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Metropolitan Police Video Training

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@IsItBroke on Twitter

Video Measurement - Principals (4 days)

Course Aim

The aim of the course is to provide grounding in video fundamentals, compression and picture quality analysis for staff who work with video processing, detection and vision systems.

Course Structure

- Day 1 - TV Fundamentals; *Scanning and Sampling, Colour Systems, Analogue Composite Coding*
- Day 2 - TV Fundamentals; *Digital Component Coding, Conversion of Film to Television, High Definition*
- Day 3 - Compression; *DCT principles, Intra-Frame vs Inter-Frame Encoding, blocks and macroblocks*
- Video Tape Recording; *Magnetic recording principles, rotary recording, Simple VT maintenance.*
- **Day 4 - Television Measurements; *Analogue, Digital***
- Picture Quality Analysis; *Analogue picture impairments, digital picture impairments, compression*
- TV Displays; *CRT, LCD and Plasma displays. Problems with LCD and Plasma, Projection systems.*

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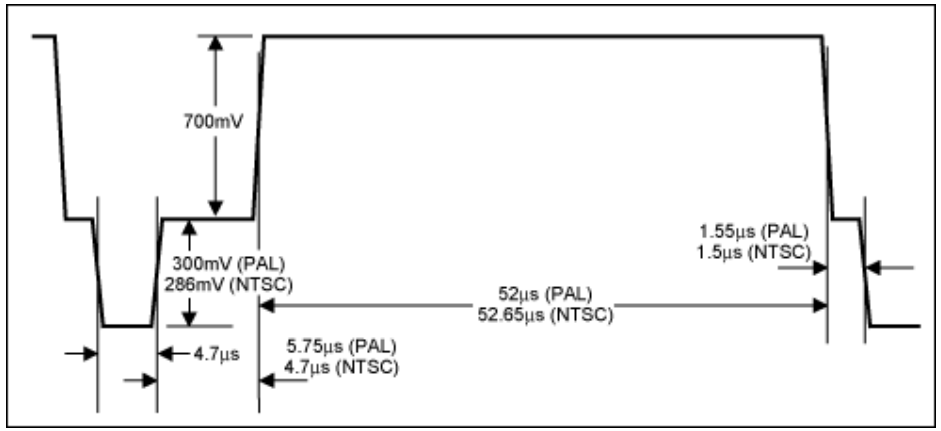
Television Measurements

Analogue levels; just the luminance part of the signal.



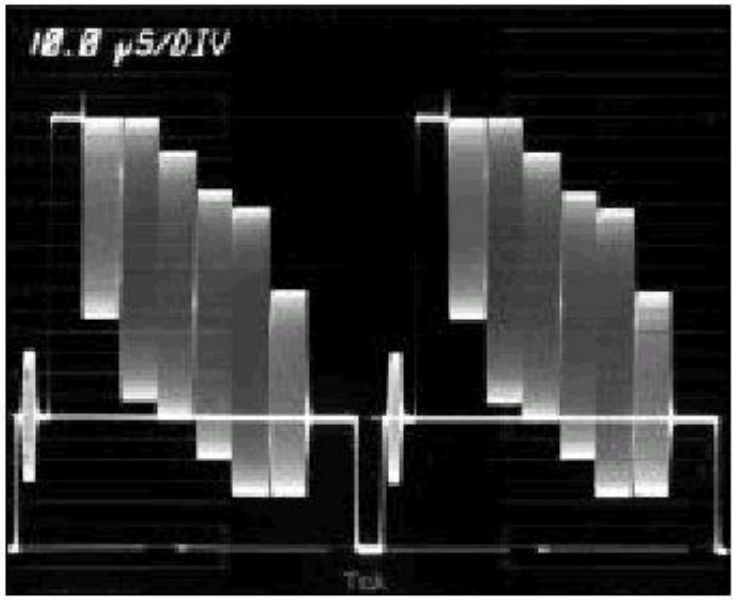
- Overall white level is 700mV above black
- Syncs are 300mV below black
- Line is 64µs overall, 52µs active picture
- Sync pulse width is 4.7µs

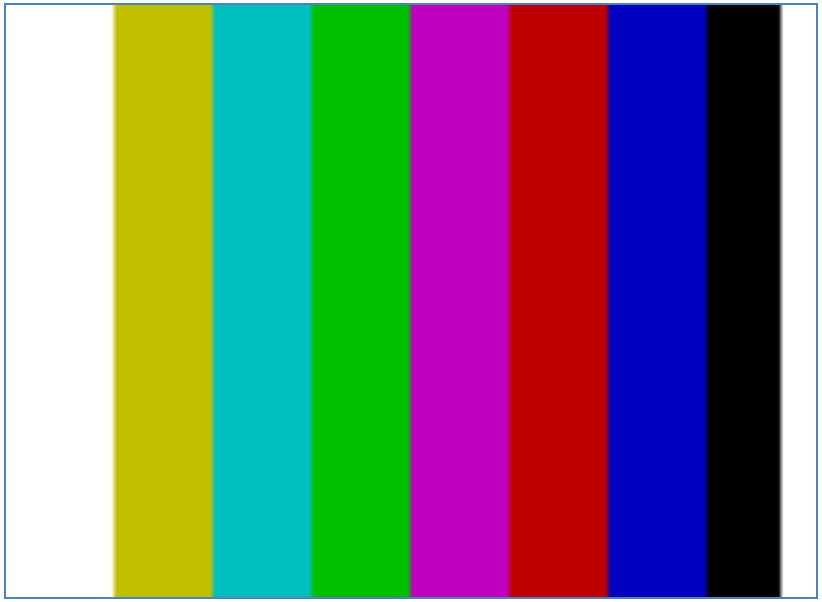
These are the basic timing and level values for SD analogue video; using any test set we can measure these levels to check for signal compliance.

The physical layer = the video signal, unlike digital video; cable, terminations important.

Television Measurements

Analogue levels – composite colour Bars – the classic test signal; 75%





Two lines of video – notice the colour sub-carrier; the colour burst is 300mV and the green bar just touches black levels. If this is right the picture will be correctly saturated.

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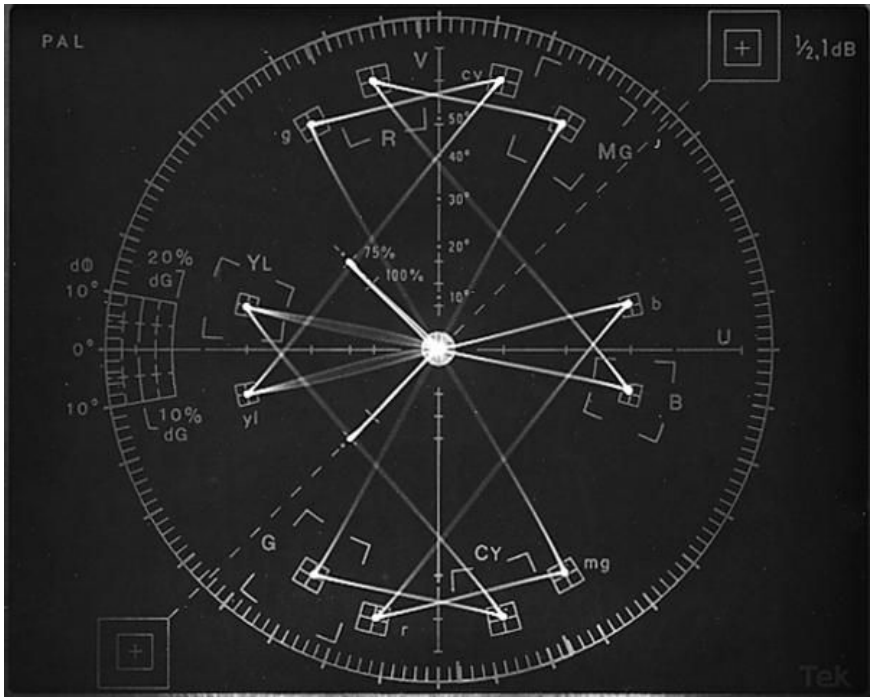
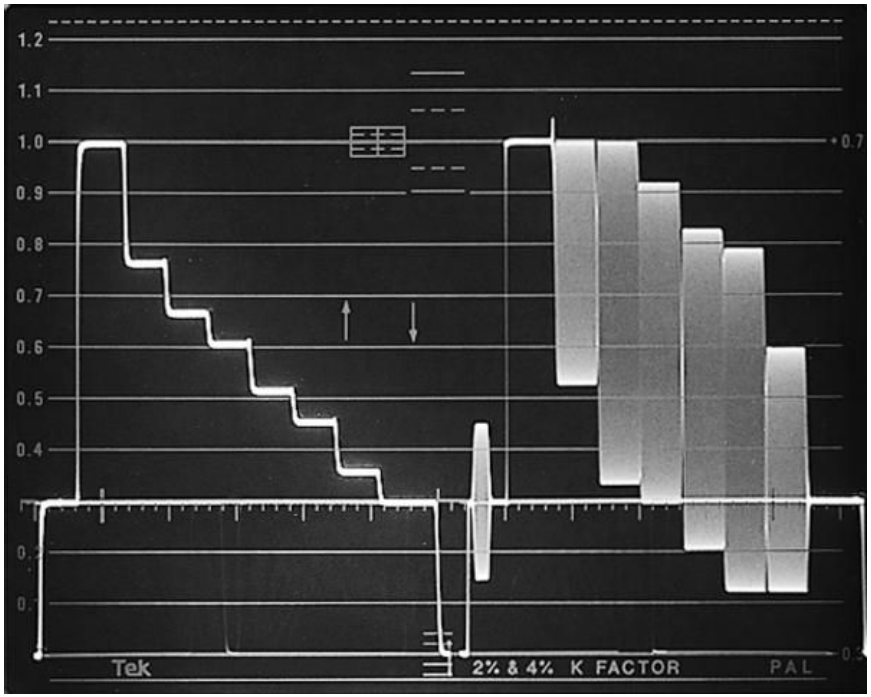
Television Measurements

Analogue levels – composite colour Bars – the classic test signal; 75%, vectors & LF/HF





Remember – the PAL V-axis switch

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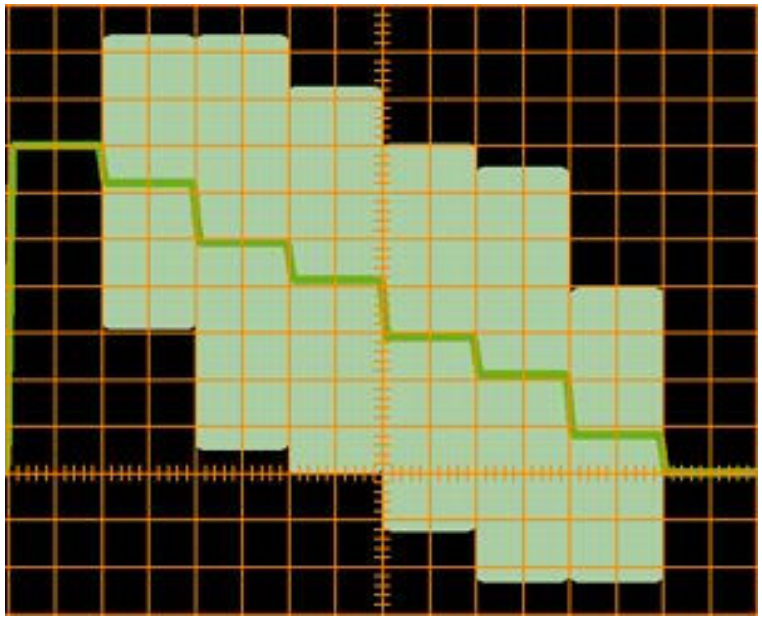
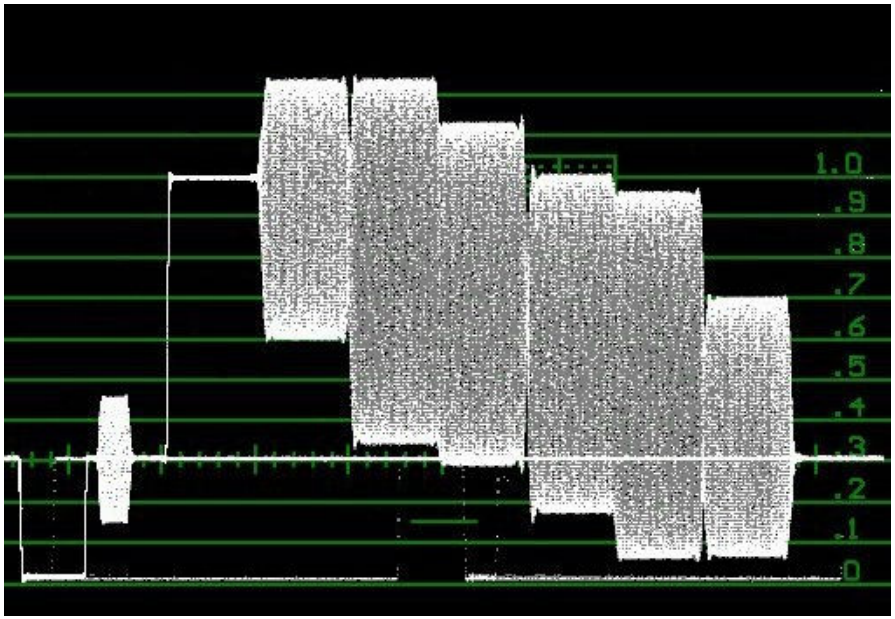
Television Measurements

Analogue levels – composite colour Bars – 100% bars; not so common.





Note; green bar still just touches the black level but the yellow, cyan and green bars extend above 1v – can be a problem.

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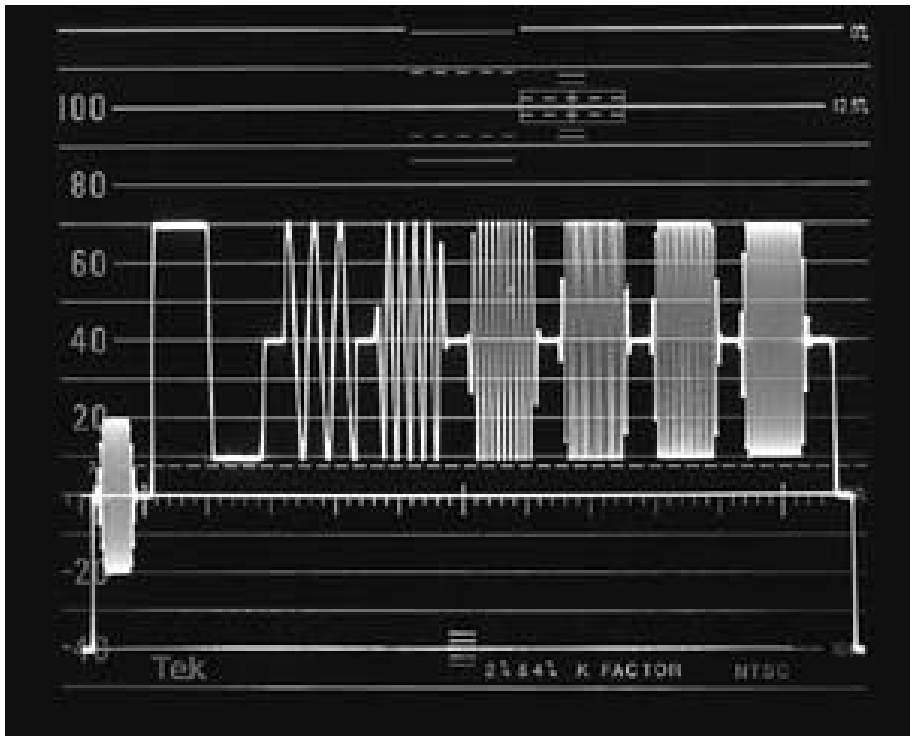
Analogue measurements for gain inequality across frequencies

Our analogue signal requires a 'flat' response from low frequency (field-rate of 50hz) to high frequency (5.5Mhz).



The ***multi-burst*** signal has parts at;

- Low-frequency bar
- 500Khz
- 1.0Mhz
- 2.0Mhz
- 3.0Mhz
- 4.0Mhz
- 5.0Mhz
- Colour subcarrier sits at 4.43Mhz in PAL

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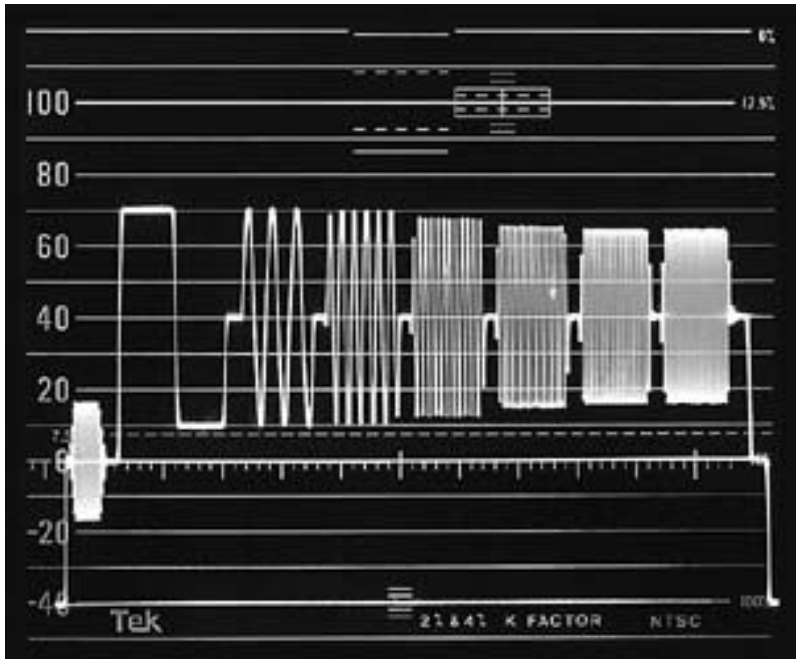
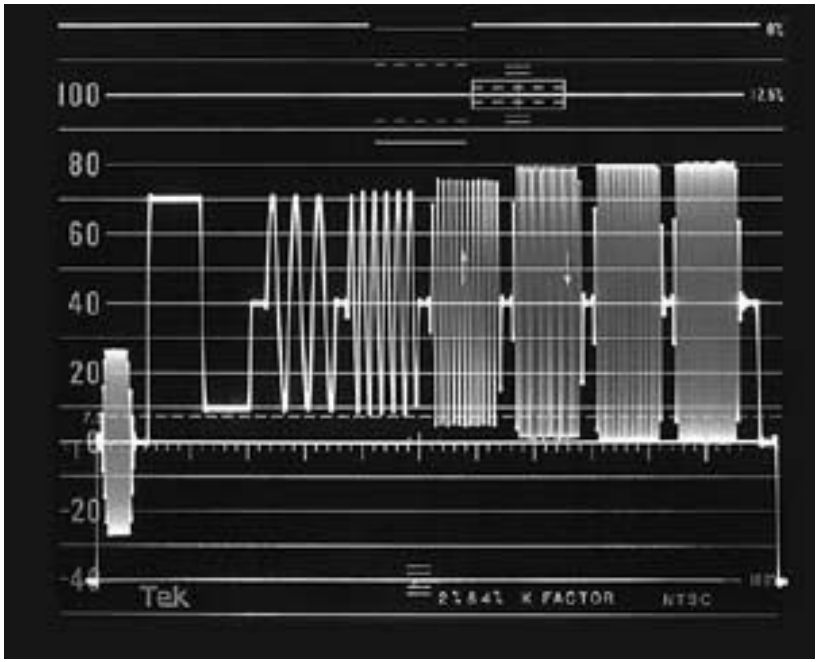
Analogue measurements for gain inequality across frequencies





HF gain inequality – signal loss at high frequency & signal boost at high frequency

note: both are fine at low frequency; what effect would these troubles have on pictures?

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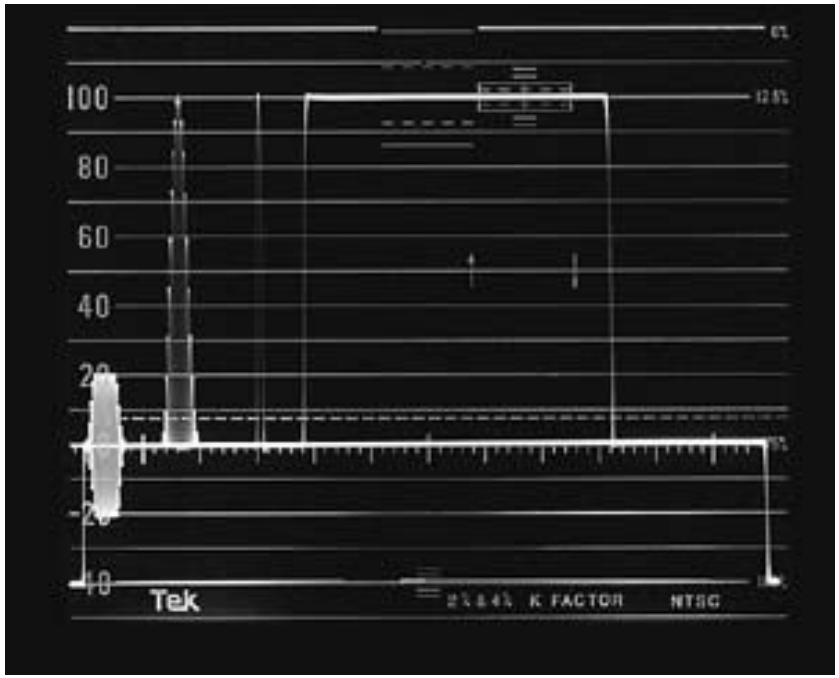
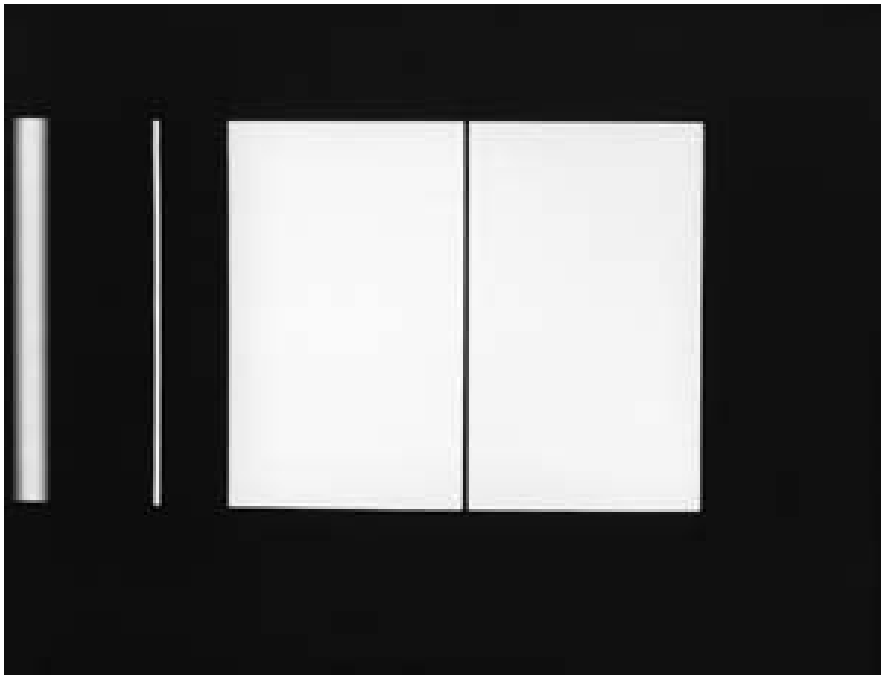
Pulse and bar – testing low frequency and delay-inequality





The pulse is a short amount of colour sub-carrier which has been shaped so that it just fits into a 5.5Mhz signal. The bar is low frequency which is useful for field-rate tests.

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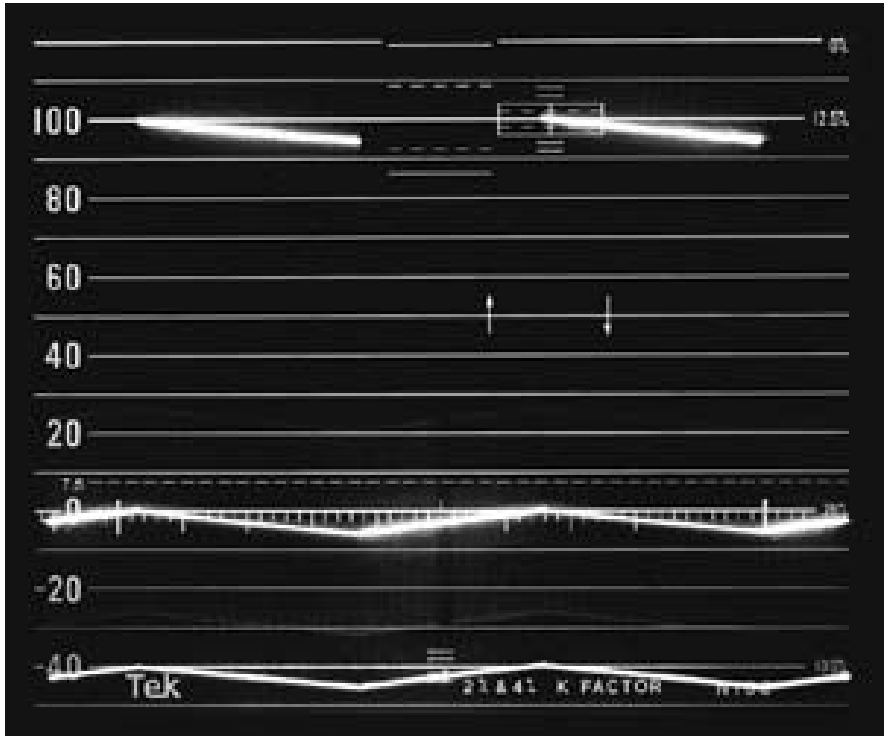
Pulse and bar – testing low frequency



- In this case we have switched the waveform monitor to 'field mode'
- We're not seeing 64µs video lines, rather two 20ms video fields
- The low-frequency response is poor because of the slope
- On pictures this would look like the bar getting dimmer as it goes down the screen

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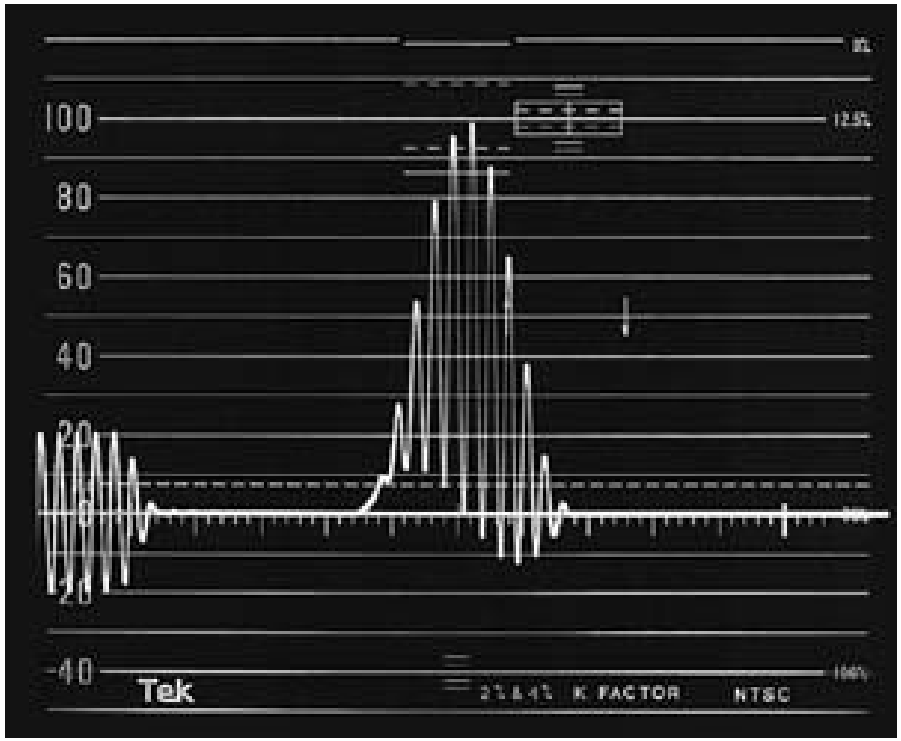
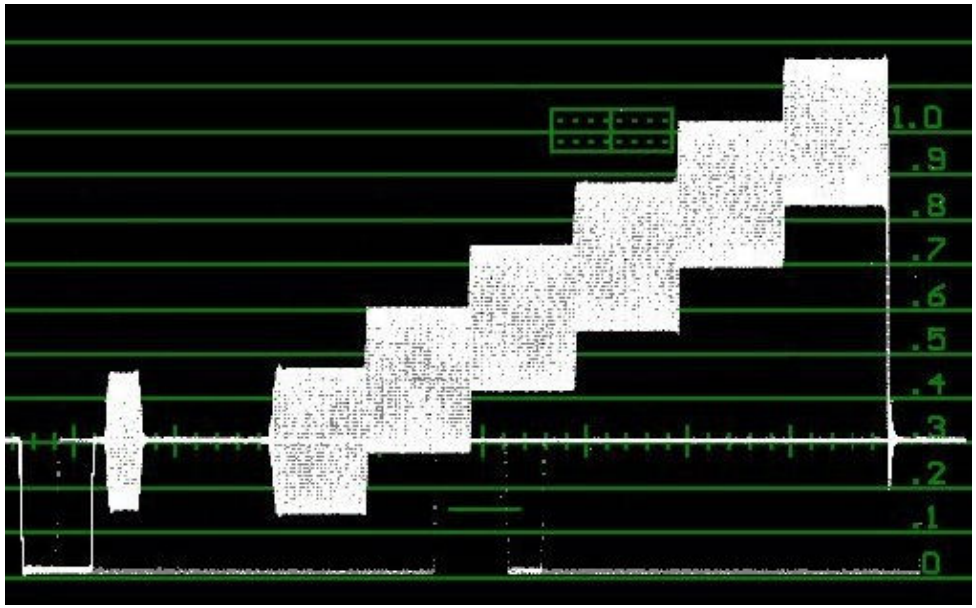
Pulse and bar – delay-inequality



- Back to line rate and zoom'ed in on the pulse part of the line;
- The sine-wave effect shows there is a delay between the luminance and the chrominance
- On pictures this shows itself as the colours in the image being de-registered.
- To correct for this effect you have to go back to the VTR (or whatever was sending the pictures) and adjust Y-C delay

Chroma-luma gain inequality



We are trying to make sure that both the luminance and chrominance are faithfully preserved. We don't want there to by any interaction (i.e. as the luma goes up it effects the chroma or vice versa).

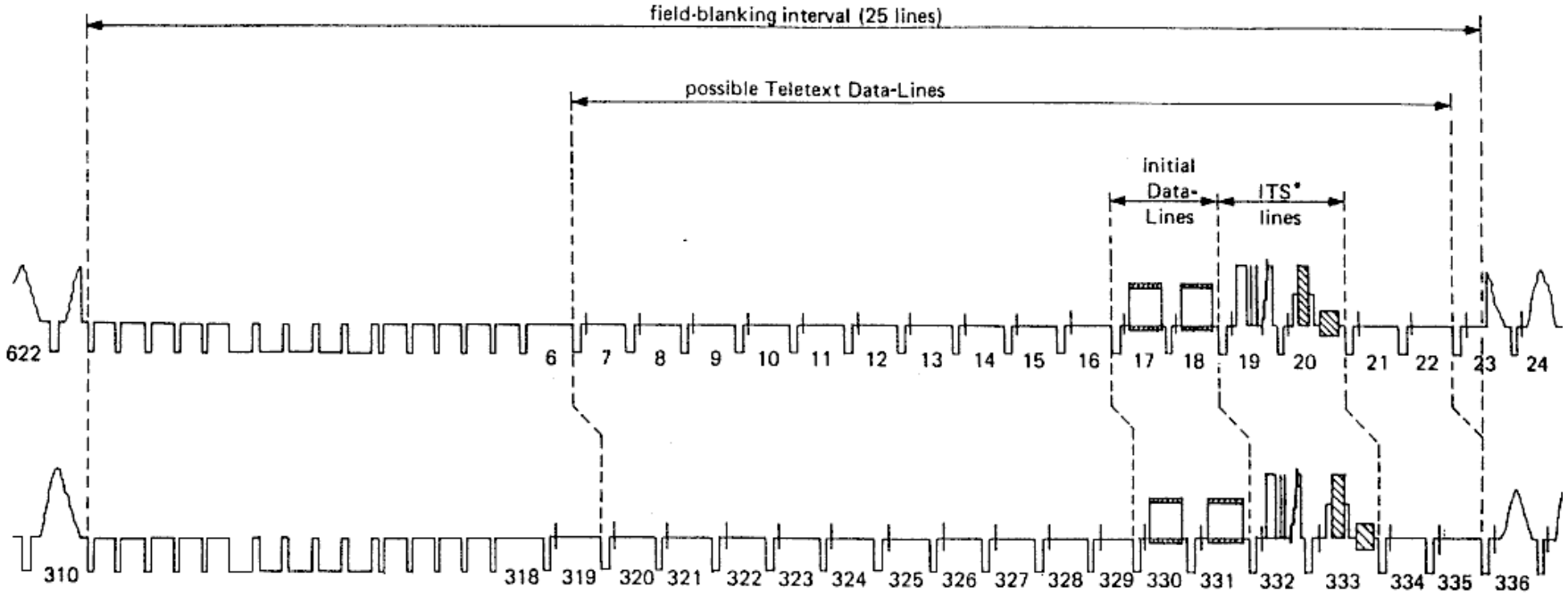
The modulated-step waveform has the same amount of chroma applied to equally changing luma steps.

Using the cursor feature you can measure the relative size of the chroma content on each step.

Effects on pictures

Low-end of the signal faithfully reproduced from 0v upwards	Black level depends on 0v and the picture will sit-up or sit-down if this is wrong
High-end of the signal faithfully reproduced up to 1.0v	White level depends on 1v and if this is wrong bright parts of the picture will suffer
Relative differences in signal are faithfully reproduced	If the steps get bigger then the gamma of the picture will be wrong
The 4.43Mhz colour subcarrier level is faithfully reproduced	The level of CSC determines the saturation of the colour content
There is no delay-inequality between the luma and chroma parts of the signal	If the colour is delayed relative to the luma then the picture will be 'de-registered'
There is no gain-inequality between the luma and chroma parts of the signal	This will show itself as darker parts of the picture having different colour saturation to lighter parts.
The signal level is faithfully reproduced from low frequency all the way to 5.5Mhz	If the frequency response is not 'flat' then detail will suffer or be overly exaggerated.

Insertion Test Signals



Sometimes measurements need to be made on live signals and so in this case a single line of test signal can be inserted (into lines 19 & 20 in this case). We'll look at home the Tektronix allows you to 'select out' a line rather than seeing the whole field.

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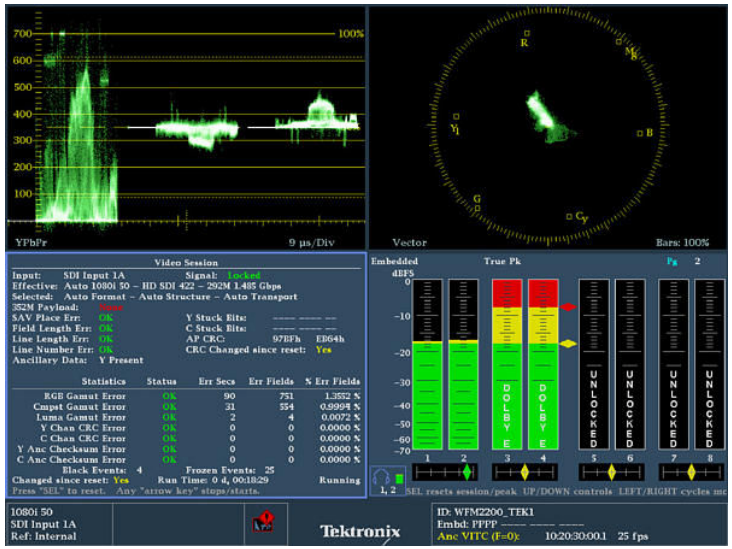
Digital measurements

- In the case of analogue video the physical-layer (the electrical signal travelling down the video coaxial cable) directly corresponds to what's happening in the picture
- In the case of SDi digital video the physical layer is merely carrying digital bits – they represent the picture
- Now we have to consider the pictures (and embedded audio) separately from the physical layer measurements.
- The Tektronix WVR / WFM test sets allow this

EDH (error detection and handling)

SMPTE RP165 is a standard for detecting errors in the digital data stream. Sending equipment inserts EDH packets into the video stream; the formula for calculating this CRC (Cyclic Redundancy Check) is defined and the receiving test set re-calculates this and compares it to the provided CRC.



To measure a serial digital link, the source must insert EDH information. Serial repeaters or processing equipment between the source and the destination receiver must pass ancillary data on the lines where the EDH is inserted. For 525 line standards, EDH data is on lines 9 and 272 and, for 625 line standards, on lines 5 and 318.

We'll go over it on the Tektronix, but in this screen-cap the CRC measurements are in the ***Video Session*** tile (bottom left).

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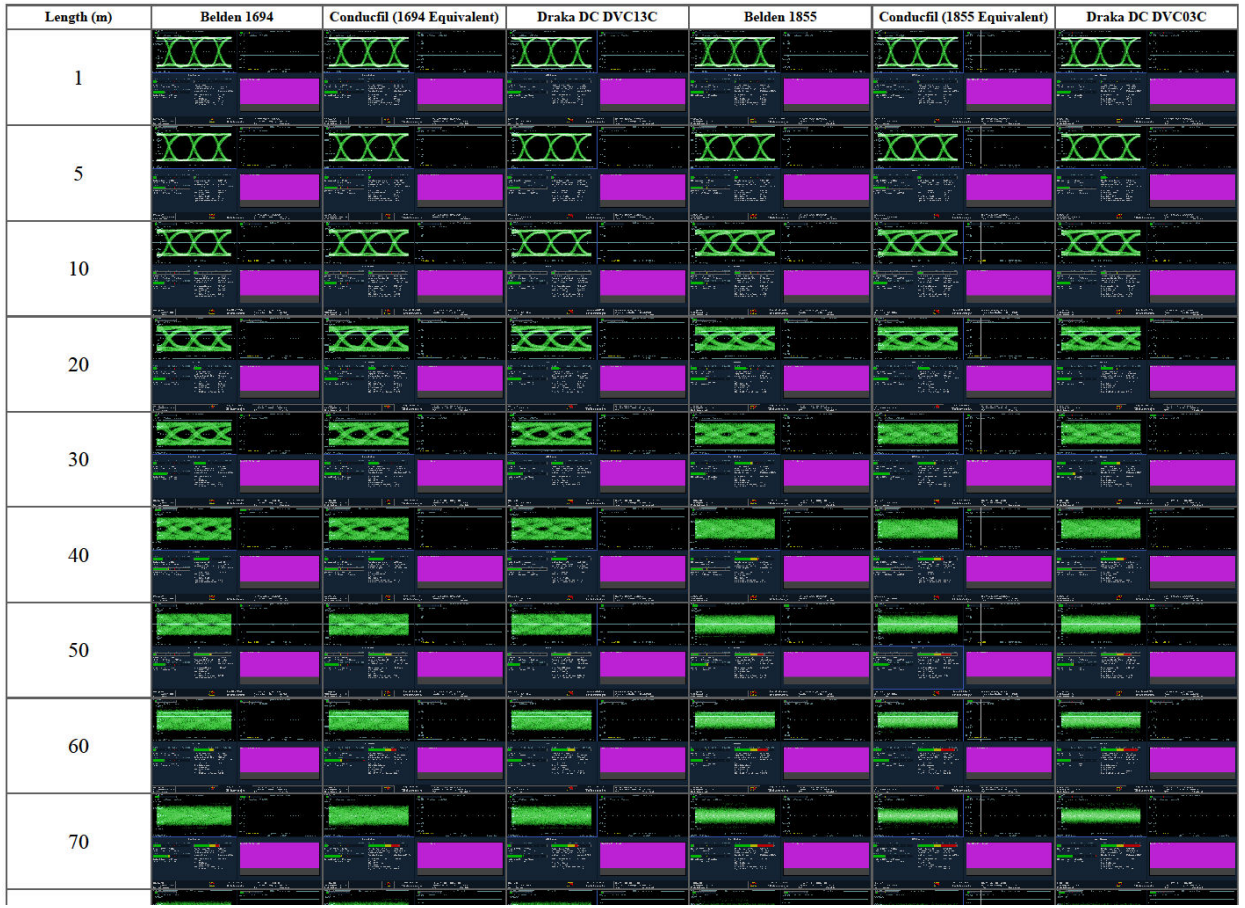
Practical demonstrations of typical test equipment which include:

Analogue: Tektronix WVR611 (MET equipment)

Digital: Tektronix WFM7120 and WVR611



Video displays of the WVR/WFM-series

There are several displays that allow you to monitor the state of the video signal – since these can be tile'd in a group of four you can keep an eye on multiple parameters;

- Waveform display – Component parade
- Waveform display – RGB parade
- Waveform display – simulated composite display

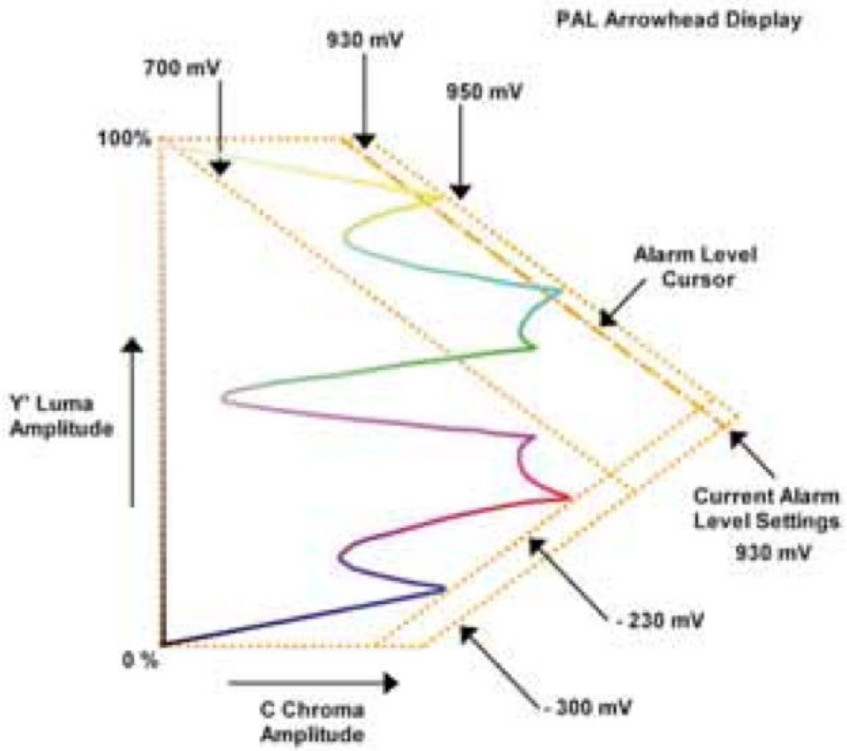
The waveforms are normally displayed as one or two television lines overlaid so that you see a whole frame of video but sliced into "2H" or "1H" – you can also overlay one or two video fields – "1V" or "2V"

Since the colour (or "chroma") portion of the signal is often troublesome the Tek has several display modes;

- Vectorscope – the traditional colour component display
- Arrowhead display – combines luminance and chrominance levels into a single gamut display
- Diamond display – shows the two colour difference signals in their own diamonds – useful for colourists and studio engineers.

We'll spend a while looking at these on the machine – they are also shown in the Tek poster.

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!

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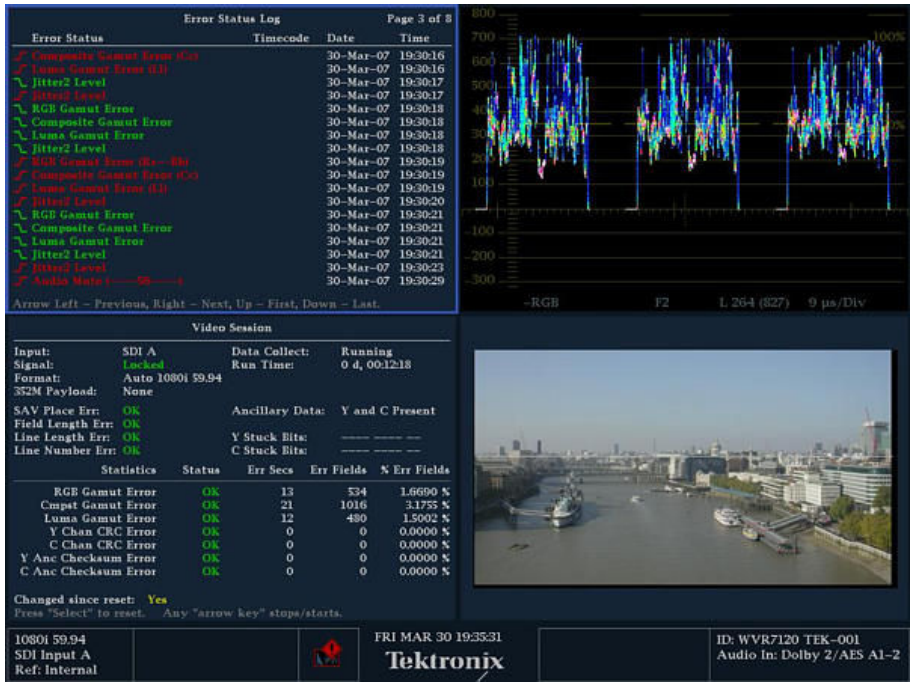
Status displays of the WVR/WFM-series

The real power of a rasterising test set is in that it can detect lots of things about the incoming signal – not only over and under-levels but loss of signal, bad standards, and even extended periods of audio silence (very useful if the device is across a transmission feed).



In this example the two left tiles are showing the QC log as it has entries written into it (upper) and the video status page – this shows more about the state of the video signal and as errors occur (as defined in the template) they are written into the log.

As errors happen then can cause one/many of several things to happen;

- Entry in the log
- The 'red diamond' alert on screen
- GPI (via D-type connector on the back)
- SNMP trap (network alert – email, SMS)

Each can be uniquely useful.

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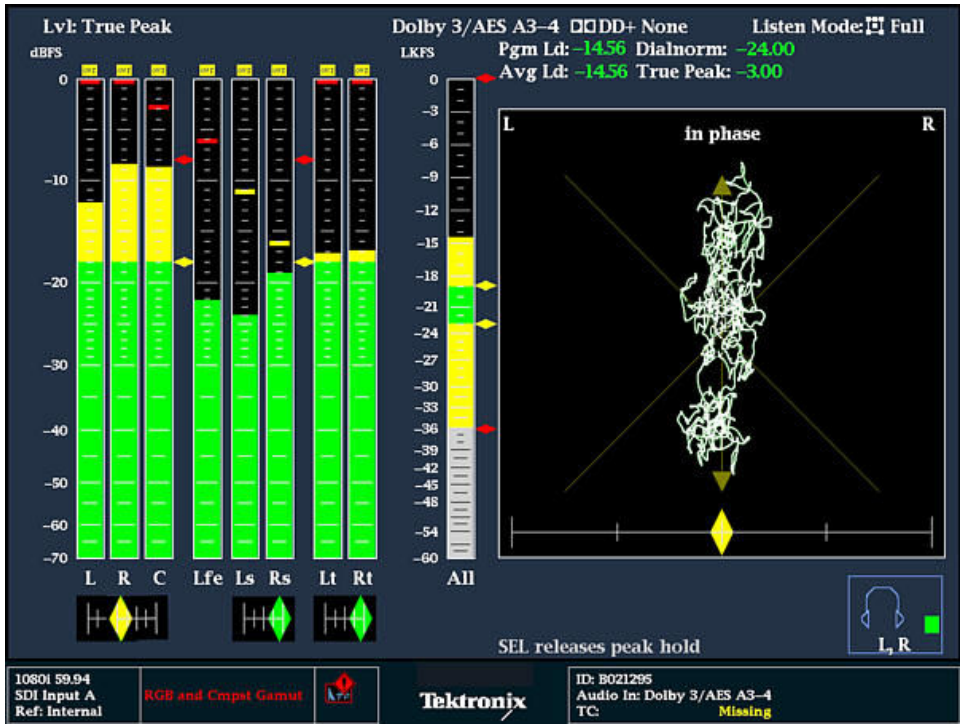
Audio displays of the WVR/WFM-series

The audio display differ slightly in that there is only one that can be assigned to the 4-way tile display.



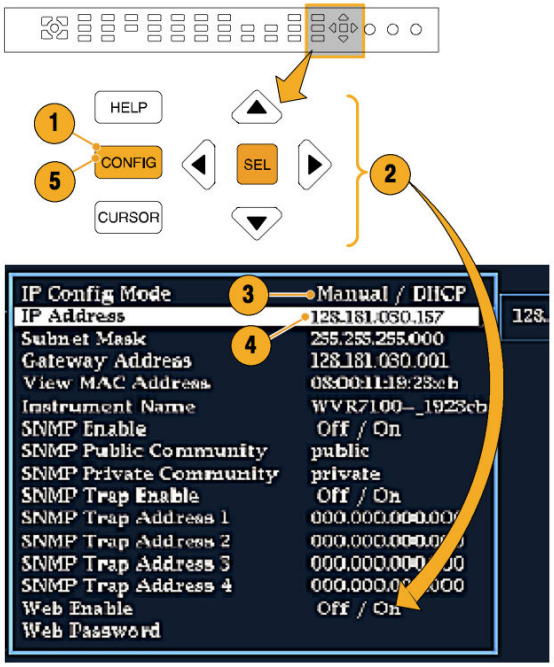
The bar-graphs on the left differ from the bar-displays on a VTR in that they can have digital or PPM-type scales. This image shows the digital level in dBfs. In this case the audio is Dolby-D encoded and the machine is deriving the six surround channels and making a pair of stereo bars for reference. 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.

Complete run-through of the network QC features of the WVR/WFM-series

Automated QC starts with the network connector on the back of the device. Once connected to the network it can be controlled and all logs (both system error and session QC) can be downloaded (via a web browser) to a computer.



Once you have the instrument physically attached to the network you need to set it up for TCP/IP communication – you may need to get these details from your in-house IT team.

Once your PC and the Tek are on the same sub-net then you can use a web-browser (Firefox, Internet Explorer etc.) to take control.
From the browser you can download either the error log or the QC log but if you have Java installed (at least v. 1.4) you can download and run an applet that allows you to not only control all aspects of the machine but you can even see the display (delayed by a couple of seconds and not particularly real-time). If you can persuade IT you can even open a hole in your firewall and do this from home! I've been saved several 3:00am dashes because of this!

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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.

Parameter sets and building/maintaining presets for WVRs

A good starting point for building broadcaster-specific templates is the built-in EBU103 standard. This is the video-standard that most UK-based television has to conform to. Additionally it's a lot easier to set up a preset template over the Java interface rather than poking the left-down keys on the front of the Tek.

The five present buttons on the front act to recall a preset when pressed momentarily, but if you hold in the button for three seconds that preset records the entire state of the machine. So, get the instrument exactly as you want it – what displays are in the four tiles, what parameters are being monitored etc and then store it away. You can download and upload preset templates over the web interface or via a USB stick on the WFM-version.