Guidelines

TPRF-HDTV

2016

for the Production of Television Programs for ARD, ZDF and ORF

Status of:
November 2016

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This document was prepared on behalf of the Conference of Television Operations Managers (AG FSBL) by the “Technical Production Guidelines for Television” (TPRF) work group. It represents the status of their work in November 2016, as approved by the AG FSBL.

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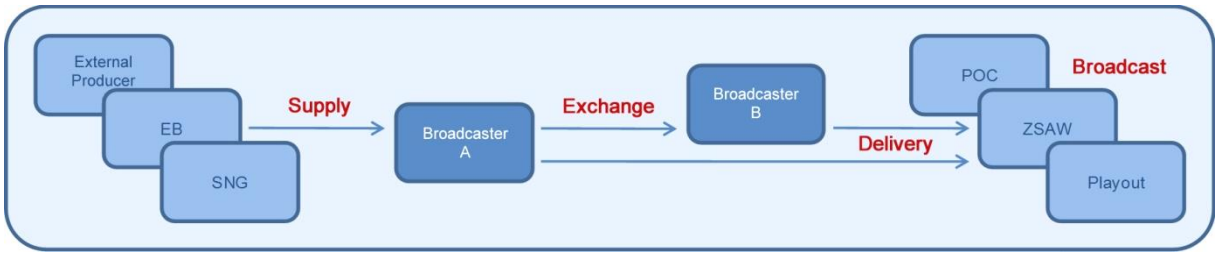
Technical guidelines and standards referred to in these guidelines are available from the reference sources listed at the end of this document.

Introduction

These guidelines cover all high-definition (HD) program material delivered or supplied to, exchanged with or broadcast by ARD, ZDF, or ORF.

In principle, any such program material has to be available in a format suitable for broadcast.



For the production of such program material, compliance with the agreements detailed in this document is mandatory, both for in-house processing and the commissioning of outside contractors.

By and large, the key technical details of the specifications listed in these guidelines follow the recommendations of the European Broadcasting Union (EBU) and the guidelines of ARD, ZDF, and ORF, including the standards that are referenced in the text.

The definition of the technical parameters listed in these guidelines is based on the HDTV scanning rasters specified for Europe in EBU Tech 3299. Corresponding specifications for these scanning rasters can be found in SMPTE 274M and 296M, and for the HD serial digital interface (HD-SDI) in SMPTE 292M.

Procedures and formats for shooting, post-production, and supply shall be defined in individual agreements with contractees.

Exceptions from these specifications are only permissible upon written mutual agreement.

Important Changes in This Edition

The Technical Guidelines – HDTV are periodically revised by the TPRF Working Group and aligned with the current technical standards. Relevant amendments, modifications, and revisions are noted in each new edition. The specifications in each edition remain in force up to the publication of the next edition. Interim versions of the TPRF-HDTV Guidelines contain amendments and revisions for purposes of information and clarification as well as minor modifications, and they are identified by a new status date.

TPRF Reorganized

For the current edition, the TPRF Guidelines have been thoroughly revised and restructured, in order to account for the constantly evolving demands and conditions of the production environment, among other factors. Here is a brief overview of the new chapter structure:

As in previous editions, chapter 1 describes the basic quality requirements for television productions. Chapter 2 summarizes all the parameters for video and audio essence, interfaces, and carrier formats, thus specifying the characteristics of the various supply formats. Chapter 3 describes regulations and guidelines for the actual production. The subchapters are arranged roughly in the order of a typical production, including outside broadcasts and live contribution. Chapter 4 lists the formats permitted for various application scenarios and describes the extent of and specifications for delivery, referencing the formats described in chapter 2. Chapter 5 defines the archiving format for HDTV.

Introduction of the Media Data Card

For the supply of program material both in-house (internal) and from outside sources (external), a uniform Media Data Card has been developed, which may be interpreted as an electronic version of – and eventual replacement for – the familiar VTR record card. It was agreed that the Media Data Card should be handled separately from the MXF file, in order to avoid, for example, problems with transcoders, MXF fixers, or files in automated processing, and to make it conveniently available within an office network – for executive producers, for instance – without the large essence file.

The specifications of the Media Data Card may be downloaded free of charge from the IRT Website (Weblink: Medienbegleitkarte, irt.de – in German). Its use will be mandatory when using Medienfiletransfer 2.0.

For further information, please refer to item 2.7.

Introduction of Medienfiletransfer 2.0

The ARD file transmission system (Video File Transfer – VFT) is currently replaced by a system called Medienfiletransfer 2.0 (MFT 2.0). The new system is expected to be implemented during 2017.

In the new system MFT 2.0 all meta data including information about the delivery process as well as the delivered essence, will be transmitted within an XML file. Additionally, subtitle files will be transmitted via the MFT 2.0 in future.

In this document the notation „VFT / MFT 2.0“ is used as a placeholder for the file transfer system used at a time. This is the VFT until the system is replaced, and the MFT 2.0 afterwards.

Introduction of the MXF Profiles

ARD and ZDF have decided to introduce clearly defined profiles for the supply and exchange of MXF files. For this purpose, the six ARD_ZDF_HDF profiles for the MXF file format were defined and published, each forming one of the standard's subsets and thus covering the broadcaster's video codecs and formats currently in use. The publication aims at improving the interoperability between different MXF applications.

The profiles (at the time of publication in version 1.1) should be used from now on. As of 1 January 2017, they are a mandatory requirement for the supply of external production as well as for the exchange between broadcasters. From this date on, all MXF files supplied or exchanged have to comply with one of the six profiles.

The specifications for MXF profiles may be downloaded from the IRT Website (Weblink: MXF Profile, irt.de).

For further information, please refer to item 2.4.

Smart Production

Smart productions are usually planned with the intention of producing in a different, simpler, and/or more cost-efficient way. In general, TPRF Guidelines also apply to smart productions. However, these productions require – even more than programs produced in the traditional way – pre-production coordination between all departments involved in the workflow, in order to discuss the opportunities as well as limitations that a smart production might entail.

The current edition includes a new chapter for this particular production approach, elaborating the particularities of smart productions, in order to ensure a smooth production process.

For further information, please refer to item 3.2.

IP Contribution via Public Networks

The significance of IP-based signal contribution from the production site to the control room via public networks is growing rapidly, as cellular networks and Internet lines keep increasing their bandwidths and availability.

In this edition, a chapter on contribution via public networks was added (cf. item 3.5.4), describing the key parameters for transmission options via public networks (e.g. LTE, DSL connections) and listing a variety of applications (LiveU, *Tagesschau* app). In addition, the chapter gives basic guidelines on the use of these transmission paths.

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1 Basic Quality Requirements

1.1 Quality for the Viewer

The audience's viewing and listening habits demand the best possible video and audio quality. In order to achieve this, the technical provisions for audio and video recording as well as acoustics and lighting conditions have to be of suitable quality and used to their best effect.

Considering the conceptual ideas and expectations on the part of the executive producers as well as the variety of new options, technical implementation needs to observe a number of basic requirements. The desired result can only be achieved, if potential technical challenges during actual production are addressed in the earliest pre-production phases.

As early as the production stage, it should be taken into consideration whether the employment of certain artistic devices, the use of low-quality equipment, or the inappropriate application of certain technologies might lead to effects down the distribution chain that would be perceived as technical flaws, for example:

- video noise may lead to a loss of resolution down the line;
- numerous dark portions of the frame may create blocking artifacts down the line;
- a downmix from multi-channel to stereo sound may compromise the intelligibility of speech on the user device.

Each stage of the production chain – including acquisition, production, and contribution – needs to meet the quality target set for the program. Even in a tapeless production chain, copying and cascading effects have to be avoided wherever possible.

1.2 Accessibility

People with handicaps should also be able to benefit from the technical innovations introduced in public-television programming. ARD, ZDF, and ORF are pioneers in barrier-free access to media, e.g. through closed-captioning, signing and audio description.

All program suppliers, both in-house and outside, are therefore urged to consider the needs of the deaf and hard-of-hearing as well as the blind and visually impaired when producing titles, subtitles, captions, and graphics (item 2.1.5), off-camera narration and sound mixes (item 2.1.1).

Even after the transition of audio leveling from QPPM to loudness-based leveling, programs must not contain any unintentional alterations of the acoustic ambiance and must have a balanced mix throughout. In particular, a version deemed suitable for broadcast must always favor speech intelligibility in its audio mix.

Closed captions are intended to provide hearing-impaired viewers with the same level of information as non-handicapped audiences. In order to achieve this, the nine regional broadcasters of ARD, ARD Text, ORF, SRF, and ZDF have specified certain basic standards for the display of subtitles and captions. Closed-captioned productions should follow these guidelines (cf. item 2.6).

The goal of audio description is to allow blind and visually impaired audiences to enjoy motion pictures in a way that is similar to the experience of the seeing audience, without detracting from the artistic character of the film.

The nine regional broadcasters of ARD, ORF, SRF, ZDF, as well as Deutsche Hörfilm GmbH, Hörfilm e.V., and audioskript have therefore agreed on a number of basic principles for the production of audio

descriptions in the German-speaking world (Weblink: Vorgaben Audiodeskription, ndr.de – in German).

2 Technical Parameters of Television Production

2.1 Video

In general, any program commissioned has to be produced in HD throughout, i.e. from shooting through editing all the way to its delivery. Basic Quality Requirements (cf. item 1) have to be fulfilled.

Television programs have to be full-frame, i.e. the active video content has to fill the entire 16:9 image area without any pillarboxing or letterboxing. If material with other aspect ratios has to be used (e.g. 4:3 or CinemaScope), the specifications listed under item 3.6.2 have to be observed.

The parameters described hereunder are meant to ensure a quality standard suitable for television, in particular with regard to subsequent processing stages and the broadcast path.

2.1.1 HD Format

EBU Tech Doc 3299 specifies the scanning rasters relevant to Europe. In order to avoid quality-reducing conversion processes, the scanning raster of the target format should be employed throughout the entire production chain.

The 1080i/25 HD format has

- a resolution of 1,920 pixels × 1,080 pixels
- an aspect ratio of 16:9
- a color subsampling rate of 4:2:2
- a frame rate of 25 frames per second interlaced (50 fields)

The 720p/50 HD format has

- a resolution of 1,280 pixels × 720 pixels
- an aspect ratio of 16:9
- a color subsampling rate of 4:2:2
- a frame rate of 50 frames per second

The 1080p/25 format has to be regarded as a special format and requires a separate arrangement on delivery, in order to avoid additional costs and/or technical quality issues. In order to avoid problems down the process chain, 1080p/25 material has to be transmitted as 1080psf/25 and signaled and processed as 1080i/25 (cf. Appendix 6.2).

2.1.2 Compression Formats

The following compression formats are permitted in the file-based production chain (henceforth also called production codecs or mainstream codecs):

- MPEG-2, 4:2:2, 8 bit, long GOP, 50 Mbit/s (*XDCAM-HD422* implementation);
- AVC-I 100, 4:2:2, 10 bit, I-Frame, 112 Mbit/s (*SMPTE RP 2027*).

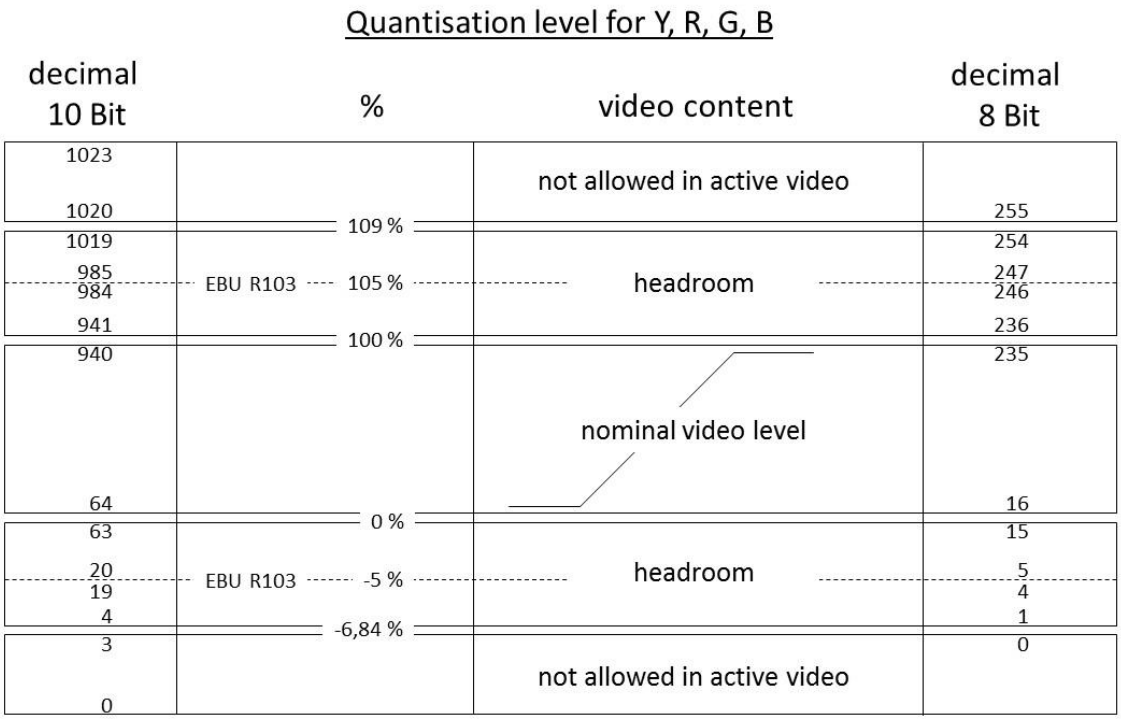
It has to be ensured during production that the master has the least possible number of generations (re-encodings), and any kind of format or frame-rate conversion has to be avoided.

If codecs other than those listed above have to be employed in production, it has to be ensured that they have at least a quality equivalent to that of the production codecs.

2.1.3 Video Level and Gamut (Illegal Signals)

Digital signals are assessed on the basis of the *ITU-R BT709-6* recommendation.

Video levels of the material supplied have to fall within the specified range, in order to allow the program to be used without any further calibration. Any signal outside the specified range will be considered a gamut error.



In practice, it is difficult to avoid that signals occasionally slightly overshoot the specified limits. It is therefore customary to allow for a small tolerance, which is defined as follows in *EBU R 103*:

- The RGB components and the resulting luminance (Y) signal have to fall between –5% and 105% (–35mV and 735mV).

The headroom provided for in the ITU specifications is intended for unavoidable short gamut overshoot errors, e.g. during the transient state of filters, unexpected peaks caused by camera pans, etc. This headroom must not be used (i.e. exhausted) for artistic purposes. It is important that for any program material intended for exchange or broadcast, the nominal video level exceeds the signal levels specified in *ITU-R BT.709* only for a very short period

The values defined as Time Reference Signal (TRS) are absolutely prohibited in the video signal and have to be “clipped.” In 8-bit systems, they correspond to values between 0 and 255; in 10-bit systems, they correspond to the ranges 0–3 and 1020–1023.

Note

Digital video levels are usually measured by means of a device that displays the signal curve, i.e. a traditional waveform monitor. This device displays the results either in millivolts (mV), emulating an analog signal, or as a percentage of the permissible levels.

The limits of the signal levels are defined in reference to a nominal black and white level. The black level for the R, G, and B signals is zero (0% or 0 mV), and the white level for all three signals is 100% or 700 mV.

Minor over- or undershoot might be filtered out prior to measurement. This will result in errors being registered only when out-of-gamut signals occur over more than 1% of the image area, since many monitoring devices are set up according to this specification.

Note

At this point, it should also be mentioned that not all signal level combinations admissible on the analog and digital component level are necessarily "legal" signal levels.

Experience has shown that these "illegal" signal states occur with production equipment that performs internal signal manipulations or creates signals on the Y, C_R, C_B level, e.g. computers, paint systems, digital effects hardware, component mixers, and character generators. The "super black levels" used in analog technology as keying signals are also not suitable for the digital domain.

A reliable signal legality check can be performed by an oscilloscopic RGB representation. The validity of signals may be monitored by means of a suitable meter or a monitor that indicates a violation of the RGB color space in relation to its duration.

Note

Experience has shown that so-called color gamut "legalizers" should be used with caution, as they may create artifacts in the image that are more visible than the original color gamut errors (cf. EBU R 103, "Tolerances on 'illegal' colours in television").

2.1.4 Image Center and Safe Areas

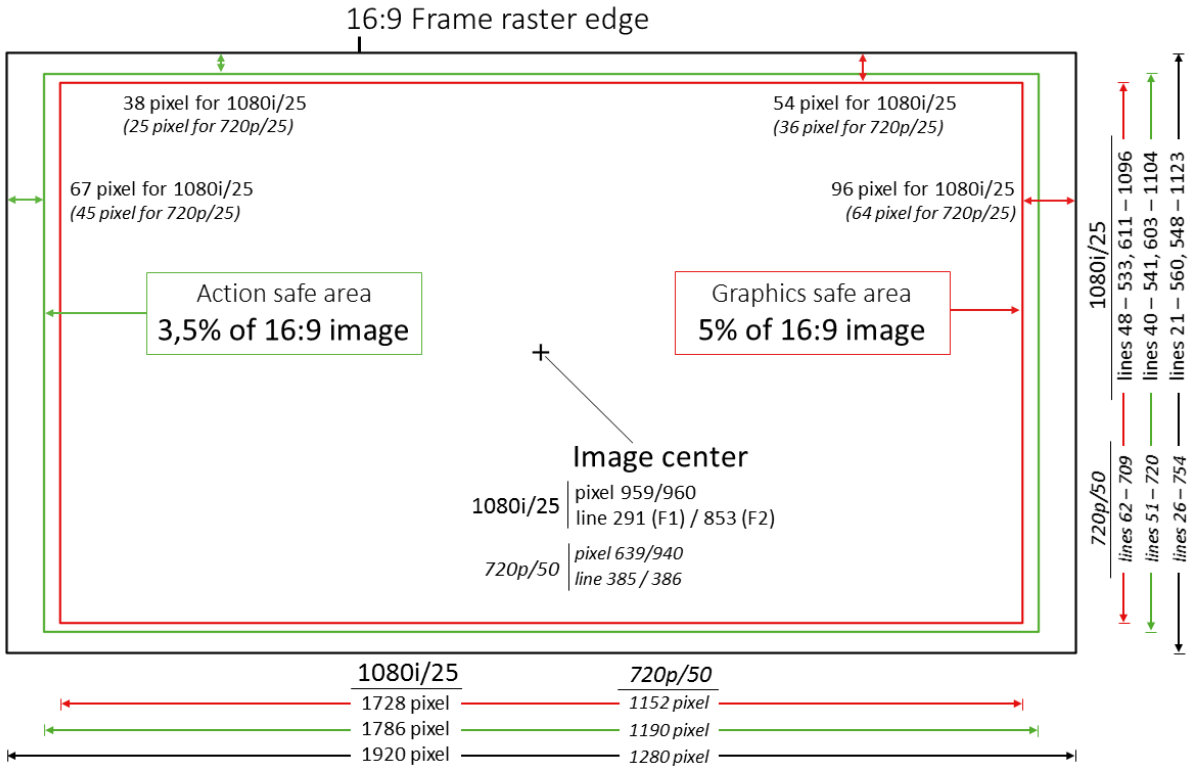
In view of the increasing number of consumer-side flat screens with the option of 1:1 pixel mapping (true pixel), it is vital to work with extreme diligence on the production side, which means that active contents has to flawlessly fill the entire image area that is transmitted, from edge to edge.

Note

In 1:1 pixel mapping, the borders on all four edges of the frame are no longer areas hidden from view by the consumer' display, as the entire active picture area is displayed without any overscan.

The relevant specifications for image center and safe areas have been specified in *EBU R 95*, “Safe areas for 16:9 television production.”

- **Image Center:** In general, the relation between the sync(hronization) signal and center of the active picture (image center) should not be altered during the production process, e.g. by editing equipment.
- **Action-Safe Area:** In order to ensure that the relevant part of the image is displayed properly on home panels commonly used today, safety margins of 3.5% have to be kept clear on all sides, in compliance with *EBU R 95*.
- **Graphics-Safe Area:** Titles, captions, and graphics for HD should be displayed within the specified limits of the graphics-safe area, meaning that safety margins of 5% have to kept clear on all sides.



2.1.5 Titles, Captions, and Graphics

In order to ensure the legibility of titles and graphics on all consumer displays, these elements should be produced with due diligence. This requires designers to use only large, readable fonts, which also increase the program’s accessibility.

Due to the simulcast of HD and SD, graphics generated in HD have to be downward-compatible to the SD domain, where characters at least 21 or 22 lines high in the 576i/25 SD scanning raster have been established. In HD terms, this translates into a character height of 40/41 lines in the 1080i/25 HD raster and 26/27 lines in the 720p/50 HD raster.

In order to ensure the legibility of crawls and scrolls on flat screens, in addition to the minimum character size, certain maximum crawl speeds must be observed.

In general, crawls and scrolls should be produced in the same raster format as the program content. Converted graphics and titles may already display very noticeable effects in the master, such as strong vertical or horizontal judder. Moreover, converted graphics will cause additional quality issues in any subsequent format conversions that may be necessary.

> ***Note***
>
> A special legibility test has been developed to determine these thresholds (cf. EBU Tech Doc 3325, 1.2 “Test pattern,” test sequence no. 6), which permits the vertical and horizontal scrolling of text in various sizes and at various speeds across the monitor. This allows a subjective assessment by running the test on various monitors.
>
> *Test patterns in electronic form may be downloaded from the EBU Publication site. (Weblink: Studio monitors – test patterns, tech.ebu.ch)*

2.2 Audio

The quality of recordings has to match state-of-the-art studio technology. Audio recordings have to correspond to video content in a meaningful way. They must not contain any unintentional changes in the acoustic atmosphere and have a balanced mix ratio throughout. The mix ratio must always favor speech intelligibility.

2.2.1 Speech Intelligibility

Along the entire production chain, the intelligibility of the spoken should always be given priority over dramatic effects achieved by music or high dynamics. Good speech intelligibility improves accessibility for the hearing-impaired.

For this purpose, the following recommendations should be observed:

- Pay attention to clear elocution and articulation.
- Speak directly into the camera, in order to facilitate lip-reading.
- Choose locations and situations in which background noises (traffic, fountains, air condition, screaming, applause, etc.) can be avoided, if possible.
- Adapt microphonics to the recording situation (e.g. use of handheld or headset microphones in case of background noise).
- Use subtitles in case of accents or dialects.
- Lower original sound significantly in case of voice-over translation.
- Music and noise should be 7 to 10 LU below speech.
- Choose music creatively and purposefully, in order to avoid distracting the viewer.
- The mix should be listened to and checked in consumer situations.

Multi-channel production (5.1 oder 3.0) may also contribute to intelligibility, since it allows an optimization of the individual listening conditions on the consumer side via a separate speech channel.

The document entitled *Sprachverständlichkeit im Fernsehen* (“Speech Intelligibility in Television”), published by ARD/ZDF, contains further in-depth information and recommendations (Weblink: Sprachverständlichkeit im Fernsehen, irt.de – in German only).

2.2.2 Audio Systems in Video Production

2.2.2.1 Stereo

Two-channel stereophonic sound is the standard format for media production and distribution.

2.2.2.2 Multi-Channel Audio

Multi-channel audio is optional and should preferably be employed in genres where the use of center and surround channels makes sense, e.g. in sports, entertainment shows, feature movies, musical productions, and documentaries.

- The exchange of multi-channel productions should be conducted with discrete PCM signals, if a sufficient number of audio channels is available.
- Alternatively, the exchange may be conducted in the Dolby E format, e.g. if the number of available audio channels is insufficient.

Further specifications and information has been summarized under item 2.2.4.

2.2.2.3 Other Systems

The following paragraphs describe historical (legacy) audio systems that are no longer in use but that will be encountered in considerable quantities in the broadcasters' archives.

Mono

Monophonic sound-pickup systems with only one audio channel have been replaced in television studios by multi-channel audio systems.

For broadcasting, monaural productions retrieved from the public broadcasters' archives must be copied to two adjacent tracks ("dual mono"), in compliance with the current audio track allocation system, and then leveled according to item 2.2.3.5. In order to assure full stereo compatibility, the two tracks carrying the mono audio signal have to be absolutely identical and in phase.

Dual-Channel Audio (Zweikanalton)

Zweikanalton ("two-channel sound"), or A2 Stereo, is a legacy technology with two independent mono channels. In television production, the two available channels were used for carrying the original and dubbed versions of a program.

Productions with dual-channel audio retrieved from the public broadcasters' archives must be reprocessed for broadcasting in compliance with the currently permissible audio track allocations.

Dolby Surround

Dolby Surround, or Dolby ProLogic, are no longer used in production but may be found in file footage. The ProLogic stereo track may be treated as an ordinary stereo track. In a stereo decoder, however, it will contain a small portion opposite in phase, while a ProLogic decoder will decode the track correctly. The decision whether this condition is tolerable has to be made in each individual case.

2.2.3 Specifications and Parameters

2.2.3.1 Encoding of Audio Signals

In a regular production chain and in predefined exchange formats, audio signals are stored as PCM raw data.

- The sampling frequency must be 48 kHz.
- The sampling depth must be 24 bits.

A data reduction is only permissible in predefined cases, e.g. in satellite (SNG) or cable contribution, or in case of Dolby-E-encoded multi-channel sound.

2.2.3.2 Mono Compatibility of Stereo Signals

In order to allow for distribution and reception situations with only one speaker, it is mandatory for stereophonic productions to ensure mono compatibility, in order to avoid the overlapping or cancellation of signals in certain usage/reception scenarios.

This has to be verified via an adding stage, not via a 90-degree filter.

The following statements can be made about the degree of correlation between two channels:

Signal Type	degree of correlation
mono	1
stereo (optimal)	0,3 … 0,7
left and right decorrelated	0
stereo (mainly negative correlation)	-0,3 … -0,7
mono (out of phase)	-1

> ***Note***
>
> The degree of correlation in a stereo signal may temporarily take a negative value. However, should the degree of correlation stay in the negative range over an extended period of time, it must be assumed that the channel is out of phase.

2.2.3.3 Definition of International Sound

International Sound (German: IT)

According to *EBU R-123 (2009)*, the conventional definition of the “international sound” track includes all the audio elements of a program that appear in-vision. The elements will thus depend on what is in the accompanying vision.

The term „IT“ („internationaler Ton“), as it is commonly used within ARD, ZDF, ORF, and SRG, however, encompasses all audio elements except for commentary and translation (voice over). This also applies when the speaker is temporarily “out of vision” (off-camera). Only then, an alternative commentary or narration with a new length may be mixed in.

This means that the IT track also includes reporters and their interview partners, if they are in-vision (on camera).

Other IT variants, which include only certain elements of the audio mix, require bilateral agreement. They include, for example, footsteps, clean FX, world feed, music track (cf. also *EBU R-123*).

IT for Audio Description

IT for audio description is nearly identical to the IT described above. Only when a program contains sequences which are not audio-described, the audio track designated as “IT for audio description” must contain the main audio mix for these sequences and not their IT.

2.2.3.4 Audio Track Allocation

The audio track allocation described in the table below applies to program exchange and supply as well as to the delivery of programs to the Playout Center (ZSAW), regardless of the mode, i.e. on a physical medium, via line, or as files.

> ***Note***
>
> *Supply and exchange of material with 16 audio tracks (for allocation, cf. item 6.3, appendix 4) is possible upon mutual agreement between contractor and broadcaster, or between broadcasters.*

Footnotes (for Track Allocation Table)

(1) The SAP (second audio program) may consist of: foreign language, audio description, commentary, original version, etc. For the audio-descriptive version, visual content description is added to the German-language broadcast version.

(2) Caution**:** Productions with Dolby E have to be clearly identified and labeled as “Dolby E,” e.g. on the Media Data Card or on the VTR record card for carriers.

If a Dolby E signal has to be encoded from a multi-channel audio source which also uses tracks 7 and 8, e.g. for M&E (IT) or STEREO, the Dolby E signal has to be recorded with a resolution of 20 bits. This exception requires a specific agreement.

(3) In option 4 (8-CH ST), audio 7 and 8, a Dolby E signal must only be present in the case of a multi-channel production. In all other cases, audio 7 and 8 must contain a PCM signal (e.g. audio silence) (NO Dolby E frame).

(4) For recording the discrete channels of multi-channel audio in the production environment, it is necessary to record the stereo version on tracks 1 and 2.

(5) Audio track allocation options used in the past, which may be found, for example, in stock footage or other legacy material (Audio 1 = German-language broadcast version, mono; Audio 2 = original version or audio description, mono) have to be processed in such a way that the German-language version is available on tracks 1 and 2, the audio description on tracks 3 and 4 for exchange and delivery.

Note: In this regard, it has been agreed that for playout via the ARD-POC (Play-Out Center) or ARD-CC (Compression Center), audio tracks 1 and 2 (Audio PID1) shall henceforth be signaled as “stereo” without variation, while tracks 3 and 4 (Audio PID2) follow PDC (program delivery control). This permits the supplying broadcaster to control signaling on Audio PID2.

(6) Caution**:** Option 6 is used, for example, for acquired programs with two language versions. It has to be noted that it is NOT possible at this time to broadcast two multi-channel versions simultaneously, NOR is it possible to transfer two Dolby E versions simultaneously via SNG.

Option	1	2	3	4	5	6[6]
Name	4-channel Documentary M&E	4-channel SAP	4-channel Dolby E	8-channel standard	8-channel 5.1 discrete	8-channel SAP, Dolby E
Audio 1	stereo broadcast audio left	stereo broadcast audio[5] left	stereo broadcast audio left	stereo broadcast audio left	stereo broadcast audio[4] left	stereo broadcast audio left
Audio 2	stereo broadcast audio right	stereo broadcast audio[5] right	stereo broadcast audio right	stereo broadcast audio right	stereo broadcast audio[4] right	stereo broadcast audio right
Audio 3	M&E left	SAP[1][5] left	Dolby E[2]	M&E left	multi-channel audio / L	Dolby E[2]
Audio 4	M&E right	SAP[1][5] right	Dolby E[2]	M&E right	multi-channel audio / R	Dolby E[2]
Audio 5				SAP[1] left	multi-channel audio / C	SAP[1] left
Audio 6				SAP[1] right	multi-channel audio / LFE	SAP[1] right
Audio 7				Dolby E[2][3]	multi-channel audio / LS	SAP[1] Dolby E[2]
Audio 8				Dolby E[2][3]	multi-channel audio / RS	SAP[1] Dolby E[2]

2.2.3.5 Loudness-Based Audio Leveling

For new productions, the leveling of analog and digital audio signals has to be performed according to *ITU-R BS.1770* and *EBU Technical Recommendation R 128*, “Loudness normalisation and permitted maximum level of audio signals.”

Program Loudness:

Program loudness describes the integrated loudness over the entire duration of a program.

program loudness: **–23.0 LUFS ±0.5 LU**

measured using the algorithm for integrated loudness according to *ITU-R BS.1770*

In cases where exact compliance with a target level is not practically feasible – e.g. in live broadcasts –, a tolerance of ±1.0 LU is accepted.

Program loudness describes the integrated loudness over the duration of a program, regardless of the type of program and specific elements, such as speech, music, sound effects, etc. A program is a thematically self-contained audio-visual item, produced as a unit, including commercials, trailers, promos, interstitials, etc.

The program loudness parameter is expressed in a single figure with one decimal in LUFS. 1 LU is equivalent to 1 dB.

Maximum Short-Term Loudness

Short-term loudness describes the integrated loudness of a program sequence over three seconds. The value is used during a sound mix to assess the current loudness impression and may vary in very dynamic sound mixes. Maximum short-term loudness describes the maximum value of all the values measured throughout the program.

For short-form programs – such as commercials, promos, etc. –, EBU standard *R128 s1* applies:

maximum short-term loudness: **–18.0 LUFS**

Loudness Range:

Loudness range is a numerical value that describes the statistical average of a program’s loudness dynamics.

loudness range in production: **maximum 15 LU**

Typical values for the loudness range (LRA), expressed in loudness units (LU), are:

- LRA < 5 LU – small
- LRA ~ 10 LU – medium
- LRA > 15 LU – large

True Peak:

The true peak level describes the maximum level of the continuous (linear) signal, measured according to *ITU-R BS.1770* and *EBU Tech 3341*.

maximal permitted true peak level (MTPL) in production: **–1 dBTP**

2.2.3.6 Audio/Video Offset

In television production in general, audio/video offset (asynchronicity) should be avoided.

In live programs with digital effects or the use of digital wireless camera systems, however, delays may occur that cannot be fully compensated. It should be noted that in those cases, too, the

tolerances specified in *EBU Technical Recommendation R 37* should not be exceeded at the end of the entire production chain (at the broadcaster's reception point):

- **audio must not lead video by more than 40 ms,**
- **audio must not lag video by more than 60 ms.**

> ***Note***
>
> *In cases where wireless cameras are used side-by-side with delay-free wirebound cameras, sound should be delayed in such a way that the audio/video offset to the wireless camera is less than that to the wirebound camera, as audio lagging video will be perceived as less annoying than audio leading video.*
>
> *Technically, it is also possible – but significantly more complex – to delay the wirebound cameras. This will compensate the offset completely.*

In general, it should be noted that seemingly minor offsets between video and audio will add up throughout the production chain. For this reason, everybody involved is responsible for achieving the smallest possible audio/video offset during his or her part of the chain. A single device or production change must never use the full tolerance granted for the entire process. Therefore, there is a strict demand to pay close attention to the A/V offset during shooting, editing, and transmission.

In accordance with *EBU Technical Recommendation R 37*, it is therefore recommended that any differences in the relative timing of the sound and vision components of a television signal be minimized whenever and wherever possible. At any given point, the delay should not exceed the following limits:

- audio must not lead video by more than 5 ms,
- audio must not lag video by more than 15 ms.

If a significant audio/video offset occurs in a production, it has to be minimized immediately, preferably by the use of automated correction techniques.

When using Dolby E for carrying multi-channel signals, special rules for A/V synchronicity apply (cf. item 2.2.4.4).

2.2.4 Multi-Channel Audio

For broadcast purposes, productions using multi-channel audio do require an additional mono-compatible stereo version in all cases (cf. also *EBU Technical Recommendation R96*).

The document entitled *Production Guideline Mehrkanalton im Fernsehen*, published by ARD/ZDF, contains further in-depth information and recommendations (Weblink: Guideline Mehrkanalton, irt.de – in German only).

2.2.4.1 Multi-Channel Stereophonic Sound Systems

ITU-R BS.775-2 describes the standard configuration for multi-channel stereophonic sound systems designated as 5.0 or 5.1 systems (cf. item 6.4). It is a sound system with 5 discrete broadband channels: 3 front channels and 2 rear/side channels for surround sound.

The extension, ".1", in "5.1" represents an additional – optional – sixth (LFE, or low-frequency effects) channel with a limited bandwidth, which may be used to carry low-frequency effects (cf. item 2.2.4.3).

3.0 is a subcategory of 5.1 and has to be treated as if it was 5.1 with the LFE and surround channels silent. The same applies to other subcategories, from 1.0 through 5.1.

2.2.4.2 Downmix

In order to ensure downward compatibility within the hierarchy of multi-channel audio systems, provisions have been made for simple matrixing conditions to add missing channels or signal components to the remaining channels. *ITU-R BS.775-2* should be used for reference. According to this recommendation, the formula for the downmix from 5.0 to conventional (2.0) stereo is as follows (with a factor of 0.7 corresponding to a level change of –3 dB):

	L	R	C	LS	RS
L' =	1,0 L	0,0 R	0,7 C	0,7 LS	0,0 RS
R' =	0,0 L	1,0 R	0,7 C	0,0 LS	0,7 RS

Since multi-channel signals are not necessarily identifiable as such, the production has to document the meta data in the Media Data Card (or VTR record card or tape label) and label them clearly as multi-channel, e.g. “5.1 discrete” or “3.0 discrete,” including the corresponding presets.

2.2.4.3 LFE Signal

The low frequency effects (LFE) signal typically has a bandwidth of less than 120 Hz and is used optionally for low frequency effects.

According to SMPTE, the LFE channel should be reserved for parts of the program with extremely low frequencies and very high levels, whose lack during reproduction does not impair the artistic integrity of the program.

> ***Note***
>
> The LFE signal is not a “subwoofer signal.” However, the subwoofer signal may be identical to the LFE signal, e.g. in theatrical motion-picture productions. For home cinema systems, 99 percent of which include satellite subwoofers and thus bass management, the subwoofer signal consists of the LFE signal plus the low frequencies of the five main channels.

For practical purposes during production, the LFE signal has to be recorded with a level offset of -10 dB, according to *ITU-R BR.1384-1*.

As a consequence, the level of the LFE channel has to be raised by 10 dB for loudspeaker calibration in production practice. However, if the check is conducted with a consumer decoder, the level must not be raised externally, since the gain will be performed by the decoder.

Cf. also *ITU-R BS.775* and *SMPTE 320*.

> ***Note***
>
> *When broadcasting Dolby signals, the level of the LFE channel must be carried at –10 dB at all times, since the Dolby decoder will automatically raise the level of the LFE channel by 10 dB. In television productions, this offset is carried through the entire production chain. For radio productions, this is not the case, since the offset will only be performed with the broadcast. Therefore, when exchanging material between radio and television productions, attention has to be paid to the correct leveling of the LFE channel, meaning that the level of the LFE channel has to either raised or lowered.*

2.2.4.4 Dolby E

Dolby E is an encoded audio format for professional use, which is able to carry up to 8 data-reduced audio channels, along with corresponding metadata and time codes via an existing stereo-PCM infrastructure and coupled to video.

For supply and exchange (line and file transfer), Dolby E signals have to be encoded with a word size of 16 bits (corresponding to 6 audio channels or less). A 20-bit word size is only permissible by bilateral agreement.

> ***Note***
>
> *Beware of unintentional listening! The Dolby E signal is a full-scale (0 dBFS) encoded data stream, not a linear audio signal. No changes whatsoever (such as level changes or sample-rate conversions) must be performed.*

In order to ensure a trouble-free workflow, the Dolby E frame has to be positioned in the following lines of the video frame:

- 1080i/25: positioning in line 21 (tolerance ±2 = lines 19–23)
- 720p/50: positioning in line 28 (tolerance ±3 = lines 25–31)

For encoded audio signals, e.g. Dolby E, no additional offset against discrete audio signals – e.g. PCM – is permissible, i.e. they have to be offered in sync (±0 full frame) with the corresponding video and stereo audio signal, e.g. on medium, file, exchange line, etc.

This means that the delay of 40 ms that occurs in a subsequent Dolby E decoding is not "precompensated." This ensures that for all programs supplied, both the discrete audio signals and the Dolby E signals have no offset against the video signal.

Synchronicity is achieved by delaying both video and PCM audio by 40 ms when decoding Dolby E.

2.2.5 Meta Data

For broadcasting Dolby Digital signals (AC3), Dolby meta data have to be set in all cases, both for multi-channel and for stereo productions. Only the predefined meta-data presets must be used, which have been optimized for various applications.

In Dolby-E-encoded data streams, the meta data of the preset used may be carried within the stream. For discrete multi-channel audio, the preset used must be communicated separately via the Media Data Card or by e-mail to the broadcasting play-out center.

Overview of meta data presets

Preset	#	Format	Program Type
loud	1	stereo (Dolby 2.0)	entertainment show, rock concert
	2	multi-channel (Dolby 5.1)	
standard	3	stereo (Dolby 2.0)	weather, news, TV series, daytime drama, documentary, entertainment news, magazine, children's movie, crime drama, morning TV, live reports on current events, commercials, trailers, interstitials, station ID, jazz concerts, crossover concerts
	4	multi-channel (Dolby 5.1)	
dynamic	5	stereo (Dolby 2.0)	church service, theater, theatrical motion picture, high-quality crime drama, concert programs with a high percentage of spoken dialog
	6	multi-channel (Dolby 5.1)	

classic	7	stereo (Dolby 2.0)	opera, classic concert, chamber music
	8	multi-channel (Dolby 5.1)	
sports	9	stereo (Dolby 2.0)	not sports magazines live broadcast of major event: Olympic Games, soccer World Cup, track and field world championships, handball, etc.
	10	multi-channel (Dolby 5.1)	

The Dolby meta data contain important information for the Dolby decoder, such as e.g.:

- on loudness: dialog level
- on dynamic-range control (DRC)
- on the downmix from 5.1 to stereo (Lo, Ro) or ProLogic (Lt, Rt)

The loudness meta datum in the Dolby E “dialog level” has to match the actual program loudness precisely. According to *EBU R 128*, all mixes have to be leveled with an integrated loudness of –23 LUFS.

2.3 HD-SDI (HD Serial Digital Interface)

Detailed information on and explanations of relevant HD interfaces can be found at the following link (web link: Technical Guidelines, irt.de) in the section called „Handbuch der Fernsehsystem-technik“ (“Handbook of Television System Engineering”). The relevant document is entitled „Fernsehsystemtechnik Kapitel 5, Messtechnik für Multiformat-Systeme“ (“Television System Engineering, Chapter 5, Measurement Techniques for Multi-Format Systems”).

The following paragraphs summarize part of the information with regard to the HD SDI.

2.3.1 Transmission Capacities of Various HD-SDIs

The following table lists the physical interface specifications for the four HD systems recommended in *EBU Tech Doc 3299* and the corresponding SMPTE standards. As an additional information, the video net data rates and the total data rates for the various HD systems have been listed.

EBU HD Systems		SMPTE		292M	372M 292M	424M	435M
		Data Rates in Gbit/s		1,485	2x1,485	2,97	10,692
		Video Data Rate	Total Data Rate				
S1 720p/50	4:2:2	0,9216	1,4850	X			
	4:4:4	1,3824	2,2275		X	X	
S2 1080i/25	4:2:2	1,0368	1,4850	X			
	4:4:4	1,5552	2,2275		X	X	
S3 1080p/25	4:2:2	1,0368	1,4850	X			
	4:4:4	1,5552	2,2275		X	X	
S4 1080p/50	4:2:2	2,0736	2,9700		X	X	
	4:4:4	3,1104	4,4550				X

2.3.2 1,5-Gbit/s Interface

The HD-SDI with a 1.485 Gbit/s data transmission rate is specified in *SMPTE 292M* and *ITU-R BT.1120*.

Among others, this interface is used by the four digital HDTV formats recommended by EBU. The serial digital transmission of the signals (video, audio, and data) with bit rates of 1.485 Gbit/s is performed via 75-Ω coaxial cable or fiber-optic cable.

2.3.3 Dual-Link

If data rates higher than 1.485 Gbit/s are required, as in EBU HDTV system 3, two transmission paths are used in a so-called “dual link.”

A dual link consists of two identical 1.485-Gbit/s channels (link A and B), which are being assigned depending to the application at hand. The assignment of links A and B for EBU HDTV systems 1 through 4 is specified, complete with diagrams, in the Handbuch der Fernsehsystemtechnik (“Handbook of Television System Engineering”).

2.3.4 3-Gbit/s Interface

The 3-Gbit/s interface with a data transmission rate of 2.97 Gbit/s is specified in *SMPTE 424M* and *SMPTE 425M*, whereby *SMPTE 424M* lists primarily the physical specs and *SMPTE 425M* specifies the mapping structure.

HD-SDI signals are routed in the 3-Gbit/s interface via different paths, e.g. 2 × HD-SDI and 1 × dual link. For this reason, the structure of the 3-Gbit/s signal’s multiplex data varies, depending on the signal processing performed by the serializer. While the 3-Gbit/s signal maintains the same physical properties throughout, incompatibilities occur on the logical level. In practice, this means that 3-Gbit/s-capable equipment without signal processing (such as distributors and routers, etc.) will support all 3-Gbit/s signal types. Equipment, however, that does perform signal processing (such as mixers, NLE systems, etc.) has to be compatible to the level and mapping chosen.

SMPTE 425M currently defines two different “levels” and distinguishes between two different mapping formats within Level B:

Level A	–	direct image format mapping
Level B-DL	–	SMPTE 372 dual-link mapping
Level B-DS	–	2× SMPTE 292 (HD-SDI) dual-stream mapping

A detailed explanation of the different mapping structure in the various levels is given in the „Handbuch der Fernsehsystemtechnik“ (“Handbook of Television System Engineering”), chapter 5, „Messtechnik für Multiformat-Systeme“ (“Measurement Techniques for Multi-Format Systems”) (web link: Handbook of Television System Engineering, irt.de).

2.4 MXF File Format

For exchange, delivery, and supply, the MXF file format has become the standard carrier format. In order to improve interoperability, establish a foundation for automated quality checks, and support both users and manufacturers, uniform MXF profiles have been developed that clearly specify relevant file parameters. The MXF profile specifications may be downloaded from the IRT Website (Weblink: MXF-Profile, irt.de).

The following rules apply to MXF files:

- An MXF file must comply with one of the ARD_ZDF_HDF profiles.
- The b profiles require advance coordination, since they contain 16 audio tracks.
- For new productions, the material must not contain any technical leaders.

- The audio track allocation must comply with one of the predefined audio track variants.

2.4.1 Overview of MXF Profiles

The table below lists the specific MXF profiles.

ARD_ZDF_HDF01a	XDCAM HD422, 1080i/25, 8 mono AES3 tracks
ARD_ZDF_HDF01b	XDCAM HD422, 1080i/25, 16 mono AES3 tracks
ARD_ZDF_HDF02a	AVC-I 100, 1080i/25, 8 mono AES3 tracks
ARD_ZDF_HDF02b	AVC-I 100, 1080i/25, 16 mono AES3 tracks
ARD_ZDF_HDF03a	AVC-I 100, 720p/50, 8 mono AES3 tracks
ARD_ZDF_HDF03b	AVC-I 100, 720p/50, 16 mono AES3 tracks

> ***Note***
>
> *The use of profiles with 16 audio tracks requires bilateral agreement (cf. also the information on audio track allocation).*

All profiles use operational pattern OP1A.

Structurally, the XDCAM HD422 profiles are based on variant 1, “Multiple Body Partitions,” from *SMPTE RDD 9*, “MXF Interoperability Specification of Sony MPEG Long GOP Products” (published in 2013). An MXF file compliant with ARD_ZDF_HDF01a v1.1 is compatible to Professional Disc.

In MXF, the 16-bit Dolby E signal is transported in a 24-bit AES3 stream and filled up (“stuffed”) to 24 bits for this purpose.

2.4.2 Audio Track Allocation

According to the MXF profiles, an MXF file does not contain any information on the audio track allocation, which has to be communicated separately (e.g. via the Media Data Card). The assignment of the AES3 “audio tracks” in the MXF file to the audio track allocation is based on the sequence in which the audio tracks are stored in the essence container, meaning that the first audio track in the essence container is allocated to channel 1, the second track to channel 2, etc. For this reason, it is important that applications alter the storage sequence of audio tracks only when this is intended in terms of audio track allocation.

2.4.3 Time Code

The MXF time code must be present in material package, source package, and system item, and it must be in sync with the video. None of these three MXF time codes must contain jumps. A start value of 10:00:00:00 is recommended for the material package time code.

In order to avoid erroneous interpretations, the essence stream should not contain a time code.

The use of various time codes in MXF is currently under discussion at ARD.

Note

When Linear Time Code (LTC) or Vertical Interval Time Code (VITC) are being used, the corresponding specifications have to be observed:

- *SMPTE ST 12 1:2008, "Time and Control Code," describing the time-code format (replacing previous documents SMPTE 12M, RP164 and RP159), and*
- *SMPTE ST 12 2:2008, "Transmission of Time Code in the Ancillary Data Space," describing the transmission of time code in the ancillary data space (replacing document RP 188).*

Most current and new recording formats no longer support the traditional form of VITC (digitized analog signal) but implement the time code as an ancillary data packet in the VBI (Ancillary Time Code = ATC) in accordance with SMPTE ST 12 1:2008.

The SMPTE time code standard, 12M, was developed in 1975 (!) for analog recording systems and thus referred only to interlaced broadcast formats with up to 30 (full) frames per second. It proved, however, flexible enough to be adopted for digital broadcast systems, both SDTV and HDTV. However, for frame rates of more than 30 f/s, which are achieved by most progressive systems, the counting capacity of the time address is exhausted, and frames can only be referenced in pairs, resulting in an editing accuracy of 2 frames for traditional linear time-code application.

This situation required a revision for progressive video systems with more than 30 f/s, as documented by a "de facto implementation" that is already widely used, employing a field flag in VITC and ATC to distinguish and identify the first and second frame of a frame pair. The preferred implementation sets the field flag to 0 for the first and to 1 for the second frame.

In the future, it should be noted that equipment and applications based solely on VITC in its traditional form can no longer be used.

2.5 Professional Disc

In individual cases, a supply on Professional Disc (PFD) is also permitted. The Professional Disc must be in the XDCAM HD 422 (50 Mbit/s) format. The MXF structure must comply with *SMPTE RDD 9*.

2.5.1 Technical Leaders

In file-based production, leaders usually do not exist, meaning that the file will start on the first full frame of the program and end on the last full frame.

For material supplied on Professional Disc (XDCAM and XDCAM-HD), leaders are still required for operational reasons. It is therefore stipulated that the following three files be created for playout of XDCAM on Professional Disc:

File 1: content "10 sec. black/technical leader (10 sec. start)," representing the leader;
File 2: content "program 1";
File 3: content "10 sec. black," representing the trailer.

For the supply of more than one program file on a single Professional Disc (XDCAM and XDCAM-HD), a separation file is required for operational reasons. For the playout of such Professional Discs, the following sequence of files is therefore stipulated:

File 1: content "10 sec. black/technical leader (10 sec. start)," representing the leader;

File 2: content “program 1”;
File 3: content “10 sec. black,” representing the separation;
File 4: content “program 2”;
File 5: content “10 sec. black,” representing the trailer or, in the case of additional program files, the separation;
File n: for additional program files.

In order to ensure a smooth process, the time code has to be consistent across all files on the Professional Disc.

> ***Note***
>
> *Video contributions, e.g. on Professional Disc, require a “black leader” for automated processes. File contributions do not require any leaders, in order to avoid unnecessary extra trimming. The three-file option allows for both.*

2.6 Subtitles for HDTV Productions

2.6.1 Subtitles in Television Production

Subtitles (ST) or captions must be supplied in the EBU STL format as a separate file. The following issues have to be observed:

- For new productions, subtitles have to comply with the guidelines established by ARD, ARD Text, ORF, SRF, and ZDF regarding style, display time, and form (Weblink: Untertitel-Standards, daserste.de – in German only).
- Within a program, subtitles – e.g. the partial translation of a foreign language – will still be inserted into the corresponding video. These sequences should not be captioned additionally for the hearing-impaired. Overlapping must be avoided.

2.6.2 Subtitles for Internet Broadcast

For the exchange and delivery of subtitles for online distribution, an XML format based on EBU-TT has been specified. The “EBU-TT-D-Basic-DE” format has been described in the project report entitled *XML-Format für die Distribution von Untertiteln in den ARD Mediatheken* and has been published on the IRT Website (Weblink: EBU-TT-D-Basic-DE, irt.de).

2.7 Meta Data

In the future, meta data will be exchanged via the Media Data Card.

The basis of the Medienbegleitkarte is an XML schema (BMF subschema), which is mandatory when transmitting metadata in MFT 2.0. It has been adapted to the requirements of various applications. The specifications of the Media Data Card may be downloaded from the IRT Website (Weblink: Medienbegleitkarte, irt.de – in German only).

In general, the Medienbegleitkarte must be usable in a variety of visualization formats, e.g. on a printed page, as a PDF, or electronically integrated into a graphic user interface. In addition to the shared information, individual broadcasters may need different metadata for their own specific requirements, such as in-house IDs. For this reason, it is important that a uniform data model exists which forms the basis of the Medienbegleitkarte and from which the various display options may be generated, e.g. hard copy or graphic user interface (GUI).

Meta data sets have been developed for various application scenarios, e.g. for program exchange or broadcast delivery. These meta data sets constitute a minimum amount of meta data for the application scenario at hand. They are listed in the Appendix under item 6.10.

3 Production Process

3.1 Pre-Production Planning and Counseling

A successful production requires adequate pre-planning, in which producers and executive producers agree what cost and effort would yield an accepatable and economical relation to the result. As the case may be, production levels – such as “premium/high-quality,” “mainstream,” or “smart production” may have to be defined.

- The technical side should, in general, offer production counseling.
- In case of new productions or deviations from previously used standard workflows – e.g. for one-off events or smart productions – such counseling is mandatory.

The following items have to be observed:

- All counseling has to be based on the TPRF and supplemental operational provisions.
- Special applications which may deviate from the specifications in these Guidelines require individual counseling.
- A checklist should be used, e.g. for smart production (cf. item 3.2).
- The production process has to be considered in its entirety with regard to an economical, efficient, state-of-the-art implementation.
- Conflicts in the real-life technical environment, their impact on workflows as well as further expenses and outlays down the line have to be eliminated.
- In case special production means – such as e.g. consumer cameras or DLSRs – are used, their impact on production processes has to be assessed.
- In order to achieve an optimum quality in video and audio, technical provisions for audio and video recording, acoustics and lighting have to be discussed ahead of the actual shoot between director, producers, and crew.

3.2 Smart Production

3.2.1 Motivation and Opportunities

The term “smart production” is used in very different ways, often as a synonym for “lean” or “light” production. In all these cases, the aim is to produce in a different, simpler, and/or cheaper way. The essence of smart production is a defined, integral view of parameters and workflows.

The overall process must show a reasonable proportion between the means of production and the process on the one hand and the intended use on the specific program platforms on the other, i.e. it must be realized with reasonable effort, yet meet all the requirements. Conscientious handling of human, technical, and financial resources plays a key role here.

Smart production not only focuses on television production but has to be considered as media-transcendent. From a technical point of view, new concepts and innovative technologies are intended to supplement the existing portfolio of production means, ensuring that suitable and optimal production means – including adequate staff – will be available at all times for the bandwidth at hand, from narrow to wide. Smart production thus offers:

- the opportunity to realize productions which would hardly be feasible with traditional equipment or would be too costly;
- opportunities for program areas with small video budgets (Internet, radio);
- additional creative leeway for new program formats, e.g. in terms of visual language;
- a new quality in program dialog (e.g. establishment of a consultant position within the production companies, risk agreement);
- efficiency boosts by dovetailing operations, reorganization of work assignments, possibly resulting in minimized downtime or waiting.

More so than with traditional productions, smart production requires pre-production coordination between all departments involved in the workflow, in order to discuss the opportunities as well as limitations that a smart production might entail.

Strict adherence to the agreements will ensure the fulfillment of coordinated expectations and lead to a successful, economical, and thus “smart” overall result.

3.2.2 Notes on Implementation

Since smart productions frequently diverge from the standard workflows we have learned, an intense advance counseling is necessary to assess risks and opportunities, loss of comfort and potential constraints. The following issues should be taken into consideration:

- **Unambiguous joint specifications** of key parameters and limitations (quality standards, security, flexibility, etc.) have to be established and adhered to.
- The individual **quality standard** in relation to client expectations has to be reviewed.
- A **comprehensive assessment of the production processes** with regard to an economical, efficient, state-of-the-art implementation has to be conducted.
- **Conflicts in the** real-life **technical environment**, their impact on workflows as well as further expenses and outlays down the line have to be eliminated.
- In case **special production means** – such as e.g. consumer cameras or DLSRs – **are used**, their impact on production processes has to be specified.

Although we also recommend production counseling for traditional productions, such counseling has to be far more comprehensive for smart productions.

3.2.3 Risks

The following is a list of risks that have to be taken into consideration when planning smart productions:

- Transfer of expectations from traditional production means to smart technology: loss of quality, limited broadcast security and flexibility have to be addressed.
- Lack of comprehensive assessment: increased efforts in the overall workflow (post-production) may be overlooked.
- Compatibility with existing production means and staff skills: changed production sequences and staff reductions affect the tasks of the remaining staff; in some cases, labor contracts may not cover multifunctional work.

3.2.4 Checklist Smart Production

The decision whether a production is realized with traditional production means or using “smart” means, depends on a variety of factors. Parameters and conditions that may influence this decision

are different for each production. In order to find a viable solution, the following checklist should help by specifically checking relevant requirements and conditions.
At the core of the matter, there are always two key questions:

- Does it make sense to realize a specific production as a “smart production”?
- Which aspects require special attention?

1. General	
1.1	What do the executive producers expect from smart production (esthetics, savings, special groups, etc.)?
1.2	What play-out channel(s) is the production intended for?
1.3	Are there any existing joint agreements, e.g. Service-Level Agreements (SLAs)?
2. Executive Producers	
2.1	Are the executive producers interested in dealing with state-of-the-art production means or in distinguishing themselves?
2.2	Do innovative technologies allow new content options to be realized or created (e.g. image building, program distinction)?
2.3	Are the executive producers prepared to accept certain constraints in production comfort?
2.4	Is the production a “non-premium” format?
2.5	Is the burden of potential restrictions shared?
3. Resources and Qualifications	
3.1	Is there an intention to generate savings with smart production, compared to a traditional production?
3.2	Does the limited budget preclude a traditional production?
3.3	Is the effort in logistics and setup appropriate for a smart production?
3.4	Can the production process be accelerated by smart production?
3.5	Can available traditional production means be used in a smart way (e.g. with reduced staff)?
3.6	Is multifunctional staff available?
4. Technical Parameters	
4.1	Can or should smart production means be used for reasons of space or technology?
4.2	Can the requirements be met by the possibilities of smart production means (number of cameras needed, audio post-production, feeds, graphics, different signal types, multi-track recording, acoustics, listening situation, command, etc.)?
4.3	Can particularly elaborate safeguards (e.g. general average) be dispensed with, while preserving production and broadcast security?
5. Workflow	
5.1	Has the overall workflow with regard to the inclusion of smart production means been specified?
5.2	Is smart production on the set possible without requiring elaborate post-production (e.g. multicam/multi-track recording, color timing, format conversion)?

3.3 Acquisition

3.3.1 Cameras

In order to achieve the required quality, the quality of the camera has to meet workflow specifications, i.e. apart from an HD-capable optical system, the resolution available on the image sensor, including subsequent processing steps in the proposed workflow, has to meet the requirements specified for the applicable production platform.

Based on the technical regulations of the broadcaster involved, the decision which camera system will be used should be based, first and foremost, on the esthetic, ergonomic, and economic demands and parameters. This decision has to be made in cooperation with the camera operators and workflow experts in charge.

In general, the production format of the broadcaster involved should be supported, in order to avoid additional expenses, transcoding, and loss of quality. This includes:

- mainstream codec,
- frame rate according to production standard,
- file format,
- further details according to the Technical Guidelines, item 2.

All other technical parameters of the camera system follow Technical Guideline 8/4 (Weblink: Technische Richtlinien, irt.de – in German only).

In case of oversampling by UHD camera systems, it has to be ensured that suitable down-converters are being used and that the result is assessed in an HD-SDI signal 1080i/25.

For the use of different camera types and sensor sizes, the following parameters have to be observed.

3.3.1.1 ⅔-Inch Broadcast Cameras for Mainstream Production

For Mainstream productions, HD camera sensors need to have a minimum size of ⅔" and should have a native resolution of 1920 pixels × 1080 pixels. In this context, system cameras (studio and OB) are always also Mainstream cameras.

As lenses, only broadcast HD lenses (or better) must be used. These lenses have to comply with the specifications detailed in the *Technical Guidelines: Parameters for the Classification of HD Lenses for ARD, ZDF, ORF, and SRG*, which lists HDTV thresholds and explains terminology and interrelationships (Weblink: Technische Richtlinien, irt.de).

3.3.1.2 Large-Sensor Cameras/Digital Cinema

Single-sensor cameras for digital cinema production have become widely available on the market. Depending on the demands of concept and content, single-sensor cameras are thus used over the entire range as well, from premium to smart-production.

The Super-35-mm target has been established as a standard for the “large sensor.” It has to be noted that sensor size alone is not necessarily an indicator of the actual performance of a single-sensor camera! The quality of the lenses – which have to comply at least with the specifications detailed in the *Technical Guidelines: Parameters for the Classification of HD Lenses for ARD, ZDF, ORF, and SRG* – as well as the camera’s internal signal processing also have to be taken into account here (Weblink: Technische Richtlinien, irt.de).

If single-sensor cameras are to be used for certain particular properties they possess and if they do not meet the requirements for the Mainstream codecs listed under item 2.1, it is necessary to ensure in advance whether the subsequent production process can be covered by existing workflows. In any case, special requirements (data format, file format, compression, sampling structure, raster, audio, time code, meta data) will entail special (extra) costs.

3.3.1.3 DSLR and System Cameras

Nearly all state-of-the-art still cameras offer a video recording feature, which supports both native HD resolutions and 4K resolutions. The cameras' sensors range from 35-mm format (24 mm × 36 mm) up to the ⅔" format. They all support the 16:9 aspect ratio.

The video quality and the optical features of these cameras are comparable to large-sensor cameras. The lenses used include manufacturer-specific prime lenses as well as photo zoom lenses. They only partially meet the requirements of traditional video or film lenses.

The preferred recording codec of these cameras is H.264. However, they use manufacturer-specific wrappers, which frequently require transcoding down the line. For this reason, the workflows have to be adjusted in advance to the camera system used.

The audio recording system of these camera systems usually features only two audio channels. The interfaces do not meet broadcast standards.

3.3.1.4 Compact Cameras for Single-Camera Workflows

For "smart" production forms as well as news (including VJ productions) or the production of online content, cameras with sensors of sizes up to and including half an inch (½") may be used as well. These are usually single-camera workflows. However, these applications also require HD-suitable lenses.

1. At least in single-camera application, these cameras have to meet the basic requirements of an HD-capable camera system.
2. Under no circumstances whatsoever should the internal converters or transcoders built into these cameras be used! Any conversions necessary should under no circumstances be performed inside the camcorder but instead by external converters which guarantee high video quality, before or after processing the material to the target format.
3. In these formats, any chaining or cascading should be avoided in professional acquisition, as it leads to an increase in noise and a loss of resolution.
4. In selecting a camera system, attention should be paid that Mainstream video codecs are being supported, in order to avoid transcoding down the line.

3.3.1.5 Miniature Cameras / Smartphone Cameras

Thanks to the innovations in sensor and processor technology, camera technology has been further miniaturized to the point that miniature camera systems all the way down to smartphone cameras are available today that – with certain reservations – may meet the requirements of an HD production.

Due to their compactness, inconspicuousness, and flexibility, they open up entirely new avenues in terms of concept and content.

The preferred recording codec of these cameras is H.264. However, they use manufacturer-specific wrappers, which frequently require transcoding down the line. For this reason, the workflows have to be adjusted in advance to the camera system used.

Due to the use of low data rates and image-enhancing processing within the camera, transcoding may yield unexpected and quality-reducing video artifacts.

The audio recording system of these camera systems usually features only two audio channels. The interfaces do not meet broadcast standards.

Examples for these cameras would be products like GoPro, dji, or iPhone. The products offered keep changing constantly, and so do the inherent parameters. For this reason, it has to be determined in each individual case, how the workflow integration should be performed.

3.3.2 Lightning

With the development of new light sources with a higher light yield, these have now also become available options for lighting TV productions. Their benefits include reduced power consumption and heat emission, but on the other hand, they yield an inhomogeneous light spectrum in combination with television cameras.

LEDs emit light which, compared to traditional light sources, does not cover a continuous spectrum of light but rather a line spectrum. As a consequence, the colors of objects recorded by a camera are recorded differently than with traditional lighting. This requires a certain amount of extra work in color matching. A mixed use of conventional lights and LED lights in particular will cause problems. The suitability of a light source can be determined by means of a process published by EBU (EBU Tech 3355). The BBC has tested several light sources using this process and published their results in a document entitled “Low Energy Lighting Guide for TV Productions” in October 2014. (web link: Lighting Guide, bbc.co.uk)

Various techniques are used for dimming LEDs. The most common one is currently pulse-width modulation. This technique may cause interferences between the camera (shutter speed/exposure time) and the modulation frequency of the pulse-width control unit, which appear as interference patterns. To avoid these interferences, it has to be ensured in advance that the camera technology to be used will be in sync with the lighting technology.

Phosphor-converted LEDs in particular have a relatively high spectral component in the blue range that may be hazardous to the eye (blue-light hazard). For further information on this subject, please consult DIN EN 62471(VDE 0837 471) and guideline 2006/25/EG.

None of the manufacturers of LED lights for studio or field use has yet classified them according to EN 62471, and thus a key factor for the required risk assessment is missing.

As a precautionary measure, however, LED floor lights should not be used for productions involving children. For reasons of occupational safety and health, the use of LED lights, luminaires, and effect devices should always be assessed and decided individually for each device and scenario at hand.

3.3.3 Notes on Color Rendering

Cameras often react to inhomogeneous light spectra with a limited color rendition, compared to traditional artificial halogen light or natural daylight.

Productions should therefore work with a clearly defined lighting concept. The main light source should cover a spectrum that is as natural as possible, since the cameras’ standard color matrix and thus their color rendition is attuned to such natural light.

The following procedures are recommended:

1. State-of-the-art lighting should cover a spectrum that is as natural as possible. Lighting cameramen are encouraged to use such light sources as key lights.
2. Cameras are usually measured at the main light source. Video engineering will determine white balance and color matching here.
3. If necessary, a manual adjustment of the white balance might improve skin tones. This, however, will negatively affect other hues.

For further information on this subject, please refer to the *EBU Tech 3355* document.

3.4 Outside Broadcasts (OB)

Outside broadcasts (OB) use cable-linked transmission facilities (e.g. fiber-optic cable), satellite uplinks (SNG), or mobile microwave radio relay systems owned by public broadcasters as well as commercially operating producers and service providers.

Both for in-house productions and programs produced outside, the broadcasters' offices in charge of transmission are the primary contacts for all contribution-related issues. They will support producers in finding available options for transmission:

- via broadcaster-owned network lines,
- via broadcast service providers' lines,
- via satellite, or
- by other means, e.g. UMTS, Internet.

The line-management offices (*Leitungsbüros*) will communicate the options to the producers and arrange booking procedures as specified by the service provider. The offices are aware of the current service portfolios offered by various providers and of any general agreements that might exist between the broadcaster and the service provider. They will also coordinate available capacities (e.g. permanently available transponders on various satellites) with the *ARD-TV Leitungsbüro*, the *ZDF-Leitungswesen*, or the *WDR Leitungsbüro*.

The producers will be responsible for procuring and organizing the technical facilities and equipment needed at the uplink location, such as booking an SNG vehicle and a fiber-optic link!

3.4.1 Organization of SNG Transmissions

Ordering an SNG transmission requires the booking of a space segment and of SNG uplink and downlink capacities.

"Booking a transponder" for SNG purposes requires the following information:

- start/end date and time (on an international level in UTC);
- originating location for assessing footprint and availability of the satellite to be booked;
- receiving location for assessment of the downlink situation, possibly simultaneous activities at the receiving facility;
- content of the transmission with program title, information on: SD or HD, live or transfer, audio track allocation;
- information on SNG, operator, Earth Station Code and corresponding telephone number (available for the satellite operator throughout the transmission); name of operator with telephone number, if possible;
- desired bandwidth with profile specification and type of modulation: DVB-S, DVB-S2, MPEG4-2, H.264;
- name of person ordering, with telephone number for any queries;
- production number or cost center for billing.

The technical parameters of SNG transmissions are listed under item 3.5.2.

3.4.2 Operation of Proprietary Mobile Microwave Systems

According to the applicable administrative regulations of the Federal Network Agency (FNA/BNetzA), microwave systems (*VV RiFu, 2015*) require a frequency and location coordination for each case of operation as well as a day permit for the period of operation. This makes it next to impossible to use such devices in the field *ad hoc* or on short notice.

According to the FNA's frequency plan, proprietary (broadcaster-owned) mobile radio systems may be used in the 2.3-GHz band and mobile microwave systems in the 12-GHz and 21 GHz band for outside broadcasts (OBs).

The general-permit 2.4-GHz WLAN band is already very busy, and the alternative 5.8-GHz band is also occupied increasingly by consumer applications.

It is possible to use digital WLAN equipment in video-over-IP mode for wireless signal transmission. Both range and vulnerability may be significantly improved by using directional antennas, which will serve as spatial filters that minimize disruptive interference outside the angular range used.

The 10.4-GHz and 10.68-GHz band, which – according to the administrative regulations for frequency allocations in non-public mobile radio (*VVnömL, 2011*) – is also available for mobile video transmissions, does require a license but is, for exactly this reason, not generally accessible and thus less likely to encounter interference from other users when using directional antennas.

3.5 Live Contribution

The live contribution of HDTV material should be handled, whenever possible, in a transparent form (1.5 Gbit/s, HD SDI). Avoiding codecs not only preserves the original video quality but also avoids the problems of latency. In any case, only 4:2:2 profiles should be used in live contribution!

In general, the specifications in these Guidelines also apply to live contribution. For profile recommendations, the operational applications listed in the tables below apply.

Special attention has to be paid to the fact that in the domain of live contribution, several production stages are cascaded. Quality losses at each stage affect the overall quality on the receiving end for the consumer. The final quality will never be higher than that of the stage with the lowest quality!

Thus, if live contribution continually falls below the required thresholds (i.e. if they are not achievable, available, or affordable), the quality demanded for this particular application cannot be achieved!

Based on experience with H.264 codecs, it turns out that three SNG profiles are more than sufficient for day-to-day operations (cf. item 3.5.2).

3.5.1 Latency

The latency for live contributions should be kept to a minimum, even with the H.264/AVC encoding process. Up to now, almost all SNG transmissions, including interviews in MPEG 2 SDTV, have had an encoder delay of 470 ms, in addition to the satellite propagation delay (260 ms)! In view of this situation, the demand for a latency of less than 400 ms may be ambitious but desirable!

The paramount demand on the operational units involved is the secure handling of all necessary processes, even if it requires the use of codecs from different manufactures. For this reason, latency demands which tend to favor a single-manufacturer solution (e.g. for encoder and decoder in “stripe-refresh mode” with latencies in the 80-ms range) should be seen in a critical light in the ultra-low-delay (ULD) mode. Moreover, the ULD mode is not necessarily operationally relevant for sportscasts and newscasts (except for interviews).

In general, the latency actually available depends on the GOP structure (e.g. GOP length, number of B frames) and the combination of encoder/decoder manufacturers. Current implementations show that a pure H.264 encoder/decoder latency of 800 ms seems realistic.

3.5.2 SNG

In the area of SNG, the bottleneck with regard to the achievable HDTV quality is determined by both available capacities and affordable bandwidths. Usually, transponders with bandwidths between 6 and 36 MHz are available, i.e. a maximum of 56 Mbit/s is available for HDTV video in the DVB S2 modulation format with 8 PSK.

3.5.2.1 SNG Profiles

With a few exceptions, codecs with MPEG-2 compression were the only ones offered for SNG applications at the time when HDTV was launched. The basis for transmission were the three MPEG-2 HD profiles specified by EBU Eurovision: 60HD, 42HD, and 32HD.

By now, all relevant manufacturers are offering codecs with the more efficient video compression format, H.264/AVC. These codecs were also introduced for EBU’s Eurovision Satellite Network. The H.264 profiles specified for the EBU’s Eurovision Satellite Network also form the foundation for domestic SNG applications. However, some parameters have to be adapted to slightly differing

practical condition, e.g. the use of mainly 4-meter dishes for Eurovision and 1.5-meter dishes domestically. Only strict adherence to these specifications will warrant sufficient reliability for the actual transmission paths.

The roll-off factor is thus set at 25% for all profiles in domestic use (EBU profiles 11HD and 22HD are set at 20%). However, depending on the case at hand (cf. item 3.5.2.2), Dolby E is optional on the national level, e.g. for profile **HD 8-18 PAA** (18 MHz transponder). This will more than compensate for the video data-rate loss caused by the increase of the roll-off factor.

The “domestic” H.264 profiles are listed in the table “SNG Profiles for H.264 Recommended by ARD, ZDF, ORF, and SRG” under item 6.14, both for 8 PSK and the more efficient 16 APSK modulation. The only difference lies in the modulation parameters, while audio and video parameters are identical in both modulation processes. There is no obligation to accept 16 ASPK modulation, which means that its use has to be agreed upon bilaterally.

> ***Note***
>
> *The term PAA (phase-aligned audio) may be copyrighted, but (also due to the distribution of the Eurovision codecs), it has become common practice to use this term for “phase-locked discrete audio” (PDA).*

3.5.2.2 SNG Scenarios

As a guideline, three relevant scenarios have been identified for an HDTV transmission: HD Mega-Low Delay, HD Standard, and HD Remote Interview (cf. table below, “Relevant Scenarios for SNG”). The corresponding SNG profiles in H.264 can now be matched to these scenarios.

The HD Remote Interview Profile is NOT suitable for content requiring high motion resolution! It should only be used for low-demand video content, i.e. when content is technically simple, e.g. a press conference, or not essential to the program, e.g. for one of several remote contributions. As a rule of thumb, the HD Remote Interview Profile should be considered unsuitable in the following cases:

- scenes with numerous camera positions
- sportscasts
- broadcast line

Since a satellite broadcast channel is not a constant and since the quality of transmission may vary with a variety of parameters, additional considerations are relevant in practical application.

- Since transmission margins vary constantly, depending on a variety of parameters, recommendations can only be given that apply to the majority of transmissions. The actual results will depend on the following parameters:
  - the satellite system used,
  - solar flux and the resulting variations in solar panel output,
  - the overall load on the transmission transponder,
  - the type (TWTA or SSPA) and characteristic level control of the output amplifier,
  - the current weather conditions at the uplink and downlink end of the transmission.
- An optimized calibration of the transmission parameters is only possible, if information about the signal margin at the receiving location is available to the sender. For a high-quality transmission, the highest possible payload rate should be aimed at. This data rate can only be transmitted, though, if the receiving system can achieve the necessary margin for the satellite system used and for the current weather conditions.

Live Contribution via SNG		Requirements		
Short Form [1)]	**Scenario**	**Video Quality**	**Latency**	**Audio Tracks**
HD 8-18 PAA	**HD Mega-Low Delay** (high-quality transmission with low latency)	very good [422]	low, approx. 600 ms	8 phase-locked
HD 8-12 PAA	**HD Standard**	very good [422]	low, approx. 1 s	8 phase-locked
HD 8-9 PAA	**HD Remote Interview [2)]**	low [422]	low, approx. 1 s	8 phase-locked

[1)] The short form for the profiles is generated as follows: [SD/HD] [modulation type]-[bandwidth satellite/MHz] [suffix, if applicable, e.g. PAA].

[2)] For the use of the Profile HD Remote Interview, the restrictions listed below must be observed.

The following paragraphs list, apart from an application example, the specifications for video quality, latency, and audio channels for each of the three scenarios.

> ***Note***
>
> *In practical usage, additional specifications apply, e.g. bit depth, GOP structure, and profile/level of the encoding formats (cf. item 6.14).*

HD Mega Low Delay (High-Quality Transmission with Low Latency)

Example: A live connection with a remote interviewee during a magazine program requires minimal latency. Video quality has to be adequate for a magazine program. The low latency is achieved by dropping B frames. The reduced encoding efficiency, compared to the HD Standard profile, is achieved by a higher symbol rate and consequentially larger bandwidth.

Video: Very good video quality: If no further processing follows, the effect of the SNG codec on video quality may be just noticeable for the viewer, even in complex images with a lot of movement, i.e. for images rich in detail, a slightly lower resolution and possible slightly more noise may be acceptable, but no additional artifacts (such as pixel structures) must be visible.

Latency: Mega-low delay mode IP; the actual latencies for the entire path are in the range of significantly less than one second.

Audio: Eight mono channels (phase-locked for discrete multi-channel audio), i.e. 4 × 384 kbit/s, MPEG-1, Layer 2.

Note: *If required, a stereo pair may be replaced by one 2.304 Mbit/s (7/8) transparent AES channel for Dolby E (20 bit). However, this will reduce the available video data rate, depending on the manufacturer, by up to 3 Mbit/s.*

HD Standard (Standard Transmission)

Example: This profile is the first choice for standard SNG applications. Video quality and latency have to match the target program.

Video: Very good video quality: If no further processing follows, the effect of the SNG codec on video quality may be just noticeable for the viewer, i.e. for images rich in detail, a slightly lower resolution and slightly more noise may be acceptable, but no additional artifacts (such as pixel structures) must be visible.

Latency: Low-delay mode IBBP; the actual latencies for the entire path are in the range of just slightly more than one second.

Audio: Eight mono channels (phase-locked for discrete multi-channel audio), i.e. 4 × 384 kbit/s, MPEG-1, Layer 2.

Note: *If required, a stereo pair may be replaced by one 2.304 Mbit/s (7/8) transparent AES channel for Dolby E (20 bit). However, this will reduce the available video data rate, depending on the manufacturer, by up to 3 Mbit/s.*

HD Remote Interview

Example: This profile is NOT suitable for content requiring high motion resolution! It is only sufficient for video content with low demands on the encoder. It may be used when content is technically simple, e.g. at a press conference, or not essential to the program, e.g. for one of several remote contributions.

Video: Sufficient video quality, if no further processing follows. For unsuitable content requiring high motion resolution, a higher-quality profile has to be chosen, in order to avoid a deterioration of video quality.

Latency: Low-delay mode IBBP; the actual latencies for the entire path are in the range of just slightly more than one second.

Audio: Eight mono channels (phase-locked for discrete multi-channel audio), i.e. 4 × 384 kbit/s, MPEG-1, Layer 2.

3.5.3 Private IP Networks (with QoS)

Audio, video, and Ethernet/IP connections are being established in the networks currently available (e.g. cross-connected carrier-class multi-service edge routers) by means of special mechanisms and a special control software. For the integration of live telecast contributions, more and more connections are being offered using H.264 and J2K codecs.

H.264-encoded Connections

In general, hardware configurations in this case are similar to those in SNG vehicles, and thus the data rates used for landlines may use them as a guideline. However, the underlying parameters (bandwidth of carrier link, latency requirements) are different for landlines.

Recommendations for the implementation of BNS profiles are currently under discussion in the FELA expert group. For HD, the solution will have two phases. Based on the profiles currently available, the following profiles are recommended:

- transfer: HD-422-20-A2
- remote interview: HD-422-29-A2-LD
- return audio and video for remote interview: HD-422-14-A1-LD

J2K-encoded Lines

Currently, a variety of transmission profiles with J2K codecs is offered for landlines booked to carry HD signals, apart from a transparent connection (1.5 Gbit/s).

Based on operational experience, the following reference values are recommended:

- If further cascading with other codecs is necessary, connections with no less than 200 Mbit/s are required for very good video quality.
- For simple connections without any further cascading, connections with 175 Mbit/s will suffice for very good video quality.

- For good video quality, a profile with 150 Mbit/s seems to be sufficient, i.e. for images rich in detail, a slightly lower resolution and possible slightly more noise may be acceptable, but no additional artifacts (such as pixel structures) must be visible.

3.5.4 Public IP Networks (without QoS)

The IP-based transmission of signals from the production location to the control room via public networks is constantly gaining in importance, as cellular networks and Internet lines are becoming more available and offer increasingly wider bandwidth. In many cases, this cost-efficient and by now reliable alternative may be employed. So far, UMTS networks have been used, but the introduction of LTE has brought another significant boost in performance, allowing even transmissions in HD quality. DSL connections are also being used as Internet access points for this purpose.

Technology

An encoder converts video signals (SDI/HDSDI) into a data stream (e.g. H.264), which is transmitted via Internet to a decoder that converts it back into a video signal. This technology has to adapt to the bandwidth fluctuations of the Internet and reassemble the data packages, which reach their target over different physical paths, with the lowest latency possible and with the best possible error protection. In order to boost overall bandwidth, several cellular connections and landlines are bundled in a process called “bonding.” The simultaneous use of different cellular operators increases transmission safety in case of high network loads, as they may occur during large events or disaster emergencies. The technology is used for both live contribution and the transmission of recorded material.

Application

A variety of hardware and software products (streaming backpacks, apps) are currently available on the market, which combine encoders and cellular modems on the sender side and also offer corresponding receiving stations. As of January 2016, these solutions include primarily:

Product	Headquarter
LiveU	Israel
TVU	USA
Aviwest	Frankreich
Mobile Viewpoint	Niederlande
Dejero	Kanada
Prodys	Spanien
Quicklink	UK

LiveU is currently (2016) being used by many ARD broadcasters. Signaling as well as the transmission itself are proprietary technologies of the manufacturers, and the systems are not compatible with each other. In some cases, operation and content use are only possible in connection with “public or provider-owned cloud services.”

As an alternative to the above-mentioned products, Viprinet routers, which also allow channel bonding in cellular networks, are gaining acceptance on the market. However, these routers require separate encoders/decoders for generating the compressed data streams.

Beyond that, the entire market for contribution via public cellular networks is evolving at a very dynamic pace. Some manufacturers have already started to integrate this feature into their cameras.

Transmission Quality

Due to the bandwidth dynamics of cellular networks, it is necessary for the compression codecs to keep readjusting the data rate. With all manufacturers, diminishing bandwidth will therefore result in a deterioration of video quality.

In practice, cells operating at the limits of their capacity may also cause complete video and audio dropouts.

In live transmissions, where the margin of error is very small, this production tool should therefore not be employed, choosing a transmission path with quality of service (QoS) instead.

3.6 Post-Production

3.6.1 Handling Consumer Formats

Consumer or special formats that do not meet production standards may come up in post-production in the context of special workflows (cf. also item 3.2). In order to achieve the best possible video and sound quality in processing such material, the following issues should be observed:

- The material should be converted at the earliest possible stage into the in-house production format. Any filters to be used (e.g. for noise reduction) should only be employed after transcoding.
- Transcoding requires extra time and expense in post-production.
- The transcoded material should be checked carefully with regard to color space, signal leveling, contour sharpness, and motion artifacts.
- In order to improve image quality, filters for noise reduction may be used.
- The quality of the result should be assessed with an HD-SDI signal 1080i/25.

3.6.2 Aspect Ratio

For SD material that is available in a 4:3 aspect ratio, the executive producers will decide whether the existing 4:3 framing should be maintained (“pillarboxing”), or whether the 4:3 frame should be panned and scanned (usually shot by shot), in order to adapt it to the 16:9 aspect ratio of the HDTV frame.

In cases where 4:3 file footage is intended for HD transmission in a program exchange, a pillarbox version must be generated prior to converting to HD, in order to preserve image geometry

> ***Note***
>
> *If the 4:3 aspect ratio of the image is to be preserved, it is currently common practice to choose one of the following options: either fill the right and left margin with black (pillarboxing) or with an out-of-focus duplication of the active content, thus creating areas to the right and left in matching colors.*

SD material supplied in a widescreen format (e.g. 1.85:1, 2.35:1) has to be centered along the vertical axis (letterboxed). Zooming or pan & scan are only permissible if the artistic intention of the original material is preserved.

3.6.3 Use of SD Material

Regarding color space, in the case of up-conversions, attention has to be paid to the correct adjustment / choice of the HDTV matrix.

The standardized color spaces for SDTV and HDTV are nearly identical in their primary valences and their white levels. The main difference is caused by the different specification of the Y matrix:

- SDTV: $E'_Y = 0.299\ E'_R + 0.587\ E'_G + 0.114\ E'_B$ (ITU-R BT.470)
- HDTV: $E'_Y = 0.212\ E'_R + 0.715\ E'_G + 0.072\ E'_B$ (ITU-R BT.709)

For this reason, in any up- or down-conversion, attention has to be paid to the correct adjustment / selection of the target matrix (SDTV matrix or HDTV matrix)

> ***Note***
>
> *The integration of non-broadcast-specific sources with "alien" color spaces requires a color-space conversion!*

In producing television programs with digital component signals (Y, C_R, C_B), care has to be taken that the reproduction of the broadcast material (tape or file) will permit an encoding into MPEG-2 and/or H.264 compliant with the respective standard.

3.7 Technical Acceptance Tests

Video and audio acceptance tests should be conducted in control rooms compliant with the *DIN 15996* standard ("Image and Sound Production in Film and Video Studios and Radio Stations: Principles and Provisions for a Work Station").

For a correct assessment, it is essential to establish the correct relative timing of the audio and video signals of the program to be tested. For this propose, it may be necessary to delay, for example,

- all corresponding audio signals when displaying the image on flat screens (due to the internal delay in image reproduction), or
- the corresponding video signal when testing of Dolby-E-encoded audio signals (due to the audio delay caused by decoding).

In a file-based production environment, automated testing procedures are used with increasing frequency, since they are capable of checking numerous technical parameters simultaneously, but they are not yet able to replace a subjective (human) assessment of audio and video quality.

The results of the technical audio and video acceptance test are documented in an Acceptance Test Record (VTR record card / metadata / Medienbegleitkarte). A sample is shown under item 6.12.

3.7.1 Technical Video Acceptance Tests

HD productions should be tested for acceptance on a Class 1 monitor with a screen diameter greater than 23 inches. In addition, the use of a display with a diameter of 42 inches or more is strongly recommended for focus assessment and the detection of motion artifacts.

Since all flat screens have to scale the raster and de-interlace the television signal (as they display the image only progressively), the acceptance-tester has to pay particular attention to the display of graphic elements, such as scrolling or crawling titles, which has to be as flawless as possible.

Screen size is of fundamental importance for the assessment and acceptance of a program's HD quality! During the transition period, as long as no reference monitor with a screen diagonal of

approximately 50 inches is available, the use of two monitors is recommended for acceptance-testing image quality:

a) an available reference monitor with a screen diagonal of no less than 23 inches, and

b) a high-quality flat screen from an established manufacturer, with good properties and a screen diagonal between 42 inches and 50 inches, preferably plasma (for economic reasons, a consumer display may be used as a substitute).

> ***Note***
>
> *In order to make an identical reference available to all partners involved in the production, both in-house and outside, ARD, ZDF, ORF, and SRG are aiming at establishing a uniform display type as a common reference.*

In any case, an optimum viewing distance of **3 times the height of the screen** has to be maintained for a proper assessment of HD video quality.

> ***Note***
>
> *The specifications for Class 1 monitors are documented in EBU Tech Doc 3320. The measurement methods relevant to monitor adjustment are specified in EBU Tech Doc 3325.*

3.7.1.1 Gamma Characteristics

The luminance gamma characteristics (electro-optical transfer function) of the screen should be equivalent to that of a reference CRT with the rendering intent (dim-surround) expected of a TV system.

The EBU, in *EBU Tech 3320*, recommends that a nominal value of **2.35** be used.

3.7.2 Technical Audio Acceptance Tests

The listening conditions for the assessment of sound program material, both monophonic and two-channel stereophonic, are described in *EBU Tech Doc 3276*, and for multi-channel material in *EBU Tech Doc 3376, Supplement 1*.

In general, all audio tracks intended for broadcast have to be listened to from beginning to end and approved, in order to ensure that they are completely free of any technical deficiencies. If sound is only spot-checked, this fact has to be noted in the acceptance test record. In this case, the audio acceptance test cannot be considered complete and comprehensive.

For a qualified sound assessment, the audio reproduction (mono, stereo, or multi-channel) has to be performed using high-quality professional loudspeakers with linear frequency response, if possible (cf. *EBU Tech Doc 3276*). Multi-channel sound requires a suitable 5.1 set-up for listening and monitoring (cf. *EBU Tech Doc 3376, Supplement 1*).

The mere audio reproduction via built-in TV-set speakers or other consumer loudspeakers or speaker systems is not sufficient. It has to be emphasized that they do not cover the full range and variety of the audience's listening conditions.

3.7.2.1 Acceptance Tests of Programs with Encoded Audio Signals

Multi-channel programs supplied in an encoded format as a Dolby E data stream have to be decoded for acceptance-testing. Since Dolby metadata are not read out and interpreted in Dolby E decoding, it is recommended that the audio signal either be routed through a Dolby Digital encoder and decoder, or that the Dolby Digital path be simulated by means of a suitable audio tool, e.g. Dolby DP 570, in order to read out the metadata (cf. item 6.6).

> ***Note***
>
> *If the acceptance test of a Dolby-E-encoded 5.1 signal is performed without the option to simulate the effects of the metadata, the following limitations have to be taken into account:*
>
> - *In this case, the full dynamic range is always played back, while the home viewer has the option to limit the dynamic range.*
> - *Due to the lack of metadata interpretation, the loudness of the signal relative to other programs cannot be assessed.*
> - *No automatic downmix of the 5.1 signal to mono, stereo, or Dolby Surround can be listened to.*

For decoded linear audio signals, the listening arrangement described above has to be used in conjunction with a loudness meter capable of measuring multi-channel sound.

3.7.3 Acceptance Tests of MXF Files

In addition to checking audio and video, technical acceptance tests should also include the MXF file, in order to

- avoid quality loss caused by issues in the encoded essence, and
- ensure the file's interoperability in subsequent workflows.

Various products are available on the market for testing MXF files, offering different features and different degrees of detail. So far, there is no standardized test method. The choice and configuration of the products must be adapted to the requirements of the target system at hand.

As a basis for checking MXF parameters, the ARD_ZDF_HDF profiles may be used (cf. item 2.4). They significantly restrict the options of the MXF standard. Some products already offer preset configurations (templates) for checking against the ARD_ZDF_HDF profiles. It has to be noted, however, that in most cases not all of the parameters specified can be tested.

Any transcoding that might be necessary should always take place BEFORE the video and audio check. Manual acceptance tests should be conducted with the essence that will be broadcast.

4 Supply and Delivery

4.1 Supply by Outside Contractors

The subject of this application scenario are all programs supplied by outside contractors to an ARD broadcasting company, to ZDF, or to ORF.

For communication with the outside, a brief outline of requirements may be quite useful, giving a brief yet informative overview. For support, item 6.11 lists an example based on the WDR document entitled *Allgemeine Festlegung der HD-Produktionsformate des WDR* („General Specification of HD Production Formats for WDR“).

4.1.1 Supply Format

The program is supplied as an MXF file or on Professional Disc, with the following requirements:

- Audio and video quality must meet the basic quality requirements (cf. item 1).
- The technical parameters for video and audio have to be observed (cf. items 2.1 and 2.2).
- The technical parameters for MXF files or Professional Disc, as the case may be, have to be observed (cf. items 2.4 or 2.5). [1)]
- If subtitles/captions are included, they have to be supplied as a separate STL file and comply with the specifications listed under item 2.6.1.
- Additional regulations by the broadcasting company involved, if applicable, have to be observed as well.
- The program has to be supplied without commercial breaks and without technical leaders, which also includes a leader for Dolby E. The only exception is a supply on Professional Disc, where leaders (before and after) are still required (cf. item 2.4).

> ***Note***
>
> *[1)] MXF profiles are supported by a large number of manufactures already, however, implementations have not all been finalized yet. For this reason, noncompliant MXF files are still being supplied at this time (Nov. 2016).*

The following table lists the formats of the individual broadcasting companies that are usually demanded for external contract productions.

Acceptance of complete HD programs on	BR, DW, NDR, ORF, RB, SR, SWR, WDR	HR, MDR	RBB	ZDF
Professional Disc (XDCAM HD422)	1080i/25		1080i/25	
MXF file XDCAM HD422	1080i/25			
MXF file AVC-I 100		1080i/25	1080i/25	1080i/25 720p/50
MXF profile ARD_ZDF_HDF	01a - - - - -	- 02a - - 02b -	- 02a - - - -	- 02a 03a - - -

4.1.2 Provision

The supply path has to be arranged with the broadcaster involved (e.g. supply on mobile storage medium, via FTP, or via media file transfer).

4.1.3 Meta Data

The meta data required in each case as well as the meta-data format have to be arranged with the broadcaster involved. In the medium tern, the aim is to use the Media Data Card for this purpose.

4.2 Delivery to the Playout Centers

The subject of this application scenario are all programs delivered to the ARD playout centers (POCs), to ARTE, ZDF, or ORF.

4.2.1 Supply Format

In general, the program has to comply with the technical parameters. The following requirements apply:

- Audio and video quality must meet the basic quality requirements (cf. item 1).
- The technical parameters for video and audio have to be observed (cf. items 2.1 and 2.2).
- The technical parameters for MXF files or Professional Disc, as the case may be, have to be observed (cf. items 2.4 or 2.5).[1)]
- In the case of legacy material, loudness will be normalized at the place of use, i.e. the playout center.
- The program has to be supplied without commercial breaks and without technical leaders, which also includes a leader for Dolby E. The only exception is a supply on Professional Disc, where leaders (before and after) are still required.

> ***Note***
>
> *[1] The introduction of the MXF profiles within the companies is far advanced but not complete yet. For this reason, noncompliant MXF files are still being delivered at this time (Nov. 2016). With the introduction of the new MFT 2.0 file exchange system, the specified MXF profiles should be used exclusively.*

The following formats are acceptable for delivery (preferred formats are highlighted in **bold** letters):

Acceptance of complete HD programs on	ARD Playout Centers [1]	3sat	ZDF	ORF	ARTE
Professional Disc (XDCAM HD422)	1080i/25	1080i/25 720p/50		**1080i/25**	
MXF file XDCAM HD422	**1080i/25**	**1080i/25** 720p/50	**1080i/25** 720p/50	**1080i/25**	**1080i/25** 720p/50
MXF file AVC-I 100	**1080i/25**	**1080i/25** 720p/50	**1080i/25** 720p/50		**1080i/25** 720p/50
MXF profile ARD_ZDF_HDF	01a 02a - - 02b [2] -	01a 02a 03a - - -	01a 02a 03a - - -	01a - - - - -	01a 02a 03a 01b 02b 03b
transmission via cable	x	-	-	-	-

[1] *ZSAW, ONE, tagesschau24, KiKA*
[2] *only for ZSAW and KiKA.*

The following audio track allocations are acceptable for delivery (preferred formats are highlighted in **bold** letters):

Audio Track Allocation according to TPRF	ARD Playout Centers [1]	3sat	ZDF	ORF	ARTE
1 (4 Kanal)	x	x	x	x	x
1 (4 Kanal)	-	x	x	x	x
1 (4 Kanal)	-	x	x	x	x
4 (8 Kanal)	**x**	**x**	**x**	**x**	**x**
5 (8 Kanal)	-	x	x	x	x
6 (8 Kanal)	-	x	x	x	x
7 (16 Kanal)	*x [2]*	-	-	-	*x*

[1] ZSAW, ONE, tagesschau24, KiKA
[2] Deliveries with 16 audio tracks (profile 02b) are only possible for ZSAW and KiKA.

4.2.2 Provision and Additional Regulations

If the program is delivered as an MXF file, delivery is generally performed via file transfer (VFT / MFT 2.0). The specific regulations of the various playout centers are listed in the following table. The regulations for the delivery of subtitles/captions are listed in the next chapter.

Playout Center	Additional Regulations
ZSAW	• The MXF file is provided via file transfer (VFT / MFT 2.0). • Programs delivered via VFT have to be announced in the Web registration tool for VFT, listing play number and title in each instance. • The delivery has to be concluded at least six (6) hours plus program run time before the scheduled start of the broadcast! • In naming the files, the broadcast title given in Plan1 has to used, but without umlauts (ä, ö, ü), ß or other special characters.
ARD POC **(ONE, tagesschau24)**	• The MXF file is provided via file transfer (VFT / MFT 2.0). • The delivery has to be concluded at least six (6) hours plus program run time before the scheduled start of the broadcast. A shorter lead time may be mutually arranged. • The broadcast title has to be in the VFT title.
KiKA	• The MXF file is provided via file transfer (VFT / MFT 2.0). • The program has to start on time code 10:00:00:00.
3Sat	• The MXF file is usually provided via file transfer (VFT / MFT 2.0) to SWR (ARD coordination for 3sat). • The broadcast title has to be in the VFT title. ARD coordination for 3sat will probably be transferred to BR at the end of 2017.
ZDF	• Provision and lead time will be arranged individually for each delivery.
ORF	• By arrangement, programs are delivered either on Professional Disc or via a file transfer system. • The file name has to match the broadcast title, but without umlauts (ä, ö, ü) or special characters. • The program has to start on time code 10:00:00:00. • Lead time to be arranged
ARTE	• The MXF file is provided via file transfer (VFT / MFT 2.0). • The meta data required for the program delivery, the delivery note, and the subtitles/captions have to be made available at the broadcast companies via the APAX ARTE tool.

4.2.3 Subtitles/Captions

In general, subtitles/captions are provided additionally. Subtitles must be delivered as separate files in the STL format and have to comply with the regulations under item 2.6.1.

Until an integrated solution for the exchange of subtitle files becomes available, subtitles have to be delivered via e-mail:

Playout Center	Delivery of Subtitles
ZSAW	STL files have to be sent to ZSAW by e-mail to: ARDSZ-Untertitel@ard-stern.de The subject line of the e-mail has to include the play number of the broadcast center (SZ) and, as a safeguard, also the program title.
ARD POC **(ONE, tagesschau24)**	STL files have to be sent to the Potsdam POC by e-mail to: UT@ard-poc.de The subtitle file name must contain the main broadcast title or the series titles + episode title or episode number. If possible, the e-mail should also contain the original air date of the originating broadcaster.
KiKa	STL files have to be sent to KiKA by e-mail to: VTXUT@kika.de The name of the STL file must be composed of title_episode-number_program-subtitle.
3Sat	ARD STL files must be delivered proactively to SWR by e-mail to: 3sat-untertitel@swr.de • The subtitles will then be forwarded by SWR (ARD coordination 3sat) via e-mail to the 3sat Playout Center. Short-term repeats (within two working days) should be delivered by the delivering broadcast company via e-mail to 3sat-untertitel@swr.de and additionally to 3satAvD@zdf.de. ORF STL files will be downloaded by the 3sat broadcast center from ORF directly. ARD coordination for 3sat will probably be transferred to BR at the end of 2017.
ZDF	STL files will be delivered by e-mail in coordination with „Hauptredaktion Neue Medien Untertitel“ (“Main Office New Media Subtitles”).
ORF	STL files will be delivered by e-mail in coordination with the department in charge.
ARTE	STL files will be delivered via APAX.

4.2.4 Meta Data

In video file transfer (VFT), a minimum amount of meta data will be made available via a VFT Web input form.

In media file transfer, meta data are transmitted in the form of the Media Data Card as an XML file. For deliveries to ZSAW, the meta data set is listed under item 6.10.

For deliveries to ARTE, the required meta data have to be provided via the APAX system.

4.3 Exchange between Broadcasters

4.3.1 Supply Format

The program has to be supplied as an MXF file that complies with the technical parameters listed under item 2. Formats acceptable without any further arrangement are: [1)]

- ARD_ZDF_HDF01a
- ARD_ZDF_HDF02a
- ARD_ZDF_HDF03a

> ***Note***
>
> *[1)] The introduction of the MXF profiles within the companies is far advanced but not complete yet. For this reason, noncompliant MXF files are still being delivered at this time (Nov. 2016). With the introduction of the new MFT 2.0 file exchange system, the specified MXF profiles should be used exclusively.*

Attention has to be paid to the following issues:

- A format conversion to the “in-house format” will be performed, if necessary, on the recipient’s side. An exchange of MXF files with 16 audio tracks (all “b” profiles) is only possible by bilateral arrangement.
- The program has to be supplied without commercial breaks. New productions must be free of lead-ins or lead-outs as well as any technical leaders. Files generated from legacy material may contain technical leaders and/or lead-in and lead-outs.
- In the case of legacy material, loudness will be normalized at the place of use, i.e. the accepting broadcaster.

4.3.2 Provision

The exchange is performed via file transfer (VFT / MFT 2.0).

4.3.3 Subtitles/Captions

If available, subtitles/captions should be provided additionally. Subtitles must be delivered as separate files in the STL format.

Until an integrated solution for the exchange of subtitle files becomes available, subtitles have to be delivered via e-mail.

4.3.4 Meta Data

In video file transfer (VFT), a minimum amount of meta data will be made available via a VFT Web input form.

In media file transfer, meta data are transmitted in the form of the Media Data Card as an XML file. The meta data set for program exchange is listed under item 6.10.

4.4 Live Contribution via Hybnet

Live contribution via Hybnet is used in the playout centers for the supply of a live signal or a live segment within a program. In order to control Hybnet capacities, it requires an application at the „ARD-TV-Leitungsbüro“.

Regarding audio track allocation and subtitles, attention has to be paid to the following issues:

- For audio track allocation, variant 4 of the TPRF (cf. item 2.2.3.4) is used as a standard. Other audio track allocations have to be arranged with the receiving institution before the live contribution.
- For live contributions, subtitles/captions have to be delivered separately. Live delivery of subtitles is handled using the Newfor protocol via IP. The Newfor protocol is not standardized but is supported by all relevant captioning-system manufacturers. In principle, the use of proprietary protocols is possible, but it requires an unambiguous arrangement in advance, including a test transmission.
- Apart from the options described above, delivery to the ARD Playout Center is also possible via FAB’s proprietary protocol. DVB captions for ARD „Das Erste“ are generated directly at the ARD Playout Center and do not require a separate delivery.

4.5 Provision for Online Distribution

For the supply of material for online distribution, the broadcast companies are using the regular processes of video production. In analogy to broadcast, where compression and conversion into the distribution formats is performed at the playout point, the formats required for online distribution are also generated only at the point of transfer from the production systems to the Websites or TV-on-demand sites/applications („Mediathek“). The formats required for distribution are defined in the Web-technology manual (Weblink: Web-Handbuch, irt.de).

For online distribution via third-party platforms such as Facebook and YouTube, the broadcast companies have established specific procedures.

4.5.1 Exemplary Procedure within the Broadcast Companies

Even though specific procedures may differ between broadcasters, they can be represented by the following example:

Provision of Pre-Produced Content:

Material is produced in the broadcaster’s production format and transferred from the production system into the Web content management system. Transcoding into the required distribution formats and insertion of the broadcaster’s logo are performed with the transition into the Web CMS.

Provision of Live Signals:

The required signal is provided via the broadcaster’s main control rooms in broadcast HD quality (HD-SDI) and encoded into the required distribution formats using suitable live encoders. Depending on the case of application, the signals will be manipulated additionally, in order, for example, to respond to legal restrictions or to insert graphics. For a subsequent use on demand, the encoded signals will be manually or automatically trimmed and processed within the management systems.

Note

Even tough many production mixers and post-production systems include built-in features for generating live streams and/or Web formats, such workflows are not used for the following reasons:

- *the number of formats needed for Web playout;*
- *the necessity for high-quality archiving;*
- *and the necessity to control graphics inserts (e.g. broadcaster logo).*

4.5.1 Application Scenario „ARD-Mediathek“

For the „ARD-Mediathek“, essences are not provided separately or independently. The „ARD-Mediathek“ player uses exactly those essences that were generated by the broadcasters and ARD Das Erste for their respective online catalogs and integrates them into the „ARD-Mediathek“ presentation.

4.5.2 Application Scenario „Das Erste Mediathek“

Pre-produced content for the on-demand video catalog of ARD Das Erste is provided by the ARD Playout Center in Frankfurt. The department in charge of programming for Das Erste will label programs intended for online availability in Das Erste’s program planning system PLAN1. At the ARD Playout Center, the programs thus labeled will be pre-coded into a mid-res format (12 Mbit/s) and handed over to Das Erste in Munich for final transcoding for the intended distribution channels. As with all broadcast material for „Das Erste“, the source material is pre-checked at the ARD Playout Center for broadcast suitability. This will ensure that only technically flawless material is delivered to the „Mediathek“. This workflow also applies to programs which had already been published on the „Das Erste Mediathek“ before their linear broadcast (“online first”). This kind of material has to be delivered earlier – i.e. before the online publication – to the ARD Playout Center. By direct arrangement with the department in charge of programming („Programmdirektion“) of ARD Das Erste, a separate delivery of essences for online use is possible.

First and foremost, the broadcasters’ online departments are responsible for providing subtitle data to the joint video-on-demand sites/apps, „ARD Mediathek“ and „Das Erste Mediathek.“ Subtitles/captions may only be delivered in the EBU-TT-D-Basic-DE format.

4.6 Exchange of Audio Content between Radio and Television Productions

Due to the increase of tri-media exchange, several production-related and system-related interoperability problems have occurred. Special attention has to be paid to the following issues:

- **LFE signal level:** In contrast to television productions, radio productions do not lower the LFE signal by 10 dB. For this reason, in an exchange, the correct leveling of the LFE channel has to be ensured (cf. item 2.2.4.3).
- **Channel configuration for multi-channel audio**: Radio uses an audio channel allocation according to *EBU R91*, placing a corresponding stereo sound behind the multi-channel sound on tracks 7 and 8. None of the 6 different audio track allocations is thus compatible with this format (cf. item 2.2.3.4). In any exchange, the audio track allocation therefore has to be indicated.

5 Archiving Format for HDTV

The goal is to preserve all productions in the best possible quality and in the best, most efficient and most economic form possible that allows easy retrieval and re-use.

5.1 Mainstream

In the area of HDTV Mainstream productions, the archiving of program material as files in a mass storage system, such as a datatape library, seems practical, as the XDCAM HD422 and AVC I 100 compression formats are already used with tapeless systems in HDTV Mainstream production. VTR formats are no longer available. It has to be noted that a minimum of eight audio channels are required.

> ***Note***
>
> *For XDCAM HD422, programs may be played out to optical disc for archiving. For AVC I 100, a playout to P2 memory cards for archiving is not economical.*

5.2 Premium / High Quality

In the case of costly premium productions, the individual broadcast companies will apply their own rules and regulations. In addition to file formats, the HDCAM-SR format is still in use for high-quality archiving.

Moreover, it might make sense to keep a copy in a Mainstream format that is operationally necessary, e.g. to store an MXF file with XDCAM HD422 or P2 AVC-I 100 in mass storage.

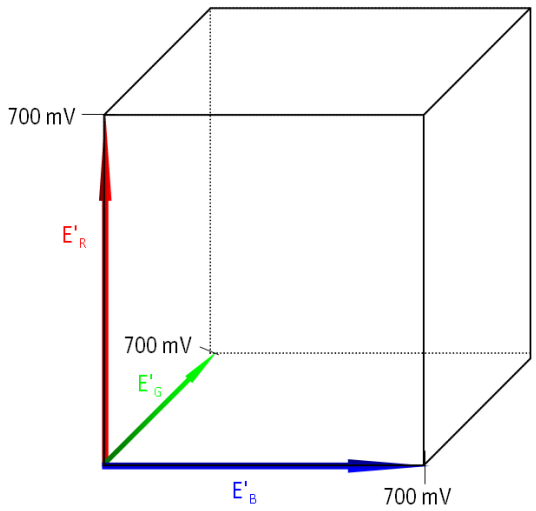
5.3 Audio Track Allocation in Archives

It would make sense to use the mandatory audio-track assignment specified under item 2.2.3.4 for the archiving of program material as well.

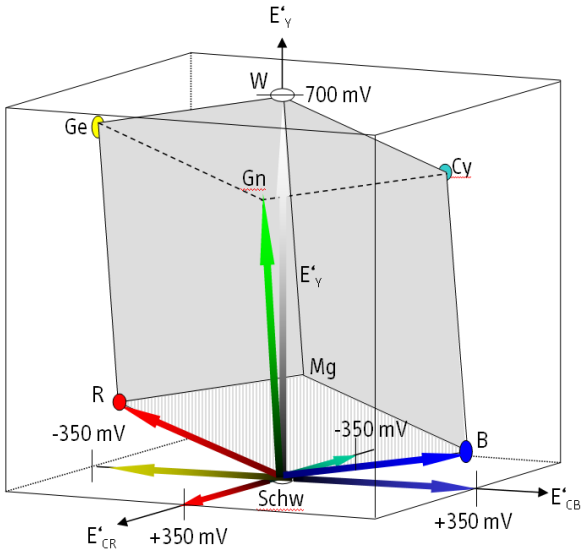
Any audio-track allocation that diverges from this standard has to be re-arranged for program exchange and playout delivery!

6 Appendix

6.1 RGB Color Space



RGB Color Space



„RGB“ color space within E’Y E’CR E’CB color space

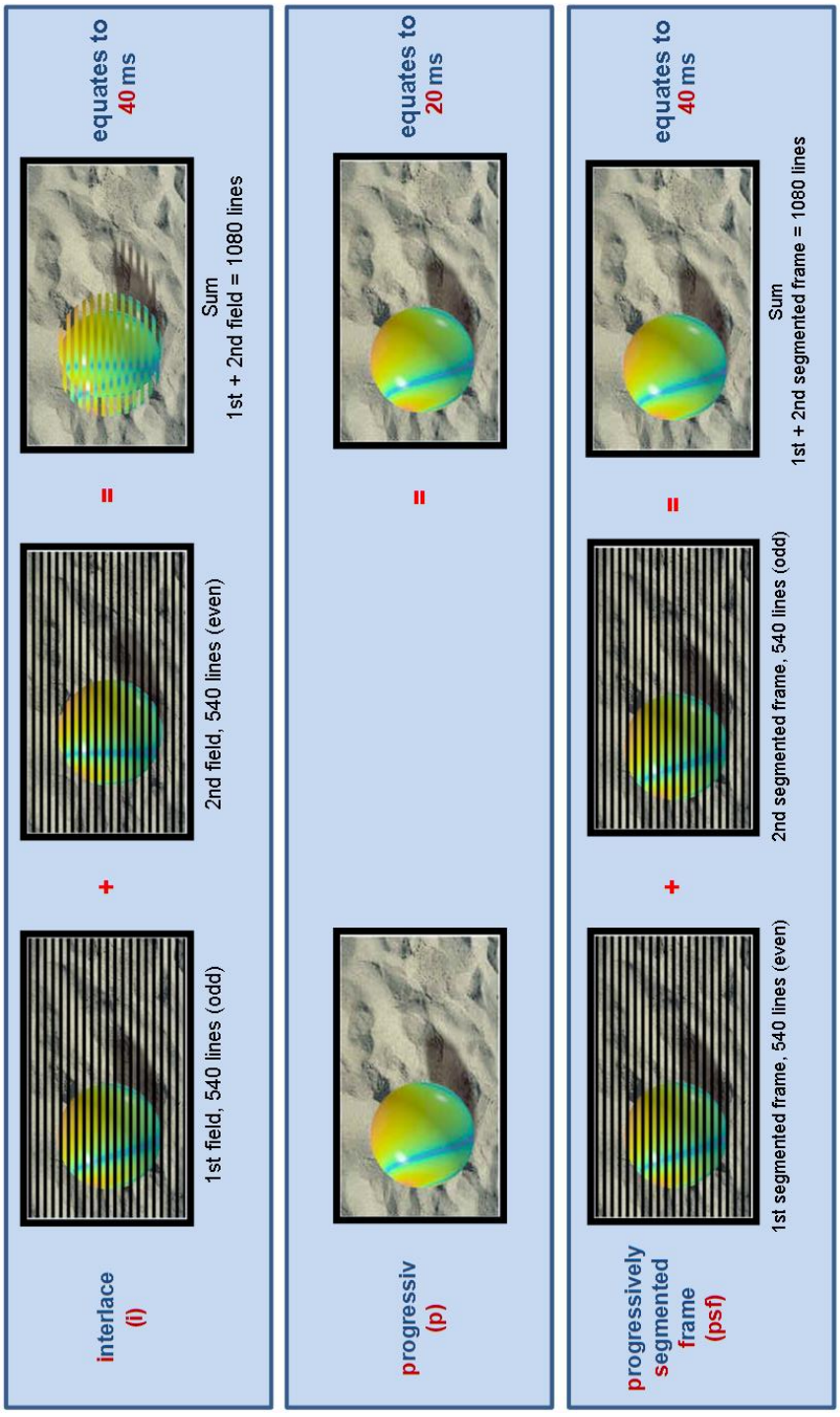
Matrixing according to the formula:

$$E'_{CR} = 0{,}71(E'_R - E'_Y)$$

$$E'_{CB} = 0{,}56(E'_B - E'_Y)$$

will turn the E’R E’G E’B color space (cube) displayed on the left into a parallelepiped (a body defined by three pairs of parallelograms) position within the E’YE’CRE’CB color space as shown in the figure on the right.

6.2 1080psf/25



Programs produced in the 1080p/25 scanning format are frequently transported (transmitted, stored) as 1080i/25. This option, designated as “1080psf/25,”.

Attention: If 1080psf/25 material is treated as 1080i/25 material (i.e. if psf was not flagged) and subsequently played out as 1080p/25 material, vertical resolution may be cut in half under certain circumstances.

6.3 Specification for a 16-Channel Audio Track Allocation

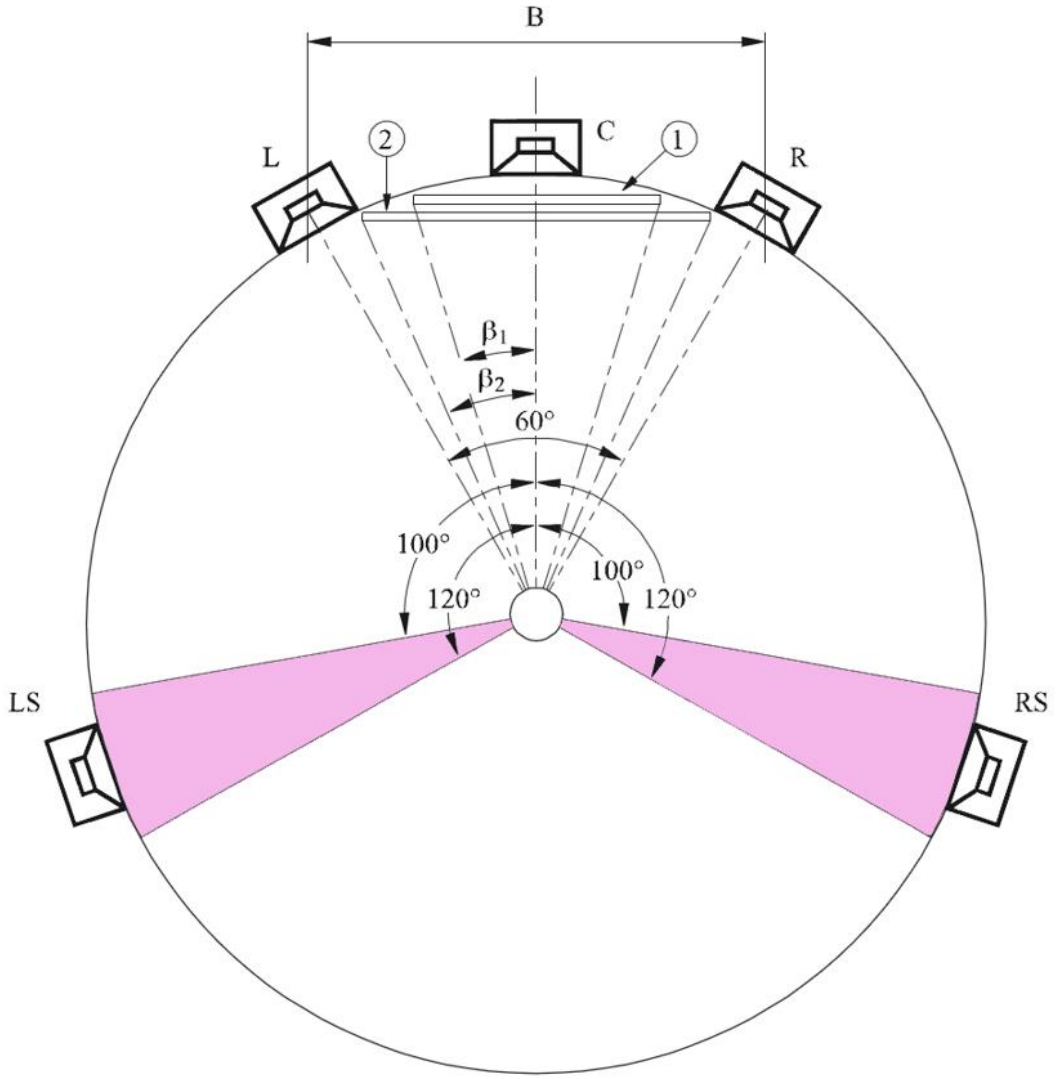
Attention: This audio track allocation is for in-house use with 16 channels. For the supply and exchange of programs, this option is currently only admissible by mutual agreement.

Option	7 (IN-HOUSE)
Name	16-channel, standard
Audio 1	stereo broadcast audio(1) L
Audio 2	stereo broadcast audio(1) R
Audio 3	music and effects (M&E) L
Audio 4	music and effects (M&E) R
Audio 5	second audio (SAP)(2) L
Audio 6	second audio (SAP)(2) R
Audio 7	broadcast audio Dolby E(3, 4)
Audio 8	broadcast audio Dolby E(3, 4)
Audio 9	multi-channel broadcast audio L
Audio 10	multi-channel broadcast audio R
Audio 11	multi-channel broadcast audio C
Audio 12	multi-channel broadcast audio LFE
Audio 13	multi-channel broadcast audio LS
Audio 14	multi-channel broadcast audio RS
Audio 15	blank
Audio 16	blank

For footnotes, cf. item 2.2.3.4.

6.4 Multi-Channel Stereo Systems

Reference Loudspeaker Arrangement According to *ITU-R BS.775*



Reference Speaker Arrangement

with speakers L/C/R and LS/LR
Screen 1:
Screen 2:
H = height of screen

(from ITU-R BS.775-1)
reference distance = 3H ($2\beta_1 = 33°$)
reference distance = 2H ($2\beta_2 = 48°$)
B = loudspeaker base width

Loudspeaker	Horizontal angle	Height	Inclination
C	0°	1.2 m *	0° *
L, R	± 30°	1.2 m	0°
LS, LR	± (100…120)°	≥ 1.2 m	≤15°

*) depending on screen shape and size

6.5 Dolby E – Frame Positioning

The Dolby E frame positions shown in the table below are recommended by Dolby Laboratories.

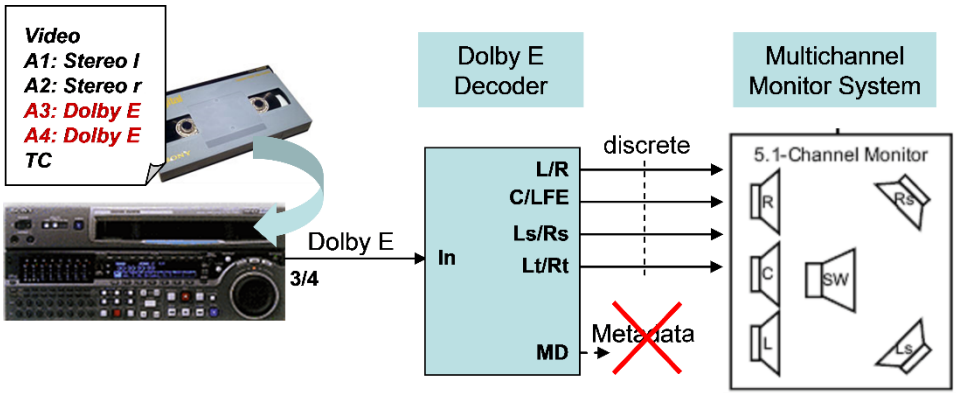
		576i/25	1080i/25	720p/50 (2)
Potentially earliest valid Dolby E position	TV line	8	13	17
	Position/µs(1)	450	450	450
	48 kHz AES sample(3)	22	22	22
Ideal Dolby E line position –80 µs	TV line	11	19	25
	Position/µs(1)	650	650	650
	48 kHz AES sample(3)	32	32	32
Ideal Dolby E line position ±80 µs	TV line	**12**	**21**	**28**
	Position/µs(1)	**730**	**730**	**730**
	48 kHz AES sample(3)	**36**	**36**	**36**
Ideal Dolby E line position +80 µs	TV line	13	23	31
	Position/µs(1)	810	810	810
	48 kHz AES sample(3)	39	39	39
Potentially latest valid Dolby E position	TV line	30	53	70
	Position/µs(1)	1860	1860	1860
	48 kHz AES sample(3)	90	90	90

1) in relation to SMPTE RP168 reference point and approximate values

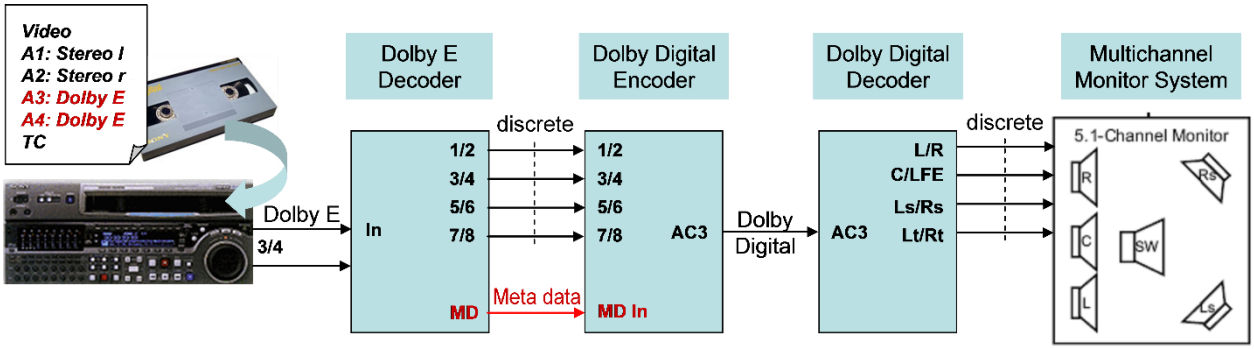
2) relative to the first (odd) frame

3) where the start of 48 kHz AES sample number 1 is approximately aligned to the SMPTE RP168 reference point

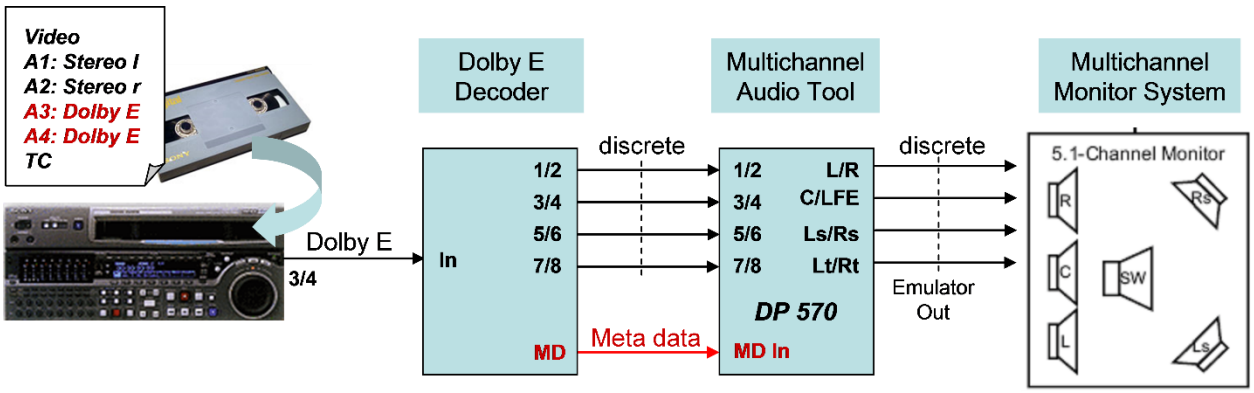
6.6 Acceptance of Dolby-E-Encoded Audio Signals



Encoded audio signals without meta data readout



Encoded audio signals with meta data readout – Dolby En-/Decoders using Dolby Digital encoder and decoder.



Encoded audio signals with meta data readout – audio tools using a suitable audio tool.

6.7 Dolby Meta Data Presets

Preset: „Loud“ – highly compressed, low dynamic range		
Preset #	**Preset 1** (Stereo)	**Preset 2** (Dolby 5.1)
Parameter		
PRG Config	3x2	5.1
PRG Descrpt Text	loud	loud
Dialog level	-23	-23
Channel Mode	2/0	3/2
LFE Channel	disabled	enabled
Bitstream Mode	main complete	Same as left column
Line Mode Pro	Film Light	
RF Mode Pro	Film Light	
RF Ovmd Protect	disabled	
Center Dwnmx Lvl	- 3 dB	
Surnd Dwnmx Lvl	- 6 dB	
Dolby Srnd Mode	disabled	
Audio Prod Info	no	
Mix Level	N/A	
Room type	N/A	
Copyright	yes	
Orig Bitstream	yes	
Prfd Stereo Dwnm	Lo/Ro	
Lt/Rt Ctr Dwnm Lv	- 3 dB	
Lt/Rt Srd Dwnm Lv	- 6 dB	
Lo/Ro Ctr Dwnm Lv	- 3 dB	
Lo/Ro Srd Dwnm Lv	- 6 dB	
Dolby Srd Ex Mode	disabled	
A/D Converter Type	standard	
DC Filter	enabled	
Lowpass Filter	enabled	
LFE Lowpass Filter	enabled	
Srnd 3 dB Atten	disabled	
Srnd Phase Shift	disabled	

extended bit stream information in italics

Notes	16-bit word size
Program Type	entertainment show, rock concert
Examples	Verstehen Sie Spaß? Wetten dass..? Rockpalast

Preset: „Standard“ – medium dynamic range		
Preset #	**Preset 3** (Stereo)	**Preset 4** (Dolby 5.1)
Parameter		
PRG Config	3x2	5.1
PRG Descrpt Text	standard	standard
Dialog level	-23	-23
Channel Mode	2/0	3/2
LFE Channel	disabled	enabled
Bitstream Mode	main complete	Same as left column
Line Mode Pro	Film Standard	
RF Mode Pro	Film Standard	
RF Ovmd Protect	disabled	
Center Dwnmx Lvl	- 3 dB	
Surnd Dwnmx Lvl	- 6 dB	
Dolby Srnd Mode	disabled	
Audio Prod Info	no	
Mix Level	N/A	
Room type	N/A	
Copyright	yes	
Orig Bitstream	yes	
Prfd Stereo Dwnm	Lo/Ro	
Lt/Rt Ctr Dwnm Lv	- 3 dB	
Lt/Rt Srd Dwnm Lv	- 4.5 dB	
Lo/Ro Ctr Dwnm Lv	- 3 dB	
Lo/Ro Srd Dwnm Lv	- 4.5 dB	
Dolby Srd Ex Mode	disabled	
A/D Converter Type	standard	
DC Filter	enabled	
Lowpass Filter	enabled	
LFE Lowpass Filter	enabled	
Srnd 3 dB Atten	disabled	
Srnd Phase Shift	disabled	

extended bit stream information in italics

Notes	16-bit word size
Program Type	weather, news, TV series, daytime drama, documentary, entertainment news, magazine, children’s movie, crime drama, morning TV, live reports on current events, commercials, trailers, interstitials, station ID, jazz concerts, crossover concerts
Examples	Band and Orchestra

Preset: „Dynamic“ – wide dynamic range		
Preset #	**Preset 5** (Stereo)	**Preset 6** (Dolby 5.1)
Parameter		
PRG Config	3x2	5.1
PRG Descrpt Text	dynamic	dynamic
Dialog level	-23	-23
Channel Mode	2/0	3/2
LFE Channel	disabled	enabled
Bitstream Mode	main complete	Same as left column
Line Mode Pro	Film Standard	
RF Mode Pro	Film Standard	
RF Ovmd Protect	disabled	
Center Dwnmx Lvl	- 3 dB	
Surnd Dwnmx Lvl	- 3 dB	
Dolby Srnd Mode	disabled	
Audio Prod Info	no	
Mix Level	N/A	
Room type	N/A	
Copyright	yes	
Orig Bitstream	yes	
Prfd Stereo Dwnm	Lo/Ro	
Lt/Rt Ctr Dwnm Lv	- 3 dB	
Lt/Rt Srd Dwnm Lv	- 3 dB	
Lo/Ro Ctr Dwnm Lv	- 3 dB	
Lo/Ro Srd Dwnm Lv	- 3 dB	
Dolby Srd Ex Mode	disabled	
A/D Converter Type	standard	
DC Filter	enabled	
Lowpass Filter	enabled	
LFE Lowpass Filter	enabled	
Srnd 3 dB Atten	disabled	
Srnd Phase Shift	disabled	

extended bit stream information in italics

Notes	16-bit word size
Program Type	church service, theater, theatrical, motion picture, high-quality crime drama, concert programs with a high percentage of spoken dialog
Examples	motion pictures, such as *Blade Runner*, *The Bridge of Remagen* (theatrical mix), *ZDF Klassik* with G. Alsmann

1st Special: „Classic“ – very wide dynamic range, „soft“		
Preset #	**Preset 7** (Stereo)	**Preset 8** (Dolby 5.1)
Parameter		
PRG Config	3x2	5.1
PRG Descrpt Text	classic special	classic special
Dialog level	-23	-23
Channel Mode	2/0	3/2
LFE Channel	disabled	enabled
Bitstream Mode	main complete	Same as left column
Line Mode Pro	Music light	
RF Mode Pro	Music light	
RF Ovmd Protect	disabled	
Center Dwnmx Lvl	- 3 dB	
Surnd Dwnmx Lvl	- 6 dB	
Dolby Srnd Mode	disabled	
Audio Prod Info	no	
Mix Level	N/A	
Room type	N/A	
Copyright	yes	
Orig Bitstream	yes	
Prfd Stereo Dwnm	Lo/Ro	
Lt/Rt Ctr Dwnm Lv	- 3 dB	
Lt/Rt Srd Dwnm Lv	- 6 dB	
Lo/Ro Ctr Dwnm Lv	- 3 dB	
Lo/Ro Srd Dwnm Lv	- 6 dB	
Dolby Srd Ex Mode	disabled	
A/D Converter Type	standard	
DC Filter	enabled	
Lowpass Filter	enabled	
LFE Lowpass Filter	enabled	
Srnd 3 dB Atten	disabled	
Srnd Phase Shift	disabled	

extended bit stream information in italics

Notes	16-bit word size
Program Type	few spoken words, little compression, radio broadcast material, typically: 3sat
Examples	opera, classic concert, chamber music

2nd Special: „Sports“ – live broadcast

Preset #	**Preset 9** (Stereo)	**Preset 10** (Dolby 5.1)
Parameter		
PRG Config	3x2	5.1
PRG Descrpt Text	sports live	sports live
Dialog level	-23	-23
Channel Mode	2/0	3/2
LFE Channel	disabled	enabled
Bitstream Mode	main complete	Same as left column
Line Mode Pro	Film Standard	
RF Mode Pro	Film Standard	
RF Ovmd Protect	disabled	
Center Dwnmx Lvl	- 3 dB	
Surnd Dwnmx Lvl	- 6 dB	
Dolby Srnd Mode	disabled	
Audio Prod Info	no	
Mix Level	N/A	
Room type	N/A	
Copyright	yes	
Orig Bitstream	yes	
Prfd Stereo Dwnm	Lo/Ro	
Lt/Rt Ctr Dwnm Lv	0 dB	
Lt/Rt Srd Dwnm Lv	- 4.5 dB	
Lo/Ro Ctr Dwnm Lv	0 dB	
Lo/Ro Srd Dwnm Lv	- 4.5 dB	
Dolby Srd Ex Mode	disabled	
A/D Converter Type	standard	
DC Filter	enabled	
Lowpass Filter	enabled	
LFE Lowpass Filter	enabled	
Srnd 3 dB Atten	disabled	
Srnd Phase Shift	disabled	

extended bit stream information in italics

Notes	16-bit word size
Program Type	not sports magazines. Live broadcast of major event: Olympic Games, soccer World Cup, track and field world championships, handball, etc.

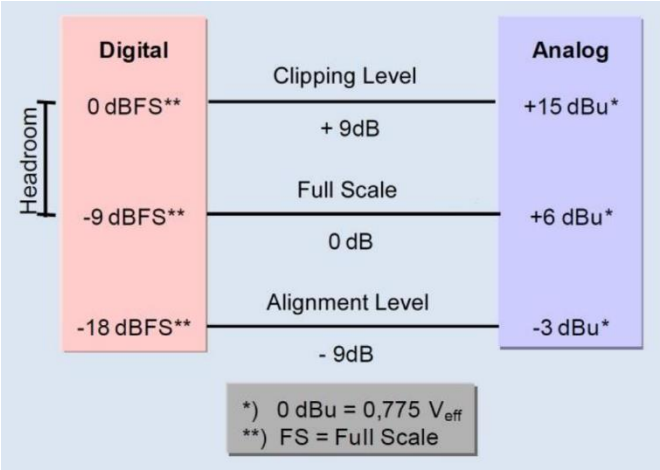
6.8 Peak Normalization – Dynamic Range

For guidance when using non-normalized material (e.g. stock footage or foreign productions), the following audio signal leveling guidelines still apply, as specified in the *Technical Guidelines for SDTV* (December 2006 edition). The following is an excerpt from chapter 6.2:

EBU Technical recommendation R68 specifies coding level as well as a uniform reference level for digital audio systems. The value for this alignment level has to be 18 dB below the clipping level, regardless of the number of bits available (16, 18, 20, …).

This will result in a 9 dB headroom.

A system calibrated to +6 dB full scale will show the following relationship between digital and analog signals (cf. also *HFBL-K Recommendation 15IRT*):



Relation of analog and digital alignment levels, based on Recommendation ITU-R BS.646

Only digital audio signals with a sampling rate of 48 kHz shall be used.

6.9 Production Counseling Check List

The proposed check list is meant to provide technical service providers with a basis for production counseling.

It has to be accepted, in general, that EVERYBODY is looking for the ultimate NEW look, particularly in dramatic productions! For this reason, the creative side will appreciate (and want to use) each and every feature that new cameras have to offer.

In this context, it is necessary to discuss to which degree the cameras and equipment intended for the production at hand are actually capable of fulfilling expectations. In addition, the expenses expected to be incurred by special workflows and solutions should be addressed as early as possible.

It has to be noted that special demands will incur special (extra) costs.

6.9.1 Basics

- Can all scenes be shot at the intended location (genre) with the intended look?
- Do certain situations require quick switches in field size that cannot be achieved with prime lenses?
- Do certain locations require the use of very small, compact cameras, while maintaining the overall look of the production?
- Is the mix of camera types and recording formats supported by the crew, who can secure these materials in a responsible manner?
- What are the requirements for raw data back up and protection, with regard to insurance issues and potential extra costs due to the recording and storage formats chosen?
- The target has to be: achieving maximum technical quality in digital recording, while guaranteeing sufficient production security.
- Is it possible to achieve the desired image characteristics with suitable technical options?
- Counseling on and possibly testing of the DP’s visual concept with regard to its feasibility in production and post-production
- Planning of the actual workflow, taking into consideration that complex workflows will incur extra costs!

6.9.2 Camera Type

- Is all relevant information available about camera type, storage medium, and the formats to be supplied at the output as well as their specific capabilities and limitations? How far does built-in signal processing affect quality (e.g.: although the Canon EOS has a large image sensor, its built-in signal processing is relatively low in quality, which practically rules out any long shots that are rich in detail!)?
- Are any alterations in the shooting parameters which might be necessary for optimizing the desired image characteristics feasible within the scope of look management, e.g. matching in multi-camera production?
- Do the available options for focus control and lighting as well as the audio settings meet the requirements?
- Does the camera have an HD SDI or HDMI output that allows “good” camera quality to be recorded on a suitable external recording device, such as AJA, Blackmagic, nanoFlash (8 bit limit!)?
- Consideration of operational aspects, e.g. the time required for any conversion of the recorded material that might be necessary (in multiples of real time)

- Which sampling formats are supported? Does recording require built-in signal converters? How will standard format conversions (30/25 f/s) be handled?
- Special aspects of single-sensor cameras for high-end, low-end, and DSLR competing products (Panasonic AG AF 101 and Sony NEX FS100, PMW F3)
- Is additional time-code equipment necessary, e.g. for the wireless transmission of the TC to the camera?
- Can the external recorder be triggered from the camera, e.g. via TC trigger?

6.9.3 Production Ramifications

- Does the intended camera type fit into the workflows of the proposed production, and does it fit its production and post-production techniques, which might be different?
- Will an additional specialist be required for the camera department, who might take over new, additional tasks and offer advice to the team?
- Is a preliminary technical quality check of the recording (digital gate check) possible or necessary on location? Who will be in charge?
- Assessment of data security for various storage media used in recording
- Coordination of data mapping and data management (spot-checks, possibly back-up) with post-production
- Equipment selection and assembly with the camera assistant
- Is there a lo-res preview concept, which takes into account the camera's options (metadata) and the demands of the executive producers?

6.9.4 Post-Production Ramification

- Demonstration of technical options and workflows in post-production, e.g. ingest, color-grading, etc.
- Specification of material logistics, e.g. handover of footage for post-production, data back up, transfer, etc.
- In which format will the technical acceptance check of the material be conducted?
- Can the technical/visual check of the material with the necessary equipment be guaranteed?

6.9.5 Delivery – Broadcaster Requirements

- Selection of the data supply format for productions using digital motion-picture cameras, e.g. Red, Arri Alexa, Arriflex D 2, etc.
- Scope of supply, data format, file format, compression format, scanning raster (e.g. 1080i/25), and data storage medium (e.g. Professional Disc)
- Which are the absolute minimum requirements, and does the supply format have to match the in house platform(s) in each and every case?
- Are there any differences regarding the supply of Mainstream vs. Premium productions?
- Can a camcorder system only be used with different crews (standard crew or special crew)?
- How will the use of DSLR cameras be handled? Some external producers already use them for 30 minute reports, i.e. they have already entered the Mainstream segment.

6.10 Meta Data Sets for Various Application Cases

The following tables list the minimal amount of meta data for various application cases (scenarios). These data sets were agreed upon by the ARD broadcasters in the course of introducing MFT 2.0.

The tables give a general description of the meta data, but they do not represent the XML data structure on which the Media Data Card is based. For this data structure, please refer to the specifications of the Media Data Card.

6.10.1 Program Exchange

Name	Description
application	specifies the application case
Delivery Data	
relation to production	production for which the material was ordered; has to use ID
order ID	ID for the complete order (itemized).
supplying broadcaster	details on the supplying broadcast company
Broadcast Data	
program main title (or series title)	currently used main title of the program (or series)
episode title (only for series)	title of the episode in a series Note: If the program is an episode of a series, the broadcast/main title is identical to the series title, and the episode title is thus the broadcast/main title, e.g.: series title = *Tatort* broadcast/main title = *Tatort* episode title = „Kaltes Herz“).
episode number (only where applicable)	number of the episode within a series
Essence Data	
video file	storage of the video signal
TC start	mark-IN point of the first frame to be broadcast = start of program, i.e. start of material without technical leader, pre-charge, lead-in
material RT	broadcast run time
aspect ratio	ratio of frame width to frame height for the frame format used in recording the program and required for an undistorted display
scanning format	scanning raster of the video signal
encoding method	manufacturer name of the encoding standard with additional encoding parameters
audio coding	audio signal coding
audio status	audio status of a group of audio tracks
audio label	useful capacity of a group of audio tracks
audio status element	audio status of all audio tracks (audio track allocation)

6.10.2 Broadcast Delivery ZSAW

Name	Description
application	specifies the application case
Delivery Data	
order ID	ID for the complete order (itemized).
supplying broadcaster	details on the supplying broadcast company
Broadcast Data	
program main title (or series title)	currently used main title of the program (or series)
episode title (only for series)	title of the episode in a series Note: If the program is an episode of a series, the broadcast/main title is identical to the series title, and the episode title is thus the broadcast/main title, e.g.: series title = *Tatort* broadcast/main title = *Tatort* episode title = „Kaltes Herz“).
episode number (only where applicable)	number of the episode within a series
Publication Data	
publication identifier	identifier for a publication that is valid across organizations and systems
publication identifier name	name for an identifier for a publication that is valid across organizations and systems (e.g. Plan1 number)
air date	date of broadcast
Essence Data	
video file	storage of the video signal
TC start	mark-IN point of the first frame to be broadcast = start of program, i.e. start of material without technical leader, pre-charge, lead-in
material RT	broadcast run time
aspect ratio	ratio of frame width to frame height for the frame format used in recording the program and required for an undistorted display
scanning format	scanning raster of the video signal
encoding method	manufacturer name of the encoding standard with additional encoding parameters
audio coding	audio signal coding
audio status	audio status of a group of audio tracks
audio label	useful capacity of a group of audio tracks
audio status element	audio status of all audio tracks (audio track allocation)

6.11 Example: Broadcaster HD Format Specs

WDR

DIREKTION PRODUKTION UND TECHNIK / HA AKTUELLE PRODUKTION UND SENDUNG

GENERAL HD PRODUCTION FORMAT SPECS OF WDR

In the production of HD programs, there is a general distinction between Premium and Mainstream productions. The term *Premium* is applied to special high-quality workflows for drama and repertory productions, such as the *Tatort* series or the New Year's Concert. The allocation of a production to either of the two formats will be specified in the contract.

REQUIRED HD-FORMAT FOR SHOOTING WDR PRODUCTIONS

For **HD productions,** the following parameters are specified:

1. HD Mainstream Production

- Sampling: **4:2:2**
- Scanning raster **1920 x 1080**
- Resolution: **i/25** (50 fields per second)
- Audio: min stereo (multi-channel audio 2.0)

2. HD Premium Production

- Sampling: **4:4:4** (minimum 4:2:2)
- Scanning raster: **1920 x 1080**
- Resolution: **p/25** (25 frames per second), or
  i/25 (50 fields per second)
- Audio: min stereo (multi-channel audio 2.0)
- camera examples for HD Premium Productions:
  Sony F35, F23 and HDW-9000, Red One and Epic, Arri Alexa and Amira.

For supply, no less than 75% of the finished program have to consist of native formats according to the specifications above.

The following formats no longer meet current minimum quality requirements and thus **are no longer accepted as HD production formats**:

- HDCAM (3.1.1, 1440 x 1080, 8 bit, Intra)
- XDCAM 35 Mbps (4:2:0, 1920 x 1080, 8 bit, Long GOP)
- XDCAM 18 oder 25 Mbps (4:2:0, 1440 x 1080, 8 bit, Long GOP)
- HDV (4:2:0, 1440 x 1080, 8 bit, Long GOP)

MANDATORY HD SUPPLY MATERIAL FOR SUPPLY TO WDR

"Supply material" designates the medium which has to be supplied to the broadcaster according to the contractual agreement.

1. HD Mainstream Production **(1080i/25)**
XDCAM HD Optical Disc (4:2:2, 1920 x 1080, 8 bit, 50 MBit/s, Long Gop)

2. HD Premium Production (1080p/25,1080i/25, as well for 2K and 4K-Productions)
HDCAM-SR tape (4:2:2, 1920 x 1080, 10 bit) and additionally an
XDCAM HD Optical Disc (4:2:2, 1920 x 1080, 8 bit, i/25, 50 MBit/s, Long Gop)

Formats other than those specified above are only admissible on prior arrangement with the production manager in charge of programming.

1/1 Status of: 06.11.2015

6.12 Example of an Acceptance Test Record

SWR

Technisches Abnahmeprotokoll

Nr. 2

Prod.-Nr.:

Serien-/Sendetitel:
Unter-/Originaltitel:
Eigen-Produktion:

Fremd-Produktion:

Programm:
Sendelänge:

Folgenummer:
Sendedatum:

Medien / Dateien

Sendematerial/Medium XDCAM-HD
Sendefassung ARTE: Erstlieferung

Medium: ❑ **Datei:** ❑

Erstes Bild:
Letztes Bild:

Erster Ton:
Letzter Ton:

Video

Seitenverhältnis:	16:9 Vollformat
Abtastformat:	1080i/25
Abtastung psf:	❑
VITC/ATC vorhanden:	❑
LTC durchgeh./aufst.:	❑
VITC = LTC:	❑
Abnahme in Stichproben:	❑
Abnahme in voller Länge:	❑

Audio

	Tonart	Tonstatus	Sprache
Kanal 1	Sendeton	Stereo	
Kanal 2	Sendeton	Stereo	
Kanal 3	IT Fassung	Stereo	
Kanal 4	IT Fassung	Stereo	
Kanal 5			
Kanal 6			
Kanal 7			
Kanal 8			

Untertitel

Art:
Sprache:

Sprachfassung (ARTE):

Bemerkungen

grafftps

Datum	Name	Unterschrift

Seite 1 von 2 Gedruckt am um

SWR

Technisches Abnahmeprotokoll

Nr. 2

Prod.-Nr.:

Serien-/Sendetitel:
Unter-/Originaltitel:
Eigen-Produktion:

Fremd-Produktion:

Programm:
Sendelänge:

Folgenummer:
Sendedatum:

Medium / Datei Nr. 1

Unique-Key POC:

TC-Anfang:
TC-Ende:

Technischer Vorspann

Bild:		**sek**	**Ton:**		**dBFS**
Farb-balken	❑	0	1 kHz	❑	0
schwarz	❑	0			

Beurteilung Video

Qualitätsbeurteilung Bild

	i.O.	n.i.O.
Weißwert	❑	❑
Schwarzabhebung	❑	❑
Schärfe	❑	❑
Farbstiche/-	❑	❑
Farbsättigung	❑	❑
Farbraum	❑	❑
Digitale Fehler	❑	❑
sonstige	❑	❑

Technischer Befund Video

❑ i.O. ❑ Mängel
❑ Techn. abzulehnen

Beurteilung Audio

Qualitätsbeurteilung Ton

	i.O.	n.i.O.
Aussteuerung	❑	❑
Synchronität	❑	❑
Sprachverständlichk.	❑	❑
Klangbild	❑	❑
Dynamik	❑	❑
Verzerrungen	❑	❑
Stereobalance / Surround-Balance	❑	❑
Korrelation	❑	❑
sonstige	❑	❑

Lautheit

Programmlautheit (LUFS)	0.0
Maximaler True Peak (dBTP)	0.0
Lautheitsbereich (LU)	0.0

Abnahmeart

	Volle Länge	Stichprobe
Kanal 1	❑	❑
Kanal 2	❑	❑
Kanal 3	❑	❑
Kanal 4	❑	❑
Kanal 5	❑	❑
Kanal 6	❑	❑
Kanal 7	❑	❑
Kanal 8	❑	❑

Technischer Befund Audio

❑ i.O. ❑ Mängel
❑ Techn. abzulehnen

Beurteilung Untertitel

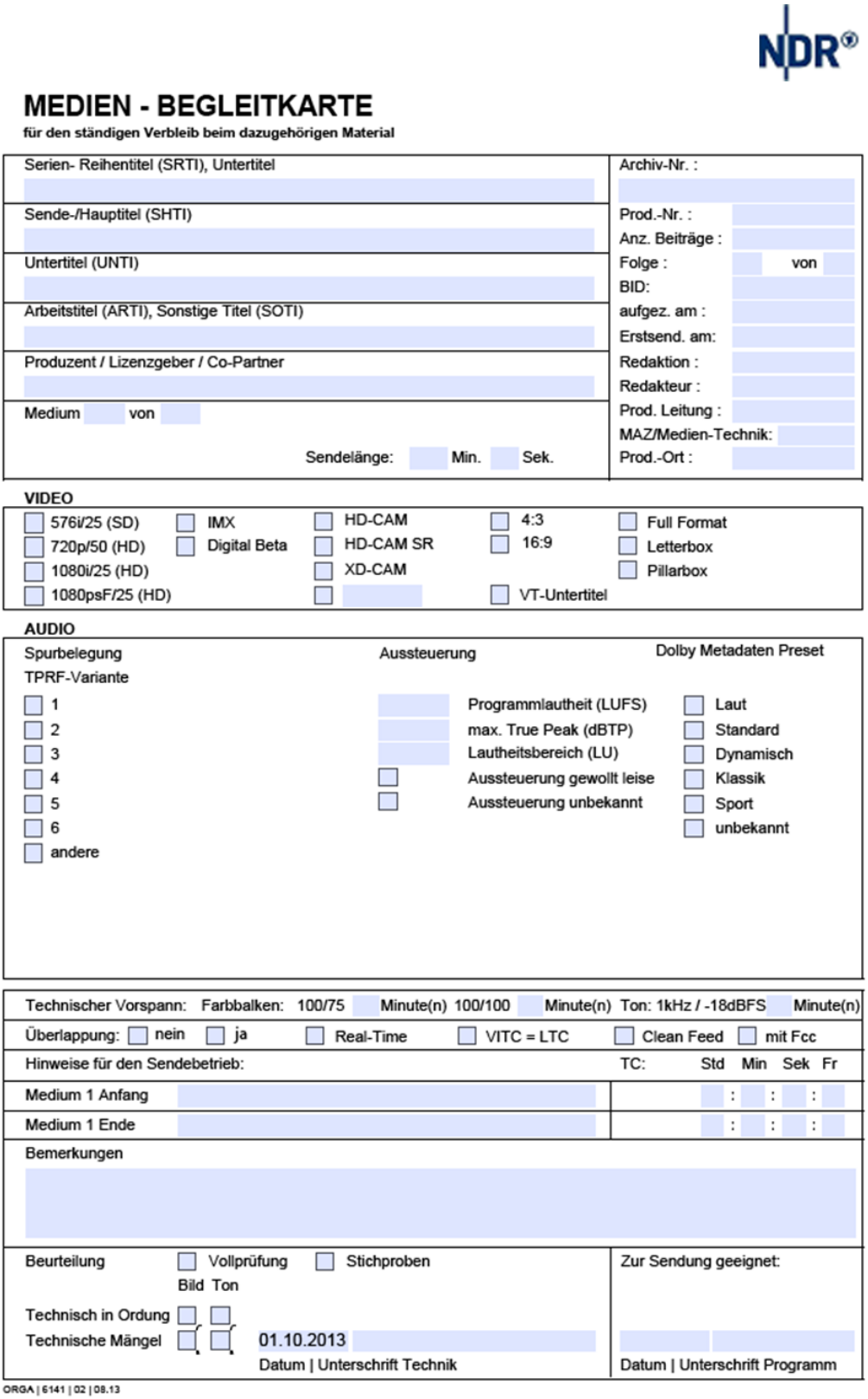
Dateinamen

Technischer Befund Untertitel

❑ i.O. ❑ Mängel
❑ Techn. abzulehnen

grafips

6.13 Sample of a Medienbegleitkarte



NDR

MEDIEN - BEGLEITKARTE

für den ständigen Verbleib beim dazugehörigen Material

Serien- Reihentitel (SRTI), Untertitel	Archiv-Nr. :
Sende-/Hauptitel (SHTI)	Prod.-Nr. :
Untertitel (UNTI)	Anz. Beiträge :
Arbeitstitel (ARTI), Sonstige Titel (SOTI)	Folge : von
Produzent / Lizenzgeber / Co-Partner	BID:
Medium von	aufgez. am :
Sendelänge: Min. Sek.	Erstsend. am:
	Redaktion :
	Redakteur :
	Prod. Leitung :
	MAZ/Medien-Technik:
	Prod.-Ort :

VIDEO

☐ 576i/25 (SD)	☐ IMX	☐ HD-CAM	☐ 4:3	☐ Full Format
☐ 720p/50 (HD)	☐ Digital Beta	☐ HD-CAM SR	☐ 16:9	☐ Letterbox
☐ 1080i/25 (HD)		☐ XD-CAM		☐ Pillarbox
☐ 1080psF/25 (HD)		☐	☐ VT-Untertitel	

AUDIO

Spurbelegung	Aussteuerung		Dolby Metadaten Preset
TPRF-Variante			
☐ 1		Programmlautheit (LUFS)	☐ Laut
☐ 2		max. True Peak (dBTP)	☐ Standard
☐ 3		Lautheitsbereich (LU)	☐ Dynamisch
☐ 4	☐	Aussteuerung gewollt leise	☐ Klassik
☐ 5	☐	Aussteuerung unbekannt	☐ Sport
☐ 6			☐ unbekannt
☐ andere			

Technischer Vorspann: Farbbalken: 100/75 Minute(n) 100/100 Minute(n) Ton: 1kHz / -18dBFS Minute(n)

Überlappung: ☐ nein ☐ ja ☐ Real-Time ☐ VITC = LTC ☐ Clean Feed ☐ mit Fcc

Hinweise für den Sendebetrieb:	TC: Std Min Sek Fr
Medium 1 Anfang	: : :
Medium 1 Ende	: : :

Bemerkungen

Beurteilung	☐ Vollprüfung ☐ Stichproben	Zur Sendung geeignet:
	Bild Ton	
Technisch in Ordung	☐ ☐	
Technische Mängel	☐ ☐ 01.10.2013	
	Datum | Unterschrift Technik	Datum | Unterschrift Programm

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6.14 SNG Profiles for H.264 Recommended by ARD, ZDF, ORF, SRG

In the two tables below, the “domestic” H.264 profiles are listed, both for 8 PSK and the more efficient 16 APSK modulation. The only difference lies in the modulation parameters, while audio and video parameters are identical in both modulation processes. There is no obligation to accept 16 ASPK modulation, which means that its use has to be agreed upon bilaterally.

Applicable to all DVB-S2 – profiles:	Roll-off-Factor: 25%	GOP length: 24	video sampling: 4:2:2
Frame (64800 bit) = normal	Pilot: On	Phase Aligned Audio: On	PMT Repetition Time: 100ms

8PSK	**PID**	HD	HD	HD
		H.264	H.264	H.264
Profile Name		**HD 8-18**	**HD 8-12**	**HD 8-9**
PMT	32	Service ID: 1	Service ID: 1	Service ID: 1
PCR (embedded)	308	embedded	embedded	embedded
Video Mbit/s	308	**28,940**	**18,697**	**13,575**
Audio 1 Mbit/s	256	PAA 0,384	PAA 0,384	PAA 0,384
Audio 2 Mbit/s	257	PAA 0,384	PAA 0,384	PAA 0,384
Audio 3 Mbit/s	258	PAA 0,384	PAA 0,384	PAA 0,384
Audio 4 (or Dolby E) Mbit/s	259	PAA 0,384	PAA 0,384	PAA 0,384
Latency [2] ms		< 300ms	< 500ms	< 500ms
GOP Constellation		IP	IBBP	IBBP
Info Bit Rate (Netto) Mbit/s		**31,356**	**20,904**	**15,678**
Overall Bit Rate Mbit/s		32,400	21,600	16,200
FEC		3/4	3/4	3/4
Modulation		8PSK	8PSK	8PSK
Symbolrate Msymb/s		**14,4**	**9,6**	**7,2**
Allocated bandwidth MHz		**18**	**12**	**9**
		HD Mega Low Delay	HD Standard	HD Schaltgespräche

(1) ***Note:*** *As an alternative to 0.384 Mbit/s, Dolby E is only recommended in profile HD 8-18 PAA or HD 8-12. The use of Dolby E will reduce the available video data rate, depending on the manufacturer, by up to 3 Mbit/s.*

(2) *Latency (with Ericsson Voyager-II): Low Delay & IBBP ≤ 500 ms (470 ms) / Mega Low Delay & IP ≤ 300 ms (291 ms).*

16APSK	PID	HD H.264	HD H.264	HD H.264
Profile Name		**HD 16-12**	**HD 16-9**	**HD 16-6**
PMT	32	Service ID: 1	Service ID: 1	Service ID: 1
PCR (embedded)	308	embedded	embedded	embedded
Video Mbit/s	308	**25,459**	**18,647**	**11,835**
Audio 1 Mbit/s	256	PAA 0,384	PAA 0,384	PAA 0,384
Audio 2 Mbit/s	257	PAA 0,384	PAA 0,384	PAA 0,384
Audio 3 Mbit/s	258	PAA 0,384	PAA 0,384	PAA 0,384
Audio 4 (or Dolby E) Mbit/s	259	PAA 0,384	PAA 0,384	PAA 0,384
Latency [2] ms		< 300ms	< 500ms	< 500ms
GOP Constellation		IP	IBBP	IBBP
Info Bit Rate (Netto) Mbit/s		**27,805**	**20,854**	**13,902**
Overall Bit Rate Mbit/s		28,800	21,600	14,400
FEC		3/4	3/4	3/4
Modulation		16APSK	16APSK	16APSK
Symbolrate Msymb/s		**9,6**	**7,2**	**4,8**
Allocated bandwidth MHz		**12**	**9**	**6**
		HD Mega Low Delay	HD Standard	HD Schaltgespräche

(1) ***Note:*** *As an alternative to 0.384 Mbit/s, Dolby E is only recommended in profile HD 16-12 PAA or HD 16-9. The use of Dolby E will reduce the available video data rate, depending on the manufacturer, by up to 3 Mbit/s.*

(2) *Latency (with Ericsson Voyager-II): Low Delay & IBBP ≤ 500 ms (470 ms) / Mega Low Delay & IP ≤ 300 ms (291 ms).*

Links

Name	Link
Vorgaben Audiodeskription	http://www.ndr.de/fernsehen/service/audiodeskription/Vorgaben-fuer-Audiodeskriptionen,audiodeskription140.html
ARD UT Standards	http://www.daserste.de/service/kontakt-und-service/barrierefreiheit-im-ersten/untertitel-standards/index.html
EBU-TT-D-Basic-DE	https://www.irt.de/publikationen/technische-richtlinien/kostenfreie-richtlinien/
Guideline Mehrkanalton	https://www.irt.de/publikationen/technische-richtlinien/kostenfreie-richtlinien/
Medienbegleitkarte	http://bmf.irt.de/medienbegleitkarte
MXF Profile	https://www.irt.de/publikationen/technische-richtlinien/kostenfreie-richtlinien/
Sprachverständlichkeit im Fernsehen	https://www.irt.de/publikationen/technische-richtlinien/kostenfreie-richtlinien/
Technische Richtlinien	http://webdb.irt.de/richtlinien/
Lighting Guide	http://www.bbc.co.uk/responsibility/environment
Web-Handbuch	http://av-standard.irt.de/wiki/index.php/ARD_Webtechnik-Handbuch
Studio monitors – test patterns	https://tech.ebu.ch/publications/tech3325s
Handbuch der Fernsehsystemtechnik	http://webdb.irt.de/richtlinien/

Resources

Technical guidelines:

Institut für Rundfunktechnik GmbH (IRT)
Floriansmühlstr. 60
80939 München (Munich)
Germany

e-mail: gierlinger@irt.de
Web site: http://irt.de/richtlinien
phone: +49 89 32399-391
fax: +49 89 32399-200

EBU documents:

European Broadcasting Union (EBU)
Ancienne Route 17A
1218 Grand-Saconnex GE
Switzerland

e-mail: miles@ebu.ch
Web site: http://tech.ebu.ch/publications
phone: +41 22 717-2743
fax: +41 22 717-2710

SMPTE publications:

Society of Motion Picture and Television Engineers
595 West Hartsdale Avenue
White Plains, NY 10607 U.S.A.

general e-mail: smpte@smpte.org
Web site: https://www.smpte.org/standards
phone: +1 914 761-1100
fax: +1 914 761-3115

ITU documents:

International Telecommunication Union (ITU)
Publication Sales
Place des Nations
1211 Genève 20
Switzerland

e-mail: sales@itu.int
Web site: http://www.itu.int/publications
phone: +41 22 730-6141
fax: +41 22 730-5194

DIN/ISO standards:

Beuth Verlag GmbH
Burggrafenstr. 6
10787 Berlin
Germany

e-mail: info@beuth.de
Web site: http://www2.beuth.de
Phone: +49 30 2601-2260
fax: +49 30 2601-1260

IEC-Publikationen:

VDE Verlag GmbH
Postfach 12 0143
10591 Berlin
Germany

e-mail: vertrieb@vde-verlag.de
Web site: http://www.vde-verlag.de
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---------- **Notice** ----------

Access tot he guidelines and work-group findings of

http://www.irt.de/richtlinien

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B Vol. 65 No. 5191