Chapter Seventeen: ToasterScope

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Computer displays of your video are handy, but you need an objective way to ensure that you are producing crisp, legal video. ToasterScope helps you measure the brightness and color values of your signal. This 60 field-per-second display gives you a quantitative view to ensure that you actually get what you see (60 field-per-second NTSC; 50-field-per-second PAL).

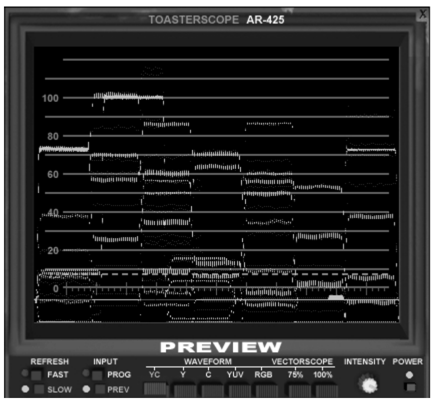

Figure 17.1. ToasterScope panel showing a vectorscope.

Professionals rely on waveform monitors to monitor and verify the incoming signal in real-time. The ToasterScope is a real-time vectorscope/waveform monitor that displays the data from Program and Preview of the Switcher. A waveform monitor measures the luminance, or brightness, of a picture. A vectorscope is used to calibrate the color and levels in a video signal.

One use of ToasterScope is to calibrate the signals from multiple cameras so that when you switch between them, the scanning and colors match. ToasterScope is an excellent resource for calibrating your input because it tells you the voltage and color phase values, which are objective values. Visually turning the phase knob until a flesh-tone looks correct is subjective, and can be incorrect. This chapter gives you information to help you understand waveform monitors and vectorscopes.

Monitoring a Signal

You can use ToasterScope to monitor the output of a video source, such as a camera, to verify that the signal falls within black or peak white signal limits. You can also use ToasterScope to verify that the gain for a record/playback system is acceptable (i.e., that a recording made with a standard amplitude video signal at the machine's input will produce standard amplitude video at its output during playback.)

To test your system and equipment, you use a well-defined, highly stable test signal with known characteristics, such as color bars. If the system can pass the test signal from input to output with little or no distortion, it can cleanly pass picture signals as well.

You need a test signal generator (TSG), such as the NewTek Calibar or a professional video camera, to create the signals. The TSG produces a set of precise video signals with carefully defined and controlled characteristics. Each signal is ideal for verifying one or more specific attributes of the video system. Most semi-professional cameras can send a color bars signal. These test signals serve as a reference that should be "perfect," so you can identify problems when they are not perfect.

Vectorscopes and waveform monitors complement one another and fully represent all information about the video signal. This section identifies the correct display that you should see when you send test signals to the ToasterScope. To correct distorted signals, you need to correct your input equipment, or use the Processing Amplifier. The section on the Proc Amp includes information about adjusting distorted signals.

Interface

Refresh

ToasterScope offers you two refresh rates for viewing the waveform monitor or the vectorscope. If you choose **Slow**, ToasterScope uses less processing power from your CPU, and you can maintain more than one ToasterScope panel on your desktop. If you choose **Fast**, ToasterScope needs more processing power to display the monitor. Depending on your CPU, you may want to show only one ToasterScope panel when you use this setting.

Figure 17.2. Refresh options at the far left.

Note
Many systems sample only a single line of video to produce waveform/vectorscope signals. Video Toaster [2] uses the full video frame, which is the way that professional hardware units sample a video signal.

Waveform

You read the waveform monitor from left to right: the signal on the left side of the waveform corresponds to information on the left side of the video picture, and of course, what you see on the right directly corresponds to the right side of your video.

In Figure 17.3, you see the luminance information for a color bars signal. Notice that the signal toward the left sits at 100. This is the IRE measurement for a white luminance value (see the sidebar on page 17.6).

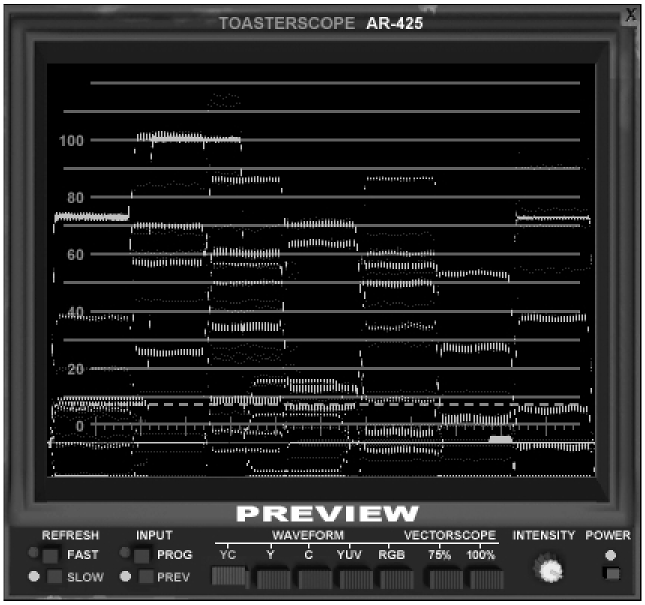

Figure 17.3. ToasterScope panel showing a waveform.

You access the waveform monitor by choosing one of the options at the bottom right of the panel. The waveform options are **YC**, **Y**, **C**, **YUV**, and **RGB**. The **YC** signal shows, the Y (luminance) signal and the C (chrominance) signal together, while **Y** shows only luminance and **C** shows only chrominance. **YUV** represents a composite signal including sync, and **RGB** represents the signal translated into RGB values.

YC Waveform

The graph that appears when you choose **YC** is a single graph that displays luminance and chrominance signals for a single video source. The graph for the **Y** option is also a single graph where you see only the luminance signal for the video source; the chrominance data is ignored. The graph for the **C** option shows only the chrominance signal of your video source, but remember that you see luminance values for color signals, so you see how much brightness or darkness the colors generate.

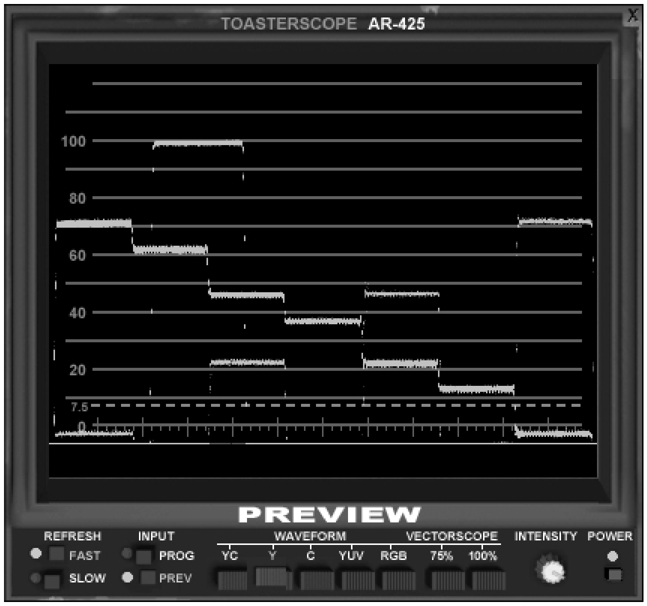

Figure 17.4. ToasterScope panel showing a Waveform Monitor with Y option selected.

YUV and RBG Waveform

When you choose one of the **YUV** or **RGB** options, three columns of graphs appear. The **YUV** graph shows separate columns for each of the Y, U, and V signals. This graph shows you how luminance and chrominance are combined in one signal. and the **RGB** graph shows separate columns for each of the R, G, and B signals.

NOTE
Even if you feed a single color to the waveform monitor, you may still see spikes or discrepancies because in the digital world, the video signal is synthesized.

Luminance Signal

The luminance of a video signal is measured on a scale of 7.5 to 100 for North American NTSC. By understanding the scale you can modify a signal that goes above the 100 mark or below the 7.5 mark. Signals that fall outside of this range lose all detail. For example, if a light-colored face goes above 100 units, it will be washed out. A dark-colored face that falls below 7.5 units will be too dark to show any detail. Faces in the +50 to +80 range are usually considered properly exposed.

Color Bars and the Waveform Monitor

When you send a color bars test signal to the waveform monitor, you should see the following:

- Waveform black level at 7.5 IRE (U.S. NTSC)
- Waveform luminance (white bar) at 100 IRE

VIDEO 101: HOW TO READ THE WAVEFORM MONITOR

We measure video luminance in amplitude, or volts; one volt peak-to-peak (1V p-p) is the nominal signal for video. A perfect white signal is equal to one volt. This standard guarantees that signals from different sources are compatible. Test signals, which are considered perfect signals, match the standard. Regular video does not contain any peak white levels and never measures 1V p-p.

You measure the video signal on the graph, or graticule, of the waveform monitor. The vertical axis shows amplitude, which is measured from 0 to 100 IRE units.

The IRE unit is a standard set by the Institute of Radio Engineers. An IRE is a relative unit of measure that equals 1/140th of the peak-to-peak video amplitude.

Dark areas in the signal fall into the lower IRE units, while bright areas appear at the top of the graph with higher IRE units.

The horizontal axis at 0 IRE measures time intervals in the video signal. Each tick mark along the axis indicates a division of time. Large ticks represent vertical blanking intervals and small ticks represent horizontal blanking intervals.

A video signal contains pulses with instructions for the electron beam of the monitor. The vertical blanking pulse tells the electron beam to shut off so it can travel to the top of the screen and begin the next frame. The horizontal blanking pulse tells the beam to shut off so it can travel to the left and start the next line. Blanking intervals represent the time that the beam is shut off.

For more information on blanking, see the sidebar at the end of this chapter.

VECTORSCOPE

A vectorscope displays information about only the chrominance (color) portion of the video signal. U.S. television is built around three primary colors: red, green, and blue. A mathematical formula encodes color information for broadcasting, but that formula must have a reference point, or color burst. The color burst appears on the vectorscope, along with other colors in the video picture.

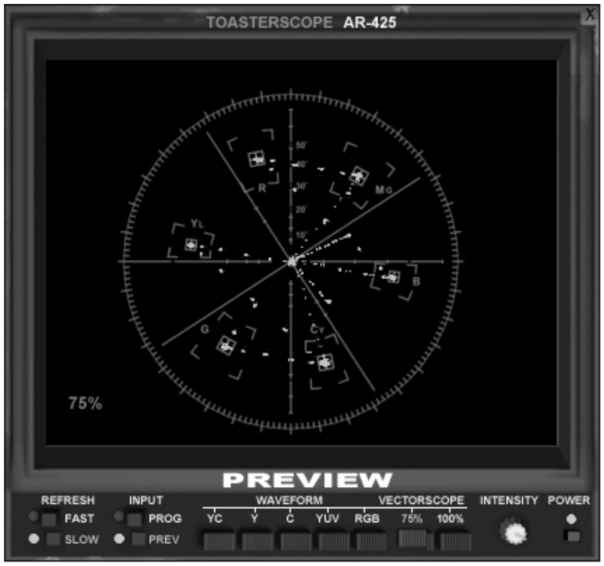

Figure 17.5. ToasterScope panel showing a 75% vectorscope.

VIDEO 101: HOW TO READ THE VECTORSCOPE

A vectorscope display comprises the graticule and the trace. The graticule measures the video signal and the trace represents the color burst (see Blanking and Burst on the next page.)

The graticule is a full circle with tick marks in 2- and 10-degree increments. These marks represent the angle of a color, from 0 to 360 degrees. (Look at the Color Picker; the Hue values range from 0 to 360 degrees.) The cross point in the center is the reference mark for centering the trace.

The circle is sliced into six wedges, each with small, graph targets. The targets are where each dot of a color bars signal should fall if chroma gain and phase relationships are correct.

The chrominance signal can suffer distortions in amplitude (gain), and timing (phase) that cause obvious picture problems. The waveform monitor measures amplitude. The vectorscope will reveal distorted phase, where the color burst and target dots from a test signal do not align properly.

You access the vectorscope by choosing **100%** or **75%** mode under the Vectorscope heading at the bottom of the panel. The **100%** and **75%** labels refer to the saturation of the colors in the signal. Usually you use color bars signals with vectorscopes—75% and 100% full field color bars and the SMPTE color bars. You use the appropriate mode with its associated test signal so that you can correctly place the dots generated for the signal values. Thus, if you sent a 75% Color Bars test as your input, you select the **75%** mode for the vectorscope.

TIDBIT

The vectorscope shows no luminance information at all. You can see this if you generate a red background on the Background Generator. If you add white to the red so it's more pink, the signal on the vectorscope still stays the same.

VIDEO 101: BLANKING AND BURST

Images on a television screen are created by an electron beam that scans across the back of the picture tube and causes the phosphor on the tube to glow. The beam sweeps across the tube 525 times (NTSC) for each video frame, in a process called interlaced scanning. Odd lines are scanned in the first pass, then the beam returns to the top to scan even lines.

The beam shuts off briefly when it moves from left to right, and this down time is called horizontal blanking. The beam also shuts off briefly when it moves from bottom to top, which is called vertical blanking.

Though the beam is shut off, the signal is not. During the blanking interval, synchronizing pulses (sync) and color reference (color burst) are sent. These bursts and pulses make sure the beam is in the right place at the right time, using the right color.

When the beam returns to the top of the screen, an equalizing pulse tells it which field the next scan represents, and a vertical syncing pulse verifies that the beam starts at the correct line.

When we talk about sync, we are referring to these phenomena of blanking and burst. You want your equipment to be synced, that is to be on the same line in different videos at the same time, especially during live switching. If one camera is scanning line 500 and another is scanning line 120, you will see a visible jump on screen when you switch between them. (However, Video Toaster will sync all but the worst signals.) The same is true for color burst, you want the color reference for your inputs to match so that strange shifts in color do not occur when you switch between sources.

Chrominance Signal

Vectorscopes work well with a color bars signal while you adjust the signal with a processing amplifier. Each bar of the color bars signal creates a dot on the vectorscope's display. Where these dots fall in relation to targets in the graph and the phase of the burst vector give you information about the status of the chrominance (color) signal.

Color Bars and the VectorScope

When you send a color bars test signal to the vectorscope, you should see:

- A bright dot in the center of the display
- Color burst straight out on the horizontal axis extending to the 75% mark.
- Dots in the targets for each of the colors in the color bars.