NorDig Unified Requirements

for

Integrated Receiver Decoders

for use in
cable, satellite, terrestrial and IP-based networks

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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, in addition it includes requirements for reception via IP-based networks. The specifications cover IRDs, both as separate units (set-top-boxes) and as relevant parts of integrated digital TV-sets.

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

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

The NorDig Unified Requirements were first issued in 2002 and include the profiles; ***Basic TV***, ***Enhanced, Interactive*** and ***Internet Access,*** in addition to the initial ***NorDig I*** profile. The NorDig Unified specification includes the NorDig I and NorDig II specifications, plus new requirements for the Basic TV, Enhanced Broadcast and Internet access profiles.

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

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

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

The ***NorDig Internet Access profile*** covers the NorDig requirements for interactive services that depend on a standardised Internet access, based on the DVB-MHP1.1 Internet Access profile. The Internet Access profile includes the NorDig Interactive profile as a subset.

The ***NorDig I profile*** covers the NorDig requirements for services that do not depend on a standardised application interface and a mandatory interaction channel. The NorDig I profile was created before a standard API had been recognised by a European standards institute. It is the intention of the NorDig members to migrate interactive services from the NorDig I to the NorDig Interactive (NorDig II) profile in order to achieve a common standardised API for the interactive services in networks controlled by the NorDig members.

The NorDig unified specification incorporates the NorDig II and NorDig I specifications, as explained in the document history below, see section 1.2. The NorDig Unified specification text relates to all profiles. All requirements specified in this document are mandatory unless otherwise specified. The NorDig Unified Requirements were updated in 2003 and now in 2004; some new requirements were introduced as options or as mandatory requirements after a specified grace period. The current issue therefore includes some requirements that will become mandatory after June 2005, and some new requirements that will become mandatory after June 2006, as indicated in the specification text.

NorDig has also specified NorDig Rules of Operation for NorDig compliant networks [43], and the Unified NorDig Test Specifications [44], in order to verify compliance with the NorDig Unified Requirements for new IRDs. These Rules of Operation and Test Specifications cover all NorDig profiles. **It should be noted that the NorDig I profile will be removed from these specifications**

after June 2005, after which date compliance with ther NorDig requirements will require full compliance with at least one of the remaining profiles (Basic, Enhanced, Interactive or Internet Acces)

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

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

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

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

The various members of NorDig are independent of each other but intend to transmit to IRDs that satisfy the specified common requirements. In order to ensure compliance with the NorDig requirements, the NorDig IRDs will be subject to a set of verification tests, based on NorDig Test Specifications [44].

Figure 1.1 indicates the relationships between the NorDig profiles and the various building blocks (except for NorDig I that is not shown).

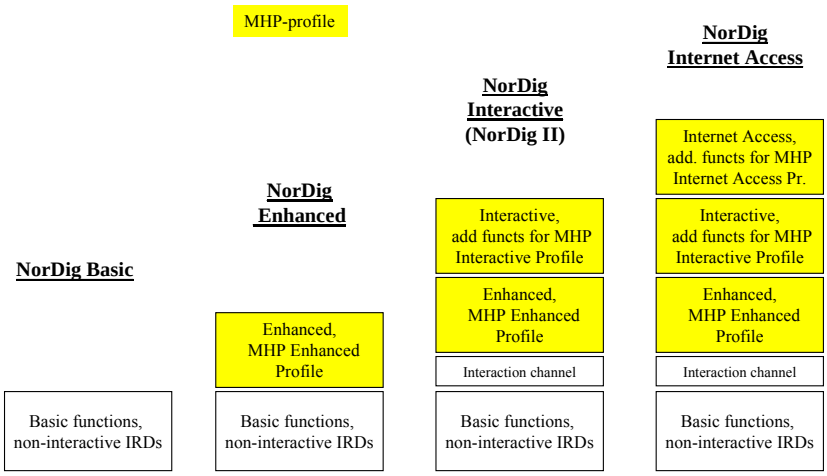

Figure 1.1The NorDig profiles and the building blocks (NorDig I not shown)

1.2 Document History

Version	Date	Comments
NorDig I ver. 1.1	12.05.98	This is the first approved version of the complete NorDig I specification
NorDig I ver. 1.3	01.03.01	Some editorial changes are performed, to bring the text in line with NorDig II (ver. 0.9). Some requirements are relaxed, when relaxed in NorDig II (ver. 0.9). Some new optional requirements are introduced in NorDig I that are mandatory requirements to NorDig II. References are updated to reflect the present status of the original references.
NorDig I ver. 1.4	01.10.2002	This update of the NorDig I specification is contained in the NorDig Unified, ver 1.0, see below. This update includes relaxation of some specifications, partly due to experience from testing of IRDs, but mainly in order to keep the same minimum requirements for non-interactive services as for the Basic TV profile. Some text is modified, in order to improve clarity and unify text for identical requirements in the NorDig I and NorDig II specifications. Furthermore, some additional parameters/descriptors are specified in sections 12 and 13, in order to bring the specification in line with NorDig II, ver.1.1. Some requirements will be increased to mandatory after a grace period; these increases are due to technical progress and satisfied by most IRDs sold in 2002.
NorDig II ver. 0.9	08.06.2000	This is the first approved version of the NorDig II specification, based on DVB-MHP-ver.1.0 until ver.1.1 becomes available
NorDig II ver. 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 and the text is modified for better clarity. In addition some relaxations in line with the NorDig I ver. 1.3 specification have been included.
NorDig II ver. 1.1	01.10.2002	This update of the NorDig II specification is contained in the NorDig Unified, ver 1.0, see below. This update includes relaxation of some requirements, partly due to experience from testing of IRDs, but mainly in order to keep the same minimum requirements for non-interactive services as for the Basic TV profile. Some text is modified, in order to improve clarity. Some requirements, mainly related to the terrestrial front-end will be increased to mandatory after a grace period; these increases are due to technical progress and operational experience.
NorDig Basic TV	01.10.2002	This is the first approved version of the NorDig Basic TV profile. The specification text is based on NorDig II, ver 1.0 and harmonised with NorDig II, ver. 1.1 when relevant. The specification text is a subset of the NorDig Unified, ver 1.0; see below.
NorDig Internet	01.10.2002	This is the first approved version of the NorDig Internet Access profile. It is based on the specification text for NorDig II, ver. 1.1, with necessary additions to include the DVB-MHP-Internet Access profile. The specification text is included in the NorDig Unified, ver 1.0; see below.
NorDig Enhanced	16.10.2002	This is the first approved version of the NorDig Enhanced profile. The specification text is based on NorDig II, ver 1.1 and harmonised with NorDig Basic TV when relevant. The specification text is a subset of the NorDig Unified, ver 1.0; see below.
NorDig Unified, ver. 1.0	16.10.2002	This is the first approved version of the NorDig Unified requirements for IRDs and includes requirements for all NorDig profiles; including Basic, Enhanced, NorDig I, Interactive (NorDig II) and Internet.

NorDig Unified, ver. 1.0.1	01.07.2003	This version includes updates of requirements that were introduced in version 1.0 with a grace period, and some new requirements with corresponding grace periods, mainly related to the terrestrial front-end, SI (chapters 12 and 13) and the user interface (chapters 16 and 17). Some text is modified in order to improve clarity.
NorDig Unified, ver. 1.0.2	30.4.2005	This version includes updates of requirements that were introduced in version 1.0.1 with a grace period, some new requirements and modifications of the mandatory CA-requirements (see section 15.1). The specification is also expanded to include requirements for IP-front-ends (provided as a separate addendum to this specification) and requirements for terrestrial front-ends in the VHF-band.

1.3 Terminology

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

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

1.4 Definitions

NorDig Basic TV
The NorDig Basic TV IRDs (hereafter denoted NorDig Basic) consist of a user terminal, including all possible low to high functionality implementations and its associated peripherals. NorDig Basic, ver 1.0 is specified as a subset of this unified NorDig-specification.

NorDig Enhanced
The NorDig Enhanced IRDs (hereafter denoted NorDig Enhanced) consist of a user terminal, including all possible low to high functionality implementations and its associated peripherals. NorDig Enhanced, ver 1.0 is specified as a subset of this unified NorDig-specification.

NorDig Interactive (NorDig II)
The NorDig Interactive IRDs (hereafter denoted NorDig Interactive or NorDig II) consist of a user terminal, including all possible low to high functionality implementations and its associated peripherals. NorDig II, ver 1.1 is specified as a subset of this unified NorDig specification.

NorDig Internet Access
The NorDig Internet Access IRDs (hereafter denoted NorDig Internet) consist of a user terminal, including all possible low to high functionality implementations and its associated peripherals. NorDig Internet, ver 1.0 is specified as a subset of this unified NorDig-specification.

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, ver 1.4 is specified as a subset of this unified NorDig-specification.

1.5 References

[1] Bluetooth 1.1 Specification of the Bluetooth system, v 1.1, February 2001, Bluetooth SIG.

[2] DVB A 011 Common Scrambling Algorithm. DVB Blue Book A011.

[3] 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. European Telecommunications Standards Institute ETSI.

[4] 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.

[5] 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.

[6] 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.

[7] EN 300 473 — Digital Satellite Master Antenna Television Distribution System (SMATV).

[8] EN 300 744 v1.4.1 — Digital Video Broadcasting (DVB); DVB Framing structure, channel coding and modulation for digital terrestrial television. European Telecommunications Standards Institute, ETSI.

[9] EN 50049-1 — Domestic and similar electronic equipment interconnection requirements: Peritelevision Connector

[10] 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.

[11] EN 50157-2-1 — Domestic and similar equipment interconnection requirements: AV.link-Part 2-1: Signal quality matching and automatic selection of source devices.

[12] EN 50221 — Common Interface for Conditional Access and other Digital Video Broadcasting Decoder Applications.

[13] EN 61319-1 — Interconnections of satellite receiving equipment - Part 1: Europe.

[14] ES 201 488 v1.1.1 — Data-Over-Cable Service Interface Specifications Radio Frequency Interface Specification

[15] 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.

[16] 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.

[17] 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.

[18] ETR 289	Digital Video Broadcasting (DVB); Support for use of scrambling and Conditional Access within digital broadcasting systems. European Telecommunications Standards Institute ETSI.
[19] ETS 300 012 – 11	Integrated Services Digital Network (ISDN); Basic User-Network Interface (UNI), October 1998.
[20] ETS 300 175	Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI).
[21] ETS 300 743 ed1	Digital Video Broadcasting (DVB): DVB Subtitling Systems. European Telecommunications Standards Institute ETSI.
[22] ETSI MHP Test Suite Version 1.0.2.b/1.0.3	MHP Test Suite Version 1.0.2.b, to be superseded by Version 1.0.3.
[23] ETSI TS 101 812 v1.1.3	Digital Video Broadcasting (DVB); Multimedia Home Platform (MHP) Specification version 1.0.3
[24] ETSI TS 102 006	DVB-Data: Data download specification
[25] ETSI TS 102 201 v1.1.1	Digital Video Broadcasting (DVB); Interfaces for DVB Integrated Receiver Decoder (DVB-IRD)
[26] ETSI TS 102 812 V1.1.1	Digital Video Broadcasting (DVB); Multimedia Home Platform (MHP) Specification 1.1.1.
[27] IEC 60169-2	Radio-frequency connectors, Part 2: Coaxial unmatched connectors.
[28] 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.
[29] IEC 60958	Digital audio interface.
[30] IEC 61883-1	Consumer audio/video equipment – Digital interface – Part1: General.
[31] IEC 61937	Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 [29].
[32] IEEE 1394	Standard for a high performance serial bus (IEEE1 Standard 1394-1995).
[33] IEEE 802.11	The Working Group for Wireless Local Area Networks (WLANs).
[34] IEEE 802.3	CSMA/CD (ETHERNET).
[35] ISO 3166 – Part 1-3	Codes for the representation of names of countries and their subdivisions: Part 1: Country codes, 1997 Part 2: Country subdivision code, 1998 Part 3: Code for formerly used names of countries, 1999
[36] ISO 8859-1	Information technology -- 8-bit single-byte coded graphic character sets -- Part 1: Latin alphabet No. 1, 1998
[37] ISO/IEC 13818 - 1	Information Technology - Generic Coding of Moving Pictures and Associated Audio Information. Part 1: Systems. ISO/IEC International Standard IS 13818.

[38] ISO/IEC 13818 – 3 — Information Technology - Generic Coding of Moving Pictures and Associated Audio Information. Part 3: Audio. ISO/IEC International Standard IS 13818.

[39] ISO/IEC 7816, 1-3 — Identification cards - Integrated circuit cards with contacts, Parts 1-3. ISO/IEC International Standard IS 7816.

[40] ITU/R Report 624-4 — Characteristics of Television Systems.

[41] ITU-R BT.653-3 — Teletext systems.

[42] ITU-T V.90 — Recommendation for V.90 modem

[43] NorDig RoO — NorDig Rules of Operation, ver 1.0, November , 2004

[44] NorDig Test — Unified NorDig Test Specification, ver. 1.0. November 2004.

[45] Universal Serial Bus — Universal Serial Bus (USB) Specification, Revision 2.0, April 27, 2000.

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
IDTV	integrated Digital TV
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
uimsbf	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 IRD

2.1 Introduction

This chapter describes the overall structure of the NorDig IRD 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 front-end, with a cable or satellite or terrestrial Tuner & Demodulator, or a front-end for IP-based networks, an input/output for the interaction channel (combined with the front-end for IP-based IRDs and thus only partly relevant for Basic IRDs), a Common Interface and a Smart Card Interface. These and other external interfaces are shown in Figure 2.2A.

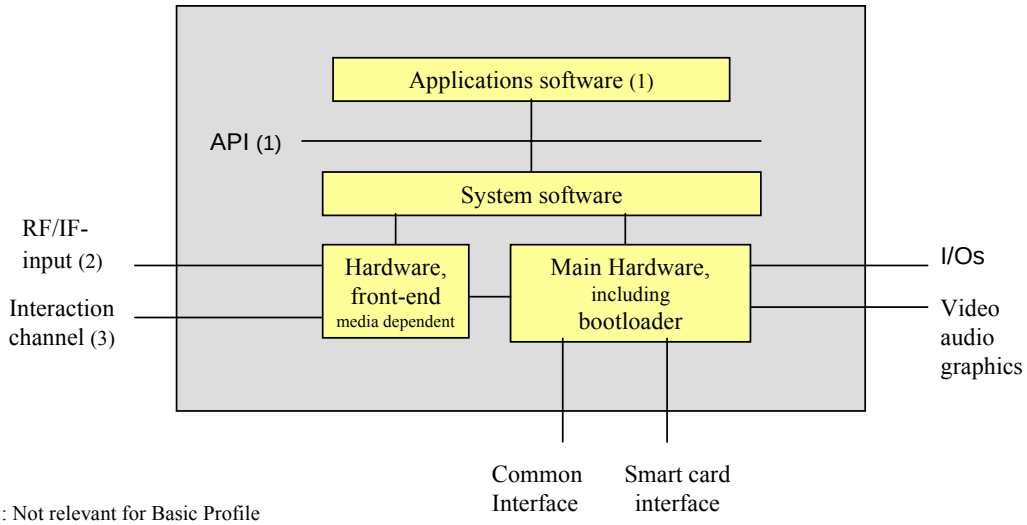

Figure 2.1 Basic IRD architecture

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 2.2A and Figure 2.2B. The IRD developer is free to decide on the hardware architecture as long as it fulfils the NorDig requirements for the relevant profile.

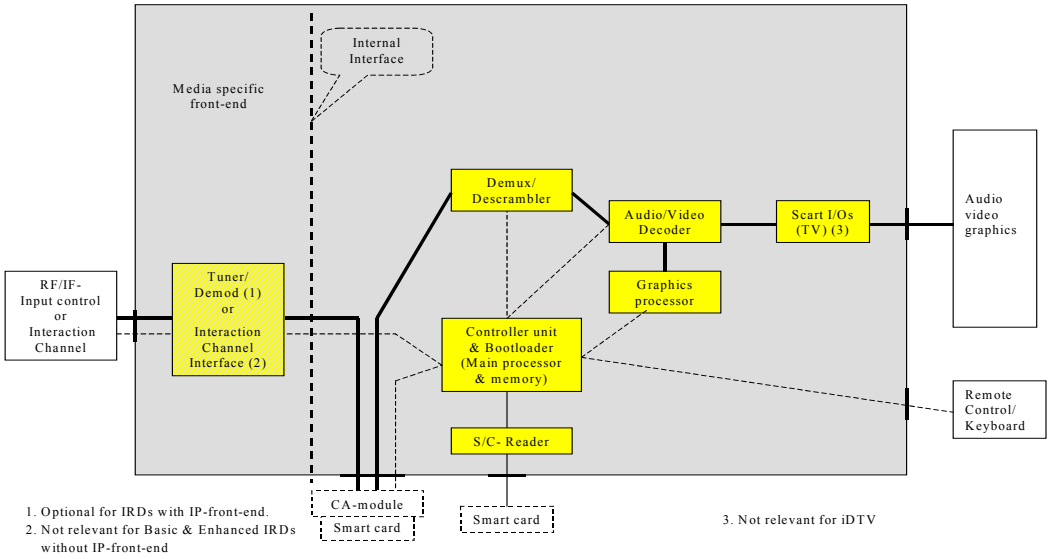

Figure 2.2A Functionality of Hardware and Firmware for NorDig IRD

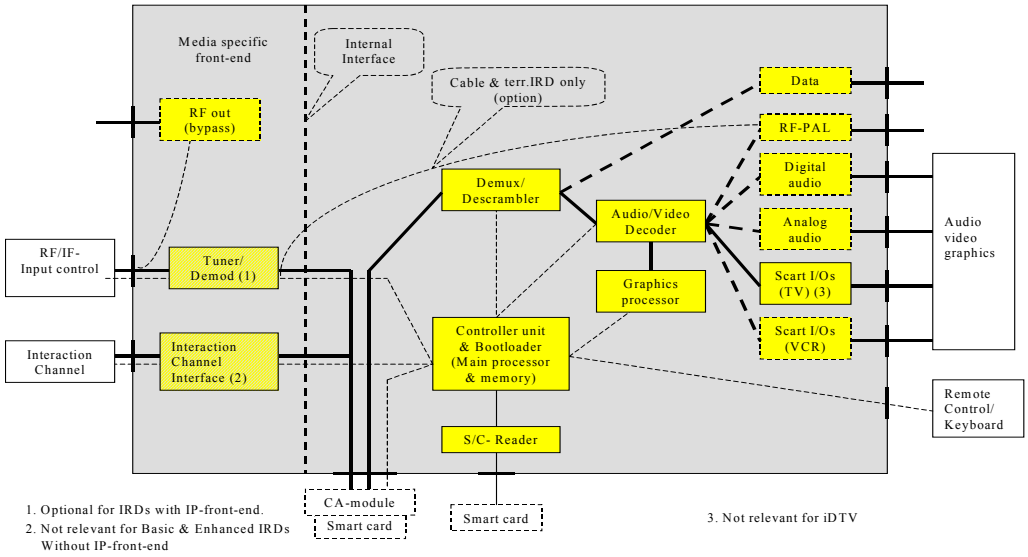

Figure 2.2B Functionality of Hardware and Firmware for NorDig Basic IRD

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 supplies power to it.

The RF-interface is not relevant for IRDs intended for IP-based networks, where the front-end functions are performed by the Interaction Channel Interface, see below.

All channel selections in the T/D blocks are controlled by the central Controller unit. See also chapter 3.

2.2.3 RFin-RFout Bypass (option)

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

2.2.4 Interaction Channel Interface

The interaction channel interface connects to the interaction channel. It allows the user to perform electronic ordering and request information services. See also section 9.3.

The interaction channel interface is not relevant for NorDig Basic and NorDig Enhanced IRDs with RF-interface and tuner demodulator. However, a corresponding two-way interface will act as front-end interface in case of IP-based networks, see section 9.3.

2.2.5 Demultiplexer

The demultiplexer block synchronises with the transport stream coming from the tuner/demodulator, the interaction channel (in case of IP front-end) 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.

2.2.6 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-PAL modulator. See also chapters 5 and 6.

2.2.7 Graphics Processor, OSD

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

2.2.8 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 section 7.2.

The Bootloader is a system software download capability, implemented as a firmware module independent of the system software. Initiated via the Navigator. See also section 7.2.

2.2.9 Common Interface and Plug-in CA Module

The 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 9.5.

2.2.10 Smart Card Interface(s) and Smart Card Reader(s)

The smart card readers allow external smart card(s) to be connected to the Controller unit. See also sections 9.4 and 15.3.

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

SCART interfaces (one SCART interface for TV-sets (1) and a second SCART interface for VCR (2). See also section 9.6.

Note 1: Not relevant for iDTV. Note 2: Optional

2.2.13 Analogue Audio Interface (option)

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

2.2.14 Digital Audio Interface (option)

One digital audio output interface. See also section 9.7.

2.2.15 Data Interface (option)

One Data interface. See also section 9.8.

Note: NorDig IRDs with IP-based front-end should support one local data interface (in addition to the front-end interface).

2.2.16 RF-PAL Modulator (option)

An internal AM-DSB modulator and PAL encoder (not shown in Figure 2.1) 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 software may contain two main parts, system software and applications (not relevant for NorDig Basic). The system software shall provide two main sets of functions. One set is accessible within the system software only and includes functions for control of hardware/firmware and handling of service information. Another set is available internally and externally for applications, and constitutes the Application Programming Interface, API (not relevant for NorDig Basic). 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.

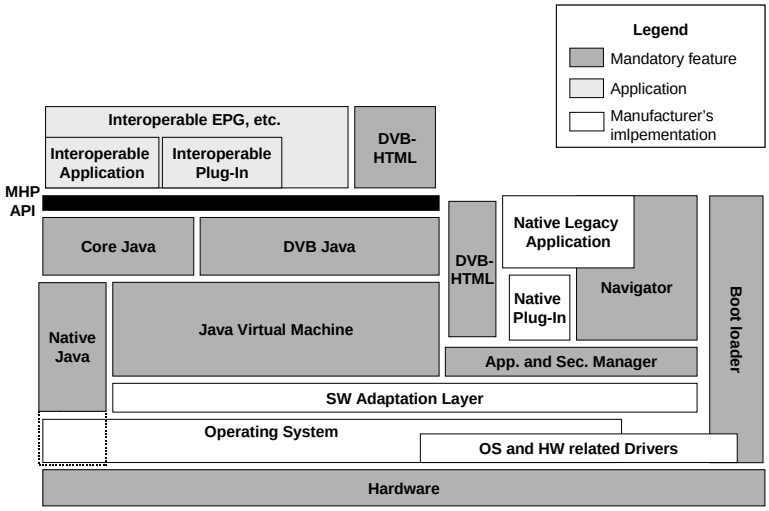

Figure 2.3 A: Possible software structure of a NorDig II IRD

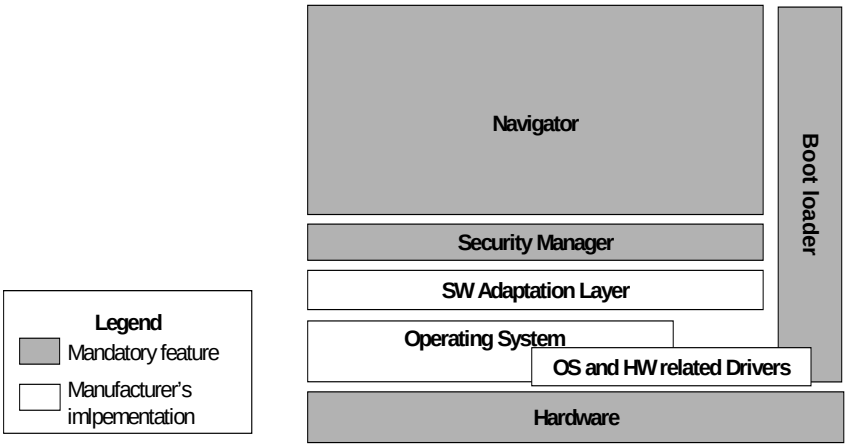

Figure 2.3 B: Possible software structure of a NorDig Basic IRD.

Figure 2.3 A illustrates only an example of the NorDig IRD interactive software structure, while figure 2.3B illustrates the software structure for a NorDig Basic IRD. The IRD manufacturers are free to implement system the way they want as long as it fulfils the NorDig IRD specification.

2.3.3 System Software

The NorDig IRD includes a System Software in compliance with DVB specifications, i.e. APIs, PSI/SI (1), Navigator, teletext, subtitling and Common Interface. The system software can be completely upgraded via the bootloader (2).

Note 1:	The NorDig IRD with an IP-based front-end will be based on a modified use of the DVB service information (SI), see chapter 12 and Annex D.
Note 2:	The bootloader is by definition a part of the hardware/firmware.

2.3.4 NorDig APIs

The NorDig IRD includes an open API in compliance with the DVB MHP APIs (not relevant for NorDig Basic and NorDig I).

PART A: Hardware and firmware

3 The Frontend of the NorDig IRD

3.1 Common Features

3.1.1 General Features

The NorDig IRD shall contain at least one Tuner/Demodulator for cable or one for satellite or one for terrestrial DVB/MPEG 2 signals, or an interface for reception of corresponding signals from IP-based networks, see section 3.5

3.1.2 Common Scanning Procedures

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

Note: Frequency scanning is not relevant for NorDig IRDs with IP-based front-end.

3.1.3 Quality Reception Detector

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

3.2 Satellite Tuner and Demodulator

3.2.1 General

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

The NorDig IRD should have an RF[1]-bypass (RF_{in} - RF_{out}). 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 [3]. The NorDig IRD 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.

The NorDig IRD 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 IRD 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 [7]) the tuning data given in the NIT may not be valid. In such cases is should be possible to select a tuning procedure

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[1] In this specification RF_{in} means the input to the IRD, unless otherwise specified.

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 [17]. Such information shall be decoded and used for updating the service list. See also section 13.2.

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 [13], 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 [3].

3.2.7 Satellite Tuner Interface and Signal Levels

3.2.7.1 RF Input Connector

The NorDig IRD shall include one input connector, type: IEC 60169-2 [27], F-type, female, 75 ohms.

3.2.7.2 RF Output Connector (option)

The NorDig IRD should include one output connector, type: IEC 60169-2 [27], 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 IRD 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 IRD 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 400 mA
- control tone: amplitude: 0.65 V +/- 0.25V
  frequency: 22 kHz
  duty cycle: 50% +/- 10%

(see also ref EN 61319-1 (DiSEqC) [13].

3.2.8 Performance

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

The NorDig IRD IF back/back error performance for a single carrier shall comply with the requirements given in EN 300 421 (section 5) [3].

The NorDig IRD 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 IRD itself is measured).

The NorDig IRD 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·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 IRD 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 IRD 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 IRD 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 IRD 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.

Analogue PAL television signals using AM-VSB modulation are specified in ITU/R Report 624-4 [40], standards PAL-B, PAL-G.

The NorDig IRD shall be able to operate flawless in a CATV network specified in accordance to EN 50083 [10].

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 should include 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 IRD 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 [27], female, 75ohms
Input level:	Digital signals	47 - 70 dBµV at 75 Ohms

	Analogue signals	57 - 80 dBµV 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 IRD shall either use the NIT information or the scanning procedure for retrieving the services available on the cable network.

In general the NorDig IRD 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_other is transmitted, this shall be treated as described in section 12.2.

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_{in} to RF_{out}

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

The signal level at RF_{out} shall be less than 2 dB below and less than 1 dB above the signal level at the RF_{in}, 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 have a BER performance better than 10^{-4} for the C/N ratios specified below for all specified input levels:

QAM:	C/N:
256	32.5 dB
128	29.5 dB
64	26.5 dB
16	20.5 dB

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^{-7}.

Note: For C/N measurement the reference noise bandwidth is 8 MHz

The performance shall be measured under the following conditions:

1. In any CATV-network confirming to EN 50083 [10] with at least a flat 42 analogue channel loading confirming to EN 50083 [10] 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-off (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

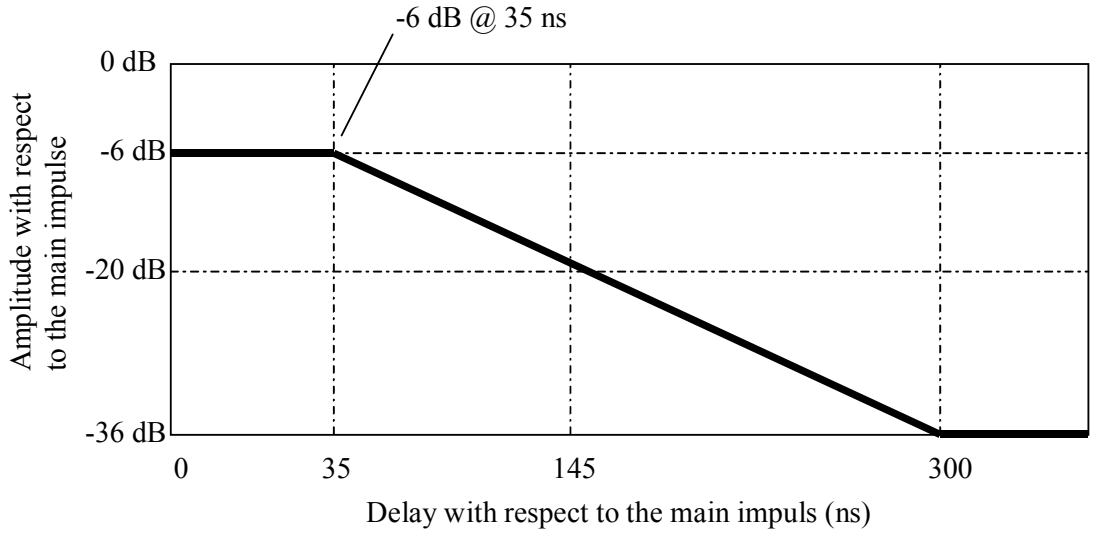


Figure 3.1: Template for echoes

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 IRD shall include one tuner/demodulator for reception of signals from terrestrial transmitters, broadcasting in accordance with EN 300 744 rev R1.4.1 [8].

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).

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

3.4.2 Frequencies and Signal Bandwidths

3.4.2.1 General

The NorDig IRD shall be able to receive channels in the VHF band III (1) and UHF bands IV, V and should be able to receive channels in VHF S band I, VHF S band II, UHF S Band III (see Table 3.1).

	Band	Frequency range	Requirement
VHF	*VHF I*	*47 – 68 MHz*	*N/A*
	S Band I	104 – 174 MHz	Optional
	VHF III	174 – 230 MHz	Mandatory (1)
	S Band II	230 – 300 MHz	Optional
UHF	S Band III	300 – 470 MHz	Optional
	UHF IV	470 – 606 MHz	Mandatory
	UHF V	606 – 862 MHz	Mandatory

Table 3.1 Mandatory and optional frequency bands

Note 1: Reception from the VHF band III will become mandatory for IRDs that are released after 1 July 2006. Reception from other VHF bands is optional.

3.4.2.2 Center Frequencies

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

8 MHz raster:

f_c = 114 MHz +K * 8 MHz, where

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

7 MHz raster:

f_c = 107.5 MHz + L * 7 MHz, where

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

Note 1: 8 MHz raster is mandatory for the UHF-bands. 7MHz band will become mandatory for VHF band III after 1 July 2006. 8 MHz raster for VHF is optional.

3.4.2.3 Maximum Frequency Offset

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

Note 1: NorDig IRDs that are released before 1 July 2006 the requirement is 10 kHz.

3.4.2.4 Signal bandwidths

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

VHF Bands:

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

UHF Bands:

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

Note 1: Reception from the VHF band III will become mandatory for IRDs that are released after 1 July 2006. Reception from other VHF bands are optional.

3.4.3 Modes

The NorDig IRD terrestrial front-end shall be capable of correctly demodulating all non-hierarchical modes specified in EN 300 744 [8]. The front-end shall therefore be able to work with any combination of constellation (QPSK, 16-QAM or 64-QAM), code rate (1/2, 2/3, 3/4, 5/6 or 7/8), guard interval ($T_U/4$, $T_U/8$, $T_U/16$ or $T_U/32$) and transmission mode (2K or 8K). The receiver shall automatically detect which mode is being used.

The NorDig IRD should be able to receive the hierarchical modes in the DVB-T specification, see Annex B3.

3.4.4 Tuning/Scanning Procedures

3.4.4.1 General

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

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

3.4.4.2 Status check: Basic

The IRD shall (1) provide at least a basic status check function (accessible through the Navigator) that presents reception quality information for a selected service (currently viewed by the user).

The basic status check should be presented on the OSD and shall include:

- channel id (or centre frequency)
- signal strength indicator and
- reception quality indicator

with the classification “poor/fair/good” for the indicators e.g. displayed as bars.

The algorithm to calculate the reception quality could be based on a combination of C/N and BER. The signal strength and quality reception indicators should be updated continuously (e.g. every second) in order to simplify the antenna installation.

3.4.4.3 Status check: Advanced

The IRD should provide an advanced status check function that presents the following information on the IRD OSD:

- channel id (or centre frequency)
- signal strength (dBµV)
- C/N (dB)
- BER (including information if the current value is classified as “poor/fair/good” for reception)

In addition, it is recommended that also the following information can be presented:

- code rate
- guard interval
- transport stream id
- original network id
- network id
- service id

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

3.4.4.4 Installation mode: Automatic Search, best service

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

The IRD shall only display a service once in the service list (i.e. avoiding duplicate of the same services), even if the same service (same triplet original_network_id, transport_stream_id and service_id) is received from multiple transmitters. If the same service can be reached from several transmitters the one with best quality criterion of RF-channel should be chosen. The criteria to select transport streams should be based on the reception quality, using a combination of C/N ("signal strength") and signal quality (e.g. BER, CSI (Channel state information)).

During the scanning procedure it is recommended that the IRD use, for each supported VHF/UHF channel, the priority defined in Table 3.2, to speed up the scanning process.

Priority order*	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Parameters *FFT mode* *Guard Interval*	*8K* *1/8*	*8K* *¼*	*8K* *1/16*	*8K* *1/32*	*2K* *1/8*	*2K* *¼*	*2K* *1/16*	*2K* *1/32*

*Priority order 1 has highest priority.

Table 3.2 Priority order for parameters used at each channel

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

3.4.4.5 Installation mode: Manual Search

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

It is recommended that the graphical interface for the manual search make it easy for the end user to perform consecutive manual searches without too much effort."

3.4.5 Changes In Modulation Parameters

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

The NorDig IRD shall have one input tuner connector, type: IEC female in accordance with IEC 60169-2, part 2 [27]. The input impedance shall be 75 ohm.

If the RF input supports DC power to an external antenna with amplifier, it shall not degrade to the performance of the RF input characteristics. The DC power supply shall be protected against short circuit. Furthermore, there shall be an alternative in the menu system to turn the DC power supply source on/off. In the first time initialisation and resetting to factory default settings, the DC power supply shall be switched off, see chapter 17.3.

3.4.7 RF Output Connector (option)

For a NorDig IRDs equipped with a RF bypass (RF_{in} - RF_{out}), the connector shall be of type: IEC male in accordance with IEC 60169, part 2 [27]. The frequency range for the RF bypass should be from 47 MHz to 862 MHz and the RF bypass gain should be from –1 dB to +3 dB.

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

Note:	The RF Output Connector could be combined with the connector for RF-PAL Output, see section 9.2.

3.4.8 Performance

3.4.8.1 Definitions

The performance requirements used in this section (3.4.8) are referring to the QEF definition provided in EN 300 744, where Quasi Error Free (QEF) means less than one uncorrected error event per hour. This requirement corresponds to BER = 10^{-11} at the input of the MPEG-2 multiplexer, and the details of how this requirement shall be measured is provided in Annex C.

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

The carrier-to-noise (C/N) ratio and minimum receiver signal input level ($P_{min)}$ values in tables 3.1 and 3.2 are specified for two profiles:

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

Profile 2: The wanted signal (C) includes the direct path signal and an echo. The echo has the same power (0 dB echo) as the direct path signal and is delayed from 1.95 µs to 0.95 times the guard interval length and has 0 degree phase at the channel center.

3.4.8.2 C/N Performance

The NorDig IRD shall have a QEF performance for the C/N ratios given in Table 3.3, or better performance.

		C/N performance (dB)	
Modulation	**Code rate**	**Profile 1 : Gaussian**	**Profile 2 : 0 dB echo**
QPSK	1/2	5.1	8.8
QPSK	2/3	6.9	13.7
QPSK	3/4	7.9	15.4
QPSK	5/6	8.9	-
QPSK	7/8	9.7	-
16-QAM	1/2	10.8	13.3
16-QAM	2/3	13.1	17.9
16-QAM	3/4	14.6	22.1
16-QAM	5/6	15.6	-
16-QAM	7/8	16.0	-
64-QAM	1/2	16.5	19.0
64-QAM	2/3	18.7	23.2
64-QAM	3/4	20.2	27.6
64-QAM	5/6	21.6	-
64-QAM	7/8	22.5	-

Table 3.3 Maximum required C/N for QEF reception at TS output (with 1/4 guard interval and FFT size 8K) for profiles 1 and 2

Note: For NorDig IRDs that are released before July 2005, the above requirements for code rates ¾ are optional in profile 2.

3.4.8.3 Minimum Receiver Signal Input Levels

The NorDig IRD shall have a noise figure (NF) for supported frequency ranges better than:

	Band	Noise Figure (NF)
VHF	S Band I	10 dB
	VHF III	5 dB
	S Band II	10 dB
UHF	S Band III	10 dB
	UHF IV	8 dB (1)
	UHF V	8 dB (1)

Table 3.4 Maximum noise figures

Note 1: The Noise Figure (NF) should be better than 7 dB in the UHF IV and V bands

The NorDig IRD shall have at least the performance for the signal input levels for the supported frequency range and should have a performance which is one dB better than specified in Table 3.5.

The NorDig IRD shall provide QEF reception for the minimum signal levels (P_{min}) stated below.

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

For 8 MHz DVB-T signal: P_{min} = -105.2 dBm+NF [dB]+ C/N [dB], where

C/N is specified in Table 3.3 and NF is as above specified.

(delay = 1.95 µs to 0.95 times the guard interval, 0 degree phase at channel centre)

		Minimum input level (dBm)					
		Profile 1: Gaussian				Profile 2: 0 dB echo	
Frequency band		VHF Band III	VHF S Band I & II	VHF S Band I & II and UHF S Band III	UHF Band IV&V	VHF Band III	UHF Band IV&V
Modulation	Code Rate	7 MHz signal	7 MHz signal	8 MHz signal	8 MHz signal	7 MHz signal	8 MHz signal
QPSK	1/2	-94.6	-90.6	-90.1	-92.1	-90.9	-88.4
QPSK	2/3	-92.8	-88.8	-88.3	-90.3	-86.0	-83.5
QPSK	3/4	-91.8	-87.8	-87.3	-89.3	-84.3	-81.8
QPSK	5/6	-90.8	-86.8	-86.3	-88.3	-	-
QPSK	7/8	-90.0	-86.0	-85.5	-87.5	-	-
16-QAM	1/2	-88.9	-84.9	-84.4	-86.4	-86.4	-83.9
16-QAM	2/3	-86.6	-82.6	-82.1	-84.1	-81.8	-79.3
16-QAM	3/4	-85.1	-81.1	-80.6	-82.6	-77.6	-75.1
16-QAM	5/6	-84.1	-80.1	-79.6	-81.6	-	-
16-QAM	7/8	-83.7	-79.7	-79.2	-81.2	-	-
64-QAM	1/2	-83.2	-79.2	-78.7	-80.7	-80.7	-78.2
64-QAM	2/3	-81.0	-77.0	-76.5	-78.5	-76.5	-74.0
64-QAM	3/4	-79.5	-75.5	-75.0	-77.0	-72.1	-69.6
64-QAM	5/6	-78.1	-74.1	-73.6	-75.6	-	-
64-QAM	7/8	-77.2	-73.2	-72.7	-74.7	-	-

Table 3.5 Minimum signal input levels (Pmin) for QEF reception at TS output (with 1/4 guard interval and FFT size 8K) for profiles 1 and 2.

Note: For NorDig IRDs that are released before July 2005, the above requirements for code rates ¾ are optional in profile 2.

3.4.8.4 Maximum Receiver Signal Input Levels

The receiver shall provide QEF reception for DVB-T signals up to a level of –35dBm.

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

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

3.4.8.5 Immunity to “analogue” signals in Other Channels

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

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

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

3.4.8.6 Immunity to "digital" signals in Other Channels

The NorDig IRD shall, for the supported frequency ranges, permit an interfering DVB-T signal with a minimum interference to signal level ratio (I/C) as stated in the Table 3.6 while maintaining QEF reception.

Band	Signal Bandwidth MHz	Channel frequency raster MHz	Minimum I/C (dB)		
			Adjacent channels	Other Channels (1)	Image channel
VHF S Band I	7	7	20	25	-
	8	8	20	25	-
VHF III	7	7	28	38	-
	8	8	28	38	-
VHF S Band II	7	7	20	25	-
	8	8	20	25	-
UHF S Band III	8	8	20	25	-
UHF IV	8	8	28	38	28
UHF V	8	8	28	38	28

Table 3.6 Minimum required I/C for QEF reception with interfering DVB-T signal on the adjacent, other and image channels

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

Note 1: The requirements for "Other channels" are optional for NorDig IRDs that are released before July 2006.

3.4.8.7 Immunity to Co-Channel Interference From Analogue TV Signals

The sensitivity for interference from analogue TV is specified as the minimum carrier to interference ratio, C/I, required for a QEF reception. The NorDig IRD shall perform better than specified in Table 3.7 when a 8 MHz DVB-T signal is exposed to interference from a co-channel G/PAL signal including video with teletext, an FM sound and a NICAM sub carrier as specified above (see section 3.4.8.5).

Constellation	64QAM	
Code rate	2/3	3/4
CEPT mode	C2	C3
C/I	3 dB	7 dB

Table 3.7 Carrier to Interference, C/I (dB) for QEF, when interfered by analogue TV carrier

3.4.8.8 Performance In Time-Varying Channels

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

The increase in required C/N for QEF reception shall be less than 3 dB for a 0 dB echo with frequency separation equal to 20 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 10 Hz (after AFC), compared to a 0 dB echo with frequency separation equal to 1 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 0.5 Hz (after AFC). The requirements in this paragraph refer to the modes {8K, 64-QAM, R=2/3, Δ/Tu =1/8} and {8K, 64-QAM, R=2/3, Δ/Tu =1/4}.

The increase in required C/N for QEF reception shall be less than 3 dB for a 0 dB echo with frequency separation equal to 10 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 5 Hz (after AFC), compared to a 0 dB echo with frequency separation equal to 1 Hz and a delay of 20 µs, corresponding to a Doppler shift of +/- 0.5 Hz (after AFC). The requirement in this paragraph refer to the mode {8K, 64-QAM, R=3/4, Δ/Tu =1/4}.

Note:	For NorDig IRDs that are released before July 2005, the above requirement for the mode {8K, 64-QAM, R=3/4, Δ/Tu =1/4} is optional.

3.4.8.9 Synchronisation for varying echo power levels in SFN

For the modes {8K, 64-QAM, R=2/3, Δ/Tu=1/8}, {8K, 64-QAM, R=2/3, Δ/Tu =1/4} and {8K, 64-QAM, R=3/4, Δ/Tu =1/4}, the required C/N value (specified in Table 3.8 below) for subjective error free reception shall (1) be obtained when the channel contains two paths with relative delay from 1.95 µs up to 0.95 times guard interval length and the relative power levels of the two paths are dynamically varying including 0dB echo level crossing. The C/N value is defined at 0 dB level crossing.

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

Table 3.8 Maximum required C/N for subjective error free reception with dynamically varying echo power levels

Note 1: Optional for NorDig IRDs that are released before July 2006.

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

If there exists one or more FFT window positions for the time synchronisation that will give an aggregate available C/(N+I) larger than or equal to the required EPT (Effective Protection Target), the NorDig IRD shall be able to find one of these positions, independently of echo profile. The NorDig IRD shall also be able to correctly equalise the signal for echoes up to $7T_U/24$ (for 7 MHz DVB-T signal up to 298 µs and for 8 MHz DVB-T signal up to 260 µs) (Interval of correct equalisation), independently of the echo profile. See also Annex B1.

For the modes {8K, 64-QAM, R=2/3, Δ/T_u=1/8}, {8K, 64-QAM, R=2/3, Δ/T_u =1/4} and {8K, 64-QAM, R=3/4, Δ/T_u =1/4}, the required C/N value for profile 2 (specified in Table 3.3) for QEF reception shall be obtained when the channel contains two static paths with relative delay from 1.95 µs up to 0.95 times guard interval length, independently of the relative amplitudes and phases of the two paths.

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

For echoes outside the guard interval, for 8 MHz DVB-T signal, QEF reception shall be possible with echo levels up to the values defined in Table 3.9.

For echoes outside the guard interval, for 7 MHz DVB-T signal, QEF reception shall be possible with echo levels up to the values defined in Table 3.10.

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

Table 3.9 QEF reception for echoes outside the guard interval, for 8 MHz DVB-T signal

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

Table 3.10 QEF reception for echoes outside the guard interval, for 7 MHz DVB-T signal.

Note 1: The following requirements are optional for NorDig IRDs that are released before July 2005: required performance for C/N for codes rates ¾ in profile 2 and echoes outside the guard interval.

3.5 IP Based Front-End

(Front-end for IP-based networks, see separate Addendum)

4 MPEG-2 Demultiplexer

4.1 General

The Demultiplexer shall be compliant to the MPEG-2 transport layer defined in ISO/IEC 13818-1 [37]. The NorDig IRD shall support ETR 154 [15] and the additional requirements stated below:

- The NorDig IRD shall utilise the MPEG-2 Service Information as specified in Part B.
- The NorDig IRD shall interpret the CA descriptor as defined in ETR 289 [18].
- The NorDig IRD shall be able to decode an ISO/IEC 13818-1 [37] 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 IRD shall be capable to utilise at least 32 elementary streams simultaneously, which requires 32 PID filters.
- The NorDig IRD shall provide at least 32 section filters.

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

- The NorDig IRD shall use the video stream descriptor to recognise still picture data.
- The NorDig IRD 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 15.3.2 (ECM and EMM Filtering). It shall (1) be able to descramble on transport level and on PES format. The NorDig IRD shall (1) 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 1: See section 15.1 The DVB descrambler is mandatory for IRDs with a mandatory smart card interface for conditional access.

Note 2: 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 ± 10 µs.
- 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) [15].

The video decoder shall (1) be able to decode at bit rates down to 1.0 Mbps for video resolutions up to full resolution video (720x576).

Note 1: This requirement is optional for IRDs that are launched before 1 July 2006

5.2 Constraints and Extensions

This section sets out the requirements to the NorDig IRD in addition to the DVB requirements expressed by ETR 154 [15].

5.2.1 Active Format Description

The NorDig IRD should be able to support usage of the Active Format Description (AFD) as defined in the ETR 154 [15].

5.2.2 Display Mode for 16:9 Material on 4:3 Monitors

The viewer shall be able to choose at least one of 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 when this mode is present).
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 when this mode is present. 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 IRD shall signal 4:3 material as specified in section 9.6 for SCART signalling and equivalent for iDTV.

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 IRD 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 full input resolution (720x576, 544x576, 480x576, 352x576 or 352x288 pixels) to 1/4 respective 1/16 of displayed screen size (360x288 and 180x144) shall(1) be implemented.

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

Note 1: Not relevant for NorDig Basic. Optional for NorDig I Note 2: 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 full input resolution (1) (720x576, 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.

Note 1: Up-conversion to other values than full 720x576 is optional for NorDig Basic

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 IRD (1) 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.

Note 1: Recommended for NorDig Basic and NorDig I

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 [15].

6.2 Constraints and Extensions

6.2.1 Audio Video Synchronisation

The NorDig IRD shall provide at least one audio decoder that is able to meet the minimum decoding requirements, which is set out in ETR 154 [15]. Additionally, receivers shall not introduce more than ± 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 [15].

6.2.3 Multichannel Audio (option)

The NorDig IRD should be able to output an audio stream as non-PCM encoded audio to the digital audio interface (se section 9.7) according to IEC 61937 [31] if there is a Dolby Digital (AC-3) or MPEG2 BC (ISO/IEC 13818-3 [38]) stream present for the chosen service in the incoming transport stream.

The AC-3 multi-channel audio decoding should, when present, be decoded to a stereo down-mix of the format indicated in the Dolby Digital metadata, e.g. to a Dolby Surround ProLogic compatible stereo down-mix (Lt/Rt signal) or to a normal stereo down-mix (Lo/Ro signal) and should be fed to the (stereo) analogue output connectors (SCART and chinch).

The choice and priority between MPEG-1 Layer II audio and Dolby Digital (AC-3) for the analogue outputs shall then be as specified in section 6.2.4 point 1 and 2 (defined for digital output). When Dolby Digital (AC-3) audio is present, it is recommended to show a visual indication.

6.2.4 Digital Audio Output (option)

The digital audio output as defined in section 9.7 shall always give either a valid PCM-output according to IEC 60958 [29] or a non-PCM encoded audio bit-stream according to IEC 61937 [31]. 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 [29] (Part1 General, Part 3 Consumer).
2. Non-audio-data output according to IEC 61937 [31] when present -and if not present output PCM according to IEC 60958 [29]. 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 IRD shall, when the digital audio output function is present, 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 [31] 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 IRD should to be able to A/D-convert incoming analogue audio signals (e.g. VHS) and output them to the digital audio interface (se section 9.7).

6.2.5 Half Sampling Rates

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

6.3 Applications

The NorDig IRD shall be able to read and use the ISO 639 language descriptors associated with the audio-streams in the ISO/IEC 13818-1 [37] 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 IRD 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 IRD 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 [5], see chapter 12. The NorDig IRD 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 IRD are:

- The NorDig IRD shall have a real time clock/calendar running continuously. The clock shall be updated by incoming TDT and TOT from SI.
- The NorDig IRD 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 IRD 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

7.1.2.1 NorDig Basic and NorDig I

Not specified for NorDig Basic TV and NorDig I.

7.1.2.2 NorDig Enhanced, Interactive (NorDig II) and Internet Access

The NorDig should be performing well with the applications that are developed based on the DVB-MHP API [26] specifications.

7.1.3 Memory

7.1.3.1 NorDig BasicTV

Not specified for NorDig Basic TV.

7.1.3.2 NorDig I

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

- 4 Mbytes RAM
- 2 Mbytes video RAM
- 4 Mbytes Flash memory

7.1.3.3 NorDig Interactive (NorDig II) and NorDig Enhanced

The minimum memory configuration for the NorDig Enhanced and Interactive IRDs shall be:

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

7.1.3.4 NorDig Internet Access

The minimum memory configuration for the NorDig Internet IRD is not specified.

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

7.2 The Bootloader (System Software Update)

7.2.1 Introduction

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

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

Note 1: See section 15.1. Replacement of CA-system software is mandatory for IRDs with a mandatory smart card interface for conditional access.

The actual upgrade of NorDig IRD software shall be initiated by the user. The NorDig IRD 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 IRD 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 IRD.

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 IRD.

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

NorDig shall provide a download mode based on broadcast over-the-air/via in-network channel, and should provide a mode for download over the local data interface when such local interface is implemented.

7.2.2 Over-the-air/in-network via Broadcast Download

The NorDig IRD 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. One of the following formats shall be used:

1. DVB Data Download streams
2. NorDig Bootload streams

In case of (1) the PSI and SI signalling shall be as specified in ref [24]

In case of (2) the PSI and SI signalling of the system software download shall be as specified in chapter 12.

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

The software download mechanism (as defined in section 7.2.1) shall check availability of new system software either when the box enters (recommended) or leaves stand-by mode. If new software version is available the actual upgrade shall be initiated by the user, as specified in section 7.2.1. It is recommended that the user preferences and service lists stored in the IRD will not be affected (i.e. not deleted) by an update of system software.

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

7.2.3 Local Download

Download should be possible using a local data interface. The NorDig IRD 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:

8.1 NorDig Basic and NorDig I

i. Support resolutions of 720 by 576 pixels and lower.
ii. Support at least one colour look-up table (CLUT) with a minimum of 16 entries including transparency. It should be possible to choose any 24-bit RGB colour into the 16 entries.
iii. Support 2 logical display planes:
   - Video plane for full screen MPEG video.
   - Graphic plane for graphics (used for menus, teletext, DVB sutitling ,etc.)
iv. Support blending of the graphics with video or stills backgrounds. At least 5 levels of transparency shall be provided (0%, 30%, 50%, 70%, 100%).
v. Support aspect ratios as set in the installation setting (at the SCART 1 interface, or equivalent for iDTV), see chapter 17.

8.2 NorDig Enhanced, Interactive (NorDig II) and Internet Access

i. Support resolutions of 720 by 576 pixels and lower.
ii. 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 [26] specification.

Note: 16 bits colour resolution is recommended.

iii. 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 planes.
iv. Support blending of the graphics with video or stills backgrounds. At least 5 levels of transparency shall be provided (0%, 30%, 50%, 70%, 100%).
v. Support aspect ratios as set in the installation setting (at the SCART 1 interface, or equivalent for iDTV), (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 IRD should have an RF-bypass ($RF_{in} - RF_{out}$)

The NorDig IRD with embedded cable or terrestrial tuner should have an additional path for analogue signals. This path includes the tuner function and a VSB demodulator (option), a combiner for mixing of composite PAL video with on screen display graphics (from stored data in NorDig IRD), 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 (option)

The NorDig IRD 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 [40].
- 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 IRD RF output shall have one connector: IEC male, compliant with IEC 60169-2 part 2 [27].

(The RF-PAL output connector (see above) may be combined with an RF-bypass and/or an additional path for analogue signals for cable and terrestrial front-ends, see section 9.1 above).

9.3 Interaction Channel Interface

9.3.1 NorDig Basic and NorDig Enhanced

The Interaction Channel Interface is not relevant for the NorDig Basic and NorDig Enhanced profiles, except as a front-end for IP-based networks, see section 3.5.

9.3.2 NorDig I, NorDig Interactive (NorDigII) and Internet Access

The NorDig IRD shall (optional for NorDig I) support at least one of the following interaction channel interfaces:

1. Standard modem interface: ITU-T: V 32bis (14400 bit/s) with the following properties:
   - The use of AT Commands is not required.
   - Off hook detection has to be implemented so that the modem will never start a call when the telephone is in use.
   - The modem shall be able to dial a (up to) 16 digits telephone number in order to establish the link to the return channel network.
   - The modem shall support DTMF (dual tone modulation frequency).
   - The modem link shall use the error correction according ITU-T: V.42.
   - Connector RJ-11 C jack 6 Pins (Western jack).
   - Type and attachment approval is required (country specific).
   - For PABX systems a modification of the telephone code adding at least two digits shall be possible under the control of the customer.

- When the standby mode is selected from the operational mode, a service routine of the controller shall initialise the modem in order to terminate any link being in operation at that time.
- The cable for the modem shall be configured according to national requirements.

2. V.90 modem (56 kbit/s) in accordance with ITU-T V.90 [42].
3. Ethernet (IEEE 802.3 [34] or faster).
4. EURO-ISDN adapter, according to ETS 300 012 - 11 [19].
5. Wireless GSM modem/GPRS (see relevant ETSI specifications).
6. EuroDocsis return channel modem in accordance with ES 201 488 [14] (only in a Cable STB).
7. IEEE 1394 [32].

Note:	The interaction channel interface is normally provided by the front-end interface for NorDig IRDs with an IP-based front-end.

9.4 Smart Card Interface

9.4.1 All NorDig profiles

The NorDig IRD should include at least one (1) embedded smart card reader for use with conditional access and/or other applications.

The smart card interface shall comply with ISO/IEC 7816 Part 1-3 [39]. The NorDig IRD does not need to support synchronous cards. The NorDig IRD shall implement all aspects related to asynchronous cards with the following exceptions:

- support for Vpp is not required
- support for AFNOR pin-out is not required
- Vcc range is 5V+/- 5%
- Icc 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.

Note 1: See section 15.1.

9.4.2 NorDig II and Internet Access

The smart card interface for NorDig II and NorDig Internet Access IRDs shall support the non-CA smart card API as defined in DVB-MHP [26] and CA functions, in addition to the requirements in section 9.4.1, see section 15.3.

9.5 Transport Stream Input/Output (Common Interface)

The NorDig IRD should (1) support the Common Interface. The Common Interface shall support EN 50221 [12] and be prepared for modules of type 2. Support for type 3 is optional.

Note 1: See section 15.1.

9.6 SCART Interfaces

The NorDig IRD shall have one SCART Interface in accordance with EN 50049-1 [9] and EN 50157-2-1 [11].

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	Optional	in and out (3)	In	In	In (4)

* Not relevant for iDTV

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)
(4): the voltage should be forwarded from in to out (0V or 1 - 3V)

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 (Option)

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 analog audio interface connectors shall be:

- Two Cinch connectors, female type IEC 60603-14 [28].

9.8 Data Interface (option)

The NorDig IRD should support one local data interface.

The NorDig IRD data interface should comply with:

i. TS 102 201 section 4.6.1 (RS232C, connector: 9 PIN SUB-D connector, male type) in up to 115200 bit/s transfer speed.
ii. Universal Serial Bus Port [45].
iii. Ethernet: IEEE 802.3 [34]framing, MAC layer functions, multicast support, 10Base-T physical layer .
iv. Ethernet: IEEE 802.3 [34]100Base-T physical layer.
v. WLAN (IEEE 802.11[33]).
vi. Bluetooth [1]
vii. IEEE 1394 [32].

Note: Combinations of the functional requirements specified in sections 3.5 and 9.5 may be provided by the same physical connector.

9.9 Remote Control Interface

The IRD manufacturer will specify the interface to the Remote Control Unit. See also chapter 16.

9.10 Remote Keyboard Interface (Option)

The NorDig should have a remote keyboard interface.

(Not relevant for NorDig Basic TV and NorDig I)

10 Performance

10.1 Introduction

In this chapter the performance of decoded digital video and audio signals are specified (only relevant for IDTV in case of external interfaces). 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 IRD 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 IRD shall meet the characteristics given in ITU report 624-4 [40].

The NorDig IRD 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 IRD 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) 80 Hz to 13,5 kHz 13,5 kHz to 20 kHz	 -2 -1 -2		 +2 +1 +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.

10.4 Zapping Time for TV Services

The zapping time for the services shall satisfy the requirements given in table 10.3.

Note: The figures in Table 10.3 shall be met for a GOP length of 12, a repetition rate of ECM of 2 per second and a repetition rate of PAT and PMT of 10 times per 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 the table 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	2.5 second	1.5 second	1 second
Digital Services	2.5 second	1.5 second	1 second
Analogue Services	2.5 second	1.5 second	1 second

* When demodulation of analogue RF programmes is available

Table 10.3 Maximum zapping time

10.5 Analogue Demodulated Video and Audio

Demodulation of analogue RF programmes is optional (relevant for NorDig IRDs with embedded cable front-ends only). When provided, they shall satisfy the requirements specified in sections 10.4, 10.5.1 and 10.5.2.

10.5.1 Video Performance of the Demodulated Analogue Signal

The NorDig IRD 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 IRD 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

11.1 NorDig Basic

The NorDig Basic TV IRD shall have a system software for interpretation and handling of the active service information and control of the local hardware/software.

11.2 NorDig I

The API as specified for the DVB-MHP Enhanced or Interactive Profile, see [26], is the preferred API, depending on the implementation or not of the interactive channel (option for NorDig I).

11.3 NorDig Enhanced

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

11.3.1 Detailed Profile Definition

The NorDig Enhanced shall support at least all the mandatory features specified for the DVB-MHP Enhanced Broadcast Profile, as defined in DVB-MHP version 1.1 [26].

Note:	Verification testing of the API parts will initially be based on DVB-MHP test suites [22] for DVB-MHP version 1.0.3 [23]. Final API testing will be based on the full test suites for DVB-MHP version 1.1.1 Interactive Broadcast profile [26], when available.

11.3.2 Content Formats

The NorDig Enhanced shall support at least the mandatory content formats specified for DVB-MHP Enhanced Broadcast Profile, version 1.1 [26].

11.4 NorDig Interactive (NorDig II)

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

11.4.1 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 [26].

Note:	Verification testing of the API parts will initially be based on DVB-MHP test suites [22] for DVB-MHP version 1.0.3 [23]. Final API testing will be based on the full test suites for DVB-MHP version 1.1.1 Interactive Broadcast profile [26], when available.

11.4.2 Content Formats

The NorDig II shall support at least the mandatory content formats specified for DVB-MHP Interactive Broadcast Profile, version 1.1 [26].

11.5 NorDig Internet Access

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

11.5.1 Detailed Profile Definition

The NorDig Internet Access shall support at least all the mandatory features specified for the DVB-MHP Internet Access Profile, as defined in DVB-MHP version 1.1 [26].

11.5.2 Content Formats

The NorDig Internet Access shall support at least the mandatory content formats specified for DVB-MHP Internet Access Profile, version 1.1 [26].

12 Service Information

12.1 General

The NorDig IRD shall be able to process, i.e. sort out, store and make available through the Man-Machine Interface (NorDig Basic) or an API (NorDig I) or the MHP API (NorDig II, NorDig Enhanced and NorDig Internet Access) 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 [5] and ETR 211 [17].

The NorDig IRD with an MHP-based profile (NorDig II, NorDig Enhanced and NorDig Internet Access) shall support all the DVB SI additions as defined in the DVB-MHP specification version 1.1 [26].

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

The NorDig IRD shall be able to process the PSI/SI tables, both for the ‘Actual’ and for ‘Other’ transport streams.

The NorDig IRD shall at least start updating for any changes in the received "quasi-static" SI data after it returns to active from stand-by mode. “Quasi static “ SI-data includes NIT and SDT, i.e. SI that is typically stored in the flash memory for service navigations, such as service name, service_ID, number of services. (The 'running status' is not included in the quasi-static SI data. As a guideline for the implementation, this updating may be performed in the background, to shorten the start-up of the basic video and audio). The NorDig IRD shall at least start action for any changes in the received "dynamic" PSI and SI data, (PMT, EIT, TDT/TOT, running status and CA mode) within 1 second. (As a guideline for the implementation, the trigger for changes in received tables can be based on comparing the 'version id' in the tables).

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 [17] and ETR 162 [16].

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
carousel_id_descriptor	0x13	-	-	-	-	-	-	mb Mr (1)
network_name_descriptor	0x40	Mb Mr	-	-	-	-	-	-
service_list_descriptor	0x41	Ob Mr	-	-	-	-	-	-
satellite_delivery_system_descriptor	0x43	mb Mr	-	-	-	-	-	-
cable_delivery_system_descriptor	0x44	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 (2)	-	-	-	-	-	-
private_data_specifier_descriptor	0x5F	mb Mr (4)	-	mb Or	mb Or	-	-	mb Mr
frequency_list_descriptor	0x62	Ob Mr (4)	-	-	-	-	-	-
data_broadcast_id_descriptor	0x66	-	-	-	-	-	-	mb Mr
AC-3 descriptor	0x6A	-	-	-	-	-	-	mb Or
application_signalling_descriptor	0x6F	-	-	-	-	-	-	mb Mr (1)
service_identifier_descriptor	0x71	-	-	Ob Mr (1)				
user defined	0x80-0xFE	-	-	-	-	-	-	-
NorDig private: logic_channel_descriptor (Version 1)	0x83	Ob Or (4)	-	-	-	-	-	-
NorDig private: logic_channel_descriptor (Version 2)	0x87	Ob Mr (3) (4)	-	-	-	-	-	-
Forbidden	0xFF	Fb	Fb	Fb	Fb	Fb	Fb	Fb

- *Descriptor not applicable or not yet used as minimum within NorDig*
Mb Mandatory to Broadcast, always/all time
mb Mandatory to Broadcast if applicable, i.e. if certain criteria is met (e.g. if scrambling is used)
Ob Optional to broadcast, but recommended (if applicable)
Fb Forbidden to broadcast (may cause misinterpretation)
Mr Mandatory to receive and interpret if broadcast
Or Optional to receive and interpret (if broadcasted)
* Optional for satellite and cable IRDs.

Note 1: Mandatory for IRD with MHP API based profiles
Note 2: Mandatory to broadcast, in accordance with ETR 211 [17].
Note 3: This descriptor (version 2) is mandatory to receive for IRD released after 1 July 2007, see section 12.2.7.
Note 4: Recommended for NorDig I.

Table 12.1 Overview over minimum used descriptors in NorDig broadcast and receivers

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 (1)	mandatory	mandatory	mandatory
Frequency_list_descriptor (1)	optional	optional	mandatory
(NorDig) logic_channel_descriptor (Version 2)	mandatory(2)	mandatory(2)	mandatory(2)

Table 12.2 NIT descriptors

Note 1: Recommended for NorDig I Note 2: Version 2 of this descriptor is optional for IRDs that are released before 1 July 2007.

12.2.2 Cable Delivery System Descriptor

Reference to analogue services (PAL) may be used in NorDig digital (cable) networks. These services will be signalised 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 [5] (0x07, PAL coded signal).

12.2.3 Terrestrial Delivery System Descriptor

Receivers should use the modulation parameters (see below) in the terrestrial_delivery_system_descriptor as a recommendation when trying to tune to a multiplex. The receiver should, however, always be able to detect the modulation from the transmission itself (e.g. assisted by TPS bits).

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

The modulation parameters carried in the terrestrial_network_descriptor are recommended to be the one applicable to the majority of receivers in that network. The modulation parameter in the terrestrial_delivery_system_descriptor shall be consistent with the multiplex carried on the frequency indicated in the terrestrial_delivery_system_descriptor.

12.2.4 Linkage Descriptor

The following linkage_type values shall be interpreted by a Nordig IRD receiver, when used inside the NIT

- 0x01, linkage to a service that contain information about the network (2)
- 0x02, linkage to an EPG service (1)(2)
- 0x04, linkage to transport stream which carries EIT schedule information for all of the services in the network (i.e. "barker channel" service) (2)
- 0x09, linkage to DVB System Software Update service (bootloader), see section 7.2
- 0x81, linkage to NorDig 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.

Note 1: Not relevant for NorDig Basic Note 2: Interpretation of these values is recommended for NorDig I

12.2.5 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.)

Note: This descriptor is recommended for NorDig I.

12.2.6 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 [5] 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.

12.2.7 NorDig private; Logic_Channel_descriptor

12.2.7.1 NorDig private; Logical Channel Descriptor (version 1)

Note: This older version of the NorDig Logical Channel Descriptor will be replaced by the newer version 2 below.

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	
service_id	1	uimsbf
visible_service_flag	1	bslbf
reserved	14	bslbf
logical_channel_number		uimsbf
}		
}		

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.

visible service flag	Logic channel number (decimal value)	Description
0	0	Service not suitable for selection by the user. *For example, the value zero may be used for data services only intended for selection from interactive applications or for firmware download services etc.*
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. *Service do not have any event information*).
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 examples in Table 12.6 and Table 12.7 below illustrates how broadcasted services shall be ordered in the IRD's service lists according to (a terrestrial) broadcast.

S_ID	ON_ID	TS_ID	N_ID	VSF	LCN	Service type	Comment
100	100	10	101	1	10	0x01 (TV)	
100	**200**	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	**0x02** (Radio)	other type of service
120	100	10	**102**	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. The abbreviations 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.

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			
Number	**S_ID**	**ON_ID**	**N_ID**
10	100	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

Radio service list			
Number	**S_ID**	**ON_ID**	**N_ID**
23	200	100	101

Table 12.7 Receiver service list example

12.2.7.2 NorDig private; Logical Channel Descriptor (version 2)

Note: The (new) logic channel descriptor (LCN) version 2 is used in the second descriptor loop in the NIT, i.e. in each transport streams loop. Several LCN's (version 2) may be listed 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**. The descriptor enables an IRD to create a (first time) default orders of the services in the IRD's service lists controlled by the operator, observe that this shall not effect the end-user defined lists in the IRD, if any.

Syntax	**No. of bits**	**Identifier**
Logical_channel_descriptor(){		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
for (i=0;i<N;i++){		
channel_list_id	8	uimsbf
channel_list_name_length	8	uimsbf
for (i=0;i<N;i++) {		
char	8	uimsbf
}		
country_code	24	uimsbf
descriptor_length	8	uimsbf
for (i=0;i<number_of_services;i++){		
service_id	16	uimsbf
visible_service_flag	1	bslbf
reserved_future_use	1	bslbf
logical_channel_number	14	uimsbf
}		
}		
}		

Table 12.8 Logical_Channel_descriptor

descriptor_tag: This shall be assigned to be 0x87 (decimal 135)

channel_list_id: This is an 8-bit field which serves as a label to identify the channel list (uniquely allocated within each original_network_id). The user shall be able to select a preferred channel list to be used, when several are available during the first-time installation (or complete re-installation).

channel_list_name_length: This 8-bit field specifies the number of bytes that follow the channel_list_name_length field for describing characters of the name of the Channel List. Maximal length is 23 bytes for the channel_list_name.

Note: There might be several channel lists available that are not relevant for the specific IRD. The box shall ignore these automatically by supporting the following behaviour:

Primary: Ignore all channel lists that is not according to the default country setting.

Secondly: Only include LCD according to the NIT that is default for NIT search.

To avoid several non relevant service lists if for any reason a complete search has to be done, the LCD shall still be chosen from the NIT that is according to the default settings.

char: This is an 8-bit field. A string of character fields specify the name of the channel list, the channel_list_name. (Maximal length is 23 bytes for the channel_list_name). Text information is coded using the character sets and methods described in EN 300 468, annex A. The IRD is recommended to use the channel_list_name to present information on the OSD, for example when the user chooses a preferred channel list among several to create the IRD's service list(s).

country_code: This 24-bit field identifies a country using the 3-character code as specified in ISO 3166 [35] . Each character is coded into 8-bits according to ISO 8859-1 [36] and inserted in order into the 24-bit field. In the case that the 3 characters represent a number in the range 900 to 999, then country_code specifies an ETSI defined group of countries. These allocations are found in ETR 162 [16].

EXAMPLE: Sweden has 3-character code "SWE", which is coded as:

'0101 0011 0101 0111 0100 0101'.

The IRD may use this field (in combination with the IRD's user preference settings) to propose a channel list to be chosen as preferred when several are available.

service_id: A service_id that belongs to the TS (i.e. services from other TS shall not be listed). One service may only be listed once in each channel list, but may belong to/be listed in more than one channel list.

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

Reserved: All "reserved" bits shall be set to '1', (observe however the IRD shall be able to handle (neglect) future use of reserved bits).

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 below.

visible service flag	Logic channel number (decimal value)	Description
0	0	Service not suitable for selection by the user. For example, the value zero may be used for data services only intended for selection from interactive applications or for firmware download services etc.
1	0	Reserved for future use

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. Service do not have any event information).
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 12.9 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 (others is not applicable for zapper boxes without API). If the receiver has several service_lists, the addressing of each service in each list shall match the logic_channel_number value (if no collision within a list).

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.

"Visible" services listed in the preferred channel list, shall have higher priority when ordering the services in the default service list, than services that are listed in other channel list(s) or not listed at all. New services listed in other channel list(s) than the preferred, shall be displayed in the service list(s), but be located after the last service of the preferred channel list.

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 (within the same channel list, 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 other(s) shall be placed after the last service for that channel 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 examples in *Table 12.10* and Table 12.11 below illustrates how broadcasted services shall be ordered in the NorDig IRD's service lists according to (a terrestrial) broadcast.

CL_ID	ON_ID	TS_ID	S_ID	N_ID	VSF	LCN	Service type	Comment
1	100	10	100	101	1	10	0x01 (TV)	
1	**200**	10	100	200	1	10	0x01 (TV)	other network provider and other combination channel_list_id, ONID
1	100	10	110	101	1	11	0x01 (TV)	
-	100	10	90	101	-	-	0x01 (TV)	no logic_channel_descr attached to this service
1	100	20	120	101	1	23	0x01 (TV)	
1	100	20	200	101	1	23	**0x02** (Radio)	other type of service
1	100	20	120	**102**	1	23	0x01 (TV)	same service from other terrestrial region (and other transmitter point)
1	100	20	130	101	1	24	0x01 (TV)	
1	100	10	400	101	0	100	0x01 (TV)	e.g. sub-service, information channel
2	100	10	100	101	0	0	0x01 (TV)	Same service listed in a other channel list
1	100	10	500	101	0	0	0x0C (Data)	e.g. Bootloader or EPG service

Table 12.10 Example of broadcast of SI and services. The abbreviations are defined as: CL_ID; Channel_list_ID, ON_ID; original_network_ID; TS_ID; transport_stream_ID, NID; network_ID, S_ID; service_ID, VSF; visible_service_flag, LCN; logic_channel_number.

Table 12.10 exemplifies how services shall be listed in the receiver (from broadcast above) in an NorDig IRD with at least two service_lists, one for TV and one for Radio services and here with the channel list CL_ID 1 and ON_ID 100 as the chosen preferred channel list. 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				
Number	ON_ID	TS_ID	S_ID	N_ID
10	100	10	100	101
11	100	10	110	101
23	100	20	120	102
24	100	20	130	101
25	200	10	100	200
26	100	10	90	101

Radio service list				
Number	ON_ID	TS_ID	S_ID	N_ID
23	100	20	200	101

Table 12.11 Receiver service list example

The service [ONID, TSID, SID] = 100, 20, 120 is listed only once (even though that service is transmitted twice). This due to that the IRD in this example above has a stronger and a better reception (quality) of the TS where service [ONID, TSID, SID, NID] = 100, 20, 120, 102 belongs to, than for the TS where the service [ONID, TSID, SID, NID] = 100, 20, 120, 101 belongs to.

12.3 Service Description Table (SDT)

12.3.1 The Service Descriptor Table Descriptors

SDT descriptors
Service_descriptor
CA_identifier_descriptor
Linkage_descriptor
Service_identifier_descriptor

Table 12.12 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 [16]. 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 (1) be interpreted by a NorDig 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).

Note 1: Recommended for NorDig I

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 12.13 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 [16]. When used, it will be used dynamically, i.e. following the services scrambling status, mainly targeting the ESG/EPG applications.

12.4.3 Content Descriptor

The NorDig IRD should handle all content nibbles listed in the DVB SI specification (ETSI EN 300 468 [5]), but shall at least be able to handle all content nibble level 1 classes. If there is no content coding in conformance with table present for an event, the default content description "unclassified" shall be assumed by the receiver.

12.5 Event Information Table Schedule

Upon user request for EIT schedule information, the IRD shall (1) 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.

Note 1: Recommended for NorDig Basic

12.5.1 Event Information Table, Schedule, Descriptors

Event schedule descriptors
Short_event_descriptor
Component_descriptor
Content_descriptor
Parental_rating_descriptor
CA_identifier_descriptor (optional)

Table 12.14 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 [16]. When used, it will be used dynamically, i.e. following the services scrambling status, mainly targeting the ESG/EPG applications.

12.5.3 Content Descriptor

The NorDig IRD should handle all content nibbles listed in the DVB SI specification (ETSI EN 300 468 [5]), but shall at least be able to handle all content nibble level 1 classes. If there is no content coding in conformance with table present for an event, the default content description ”unclassified” shall be assumed by the receiver.

12.6 Time and Date Table and Time Offset Table

NorDig IRD 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 Desriptor

Time Offset Table
local_time_offset_descriptor

Table 12.15 TOT descriptors

12.7 PSI Requirements

12.7.1 Program Map Table Desriptors

Program map Table
teletext_descriptor
Subtitling_descriptor
stream_identifier_descriptor
video_stream_descriptor
CA_descriptor (1)
ISO_639_language_descriptor (1)
Private_data_specifier_descriptor (1)
data_broadcast_id_descriptor (2)
application_signalling_descriptor (2)
carousel_id_descriptor (2)

Table 12.16 PMT descriptors

Note 1: Recommended for NorDig I

Note 2: This descriptor is only mandatory for the MHP receivers (i.e. Enhanced, Interactive and Internet Access Profiles)

13 Navigator

13.1 General

The NorDig IRD 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 [5]. The Navigator shall also initiate bootloading, as described in section 7.2.

13.2 Service List

13.2.1 Service List Requirements

The NorDig IRD shall maintain a service list based on SI-information. The NorDig 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 throught the combination of only original_network_id and service_id). The service list shall include the services and should also include 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 3.1.2). The corresponding part of the service list shall be updated within 1 second after reception of an updated SI table; updates should be made each time the NorDig IRD is switched from active to stand-by and shall be made each time the NorDig IRD is switched from stand-by to active.

The IRD shall (1) 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 [5], 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 makes changes in his part of the service list, the NorDig 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.

Note 1: Recommended for NorDig I

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

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

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

A cable NorDig IRD should provide functionality for fast installation of services by typing the network_ID into the receiver. In such a case, the IRD shall process only that specific NIT (actual and

other) table (with corresponding network_ID) from current/actual transport stream and only install/display services listed in that table's service_list_descriptors.

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

A NorDig IRD shall (1) 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 [16] (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).

Note 1: Recommended for NorDig I

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 (2)
Cable_delivery_system_descriptor (2)
Terrestrial_delivery_system_descriptor (2)
Service_list_descriptor
(Nordig) Logic_channel_descriptor

Table 13.1 NIT descriptors

Note 2: Recommended for NorDig I

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 (1)

Table 13.2 SDT descriptors

Note 1: Recommended for NorDig I

13.2.4 Network Evolution and Service Changes

The NorDig IRD shall (1) dynamically update the Service List whenever changes occur in the NIT and SDT tables (i.e. typically handling the version numbers of the tables).

Note 1: Recommended for NorDig I

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).

13.3 Event Schedule Guide (ESG)

13.3.1 ESG Requirements

The ESG shall include the EIT present/following tables, see EN 300 468 [5] ("The EIT schedule tables are not a part of the ESG").

The NorDig IRD 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 IRD shall make use of the EIT p/f tables from both EIT_actual and EIT_other tables.

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

If information is missing (i.e. not included in the transmission) the ESG shall (1) not display an error message, instead the text information field shall stay empty (i.e. no information like “no information available”).

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 IRD shall be able to demultiplex in parallel the Teletext service transmitted in a packetised format according EN 300 472 [6].

The NorDig IRD 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 NorDig IRD shall be able to display Teletext subtitling, meeting the requirements for level 1.5 in ref. [ETS 300 706, "Enhanced Teletext Specification"], (even if VBI insertion is used for the teletext pages).

The VBI insertion shall be compliant with ITU-R BT.653-3 [41]. 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 1.5 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 IRD 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 IRD 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 [21], and displayed using the OSD capabilities whilst decoding the full television service (video and audio) to which it is associated.

The DVB subtitling shall be able to coexist with applications, and shall coexist with MHP-applications as specified in the DVB-MHP specification v1.1 [26]. The enabling and disabling of the subtitles shall be user controlled through the user interface, but with subtitles enabled as default option. The enabling and disabling of the subtitle composition pages and selection of “normal” or “hard of hearing” subtitling should be user controlled, with composition pages and normal subtitling enabled as default option. The enabling or disabling of the subtitle ancillary pages, if available, should 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 (2) 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 1:	If both DVB-subtitling and Teletext subtitling are received simultaneously the IRD shall (2) only display the DVB-Subtitling stream.
Note 2:	Optional for NorDig I

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

14.2.1 Subtitling subset

The NorDig IRD 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 [21] 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 IRD 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 IRD shall implement at least 5 levels of transparency; 0% (opaque), 30%, 50%, 70% and 100% (completely transparent) (1). Implementation of additional intermediate levels of transparency is optional. Where the NorDig IRD 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 (2) 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%.
	Note 1: For NorDig I: only transparent for black RGB(0,0,0) Note 2: Optional for NorDig I.
Number of streams:	The receiver shall support at least one DVB-subtitling streams i.e. at least support decoding of one subtitling composition page while support of one simultaneously available ancillary page is optional.

15 Interfaces for Conditional Access

15.1 General

The NorDig IRD shall (1) support at least one DVB Common Interface (for CA module) for conditional access. In addition it shall (1) support at least one smart card interface for conditional access. The smart card interface with associated embedded functions should support use of external smart card(s) for at least one CA-system.

Note 1: The NorDig IRDs are intended for use in networks broadcasting signals that are accessed controlled, as well as not access controlled. The mandatory requirements for at least one DVB Common Interface and one smart card interface are temporarily suspended, until the Nordic regulatory authorities have clarified their views regarding these matters or further decisions by NorDig's Board. For this interim period the following requirements apply:

The requirements for conditional access interfaces are specified by the relevant network/CA operator.

IRDs for access-controlled broadcasts shall provide embedded functions as specified for the DVB Common Interface and/or the smart card interface, see below, and minimum requirements as specified for the relevant network.

IDTV sets with screen diameters larger than 30 cm shall be equipped with DVB Common Interface, see below.

15.2 Use of the DVB Common Interface

15.2.1 General

The DVB Common Interface can be used for conditional access and other purposes. See also section 9.5. A conditional access (CA) module may be connected to the Common Interface of the NorDig IRD in order to provide access control of the incoming services.

15.2.2 Minimum requirements for the Common Interface

Each CI-slot of the NorDig IRD shall be in compliance with the Common Interface specification EN 50221 [12]. See also section 9.5.

15.2.3 Minimum requirements for the NorDig CA-Module

15.2.3.1 General – the CA-modules

The CA-module may contain the CA security device ("CA-module with fully embedded CA-system") or a smart card interface for connection to an external smart card ("CA-module with partly embedded CA-system").

15.2.3.2 CA-module with fully embedded CA-system

The CA-module will be CA-system specific and contain all CA-functions, including the security device. For this case the relevant specifications have to be obtained from the relevant CA-system vendor.

15.2.3.3 CA-module with partly embedded CA-system

Proprietary CA-module (CAM):
The CAM will be connected to a security device (smart card). The CAM shall provide the CI-functions

specified in EN 50221 [13] and the additional functions specified by the relevant CA-system vendor for the smart card interface

15.3 Use of Smart Card Reader

15.3.1 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 smart card reader shall support an interface as partially 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.

The IRD shall be capable of replacing the CA-system software by download of new IRD and CA-system software via the bootloader, over air or locally.

15.3.2 ECM and EMM Filtering

The NorDig IRD shall implement ECM and EMM acquisition in accordance with ETR 289 [18].

The NorDig IRD 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 IRD 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.

15.3.3 Descrambling of selected services

The NorDig IRD shall implement descrambling of selected services, see section 4.2.

15.3.4 Application Level Interface for Conditional Access.

The application level smart card interface for conditional access is CA-system specific. The application level interface definitions are restricted information that can be obtained from relevant CA-system vendors.

16 The Remote Control and Remote Keyboard

16.1 General

The NorDig Basic IRD shall have a remote control. The IRD manufacturer will determine the functionality.

NorDig IRDs for Enhanced, Interactive and Internet profiles shall have a remote control with properties as specified in section 16.2 below.

NorDig Internet IRDs should have a remote keyboard.

The keys for basic TV functions (section 16.2.2) shall function independently of applications running in the IRD.

16.2 Functions

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

16.2.1 Numeric Entry

The NorDig IRD's remote control shall include 10 digit keys, labelled 0-9.

16.2.2 Basic TV Functions

The NorDig IRD's 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.
- Subtitle – This function displays the subtitle as defined in section 14.2.
- Info – This function displays additional information if available.

16.2.3 Digital TV Functions

The NorDig IRD's 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 (1) be red, green, yellow and blue
- Text –This function displays the teletext as defined in section 14.1 or a Digital Super Teletext if present. (1)

Note 1: Optional for NorDig I

In addition the NorDig IRD 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.
- Back –This function exits from the current menu or "page" and returns to the previous state.

16.2.4 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 IRD remote control in Figure 16.1.

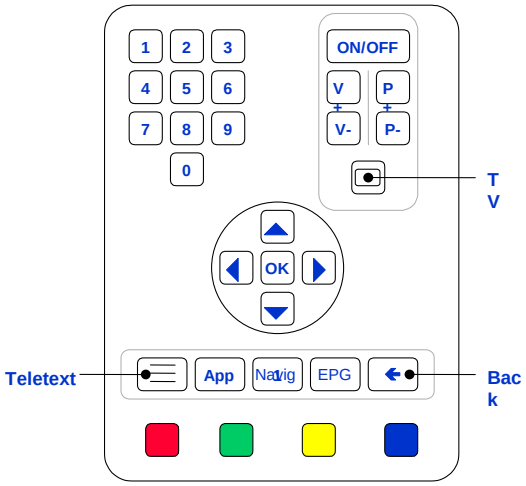


Figure 16.1 Conceptual illustration of the NorDig IRD remote control

16.2.5 Mapping of Key Events

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

Key	KeyEvent
0-9	VK_0 to VK_9
ON/OFF	VK_POWER
P+	VK_CHANNEL_UP
P-	VK_CHANNEL_DOWN
V+	VK_VOLUME_UP
V-	VK_VOLUME_DOWN
UP	VK_UP
DOWN	VK_DOWN
LEFT	VK_LEFT
RIGHT	VK_RIGHT
OK	VK_ENTER
TEXT	VK_TELETEXT
SUBTITLE	VK_SUBTITLE
BACK	VK_PAGE_UP
EPG	VK_GUIDE
INFO	VK_INFO
TV	VK_ESCAPE
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

17.1 Stored preferences

The user shall be able to store preferences in persistent memory. The following user preferences shall (1) be implemented in the NorDig IRD.

- 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.

Note 1: Recommended for NorDig I

17.2 Deletion of service lists

The IRD shall provide a function to remove all service lists (default and user defined); this function should not affect other parameters (e.g. user preferences).

17.3 Reset to factory mode

The IRD shall provide a function to reset all parameters to factory mode, thus removing all service lists, user preferences, etc. After reset, the IRD shall enter installation state.

The factory mode should be set to the following:

RF input DC power supply source for satellite front-end:	on
RF input DC power supply source for terrestrial front-end:	off (1)
RF-output preset channel:	Channel 43 (PAL-G) (2)
Menu language:	equal to country settings
Primary audio language:	equal to country settings
Subtitling (normal):	on
Primary subtitling language:	as country settings
Subtitling; hard of hearing/hearing impaired:	off

Note 1: In the first time installation and resetting to factory default settings, the DC power supply shall be switched off. It is recommended that the receiver ask if the DC power supply is turned on in the first time installation and in the installation after resetting to factory settings, to speed up the initialisation procedure. Note 2: Applicable for IRDs with RF PAL modulator

Annex A: NorDig Members

The NorDig group represents per November 1, 2004 the following broadcasters, operators and service providers in the Nordic countries:

Denmark

Broadcast Service Danmark A/S
Danmarks Radio (DR)
TDC Kabel TV A/S
TV2

Finland

Digita OY
MTV OY
TeliaSonera Finland Oyj
Swelcom OY
Yleisradio (YLE)

Iceland

Landsiminn Island
Riksutvarpid Sjonvarp Islands

Norway

Canal Digital AS
Norkring AS
Norsk Rikskringkasting (NRK)
Telenor AS
TV2

Sweden

Boxer TV Access AB
Canal+ Television AB
Kanal 5 (SBS AB)
Nordic Satellite AB
Sveriges Television AB (SVT)
Telia AB (Comhem)
Teracom AB
TV4 AB
Viasat, Modern Times Group (MTG AB)

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

1 Terminology and Definitions for Single Frequency Networks Performance Parameters

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

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

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

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

- For fixed reception, the Ricean channel (F_1, see EN 300 744 [8]) is used for the main transmitter contribution. The *EPT* depends on the amplitude of the artificial echoes from the other transmitters, and can vary from $C/N|_F$ (single transmitter, Ricean channel (F_1) for low artificial echoes to $C/N|_P$ (single transmitter, Rayleigh channel (P_1), for high artificial echoes. The number and the delay of artificial echoes within the guard interval does not affect significantly the system performance, but their total power compared to the power of the main path has an important effect on the channel *criticality*. A parameter, K_A, has been identified as the "channel criticality due to artificial echoes" and is the ratio (in dB) between the power received from the main transmitter and the total power of the artificial echoes inside the interval of correct equalisation T_F. It should be noted that $K_A = 0$ dB corresponds to the most critical case.
- For portable reception, the channel (Rayleigh) is adopted for each transmitter contribution (natural echoes), and the computer simulations have indicated that *EPT* is not significantly affected by the presence of the other SFN transmitters (in fact the channel model is of Rayleigh type also with a single transmitter).

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

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

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

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

where:

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

C is the total power of the effective useful signal.

I is the total effective interfering power.

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

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

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

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

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

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

where:

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

2 List of DVB-T centre frequencies

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

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

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

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

3 Hierarchical mode reception

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

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

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

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

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

	α = 1		α = 2	
Code rate	HP QPSK	LP 16QAM	HP QPSK	LP 16QAM
½	6.8	15	5.8	19.5
2/3	9.1	17.2	7.9	21.4
¾	10.4	18.4	9.1	22.5

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

Annex C: QEF Quality Measurement Methods

The quality limit used in the NorDig specification refers to 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 and corresponds to BER = 10^{-11} at the input of the MPEG-2 demultiplexer.

In practice, it takes long time to measure such a low BER at TS data level. Therefore, the reception quality can be evaluated either indirectly by measuring the BER after the inner (Viterbi) decoder (i.e. directly before the outer (Reed-Salomon) decoder) or by subjectively inspecting the video screen for a certain period of time and looking for errors in the decoded video.

Direct measurements on the TS packets shall be the preferred measurement method, but if this is not possible or acceptable for some reason, the indirect measurements may be used. The indirect measurement methods, which can be used, are objective BER measurement after inner (Viterbi) decoder or subjective quality measurement. 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 x 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 the indirect objective method the BER of $2*10^{-4}$ after Viterbi decoder is considered to correspond to an approximation of QEF reception quality for Gaussian type of channels. But for channels interfered by impulse-like interference, for example interfering PAL signals or internal interference, the average BER of $2*10^{-4}$ after inner (Viterbi) decoder is not valid due to the fact that the outer (RS) decoder is not able to correct the burst of erroneous bytes caused by these impulse-like interference. Therefore, for impulse like interfered channels, the quality measurements shall be done by using the BER of 10^{-11} measurement method at the TS level at MPEG-2 demultiplexer input or by using the subjective measurement method.

In the indirect subjective measurement method the certain period of time of error free video decoding is considered to corresponds to a good reception quality. The specified video test sequence is ‘Mobile and calendar’ which contains movement everywhere, in order to minimise the number of errors not being observed due to error concealment techniques in the receiver.

The result of the indirect quality measurements may differ.

Annex D: IP-based Networks Used for Distribution of Broadcasting signals

See separate Addendum.

Annex E: Implementations Guidelines for NorDig Bootloader

Introduction

The NorDig bootloader provides a transport mechanism for downloading load modules for a system software upgrade. The transport mechanism for the bootloader is based on the DSM-CC User-to-Network download and the one-layer DVB data carousel. Note: The two-layer DVB data carousel is **not** used in the NorDig bootloader protocol.

Definition

Loadmodule	The complete system software for a receiver.
Module	A data container defined in DSM-CC. A loadmodule may be segmented in one or more modules.
DII	A control message that describes the modules within a datacarousel.
Datablock	A module is segmented into a number of datablocks that are transmitted to the receiver.
Transaction_Id	Provides both an identification and versioning mechanism for DIIs.
Manufacturer_Id	a unique identification of a manufacturer within the Nordic markets. The NorDig project maintains the manufacturer_id.
Version_Id	An identification that is maintained and handled by the manufacturer.

Guidelines

The service on which a certain loadmodule is transmitted is conveyed in a NorDig specific linkage descriptor that is included in the Network Information Table. The private linkage descriptor, with linkage type set to 0x81, contains the triplet *original_network_id/transport_stream_id/service_id* that uniquely identifies the correct transport stream and the service that carries the DownloadInfoIndication, DII, message. More than one DII may exist on the same PID. A DII is uniquely identified by the transaction_id, which is also indicated in the manufacturer/version loop of the linkage descriptor, see table D.1. A number of different *manufacturer_id/version_ids* may share the same transaction_id, i.e. be described in the same DII, or a network operator may want to have a unique transaction_id for each *manufacturer_id/version_id*. The usage of the transaction_id shall follow the guidelines in TR 101 202 [41] (Implementation guidelines for Data Broadcasting).

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
transaction_id	32	uimsbf
start_time }	40	bslbf
}		

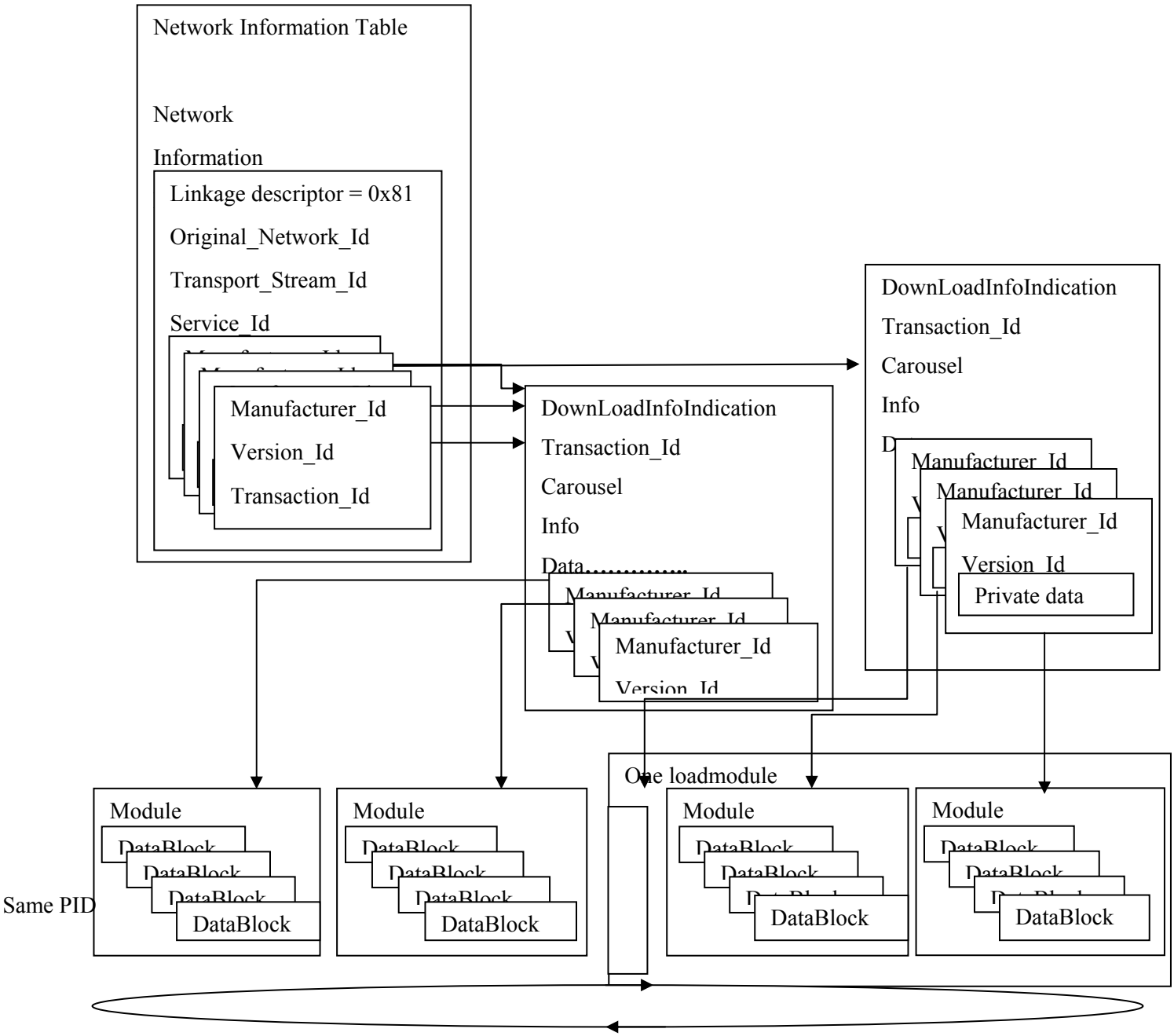
Table D.17.1 Bootloader descriptor

Each unique loadmodule, i.e. combination of *manufacturer_id/version_id*, is associated to a start time, which indicates the next time the loadmodule is available for download. To guarantee multiple trials of the download the duration of the download should be magnitudes longer than one download cycle.

A network operator may want to associate one loadmodule with one DVB data carousel module. All modules are defined by one or more DIIs where the module info bytes carry the information about the *manufacturer_id/version_id*. Since the maximum capacity of one DII is 4 Kbytes it is possible use more than one DII by having different transaction_Ids.

It is also possible to segment a loadmodule over multiple modules and have one unique DII for each combination of *manufacturer_id/version_id*. All modules, belonging to the same loadmodule, shall be described by the same DII. The private data bytes are used to describe the structure between modules. The usage of the private data bytes is proprietary for each receiver.

The example in the figure below describes a download scenario with one data-carousel, identified by one transaction_id, that contains single-module loadmodules all described by one DII and one datacarousel, identified by another transaction_id, containing a multiple-module loadmodule. The private data bytes may have the same structure as the module link descriptor as defined in DVB data broadcast.


Network Information Table
Network
Information
Linkage descriptor = 0x81
Original_Network_Id
Transport_Stream_Id
Service_Id
Manufacturer_Id
Version_Id
Transaction_Id
DownLoadInfoIndication
Transaction_Id
Carousel
Info
Data
Manufacturer_Id
Version_Id
DownLoadInfoIndication
Transaction_Id
Carousel
Info
Manufacturer_Id
Version_Id
Private data
One loadmodule
Module
DataBlock
Module
DataBlock
Module
DataBlock
Module
DataBlock
Same PID

Assignment and use of transactionId values

The use of the **transactionId** in the DVB data carousel is inherited from its use as defined by the DSM-CC specification, and as such it can appear somewhat complex. The **transactionId** has a dual role, providing both identification and versioning mechanisms for download control messages, i.e. DownloadInfoIndication and DownloadServerInitiate messages. The transactionId should uniquely identify a download control message within a data carousel, however it should be ”incremented” whenever any field of the message is modified.

Note: The term ”incremented” is used in the DSM-CC specification. Within the scope of the DVB data carousel this should be interpreted as ”changed”.

The transactionId has been split up into a number of sub-fields defined in table D.2. This reflects the due role of the transactionId (outlined above) and constraints imposed by DVB to reduce the minimum level of filtering required by receivers. However, to increase interoperability the assignment of the transactionId has been designed to be independent of the expected filtering in target receivers.

Bits	Value	Sub-field	Description
0	User-defined	Updated flag	This must be toggled every time the control message is updated
1-15	User-defined	Identification	This must and can only be all zeros for the top-level control message. All non-top-level control messages must have one or more non-zero bit(s).
16-29	User-defined	Version	This must be incremented/changed every time the control message is updated.
30-31	Bit 30 - zero Bit 31 - non-zero	Originator	This is defined in the DSM-CC specification [37] as 0x02 if the transactionId has been assigned by the network - in a broadcast scenario this is implicit.

Table D.2: Sub-fields of the transactionId

Due to the role of the **transactionId** as a versioning mechanism any change to any message in the data carousel will cause the **transactionId** of the top-level control message to be incremented. The change propagates up through the structure of the data carousel as follows. Any change to a Module will necessitate incrementing its **moduleVersion** field. This change must be reflected in the corresponding field in the description of the Module in the DownloadInfoIndication message(s) that describes any Group(s) that includes it. Since a field in the DownloadInfoIndication message is changed its **transactionId** must be incremented to indicate a new version of the message. Again (in the case of a two-layer data carousel) this change must be reflected in the corresponding field in the description of the Group in the DownloadServerInitiate message that describes the SuperGroup. Since fields in the DownloadServerInitiate message have changed its **transactionId** must also be incremented. This is useful since just by looking at the **transactionId** of the top-level control message a change to any message in the data carousel can be detected.

If the **transactionId** of any control message is referenced in the corresponding field of a data_broadcast_descriptor in SI (see [5], section 6.2.6) then this will need to be updated to reflect any changes. One consequence of this is that changes to the content of the data carousel may necessitate re-aquisition of the modified SI tables. Due to the repetition rate of SI which can be up to 2 seconds, this may be an undesired side-effect that reduces the speed of response of dynamic data services. To avoid this behavior the value of 0xFFFFFFFF for the contents of the **transactionId** field in the data_broadcast_descriptor can be used to indicate any top-level control message is valid.

The encapsulation of download control messages within MPEG-2 Transport Streams is defined in the DSM-CC specification. It specifies that the 2 least significant bytes of the **transactionId** field are copied into the **table_id_extension** field of the DSMCC_section header. This means that if the PID on which the DVB data carousel is being broadcast is known the top-level control message can be located without knowing its **transactionId** by setting up the section filters for **table_id** = 0x3B (download control messages) and **table_id_extension** = 0x0000 or 0x0001.

Annex F: Comparison of NorDig profiles

1. Introduction

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

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

2. Legend

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

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

Xxx (Yellow): marks deviations from mandatory requirement for NorDig II Interactive

M: Mandatory requirement for all NorDig profiles (identical text).
M1, M-B, ME, M-IB (or M2), M-IA:
Mandatory requirements as specified for NorDig Basic, NorDig I, NorDig Enhanced, NorDig Interactive Broadcast, and NorDig-Internet Access (requirement/text differs between profiles).
O: Optional or recommended.

Note that:

- O, M, M1, etc only refer to the specification paragraph. The actual requirements can only be found by looking up the actual text in the relevant paragraph of the specification.
- M marked for a full chapter/section with subparagraphs indicates that the section function is mandatory and that all corresponding requirements are identical, unless subparagraphs are shown with deviations.

Chapter/section	**ND-I**	**ND Basic**	**ND-E**	**ND-IB**	**ND-IA**	**Comment**
1. Introduction	----	----	----	----	----	
2. General Features	----	----	----	----	----	

Part A. Hardware and firmware						
Chapter/section	**ND-I**	**ND Basic**	**ND-E**	**ND-IB**	**ND-IA**	**Comment**
3. The Frontend of the NorDig box	----	----	----	----	----	
3.1 Common Features	----	----	----	----	----	
3.1.1 General features	M	M	M	M	M	
3.1.2 Common scanning procedures	M	M	M	M	M	(Not relevant for IP-based front-end)

Chapter/section	ND-I	ND Basic	ND-E	ND-IB	ND-IA	Comment
3.1.3 Quality Reception Detector	M	M	M	M	M	
3.2 Satellite Tuner and Demodulator	-----	-----	-----	-----	-----	(Not relevant for cable, terrestrial and IP-based front-end)
3.2.1 General	M	M	M	M	M	
3.2.2 RF/IF Characteristics	M	M	M	M	M	
3.2.3 Input Frequency range/ Tuning range	M	M	M	M	M	
3.2.4 Tuning/Scanning Procedures	M	M	M	M	M	
3.2.5 Control Signals	M	M	M	M	M	
3.2.6 Demodulation	M	M	M	M	M	
3.2.7 Satellite Tuner Interface and Signal Levels	-----	-----	-----	-----	-----	
3.2.7.1 RF Input Connector	M	M	M	M	M	
3.2.7.2 RF Output Connector (option)	O	O	O	O	O	
3.2.7.3 Signal Level	M	M	M	M	M	
3.2.7.4 Power Supply and Control Signals (to RF unit)	M	M	M	M	M	
3.2.8 Performance	M	M	M	M	M	
3.3 Cable Tuner and Demodulator	-----	-----	-----	-----	-----	(Not relevant for satellite, terrestrial and IP-based front-end)
3.3.1 General	M	M	M	M	M	
3.3.2 RF Characteristics	M	M	M	M	M	
3.3.3 Tuning/Scanning Procedure	M	M	M	M	M	
3.3.4 Bypass RF_{in} to RF_{out}	O	O	O	O	O	
3.3.5 Performance Data	-----	-----	-----	-----	-----	
3.3.5.1 Analogue and Digital Signals	M	M	M	M	M	
3.3.5.2 Digital Signals	M	M	M	M	M	
3.4 Terrestrial Tuner and Demodulator	-----	-----	-----	-----	-----	(Not relevant for satellite, cable and IP-based front-end)
3.4.1 General	M	M	M	M	M	

Chapter/section	ND-I	ND Basic	ND-E	ND-IB	ND-IA	Comment
3.4.2 Frequencies	M	M	M	M	M	
3.4.3 Modes	M	M	M	M	M	
3.4.4 Tuning/Scanning Procedures	M	M	M	M	M	
3.4.5 Changes in Modulation Parameters	O	O	O	O	O	
3.4.6 Connector	M	M	M	M	M	
3.4.7 RF Output Connector	O	O	O	O	O	
3.4.7 Performance	-----	-----	-----	-----	-----	
3.4.8 Performance	-----	-----	-----	-----	-----	
3.4.8.1 Definitions	-----	-----	-----	-----	-----	
3.4.8.2 C/N Performance	M	M	M	M	M	
3.4.8.3 Minimum Receiver Signal Input Levels	M	M	M	M	M	
3.4.8.4 Maximum Receiver Signal Input Levels	M	M	M	M	M	
3.4.8.5 Immunity to “analogue” signals in Other Channels	M	M	M	M	M	
3.4.8.6 Immunity to “digital” signals in Other Channels	M	M	M	M	M	
3.4.8.7 Immunity to Co-Channel Interference From Analogue TV-Signals	M	M	M	M	M	
3.4.8.8 Performance in Time-Varying Channels	M	M	M	M	M	
3.4.8.9 C/(N+I) Performance in Single Frequency Networks	M	M	M	M	M	
3.5 IP Based Front-end	-----	-----	-----	-----	-----	(Not relevant for cable, satellite and terrestrial based front-end)
3.5.1 General	M	M	M	M	M	(Front-end for IP-based networks, see separate Addendum)
4 MPEG-2 Demultiplexer	-----	-----	-----	-----	-----	
4.1 General	M	M	M	M	M	
4.2 DVB Descrambler Performance	M/O*	M/O*	M/O*	M/O*	M/O*	4.2 and* See 15.1

Chapter/section	ND-I	ND Basic	ND-E	ND-IB	ND-IA	Comment
4.3 System Clock Recovery	M	M	M	M	M	
5 MPEG-2 Video Decoder	-----	-----	-----	-----	-----	
5.1 General	M	M	M	M	M	
5.2 Constraints and Extensions	-----	-----	-----	-----	-----	
5.2.1 Active Format Description	O	O	O	O	O	
5.2.2 Displaying 16:9 Material on 4:3 Monitors	O	O	O	O	O	
5.2.3 Displaying 4:3 Material on 16:9 Monitors	M	M	M	M	M	
5.2.4 16:9 Letterbox Conversion	M	M	M	M	M	
5.2.5 14:9 Letterbox Conversion	O	O	O	O	O	
5.2.6 Down conversion	O	O	M	M	M	
5.2.7 Up conversion	M	O	M	M	M	
5.2.7.1 Default Location Mode	M	O	M	M	M	
5.2.8/5.3 Still picture support	O	O	M	M	M	
6 MPEG-2 Audio Decoder	-----	-----	-----	-----	-----	
6.1 General	M	M	M	M	M	
6.2 Constraints and Extensions	-----	-----	-----	-----	-----	
6.2.1 Audio Video Synchronisation	M	M	M	M	M	
6.2.2 Set-up Levels	M	M	M	M	M	
6.2.3 Multichannel Audio	O	O	O	O	O	
6.2.4 Digital Audio Output	O	O	O	O	O	
6.2.3/6.2.5 Half sampling rates	O	O	O	O	O	
6.3 Applications	M	M	M	M	M	
7 Controllers and memory	--	--	--	--	--	
7.1 Hardware /Hardware Capacity	M1	M-B	M	M	M	
7.1.1 General	M	M	M	M	M	
7.1.2 Controllers	--	--	O2	O2	--	
7.1.3 Memory	M1	--	M2	M2	--	
7.2 The Bootloader	-----	-----	-----	-----	-----	
7.2.1 Introduction	M	M	M	M	M	
7.2.2 Over-the-air via Broadcast Download	M	M	M	M	M	

Chapter/section	ND-I	ND Basic	ND-E	ND-IB	ND-IA	Comment
7.2.3 Local Download	O	O	O	O	O	
8. Graphics processing	M-B	M-B	M2	M2	M2	
9. Interfaces and Signal Levels	-----	-----	-----	-----	-----	
9.1 Introduction	O	O	O	O	O	
9.2 RF-PAL Output	O	O	O	O	O	
9.3 Interaction Channel Interface	O	--	--	M	M	No int. channel for ND-Basic and NorDig Enhanced, except for IP-based front-ends
9.4 Smart Card Interface	M/ O*	M/ O*	M/ O*	M/ O*	M/ O*	* See 15.1
9.5 Transport Stream Input/Output (Common Interface)	M/ O*	M/ O*	M/ O*	M/ O*	M/ O*	* See 15.1
9.6 Scart Interface	M	M	M	M	M	
9.7Audio Interfaces	O	O	O	O	O	
9.8 Data Interface	O	O	O	O	O	
9.9 Remote Control Interface	M	M	M	M	M	
9.10 Remote Keyboard Interface	O	O	O	O	O	
10 Performance	-----	-----	-----	-----	-----	
10.1 Introduction	-----	-----	-----	-----	-----	
10.2 Video Performance of RGB and PAL Signals	M	M	M	M	M	
10.3 Audio Performance of the Decoded Digital Signal	M	M	M	M	M	
10.4 Zapping Time for TV Services	M	M	M	M	M	
10.5 Analogue Demodulated Video and Audio	M	M	M	M	M	
10.5.1 Video Performance of the Demodulated Analogue Signal	M	M	M	M	M	
10.5.2 Audio Performance of the Demodulated Analogue Signal	M	M	M	M	M	

Part B: **The system software with application programming interfaces (API)**						
Chapter/section	**ND-I**	**ND Basic**	**ND-E**	**ND-IB**	**ND-IA**	**Comment**
11 IRD System Software and API	----	-----	-----	----	----	
11.1 NorDig Basic	----	M-B	----	----	----	
11.2 NorDig I	M1	----	----	----	----	
11.3 NorDig Enhanced	----	----	ME	----	----	
11.4 NorDig II Interactive	----	----	----	M2	----	
11.5 NorDig Internet Access	----	----	----	----	M-IA	
12 Service Information	-----	-----	-----	----	----	
12.1 General	M1	M-B	M2	M2	M2	
12.2 Network Information Table (NIT)	-----	-----	-----	----	----	
12.2.1 Network Information Table Descriptors (NIT)	M1	M	M	M	M	
12.2.2 Cable Delivery System Descriptor	M	M	M	M	M	
12.2.3 Terrestrial Delivery System Descriptor	M	M	M	M	M	
12.2.4 Linkage Descriptor	M1	M-B	M2	M2	M2	*No linkage to EPG-service.
12.2.5 Frequency List Descriptor	O	M	M	M	M	
12.2.6 NorDig linkage for bootloader	M	M	M	M	M	
12.2.7 NorDig private Logic_channel_descriptor	O	M/ O	M/ O	M/ O	M/ O	Version 1 is optional Version 2 mandatory after June 2006
12.3 Service Description Table (SDT)	M1	M	M	M	M	
12.4 Event Information Table Present/Following (EIT p/f)	M1	M	M	M	M	
12.5 Event Information Table schedule	M	O	M	M	M	
12.6 Time and Date table and Time Offset Table	M	M	M	M	M	
12.7 PSI requirements	M1	M	M	M	M	
13 Navigator	-----	-----	-----	-----	-----	

Chapter/section	ND I	ND-Basic	ND-E	ND-IB	ND-IA	Comment
13.1 General	M1	M	M	M	M	
13.2 Service List	-----	-----	-----	----	----	
13.2.1 Service List Requirements	M1	M	M	M	M	
13.2.2 Mandatory Descriptors for the NIT	M1	M	M	M	M	
13.2.3 Mandatory Descriptors for the SDT	M1	M	M	M	M	
13.2.4 Network Evolution and Service Changes	M1	M	M	M	M	
13.3 ESG	-----	-----	-----	----	----	
13.3.1 ESG Requirements	M	M	M	M	M	
13.3.2 Event Information Table p/f (EIT p/f)	M	M	M	M	M	
13.3.3 Time and Date Table (TDT) and Time Offset Table (TOT)	M	M	M	M	M	
14 Teletext and subtitling	-----	-----	-----	-----	-----	
14.1 Teletext	M	M	M	M	M	
14.2 DVB Subtitling	M1	M	M	M	M	
15 Interfaces for Conditional Access	-----	-----	-----	-----	-----	
15.1 General	M/ O*	M/ O*	M/ O*	M/ O*	M/ O*	*** See 15.1**
15.2 Use of the DVB Common Interface	M/ O*	M/ O*	M/ O*	M/ O*	M/ O*	*See 15.1
15.3 Use of smart card reader	-----	-----	-----	----	----	
15. 3.1 General	M/ O*	M/ O*	M/ O*	M/ O*	M/ O*	*See 15.1.
15.3.2 ECM and EMM Filtering	M/ O*	M/ O*	M/ O*	M/ O*	M/ O*	*See 15.1.
15.3.3 Descrambling of Selected Services	M/ O*	M/ O*	M/ O*	M/ O*	M/ O*	*See 15.1
15.3.4 Application Level Interfaces for Conditional Access	M/ O*	M/ O*	M/ O*	M/ O*	M/ O*	*See 15.1
16 The Remote Control	M1	M-B	M	M2	M2	
16.1 General	M	M-B	M	M	M	

Chapter/section	ND I	ND-Basic	ND-E	ND-IB	ND-IA	Comment
16.2 Functions	M1	M-B	M	M	M	
16.2.1 Numeric Entry	M	--	M	M	M	
16.2.2 Basic TV-functions	O	--	O	O	O	
16.2.3 Digital TV functions	M	--	M	M	M	
16.2.4 Design and labelling	O	--	O	O	O	
16.2.5 Mapping of Key Events	O	--	M	M	M	
17 User preferences						
17.1 Stored Preferences	O	M	M	M	M	
17.2 Deletion of service lists	M	M	M	M	M	
17.3 Reset to factory mode	M	M	M	M	M	

Chapter/section	ND I	ND-Basic	ND-E	ND-IB	ND-IA	Comment
Annex A: NorDig Members	-----	-----	-----	-----	-----	
Annex B: Background and options for IRDs with a terrestrial front-end	-----	-----	-----	-----	-----	
Annex C: QEF Quality Measurement Methods	-----	-----	-----	-----	-----	
Annex D: IP-based Networks Used for Distribution of Broadcasting signals	-----	-----	-----	-----	-----	
Annex E: Implementations Guidelines for NorDig Bootloader	O	O	O	O	O	
Annex F: Comparison of NorDig profiles	-----	-----	-----	-----	-----	