# LEADER TELEPRODUCTION TEST

VOLUME 2 NUMBER 2

## NTSC/PAL VECTORSCOPE

Leader's Model 5212 represents the new generation of vectorscopes. It is equally at home in NTSC and PAL operations, and this will give us an opportunity to compare monitoring aspects of both systems in this issue. Other operating features that will be covered include 3-channel operation, simplified, high-resolution measurements of differential gain and phase, precise inter-signal phase measurements, Y/C operation, and the use of the vectorscope in stereo monitoring. Other aspects include menu-selected calibration, the use of presets and remote control.

### 3-Channel Operation

Despite a multi-fold increase in operating functions, the front panel of the 5212 remains simple and familiar. Look at Figure 2-1. The INPUT selectors show a choice of three channels plus an EXTernal reference. The latter may raise a question because the sync REF key also refers to INT/EXT. So what's EXT doing in the INPUT group? The answer is that keying EXT in the INPUT group causes the burst of the external reference to appear on the vector display. This means that you can overlay one to three channels and also display the burst of the external reference at the same time. Figure 2-2

**Fig. 2-1** Front panel of Leader's NTSC/PAL 3-channel vectorscope, Model 5212.

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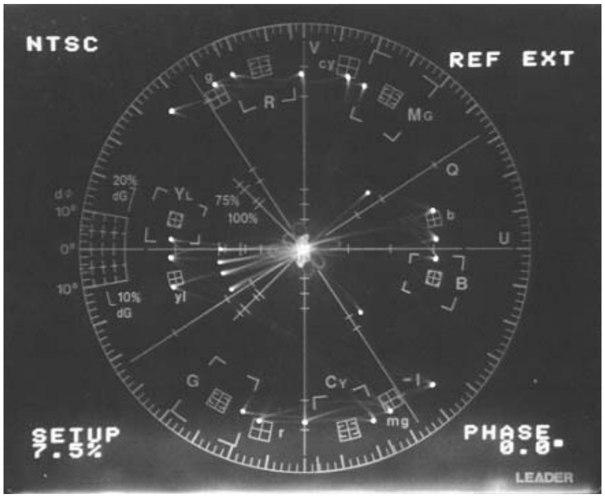

**Figure 2-2** Three-channel overlay with the burst of the external reference on the (B-Y) axis.

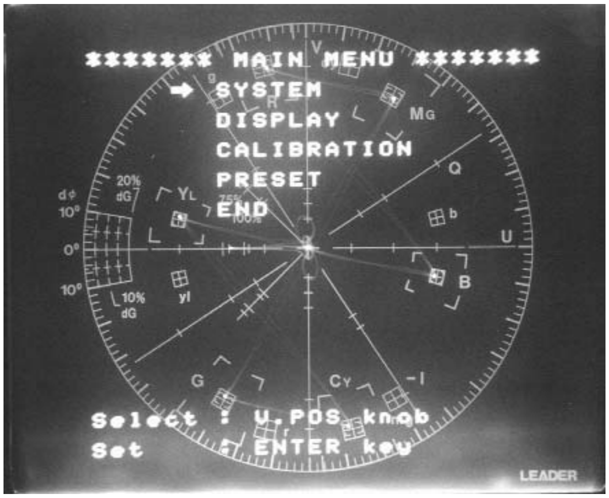

**Figure 2-3** Main menu called up by pressing the MENU key allows four choices.

shows an example of three channel overlay display using three genlocked sources. The display includes the burst vector of the external reference on the -(B-Y) axis at nine-o'clock. To make this photo the phases of the three genlocked sources were advanced about 10°, 20° and 30°. This is shown by the spread in the four burst vectors.

Correct genlock phase adjustments are easy when the signals are overlaid as shown in Figure 2-2. Subcarrier is adjusted at each genlocked source to overlay all burst signals at -(B-Y). If desired, each channel can be viewed alone with the chosen reference, CH1 and EXT, for example, to simplify the display.

The notice at the upper right of the screen shows that the selected synchronization reference is the EXT input. This selection is made with the REF key, and repeated touching causes the reference to step through INT CH1, CH2, CH3 and EXT.

## Auto Phase

Just as a waveform monitor display needs a proper vertical position adjustment (blanking put at zero IRE) before readings can be taken, the phase in the vectorscope must be set to place the burst signal on the -(B-Y) axis. A routine adjustment before the vector dots can be examined quantitatively. The new button on the front panel of the 5212 makes that routine job instantaneous. When AUTO PHASE is pressed, the burst signal for the selected phase reference is automatically placed on the -(B-Y) axis. At that instant, the phase readout at the lower right of the screen zeros to 0.0°. The PHASE/POS button must be lit for the phase reading to appear, and for the H POS/PHASE control to affect phase adjustment. Once the phase reading has been zeroed, the phase of any vector can be read with respect to the burst of the selected phase reference. More on this shortly.

Return to Figure 2-2 for a moment to look at the remaining on-screen notices. "NTSC" appears at upper left. This notice appears automatically when the unit is working in the auto mode, and changes automatically when the instrument recognizes NTSC or PAL signals.

## The Effect of Setup

An important notice for NTSC operations appears at the lower left of the screen. It reads SETUP 7.5% in Figure 2-2. This means that the instrument is calibrated for NTSC signals with the pedestal of 7.5% known as setup that is standard practice in the U.S. Not all NTSC countries have retained setup. Japan is an example. But removing setup increases dynamic range and the chroma signal grows accordingly. Thus the vectorscope must be recalibrated for signals without setup. This is a simple menu selection in the 5212. Figure 2-3 shows the MAIN menu and Figure 2-4 shows the SYSTEM menu where calibration is chosen to match the system in use. In Figure 2-4 the asterisk is placed opposite 7.5%, which would be the choice in the U.S. Figure 2-5 shows a vector display for SMPTE color bars, which are 75% (amplitude) bars with setup. The 5212 is shown calibrated for

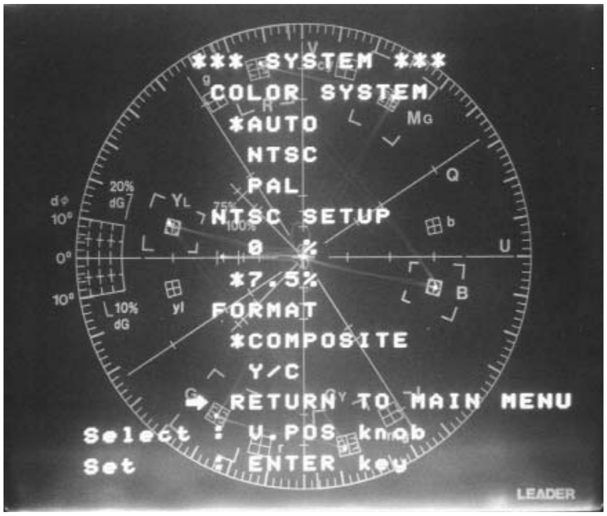

**Figure 2-4** The SYSTEM menu offers auto or manual system selection, cal for 0% or 7.5% setup, and composite or Y/C operation.

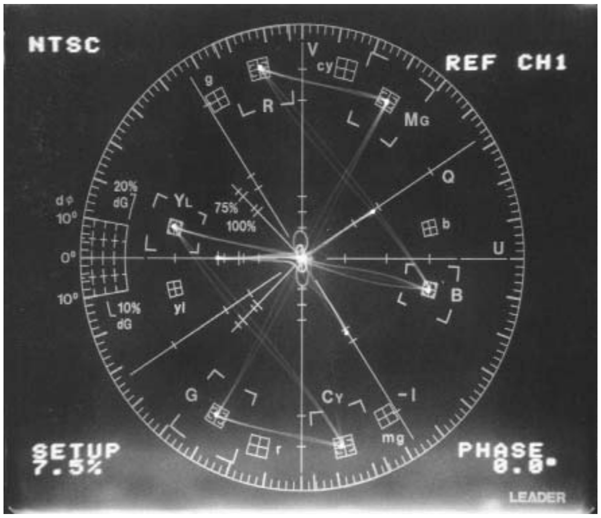

**Figure 2-5** Normal vector display for SMPTE bars and the vectorscope calibrated for signals with 7.5% setup.

signals with 7.5% setup. An example of mismatch is shown in Figure 2-6. Here the 5212 has been recalibrated for signals with zero setup using the 0% choice on the SYSTEM menu. Since chroma signal amplitude is higher in signals without setup, the gain of the vectorscope is reduced for the vector dots to land on the graticule targets. As you can see in Figure 2-6, the dots fall short of the graticule targets. The opposite is true of a vectorscope calibrated for 7.5% setup driven from a source with zero setup; the vector dots then appear ***outside*** the targets.

It's Leader's practice to calibrate vectorscopes intended for use in the U.S. for signals with setup. The newer vectorscopes are switchable (menu selected.) And many of the generators (Models 408, 408NPS, 410C, 411, 411D, 425A) include a SETUP 0/7.5% switch. Setup is not an issue in PAL, so only one calibration is needed for the 5212 for PAL operations. Note in Figure 2-4 that there is no setup choice for PAL.

## How PAL Works

Vector displays in PAL look more complex because there are twice as many vector dots. Look at Figure 2-7. There are two vectors for burst that straddle the -(B-Y) axis (called -U in PAL parlance.) There are two vector dots for each of the six colors in the standard color bar display. Figure 2-8 makes this easier to see by showing the vector display for a full red raster. PAL means ***phase alternation line***, and the part that alternates from line to line is the R-Y component, called V. During one line of the raster, the V component for R is positive and the R vector results from the vector addition of -U

**Figure 2-6** Vectors fall short of the targets for SMPTE bars if the vectorscope is calibrated for signals without setup.

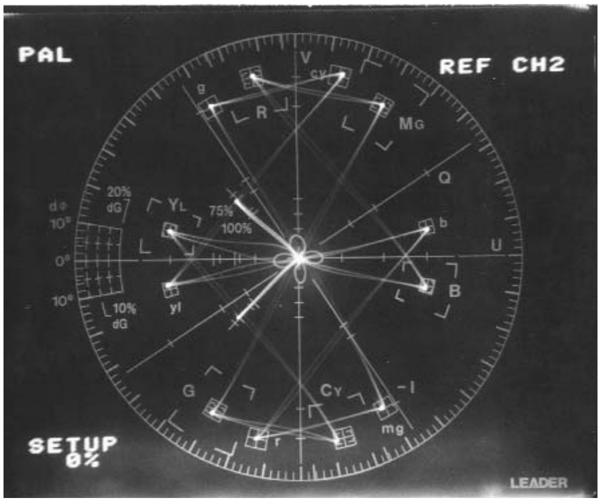

**Figure 2-7** Normal PAL color bar vector display. Note that there are two vectors for each of the six colors as well as two bursts.

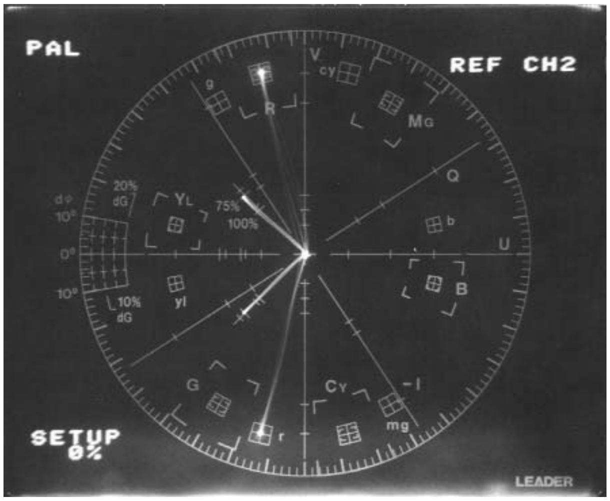

**Figure 2-8** PAL, vector display for red only. Note the R and r vectors caused by + and - V (R-Y) components.

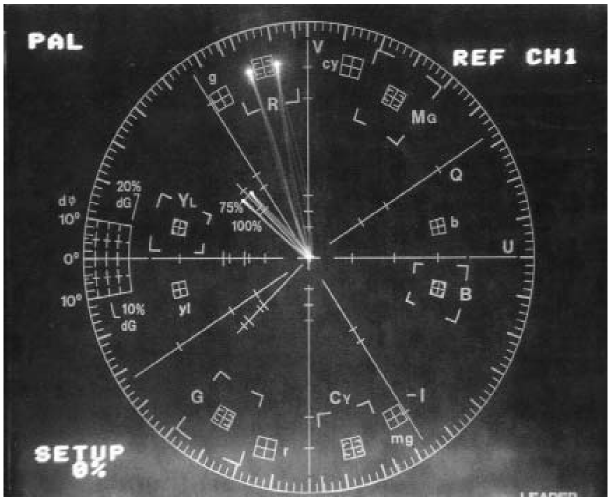

**Figure 2-9** Simulated phase error with the +V switch on. Note that the two vectors straddle the correct R target.

and +V components. The burst that precedes the line lags -U and is at 180°-45° or 135°. On the next line of the raster, the V component is inverted and another vector labeled with a lower case r is constructed of the same -U and a new -V. Burst for this line leads -U by 45°. (Vectors are measured CCW from +U so the leading burst is at 180° + 45° = 225°.) The two phases for burst also tell the PAL decoder when the line should be +V or -V.

The reason for phase alternation line is to produce a system that effectively cancels the effect of phase errors in the system. Consider, for example, a phase error in Figure 2-9 that caused R to shift a few degrees in the leading direction (CCW) to the left of the R target. During the next line r would shift the same amount, also CCW, to the right of the r target. But the PAL decoder senses the -V line and inverts V to make it positive. The result is a new r vector to the right of the R target. These two straddle R, and the error in two lines cancels out. Figure 2-9 shows a simulation of this situation causes by mis-adjusting the PHASE control to show a leading phase error at R and then pressing the +V key. (Refer back to Figure 2-1.) Note the two vector dots that straddle R. (Burst shows the same split effect in this simulation.) Cancellation of the phase (hue) shift is visual in the original, simple PAL system, but is effected electronically by averaging alternate-line V signals through delay-line storage. Note that when PHASE is set correctly, the pairs of dots merge when +V is selected, as shown in Figure 2-10. Also note the automatic PAL and SETUP 0% notices in Figure 2-10. The use of the +V key also results in a vastly simplified vector display for live video, making it easier to match colors during editing operations.

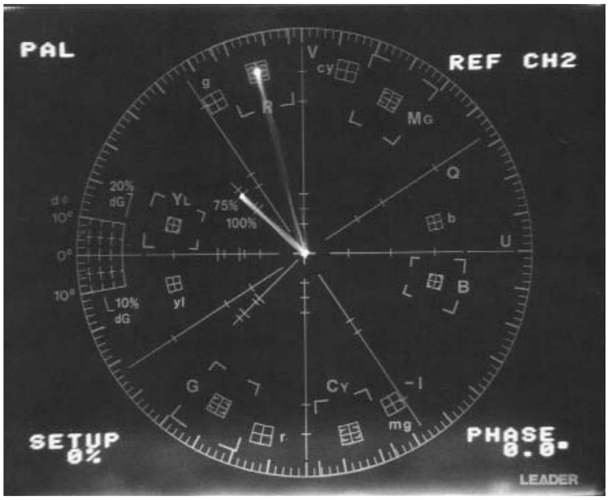

**Figure 2-10** Normal display for red only with the +V switch on.

## The Gain Group

Look back at Figure 2-1 for a moment and notice the three controls in the GAIN group. The BARS switch is familiar. It alters the gain of the vectorscope for proper calibration for either of two types of color bars: 75% or 100%. The percentage refers to the amplitude of GBR into the encoder, not color saturation. Both 75% and 100% bars are 100% saturated. Most color bar signals used in routine practice are 75% bars.

The center, MAG button alters gain for three uses. When OFF, the standard calibration for the

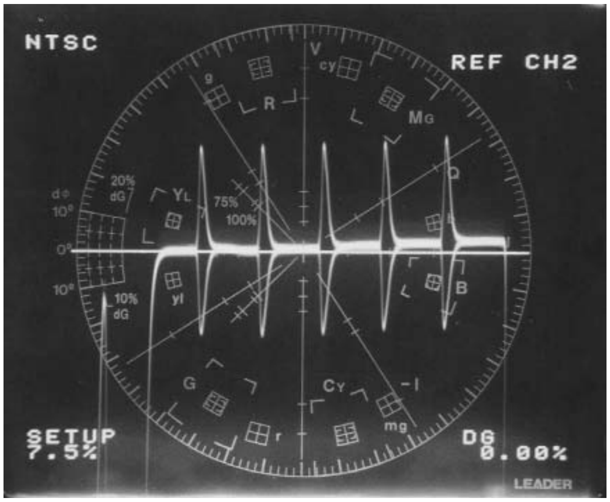

**Figure 2-11** Step 1 of the DG measurement sets the lowest "flat" on the reference line and the reading to 0.00%.

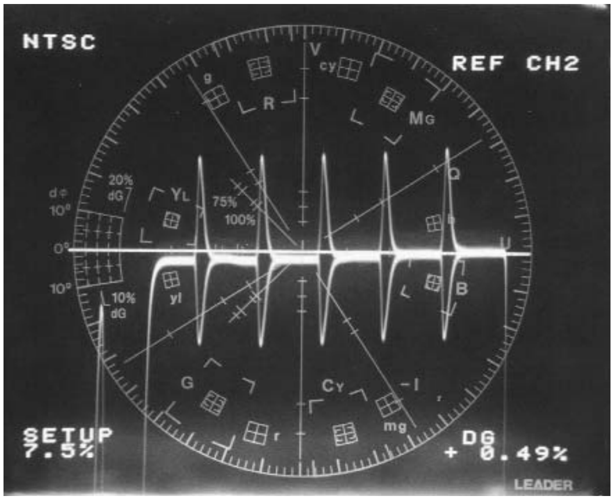

**Figure 2-12** Step 2 of DG puts the highest step on the reference line for a DG reading of +0.49%.

vectorscope applies. The BURST setting alters gain to place burst on the large outer circle of the graticule. This is an important first step in calibrating the instrument for differential gain and phase measurements. It is also useful to put bursts on the graticule circle to make accurate comparative measurements, as you will see. The X5 setting multiplies vector gain by a factor of five. High gain operation is extremely useful in making precise camera balance adjustments, in which GBR is equalized using the light source for shooting, and the camera is framed on a white or neutral test chart. GBR gain adjustments are made to make chroma vectors collapse to zero (the center origin of the vectorscope) and the higher the vectorscope gain, the more sensitive the error indication.

The VAR control in the GAIN group allows continuous control over vector gain and is useful for manual calibration purposes.

## Differential Gain

A unique feature of the 5212 is a very easy method measuring differential gain and phase. The unit or system under test must be driven with a modulated staircase or ramp signal, and the output supplied to the vectorscope. To measure differential gain, press DG in the MODE group. You will see the instrument step quickly through an automatic calibration procedure. That is, burst expands to fall on the large circle, and in a split second the display for DG and a horizontal reference line appears. See Figure 2-11. The positive and negative spikes are formed by the transitions at the step edges, and are ignored for measurement purposes. But the "flats" between the spikes represent the amplitude of subcarrier at each step.

Two simple steps are needed for the measurement. First, the V POS/DG/DP knob is set to place the first flat (the floor of the staircase on the reference line.) Press REF SET and the notice DG 0.00% will appear at lower right. Then reset V POS/DG/DP to place the highest (or lowest) step on the reference line. A reading of +0.49% is shown under DG at the lower right of the screen. Keep in mind that resolution is to one one-hundredth of a % but measuring accuracy is specified as 0.5% or better. But the high resolution of the reading is useful in comparative measurements or in noting improvements or modifications.

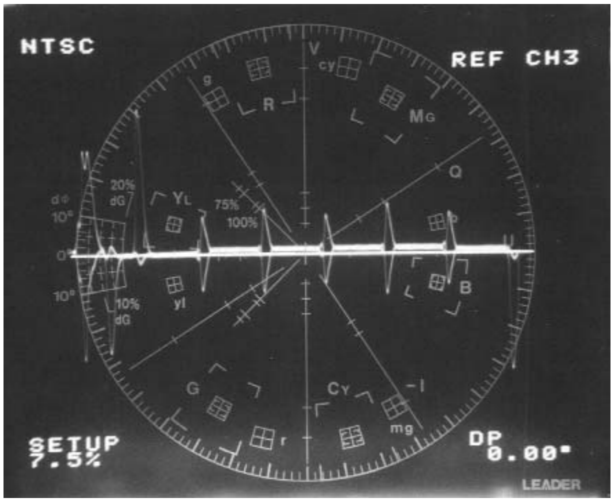

**Figure 2-13** Step 1 of the DP measurement puts the lowest staircase step on the reference, and sets the reading to 0.00°.

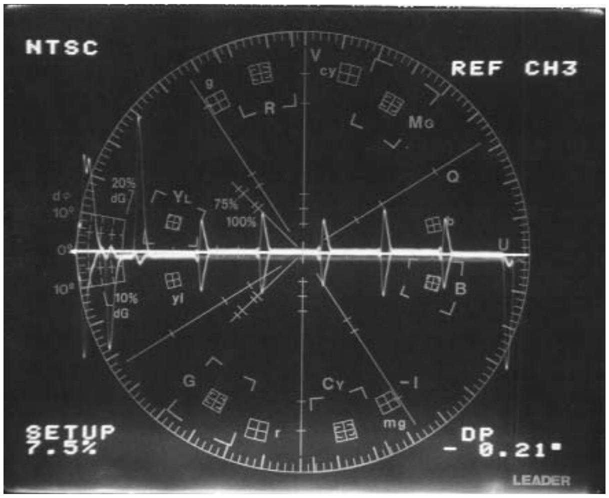

**Figure 2-14** Step 2 of DP puts the "flat" that deviates most of the reference line for a reading of -0.21°.

## Differential Phase

Differential phase is measured in the same way as DG. A rapid automatic calibration procedure will be noted when DP is pressed, and the display appears as shown in Figure 2-13. Here again a simple two-step procedure is followed. First V POS/DG/DP is adjusted to put the first step "flat" in the reference line, and REF SET is pressed for a 0.00° reading. Then V POS/DG/DP is reset to put the flat that deviates furthest from reference line of the reference line. See Figure 2-14. Here a reading of -0.21° is given.

DG and DP distortions of ±10% or ±10° can be handled by the automatic procedures of the 5212. For larger values of distortion, conventional methods should be applied. (Refer to Teleproduction Test Volume 1, Numbers 9 and 12.)

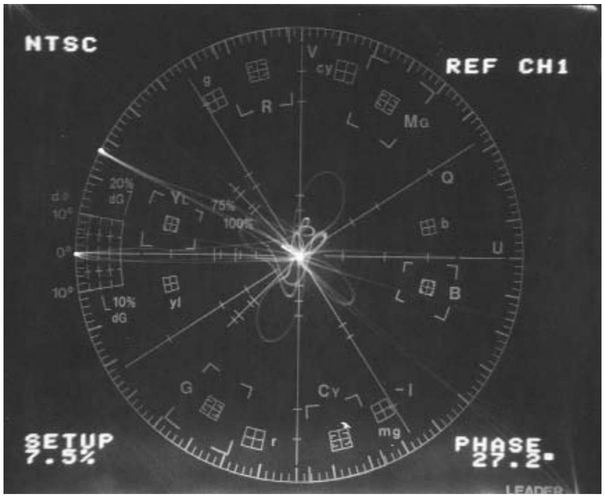

**Figure 2-16** Presetting PHASE to put the slave burst on the -(B-Y) axis show that it leads the master by 27.2°.

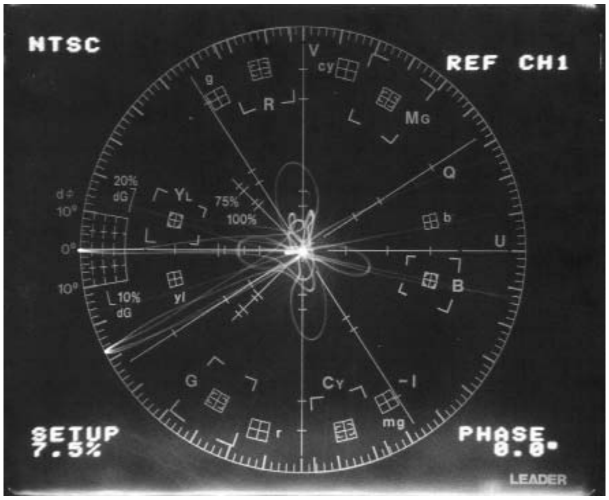

**Figure 2-15** Two synchronized bursts with AUTO PHASE set to put the master burst on the -(B-Y) axis and the PHASE reading to 0.0°.

## Relative Phase Measurements

It is sometimes useful to know the precise phase difference between signal sources, either genlocked sources or perhaps composite and black burst feeds from a single source. The procedure is easy using the digital phase readout of the 5212. An example is shown in Figures 2-15 and 16. Here the reference signal is applied to CH1 and that of the synchronized source to CH2. AUTO PHASE sets the burst of CH1 on the -(B-Y) axis and sets the PHASE reading to 0.0°. The MAG button has been set to BURST to place burst from the two sources on the graticule circle. Note that the second burst is advanced (further counterclockwise) from the reference burst. To measure the phase difference, adjust PHASE to place the second burst on the -(B-Y) axis. See Figure 2-6. The second signal is advanced 27.2° as shown by the PHASE reading in the lower-right corner.

Note that phase readings are with respect to the burst of the designated reference. They do not refer, directly, to the phase of color vectors, which are measured CCW from the +(B-Y) axis (180° away from burst.) For example, the yellow color bar vector is at 167° (reference EIA RS-189A.) If the yellow vector is placed on the -(B-Y) axis after the unit is AUTO SET for burst, a reading of 347° is obtained. Subtracting 180° from this reading yields 167°, the correct phase for yellow. For readings between 0 and 180°, add 180°. The green vector reads 60.8°, for example, as it is advanced (CCW) from burst 180° + 60.8°

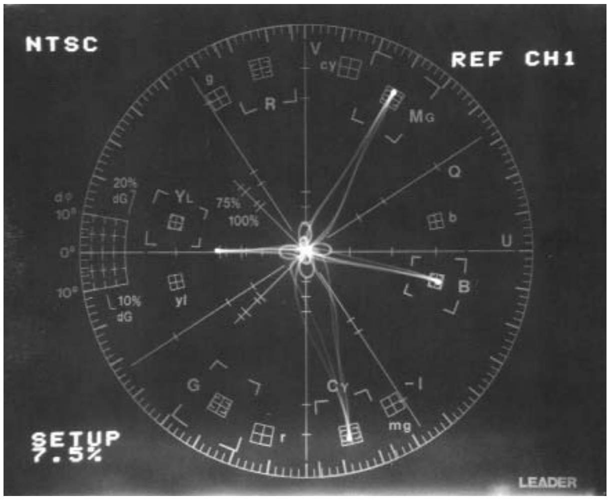

**Figure 2-17** Vector display in the line-select mode is enabled by control from the 5222. The vectors are those of the extra band of magenta-blue-cyan of SMPTE bars.

**Figure 2-18** Vector display of Y/C signal, Y applied to CH1, C to CH2.

yields 240.8°, the correct value for green.

## Line Select

The 5212 will display the polar display for selected lines in the raster when used in conjunction with the 5222 waveform monitor. All that is needed is connection of a cable equipped with 9-pin D sub-connectors between the REMOTE connector on the 5212 and the REMOTE A connector on the 5222. This cable is supplied with the 5212. When the 5222 is placed in the line select mode, the 5212 will then follow to show the vector display for the selected line(s). Figure 2-17 shows an example where a line select window of 10 lines was placed in that area of the SMPTE bar pattern that contains the extra set of bars used for monitor setup. It contains the color bars blue, magenta and cyan, as shown.

## Y/C Operation

Older vectorscopes could not handle separate Y and C signals unless synchronized by a composite or black-burst signal applied to a second channel or an external sync input. The 5212 accepts Y/C signals if set up to Y/C operation on the SYSTEM menu (look back at Figure 2-4,) and Y is fed to CH1 and C to CH2. Figure 2-18 shows the result. The Y/C notice with REF CH1 and CH2 appears in the upper right hand corner. This ties up two of the instrument inputs, but CH3 is available for genlocked composite or C signals.

## Y/C (Stereo) Monitoring

The vectorscope is a natural for monitoring the amplitudes, and perhaps more important for TV work, the relative phase of stereo audio signals. For this application, the B-Y/R-Y signals from the chroma decoder are disconnected from the horizontal (X) and vertical (Y) amplifiers of the instrument and the left and right stereo signals take their places. This is accomplished in the 5212 by simply pressing the X-Y key in the MODE group on the front panel.

Balanced (three-wire) stereo feeds are applied to the 15-pin D-sub connector labeled X-Y INPUT on the rear panel. Vector and X-Y operations are isolated so it is possible to switch back and forth from vector to stereo observations from the front panel mode selectors.

Choosing the X-Y mode with stereo signals applied calls up the display shown in Figure 2-19. The balanced left and right signals applied in this

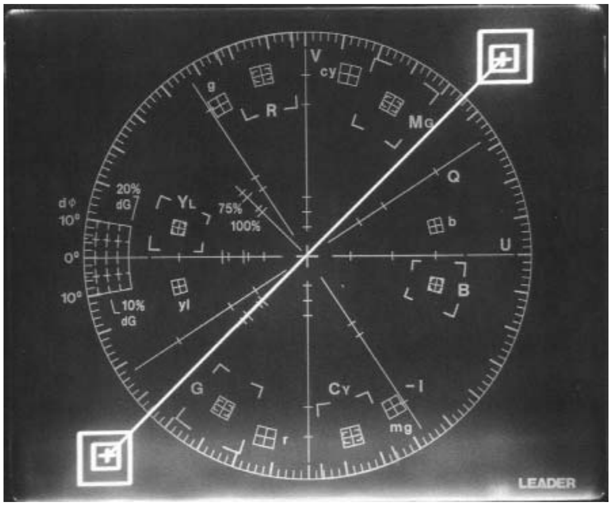

**Figure 2-19** X-Y stereo display with in-phase signals at 0 dBm.

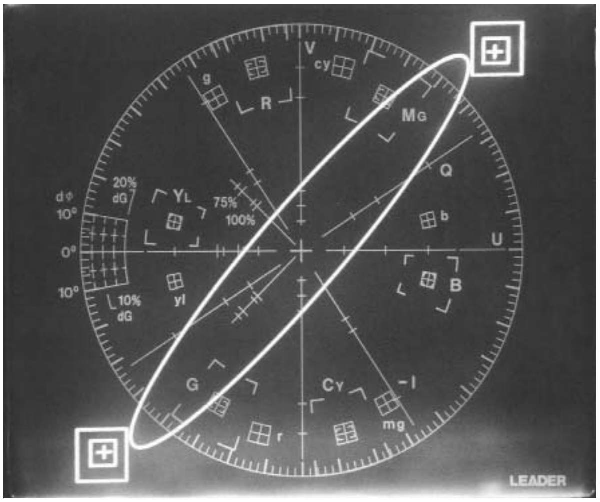

**Figure 2-20** Lissajous pattern with 16° phase shift between left and right channels.

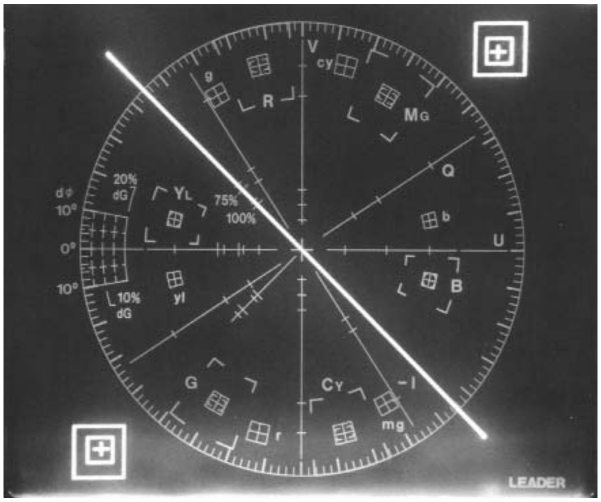

**Figure 2-21** Serious fault indicated by a 180° phase difference between left and right channels.

case are in balanced form, at zero dBm level, and in phase. The result is a Lissajous pattern that forms a straight line at 45° slanting upwards to the right. The electronic scale that's called up in the X-Y mode is calibrated for in-phase zero dBm signals at the crosses in the concentric squares. The inner squares represent a spread of ±0.5 dBm, the larger squares a spread of ±1 dBm.

Feeds that are not in phase cause the Lissajous display to open up as shown in Figure 2-20. Here the phase difference between L and R is about 16°. Signals that are 90° out of phase, but equal in amplitude, form a perfect Lissajous circle. Total phase inversion, 180°, causes the Lissajous pattern to swing over to a line that slants downward from left to right as shown in Figure 2-21. Signal inversion, of no consequence in monophonic operations, is somewhat of a disaster if it occurs in one of the stereo feeds. That is particularly true of TV stereo because the result is the cancellation of the vital L+R signal, and many TV viewers with single-speaker TVs would lose sound if the L+R (mono) signal disappears. Since it is easy for the phase of one of the stereo signals to be inadvertently inverted in STL links or temporary hookups, it is vital to use test signals and the X-Y display to monitor for in-phase conditions.

Live stereo monitored in the X-Y mode looks like a round and complex ball of string. Actual audio is out of phase as often as it is in and depends upon such factors as mic placement and frequency. In some cases, stereo mode for TV is tailored somewhat by mic placement to ensure that the out-of-phase component is minimized, and so protect the vital L+R signal.

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