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tech tips

Understanding The VG91 Bar Sweep Patterns

To accurately reproduce each video scene, the Video-IF, comb filters, luminance amps, color circuits, CRT driver and video output stages must pass a wide range of video (luminance and chroma) frequencies.

The VG91 Universal Video Generator has special analyzing "Bar Sweep" video patterns to duplicate the full frequency range that video circuits must process. They are: Multiburst Bar Sweep, Chroma Bar Sweep, and Luma/Chroma Bar Sweep. These three Bar Sweep patterns are available on the RF-TV channel, 45.75 MHz Video-IF, standard video or Y/C output to analyze any video circuit block. This Tech Tip shows how video frequencies relate to picture quality and describes each of the VG91's "Bar Sweep" video patterns.

Why Use Video Analyzing Patterns

Many problems in video systems affect the quality of the video on the CRT. Troubles such as smear, weak contrast, harsh edges, or poor picture detail are tough to track down. Often, these problems don't cause a noticeable difference in the DC bias or peak-to-peak signal voltages in the video circuits but only effect the overall bandwidth or waveshape of the composite video signal.

Problems which degrade the video picture may be related to problems in the Video IF, comb filter, luminance or chroma circuits. These stages must pass wide bands of luminance and chroma frequencies to accurately reproduce each video scene viewed on the CRT.

Most sources of video patterns don't duplicate the full range of video or chroma signal frequencies. Color bar patterns contain only low frequency signals. This is why they often do not show video related performance problems. Video signals from local transmitters or cable systems continuously change in frequency content, making it difficult to isolate a video stage with poor frequency response with these signal sources.

With the VG91's Bar Sweep video patterns you may judge the performance of video circuits by looking at the CRT screen or signal trace video problems to the defective circuit. To understand how this is possible, you need a better understanding of the bar sweep patterns and how different video and chroma signals relate to frequency.

How Video Signals Relate To Frequency

A video signal contains many different frequencies ranging from 0 to 4.2 MHz. Video circuits must be able to treat all the frequencies the same to produce a good picture. But, how do video frequencies relate to picture quality?

A TV picture is made up of 525 horizontal scan lines, repeating at a rate of 15,734 Hz. Each line changes in amplitude to form the picture as the beam moves across the front of the screen. The video frequency depends on how often the amplitude changes during the scan line. We can calculate the frequency if we know how often the beam is interrupted as it moves across the screen.

To make these calculations, we need to consider the active scan time. This is the time between sync blanking or "active video". To determine active video time, divide 1 by 15,734 to get 63.5 microseconds. Subtract approximately 11.1 microseconds for blanking and sync for 52.4 microseconds of active video.

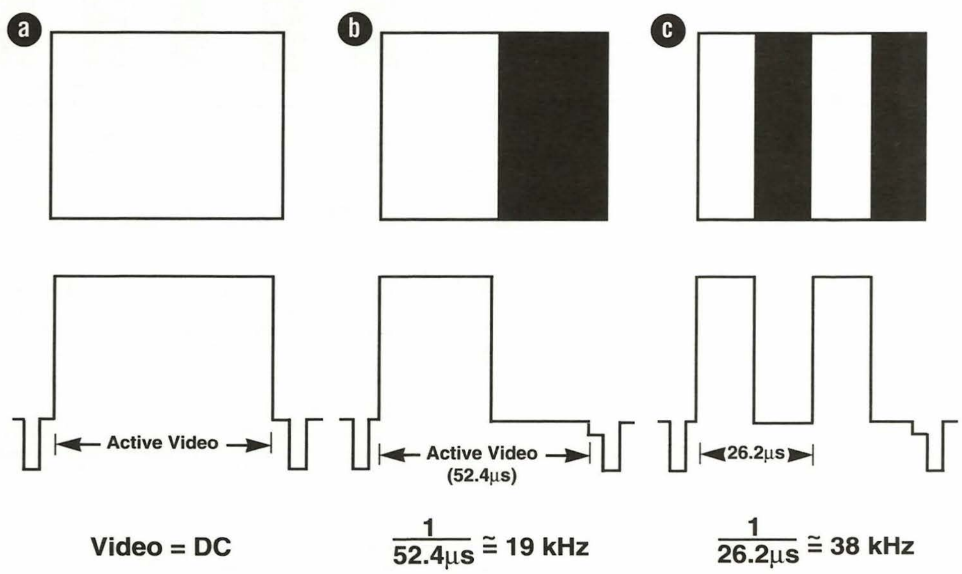

Fig. 1: Interrupting the video from black to white creates video frequencies determined by the time for one cycle.

Let's see what happens as we apply video to interrupt the beam as illustrated in Figure 1. We will start when the screen is completely white. The video signal is now interrupted only by horizontal blanking. Since the signal is at a fixed level for 84% of the time, it is more like a DC signal than an AC signal.

Next, lets see what happens when we change the picture, by making the left half black and the right half white (See Figure 1b). The video signal now becomes a square wave, forming one complete cycle during the active time of each horizontal scan line. Since one scan line is approximately 52.4 microseconds and the video completes one full cycle, the video frequency is approximately 19 kHz. This is the lowest video frequency possible.

Now, let's double the interruption rate to form two white stripes of equal size. The time for each cycle is half as long as our first example. This calculates to twice the first frequency or 38 kHz. As we interrupt the screen more often, we can translate the interruptions into frequencies by multiplying the number of interruptions by 19 kHz or by taking the inverse of the scan time for one complete video cycle.

Most pictures have a mixture of large and small objects instead of a row of identically sized objects. This causes the video signal to be a mixture of many frequencies. Each different size picture element produces a signal of the same frequency as it would if it were repeated all the way across the screen. Large objects create low video frequencies and small objects create high frequencies. The drawing in Figure 2 may put this into better perspective.

The ten soldiers across the screen are each one-twentieth the scan width of the screen. If we think of the soldier as a high level and the in-between space as a low level, the video is interrupted ten times across the screen. The ten soldiers then calculate to 10 times 19 kHz, or 190 kHz.

But if a video circuit only amplified video frequencies from 0 to 190 kHz, we wouldn't see the soldiers. We only see their outline and not a very clear outline at that. We need more bandwidth to see smaller details.

If the soldier's ties are one-fifth the width of the soldier, we need enough bandwidth to place 50 necktie-sized objects (plus equal blank spaces) on the screen. This requires 50 times 19 kHz, or approximately a 1 MHz bandwith to provide 53 neckties across the screen.

Any picture element that is one-half the size of the necktie creates a video frequency twice that of the necktie, or 2 MHz. A 2 MHz signal represents one object 1/106th the screen's width. This might be the bayonet on the end of the soldiers rifles.

Increasing the frequency to 3 MHz allows us to form objects 1/159th the width of the screen, such as the hair on the soldier's head. Since most TV receivers have 3 MHz of video response, this is the smallest object they can show on the picture.

A monitor with a direct video input (which bypasses the tuner and IF circuits) may provide a response between 4 to 4.5 MHz. If so, 238 objects can be placed across the screen with spaces of the same size.

How Chroma Signals Relate To Frequency

The color frequencies included in the composite video signal add color to the large and medium sized objects. The color circuits must treat all color frequencies the same to produce a good color picture. Color frequencies relate to picture quality in the similar manner as luminance frequencies.

During the horizontal scan lines, the color signals interrupt the conduction of the 3 color beams to add color to the objects of the picture. The color frequency relates to how often the color beam changes amplitude during the scan line or the size of the object being colored.

In the case of the EIA color bars in Figure 3, the bars represent objects of one-seventh the width of the screen. The frequency response needed to color objects this size is only approximately 68 kHz (To solve for this take the scan time of two bars, 1 complete signal cycle which is 15 microseconds scan time, and invert it.) To color smaller objects, a higher color frequency is required.

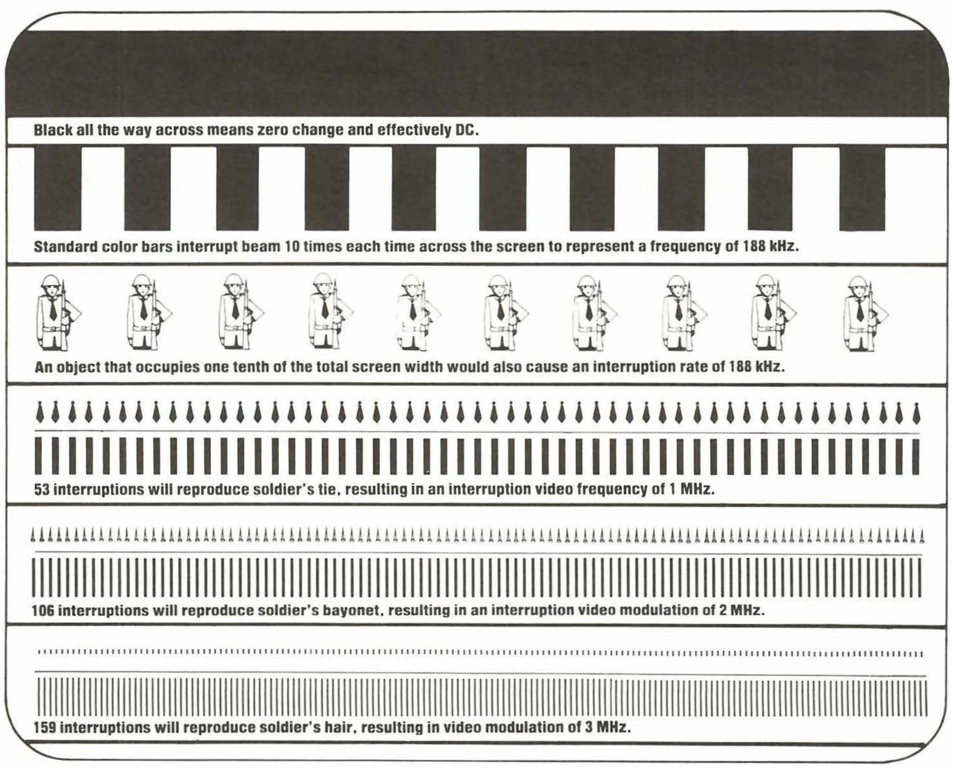

Fig. 2: A video picture is of many video frequencies all mixed together, as these soldiers represent.

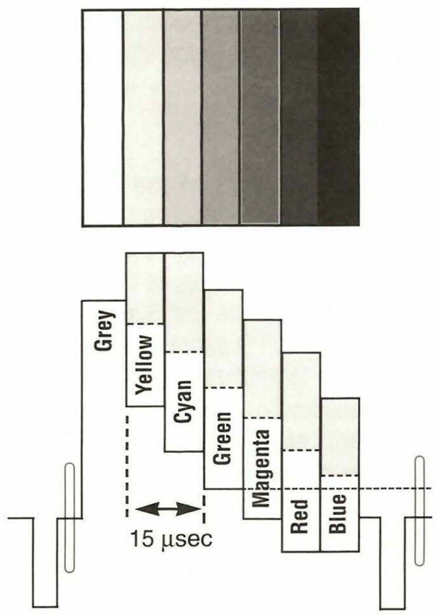

Fig. 3: The EIA Color Bars pattern develops a chroma frequency of approximately 68 kHz to reproduce. Smaller objects require higher chroma frequencies.

The response of the human eye to color changes with object size. We cannot distinguish color in smaller objects. This makes it possible to reduce the range of color frequencies needed for a given video scene. In terms of a 23 inch screen, objects sizes ranging from .34 inch to .12 inch correspond to a half cycle of video, or 1.5 MHz. The human eye is sensitive to objects in this size range only if they are comprised of orange or cyan. Objects .34 inches or larger correspond to .5 MHz and require all primary colors for reproduction. The eye characteristics require only color frequencies ranging from 0 to 1.3 MHz to adequately reproduce color.

The color signals from a video camera are matrixed to produce R-Y and B-Y signals. These signals are increased in frequency and separated by 90 degrees with a balanced modulator centered at 3.58 MHz. This produces I and Q frequency color chroma signals which extend 1.3 MHz below and .5 MHz above 3.58 MHz. The chroma sideband signals are added to the luminance signals to form the composite video signal.

Most TV receivers only use chroma frequencies .5 MHz above and below 3.58 MHz. This range of frequencies reproduces a satisfactory color picture. Some receivers increase the Video IF bandpass by the use of a "wideband" I color demodulator. These receivers use the wider I chroma frequencies which extend 1.3 MHz below 3.58 MHz making it possible to color smaller objects.

A monitor with a direct video input or an S-video input also makes use of the increased range of color and luminance frequencies.

The Multiburst Bar Sweep Patterns

The Multiburst Bar Sweep pattern, shown in Figure 4, provides ten frequency bars (bursts) of video, each with a different test frequency. Any frequency response roll-off or distortion in the the video circuits will alter the amplitude or shape of the bars.

The Multiburst Bar Sweep pattern consists of ten frequency bars beginning with a solid white "0 MHz" reference bar, and increasing in .5 MHz steps to 4.5 MHz. The individual bars (frequencies) interrupt the video between black and white at rates between DC and 4.5 MHz. The bar frequencies sample the full range of luminance (Y) frequencies that video systems process.

Each of Multiburst Bar Sweep frequencies are generated as square waves. A square wave needs correct phase and gain response to of all its odd harmonics to retain its proper shape. The harmonics of the square waves for each bar frequency effectively fill in the gaps between the .5 MHz fundamental test frequencies. This insures that problems between the fundamental test frequencies are not overlooked as they might be with sinewaves.

Use the Multiburst Bar Sweep pattern to test and isolate frequency response problems in any stage that must amplify the full range of luminance frequencies. This includes circuits such as video IFs, comb filters and luminance amplifier circuits. The pattern can also be used to align video IF stages for the best overall frequency response and gain with minimum picture distortion.

The Chroma Bar Sweep Pattern

The Chroma Bar Sweep pattern provides 3 chroma test bar frequencies. The chroma test frequencies are in the middle and edges of the color bandpass frequencies that the chroma stages must pass. Any response roll-off or distortion will change the amplitude or shape of these color frequency bars.

The Chroma Bar Sweep pattern consists of three chroma frequency bars at 3.08, 3.5, and 4.08 MHz, as shown in Figure 4. All three color bars are phased as chroma, and should appear at the color output of a properly aligned and working comb filter. The 3.08 and 4.08 MHz bars are interrupted with chroma changing at a 500 kHz rate. This produces chroma sideband frequencies at 3.08 and 4.08 MHz.

The middle (3.58 MHz) frequency bar is 75% color saturated cyan and matches the phase of the cyan bar of the EIA Color bar pattern. This bar is not interrupted and should appear as a constant cyan color. Cyan is the largest amplitude color signal which a color circuit must pass without clipping or limiting. This is important when setting chroma levels such as the record chroma level in a VCR. The right and left sides of Chroma Bar Sweep provide a white reference level for special tests and alignments.

Chroma circuits with a poor response may result in no color, washed out color or color smearing. Use the Chroma Bar Sweep pattern to test and troubleshoot color problems in video-IF, comb filters, color bandpass circuits or any chroma processing circuits.

The Luma/Chroma Bar Sweep Pattern

The Luma/Chroma Bar Sweep pattern, shown in Figure 4, provides luminance and chroma phased test frequency bars in a single video pattern. The combination of luminance and chroma signals in a single pattern closely duplicates a composite video signal with a high luminance and chroma frequency content. The luminance and chroma test frequencies are specially chosen to dynamically test circuits in the band of frequencies were the luminance and chroma frequencies overlap. The frequencies are at the bandpass edges of the luminance and I color signals.

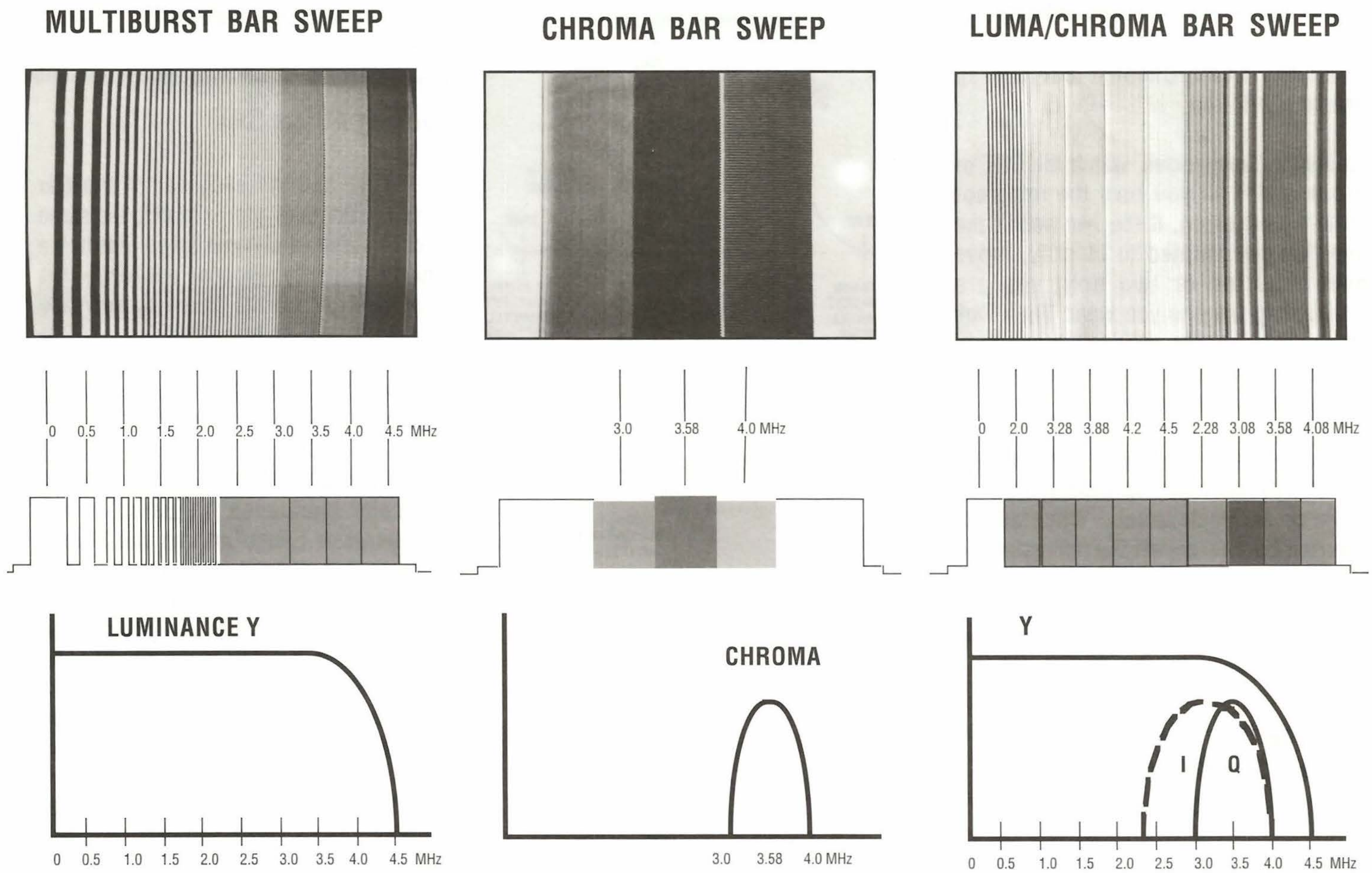

Fig. 4: The "Bar Sweep" patterns test the bandpass responses of video (luminance and chroma) stages.

The Luma/Chroma Bar Sweep pattern includes 6 luminance phased bars: 0 MHz reference white, and 2.0, 3.28, 3.88, 4.2, and 4.5 MHz. The luminance bars are identical to the Multiburst Bar Sweep but differ in frequency. The 4.2 MHz frequency bar is the highest luminance frequency that can be transmitted. The 3.28 and 3.88 MHz bars occupy the same frequency spectrum as the chroma frequencies for analyzing comb filter circuits.

Located to the right of the B&W luminance bars on the raster, are four chroma-phased bars at 2.28, 3.08, 3.58, and 4.08 MHz. The Chroma bars are the same as the Chroma Bar Sweep pattern with the addition of a 2.28 MHz chroma frequency bar. This bar represents the highest I chroma sideband which may be transmitted in the composite video signal. These bars are color phased and should appear on the color output of a properly operating comb filter.

Use the Luma/Chroma Bar Sweep pattern to analyze and align comb filters and to analyze other wideband luminance and chroma circuits, such as wideband I color demodulators or circuits fed by S-Video (Y/C) Inputs.

Identifying Test Frequencies with the Bar Sweep Interrupts

The BAR SWEEP INTERRUPTS switches allow you to turn on and off individual bars of the Multiburst Bar Sweep, Chroma Bar Sweep and Luma/Chroma Bar Sweep video patterns. This is useful for easily identifying a particular bar frequency.

NOTE: Only the 3.0. 3.5 and 4.0 MHz bars can be activated in the Chroma Bar Sweep pattern.

The numbers shown above and below the BAR SWEEP INTERRUPT switches indicate the video, chroma and equivalent IF frequencies produced by the video patterns. The top row of numbers indicate the composite video frequencies when the Multiburst Bar Sweep and Chroma Bar Sweep patterns are selected. The row just above the push-buttons indicates the

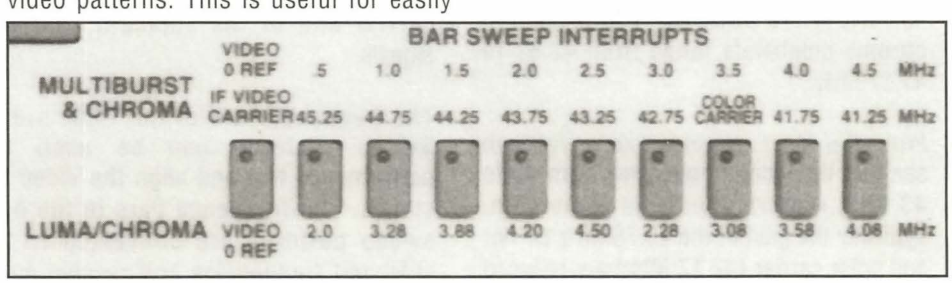

Fig. 5: Use the Bar Sweep Interrupt switches to turn the individual bars of the Bar Sweep patterns on and off. The corresponding video and IF frequencies are indicated.

equivalent IF sideband frequencies. The values below the switches indicate the composite video frequencies produced when the Luma/Chroma Bar Sweep pattern is selected.

To identify frequencies, watch the CRT or oscilloscope as you turn the interrupt switches off or on. If the bar wasn't the one that you wanted to identify, move over a button or two until you are interrupting the one you want. Then look above or below the interrupt button and read the video frequency relating to the pattern you have selected.

You may also use the BAR SWEEP INTERUPT switches to produce an all white or all black raster. When all the interrupt buttons are off the full raster will be black in the Multiburst or Luma/Chroma Bar Sweep patterns and a white raster will be produced when the Chroma Bar Sweep pattern is selected.

How The Bar Sweep Patterns Relate To The Video IF Response Curve

The IF response or gain to the range of IF frequencies is commonly shown with an IF response curve. The response curve offers a convenient way for indicating the relative amplification of the video frequencies within the bandpass of the video-IF. Although the IF response between receivers varies, you may use the ideal response curve in Figure 6 as a reference when performance testing or aligning the video-IF stages using the VG91's "Bar Sweep" patterns.

The results of heterodyning in the tuner reverses the frequency order of the luminance and chroma sideband frequencies in the video-IF. The video carrier is positioned at 45.75 MHz with video sideband frequencies ranging from 45.75 to 41.75 MHz. The 1 MHz band of chroma sidebands range from 42.67 to 41.67 MHz.

From the ideal response curve you can see that the video frequencies from 45 to 43 MHz receive about the same gain. Typically the gain of the 45.75 MHz carrier and color carrier (42.17 MHz) are reduced to about 50%. The bandpass rolls-off quickly to minimize gain to the audio

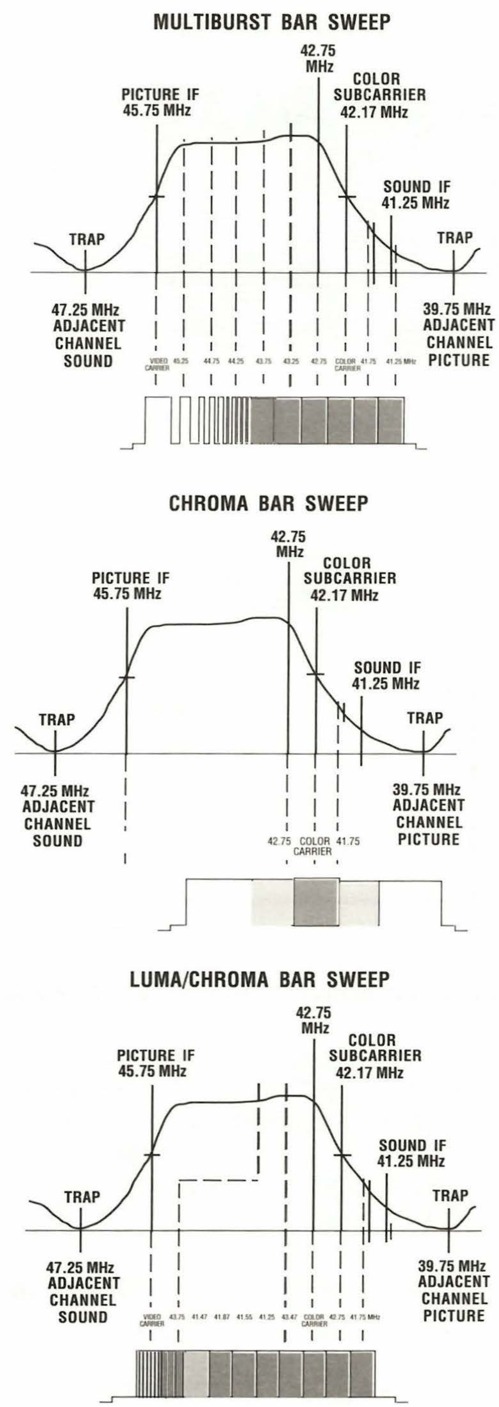

Fig. 6: The IF gain relative to individual bars of the Bar Sweep patterns.

carrier and to the adjacent channel signals.

The frequency bars of the VG91's Bar Sweep patterns can be used to performance test and align the Video IF stages. The frequency bars in the bar sweep patterns are converted to IF sideband frequencies and receive gain relative to the IF response curve. The amplitude of each bar at the output of the video detector provides an indication of the IF frequency response curve.

How To Test Response By Looking At The CRT

The VG91 outputs each bar of the Bar Sweep patterns at approximately the same level. A video or chroma stage that has a limited frequency response will reduce the amplitude, distort the shape or decrease the sharpness or brightness of one, or several of the frequency bars. You may use the CRT to tell if each bar sweep frequency has made it to the CRT.

Looking at a CRT monitor, you know a particular luminance frequency of the Multiburst or Luma/Chroma Bar Sweep patterns has passed through the video stages if the bar shows detail in the form of black and white vertical stripes. In addition, the background brightness (white level) of each bar on the CRT shows how the gain at one test frequency compares to others. Simply lower the brightness or contrast controls to see whether all bars have the normal brightness level. Restricted bars (reduced level) turn dark before others.

The shape of the video-IF stages affects the squarewave bar sweep frequencies. The sharpness of the black and white stripes indicates how well the initial odd harmonics of each bar frequency are restricted by the video-IF. Any excessive gain to any of the lower frequency bars produces harsh edges or ringing on the square wave transition.

You can use a CRT to determine if a color phased frequency bar of the Chroma Bar Sweep or Luma/Chroma Bar Sweep patterns is passing through the video-IF or chroma circuits. On a CRT monitor, the 3.08 or 4.08 MHz frequency bars show detailed color stripes if they are passing through the video stage as shown in figure 7. A stage that is restricting the band of chroma signals will reduce the detail of the stripes. In addition, the amplitudes of the bars can be determined by reducing the color level control and observing when each bar turns grey.

A color TV receiver should show video response to 3.0 MHz with an RF video signal applied to the antenna input. The

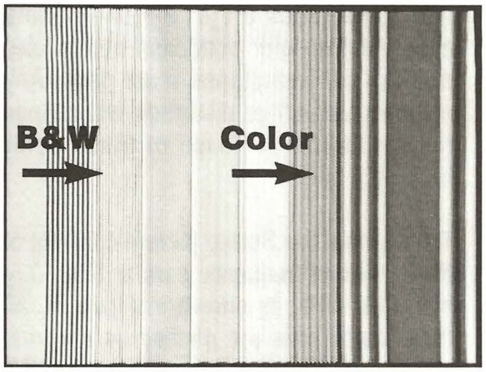

Fig. 7: You know a luminance or chroma phased frequency bar has passed through the video stages if the CRT shows detail in the form of black and white or colored vertical stripes.

response is limited by the IF response which rolls-off frequencies above 3 MHz. The 4.5 MHz frequency bar should be trapped out by the 4.5 MHz trap.

A monitor with a direct video input bypasses the bandpass restrictions of the video-IF circuits. This extends the luminance frequency response as high as 4.0 or even 4.5 MHz. A direct video input provides a wider and more even gain of chroma frequencies as well.

A monitor with a Y/C input (S-Video input) provides a wideband luminance and chroma input. The S-Video input bypasses the video-IF and comb filter circuits. Since the luminance and chroma are separate, the luminance response extends a full 4.5 MHz and the chroma a full 1.3 MHz. This produces clear luminance and chroma stripes on any of the bar sweep patterns.

In each case, the Bar Sweep patterns tests every video circuit from the input right to the CRT. Simply look at the CRT to see whether the circuits show normal response.

How To Test Response And Troubleshoot With A Scope

The symptoms observed on the CRT during initial video performance checks with the Bar Sweep patterns point you to suspect circuits. Relate these symptoms to the particular luminance or chroma frequency bar(s) and use an oscilloscope to trace the defective video stage to isolate difficult video problems in the least amount of time.

The frequency bars of the Bar Sweep patterns repeat every horizontal scan line for easy interpretation on a scope. You'll recall that the VG91 outputs the individual frequency bars of the Bar Sweep patterns at approximately the same level, so use the oscilloscope to analyze the relative level of each frequency bar. Judge the response of the video stage by comparing the amplitude of the frequency bars to the "0 Ref" or 3.58 MHz (color carrier) bar. The amplitude of the individual frequency bars of the Bar Sweep pattern indicate how the video stage effected the range of luminance or chroma frequencies.

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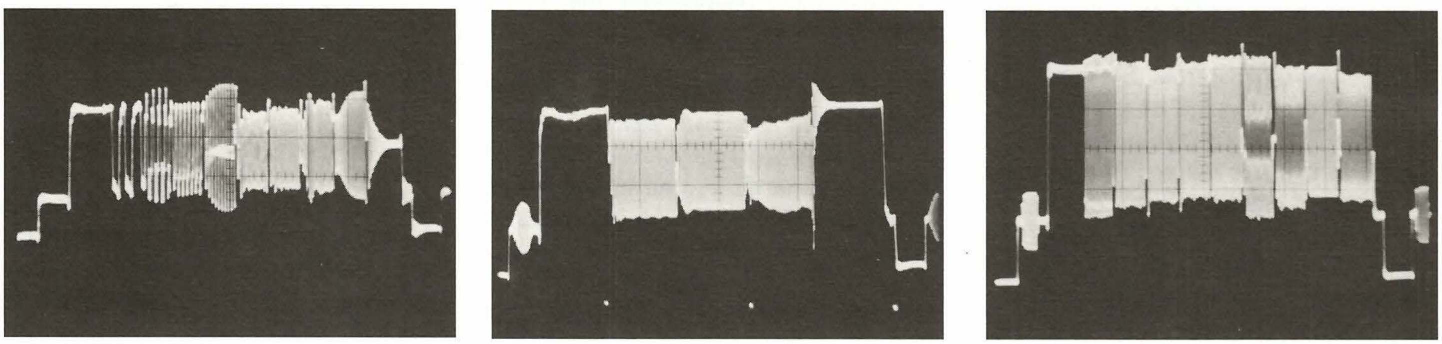

Multiburst Bar Sweep — Chroma Bar Sweep — Luma/Chroma Bar Sweep

Fig. 8: Use the Bar Sweep patterns to align or troubleshoot video stages. The above waveforms are typical waveforms in a wideband chassis.

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