

1. SCOPE

This document recommends the format of and the quality of the video and audio associated with program material delivered to the Australian terrestrial television broadcast industry.

2. BACKGROUND

- 2.1 Program content delivered in Standard Definition may be subject to an up conversion process to a HD resolution level. This places significant demands on the quality of the product especially with respect to spatial resolution. In the case of both Upconversion and Downconversion, it is essential that the luminance and chrominance values are transferred accurately from one resolution level to the other.
- 2.2 For transmission in the digital services, the product will be subject to MPEG video compression at high compression ratios. This places a significant demand on the quality of the program content with respect to video signal to noise ratio, image stability and freedom from artefacts which may waste data in the MPEG coding process.
- 2.3 With respect to the very important issue of Standards Conversion, it will be necessary in the transition to digital to maintain the current situation of temporal artefact free conversions, from both film and video originated product.
- 2.4 Due to the continually advancing state of television technology, this documentation will evolve and will be added to and modified as required in the future. Due to the continually advancing state of television technology, this documentation will evolve and will be added to and modified as required in the future.

3. DEFINITIONS

3.1 Standard Definition

- 3.1.1 Standard Definition is a 625 line, 25 frames per second, 2:1 interlaced signal produced in agreement with the specifications of ITU-R Recommendation BT 601¹. The aspect ratio of the image shall be 16:9.

The associated audio signal should be a stereo pair, optionally encoded Dolby Surround (Pro Logic II), with the centre and surround information encoded into the Lt and Rt signals. For archival material a stereo pair or mono audio may be accepted.

¹ The companion signal interface document is Recommendation ITU-R BT.656-5 *Interfaces for digital component video signals in 525-line and 625-line television systems operating at the 4:2:2 level of Recommendation ITU-R BT.601*.

3.2 High Definition

3.2.1 High Definition is a signal produced in agreement with the specifications of ITU-R Recommendation BT. 709-6².

3.2.2 The Aspect Ratio of the image shall be 16:9. The preferred video format for the exchange of program material is:

1125 lines total per frame

1920 horizontal pixels by 1080 active lines

25 frames per second, 2:1 interlace

3.2.3 The associated audio signal should be 6 discrete channels representing - Left / Right /Centre / Low Frequency Effects (LFE) / Left Surround / Right Surround³.

These audio signals shall be carried on the video storage medium by means of an agreed audio multiplex, or as discrete PCM channels, but clearly identified.

The preferred minimum audio requirement should be a stereo pair, optionally encoded Dolby Surround (Pro Logic II), with the centre and surround information encoded into the Lt and Rt signals. Regular stereo (Lo and Ro) is also acceptable.

3.2.4 Delivery of HDTV content in a High Dynamic Range image format should comply with the specifications for Hybrid Log Gamma found in Recommendation ITU-R BT.2100 *Image parameter values for high dynamic range television for use in production and international programme exchange*.

3.2.5 Down conversion from a UHDTV HDR image format found in Recommendation ITU-R BT.2100 to the HD image format⁴ Recommendation BT. 709-5 should be undertaken in accordance with ITU-R Report ITU-R BT.2446 *Methods for conversion of high dynamic range content to standard dynamic range content and vice-versa*.

3.2.6 Reference to UHDTV image formats should be undertaken in accordance with Recommendation ITU-R BT.2020 *Parameter values for ultra-high definition television systems for production and international programme exchange*.

4. DELIVERY

4.1 Standard Definition

4.1.1 For Standard Definition product, the program shall be supplied on a

² The companion signal interface document is Recommendation ITU-R BT.1120-9 *Digital interfaces for studio signals with 1 920 × 1 080 image formats*

³ In an audio channel / track order as specified in SMPTE 320M

⁴ Recommendation ITU-R BT.2100 specifies progressive image formats.

625 line 25 frame per second 2:1 interlace component digital delivery system. The delivery system is to be mutually agreed upon between the program distributor and the television network.

4.2 High Definition

4.2.1 For High Definition program content the program shall be supplied on an 1125 line, 1080 active 25 frame per second 2:1 interlace format delivery system. The delivery system is to be mutually agreed upon between the program distributor and the television network.

4.3 Common Delivery Specifications

4.3.1 The program shall be the full Texted version.

4.3.2 The audio content of the program shall be a final mix in the English language and in correct synchronisation with the video content. However, if required by a broadcaster an alternative language may be supplied.

4.3.3 The supplied program shall be free of extraneous material, such as closed caption and censorship classification indicators.

4.3.4 Alternatively, if textless material is supplied at the end of a program, it shall start at 1 minute from the end of the program and be identified on the program identification board at the head of the program.

5. VIDEO REQUIREMENTS

5.1 Common Video Requirements

5.1.1 The recorded image when displayed with the correct geometry has an aspect ratio of 16:9.

Distortion of the geometry of the original picture aspect ratio is not acceptable.

When the program has been derived from an original of aspect ratio wider than 16:9 then a letterbox of the image is permitted in order to reveal additional width. This letterbox shall not be deeper than 21:9.

5.1.2 Archival material may be accepted with a 4:3 aspect ratio.

5.1.3 All titles and essential information must fall into the safe areas defined in Annex A and Annex B.

5.1.4 Broadcasters seek to have signals encoded in the Recommendations BT.601 and BT.709 formats as a 10 bit stream specified as levels in 0 – 1023. Maximum video levels of program material with reference to line-up signals shall be equivalent to 700 mV including an operational tolerance of + 25mV for luma (Y) and 700mV peak-to-peak for each colour difference signal for P_R , P_B in the analog domain. (Note this does not correspond to C_B and C_R in the digital domain). Whatever the combination of luminance and chrominance components the signal shall not produce an R.G.B. coded gamut error when measured by an

appropriate instrument.

Program black level shall not extend below blanking level (0mV luminance in the analog domain).

- 5.1.5 The line-up colour bar test signal shall replay at the correct levels. Program video levels shall be consistent with line-up video levels.
- 5.1.6 If the program is made as a film product then the supplied program shall be a true 625/25 or HD1125/25 frame transfer of that film. In other words not a standards conversion. However, film product or other product mastered at 24 frames progressive should be converted to 25 frame product by a speed change by a 4% speed change and NOT by repeated frames. This latter conversion process should take place before delivery of the program to the Australian networks.
- 5.1.7 If the program is originated on film but post-produced in the 525/60 or HD 1125/60⁵ domain then the supplied program shall be a standards conversion, via in the case of 525/60 the TK3:2, DEFT or Image FIT systems. In the case of an HD1125/60 original the supplied converted program shall be a standards conversion which ensures the elimination of temporal motion artefacts, normally by means of a 'Reverse Telecine' process producing a 24 frame product which must then be converted to a 25 frame product.
- 5.1.8 If the program is originated using electronic cameras in the 525/60 or HD 1125/60 domain then the supplied program shall be a standards conversion via a 'Motion Vector Compensated' or phase correlation standards conversion system.

Again the object is the elimination of temporal motion artefacts.

- 5.1.9 If the program is a product from film the horizontal and vertical instability the rate of any picture movement shall not be subjectively annoying.

The film elements shall be clean and free of both surface dirt and printed dirt and shall not have any emulsion or base side damage.

- 5.1.10 In all cases the program shall be of the highest quality suitable for television broadcast without further processing of the picture. The program quality of Standard Definition 601 level product shall be such that an acceptable Upconversion to an HD resolution level can be made.
- 5.1.11 Production techniques should take into account the need to consider field dominance. Field dominance problems become apparent on television picture monitors when the fields of an interlaced signal are presented in the wrong order. To mitigate this problem, correct field dominance must be indicated or agreed to by all parties. Field

⁵ HDTV 1125/60 is a generic description of any non 50Hz production system other than 24 frame progressive.

dominance' simply states whether the top/odd field or the bottom/even field is supposed to be shown first. For example, a dominance of 'top field first' would mean that the top field is displayed before the bottom field in a frame. 'Top field first' is the requirement in the context of this document.

5.2 Standard Definition

5.2.1 For Standard Definition the video signal shall be a 625 total lines, 576 active lines, 25 frames per second, 2:1 interlace signal produced in accordance with ITU-R Recommendation BT. 601.

5.2.2 Vertical and Horizontal blanking shall be in accordance with ITU-R Recommendation BT. 1848. The active digital picture line width is 720 pixels producing what is commonly called 'Narrow' blanking. For product produced purely in the digital domain this is the preferred blanking. Reference to Annex A of this Operational Practice indicates that only the central 720 pixels will normally reach the display.

The centre of the picture should retain its position throughout all production processes unless there are creative reasons to deliberately do otherwise. The horizontal centre of the image is located between pixels 359 and 360. The vertical centre of the image is located midway between line 167 of field 1 and line 479 of field 2.

5.2.3 For programs transferred into the digital component domain from archival material originated in a composite PAL or NTSC format, care is necessary to ensure that any burst to chroma phase errors do not exceed 5° since these errors cannot be corrected on playback.

5.3 High Definition

5.3.1 For High Definition the video signal shall be an 1125 total lines, 1080 active lines by 1920 pixels horizontally, 25 frames per second, 2:1 interlace signal produced in accordance with ITU-R Recommendation BT. 709-6.

6. SUBJECTIVE VIDEO QUALITY

6.1 Common Subjective Video Quality

6.1.1 Picture quality appreciation and production grading shall be made in a Review Room which meets SMPTE recommendations for that purpose including a D6500 illuminant monitor surround.

6.1.2 The picture black level shall appear to be subjectively correct with respect to content, free of any noticeable black crushing, compression or clipped dark areas.

6.1.3 Low key scenes shall have sufficient contrast and APL (average picture level) to appear acceptable under typical domestic viewing conditions.

6.1.4 Picture white areas where detail is required shall appear normal and

free of noticeable highlight compression.

6.1.5 The transient (edge) response shall be crisp and clean - free of any noticeable horizontal or vertical pre-shoot, overshoot, ringing, smear/streak, echoes or telecine afterglow errors.

6.1.6 Moire and fixed pattern noise shall not be visible.

6.1.7 Any video noise shall be fine grained (i.e. high frequency) and not visible at normal viewing distances. However, the use of MPEG video data compression does require an image which is not only noise free but also free of artifacts such as film dirt or scratches or unwanted image movement.

Note: The excessive use of noise reduction will cause motion artefacts and a noticeable loss of resolution. The amount of noise reduction should only be sufficient to minimise noise.

6.1.8 The colour balance of the image shall be basically neutral when displayed on a monitor adjusted for 6500K.

6.2 Standard Definition

6.2.1 Standard Definition images shall be viewed on a correctly calibrated equivalent grade 1 display⁶, of at least 60cm diagonal and viewed at approximately 5 times picture height.

6.2.2 Standard Definition images must be judged critically with respect to their capacity for Upconversion. A high quality ITU-R Recommendation BT. 601 level product can produce acceptable HD level material - equally, poor to average BT.601 level product will not produce acceptable HD level material.

6.3 High Definition

6.3.1 High Definition images shall be viewed on a correctly calibrated grade 1 display of at least 100cm diagonal and viewed at approximately 3 times picture height. The light emitters shall have ITU-R Recommendation BT. 709-6 colorimetry.

7. AUDIO REQUIREMENTS

7.1 Standard Definition

7.1.1 For the Standard Definition programmes the preferred audio shall be a Dolby Surround (Pro Logic II) encoded stereo pair (Lt and Rt). Regular stereo (Lo and Ro) is also acceptable. The L and R stereo pair shall have a combined loudness measuring -24LKFS across representative sections of the programme. Refer to OP-59 for

⁶ Advice on set-up of Grade 1 monitors is available in Report BT.2129 *User requirements for a Flat Panel Display (FPD) as a Master monitor in an HDTV programme production environment* (<http://www.itu.int/pub/R-REP-BT.2129>) and Recommendation BT.2022 *General viewing conditions for subjective assessment of quality of SDTV and HDTV television pictures on flat panel displays* (<http://www.itu.int/rec/R-REC-BT.2022/en>)

loudness measurement and management techniques.

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|-------|-----------------------|---|
| 7.1.2 | For Stereo recordings | Track 1 shall carry the left channel
Track 2 shall carry the right channel |
| | If used | Track 3 shall carry M and E left
Track 4 shall carry M and E right |

If the M and E is a mono recording it shall be carried on Track 3. For a Mono soundtrack the program sound shall be dual recorded in phase on both tracks 1 and 2.

Optionally, by agreement between the parties tracks 3 and 4 may carry a Dolby E, or other audio multiplex for 5.1 multi-channel audio.

In the case of Dolby E, the multi-channel audio elements, prior to encoding, shall be advanced with respect to the video by 2 frames. Thus the *encoded* audio data will be 1 frame advanced with respect to picture.

- 7.1.3 All audio recordings shall have the correct basic 'in phase' relationship between channels on both line-up tone and program content (program content will dynamically produce varying phase relationships).
- 7.1.4 Any supplied 5.1 audio shall be mixed in such a way that it will create an acceptable downmix to 2.0 stereo L_t and R_t if required, using industry standard downmix parameters. Refer Free TV OP60 for advice on down mixing of sound tracks.
- 7.1.5 Correct relative synchronisation of M and E to final mix tracks shall be maintained at all times.
- 7.1.6 The alignment level shall be minus 20 db with respect to the onset of digital clipping i.e. minus 20 dBFS (SMPTE RP 155). The EBU standard of minus 18 dBFS will also be accepted.
- 7.1.6 The True Peak recorded program level as measured with a BS-1770-3 compliant loudness meter, shall be no greater than -2dBTP

The average value of the recorded program signal is normally measured by a VU meter. The alignment level of -20dBFS equates to 0VU on a properly calibrated VU meter and, as a generality the average program level should be in the 0VU range. The balance between dialogue and M and E may vary according to program genre⁷.

7.2 High Definition

- 7.2.1 For the High Definition product the audio should consist of 6 discrete channels representing Left / Right / Centre / Low Frequency Effects (LFE) / Left Surround / Right Surround.

⁷ There is a variation between average levels in differing genre such as documentaries, news, drama, movies etc. For example, typical news product may have dialogue at 0 VU balanced with M and E, where a drama may have dialogue at minus 2 VU.

The preferred minimum audio requirement should be a Dolby Surround (Pro Logic II) encoded stereo pair (Lt & Rt); however, regular stereo (Lo & Ro) or dual mono is also acceptable. The average dialog level on the L_t and R_t shall have a loudness measuring -24LKFS across the duration of the programme.

By agreement between the parties, tracks 3 and 4 may carry a Dolby E, or other audio multiplex for the 5.1 multi-channel audio.

7.2.2 The videotape machine track assignment shall be:

Track 1	Downmix Lt
Track 2	Downmix Rt
Track 3	Audio Multiplex
Track 4	Audio Multiplex

7.2.3 If multi-channel audio in the form of an audio multiplex is present on tracks 3 and 4, then tracks 1 and 2 shall carry a suitably downmixed Lt/Rt version of the multi-channel signal. Refer to Free TV OP60 for advice on downmixing sound tracks.

It is essential that the *decoded* audio signals recorded on tracks 1/2 and tracks 3/4 (Dolby E) be in sync with the vision during playback. Thus the Dolby E data signal should be pre-advanced 1 frame, to compensate for 1 frame of Dolby E decode delay upon playback. Therefore, multi-channel audio elements, prior to encoding, shall be advanced with respect to the video by 2 frames. Thus the encoded audio data will be 1 frame advanced with respect to picture.

7.2.4 If the minimum audio requirement of the HD service of Dolby Surround (Pro Logic II) Lt/Rt or Lo/Ro is present on tracks 1 and 2 (meaning NO audio multiplex present) then tracks 3 and 4 shall carry the stereo M and E of the Dolby Surround (Pro Logic II) or Lo/Ro signal which is on tracks 1 and 2.

7.2.5 The audio multiplex shall potentially carry 8 audio channels plus associated Meta data.

If Dolby E is specified as the audio multiplex, then in this usage the minimum Metadata to be included in the Dolby E signal shall be:

DYNRNG
DIALNORM
AUDIO CODING MODES

7.2.6 Within the audio multiplex the channel assignment shall be as per SMPTE 320M.

Channel 1	Left	(5.1 mix)
Channel 2	Right	(5.1 mix)
Channel 3	Centre	(5.1 mix)
Channel 4	LFE ⁸	(5.1 mix)

⁸ Note on LFE use/misuse: The LFE channel should be used as intended; as an occasional low frequency special effects channel only, and not simply for bass that is filtered off from the main channels.

Channel 5	Left Surround	(5.1 mix)
Channel 6	Right Surround	(5.1 mix)
Channel 7	Lt or Freely Assigned	
Channel 8	Rt or Freely Assigned	

7.2.7 Broadcasters reserve the right to edit Meta-data for program presentation purposes. If the measured audio loudness equals -24 LKFS as per OP59, then the Dolby DialNorm parameter will normally also be set to -24 by the Broadcaster.

7.2.8

If a HD format is provided that can cater for up to 12 audio channels, then the Dolby E/Multiplex coding method is not necessarily required for a 5.1 audio mix (although still acceptable). In this case, the audio track layout shall be as follows:

Track 1	L _t (Full Stereo Mix)	
Track 2	R _t (Full Stereo Mix)	
Track 3	L _t M+E	
Track 4	R _t M+E	
Track 5	Left Front	(5.1 mix)
Track 6	Right Front	(5.1 mix)
Track 7	Centre	(5.1 mix)
Track 8	LFE ⁹	(5.1 mix)
Track 9	Left Surround	(5.1 mix)
Track 10	Right Surround	(5.1 mix)
Track 11	MOS (or freely assigned)	
Track 12	MOS (or freely assigned)	

7.2.9 On the output of a server, all audio shall play in sync with video, whether the audio has been decoded from an audio multiplex (Dolby E), or is baseband PCM.

8. SUBJECTIVE AUDIO QUALITY

- 8.1 The overall quality shall be pleasing and free of any audible noise or spurious signals (e.g. hum, buzz, distortion, wow, flutter or excessive sibilance) when monitored in a noise free environment on an essentially flat wide-band speaker system.
- 8.2 The tonal balance, bass to mid range to treble shall be pleasing and natural.
- 8.3 Stereo and multichannel program material shall have the correct spatial relationships between audio and picture content (such as left-right or front-rear).
- 8.4 Program audio shall be in synchronisation with the picture content.
- 8.5 Any supplied 5.1 audio shall be mixed in such a way that it will create an acceptable downmix to 2.0 stereo L_t and R_t, if required, using industry standard downmix parameters. (Rec ITU-R BS.1196-1, page 104)
- 8.6 Dynamic Range.

That the digital transmission audio via Dolby Digital AC-3 coding is not processed but that the appropriate meta-data 'DYNRNG' and

'DIALNORM' is included so that the viewer can choose the nature of the reproduced audio. Refer Free TV Operational Practice OP 59.

9. SEQUENCE OF ALIGNMENT SIGNALS

- 9.1 Due to the wide differences in practices between different parts of the world and between production houses, it is intended to provide only a general guide relating to the essential elements of the recorded signal format.
- 9.2 At the start of the recording there shall be a minimum 60 seconds of an alignment video signal consisting of a colour bar signal of either 100/0/100/0 or 100/0/75/0 content. This signal shall occupy at least half the picture height. The 100/0/100/0 signal is preferred.
- 'Matrix' type alignment signals which meet the intent of the above are acceptable.
- 9.3 Simultaneously with the video alignment signal, an alignment level (as specified by SMPTE RP155) audio tone of 1000Hz shall be recorded in phase on all tracks intended to carry program content.
- 9.4 Following the alignment signal there shall be recorded for a minimum of 30 seconds a Visual Identification. This identification shall contain:
- Program Title
 - Episode
 - Production Number
 - Production House Name
 - Date of Recording
 - Audio Status incl. track assignment and content i.e. Mono, Lo/Ro, Lt/Rt, PCM 5.1 Audio on Tracks 5 through 10 etc.
 - Audio Status incl. track assignment and content i.e. Mono, Lo/Ro, Lt/Rt,
 - Audio loudness level or compliance (-24LKFS)
 - Audio Multiplex – Type of System and Meta-data
 - Aspect Ratio
 - Protected Aspect Ratio
 - Standards Conversion – type
 - Closed Captions
- 9.5 Following the visual identification a countdown to program start may be recorded. This countdown should be at least 10 seconds in duration going to black following the 2 second indicator.
- 9.6 Continuity of Recorded Signals. There shall be continuity of recorded signals from a point at least 30 seconds before program start. Video black and silence shall continue for at least 10 seconds following the end of the program.

10. CLOSED CAPTIONS – STANDARD DEFINITION

- 10.1 The Australian Standard for closed captioning is for the data to be carried on line 21/334 for a 625/25 signal. The data format is in accordance with ETSI EN 300 742. Caption data shall be distributed, transmitted and monitored

according to the requirements of Free TV Australia Operational Practice OP42.

- 10.2 Identification of the presence of closed caption information is necessary on the program content.
- 10.3 A Command to clear any existing caption shall be included in the first two (2) seconds of a program. A Command to clear shall also be included two (2) seconds before the end of a program.

11. CLOSED CAPTIONS – HIGH DEFINITION

- 11.1 Carriage of closed captions for High Definition shall be in accordance with the requirements of Free TV Australia Operational Practice OP47 and SMPTE Registered Disclosure Document RDD 8.

A Command to clear any existing caption shall be included in the first two (2) seconds of a program. A Command to clear shall also be included two (2) seconds before the end of a program.

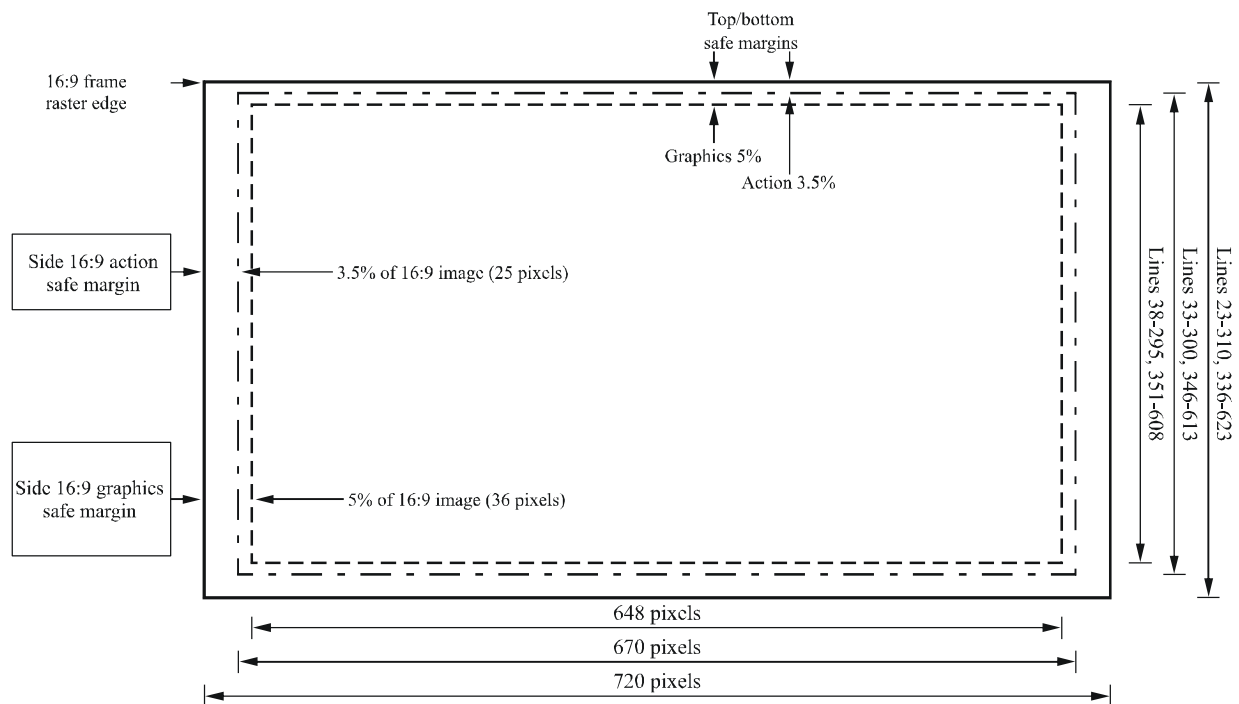
Annex A.

1. SDTV - SAFE ACTION AND SAFE GRAPHIC AREAS

- 1.1 The recommended 'Safe Action' and 'Safe Graphic' areas are defined by the following diagram.
- 1.2 The active video line length is defined as a nominal 720 pixels which represents normal digital active line length (refer to Clause 5.2.2).
- 1.3 The overscan of displays is assumed to be a maximum of 7% of overall picture width or height i.e. 3.5% at each edge but any one picture edge should not exceed 4% of total picture width or height.
- 1.4 Figure 1 - Widescreen shoot to protect the 16:9 full image (this is equivalent to a protected aspect ratio of 16:9).

This indicates the safe areas of a 16:9 widescreen display.

FIGURE 1
16:9 shoot-to-protect the 16:9 full image, 625-line interlaced scan



1848-01

FREE TV AUSTRALIA OPERATIONAL PRACTICE OP-30

QUALITY SPECIFICATION FOR THE INTERNATIONAL AND NATIONAL EXCHANGE OF PROGRAMS IN SDTV AND HDTV FORMATS

Issue 7
November 2019
Page 14 of 17

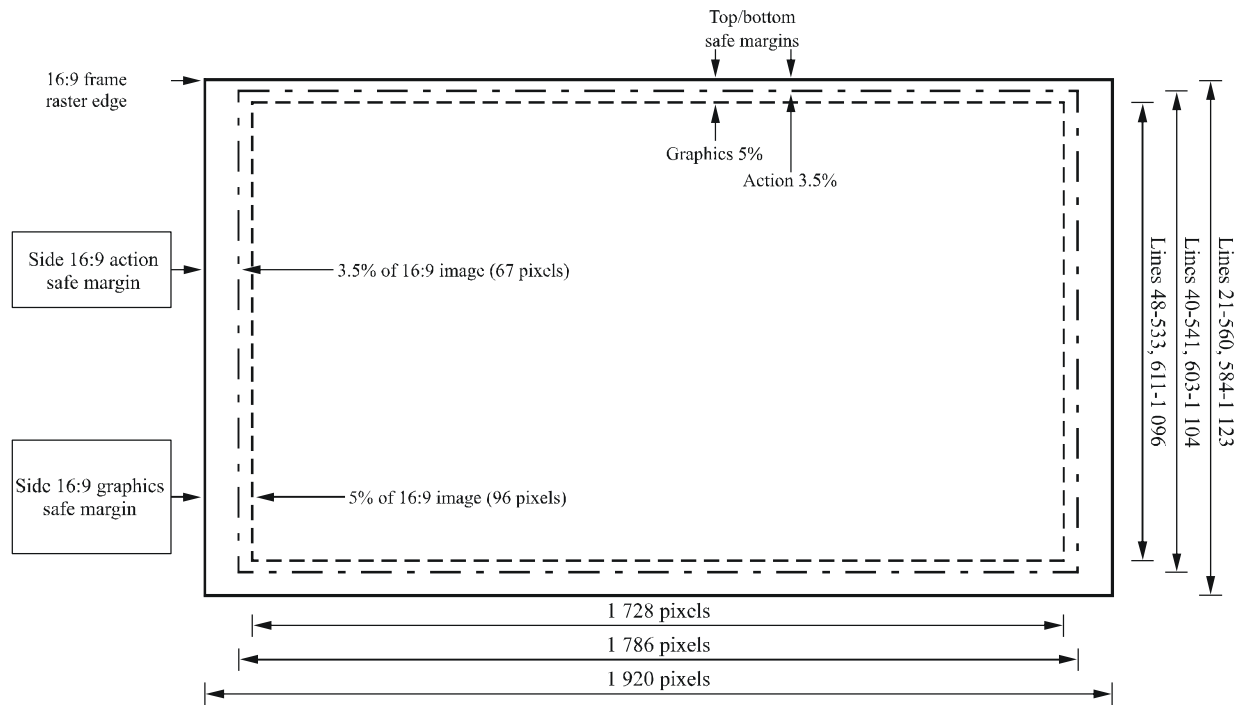
Annex B.

1. HDTV – SAFE ACTION AND SAFE GRAPHIC AREAS

The recommended HDTV 'Safe Action' and 'Safe Graphic' areas are defined by the following diagram.

- 1.2 Figure 1 is the HD transmission situation, 16:9 Shoot to Protect 16:9, with a line length of 1920 pixels. The safe areas are calculated to this base.
- 1.3 The overscan of displays is assumed to be 7% of overall picture width or height (i.e. 3.5% at each edge) but any one picture edge should not exceed 4% of total picture width or height.

FIGURE 1
16:9 shoot-to-protect the 16:9 full image, 1 080-line interlaced scan



1848-04

Annex C.

1. Audio Levels and Loudness.

This annex provides advice on the relationship of this OP and Free TV Australia OP59 *Measurement & management of loudness in soundtracks for television broadcasting*.

The elements of a soundtrack, namely dialogue, music and effects are subject to various processes during production. Where these elements sit in the final sound track, with respect to audio levels and loudness, is the result of a final mix and effectively it is here that the loudness of the soundtrack will be principally influenced.

Most sound track pre-final mix elements are passed through devices such as *equalisers* and *compressors*, which are designed to enhance their *presence* i.e. to make them sound “up close” or brighter or more immediate. This is referred to as “processing”.

Material that has been compressed will sound louder, even though there is no increase in volume. This is because compression of a sound track raises the energy content of the sound by reducing the dynamic range (i.e. the difference between the loudest and softest levels of the sound) thereby making it more dense.

Many modern processors are not calibrated in dB, have constantly varying compression ratios and are likely to be multi-band devices which apply different amounts of compression in different frequency bands. This makes it difficult for sound track producers to accurately measure and quantify how much compression is applied to a soundtrack. However, prior to the final mix it is recommended that every effort should be made to ensure that the nature of any compression or equalisation used is such that the end result does not produce a sound track with a loudness characteristic which is incompatible with program material.

Broadcasters provide the following advice and recommendations for definition of a compression profile related to any processing applied AFTER the final mix. Figure 1 provides a diagrammatic representation of this simple profile. In all cases the loudness of the final mix should be measured using a ITU-R BS-1770-3⁹ compliant loudness meter to ensure conformance to the -24LKFs loudness level.

If any further peak limiting were to be necessary, it would be provided automatically by the transmission processor.

⁹ Loudness measurements made on BS.1770-2 and BS.1770-3 meters are identical.

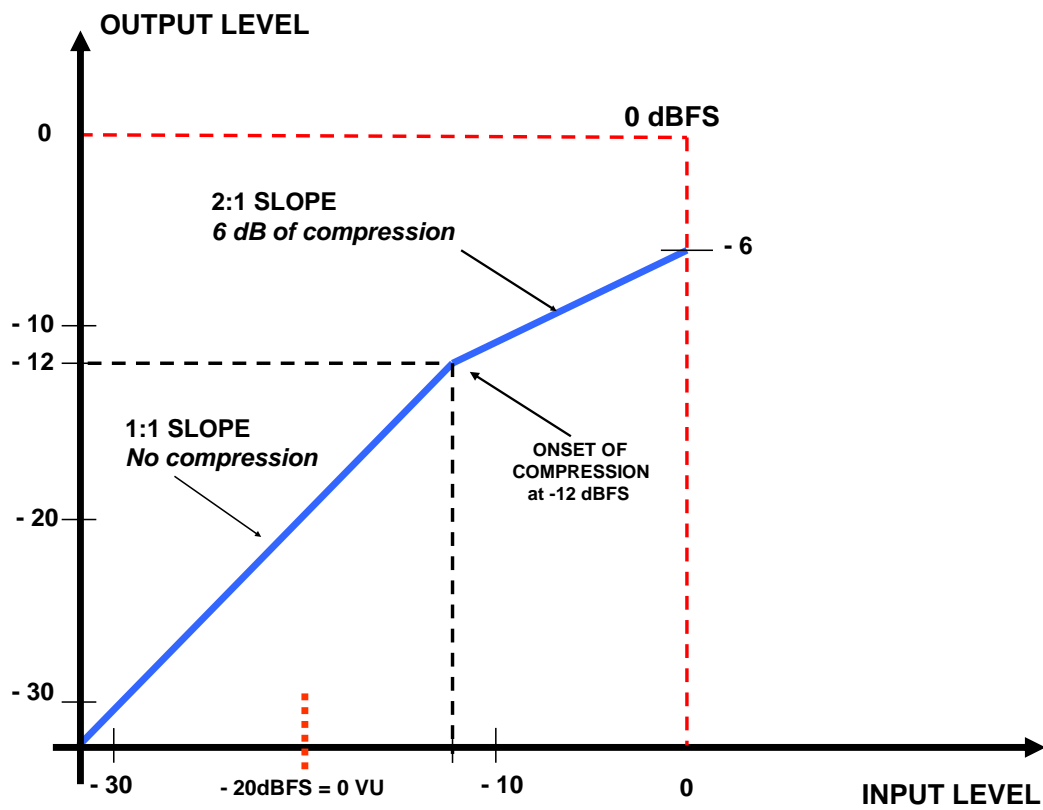


Figure 1