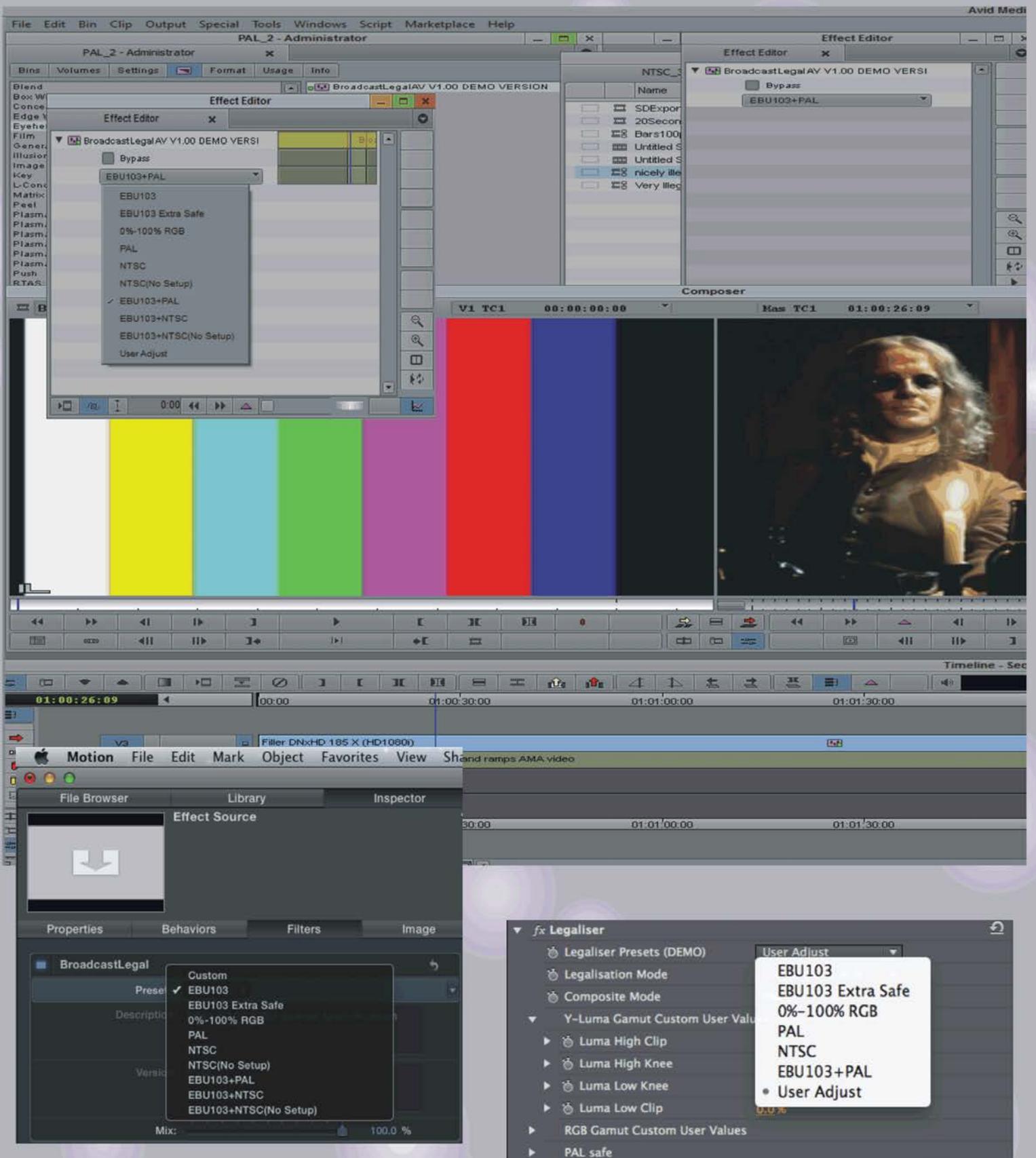
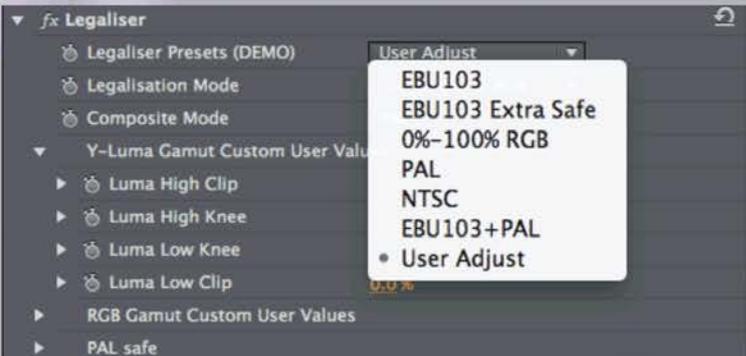


✓ A guide to file based legalisation



The screenshot displays the Avid Media Composer interface with the BroadcastLegal effect editor open. The effect editor shows a dropdown menu for 'BroadcastLegalAV V1.00 DEMO VERSI' with options including EBU103, EBU103 Extra Safe, 0%-100% RGB, PAL, NTSC, and EBU103+PAL. The timeline shows a video clip with a color bar and a video frame of a person. The interface includes various panels like File Browser, Library, Inspector, and Properties.



This close-up shows the 'fx Legaliser' settings. The 'Legaliser Presets (DEMO)' dropdown is set to 'User Adjust'. The 'Legalisation Mode' is set to 'User Adjust'. The 'Composite Mode' is set to 'User Adjust'. The 'Y-Luma Gamut Custom User Values' are set to 'User Adjust'. The 'Luma High Clip', 'Luma High Knee', 'Luma Low Knee', and 'Luma Low Clip' are all set to 'User Adjust'. The 'RGB Gamut Custom User Values' and 'PAL safe' are also set to 'User Adjust'.

A GUIDE TO FILE BASED LEGALISATION

This guide has been introduced to help explain the complex world of technical video level compliance in the file based domain. It is being produced by Eyeheight Ltd who manufactures both hardware SDI legalisers and also software legaliser plug-ins for the most commonly used editing platforms, namely Avid Media Composer, Apple Final Cut and Adobe Premiere Pro.

WHY LEGALISE AT ALL?

When a finished programme is delivered to a broadcaster, the broadcaster will evaluate the quality of the content (Quality Assessment, or QA). It will be evaluated for many things such as its production content (violence, sex, bad language, legal issues etc) but it will also be evaluated in the technical domain where both the video and audio must meet precise technical specifications. If you do not meet these specifications the content will be rejected by the broadcaster and sent back to be re-edited until it meets those specifications.

The “BroadcastLegal” plug-in will force the content to meet the specification automatically.

WHAT ARE THE SPECIFICATIONS AND WHY ARE THEY THERE?

The video specifications relate mostly to video levels. This can be a combination of black and white levels, RGB levels and also “composite colour – PAL NTSC” levels. The level restrictions are there to ensure that the content that is seen at the editing stage will remain faithful through transmission to the consumer. It is possible to produce video content at the editing stage that will change when it is passed through the video transmission process and consequently change colour from edit to consumer. This is undesirable. Currently we only know of one published recommendation by a standards committee which is an EBU technical recommendation “R103-2000”. Many (mostly European) broadcasters’ technical compliance documents follow these recommendations. Many other worldwide broadcasters have their own specific requirements.

FILE BASED LEGALISERS IN THE EDIT

Eyeheight target the editing platform to perform legalisation. It is recommended by most broadcasters that legalisation is in the domain of post production. Here the production staff can evaluate any colour changes that may occur as a result of the legalisation process and even decide to re-edit if the results of the legaliser are unsatisfactory. Eyeheight legalisers have a lot of parameters to enable soft clipping and in the composite domain, constant hue clipping. The factory presets within our legaliser XML file are also optimised to keep picture quality as high as possible. Users can also choose to use our “BroadcastEvaluate” plug-in which will indicate technically non-compliant parts of the content which can then be corrected using native image level tools.

CODING AND DECODING

For those of you who are familiar with the world of SDI and the use of our SDI legalisers, you might say, things were simple and predictable compared to the file based world. All SDI video is uncompressed and there are no coders and decoders involved (Although broadcast tape machines employed some compression it was generally low compared to many file formats). This meant that once your video was legal it would stay that way unless you put it through another bit of kit with active video processing to change levels. Not so with the file based world and you need to be very careful with the quality of your coding and decoding. Codecs vary in quality enormously and the bit rate is usually the biggest driver of quality. Generally nowadays the broadcasters will specify a file delivery type of high quality. Typical High quality codecs are “Apple Pro Res” and “AVC Intra 100”.

Below are three snapshots. Figure 1 shows the original highly illegal material. Figure 2 shows the same material after being exported using the BroadcastLegal plug-in via a high quality codec. Figure 3 shows the same material after being exported using the BroadcastLegal plug-in via a low quality codec.

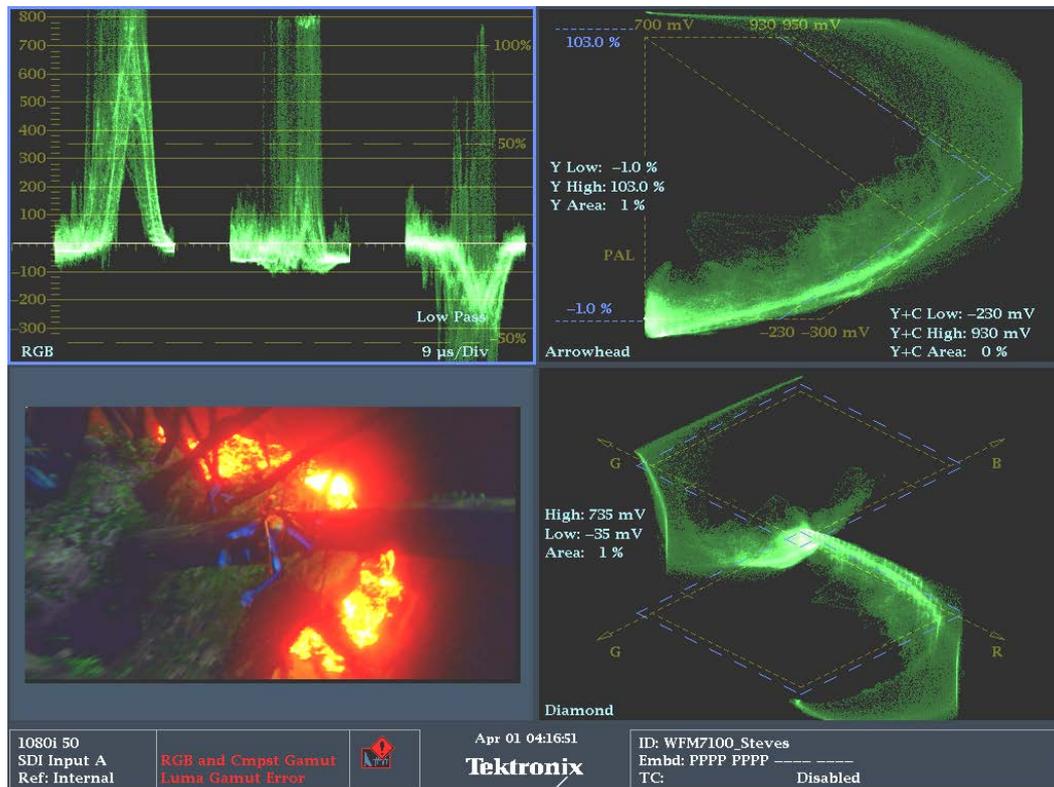


Figure 1 - Original content which has many level issues RGB and composite.

The legalisation standard used is EBU103+PAL. You will notice that legalising with the high quality codec produces an acceptable result. The low quality codec re-introduces artefacts causing an error to be flagged on the Tektronix waveform monitor.

Any codec will introduce some compression artefacts and for this reason all of the Eyeheight preset parameters are set to account for some error by pulling in the levels a little more than the specification allows. All the Eyeheight preset standards do this.

In Conclusion:

1. Do not export content through the BroadcastLegal plug-in using a low quality codec as it will re-introduce artefacts that may cause the content to be rejected
2. Remember that ANY codec will introduce some artefacts no matter how small. Always account for this by setting up the BroadcastLegal parameters tighter than the broadcaster recommendations.

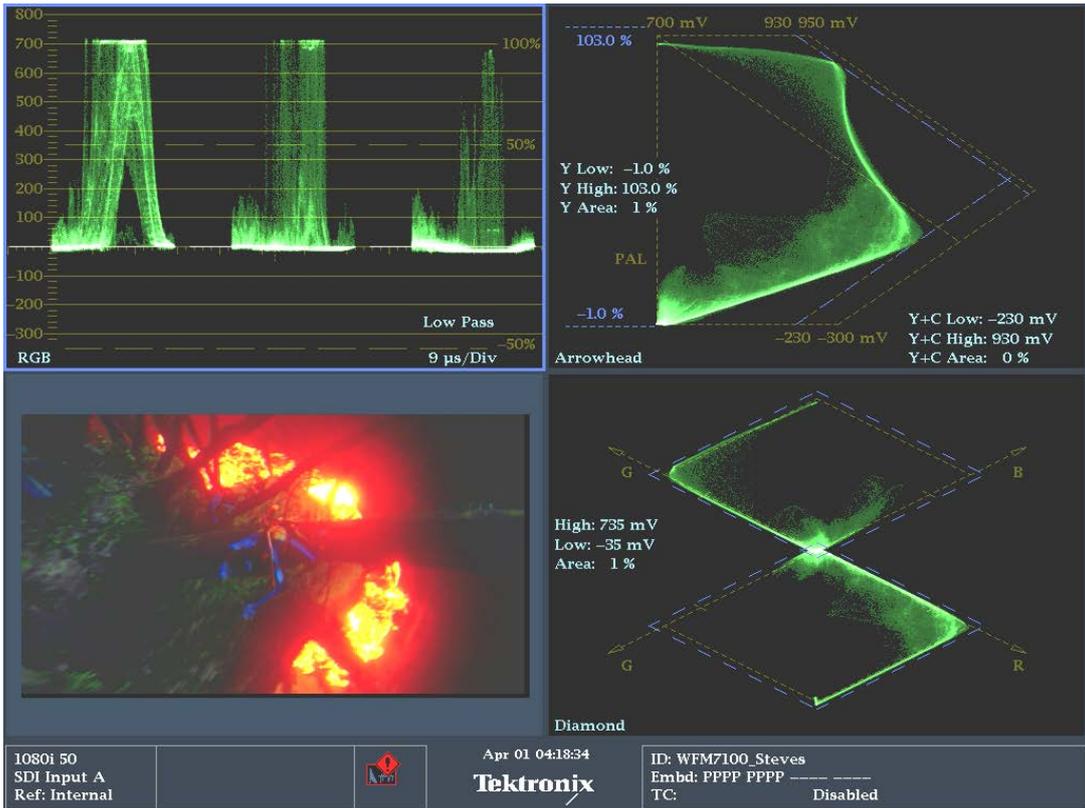


Figure 2 - Content after exporting using the BroadcastLegal plug-in preset to EBU103+PAL via a high quality codec.

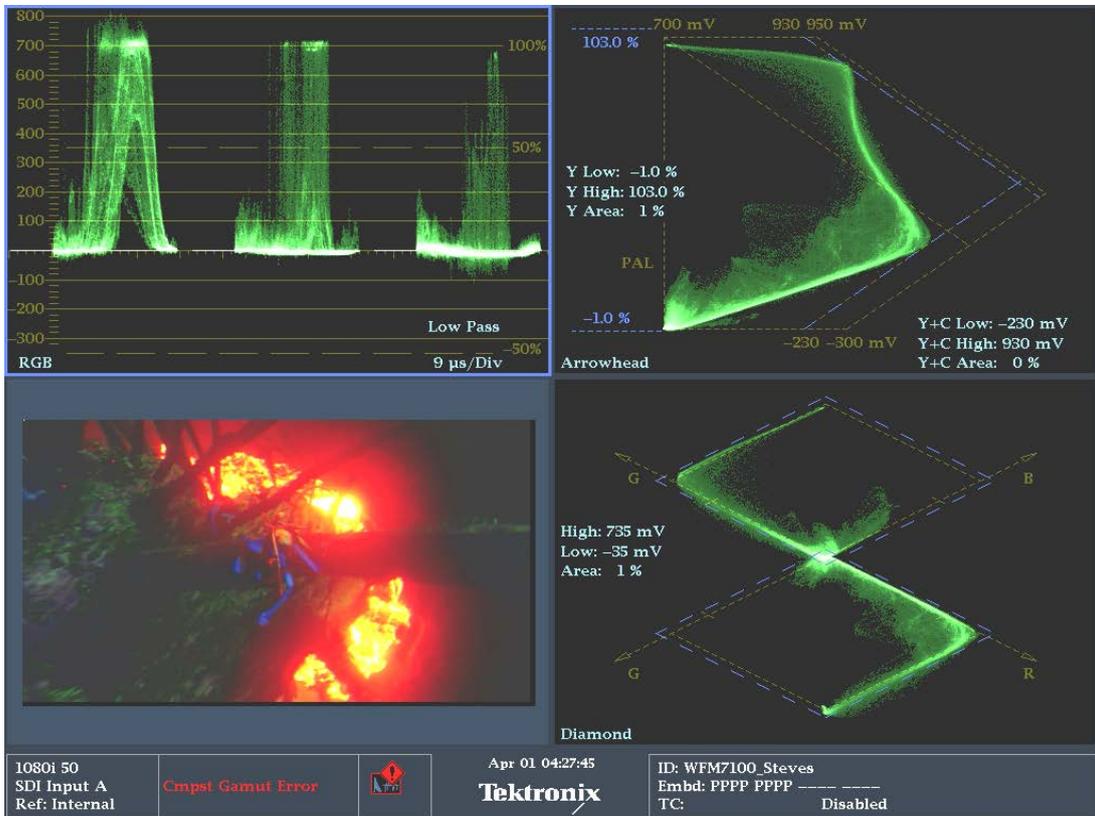


Figure 3 - Content after exporting using the BroadcastLegal plug-in preset to EBU103+PAL via a low quality codec with errors.

OVERUSE OF THE LEGALISER

If you take a look at the previous section and look at Figure 1 you will notice that the levels of the original content would be considered to be a long way from any broadcaster specification. In our view and the view of most experts it is not good practise to just legalise such content as this will lose a lot of content detail and even produce artefacts from the legaliser if it is set up badly.

The editor should, particularly for quality content, keep an eye on levels using a waveform monitor set to YRGB. If the editor is keeping the content within reasonable limits the legaliser can then be used to catch any stray levels. This ensures that the content remains faithful after legalisation.

WHAT SETTING SHOULD I USE?

This is one of the most frequently asked questions and the real answer is “do not ask us”! You should be asking the broadcaster. Every broadcaster has a delivery specification. Nowadays this specification will usually involve restricting the RGB and luminance levels. A typical example is shown below courtesy of the Digital Production Partnership (DPP) in the UK.

2.3 Video Levels and Gamut (illegal signals)

High Definition digital signals will be assessed according to the recommendation **ITU-R BT709-5 Part 2**. Video levels must be received within the specified limits so that the programme material can be used without adjustment. Any signal outside the specified limits is described as a gamut error.

2.3.1 Measuring signal levels

Digital video levels are usually measured with a device which displays a trace like a traditional waveform monitor. This gives readings in mV (emulating an analogue signal), or as a percentage of the allowable levels.

The limits of signal levels are defined by reference to a nominal black level and a nominal white level. Black level comprises R, G and B all at zero (or 0% or 0mV) and white level is all three components at 100 % or 700mV.

Page 10 of 53

UK Version 4.0 - 2013

Broadcaster Version 4.0 - 2013

In a picture signal, each component is allowed to range between 0 and 100% (or 0mV and 700mV).

This equates to digital sample levels 16 and 235 (8-bit systems) or 64 and 940 (10 bit systems).

2.3.2 Tolerance of out of gamut signals

In practice it is difficult to avoid generating signals slightly outside this range, and it is considered reasonable to allow a small tolerance, which has been defined as follows under **EBU Rec103**:

RGB components must be between -5 % and 105% (-35 and 735mV)

and

Luminance (Y) must be between -1% and 103% (-7mV and 721mV)

Slight transient overshoots and undershoots may be filtered out before measuring, and an error will only be registered where the out of gamut signals total at least 1% of picture area. Many monitoring devices are designed to detect errors to this specification.

In the above case this could be met with the EBU-103 preset on the BroadcastLegal plug-in.

You may also come across specifications like this:

COMMERCIAL DELIVERY SPECIFICATIONS

2.1.

STANDARD DEFINITION VIDEOSPECIFICATIONS

1.1.

Commercial luminance level (maximum white level) shall nominally be 100 IRE with momentary transients of 105 IRE as measured with an IRE filter.

1.2.

Composite video levels (luminance and chrominance) shall have an absolute maximum of 120 IRE as measured in flat response mode.

1.3.

There shall be no false starts.

1.4.

SCH phase (sub-carrier to horizontal timing) shall be maintained continuously across all edits (color-framed edits).

This relates to a broadcaster in the USA. In this case it is composite video specification and would be satisfied with the NTSC preset on the BroadcastLegal plug-in.

CUSTOMISING PRESET LEVELS AND A LITTLE ABOUT UNITS - IRE , MV AND %

It is possible to customise the BroadcastLegal plug-in by adding your own presets. These are contained within an XML file which is part of the plug-in folder (for Windows) or Package (for Mac). An example is shown below. This is our standard EBU103+PAL preset.

```
<legalPreset>
  <name>EBU103+PAL</name>
  <legalisationMode>RGB+COMP</legalisationMode>
  <compositeMode>PAL</compositeMode>
  <luminanceHighClip_IRE>99.5</luminanceHighClip_IRE>
  <luminanceHighKnee_IRE>94.5</luminanceHighKnee_IRE>
  <luminanceLowClip_IRE>0</luminanceLowClip_IRE>
  <luminanceLowKnee_IRE>0</luminanceLowKnee_IRE>
  <compositeHighClip_IRE>128</compositeHighClip_IRE>
  <compositeLowClip_IRE>-28</compositeLowClip_IRE>
  <rgbHighClip_IRE>101.5</rgbHighClip_IRE>
  <rgbHighKnee_IRE>96.5</rgbHighKnee_IRE>
  <rgbLowClip_IRE>-1.5</rgbLowClip_IRE>
  <rgbLowKnee_IRE>0</rgbLowKnee_IRE>
</legalPreset>
```

The numeric values above are in IRE. IRE is however exactly the same as “%”. mV (milli-Volt) are units of 1/1000th of a volt. The equivalence is 700mV = 100IRE = 100%. So if you have a specification in mV then you need to convert this to IRE with the formula:

$$\text{IRE} = (\text{mV}/700) \times 100.$$

So for example... 721mV = (721/700) x 100 IRE which = 103 IRE.

CHECKING LEGALISED CONTENT

Customers often wish to check our legalised content for internal QA before it is sent to a broadcaster. Here are a few tips about how to go about this.

The complete legalised exported file can be imported back into an editing system. Many editing systems will be fitted with SDI hardware cards that can then be monitored by a Tektronix waveform monitor or similar device.

Most edit systems are fitted with an internal software based waveform monitor. We generally find that these are of little use to evaluate a signal because they rarely have a low pass filter function which is necessary for, at least, a simple evaluation of legality. They are good however for keeping your signals within the ballpark.

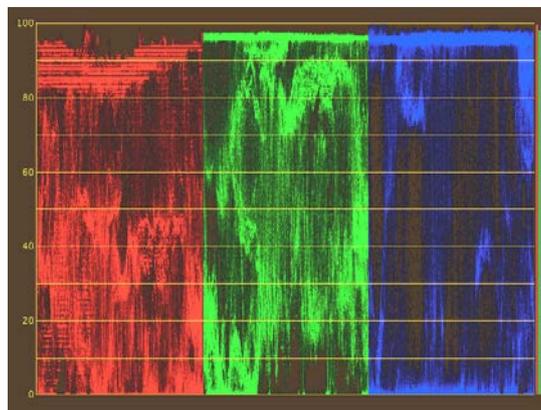


Figure 4 - An internal waveform monitor on an edit system.

If you are monitoring with an SDI waveform monitor then the simplest evaluation can be done by setting the monitoring device to YRGB parade and using a Low Pass Filter function as shown below. This will give a good indication as to the legality of your picture in RGB colour space. An example is shown in figure 5.

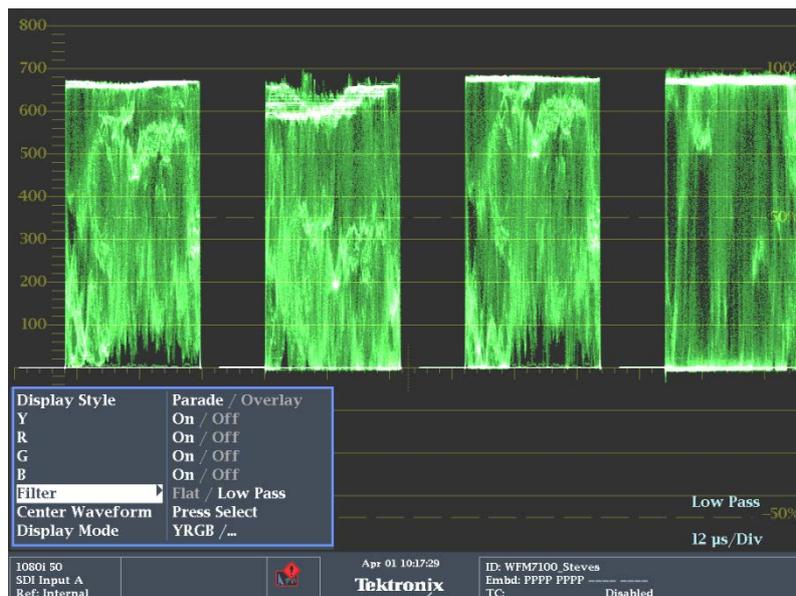


Figure 5 - YRGB waveform with Low Pass Filter. Legalised to the 0%-100% RGB preset

The best way to evaluate legality is to use the Tektronix Diamond display for RGB legality and the Arrowhead display for composite legality. These are specially formulated displays designed to check colour gamut. Examples of these are shown in figure 6.

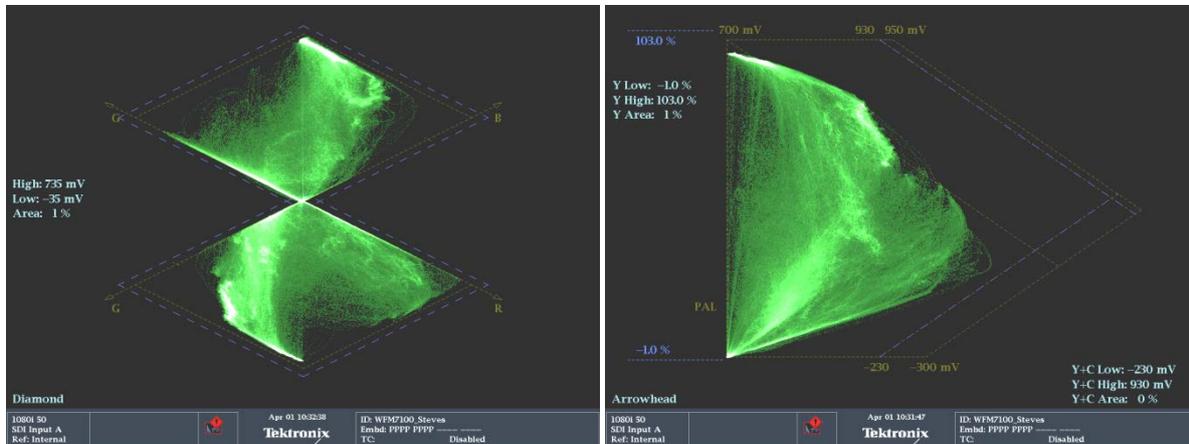
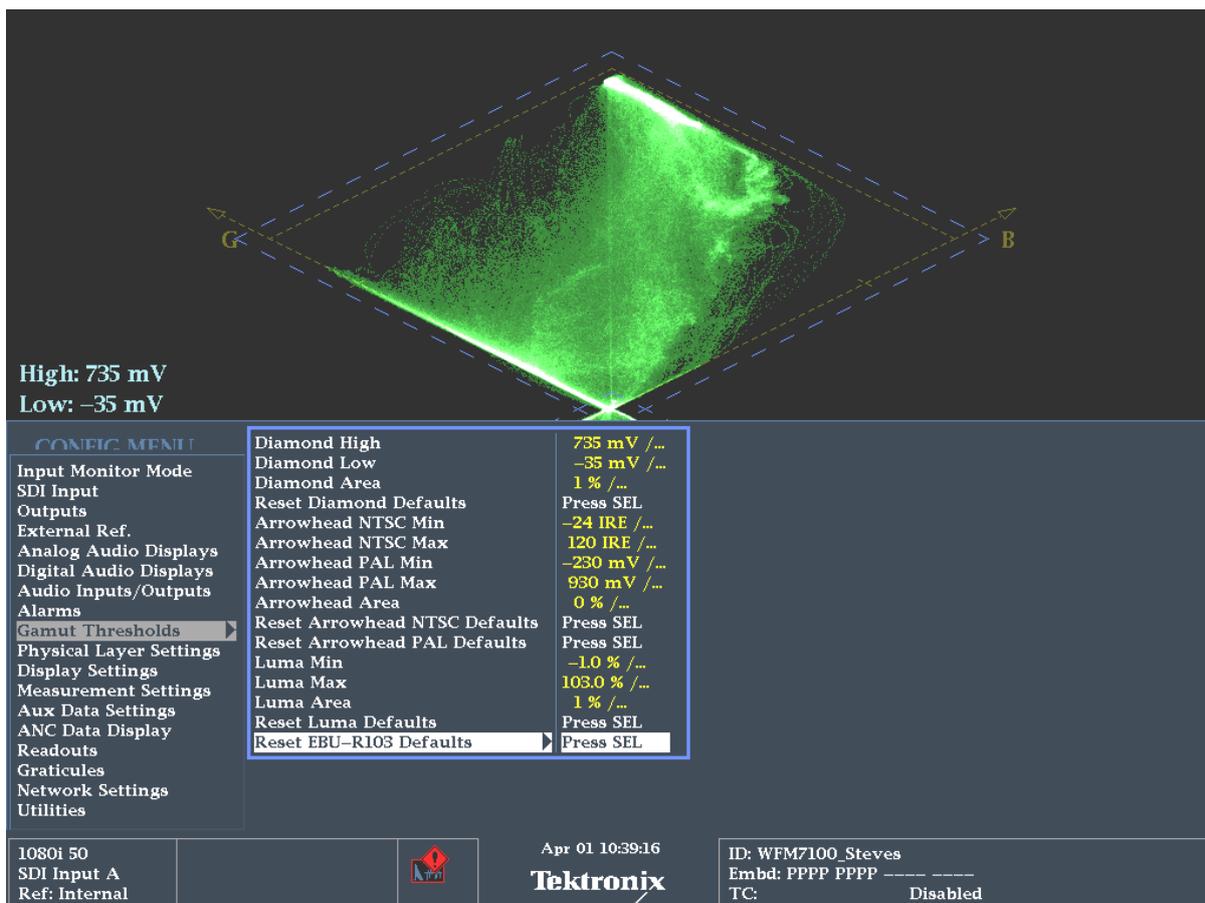


Figure 6 - Tektronix Diamond and arrowhead displays.

Also ensure that the settings for these are set to the default values. This is shown in figure 7.



The displays show a blue dotted line. In both cases the signal should be within these boundaries.

CHECKING LEGALISED CONTENT USING THE BROADCASTEVALUATE PLUG-IN.

Many customers will wish to check the legalised signal using external equipment, however, the Eyeheight “BroadcastEvaluate” plug-in is there to do this also and provides a simple display which will highlight any areas of illegality on the edit picture viewer. The BroadcastEvaluate plug-in has been set precisely to current legal standards. This check is a good idea particularly if you are using a lower quality codec. Remember that the exported file is coded after the legalisation process and so it will be subject to some change post legalisation as discussed in the previous section.

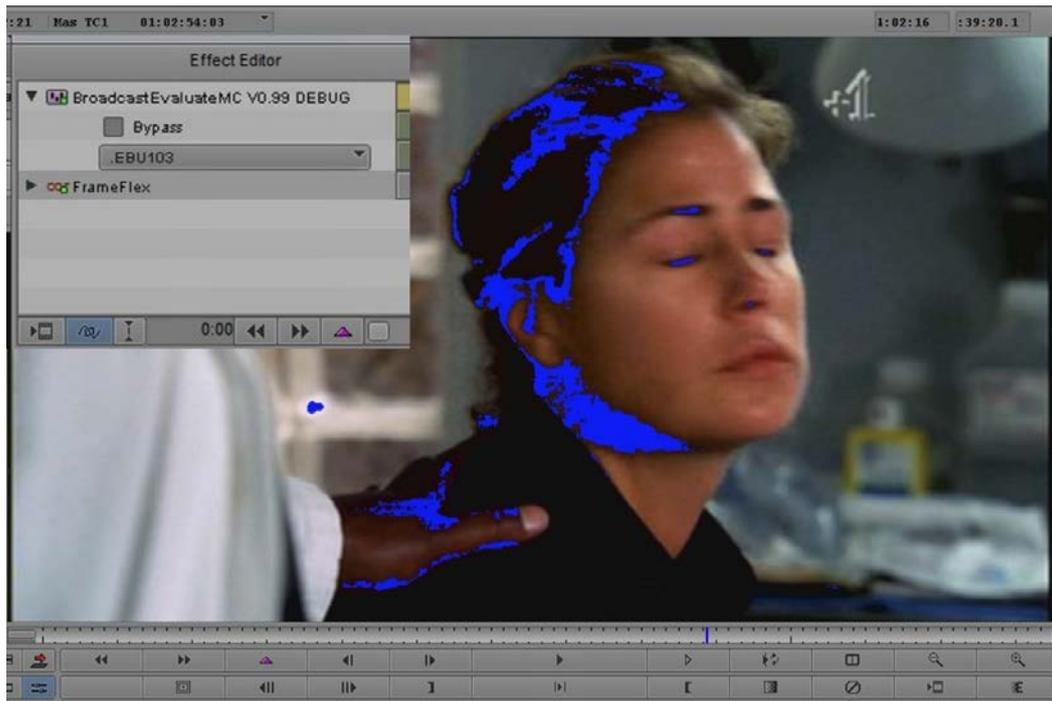


Figure 7 - An example of BroadcastEvaluate which shows the (blue) non compliant EBU103 areas

USING THE “KNEE” –WHY SOFT CLIP?

The BroadcastEvaluate legaliser is not just a simple limiter. One of the best features is the ability to “soft clip”. This means that you can keep the detail in the picture that would normally be “clipped” out. The waveforms below show this in action.



Figure 8 - A waveform showing levels below 0mV and above 700mV with a small notch (detail) in these sections.

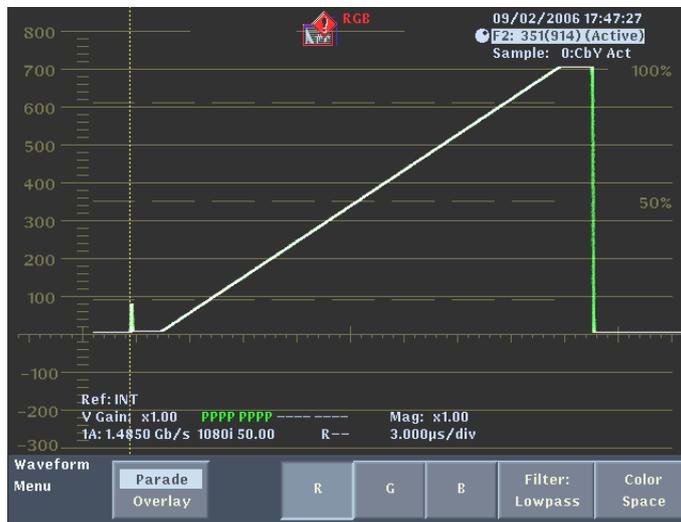


Figure 9 - This is the result of hard clipping or limiting. The detail is missing but the signal is within 0-700mV.

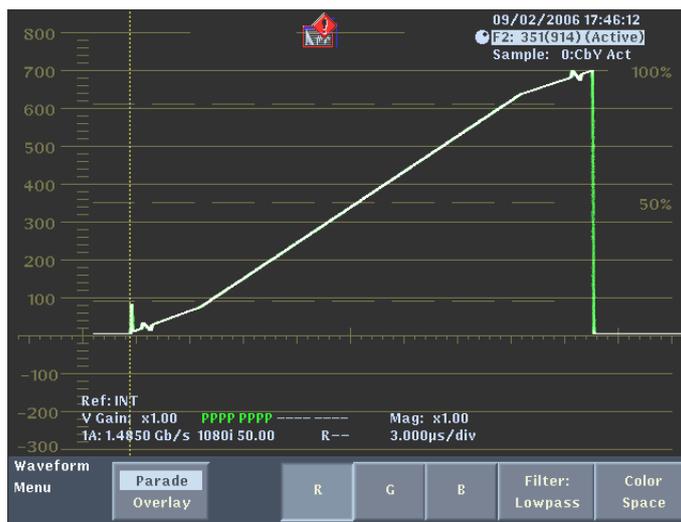


Figure 10 - This is the result of soft clipping. The detail is still visible and the signal is now within 0-700mV.

The soft clip introduces a “knee” into this linear ramp effectively changing the “gain” at high and low areas of the picture. The “knee” is defined as the point (in this case at around 70mV for the low knee and 640mV for

the high knee) at which the gain changes thus compressing the picture from that point. Subjectively this signal compression is better than losing the detail.

THE BROADCASTLEGAL PRESETS

This section just gives you a quick tour of the current BroadcastLegal presets and shows the current parameters.

	EBU103	EBU103 Extra Safe	0%- 100% RGB	PAL	NTSC	NTSC (No Setup)	EBU 103 + PAL	EBU103 + NTSC	EBU103 + NTSC (No Setup)
Legalisation Mode	YRGB	YRGB	RGB	COMP	COMP	COMP	RGB+COMP	RGB+COMP	RGB+COMP
Composite Mode	X	X	X	PAL	NTSC+SETUP	NTSC	PAL	NTSC+SETUP	NTSC+SETUP
Luminance High Clip	101.5	100	X	99.5	99.5	99.5	99.5	99.5	99.5
Luminance High Knee	96.5	95	X	94.5	94.5	94.5	94.5	94.5	94.5
Luminance Low Clip	0	0	X	0	0	0	0	0	0
Luminance Low Knee	0	0	X	0	0	0	0	0	0
Composite High Clip	X	X	X	128	115	115	128	115	115
Composite Low Clip	X	X	X	-28	-19	-19	-28	-19	-19
RGB High Clip	103	101.5	100	X	X	X	101.5	101.5	101.5
RGB High Knee	98	96.5	95	X	X	X	96.5	96.5	96.5
RGB Low Clip	-3	-1.5	0	X	X	X	-1.5	-1.5	-1.5
RGB Low Knee	0	0	0	X	X	X	0	0	0

Figure 11 - Table of the current settings in the BroadcastLegal presets.

PRESET - EBU103

This Preset conforms to the EBU specification:

“EBU Technical Recommendation R103-2000 Tolerances on "Illegal" colours in television”

It is generally tighter by 2% on RGB and up to 1.5% on luminance to allow for any coding errors.

(Note we never put lift on a signal so the highest luminance low clip is 0%). Soft clipping is used to preserve detail.

PRESET - EBU103 EXTRA SAFE

This Preset conforms to the EBU specification:

“EBU Technical Recommendation R103-2000 Tolerances on "Illegal" colours in television”

It is generally tighter by 3.5% on RGB and up to 3% on luminance to allow for any coding errors. Soft clipping is used to preserve detail.

PRESET – 0%-100% RGB

This preset clips strictly at 0% and 100% RGB. It employs soft clipping in the highlights to preserve detail. This preset also by a quirk of equivalence also legalises to the PAL standard.

PRESET- PAL

This preset legalises to analogue PAL standard. It employs soft clipping in the highlights to preserve detail. It is generally tighter by at least 2% to allow for coding errors. This does not legalise RGB.

PRESET- NTSC

This preset legalises to analogue NTSC standard employed in the USA. It employs soft clipping in the highlights to preserve detail. It is generally tighter by at least 2% to allow for coding errors. This does not legalise RGB.

PRESET- NTSC (NO SETUP)

This preset legalises to analogue NTSC standard employed anywhere except the USA. It employs soft clipping in the highlights to preserve detail. It is generally tighter by at least 2% to allow for coding errors. This does not legalise RGB.

PRESET- EBU103+PAL

This preset is a combination of two presets. These are “EBU103 Extra Safe” and “PAL”.

PRESET- EBU103+NTSC

This preset is a combination of two presets. These are “EBU103 Extra Safe” and “NTSC”.

PRESET- EBU103+NTSC (NO SETUP)

This preset is a combination of two presets. These are “EBU103 Extra Safe” and “NTSC (No Setup)”.