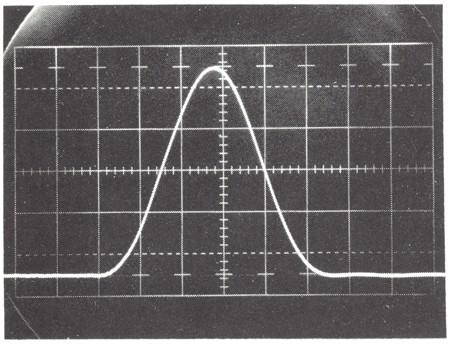


Fig. 1 The sine-squared pulse widely used in testing TV and other bandlimited systems.

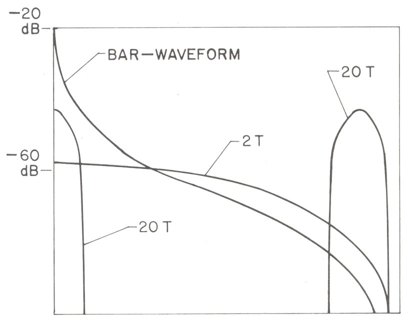


Fig. 2 Energy distribution of sine-squared 2T, 20T and bar signals.

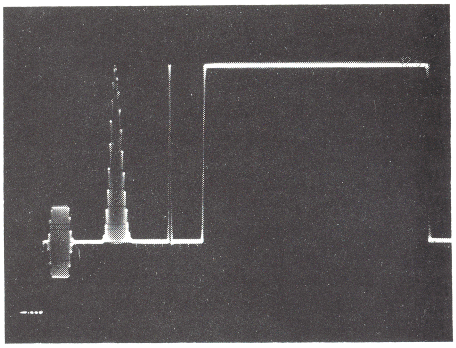


Fig. 3 Sine-squared pulse and bar with modulated 20T pulse.

1) Being an analog signal, serious picture impairments result from small non-linearities in any one of several transfer characteristics. Both PAL and SECAM color systems were developed to reduce picture impairment due to these non-linearities.

2) The signal is band limited due to the scarcity of RF spectrum vs demand. Each TV channel is 6-9 MHz wide. TV is the greatest consumer of the spectrum below 1 GHz and uses significant spectrum above 1 GHz.

3) The mean level of signal is not constant, i.e. average brightness of the TV scene represents a DC video signal level. This must be transmitted with accuracy.

While the highest video frequency is limited by both spectrum conservation and noise, the TV signal is not considered in the frequency domain for measurement purposes. Video waveforms are nearly always non-sinusoidal. Hence, time domain measurements permit measurements which can be correlated with picture impairments such as smear or streaking. For example, tilt in a 10 ms squarewave produces objectionable streaking from left to right; in a 10 ms squarewave, it produces a variation in picture shading from top to bottom.

The time domain may be conveniently broken up into four parts, each giving rise to differently perceived picture impairments:

1) Short Time Distortions (0.125 µs to 1 µs). These affect picture crispness or resolution, horizontally. Undershoots make the picture "soft" or blurry. Overshoots, if not too great in amplitude, tend to enhance picture sharpness. Ringing results in echoes or halos.

2) Line Time Distortions (1-50 µs). These cause horizontal streaking which is positive if due to overshoot or negative if due to undershoot.

3) Field Time Distortion (50 µs-16 ms). These cause shading in the vertical direction.

4) Long Time Distortions (> 16 ms)—cause flicker.

In television, the limit on bandwidth (4.2MHz in North and South America, Japan) makes the usual fast rise squarewave type of test signal of very limited usefulness. Such pulses, introduced into sharp cutoff systems, suffer out-of-band component attenuation which results in ringing in the output pulse at the approximate cutoff frequency (f_c) of 4.2 MHz. This behavior is predicted by theory; there is no need to obscure inband distortions with the out-of-band distortion.

The sine-squared pulse (Fig. 1) is widely used in TV measurements and in other band limited systems. It possesses negligible energy at frequencies above $f=\frac{1}{\text{h.a.d.}}$, where h.a.d. = half amplitude duration, or pulse width, as measured at the 50% points. It is important to note how its energy is distributed within its passband. This is shown in Fig. 2. At $f=\frac{1}{2\,\text{h.a.d.}}$, energy is at −60 dB, thus energy is rather evenly distributed across the passband.

In testing, where the response is not limited by a sharp cutoff at f_c, we use a pulse whose h.a.d. = 0.125 µs. Where the system does have a sharp cutoff characteristic (e.g. the broadcast transmitter, video tape recorder or CATV modulator or demodulator) we use a pulse of 0.25 µs h.a.d. These pulses are 1T and 2T pulses respectively. T, the Nyquist interval, is taken at 0.125 µs in the Western Hemisphere and Japan (where $f_c = 4.2$ MHz).*

The sine-squared pulse may be compared to impulse testing in time-domain reflectometry. The step type test signal corresponds with the "sine-squared bar" which is actually an integrated sine-squared pulse (See Fig. 3). Mathematically, the risetime, 10-90% amplitude, of an integrated sine-squared pulse = 0.96 of its h.a.d. Its energy spectrum is shown in Fig. 2. In actual practice, this test signal is usually generated by driving a very fast step signal of the desired width and repetition rate into a sine-squared shaping filter. Such filters were originally developed by Mr. W.E. Thompson in England about 1951 (See Fig. 4a).

Recently, Mr. Arend Kastelein of the Television Engineering Staff, Tektronix, Inc., designed very similar filters, but having somewhat improved properties.[1] These are used in nearly all TEKTRONIX sine-squared pulse formation circuits. Fig. 4 b compares the ideal sine-squared pulse with that of Kastelein's 9-pole filter.

It is possible to use the sine-squared pulse or bar to measure Short Time Distortion, one being the integral of the other. The bar is used to measure Line Time Distortion. To facilitate these measurements when using a television waveform monitor, special graticules are often used. Fig. 5 shows one such recently developed graticule[2], which will be available for the TEKTRONIX 529 Waveform Monitors. It is intended to measure the waveform distortion in terms of a picture impairment K factor. In such testing, the worst distortion of the bar establishes the picture

**On the European scene, T = 0.100 us to correspond with a nominal fc = 5 MHz (although some countries actually have somewhat higher bandpass limits).*

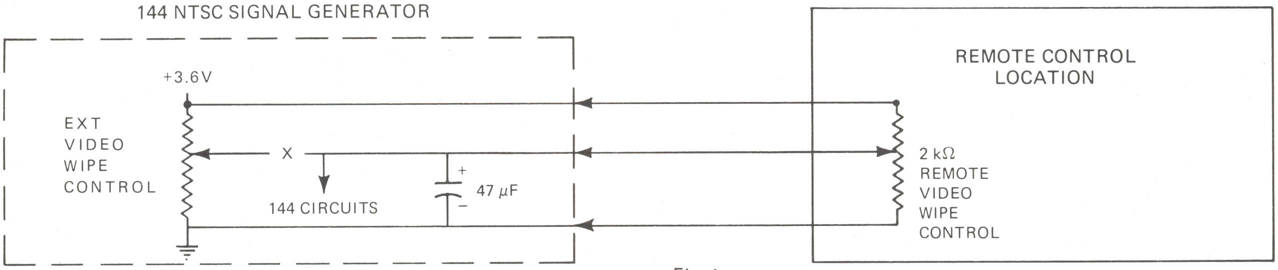


Fig. 1

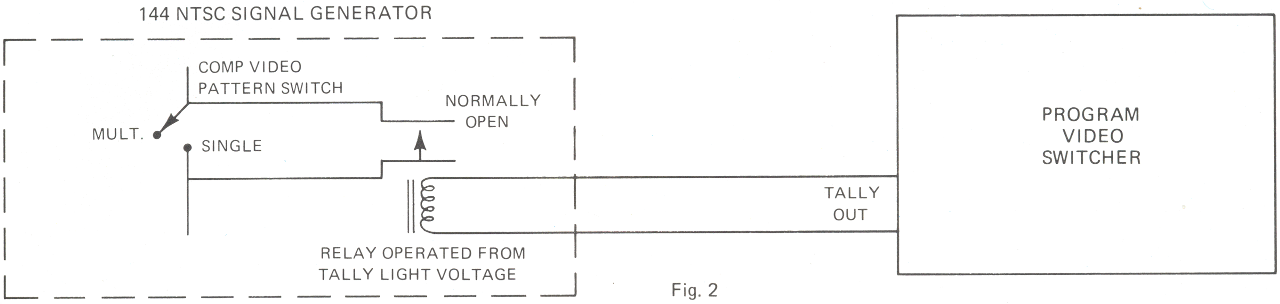


Fig. 2

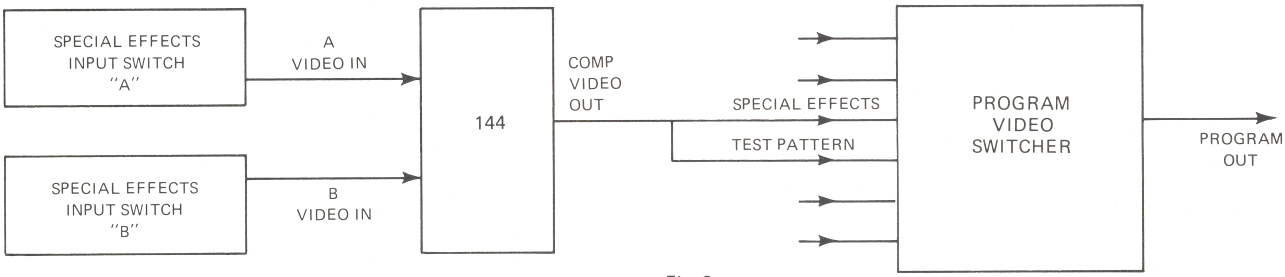
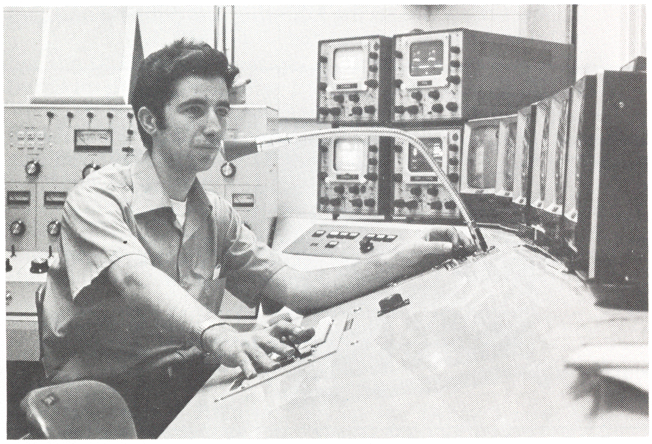


Fig. 3

voltage from the color bar input column. If the test pattern signal is desired, the relay closes the contacts of the PATTERN switch in the 144, and if it is desired to use it as an effects generator, the relay opens the circuit. See Fig. 2. Note that the PATTERN switch on the 144 must be in the MULT position for the relay to have any effect.

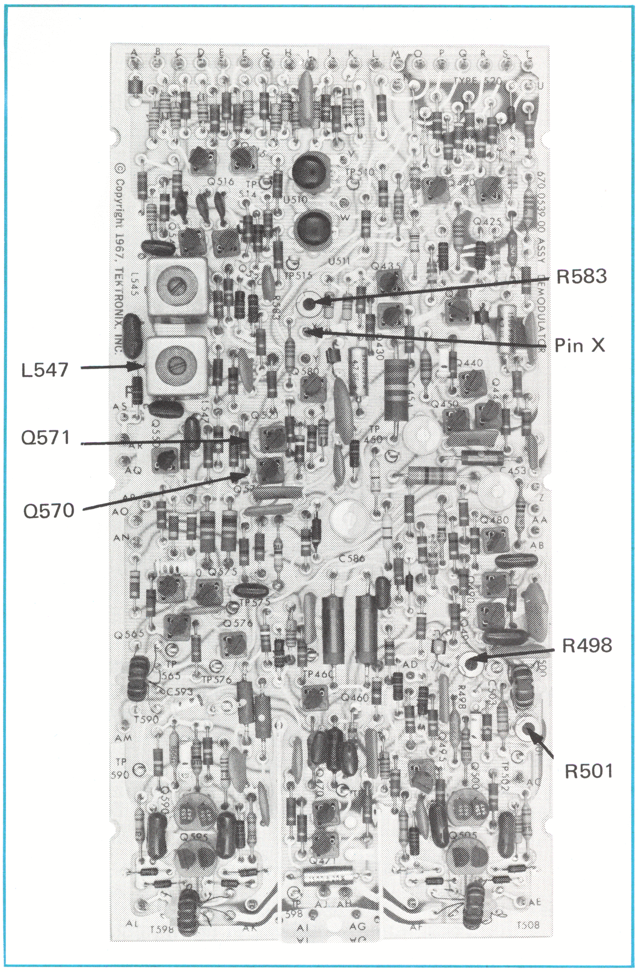
Since the composite video output appears at a single BNC connector on the rear panel of the 144, provision must be made at the video switcher to couple this single output to both the special effects and test pattern inputs of the switcher as in Fig. 3.

As an added benefit, the 144 can be programmed by front panel controls to insert VITS in the video output for on-the-air testing of video circuit functions and adjustments.



Stewart A. Rasmussen *— Stu started his career with Tektronix three years ago calibrating and troubleshooting production line instruments. From the test department, he moved to the communications department, and then to the education and training group. Here, a long-standing interest in TV and movie production blossomed into a new career for Stu when an opportunity came to work with the group producing video tapes and movies used for training at Tektronix.*

Stu is currently pursuing studies in this field at Portland State University. He is also a member of the Society of Motion Picture Television Engineers.



Demodulator Board test point and control locations.

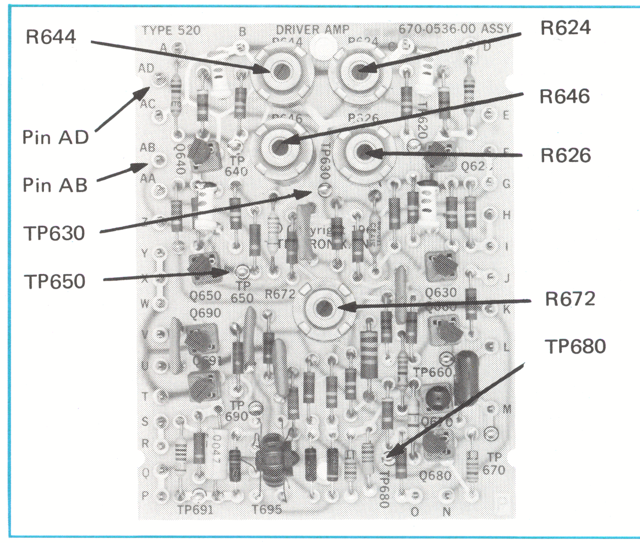
TP 630—Adjust R624 for 0 volts
TP 650—Adjust R644 for 0 volts
TP 680—Adjust R672 for +0.5 volts

5) Check the Unblanking Bias Adjustment:
Depress: VECTOR
FULL FIELD
A CAL
A circle will be displayed. Adjust R1478 on the rear panel of the 520 for uniform intensity of the circle.

6) Check the Common Mode Level Adjustments:
Depress: VECTOR
FULL FIELD
Set the INTENSITY control so the displayed spot doesn't burn the phosphor. Center the spot using the HORIZ and VERT POSITION CLAMP controls on the 520 front panel. Connect the VOM to TP980 on the Output Amplifier board and adjust R985 for +5.6 volts. Check TP870 and adjust R875 for +5.6 volts.

7) Check FOCUS and ASTIGMATISM setting:
The front panel FOCUS and rear panel ASTIGMATISM should be set for a well defined spot.

8) Check the BEAM ROTATE and ORTH adjustments:
Depress: VECTOR
FULL FIELD
A CAL
Remove the lead from pin AB on the Driver board. You should have a vertical line. Adjust BEAM ROTATE on

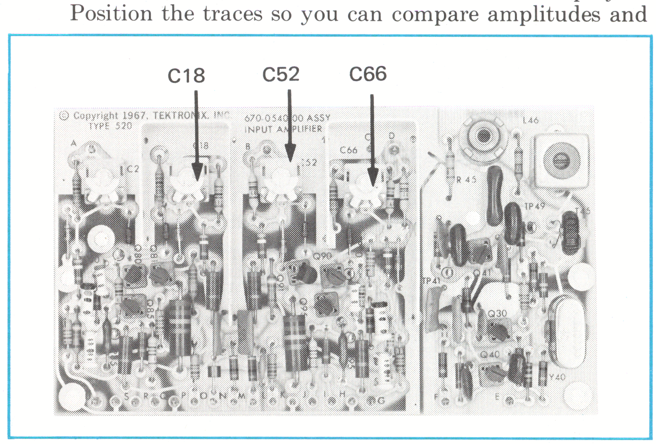


Driver Amplifier Board test point and control locations.

the front panel if necessary. Reconnect lead to pin AB and remove lead on pin AD. You should have a horizontal line. Adjust ORTH control on the rear panel if necessary. Reconnect lead to pin AD. The BEAM ROTATE and ORTH controls interact so recheck as needed

9) Check Burst Flag Timing:
Depress: VECTOR
FULL FIELD
CH A
AΦ
Feed composite video from the 140 NTSC Signal generator into CH A input on the rear of the 520. Terminate CH A and CH B loop-thrus with 75Ω. These terminations should remain in place for the remainder of the cal procedure unless noted otherwise. You should have a vector display. Set the A PHASE control so the burst vector is at the 90° position. Now depress the LINE SWEEP button. Turn down the intensity so you can see the brightened portion of the display and adjust the BURST FLAG TIMING control on the front panel for equal brightness either side of the peak of the waveform.

10) Check the Video Amplifier Gain:
a) Luminance Gain:
Depress: Y
FULL FIELD
A CAL
B CAL
You should have two calibrator waveforms displayed. Position the traces so you can compare amplitudes and



Input Amplifier board control locations.