Phil Crawley

16th February 2011, 16:30

A video & audio test & measurement primer

Television QC using Tektronix test sets as an illustration - Ideal for junior engineers or machine room staff who are moving up to QC'ing finished programmes. **Our *Video 101 & Audio 101 courses are pre-requisite.***

- Recap of Video & Audio measurement principles and requirements
- What does the video signal look like?
- How legalisers fit into the television delivery process
- Different colour spaces - composite colour in HD
- Audio
- More advanced problems - PSE, BCAP captions sizes etc.
- Physical transport problems - Timecode & AES timing etc.
- Dolby E and advanced audio parameters
- Problems of BRR and codecs.

This is by its nature an introduction – you can't cover in a few hours what BBC training takes weeks over but it will give you a confidence in the basics to start investigating for yourself.

www.root6.com   +44 (0) 20 7437 6052

1

Recap of Video & Audio measurement principles and requirements

To avoid finished programmes from being thrown back by (often over-zealous) broadcasters it is necessary to ensure the technical aspects of the recording (be it on video tape or as a file) conform to the delivery specification. Since all broadcasters (as well as sell-through and other commissioning companies) have slightly difference requirement a familiarity with their published documents is important;

- Video – is the material constrained level-wise (both for luminance – the black and white image, and chrominance – the colour content)?

- Audio – Is the sound track constrained to +8dBu and have a sensible dynamic range?

- Content

  o Are captions compliant with the BCAP regulations
  o Is the programme Action and Graphics Safe?
  o PSE – no excessive flashing frames
  o Timecode – does programme starts and finish as specified (typ. 10:00:00:00)
  o Clock and identification
  o Consistent aspect ratio

www.root6.com   +44 (0) 20 7437 6052

Video – colour bars
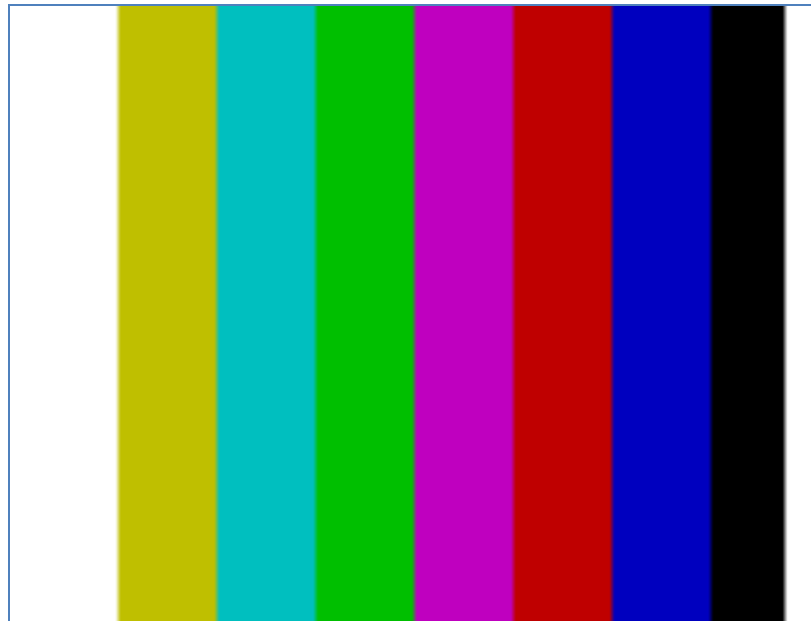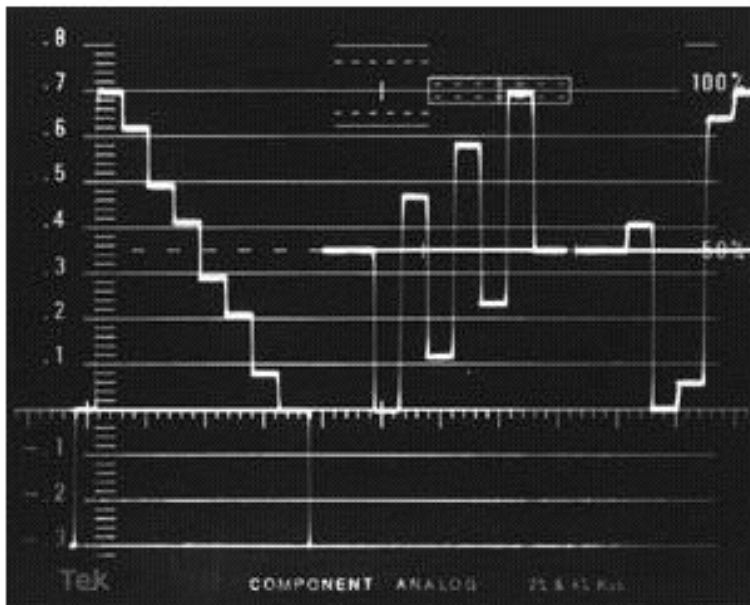
Again – count the number of bars (white through black) and match them to the colour bars on the monitor.

www.root6.com   +44 (0) 20 7437 6052

How legalisers and audio compressors fit into the television delivery process

The first display shows the input signal that goes out of bounds at the black end (left; sub-black) and overshoots white (right end). The second shows the signals hard-clipped with all the detail in the blacks and whites cut off. The right-hand most waveform shows the result of using a legaliser which has applied a more graceful attenuation in the whites and gain in the blacks to maintain all of the black and white detail whilst producing pictures that comply with standard.

In the case of audio the top-end levels can be similarly auto-corrected with a compressor. These are devices that limit the dynamic range of audio and when configured in 'limiting mode' can ensure that no audio peaks go above +8dBu (6 on a PPM, +4 on a VU meter). **Remember the two uses of the word *compression!*** However – legalisers and compressors will never improve badly produced television.

www.root6.com   +44 (0) 20 7437 6052

Overview of the four-tiles style of current WVR/WFM models and operation
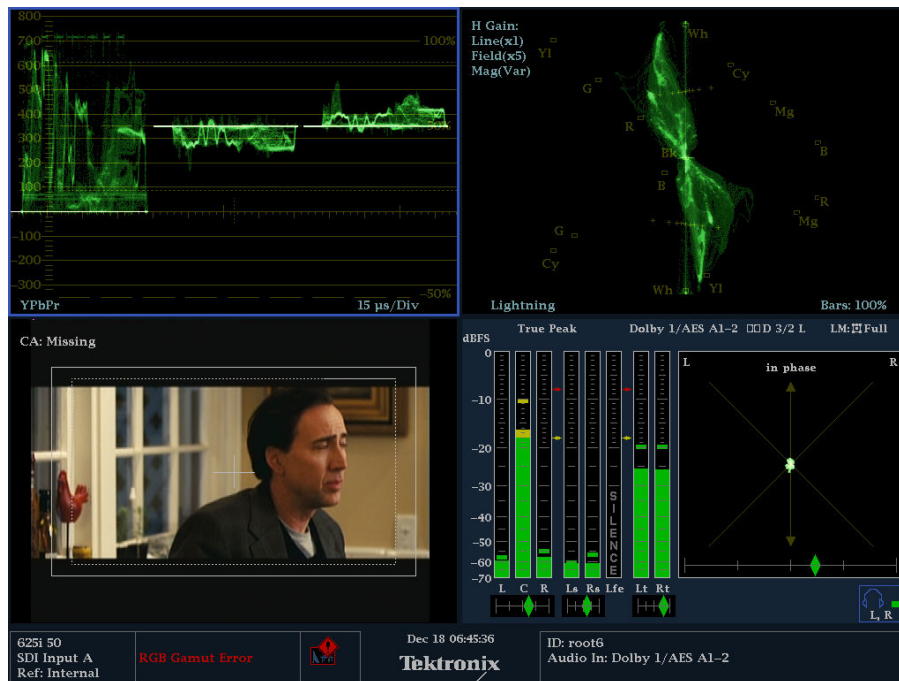
The Tektronix provides a quad display to allow the user to monitor several aspects of the signal – here you can see the component video display, a lightning display, the picture and the audio.

The waveforms are normally displayed as one or two television lines overlaid so that you see a whole frame of video but sliced into "2H" or "1H" – you can also overlay one or two video fields – "1V" or "2V"

www.root6.com   +44 (0) 20 7437 6052

Different colour spaces - composite colour in HD
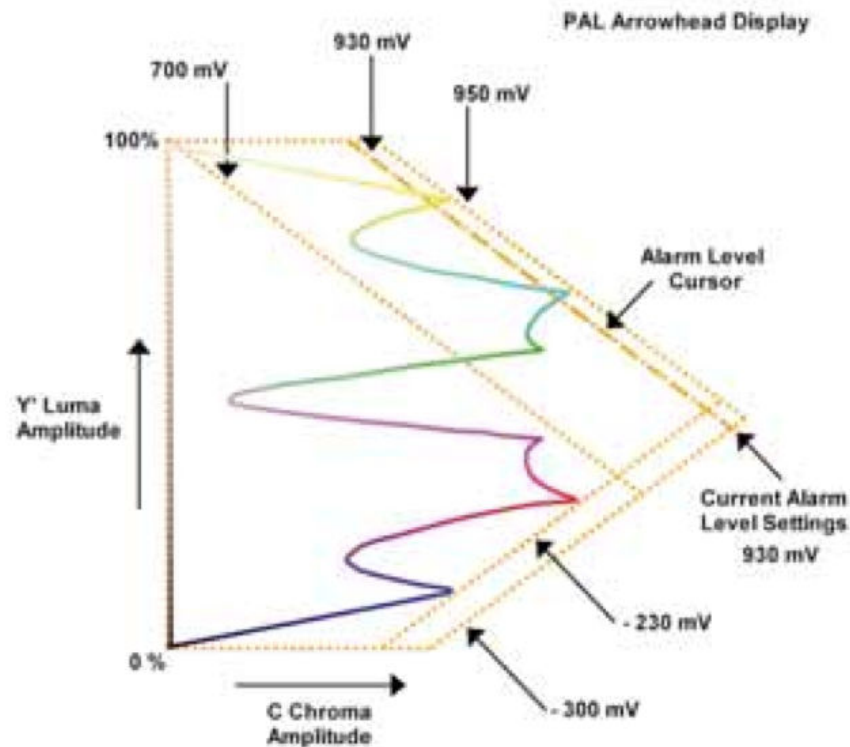
The arrowhead display is very useful as a single display that shows both overall video levels and colour gamut. The Arrowhead display plots luminance on the vertical axis, with blanking at the lower left corner of the arrow. The magnitude of the chroma subcarrier at every luminance level is plotted on the horizontal axis, with zero subcarrier at the left edge of the arrow. The upper sloping line forms a graticule indicating 100% colour bar total luma + subcarrier amplitudes. The lower sloping graticule indicates a luma + subcarrier extending towards sync tip (maximum transmitter power).

In the case of HD one large broadcaster insists that HD recordings have their colour space constrained to SD (rec.601) colour. Using the arrowhead display (above) allows you to monitor HD video but ensure that its colour content is limited to composite standard definition gamut. The Vodafone break-bumper confusion!

www.root6.com   +44 (0) 20 7437 6052

6

Audio – real sounds (not test tones!)
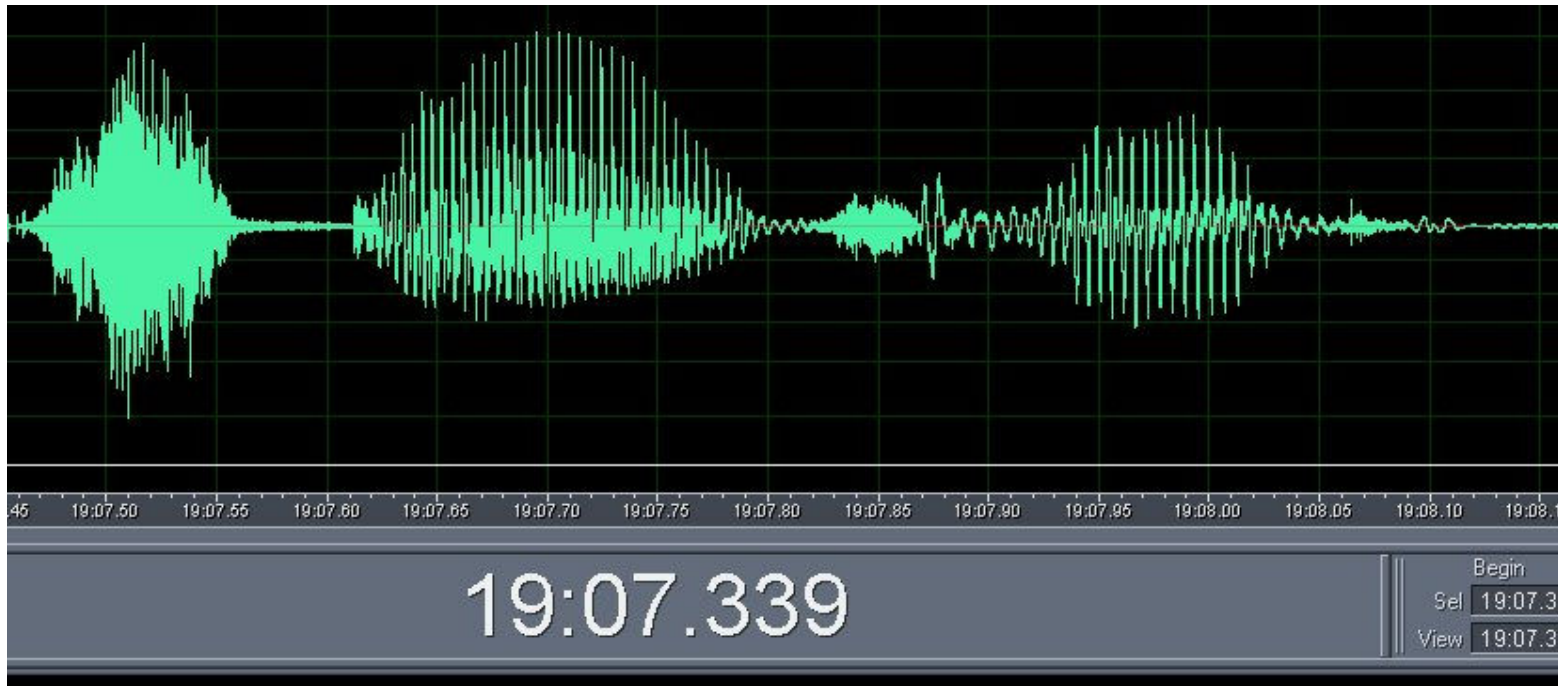
This is a recording of a man's voice saying "...it starts with..." – you can see how complicated it is with many different levels and frequencies. All this richness is due to harmonics.

www.root6.com   +44 (0) 20 7437 6052

Levels, how they equate and why it matters (headroom etc.)

- Because all systems that store sound (videotape, CD, DAT, MP3 etc.) have a limited range we have to be aware of levels.
- The difference in level between the quietest and the loudest sounds that a system can store without losing the signal or distorting it is referred to as the 'dynamic range' and it is sensible to place average programme audio somewhere in the middle of that range.
- Broadcasters are very hot on audio levels and expect the line-up tone at the head of the tape and the programme audio to follow quite tight limits.
- It stands to reason that if you try and record a signal that is too loud for the system you're using it won't sound very nice! (It's called distortion).
- In the case of analogue systems they 'degrade gracefully' – as you push the signal up towards the end of the dynamic range they distort a tiny bit, then a bit more and when you are really pushing your luck they sound awful.
- In the case of digital machinery (Avids, DigiBeta VTRs etc.) they sound pristine until the signal hits the end-stop when it totally max'es out and sounds worse than awful.
- A common term heard in audio measurements is the dB (decibel) which is really just a measurement of change (like a percentage or a ratio) – if you want to express an actually level you have to qualify it – "line up tone is at 0dBu" or "the speakers in our audio suite never go above 96dBA" – saying something in dBs only means a fraction (of something else?).
- Easy dB ratios to remember; 6dB – twice or half the signal. 20dBs – ten times (or a tenth)
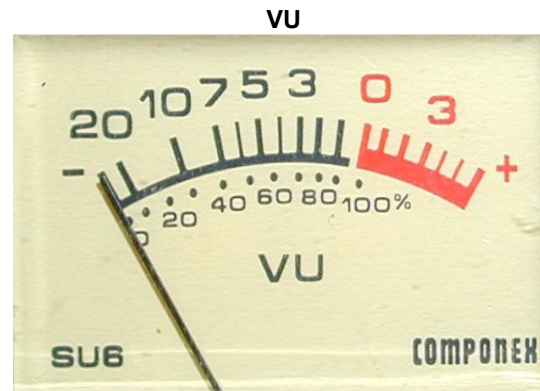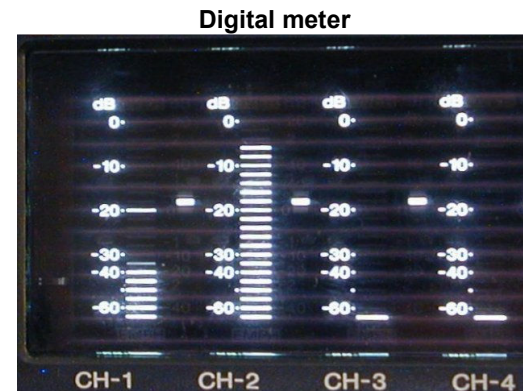
8

How to use a PPM – over-levels etc

We often refer to 'zero level' for line-up – what does this mean? Because the measurement comes from the days when all audio recording was analogue it refers to a signal level of 0dBu (which is 0.773v RMS into a 600ohm load, fact fans!). This is not important, what is important to know is that this level shows itself as 4 on a BBC Peak Programme Meter (PPM) – the needle points straight up. BUT, PPMs aren't the only meter you'll come across – there are also VU ('volume units' – an American standard) and newer digital meters (found on all digital VTRs). They all just fundamentally show the loudness of the sound and so this handy table will allow you to convert between:

PPM	**VU**	**Digital meter**
line-up: 4 (needle straight up)	line up:-4 (between 3 & 5 black)	line up: -18 (notch below 20)
Max level: 6	Max level: +4 (red notch above 3)	Max level: -10
Each division: 4dBs	Each division: 1dB	Each division: 1dB
Average level: 5	Average level: 0	Average level: -14
Edit suite/CTA measurement	**Analogue VTRs**	**Digital VTRs**

www.root6.com   +44 (0) 20 7437 6052

Audio displays of the WVR/WFM-series

The audio display differ slightly in that there is only one that can be assigned to the 4-way tile display.
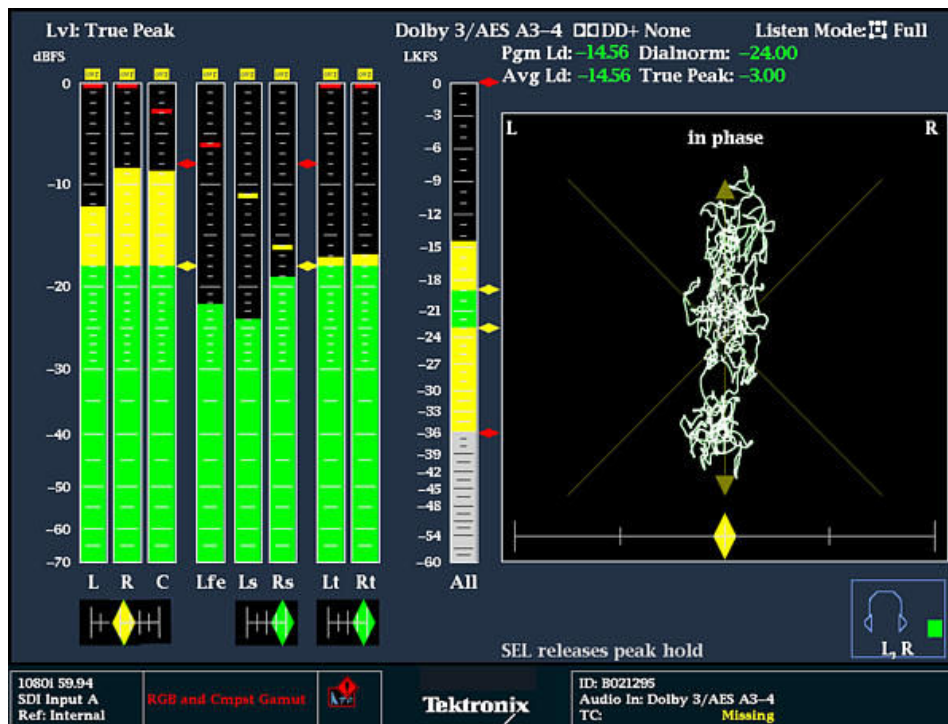
The bar-graphs on the left differ from the bar-displays on a VTR in that they can have digital or PPM-type scales. This image shows the digital level in dBfs. In this case the audio is Dolby-D encoded and the machine is deriving the six surround channels and making a pair of stereo bars for reference. The final bar shows various level and average values relating to the Dolby audio.

The phase display is showing the left and right channels set at ninety degrees to give a proper representation of audio phase.

The yellow diamond give a quick check on gross phase errors.

www.root6.com   +44 (0) 20 7437 6052

Advanced problems – Photo Sensitive Epilepsy

The issue of Photosensitive Epilepsy comes up often in television - back in the late nineties there was an episode of Pokémon that featured flashing images that provoked kids in Japan to have seizures. Since then Ofcom have been very keen to avoid this on British television and since 2003 have produced the guidelines;

This is an extract from the document but it does include the important details which hinge around the following;

3. A potentially harmful flash occurs when there is a pair of opposing changes in luminance (i.e., an increase in luminance followed by a decrease, or a decrease followed by an increase) of 20 candelas per square metre (cd.m-2) or more (see notes 1 and 2). This applies only when the screen luminance of the darker image is below 160 cd.m-2. Irrespective of luminance, a transition to or from a saturated red is also potentially harmful.

3.1.1. Isolated single, double, or triple flashes are acceptable, but a sequence of flashes is not permitted when both the following occur:
i. the combined area of flashes occurring concurrently occupies more than one quarter of the displayed (see note 3) screen area; and
ii. there are more than three flashes within any one-second period. For clarification, successive flashes for which the leading edges are separated by 9 frames or more are acceptable, irrespective of their brightness or screen area.

www.root6.com   +44 (0) 20 7437 6052

Advanced problems - BCAP captions sizes

The preferred minimum heights of on-screen text in TV advertisements made in different formats are given in the table.

	4:3 aspect ratio	16:9 aspect ratio	
	Standard Definition Television (SDTV) format	SDTV format	1080-line High Definition Television (HDTV) format[1]
Preferred minimum text height	14 lines	16 lines	30 lines
Minimum text height (when placed on an opaque single-coloured block with a clear margin all around the text)	12 lines	14 lines	26 lines

Rule 5.4.2 of the advertising Code requires that text 'must be legible' and must comply with this note. The aim is to achieve a standard of legibility that will enable an interested viewer, who makes some positive effort, to read all text messages. Sections 4 to 8 below indicate the minimum standards with which relevant text must comply.

www.root6.com   +44 (0) 20 7437 6052

Advanced problems – Cages

The Tek WVR/WFM-series test sets include safe area markers as well as movable cursors that allow you to check the size of captions to ensure compliance with the BCAP.

www.root6.com   +44 (0) 20 7437 6052
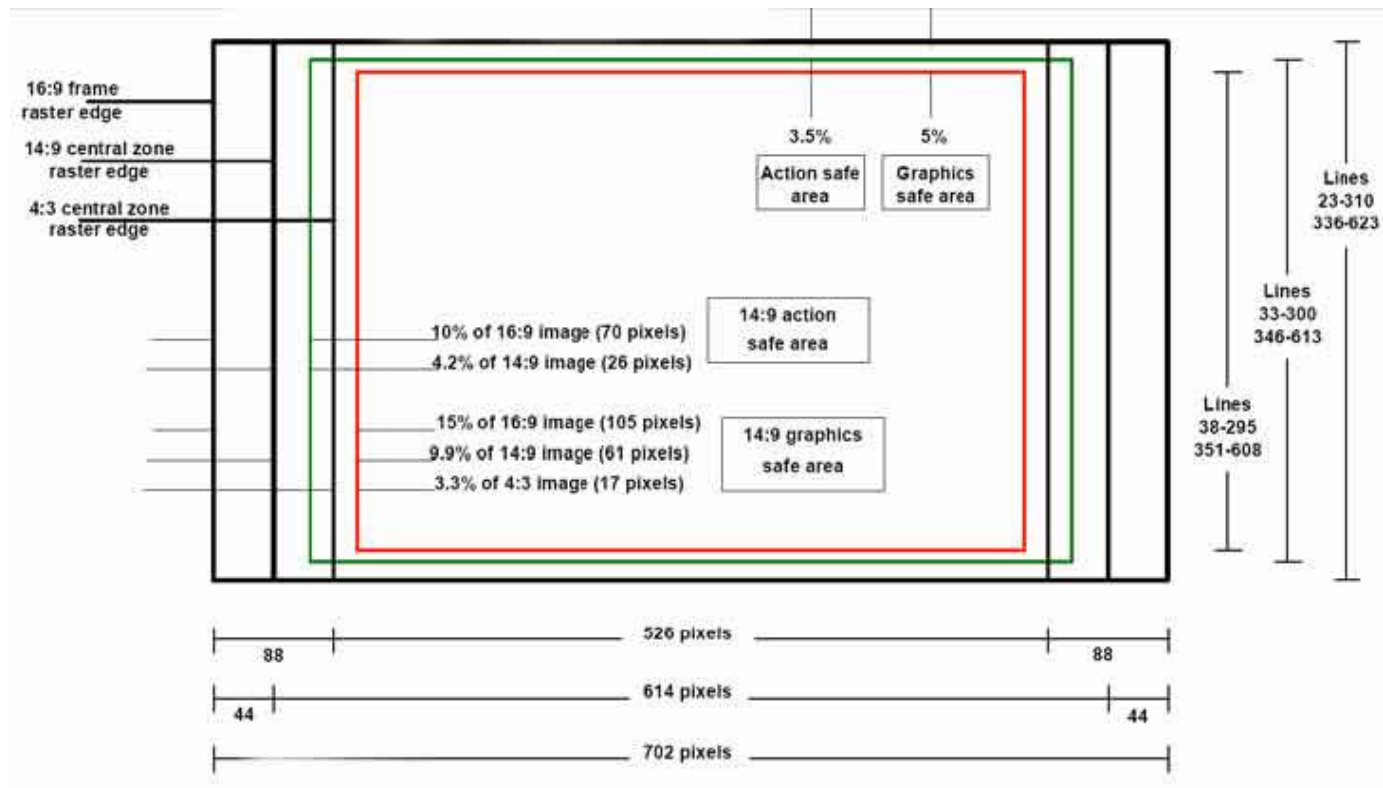
Physical transport problems - Timecode & AES timing etc.

If a programme is to be delivered on videotape there are a few other considerations aside from the quality/conformity of the video and audio signals (increasingly referred to as the 'essence' to distinguish it from physical layer considerations).
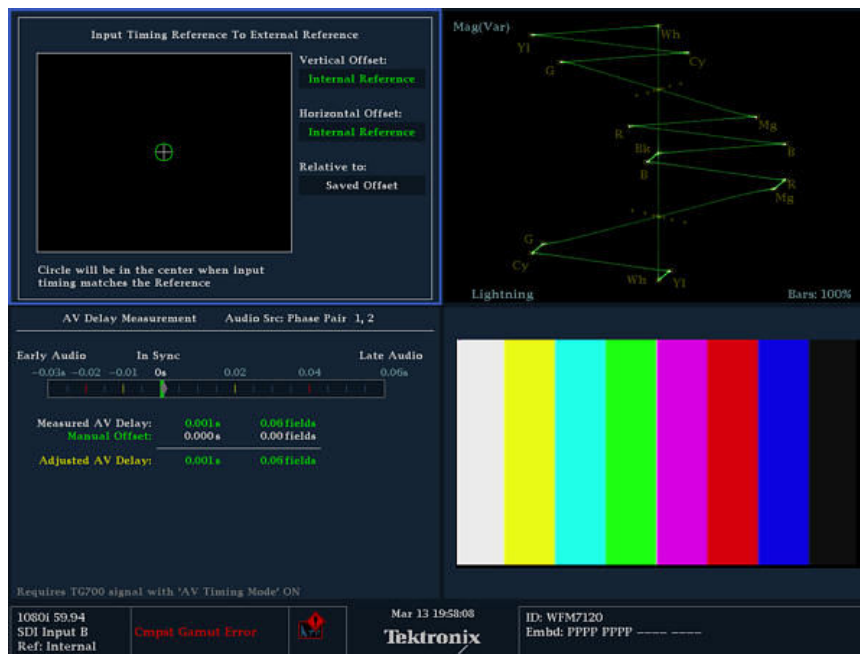
The timing displays (available on the button marked 'other') allow you to check the correct placement on tape of;

- Timecode – does the Timecode 'phase' match the start/end of pictures.
- AES – is the digital audio contained within the SDi stream correctly timed and locked to the video as it should be?

The fallacy that the flashing stop-light on a deck always indicates a loss of reference can be further investigated if your layback isn't working and you've got a proper waveform monitor to hand.

www.root6.com   +44 (0) 20 7437 6052

Dolby E and advanced audio parameters

Multiple-channel audio (5.1 and now 7.1 – six and eight channels respectively) is becoming more common and may be delivered on discrete channels (of a DA88 or videotape) or, more commonly, encoded using the Dolby-E system onto two channels of a VTR running in 'data mode'.

The following are important;

- **_Loudness_** – the broadcasters are getting very hot on perceived loudness as a common complaint is that 'the commercials are louder'. The emerging standard is that loudness is measured on a similar scale to PPM for audio level – this is what the Tektronix measures, and in this display shows it over the duration of the show.
- **_Dialnorm_** – a Dolby parameter than gets encoded with the audio – the Tek shows the presence and value.
- **_Dynamic Range_** – Another Dolby parameter that gets carried with the data stream.

www.root6.com   +44 (0) 20 7437 6052

Problems of BRR and codecs.

Remember the two uses of the word *compression!*

A typical production/post-production workflow for HD television might look like this;

- Shooting on Z1 camcorders – 18Mbits^{-1} MPEG2 long-GOP HDV

- Ingesting into Avid – 145 Mbits^{-1} DNxHD - iFrame (short-GOP)

- Layback to HDCamSR tape - 440 Mbits^{-1} MPEG4 long-GOP 'studio profile'

- Load into TX server - 20 Mbits^{-1} H.264 long-GOP

- Coding & MUX for transmission - 9 Mbits^{-1} MPEG4 long-GOP StatMux for DVB-T2

It's amazing there is anything left by the time it's gets to the viewer's television!

Even if you replaced each step with the optimal (i.e. shooting on HDCamSR, editing uncompressed etc – money no object!) there will be at least three dissimilar codecs/data-rates between the camera and the viewer. That is why it's important to watch for compression artefact early in the chain as they **will only** get worse. The *Fame Academy* example.

www.root6.com   +44 (0) 20 7437 6052

The future – file-based QC


As television in increasingly acquired on file-based camcorders and post-produced on workstations there will be and increased requirement to deliver finished programmes to the broadcaster as files. This bypasses the traditional tools we'd use to keep things in check (legalisers, waveform monitors etc). To this end Tektronix have been selling **Cerify** for the last few years.

Can you see the similarity with the file produced by the WVR/WFM-series rasteriser?

Cerify is network or SAN attached.

www.root6.com   +44 (0) 20 7437 6052
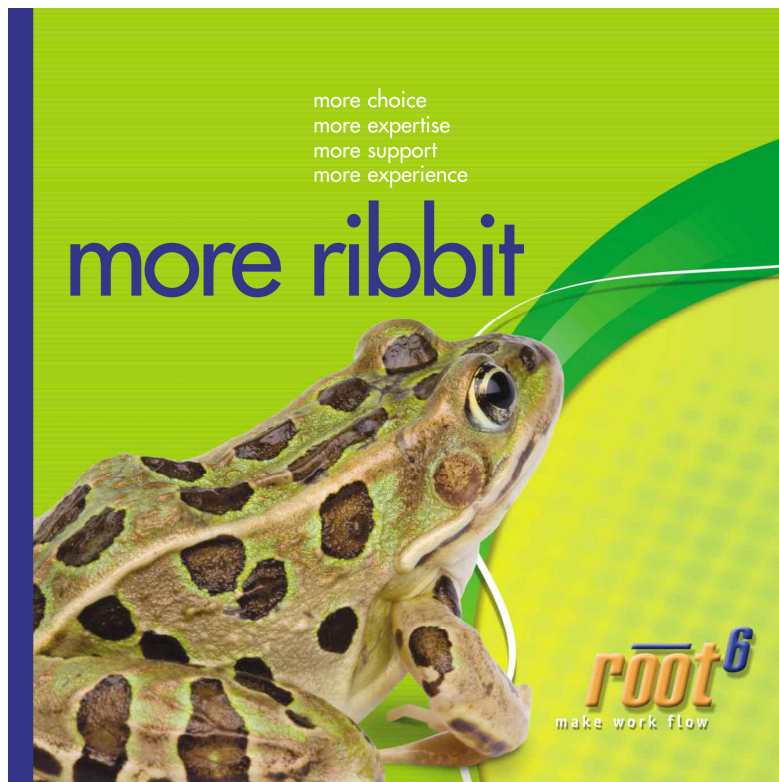
Please see www.root6.com for details of all of root6's training packages.

If you get **your badge scanned** at the root6 booth then you will be eligible for a discount when attending the full version of this taster session.

TCP/IP for Broadcast Engineers

Audio 101

Video 101

Television QC101

http://www.root6.com/blog
download today's notes

www.root6.com   +44 (0) 20 7437 6052