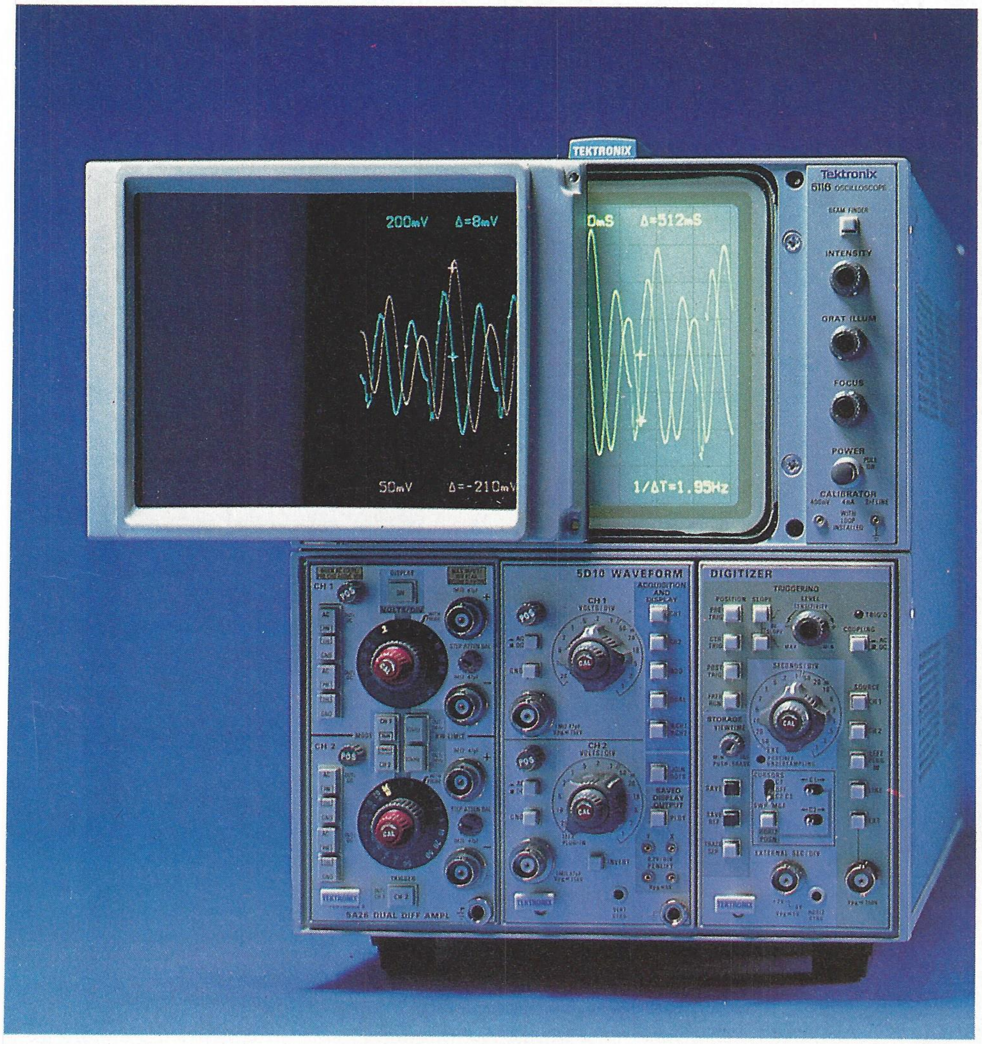
# Color Comes to Scope Display

A few minor modifications turned a monochrome oscilloscope into one with a color-coded display.




*1. **The CRT in green** is converted to a three-color CRT with the addition of the Liquid Crystal Color Shutter, shown sliding off the 5116.*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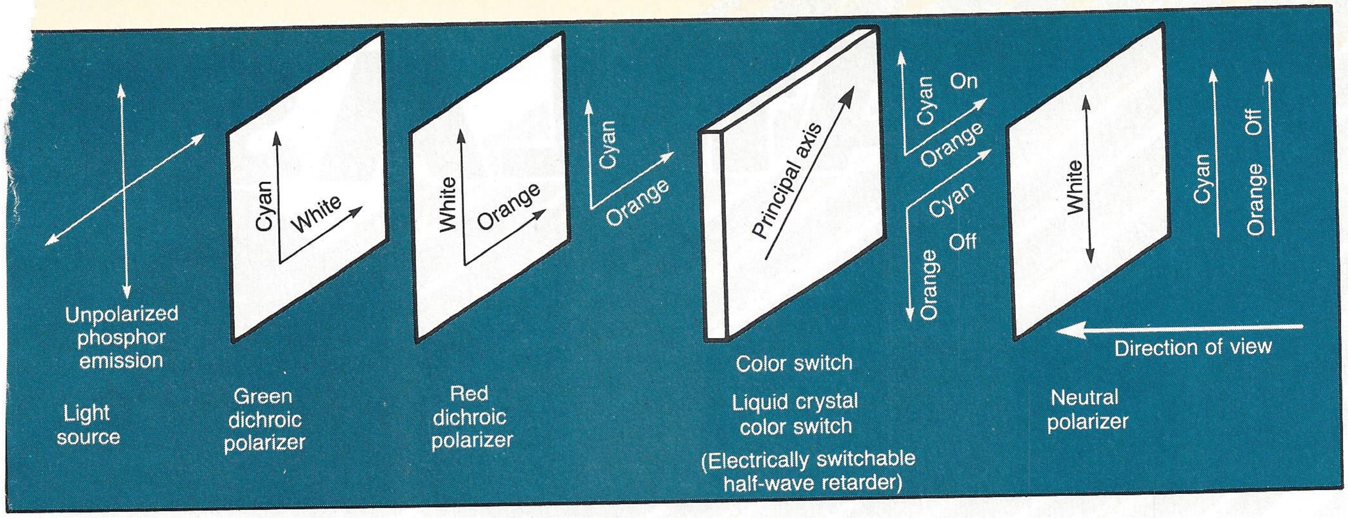
Until now, the only practical way to color code an instrument display has been through the use of a shadow-mask CRT. While this approach is acceptable in many applications, it does not offer the resolution required for oscilloscope waveform measurements. Now, however, a new technology called the Liquid Crystal Color Shutter (LCCS) has been teamed with a high-resolution monochrome CRT to bring color to a scope display.

An important feature of the color shutter is its ability to be easily integrated into an existing product with a monochrome CRT. The 5116 color display oscilloscope is an enhanced version of its predecessor, the 5110, which uses a high-resolution monochrome CRT to produce waveform traces and alphanumeric measurement information. The transition from monochrome to color began with the selection of a CRT phosphor mix that peaks in the orange and cyan wavelengths. This requirement was easily met through two commonly available phosphors. The color shutter itself is only 8-mm thick and fits over the face of the CRT.

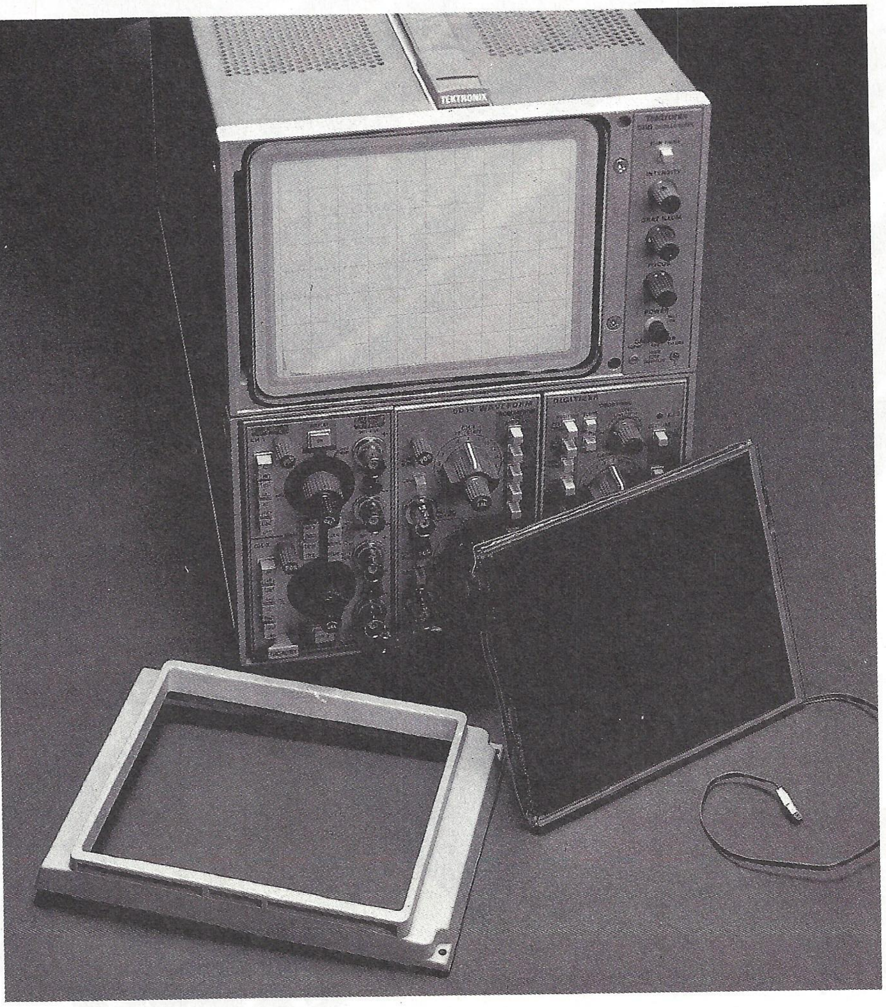
### *Built like a sandwich*

In operation, the color coding is produced in a two-step sequence which writes an orange field and then a cyan field. Persistence of vision allows this to appear as a flicker-free color display. In addition, any information that appears in both fields simultaneously will be displayed in a third neutral color, created by mixing the two primary colors. Further color variations can also be created by varying the CRT beam intensity while writing the fields. This has the effect of altering the mix of orange and cyan, thus changing the resulting colors.

Internally, the color shutter is




*2. **The liquid crystal** color switch assembly operation.*




*3. **The Liquid Crystal** Color Shutter outside of the bezel.*

composed of a series of polarizing filters with a device called the Liquid Crystal π Cell sandwiched between them (Fig. 1). First, two dichroic polarizing filters act upon light leaving the CRT and position the orange and cyan waveplanes at 90 degrees from each other. Next, the π Cell has the ability to rotate the orange and cyan waveform planes by 90 degrees when a specific AC signal is applied to the device. This means that when the AC signal is present, the cyan waveform plane will be lined up for transmission through the final neutral polarizer; when the signal is absent, the orange waveform plane is transmitted.

The logic required to write the two color fields and control the switching of the color shutter is contained in the 5D10 Waveform Digitizer, which occupies two of the 5116's three plug-in compartments. As a consequence, almost all of the logic required for color control was implemented through firmware within the 5D10, which meant the color control function imposed minimal additional mechanical and packaging requirements. The control pulse that switches the color shutter is sent from the 5D10 to a separate circuit board mounted in the mainframe. This circuitry generates the actual drive signal required by the color shutter: an AC square wave of about 1 kHz and approximately 30 V peak to peak.

Another requirement when applying the color shutter to the 5116 was the need for backlighting of the display. This was necessary because of the high contrast ratio produced by the CRT color shutter operation. Backlighting was achieved by a green-tinted light pipe which simultaneously provides backlighting and gradual illumination.

To meet EMI requirements, an indium tin oxide (ITO) coated glass faceplate was added to reduce emissions. (The CRT acceleration voltage was increased slightly, increasing the brightness in order to compensate for the attenuation of the color shutter.) Finally, a new bezel was required to accommodate the addition of the color shutter.

In all, the modifications required to convert the 5110 monochrome scope into the color-coded 5116 were relatively minor. The color shutter's compact physical size, its relatively simple drive-circuitry requirements, the use of a conventional monochrome CRT and the fact that most of the color generation control can be implemented in firmware, make the Liquid Crystal Color Shutter a suitable candidate for use in instruments like the 5116. ■

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