Requirements to NorDig-T2 compliant IRDs

Addendum
to the

NorDig Unified Requirements
(ver 2.1)

for

Integrated Receiver Decoders

for use in

cable, satellite, terrestrial and IP-based networks

Background to this NorDig IRD-T2 Addendum

This document specifies the requirements for NorDig-T2 compliant **IRDs** for reception of DVB-T2 signals that target NorDig compliant receivers.

This document refers to the NorDig Unified Requirements version 2.1 ("NorDig-Unified") with additional requirements and comments, in order to provide the performance minimum additional requirements for NorDig DVB-T2 IRDs. Note that the specified requirements in "NorDig-Unified" and in this Addendum together specify the total requirements for NorDig-T2 IRDs.The following notations are used:

Unchanged (black fonts on shaded background) if there are complete chapters or sections in NorDig Unified that remain unchanged, without any additions, the text is skipped in this document and replaced by this word.

In chapters that have been modified or changed compared to the NorDig Unified version 2.1, the chapter's complete original text is included as unmarked text (in black). Original text that has been removed/changed compared to the NorDig Unified v2.1 is still included but marked as ~~line-through~~ text.

New text (marked in yellow) is new requirement/text or modified text compared to the NorDig Unified version 2.1 that has been added or changed for the NorDig PVR.

This addendum will be kept as a separate document for some time, but the text will be merged into a NorDig Unified document in the future. This version 1.0.1 includes some updates to version 1.0, see section 1.2.

It should be noted that the NorDig specifications use the term "IRDs", which includes both separate receiver units (Set Top Boxes = STBs) and relevant parts of Integrated Digital TV-sets (IDTVs).

1 Introduction

1.1 Scope

This document specifies a set of equipment requirements for reception of DVB-based and related services from cable, satellite and/or terrestrial broadcast networks; in addition it includes requirements for reception via IP-based networks. The specifications cover IRDs, both as separate units (set-top-boxes) and as relevant parts of integrated digital TV-sets.

The NorDig IRD technical specifications are established with the aim to ensure that IRDs in the Nordic market satisfy a common set of minimum requirements, independent of operator/service provider and transmission media.

The NorDig I specification was first issued in 1998 when the common DVB API solution had not taken specific direction and based on the technical status of that time. The NorDig II specification was first issued in 2000 and added some hardware and software requirements mainly to include a standard API, as specified for the DVB MHP Interactive Broadcast profile.

The NorDig Unified Requirements were first issued in 2002 and included the profiles; ***Basic TV***, ***Enhanced, Interactive*** and ***Internet Access,*** in addition to the initial ***NorDig I*** profile. The NorDig Unified specification included the NorDig I and NorDig II specifications, plus new requirements for the Basic TV, Enhanced Broadcast and Internet Access profiles; the MHP Internet Access profile has, however, later been removed from the NorDig Unified Requirements.

The ***NorDig Basic TV profile*** corresponds to basic requirements for digital broadcasting, services that do not depend on enhancements by applications or interaction. This profile is a subset of the Enhanced Profile.

The ***NorDig Enhanced profile*** covers the NorDig requirements for enhanced services that do not depend on an interaction channel, but depend on a standardized API, based on the DVB-MHP 1.1 Enhanced Broadcast Profile. The Enhanced profile is a subset of the Interactive profile.

The ***NorDig Interactive profile*** covers the NorDig requirements for interactive services, including a standardized API, based on the DVB-MHP 1.1 Interactive Broadcast Profile.

The various profiles refer both to the ***SD Level***, which includes SDTV based on MPEG 2 video compression and ***HD Level***, which also includes HDTV and SDTV, based on MPEG 4 AVC video compression. The NorDig profiles at HD Level are furthermore specified with some additional requirements, reflecting necessary enhancements for the provision of HDTV, and improvements in front-end performance. The NorDig HD Level IRD (“HD-IRD”) is specified to include the NorDig SD Level; i.e. backward compatibility with existing SDTV transmissions will be provided by NorDig compliant HD-IRDs.

The NorDig Unified specification text relates to all profiles. All requirements specified in this document are mandatory unless otherwise specified.

Figure 1.1 indicates the relationships between the NorDig profiles at ***SD Level***, and the various building blocks. Figure 1.2 indicates the relationship between the NorDig profiles at ***HD Level*** and the various building blocks; note that e.g. NorDig Basic profile at HD Level also includes the NorDig Basic Profile at SD Level.

In addition to the different versions of the NorDig IRDs above, the NorDig IRDs may include support for recording services and later playback of them, then becoming a NorDig PVR IRD (or simply a NorDig PVR). Note that the PVR functionality can be added to both SD and HD Level IRDs, see figures 1.1 and 1.2. The basic PVR functionality that is specified for NorDig does not require support from the API (MHP).

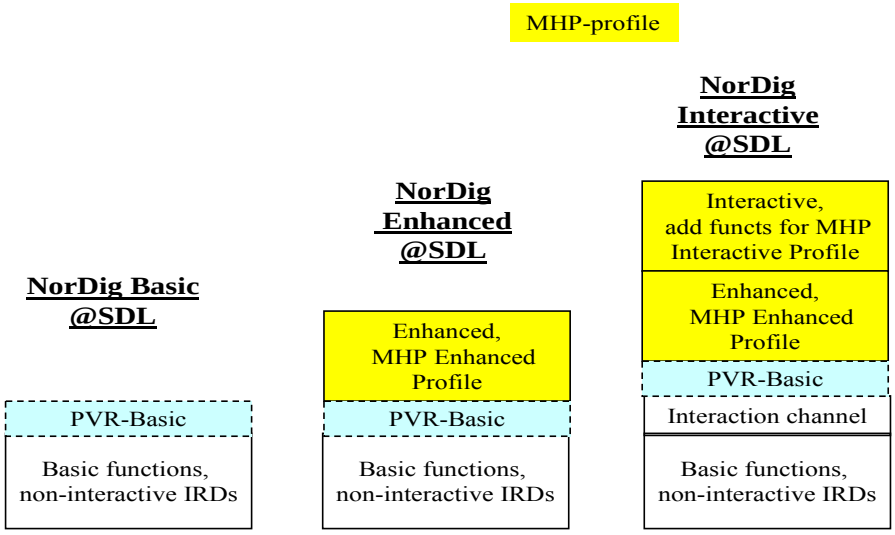

Figure 1.1 The NorDig profiles and the building blocks at SD Level IRDs

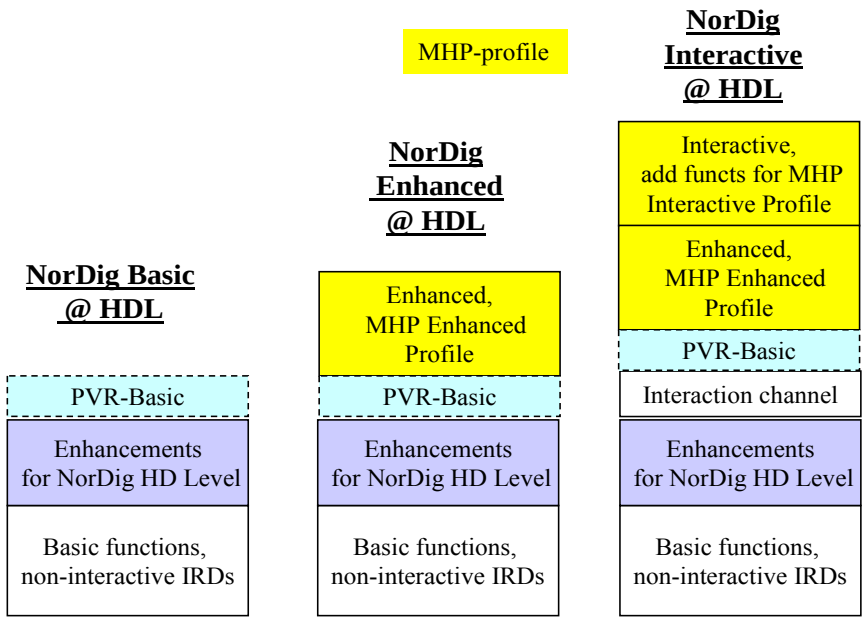

Figure 1.2 The NorDig profiles at HD Level IRDs. The HD Level includes enhancements to provide HDTV (and SDTV) based on MPEG 4AVC compression.

The NorDig Unified Requirements were updated in 2003, in 2004/2005 (Version 1.0.2) and in 2006 (version 1.0.3) when the IPTV-Addendum was merged into the text; in addition some new requirements were introduced as mandatory after a specified grace period. These requirements were all based on the SD Level only.

Version 2.0 was established in 2008 and includes the NorDig HDTV-Addendum; i.e. requirements to both SD- and HD- level IRDs and some updates to the older specification text.

This version 2.1 includes updates to version 2.0 up to July 2009 and the addition of basic requirements for NorDig PVR, which were available as an Addendum to NorDig Unified 2.0.

This Addendum includes requirements for reception of DVB-T2 based signals. The requirements are mandatory, unless specified otherwise, for IRDs that target NorDig compliant signals based on the DVB-T2 specification.

It should be noted that compliance with the NorDig requirements will require full compliance with at least one of the specified sets of level/ profiles; SD/Basic, Enhanced or Interactive or HD/Basic, Enhanced or Interactive.

NorDig has also specified NorDig Rules of Operation for NorDig compliant networks [66], and the Unified NorDig Test Specifications [68], in order to verify compliance with the NorDig Unified Requirements for new IRDs. These Rules of Operation and Test Specifications cover all NorDig profiles. -It should be noted that the **NorDig Rules of Operation** [66] and the **NorDig Test Specifications** [68] may provide additional detail to the specified requirements (in this specification), and should be used when additional background is needed in order to interpret the specified requirements.

The specifications of the NorDig IRDs are divided into two parts.

Part A: Hardware and firmware
Part B: The Software system and Application Programming Interfaces (API) as relevant.

The specification parts A and B outline the desired hardware and software architectures. Based on this framework the mandatory interfaces, functionality and performance requirements of the IRD are specified. Part B deals also with requirements to the operating system. Optional requirements are specified for recommended, but not mandatory functions.

The NorDig group represents broadcasters, operators and service providers in the Nordic countries, see Annex A.

The various members of NorDig are independent of each other but intend to transmit to IRDs that satisfy the specified common requirements. In order to ensure compliance with the NorDig requirements, the NorDig IRDs will be subject to a set of verification tests, based on **NorDig Test Specifications** [68].

1.2 Document History

Version	Date	Comments
NorDig-T2 ver. 1.0	01.07 2009	This is the first version of the approved NorDig requirements for IRD-T2. This specification includes the additional requirements for a NorDig IRD to receive NorDig compliant signals that are based on the DVB-T2 specification.
NorDig-T2 ver. 1.0.1	01.02.2010	This version includes some clarifications and updates of the performance figures (mainly for C/N (all modes), see sections 3.4.10.3, 3.4.10.10, 3.4.10.11 and Annex F). The requirements for TFS and 1.7 MHz frequency raster are made optional while some of the corresponding performance parameters have been updated.

1.3 Terminology

Shall (Mandatory) This word means that the item is mandatory.

Should (Recommended) This word means that this item is not mandatory, but is highly recommended.

1.4 Definitions

NorDig Basic
The NorDig Basic IRDs (hereafter denoted NorDig Basic) consist of a user terminal, including all possible low to high functionality implementations and its associated peripherals. NorDig Basic is specified as a subset of this unified NorDig-specification.

1.6 List of Abbreviations

Unchanged. plus addition of:

ACE	Active Constellation Extension
FEF	Future Extension Frame
GS	Generic Stream
PAPR	Peak-to-Average Power Ratio
PLP	Physical Layer Pipe
TFS	Time Frequency Slicing
TR	Tone Reservation

2 General Features of the NorDig IRD

2.1 Introduction

Unchanged.

2.2 IRD Hardware and Firmware

Unchanged.

2.3 *System Software and API*

Unchanged.

2.4 General Product Requirement

Unchanged.

PART A: Hardware and Firmware

3 The Frontend of the NorDig IRD

3.1 Common Features

Unchanged.

3.2 Satellite Tuner and Demodulator

Unchanged.

3.3 Cable Tuner and Demodulator

Unchanged.

3.4 Terrestrial Tuner and Demodulator

3.4.1 General

The NorDig IRD shall include at least one tuner/demodulator for reception of signals from terrestrial transmitters, broadcasting in accordance with EN 300 744 [20] (DVB-T), or in accordance with EN 302 755 (DVB-T2)(1).

NorDig IRD-T2s, capable of receiving broadcasts according to EN 302 755 [21](1), shall also be capable of receiving broadcasts according to EN 300 744 [20]. Such a receiver is in the following referred to as "NorDig IRD-T2", when there is a need to differentiate such a receiver from a receiver supporting DVB-T only.

Note 1: This specification is currently (January 2010) being updated by DVB, and is likely to be issued as a revised version. It is NorDig's intention to refer to the revised specification when it is fully standardized by ETSI.

The digital transmissions may share frequency bands with other transmissions; successful reception will depend on e.g. network configuration, channel characteristics, time-varying interference from other "analogue" or "digital" transmitters and the receiver performance. The transmission networks of DVB-T/T2 may include single frequency networks (SFN).

Comment: The possibility to receive DVB-T/T2 signals in MATV networks is optional for NorDig IRDs with a terrestrial front-end. Such networks use a 7 MHz channel frequency raster in the VHF and an 8 MHz raster in the UHF frequency range for analogue TV services. For re-distribuition of DVB-T/T2 signals it should be possible to maintain these rasters and to use only an 8 MHz raster.

3.4.2 Frequencies and Signal Bandwidths

3.4.2.1 General

The NorDig IRD shall be able to receive channels in the VHF band III (1) and UHF bands IV, V and should be able to receive channels in VHF S band I, VHF S band II, UHF S Band III (see Table 3.3).

	Band	Frequency range	Requirement
VHF	*VHF I*	*47 – 68 MHz*	*N/A*
	S Band I	104 – 174 MHz	Optional
	VHF III	174 – 230 MHz	Mandatory
	S Band II	230 – 300 MHz	Optional
UHF	S Band III	300 – 470 MHz	Optional
	UHF IV	470 – 606 MHz	Mandatory
	UHF V	606 – 862 MHz	Mandatory

Table 3.3 Mandatory and optional frequency bands

3.4.2.2 Center Frequencies

The front-end shall (1) for the supported frequency ranges be capable of tuning to the centre frequency f_c of the incoming DVB-T/T2 RF signal, see below and Annex B2:

8 MHz raster:

f_c = 114 MHz +K * 8 MHz, where

K is an integer number, running from 0 to 93.

7 MHz raster:

f_c = 107.5 MHz + L * 7 MHz, where

L is an integer number, running from 0 to 27.

1.7 MHz raster (DVB-T2):

f_c shall be as specified in Annex B2.

Note 1: 8 MHz raster is mandatory for the UHF-bands. 7 MHz raster is mandatory for VHF band III. 8 MHz raster for VHF is optional. The support for 1.7 MHz raster in VHF Band III is optional.

3.4.2.3 Maximum Frequency Offset

The NorDig IRD shall be able to receive signals with an offset of up to 50 kHz (1) from the nominal frequency.

3.4.2.4 Signal bandwidths

For a DVB-T signal, an 8 MHz DVB-T signal corresponds to a signal bandwidth of 7.61 MHz and a 7 MHz DVB-T signal corresponds to a signal bandwidth of 6.66 MHz.

The NorDig IRD-T2 shall support both the normal and extended carrier modes, see EN 302 755 [21].

For 8 MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth of 7.61 MHz and an extended carrier mode corresponds to a signal bandwidth of 7.71 MHz for FFT size of 8K and 7.77 MHz for FFT size of 16K and 32K.

For 7MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth of 6.66 MHz and an extended carrier mode corresponds to a signal bandwidth of 6.80 MHz.

For 1.7 MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth 1.54 MHz and an extended carrier mode corresponds to a signal bandwidth of 1.57 MHz.

The NorDig IRD-T2 shall follow network parameter change from normal to extended carrier mode and vice versa automatically without any need for user action.

VHF Bands:

The NorDig IRD-T/T2 shall (1) for the supported frequency ranges be able to receive 7 MHz and should be able to receive 8 MHz DVB-T and DVB-T2 signals as well as 1.7 MHz DVB-T2 signals. If 8 MHz bandwidth is supported it shall automatically detect which DVB-T/T2 signal bandwidth is being used, and it shall be possible to receive the 8 MHz DVB-T/T2 signals on the 7 MHz channel frequency raster. If 1.7 MHz bandwidth is supported, the NorDig IRD-T2 shall automatically detect which DVB-T/T2 signal bandwidth is being used.

UHF Bands:

The NorDig IRD-T/T2 shall for the supported frequency ranges be able to receive 8 MHz DVB-T and DVB-T2 signals.

Note 1: Reception from the VHF band III is mandatory. Reception from other VHF bands is optional.

3.4.3 Modes

The NorDig IRD terrestrial front-end shall be capable of correctly demodulating all non-hierarchical modes specified in EN 300 744 [20]. The front-end shall therefore be able to work 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).

The NorDig IRD should be able to receive the hierarchical modes in the DVB-T specification, see Annex B - 3.

The NorDig IRD-T2 shall be capable of correctly demodulating all allowed configurations, or "DVB-T2 modes", as specified in EN 302 755 [21], with the following exceptions:

- Support for 1.7 MHz bandwidth is optional
- Support for Time Frequency Slicing (TFS) is optional
- Support for 10 MHz bandwidth is not required
- Support for PLPs carrying GS/GSE is not required
- Support for Transmission modes 16K and 32K, when 1.7 MHz RF bandwidth is supported, is not required

The existence of transmissions using configurations that the NorDig IRD-T2 is not required to support shall not cause the NorDig IRD-T2 to malfunction.

When TFS is supported the following shall apply: For 8MHz DVB-T2 signals with modulation parameters {32K, 256-QAM, CR=3/5, GI=1/16} on all data PLPs the NorDig IRD-T2 shall support reception of variable-bit rate PLPs in TFS with a TS peak data rate of up to 15 Mbps using up to six RF frequencies. Each TS is split into one data PLP and a common PLP.

Note 1: Although the bit rate of a TS is fixed the payload (of non-null packets) may be variable, which will require a variable-bit-rate PLP, since null packets in the TS are removed by DVB-T2 before transmission and re-introduced by the receiver.

Note 2: In order to perform the TFS frequency hopping fast enough, in the general case the NorDig IRD will need to include two analogue tuners, with each tuner having a tuning time of 5 ms or better. However, NorDig IRD-T2s using a single tuner may still allow TFS in many configurations, e.g. when Type 1 PLPs are used in the beginning of the T2 frame, which allows for frequency hopping at the boundary between two T2 frames.

Within the NorDig IRD specification the concept of "DVB-T2 mode" includes e.g. (the list is not exhaustive):

- Constellation (QPSK, 16-QAM, 64-QAM, 256-QAM), both rotated and non-rotated
- Code rate (1/2, 3/5, 2/3, 3/4, 4/5, 5/6)
- Guard interval ($T_U/128$, $T_U/32$, $T_U/16$, $T_U*19/256$, $T_U/8$, $T_U*19/128$, $T_U/4$)
- Transmission mode (1K, 2K, 4K, 8K normal and extended, 16K normal and extended, 32K normal and extended)
- Pilot pattern (PP1, PP2, PP3, PP4, PP5, PP6, PP7, PP8)
- SISO/MISO

- PAPR (No PAPR reduction is used, ACE-PAPR only is used, TR-PAPR only is used, both ACE and TR are used)
- FEC Frame length (64800, 16200)
- Input Mode A (single PLP) or Input Mode B (Multiple PLPs – Common PLP, Type 1 and 2 up to the maximum allowed figure 255)
- Single RF frequency or Time Frequency Slicing (TFS)
- Normal Mode or High Efficiency Mode
- FEF parts (2)
- Auxiliary streams (2)

Note 1: For allowed combinations of the DVB-T2 parameters see EN 302 755 [21].

Note 2: The receivers are not required to demodulate or decode the content of FEF parts and auxiliary streams, but the existence of FEFs and/or auxiliary streams shall not cause receiver to malfunction.

The NorDig IRD shall automatically detect which mode is being used.

3.4.4 Reception quality/Tuning/Scanning Procedures

3.4.4.1 General

The NorDig IRD shall provide a scanning procedure over the whole (supported) frequency range.

The NorDig IRD shall be able to provide reception quality information for a selected received frequency according to section 3.4.4.2 (Status check: Basic).

The NorDig IRD should be able to provide reception quality information for a selected received frequency according to section 3.4.4.3 (Status check: Advanced).

3.4.4.2 Status check: Basic

The IRD shall provide at least a basic status check function (accessible through the Navigator) that presents reception quality information for a selected frequency (currently viewed by the user).

The basic status check shall include:

- channel id, according to Annex B.2
- centre frequency
- Signal Strength Indicator, SSI (%), according to section 3.4.4.6
- Signal Quality Indicator, SQI (%), according to section 3.4.4.7

3.4.4.3 Status check: Advanced

The IRD should provide an advanced status check function (accessible through the Navigator) that presents the following information:

- channel id, according to Annex B.2
- centre frequency
- signal strength (dBm or dBµV)
- signal strength indicator, SSI (%), according to section 3.4.4.6
- signal quality indicator, SQI (%), according to section 3.4.4.7
- C/N (dB)
- BER before Reed Solomon decoding (DVB-T) or BCH decoding (DVB-T2)
- Uncorrected packets

The integration time for the BER and uncorrected packets calculations shall be a period of 1 second.

It is recommended to make the end-user antenna installation easier by providing an overall view of reception quality according to section 3.4.4.2 (Status check: Basic) for all installed multiplexes (frequencies) or enable the end-user to change the installed multiplexes (frequencies) easily. Reception quality information should be updated cyclically until this mode is exited.

In addition, it is recommended that the following information can be presented for the received frequency, transport stream and service:

- DVB-T/T2 mode
- transport stream id
- original network id
- network id
- service id
- T2 system id (NorDig IRD-T2)
- PLP id (NorDig IRD-T2)

The advanced status check values shall be updated regularly (e.g. every second).

3.4.4.4 Installation mode: Automatic Search, best service

The IRD shall provide an automatic search that finds all of the multiplexes and services in the whole (supported) frequency range, see section 3.4.2. Before the automatic search is started, all service lists shall be deleted (if present).

The IRD shall only display a service once in the service list (i.e. avoiding duplicate of the same services), even if the same service (1) (same triplet original_network_id, transport_stream_id and service_id) is received from multiple transmitters. If the same service can be received from several transmitters, the one with best reception quality shall be selected. The criteria for selection of the best received service (i.e. best reception quality) shall be based on the combination of the signal strength and signal quality according to sections 3.4.4.6 and 3.4.4.7. An example of a possible selection algorithm is described in Annex E.

Note 1: A service is uniquely identified by its DVB triplet (original_network_id, transport_stream_id and service_id) in all NorDig compliant terrestrial networks, except for the Norwegian terrestrial network, where only original_network_id and service_id are used to identify a service.

It is recommended that the complete search function takes less than 5 minutes (at a reception location providing maximum 10 receivable DVB-T/T2 RF channels).

Note: In order to speed up the automatic channel search with a reception quality measurement, an approach with an automatic gain controller (AGC) based DVB-T/T2 signal detection can be implemented. IRD implementation may sweep all the supported frequencies by detecting if there exists an RF signal by analyzing the AGC. After the sweep the IRD analyses only the frequencies where the AGC reported an RF signal present and verifies if the signal is a DVB-T/T2 signal. In case of DVB-T/T2 signal reception quality is measured.

3.4.4.5 Installation mode: Manual Search

In addition to the automatic search, it shall be possible to perform a manual search where the channel id (or frequency) is entered by the end user. The IRD shall tune to this channel, search all available DVB-T/T2 modes, add all new services and replace existing equal services (same triplet original_network_id, transport_stream_id and service_id) in the service list (without considering any quality criteria).

It is recommended that the graphical interface for the manual search shall make it easy for the end-user to perform consecutive manual searches.

The IRD should not override installed service parameters for a service stored in the manual search by a "quasi-static" (automatic) update. E.g. if an end-user has performed manual search for a frequency, the stored frequency in the manual search should not be overritten by a "quasi-static" (automatic) update procedure.

3.4.4.6 Requirements for the signal strength indicator (SSI)

The NorDig IRD shall (1) be provided with a signal strength indicator (SSI). The value for theSSI shall (1) be referred to the IRD RF signal input.

Note 1: Optional for IRDs that are launched before 2010. Until 2010 it is recommended that receiver manufacturers provide at least a receiver manufacture specific method referring to RF input signal level expressed in [%].

The NorDig IRD shall be able to determine signal strength within a range starting from 15 dB lower than the reference signal level defined in Table 3.4 and up to 35dB above that value or maximum signal input level defined in section 0.

The absolute accuracy shall be ±5 dB at RF signal input levels -80 dBm to -60 dBm and ±7 dB for RF signal input levels higher than -60 dBm.

The relative accuracy should be ±3 dB between centre frequencies within one frequency band, e.g. VHF Band III or UHF Band IV/V, supported by the receiver.

Signal strength indicator shall have a relative value within a range from 0% to 100% and with a resolution of 1%.

The signal strength indicator shall be updated regularly once per second.

The formulas to calculate the signal strength indicator (SSI) value in [%] are defined below.

$SSI = 0$ if $P_{rel} < -15dB$

$SSI = (2/3) * (P_{rel} + 15)$ if $-15\ dB \leq P_{rel} < 0dB$

$SSI = 4 * P_{rel} + 10$ if $0\ dB \leq P_{rel} < 20\ dB$

$SSI = (2/3) * (P_{rel} - 20) + 90$ if $20\ dB \leq P_{rel} < 35\ dB$

$SSI = 100$ if $P_{rel} \geq 35\ dB$

where

$P_{rel} = P_{rec} - P_{ref}$

P_{rec} is referred to signal level expressed in [dBm] at receiver RF signal input.

P_{ref} is reference signal level value expressed in [dBm] specified in Table 3.4 for DVB-T and in Table 3.5 for DVB-T2.

Modulation	Code Rate	Reference signal level [dBm]
QPSK	½	-93
QPSK	2/3	-91
QPSK	3/4	-90
QPSK	5/6	-89
QPSK	7/8	-88
16-QAM	1/2	-87
16-QAM	2/3	-85
16-QAM	3/4	-84
16-QAM	5/6	-83
16-QAM	7/8	-82
64-QAM	1/2	-82
64-QAM	2/3	-80
64-QAM	3/4	-78
64-QAM	5/6	-77
64-QAM	7/8	-76

Table 3.4 Specified P_{ref} values expressed in dBm for all signal bandwidths, guard intervals and FFT for DVB-T signals.

Modulation	Code Rate	Reference signal level [dBm]
QPSK	1/2	TBD
QPSK	3/5	TBD
QPSK	2/3	TBD
QPSK	3/4	TBD
QPSK	4/5	TBD
QPSK	5/6	TBD
16-QAM	1/2	TBD
16-QAM	3/5	TBD
16-QAM	2/3	TBD
16-QAM	3/4	TBD
16-QAM	4/5	TBD
16-QAM	5/6	TBD
64-QAM	1/2	TBD
64-QAM	3/5	TBD
64-QAM	2/3	TBD
64-QAM	3/4	TBD
64-QAM	4/5	TBD
64-QAM	5/6	TBD
256-QAM	1/2	TBD
256-QAM	3/5	TBD
256-QAM	2/3	TBD
256-QAM	3/4	TBD
256-QAM	4/5	TBD
256-QAM	5/6	TBD

Table 3.5 Specified P_{ref} values expressed in dBm for a PLP, all signal bandwidths, guard intervals and 32k FFT for DVB-T2 signals (1).

Note 1: The reference signal levels in table 3.5 are not available for this version of this specification. Values for the Reference signal levels will be provided in a future update of this specification, when measured results from practical receivers for DVB-T2 signals have been analysed.

3.4.4.7 Requirements for the signal quality indicator (SQI)

3.4.4.7.1 DVB-T signals

The NorDig IRD shall (1) be provided with a signal quality indicator (SQI). The value for the SQI shall be referred to the IRD RF signal input.

Note 1: Optional for NorDig IRD-Ts that are launched before 2010 and for NorDig IRD-T2s (in DVB-T receiving mode) that are launched before 2012.

The absolute accuracy of the C/N value shall be of ±1dB for C/N values of 17 dB to 27 dB at the IRD RF signal input.

The signal quality indicator shall have a relative value within a range from 0% to 100% and with a resolution of 1%.

The signal quality indicator shall be updated regularly once per second.

The signal quality indicator (SQI) in [%] shall be calculated according to the following formulas.

$SQI = 0$ if $C/N_{rel} < -7$ dB

$SQI = (((C/N_{rel} - 3)/10) + 1) * BER\_SQI$ if $-7 \text{ dB} \leq C/N_{rel} < +3$ dB

$SQI = BER\_SQI$ if $C/N_{rel} \geq +3$ dB

where

C/N_{rel} is DVB-T mode depended of the relative C/N of the received signal value in [dB]

and

$C/N_{rel} = C/N_{rec} - C/N_{NordigP1}$

where

$C/N_{NordigP1}$ is the required C/N value in [dB] for the non-hierarchical DVB-T mode in profile 1 defined in Table 3.8. For the hierarchical DVB-T modes, required C/N value in [dB] is specified in Annex B-3, Tables 1 and 2.

C/N_{rec} is the C/N value in [dB] of the received signal

BER_SQI is calculated with the formula

$BER\_SQI = 0$ if $BER > 10^{-3}$

$BER\_SQI = 20*LOG_{10}(1/BER)-40$ if $10^{-7} < BER \leq 10^{-3}$

$BER\_SQI = 100$ if $BER \leq 10^{-7}$

where

BER is referenced to Bit Error rate after Viterbi and before Reed Solomon decoding.

The integration time for the BER_SQI calculation shall be over a period of 5 seconds.

3.4.4.7.2 DVB-T2 signals

The NorDig IRD-T2 shall be provided with a signal quality indicator (SQI). The value for the SQI should be referred to a PLP in the received signal at the NorDig IRD RF signal input.

The signal quality indicator should have a relative value within a range from 0% to 100% and with a resolution of 1%.

The signal quality indicator should be updated regularly at least once per second.

The SQI should refer to a PLP in the received signal and its combination of C/N and BER before BCH where the signal quality is weigthed by the received C/N. E.g. PLP without bit error before BCH should be weighted with C/N.

3.4.5 Changes In Modulation Parameters

The NorDig IRD should recover from changes in modulation parameters and output an error free TS. This should take less than one second for any change. The NorDig IRD should be able to detect a change of modulation parameters signalled in the TPS data of the DVB-T signal, in order to reduce the recovery time.

The NorDig IRD-T2 shall automatically recover from changes in P1, L1 pre-signalling data and L1 post-signalling. An error-free TS shall be available within five seconds for any P1 and/or L1 pre-signalling change. An error-free TS shall be output within two seconds for any L1 post-signalling change.

3.4.6 RF Input Connector

The NorDig IRD shall have one input tuner connector, type: IEC female in accordance with IEC 60169-2, part 2 [44]. The input impedance shall be 75 ohm.

If the RF input supports DC power to an external antenna with amplifier, it shall not degrade to the performance of the RF input characteristics. The DC power supply shall be protected against short circuit. Furthermore, there shall be an alternative in the menu system to turn the DC power supply source on/off. In the first time initialisation and resetting to factory default settings, the DC power supply shall be switched off, see chapter 16.4.

3.4.7 RF Output Connector (option)

For a NorDig IRDs equipped with a RF bypass (RF_{in} - RF_{out}), the connector shall be of type: IEC male in accordance with IEC 60169, part 2 [44]. The frequency range for the RF bypass should be from 47 MHz to 862 MHz and the RF bypass gain should be from –1 dB to +3 dB.

The RF signals should be bypassed from RF_{in} to RF_{out} independently from the status of the NorDig IRD (operational or stand by), so that connected equipment (e.g. TV set) can operate even if the NorDig IRD is in stand by.

3.4.8 Time Interleaving

The NorDig IRD-T2 shall at least include time interleaving capability corresponding to the maximum time interleaving according to EN 302 755 [21], i.e. $2^{19}+2^{15}$ OFDM cells for a data PLP and its common PLP together.

3.4.9 Input/Output Data Formats

The NorDig IRD-T2 shall be able to support TS bit rates ≤ 72 Mbit/s.

Note:	The maximum total input bitrate to the DVB-T2 system (considering the sum of all input streams) is therefore 72Mbit/s * 255. Thanks to the null packet deletion process most of this data is, however removed before transmission. The maximum input bit rate in terms of payload, taken over all input streams is limited by the T2 transmission capacity.

3.4.10 Performance

3.4.10.1 General

A wide set of performance requirements is defined for a limited set of DVB-T2 modes, see Table 3.6. A more limited set of performance requirements is defined for a wider set of DVB-T2 modes, as specified elsewhere in this section 3.4.10.

Note:	The following performance requirements for DVB-T2 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.

	VHF III 7MHz SFN						VHF III 7MHz MFN			UHF 8MHz SFN				UHF 8MHz MFN	
Transmission mode	32K normal						32K normal			32K extended				32K extended	
Constellation	256-QAM rotated						256-QAM rotated			256-QAM rotated				256-QAM rotated	
Code rate	3/5	2/3	3/4	3/5	2/3	3/4	3/5	2/3	3/4	3/5	2/3	3/4	3/5	2/3	3/4
Guard interval	1/8 1/16	1/8 1/16	1/8 1/16	1/16 1/32	1/16 1/32	1/16 1/32	1/128	1/128	1/128	1/16 1/32	1/16 1/32	1/16 1/32	1/32	1/128	1/128
Pilot Pattern	PP2			PP4			PP7			PP4			PP6	PP7	
PAPR	TR-PAPR						TR-PAPR			TR-PAPR				TR-PAPR	
SISO/MISO	SISO						SISO			SISO				SISO	
FEC Frame length	64800						64800			64800				64800	
Input mode	Mode A						Mode A			Mode A				Mode A	
TFS	No						No			No				No	
Normal mode (NM)/high efficiency mode (HEM)	HEM						HEM			HEM				HEM	
FEF	Not used						Not used			Not used				Not used	
Auxiliary streams	Not used						Not used			Not used				Not used	

Table 3.6 A limited set of DVB-T2 modes for performance requirements (see note above).

3.4.10.2 Definitions

The performance requirements used in this section (3.4.10) are referring to the QEF definition provided in EN 300 744, where Quasi Error Free (QEF) means less than one uncorrected error event per hour. This requirement corresponds to BER = 10^{-11} at the input of the MPEG-2 demultiplexer.

The performance refers to the entire frequency range (see section 3.4.2).

The carrier-to-noise (C/N) ratio in Table 3.7 and minimum receiver signal input level ($P_{min)}$ values in Table 3.9 are specified for two profiles:

Profile 1: Gaussian noise (N) is applied together with the wanted carrier (C) in a signal bandwidth of a DVB-T signal. No echo is applied.

Profile 2: The wanted signal (C) 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 µs to 0.95 times the guard interval length and has 0 degree phase at the channel center.

3.4.10.3 C/N Performance

The NorDig IRD shall have at least the QEF performance for the C/N ratios given in, Table 3.7(DVB-T) and Table 3.8 Example of maximum required C/N for QEF reception at TS output (with 1/8 guard interval, PP2 and FFT size 32K) for profiles 1 and 2. (DVB-T2).

Note:	For DVB-T2 the required C/N for QEF and for error-free video are expected to be virtually identical due to the sharp waterfall characteristic of the LDPC+BCH decoding.

The C/N figures in Table 3.8 are derived as follows:

$C/N = (C/N)_{RAW} + A + B + C + D$ [dB], where

- $(C/N)_{RAW}$ = Required raw C/N for BER=10^{-6} before BCH decoding, according to Annex F
- A = 0.1dB assumed additional C/N to achieve the BER=10^{-7} before BCH decoding (assumed QEF transport stream after BCH decoding)
- B = correction for pilot boosting
- C = 2.0 dB (PP1-PP2), 1.5 dB (PP3-PP4), 1.0 dB (PP5-PP8). Assumed C/N loss due to real channel estimation, imperfect LDPC decoding and other imperfections not considered part of the back-stop noise.
- D = additional C/N term corresponding to a back-stop noise level at -33 dBc. This term is derived by first calculating the sum of all terms except D and then check how much C/N degradation is caused by the -33 dBc backstop noise level. The term D is identical to this degradation. It should be noted that a change of pilot pattern from e.g. PP4 to PP2, which increases C from 1.5 dB to 2.0 dB, will also cause a slight increase of D.

For all other DVB-T2 modes the NorDig IRD -T2 shall fulfil C/N requirements accordingly, based on this calculation scheme.

Note:	The scheme above defines the required C/N for all possible T2 configurations. The C/N figures found in Tables 3.8 and minimum power level figures found in Table 3.12 are only examples, applicable for a particular configuration. Changing pilot pattern from PP2 to something else will e.g. normally result in a change of required C/N and Pmin.

		C/N performance (dB)	
Modulation	**Code rate**	**Profile 1 : Gaussian**	**Profile 2 : 0 dB echo**
QPSK	1/2	5.1	8.8
QPSK	2/3	6.9	13.7
QPSK	3/4	7.9	17.4
QPSK	5/6	8.9	-
QPSK	7/8	9.7	-
16-QAM	1/2	10.8	13.3
16-QAM	2/3	13.1	17.9
16-QAM	3/4	14.6	22.1
16-QAM	5/6	15.6	-
16-QAM	7/8	16.0	-
64-QAM	1/2	16.5	19.0
64-QAM	2/3	18.7	23.2
64-QAM	3/4	20.2	27.6
64-QAM	5/6	21.6	-
64-QAM	7/8	22.5	-

Table 3.7 Maximum required C/N for QEF reception at TS output (with 1/4 guard interval and FFT size 8K) for profiles 1 and 2

		C/N performance (dB)	
Modulation	Code rate	Profile 1 : Gaussian	Profile 2 : 0 dB echo
QPSK	1/2	3.5	5.2
QPSK	3/5	4.7	6.8
QPSK	2/3	5.6	8.4
QPSK	3/4	6.6	9.8
QPSK	4/5	7.2	10.9
QPSK	5/6	7.7	12.0
16-QAM	1/2	8.7	10.9
16-QAM	3/5	10.1	12.7
16-QAM	2/3	11.4	14.3
16-QAM	3/4	12.5	16.3
16-QAM	4/5	13.3	17.8
16-QAM	5/6	13.8	18.9
64-QAM	1/2	13.0	16.0
64-QAM	3/5	14.8	18.0
64-QAM	2/3	16.2	19.7
64-QAM	3/4	17.7	22.0
64-QAM	4/5	18.7	24.0
64-QAM	5/6	19.4	25.5
256-QAM	1/2	17.0	20.6
256-QAM	3/5	19.4	23.1
256-QAM	2/3	20.8	25.1
256-QAM	3/4	22.9	28.0
256-QAM	4/5	24.3	30.8
256-QAM	5/6	25.1	33.6

Table 3.8 Example of maximum required C/N for QEF reception at TS output (with 1/8 guard interval, PP2 and FFT size 32K) for profiles 1 and 2. For 1.7 MHz modes the C/N figures refer to 1/8 guard interval, PP2 and FFT size 8K with Normal bandwidth.

The required C/N, as defined above in Table 3.8, applies generally for Input Mode A (single PLP) and Input Mode B (multiple PLPs), including TFS (using 2-6 frequencies). For TFS, the level of all RF channels involved, are identical. For TFS, the 0 dB echo profile is also identical on all RF channels.

Note: Performance requirements for TFS modes with unequal levels and with other channel profiles may be defined in a later release of this specification.

3.4.10.4 Minimum Receiver Signal Input Levels

The NorDig IRD shall have a noise figure (NF) for supported frequency ranges equal or better than the values specified in Table 3.9.

NorDig IRD-T2s shall (1) have a noise figure (NF) for supported frequency ranges equal or better than the values in Table 3.10.

Note 1: NorDig IRD-T2s that are launched before 2012 shall have a NF for supported frequency ranges equal or better than the values specified in table 3.9, while the values in Table 3.10 are recommended.

Note 2: The NorDig IRD noise figure refers to the noise figure of the complete receiver. In case of RF-loop-through the tuner NF will have to be somewhat better than the resulting NorDig IRD noise figure because of the attenuation of the RF-loop-through path.

	Band	Noise Figure (NF)
VHF	S Band I	10 dB
	VHF III	7 dB
	S Band II	10 dB
UHF	S Band III	10 dB
	UHF IV	7 dB
	UHF V	7 dB

Table 3.9Maximum noise figures for NorDig IRD-T

	Band	Noise Figure (NF)
VHF	S Band I	10 dB
	VHF III	6 dB (3)
	S Band II	10 dB
UHF	S Band III	10 dB
	UHF IV	6 dB
	UHF V	6 dB

Table 3.10 Maximum noise figures for the NorDig IRD-T2

Note 3: If 1.7 MHz bandwidth is supported (i.e. VHF band III) the NF shall be equal or better than 7 dB.

Comment: Thanks to the much better robustness of DVB-T2 (compared to DVB-T) against impulsive interference an improvement in noise figure is likely to have a much more positive effect on coverage with DVB-T2 than with DVB-T.

The NorDig IRD shall provide QEF reception for the minimum signal levels (P_{min}) for the supported frequency range as stated below (at 290K).

For 7 MHz Normal Bandwidth DVB-T/T2signal: P_{min} = -105.7 dBm+NF [dB]+ C/N [dB], and

For 8 MHz Normal Bandwidth DVB-T/T2signal: P_{min} = -105.2 dBm+NF [dB]+ C/N [dB] and

For 1.7 MHz Normal Bandwidth DVB-T2 signal: P_{min} = -111.1 dBm+NF [dB]+ C/N [dB], and

For 7 MHz Extended Bandwidth DVB-T2 signal: P_{min} = -105.7 dBm+NF [dB]+ C/N [dB], and

For 8 MHz Extended Bandwidth DVB-T2 signal: P_{min} = -105.1 dBm+NF [dB]+ C/N [dB], and

For 1.7 MHz Extended Bandwidth DVB-T2 signal: P_{min} = -111.1 dBm+NF [dB]+ C/N [dB],

where

P_{min} values are listed in Table 3.11 (DVB-T) and examples of P_{min} values are listed in Table 3.12 (DVB-T2) below as calculated from the equations above together with NF values in Table 3.9 and Table 3.10 plus C/N values in Table 3.7 (DVB-T) and Table 3.8 (DVB-T2). The values in Table 3.12 show the required P_{min} values after 2011. For all other DVB-T2 modes the NorDig IRD for DVB-T2 shall fulfil P_{min} requirements accordingly, based on the formulas above.

		Minimum input level (dBm)					
		Profile 1: Gaussian				**Profile 2: 0 dB echo**	
Frequency band		VHF Band III	VHF S Band I & II	VHF S Band I & II and UHF S Band III	UHF Band IV&V	VHF Band III	UHF Band IV&V
Modulation	Code Rate	7 MHz signal	7 MHz signal	8 MHz signal	8 MHz signal	7 MHz signal	8 MHz signal
QPSK	1/2	-93.6	-90.6	-90.1	-93.1	-89.9	-89.4
QPSK	2/3	-91.8	-88.8	-88.3	-91.3	-85.0	-84.5
QPSK	3/4	-90.8	-87.8	-87.3	-90.3	-81.3	-80.8
QPSK	5/6	-89.8	-86.8	-86.3	-89.3	-	-
QPSK	7/8	-89.0	-86.0	-85.5	-88.5	-	-
16-QAM	1/2	-87.9	-84.9	-84.4	-87.4	-85.4	-84.9
16-QAM	2/3	-85.6	-82.6	-82.1	-85.1	-80.8	-80.3
16-QAM	3/4	-84.1	-81.1	-80.6	-83.6	-76.6	-76.1
16-QAM	5/6	-83.1	-80.1	-79.6	-82.6	-	-
16-QAM	7/8	-82.7	-79.7	-79.2	-82.2	-	-
64-QAM	1/2	-82.2	-79.2	-78.7	-81.7	-79.7	-79.2
64-QAM	2/3	-80.0	-77.0	-76.5	-79.5	-75.5	-75.0
64-QAM	3/4	-78.5	-75.5	-75.0	-78.0	-71.1	-70.6
64-QAM	5/6	-77.1	-74.1	-73.6	-76.6	-	-
64-QAM	7/8	-76.2	-73.2	-72.7	-75.7	-	-

Table 3.11 Minimum DVB-T signal input levels (Pmin) for QEF reception at TS output (with 1/4 guard interval and FFT size 8K) for profiles 1 and 2.

		Minimum input level (dBm)							
		Profile 1: Gaussian					Profile 2: 0 dB echo		
Frequency band		VHF Band III		VHF S Band I & II	VHF S Band I & II and UHF S Band III	UHF Band IV&V	VHF Band III		UHF Band IV&V
Modulation	Code Rate	1.7 MHz signal	7 MHz signal	7 MHz signal	8 MHz signal	8 MHz signal	1.7 MHz signal	7 MHz signal	8 MHz signal
QPSK	1/2	-100.6	-96.2	-92.2	-91.6	-95.6	-98.9	-94.5	-93.9
QPSK	3/5	-99.4	-95	-91	-90.4	-94.4	-97.3	-92.9	-92.3
QPSK	2/3	-98.5	-94.1	-90.1	-89.5	-93.5	-95.7	-91.3	-90.7
QPSK	3/4	-97.5	-93.1	-89.1	-88.5	-92.5	-94.3	-89.9	-89.3
QPSK	4/5	-96.9	-92.5	-88.5	-87.9	-91.9	-93.2	-88.8	-88.2
QPSK	5/6	-96.4	-92	-88	-87.4	-91.4	-92.1	-87.7	-87.1
16-QAM	1/2	-95.4	-91	-87	-86.4	-90.4	-93.2	-88.8	-88.2
16-QAM	3/5	-94	-89.6	-85.6	-85	-89	-91.4	-87	-86.4
16-QAM	2/3	-92.7	-88.3	-84.3	-83.7	-87.7	-89.8	-85.4	-84.8
16-QAM	3/4	-91.6	-87.2	-83.2	-82.6	-86.6	-87.8	-83.4	-82.8
16-QAM	4/5	-90.8	-86.4	-82.4	-81.8	-85.8	-86.3	-81.9	-81.3
16-QAM	5/6	-90.3	-85.9	-81.9	-81.3	-85.3	-85.2	-80.8	-80.2
64-QAM	1/2	-91.1	-86.7	-82.7	-82.1	-86.1	-88.1	-83.7	-83.1
64-QAM	3/5	-89.3	-84.9	-80.9	-80.3	-84.3	-86.1	-81.7	-81.1
64-QAM	2/3	-87.9	-83.5	-79.5	-78.9	-82.9	-84.4	-80	-79.4
64-QAM	3/4	-86.4	-82	-78	-77.4	-81.4	-82.1	-77.7	-77.1
64-QAM	4/5	-85.4	-81	-77	-76.4	-80.4	-80.1	-75.7	-75.1
64-QAM	5/6	-84.7	-80.3	-76.3	-75.7	-79.7	-78.6	-74.2	-73.6
256-QAM	1/2	-87.1	-82.7	-78.7	-78.1	-82.1	-83.5	-79.1	-78.5
256-QAM	3/5	-84.7	-80.3	-76.3	-75.7	-79.7	-81	-76.6	-76
256-QAM	2/3	-83.3	-78.9	-74.9	-74.3	-78.3	-79	-74.6	-74
256-QAM	3/4	-81.2	-76.8	-72.8	-72.2	-76.2	-76.1	-71.7	-71.1
256-QAM	4/5	-79.8	-75.4	-71.4	-70.8	-74.8	-73.3	-68.9	-68.3
256-QAM	5/6	-79	-74.6	-70.6	-70	-74	-70.5	-66.1	-65.5

Table 3.12 Examples of minimum DVB-T2 signal input levels (P_{min}) for QEF reception at TS output (with 1/8 guard interval, PP2 and FFT size 32K, Extended bandwidth for UHF) for profiles 1 and 2. For 1.7 MHz modes the P_{min} figures refer to 1/8 guard interval, PP2 and FFT size 8K with Normal bandwidth(1).

Note 1: The P_{min} values for 1.7 MHz have been calculated using a NF of 7dB (See note 1 to Table 3.10).

The required P_{min} values shall apply generally for Mode A and Mode B, including TFS (1) (2), when supported.
For TFS, the levels of all RF channels involved are identical. For TFS, the 0 dB echo profile is also identical on all RF channels.

Note 1: Performance requirements for TFS modes with unequal levels and with other channel profiles may be defined in a later release of this specification.

Note 2: For NorDig IRD-T2s lauched before 2012 the values for non-S-band channels may be increased with 1 dB, due to a 1 dB worse noise figure.

3.4.10.5 Maximum Receiver Signal Input Levels

The NorDig IRD shall provide QEF reception for DVB-T and DVB-T2 signals up to a level of –35dBm.

The maximum analogue TV signal input level is restricted to –20 dBm defined as the r.m.s (root mean square) value of the vision carrier at peaks of the modulated envelope.

The DVB-T signal input level is valid for the modes {8K, 64-QAM, R=2/3, Δ/Tu=1/8}, {8K, 64-QAM, R=2/3, Δ/Tu =1/4} and {8K, 64-QAM, R=3/4, Δ/Tu =1/4}.

The DVB-T2 signal input level is valid for the modes shown in Table 3.6.

3.4.10.6 Immunity to “analogue” signals in Other Channels

The NorDig IRD shall permit adjacent PAL-G carriers with up to 33 dB higher power with QEF reception. (The level of the FM sound relative to the vision carrier is -13 dB. The level of the NICAM signal relative to the vision carrier is -20 dB).

On any other channels QEF reception shall be possible with “analogue” signals with up to 44 dB higher level than the DVB-T/T2 signal.

For DVB-T the requirements in this paragraph refer to signals within UHF Bands IV and V and to the modes {8K, 64-QAM, R=2/3, Δ/Tu =1/8} and {8K, 64-QAM, R=2/3, Δ/Tu =1/4} and {8K, 64-QAM, R=3/4, Δ/Tu =1/4}.

For DVB-T2 the requirements in this paragraph refer to signals within UHF Bands IV and V and to the modes given in Table 3.6.

3.4.10.7 Immunity to “digital” signals in Other Channels

The NorDig IRD shall, for the supported frequency ranges, permit an interfering DVB-T or DVB-T2 signal with a minimum interference to signal level ratio (I/C) as stated in the Table 3.13 while maintaining QEF reception.

Band	Signal Bandwidth MHz	Channel frequency raster MHz	Minimum I/C (dB)		
			Adjacent channels	Other Channels	Image channel
VHF S Band I	7	7	20	25	-
	8	8	20	25	-
VHF III	1.7	1.7	28	38	-
	7	7	28	38	
	8	8	28	38	-
VHF S Band II	7	7	20	25	-
	8	8	20	25	-
UHF S Band III	8	8	20	25	-
UHF IV	8	8	28	38	28
UHF V	8	8	28	38	28

Table 3.13 Minimum required I/C for QEF reception with interfering DVB-T/T2 signal on the adjacent, other and image channels

The requirements in this paragraph refer, for DVB-T, to the modes {8K, 64-QAM, R=2/3, Δ/Tu =1/8} and {8K, 64-QAM, R=2/3, Δ/Tu =1/4} and {8K, 64-QAM, R=3/4, Δ/Tu =1/4} and for DVB-T2 to the modes given in Table 3.6.

3.4.10.8 Immunity to Co-Channel Interference From Analogue TV Signals

The sensitivity for interference from analogue TV is specified as the minimum carrier to interference ratio, C/I, required for a QEF reception. The NorDig IRD shall perform better than specified inTable 3.14 when a 8 MHz DVB-T signal is exposed to interference from a co-channel G/PAL signal including video with teletext, an FM sound and a NICAM sub carrier as specified above (see section 3.4.10.6 and in Table 3.15 when an 8 MHz DVB-T2 signal is exposed to interference from a co-channel G/PAL signal including video with teletext, an FM sound and a NICAM sub carrier as specified above (see section 3.4.10.6).

Constellation	64QAM	
Code rate	2/3	3/4
C/I	3 dB	7 dB

Table 3.14 Carrier to Interference, C/I (dB) for QEF reception, when the DVB-T signal is interferred by an analogue TV carrier.

Constellation	256QAM		
Code rate	3/5	2/3	3/4
C/I	3 dB	5 dB	7dB

Table 3.15 Carrier to Interference, C/I (dB) for QEF reception, when DVB-T2 signal is interferred by an analogue TV carrier.

3.4.10.9 Performance In Time-Varying Channels

The NorDig IRD shall 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.

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 20 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 10 Hz (after AFC), compared to a 0 dB echo with frequency separation equal to 1 Hz and a delay of 20 µs,

corresponding to a Doppler shift of +/- 0.5 Hz (after AFC). The requirements in this paragraph refer for DVB-T to the modes {8K, 64-QAM, R=2/3, Δ/Tu =1/8} and {8K, 64-QAM, R=2/3, Δ/Tu =1/4}.

The increase in required C/N for QEF reception shall be less than 3 dB for a 0 dB echo with frequency separation equal to 10 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 5 Hz (after AFC), compared to a 0 dB echo with frequency separation equal to 1 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 0.5 Hz (after AFC). The requirement in this paragraph refer for DVB-T to the mode {8K, 64-QAM, R=3/4, Δ/Tu =1/4} and for DVB-T2 to the modes given in Table 3.6.(1) For 1.7 MHz these DVB-T2 modes apply as well, except that the FFT size is 8K.

Note 1: For DVB-T2 modes in Table 3.6 using code rate ¾ the increase in required C/N may be up to 5 dB before 2012.

3.4.10.10 Synchronisation for varying echo power levels in SFN

For the DVB-T modes {8K, 64-QAM, R=2/3, Δ/Tu=1/8}, {8K, 64-QAM, R=2/3, Δ/Tu =1/4} and {8K, 64-QAM, R=3/4, Δ/Tu =1/4}, the required C/N value, specified in Table 3.16 below, for QEF-reception shall be obtained when the channel contains two paths with relative delay from 1.95 µs up to 0.95 times guard interval length and the relative power levels of the two paths are dynamically varying including 0dB echo level crossing. The C/N value is defined at 0 dB level crossing.

For the DVB-T2 modes given in Table 3.6, the required C/N value, specified in Table 3.17 below, for QEF reception shall be obtained when the channel contains two paths with relative delay from 1.95 µs up to 0.95 times guard interval length and the relative power levels of the two paths are dynamically varying including 0dB echo level crossing. The C/N value is defined at 0 dB level crossing.

Modulation	Code rate	C/N performance (dB)
64-QAM	R2/3	26.2
64-QAM	R3/4	30.6

Table 3.16 Maximum required C/N for QEF reception with dynamically varying echo power levels using DVB-T

Modulation	Code rate	C/N performance (dB)
256-QAM	R3/5	26.1
256-QAM	R2/3	28.1
256-QAM	R3/4	31.0

Table 3.17 Maximum required C/N for QEF with dynamically varying echo power levels using DVB-T2.

3.4.10.11 C/(N+I) Performance in Single Frequency Networks

If there exists one or more FFT window positions for the time synchronisation that will give an aggregate available C/(N+I) larger than or equal to the required EPT (Effective Protection Target), the NorDig IRD shall be able to find one of these positions, independently of echo profile. The NorDig IRD shall also be able to correctly equalise the signal (sometimes referred to as Interval of correct equalisation) for echoes up to

IRD-T:

- $7T_U/24$ (i.e. for 7 MHz signal up to 298 µs and for 8 MHz signal up to 260 µs)

IRD-T2:

- 57/64 (≈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. See also Annex B1.

Example: Using 32K, GI 1/16 (224 µs) and PP4 it shall be possible to equalize echoes up to (57/64)*(3584/12) µs = 266 µs.

For the DVB-T modes {8K, 64-QAM, R=2/3, Δ/T_u=1/8}, {8K, 64-QAM, R=2/3, Δ/T_u =1/4} and {8K, 64-QAM, R=3/4, Δ/T_u =1/4}, the required C/N value for profile 2 (specified in Table 3.7) for QEF reception shall be obtained when the channel contains two static paths with relative delay from 1.95 µs up to 0.95 times guard interval length, independently of the relative amplitudes and phases of the two paths.

For the DVB-T2 modes shown in Table 3.6, the required C/N value for profile 2 (specified in Table 3.8) for QEF reception shall be obtained when the channel contains two static paths with relative delay from 1.95µs up to 0.95 times guard interval length, independently of the relative amplitudes and phases of the two paths. For 1.7 MHz these DVB-T2 modes apply as well, except that the FFT size is 8K.

For a specific echo attenuation the required C/N shall have approximately the same value, independent of the actual delay length. The deviation in required C/N from the median value shall be less than 1 dB, for any echo length from 1.95 µs up to 0.95 times guard interval length.

For echoes outside the guard interval, for:

- 8 MHz DVB-T signal, QEF reception shall be possible with echo levels up to the values defined in Table 3.18.
- 7 MHz DVB-T signal, QEF reception shall be possible with echo levels up to the values defined in Table 3.19.
- 8 MHz DVB-T2 signal, QEF reception shall be possible with echo levels up to the values defined in Table 3.20.
- 7 MHz DVB-T2 signal, QEF reception shall be possible with echo levels up to the values defined in Table 3.21.
- 1.7 MHz DVB-T2 signal, when supported, QEF reception shall be possible with combinations of delays and echo levels following the general outside-the-guard-interval behavior of Table 3.21, scaled appropriately for 1.7 MHz bandwidth and 8K FFT size.
  This means that for 1.7 MHz bandwidth (i.e. elementary period T=71/131 µs) and FFT size 8K the symbol time will be 142/131 times longer (about a factor 1.084) compared to 32K in 7 MHz. The performance requirement for a given original echo level and delay shall therefore also be met when the delay is multiplied by 142/131, but the echo level is kept unchanged.

	Echo attenuation in dB relative reference									
Delay (µs)	*-260*	*-230*	*-200*	*-150*	*-120*	*120*	*150*	*200*	*230*	*260*
Mode										
8K, 64-QAM, R=2/3, Δ/T_u=1/8	15	-	13	10	5	5	10	13	-	15
8K, 64-QAM, R=2/3, Δ/T_u=1/4	10	5	n/a	n/a	n/a	n/a	n/a	n/a	5	10
8K, 64-QAM, R=3/4, Δ/T_u=1/4	12	6	n/a	n/a	n/a	n/a	n/a	n/a	6	12

Table 3.18 QEF reception for echoes outside the guard interval, for 8 MHz DVB-T signal

	Echo attenuation in dB relative reference													
Delay (µs)	*-298*	*-266*	*-256*	*-215*	*-165*	*-135*	*-128*	*128*	*135*	*165*	*215*	*256*	*266*	*298*
Mode														
8K, 64-QAM, R=2/3, Δ/T_u=1/8	**16**	**-**	**-**	**13**	**10**	**5**	**1**	**1**	**5**	**10**	**13**	**-**	**-**	**16**
8K, 64-QAM, R=2/3, Δ/T_u=1/4	**10**	**5**	**1**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**1**	**5**	**10**
8K, 64-QAM, R=3/4, Δ/T_u=1/4 (1)	**12**	**6**	**2**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**2**	**6**	**12**

Table 3.19 QEF reception for echoes outside the guard interval, for 7 MHz DVB-T signal.

	Echo attenuation in dB relative reference									
Delay (µs)	-260	-230	-200	-150	-120	120	150	200	230	260
Mode										
32K, 256-QAM, PP4, R=3/5, Δ/Tu=1/16,	4(20)*	2	n/a	n/a	n/a	n/a	n/a	n/a	2	4(20)*
32K, 256-QAM, PP4, R=2/3, Δ/Tu=1/16,	6(22)*	3	n/a	n/a	n/a	n/a	n/a	n/a	3	6(22)*
32K, 256-QAM, PP4, R=3/4, Δ/Tu =1/16	8(24)*	4	n/a	n/a	n/a	n/a	n/a	n/a	4	8(24)*
32K, 256-QAM, PP4, R=3/5, Δ/Tu=1/32	10(20)*	9	7	4	2	2	4	7	9	10(20)*
32K, 256-QAM, PP4, R=2/3, Δ/Tu=1/32	12(22)*	11	10	6	3	3	6	10	11	12(22)*
32K, 256-QAM, PP4, R=3/4, Δ/Tu=1/32	14(24)*	13	12	8	4	4	8	12	13	14(24)*

Table 3.20 QEF reception for echoes outside the guard interval, for 8 MHz DVB-T2 signal (See note 1).*

Echo attenuation in dB relative reference								
Delay (µs)	-/+608	-/+512	-/+400	-/+298	-/+266	-/+215	-/+165	-/+135
Mode								
32K, 256-QAM, PP4, R=3/5, Δ/Tu=1/16	n/a	n/a	n/a	4(20)*	2(20)*	n/a	n/a	n/a
32K, 256-QAM, PP4, R=2/3, Δ/Tu=1/16	n/a	n/a	n/a	6(22)*	3(22)*	n/a	n/a	n/a
32K, 256-QAM, PP4, R=3/4, Δ/Tu=1/16	n/a	n/a	n/a	8(24)*	4(24)*	n/a	n/a	n/a
32K, 256-QAM, PP4, R=3/5, Δ/Tu=1/32	n/a	n/a	n/a	10(20)*	9	7	4	2
32K, 256-QAM, PP4, R=2/3, Δ/Tu=1/32	n/a	n/a	n/a	12(22)*	11	10	6	3
32K, 256-QAM, PP4, R=3/4, Δ/Tu=1/32	n/a	n/a	n/a	14(24)*	13	12	8	4
32K, 256-QAM, PP2, R=3/5, Δ/Tu=1/16	12(20)*	11	9	4	2	n/a	n/a	n/a
32K, 256-QAM, PP2, R=2/3, Δ/Tu=1/16	15(22)*	14	11	6	3	n/a	n/a	n/a
32K, 256-QAM, PP2, R=3/4, Δ/Tu=1/16	18(24)*	16	14	8	4	n/a	n/a	n/a

*Table 3.21 QEF reception for echoes outside the guard interval, for 7 MHz DVB-T2 signal (*See note 1).*

Note 1: Values marked by asterisks (*) in tables 3.20 and 3.21 are temporarily relaxed; the values in parentheses apply before 2012.

3.4.10.12 Time-Frequency Slicing (TFS)

The requirements in the remainder of this section 3.4.10.12 apply when TFS is supported:

For a particular LDPC code rate CR, CR ∈ {1/2, 3/5, 2/3, 3/4, 4/5, 5/6}, The NorDig IRD -T2 shall in TFS mode be able to output a QEF TS when the proportion R of lost RF frequencies, of the total number of TFS RF frequencies, fulfils the relation R ≤ 0.75*(1-CR) and the received RF frequencies have equal power and no noise, interference or echoes.

Example 1: Using TFS with 4 RF frequencies and CR=3/5 it shall be possible to lose one RF frequency since ¼ = 0.25 < 0.75*(1-0.60) = 0.30.

Example 2: Using TFS with 4 RF frequencies and CR=2/3 it shall be possible to lose one RF frequency since ¼ = 0.25 = 0.75*(1-2/3)

The NorDig IRD for DVB-T2 should be able to correctly demodulate a TS when TFS is performed on a combination of UHF band IV/V frequencies (8 MHz channel spacing) and VHF band III frequencies (7 MHz spacing) provided that the following conditions are fulfilled:

- The RF signals on VHF have nominally the same modulation parameters as those on UHF, including T2 frame length, symbol time, guard interval etc.
- The edge carriers on the VHF signal are symmetrically surpressed already from the transmitter (e.g. by setting the corresponding FFT bin values to zero) so that the actually transmitted RF bandwidth of the VHF signal is identical to a standard 7 MHz DVB-T2 signal.

Note 1: The NorDig IRD-T2 should consider these edge carriers as unreliable. With two RF frequencies about 6.25% of the total number of TFS carriers would then be erased, which should have a very small impact on the capacity/robustness (required C/N < 1 dB degradation, but about corresponding increase in capacity), but with additional TFS gain.

Note 2: In a future release of this specification more detailed performance requirements for TFS operation may be included.

3.5 IP Based Front-End

Unchanged.

4 MPEG-2 Demultiplexer

Unchanged.

5 Video Decoder

Unchanged.

6 Audio Decoder

Unchanged.

7 Teletext and Subtitling

Unchanged.

8 Interfaces and Signal Levels

Unchanged.

9 Interfaces for Conditional Access

Unchanged.

10 The Bootloader (System Software Update)

Unchanged.

11 Performance

Unchanged.

Part B: The system software with application

12 Service Information

12.1 General

12.1.1 General Requirements

Unchanged.

12.1.2 PSI/SI classification

Unchanged.

12.1.3 Private data specifier value

Unchanged.

12.1.4 Service Types

Unchanged.

12.1.5 Service Categories

Unchanged.

12.1.6 Used PSI/SI descriptors

Descriptor	Tag value	NIT (3)	BAT	SDT	EIT	TOT/ TDT	CAT	PMT
video_stream_descriptor	0x02	-	-	-	-	-	-	mb Mr
audio_stream_descriptor	0x03	-	-	-	-	-	-	mb Or
target_background_grid_descriptor	0x07	-	-	-	-	-	-	Ob Or
video_window_descriptor	0x08	-	-	-	-	-	-	Ob Or
CA_descriptor	0x09	-	-	-	-	-	mb Mr	mb Mr
ISO_639_language_descriptor	0x0A	-	-	-	-	-	-	mb Mr
carousel_id_descriptor	0x13	-	-	-	-	-	-	mb Mr (1)
network_name_descriptor (3)	0x40	Mb Mr	-	-	-	-	-	-
service_list_descriptor (3)	0x41	Ob Mr	-	-	-	-	-	-
satellite_delivery_system_descriptor (3)	0x43	mb Mr	-	-	-	-	-	-
cable_delivery_system_descriptor (3)	0x44	mb Mr	-	-	-	-	-	-
service_descriptor	0x48	-	-	Mb Mr	-	-	-	-
linkage_descriptor (3)	0x4A	mb Mr	-	Ob Mr	*	-	-	-
short_event_descriptor	0x4D	-	-	-	mb Mr	-	-	-
extended_event_descriptor	0x4E	-	-	-	Ob Mr	-	-	-
component_descriptor	0x50	-	-	-	Ob Mr	-	-	-
stream_identifier_descriptor	0x52	-	-	-	-	-	-	Ob Mr
CA_identifier_descriptor	0x53	-	-	Ob Mr	Ob Mr*	-	-	-
content_descriptor	0x54	-	-	-	mb Mr	-	-	-
parental_rating_descriptor	0x55	-	-	-	Ob Mr	-	-	-
teletext_descriptor	0x56	-	-	-	-	-	-	mb Mr
local_time_offset_descriptor	0x58	-	-	-	-	Mb Mr	-	-
subtitling_descriptor	0x59	-	-	-	-	-	-	mb Mr
terrestrial_delivery_system_descriptor (3)	0x5A	mb Mr (2)	-	-	-	-	-	-
private_data_specifier_descriptor (3)	0x5F	mb Mr	-	mb Or	mb Or	-	-	mb Mr
frequency_list_descriptor (3)	0x62	Ob Mr	-	-	-	-	-	-
data_broadcast_id_descriptor	0x66	-	-	-	-	-	-	mb Mr
AC-3 descriptor	0x6A	-	-	-	-	-	-	mb Or
application_signalling_descriptor	0x6F	-	-	-	-	-	-	mb Mr (1)
service_identifier_descriptor	0x71	-	-	Ob Mr (1)				

Descriptor	Tag value	NIT (3)	BAT	SDT	EIT	TOT/ TDT	CAT	PMT
default_authority_descriptor (4)	0x73	Ob Mr (4)	-	Ob Mr (4)	-	-	-	-
content_identifier_descriptor (4)	0x76	-	-	-	Ob Mr (4)	-	-	-
extension descriptor (5)	0x7F	mb Mr	-	mb Mr	mb Mr	-	-	mb Mr
user defined	0x80-0xFE	-	-	-	-	-	-	-
NorDig private: logic_channel_descriptor (Version 1) (3)	0x83	Ob Or	-	-	-	-	-	-
NorDig private: logic_channel_descriptor (Version 2) (3)	0x87	Ob Mr	-	-	-	-	-	-
NorDig private: content_protection_descriptor	0xA0	-	-	-	-	-	-	Ob Mr
Forbidden	0xFF	Fb	Fb	Fb	Fb	Fb	Fb	Fb

- *Descriptor not applicable or not yet used as minimum within NorDig*

Mb Mandatory to Broadcast, always/all time
mb Mandatory to Broadcast if applicable, i.e. if certain criteria is met (e.g. if scrambling is used)
Ob Optional to broadcast, but recommended (if applicable)
Fb Forbidden to broadcast (may cause misinterpretation)
Mr Mandatory to receive and interpret if broadcast
Or Optional to receive and interpret (if broadcasted)
* Optional for satellite and cable IRDs.

Note 1: Mandatory for IRD with MHP API based profiles
Note 2: Mandatory to broadcast, in accordance with ETSI TR 101 211 [31].
Note 3: Descriptors carried in the NIT are not relevant for IRDs with IP-based Front-end, see Annex C
Note 4: NorDig PVR only. Optional for NorDig PVR IRDs that are released before 1 January 2011.
Note 5: Only applicable for NorDig IRD-T2

Table 12.2 Overview over minimum used descriptors in NorDig broadcast and receivers

Descriptor	Tag extension value	NIT (3)	BAT	SDT	EIT	TOT/ TDT	CAT	PMT
T2_delivery_system_descriptor	0x04	mb Mr	-	-	-	-	-	-
reserved for future use	0x09-0x7F	-	-	-	-	-	-	-
user defined	0x80-0xFF	-	-	-	-	-	-	-

- Descriptor not applicable or not yet used as minimum within NorDig

Mb Mandatory to Broadcast, always/all time
mb Mandatory to Broadcast if applicable, i.e. if certain criteria is met (e.g. if scrambling is used)
Ob Optional to broadcast, but recommended (if applicable)
Fb Forbidden to broadcast (may cause misinterpretation)
Mr Mandatory to receive and interpret if broadcast
Or Optional to receive and interpret (if broadcasted)
* Optional for satellite and cable IRDs.

Note 1: Mandatory for IRD with MHP API based profiles
Note 2: Mandatory to broadcast, in accordance with ETSI TR 101 211 [31].
Note 3: Descriptors carried in the NIT are not relevant for IRDs with IP-based Front-end, see Annex C

Table 12.3 Overview over minimum used descriptors in the extension_descriptor in NorDig broadcast and receivers

12.1.7 Character sets in text strings

Unchanged.

12.2 Network Information Table (NIT)

12.2.1 The Network information Table Descriptors

NIT descriptors	Cable IRD	Satellite IRD	Terrestrial IRD
Network_name_descriptor	mandatory	Mandatory	Mandatory
Service_list_descriptor	mandatory	Mandatory	Mandatory
Satellite_delivery_system_descriptor	n/a	Mandatory	n/a
Cable_delivery_system_descriptor	mandatory	n/a	n/a
Terrestrial_delivery_system_descriptor	n/a	n/a	Mandatory
T2_Terrestrial_delivery_system_descriptor (2)	n/a	n/a	Mandatory (2)
Linkage_descriptor	mandatory	Mandatory	Mandatory
Private_data_specifier_descriptor	mandatory	Mandatory	Mandatory
Frequency_list_descriptor	optional	Optional	Mandatory
default_authority_descriptor (3)	Mandatory (3)	Mandatory (3)	Mandatory (3)
(NorDig) logic_channel_descriptor (Version 2)	Mandatory	Mandatory	Mandatory

Table 12.5 NIT descriptors

Note 1: The NIT is not used with NorDig IRDs with IP-based frontends. Hence if NIT is transmitted, the NorDig IP IRDs shall ignore this table. Instead, the information provided by the NIT will be replaced by the Service Discovery and Selection mechanisms, specified in Section 13.4.

Note 2: Descriptor is signaled in the extension_descriptor and only applicable for NorDig IRD T2.

Note 3: NorDig PVR only. Optional for NorDig PVR IRDs that are released before 1 January 2011.

The Default Authority Descriptor (DAD), defined in DVB document Carriage and signalling of TV-Anytime (TVA) information ETSI TS 102 323 [38], may be used to shorten the CRIDs carried within EIT by defining an appropriate CRID default authority over a defined scope.

The DAD may be used in first loop of NIT to set a common Default Authority (DA) for all services within that Network. It may also be used in second loop (TS loop) to set a common Default Authority for all services within a Transport Stream.

The prefix “crid://” may be omitted from the start of the text string in the Default Authority in the NIT (both first or second loop). See separate section about CRID usage in 12.4.8

As described in ETSI TS 102 323 [38], where an event in the EIT does not have a complete URL within the Content Identifier Descriptor (CID) (i.e. a CRID starting with ‘/’), the NorDig PVR IRD shall (1):

- Use default authority (DA) defined for this service in the SDT.
- If no default authority is defined in the SDT, the PVR shall use the default authority in the second TS loop of the NIT for the actual transport stream this service belongs to.
- If no default authority is defined for the actual transport stream in second loop of NIT, the receiver shall use default authority in first loop in NIT for the network this service belongs too.

Note 1: Optional for NorDig PVR IRDs that are released before 1 January 2011.

12.2.2 Cable Delivery System Descriptor

Unchanged.

12.2.3 Terrestrial Delivery System Descriptor

Unchanged.

12.2.4 T2 Delivery System Descriptor

T2_delivery_system_descriptor is signaled in the extension_descriptor.

The NorDig IRD-T2 shall use the system parameters in the T2_delivery_system_descriptor to determine the mapping between original_network_id/network_id/transport_stream_id and T2_system_id/plp_id.

The NorDig IRD-T2 should use the other system parameters in the T2_delivery_system_descriptor as a recommendation when trying to tune to a multiplex. The NorDig IRD-T2 should, however, always be able to detect these system parameters from the transmission itself (i.e. assisted by L1 signaling).

Operators can broadcast the same transport stream in the same network using different system parameter settings, reflected in a different T2_system_id. This allows for optimization of the network coverage in frequency planning involving SFN and MFN combination networks.

12.2.5 Linkage Descriptor

Unchanged.

12.2.6 Frequency List Descriptor

Unchanged.

12.2.7 NorDig linkage for bootloader

Unchanged.

12.2.8 Default authority descriptor (in NIT) (NorDig PVR only)

Unchanged.

12.2.9 NorDig private; Logic_Channel_descriptor (LCD)

Unchanged.

12.3 Service Description Table (SDT)

Unchanged.

12.4 Event Information Table

Unchanged.

12.5 Time and Date Table and Time Offset Table

Unchanged.

12.6 PSI Requirements

Unchanged.

13 Navigator

13.1 General

13.2 Service List

13.2.1 Service List Requirements

Unchanged.

13.2.2 Service list functions for the Network Information Table (NIT)

The NorDig IRD shall (1) make use of the descriptors listed in table 13.1 in all NIT_actual (the transport stream the NorDig IRD is tuned to) and NIT_other (other transport stream) tables available in order to update the service list (system delivery data, number of transport streams, logic channel number etc).

Note 1: NorDig IRDs with a terrestrial front-end shall be able to install and update the service list components even if the transport stream does not contain the terrestrial_ delivery_ system_descriptor in the NIT_actual and the NIT_other streams (NIT_actual: the transport stream the IRD is tuned to. NIT_other: other transport stream). NorDig IRDs with a IP-based front-end: Not relevant. See Annex C

A cable NorDig IRD should provide functionality for fast installation of services by typing the network_ID into the receiver. In such a case, the IRD shall process only that specific NIT (actual and other) table (with corresponding network_ID) from current/actual transport stream and only install/display services listed in that table's service_list_descriptors.

A Navigator shall never display services that the IRD is not able to receive or decode except for de-scrambling (i.e. a pure satellite IRD shall not display services which are described in NITother tables for secondary cable networks).

A NorDig IRD shall not install, be able to reach or display services or networks with original_network_ID and/or network_ID which are marked as 'private_temporary_use' as defined in ETSI ETR 162 [27] (i.e. an original_network_ID 0xFF00 – 0xFFFF and/or network_ID 0xFF01 – 0xFFFF). (This descriptor may be used by broadcasters to avoid confusing consumers with (shorter) test and demonstration transmissions).

Services that are not listed in NorDig Logic_channel_descriptor, shall be displayed in the service list(s) and shall be located last in the list (for that service_type).

NIT descriptors
Network_name_descriptor
Satellite_delivery_system_descriptor
Cable_delivery_system_descriptor
Terrestrial_delivery_system_descriptor
T2_delivery_system_descriptor (1)
Service_list_descriptor
(Nordig) Logic_channel_descriptor
Note 1: Descriptor is signaled in the extension_descriptor and is only applicable for NorDig IRD-T2.

Table 13.1 NIT descriptors

13.3 Event Schedule Guide (ESG)

Unchanged.

13.4 Service Discovery and Selection for IRDs with IP-based front-end

Unchanged.

14 NorDig PVR feature requirements (NorDig PVR only)

Unchanged.

15 IRD System Software and API

Unchanged.

16 User Preferences

Unchanged.

Annex A: NorDig Members

Unchanged.

Annex B: Background and options for IRDs with a terrestrial front-end

1 Terminology and Definitions for Single Frequency Networks Performance Parameters

Although it might be believed that the delay spread of the channel can be assumed to stay within the length of the guard interval used, this is not always the case in practice. In single frequency networks there will normally be all sorts of delayed components and significant components having a delay far greater than the guard interval will often exist, although normally at a low but not insignificant level, and have a significant impact on the coverage area. In many cases delayed components will be significantly stronger than the earliest component.

In order to have good performance in single frequency networks it is therefore very important that:

1. the receiver is able to time synchronise in a quasi-optimum way in order to minimise the intersymbol interference that will exist when pre- and/or post echoes are longer than the guard interval.
2. the receiver is able to correctly equalise also in channels with echoes longer than the guard interval. It should be noted that the optimum way of frequency interpolation is dependent on the actual FFT time window position.

The required EPT depends on the system parameters and on the characteristics of the echoes inside and outside the guard interval, which determine the *criticality* of the channel (its frequency selectivity).

- For fixed reception, the Ricean channel (F_1, see EN 300 744 [20]) is used for the main transmitter contribution. The *EPT* depends on the amplitude of the artificial echoes from the other transmitters, and can vary from $C/N|_F$ (single transmitter, Ricean channel (F_1) for low artificial echoes to $C/N|_P$ (single transmitter, Rayleigh channel (P_1), for high artificial echoes. The number and the delay of artificial echoes within the guard interval does not affect significantly the system performance, but their total power compared to the power of the main path has an important effect on the channel *criticality*. A parameter, K_A, has been identified as the "channel criticality due to artificial echoes" and is the ratio (in dB) between the power received from the main transmitter and the total power of the artificial echoes inside the interval of correct equalisation T_F. It should be noted that K_A = 0 dB corresponds to the most critical case.
- For portable reception, the channel (Rayleigh) is adopted for each transmitter contribution (natural echoes), and the computer simulations have indicated that *EPT* is not significantly affected by the presence of the other SFN transmitters (in fact the channel model is of Rayleigh type also with a single transmitter).

Neglecting other interference sources, the equivalent total available *C/(N+I)* [dB] in a given location of the service area can be estimated by using formula (A.3).

$$w_i = \begin{cases} 0 & \text{if } \tau \le 0 \\ 1 & \text{if } 0 < \tau \le T_g \\ \left(\dfrac{T_u - \tau + T_g}{T_u}\right)^2 & \text{if } T_g < \tau \le T_F \\ 0 & \text{if } \tau > T_F \end{cases}$$

$$C = \sum_i w_i \, C_i \qquad \text{(A.3)}$$

$$I = \sum_i (1 - w_i) \, C_i$$

where:

C_i is the power contribution from the i-th echo (natural or artificial) at the receiver input.

C is the total power of the effective useful signal.

I is the total effective interfering power.

w_i is the weighting coefficient for the i-th component.

T_F is the interval of correct equalisation. The theoretical maximum value for T_F is 1/3 T_U for conventional channel estimation.

The system can operate satisfactorily in a given location when the aggregate available *C/(N+I)* is larger or equal to the required effective protection target *EPT*:

$$\left.\frac{C}{N+I}\right|_{\text{Available}} \equiv \frac{1}{\left(\frac{C}{N}\right)^{-1} + \left(\frac{C}{I}\right)^{-1}} \ge EPT \qquad \text{(A.4)}$$

The required Effective Protection Target is given by (all the items are expressed in dB):

$$EPT = \begin{cases} \left.\frac{C}{N}\right|_F + \left(\left.\frac{C}{N}\right|_P - \left.\frac{C}{N}\right|_F\right)\left(\dfrac{0.5}{\left.\frac{C}{N}\right|_P - \left.\frac{C}{N}\right|_F}\right)^{\frac{K_A}{10}} & \text{for fixed reception} \\ \left.\frac{C}{N}\right|_P & \text{for portable reception} \end{cases} \qquad \text{(A.5)}$$

where:

EPT	is the required system effective protection target in a particular SFN echo environment
$C/N\|_F$	is the carrier to noise ratio required by the system on the F_1 channel (single transmitter, Rice channel).
$C/N\|_P$	is the carrier to noise ratio required by the system on the P_1 channel (single transmitter, Rayleigh channel).
K_A	*"channel criticality due to artificial echoes"* is the ratio (in dB) between the power received from the main transmitter and the total power of the artificial echoes inside the interval of correct equalisation T_F; (if K_A<0 dB, then K_A is forced to 0 dB)

2 List of DVB-T/T2 centre frequencies

Band	Channel id	Centre Frequency	Signal Bandwidth
VHF I	*K2*		
	K3		
	K4		
(VHF) S I	*S1*	*107.5*	*7*
	D1	114.0	8
	S2	114.5	7 alt 8
	S3	121.5	7 alt 8
	D2	122.0	8
	S4	128.5	7 alt 8
	D3	130.0	8
	S5	135.5	7 alt 8
	D4	138.0	8
	S6	142.5	7 alt 8
	D5	146.0	8
	S7	149.5	7 alt 8
	D6	154.0	8
	S8	156.5	7 alt 8
	D7	162.0	8
	S9	163.5	7 alt 8
	D8	170.0	8
	S10	170.5	7 alt 8
VHF III	5 (K5)	177.5	7 alt 8
	D9	178.0	8
	K6	184.5	7 alt 8
	D10	186.0	8
	K7	191.5	7 alt 8
	D11	194.0	8
	K8	198.5	7 alt 8
	D12	202.0	8
	K9	205.5	7 alt 8
	D13	210.0	8
	K10	212.5	7 alt 8
	D14	218.0	8
	K11	219.5	7 alt 8
	D15	226.0	8
	K12	226.5	7 alt 8
(VHF) S II	S11	233.5	7 alt 8
	D16	234.0	8
	S12	240.5	7 alt 8
	D17	242.0	8
	S13	247.5	7 alt 8
	D18	250.0	8
	S14	254.5	7 alt 8
	D19	258.0	8
	S15	261.5	7 alt 8
	D20	266.0	8
	S16	268.5	7 alt 8
	D21	274.0	8
	S17	275.5	7 alt 8
	D22	282.0	8
	S18	282.5	7 alt 8
	S19	289.5	7 alt 8
	D23	290.0	8
	S20	296.5	7 alt 8
	D24	298.0	8

Band	Channel id	Centre Frequency
(UHF) S III	S21	306
	S22	314
	S23	322
	S24	330
	S25	338
	S26	346
	S27	354
	S28	362
	S29	370
	S30	378
	S31	386
	S32	394
	S33	402
	S34	410
	S35	418
	S36	426
	S37	434
	S38	442
	S39	450
	S40	458
	S41	466

Band	Channel id	Centre Frequency
UHF IV	K21	474
	K22	482
	K23	490
	K24	498
	K25	506
	K26	514
	K27	522
	K28	530
	K29	538
	K30	546
	K31	554
	K32	562
	K33	570
	K34	578
	K35	586
	K36	594
	K37	602
UHF V	K38	610
	K39	618
	K40	626
	K41	634
	K42	642
	K43	650
	K44	658
	K45	666
	K46	674
	K47	682
	K48	690
	K49	698
	K50	706
	K51	714
	K52	722
	K53	730
	K54	738
	K55	746
	K56	754
	K57	762
	K58	770
	K59	778
	K60	786
	K61	794
	K62	802
	K63	810
	K64	818
	K65	826
	K66	834
	K67	842
	K68	850
	K69	858

All Center Frequencies and Signal Bandwidth are listed in MHz. Names for channel_ids are proposed.

T2 block number	Centre frequency (MHz)	Frequency range* (MHz)
5A	174.928	174.0-181.0
5B	176.640	
5C	178.352	
5D	180.064	
6A	181.936	181.0-188.0
6B	183.648	
6C	185.360	
6D	187.072	
7A	188.928	188.0-195.0
7B	190.640	
7C	192.352	
7D	194.064	
8A	195.936	195.0-202.0
8B	197.648	
8C	199.360	
8D	201.072	
9A	202.928	202.0-209.0
9B	204.640	
9C	206.352	
9D	208.064	
10A	209.936	209.0-216.0
10B	211.648	
10C	213.360	
10D	215.072	
11A	216.928	216.0-223.0
11B	218.640	
11C	220.352	
11D	222.064	
12A	223.936	223.0-230.0
12B	225.648	
12C	227.360	
12D	229.072	
13A	230.784	230.0-240.0
13B	232.496	
13C	234.208	
13D	235.776	
13E	237.488	
13F	239.200	

3 Hierarchical mode reception

The NorDig IRD should be able to receive the hierarchical modes in the DVB-T specification: QPSK in 16QAM and QPSK in 64 QAM with the constellation proportion parameter α= 1,2 and 4. The NorDig IRD shall be able to use both the Low Priority (LP) and High Priority bit stream (HP) to receive a MPEG transport stream.

The carrier-to-noise (C/N) ratio values in tables1 and 2 are specified for channel Profile 1.

Profile 1: Gaussian noise (N) is applied together with the wanted carrier (C) in a signal bandwidth.

No echo is applied.

	α = 1		α = 2	
Code rate	HP QPSK	LP 64QAM	HP QPSK	LP 64QAM
½	10.9	16.7	8.5	18.5
2/3	14.1	19.1	11	21.2
¾	15.7	20.9	12.8	23.6

Table 1 Required C/N (dB) for a QEF receiption for channel Profile 1 for hierarchical reception QPSK in 64QAM.

	α = 2		α = 4	
Code rate	HP QPSK	LP 16QAM	HP QPSK	LP 16QAM
½	6.8	15	5.8	19.5
2/3	9.1	17.2	7.9	21.4
¾	10.4	18.4	9.1	22.5

Table 2 Required C/N (dB) for a QEF receiption for channel Profile 1 for hierarchical reception QPSK in 16QAM.

Annex C: Bootloading and Service Lists in IP-based and other networks

Unchanged.

Annex D: Implementations Guidelines for NorDig Bootloader

Unchanged.

Annex E: Implementations Guidelines for best service selection in automatic channel search in terrestrial networks

Unchanged.

Annex F: Raw carrier to noise values,$(C/N)_{RAW}$ in dB, used to calculate required C/N for BER 10^{-6} after LDPC decoding

Modulation	Code rate	(C/N)raw (dB)Profile 1 Gaussian Channel	(C/N)raw (dB) Profile 2: 0 dB echo
QPSK	1/2	1.0	2.7
QPSK	3/5	2.2	4.3
QPSK	2/3	3.1	5.9
QPSK	3/4	4.1	7.3
QPSK	4/5	4.7	8.4
QPSK	5/6	5.2	9.5
16-QAM	1/2	6.2	8.4
16-QAM	3/5	7.6	10.2
16-QAM	2/3	8.9	11.8
16-QAM	3/4	10.0	13.7
16-QAM	4/5	10.8	15.2
16-QAM	5/6	11.3	16.3
64-QAM	1/2	10.5	13.4
64-QAM	3/5	12.3	15.4
64-QAM	2/3	13.6	17.0
64-QAM	3/4	15.1	19.2
64-QAM	4/5	16.1	21.0
64-QAM	5/6	16.7	22.3
256-QAM	1/2	14.4	17.9
256-QAM	3/5	16.7	20.2
256-QAM	2/3	18.1	22.0
256-QAM	3/4	20.0	24.3
256-QAM	4/5	21.3	26.3
256-QAM	5/6	22.0	27.8

Annex G:Comparison of NorDig profiles

1 *Introduction*

This annex gives a comparison between the NorDig specification profiles; Basic TV, , Enhanced and Interactive.

The following list indicates the requirement status (mandatory, optional or descriptive) of the various sections of the various NorDig specification profiles.

2 *Legend*

The profiles are referred to as **ND-B** (NorDig Basic)**, ND-E** (NorDig Enhanced) and **ND-I (**NorDig Interactive).

----: no mandatory requirement included in this part/section (may refer to a heading, while requirement is specified in text below).

M: Mandatory requirement for all NorDig profiles (identical text).

M-B, M-E, M-I:
Mandatory requirements as specified for NorDig Basic, NorDig Enhanced and NorDig Interactive (requirement/text differs between profiles).

M-HD: Additional mandatory requirement for HD-level IRDs

O: Optional or recommended, not mandatory.

O-HD: Additional optional or recommended for HD-level

Note that:

- O, M, etc only refer to the specification paragraph. The actual requirements can only be found by looking up the actual text in the relevant paragraph of the specification.
- M marked for a full chapter/section with subparagraphs indicates that the section function is mandatory and that all corresponding requirements are identical, unless subparagraphs are shown with deviations.
- Differences between STBs and iDTV-sets are stated in the comment column

Chapter/Section		ND-Basic		ND-E		ND-I		Comment
		STB	IDTV	STB	IDTV	STB	IDTV	
1	Introduction	---	---	---	---	---	---	-
1.1	Scope	---	---	---	---	---	---	
1.2	Document History	---	---	---	---	---	---	
1.3	Terminology	---	---	---	---	---	---	
1.4	Definitions	---	---	---	---	---	---	
1.5	References	---	---	---	---	---	---	
1.6	List of Abbreviations	---	---	---	---	---	---	
2	General Features of the NorDig IRD	---	---	---	---	---	---	
2.1	Introduction	---	---	---	---	---	---	
2.2	IRD Hardware and Firmware	---	---	---	---	---	---	
2.2.1	Overview	---	---	---	---	---	---	

Chapter/Section		ND-Basic		ND-E		ND-I		Comment
		STB	IDTV	STB	IDTV	STB	IDTV	
2.2.2	RF Interface and Tuner/Demodulator	---	---	---	---	---	---	
2.2.3	RFin-RFout Bypass (option)	---	---	---	---	---	---	
2.2.4	Interaction Channel Interface	---	---	---	---	---	---	
2.2.5	Demultiplexer	---	---	---	---	---	---	
2.2.6	Video/Audio Decoding	---	---	---	---	---	---	
2.2.7	IRD Controller Unit and Bootloader	---	---	---	---	---	---	
2.2.8	Common Interface and Plug-in CA Module	---	---	---	---	---	---	
2.2.9	Smart Card Interface(s) and Smart Card Reader(s)	---	---	---	---	---	---	
2.2.10	Remote Control and Remote Keyboard	---	---	---	---	---	---	
2.2.11	Scart Interfaces	---	---	---	---	---	---	
2.2.12	Audio Output Interfaces (option)	---	---	---	---	---	---	
2.2.13	Data Interface (option)	---	---	---	---	---	---	
2.2.14	Main hardware/firmware functions-Overview per configuration	---	---	---	---	---	---	
2.2.15	Additional hardware/firmware for the PVR features	---	---	---	---	---	---	
2.3	System Software and API	---	---	---	---	---	---	
2.3.1	Introduction	---	---	---	---	---	---	
2.3.2	Principal Software Structure	---	---	---	---	---	---	
2.3.3	System Software	---	---	---	---	---	---	
2.3.4	NorDig APIs	---	---	---	---	---	---	
2.3.5	PVR related software	---	---	---	---	---	---	
2.4	General Product Requirement	---	---	---	---	---	---	
2.4.1	General	M	M	M	M	M	M	
2.4.2	Energy Efficiency	M	M	M	M	M	M	
	PART A: Hardware and Firmware							
3	The Frontend of the NorDig IRD	---	---	---	---	---	---	
3.1	Common Features	---	---	---	---	---	---	
3.1.1	General Features	M	M	M	M	M	M	
3.1.2	Common Scanning Procedures	M	M	M	M	M	M	
3.1.3	Quality Reception Detector	M	M	M	M	M	M	
3.2	Satellite Tuner and Demodulator	---	---	---	---	---	---	
3.2.1	General	M	M	M	M	M	M	
3.2.2	RF/IF Characteristics	M, M-HD	M, M-HD	M, M-HD	M, M-HD	M, M-HD	M, M-HD	
3.2.3	Input Frequency Range/Tuning Range	M	M	M	M	M	M	
3.2.4	Tuning/ Scanning Procedures	M	M	M	M	M	M	
3.2.5	Control Signals	M	M	M	M	M	M	

Chapter/Section		ND-Basic		ND-E		ND-I		Comment
		STB	IDTV	STB	IDTV	STB	IDTV	
3.2.6	Demodulation	M, M-HD	M, M-HD	M, M-HD	M, M-HD	M, M-HD	M, M-HD	
3.2.7	Satellite Tuner Interface and Signal Levels	M	M	M	M	M	M	
3.2.8	Performance	M	M	M	M	M	M	
3.3	Cable Tuner and Demodulator	---	---	---	---	---	---	
3.3.1	General	M	M	M	M	M	M	
3.3.2	RF Characteristics	M	M	M	M	M	M	
3.3.3	Bypass RFin to RF out	M	M	M	M	M	M	
3.3.4	Tuning/Scanning Procedure	M	M	M	M	M	M	
3.3.5	Performance Data	M	M	M	M	M	M	
3.3.6	Spurious Emission	M	M	M	M	M	M	
3.4	Terrestrial Tuner and Demodulator	---	---	---	---	---	---	
3.4.1	General	M	M	M	M	M	M	
3.4.2	Frequencies and Signal Bandwidths	M	M	M	M	M	M	
3.4.3	Modes	M	M	M	M	M	M	
3.4.4	Reception quality/Tuning/Scanning Procedures	M	M	M	M	M	M	
3.4.5	Changes In Modulation Parameters	M	M	M	M	M	M	
3.4.6	RF Input Connector	M	M	M	M	M	M	
3.4.7	RF Output Connector (option)	O	O	O	O	O	O	
3.4.8	Time Interleaving	M	M	M	M	M	M	
3.4.9	Input/Output Data Formats	M	M	M	M	M	M	
3.4.10	Performance	M	M	M	M	M	M	
3.5	IP Based Front-End	---	---	---	---	---	---	
3.5.1	General	M	M	M	M	M	M	
3.5.2	Network Interface	M	M	M	M	M	M	
3.5.3	Protocol Suite	M	M	M	M	M	M	
3.5.4	Dynamic Address Allocation	M	M	M	M	M	M	
3.5.5	Service Selection	M	M	M	M	M	M	
4	MPEG-2 Demultiplexer	---	---	---	---	---	---	
4.1	General	M	M	M	M	M	M	
4.2	DVB Descrambler Performance	M	M	M	M	M	M	
4.3	System Clock Recovery	M	M	M	M	M	M	
5	Video Decoder	---	---	---	---	---	---	
5.1	Requirements for Video Decoder in NorDig SD IRDs	M	M	M	M	M	M	
5.1.1	General	M	M	M	M	M	M	
5.1.2	Constraints and Extensions	M	M	M	M	M	M	
5.2	Additional requirements for Video Decoder in NorDig HD IRDs	---	---	---	---	---	---	
5.2.1	General	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	

Chapter/Section		ND-Basic		ND-E		ND-I		Comment
		STB	IDTV	STB	IDTV	STB	IDTV	
5.2.2	Constraints and Extensions	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
6	Audio Decoder	---	---	---	---	---	---	
6.1	Requirements for Audio Decoder in NorDig SD IRD	M	M	M	M	M	M	
6.1.1	General	M	M	M	M	M	M	
6.1.2	Constraints and Extensions	M	M	M	M	M	M	
6.1.3	Applications	M	M	M	M	M	M	
6.2	Additional Audio Decoder requirements for HD IRDs	---	---	---	---	---	---	
6.2.1	General	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
6.2.2	Audio formats	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
6.2.3	Audio prioritising	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
6.2.4	Clean Audio	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
6.2.5	Audio stream mixing	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
6.2.6	Adjustment of video/audio-delay	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
6.2.7	Audio handling when changing service or audio format	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
6.2.8	IRD Internal Reference Level	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
7	Teletext and Subtitling	---	---	---	---	---	---	
7.1	General	---	---	---	---	---	---	
7.2	Teletext	---	---	---	---	---	---	
7.2.1	Teletext for NorDig SD IRD	M	M	M	M	M	M	
7.2.2	Teletext for NorDig HD IRD	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
7.3	DVB Subtitling	---	---	---	---	---	---	
7.3.1	General	M	M	M	M	M	M	
7.3.2	Subtitling subset	M	M	M	M	M	M	
8	Interfaces and Signal Levels	---	---	---	---	---	---	
8.1	Introduction	---	---	---	---	---	---	
8.2	RF- bypass (option)	O	O	O	O	O	O	
8.3	Interaction Channel Interface	O	O	O	O	O	O	
8.3.1	NorDig Basic and NorDig Enhanced	O	O	O	O	O	O	
8.3.2	NorDig Interactive	M	M	M	M	M	M	
8.4	SCART Interfaces	M	---	M	---	M	---	
8.5	Audio Output Interfaces (Option)	O	O	O	O	O	O	
8.5.1	VCR SCART connector for analogue audio	O	O	O	O	O	O	
8.5.2	RCA connector for analogue audio	O	O	O	O	O	O	
8.5.3	S/PDIF connector for digital audio	O	O	O	O	O	O	
8.6	Data Interface (Option)	O	O	O	O	O	O	
8.7	Remote Control Interface	---	---	---	---	---	---	

Chapter/Section		ND-Basic		ND-E		ND-I		Comment
		STB	IDTV	STB	IDTV	STB	IDTV	
8.7.1	General	M	M	M	M	M	M	
8.7.2	Functions	M	M	M	M	M	M	
8.8	Remote Keyboard Interface (Option)	---	---	O	O	O	O	
8.9	The HD Interface for NorDig HD IRDs	---	---	---	---	---	---	
8.9.1	General	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
8.9.2	Video Output and Display	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
8.9.3	Audio Output	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
8.9.4	Signal protection	M-HD	M-HD	M-HD	M-HD	M-HD	M-HD	
8.10	Additional analogue interfaces (optional) for NorDig HD IRDs	O-HD	O-HD	O-HD	O-HD	O-HD	O-HD	
8.10.1	General	O-HD	O-HD	O-HD	O-HD	O-HD	O-HD	
8.10.2	Analogue video interface (optional)	O-HD	O-HD	O-HD	O-HD	O-HD	O-HD	
8.10.3	Analogue audio interfaces (optional).	O-HD	O-HD	O-HD	O-HD	O-HD	O-HD	
9	Interfaces for Conditional Access	---	---	---	---	---	---	
9.1	General	M	M	M	M	M	M	
9.2	Use of the DVB Common Interface	M	M	M	M	M	M	
9.2.1	General	---	---	---	---	---	---	
9.2.2	Minimum requirements for the Common Interface	M	M	M	M	M	M	
9.2.3	Minimum requirements for the NorDig CA-Module	M	M	M	M	M	M	
9.3	Use of Smart Card Reader	---	---	---	---	---	---	
9.3.1	General	M	M	M	M	M	M	
9.3.2	The Smart Card Interface	M	M	M	M	M	M	
9.3.3	ECM and EMM Filtering	M	M	M	M	M	M	
9.3.4	Descrambling of selected services	M	M	M	M	M	M	
9.3.5	Application Level Interface for Conditional Access.	---	---	M	M	M	M	
10	The Bootloader (System Software Update)	---	---	---	---	---	---	
10.1	Introduction	M	M	M	M	M	M	
10.2	Over-the-air/in-network via Broadcast Download	M	M	M	M	M	M	
10.3	Local Download	M	M	M	M	M	M	
10.4	Network Management and Provisioning	M-IP	M-IP	M-IP	M-IP	M-IP	M-IP	
11	Performance	---	---	---	---	---	---	
11.1	Introduction	---	---	---	---	---	---	
11.2	Video Performance of RGB and PAL Signals	M	M	M	M	M	M	
11.3	Audio Performance of the Decoded Digital Signal	M	M	M	M	M	M	
11.4	Zapping Time for TV Services	M	M	M	M	M	M	

Chapter/Section		ND-Basic		ND-E		ND-I		Comment
		STB	IDTV	STB	IDTV	STB	IDTV	
	Part B: The system software with application							
12	Service Information	---	---	---	---	---	---	
12.1	General	---	---	---	---	---	---	
12.1.1	General Requirements	M	M	M	M	M	M	
12.1.2	PSI/SI classification	M	M	M	M	M	M	
12.1.3	Private data specifier value	M	M	M	M	M	M	
12.1.4	Service Types	M	M	M	M	M	M	
12.1.5	Service Categories	M	M	M	M	M	M	
12.1.6	Used PSI/SI descriptors	M	M	M	M	M	M	
12.1.7	Character sets in text strings	M	M	M	M	M	M	
12.2	Network Information Table (NIT)	M	M	M	M	M	M	
12.2.1	The Network information Table Descriptors	M	M	M	M	M	M	
12.2.2	Cable Delivery System Descriptor	M	M	M	M	M	M	
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