LEADER
TELEPRODUCTION TEST
VOLUME 3 NUMBER 1

# OPERATIONS ALERT: WATCH THOSE CHROMA LEVELS IN MIXED ANALOG-DIGITAL FACILITIES

Some confusion and outright program material rejection has occurred as the result of applying chroma-level adjustments that have become SOP in the familiar analog-component environment to signals that are processed in the digital-component world. There are significant differences in the scaling factors applied to B-Y and R-Y in analog-systems such as Betacam and MII and the corresponding factors applied in digital components.

A look at the output signals of a digital Betacam deck makes the differences evident. Figure 1 shows how E-E analog output looks on the parade waveform using Y/B-Y/R-Y SMPTE (**75%**) color bars as the input signal. Note that the full p-p swing of both color-difference components spans 100 IRE (700 mV). This is because Sony chose to use the full available gamut for the chroma signals of **75% color bars**. Makes sense. But a look at the decoded digital output from the same deck, operated under the same conditions, tells a different story. See Figure 2. For digital components 75% means 75%. Hence the p-p swing for B-Y and R-Y (called Cb and Cr in the digital world) spans 75 IRE or 525 mV. You can guess at the disaster that might result from adjusting digital processors so that Cb and Cr fit the familiar 100 IRE span. Material will be rejected because chroma is way too hot!

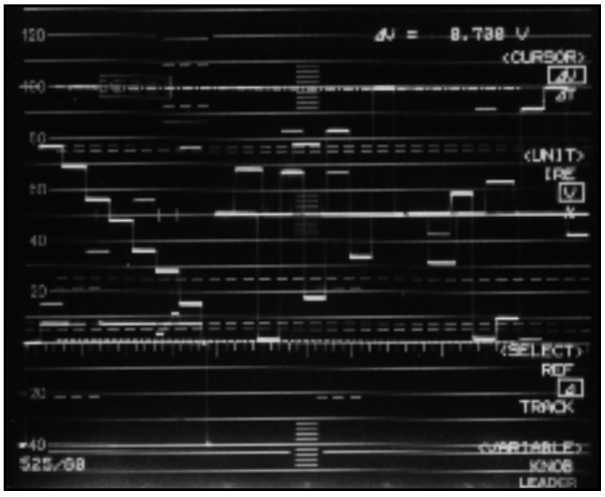


**Figure 1. Analog Betacam 75% SMPTE bars show B-Y and R-Y spanning 100 IRE.**

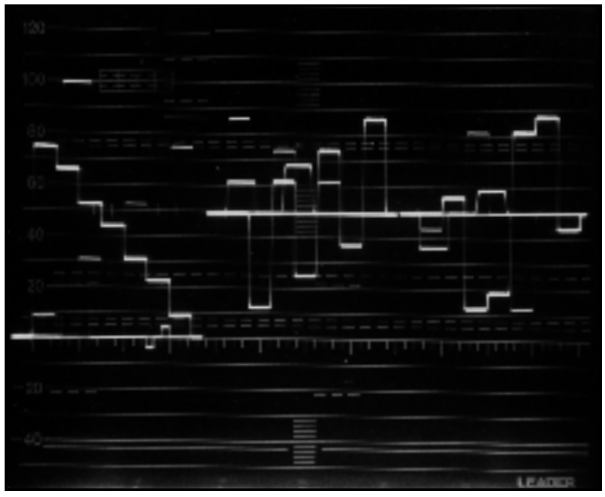


**Figure 2. Digital components for SMPTE bars show Cb and Cr spanning 75 IRE.**



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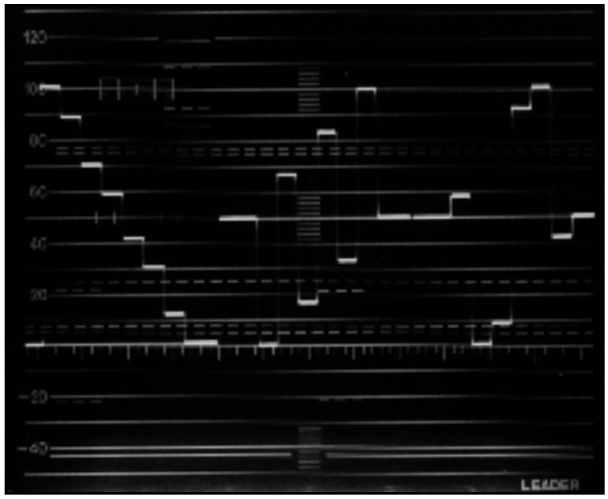

**Figure 3. Digital components for 100% color bars show Cb and Cr scaled to fit 100 IRE.**

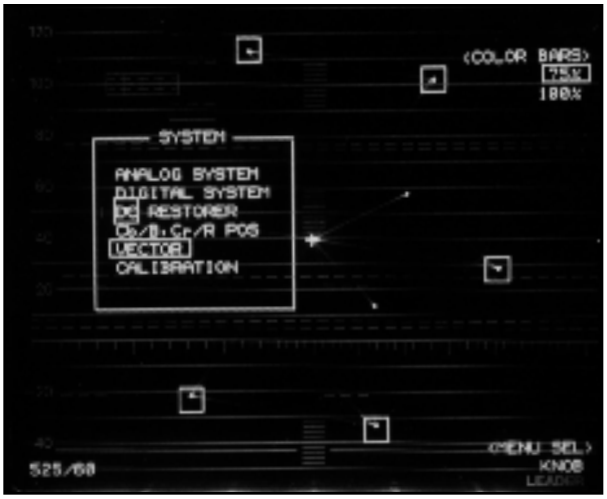


**Figure 4. Vector display set for 75% bars shows correct chroma levels.**

### What Happened to Setup?

A look at the Y signals in Figures 1 and 2 reveals another change that might take some getting used to. The analog Y shows the ± 4 IRE Pluge signal of SMPTE bars sitting on the familiar 7.5% pedestal. But the decoded digital components shown in Figure 2 puts Pluge at the blanking level — no setup. There is no provision for setup in the digital standards. Is zero setup in digital signals universally applied??? Time will tell. Setup also affects the amplitude of the chroma signals. Remove setup and the available dynamic range and chroma amplitude grows. (Vectorscopes for use in the U.S. are calibrated for signals with setup.) That 75% or 525 mV span for chroma signals in the digital domain is correct for signals without setup.

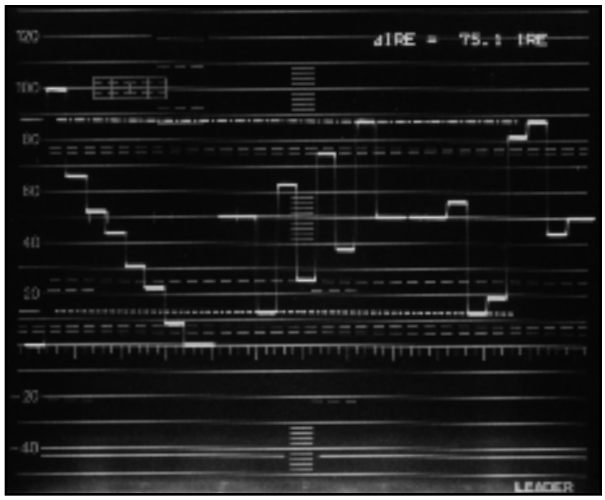

**Figure 5. Using preset cursors as the Cb and Cr graticule for 75% bars.**

### How to Check 75% (525 mV) Levels

Waveform monitors designed for SDI work are set up to monitor 100% color bars. This is shown in Figure 3. Note that here the Cb and Cr signals span the full 100 IRE and the graticule scale makes this easy. But the Cb/Cr swings for 75% color bars are not quite so easy as graticule marks spanning this swing on the 50% chroma pedestal are not provided (on any SDI waveform monitor.) Look again at Figure 2. But 75% color bars are standard in both composite and analog component operations. And A/D conversions are going to make them show up in the digital world. So a way has to be found to easily gauge the correct signal span for 75% bars in digital signals.

One easy way to check 75% levels is to set up the monitor to show the component vector display with calibration chosen for 75% bars. See Figure 4. The lightning display available on Tek waveform monitors also applies and it adds a check of luminance values. But if you prefer to check levels using the Y/Cb/Cr waveforms in the parade display, there are a couple of options. One is to preset level cursors to 75 IRE or 525 mV as shown in Figure 5. This yields a built-in gauge. The entire setup including the cursors and cursor centering can be stored as one of the 10 presets available for the monitor (Leader Model LV 5100D.)

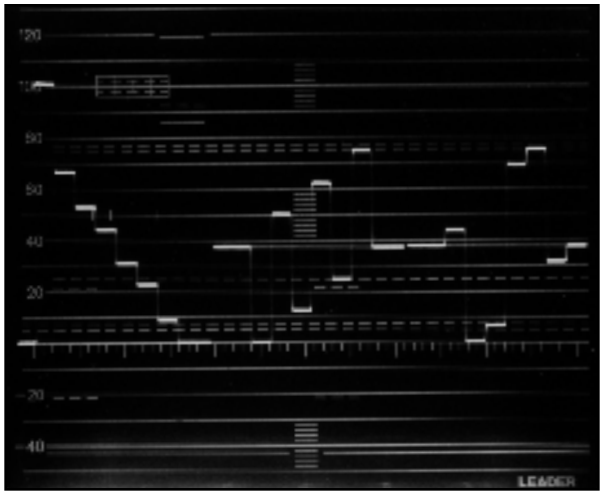

**Figure 6. To use the standard graticule, reset position for Cb and Cr to form a 37.5 IRE pedestal.**

The second option is to alter the pedestal on which the chroma signals ride so that the signal span can be read against regular IRE scale. See Figure 6. Here 75% color bars from a digital-component generator have been applied and centering for Cb and Cr set so that the signals span from the blanking level to the 75% mark. (There is a horizontal dashed graticule mark at 75% and another at 77%.) Once again the setup shown may be stored as one of the available presets. What you have done is reset the pedestal on which the chroma signals ride from the normal 50% to a new 37½%. This allows the amplitude of the chroma signals to be gauged against the graticule marks of zero (the blanking level with the time ticks) and the lower dashed line at 75%.

**Chroma Scale Factors: Some Background**

Color difference signals have always been squashed (scaled down) to fit available signal gamuts. The reason is obvious if you look at the construction of Y, B-Y, R-Y and G-Y from RGB signals for 100% color bars. See Figure 7. Here the Y signal is built from the basic recipe Y = 30% R + 59%G + 11%B. Hence Y for yellow becomes 30 R + 59 G and zero B to become 89% (or 89 IRE.) Take a second to work out Y for the rest of the bars as shown. Now look at B-Y. For yellow B-Y is zero - 89 or -89. For blue B-Y is 100- 11 = + 89. This makes the p-p swing for B-Y 178 IRE! Going through the numbers for R-Y

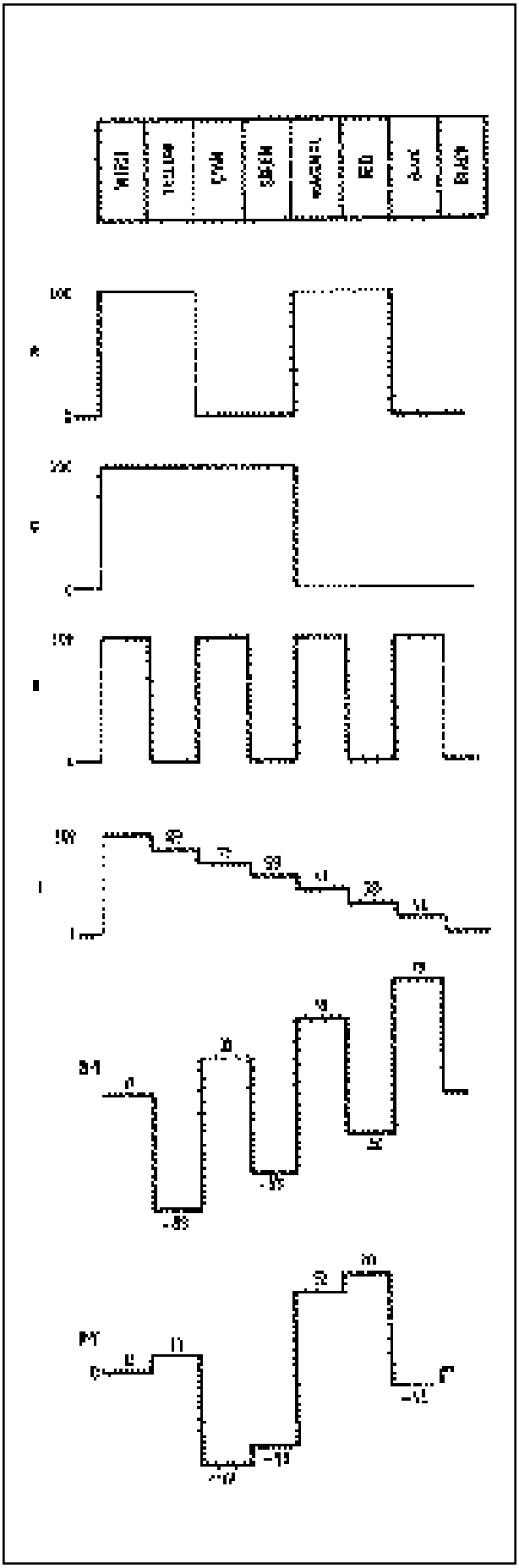

**Figure 7. Construction of Y B-Y R-Y from 100% RGB. (No setup.)**

yields a p-p swing of 140 IRE. Clearly both have to be knocked down to fit the normal 100 IRE gamut and B-Y needs the larger hit.

For composite video, the picture is complicated by trigonometry of the 90° B-Y R-Y modulation axes. But the scaling factors have been worked out so that Y + subcarrier excursions fit within 133 IRE for 100% color bars (allowing a 33% excess.) the scale factors are 0.492 for B-Y and 0.877 for R-Y. (In the decoder B-Y and R-Y are multiplied by the inverse of these factors (2.03 and 1.14) to restore them to correct relative values.) Of course, 100% color bars are seldom seen and 75% bars are the operating norm. And the numbers work out just great for 75% bars Y + C just fit 100 IRE. Incidentally, 75% bars mean that you start out with RGB at 75%. The percentage does not refer to saturation; all color bars are 100% saturated.

As mentioned earlier, the chroma components for analog Betacam are scaled to fit 100% or 700 mV p-p for 75% color bars with setup. Matsushita's MII takes a course that is closer to the digital standards. That is the p-p swing for the chroma signals of 100% color bars is 92.5% (what you get when the 7.5% set aside for setup is subtracted from 100%.) In volts, this is 92.5% of 700 mV or 628 mV p-p. For 75% color bars, the p-p signal span is 92.5% x 75% or 69.4% which translates to 486 mV p-p.

Scale factors for digital components are straightforward since setup is left out. Here Cb and CR are scaled to fit 100% for 100% color bars. We saw earlier that B-Y is 178% p-p for 100% color bars (without setup.) The number is 177.2% if the basic recipe for Y is taken to three decimal places. (Y=29.9%R + 58.7%G + 11/4%B.) This makes the scale factor for Cb 100/177.2 = 0.564. A similar calculation for the Cr scale factor results in 0.713.

**A Word About the Waveform Monitor**

The waveform/vector photographs used in this issue were taken from the screen of Leader's Model LV 5100D. This instrument is unique in that it handles both digital and analog components. In addition, a high degree of flexibility is afforded in both operations. Menus are provided for analog and digital system setups with such operation options as the selection of 700 mV or 714 mV for 100% in analog work and EAV/SAV pass/remove for digital observations. Presets, 10 of them, are particularly useful as they store practically all settings including the use of cursors, position adjustments and special functions such as line select. And the presets may be labeled by the operator to aid in recall.
For full technical details on the LV 5100D ask for the four-page bulletin entitled "Digital/Analog Component Waveform Monitor LV 5100D."

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