VF/VFKD TD 0050

Broadcast Signal Delivery Requirements

Service Engineering

Version 1.6.4

2017-10-04

IMPORTANT NOTE: This document is subject to change.
This document replaces documents with lower version numbers.

Contents

1. Introduction

1.1. Scope of this document

This document describes audio and video interfaces for the handover of linear broadcast signals from a third party into the Vodafone Kabel Deutschland TV broadcast infrastructure.

1.2. Disclaimer

The technical data contained in this documentation has been researched and compiled with due diligence. However, no guarantee is made as to the currency, accuracy, completeness or quality of the documentation.

1.3. Revision History

Version	Date	Editor	Description
1.5.1	2012-10-10	Andreas Lautner	Complete Rework
1.5.2	2013-10-07	Andreas Lautner	Added Radio Signal Delivery
1.6.1	2014-08-08	Andreas Lautner	Added Regional HD Delivery
1.6.2	2016-02-22	Andreas Lautner	CI Adaption
1.6.3	2016-03-04	Andreas Lautner	CI Adaption
1.6.4	2017-10-04	Manuel Mann	Added Analog Radio

1.4. Verbal Forms for the Expression of Provisions

Verbal form	Indication	Equivalent expression
shall	Requirement	must
shall not	Requirement	must not
should	Recommendation	it is recommended that
should not	Recommendation	it is not recommended that
may	Permission	is allowed
need not	Permission	it is not required that
can	Possibility/Capability	be able to
cannot	Possibility/Capability	be unable to

1.5. References

[1] ITU-R BT.656 “Interfaces for digital component video signals in 525-line and 625-line television systems operating at the 4:2:2 level of Recommendation ITU-R BT.601 (Part A)”

[2] SMPTE 259M “Television – SDTV Digital Signal/Data – Serial Digital Interface”

[3] SMPTE 291M “Ancillary Data Packet and Space Formatting”

[4] SMPTE 272M “Television – Formatting AES/EBU Audio and Auxiliary Data into Digital Video Ancillary Data Space"

[5] IEC 60958-4 “Digital audio interface – Part 4: Professional applications"

[6] ETSI TS 102 366 “Digital Audio Compression (AC-3, Enhanced AC-3) Standard”

[7] ETSI EN 300 706 "Enhanced Teletext specification"

[8] ETSI EN 300 294 "Television Systems; 625-line television Wide Screen Signaling (WSS)”

[9] ITU-R BT.709 “Parameter values for the HDTV standards for production and international programme exchange”

[10] SMPTE 292M “1.5 Gb/s Signal / Data Serial Interface”

[11] SMPTE 299M “24-Bit Digital Audio Format for SMPTE Bit-Serial Interfaces at 1.5 Gb/s and 3 Gb/s”

[12] ETSI EN 300 421 “Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services"

[13] ETSI EN 302 307 “Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interacive Services, News Gathering and other broadband satellite applications”

[14] ISO/IEC 13818-1 | ITU-T H.222.0 "Information technology - Generic coding of moving pictures and associated audio information: Systems"

[15] ETSI EN 300 468 "DVB; Specification for Service Information (SI) and DVB systems"

[16] ETSI EN 101 154 "DVB; Implementation guidelines for the use of MPEG-2 Systems, Video and Audio in satellite, cable and terrestrial broadcasting applications"

[17] ETSI TR 101 211 "DVB; Guidelines on implementation and usage of Service Information (SI)"

[18] ETSI TR 101 290 "DVB; Measurement guidelines for DVB systems"

[19] EN 50093-9 Appendix B “Asynchronous Serial Interface”

[20] ISO/IEC 13818-2 | ITU-T H.262 "Information technology - Generic coding of moving pictures and associated audio information: Video"

[21] ISO/IEC 11172-3 "Information technology - Coding of moving pictures and associated audio for digital storage media at up to about 1,5 MBit/s - Part 3: Audio"

[22] ETSI EN 300 472 "DVB; Specification for conveying ITU-R System B Teletext in DVB bit streams"

[23] ETSI EN 301 775 "DVB; Specification for the carriage of Vertical Blanking Information (VBI) data in DVB bit streams"

[24] ETSI TS 102 809 "Digital Video Broadcasting (DVB); Signalling and carriage of interactive applications and services in Hybrid broadcast/broadband environments"

[25] ISO/IEC 14496-10 „Information technology -Coding of audio-visual objects - Part 10: Advanced video coding“

[26] Vodafone Kabel Deutschland document “Broadcast Signal Handover Interface Points at VF/VFKD Network Nodes (BPOPs)”

[27] Vodafone Kabel Deutschland specification TS T14 0023 “Übergabeparameter für digitale regionale Programme”

[28] Vodafone Kabel Deutschland document “Broadcast Signal Handover – Available Satellite Positions at VF/VFKD Satellite Downlinks”

[29] Thales document “JADE - High Level XML Format description for Service Information Import / Export”

[30] RFC 4607 “Source-Specific Multicast for IP”

[31] ETSI EN 300 743 "Digital Video Broadcasting (DVB);.Subtitling Systems"

[32] SMPTE RP 186:2008 "Video Index Information Coding For 525- And 625-line Television Systems"

1.6. Abbreviations

AIT	Application Information Table
ASI	Asynchronous Serial Interface
CBR	Constant Bit Rate
dBFS	Decibels relative to full scale
DVB	Digital Video Broadcasting
EIRP	Equivalent Isotropically Radiated Power
EIT	Event Information Table
GbE	Gigabit Ethernet
HD	High Definition
IGMP	Internet Group Management Protocol
IP	Internet Protocol
MPTS	Multi Program Transport Stream
NIT	Network Information Table
PAT	Program Association Table
PID	Packet Identifier
PMT	Program Map Table
POC	Playout Center
PSI	Program Specific Information
SD	Standard Definition
SDI	Serial Digital Interface
SDT	Service Description Table
SI	Service Information
SPTS	Single Program Transport Stream
SSM	Source Specific Multicast
STB	Set-top box
TDT	Time and Date Table
TOT	Time Offset Table

TS	Transport Stream
UDP	User Datagram Protocol
VBR	Variable Bit Rate
VF	Vodafone
VFKD	Vodafone Kabel Deutschland
WSS	Wide Screen Signaling

2. Playout Center - National services delivery

This chapter describes the possible types of delivery for the handover of national linear broadcast audio and video signals at the Vodafone Kabel Deutschland Playout Center Frankfurt-Rödelheim “POC Rödelheim” and Vodafone Kabel Deutschland Playout Center Kirchheim “POC Kirchheim”.

National signals **shall** be handed over in the POC Rödelheim at the following location and address (unless otherwise stated in contract referencing this specification):

Vodafone Kabel Deutschland GmbH

Breitlacher Str.96

60489 Frankfurt / Main

Germany

National signals **shall** be handed over in the POC Kirchheim at the following location and address (unless otherwise stated in contract referencing this specification):

Vodafone Kabel Deutschland GmbH

c/o e-shelter colocation GmbH

Ammerthalstr. 10

85551 Kirchheim-Heimstetten

Germany

The following general rules **shall** apply for signal delivery to POC Rödelheim and POC Kirchheim:

- The handover of signals **shall** always take place for redundancy reasons at both Playout Center locations simultaneously.
- SDI and HD-SDI **shall** be the main signal interface at the Playout Center locations.
- The transport of SDI and HD-SDI signals from signal origin to POC Rödelheim and POC Kirchheim **shall** be bit-transparent and mathematical lossless.

The delivered signals **shall** only be signals for national distribution - regional signal handover **shall** take place at Vodafone Kabel Deutschland Backbone Network nodes or TV-PoPs.

The following signal interfaces *can* be used for signal delivery to POC Rödelheim and POC Kirchheim:

- SDI for SD services as specified in chapter “5.1 SDI”
- HD-SDI for HD services as specified in chapter “5.2 HD-SDI”

Optionally a data connection according to “5.6 IP Data Connection for SDI/HD-SDI” or "5.7 ASI Data Connection for SDI/HD-SDI" *can* be used to deliver components or data which *cannot* be transported embedded in SDI/HD-SDI signals.

In exceptional cases and only after approval of Vodafone Kabel Deutschland the following combinations of signal interfaces and encoding profiles *can* be used as replacement or backup for SDI and HD-SDI signals:

- Satellite reception and encoding for SD services as specified in “5.3 Satellite Downlink” and “6.2 National services – SD”
- ASI and encoding for SD services as specified in “5.4 ASI” and “6.2 National services – SD”
- Satellite reception and encoding for HD services as specified in “5.3 Satellite Downlink” and “6.3 National services – HD”
- ASI and encoding for HD services as specified in “5.4 ASI” and “6.3 National services – HD”

As alternative to the long distance transport of signals it is also possible to place broadcast equipment for signal playout or preparation directly into rented rack hotel space at POC Rödelheim and POC Kirchheim. The rack hotel rental conditions *can* be requested from Vodafone Kabel Deutschland.

3. Network Node – Regional services delivery

The Vodafone Kabel Deutschland backbone network consists of several large networks nodes across Germany. As the new Vodafone Kabel Deutschland cable headend architecture is based purely on IP Multicast delivery via the Vodafone Kabel Deutschland backbone network, it is possible to handover regional signals directly at the network nodes.

To allow comfortable and easy access for content providers the network nodes available for the handover of signals are chosen by the following criteria:

- Presence of a variety of line carriers
- Availability of rack space offered by third parties

As the list of network nodes available for signal handover is constantly progressing, an up-to-date list including addresses and more detailed information for the single locations is available from Vodafone Kabel Deutschland on request [26].

The delivered signals **shall** only be signals for regional distribution - national signal handover **shall** take place at the Vodafone Kabel Deutschland Playout Centers.

The following combinations of signal interfaces and encoding profiles *can* be used for signal delivery to Vodafone Kabel Deutschland backbone network nodes:

- IP multicast and encoding for SD services as specified in “5.5 IP Multicast” and “6.1 Regional services – SD”

4. TV-PoP – Regional services delivery

The new IP based architecture of Vodafone Kabel Deutschland cable headends allows a limited directly handover of regional signals. Once a signal is handed over at one cable headend it is possible to use the signal at other cable headends connected to the Vodafone Kabel Deutschland backbone network as well.

The delivered signals **shall** only be signals for regional distribution - national signal handover **shall** take place at the Vodafone Kabel Deutschland Playout Centers.

The following combinations of signal interfaces and encoding profiles *can* be used for signal delivery to TV-PoP cable headends in case the delivered signal **shall** be used for “digital” or “digital and analog” distribution:

- ASI and encoding for analog and digital services as specified in “5.4 ASI” and “6.1 Regional services – SD”

Important Note:

Due to limitations of available signal interfaces at cable headends the following rules **shall** override corresponding definitions in above referenced signal interface and encoding profile subchapters:

- The signal interfaces *cannot* be handed over redundantly at two connectors.
- In case more than one service is handed over via ASI the format of the transport stream **shall** be MPTS instead of SPTS.
- In case more than one service is handed over via ASI and therefore MPTS format is used, the MPEG-2 TS overall bit rate definitions **shall** be valid instead for each single service (including all components) forming the MPTS. Statistical multiplexing or shifting of bit rate between services **shall not** be used.

This specification replaces the Vodafone Kabel Deutschland specification TS T14 0023 [27] in case of a cable headend completely.

5. Signal Interfaces

5.1. SDI

Uncompressed SD signals **shall** be handed over as SDI signals. The following technical parameters **shall** apply:

Physical connection / *Redundancy:*

- The physical connection **shall** be BNC connectors.
- The used cable impedance **shall** be 75 Ohm.
- If not otherwise stated in the delivery contract the signal **shall** be handed over redundant at two BNC connectors.

Transport parameters*:*

- The SDI signal transport **shall** be according to ITU-R BT.656 [1] / SMPTE 259M [2].
- Ancillary data inside the SDI **shall** be according to SMPTE 291M [3].
- The bit rate **shall** be 270 Mbit/s.

Video parameters:

- The video parameters **shall** be according to ITU-R BT.601 [1] / SMPTE 259M [2].
- The video **shall** be delivered in 576i50 with a horizontal resolution of 720 pixels (720 x 576 pixels, interlaced, 50 fields per second).
- The chroma subsampling **shall** be YCrCb 4:2:2 at 10bit per channel.
- Other video formats possible over SDI **shall not** be used.
- The video signal **shall not** contain illegal or invalid levels which would avoid a standard compliant PAL conversion.
- The video signal **shall** carry “16:9 full screen” content in an anamorphic way while signaling 16:9 (see also “Additional parameters”).
- The video signal **shall** carry “4:3 and 16:9 letterbox” content as standard 4:3 signal while signaling 4:3 (see also “Additional parameters”).

Aspect Ratio:

Signalization of aspect ratio *can* be done in following three ways:

- Applying a fixed aspect ratio (i.e. no alteration of aspect ratio).
- Video Index according to SMPTE RP 186:2008 [32] in video line 11.
- WSS aspect ratio information according to ETSI EN 300 294 [8] in video line 23.

Audio parameters:

- Audio **shall** be embedded into ancillary data space according to SMPTE 272M [4].
- Separate audio delivery outside the SDI signal **shall not** be used.
- The audio payload **shall** be AES3 (Stereo) according to IEC 60958-4 [5], AES3 (Dual Mono) according to IEC 60958-4 [5] or AC-3 (2.0 or 5.1) according to ETSI TS 102 366 [6].
- Each single audio payload (AES3 / AC-3) **shall** be permanently available.
- Dolby E **shall not** be used
- The parameters for **AES3 shall** be 48 kHz sampling rate and 20 or 24 bit quantization.

- The maximum audio level for AES3 **shall** be -9 dBFS.
- The maximum of used embedded audio channels pairs **shall** be 4 (group 1 channel pair 1, group 1 channel pair 2, group 2 channel pair 3, group 2 channel pair 4).
- The SDI embedded audio channel pairs **shall** be filled starting group 1 channel pair 1.
- In case AES3 and AC-3 audio is delivered, the embedded audio channel pairs **shall** be filled starting with AES3 audio.
- In case different audio languages are delivered, the embedded audio channel pairs for AES-3 or AC-3 **shall** be filled starting with German audio.
- *Valid audio configuration example: group 1 channel pair 1: AES3 Stereo German, group 1 channel pair 2: AES3 Stereo English, group 2 channel pair 3: AC-3 5.1 German, group 2 channel pair 4: AC-3 2.0 English*

Additional parameters:

Teletext *may* be used as additional component.

Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].

For teletext carriage video lines in the range of 7-15, 19-22, 320-328 and 332-335 **shall** be used.

A use of less than the above specified teletext lines is possible; however in any case as well as on changes actual usage of teletext lines **shall** be communicated to VODAFONE KABEL DEUTSCHLAND.

5.2. HD-SDI

Uncompressed HD signals **shall** be handed over as HD-SDI signals. The following technical parameters **shall** apply:

Physical connection / Redundancy:

- The physical connection **shall** be BNC connectors.
- The used cable impedance **shall** be 75 Ohm.
- If not otherwise stated in the delivery contract the signal **shall** be handed over redundant at two BNC connectors.

Transport parameters:

- The HD-SDI signal transport **shall** be according to ITU-R BT.709 [9] / SMPTE 292M [10].
- Ancillary data inside the HD-SDI **shall** be according to SMPTE 291M [3].
- The bit rate **shall** be 1.485 Gbit/s.

Video parameters:

- The video parameters **shall** be according to ITU-R BT.709 [9] / SMPTE 292M [10].
- The video **shall** be delivered in 1080i50 with a horizontal resolution of 1920 pixels (1920x1080 pixels, interlaced, 50 fields per second).
- The chroma subsampling **shall** be YCrCb 4:2:2 at 10bit per channel.
- Other video formats possible over HD-SDI (e.g. 720p) **shall not** be used.

Audio parameters:

- Audio **shall** be embedded into ancillary data space according to SMPTE 299M [11].
- Separate audio delivery outside the HD-SDI signal **shall not** be used.
- The audio payload **shall** be AC-3 (2.0 or 5.1) according to ETSI TS 102 366 [6].
- Each single audio payload **shall** be permanently available.
- Dolby E and AES3 **shall not** be used.
- The maximum of used embedded audio channels pairs **shall** be 4 (group 1 channel pair 1, group 1 channel pair 2, group 2 channel pair 3, group 2 channel pair 4).
- The HD-SDI embedded audio channel pairs **shall** be filled starting group 1 channel pair 1.
- In case different audio languages are delivered, the embedded audio channel pairs **shall** be filled starting with German audio.
- *Valid audio* configuration *example: group 1 channel pair 1: AC-3 5.1 German, group 1 channel pair 2: AC-3 2.0 English, group 2 channel pair 3: empty, group 2 channel pair 4: empty*

HD-SDI to SDI conversion:

- On request HD-SDI signals *may* be converted by Vodafone Kabel Deutschland to SDI signals to create an SD service carrying the same content.

5.3. Satellite Downlink

The Vodafone Kabel Deutschland TV infrastructure includes two satellite downlinks which allow redundant reception of satellite signals. The first downlink is located at POC Rödelheim, the second downlink is located at POC Kirchheim.

There is a variety of already established and receivable satellite positions. A full list of currently available positions *can* be requested from Vodafone Kabel Deutschland [28].

The following technical parameters and rules **shall** apply:

- The satellite position **shall** be present in the Vodafone Kabel Deutschland's list of available positions.
- The transmission channel coding **shall** be DVB according to ETSI EN 300 421 [12] or DVB-S2 according to ETSI EN 302 307 [13].
- The satellite downlink transmission **shall** be only in the Ku-Band (10.7 – 12.75 GHz).
- The satellite downlink transmission **shall** be only linear vertical or horizontal polarization.
- The satellite downlink transmission **shall not** be via a satellite (spot) beam not intended for reception across Germany.
- The EIRP level of the used satellite beam at POC Rödelheim and POC Kirchheim location **shall** be equal or greater than 44dBW.
- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

5.4. ASI

The following technical parameters and rules **shall** apply:

- The physical connection **shall** be BNC connectors.
- The used cable impedance **shall** be 75 Ohm.
- If not otherwise contractually stated the signal **shall** be handed over redundant at two BNC connectors.
- The Asynchronous Serial Interface (ASI) signal transport **shall** be according to EN 50093-9 Appendix B [19].
- The used TS packet size at the ASI interface **shall** be 188 bytes.
- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

5.5. IP Multicast

The following technical parameters and rules **shall** apply:

- The physical connection interface at Vodafone Kabel Deutschland network nodes **shall** be optical Gigabit Ethernet, Single Mode (SM) 1310 nm.
- If not otherwise contractually stated the signal **shall** be handed over redundant using two connectors.
- All IP multicast signals of one delivering party (carrier, technical service provider or institution) **shall** be bundled on one line.
- The IP transport **shall** be offered as Source Specific Multicast (SSM) according to RFC 4607 [30]. All IP multicast streams **shall** be handed over without any needs for IGMP joins (flooding multicast streams on the interface).
- The Group IP address, Source IP addresses and port numbers *may* be chosen freely by the content signal provider.
- The transport **shall** be encapsulated as IP/UDP/MPEG-2 TS.
- Each UDP frame **shall** consist of a maximum of seven MPEG-2 TS packets.
- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

5.6. IP Data Connection for SDI/HD-SDI

For the delivery of additional service components and/or other data which *cannot* be transported embedded in SDI/HD-SDI signals an IP data connection *can* be added.

The following technical parameters and rules **shall** apply:

- The physical connection interface for IP data connection at Vodafone Kabel Deutschland **shall** be optical Gigabit Ethernet, Multi Mode (MM) 850 nm, LC/PC connectors. Other type of GbE interfaces on request.
- If not otherwise contractually stated the signal **shall** be handed over redundant using two connectors.
- The connection **shall** be able to transport IP Multicast signals according to “5.5 IP Multicast”.
- The connection **shall** be able to transport standard IP Unicast traffic.
- Security and firewall rules for the connection **shall** be agreed between all involved parties.
- Used IP addresses and port for the connection **shall** be agreed between all involved parties.
- The maximum data rate for the data connection **shall** be agreed between all involved parties.
- Additional service components (e.g. DVB subtitles, AIT) **shall** be conveyed as MPEG programs and referenced in PAT/PMT. Each program **shall** contain a PCR that **shall** be identified by the pcr_pid value in the corresponding PMT. For convenience the usage of an SDT is recommended. Other data or tables (e.g. EIT) **shall** be conveyed on reserved DVB PIDs or unique unreferenced PIDs (Ghost PIDs) as agreed between all involved parties.

5.7. ASI Data Connection for SDI/HD-SDI

For the delivery of additional service components or other data which *cannot* be transported embedded in SDI/HD-SDI signals an ASI data connection *can* be added.

The following technical parameters and rules **shall** apply:

- The physical connection **shall** be BNC connectors.
- The used cable impedance **shall** be 75 Ohm.
- If not otherwise contractually stated the signal **shall** be handed over redundant using two connectors.
- The connection **shall** be able to transport MPEG-2 Transport Streams according to “5.4 ASI”.
- The maximum data rate for the data connection **shall** be agreed between all involved parties.
- Additional service components (e.g. DVB subtitles, AIT) **shall** be conveyed as MPEG programs and referenced in PAT/PMT. Each program **shall** contain a PCR that **shall** be identified by the pcr_pid value in the corresponding PMT. For convenience the usage of an SDT is recommended. Other data or tables (e.g. EIT) **shall** be conveyed on reserved DVB PIDs or unique unreferenced PIDs (Ghost PIDs) as agreed between all involved parties.

6. Encoding profiles

6.1. Regional services – SD

Regional SD services *can* be delivered as pre-encoded signals intended for direct insertion into digital signals at the cable headends. Furthermore the same signal *can* be used as source for analog distribution. By using pre-encoded signals it is not necessary to do a second re-encoding by Vodafone Kabel Deutschland, which would imply additional signal delays and degradation of video quality.

As the signals are directly transferred to the cable headend edge devices it is crucial to follow the specified parameters exactly and to perform interoperability testing in collaboration with Vodafone Kabel Deutschland before the signal is used productive or if there are later changes (e.g. usage of a different encoder).

The specified technical parameters apply for SD services only.

The following technical parameters **shall** apply:

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].
- The MPEG-2 TS packet size **shall** be 188 bytes.
- The transport stream **shall** be a Single Program Transport Stream (SPTS) carrying only one service.
- The overall bit rate of the delivered MPEG-2 TS **shall** be constant (CBR).
- The overall bit rate of the carried MPEG-2 TS **shall** be 4 Mbit/s

Video parameters:

- The video codec **shall** be MPEG-2 Main Profile at Main Level according to ISO/IEC 13818-2 [20].
- The video bit rate **shall** be chosen as high as possible within the limits given by the overall MPEG-2 TS bit rate.
- The video bit rate **shall** be constant (CBR).
- The video **shall** be delivered in 576i50 with a horizontal resolution of 720 pixels (720 x 576 pixels, interlaced, 50 fields per second).
- The chroma subsampling **shall** be 4:2:0.
- The GOP **shall** be M=3 N=12.
- 16:9 video **shall** be encoded anamorphic.
- The aspect ratio information **shall** be correctly signalized in the video elementary stream sequence header.

Audio parameters:

- The audio codec **shall** be MPEG-1 audio Layer 2 according to ISO/IEC 11172-3 [21].
- The audio sampling rate **shall** be 48 kHz.
- The audio bit rate **shall** be constant.
- The audio bit rate for stereo (L/R) **shall** be 192 kbit/s.

- The audio bit rate for mono **shall** be 96 kbit/s.
- The maximum audio level **shall** be -9 dBFS.
- The audio/video delay **shall** be in the range of +/- 10 ms.

Teletext parameters:

- Teletext *may* be used as additional component.
- Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].
- Teletext **shall** be delivered according to ETSI EN 300 472 [22].
- Teletext components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- Teletext components **shall** be signalized with a DVB teletext_descriptor.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14]
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The following tables **shall** be present: PAT, PMT, SDT.
- The following tables *may* be present: TDT, TOT
- EIT p/f (actual transport stream) **shall** be present.
- EIT schedule (actual transport stream) *may* be present.
- EIT_present_following_flag and EIT_schedule_flag **shall** be signalized correctly in SDT.
- TransportStreamID (TSID), OriginalNetworkID (ONID), ServiceID (SID) and PacketIDentifier (PID) for PMT and elementary streams **shall** be requested by the content provider from Vodafone Kabel Deutschland for each stream to be delivered.
- PAT and PMT repetition interval **shall** be 100ms.
- SDT repetition interval **shall** be 1000ms.
- Service names *should not* be longer than 16 characters (including spaces).
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Kabel Deutschland.

Other parameters:

- Other service components (e.g. DVB AIT for HbbTV) **shall** be chosen and tested in close collaboration with Vodafone Kabel Deutschland to secure interoperability.

In case of DVB HbbTV:

- DVB HbbTV and DVB AIT shall comply with ETSI TS 102 809 [24].
- DVB AIT components **shall** be signalized with ISO stream_type '0x05' [private sections].
- DVB AIT components **shall** be signalized with a DVB application_signalling_descriptor and application_type set to DVB registered MHP_Application_Type_ID '0x10' (decimal value '16') [HBBTV]. See also http://www.dvbservices.com/identifiers/mhp_app_type_id

6.1.1. Signal delivery for analog distribution only

If the signal delivery is intended for analog distribution only, following parameters *can* apply:

Transport parameters:

- The overall bit rate of the carried MPEG-2 TS *can* be 7 Mbit/s

Video parameters:

- The video bit rate *can* be 6 Mbit/s.

PSI/SI parameters:

- EIT p/f (actual transport stream) *need not* be delivered.

6.2. Regional services – HD

Regional HD services **shall** be delivered as pre-encoded signals intended for direct insertion into digital signals at the cable headends.

As the signals are directly transferred to the cable headend edge devices it is crucial to follow the specified parameters exactly and to perform interoperability testing in collaboration with Vodafone Kabel Deutschland before the signal is used productive or if there are later changes (e.g. usage of a different encoder).

The specified technical parameters apply for HD services only.

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].
- The MPEG-2 TS packet size **shall** be 188 bytes.
- The transport stream **shall** be a Single Program Transport Stream (SPTS) carrying only one service.
- The overall bit rate of the delivered MPEG-2 TS **shall** be constant (CBR).
- The overall bit rate of the carried MPEG-2 TS **shall** be 7 Mbit/s

Video parameters:

- The video codec **shall** be H.264 High Profile Level 4 according to ISO/IEC 14496-10 [25].
- The video bit rate **shall** be chosen as high as possible within the limits given by the overall MPEG-2 TS bit rate.
- The video **shall** be delivered in 1080i50 with a horizontal resolution of 1920 pixels (1920x1080 pixels, interlaced, 50 fields per second).
- The video bit rate **shall** be constant (CBR).
- The chroma subsampling **shall** be 4:2:0.
- The video **shall** be encoded anamorphic.

Audio parameters:

- The audio codec **shall** be AC-3 (2.0 or 5.1) according to ETSI TS 102 366 [6].
- The maximum bit rate for AC-3 **shall** be 384 kbit/s.
- AC-3 components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- AC-3 components **shall** be signalized with a DVB AC-3_descriptor.
- The audio/video delay **shall** be in the range of +/- 10 ms.

Teletext parameters:

- Teletext *may* be used as additional component.
- Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].
- Teletext **shall** be delivered according to ETSI EN 300 472 [22].
- Teletext components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- Teletext **shall** be signalized with a DVB teletext_descriptor.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14].
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The following tables **shall** be present: PAT, PMT, SDT
- The following tables *may* be present: TDT, TOT
- EIT p/f (actual transport stream) **shall** be present.
- EIT schedule (actual transport stream) *may* be present.
- EIT_present_following_flag and EIT_schedule_flag **shall** be signalized correctly in SDT.
- PAT and PMT repetition interval **shall** be 100ms.
- SDT repetition interval **shall** be 1000ms.
- Service names **shall not** be longer than 16 characters (including spaces).
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Kabel Deutschland.

Other parameters:

- Other service components (e.g. DVB subtitles, DVB AIT for HbbTV, private data delivery) or other PSI/SI tables **shall** be chosen and tested in close collaboration with Vodafone Kabel Deutschland to secure interoperability.

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- DVB subtiling components **shall** be signalized with a DVB subtiling_descriptor.

In case of DVB HbbTV:

- DVB HbbTV and DVB AIT shall comply with ETSI TS 102 809 [24].
- DVB AIT components **shall** be signalized with ISO stream_type '0x05' [private sections].
- DVB AIT components **shall** be signalized with a DVB application_signalling_descriptor and application_type set to DVB registered MHP_Application_Type_ID '0x10' (decimal value '16') [HBBTV]. See also http://www.dvbservices.com/identifiers/mhp_app_type_id

6.3. National services – SD

The following technical parameters **shall** apply:

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

Video parameters:

- The video codec **shall** be MPEG-2 Main Profile at Main Level according to ISO/IEC 13818-2 [20]. H.264 according to ISO/IEC 14496-10 [25] on request only.
- The video **shall** be delivered in 576i50 with a horizontal resolution of 720 pixels (720 x 576 pixels, interlaced, 50 fields per second).
- The chroma subsampling **shall** be 4:2:0 (4:2:2 on request).
- The video **shall** have a minimum bit rate of 7.0 Mbit/s CBR or equivalent statistical multiplexing rate.

Audio parameters:

- The audio codec **shall** be MPEG-1 audio Layer 2 according to ISO/IEC 11172-3 [21].
- The minimum audio bit rate for stereo (L/R) **shall** be 192 kbit/s.
- The maximum audio level **shall** be -9 dBFS.
- An additionally audio codec *may* be AC-3 (5.1) according to ETSI TS 102 366 [6].
- AC-3 components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- AC-3 components **shall** be signalized with a DVB AC-3_descriptor.
- The audio/video delay **shall** be in the range of +/- 10 ms.

Teletext parameters:

- Teletext *may* be used as additional component.
- Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].
- Teletext **shall** be delivered according to ETSI EN 300 472 [22].
- Teletext components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- Teletext components **shall** be signalized with a DVB teletext_descriptor.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14].
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The following tables **shall** be present: PAT, PMT, SDT.
- The following tables *may* be present: NIT, TDT, TOT, EIT.
- PAT and PMT repetition interval **shall** be 100ms.
- SDT repetition interval **shall** be 1000ms.
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Kabel Deutschland.

Other parameters:

- Other service components (e.g. DVB subtitles, DVB AIT for HbbTV, private data delivery) or other PSI/SI tables **shall** be chosen and tested in close collaboration with Vodafone Kabel Deutschland to secure interoperability.

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- DVB subtiling components **shall** be signalized with a DVB subtiling_descriptor.

In case of DVB HbbTV:

- DVB HbbTV and DVB AIT shall comply with ETSI TS 102 809 [24].
- DVB AIT components **shall** be signalized with ISO stream_type '0x05' [private sections].
- DVB AIT components **shall** be signalized with a DVB application_signalling_descriptor and application_type set to DVB registered MHP_Application_Type_ID '0x10' (decimal value '16') [HBBTV]. See also http://www.dvbservices.com/identifiers/mhp_app_type_id

Encrypted signal delivery:

- In case the signal is encrypted on the satellite delivery path, the content provider **shall** deliver a minimum of 4 Professional CAMs including smartcards suitable for use in professional IRDs.

6.4. National services – HD

The following technical parameters **shall** apply:

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

Video parameters:

- The video codec **shall** be H.264 High Profile Level 4 according to ISO/IEC 14496-10 [25].
- The video **shall** be delivered in 1080i50 with a horizontal resolution of 1920 pixels (1920x1080 pixels, interlaced, 50 fields per second).
- The chroma subsampling **shall** be 4:2:0 (4:2:2 on request).
- The video **shall** have a minimum bit rate of 15.0 Mbit/s CBR or equivalent statistical multiplexing rate.

Audio parameters:

- The audio codec **shall** be AC-3 (2.0 or 5.1) according to ETSI TS 102 366 [6].
- The minimum bit rate for AC-3 **shall** be 384 kbit/s.
- AC-3 components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- AC-3 components **shall** be signalized with a DVB AC-3_descriptor.
- The audio/video delay **shall** be in the range of +/- 10 ms.

Teletext parameters:

- Teletext *may* be used as additional component.
- Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].
- Teletext **shall** be delivered according to ETSI EN 300 472 [22].
- Teletext components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- Teletext **shall** be signalized with a DVB teletext_descriptor.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14].
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The following tables **shall** be present: PAT, PMT, SDT.
- The following tables *may* be present: NIT, TDT, TOT, EIT
- PAT and PMT repetition interval **shall** be 100ms.
- SDT repetition interval **shall** be 1000ms.
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Kabel Deutschland.

Other parameters:

- Other service components (e.g. DVB subtitles, DVB AIT for HbbTV, private data delivery) or other PSI/SI tables **shall** be chosen and tested in close collaboration with Vodafone Kabel Deutschland to secure interoperability.

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- DVB subtiling components **shall** be signalized with a DVB subtiling_descriptor.

In case of DVB HbbTV:

- DVB HbbTV and DVB AIT shall comply with ETSI TS 102 809 [24].
- DVB AIT components **shall** be signalized with ISO stream_type '0x05' [private sections].
- DVB AIT components **shall** be signalized with a DVB application_signalling_descriptor and application_type set to DVB registered MHP_Application_Type_ID '0x10' (decimal value '16') [HBBTV]. See also http://www.dvbservices.com/identifiers/mhp_app_type_id

Encrypted signal delivery:

- In case the signal is encrypted on the satellite delivery path, the content provider **shall** deliver a minimum of 4 Professional CAMs including smartcards suitable for use in professional IRDs.

6.5. Radio Services

6.5.1. Digital Radio

The following technical parameters **shall** apply:

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

Audio parameters:

- The audio codec **shall** be MPEG-1 audio Layer 2 according to ISO/IEC 11172-3 [21].
- The minimum audio bit rate for stereo (L/R) **shall** be 192 kbit/s.
- The maximum audio level **shall** be -9 dBFS.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14].
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The service type **shall** be 0x02 (digital radio sound service)
- The following tables **shall** be present: PAT, PMT, SDT.
- The following tables *may* be present: NIT, TDT, TOT, EIT.
- PAT and PMT repetition interval **shall** be 200ms.
- SDT repetition interval **shall** be 1000ms.

Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Kabel Deutschland.

6.5.2. Analog Radio

The following technical parameters **shall** apply:

- The radio signal **shall** be in UKW from 87,5 MHz to 108 MHz
- The signal strength **shall** be at 30 – 100 dbuV for Stereo.
- The radio service signal **shall** be a standard analog stereo signal with 40 Hz to 15 kHz.
- The radio service **shall** contain RDS data.

7. EPG and Service Information delivery

7.1. National services

EPG and Service Information data for national services *can* be delivered using one of the following ways:

- Delivery of DVB EIT data within the delivered signal (in case of SDI or HD-SDI signals, delivery within a separate signal via satellite or ASI line is also possible)
- via mediapress /pps
- via Gracenote
- E-Mail or FTP Upload in the format specified in “JADE - High Level XML Format description for Service Information Import / Export” [29]. The specification and further information *can* be requested from Vodafone Kabel Deutschland.

Only the delivery via DVB EIT within the signal, allows an immediate reflection of EPG data changes within the Vodafone Kabel Deutschland network.

All EPG TV-data are fed automatically into Vodafone Kabel Deutschland EPG barker which is used by Vodafone Kabel Deutschland set-top-boxes for displaying a comprehensive EPG.

7.2. Regional services

EPG and Service Information data for regional services *can* be delivered using one of the following ways:

- EIT p/f (actual transport stream) **shall** be present within the delivered signal and will be displayed on all set-top-boxes.
- EIT schedule (actual transport stream) *may* be present within the signal. However EIT schedule information will only be available on few set-top-boxes because Vodafone Kabel Deutschland set-top-boxes are using the Vodafone Kabel Deutschland EPG Barker. Therefore it is not suggested to use this method.

7.3. EPG data for PVRs (tvtv)

Vodafone Kabel Deutschland set-top-boxes having recording capabilities (Personal Video Recorder PVR) using a different mechanism for EPG data delivery in order to allow a schedule reaching further into the future and to provide more detailed program information. The underlying service for this functionality is the tvtv EPG service. To deliver also EPG data to PVRs the service provider has to setup the service together with gracenote. More information regarding tvtv delivery *can* be requested from Vodafone Kabel Deutschland.

8. DRM information

For specific information on metadata or controlling data related to DRM delivered typically via Conditional Access Systems please contact Vodafone Kabel Deutschland for more information.