
Minimum Requirements for DVB-T2 Devices in Germany

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1. Introduction

1.1. Background

In Germany the digital terrestrial television DVB-T will be replaced by the more efficient successor DVB-T2 from mid-2016 onwards. The migration process will be concluded with the shutdown of the last DVB-T transmitter in 2019.

With comparable reception conditions DVB-T2 offers an increased supply security, more flexibility and a 50% higher transmission capacity compared to DVB-T. In combination with the very efficient new video compression format High Efficiency Video Coding (“HEVC” or H.265) the system enables economic broadcasting of TV content in high definition (“HD”) across the terrestrial broadcasting network.

Furthermore, the Digital Dividend II leads to the loss of frequencies above 694 MHz for the terrestrial broadcasting.

Against this background the public and private television broadcaster as well as the network operator decided to initiate a migration process to the modern DVB-T2 / HEVC network coordinated by the State Media Authorities.

Contemporaneously with the introduction of the new transmission standard, the operation of a Germany-wide commercial DVB-T2 platform as well as the encrypted distribution was determined.

Public broadcaster signals will still be unencrypted receivable after the migration to DVB-T2.

After the migration process completion and with the DVB-T shutdown, frequencies over 694 MHz are used for mobile telecommunication.

1.2. Scope

This document describes the minimum requirements on IDTVs and set top boxes (in the following called “devices”) designated for the reception of DVB-T2 signals in Germany. Only Devices without an integrated conditional access system are covered by this document.

Concerning the reception modes this document focusses on stationary reception with a roof-top antenna and on portable-indoor or portable-outdoor reception with non-moving antennas. The minimum requirements described in this document are based on open standards and follow DVB, D-Book and NorDig Unified v. 2.5.1 [18], but include specific requirements regarding the conditions in Germany.

The existing documents (D-Book and Nordig [18] specification) can only serve as a basis document on reception development as they do not sufficiently define the technical specifications for the launch of DVB-T2 in Germany. The special features in Germany are for example (1) the usage of HEVC, (2) the possibility to receive the signals with portable devices and (3) the device stability after the implementation of LTE signals in the frequency band immediate above 694 MHz.

All of the receiving units for DVB-T2 in Germany should be compatible to the minimum requirements and branded with a logo.

Details regarding the logo usage will be released soon by Deutsche TV-Plattform (DTVP) (www.tv-plattform.de).

The minimum requirements on DVB-T2 devices were developed as part of the round table of the State Media Agencies on the implementation of DVB-T2 in Germany by representatives of the State Media Agencies, the public and private broadcasters, some industry representatives as well as ZVEI and VPRT.

The minimum requirements described in this document do not apply for devices with integrated conditional access system, which operates in accordance to the DVB-T2 platform provider. The DVB-T2 platform provider is responsible regarding the specifications of these device classes that can be received by respectively.

It shall be possible to receive, display and use free to air DVB-T2 broadcast signals that are compliant with the minimum requirements of this document with receivers of the commercial DVB-T2 platform.

1.3. Version History

1.0	E. Möller	Elmar.moeller@media-broadcast.com	Initial Release on behalf of workgroup members
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 - [20] EBU Tech 3348 'Frequency and network planning aspects of DVB-T2', Revision 3, Geneva, November 2013
 - [21] Report ITU-R BT. 2254 „Frequency and network planning aspects of DVB-T2“, 11/2013
 - [22] ETSI TS 102 831 V1.2.1 (2012-08): Digital Video Broadcasting (DVB); Implementation guidelines for a second generation digital terrestrial television broadcasting system (DVB-T2)
 - [23] ETSI TS 102 366 V1.3.1 (2014-08): Digital Video Broadcasting (DVB); Digital Audio Compression (AC-3, Enhanced AC-3) Standard
 - [24] NorDig Unified Test Plan for Integrated Receiver Decoders for use in cable, satellite, terrestrial and IP-based networks, NorDig Unified Test plan, ver 2.4
 - [25] EBU Tech 3344 V2.0 (2015-05): Practical guidelines for distribution systems in accordance with EBU R 128

1.5. Abbreviations

AAC:	Advanced Audio Coding
AC-3:	Audio Coding 3 (Dolby Digital)
ACS:	Adjacent Channel Suppression
CAM:	Conditional Access Module
CI:	Common Interface
DASH:	Dynamic Adaptive Streaming over Http
DRM:	Digital Rights Management
DVB:	Digital Video Broadcasting
E-AC-3:	Enhanced AC-3 (Dolby Digital Plus)
EIT:	Event Information Table
EPG:	Electronic Program Guide
FEF:	Future Extension Frames
FFT:	Fast Fourier Transformation
HbbTV:	Hybrid Broadcast Broadband Television
HDCP:	High-bandwidth Digital Content Protection
HDMI:	High Definition Multimedia Interface
HE AAC:	High Efficiency Advanced Audio Codec
HEVC:	High Efficiency Video Coding
IDTV:	Integrated Decoder Television
LCN:	Logical Channel Number
MPEG:	Moving Pictures Expert Group
MMI:	Man Machine Interface
NID:	Network Identifier
NIT:	Network Information Table
ONID:	Original Network Identifier
OSD:	On Screen Display

PLP:	Physical Layer Pipe
PP:	Pilot Pattern
PSK:	Phase Shift Keying
QAM:	Quadrature Amplitude Modulation
QPSK:	Quadrature Phase Shift Keying
SDT:	Service Description Table
SI:	Service Information
SID:	Service Identifier
STB:	Set Top Box
TFS:	Time Frequency Slicing
TSID:	Transport Stream Identifier
UI:	User Interface
USB:	Universal Serial Bus

1.6. Definitions

The following terminology definition is used in this specification:

Terminology	Definition	Explanation
shall	Requirement	Implementation mandatory
shall not	Requirement	Implementation prohibited
<i>should</i>	Recommendation	Implementation recommended, but not mandatory
<i>should not</i>	Recommendation	Implementation not recommended, but not prohibited
<i>may</i>	Permission	Implementation allowed
<i>need not</i>	Permission	Implementation not necessary

2. Hardware and supplied equipment

2.1. Connectivity

This section lists the physical interfaces required for IDTVs and/or STBs and thus mainly indicates the presence of mandatory interfaces. More information detailing the functionality exported through these interfaces are given in further sections of this document.

2.1.1. Terrestrial Reception Front End

The device shall at least have one common commercially available antenna connector. One example reference could be IEC 61169-2 [14].

It should be possible to activate 5V antenna power in device software.

2.1.2. HDMI

STBs shall have a minimum of one HDMI [6] output and shall support HDCP.

2.1.3. S/PDIF

The device should have an S/PDIF Interface (either an optical or coaxial outputs), compliant with ISO/IEC 60958-1 [7].

2.1.4. RCA

The device should have RCA Audio left (colour – white) and right (colour – red) connectors for analogue audio output.

2.1.5. COMPONENT VIDEO

STBs should have a minimum of one component video output.

2.1.6. SCART

The device should have a minimum of one SCART interface, as defined in [8].

2.1.7. Network Interface

The device should support network connectivity via RJ 45 (Ethernet IEEE802.3) or Wifi (IEEE802.11).

3. Front End

3.1. DVB-T

All reception devices shall be “DVB-T Minimum Requirements and Guideline for DVB-T Receivers” [19] compliant.

Section is valid until German DVB-T switch off.

3.2. DVB-T2

3.2.1. General Standard Compliance

The device shall generally comply with the specifications of the DVB-T2 standard ETSI EN 302 755 [12] with the following restriction, that devices are not required to decode FEFs but they should not be disturbed by them as long they follow the pattern described in section 13 of the DIGITAL EUROPE White paper: Standardized DVB-T2 RF specifications [13].

3.2.2. Bandwidth

Device shall support 8 MHz bandwidth according to ETSI EN 302 755 [12]. It is not required to support 1.7 MHz, 5 MHz, 6 MHz, 7 MHz or 10 MHz bandwidth signals.

Device shall support Normal and Extended Carrier mode.

3.2.2.1. Tuning Range

The device shall support the tuning range 470 MHz – 790 MHz (center frequencies 474 MHz – 786 MHz).

Note:

Due to Digital Dividend II, frequencies above 694 MHz will not be used in Germany for digital terrestrial broadcasting in future. Until the end of the migration process from DVB-T to DVB-T2 in Germany the devices need to support the entire frequency band 470 - 790 MHz. After DVB-T switch off in Germany, devices need not to support frequencies above 694 MHz, but should provide adequate protection against interferences from LTE services above 694 MHz (see also section Interference Immunity).

3.2.2.2. DVB-T2 Variants & Dynamic Changes

The device shall be capable of receiving and demodulating DVB-T2 signals with any valid combination of the following parameters as specified in [12]:

FFT Sizes	1K, 2K, 4K, 8K, 16K and 32K
Constellations	QPSK, 16-QAM, 64-QAM and 256-QAM, all rotated and unrotated
Forward Error Correction Codes	1/2, 3/5, 2/3, 3/4, 4/5 and 5/6
Guard Intervals	1/128, 1/32, 1/16, 19/256, 1/8, 19/128 and 1/4
Pilot Patterns	PP1, PP2, PP3, PP4, PP5, PP6 and PP7
PLPs	Single PLP, Multiple PLP Type 1 and 2

The device shall be able to receive SISO and MISO transmissions, modulations with and without rotated constellation, and shall support the usage of extended carrier mode.

When tuning to a broadcast signal, the device shall be capable of automatically detecting the modulation parameters.

The device shall not be required to handle Time Frequency Slicing (TFS) mode.

The device shall be able to receive DVB-T2 transmissions consisting of a single PLP and transmissions consisting of a common PLP together with one or more data PLPs.

The DVB-T2 specification [12] provides the possibility of a really enormous number of modulation parameter combinations. However, only a small subset is being used in real installation or may be specified in industry specifications.

The table 3.2.2.2 below contains a subset of parameter combinations identified as probably most interesting candidates. This should give the manufacturer an indication on which modes they may concentrate for more extensive testing.

For most of the DVB-T2 variants in the table below, NorDig Unified v.2.5.1 [18] does not give explicit performance figures in their strongly limited set of examples. But [18] provides a scheme (see chapter 3.4.10.3, page 47 in [18]) that shall be used to derive all other required mandatory performance figures for all other T2 modes not given in examples for i.e. modes with other Pilot Pattern.

DVB-T2 Variant	FFT	Constellation	LDPC Code Rate	GI	Pilot Pattern	nTi/Lf	Data Rate [mbps]
G1	16K	64 QAM	1/2	19/128	PP2	3/119	18,32
G2	16K	64 QAM	3/5	19/128	PP2	3/119	22,01
G3	32K	64 QAM	3/5	1/16	PP2	3/64	23,87
G4	16K	64 QAM	2/3	1/8	PP3	3/120	26,04
G5	16K	64 QAM	2/3	19/256	PP2	3/129	26,24
G6	32K	256 QAM	3/5	1/32	PP4	3/56	33,53
G7	32K	64 QAM	2/3	1/16	PP2	3/64	26,56
G8	32K	64 QAM	2/3	1/16	PP4	3/62	27,60
G9	16K	64 QAM	1/2	19/256	PP2	3/129	19,62
G10	16K	QPSK	1/2	19/128	PP2	3/121	6,09

Table 3.2.2.2 DVB-T2 Variants

For all DVB-T2 modes in the table above non-rotated constellation, extended carrier mode (except variant G6) and an LDPC block length of 64.800 bits is used. The L1 Information is modulated with BPSK generally.

Data Rates and Pilot Pattern are given for SISO Modulation. Tone Reservation for PAPR reduction is not considered. High Efficiency Mode (HEM) is considered, Null Packet Deletion is not considered.

3.2.2.3. Performance Requirement

The NF and C/N values together determine the minimum signal level provided in section 3.2.2.6 as an essential requirement.

Note:

The performance requirements for DVB-T2 with respect to C/N are based on computer simulations plus a reasonable implementation margin. The specified performance figures will be reviewed for a future update of this specification, when more information about realistic receiver performance is available from laboratory and field tests. The review may result in modifications of the specified figures and in additional requirements (see also NorDig Unified v.2.5.1 [18], Chapter 3.4.10.1).

First measurement results from lab and from field tests (see e.g. also [20], Annex A4.2) give the following indication: For the Gaussian channel, the calculated C/Ns are 1.5 - 2.0 dB higher than the measured. A similar tendency can be observed for the static Rayleigh channel, where the calculated values are about 1 dB higher than the measured values.

3.2.2.4. Receiver Noise Figure

The tuner noise figure shall be 6 dB or better in accordance with NorDig Unified v.2.5.1 [18].

Note:

The noise figure is already included in the values of section 3.2.2.6.

3.2.2.5. C/N Performance

The device shall comply with the C/N values for Gaussian channels as required by NorDig Unified v.2.5.1 [18] in chapter 3.4.10.3 and NorDig Unified Test plan, ver 2.4 (Table 2.3 und Table 2.4)[24].

Table A in Annex A includes a compilation of the concrete values for DVB-T2 variants G1 to G10 (column $C/N_{Gauss}[dB]$)

In addition the device should comply with C/N values in table A Annex A (columns $C/N_{Rice}[dB]$ and $C/N_{Rayleigh}[dB]$) for Rice and Rayleigh channels derived from the methodology described in Report ITU-R BT.2254 [21]. The channel models for Rice and static Rayleigh profile should be applied as defined in ETSI TS 102 831 [22]^{*1)}. These C/N values may be used as an orientation for network planners and manufacturers and offers the possibility to produce feedback for future adjustments.

*1)

For the 21 path Ricean fading profile defined in [22] Table 39, i.e. path 20 or i.e. another weak path may be omitted for practical tests using fading simulators providing only 20 paths.

3.2.2.6. Minimum Input Levels

The device shall be compliant with performance requirements as derived in chapter 3.4.10.4 in NorDig Unified 2.5.1 [18] for the required minimum input levels.

3.2.2.7. Maximum Input Level

The device shall support the maximum input level of -25 dBm in the receiving channel.

3.2.2.8. Multipath Operation

3.2.2.8.1. Tolerance to Equal Amplitude SFN Signals

The device shall comply with specification of NorDig Unified v.2.5.1 [18] chapter 3.4.10.3 Table 3.11 and NorDig Unified Test plan, ver 2.4 (Table 2.3 und Table 2.4)[24] respectively for C/N values for the 0 dB echo channel.

The wanted signal includes the direct path signal and an echo. The echo has the same power (0 dB echo) as the direct path signal and is delayed from 1.95 μ s to 0.95 times the guard interval length and has 0 degree phase at the channel center.

Table A in Annex A includes a compilation of the concrete values for DVB-T2 variants G1 to G10 (column $C/N_{0\text{ dB}}[dB]$)

3.2.2.8.2. Presence of Echoes

The device shall comply with specification of NorDig Unified v.2.5.1 [18]. The same values as described in 3.2.2.8.1 shall be obtained when the channel contains two static paths with a relative delay from 1.95 μ s to 0.95 times the guard interval length, independently of the relative amplitudes and phases of the two paths.

For specific echo attenuation, the required C/N shall not be more than 1 dB higher compared to the median value when calculated for the required C/N values over the echo delays from 1.95 μ s up to 0.95 times guard interval length.

3.2.2.8.3. Presence of Echoes outside the guard interval

The device shall comply with specification of NorDig Unified v.2.5.1 [18] chapter 3.4.10.9, particularly with regard to Table 3.22.

The device shall be able to correctly equalise the signal for an echo range (i.e. distance from first to last echo) up to 57/64 (\approx 89,1%) of the Nyquist time for the scattered pilots (after time interpolation) for a particular FFT size, pilot pattern and RF bandwidth, independently of the echo profile.

Neglecting other interference sources, the equivalent total available $C/(N+1)$ in a given location can be determined by the formula given in NorDig [18] Annex B.

For echoes outside the guard interval, QEF reception should be possible with echo levels up to the values presented in table below. This table gives some additional test values for the performance outside the guard interval for the most interesting DVB-T2 variants. The underlying concept is based on NorDig Unified v.2.5.1 [18]. Deviating from the methodology applied by NorDig Unified v.2.5.1 [18], the echo attenuation in Table 3.2.2.8.1 are calculated by assuming the C/N values for 0 dB echo channel from table A in Annex A column $C/N_{0\text{ dB}}[dB]$.

The values in Table 3.2.2.8.1 are less demanding compared to the matching values in Table 3.22 from NorDig Unified v.2.5.1[18].

Delay [μ s]	Echo attenuation [dB]											
	-530	-420	-320	-260	-200	-160	160	200	260	320	420	530
DVB-T2 variants												
G1	*	*	*	*	*	*	*	*	*	*	*	*
G2	*	*	*	*	*	*	*	*	*	*	*	*
G3	9,8	7,6	3,8	*	*	*	*	*	*	3,8	7,6	9,8
G4	*	*	*	*	*	*	*	*	*	*	*	*
G5	*	*	*	10,8	7,7	2,6	2,6	7,7	10,8	*	*	*
G6	*	*	*	11,4	9,0	5,9	5,9	9,0	11,4	*	*	*
G7	11,6	9,6	6,0	*	*	*	*	*	*	6,0	9,6	11,6
G8	*	*	*	*	*	*	*	*	*	*	*	*
G9	*	*	*	6,6	3,0	*	*	3,0	6,6	*	*	*
G10	*	*	*	*	*	*	*	*	*	*	*	*

Table 3.2.2.8.1: Echo attenuation for echoes outside the guard interval

*) A specification of echo attenuation value is not reasonable due to the limitation from guard interval and Nyquist time or the combination of useful symbol length, guard interval and required C/N value for 0 dB echo, respectively.

3.2.2.9. Interference Immunity

The device shall comply with the interference immunity as outlined in NorDig Unified v.2.5.1 [18].

Guideline for Interference Immunity against LTE signals:

The requirement is sub-divided into three parts, according to the time schedule:

- a) The device should [provide] an ACS of at least 60 dB for frequencies below 470 MHz.
- b) Devices introduced into the market before 2020 should [provide] an ACS of at least 50 dB for 694 MHz and frequencies above. The device should apply a frequency filter to the incoming RF antenna signal for masking LTE 700 signals. This optional filter shall provide an attenuation of at least 15 dB for 703 MHz and above. The application of this optional filter should be switchable via the device's set up menu. The initial manufacturer's setting shall come with deactivated LTE filter. In case this option is turned off, no (external) LTE filter shall be applied to the incoming RF antenna signal.
- c) Devices introduced into the market after 1 January 2020 should provide an ACS of at least 70 dB for 694 MHz and frequencies above 694 MHz after 2020. This includes the above mentioned 50 dB as well as a frequency filter to the incoming RF antenna signal for 703 MHz and above, switchable via the device set up menu or fixed installed in the device tuner.

4. Service Discovery

4.1. Digital Terrestrial Television

4.1.1. LCN Support

The device should support Logical Channel Numbering at least version 1 as described in the technical specification NorDig Unified v.2.5.1 Requirements [18].

All services, collected from all receivable NIT of the actual and other networks and flagged as “visible”, should be displayed in the service list(s), sorted according to logic_channel_number and be addressed with a number in the service list equal to the logic_channel_number, as far as possible.

In case of a collision the NIT of the actual network is preferred for the NIT of the other network.

4.1.2. Service List Management

4.1.2.1. Case of Identical Services

If there are multiple identical services, then the instance of the service with the highest signal quality should be granted the channel number according to the broadcast LCN. If several instances of the same service have the same quality level, then the instance with the highest signal level should be granted the channel number according to the broadcast LCN.

Note:

It is assumed that identical services will have the same broadcast LCN.

4.1.2.2. Services with LCN 0 or Hidden Services

Services marked as “hidden” in the LCN descriptor or where the LCN is zero (0) shall be stored but should not be visible in the service list presented to the viewer.

4.1.3. Update of Service Lists

The device shall be capable of automatically detecting changes in the services configuration of each broadcast transport stream provided that such changes are implemented by the broadcaster in accordance to ETSI TS 101 211 [5].

The intent of this requirement is to allow the broadcaster to vary the services offering within the relevant broadcast transport stream(s) or change the frequency and other parameters of the terrestrial network over night without the viewer needing to rescan the device.

User defined channel lists shall be updated (with or without confirmation by the user) in a way that services that have been moved and which still can be received are kept at the same position of the list(s). For this purpose, services shall be identified by the Original Network ID (ONID) and Service ID (SID).

Changes should be processed within 24 hours of the presence of correct SI signaling including NIT for the actual networks and NIT for the other networks.

Note:

For service identification during the initialization process, it is recommended to use Original Network ID (ONID), Transport Stream ID (TSID) and Service ID (SID)

5. Service Play

5.1. Video / HEVC Support

The device shall fulfil the requirements for 50 Hz HEVC HDTV 8-bit devices as defined in ETSI TS 101 154 v2.1.1. [9].

Luminance resolution		Scan (interlace/ progressive)	Aspect ratio
Horizontal	Vertical		
1920	1080	i25	16:9
1920	1080	p50	16:9
1280	720	p50	16:9
960	540	p50	16:9

Note:

To fulfill the above requirements the device shall decode and display correctly HEVC Bitstreams that are in compliance with the Main Profile, Main Tier, Level 4.1 as defined in [Recommendation ITU-T H.265]

5.2. Audio Support

The device shall always have at least a stereo audio signal present on any output.

If a service provides more than one audio bitstream, the device shall select the appropriate audio bitstream according to NorDig Unified v.2.5.1, section 6.5 [18].

The device shall be able to gracefully handle dynamic changes in the bitstream according to NorDig Unified v.2.5.1, section 6.9 [18].

5.2.1. Codecs

The device shall be able to decode or transcode the following incoming audio stream formats:

- MPEG-1 Layer II [2] as specified in TS 101 154, section 6.1 [9]
- E-AC-3 as specified in TS 101 154, section 6.2 [9]
- MPEG-4 HE-AAC Profile Level 4 [1] as specified in TS 101 154, section 6.4 [9]

The audio decoders shall support sampling rates as of NorDig Unified v.2.5.1 [18], section 6.2.

5.2.2. Audio Output Formats, Transcoding and AV Synchronisation

A STB shall have an HDMI output and should have an S/PDIF output. An IDTV shall have an HDMI ARC or S/PDIF output. The decoding or transcoding for HDMI, HDMI ARC and S/PDIF outputs shall be performed according to NorDig Unified v.2.5.1, section 6.6 and section 6.8.2 [18].

An incoming mono bitstream shall be output as dual-stereo signal.

If the device is equipped with analogue outputs (e.g. SCART and/or RCA and/or headphone output), it shall behave as described in NorDig Unified v.2.5.1, section 6.8.1 [18]. Built-in speakers of an IDTV and headphone outputs of a device (if available) should be handled like analogue outputs.

The user shall be able to choose if the device outputs a stereo signal (Stereo mode) or a multichannel signal (Multichannel mode) via the digital outputs.

The device shall be capable of transcoding E-AC-3 according to NorDig Unified v.2.5.1, section 6.2.2 and section 6.6 [18]. The device shall be capable of transcoding HE-AAC according to NorDig, section 6.2.3 and section 6.6 [18].

The device shall meet the requirements for audio / video synchronization as specified in NorDig, section 6.7 [18].

5.2.3. Metadata and Loudness

For decoding and transcoding E-AC-3 the device shall support the use of a complete set of Dolby Metadata according to TS 102 366 [23]. For decoding and transcoding HE-AAC the device shall at least support the AAC metadata parameters according to NorDig Unified v.2.5.1, section 6.2.3.2 [18]. If metadata is available for an incoming bitstream format, it shall be applied to the audio signal by the device during decoding and/or downmixing.

For HE-AAC bitstreams, which do not contain metadata, the device shall use default values according TS 101 154 [9], annex C.5.2.8. In accordance with TS 101 154, section 6.4.3 [9] a Program Reference Level of -23dBFS shall be assumed as default.

Devices shall support DRC presentation mode as defined in TS 101 154 section C5.4 [9]. If “DRC presentation mode” is not indicated in the bitstream the device shall apply metadata as per “DRC presentation mode 1”.

The device shall provide a consistent loudness experience according to NorDig Unified v.2.5.1, section 6.13 [18] and should be fully compliant to EBU Tech 3344 [25].

5.2.4. Supplementary Audio Stream

The device shall support supplementary audio services according to NorDig Unified v.2.5.1, section 6.11 [18], particularly section 6.11.6 and TS 101 154, annex E [9] including pan & fade control. Both, broadcast-mixed and receiver-mixed Supplementary Audio shall be supported for all mandatory codecs. Receiver mixing requirement is only applicable if “normal” and Supplementary Audio streams are of the same codec family, sampling rate and on two different PIDs.

The device shall support supplementary audio settings as specified in NorDig Unified v.2.5.1, section 6.11.3 [18]. The device shall be able to mix the “normal” audio stream together with a Supplementary Audio stream according to the receiver-mixing specifications in NorDig Unified v.2.5.1, section 6.11.6 [18].

The user should be able to enable / disable supplementary audio, change the default Audio Type (stored in the device), temporarily change the audio type and separately adjust the audio mixing level of the receiver mixed audio relative to the “normal” audio via easy accessible remote control functions.

Devices with head-phones output should additionally offer a separate receiver-mixed Supplementary Audio stream selectable on the head-phones interface as specified in NorDig Unified v.2.5.1, section 6.11.7 [18] and at the same time presenting the “normal” audio on its own on the other main audio outputs (HDMI, S/PDIF etc.). This should be selectable by the user as an alternative to the ordinary receiver mix.

Devices may optionally support Advanced Clean Audio Services as specified in TS 101 154, section E7.4 [9] or a receiver-side post-processing for Dialogue Enhancement. Devices may optionally support metadata according TS 102 366, Annex H [23].

Note:

Account should be taken in the design of controls that many users of audio description are visually impaired.

5.3. Broadcast Service Access

5.3.1. Favourite Lists

The device should support at least one favourite list.

The device should offer the possibility to create / modify favourite lists.

The device should offer the possibility to add / remove services from the favourite lists.

The device should offer the possibility to rename the favourite lists.

The favourite list(s) should be under full control of the user and independent of the LCN mechanism.

5.4. Dynamic PSI & SI

The device shall be able to manage changes in PSI in the PMT, CAT and PAT (like changes of PIDs and availability of components) in a graceful way for the user.

Device shall be able to manage changes in SDT, NIT of the actual networks and NIT of the other networks according to 4.1.3.

The device shall be able to handle dynamic changes in the Program Map Table (PMT).

A practical use case for dynamic PMT changes is for example the requirement to support switching on and off regional variants of programs by a broadcaster.

The device shall handle dynamic PMT changes in the correct manner:

- Dynamic changes in the PMT shall not produce any disturbances in the Audio/Video output.
- In case switching of elementary audio and/or video streams is triggered, the maximum switching time (measured from PMT update to clear picture) shall be 3 seconds. The maximum switching time shall be met regardless the elementary streams are scrambled or not.

It is recommended, that the video stream should freeze (freeze frame), until the new video stream is displayed.

5.5. Character Sets for DVB Service Information, Teletext and Subtitles

The default Character set of the device shall be the “Character code table 0B” as specified in ETSI EN 300 468 V1.14.1 Annex A [4].

The device shall also support UTF-8 table to display internet and web related content.

5.6. Teletext

The device shall include a Teletext decoder as defined by ETSI standard EN 300 706 [10] Enhanced Teletext Specification including up to Teletext level 1.5. A suitable (virtual) remote control key must be provided to launch the Teletext OSD display. The device shall have an internal storage for a least 1,000 teletext pages (main and subpages). It's recommended to use storage for 2,000 pages.

5.7. Subtitles

The device shall support EBU and DVB subtitles as defined in [3].

The device shall select available subtitles based on the user preferences settings automatically (see 5.8).

5.8. Language Selection

German shall be selected as primary and secondary language by country default.

5.9. EPG

Manufacturer is free to design device based EPG.

The device shall support an EPG application based on DVB-SI according to ETSI EN 300 468 [4].

5.10. Service and Event Information processing

The device should support service and event information processing.

If the device supports service and event information processing, then

- “Now/Next” information for use in an on-screen banner shall be derived using information from DVB SI EITp/f tables defined in [4].
- The EPG “Now and next” should be displayed for a short period when the user changes service and shall also be launched using the “Info” (virtual) button on the remote control unit.
- Changes of the "Now/Next" event information using the Current_next_indicator shall result in an immediate change of the "now" event as described in [4] 5.1.1e.
- The following items for “Now/Next” information should be displayed:
 - Current time
 - Start time of now and next programme
 - End time or durations of now and next programme
 - Logical Channel Number of current service if supported
 - Service Name
 - Icon or message for parental locked services and events.
- Linkage Descriptor as in [4], section 6.2.19 and Event Linkage as in [4], section 6.2.19.2 shall be processed in order to save bandwidth by avoiding multiple repetitions of EIT-content e.g. in regional services.
- The processing of the component_descriptor [4], section 6.2.8 shall support the transmission of event informations in SDT.
- Multiple sections starting per transport stream packet shall be supported, thus allowing utilisation of the complete transport stream body data ("optimized EIT packetisation"). Even sections starting with only the first byte at the end of a transport stream packet and the remaining data continuing in the next transport stream packet shall be supported.
- EPG preview of four weeks, derived by the EIT-schedule sections, should be supported.

6. User Interface

6.1. Support Languages and Character Sets

The device shall, as a minimum, support the following menu and UI languages: German, English.

The device shall support the language characters ISO/IEC 6937 [11] and ISO/IEC 8859-1[17].

7. Common Interface Plus

The device shall include at least one common interface slot with an associated software stack compliant with EN 50221, TS 101 699 and CI Plus according to the regime under CI Plus License Agreement with CI Plus LLP.

Notes:

Note 1: Compliance to CI+1.3 specifications includes:

- MMI, which allows the CAM to display messages (depending on the CAM capabilities) including any error messages, the Smartcard-ID and the CAM-ID.

Note 2: TV services which are broadcasted unencrypted shall be usable without restrictions.

8. Interactive Support

8.1. HbbTV Middleware

If the device (STB or IDTV) supports broadband network connectivity as described in 2.1.7., it shall support HbbTV at least in the Version 1.5 as specified in [16].

Note:

The HbbTV consortium has recently published its version 2.0 of the standard which is to be published soon by ETSI. Devices supporting broadband network connectivity should therefore support version HbbTV 2.0 as soon as possible following the publication by ETSI.

HbbTV should be activated by default. It shall be possible for the user to easily enable and disable the HbbTV functionality.

8.2. Display of Subtitles and Applications

The device shall support simultaneous display of application and subtitles, as it is stated in [15] Annex H.1.

8.3. DRM Support

Devices should support at least one DRM when the A/V content is delivered by using MPEG DASH. Microsoft PlayReady should be supported at least.

9. Software System Upgrade

The device should support a System Software Update. It's up to manufacturer how it is implemented.

Annex A

Compilation of C/N values regarding DVB-T2 variants G1 to G10 (see chapter 3.2.2.2, table 3.2.2.2 for variants details)

DVB-T2 variant	C/N_{Gauss} [dB]	$C/N_{0\ dB}$ [dB]	C/N_{Rice} [dB]	$C/N_{Rayleigh}$ [dB]
G1	13,0	16,0	13,3	15,1
G2	14,8	18,0	15,1	16,9
G3	14,8	18,0	15,1	16,9
G4	15,8 ^{*1}	19,3 ^{*1}	16,1	17,9
G5	16,2	19,7	16,5	18,3
G6	18,9	22,6	19,2	21,3
G7	16,2	19,7	16,5	18,3
G8	15,7	19,2	16,1	17,9
G9	13,0	16,0	13,3	15,1
G10	3,5	5,2	3,7	4,5

Table A: C/N values for different channel profiles and DVB-T2 variants.

^{*1} C/N values for variant G4 are not directly provided by NorDig but can be derived using the scheme in chapter 3.4.10.3, page 47 in [18]