



PBS Technology & Operations

TECHNICAL OPERATING SPECIFICATIONS

Program Distribution from PBS

2013 Edition

1. SCOPE AND PURPOSE

This TOS describes standards PBS adheres to in distributing programs of consistently high technical quality over the Public Television Interconnection System. Other entities using the interconnection system are encouraged to adhere to these standards, but may or may not do so. Some of the items described in this document are predicated on the use of PBS supplied decoding equipment at the receiving end. Consult with those distributors for their specifications.

For questions related to PBS program distribution and this TOS, contact the Director, NOC Technical Maintenance & Engineering at PBS.

2. VIDEO

2.1 Video Level

2.1.1 Video levels will be measured with direct digital waveform monitoring equipment calibrated to represent video levels on the final submission.

2.1.2 The GBR gamut will be hard limited (“legalized”) to the 0 to 700 millivolt range prior to transmission.

2.2 Video Image

2.2.1 The production aperture of full-screen content is defined for each field as shown:

Format	Field 1	Field 2
480i	23-262	286-525
1080i	21-560	584-1123

2.2.2 When 16:9 content is placed within a 4:3 production aperture ("letterbox") the image will fill the following lines, thus vertically centering the image:

	Field 1	Field 2
480i 16:9 Letterbox	53-232	316-495

2.2.3 When 4:3 content is placed within a 16:9 production aperture (“pillarbox”) the image will fill the following pixels on every line, thus horizontally centering the image. (+/- 5 pixels)

Format	Line Pixels
1080i 16:9 Pillarbox	241-1680

2.2.4 When content in a 16:9 production aperture is 4:3 protected then the image will be centered in the middle 75% of the picture aperture thus horizontally centering the critical image.

2.2.5 The Safe Areas are:

2.2.5.1 Safe Action is the area within which all signification action must be contained. The area is 93% of the width and height of the production aperture.

Format	Production Aperture	Safe Action Area	4:3 Protected Safe Action Area
480i	720 x 480	670 x 446	-
1080i	1920 x 1080	1786 x 1004	1296 x 972

2.2.5.2 Safe Title Area is the area within which all significant titles must be contained. The area is 90% of the width and height of the production aperture.

Format	Production Aperture	Safe Title Area	4:3 Protected Safe Title Area
480i	720 x 480	648 x 432	-
1080i	1920 x 1080	1728 x 972	1296 x 972

2.2.5.3 Open Captions will be limited to 80% of the width and 80% of the height of a 4:3 protected area (when there is a 4:3 protected area).

2.2.6 The aspect ratio of all HD programming is 16:9.

2.3 Field and Frame Rate

2.3.1 The field rate for both standard and high definition is 59.94 fields per second (exactly 60 multiplied by 1000/1001). The frame rate for both standard and high definition is 29.97 frames per second (exactly 30 multiplied by 1000/1001).

3. AUDIO

Main service audio is defined as the primary service that is intended to serve the majority of the audience. Secondary services include alternate languages (SAP) and the Descriptive Video Information (DVI).

3.1 Audio Level

Refer to the audio level diagram below and ATSC A/85, "Techniques for Establishing and Maintaining Audio Loudness for Digital Television".

3.1.1 The operating level and tone frequency will be -20 dBFS at 400 Hz on all channels, with the exception of the LFE channel within 5.1 channel transmissions, which will be -30 dBFS at 80 Hz.

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3.1.2 Metering will conform to ITU BS.1770-3 for loudness and true-peak measurement and will apply to all channels of a 5.1 channel submissions, with the exception of the LFE channel which is not included in the loudness measurement.

3.1.3 The program must have an average loudness of -24 LKFS, ± 2 dB, measured for the duration of the program.

3.1.4 Sections of dialog within music programs must also meet the ± 2 dB LKFS loudness specification, even if when the duration of dialog is so limited as to not affect the average loudness of the program as a whole.

3.1.5 Audio levels between programs (i.e., "boundary problem") will be consistent. Consumer dissatisfaction is apparent when there are instantaneous or abrupt level changes; for example, if the funding credit is much louder than the body of the program.

3.1.6 Programs will have music or effects true-peak levels as high as -2 dBFS during moments of dramatic impact, as long as average dialog levels are maintained as specified in 3.1.3 and 3.1.4.

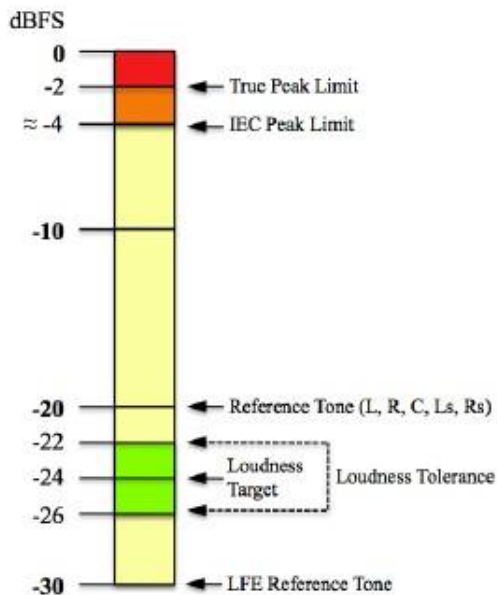
3.1.7 Music and effects levels will be sufficiently below dialog to insure that a wide variety of viewers can understand the dialog upon first viewing, in home listening conditions with high ambient noise, moderate program levels, and a wide variety of audio monitoring systems.

3.1.8 The anchor element of an audio mix will be monitored for proper levels. The anchor element is “The perceptual loudness reference point or element around which other elements are balanced in producing the final mix of the content, or that a reasonable viewer would focus on when setting the volume control.” This is usually program dialog, however, in some programs such as performance programs where the length of dialog is very short and the remainder of the program audio is not dialog, the anchor element is the non-dialog program audio.

Programs will be monitored for downmix compatibility of 5.1 submission using appropriate downmix settings of -3 dB in the center channel and -3 dB in the surround channels.

The audio mix of 5.1 programs will be created in such a manner that the stereo downmix will have similar overall loudness levels of -24 LKFS + 2 / - 2 dB.

Performance Programs that are predominately music will be monitored for stereo downmix and must have overall loudness levels of -24 LKFS + 4 /- 4 dB. Any dialog in this performance program should meet the loudness levels of -24 LKFS + 2 / - 2 dB.



3.2 Audio Quality

3.2.1 The audio mix will be free of audible clipping and other distortions.

3.2.2 The audio mix will be free of obvious noise except where that noise is an intended part of the content.

3.2.3 The dialog will be intelligible under all conditions, including when the audio channels are upmixed or downmixed

3.3 Audio Phasing & Synchronization

3.3.1 Audio timing and phase will remain consistent across all channels and tracks.

3.3.2 Audio/video synchronization (lip sync) will appear to be correct during the program itself. During the program countdown, or by any in-service measurement technique adopted in the future, audio will not lead video by more than one half frame, nor will audio lag video by more than two frames. See Figure 1.

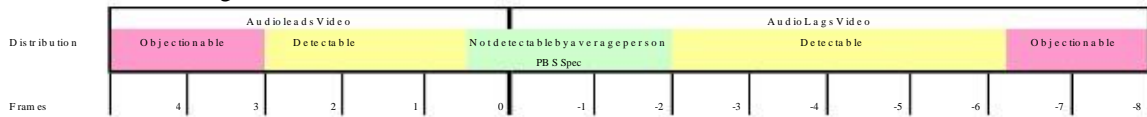


Figure 1: Audio and Video Lead/Lag Specification

3.3.3 Audio will be within two frames between services (e.g., between main and secondary services).

3.4 Audio Channel/Track Assignments

3.4.1 Standard Definition Programming Audio Service

3.4.1.1 Standard definition programming will always be transmitted with the primary audio service in stereo.

Channel/Track	Primary Audio Service Assignment
Ch 1	Left or Left Total
Ch 2	Right or Right Total

3.4.1.2 Programs may be encoded using Dolby Pro-Logic with Lt/Rt replacing the normal stereo audio on channels/tracks 1 & 2.

3.4.1.3 Standard definition programming will be transmitted with the second audio service as SAP when provided. If no SAP audio is provided a mix of the primary audio will be supplied. This service will always be in stereo format.

Channel/Track	Secondary Audio Service Assignment
Ch 1	SAP Left or Mix of Main Audio
Ch 2	SAP Right or Mix of Main Audio

3.4.1.4 Standard definition programming will be transmitted with the third audio service as Descriptive Video when provided. If no Descriptive Video is provided, a mix of the primary audio will be supplied. This service will always be in a stereo format.

Channel/Track	Secondary Audio Service Assignment
Ch 1	DVS Left or Mix of Main Audio
Ch 2	DVS Right or Mix of Main Audio

3.4.2 High Definition Programming Audio Service

3.4.2.1 High definition programming will always be transmitted with the primary audio service in stereo or with 5.1 channels. If the primary audio service is transmitted in stereo the table in 3.4.1.1 applies. If the primary audio service is transmitted in 5.1 channel audio the following table applies.

Channel/Track	Primary Audio Service Assignment
Ch 1	Left Front (L)
Ch 2	Right Front (R)
Ch 3	Center (C)
Ch 4	Low Frequency Effects (Lfe)
Ch 5	Left Surround (Ls)
Ch 6	Right Surround (Rs)

3.4.2.2 Programs may be encoded using Dolby Pro-Logic with Lt/Rt replacing the normal stereo audio on channels/tracks 1 & 2.

3.4.2.3 Standard definition programming will be transmitted with the second audio service as SAP when provided. If no SAP audio is provided a mix of the primary audio will be supplied. This service will always be in stereo format.

Channel/Track	Secondary Audio Service Assignment
Ch 1	SAP Left or Mix of Main Audio
Ch 2	SAP Right or Mix of Main Audio

3.4.2.4 High definition programming will be transmitted with the third audio service as Descriptive Video when provided. If no Descriptive Video is provided, a mix of the primary audio will be supplied. This service will always be in a stereo format.

Channel/Track	Secondary Audio Service Assignment
Ch 1	DVS Left or Mix of Main Audio
Ch 2	DVS Right or Mix of Main Audio

4. Ancillary Information

4.1 Time

4.1.1 Where provided on specific services (SD01) Time-of-Day Time Code is provided on the fourth audio service according to the following table.

Channel/Track	Time of Day Time Code Type
1	UTC (Universal Coordinated Time)
2	ET (Eastern Time – standard or daylight adjusted)

4.1.2 The time in Channel/Track 2 (ET) is advanced by PBS to account for encoding and transit delays such that the transmitted clock is received in the center of the continental United States at the actual correct time.

4.2 Closed Captioning

4.2.1 For High Definition transmission, CEA-708-C DTVCC captions and CEA-608-C defined by 608 compatibility bytes will be carried in the vertical ancillary data space (VANC) per SMPTE 334M-2000. The captioning ANC data will be present on line 9 field 1 only.

4.2.2 For Standard Definition transmission, CEA-608-C captions will be present on line 21. In addition CEA-708-C DTVCC captions and CEA-608-C defined by NTSC compatibility bytes will be carried in the vertical ancillary data space (VANC) per SMPTE 334M-2000. The captioning ANC data will be present on line 12 field 1 only.

4.3 Active Format Description (AFD)

4.3.1 AFD data will be encoded per SMPTE 2016-1-2009 and will be packetized per SMPTE 2016-3-2009.

4.3.2 Ancillary codes will be set per SMPTE RP 291-2009.

4.3.3 For high definition transmissions the AFD data will be present on field 1 and field 2 of line 11.

4.3.4 For standard definition transmissions the AFD data will be present on field 1 and field 2 of line 12.

4.3.5 All AFD data and ancillary codes will be placed in the line after any closed captioning data.

4.3.6 For all programming that includes AFD data the data will be frame accurate, that is any AFD code change signaling a change in the image within a program will occur on the frame it references.

4.3.7 The AFD codes transmitted will be:

AFD Code (binary and decimal)	Description (per SMPTE 2016-1)
'1000' (8)	Image is full frame, with an aspect ratio that is the same as the 16:9 coded frame.
'1001' (9)	Image with a 4:3 aspect ratio as a horizontally centered pillarbox image in a 16:9 coded frame.
'1010' (10)	Image is full frame, with a 16:9 aspect ratio and with all image areas protected.
'1111' (15)	Image with a 16:9 aspect ratio and with an alternative 4:3 center in a 16:9 coded frame.