



MINIMUM REQUIREMENTS FOR DVB-T2 SET TOP BOXES

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Symbols and Acronyms

AAC	Advanced Audio Coding
ACE	Active Constellation Extension
AC-3	Audio Compression-3
ASI	Asynchronous Serial Interface
AVC	Advanced Video Coding
BAT	Bouquet Association Table
BER	Bit Error Rate
CA	Conditional Access
CI	Common Interface
CI+	Common Interface Plus
CISPR	Special International Committee on Radio Interference
CVBS	Composite Video Broadcast Signal
C/N	Carrier to Noise signal ratio
CPU	Central Processing Unit
dB	Decibel
dBm	Decibel Millie Watt
DDRAM	Double Data Random Access Memory
DIT	Data Information Table
DTT	Digital Terrestrial Television
DVB	Digital Video Broadcasting
DVB-T	System defined by the ETSI EN 300 744 standard for providing terrestrial digital broadcasting
DVB-T2	Second generation system defined by the EN 302 755 standard for providing terrestrial digital broadcasting
E-AC-3	Enhanced Audio Compression -3
EIT	Event Information Table
EPG	Electronic Programme Guide
ETSI	European Telecommunication Standards Institute
FEC	Forward Error Correction
FTA	Free-To-Air
FFT	Fast Fourier Transforms
HbbTV	Hybrid Broadcast Broadband TV
HDCP	High-bandwidth Digital Content Protection
HDMI	High Definition Multimedia Interface
HDTV	High Definition Television
HE AAC	High Efficiency AAC
HEM	High Efficiency Mode
I/C	Interference to Carrier signal ratio.
ID	Identification
IEC	International Electro Technical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organisation for Standardisation
ITU	International Telecommunication Union
LCN	Logical Channel Numbers
LDPC	Low Density Parity Check
mA	Milliamps
mm	millimetres
mS	milliseconds
mV	millivolts

MHz	Mega Hertz
MISO	Multiple Input/Single Output
MPEG	Motion Picture Experts Group
MUL	Multiple Language
NIT	Network Information Table
NM	Normal Mode
OFDM	Orthogonal frequency-division multiplexing
OSD	On Screen Display
OUI	Organisation Unique Identifier
PAL	Phase Alternating Line
PAT	Program Association Table
PAPR	Peak-to-Average Power Ratio
PID	Packet Identifier
PIN	Personal Identification Number
PLP	Physical Layer Pipe
PMT	Programme Map Table
PP	Pilot Pattern
PSI	Programme Specific Information
QAM	Quadrature Amplitude Modulation
QEF	Quasi Error Free
QPSK	Quadrature Phase Shift Keying
RCA	Phono connector or cinch connector
RCU	Remote Control Unit
RF	Radio Frequency
RST	Running Status Table
RTC	Real Time Clock
SCART	21-pole connector for connecting audio/video equipment
SDT	Service Description Table
SDTV	Standard Definition Television
SFN	Single Frequency Network
SI	Service Information
SIT	Selection Information Table
SISO	Single Input Single Output
S/PDIF	Sony/Philips Digital Interface
SSU	System Software Update
ST	Stuffing Table
STA	Common TV Antenna (block distribution)
STB	Set-top Box
TDT	Time and Date Table
TOT	Time Offset Table
TR	Tone Reservation
TS	Technical Specification
T _U	Useful symbol period
TV	Television
UHF	Ultra High Frequency
USB	Universal Serial Bus
V	Voltage
VBI	Vertical Blanking Interval
VHF	Very High Frequency
WLAN	Wireless Local Area Network
YP _B P _R	Component video

1 Introduction

The document defines the revised minimum technical requirements for DVB-T2/MPEG-4 Digital Set Top Boxes (STBs) for use with the DTT networks. The requirements are established to enable equipment manufacturers and/or suppliers to bring into Uganda STBs that will provide good indoor reception of digital terrestrial transmission signals.

The requirements cover both Free-To-Air (FTA) and Pay TV services.

In this document, all requirements are mandatory. Where the phrase “*may*” is used on a specific requirement, the requirement is recommended.

In the case of where a specific feature is silent in the document, the feature is regarded as being optional. The inclusion of optional features can be seen as part of the marketing strategy of the manufacturer.

1.1 Definitions

For the purpose of this document, the following definitions apply:

(a) Digital Terrestrial Television

Terrestrial delivery of digital transmissions in the UHF/VHF frequency bands using the DVB-T2 standard as set out in ETSI EN 302 755[1].

(b) Free-to-Air

Service which is broadcast and capable of being received without payment of subscription fees.

(c) Multiplex

A group of digital terrestrial television (DTT) channels that are combined together into one output signal for broadcast.

(d) Set Top Box

A stand-alone device that converts a DVB-T signal to analogue video and audio signals for presentation on a television receiver or other suitable display device.

2 General Requirements

2.1 Electromagnetic compatibility, equipment security (EMC compatibility)

The DVB-T2 STB shall comply with § 5.3, § 5.6 and § 5.7 of ISO/IEC CISPR 13[2] or equivalent based on ISO/IEC CISPR 22 [3]

2.2 Power Supply

The DVB-T2 STB may be AC powered or DC powered. For AC powered IDTV, it shall be equipped for power supply from the 230 V \pm 10 % / 50 Hz \pm 2% mains. Where external power supply is used, e.g. AC adaptor, it shall not affect the capability of the IDTV to meet the rest of the minimum specifications

For DC powered STB, it shall be capable of operating over a voltage range of 10.8 V to 14.4 V DC with a socket for connection to a 12 V DC source. Both protection against over/under-voltage and reversed polarity shall be incorporated.

2.3 Identification of the equipment

The DVB-T2 STB shall be marked with the supplier or manufacturer's name or identification mark, and the supplier or manufacturer's model or type reference. In addition, the DVB-T2 STB should be marked with the UCC certification mark to indicate to the public that the STBs meet the required technical specifications. The markings required shall be legible, indelible and readily visible.

2.4 Safety Requirements

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

2.5 Support Package

The following peripheral items should be included in the package:

- A 230 V AC to 12 V DC adapter (in the case of a DC powered STB).
- An RF lead/cable of at least 500mm with one male and one female connector at either end.
- A Composite (CVBS) and stereo audio RCA cable of 1m minimum length.
- Remote control unit complying with Section 5.5 together with 'AA' or 'AAA' sized batteries.
- An easy to understand user manual in English language in either paper or electronic form. If an electronic user manual is provided, there must be a quick installation guide and the electronic user manual must be viewable on the device.
- Provision of a coaxial cable or optical cable for digital audio is optional.
- Provision of an HDMI Cable is optional.

2.6 Power Supply Cord and Mains Plug

The DVB-T2 STB shall be fitted with a suitable and appropriate approved power supply cord and mains plug.

The power supply cord shall be certified as according to any of the following standards standards:BS 6500[5] ,IEC 60227-5[6], IEC 60245-4[7] and any other international standards.

The main plug shall be certified as according to 13A fused plugs as per BS 1363/MS 589- Part 1[8].

2.7 Processor and Memory

The processing power and memory configuration of the DVB-T2 STB must be suitable for the routine operation of digital Terrestrial reception, together with the embedded operation of the interactive application and the provision of the routine replacement of all software via “over-air download”. The configurations should cater for DDRAM , flash memory, storage memory and CPU processor for the minimum baseline functions.

2.8 Maintenance & Upgrade

To allow for software changes, the DVB-T2 STBs must be upgradeable in a practical manner, for example, over the air download. The process of upgrading should cause minimal disruption to the viewer. However, to minimise the diversity of deployed software builds and to most efficiently use the available broadcast capacity, the DBV-T2 STB must detect and act upon the broadcast of a relevant software download within 24 hours of its transmission commencing.

2.8.1 Over Air Download

- Support for the use of DVB SSU, to at least the simple profile as defined in ETSI TS 102 006 [9] is required.The DVB-T2 STBs shall be able to handle the presence of software downloads in any NIT referred carrier signal.
- The DVB-T2 STBs shall be capable of automatic (in otherwards not user initiated) software upgrade by over-air download with minimal interruption to the viewer.
- Manufacturers shall ensure that the DVB-T2 STBs offered shall only respond to a unique OUI code. This means that the DVB-T2 STB offered shall not react to any other OUI from any other manufacturer nor react to any other OUI from the same company which relates to a different model STB.
- The default DVB-SSU mode for DVB-T2 STBs shall be with DVB-SSU “enabled”.
- For Conformance testing, manufacturers will be required to deliver two ASI transport streams containing relevant converted binary image files,

together with all relevant NIT and PMT data necessary for their DVB-T2 STB to properly undergo a successful DVB-SSU operation. One stream will replace the software in the DVB-T2 STB as demonstrated by a new version number, or some other visible indicator, the other will restore the DVB-T2 STB to its then current configuration.

2.8.2 User Software Upgrade

The DVB-T2 STB may provide one or more of the following data interfaces to enable the user to perform software upgrades.

- Universal Serial Bus (USB)
- RJ 45 (Ethernet IEEE802.3)
- Appropriate Memory Card

2.9 Front Panel Features

The front panel of the DVB-T2 STB should have the following buttons:-

- a) Power button- To turn the STB on and off
- b) Programme button (CH- and CH+)- To scroll up and down through the channels
- c) Volume button (V- and V+) –To adjust the volume output level

3 Front-end Characteristics

3.1 Radio Frequencies and Bandwidths

The DVB-T2 STBs must be able to receive on all channels of TV band III(174-230MHz at a channel bandwidth of 7MHz and on all channels of TV band IV and V (470 – 694 MHz) at a channel width of 8 MHz as shown in **Table 1**.

Table 1: Mandatory Frequency Bands

BAND	FREQUENCY RANGE (MHZ)	SIGNAL BAND WIDTH (MHZ)
VHF III	174 - 230	7
UHF IV	470 - 606	8
UHF V	606 - 694	8

Note: For solving certain specific issues related to the reception of the DVB-T2 terrestrial digital television broadcasting through a STA (common antenna) it is an advantage if the STB is also capable to receive on the channels of TV band III with a channel width of 8 MHz (According the channel Band plan , it is 7MHz).

Annex 1 provides details of the TV RF channels and channel numbers.

3.2 Maximum Frequency offset

The DVB-T2 STB should be able to receive signals with an offset of up to $\pm 1/6$ MHz (166 KHz) from the nominal frequency.

3.3 Operating Modes:

The DVB-T2 STB shall be able to demodulate all non-hierarchical modes specified in the ETSI EN 302 755 [1]. The frontend shall work compatibly with any combination of constellation (QPSK, 16-QAM,64-QAM, 256 QAM), code rate ($1/2$, $3/5$, $2/3$, $3/4$, $4/5$, $5/6$), guard interval ($1/4$, $1/8$, $1/16$, $1/32$, $1/128$, $19/128$, $19/256$) and transmission mode (1K,2K,4K,8K,16K,32K[Normal Mode],8K extended,16K extended, 32K extended).

The DVB-T2 STB should be able to detect which DVB-T2 mode is being used. The DVB-T2 parameters or modes are outlined in **Table 2** below.

Table 2: DVB T2 Operational Modes

DVB T2 Parameter	Mode / requirement
Constellation	QPSK, 16 QAM, 64 QAM, 256QAM 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 FTT Size	1k, 2k, 4k, 8k normal, 8k extended, 16k normal, 16k extended, 32k normal or 32k extended
Pilot Pattern (PP)	PP1, PP2, PP3, PP4, PP5, PP6 or PP7
Antenna	SISO, MISO
Signaling 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 frame length (FEC)	64 800 bits for normal FECFRAME; 16 200 bits for short FECFRAME
Input Mode	A Single PLP or B Multiple PLP
Mode Adaptation	Normal Mode (NM), High Efficiency Mode (HEM)
Scrambling of L1 Post signaling. (L1_POST_SCRAMBLED)	Feature shall be supported by the DVB-T2 STB

3.4 Operation in Single frequency Network

The DVB-T2 STB should be able to operate in SFN with echo signals within the guard interval. When the DVB-T2 STB 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 STB should be able to select the better signal.

4 Service Information (SI)

The DVB T2 STB must be able to process the necessary SI transmitted within individual DVB-T2 transport data streams so that its proper function is secured and the end user is able to make full use of the services provided. The processing of the SI is governed by the conditions and rules set out in the EN 300 468[10] Standard.

4.1 Use of DVB SI

The DVB-T2 STB 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 STB can automatically configure itself for the selected service.

The DVB-T2 STB shall comply with the implementation guidelines outlined in the ETSI TR 101 211 [11] for the use of DVB SI as specified in the ETSI EN 300 468[10].

The SI table mechanism, syntax and semantics, and minimally, the Service Description Table (SDT), the Event Information Table (EIT) and the Time and Date Table (TDT) should be supported.

4.2 System Timing

The DVB-T2 STB should be able to make use of TDT for the device system time or Real Time Clock (RTC) setting.

4.3 Optional and Unrecognised SI

For DVB-T2 STB 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 STB should ignore any incomprehensive SI or tables. The DVB-T2 STB should discard any PSI/SI signals if it is unrecognised or not supported.

4.4 PSI/SI and PID Update

The DVB-T2 STB should 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 STB should update PSI / SI information in memory whenever any update or modification happens on a real-time basis. The DVB-T2 STB should be able to take prompt action with changes or modifications on the parameters of transmissions, networks and services.

4.5 Dynamic Response to PAT, PMT, NIT and SDT Updates

The DVB-T2 STB shall be capable of identifying changes or new services in the current channel/multiplex. And respond to these changes in real time.

Changes may occur, in particular:

- when a new programme is added to the transport flow;
- when the transmission of a certain programme is terminated;
- during regular exchange of programmes within the daily or weekly cycle;
- when switching between the regional programme versions;

- when language versions are added or removed;
- when subtitles are added;
- when the transmission frequency is changed as planned (NIT table)
- when other data services are added, such as SSU.

The number of the changed table's version is incremented with each change.

4.6 Service Identification and Logical Channel Number (LCN)

The DVB-T2 STB should 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 STB should support LCN by using descriptor with tag value is 0x83 (Version 1) and 0x87 (Version 2). **A.2.1. of Annex 2** provides important notes on logical channel numbering.

All services should be sorted, listed and managed accordingly with assigned LCN. **A.2.2. of Annex 2** lists some of the broadcast services.

In case duplicated and conflicted LCNs are found, they should be given to services with better signal quality, other services shall be arranged to reserved LCN range.

Broadcasters will be assigned with the logical channel numbering (LCN) range for terrestrial FTA channels to facilitate easy access to these channels. **A.2.3 and A.2.4 of Annex 2** provides examples of logical channel numbers for various programmes and channel numbering range for FTA channels.

The following DVB identifiers shall be used for digital terrestrial transmission: Private Data Specifier and Original Network ID. For details of the DVB identifiers, the stakeholders shall revert to Uganda Communications Commission for further clarification.

4.6.1 Logical Channel Descriptor Simultaneous Version 1 & 2 Transmissions

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

4.6.2 Listing of Broadcast Descriptors

The list of broadcast descriptors is attached in **Annex 3**.

4.7 Responses to Network Changes

4.7.1 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 STB shall recognise the change of version_number of the NIT table and that a new transport_stream_id is present in the NIT (actual).

4.7.2 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 STB 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 STB to acknowledge the presence of a new service. The DVB-T2 STB 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 [11].

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

4.7.3 Transmission mode change

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

4.8 Summary of SI transmitted and received in the DVB T2 system

Data contained in the transmitted transport streams intended for processing in DVB T2 STB are listed in Table 5.

Table 5: DVB T2 service information that is transmitted

Table	Actual
Programme association table (PAT)	M, m
Programme map table (PMT)	M, m
Conditional access table (CAT)	C, m
Network information table (NIT)	M, m
Service description table (SDT)	M, m
Event information table (EIT) present/following	M, m
Event information table (EIT) schedule	R, m
Time and date table (TDT)	M, m
Time offset table (TOT)	R, m

Running status table (RST)	R
----------------------------	---

Key:

M mandatorily transmitted

m mandatorily interpreted in the STB

C transmitted under certain conditions (e.g. in the case of paid services)

R recommended to be transmitted

5 Services

5.1 Subtitling

5.1.1 Specification for Subtitling

The DVB-T2 STB shall support DVB subtitling in accordance with ETSI EN 300 743[12] 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).

Support to at least certain characteristics is required:

- a) At least objects of type 0x00 must be drawn up (basic bit map).
- b) The range of regions must cover at least four lines of subtitles in one picture. The total number of processed points in one picture must be 112,960 points in the SD service and 457,440 points in the HD service. At least one line must be extensible to 706 • 40 points in the SD service and to 1,906 • 60 points in the HD service.
- c) At least 128 objects must be processed.
- d) At least one CLUT table must be supported with 16 items for each region. The use of the **non_modifying_colour** flag is optional.
- e) At least five transparency levels must be implemented (0%, 30%, 50%, 70% and 100%). The remaining values may be rounded to the nearest implemented levels.
- f) The receiving equipment must be able to process at least one DVB subtitle stream.

As to teletext subtitles, the STB may either decode them and display them directly or may ensure that teletext is inserted in the vertical blanking impulse (VBI) – only on the SCART, RCA interfaces.

5.1.2 Multiple Subtitling Language

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

The STB should 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 DVB-T2 STB 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 STB for subtitling set to “ON”

The primary preferred language set to “Multiple Languages” (MUL)

The secondary preferred language set to “Multiple Languages” (MUL)

5.1.3 Support for Hearing Impaired

The DVB-T2 STB should be capable of displaying subtitles for the hearing impaired. The STB should be capable of overlaying the subtitle text on the picture. The subtitles for the hearing impaired may differ from the normal subtitles by the amount of text displayed per second, which is controlled by the broadcasted content.

When enabled, subtitles will automatically be displayed. When disabled, the decoder shall allow manual selection from the available list of broadcasted subtitle services.

5.2 Electronic Programme Guide (EPG)

5.2.1 Specification for EPG

The DVB-T2 STB 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[11] and requirements defined in ETSI EN 300 468[10] . The STB shall also be able to continue to operate in the absence of EIT transmission.

- The DVB-T2 STB must provide users with a navigation function through the OSD interface to guide them through the environment of the services provided. The data necessary for preparing and updating the guide should be transmitted within the transport data stream part reserved for the transmission of service information (SI/PSI).
- The DVB-T2 STB must be able to process the EPG data flow at a rate of 1 Mbps. It is governed by the EN 300 468[10] Standard and the TR 101 211[11] Recommendation and by the ISO/IEC 13818-1[13] Standard and the ETSI TR 101 154[14] Recommendation.
- The graphic format and extent of the electronic programme guide are given by the STB’s system software, which must meet the conditions set out in the preceding sections, including localisation for the national environment.
- The DVB-T2 STB must mandatorily display the present/following information immediately after switching the programme and at any time on request (after pressing the relevant Info button to ‘DO’). The overview of the planned programmes must be available for at least seven (7) days.
- The DVB-T2 STB must display all characters of the **short_event_descriptor** item, which is responsible for displaying the name and short description of the programme.

5.2.2 EPG Presentation

EPG presentation shall include but not limited to the following:

- Service name
- Programme title
- Programme duration
- Elapsed duration (optional)
- Short description
- Long description (extended text)
- Present / following (now/next) event

- Current date/time
- Parental guidance information

The DVB-T2 STB shall provide an EPG organizer to access Next seven-day programme guide with all information in above list. It should be a practical and easy to use search function.

5.2.3 Languages and Fonts

The STB shall support the approved character coding for EPG and other labeling decoding and presentation. Table 6 provides the format of the character coding details.

Table 6: Character coding details

Font	Coded Character Set	First byte
-	-	-

In relation to the approved character coding, the stakeholders shall revert to the Uganda Communications Commission (UCC) for further clarification.

5.2.4 Parental Lock Feature

The DVB-T2 STB shall have parental lock capabilities to block television programme with a particular Classification Code from being shown unless the correct PIN code is entered by the user.

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

The Classification Codes are defined as follows:

- General (G) – Suitable for all ages;
- Parental Guidance (PG) – Suitable for all, but parents should guide their young;
- Parental Guidance 13 (PG13) – Suitable for persons aged 13 and above but parental guidance is advised for children below 13;
- No Children Under 16 (NC16) – Suitable for persons aged 16 and above;
- Mature 18 (M18) – Suitable for persons aged 18 and above; and
- Restricted 21 (R21) – Restricted to persons aged 21 and above.

5.2.5 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 programme title or programme description by the broadcaster.

Manufacturers can add additional displays of programme ratings, but they must display the full rating information.

5.3 Multi-Language Support

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

Language	ISO 639-3 Code
English	ENG
Swahili	SWH
French	FRA
Original Audio	QAA*
Multiple Languages	MUL**

* Original Audio is only applicable for Audio

** Multiple Languages is only applicable for Subtitle

5.4 Teletext

The DVB-T2 STB should be able to demultiplex in parallel with the teletext service transmitted in a packetised format according to ETSI EN 300 472 [15]. The DVB-T2 STB shall be able to display teletext service, meeting the requirements for at least Level 1.5. Details of the presentation levels are provided in ETSI EN 300 706 [16].

5.5 Remote Control Unit (RCU)

An RCU shall be bundled with the DVB-T2 STB. 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 STBs.

The DVB-T2 STB's remote control interface will need to have inbuilt hysteresis, allowing enough time to capture a single, double or triple digit entry. This is to cater for the possibility of large numbers of services thus requiring the TV receivers to expect up to three (3) numbers, entered via remote control, to select the LCN of a programme service. The list of basic and digital TV function keys is attached in Annex 4.

It is recommended that manufacturers make available alternative Remote Control Units for those with impaired vision or impaired manual dexterity (e.g. over-sized keys and character fonts, shaped keys).

5.5.1 Reliability

(a) Robustness

The RCU shall be designed to withstand frequent usage, with a robust case that is resistant to damage from being dropped onto hard surfaces or sat upon.

(b) Environmental

The RCU shall be designed to work in the same environmental conditions (i.e. ambient temperature and humidity) as specified for the STB decoder.

(c) Key life

The design of the key mechanism shall be such as to provide a minimum of five (5) years operation under normal expected usage.

5.5.2 Channel Entry

All television, radio and interactive services will be assigned a three-digit LCN. The RCU shall be configured for three-digit LCN operation.

5.6 Signal Strength and Quality Bar

The DVB-T2 STB 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.

5.7 Service Unavailability

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

5.8 Listing of All Available Services

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

5.9 First-time Power Up

Upon powering up for the first-time, the DVB-T2 STB 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 services, and;
- d) Set other configurations (user data, preferences and others).

5.10 Initial Channel Scan

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

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

6 Interfaces and Connectors

6.1 RF Input Connector

The connector at the input of the DVB-T2 STB must be of the IEC female type with an impedance of 75 Ω according to the IEC 60169-2 [17] recommendation.

The input connector may provide input for connecting an active antenna and in such case it must meet the following parameters:

Table 7: Required parameters for input connector

voltage	5 V (the positive conductor being the central wire)
current load	Minimum 30 mA, short-circuit protected
control	ON/OFF from the STB's user interface
Initial status	OFF

6.2 RF Output Connector

The DVB-T2 STB 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 cover VHF and UHF frequencies given in Annex 1.
- c) The RF loop-through signal shall be present independently from the status of the DVB-T2 STB (operational or standby), such that the 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 be 4dB and when the RF bypass gain is enabled, the RF bypass gain should be from -1 dB to $+3$ dB.

6.3 Modulator output

The DVB-T2 STB should provide a re-modulated output for use with a PAL TV receiver. If so, the output must be tunable to any of the channels listed in VHF and UHF Bands as indicated in Annex 1. The peak signal level should be 3 mV nominal across 75 ohm (-39 dBm).

6.4 Antenna Output Power

The DVB-T2 STB may 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.

6.5 Component Analogue Outputs

The DVB-T2 STB may provide component analogue output (Y_PB_R).

6.6 HDMI

The DVB-T2 STB shall provide HDMI interface for digital video and audio output. HDMI interface must comply with the specification of HDMI release 1.3 or higher releases.

The HDMI profile used by the STB shall be able to at least output the highest resolution supported by the STB.

6.7 Copy Protection on Outputs

The DVB-T2 STB that has the HDMI interface above shall provide High Bandwidth Digital Content Protection (HDCP) on the HDMI output for all output resolutions.

6.8 Common Interface

A common interface slot is optional for FTA STBs. All pay TV DVB-T2 STB shall incorporate a DVB-CI (Common Interface) slot. This slot shall be a certified CI+ slot as outlined in CI+ specification V1.3[18] meeting all the required robustness rules.

6.9 SCART Interface

The configuration of the SCART interface must be in compliance with the EN 50049-1[19] Standard and in certain cases also EN 50157-2-1[20] Standard. Presence of another SCART interface, enabling connection of external equipment, is recommended for the DVB-T2 STBs.

6.10 Summarised Table of the Audio and Video Interfaces.

The tables below show an overview of A/V inputs/outputs to be available in the receiving equipment of each category.

Table 8: A/V Inputs/Outputs

VIDEO		DVB-T2 STB
SCART	input	N/A
	output	R
RCA (composite)	input	N/A
	output	M
RCA (component YPbPr)	input	N/A
	output	R
HDMI	input	N/A
	output	M
HDCP	Input	N/A
	Output	M

AUDIO		DVB-T2 STB
SCART	input	N/A
	output	R
RCA (stereo L/R)	input	N/A
	output	M
S/PDIF	input	N/A
	output	M
HDMI	input	N/A
	output	M
Headphone output 3.5 mm jack	output	N/A

M- Mandatory: O- Optional: R- Recommended, N/A - Not Applicable

6.11 Data Interfaces and Interactivity

The DVB-T2 STB may be furnished with any of the interfaces indicated below, intended for data transmission:

Table 9: Data Interface

Data Interface	Prevailing Use	STB
RS-232C	servicing (e.g., for equipment firmware updating)	R
USB	servicing (e.g., for equipment firmware updating); for content playing/recording from/to external storage device	R
Ethernet under IEEE 802.3 (at least 100Base-T)	back channel, internet access	R
WLAN under IEEE 802.11, b, g	back channel, internet access	O

O- Optional: R- Recommended

If any data interface is used for recording the received content to an external storage medium, the protection (if any) against unauthorised access must also be maintained in the data provided at such an interface (i.e., the data at this interface must not be modified by decoding or removing this protection).

When any of the interfaces (Ethernet, WLAN) is used as a back channel, it is recommended – as a platform for the provision of interactive services – to use the HbbTV system implemented in accordance with the current versions of the technical specifications of ETSI TS 102 796[21] (Hybrid Broadcast Broadband TV) and ETSI TS 102 809[22] (Digital Video Broadcasting (DVB); Signalling and carriage of interactive applications and services in Hybrid broadcast/broadband environments).

7 Video & Audio Decoding Requirement

7.1 Video Decoding

The DVB-T2 STB shall be able to decode video formats as specified below for SDTV and HDTV based on the ITU-T Recommendation H.264[23] or ISO /IEC 14496-10[24] .

1. Standard Definition SDTV

- Main Profile @ Level 3
- Frame frequency 25 Hz
- Image format / Aspect Ratio 4:3, 16:9
- Definition 720, 704, 544, 480 (point) x 576 (lines).

2. High Definition HDTV

- High Profile @ Level 4
- Frame frequency 25 and 50Hz (see the table below)
- Image format Aspect Ratio 16:9
- Formats supported: at least by details in Table 10 below.

Table 10: Details based on ITU-T R H.264 /or ISO / IEC 14496-10

Vertical size	Horizontal size	Frame rate	Progressive/ Interlaced
1080	1920	25	I
1080	1440	25	I
720	1280	50	P

7.1.1 Aspect Ratio

The DVB-T2 STB 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.

7.1.2. Active Format Description (AFD)

When AFD is used, the DVB-T2 STB 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 DVB-T2 STB shall support at least the Active Formats shown in Table 11.

Table 11: Active format

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)

Refer to Annex 5 for the illustration on the required outputs based on the AFD values specified.

7.2 Audio Decoding

The DVB-T2 STBs must support (decode) sounds compressed:

- In accordance with the ETSI TS 101 154 [14] i.e. MPEG-1 Audio Layer II (with bit streams according to specification, using sampling rates of 32, 44.1 and 48 kHz and with support to the stereo, joint stereo and mono modes);
- In accordance with the ISO/IEC 14496-3[24] standard, coding MPEG-4 HE AAC. Support to multichannel (surround) audio in this format is also recommended;
- In the E-AC-3 (Dolby Digital Plus) format, including multichannel (surround) audio. The equipment must enable transparent E-AC-3 transmission via HDMI output, and provide conversion from E-AC-3 to AC-3 for S/PDIF output. As to multichannel audio, the equipment must enable conversion to stereo audio (L/R) and enable audio description.

8 DVB-T2 Performance Requirements

8.1 Minimum sensitivity (DVB-T2)

The ETSI TS 102 831[25] technical specification (DVB BlueBook A133) contains tables of minimum spacing between signal (carrier) and noise (C/N) necessary to reach the required error rate level at a FEC frame length of 64800 bits. Upon corrections, taking into account the transmission mode used (32k), the pilot carrier distribution (pilot pattern PP2 and PP4, respectively), the tolerance respecting the assumed practical implementation of the DVB-T2 STB and the error rate roughly corresponding to QEF reception ($BER = 1 \times 10^{-7}$ after LDPC decoder), these values of the minimum C/N required for the individual modes of the T2 signal and the Gaussian channel are as indicated in the table below:

Table 12: Minimum C/N for the individual modes of the T2 signal and the Gaussian channel

Constellation	Code rate	Gaussian channel C/N [dB] for 32k, PP2	Gaussian channel C/N [dB] for 32k, PP4
QPSK	1/2	3.5	3.1
	3/5	4.7	4.3
	2/3	5.6	5.2
	3/4	6.6	6.2
	4/5	7.2	6.8
	5/6	7.7	7.3
16-QAM	1/2	8.7	8.3
	3/5	10.1	9.7
	2/3	11.4	11.0
	3/4	12.5	12.1
	4/5	13.3	12.9
	5/6	13.8	13.4
64-QAM	1/2	13.0	12.6

	3/5	14.8	14.4
	2/3	16.2	15.7
	3/4	17.7	17.3
	4/5	18.7	18.3
	5/6	19.4	18.9
256-QAM	1/2	17.0	16.5
	3/5	19.4	18.9
	2/3	20.8	20.4
	3/4	22.9	22.4
	4/5	24.3	23.8
	5/6	25.1	24.6

From the indicated minimum C/N values necessary to provide QEF reception, it is possible, using a simple calculation, to derive the minimum necessary levels of the T2 signal at the receiving equipment's input, or the minimum sensitivities for the individual mode combinations.

The calculations used:

$$P_n = F + 10 \log (kT_0B) + 30$$

$$P_{smin} = P_n + C/N$$

where

- B – noise bandwidth of the DVB-T2 STB [Hz]
- C/N – minimum spacing between signal and noise required by the system [dB]
- F – noise number of the DVB-T2 STB [dB]
- P_n – input noise performance of the DVB-T2 STB [dBm]
- P_{smin} – minimum signal performance at DVB-T2 STB input [dBm]
- k – Boltzmann’s constant = 1.38 x 10⁻²³ Ws/K
- T₀ – absolute temperature = 290 K

The minimum levels necessary for QEF reception for the individual T2 signal modes are indicated in the table 13 below. The values are indicated for the bandwidth of B = 7.77 MHz (corresponding to the 8 MHz channel) and for DVB-T2 STB noise figure F = 6 dB.

Table 13: The minimum levels necessary for QEF reception for the individual T2 signal modes.

Constellation	Code rate	Gaussian channel min. sensitivity [dBm] for 32k, PP2	Gaussian channel min. sensitivity [dBm] for 32k, PP4
QPSK	1/2	-95.5	-96.0
	3/5	-94.3	-94.8
	2/3	-93.4	-93.9
	3/4	-92.4	-92.9
	4/5	-91.8	-92.3
	5/6	-91.3	-91.8
16-QAM	1/2	-90.3	-90.8
	3/5	-88.9	-89.4
	2/3	-87.6	-88.0
	3/4	-86.5	-86.9
	4/5	-85.7	-86.1
	5/6	-85.2	-85.6
64-QAM	1/2	-86.0	-86.4
	3/5	-84.2	-84.6
	2/3	-82.9	-83.3
	3/4	-81.3	-81.8
	4/5	-80.3	-80.7
	5/6	-79.7	-80.1
256-QAM	1/2	-82.0	-82.5
	3/5	-79.7	-80.1
	2/3	-78.2	-78.6
	3/4	-76.2	-76.6
	4/5	-74.7	-75.2
	5/6	-73.9	-74.4

DVB- T2 STB must reach the minimum sensitivity values indicated in the table above for the individual modes. The noise figure must be equal to 6 dB at the maximum in all frequency bands (bands III, IV and V).

8.2 Maximum input signal

DVB- T2 STB must enable QEF reception for T2 signals up to the level of -35 dBm.

8.3 STB decoder immunity to digital signals in other channels

DVB- T2 set top boxes must enable QEF reception in the presence of an interfering DVB-T2 signal on a neighbouring, mirror or other channel, provided that the maximum admitted ratio between the interfering and useful signal I/C shown in the table below is not exceeded.

Table 14: Minimum required I/C for QEF reception with interfering DVB-T2 signals

Band	Bandwidth [MHz]	Minimum I/C ratio [dB]		
		adjacent channels	other channels	mirror channels
TV band III	7	28	38	---
TV band IV	8	28	38	28
TV band V	8	28	38	28

REFERENCED STANDARDS

All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below.

- [1] 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)
- [2] IEC CISPR 13 (Jun 2009) Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement
- [3] IEC CISPR 22 (Sept 2008) Information Technology equipment – Radio disturbance characteristics – Limits and methods of measurement
- [4] IEC 60065 (Feb 2011) Audio, video and similar electronic apparatus – Safety Requirements
- [5] BS 6500 - British Standard, which specifies the requirements for flexible cables with voltage ratings up to 300V/500V used in appliances and equipment intended for domestic, office or similar environments
- [6] IEC 60227-5: Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 5: Flexible cables (cords)
- [7] IEC 60245-4 Edition 2.2-2004 Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 4: Cords and flexible cables
- [8] BS1363/MS589 - Specification for rewirable and non-rewirable 13A fused plugs
- [9] ETSI TS 102 006 v1.3.2 (2008-07) Digital Video Broadcasting (DVB); Specification for System Software Update in DVB Systems.
- [10] ETSI EN 300 468 v1.13.1 (2012-04) Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems
- [11] ETSI TR 101 211 v1.9.1 (2009-06) Digital Video Broadcasting (DVB) Guidelines on implementation and usage of Service Information (SI)
- [12] ETSI EN 300 743 v1.4.1 (2010-11) Digital Video Broadcasting (DVB); Subtitling systems
- [13] ISO/IEC 13818-1 Information technology — Generic coding of moving pictures and associated audio information systems
- [14] ETSI TR 101 154 V1.11.1 (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
- [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 Radio-frequency connectors, Part 2: Coaxial unmatched connectors
- [18] CI Plus specification V1.3 (2011-01) CI Plus Specification, Content Security Extensions to the Common Interface
- [19] EN 50049-1(1997) Domestic and similar electronic equipment interconnection requirements: Peri-television connector
- [20] EN 50157-2-1 (1999) Domestic and similar electronic equipment interconnection requirements: AV. link. Signal quality matching and automatic selection of source devices
- [21] ETSI EN 102 796 v1.2.1 (2011-12) Hybrid Broadcast Broadband TV
- [22] ETSI TS 102 809 v1.1.1 (2001-10) Signalling and carriage of interactive applications and services in hybrid broadcast/broadband environments
- [23] ITU-T Rec. H.264 (2003-12) Advanced video coding for generic audiovisual services.
- [24] ISO/IEC 14496-28 (2012), Information technology, Coding of audio-visual objects, Part 28: Composite font representation
- [25] ETS EN 102 831 V1.2.1_(2008-12) Implementation guidelines for a second generation digital terrestrial television broadcasting system (DVB-T2)

ANNEX 1 Table of the TV RF channels and Channel Numbers

TV Band III Bandwidth 7 MHz		TV Band III Bandwidth 8 MHz		TV Band IV/V Bandwidth 8 MHz	
Channel	Frequency ¹ [MHz]	Channel	Frequency ¹ [MHz]	Channel	Frequency ¹ [MHz]
5	177.5	6	178	21	474
6	184.5	7	186	22	482
7	191.5	8	194	23	490
8	198.5	9	202	24	498
9	205.5	10	210	25	506
10	212.5	11	218	26	514
11	219.5	12	226	27	522
12	226.5			28	530
				29	538
				30	546
				31	554
				32	562
				33	570
				34	578
				35	586
				36	594
				37	602
				38	610
				39	618
				40	626
				41	634
				42	642
				43	650
				44	658
				45	666
				46	674
				47	682
				48	690

¹ Frequency in the centre of the channel's frequency range

ANNEX 2 Logical Channel Numbering

A.2.1 Important Notes on Logical Channel Numbering

- LCNs can range from 1 to 999. In order to provide some recognised order to the various programme choices, a scheme has been devised which allows services to be selected from
 - 1 a single button push – 1 to 9;
 - 2 a double button push – 10 to 99;
 - 3 a triple button push – 100 to 999.
- The possibility of large numbers of services requires DVB-T2 STBs to expect up to 3 numbers, entered via remote control, to select the LCN of a programme service. This means that the STB's remote control interface will need to have inbuilt hysteresis, allowing enough time to capture a single, double or triple digit entry.
- In the DTT implementation of the Logical Channel Number descriptor, a service can be identified by more than one logical channel. This allows Logical Channel “place markers” to be present all the time, pointing to virtual services with no additional data bandwidth overhead, providing the broadcaster with the ability to dynamically re-assign the logical channel number of an intermittent or absent service, to another service that is currently present, even though that service already has an existing LCN allocated to it.
- The implementation of the Logical Channel Number is of benefit to both the broadcaster and the viewer.

For the viewer:

- 1) A familiar menu of numbered service listings is maintained; and
- 2) The DVB-T2 STB will not attempt to select an absent service with unpredictable results.

For the broadcaster:

- 1) The service list can be efficiently maintained without the need to reserve (waste) valuable data bandwidth to maintain absent (empty) services.
- **Without an organised system of user readable programme numbering;**
 1. A broadcaster has no control over the order and priority of the transmitted services;
 2. An STB could assign numbers as it finds them, either during the initial set-up and tuning process, or in the process of finding new services.

A.2.2 Examples of Broadcast Services

Each broadcast station may offer several types of service including:

- A main service, presumably the SD service,
- A HDTV service
- Multiple SD programme channels
- Multi-view SD channels,
- Digital radio services,
- Interactive television,
- Data-broadcasting
- Enhancement/information services.

A.2.3 Example of Channel Numbering Range for LCN channels

001 – 009	Free To Air Local Programming Channels
010 –099	Free To Air Regional (East African and other African channels) Free to Air International Programming channels
100 – 999	Subscription / Pay to View Programming Channels. Digital radio / Audio services. Data Services

A.2.4 Example of Channel Numbering Range for FTA channels

001 – 005	Free to Air Public Broadcaster MUX programming
010 – 030	Free to Air Incumbent analogue broadcasters
035 – 055	Free to air Regional (East Africa and other parts of Africa) programming.
060 -070	Free to air International Programming Channels.

ANNEX 3 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.

This is extracted from ETSI EN 300 468 Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems.

ANNEX 4 Basic and Digital TV Function Keys

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

- a) Power on/off [on/off] – turn the DVB-T2 STB on and off
- b) Programme up/down [P+, P-] – switch between programmes
- 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 STB 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 Programme Guide.

ANNEX 5 AFD Illustration for Required TV Output Display

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

This is extracted from **IDA/MDA TS DVB-T2 IRD Issue 1 Rev 1, March 2013**