OFFICE OF THE REGULATOR

RECEIVER SPECIFICATION

FOR DIGITAL TERRESTRIAL TELEVISION

SAMOA

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Table of contents

Page

1. Introduction

This Specification defines the requirements for receivers for digital television intended for use with the second generation Digital Terrestrial Television broadcasting system (DVB-T2) in Samoa. The receiver may be either an Integrated Digital Television (IDTV) or Set Top Box (STB) Receiver Decoder. The requirements for advanced features such as Personal Video Recorders (PVRs) and interactive services are not included in the scope of this Specification.

This Specification is established to enable equipment manufacturers and/or suppliers / retailers to bring into Samoa compatible DVB-T2 IDTVs and STBs that will provide good reception of Free-To-Air (FTA) Digital Terrestrial Television (DTT) services.

2. Scope

This Specification defines the minimum requirements for receivers in accordance with the implementation guidelines outlined in the DVB Specification for the use of video and audio coding in broadcasting applications based on the MPEG-2 transport stream (ETSI TS 101 154 [1]). The minimum functionality of the receiver shall be defined by the following dimensions:

a) 25 Hz and 50 Hz;
b) SDTV and HDTV;
c) Input and Output interfaces;
d) H.264/AVC video coding formats; and
e) MPEG-4 HE AAC audio coding formats.

This Specification requires that the receiver be compatible with the DVB-T2 baseline system for DTT as defined in the ETSI EN 302 755 [2].

This Specification also requires that the receiver be capable of decoding broadcasts of television, radio and enhanced services. This shall include the following capabilities:

a) Subtitling (where available and selected by viewer);
b) Electronic Program Guide;
c) Parental Lock Feature; and
d) Multiple Audio Selection

This standard uses wherever possible what has been assessed as the most common features for receiver functionality, particularly drawing on the functionality common to neighbouring countries such as Australia and New Zealand, such as :

- the Australian implementation of the logical channel number (LCN), but the LCN reserved range is set from 800 – 999.
- The Australian Parental rating codes are used.

But, it should be noted that the transmissions are DVB-T2 (different to the Australian transmissions and most of the New Zealand transmissions) and the broadcast bands used are assigned with slight differences, New Zealand does not use VHF Band III and Australia's use of UHF Band IV/V is with 7 MHz channelling rather than 8 MHz channelling.

However, there are some specific elements of data unique to Samoa which are emphasised for receiver manufacturers to note:

a) Samoa's timezone is normally +13 hours UTC and daylight saving is observed in the summer making the timezone +14 hours UTC. Manufacturers are requested to ensure operation of displayed times are correct when receiving a TOT or TDT of +13 or +14.
b) There is the possibility that the audio for some services may be identified as being broadcast in the Samoan language. The ISO-639-2 [19] language code for English is "eng" while the code for Samoan is "smo". It is recommended that the receiver display at least "English" and "Samoan" when displaying the audio options menu.
c) Descriptors which include a **country_code** field in their syntax shall be coded with the 3 character code "WSM", which is coded as "0101 0111 0101 0011 0100 1101".

Suppliers and consumers arranging purchases outside of Samoa should highlight these points whilst purchasing receivers in order to have the most compatible receiver to Samoa's digital broadcasts.

Note: Unless otherwise specified, all requirements are mandatory.

The word ''Recommended' means this item is not mandatory but is highly recommended

3. General Requirements

3.1. Power Supply

The receiver may be AC powered or DC powered. For AC powered equipment, the Specification shall be complied with when operating from an AC mains supply of voltage, 230V ± 10% and frequency, 50 Hz ± 2%.

3.2. Safety Requirements

The receiver shall be tested for compliance with the International Electrotechnical Commission IEC 60065 [3] safety standards.

3.3. Electromagnetic Compatibility (EMC) Requirements

The receiver shall comply with Sections 5.3, 5.6 and 5.7 of ISO/IEC CISPR13 [4] or equivalent based on ISO/IEC CISPR 22 [5].

3.4. Identification of Equipment

The receiver shall be marked with the supplier or manufacturer's name or identification mark, and the supplier or manufacturer's model or type reference. The markings required shall be legible, indelible and readily visible.

4. Use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream

4.1. Transport Stream Bit-streams

The receiver shall comply with implementation guidelines outlined in Section 4 of ETSI TS 101 154 [1], based on the MPEG-2 Transport Stream bit-streams requirements defined in Section 2.4 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [6].

The receiver shall be able to de-multiplex and present programs according to the Program Specific Information (PSI) defined in Section 2.4 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [6].

The Transport Stream supports the multiplexing of video and audio compressed streams from one program with a common time base or from multiple programs with independent time bases. Programs are composed of one or more elementary streams, each labelled with a Packet Identifier (PID). The receiver shall be able to handle simultaneously at least 32 PIDs and elementary streams.

The receiver shall be able to skip over data structures which are currently "reserved" (Section 4.1 of ETSI TS 101 154 [1]).

The receiver shall operate over the full tolerance range of the system clock frequency as specified in Section 2.4.2.1 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [6].

The receiver shall operate correctly with Program Clock References (PCRs) for a program arriving at intervals not exceeding 100 ms as specified in Section 2.7.2 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [6].

4.2. Video Decoding

The receiver shall comply with the implementation guidelines outlined in Sections 5.5, 5.6 and 5.7 of ETSI TS 101 154 [1] for decoding MPEG-2 video. The receiver shall be able to decode video formats as specified in Table 1, based on the ITU-T Rec. H.264 / ISO/IEC 14496-10 [7].

Table 1 Video decoding to ITU-T Rec. H.264 or ISO/IEC 14496-10

Resolution	Frame. Rate	Scanning	Aspect Ratio	Profile	Picture Format
720 x 576	25	Interlaced	4:3 or 16:9	AVC MP@L3	SD
1 280 x 720	50	Progressive	16:9	AVC HP@L4	HD
1 440 x 1 080	25	Interlaced	16:9	AVC HP@L4	HD
1 920 x 1 080	25	Interlaced	16:9	AVC HP@L4	HD
1 920 x 1 080	25	Progressive	16:9	AVC HP@L4	HD

The receiver shall provide convenient user control for appropriate aspect ratio switching between 4:3 and 16:9 to adapt to display in different size and aspect ratio.

4.2.1. Down conversion High Definition Video for Standard Definition output

For CVBS outputs, the decoded HD video shall

a) be down-converted by the SD Format Converter to SD resolution for output via these outputs.
b) Down-conversion of pictures shall be implemented, from any of the incoming encoded HD full screen luminance resolution values (1920x1080, 1440x1080, and 1280x720) to SD resolution (720x576).
c) When down-converting any 1:1 pixel aspect ratio format (i.e. 1280x720 or 1920x1080) in the Decoder Composition Output to 720x576 resolution, the target shall be 702x576 pixels to be centred in the 720x576 grid with nine black pixels inserted as the start of the 720 pixel active line and nine pixels inserted as the end of the 720 pixel active line.
d) The Down-converted HD video shall be displayed as 16:9 letter box on 4:3 displays. (Allowing centre cut would limit the safe area to 4:3 for HD production, hence not an allowed display option).

The SD Format Converter should apply;

a) appropriate re-interlacing (field mode integration re-interlacing).
b) It shall process and output 720x576i25 in 4:3 frame aspect ratio or 16:9 frame aspect ratio video with colours according to the standards listed in Table 7.

Table 2 Video Decoder – colour frame aspect ratio

Active composition resolution in the "Decoder Composition Output" (Horizontal x Vertical)	**Documentation for appropriate Colour Processing**	**Comments**
720x576	ITU-R BT.1700 [16] (replaces ITU-R BT.470 System B, G)	Note that 576 lines in both interlaced scan (576i) and progressive scan (576p) shall be processed and output with equal colour parameters.
1280x720	SMPTE 296M [17]	The colour parameters in SMPTE 296M are the same as in ITU-R BT.709.
1920x1080	ITU-R BT.709 [18] (SMPTE 274M)	The colour parameters in SMPTE 274M are the same as in ITU-R BT.709.

4.2.2. Aspect Ratio

The DTT Receiver decoder shall support;

a) both 16:9 (widescreen) and 4:3 picture format changes, including descriptor (AFD) as defined in ETR 101 154.
b) For the HD output, the DTT Receiver shall be able to use the EDID information provided by the display to automatically determine DTT Receiver output.

c) and provide an "Original Format" option, i.e. to output the same format as received if supported by the display, as indicated by the EDID information.
d) If the received format is not supported, the DTT Receiver should select the display mode providing the best possible video quality. This is to avoid the DTT Receiver output to go black, if there is a mismatch between received format and display capabilities.
e) also be possible to manually set the default output format from the DTT Receiver to a fixed format.
f) Manual selection of the required aspect ratio for the down converted SD format.

Following are the options for SD video and down converted HD video the combination of coded frame aspect ratio information:

a) **16:9 material on 4:3 displays**. The decoder shall provide the following viewer options:
   1. display the material as a 16:9 letterbox within a 4:3 frame; or
   2. perform a 4:3 centre cut-out on the originating material and present this full-frame within the 4:3 display. In this case the decoder shall support pan and scan operation
b) **4:3 material on 16:9 displays**. The decoder shall allow "pillarboxing" of 4:3 material into a 16:9 frame, in order to maintain the correct aspect ratio of the originating material.

Receivers are to include a convenient user control for appropriate aspect ratio display selection within the user setup menu structure.

4.2.3. Support of Still Pictures

DTT Receiver decoder shall be able to decode and display still pictures (frame), i.e. a video sequence that contains a single intra-coded picture. While the decoding process shall continue to examine the buffer, the display process associated with the decoder shall repeat the previously decoded picture until the normal operation of the buffer can resume.

4.3. Audio Decoding

4.3.1. MPEG-4 HE AAC Version 2 Audio (Level 4)

The receiver shall comply with the implementation guidelines outlined in Section 6.4 and Annex C5 of ETSI TS 101 154 [1] for decoding MPEG-4 HE AAC version 2 audio Level 4 and sampling rates of up to 48 kHz, based on ISO/IEC 14496-3 [8]. The receiver shall apply bit-stream metadata parameters and down-mix multi-channel input configurations to stereo PCM.

The decoding and presentation of audio components shall be as indicated in Table 3 for the various outputs where fitted.

Table 3 Audio Presentation Output Options

Codec	Analogue Output / Speaker (IDTV)	Optical / Coaxial (S/PDIF)	HDMI
MPEG-4 HE AAC	Mono / Stereo	PCM stereo Pass through of HE-AAC bit stream	PCM stereo Pass through of HE-AAC bit stream

The receiver should gracefully handle change of service or audio format at the audio outputs without significant disturbances to the end user.

For all supported formats of audio, the maximum timing misalignment between audio and video in reference with Program Clock Reference (PCR) - time stamp carried by video shall be confined within ±20 ms.

Optionally, the receiver should apply format dependent attenuation to decoded stereo PCM audio, in order to achieve loudness alignment between different input formats.

4.3.2. Multiple Audio Services

It is likely that if multiple languages are broadcast, they will be in English and Samoan. Receivers are to include a convenient user control for appropriate audio language selection on a service with multiple audio language options.

Where multiple languages are broadcast, these may be identified by an ISO-639-2 [19] language code in the component descriptor. The code for English is “eng” while the code for Samoan is “smo”

4.3.3. Multi-channel Audio

General

The receiver shall identify, accept and decode input bit-streams coded in accordance with the following formats:

a) Enhanced AC3 (E-AC3) as specified in ETSI TS 102 366 [15]; and
b) MPEG-4 HE AAC version 2 Level 4 as defined in ISO/IEC 14496-3 [8]

The receiver shall apply bit-stream metadata parameters and down mix multi-channel input configurations to stereo PCM for Enhanced AC-3 in accordance with guidelines given in ETSI TS 102 366 [15] and MPEG-4 HE AAC as specified in ISO/IEC14496-3 [8] and ETSI TS 101 154 [1].

Receivers shall support;

c) decoding of E-AC-3 elementary streams encoded at bit rates of up to 3024 kbit/s.
d) decoding of E-AC-3 elementary streams encoded at a sample rate of 48 kHz.

The receiver shall pass through the native audio elementary input bit-stream over the HDMI output for standalone module or ARC output for receiver (where an HDMI output is fitted) as well as the optical/coaxial output (where an optical/coaxial output is fitted).

Trans-coding

If a receiver includes either an optical / coaxial (S/PDIF) output or an HDMI output, then it shall trans-code audio and metadata from E-AC3 input bit-streams to AC-3 output bit-streams at a data rate of 640kbps. The receiver shall transcode audio and metadata from MPEG-4 HE AAC input bit-streams to an AC-3 output bit-stream at a data rate of 640kbps. The number of channels on the output AC-3 bit-stream shall be equal to or greater than the number of channels contained within the input bit-stream. The AC-3 bit-stream shall be provided over the optical / coaxial (S/PDIF) outputs and HDMI output for standalone module or ARC output for receiver. Decoding and presentation options for Multi-Channel Audio are shown in Table 4.

Table 4 Multi-Channel Decoder Audio Presentation Output Options

Codec	Analogue Output / Speaker (IDTV)	Optical / Coaxial (S/PDIF)	HDMI
E-AC3 multi-channel	Down-Mixed Stereo	Trans-code to AC-3 bit-stream and pass through PCM stereo	Pass through of E -AC3 bit-stream Trans-code to AC-3 bit-stream and pass through PCM stereo and multi-channel Refer Note 1
MPEG-4 HE AAC multi-channel	Down-Mixed Stereo	Trans-code to AC-3 bit-stream and pass through PCM stereo Pass through of HE-AAC bit stream	Pass through of HE-AAC bit-stream Trans-code to AC-3 bit-stream and pass through PCM stereo and multi-channel Refer Note 2

Note 1: Receivers that include an HDMI output, the following audio specific requirements shall be implemented;

a. receivers shall determine the audio decoding capability of a connected HDMI sink device by reading the E-EDID structure of the sink device
b. If the HDMI sink device indicates support for E-AC-3 decoding, the receiver shall output the E-AC-3 elementary stream directly to the HDMI sink device
c. If the HDMI sink device does not indicate support for E-AC-3 decoding, but supports AC-3 decoding, the receiver shall convert the E-AC-3 elementary stream to an AC-3 bitstream prior to HDMI output
d. If the sink device does not indicate support for either AC-3 or E-AC-3 decoding, or the user has selected “stereo” output via the on screen menu, the receiver shall decode the elementary stream to stereo PCM prior to HDMI output.

Note 2: Receivers that include an S/PDIF output, the following audio specific requirements shall be implemented;

a. The receiver shall convert the E-AC-3 elementary stream to AC-3 prior to S/PDIF output
b. Based on user selection via the on screen menu, the receiver shall output either the trans coded AC-3, pass through of HE-AAC bit stream, or decode the elementary stream to stereo PCM prior to output.

Note 3: Receiver shall include an analogue audio output and decode the audio elementary stream prior to analogue audio output

Audio Output Delay

If a receiver includes either an optical / coaxial (S/PDIF) output or an HDMI output the receiver should include a function to adjust the audio-delay on the S/PDIF output up to 250 ms and it should be adjustable in 10 ms steps, to compensate for the different a/v processing delays in the downstream connected devices e.g. to several types of external audio-amplifiers and the receiver may be connected to several types of external screens.

5. Frontend Characteristics

5.1. General Considerations

The receiver shall be compatible with the DVB-T2 baseline system according to the ETSI EN 302 755 [2] for digital terrestrial TV (DTT), and able to receive DTT services in the existing VHF and UHF spectrum allocation for analogue transmissions.

5.2. Noise

Maximum noise figure of the decoder tuner shall not exceed 6 db across the operational frequency range.

5.3. Maximum Input Level

The receiver shall provide QEF reception in DVB-T2 signals up to an input level of -35 dBm.

5.4. Return Loss

Return loss measured at the antenna input shall be equal to or less than 6 dB (75 Ω) across the operational frequency range.

5.5. Transmission Frequencies and Signal Bandwidths

Table 5 Mandatory Frequency Bands

Band	Frequency Range	Signal Bandwidth
VHF III	174 – 230 MHz	7 MHz or 8 MHz
UHF IV	470 – 606 MHz	8 MHz
UHF V	606 – 694 MHz	8 MHz

The tuner shall be capable of tuning to the centre frequency of the incoming DVB-T2 signal

a) VHF 7 MHz Tuning

$$f_c = 177.5 \text{ MHz} + (K-4)*7 \text{ MHz}$$

where, f_c is the centre frequency of the incoming DVB-T2 signal; K is an integer from 4 to 11 and optionally to 14.

b) VHF 8 MHz Tuning[1]

$$f_c = 178 \text{ MHz} + (D-1)*8 \text{ MHz}$$

where, f_c is the centre frequency of the incoming DVB-T2 signal; D is an integer from 1 to 7 and optionally to 9.

[1] At the time of writing an 8 MHz VHF channel raster was under consideration by the OOTR

c) UHF Tuning

$$f_c = 306 \text{ MHz} + K * 8 \text{ MHz}$$

where, f_c is the centre frequency of the incoming DVB-T2 signal; K is an integer from 21 to 48.

5.6. Maximum Frequency Offset

The DVB-T2 IRD shall be able to receive signals with an offset of up to ± 1/6 MHz from the nominal frequency.

5.7. Operating Modes

The receiver shall be able to detect which DVB-T2 mode is being used. The DVB-T2 parameters or modes are outlined in Table 6.

Table 6 DVB-T2 Parameters/Modes

DVB-T2 Parameter/Mode	Requirement
Constellation	QPSK, 16-QAM, 64-QAM or 256-QAM With or without constellation rotation
Code Rate	1/2, 3/5, 2/3, 3/4 , 4/5 or 5/6
Guard Interval	TU/128, TU/32, TU/16, TU*19/256, TU/8, TU*19/128 or TU/4
Transmission Mode (Fast Fourier Transform, FFT size)	1k, 2k, 4k, 8k normal, 8k extended, 16 normal, 16k extended, 32k normal or 32k extended
Pilot Pattern (PP)*	PP1, PP2, PP3, PP4, PP5, PP6 or PP7
Antenna	SISO or MISO
Signalling format for Peak Average Power Ratio (PAPR) reduction	L1-ACE is used and TR is used on P2 symbols only; L1-ACE and ACE only are used; L1-ACE and TR only are used; or L1-ACE, ACE and TR are used.
Forward Error Correction (FEC) Frame Length	64 800 bits for normal FECFRAME; 16 200 bits for short FECFRAME
Input Mode	'A' (single PLP) or 'B' (multiple PLPs)
Mode Adaptation	Normal Mode (NM); or High Efficiency Mode (HEM)
Scrambling of L1 post signalling (L1_POST_SCRAMBLED)	Feature shall be supported by the DVB-T2 IRD.

Note: *Support for Pilot Pattern 8 is optional
In addition, support for time frequency slicing (TFS) is not required for the receiver with a single front-end/tuner.

5.8. Performance in Time-Varying Channels

The increase in required C/N for QEF reception shall be less than 3 dB for a 0 dB echo with frequency separation equal to 10 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 5 Hz (after AFC), compared to a 0 dB echo with frequency separation equal to 1 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 0.5 Hz (after AFC).

5.9. Operation in Single Frequency Network (SFN)

Initial planning for broadcast networks in Samoa will not use SFNs. However, this may be required in the future, hence the receiver shall be able to operate in SFN with echo signals within the guard interval. When the receiver tunes to a mix of two signals from a SFN where the received signals are close in amplitude, it is recommended that the receiver selects the best signal.

6. Service Information (SI)

6.1. Use of DVB Service Information (SI)

In addition to the PSI defined in Section 2.4 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [6], the receiver shall be able to decode the SI data in the Transport Stream bit-streams which provides users with information to select services so that the receiver can automatically configure itself for the selected service. The receiver shall comply with the implementation guidelines outlined in the ETSI TR 101 211 [9] for the use of DVB SI as specified in the ETSI EN 300 468 [10]. The SI table mechanism, syntax and semantics, and minimally, the Service Description Table (SDT), the Event Information Table (EIT) and the Time and Date Table (TDT) shall be supported.

6.2. System Timing

The receiver shall make use of Time and Date Table (TDT) for the device system time or Real Time Clock (RTC) setting.

In the local_time_offset descriptor:

> **country_region_id** field shall be coded as “00 0000” indicating no time zone extension is used.
>
> **local_time_offset**: This 16-bit field contains the offset time from UTC at a time when current UTC time is early with respect to time_of_change. In conjunction with the local_time_offset_polarity, this indicates the time offset in the area which is indicated by the combination of country_code and country_region_id. These 16 bits are coded as 4 digits in 4-bit BCD in the order hour tens, hour, minute tens, and minutes. For Samoa this field shall be coded as 1300 for normal time and 1400 for summer time (daylight saving time).

6.3. Country Code

Descriptors which include a in their syntax a **country_code** field shall be coded as specified in ISO 3166 [11]. Each character is coded into 8-bits according to ISO/IEC 8859-1 [12] and inserted in order into the 24-bit field. In the case that the 3 characters represent a number in the range 900 to 999, then country_code specifies an ETSI defined group of countries. These allocations are found in ETSI TS 101 162 [21].

Samoa has 3-character code "WSM", which is coded as "0101 0111 0101 0011 0100 1101".

If a number allocation is used, “882” has been allocated to Samoa and “908” allocated to Oceania which includes the following countries:

Australia, Fiji, Kiribati, Marshall Islands, Micronesia, Nauru, New Zealand, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu

6.4. PSI/SI and PID Update

The receiver shall be able to monitor and update all PSI with shorter than 100 ms interval and all SI with less than 1000 ms interval. The receiver shall update PSI / SI information in memory whenever any update or modification happens on a real-time basis. The receiver shall take prompt action with changes or modifications on the parameters of transmissions, networks and services.

6.5. Dynamic Response to PAT, PMT, NIT and SDT Updates

The receiver shall be capable to identify changes or new services in the current channel/multiplex.

6.6. Service Identification and Logical Channel Number (LCN)

The receiver shall be able to automatically scan through the whole frequency range available for each of the available Tuners/Demodulators and tune in to the correct DVB framing structure, channel coding and modulation to deliver the incoming transport stream to the next units. The tuning data shall be stored to allow a quick tune in to the selected transport stream.

All services shall be sorted, listed and managed accordingly with assigned LCN. In case duplicated and conflicted LCNs are found, shall be given to services with better signal quality, other services shall be arranged to reserved LCN range. The LCN reserved range is set from 800 – 999.

The Logical Channel Descriptor may be inserted once in the second descriptor loop of the Network Information Table. The Logical Channel Descriptor is assigned the tag value of 0x83 within the DVB Service Information and is treated as a public descriptor.

Table 7 Logical Channel Descriptor Syntax

Syntax	No. of bits	Identifier
logical_channel_descriptor(){		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
for (i=0; i<N;i++){		
service_id	16	uimsbf
visible_service_flag	1	bslbf
reserved	5	bslbf
logical_channel_number	10	uimsbf
}		
}		

descriptor_tag: This shall be assigned to be 0x83

service_id: This is a 16-bit field which serves as a label to identify this service from any other service within the Transport Stream. The service_id is the same as the program_number in the corresponding program_map_section. Services shall be included irrespective of their running status.

visible_service_flag: This 1-bit field when set to '1' indicates that the service is normally visible and selectable (subject to the service type being suitable etc.) via the receiver service list. When set to '0' this indicates that the receiver is not expected to offer the service to the user in normal navigation modes however the receiver may provide a mechanism to access these services (for example, during the execution of an application, resident within the STB).

reserved: All "reserved" bits shall be set to "1".

logical_channel_number: this is a 10-bit field which indicates the preference for ordering services as assigned by the Office of the Regulator.

7. Services

7.1. Subtitling

The receiver shall support DVB subtitling in accordance with ETSI EN 300 743 [13], and displayed using the On Screen Display (OSD) capabilities while decoding the full television service (video and audio). The subtitle object code shall be handled as pixels (bitmap).

It is preferred that the receiver shall have a user selection button on the remote control to conveniently display or hide the subtitles.

7.2. Electronic Program Guide (EPG)

The receiver shall decode full EIT information with capability to display "present / following" (or "Now / Next") and schedule EPG information in accordance with guidelines given in ETSI TR 101 211 [9] and requirements defined in ETSI EN 300 468 [10].

The receiver shall also be able to continue to operate in the absence of EIT transmission.

The receiver shall be capable of displaying a banner message containing key information for the service and event currently accessed. The banner should be visible on screen for a user defined period after a channel change or when the "Info" button on the remote control is pressed. Banner presentation shall include but not limited to the following information:

a) the name and logical channel number of the current service,
b) the name of the current event (40 characters),
c) the start and end times of the current event,
d) the parental control rating for the current event,
e) the name and start time of the following event,
f) the service options.

EPG presentation shall typically be displayed as a grid on screen and include but not limited to the followings:

a) service name and LCN
b) program title
c) program duration
d) elapsed duration (optional)
e) short description (200 characters)
f) long description (extended text)
g) present / following (now / next) event
h) current date/time
i) parental rating information (refer to codes to be displayed inTable 8)

The receiver shall provide an EPG organizer to access the next eight-day program guide with all information in above list. It is preferable that a practical and easy to use search function be included.

For EPG and other labelling decoding and presentation, the receiver shall support the Latin character coding tables specified in ISO 6937[20]. The first byte value is signalled according to ETSI EN 300 468 Annex A [10].

7.3. Parental Lock Feature

The receiver shall have parental lock capabilities to block television program with a particular Classification Code from being shown unless the correct personal identification number (PIN) code is entered by the user.

The receiver must be able to identify the Parental Rating Code that is applied to the television program and shall allow user to set the rating that he/she wants to block. When the viewer selects a setting shown in the third column of Table 8, programmes assigned that hexadecimal code and any programmes with higher hexadecimal codes shall be blocked from viewing until the user entered the pin to unblock the program. If no code or "Nothing" as shown in Table 8 is selected, all programs are allowed to display on screen.

Table 8 Parental Ratings

Transmitted rating hex code	Parental Guide Code	On Screen Display
0x00	**Not Classified**	**Nothing**
0x01	Not used	Nothing
0x02	**Pre School**	**P**
0x03	Not used	P
0x04	**Children**	**C**
0x05	Not used	C
0x06	**General**	**G**
0x07	Not used	G
0x08	**Parental Guidance Recommended**	**PG**
0x09	Not used	PG
0x0A	**Mature Audience**	**M**
0x0B	Not used	M
0x0C	**Mature Adult Audience 15+**	**MA 15+**
0x0D	Not used	MA 15+
0x0E	**Adult Strong Violence 15+**	**AV 15+**
0x0F	**Restricted 18+**	**R**

7.4. Genre (Optional)

If the receiver displays the genre of events, this shall display the meaning of the **content_descriptor** associated with the event. **content_descriptor** meanings shall be as assigned in ETSI EN 300 468 [10]. As shown for content_nibble_level_1.

7.5. Remote Control Interface

A Remote Control shall be bundled with the receiver. It should be simple and easy to use. Basic functionality such as power, volume control and numerical number 0-9 shall be placed on prominent locations on the remote control. Colour-coded multifunctional buttons shall be included to enhance user experience and ease the navigation on the receivers.

It is recommended that the remote control shall include the following keys for basic TV functionality or equivalent:

a) Power on/off [on/off] – turn the receiver on and off
b) Program up/down [P+, P-] – switch between programs
c) Volume up/down [V+, V-] – adjust the volume output level
d) Subtitle/option [Subt/option] – display the subtitle or select other user selectable options (e.g. change subtitling language if several available, audio language/track if several available, video aspect ratio output format etc.)
e) Menu – to access the receiver's menu structure for tuning etc

The receiver's remote control shall include the following keys for digital TV functions or equivalent:

a) A navigation or pointing system for navigation on the OSD
b) OK [OK] – a function that selects or confirms current choice or statement
c) Multifunctional keys – four color-coded keys for non-dedicated functions. The colours shall be red, green, yellow and blue.
d) Guide/EPG [Guide] – This function displays an Electronic Program Guide.
e) Info [Info] – display the information plate (i-plate) providing current and next programmes and channel information

8. Interfaces and Connectors

8.1. RF Input Connector

The receiver shall have one input tuner connector, type: IEC female in accordance with IEC 60169-2, part 2 [14]. The input impedance shall be 75 ohm.

8.2. RF Output Connector

A receiver without an integrated display (i.e. a set top box) should provide a connector with a loop-through of input RF signal.

a) The connector shall be of type: IEC male in accordance with IEC 60169, part 2 [14].
b) The frequency range for the RF loop-through should be from 47 MHz to 862 MHz.
c) The RF loop-through signal shall be present independently from the status of the receiver device (operational or standby), such that that connected equipment (e.g. TV set) can operate even if the device is in standby mode.
d) When the RF bypass gain is disabled, the maximum RF bypass gain should -4dB and when the RF bypass gain is enabled, the RF bypass gain should be from –1 dB to +3 dB.

8.3. Modulator output (Optional)

The receiver without an integrated display should provide a re-modulated output for use with a PAL receiver. If so, the output must be tuneable to any of UHF channels 21 to 68. The peak signal level should be 3 mV nominal across 75 ohm (-39 dBm).

8.4. Component Analogue Outputs (Optional)

It is optional for the receiver to provide component analogue output (YPbPr).

8.5. Composite Video Outputs

A receiver without an integrated display the composite video output shall comply with PAL Connector IEC 48B Section 316 (RCA- phono).

8.6. Analogue Audio

A receiver without an integrated display shall provide RCA-phono output interface for analogue stereo audio.

8.7. Digital Audio Data Stream Output (Optional)

It is optional for the receiver to provide an S/PDIF digital audio output – electrical (coaxial) or optical (TOSLINK). The capabilities of this interface are defined in Table 3 and Table 4 of this document.

8.8. HDMI

A receiver without an integrated display shall provide an HDMI interface for digital video and audio output.

8.9. Copy Protection on Outputs

Any HDMI outputs shall include High Bandwidth Digital Content Protection (HDCP) for all output resolutions.

8.10.Common Interface (Optional)

The receiver may incorporate a DVB-CI (Common Interface) slot. If available this slot shall be a certified CI+ slot as outlined in CI+ specification V1.3 meeting all the required robustness rules.

9. Firmware Operation

9.1. Operating System and Memory

The receiver shall have an embedded real time operating system. It shall include a non-volatile memory for retaining user settings and other data.

9.2. On Screen Menu

Main menu shall provide access to functional features of the receiver, through a structured and explicit organisation of these features.

The receiver shall provide the option of requiring the entry of a menu access PIN before displaying the parental control menu and allowing access to its option screens.

Within the menu structure a Diagnostics screen shall provide the following;

a) Hardware and software version number
b) Middleware and other resident application version numbers
c) Received multiplex with indications of signal strength and bit error rates based on the received PLP
d) The unique serial number and state of the receiver (e.g. error code)

9.3. First-time Power Up

Upon powering up for the first-time, the receiver shall initiate the following process:

a) Set OSD language (Default – English);
b) Set active antenna power [if available] (Default – Off,);
c) Prompt tuning/scanning for all available FTA services; and
d) Set other configurations (user data, preferences, etc).

9.4. Channel Scan

The tuning / scan process should have automatic and manual options.

Auto Tuning

The receiver shall be capable of;

a) Automatic tuning over the frequency ranges indicated in Table 5
b) Automatically detect which mode is being used as indicated in Table 6
c) Analysing and interrogate the SI information
d) Displaying a given service only once in the service list or place duplicated above LCN 800

Manual Tuning

In addition to automatic tuning STB decoder shall be capable of;

a) Manual tuning where the channel number or frequency is entered by viewer
b) Tuning to the channel entered by viewer
c) Search all available modes as indicated in Table 6
d) Add any new services and

e) Replacing existing services in the service list

9.5. Subsequent Power On

The receiver shall return either to last watched or preset start-up service.

9.6. Listing of all available services

The receiver shall provide a listing of all available FTA services after scanning.

9.7. Responses to Network Changes

When a multiplex is added to the network, it shall make reference in the second loop of the NIT actual table. The NIT (actual) and SDT (actual and other) version_number shall be changed. The receiver shall recognise the change of version_number of the NIT table and that a new transport_stream_id is present in the NIT (actual).

When a service has been added to a multiplex, there shall be an update in the SDT (actual) for that multiplex which references the new service. The receiver shall consider a service to be removed from a multiplex if the service is not referenced in the SDT (actual) of that particular service.

A rescan of any or all the terrestrial multiplexes shall not be required for the receiver to acknowledge the presence of a new service. The receiver shall process the SDT (actual) and EIT-present/following (actual) when tuning to a different multiplex or every 2 seconds as recommended by ETSI TR 101 211 [9].

When a new service is added or removed from a multiplex, the receiver may inform the user that a new service has been added or removed using an appropriate method e.g. a short screen pop-up lasting not more than 3 seconds.

In the event that there is any transmission mode changes, the receiver shall automatically perform update to capture these changes without disruption to the viewer.

9.8. Signal strength and quality bar

The receiver shall be able to display both signal strength and quality (BER) level. This will aid the user in setting up indoor antenna to ensure best reception position or identifying other reception problems.

9.9. Service unavailability

In the event of service unavailable, poor or no RF signal, the receiver shall display an on-screen message.

9.10.Hardware reset / reboot / factory default setting

The receiver shall support hot reset, cold reset, and a full reset to manufacturer's default start-up settings.

9.11.Channel change time

The time to change between channels within same multiplex shall be between 1.5 to 2 seconds. It shall be met for a GOP length of 12, and a repetition rate of PAT and PMT of 10 tables per second. Interruption to viewer during channel changing shall be kept at minimal.

9.12.User system software upgrade

It is recommended that the receiver provide one or more of the following data interfaces to enable the user to perform software upgrades.

a) Universal Serial Bus (USB)
b) RJ 45 (Ethernet IEE802.3)
c) Appropriate Memory Card

10. Abbreviations

AC	Alternating Current
ACE	Active Constellation Extension
AC-3	Dolby Digital (5.1 Channel)
AFC	Automatic Frequency Control
ARC	Audio Return Channel
AVC	Advanced Video Coding
BAT	Bouquet Association Table
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BW	Bandwidth
CI	Common Interface
COFDM	Coded orthogonal frequency division multiplexing
CVBS	Composite Video Baseband Signal
DC	Direct Current
DIT	Data Information Table
DRM	Digital Rights Management
DTCP	Digital Transmission Content Protection
DTS	Digital Theatre System
DTT	Digital terrestrial television
DVB-T2	Digital Video Broadcasting Terrestrial Second Generation
DVB SI	Digital Video Broadcasting Service Information
E-AC3	Enhanced AC3/ Dolby Digital Plus
EDID	Extended display identification data
EIT	Event Information Table
ETSI	European Telecommunications Standards Institute
FEC	Forward error correction
FEF	Future Extension Frame
FFT	Fast Fourier Transform
FTA	Free To Air
HD	High Definition
HDCP	High Bandwidth Digital Content Protection
HDMI	High-Definition Multimedia Interface
HDTV	High Definition Television
HE-AAC	High Efficiency Advanced Audio Coding
HEM	High Efficiency Mode
HP	High Profile
IDTV	Integrated Digital Television
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
LCD	Logical Channel Descriptor
LCN	Logical Channel Number
LDPC	Low Density Parity Check
NF	Noise Figure
NIT	Network Information Table
MFN	Multiple Frequency Network
MP	Main Profile
MPEG	Moving Pictures Expert Group
OAD	Over Air Download
ONID	Original Network Identification

OTA	Over the Air
OUI	Organization Unique Identifiers
PAT	Program Association Table
PAPR	Peak to Average Power Ratio
PCM	Pulse Code Modulation
PCR	Program Clock Reference
PES	Packetized Elementary Stream
PID	Program Identification Descriptor
PIN	Personal Identification Number
PMT	Program Management Table
PP	Pilot Pattern
PLP	Physical Layer Pipe
PSI	Program Specific Information
PTS	Presentation Time Stamp
QAM	Quadrature Amplitude Modulation
QEF	Quasi Error Free
QPSK	Quadrature Phase Shift Keying
RCA	Radio Corporation of America
RF	Radio Frequency
SD	Standard Definition
SDT	Service Description Table
SDTV	Standard Definition Television
SFN	Single Frequency Network
SI	Service Information
SIT	Selection Information Table
S/PDIF	Sony/Philips Digital Interface
SQB	Signal Quality Bar
SSI	Signal Strength Indicator
ST	Stuffing Table
STB	Set Top Box
TDT	Time and Date Table
TOT	Time Offset Table
TPS	Transmitter Parameter Signalling
TR	Tone Reservation
TS	Transport Stream
RST	Running Status Table
RTC	Real Time Clock
UHF	Ultra-High Frequency
UTC	Universal Time Clock
VBI	Vertical Blanking Interval
VHF	Very-High Frequency
YCbCr/YPbPr	Component Video Signal

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