



DVB-T2 Technical
Panel Committee
(TPC)

Telecommunications
Standards Advisory
Committee (TSAC)

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

Integrated Receiver
Decoder - T2

**Draft IDA TS IRD-T2
Issue 1, August 2012**

Infocomm Development Authority of Singapore
Resource Management & Standards
10 Pasir Panjang Road
#10-01 Mapletree Business City
Singapore 117438

© Copyright of IDA, 2012

This document may be downloaded from the MDA website at <http://www.mda.gov.sg> and the IDA website at <http://www.ida.gov.sg>, and shall not be distributed without written permission from IDA.

Acknowledgement

The Media Development Authority (MDA), the Info-communications Development Authority of Singapore (IDA) and the Telecommunications Standards Advisory Committee (TSAC) would like to acknowledge the following organisations represented in the MDA DVB-T2 Technical Panel Committee (TPC) for their invaluable contributions to the formulation of the DVB-T2 basic receiver technical specifications for Singapore:

MediaCorp Pte Ltd
StarHub Ltd
Sony EMCS (M) Sdn. Bhd.
Panasonic Singapore R&D Pte Ltd
TP Vision Singapore Pte Ltd
LG Electronics Singapore Pte Ltd
Samsung Asia Pte Ltd
SkyCom Satellite Systems Pte Ltd

List of Technical Panel Committee members

Mr Lim Chin Siang	Media Development Authority
Miss Tan Sze Siang	Media Development Authority
Miss Zoey Moh	Media Development Authority
Miss Agnes Chong	Media Development Authority
Mr Yong Seong Wei	Media Development Authority
Mr Calvin Lim	Media Development Authority
Mr Yeo Kim Pow	MediaCorp Pte Ltd
Mr Lau Hing Tung	MediaCorp Pte Ltd
Mr Roland Tan	MediaCorp Pte Ltd
Mr Tan Sai Yoon	MediaCorp Pte Ltd
Mr Peh Beng Yeow	MediaCorp Pte Ltd
Mr Tan Jek Thoon	MediaCorp Pte Ltd
Ms Ong Bee Lian	StarHub Ltd
Mr Lu Jin	StarHub Ltd
Mr Andrew Nai	StarHub Ltd
Mr Muzaffar Fakhruddin	Sony EMCS (M) Sdn. Bhd
Ms Lee Shook Yee	Sony EMCS (M) Sdn. Bhd
Mr William Wong	Panasonic Singapore R&D Pte Ltd
Mr Philip Ong	Panasonic Singapore R&D Pte Ltd
Mr Low Kwong Wai	TP Vision Singapore Pte Ltd
Mr Eric Poh	TP Vision Singapore Pte Ltd
Mr Hyek Seong Kweon	LG Electronics Singapore Pte Ltd
Mr Leon Chew	LG Electronics Singapore Pte Ltd
Mr Yogesh Thalpati	Samsung Asia Pte Ltd
Mr Sonu Mahajan	Samsung Asia Pte Ltd
Mr Simon Tso	SkyCom Satellite Systems Pte Ltd
Mr Ben Irol	SkyCom Satellite Systems Pte Ltd

MDA and IDA would also like to acknowledge the work of the TSAC Working Group 3 (TSAC WG3) in incorporating these recommended DVB-T2 basic receiver technical specifications into this Specification.

IDA TS IRD-T2 Issue 1, September 2012 [Revision: 0]	Technical Specification for Integrated Digital Receiver for use with second generation Digital Terrestrial Television broadcasting system (DVB-T2)
TSAC WG3 Chairman	Dr Yau Wei Yun, I2R, ASTAR
TSAC WG3 Editor(s)	Ms Woo Yim Leng, IDA Ms Tan Sze Siang, MDA

List of TSAC WG3 members

Telecommunications Standards Advisory Committee (TSAC)

The TSAC advises IDA on the setting of ICT standards as well as on the development and recommendation of specifications, standards, information notes, guidelines and other forms of documentation for adoption and advancement of the standardisation effort of the Singapore ICT industry (hereafter termed "IDA Standards").

Telecommunications standards-setting in Singapore is achieved with the assistance of TSAC, where professional, trade and consumer interest in telecommunications standards is represented on the TSAC with representatives from network and service operators, equipment suppliers and manufacturers, academia and researchers, professional bodies and other government agencies.

List of TSAC Members

Content

Section	Title	Page
1.	Scope	2
2.	General Requirements	2
3.	Abbreviations	4
4.	Use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream	6
5.	Frontend Characteristics	10
6.	Service Information (SI)	12
7.	Services	16
8.	Interfaces and Connectors	19
9.	Firmware Operation	21
10.	References	23
Annex A	Broadcast Channel Numbers and Centre Frequencies	24
Annex B	Classification Code Matrix	25
Annex C	Basic and Digital TV Function Keys	26
Annex D	DVB-T2 Performance Requirements	27
Annex E	Proposed Logical Channel Numbering Range	29
Annex F	List of Broadcast Descriptors	30

NOTICE

THE INFOCOMM DEVELOPMENT AUTHORITY OF SINGAPORE (“IDA”) MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THE MATERIAL PROVIDED HEREIN AND EXCLUDES ANY EXPRESS OR IMPLIED WARRANTIES OR CONDITIONS OF NON-INFRINGEMENT, MERCHANTABILITY, SATISFACTORY QUALITY AND FITNESS FOR A PARTICULAR PURPOSE. SUBJECT TO THE MAXIMUM EXTENT PERMITTED UNDER LAW, IDA SHALL NOT BE LIABLE FOR ANY ERRORS AND/OR OMISSIONS CONTAINED HEREIN OR FOR ANY LOSSES OR DAMAGES (INCLUDING ANY LOSS OF PROFITS, BUSINESS, GOODWILL OR REPUTATION, AND/OR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES) IN CONNECTION WITH THE USE OF THIS MATERIAL.

IDA DRAWS ATTENTION TO THE POSSIBILITY THAT THE PRACTICE OR IMPLEMENTATION OF THIS STANDARD MAY INVOLVE THE USE OF INTELLECTUAL PROPERTY RIGHTS AND TAKES NO POSITION CONCERNING THE EXISTENCE, VALIDITY AND/OR APPLICABILITY OF ANY SUCH INTELLECTUAL PROPERTY RIGHTS, WHETHER ASSERTED BY TSAC MEMBERS OR ANY THIRD PARTY.

AS OF THE DATE OF APPROVAL OF THIS STANDARD, IDA [HAS/HAS NOT] RECEIVED WRITTEN NOTICE OF ANY PATENT RIGHTS WHICH MAY BE RELEVANT IN RELATION TO THE IMPLEMENTATION OF THIS STANDARD. HOWEVER, IMPLEMENTERS ARE CAUTIONED THAT THIS MAY NOT REPRESENT THE LATEST INFORMATION AND ARE THEREFORE STRONGLY URGED TO CHECK WITH THE RELEVANT DATABASE IN ITU, ISO, IEC OR THE RELATED STANDARDS DEVELOPMENT ORGANISATION FOR INFORMATION OF PATENT RIGHTS. IMPLEMENTERS ARE ADVISED TO OBTAIN THEIR OWN LEGAL AND/OR TECHNICAL ADVICE IN RELATION TO THE IMPLEMENTATION OF THE STANDARD IF REQUIRED.

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

1 Scope

- 1.1 This Specification defines the minimum 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.
- 1.2 This Specification is established to enable equipment manufacturers and/or suppliers to bring in compatible IRD-T2 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 "IRD-T2".
- 1.3 This Specification (§ 3) defines the minimum requirements for the IRD-T2 in accordance with the implementation guidelines outline 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 IRD-T2 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; and
 - e) MPEG-1 Layer II, Enhanced AC-3 and MPEG-4 HE AAC audio coding formats.
- 1.4 This Specification also requires that the IRD-T2 be capable of decoding Singapore's FTA DVB-T and DVB-T2 broadcast of television, radio and enhanced services (§ 4). This shall include the following capabilities:
 - a) Subtitling (where available and selected by viewer);
 - b) Audio Description in Broadcast-mix mode;
 - c) Electronic Program Guide;
 - d) Teletext;
 - e) Parental Lock Feature; and
 - f) Multiple Audio Selection

Note: Unless otherwise specified, all requirements are mandatory.

2 General Requirements

2.1 Power Supply

The IRD-T2 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, $230V \pm 10\%$ and frequency, 50

Hz \pm 2%. Where external power supply is used, e.g. AC adaptor, it shall not affect the capability of the equipment to meet the Specification.

2.2 Safety Requirements

The IRD-T2 shall be tested for compliance with the International Electrotechnical Commission IEC 60065 [2] safety standards.

2.3 Electromagnetic Compatibility (EMC) Requirements

The IRD-T2 shall comply with the EMC requirements defined in ISO/IEC CISPR 13 [3].

2.4 Identification of Equipment

The IRD-T2 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
DVB-T2	Digital Video Broadcasting Terrestrial Second Generation
DVB SI	Digital Video Broadcasting Service Information
E-AC3	Enhanced Dolby Digital
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 Advance 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
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 IRD-T2 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 [4].
- 4.1.2 The IRD-T2 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 [4].
- 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 IRD-T2 shall be able to handle simultaneously at least 32 PIDs and elementary streams.
- 4.1.4 The IRD-T2 shall be able to skip over data structures which are currently "reserved" (§ 4.1 of ETSI TS 101 154 [1]).
- 4.1.5 The IRD-T2 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 [4].
- 4.1.6 The IRD-T2 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 [4].

4.2 Video Decoding

- 4.2.1 The IRD-T2 shall comply with the implementation guidelines outlined in § 5.1 and § 5.2 of ETSI TS 101 154 for decoding MPEG-2 video. The IRD-T2 shall be able to decode video formats as specified in Table 1, based on the ITU-T Rec. H.262 / ISO/IEC 13818-2 [5].

IRD-T2	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

- 4.2.2 The IRD-T2 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 IRD-T2 shall be able to decode video formats as specified in Table 2, based on the ITU-T Rec. H.264 / ISO/IEC 14496-10 [6].

IRD-T2	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 IRD-T2 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 IRD-T2 shall present the video aspect ratio properly according to the current AFD value and response in next frame as defined in the ETSI EN 101 154 Annex B. The IRD-T2 shall support at least the Active Formats shown in Table 3. For illustration of Active Formats, refer to Table B.6 of ETSI TS 101 154 [1].

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)

4.3 Audio Decoding

4.3.1 MPEG-1 Layer II Audio

4.3.1.1 The IRD-T2 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 13813-3 [7] 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 IRD-T2 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 (up to Level 3)

The IRD-T2 shall comply with the implementation guidelines outlined in § 6.4 of ETSI TS 101 154 [1] for decoding MPEG-4 HE AAC version 2 audio up to Level 3 and sampling rate of 48 kHz, based on ISO/IEC 14496-3 [8].

4.3.3 Decoding & Presentation Options for 2 Channels of Decoder Output

Codec	Analogue Output / Speaker (IDTV)	Optical / Coaxial (SPDIF)	HDMI*
MPEG-1 Layer II	Mono / Stereo	PCM	PCM
MPEG-4 HE AAC	Mono / Stereo	PCM	PCM

Note: * Only applicable to IRD-T2 with HDMI output

Table 4: Presentation Options for 2 Channels of Decoder Output

4.3.4 Multi-Channel Audio

4.3.4.1 Format

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

- a) Enhanced AC-3 as specified in ETSI TS 102 366 [9]; and
- b) MPEG-4 HE AAC version 2 Level 4 as defined in ISO/IEC 14496-3 [8]

4.3.4.2 Metadata

The IRD-T2 shall apply bit-stream metadata parameters and down mix multichannel input configurations to stereo PCM for Enhanced AC-3 and MPEG-4 HE AAC in accordance with guidelines given in ETSI TS 101 154 [1], and as specified in ETSI TS 102 366 [9] and ISO/IEC 14496-3 [8] respectively.

4.3.4.3 Pass-through

The IRD-T2 shall pass through the native input bit-stream over the HDMI (and ARC on compatible HDMI inputs) output.

4.3.4.4 Trans-coding

The IRD-T2 shall trans-code audio and metadata from E-AC-3 and MPEG-4 HE AAC input bit-streams to AC-3 output bit-streams 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 following outputs:

- a) S/PDIF; and

b) HDMI (and ARC on compatible HDMI inputs)

4.3.4.5 Decoding & Presentation Options for Multi-Channel Decoder

Codec	Analogue Output / Speaker (IDTV)	Optical / Coaxial (SPDIF)	HDMI*
Enhanced AC-3 multi-channel	Down-Mixed Stereo	Trans-code to AC-3 bit-stream and pass through PCM stereo	Pass through of E AC-3 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 Trans-code to AC-3 or DTS bit-stream and pass through PCM stereo and multi-channel

Note: * Only applicable to IRD-T2 with HDMI output

Table 5: Presentation Options for Multi-Channel Decoder

4.3.5 Audio handling when changing service or audio format

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

4.3.6 Lip-Sync

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.

4.3.7 Loudness Matching

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

5 Frontend Characteristics

5.1 General Considerations

The IRD-T2 shall be compatible with the DVB-T baseline system according to the ETSI EN 300 744 [10] and the DVB-T2 baseline system according to the ETSI EN 302 755 [11] 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.

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 6: Mandatory Frequency Bands

5.2 Maximum Frequency Offset

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

5.3 Operating Modes

5.3.1 The IRD-T2 shall be able to demodulate all non-hierarchical modes specified in the ETSI EN 300 744 [10]. 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 IRD-T2 shall be able to demodulate all the allowed combinations of the DVB-T2 parameters or DVB-T2 modes as specified in the ETSI EN 302 755 [11].

5.3.3 The IRD-T2 shall be able to detect which DVB-T2 mode is being used. The DVB-T2 parameters or modes are outlined in Table 7.

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
Peak Average Power Ratio (PAPR)	No PAPR reduction is used; ACE-PAPR is used; TR-PAPR is used; or Both ACE and TR techniques 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)

Table 7: DVB-T2 Parameters/Modes

5.4 DVB-T2 Performance Requirements

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

5.5 Performance in Time-Varying Channels

5.5.1.1 The IRD-T2 be able to operate with all signal time variations that naturally exist in connection with fixed roof-top reception (e.g. mast sway, antenna sway) and in-house portable reception (e.g. people walking around the receiving antenna). None of the above mentioned performance parameters should be significantly negatively affected when such channel time variations exist.

5.5.1.2 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 μ s, 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 μ s, corresponding to a Doppler shift of +/- 0.5 Hz (after AFC).

5.6 Operation in Single Frequency Network (SFN)

The IRD-T2 shall be able to operate in SFN with echo signals within the guard interval. When the IRD-T2 tunes to a mix of two signals from a SFN where the received signals are close in amplitude, it is recommended that the IRD-T2 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 [4], the IRD-T2 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 IRD-T2 can automatically configure itself for the selected service. The IRD-T2 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 IRD-T2 shall make use of Time and Date Table (TDT) for the device system time or Real Time Clock (RTC) setting. Time zone support is required with UTC or GMT as the default time zone.

6.3 Optional and Unrecognised SI (Optional)

For IRD-T2 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 IRD-T2 shall ignore any incomprehensible SI or tables. The IRD-T2 shall discard any PSI/SI signals if it is unrecognised or not supported.

6.4 PSI/SI and PID Update

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

6.6 Service Identification and Logical Channel Number (LCN)

The IRD-T2 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 in a service list, in order to allow a quick tune in to the selected transport stream.

The IRD-T2 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 assigned private data specifier is "0x00000019".

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 E 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 IRD-T2, so the IRD-T2 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 8 below, as follows:

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

Table 8: 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 IRD-T2 service list.
- = 0: The service is invisible and not selectable via the IRD-T2 service list, however the IRD-T2 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.

LCN numbering can be from 0 to 1023 (210). 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 9.

Syntax	No. of bits	Identifier
Logical_channel_descriptor(){		
descriptor_tag	8	Uimsbf
descriptor_length for (i=0;i<N;i++){	8	Uimsbf
channel_list_id	8	Uimsbf
channel_list_name_length	8	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 9: 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). The user should be able to select a preferred channel list to be used, when several are available during the first-time installation (or complete re-installation).

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.

country_code: This 24-bit field identifies a country using the 3-character code as specified in ISO/IEC 3166 [20]. Each character is coded into 8-bits according to ISO/IEC 8859-1[21] 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 IRD-T2's service list. When set to '0'/'false' this indicates that the IRD-T2 is not expected to offer the service to the user in normal navigation modes however the IRD-T2 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 IRD-T2 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 IRD-T2 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 F.

7 Services

7.1 Subtitling

7.1.1 Specification for Subtitling

The receiver shall support DVB subtitling in accordance with ETSI EN 300 743 [14], 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).

The default setting on the receiver for subtitling should be "OFF".

7.1.2 Multiple Subtitling Language

The receiver 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.

7.1.3 Support for hearing impaired

The receiver 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 (signalled 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 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 [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
- 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 may 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 or 0x15
Tamil	Unicode range U+0B80-U+0BFF	0x11 or 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.

7.2.4 Parental Lock Feature

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

The receiver 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 B.

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 user shall be provided with primary and secondary language options for both Subtitles and Audio selection. The list of languages provided shall as a minimum contain all the languages outlined in the table below.

Language	ISO 639-3 Code
English	ENG
Bahasa Melayu	MSA
Chinese	ZHO
Tamil	TAM
Original Audio	QAA*

* Original Audio is only applicable for Audio

7.4 Teletext

The receiver shall be able to demultiplex in parallel the Teletext service transmitted in a packetised format according ETSI EN 300 472 [15]. The receiver shall be able to display Teletext service, meeting the requirements for at least Level 1.5 in ETSI EN 300 706 [16] - Enhanced Teletext specification.

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.

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

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 [17]. The input impedance shall be 75 ohm.

8.2 RF Output Connector

The receiver 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 [17].
- 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 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 IRD-T2 (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

For the analogue outputs, the IRD-T2 (standalone module) shall 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 might be used instead of the one in the receiver. The VBI insertion shall be compliant with ITU-R BT.653-3 [18]. The Teletext data shall be inserted in the lines 7 to 22 and lines 320 to 335.

8.8 Analogue Audio

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

8.9 Digital Audio Data Stream Output (Optional)

It is optional for the IRD-T2 to provide an S/PDIF digital audio output – electrical (coaxial) or optical (TOSLINK). This digital interface may carry PCM stereo audio and/or AC3 coded audio and/or MPEG1-Layer II audio streams to an external decoder multichannel sound system.

8.10 HDMI

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

8.11 Copy Protection on Outputs

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

8.12 Common Interface (Optional)

The IRD-T2 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 IRD-T2 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 IRD-T2 shall initiate the following process:

- a) Set OSD language (Default – English);
- b) Select time zone (Default – GMT +8);
- c) Set active antenna power (Default – Off);
- d) Prompt tuning/scanning for all available FTA services; and
- e) 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 IRD-T2 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 IRD-T2's scan process shall include all possible combinations of OFDM parameters until the transmission parameters are found.

9.4 Subsequent Power On

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

9.5 Listing of all available services

The IRD-T2 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 IRD-T2 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 IRD-T2 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 IRD-T2 to acknowledge the presence of a new service. The IRD-T2 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 [12].

When a new service is added or removed from a multiplex, the IRD-T2 may inform the user

that a new service has been added or removed using an appropriate IRD-T2 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 IRD-T2 shall automatically perform update to capture these changes without disruption to the viewer.

9.6.4 Clash resolution

The IRD-T2 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 IRD-T2 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 IRD-T2 shall display an on-screen message.

9.9 Hardware reset / reboot / factory default setting

The IRD-T2 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 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 zapping shall be kept at minimal.

9.11 System software update (SSU/OTA/OAD)

The IRD-T2 shall be able to support Over-The-Air firmware upgrade by using System Software Update mechanism in accordance with standard of ISO/IEC 13818-1 [4], ETSI TS 101 154 [1] and ETSI TS 102 006 [19]. The IRD-T2 shall automatically detect and invoke OTA (SSU) service by recognized Organization Unique Identifiers (OUI) in the NIT linkage with tag value as 0x9. The IRD-T2 shall at least support DVB-SSU simple profile.

The default DVB-SSU mode for IRD-T2s shall be with DVB-SSU "enabled".

9.12 User system software upgrade

The IRD-T2 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 v1.10.1 (2011-06) Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream
- [2] IEC 60065 (Feb 2011) Audio, video and similar electronic apparatus – Safety requirements
- [3] IEC CISPR 13 (Jun 2009) Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement
- [4] ITU-T Rec. H.222.0 / ISO/IEC 13818-1 (2012), Information technology – Generic coding of moving pictures and associated audio information: Systems
- [5] ITU-T Rec. H.262 / ISO/IEC 13818-2 (2012), Information technology – Generic coding of moving pictures and associated audio information: Video
- [6] 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
- [7] ISO/IEC 13818-3 (Apr 1998) Information technology — Generic coding of moving pictures and associated audio information- Part 3: Audio
- [8] ISO/IEC 14496-3 (Sep 2009) Information technology — Coding of audio-visual objects —Part 3: Audio
- [9] ETSI TS 102 366 v1.2.1 (2008-8) Digital Audio Compression (AC-3, Enhanced AC-3) Standard
- [10] ETSI EN 300 744 v1.6.1 (2009-01) Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television
- [11] 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)
- [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] ETSI EN 300 743 v1.4.1 (2011-10) Digital Video Broadcasting (DVB); Subtitling systems
- [15] ETSI EN 300 472 v1.3.1 (2003-05) Digital Video Broadcasting (DVB); Specification for Conveying ITU-R System B Teletext in DVB bitstreams
- [16] ETSI EN 300 706 v1.2.1 (2003-04) Digital Video Broadcasting (DVB); Enhanced Teletext Specification
- [17] IEC 60169-2 (1995) Radio-frequency connectors, Part 2: Coaxial unmatched connectors
- [18] ITU-R Rec. BT.653-3 (02/1998) Teletext systems
- [19] ETSI TS 102 006 v1.3.2 (2008-07) Digital Video Broadcasting (DVB); Specification for System Software Update in DVB Systems
- [20] ISO/IEC 3166-1 Countries and Subdivisions Codes (2006)
- [21] ISO/IEC 8895 Information technology — 8-bit single-byte coded graphic character sets (1998)

Annex A

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 B

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					Receiver End (Rating to Block)							
Parental Rating Code	SG Parental Code	SG Parental Classification	Description	OSD	User Setting Value							
					None	G	PG	PG13	NC16	M18	R21	
					Green : Show Program Red : Blocked until PIN is entered							
0x00	Undefined				Show	Show	Show	Show	Show	Show	Show	Show
0x01	G	General	Suitable for all ages	G	Show	Blocked	Show	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	Show
0x05												
0x06												
0x07	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	Show
0x08												
0x09												
0x0A	NC16	No Children under 16	Suitable for persons aged 16 and above.	NC16	Show	Blocked	Blocked	Blocked	Blocked	Show	Show	Show
0x0B												
0x0C												
0x0D	M18	Mature 18	Suitable for persons aged 18 and above.	M18	Show	Blocked	Blocked	Blocked	Blocked	Blocked	Show	Show
0x0E												
0x0F	R21	Restricted 21	Suitable for adults aged 21 and above.	R21	Show	Blocked	Blocked	Blocked	Blocked	Blocked	Blocked	Blocked

Where the broadcasted rating value is not classified (grey area), the IRD-T2 shall interpret the rating to be the next higher classification. Example: If 0x05 is transmitted, it shall be treated as 0x07 (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. IRD-T2 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 C

Basic and Digital TV Function Keys

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

- a) Power on/off [on/off] – turn the IRD-T2 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 IRD-T2'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 D

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)	27.6	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 E**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 F

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			*		
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.