# TELEPRODUCTION TEST

VOLUME 1 NUMBER 6


## A PRIMER IN THE USE OF VECTORSCOPES PART 3

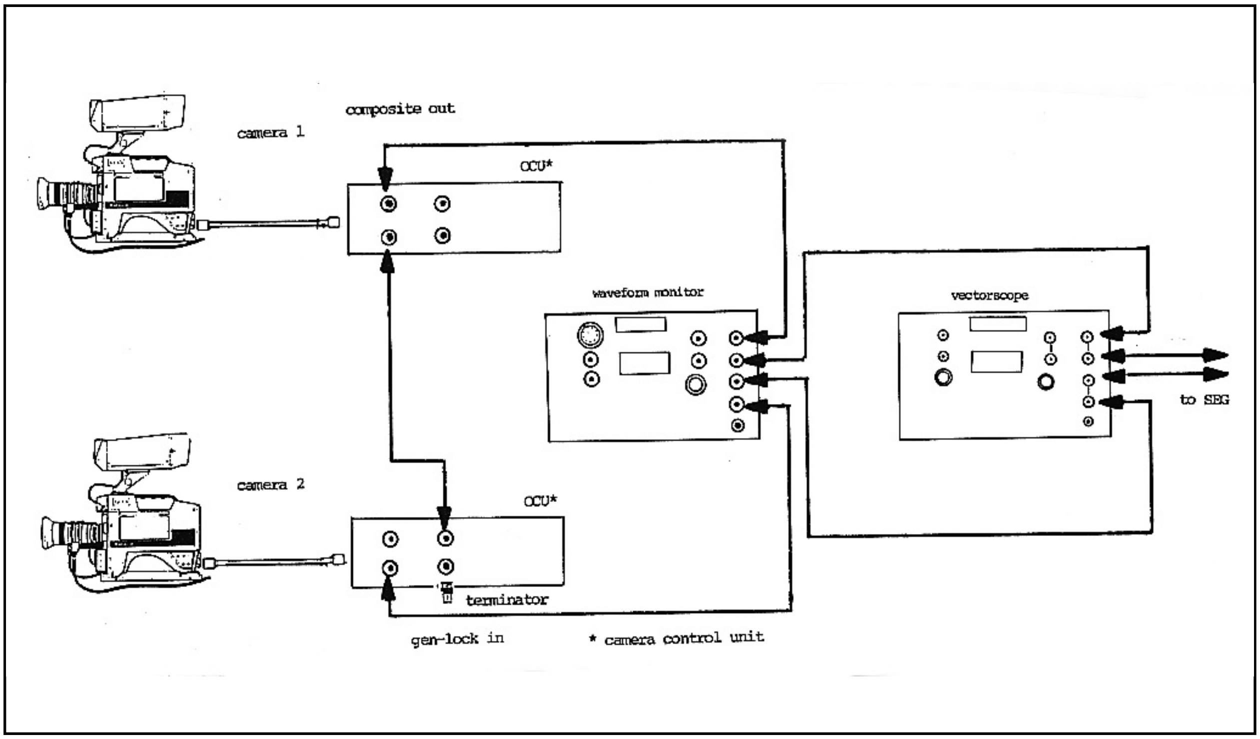


**Figure 6-1. Genlock hookup for a simple two camera setup.**

This installment winds up coverage of basic vectorscope operations with system phasing adjustments, differential gain and phase checks and live camera vectorscope uses.

### System Phasing

Video signals from two or more sources must match in terms of subcarrier phase at the point where the signals are brought together at the input to an SEG or switcher. This means that each source, camera or VCR/TBC combination must lock to a master source of sync and subcarrier and each source must be adjustable in terms of subcarrier phase and sync timing so that wipes, lap dissolves, switching and other special effects can be made between the connected sources. Smooth transitions from one source top another dictate line and field synchronism as well matched subcarrier phase.

Several factors affect the subcarrier phase of a genlocked source such as a camera. Connecting cables, both the genlock sync feed to the camera and the return composite video cable, introduce a phase shift depending upon cable length. Coax introduces about 20° of subcarrier phase shift (15 1/2 ns of delay) for each 10 feet of cable. Then too, there is a phase delay introduced by the genlocked source itself. And finally, the video cable to the SEG or switcher. This means that phasing adjustments must be completed after all system connections have been made and must be rechecked if any changes are made to cable lengths.

System phasing adjustments are often made visually using a picture monitor. The usual procedure is to set up a vertical wipe with reference full-field color bars from the sync gen or internal bars from the SEG in the lower half and the source to be adjusted in the top half. It's then just a case of matching color bars visually, in terms of hue, from top to bottom. But the

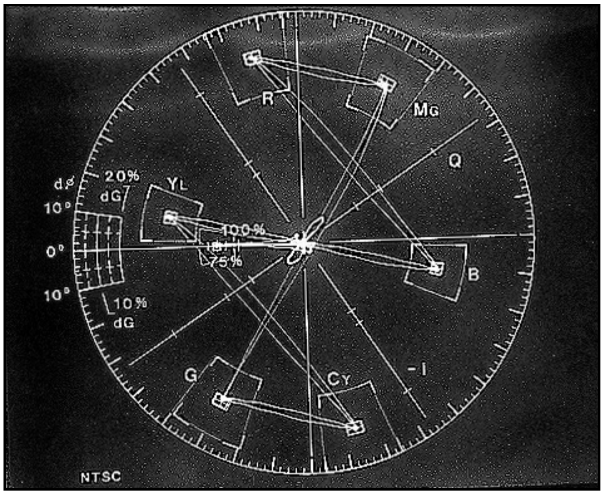


**Figure 6-2. Correct vector display puts burst at 9 o'clock.**

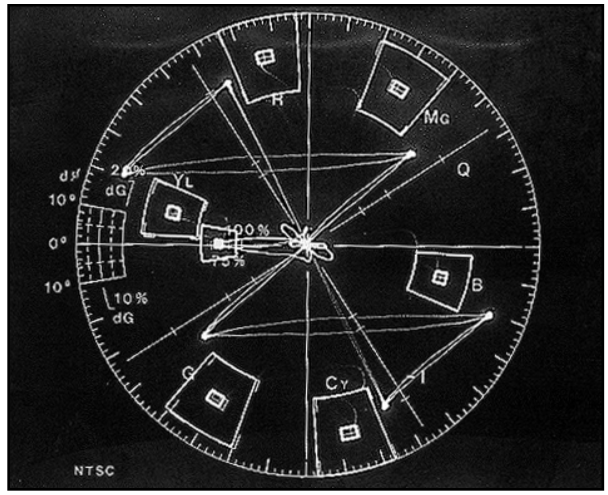


**Figure 6-3. Incorrect phase of SEG output. Note that burst is positioned incorrectly.**

vectorscope removes the vagaries of color vision and the condition of the picture monitor and facilitates much more precise alignment.

The basic setup requires each genlocked source to be compared with the system master sync generator. the latter may be a test/sync generator, a sync generator built into the SEG, or in very simple systems, a camera that is simply designated as the "master".

Figure 1 shows a very simple two camera setup in which camera 1 acts as the sync source for the system; camera 2 is genlocked to the composite video output of camera 1.

If all internal time/phase delays of the cameras were fixed, the signal produced by camera 2 would be late by the delay introduced by the cable that connects the composite output jack of camera 1 with genlock input jack of camera 2. And the delays are predictable — approximately 1 ns or 1° phase shift at 3.58 MHz for each 6 inches of cable length. Fortunately, the genlocked camera has adjustments for both H sync delay and subcarrier phase. Typical adjustment ranges are ±2 µs for H delay and 360° in phase, enough for a system that isn't spread over too much real estate.

The object is to match phase at the input jacks of the SEG or switcher. Figure 1 shows a basic hookup for two cameras where the two signals are looped through the A and B inputs of the vectorscope on the way to the switcher. Cable lengths between the vectorscope and the switcher must be identical to preserve the match at the vectorscope jacks. The reference camera, #1 goes to the A input. To make the phase adjustments, input A is selected for vectorscope display and the A input is also selected for the vectorscope phase, Ø, reference. Both cameras are set for color bars.

To establish the phase reference, the front panel PHASE control is set for the normal vector display with burst at 9 o'clock. See Figure 1. Leave the vectorscope PHASE control as set from here on.

Next, select input B for display, the AØ pushbutton set in. If camera 2 is genlocked, its vector display

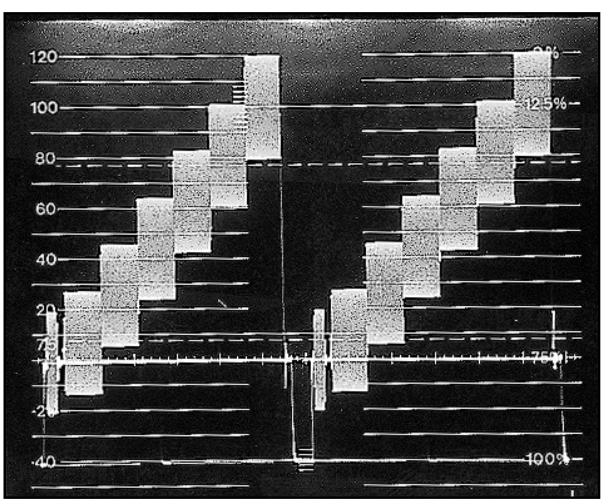


**Figure 6-4. Modulated staircase signal used to measure differential gain and phase.**

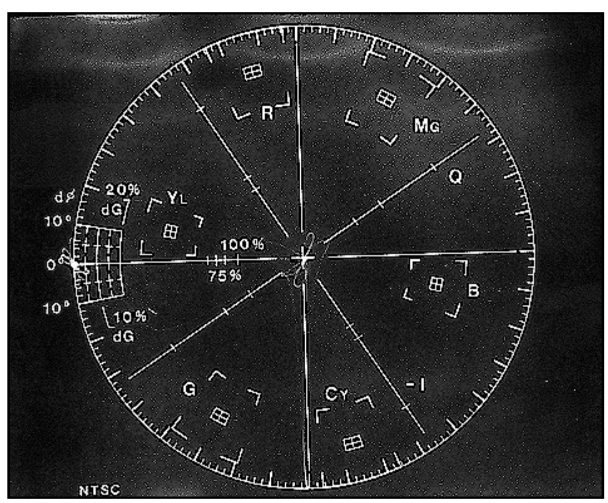


**Figure 6-5. Vector spots placed at 9 o'clock with GAIN set to put them on the large circle.**

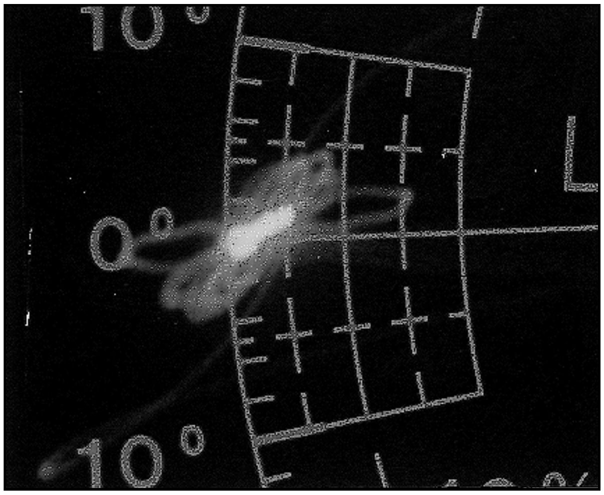


**Figure 6-6. Vector spots spread in both radii (distance from the origin) and phase angle due to differential gain and phase.**

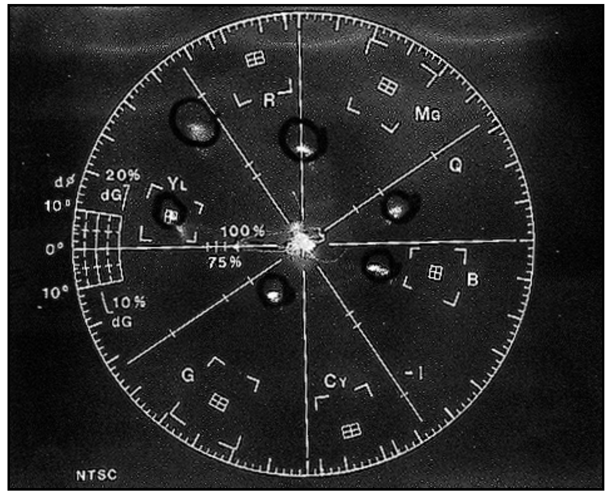


**Figure 6-7. Vectorscope marked to show vector position using a reflective, color bar test chart.**

will be stationary but probably wrong. (If the display spins, the camera is not locking.) Now, adjust genlock phase at camera 2 to swing the vector display into line with burst at 9 o'clock and the six colors in their respective targets as shown in Figure 2.

For large systems, the waveform monitor and vectorscope are usually connected to program and preview outputs of the SEG. Since all sources should undergo the same phase shift through the SEG, a match at the output is the same as a match for the input.

The phase reference in this case is a 3.58 MHz CW feed from the master sync generator. However, the general trend today is to use a black burst feed. SEGs often have internal sync generators and provide a number of black burst feeds for genlock purposes.

One of the vectorscope inputs (A or B) may be used as the phase reference. Simply select the sync gen feed (A or B) as the 0 reference from the appropriate front panel button. An alterative is to feed the phase reference to the EXT SUBCARRIER jacks on the rear panel and select EXT CW as the phase reference. To set reference phase, the sync generator color bar signal (or internal color bars from the SG) is punched up for display and the reference (A, B or EXT CW) selected as the phase reference. Vectorscope PHASE is then set for the correct vector display. Refer back to Figure 2, Next, each camera in the system is punched up on the program line and genlock phase for each is adjusted for the correct vector display.

The vector display acts differently at the output of an SEG or switcher, however. These components shape up sync and install new, reference burst into the output feeds from the reference input. This burst does not move when genlock adjustments are made at the genlocked cameras. But the six color vectors do. Thus, genlock phase adjustments are made to put the six colors into their respective targets. Figure 3 shows a typical mis-phased display. Note that burst is correct but all the colors are rotated CCW from the correct locations.

### Differential Phase and Gain

The vectorscope provides the means to evaluate the degree of phase and gain distortion that takes place when the subcarrier rides on different luminance levels. The signal used to evaluate dG and dØ is the modulated stairstep shown in Figure 4. This signal consists of five steps having equal luminance "risers".

Riding on each step are equal amplitudes of subcarrier (20 IRE p-p in Figure 4) and having the same phase on each step. Phase is usually the same as burst -(B-Y). Differential gain distortion expands or squashes subcarrier at one or more steps. Differential phase distortion causes a phase error at one or more steps, usually the top step.

If there is no differential gain or phase distortion, the vectorscope will show vector spots for each step at the same locations or one bright spot. To evaluate dG/dØ, PHASE is set to put those bright spots at 9 o'clock and GAIN is switched out of the calibrated detented setting to put the spot(s) on the outer circle on the display where the special dG/dØ scale is found. See Figure 5. This is right out of the generator and there is practically no error. Look only at the bright spots and ignore those faint loops. They show gain and phase gyrations at the step transitions (at the abrupt risers).

Figure 6 shows what a consumer-grade VCR does to the stairstep in the E-E mode. This includes only the video AGC processor in the VCR. But now there is both differential gain and phase distortion. Differential gain shows up as a spread in the radii of the spots. Differential phase shows up as a spread in phase angle (CW and CCW) from -(B-Y). Set GAIN to put the outermost spot on the large circle and evaluate differential gain using the scale at the 9 o'clock position on the graticule. Each major division is 5% (20%) overall. The spread in spot radii is about one major division or 5%. The spots also spread out in rotation but not much. Looks like a little more than 1 major division around the circle or 2°.

**Live Camera Vector Displays**

Consumer-grade cameras that do not have internal, electronic color bar generators cannot be evaluated using the standard graticule scale. Fully-saturated colors cannot be produced by cameras framed on reflective color bar charts or even the gel-type charts used in light boxes. The best approach, when using these, is to start with a camera of a given model that is known to be working to factory specs and to note the vector display under given lighting conditions by marking the graticule with a grease pencil or with a tracing paper overlay. Figure 7 shows an example of trial calibration marks for a reflective color bar chart made with a camera.

It is common practice given the locations of designated vector spots for consumer guide cameras using reflective charts in terms of vector angles and radius in relation to burst amplitude. For example, red may be given as 104° ± 10° and 1.5b. Here the vector should be 1.5 times the normal length of burst. In some cases, a plastic overlay is offered to be affixed to the vectorscope screen. The overlay shows correct vector locations and tolerances.

A typical example of vector specs for an industrial grade camera using a specified reflectance chart under controlled lighting conditions (3200°K, 1400 lux) is as follows:

| Color | Amplitude (Burst = 100%) | Phase |
|---|---|---|
| red | 233% ± 40% | 103 ± 2° |
| yellow | 194% ± 40% | 152 ± 2° |
| green | 162% ± 45% | 240 ± 7° |
| cyan | 326% ± 45% | 288 ± 7° |
| magenta | 186% ± 30% | 77 ± 7° |
| blue | 149% ± 25% | 339 ± 7° |

Usually these numbers are all that is given for a particular camera model. If this camera is serviced on a regular basis, the technician might want to make up a clear plastic overlay to fit on the screen of the vectorscope. Figure 6-8 shows how such a temporary overlay would look.

One thing is clear from these examples and should be stored in memory. The vectorscope's internal graticule is intended for use with *electronically-generated* color bars only. Signals from cameras aimed at light boxes or reflective charts require some extra work before they can be evaluated.

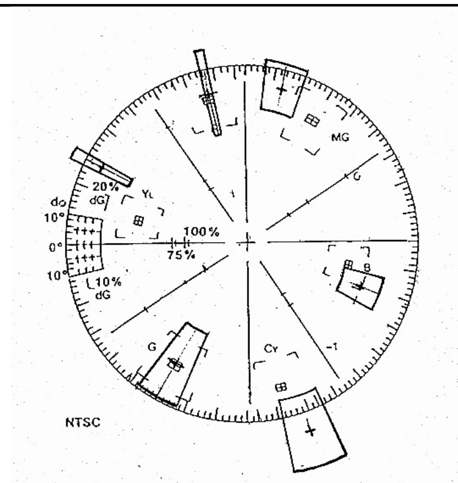


**Figure 6-8. Scratch-built overlay to handle specific camera model with reflective color charts.**