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DVB-T2 Technical Panel Committee (TPC)

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2nd Generation Digital Terrestrial Television Broadcasting System (DVB-T2)

Technical Specification

Integrated Receiver Decoder (IRD)

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Content

NOTICE

Integrated Receiver Decoder (IRD) for use with the second generation Digital Terrestrial Television Broadcasting System (DVB-T2)

Introduction

1.   This Specification defines the requirements for the Integrated Receiver Decoder (IRD) functionality which may be incorporated as a standalone module such as receiver box, an Integrated Digital Television (IDTV) or any other similar device intended for use with the second generation Digital Terrestrial Television broadcasting system (DVB-T2). The requirements for advanced features such as Personal Video Recorders (PVRs) and interactive services are not included in the scope of this Specification.

2.   This Specification is established to enable equipment manufacturers and/or suppliers to bring in compatible DVB-T2 IRD modules and IDTVs that will provide good indoor reception of Free-To-Air (FTA) Digital Terrestrial Television (DTT) services. For the purpose of this Specification, the IRD functioning as standalone modules or built-in modules of IDTVs shall be termed "DVB-T2 IRD".

3.   This Specification comprises 2 parts: Part A on "Basic DVB-T2 IRD Requirements", which specifies the minimum requirements for using the DVB-T2 IRD with DTT networks; and Part B on "Additional DVB-T2 IRD Requirements for supporting Multi-channel Audio". Part B is to be applied in addition to Part A for DVB-T2 IRDs that are capable of supporting the multi-channel audio feature defined therein.

Part A   Basic DVB-T2 IRD Requirements

1   Scope

1.1   Part A of this Specification (§ 4) defines the minimum requirements for the DVB-T2 IRD 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 DVB-T2 IRD shall be defined by the following dimensions:

   a)   25 Hz and 50 Hz;

   b)   SDTV and HDTV;

   c)   Input and Output interfaces;

   d)   MPEG-2 and H.264/AVC video coding formats[1]; and

   e)   MPEG-1 Layer II and MPEG-4 HE-AAC audio coding formats[2].

1.2   Part A of this Specification (§ 5) requires that the DVB-T2 IRD be compatible with the DVB-T2 baseline system for DTT as defined in the ETSI EN 302 755 [2] as well as the DVB-T baseline system as defined in the ETSI EN 300 744 [3].

1.3   Part A of this Specification also requires that the DVB-T2 IRD be capable of decoding Singapore's FTA DVB-T and DVB-T2 broadcast of television, radio and enhanced services (§ 6 and § 7). This shall include the following capabilities:

   a)   Subtitling (where available and selected by viewer);

   b)   Audio Description

   c)   Electronic Program Guide;

   d)   Teletext (where available);

   e)   Parental Lock Feature; and

   f)   Multiple Audio Selection

Note: Unless otherwise specified, all requirements are mandatory.
The word ''Recommended' means this item is not mandatory but is highly recommended.

2   General Requirements

2.1   Power Supply

   The DVB-T2 IRD 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%. Where external power supply is used, e.g. AC adaptor, it shall not affect the capability of the equipment to meet the Specification.

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[1] Please note that such coding formats may be intellectual property of third parties.
[2] Same as Footnote 1.

2.2 Safety Requirements

The DVB-T2 IRD shall be tested for compliance with the International Electrotechnical Commission IEC 60065 [4] safety standards.

2.3 Electromagnetic Compatibility (EMC) Requirements

The DVB-T2 IRD shall comply with § 5.3, § 5.6 and § 5.7 of ISO/IEC CISPR13 [5] or equivalent based on ISO/IEC CISPR 22 [6].

2.4 Identification of Equipment

The DVB-T2 IRD 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.

3   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
CGMS-A	Content Generation Management System-Analog
CSS	Content Scramble System
CVBS	Composite Video Baseband Signal
DC	Direct Current
DIT	Data Information Table
DRM	Digital Right Management
DTCP	Digital Transmission Content Protection
DTS	Digital Theatre System
DVB-T2	Digital Video Broadcasting Terrestrial Second Generation
DVB SI	Digital Video Broadcasting Service Information
E-AC3	Enhanced AC3/ Dolby Digital Plus
EIT	Event Information Table
ETSI	European Telecommunications Standards Institute
FEF	Future Extension Frame
FFT	Fast Fourier Transform
FTA	Free To Air
GMT	Greenwich Mean Time
HDCP	High Bandwidth Digital Content Protection
HDMI	High-Definition Multimedia Interface
HE-AAC	High Efficiency Advanced Audio Coding
HEM	High Efficiency Mode
HP	High Profile
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
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
RF	Radio Frequency
SDT	Service Description Table
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
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

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

4.1   Transport Stream Bit-streams

4.1.1   The DVB-T2 IRD shall comply with implementation guidelines outlined in § 4 of ETSI TS 101 154 [1], based on the MPEG-2 Transport Stream bit-streams requirements defined in § 2.4 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [7].

4.1.2   The DVB-T2 IRD shall be able to de-multiplex and present programs according to the Program Specific Information (PSI) defined in § 2.4 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [7].

4.1.3   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 DVB-T2 IRD shall be able to handle simultaneously at least 32 PIDs and elementary streams.

4.1.4   The DVB-T2 IRD shall be able to skip over data structures which are currently "reserved" (§ 4.1 of ETSI TS 101 154 [1]).

4.1.5   The DVB-T2 IRD shall operate over the full tolerance range of the system clock frequency as specified in § 2.4.2.1 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [7].

4.1.6   The DVB-T2 IRD shall operate correctly with Program Clock References (PCRs) for a program arriving at intervals not exceeding 100 ms as specified in § 2.7.2 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [7].

4.2   Video Decoding

4.2.1   The DVB-T2 IRD shall comply with the implementation guidelines outlined in § 5.1 of ETSI TS 101 154 [1] for decoding MPEG-2 video. The DVB-T2 IRD shall be able to decode video formats as specified in Table 1, based on the ITU-T Rec. H.262 / ISO/IEC 13818-2[3] [8].

DVB-T2 IRD	Bit-stream	Frame Rate	Aspect Ratio	Luminance Resolution
25 Hz MPEG-2 SDTV (§ 5.1 of ETSI TS 101 154)	MP@ ML	25 Hz interlaced	4:3 or 16:9 Use of pan vectors and up sampling	720 x 576 Capable of decoding lower picture resolutions

Table 1: Video decoding to ITU-T Rec. H.262 / ISO/IEC 13818-2

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[3] Please note that such video formats may be intellectual property of third parties.

4.2.2   The DVB-T2 IRD shall comply with the implementation guidelines outlined in § 5.5, § 5.6 and § 5.7 of ETSI TS 101 154 [1] for decoding H.264/AVC video. The DVB-T2 IRD shall be able to decode video formats as specified in Table 2, based on the ITU-T Rec. H.264 / ISO/IEC 14496-10[4] [9].

DVB-T2 IRD	Bit-stream	Frame Rate	Aspect Ratio	Luminance Resolution
25 Hz H.264/AVC SDTV (§ 5.6 of ETSI TS 101 154)	HP@L3	25 Hz interlaced	4:3 or 16:9 Frame cropping	720 x 576 Capable of decoding lower picture resolutions
50 Hz H.264/AVC HDTV With backward compatibility (§ 5.7 of ETSI TS 101 154)	HP@L4	50 Hz progressive	16:9 Up sampling	1280 x 720
25 Hz H.264/AVC HDTV	HP@L4	25 Hz interlaced	16:9 Up sampling	1920 x 1080
25 Hz H.264/AVC HDTV	HP@L4	25 Hz progressive (Optional)	16:9 Up sampling	1920 x 1080

Table 2: Video decoding to ITU-T Rec. H.264 or ISO/IEC 14496-10

4.2.3   Aspect Ratio

The DVB-T2 IRD 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.

4.2.4   Active Format Description (AFD)

When AFD is used, the DVB-T2 IRD shall present the video aspect radio properly according to the current AFD value and response in next frame as defined in the ETSI EN 101 154 Annex B. The DVB-T2 IRD shall support at least the Active Formats shown in Table 3.

Refer to Annex A for the illustration on the required outputs based on the AFD values specified in Table 3.

Active Format	Aspect ratio of the "area of interest"
1000	Active format is the same as the coded frame.
1001	"Pillar box" 4:3 (centre)
1010	"Letter box" 16:9 (centre)

Table 3: Active format (Table B.5/ETSI TS 101 154)

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[4] Please note that such video formats may be intellectual property of third parties.

4.3 Audio Decoding

4.3.1 MPEG-1 Layer II Audio[5]

4.3.1.1 The DVB-T2 IRD shall comply with the implementation guidelines outlined in § 6.1 of ETSI TS 101 154 [1] for decoding MPEG-1 Layer II audio, based on ISO/IEC 13818-3 [10] in single (mono), dual, joint stereo and stereo modes with bit rates between 64 kbit/s and 256 kbit/s, and sampling rates of 32 kHz, 44.1 kHz and 48 kHz.

4.3.1.2 The DVB-T2 IRD shall provide convenient user control for appropriate audio output format switching between different audio modes.

4.3.2 MPEG-4 HE-AAC Version 2 Audio (Level 4)[6]

The DVB-T2 IRD shall comply with the implementation guidelines outlined in § 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 [11]. The DVB-T2 IRD shall apply bit-stream metadata parameters and down-mix multi-channel input configurations to stereo PCM.

4.3.3 Decoding & Presentation Options for 2 Channels of Decoder Output

Codec	Analogue Output / Speaker (IDTV)	Optical / Coaxial (S/PDIF) / HDMI ARC output**	HDMI*
MPEG-1 Layer II	Mono / Stereo	PCM stereo	PCM stereo
MPEG-4 HE-AAC	Mono / Stereo	PCM stereo Pass through of HE-AAC bit stream (Optional)	PCM stereo Pass through of HE-AAC bit stream (Optional)

Note: * Only applicable to DVB-T2 IRD with HDMI output
         ** Only applicable to DVB-T2 IRD with S/PDIF or HDMI ARC output

Table 4: Presentation Options for 2 Channels of Decoder Output

4.3.4 Audio handling when changing service or audio format

The DVB-T2 IRD should gracefully handle change of service or audio format at the audio outputs without significant disturbances to the end user.

4.3.5 Lip-Sync (Recommended)

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 should be confined within ±20 ms.

4.3.6 Loudness Matching (Optional)

The DVB-T2 IRD should apply format dependent attenuation to decoded stereo PCM audio, in order to achieve loudness alignment between different input formats.

4.3.7 Audio Description

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[5] Please note that such audio formats may be intellectual property of third parties.
[6] Same as footnote 5

The DVB-T2 IRD shall support audio description in Broadcast-mix mode according to Annex E of ETSI TS 101 154 [1].

4.3.8   Audio Prioritising

The DVB-T2 IRD shall apply audio prioritising in the following order:

- User preferred audio language selection
- First Audio appeared in the elementary stream loop of the Program Map Table (PMT) or the stream having the lowest PID value

If a service offers both multichannel and stereo audio, the DVB-T2 IRD shall continue to apply the priority as described above.

If the DVB-T2 IRD supports prioritising based on OSD language or country's default language, then the following audio prioritising applies:

- Audio streams signalled as English (ENG), Chinese (ZHO), Bahasa Melayu (MSA) and Tamil (TAM) shall have equal priorities.
- Audio streams signalled as English (ENG), Chinese (ZHO), Bahasa Melayu (MSA) and Tamil (TAM) shall have equal or higher priorities over the other languages defined in § 7.3 Multi-Language Support of Part A of the TS DVB-T2 IRD.

5 Frontend Characteristics

5.1 General Considerations

The DVB-T2 IRD shall be compatible with the DVB-T baseline system according to the ETSI EN 300 744 [3] and 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. It is required that the DVB-T/T2 system will provide sufficient protection against high levels of Co-Channel Interference (CCI) and Adjacent Channel Interference (ACI) emanating from existing PAL and digital TV services.

Note: * Support for DVB-T2 Lite is optional

Transmission Frequencies and Signal Bandwidths

Band	Frequency Range	Signal Bandwidth
VHF III	174 – 230 MHz	7 MHz
UHF IV	470 – 606 MHz	8 MHz
UHF V	606 – 862 MHz	8 MHz

Table 5: Mandatory Frequency Bands

5.2 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.

5.3 Operating Modes

5.3.1 The DVB-T2 IRD shall be able to demodulate all non-hierarchical modes specified in the ETSI EN 300 744 [2]. The frontend shall work compatibly with any combination of constellation (QPSK, 16-QAM OR 64-QAM), code rate (1/2, 2/3, 3/4, 5/6 or 7/8), guard interval ($T_U/4$, $T_U/8$, $T_U/16$, or $T_U/32$) and transmission mode (2k or 8k).

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

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	$T_U/128$, $T_U/32$, $T_U/16$, $T_U*19/256$, $T_U/8$, $T_U*19/128$ or $T_U/4$
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 DVB-T2 IRD with single front-end/tuner.

Table 6: DVB-T2 Parameters/Modes

5.4   DVB-T2 Performance Requirements

The performance requirements of the DVB-T2 IRD shall be measured according to the list modes outlined in Annex E.

5.5   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).

5.6   Operation in Single Frequency Network (SFN)

The DVB-T2 IRD shall be able to operate in SFN with echo signals within the guard interval. When the DVB-T2 IRD tunes to a mix of two signals from a SFN where the received signals are close in amplitude, it is recommended that the DVB-T2 IRD selects the best signal.

6 Service Information (SI)

6.1 Use of DVB Service Information (SI)

In addition to the PSI defined in § 2.4 of ITU-T Rec. H.222.0 / ISO/IEC 13818-1 [7], the DVB-T2 IRD 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 DVB-T2 IRD can automatically configure itself for the selected service. The DVB-T2 IRD shall comply with the implementation guidelines outlined in the ETSI TR 101 211 [12] for the use of DVB SI as specified in the ETSI EN 300 468 [13]. 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 DVB-T2 IRD shall make use of Time and Date Table (TDT) for the device system time or Real Time Clock (RTC) setting.

6.3 Optional and Unrecognised SI (Optional)

For DVB-T2 IRD with recording features, it is recommended that Selection Information Table (SIT) be supported for partial transport stream selection and recording. Support of Bouquet Association Table (BAT), Stuffing Table (ST) and Data Information Table (DIT) is optional. The DVB-T2 IRD shall ignore any incomprehensive SI or tables. The DVB-T2 IRD shall discard any PSI/SI signals if it is unrecognised or not supported.

6.4 PSI/SI and PID Update

The DVB-T2 IRD 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 DVB-T2 IRD shall update PSI / SI information in memory whenever any update or modification happens on a real-time basis. The DVB-T2 IRD 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 DVB-T2 IRD shall be capable to identify changes or new services in the current channel/multiplex.

6.6 Service Identification and Logical Channel Number (LCN)

The DVB-T2 IRD 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.

The DVB-T2 IRD shall support LCN by using descriptor with tag value is 0x83 (Version 1) and 0x87 (Version 2). 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 channel map shall be from 1-999 with valid LCN's is being assigned in the range from 1-799 by the broadcaster (Contain all types of services including Radio/Data/Video). The LCN reserved range is set from 800 – 999.

The following DVB identification values shall be used for digital terrestrial transmission.

Identifier	Value
Private Data Specifier	0x00000019
Original Network ID	0x22BE

Broadcaster will be assigned with the logical channel numbering (LCN) range for terrestrial FTA channels to facilitate easy access to these channels. For example, by pressing '2' on remote control will allow user to switch to Channel 5, '3' to switch to Channel 8 (See Annex F for the proposed Channel Numbering Range for FTA channels.)

6.6.1   Logical Channel Numbering (LCN)

The intention of the LCN service information is to provide a broadcaster assigned virtual channel number or label, for each of the available DTV services to the DVB-T2 IRD, so the DVB-T2 IRD is able to easily facilitate the channel sorting, indexing, ordering, and searching. The LCN descriptor also defines visibility of the service to the viewer.

The syntax and semantics of the logical_channel_descriptor is indicated in Table 7 below, as follows:

Syntax	Bits	Identifier
logical_channel_descriptor(){		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
for (i=0;i<N;i++){		
service_id	16	uimsbf
visible_service3_flag	1	bslbf
reserved	5	bslbf
logical_channel_number	10	uimsbf
}}		

Table 7: Syntax and Semantics of the Logical Channel Descriptor

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:
= 1:   The service is visible and selectable via the DVB-T2 IRD service list.
= 0:   The service is invisible and not selectable via the DVB-T2 IRD service list, however the DVB-T2 IRD may provide a mechanism to access these services.

reserved: This 5-bit field is reserved for future use, shall be set to "1".

logical_channel_number: This is a 10-bit field which indicates the broadcaster preference for ordering service.

The channel map shall be from 1-999. A broadcaster may or may NOT allocate more than one Logical Channel Number to a service. This is to avoid multiple LCN assignment which could lead to cross reference and confusion.

6.6.2   Logical Channel Descriptor (Version 2)

The syntax of the Logical Channel Descriptor (version 2) is shown in below Table 8.

Syntax	No. of bits	Identifier
Logical_channel_descriptor(){		
	8	Uimsbf
descriptor_tag	8	Uimsbf
	8	Uimsbf
descriptor_length for		
(i=0;i<N;i++){	8	Uimsbf
channel_list_id		
	8	Uimsbf
channel_list_name_length		Uimsbf
for (i=0;i<N;i++) {	24	Uimsbf
char	8	Uimsbf
}		Bslbf
country_code	16	Bslbf
descriptor_length		Uimsbf
for (i=0;i<number_of_services;i++){	1	
service_id		
	5	
visible_service_flag		
	10	
reserved_future_use		
logical_channel_number		
}		
}		
}		

Table 8: Syntax and Semantics of the Logical Channel Descriptor (Version 2)

descriptor_tag: This shall be assigned to be 0x87 (decimal 135).

channel_list_id: This is an 8-bit field which serves as a label to identify the channel list (uniquely allocated within each original_network_id).

When several Channel Lists are available from same network (original network id) and same country code for the IRD during first time installation (or complete re-installation), the receiver shall choose the channel list as the default one with following priority:

The IRD shall choose the one with lowest list_id value OR let the viewer choose from a list, (typically using the channel_list_name)

channel_list_name_length: This 8-bit field specifies the number of bytes that follow the channel_list_name_length field for describing characters of the name of the Channel List. Maximal length is 23 bytes for the channel_list_name.

char: This is an 8-bit field. A string of character fields specify the name of the channel list, the channel_list_name. (Maximal length is 23 bytes for the channel_list_name). Text information is coded using the character sets and methods described in EN 300 468 [13].

country_code: This 24-bit field identifies a country using the 3-character code as specified in ISO/IEC 3166 [14]. Each character is coded into 8-bits according to ISO/IEC 8859-1[15] and inserted in order into the 24-bit field. This shall be set to "SGP".

service_id: A service_id that belongs to the TS (i.e. services from other TS shall not be listed). One service may only be listed once in each channel list, but may belong to/be listed in more than one channel list.

visible_service_flag: This 1-bit field when set to '1 '/'true' indicates that the service is normally visible and selectable (subject to the service type being suitable etc.) via the DVB-T2 IRD's service list. When set to '0'/'false' this indicates that the DVB-T2 IRD is not expected to offer the service to the user in normal navigation modes however the DVB-T2 IRD should provide a mechanism to access these services (for example by direct entry of the logical channel number).

Reserved: All "reserved" bits shall be set to '1' (observe, however, that the DVB-T2 IRD shall be able to handle (neglect) future use of reserved bits).

logic_channel_number: The channel map shall be from 1-999 with valid LCN's is being assigned in the range from 1-799 by the broadcaster (Contain all types of services including Radio/Data/Video).

6.6.3 Logical Channel Descriptor Simultaneous Version 1 and Version 2 Transmissions

When both Logical Channel Descriptor version 1 and version 2 are broadcasted within one Original Network ID, the DVB-T2 IRD supporting both descriptors shall only sort according to the version 2 (higher priority).

6.6.4 Listing of Broadcast Descriptors

The list of broadcast descriptors is attached in Annex G.

7   Services

7.1   Subtitling

7.1.1   Specification for Subtitling

The DVB-T2 IRD shall support DVB subtitling in accordance with ETSI EN 300 743 [16], 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).

7.1.2   Multiple Subtitling Language

The DVB-T2 IRD shall be able to handle multiple subtitling streams within the same service and the correspondent PSI/SI information like languages descriptors.

The receiver shall provide convenient user control for enabling, disabling displaying and to select primary and secondary subtitling languages.

In case of subtitling is set to "ON" and the subtitle streams do not match any of the settings of preferred languages, the receiver shall select the first subtitle stream signaled in the elementary stream loop of the PMT.

The recommended factory default setting:

The default setting on the receiver for subtitling set to "ON"
The primary preferred language set to "Multiple Languages" (MUL)
The secondary preferred language set to "Multiple Languages" (MUL)

7.1.3   Support for hearing impaired

The DVB-T2 IRD shall have user selection of subtitling preferences for 'normal' or 'hard of hearing' subtitles.

In case of 'hard of hearing' subtitling mode is selected and if no 'hard of hearing'/'hearing impaired' pages are received (signalised in subtitling descriptor and/or teletext descriptor), then the receiver shall as a default use 'normal' subtitling pages from the same selected language.

7.2   Electronic Program Guide (EPG)

7.2.1   Specification for EPG

The DVB-T2 IRD 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 [12] and requirements defined in ETSI EN 300 468 [13].

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

7.2.2   EPG Presentation

EPG presentation shall include but not limited to the followings:

a)   service name
b)   program title
c)   program duration
d)   elapsed duration (optional)
e)   short description
f)   long description (extended text)
g)   present / following (now / next) event

h) current date/time
i) parental guidance information

The receiver shall provide an EPG organizer to access Next seven-day program guide with all information in above list. It should be a practical and easy to use search function.

7.2.3 Languages and Fonts

For EPG and other labeling decoding and presentation, the receiver shall support the character coding tables specified in below table:

Font	Coded Character Set	First byte value
Latin	ISO 6937	N/A
Chinese	GB18030-2005	0x11 and 0x15
Tamil (Optional)	Unicode range U+0B80-U+0BFF	0x11 and 0x15

Note:

a) The first byte value is signalled according to ETSI EN 300 468 Annex A [13].
b) GB18030-2005 characters are broadcasted as ISO 10646 UTF-16 or UTF-8 code points. The receiver is not required to support code points beyond the Basic Multilingual Plane.

Multi-Language Support for EPG presentation

The DVB-T2 IRD shall support EPG presentation signalled with ENG, ZHO and MSA by offering a means to select the EPG language.

It is optional to support EPG presentation signalled with TAM.

When EPG data is offered in multiple languages, it is recommended that the DVB-T2 IRD provides an easy to use option to allow the user to select the language for EPG presentation.

When the user preferred language for EPG presentation does not match any languages that are available, the DVB-T2 IRD is recommended to select the language of the First EPG data (Short Event Descriptor) appeared in the descriptor loop of the of the Event Information Table (EIT).

It is recommended to allow the user to toggle the languages when viewing the EPG presentation.

7.2.4 Parental Lock Feature

The DVB-T2 IRD 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 DVB-T2 IRD must be able to identify the Classification Code that is applied to the television program and shall allow user to set the rating that he/she wants to block.

The matrix table which shows the list of Classification Code and their assigned hexadecimal code is attached in Annex C.

The Classification Codes are defined as follows:

a) General (G) – Suitable for all ages;
b) Parental Guidance (PG) – Suitable for all, but parents should guide their young;
c) Parental Guidance 13 (PG13) – Suitable for persons aged 13 and above but parental guidance is advised for children below 13;
d) No Children Under 16 (NC16) – Suitable for persons aged 16 and above;

e) Mature 18 (M18) – Suitable for persons aged 18 and above; and

f) Restricted 21 (R21) – Restricted to persons aged 21 and above.

7.2.5 Parental Rating Display

The parental rating information shall be displayed clearly as part of EPG.

The parental rating descriptor shall be transmitted and the full parental rating information shall be appended to the front of the program title or program description by the broadcaster. Manufacturers can add additional displays of programme ratings, but they must display the full rating information.

7.3 Multi-Language Support

The DVB-T2 IRD shall provide a mechanism for the selection of primary and secondary language options for both subtitles and audio selection. The receiver shall as a minimum, interpret the language codes outlined in the table below.

Language	ISO 639-3 Code
English	ENG
Chinese	ZHO
Bahasa Melayu	MSA
Tamil	TAM
Original Audio	QAA
Second Audio	QAB*
Third Audio	QAC*
Multiple Languages	MUL

Note:

a) Original, Second and Third Audio are only applicable for Audio

b) Multiple Languages is only applicable for Subtitle

c) *Optional for IRDs that are launched before 2015

When the audio streams are not signalled with ISO 639 Language Descriptor, the DVB-T2 IRD shall continue to indicate the presence of the audio streams and provide a mechanism for the user to select such streams.

7.4 Teletext (Optional)

The DVB-T2 IRD should be able to demultiplex in parallel the Teletext service transmitted in a packetised format according ETSI EN 300 472 [17]. Where available, the DVB-T2 IRD shall be able to display Teletext service, meeting the requirements for at least Level 1.5 in ETSI EN 300 706 [18] - Enhanced Teletext specification.

7.5 Remote Control Interface

A Remote Control shall be bundled with the DVB-T2 IRD. 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.

The list of basic and digital TV function keys is attached in Annex D.

8   Interfaces and Connectors

8.1   RF Input Connector

The DVB-T2 IRD shall have one input tuner connector, type: IEC female in accordance with IEC 60169-2, part 2 [19]. The input impedance shall be 75 ohm.

8.2   RF Output Connector

The DVB-T2 IRD without an integrated display 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 [19].

   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 DVB-T2 IRD 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 DVB-T2 IRD 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   Antenna Output Power (Optional)

It is optional for the receiver to provide 5V DC output for the active antenna power supply. If it is provided, the 5V DC shall be able to be turned on/off.

8.5   Component Analogue Outputs (Optional)

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

8.6   Composite Video Outputs

For DVB-T2 IRD (standalone module) the composite video output shall comply with PAL Connector IEC 48B Section 316 (RCA- phono).

8.7   Additional Requirements for Composite Video Interface (Optional)

For the analogue outputs, the DVB-T2 IRD (standalone module) should also support insertion of the teletext data in the VBI of the analogue CVBS video output. In this case, the teletext decoder of the TV-set may be used instead of the one in the IRD, and the VBI insertion shall be compliant with ITU-R BT.653-3 [20]. Where available, the Teletext data shall be inserted in the lines 7 to 22 and lines 320 to 335.

8.8   Analogue Audio

The DVB-T2 IRD (standalone module) shall provide RCA-phono output interface for analogue stereo audio.

8.9   Digital Audio Data Stream Output (S/PDIF) or HDMI Audio Return Channel (Optional)

It is optional for the DVB-T2 IRD to provide the following interface:

a)   S/PDIF digital audio output – electrical (coaxial) or optical (TOSLINK); or

    b)   HDMI Audio Return Channel (HDMI ARC).

The capabilities of this interface are defined in § 4.3.3 of Part A and § 5 of Part B of this document.

8.10   HDMI[7]

The DVB-T2 IRD (standalone module) shall provide HDMI interface for digital video and audio output.

8.11   Copy Protection on Outputs

The DVB-T2 IRD (standalone module) shall provide High Bandwidth Digital Content Protection (HDCP) on the HDMI output for all output resolutions.

8.12   Common Interface (Optional)

The DVB-T2 IRD 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.

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[7] Please note that such multimedia interface for transferring data may have intellectual property of third parties.

9   Firmware Operation

9.1   Operating System and Memory

The DVB-T2 IRD shall have an embedded real time operating system. It shall include a non-volatile memory for retaining user settings and other data.

9.2   First-time Power Up

Upon powering up for the first-time, the DVB-T2 IRD 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).

9.3   Initial Channel Scan

The tuning/ scan process should be manually initiated to prevent scanning before the antenna is connected.

The DVB-T2 IRD shall do a full scan of all available services in all the TV broadcast bands starting with VHF TV Band III to UHF Band. The DVB-T2 IRD's scan process shall include all possible combinations of OFDM parameters until the transmission parameters are found.

9.4   Subsequent Power On

The DVB-T2 IRD shall return either to last watched or preset start-up service.

9.5   Listing of all available services

The DVB-T2 IRD shall provide a listing of all available FTA services after scanning.

9.6   Responses to Network Changes

9.6.1   Addition of multiplex on a network

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 DVB-T2 IRD shall recognise the change of version_number of the NIT table and that a new transport_stream_id is present in the NIT (actual).

9.6.2   Addition or removal of service on a multiplex

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 DVB-T2 IRD 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 DVB-T2 IRD to acknowledge the presence of a new service. The DVB-T2 IRD shall consider a service is added to a multiplex if the new service is referenced in the SDT (actual).

When a new service is added or removed from a multiplex, the DVB-T2 IRD may inform the user that a new service has been added or removed using an appropriate DVB-T2 IRD specific method e.g. a short screen pop-up lasting not more than 3 seconds.

9.6.3 Transmission mode change

In the event that there is any transmission mode changes, the DVB-T2 IRD shall automatically perform update to capture these changes without disruption to the viewer.

9.6.4 Clash resolution

The DVB-T2 IRD shall base on the PDS (Private Data Specifier) before assigning LCN to the services and put other services (if any) with the same LCN from undefined PDS to 'reserved' LCN range.

9.7 Signal strength and quality bar

The DVB-T2 IRD 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.

9.8 Service unavailability

In the event of service unavailable, poor or no RF signal, the DVB-T2 IRD shall display an on-screen message.

9.9 Hardware reset / reboot / factory default setting

The DVB-T2 IRD shall support hot reset, cold reset, and a full reset to manufacturer's default start-up settings.

9.10 Channel zapping time

The channel zapping time between channels within same multiplex shall be between 1.5 to 3 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 zapping shall be kept at minimal.

9.11 System software update (SSU/OTA/OAD)

The DVB-T2 IRD shall be able to support Over-The-Air firmware upgrade by using System Software Update mechanism in accordance with the ETSI TS 102 006 [21]. The DVB-T2 IRD shall automatically detect and invoke OTA (SSU) service by recognized Organization Unique Identifiers (OUI) in the NIT linkage with type value as 0x9. The DVB-T2 IRD shall at least support DVB-SSU simple profile.

The default DVB-SSU mode for DVB-T2 IRDs shall be with DVB-SSU "enabled".

9.12 User system software upgrade

The DVB-T2 IRD shall 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   References

[1]   ETSI TS 101 154 v.1.11.1 (2012-11) Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream

[2]   ETSI EN 302 755 v1.3.1 (2012-04) Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2)

[3]   ETSI EN 300 744 v1.6.1 (2009-01) Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television

[4]   IEC 60065 (Feb 2011) Audio, video and similar electronic apparatus – Safety requirements

[5]   IEC CISPR 13 (Jun 2009) Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement

[6]   IEC CISPR 22 (Sept 2008) Information Technology equipment – Radio disturbance characteristics – Limits and methods of measurement

[7]   ITU-T Rec. H.222.0 / ISO/IEC 13818-1 (2012), Information technology – Generic coding of moving pictures and associated audio information: Systems

[8]   ITU-T Rec. H.262 / ISO/IEC 13818-2 (2012), Information technology – Generic coding of moving pictures and associated audio information: Video

[9]   ITU-T Rec. H.264 / ISO/IEC 14496-10 (01/2012), Infrastructure of audiovisual services – Coding of moving video: Advanced video coding for generic audiovisual services

[10]   ISO/IEC 13818-3 (Apr 1998) Information technology — Generic coding of moving pictures and associated audio information- Part 3: Audio

[11]   ISO/IEC 14496-3 (Sep 2009) Information technology — Coding of audio-visual objects —Part 3: Audio

[12]   ETSI TR 101 211 v1.9.1 (2009-06) Digital Video Broadcasting (DVB) Guidelines on implementation and usage of Service Information (SI)

[13]   ETSI EN 300 468 v1.13.1 (2012-04) Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems

[14]   ISO/IEC 3166-1 Countries and Subdivisions Codes (2006)

[15]   ISO/IEC 8859 Information technology — 8-bit single-byte coded graphic character sets (1998)

[16]   ETSI EN 300 743 v1.4.1 (2011-10) Digital Video Broadcasting (DVB); Subtitling systems

[17]   ETSI EN 300 472 v1.3.1 (2003-05) Digital Video Broadcasting (DVB); Specification for Conveying ITU-R System B Teletext in DVB bitstreams

[18]   ETSI EN 300 706 v1.2.1 (2003-04) Digital Video Broadcasting (DVB); Enhanced Teletext Specification

[19]   IEC 60169-2 (1995) Radio-frequency connectors, Part 2: Coaxial unmatched connectors

[20]   ITU-R Rec. BT.653-3 (02/1998) Teletext systems

[21]   ETSI TS 102 006 v1.3.2 (2008-07) Digital Video Broadcasting (DVB); Specification for System Software Update in DVB Systems

[22]   ETSI TS 102 366 v1.2.1 (2008-8) Digital Audio Compression (AC3, Enhanced AC3) Standard

Part B Additional DVB-T2 IRD Requirements for supporting Multi-channel Audio

Multi-channel Audio

1 Format

The DVB-T2 IRD shall identify, accept and decode input bit-streams in the following formats:

a) E-AC3 as specified in ETSI TS 102 366[8] [22]; and

b) MPEG-4 HE-AAC version 2 Level 4 as defined in ISO/IEC 14496-3[9] [11]

2 Metadata

The DVB-T2 IRD 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 [22] and MPEG-4 HE-AAC as specified in ISO/IEC14496-3 [11] and ETSI TS 101 154 [1].

3 Pass-through

The DVB-T2 IRD shall pass through the native audio elementary input bit-stream over the HDMI output for standalone module or ARC output for DVB-T2 IRD (where applicable) as well as the optical/coaxial output (where applicable).

4 Trans-coding

The DVB-T2 IRD 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 DVB-T2 IRD 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 or alternatively to a DTS output bit stream at a data rate of 1.5 Mbps. The number of channels on the output AC-3 or DTS bit-stream shall be equal to or greater than the number of channels contained within the input bit-stream. The AC-3 or DTS bit-stream shall be provided over the following outputs:

a) S/PDIF; and

b) HDMI output for standalone module or ARC output for DVB-T2 IRD (where applicable).

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[8] Please note that such audio formats may be intellectual property of third parties.
[9] Same as footnote 8

5   Decoding & Presentation Options for Multi-Channel Decoder

Codec	Analogue Output / Speaker (IDTV)	Optical / Coaxial (S/PDIF)/ HDMI ARC output **	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
MPEG-4 HE-AAC multi-channel	Down-Mixed Stereo	Trans-code to AC-3 or DTS bit-stream and pass through PCM stereo Pass through of HE-AAC bit stream (Optional)	Pass through of HE-AAC bit-stream (Optional) Trans-code to AC-3 or DTS bit-stream and pass through PCM stereo and multi-channel

Note: * Only applicable to DVB-T2 IRD with HDMI output
       ** Only applicable to DVB-T2 IRD with S/PDIF/ HDMI ARC output

Table 9: Presentation Options for Multi-Channel Decoder

6   Audio Description (Optional)

The DVB-T2 IRD should support audio description in Receiver-mix mode according to Annex E of ETSI 101 154 [1].
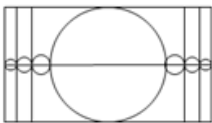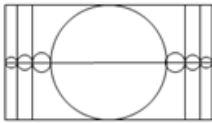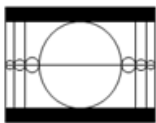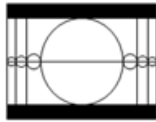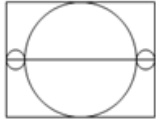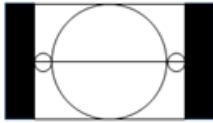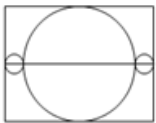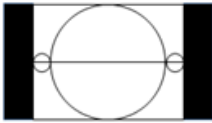
Where available, the audio description service shall be provided as an associated service in a separate stream encoded with the same audio codec as used for the main program.

In case of the use of E-AC3 as audio codec, the mixing data shall be included as part of the E-AC3 bit stream as defined in ETSI TS 102 366 Annex E [39] and the AD_descriptor defined in ETSI TS 101 154 Annex E.2 [1], if present, shall be ignored.

Annex A

AFD Illustration for Required TV Output Display

The illustration below is the required outputs based on the AFD values specified in Table 3 of section 4.2.4.

INPUT				OUTPUT DISPLAY	
Source		Broadcasted Frame	AFD Code	16:9	4:3
Source	Source Image				
16:9		16:9	1000		
			1010		
		4:3	1010		
4:3		4:3	1000		
			1001		
		16:9	1001		

Annex B

Broadcast Channel Numbers and Centre Frequencies

	Bandwidth (MHz)	Channel Number	Centre Frequency (MHz)		Bandwidth (MHz)	Channel Number	Centre Frequency (MHz)
TV BAND III	7	5	177.5	**TV BAND V**	8	38	610
		6	184.5			39	618
		7	191.5			40	626
		8	198.5			41	634
		9	205.5			42	642
		10	212.5			43	650
		11	219.5			44	658
		12	226.5			45	666
TV BAND IV	8	21	474			46	674
		22	482			47	682
		23	490			48	690
		24	498			49	698
		25	506			50	706
		26	514			51	714
		27	522			52	722
		28	530			53	730
		29	538			54	738
		30	546			55	746
		31	554			56	754
		32	562			57	762
		33	570			58	770
		34	578			59	778
		35	586			60	786
		36	594			61	794
		37	602			62	802
						63	810
						64	818
						65	826
						66	834
						67	842
						68	850
						69	858

Annex C

Classification Code Matrix

The EIT will carry DVB parental_rating_descriptor (with the tag of 0x55 as outlined in EN 300 468 [13]) alongside with the country code "SGP". The rating value (parental rating code) carried by this descriptor is associated with the matrix table shown below for on-screen display and channel block.

DVB parental rating codes for Singapore

Parental Rating Code	SG Parental Code	SG Parental Classification	Description	OSD	None	G	PG	PG13	NC16	M18	R21
								Red : Blocked until PIN is entered			
0x00	Undefined				Show	Show	Show	Show	Show	Show	Show
0x01	G	General	Suitable for all ages	G	Show	Blocked	Show	Show	Show	Show	Show
0x02											
0x03											
0x04	PG	Parental Guidance	Suitable for all, but parents should guide young	PG	Show	Blocked	Blocked	Show	Show	Show	Show
0x05											
0x06											
0x07											
0x08											
0x09											
0x0A	PG13	Parental Guidance 13	Suitable for persons aged 13 and above, parental guidance advised for children under 13.	PG13	Show	Blocked	Blocked	Blocked	Show	Show	Show
0x0B											
0x0C											
0x0D	NC16	No Children under 16	Suitable for persons aged 16 and above.	NC16	Show	Blocked	Blocked	Blocked	Blocked	Show	Show
0x0E											
0x0F	M18	Mature 18	Suitable for persons aged 18 and above.	M18	Show	Blocked	Blocked	Blocked	Blocked	Blocked	Show
0x10											
0x11											
0x12	R21	Restricted 21	Suitable for adults aged 21 and above	R21	Show	Blocked	Blocked	Blocked	Blocked	Blocked	Blocked

Receiver End (Rating to Block) — *User Setting Value* — *Green : Show Program* — *Broadcaster End (Hex Code of Transmitted Content)*

Where the broadcasted rating value is not classified (grey area), the DVB-T2 IRD shall interpret the rating to be the next higher classification. Example: If 0x05 is transmitted, it shall be treated as 0x0A (PG13). (By choosing a higher classification, it gives better protection in case the intent is to transmit a higher classification.)

Grey fill area are reserved for future use. (E.g. New classification/rating in future will be fitted into the grey area.)

Reference to the above Yellow Box:
The column "Parental Rating Code" (Hex code) is transmitted together with the television program. DVB-T2 IRD should be able to identify the assigned hex code according to the classification code.

Example: When user selects to block PG13, programs with classification Undefined, General (G) and Parental Guidance (PG) are allowed to display on screen while programs with classification PG13, NC16, M18 and R21 are blocked from viewing until the user entered the pin to unblock the program.

Annex D

Basic and Digital TV Function Keys

The DVB-T2 IRD's remote control shall include the following keys for basic TV functionality or equivalent:

a) Power on/off [on/off] – turn the DVB-T2 IRD 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) Info [Info] – display additional information if available

The DVB-T2 IRD'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 colors shall be red, green, yellow and blue.

d) Text [Text] – This function displays the Teletext as defined in this Specification.

e) Guide/EPG [Guide] – This function displays an Electronic Program Guide.

Annex E

DVB-T2 Performance Requirements

Identifier	SG1	SG2	SG3	SG4	SG5
Purpose	Fixed Outdoor Reception	Indoor Reception	Indoor Reception	Indoor Reception	Indoor Reception
Overall					
FFTSize	32K	16K	16K	16K	16K
GI	1/32	1/16	1/16	1/16	1/16
SISO/MISO	SISO	SISO	SISO	SISO	SISO
PAPR	TR	TR	TR	TR	TR
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz
Carrier Mode	Extended	Extended	Extended	Extended	Extended
Pilot Pattern	PP4	PP2	PP2	PP2	PP2
L1 Modulation	BPSK	BPSK	BPSK	BPSK	BPSK
Data Symbols per Frame (Ldata)	61	130	130	130	130
OFDM Symbols per Frame (Lf)	62	131	131	131	131
Frame Duration (ms)	229	250	250	250	250
Frames Per SuperFrame	2	2	2	2	2
PLP Parameter					
PLP Type	1	1	1	1	1
Time Interleaver Type (TIME_IL_Type)	0	0	0	0	0
Modulation	256 QAM	64QAM	64QAM	64QAM	256QAM
Rate	2/3	3/5	2/3	3/4	3/5
FEC Type	Normal (64k)	Normal (64k)	Normal (64k)	Normal (64k)	Normal (64k)
Rotated QAM	No	No	No	No	No
FEC blocks per interleaving Frame Full channel (Trial mode)	200	151	151	151	202
TI blocks per frame (N_TI)	3	3	3	3	3
Frame_Interval (I_JUMP)	1	1	1	1	1
Approx. Time Interleaving Length (ms)	78	84	84	84	84
Approx. Channel Data Rate (Mbit/s)	37.66	23.48	26.12	29.39	31.41
Performance assuming implementation losses is 2dB for PP2 and 1.5dB for PP4	8MHz UHF Band IV & V	8MHz UHF Band IV & V	8MHz UHF Band IV & V	8MHz UHF Band IV & V	8MHz UHF Band IV & V
C/N Performance on Gaussian channel (dB)	20.4	14.8	16.2	17.7	19.4
C/N performance on 0dB echo channel (dB)	24.6	18.0	19.7	22.0	23.1
Minimum receiver signal input levels on Gaussian channel (dBm)	-78.7	-84.3	-82.9	-81.4	-79.7
Minimum IRD Signal Input Levels on 0dB echo channel (dBm)	-74.5	-81.1	-79.4	-77.1	-76.0
Receiver noise figure on Gaussian channel	6.0	6.0	6.0	6.0	6.0
Maximum Receiver Signal Input Levels (dBm)	-35	-35	-35	-35	-35
Immunity to "digital" signals in Other Channels					
Digital ACI N+/-1 C/I (dB)	-28	-34	-32	-31	-28

Digital ACI N+/-2 C/I (dB)	**-38**	**-44**	**-42**	**-41**	**-38**
Digital ACI N+9 C/I (dB)	**-28**	**-34**	**-32**	**-31**	**-28**
Immunity to Co-Channel Interference From Analogue TV Signals					
PAL B/G CCI C/I (dB)	**5**	**-3**	**1**	**4**	**3**
Immunity to Adjacent Channel Interference From Analogue TV Signals					
PAL B/G ACI C/I N+/-1 (dB)	**-33**	**-39**	**-37**	**-36**	**-33**
PAL B/G ACI C/I N+/-2 (dB)	**-44**	**-50**	**-48**	**-47**	**-44**
PAL B/G ACI C/I N+9 (dB)	**-44**	**-50**	**-48**	**-47**	**-44**
Performance in Time-Varying Channels 10Hz doppler (5Hz after AFC) 20us 0dB echo	**3dB**	**3dB**	**3dB**	**3dB**	**3dB**
Synchronisation for varying echo power levels in SFN (dB)	**28.1**	**21.0**	**22.7**	**25.0**	**26.1**
C/(N+I) Performance in Single Frequency Networks for more than one echo (dB)	**24.6**	**18.0**	**19.7**	**22.0**	**23.1**
C/(N+I) Performance in Single Frequency Networks inside the guard interval (dB)	**24.6**	**18.0**	**19.7**	**22.0**	**23.1**
C/(N+I) Performance in Single Frequency Networks outside the guard interval (dB)					
Delay us	**Echo level dBc**	**Echo level dBc**	**Echo level dBc**	**Echo level dBc**	**Echo level dBc**
-266	**-12**	**-9**	**-10**	**-12**	**-13**
-230	**-11**	**-8**	**-9**	**-11**	**-12**
-200	**-10**	**-7**	**-8**	**-9**	**-11**
-150	**-6**	**-3**	**-4**	**-6**	**-8**
-120	**-2**	**-2**	**-2**	**-2**	**-2**
120	**-2**	**-2**	**-2**	**-2**	**-2**
150	**-6**	**-3**	**-4**	**-6**	**-8**
200	**-10**	**-7**	**-8**	**-9**	**-11**
230	**-11**	**-8**	**-9**	**-11**	**-12**
266	**-12**	**-9**	**-10**	**-12**	**-13**

Note: The performance requirement is based on 30 seconds error free video.

Annex F

Proposed Logical Channel Numbering (LCN) Range

MediaCorp's Free to Air (FTA) channel numbering on terrestrial platform

LCN	Channel
1	Preview Channel (Define as Reserved)
2	Channel 5
3	Channel 8
4	Suria
5	Vasantham
6	Channel News Asia
7	Channel U
8	Okto

Annex G

List of Broadcast Descriptors

Descriptors in use (exclude data broadcasting)	Tag	NIT	SDT	EIT	TOT	PMT
network_name_descriptor	0x40	*				
terrestrial_delivery_system_descriptor	0x5A	*				
T2_delivery_system_descriptor	0x7F/0x04 (ext)	*				
service_list_descriptor	0x48	*				
logical_channel_descriptor	0x83	*				
private_data_specifier_descriptor	0x5F	*				
service_descriptor	0x41		*			
multilingual_service_name_descriptor	0x5D		*			
component_descriptor	0x50			*		
short_event_descriptor	0x4D			*		
extended_event_descriptor	0x4E			*		
local_time_offset_descriptor	0x58				*	
iso_639_language_descriptor	0x0A					*
stream_identifier_descriptor	0x52					*
AC-3 descriptor	0x6A					*
subtitling_descriptor	0x59					*
teletext_descriptor	0x56					*
video_stream_descriptor	0x02					*
audio_stream_descriptor	0x03					*
content_descriptor	0x54			*		
parental_rating_descriptor	0x55			*		
Enhanced_AC-3 descriptor	0x7A					*
AAC_descriptor	0x7C					*

Descriptors required for SSU	Tag	NIT	SDT	EIT	TOT	PMT
linkage_descriptor	0x4A	*				
Data_broadcast_id_descriptor	0x66					*

Note: The list is not exhaustive; it shows the typical descriptors that may be broadcast by terrestrial broadcasters.

Annex H

Addendum/Corrigendum

Changes to IDA/MDA TS DVB-T2 IRD Issue 1 Revision 1, Mar 2013			
Page	**TS Ref**	**Items Changed**	**Date of Issue**
3 &18 &19	Part A § 1.3 & § 7.4 & § 8.7	Part A § 1.3 <u>Scope of Part A: Basic DVB-T2 Requirements</u> Part A § 7.4 <u>Teletext</u> Part A § 8.7<u>Additional Requirements for Composite Video Interface</u> The requirement to support Teletext service has been amended as "Optional".	<mark>TBC</mark> 2014
8	Part A § 4.3.5	<u>Lip Sync</u> Lip sync requirement has been amended as "Recommended". Manufacturers should ensure this basic performance of their product.	
8 25	Part A § 4.3.3 Part B § 5	<u>Decoding & Presentation Options for 2 Channels of Decoder Output</u> <u>Decoding & Presentation Options for Multi-Channel Decoder</u> The support for HE-AAC bit stream pass through via S/PDIF and HDMI output has been amended as "Optional". For multi-channel receiver, there is no impact to the consumer as HE-AAC 5.1 can be trans-coded to AC-3 or DTS for decoding by existing AV Receiver.	
8 & 19 25	Part A § 4.3.3 & § 8.9 Part B § 5	<u>Digital Audio Data Stream Output (S/PDIF)</u> HDMI Audio Return Channel (ARC) output has been included in Part A § 4.3.3 and § 8.9 and Part B § 5 to give clarity that the requirement for S/PIF also applies to the HDMI ARC interface.	
9	Part A § 4.3.8	Added Part A § 4.3.8 to give clarity on the audio prioritizing, according to the broadcaster's transmission.	
14	Part A § 6.6.2	<u>Logical Channel Descriptor (Version 2)</u> The following text has been added to give clarity on the expected behaviour of the IRD if it does not offer any User Interface (UI) to select the Channel List described in LCNV2. When several Channel Lists are available from same network (original network id) and same country code for the IRD during first time installation (or complete re-installation), the receiver shall choose the channel list as the default one with following priority: The IRD shall choose the one with lowest list_id value OR let the viewer choose from a list, (typically using the channel_list_name)	

Changes to IDA/MDA TS DVB-T2 IRD Issue 1 Revision 1, Mar 2013 (Cont'd)			
Page	**TS Ref**	**Items Changed**	**Date of Issue**
17	Part A § 7.2.3	<u>Languages and Fonts</u> The following text is added to give clarity on the multi-language support for EPG presentation: The DVB-T2 IRD shall support EPG presentation signalled with ENG, ZHO and MSA by offering a means to select the EPG language. It is optional to support EPG presentation signalled with TAM. When EPG data is offered in multiple languages, it is recommended that the DVB-T2 IRD provides an easy to use option to allow the user to select the language for EPG presentation. When the user preferred language for EPG presentation does not match any languages that are available, the DVB-T2 IRD is recommended to select the language of the First EPG data (Short Event Descriptor) appeared in the descriptor loop of the of the Event Information Table (EIT). It is recommended to allow the user to toggle the languages when viewing the EPG presentation.	<mark>TBC</mark> 2014
18	Part A § 7.3	<u>Multi-Language Support (For Audio)</u> The ISO 639 language codes "QAB" and "QAC" have been included to give broadcasters the flexibility in adopting the appropriate signalling for the Second and the Third Audio, respectively.	
21	Part A § 9.6.2	<u>Addition or removal of service on a multiplex</u> The description on EIT- present/following (p/f) was removed as the processing of EIT p/f is not required for addition of a service. In addition, the description on the SDT (actual) to be transmitted at least every 2 sec was also removed as it is a transmission requirement.	
22	Part A § 9.10	<u>Channel Zapping Time</u> The channel zapping time between channels within same multiplex has been amended to be between 1.5 and 3 seconds to give manufacturers the flexibility in deployment of the video decoder chipsets.	

Changes to IDA/MDA TS DVB-T2 IRD Issue 1 Revision 1, Mar 2013 (Cont'd)			
Page	**TS Ref**	**Items Changed**	**Date of Issue**
25	Part B § 6	Audio Description (AD) The requirement to support audio description in receiver-mix mode for multi-channel receiver has been amended as "Optional" in view that there is no immediate plan to implement audio description in receiver-mix mode. Nevertheless, AD in Broadcast-mix mode is supported by both stereo and multi-channel receivers. The following text is included to give clarity on the method for transporting of the audio description between HE-AAC and DD+: The audio description service shall be provided as an associated service in a separate stream encoded with the same audio codec as used for the main program. In case of the use of E-AC3 as audio codec, the mixing data shall be included as part of the E-AC3 bit stream as defined in ETSI TS 102 366 Annex E [39] and the AD_descriptor defined in ETSI TS 101 154 Annex E.2 [1], if present, shall be ignored.	
27	Annex C	Classification Code Matrix Annex C has been amended to indicate that "Where the broadcasted rating value is not classified (grey area), the DVB-T2 IRD shall interpret the rating to be the next higher classification. Example: If 0x05 is transmitted, it shall be treated as **0x0A** (PG13)."	TBC 2014

Changes to IDA/MDA TS DVB-T2 IRD Issue 1, Nov 2012			
Page	**TS Ref**	**Items Changed**	**Date of Issue**
22	Part A § 10 [1]	Scope of Part A: Basic DVB-T2 Requirements Existing reference to the ETSI TS 101 154 v.1.10.1 (2011-06) has been updated with the latest version v.1.11.1 (2012-11) for use of video and audio coding in broadcasting applications based on the MPEG-2 transport stream. This latest version provides clarity to the metadata used in the multi-channel audio. As revisions to the ETSI TS 101 154 have been developed largely in a backward compatible manner, updating of this reference will not bring about any change to the mandatory requirements previously defined for the DVB-T2 IRD.	15 Mar 2013
3	Part A § 1.1 e)	"E-AC3" has been deleted from the existing text as E-AC3 is an additional requirement for supporting multi-channel audio under Part B of the Specification.	
6	Part A § 4.2.1	Video Decoding "§ 5.2" of ETSI TS 101 154 for supporting the 25 Hz MPEG2 HDTV video format has been deleted from the existing text to align with Table 1, which only requires that the 25 Hz MPEG2 SDTV video format be supported.	15 Mar 2013

Changes to IDA/MDA TS DVB-T2 IRD Issue 1, Nov 2012 (Cont'd)			
Page	**TS Ref**	**Items Changed**	**Date of Issue**
10	Part A § 5.3.2	Operating Modes As Part A § 5 has specified that the frontend/tuner shall comply with the Layer 1 signalling requirements of the DVB-T2 baseline system defined in the ETSI 302 755 v1.3.1, signalling formats for Peak Average Power Ratio (PAPR) reduction given in Table 6 are replaced as shown below, and support for scrambling of L1 post signalling is indicated as required. <table><tr><td>Signalling format for Peak Average Power Ratio (PAPR) reduction</td><td>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.</td></tr><tr><td>Scrambling of L1 post signalling (L1_POST_SCRAMBLED)</td><td>Feature shall be supported by the DVB-T2 IRD.</td></tr></table> Also, the support for time frequency slicing (TFS) is not required for the DVB-T2 IRD with single front-end/tuner.	15 Mar 2013
12	Part A § 6.6	Service Identification and Logical Channel Number (LCN) The "Original Network ID value (ONID)" has been added to the list of DVB identification values that has been uniquely assigned for and used by the broadcaster in Singapore. This provides further information of the network identification values that have been allocated to Singapore for broadcasting applications.	15 Mar 2013
18	Part A § 8.9	Digital Audio Data Stream Output (Optional) For clarity of reference, the text "section 4" has been replaced by "§ 4.3.3 of Part A and § 5 of Part B".	15 Mar 2013
21	Part A § 9.11	System Software Update References to "ISO/IEC 13818-1 [5], ETSI TS 101 154 [1]" have been deleted as reference to "ETSI TS 102 006 [21]" should suffice for specifying requirements for system software update in DVB systems.	15 Mar 2013