mV, superposed on Y	700 mV_{p-p} Sync signal (VD, HD): -300 mV, not superposed on G, B, or R
Colorimetry parameter	See Table 5-5.	
Impedance	75 Ω	75 Ω
Connector	The use of D terminal is desirable.	RCA pin x 3 Sync-signal pin x 2

(5) NTSC composite output

Signal format	NTSC composite signal
Output level	1.0 V_{p-p}, positive polarity
Impedance	75 Ω
Connector	RCA pin

(6) NTSC Y/C (S video) output

Signal format	NTSC Y/C signal
Output level	Luminance signal: 1.0 $V_{p\text{-}p}$ Burst signal: 286 $mV_{p\text{-}p}$
Impedance	75 Ω
Connector	S video terminal (mini DIN 4-pin)

Table 5-5 Colorimetry parameters

Item	480i, 480p	1080i, 720p
Primary-color chromaticity	The CIE chromaticity coordinates should be as follows: X Y G 0.310 0.595 B 0.155 0.070 R 0.630 0.340	The CIE chromaticity coordinates should be as follows: X Y G 0.300 0.600 B 0.150 0.060 R 0.640 0.330
Reference white	D65. The CIE chromaticity coordinates should be as follows: x = 0.3127, y = 0.3290	D65. The CIE chromaticity coordinates should be as follows: x = 0.3127, y = 0.3290
Luminance (Y) /color-difference signal equation	The equations of Y, P_B, and P_R should be as follows: Y = 0.587 x G + 0.114 x B + 0.299 x R P_B = 0.564 x (B-Y) P_R = 0.713 x (R-Y) Note that G, B, and R correspond to gamma pre-corrcted signals.	The equations of Y, P_B, and P_R should be as follows: Y = 047152 x G + 0.0722 x B + 0.2126 x R P_B = 0.5389 x (B-Y) P_R = 0.6350 x (R-Y) Note that G, B, and R correspond to gamma pre-corrcted signals.
Gamma correction characteristic	Vc = 1.099XLc (^0.4500) - 0.099 (0.018 ≤ Lc ≤ 1) = 4.500XLc (0 ≤ Lc ≤ 0.018), where Vc is the video-signal camera output, and Lc is the input light of the camera. Both values must be normalized by the reference white.	Vc = 1.099XLc (^0.4500) - 0.099 (0.018 ≤ Lc ≤ 1) = 4.500XLc (0 ≤ Lc ≤ 0.018), where Vc is the video-signal camera output, and Lc is the input light of the camera. Both values must be normalized by the reference white.

Remarks : This standard is not intended to define terminal names.
: With respect to (5) and (6), luminance (Y)/synchronizing signals should have a V/S ratio
of + 714 mV/-286 mV.
: This standard is designed for use with BS digital broadcasting and, in particular, is not intended to define the permissible deviation.

5.1.3.2 Identification output of the format type

The output of identification signals of the format type is optional. However, with the adoption of a D terminal, it is possible to transmit format identification signals (480i, 480p, 720p, 1080i) and the aspect ratio to a television broadcasting receiver.

5.1.3.3 Digital output

(1) Digital video output
Receivers equipped with DVI interfaces shall comply with the Digital Visual Interface issued by the Digital Display Working Group (DDWG).
The receiver equipped with GVIF (Gigabit Video Interface) shall comply with "8. Data Transmission Standard 3" in Digital Monitor Interface GVIF issued by JEITA (formerly JEIDA [Japanese Electronic Industry Development Association]).

(2) Digital audio-video output
Receivers equipped with HDMI interfaces shall comply with the High-Definition Multimedia Interface Specification issued by the HDMI Licensing, LLC.digital interface.
The receiver can be equipped with the wireless digital audio-video output function according to the output method specified by the broadcasting company.

5.1.4 Copy protection

The receiver should be equipped with a copy guard management system specified by the broadcast service carrier.

5.2 Audio decoding process and output

The following specification shall be applied to any and elementary stream if not specified otherwise.

5.2.1 Audio decoding process

It shall conform to the LC profile of MPEG2-AAC (ISO/IEC 13818-7), MPEG-4 HE-AAC (ISO/IEC 14496-3:2001/Amd.1), and MPEG-4 HE-AAC v2 (ISO/IEC 14496-3:2005/Amd.2:2006), as well as ADTS (Audio Data Transport Stream). When receiving an MPEG Surround (ISO/IEC 23003-1) stream, the receiver supporting MPEG Surround should be capable of surround output, while the receiver not supporting MPEG Surround should perform AAC decode properly. Furthermore, it shall conform to the following restrictions.

(1) Sampling frequency: Corresponds to 48 kHz, 44.1 kHz, 32 kHz, 24 kHz, 22.05 kHz, 16 kHz

(2) Quantized bit number: Corresponds to reproduction at 16 bits

(3) Decodable number of channels: Corresponds to AAC stream up to 5.l channels per ADTS.

(4) Number of maximum multiple ADTS: Corresponds to a maximum of 8 ADTS streams within the same program.

(5) Audio decoding functions: Decodes audio modes of monaural, stereo, multi-channelstereo (3/1, 3/2, 3/2+LFE) and2-audio (dual monaural).

Note: Multi-channel stereo (3/1, 3/2, 3/2+LFE) means the number of audio channels to the assumed front and rear speakers. (Ex: 3/1 = 3 speakers in front + l at rear, 3/2 = 3 speakers in front 4 + at rear). LFE is an abbreviation of Low Frequency Effects, which means low frequency enhanced channel.

(6) Decoding process when switching the audio mode and coded parameter at the transmission side

It shall return to normal operation without making noise within the muting time of audio parameter switching, in accordance With ARIB STD-B32.

(7) Down mixing function from multi-channel to 2-channel stereo.

(7-1) Down mixing process to 2-channel stereo

When a receiver with the capability of 2-channel stereophonic reproduction reproduces the multi-channel audio stream, it shall perform the down mixing process shown in Table 5-DM1. There is hereby a possibility of overloading but noise shall not occur even in such case (it may not be turned back even at maximum audio level or more).

Note: For the method to realize the above fuctions, there are several methods such as automatic volume adjustment after AAC decoder or preventing overload by increasing quantifying bit number, etc. along with such simple methods as implementing a clipping process. The realization method shall be decided by the product planning division.

Table 5-DM1 Formula of down mixing audio signal to 2-channel stereo

<table>
<tr><th colspan="3">Bit value of the received AAC stream</th><th colspan="2">Signal process at receiver</th></tr>
<tr><th>matrix_mix down_idx_ present</th><th>pseudo_ surround _enable</th><th>matrix_ mixdow n _idx</th><th>Value of k</th><th>Formula of down mixing audio signal: Note 1</th></tr>
<tr><td rowspan="4">1</td><td rowspan="4">0/1: Note 5</td><td>0</td><td>1/√2</td><td rowspan="4">Set1: Note 2, Note 3
Lt= L+1/√2*C+k*Ls
Rt= R+1/√2*C+k*Rs</td></tr>
<tr><td>1</td><td>1/2</td></tr>
<tr><td>2</td><td>1/2√2</td></tr>
<tr><td>3</td><td>0</td></tr>
<tr><td>0 Note 6</td><td colspan="2"></td><td></td><td>Set3: Note 3, Note 4
Lt=(L+1/√2*C+1/√2*Ls)
Rt=(R+1/√2*C+1/√2*Rs)</td></tr>
</table>

Note 1: L means the left front channel of the 3/2 system audio, C, the center channel, R, the right front channel, Ls, the left rear channel, and Rs, the right rear channel. Lt and Rt indicate the stereo audio left and right channels, respectively, generated by down mixing.

Note 2: The above formulas are different from those described in Section 8.5.4.2 "Matrix-mixdown process" in ISO/IEC 13818-7 as to the coefficients.. Refer to Attachment 4, ARIB STD-B21 Version 5.3 for the details.

Note 3: The Set 1 or Set 3 formulas are also used when transmitting LFE signals in the 3/2+LFE multi-channel stereo.

Note 4: Because k cannot be transmitted in the 3/1 system, the down mixing process is expressed by substituting Ls and Rs for the surround signal S of the 3/1 system in the Set 3 formulas (S = Ls = Rs).

Note 5: The Set 1 formulas are used regardless of the pseudo_surround_enable value. As described in (7-2), however, the Set 2 formulas can be added as an option when pseudo_surround_enable = "1".

Note 6: When PCE is not acquired, the down mixing process for the case of matrix_mixdown_idx_present = "0" shall be used.

(7-2) Down mixing process for external pseudo-surround processor

When down mixing to 2-channel stereo signals for surround audio reproduction using an external pseudo-surround processor, the down mixing process shown in Table 5-DM2 can be added as an option.

Table 5-DM2 Formula of down mixing audio signal for external pseudo-surround processor

Bit value of the received AAC stream			Signalprocess at receiver	
matrix_mixdown_idx_present	pseudo_surround_enable	matrix_mixdown_idx	Value of k	Formula of down mixing audio signal
1	1	0	1/√2	Set2: Note Lt= (L+1/√2*C−k(Ls+Rs)) Rt= (R+1/√2*C+k(Ls+Rs))
		1	1/2	
		2	1/2√2	
		3	0	

Note: The above formulas are different from those described in Section 8.5.4.2 "Matrix-mixdown process" in ISO/IEC 13818-7 as to the coefficients. Refer to Attachment 4, ARIB STD-B21 Version 5.3 for the details.

(7-3) Down mixing process for stereo audio field extension

To reproduce a simulated surround stereo audio field in 2-channel stereo reproduction, down mixing can be added as an option. Although the details of the down mixing process shall be decided by the product planning division, the process must satisfy the following requirements:

- The audio volume generated by the 2-channel stereo audio stream should be as close as possible to the volume of the 2-channel stereo audio generated by decoding the multi-channel audio stream and down mixing.
- Overloading may occur when audio volume is sustained during down mixing, but noise shall not occur even in such a case.

5.2.2 Audio mode discrimination and indication

(l) Monaural, stereo and multi channel stereo (3/l, 3/2, 3/2+LFE), 2 audio (dual monaural) audio mode correspond to each discrimination and indication. However, the audio mode of an entire program comprised of multiple audio elementary streams shall be a combination of the above audio modes.

(2) It shall correspond to discrimination and indication of bilingual/2-audio mode.

(3) It shall correspond to discrimination and indication of mode 1/mode 2/mode 3.

5.2.3 Audio output

5.2.3.1 Audio output function

It shall be equipped with an audio output function of 2-channel stereo or more.

5.2.3.3 Audio-signal output interface for multi-channel

Recommended to conform to the standard of IEC 61937-6 (2006-01) Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 - Part 6: Non-linear PCM bitstreams according to the MPEG-2 AAC and MPEG-4 AAC audio formats or have IEEE-1394 compliant output.

5.2.3.4 Audio output using Bluetooth

Recommended to conform to the standard of Bluetooth SIG: Advanced Audio Distribution Profile (A2DP)*.

- http://www.bluetooth.org/foundry/adopters/document/A2DP_Spec_V1_0/

Chapter 6: Specifications of the Primary Data Decoder

The specifications of the primary data decoder must be in accordance with “ARIB STD-B24.”

Chapter 7: Specifications of EPG/ECG

The functions of EPG/ECG utilizing SI and metadata (program guide table representation, program searching, program reservation, etc.) and an EPG/ECG user interface are, in principle, a matter of the manufacturers' product planning. However, EPG/ECG is a very peculiar function in digital broadcasting, allowing the viewer to select a desired service efficiently. It is therefore recommended that the receiver have as convenient an EPG/ECG as possible. Stipulations and guidelines for the EPG/ECG function must be satisfied in accordance with the broadcasting company's specifications.

Chapter 8: Specifications for High-speed Digital Interfaces

The high-speed digital interface should use the IP interface and comply with DLNA Networked Device Interoperability Guidelines Expanded (DLNA Guidelines). Details are given separately as operational specifications.

Chapter 9: Specifications of the Conditional Access Controller

It is preferable that the receiver is equipped with the conditional access interface based on Part 4 of “Conditional Access System Specifications for Digital Broadcasting,” ARIB STD-B25 as the interface to the conditional access controller.

Chapter 10: Specifications of the Bidirectional Communication Function

Bidirectional communication should use IP communication. The examples of the assumed interfaces are as follows: 3GPP, 3GPP2, LTE, wired LAN, and wireless LAN. Refer to the standard of each interface for the details.

Chapter 11: Downloading Function

The downloading function used to update software/data stored in nonvolatile memory should possess certain characteristics as described below. First, an information transmission scheme is specified, along with preferable specifications for the receiver to be updated by this downloaded information.

11.1 Definitions of terms and service content

11.1.1 Definitions of terms

Notification information: Information used for notification such as the service ID for downloading, scheduling information thereof, and the targetted model of receiver to be updated. It is transmitted using SDTT.
Receiver information: Information on the receiving set, such as maker ID, model number, group number, version number, etc. These pieces of information are stored in nonvolatile memory such as flash memory before shipping.
Compulsory downloading: Downloading that must be executed.
Discretionary downloading: Executable downloading displayed on the screen, and executed in accordance with the viewer's content selections.

11.1.2 Service contents

11.1.2.1 Receiver built-in information update service

Receiver built-in information update service in this document includes the following services that are stored in memory.

(1) Engineering service (see 11.1.2.2)

(2) Information transmission service related to the necessity of updating the receiver software, method, and re-packing transmitted by the SDTT for partial-reception hierarchy of TS for all the broadcasting stations in multimedia broadcasting
Services of EPG/ECG, data service, and video/audio service to store memory are not included in the receiver built-in information update service of this standard.

11.1.2.2 Engineering service

The engineering service means the following services transmitted by the data carrousel. Generally, the engineering service is reported by the SDTT transmitted by the TS of the whole broadcasting station.

(1) Function updating of the receiver software
Function updating and addition of the receiver software

(2) Common data updating
Updating the data used commonly in the receiver.
- Frequency list, change information

11.2 Transmission scheme relevant to downloading

In this section, stipulations of transmission scheme are provided for both notification information concerning download scheduling, etc., and download contents.

11.2.1 Transmission scheme of notification information

11.2.1.1 Software Download Trigger Table

To provide notice of download information, a Software Download Trigger Table is used.

Table 11-1 Data structure of Software Download Trigger Table

Data structure	Number of bits	Representation of bit string
Software_download_trigger_section(){		
Table_id	8	uimsbf
Section_syntax_indicator	1	bslbf
Reserved_future_use	1	bslbf
Reserved	2	bslbf
Section_length	12	uimsbf
Table_id_ext	16	uimsbf
Reserved	2	bslbf
Version_number	5	uimsbf
Current_next_indicator	1	uimsbf
Section_number	8	uimsbf
Last_section_number	8	uimsbf
Transport_stream_id	16	uimsbf
Original_network_id	16	uimsbf
Service_id	16	uimsbf
Num_of_contents	8	uimsbf
For(i=0;i<num_of_contents;I++){		
Group	4	bslbf
target_version	12	uimsbf
new_version	12	uimsbf
download_level	2	bslbf
version_indicator	2	bslbf
content_description_length	12	uimsbf
Reserved	4	bslbf
schedule_description_length	12	uimsbf
schedule_time-shift_information	4	uimsbf
for(i=0;i<N;i++){		
start_time	40	uimsbf
duration	24	uimsbf
}		
for(j=0;j<N2;j++){		
descriptors()		
}		
}		
CRC_32	32	rpchof
}		

Definitions for the Software Download Trigger Table:

table_id: 0xC3

section_syntax_indicator: 1

section_length: This field contains the number of bytes from immediately after the section-length field to a section end, including CRC. Section length must not exceed 4093.

table_id_extension:

Data structure	Number of bits	Representation of bit string
maker_id	8	uimsbf
model_id	8	uimsbf

version_number: This field indicates a version number of a sub table. The version number is incremented, accompanied with a change of information in the Sub-Table. When the value reaches 31, it returns to 0.

current_next_indicator: 1

section_number: This field indicates the section number.

last_section_number: This field indicates the last section number of the sub table to which the section belongs.

transport_stream_id:

A label with which the transport stream is identified from other multiplexed transport streams in the network.

original_network_id:

A label that designates the network identification of the original delivery network.

service_id: A label to discriminate the service by which the download content is transmitted.

num_of_contents: This field indicates the number of download content notified in this table.

group: This field contains group_id.

target_version: This field indicates version number of the download content to be updated.

new_version: This field indicates a version number of content to be downloaded.

download_level: "01" indicates compulsory downloading, and "00" indicates discretionary downloading.

version_indicator:

00: All versions are targeted (Version specification is invalid).
01: Version(s) specified or later are targeted.
02: Version(s) specified or earlier are targeted.
03: Only specified version is targeted.

content_description_length(): This field indicates total byte length of a schedule loop and a descriptor loop.

schedule_description_length:

This field indicates byte length of the schedule loop. When this value is 0 in all receiver common data, it indicates that the intended download content is being transmitted.

schedule_time-shift_information: Explanation of the schedule time-shift information follows.

- 0: The same download content is transmitted by the same schedule with multiple service_id
- 1 to 12: The same download content is transmitted by shifting the time of 1 to 12 hours for each service_id with multiple service_id
- 13 to 14: Reserved
- 15: The download content is transmitted with a single service_id.

For detailed operation such as specification method of service_id when transmitting the download content in multiple service_id, see “Download Function” in Appendix 3 of this document and Operational Manual for Broadcasting Service Provider.

start_time: This field indicates time of distribution of download content, using Japan Standard Time (JST) and Modified Julian Date (MJD).

duration: This field indeicates duration time of distribution in second.

descriptor(): Download Content Descriptor shown in Table 12-2 is placed.Table

Table 11-2: Structure of Download Content Descriptor

Data structure	Number of bits	Representation of bit string
Download_content_descriptor () {		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
reboot	1	bslbf
add_on	1	bslbf
compatibility_flag	1	bslbf
module_info_flag	1	bslbf
text_info_flag	1	bslbf
reserved	3	bslbf
component_size	32	uimsbf
download_id	32	uimsbf
time_out_value_DII	32	uimsbf
leak_rate	22	uimsbf
reserved	2	bslbf
component_tag	8	uimsbf
if (compatibility_flag == '1') {		
compatibilityDescriptor()		
}		
if (module_info_flag == '1') {		
num_of_modules	16	uimsbf
for (i=0; i<num_of_modules; i++) {		
module_id	16	uimsbf
module_size	32	uimsbf
module_info_length	8	uimsbf
for (i=0; i< module_info_length; i++) {		
module_info_byte;	8	uimsbf
}		
}		
}		
private_data_length	8	uimsbf
for (i=0; i<private_data_length ; i++) {		
private_data_byte	8	uimsbf
}		
if (text_info_flag == '1') {		
ISO_639_language_code	24	uimsbf
text_length	8	uimsbf
for(i=0;i<N;i++){		
text_char	8	uimsbf
}		
}		
}		

descriptor_tag: A label with which the Download Content Descriptor is identified. The value is 0xC9.

reboot: Flag indicating whether it is necessary to restart the receiver upon completion of downloading. “1” indicates restart, and “0” indicates continuous operation.

add_on: Flag indicating whether an overwrite of an existing module or addition occurs. “1” indicates addition, and “0” indicates overwrite.

compatibility_flag: Flag indicating the presence/absence of a compatibilityDescriptor() in the descriptor. “1” indicates that compatibilityDescriptor() is present, and “0” indicates that it is not.

module_info_flag: Flag indicating the presence/absence of information for each module in the descriptor. “1” indicates that information for each module is present, and “0” indicates that it is not.

text_info_flag: Flag indicating the presence/absence of service description at the end of the descriptor. “1” indicates that the service description is present, and “0” indicates that it is not.

component_size: This field contains the sum of data sizes that are transmitted in the carousel in byte.

download_id: This field specifies download identification for the purpose of identifying an application number for this download. The download identification specified here is also specified in DII/DDB when actual distribution is done.

time_out_value_DII: This field indicates recommended time-out value in millisecond for all DII section reception of the corresponding carousel.

leak_rate: Leak rate of the transport buffer of the receiver. Unit is bytes/s.

reserved: This 3-bit field is reserved for future use.

component_tag: This 8-bit field contains a component tag of a corresponding stream that is given by a stream identification descriptor in PMT.

compatibilityDescriptor(): This field contains compatibilityDescriptor which is the same as that in DII. Any target to be updated by this download which cannot be specified by table_id_ext/group in SDTT must be specified by using information here.

number_of_modules: This field indicates the number of modules.

module_id: Identification of a module in the carousel to download contents.

module_size: This field indicates byte length of the module concerned. “0” indicates undefined length.

module_info_length: Byte length of module_info_byte.

module_info_byte: This field contains necessary descriptors, i.e., Type Descriptor, Name Descriptor,Info Descriptor, or Control Descriptor as described in DII.

private_data_length: Byte length of private_data_byte.

private_data_byte: Use of this area is beyond the scope of this specification.

ISO_639_language_code: This field specifies language of character description used for the service description.

text_length: Length of the service description in byte.

text_char: Description concerning the service of the download content to be transmitted.

11.2.2 Transmission scheme of the content

The download content can be transmitted by a data carousel and section table.

11.2.2.1 Download content data carousel transmission scheme

Additional specifications concerning download to the DSM-CC data carousel transmission regulations are described below.

(1) Addition of compatibility Descriptor in DII
Additional specifications to original DSM-CC data carousel are described to specify the target receiver of download. It is assumed that the semantics and syntax of compatibilityDescriptor are used. The syntax is shown in Table 11-3.

Table 11-3 CompatibilityDescriptor format

Syntax	Number of bytes
CompatibilityDescriptor(){	
CompatibilityDescriptorLength	2
DescriptorCount	2
for (i=0 ; i<descriptorCount ; i++){	
descriptorType	1
descriptorLength	1
specifierType	1
specifierData()	3
model	2
version	2
subDescriptorCount	1
for (j=0 ; j< subDescriptorCount ; j++){	
subDescriptor()	
}	
}	
}	
SubDescriptor() {	
SubDescriptorType	1
SubDescriptorLength	1
for (k=0 ; k< subDescriptorLength ; k++){	
additionalInformation	1
}	
}	

Maker identification (maker_id), model identification (model_id) and version identification (version_id) must be contained in compatibilityDescriptor in the header of DII (Download Info Indication).
By including a plurality of descriptors in this compatibilityDescriptor describing models that should download the software, it becomes possible for models from multiple makers to download the software at the same time. Note that if there are two or more Descriptors of the same DescriptorType, the models that should download the software must be specified by an OR (logical sum) operation of the Descriptors; however, if there are two or more Descriptors of each different DescriptorType, the models that should download the software must be specified by an AND (logical product) operation.
A method of specifying models of the target receivers of download must be specified by DescriptorType, and specification by hardware and/or by software must be possible.

Identification fields of the model information are shown in Table 11-4.

Table 11-4 Identification field

Field	Content	Number of bits
specifierType	0xFF	8
specifierData()	Code indicating “ARIB”(0x819282)	24
model	Equivalent to (maker_id)	8
	Equivalent to (model_id)	8
version	Assigned to (group_id)	4
	Equivalent to (version_id)	12

The version field is divided between a version_id of 12 bits and a group_id of 4 bits (group identification). Here, group_id is provided to divide the receivers that should download the software into several groups with the intention to mitigate power plant load.
It is also possible to consider Virtual Machine as a specific model, and hence, all receivers having Virtual Machine are made to download the same software.

(2) Addition of descriptor for DII Module Info

Information of the download content must be described in Module Information area in a DII message of DSM-CC data carousel. The information is transmitted using several descriptors that have already been defined in other ARIB specifications. DII (DownloadInfoIndication Message) format is shown in Table 11-5.

Table 11-5　DII (DownloadInfoIndication Message) format

Syntax	Number of bytes
DownloadInfoIndication(){	
DsmccMessageHeader()	
DownloadId	4
BlockSize	2
WindowSize	1
AckPeriod	1
TCDownloadWindow	4
TCDownloadScenario	4
CompatibilityDescriptor()	
NumberOfModules	2
for (i=0 ; i< numberOfModules ; i++){	
moduleId	2
moduleSize	4
moduleVersion	1
moduleInfoLength	1
for (j=0 ; j< moduleInfoLength ; j++){	
ModuleInfoByte	1
}	
}	
PrivateDataLength	2
for (i=0 ; i< PrivateDataLength ; i++){	
PrivateDataByte	1
}	
}	

Descriptors contained in ModuleInfoByte for the use of download will be described in the following.

Type Descriptor contains module type description that indicates the module carries download content. A receiver discriminates that whether the module carries content of the data services or content of the download by this descriptor. Notation of module type follows the “Media Type” notations in RFC2046.

Example: application/x-download indicates that it is the download content.

Though actual description of module type may vary by targeted receiver model, the notation must always follow that in RFC2046.

A module name is described in the Name Descriptor. The name should be unique in all the module names in a receiver system. For example, if all software components of a receiver system consist of module based manner on a file system, the path of the targeted module on the file system is described in this Name Descriptor.

Further additional information of the module to be downloaded is described in info Descriptor. The information content in Info Descriptor must be in Plain Text. When an optional byte data is added to the module, the Control descriptor should be operated.

11.3 Preferable specifications of the receiver

The necessary functions and capacity and performance of the receiver to achieve information revision service for the receiver are described below.

11.3.1 Necessary functions

The receiver should have following functions for information revision service for the receiver.
(1) To schedule the execution of download, the receiver should have abilities:

- to receive notification information with satisfying other receiver operations
- to determine to schedule the execution or not in accordance with the result of evaluation, such as download of common data for all receivers or download of receiver content that meets receiver information etc.
- not to attract users' attention when notified download is compulsory download and users' permission was given beforehand
- to display selection list and to offer a control method to users to select content to be downloaded, then to follow the users' selection for scheduling when notified download is discretionary download

(2) When receiving download content, the receiver should:
In case of data carousel format download content

- have the ability to receive the download content that is transmitted in DSM-CC data carousel according to the notification information and store the downloaded content in non-volatile memory[1)]
- have the ability to evaluate the validity and compatibility of the received download content and store the downloaded content in non-volatile memory
- follow the notification information; i.e. When schedule information[2)] is available, the receiver executes the downloading according to the schedule information while the receiver is on standby. When there is no schedule information, the receiver tries to perform the downloading when a switch-OFF operation is initiated.
- avoid any disturbances to current program viewing. For example, the receiver is permitted to execute the reception of downloading content when a service for download is found in a TS that is currently selected for users' program viewing, reboot of modified software in receiver memory is suspended until the receiver is turned off (on standby), etc.

(3) To recover the functions of a receive in case of emergency, the receiver should:

- have ability to detect emergency, such as turning off the receiver while receiving, error or exception while processing the downloaded content, or imperfection of received data etc.
- have ability to start system recovery method
- have ability to invalidate downloaded content and to secure system configuration necessary to reacquire the download content once emergency was detected while downloading
- execute the program existed before downloading to start the receiver if it has two-bank memory system in which two memory areas to be used for overwriting through the downloading are equipped to enhance safety, or execute the inherit program to start the receiver if it has one-bank plus α memory system in which an inherit program area that cannot be overwritten and a memory area to be overwritten through downloading are equipped in order to secure minimum receiver functions.

---

1 In compulsory downloading, the user must not be inconvenienced.

2 "When schedule information is available" refers to cases where the number of loops of the schedule information in SDTT is not 0; "when there is no schedule information" refers to a case where it is 0.

(4) To permit a receiver to execute download, the receiver should have abilities to:
- offer a control method to users to choose whether it is granted or not
- retain given permission information

(5) A receiver should have abilities to control its power supply unit to:
- turn on necessary circuits to receive download content by its own timer programmed by itself according to the notification information
- turn off the circuits when download operation completed
- keep necessary circuits functional to perform download when a receiver is turned off. After the completion of downloading, the circuits should also be turned off in this case.

11.3.2 Necessary capacity and performance of receiver hardware

A receiver that satisfies the specification described in 11.3.1 should have the following capacity and performance.

(1) A receiver should have enough buffer memory against transmission speed for both notification information and download contents.

(2) The storage area for frequency lists and modification information should be secured. See Operational Guidelines for Transmission System of Terrestrial Mobile Multimedia Broadcasting Based on Connected Segment transmission for the operational specifications.

(3) To recover a receiver functions and maintain the ability to receive broadcasting services, the receiver must have one of the two following memory structures: a two-bank memory system (in which two banks of nonvolatile memory are used to enable backtracking to a state prior to the downloading); or a one-bank plus α memory system (in which one bank of memory area is assigned to be overwritten by the downloading and the inherent program is kept permanently in the memory).

Chapter 12: Signal Processing Functions of the Receiver

12.1 Service information

The receiver must have a function of receiving and presenting the several pieces of information that are stipulated as required to the service information as defined separately by an ARIB standard, including PSI provided by the Ordinance.

12.2 Identification between broadcasting and non-broadcasting

DIRD must have a function of selecting signals that are defined as of broadcasting according to the flow shown in Fig. 12-1 with the use of the system management descriptor that is separately stipulated.

12.3 Number of PIDs to be simultaneously processed

The number should be 10 or more. (TBD)
The assumed processes are as follows: video × 1, audio × 2, caption and superimpose × 2, data broadcasting × 4, and PCR × 1.

12.4 Number of scramble keys that can be set for scrambling

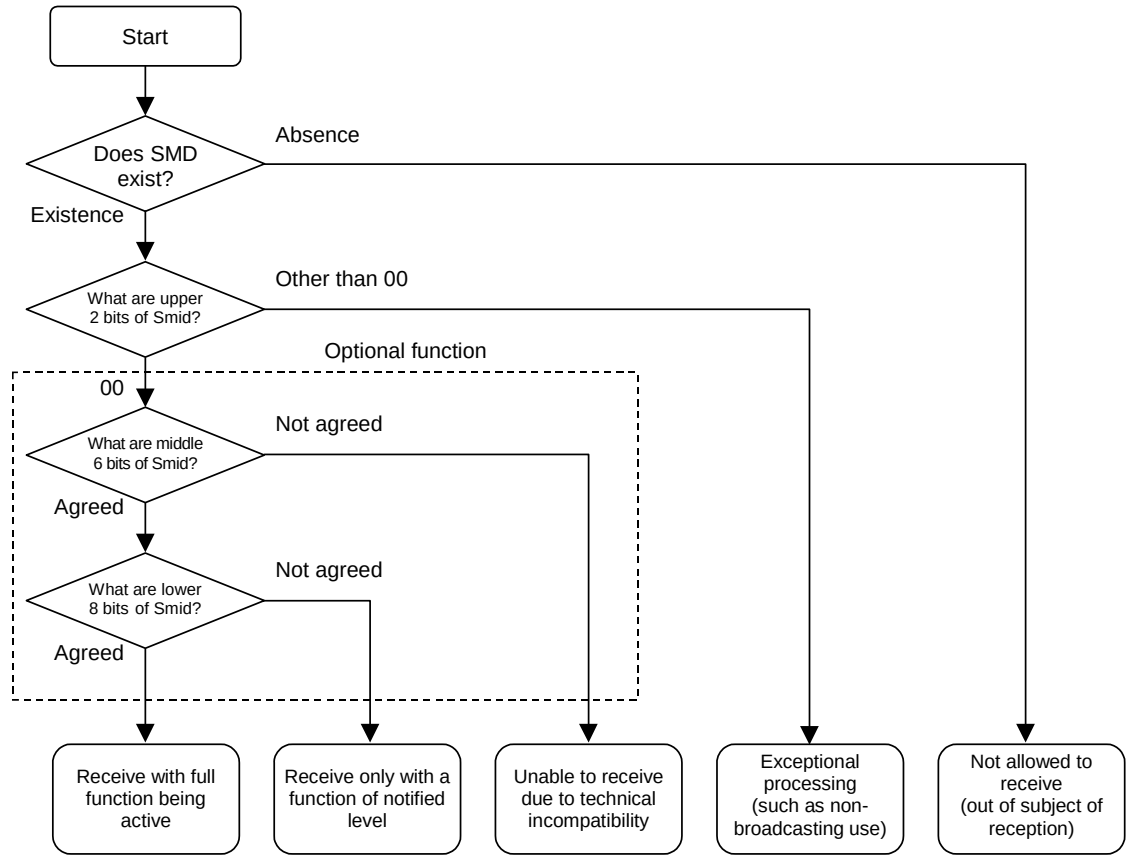
One pair or more should be processed, where one pair is composed of one odd key and one even key. (TBD)

12.5 Signal processing functions for real-time-based broadcasting

Program selection must be performed according to the flow of Fig. 12-2.

12.6 Signal processing functions for download-based broadcasting

For the signal processing functions for download-based broadcasting, refer to Part 2, ARIB STD-B45. Note that the number of FLUTE sessions concurrently processed for EPG/ECG metadata and download-based broadcasting contents together should be two or more. (TBD)



SMD: System management descriptor Smid: System management id

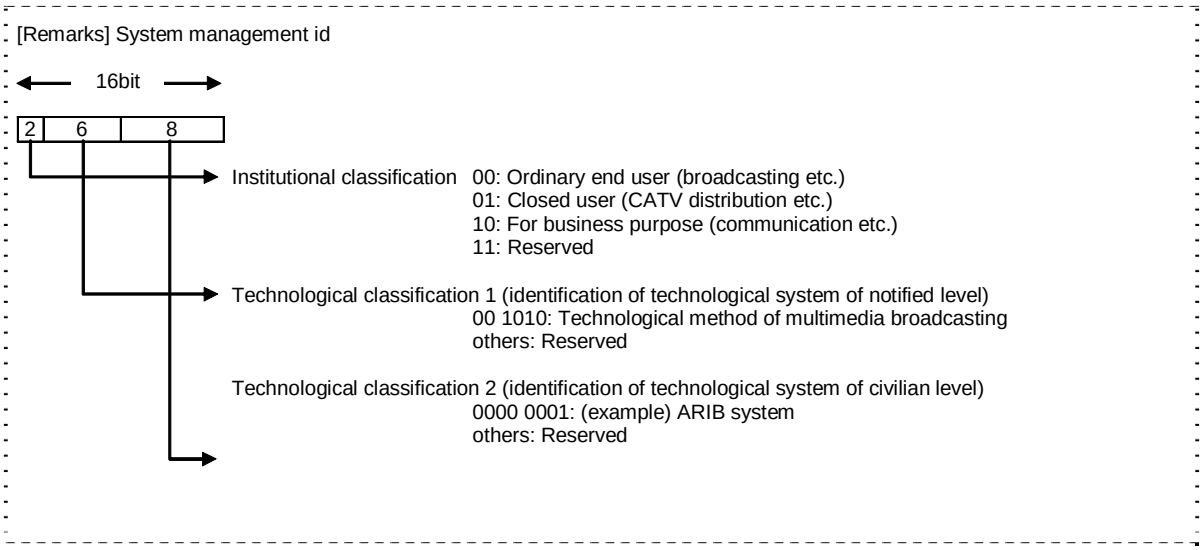
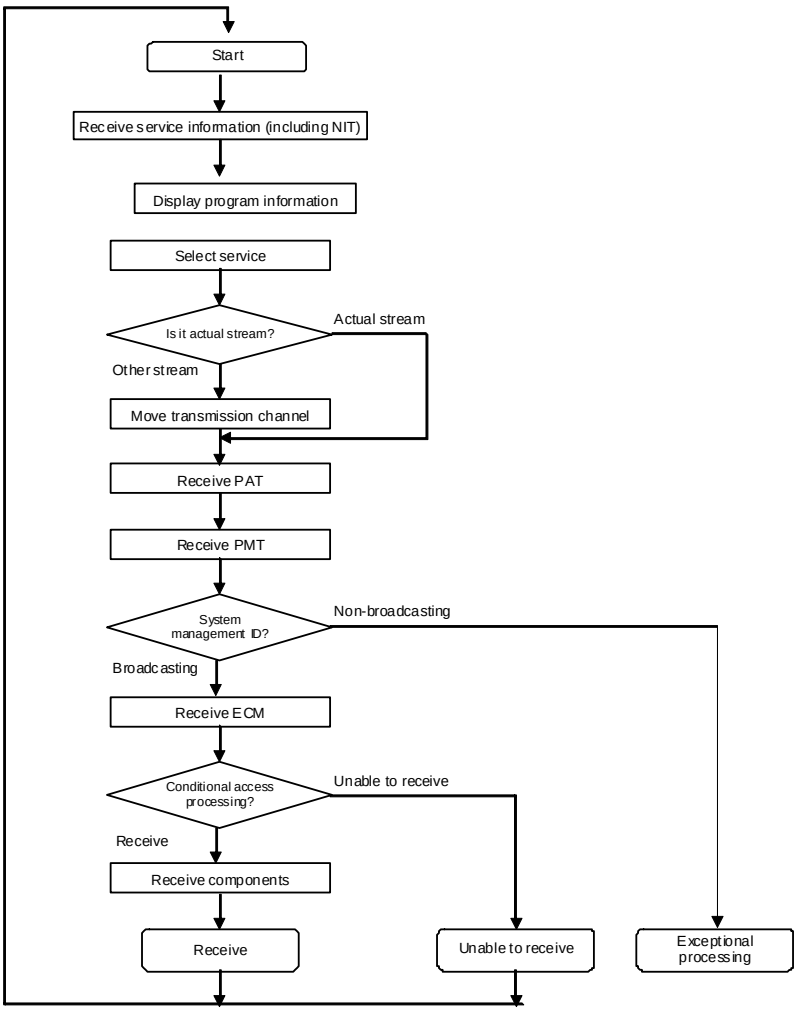


Fig. 12-1 Identification flow of broadcasting/non-broadcasting



[Notes]

(1) Only basic flow is showed. It is also acceptable to provide branching/short-circuit routes, etc. as an additional receiver function.

(2) After reception of a broadcast containing proper NIT and service information, the flow would not proceed into the exceptional processing.

(3) Exceptional processing, processing such as re-setting to capture the broadcast wave correctly, or special processing when the receiver is used for non-broadcasting reception (uploading of the system management ID, etc.) is conducted.

Fig. 12-2: Basic flow of program selection

Chapter 13: Rights Protection Function

The digital copy control descriptor and the content availability descriptor are defined in the STD-B10 standard specification, and other rights protection functions are defined in the Part 4, STD-B25 standard specification.

RECEIVER FOR TERRESTRIAL MOBILE MULTIMEDIA BROADCASTING BASED ON CONNECTED SEGMENT TRANSMISSION

ARIB STANDARD
(DESIRABLE SPECIFICATIONS)

ARIB STD-B53 Version 1.2

(March 19, 2013)

This Document is based on the ARIB standard of "Receiver for Terrestrial Mobile Multimedia Broadcasting Based on Connected Segment Transmission" in Japanese edition and translated into English in July, 2013

Published by

Association of Radio Industries and Businesses

11F, Nittochi Building
1-4-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-0013, Japan

TEL 81-3-5510-8590
FAX 81-3-3592-1103

Printed in Japan