SERVICE SCOPE

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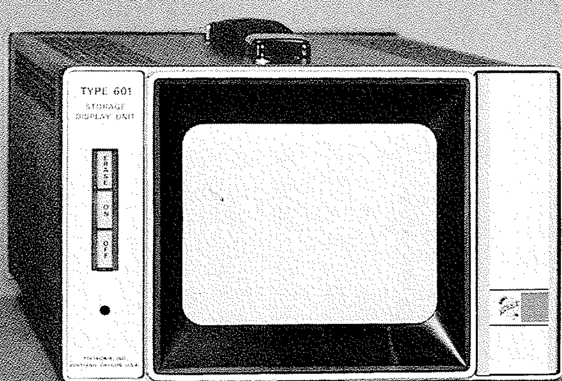

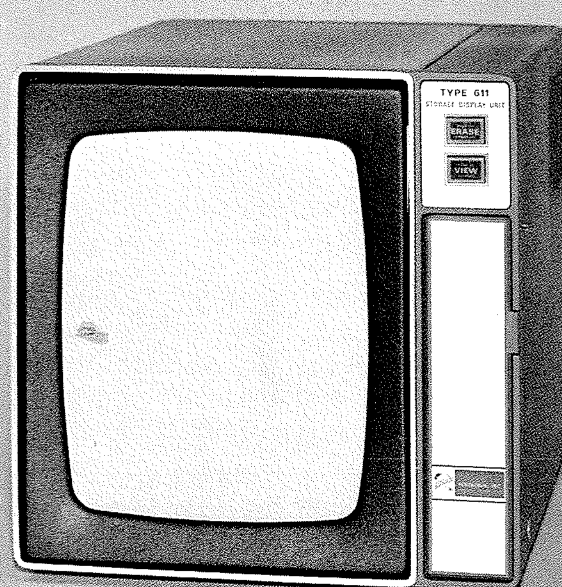

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A NEW VECTORSCOPE

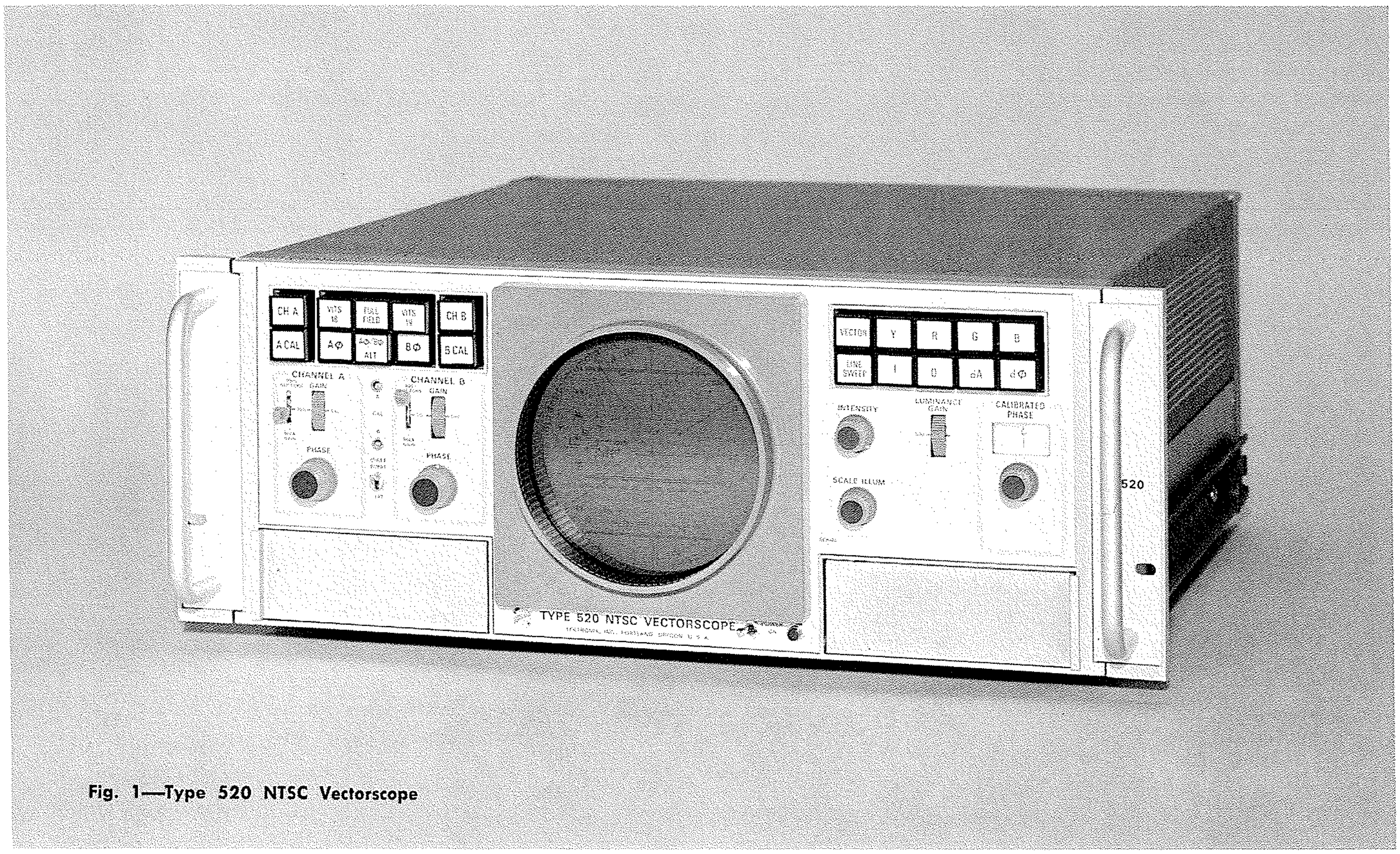


Fig. 1—Type 520 NTSC Vectorscope

INTRODUCTION

Color TV has caused Television Broadcast facilities to expand at a rapid rate. The resulting increase in the quantity and complexity of studio equipment has created a need for more versatile, easier to use, measuring equipment. Oscilloscopes are extensively used in the TV Broadcast industry as program monitors to measure picture levels, as troubleshooting devices to isolate equipment malfunctions, and as a measurement tool to determine waveform compliance with FCC Standards.

The studio operator now routinely verifies or adjusts a variety of parameters that were not required with black and white equipment; burst phase, I, Q, burst level, color bar phase, luminance to chrominance level and others.

In addition to the variety of color system setup requirements, greater emphasis is being placed on in-service monitoring of picture quality. Signal distortion limits which define acceptable picture quality are well established. Suitable test signals have been developed to check distortion; i.e. NTSC Color Bar Test Signal, Linearity stair-step, etc. Using these standard test signals as reference values, quantitative measurements of picture quality are readily made. However, certain signal distortions—particularly differential phase may be difficult to identify or diagnose.

NEW VECTORSCOPE

A new Vectorscope was developed, to assist the Broadcast Engineer and Technician in making these color measurements. The new Tektronix 520 NTSC Vectorscope (Fig 1) was designed with emphasis as an "operating" instrument rather than a special test oscilloscope used only to identify or solve special video problems.

The new oscilloscope is designated as a "vectorscope", however, the addition of a luminance channel has extended the measurement versatility to include most of the routine checks required in a color camera chain.

While measurement versatility is important when considering the purchase of any piece of equipment, ease of operation and long term reliability are equally important. Through special design efforts the Type 520 Vectorscope provides the user with stable drift-free displays at the touch of a button, without sacrificing measurement resolution or accuracy.

PUSH-BUTTON OPERATING CONVENIENCE

The push-button operating controls are arranged into two groups—one for signal selection and one for measurement display mode. All controls unnecessary for specific measurement are automatically disconnected from use to eliminate front-panel confusion. Controls such as the CRT display focus and positioning controls which require only periodic adjustment are located behind front-panel doors.

Fig 2 shows the typical vector display of a 75% saturated color bar test signal. Note the sharply defined spots which permit increased phase-angle resolution, particularly useful for detecting phase jitter or very small phase errors.

Fig 3 illustrates the comparison of two signals on a time-shared basis. Channel A is displayed for two scanning lines and channel B displayed on the next successive two scanning lines. The time-shared signals appear as if they were being displayed on a dual-beam oscilloscope. The time difference between the two input signals normally causes a phase-angle displacement between the two displays (Note Fig 3). This condition is normal and is due to subcarrier reference in the instrument being locked to only one of the signals. By adding a second phase-control knob to the front panel and time sharing its operation with the first phase control, the burst of each input signal can be independently rotated to the X axis permitting an overlay of the vectors for direct comparison. For example, Fig 4 illustrates the input and output waveforms of a distribution amplifier, with intentional distortion, applied to Channel A and Channel B inputs respectively. Differential phase and differential gain can easily be seen to exist on the yellow, cyan and to a lesser extent, the green, red and magenta vectors. Only slight differential phase is evidenced by the blue vector. While this illustration is somewhat severe, note that the differential gain is more severe than the differential phase—a valuable clue when determining the cause of the distortion, such as clamping failure in an amplifier.

DIFFERENTIAL GAIN AND DIFFERENTIAL PHASE

One of the more familiar applications of the vectorscope is the measurement of differential phase and differential gain. The Type 520 Vectorscope provides these measurement capabilities quickly and accurately at the touch of a button. Fig 5 illustrates the Differential Gain operating mode using a modulated stairstep waveform. A different graticule is used to measure differential gain than was used to make the measurement in Fig 4. The IRE Graticule and the parallax-free vector graticule are in place but each graticule is selectively illuminated when the button for the desired measurement is depressed. The one percent error on the tenth step (counting from left to right) is easily observed.

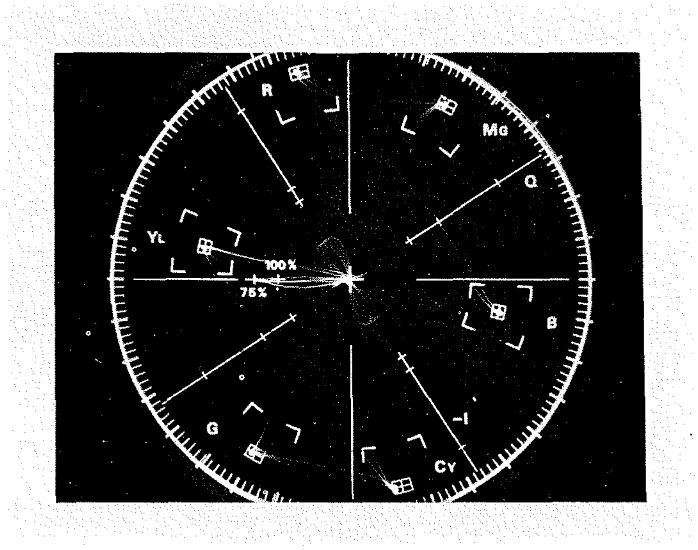


Fig 2—Vector display of 75% saturated color bar test signal

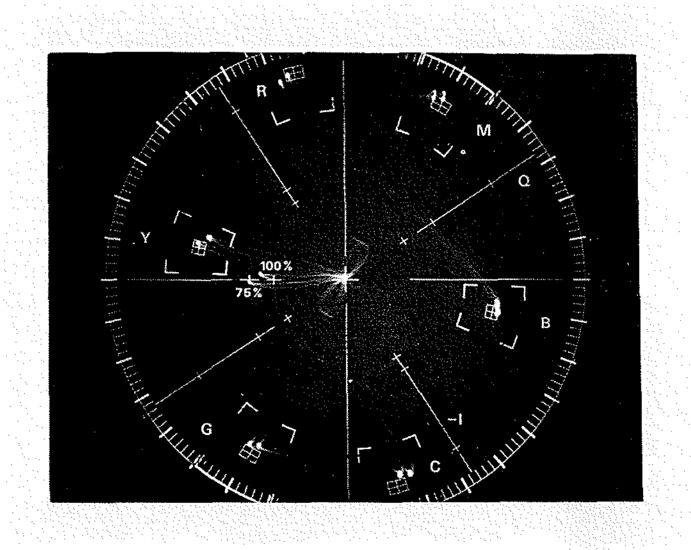


Fig 3—Vector display with channel A and B time-shared

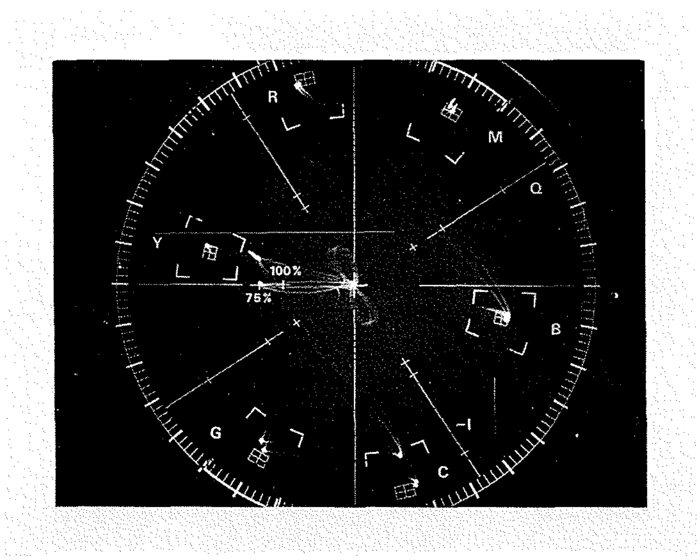


Fig 4—Vector display of input and output waveforms from a distribution amplifier

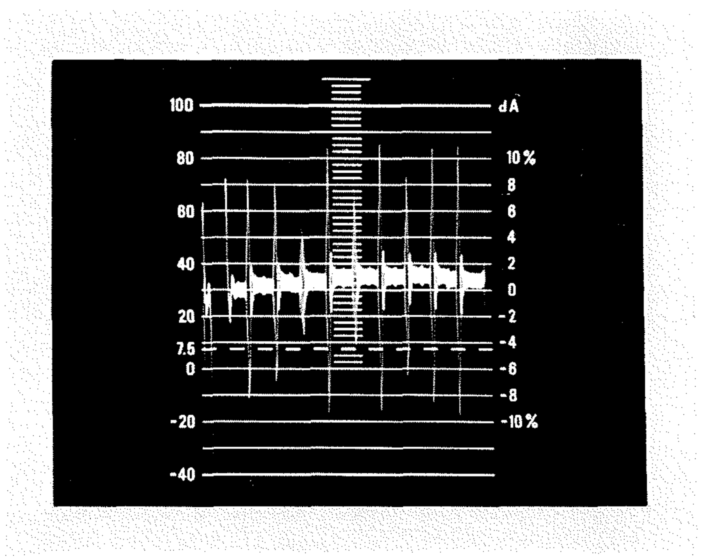


Fig 5—Differential Gain display using a modulated stairstep waveform

When the d ϕ (differential phase) button is depressed, the display is automatically repositioned to the center of the CRT and the graticule illumination removed. The measurment is then taken from the calibrated phase shift dial and the CRT display now serves only as a null indicator. Since considerable amplifier gain is required to resolve phase differences of 0.2 degree or less, small amounts of noise existing on either the applied signal or in the vectorscope will make display interpretation difficult. Display interpretation is simplified by alternately inverting the display to produce the mirror image observed in Fig 6. Any noise on the display (as evidence by a wide trace) can then be averaged out by simply adjusting the overlayed traces for minimum trace width. In Fig 6 each step has a phase transient in the middle amounting to about 0.09°.

NEW MEASUREMENT CAPABILITY

The Type 520 Vectorscope utilizes the luminance portion of the composite color signal to permit measurement of the transformed red, green and blue picture values which normally appear at the picture tube of a color monitor. The Y (or M) luminance signal and the chrominance signal are transformed at the receiver into red, green and blue picture components. Currently, the only means by which the transformation can be verified is by observing the display from the color picture tube itself. Subjective evaluations of picture quality made from color bars viewed directly on a color monitor are influenced by several variables:

1) Phosphor light output efficiency is reduced with age or usage.
2) Color response of the human eye varies from viewer to viewer making consistent readings difficult.
3) Picture monitor characteristcis may vary.
4) Small error differences between the luminance and chrominance waveform amplitudes are almost impossible to detect without using picture comparison techniques.

MEASURING Y, R, G, and B

Measurement of the transformed signal is made by selecting one of four buttons labeled Y, R, G, B. These buttons correspond to luminance, red, green and blue video displays.

When saturated colors (75% or 100%) are displayed on a picture monitor, the monitor electron guns are either on or

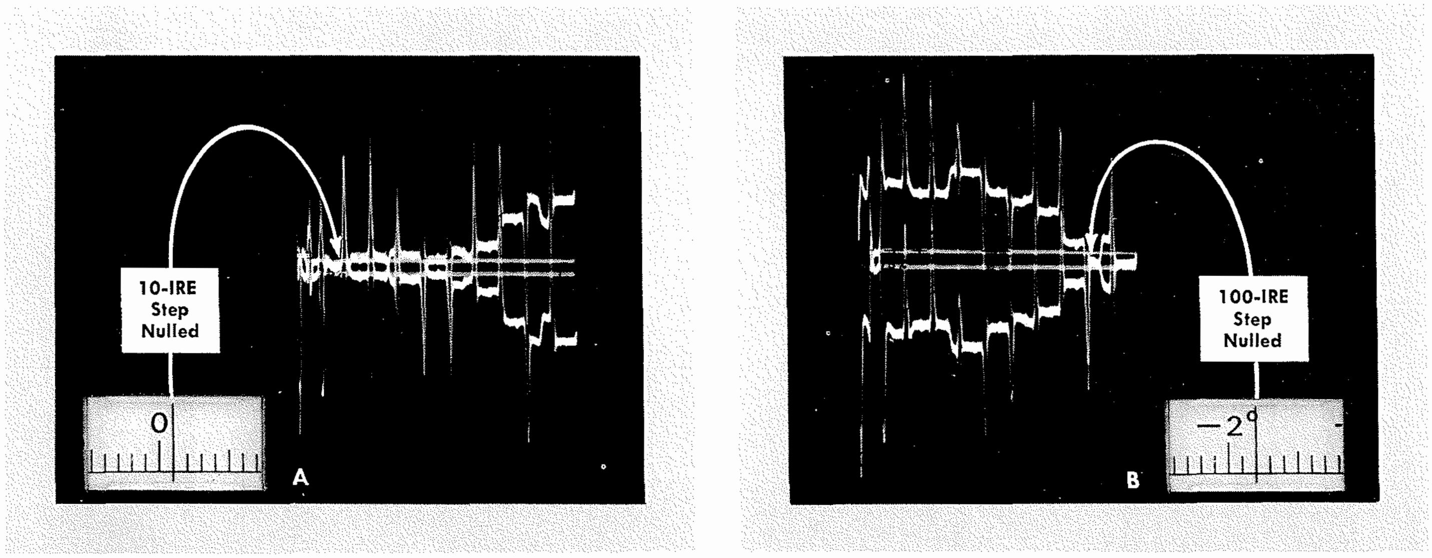


Fig 6. Differential Phase measurement using a modulated stair-step signal. Dial reading A to dial reading B indicates 2.1° differential phase.

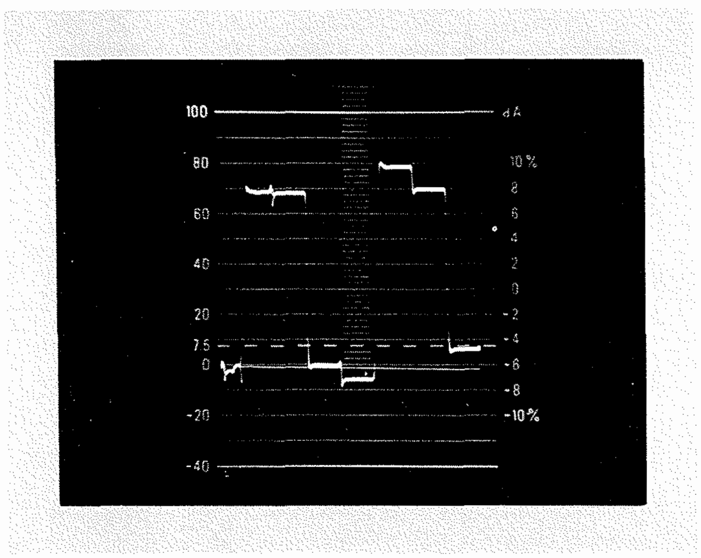


Fig 7—Red values of NTSC Color Bar Test Signal with magenta and red bars oversaturated

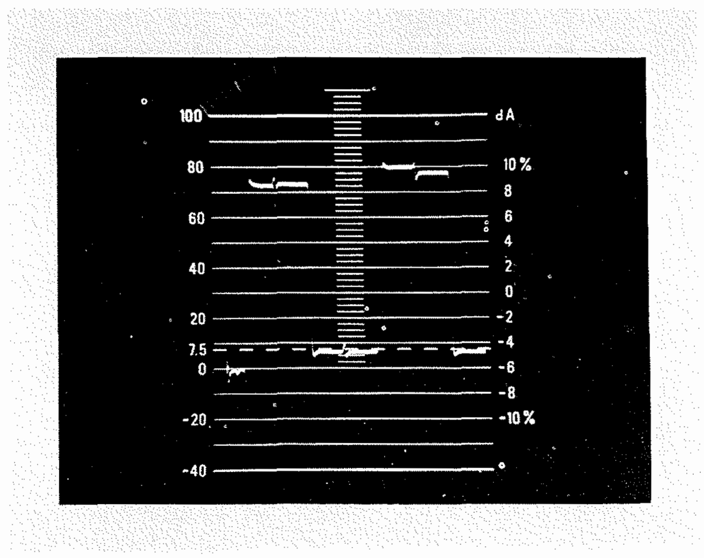


Fig 8—Red values of the NTSC Color Bar Test Signal with luminance amplifier nonlinearity in the white region

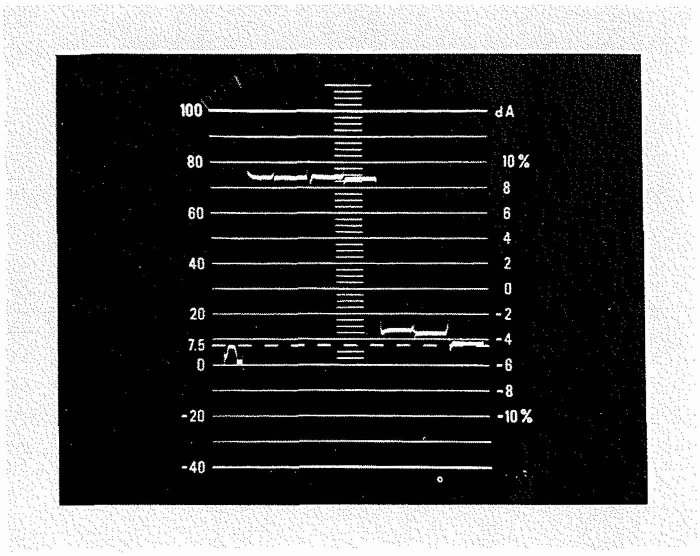


Fig 9—Green values of NTSC Color Bar Test Signal

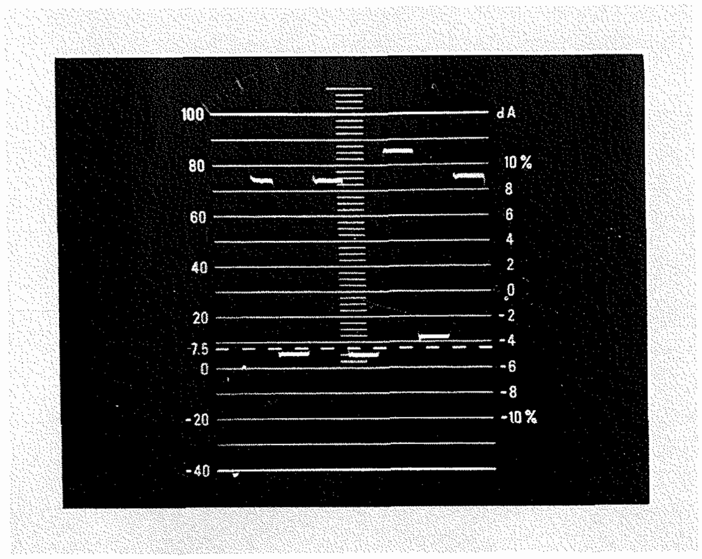


Fig 10—Blue values of NTSC Color Bar Test Signal

off as primary and complementary colors are reproduced. During the primary color "Red", for instance, the red gun is on and green and blue guns are off. The complementary color of "Red" is "Cyan", which is reproduced by the green and blue guns with the red gun held off.

In Fig 7 the red (R) "image" is displayed on the vectorscope using the "standard" decoded color bar signal. The colors are arranged from the left of the display to the right in order of descending luminance—grey, yellow, cyan, green, magenta, red, and blue. Note that the magenta and red bars are over-saturated, however, the error is not easily detected by the eye on the picture monitor because the error is not too large. Observing the vector display of the same signal in Fig 2 indicates that the chrominance portions of the encoded color bars are correct. Therefore the luminance levels for magenta and red must be incorrect —too high in this case. In this illustration, since only two color bars are affected, the error is not due to non-linear luminance gain but simply because the luminance pedestal levels of the color bar generator are incorrectly adjusted.

Fig 8 shows the same display except that the luminance amplifier is non linear in the white region. The *effect* however, is not apparent on the grey and yellow bars but on the magenta, red and blue bars and is due to the luminance amplifier gain having been adjusted with a white pedestal.

Fig 9 illustrates the green (G) display of the same waveform. Note the luminance distortion previously observed affects the green more seriously. Green should be off during the last three bars. While the slight presence of green during the red bar will cause the displayed red to appear orange to the eye (because red is a primary color) the magenta error would be more difficult to detect in the reproduced picture.

Fig 10 shows the blue picture display which is not as seriously affected by luminance errors.

SUMMARY OF 520 NTSC VECTORSCOPE CHARACTERISTICS

Push-button controls provide new operating convenience and permit rapid selection of displays for quick analysis of television color signal characteristics. Amplitude calibrated displays of chroma and luminance are assured with internal calibration test signals to verify amplifier accuracy. The luminance component of the composite color signal is derived for displaying separately or in combination with the red (R), green (G), or blue (B) components.

Two 0° to 360° phase-shifters provide independent phase control of channel A and B. Phase differences caused by unequal signal paths are easily cancelled. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length provides excellent resolution for making small phase angle measurements. Video cable lengths can be accurately matched for time delay at the color subcarrier frequency to less than 0.5° phase difference. Differential gain and differential phase measurement capabilities are provided with accuracies within 1% for gain and 0.2° for phase.

A digital line selector permits the display of a single line Vertical Interval Test Signal from a selected line of either field 1 or field 2.

A parallax-free vector graticule, or IRE graticule, is automatically selected and edge-lighted concurrent with operating mode selection. All silicon solid-state design provides long-term reliability and cool, quiet operation.

The Type 520 NTSC Vectorscope is available in electrically identical cabinet or rackmount models.

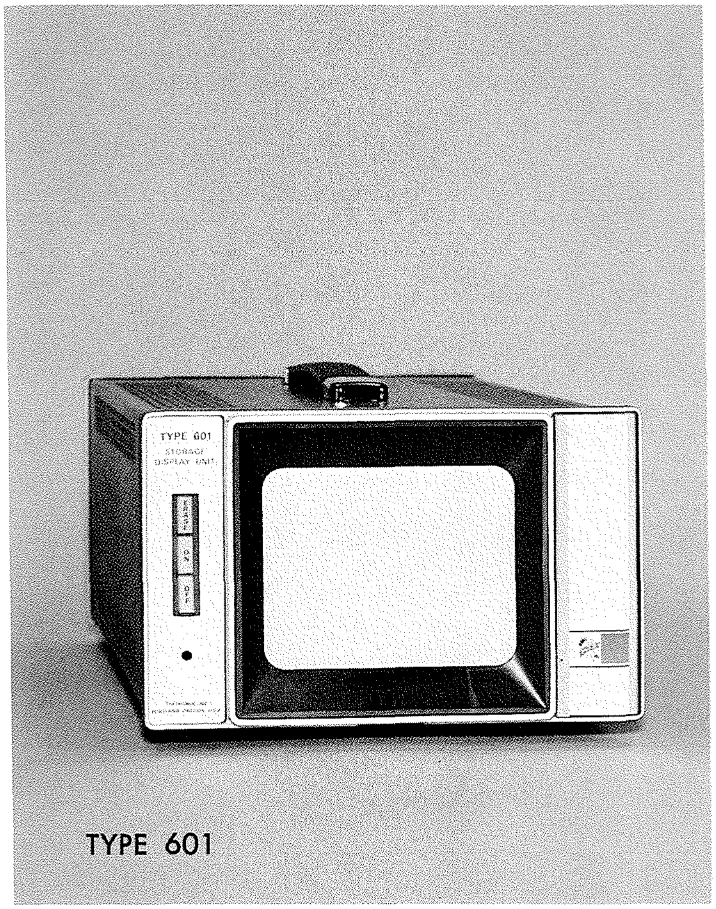
A more complete description of this instrument is found in the Tektronix New Products Catalog Supplement recently distributed.

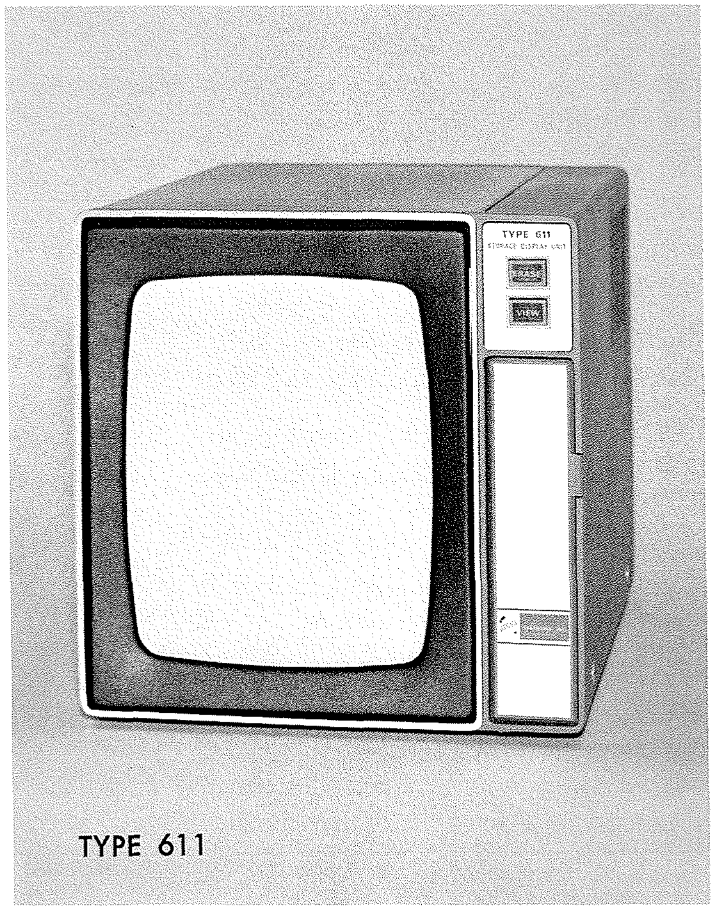
TYPE 520 NTSC VECTORSCOPE $1850

TYPE R520 RACKMOUNT $1850

U.S. Sales Price FOB Beaverton, Oregon

STORAGE DISPLAY INSTRUMENTS





INTRODUCTION

The Type 564 Storage Oscilloscope, a measuring instrument, served as an excellent exploratory tool to determine the advantages of bistable-storage cathode-ray tubes as computer readout devices. Several groups experimented with the bistable storage tube in this application and the results show that a bistable storage tube when used with the appropriate periphal equipment provides high-resolution, non-refreshed, alpha-numeric and graphics displays without flicker or fade.

A sequence of events occurred as the computer market developed that contributed toward the development of the bistable storage tube as a computer display device.

(1) Computer usage was being discouraged by man-to-machine interface problems, that is, a problem is submitted through a programmer, a misunderstanding is found after a period of time, the problem is resubmitted, etc.

(2) Larger and faster computers were developed to help offset computation costs.

(3) Techniques to improve computer time utilization were developed.

(4) Computer time-sharing appeared to be a solution to efficient use of computer time but because of input-output limitations, many parallel or time-shared users are required in order to keep the computer busy.

(5) Time-sharing a central computer requires remote terminals convenient to the users.

(6) The cost per remote terminal for time-sharing application must be sensibly low.

(7) A major economic consideration of remote terminals is local memory cost, especially if arbitrary format alpha-numeric and graphic capabilities are required. It is not economically wise to provide display refreshing from the computer memory, and even with a buffer memory the communication link bandwidth may be too narrow to allow refreshing a display at above flicker rates.

(8) For applications where flexible format is required and large amounts of data are to be presented, the Tektronix simplified direct-view bistable-storage CRT provides an economic solution to the memory/display problem.

A NEED FOR NEW INSTRUMENTS

The interested groups who experimented with the Type 564 Storage Oscilloscope as a computer remote-terminal readout device were encouraged by the results obtained and indicated the need for an instrument optimized for computer display rather than measuring applications. Producing an instrument specifically for computer readout purposes required different design objectives than those for measuring devices.

(1) Writing-speed parameters could be traded off for more uniform and smaller spot size.

(2) Plug-ins replaced with built-in amplifiers resulting in a more compact unit.

(3) The Z axis modified for "on-off" operation.

(4) The CRT target modified for improved isolated stroke or dot appearance (a key contribution).

NEW DISPLAY DEVICES

The recently announced Types 601 and 611 Storage Display Units were designed to be used as integral parts of computer remote terminals. When driven by the appropriate periphal equipment these units will present non-refreshed displays of alpha-numerics and graphics without flicker or fade.

The Type 601 and 611 are intended for *individual* use, *not* group viewing. The high resolution of the 601 and 611, require the viewer to sit fairly close to the instruments in order to resolve the displayed information.

5-INCH STORAGE DISPLAY UNIT

The Type 601 Storage Display Unit features a new, Tektronix developed, 5-inch bistable-storage display tube, providing clear, non-fading presentations. Resolution in an 8-cm x 10-cm display area is 100 stored line pairs in the vertical axis and 125 stored line pairs in the horizontal axis providing an information capacity of about 400 alpha-numerics. The information storage rate is 100-thousand dots per second and time required to erase the stored information is 200 ms. All solid-state modular circuit design insures long-term stable performance.

The operating functions are remotely programmable by simply grounding program lines at a rear-panel connector. Access to X, Y and Z inputs is through rear-panel BNC connectors or a remote program connector.

11-INCH STORAGE DISPLAY UNIT

The Type 611 Storage Display Unit features an 11-inch magnetically deflected, bistable-storage display tube developed by Tektronix. This new storage tube offers high information density and excellent resolution on a 21-cm x 16.3-cm display screen. The information capacity of the Type 611 is about 4000 alpha-numerics. Dot settling time is 3.5 μs/cm plus 5 μs and dot writing time is 20 μs. The time required to erase and return to ready-to-write status is 0.5 seconds.

The operating functions are remotely programmable through a rear-panel connector with access to X, Y and Z inputs through rear BNC connectors or the remote program connector. A "Write-Through Cursor" feature permits positioning the writing beam to any point on the display area without storing the cursor or destroying previously stored information. Write through for alpha-numerics and graphics can be done by shortening the unblank pulse duration from the normal value of 9 μs (Type 601) or 20 μs (Type 611). This mode of operation is useful for manual graphics, with the aid of equipment like the Rand Tablet or with an SRI Mouse. An internal test signal provides a quick check of focus, storage and general performance status of the instrument.

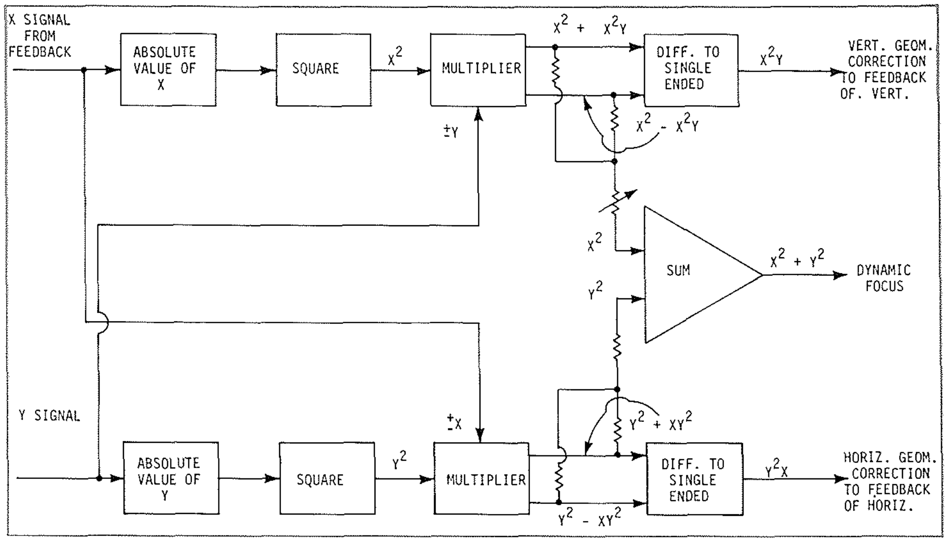


Fig 1—Block diagram of Type 611 pincushion and dynamic focus correction.

SOME DESIGN CONSIDERATIONS

Compatibility between the Types 601 and 611 is maintained with regard to the input connectors and selection of common functions, such as erase. However there are differences which should be kept in mind. The Type 601 has $\pm$ 6 cm continuously variable position controls for X & Y, while the Type 611 has three position switches that permit the operator to select one of nine beam resting positions. Variable controls provide a $\pm 10\%$ range for small adjustments of each position. The limited variable range was chosen because of the more stringent drift requirements of the Type 611. Both units have internal gain calibration adjustments to set the full screen deflection voltage within 2% of 1 volt. Both units have provision for other less-sensitive deflection factors.

Trace alignment of the two instruments is different. The Type 611, using an electromagnetrically-deflected tube, has an external deflection yoke which may be rotated to align the traces; orthogonality is a function of how well the yoke was manufactured. The larger screen requirement of the Type 611 requires magnetic deflection through an angle of 70°, in order to keep the length of the instrument reasonable (the Type 611 is about 20% longer than the Type 601). The wide magnetic deflection angle of the Type 611 CRT, together with the flat faceplate, requires correction to the deflection geometry, linearity and focus. Without going into the mathematical details, it can be said that both pincushion and dynamic focus require squared deflection terms. Figure 1 shows the block diagram. The squaring circuit is a single FET. The multiplier is a differential pair driven from a current source. Thus with comparatively simple circuitry, the circuit generates the required X^2Y and Y^2X for pincushion correction, and $X^2 + Y^2$ for focus correction. The dynamic focus summing circuit gets its input from the multipliers, rather than the squaring circuits directly, because of the signal levels involved; that is, the output of the multiplier is at a more convenient level than the squaring circuit. This combination of corrections appears to be new, and unexpectedly simple.

The Type 601 with an electrostatically deflected tube has a *unique* method of correction; instead of the usual rotation coil, signals are independently mixed from the X and/or Y amplifiers into the Y and/or X amplifier, thus introducing tilt and/or slant as necessary to correct trace alignment and/or orthogonality. Because of this cross-mixing, the use of the Type 601 as a waveform monitor should be restricted to applications involving bandwidths below 100 kHz. The smaller deflection angle and lower resolution requirement of the Type 601 make dynamic scan or focus corrections unnecessary.

SUMMARY

The first instrument to use the Tektronix developed bistable storage tube was the Type 564 Storage Oscilloscope, introduced in the spring of 1962. Since that time, the Type 564 has found extensive use in a multiplicity of applications including information display. Early experiments with the Type 564 as an information display device proved the validity of the concept and helped define new storage tube requirements; the Type 601 and 611 Storge Display Units are the first display instruments to employ these new storage tubes.

A more complete description of these new instruments is found in the Tektronix New Products Catalog Supplement recently distributed.

Type 601 Storage Display Unit .. $1050

Type 611 Storage Display Unit .. $2500

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