



# NorDig II

## Digital Integrated Receiver Decoder Specification

for use in cable, satellite and terrestrial networks

Version 1.0



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# 1 Introduction

## 1.1 Scope

This document specifies a set of equipment requirements for reception of DVB/MPEG-2 and related services from cable, satellite and/or terrestrial broadcast networks. This document is based on the NorDig I specification [38] and has been adopted to fulfil current technical requirements for Nordic digital broadcasting market.

A common Nordic IRD technical specification is 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 with the obtainable technical requirements of that time. The NorDig II specification includes some hardware modifications and the DVB MHP API specification according to the Interactive broadcast profile.

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

All requirements specified in this document are mandatory unless otherwise specified.

The various members of NorDig are independent of each other and do not intend to perform joint purchases of IRDs, but do intend to transmit to IRDs that satisfy the specified common requirements. In order to ensure compliance with the NorDig requirements, the NorDig II will be subject to a set of verification tests.

The specification of the NorDig II is divided into two parts.

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

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. Desired optional functionality is outlined both for the hardware parts and software parts.

## 1.2 Document History

Version	Date	Comments
0.9	08.06.2000	This is the first approved version of the NorDig II specification
1.0	13.06.2001	This version includes an update to reflect the changes in DVB-MHP-ver1.1 compared to MHP-ver1.0, and some clarifications of the text. Furthermore, some additional parameters/descriptors are specified in sections 12 and 13. In addition some relaxations in line with the NorDig I ver. 1.3 specification have been included.



### 1.3 Terminology

<b>Shall</b> (Mandatory)	This word means that the item is mandatory.
<b>Should</b> (Recommended)	This word means that this item is not mandatory, but is highly recommended.

### 1.4 Definitions

#### NorDig I

The NorDig I IRDs (hereafter denoted NorDig I) consist of a user terminal, including all possible low to high functionality implementations and its associated peripherals. NorDig I is specified in the NorDig 1.3 specification [38].

#### NorDig II

The NorDig II IRDs (hereafter denoted NorDig II) consist of a user terminal, including all possible low to high functionality implementations and its associated peripherals.

The NorDig II supports several levels of interactive services / applications as they are defined in the DVB-MHP Interactive Broadcasting Profile.

Figure 1.1 illustrates relations between NorDig II and DVB-MHP APIs.

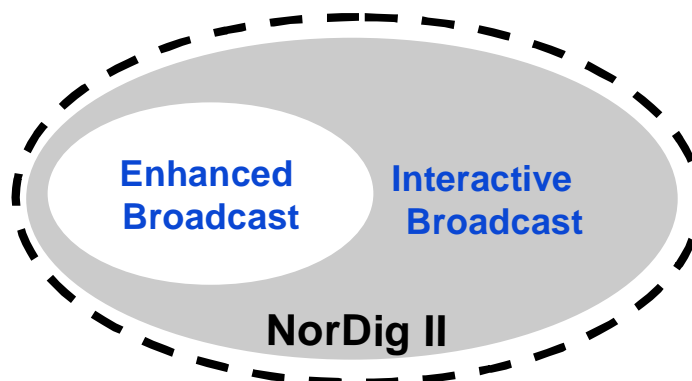


Figure 1.1: DVB-MHP Profiles and NorDig II

### 1.5 References

- |     |                   |   |
|-----|-------------------|---|
| [1] | Bluetooth         | Specification of the Bluetooth system, v 1.0 A.   |
| [2] | DVB A 011         | Common Scrambling Algorithm. DVB Blue Book A011.  |
| [3] | DVB – MHP         | Digital Video Broadcasting (DVB); Multimedia Home Platform (MHP) Specification 1.1. SB 34(01)23, tm 2485,tam 668r12. .  |
| [4] | EN 300 421 v1.1.2 | Digital Video Broadcasting (DVB): Digital broadcasting systems for television, sound and data services: Framing structure, channel coding and modulation for 11/12 GHz Satellite services.<br>European Telecommunications Standards Institute ETSI. |
| [5] | EN 300 429 v1.2.1 | Digital Video Broadcasting (DVB): Digital Broadcasting Systems for Television, Sound and Data Services; Framing Structure, Channel Coding and Modulation for Cable Systems. European Telecommunications Standards Institute ETSI.                   |



- [6] EN 300 468 v1.3.1 Digital Video Broadcasting (DVB): Digital broadcasting systems for television, sound and data services: Specification for Service Information (SI) in Digital Video Broadcasting (DVB) systems European Telecommunications Standards Institute ETSI.
- [7] EN 300 472 v1.2.2 Digital Video Broadcasting (DVB): Digital Broadcasting Systems for Television, Sound and Data Services; Specification for Conveying ITU-R System B Teletext in Digital Video Broadcasting (DVB) Bitstreams. European Telecommunications Standards Institute ETSI.
- [8] EN 300 473 Digital Satellite Master Antenna Television Distribution System (SMATV).
- [9] EN 300 744 v1.2.1 Digital Video Broadcasting (DVB); DVB Framing structure, channel coding and modulation for digital terrestrial television. European Telecommunications Standards Institute, ETSI.
- [10] EN 50049-1 Domestic and similar electronic equipment interconnection requirements: Peritelevision Connector
- [11] EN 50083-9 Cabled distribution systems for television, sound and interactive multimedia signals -- Part 9: Interfaces for CATV/SMATV headends and similar professional equipment for DVB/MPEG-2 transport streams.
- [12] EN 50157-2-1 Domestic and similar equipment interconnection requirements: AV.link-Part 2-1: Signal quality matching and automatic selection of source devices.
- [13] EN 50221 Common Interface for Conditional Access and other Digital Video Broadcasting Decoder Applications.
- [14] EN 61319-1 Interconnections of satellite receiving equipment - Part 1: Europe.
- [15] ES 201 488 v1.1.1 Data-Over-Cable Service Interface Specifications Radio Frequency Interface Specification
- [16] ETR 154 ed3 Digital Video Broadcasting (DVB); Implementation Guidelines for the use of MPEG-2 Systems, Video and Audio in Satellite Cable and Terrestrial Broadcasting Applications. European Telecommunications Standards Institute ETSI.
- [17] ETR 162 Digital Broadcasting Systems for Television, Sound and Data Services; Allocation of Service Information (SI) Codes for Digital Video Broadcasting (DVB) Systems. European Telecommunications Standards Institute ETSI.
- [18] ETR 211 Digital Broadcasting Systems for Television, Sound and Data Services; Guidelines on the Implementation and Usage of DVB Service Information. European Telecommunications Standards Institute ETSI.
- [19] ETR 289 Digital Video Broadcasting (DVB); Support for use of scrambling and Conditional Access within digital broadcasting systems. European Telecommunications Standards Institute ETSI.
- [20] ETS 300 012 - 11 Integrated Services Digital Network (ISDN); Basic User-Network Interface (UNI), October 1998.
- [21] ETS 300 175 Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI).
- [22] ETS 300 743 ed1 Digital Video Broadcasting (DVB): DVB Subtitling Systems. European Telecommunications Standards Institute ETSI.



[23]	ETS 300 800 ed1	Digital Video Broadcasting (DVB); Interaction channel for Cable TV distribution systems (CATV) European Telecommunications Standards Institute, ETSI.
[24]	IEC 60169-2	Radio-frequency connectors, Part 2: Coaxial unmatched connectors.
[25]	IEC 60603-14	Connectors for frequencies below 3 MHz for use with printed boards – Part 14: Detail specification for circular connectors for low-frequency audio and video applications such as audio, video and audio-visual equipment.
[26]	IEC 61883-1	Consumer audio/video equipment – Digital interface – Part1: General.
[27]	IEC 61937	Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 [28].
[28]	IEC 60958	Digital audio interface.
[29]	IEEE 1394	Standard for a high performance serial bus (IEEE1 Standard 1394-1995).
[30]	IEEE 802.3	CSMA/CD (ETHERNET).
[31]	IEEE 802.11	The Working Group for Wireless Local Area Networks (WLANs).
[32]	ISO/IEC 13818 - 1	Information Technology - Generic Coding of Moving Pictures and Associated Audio Information. Part 1: Systems. ISO/IEC International Standard IS 13818.
[33]	ISO/IEC 13818 - 3	Information Technology - Generic Coding of Moving Pictures and Associated Audio Information. Part 3: Audio. ISO/IEC International Standard IS 13818.
[34]	ISO/IEC 7816, 1-3	Identification cards - Integrated circuit cards with contacts, Parts 1-3. ISO/IEC International Standard IS 7816.
[35]	ITU/R Report 624-4	Characteristics of Television Systems.
[36]	ITU-R BT.653-3	Teletext systems.
[37]	ITU-T V.90	Recommendation for V.90 modem
[38]	NorDig 1.3	NorDig I Digital Integrated Receiver Decoder Specification, ver 1.3, 01.03.2001.
[39]	Universal Serial Bus Port	Specification, Revision 1.1, September 23, 1998.
[40]	TS 101 812 v1.1.1	Digital Video Broadcasting (DVB); Multimedia Home Platform (MHP) Specification 1.0
[41]	TS 102 201 v1.1.1	Digital Video Broadcasting (DVB); Interfaces for DVB Integrated Receiver Decoder (DVB-IRD)

## 1.6 List of Abbreviations

API	Application Programming Interface
AFNOR	Association Francaise de Normalisation
AFC	Automatic Frequency Control
AFD	Active Format Descriptor
BAT	Bouquet Association Table
BCD	Binary Coded Decimal
BER	Bit Error Ratio
bslbf	bit string, left bit first
C/N	Carrier to Noise ratio
CA	Conditional Access



CAT	Conditional Access Table
CATV	Community Antenna Television
CENELEC	Comité Européen de Normalisation Electrotechnique
CI	Common Interface
CRC	Cyclic Redundancy Check
CSO	Composite Second Order
CTB	Composite Triple Beat
CVBS	Composite Video Baseband Signal
D/A	Digital-to-Analogue converter
DAVIC	Digital Audio-Visual Council
DECT	Digital Enhanced Cordless Telecommunications
DSB	Double SideBand
DSM-CC	Digital Storage Media Command and Control
DVB	Digital Video Broadcasting
DVB-C	Digital Video Broadcasting - Cable
DVB-data	Digital Video Broadcasting - Data Broadcasting
DVB-MHP	Digital Video Broadcasting - Multimedia Home Platform
DVB-S	Digital Video Broadcasting - Satellite
DVB-T	DVB-Terrestrial
EBU	European Broadcasting Union
ECCA	European Cable Communications Association
ECL	EuroCableLabs, technical cell of ECCA
EPT	Effective Protection Target
FFT	Fast Fourier Transform
GAP	Generic Access Protocol
GOP	Group Of Pictures
GPRS	General Packet Radio System
GSM	Group Special Mobile
IEC	International Electrotechnical Commission
IEEE	Institute for Electrical and Electronic Engineers
IEFT	Internet Engineering Task Force
INA	Interactive Network Adapter
IP	Internet Protocol
IRD	Integrated Receiver Decoder
ISO	International Organisation for Standardisation
JTC	Joint Technical Committee
MAC	Medium Access Control
MPEG	Moving Pictures Expert Group
NEM	Network Element Management
NIT	Network Information Table
NT	Network Termination in general
NVOD	Near Video On Demand
OSD	On Screen Display
PAL	Phase Alternating Line
PAT	Program Association Table
PID	Packet Identifier
PMT	Program Map Table
PSI	Program Specific Information



PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation
QEF	Quasi Error Free
QoS	Quality of Service
QPSK	Quaternary Phase Shift Keying
OSD	On-screen display
RF	Radio Frequency
RMS	Root Mean Square
rpchof	remainder polynomial coefficients, highest order first
RS	Reed-Solomon
RST	Running Status Table
SDT	Service Description Table
SDTV	Standard Definition Television
SFN	Single Frequency Network
SI	Service Information
SMATV	Satellite Master Antenna Television
ST	Stuffing Table
STB	Set-top box
SW	Software
TCP	Transmission Control Protocol
TDT	Time and Date Table
TFTP	Tunnelling File Transfer Protocol
TOT	Time Offset Table
TPS	Transmission Parameter Signalling
TS	Transport Stream
TV	Television
UHF	Ultra-High Frequency
uimbsf	unsigned integer most significant bit first
UTC	Universal Time, Co-ordinated
VCR	Video Cassette Recorder
VHF	Very-High Frequency
VoIP	Voice over IP
VPN	Virtual Private Network
VHS	Video Home System
VSB	Vestigial SideBand
xDSL	x Digital Subscriber Line



## 2 General Features of the NorDig II

### 2.1 Introduction

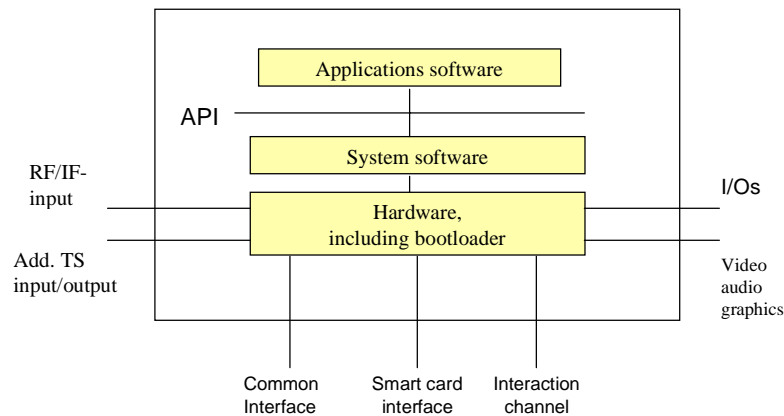
This chapter describes the overall structure of the NorDig II specification. The detailed requirements are specified in the chapters 3 - 17.

The IRD implements the services by a combination of hardware and software solutions. The main functional blocks are shown in Figure 2.1.

The IRD shall include a bootloader as firmware in the box. The bootloader can upgrade all resident system-software and application software in the receiver by new software loaded either via the distribution channel or locally.

The software solution is only restricted by the hardware programming interface, i.e. the hardware functionality, capacity and performance.

The IRD will be provided with an installed cable, satellite or terrestrial Tuner & Demodulator, a Common Interface, a Smart Card Interface (Reader), an input/output for a separate transport stream and an interface for the interaction channel. These and other external interfaces are shown in Figure 2.1.



*Figure 2.1: Basic IRD architecture*

The Transport Stream (TS) input can be connected to an external Tuner & Demodulator module (cable, satellite or terrestrial).

The user shall be able to access the services from all the tuners by means of the remote control.

### 2.2 IRD Hardware and Firmware

#### 2.2.1 Overview

The IRD hardware and firmware consists of a number of functional blocks as outlined in Figure 2.2. The hardware architecture shall be decided by the IRD developer.

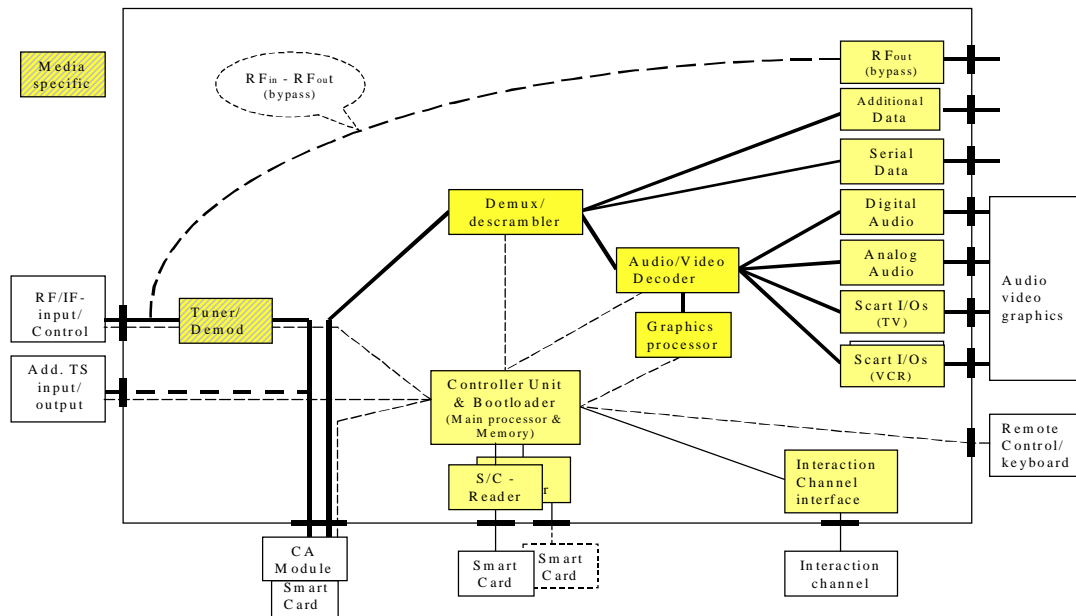


Figure 2.2: Functionality of Hardware and Firmware

### 2.2.2 RF Interface and Tuner/Demodulator

The RF interface connects to the incoming modulated signal. The tuner/demodulator block performs channel (frequency) selection, demodulation and error correction of the incoming MPEG-2 signal. Output from the tuner/demodulator block is an MPEG-2 transport stream that is fed to the demultiplexer block, or - if present - the external plug-in conditional access (CA) module. One embedded tuner/demodulator block is required, for cable, satellite or terrestrial input. The satellite tuner/demodulator block controls the frequency band selection of the external RF unit and shall supply power to it. All channel selections in the T/D blocks are controlled by the central Controller unit. See also chapter 3.

### 2.2.3 Additional Transport Stream Input/Output, External Tuner Input

The transport stream input allows an external Tuner/Demodulator for cable, satellite or terrestrial, or any other equipment, to be connected to the IRD. The TS interface provides controls signals for the external unit. The TS interface may be combined with the Main Common Interface. See also section 3.5 and section 9.3.

### 2.2.4 Demultiplexer

The demultiplexer block synchronises with the transport stream coming from the tuner/demodulator or the CA module, and selects the appropriate audio, video and/or private data elementary streams according to the service selections made by the user. The demultiplexer block also contains circuits for descrambling of services subject to conditional access data in the smart card. The private data streams are managed by the IRD controller unit (main processor), while the audio and video streams are output to the Video/Audio decoder block. See also chapter 4.

### 2.2.5 Video/Audio Decoding

The audio and video decoding units recover the analog audio and video signals from the input elementary packet streams. This involves processes like de-packetisation, decompression, synchronisation with



related services, digital to analog conversion, etc. The analog signals are output to external baseband connectors and (optionally) to an RF modulator. See also chapters 5 and 6.

### 2.2.6 Graphics Processor, OSD

The graphics processor unit generates graphics and text to be displayed for the user. See also chapter 8.

### 2.2.7 IRD Controller Unit and Bootloader

The IRD controller unit is a microprocessor system that manages all the internal units and all attached external plug-in units. See also chapter 7.

The Bootloader is a system software download capability, implemented as a firmware module independent of the system software. Initiated via the Navigator. See also chapter 13.

### 2.2.8 Main Common Interface and Plug-in CA Module

The Main Common Interface is a transport stream input/output.

The Plug-in CA module is an external plug-in conditional access (CA) module to be attached via the Common Interface. The main task of the CA module is to perform descrambling of services subject to conditional access. The CA module may be connected to an external smart card. See also chapter 15 and section 9.3.

### 2.2.9 Smart Card Interfaces and Smart Card Readers

The smart card readers allow external smart card(s) to be connected to the Controller unit. See also sections 9.4 and 15.2.

### 2.2.10 Interaction Channel Interface

The interaction channel interface connects to the interaction channel. It allows the user to perform electronic ordering and request information services, etc. See also section 9.5.

### 2.2.11 Remote Control and Remote Keyboard

The remote control allows the user to move cursors and graphical pointers and to make selections in menus displayed by the graphics processor. See also chapter 16.

The remote keyboard (option) allows the user to enter alphanumeric symbols in addition to the functions provided by the remote controls.

### 2.2.12 Scart Interfaces

Two SCART interfaces (one SCART interface for TV-sets and a second SCART interface for VCRs). See also section **Fel! Hittar inte referenskölla.**

### 2.2.13 Analogue Audio Interface

One analogue stereo audio output interface. See also section 9.7.

### 2.2.14 Digital Audio Interface

One digital audio output interface. See also section 9.7.



#### 2.2.15 Serial Data Interface (option)

One serial Data interface. See also section 9.8.

#### 2.2.16 Additional Data Interfaces

One additional data interface. See also section 9.9.

#### 2.2.17 RF<sub>in</sub>-RF<sub>out</sub> Bypass (option)

An internal bypass from input to output of IRD. See also section 9.2.

#### 2.2.18 RF-PAL Modulator (option)

An internal AM-DSB modulator and PAL encoder (not shown in Figure 2.2) provides an external RF-PAL signal to e.g. a TV set or VHS-VCR. See also section 9.2.

### 2.3 ***System Software and API***

#### 2.3.1 Introduction

The NorDig II software is divided into two main parts, applications and system software. The system software shall provide two main sets of functions. One set is accessible within the system software only. Another set is available internally and externally for applications, and constitutes the Application Programming Interface, API. Figure 2.3 illustrates relations between NorDig II and DVB-MHP APIs. See also chapter 11.

#### 2.3.2 Principal Software Structure

In general the software structure shall be defined as an open and public structure. This allows further developments according to market requirements.

An important feature in this software structure is the possibility of replacing the whole software, with exception of the bootloader software itself. This allows the exchange or upgrade of the entire software 'over the air' according to the need for new functionality or for bug fixing (e.g. drivers).

The download of applications uses an internal function from the API, outside of the bootloader software.

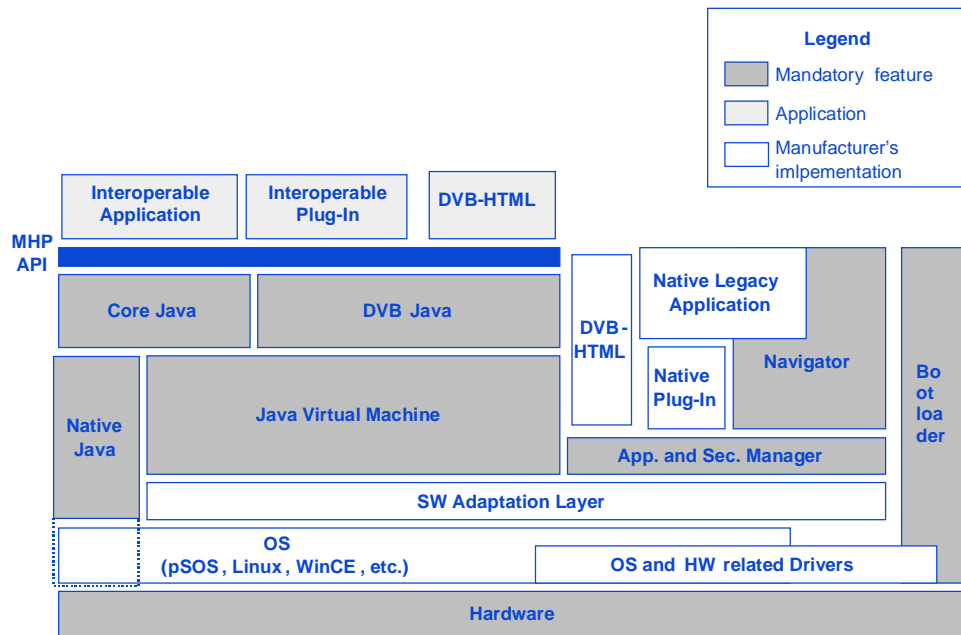


Figure 2.3: Possible software structure of a NorDig II IRD

Figure 2.3 illustrates only an example of the NorDig II IRD software structure. The IRD manufacturers are free to implement system the way they want as long as it fulfils the NorDig II specification.

### 2.3.3 System Software

The NorDig II includes System Software in compliance with DVB specifications, i.e. APIs, PSI/SI, Navigator, teletext, subtitling and Common Interface. The system software can be completely upgraded via the bootloader.

Note: The bootloader is by definition a part of the hardware/firmware.

### 2.3.4 NorDig II APIs

The NorDig II includes an open API in compliance with the DVB MHP APIs. In order to be backward compatible, one or more of the legacy APIs may be included as plug-ins.



## PART A: Hardware and firmware



## 3 The Frontend of the NorDig II

### 3.1 Common Features

#### 3.1.1 General Features

The NorDig II shall contain one Tuner/Demodulator for cable or satellite or terrestrial DVB/MPEG 2 signals.

In addition it shall contain an input/output Transport Stream interface for connection to an external Tuner/Demodulator (cable or satellite or terrestrial). The Transport Stream Interface may be combined with the Common Interface, see section 3.5

#### 3.1.2 Common Scanning Procedures

The NorDig II shall be able to automatically scan through the whole frequency range available for each of the available Tuners/Demodulators and tune in to the correct modulation, symbol rate and error correction scheme to deliver the incoming transport stream to the next units. The tuning data shall be stored in a service list, in order to allow a quick tune in to the selected transport stream. For more detail see below.

#### 3.1.3 Quality Reception Detector

The NorDig II receiver shall be equipped with a reception quality detector.

### 3.2 Satellite Tuner and Demodulator

#### 3.2.1 General

The NorDig II shall include one tuner/demodulator unit for reception of signals from a satellite RF-outdoor unit.

NorDig II should have an RF<sup>1</sup>-bypass (RF<sub>in</sub> - RF<sub>out</sub>). An RF-bypass is recommended to allow other IRDs to be connected to the same RF unit.

#### 3.2.2 RF/IF Characteristics

The available transponder bandwidths and transponder powers vary with the different satellites. Consequently, a range of symbol rates and forward error correction rates may be employed.

The incoming digital DVB signals will comply with EN 300 421 [4]. The NorDig II shall accept symbol rates on the incoming carrier in the range 10 Mbaud to 30 Mbaud.

#### 3.2.3 Input Frequency Range/Tuning Range

The input frequency band to the RF-unit with antenna may cover the frequency range 10.7 to 12.75 GHz on each of two polarisations. The RF unit may be configured to select and convert any of the four 1 GHz bands (upper or lower half band on each polarisation) to IF.

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<sup>1</sup> In this specification RF<sub>in</sub> means the input to the IRD, unless otherwise specified.



The NorDig II shall be able to tune to any DVB carrier located within the IF band 950-2150 MHz with characteristics and symbol rate as specified in section 3.2.2.

### 3.2.4 Tuning/ Scanning Procedures

The NorDig II shall either use the NIT information or the scanning procedure for retrieving the services available on the network.

In some cases (e.g. some of the SMATV distribution systems described in EN 300 473 [8]) the tuning data given in the NIT may not be valid. In such cases it should be possible to select a tuning procedure based on a frequency search - in conjunction with the possibility to discard the information given in NIT.

Information will also be given in PSI/SI which will enable the IRD to track a service which is moved from one multiplex to another, see ETR 211 [18]. Such information shall be decoded and used for updating the service list.

### 3.2.5 Control Signals

The Tuner/Demodulator shall be able to select between at least two RF units, upper and lower band as well as polarisation within each unit in accordance with ref. EN 61319-1 [14], level 1 (the “DiSEqC” specification, level1).

### 3.2.6 Demodulation

Demodulation, descrambling and error correction shall be performed for all symbol rates given above and for all error correction rates specified in EN 300 421 [4].

### 3.2.7 Satellite Tuner Interface and Signal Levels

#### 3.2.7.1 RF Input Connector

The NorDig II shall include one input connector, type: IEC 60169-2 [24], F-type, female, 75 ohms.

#### 3.2.7.2 RF Output Connector (option)

The NorDig II should include one output connector, type: IEC 60169-2 [24], F-type, female, 75 ohms.

The RF output shall be available independently from the operational status of the IRD (operational or stand by), so that there is no restriction for the operation of the connected equipment. The control of the RF unit has to be solved for the case with one or more additional IRDs.

#### 3.2.7.3 Signal Level

The NorDig II shall accept input signals with a level in the range -25 to -60 dBm.

#### 3.2.7.4 Power Supply and Control Signals (to RF unit)

The NorDig II shall provide power supply and control signals to the external RF-unit as specified below:

- voltage: 13.5/18.5 V +/- 5%
- current: at least 300 mA
- control tone: amplitude: 0.65 V +/- 0.25V  
frequency: 22 kHz  
duty cycle: 50% +/- 10%  
(see also ref EN 61319-1 (DiSEqC) [14].



### 3.2.8 Performance

The NorDig II shall be able to store tuning data for all MPEG2/DVB carriers in the satellite network.

The NorDig II IF back/back error performance for a single carrier shall comply with the requirements given in EN 300 421 (section 5) [4].

The NorDig II error performance in a multi-carrier environment shall be tested in IF back/back. ("Back-to back" implies that the test signal shall be applied at the input of the RF/IF (tuner) input, see Figure 2.2, i. e. only degradation in the NorDig II itself is measured).

The NorDig II shall be able to select any channel within an array of digital channels with equal carrier level, bandwidth and channel spacing. Given that the symbol rate is  $R$  the channel spacing shall be  $1.25 \cdot R$ .

With adjacent carriers as specified above, and with the noise margin increased by 0.5 dB compared to the single channel IF back/back requirements, the NorDig II shall demodulate and decode a wanted TV service with no visible defects in the decoded picture.

For adjacent analogue D2MAC or PAL carriers, the NorDig II shall be tested in IF back/back mode as follows.

The modulation sensitivity and energy dispersal of the analogue carriers are adjusted to 16 MHz/V and 600 kHz respectively.

For the wanted digital carrier a symbol rate in the range 24 – 30 Mbaud shall be used. The corresponding value shall be used for the channel spacing.

With equal levels for the adjacent carriers and the wanted carrier, and with the noise margin increased by 0.5 dB compared to the single channel IF back/back requirements, the NorDig II shall demodulate and decode a wanted TV service with no visible defects in the decoded picture.

## 3.3 *Cable Tuner and Demodulator*

### 3.3.1 General

The NorDig II shall provide the possibility to access existing digital DVB carriers and should provide the possibility to access existing analogue PAL TV carriers via the internal front-end for cable networks.

The digital DVB signals are QAM modulated as specified in EN 300 429 [5].

Analogue PAL television signals using AM-VSB modulation are specified in ITU/R Report 624-4 [35], standards B, G PAL.

The NorDig II shall be able to operate flawless in a CATV network specified in accordance to EN 50083 [11].

The front-end shall convert signals received via a cable system (CATV) from RF level to baseband level. It shall include QAM demodulation for provision of digital transport streams and VSB/PAL demodulation for provision of baseband PAL signals with associated audio.



Today many CATV systems use a 7 MHz frequency raster in the VHF frequency range and an 8 MHz raster in the Hyperband and UHF-band for analogue PAL TV services. For digital DVB signals an 8 MHz frequency raster will be used over the whole CATV frequency range. However, the frequency rasters may be different in the different cable networks.

The analogue signals shall be identified by the vision carrier and on a frequency channel allocation basis.

### 3.3.2 RF Characteristics

The NorDig II shall have RF characteristics equal to or better than specified below:

Input Frequency range:	Digital signals	110 - 862 MHz
	Analogue signals	47 - 862 MHz
Channel bandwidth:	Digital signals	8 MHz
	Analogue signals	7 and 8 MHz
Step size of the Tuner:		62.5 kHz or less
Input connector:		IEC 60169-2 [24], female, 75ohms
Input level:	Digital signals	47 - 70 dB $\mu$ V at 75 Ohms
	Analogue signals	57 - 80 dB $\mu$ V at 75 Ohms
Input Impedance:		75 Ohms
Symbolrate:	Digital signals	4.0 Msymbols/s to 7.2 Msymbols/s
Modulation:	Digital signals	16-QAM and 64-QAM, optional 128-QAM and 256-QAM

### 3.3.3 Tuning/Scanning Procedure

The NorDig II shall either use the NIT information or the scanning procedure for retrieving the services available on the cable network.

In general the NorDig II shall provide a scanning procedure over the whole CATV frequency bands (47 - 862 MHz). During this scanning procedure all relevant information about the available digital and analogue services shall be accessible by the application. The analogue signals shall be identified by the vision carrier. The digital signals shall be identified by the QAM carrier frequencies.

The used symbol rate out of the possible symbol rates for digital services shall be detected automatically during the scanning procedure.

In smaller cable networks with a simple QPSK-QAM converter without the possibility for SI information correction (e.g. the NIT of the satellite distribution system has not been replaced by the correct CATV-NIT) the scanning procedure is the only way to find any digital or analogue services. The scanning procedure shall also be available for use in the worst case when no SI information is available, because



there is a system failure. In case NIT<sub>other</sub> is transmitted, this shall be treated as described in section 12.1.

The scanning for both analogue and digital services should be made on a fixed cable channel allocation basis. The scanning of analogue services should be made on a continuous frequency scanning on basis of 62,5 kHz steps.

In order to achieve a fast installation the scanning procedure should be adapted to the used channel raster of the cable network that the decoder shall be connected to.

### 3.3.4 Bypass RF<sub>in</sub> to RF<sub>out</sub>

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

The signal level at RF<sub>out</sub> shall be less than 2 dB below and less than 1 dB above the signal level at the RF<sub>in</sub>, measured over the complete RF bandwidth, 47 to 862 MHz.

The overall S/N degradation of the RF bypass shall be less than 1 dB.

The Composite Second Order (CSO) shall be equal or better than 60 dB and the Composite Triple Beat (CTB) shall be equal or better than 68 dB.

### 3.3.5 Performance Data

#### 3.3.5.1 Analogue and Digital Signals

The performance data below shall be satisfied:

- Return loss: 10 dB (typically), in worst case 7 dB min.
- Noise figure: 8 dB (typically), in worst case 10 dB max.

#### 3.3.5.2 Digital Signals

The performance data below shall be satisfied:

The bit error rate before Reed Solomon decoding is used as the quality criterion. The NorDig IRD shall meet the following characteristics:

256 QAM:	C/N ratio 32.5 dB for BER 10 <sup>-4</sup>
128 QAM:	C/N ratio 29.5 dB for BER 10 <sup>-4</sup>
64 QAM:	C/N ratio 26.5 dB for BER 10 <sup>-4</sup>
16 QAM:	C/N ratio 20.5 dB for BER 10 <sup>-4</sup>

The residual BER for C/N >36 dB (256-QAM), >33 dB (128-QAM), >30 dB (64-QAM) and >24 dB (16-QAM) shall be less than 10<sup>-7</sup>.

Note:	For C/N measurement the reference noise bandwidth is 8 MHz
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The performance shall be measured under the following conditions:

1. In any CATV-network confirming to EN 50083 [11] with at least a flat 42 analogue channel loading confirming to EN 50083 [11] and
2. Adjacent PAL/G, with NICAM stereo carrier and
3. Applying a modulator and upconverter of the manufacturers choice, and
4. Applying a 10 dB back (see note below), and
5. At any carrier frequency, with restriction of adjacent channels, and
6. At minimum and at maximum input level of the IRD, and
7. Additionally applying an echo with any of the following values

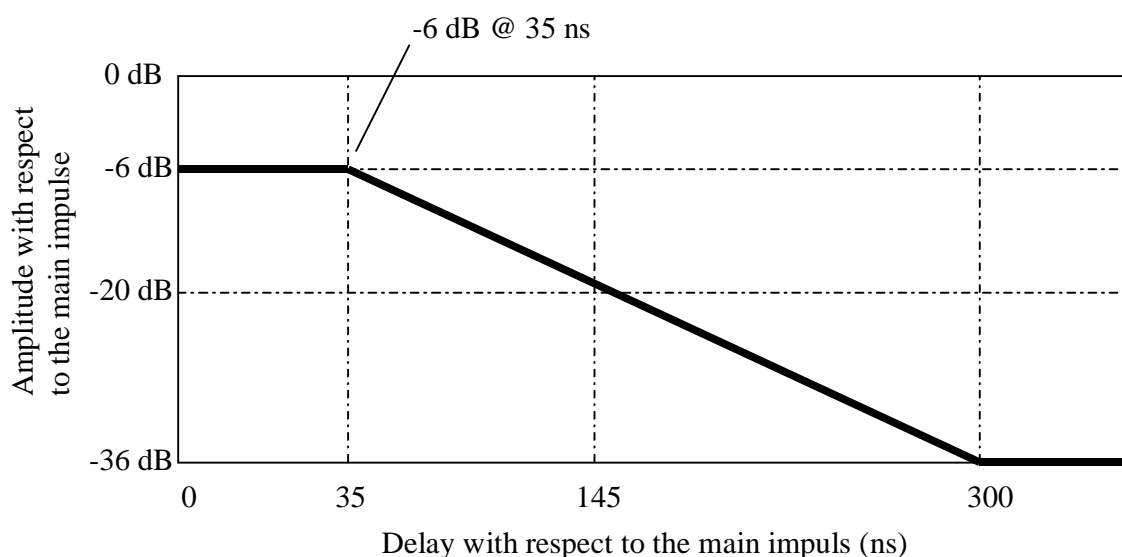


Figure 3.1: Template for echoes

Note: The back off is the ratio between the RMS value of the peak PAL vision carrier level and the average QAM level. The Peak QAM signal level in the DVB cable system is about 6 dB higher than the average level

### 3.4 Terrestrial Tuner and Demodulator

#### 3.4.1 General

The NorDig II shall include one tuner/demodulator for reception of signals from terrestrial transmitters, broadcasting in accordance with EN 300 744 [9].

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 may include single frequency networks (SFN).

The performance requirements used in section 3.4.7 are referring to the QEF definition provided in EN 300 744 [9], 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, and the details of how this requirement shall be measured is provided in Annex C: Subjective QEF Quality Measurement.

### 3.4.2 Frequencies

The NorDig II shall be able to receive all channels in the UHF bands IV and V (channel 21-69).

The front end shall be capable of tuning to the centre frequency  $f_c$  of the incoming DVB-T RF signal, where:

$$f_c = 474 \text{ MHz} + (N-21) \times 8 \text{ MHz} + f_{fine},$$

$N \in \{21, \dots, 69\}$  (UHF channel number)

$f_{fine} \in [-10 \text{ kHz}, 10 \text{ kHz}]$  (continuous fine frequency offset range)

### 3.4.3 Modes

The NorDig II terrestrial frontend shall be capable of correctly demodulating all non-hierarchical modes specified in EN 300 744 [9]. The frontend 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 receiver shall automatically detect which mode is being used.

### 3.4.4 Tuning/Scanning Procedures

The NorDig II shall provide a scanning procedure over the whole frequency range.

It shall also be able to receive and react on tuning parameters found in PSI/SI (e.g. NIT information).

### 3.4.5 Changes In Modulation Parameters

NorDig II should recover from changes in modulation parameters and output an error free TS. This should take less than one second for any change. The receiver 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.

### 3.4.6 Connector

The NorDig II shall have one input tuner connector, type: IEC female in accordance with IEC 60169-2, part 2 [24]. The input impedance shall be 75 ohm.

NorDig II should have an RF bypass ( $RF_{in}$  -  $RF_{out}$ ) output connector, type: IEC male in accordance with IEC 60169, part 2 [24].

### 3.4.7 Performance

#### 3.4.7.1 C/N Performance

The NorDig II should have a noise figure better than 8 dB.

The NorDig II should have at least the performance given in Table 3.1 when noise (N) is applied together with the wanted carrier (C) in a signal bandwidth of 7.61 MHz. The Ricean and Rayleigh models are specified in EN 300 744 [9].



Modulation	Code rate	Gaussian	Ricean	Rayleigh
QPSK	1/2	5,1	5,6	7,4
QPSK	2/3	6,9	7,7	10,4
QPSK	3/4	7,9	8,8	12,7
QPSK	5/6	8,9	10,0	15,2
QPSK	7/8	9,7	10,7	18,4
16-QAM	1/2	10,8	11,6	13,2
16-QAM	2/3	13,1	13,6	16,3
16-QAM	3/4	14,6	15,1	18,9
16-QAM	5/6	15,6	16,5	21,6
16-QAM	7/8	16,0	17,1	25,5
64-QAM	1/2	16,5	16,8	18,1
64-QAM	2/3	18,7	19,3	21,6
64-QAM	3/4	20,2	20,9	24,2
64-QAM	5/6	21,6	22,4	28,7
64-QAM	7/8	22,5	23,5	32,8

Table 3.1: C/N (dB) for QEF reception at TS output

Note: Quasi Error Free (QEF) reception corresponds to BER =  $10^{-11}$  at the input to the MPEG-2 demultiplexer.

#### 3.4.7.2 Minimum Receiver Signal Input Levels

The NorDig II should provide QEF reception for the minimum signal levels ( $P_{\min}$ ) stated below.

$P_{\min} = -97.2 \text{ dBm} + C/N \text{ [dB]}$ , where C/N is specified in Table 3.1.

For the modes {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/8$ } and {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/4$ } QEF reception shall be achieved for the following minimum input levels and channels:

Gaussian channel:  $P_{\min} = -77.2 \text{ dBm}$   
 Static 0 dB echo:  $P_{\min} = -70.2 \text{ dBm}$   
 (delay = 1.95  $\mu\text{s}$ , 0 degree phase at channel centre)

#### 3.4.7.3 Maximum Receiver Signal Input Levels

The receiver shall be able to handle DVB-T signals up to a level of -35 dBm.

#### 3.4.7.4 Immunity to “analogue” and/or “digital” Signals in Other Channels

NorDig II receivers should permit adjacent VSB/PAL carriers with up to 35 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 should be possible with “analogue” signals with up to 46 dB higher level than the DVB-T signal.



The NorDig II should permit adjacent DVB-T carriers with up to 30 dB higher power level while maintaining QEF reception on selected carrier. For all other channels, excluding image channels, it should be possible to have DVB-T signals with up to 40 dB higher level while maintaining QEF reception on selected carrier. For image channels, it should be possible with up to 30 dB higher level while maintaining QEF reception on selected signal.

The requirements in this paragraph refer to the modes {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/8$ } and {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/4$ }.

#### 3.4.7.5 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 II should perform better than specified in Table 3.2 when exposed to interference from a co-channel VSB/PAL signal including video with teletext, an FM sound and a NICAM subcarrier as specified above (see section 3.4.7.4).

For the modes {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/8$ } and {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/4$ } the NorDig II shall provide a C/I better than 3 dB, measured in the signal bandwidth of 7.61 MHz.

	QPSK					16QAM					64QAM				
Code rate	1/2	2/3	3/4	5/6	7/8	1/2	2/3	3/4	5/6	7/8	1/2	2/3	3/4	5/6	7/8
CEPT mode	A1	A2	A3	A5	A7	B1	B2	B3	B5	B7	C1	C2	C3	C5	C7
C/I	<b>-12</b>	<b>-8</b>	<b>-4</b>	<b>3</b>	<b>9</b>	<b>-8</b>	<b>-3</b>	<b>3</b>	<b>9</b>	<b>16</b>	<b>-3</b>	<b>3</b>	<b>7</b>	<b>17</b>	<b>24</b>

Table 3.2: Carrier to Interference, C/I (dB) for QEF, when interfered with by analogue TV carrier

#### 3.4.7.6 Performance In Time-Varying Channels

The NorDig II should be able to operate with all signal time variations which naturally exists 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 should be less than 1 dB for a 0 dB echo with frequency separation equal to 20 Hz, corresponding to a Doppler of +/- 10 Hz (after AFC), compared to the same 0 dB echo without frequency separation (0 Hz Doppler).

The requirement in this paragraph refer to the modes {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/8$ } and {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/4$ }.

#### 3.4.7.7 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, the NorDig II should be able to find one of these positions, independently of echo profile. The receiver should also be able to correctly equalise the signal for echoes up to  $7T_u/24$  (Interval of correct equalisation), independently of the echo profile. See also Annex B: Terminology and Definitions for Single Frequency Networks Performance Parameters.

For the modes {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/8$ }, {8K, 64-QAM, R=2/3,  $\Delta/T_u = 1/4$ } and {8K, 64-QAM, R=3/4,  $\Delta/T_u = 1/4$ } QEF reception shall be possible when the channel contains two static paths



with relative delay from 0.2 us up to (not including) the guard interval length  $\Delta$ , independently of the relative amplitudes and phases of the two paths. No noise is added.

### **3.5 Transport Stream Input/Output**

#### **3.5.1 Use of Transport Stream Input/Output**

The NorDig II should at least have one Transport Stream input/output in addition to the mandatory Common Interface. This additional transport stream input /output shall either be implemented as an additional Common Interface or an IEEE 1394 [29]. (The additional Transport Stream input/output may, however, be combined with the mandatory Main Common Interface).

The additional transport stream input/output is primarily intended for connection of an external Tuner/Demodulator unit. However, it is also envisaged that it will be used for connection to an external CD, storage devices and other external devices.

#### **3.5.2 Bit Rate (Capacity)**

The transport stream interface shall be able to carry bit rates in the range up to 58 Mbps, excluding error correction.

### **3.6 Additional Front-end**

It should be possible to connect an additional front-end to NorDig II.

The functionality and performance of the additional tuner/demodulator should be as specified in sections 3.2 (Satellite Tuner and Demodulator), 3.3 (Cable Tuner and Demodulator) and 3.4 (Terrestrial Tuner and Demodulator).



## 4 MPEG-2 Demultiplexer

### 4.1 General

The Demultiplexer shall be compliant to the MPEG-2 transport layer defined in ISO/IEC 13818-1 [32]. The NorDig II shall support ETR 154 [16] and the additional requirements stated below:

- The NorDig II shall utilise the MPEG-2 Service Information as specified in Part B.
- The NorDig II shall interpret the CA descriptor as defined in ETR 289 [19].
- The NorDig II shall be able to decode an ISO/IEC 13818-1 [32] stream with data rates up to 58 Mbit/s.
- It should be possible to select one or many section-based data streams and output them as data on RS232 or USB (if present).
- The NorDig II shall be capable to utilise at least 32 elementary streams simultaneously which requires 32 PID filters.
- The NorDig II shall provide at least 32 section filters.

Note: This feature enables the NorDig II to utilise several components as video, audio, teletext, SI, subtitling and data for additional services.

- The NorDig II shall use the video stream descriptor to recognise still picture data.
- The NorDig II shall support variable bitrate elementary streams within a constant bitrate transport stream (excluding audio).

### 4.2 DVB Descrambler Performance

The descrambler unit is based on the common scrambling algorithm as specified by DVB, see DVB A 011 [2]. See also section 15.2.3 (ECM and EMM Filtering). It shall be able to descramble on transport level and on PES format. NorDig II shall be able to process in parallel up to at least 6 different streams (either PES or transport level) with different access conditions. Data streams without access control shall be bypassed by the descrambling unit.

Note: ETSI acts as a neutral custodian for the distribution of the system information concerning the common scrambling system



### **4.3 System Clock Recovery**

During the system time clock (STC) acquisition audio and video shall be muted. (The transition shall be smooth and seamless when the customer changes the channel). The decoder shall be able to:

- recover the STC using PCR with maximum jitter of  $\pm 50 \mu\text{s}$ .
- track long-term variations in the frequency of the encoder's STC.

For each service, the demultiplexer shall recover the source clock by extracting the associated PCR values received within the incoming multiplex and insert them into the appropriate Phase Locked Loop.



## 5 MPEG-2 Video Decoder

### 5.1 General

The Video decoder shall fully comply with the DVB; Implementation guidelines for the use of MPEG-2 systems, video and audio in satellite, cable and terrestrial broadcasting applications, ETR 154, (video subclause 5.1; 25Hz standard TV) [16].

### 5.2 Constraints and Extensions

This section sets out the requirements to the NorDig II in addition to the DVB requirements expressed by ETR 154 [16].

#### 5.2.1 Active Format Description

The NorDig II shall be able to support usage of the Active Format Description (AFD) as defined in the ETR 154 [16].

#### 5.2.2 Displaying 16:9 Material on 4:3 Monitors

The viewer shall be able to choose between the following storable display mode preferences:

1. display picture part by use of transmitted pan vectors or if the pan-vectors are not present display with letterbox conversion (default mode in decoder settings).
2. display 16:9 material as 16:9 letterbox regardless of pan-vectors.
3. display picture part by use of transmitted pan vectors or if the pan-vectors are not present display with center cut-out.

The viewer should be able display 16:9 material as 14:9 letterbox regardless of pan-vectors.

In addition the viewer shall be able to enable or discard the usage of Active Format Description. If the AFD is enabled and valid AFD data is received the above settings shall be overridden.

#### 5.2.3 Displaying 4:3 Material on 16:9 Monitors

The NorDig II shall signal 4:3 material as specified in section **Fel! Hittar inte referensskälla.** for SCART signalling.

The viewer shall be able to enable or discard usage of Active Format Description.

#### 5.2.4 16:9-Letterbox Conversion

16:9 letterbox conversion (i.e 16:9 broadcast, which the IRD converts into 16:9 letterbox inside a 4:3 frame raster edge) shall be implemented for the display of video using the 16:9 aspect ratio on 4:3 monitors. This conversion shall be implemented by vertical filtering. Signal degradation due to the filtering should be subjectively imperceptible. Line 23 and line 623 should be masked before the letterbox conversion to avoid the irritating half lines.

#### 5.2.5 14:9-Letterbox Conversion

The NorDig II should be able to present 16:9 aspect ratio material as 14:9-letterbox on 4:3 monitors (e.g. a 14:9 centre cut-out with preserved geometry of the program content). The conversion of the 14:9 centre cut-out should be implemented by both vertical and horizontal filtering. Signal degradation due to the



filtering should be subjectively imperceptible. Line 23 and line 623 should be masked before the letterbox conversion to avoid the irritating half lines.

### 5.2.6 Down-conversion

Down-conversion from any valid input resolution (720x576, 704x576, 544x576, 480x576, 352x576 or 352x288 pixels) to 1/4 respective 1/16 of displayed screen size (360x288 and 180x144) shall be implemented.

It shall be possible to locate the down-converted video anywhere on the screen.

Note: The control of down-conversion (size and position) is handled by DVB-MHP APIs, see chapter 11.

### 5.2.7 Up-conversion

Up-sampling of video shall be supported from any valid input resolution (720x576, 704x576, 544x576, 480x576, 352x576 or 352x288 pixels) to any valid resolution. There shall be no conversion between 704x576 and 720x576.

It shall be possible to locate the up-converted video anywhere on the screen.

#### 5.2.7.1 Default Location Mode

If no application requests a specific location of the up converted video the following default mode shall apply:

An input video with the resolution 704x576 shall not be up-sampled, thus it shall be located as indicated below.

If the result of the up-sampling process is *less* than 720 pixels wide then the output of the video decoder shall be centered within the region of 720 active digital video pixels. The offset from the start of the active digital video pixel area to the first (left most) pixel of video decoder output is the difference in their widths divided by 2 and truncated towards zero. Equivalent centering should be used to position the video decoder vertically within the 576 active lines of the analogue display.

If the result of the up-sampling process is *greater* than 720 pixels wide then the output of the video decoder shall be cropped symmetrically to fit within the region of 720 active video pixels. The number of pixels cropped from the left-hand side of the video decoder output shall be the difference between its width and 720 divided by 2 and truncated towards zero. The remaining difference shall be cropped from the right hand side of the video decoder output.

### 5.2.8 Still Picture Support

The NorDig II shall support the decoding and displaying of still pictures (frame). A still picture is a video sequence containing exactly one intra-coded picture. Such a video bit stream will cause the buffer to under flow. In this situation, while the decoding process shall continue to examine the buffer, the display process associated with the decoder shall repeat the previously decoded picture until the normal operation of the buffer can resume.



## 6 MPEG-2 Audio Decoder

### 6.1 General

The Audio decoders shall fully comply with the DVB Implementation Guidelines for the use of MPEG-2 Systems, Video and Audio in Satellite and Cable Broadcasting Applications ETR 154 [16].

### 6.2 Constraints and Extensions

#### 6.2.1 Audio Video Synchronisation

The NorDig II shall provide at least one audio decoder that is able to meet the minimum decoding requirements, which is set out in ETR 154 [16]. Additionally, receivers shall not introduce more than  $\pm 5$  ms of relative delay between the audio and video components.

#### 6.2.2 Set-up Levels

The level for reference tones for transmission shall be 18 dB below clipping level, in accordance with EBU Recommendation R.68 "Alignment level in digital audio production equipment and in digital recorders" as recommended by ETR 154 [16].

#### 6.2.3 Multichannel Audio

The NorDig II shall be able to output an audio stream as non-PCM encoded audio to the digital audio interface (see section 9.7) according to IEC 61937 [27] if there is an AC-3 or MPEG2 BC (ISO/IEC 13818-3 [33]) stream present for the chosen service in the incoming transport stream.

Decoding of audio according to AC-3 or MPEG2 BC (ISO/IEC 13818-3 [33]) is optional.

#### 6.2.4 Digital Audio Output

The digital audio output as defined in section 9.7 shall always give either a valid PCM-output according to IEC 60958 [28] or a non-PCM encoded audio bit-stream according to IEC 61937 [27]. The user shall be able to choose between the following storable output modes on the digital audio output interface:

1. Forced PCM output according to IEC 60958 [28] (Part1 General, Part3 Consumer).
2. Non-audio-data output according to IEC 61937 [27] when present -and if not present output PCM according to IEC 60958 [28]. Non-audio-data-formats like AC-3 and MPEG2-BC shall be possible to order and enable/disable according to priority set by the user.

The NorDig II shall be able to implement, by software, new future-formats (e.g. MPEG-2 AAC, DTS etc.) in the priority-list if/when they get allowed to be broadcast by DVB ETR-154 – and if/when they are implemented in IEC 61937 [27] to be output as non-audio-data at a S/PDIF-interface.

If the specific IRD can also tune analogue PAL, the Nicam-stereo, if present, or alternatively analogue audio shall be AD-converted to PCM-audio as stereo or 2 channels of mono to be output at the S/PDIF-interface.

The NorDig II should to be able to A/D-convert incoming analogue audio signals (e.g. VHS) and output them to the digital audio interface (see section 9.7).



### 6.2.5 Half Sampling Rates

The NorDig II should support the half-sampling rates (22.05 and 24 kHz).

## 6.3 Applications

The NorDig II shall be able to read and use the ISO 639 language descriptors associated with the audio-streams in the ISO/IEC 13818-1 [32] MPEG2 transport stream.

The user shall be able to select storable preferences for primary and secondary audio language. If an audio-stream according to the primary audio language preference is not associated with the chosen service the NorDig II shall automatically chose the audio stream according to the secondary audio language preference, if present. In addition the user shall be able to manually select between all audio-streams that are associated with the active service.

The NorDig II shall be able to read the audio information contained in the DVB\_SI stream\_content and component\_type of the component descriptor as defined in EN 300 468 [6], see chapter 12. The NorDig II should be able to present the audio information, including the descriptors for audio description for the visually impaired and audio for the hard of hearing, contained in the component descriptor to the user for information and selection purposes.



## 7 Controllers and Memory

### 7.1 Hardware /Hardware Capacity

#### 7.1.1 General

The minimum Hardware requirements of the NorDig II is:

- The NorDig II shall have a real time clock/calendar running continuously. The clock shall be updated by incoming TDT and TOT from SI.
- The NorDig II should have an internal timer for the possibility to automatically switch from stand by mode to the operational mode. This timer shall be initiated locally (accepted by end user).

Note: During this kind of start up or during any pre-programmed zapping, it is advisable that the NorDig II does not try to start anything which requires user acknowledgement or similar, for example updating of service list data or bootloader software.

#### 7.1.2 Controllers

The NorDig II should be performing well with the applications that are developed based on the DVB-MHP API [3] specifications.

#### 7.1.3 Memory

The minimum memory configuration for the NorDig II IRD shall be:

- 16 Mbytes RAM
- 4 Mbytes video RAM
- 8 Mbytes Flash memory

Note: If the IRD has a persistent Read/Write memory device, it is up to the manufacturer to decide amount of the flash memory.

#### 7.1.4 Persistent Memory Device

The NorDig II should have persistent mass memory capability.

## 7.2 The Bootloader

### 7.2.1 Introduction

The NorDig II shall provide a software download mechanism that enables download of software modules. The modules may constitute a complete system, i.e. drivers, operating system and applications, or individual system components like updated parts of the system software or new applications. When individual components are downloaded, a mechanism shall be provided that assures that dependencies between separate modules are fulfilled. It shall be possible to replace all parts of the system software.

The NorDig II software download mechanism shall provide the possibility to:

1. replace and/or add an API with another (i.e. independence of API vendors)
2. replace and/or add a CA system (i.e. independence of CA vendors)



The actual upgrade of NorDig II software shall be initiated by the user. The NorDig II manufacturer shall provide the procedure and functions carrying out the upgrade in the receiver. The user procedure for initiating the upgrade shall be part of the Navigator function. The NorDig II manufacturer should also provide a mechanism for indicating when new system software is available for download.

The user procedure shall in an unambiguous way indicate which network the user is connected to (from NIT, SI, see Chapter 12), and then ask the user if upgrade is wanted, with a possibility to abort the system software upgrade. The progress of the download shall be displayed by the NorDig II.

The manufacturer should, with reasonable confidence, ensure that download of non-certified system-software is prevented. NorDig recommend the use of a public-key/private-key mechanism, with the public-keys present in the NorDig II.

If the NorDig II System software is corrupt, the NorDig II manufacturer shall provide a backup mechanism, either on local storage or via download, which can make the NorDig II operational again.

NorDig II shall provide the two following download modes:

- Over-the-air via broadcast
- Download over the local data interface

### 7.2.2 Over-the-air via Broadcast Download

The NorDig II shall provide a system software download mechanism accessing software files output cyclically broadcast in one PID within a MPEG-2 transport stream. The data transport protocol should be based on MPEG data structures.

The security aspects shall be the responsibility of the NorDig II manufacturer. An authentication scheme using private/public key cryptographic algorithm is recommended.

Note: The NorDig II manufacturer is expected to provide the required TS file for cyclic broadcast and in addition the necessary parameters that is to be signalled in the NIT (see section 12.2).

### 7.2.3 PSI and SI Specification

The NorDig II shall use the linkage descriptor transmitted in the NIT for over-the-air system download. The linkage\_type and the coding of the private data shall be as defined in section 12.2 and service\_type shall be as defined in section 12.3.

### 7.2.4 Local Download

Download shall be possible using a local data interface. The NorDig II manufacturer shall define the protocols and security mechanisms. The actual download is the user's responsibility and shall be performed under the full control of the user.



## 8 Graphics Processing

An OSD graphic display shall be implemented and fulfil at least the following requirements:

- Support resolutions of 720 by 576 pixels and lower.
- Support at least one colour look-up table (CLUT) with a minimum of 256 entries including transparency. It shall be possible to choose any 24-bit RGB colour into the 256 entries. The actual presentation shall be specified as defined in the DVB-MHP [3] specification.
- Support 4 logical display planes:
  - Video plane for full screen MPEG video.
  - Graphic plane I for MPEG I-still frames, JPEGs, GIFs, PNGs and / or decimated live MPEG video.
  - Graphic plane II for graphics (full screen).
  - Cursor plane: 32 x 32 pixel, RGB format.
  - Simultaneous overlapping displays of all plans.
- Support blending of the graphics with video or stills backgrounds. At least 5 levels of transparency shall be provided (0%, 30%, 50%, 70%, 100%).
- Support aspect ratios as set in the installation setting at the SCART 1 interface (see chapter 17).



## 9 Interfaces and Signal Levels

### 9.1 Introduction

This chapter includes requirements to the various external interfaces, except for the frontends (tuner/demodulators) that are treated in chapter 3.

The main functional blocks are described in chapter 2 for the case with embedded tuner/demodulator.

NorDig II should have an RF-bypass ( $Rf_{in} - Rf_{out}$ )

The NorDig II with embedded cable tuner should have an additional path for analogue signals. This path includes the tuner function and a VSB demodulator (addition to basic NorDig II), a combiner for mixing of composite PAL video with on screen display graphics (from stored data in NorDig II), and switches to allow the baseband composite video and associated audio to appear at the scart, audio and RF-PAL output.

### 9.2 RF-PAL Output

The NorDig II with embedded cable tuner should have one RF-PAL output unit including a DSB modulator with the following properties:

- The modulator shall modulate the CVBS signal into the PAL-G in accordance with ITU/R rec. 624-4 [35].
- Volume control as specified for the TV set scart interface shall also be available at the modulator output.
- The modulator shall support PAL mono audio output.
- The NorDig II RF output shall have one connector: IEC male, compliant with IEC 60169-2 part 2 [24].

### 9.3 Transport Stream Input/Output

#### 9.3.1 General

NorDig II shall have one main Common Interface, and should have an additional transport stream input/output interface.

#### 9.3.2 Main Common Interface

The NorDig II shall support the Common Interface, EN 50221 [13]. The main Common Interface shall be prepared for modules of type 2. Support for type 3 is optional.

#### 9.3.3 Additional Transport Stream Input/Output

The additional (optional) Transport Stream input/output shall be either IEEE 1394 [29] or an additional Common Interface.



### 9.3.3.1 IEEE 1394

The physical, link and transport layers are specified in IEEE 1394 [29]. The NorDig II shall support bitrates up to 58 Mb/s.

The packet layer and data format for MPEG2 transport capability shall be compliant to IEC 61883-1 [26].

### 9.3.3.2 Additional Common Interface

The NorDig II shall support the Common Interface, EN 50221 [13]. The additional Common Interface shall be prepared for modules of type 2. Support for type 3 is optional. The TS interface must be able to operate with different input and output rates, and even with an input or output rate equal to zero.

## 9.4 Smart Card Interface

The NorDig II shall include at least two embedded smart card readers for use with conditional access and/or other applications.

Both smart card readers shall support the non-CA smart card API as defined in DVB-MHP [3] and at least one shall support CA, see section 15.2.

The smart card interface shall comply with ISO/IEC 7816 Part 1-3 [34]. The NorDig II does not need to support synchronous cards. The NorDig II shall implement all aspects related to asynchronous cards with the following exceptions:

- support for  $V_{pp}$  is not required
- support for AFNOR pin-out is not required
- $V_{cc}$  range is  $5V \pm 5\%$
- $I_{cc}$  max is 65 mA

The clock frequency shall be at least 3.72 MHz, preferably 5 MHz.

The possibility of using the data exchange protocol  $T=0$  shall be supported. It shall be possible to include support for the data exchange protocol  $T=1$  through an IRD software upgrade.

## 9.5 Interaction Channel Interface

The NorDig II shall support at least one of the following interaction channel interfaces:

1. V.90 modem (56 kbit/s) in accordance with ITU-T V.90 [37].
2. Ethernet (IEEE 802.3 [30] or faster).
3. EURO-ISDN adapter [20].
4. Wireless DECT modem (32 kbit/s GAP profile, according to ETS 300 175 [21]).
5. Wireless GSM modem/GPRS (see relevant ETSI specifications).
6. DVB return channel modem in accordance with ETS 300 800 [23] (only in a Cable STB).
7. EuroDocsis return channel modem in accordance with ES 201 488 [15] (only in a Cable STB).

## 9.6 SCART Interfaces

The NorDig II shall have two SCART Interfaces in accordance with EN 50049-1 [10] and EN 50157-2-1 [12].



The following table summarises the input/output signals available at all SCART interfaces:

SCART	requirement	CVBS/AUDIO	RGB	PIN 8	PIN 16
1 TV	mandatory	Out	Out	out (1)	out (2)
2 VCR	mandatory	in and out (3)	In	In	in

*Table 9.1: SCART requirements*

- (1): the voltage shall be forwarded from in to out (12V or 6V)
- (2): the voltage shall be forwarded from in to out (0V or 1 - 3V)
- (3): the OSD graphics should not be present on the VCR scart output except for DVB subtitling (if present and chosen)

Control signal definitions:

PIN 8: nom. 0 Volt/DC: internal source of the TV set  
 nom. 6 Volt: external source, 16:9 format  
 nom. 12 Volt: external source, 4:3 format

PIN 16: nom.0 Volt/DC: CVBS active  
 1-3 Volt/DC: RGB active

The difference in delay between the CVBS and the RGB signals should be user adjustable by up to at least +/- 1.5µs

### **9.7 Audio Interfaces**

The audio interface of the VCR SCART shall deliver the same audio signal as available at TV SCART Interface. The internal volume control should only affect the audio signal at TV SCART interface, but not the audio signal of the VCR SCART audio interface.

The NorDig II analog audio interface connectors shall be Two Cinch connectors, female type IEC 60603-14 [25].

The NorDig II should include a cinch connector for digital audio interface according IEC 60958 [28] for digital audio out or should support digital audio out with optical connector according IEC 60958 [28].

### **9.8 Serial Data Interface**

The NorDig II serial data interface should comply with TS 102 201 [41] section 4.6.1 (RS232C, connector: 9 PIN SUB-D connector, male type) in up to 115200 bit/s transfer speed or Universal Serial Bus Port, Revision 1.1 [39].

### **9.9 Additional Data Interfaces**

The NorDig II should support one of these additional physical data interfaces:

- IEEE 1394 [29]: Transmission rate 100 Mbit/s, isochronous or asynchronous data format,
- Ethernet: IEEE 802.3 [30] framing, MAC layer functions, multicast support, 10Base-T-physical layer (1.2 Mbit/s peak)
- Ethernet: IEEE 802.3 [30] 100BaseT
- Universal Serial Bus Port, Revision 1.1 [39].



- WLAN (IEEE 802.11 [31]).
- Bluetooth [1].

Note:	Combinations of the functional requirements specified in sections 3.5, 9.5 and 9.9 may be provided by the same physical connector.
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### ***9.10 Remote Control Interface***

The IRD manufacturer will specify the Remote Control Unit. Remote control keys available for applications are specified in chapter 16.

### ***9.11 Remote Keyboard Interface***

The NorDig II should have a remote keyboard interface.



## 10 Performance

### 10.1 Introduction

In this chapter the performance of decoded digital video and audio signals are specified. It also includes zapping performance regarding the time to recover when changing services. The performance for demodulated analogue video and audio signals (optional for NorDig II with embedded analogue cable front-end) is also specified.

Other performance issues are treated in other chapters.

### 10.2 Video Performance of RGB and PAL Signals

The RGB- and CVBS-signals at the appropriate interfaces of the NorDig II shall meet the characteristics given in ITU report 624-4 [35].

The NorDig II shall at least satisfy the performance as stated below:

Measurement Item	Value
S/N, weighted acc ITU/R Rec. 567-2 (dB)	>54
Output impedance tolerance (% rel to 75 Ohm)	+/-10
Bar amplitude tolerance (dB rel to 700mV)	+/-1
Sync pulse amplitude tolerance (dB rel to 300mV)	+/-1
Burst amplitude tolerance (dB rel to 300mV)	+/-1
2T pulse response (%)	<5
Amplitude Characteristics (DC to 4.8 MHz in dB)	+/-3
R, G, B, PAL Non-linearity (%)	<6
Chroma/Luma intermodulation (%)	<5
Intercomponent level inequality (RGB) (dB)	+/-0.5
Intercomponent timing (RGB) (ns)	<40
LO Phase noise (dBc/Hz at 10kHz)	<-80

Table 10.1: Video performance



### 10.3 Audio Performance of the Decoded Digital Signal

Reference for the performance of all audio measurement is full scale -12dB and the measurement shall be made at a sampling rate of 48 kHz.

The NorDig II shall at least satisfy the performance as stated below:

Measurement item	Min	Typical	Max.
Output impedance (Ohm)		600	1000
Output level (mV at 1 kHz)		500	
Flatness of amplitude response: (dB)(at 40 Hz to 80 Hz)	-2		+2
80 Hz to 13,5 kHz	-1		+1
13,5 kHz to 20 kHz	-2		+2
Dynamic range (dB)	80		
Harmonic distortion ratio (%)			0.1
Cross-talk between channels (dB, at 20 Hz to 20 kHz)			-60
Hum suppression (dB)	60		
S/N (dB, weighted, quasi peak, ITU/R rec. 468)	66		
Phase difference between channels (°), 40 Hz to 13,5 kHz			10
13,5 kHz to 15 kHz			15
Amplitude difference between channels (dB, 20 Hz to 20 kHz)			±1
Volume control (affected steps with 3 dB/step)		6	
Signal attenuation at mute (dB)	70		

Table 10.2: Audio performance

Note:	Full scale is defined, for a digital signal, as the maximum signal in accordance with the encoding system specification. Full scale amplitude is defined after pre-emphasis and is the same for all frequencies after encoding.
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### 10.4 Zapping Time for TV Services

The zapping time for the services shall pass the following test: 20 measurement series, each of 20 single measurements of the zapping time shall be carried out (together 20 x 20 measurements). The 14<sup>th</sup> smallest measurement in each series shall be less or equal to the figures in Table 10.3, in at least 19 series. The 18<sup>th</sup> smallest measurement in each series shall be less or equal to the figures in the table + 80% in at least 19 series.

The GOP length shall be 12, and the repetition rate of ECM shall be 10 per second. The repetition rate of the PAT and PMT shall be 10 times a second. The picture on the display during the zapping time shall be either frozen or black and the sound shall be muted until the new session has been stabilised. The figures in Table 10.3 are valid for two channels on one multiplex as well as for two multiplexes.



Coming from ↓	Going to ⇒	Digital Scrambled Services	Digital Services	Analogue Services
Digital Scrambled Services		1.8 second	1 second	1 second
Digital Services		1.8 second	1 second	1 second
Analogue Services		1.8 second	1 second	1 second

Table 10.3: Zapping time

The figures in Table 10.3 apply for all digital services, also including services with MHP applications. The figures in the table relate to the maximum time allowed for the presentation of audio and video. The receiver shall be able to present subtitling data within two seconds after the first video frame is presented.

An (immediate) rezapping shall be within the same figures.

### 10.5 Analogue Demodulated Video and Audio

For NorDig II with embedded cable front-ends the demodulation of analogue RF programmes is optional.

#### 10.5.1 Video Performance of the Demodulated Analogue Signal

The NorDig II shall comply with the following performance of the analogue demodulated CVBS signal measured at the SCART interfaces:

- Video Signal to Noise ratio: S/N weighted: > 48 dB
- The overall equivalent BB amplitude characteristic shall be within a 3 dB template.
- The overall equivalent BB Group Delay characteristic shall be within a 70 ns template.

#### 10.5.2 Audio Performance of the Demodulated Analogue Signal

The NorDig II shall comply to the following performance of the analogue demodulated audio signals measured at the SCART interfaces:

Measurement item	Value
Nominal output level (mV RMS at 1 kHz) For a modulation factor at the transmitter of 54%	500
Flatness of amplitude response: (Max dB) 40 Hz to 13,5 kHz	±3
Hum suppression (dB)	>60
Max. Harmonic distortion ratio (%)	<1
S/N (dB, weighted, quasi peak, ITU/R rec. 468, ref. 6 dBu)	>46
Volume control (affected steps with 3 dB/step)	6
Signal attenuation at mute (dB)	>60
Outband rejection (dB)	>60

Table 10.4: Analogue audio performance



Part B: The system software with application programming interfaces (API)



## 11 IRD System Software and API

The NorDig II shall support the API and content formats defined by DVB for the Multimedia Home Platform.

### 11.1 Detailed Profile Definition

The NorDig II shall support at least all the mandatory features specified for the DVB-MHP Interactive Broadcast Profile, as defined in DVB-MHP version 1.1 [3].

Note:	Verification testing of the API parts will initially be based on DVB-MHP test suites for DVB-MHP version 1.0 [40]. Final API testing will be based on the full test suites for DVB-MHP version 1.1 Interactive Broadcast profile, when available.
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### 11.2 Content Formats

The NorDig II shall support at least the mandatory content formats specified for DVB-MHP Interactive Broadcast Profile, version 1.1 [3].



## 12 Service Information

### 12.1 General

The NorDig II shall be able to process, i.e. sort out, store and make available through the DVB MHP API, the incoming SI data (descriptors) as tabulated in sections 12.2 - 12.7, i.e. these are (minimum) mandatory descriptors for the receiver to decode and interpret, (see also Table 12.1 for an overview over minimum broadcast and receiver requirements). The processing shall be compliant with EN 300 468 [6] and ETR 211 [18]. The NorDig II shall support all the DVB SI additions as defined in the DVB-MHP specification version 1.1 [3].

Descriptors or other data structures that are currently undefined or are unknown to NorDig II shall be skipped and shall not cause any harm.

The NorDig II shall be able to process the PSI/SI tables, both for the 'Actual' and for 'Other' transport streams. Changes in the received tables shall start actions within 1 second.

NorDig defined private descriptors and data inside PSI and/or SI tables are recognised with `private_data_specifier_value` set to 0x00000029, used according to ETR 211 [18] and ETR 162 [17].



Descriptor	Tag value	NIT	BAT	SDT	EIT	TOT	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
network_name_descriptor	0x40	Mb Mr	-	-	-	-	-	-
service_list_descriptor	0x41	Ob Mr	-	-	-	-	-	-
satellite_delivery_system_descriptor	0x43	mb Mr	-	-	-	-	-	-
service_descriptor	0x48	-	-	Mb Mr	-	-	-	-
linkage_descriptor	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	0x5A	mb Mr	-	-	-	-	-	-
private_data_specifier_descriptor	0x5F	mb Mr	-	mb Mr	mb Mr	-	-	mb Mr
service_move_descriptor	0x60	-	-	-	-	-	-	Ob Mr
frequency_list_descriptor	0x62	Ob Mr	-	-	-	-	-	-
CA_system_descriptor	0x65	-	-	-	-	-	-	mb Mr
user defined	0x80-0xFE	-	-	-	-	-	-	-
NorDig private: Logic_channel_descriptor	0x83	Ob Mr	-	-	-	-	-	-
Forbidden	0xFF	Fb	Fb	Fb	Fb	Fb	Fb	Fb
<p>- Descriptor not applicable or not yet used as minimum within NorDig</p> <p>Mb Mandatory to Broadcast, always/all time</p> <p>mb Mandatory to Broadcast if applicable, i.e. if certain criteria is met (e.g. if scrambling is used)</p> <p>Ob Optional to broadcast, but recommended (if applicable)</p> <p>Fb Forbidden to broadcast (may cause misinterpretation)</p> <p>Mr Mandatory to receive and interpret if broadcast</p> <p>Or Optional to receive and interpret (if broadcasted)</p>								

Table 12.1: Overview over minimum used descriptors in Nordig broadcast and receivers

\* Optional for satellite and cable IRDs.



## 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
Linkage_descriptor	mandatory	mandatory	mandatory
Private_data_specifier_descriptor	mandatory	mandatory	mandatory
Frequency_list_descriptor	optional	optional	mandatory
(NorDig) logic_channel_descriptor	mandatory	mandatory	mandatory

Table 12.2: NIT descriptors

Reference to analogue services (PAL) may be used in Nordig digital (cable) networks. These services will be signalled in the SI as an own “transport stream”. The cable\_delivery\_system\_descriptor for these analogue services will contain the correct centre frequency for the (PAL) vision carrier, while the other delivery parameters will be set to zero (i.e. not defined; FEC Outer = 0, Modulation = 0 etc). The service\_list\_descriptor for this “transport stream” (analogue service) will list only one TV service, with service\_type set according to Table 72 in EN 300 468 [6] (0x07, PAL coded signal).

#### 12.2.2 Linkage descriptor

The following linkage\_type values shall be interpreted by a Nordig II receiver, when used inside the NIT

- 0x01, linkage to a service that contain information about the network
- 0x02, linkage to an EPG service
- 0x04, linkage to transport stream which carries EIT schedule information for all of the services in the network (i.e. “barker channel” service)
- 0x081, linkage to bootloader (software download) service, see section 7.2. When more than one bootloader is available in the network, the descriptor may occur once or several times in the descriptor loop.

#### 12.2.3 Frequency List Descriptor

The Frequency List Descriptor lists frequencies where the transport stream occurs, in addition to the frequency given by the system delivery descriptor. (e.g. the transport stream is broadcast on the frequency given by the system delivery descriptor or broadcast on one of the frequencies given by the frequency list descriptor. This feature can be used in terrestrial networks where the same transport stream can be received on more than one frequency.)

#### 12.2.4 NorDig linkage for bootloader

The parameter linkage\_type (under the linkage\_descriptor) value 0x81 is reserved for the bootloader use (see section 7.2).

Syntax	No. Of bits	Identifier
--------	-------------	------------



linkage_descriptor(){		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
transport_stream_id	16	uimsbf
original_network_id	16	uimsbf
service_id	16	bslbf
linkage_type	8	uimsbf
for (i=0; i<N ;i++){		
manufacturer_id	16	uimsbf
version_id	64	uimsbf
private_id	32	uimsbf
start_time	40	bslbf
}		
}		

Table 12.3: Linkage descriptor for bootloader.

Those identifiers not defined in EN 300 468 [6] are specified below:

**manufacturer\_id:** This is a 16-bit field which identifies the manufacturer of the IRD, the registration of manufacturer\_id is done via the NorDig project office.

**version\_id:** This is a 64-bit field that uniquely identifies the software that is downloaded within the manufacturer\_id, i.e. the manufacturer\_id / version\_id uniquely identifies all software within the NorDig marketplace.

**private\_id:** This is a 32-bit field that carries private data. In case of DSM-CC the private\_id can be used for transaction\_id where it has a dual role, providing both identification and versioning mechanisms for download control messages.

**start\_time:** This is a 40-bit field that defines at what time and date the software will be available to download. This field is coded as the UTC\_time field in the TDT.

#### 12.2.5 NorDig private; Logic\_Channel\_descriptor

The logic channel descriptor is used in the second descriptor loop in the NIT, i.e. in each “TS loop”. Data in this descriptor shall be treated as quasi-static and is used to order services in the receiver’s default **service lists**.



Syntax	No. of bits	Identifier
logical_channel_descriptor(){		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
for		
(i=0;i<number_of_services;i++){	16	uimsbf
service_id	1	bslbf
visible_service_flag	1	bslbf
reserved	14	uimsbf
logical_channel_number		
}		
}		

Table 12.4: Logical\_Channel\_descriptor

**descriptor\_tag:** This shall be assigned to be 0x83 (decimal 131)

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

**reserved:** All "reserved" bits shall be set to '1'.

**logic\_channel\_number:** this is a 14-bit field which indicates the broadcaster preference for ordering services. It shall be working together with service\_type. Each broadcaster shall, as far as possible, allocate unique logic\_channel\_number within his original\_network for each service\_type. The logic\_channel\_number use is defined in Table 12.5 below:

visible service flag	Logic channel number (decimal value)	Description
0	0	Service not suitable for selection by the user. <i>For example, the value zero may be used for data services only intended for selection from interactive applications or for firmware download services etc.</i>
1	0	Reserved
0	1 – 9999	Service not displayed in service list (default nor personal) nor ESG, not accessible via P+/- keys. But service shall (if possible) be able to be reached from numeric keys (same value as decimal value of logic_channel_number. <i>Service do not have any event information).</i>
1	1 – 9999	Service displayed in service list and ESG. Accessible via P+/- keys or from numeric keys (same value as decimal value of logic_channel_number)
0	> 9999	Reserved for future use
1	> 9999	Reserved for future use

Table 12.5: Logic\_channel\_number allocation

All "visible" services shall 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.



The receiver may have several default service lists (or sections inside one) for the different service\_types, for example one for each service\_type or typically three main categories; TV, Radio and Others. If the receiver has several service\_lists, the addressing of each service in each list shall match, as much as possible the logic\_channel\_number value.

Services shall first be ordered depending on their service\_type and secondly on the logic\_channel\_number (independently of several services have collision in the logic\_channel\_number or if they are listed or not in the logic\_channel\_descriptor). I.e. first all services with service\_type 0x01 (digital television services), after that 0x02 (digital radio sound services) and so on.

Services listed in the logic\_channel\_descriptor, shall have higher priority when ordering the services in the default service list, than services that are not listed. With other words, broadcast services may not be listed in any logic\_channel\_descriptor and these shall be displayed and accessible in the default service list, but be located last in the service list, in order to their service\_type.

Note: If several services are allocated to the same logic\_channel\_number, (may be the case, for example, if several terrestrial regions can be received at the same location or several satellite networks are received), one shall be ordered according to the logic\_channel\_number and the others shall be placed last in that list. Empty spaces in the broadcast logic channel numbering shall not be used then, instead they shall be located last, after the service with highest logic\_channel\_number of that service\_type. (The broadcaster may quite consciously choose to leave empty spaces in the logic channel numbering for example future coming services, etc). This to avoid a complete rearrangement of the list. How to choose which one that should be placed according to the channel list is up to the receiver manufacturer.

The example in Table 12.6 and 12.7 below illustrates how broadcasted services shall be ordered in the IRD's service lists according to (a terrestrial) broadcast. The abbreviations in the Table 12.6 are defined as: S\_ID; service\_ID, ON\_ID; original\_network\_ID; TS\_ID; transport\_stream\_ID, NID; network\_ID, VSF; visible\_service\_flag, LCN; logic\_channel\_number.

S_ID	ON_ID	TS_ID	N_ID	VSF	LCN	Service type	Comment
100	100	10	101	1	10	0x01 (TV)	
100	<b>200</b>	10	200	1	10	0x01 (TV)	other network provider
110	100	10	101	1	11	0x01 (TV)	
90	100	10	101	-	-	0x01 (TV)	no logic_channel_descr attached to this service
120	100	10	101	1	23	0x01 (TV)	
200	100	10	101	1	23	<b>0x02</b> (Radio)	other type of service
120	100	10	<b>102</b>	1	23	0x01 (TV)	same service from other terrestrial region (and other transmitter point)
130	100	10	101	1	24	0x01 (TV)	
400	100	10	101	0	100	0x01 (TV)	e.g. sub-service, information channel
500	100	10	101	0	0	0x0C (Data)	e.g. Bootloader or EPG service

Table 12.6: Example of broadcast of SI and services

Table 12.7 exemplifies how services shall be listed in the receiver (from broadcast above) in a receiver with at least two service\_lists, one for TV and one for Radio services. Displayed for the viewer in each service list, will typically be the number (LCN) and the service\_name. Here Service 400, only accessible



via direct keying (numeric keys) 100 or linked from other service (e.g. EPG), not accessible via P+/- and not displayed in any service lists nor ESG.

TV service list				Radio service list			
Number	S_ID	ON_ID	N_ID	Number	S_ID	ON_ID	N_ID
10	100	100	101	23	200	100	101
11	110	100	101				
23	120	100	101				
24	130	100	101				
25	90	100	101				
26	120	100	102				
27	100	200	200				

Table 12.7: Receiver service list example

## 12.3 Service Description Table (SDT)

### 12.3.1 The Service Descriptor Table Descriptors

SDT descriptors
Service_descriptor
CA_identifier_descriptor
Linkage_descriptor

Table 12.8: SDT descriptors

### 12.3.2 Service Descriptor

The service\_type (under the service\_descriptor) value 0x81 is reserved for the bootloader use (see section 7.2).

### 12.3.3 CA Identifier Descriptor

This descriptor may be present in the SDT when at least one service component is scrambled. The CA\_system\_id is allocated by ETSI and is given by ETR 162 [17]. The descriptor may be used statically (recommended). It will in that case be set according to the services regular/normal scrambling status. Alternatively it may be used dynamically, in accordance with the current services scrambling status.

This static use enables IRDs to “grey mark” services that cannot be descrambled due to lack of the required CA-system for the relevant service(s). It allows the IRD to display services that are only temporary (event based) scrambled

### 12.3.4 Linkage Descriptor

The following linkage\_type value shall be interpreted by a NorDig II IRD when used inside the SDT:

- 0x03, linkage to a CA replacement service. When present, the receiver shall automatically switch to the replacement service if the receiver are not able descramble the (original) service and if the receiver are able to receive the SDT containing the original service during the replacement, also switch back when ‘free\_CA\_mode’ is set to “0”.



- 0x05, linkage to a service replacement service. When present, the receiver shall automatically switch to the replacement service if the 'running\_status' is set to "1" (not running) and if the receiver are able to receive the SDT containing the original service during the replacement, also switch back when 'running\_status' is set to "4" (running).

## 12.4 Event Information Table Present/Following (EIT p/f)

### 12.4.1 The Event Information Table, Present/Following, Descriptors

Event p/f descriptors
short_event_descriptor
Component_descriptor
Extended_event_descriptor
Content_descriptor
Parental_rating_descriptor
CA_identifier_descriptor (optional)

Table 12.9: EIT p/f descriptors

#### 12.4.2 CA Identifier Descriptor

This descriptor is optional, however, it may be present in the EIT whenever at least one service component is scrambled. The CA\_system\_id is allocated by ETSI and is given by ETR 162 [17]. When used, it will be used dynamically, i.e. following the services scrambling status, mainly targeting the ESG/EPG applications.

## 12.5 Event Information Table Schedule

Upon user request for EIT schedule information, the IRD shall look for the reference using linkage descriptor mechanism in the NIT and perform a frequency re-tuning if necessary. Linkage\_type 0x04 ("Transport Stream containing complete network/bouquet SI") shall be used to refer to EIT schedule information.

### 12.5.1 Event Information Table, Schedule, Descriptors

Event schedule descriptors
Short_event_descriptor
Component_descriptor
Extended_event_descriptor
Content_descriptor
Parental_rating_descriptor
CA_identifier_descriptor (optional)

Table 12.10: EIT schedule descriptors

#### 12.5.2 CA Identifier Descriptor

This descriptor is optional, however, it may be present in the EIT Schedule whenever at least one service component is scrambled. CA\_system\_id is allocated by ETSI and is given by ETR 162 [17]. When used,



it will be used dynamically, i.e. following the services scrambling status, mainly targeting the ESG/EPG applications.

## **12.6 Time and Date Table and Time Offset Table**

NorDig II shall display the correct time for each country based on TDT, TOT, and the country name selected by the user.

### 12.6.1 Time Offset Table Descriptor

Time Offset Table
local_time_offset_descriptor

*Table 12.11: TOT descriptors*

## **12.7 PSI Requirements**

### 12.7.1 Program Map Table Descriptors

Program map Table
service_move_descriptor
teletext_descriptor
Subtitling_descriptor
stream_identifier_descriptor
video_stream_descriptor
CA_descriptor
ISO_639_language_descriptor
Private_data_specifier_descriptor

*Table 12.12: PMT descriptors*



## 13 Navigator

### 13.1 General

The NorDig II shall implement a basic Navigator, which provides user access to system information, and allows the user to control the operation of the IRD. The Navigator is by definition part of the system software. A minimum functionality is required as specified below.

The Navigator shall include a service list function and a basic Event Schedule Guide (ESG), see EN 300 468 [6].

The Navigator shall also initiate bootloading, as described in section 7.2.

### 13.2 Service List

#### 13.2.1 Service List Requirements

The IRD shall maintain a service list based on SI-information. The IRD identifies a service uniquely through the combination of `original_network_id`, `transport_stream_id` and `service_id`. (The broadcaster however shall make services uniquely identified in the broadcast through the combination of only `original_network_id` and `service_id`). The service list shall include the services and the corresponding network names. The service list can be completely updated by the user by initiating the tuning/scanning procedure(s) for the connected tuners (see section 3.6). The corresponding part of the service list shall be updated within 1 second after reception of an updated SI table.

The IRD shall build up different sections inside one service list or build up several service lists, one for each different `service_type` as the default IRD service list(s). Minimum three different sections/lists shall be supported for three different categories of `service_types` and they are 'TV', 'Radio' and 'Data'/'other' services. (An IRD only supporting less default lists/sections than listed `service_types` in ETSI EN 300 468 [6], may sort `service_types` into one of the supported lists, e.g. 'digital radio sound service' and 'FM radio' services may be sorted into same list, Radio).

The service list shall be displayed to the user. The user shall be able to select a service from the displayed service list. The selected service shall appear immediately (see section 10.4).

The IRD should provide functionality for the viewer to build up additional personal service lists with the viewer's own preferred services (like mixed `service_type`) and own preferred order or manually re-order the default service list(s). If any network operator make changes in his part of the service list, the NorDig II should place new entries at the end of the corresponding part of the user service list.

The information in the descriptors specified in table 13.1 and 13.2 shall be displayed. The original network operator name may be omitted in case only one network is available.

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

The NorDig II shall make use of the descriptors listed in table 13.1 in all `NIT_actual` (the transport stream the NorDig II 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).



A cable NorDig II 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 (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 NIT other tables for secondary cable networks).

A NorDig II 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 ETR 162 [17] (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
Service_list_descriptor
(Nordig) Logic_channel_descriptor

*Table 13.1: NIT descriptors*

### 13.2.3 Service List functions for the Service Description Table (SDT)

The IRD shall use the descriptors listed in table 13.2 from both SDT\_actual and SDT\_other tables to update the service list (service names etc.).

SDT descriptors
Service_descriptor
CA_identifier_descriptor

*Table 13.2: SDT descriptors*

### 13.2.4 Network Evolution and Service Changes

The NorDig II shall dynamically update the Service List whenever changes occur in the NIT and SDT tables (i.e. typically handling the version numbers of the tables).

Initiation of update in the Service List that the IRD is not able to perform in the 'background' without disturbances or user action/confirmation, shall (only) be made after manual power up or after user selection to an affected service/transport stream (e.g. when re-scanning is needed).



The NorDig II IRD shall not remove any service(s) automatically without user confirmation (to avoid irritation), when services are permanently removed from the SI. When a service and/or a transport stream is added or removed within the installed networks, the user shall automatically be informed after a manual power up or when accessing the navigator.

### 13.3 Event Schedule Guide (ESG)

#### 13.3.1 ESG Requirements

The ESG shall include the EIT present/following tables, see EN 300 468 [6] (The EIT schedule tables are not a part of the ESG).

The NorDig II shall be able to handle situations when the EIT is not present.

The ESG shall be non-discriminatory and display all services on an equal basis.

The ESG shall process and display the relevant content of the following tables (including start-time, end-time/duration and content of all descriptors specified below):

#### 13.3.2 Event Information Table Present/Following (EIT p/f)

NorDig II shall make use of the EIT p/f tables from both EIT\_actual and EIT\_other tables.

The NorDig II manufacturer should provide a procedure that allows the user to configure blanking of video and muting of sound for certain parental rating values.

Event p/f descriptors
Short_event_descriptor
Extended_event_descriptor
Component_descriptor
Content_descriptor
Parental_rating_descriptor

*Table 13.3: EIT p/f descriptors*

#### 13.3.3 Time and Date Table (TDT) and Time Offset Table (TOT)

The ESG shall display correct event times as conveyed by the TDT, adjusted by the offset relayed in the TOT and the country name selected by the user.

Time Offset Table
Local_time_offset_descriptor

*Table 13.4: TOT descriptors*

Note:	TDT contains UTC time, but no descriptors.
-------	--



## 14 Teletext and Subtitling

### 14.1 Teletext

During normal operation (decoding of MPEG2-video/audio/data-streams), the NorDig II shall be able to demultiplex in parallel the Teletext service transmitted in a packetised format according EN 300 472 [7].

The NorDig II shall be able to display Teletext using the OSD and/or by the insertion of the teletext data in the VBI of the analogue CVBS video output.

The VBI insertion shall be compliant with ITU-R BT.653-2 [36]. The Teletext data shall be inserted in the lines 6 to 22 and lines 320 to 335.

It shall be possible to use the OSD to present the decoded Teletext pages, meeting the ITU-R BT.653-2 level 2.5 requirements.

The NorDig II shall be able to display Teletext subtitling, meeting the ITU-R BT.653-2 level 2.5 requirements.

The user shall be able to select primary and secondary subtitling language.

The Nordic characters defined in the Latin G2 supplementary set shall be supported.

The NorDig II with OSD presentation should be able to cache at least 50 decoded Teletext pages in order to improve the access time for frequent used pages. When displaying a certain page the decoder should cache a certain number of pages requested by the customer before that page and decode a certain number of pages that are most likely to be requested by the customer later.

### 14.2 DVB Subtitling

The NorDig II shall be capable of decoding, as a minimum, a subset of the DVB subtitle services as specified in section 14.2.1 and transmitted in conformance with ETS 300 743 [22], and displayed using the OSD capabilities whilst decoding the full television service (video and audio) to which it is associated. Both bit mapped graphics and character reference mode shall be supported.

The NorDig II shall support the DVB Subtitling standard according to DVB-MHP specification version 1.1 [3].

The enabling and disabling of the subtitle composition pages and selection of “normal” or “hard of hearing” subtitling shall be user controlled, with composition pages and normal subtitling enabled as default option.

The enabling or disabling of the subtitle ancillary pages, if available, shall be user controlled, with subtitle ancillary pages enabled as default option. The selection of subtitle ancillary pages shall be independent of the enabling of subtitle composition pages.

The user shall be able to select primary and secondary subtitling language.



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

The precision of the presentation of the subtitles shall be within 2 frames.

Note: If both DVB-subtitling and Teletext subtitling is received simultaneously the IRD shall only display the DVB-Subtitling stream.

#### 14.2.1 Subtitling subset

The NorDig II shall at least be capable of decoding the following DVB subtitling services:

- Object types: The handling of the object type (0x00) 'basic object, bitmap' shall be supported. The handling of the other object types (i.e. 0x01), 'basic object, character' and (0x02) 'composite object, string of characters') is optional.
- Regions: The number of regions shall be according to the ETS 300 743 [22] specification, however a limitation in the display area due to memory restrictions is allowed. The total number of regions to handle shall be able to cover four complete subtitle rows (per frame) where one subtitle row shall be extendable to 706 pixels \* 40 pixels. The regions shall have the possibility to cover 112960 pixels per frame.
- Number of objects: The number of objects shall be at least 128.
- CLUT: The NorDig II receiver shall be able to handle at least one colour look-up table (CLUT) with a minimum of 16 entries per region and the possibility to have one colour scheme applied in each of the regions.

It shall be possible to choose any 24-bit RGB colour into the 16 entries. The decoder shall be able to handle the mapping to the closest colour match if the decoder has some limitation in the colour presentation.

The use of the `non_modifying_colour` flag is optional.

- Transparency: The NorDig II receiver shall implement at least 5 levels of transparency; 0% (opaque), 30%, 50%, 70% and 100% (completely transparent). Implementation of additional intermediate levels of transparency is optional.

Where the MHP terminal cannot complement a particular value of semi-transparency it shall replace it with the nearest value of transparency it can implement.

However, if the encoded value of transparency is in the range 10%-90% it shall not be approximated as either 0% or 100% transparency.

So, 9% may be approximated as 0% but 10% shall be represented with a value in



the range 10% to 90%, such as 30%. Similarly, 91% may be approximated as 100%.

Number of streams: The receiver shall support at least 2 simultaneously DVB-subtitling streams.



## 15 Interfaces for Conditional Access

### 15.1 Use of the DVB Common Interface

#### 15.1.1 General

The DVB Common Interface can be used for conditional access and other purposes. See also section 9.3.

A conditional access (CA) module may be connected to one (of the) Common Interface(s) of the NorDig II (see section 9.3) in order to provide access control of the incoming services.

The CA-module will be connected to a security device (smart card) and provide the CA functions by use of the CI-functions specified in EN 50221 [13] and the additional functions specified as extensions below.

Each CI-slot of the NorDig II shall be in compliance with the Common Interface specification EN 50221 [13].

The NorDig II shall support at least one DVB Common Interface (for CA module) and should support at least one embedded CA-System.

### 15.2 Use of Smart Card Reader

#### 15.2.1 General

The smart card hardware with associated software can be used for conditional access and other purposes. This section will only consider use related to conditional access. See also section 9.4.

The NorDig II shall include at least two smart card readers, with interface as specified in section 9.4 and hardware/firmware for descrambling as specified in chapter 4. In addition there shall be filtering of ECM/EMM streams and program interfaces as specified below for conditional access.

#### 15.2.2 Application Level Interface for Conditional Access.

NorDig II shall support Interfaces for Conditional Access as defined in chapter 15 and in addition to this, NorDig II shall support the CA-application level interface, as specified in the DVB-MHP specification [3].

#### 15.2.3 ECM and EMM Filtering

The NorDig II shall implement ECM and EMM acquisition in accordance with ETR 289 [19].

The NorDig II shall be able to simultaneously acquire at least two ECM streams. The ECMs shall be filtered based on PID, TID and toggle bit.

The NorDig II shall be able to acquire EMMs from at least one EMM stream (one PID). The EMMs shall be filtered based on PID, TID and section address field. The section address field is CA system specific, and described as part of the smart card application interface. The IRD shall be able to filter on three TID and address field combinations simultaneously.



## 16 The Remote Control

### 16.1 Functions

The remote control for the NorDig II shall include the following functions:

#### 16.1.1 Numeric Entry

The NorDig II remote control shall include 10 digit keys, labelled 0-9.

#### 16.1.2 Basic TV Functions

The NorDig II remote control should include the following keys for basic TV functionality. If present, they shall have the following functionality:

- Power on/off – turns the IRD on and off
- Programme up/down – function to switch between programmes
- Volume up/down – function to adjust the volume output level
- TV – function that puts the IRD directly into conventional television state, i.e. only audio, video and subtitling

#### 16.1.3 Digital TV Functions

The NorDig II remote control shall include the following keys for digital TV functions:

- A navigation or pointing system for navigation on the OSD
- OK – a function that selects or confirms current choice or statement
- Multifunctional keys – four colour-coded keys for non-dedicated functions. The colours shall be red, green, yellow and blue
- Back – This function exits from the current menu or “page” and returns to the previous state.
- Text – This function displays the teletext as defined in section 14.1 or a Digital Super Teletext if present.

In addition the NorDig II remote control should include the following keys for digital TV functions:

- Navigator – this function starts the “Navigator”, as specified in chapter 13.
- Application – this function signals to the application that the user wants to interact with the default application that is connected to the current event.
- EPG/Guide – this function displays an Electronic Programme Guide.

#### 16.1.4 Design and Labelling

The manufacturer is free to modify the design of the remote control and the labelling of the Basic TV, "Navigator", "EPG" and "Application" -functions. All other functions should be labelled as in the conceptual illustration of the NorDig II remote control in Figure 16.1.

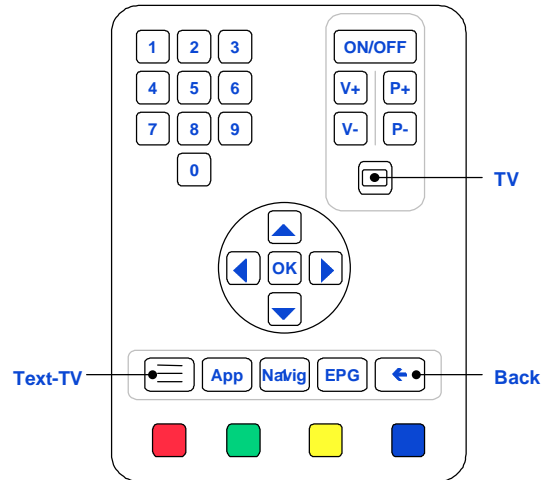


Figure 16.1 Conceptual illustration of the NorDig II remote control

### 16.1.5 Mapping of Key Events

The NorDig II shall generate events according to table 16.1 when a key is pressed on the NorDig II remote control.

Key	KeyEvent
0-9	VK_0 to VK_9
UP	VK_UP
DOWN	VK_DOWN
LEFT	VK_LEFT
RIGHT	VK_RIGHT
OK	VK_ENTER
TEXT	VK_F8
BACK	VK_F9
EPG	VK_F10
APPLICATION	VK_F11
RED	VK_COLORED_KEY_0
GREEN	VK_COLORED_KEY_1
YELLOW	VK_COLORED_KEY_2
BLUE	VK_COLORED_KEY_3

Table 16.1: Key Events



## 17 User Preferences

The user shall be able to store preferences in persistent memory. The following user preferences shall be implemented in the NorDig II.

- Video display preferences as defined in section 5.2.2 and 5.2.3.
- Audio preferences as defined in section 6.2.4 and 6.3.
- Primary and secondary audio language as defined in section 6.3.
- Primary and secondary subtitling language as defined in chapter 14.
- Service list as defined in section 13.2.



## Annex A: NorDig Members

The NorDig group represents per June 13, 2001 the following broadcasters, operators and service providers in the Nordic countries:

Danmarks Radio (DR)  
Tele Danmark  
TV2/Danmark

Helsinki Media

MTV3  
Sonera  
Yleisradio (YLE)

Ríkisútvarpið (RÚV)  
Landsími Íslands

Canal Digital  
Norsk Rikskringkasting (NRK)  
Norkring  
Telenor  
TV2 Norge

Canal+  
Modern Times Group (MTG)  
NSAB  
Scandinavian Broadcasting Service (SBS)  
Senda  
Sveriges Television (SVT)  
TV4 Sweden  
Telia  
Teracom



## Annex B: 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 [9]) 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).



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

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

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

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  $EPT$ :

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

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

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

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)



## Annex C: Subjective QEF Quality Measurement

The quality limit used in the NorDig II specification for the terrestrial front-end is QEF reception, where Quasi Error Free (QEF) means less than one uncorrected error event per hour. The definition of QEF is provided in EN 300 744 [9] and corresponds to  $BER = 10^{-11}$  at the input of the MPEG-2 demultiplexer. The quality must therefore be evaluated at the TS level, either directly by checking the correctness of the TS packets or indirectly by subjectively inspecting the video screen for a certain period of time and looking for errors in the decoded video. In the latter case the specified video test sequence ‘Mobile and calendar’ shall be used. This test sequence contains movement everywhere, in order to minimise the number of errors not being observed due to error concealment techniques in the receiver.

Direct measurements on the TS packets shall be the preferred measurement method, but if this is not possible, the subjective quality method shall also be acceptable. The subjective quality method does not require any access to MPEG-2 TS and will always be possible to perform.

The RS decoder can correct up to 8 erroneous bytes in a 204 byte RS code word. If there are 9 byte errors, or more, in a codeword, the RS decoder will just pass on the 188 bytes of the TS packet without trying to decode the errors. For each error event there will therefore be (on average) at least  $9 \times 188/204 = 8.3$  byte errors per erroneous TS packet. If these erroneous bytes contain on average 4.5 erroneous bits there are on average at least 37 bit errors per error event. With a BER of  $10^{-11}$  and a bit rate of 22 Mbit/s this corresponds to about 47 hours between error events.

In practice this means that using relatively short measurement periods, compared to 47 hours, such as e.g. 1 minute, any observed error during the measurement period makes it extremely likely that the receiver does not meet the quality requirement. However, there is always the possibility that the receiver in fact fulfils the requirement but the error event appeared during the measurement period just by coincidence (although this is very unlikely). However, in order to rule out the risks for false non-compliance the measurements are repeated three times, as soon as any error appeared during the first measurement, see below.

The measurement period for performance tests is 1 minute for objective and K times this for subjective measurements, where K is the ratio between the TS bit rate and the video bit rate. With TS bit rate being 22 Mbit/s and video bit rate being 5.5 Mbit/s, K equals 4 and the subjective measurement time is 4 minutes. If any error is discovered during the measurement period this is a strong indication of non-compliance. The measurement is then repeated three times, all of which should result in no errors. If any error is discovered in the second set of measurements, the receiver should be considered as having failed the test.

For tests that are not performance tests but functionality tests, the measurement period is reduced to 15 seconds for both objective and subjective measurements.