INSTRUCTION MANUAL

Serial Number ____________

TYPE 520/R520 NTSC VECTORSCOPE

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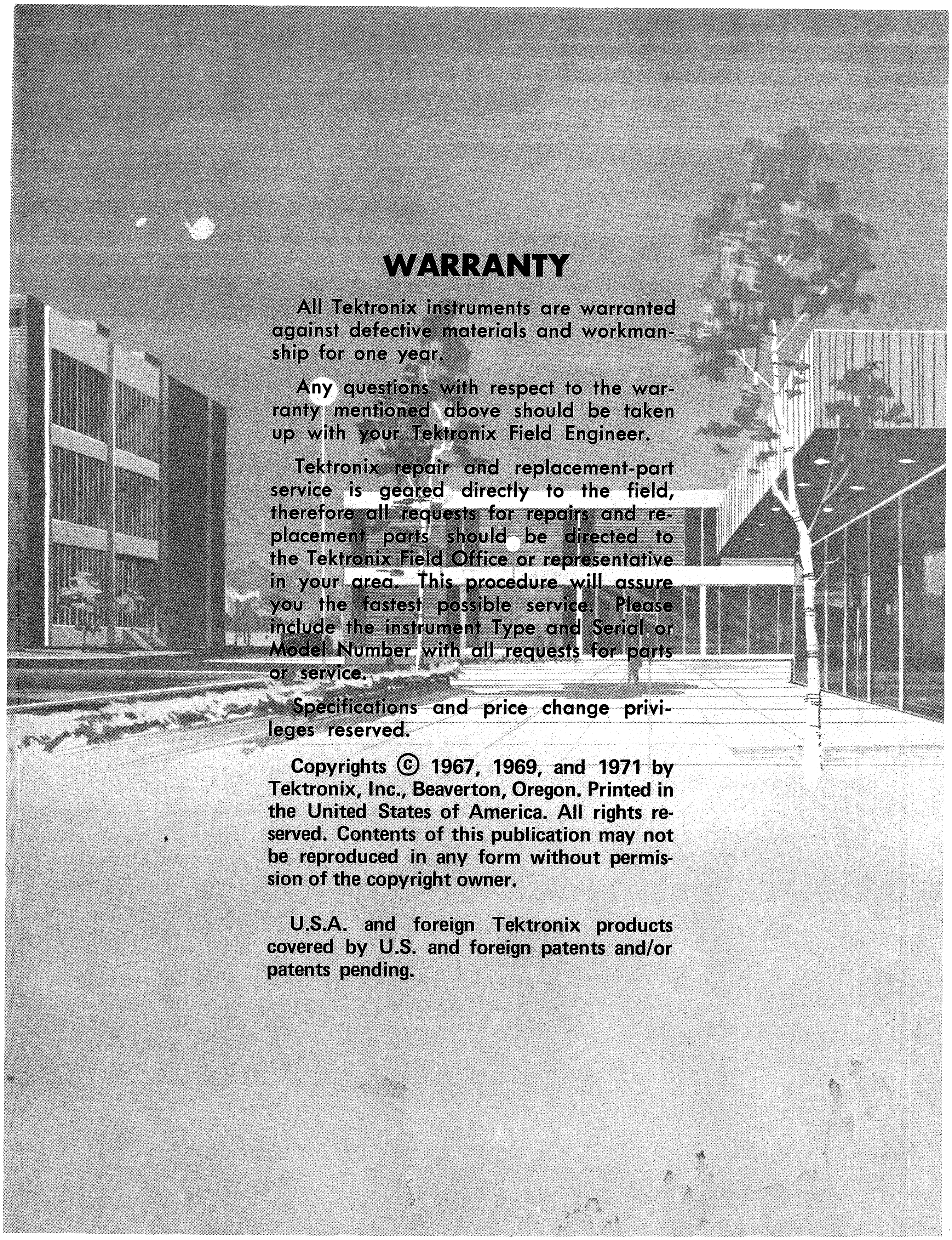


WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

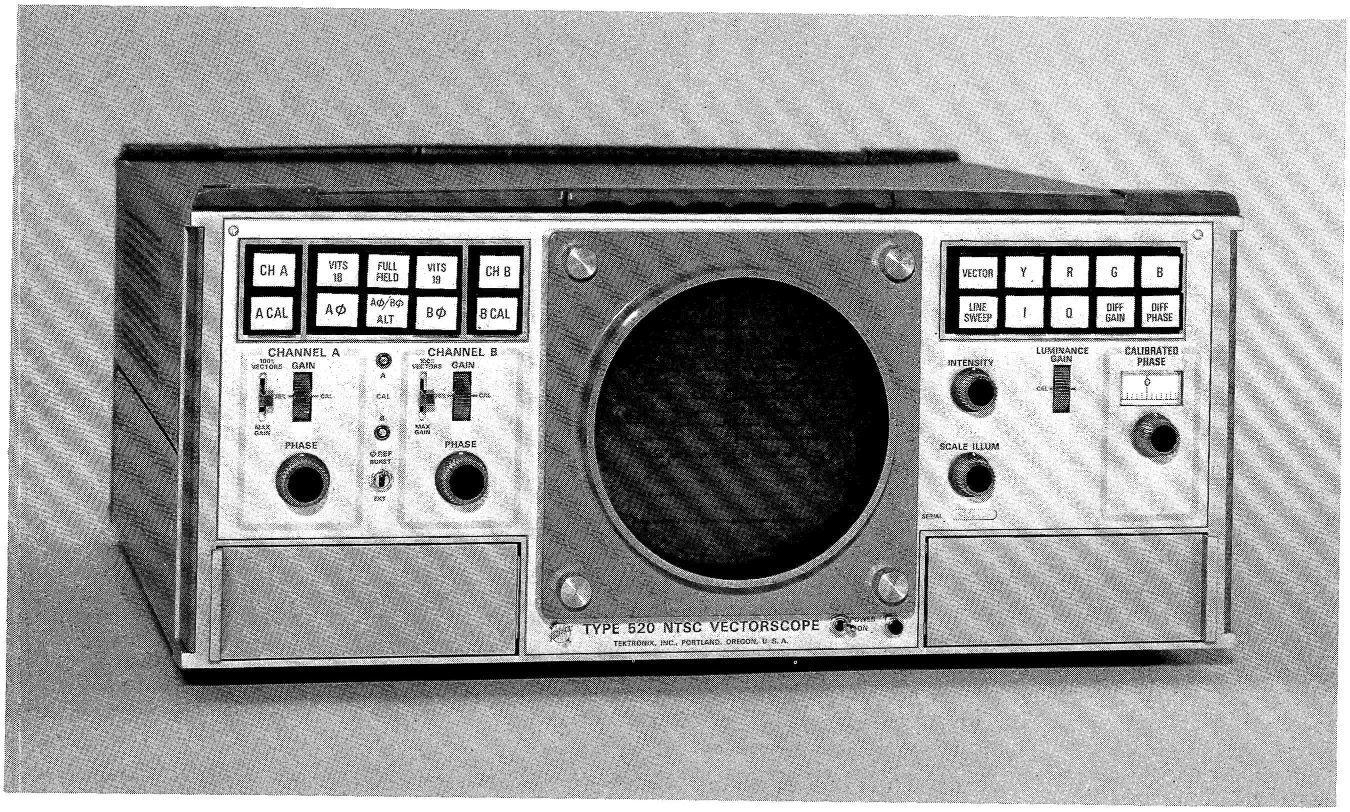
Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

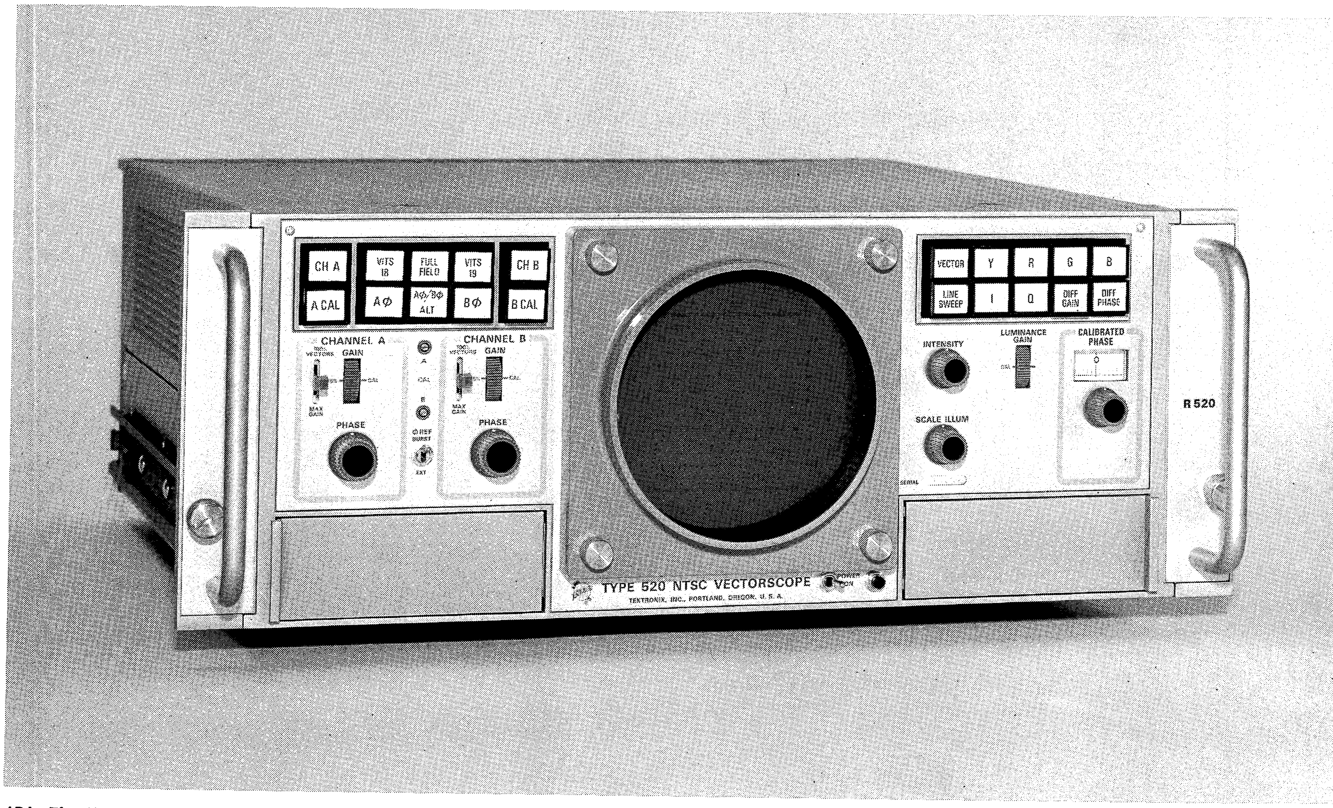
U.S.A. and foreign Tektronix products covered by U.S. and foreign patents and/or patents pending.

CONTENTS

Abbreviations and symbols used in this manual are based on, or taken directly from, IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of the manual.



(A) The Type 520 NTSC Vectorscope (bench model).



(B) The Type R520 NTSC Vectorscope (rackmount model).

Fig. 1-1. Both models of the Vectorscope are electrically identical. Mechanical parts are available from Tektronix, Inc. to permit easy field conversion from one type of Vectorscope to the other (see Section 10 in this manual).

SECTION 1
TYPE 520/R520 NTSC SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

The Tektronix Type 520 or R520 NTSC Vectorscope[1] is designed to measure luminance, hue and saturation of the NTSC[2] composite color television signal. This instrument uses silicon solid-state circuitry for low-wattage power consumption and cool operation. No fan is required; hence, instrument operation is quiet. The Type R520 is intended for continuous monitoring of the signal. Self-canceling push-button switches permit rapid selection of displays for quick analysis of the television signal characteristics, and to check the Vectorscope calibration.

The luminance channel in the Type R520 separates and displays the luminance (Y) component of the composite color signal. The Y component is combined with the output of the chrominance demodulators for R, G and B modes which are displayed at a line rate. The chrominance channel demodulates the chrominance signal to obtain color information from the composite video signal in VECTOR, LINE SWEEP, R, G, B, I, Q, DIFF GAIN and DIFF PHASE displays.

Horizontal displacement is a function of time in all modes except VECTOR. In the VECTOR mode a polar plot is displayed. The radius of a polar plot is a function of the peak-to-peak amplitude of the chrominance signal; the angular (phase) displacement is relative to the phase of the reference vector (burst).

Two inputs are provided which can be operated independently or on a time-sharing basis. Each channel can be checked for chrominance-channel gain calibration and luminance-channel gain calibration accuracy with an internal test signal. A digital line selector allows the display of a single line Vertical Interval Test Signal (VITS) from a selected line of either field 1 or field 2.

ELECTRICAL CHARACTERISTICS

The following performance requirements are valid over the stated environmental range for instruments calibrated at an ambient temperature of +20°C to +30°C. A 20 minute warmup is required for rated accuracies.

TABLE 1-1
CHROMINANCE ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Frequency Response Chrominance Bandwidth: Subcarrier Frequency (F_{sc})	3.579545 MHz
Upper —3dB Point	F_{sc} +500 kHz, ±100 kHz
Lower —3 dB Point	F_{sc} —500 kHz, ±100 kHz
Vector Phase Accuracy	1° or less error between marker and graticule.
Incremental Phase Accuracy	0.5° or less error in any 10° segment on vector graticule.
QUAD PHASE Adjustment Range	+2° to —2°, total of 4°.
Test Circle Amplitude	Within 1% of 707 mV.
Color Decoding Accuracy in R, G and B Modes	Within 3% amplitude of Red, Green or Blue component.
I	Demodulation axis 57° from burst within 2° when burst axis has been aligned with vector graticule.
Q	Demodulation axis 147° from burst within 2° when burst axis has been aligned with vector graticule.
DIFF GAIN Deflection Factor	SN B150100 and up: 5% change deflects trace 5% (25 IRE units, 0.5 inches) within 5% (VITEAC Modulated Stairstep Signal, chrominance +3 dB, —6 dB of 143 mV). Below SN B150100: With variable GAIN control set to CAL, 5% change of a 143-mV signal deflects trace 5% (25 IRE units, 0.5 inches) within 5%.
Differential Gain: (50% APL)	1% or less last 90% of trace.
Dynamic Gain (10% to 90% APL)	1% or less last 90% of trace.
DIFF PHASE Resolution	0.1° of differential phase will produce at least 1 IRE unit of deflection on a normal staircase test signal 143 mV P-P subcarrier.
Burst φ REF: (50% APL)	0.3° of differential phase last 80% of trace.
Dynamic Phase (10% to 90% APL)	0.3° of differential phase last 80% of trace.

[1]Since both models of the Vectorscope are electrically identical, the Type R520 is used for the text and illustrations in this manual unless noted otherwise.

[2]National Television System Committee.

TABLE 1-1 (cont)

CHROMINANCE ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
External ϕ REF: (50% APL)	0.15° or less of differential phase last 90% of trace.
Dynamic Phase (10% to 90% APL)	0.15° or less of differential phase last 90% of trace.
CALIBRATED PHASE Range	+15° to −15°, total 30°.
Accuracy	Within 10% per 2° increment. Total incremental error 0.5° or less between +14° and −14°.
ϕ Reference Burst: Jitter	1° or less.
Displayed Noise	Trace will shift <0.2° in 10 s.
Pull-In Range	Within 15 Hz of 3.579545 MHz.
Pull-In Time	15 s or less with F_{sc} within 15 Hz.
Pull-In Time from Turn On at 20°C to 30°C	3 minutes, subcarrier within 15 Hz.
Ext. 3.58 CW Input Range	1.5 V to 2.5 V.

TABLE 1-2

LUMINANCE ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Luminance Bandwidth −3 dB Rolloff Frequency	700 kHz to 1.1 MHz.
Luminance Gain	140 IRE units within 1% per volt in the 75% CAL.
LUMINANCE GAIN Range	0.7:1 to 1.4:1 (+3 dB to −3 dB).

TABLE 1-3

INPUT ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Input Amplitude Range	0.7 V to 1.4 V video (sync tip to peak white).
Maximum DC Level	+20 V, −20 V.
Gain Stability With Time, Temperature and Line Volts	Within 1% (except in DIFF PHASE and DIFF GAIN) with line voltage. Within 5% with temperature.
Time Sharing Switching Rate	One fourth H rate. Locked to H sync.
Input Horiz Sync Input Range 50% APL	0.7 V to 1.4 V.
Dynamic (10% to 90% APL)	0.8 V to 1.4 V.
Ext Horiz Sync Input Range 50% APL Composite Video	0.7 V to 1.4 V.
Dynamic (10% to 90% APL) Composite Video	0.7 V to 1.4 V.
Composite Sync	3.5 V to 7.5 V.
Channel A GAIN and Channel B GAIN Range (Variable)	0.5:1 to 1.4:1 (+3 dB, −6 dB).
Input Attenuator 100% VECTOR (Chrominance and Luminance)	Within 2% of 0.75 times gain in 75% CAL.
75% (Chrominance and Luminance)	Within 1% of 140 IRE units per volt.
Maximum GAIN (Chrominance only)	SN B150100 and up: Internally adjustable to 5 times gain in 75% CAL. Below SN B150100: Within 5% of 3.5 times gain in 75% CAL.
Return Loss (terminated in 75 ohms, Input in Use or Not in Use, Instrument On or Off). Input A	Greater than 40 dB (DC to 5 MHz).
Input B	Greater than 40 dB (DC to 5 MHz).
Ext ϕ Reference	Greater than 40 dB at 3.58 MHz.
Ext Sync for 4 V Composite Sync (Factory Connected)	Greater than 46 dB (DC to 5 MHz).
1 V Composite Video (Optional Connection)	Greater than 40 dB (DC to 5 MHz).

TABLE 1-4

VERTICAL & HORIZONTAL AMPLIFIER ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Clamp Stability With Temperature and Line Voltage	1 minor div or less.
VECTOR With Rotation of A PHASE, B PHASE Control	2 minor div or less X and Y axis. 3.58 MHz component on sync tips 2 mV or less.
Y (Luminance) Display Shift	1 minor div or less with dynamic shift (10% to 90% APL).
Display Shift with Operation of LINE SWEEP, I, Q and DIFF PHASE	3 IRE units or less.

TABLE 1-5

POWER SOURCE ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Line Voltage Ranges	90 VAC to 110 VAC
	104 VAC to 126 VAC
	112 VAC to 136 VAC
	180 VAC to 220 VAC
	208 VAC to 252 VAC
	224 VAC to 272 VAC
Maximum Power Consumption at 115 VAC, 60 Hz.	100 watts
Maximum Amperes at 115 VAC, 60 Hz.	1.1 A
Line Frequency	47 Hz to 63 Hz

TABLE 1-6

CRT DISPLAY ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Type T5201	
Horizontal Resolution	At least 12 lines/cm
Vertical Resolution	At least 10 lines/cm
Usable Scanning Radius	5.5 cm
Geometry	0.05 cm or less
Orthogonality	Within 1°
Trace Rotation	At least +3° to —3°, total of 6°.

TABLE 1-7

PHYSICAL CHARACTERISTICS

Characteristic	Information
Finish	Anodized aluminum front panel. Blue vinyl painted cabinet.
Overall Dimensions (measured at maximum points)	
Type 520	7 inches high, 16 7/8 inches wide and 19 1/8 inches long. 17.8 cm high, 42.9 cm wide and 48.7 cm long.
Type R520	7 inches high, 19 inches wide and 19 3/4 inches long. 17.8 cm high, 48.3 cm wide and 50.2 cm long.

ENVIRONMENTAL CHARACTERISTICS
(see Table 1-8)

The following environmental test limits apply when tested in accordance with the recommended test procedure. This instrument will meet the electrical performance requirements given in this section following an environmental test. Complete details on environmental test procedures, including failure criteria, etc., may be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

TABLE 1-8

Characteristic	Information
Temperature	
Non-operating	—40° C to +65° C
Operating	0° C to +50° C
Altitude	
Non-operating	To 50,000 feet.
Operating	To 15,000 feet.
Transportation	Qualified under National Safe Transit Committee procedure 1A, Category I (18-inch drop), when properly packaged (see Section 4 of this manual for repackaging instructions).

ACCESSORIES

Standard accessories supplied with this instrument can be found on the last page of the Mechanical Parts List Illustrations in this manual. For additional accessories, see the current Tektronix, Inc. catalog.

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

CONTENTS

INSTALLATION

Rackmounting

Complete information for mounting the Type R520 in a rack is given on the Rackmounting fold-out pages located in Section 10 at the rear of the manual.

Rackmount-to-Bench Conversion

To convert a rackmount Vectorscope (Type R520) into a bench model (Type 520), or vice versa, refer to Section 10 in this manual.

Operating Voltage

The Vectorscope may be operated from either a 115-V or a 230-V line voltage source. Quick-change line-voltage selector plugs, located under the fuse cover on the rear panel, change the transformer primary connections so the instrument can operate from one line voltage or the other (115 V or 230 V). In addition, the plugs permit one of three line voltage operating ranges to be selected. Table 2-1 lists all the voltage ranges that enable the instrument DC power supplies to regulate properly.

To convert to a different line voltage, proceed as follows:

1. Disconnect the Vectorscope from the power source.

TABLE 2-1

115/230 Voltage Selector Plug Position	Range Selector Plug Position	Nominal Line (center) Voltage	Line Voltage Operating Range[1]
115	LO (Low)	100 VAC	90 to 110 VAC
	M (Medium)	115 VAC	104 to 126 VAC
	HI (High)	124 VAC	112 to 136 VAC
230	LO (Low)	200 VAC	180 to 220 VAC
	M (Medium)	230 VAC	208 to 252 VAC
	HI (High)	248 VAC	224 to 272 VAC

2. Unscrew the two captive screws which hold the fuse cover. Remove the cover with attached fuses.

3. To convert to a different line voltage (115 V or 230 V), pull out the 115/230 Voltage Selector plug (see Fig. 2-1). Rotate the plug 180° and insert it into the opposite set of holes. The 115/230 Voltage Selector plug is located in the upper position for 115-V operation and in the lower position for 230-V operation.

4. To change the line-voltage operating range (LO, M or HI), pull out the Range Selector plug (see Fig. 2-1) and insert it in the desired hole locations. Select a range which has a center voltage (see column 3 in Table 2-1) that closely corresponds to the line voltage that will be applied when completing this procedure.

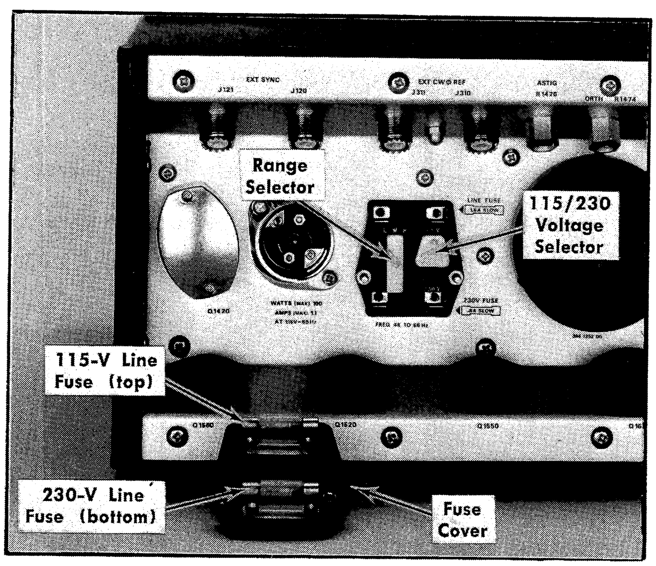


Fig. 2-1. Location of Range and Voltage Selector plugs with fuse cover removed. The plugs as shown are set for 115-V medium range operation.

5. Re-install the cover with the two captive screws and fuses. Be sure the cover fits firmly against the rear panel. This indicates that the line fuses are seated properly in the fuse clips.

[1]**Applicable when the line contains less than 2% total distortion.**

6. Before applying power to the instrument, check that the indicating tabs on the selector plugs protrude through the proper holes in the cover for the correct line voltage and the proper operating range.

CAUTION

The Vectorscope should not be operated when the 115/230 Voltage Selector and/or Range Selector plugs are not in the correct position for the line voltage to be applied. Operation of the instrument with either plug in the wrong position may cause incorrect operation or damage to the instrument.

BASIC INFORMATION

In color television the visual sensation of color is described in terms of three quantities; luminance, hue and saturation. Fig. 2-2A shows a conical representation of these concepts.

Luminance is brightness as perceived by the eye. As the eye is most sensitive to green and least to blue light of equal energy, green is a bright color, blue is a dark color as conveyed by the luminance signal to monochrome TV receivers. Color TV receivers utilize the luminance signal to produce both monochrome and color pictures.

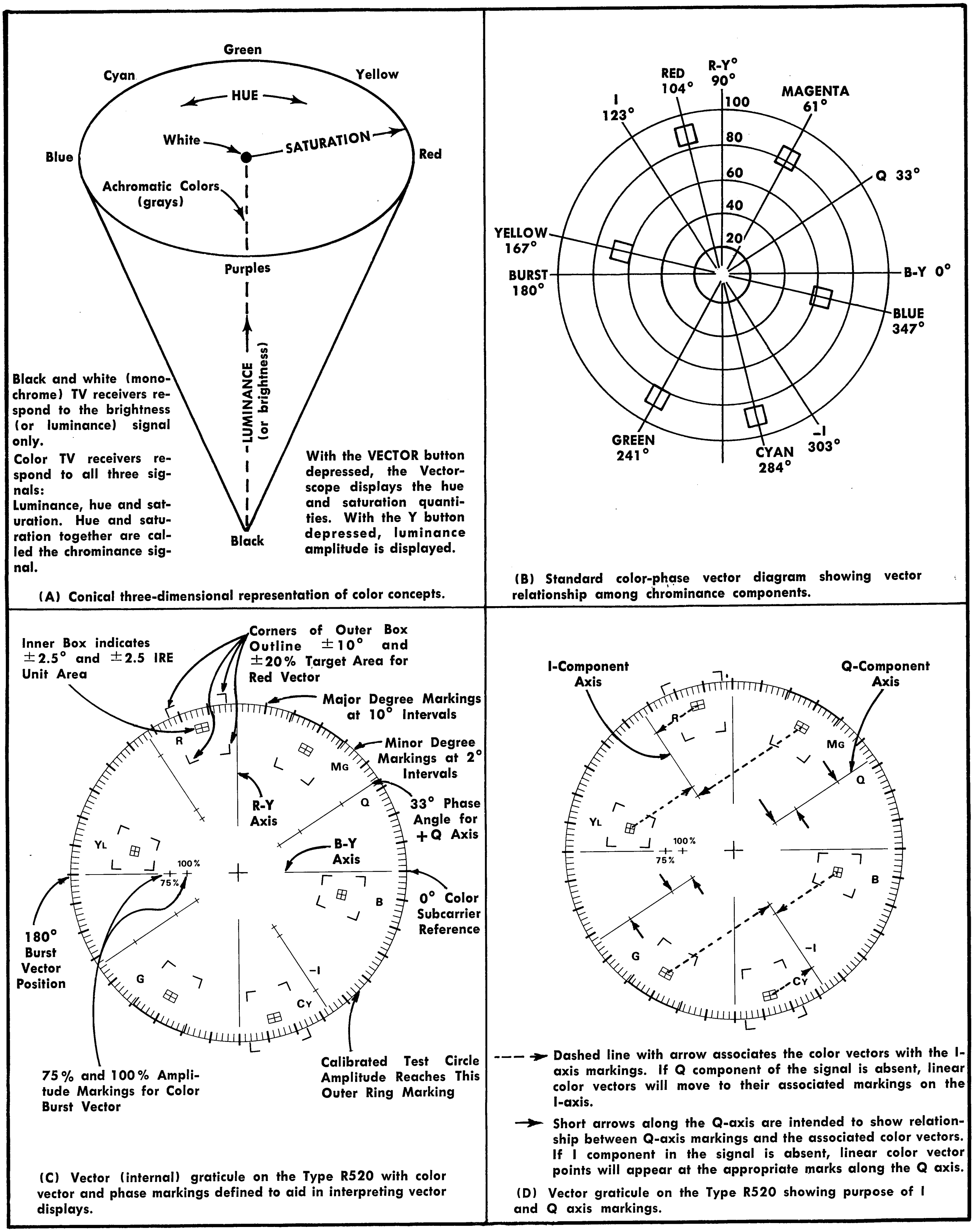
Chrominance consists of two additional quantities: hue and saturation. Hue is the attribute of color perception that determines whether the color is red, blue, green or the like. White, black and grey are not considered hues. Hue is presented on the Vectorscope CRT as a phase angle and not in terms of wavelength. For example, red, having a wavelength of 610 millimicrons is indicated as 104° on the standard color phase vector diagram (see Fig. 2-2B) and the Type R520 vector graticule (see Fig. 2-2C).

Saturation is the degree to which a color (or hue) is diluted by white light in order to distinguish between vivid and weak shades of the same hue. For example, vivid red is highly saturated and pastel red has little saturation. Using the Vectorscope, saturation is the radial distance from the center (where zero saturation exists) to the end of the color vector where 75% or 100% saturation exists for a particular color. If burst vector amplitude corresponds to the 75% marking, (see Fig. 2-2C) the colors are 75% saturated. If the burst vector amplitude corresponds to the 100% marking, the colors are 100% saturated.

NOTE

At the time of the preparation of this Instruction Manual, a portion of publication RS-189 is being amended to use the 7.5% black-level setup instead of the 10% setup formerly used. (RETMA Engineering Committee TR-4 on Television Transmitters prepared publication RS-189.)

In an NTSC color television transmission system, the hue and saturation information are carried on a single color subcarrier, 3.579545 MHz. These signals, in modulated subcarrier form, are called chrominance. The hue information is carried by the subcarrier phase; the saturation information is carried by means of amplitude modulation with the subcarrier suppressed. A subcarrier which supplies phase information is required for demodulation. No chrominance signals are present during the horizontal blanking interval, and a sample of the subcarrier is provided within this interval and is called burst.



(A) Conical three-dimensional representation of color concepts.

(B) Standard color-phase vector diagram showing vector relationship among chrominance components.

(C) Vector (internal) graticule on the Type R520 with color vector and phase markings defined to aid in interpreting vector displays.

(D) Vector graticule on the Type R520 showing purpose of I and Q axis markings.

Fig. 2-2. Illustrations showing relationships between basic color concepts, standard color-phase vector diagram and the vector graticule on the Type R520.

To recover the hue information, phase demodulators are employed in the Vectorscope. The phase reference is the color subcarrier which is regenerated by an oscillator in the instrument. The oscillator is locked in both phase and frequency to the color burst signal. When the VECTOR button is pressed, the Vectorscope displays the relative phase and amplitude of chrominance signal on polar coordinates. To identify these coordinates the vector graticule (see Fig. 2-2C) has points which correspond to the proper phase and amplitude of the three primary colors: R (Red), B (Blue) and G (Green). In addition, the complements of the primary colors are indicated as follows: C_Y (Cyan), Y_L (Yellow) and M_G (Magenta).

Any errors in the color encoding, video tape recording or transmission processes which change these phase and/or amplitude relationships cause color errors on the television receiver picture. The polar coordinate type of display such as that obtained on the Type R520 CRT has proved to be the best method for portraying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Relative amplitude of chrominance to burst is expressed in terms of the displacement from center (radial dimension of amplitude) towards the color point which corresponds to 75% (or 100%) saturation of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits per FCC requirements (±10°, ±20%). The inner boxes indicate ±2.5° and 2.5 IRE units. These limits correspond to phase and amplitude error limits per EIA specification RS-189, amended for 7.5% setup.

Fig. 2-2D shows the purpose of the small marks that intersect the I and Q axis. The topic "Color Encoder" provided later in this section describes the distortions that may occur in a signal when an improper display is obtained.

The vector graticule inscribed inside the Type R520 CRT permits accurate amplitude measurements of color and burst vectors to be made when a 7.5% color setup signal is applied to the instrument. Fig. 2-3 illustrates the details of a standard encoded color bar test signal using the 7.5% setup. Color signals having 10% setup can also be measured just as accurately if the slight differences between the two setups are considered. The following paragraph describes the differences.

Table 2-2 provides a side-by-side comparison of the 10% and 7.5% setup color bar amplitudes. To use the Type R520 for 10% setup vector measurements, apply the 10% setup color test signal to the instrument. Obtain the vector display in the usual manner. Set the channel GAIN control to position the color vectors within the inner box marking on the vector graticule. When this is accomplished, the 10% setup burst vector will be slightly less than 1/32 inch (or less than 0.6 mm) **longer** than the 75% mark located at the 180° position. This is the normal location for the 10% setup burst vector. Usually the 1/32 inch difference can be considered to be negligible. The 1/32 inch difference is derived from these distances: The distance from the center of the vector graticule to the 75% mark is 0.84870 inch for 7.5% setup. Using a 10% setup color signal, the distance of the burst vector is 0.87228 inch or a difference of only 0.02358 inch.

The two major distortions to which the chrominance signal is subject are differential gain and differential phase. Both can be measured on the Type R520 Vectorscope. Differential gain is a change in color subcarrier amplitude due to a change in the luminance signal while hue and saturation of the original signal are held constant. In the reproduced picture, the saturation will be distorted in the areas between the light and dark portions of the scene.

Differential phase is a phase change of the chrominance signal by the luminance signal while the original chrominance signal is held constant. In the reproduced picture, the hue will vary with scene brightness. Differential gain and differential phase may occur separately or together. The causes of these distortions are chrominance nonlinearities caused by luminance amplitude variations. To measure differential phase using the Type R520 no graticule is needed. Instead, the trace overlay and slide-back technique using the CALIBRATED PHASE control provides the means for performing the measurement.

The IRE graticule (see Fig. 2-4) is used primarily for measuring differential gain and video signal amplitude. To measure video signal amplitude, the IRE graticule is marked in IRE units. In standard TV practice, 140 IRE units equal 1 volt. Hence, with the aid of the IRE graticule, the composite video signal will be exactly 1 volt in amplitude when the equipment is adjusted to obtain a display amplitude of exactly 140 IRE units. Next, the IRE graticule is used as a guide for checking and adjusting the composite video signal for the following typical proportions:

1. The white level should correspond to the +100 IRE unit graticule marking.

2. The reference black level should correspond to the 7.5% setup marking.

3. The blanking level of the video signal should coincide with the 0 IRE graticule line.

4. The sync pulse amplitude should correspond to the —40 IRE unit graticule line.

Fig. 2-5 shows a modulated stairstep (or staircase) Vertical Interval Test Signal that is inserted in line 19 of field two to provide in-service trouble diagnosis. This signal has ten equal steps going from black level to white level with a burst of 3.58 MHz sine waves on each step. This signal is used for checking differential gain and differential phase. Differential gain is checked on the Type R520 by amplitude-demodulating the signal and presenting a magnified display of the successive stairstep segments. The IRE graticule has a Diff Gain scale to facilitate differential gain measurements in percent of signal gain or loss. The measurement technique is described later in step 22 of the First-Time Operation procedure.

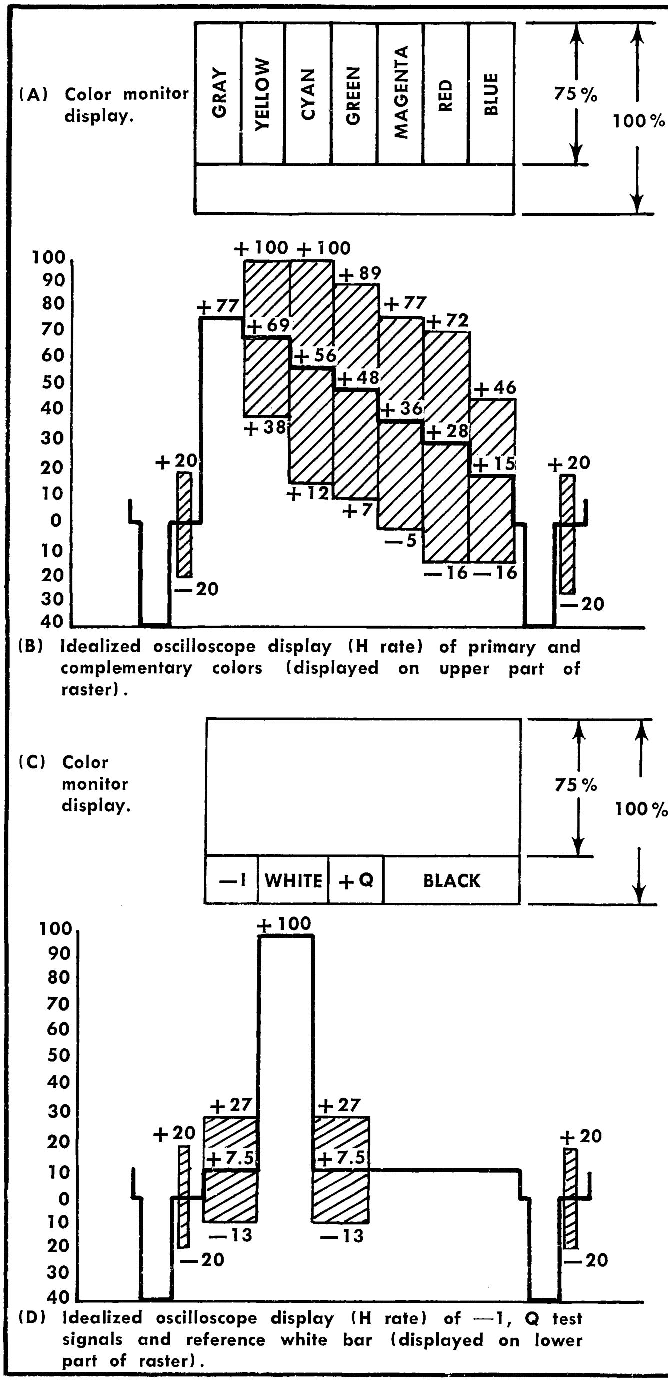
CONTROLS AND CONNECTORS

Introduction

A brief description of the function or operation of the Type R520 front- and rear-panel controls, adjustments and connectors is provided here (see Fig. 2-6).

NOTE

Some photographs of the Type R520 may show the instrument having a snap-in graticule cover and pushbuttons labeled dA and dϕ. These are pictures of an earlier instrument (below SN B150100). For later instruments (SN B150100 and up), the graticule cover is held in place with four thumb screws, dA, is changed to DIFF GAIN, and dϕ is changed to DIFF PHASE.



NOTES:

1. Solid lines indicate luminance signal levels.
2. Dash lines indicate color subcarrier envelope levels.
3. Measurements are made by using a standard IRE unit scale where reference white equals 100 units and sync equals −40 units.
4. Encoded color-bar signal levels shall be in accordance with standard video transmission levels.
5. (A) Amplitude tolerance of all luminance values at origination point equals ±2.5 IRE units.

   (B) Amplitude tolerance of all peak-to-peak subcarrier values at origination point equals ±2.5 IRE units.

   (C) Phase tolerance of colors at origination point equals ±2.5°.
6. Nominal values of luminance and peak-to-peak chrominance amplitudes for fully saturated color bars, 75% of full amplitude, using 10% and 7.5% setup, are as follows (see Table 2-2):

TABLE 2-2

	10% Setup		7.5% Setup	
	Luminance	Peak-to-Peak Chrominance	Luminance	Peak-to-Peak Chrominance
SETUP	10		7.5	
WHITE	100		100	
GRAY	77		77	
YELLOW	70	60	69	62
CYAN	57	86	56	88
GREEN	50	80	48	82
MAGENTA	38	80	36	82
RED	30	86	28	88
BLUE	17	60	15	62
−I	10	40	7.5	40
+Q	10	40	7.5	40

7. The duration of each of the primary (and complementary) bars is to be 1/7 of the active portion of a scanning line within a tolerance of ±10%.
8. The rise and fall times of the luminance signal component shall not exceed 0.2 microseconds as measured at the point of generation.

Reference—RETMA Engineering Committee TR-4 on Television Transmitters, "EIA Standard for Encoded Color Bar Signals": RS-189, page 3; Revised RS-189, pages 14538: 3a-4:5/66 and 14538:4a-4:5/66.

Fig. 2-3. Illustrations with notes showing the characteristics of a standard encoded color bar signal using a 7.5% setup. Table 2-2 compares the amplitude of the color bars for 10% and 7.5% setup.

Main Front-Panel Controls

Signal Selector Switch — Contains ten pushbuttons but consists of four separate self-canceling switches to select the following signals:

First Switch: Selects channel A signal source.

CH A: Channel A signal applied to CH A connector.

A CAL: 1-V luminance amplitude calibration test signal is applied internally to Channel A in Y, R, G and B modes. A test circle display is obtained in the VECTOR mode for amplitude calibration and QUAD PHASE alignment.

Second Switch: Unblanks the CRT to display the selected line(s).

[2]VITS 18: Vertical Interval Test Signal on line 18 in either field.

FULL FIELD: Total signal for one picture (all lines).

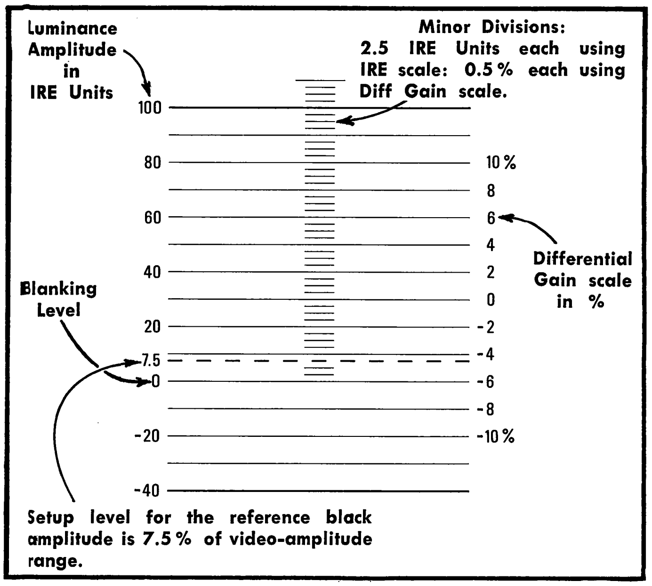


Fig. 2-4. The Type R520 IRE (external) graticule. Illuminated when Y, R, G, B, LINE SWEEP, I, Q or DIFF GAIN pushbutton is depressed.

²VITS 19: Vertical Interval Test Signal on line 19 in either field.

Third Switch: Turns on the PHASE and CALIBRATED PHASE controls.

Aϕ: Places A PHASE and CALIBRATED PHASE controls in operation. Operates with CH A or CH B, depending on which button is pressed.

Aϕ/Bϕ ALT: Enables A and B PHASE controls to operate on a time-shared basis. Used in conjunction with CH A and/or CH B pushbuttons for dual-display mode of operation. Also, used in conjunction with the CALIBRATED PHASE control.

²The circuits controlled by these buttons can be changed to display other lines as described later in this section. These buttons are used in conjunction with the FIELD switch.

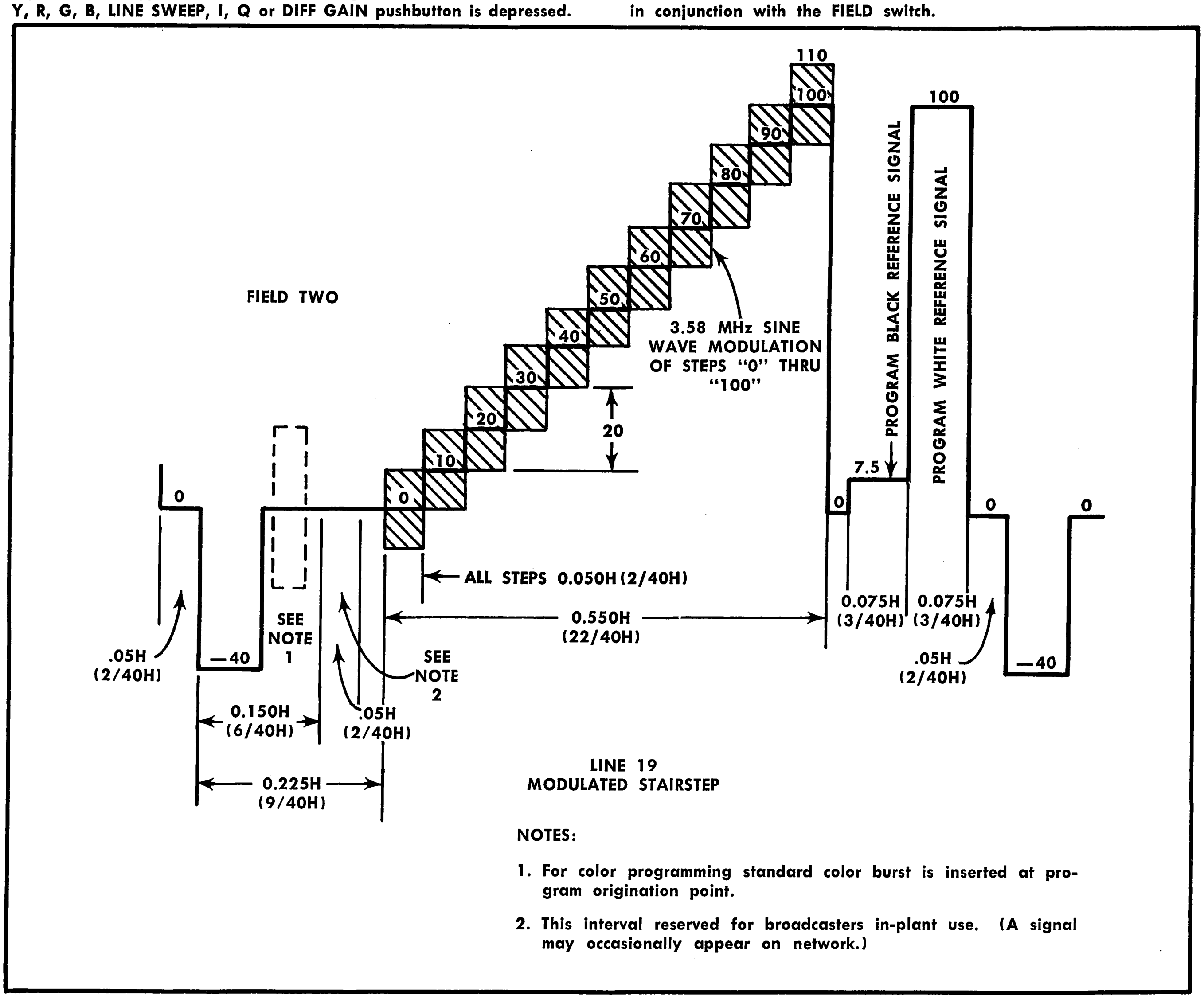


Fig. 2-5. Details of ten-step linearity test signal. Reproduced from a paper by S. C. Jenkins, Transmission Engineer, Long Lines Dept., American Telephone and Telegraph Co., "Vertical Interval Test Signals", April 8, 1964, Figure 4.

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In CH A and CH B dual-display mode of operation, the A PHASE control operates with CH A and the B PHASE controls operates with CH B.

Bϕ: Places B PHASE and CALIBRATED PHASE controls in operation. Operates with CH A or CH B, depending on which button is pressed.

Fourth Switch: Selects Channel B signal source.

CH B: Channel B signal applied to the CH B connector.

B CAL: 1-V luminance amplitude calibration test signal is applied internally to Channel B in Y, R, G and B modes. A test circle display is obtained in the VECTOR mode for amplitude calibration and QUAD PHASE alignment.

Channel A and B 100%-75%-MAX GAIN — Three-position lever switch. Two positions provide a calibrated gain change for observing either 100% or 75% amplitude color bar signals per EIA Spec RS-189, corrected for 7.5% setup. These percentages are International Standards. The third position is MAX GAIN for maximum calibrated gain in the DIFF GAIN mode; maximum uncalibrated gain in the other modes.

GAIN — Thumbwheel control to vary the amplitude of the input composite video signal. The control has a CAL (calibrated) detent position.

A CAL — A screwdriver adjustment which provides a means for calibrating the gain of Channel A amplifier when CH A GAIN and LUMINANCE GAIN controls are set to CAL.

B CAL — A screwdriver adjustment which provides a means for calibrating the gain of Channel B amplifier when CH B GAIN and LUMINANCE GAIN controls are set to CAL.

PHASE — Provides for continuously uncalibrated control of phase. Range is 360°.

ϕ REF — Two-position lever switch to provide for selection of internal or external CW source.

BURST: Internal 3.58 MHz CW from an automatic phase and frequency controlled oscillator.

EXT: External CW source obtained via the EXT CW ϕ REF connectors.

Display Selector Switch — A 10-position self-canceling pushbutton switch that selects the displays that follow.

NOTE

In all Display Selector pushbutton modes except VECTOR, the displays are presented at the line rate on a linear time base. In the VECTOR mode, a polar plot display is presented.

VECTOR: Presents a test circle display when A CAL (or B CAL), FULL FIELD and Aϕ (Aϕ/Bϕ ALT or Bϕ) buttons are pressed. Presents a color-vector display when CH A (or CH B), FULL FIELD or VITS and Aϕ (Aϕ/Bϕ ALT or Bϕ) buttons are pressed.

Y: Presents a luminance calibration display when A CAL (or B CAL), FULL FIELD and Aϕ (Aϕ/Bϕ ALT or Bϕ) buttons are pressed.

Presents the luminance portion of the color signal with chrominance removed when CH A (or CH B), FULL FIELD and Aϕ (Aϕ/Bϕ ALT or Bϕ) buttons are pressed.

NOTE

In the Y and DIFF GAIN modes the Aϕ (Aϕ/Bϕ ALT or Bϕ) buttons need not be depressed to obtain a useful display. In the R, G, B, LINE SWEEP, I, Q and DIFF PHASE modes, the Aϕ (Aϕ/Bϕ ALT or Bϕ) button must be depressed with the CH A (or CH B) and FULL FIELD buttons to obtain a useful display of the applied signal.

R: Presents the output signal from the red camera or the red portion of the signal supplied to a color kinescope.

G: Presents the output signal from the green camera or the green portion of the signal supplied to a color kinescope.

B: Presents the output signal from the blue camera or the blue portion of the signal supplied to a color kinescope.

LINE SWEEP: Presents the R-Y component of the color signal when burst is aligned at 180°. Indicates time relationship of the chrominance portion of the signal; that is, the sequence in which the color vectors will be portrayed by the CRT beam when the VECTOR mode is used.

The LINE SWEEP mode is also used as the calibration mode for the Type R520. When the CH A (or CH B), FULL FIELD and Aϕ (Aϕ/Bϕ ALT or Bϕ) buttons are depressed, the burst portion of the waveform is brightened to facilitate proper adjustment of the BURST FLAG TIMING control. When the A CAL (or B CAL), FULL FIELD and Aϕ (Aϕ/Bϕ ALT or Bϕ) buttons are depressed, a horizontal trace for checking the BEAM ROTATE control is presented.

I: Presents the portion of the color signal demodulated along the I axis.

Q: Presents the portion of the color signal demodulated along the Q axis.

DIFF GAIN: Presents a magnified display of the peak amplitude of the 3.58 MHz component in the color signal for use in checking differential gain.

DIFF PHASE: Phase-demodulates a modulated signal and presents the display greatly magnified and inverted on alternate lines allowing the use of the slide-back method to overlay the two traces when measuring small phase changes. The CALIBRATED PHASE control is used for direct readout of differential phase in degrees.

INTENSITY — Controls brightness of the display by varying the CRT beam current.

SCALE ILLUM — Controls graticule illumination by varying the edge-light intensity.

LUMINANCE GAIN — Thumbwheel control for varying the gain in the luminance channel without affecting the chrominance gain. The control has a CAL (calibrated) detent position. The control varies the amplitude of the display in Y, R, G and B modes only.

CALIBRATED PHASE — Provides for accurate incremental phase measurements, with a ±15° total range using a metal tape dial for readout.

POWER — Switch: Toggle switch to apply power to the instrument.

Light: Indicates that the POWER switch is on and the instrument is connected to a line source.

Recessed Front-Panel Operational Controls (right door)

FOCUS — Permits adjustment of CRT beam for optimum display resolution.

FIELD — Two-position slide switch to select Field 1 or Field 2 when used in conjunction with the VITS 18 and VITS 19 pushbuttons.

VERT POSITION — Positions the display vertically on the CRT in Y, R, G, B and DIFF GAIN pushbutton modes only.

BURST FLAG TIMING — Adjusts sync circuits to compensate for variation in time between the leading edge of the sync pulse and the burst flag of the composite video signal. Adjusted when CH A (or CH B), FULL FIELD, Aϕ (or Bϕ) and LINE SWEEP buttons are depressed.

IMPORTANT

If an unstable display is obtained on the Type R520 CRT, always check the positions of the ϕ REF and SYNC switches first and then check that the BURST FLAG TIMING adjustment is properly adjusted. The BURST FLAG TIMING adjustment varies the burst sampling point by varying the start of the sweep generator. This, in turn, varies the action of the various clamps in the Type R520 circuitry and also the lock-in stability of the sweep generator. Misadjustment of the BURST FLAG TIMING control varies the stability of the subcarrier regenerator, affects the gain of the luminance channel, and may cause the horizontal sweep to drop out of sync. Hence, if an unstable display or improper luminance display amplitude is obtained, check that the BURST FLAG TIMING adjustment is adjusted properly as described in steps 8 and 9 in the First-Time Operation procedure.

SYNC — Two-position slide switch to select INT (internal) or EXT (external) sync signal source.

INT: Channel A or B amplifier is the internal sync source when CH A or CH B pushbuttons respectively are used. Channel A amplifier is the internal sync source when both CH A and CH B pushbuttons are depressed.

EXT: External sync source is obtained via the EXT SYNC input connector.

HORIZ POSITION — Positions the display horizontally on the CRT in all Display Selector pushbutton modes except VECTOR.

Recessed Front-Panel Maintenance Adjustments (left door)

QUAD PHASE — Screwdriver adjustment to provide for fine adjustment of the 90°phase difference between the R-Y and B-Y demodulators. adjusted for optimum overlay of two test circles. Adjusted when A CAL (or B CAL), FULL FIELD, Aϕ (or Bϕ) and VECTOR buttons are depressed.

GAIN BAL — Screwdriver adjustment for controlling B-Y demodulator gain. Rounds out the two merged test ellipses so a circle is obtained. Adjusted when A CAL (or B CAL), FULL FIELD, Aϕ (or Bϕ) and VECTOR button are depressed.

HORIZ POSITION CLAMP — Screwdriver adjustment that controls the horizontal clamp level of the display in all modes.

BEAM ROTATE — Screwdriver adjustment that rotates the beam so the vertical trace can be aligned with the graticule 90°-to-270° vector graticule line. Adjusted when A CAL (or B CAL), FULL FIELD, Aϕ (or Bϕ) and VECTOR buttons are depressed; blue-on-white wire to pin AB on Driver Amplifier board is disconnected. An alternate procedure is given in step 11 of the First-Time Operation procedure.

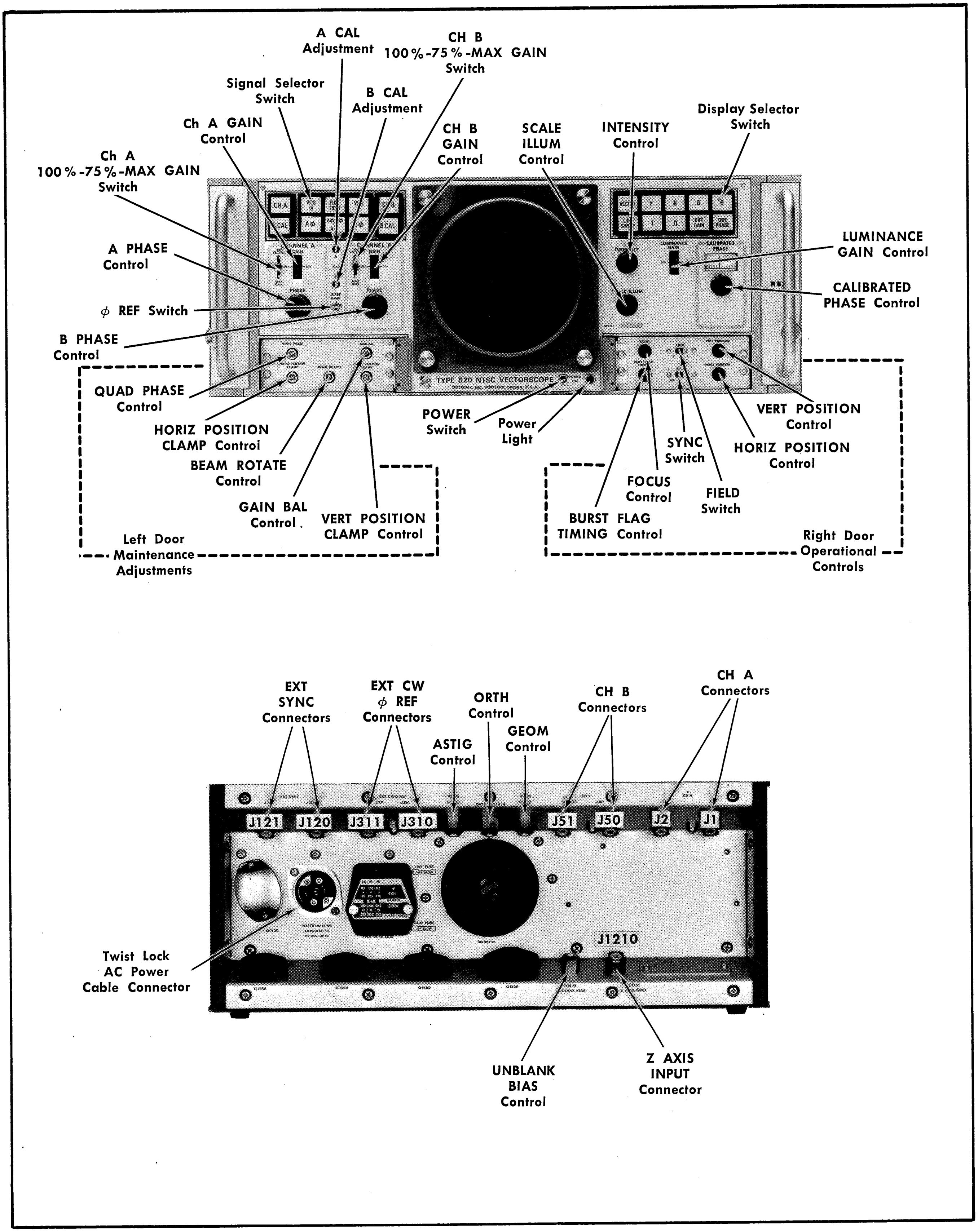


Fig. 2-6. Front- and rear-panel controls and connectors on the Type R520 Vectorscope.

VERT POSITION CLAMP — Screwdriver adjustment for controlling the vertical clamp level of the display in all modes.

Rear-Panel Adjustments

ASTIG (R1476) — Screwdriver adjustment used in conjunction with the FOCUS control to adjust the beam for optimum display resolution.

ORTH (R1474) — Screwdriver adjustment for aligning the horizontal trace parallel with nearest luminance graticule line. Adjusted when the A CAL (or B CAL), FULL FIELD, Aϕ (or Bϕ) and VECTOR buttons are depressed; green-on-white wire to pin AD on Driver Amplifier board is disconnected.

GEOM (R1472) — Screwdriver adjustment for minimizing any bowing of vertical and horizontal lines. Proper adjustment is obtained when the voltage at the center arm of the GEOM control equals the voltage at the upper vertical-deflection plate (blue lead to CRT neck pin). Adjusted when FULL FIELD, Aϕ (or Bϕ) and VECTOR buttons are depressed.

UNBLANK BIAS (R1478) — Screwdriver adjustment for obtaining a uniform brightness test circle. Adjusted when A CAL (or B CAL), FULL FIELD, Aϕ (or Bϕ) and VECTOR buttons are depressed.

Rear-Panel Connectors

EXT SYNC (J120 and J121) — BNC connectors permit loop-through (or terminated into 75 ohms) external synchronization on composite video or sync signals.

EXT CW ϕ REF (J310 and J311) — BNC connectors for loop-through (or terminated into 75 ohms) external 3.58 MHz CW signal.

CH A (J1 and J2) and CH B (J50 and J51) — Dual-input BNC connectors. Permits loop-through (or terminated into 75 ohms) operation for each channel with a bridging resistance of $\approx$14 kΩ and a bridging capacitance of $\approx$16 pF.

Z Axis INPUT (J1210) — BNC connector permits Z-axis modulation of CRT display.

SIGNAL CONNECTIONS

Introduction

All signal connections to the Vectorscope are made through BNC coaxial connectors on the rear panel of the instrument (see Fig. 2-6). Two connectors for each input (except Z AXIS input) provide high-impedance loop-through connections so that the Vectorscope may be connected into any part of a system.

When the Vectorscope is connected to the output of a system (loop-through connections not required), a 75-ohm terminating resistor should be connected to the unused input connector to properly terminate the system.

Chrominance Signal Inputs

The signal (or signals) from the system under test is applied to the CH A input and/or CH B input connector. This may be either a composite color signal with negative-going sync pulses, or a chrominance signal only without the sync pulses. If a chrominance signal only is applied and synchronization of the sweep and unblanking is desired, separate sync pulses and usually an external subcarrier signal must be applied as described in the Sync Input and External Subcarrier Input topics that follow.

Sync Input

The EXT SYNC input connector accepts external signals for synchronizing the Vectorscope sweep and unblanking circuitry. This input is connected to the synchronizing circuit when the SYNC switch (located behind the right side front-panel door) is set to the EXT position. Sync-negative composite video, about 0.7 V to 1.4 V, peak to peak, or negative-going composite sync, about 3.5 V to 7.5 V, can be used. A choice of pin connections on the Sync board permits either amplitude signal to be used.

The Type R520 is normally connected at the factory for use with a 3.5 V to 7.5 V peak-to-peak negative composite sync external signal. To accomplish this, the black-red-on-white wire is connected to pin E on the Input Sync board as shown in Fig. 2-7. The Input Sync board is located on the top right rear of the chassis. If a 0.7 V to 1.4 V peak-to-peak negative-going composite video signal is applied to the EXT SYNC connector, the black-red-on-white wire should be connected to pin D.

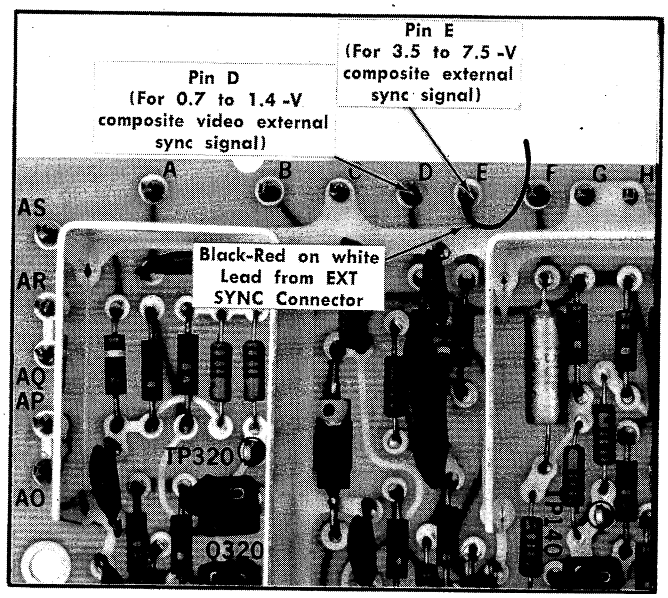


Fig. 2-7. Selecting the external sync pin connection on the Input Sync board. Pin E is the normal connection.

NOTE

The SYNC switch should not be placed in the EXT position unless an external sync signal is applied to the EXT SYNC input connectors; otherwise, unstable displays will be obtained. When using the Type R520 to observe non-composite video, a 1-V sync-negative composite video should be applied to EXT SYNC connector, pin E on the Sync board should be used and the SYNC switch should be set to EXT.

Horizontal drive pulses may also be used to synchronize the Vectorscope; however, with this type of synchronization it is not possible to view vertical interval test signals. Also, if the internal Subcarrier Regenerator (ϕ REF switch is set to BURST) is used when horizontal drive pulses are applied to EXT SYNC connector, it will be necessary to readjust the BURST FLAG TIMING control to obtain synchronized operation. This control is located behind the right front-panel door. Then, it will be necessary to readjust the control again when returning to the use of horizontal sync pulses. This is because the leading edge of a horizontal drive pulse occurs some time before the leading edge of the corresponding horizontal sync pulse.

It is important to note that the sweep circuits in the Vectorscope will free run and not be locked if the synchronizing pulses are not present. However, it is possible to present, without synchronizing pulses, a vector display of a chrominance signal only, using an external subcarrier signal.

External Subcarrier Input

The EXT CW ϕ REF subcarrier input connector accepts an external 3.579545-MHz subcarrier necessary for demodulating the input chrominance signal. The external subcarrier signal must have a peak to peak amplitude of 1.5 V to 2.5 V. This signal is connected to the subcarrier processing circuits of the Vectorscope when the ϕ REF switch is set to the EXT position.

If the external subcarrier signal is 1 volt peak to peak in amplitude, the instrument can be modified to accomodate this signal by changing the values of R301, R320, and R321. These resistors are located on the Input Sync board (see Fig. 2-8) and the resistance values are given in Table 2-3.

TABLE 2-3

Resistor Circuit Number	Description			Tektronix Part Number
	Resistance	Wattage	Tolerance	
R301	15 kΩ	1/4	5%	315-0153-00
R320	7.5 kΩ	1/4	5%	315-0752-00
R321	10 kΩ	1/4	5%	315-0103-00

If a subcarrier is not conveniently available, it can be generated within the Vectorscope by placing the ϕ REF switch to the INT position. This switch position applies the color-burst portion of the applied chrominance signal to the internal Subcarrier Regenerator circuit. The Subcarrier Regenerator then generates a 3.579545-MHz signal of the proper phase relationship to burst to be used throughout the Vectorscope in place of the external subcarrier.

Trace Intensification Input

SN B150100 and up.

As shipped from the factory, the Z-axis input lead connects internally from the Z AXIS INPUT connector J1210 on the rear panel to pin BO (see Fig. 2-9) on the Sweep board. This board is located on the bottom side, center-rear portion, of the chassis.

Depending on the intended use of the Type R520, the Z axis input lead may be connceted to either pin BO or BQ. Pin BO is the normal connection. The purpose of this connection is intended for use with short-term trace intensific-

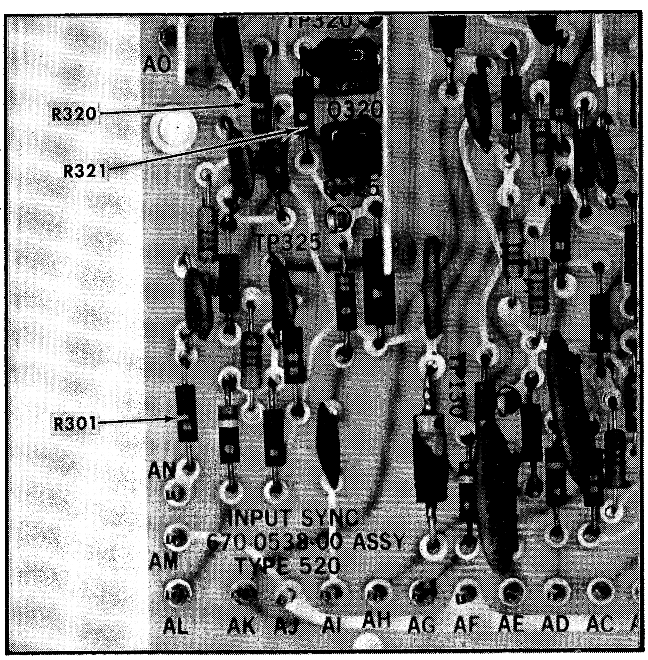


Fig. 2-8. Location of the resistors on the Input Sync board.

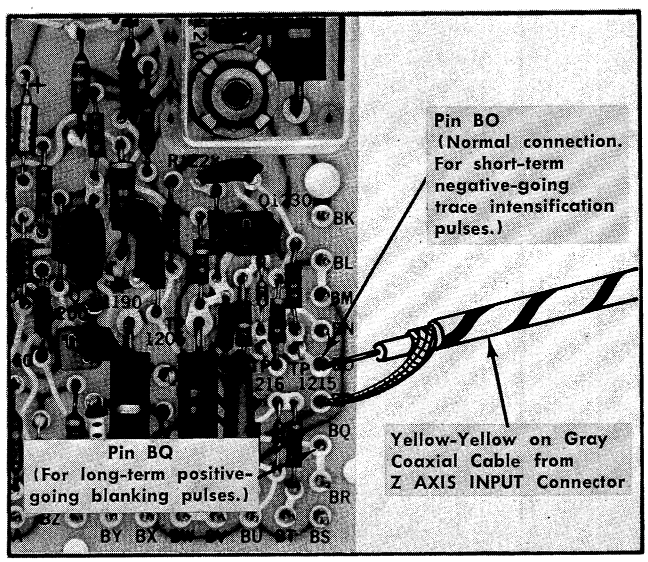


Fig. 2-9. Selecting the Z axis input pin connection on the Sweep board.

ation pulses; for example, to identify a television line or a portion thereof. This connection is AC coupled into the grid of the CRT and a negative-going signal of about 5 volts will cause noticeable brightening of the trace. The pulses should not exceed 15 volts in amplitude.

To view several lines, connect the Z-axis input lead to pin BQ. When using this connection, the deflection blanking feature of the CRT is employed rather than the AC-coupled connection to the CRT grid that was previously described. Pin BQ connection requires a positive-going signal of about one volt in amplitude to blank the CRT. This signal should not exceed 5 volts in amplitude. Since this connection is direct coupled, any number of lines can be blanked (or left unblanked). For example, if an appropriate switching signal were available, it would be possible to use this signal to display a selected group of 17 lines while the undesired lines were blanked.

Below SNB150100

Circuit operation is the same (as above), except that pin BO is pin AP, and pin BQ is pin AW.

FIRST-TIME OPERATION

The following procedure is a suggested method for becoming familiar with the basic operation of the Type R520. In addition, this procedure is a quick check for the front-panel adjustments, including the rear-panel ASTIG and UNBLANK BIAS adjustments. Exception: The BEAM ROTATE adjustment procedure in step 11 will normally be a satisfactory method for general operating use, but a precise method is given in the Calibration Procedure, Section 6, in this manual.

NOTE

The GEOM and ORTH adjustments are not included in the First-Time Operation procedure. The Calibration Procedure in Section 6 should be used when performing these adjustments.

Only two signals are required for this procedure; (1) A 75%-amplitude encoded color-bar test signal, and (2) a ten-step linearity test signal. Fig. 2-10 shows the waveforms as photographed using a Waveform Monitor. These particular signals have a 7.5% setup level. The First-Time Operation procedure is as follows:

1. Set the INTENSITY control fully counterclockwise.

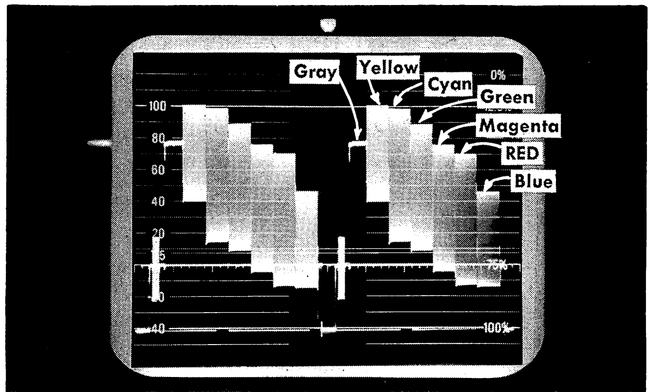
2. Connect a 75%-amplitude encoded color-bar signal to the CH A input connector.

NOTE

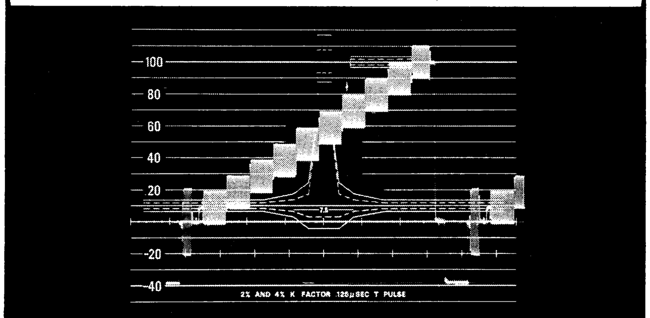
If the Type R520 is connected to the output of a test-signal distribution system, connect a 75-ohm terminating resistor to the other unused CH A input connector.

3. Connect a ten-step linearity test signal to the CH B input connector. If the other CH B input connector is not used, connect a 75-ohm terminating resistor to the unused connector as directed in step 2 NOTE.

4. Connect the instrument to a suitable power source and turn on the POWER switch.



(A) 75%-saturated encoded color-bar test signal waveform.



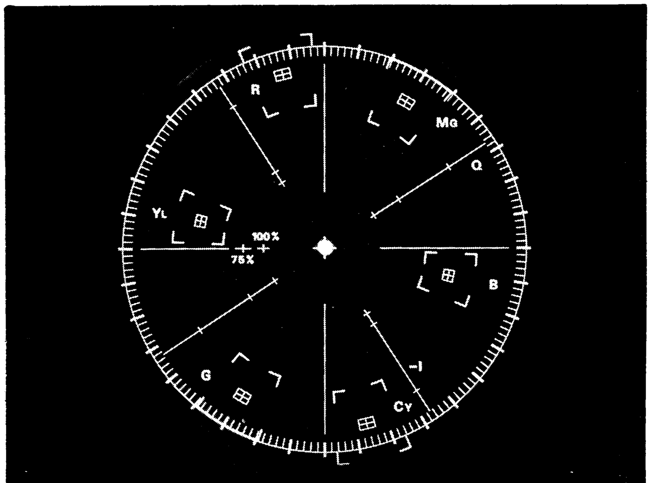
(B) Ten-step linearity test signal waveform.

Fig. 2-10. Signals required for performing the First-Time Operation procedure. A waveform monitor was used to obtain the displays.

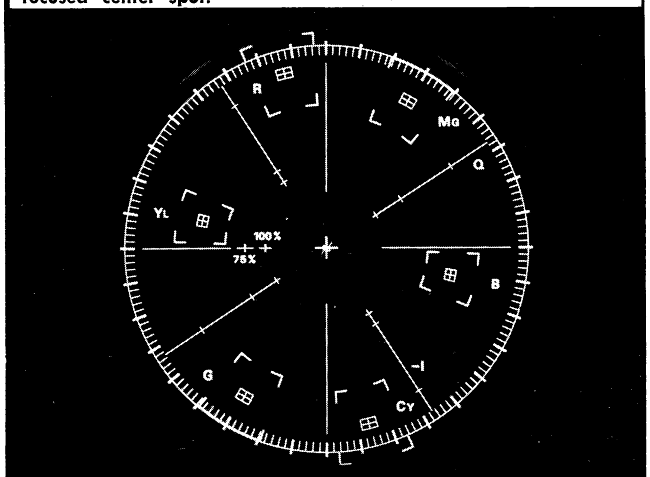
5. While the instrument is warming up (at least 20 minutes), set the Type R520 front-panel controls to these positions:

Signal Selector	FULL FIELD Aϕ[3] (CH A & A CAL: Off) (CH B & B CAL: Off)
Ch A 100%-75%-MAX GAIN	75%
Ch A GAIN	CAL
A PHASE	As is
Ch B 100%-75%-MAX GAIN	75%
Ch B GAIN	CAL
B PHASE	As is
ϕ REF	BURST
Display Selector	VECTOR
LUMINANCE GAIN	CAL
CALIBRATED PHASE	0°
SCALE ILLUM	As desired
FOCUS	Fully CCW
FIELD	1
SYNC	INT
VERT POSITION	Midrange
HORIZ POSITION	Midrange

[3]Either the Aϕ or Bϕ button can be depressed to make the corresponding A PHASE or B PHASE control operable. In this procedure the Aϕ button was arbitrarily used.



(A) ASTIG control properly adjusted to obtain a round defocused center spot.



(B) FOCUS control properly adjusted to obtain a well-defined center dot.

Fig. 2-11. Adjusting the ASTIG and FOCUS controls. Pushbuttons depressed: FULL FIELD, Aϕ and VECTOR.

6. Rotate the INTENSITY control clockwise until the center dot is the desired brightness. The dot will be out of focus (see Fig. 2-11A) until step 7 has been completed.

7. If the center dot does not have a round shape, adjust the rear-panel ASTIG control to obtain a round spot similar to the display shown in Fig. 2-11A. Next, adjust the FOCUS control to obtain a well-defined center dot (see Fig. 2-11B).

CAUTION

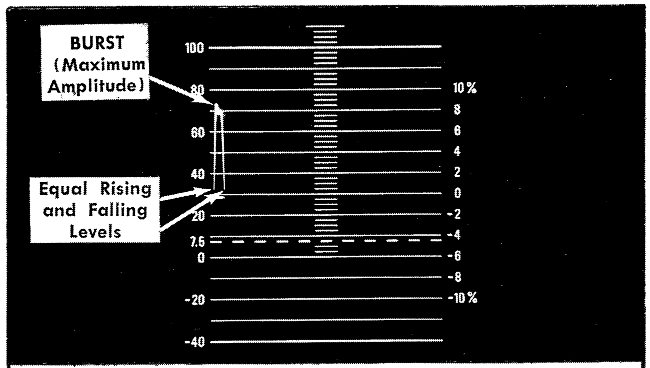
Avoid using excessive intensity when displaying the focused dot. Excessive intensity (a spot or dot having a bright halo around it) may burn the CRT phosphor.

8. Press the CH A and LINE SWEEP buttons. Leave the FULL FIELD and Aϕ buttons depressed.

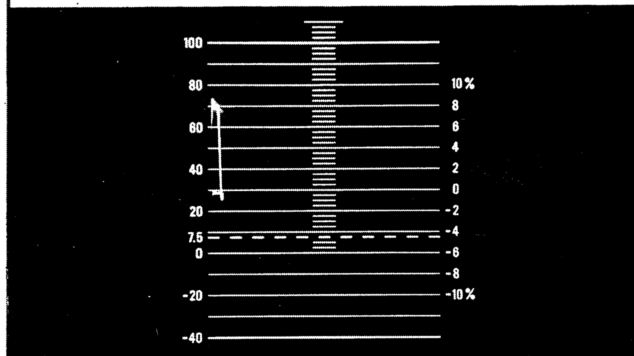
9. Rotate the A PHASE control to obtain maximum burst amplitude (see Fig. 2-12A).

NOTE

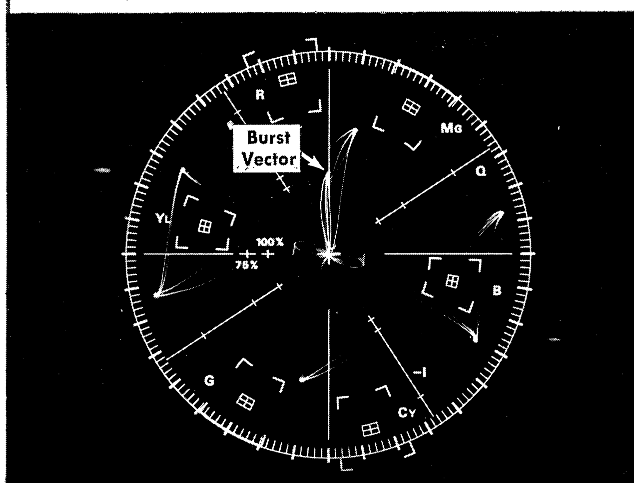
Another method for obtaining maximum burst amplitude is to depress the VECTOR button, set



(A) Properly adjusted.



(B) Misadjusted.



(C) Burst vector position at 90° using the alternative method.

Fig. 2-12. Adjusting the BURST FLAG TIMING control. Pushbuttons pressed for (A) and (B): CH A, FULL FIELD, Aϕ and LINE SWEEP; for (C): CH A, FULL FIELD, Aϕ and VECTOR.

the A PHASE control so the burst vector coincides with the 90° position (see Fig. 2-12C) or 270° (produces a negative-going burst display in the LINE SWEEP mode). Then, press the LINE SWEEP button and continue with step 9 procedure.

Check that the intensified rising and falling portions of the burst waveform are equal. (Use the INTENSITY control to decrease the brightness of these portions for better viewing contrast.) If the rising and falling portions are not equal, adjust the BURST FLAG TIMING control to obtain the proper display as shown in Fig. 2-12A. Fig. 2-12B shows one effect obtained when the adjustment is incorrect.

10. Depress the A CAL button. Leave the FULL FIELD, Aϕ and LINE SWEEP buttons depressed.

11. Check that the trace aligns with the 30 IRE unit graticule marking as shown in Fig. 2-13A. If not, adjust the BEAM ROTATE control to obtain proper alignment.

NOTE

If the trace is located above or below the 0°-180° vector graticule marking, preadjust the VERT POSITION CLAMP control to position the trace.

12. Depress the Y button. Leave the A CAL and FULL FIELD buttons depressed. Check that the display amplitude is 140 IRE units in the vertical center area of the graticule. Overlook the starting portion of the waveform. Use the VERT POSITION and HORIZ POSITION controls to position the display for best viewing (see Fig. 2-14). To minimize parallax viewing errors, use the pupil of the eye reflected from the —40 IRE unit graticule marking to align the bottom of the waveform with the graticule marking. Next, check the position of the top of the waveform with respect to the (+) 100 IRE graticule marking by reflecting the pupil of the eye from this graticule mark.

If the displayed amplitude is not 140 IRE units within ±1% (1.4 IRE units), set the A CAL screwdriver adjustment to obtain the correct amplitude.

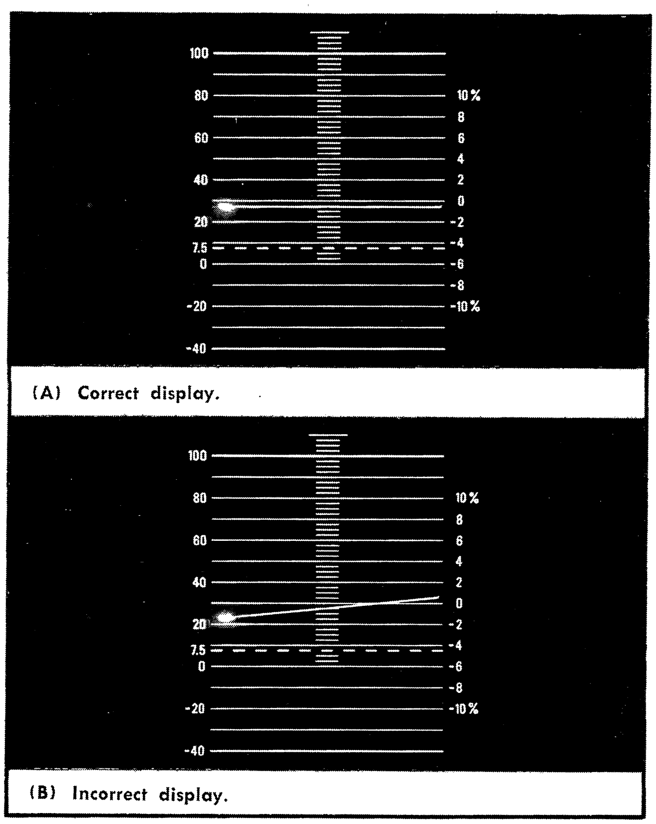


Fig. 2-13. Adjusting the BEAM ROTATE control. Pushbuttons depressed: A CAL, FULL FIELD, Aϕ and LINE SWEEP.

Press the B CAL button and cancel the A CAL button. Repeat the procedure for channel B. If necessary, adjust the B CAL screwdriver adjustment to obtain the same 140 IRE unit display amplitude as obtained for channel A.

13. Depress the A CAL and VECTOR buttons. Cancel the B CAL button. Check that the FULL FIELD and Aϕ buttons are depressed. The test circle should match the guide circle inscribed on the vector graticule.

NOTE

If the test circle trace is too dim for a portion of its circumference, preset the rear-panel UNBLANK BIAS control as described in step 17 and then continue with step 13 and on.

If the test circle is out-of-round, or if the circles do not overlay properly (within 0.032 inch, 1/3 of a 2° phase mark length on the vector graticule), use Table 2-4 to obtain the proper display as shown in Fig. 2-15A. Repeat the adjustments, as necessary, to obtain optimum results. Figs. 2-15B and 2-15C show two examples where the adjustments are set incorrectly.

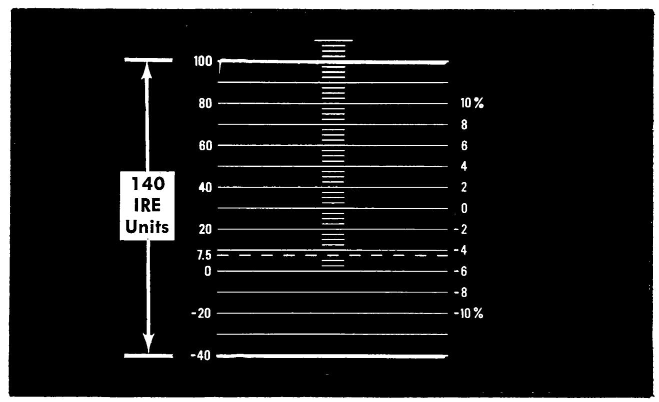


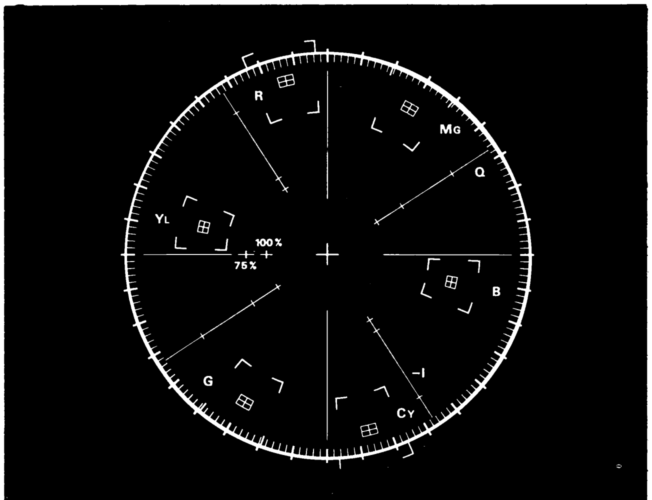
Fig. 2-14. Proper luminance calibrated test signal amplitude. Pushbuttons depressed: A CAL, FULL FIELD, Aϕ (not required) and Y.

TABLE 2-4

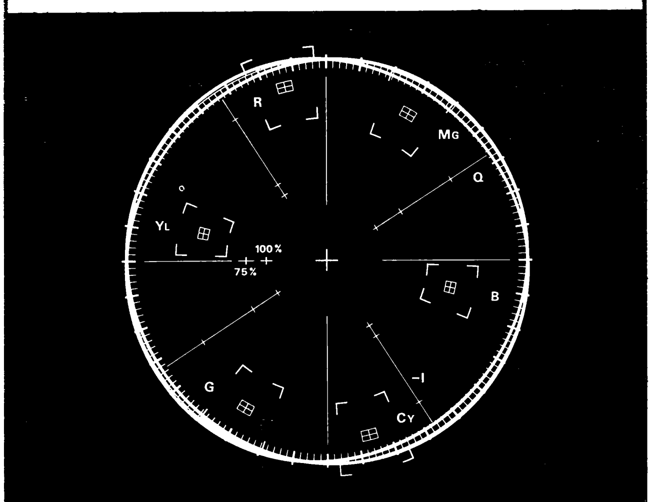
Adjustments	Effect on Test Circle Display
VERT POSITION CLAMP	Vertical positioning.
HORIZ POSITION CLAMP	Horizontal positioning.
QUAD PHASE	Merges the two ellipses to form a superimposed ellipse or circle.
GAIN BAL	Left and right portions.

After completing the adjustments, the test circles may not overlay perfectly, but they should be within the 0.032-inch radial separation limit. Accurate vector measurements can be made if the effects caused by a slight separation of the test circles are considered. In general, radial trace separation between the test circles is maximum at or near one or more of these points: 45°, 135°, 225° or 315°. The effect of this separation on a vector is as follows:

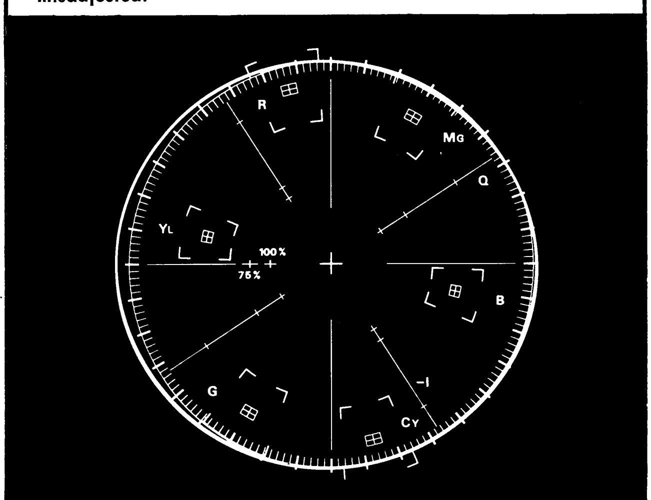
a. No phase error for a vector positioned at 90° or 270°.



(A) Test circle properly adjusted. This display is assurance that precise vector displays can be obtained.

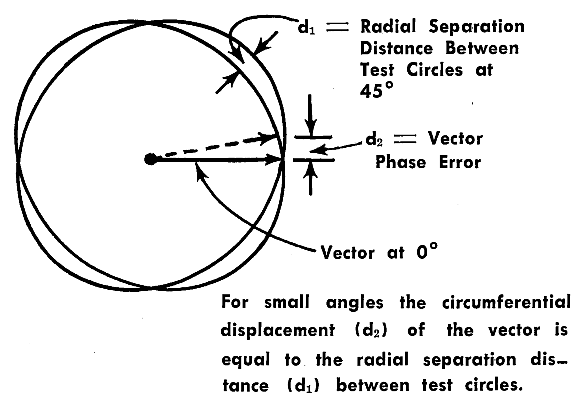


(B) Results obtained when the QUAD PHASE control is misadjusted.

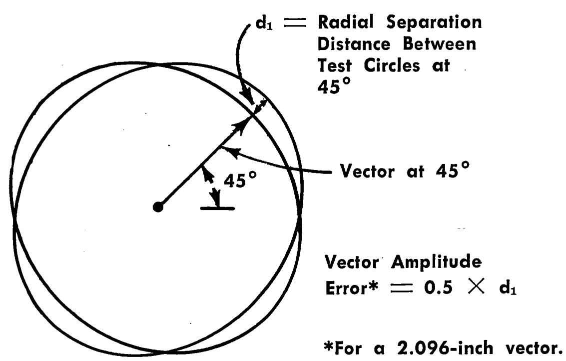


(C) Results obtained when GAIN BAL and HORIZ POSITION CLAMP controls are misadjusted.

Fig. 2-15. Obtaining a properly adjusted test circle display. Pushbuttons depressed: A CAL, FULL FIELD, Aϕ and VECTOR.



(A) Determining vector phase error. Maximum phase error exists at 0° or 180°.



(B) Determining vector amplitude error. Vector amplitude error is maximum at 45°, 135°, 225° or 315°.

Fig. 2-16. Determining phase and amplitude errors of vectors when the test circles have maximum radial separation at 45°, 135°, 225° or 315°.

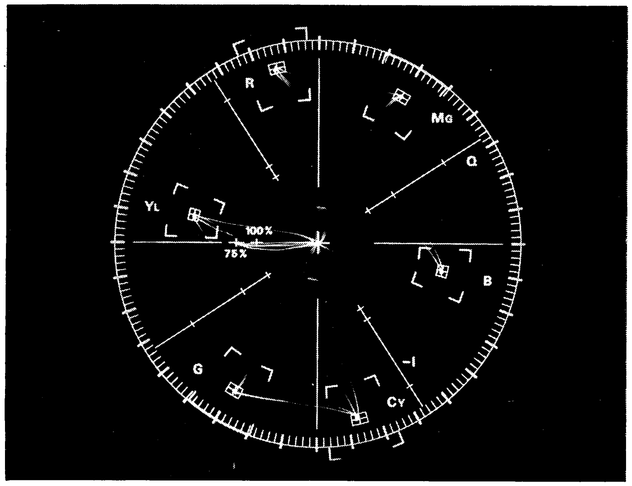
b. For a vector positioned at 0° or 180°, the phase error is equal to the radial separation distance between test circles (see Fig. 2-16A). For example, if the separation is 0.032 inch, the circumferential displacement of the vector is 0.032 inch or slightly less than 1° using this formula:

$$\phi = 2 \arcsin \frac{d_1}{2R}$$

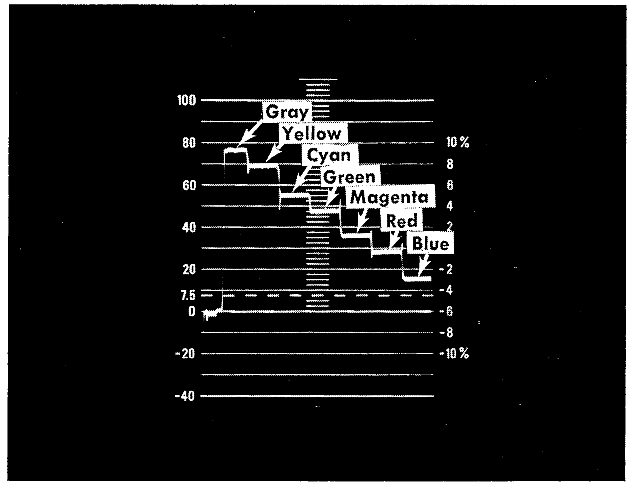
where ϕ is the vector phase error in degrees, d_1 is the radial separation between the test circles at 45° and R is the 2.096-inch radius of the inscribed test circle.

c. No vector amplitude error for vectors positioned at 0°, 90°, 180° or 270°.

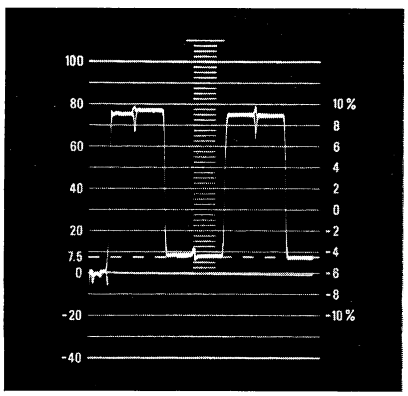
d. For a vector positioned at 45°, 135°, 225° or 315°, the vector amplitude error for a 2.096-inch vector is 0.5 times the radial separation distance between test circles (see Fig. 2-16B). A 2.096-inch vector is used in the calculation because



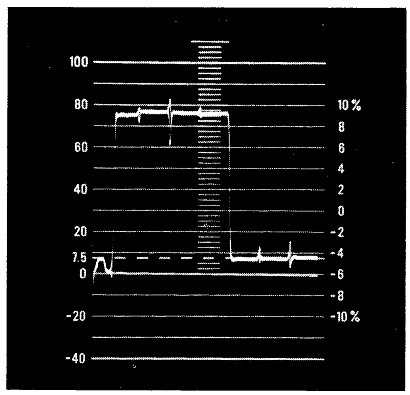
(A) VECTOR button is depressed to display the chrominance portion of the color-bar signal. Position of the dots within the smaller boxes indicate that the displayed color vectors are within ±2.5° and ±2.5 IRE units of the assigned hue (in degrees) and saturation (vector amplitude).



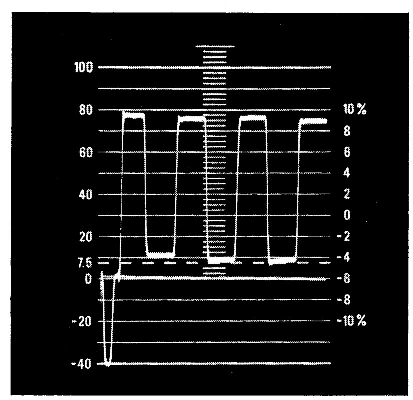
(B) Pushbutton Y is depressed to display the luminance amplitude of the color-bar signal. The vertical deflection is calibrated in IRE units as indicated by the left-hand scale.



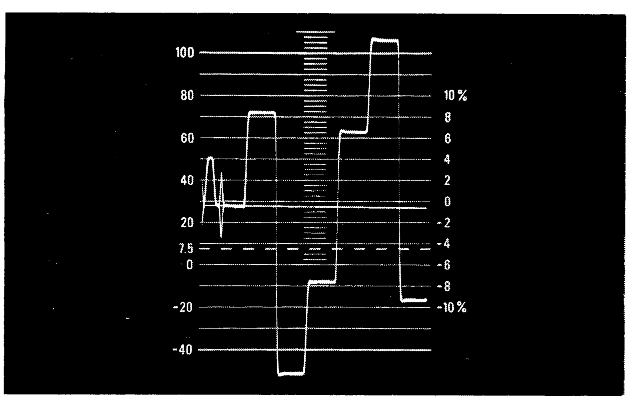
(C) Pushbutton R is depressed to display the red output waveform.



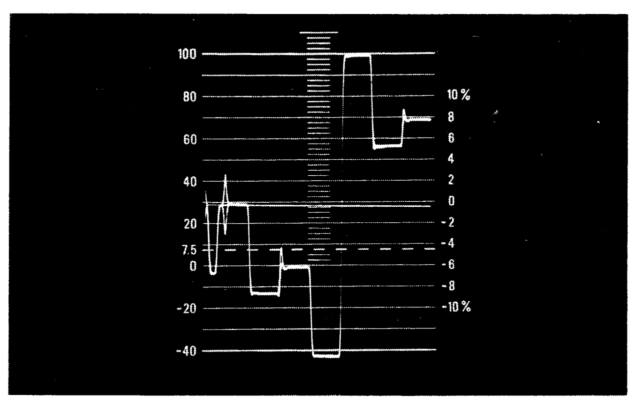
(D) Pushbutton G is depressed to display the green output waveform.



(E) Pushbutton B is depressed to display the blue output waveform.



(F) Pushbutton I is depressed to display the I component of the signal.



(G) Pushbutton Q is depressed to display the Q component of the signal.

Fig. 2-17 Typical waveforms obtained when displaying the chrominance and luminance portions of a color-bar test signal. Signal Selector pushbuttons depressd: CH A, FULL FIELD and Aϕ. Display Selector pushbuttons depressed: See individual waveforms.

the radius of the inscribed graticule test circle is this distance. For example, if the separation distance between test circles is 0.032 inch, then 0.5 times 0.032 inch is 0.016 inch. The amplitude error for a 2.096-inch vector is 0.016 inch, or about 0.8% amplitude error for any vector positioned at 45°, 135°, 225° or 315°.

For most distortions in which the test circles overlay properly but deviate slightly from the inscribed circle at some point, the effect on the vector is as follows:

For small angles the circumferential displacement (phase error) of a 2.096-inch vector located about 45° from the point of maximum circle deviation will be equal to the distance between the test circle deviation and the graticule circle. For a 2.096-inch vector pointing toward the circle distortion area, the vector amplitude error is equal to the test circle deviation distance from the graticule circle.

14. Press the B CAL button and cancel the A CAL button. Leave the FULL FIELD, Aϕ and VECTOR buttons depressed.

15. Check that a proper size (same size as obtained in step 13) test circle is obtained. The test circle should align with the vector graticule guide circle within the limits described in step 13.

16. Depress the A CAL button and cancel the B CAL button. Leave the FULL FIELD, Aϕ and VECTOR buttons depressed.

17. Set the INTENSITY control to obtain a dim circle under low-ambient light conditions. If trace intensity is not uniform, adjust the rear-panel UNBLANK BIAS control to obtain uniform intensity for the full circumference of the circle.

18. Reset the INTENSITY control to obtain a normal brightness display.

19. Press the CH A button. Leave the FULL FIELD, Aϕ and VECTOR buttons depressed. Adjust the A PHASE control to align burst with the 180° position. The burst tip should coincide with the 75% mark on the vector graticule and all color vectors should appear in their respective inner boxes (see Fig. 2-17A). This indicates that the color-bar signal input is 1 V peak-to-peak, the colors are 75% saturated, burst amplitude is 286 mV peak to peak, and the color-vector phase and amplitude are within ±2.5° and ±2.5 IRE unit tolerance.

20. Using Table 2-5 and Figs. 2-17B through 2-17G as a guide, check the displays obtained when Y, R, G, B, I and Q buttons are depressed in the order just given.

TABLE 2-5

Display Selector Pushbutton	Typical Waveform
Y	Fig. 2-17B
R	Fig. 2-17C
G	Fig. 2-17D
B	Fig. 2-17E
I	Fig. 2-17F
Q	Fig. 2-17G

21. With a staircase signal applied to the CH B input connector, press the following pushbuttons:

Signal Selector	CH B
Display Selector	Y

Cancel the CH A button. Check that the FULL FIELD and Aϕ buttons are depressed. The waveform should be a staircase signal as shown in Fig. 2-18A.

SN B150100 and up

22. Differential Gain Measurements. The Diff Gain scale on the line sweep graticule can be used to make differential gain measurements within an accuracy of 1% if the test signal modulation is preset to a standard amplitude. The procedure that follows describes how to preset a test signal to a standard modulation amplitude before proceeding with the measurement.

NOTE

As a test signal for differential gain measurements, it is possible to use any signal at the subcarrier frequency that retains a constant modulation amplitude (within a 70-mV to 196-mV range) throughout the line or portion being measured while the DC level of the signal varies. No burst or external subcarrier is required. However, the staircase vector display obtained in steps 22e and 22f will be free running and jittering will occur. A ramp with 100-mV peak-to-peak modulation and a staircase with 140-mV peak-to-peak modulation are examples of signals (see Fig. 2-18) that meet the stated test requirements.

a. Press the VECTOR button. Check that the CH B, FULL FIELD and Aϕ buttons are depressed. Check that the Ch B 100%-75%-MAX GAIN switch is set to 75%.

b. Use the A PHASE control to align the staircase vector at 0° or 180°. If burst is present disregard it in making this measuremnt.

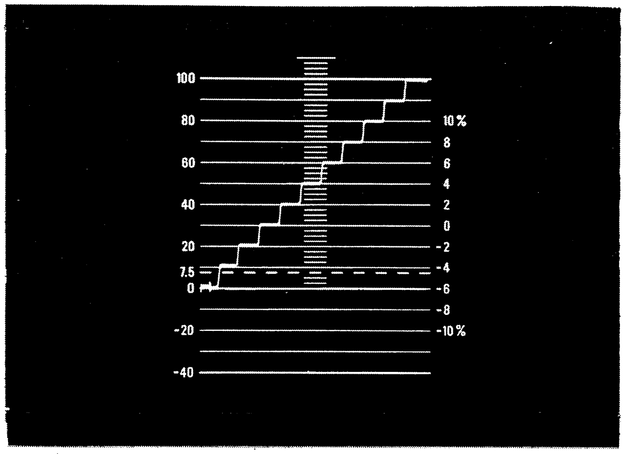
c. Set the Ch B 100%-75%-MAX GAIN switch to MAX GAIN. Check that the origin of the staircase vector coincides with the vector graticule center (see Fig. 2-18B). If it does not, adjust the VERT POSITION CLAMP and HORIZ POSITION CLAMP controls to center the vector origin.

d. Check that the tip of the staircase vector (not the burst vector) coincides with the vector graticule inscribed circle. If it does not, adjust the CH B GAIN control for proper vector tip and inscribed circle coincidence (see Fig. 2-18B). Readjust, if necessary, the A PHASE control to position the staircase vector at 0° or 180°.

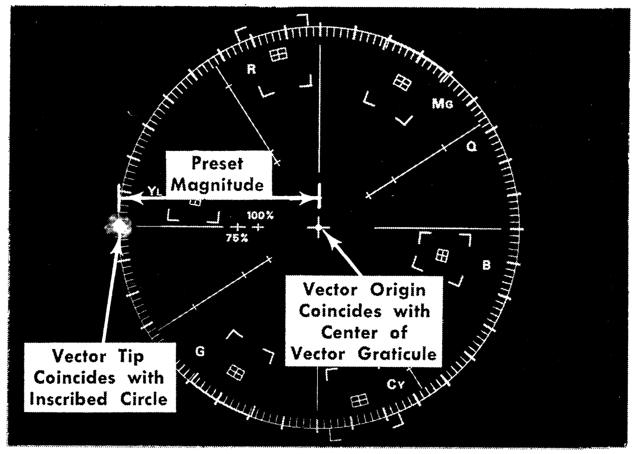
Up to this point in the procedure, the staircase vector has been preset to a standard magnitude for use in making the differential gain measurements that follow. In addition, the staircase vector has proper phase for performing the differential phase measurement.

e. Press the DIFF GAIN button. Check that the CH B, FULL FIELD and Aϕ buttons are depressed and the Ch B 100%-75%-MAX GAIN switch is set to MAX GAIN.

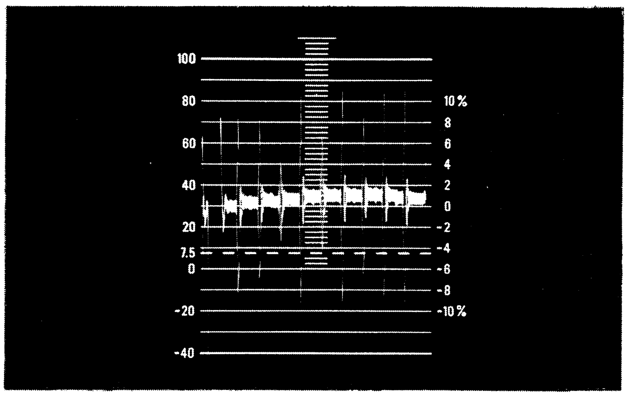
f. Adjust, if necessary, the VERT POSITION control to position the first step to the 0% Diff Gain graticule line as a reference. If there is no differential gain, all the stairstep



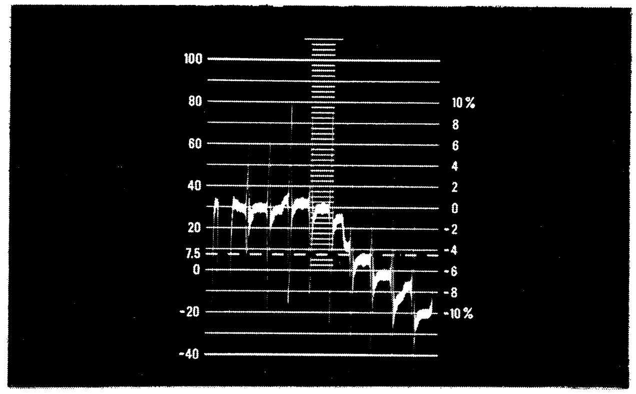
(A) 10-step linearity test signal. Buttons depressed: CH B, FULL FIELD, Aϕ and Y.



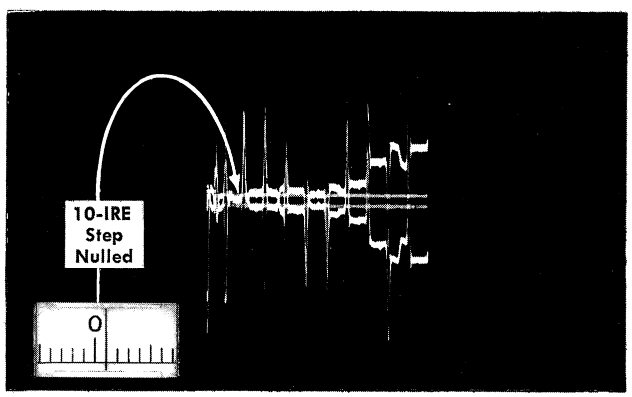
(B) Presetting the staircase vector to a standard magnitude before performing the differential gain measurement. Buttons depressed: CH B, FULL FIELD, Aϕ and VECTOR.



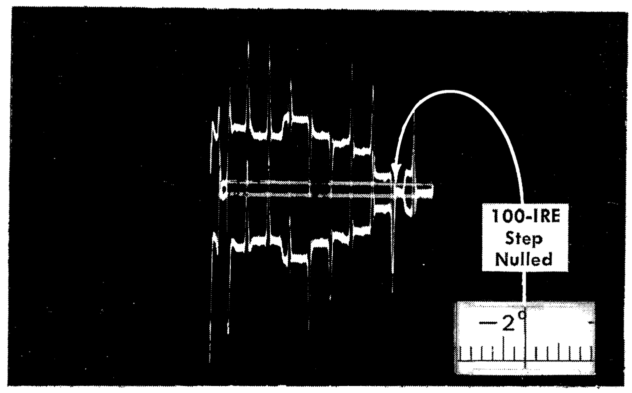
(C) Typical display obtained when test signal is linear within 1%. If no distortion were present, the staircase segments would form a straight horizontal line. Buttons depressed: CH B, FULL FIELD, Aϕ and DIFF GAIN.



(D) Waveform illustrating presence of severe differential gain. The tenth stairstep shows a 10% loss in signal amplitude. Buttons depressed: Same as (B).



(E) Initial CALIBRATED PHASE dial setting when measuring differential phase. Buttons depressed: CH B, FULL FIELD, Aϕ and DIFF PHASE.



(F) Final CALIBRATED PHASE dial setting when measuring differential phase between the 10-IRE and 100-IRE steps on the waveform. Buttons depressed: Same as (E).

Fig. 2-18. Typical waveforms obtained when displaying a ten-step linearity test signal. Waveforms (B) through (F) were obtained with the CH B 100%-75%-MAX GAIN switch set to MAX GAIN.

Ⓑ

segments will coincide with the 0% Diff Gain graticule line (see Fig. 2-18C). If a stairstep does not coincide with the 0% graticule line (for an example, see Fig. 2-18D), differential gain is present.

Table 2-6 is a conversion chart to equate the Diff Gain scale to percent of signal gain or loss, voltage ratio and dB. Using Fig. 2-18D display as an example, the sixth step has a signal loss of 2%, a voltage ratio of 0.98 and is 0.176 dB down.

BELOW SN B150100

Follow the above procedure, except for step d. The input signal must be 143 mV in amplitude in order to read differential gain in % directly from the graticule and TABLE 2-5. If the input signal is less than or greater than 143 mV, the readings obtained from the external graticule scale will decrease or increase by a direct ratio; for example, if the input signal is 157.3 mV (an increase of 10%), the readings from the graticule scale will increase by 10% and TABLE 2-6 will need revision.

TABLE 2-6

Differential Gain Conversion Chart

(Based on a staircase vector magnitude equal to the radius of the vector graticule inscribed circle as shown in Fig. 2-18B).

Line Sweep Graticule Diff Gain Scale	100%-75%-MAX GAIN Switch Set to MAX GAIN		
	% of Signal Gain or Loss	Voltage Ratio	dB
10%	+10%	1.10	+0.828
8	+8%	1.08	+0.668
6	+6%	1.06	+0.506
4	+4%	1.04	+0.341
2	+2%	1.02	+0.172
0	0%	1.00	+0.000
—2	—2%	0.98	—0.176
—4	—4%	0.96	—0.354
—6	—6%	0.94	—0.538
—8	—8%	0.92	—0.724
—10%	—10%	0.90	—0.916

23. Differential Phase Measurements. Press the DIFF PHASE button. Check that the Ch B, FULL FIELD and Aϕ buttons are depressed. Check that the Ch B 100%-75%-MAX GAIN switch is set to MAX GAIN, and the Ch B GAIN control is set to CAL.

a. Check that the CALIBRATED PHASE is set to 0°. Use the A PHASE control as a coarse adjustment to null the first step on the display (see Fig. 2-18).

NOTE

As an alternative method for roughly nulling the first step in the display, press the VECTOR button and use the A PHASE control to position the staircase vector at 180° or 0°. After properly positioning the staircase vector, press the DIFF PHASE button and proceed to step 23b.

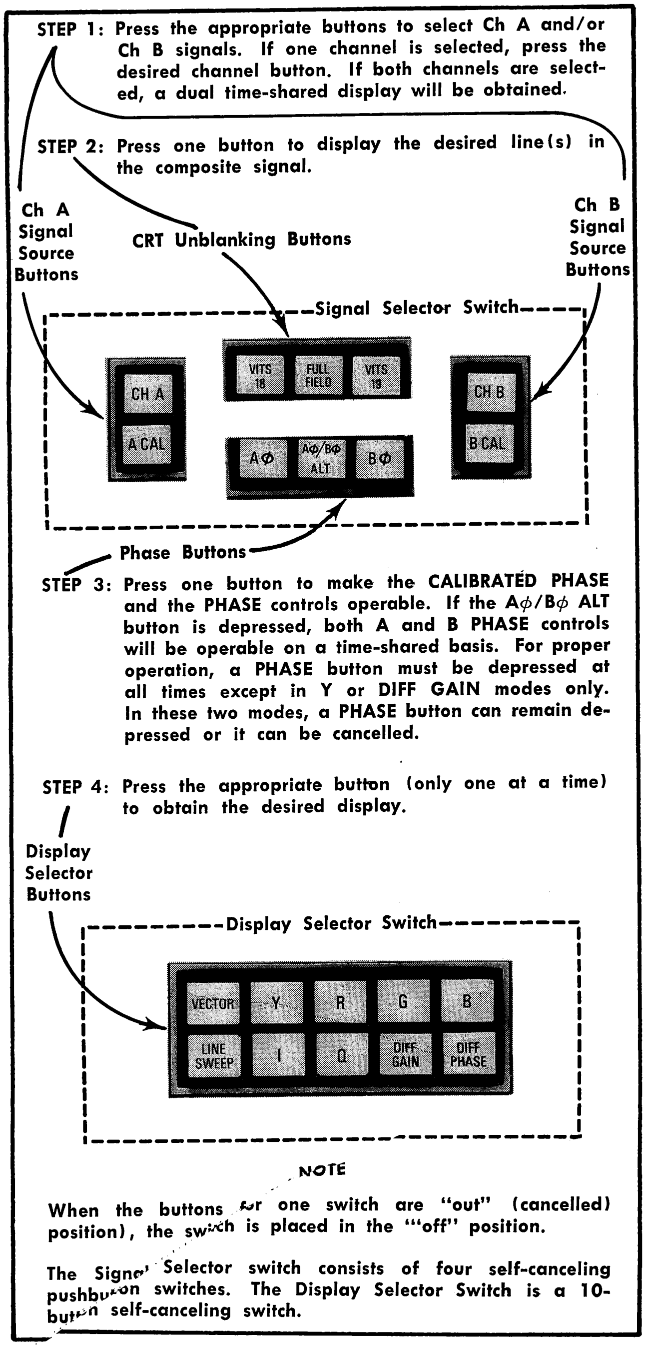


Fig. 2-19. Grouping of the pushbuttons for each switch. One button for each group, with exceptions as given in Steps 1 and 3, should be depressed to obtain a useful display.

b. Use the CALIBRATED PHASE control as a vernier adjustment for nulling the first step. Note the dial reading. For example, in Fig. 2-18E the dial reading is —0.1°.

c. Set the CALIBRATED PHASE control so the last step is at null. Note the dial reading. Fig. 2-18F indicates a dial reading of —2.2°.

d. Subtract the dial difference readings noted in steps 23b and 23c. The result should be the amount of differential phase between the first and last step in the 10-step linearity test signal. Using Figs. 2-18E and 2-18F as an example: —0.1° subtracted from —2.2° equals 2.1° differential phase. Since total differential phase is the point of interest, the algebraic sign of the resultant may be omitted.

NOTE

Using step 23 as a guide, differential phase between any two steps on the waveform can be measured if desired. Best accuracy is obtained when the CALIBRATED PHASE control is turned in one direction (without reversing direction) when nulling between steps on the waveform. Turning the dial in one direction eliminates any possible backlash as a source of error.

GENERAL OPERATING INFORMATION

Pushbutton Switches

The Signal Selector switch consists of four self-canceling switches arranged as shown in the upper part of Fig. 2-19. The Display Selector switch is a 10-button self-canceling switch as shown in the lower part of Fig. 2-19. For proper instrument operation and to produce useful displays, follow the procedure given in the illustration

NOTE

To cause a depressed button in any self-canceling switch button group to cancel so all buttons in that group are "out", apply slight finger pressure at a point on an "out" button that permits the finger to extend over the "in" (depressed) button. Let the "in" button release outward until it touches the finger. Then remove the finger so both buttons can spring to their "out" (canceled) positions. When all buttons for one group are "out", the self-canceling switch is in the "Off" position.

The First-Time Operation procedure provides one way to become familiar with the operation of the pushbuttons. Another source of information is the Pushbutton Logic topic provided in the Performing The Measurements portion of this Operating Iinstructions section.

Internal Triggering Source

Table 2-7 lists the internal triggering source for each possible combination of the CH A, A CAL, CH B and B CAL pushbutton positions. Use this information to check that a signal is applied to the proper rear-panel connector for the pushbutton combination to be used. This assures that optimum display stability will be obtained when operating the instrument. To obtain a stable dual-channel display (CH A and CH B), CH B input signal must be synchronous with CH A input signal, since the CH B display is triggered from the CH A input .

Note that for the A CAL/B CAL dual-display mode of operation, no signal to the CH A or CH B connectors is required, When A CAL, B CAL and VECTOR buttons are depressed, the internal calibration signal originates from the 3.59-MHz Test Circle Oscillator located on the Input Amplifier board. (In the absence of a video sync source during the VECTOR mode of operation with the A CAL and/or B CAL buttons depressed, it may be necessary to adjust the BURST FLAG TIMING control to obtain a stable test circle display.)

When A CAL, B CAL and any Display Selector switch button except VECTOR is depressed, the internal calibration signal originates from the collector of Q570 located on the Demodulator board. Repetition rate of this sync signal is H/4.

Opening the Access Doors

The right door opens at the right side and can be slid into a slot located at the left side of the recessed area. The left door opens at the left side and can be slid into a slot located at the right side of the recessed area.

TABLE 2-7

Pushbutton Channel A	Combination Channel B	Internal Sync Source	For Optimum Display Stability
CH A	Off	Channel A	Apply signal to CH A Input connector.
CH A	CH B		
CH A	B CAL		
Off	B CAL		
A CAL	Off	Channel B	Apply signal to CH B input connector.
A CAL	CH B		
Off	CH B		
Off	Off		
A CAL	B CAL	None required	No input signal required.

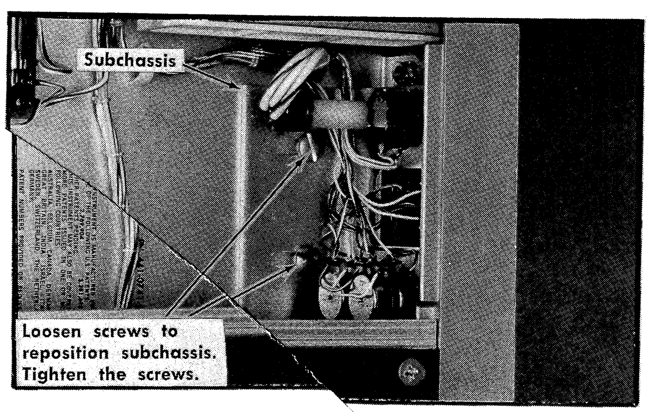
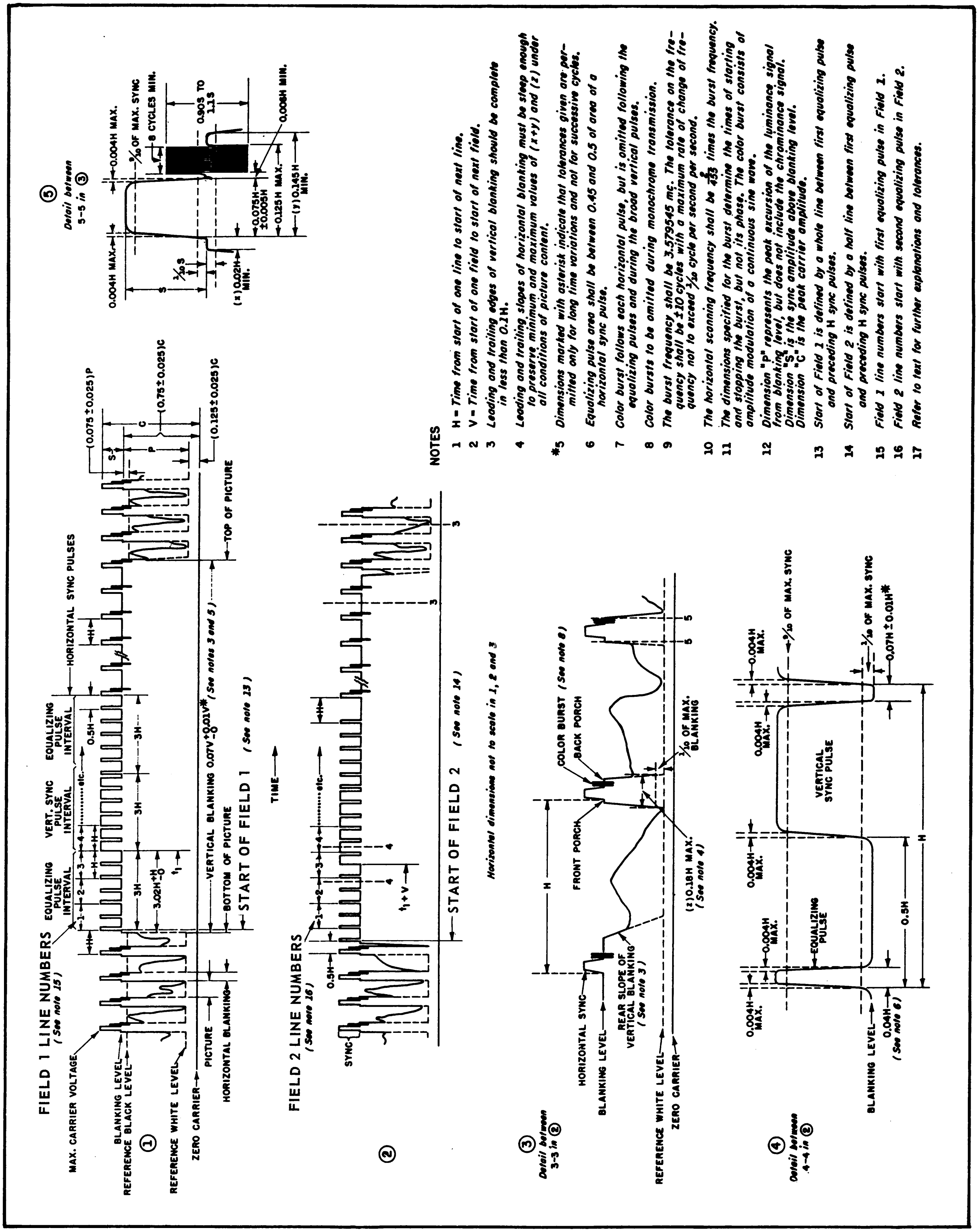


Fig. 2-20. Bottom right-front portion of the Type R520 showing location of the subchassis mounting screws.



NOTES

1 H = Time from start of one line to start of next line.

2 V = Time from start of one field to start of next field.

3 Leading and trailing edges of vertical blanking should be complete in less than 0.1H.

4 Leading and trailing slopes of horizontal blanking must be steep enough to preserve minimum and maximum values of (x+y) and (z) under all conditions of picture content.

*5 Dimensions marked with asterisk indicate that tolerances given are permitted only for long time variations and not for successive cycles.

6 Equalizing pulse area shall be between 0.45 and 0.5 of area of a horizontal sync pulse.

7 Color burst follows each horizontal pulse, but is omitted following the equalizing pulses and during the broad vertical pulses.

8 Color bursts to be omitted during monochrome transmission.

9 The burst frequency shall be 3.579545 mc. The tolerance on the frequency shall be ±10 cycles with a maximum rate of change of frequency not to exceed 1/10 cycle per second per second.

10 The horizontal scanning frequency shall be $\frac{2}{455}$ times the burst frequency.

11 The dimensions specified for the burst determine the times of starting and stopping the burst, but not its phase. The color burst consists of amplitude modulation of a continuous sine wave.

12 Dimension "P" represents the peak excursion of the luminance signal from blanking level, but does not include the chrominance signal. Dimension "S" is the sync amplitude above blanking level. Dimension "C" is the peak carrier amplitude.

13 Start of Field 1 is defined by a whole line between first equalizing pulse and preceding H sync pulses.

14 Start of Field 2 is defined by a half line between first equalizing pulse and preceding H sync pulses.

15 Field 1 line numbers start with first equalizing pulse in Field 1.

16 Field 2 line numbers start with second equalizing pulse in Field 2.

17 Refer to text for further explanations and tolerances.

Fig. 2-21. Details of a television synchronizing waveform for color transmission. Similar to the illustration shown on page 265 of the FCC Rules and Regulations, Volume III, March 1968 edition.

Positioning the Right Recessed Control Subchassis

The FOCUS, BURST FLAG TIMING, VERT POSITION and HORIZ POSITION recessed controls are mounted on an adjustable position subchassis (see Fig. 2-20). The subchassis has slotted mounting holes to adjust the protrusion distance of these controls. With the subchassis positioned to its maximum inward position, the control knobs will protrude 1/8 inch or less from the recessed front panel. This position permits full closure of the right door. With the door opened, the controls can be adjusted by placing a screwdriver in the arrowed slot to turn the knob. The arrowed slot is a simple indicator for the relative rotational position of the knob.

If the subchassis is positioned to its maximum outward position, the knobs will protrude about 1/2 inch or more from the recessed front panel. This subchassis position enables the knobs to be easily turned by hand, so a screwdriver is not needed. If the subchassis is mounted in this position, the protruding control knobs will prevent the right door from closing; hence, the door should be left open and out of the way by sliding the door fully into its slot.

Graticule Illumination

When the VECTOR button is depressed, the SCALE ILLUM control varies the illumination of the vector graticule. When any Display Selector button except VECTOR and DIFF PHASE buttons are depressed, the SCALE ILLUM control varies the illumination of the IRE graticule. No graticule illumination occurs when the DIFF PHASE button is depressed.

Burst Brightening

Trace intensification occurs during the first 3 microseconds of the linear sweep, when the burst amplifier is keyed on and the CRT trace is brightened. This intensified portion provides positive identification of the burst signal. Burst brightening takes place in the LINE SWEEP mode only.

Vector Displays

The VECTOR presentation is a graphic display for operational measurements with color bars, modulated staircase waveform of the VITS, or other industry test signals. Carrier balance corrections can be made while on the air because the VECTOR display shows direction and magnitude of the required adjustments.

With a VECTOR display, phase measurements can be made within 1° and saturation measurements, within ±1% on the graticule, and even closer when comparing two signals in dual-channel operation.

The internally generated test circle matched with the graticule circle verifies the accuracy of the VECTOR display.

Linear Sweep Displays

The color signals can be demodulated along any desired axis, I, Q, R-Y, B-Y, G-Y, etc. and displayed at the line rate on a linear time base. The various linear time base display modes permit a variety of useful operational tests and measurements to be made. This is accomplished by selecting the appropriate Display Selector modes: I, Q, R, B, G, DIFF GAIN, DIFF PHASE.

Calibrated phase shift using the trace overlay technique permits a slide-back type of phase measurement with a resolution of at least 0.1°.

Dual Displays

In dual-channel operation, successive samples of each channel are displayed on a time-shared basis. For example, the input signal to some location in the broadcast plant can be compared to the output signal to measure any phase and/or amplitude distortion caused at that location. Also, the outputs of any two areas of the broadcast plant can be compared. Video cable lengths can be accurately matched for time delay at color subcarrier frequency to less than 1° phase difference.

Using the VECTOR display, either channel can be turned off to provide a zero reference point for the other channel. The reference point is a sharply defined spot in the center of the display.

Using the linear-sweep displays, turning off one channel while the other remains in use provides a zero reference line against which signals can be nulled.

When using dual-channel operation and internal triggering, refer to Table 2-7 in this section of the manual. This table lists the internal triggering source for each pushbutton combination.

Vertical Interval Testing

The binary counters in the Type R520 Line Selector Matrix operate in conjunction with the Field Selector circuit to select lines in either field that may carry suitable test signals. These circuits enable the Vectorscope to be used for measuring differential gain and differential phase during color broadcasts on the test signals which may be transmitted during the vertical blanking interval. The topics, "VITS Line Selection" and "VITS Field Selection", that follow describe how to select any NTSC line from 7 through 22 in the same field or in opposite fields. BELOW SN B150100: Lines selected are from 7 through 21.

To aid in the identification of fields and lines, a television synchronizing waveform illustration is shown in Fig. 2-21 to accompany the following definitions:

a. FIELD 1: The start of Field 1 is defined by a **whole H line** between the first equalizing pulse and the preceding H sync pulse.

b. FIELD 2: The start of Field 2 is defined by a **half H line** between the first equalizing pulse and the preceding H sync pulse.

c. Line numbering for Field 1: Field 1 line numbers start with the **first equalizing pulse** in Field 1.

d. Line Numbering for Field 2: Field 2 line numbers start with the **second equalizing pulse** in Field 2.

VITS Line Selection

SN B150100 and up

The Type 520 is normally connected at the factory to permit selection of lines 18 and 19 in either television field by means of the VITS 18 and VITS 19 pushbuttons in conjunction with the FIELD switch. Quick-disconnect jumper wires are used on the Sweep board to preselect the lines so that, if desired, any pair of NTSC lines (from 7 through 22) or the same lines in each field can be preselected. Intensity and focus are automatically adjusted for optimum viewing of VITS; that is, the front-panel INTENSITY and FOCUS controls do not need to be readjusted when switching from FULL FIELD to VITS 18 or VITS 19.

To preselect a pair of lines in a television field, use TABLE 2-8 and Fig. 2-22A as a guide for the VITS 18 pushbutton. Use TABLE 2-9 and Fig. 2-22A as a guide for the VITS 19 pushbutton. The connectors with jumpers are located on the Sweep board. The Sweep board is located on the bottom center-rear of the chassis. Five jumpers for each VITS pushbutton control the selection of lines.

NOTE

Whenever the jumper wires are connected to select lines other than 18 and 19, be sure to change the number on the button to match the new line number. Button numbers can be changed by covering the old number with a new number.

BELOW SN B150100

Line preselection is made by placement of jumpers between various pins located on the Sweep board. Any pair of lines (or the same lines) within a group of lines can be made selectable by the VITS 18 and VITS 19 pushbuttons. There are two groups of lines for preselection: Group 1 (lines 7 through 14) and Group 2 (lines 15 through 21).

To preselect a pair of lines within Group 1 (lines 7 through 14), in a television field, use Table 2-10 and Fig. 2-22B as a guide. To preselect a pair of lines within Group 2 (lines 15

TABLE 2-8

SN B150100 and up

Line Preselection For VITS 18 Pushbutton

<table>
<tr><th rowspan="2">Lines to be pre-selected</th><th colspan="5">Jumper Wire Pin Connections</th></tr>
<tr><th>Pin AA to</th><th>Pin S to</th><th>Pin M to</th><th>Pin G to</th><th>Pin A to</th></tr>
<tr><td>7</td><td>AC</td><td rowspan="2">U</td><td rowspan="4">O</td><td rowspan="8">I</td><td rowspan="16">C</td></tr>
<tr><td>8</td><td>AB</td></tr>
<tr><td>9</td><td>AC</td><td rowspan="2">T</td></tr>
<tr><td>10</td><td>AB</td></tr>
<tr><td>11</td><td>AC</td><td rowspan="2">U</td><td rowspan="4">N</td></tr>
<tr><td>12</td><td>AB</td></tr>
<tr><td>13</td><td>AC</td><td rowspan="2">T</td></tr>
<tr><td>14</td><td>AB</td></tr>
<tr><td>15</td><td>AC</td><td rowspan="2">U</td><td rowspan="4">O</td><td rowspan="8">H</td></tr>
<tr><td>16</td><td>AB</td></tr>
<tr><td>17</td><td>AC</td><td rowspan="2">T</td></tr>
<tr><td>18</td><td>AB</td></tr>
<tr><td>19</td><td>AC</td><td rowspan="2">U</td><td rowspan="4">N</td></tr>
<tr><td>20</td><td>AB</td></tr>
<tr><td>21</td><td>AC</td><td rowspan="2">T</td></tr>
<tr><td>22</td><td>AB</td></tr>
</table>

TABLE 2-9

SN B150100 and up

Line Preselection For VITS 19 Pushbutton

<table>
<tr><th rowspan="2">Lines to be Pre-selected</th><th colspan="5">Jumper Wire Pin Connections</th></tr>
<tr><th>Pin AG to</th><th>Pin W to</th><th>Pin Q to</th><th>Pin K to</th><th>Pin E to</th></tr>
<tr><td>7</td><td>AH</td><td rowspan="2">X</td><td rowspan="4">R</td><td rowspan="8">L</td><td rowspan="16">F</td></tr>
<tr><td>8</td><td>AF</td></tr>
<tr><td>9</td><td>AH</td><td rowspan="2">V</td></tr>
<tr><td>10</td><td>AF</td></tr>
<tr><td>11</td><td>AH</td><td rowspan="2">X</td><td rowspan="4">P</td></tr>
<tr><td>12</td><td>AF</td></tr>
<tr><td>13</td><td>AH</td><td rowspan="2">V</td></tr>
<tr><td>14</td><td>AF</td></tr>
<tr><td>15</td><td>AH</td><td rowspan="2">X</td><td rowspan="4">R</td><td rowspan="8">J</td></tr>
<tr><td>16</td><td>AF</td></tr>
<tr><td>17</td><td>AH</td><td rowspan="2">V</td></tr>
<tr><td>18</td><td>AF</td></tr>
<tr><td>19</td><td>AH</td><td rowspan="2">X</td><td rowspan="4">P</td></tr>
<tr><td>20</td><td>AF</td></tr>
<tr><td>21</td><td>AH</td><td rowspan="2">V</td></tr>
<tr><td>22</td><td>AF</td></tr>
</table>

TABLE 2-10

Below SN B150100

Preselecting VITS Pushbutton Lines 7 through 14 (Group 1)

<table>
<tr><th>Push-buttons</th><th>Lines to be Prese-lected</th><th colspan="5">Jumper Wire Pin Connections</th></tr>
<tr><td rowspan="8">VITS 18</td><td>7</td><td>U to T</td><td rowspan="2">O to N</td><td rowspan="4">I to H</td><td rowspan="8">BM to C</td><td rowspan="16">BO to BN</td></tr>
<tr><td>8</td><td>U to V</td></tr>
<tr><td>9</td><td>U to T</td><td rowspan="2">O to P</td></tr>
<tr><td>10</td><td>U to V</td></tr>
<tr><td>11</td><td>U to T</td><td rowspan="2">O to N</td><td rowspan="4">I to J</td></tr>
<tr><td>12</td><td>U to V</td></tr>
<tr><td>13</td><td>U to T</td><td rowspan="2">O to P</td></tr>
<tr><td>14</td><td>U to V</td></tr>
<tr><td rowspan="8">VITS 19</td><td>7</td><td>R to S</td><td rowspan="2">L to M</td><td rowspan="4">F to G</td><td rowspan="8">BL to B</td></tr>
<tr><td>8</td><td>R to Q</td></tr>
<tr><td>9</td><td>R to S</td><td rowspan="2">L to K</td></tr>
<tr><td>10</td><td>R to Q</td></tr>
<tr><td>11</td><td>R to S</td><td rowspan="2">L to M</td><td rowspan="4">F to E</td></tr>
<tr><td>12</td><td>R to Q</td></tr>
<tr><td>13</td><td>R to S</td><td rowspan="2">L to K</td></tr>
<tr><td>14</td><td>R to Q</td></tr>
</table>

through 21), use Table 2-11 and Fig. 2-22B as a guide. The connector pins with jumpers are located on the bottom side, center-rear portion, of the chassis. Three of the jumpers control the selection of a group of lines, and three jumpers for each VITS push-button control the selection of lines within a group.

In general, it is not possible to use one VITS pushbutton to select a line in Group 1 and the other VITS pushbutton to select a line in Group 2. However, some overlap from Group 1 into the first few lines of Group 2 is possible. The amount of overlap depends on circuit tolerances and may vary from instrument to instrument. Usually it is possible to extend two or three lines from Group 1 into Group 2 by means of the BO and BN jumper connection. For example, to preselect line 10 with the VITS 18 button and line 16 with the VITS 19 button, refer to Table 2-12.

TABLE 2-11

Below SN B150100

Preselecting VITS Pushbutton Lines 15 Through 21 (Group 2)

Push-buttons	Lines to be Prese-lected	Jumper Wire Pin Connections				
VITS 18	15	U to T	O to N	I to H	BM to D	BO to BP
	16	U to V				
	17	U to T	O to P			
	18[5]	U to V				
	19	U to T	O to N	I to J		
	20	U to V				
	21	U to T	O to P			
VITS 19	15	R to S	L to M	F to G	BL to A	
	16	R to Q				
	17	R to S	L to K			
	18	R to Q				
	19[5]	R to S	L to M	F to E		
	20	R to Q				
	21	R to S	L to K			

[5]Fig. 2-22B illustrates the connections for preselecting these lines (18 and 19).

TABLE 2-12

Below SN B150100

Push-buttons	Lines to be Prese-lected	Jumper Wire Pin Connections				
VITS 18	10	U to V	O to P	I to H	BM to C	BO to BN
VITS 19	16	R to Q	L to M	F to G	BL to A	

Note that for the example given in Table 2-12, the BO to BN connection keeps both buttons in Group 1. Then by connecting the VITS 19 group selector jumper wire between pins BL and A(see Table 2-11), the VITS 19 button can be set to preselect one of the first few lines in Group 2. In the example just given, line 16 was preselected.

VITS Field Selection

As mentioned previously, the Type R520 is normally connected at the factory to permit selection of lines 18 and 19 in either field by means of the VITS 18 and VITS 19 pushbuttons in conjunction with the FIELD switch. For example, if the FIELD switch is set to 2, line 18 or 19 in field 2 can be selected by depressing the VITS 18 or VITS 19 button, respectively.

Suppose, however, that the color test signals are being transmitted on line 19 in field 1 and on the same line (19) in field 2. Suppose further that the operator desires to select these signals by means of the VITS pushbuttons only (without opening the right-hand door to move the FIELD switch when selecting the pushbutton positions). This can be accomplished by first using Table 2-9 to change the VITS 18 button to select line 19. Next, leave the FIELD switch in the 2 position and preselect field one for the left-hand pushbutton by moving the VITS 18 field selector jumper to the proper connections (AK to AL) using the information provided in Table 2-13 and illustrated in Fig. 2-23. Note that the pushbutton field-selector jumper connections are located conveniently near the line-selector jumper connections.

TABLE 2-13

SN B150100 and up

Field Preselection For VITS Pushbuttons

Push-button	FIELD Switch Position	Field to be Preselected	Jumper Wire Pin Connections
VITS 18	1	1	AK to AM
	2	2	(Normal connection)
	1	2	AK to AL[6]
	2	1	
VITS 19	1	1	AO to AN
	2	2	(Normal connection)
	1	2	AO to AP[6]
	2	1	

[6]Note that these connections reverse the FIELD switch positions.

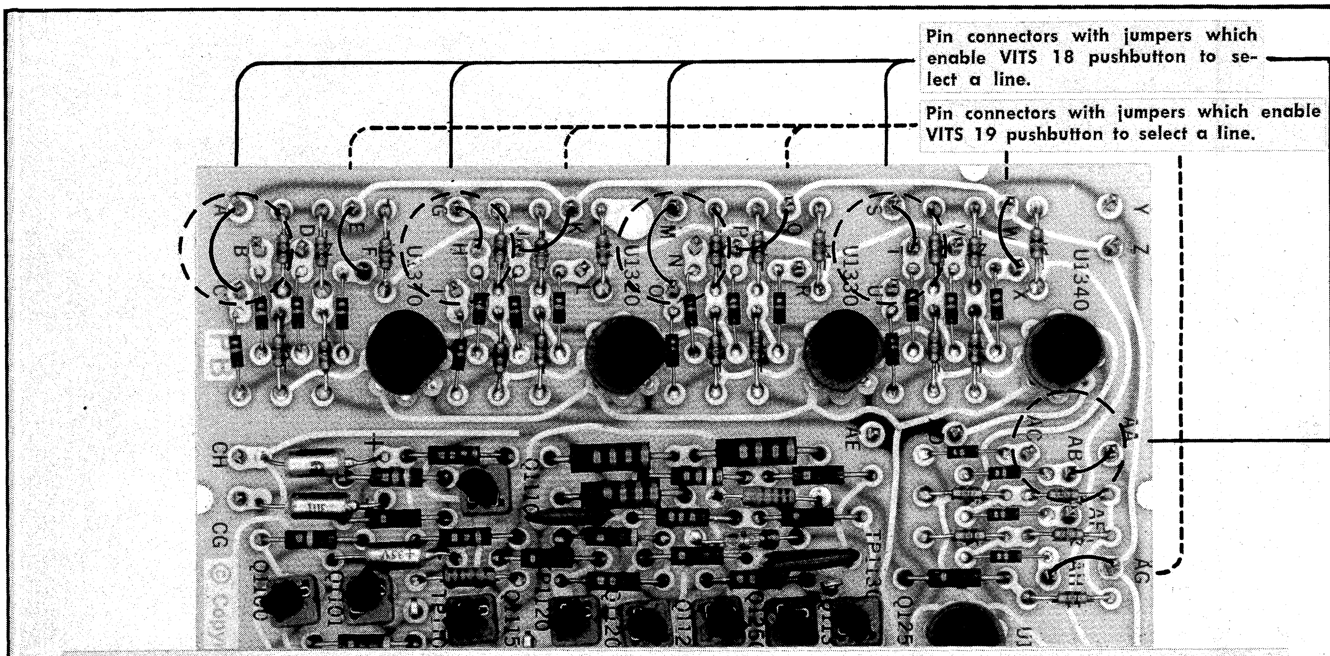
TABLE 2-14

Below SN B150100

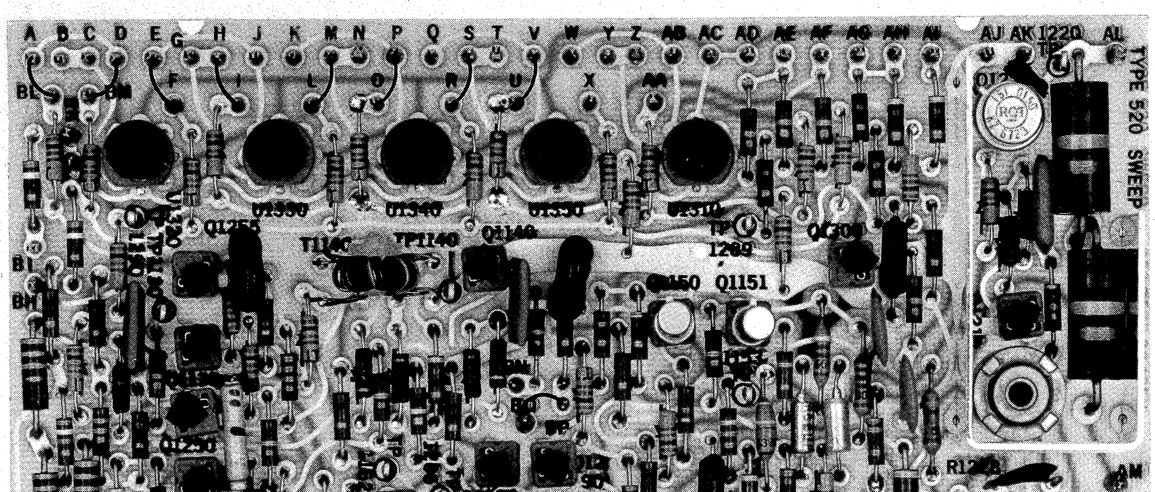
Field Preselection For VITS Pushbuttons

Push-button	FIELD Switch Position	Field to be Preselected	Jumper Wire Pin Connections
VITS 18	1	1	AA to Z
	2	2	(Normal connection)
	2	1	AA to AB[7]
	1	2	
VITS 19	1	1	X to Y
	2	2	(Normal connection)
	2	1	X to W[7]
	1	2	

[7]Note that these connections reverse the FIELD switch positions.



(A) SN B150100 and up. Location of VITS 18 and VITS 19 line selector jumper wires and pin connectors on the Sweep board. This illustration shows the jumpers connected to preselect lines 18 and 19 in fields 1 or 2.



(B) Below SN B150100. This illustration shows the jumpers connected to preselect lines 18 and 19 (normal connections) in Group 2.

Fig. 2-22. Location of the line selector jumper wires on the Sweep board. These illustrations are examples to show how to preselect a pair of lines using the information given in Tables 2-8 and 2-9 (SN B150100 and up) or Tables 2-10 and 2-11 (below SN B150100).

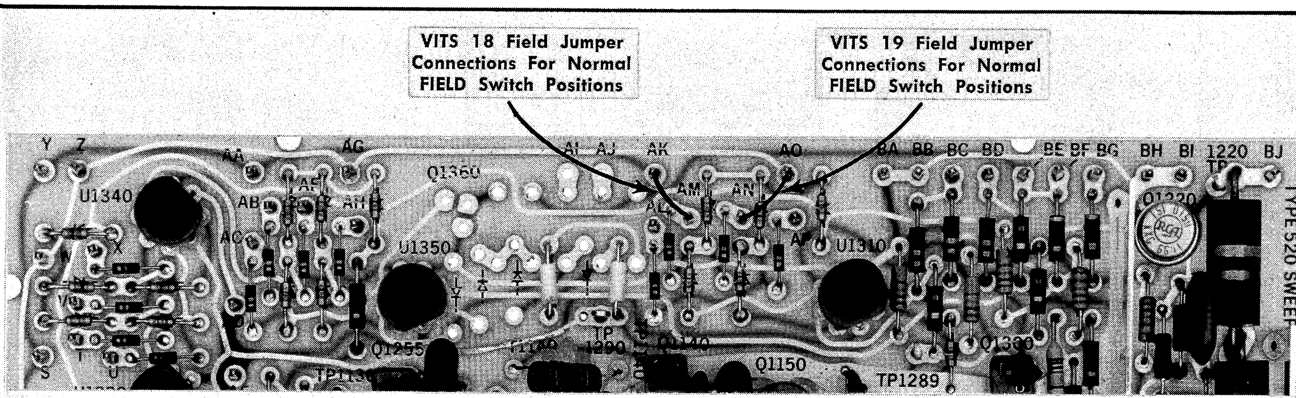
NOTE

When preselecting VITS pushbutton lines and fields, be sure to indicate these changes on the front panel of the instrument for your information and to notify other operators. Using the latter example (line 19 in both fields); the left-hand button nomenclature should read: VITS 19, FIELD 1 and the FIELD switch nomenclature for the 2 position should read: LEAVE AT 2. The right-hand button should read: VITS 19, FIELD 2.

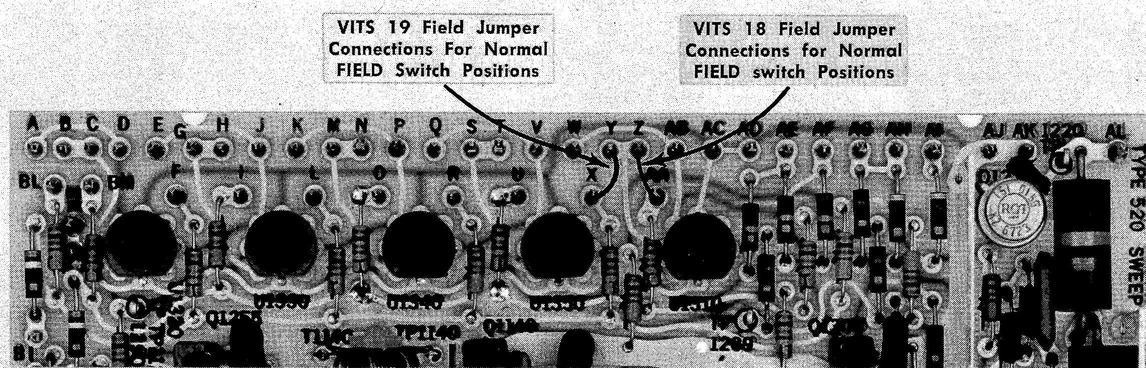
PERFORMING THE MEASUREMENTS

Pushbutton Logic

In Section 11 of this manual there is a table printed on three pullout pages entitled, "Operating Displays". This table provides a concise list of pushbutton combinations for check or measurement to be performed. Space at the end of the table has been provided for adding new data if desired. Note that for a single channel operation in this table, the signal is applied to the CH A input connector. Internal sync and burst signals are used. These assumed conditions simplify the table and setup procedure. In actual practice, either CH A or



(A) SN B150100 and up. Normal connections for Field selection. With the FIELD switch set to 1, the pushbuttons select the lines in Field 1. If the FIELD switch is set to 2, the pushbuttons select the lines in Field 2.



(B) BELOW SN B150100. Normal connections for the pushbuttons when lines in the same field are selected. For example, with the FIELD switch set to 2, the pushbuttons select the lines in Field 2. If the FIELD switch is set to 1, the pushbuttons select the lines in Field 1.

Fig. 2-23. Location of the field-selection jumper wires on the Sweep board. Note that the jumpers can be connected so the buttons select lines in the same field or opposite fields while the FIELD switch remains at a predetermined position.

CH B input connectors can be used. In addition, external sync and burst signals can be used if desired. The only requirement is that the pushbutton switches and controls associated with the channel to be displayed are set properly. If external sync and burst signals are applied to the Type R520, then the SYNC and ϕ REF switches should be set to the EXT positions when the INT option is not desired.

Color Encoder

All necessary adjustments to the encoder can be made with the Type R520. Using the VECTOR mode, the I matrix may be checked for accuracy by turning off the Q channel and observing that all six dots align with the cross marks along the I axis of the vector graticule.

Check that the Type R520 100%-75%-MAX GAIN switch is set to 75% and the GAIN control for the channel is set to CAL. Set the I chroma gain on the encoder so that the largest amplitude (red and cyan) dots align with the I-axis cross marks. All the other dots should align, too.

Some typical causes of I-axis dot misalignment may be due to incorrect matrixing from the R, G and B signals to the I signal, matrix resistor value changes, incorrect gain of an inverting amplifier associated with the matrix function, nonlinear amplification of the matrixed signals, or nonlinear amplification of the doubly-balanced I modulators.

The remarks given for the I channel apply equally to the Q channel.

Having established independently the correct operation of the I or Q channel, with the other channel temporarily disabled, the quadrature phasing between the I and Q channels is facilitated as follows:

1. Turn on both channels in the encoder.

2. Adjust the encoder quadrature phasing and the Type R520 A PHASE (or B PHASE) control so that all color dots lie within their respective inner boxes on the vector graticule.

3. Burst phasing of the encoder may then be adjusted so that the burst vector is at exactly 180° on the vector graticule.

4. The amplitude of the burst vector may be set on the encoder.

5. The luminance levels in the encoder can now be set to their correct amplitudes using the Y (luminance) mode of operation.

Color Saturation

The saturation of the displayed colors can be checked by using the 75% and 100% burst amplitude markings on the vector graticule and by noting the position of the 100%-75%-MAX GAIN switch. The general procedure for making this check is as follows:

1. While obtaining a normal VECTOR display, check that the GAIN control for the channel is set to CAL.

2. Set the 100%-75%-MAX GAIN switch to a position that causes the displayed color vectors to appear within the target areas. Note the location of the burst tip along the 180° axis on the vector graticule and the position of the 100%-75%-MAX GAIN switch. If both the burst tip location and the switch position indicate 75%, the colors are 75% saturated. If the burst tip location and the switch position indicate 100%, the colors are 100% saturated.

Differential Gain

In general, any differential gain present in the signal can be checked by using the DIFF GAIN mode of operation and by setting the 100%-75%-MAX GAIN switch to MAX GAIN. With a standard 10-step linearity staircase signal applied to the Type R520, any differential gain present will cause a variation in the segment levels as described in step 22 of the First-Time Operation procedure and illustrated in Fig. 2-18D.

The IRE graticule major divisions represent % of signal gain or loss when the displayed 100 IRE level coincides with the 0% graticule lines. Using the right-hand graticule marking for the scale in conjunction with the major and minor graticule markings, differential gain measurements can be made within an accuracy of 1%.

If the 10-step linearity staircase signal is transmitted as a VITS signal, the Type R520 can be used to monitor this test signal and perform differential gain measurements while the test signal is being broadcast with the regular program material. The VITS buttons can be set to preselect any line between 7 and 22 in either field as described in VITS Line Selection and VITS Field Selection topics presented previously in this section of the manual. BELOW SN B150100: lines that can be preselected are from 7 through 21.

NOTE

Any signal at the subcarrier frequency that retains constant amplitude throughout the line or portion being measured while the DC level of the signal varies can be used as a test signal for differential gain measurements.

Differential Phase

Any differential phase present can be detected by noting the dial settings of the CALIBRATED PHASE control when using the slideback method for overlaying two traces in DIFF PHASE mode of operation. As described previously in step 23 of the First-Time Operation procedure, no phase distortion is present if the traces are parallel.

If phase distortion is present, the phase demodulated lines of both traces will not be parallel; that is, the traces are farther apart at certain points as distortion increases, as shown in Figs. 2-18E and 2-18F. The two magnified presentations show the 10 IRE step nulled as compared to the 100 IRE step nulled. The difference in CALIBRATED PHASE dial settings required to null these two is the difference in phase which, in this instance, is 2.1°.

Using the standard linearity test signal, a differential phase error of 0.2° can be measured. The CALIBRATED PHASE dial provides excellent resolution since 1° of phase shift is represented by approximately one inch of dial tape movement.

NOTE

Any signal at the subcarrier frequency that retains constant phase throughout the line or portion being measured while the DC level of the signal varies can be used as a test signal for differential phase measurements.

Phase vs Time Delay

Time delay between two signals can be checked, because the phase difference at any particular frequency can be related to time difference. An example of this is the setup of two color cameras some distance apart. With the outputs of the cameras connected to the inputs on the Vectorscope, and the following pushbuttons depressed: CH A, CH B, FULL FIELD, Aϕ and VECTOR, the two signals can be viewed together on a time-shared basis. Any time-delay difference between the two camera links will appear as a phase difference in the vectorial display.

This time-delay difference can be determined by noting that 360° on the graticule equals 280 nanoseconds of time. The difference can be minimized by adjusting the connecting cable lengths so that there will be no hue or phase difference from one camera to the other.

OBTAINING WAVEFORM PHOTOGRAPHS

Fig. 2-24 shows the Tektronix C27 camera setup that was used when photographing the vector displays and waveform for this manual. Polaroid[8] Land film pack Type 107 with an ASA rating of 3000 was used in the camera. Similar results can be obtained if roll film Type 47 with an ASA rating of 3000 is used in a Polaroid Land 3¼ x 4¼ Roll-Film Back Part No. 122-0603-00. If a Roll-Film Back is used, the part number for the focusing plate that should be used in steps 9 through 14 is 387-0460-00.

Fig. 2-25A shows the size of the image with respect to the recording area when the F1.9—1:0.5 lens is used. If a larger size image area is desired as shown in Fig. 2-25B, use a F1.9—1:0.7 lens (122-0547-00). However, this lens should be used with a pack-film back to obtain consistent alignment of the image within the recording area.

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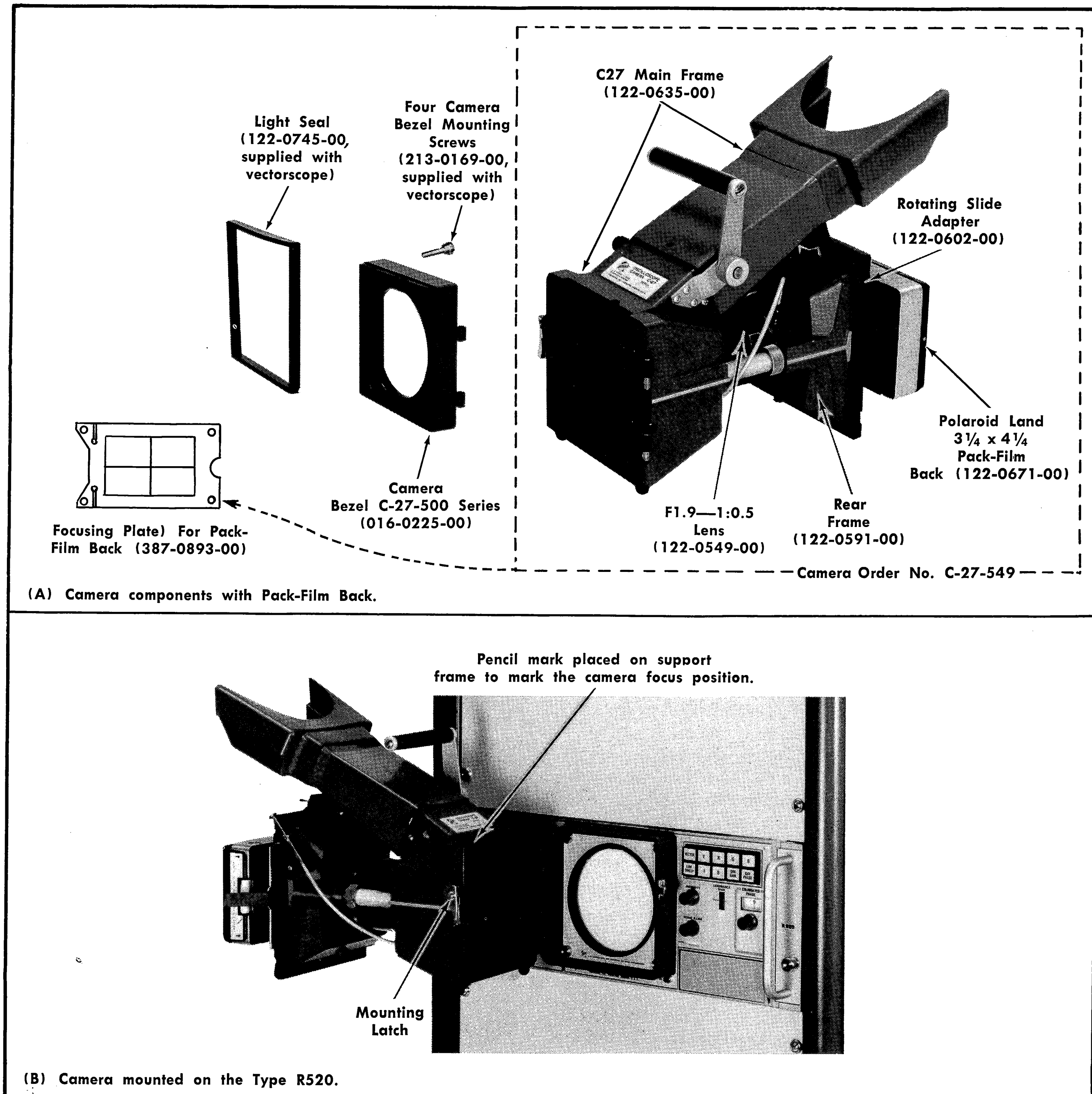
[8]Registered Trade Mark, Polaroid Corporation.



(A) Camera components with Pack-Film Back.

(B) Camera mounted on the Type R520.

Fig. 2-24. Tektronix C27 camera setup used in obtaining the waveform photographs for the Instruction Manual. If a larger size image (see Fig. 2-25B) on the recording area is desired, use a 1.9-1:0.7 lens (122-0547-00).

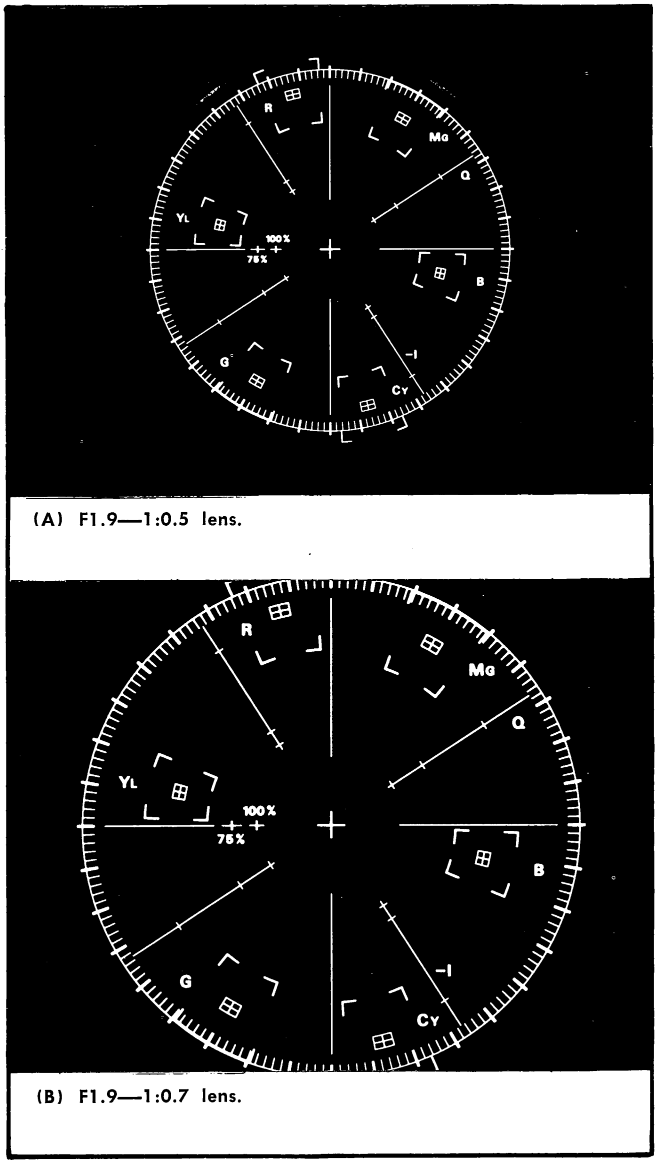
Camera types other than those made by Tektronix, Inc. can be adapted to fit the Type R520 if the proper bezel is used. Contact your local Field Engineer or Field Office for more information about the availablity of other bezels.

To obtain the photographs for this section (Operating Instructions, Section 2) of the manual, the camera was set as follows: Shutter speed, 1/5 second; aperature selector, F5.6.

The following procedure is suggested for mounting the camera on the instrument and obtaining the pictures.

1. Remove the graticule cover with accompanying parts by removing four graticule thumb screws (see Fig. 2-26A). BELOW SN B150100. Loosen the graticule cover by pulling outward on the rim near the lower left-hand corner. Hold the unsnapped corner with one hand and use the other hand to pull outward on the opposite rim near the upper right-hand corner. Carefully remove the graticule cover with all accompanying parts.

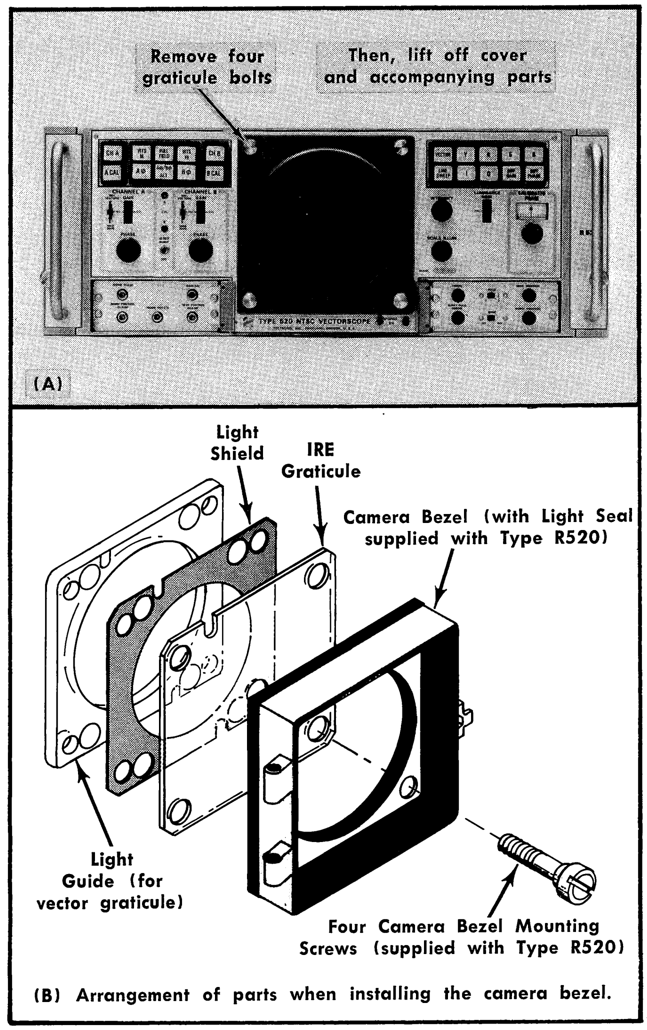
2. Remove the light seal from the camera bezel and install the one supplied with the Type R520. Save the removed light seal, if desired.



(A) F1.9—1:0.5 lens.

(B) F1.9—1:0.7 lens.

Fig. 2-25. Comparing the image size with respect to the recording area when using different object-to-image ratio lenses.



(B) Arrangement of parts when installing the camera bezel.

Fig. 2-26. Removing the graticule cover and installing the camera bezel.

3. Place the IRE graticule, paper light shield and light guide (see Fig. 2-26B) in the camera bezel.

NOTE

To obtain the highest quality vector waveform pictures for use in this section of the manual, the IRE graticule was removed. If utmost clarity is not important, good vector pictures can be obtained without removing the IRE graticule. In addition, the IRE graticule provides protection against marring the plastic face plate bonded to the face of the CRT.

4. Mount the camera bezel together with the graticule parts on the front of the Vectorscope CRT. Use the four thumb screws supplied with the Type R520. (The bezel mounting nuts furnished with the camera are not used with the Type R520, but they can be used when mounting the bezel on oscilloscopes having the appropriate mounting studs.

5. Apply a color signal to the Vectorscope and set the controls to obtain a normal vector display.

6. Adjust the FOCUS and INTENSITY controls for well-defined vector dots with less than normal brightness. Set the SCALE ILLUM control to illuminate the vector graticule.

7. Attach the camera to the bezel hinge and secure the camera against the Vectorscope with the Mounting Latch (see Fig. 2-24B).

8. Open the camera back and install the focusing plate with frosted side towards the camera lens.

9. Set the camera Aperture selector to F1.9 and place the shutter Speed selector at "T". Press the Shutter Release control to open the shutter.

10. Carefully focus the camera on the vector display and illuminated vector graticule markings. Use low ambient light

conditions to facilitate accurate focusing. Place a pencil mark on the camera support frame (see Fig. 2-24B) as a reference for the focus position.

11. Check that the display is centered in the focusing plate area. If not, the rotating slide adapter can be adjusted to permit proper centering of the image within the film frame. Refer to the camera manual for further information.

12. IMPORTANT: Press the Shutter Release control to close the shutter before setting the following camera controls:

Shutter Speed	1/5 s
Aperture Selector	F5.6

NOTE

F-stops higher than F4 are used to obtain better depth of field.

13. Remove the focusing plate. Load the camera back with 3000 ASA rating film. Close the camera viewing door.

14. Press the Shutter Release control to photograph the vector display. Develop the picture. If the vector photograph is not satisfactory; i.e., display and/or graticule markings are not properly exposed, readjust the INTENSITY and SCALE ILLUM controls. Take another picture.

NOTE

Initially, several pictures will have to be taken in order to find the best control settings. Once these settings are known by mentally noting the display presentation or by logging the control settings, then it is possible to duplicate the picture with less experimentation when the camera is used the next time. For additional information concerning the use of the camera, refer to the manual shipped with the C27 camera.

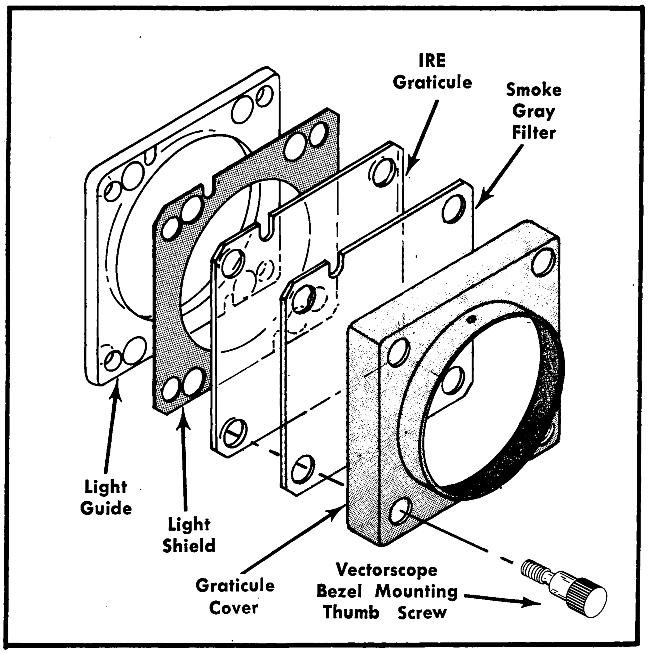


Fig. 2-27 Arrangement of parts when re-installing the graticule cover.

15. To obtain a double exposure photograph of two displays using a common graticule for both, proceeds as follows:

With the graticule illuminated and the desired display presented on the CRT, press the Shutter Release control to photograph the display. Set the Vectorscope controls to present the second display, turn down the SCALE ILLUM control so the graticule is not illuminated, and press the Shutter Release control. Develop the picture.

16. To obtain good photographs using the IRE (external) graticule, consider the following hints:

(a) Check that the IRE graticule fits close to the CRT face. This position will minimize parallax. (The CRT face should protrude from the front panel the same distance as the thickness of the vector graticule light guide.)

(b) Since another set of graticule lamps is turned on, readjust (if necessary) the SCALE ILLUM control to obtain proper graticule illumination.

(c) Use the channel variable GAIN control to produce a slightly greater amplitude display to compensate for the parallax between the trace and IRE graticule as "seen" by the camera.

(d) If the vector graticule appears on the photograph, remove the camera bezel. Position the IRE graticule lamp holders so the filaments are in line with the IRE graticule position. This will ensure that only the IRE graticule will receive proper edge lighting.

17. After completing the picture taking and the use of the camera, remove the camera and bezel. Re-install the graticule cover with all its associated parts (see Fig. 2-27) on the front of the Vectorscope CRT.

GLOSSARY OF TERMS

CHROMINANCE: This term is used to indicate both hue and saturation of a color.

CHROMINANCE SIGNAL: In television, the sidebands of the modulated chrominance subcarrier which are added to the monochrome signal to convey color information. The chrominance signal components (I and Q signals NTSC) transmit the qualities of hue and saturation but do not include luminance or brightness.

COLOR BURST: In NTSC color, normally refers to a burst of approximately 8 cycles of 3.579545 MHz subcarrier on the back porch of the composite video signal. This serves as a color synchronizing signal to establish a frequency and phase reference for the chrominance signal.

COMPOSITE VIDEO SIGNAL: The complete video signal. For monochrome, it consists of the picture signal and the blanking and synchronizing signals. For color, additional color synchronizing signals and color picture information are added.

DIFFERENTIAL GAIN: The amplitude change, usually of the NTSC 3.579545 MHz color subcarrier, introduced by the over-all circuit, measured in dB or per cent, as the picture signal on which it rides is varied from blanking to white level.

DIFFERENTIAL PHASE: The phase change of the 3.579545 MHz NTSC color subcarrier introduced by the over-all circuit, measured in degrees, as the picture signal on which it rides is varied from blanking to white level.

DYNAMIC: (When referred to a characteristic of the Type R520) Denotes the change of that characteristic with respect to a 10%-90% change in Average Picture Level (APL). Examples: Dynamic Phase, Dynamic Gain.

GEOMETRY: The degree to which a rectilinear display on a CRT screen is accurately reproduced. Generally associated with properties of a CRT.

H PULSE: Applicable only to the Type 520/R520. A pulse of approximately 6 μs duration generated during horizontal blanking time and used as a timing pulse.

H RAMP: Applicable only to the Type 520/R520. A ramp voltage generated coincident with the H pulse and having the same time duration as the H pulse.

H RATE: The time for scanning one complete line, including trace and retrace, NTSC equals 1/15734 sec (color) or 63.5 μs.

HUE: The attribute of color perception that determines whether an object is red, yellow, green, blue, purple, or the like. White, black, and gray are not considered as being hues.

LUMINANCE: This indicates the amount of light intensity, which is perceived by the eye as brightness.

ORTHOGONALITY: The extent to which traces parallel to the vertical axis of a cathode-ray-tube display conform to a right angle with the horizontal axis.

SATURATION: This indicates how little a color is diluted by white light, distinguishing between vivid and weak shades of the same hue. The more a color differs from white the greater is its saturation. Saturation is also indicated by the terms purity and chroma. High purity and chroma correspond to high saturation and vivid color.

SCR: Subcarrier regenerator (applicable only to Type 520/R520).

COLOR SUBCARRIER: In NTSC color, the carrier whose modulation sidebands are added to the monochrome signal to convey color information, i.e. 3.579545 MHz.

VIDEO STRIPPING: The process of removing the video information from the composite video signal.

VITS: Vertical interval test signal.

9 LINE KEY-OUT: The period of time utilized by the equalizing pulses and the serrated vertical pulse, equal to the time duration of nine television lines during which burst is not present.

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains an electrical description of each circuit in the Type R520 Vectorscope. Block diagrams illustrating signal flow for six modes of operation are described prior to the detailed circuit description. A detailed block diagram of the complete instrument is included in the Diagrams section as an aid in troubleshooting. Complete schematics are also included in the Diagrams section. These diagrams should be referred to during the detailed circuit description. The electron convention of current flow is used in all references to current flow in the circuit description.

Proper understanding of the circuit description to follow will depend to some extent on the reader's understanding of typical electronic circuits. The list of references which follows provides an index of reference material relating to some of these typical circuits.

1. Operational Amplifiers

   Jacob Millman and Herbert Taub, "Pulse, Digital and Switching Waveforms", McGraw-Hill, New York, 1965, pp. 15-18.

2. Field-Effect Transistors

   Jacob Millman and Herbert Taub, "Pulse, Digital and Switching Waveforms", McGraw-Hill, New York, 1965, pp. 658-663.

3. Miller Sweep Circuit

   Jacob Millman and Herbert Taub, "Pulse, Digital and Switching Waveforms", McGraw-Hill, New York, 1965, pp. 536-538, 540-554.

4. Regulated Power Supply

   Phillip Cutler, "Semiconductor Circuit Analysis", McGraw-Hill, New York, 1964, pp. 559-625.

5. Class "C" Oscillators

   Frederick E. Terman, "Electronic and Radio Engineering", fourth edition, McGraw-Hill, New York, 1955, pp. 493.

6. Oscillators, Crystal

   Frederick E. Terman, "Electronic and Radio Engineering", fourth edition, McGraw-Hill, New York, 1955, pp. 506-519.

7. Synchronous Demodulators

   A. Frederick E. Terman, "Electronic and Radio Engineering", fourth edition, McGraw-Hill, New York, 1955, pp. 1007.

   B. Bernard Grob, "Basic Television Principles and Servicing", third edition, McGraw-Hill, New York, 1964, pp. 591, 602-607.

SIGNAL FLOW BLOCK DIAGRAMS

In the following description when a specific block has the same function in all modes of operation, only the initial description will be given. The switch selection for each mode of operation is specified on each block diagram.

Mode one (Fig. 3-1). Color bar signals are coupled into channel A and channel B Input Amplifiers of the Type R520. Channel A and B Input Amplifiers are operational amplifiers with a gain of one. The composite signal from the channel A amplifier is coupled to the Burst and Sync Amp, which has a gain of approximately two. The signal is then coupled to the Subcarrier Regenerator and to the Sweep circuit. The Sync Processing circuit removes the video from the composite signal and recovers the sync. This composite sync pulse is used as a timing reference for the regeneration of the sweep sawtooth and for the Field Selector circuit. The color burst is recovered from the composite signal that was coupled to the Subcarrier Regenerator and is used to phase and frequency-lock the internal oscillator that generates the reference subcarrier. The reference subcarrier is coupled into the Precision Phase Shifter, which is the front panel CALIBRATED PHASE control, to adjust the phase of the subcarrier up to $\pm 15°$. The subcarrier is then coupled through the Subcarrier Amplifier to the A and B PHASE Goniometers. The A and B PHASE Goniometers are continuously variable and are controlled from the front panel. They can shift the phase of the reference subcarrier through 360°. The subcarrier is then coupled into the Subcarrier Switching circuit on the Demodulator board. The composite signals from the channel A and channel B Input Amplifiers are also coupled to the Demodulator board through the channel A and channel B Switching circuit.

The Subcarrier Switching circuit and channel A/channel B Switching circuits are controlled by a J-K flip flop with an output pulse at one quarter of the horizontal scanning frequency. Therefore the output of the channel A/channel B Switching circuit is a time-shared signal containing two lines of channel A information and two lines of channel B information. These signals are coincident with the time-shared A and B phase outputs of the Subcarrier Switching circuit. The reference subcarrier is coupled through a Subcarrier Amplifier to the Horizontal Demod Driver. The output of the Horizontal Demod Driver is coupled to the Horizontal Demodulator and to the Vertical Demod Driver. The reference subcarrier is shifted 90° in phase through the Vertical Demod Driver and coupled into the Vertical Demodulator. The composite signal from the channel A and B Switching circuit is coupled through a Composite Video Amplifier to a Chrominance Amplifier. The input to the chrominance amplifier is a high pass filter that removes all but the chrominance information from the signal. The output of the chrominance amplifier is coupled to the Vertical and Horizontal Demodulators.

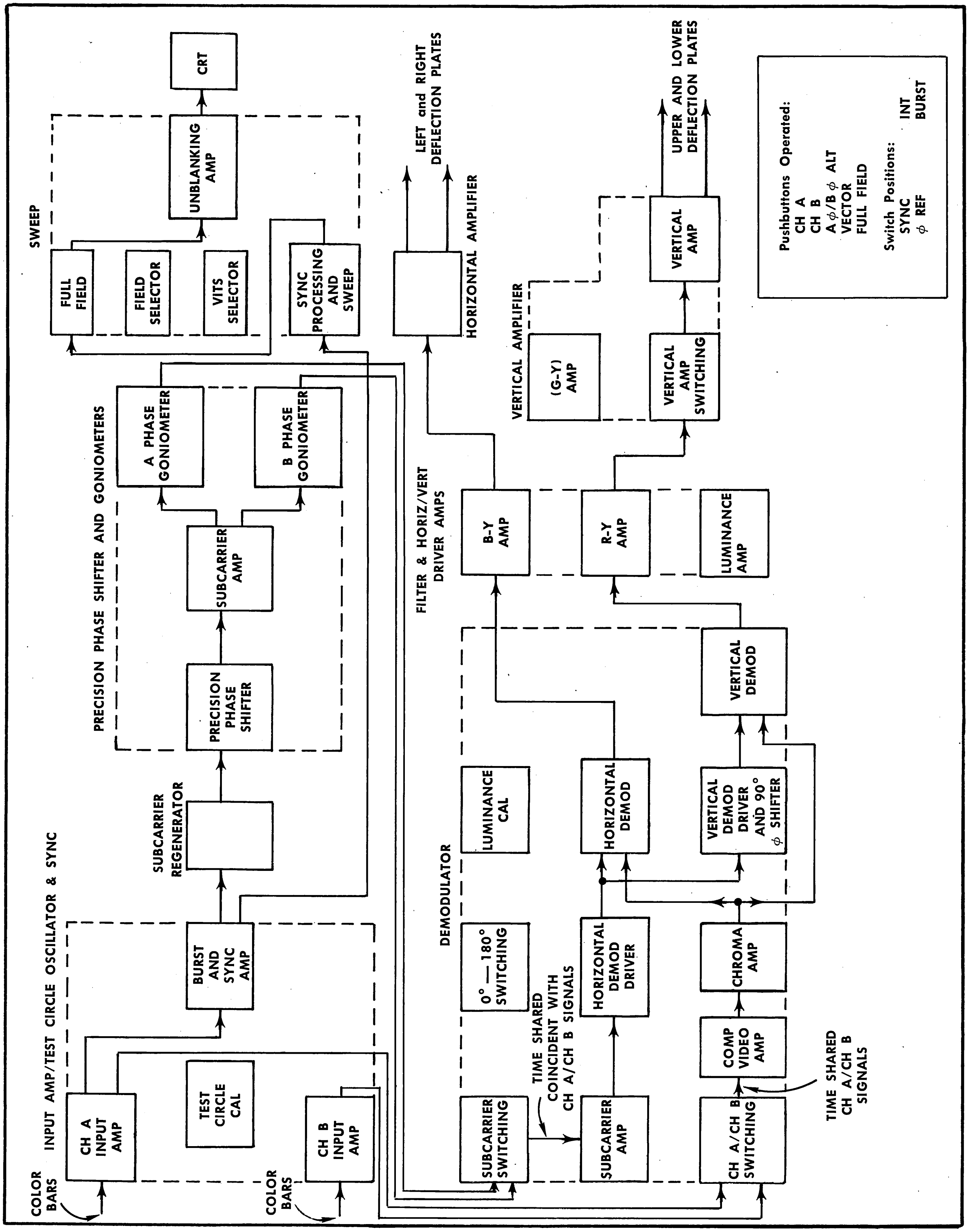


Fig. 3-1. Mode one, signal flow block diagram.

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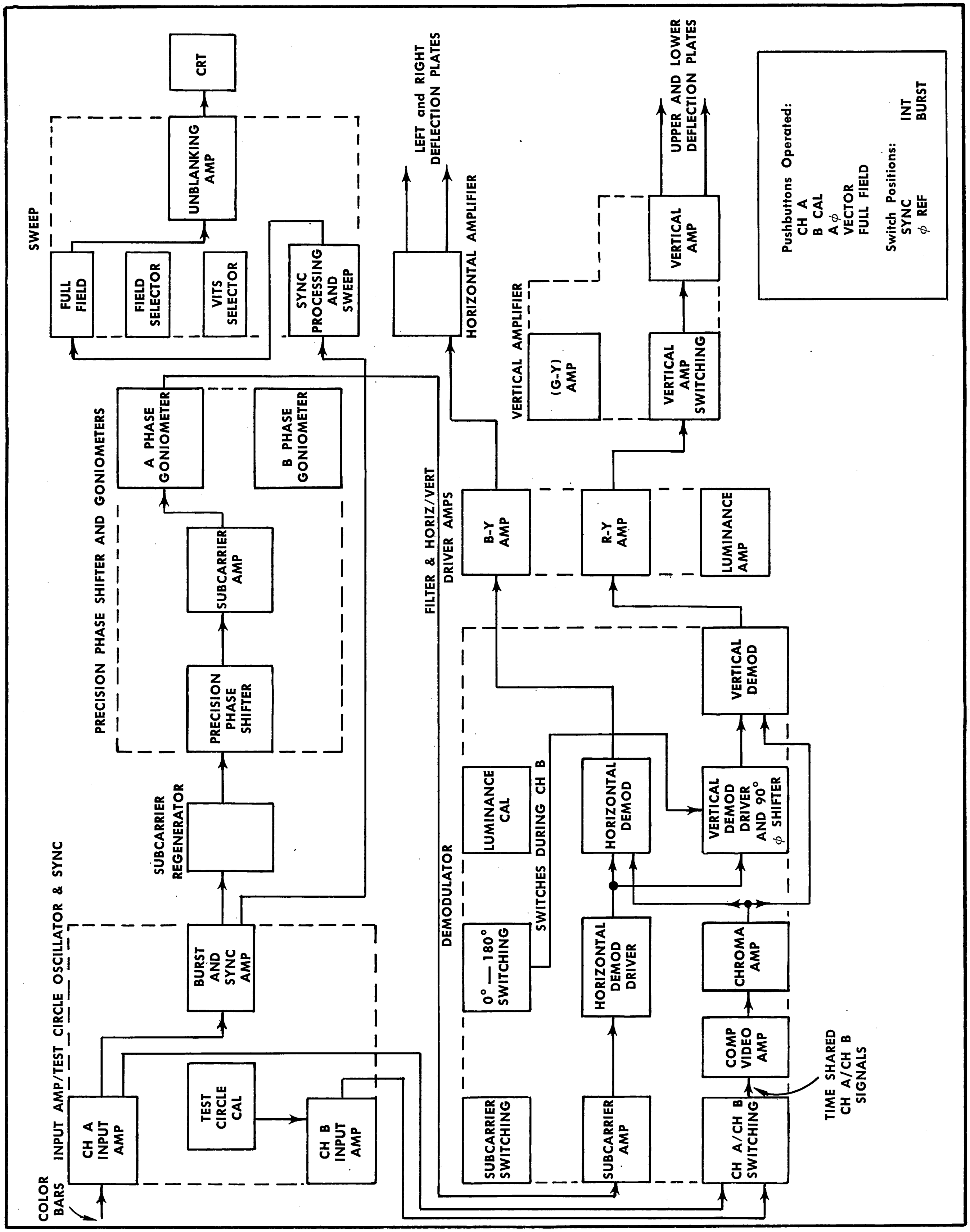

Fig. 3-2. Mode two, signal flow block diagram.

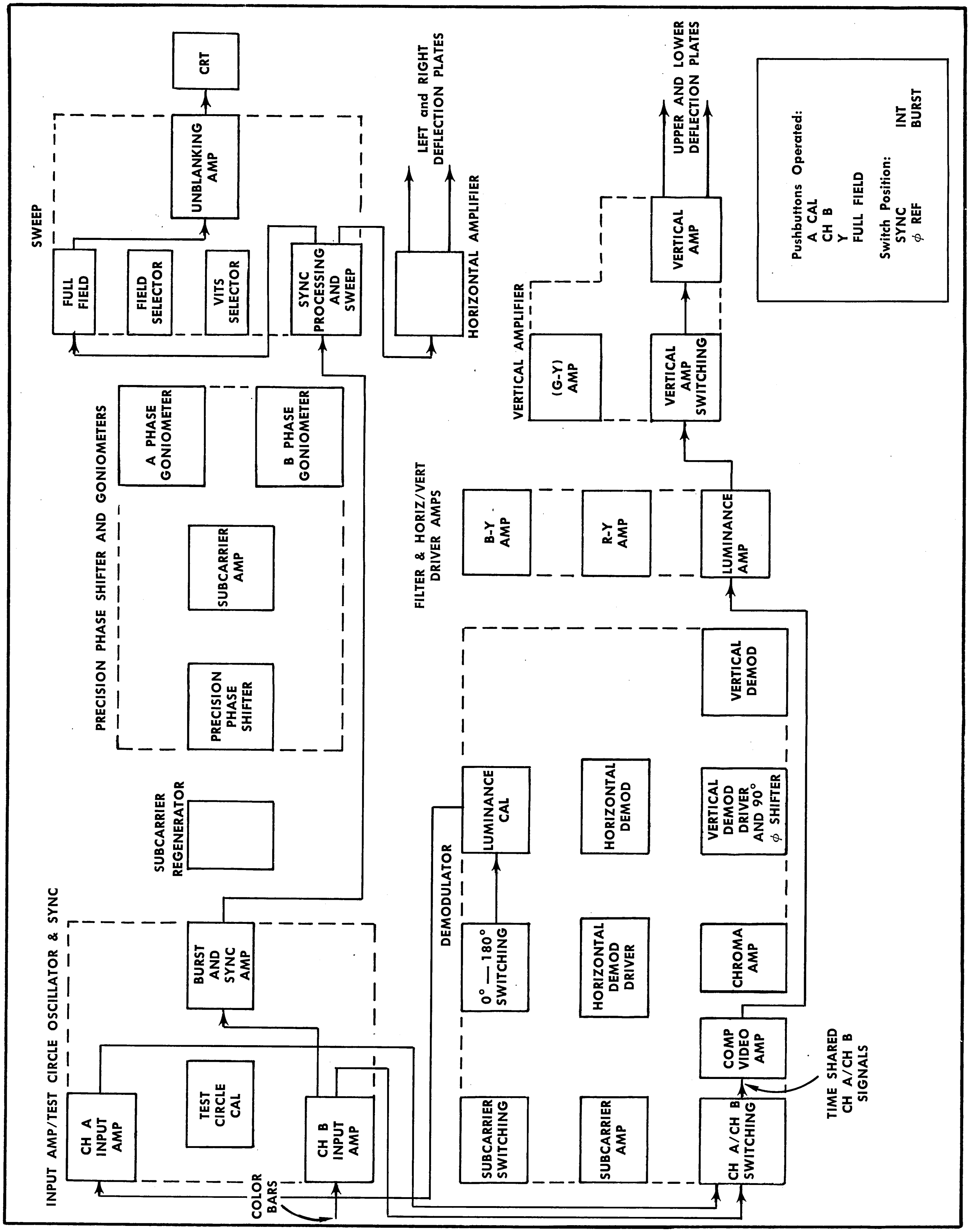

Fig. 3-3. Mode three, signal flow block diagram.

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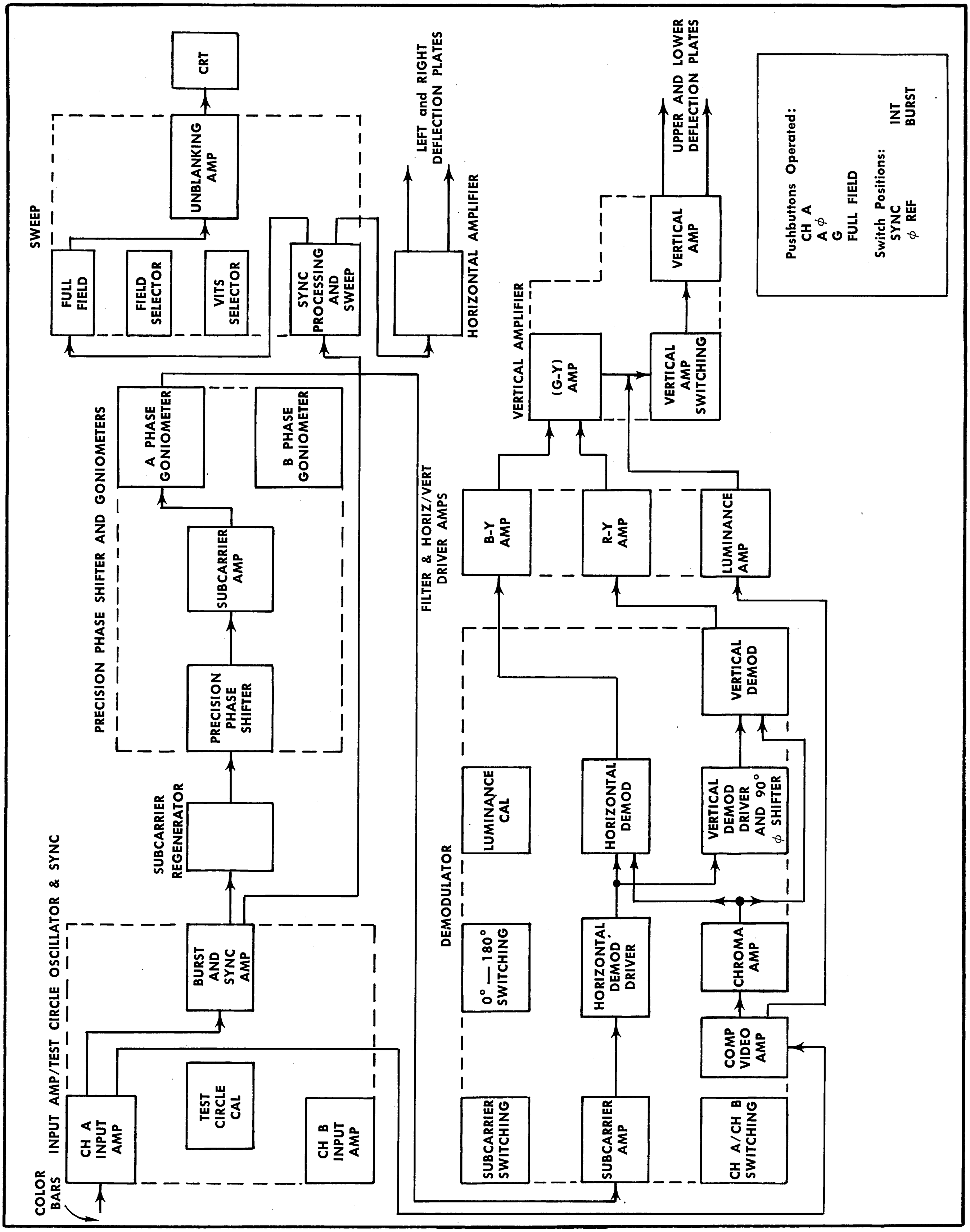


Fig. 3-4. Mode four, signal flow block diagram.

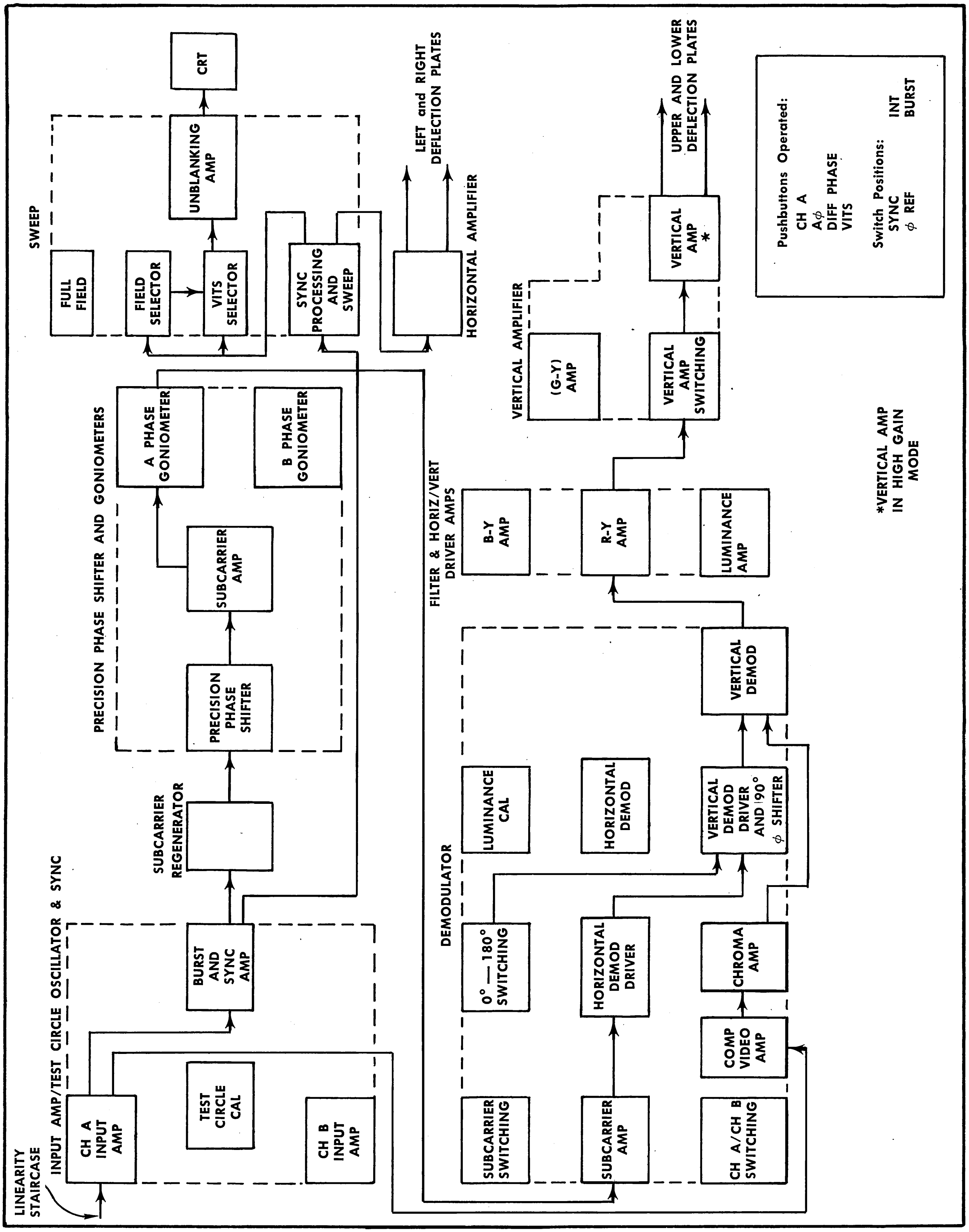


Fig. 3-5. Mode five, signal flow block digaram.

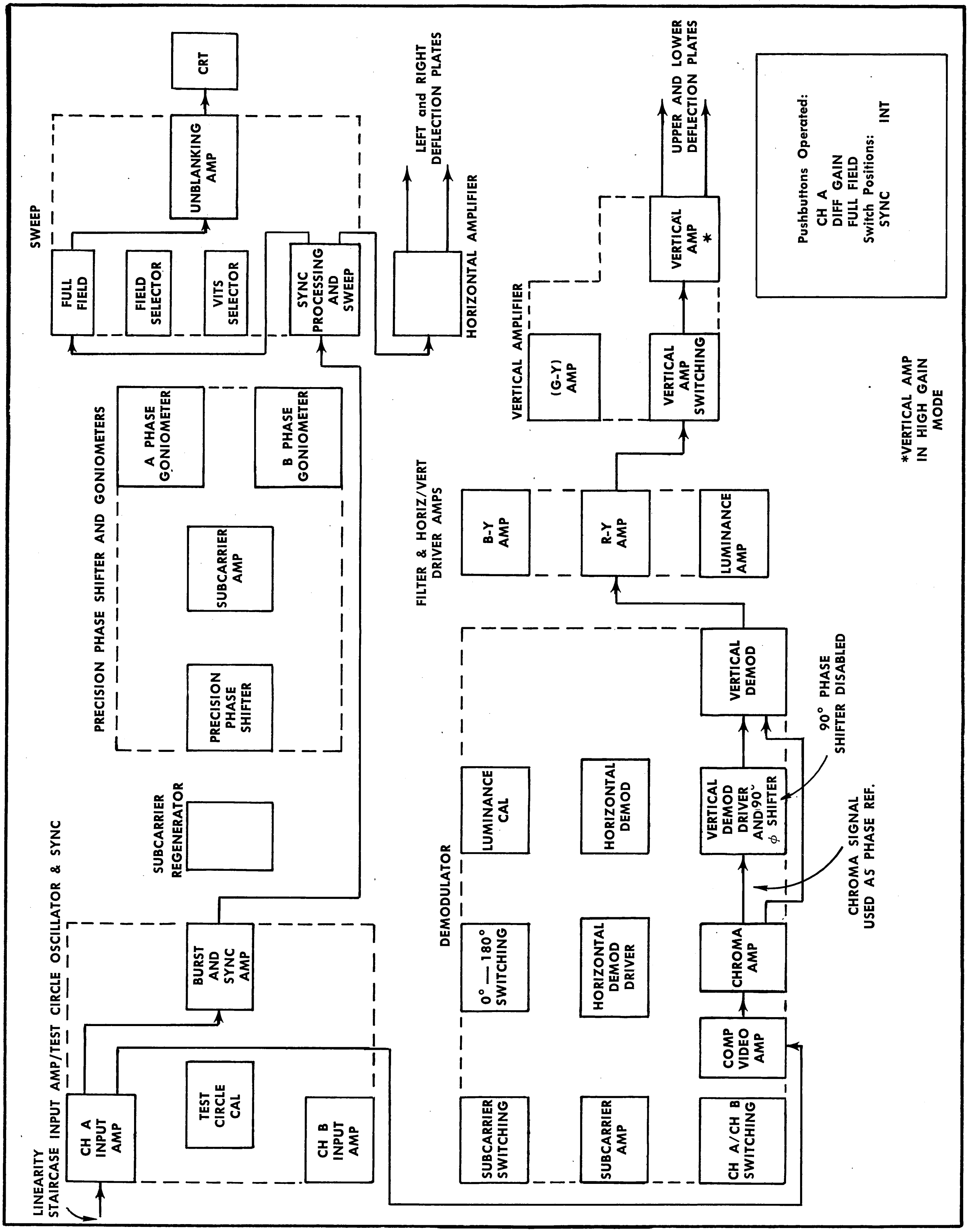


Fig. 3-6. Mode six, signal flow block diagram.

The Vertical and Horizontal Demodulators are synchronous demodulators. The output of the demodulators corresponds to the amplitude of two components of the chrominance signal, with 90° phase difference between the Horizontal Demodulator and the Vertical Demodulator. The output of the Horizontal Demodulator is coupled through the B-Y Amplifier to the Horizontal Amplifier. The output of the Vertical Demodulator is coupled through the R-Y Amplifier to the Vertical Amplifier Switching circuit, which selects the signal to be coupled to the Vertical Amplifier. The output of the Vertical Amplifier Switching circuit is coupled to the Vertical Amplifier. The Vertical and Horizontal Amplifiers are push-pull amplifiers driven paraphase. The outputs of the amplifiers are coupled to the deflection plates of the CRT where a display is obtained.

Mode two (Fig. 3-2). In this mode of operation, color bars are coupled into the channel A Input Amplifier only and channel B receives the signal from the Test Circle Oscillator. The Test Circle Oscillator is a crystal-controlled oscillator tuned to a frequency of 3.59 MHz. The test circle oscillator signal is coupled into the channel A/channel B Switching circuit and time shared with the signal from channel A input. Since Aϕ is selected, the output of the A and B PHASE Goniometer is not time-shared, and only the A phase reference is coupled to the Subcarrier Amplifier.

In this mode of operation, since test circles are being displayed, the polarity of the reference subcarrier driving the Vertical Demodulator is inverted every television line. This is accomplished by the 0°-180° Switching circuit. The 0°-180° Switching circuit is controlled by the divide-by-two J-K flip flop. When QUAD PHASE is misadjusted, reversing the phase of the subcarrier driving the Vertical Demodulator every television line will produce two test circles, and a more accurate adjustment of the QUAD PHASE can be accomplished.

The remainder of the circuits used in this mode are as previously explained.

Mode three (Fig. 3-3). The Type R520 is being used to analyze the luminance component of this signal. Color bars are coupled into the B channel, and the cal signal for line sweep operation is coupled through the A channel. The square wave from the 0° - 180° Switching circuit is used as the cal signal for line sweep displays. It provides a display of two horizontal traces adjusted for 140 IRE units of separation (1 volt peak-to-peak).

The luminance component is coupled from the Composite Video Amplifier through a filter to the Luminance Amplifier. The signal is then coupled to the Vertical Amplifier through the Vertical Amp Switching circuit. The sawtooth voltage from the Sweep circuit is coupled to the Horizontal Amplifier to provide the time base for the display.

Mode four (Fig. 3-4). This is another line sweep mode of operation used to measure the green signal. Color bars are coupled into channel A and the B channel is off.

The luminance component is coupled from the Composite Video Amplifier through the Luminance Amplifier to the Vertical Amplifier Switching circuit. The outputs of the Vertical and Horizontal Demodulators are coupled through the R-Y and B-Y Amplifiers respectively to the G-Y Amplifier. The R-Y and B-Y signals are added at the input of the G-Y Amplifier to form the G-Y signal. The amplifier inverts the signal and produces the G-Y signal. The G-Y signal is then added to the luminance signal to produce the green signal. The green signal is then coupled to the vertical amplifier.

Mode five (Fig. 3-5). The Type R520 is being used to make a differential phase measurement and the linearity staircase signal is coupled into channel A. Channel B is off and there is no cal signal.

The 0° - 180° Switching circuit is operating in this mode of operation and the phase of the reference subcarrier in relation to the Vertical Demod Driver is being inverted every television line. This produces two horizontal traces on the CRT that can be adjusted to coincide by adjusting the phase of the reference subcarrier. The phase of the reference subcarrier is shifted by the Precision Phase Shifter and when the two traces coincide, the amount of differential phase can be read from the CALIBRATED PHASE shifter dial. The gain of the output from the Vertical Demodulator is changed to ×5 in the Vertical Amplifier Switching circuit for DIFF PHASE and DIFF GAIN measurements.

The recovered sync pulse is now coupled to the Field Selector and VITS Selector so an unblanking pulse is developed during the selected field and television line. This is another line sweep mode of operation.

Mode six (Fig. 3-6). A differential gain measurement is being made and the linearity staircase signal is coupled into channel A with channel B off. The reference subcarrier is not used when making this type of measurement. The chrominance signal from the Chrominance Amplifier is coupled to the Vertical Demod Driver and to the Vertical Demodulator. The 90° Phase Shifter in the Vertical Demod Driver is disabled in DIFF GAIN mode of operation. The chrominance signal is used as the phase reference in the Vertical Demodulator so that phase distortion will not influence the accuracy of differential gain measurements.

The previous modes of operation illustrate some of the uses of the Type R520 vectorscope. A detailed description of the circuits used is given in the following pages of this section.

INPUT AMPLIFIERS AND TEST CIRCLE OSCILLATOR

This circuitry contains the Test Circle Oscillator and two input amplifier channels (A and B). Inputs to each amplifier can be selected from: composite video, the Test Circle Oscillator output for calibration of the vector display, or the Cal signal for calibration of the line sweep display. As an example, if channel A is selected for composite video, channel B might be selected for Test Circle Oscillator output. The channel that is selected for composite video has an output that is coupled to the Subcarrier Regenerator and if external sync is not used, the composite video signal is coupled to the Sweep circuit for triggering purposes and timing. Also, each channel has an output that is coupled to the Demodulator. Each amplifier is an operational amplifier with high input impedance. Therefore, the Type R520 does not present any appreciable loading effect to the signal under test, permitting the signal connections to remain in place when the Type R520 is not in operation.

Input Amplifiers

The Input Amplifiers for both the A and B channels are the same; therefore, a description of the A channel will apply to both amplifiers.

Assume switch SW5 is in the A position. A negative 15 volts is applied to the cathode of D14, and D14 is forward biased. This causes the anode of D18 to be about negative 0.6 V (set by D16) and D18 is reverse biased. The output of the Test Circle Oscillator, therefore, cannot be coupled to the base of Q80. Composite video is connected to either J1 or J2. D8 is forward biased through the divider consisting of R3 and R4, so composite video is coupled to the base of Q80 through D8. Transistors Q80, Q81, and Q85 comprise the operational amplifier for the A channel, which has a gain of about one. D85 limits the collector of Q81 to about +10 V. Appearing on the collector of Q85 is the composite video signal, with about the same amplitude that is present at J1. Capacitor C2 is for frequency compensation.

The resistive networks containing D112 and D108 perform an AND function to either forward bias or reverse bias D116. If SW5 and SW55 are selected so —15 V is applied to R111 and R105, D112 and D108 are reverse biased. D114 is forward biased and D116 is reverse biased. Thus, any signal on the collector of Q85 cannot be coupled to the base of Q140. With the switches in this position, D100 in the B channel signal path is forward biased.

Since initially SW5 is assumed to be in the A position, R111 is not connected to —15 V, the voltage on the cathode end of D114 becomes positive and D114 is reverse biased. With D114 reverse biased, D116 becomes forward biased and the signal path from the collector of 85 to the base of Q140 is uninterrupted. With SW5 in the A position, —15 V is applied to the cathode of D102 which forward biases D102 and reverse biases D100.

The composite video that is present on the collector of Q85 is coupled through R88 to the Demodulator, and to the base of Q140 through D116. Q140 and Q141 form an operational amplifier with a gain of about two. (For Instruments SN B241650-up only. R141 and C143 provides the AC coupled feedback path from the collector of Q141 and to the base of Q140 to set this gain. In addition, R142, D142, R144, C144 and D144 provide sync-tip clamping at +4 volts. Clamping Q141's collector to this level insures the SCR output will not change with APL changes.) The composite video is coupled from the collector of Q141 through R149 to the Subcarrier Regenerator. Also, if Ext Sync is not used and SW130 is in the INT SYNC position, D134 is forward biased. Composite video is coupled to the Sweep Circuit through D134 and C136. If Ext Sync is used and SW130 is in the EXT position, D134 is reverse biased through D132. Ext Sync is coupled through D122, which is forward biased, to the Sweep circuit. Provisions are made so either 4 V or 1 V of Ext Sync can be used. R120 should be pin-connected to J120/J121 if 4 V of sync is used, and R121 should be connected if 1 V of Ext Sync is used.

Test Circle Oscillator

The Test Circle Oscillator supplies a calibrated 3.59 MHz sine wave to the input amplifier when a test circle display is desired for calibration purposes. The Test Circle Oscillator consists of a crystal oscillator Y40 and Q40, a feedback amplifier transistor Q30 and a transistor used to isolate the oscillator from the input amplifier, Q41.

When a vector display is selected, +10 V is removed from R33 and the base of Q30 goes negative. This turns Q30 on. As Q30 conducts, its collector goes in the positive direction, turning on oscillator transistor Q40. The oscillator output is taken off the collector of Q41 through a Pi filter which is resonant at 3.59 MHz, and coupled to the anode of D18 and D68. The oscillator output is fed back to the base of Q30 through D48. By controlling the amount of feedback to Q30, the amplitude of the output from the oscillator is controlled. Resistor R45 sets the DC level across D48. This determines at what point on the positive half cycle of the oscillator output D48 will become forward biased, which determines the amount of feedback to the base of Q30. Therefore, the oscillator output is maintained at a constant amplitude.

The primary and secondary windings of T45 act as RF chokes to decouple the oscillator output from the DC supply. Resistor R39 is used as a parasitic suppressor in the oscillator circuit. C18 and C66 are frequency compensating capacitors for the input amplifier.

SUBCARRIER REGENERATOR

The Subcarrier Regenerator (SCR) develops a continuous sine wave at the subcarrier frequency that can be used in place of an external subcarrier. The Internal Subcarrier Oscillator frequency is phase- and frequency-locked to the color burst, and is therefore locked to the chrominance signal. All the critical components of the oscillator and feedback amplifier are contained in a temperature controlled oven, and thus are free of any adverse affects caused by components. The burst intensification pulse for the unblanking amplifier is also developed in the SCR. Fig. 3-7 is a simplified block diagram of the SCR.

SCR Blocking Oscillator

The SCR Blocking Oscillator includes Q205 and T205. The blocking oscillator is triggered by Q200. The back-swing of the blocking oscillator is used to switch the gain of a feedback amplifier during burst time and to develop the burst intensification pulse.

In the quiescent condition (no input signal) Q200 is off. D206 in the base circuit of Q205 is forward biased and Q205 is turned off. Since there is no current in the center-tapped secondary of T205, diodes D212 and D214 are off. D212 and D214 are matched diode units containing two diodes each. The two diodes in each unit develop sufficient voltage to provide adequate pulse amplitude for the burst intensification pulse.

The -H pulse is coupled to the base of Q200 through a differentiator consisting of C201 and R201. Q200 is forward biased by the positive spike of the differentiated waveform, causing the collector of Q200 to be pulled down. Through transformer coupling, the junction of the secondary of T205 and D206 goes positive and reverse biases D206. Q205 turns on and is driven into saturation. D212 and D214 remain off during the on time of Q205, since they are reverse biased by the secondary winding polarity of T205. As D206 is reverse biased, C208 starts to charge through R206. When C208 is charged to a voltage approximately 0.6 V more positive than the voltage on the base winding of T205, D206 starts conducting. The conduction of D206 causes the base of Q205 to be pulled down. The voltage drop in the base winding of T205 is coupled to the collector winding of T205, causing Q205 to be turned off very fast. During the backswing of T205, the polarity across the center-tapped second-

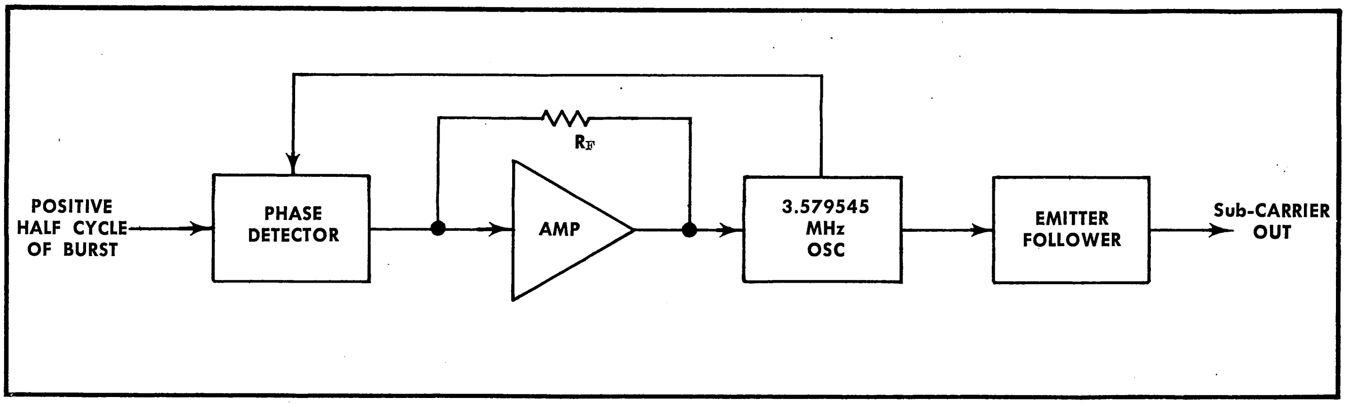


Fig. 3-7. Simplified block diagram of SCR.

ary reverses and forward biases D212 and D214. With D212 and D214 forward biased, the emitter resistance for Q220 becomes about 100 ohms (the parallel combination of D212 and D214 in series with R216).

The pulse developed by the blocking oscillator during back-swing is fed to the sweep board after going through a pulse shaping network, and is used to intensify the CRT trace during burst time.

Transistors Q220 and Q225 comprise a feedback amplifier that has its gain switched during burst time by the blocking oscillator.

The composite video signal is coupled through R220 to the 600 kHz band-pass filter consisting of L220, C220, L221 and C221, which removes the luminance component of the incoming signal and rejects any noise outside the pass-band. The chrominance component then appears at the base of Q220. The feedback amplifier normally has a gain of about one during burst time of the chrominance signal except when the back-swing of the blocking oscillator is occurring. Presence of burst causes the emitter resistance of Q220 to become about 100 ohms. The gain now becomes about 20, and burst is amplified approximately 20 times. D224 clamps the base of Q225 at approximately +10.6 V. The output of Q225 is coupled to the base of Q230 through C231.

SCR Limiter SN B251880 and up

The SCR Limiter consists of Q230, Q236 and Q238. Q238 provides constant current to either Q236 (normally on) or Q230. Q236 and Q230 are connected as a differential comparator.

With no burst applied to the base of Q230, the base is held at approximately —0.7 volts by divider R231 and R232. Q236 base is at approximately 0 volts; therefore, Q230 is off and Q236 is on. Under these conditions, any noise or residual chroma less than 0.6 volts appearing at the base of Q230 will not appear in the phase detector.

During burst time, the burst intensification pulse (discussed above) is applied to the base of Q236. The negative portion of this pulse drives the base negative and is clamped to about —0.6 volts by D235. Under these conditions, only the positive portions of burst are of sufficient amplitude to switch the current from Q236 to Q230 to drive the phase detector. Driving the phase detector in this manner minimizes any natural ringing of the primary winding which would affect the oscillator frequency.

Below SN B251880. Q230 is a clamp and is biased so that it only turns on during the positive half cycle of burst. The emitter of Q230 is limited to —0.6 V by D234. A positive-going signal greater than 0.6 volt is required to turn on Q230; therefore, any noise or any residual chroma less than 0.6 V from the feedback amplifier will not turn Q230 on.

Phase Detector

The Phase Detector is composed of C242, T235, C244, D242 and D244. The diodes are normally reverse-biased and the output of the Subcarrier Oscillator appears at the junction of D242 cathode and D244 anode. The potentiometer, R243[1], is used to Balance the Phase Detector.

When Q230 is turned on during the positive half cycle of burst, its collector goes in the negative direction. This causes the upper end of T235 secondary to become positive and the lower end negative. D242 and D244 are now forward biased, and a sample is taken of the subcarrier oscillator frequency. If the feedback oscillator signal is of the correct frequency and shifted in phase exactly 90° from burst, the error signal at this time will be 0 volts. If the oscillator is off frequency, the error voltage will be either positive or negative, depending on whether the oscillator frequency is too high or too low. (Refer to Fig. 3-8). The RC time constant of the feedback circuit of the oscillator is sufficiently long that it requires the phase relationship to be incorrect for several television lines before a correction is made.

During the time D242 and D244 are forward biased, C242 and C244 are being charged to the burst amplitude. During the time when burst is absent, the capacitors discharge through R242, R243 and R244, keeping D242/D244 reverse biased. The discharge time of these capacitors is sufficiently long so the capacitors will only discharge a small amount during 9 line key-out.

[1]R243 was added starting SN B150100.

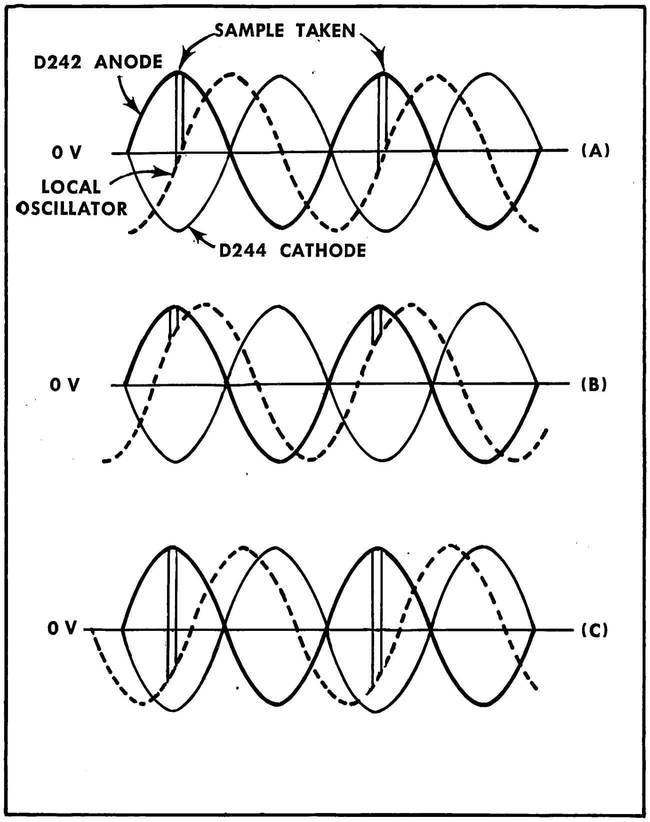


Fig. 3-8. Signals present in Phase Detector when D242 and D244 are forward biased and sample is taken. (A) Local oscillator same frequency as color burst. (B) Local oscillator at a higher frequency than color burst. (C) Local oscillator at a lower frequency than color burst.

Oscillator Section

The Subcarrier Oscillator is a crystal controlled oscillator contained in a constant temperature oven. The oscillator is not affected by heat dissipation of components or by environmental temperature changes.

The oscillator consists of Q260, Y260, and D260. Diode D260 is used as a voltage-variable capacitor across the crystal. By causing the voltage across the diode to change, the capacitance of the diode is changed and the crystal frequency is made to change. The voltage across D260 is controlled by the operational amplifier Q250 and Q255.

Q250 and Q255 are normally on. The gate of Q250 is referenced to 0 V DC and a signal voltage is present on the gate only during the time D242 and D244 are forward biased. The collector of Q255 is at a quiescent level which establishes the voltage across D260, and thus sets the crystal frequency. As D242 and D244 are forward biased, the error signal at their junction appears on the gate input of Q250. If the oscillator frequency and phase are correct the error voltage will be zero and the collector voltage of Q255 will remain at its quiescent level. If the oscillator frequency is high at the time the sample is taken, the error voltage appearing at the gate of Q250 will be positive. Q250 will turn on harder, causing Q255 to conduct more. Q255 collector goes in the negative direction, causing the cathode of D260 to become less positive. The capacitance of D260 increases and this returns the oscillator to the correct frequency.

The feedback network (low pass filter) for the feedback amplifier Q250 and Q255 consists of R254, C254, C255 and R255. R254 (R_f) and the parallel combination of R242 and R244 (R_i) set the DC gain for this amplifier. The amplifier has a gain of about 60 for the DC level change. The feedback path for the operational amplifier consists of a low pass filter to eliminate frequency components higher than 30 Hz, which stabilizes the oscillator.

Resistor R250 DC BAL, is provided to adjust the oscillator frequency. The adjustment of R250 changes the operating bias of Q250 and Q255, which sets the quiescent collector voltage of Q255. The collector voltage of Q255 establishes the voltage across D260, the voltage-variable capacitor.

The output of Q260 is coupled through Q270, which isolates the oscillator from the output, through a Pi filter designed to pass only the subcarrier frequency to the base of Q275. The output of the SCR is taken off the emitter of Q275 and the signal to the Phase Detector is taken off the collector of Q275. Therefore, the output of the SCR is isolated from the Phase Detector. The collector impedance of Q275 is approximately two times the emitter impedance of Q275 at the subcarrier frequency. The signal to the Phase Detector is 2× the subcarrier output to R301. The low DC resistance of the parallel combination R279 and L279 allows the feedback signal to be referenced at 0 volts DC.

SCR Oven

The critical components of the Subcarrier Regenerator oscillator are contained in an oven which is maintained at a constant temperature of about 85°C. A bridge consisting of two wire-wound nickel resistive elements and two wire-wound manganin resistive elements form the heating element and also the sensing element. The temperature coefficient for manganin is 0%/°C and for nickel it is +0.55%/°C. The resistors are designed so their resistances are equal at about 85°C. A comparator, Q280A and Q280B, is used to sense any unbalance across the bridge and to operate the current control transistor Q285.

When power is initially applied to the Type R520 the bridge is unbalanced, since the oven is not up to operating temperature. The resistances of R280B and R280D are less than those of R280A and R280C making the base of Q280A more negative than the base of Q280B. Thus, Q280A is on and Q280B is off. With Q280A on, its collector is pulled up and Q285 is turned on, conducting through the bridge. Q295, which controls the current through the quick-heater (R299), is on and the quick-heater is operating. This eliminates long warm up time. As the oven comes up to operating temperature, the resistance of R280B and R280D increases and Q280B turns on. Q280B conducts through the base-emitter junction of Q291 and turns Q291 on. As Q291 turns on, its collector goes negative and turns Q295 off. This turns the quick-heater off. Also as the oven approaches its operating temperature, the base of Q280A becomes more positive which decreases the conduction of Q280A. This causes the base of Q285 to becomes more negative, decreasing the conduction of Q285. When the oven is at its operating temperature, the voltage across the bridge is balanced. This balances the comparator and the current through Q285 is at a constant level. If the temperature of the oven either increases or decreases the resistance of R280B and R280D reacts in the same manner, unbalancing the bridge and causing either more or less current to flow through Q285. Thus, the oven is returned to its operating temperature.

Any tendency of the circuit to oscillate due to common mode signals is eliminated by R287, which establishes the common mode gain as less than unity. "Hunting", sometimes experienced in this type of circuit when the oven reaches its operating temperature, is offset by R292. The heater circuitry is very stable and the oven temperature is maintained within about one degree of its operating point. A thermal cutout, TK280, is provided to disable the heater circuit by removing the +10 V supply if the oven temperature should ever exceed approximately 95°C.

PRECISION PHASE SHIFTER AND GONIOMETERS

The purpose of the Precision Phase Shifter is to provide extremely accurate incremental phase measurements. The CALIBRATED PHASE control is capable of shifting the phase of the reference subcarrier + and —15°. The Goniometers provide a non-calibrated means of shifting the phase of the reference subcarrier through 360°.

Either the internal reference subcarrier or an external reference subcarrier can be coupled into the Precision Phase Shifter circuit. Switch SW305 selects either of the two reference subcarriers. Assume that the internal subcarrier is selected, and SW305 is placed in the BURST position. A positive 10 volts is connected to R316, and D312 becomes forward biased. When D312 is forward biased, D311 is reverse biased and the external reference subcarrier is prevented from being coupled into the Precision Phase Shifter. C314 establishes AC ground on the anode of D312 and prevents any subcarrier from being coupled through the capacitance of D311. D302 is reverse biased through R304, and D301 is forward biased through R302 and R320. The internal reference subcarrier is coupled to the base of Q320. Q320 and Q325 form an operational amplifier with the output taken off the emitter of Q235. The reference subcarrier is coupled into the Precision Phase Shifter from the emitter of Q325. The Precision Phase Shifter consists of R331, R333, R335, R337, L331, L332, C332 and C335. L331 and L332 are used during the calibration of the instrument to tune the circuit to resonance. R335 is adjusted during calibration to obtain the correct dial reading. C335 (CALIBRATED PHASE), is the front panel control, and as it is varied the capacitance to ground is changed. This causes the phase of the signal out of the Precision Phase Shifter to shift in increments between + and —15°. The reference subcarrier is coupled from the Precision Phase Shifter through an operational amplifier consisting of Q340 and Q345 to the A and B PHASE Goniometers.

Goniometers

The A and B PHASE Goninometers are the same except for circuit numbers; therefore, only the A PHASE Goniometer will be described.

The Goniometer consists of two sets of primary coils at right angles to each other, and a secondary coil that can be rotated through 360°. R354 and C354 provide a fixed 90° phase shift in the horizontal coils, which is necessary for a rotating magnetic field when a sine wave is applied. R354 and C354 are designed so the circuit has a Q of one, so the current in the two sets of coils is equal. The entire circuit is resonant to the reference subcarrier frequency.

The secondary coil can be rotated manually and placed in any position relative to the primary coils. The magnetic lines of force formed by the currents in the primary coils induce a voltage into the secondary. The phase relationship of the output voltage to the input voltage will be determined by the physical position of the secondary coil in relationship to the primary coils. The output of the Goniometer is inductively coupled into the Demodulator circuit. The secondary coil is rotated by the PHASE control on the front panel.

DEMODULATORS

The Vertical and Horizontal Demodulator circuits are both located on the Demodulator circuit board The circuit operation of the Vertical and Horizontal Demodulators is the same except for a 90° phase difference between the demodulated chrominance signals out.

The 0° and 180° switching for test circle operation and differential phase measurements takes place on the Demodulator board, as does the 33° phase shift for demodulation along the I and Q axis.

Since the operation of the Horizontal and Vertical Demodulators is the same, only the operation of the Horizontal Demodulator will be described.

Horizontal Demodulator

The Horizontal Demodulator is composed of Q590A, Q590B, Q595A, Q595B, and T598. Transistors Q595A and Q595B are used as switches to alternately switch each end of T598 to ground at the subcarrier rate. The reference subcarrier is coupled to the bases of Q590A and Q590B. As Q590A and Q590B are alternately turned on and off they cause Q595A and Q595B to be turned on and off. Therefore, the polarity of the secondary of T598 is reversed at the reference subcarrier rate. Diodes D594 and D596 prevent Q595A from saturating. D594 is forward biased during the entire time power is applied to the Type R520. D596 becomes forward biased when the collector voltage of Q595A equals the base voltage, so the collector voltage can never become more negative than the base voltage, and Q595A is not allowed to saturate. The effects of transistor storage time are thus eliminated. In the same manner as just described, D598 and D599 prevent Q595B from saturating. Diodes D595 and D597 clamp the collectors of Q595A and Q595B at approximately .8 volt.

The chrominance signal (modulated subcarrier) is applied to the primary winding of T598. By switching the polarity of the secondary of T598 at the subcarrier rate an effect is produced as if the reference subcarrier were present in the secondary winding. There is a voltage developed at the secondary center-tap of T598 that is dependent upon the phase relationship of the modulated signal in the primary, and the rate at which the polarity of the secondary is switched. As the phase relationship changes, the amplitude of the voltage developed at the center-tap will also change. These voltage changes correspond to the modulating signal (or the difference frequency), so the demodulated chrominance signal is present on the center-tap of T598. The demodulated chrominance signal is essentially free of any subcarrier.

Fig. 3-9 is a simplified illustration of the action taking place in T598 as each end of the secondary is switched to ground through the transistor. The transistors are represented

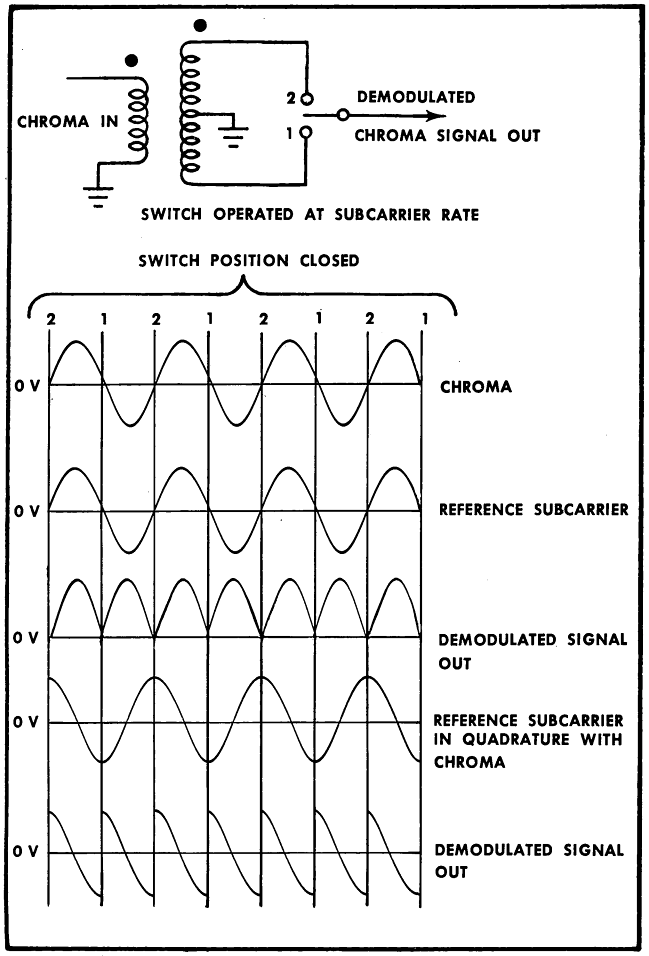


Fig. 3-9. Simplified illustration of Vertical/Horizontal Demodulators.

would have been disconnected. When it is desired that channel A and channel B inputs alternate, SW520 (Aϕ/Bϕ ALT) is depressed and —15 V is connected to the emitters of Q515 and Q516 through R519, D515 and D517. With SW520 depressed, Q515 and Q516 are connected in a common emitter configuration and driven in a paraphase manner by pins 5 and 7 of U511.

With channel A selected, D520 and D522 are forward biased and the reference subcarrier appears on the base of Q530. Q530 is an operational amplifier with the AC feedback path being C535, D532 and D533. Since the forward resistance of the diodes will change with any change in amplitude of the signal, R_f is effectively variable (greater for small signals and less for larger signals). Thus, the peak amplitude of the signal is limited by the forward resistance of the diodes. The RC network consisting of R532, R533 and C532 sets the DC level of the signal on the collector of Q530 by a toggle switch and the waveforms for each position of the toggle switch are illustrated. C593 is a subcarrier balance capacitor to balance out any reference subcarrier from the Vertical Demodulator that is coupled into the Chrominance Amplifier, Q470/Q471. The reference subcarrier driving the Horizontal Demodulator is capacitively coupled through C593 and C594 to the Chrominance Amplifier. The subcarrier driving the Vertical Demodulator is shifted in phase 90° from the subcarrier driving the Horizontal Demodulator. The fed-back signal from the Horizontal Demodulator to the Chrominance Amplifier will appear 180° out of phase with any signal coupled into the Chrominance Amplifier from the Vertical Demodulator, thereby canceling the unwanted signal.

Vertical Demodulator

The Vertical Demodulator includes T508, Q500A, Q500B, Q505A and Q505B. The demodulator operates in the same manner as the Horizontal Demodulator and the components have the same function as their counter parts in the Horizontal Demod.

To display a vector presentation, a 90° phase shift between the vertical and horizontal signals driving the deflection circuits is required. The reference subcarrier is shifted 90° in the vertical circuit by C491, the feedback capacitor for the Vertical Demod Driver Q490/Q491.

R501 is a Subcarrier Balance to balance out any subcarrier from the Vertical Demodulator that is coupled into the chrominance signal that is being demodulated by the Vertical Demodulator. A portion of the subcarrier driving the Vertical Demodulator is coupled into the Chrominance Amplifier by the adjustment of R501. The fed-back signal appears 180° out of phase with the unwanted subcarrier that is coupled into the Chrominance Amplifier from the Vertical Demodulator, thereby canceling the unwanted signal. In line sweep operation if the unwanted subcarrier was not canceled out, the DC level of the demodulated signal out of the Vertical Demodulator would change and there would be a noticeable trace shift on the CRT when the instrument was operated in DIFF PHASE.

Reference Subcarrier Channel

The reference subcarrier for the Horizontal and Vertical Demodulators is received from the A and B PHASE Goniometers. The A channel input consists of D520, D521 and D522 The B channel input consists of D524, D525 and D526. Either channel may be selected by switching transistors Q515 and Q516. The switching transistors can also be operated in an alternate mode which displays two lines of channel A and then two lines of channel B. Of the three buttons, Aϕ, Bϕ, Aϕ/Bϕ ALT, only one can be depressed at a time. The selected channel is coupled into an operational amplifier Q530.

Integrated circuits U510 and U511 are J-K flip flops. Pins 5 and 7 are the output pins and pin 2 receives the trigger pulse. Each time a negative-going trigger is received on pin 2, the multi will flip and the output pins will change states. U510 is triggered by the —H pulse coupled through D511. Pin 5 of U510 is connected to pin 2 of U511, so each time pin 5 of U510 is down, U511 receives a trigger. With the integrated circuits connected in this manner U510 is a divide-by-two multi and U511 is a divide-by-four multi. The outputs of U511 operate the switching transistors for the A and B channels in the alternate mode and the output of U510 is used to do the 0° to 180° switching. Refer to Fig. 3-10 for U510 and U511 output pin logic.

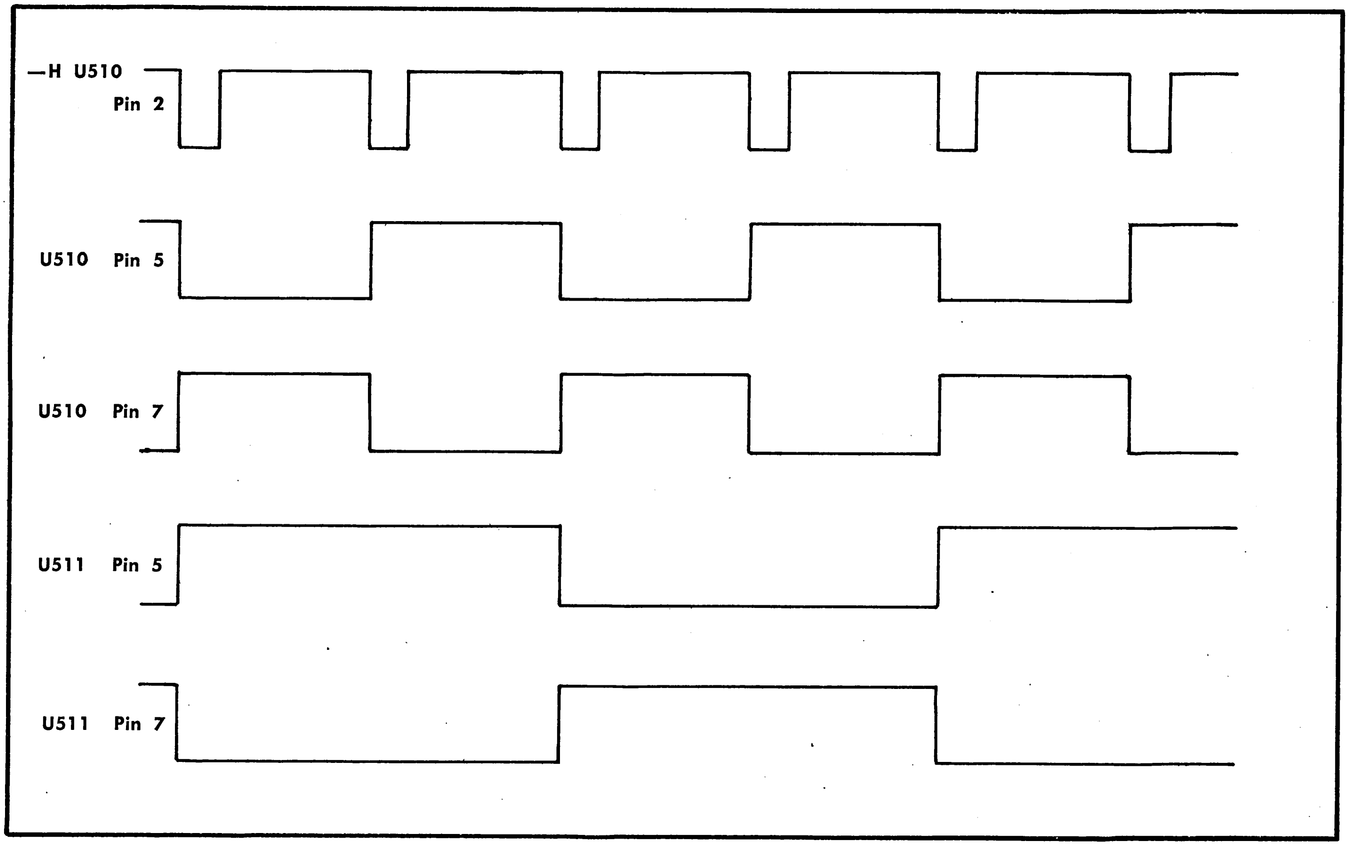


Fig. 3-10. Logic for output pins of U510 and U511.

Assume that it is desired to select channel A, and SW510 is placed in the Aϕ position. —15 V is applied to the emitter of Q515 through R517. Q515 turns on and its collector is pulled down. With the collector of Q515 pulled in the negative direction D524 and D526 are reverse biased. D525 is forward biased, preventing the collector of Q515 from going below approximately +3.0 V.

Therefore, any signal appearing on the B channel is blocked by D524 and D526 and if any signal is fed through D524, it is shorted to ground by D525. SW515 and SW520 are off so the emitter circuit of Q576 is open and Q576 is off. D521 is reverse biased, D520 and D522 are forward biased through R521, and the reference subcarrier on the A channel is coupled through D520, D522 and C529 to the base of Q530. If channel B had been selected, Q516 would have been turned on and D520/D522 in the A input line through negative feedback. The output of Q530 is coupled to the base of Q540, another operational amplifier that is operated as a limiter. D543 in the emitter circuit of Q540 clamps the emitter at approximately —0.6 V. If the negative peak swing of the signal on the base of Q540 is greater than approximately —0.6 V, Q540 will cut off and limit the negative half of the signal. The current through Q540 when the base swings positive is limited by R543 to about 6 mA. Since the average current through Q540 is controlled by the feedback resistor, R545, both the amplitude and duty cycle of the collector current are relatively independent of input signal amplitude. The signal on the collector of Q540 is coupled through a Pi section filter to the base of Q560. Q560 and Q565 form an operational amplifier, with R556 as R_i and R566 as R_f, driving the primary of T590. The reference subcarrier is induced into the two seconary windings of T590 which drive the Horizontal Demodulator and Vertical Demod Driver.

The 33° phase shift for the I and Q signal is accomplished by C554, which swings the Pi section tank to the other side of resonance. When either the I or Q signal is selected, a positive voltage is removed from the base of Q550, which turns off Q550. This disconnects C554 from the low pass filter through Q550 and shifts the reference subcarrier by 33°.

The reference subcarrier from the center-tapped secondary of T590 is coupled through D488 to an operational amplifier consisting of Q490 and Q491. Q490 and Q491 are operated as an integrator with R586 as R_i and C491 as C_f providing the 90° phase shift required for the Vertical Demod. The collector load for Q491 is the primary of T500, whose secondary drives the Vertical Demodulator. Fig. 3-11 (A) illustrates phase relationship of E_{in} and E_{out} through Q490/Q491.

A QUAD PHASE control (R588) is provided so the phase of the reference subcarrier driving the Vertical Demodulator can be adjusted for exactly 90° phase difference between the Vertical and Horizontal Demodulators. When displaying test circles, if the phase difference is exactly 90°, a perfect circle will be displayed. If the phase difference between the outputs of the Vertical and Horizontal Demodulators is not exactly 90° two ellipses will be displayed. This adjustment will affect the vertical demodulation axis whether test circles are being displayed or not; therefore, it should only be adjusted when test circles are being displayed. The adjustment of R588 changes the voltage on D586 which is a voltage-variable capacitor. As the voltage on D586 changes, the capacitance also changes, shifting the phase of the reference subcarrier.

When differential gain measurements are being made the reference subcarrier is disconnected from the Vertical Demodulator and the chrominance signal is coupled to the Vertical Demodulator. This is accomplished by Q480, D486, D487, and D488. With Q480 off, D488 is forward biased. When making a differential gain measurement, a positive voltage is applied to the base of Q480 through R484 and Q480 turns on. When Q480 turns on, D488 is reverse biased and D487 is forward biased. The chrominance signal is coupled to the Vertical Demodulator Driver through C474 in place of the reference subcarrier.

Since the Z_i to Q490/Q491 is now capacitive rather than resistive, the chrominance signal into the amplifier will undergo a phase inversion through the amplifier, but will not be shifted in phase 90° (as is the subcarrier in all other modes of operation). The signal applied to the bases of Q500A and Q500B is then in phase with the chrominance signal applied to T508. The output of the demod will then be proportional only to the amplitude of the incoming signal, and differential gain measurements will not be influenced by the presence of differential phase. Fig. 3-11 (A) Illustrates the configuration of Q490/Q491 and the phase relationship of E_{in} to E_{out} for all modes of operation other than DIFF GAIN. Fig. 3-11 (B), illustrates the DIFF GAIN configuration of Q490/Q491 and the phase relationship of E_{in} to E_{out}.

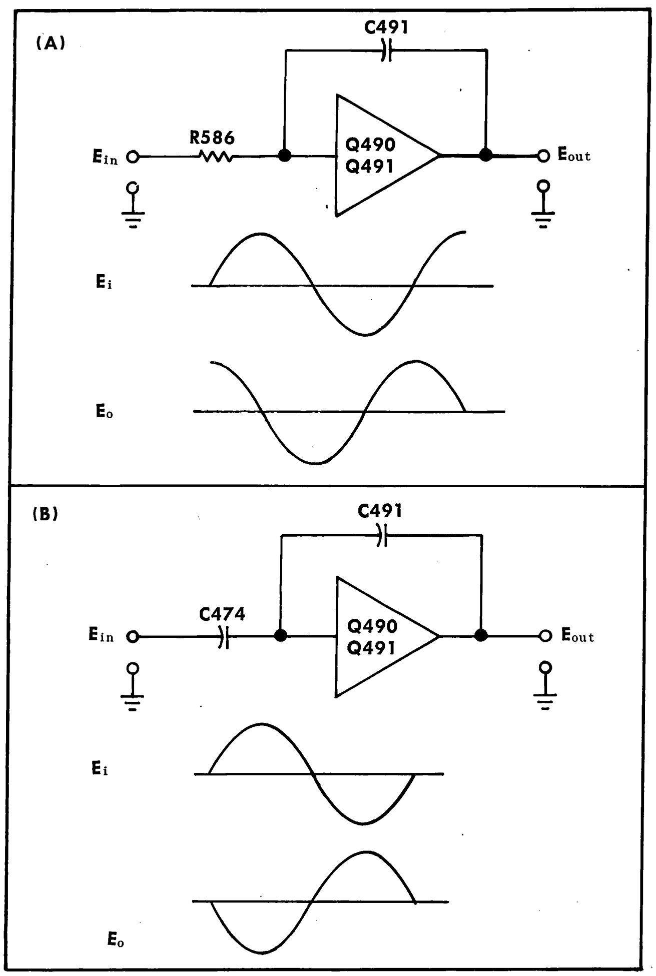


Fig. 3-11. Q490/Q491 configuration; (A) For all modes except DIFF GAIN, E_o phase-inverted and phase-shifted 90° lagging in relation to E_i. (B) For DIFF GAIN, E_o phase-inverted in relation to E_i.

When making differential gain measurements, the output of the Vertical Demodulator is referenced at essentially 0 volts during H pulse time by the action of Q495. At the completion of the —H pulse the associated circuitry of Q495 provides an offset current to the summing junction of Q620/Q630, the Vert Driver Amps. The offset current allows the greatly magnified display in DIFF GAIN to be positioned on screen by the VERT POSITION control. Fig. 3-12 a partial diagram of the Vertical Demodulator.

When the DIFF GAIN switch is pressed, +10 volts is connected to R495 in the emitter circuit of Q495, turning off D496 and causing Q495 to conduct during the time the —H pulse is present on its base. The —H pulse also turns on D497, causing its anode to go in the negative direction to reverse bias D498. When Q495 conducts its collector goes in the positive direction, which turns off Q500A and Q500B. With Q500A and B turned off, the ends of the center-tapped secondary of T508 are clamped to ground by Q505A and Q505B. This establishes a reference for the clamping circuit in the Vertical Amplifier.

At the end of the —H pulse Q459 will turn off and the Vertical Demodulator will operate normally. The output of the demodulator will be negative with respect to the reference level, and will go more negative with increasing signal. However, D497 turns off at the completion of the —H pulse and the current that was flowing through it flows through D498 to the summing junction of Q620/Q630. This current is opposing the output of the demodulator and is used to provide an offset to position the magnified chrominance signal on screen.

When the DIFF GAIN switch is not pressed Q495 is off, and D496 is forward biased. The current that was flowing through D498 now flows through D496 and the offset current is disconnected from the summing junction of Q620/Q630.

The DIFF GAIN switch SW530 also applies a positive voltage to the base of Q530 through R528 and to Q540 through R541 to saturate the transistors and prevent any subcarrier from being coupled through to the demodulators.

Input Channel Switching

The A and B inputs to the chrominance channel are coupled in from the input amplifier. Each input contains a resistive network where the attenuation ratio can be changed by SW405 (A input) or SW415 (B input) to display the 100 per cent or 75 per cent color bar signals properly in the vector display. The 100% position on the GAIN switch permits the vector presentation of 100% bars to occupy the same display area (except for burst) as the 75% bars. The instrument is calibrated in IRE only in the 75% position. The third position of SW405 and SW415 is the MAX GAIN position, which provides maximum gain of the chrominance signal for DIFF GAIN and DIFF PHASE. When the MAX GAIN position of either SW405 or SW415 is selected, the luminance component of the signal is filtered out by either L401 or L411 respectively. (Below SN B150100, the filter is L402 or L412). This allows the signal to be analyzed very closely. The GAIN controls are R403 for the A channel and R413 for the B channel. The GAIN controls vary the attenua-

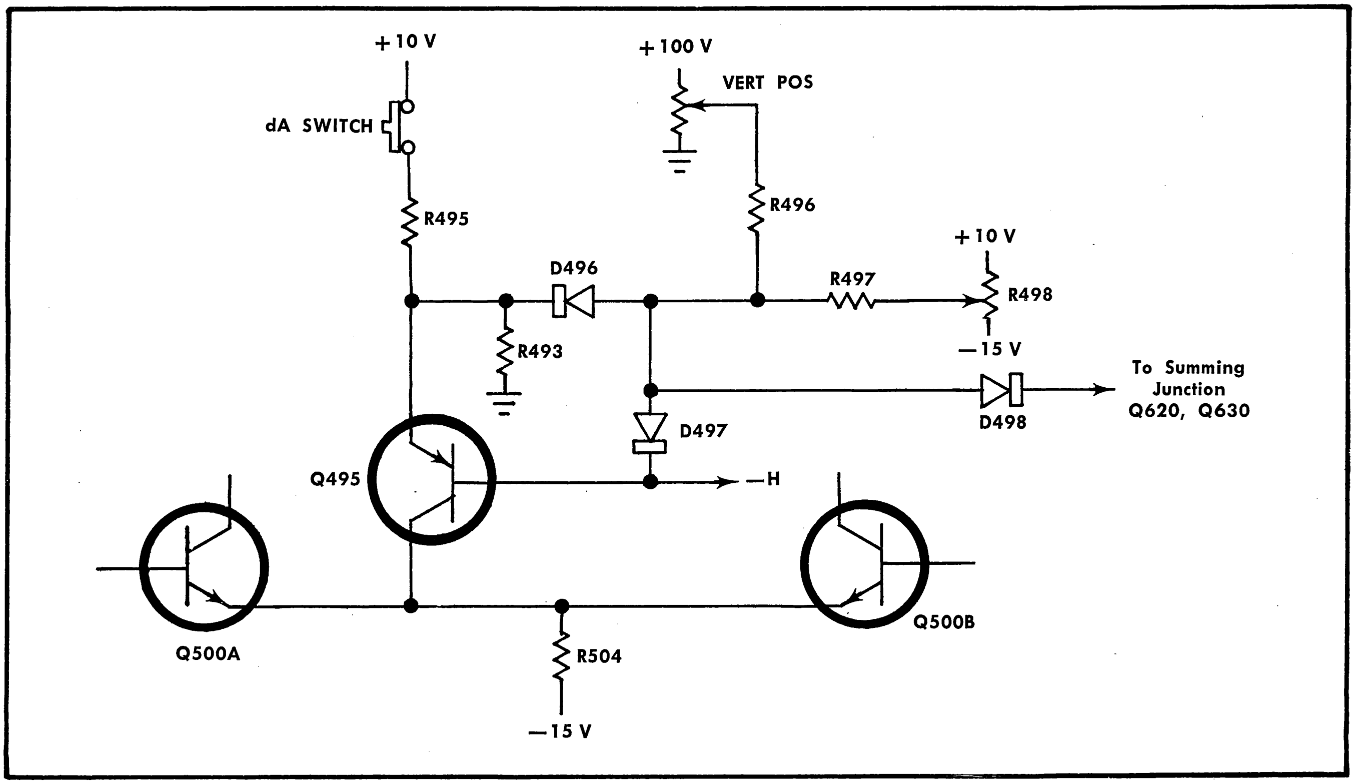


Fig. 3-12. Partial diagram of Vertical Demodulator.

tion of the divider which changes the amplitude of the signal into the demodulator. Both the A and B input lines have switching diodes—D407, D408, D409 and D429 for the A channel, and D417, D418, D419 and D424 for the B channel. These diodes select the desired channel for viewing. The diodes are controlled by switching transistors Q420 and Q425.

Assume that the demodulator is being used in the alternate mode of operation Aϕ/BϕALT-. In this mode of operation both the channel A switch (SW5) and the Channel B switch (SW55) are pressed and neither pin P nor pin S is connected to + 10 volts. Therefore, Q421 is turned off and the only source of emitter current for Q420 or Q425 is through R428 to +10 volts. Transistors Q420 and Q425 are alternately being turned on and off by the divide-by-four J-K flip-flop U511. Each transistor is on for two television lines and off for two lines. When pin 5 of U511 is down, Q420 is turned on and conducts through D421 and R428 to +10 V. With Q420 conducting, its collector is pulled up and D408/D429 are reverse biased. D407 is forward biased through R409 to +10 V. The signal appearing on the A input line is shorted to ground by D407 and blocked from the chrominance channel by D408 and D409. D409 clamps the collector of Q420 to +0.6 V. When pin 5 of U511 is down, pin 7 is up and Q425 is off. With Q425 off, D418 and D424 are forward biased through R429 and D417 is reverse biased. The signal appearing on the B channel line is coupled through to the base of Q440. When U511 receives the next trigger from U510, pins 5 and 7 change states, Q420 turns off, and Q425 turns on. Now the A signal is coupled to the base of Q440 and the B signal is blocked.

Now assume that A channel is selected. SW5 (channel A) is pressed and the +10 V is removed from the emitter of Q420 through R421. Q420 turns off and D408/D429 are forward biased through R424, D407 and D409 are reverse biased. The signal on the A channel input line is coupled into the amplifier consisting of Q440, Q445 and Q450. Since SW55 (channel B) is not pressed, +10 V is connected to the emitter of Q425 through R426 and Q425 is on. With Q425 on, the diodes in the B input line are reverse biased and the signal is prevented from being coupled through to the chrominance channel. The +10 V at the junction of R423 and R426 supplies base current to Q421 so Q421 is conducting. With Q421 conducting its collector is pulled down and D421/D427 are reverse biased. If either SW5 or SW55 is in the off position, the pulse from U511 is not sufficient to cause Q420 and Q425 to switch.

The composite signal is coupled through an operational amplifier consisting of Q440, Q445 and Q450. When the 100%, 75%, MAX GAIN switch (SW415/SW405) is placed in the MAX GAIN position, the gain of the amplifier is increased X5. This is accomplished by the feedback network located on the Feedback board which changes the amount of current fed back in the amplifier. The feedback circuit for both the A and B channels operate in the same manner, therefore only channel A will be discussed.

The feedback resistors are R433/R434, with the amount of current through R433 controlled by Q432. In the 100% or 75% position of SW405, the base of Q432 is connected to ground and the transistor is off. R437, in the collector of Q432, presents a high impedance to ground at the junction of R433/R434 and the majority of the feedback current flows through R433.

When SW405 is placed in the MAX GAIN position, the ground is removed from the base of Q432 and +10 volts is applied to the base through R438. The transistor now saturates and approximately 4/5 of the current that was flowing through R433 now flows through the transistor, thus reducing the amount of feedback current in the amplifier and increasing the gain to approximately X5. The gain of the amplifier is adjusted by C434, which changes the amount of current flowing through Q432, and the phase of the feedback current is adjusted by C430. If the A CAL pushbutton is pressed in during the time SW405 is in the MAX GAIN position, —15 volts is connected to the base of Q432 through R439, which turns the transistor off. This prevents an erroneous display of the CAL signal.

D450 limits the base of Q450 to about +10.6 V. The luminance component is coupled from the collector of Q450 through R452 to the luminance filter. The chrominance is coupled through R453 and R455, through a high-pass filter (L455, C455, L457 and C457) to the emitter of Q470. Transistors Q470 and Q471 form an operational amplifier with the output taken off the collector of Q471. The chrominance signal is coupled from the collector of Q471 to the Vertical and Horizontal Demodulators. The chrominance is also coupled through C474 to the anode of D487 and cathode of D486. D487 is reverse biased and D486 is conducting, except when differential gain measurements are being made.

The 3rd and 5th harmonics of the chrominance signal are prevented from being fed into the demodulators by traps in the collector circuit of Q450. L453 and C453 comprise the 5th harmonic trap, L454 and C454 comprise the 3rd harmonic trap.

During the horizontal blanking pulse time, the junction of C455 and C457 is effectively at AC ground. Any signal appearing at the junction is shorted to ground during this time. The clamps in the Vertical and Horizontal Amplifiers can now clamp to zero signal level during sync tip time. Q460 is normally off and is turned on by the —H pulse coupled through C461 to the base of Q460. When Q460 turns on, D463 and D465 are forward biased to effectively connect the base and collector of Q460 together. The collector of Q460 is at a very low impedance to ground, which effectively grounds any signal at the junction of C455 and C457.

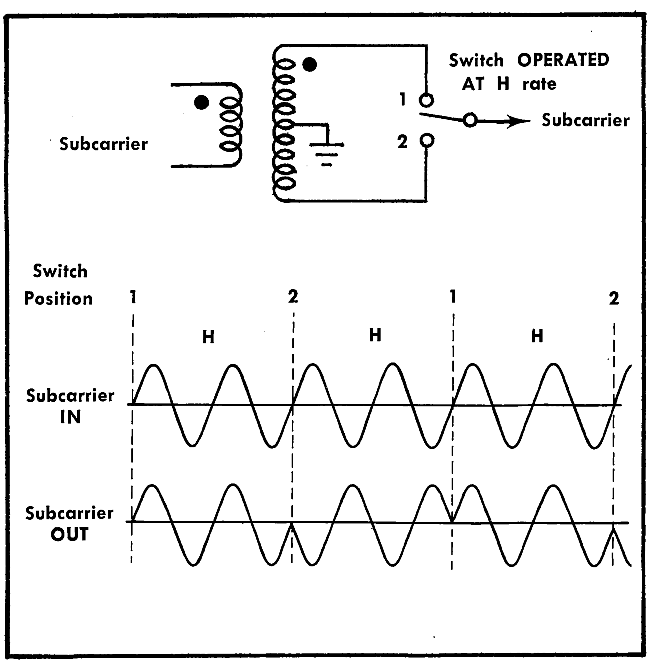


Fig. 3-13. Simplified illustration of the 0° to 180° switching action.

0° and 180° Switching

During the time test circles are being displayed or differential phase measurements are being made, the phase relationship of the reference subcarrier to the Vertical Demodulator is switched between 0° and 180°. Transistors Q575 and Q576 alternately switch each end of the center tapped secondary of T590 to the signal ground. Therefore, the phase of the signal at the center-tap is alternately switched from 0° to 180°. The operation of the 0° to 180° switching is similar to the switching action of the demodulators except that a slower switching rate is used. Fig. 3-13 is a simplified illustration of the 0° to 180° switching action, in which Q575 and Q576 are represented by a toggle switch.

When no CAL signal is selected or differential phase measurements are not being made, the 0° and 180° switching circuit is not operating. The +10 V supply is connected to the base of Q571 through the divider consisting of R578, R576 and R577. D576 is reverse biased and Q571 is saturated. Q570 is off and the pulse from the divide-by-two flip flop U510 will not cause Q570 and Q571 to switch. The phase of the reference subcarrier at the center-tapped secondary of T590 is unchanged Now, assume that a differential phase measurement is to be made. The +10 V is removed from R578, and D576 becomes forward biased. Q571 is not conducting as hard, and the pulse from the divide-by-two flip flop will now cause Q570 and Q571 to switch. As Q570 and Q571 are switched, Q575 and Q576 are alternately turned on and off, causing each end of the center-tapped secondary of T590 to be alternately switched to signal ground. The switching square wave from pin 7 of U510 is occurring at an H/2 rate; therefore, the phase of the reference subcarrier at the center-tap of T590 secondary is being inverted every television line.

Test Circles

Test circles are provided as a CAL signal to insure an exact 90° phase relationship of the Horizontal and Vertical Demodulators, and correct gain adjustment of the Vertical and Horizontal circuits. This insures a true representation of the phase of the vectors displayed in vector operation.

When test circles are being displayed, the signal from the Test Circle Oscillator is coupling into either the A or B chrominance input of the demodulator. The signal is then coupled through the chrominance channel to the Vertical and Horizontal Demodulators. The reference subcarrier from either the A or B PHASE Goniometer is coupled through the reference subcarrier channel to the Horizontal and Vertical Demodulator. The reference subcarrier that is coupled to the Vertical Demodulator has its phase reversed 180° every television line by the 0° to 180° Switching circuit. This causes the output of the Vertical Demodulator to be inverted every other line. Without this inversion, a misadjustment of QUAD PHASE would have caused the test circle to look like an ellipse. Now, with the vertical axis reversed, a misadjustment of QUAD PHASE appears as two crossed ellipses, allowing a more accurate adjustment of QUAD PHASE. The output of both the Horizontal and Vertical Demodulators is the difference frequency of the Test Circle Oscillator and the reference subcarrier. The output of the Vertical Demodulator

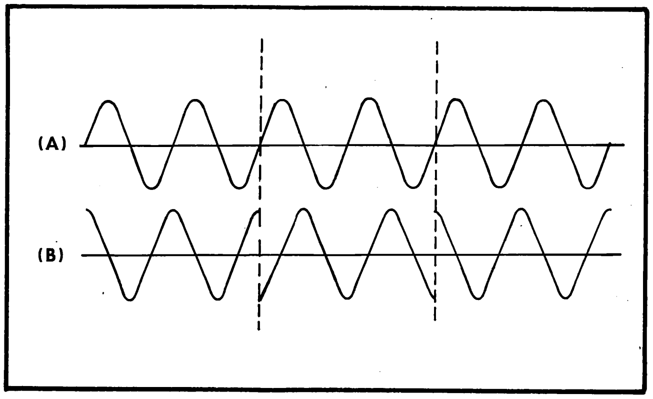


Fig. 3-14. Simplified illustration of demodulator outputs in test circle operation. (A) Horizontal output, (B) Vertical output.

on the CRT, but if there is exactly 90° phase difference between the vertical and horizontal circuits the circles will coincide and appear as one. If during calibration of the instrument the two circles do not coincide, a quadrature adjustment (R588) is provided to adjust the phase difference for exactly 90°.

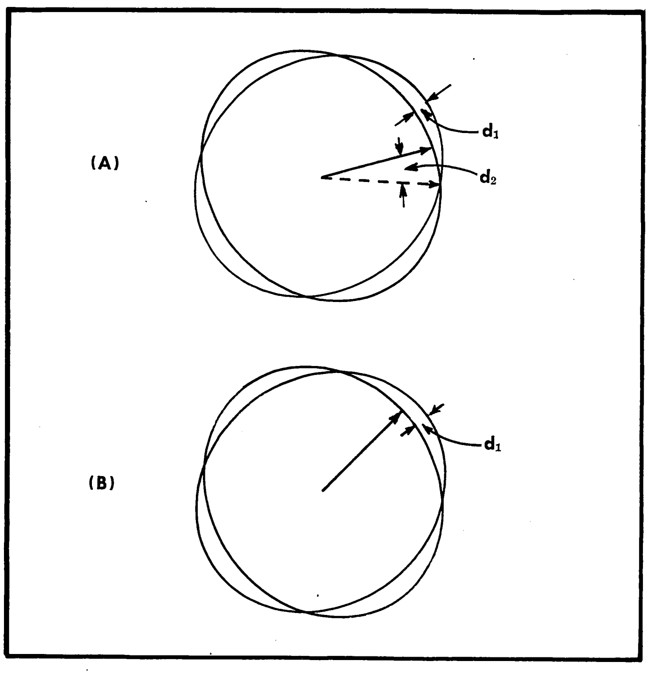


Fig. 3-15. Phase and Amplitude error of vectors when QUAD PHASE is misadjusted. Phase and Amplitude error may be positive or negative depending on whether phase shift between vertical and Horizontal Demodulators is greater or less than 90°.

(A) Phase error when QUAD PHASE is misadjusted ($d_1 = d_2$).

(B) Amplitude error when QUAD PHASE is misadjusted. Amplitude error is ½ of d_1 and is maximum for vectors along 45°, 135°, 225° and 315° axis.

The misadjustment of QUAD PHASE does not affect vectors lying on the vertical axis, but has its maximum effect on the horizontal axis. The amount of radial separation of the test circles is related to the angular displacement of a vector, lying on the horizontal axis and having an amplitude is shifted in phase 90° with respect to the Horizontal Demodulator output. Fig. 3-14 is a simplified illustration of the phase relationship of the outputs of the Vertical and Horizontal Demodulators in test circle operation. The outputs of the Horizontal and Vertical Demodulators are coupled to the deflection circuits and there will be two circles displayed equal to that of the test circle. The radial separation is equal to the displacement of the vector. Fig. 3-15 illustrates the test circle display when QUAD PHASE is misadjusted. As an example; one degree of error in a vector lying on the horizontal axis having an amplitude equal to the test circle means that the vector is 0.0366 inches (pertaining to Type R520) away from where it should be. If this error were due to a misadjustment of QUAD PHASE, the test circles would have a separation of 0.0366 inches. The angular error would be at a maximum for vectors measuring 0° and 180°. The maximum error in amplitude is one-half the separation of the circles, and would be most prominent for vectors at 45°, 135°, 225° and 315°. In this case, the maximum amplitude error would be 0.0183 inches or 0.9% since the radius of the test circle is 2.096 inches.

Assume that it is desired to display test circles on channel B. The B CAL switch SW55 is actuated and Q425 is turned off (refer to Chrominance Channel Switching for operation of Q420 and Q425). SW55 also connects —15 V to the emitter of Q430 through R432. Q420 is on, so its collector is pulled up which causes the base of Q430 to go positive and turns on Q430. Q430 turning on decreases the positive voltage at the cathode end of D576 and D576 becomes forward biased. The positive bias on Q571 is decreased and the 0° and 180° Switching operates as previously described in the 0° and 180° Switching description.

Cal Signal, Line Sweep

The CAL signal available in the LINE SWEEP mode of operation is two horizontal traces separated vertically by 140 IRE units. When either the A CAL or B CAL switch is operated the 0° and 180° switching circuit operates as previously described. The square wave that is developed on the collector of Q570 is coupled through Q580 to the input amplifier circuit. From the input amplifier, it is coupled back into the chrominance channel through either the A or B input line. The CAL signal is then taken off the collector of Q450 through R452 and coupled into the luminance input filter. The network consisting of D580 and C580 delays the turn-on of Q580 to allow the clamps in the Luminance Amplifier and the Vertical Amplifier to always sample the bottom of the CAL square wave. Resistor R583 LUMINANCE CAL in the collector circuit of Q580 is an adjustment used during calibration to adjust for 140 IRE units of vertical separation between the two horizontal traces.

FILTER AND HORIZ/VERT DRIVER AMPS

Since the operation of the Vertical and Horizontal Driver Amplifiers is essentially the same, only the operation of the Vertical circuit will be described.

Vertical Driver Amplifier

The demodulated signal from the Vertical Demodulator is coupled into a low pass filter having a 600 kHz bandpass, consisting of L601, C601, L602 and C602. From the low pass filter, it is coupled through the terminating resistor R621 to the base of Q620. Q620 and Q630 form an operational amplifier with a gain of approximately 10. The signal is coupled from the emitter of Q630 to the Vertical Amplifier. An offset current is also coupled to the summing junction of Q620 and Q630 when differential gain measurements are being made. The gain of the Vertical Amplifier is increased during the time of differential gain measurements and the offset current at the base of Q620 maintains the display within the control limits of the deflection circuits. One of the feedback resistors R626 is variable (R-Y GAIN) so the gain of the operational amplifier can be adjusted during calibration. R624 establishes the operating point for Q620 and is adjusted for a 0 V DC output level at the emitter of Q630 during sync time with VECTOR button depressed. C632 is a frequency compensating capacitor.

The GAIN BAL adjustment in the feedback circuit of the Horizontal Driver permits slight adjustment of the horizontal gain from the front panel.

Luminance Driver

The luminance signal and the luminance CAL signal from the collector of Q450 in the Video Amp is coupled into a low pass filter consisting of L610-L618 and C610-C619. From the low pass filter the signal is coupled through emitter follower Q660 to the gate of FET, Q670. The signal is coupled through the operational amplifier, Q670 and Q680, through R688 to the Vertical Amplifier. R672 (LUM DC BAL) is adjusted during calibration to establish the operating point for Q680 during sync tips. D680 is a protection diode that prevents the base of Q680 from going more positive than +10.6 volts.

The gate of Q670 is referenced to ground during sync tip time by the action of the sync tip blocking oscillator, Q691. The blocking oscillator is triggered by the -H pulse. Assume a quiescent condition, no trigger in. Q690 and Q691 are off and D694 is forward biased through R694. The zener diodes D695 and D696 are conducting through R697 and R698. The voltage at the junction of D695 and R697 is +3 volts, and the voltage at the junction of D696 and R698 is —3 volts. Sampling diodes D697 and D698 are reverse biased.

The -H pulse is coupled to the emitter of Q690 through C690. Q690 is turned on by the leading edeg of the -H pulse. When Q690 turns on, the incoming pulse is clamped at —0.6 V by the base-emitter impedance. Thus, Q690 remains on for a short duration and triggers the blocking oscillator. The current from Q690 into the primary winding of T695 induces a positive voltage into the secondary winding at the junction of D694, and D694 is reverse biased. As D694 is reverse biased the base of Q691 goes positive and Q691 turns on. The center-tapped secondary of T695 is wound in such a manner that the polarity of the induced voltage is positive at the end of the center-tapped secondary connected to D695 during the time Q690 or Q691 is on. D697 and D698 remain reverse biased during the conduction time of Q691. When D694 is reverse biased C695 starts to charge in the positive direction. When the end of C695 that is connected to the anode of D694 becomes approximately 0.6 V more positive than the induced voltage into the secondary winding of T695, D694 is forward biased. When D694 is forward biased, Q691 is turned off. When Q691 turns off, the polarity of the voltage across the center-tapped secondary reverses and the junction of D695 and D697 goes negative. At the same time, the junction of D696 and D698 goes positive. Diodes D697 and D698 are forward biased by the back swing of the blocking oscillator and the gate of Q670 is clamped to ground during sync tip time.

A LUMINANCE GAIN control (R685) is provided as a front panel control. The gain of the luminance channel is adjusted during calibration with SW685 in the CAL or open position, and the luminance signal is coupled through R688. If the front panel GAIN control is operated, SW685 is closed and R688 is shunted. The luminance signal is then divided down through R685 and R687.

VERTICAL AMPLIFIER

The signals from the Horiz/Vert Driver Amps are coupled into the Vertical Amplifier board. The luminance, R-Y and B-Y signals are matrixed to form the G-Y, red, blue and green signals. The input signal to the Vertical Amplifier is selected by transistors operated as switches. The transistors are controlled by the buttons located on the front panel labeled, VECTOR, LINE SWEEP, Y, I, R, Q, G, DIFF GAIN, B and DIFF PHASE. The output of the Vertical Amplifier is a cascode amplifier which drives the upper and lower deflection plates.

Signal Switching

The R-Y signal from the Vertical Demodulator is coupled to D716 through R718, to D746 through R745, and to D766 through R765. The B-Y signal from the Horizontal Demodulator is coupled through R728 to D726, and to D756 through R755. This signal is also connected from the input connector to the Horizontal Amplifier. The luminance signal is coupled to D706, D716, D726 and D736 through R705, R715, R725 and R735.

The R-Y and B-Y signals are coupled to the emitter of Q770 through R770 and R771. Q770 and Q780 form an operational amplifier.

The R-Y and B-Y signals are added together through R770 and R771 and coupled into the amplifier to form the G-Y signal on the collector of Q780. The G-Y signal is coupled through R786 to the cathode of D706. D780 in the base circuit of Q780 is a protection diode that clamps the base at +10.6 V when the amplifier is overdriven. D775 sets the base of Q770 at +0.6 V and is for temperature compensation.

Since the switching transistors (Q700, Q710, Q720, Q730, Q740, Q750 and Q760) and the switching diodes (D706, D716, D726, D736, D746, D756 and D766) all operate in the same manner, only the operation of Q710 and D716 will be described. The switching transistors are normally conducting, so the collectors are pulled up and the diodes (D706 - D766) are reversed biased. Assume it is desired to display the red signal. SW710 is pressed and a positive voltage is connected to the base of Q710 through R712, so Q710 is turned off. All of the other switching transistors will remain on. —15 V is connected to the cathode of D716 through R716 and D716 turns on. The R-Y signal is coupled through R718 to the cathode of D716 and the luminance signal is coupled through R715 to the cathode of D716. When the two signals are added algebraically (R-Y + Y) the red signal is produced and coupled through D716 to the vertical amplifier. The amplitude of the R-Y signal at the input to the Vertical Amplifier board is equal to (R-Y) 2/1.14. To completely cancel out the Y component at the summing point (the cathode of D716), the R-Y signal must be attenuated. This is accomplished by the resistance ratio of R715 and R718.

The resistance values for R725 and R728 have been chosen to completely cancel the Y component when the blue signal is selected. The amplitude of the B-Y signal at the input of the Vertical Amplifier board is (B-Y) 2/2.03.

The amplitude of the G-Y signal on the collector of Q780 is equal to (G-Y) 2/0.71. Therefore, the resistance values for R786 and R705 have been selected to completely cancel the Y component when the green signal is selected.

The gain of the vertical amplifier is increased $\times 5$ when DIFF GAIN or DIFF PHASE measurements are being made. When either DIFF GAIN or DIFF PHASE is selected, R765 becomes R_i for the operational amplifier Q830/Q835 in the Vertical Amplifier. The resistance value for R765 is 953 Ω, while R_i in the other modes of operation is 4.99 kΩ.

Vertical Amplification

The signal selected by the switch transistors is coupled to the base of Q830. Q830 and Q835 form an operational amplifier that drives a paraphase amplifier. The vertical gain is adjusted by changing the R_f of the operational amplifier (R_f/R_i = gain). The collector of Q835 drives Q836, which is one half of the paraphase amplifier. The signal on the emitter of Q835 is coupled to the emitter of Q855, which drives the other half of the paraphase amplifier, Q856. The signals appearing on the collectors of the paraphase are about equal in amplitude, but of opposite polarity. The output of Q836 is coupled to the upper deflection plate and the output of Q856 is coupled to the lower deflection plate. L838 and L858 are series peaking coils. Capacitor C848 is adjusted for high frequency response and resistor R849 is used to adjust damping, and is adjusted for the best transient response. Transistor Q840 provides a constant current source for the paraphase amplifier.

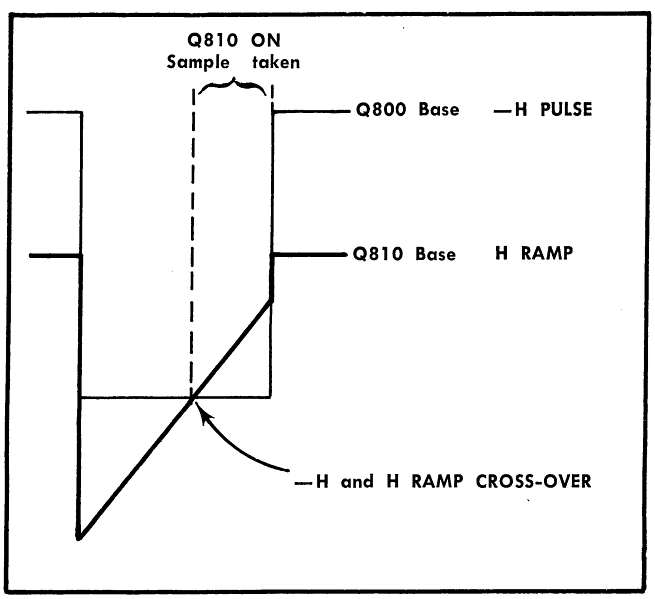


Fig. 3-16. Signals present on Q800 and Q810 bases when deflection plate voltage is sampled.

Vertical Positioning

During sync tip time, a sample of the output of the paraphase amplifier is taken. If there is any voltage difference, an error signal is coupled to the Vertical Amplifier to balance the outputs and position the CRT trace in the center of the CRT vertically. The front panel VERT POSITION control is in the circuit only when either Y, R, G, B or DIFF GAIN is selected.

The collector of Q856 is coupled to the base of Q870A through R876, and the collector of Q836 is coupled to the base of Q870B through R886. Q870A and Q870B form a differential amplifier with the common mode level of the bases set by R875 Vert Com Mode Lev. D875 and D876 clamp the difference of potential between the bases of Q870A and Q870B at 0.6 volts. Therefore Q870A and Q870B are prevented from being overdriven excessively. The bias on the base of Q870B is set by the adjustment of R880 VERT POSITION CLAMP. R880 is adjusted so the spot is in the center of the CRT in VECTOR operation with no input. Q860 is conducting unless either G, R, B, or Y is selected. With Q860 conducting, its collector is positive and D873 is reverse biased. D862 is reverse biased through R864 and D861. With D862 and D873 reverse biased, any voltage change produced by the VERT POSITION control is blocked from the bases of the differential amplifier, and the VERT POSITION control cannot set the position of the trace on the CRT.

The output of the differential amplifier is taken off the collector of Q870B and coupled to a four-diode gate consisting of D805A, B, C and D. Q800 is normally on and its collector is pulled down. Q810 is normally off, so its collector is positive. With Q800 on and Q810 off the charge across C807 and C817 is such that the four-diode gate is reverse biased and the signal from the differential amplifier is not coupled to the gate of Q820. During sync tip time, the —H pulse is coupled to the base of Q800 and the H ramp from the Sweep circuit is coupled to the base of Q810. The —H pulse and the H ramp are coincident with each other. Refer to Fig. 3-16 for the voltage and time relationship of the —H pulse and the H ramp. As the —H pulse and the H ramp step negative, Q800 continues to conduct and remains on during the time the ramp is running up to the cross-over point of the H ramp and the —H pulse. At the cross-over point, the base of Q810 becomes more positive than the base of Q800 and Q810 turns on. As Q810 turns on, its collector goes negative and the collector of Q800 goes positive. The charge then across C807 and C817 forward biases the four-diode gate and the error signal from the collector to Q870B is coupled to the gate of Q820. Q820 is a source follower and the error signal is coupled to the base of Q855. If there is a difference of potential between the upper and lower deflection plates during sample time the current in Q856 is either increased or decreased to balance the output of the paraphase amplifier. When the -H pulse and H ramp steps up, Q810 turns off and Q800 turns on. Thus the diode gate is closed until the next sync tip time.

If either G, R, B, or Y is selected, +10 V is connected to the junction of D861 and R865. D861 is reverse biased and Q860 is turned off. Since D861 is reverse biased, D862 is forward biased through R862; and with Q860 off, D873 is forward biased through R867. The bias on the bases of the differential amplifier can now be changed by the VERT POSITION control and the CRT trace can be positioned vertically.

Q890 is an emitter follower which develops the +3 V supply.

HORIZONTAL AMPLIFIER

The Horizontal Amplifier and horizontal positioning circuits operate essentially in the same manner as the vertical circuits. Therefore, the circuit description given for the Vertical Amplifier applies to the Horizontal Amplifier except for circuit numbers.

Signal Switching

The sawtooth sweep from the Sweep circuit is coupled to the Horizontal Amplifier through D940 except during the VECTOR mode of operation. During VECTOR operation the horizontal video signal from the Horizontal Demodulator is coupled through D944 to the Horizontal Amplifier.

Signal switching is accomplished by Q930. Transistor Q930 is conducting except when SW30 (VECTOR) is actuated. With Q930 conducting, its collector is pulled up and D944 is reverse biased. D940 is forward biased through R934 and the sawtooth voltage is coupled to the Horizontal Amplifier. When SW30 is actuated, +10 V is connected to the junction of R930 and R936, which turns Q930 off. When Q930 turns off, D944 is forward biased through R939 and the horizontal video signal is coupled to the Horizontal Amplifier. The +10 V at the junction of R936 and R930 forward biases D932, and D940 is reverse biased which disconnects the sawtooth voltage from the Horizontal Amplifier.

The HORIZ POSITION control operates in all switch positions except VECTOR. When SW30 is actuated, +10 V is connected to the base of Q1010 through R1016 and Q1010 turns on. When Q1010 turns on, its collector goes negative and D993 is reverse biased. +10 V is also connected to the cathode of D983 through D982, and D983 is reverse biased. With D983 and D993 reverse biased, the HORIZ POSITION control cannot change the bias on the bases of the differential amplifier.

The adjustment for setting the DC level of the -H pulse is in the base circuit of Q900. The adjustment of R905 sets the bias on Q900 and Q800 which determines where the crossover of the -H pulse and the H ramp will occur and the sample of the error signal will be taken.

SWEEP

Sync Separator

The Sync Separator circuit (Q1100, Q1101, Q1110, Q1115) removes the video information from the composite video signal, leaving sync with sync tips clamped at a certain voltage level. This circuit is an operational amplifier that has three possible feedback paths:

1. From the collector of Q1101 through Q1115 base-emitter junction, D1110, Q1110 base-emitter junction, and R1101 to the base of Q1100. This is the primary feedback path under no-signal quiescent conditions.

2. From the collector of Q1101 through R1116, R1114, Q1110 base-emitter junction, R1102 and C1102 to the base of Q1100. This path is shunted by R1108. This parallel circuit is the primary feedback path when the signal is applied to the base of Q1100. During sync pulse transitions (leading and trailing edges), the dominant feedback path is through R1108 which gives maximum circuit gain.

3. From the collector of Q1101 through D1106 and D1105 to the emitter of Q1100. Although these diodes are primarily anti-saturation diodes, they can be considered as a local feedback path when both diodes are on and the signal is not at the sync tip level.

To understand the circuit operation, first assume a quiescent condition with no input signal. All the transistors are conducting and the voltage at the emitter of Q1100 is about +0.6 V. With Q1101 on, the voltage at the collector of Q1101 is about +3.4 V. Thus, D1105 is forward biased; D1106 reverse biased. The voltage at the base of Q1100 is about 0 V and about 150 μA of current is flowing through R1103 and the parallel combination of R1101 and R1108. This sets the emitter voltage of Q1110 at about +3.2 V and the base voltage is at +3.8 V. C1114 charges to the positive DC level at the base of Q1110. With Q1115 on and its base at the same voltage as Q1101 collector, the emitter voltage of Q1115 is at +4.1 V. This voltage enables D1110 to be slightly forward biased to maintain the charge on C1114.

Assume that a sync-negative composite video signal has been applied to the base of Q1100. Under this condition, D1110 is reverse biased between sync pulses. As the leading edge of the sync pulse goes in the negative direction, the emitter of Q1100 tends to go negative, causing the collector of Q1101 to go in the positive direction. D1110 becomes forward biased to provide a charge path for C1114. The feedback path is from the collector of Q1101 through R1116, R1114, Q1110 base-emitter junction, R1102 and C1102 to the base of Q1100. This path is shunted by R1108. This parallel-connected feedback path establishes the sync tip clamp level by providing the DC operating level for Q1100. This operating level shifts with the average picture level and is controlled by the charge of C1114.

As the trailing edge of the negative-going sync pulse at the base of Q1100 starts going in the positive direction, the collector of Q1101 starts in the negative direction. When the collector voltage of Q1101 goes slightly more negative than the charge of C1114, D1110 becomes reverse biased.

When the collector and base voltage of Q1101 become equal, D1106 is forward biased. This diode prevents Q1101 from saturating and returns the collector of Q1101 to approximately +0.7 V between sync pulses when the signal is not at the sync tip level. Only a small fraction of the positive-going video at the base of Q1100 will appear at the output of Q1101 (at TP1101). Thus, the output signal will be positive-going sync pulses approximately 3.5 volts peak to peak in amplitude, with the video greatly attenuated. Because of the state of D1110 during the sync pulse transitions, R1108 is the dominant feedback path during these intervals and the circuit has high gain.

DC restoration is accomplished by the RC combination of C1114 R1114, C1116 and R1116 with diode D1110. Also, any hum content of the incoming signal will always go through the feedback path consisting of R1101, C1114, R1114, C1116 and R1116. Any hum appearing at the input is thus greatly reduced on the restored output. Noise with a peak-

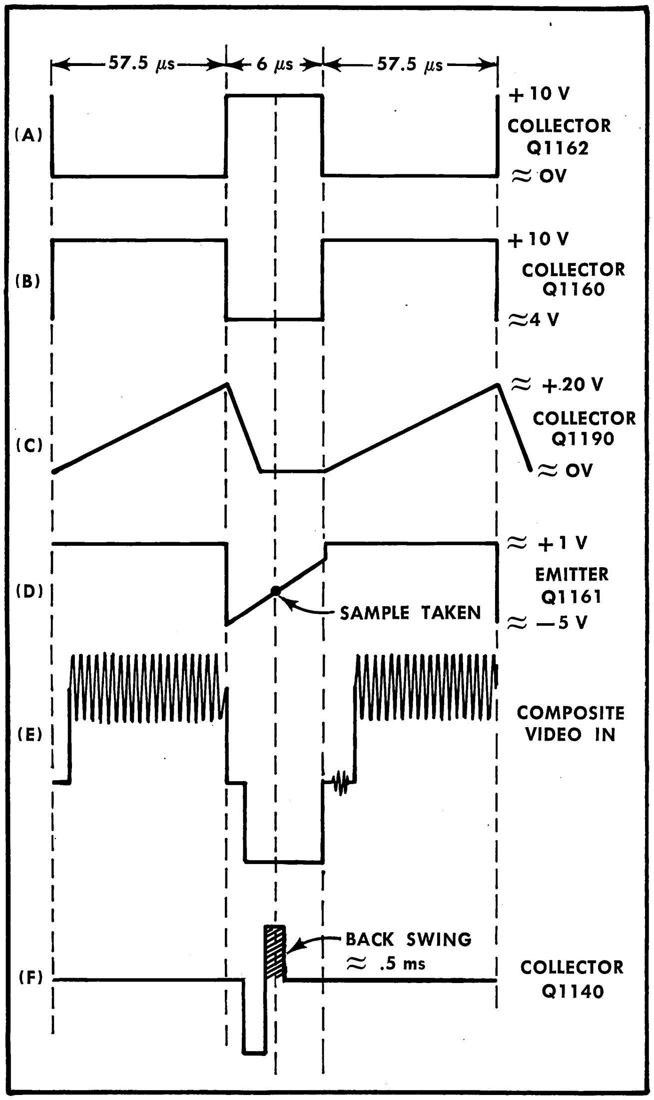


Fig. 3-17. Time relationship of signals present in Miller sawtooth generator.

to-peak amplitude slightly less than the amplitude of the incoming sync will not influence the operation of the circuit. Sharp transients greater in amplitude than sync will not affect the operation of the circuit because of the action of Q1115.

The video stripped sync pulse is applied to the base of the Sync Comparator circuit consisting of Q1120 and Q1121. Q1121 has its base set at —2 V by divider resistors R1128 and R1129. Q1121 is normally conducting, and the level shift across R1118 and R1120 during the video portion of the incoming signal is not sufficient to cause Q1120 to conduct. As the positive-going sync pulse at the collector of Q1101 is applied to the base of Q1120 through the level shifting divider consisting of R1118 and R1120, Q1120 turns on when the level reaches —2 V. This corresponds to a level midway between sync tip and blanking level. Then the signal appearing on the collector of Q1120 is a clean (noise free) sync pulse 0 to —1.6 V in amplitude. The use of this pulse will be discussed in the Miller Integrator description for the Field Selector circuit.

Miller Sawtooth Generator

The purpose of the Miller sawtooth generator is to generate a continuous chain of H rate pulses and a sweep at the television horizontal rate (63.5 μs in the NTSC). The H rate pulses are used as clock pulses to trigger other circuits in the Type R520. The Miller sawtooth generator is free running in the absence of incoming sync.

The complete Miller sawtooth generator is composed of the following circuits: Multivibrator, Miller runup, blocking oscillator, and a comparator circuit. During the following circuit description, constant reference to Fig. 3-17 will aid in understanding the sequence of events.

Transistors Q1160, Q1161, and Q1162 are the active devices of the multivibrator. The timing capacitor and resistor for the multi are C1164 and R1165.

Assume that there is no sync input and the Miller circuit is in its free running state. Q1162 begins to conduct and Q1160 turns off with its base clamped at —0.6 volts by D1160. The negative-going signal on the collector of Q1162 is coupled through the gating emitter-follower Q1180 to the anodes of D1190 and D1192, the disconnect diodes for the Miller runup generator Q1190.

The timing capacitor and resistor for the Miller circuit are C1190 and R1190. To understand Miller Runup operation, assume no current through R1152. When a negative-going signal from the collector of Q1162 is applied to the anodes of D1190 and D1192 through Q1180, the diodes become reverse biased and C1190 charges through R1190. This produces a positive-going ramp at the collector of Q1190, which is fed back through a resistive divider (R1160/R1161) to the base of Q1160 in the multivibrator. When the ramp at the collector of Q1190 reaches about +20 volts, Q1160 turns on and its collector goes from +10 V to about +4 V. This negative-going signal forward biases D1164 and the signal is coupled through Q1161, turning Q1162 off so that its collector goes positive. This positive-going signal is coupled through emitter-follower Q1180 to the anodes of D1190 and D1192, forward biasing D1192. With D1192 forward biased, C1190 begins to discharge and the runup of the ramp is terminated. When the collector voltage of Q1190 approaches the voltage on the base end of C1190, diode D1190 turns on and clamps the collector of Q1190 to its base. In this free running state (no incoming sync) the time duration of the runup will be about 61 μs.

The ramp will not run up again until Q1162 turns on, and Q1162 is controlled by the time constant of C1164 and R1165. When the collector of Q1160 goes negative, this produces a negative-going step on the end of C1164 connected to D1166, which reverse biases D1166. With D1166 reverse biased, C1164 charges through R1165. Since R1165 is connected to +100 V, the positive-going ramp produced by C1164 is essentially linear. When the potential at the base of Q1161 approaches about 0 volts, Q1162 is turned on through Q1161. This turns off Q1160, and as the collector of Q1160 starts positive, D1164 is reverse biased. D1166 clamps the base of Q1161 to about +1 V. With D1164 reverse biased, C1164 is disconnected from the collector of Q1160. The collector voltage of Q1160 steps quickly to +10 volts, since C1164 does not have to discharge through R1163. The time duration of the positive-going step waveform on the collector of Q1162 is 6 μs, which determines the rundown and clamp time of the Miller (67 μs in the free running state).

A +H pulse is available at the collector of Q1162, a —H pulse at the collector of Q1160, and a — H ramp at the emitter of Q1161. The +H pulse is coupled to other circuits through emitter follower Q1170. The —H pulse is coupled through emitter follower Q1200 to other circuits in the Type R520.

An AFC circuit is used to establish the frequency of the sweep from the Miller circuit at the television line frequency. The AFC circuit times the sweep to start at the beginning of each television line.

The circuit consists of coincident emitter follower Q1130, a blocking oscillator Q1140, which generates a gate to sample a portion of the —H ramp created by C1164 in the Gating Multi, and a Comparator circuit that increases or decrease the charging current of C1190 in the Miller circuit. As the charging current of C1190 is changed, the positive-going ramp will either speed up or slow down in time.

During the time a +H pulse is not present on the emitter of Q1170, D1178 is forward biased through R1174 and R1127 to ground. Q1130 is normally conducting slightly, with its base held at ground (or slightly negative) by R1127 and D1178. Any positive-going signal appearing on the base of Q1130 during the absence of the +H pulse will be coupled through D1178, and will not trigger the blocking oscillator. This action rejects most noise signals and greatly improves noise pulse immunity. Also, if a +H pulse occurs in the absence of a sync pulse, D1178 is reverse biased and the blocking oscillator is not triggered. Now, assume a sync pulse is present at the base of Q1120 coincident with the +H pulse on the emitter of Q1170. This turns Q1120 on and Q1121 off. When Q1121 turns off, a positive pulse is developed on its collector which is differentiated by C1126 and R1127. Since D1178 is reverse biased by the +H pulse, the positive spike is coupled through Q1130 and triggers the blocking oscillator which is normally non-conducting.

The waveform appearing on the collector of Q1140 is transformer-coupled to the center-tapped secondary of T1140. Zener diodes D1142 and D1144 keep D1143 and D1145 reverse biased, so there is normally no current flow in D1143 and D1145. During the time the blocking oscillator is conducting, the initial negative portion of the waveform increases the reverse bias on D1143 and D1145 and the loop remains open. During the backswing of the oscillator, the polarity of the voltage across the center-tapped secondary reverses to forward bias D1143/D1145 and the loop is closed. Also coupled in through the center tap of the secondary is the negative-going ramp generated in the multi. Refer to Fig. 3-17. During the backswing a narrow sample is taken which charges the memory capacitor C1150 to the value of the ramp voltage appearing at the center-tap during sample time. At the completion of the backswing of the blocking oscillator, D1143 and D1145 are again reverse biased by D1142 and D1144. There is no signal current flowing in the base circuit of Q1140 during the backswing of the oscillator, as the backswing reverse biases D1135 and disconnects the base of Q1140.

The Comparator circuit consisting of dual FET Q1150 is supplying a small percentage of timing current to C1190. With the sweep running at the correct rate (63.5 μs), the sample of the ramp taken by the blocking oscillator will appear at the same voltage level each time, and the memory capacitor C1150 will acquire a charge representing the ramp level attained at the time of the sample. The Comparator then will supply its specified amount of timing current. Now, assume that the sweep from the Miller is running too fast. This will cause the sample of the ramp from C1164 to be taken later, at a more positive level. The gate of Q1150 and the charge on C1150 will go in the positive direction, turning Q1150A on harder. Increased conduction of Q1150A decreases the conduction of Q1150B, which decreases the timing current to C1190 and causes the sweep to slow down, returning to 63.5 μs.

The DC gain of the comparator loop is quite high to combat drift, while the AC signal gain is less than unity to prevent oscillatory action of the AFC circuit. The AC signal gain is reduced by R1153 and C1153 forming a signal current divider with R1152. For a 1 μs error in sweep frequency, approximately 6 μA of error current from the Comparator is required to restore the sweep to the correct frequency. The Burst Flag Timing control R1158 sets the voltage level on the gate of Q1150B and, in turn, the voltage level of the negative ramp at which the sample is taken. This adjustment determines the time relationship between the H pulse and incoming sync.

The Miller Sawtooth Generator has generated a positive H pulse, a negative H pulse, a negative H ramp, and a sweep, each with a rate of 63.5 μs, with the start of each referenced by the incoming sync pulse. Refer to Fig. 3-17 for a time relationship of the Miller sawtooth generator signals.

Miller Integrator

The Miller Integrator is designed to integrate the vertical sync pulse and produce (at the collector of Q1255) an integrated sawtooth which starts at 0 V and rises in amplitude to about positive 20 volts. The timing resistor and capacitor for the Miller Integrator are R1254 and C1252.

The negative-going sync pulse from the collector of Q1120 is coupled through a current transfer transistor Q1250 to the anodes of D1252 and D1253. The negative-going pulse on the collector of Q1250 reverse biases D1252 and D1253, and C1252 charges through R1254. The time duration of the horizontal sync pulse is not sufficient to allow the charge of C1252 to attain any appreciable level. During the vertical sync group, D1252 and D1253 are reverse biased for a sufficient duration so that C1252 attains the desired charge. During the vertical serration time, C1252 will discharge only a slight amount through R1253. At the end of vertical sync time the signal at the collector of Q1255 is a positive-going ramp whose peak corresponds to the end of the vertical sync group. After the collector of Q1250 has gone positive and sync pulse ends, D1253 will be forward biased, discharging C1252 through R1253. The recovery of the sawtooth voltage is disconnected from the sync circuit by Q1250. As the charge on both sides of the capacitor becomes equal, D1252 will be forward biased. This stops the rundown. The capacitor will remain essentially in this condition until the next vertical sync pulse.

The sawtooth voltage at the collector of Q1255 is applied to a peak detector consisting of D1256, C1259, R1259, R1270, D1270 and the base-emitter junction of Q1270.

When the Type R520 is turned on, C1259 acquires an initial charge, with the end connected to the cathode of

D1256 being positive. As the ramp developed on the collector of Q1255 goes in the positive direction, diode D1256 becomes forward biased when its anode voltage exceeds the charge of C1259. When D1256 becomes forward biased, some of the current that was flowing through R1270 is used to charge C1259. As the sawtooth voltage starts in the negative direction and the charge on C1259 exceeds the anode voltage of D1256, the diode becomes reverse biased and C1259 can no longer charge. The signal developed on the base of Q1260 is a positive-going signal whose amplitude is determined by the current change through R1270, corresponding in time to the peak of the integrated waveform on the collector of Q1255. The time constant of R1259 and C1259 is sufficiently long that C1259 can discharge only a slight amount before the next vertical sync group. The DC level at the end of the capacitor connected to Q1260 is approximately 0 volts.

This level remains constant because of temperature compensating diode D1270 and the base-emitter junction of Q1270.

Field Rate Multivibrator

The Field Rate Multi, Q1260 and Q1265, generates a pulse to preset the Line Selector J-K flip flops and to trigger the Field J-K flip flop. The duration of the pulse from the multi extends for approximately 27 television lines. Below SN B150100, the pulse duration is approximately 20 lines.

The Field Rate Multivibrator is a monostable multi, and Q1265 is normally conducting. The timing resistor and capacitor for the multi are R1265 and C1263. With Q1265 conducting, the end of the capacitor connected to Q1260 is at +10 V and the end connected to the base of Q1265 is at 0 V. The base voltage of Q1265 is clamped by D1265 and D1266, which are also temperature-compensating diodes.

When the positive-going pulse from the peak detector is applied to the base of Q1260, the multi switches states and Q1260 turns on. This causes its collector to go in the negative direction to approximately +3.5 volts. This negative-going signal is coupled to the base of Q1265, turning Q1265 off. With Q1260 conducting and Q1265 off, the capacitor charges through R1265. When the charge on C1263 increases enough to overcome the bias on Q1265, the multi switches states, turning Q1265 on and Q1260 off. The multi remains in this condition until the arrival of the next positive-going pulse at the base of Q1260. The signal at the collector of Q1260 is a negative-going pulse whose leading edge is approximately coincident with the ending of the vertical sync group, and whose duration is equivalent to 27 horizontal lines of either field. Below SN B150100, the pulse duration is 20 lines.

This negative-going pulse is coupled (and has its level shifted) through emitter follower Q1290 to pin 6 of U1320, U1330, U1340, U1350, and U1370, the preset input of the Line Selector J-K flip flops. The pulse is also coupled to pin 2 of U1310, the trigger input of the Field J-K flip flop. Below SN B150100, omit U1370.

Field One Multivibrator

The Field One Multi consists of Q1280 and Q1285, with Q1285 normally conducting. The multi develops a positive-going pulse on each even field. This pulse is used to turn on either Q1300 in the Field Selector circuit, or to preset the Field J-K flip flop. Q1270 is an AND gate or coincidence amplifier whose output is used to trigger Field One Multi.

The positive-going integrated waveform that was developed and peak-detected from the vertical sync group is available at the base of Q1260. This signal is coupled through D1270 to the emitter of Q1270. The +H pulse is coupled from emitter follower Q1170 through R1176 to the emitter of Q1270. Q1270 is biased so that it requires coincidence of the +H pulse and the peak-detected signal to turn it on. Since the odd field (field two) starts with ½ H and the even field (field one) starts with a full H, coincidence will only occur on the even field.

When Q1270 is turned on, its collector goes positive, turning on Q1280. As Q1280 is turned on, the multi changes states and Q1285 is turned off. The collector of Q1285 goes positive. With Q1280 conducting the base end of C1283, the timing capacitor for the multi, charges through R1285 in a positive direction. When the charge on C1283 becomes sufficiently positive to overcome the bias on Q1285, transistor Q1285 turns on and the multi is returned to its stable state. The resulting signal on the collector of Q1285 is a positive-going pulse whose duration is equivalent to line 6 through approximately line 22, occurring only on the even field. Below SN 150100, the pulse duration is equivalent to line 7 through approximately line 17.

The multi is clamped and temperature-compensated by diodes D1285 and D1286. D1275 clamps the base of Q1280 to about —0.6 V when there is not coincidence between the +H pulse and the peak-detected signal from the vertical sync group.

Field Selector

The Field Selector circuit is composed of Q1300, U1310 (a J-K flip flop), and diodes D1310, D1312, D1314, D1316, and D1318. D1310 and D1314 are each connected to one of the VITS Line Selectors, and operates in conjunction with the Line Selector diodes in determining when the CRT will be unblanked. By an arrangement of pin connectors, either VITS line can be connected to the same field. To unblank the CRT for either VITS line, all the diodes connected to that line must be reverse biased. Below SN B150100, omit D1312, D1316 and D1318.

The J-K flip flop used in the Field Selector is the same type as the ones in the VITS Line Selector. Pins 5 and 7 are the output pins, pin 2 receives the trigger pulse and requires a negative going trigger. The preset pin is pin 6 and it must be low to enable the multi to change states when a trigger pulse is applied. In the preset condition if pin 6 has a high applied, pin 7 is low.

Assume the Field Switch SW1305 is in the 2 position, and —15 volts is now applied through R1302 to the base of Q1300, which is sufficient to reverse bias Q1300. This negative voltage is also applied to pin 6 of U1310 through the voltage divider, and the multi is released to change states if it receives a negative-going trigger on pin 2.

The positive-going pulse from the collector of Q1285 in the Field One Multi is applied to pin 6 of U1310 through R1307, which causes pin 7 to go low and pin 5 high. Simultaneously, the negative-going pulse from the Field Multi is coupled through Q1290 to pin 2 of U1310. Thus, pin 7 is low on the even field. The positive-going pulse from Q1285 is also applied to the base of Q1300, but is not of sufficient amplitude to forward bias Q1300. As the next field pulse from Q1290 is applied to pin 2 of U1310, the multi changes states and pin 7 goes high. The positive-going pulse from Q1285 is absent at this time, as the field pulse is occurring on an odd field or field two. From the foregoing sequence of events, it can be determined that the even field pulse insures pin 7 is low on each even field.

SN B150100 and up.

The diodes in the output lines of U1310 can be pin connected to either VITS 18 or VITS 19. When either VITS button is pressed, —15 volts is connected to that line and the diodes connected to the selected line are forward biased through R1319 to +10 volts. When a low occurs on either output pin of U1310, this puts an effective ground on that pin. If the diodes in the output line are forward biased, then the effective ground is coupled through the diodes, through D1359 (which is forward biased unless the FULL FIELD switch is pressed), to the base of the Unblanking Amplifier, Q1220. This turns Q1220 off and the CRT is blanked. When a high occurs on the selected output pin of U1310, Q1220 is turned on and the CRT is unblanked.

BELOW SN B150100

If either D1310 or D1314 is connected to pin 5, the diode is reverse biased at this time and the associated VITS line is selected on field one. If either of the diodes is connected to pin 7 it is reverse biased on the odd field and its associated VITS line is selected.

By changing SW1305 to the 1 position, the reverse bias on Q1300 is decreased and pin 6 of U1310 is pulled farther in the negative direction. Now, as the even field pulse from Q1285 occurs it is sufficiently positive to forward bias Q1300, but is not sufficient to overcome the negative voltage on pin 6 of U1310. On each even field pulse, Q1300 turns on and pin 5 of U1310 is pulled low. The multi will operate as previously explained, except now each time an even field pulse occurs, pin 5 of U1310 is low and pin 7 is high. Table 3-1 shows the condition of pins 5 and 7 as related to field one and two with SW1305 in position 1 and 2.

TABLE 3-1

(A) SW1305 Position 2	Field 1	Field 2
Pin 5/U1310	H	L
Pin 7/U1310	L	H
(B) SW1305 Position 1	Field 1	Field 2
Pin 5/U1310	L	H
Pin 7/U1310	H	L

Line Selector Matrix

SN B150100 and up.

The Line Selector Matrix is composed of J-K flip flop integrated circuits U1320, U1330, U1340, and U1370 with their associated diodes. The integrated circuits are used as binary counters to supply either a high or low through the gating diodes to the base of the Unblanking Amplifier (Q1220). The diodes are connected in such a manner that any line from line 7 through line 22 of either field can be selected. The line pre-selection is accomplished by an arrangement of pin connector jumpers on the Sweep board and by front-panel pushbuttons.

The J-K flip flops used in the Line Selector are connected in such a manner that pins 5 and 7 are the output, pin 6 is the preset and pin 2 receives the clock pulse or the trigger. Pin 2 requires a negative-going clock pulse to flip the counter from one state to the other. A high on pin 6 presets pin 7 low, and the counter is locked in this condition. If pin 2 receives a clock pulse at this time, the counter will not change states. When pin 6 is changed to a low, the counter is released to change states but will not flip until pin 2 receives a clock pulse.

The negative preset pulse from the emitter of Q1290 is coupled to pin 6 of the counters, and pin 7 is low. The low on pin 6 of the counters releases them to change states, but they will not do so until pin 2 of each counter receives a negative-going clock pulse.

The —H pulse, which is occurring at the television line rate, is coupled through Q1200 to pin 2 of the ÷2 counter (U1350). Upon the arrival of the first —H pulse after the counters are released, U1350 will change states. When U1350 flips, pin 5 goes high. This applies a high to pin 2 of U1340 and since the flip flops require a negative-going clock pulse, the multi will not change states and the remaining counters will stay in their preset condition. When the next —H pulse arrives at pin 2 of U1350, the multi changes states and pin 5 goes low. A negative-going clock pulse is now applied to pin 2 of U1340 and the ÷4 counter changes states, which causes pin 5 to go low. The signal (low) on pin 5 of U1340 is coupled to pin 2 of the ÷8 counter (U1330) which changes states, pulling pin 5 low. The low on pin 5 of U1330 is coupled to pin 2 of the ÷16 counter (U1320), causing it to flip and changing pin 5 of U1320 to the low state. This, in turn, is coupled to the ÷32 counter (U1370) which changes states and results in a low on pin 5 of U1370.

By referring to Table 3-2, a truth table for the ÷2 (U1350), ÷4 (U1340), ÷8 (U1330), ÷16 (U1320), ÷32 (U1370) counters, the condition of the output pins can be readily determined as each successive —H pulse is applied to pin 2 of U1350. When the Field Rate Multi changes states again (after approximately 27 television lines) the collector of Q1260 goes in the positive direction and the counters are restored to their preset condition.

The diodes connected to the output pins of the line counters can be pin-connected to either VITS 18 or VITS 19, to pre-select a television line to be displayed when either VITS button is pressed. When a VITS button is pressed, —15 volts is connected to the output of the counters that are pin-connected to that VITS line. The diodes connected

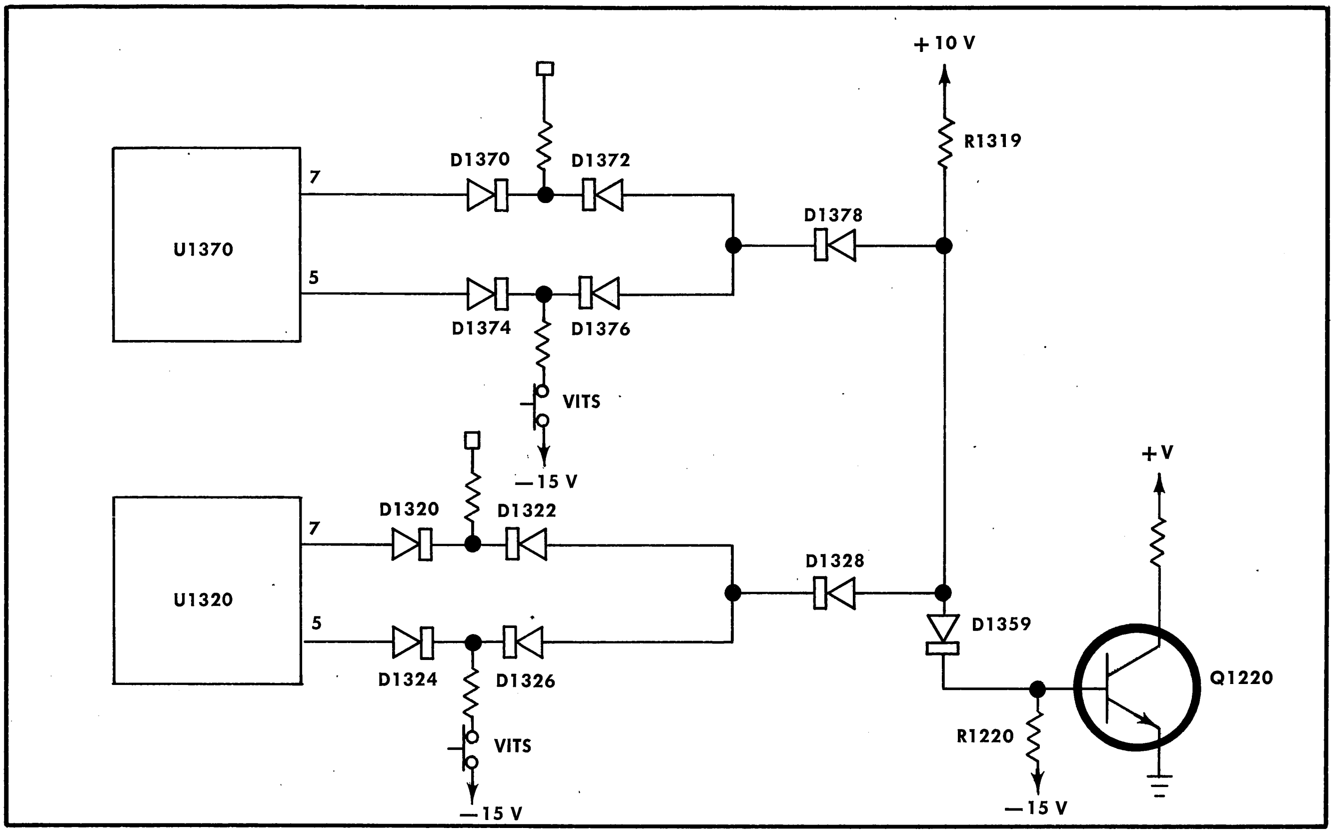


Fig. 3-18. Simplified drawing of the Line Selector circuit.

to the output pins of the counters are then forwarded biased through R1319 to +10 volts. D1359 is foward biased at all times unless the FULL FIELD switch is pressed in.

Fig. 3-18 is a simplified drawing of the Line Selector circuit illustrating the operation with only two counters.

Referring to Fig. 3-18, assume pins 5 of U1320 and U1370 are pin-connected to a VITS line. Diodes D1374, D1376, D1378 of U1370 and diodes D1324, D1326, D1328 of U1320 become forward biased. D1370/D1372 and D1320/D1322 are reverse biased since they are not connected to a VITS line. D1359 is forward biased. First, assume pin 5 of U1320 is low and pin 5 of U1370 is high. When a low occurs on the output pin of a counter, an effective ground is established on that pin. Since D1324, D1326, D1328, and D1359 are forward biased, the ground appearing on pin 5 of U1320 also appears at the base of the Unblanking Amplifier, Q1220. Therefore the transistor is off, its collecter is up and the CRT trace is blanked. Now, assume U1320 receives a clock pulse and the counter multi switches states; this causes pin 5 to go high and pin 7 low. U1370 does not receive a clock pulse, therefore the counter does not flip. Since pins 5 of both U1320 and U1370 are high, a high is coupled through the diodes to the base of the Unblanking Amplifier, which turns the transistor on. The collector of Q1220 is pulled down and a negative-going pulse is coupled to the CRT, which unblanks the trace. The CRT will remain unblanked until the next clock pulse causes the counters to change states. The remaining counters in the Line Selector circuit operate in the same manner as just described for U1320/U1370. A high is required on all the output pins that are connected to the selected VITS line before the Unblanking Amplifier will turn on and unblank the CRT trace.

By referring to Table 2-8 and Table 2-9 in Operating Instructions, television lines 7 through 22 can be preselected to be displayed on either VITS 18 or VITS 19.

When the FULL FIELD switch (SW1314) is pressed, +10 volts is connected to the base of Q1220 through R1209, which turns the transistor on and also reverse biases D1259. The transistor is turned off during sweep retrace time by the —H pulse which is coupled to its base through C1204.

Line Selector Matrix

BELOW SN B150100

The Line Selector Matrix is composed of J-K flip flop integrated circuits U1320, U1330, U1340, U1350 with diodes D1320, D1324, D1330, D1334, D1340, D1344, D1350, D1354 and D1360/D1362. The integrated circuits are used as binary counters to either forward or reverse bias the diodes, which in turn control the Unblanking Amplifier, Q1220. The diodes are connected so that any line from line 7 through line 14 or line 15 through line 21 of either television field can be pre-selected. Refer to Tables 2-10 and 2-11 in Section 2 of this manual. The pre-selected line selection is accomplished by an arrangement of pin connectors on the Sweep board and by front panel pushbuttons.

TABLE 3-2

SN B150100 and up

VITS Line Selector Truth Table for Pin 5																			
No. of —H Pulses	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
÷2 (U1350)	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
÷4 (U1340)	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H
÷8 (U1330)	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H	L	L	L
÷16 (U1320)	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	L	L	L
÷32 (U1370)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H
TV Line	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

The J-K flip flops used in the Line Selector are connected in such a manner that pins 5 and 7 are the output, pin 6 is the preset and pin 2 receives the clock pulse or the trigger. Pin 2 requires a negative-going clock pulse to flip the counter from one state to the other. A high on pin 6 presets pin 7 low, and the counter is locked in this condition. If pin 2 receives a clock pulse at this time the counter will not change states. When pin 6 is changed to a low, the counter is released to change states but will not flip until pin 2 receives a clock pulse.

The anodes of D1324, D1334, D1344 and D1354 are connected together to control one VITS Line Selector, and D1320, D1330, D1340 and D1350 control the other VITS Line Selector. When all the diodes in the selected line are reverse biased, a positive voltage forward biases either D1360 or D1362, causing the base of Q1220 to go in the positive direction. This turns on the Unblanking Amplifier, which unblanks the CRT.

By referring to Table 3-3 which is a truth table for the ÷2 (U1350), ÷4 (U1340), ÷8 (U1330) and ÷16 (U1320) counters, the Line Selector circuit can be more easily understood.

For the following sequence of events assume D1324, D1344 and D1354 are pin-connected to pin 5 of their respective counters and D1334 is connected to pin 7 of U1330. Switch SW1310 is in the on position, which applies +10 V to one end of R1310. (With D1324, D1334, D1344 and D1354 connected in this manner television line 18 is to be selected.) Assume D1314 is reverse biased.

The negative-going pulse from the collector of Q1260 in the Field Multi is coupled through emitter follower Q1290 to pin 6 of the Line Selector J-K flip flops. The counters are released to change states during the entire duration of the pulse which is from line 7 through line 27 or line 7 through 19 of the television field. The —H pulse from Q1160 in the Gating Multi is coupled through emitter follower Q1200 to pin 2 of U1350. With a negative-going clock pulse at pin 2, U1350 changes states and pin 5 goes low. The output of pin 5 is connected to D1354 and pin 2 of U1340. A low on pin 2 of U1340 causes it to flip, so pin 5 of U1340 goes low. Pin 5 of U1340 is connected to D1344 and to pin 2 of U1330. A low on pin 2 of U1330 causes it to change states and pin 5 to go low, which causes U1320 to flip. This puts a low on pin 5 of U1320. A low on the output pin of U1320, U1330, U1340 or U1350 puts an effective ground at the cathode end of the diode connected to that pin. Since SW1310 is on, there is +10 volts through R1310 to the anodes of D1324, D1334, D1344 and D1354. With an effective ground at the cathodes of D1324, D1344 and D1354 they are forward biased. This establishes an effective ground at their anodes which reverse biases D1360. This keeps Q1220 turned off and prevents the CRT from being unblanked. D1334 is connected to pin 7 of U1330 and pin 7 is high at this time; therefore, D1334 is reverse biased. When the second —H pulse appears at pin 2 of U1350, the multi flips and pin 5 goes high. Since the J-K's require a negative trigger, the ÷4 counter can not change states and the ÷8 and ÷16 counters do not receive a trigger. By referring to Table 3-2, the condition of the output pins of U1320, U1330, U1340, and U1350 can be readily determined as each successive —H pulse is applied to pin 2 of U1350.

Continuing through the sequence of —H pulses to the twelfth one after the J-K flip flops were released, (which corresponds to television line 18) it is found that the cathodes of D1324, D1334, D1344 and D1354 all have a high applied to them. Therefore, the diodes are reverse biased and +10 V is applied through R1310 and D1360 to the base of Q1220, forward biasing Q1220. The collector of Q1220 is pulled down and the CRT is unblanked. Q1220 remains on

TABLE 3-3

BELOW SN B150100

VITS Line Selector Truth Table for Pin 5															
No. of —H Pulses	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
÷2	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
÷4	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H
÷8	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H
÷16	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H
TV Line	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Pin Combination															
÷2	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7
÷4	7	7	5	5	7	7	5	5	7	7	5	5	7	7	5
÷8	7	7	7	7	5	5	5	5	7	7	7	7	5	5	5
÷16	7	7	7	7	7	7	7	7	5	5	5	5	5	5	5

until the arrival of the next —H pulse from Q1200 which forward biases D1208 and turns Q1220 off, blanking the CRT during the retrace time of the sweep.

The usable lines that can be selected are limited by the duration of the negative pulse applied to pin 6 of the multis, which releases the J-K's to change states from line 7 through line 27, or line 7 through line 19. Therefore, the usable lines are 7through 14 or 15 through 21.

Unblanking Amplifier

The Unblanking Amplifier is composed of Q1220 and Q1230. A negative-going unblanking pulse from the collector of Q1220 is applied to the unblanking plates of the CRT. Q1230 applies a positive-going signal to the CRT grid during the unblanking time.

Q1220 is forward biased by either the VITS Line Selectors or the FULL FIELD Switch (SW1314), and is reverse biased by the —H pulse during sweep retrace time. The collector of Q1220 is limited to +100 volts by D1225. D1220 and D1222 prevent Q1220 from saturating, thereby eliminating the storage time effects of a saturated transistor.

The negative-going unblanking pulse from the collector of Q1220 is AC coupled to the base of Q1230, an operational amplifier. For full field operation, the average level at the base of Q1230 during each television line holds the collector of Q1230 at a given level. During VITS the change in duty cycle of the unblanking waveform at the collector of Q1220 produces a large negative pulse at the base of Q1230. This produces a positive pulse on the collector of Q1230 which is AC coupled to the CRT grid as a VITS intensifying pulse. Diodes D1235 and D1239 limit the swing of Q1230's collector from about —0.6 V to +40 V. R1233 and C1233 compensate for the time constants in the CRT grid circuit.

A negative-going burst intensification pulse is coupled to the base of Q1230 through R1216 during burst time, which causes the collector of Q1230 to become more positive during burst, thus intensifying burst. A Z axis input to the base of Q1230 is available to externally intensify any portion of the sweep. Because the grid of the CRT is AC coupled, this input should be used for short duration pulses only.

Q1210 provides a DC coupled input to the Unblanking Amplifier Q1220, and is used to blank (or unblank) the CRT for extended time periods.

CRT CIRCUIT

The CRT Circuit provides the high voltage necessary for operation of the cathode ray tube (CRT). The control circuits for controlling the electron beam and the power supply for the integrated circuits are contained in the CRT circuit.

High Voltage Oscillator

Q1420 with its associated circuitry is operated as a class C oscillator to produce the drive for the high voltage transformer T1450. The amplitude of the high voltage oscillations is controlled by a sensing circuit consisting of Q1400, Q1410, and the sensing winding (center-tapped primary) of T1450.

As the equipment is turned on, a negative voltage is applied to the base of Q1400 through R1402, and Q1400 saturates. The collector of Q1400 is pulled up near ground and Q1410 saturates, allowing R1414 to supply base drive to Q1420. This turns on the High Voltage Oscillator. D1414 is reversed biased as the oscillator is turning on. As the amplitude of the oscillations fed back from the collector winding to the base winding of T1450 increases, the collector of Q1410 becomes more negative until D1414 is forward biased. When D1414 becomes forward biased, the available base drive to Q1420 increases. As the amplitude of the oscillations increases, a voltage is induced into the sensing winding of T1450. The induced voltage is coupled through C1438 to a voltage doubler circuit consisting of D1432, D1436, C1433 and C1436. The voltage developed across C1433 at the cathode end of D1432 is coupled to the base of Q1400. The signal is coupled through Q1400 to emitter follower Q1410. The emitter of Q1410 is coupled to the base of Q1420 to control the amplitude of the high voltage oscillations. The frequency response of the feedback loop is compensated by R1430 and C1430.

R1404 to ground and the return for the high voltage form a current feedback loop for the CRT cathode current. Any change in cathode current causes a corresponding change in current through R1404. As the cathode current changes, the voltage developed across R1404 produces an apparent shift of the reference voltage for the supply. For an increase in CRT cathode current, the output of the supply will increase slightly, thus making the output resistance of the supply lower than it would be without the feedback. The frequency of the High Voltage Oscillator is approximately 30-50 kHz.

Diodes D1404 and D1405 provide overload protection for Q1400. L1422, C1422, and C1423 form a decoupling network to decouple the high voltage oscillations from the +10 V and —15 V power supplies. Switching transients are filtered out by L1426, R1426, R1420 and L1420.

The center-tapped primary of T1450 is also used in conjunction with D1440 and D1442 to form a full-wave rectifier. The rectifier has a choke input filter (L1440) and is the +3.6 volt supply for the integrated circuits.

The high voltage transformer T1450 has two secondary windings. One secondary winding supplies the filament voltage for the cathode ray tube. The other secondary winding in conjunction with the voltage doubler (D1452, D1453, C1452 and C1453) provides the high voltage, (approximately negative 3.875 kV), for the cathode ray tube elements. The filtered high voltage at the junction of R1453 and C1454 is connected to a divider consisting of R1469, the most negative point in the divider, through R1462, the most positive point in the divider. D1468 provides a constant 100 V drop across R1468 and R1469, thus allowing sufficient negative grid bias to turn off the CRT.

Resistor R1460 is switched in and out of the divider by SW1314, the FULL FIELD switch. There is a positive-going signal from the Sweep circuit coupled into the CRT control grid through C1490 and C1480 to intensify the sweep (or portions thereof) during burst time, in VITS operation, or if there is a signal connected to the Z AXIS INPUT jack. To prevent any de-focusing that might occur because of the increased beam current, the focusing anode voltage is made correspondingly more negative by adding R1460 to the divider. This is done by opening SW1314 in either of the VITS modes. During full field operation, R1460 is shorted out by SW1314.

CRT Control Circuits

Focus of the CRT display is controlled by the FOCUS control, R1465. The voltage applied to the focus grid is more positive (less negative) than the voltage on either the control grid or the CRT cathode. The ASTIG adjustment, R1476, which is used in conjunction with the FOCUS control to provide a well-defined display, varies the positive level on the astigmatism grid.

The GEOMETRY adjustment, R1472, varies the positive level on the horizontal deflection plate shields and the CRT screen to control the overall geometry of the display.

Two adjustments control the trace alignment by varying the magnetic field around the CRT. The ORTH adjustment, R1474 controls the current through L1474, which rotates the beam before the vertical deflection has been accomplished, insuring that the vertical and horizontal deflections are truly at right angles to each other. The BEAM ROTATE adjustment, R1470 controls the current through L1470, which rotates the beam after both the vertical and horizontal deflection plates, in order to align the trace and graticule.

The UNBLANK BIAS adjustment changes the difference of potential between the unblanking plates and is adjusted for uniform intensity on the CRT.

The INTENSITY control adjusts the DC potential of the control grid, thus controlling the quantity of electrons in the electron beam.

LOW VOLTAGE POWER SUPPLY

The Low Voltage Power Supply circuit provides the operating power for this instrument from four regulated supplies. Electronic regulation is used to provide stable, low ripple output voltages. Each regulated supply, except the +10 V supply which is current limited, is fused to prevent instrument damage if a supply is inadvertently shorted to ground. The power input stage includes the Voltage Selector Assembly. This assembly allows selection of the operating voltage range and regulating range for the instrument.

Power Input

Power is applied to the primary of transformer T1501 through the 115 volt line fuse F1500, POWER switch SW1500, Range Selector SW1503, and Voltage Selector SW1502. The Range Selector SW1503 connects the split primaries of T1501 in parallel for 115 volt range of operation, or in series for 230 volt range of operation. A second line fuse, F1501, is connected in the circuit when the Range Selector switch is set to the 230 volt position to provide the correct protecion for 230 V operation (F1501 current rating is one-half of F1500).

The Voltage Selector switch SW1502 allows the instrument to regulate correctly on higher or lower than normal line voltages. Each half of the primary has taps above and below the 115 volt (230 V) point. As the Voltage Selector switch is switched from LO to M to HI, more turns are added to the primary winding. Therefore, whether the primary voltage has increased or decreased, the secondary voltage can be maintained at a nearly constant level ($E_s = E_p \times N_s/N_p$).

—15 Volt Supply

The —15 volt supply provides the reference voltage for the remaining supplies. The reference for the —15 V supply is a 9 volt zener (D1570) that is contained in an oven and

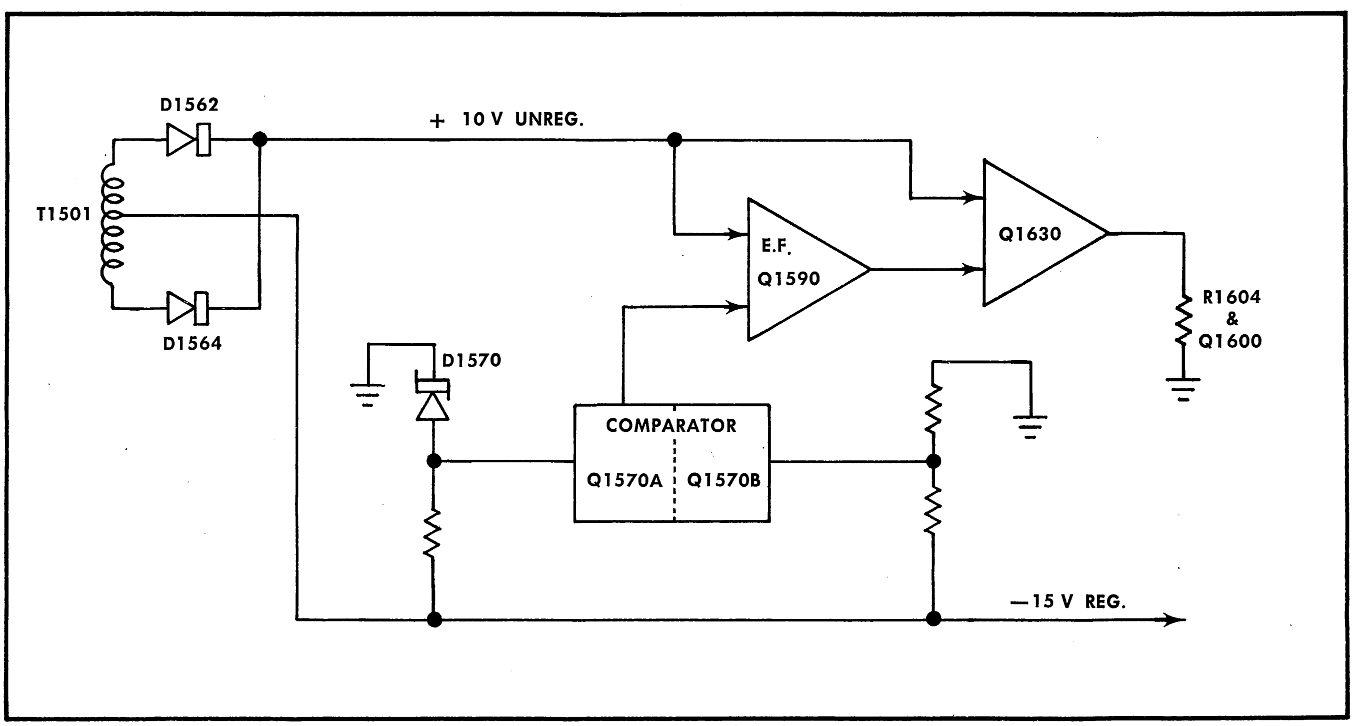


Fig. 3-19. Simplified block diagram of regulated —15 volt supply.

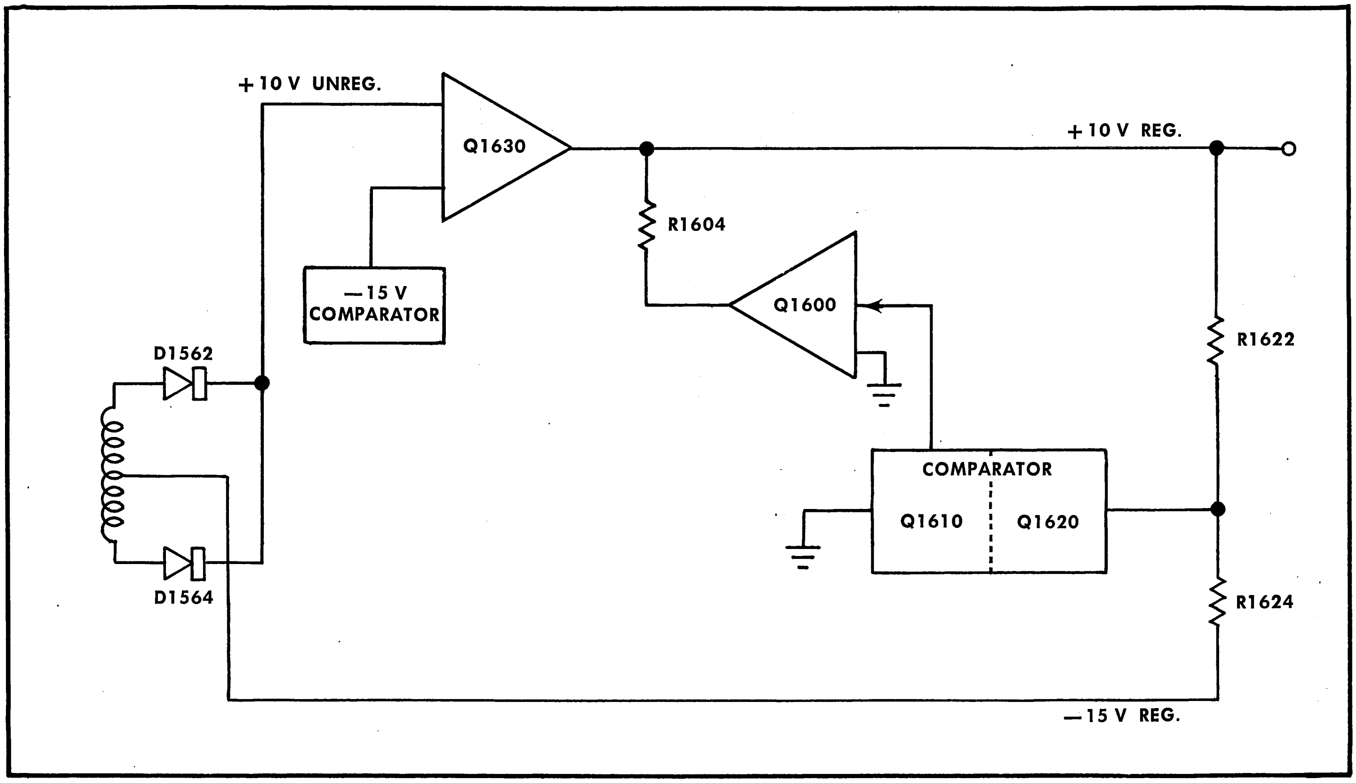


Fig. 3-20. Simplified block diagram of regulated +10 volt supply.

maintained at a constant temperature. The output from the secondary of T1501 is rectified by a full wave rectifier, D1562 and D1564, and then applied to the —15 V Series Regulator stage Q1630, to provide a stable output voltage. The Series Regulator can be compared to a variable resistance which is changed to control the output current, thus controlling the output voltage. The Series Regulator stage is controlled by the Error Amplifier, Q1570A and Q1570B.

The Error Amplifier is connected as a comparator. The base of Q1570A is referenced to —9 V by zener diode D1570. The voltage on the base of Q1570B is determined by the divider consisting of R1584, R1585, R1587 and R1588. R1588 adjusts the base voltage of Q1570B so the output voltage of this supply is —15 volts. The collector current of Q1570A is amplified by Q1590, an emitter follower, to control the Series Regulator Q1630.

Assume that the —15 volt supply tries to go in the positive direction. The base of Q1570B goes positive, turning Q1570B on harder. This decreases the conduction of Q1570A. The collector of Q1570A goes positive, causing Q1590 to increase conduction. The emitter of Q1590 becomes more positive and Q1630 turns on harder, which increases the current through the load and returns the supply to —15 volts. Fig. 3-19 is a simplified block diagram of the —15 V supply. R1600 and C1600 are for frequency compensation.

+10 Volt Supply

Since the current through the —15 V supply to ground exceeds the current through the +10 volt supply to ground, the +10 V supply is shunt regulated and derived from the —15 V supply. The current through the shunt regulator Q1600 is controlled by the Comparator consisting of Q1610 and Q1620. The current through the Comparator is determined by the voltage developed across R1622 and R1624. If the +10 V supply tries to go more positive, the base of Q1620 becomes more positive. This increases the conduction of Q1620 and decreases the conduction of Q1610. The collector of Q1610 goes positive, turning Q1600 on harder. As Q1600 increases conduction, the current through R1622 and R1624 is reduced and the +10 V supply returns to +10 volts. Q1600 effectively reduces the impedance of the +10 V supply. Fig. 3-20 is a simplified diagram of the +10 volt supply.

If the differential current between the +10 V supply and the —15 volt supply exceeds approximately 206 mA, the +10 V supply will go out of regulation. With the —15 V supply drawing an excessive amount of current, the voltage at the junction of R1604 and Q1600 will decrease sufficiently to begin to saturate Q1600. When Q1600 starts to saturate, D1590 turns on and prevents the +10 volt supply from going below approximately 9.8 volts.

+100 Volt Supply

Rectified voltage for the +100 V supply is provided by the bridge rectifier consisting of D1532A-D. The rectified voltage is connected to Series Regulator, Q1550. Reference voltage for this supply is provided by voltage divider R1552 and R1554 connected between the —15 V supply and the output of this supply. The —15 V supply is held stable as previously explained. If the +100 V output changes, this change appears at the base of the Error Amplifier, Q1540, as an error signal. The change on the collector of Q1540 is emitter-coupled through Q1545 to the base of Q1550, and the conduction of Q1550 either increases or decreases to restore the supply to +100 volts. Q1541 is connected as a diode and provides temperature compensation for Q1540. Zener diode D1540 provides DC coupling to the base of Q1545 without any appreciable loss. D1554 is a protection diode that clamps the base of Q1540 at —0.6 volts.

+275 Volt Supply

The bridge rectifier consisting of D1502A-D provides the rectified voltage for Series Regulator Q1520. The +275 volt supply operates in a manner similar to the supplies previously explained. The +100 volt supply is connected to the negative side of the +275 volt supply to elevate the output level to +275 volts. D1503 clamps the negative side of the +275 volt supply at —0.6 V to prevent the +100 V supply from going negative if the +275 volt supply is accidentally shorted. D1510 protects Q1510 against reverse breakdown.

Graticule Lights

The graticule lights are connected in series with Q1560 between the unregulated +10 V and the —15 V supplies. The current through Q1560 determines the intensity of the lights. The base voltage of Q1560 is controlled by R1564, SCALE ILLUM, a variable resistor connected between the +10 V and —15 V supplies.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance or troubleshooting of the Type R520.

Cover Removal

The top and bottom covers of the instrument are held in place by slot-headed fasteners located on the top and bottom of the instrument. To remove the covers, use a coin to turn the fasteners 90° counterclockwise. Lift the covers off the instrument.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection, lubrication, etc. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the Type R520 is subjected determines the frequency of maintenance. A convenient time to perform preventive maintenance is preceding recalibration of the instrument.

Cleaning

General. The Type R520 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

The top and bottom covers provide protection against dust in the interior of the instrument. Operation without the covers in place increases the frequency of cleaning.

Exterior. Loose dust accumulated on the outside of the Type R520 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

CRT. Clean the smoke-gray light filter, IRE graticule, light guide and the CRT face with a soft, lint-free cloth dampened with denatured alcohol.

Interior. Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton tipped applicator is useful for cleaning in narrow spaces or for cleaning the circuit boards.

The high-voltage circuits, particularly parts located in the high-voltage compartment should receive special attention. Excessive dirt in these areas may cause high-voltage arcing and result in improper instrument operation.

Lubrication

General. The reliability of potentiometers, rotary switches and other moving parts can be maintained if they are kept properly lubricated. Use a cleaning-type lubricant (e.g., Tektronix Part No. 006-0218-00) on switch contacts. Lubricate switch detents with a heavier grease (e.g., Tektronix Part No. 006-0219-00). Potentiometers which are not permanently sealed should be lubricated with a lubricant which does not affect electrical characteristics (e.g., Tektronix Part No. 006-0220-00). The pot lubricant can also be used on shaft bushings. Do not over-lubricate. A lubrication kit containing the necessary lubricants and instructions is available from Tektronix, Inc. Order Tektronix Part No. 003-0342-00.

Visual Inspection

The Type R520 should be inspected occasionally for such defects as broken connections, loose or disconnected pin connectors, improperly seated transistors, damaged circuit boards and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

Transistor and Integrated Circuit Checks

Periodic checks of the transistors and integrated circuits in the Type R520 are not recommended. The best check of transistor and integrated circuit performance is its actual operation in the instrument. Performance of the circuits is thoroughly checked during recalibration; substandard transistor and integrated circuits will usually be detected at that time.

Recalibration

To assure accurate measurements, check the calibration of this instrument after each 1000 hours of operation or every six months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in the Calibration section.

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by recalibration.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the Type R520. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles. See the Circuit Description section for complete information.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 9. The component number and electrical value of each component in this instrument are shown on the diagrams. Each main circuit is assigned a series of component numbers. Table 4-1 lists the main circuits in the Type R520 and the series of component numbers assigned to each. Important voltages and waveforms are also shown on the diagrams. The portions of the circuit mounted on circuit boards are enclosed with a blue line.

TABLE 4-1

Component Numbers

Component Numbers on Diagrams	Diagram Number	Circuit
1-199	1	Input Amp/Test Circle Oscillator and Sync
200-299	2	Subcarrier Regenerator
300-399	3	Precision ϕ Shifter & Goniometers
400-599	4	Demodulators
600-699	5	Filter & Horiz/Vert Driver Amps
700-899	6	Vertical Amplifier
900-1099	7	Horizontal Amplifier
1100-1399	8	Sweep
1400-1499	9	CRT Circuit
1500-1699	10	Power Supply

Circuit Boards. Fig. 4-9 through Fig. 4-27 for instruments SN B150100 and up, and Fig. 4-9 through Fig. 4-26 for instruments below SN B150100 show the circuit boards used in the Type R520. Fig. 4-8 shows the location of each board within the instrument. Each electrical component on the boards is identified by its circuit number. The circuit boards are also outlined on the diagrams with a blue line. These pictures, used along with the diagrams aid in locating the components mounted on the circuit boards.

For instruments SN B150100 and up, some component and pin connector locations on the circuit boards are not used in this instrument but they are used in another instrument (Type 520 MOD 188M). For example, transistor Q1360 and surrounding area on the Sweep board (see Fig. 4-22A) is not used.

Wiring Color-Code. All insulated wire and cable used in the Type R520 is color-coded to facilitate circuit tracing. Signal carrying leads are identified with one or two colored stripes. Voltage supply leads are identified with three stripes to indicate the approximate voltage using the EIA resistor color code. A white background color indicates a positive voltage and a tan background indicates a negative voltage. The widest color stripe identifies the first color of the code. Table 4-2 gives the wiring color-code for the power-supply voltages used in the Type R520.

TABLE 4-2

Power Supply Wiring Color Code

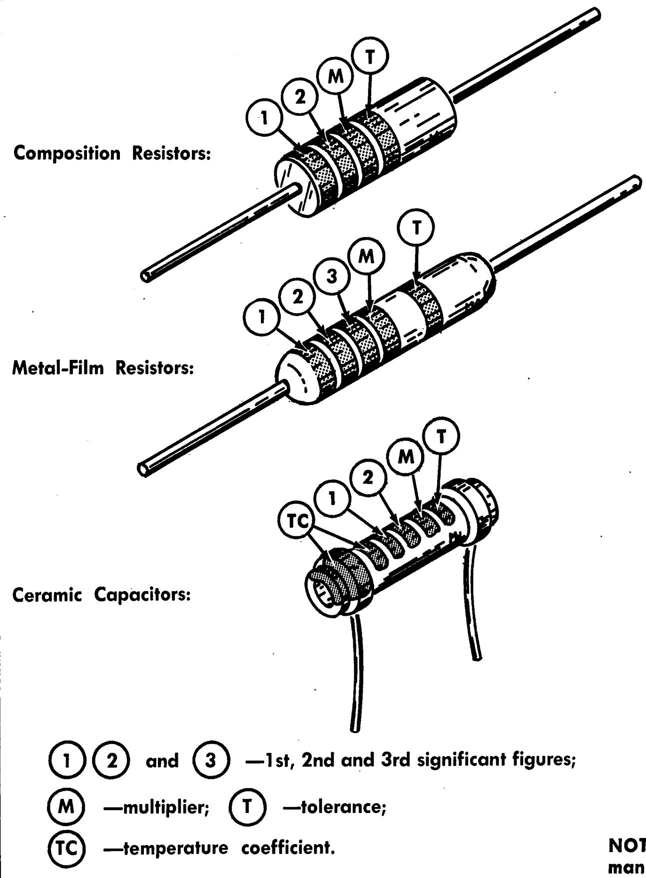
Supply	Color Code
+275 V	Orange-Black-Brown on White
+100 V	Brown-Black-Brown on White
+10 V	Brown-Red-Black on White
+3.6 V	Black-Orange on White
—15 V	Brown-Green-Black on Tan

Resistor Color-Code. In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used in the Type R520. The resistance values of wire-wound resistors are printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color-coded on the components with EIA color-code (some metal-film resistors may have the value printed on the body). The color-code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a multiplier and a tolerance value (see Fig. 4-1). Metal-film resistors have five stripes consisting of three significant figures, a multiplier and a tolerance value.

Capacitor Marking. The capacitance values of common disc capacitors and small elecrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors used in the Type R520 are color coded in picofarads using modified EIA code (see Fig. 4-1).

Diode Color-Code. The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes or a dot. For most silicon or germanium diodes with a series of stripes, the first stripe (pink or blue) of the color-code identifies that the following three stripes are the three significant digits of the Tektronix Part Number using the resistor color-code system (e.g., a diode color-coded pink-(or blue) brown-gray-green indicates Tektronix Part Number 152-0185-00). The cathode and anode ends of a metal-encased diode can be identified by the diode symbol marked on the body.

Transistor Lead Configuration. Fig. 4-2 shows the top-view electrode configurations of the transistors and integrated circuits used in this instrument.



Resistor and Capacitor Color Code

Color	Significant Figures	Multiplier: Resistors	Multiplier: Capacitors	Tolerance: Resistors	Tolerance: Capacitors
Silver	---	10^{-2}	---	±10%	---
Gold	---	10^{-1}	---	±5%	---
Black	0	1	1	---	±20% or 2 pF*
Brown	1	10	10	±1%	±1% or 0.1 pF*
Red	2	10^2	10^2	±2%	±2%
Orange	3	10^3	10^3	±3%	±3%
Yellow	4	10^4	10^4	±4%	+100% −0%
Green	5	10^5	10^5	±0.5%	±5% or 0.5 pF*
Blue	6	10^6	10^6	---	---
Violet	7	---	---	---	---
Gray	8	---	10^{-2}	---	+80% −20% or 0.25 pF*
White	9	---	10^{-1}	---	±10% or 1 pF*
(none)	---	---	---	±20%	±10% or 1 pF*

***For capacitance of 10 pF or less.**

NOTE: (T) and/or (TC) color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 4-1. Color code for resistors and ceramic capacitors.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the Type R520.

1. Transistor Tester

Description: Tektronix Type 575 Transistor-Curve Tracer or equivalent.

Purpose: To test the semiconductors used in this instrument.

2. Multimeter

Description: VTVM, 10 megohm input impedance and 0 to 500 volts range; ohmmeter, 0 to 50 megohms. Accuracy, within 3%. Test prods must be insulated to prevent accidental shorting.

Purpose: To check voltages and for general troubleshooting in this instrument.

NOTE

A 20,000 ohms/volt DC VOM can be used to check the voltages in this instrument if allowances are made for the circuit loading of the VOM at high-impedance points.

3. Test Oscilloscope

Description: DC to 8 MHz frequency response. 10 millivolts to 5 volts/division deflection factor. Use a 10× probe.

Purpose: To check waveforms in this instrument.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple possibilities before proceeding with extensive troubleshooting. The first few checks assure proper connection, operation and calibration. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedures given under Corrective Maintenance.

1. Check Control Settings. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instructions section of this manual.

2. Check Associated Equipment. Before proceeding with troubleshooting of the Type R520, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source.

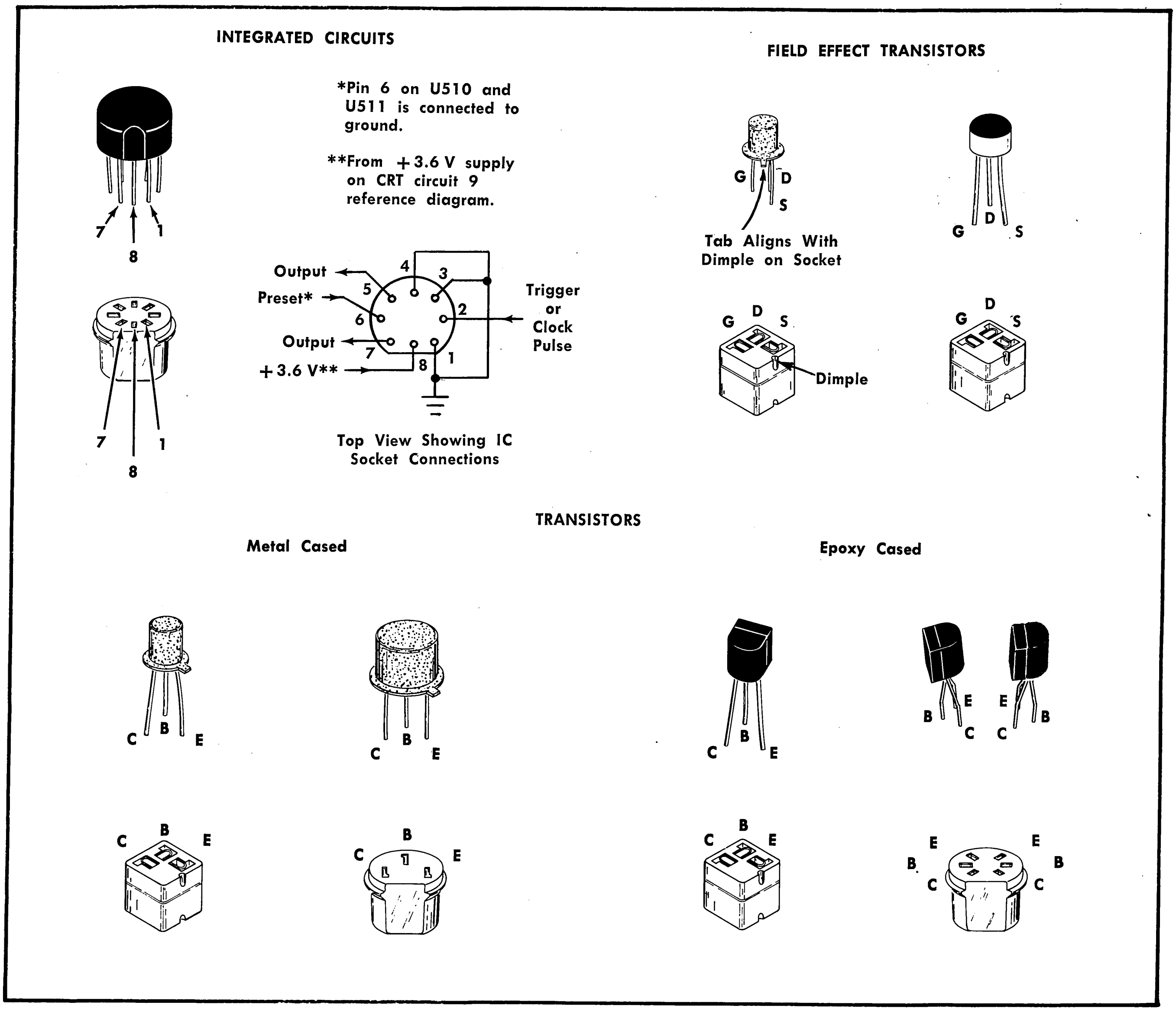


Fig. 4-2. Electrode configuration for socket-mounted transistors and integrated circuits, top view.

3. Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, disconnected or loose pin connectors, broken wires, damaged circuit boards, damaged components, etc.

4. Check Instrument Calibration. Check the calibration of this instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may only be a result of misadjustment or may be corrected by calibration. Complete calibration instructions are given in the Calibration section of this manual.

5. Isolate Trouble to a Circuit. To isolate trouble to a circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. For example, poor focus indicates that the CRT (includes high voltage) circuit is probably at fault. When trouble symptoms appear in more than one circuit, check affected circuits by taking voltage and waveform readings.

Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltage of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits. Table 4-3 lists the tolerances of the power supplies in this instrument. If a power-supply voltage is within the listed tolerance, the supply can be assumed to be working correctly. If outside the tolerance, the supply may be misadjusted or operating incorrectly. Use the procedure given in the Calibration section to adjust the power supplies.

Figs. 3-1 through 3-6 in the Circuit Description section provide a guide for isolating a trouble to a block or circuit. These illustrations are functional block diagrams showing

TABLE 4-3

Power Supply Tolerance

Power Supply	Tolerance
+275 V	±7% or ±19.25 V
+100 V	±3.5% or ±3.5 V
+10 V	±3.5% or ±0.35 V
+3.6 V	±5% or ±0.18 V
—15 V	±0.5% or ±0.075 V

signal flow for six different modes of operation. By selecting a mode of operation, it is possible to bypass some blocks and connect others into the circuit to determine the blocks that function properly and those that do not. The only blocks that cannot be bypassed are the Input Amplifier, Vertical Amplifier, low-voltage power supply (not shown) and CRT circuit. Detailed voltage and waveform checks will have to be made to find the cause of trouble in these circuits.

After the defective circuit has been located, proceed with steps 6 through 8 to locate the defective component(s).

6. Check Circuit Board Interconnections. After the trouble has been isolated to a particular block or circuit, check the pin connectors on the circuit board for correct connections. Fig. 4-9 through Fig. 4-27 for instruments SN B150100 and up, and Fig. 4-9 through Fig. 4-26 for instruments below SN B150100 show the correct connections for each board.

The pin connectors used in this instrument also provide a convenient means of circuit isolation. For example, a short in a power supply can be isolated to the power supply itself by disconnecting the pin connectors for that voltage at the remaining boards.

7. Check Voltage and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the first diagram page.

WARNING

"Ground lugs" and shield braids are not always at ground potential. Check the schematic before using such connections as a ground for the voltmeter test prod or oscilloscope probe. Some transistor cases may be elevated from 0 to 275 V. This warning note also applies to recessed screws that hold the low voltage power supply transistors to the rear panel.

8. Check Individual Components. The following procedures describe methods of checking individual components in the Type R520. Components which are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

A. TRANSISTORS AND INTEGRATED CIRCUITS. The best check of transistor and integrated circuit operation is actual performance under operating conditions. If a transistor or integrated circuit is suspected of being defective, it can best be checked by substituting a new component or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor or integrated circuit might also be damaged. If substitute transistors are not available, use a dynamic tester (such as Tektronix Type 575). Static-type testers are not recommended, since they do not check operation under simulated operating conditions.

B. DIODES. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high in one direction and very low when the leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diode.

C. RESISTORS. Check the resistor with an ohmmeter. Check the Electrical Part List for the tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

D. INDUCTORS. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response (roll-off).

E. CAPACITORS. A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open coupling capacitor can best be detected with a capacitance meter or by checking whether the capacitor passes AC signals.

9. Repair and Readjust the Circuit. If any defective parts are located, follow the replacement procedures given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

CORRECTIVE MAINTENANCE

General

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the Type R520 can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts lists for value, tolerance, rating and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the instrument, particularly at high frequencies. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special components are used in the Type R520. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special components are indicated in the Electrical Parts List by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts. When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.

2. Instrument serial number.

3. A description of the part (if electrical, include circuit number).

4. Tektronix Part Number.

Soldering Techniques

WARNING

Disconnect the instrument from the power source before soldering.

Circuit Boards. Use ordinary 60/40 solder and a 35- to 40-watt pencil type soldering iron on the circuit boards. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the wiring from the base material.

The following technique should be used to replace a component on a circuit board. Most components can be replaced without removing the boards from the instrument.

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board.

2. When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board. If not, the hole can be cleaned be reheating the solder and placing a sharp object such as a toothpick into the hole to clean it out. A vacuum-type desoldering tool can also be used for this purpose.

3. Bend the leads of the new component to fit the holes in the board. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes in the board so the component is firmly seated against the board (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.

4. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint; do not apply too much solder. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of long nose pliers (see Fig. 4-3) or other heat sink.

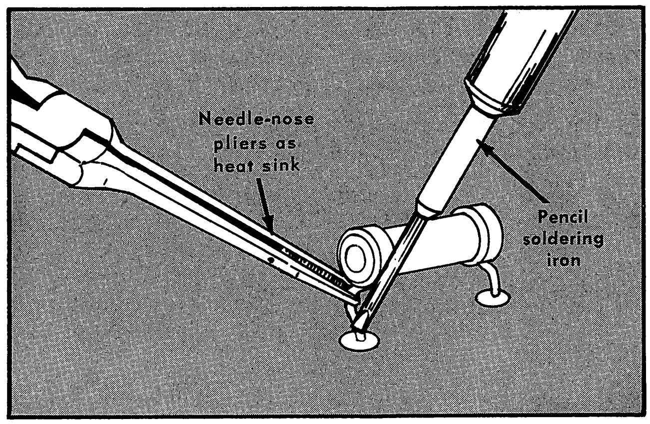


Fig. 4-3. Use of a heat sink to protect components during soldering.

5. Clip the excess lead that protrudes through the board.

6. Clean the area around the solder connection with a flux-remover solvent. Be careful not to remove information printed on the board.

Metal Terminals. When soldering metal terminals (e.g., switch terminals, potentiometers, etc), ordinary 60/40 solder can be used. Use a soldering iron with a 40- to 75-watt rating and a 1/8-inch wide wedge-shaped tip.

Observe the following precautions when soldering metal terminals:

1. Apply only enough heat to make the solder flow freely.

2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.

3. If a wire extends beyond the solder joint, clip off the excess.

4. Clean the flux from the solder joint with a flux-remover solvent.

Component Replacement

WARNING

Disconnect the instrument from the power source before replacing components.

Circuit Board Replacement. If a circuit board is damaged beyond repair, either the entire assembly including all solder-on components, or the board only, can be replaced. Part numbers are given in the Mechanical Parts List for either the completely wired or the unwired board. Most of the components mounted on the circuit boards can be replaced without removing the boards from the instrument. Observe the soldering precautions given under Soldering Techniques in this section. However, if the bottom side of the board must be reached or if the board must be moved to gain access to other areas of the instrument, release the board from the plastic clips. Exception: The Input Amplifier board can be removed by removing four screws. The interconnecting wires on some of the boards are long enough to allow the board to be moved out of the way or turned over without disconnecting all the pin connectors.

Cathode-Ray Tube Replacement. The following procedure outlines the removal and replacement of the cathode-ray tube:

WARNING

High vacuum cathode ray tubes are dangerous to handle. To prevent personal injury from flying glass in case of tube breakage, wear a face mask or safety goggles, and gloves.

Handle the CRT with extreme care. Do not strike or scratch it. Never subject it to more than moderate force or pressure when removing or installing.

Always store spare CRT's in original protective cartons. Save cartons to dispose of used CRT's.

A. REMOVAL:

1. Remove the top cover from the instrument.

2. Remove the graticule cover with associated parts.

3. Disconnect the deflection-plate connectors. Be careful not to bend the deflection-plate pins.

4. Remove the metal cover that protects the CRT base. This cover unsnaps from the rear panel.

5. Remove the CRT socket.

6. Loosen the CRT clamp screw about 4 or 5 turns (see Fig. 4-4A). Avoid loosening the screw too much because the CRT clamp wedge tightener will come loose from the screw.

7. From the rear of the instrument, push forward on the CRT base and hold the CRT faceplate to guide the CRT as it is removed from the front of the instrument (see Fig. 4-4B). Be careful not to bend the neck pins.

B. REPLACEMENT:

1. Insert the CRT into the shield. Be careful not to bend the neck pins.

2. Tighten the CRT clamp screw until the CRT is held snugly but will allow some freedom of movement so steps 4 and 5 can be performed.

3. Reconnect the CRT socket while holding the CRT faceplate.

4. Reconnect the deflection-plate connectors. Correct locations is indicated on the CRT shield.

5. Check that the 0° — 180° axis on the internal vector graticule lies on a horizontal plane. If not, turn the CRT base until proper alignment is obtained. There are some guide marks on the front panel. These marks are located on each side of the CRT opening.

6. Check that the CRT faceplate protrudes through the front panel the same distance as the thickness of the vector graticule light guide.

7. Carefully tighten the CRT base clamp.

8. Install the graticule cover with all associated parts.

9. Install the rear panel CRT cover.

10. To recalibrate the instrument, the following circuit areas need to be checked and adjusted, if necessary:

a. Check all the adjustments shown on the Horiz/Vert Driver Amps portion of diagram No. 5.

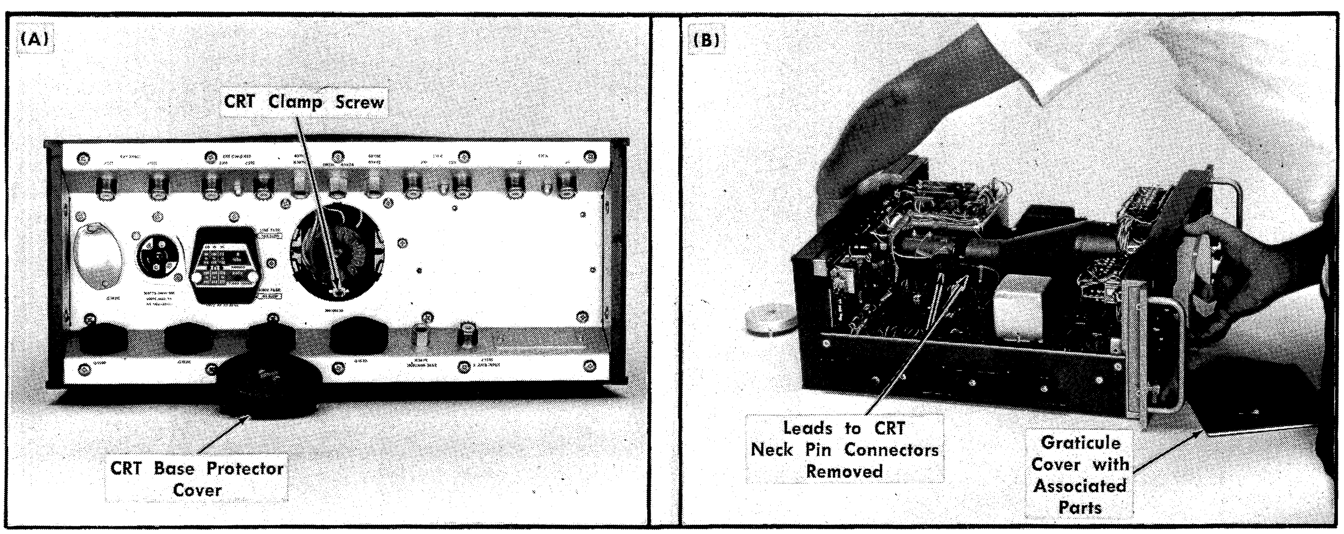


Fig. 4-4. Replacing the CRT.

b. Check the adjustment shown on the Vertical Amplifier diagram No. 6 and Horizontal Amplifier diagram No. 7.

c. Check all the CRT circuit adjustments given on diagram No. 9.

d. Check the A CAL and B CAL front-panel screwdriver adjustments.

Transistor and Integrated Circuit Replacement. Transistors and integrated circuits should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of transistors and integrated circuits may affect the calibration of this instrument. When transistors or integrated circuits are replaced, check the operation of that part of the instrument which may be affected.

CAUTION

POWER switch must be turned off before removing or replacing transistors and integrated circuits.

Replacement transistors and integrated circuits should be of the original type or a direct replacement. Fig. 4-2 shows the lead configuration of the transistors and integrated circuits used in this instrument. Some plastic case transistors have lead configurations which do not agree with those shown here. If a transistor is replaced by a transistor which is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the basing used for metal-case transistors. Transistors which have heat radiators or are mounted on the chassis use silicone grease to increase heat transfer. Replace the silicone grease when replacing these transistors.

WARNING

Handle silicone grease with care. Avoid getting silicone grease in the mouth or eyes. Wash hands thoroughly after use.

Fuse Replacement. Table 4-4 gives the rating, location, and function of the fuses used in this instrument.

TABLE 4-4

Fuse Ratings

Circuit Number	Rating	Function	Location
F1500	1.6 A Slow	115 V Line	Line Voltage Selector on rear panel
F1501	0.8 A Slow	230 V Line	
F1502 (Below SN B150100)	0.0625 A Fast	+275 V Supply	Rectifier board by power transformer
F1502 (SN B150100 up)	0.125 A Fast		
F1532	0.25 A Fast	+100 V Supply	
F1562	1.5 A Fast	+10 V Supply	

Switches. If a switch is defective, replace the entire assembly. Replacement switches can be ordered by referring to the Parts List for the applicable part numbers.

When replacing a switch, tag the leads and switch terminals with corresponding identification tags as the leads are disconnected. Then, use the old switch as a guide for installing the new one. An alternative method is to draw a sketch of the switch layout and record the wire color at each terminal. When soldering to the new switch be careful that the solder does not flow beyond the rivets on the switch terminals. Spring tension of the switch contact can be destroyed by excessive solder.

Power Transformer Replacement. The power transformer in this instrument is warranted for the life of the instrument. If the power transformer becomes defective, contact your local Tektronix Field Office or representative for a warranty replacement (see the Warranty note in the front of this manual). Be sure to replace only with a direct replacement Tektronix transformer.

When removing the transformer, tag the leads with the corresponding terminal numbers to aid in connecting the new transformer. After the transformer is replaced, check the performance of the complete instrument using the Performance Check procedure.

High-Voltage Compartment. The components located in the high-voltage compartment can be reached for maintenance or replacement by using the following procedure.

1. Remove the top cover of the instrument as described in this section.

2. Remove the six screws that hold the Input Sync board chassis to the rear panel and main chassis.

3. Disconnect some of the short length Sync board leads so the Sync board chassis can be tilted for access to the high voltage compartment screws.

4. Remove the three screws which hold the cover on the high-voltage compartment.

5. Remove the high-voltage cover to reach the boards inside the compartment.

6. To replace the high-voltage compartment, reverse the order of removal.

NOTE

All solder joints in the high-voltage compartment should have smooth surfaces. Any protrusions may cause high-voltage arcing at high altitudes.

Recalibration After Repair

After replacing any electrical component or circuit board, the calibration of that particular circuit area should be checked, as well as the calibration of other closely related circuits. Since the low-voltage supply affects all circuits, calibration of the entire instrument should be checked if work has been done in the low-voltage supply or if the power transformer has been replaced. The Performance Check Procedure in Section 5 provides a quick and convenient means of checking instrument operation.

Instrument Repackaging

If the Type R520 is to be shipped for long distances by commercial means of transportation, it is recommended that the instrument be repackaged in the original manner for maximum protection. The original shipping carton can be saved and used for this purpose. Figs. 4-5 and 4-7 illustrate how to repackage the Type R520 and give the part numbers for the packaging components if new items are needed. Figs. 4-6 and 4-7 illustrate how to repackage the Type 520, with applicable part numbers.

Inner carton assembly for Type R520: Inner box 004-0460-00
Pad set 004-1022-00

NOTE: The top and bottom pads must be installed in the positions shown.

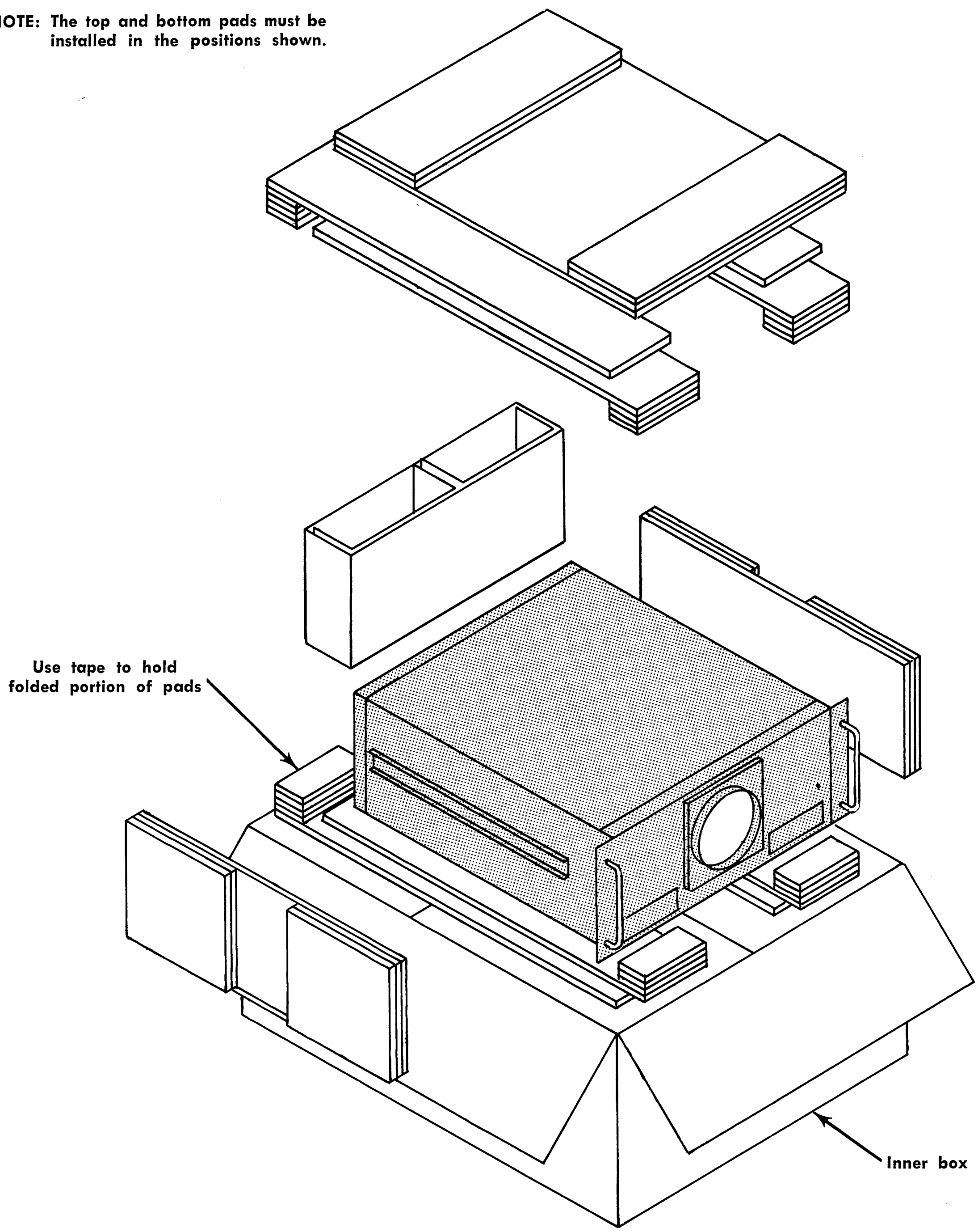


Fig. 4-5. Repackaging the Type R520 in its inner box.

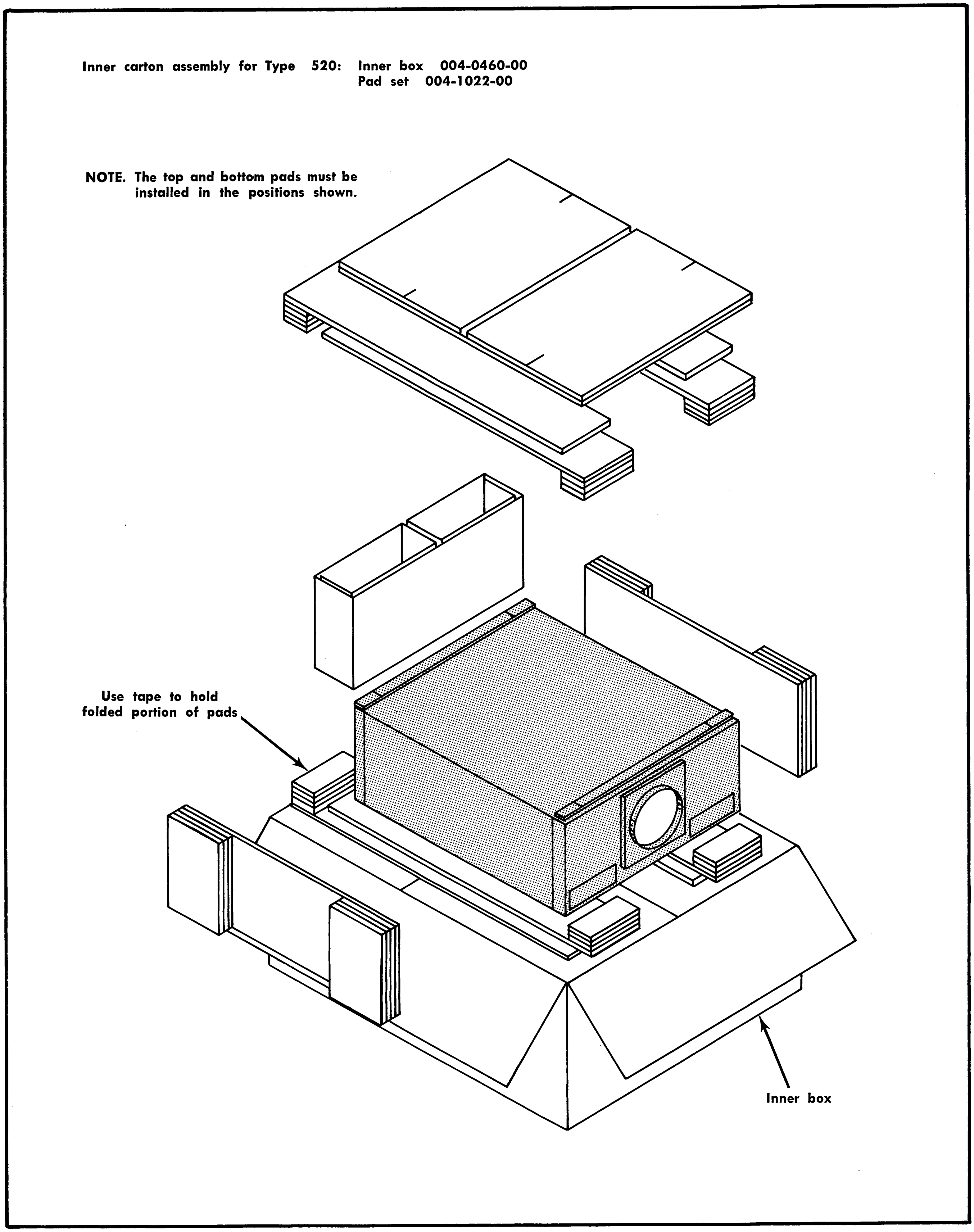


Fig. 4-6. Repackaging the Type 520 in its inner box.

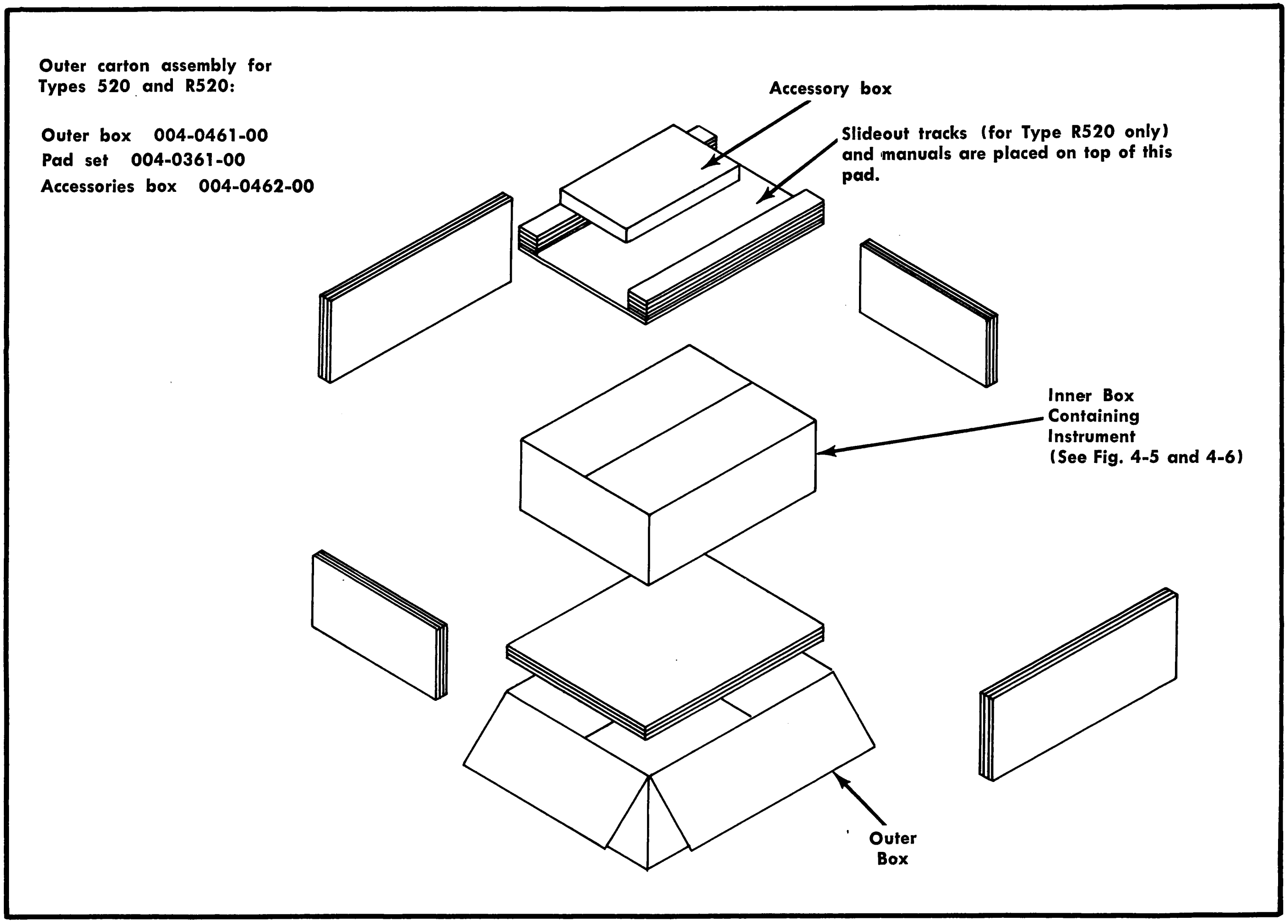


Fig. 4-7. Repackaging the Type 520 or R520 in its outer box for shipment.

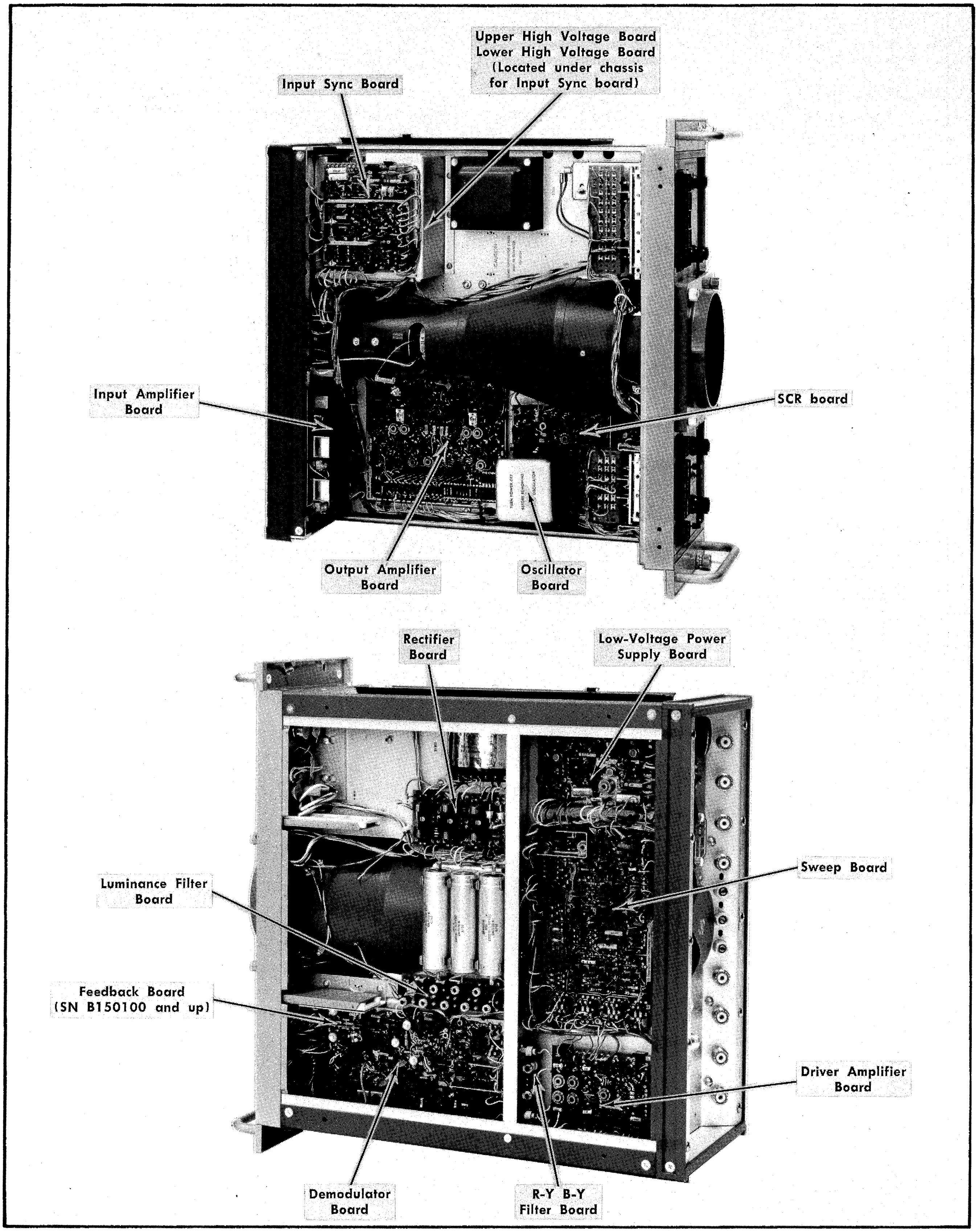


Fig. 4-8. Location of the circuit boards in the Type R520.

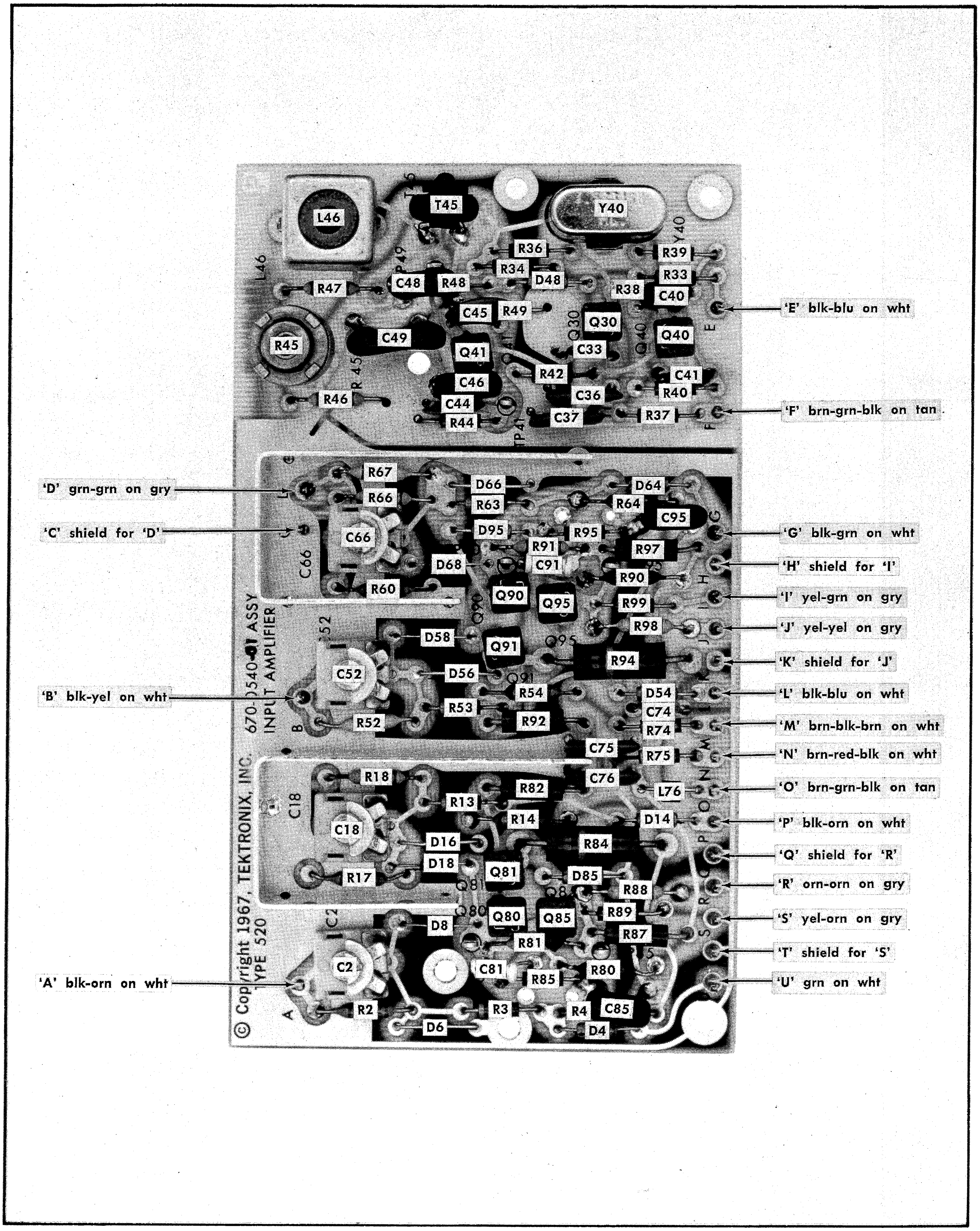


Fig. 4-9A. Input Amplifier board; component identification and wire color codes for instruments SN B150100 and up.

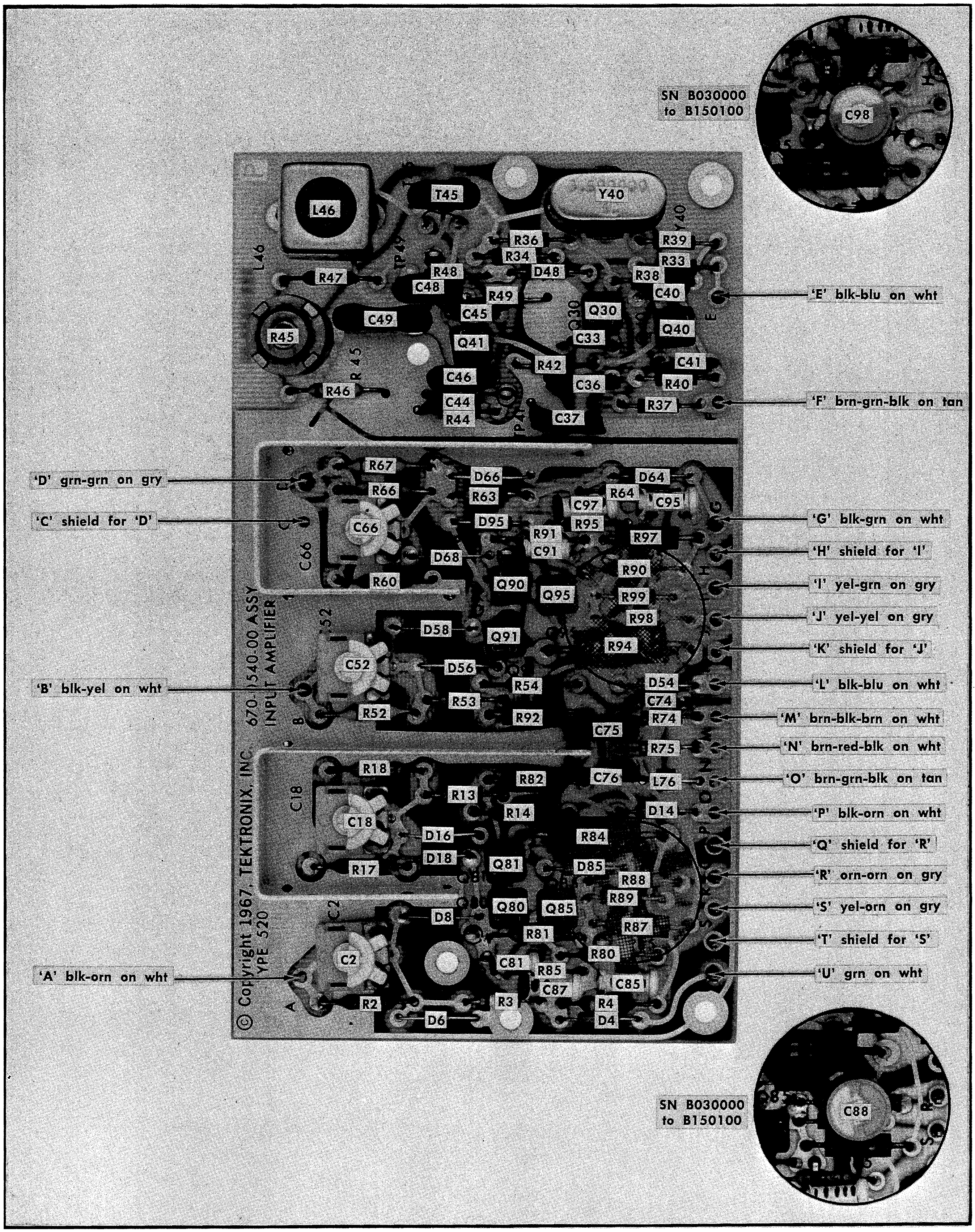


Fig. 4-9B. Input Amplifier board; component identification and wire color codes for instruments below SN B150100.

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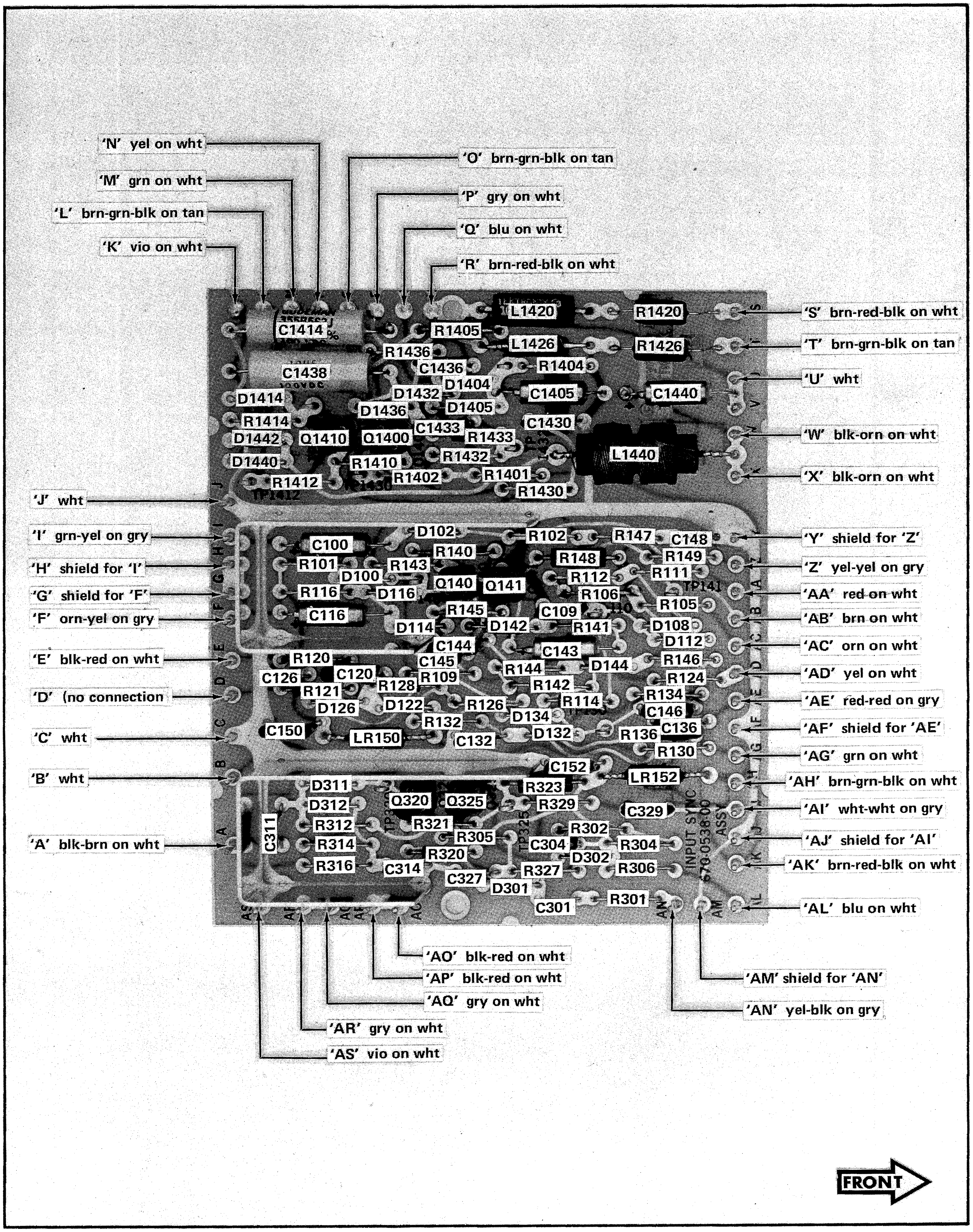


Fig. 4-10A. Input Sync board; component identification and wire color codes for instruments SN B280000-up.

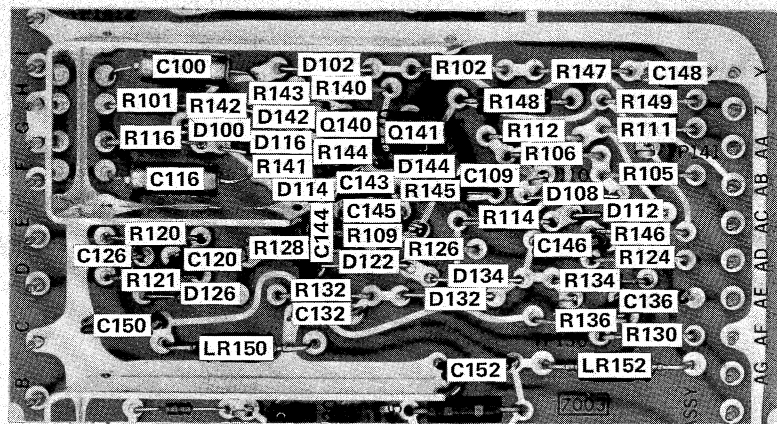


Fig. 4-10B. Input Sync partial board; component identification for instruments SN B240000-B279999.

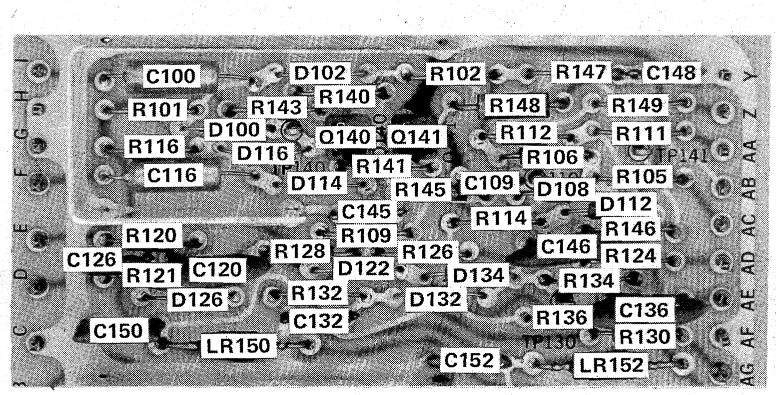


Fig. 4-10C. Input Sync partial board; component identification for instruments SN B010100-B239999.

NOTES

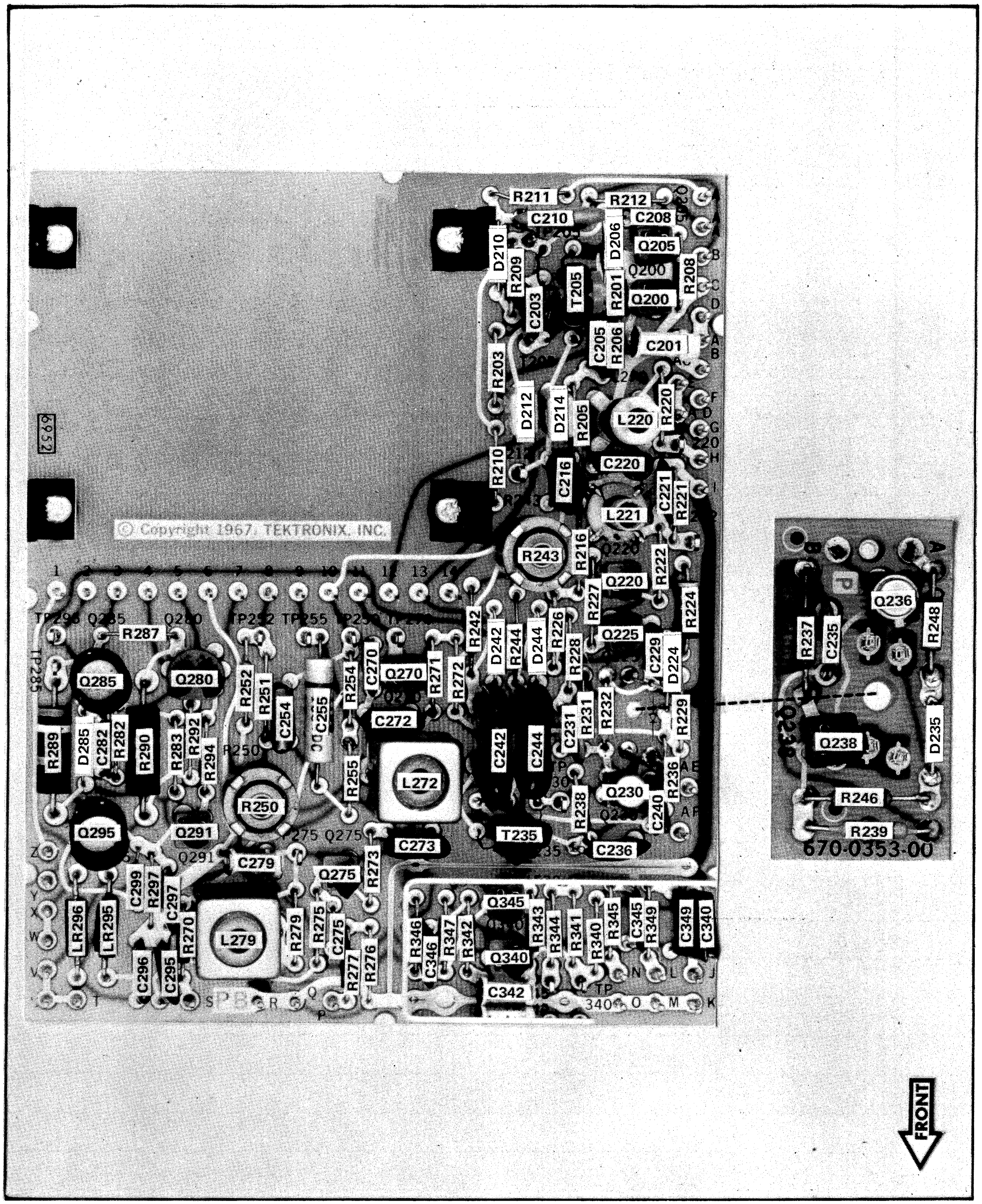


Fig. 4-11A. SCR board and SCR Limiter Board; Component identification and interconnecting wire color code for instruments SN B251880 and up.

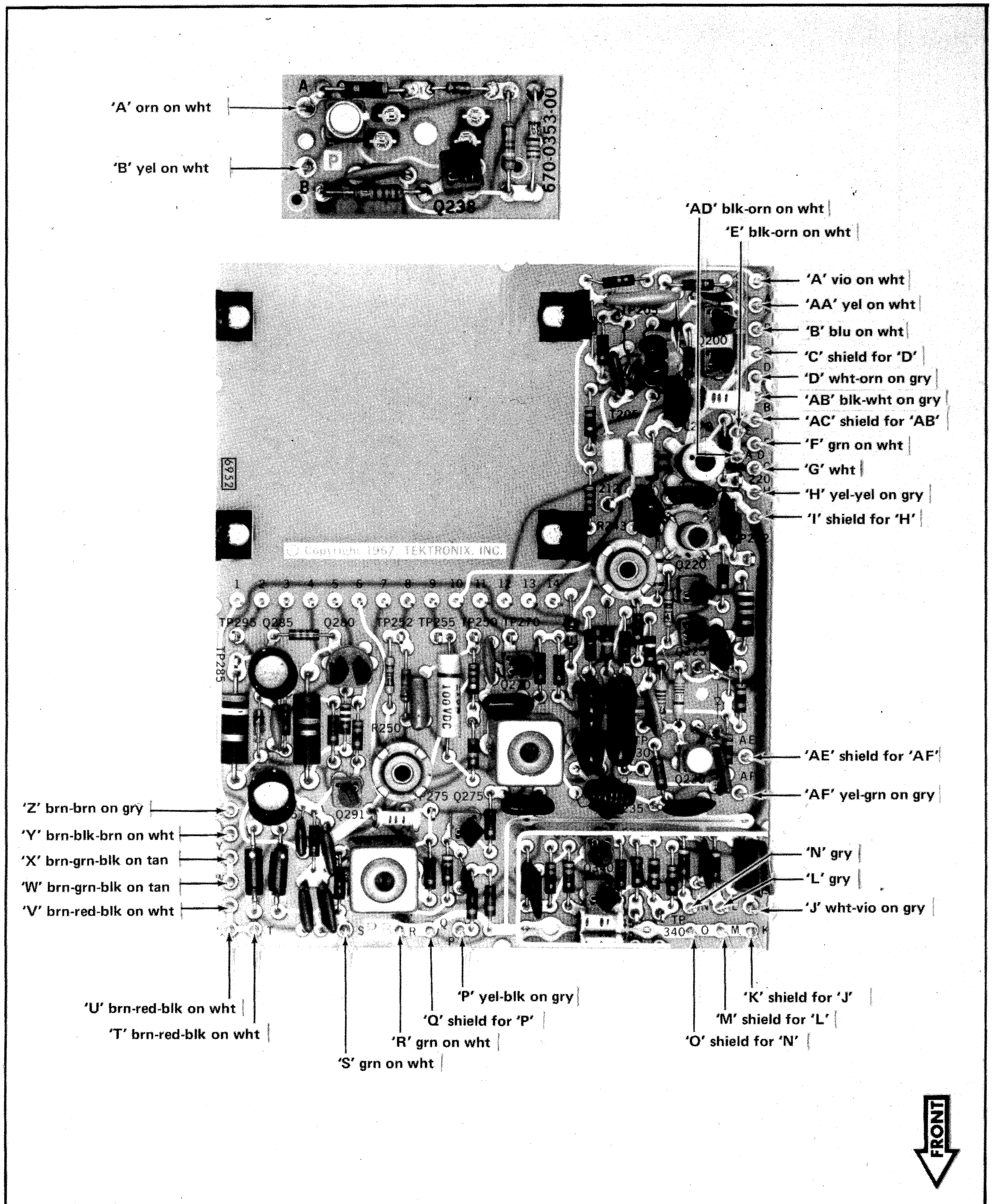


Fig. 4-11B. SCR board; wire color code for instruments SN B251880 and up.

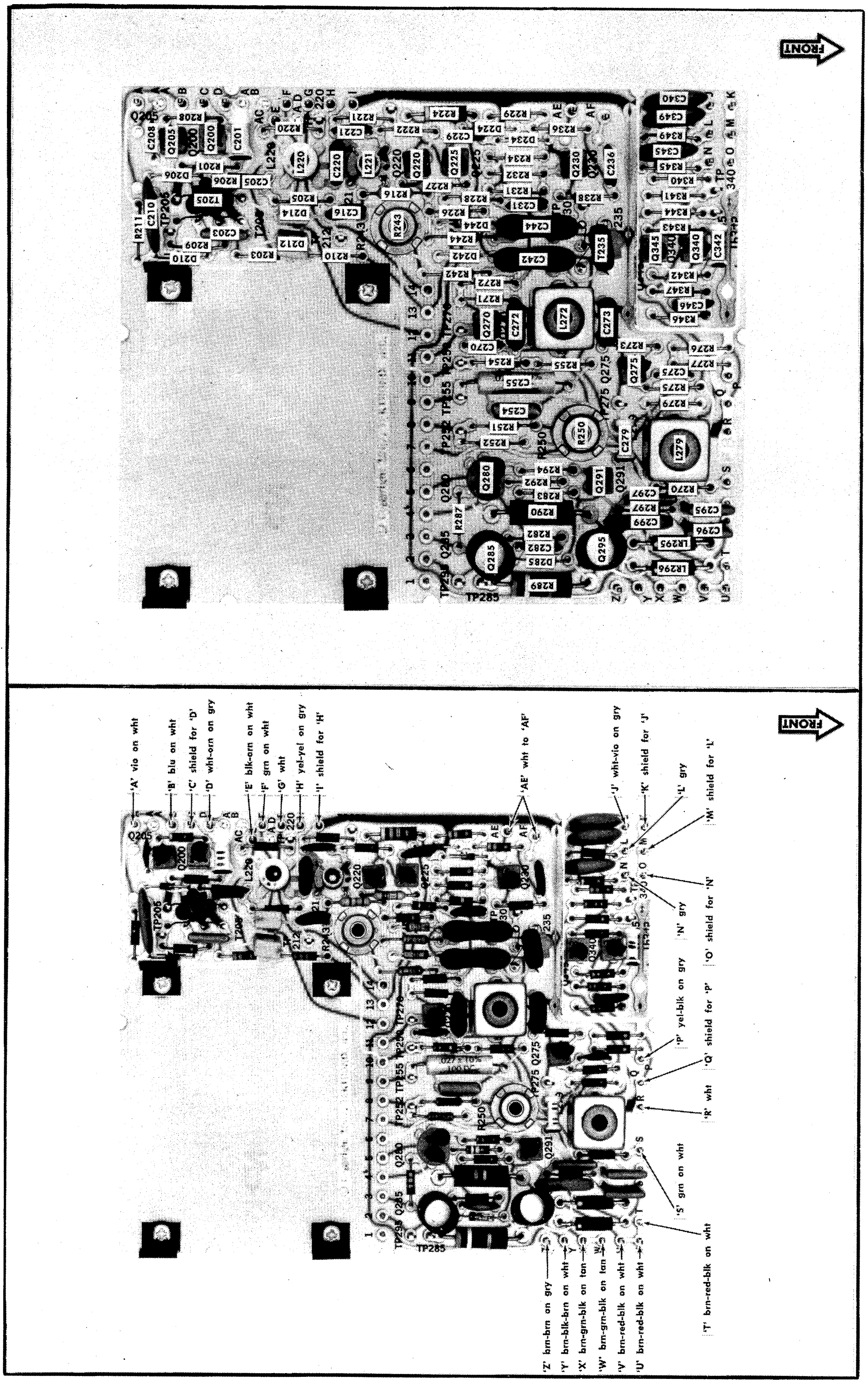


Fig. 4-12A. SCR board; component identification and wire color code for SN B150100 through B241879.

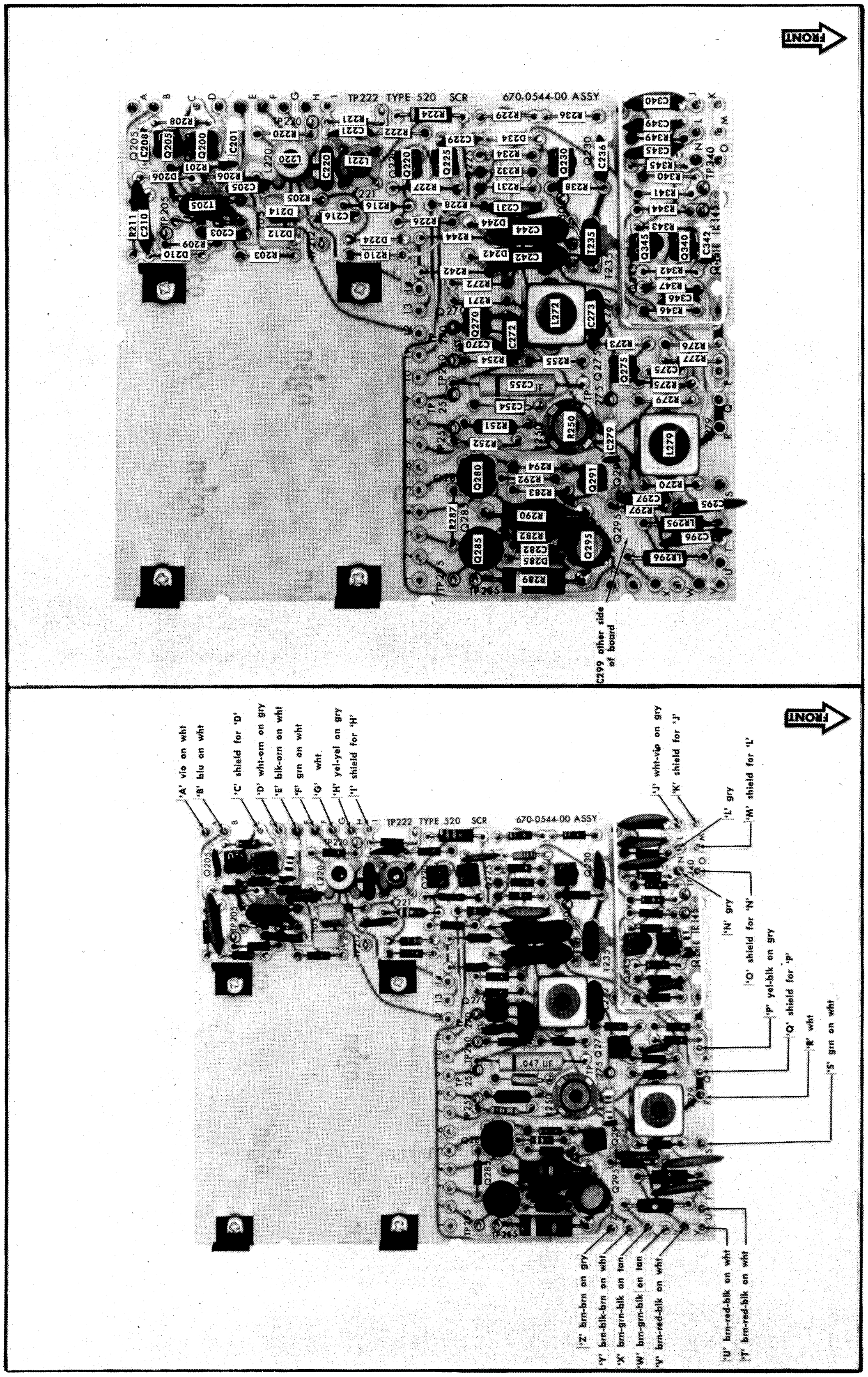


Fig. 4-12B. SCR board; component identification and wire color code for instruments below SN B150100.

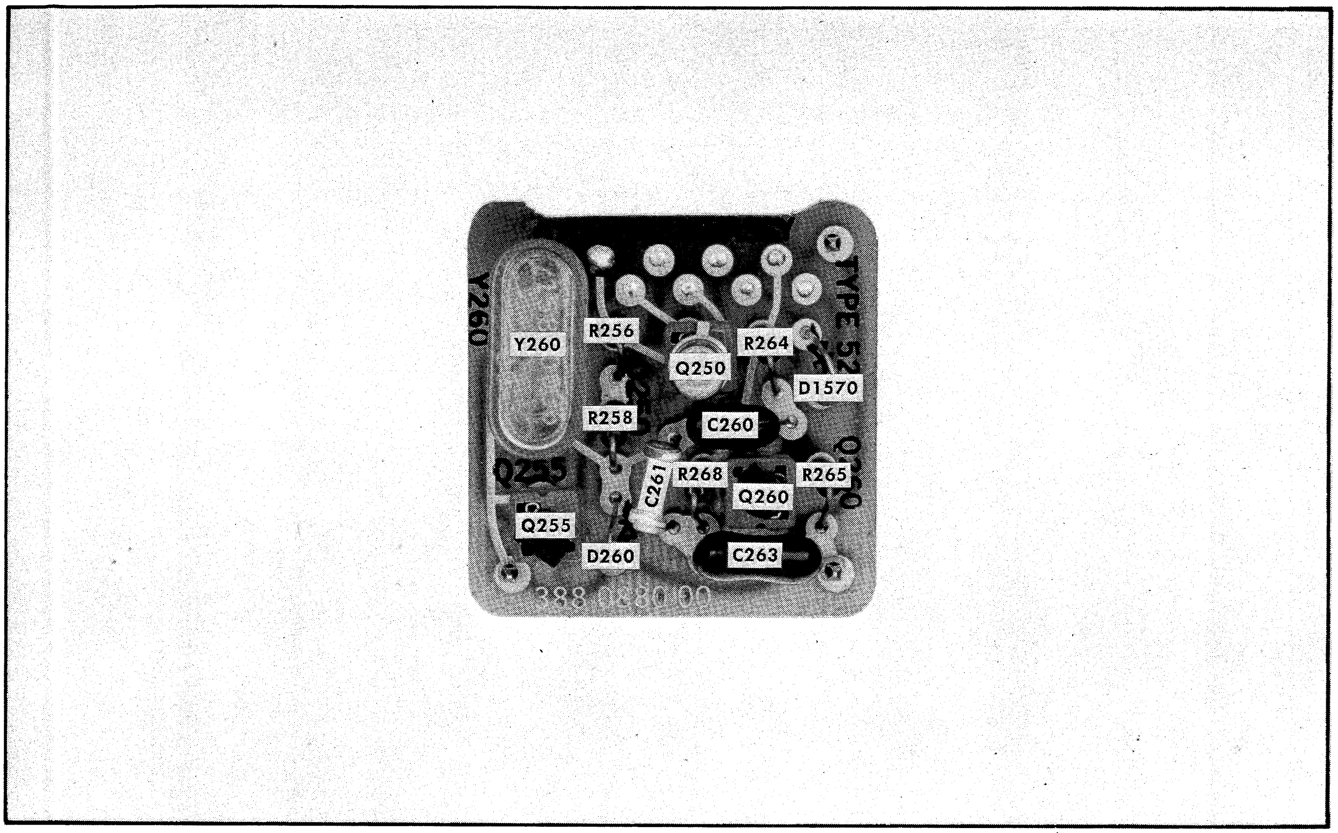


Fig. 4-13. Oscillator board; component identification.

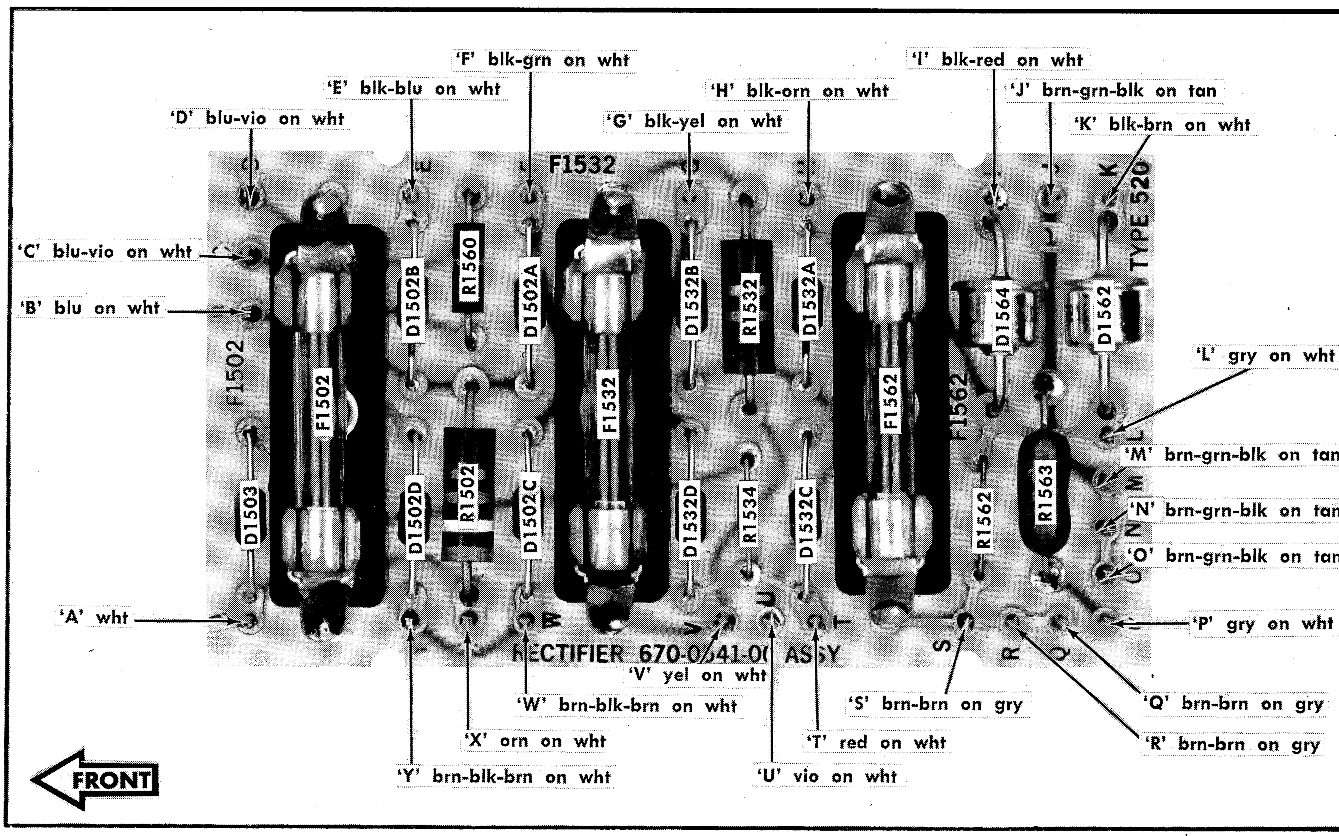


Fig. 4-14. Rectifier board; component identification and wire color codes.

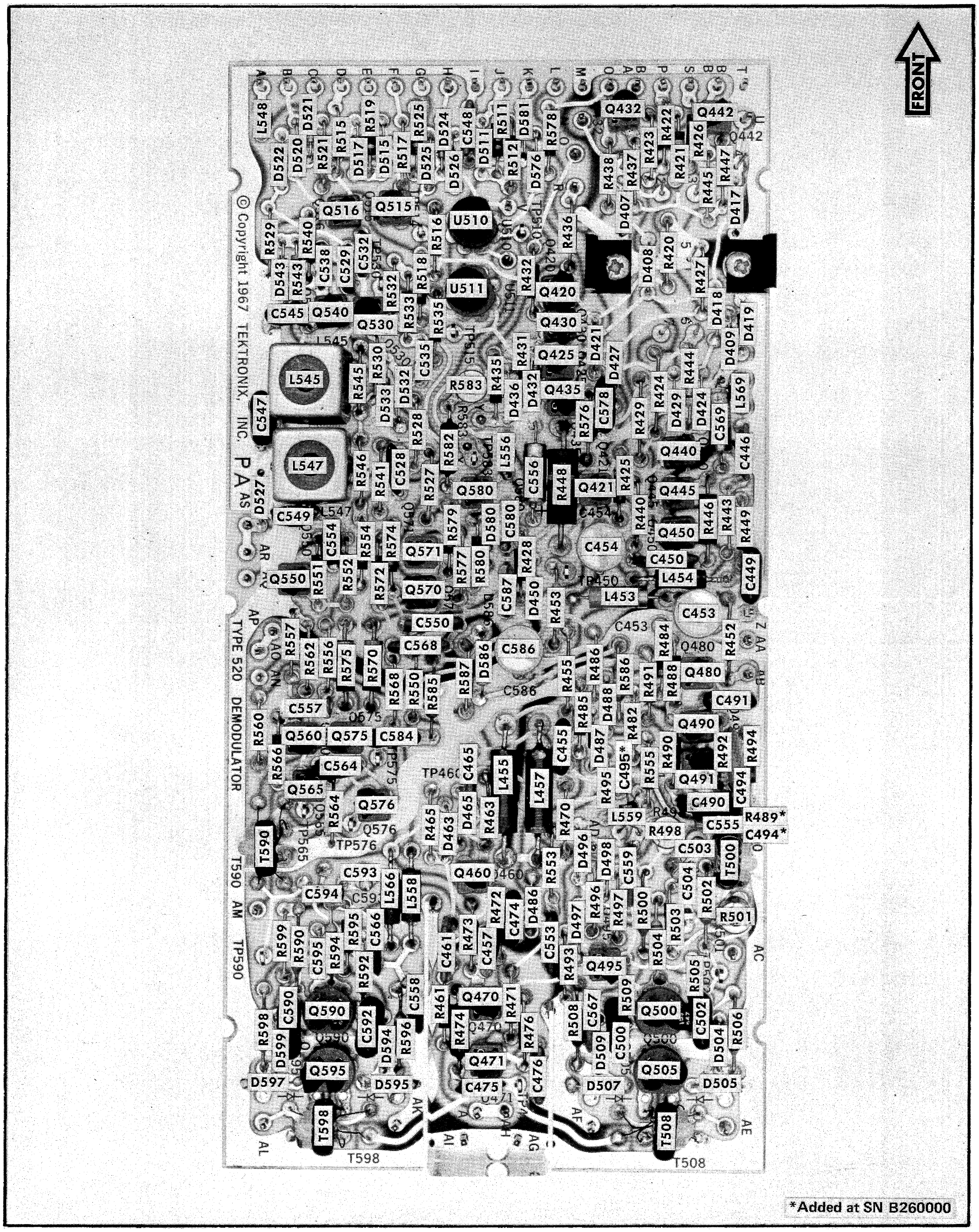


Fig. 4-15A. Demodulator board; component identification for instruments SN B150100 and up.

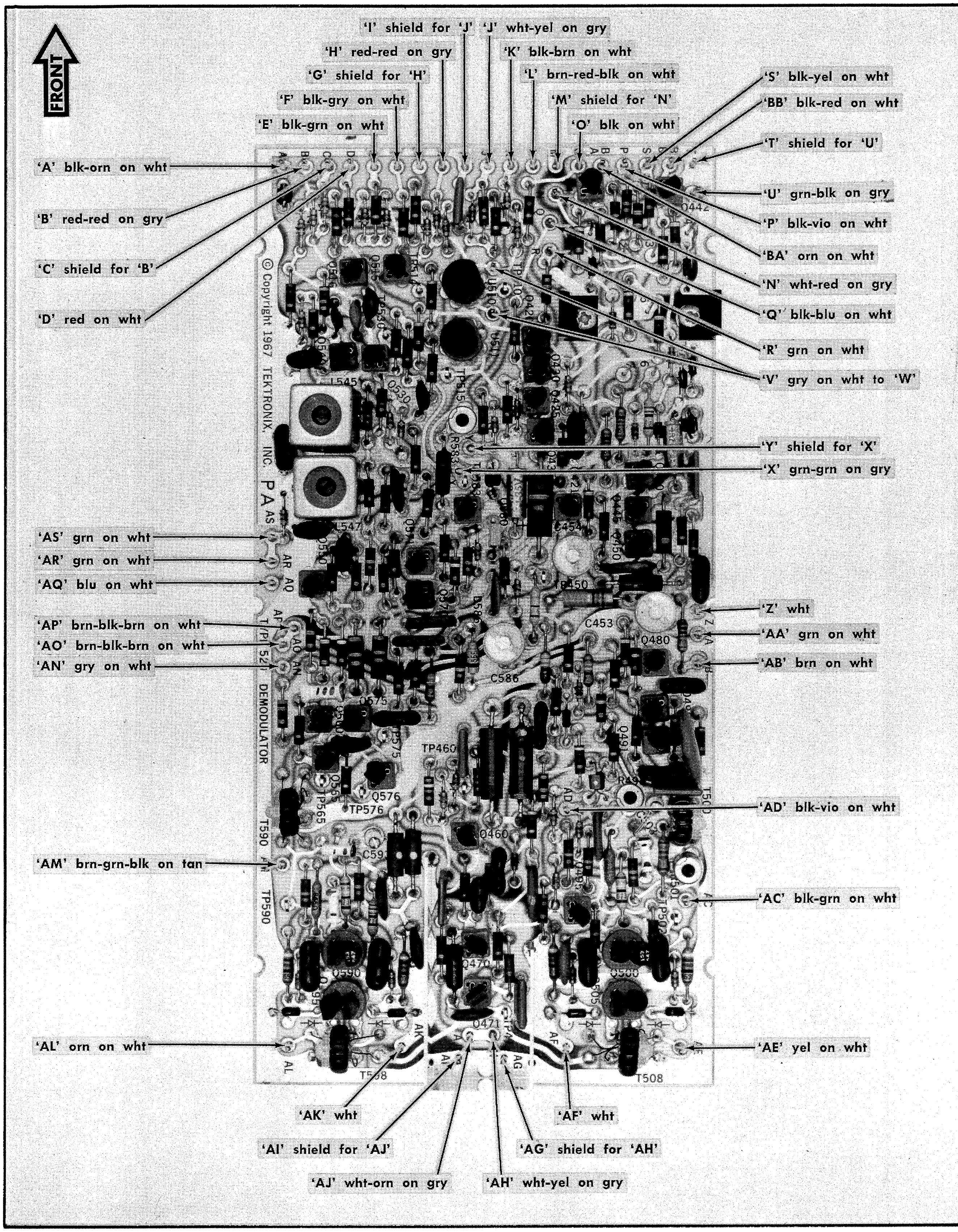


Fig. 4-15B. Demodulator board; wire color codes for instruments SNB150100 and up.

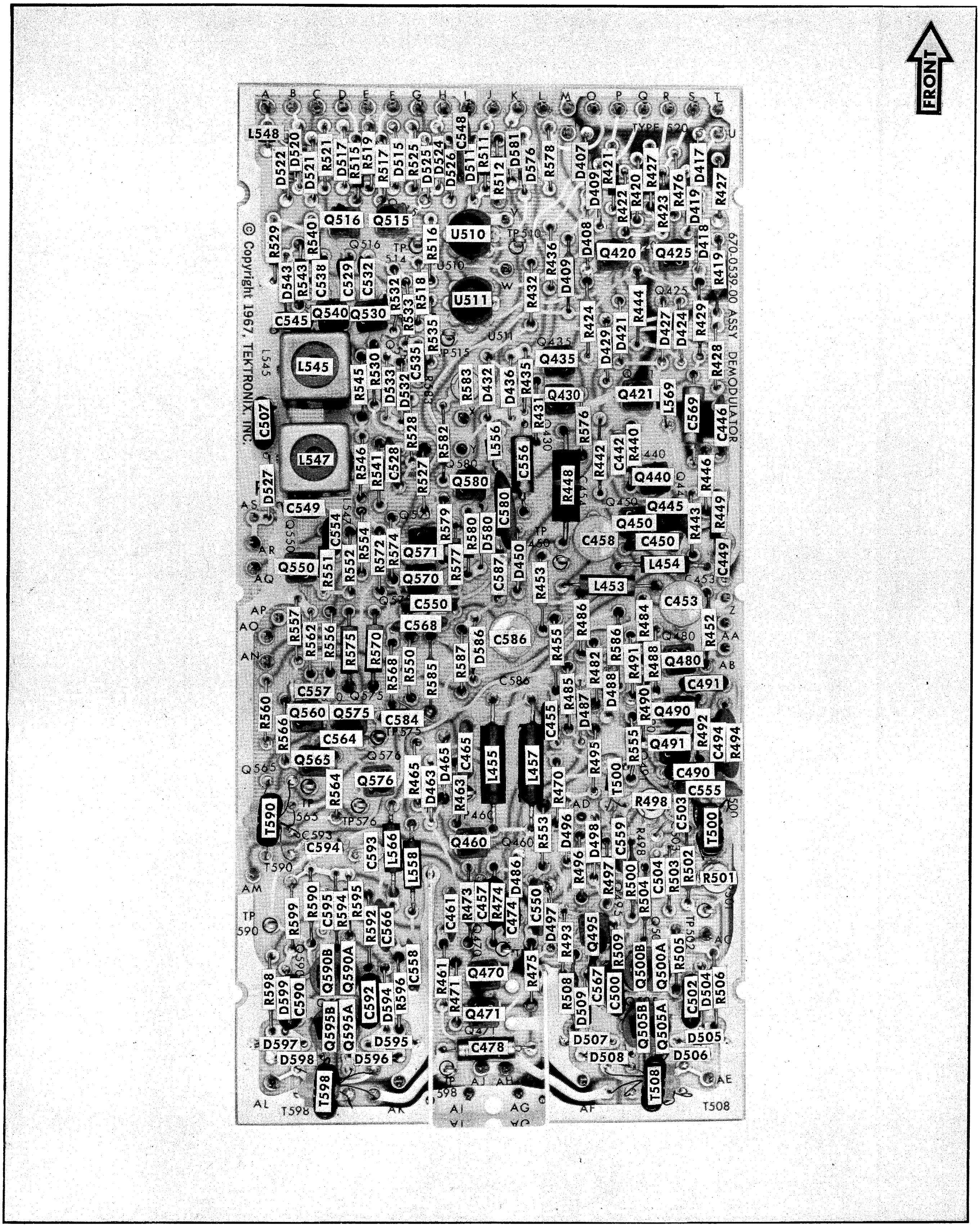


Fig. 4-16A. Demodulator board; component identification for instruments below SN B150100.

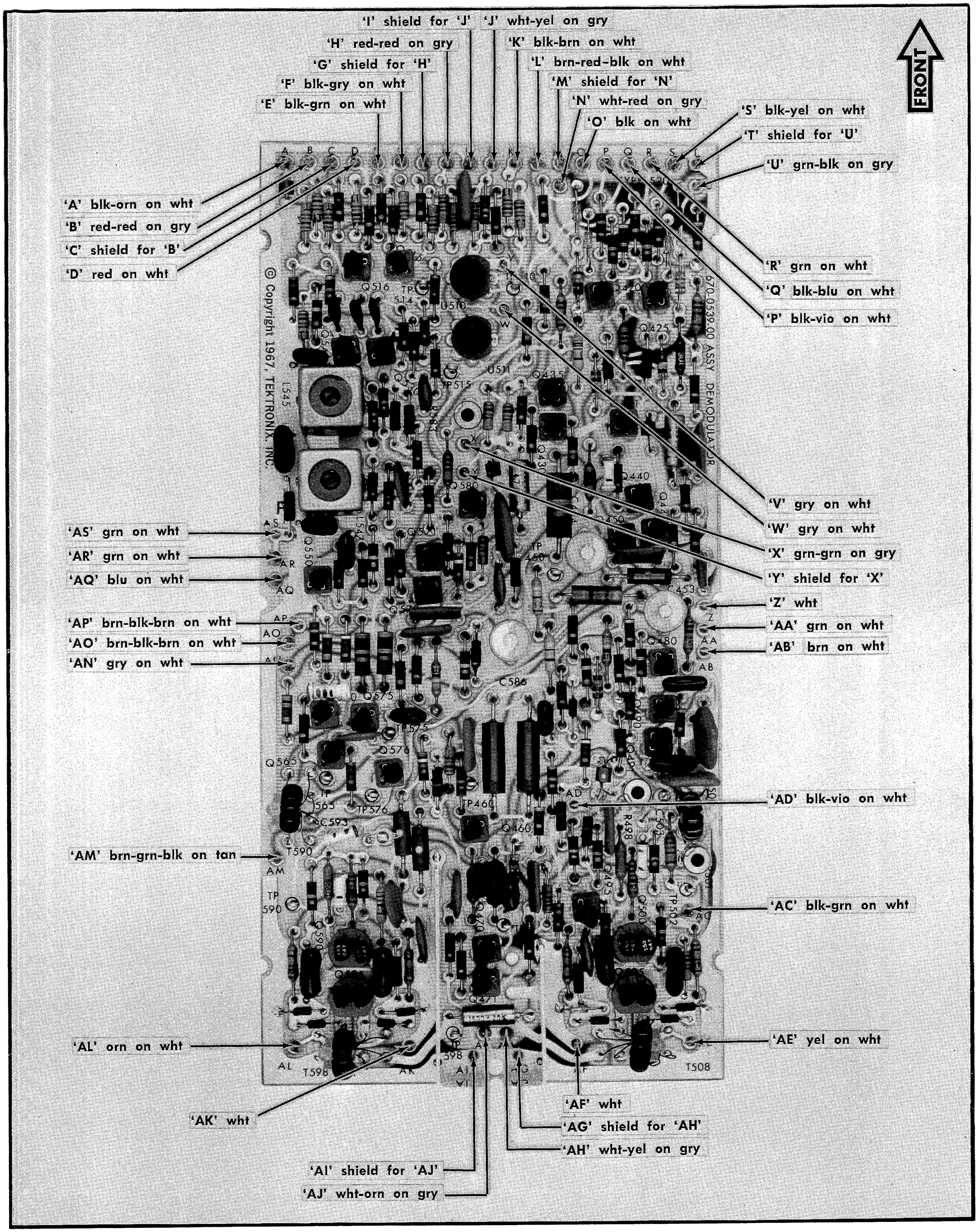


Fig. 4-16B. Demodulator board; wire color codes for instruments below SN B150100.

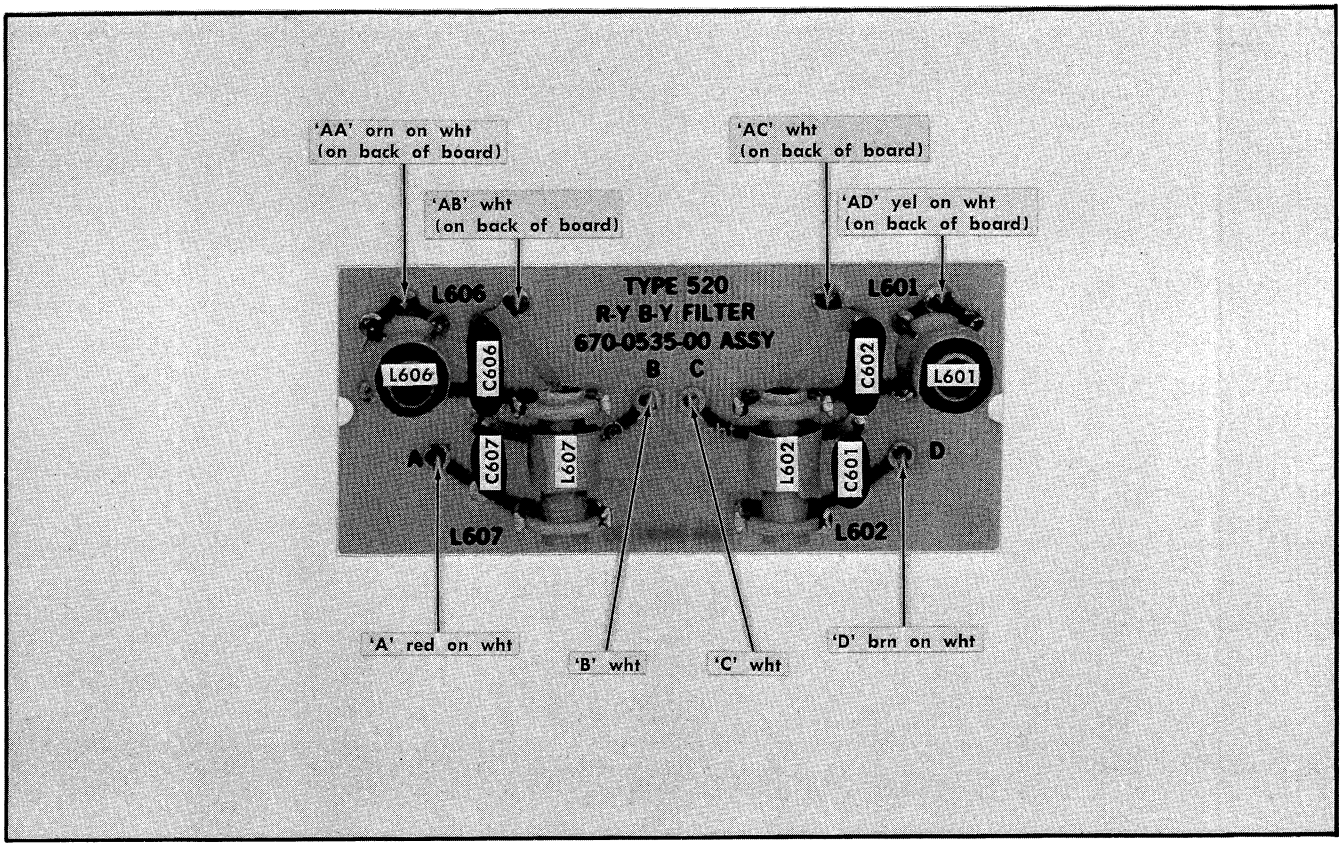


Fig. 4-17. R-Y B-Y Filter board; component identification and wire color codes.

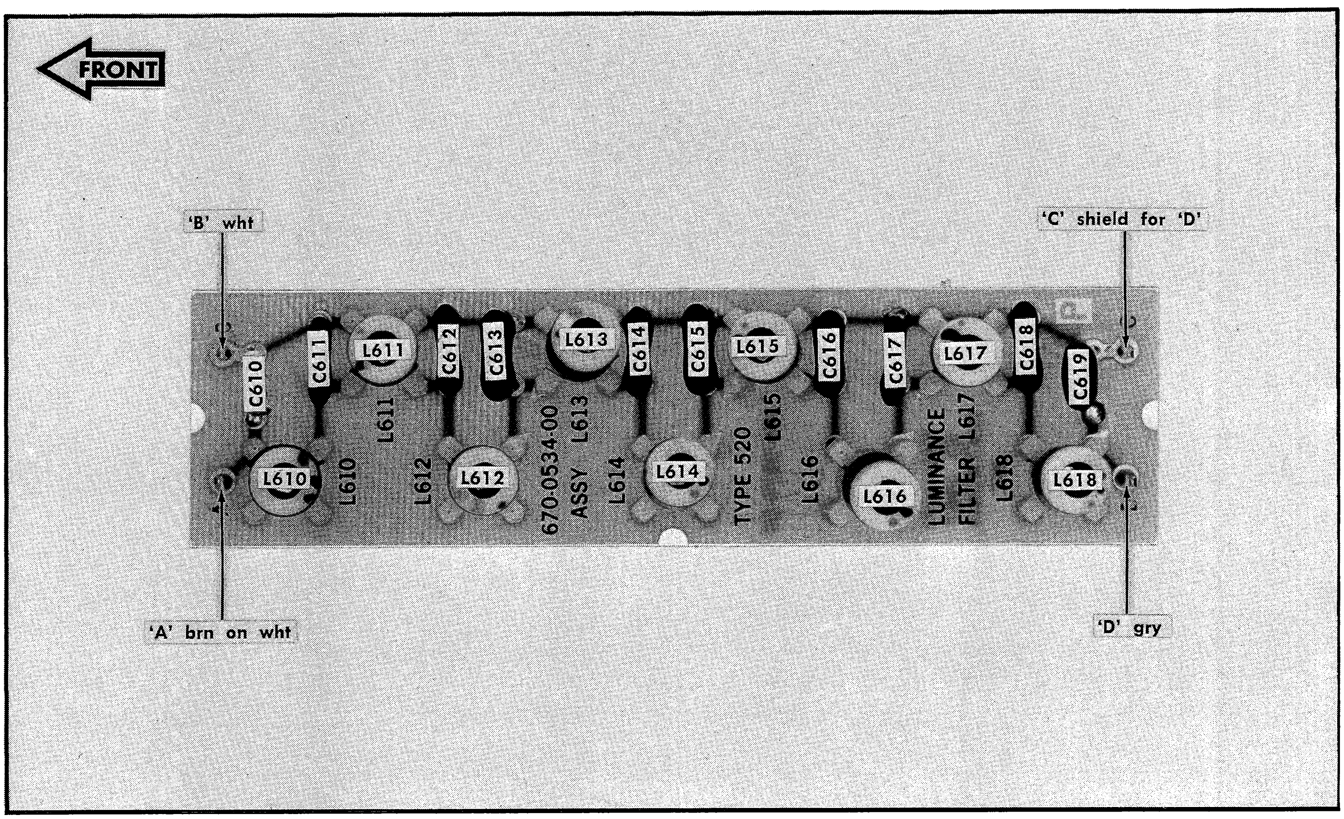
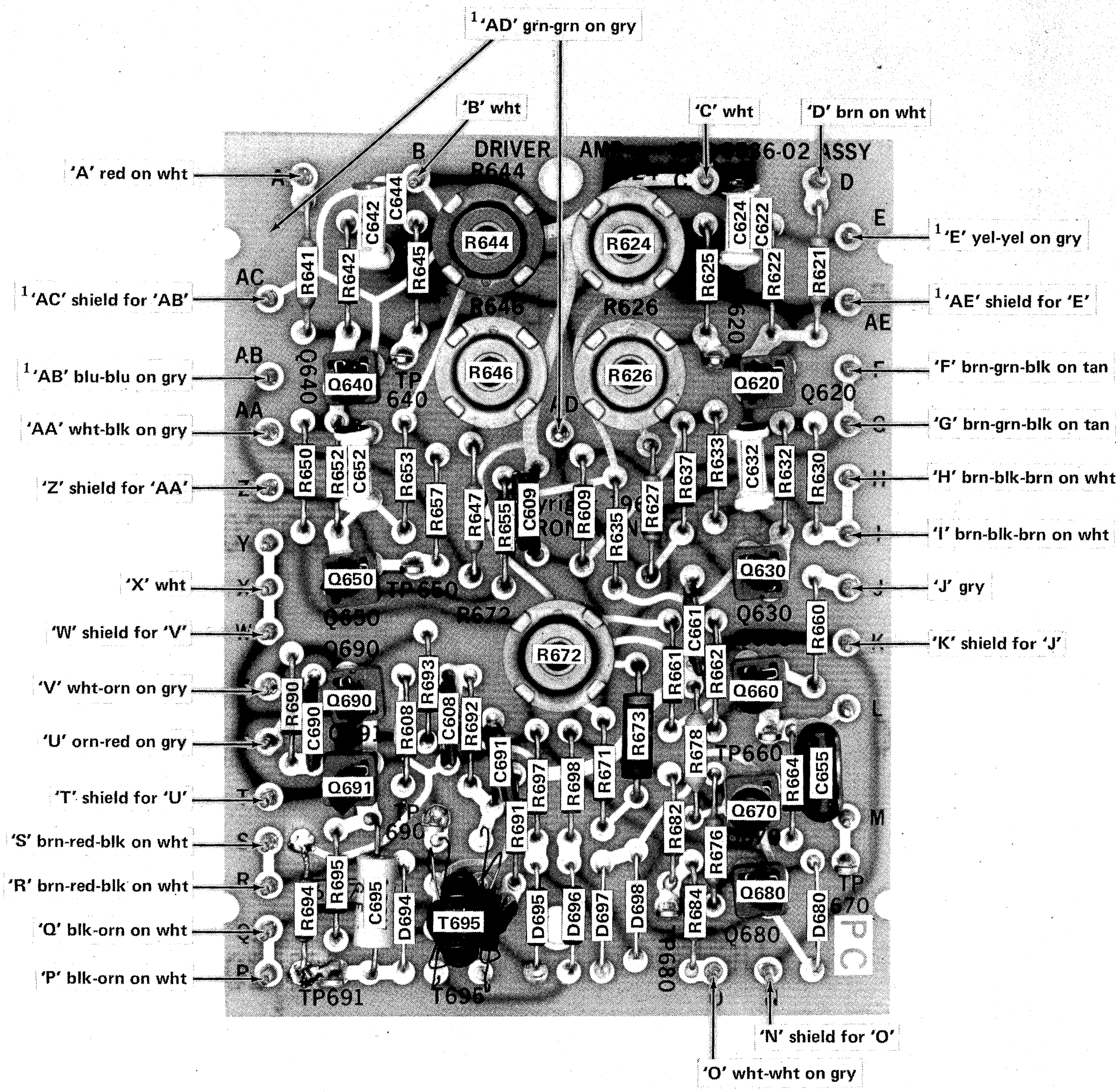


Fig. 4-18. Luminance Filter board; component identification and wire color codes.



[1]Before SN B200000, Pin 'AD' located above Pin 'AC' as shown. Wire color codes were: 'AC' wht; 'AB' blu on wht; 'AD' grn on wht; 'E' blk-vio on wht.

[2]C624 & C644 added SN 220000. Capacitors located on back of board in early production.

Fig. 4-19A. Driver Amplifier board; component identification and wire color codes for instruments SN B150100 and up.

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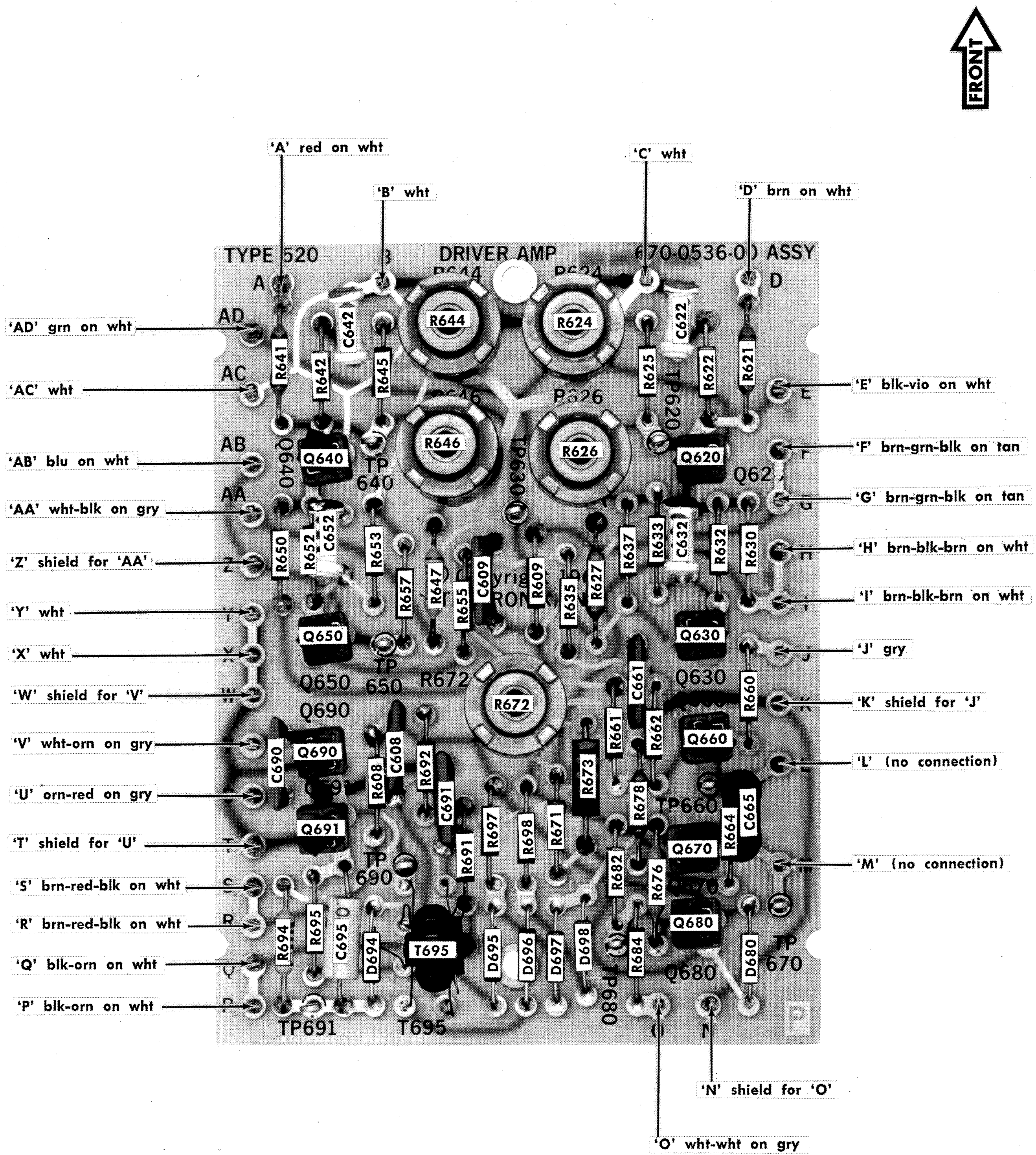

Fig. 4-19B. Driver Amplifier board; component identification and wire color codes for instruments below SN B150100.

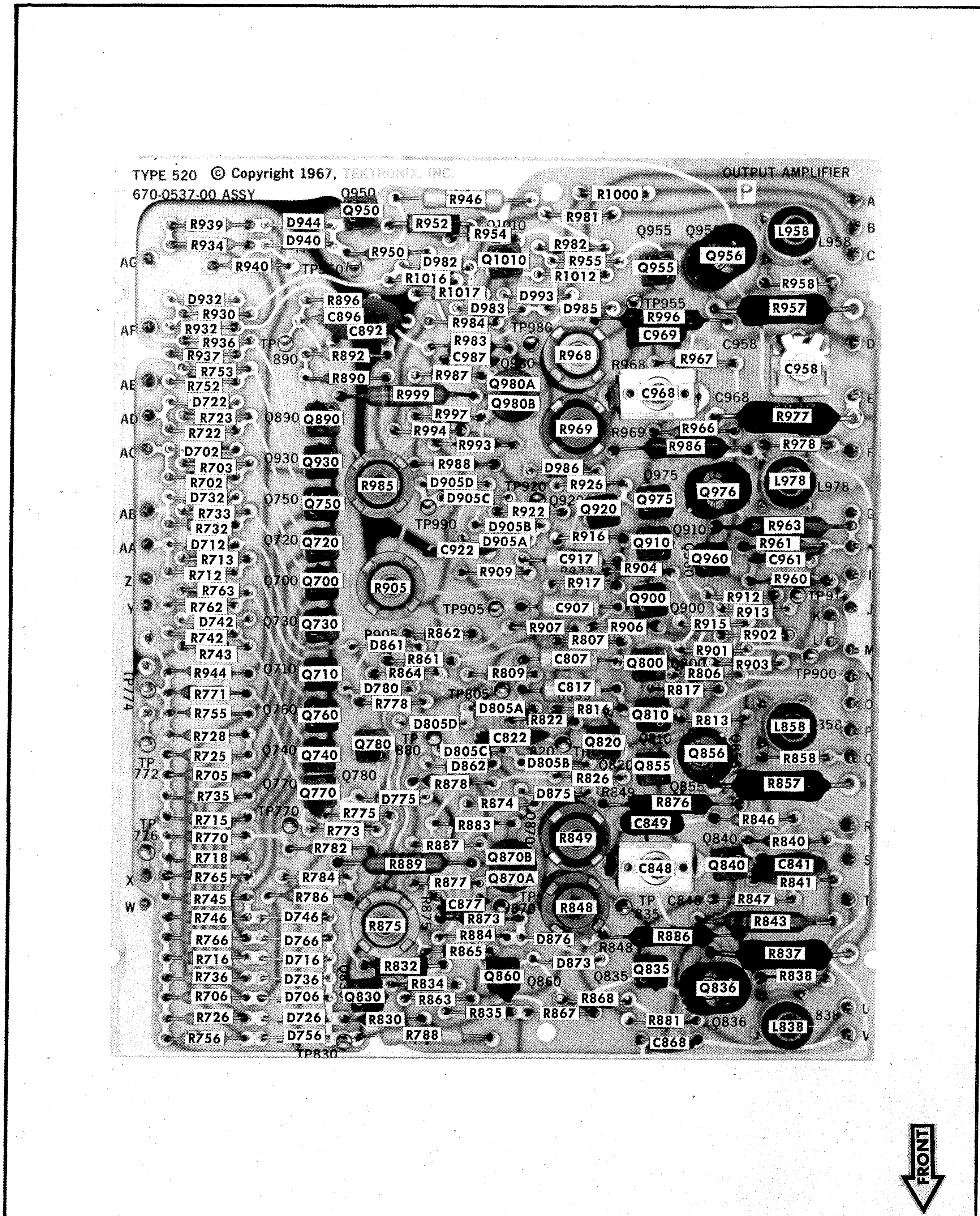

Fig. 4-20. Output Amplifier board; component identification.

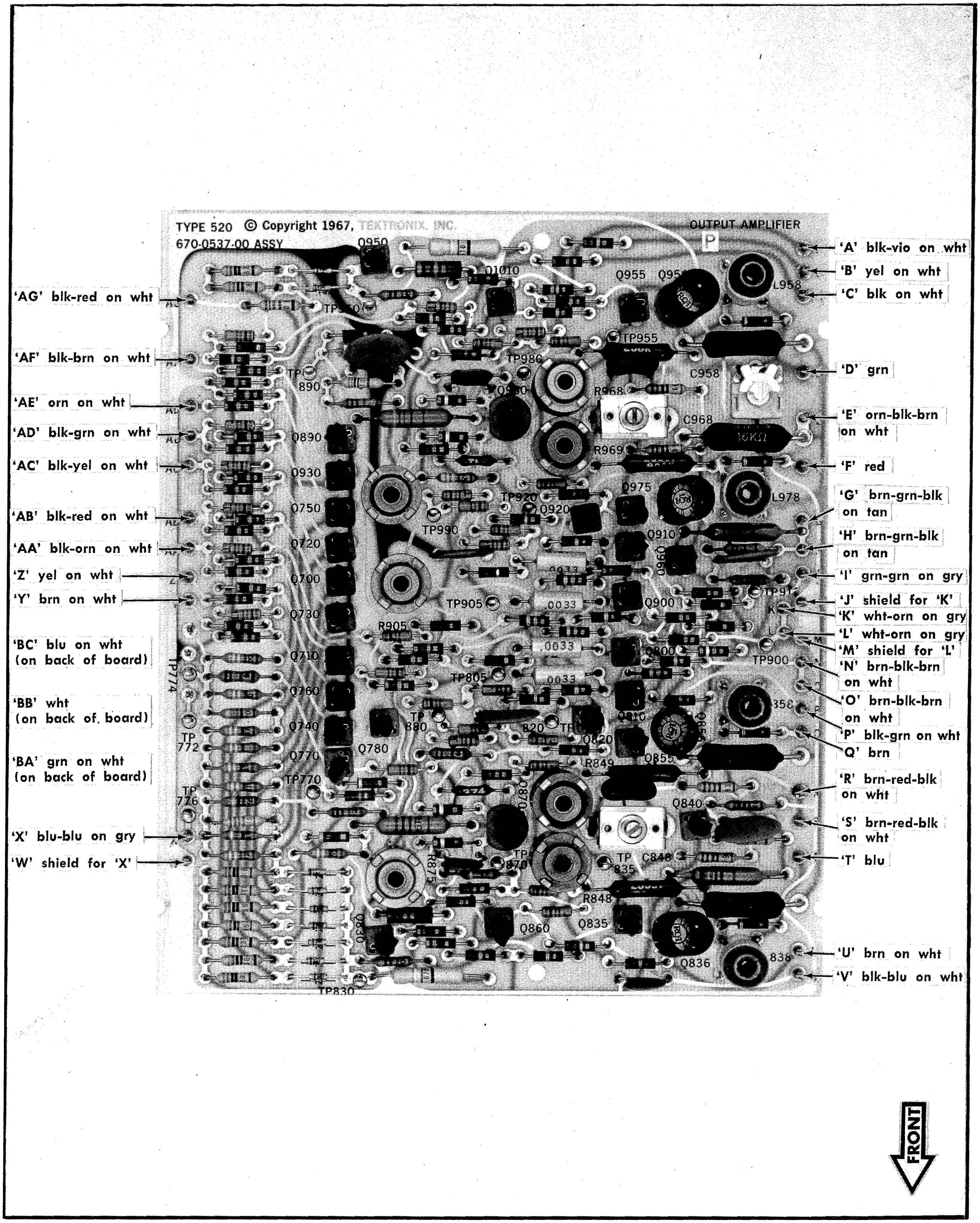

Fig. 4-21. Output Amplifier board; wire color codes.

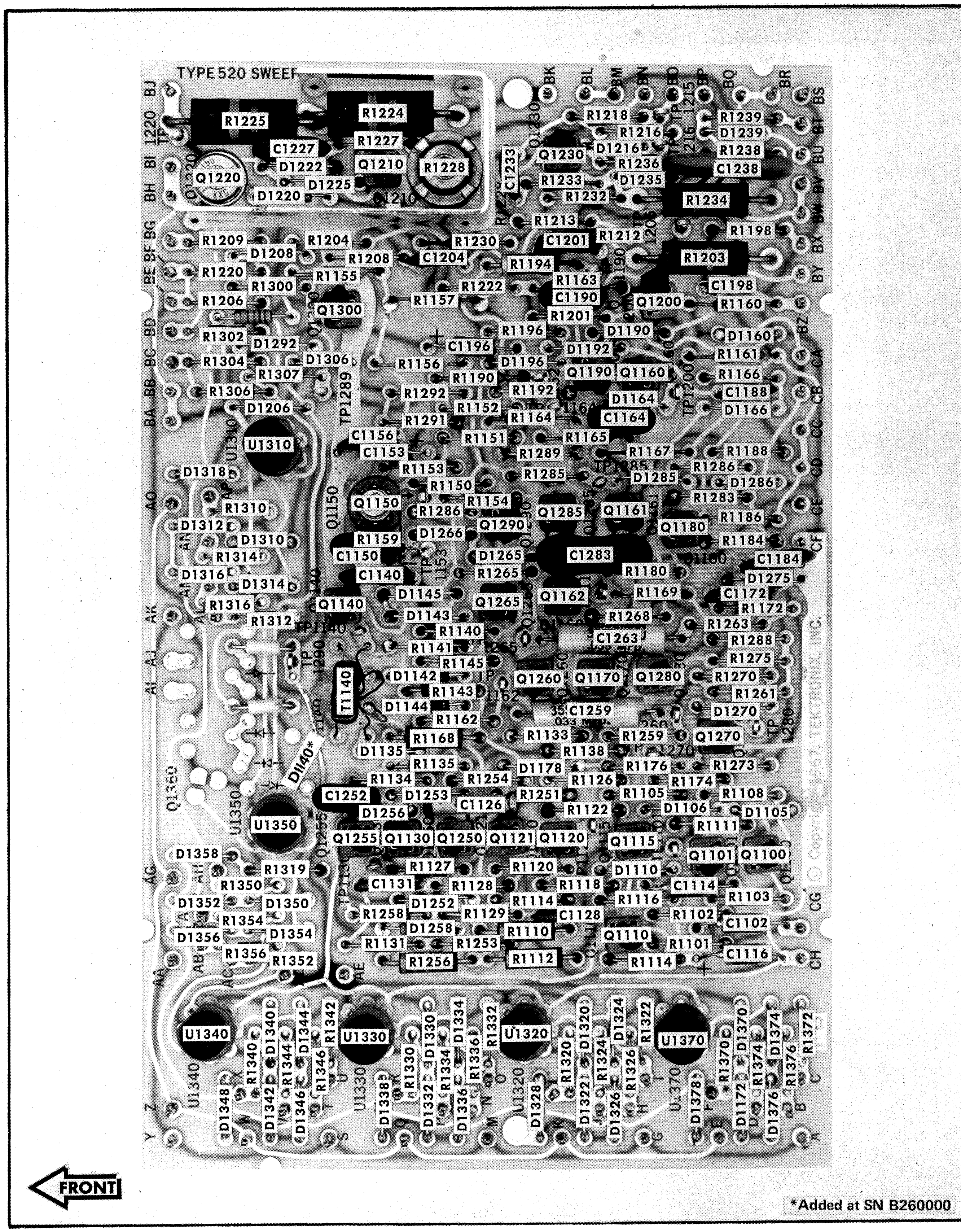

Fig. 4-22A. Sweep board; component identification for instruments SN B150100 and up.

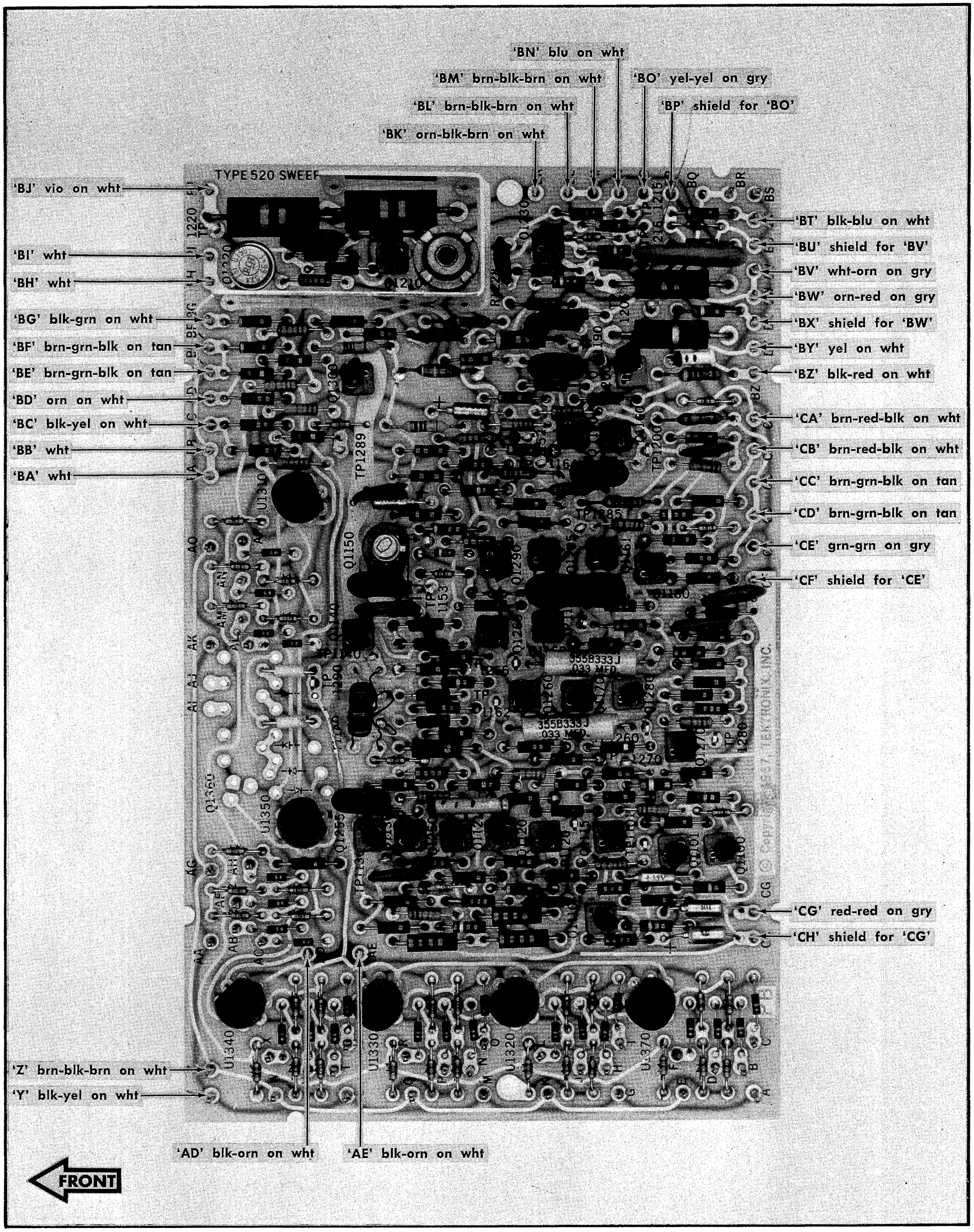

Fig. 4-22B. Sweep board; wire color codes for instruments SN B150100 and up.

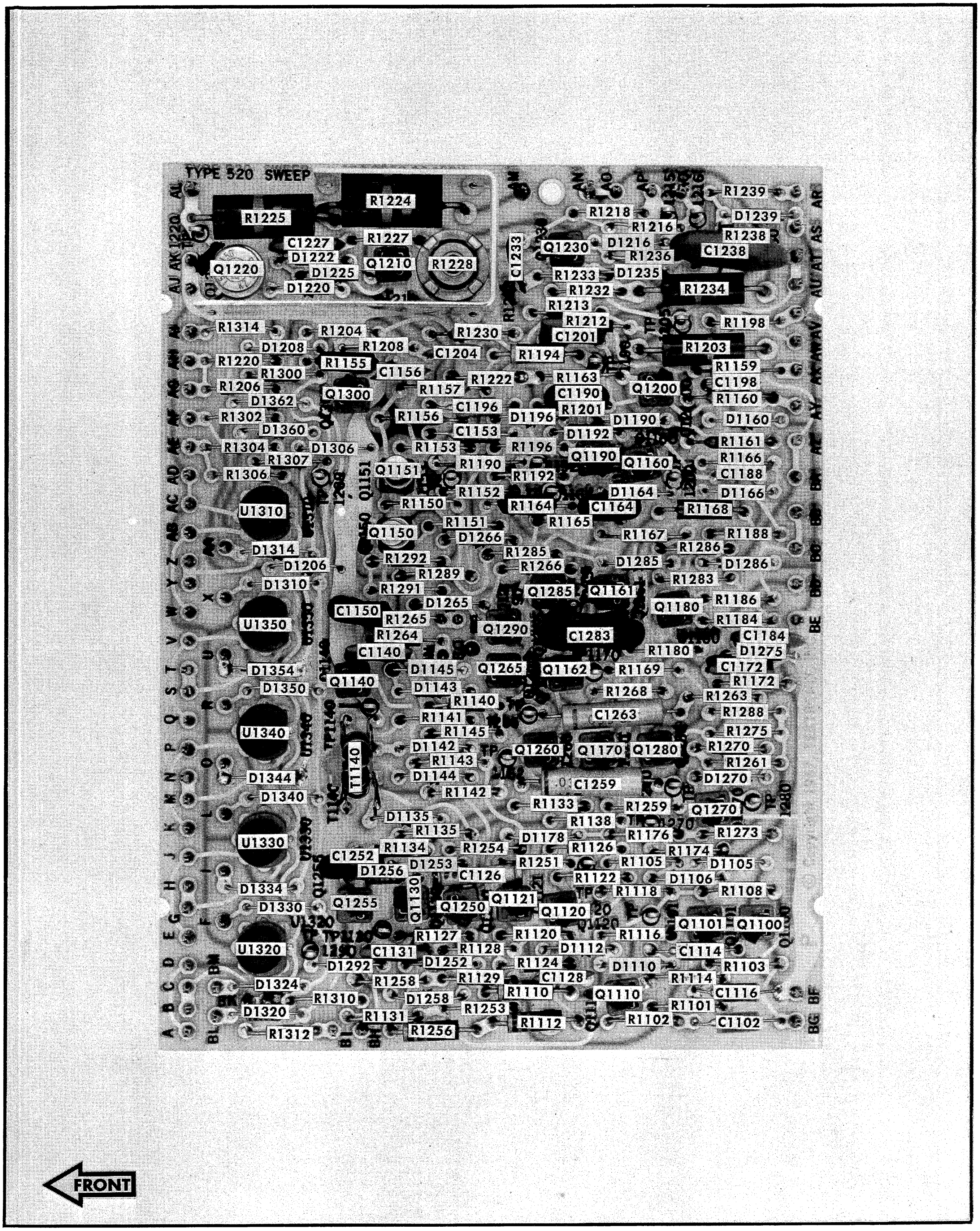

Fig. 4-23A. Sweep board; component identification for instruments below SN B150100.

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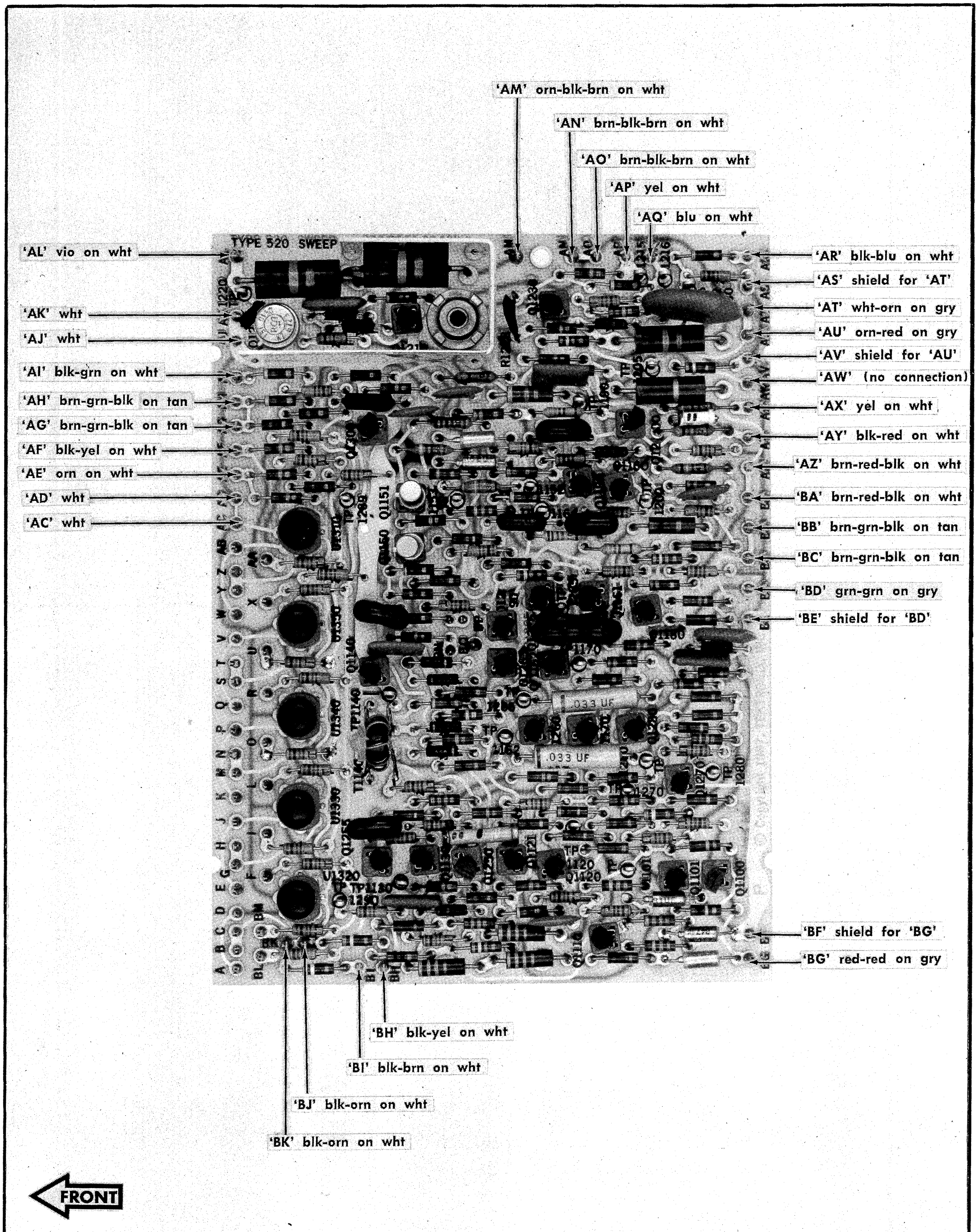

Fig. 4-23B. Sweep board; wire color codes for instruments below SN B150100.

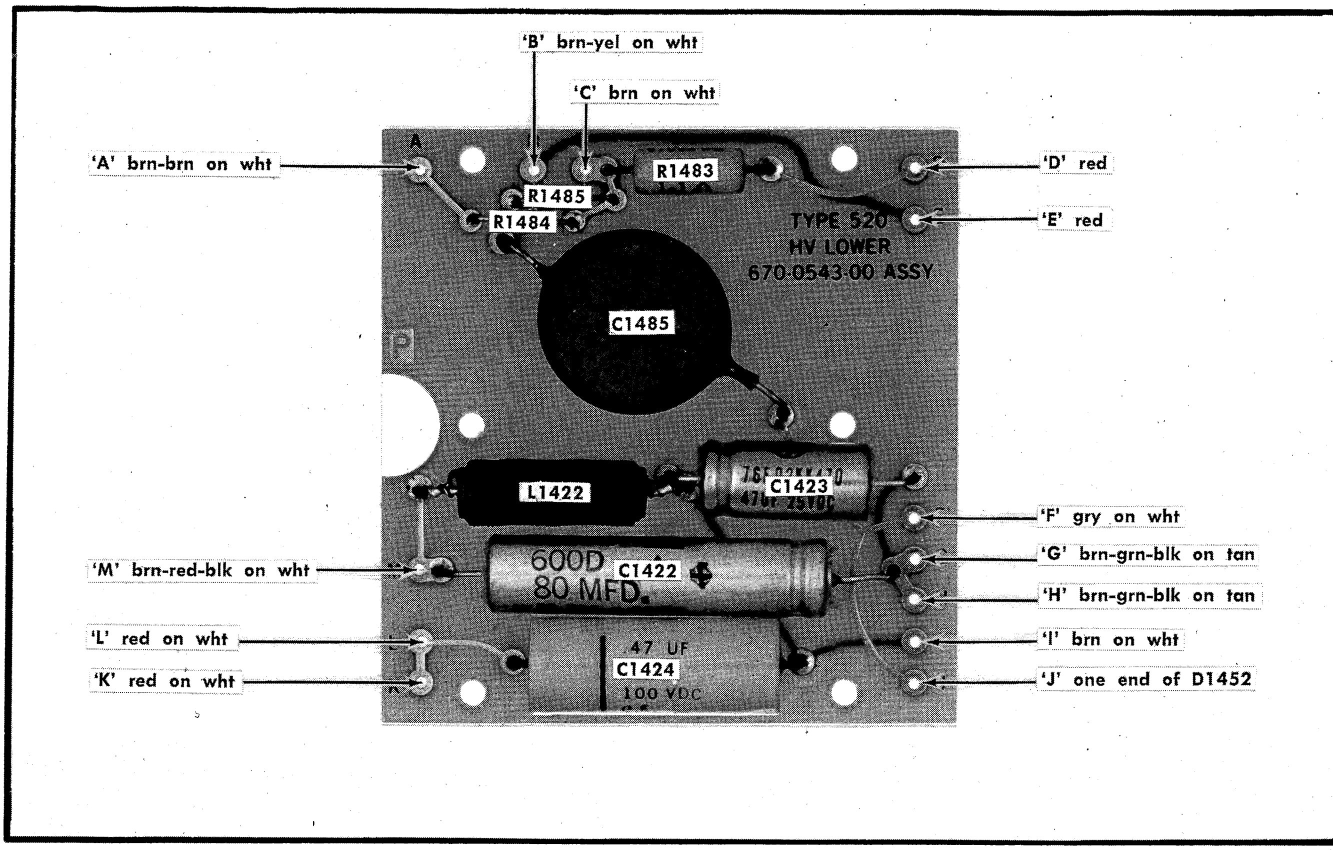

Fig. 4-24. Lower High Voltage board; component identification and wire color codes.

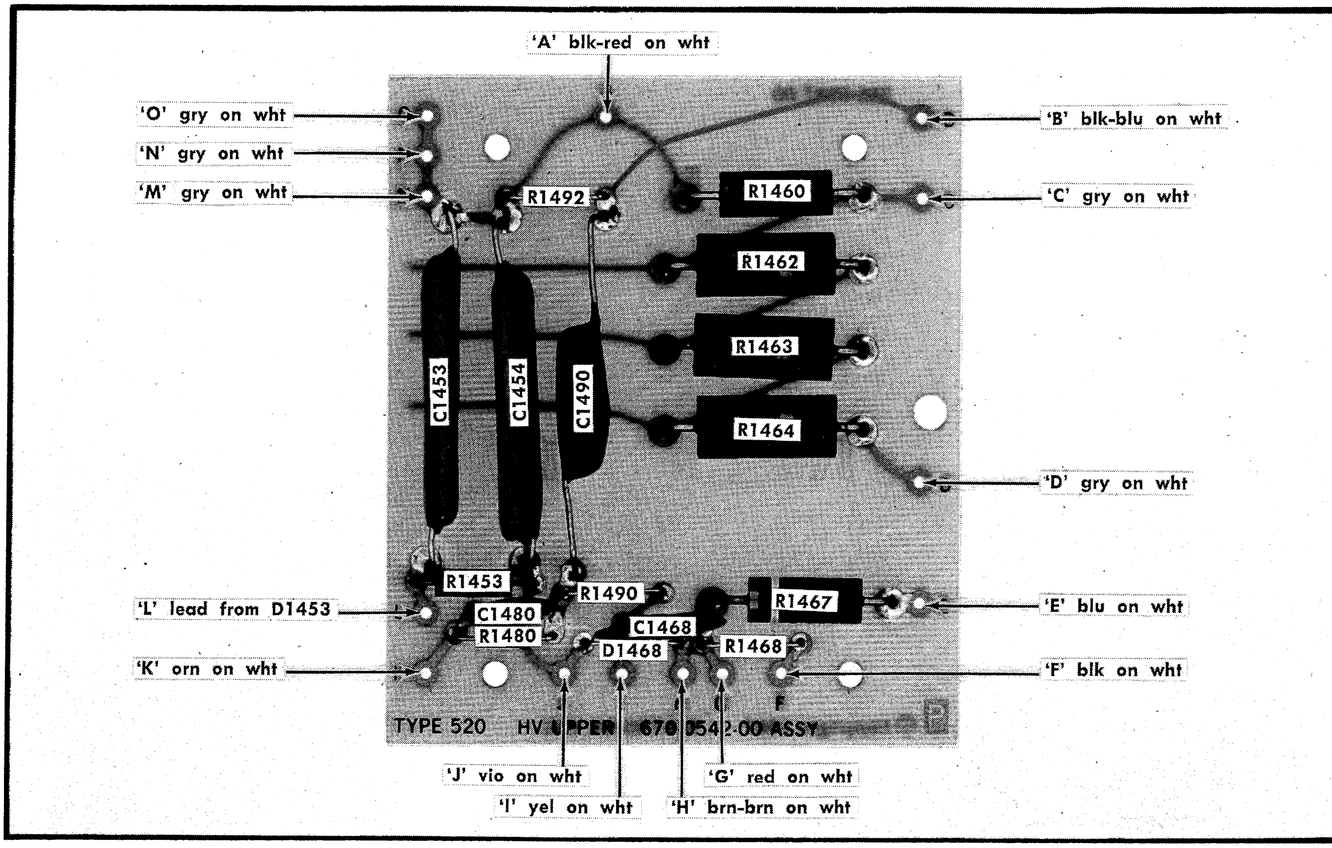

Fig. 4-25. Upper High Voltage board; component identification and wire color codes.

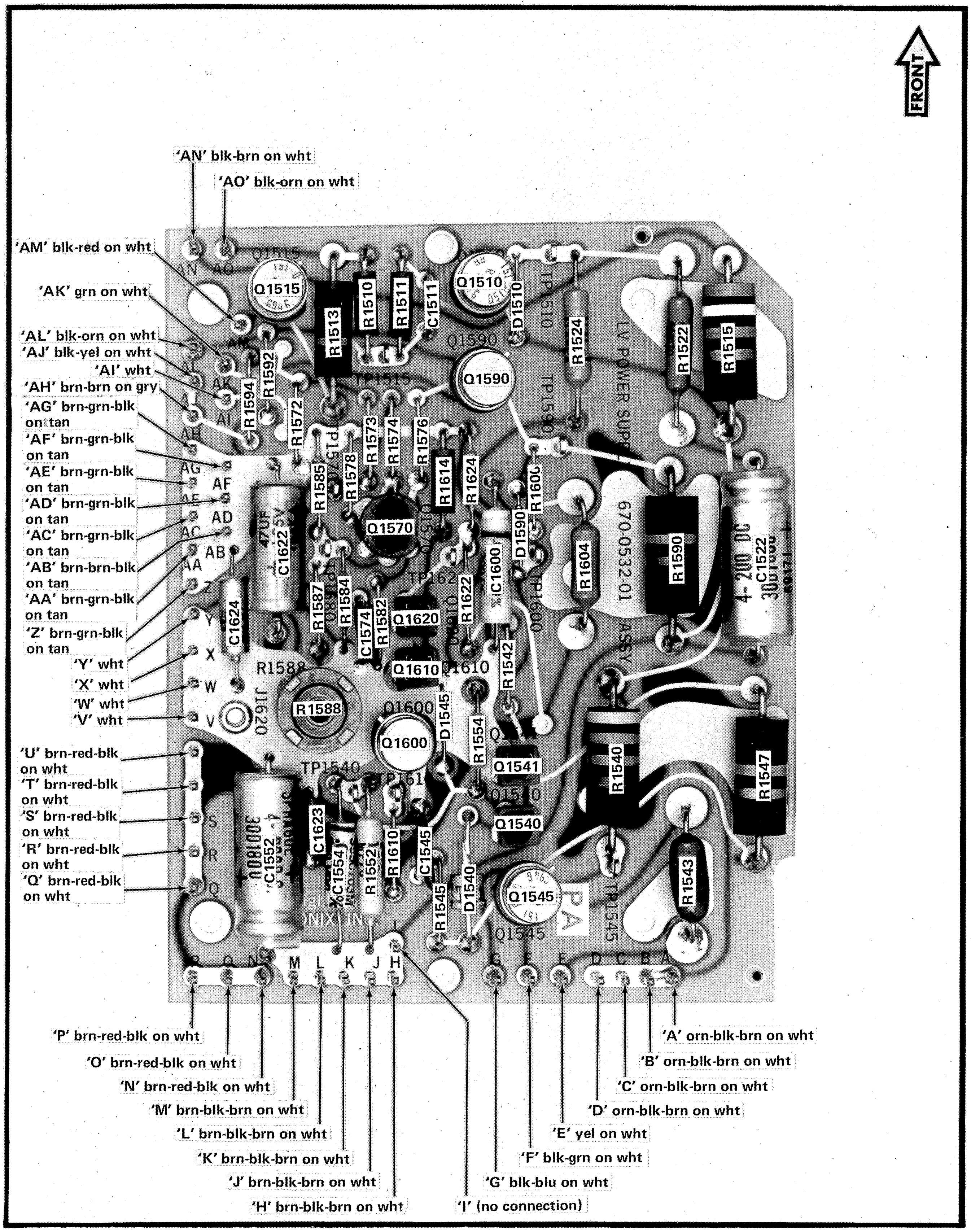

Fig. 4-26A. Low Voltage Power Supply circuit board showing components and wire codes for instruments SN B080000-up.

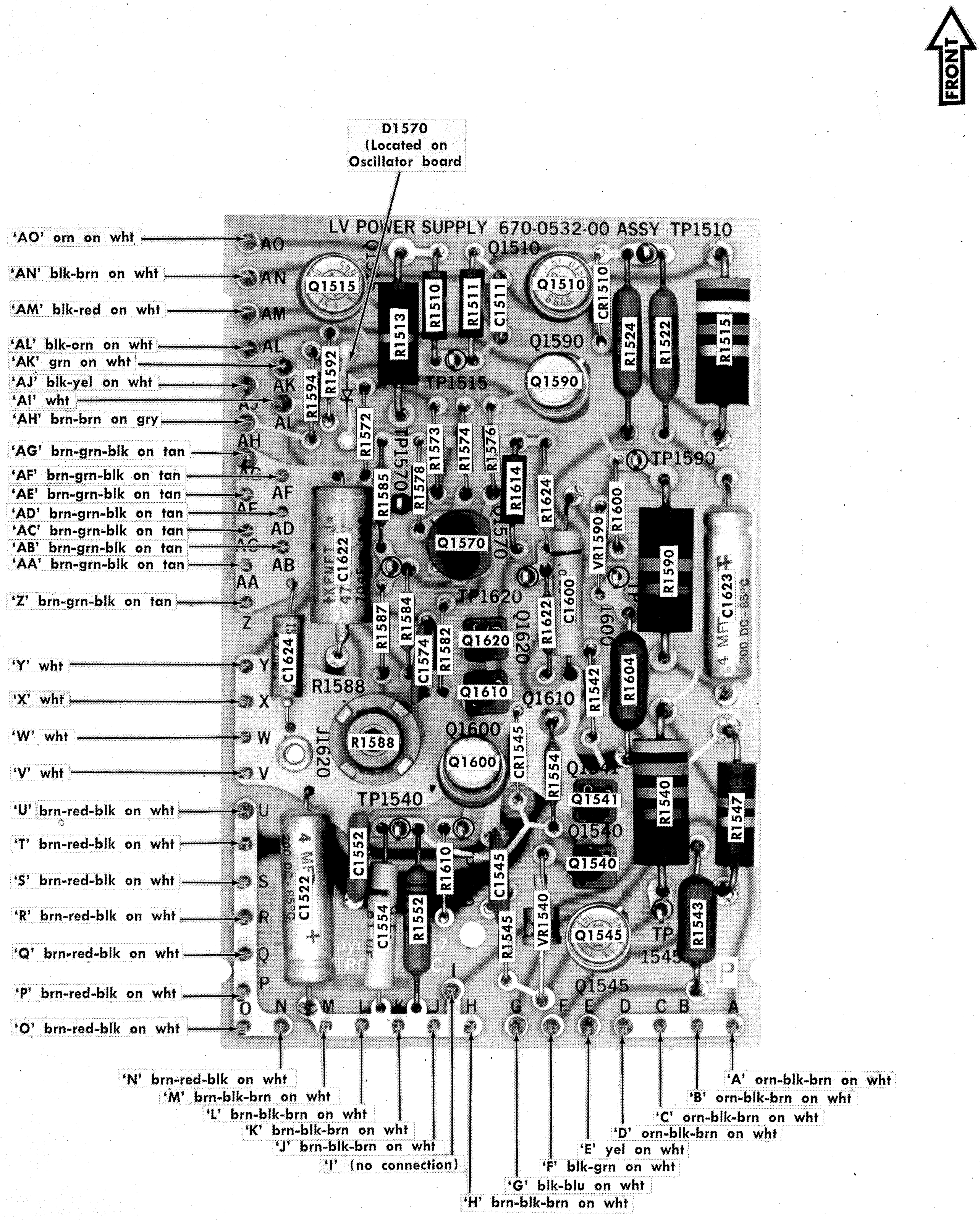

Fig. 4-26B. Low Voltage Power Supply circuit board showing components and wire codes for instruments SN B020100-B079999.

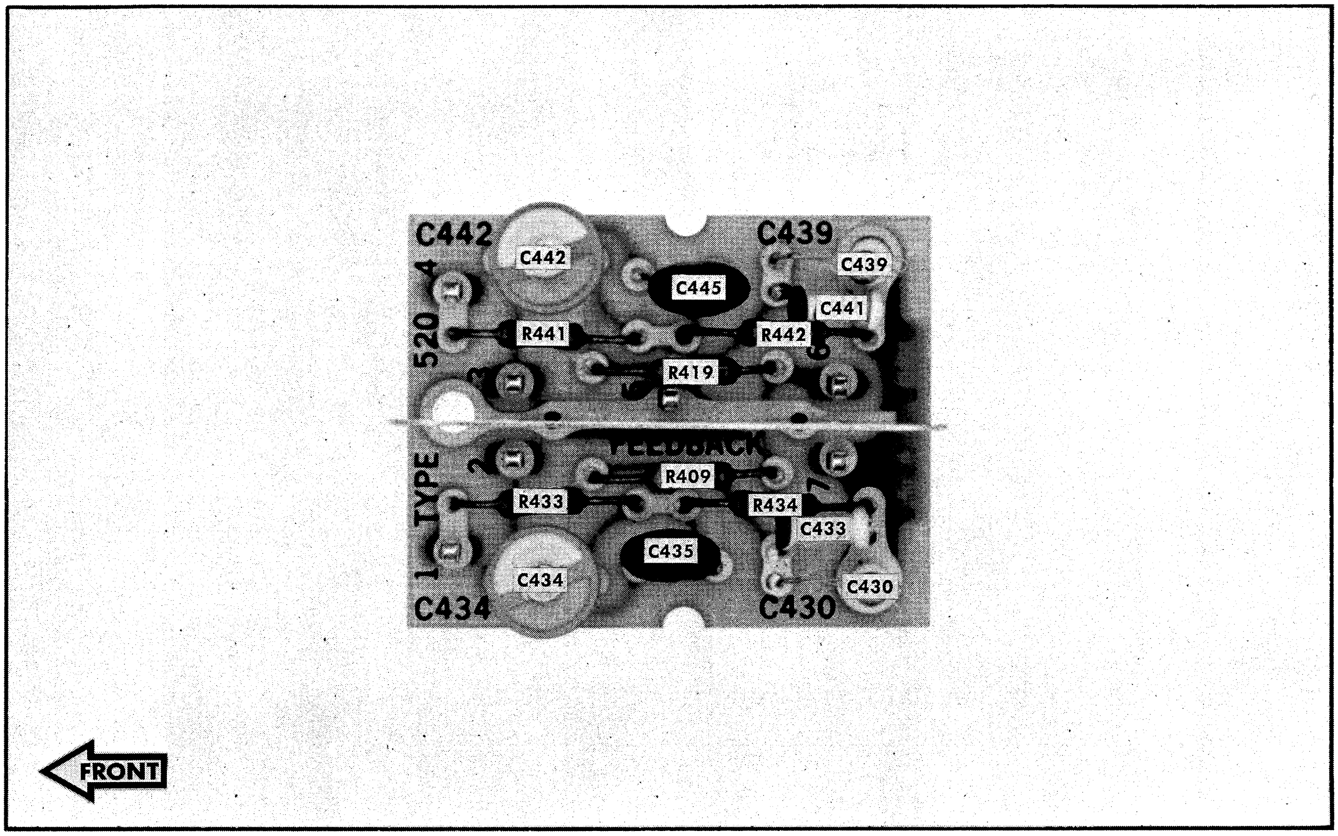

Fig. 4-27. Feedback board; component identification for instruments SN B150100 and up only.

NOTES

SECTION 5
PERFORMANCE CHECK

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual provides a procedure for rapidly checking the performance of the Type R520. This procedure checks the operation of the instrument without removing the covers (except to gain access to internal test points) or making internal adjustments. However, screwdriver adjustments which are located on the front and rear panels are adjusted in this procedure.

If the instrument does not meet the performance requirements given in this procedure, internal checks and/or adjustments are required. See the Calibration section. All performance requirements given in this section correspond to those given in the Specification section.

NOTE

All waveforms shown in this section are actual waveform photographs taken with a Tektronix Oscilloscope Camera System.

Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For the most accurate and convenient performance check, special calibration fixtures are used in this procedure. These calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Test oscilloscope. Bandwidth, DC to at least 10 MHz; minimum deflection factor, 0.005 volt/division. Tektronix Type 547 Oscilloscope with Type 1A1 and [1]Type 1A5 Plug-In Units, and a Tektronix P6023 (10X) and P6028 (1X) Probes recommended.

2. Video signal source. Signals available, unmodulated linearity staircase, 3.58 MHz (CW) variable between 1.5 and 2.5 V peak to peak, sync pulses at a line rate variable between 3.5 V and 7.5 V (0.7 V and 1.4 V) peak to peak, color bars of the proper amplitude for 75% saturation measurements, and multiburst within 1% of being flat at all frequencies. For example, Riker Industries, Inc. or Telemet Company equipment.

3. Medium frequency constant amplitude signal generator. Frequency, variable from 3 MHz to 18 MHz; output amplitude, adjustable to 1 volt; amplitude regulation accuracy, within ±5%. Tektronix Type 191 Constant Amplitude Signal Generator recommended.

4. Wide bandwidth constant amplitude signal generator. Frequency, variable from below 25 Hz to above 5 MHz; output amplitude adjustable from about 1 volt to about 2 volts; amplitude regulation, 0.5%. For example Hewlett-Packard Model 652A generator.

5. Square-wave generator. Frequency, 20 kHz, to 40 kHz; output amplitude, adjustable to 1 volt. Tektronix Type 106 Square-Wave Generator recommended.

6. Standard Amplitude Calibrator. Amplitude accuracy, within 0.25%; signal amplitude, 1 volt; output frequency, 1 kHz. Tektronix calibration fixture 067-0502-00 recommended.

7. Cable (three) (SN B180980-up). Impedance, 75 ohm; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0074-00.

7A. Cable (three) (SN 100-B170979). Impedance, 75 ohm; length, 42 inches; connectors, UHF. Tektronix Part No. 012-0002-00.

8. 067-0565-00 ramp and sine wave adder. Tektronix calibration fixture 067-0565-00 recommended.

9. Adapter (SN 100-B170979). Connectors, UHF female to BNC male. Tektronix Part No. 103-0032-00.

11. Adapter (SN 100-B170979). Connectors, UHF male to BNC female. Tektronix Part No. 103-0015-00.

13. Termination (two) (SN B180980-up). Impedance, 75 ohm; connector, BNC; type, end-line; accuracy ±3%. Tektronix Part No. 011-0102-00.

13A. Termination (two) (SN 100-B170979). Impedance, 75 ohm; connector, UHF; type, end-line; accuracy ±3%. Tektronix Part No. 011-0023-00.

14. Adapter. Connectors, GR to BNC male. Tektronix Part No. 017-0064-00.

15. Adapter. Connectors, UHF male to BNC female. Tektronix Part No. 103-0015-00.

16. Attenuator. Connectors, BNC; impedance, 50 ohms to 75 ohms; type, minimum loss when going from a 50 ohm system to a 75 ohm system. Tektronix Part No. 011-0057-00.

17. Termination (three). Impedance, 75 ohm; connector, UHF; type, end-line; accuracy, ±3%. Tektronix Part No. 011-0023-00.

18. Termination. Impedance, 75 ohm; connectors, BNC; type, feed-thru; accuracy, ±3%. Tektronix Part No. 011-0055-00.

[1]Required only if step 32 is performed.

PERFORMANCE CHECK PROCEDURE

General

In the following procedure, control settings or test equipment connections should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information. Type R520 control titles referred to in this procedure are capitalized (e.g., VERT POSITION).

The following procedure uses the equipment listed under Recommended Equipment. If equipment is substituted, control settings or setup may need to be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Connect the Type R520 to a suitable power source.

2. Set the front- and rear-panel controls of the Type R520 as follows:

Front-Panel Controls:

Signal Selector	A CAL, FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
PHASE	As is
A CAL	As is
B CAL	As is
ϕ REF	BURST
CHANNEL B	
100%-75%-GAIN	75%
GAIN	CAL
PHASE	As is
Display Selector	Y
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Left recessed front-panel controls:

QUAD PHASE	As is
GAIN BAL	As is
HORIZ POSITION CLAMP	As is
BEAM ROTATE	As is
VERT POSITION CLAMP	As is

Right recessed front-panel controls:

FOCUS	As is
FIELD	1
VERT POSITION	As is
BURST FLAG TIMING	As is
SYNC	INT
HORIZ POSITION	As is

Rear-panel controls:

ASTIG	As is
ORTHO	As is
GEOM	As is
UNBLANK BIAS	As is

3. Set the Type R520 POWER switch to ON. Allow at least 20 minutes warm up at 25°C, ±5°C for checking instrument to the given accuracy.

1. Adjust Geometry

REQUIREMENT—Vertical and/or horizontal lines should not have more than 0.05 centimeter of gradual bowing.

a. Adjust the front-panel FOCUS control and the rear-panel ASTIG control (see Fig. 5-1) to obtain a well-defined display.

b. CHECK—Type R520 display; should not show more than 0.05 centimeter of gradual bowing of the vertical or horizontal lines.

c. ADJUST—GEOM control, R1472, (see Fig. 5-1) for minimum bowing of the vertical or horizontal lines.

2. Adjust Astigmatism

REQUIREMENT—Should be a nearly perfect round spot in vector display when the FOCUS control is rotated fully counterclockwise.

a. Cancel the Signal Selector A CAL pushbutton by momentarily depressing the CH A pushbutton. The Signal Selector FULL FIELD remains down.

b. Press the Display Selector VECTOR pushbutton.

c. Rotate the FOCUS control to its fully counterclockwise position.

d. CHECK—Type R520 display; should be a nearly perfect round spot near the center of the vector graticule.

e. ADJUST—ASTIG control, R1476, see Fig. 5-1 until a nearly perfect round spot near the center of the graticule is obtained.

f. Set the FOCUS control to obtain a well-defined spot.

3. Adjust CRT Alignment

REQUIREMENT—It must be possible to adjust the horizontal trace parallel to the 0°-180° axis of the vector graticle and perpendicular to the 90°-270° axis of the vector graticule.

a. The Signal Selector FULL FIELD pushbutton remains depressed for this step.

b. Press the Display Selector Y pushbutton.

c. CHECK—Type R520 trace alignment; trace should be parallel to the 0°-180° axis of the vector graticule.

d. ADJUST—BEAM ROTATE control, R1470, (see Fig. 5-2) until trace is parallel to the 0°-180° axis of the vector graticule.

e. CHECK—Type R520 trace alignment; horizontal trace should be perpendicular to the 90°-270° axis of the vector graticule.

f. ADJUST—ORTH control, R1474, (see Fig. 5-1) until trace is perpendicular to the 90°-270° axis of the vector graticule.

g. Repeat parts d and f of this step as necessary to remove interaction between the adjustments.

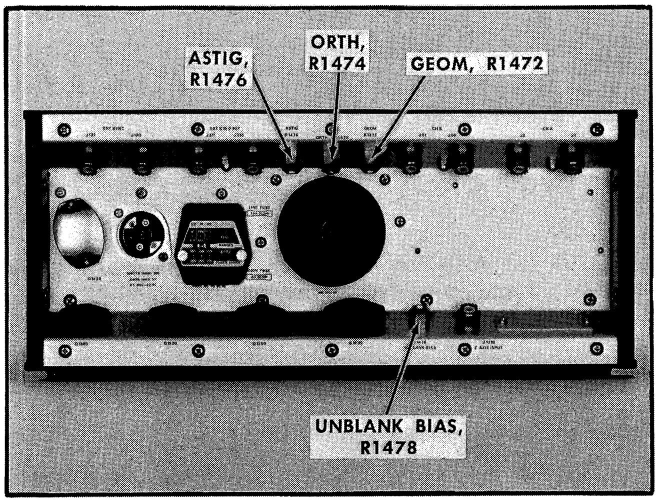

Fig. 5-1. Rear-panel control locations.

4. Unblanking Bias

REQUIREMENT—The brightness of a test circle display must be adjustable so that the test circle has uniform intensity throughout its circumference.

a. Press the Signal Selector A CAL pushbutton and the Display Selector VECTOR pushbutton.
b. Reduce the display intensity until the test circle is barely visible.

CHECK—Type R520 display; test circle should have uniform intensity throughout its circumference.
d. ADJUST—UNBLANK BIAS control, R1478, (see Fig. 5-1) for a uniform intensity throughout the circumference of the test circle.

5. Check VITS Intensity

REQUIREMENT—Display of a test signal must be at maximum brightness without any display defocusing.

a. Connect a linearity staircase video signal to the CH A J1 connector via a 75 ohm coaxial cable.

b. Connect a 75 ohm coaxial cable from the CH A J2 connector to the CH B J50 connector.

c. Connect a 75 ohm end-line termination to the CH B J51 connector.

d. Press Signal Selector CH A, Aϕ and VITS 18 pushbuttons.

e. Press the Display Selector LINE SWEEP pushbutton.

f. CHECK—Type R520 display brightness; must be maximum without any display defocusing.

g. Disconnect the video signal source, the two 75 ohm coaxial cables and the 75 ohm end-line termination.

6. Adjust Vertical and Horizontal Position Clamps

REQUIREMENT—Must have enough adjustment range to position the spot to the center of the vector graticule.

a. Depress the Signal Selector FULL FIELD pushbutton and the Display Selector VECTOR pushbutton.

b. Reduce the intensity somewhat, so the displayed spot on the CRT of the Type R520 will not burn the phosphor.

c. CHECK—Type R520 displayed spot position; must be at the center of the vector graticule.

d. ADJUST—VERT POSITION CLAMP control, R880, (see Fig. 5-2) and HORIZ POSITION CLAMP control, R1002, (see Fig. 5-2) to position the spot to the centetr of the vector graticule.

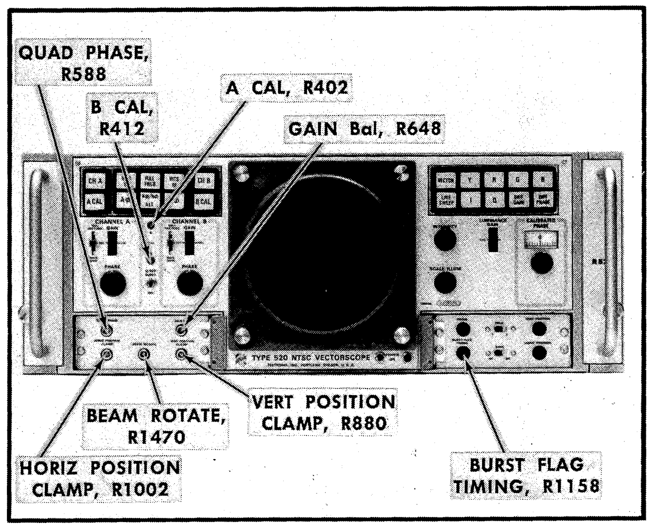

Fig. 5-2. Front-panel control locations.

7. Adjust Channel A Gain

REQUIREMENT—Must have enough adjustment range to position the spot to the center of the vector graticule.

a. Depress the Signal Selector A CAL and the Display Selector Y pushbuttons. The remaining pushbuttons remain as they are.

b. CHECK—Type R520 display amplitude; must be exactly 140 IRE units.

c. ADJUST—A CAL control, R402, (see Fig. 5-2) until the display on the Type R520 is exactly 140 IRE units in amplitude.

8. Adjust Channel B Gain

REQUIREMENT—Must have enough adjustment range to set the gain of channel B to unity.

a. Depress the B CAL and Bϕ; cancel the A CAL Signal Selector pushbuttons. The remaining pushbuttons remain as they are.

b. CHECK—Type R520 display amplitude; must be exactly 140 IRE units.

c. ADJUST—B CAL control, R412, (see Fig. 5-2) until the display on the Type R520 is exactly 140 IRE units in amplitude.

9. Adjust Burst Flag Timing

REQUIREMENT—Must have enough adjustment range to cause equal amounts of the rising and falling portions of the burst to intensify.

a. Press the Signal Selector CH A and Aϕ pushbuttons and the Display Selector LINE SWEEP pushbutton.

b. Connect a color bar video signal to CH A J1 connector via a 75 ohm coaxial cable.

c. Connect a 75 ohm end-line termination to the CH A J2 connector.

d. Rotate the channel A PHASE control to obtain maximum positive-going burst amplitude; see Fig. 5-3.

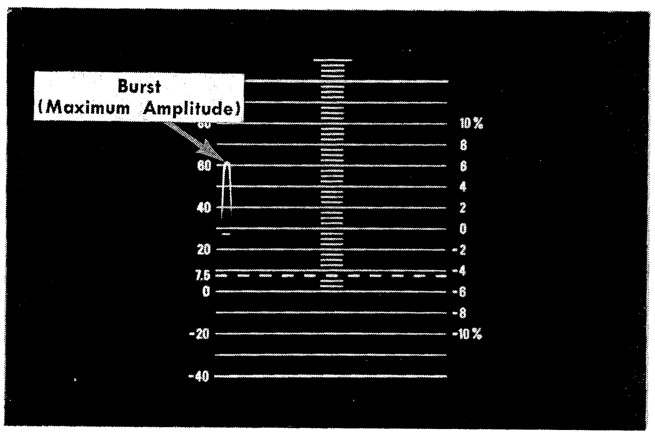

Fig. 5-3. Correct Type R520 color bar display for adjusting burst flag timing.

e. CHECK—Type R520 display intensified portions; the intensified rising and falling portions of the burst part of the display must be equal. It may be necessary to reduce the display intensity so the intensified portions may be seen.

f. ADJUST—BURST FLAG TIMING, R1158, (see Fig. 5-2) until the intensified rising and falling portions of the burst are equal.

g. Disconnect the video signal source, the 75 ohm coaxial cable and the 75 ohm end-line termination.

10. 33° Phase Shifter

REQUIREMENT—Must be a 33°, ±2° phase shift when the I or Q Display Selector pushbutton is pressed.

a. Press the Display Selector VECTOR pushbutton. The remaining pushbuttons remain as they are.

b. Connect a color bar video signal to CH A J1 connector via a 75 ohm coaxial cable.

c. Connect a 75 ohm end-line termination to the CH A J2 connector.

d. Line up the burst vector on the Type R520 exactly with the I marking on the vector graticule using the channed A PHASE control.

e. Press the Display Selector Q pushbutton.

f. Rotate the CALIBRATED PHASE control until the single trace just starts to break into two traces.

g. CHECK—Type R520 CALIBRATED PHASE dial reading; 2° or less from zero.

h. Reset the CALIBRATED PHASE dial to its zero degree dial point.

i. Press the Display Selector VECTOR pushbutton.

j. Line up the burst vector on the Type R520 exactly with the Q marking on the vector graticule using the channel A PHASE control.

k. Press the Display Selector I pushbutton.

l. Rotate the CALIBRATED PHASE control until the single trace just starts to break into two traces.

m. CHECK—Type R520 CALIBRATED PHASE dial reading; 2° or less from zero.

n. Reset the CALIBRATED PHASE dial to its zero degree dial point.

o. Disconnect the 75 ohm coaxial cable, video signal source and the 75 ohm end-line termination.

11. Adjust Subcarrier Balance

REQUIREMENT—Trace must remain within ±3 IRE units no matter whether the LINE SWEEP, I, Q or DIFF PHASE Display Selector pushbutton is pressed.

a. Cancel all the Signal Selector pushbuttons except the FULL FIELD pushbutton.

b. Press the Signal Selector A CAL pushbutton and the Display Selector LINE SWEEP pushbutton.

c. Note trace position.

d. Press the Display Selector I pushbutton.

e. Note trace position.

f. Press the Display Selector Q pushbutton.

g. Note trace position.

h. Press the Display Selector DIFF PHASE pushbutton.

i. Note trace position.

j. CHECK—Trace positions; the trace noted in parts c (LINE SWEEP trace), e (I trace), g (Q trace) and i (DIFF PHASE trace) must be within ±3 IRE units of the same location.

k. Press the Display Selector DIFF PHASE pushbutton.

l. CHECK—Type R520 display; it should consist of a single trace.

m. Press the Display Selector Q pushbutton.

n. CHECK—Type R520 display; it should consist of a single trace.

12. Adjust Gain Balance

REQUIREMENT—Must have enough range to adjust the horizontal amplifier gain to be the same as the vertical gain.

a. Press the Signal Selector Aϕ pushbutton and the Display Selector VECTOR pushbutton. The remaining pushbuttons remain as they are.

b. CHECK—Type R520 displayed test circle circularity; test circle should touch the inscribed circle on the vector graticule at the 0°, 90°, 180° and 270° points on the circumference of the test circle.

c. ADJUST—GAIN BAL control, R648, (see Fig. 5-2) until the test circle touches the inscribed circle on the vector graticule at all points on its circumference.

13. Adjust Quadrature Phase

REQUIREMENT—The two circles which make up the test circle must overlay each other at the 45° points on their circumference within 0.0366 inch.

a. Cancel the Signal Selector A CAL and Aϕ pushbuttons and press the B CAL pushbutton. The remaining pushbuttons remain as they are.

b. Connect a linearity staircase video signal to the CH A J1 connector via 75 ohm coaxial cable.

c. Connect a 75 ohm end-line termination to the CH A J2 connector.

d. CHECK—Type R520 display; test circles should overlay each other at the 45° points on their circumference within 0.0366 inch.

e. ADJUST—QUAD PHASE control, R588, (see Fig. 5-2) until the test circles overlay each other at the 45° point on their circumference within 0.0366 inch.

f. Disconnect the video signal source, 75 ohm coaxial cable and the 75 ohm end-line termination.

14. Check Chroma Bandwidth

REQUIREMENT—Upper and lower chorminance bandwidth points must be between 400 kHz and 600 kHz above and below 3.58 MHz.

a. Press the Signal Selector CH A and Aϕ pushbuttons and Display Selector LINE SWEEP pushbutton. Cancel the Signal Selector B CAL pushbutton. The remaining pushbuttons remain as they are.

b. Connect a 3.58 MHz sine wave signal about 0.75 volt in amplitude from a medium frequency constant amplitude signal generator via a 5 ns coaxial cable, a GR to BNC male adapter, a 75 ohm to 50 ohm minimum loss attenuator and a BNC female to UHF male adapter to the Type R520 CH A J1 connector.

c. Connect a 75 ohm end-line termination to the CH A J2 connector.

d. Adjust the signal generator output amplitude control to obtain a display amplitude of exactly 140 IRE units.

e. Increase the output frequency of the signal generator until the display amplitude falls to 98 IRE units (70% of its initial amplitude).

f. CHECK—Signal generator output frequency; must be between 400 kHz and 600 kHz above the 3.58 MHz initial frequency.

g. Decrease the output frequency of the signal generator through and below 3.58 MHz until the displayed amplitude falls to 98 IRE units (70% of its initial amplitude).

h. CHECK—Signal generator output frequency; must be between 400 kHz and 600 kHz below the 3.58 MHz initial frequency.

i. Disconnect the medium frequency constant amplitude signal generator, the 5 ns coaxial cable, GR to BNC male adapter, 75 ohm to 50 ohm minimum loss attenuator, the BNC female to UHF male adapter and the 75 ohm end-line termination.

15. Check Luminance Bandwidth

REQUIREMENT—Multiburst input video signal should present a display on the Type R520 as shown in Fig. 5-4.

a. Press the Display Selector Y pushbutton.

b. Connect a multiburst video signal to CH A J1 connector via a 75 ohm coaxial cable.

c. Connect a 75 ohm end-line termination to the CH A J2 connector.

NOTE

The multiburst video signal must be within ±1% of flat at all frequencies or this check will not be valid.

d. CHECK—Type R520 display; must appear the same as that shown in Fig. 5-4, see the luminance bandwidth table for the numerical figures for the display.

LUMINANCE BANDWIDTH TABLE

Multiburst Frequency	Type R520 Response Display	Typical Type R520 IRE Units of Display (Standard Video Transmission Engineering Advisory Commission, VITEAC)
500 kHz	90%, ±4%	77 minimum 81 nominal 85 maximum
1.5 MHz	40%, ±4%	32 minimum 36 nominal 40 maximum
2.0 MHz	20%, ±4%	14 minimum 18 nominal 22 maximum
3.0 MHz	≤3%	≤2.5
3.6 MHz	≤1%	≤1
4.2 MHz	≤1%	≤1

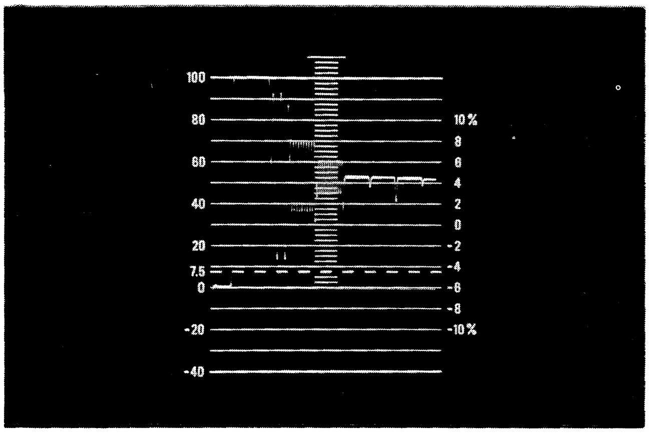

Fig. 5-4. Correct multiburst video signal display on Type R520.

e. Disconnect the video signal source, 75 ohm coaxial cable and the 75 ohm end-line termination.

16. Check Luminance Step Response

REQUIREMENT—Aberrations on a 100 IRE units high square wave must be 1% or less of the display height.

a. Connect a 30 kHz square-wave signal about 1 volt in amplitude from a square-wave generator via a 5 ns coaxial cable, a GR to BNC male adapter, a 75 ohm to 50 ohm minimum loss attenuator and a BNC female to UHF male adapter to the Type R520 CH A J1 connector.

b. Connect a 75 ohm end-line termination to the CH A J2 connector.

c. Slowly change the frequency of the square-wave generator until a stable display is obtained.

d. Adjust the output amplitude of the square-wave generator until the Type R520 display is exactly 100 IRE units in amplitude.

e. CHECK—Type R520 display; aberrations on the top of the waveform must be 1% or less of 100 IRE units in amplitude.

f. Disconnect the square-wave generator, the 5 ns coaxial cable, 75 ohm to 50 ohm minimum loss attenuator, GR to BNC male adapter, BNC female to UHF male adapter and 75 ohm end-line termination.

17. Check Input Amplitude Range

REQUIREMENT—Stable display must be obtained for input signals having sync pulse amplitudes from 200 mV to 400 mV (overall signal amplitudes from 0.7 V to 1.4 V).

a. Press the Display Selector LINE SWEEP pushbutton.

b. Connect a color bar video signal to the CH A J1 connector via a 75 ohm coaxial cable.

c. Connect a 75 ohm end-line termination to the CH A J2 connector.

d. Connect a 10× probe from the test oscilloscope vertical input connector to the input signal going to the CH A J1 connector.

e. Set the test oscilloscope for a vertical deflection of 0.01 V/division, AC coupled, at a sweep rate of 10 μs/division with internal triggering.

f. Set the sync pulse amplitude of the color bar video signal to exactly 286 mV (overall signal amplitude, 1 volt) as measured on the test oscilloscope.

g. Rotate the channel A PHASE control to obtain maximum positive-going burst amplitude; see Fig. 5-3.

h. Check that the intensified rising and falling portions of the burst part of the Type R520 display are equal. It may be necessary to reduce the display intensity so the intensified portion may be seen. If the position of the intensified portion is not correct, adjust the BURST FLAG TIMING control, R1158, (see Fig. 5-2) until the intensified rising and falling portions of the burst are equal.

i. Reduce the sync pulse amplitude of the color bar video signal to exactly 200 mV (overall signal amplitude, 0.7 volt) as measured on the test oscilloscope.

j. Set the Type R520 SYNC switch to EXT for about 15 seconds, then return it to its INT position.

k. CHECK—Type R520 display; should be stable.

l. Increase the sync pulse amplitude of the color bar video signal to exactly 400 mV (overall signal amplitude, 1.4 volts) as measured on the test oscilloscope.

m. Set the Type R520 SYNC switch to EXT for about 15 seconds, then return it to its INT position.

n. CHECK—Type R520 display; should be stable.

o. Disconnect the video signal source, 75 ohm coaxial cable, 75 ohm end-line termination, 10× probe and the test oscilloscope.

18. Check Phase Accuracy and Incremental Phase Accuracy

REQUIREMENT—Error between dots and 10° vector graticule marks must be 1° or less at any point on the inscribed vector graticule circle. Error between dots and 2° vector graticule marks must be 0.5° or less within 10° either side of an established reference point.

NOTE

Bottom cover of the Type R520 must be removed to gain access to the test point.

a. Press the Display Selector VECTOR pushbutton and set the ϕ REF switch to EXT.

b. Connect a 75 ohm coaxial cable from a 067-0546-00 calibration fixture 3.579545 MHz subcarrier 2 V p-p connector to the Type R520 EXT CW ϕ REF J311 connector.

c. Connect a 75 ohm end-line termination to the Type R520 EXT CW ϕ REF J310 connector.

d. Connect a 75 ohm coaxial cable from the 067-0546-00 calibration fixture 3.589488 MHz sideband video 707 mV connector to the Type R520 CH A J1 connector.

e. Connect a 75 ohm end-line termination to the CH A J2 connector.

f1. For instruments SN B150100 and up, connect a 1× probe from the 067-0546-00 calibration fixture phase-mark pulse output connector via a UHF male to BNC female adapter to pin BT on the Sweep board; see Fig. 5-51).

f2. For instruments below SN B150100, connect a 1× probe from the 067-0546-00 calibration fixture phase-mark pulse output connector via a UHF male to BNC female adapter to TP 1230 junction of Q1230 collector and D1235 on the Sweep board, see Fig. 5-5(b).

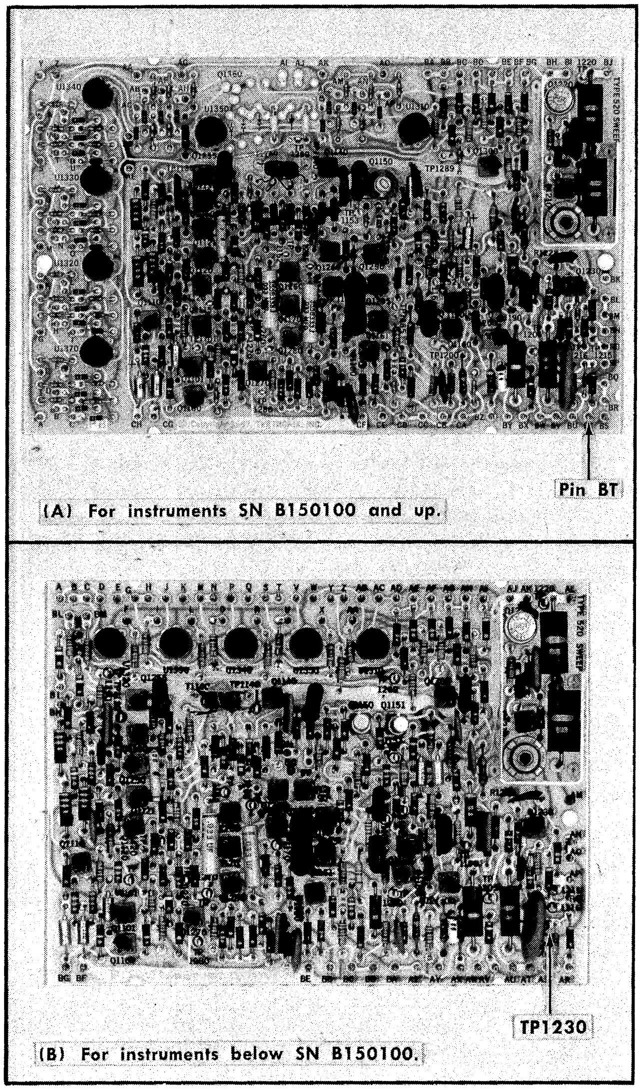

Fig. 5-5. Sweep board test point location.

g. Connect a 75 ohm coaxial cable between the 067-0546-00 calibration fixture h sync 1 V neg connector and the Type R520 EXT SYNC J120 connector.

h. Connect a 75 ohm end-line termination to the EXT SYNC J121 connector.

i. Set the Type R520 SYNC switch to EXT.

j. Set the 067-0546-00 calibration fixture to produce positive dots 10° apart.

k. Adjust the channel A PHASE control to align a dot with an arbitrarily established 0° point at one of the major points on the vector graticule.

l. CHECK—Type R520 display; the error between the 10° dots from the 067-0546-00 calibration fixture and the 10° marks on the vector graticule must be 1° or less.

m. Set the 067-0546-00 calibration fixture for an output of positive dots 2° apart.

n. Adjust the channel A PHASE control to align a dot with the arbitrarily established 0° point.

o. CHECK—Type R520 display; the area between the arbitrarily established 0° point and a point 10° away must have an error of 0.5° or less between the 2° dots from the 067-0546-00 calibration fixture and the 2° vector graticule marks.

p. Disconnect the 067-0546-00 calibration fixture, the three 75 ohm coaxial cables, the three 75 ohm end-line terminations, 1× probe and the UHF male to BNC female adapter.

19. Check Calibrated Phase Range and Accuracy

REQUIREMENT—Rotating the CALIBRATED PHASE dial from —15° to +15° must cause a vector display rotation of 30°, ±4°. CALIBRATED PHASE dial accuracy must be within ±10% per 2° change and within ±10% or 0.5°, whichever is the lesser, of the correct dial reading from +14° through —14°.

NOTE

Bottom cover of the Type R520 must be removed to gain access to the test point.

a. Set the ϕ REF switch to Burst and SYNC switch to INT. The pushbuttons remain as they are.

b. Connect a linearity staircase video signal to CH A J1 connector via a 75 ohm coaxial cable.

c. Connect a 75 ohm end-line termination to CH A J2 connector.

d. Set the CALIBRATED PHASE dial to —15°.

e. Using the channel A PHASE control set the Type R520 displayed vector to an arbitrarily established 0° point on the vector graticule.

f. Set the CALIBRATED PHASE dial to +15°.

g. CHECK—Type R520 display; displayed vector should have rotated 30°, ±4° clockwise.

h. Disconnect the video signal source, 75 ohm coaxial cable and 75 ohm end-line termination.

i. Set the ϕ REF switch to EXT and the CALIBRATED PHASE dial to 0.

j. Connect a 75 ohm coaxial cable from a 067-0546-00 calibration fixture 3.579545 MHz subcarrier 2 V p-p connector to the Type R520 EXT CW ϕ REF J311 connector.

k. Connect a 75 ohm end-line termination to the Type R520 EXT CW ϕ REF J310 connector.

l. Connect a 75 ohm coaxial cable from the 067-0546-00 calibration fixture 3.589488 MHz sideband video 707 mV connector to the Type R520 CH A J1 connector.

m. Connect a 75 ohm end-line termination to the CH A J2 connector.

n1. For instrument SN B150100 and up, connect a 1× probe from the 067-0546-00 calibration fixture phase-mark pulse output connector via a UHF male to BNC female adapter to pin BT on the Sweep board; see Fig. 5-5(a).

n2. For instruments below SN B150100, connect a 1× probe from the 067-0546-00 calibration fixture phase-mark pulse output connector via a UHF male to BNC female adapter to TP1230 (junction of Q1230 collector and D1235) on the Sweep board; see Fig. 5-5(b).

o. Connect a 75 ohm coaxial cable between the 067-0570-00 calibration fixture h sync 1 V neg connector and the Type R520 EXT SYNC J120 connector.

p. Connect a 75 ohm end-line termination to the EXT SYNC J121 connector.

q. Set the Type R520 SYNC switch to EXT.

r. Set the 067-0546-00 calibration fixture to produce positive dots 2° apart.

s. Adjust the channel A PHASE control to align a dot with an arbitrarily established 0° point on the vector graticule.

t. Rotate the CALIBRATED PHASE control from +14° toward —14° in increments of 2°.

u. CHECK—Type R520 display 2° dot which corresponds to the dial reading being checked when that dot is aligned with the established 0° point; the dial error between any 2° increment of the dial must be 2°, within ±0.2° of the dial setting noted when the dot for the previous dial setting was aligned with the established 0° point.

v. Set the CALIBRATED PHASE dial to +14°.

w. Adjust the channel A PHASE control to align a dot with an arbitrarily established 0° point on the vector graticule.

x. Rotate the CALIBRATED PHASE control from +14° toward —14° in increments of 2°.

y. CHECK—Type R520 display 2° dot which corresponds to the dial reading being checked when that dot is aligned with the estiablished 0° point; the dial error at the +12° and +10° dial settings must be 2°, within ±0.5° of the correct dial setting.

z. Disconnect the 067-0546-00 calibration fixture, the three 75 ohm coaxial cables, three 75 ohm end-line terminations, 1× probe and the UHF male to BNC female adapter.

20. Check Luminance Gain Accuracy

REQUIREMENT—1 volt of square-wave input signal must produce exactly 140 IRE units of deflection within ±1%.

a. Set the ϕ REF switch to BURST, depress the Display Selector Y pushbutton, and set the SYNC switch to INT.

b. Connect a 30 kHz square-wave signal 1 volt in amplitude from a square-wave generator via a 5 ns coaxial cable, GR to BNC male adapter, a 75 ohm to 50 ohm minimum loss attenuator and a BNC female to UHF male adapter to the Type R520 CH A J1 connector.

c. Connect a 50 ohm coaxial cable from the test oscilloscope channel 1 vertical input connector to the output square-wave signal connector of a standard amplitude calibrator.

d. Set the controls of the standard amplitude calibrator to produce a 1 volt amplitude square-wave signal.

e. Connect a 75 ohm coaxial cable via a BNC male to UHF female adapter and a 75 ohm BNC termination from the test oscilloscope channel 2 vertical input connector to the Type R520 CH A J2 connector.

f. Slowly change the frequency of the square-wave generator until a stable display is obtained.

g. Set the test oscilloscope for a vertical deflection of 0.5 V/division, AC coupled with input channels non-inverted, matched in gain and algebraically added, at a sweep rate of 5 ms/division with internal triggering.

h. Adjust the output amplitude of the square-wave generator until a test oscilloscope display indicates that the output square-wave generator signal is exactly 1 volt in amplitude, i.e., same as standard amplitude calibrator signal amplitude.

i. CHECK—Type R520 display; should be 140 IRE units in amplitude, ±1%.

j. Disconnect the square-wave generator, standard amplitude calibrator, test oscilloscope, 5 ns coaxial cable, GR to BNC male adapter, 75 ohm to 50 ohm minimum loss attenuator, BNC female to UHF male adapter, BNC male to UHF female adapter, 50 ohm BNC termination, 50 ohm coaxial cable, 75 ohm coaxial cable and 1× probe.

21. Check Luminance Calibrator Signal

REQUIREMENT—Must be 1 volt, ±0.5% in amplitude, which will produce 140 IRE units, ±0.5% of vertical deflection on the Type R520.

a. Press the Signal Selector A CAL pushbutton.

b. CHECK—Type R520 display amplitude; must be 140 IRE units, ±0.5%. The gain error noted in step 20 of this procedure should be taken into account.

22. Check Differential Gain Accuracy and Differential Phase Accuracy

REQUIREMENT—DIFF GAIN; display must not deviate more than ±5 IRE units from level in the last 90% of display. This includes both slope and aberrations. When output signal of the 067-0565-00 calibration fixture is reduced 5%, the trace must move 25 IRE units, ±3%. DIFF PHASE; deviation between the two traces at any point in the last 80% of display must not be less than 0.1°.

a. Press the Signal Selector CH A and CH B pushbuttons and the Display Selector VECTOR pushbutton. Set the SYNC switch to EXT.

b. Connect a 067-0565-00 calibration fixture to the CH A J1 connector. Connect a 75 ohm end-line termination to the CH A J2 connector.

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c. Connect a 75 ohm coaxial cable between the 067-0565-00 calibration fixture subcarrier input connector and the 067-0546-00 calibration fixture 3.579545 MHz subcarrier 2 V p-p connector.

d. Connect a 10× probe from the test oscilloscope vertical input connector to monitor the input signal going to the CH A J1 connector.

e. Set the test oscilloscope for a vertical deflection of 0.01 V/division, AC coupled, at a sweep rate of 0.5 ms/division with a free-running sweep.

f. Adjust the 067-0565-00 calibration fixture subcarrier amplitude control so a signal amplitude of exactly 143 mV is displayed on the test oscilloscope.

g. Disconnect the test oscilloscope and the 10× probe.

h. Connect a 75 ohm coaxial cable between the 067-0570-00 calibration fixture h sync 1 V neg connector and the Type R520 EXT SYNC J120 connector.

i. Connect a 75 ohm coaxial cable from the Type R520 EXT SYNC J121 connector to the vertical input of the test oscilloscope via a UHF female to BNC male adapter and a 75 ohm BNC termination.

j. Set the test oscilloscope for a vertical deflection of 1 V/division, AC coupled, at a sweep rate of 5 μs/division with internal triggering.

k. Adjust the test oscilloscope triggering controls to obtain a stable display.

l. Connect the center conductor of the 067-0565-00 calibration fixture ramp input connector to the test oscilloscope sawtooth output connector and set the 95%-100% switch to 100%.

m. Connect the shield of the 067-0565-00 calibration fixture ramp input connector to a ground point.

n. Adjust the 067-0565-00 calibration fixture ramp amplitude control for a sawtooth amplitude of exactly 140 IRE units.

o. Set the channel A 100%-75%-MAX GAIN switch to MAX GAIN and depress the Display Selector DIFF GAIN pushbutton.

p. Adjust the VERT POSITION control to position the display to a convenient point.

q. CHECK—Type R520 display; horizontal display must not deviate more than ±5 IRE units from being parallel throughout the last 90% of its length with the horizontal lines of the IRE graticule. This includes both slope and aberrations.

r. Set the 067-0565-00 calibration fixture 95%-100% switch to 95%.

s. CHECK—Type R520 display; trace must move 25 IRE units, ±3% from the position established in part q of this step.

t. Return the 067-0565-00 calibration fixture 95%-100% switch to 100%.

u. Press the Display Selector DIFF PHASE pushbutton.

v. Bring the display into the viewing area by adjusting the channel A PHASE controls until the two traces come together at a point.

w. Using the CALIBRATED PHASE dial, bring the traces together at different points, noting the degrees of difference between the various points.

x. CHECK—Type R520 CALIBRATED PHASE dial readings; deviation between the two traces in the last 80% of the display at any point on the lines must be less than 0.1°.

y. Disconnect the 067-0546-00 and 067-0565-00 calibration fixtures, test oscilloscope, three 75 ohm coaxial cables and 75 ohm end-line termination, the UHF female to BNC male adapter and the 75 ohm BNC termination.

23. Check Test Circle Amplitude

REQUIREMENT—Must be the same in diameter as the inscribed circle on the vector graticule (4 inches), ±1%.

a. Press the Signal Selector A CAL pushbutton and the Display Selector VECTOR pushbutton. Set the channel A 100%-75%-MAX GAIN switch to 75% and the SYNC switch to INT.

b. CHECK—Type R520 display; test circle must overlay within ±1% of the inscribed circle of the vector graticule at all points.

24. Check 100%-75% MAX GAIN Switch Gain

REQUIREMENT—100%; display must be 75%, ±2% of the display size seen in the 75% switch position. MAX GAIN; display must be 3.5 times, ±5% (in chrominance functions only) of the display size seen in the 75% switch position.

a. Press the Display Selector Y pushbutton.

b. CHECK—Type R520 display amplitude; exactly 140 IRE units, if it is not, readjust the Type R520 gain.

c. Set the channel A 100%-75%-MAX GAIN switch to 100%.

d. CHECK—Type R520 display amplitude; 105 IRE units ±2.8 IRE units.

e. Cancel the Signal Selector A CAL pushbutton. Set the channel A 100%-75%-MAX GAIN switch to 75%.

f. Press the Signal Selector B CAL pushbutton.

g. CHECK—Type R520 display amplitude; exactly 140 IRE units. If it is not, readjust the Type R520 gain.

h. Set the channel B 100%-75%-MAX GAIN switch to 100%.

i. CHECK—Type R520 display amplitude; 105 IRE units, ±2.8 IRE units.

j. Press the Signal Selector CH A and CH B pushbuttons and the Display Selector VECTOR pushbutton. Set the channel B 100%-75%-MAX GAIN switch to 75%.

NOTE

The following parts of this step apply only to instruments SN B150100 and up.

k. Connect a 067-0565-00 calibration fixture to the CH A J1 connector. Connect a 75 ohm end-line termination to the CH A J2 connector.

l. Connect a 75 ohm coaxial cable between the 067-0565-00 calibration fixture subcarrier input connector and the 067-0546-00 calibration fixture 3.579545 MHz subcarrier 2 V P-P connector.

m. Connect a 75 ohm coaxial cable between the 067-0546-00 calibration fixture h sync 1 V neg connector and the Type R520 EXT SYNC J120 connector.

n. Connect a 75 ohm end-line termination to the EXT SYNC J121 connector.

o. Set the Type R520 SYNC switch to EXT.

p. Connect a 10X probe from the test oscilloscope vertical input connector to monitor the input signal going to the CH A J1 connector.

q. Set the test oscilloscope for a vertical deflection of 0.01 V/division, AC coupled, at a sweep rate of 0.5 ms/division with a free-running sweep.

r. Adjust the 067-0565-00 calibration fixture subcarrier amplitude control so a signal amplitude of exactly 143 mV is displayed on the test oscilloscope.

s. Disconnect the test oscilloscope and the 10X probe.

t. Adjust the channel A PHASE control so the vector is aligned along the 0° reference line on the vector graticule.

u. Set the channel A 100%-75%-MAX GAIN switch to MAX GAIN.

v. CHECK—Type R520 display; vector must remain aligned with the 0° reference line and the end of the vector should be touching the inscribed circle on the vector graticule.

w. Disconnect the 067-0565-00 calibration fixture from the CH A J1 connector and connect it to the CH B J50 connector. Disconnect the 75 ohm end-line termination from the CH A J2 connector and connect it to the CH B J51 connector. The input signal from the 067-0546-00 calibration fixture remains connected to the 067-0565-00 calibration fixture.

x. Depress the Signal Selector Bϕ pushbutton.

y. Adjust the channel B PHASE control so the vector is aligned along the 0° reference line on the vector graticule.

z. Set the channel B 100%-75%-MAX GAIN switch to MAX GAIN.

aa. CHECK—Type R520 display; vector must remain aligned with the 0° reference line and the end of the vector should be touching the inscribed circle on the vector graticule.

ab. Disconnect the 067-0546-00 and 067-0565-00 calibration fixtures, two 75 ohm end-line terminations and two 75 ohm coaxial cables.

25. Check Subcarrier Regenerator Pull In Range, Time and Phase Shift versus Frequency

REQUIREMENT—Range; stable display must be obtained with a frequency of 3.579545 MHz ±15 Hz. Time; stable display must be obtained in 15 seconds. Phase shift versus frequency change; 0.6° or less phase shift for a 15 Hz frequency change from 3.579545 MHz.

a. Depress the Signal Selector CH A and Aϕ/Bϕ ALT pushbuttons and set the SYNC switch to EXT.

b. Set the channel B 100%-75%-MAX GAIN switch to 75%.

c. Connect a 75 ohm coaxial cable from a 067-0546-00 calibration fixture h-sync output connector to the Type R520 EXT SYNC J121 connector.

d. Connect a 75 ohm coaxial cable from the 067-0546-00 calibration fixture variable offset subcarrier 286 mV p-p connector to the Type R520 CH A J1 connector.

e. Connect a 75 ohm end-line termination to the Type R520 EXT SYNC J120 connector, to the CH B J51 connector and to the CH A J2 connector.

f. Rotate the 067-0546-00 frequency control for a zero hertz reading on the 067-0546-00 meter. This indicates that the output frequency at the variable offset subcarrier 286 mV p-p connector is 3.579545 MHz.

g. CHECK—Type R520 display; vector should be stable (not rotating).

h. Increase the 3.579545 MHz output frequency of the 067-0546-00 by 15 Hz.

i. Press the Signal Selector A CAL pushbutton for about fifteen seconds, then press the Signal Selector CH A pushbutton.

j. CHECK—Time Type R520 takes to stabilize to a stable vector display; fifteen seconds or less.

k. Decrease the output frequency of the 067-0546-00 back to 3.579545 MHz; then decrease it an additional 15 Hz.

l. Press the Signal Selector A CAL pushbutton for about fifteen seconds, then press the Signal Selector CH A pushbutton.

m. CHECK—Time Type R520 takes to stablize to a stable vector display; fifteen seconds or less.

n. Increase the output frequency of the 067-0546-00 back to 3.579545 MHz.

o. Align the vector along the 0° axis of the vector graticule, using the channel A PHASE control.

p. Increase the 3.579545 MHz output frequency of the 067-0546-00 by 15 Hz.

q. Turn off the 3.579545 MHz oscillator of the 067-0546-00 calibration fixture by pressing the pushbutton when making the following checks.

r. CHECK—Type R520 vector position; within 0.6° of the 0° axis of the vector graticule. CALIBRATED PHASE control can be used to measure the amount of vector shift.

s. Decrease the output frequency of the 067-0546-00 back to 3.579545 MHz, then decrease it an additional 15 Hz.

t. CHECK—Type R520 vector position; within 0.6° of the 0° axis of the vector graticule. CALIBRATED PHASE control can be used to measure the amount of vector shift.

u. Disconnect the 067-0546-00 calibration fixture, the two 75 ohm coaxial cables and the three 75 ohm end-line terminations.

26. Check Vertical Positioning Range

REQUIREMENT—Trace must position 45 IRE units above and 10 IRE units below the —40 IRE units graticule line in the Y, R, G and B modes of operation.

a. Cancel all Signal Selector pushbuttons except the full FIELD pushbutton. Press the Display Selector Y pushbutton and set the CALIBRATED PHASE dial to 0 and the SYNC switch to INT.

b. Turn the VERT POSITION control fully clockwise.

c. CHECK—Type R520 trace position; must be at least 45 IRE units above the —40 IRE units graticule line on the IRE graticule.

d. Turn the VERT POSITION control fully counterclockwise.

e. CHECK—Type R520 trace position; must be at least 10 IRE units below the —40 IRE units graticule line on the IRE graticule.

f. Press the Display Selector R pushbutton.

g. Repeat parts b through e of this step.

h. Press the Display Selector G pushbutton.

i. Repeat parts b through e of this step.

j. Press the Display Selector B pushbutton.

k. Repeat parts b through e of this step.

27. Check Horizontal Positioning Range

REQUIREMENT—Either end of the trace must position to within 0.3 centimeter of the center of the vector graticule. (On some instruments, the end of the trace may actually position past the center.)

a. Press the Display Selector Y pushbutton.

b. Turn the HORIZ POSITION control fully clockwise.

c. CHECK—Type R520 trace position; not more than 0.3 centimeter of trace must be to the left of the center of the IRE graticule.

d. Turn the HORIZ POSITION control fully counterclockwise.

e. CHECK—Type R520 trace position; not more than 0.3 centimeter of trace must be to the right of the center of the IRE graticule.

28. Check Vertical and Horizontal Position Clamp Range

REQUIREMENT—Either position clamp must have sufficient range to position the spot 2.5 IRE units either side of the vector graticule center and have a total positioning range of 20 IRE units.

a. Press the Display Selector VECTOR pushbutton.

b. Adjust the VERT- and HORIZ-POSITION CLAMP controls (see Fig. 5-2) to position the spot to the center of the vector graticule.

c. Rotate the VERT POSITION CLAMP control (see Fig. 5-2) fully clockwise.

d. CHECK—Type R520 spot position; must have moved up at least 2.5 IRE units from its initial position established in part b of this step. Use the IRE graticule to estimate the distance the spot moved.

e. Rotate the VERT POSITION CLAMP control (see Fig. 5-2) fully counterclockwise.

f. CHECK—Type R520 spot position; must have moved down at least 2.5 IRE units from the initial position established in part b of this step. Use the IRE graticule to estimate the distance the spot moved.

g. CHECK—Total Type R520 spot positioning; must have a total positioning range as noted in parts d and f of this step of 20 IRE units.

h. Rotate the HORIZ POSITION CLAMP control (see Fig. 5-2) fully clockwise.

i. CHECK—Type R520 spot position; must have moved right at least 2.5 IRE units from the initial position established in part b of this step.

j. Rotate the HORIZ POSITION CLAMP control (see Fig. 5-2) fully counterclockwise.

k. CHECK—Type R520 spot position; must have moved left at least 2.5 IRE units from the initial position established in part b of this step.

l. CHECK—Total Type R520 spot positioning; must have a total positioning range, as noted in parts i and k of this step, of 20 IRE units.

m. Readjust the VERT and HORIZONTAL POSITION CLAMP controls (see Fig. 5-2) to position the spot to the center of the vector graticule.

29. Check Channel A and B Gain Control Range

REQUIREMENT—Must cause the display amplitude to vary from 2 times its normal size to 0.7 times its normal size.

a. Press the Signal Selector CH A and Aϕ pushbuttons and the Display Selector Y pushbutton.

b. Connect a 30 kHz square-wave signal about 300 mV in amplitude from a square-wave generator via a 5 ns coaxial cable, GR to BNC male adapter, a 75 ohm to 50 ohm minimum loss attenuator and a BNC female to UHF male adapter to the Type R520 CH A J1 connector.

c. Connect a 75 ohm end-line termination to the CH A J2 connector.

d. Slowly change the frequency of the square-wave generator until a stable display is obtained.

e. Adjust the output amplitude control of the square-wave generator until a Type R520 display exactly 40 IRE units high is obtained.

f. Rotate the channel A GAIN control just out of its CAL detent position.

g. CHECK—Type R520 display amplitude; at least 80 IRE units of deflection.

h. Rotate the channel A GAIN control to the extreme of rotation from CAL position.

i. CHECK—Type R520 display amplitude; 28 IRE units or less.

j. Disconnect the square-wave generator, 5 ns coaxial cable, GR to BNC male adapter, 75 ohm to 50 ohm minimum loss attenuator, BNC female to UHF male adapter and 75 ohm end-line termination.

k. Cancel the Signal Selector CH A pushbutton and set the channel A GAIN control to CAL position.

l. Press the Signal Selector CH B and Bϕ pushbuttons.

m. Connect a 15 kHz square-wave signal about 300 mV in amplitude from a square-wave generator via a 5 ns coaxial cable, GR to BNC male adapter, a 75 ohm to 50 ohm minimum loss attenuator and a BNC female to UHF male adapter to the Type R520 CH B J50 connector.

n. Connect a 75 ohm end-line termination to the CH A J51 connector.

o. Slowly change the frequency of the square-wave generator until a stable display is obtained.

p. Adjust the output amplitude control of the square-wave generator until a Type R520 display exactly 40 IRE units high is obtained.

q. Rotate the channel B GAIN control just out of CAL detent position.

r. CHECK—Type R520 display amplitude; at least 80 IRE units of deflection.

s. Rotate the channel A GAIN control to the extreme of rotation from CAL position.

t. CHECK—Type R520 display amplitude; 28 IRE units or less.

u. Disconnect the square-wave generator, 5 ns coaxial cable, GR to BNC male adapter, 75 ohm to 50 ohm minimum loss attenuator, BNC female to UHF male adapter and 75 ohm end-line termination.

30. Check Luminance Gain Range

REQUIREMENT—Must cause the display amplitude to vary from 1.4 times its normal size to 0.7 times its normal size.

a. Cancel the Signal Selector CH B pushbutton and set the channel B GAIN control to CAL position.

b. Press the Signal Selector CH A and Aϕ pushbuttons.

c. Connect a 30 kHz square-wave signal about 300 mV in amplitude from a square-wave generator via a 5 ns coaxial cable, GR to BNC male adapter, a 75 ohm to 50 ohm minimum loss attenuator and a BNC female to UHF male adapter to the Type R520 CH A J1 connector.

d. Connect a 75 ohm end-line termination to the CH A J2 connector.

e. Slowly change the frequency of the square-wave generator until a stable display is obtained.

f. Adjust the output amplitude control of the square-wave generator until a Type R520 display exactly 40 IRE units high is obtained.

g. Rotate the LUMINANCE GAIN control just out of CAL detent position.

h. CHECK—Type R520 display amplitude; at least 56 IRE units of deflection.

i. Rotate the LUMINANCE GAIN control to the extreme of rotation from CAL position.

j. CHECK—Type R520 display amplitude; 28 IRE units or less.

k. Return the LUMINANCE GAIN control to CAL position.

l. Disconnect the square-wave generator, 5 ns coaxial cable, GR to BNC male adapter, 75 ohm to 50 ohm minimum loss attenuator, BNC female to UHF male adapter and 75 ohm end-line termination.

31. Check External Phase Reference Input Range

REQUIREMENT—Test circle size and shape must not change as the 3.58 MHz ϕ reference signal amplitude is varied between 1.5 volt and 2.5 volts.

a. Press the Signal Selector B CAL pushbutton and the Display Selector VECTOR pushbutton. Set the ϕ REF switch to EXT.

b. Connect a 2 volt peak to peak 3.58 MHz continuous wave (CW) video signal via a 75 ohm coaxial cable to the Type R520 EXT CW ϕ REF J310 connector.

c. Connect a color bar video signal via a 75 ohm coaxial cable to the Type R520 CH A J1 connector.

d. Connect a 75 ohm end-line termination to the EXT CW ϕ REF J311 connector and to the CH A J2 connector.

e. Connect a 10X probe from the test oscilloscope vertical input connector to the input signal going to the EXT CW ϕ REF J310 connector.

f. Set the test oscilloscope for a vertical deflection of 0.05 V/division, AC coupled, at a sweep rate of 0.2 μs/division with internal triggering.

g. Adjust the peak-to-peak output amplitude of the 3.58 MHz CW video signal until a test oscilloscope display exactly 4 major divisions high is obtained.

h. Rotate the channel A PHASE control to align the burst with the burst axis of the vector graticule.

i. Vary the 3.58 MHz CW video signal amplitude between 1.5 volt and the 2.5 volt peak to peak, using the test oscilloscope to measure the signal amplitude.

j. CHECK—Type R520 test circle display; test circle must not change in size or shape as part i of this step is accomplished.

k. Disconnect the video signal source, test oscilloscope, the two 75 ohm coaxial cables, the two 75 ohm end-line terminations and the 10X probe.

32. Check External Horizontal Sync Range

REQUIREMENT—Stable display must be obtained with an external sync input signal whose amplitude is between 3.5 volts and 7.5 volts.

a. Cancel the Signal Selector CH A pushbutton and press the CH B and Bϕ pushbuttons.

b. Set the ϕ REF switch to BURST and press the Display Selector LINE SWEEP pushbutton.

c. Set the SYNC switch to EXT.

d. Connect the linearity staircase video signal via a 75 ohm coaxial cable to the Type R520 CH B J50 connector.

e. Connect a 4 volt peak-to-peak sync video signal via a 75 ohm coaxial cable to the EXT SYNC J120 connector.

f. Connect a 75 ohm end-line termination to the EXT SYNC J121 connector and to the CH B J51 connector.

g. Connect a 10X probe from the test oscilloscope vertical input connector to the input signal going to the EXT SYNC J120 connector.

h. Set the test oscilloscope for a vertical deflection of 0.2 V/division, AC coupled, at a sweep rate of 20 μs/division with internal triggering.

i. Adjust the peak-to-peak output amplitude of the sync video signal until a test oscilloscope display exactly 2 major divisions high is obtained.

j. Adjust the BURST FLAG TIMING control for the proper Type R520 display; refer to step 9 of this procedure.

k. Vary the sync video signal amplitude between 3.5 volts and 7.5 volts peak to peak, using the test oscilloscope to measure the signal amplitude. Interrupt the sync video signal by momentarily setting the SYNC switch to INT before making the check at a particular sync video signal amplitude.

l. CHECK—Type R520 display; a stable display must be obtained whenever the SYNC switch is set to its EXT position as part k of this step is accomplished.

m. Disconnect the video signal source, test oscilloscope, the two 75 ohm coaxial cables, the two 75 ohm end-line terminations and the 10X probe.

33. Check Instrument Return Loss

a. Connect the 067-0576-00 calibration fixture to the vertical input connectors of the test oscilloscope.

b. Connect a 0.5 V, 5 MHz sine-wave signal from a wide bandwidth constant amplitude sine wave generator via a 50 ohm coaxial cable and a 75 ohm to 50 ohm minimum loss attenuator to the signal input connector on the 067-0576-00 calibration fixture.

c. Connect the matched 75 ohm terminations to the end of each coaxial cable of the 067-0576-00 calibration fixture.

d. Set the test oscilloscope for a vertical deflection of 0.2 V/division both input channels set for A-B operation with a free running sweep.

e. Remove one matched 75 ohm termination and adjust the constant amplitude sine wave generator for a 0.5 V, 5 MHz output sine wave signal as observed on the test oscilloscope, then replace the matched 75 ohm termination.

f. Set the test oscilloscope for a vertical deflection of 1 mV/division, both input channels AC coupled, and set for A-B operation at a sweep rate of 20 μs/division with a free-running sweep.

g. Vary the constant amplitude sine wave generator frequency from 25 Hz to 5 MHz.

h. CHECK—Test oscilloscope display amplitude; should be 1 mV or less at any frequency between 25 Hz and 5 MHz.

i. Disconnect a 75 ohm termination from the end of the measuring cable then, attach the measuring cable via the BNC female to UHF male adapter to the R520 CH A J1 connector and the 75 ohm termination just removed to the CH A J2 connector via the BNC female to UHF male adapter. The BNC male to UHF female adapter remains connected to the 75 ohm termination.

j. Vary the constant amplitude sine wave generator frequency from 25 Hz to 5 MHz.

k. Push the Type R520 Signal Selector CH A and then the A CAL pushbuttons.

l. CHECK—Test oscilloscope display amplitude; should never be more than 5 mV minus the signal amplitude noted in part h of this step, at any frequency from 25 Hz to 5 MHz.

m. Disconnect the measuring cable and adapter from the Type R520 CH A J1 connector and connect it to the CH B J50 connector. Disconnect the 75 ohm termination and adapters from the CH A J2 connector and connect it to the CH B J51 connector.

n. Vary the constant amplitude sine wave generator frequency from 25 Hz to 5 MHz.

o. Push the Type R520 Signal Selector CH B and then the B CAL pushbuttons.

p. CHECK—Test oscilloscope display amplitude; should never be more than 5 mV minus the signal amplitude noted in part h of this step, at any frequency from 25 Hz to 5 MHz.

q. Disconnect the measuring cable and adapter from the Type R520 CH B J50 connector and connect it to the EXT CW ϕ REF J310 connector. Disconnect the 75 ohm termination and adapters from the CH B J51 connector and connect it to the EXT CW ϕ REF J311 connector.

r. Vary the constant amplitude sine wave generator frequency from 25 Hz to 5 MHz.

s. Switch the Type R520 ϕ REF switch between its BURST and EXT positions.

t. CHECK—Test oscilloscope display amplitude; should never be more than 5 mV minus the signal amplitude noted in part h of this step, at any frequency from 25 Hz to 5 MHz.

u. Disconnect the measuring cable and adapter from the Type R520 EXT CW ϕ REF J310 connector and connect it to the EXT SYNC J120 connector. Disconnect the 75 ohm termination and adapters from the EXT CW ϕ REF J311 connector and connect it to the EXT SYNC J121 connector.

v. Vary the constant amplitude sine wave generator frequency from 25 Hz to 5 MHz.

w. Switch the Type R520 SYNC switch between its INT and EXT positions.

x. CHECK—Test oscilloscope display amplitude; should never be more than 2.5 mV (4 volt connection), or 5 mV (1 volt connection) minus the signal amplitude noted in part h of this step, at any frequency from 25 Hz to 5 MHz.

y. Disconnect the 067-0576-00 calibration fixture (this includes the 75 ohm termination and the two BNC female to UHF male adapters and the BNC male to UHF female adapter still attached to the Type R520), wide bandwidth constant amplitude sine wave generator, test oscilloscope, 50 ohm coaxial cable and 75 ohm to 50 ohm minimum loss attenuator.

34. (Optional Step) Check Phase Jitter

REQUIREMENT—Must be less than 1° of display jitter when 51 mV RMS of white noise is inserted onto an incoming video signal.

a. Depress the Signal Selector CH A, CH B and Aϕ/Bϕ ALT pushbuttons and Display Selector DIFF PHASE pushbutton. Set the channel B 100%-75%-MAX GAIN switch to MAX GAIN, ϕ REF to BURST and the SYNC switch to INT.

b. Connect a color bar video signal via a 75 ohm coaxial cable to the Type R520 CH A J1 connector.

c. Connect a linearity staircase video signal via a 75 ohm coaxial cable to the Type R520 CH B J50 connector.

d. Connect a 75 ohm end-line termination to the CH A J2 connector and to the CH B J51 connector.

e. Adjust the channel B PHASE control to position the resultant linearity staircase waveform onto the display area.

f. Insert onto the color bar video signal 51 mV RMS (73 mV peak to peak) of white noise.

g. CHECK—Type R520 display jitter on the resultant linearity staircase waveform; must be less than 1°. Use the CALIBRATED PHASE control to measure the amount of display jitter.

This completes the performance check of the Type R520. Disconnect all test equipment and replace the bottom cover.

SECTION 6
CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

Complete calibration information for the Type 520 is given in this section. This procedure calibrates the instrument to the performance requirements listed in the Specification section. The Type 520 can be returned to original performance standards by completion of each step in this procedure. Limits, tolerances, and waveforms are given as calibration guides and are not instrument specifications. To merely touch up the calibration, perform only those steps entitled "Adjust. . .". A short-form calibration procedure is also provided for the convenience of the experienced calibrator.

The Type 520 should be checked, and recalibrated if necessary, after each 1000 hours of operation, or every six months if used infrequently to assure correct operation and accuracy. The Performance Check section provides a complete check of instrument performance without making internal adjustments. Use the performance check procedure to verify the calibration of the Type 520 and determine whether recalibration is required.

TEST EQUIPMENT REQUIRED

General

The following test equipment, or its equivalent, is required for complete calibration of the Type 520. Specifications given are the minimum necessary for accurate calibration of this instrument. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

The Type 520/R520 NTSC Vectorscopes (SN B180000-up) are equipped with BNC type connectors for all signal inputs.

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed here can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Precision DC voltmeter. Accuracy, within ±0.025%; range 0 to 20 volts. For example, Fluke Model 825A.

2. DC Voltmeter (VOM). Minimum sensitivity, 20,000 ohms/volt. Accuracy within ±5% at 3.6 V; ±3.5% at 10 V and 100 V, ±7% at 275 V, and within ±3% at 3875 V. For example Triplett Model 630 NA.

3. Test oscilloscope: Bandwidth, DC to at least 10 MHz; minimum deflection factor, 0.005 volt/division; DC offset voltage, 0 to 7 volts; two input channels providing choice of independent channel operation, alternate-trace or algebraically added two channel operation, and one channel designed for display inversion. Tektronix Type 547 Oscilloscope with Type 1A1 and Type 1A5[1] Plug-In Units, and two each Tektronix P6023 (10X) and P6028 (1X) Probes recommended; or Tektronix 7403N Oscilloscope with 7A13, 7A18 and 7B53N Plug-In Units, and two P6055 (10X) and one P6011 (1X) probes recommended.

4. Variable autotransformer: Must be capable of supplying at least 200 volt/amperes over a voltage range of 90 to 136 volts (180 to 272 volts for 230-volt nominal line). If autotransformer does not have an AC voltmeter to indicate output voltage, monitor output with an AC voltmeter (RMS) with a range of at least 136 (or 272) volts. For example, General Radio W10MT3W Metered Variac Autotransformer.

5. Video Signal Source with the following outputs:

Comp Video:	Color Bar and Staircase	1 V P-P into 75 Ω
Comp Sync:		4 V into 75 Ω
Subcarrier:		2 V into 75 Ω

Tektronix Type 140 NTSC Test Signal Generator is used in this procedure.

6. Medium frequency constant amplitude signal generator. Frequency, variable from 3 MHz to 18 MHz; output amplitude, adjustable to 1 volt; amplitude regulation accuracy, within ±5%. Tektronix Type 191 Constant Amplitude Signal Generator recommended.

7. Wide bandwidth constant amplitude generator.[1] Frequency, variable from below 25 Hz to above 5 MHz; output

[1] **Required only if step 52 is performed.**

amplitude, adjustable from about 1 volt to about 2 volts; amplitude regulation, 0.5%. For example, Hewlett-Packard Model 652A generator.

8. Standard amplitude calibrator (optional); Amplitude accuracy, within 0.25%; signal amplitude, 1 volt; output frequency, 1 kHz. Tektronix calibration fixture 067-0502-00 recommended. Used in step 18A which is an alternative procedure for step 18.

9. Subcarrier Frequency Offset test fixture (optional). Used in step 44 to change the Type 140 subcarrier frequency ±15 Hz. Construct the test fixture according to the information given in Fig. 6-1A.

10. Ramp and sine wave adder: Tektronix calibration fixture 067-0565-00 recommended.

11. Return loss bridge.[1] Tektronix calibration fixture 015-0149-00 recommended.

12. Cable (four) (SN B180000-up): Impedance, 75 ohms; length, 42 inches, connectors, BNC. Tektronix Part No. 012-0074-00.

12A. Cable (four) (SN B010100-B170979): Impedance, 75 ohms, length, 42 inches, connectors, UHF; Tektronix Part No. 012-0083-00.

13. Cable. Impedance, 50 ohms; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-01.

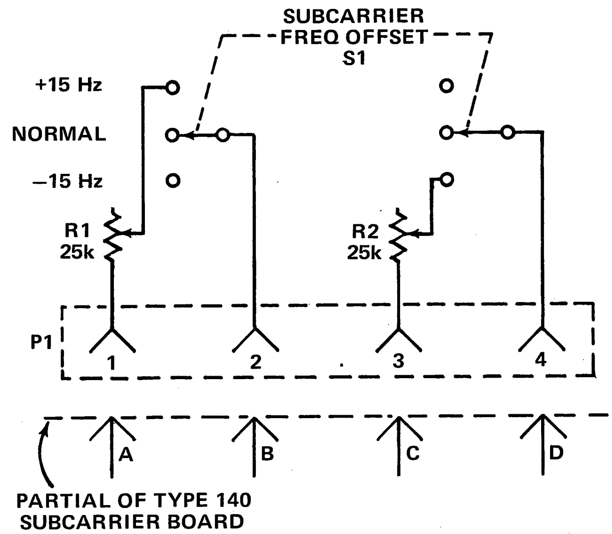
14. Connector, dual-input cable: Connectors, BNC. Tektronix Part No. 067-0525-00.

15. Attenuator. Connectors, BNC; impedance, 50 ohms to 75 ohms; type, minimum loss when going from a 50 ohm system to a 75 ohm system. Tektronix Part No. 011-0057-00.

16. Variable attenuator: For use in steps 50 and 51 to vary the Type 140 output signal. Construct according to the information given in Fig. 6-1B.

17. Termination (three) (SN B180000-up): Impedance, 75 ohms; connector, BNC; type, end-line; 0.5 W. Tektronix Part No. 011-0102-00.

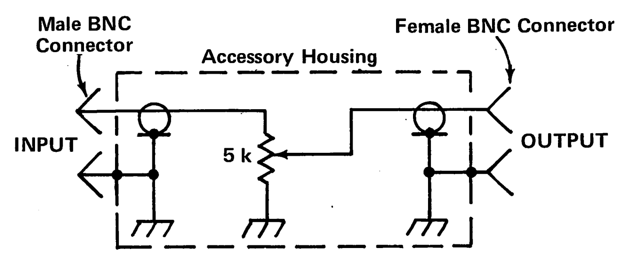
17A. Termination (three) (SN B010100-B170979): Impedance, 75 ohms; connector, UHF; type, end-line; 0.5 W. Tektronix Part No. 011-0104-00.



PARTS LIST

Ckt. No.	Tektronix Part No.	Description
R1, R2	311-0390-00	Resistor, 25 kΩ, variable, comp, ±20%
S1	260-0396-00	Switch, toggle, DP3T, miniature, center OFF
P1	352-0200-00	Holder, terminal connector, 4 wire

(A) Subcarrier frequency offset test fixture used in step 44 (optional).



PARTS LIST

Tektronix Part No.	Description
011-0081-00	Accessory housing without electrical components. Equipped with BNC connectors.
311-0310-00	Resistor, 5 k, variable, comp, miniature, ±20%
366-0083-00	Knob (optional), small, gray

(B) Variable attenuator used in steps 50 and 51.

Fig. 6-1. Special test fixtures that must be constructed for use in the calibration procedure.

18. Termination: Impedance, 75 ohms; connectors, BNC; type, feed-thru; 1 W. Tektronix Part No. 011-0055-00.

19. Termination. Impedance, 50 ohms; connectors, GR to BNC male; type, feed-thru; 1 W. Tektronix Part No. 017-0083-00.

20. Adapter, clip lead: BNC female to alligator clip leads. Tektronix Part No. 013-0076-00.

21. Adapter.[2] Connectors, UHF male to BNC female. Tektronix Part No. 103-0015-00.

22. Adapter.[2] Connectors, UHF female to BNC male. Tektronix Part No. 103-0032-00.

23. Adapter: Connectors, GR to BNC male. Tektronix Part No. 017-0064-00.

24. Adjustment tools.

	Description	Tektronix Part No.
a.	Tuning tool; 5 inches long, plastic for adjusting 0.1-inch (ID) hex cores.	003-0301-00
b.	Tuning tool Handle	003-0307-00
	Insert, low capacitance, with wire pin	003-0308-00
	Insert, for 5/64-inch (ID) hex cores	003-0310-00
c.	Insulated screwdriver, 1 1/2-inch shaft, non-metallic	003-0000-00
d.	Screwdriver, 3-inch shaft	033-0192-00
e.	Hexagonal wrench, 1/16-inch tip	033-0089-00
f.	Wrench, nutdriver, 1/2-inch shaft	033-0318-00
g.	Phillips screwdriver, small tip.	Not available through Tektronix, Inc.

CALIBRATION RECORD AND INDEX

This short-form calibration procedure may be used as a calibration guide by the experienced calibrator, or it may be used as a record of calibration. Since the step numbers and titles correspond to those used in the complete procedure, it also serves as an index to the complete procedure.

Type 520, Serial No. ______________________

Calibration Date ______________________

Calibration Technician ______________________

[2]Connected to item 10 when calibrating instruments SN B180000 and up. Three (total) are required, when calibrating instruments below SN B180000, to facilitate interconnection of test equipment with BNC connectors.

1. Adjust—15 Volt Power Supply, R1588 — Page 6-8

−15 volts, +0.5% (75 mV)

2. Check Low-Voltage Power Supply Voltages — Page 6-8

+3.6 volts, ±5% (±0.18 V); +10 volts, +3.5% (±0.35 V).

+100 volts, ±3.5% (±3.5 V); +275 volts, ±7% (±19.25 V).

3. Check Low-Voltage Power Supply Ripple — Page 6-9

Power Supply	Max Ripple
−15 volt	10 mV
+3.6 volt	100 mV
+10 volt	10 mV
+100 volt	20 mV
+275 volt	500 mV

4. Check High-Voltage Power Supply — Page 6-9

−3.875 kV ±3% (+116.25 V). Voltage reading must not change more than ±40 V as INTENSITY control is rotated from its fully clockwise position to its fully counterclockwise position.

5. Adjust Geometry, R1472 — Page 6-9

Voltage at center arm of GEOM control should be about 20 V below voltage at upper CRT plate connection. Display of vertical and horizontal lines must have 0.05 centimeter or less of gradual bowing.

6. Adjust Astigmatism, R1476 — Page 6-10

Obtain a round spot with FOCUS control set fully counterclockwise.

7. Adjust CRT alignment, R1470 and R1474 — Page 6-10

R1470—A vertical trace should be parallel throughout its length with 90°—270° axis.

R1474—A horizontal trace should be parallel throughout its length with the 0°—180° axis.

8. Adjust Unblanking Bias, R1478 — Page 6-11

Obtain uniform intensity throughout the circumference of a test circle which is barely visible.

9. Adjust VITS Intensity, R1228 — Page 6-11

With VITS 18 pushbutton pressed, should obtain maximum display brightness without display defocusing.

10. Adjust DC Balance of R-Y Amplifier, R624 — Page 6-12

Voltage at pin AD (below SN B200000, TP630) must be 0.0 volt.

11. Adjust DC Balance of B-Y Amplifier, R644 — Page 6-13

Voltage at TP650 must be 0.0 volt.

12. Adjust DC Balance of Y Amplifier, R672 — Page 6-13

Voltage at TP680 must be +0.5 volt.

13. Adjust Horizontal Common Mode Level R880, R1002, R985, and R875 — Page 6-13

R880—Vertically position spot to center of vector graticule.

R1002—Horizontally position spot to center of vector graticule.

R985—Obtain a +5.6 voltage between TP980 and ground.

R875—Obtain a +5.6 voltage between TP870 and ground.

14. Adjust Clamp Pulse Timing, R905 — Page 6-14

The alternately displayed waveforms from TP805 and TP905 must meet or exceed the minimum waveform amplitude shown in Fig. 6-9.

15. Adjust Channel A and B — Page 6-14

Input Amplifier Frequency Response Gain, C2 and C52.

C2—Peaks of yellow and cyan color bars at TP85 must be equal to 100 IRE unit white bar.

C52—Peaks of yellow and cyan color bars at TP95 must be equal to 100 IRE unit white bar.

16. Adjust Test Circle Oscillator, L46 and R45 — Page 6-16

Voltage at TP41 should be approximately —0.4 volt. The signal at TP49 should be approximately 707 mV in amplitude.

17. Adjust Test Circle Oscillator Compensation, C66 and C18 — Page 6-16

Channel A and B test circles should be the same diameter as that produced by the 707 mV 3.58 MHz signal applied from the generator to the Type 520.

18. Adjust Luminance Calibrator, R583 — Page 6-17

Voltage reading at TP583 should be 1 volt more positive with Q571 removed than when Q570 is removed.

19. Adjust Channel A Gain, R402 — Page 6-18

The signals at TP583 and TP450 must exactly match each other.

20. Adjust Channel B Gain, R412 — Page 6-18

Channel B calibrator display amplitude should match the amplitude of Channel A display.

21. Adjust Subcarrier Regenerator Input 3.58 MHz Filter, L220 and L221 — Page 6-19

L220—Signal at TP220 should be at minimum amplitude, about 2.5 volts or less.

L221—Signal at TP222 should be at maximum amplitude, about 0.2 volt or greater.

22. Check Burst Intensification Pulse — Page 6-20

Should appear similar to the waveform shown in Fig. 6-15.

23. Adjust Burst Gate Pulse, R1158 — Page 6-21

Should have a peak-to-peak amplitude of at least 7 volts or greater. Waveform should appear as shown in Fig. 6-16, Type 520 display should be stable and have no jitter. Burst sampling point should be positionable at least ±0.5 μs.

24. Adjust Subcarrier Regenerator DC Balance R250; (SN B150100-up) Centering, R243 — Page 6-21

See complete procedure.

25. Check Subcarrier Regenerator Circuit 3.58 MHz Output Signal — Page 6-22

3.58 MHz output signal must be at least 4 volts peak to peak.

26. Check Oven Preheater Operation — Page 6-23

Voltage between TP295 and ground should be the same as the voltage between pin Q, R or S of the Rectifier board and ground after the Type 520 has been on at least 20 minutes.

27. Adjust Subcarrier Filter, L545 and L547 — Page 6-24

L545—3.58 MHz subcarrier signal at TP590 should be at maximum amplitude, approximately 1.2 volts peak to peak.

L547—Should be 33°, ±2° of clockwise display rotation when the VECTOR pushbutton is held depressed and the I or Q pushbutton is pressed enough to make momentary contact.

After making the above adjustments, recheck the voltage levels at pin AD (TP630) and TP650 as per steps 10 and 11 of this procedure.

28. Adjust 10.4 MHz and 18 MHz Traps, C454 and C453 — Page 6-24

C454—Obtain minimum circle diameter or a spot when 1 volt of 10.4 MHz sinewave signal is connected to the input.

C453—Obtain minimum circle diameter or a spot when 1 volt of 18 MHz sinewave signal is connected to the input.

29. Adjust Subcarrier Balance, R501, C593 and C503 — Page 6-25

See complete procedure.

30. Adjust Quadrature Phase Alignment, C586 — Page 6-25

Test circles must overlay each other at the 45° point on their circumference within 0.0362 inch.

31. Adjust Vertical Gain, R484 — Page 6-25

1 volt luminance calibrator signal should produce exactly 140 IRE units of deflection.

32. Adjust Chroma R-Y Gain, R626 — Page 6-26

Test circle must be tangent to the inscribed circle on the vector graticule at the 90° and 270° points.

33. Adjust Horizontal Gain to match Vertical Gain, R968 — Page 6-26

After connecting the vertical (R-Y) output to the horizontal amplifier input, obtain a trace whose length is the same as the diameter of the inscribed circle on the vector graticule.

34. Adjust Chroma B-Y Gain, R646 — Page 6-26

With GAIN BAL control set to its midrange position, the test circle must be tangent to the inscribed circle on the vector graticule at the 0° and 180° points.

35. Adjust Transient Response, L610 through L618, R849, C848, L858, L838, R968, R969, C968, C958, L958, L978, L601, L602, L606 and L607 — Page 6-27

See complete procedure.

36. Adjust L272, L279; Feedback Components (for instruments B150100 and up); Input Phasing (for instruments B030000 to B150100) — Page 6-30

Differential Phase—Must have less than 0.1° deviation between the two traces at any point in the last 80% of the display.

See complete procedure.

37. Adjust Calibrated Phase Control, L331, L332, and R335 — Page 6-33

See complete procedure.

38. Adjust Diff Gain Mode Compensation, R498 — Page 6-35

With the baseline of the staircase waveform setting at the −40 IRE unit line and the top of the last step setting at the +100 IRE unit line of the luminance graticule when the Y pushbutton is pressed and the 100%-75%-MAX GAIN switch is set to 75%, the display when the DIFF GAIN pushbutton is pressed and the 100%-75%-MAX GAIN switch is set to MAX GAIN must be set at the 30 IRE unit line of the luminance graticule, see Figs. 6-26A and 6-26B.

39. Check Input Amplitude Range — Page 6-35

Stable display for sync pulse amplitudes between 200 mV and 400 mV, signal amplitudes between 0.7 volt and 1.4 volts.

40. Check Differential Gain Deflection Factor and Differential Gain — Page 6-36

Differential Gain—Trace must not have any aberrations or slope which will cause it to deviate more then ±5 IRE units away from being parallel to the luminance graticule horizontal lines throughout the last 90% of its length. When output signal of the 067-0565-00 calibration fixture is reduced 5%, the trace must move 25 IRE units, ±5%.

41. (For instruments SN B150100-up)—Check 100%-75%-MAX GAIN Switch Gain — Page 6-38

See complete procedure.

41A. (For instruments below SN B150100)—Check 100%-75%-MAX GAIN Switch Gain — Page 6-38

See complete procedure.

42. Check Color Bar Decoding Accuracy — Page 6-39

Color bars should extend from 7.5% setup to 77 IRE units within ±3% when blanking level is aligned with 0 IRE unit graticule line.

43. Check Time Sharing Switching Rate — Page 6-39

Test oscilloscope display from TP776 should show two channel A displays then two Channel B displays, etc.

44. (Optional Step)—Check Subcarrier Regenerator Pull In Range and Time — Page 6-40

Type 520 should present a stable vector display of a 3.579545 MHz, ±15 Hz, signal within 15 seconds after it is applied.

Vector position must not vary more than 0.6° as the 3.579545 MHz signal is varied 15 Hz above and below the center frequency.

45. Check Vertical Positioning Range — Page 6-40

−10 IRE units and +45 IRE units from the −40 IRE units luminance graticule line in the Y, R, G and B modes of operation.

46. Check Horizontal Positioning Range — Page 6-41

Clockwise—Not more than 3 mm of trace to left of luminance graticule center.

Counterclockwise—Not more than 3 mm of trace to right of luminance graticule center.

47. Check Vertical and Horizontal Position Clamp Range — Page 6-41

Vertical—Must position spot at least 2.5 IRE units above and below the center of the vector graticule.

Horizontal—Must position spot at least 2.5 IRE units to the left and right of the center of the vector graticule.

48. Channel A and B Gain Control Range — Page 6-42

Signal from TP450 must be at least double when the appropriate GAIN control is just moved out of its CAL detent position.

Signal from TP450 must drop to at least 0.7 times its CAL position signal when the appropriate GAIN control is rotated fully to the far end away from CAL position.

49. Check Luminance Gain Range — Page 6-42

Signal from TP776 must increase to at least 1.4 times its CAL position signal when the LUMINANCE GAIN control is just moved out of its CAL detent position. Signal from TP776 must decrease to at least 0.7 times its CAL position signal when the LUMINANCE GAIN control is rotated fully to the far end away from CAL position.

50. Check External Phase Reference Input Range — Page 6-43

Test circle must not change in size or shape, as an external 3.58 MHz video signal is varied in amplitude from 1.5 volts to 2.5 volts peak to peak.

51. Check External Horizontal Sync Range — Page 6-43

Stable display must be obtained using an external sync video signal whose amplitude is varied between 3.5 volts and 7.5 volts peak to peak. The sync video signal is interrupted momentarily before making the check at a particular sync video signal amplitude.

52. Check Instrument Return Loss — Page 6-44

See complete procedure.

53. (Optional Step) Check Phase Jitter — Page 6-46

Less than 1° of jitter on the modulated staircase resultant waveform when 51 mV RMS of white noise has been inserted onto the modulated staircase signal. Use the CALIBRATED PHASE control to measure the amount of display jitter.

CALIBRATION PROCEDURE

General

The following procedure is arranged in a sequence which allows the Type 520 to be calibrated with the least interaction of adjustments and reconnection of equipment. However, some adjustments affect the calibration of other circuits within the instrument, therefore, it will be necessary to check the operation of other parts of the instrument. When a step interacts with others, the steps which need to be checked are noted in the "INTERACTION— . . ." step.

The following procedure uses the equipment listed under Equipment Required. If equipment is substituted, control settings or test equipment setup may need to be altered to meet the requirements of the equipment used.

NOTE

All waveforms shown in this procedure are actual waveform photographs taken with a TEKTRONIX Oscilloscope Camera System.

Any maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the techniques given in the Maintenance section.

The steps titled "Adjust . . ." also provide a check of instrument performance, whenever possible, before the adjustment is made. The symbol ◐ is used to identify the steps in which an adjustment is made. To prevent recalibration of other circuits when performing a partial calibration, readjust only if the listed tolerance is not met. However, when performing a complete calibration, best overall performance will be provided if each adjustment is made to the exact setting, even if the "CHECK— . . ." is within the allowable tolerance.

In the following procedure, a list of front-panel control settings for the Type 520 is given preceding each major group of adjustments and checks. Controls whose settings are not important to the group of adjustments are not listed. To aid in locating individual controls which have been changed during complete calibration, these control names are printed in bold type. Pushbuttons which are not called out are assumed to be cancelled. If only a partial calibration is performed, start with the nearest complete list of control settings preceding the desired portion. Type 520 front- and rear-panel and internal adjustment control titles referred to in this procedure are capitalized (e.g., INTENSITY, or LUM DC BAL).

Preliminary Procedure

1. Remove the top and bottom covers from the Type 520 and set the instrument on its right side.

2. Connect the autotransformer to a suitable power source and connect the Type 520 to the autotransformer output.

3. Set the autotransformer output voltage to the design center voltage for which the Type 520 line voltage selector assembly has been set.

4. Set the front- and rear-panel controls of the Type 520 as described below.

5. Set the Type 520 POWER switch to ON. Allow at least 20 minutes warmup at 25°C, ±5°C before making any checks or adjustments.

NOTES

Front-Panel Controls:

Signal Selector	FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	No buttons pressed
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

1. Adjust —15 Volt Power Supply

a. Connect a precision DC voltmeter between ground and low voltage power supply board pin AD; see Fig. 6-2.

b. CHECK—Voltmeter reading; —15 volts, ±0.5% (±0.07 V).

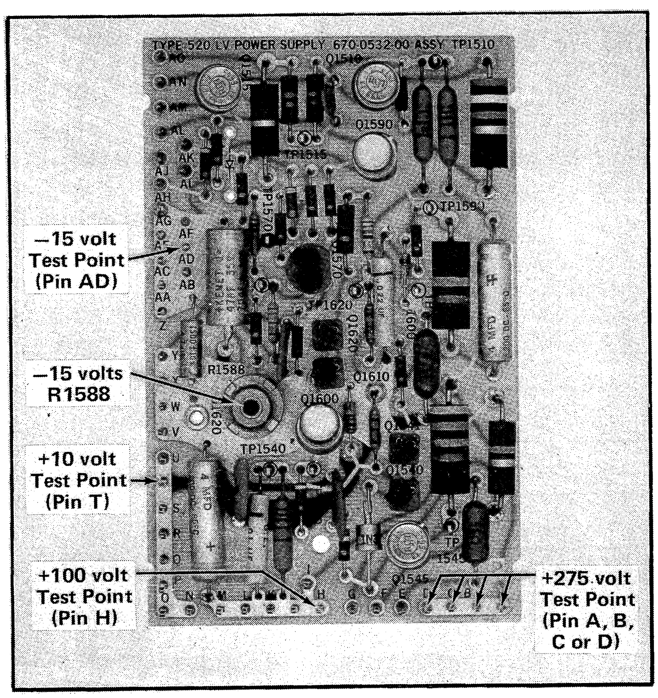


Fig. 6-2. Low-voltage power supply board voltage test point and adjustment locations.

c. Adjust— —15 volts control, R1588 (see Fig. 6-2), for exactly —15 volts.

d. INTERACTION—May affect operation of most circuits within the Type 520.

e. Disconnect the precision DC voltmeter.

2. Check Low-Voltage Power Supply Voltages

a. Connect a DC voltmeter between ground and input sync board pin W or X; see Fig. 6-3.

b. CHECK—Voltmeter reading; +3.6 volts, ±5% (±0.18 V).

c. Move the DC voltmeter connections to ground and low-voltage power supply board pin T; see Fig. 6-2.

d. CHECK—Voltmeter reading; +10 volts, ±3.5% (±0.35 V).

e. Move the DC voltmeter connections to ground and low-voltage power supply board pin H; see Fig. 6-2.

f. CHECK—Voltmeter reading; +100 volts, ±3.5% (±3.5 V).

g. Move the DC voltmeter connections to ground and low-voltage power supply board pin A, B, C or D; see Fig. 6-2.

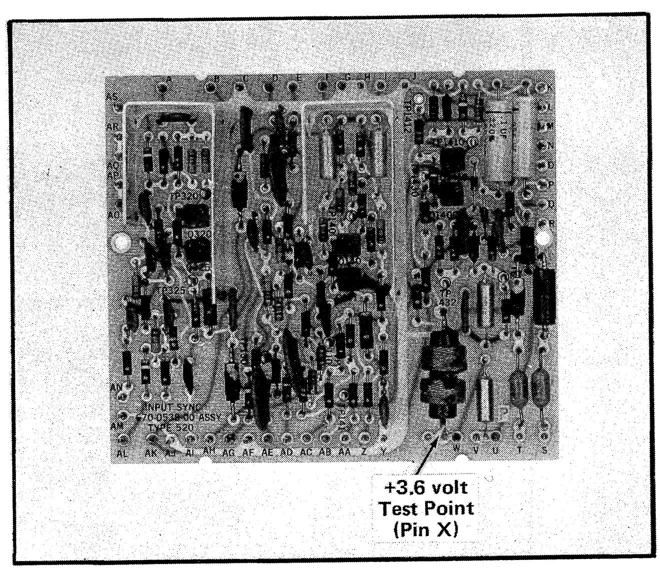


Fig. 6-3. Input sync board +3.6 V test point location.

h. CHECK—Voltmeter reading; +275 volts, ±7% (±19.25 V).

i. Disconnect the DC voltmeter.

3. Check Low-Voltage Power Supply Ripple

a. Set the test oscilloscope for 0.005 V/division vertical deflection factor, AC coupled, at a sweep rate of 5 ms/division, triggered with line frequency.

b. Connect a 1X probe, from the test oscilloscope vertical input to the appropriate power supply test point as shown in Figs. 6-2 and 6-3.

c. CHECK—Power supply ripple content as per Table 6-1 with input voltage level at both the low and high extremes of the voltage selector range.

TABLE 6-1

Voltage	Maximum Ripple Content
−15 V	10 mV peak to peak
+3.6 V	100 mV peak to peak
+10 V	10 mV peak to peak
+100 V	20 mV peak to peak
+275 V	500 mV peak to peak

d. Disconnect the 1X probe.

4. Check High Voltage Power Supply

a. Turn the Type 520 power off.

b. Remove the metal CRT protector cap from the rear of the Type 520, then remove the rear cover from the CRT socket to achieve access to the interior of the socket.

c. Connect a DC voltmeter between ground and the CRT socket terminal having a red-on-white wire attached to it (pin 2); see Fig. 6-4.

d. Turn the Type 520 power on.

e. CHECK—Voltmeter reading; −3.875 kV, ±3% (±116.25 V).

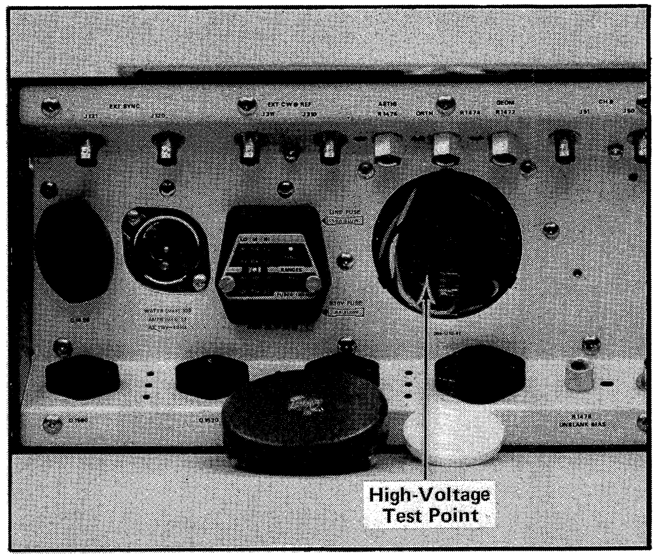


Fig. 6-4. High voltage test point location.

f. Rotate the INTENSITY control fully clockwise.

g. CHECK—Voltmeter reading; within ±40 volts of the voltage reading in part e of this step.

h. Rotate the INTENSITY control fully counterclockwise.

i. CHECK—Voltmeter reading; within ±40 volts of the voltage reading in part e of this step.

j. Turn off the Type 520 power, then disconnect the DC voltmeter.

k. Re-assemble the CRT socket cover on the socket and replace the metal CRT protector cap onto the rear of the Type 520.

l. Turn the Type 520 power on.

5. Adjust Geometry

a. Press the Signal Selector FULL FIELD pushbutton and the Display Selector VECTOR pushbutton.

b. Connect a DC voltmeter between ground and the upper CRT plate connection (blue wire); see Fig. 6-5A.

c. Note voltmeter reading.

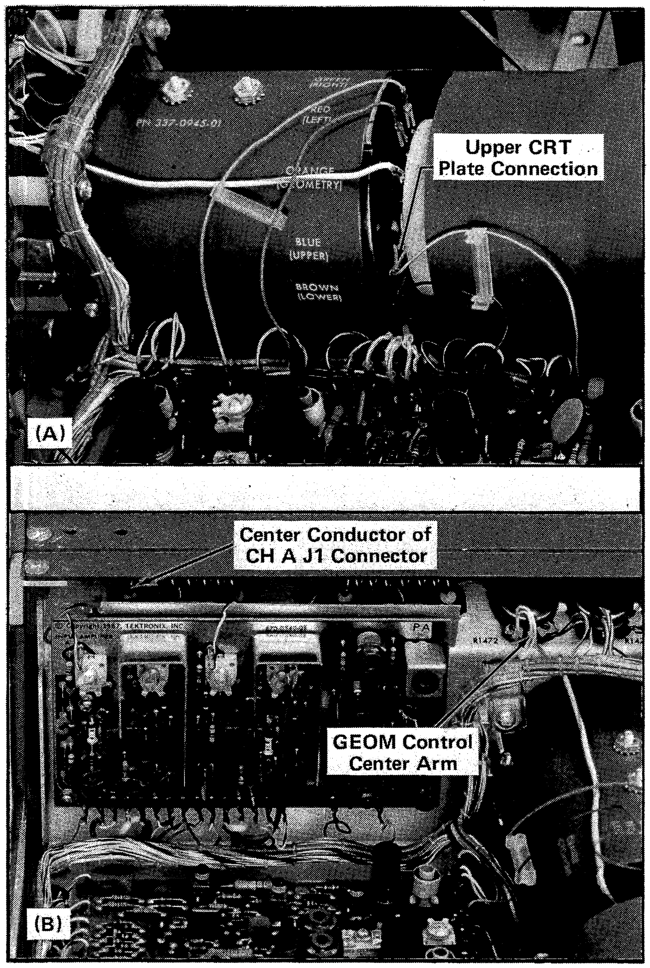


Fig. 6-5. Location of test point and adjustment locations for steps 5, 36, 39 and 40.

d. Move the DC voltmeter connections to ground and the center arm of the GEOM control, R1472 (see Fig. 6-5B).

e. CHECK—Voltmeter reading; should be about 20 volts below that noted in part c.

f. ADJUST—Rear-panel GEOM control, R1472, until the voltmeter reading is the same as that described in part e.

g. Press the Signal Selector A CAL pushbutton and the Display Selector Y pushbutton.

h. Adjust the front-panel FOCUS control and the rear-panel ASTIG control, R1476, to obtain a well defined display.

i. CHECK—Type 520 display; there should not be more than 0.05 centimeter of gradual bowing of the vertical or horizontal lines.

j. ADJUST—GEOM control, R1472, for minimum bowing of the vertical or horizontal lines.

6. Adjust Astigmatism ➊

a. Cancel the Signal Selector A CAL pushbutton by momentarily pressing the CH A pushbutton. The Signal Selector FULL FIELD pushbutton remains depressed.

b. Press the Display Selector VECTOR pushbutton and rotate the FOCUS control to its fully counterclockwise position.

c. CHECK—Type 520 display should be a round spot near the center of the vector graticule.

d. ADJUST—Rear-panel ASTIG control, R1476, until a round spot near the center of the vector graticule is obtained.

e. Adjust the FOCUS control to obtain a focused spot.

7. Adjust CRT Alignment ➊

a. Press the Signal Selector A CAL pushbutton. The Signal Selector FULL FIELD pushbutton and the Display Selector VECTOR pushbutton remain depressed for this step.

b. Turn off the Type 520 power.

c. Disconnect the blue-blue on gray coax center lead (below SN B200000, blue on white wire) from pin AB on the driver amplifier board; see Fig. 6-6.

d. Turn on the Type 520 power.

e. CHECK—Type 520 display alignment. Trace should be parallel throughout its length with the 90°-270° axis of the vector graticule. It may be necessary to adjust the HORIZ POSITION CLAMP to place the trace in a better position for checking.

f. ADJUST—Front-panel BEAM ROTATE control, R1470, until trace is parallel throughout its length to the 90°-270° axis of the vector graticule.

g. Turn off the Type 520 power.

h. Reconnect the wire disconnected in part c to pin AB on the driver amplifier board.

i. Disconnect the green-green on gray coax center lead (below SN B200000, green on white wire) from pin AD on the driver amplifier board; see Fig. 6-6.

j. Turn on the Type 520 power.

k. CHECK—R520 display alignment. Trace should be parallel throughout its length to the 0°-180° axis of the vector graticule. It may be necessary to adjust the VERT POSITION CLAMP to place the trace in a better position for checking.

l. ADJUST—Rear-panel ORTH control, R1474, until trace is parallel throughout its length to the 0°-180° axis of the vector graticule.

m. Turn off the Type 520 power.

n. Reconnect the wire disconnected in part i to pin AD on the driver amplifier board.

o. Turn on the Type 520 power.

p. Repeat parts f and l of this step several times to minimize interaction between the adjustments.

8. Adjust Unblanking Bias

a. All pushbuttons remain as they are.

b. Reduce the display intensity until the test circle is barely visible.

c. CHECK—Type 520 display; test circle should have uniform intensity throughout its circumference.

d. ADJUST—Rear-panel UNBLANK BIAS control, R1478, for a uniform intensity throughout the circumference of the test circle.

9. Adjust VITS Intensity

a. Apply a modulated staircase signal from the Type 140 comp video connector through a 75 ohm coaxial cable to the Type 520 CH A J1 connector. Connect a 75 ohm end-line termination to the CH A J2 connector.

b. Set the Type 140 VITS controls for a VIT staircase signal on line 18 of both fields.

c. Depress Signal Selector CH A, Aϕ and VITS 18 pushbuttons.

d. Depress the Display Selector Y pushbutton.

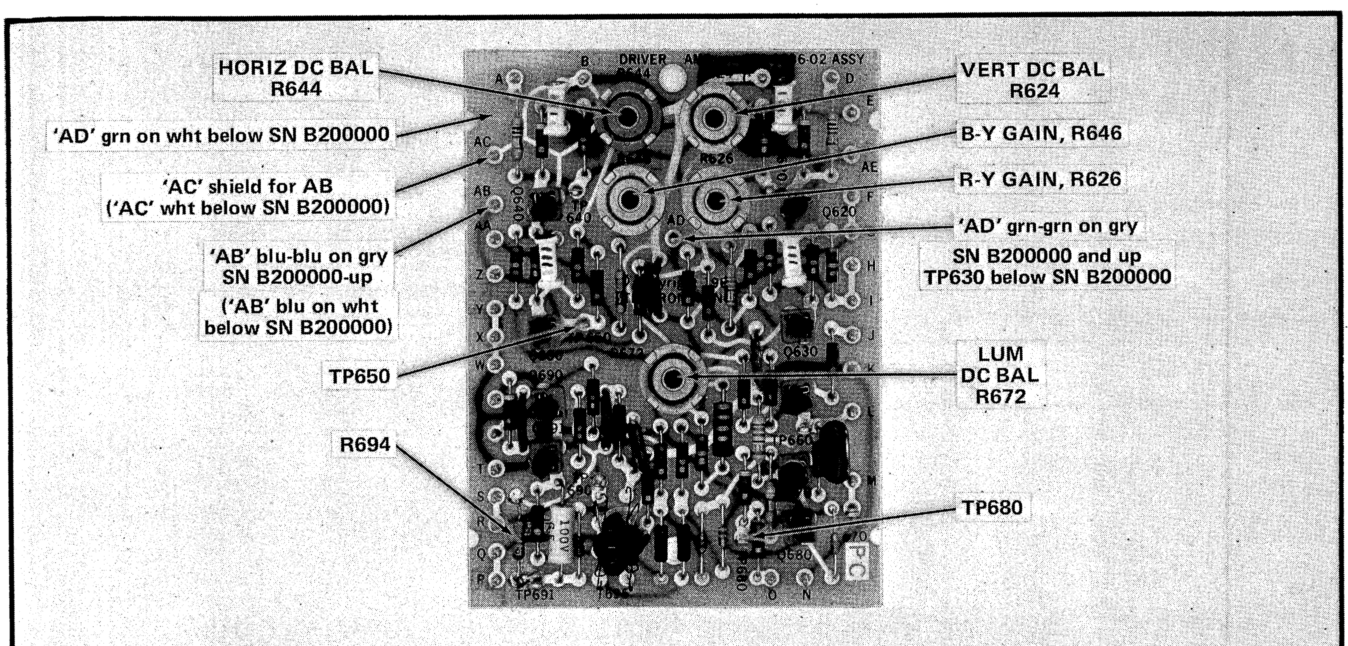
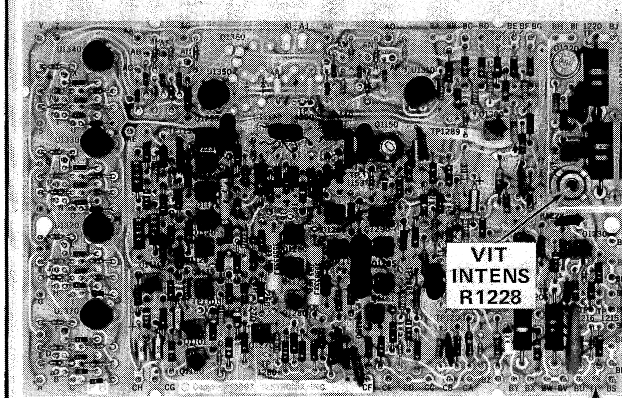


Fig. 6-6. Driver amplifier board pin connector, test point and adjustment locations.

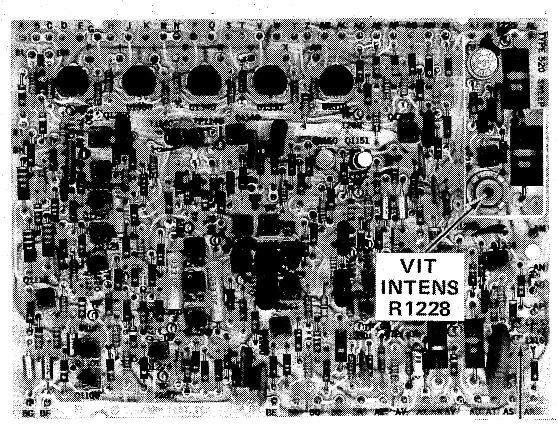
e. Set the Type 520 INTENSITY control for the desired display brightness.

f. ADJUST—VIT INTENS, R1228 (see Fig. 6-7), for maximum display intensity without any display defocusing.

g. Disconnect the video signal source, the 75 ohm coaxial cable and the 75 ohm end-line termination.



(A) For instruments SN B150100 and up.



(B) For instruments below SN B150100.

Fig. 6-7. Sweep board test point and adjustment locations.

Front-panel controls:

Signal Selector	FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	**No buttons depressed**
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER ON	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

10. Adjust DC Balance of R-Y Amplifier

a. Set the test oscilloscope for a vertical deflection factor of 5 mV/division, DC coupled, at a sweep rate of 1 ms/division with internal triggering.

b. Ground the test oscilloscope input and position the display to establish a ground reference.

c. Connect the test oscilloscope 10X probe to the driver amplifier board pin AD (below SN B200000, TP630); see Fig. 6-6.

d. CHECK—DC output voltage of amplifier must be 0.0 volt (ground potential).

e. ADJUST—VERT DC BAL control, R624 (see Fig. 6-6), until the DC voltage output of the amplifier is 0.0 volt.

f. Disconnect the 10X probe.

11. Adjust DC Balance of B-Y Amplifier

a. Set the test oscilloscope for a vertical deflection factor of 5 mV/division, DC coupled, at a sweep rate of 1 ms/division with internal triggering.

b. Establish a ground reference point on the test oscilloscope by grounding the input and positioning the trace to a graticule reference.

c. Connect the test oscilloscope 10X probe to the driver amplifier board TP650 (emitter of Q650); see Fig. 6-6.

d. CHECK—DC output voltage of amplifier must be 0.0 volt (ground potential).

e. ADJUST—HORIZ DC BAL control, R644 (see Fig. 6-6), until the DC voltage output of the amplifier is 0.0 volt.

f. Disconnect the 10X probe.

12. Adjust DC Balance of Y Amplifier

a. Set the test oscilloscope for a vertical deflection factor of 10 mV/division, DC coupled, at a sweep rate of 1 ms/division with internal triggering.

b. Establish a ground reference level on the test oscilloscope by grounding the input and positioning the display to some graticule line.

c. Connect the test oscilloscope 10X probe to driver amplifier board TP680 (collector of Q680 via R684); see Fig. 6-6.

d. CHECK—DC voltage output of amplifier must be +0.5 volt.

e. ADJUST—LUM DC BAL control, R672 (see Fig. 6-6), until the DC voltage output of the amplifier is +0.5 volt.

f. Disconnect the 10X probe and test oscilloscope.

13. Adjust Horizontal Common Mode Level

a. Press the Signal Selector FULL FIELD pushbutton and the Display Selector VECTOR pushbutton.

b. Adjust the INTENSITY control so the displayed spot on the CRT of the Type 520 will not burn the phosphor.

c. CHECK—Type 520 displayed spot position; must be at the center of the vector graticule.

d. ADJUST—Front panel VERT POSITION CLAMP (R880) and HORIZ POSITION CLAMP (R1002) controls to position the spot to the center of the vector graticule.

e. Connect a DC voltmeter between ground and TP980 on the output amplifier board; see Fig. 6-8.

f. CHECK—Voltmeter reading; should be +5.6 volts.

g. ADJUST—HORIZ COM MODE LEV control, R985 (see Fig. 6-8), until the voltmeter reading is exactly +5.6 volts.

h. Move the DC voltmeter connections to ground and TP870; see Fig. 6-8.

i. CHECK—Voltmeter reading; should be +5.6 volts.

j. ADJUST—VERT COM MODE LEV control, R875 (see Fig. 6-8), until the voltmeter reading is exactly +5.6 volts.

k. Disconnect the DC voltmeter.

l. INTERACTION—The adjustments in part d of this step interact with the adjustments performed in parts g and j of this step.

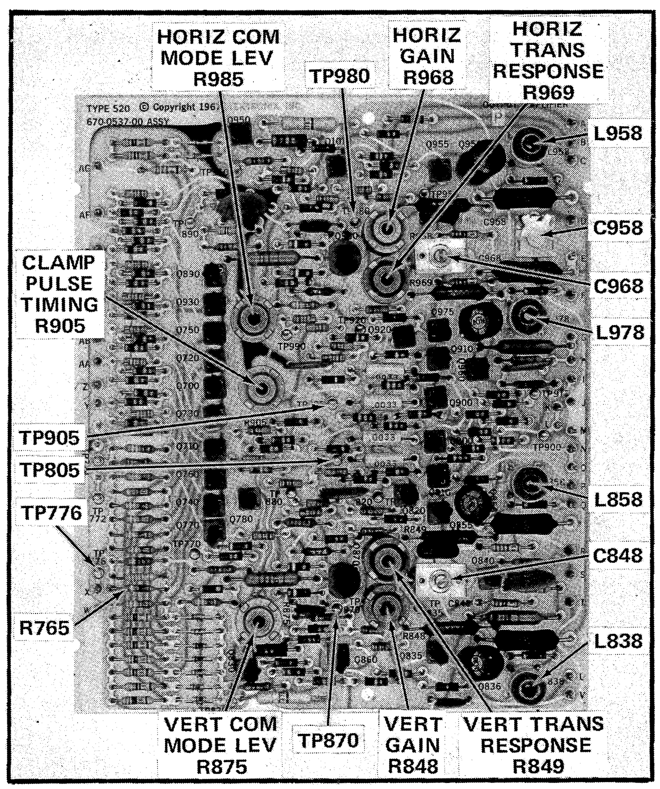


Fig. 6-8. Output amplifier board test point and adjustment locations.

Front-panel controls:

Signal Selector	**CH A, Aϕ,** and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	VECTOR
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

14. Adjust Clamp Pulse Timing ⓿

a. Connect a modulated staircase signal from the Type 140 comp video connector through a 75 ohm coaxial cable to the Type 520 CH A J1 connector.

b. Connect a 75 ohm coaxial cable from the CH A J2 connector to the CH B J50 connector.

c. Connect a 75 ohm end-line termination to the CH B J51 connector.

d. Connect a 10X probe from the test oscilloscope channel 1 vertical input connector to TP805 on the output amplifier board; see Fig. 6-8.

e. Connect another 10X probe from the test oscilloscope channel 2 vertical input connector to TP905; see Fig. 6-8.

f. Set the test oscilloscope for a vertical deflection factor of 0.2 V/division, AC coupled with input channels non-inverted and alternately displayed, at a sweep rate of 20 μs/division with internal triggering.

g. CHECK—Test oscilloscope display; superimposed channel 1 and 2 waveforms displayed for the vertical and horizontal amplifiers must meet or exceed the minimum amplitude shown in Fig. 6-9.

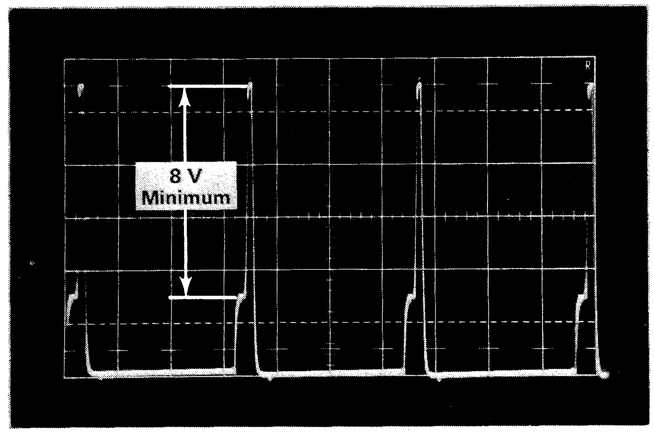


Fig. 6-9. Superimposed channel 1 and 2 waveforms showing minimum amplitude requirement for vertical and horizontal amplifiers when adjusting clamp pulse timing.

h. ADJUST—CLAMP PULSE TIMING control, R905 (see Fig. 6-8), until the alternately displayed waveforms on the test oscilloscope meet or exceed the minimum waveform amplitude shown in Fig. 6-9, but not so far as to cause waveform distortion.

i. Disconnect the test oscilloscope and the two 10X probes. Do not disconnect any of the video signal connections.

15. Adjust Channel A and B Input Amplifier Frequency Response Gain ⓿

NOTE

For final adjustment of C52, see step 36.

a. Test equipment connections are as described in parts a through c in step 14.

b. Set the Type 140 controls for a standard color bar output signal with this exception: set the White Ref switch to 100 IRE.

c. Set the test oscilloscope for single-channel operation, a vertical deflection factor of 20 mV/division, DC coupled, at a sweep rate of 10 μs/division with internal triggering.

d. Connect a 10X probe from the test oscilloscope vertical input connector to TP 85; see Fig. 6-10.

e. CHECK—Test oscilloscope display; peaks of the yellow and cyan bars are equal to the 100 IRE unit white bar as viewed on the test oscilloscope.

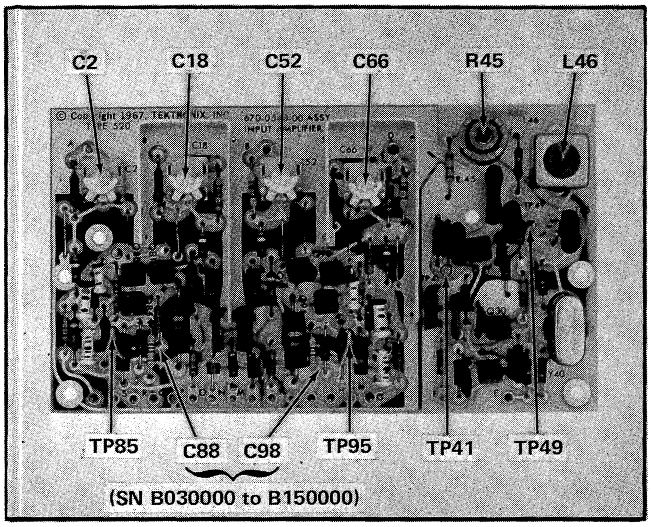


Fig. 6-10. Input amplifier board test point and adjustment locations.

f. ADJUST—C2, see Fig. 6-10, until the peaks of the yellow and cyan bars are equal to the 100 IRE white bar as viewed on the test oscilloscope (see Fig. 6-11).

g. Disconnect the test oscilloscope 10X probe from TP85 and connect it to TP95; see Fig. 6-10.

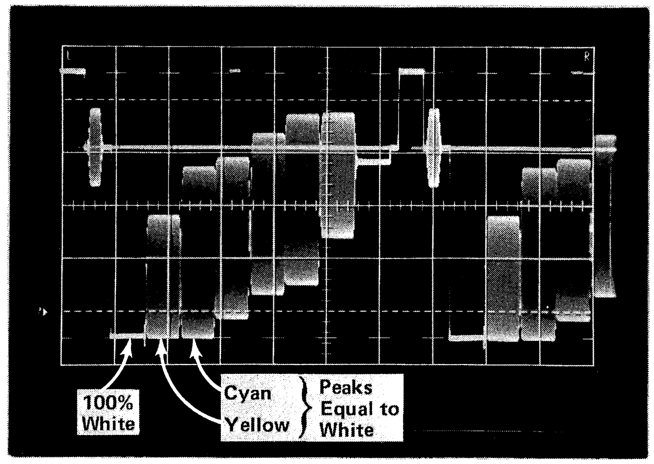


Fig. 6-11. Typical color bar display obtained when C2 and C52 are properly adjusted.

h. CHECK—Test oscilloscope display; peaks of the yellow and cyan bars must be equal to the 100 IRE unit white bar.

i. ADJUST—C52, see Fig. 6-10, until the peaks of the yellow and cyan bars are equal to the 100 IRE unit white bar as viewed on the test oscilloscope.

j. Disconnect the 10X probe, video signal source, two 75-ohm coaxial cables and the 75-ohm end-line termination.

NOTES

Front panel controls:

Signal Selector	**A CAL** Aϕ and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	VECTOR
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

16. Adjust Test Circle Oscillator

a. Connect a DC voltmeter between ground and TP41 on the input amplifier board, see Fig. 6-10.

b. CHECK—Voltmeter should read approximately −0.4 volt.

c. ADJUST—L46, see Fig. 6-10, for minimum voltage reading on the voltmeter.

d. Disconnect the DC voltmeter.

e. Connect a 10X probe from the vertical input connector on the test oscilloscope to TP49; see Fig. 6-10.

f. Set the test oscilloscope for a vertical deflection factor of 20 mV/division, AC coupled, at a sweep rate of 1 ms/division with internal triggering.

g. CHECK—Test oscilloscope display; must be 3.5 major divisions in amplitude (approximately 707 mV).

h. ADJUST—R45, see Fig. 6-10, until the test oscilloscope display amplitude is 3.5 major divisions.

i. Disconnect the 10X probe from the test point and the oscilloscope.

17. Adjust Test Circle Oscillator Compensation

a. Depress the Signal Selector CH A and B CAL pushbuttons. The other pushbuttons remain as they are.

b. Set the test oscilloscope for a vertical deflection factor of 0.2 V/division.

c. Connect a 100% amplitude, 0% setup, (R-Y and B-Y off) color bar signal from the Type 140 comp video connector through a 75-ohm coaxial cable, 75-ohm feed-thru termination and a dual-input cable connector to channels 1 and 2 of the test oscilloscope. Check that the two displays are matched in amplitude. If not, adjust the oscilloscope vertical gain control adjustment to obtain matched amplitude displays.

d. Remove the dual-input cable connector and connect the signal to channel 1.

e. Apply a 3.58 MHz signal from the Type 191 through a 50-ohm cable, a 50-ohm to 75-ohm minimum loss attenuator and a 75-ohm feed-thru termination to the test oscilloscope channel 2 Input connector.

f. Adjust the Type 191 output amplitude until the signal extends from sync tip to the green luminance level. (The Type 191 is now preset for an output amplitude of 707 mV P-P.)

g. Disconnect the Type 191 signal from test oscilloscope. Apply the signal through the 50-ohm cable and 50-ohm to 75-ohm minimum loss attenuator to the Type 520 CH A J1 connector.

h. Connect the 75-ohm feed-thru termination used in part e to the Type 520 CH A J2 connector.

i. CHECK—Type 520 displayed channel B test circle size; must be exactly the same size as the channel A displayed circle.

j. ADJUST—C66, see Fig. 6-10, until the channel B test circle is the same size as the channel A displayed circle.

k. Depress the Signal Selector A CAL pushbutton.

l. CHECK—Type 520 displayed channel A test circle size; must be exactly the same size as the channel B displayed test circle.

m. ADJUST—C18, see Fig. 6-10, until the channel A test circle is the same size as the channel B displayed test circle.

n. Disconnect the Type 191, the 75-ohm coaxial cable, minimum loss attenuator, and the 75-ohm feed-thru termination.

Front-panel controls:

Signal Selector	A CAL, Aϕ and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	Y
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

18. Adjust Luminance Calibrator

NOTE

This step uses a precision DC voltmeter. Step 18A is an alternative procedure that uses a Standard Amplitude Calibrator (Tektronix calibration fixture 067-0502-00).

a. Remove Q570 (see Fig. 6-12) from its socket on the demodulator board.

b. Connect a precision DC voltmeter between ground and TP583 (see Fig. 6-12).

c. Note the voltmeter reading (about −5 mV).

d. Re-install Q570 and remove Q571.

e. CHECK—Voltmeter reading; should be one volt more positive then the voltage noted in part c.

f. ADJUST—LUMINANCE CAL control, R583 (see Fig. 6-12), until the voltmeter reading is one volt more positive than that noted in part c.

g. Disconnect the precision DC voltmeter and re-install Q571 in its socket.

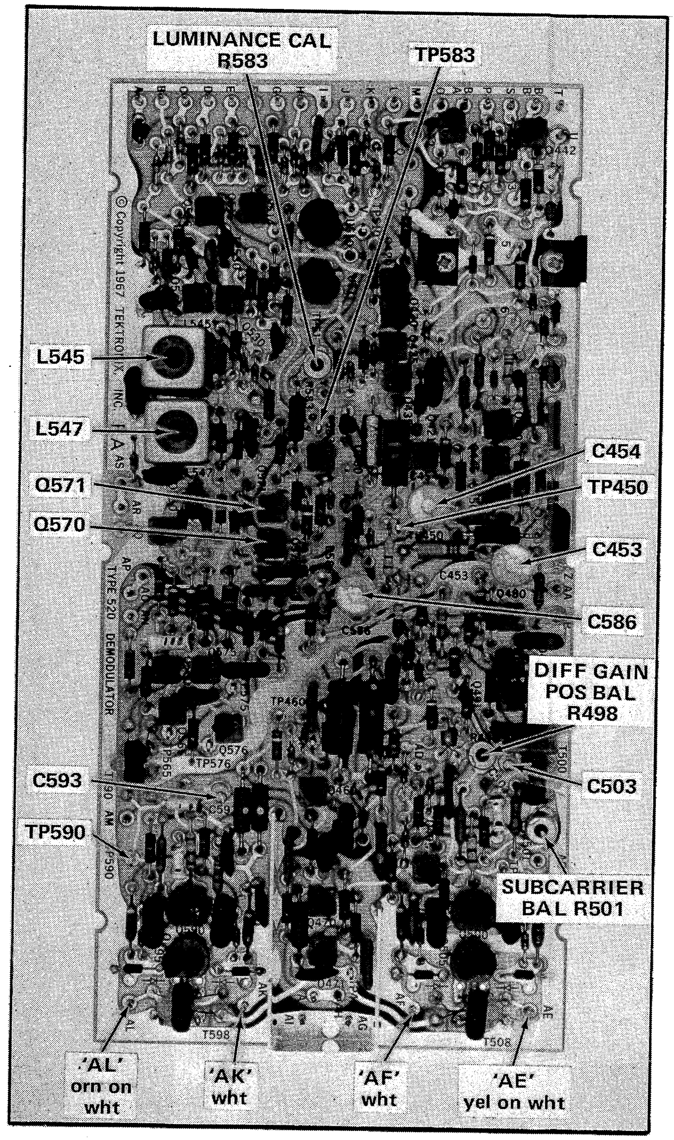


Fig. 6-12. Demodulator board test point and adjustment locations.

18A. Adjust Luminance Calibrator

NOTE

This is an alternative procedure that can be used if a Standard Amplitude Calibrator (Tektronix calibration fixture 067-0502-00) is available.

a. Connect a 1X probe to the test oscilloscope differential amplifier A input.

b. Set the controls of the standard amplitude calibrator for a square-wave signal of 1 V.

c. Connect the standard amplitude calibrator output to the differential amplifier B input.

d. Connect the 1X probe from the test oscilloscope A input connector to TP583 on the demodulator board; see Fig. 6-12.

e. Set the test oscilloscope for a vertical deflection factor of 50 mV/division, AC coupled, at a sweep rate of .5 ms/division with internal triggering.

f. CHECK—Test oscilloscope display; must appear similar to Fig. 6-13. (The bottom of the upper waveform is aligned with the top of the lower waveform.)

g. ADJUST—LUMINANCE CAL control, R583 (see Fig. 6-12) for a test oscilloscope display similar to Fig. 6-13.

h. Disconnect the standard amplitude calibrator, the test oscilloscope and the probe.

19. Adjust Channel A Gain

a. Connect a 10X probe to each input of the differential amplifier.

b. Adjust the test oscilloscope 10X probe compensation so the two probes match each other.

c. After the 10X probes have been matched, connect one probe from the test oscilloscope channel A vertical input connector to TP583 on the demodulator board; and the other probe from channel 2 vertical input connector to TP450; see Fig. 6-12.

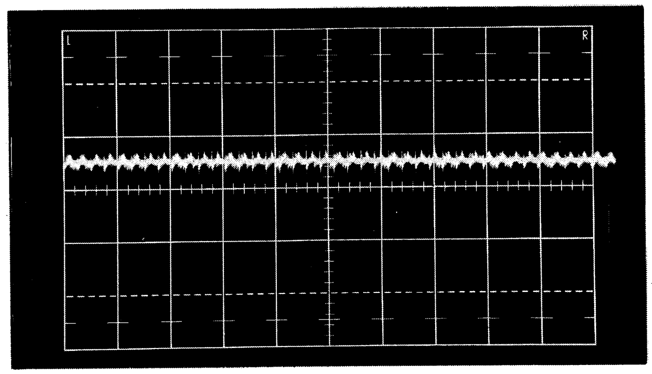


Fig. 6-13. Typical waveform obtained when LUMINANCE CAL control, R583, is correctly adjusted using step 18A procedure.

d. Set the test oscilloscope for a vertical deflection factor of 5 mV/division, ac coupled, at a sweep rate of 1 ms/division with internal triggering.

e. ADJUST—Front-panel A CAL control, R402, until the test oscilloscope display amplitude is minimum.

f. Disconnect the two 10X probes from the Type 520.

20. Adjust Channel B Gain

a. Press the Signal Selector B CAL and Bϕ pushbuttons. Do not cancel the A CAL pushbutton.

b. ADJUST—Front-panel B CAL control, R412, until the channel B waveform overlays the channel A waveform.

NOTES

Front-panel controls:

Signal Selector	CH A, Aϕ and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	Y
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

21. Adjust Subcarrier Regenerator Input 3.58 MHz Filter

a. Apply a color bar signal from the Type 140 to the CH A J1 connector via a 75 ohm coaxial cable.

b. Connect a 75 ohm coaxial cable from the CH A J2 connector to the CH B J50 connector and a 75 ohm end-line termination to the CH B J51 connector.

c. Connect a 10X probe from the test oscilloscope vertical input connector to TP220 on the subcarrier regenerator board; see Fig. 6-14.

d. Connect a 75 ohm coaxial cable from the Type 140 comp video connector to the test oscilloscope trigger input connector.

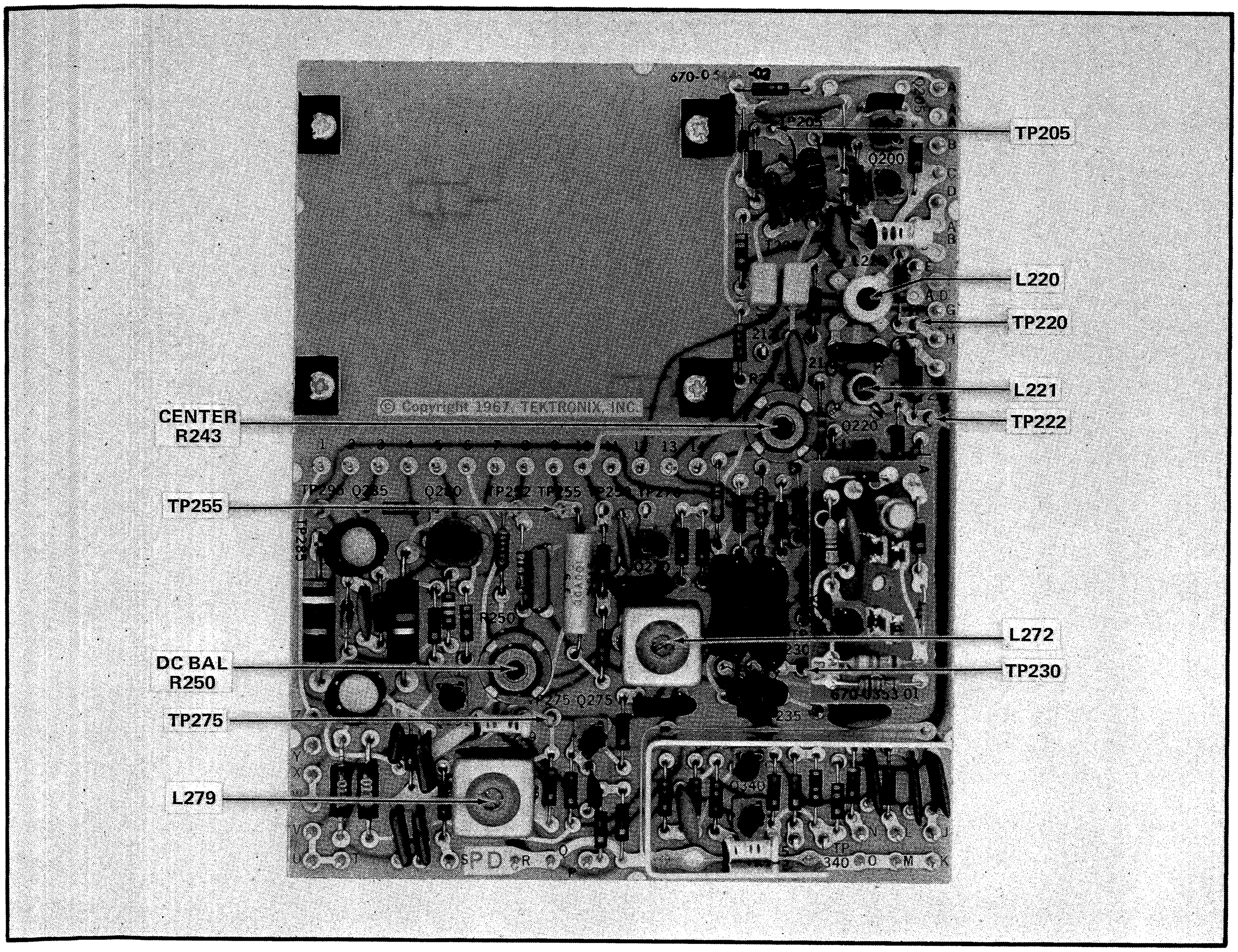


Fig. 6-14A. Subcarrier regenerator board test point and adjustment locations for instruments SN B251880 and up.

e. Set the test oscilloscope for a vertical deflection factor of 0.05 V/division, AC coupled, at a sweep rate of 10 μs/division with external triggering.

f. CHECK—Test oscilloscope display amplitude; 2.5 volts or less.

g. ADJUST—L220, see Fig. 6-14, for minimum test oscilloscope display amplitude of the 3.58 MHz burst.

h. Disconnect the test oscilloscope 10X probe from TP220 and connect it to TP222 on the subcarrier regenerator board; see Fig. 6-14.

i. Set the test oscilloscope for a vertical deflection factor of 0.01 V/division, AC coupled.

j. CHECK—Test oscilloscope display amplitude; 0.2 volt or greater.

k. ADJUST—L221, see Fig. 6-14, for maximum test oscilloscope display amplitude with the best transient response of the color bar packets.

l. Disconnect 10X probe and test oscilloscope. Video input signal remains connected.

22. Check Burst Intensification Pulse

a. Connect a 10X probe from the test oscilloscope to TP205 on the subcarrier regenerator board (see Fig. 6-14). Externally trigger the test oscilloscope from the composite sync signal of the Type 140. Set Trigger Slope switch to –, and the source switch to Ext.

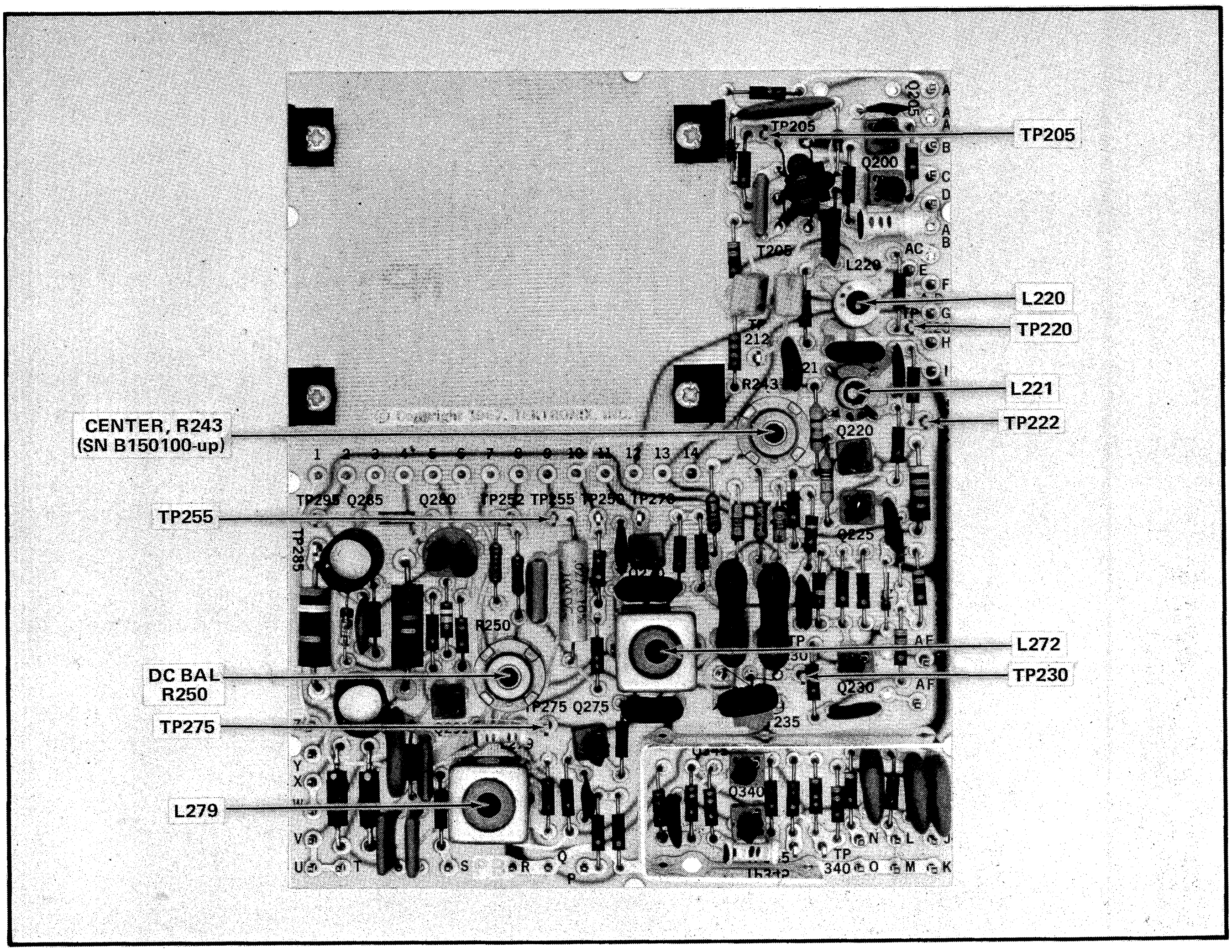


Fig. 6-14B. Subcarrier regenerator board test point and adjustment locations for instruments below SN B251880.

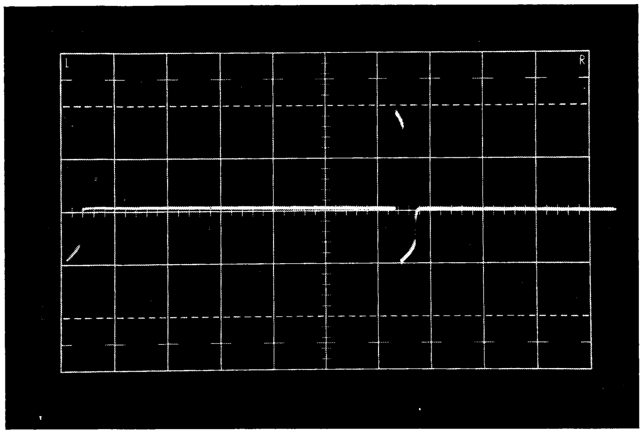


Fig. 6-15. Typical burst intensification pulse.

b. Set the test oscilloscope for a vertical deflection factor of .2 V/division, AC coupled, at a sweep rate of 10 μs/division.

c. CHECK—Test oscilloscope display; should appear similar to the waveform in Fig. 6-15.

23. Adjust Burst Gate Pulse

a. Connect the 10X probe to TP230 on the subcarrier regenerator board (see Fig. 6-14).

b. Set the test oscilloscope for a vertical deflection factor of 0.5 V/division. Leave the other controls as in step 22, parts a and b.

c. CHECK—Test oscilloscope display; should have a minimum peak to peak amplitude of 7 volts (8 volts nominal) and appear as shown in Fig. 6-16.

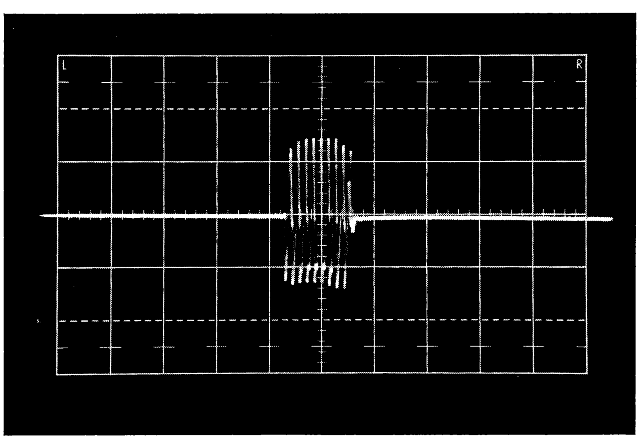


Fig. 6-16. Correct burst gate pulse waveform shape.

d. Connect the 10X probe to TP205. Set the sweep rate to 5 μs/division and the Horiz Magnifier to X10, (0.5 μs/division).

e. Depress the Display Selector LINE SWEEP pushbutton and reduce the intensity so that the intensified burst can be seen. If necessary, rotate the A PHASE control for maximum burst amplitude.

f. Rotate the front-panel BURST FLAG TIMING control R1158 until the burst intensification is centered on the burst pulse.

g. Depress the Display Selector Y pushbutton.

h. With the test oscilloscope Horizontal Position control, position a transition of the burst intensification pulse to the graticule center line.

i. CHECK—Rotate the BURST FLAG TIMING control R1158 to each of its extremes and note when the luminance display of the Type 520 loses vertical restoration; i.e., stable blanking level. Check that at these extremes the test oscilloscope display should shift ±0.5 μs from its centered position described in part h of this step.

NOTE

If either limit described in part i cannot be obtained, repeat step 21 procedure. Adjustment of L220 and L221 affects the range. If either limit cannot be obtained, select a new value for R694 (see Fig. 6-6).

j. Press the Display Selector LINE SWEEP pushbutton.

k. ADJUST—Front-panel BURST FLAG TIMING control, R1158, until the burst intensification is centered on the burst pulse.

l. Disconnect the 10X probe.

24. Adjust Subcarrier Regenerator DC Balance

a. Disconnect the 75 ohm coaxial cable from the CH A J2 connector and the CH B J50 connector. The video signal to CH A J1 connector remains connected.

b. Connect a 75 ohm end-line termination to the CH A J2 connector. The 75 ohm end-line termination on the CH B J51 connector remains connected.

c. Press the Signal Selector CH A pushbutton and the Display Selector VECTOR pushbutton.

d. Set the test oscilloscope for a vertical deflection factor of 0.02 V/division, DC coupled, at a sweep rate of 1 ms/division with internal triggering.

e. Establish a ground reference point on the test oscilloscope by grounding the input and positioning the display to a graticule line.

f. Connect the test oscilloscope 10X probe to TP255 on the subcarrier regenerator board; see Fig. 6-14.

g. Note the DC level of the test oscilloscope display. A stable vector (oscillator locked to signal) must be obtained before this DC level can be observed. If the vector is not stable, (oscillator not locked to signal) slowly adjust the DC BAL control, R250 (see Fig. 6-14), until a stable vector is obtained; then note DC level.

NOTE

Parts h through r are used for instruments SN B150100 and up. For instruments below SN B150100 proceed to part s.

h. Press the Signal Selector A CAL pushbutton.

i. CHECK—Test oscilloscope display DC level; must be the same as that noted in part g of this step.

j. ADJUST—DC BAL control, R250, until the test oscilloscope display DC level is the same as that noted in part g.

k. Press the Signal Selector CH A pushbutton and note the display DC level.

l. Repeat parts g through k of this step until the test oscilloscope DC level remains the same when either the Signal Selector CH A or A CAL pushbutton is pressed.

m. Press the Signal Selector CH A pushbutton and set the Φ REF switch to EXT.

n. CHECK—Test oscilloscope display DC level; must be the same as noted in part k of this step.

o. ADJUST—CENTER control, R243 (see Fig. 6-14), until the DC level is the same as that noted in part k.

p. Return the ϕ REF switch to BURST.

q. Repeat parts g through o until adjustment interaction is minimized.

r. Disconnect the 10X probe and the test oscilloscope. (The video input signal remains connected.)

NOTE

Parts s through y are used for instruments below SN B150100 only.

s. Press the Signal Selector A CAL pushbutton.

t. CHECK—Test oscilloscope display DC level; must be the same as noted in part g of this step.

u. ADJUST—DC BAL control, R250, (see Fig. 6-14) until the test oscilloscope display DC level is the same as that noted in part g of this step.

v. Cancel the A CAL and press the CH A Signal Selector pushbuttons.

w. CHECK—Type 520 display; a stable vector must be obtained 15 seconds after completion of part v of this step.

x. Repeat parts e through g and s through w of this step until all adjustment interaction is minimized.

y. Disconnect the 10X probe and the test oscilloscope. (The video input signal remains connected.)

25. Check Subcarrier Regenerator Circuit 3.58 MHz Output Signal

a. Connect a 10X probe from the test oscilloscope vertical input connector to TP275 on the subcarrier regenerator board; see Fig. 6-14.

b. Set the test oscilloscope for a vertical deflection factor of 0.2 V/division, AC coupled, at a sweep rate of 0.5 μs/division with internal triggering.

c. CHECK—Test oscilloscope display amplitude of the 3.58 MHz signal should equal approximately 4 volts peak to peak. Adjust L272 for maximum amplitude if amplitude is below 3.5 V. Final adjustment will be made in step 36x.

d. Disconnect the 10X probe, the two 75 ohm coaxial cables, the video signal source and the 75 ohm end-line termination.

26. Check Oven Preheater Operation

a. Connect a DC voltmeter between ground and pin Q, R, or S (+10 volts unregulated power supply) of the rectifier board; see Fig. 6-17.

b. Note voltmeter reading.

c. Disconnect DC voltmeter from pin Q, R or S of rectifier board and connect it between TP295 and ground; see Fig. 6-14.

d. CHECK—Voltmeter reading should be the same as that noted in part b of this step after at least 20 minutes of warmup.

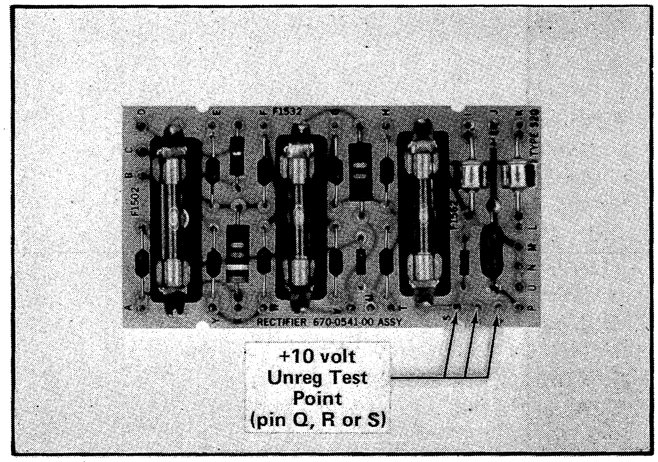


Fig. 6-17. Rectifier board test point location.

NOTE

At initial turn-on of a cold instrument, the voltage at TP295 is about −15 volts. In 3 minutes the voltage rises to approximately +20 volts and remains at this voltage while the instrument is on.

e. Disconnect the DC voltmeter.

NOTES

Front-panel controls:

Signal Selector	CH A, Aϕ and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	VECTOR
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

27. Adjust Subcarrier Filter

a. Connect a 10X probe from the test oscilloscope vertical input connector to TP590 on the demodulator board (see Fig. 6-12).

b. Set the test oscilloscope for a vertical deflection factor of 0.1 V/division, AC coupled, at a sweep rate of 0.5 μs/division with internal triggering.

c. CHECK—Test oscilloscope display amplitude of the 3.58 MHz subcarrier waveform should be approximately 1.2 volts peak to peak.

d. ADJUST—L545, see Fig. 6-12, for maximum 3.58 MHz subcarrier amplitude but not more than 1.2 volts peak to peak.

e. Disconnect the 10X probe.

f. Apply the color bar video signal to CH A J1 connector via a 75 ohm coaxial cable and connect a 75 ohm end-line termination to the CH A J2 connector.

g. Line up the burst vector on the Type 520 exactly with the I marking on the vector graticule, using the channel A PHASE control.

h. Holding the Display Selector VECTOR pushbutton all the way down, press the Display Selector I pushbutton slowly until display rotation is noted.

i. CHECK—Amount of Type 520 display rotation and direction; should rotate 33°, ±2° clockwise. This will cause the burst vector to line up with the 90° vector graticule point.

j. While still holding the Display Selector VECTOR pushbutton all the way down, press the Display Selector Q pushbutton slowly until a display rotation is noted.

k. CHECK—Amount of display rotation and direction; should rotate 33°, ±2° clockwise. This will cause the burst vector to line up with the 90° vector graticule point.

l. ADJUST—L547, see Fig. 6-12, while performing part i or k of this step until exactly 33° of display rotation in clockwise direction is noted.

m. Repeat parts g through k.

n. Repeat entire step, as needed, to remove the interaction between parts d and l.

o. Line up the burst vector on the Type 520 exactly on the I graticule mark, then press the Display Selector Q pushbutton, allowing the VECTOR pushbutton to cancel.

p. CHECK—That the burst portion of the display is nulled ±2° using the CALIBRATED PHASE control.

q. Press the Display Selector VECTOR pushbutton and line up the burst vector on the Q graticule mark, then press the Display Selector I pushbutton, allowing the VECTOR pushbutton to cancel.

r. CHECK—That the burst portion of the display is nulled ±2° using the CALIBRATED PHASE control.

s. Disconnect the 75 ohm coaxial cable and video signal source. The 75 ohm end-line termination remains connected to the CH A J2 connector.

t. INTERACTION—This step interacts with steps 10 and 11. Steps 10 and 11 should be repeated before proceeding.

28. Adjust 10.4 MHz and 18 MHz Traps

a. Connect a 10.4 MHz sine wave signal, 1 volt in amplitude, from a medium frequency constant amplitude signal generator through a 5 ns coaxial cable, a GR to BNC male adapter and a 50 ohm to 75 ohm minimum loss attenuator, to the Type 520 CH A J1 connector.

b. ADJUST—C454, see Fig. 6-12, for minimum circle diameter.

c. Apply an 18 MHz sine wave signal, 1 volt in amplitude, from the medium frequency generator to the Type 520.

d. ADJUST—C453, see Fig. 6-12, for minimum circle diameter.

e. Repeat several times because the adjustments in parts b and d interact.

f. Disconnect the medium frequency generator, 5 ns coaxial cable, GR to BNC male adapter and 50 ohm to 75 ohm minimum loss attenuator. The 75 ohm end-line termination remains connected to the CH A J2 connector.

29. Adjust Subcarrier Balance

1. Cancel all the Signal Selector pushbuttons except the FULL FIELD pushbutton.

b. Press the Signal Selector A CAL pushbutton and the Display Selector LINE SWEEP pushbutton.

c. Note trace position.

d. Press the Display Selector I, Q, and DIFF PHASE in sequence.

e. CHECK—Trace positions; the trace position noted in (LINE SWEEP trace), (I trace), (Q trace) and (DIFF PHASE trace) must be the same within 3 IRE units.

f. ADJUST—SUBCARRIER BAL control, R501 (see Fig. 6-12), so the trace remains in the same position, as the Display Selector LINE SWEEP pushbutton is pushed, then the Display Selector I, Q, and DIFF PHASE, pushbuttons are pushed.

g. Check that a 75 ohm end-line termination is connected to the Type 520 CH A J2 connector, then press the Display Selector DIFF PHASE pushbutton.

h. CHECK—There should be no separation of the traces on the Type 520 display.

i. ADJUST—C593, see Fig. 6-12, for no trace separation. Press the Display Selector Q pushbutton. Adjust C503 for no trace separation.

j. Repeat parts e through i until interaction is removed.

30. Adjust Quadrature Phase Alignment

a. Apply a modulated staircase signal to the CH A J1 connector via a 75 ohm coaxial cable. (Check that a 75 ohm end-line termination is connected to the CH A J2 connector.)

b. Set the Type 520 controls as follows:

Signal Selector	B CAL and FULL FIELD
Display Selector	VECTOR
QUAD PHASE	Midrange

c. Note the degree of overlay the test circles have to each other.

d. Rotate the QUAD PHASE control fully clockwise and note the amount of separation of the test circles with reference to the display noted in part c.

e. Rotate the QUAD PHASE control fully counterclockwise and again note the amount of separation of the test circles.

f. CHECK—Test circle separation noted in parts d and e of this step should be equal.

g. ADJUST—C586 until the test circle separations are equal.

h. Set the QUAD PHASE control for best overlay of the test circle.

i. Disconnect the video signal source, 75 ohm coaxial cable, and the 75 ohm end-line termination.

31. Adjust Vertical Gain

a. Depress the Signal Selector A CAL and Display Selector Y pushbuttons. Cancel the B CAL pushbutton. Check that the FULL FIELD pushbutton is depressed.

b. Align the bottom line of the calibrator signal with the −40 IRE line on the IRE graticule.

c. CHECK—Top of calibrator signal on the Type 520 display should align with the +100 IRE line on the IRE graticule.

d. ADJUST—VERT GAIN control, R848 (see Fig. 6-8) until the top of the calibrator signal aligns with the +100 IRE line on the IRE graticule.

32. Adjust Chroma R-Y Gain ❶

a. Depress the Display Selector VECTOR pushbutton. The other pushbuttons remain as they are.

b. CHECK—Type 520 test circle position; must be tangent to the inscribed circle on the vector graticule at the 90° and 270° points.

c. ADJUST—R-Y GAIN control, R626 (see Fig. 6-6) so test circle is tangent to the inscribed circle on the vector graticule at the 90° and 270° points.

33. Adjust Horizontal Gain to Match Vertical Gain ❶

a. Turn off the Type 520 power.

b. Disconnect the green-green on gray coax center lead (below SN B200000, green on white wire) going to the vertical amplifier from pin AD on the driver amplifier board; see Fig. 6-6.

c. Disconnect the blue-blue on gray coax center lead (below SN B200000, blue on white wire) going to the horizontal amplifier from pin AB on the driver amplifier board; see Fig. 6-6.

d. Connect the wire, disconnected in part c of this step, to pin AD on the driver amplifier board.

e. Turn on the Type 520 power.

f. CHECK—Type 520 trace length; horizontal trace should be the same length as the diameter of the inscribed circle on the vector graticule.

g. ADJUST—HORIZ GAIN control, R968 (see Fig. 6-8) until the trace length is equal to the diameter of the inscribed circle on the vector graticule.

NOTE

R968 is readjusted slightly in step 35.

h. Turn off the Type 520 power.

i. Disconnect the wire, described in part c of this step, from pin AD on the driver amplifier board.

j. Reconnect the wire, disconnected in part b of this step, to pin AD on the driver amplifier board.

k. Reconnect the wire, described in part c of this step, to pin AB on the driver amplifier board.

l. Turn on the Type 520 power.

34. Adjust Chroma B-Y Gain ❶

a. Set the front-panel GAIN BAL control, R648, to its mechanical midrange position.

b. CHECK—Type 520 test circle position; must be tangent to the inscribed circle on the vector graticule at the 0° and 180° points.

c. ADJUST—B-Y GAIN control, R646 (see Fig. 6-6) so test circle is tangent to the inscribed circle on the vector graticule at the 0° and 180° points.

Front-panel controls:

Signal Selector	**CH A, Aϕ** and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF BURST	
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	**Y**
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

35. Adjust Transient Response ❶

a. Apply a modulated staircase signal at 90% APL from the Type 140 comp video connector through a 75 ohm cable to the Type 520 CH A J1 connector.

b. Connect a 75 ohm coaxial cable from the CH A J2 connector to the CH B J50 connector and a 75 ohm end-line termination to the CH B J51 connector.

c. Connect a 10X probe from the test oscilloscope vertical input connector to TP680 (junction of R676 and R682) located on the Driver Amplifier board; see Fig. 6-6.

d. Set the test oscilloscope for a vertical deflection factor of 50 mV/division, AC coupled, at a sweep rate of 5 μs/division with internal triggering.

e. CHECK—Test oscilloscope display; waveform should have a flat top with minimum aberrations (aberrations less than 1% in amplitude); see Fig. 6-18.

f. ADJUST—L610 through L618 located on the luminance filter board (see Fig. 6-19) for a test oscilloscope waveform having a flat top with minimum aberrations.

g. Disconnect the 10X probe.

h. CHECK—Type 520 display; waveform should have a flat top with minimum aberrations (aberrations less than 1% in amplitude); see Fig. 6-20.

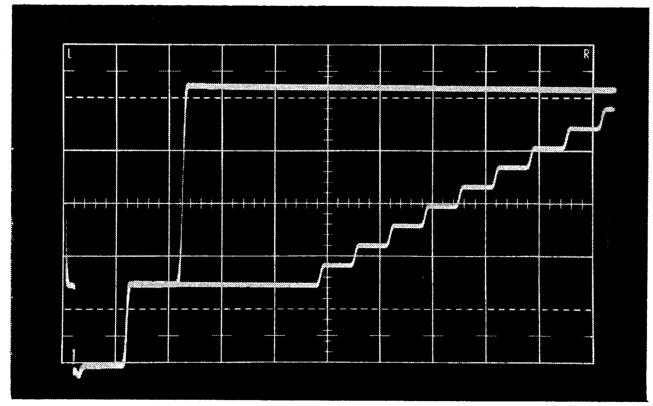


Fig. 6-18. Typical transient response of luminance filter as displayed on a test oscilloscope.

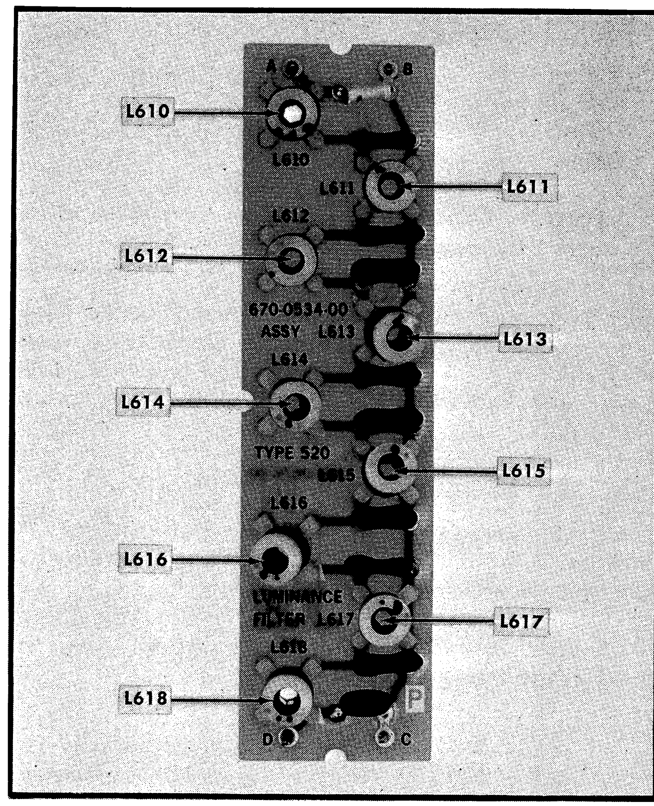


Fig. 6-19. Luminance filter board adjustment locations.

i. ADJUST—VERT TRANS RESP, R849, C848, L838 and L858 located on the output amplifier board, see Fig. 6-8, for a waveform having a flat top with minimum aberrations; see Fig. 6-20.

j. Press the Signal Selector A CAL pushbutton.

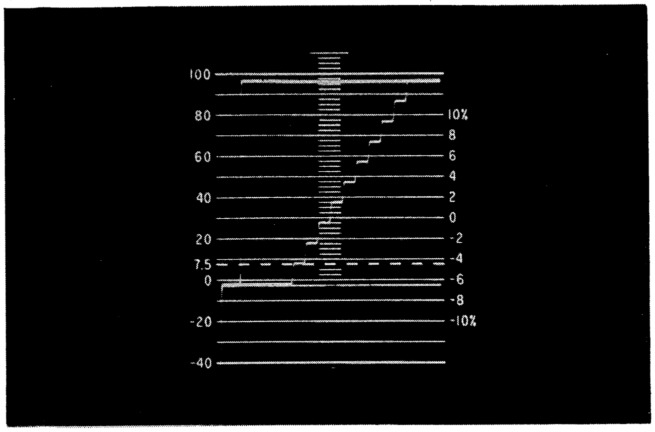


Fig. 6-20. Typical transient response of luminance filter and vertical amplifier together.

k. Set the Type 140 controls as follows:

Mod Staircase	
0° Subcarrier	Down
Steps	Down
APL	80
Synchronization	
Burst	Down
Sync	Down

l. Turn off the Type 520 power. Disconnect the green-green on gray coax center lead (below SN B200000, green on white wire) from pin AD on the driver amplifier board. Disconnect the blue-blue on gray coax center lead (below SN B200000, blue on white wire) from pin AB on the driver amplifier board; see Fig. 6-6.

m. Connect a 75 ohm coaxial cable from the Type 140 comp video output connector to a BNC clip lead adapter. Connect the black lead to the Type 520 chassis and connect the red lead to the wires disconnected in part l of this step. Turn on the Type 520 power and press the Display Selector VECTOR pushbutton.

n. CHECK—Type 520 display; should be similar to that shown in Fig. 6-21. The displayed vector should be located at 225°, have minimum overshoot (small spot size), and minimum loop amplitude (smallest loop opening).

o. ADJUST—HORIZ GAIN R968, HORIZ TRANS RESP R969, C958, C968, L958 and L978 located on the output amplifier board; see Fig. 6-8, to position the vector display to 225°, and to obtain minimum loop amplitude and vector tip overshoot. R968 affects phase; the remaining adjustments affect transient response.

p. Turn off the Type 520 and remove the clip lead adapter. Reconnect the wires to their respective pins on the driver amplifier board.

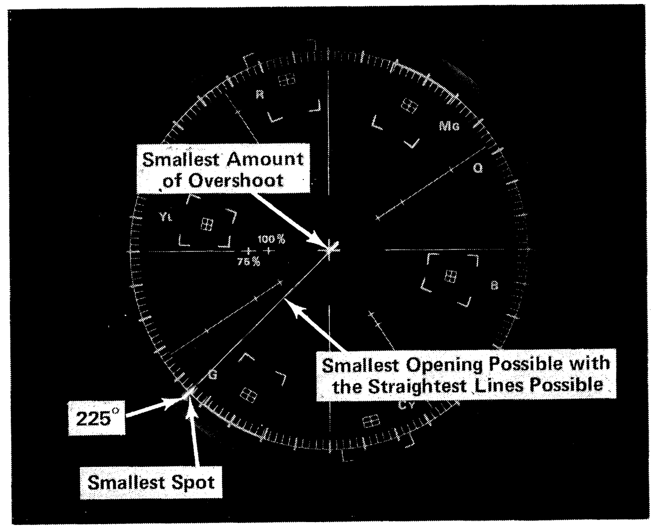


Fig. 6-21. Waveform areas to observe when adjusting horizontal amplifier transient response.

q. Turn on the Type 520 power. Return all Type 140 switches to the up position.

r. Apply the color bar signal from the Type 140 to the Type 520 CH A J1 connector via the 75 ohm coaxial cable.

s. Check that the Display Selector VECTOR pushbutton is depressed. Align burst at 180° using the channel A PHASE control.

t. Press the Display Selector Q pushbutton.

u. CHECK—Type 520 display; color bar waveform should have minimum aberrations on the leading front corner and a flat top.

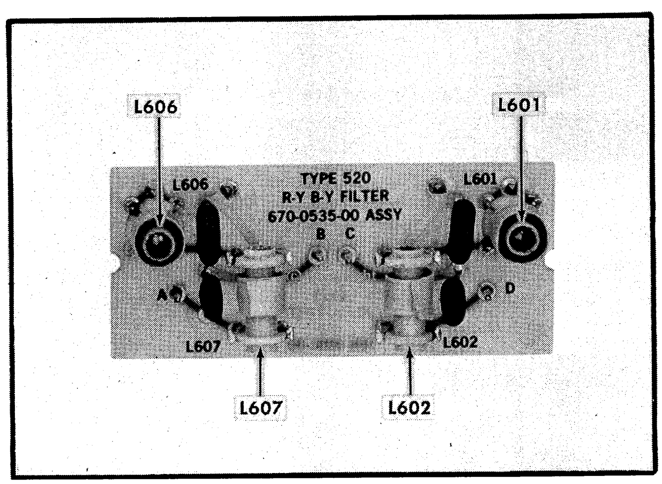


Fig. 6-22. R-Y, B-Y filter board adjustment locations.

v. ADJUST—L606 and L607 located on the R-Y, B-Y filter board, see Fig. 6-22, for best leading edge and flat top on the displayed color bars.

w. Press the Display Selector I pushbutton.

x. CHECK—Type 520 display; color bars should have minimum aberrations on the leading front corner and a flat top.

y. ADJUST—L601 and L602, see Fig. 6-22, for best leading edge and flat top on the displayed color bars.

z. *For instruments SN B200000 and up only.* Press the Display Selector VECTOR pushbutton and slowly rotate the channel A PHASE control. Check that the overshoot at the dots and the transient response between dots remains constant as the display is rotated 360°. Abnormal overshoot indicates that the adjustments performed in this step are not optimum.

aa. Disconnect the color bar signal, 75 ohm coaxial cable and 75 ohm end-line termination.

NOTES

Front-panel controls:

Signal Selector	**B CAL** and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	**VECTOR**
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

36. Adjust L272, L279; Feedback Components (for instruments SN B150100 and up); Input Phasing (for instruments SN B030000 to SN B150100) ❶

a. Connect a 10X probe from the test oscilloscope vertical input connector to TP275 on the subcarrier regenerator board; see Fig. 6-14.

b. Set the test oscilloscope for a vertical deflection factor of 0.2 V/division, AC coupled, at a sweep rate of 0.1 μs/division, with internal triggering.

c. CHECK—Test oscilloscope display amplitude; should equal about 4 volts peak to peak.

d. ADJUST—L272 and L279 (see Fig. 6-14) for maximum test oscilloscope display amplitude.

e. Disconnect the 10X probe.

f. Press the Signal Selector CH A and Aϕ pushbuttons and cancel the B CAL pushbutton.

g. Connect the 067-0565-00 calibration fixture to the CH A J1 connector. Connect a 75 ohm end-line termination to the CH A J2 connector.

h. Apply the signal from the Type 140 subcarrier output connector through a 75 ohm coaxial cable and 75 ohm feed-thru termination to the 067-0565-00 calibration fixture subcarrier input connector.

i. Connect the 10X probe, from the test oscilloscope vertical input connector, to the center conductor of the CH A J1 connector; see Fig. 6-5B.

j. Set the test oscilloscope for a vertical deflection factor of 0.01 V/division, AC coupled, at a sweep rate of 0.5 ms/division with a free-running sweep.

k. Set the 067-0565-00 calibration fixture 95%-100% switch to 95%. Adjust the calibration fixture subcarrier amplitude control so a signal amplitude of exactly 143 mV is displayed on the test oscilloscope.

l. Disconnect the 10X probe and test oscilloscope.

m. Connect a 75 ohm coaxial cable between the Type 140 comp sync and the Type 520 EXT SYNC J120 connector. Connect a 75 ohm coaxial cable from the Type 520 EXT SYNC J121 connector to the vertical input of the test oscilloscope via a 75 ohm feed-thru termination.

n. Set the test oscilloscope for a vertical deflection factor of 1 V/division, AC coupled, sweep rate 5 μs/division with internal triggering.

o. Adjust the test oscilloscope triggering controls to obtain a stable display.

p. Connect the 067-0565-00 calibration fixture ramp input connector through a 75 ohm coaxial cable and BNC-to-clip lead adapter to the test oscilloscope sawtooth output connector. (Connect the red lead to the sawtooth output connector and the black lead to the oscilloscope ground.)

q. Set the 067-0565-00 calibration fixture 95%-100% switch to 100%.

r. Press the Display Selector Y pushbutton and set the SYNC switch to EXT.

s. Adjust the 067-0565-00 calibration fixture ramp amplitude control for a sawtooth amplitude of exactly 140 IRE units as measured on the IRE graticule.

t. Set the channel A 100%-75%-MAX GAIN switch to MAX GAIN and press the Display Selector DIFF PHASE pushbutton.

u. Adjust the channel A PHASE control to bring the two traces together at the start of the display.

v. CHECK—Type 520 display, deviation between the two traces must not be greater than 0.3° in the last 80% of the display. (Use the CALIBRATED PHASE dial to read the deviation between traces.)

w. ADJUST—L272 and L279 (see Fig. 6-14) so the deviation between the traces is minimum. It is necessary to continually readjust the channel A PHASE control to keep the traces together as the adjustments are made.

x. Move the 067-0565-00 calibration fixture from the CH A J1 connector to the CH B J50 connector. Move the 75 ohm end-line termination from the CH A J2 connector to the CH B J51 connector.

y. Press the Signal Selector CH B pushbutton and cancel the CH A pushbutton. Set the channel B 100%-75%-MAX GAIN switch to MAX GAIN. Check that the Signal Selector Aϕ and FULL FIELD pushbuttons are depressed. Check that the Display Selector DIFF PHASE pushbutton is depressed.

z. CHECK—Repeat parts u and v to check the channel B input phasing.

aa. Disconnect the 067-0565-00 calibration fixture, test oscilloscope, 75 ohm end-line termination, four 75-ohm coaxial cables, two feed-thru terminations and the clip lead adapter.

NOTE

Parts ab through aw of this step apply only to instruments SN B150100 and up. For instruments SN B030000 to B150100 proceed with part ax of this step.

ab. Set the channel A and B 100%-75%-MAX GAIN switches to 75%. Press the Signal Selector CH A pushbutton and the Display Selector VECTOR pushbutton. Cancel the Signal Selector CH B pushbutton.

ac. Connect a dual-input cable connector to the CH A J2 and CH B J50 connectors and apply a modulated staircase signal, through a 75 ohm coaxial cable and 75 ohm feed-thru termination, to the dual-input cable connector.

ad. Connect a second cable from the Type 140 comp sync connector to the Type 520 EXT SYNC J120 connector. Connect a 75 ohm end-line termination to the EXT SYNC J121 connector.

ae. Adjust the channel A PHASE control so that the staircase vector coincides with the 180° reference line on the vector graticule.

af. Set the channel A 100%-75%-MAX GAIN switch to MAX GAIN.

ag. CHECK—Type 520 display; the vector dot should coincide with the inscribed graticule circle at 180°.

ah. ADJUST—C434 located on the feedback board (see Fig. 6-23) until the staircase vector dot coincides with the inscribed graticule circle. Adjust C430 until the vector dot coincides with the 180° reference line on the vector graticule.

ai. Set the channel A 100%-75%-MAX GAIN switch to 75%, then repeat parts ae through ah until interaction between C430 and C434 adjustments has been removed.

aj. Press the Signal Selector CH B and Bϕ pushbuttons and cancel the CH A pushbutton.

ak. Adjust the channel B PHASE control so that the staircase vector coincides with the 180° reference line on the vector graticule.

al. Set the channel B 100%-75%-MAX GAIN switch to MAX GAIN.

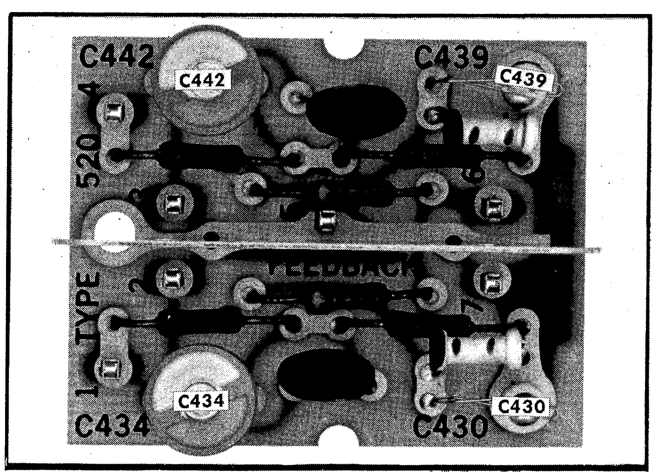


Fig. 6-23. Feedback board (SN B150100 and up) adjustment locations.

am. CHECK—Type 520 display; the vector dot should coincide with the inscribed graticule circle at 180°.

an. ADJUST—C442 (see Fig. 6-23) until the vector dot coincides with the inscribed graticule circle. Adjust C439 until the vector spot coincides with the 180° reference line on the vector graticule.

ao. Set the channel B 100%-75%-MAX GAIN switch to 75% and repeat parts ak through an until interaction between C439 and C442 adjustments has been removed.

ap. Set the Type 140 video switch up to obtain a color bar output signal and press the Signal Selector CH A and Aϕ/Bϕ ALT pushbuttons. (The other pushbuttons remain as they are.)

aq. Set Channel B input phasing capacitor, C411 (see Fig. 6-24), to its minimum capacitance position; that is, so the silvered half of the rotor section is toward the Signal Selector switch.

ar. CHECK—Type 520 display vector lengths. Corresponding vectors of channel A and channel B displays must be exactly the same length. (Use the channel A and B PHASE controls to superimpose the vectors.)

as. ADJUST—C52 (see Fig. 6-10) so the channel B vector is exactly the same length as the channel A vector. Do not disturb the setting of C2.

NOTE

Initial settings for C2 and C52 are given in step 15.

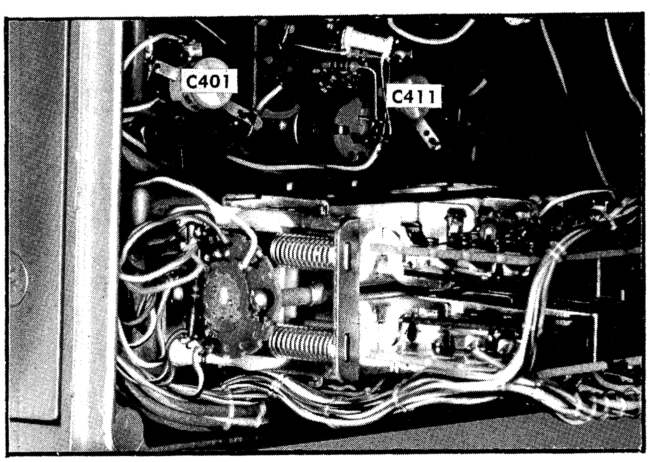


Fig. 6-24. Rear view of front-panel area below the Signal Selector switch showing location of C401 and C411 adjustments.

at. Depress the Signal Selector Aϕ pushbutton. (The other pushbuttons remain as they are.)

au. CHECK—Type 520 channel A and B vector phase difference; should not exceed 1°.

av. ADJUST—C401 (see Fig. 6-24) to superimpose the channel A vector on the channel B vector. If C401 has insufficient range to complete the adjustment, adjust C411 enough to superimpose the channel A vector on the channel B vector.

aw. Repeat parts as through av until interaction between C52 and C401 has been removed.

NOTE

Parts ax through bg apply to instruments SN B030000 to SN B150100 only.

ax. Apply a color bar signal, via a 75 ohm coaxial cable to the BNC female connector on the dual-input cable connector.

ay. Connect the dual-input cable connector to CH A J2 connector and CH B J50 connector.

az. Connect a 75 ohm end-line termination to the CH A J1 connector and the CH B J50 connector.

ba. Set the Channel A 100%-75%-MAX GAIN switch to 75%, depress the Display Selector VECTOR pushbutton, and set the SYNC switch to INT. Other pushbuttons remain as they are.

bb. Set the CH A input phasing capacitor, C88 (see Fig. 6-10), to its minimum capacitance position (silvered half of the rotor to the right of the arrow when the arrow is pointing away from you).

bc. CHECK—Type 520 display vector lengths. Corresponding vectors of channel A and channel B displays must be exactly the same length.

bd. ADJUST—C52, see Fig. 6-10, so that channel B vectors are exactly the same length as channel A vectors.

be. CHECK—Type 520 channel A and B vector phase difference should not exceed 1°.

bf. ADJUST—C98, see Fig. 6-10, to superimpose the channel B vectors upon the channel A vectors. If necessary, adjust C88 after C98 has run out of range to superimpose the channel A and channel B vectors upon each other (within 1° or less).

bg. Repeat parts bd through bf until interaction of adjustments C52 and C98 has been removed.

bh. Leave the color bar signal connected to CH A J2 and CH B J50 connectors.

37. Adjust Calibrated Phase Control

a. Cancel the Signal Selector CH B pushbutton. Check that the following pushbuttons are depressed: Signal Selector CH A, Aϕ and FULL FIELD; Display Selector VECTOR pushbutton. Check that a color bar signal is applied to the Type 520 CH A J2 and CH B J50 connectors.

b. Set the channel A variable GAIN control so that one of the displayed vectors overlays the graticule circle.

c. Set the CALIBRATED PHASE dial to −15°.

d. Using the channel A PHASE control, set the Type 520 displayed vector to an arbitrarily established 0° point on the vector graticule.

e. Set the CALIBRATED PHASE dial to +15°.

f. CHECK—Type 520 displayed vector should have rotated 30°, ±4° clockwise.

g. Adjust the channel A PHASE control to align a dot with an arbitrarily established 0° point on the vector graticule.

h. Rotate the CALIBRATED PHASE control from +14° toward −14° in increments of 2°.

i. CHECK—Type 520 display dot which corresponds to the dial reading being checked. The dial error over any 2° increment of the dial must be 2°, ±0.2° of the previous dial setting noted when the dot was aligned with the established 0° point.

j. Set the CALIBRATED PHASE dial to +14°.

k. Adjust the channel A PHASE control to align a dot with an arbitrarily established 0° point on the vector graticule.

l. Rotate the CALIBRATED PHASE control from +14° toward −14° in increments of 2°.

m. CHECK—Type 520 display dot. The dial error at the +12° and +10° dial settings must be 2°, ±0.2°, and 2°, ±0.4° respectively of the correct dial setting, while the dial error at the other dial setting must be 2°, ±0.5° of the correct dial setting.

NOTE

Parts n through x comprise the adjustment procedure.

n. Preset L331 to midrange and R335 clockwise (see Fig. 6-25).

o. Turn the CALIBRATED PHASE dial counterclockwise to the STOP setting.

p. ADJUST—L332 down until maximum distortion of the dots occurs.

q. Set the CALIBRATED PHASE dial to 0 and the A PHASE control to position one of the dots to the 0° graticule mark.

r. Rotate the CALIBRATED PHASE dial to +14°.

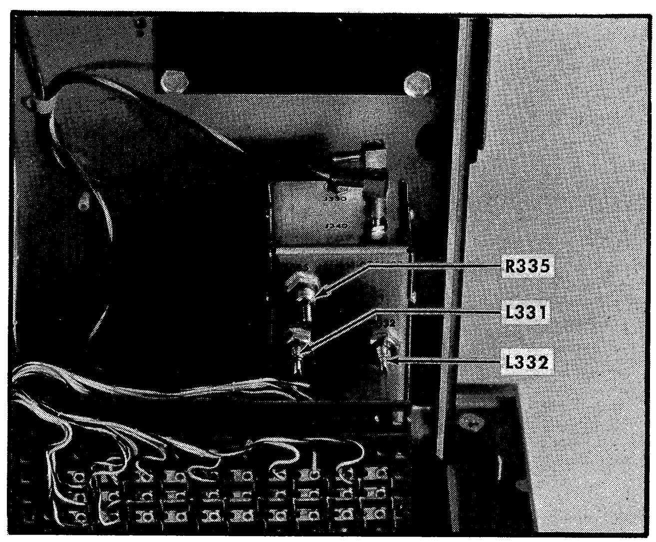


Fig. 6-25. Rear view of front-panel area below the Display Selector switch showing location of the precision phase shifter adjustments.

s. ADJUST—R335 to position the dot to the +14° graticule mark.

t. Set the CALIBRATED PHASE dial to 0 and the A PHASE control to position the dot to the 0° graticule mark.

u. Set the CALIBRATED PHASE dial to −14°.

v. ADJUST—L331 to double the dot error noted from the −14° graticule mark (if the dot is +1° from −14°, increase the error to +2° with L331).

w. Set the CALIBRATED PHASE dial to 0 and the A PHASE control to position the dot to the 0° graticule mark.

x. Repeat parts q through w as necessary to minimize interaction, then check calibrated phase range and accuracy by repeating parts c through m.

y. If continuing on to step 38, disconnect the dual input cable connector.

NOTES

Front-panel controls:

Signal Selector	CH A, Aϕ and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	**Y**
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	**0**
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

38. Adjust DIFF GAIN Mode Compensation **0**

a. Apply a modulated staircase signal to the CH A J1 connector via a 75 ohm coaxial cable.

b. Connect a 75 ohm end-line termination to the CH 2 J2 connector.

c. Adjust the HORIZ POSITION control to position the display so all steps of the staircase signal can be seen.

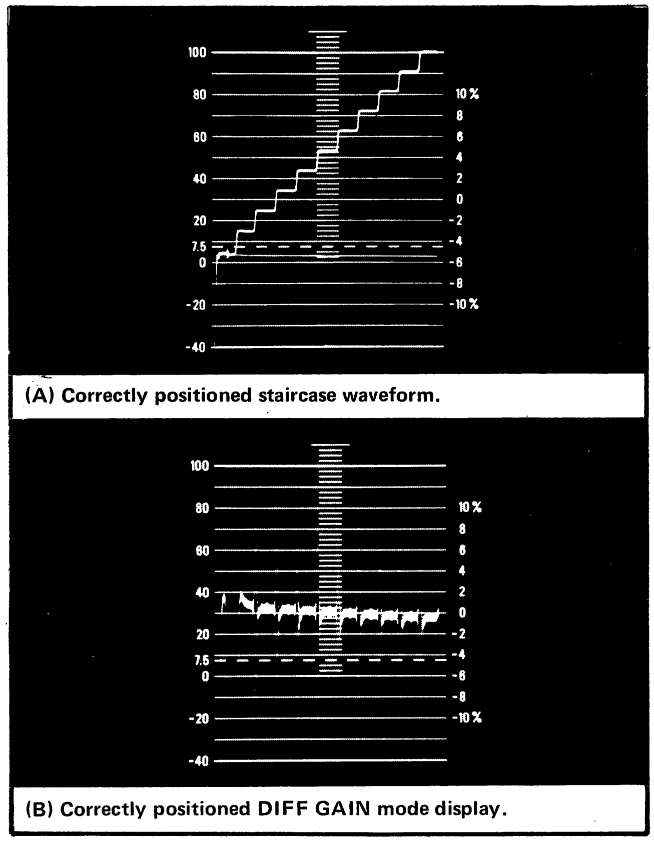
d. Using the VERT POSITION control, superimpose the base line of the staircase upon the —40 IRE unit line on the IRE graticule.

e. Adjust the channel A GAIN control so the top of the last step is superimposed upon the +100 IRE unit line on the IRE graticule; see Fig. 6-26A.

f. Press the Display Selector DIFF GAIN pushbutton and set the channel A 100%-75%-MAX GAIN switch to MAX GAIN. Do not touch the VERT POSITION control again during this step.

g. CHECK—Type 520 display; should have the information part of the waveform displayed at the 30 IRE unit line on the IRE graticule; see Fig. 6-26B.

h. ADJUST—DIFF GAIN POS BAL control, R498 (see Fig. 6-12) until the information part of the displayed waveform is superimposed upon the 30 IRE unit line on the IRE graticule; see Fig. 6-26B.



(A) Correctly positioned staircase waveform.

(B) Correctly positioned DIFF GAIN mode display.

Fig. 6-26. Typical displays obtained when performing step 38.

39. Check Input Amplitude Range

a. Press the Display Selector LINE SWEEP pushbutton.

b. Set the Type 140 video switch up to obtain a color bar output signal.

c. Connect a 10X probe, from the test oscilloscope vertical input connector, to the center conductor of the CH A J1 connector; see Fig. 6-5B.

d. Set the test oscilloscope for a vertical deflection factor of 0.01 V/division, AC coupled, at a sweep rate of 10 μs/division with internal triggering.

e. Set the sync pulse amplitude, of the color bar video signal, to exactly 286 mV (overall signal amplitude 1 volt) as measured on the test oscilloscope.

f. Rotate the channel A PHASE control to obtain maximum positive-going burst amplitude; see Fig. 6-27.

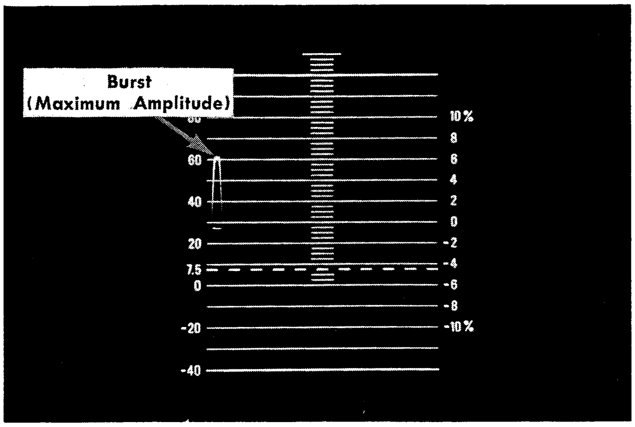


Fig. 6-27. Correct Type 520 color bar display for adjusting burst flag timing.

g. Check that the intensified rising and falling portions of the burst part of the Type 520 display are equal. It may be necessary to reduce the display intensity so the intensified portion may be seen. If the position of the intensified portion is not correct, adjust the front-panel BURST FLAG TIMING control, R1158, until the intensified rising and falling portions of the burst are equal.

h. Reduce the sync amplitude of the color bar video signal to exactly 200 mV (overall signal amplitude 0.7 volt) as measured on the test oscilloscope.

i. Set the Type 520 SYNC switch to EXT for about 15 seconds, then return it to its INT position.

j. CHECK—Type 520 display, should be stable.

k. Increase the sync pulse amplitude of the color bar video signal to exactly 400 mV (overall signal amplitude 1.4 volts) as measured on the test oscilloscope.

l. Set the Type 520 SYNC switch to EXT for about 15 seconds, then return it to its INT position.

m. CHECK—Type 520 display, should be stable.

n. Disconnect the video signal source, 75 ohm coaxial cable and 10X probe. Leave the termination connected to the CH A J2 connector.

40. Check Differential Gain Deflection Factor and Differential Gain

a. Set the SYNC switch to EXT.

b. Connect a 067-0565-00 calibration fixture to the CH A J1 connector. Check that a 75 ohm end-line termination is connected to the CH A J2 connector.

c. Connect a 75 ohm coaxial cable between the 067-0565-00 calibration fixture subcarrier input connector and the Type 140 subcarrier connector.

d. Connect a 10X probe from the test oscilloscope vertical input connector to the center conductor of the CH A J1 connector; see Fig. 6-5B.

e. Connect a 75 ohm coaxial cable between the Type 140 composite sync connector and the Type 520 EXT SYNC J120 connector.

f. Connect a 75 ohm coaxial cable from the Type 520 EXT SYNC J121 connector to the vertical input of the test oscilloscope via a 75 ohm feed-thru termination.

g. Set the test oscilloscope for a vertical deflection factor of 1 V/division, AC coupled, at a sweep rate of 5 μs/division with internal triggering.

h. Adjust the test oscilloscope triggering controls to obtain a stable display.

i. Connect the 067-0565-00 calibration fixture ramp input connector through a 75 ohm coaxial cable and BNC-to-clip lead adapter to the test oscilloscope sawtooth output connector. (Connect the red lead to the sawtooth output connector and the black lead to the oscilloscope ground.)

j. Set the 067-0565-00 calibration factor 95%-100%-MAX GAIN switch to 100%, then adjust the ramp amplitude control for a sawtooth amplitude of exactly 140 IRE units measured on the IRE graticule.

k. Set the channel A 100%-75%-MAX GAIN switch to MAX GAIN and press the Display Selector VECTOR pushbutton.

l. Adjust the calibration fixture subcarrier amplitude control so that the vector dot coincides with the inscribed graticule circle. Rotate the Type 520 A PHASE control to align the dot to 180°.

m. Press the Display Selector DIFF GAIN pushbutton and adjust the VERT POSITION control to position the display to a convenient point.

n. CHECK—Deviation of the Type 520; horizontal display must not exceed ±5 IRE units from the horizontal lines of the IRE graticule throughout the last 90% of its length. This includes both slope and aberrations.

o. Set the 067-0565-00 calibration fixture 95%-100%-MAX GAIN switch to 95%.

p. CHECK—Position of the Type 520 display; should be 25 IRE units ±1.25 IRE units below its position in part n of this step.

q. Return the 067-0565-00 calibration fixture 95%-100% switch to 100%. If requirements cannot be met, select R765 (see Fig. 6-8) for proper differential gain deflection factor as described in part p.

r. Move the 067-0565-00 calibration fixture from the CH A J1 connector to the CH B J50 connector. Move the 75 ohm termination from the CH A J2 connector to the CH B J51 connector.

s. Press the Signal Selector CH B pushbutton.

t. Using parts k through n as a guide, check the differential gain for channel B.

u. If continuing on to step 41, leave the 75 ohm termination connected to CH A J2 connector and remove all other connections to the Type 520.

NOTES

Front-panel controls:

Signal Selector	**CH A**, Aϕ and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	**75%**
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	**75%**
GAIN	CAL
Display Selector	**VECTOR**
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	**INT**

41. Check 100%-75%-MAX GAIN Switch Gain (For instruments SN B150100 and up)

a. Apply a 75% amplitude, 7.5% setup, color bar signal, from the Type 140 comp video connector, through a 75 ohm coaxial cable to the Type 520 CH A J1 connector.

b. Connect a 75 ohm coaxial cable from the CH A J2 connector to the CH B J50 connector and a 75 ohm end-line termination to the CH B J51 connector.

c. Check that the Signal Selector CH B pushbutton is cancelled, then set the channel A PHASE control so that the burst vector is at 180°.

d. Set the channel A 100%-75%-MAX GAIN switch to 100% and the Type 140 color bar amplitude switch to 100%.

e. CHECK—Type 520 display color vectors must be in their boxes.

f. Cancel the Signal Selector CH A pushbutton and set the channel A 100%-75%-MAX GAIN switch to 75%.

g. Press the Signal Selector CH B pushbutton. Set the channel A PHASE control so that the burst vector is at 180°.

h. Set the channel B 100%-75%-MAX GAIN switch to 100%.

i. CHECK—Type 520 display color vectors must be in their boxes.

j. Set the channel B 100%-75%-MAX GAIN switch to 75%.

k. Cancel the Signal Selector CH B pushbutton. (The other pushbuttons remain as they are.)

41A. Check 100%-75%-MAX GAIN Switch Gain (For instruments below SN B150100)

a. Press both the Signal Selector A CAL and the Display Selector Y pushbuttons.

b. CHECK—Type 520 display amplitude should equal 140 IRE units. If it is not, readjust the Type 520 channel A GAIN control to obtain the correct display.

c. Set the channel A 100%-75%-MAX GAIN switch to 100%.

d. CHECK—Type 520 display amplitude; 105 IRE units, ±2.8 IRE units.

e. Cancel the Signal Selector A CAL pushbutton and set the channel A 100%-75%-MAX GAIN switch to 75%.

f. Press Signal Selector B CAL pushbutton.

g. CHECK—Type 520 display amplitude; exactly 140 IRE units. If it is not, readjust the Type 520 channel B GAIN control to obtain the correct display.

h. Set the channel B 100%-75%-MAX GAIN switch to 100%.

i. CHECK—Type 520 display amplitude, 105 IRE units, ±2.8 IRE units.

j. Set the channel B 100%-75%-MAX GAIN switch to 75%.

k. Connect a 10X probe, from the test oscilloscope vertical input connector, to TP450 (junction of R452 and Q450 emitter) on the demodulator board; see Fig. 6-12.

l. Set the test oscilloscope for a vertical deflection factor of 0.05 V/division, AC coupled, at a sweep rate of 0.5 ms/division with internal triggering.

m. Adjust the test oscilloscope vertical deflection factor so that exactly one major division of display is observed on the test oscilloscope.

n. Set the channel B 100%-75%-MAX GAIN switch to MAX GAIN.

o. CHECK—Test oscilloscope display amplitude; 3.5 major divisions, ±5%.

p. Cancel the Signal Selector B CAL pushbutton and set the channel B 100%-75%-MAX GAIN switch to 75%.

q. Depress the Signal Selector A CAL pushbutton.

r. Adjust the test oscilloscope vertical deflection factor so that exactly one major division of display is observed on the test oscilloscope.

s. Set the channel A 100%-75%-MAX GAIN switch to MAX GAIN.

t. CHECK—Test oscilloscope display amplitude; 3.5 major divisions, ±5%.

u. Set the Type 520 controls as follows:

Signal Selector	Aϕ, FULL FIELD
CH A	
100%-75%-MAX GAIN	75%
Channel A and B GAIN	CAL
Display Selector	VECTOR

v. Disconnect the test oscilloscope and the 10X probe.

42. Check Color Bar Decoding Accuracy

a. Check that the Type 140 75% amplitude, 7.5% setup, and color bar signal is applied to the Type 520 as described in parts a through c of step 41.

b. Press the Signal Selector CH A pushbutton. Check that the Signal Selector Aϕ and FULL FIELD pushbuttons and the Display Selector VECTOR pushbutton are depressed.

c. Using the A PHASE control, position the Y_L vector dot into the graticule Y_L inner box.

d. Depress the Display Selector R, G, and B pushbuttons in succession.

e. CHECK—The color bars should extend from 7.5% setup to 77 IRE units, within ±3%, when the blanking level is aligned with the 0 IRE unit graticule line.

43. Check Time Sharing Switching Rate

a. Press the Signal Selector Bϕ pushbutton and the Display Selector VECTOR pushbutton. Check that the remaining controls, except the Aϕ pushbutton, are set to the same positions as those given in the list that precedes step 41.

b. Set the Type 140 controls for a convergence crosshatch pattern (all switches in the up position).

c. Change the interconnections between the Type 140 and Type 520 so that the color bar signal is applied to the CH B J50 connector and the convergence crosshatch pattern is applied to the CH A J1 connector. Connect a 75 ohm end-line termination to the CH A J2 connector. Check that a termination is connected to the CH B J51 connector.

d. Connect a 10X probe from the test oscilloscope vertical input connector to TP776 (junction of R705 and R715) on the output amplifier board; see Fig. 6-8.

e. Set the test oscilloscope for a vertical deflection factor of 0.05 V/division, AC coupled, at a sweep rate of 20 μs/division with internal triggering.

f. CHECK—Test oscilloscope display should be two complete channel A signals followed by two complete channel B signals, then two channel A signals followed by two channel B signals.

g. Disconnect the video signal source, test oscilloscope, the two 75 ohm coaxial cables, the two 75 ohm end-line terminations and the 10X probe.

Front-panel controls:

Signal Selector	CH A, **Aϕ** and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	BURST
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	VECTOR
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

44. (Optional Step) Check Subcarrier Regenerator Pull-In Range and Time

NOTE

In general, if the Type 520 subcarrier regenerator (SCR) locks in on the color bar signal after the signal is turned off or disconnected for a period of time, the SCR is operating properly. A more complete check can be made if the following test fixture (item 9) is used to offset the Type 140 subcarrier frequency ±5 Hz as described in the procedure that follows.

Subcarrier Frequency Offset test fixture used to change the Type 140 subcarrier frequency ±15 Hz. Construct the test fixture according to the information given in Fig. 6-1A. Connect the test fixture to the Type 140 subcarrier board. Connect the Type 140 subcarrier signal through a 75 ohm coaxial cable and a 75 ohm feed-thru termination to an accurate (at least ±1 Hz) frequency counter. Set the test fixture switch S1 to +15 Hz and adjust R1 until the frequency counter indicates 3.579560 MHz. Mark the position of R1 and leave the control set at this point. Set S1 to −15 Hz and adjust R2 until the frequency counter indicates 3.579530 MHz. Mark the position of R2 and leave the control at this point. The test fixture is now calibrated to offset this Type 140 subcarrier frequency ±15 Hz. Disconnect the frequency counter.

a. Apply a color bar signal from the Type 140 comp video connector through a 75 ohm coaxial cable to the Type 520 CH A J1 connector.

b. Check that a 75 ohm end-line termination is connected to the CH A J2 connector.

c. Connect the test fixture to the Type 140 subcarrier board and set the test fixture switch S1 to the Normal position.

d. CHECK—Type 520 display, vector should be stable (not rotating).

e. Set the test fixture switch S1 to +15 Hz.

f. CHECK—Time that the Type 520 takes to stabilize vector display; fifteen seconds or less.

g. Set the test fixture switch S1 to Normal and allow the display to stabilize.

h. Set the test fixture switch S1 to −15 Hz.

i. CHECK—Time that the Type 520 takes to stabilize to a stable vector display; fifteen seconds or less.

j. Set the test fixture switch S1 to Normal. Using the Type 520 A PHASE control, position the burst vector to 180°

k. Set the test fixture switch S1 to +15 Hz.

l. CHECK—Type 520 burst vector position; should be within 0.6° of the 180° point on the vector graticule. The CALIBRATED PHASE control can be used to measure the amount of burst vector shift.

m. Set the test fixture switch S1 to −15 Hz.

n. CHECK—Repeat part l of this step.

o. Disconnect the test fixture. Leave the color bar signal connected to the Type 520.

45. Check Vertical Positioning Range

a. Check that a color bar signal is applied from the Type 140 comp video connector through a 75 ohm coaxial cable to the Type 520 CH A J1 connector.

b. Check that a 75 ohm end-line termination is connected to the CH A J2 connector.

c. Press the Display Selector Y pushbutton.

d. Check that the Signal Selector CH A, Aϕ and FULL FIELD pushbuttons are depressed.

e. Turn the VERT POSITION control fully clockwise.

f. CHECK—Type 520 display, blanking level must be located at least 45 IRE units above the —40 IRE unit graticule line on the IRE graticule.

g. Turn the VERT POSITION control fully counterclockwise.

h. CHECK—Type 520 display; blanking level must be located at least 10 IRE units below the —40 IRE unit graticule line of the IRE graticule.

i. Press the Display Selector R pushbutton.

j. CHECK—Position range, by repeating parts e through h.

k. Press the Display Selector G pushbutton.

l. CHECK—Position range by repeating parts e through h.

m. Press the Display Selector B pushbutton.

n. CHECK—Position range by repeating parts e through h.

46. Check Horizontal Positioning Range

a. Press the Display Selector Y pushbutton and turn the HORIZ POSITION control fully clockwise.

b. CHECK—Type 520 display position; not more than 3 mm of the display must be to the left of the center of the IRE graticule. (The display may appear entirely to the right of center.)

c. Turn the HORIZ POSITION control fully counterclockwise.

d. CHECK—Type 520 display position; not more than 3 mm of the display must be to the right of the center of the IRE graticule. (The display may appear entirely to the left of center.)

47. Check Vertical and Horizontal Position Clamp Range

a. Press the Display Selector VECTOR pushbutton. Cancel the Signal Selector CH A pushbutton.

b. Adjust the VERT and HORIZ POSITION CLAMP controls to position the spot to the center of the vector graticule.

c. Rotate the VERT POSITION CLAMP control fully clockwise.

d. CHECK—Type 520 spot position; must have moved up at least 2.5 IRE units from its initial position established in part b of this step. Use the IRE graticule to estimate the distance the spot moved.

e. Rotate the VERT POSITION CLAMP control fully counterclockwise.

f. CHECK—Type 520 spot position; must have moved down at least 2.5 IRE units from the initial position established in part b of this step. Use the IRE graticule to estimate the distance the spot moved.

g. CHECK—Type 520 spot positioning must have a total positioning range, as noted in parts d and f, of 20 IRE units.

h. Rotate the HORIZ POSITION CLAMP control fully clockwise.

i. CHECK—Type 520 spot position; must have moved right at least 2.5 IRE units from the initial position established in part b of this step.

j. Rotate the HORIZ POSITION CLAMP control fully counterclockwise.

k. CHECK—Type 520 spot position; must have moved left at least 2.5 IRE units from the initial position established in part b.

l. CHECK—Total Type 520 spot positioning range as noted in parts i and k, must equal or exceed 20 IRE units.

m. Readjust the VERT and HORIZ POSITION CLAMP controls to position the spot to the center of the vector graticule.

48. Check Channel A and B Gain Control Range

a. Press the Signal Selector CH A and Display Selector Y pushbuttons.

b. Set the Type 140 video switch down to obtain a modulated staircase output signal.

c. Move the 75 ohm end-line termination from the CH A J2 connector to the CH B J51 connector. Connect a 75 ohm coaxial cable from the CH A J2 connector to the CH B J50 connector.

d. Connect a 10X probe from the test oscilloscope vertical input connector to TP450 on the demodulator board; see Fig. 6-12.

e. Set the test oscilloscope for a vertical deflection factor of 20 mV/division, AC coupled, at a sweep rate of 0.1 ms/division with free-running sweep.

f. Adjust the test oscilloscope vertical deflection factor for a display of exactly 3 major divisions on the test oscilloscope.

g. Rotate the channel A GAIN control throughout its range.

h. CHECK—Test oscilloscope display amplitude must vary from 6 major divisions or more to 1.2 divisions or less.

i. Return the channel A GAIN control to its CAL position. Cancel the Signal Selector CH A pushbutton and press the CH B and Bϕ pushbuttons.

j. Adjust the test oscilloscope vertical deflection factor for a display of exactly 3 major divisions on the test oscilloscope.

k. Rotate the channel B GAIN control throughout its range.

l. CHECK—Test oscilloscope display amplitude; must vary from 6 major divisions or more to 1.2 divisions or less.

m. Return the channel B GAIN control to CAL position. Disconnect the video signal source, the test oscilloscope, the two 75 ohm coaxial cables, 75 ohm end-line termination, and the 10X probe.

49. Check Luminance Gain Range

a. Cancel the Signal Selector CH B pushbutton and depress the CH A and Aϕ pushbuttons.

b. Apply a modulated staircase signal via a 75 ohm coaxial cable to the Type 520 CH A J1 connector.

c. Connect a 75 ohm end-line termination to CH A J2 connector.

d. Connect a 10X probe from the test oscilloscope vertical input connector to TP776 on the output amplifier board; see Fig. 6-8.

e. Set the test oscilloscope for a vertical deflection factor of 0.1 V/division, AC coupled, at a sweep rate of 0.1 ms/division with a free-running sweep.

f. Adjust the test oscilloscope vertical deflection factor for a display of exactly 2 major divisions on the test oscilloscope.

g. Rotate the LUMINANCE GAIN control out of its CAL detent position.

h. CHECK—Test oscilloscope display amplitude; must vary from 2.8 major divisions to 1.4 major divisions.

i. Return the LUMINANCE GAIN control to its CAL position.

Front-panel controls:

Signal Selector	**B Cal** and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	**EXT**
CHANNEL B	
100%-75%-MAX GAIN	75%
GAIN	CAL
Display Selector	**VECTOR**
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	INT

50. Check External Phase Reference Input Range

a. Apply a 2 volt peak to peak subcarrier signal from the Type 140 subcarrier output connector, via a variable attenuator and a 75 ohm coaxial cable, to the Type 520 EXT CW ϕ REF J310 connector.

b. Connect a 10X probe from the test oscilloscope vertical input connector to the center conductor of the EXT CW ϕ REF J310 connector; see Fig. 6-28.

c. Set the test oscilloscope for a vertical deflection factor of 0.05 V/division, AC coupled, at a sweep rate of 0.2 μs/division with internal triggering.

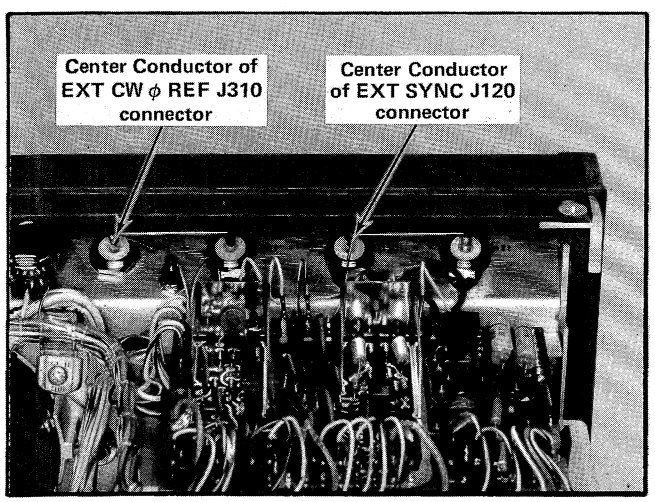


Fig. 6-28. Location of step 50 test points.

d. Adjust the peak-to-peak output amplitude of the 3.58 MHz CW video signal for a test oscilloscope display of exactly 4 major divisions.

e. Vary the 3.58 MHz CW video signal amplitude between 1.5 volt and 2.5 volts peak-to-peak, using the test oscilloscope to measure the signal amplitude.

f. CHECK—Type 520 test circle display must not change in size or shape as the 3.58 MHz signal amplitude is varied.

g. Disconnect the signal source and 10X probe.

51. Check External Horizontal Sync Range

a. Press the Signal Selector CH B and Bϕ pushbuttons.

b. Set the ϕ REF switch to BURST and press the Display Selector LINE SWEEP pushbutton.

c. Set the SYNC switch to EXT.

d. Apply a modulated staircase signal via a 75 ohm coaxial cable to the Type 520 CH B J50 connector.

e. Connect a 75 ohm end-line termination to the CH B J51 connector.

f. Apply a 4 volt peak-to-peak composite sync signal via a variable attenuator and a 75 ohm coaxial cable to the EXT SYNC J120 connector.

g. Connect a 10X probe from the test oscilloscope vertical input connector to the center conductor of the EXT SYNC J120 connector (R12 if nominal 1 volt sync signal is being used); see Fig. 6-28).

h. Set the test oscilloscope for a vertical deflection factor of 0.2 V/division, (0.05 V/division), AC coupled, at a sweep rate of 20 μs/division with internal triggering.

i. Adjust the peak-to-peak output amplitude of the sync video signal for a test oscilloscope display of exactly 2 major divisions in amplitude.

j. Adjust the BURST FLAG TIMING control for the proper Type 520 display; refer to step 23 of this procedure.

k. Vary the sync video signal amplitude between 3.5 volts and 7.5 volts peak-to-peak, using the test oscilloscope to measure the signal amplitude. Interrupt the sync video signal by momentarily setting the SYNC switch to INT before making the check at a particular sync video signal amplitude.

l. CHECK—A stable display must be obtained whenever the SYNC switch is set to its EXT position as part k of this step is performed.

m. Disconnect the video signal source, variable attenuator, test oscilloscope, the two 75 ohm coaxial cables, the 75 ohm end-line termination, and the 10X probe.

52. Check Instrument Return Loss

A differential amplifier required for this step.

a. Connect the 015-0149-00 calibration fixture to the vertical input connectors of the test oscilloscope.

b. Apply a 5 MHz sine wave signal, approximately 1 volt in amplitude, from a wide bandwidth constant amplitude sinewave generator via a 50 ohm coaxial cable and a 50 ohm to 75 ohm minimum loss attenuator to the signal input connector on the 015-0149-00 calibration fixture.

c. Connect the matched 75 ohm terminations to the end of each coaxial cable of the 015-0149-00 calibration fixture.

d. Set the test oscilloscope for a vertical deflection factor of 0.2 V/division (both input channels set for A-B operation) with a free running sweep.

e. Remove one matched 75 ohm termination and adjust the constant amplitude sinewave generator for a 0.5 V, 5 MHz output sinewave signal as observed on the test oscilloscope, then replace the matched 75 ohm termination.

f. Set the test oscilloscope for a vertical deflection factor of 1 mV/division, both input channels AC coupled, and set for A-B operation at a sweep rate of 20 μs/division with a free-running sweep.

g. Vary the constant amplitude sinewave generator frequency from 25 Hz to 5 MHz.

h. CHECK—Test oscilloscope display amplitude should be 1 mV or less at any frequency between 25 Hz and 5 MHz.

i. Disconnect a 75 ohm termination from the end of the measuring cable. Attach the measuring cable to the Type 520 CH A J1 connector and the 75 ohm termination just removed to the CH A J2 connector.

j. Vary the constant amplitude sinewave generator frequency from 25 Hz to 5 MHz.

k. Press the Type 520 Signal Selector CH A and then the A CAL pushbuttons.

l. CHECK—Test oscilloscope display amplitude should not exceed 2.5 mV minus the amplitude noted in part h for any frequency from 25 Hz to 5 MHz.

m. Disconnect the measuring cable and adapter from the Type 520 CH A J1 connector and connect it to the CH B J50 connector. Disconnect the 75 ohm termination from the CH A J2 connector and connect it to the CH B J51 connector.

n. Vary the constant amplitude sinewave generator frequency from 25 Hz to 5 MHz.

o. Press the Type 520 Signal Selector CH B and then the B CAL pushbuttons.

p. CHECK—Test oscilloscope display amplitude; should never be more than 2.5 mV minus the signal amplitude noted in part h at any frequency from 25 Hz to 5 MHz.

q. Disconnect the measuring cable from the Type 520 CH B J50 connector and connect it to the EXT CW ϕ REF J310 connector. Disconnect the 75 ohm termination from the CH B J51 connector and connect it to the EXT CW ϕ REF J311 connector.

r. Vary the constant amplitude sinewave generator frequency from 25 Hz to 5 MHz.

s. Switch the Type 520 ϕ REF switch between its BURST and EXT positions.

t. CHECK—Test oscilloscope display amplitude; should never be more than 2.5 mV minus the signal amplitude noted in part h.

u. Disconnect the measuring cable from the Type 520 EXT CW ϕ REF J310 connector and connect it to the EXT

SYNC J120 connector. Disconnect the 75 ohm termination from the EXT CW ϕ REF J311 connector and connect it to the EXT SYNC J121 connector.

v. Vary the constant amplitude sinewave generator frequency from 25 Hz to 5 MHz.

w. Switch the Type 520 SYNC switch between its INT and EXT positions.

x. CHECK—Test oscilloscope display amplitude; should never be more than 2.5 mV (4 volt connection) or 5 mV (1 volt connection) minus the signal amplitude noted in part h at any frequency from 25 Hz to 5 MHz.

y. Disconnect the 015-0149-00 calibration fixture, 75 ohm termination, wide bandwidth sinewave generator, test oscilloscope, 50 ohm coaxial cable and 50 ohm to 75 ohm minimum loss attenuator.

NOTES

Front-panel controls:

Signal Selector	**CH A, CH B, Aϕ/Bϕ ALT** and FULL FIELD
CHANNEL A	
100%-75%-MAX GAIN	75%
GAIN	CAL
ϕ REF	**BURST**
CHANNEL B	
100%-75%-MAX GAIN	**MAX GAIN**
GAIN	CAL
Display Selector	**DIFF PHASE**
INTENSITY	As desired
LUMINANCE GAIN	CAL
SCALE ILLUM	As desired
CALIBRATED PHASE	0
POWER	ON

Right recessed front-panel controls:

FIELD	1
SYNC	**INT**

53. (Optional Step) Check Phase Jitter

a. Connect a color bar video signal via a 75 ohm coaxial cable to the Type 520 CH A J1 connector.

b. Apply a modulated staircase signal via a 75 ohm coaxial cable to the Type 520 CH B connector.

c. Connect a 75 ohm end-line termination to the CH A J2 connector and to the CH B J51 connector.

d. Adjust the channel B PHASE control to position the modulated staircase resultant waveform onto the display area.

e. Insert onto the color bar video signal 51 mV RMS (73 mV peak-to-peak) of white noise.

f. CHECK—Type 520 display jitter on the modulated staircase resultant waveform; must be less than 1°. Use the CALIBRATED PHASE control to measure the amount of display jitter.

This completes the calibration of the Type 520. Disconnect all test equipment and replace the top and bottom covers.

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
inc	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
P/O	part of
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
S or SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

Oven Assembly
119-0151-00

SECTION 7
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Bulbs			
B1560	150-0045-00			Incandescent #685			
B1562	150-0047-00			Incandescent #CN8-398 200 mA			
B1563	150-0047-00			Incandescent #CN8-398 200 mA			
B1565	150-0001-00			Incandescent #47 150 mA			
B1566	150-0001-00			Incandescent #47 150 mA			
B1567	150-0001-00			Incandescent #47 150 mA			
B1568	150-0001-00			Incandescent #47 150 mA			

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C1	290-0290-00			10 μF	Elect.	25 V	
C2	281-0077-00			1.3-5.4 pF, Var	Air		
C4	283-0000-00			0.001 μF	Cer	500 V	
C14	283-0000-00			0.001 μF	Cer	500 V	
C18	281-0077-00			1.3-5.4 pF, Var	Air		
C33	283-0032-00			470 pF	Cer	500 V	5%
C36	283-0026-00			0.2 μF	Cer	25 V	
C37	283-0026-00			0.2 μF	Cer	25 V	
C40	283-0599-00			98 pF	Mica	500 V	5%
C41	283-0116-00			820 pF	Cer	500 V	5%
C44	283-0003-00			0.01 μF	Cer	150 V	
C45	283-0004-00			0.02 μF	Cer	150 V	
C46	283-0598-00			253 pF	Mica	300 V	5%
C48	283-0598-00			253 pF	Mica	300 V	5%
C49	283-0617-00			4700 pF	Mica	300 V	10%
C51	290-0290-00			10 μF	Elect.	25 V	
C52	281-0077-00			1.3-5.4 pF, Var	Air		
C54	283-0000-00			0.001 μF	Cer	500 V	
C64	283-0000-00			0.001 μF	Cer	500 V	
C66	281-0077-00			1.3-5.4 pF, Var	Air		
C74	283-0000-00			0.001 μF	Cer	500 V	
C75	283-0026-00			0.2 μF	Cer	25 V	
C76	283-0026-00			0.2 μF	Cer	25 V	
C81	281-0610-00			2.2 pF	Cer	200 V	±0.1 pF
C85	281-0623-00	B010100	B149999	650 pF	Cer	500 V	5%

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C85	283-0603-00	B150000		113 pF	Mica	300 V	2%
C87	281-0503-00	B010100	B149999X	8 pF	Cer	500 V	±0.5 pF
C88	281-0060-00	XB030000	B149999X	2-8 pF, Var	Cer		
C91	281-0610-00			2.2 pF	Cer	200 V	±0.1 pF
C95	281-0623-00	B010100	B149999	650 pF	Cer	500 V	5%
C95	283-0603-00	B150000		113 pF	Mica	300 V	2%
C97	281-0503-00	B010100	B149999X	8 pF	Cer	500 V	±0.5 pF
C98	281-0060-00	XB030000	B149999X	2-8 pF, Var	Cer		
C100	290-0135-00			15 µF	Elect.	20 V	
C109	283-0003-00			0.01 µF	Cer	150 V	
C116	290-0135-00			15 µF	Elect.	20 V	
C120	283-0059-00			1 µF	Cer	25 V	+80%—20%
C126	283-0065-00			0.001 µF	Cer	100 V	5%
C132	283-0065-00			0.001 µF	Cer	100 V	5%
C136	283-0059-00			1 µF	Cer	25 V	+80%—20%
C143	290-0261-00	XB240000		6.8 µF	Elect.	35 V	
C144	283-0059-00	XB240000		1 µF	Cer	25 V	+80%—20%
C145	283-0065-00			0.001 µF	Cer	100 V	5%
C146	283-0059-00			1 µF	Cer	25 V	+80%—20%
C148	283-0065-00			0.001 µF	Cer	100 V	5%
C150	283-0026-00			0.2 µF	Cer	25 V	
C152	283-0026-00			0.2 µF	Cer	25 V	
C201	281-0512-00			27 pF	Cer	500 V	10%
C203	283-0059-00			1 µF	Cer	25 V	+80%—20%
C205	283-0004-00			0.02 µF	Cer	150 V	
C208	283-0051-00			0.0033 µF	Cer	100 V	5%
C210	283-0081-00			0.1 µF	Cer	25 V	+80%—20%
C216	283-0004-00			0.02 µF	Cer	150 V	
C220	283-0615-00			33 pF	Mica	500 V	5%
C221	283-0119-00			2200 pF	Cer	200 V	5%
C229	283-0004-00			0.02 µF	Cer	150 V	
C231	283-0001-00			0.005 µF	Cer	500 V	
C235	283-0003-00	XB250000		0.01 µF	Cer	150 V	
C236	283-0004-00			0.02 µF	Cer	150 V	
C242	283-0593-00			0.01 µF	Mica	100 V	1%
C244	283-0593-00			0.01 µF	Mica	100 V	1%
C254	290-0267-00	B010100	B149999	1 µF	Elect.	35 V	
C254	283-0129-00	B150000		0.56 µF	Cer	100 V	
C255	285-0629-00	B010100	B149999	0.047 µF	PTM	100 V	
C255	285-0624-00	B150000		0.027 µF	PTM	100 V	10%
C260	283-0599-00			98 pF	Mica	500 V	5%
C261	281-0615-00			3.9 pF	Cer	200 V	
C263	283-0604-00			304 pF	Mica	300 V	2%
C270	283-0003-00			0.01 µF	Cer	150 V	
C272	283-0622-00			450 pF	Mica	300 V	1%
C273	283-0622-00			450 pF	Mica	300 V	1%
C275	283-0065-00			0.001 µF	Cer	100 V	5%
C279	281-0638-00			240 pF	Cer	500 V	5%

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C282	283-0003-00			0.01 µF	Cer	150 V	
C295	283-0059-00			1 µF	Cer	25 V	+80%—20%
C296	283-0059-00			1 µF	Cer	25 V	+80%—20%
C297	283-0059-00			1 µF	Cer	25 V	+80%—20%
C299	283-0111-00			0.1 µF	Cer	50 V	
C301	283-0065-00			0.001 µF	Cer	100 V	5%
C304	283-0065-00			0.001 µF	Cer	100 V	5%
C311	283-0065-00			0.001 µF	Cer	100 V	5%
C314	283-0065-00			0.001 µF	Cer	100 V	5%
C327	283-0065-00			0.001 µF	Cer	100 V	5%
C329	283-0003-00			0.01 µF	Cer	150 V	
C332	283-0612-00			82 pF	Mica	500 V	
C335A } C335B }	281-0109-01			1-16.5 pF	Piston Assembly		
C340	283-0079-00			0.01 µF	Cer	250 V	
C342	281-0580-00			470 pF	Cer	500 V	10%
C345	283-0079-00			0.01 µF	Cer	250 V	
C346	283-0004-00			0.02 µF	Cer	150 V	
C349	283-0079-00			0.01 µF	Cer	250 V	
C352[1]							
C354[1]							
C358[1]							
C362[2]							
C364[2]							
C368[2]							
C401	281-0063-00	XB150000		9-35 pF, Var	Cer		
C404	281-0550-00	XB150000	B239999	120 pF	Cer	500 V	10%
C404	283-0524-00	B240000		750 pF	Mica	500 V	5%
C411	281-0063-00	XB150000		9-35 pF, Var	Cer		
C414	281-0550-00	XB150000	B239999	120 pF	Cer	500 V	10%
C414	283-0524-00	B240000		750 pF	Mica	500 V	5%
C430	281-0064-00	XB150000		0.25-1.5 pF, Var	Tub.		
C433	281-0611-00	XB150000		2.7 pF	Cer	200 V	±0.25 pF
C434	281-0092-00	XB150000		9-35 pF, Var	Cer		
C435	283-0629-00	XB150000		65 pF	Mica	500 V	1%
C439	281-0064-00	XB150000		0.25-1.5 pF, Var	Tub.		
C441	281-0611-00	XB150000		2.7 pF	Cer	200 V	±0.25 pF
C442	281-0615-00	B010100	B149999	3.9 pF	Cer	200 V	
C442	281-0092-00	B150000		9-35 pF, Var	Cer		
C445	283-0629-00	XB150000		62 pF	Mica	500 V	1%
C446	283-0026-00			0.2 µF	Cer	25 V	
C449	283-0108-00	B010100	B149999	220 pF	Cer	200 V	10%
C449	283-0641-00	B150000		180 pF	Mica	100 V	1%
C450	283-0026-00			0.2 µF	Cer	25 V	
C453	281-0091-00			2-8 pF, Var	Cer		
C454	281-0091-00			2-8 pF, Var	Cer		
C455	283-0639-00			56 pF	Mica	100 V	1%

[1]Furnished as a unit with CH A Goniometer (*119-0133-00).
[2]Furnished as a unit with CH B Goniometer (*119-0133-00).

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C457	283-0600-00			43 pF	Mica	500 V	5%
C461	283-0004-00	B010100	B149999	0.02 μF	Cer	150 V	
C461	283-0026-00	B150000		0.2 μF	Cer	25 V	
C465	283-0059-00			1 μF	Cer	25 V	+80%—20%
C471	281-0615-00	XB030000	B149999X	3.9 pF	Cer	200 V	
C474	283-0599-00	B010100	B149999	98 pF	Mica	500 V	5%
C474	283-0632-00	B150000		87 pF	Mica	100 V	1%
C475	283-0004-00	XB150000		0.02 μF	Cer	150 V	
C476	283-0059-00	XB150000		1 μF	Cer	25 V	+80%—20%
C478	290-0135-00	XB030000	B149999X	15 μF	Elect.	20 V	
C490	283-0598-00	B010100	B259999	253 pF	Mica	300 V	5%
C490	281-0528-00	B260000		82 pF	Cer	500 V	10%
C491	283-0615-00			33 pF	Mica	500 V	5%
C494	283-0079-00	B010100	B029999	0.01 μF	Cer	250 V	
C494	283-0027-00	B030000	B259999	0.02 μF	Cer	50 V	
C494	285-0683-00	B260000		0.022 μF	PTM	100 V	5%
C495	283-0177-00	XB260000		1 μF	Cer	25 V	+80%—20%
C500	283-0604-00			304 pF	Mica	300 V	2%
C502	283-0604-00			304 pF	Mica	300 V	2%
C503	281-0064-00			0.25-1.5 pF, Var	Tub.		
C504	281-0619-00	B010100	B149999	1.2 pF	Cer	200 V	
C504	281-0609-00	B150000		1 pF	Cer	200 V	10%
C528	283-0004-00			0.02 μF	Cer	150 V	
C529	283-0032-00			470 pF	Cer	500 V	5%
C532	283-0032-00			470 pF	Cer	500 V	5%
C535	283-0065-00			0.001 μF	Cer	100 V	5%
C538	283-0103-00			180 pF	Cer	500 V	5%
C545	283-0600-00			43 pF	Mica	500 V	5%
C547	283-0604-00			304 pF	Mica	300 V	2%
C548	283-0059-00			1 μF	Cer	25 V	+80%—20%
C549	283-0600-00			43 pF	Mica	500 V	5%
C550	283-0026-00			0.2 μF	Cer	25 V	
C553	283-0026-00			0.2 μF	Cer	25 V	
C554	283-0600-00			43 pF	Mica	500 V	5%
C555	283-0059-00			1 μF	Cer	25 V	+80%—20%
C556	290-0284-00			4.7 μF	Elect.	35 V	10%
C557	281-0528-00			82 pF	Cer	500 V	10%
C558	283-0004-00			0.02 μF	Cer	150 V	
C559	283-0026-00			0.2 μF	Cer	25 V	
C564	283-0004-00			0.02 μF	Cer	150 V	
C566	283-0004-00			0.02 μF	Cer	150 V	
C567	283-0003-00			0.01 μF	Cer	150 V	
C568	283-0026-00			0.2 μF	Cer	25 V	
C569	290-0284-00			4.7 μF	Elect.	35 V	10%
C578	283-0603-00	XB150000		113 pF	Mica	300 V	2%
C580	283-0083-00	B010100	B149999	0.0047 μF	Cer	500 V	5%
C580	283-0155-00	B150000		0.01 μF	Cer	50 V	10%
C584	283-0641-00	B010100	B149999	180 pF	Mica	100 V	1%

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C584	283-0631-00	B150000		95 pF	Mica	100 V	1%
C586	281-0093-00	B010100	B259999	5.5-18 pF, Var	Cer		
C586	281-0092-00	B260000		9-35 pF, Var	Cer		
C587	283-0003-00			0.01 μF	Cer	150 V	
C590	283-0622-00			450 pF	Mica	300 V	1%
C592	283-0622-00			450 pF	Mica	300 V	1%
C593	281-0064-00			0.25-1.5 pF, Var	Tub.		
C594	281-0619-00			1.2 pF	Cer	200 V	
C595	281-0615-00			3.9 pF	Cer	200 V	
C601	283-0598-00			253 pF	Mica	300 V	5%
C602	283-0639-00			56 pF	Mica	100 V	1%
C606	283-0598-00			253 pF	Mica	300 V	5%
C607	283-0639-00			56 pF	Mica	100 V	1%
C608	283-0026-00			0.2 μF	Cer	25 V	
C609	283-0026-00			0.2 μF	Cer	25 V	
C610	281-0653-00			3.3 pF	Cer	200 V	±1 pF
C611	283-0637-00			20 pF	Mica	100 V	1%
C612	283-0636-00			36 pF	Mica	100 V	1%
C613	283-0635-00			51 pF	Mica	100 V	1%
C614	283-0634-00			65 pF	Mica	100 V	1%
C615	283-0633-00			77 pF	Mica	100 V	1%
C616	283-0632-00			87 pF	Mica	100 V	1%
C617	283-0631-00			95 pF	Mica	100 V	1%
C618	283-0630-00			110 pF	Mica	100 V	1%
C619	283-0641-00			180 pF	Mica	100 V	1%
C622	281-0528-00	B010100	B189999	82 pF	Cer	500 V	10%
C622	281-0549-00	B190000		68 pF	Cer	500 V	10%
C624	283-0026-00	XB220000		0.2 μF	Cer	25 V	
C632	281-0511-00			22 pF	Cer	500 V	10%
C642	281-0528-00			82 pF	Cer	500 V	10%
C644	283-0026-00	XB220000		0.2 μF	Cer	25 V	
C652	281-0511-00			22 pF	Cer	500 V	10%
C661	283-0026-00			0.2 μF	Cer	25 V	
C665	283-0594-00			0.001 μF	Mica	100 V	1%
C686	283-0599-00			98 pF	Mica	500 V	5%
C688	281-0637-00			91 pF	Cer	500 V	5%
C690	283-0026-00			0.2 μF	Cer	25 V	
C691	283-0059-00			1 μF	Cer	25 V	+80%—20%
C695	285-0643-00			0.0047 μF	PTM	100 V	5%
C807	285-0627-00			0.0033 μF	PTM	100 V	5%
C817	285-0627-00			0.0033 μF	PTM	100 V	5%
C822	283-0079-00			0.01 μF	Cer	250 V	
C841	283-0079-00			0.01 μF	Cer	250 V	
C848	281-0118-00			8-90 pF, Var	Mica		
C849	283-0622-00			450 pF	Mica	300 V	1%
C868	283-0110-00			0.005 μF	Cer	150 V	
C877	283-0110-00			0.005 μF	Cer	150 V	
C892	283-0079-00			0.01 μF	Cer	250 V	
C896	290-0114-00			47 μF	Elect.	6 V	

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C907	285-0627-00			0.0033 μF	PTM	100 V	5%
C917	285-0627-00			0.0033 μF	PTM	100 V	5%
C922	283-0079-00			0.01 μF	Cer	250 V	
C958	281-0076-00			1.2-3.5 pF, Var	Air		
C961	281-0079-00			0.01 μF	Cer	250 V	
C968	281-0118-00			8-90 pF, Var	Mica		
C969	283-0622-00			450 pF	Mica	300 V	1%
C987	283-0110-00			0.005 μF	Cer	150 V	
C1102	290-0267-00			1 μF	Elect.	35 V	
C1114	290-0244-00			0.47 μF	Elect.	35 V	5%
C1116	290-0282-00			0.047 μF	Elect.	35 V	10%
C1126	281-0521-00			56 pF	Cer	500 V	10%
C1128	283-0004-00			0.02 μF	Cer	150 V	
C1131	283-0059-00			1 μF	Cer	25 V	+80%—20%
C1140	283-0059-00			1 μF	Cer	25 V	+80%—20%
C1150	283-0594-00			0.001 μF	Mica	100 V	1%
C1153	290-0276-00			0.68 μF	Elect.	35 V	10%
C1156	283-0004-00			0.02 μF	Cer	150 V	
C1164	283-0594-00			0.001 μF	Mica	100 V	1%
C1172	283-0059-00			1 μF	Cer	25 V	+80%—20%
C1184	283-0010-00			0.05 μF	Cer	50 V	
C1188	283-0004-00			0.02 μF	Cer	150 V	
C1190	283-0594-00			0.001 μF	Mica	100 V	1%
C1196	290-0267-00			1 μF	Elect.	35 V	
C1198	281-0613-00			10 pF	Cer	200 V	1%
C1201	283-0059-00			1 μF	Cer	25 V	+80%—20%
C1204	283-0004-00			0.02 μF	Cer	150 V	
C1227	283-0010-00			0.05 μF	Cer	50 V	
C1233	283-0119-00			2200 pF	Cer	200 V	5%
C1238	283-0057-00			0.1 μF	Cer	200 V	+80%—20%
C1252	283-0594-00			0.001 μF	Mica	100 V	1%
C1259	285-0702-00			0.033 μF	PTM	100 V	5%
C1263	285-0702-00			0.033 μF	PTM	100 V	5%
C1283	283-0593-00			0.01 μF	Mica	100 V	1%
C1405	290-0135-00			15 μF	Elect.	20 V	
C1414	285-0684-00			0.056 μF	PTM	100 V	5%
C1422	290-0274-00			80 μF	Elect.	50 V	+75%—10%
C1423	290-0287-00			47 μF	Elect.	25 V	
C1424	285-0623-00	B010100	B309999	0.47 μF	PTM	100 V	
C1424	285-0633-00	B310000		0.22 μF	PTM	100 V	10%
C1430	283-0026-00			0.2 μF	Cer	25 V	
C1433	283-0059-00			1 μF	Cer	25 V	+80%—20%
C1436	283-0026-00			0.2 μF	Cer	25 V	
C1438	285-0622-00			0.1 μF	PTM	100 V	
C1440	290-0297-00			39 μF	Elect.	10 V	10%
C1452	283-0036-00			2500 pF	Cer	6000 V	
C1453	283-0071-00			0.0068 μF	Cer	5000 V	
C1454	283-0071-00			0.0068 μF	Cer	5000 V	
C1468	283-0006-00			0.02 μF	Cer	500 V	
C1478	283-0003-00			0.01 μF	Cer	150 V	

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C1480	283-0087-00			300 pF	Cer	1000 V	10%
C1485	283-0033-00			0.001 μF	Cer	6000 V	
C1490	283-0033-00			0.001 μF	Cer	6000 V	
C1502	290-0336-00			130 μF	Elect.	300 V	+50%—10%
C1511	283-0000-00			0.001 μF	Cer	500 V	
C1522	290-0285-00			4 μF	Elect.	200 V	+50%—10%
C1524	283-0659-00	XB310000		1160 pF	Mica	500 V	2%
C1532	290-0335-00			240 μF	Elect.	200 V	+50%—10%
C1545	283-0079-00	B010100	B309999	0.01 μF	Cer	250 V	
C1545	283-0617-00	B310000		4700 pF	Mica	300 V	10%
C1552	290-0285-00			4 μF	Elect.	200 V	+50%—10%
C1554	285-0569-00	B010100	B309999	0.01 μF	PTM	200 V	
C1554	283-0659-00	B310000		1160 pF	Mica	500 V	2%
C1562	290-0337-00			2300 μF	Elect.	50 V	+75%—10%
C1574	283-0026-00			0.2 μF	Cer	25 V	
C1600	285-0683-00			0.022 μF	PTM	100 V	5%
C1622	290-0312-00			47 μF	Elect.	35 V	10%
C1623	283-0059-00			1 μF	Cer	25 V	+80%—20%
C1624	290-0284-00			4.7 μF	Elect.	35 V	10%
Diodes							
D4	*152-0185-00			Silicon	Replaceable by 1N4152		
D6	152-0141-00	B010100	B159999	Silicon	1N4152		
D6	152-0141-02	B160000		Silicon	1N4152		
D8	*152-0322-00			Silicon	Tek Spec		
D14	*152-0185-00			Silicon	Replaceable by 1N4152		
D16	152-0141-00	B010100	B159999	Silicon	1N4152		
D16	152-0141-02	B160000		Silicon	1N4152		
D18	*152-0322-00			Silicon	Tek Spec		
D48	*152-0185-00			Silicon	Replaceable by 1N4152		
D54	*152-0185-00			Silicon	Replaceable by 1N4152		
D56	152-0141-00	B010100	B159999	Silicon	1N4152		
D56	152-0141-02	B160000		Silicon	1N4152		
D58	*152-0322-00			Silicon	Tek Spec		
D64	*152-0185-00			Silicon	Replaceable by 1N4152		
D66	152-0141-00	B010100	B159999	Silicon	1N4152		
D66	152-0141-02	B160000		Silicon	1N4152		
D68	*152-0322-00			Silicon	Tek Spec		
D85	*152-0185-00			Silicon	Replaceable by 1N4152		
D95	*152-0185-00			Silicon	Replaceable by 1N4152		
D100	*152-0185-00			Silicon	Replaceable by 1N4152		
D102	*152-0185-00			Silicon	Replaceable by 1N4152		
D108	*152-0185-00			Silicon	Replaceable by 1N4152		
D112	*152-0185-00			Silicon	Replaceable by 1N4152		
D114	*152-0185-00			Silicon	Replaceable by 1N4152		
D116	*152-0185-00			Silicon	Replaceable by 1N4152		
D122	*152-0185-00			Silicon	Replaceable by 1N4152		
D126	*152-0185-00			Silicon	Replaceable by 1N4152		
D132	*152-0185-00			Silicon	Replaceable by 1N4152		
D134	*152-0185-00			Silicon	Replaceable by 1N4152		
D142	152-0279-00	XB240000		Zener	1N751A 400 mW, 5.1 V, 5%		
D144	*152-0185-00	XB240000		Silicon	Replaceable by 1N4152		

Diodes *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
D206	*152-0185-00			Silicon	Replaceable by 1N4152
D210	*152-0185-00			Silicon	Replaceable by 1N4152
D212 } D214 }	*153-0035-00			Silicon	(Matched pair)
D224	*152-0185-00			Silicon	Replaceable by 1N4152
D234	*152-0185-00	B010100	B249999X	Silicon	Replaceable by 1N4152
D235	*152-0185-00	XB250000		Silicon	Replaceable by 1N4152
D242	*152-0153-00			Silicon	Replaceable by 1N4244
D244	*152-0153-00			Silicon	Replaceable by 1N4244
D257	152-0226-00	XB230000		Zener	1N751A 0.4 W, 5.1 V, 5%
D260	152-0358-00			Silicon	Voltage Variable Capacitance
D285	152-0278-00			Zener	1N4372A 0.4 W, 3 V, 5%
D301	*152-0185-00			Silicon	Replaceable by 1N4152
D302	*152-0185-00			Silicon	Replaceable by 1N4152
D311	*152-0185-00			Silicon	Replaceable by 1N4152
D312	*152-0185-00			Silicon	Replaceable by 1N4152
D407	*152-0322-00			Silicon	Tek Spec
D408	152-0141-00	B010100	B159999	Silicon	1N4152
D408	152-0141-02	B160000		Silicon	1N4152
D409	*152-0322-00			Silicon	Tek Spec
D417	*152-0322-00			Silicon	Tek Spec
D418	152-0141-00	B010100	B159999	Silicon	1N4152
D418	152-0141-02	B160000		Silicon	1N4152
D419	*152-0322-00			Silicon	Tek Spec
D421	*152-0185-00			Silicon	Replaceable by 1N4152
D424	152-0141-00	B010100	B159999	Silicon	1N4152
D424	152-0141-02	B160000		Silicon	1N4152
D427	*152-0185-00			Silicon	Replaceable by 1N4152
D429	152-0141-00	B010100	B159999	Silicon	1N4152
D429	152-0141-02	B160000		Silicon	1N4152
D432	*152-0185-00			Silicon	Replaceable by 1N4152
D436	*152-0185-00			Silicon	Replaceable by 1N4152
D450	*152-0185-00			Silicon	Replaceable by 1N4152
D463	*152-0185-00			Silicon	Replaceable by 1N4152
D465	*152-0185-00			Silicon	Replaceable by 1N4152
D486	152-0141-00	B010100	B159999	Silicon	1N4152
D486	152-0141-02	B160000		Silicon	1N4152
D487	*152-0322-00			Silicon	Tek Spec
D488	152-0141-00	B010100	B159999	Silicon	1N4152
D488	152-0141-02	B160000		Silicon	1N4152
D494	152-0141-02	XB260000		Silicon	1N4152
D496	*152-0185-00			Silicon	Replaceable by 1N4152
D497	*152-0185-00			Silicon	Replaceable by 1N4152
D498	*152-0185-00			Silicon	Replaceable by 1N4152
D504	*152-0185-00			Silicon	Replaceable by 1N4152
D505	*152-0322-00			Silicon	Tek Spec
D506	*152-0322-00	B010100	B149999	Silicon	Tek Spec
D507	*152-0322-00			Silicon	Tek Spec
D506 } D508 }	*153-0037-00	B150000		Silicon	(matched pair)
D508	*152-0322-00	B010100	B149999	Silicon	Tek Spec
D509	*152-0185-00			Silicon	Replaceable by 1N4152
D511	*152-0185-00			Silicon	Replaceable by 1N4152

Diodes *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
D515	*152-0185-00			Silicon	Replaceable by 1N4152
D517	*152-0185-00			Silicon	Replaceable by 1N4152
D520	*152-0185-00			Silicon	Replaceable by 1N4152
D521	*152-0185-00			Silicon	Replaceable by 1N4152
D522	*152-0185-00			Silicon	Replaceable by 1N4152
D524	*152-0185-00			Silicon	Replaceable by 1N4152
D525	*152-0185-00			Silicon	Replaceable by 1N4152
D526	*152-0185-00			Silicon	Replaceable by 1N4152
D527	*152-0185-00			Silicon	Replaceable by 1N4152
D532	*152-0185-00			Silicon	Replaceable by 1N4152
D533	*152-0185-00			Silicon	Replaceable by 1N4152
D543	*152-0185-00			Silicon	Replaceable by 1N4152
D576	*152-0185-00			Silicon	Replaceable by 1N4152
D580	*152-0185-00			Silicon	Replaceable by 1N4152
D581	*152-0185-00			Silicon	Replaceable by 1N4152
D586	*152-0269-00	B010100	B149999	Silicon	Voltage Variable Capacitance Tek Spec
D586	*152-0270-00	B150000		Silicon	Voltage Variable Capacitance Tek Spec
D594	*152-0185-00			Silicon	Replaceable by 1N4152
D595	*152-0322-00			Silicon	Tek Spec
D596	*152-0322-00	B010100	B149999	Silicon	Tek Spec
D597	*152-0322-00			Silicon	Tek Spec
D598	*152-0322-00	B010100	B149999	Silicon	Tek Spec
D596 } D598 }	*153-0037-00	B150000		Silicon	(matched pair)
D599	*152-0185-00			Silicon	Replaceable by 1N4152
D680	*152-0185-00			Silicon	Replaceable by 1N4152
D694	*152-0185-00			Silicon	Replaceable by 1N4152
D695	152-0278-00			Zener	1N4372A 0.4 W, 3 V, 5%
D696	152-0278-00			Zener	1N4372A 0.4 W, 3 V, 5%
D697	*152-0185-00			Silicon	Replaceable by 1N4152
D698	*152-0185-00			Silicon	Replaceable by 1N4152
D702	*152-0185-00			Silicon	Replaceable by 1N4152
D706	152-0141-00	B010100	B159999	Silicon	1N4152
D706	152-0141-02	B160000		Silicon	1N4152
D712	*152-0185-00			Silicon	Replaceable by 1N4152
D716	152-0141-00	B010100	B159999	Silicon	1N4152
D716	152-0141-02	B160000		Silicon	1N4152
D722	*152-0185-00			Silicon	Replaceable by 1N4152
D726	152-0141-00	B010100	B159999	Silicon	1N4152
D726	152-0141-02	B160000		Silicon	1N4152
D732	*152-0185-00			Silicon	Replaceable by 1N4152
D736	152-0141-00	B010100	B159999	Silicon	1N4152
D736	152-0141-02	B160000		Silicon	1N4152
D742	*152-0185-00			Silicon	Replaceable by 1N4152
D746	152-0141-00	B010100	B159999	Silicon	1N4152
D746	152-0141-02	B160000		Silicon	1N4152
D756	152-0141-00	B010100	B159999	Silicon	1N4152
D756	152-0141-02	B160000		Silicon	1N4152
D760	*152-0185-00			Silicon	Replaceable by 1N4152
D766	152-0141-00	B010100	B159999	Silicon	1N4152
D766	152-0141-02	B160000		Silicon	1N4152
D775	*152-0185-00			Silicon	Replaceable by 1N4152
D780	*152-0185-00			Silicon	Replaceable by 1N4152
D805A,B,C,D	*152-0185-00			Silicon	Replaceable by 1N4152

Diodes *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
D861	*152-0185-00			Silicon	Replaceable by 1N4152
D862	*152-0185-00			Silicon	Replaceable by 1N4152
D873	*152-0185-00			Silicon	Replaceable by 1N4152
D875	*152-0185-00			Silicon	Replaceable by 1N4152
D876	*152-0185-00			Silicon	Replaceable by 1N4152
D905A,B,C,D	*152-0185-00			Silicon	Replaceable by 1N4152
D932	*152-0185-00			Silicon	Replaceable by 1N4152
D940	152-0141-00	B010100	B159999	Silicon	1N4152
D940	152-0141-02	B160000		Silicon	1N4152
D944	152-0141-00	B010100	B159999	Silicon	1N4152
D944	152-0141-02	B160000		Silicon	1N4152
D982	*152-0185-00			Silicon	Replaceable by 1N4152
D983	*152-0185-00			Silicon	Replaceable by 1N4152
D985	*152-0185-00			Silicon	Replaceable by 1N4152
D986	*152-0185-00			Silicon	Replaceable by 1N4152
D993	*152-0185-00			Silicon	Replaceable by 1N4152
D1105	*152-0185-00			Silicon	Replaceable by 1N4152
D1106	*152-0185-00			Silicon	Replaceable by 1N4152
D1110	*152-0185-00			Silicon	Replaceable by 1N4152
D1112	*152-0185-00	B010100	B149999X	Silicon	Replaceable by 1N4152
D1135	*152-0185-00			Silicon	Replaceable by 1N4152
D1140	*152-0185-00	XB260000		Silicon	Replaceable by 1N4152
D1142	152-0280-00			Zener	1N753A 0.4 W, 6.2 V, 5%
D1143	152-0245-00			Silicon	High Speed
D1144	152-0280-00			Zener	1N753A 0.4 W, 6.2 V, 5%
D1145	152-0245-00			Silicon	High Speed
D1160	*152-0185-00			Silicon	Replaceable by 1N4152
D1164	*152-0185-00			Silicon	Replaceable by 1N4152
D1166	*152-0185-00			Silicon	Replaceable by 1N4152
D1178	*152-0185-00			Silicon	Replaceable by 1N4152
D1190	*152-0061-00			Silicon	Tek Spec
D1192	*152-0185-00			Silicon	Replaceable by 1N4152
D1196	*152-0185-00			Silicon	Replaceable by 1N4152
D1206	*152-0185-00			Silicon	Replaceable by 1N4152
D1208	*152-0185-00			Silicon	Replaceable by 1N4152
D1216	*152-0185-00			Silicon	Replaceable by 1N4152
D1220	*152-0185-00			Silicon	Replaceable by 1N4152
D1222	*152-0061-00			Silicon	Tek Spec
D1225	*152-0061-00			Silicon	Tek Spec
D1235	*152-0061-00			Silicon	Tek Spec
D1239	*152-0185-00			Silicon	Replaceable by 1N4152
D1252	*152-0061-00	B010100	B059999	Silicon	Tek Spec
D1252	152-0283-00	B060000		Zener	1N976B 0.4 W, 43 V, 5%
D1253	*152-0185-00			Silicon	Replaceable by 1N4152
D1256	*152-0185-00			Silicon	Replaceable by 1N4152
D1258	*152-0185-00			Silicon	Replaceable by 1N4152
D1265	*152-0185-00			Silicon	Replaceable by 1N4152
D1266	*152-0185-00			Silicon	Replaceable by 1N4152

Diodes *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
D1270	*152-0185-00			Silicon	Replaceable by 1N4152
D1275	*152-0185-00			Silicon	Replaceable by 1N4152
D1285	*152-0185-00			Silicon	Replaceable by 1N4152
D1286	*152-0185-00			Silicon	Replaceable by 1N4152
D1292	*152-0185-00			Silicon	Replaceable by 1N4152
D1306	*152-0185-00			Silicon	Replaceable by 1N4152
D1310	*152-0185-00			Silicon	Replaceable by 1N4152
D1312	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1314	*152-0185-00			Silicon	Replaceable by 1N4152
D1316	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1318	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1320	*152-0185-00			Silicon	Replaceable by 1N4152
D1322	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1324	*152-0185-00			Silicon	Replaceable by 1N4152
D1326	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1328	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1330	*152-0185-00			Silicon	Replaceable by 1N4152
D1332	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1334	*152-0185-00			Silicon	Replaceable by 1N4152
D1336	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1338	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1340	*152-0185-00			Silicon	Replaceable by 1N4152
D1342	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1344	*152-0185-00			Silicon	Replaceable by 1N4152
D1346	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1348	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1350	*152-0185-00			Silicon	Replaceable by 1N4152
D1352	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1354	*152-0185-00			Silicon	Replaceable by 1N4152
D1356	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1358	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1359	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1360	*152-0185-00	B010100	B149999X	Silicon	Replaceable by 1N4152
D1362	*152-0185-00	B010100	B149999X	Silicon	Replaceable by 1N4152
D1370	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1372	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1374	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1376	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1378	*152-0185-00	XB150000		Silicon	Replaceable by 1N4152
D1404	*152-0185-00			Silicon	Replaceable by 1N4152
D1405	*152-0107-00			Silicon	Replaceable by 1N647
D1414	*152-0185-00			Silicon	Replaceable by 1N4152
D1432	152-0141-00	B010100	B159999	Silicon	1N4152
D1432	152-0141-02	B160000		Silicon	1N4152
D1436	152-0141-00	B010100	B159999	Silicon	1N4152
D1436	152-0141-02	B160000		Silicon	1N4152
D1440	152-0333-00			Silicon	High Speed and Conductance
D1442	152-0333-00			Silicon	High Speed and Conductance

Diodes *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
D1452	152-0192-00			Silicon	7701-5X, Varo
D1453	152-0192-00			Silicon	7701-5X, Varo
D1468	*153-0034-00			Zener	0.4 W, 105 V, 5% at 200 μA
D1502A,B,C,D	152-0066-01			Silicon	400 V, 0.75 A
D1503	152-0066-01			Silicon	400 V, 0.75 A
D1510	*152-0185-00			Silicon	Replaceable by 1N4152
D1532A,B,C,D	152-0066-01			Silicon	400 V, 0.75 A
D1540	152-0295-00			Zener	1N3042B 82 V, 5%
D1554	*152-0185-00			Silicon	Replaceable by 1N4152
D1562	152-0198-00			Silicon	MR1032A (Motorola)
D1564	152-0198-00			Silicon	MR1032A (Motorola)
D1570	152-0123-00			Zener	1N935A 0.4 W, 9.1 V, 5% TC
D1590	152-0055-00			Zener	1N962B 0.4 W, 11 V, 5%

Fuses

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
F1500	159-0034-00			1.6 A 3AG	Slo-Blo
F1501	159-0018-00			4/5 A 3AG	Slo-Blo
F1502	159-0024-00	B010100	B049999	1/16 A 3AG	Fast-Blo
F1502	159-0052-00	B050000		1/8 A 3AG	Fast-Blo
F1532	159-0028-00			1/4 A 3AG	Fast-Blo
F1562	159-0016-00	B010100	B299999	1-1/2 A 3AG	Fast-Blo
F1562	159-0041-00	B300000	B309999	1-1/4 A 3AG	Slo-Blo
F1562	159-0034-00	B310000		1.6 A 3AG	Slo-Blo

Connectors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
J1	131-0081-00	B010100	B179999	1 Contact, female
J1	131-0126-00	B180000		1 Contact, BNC
J2	131-0081-00	B010100	B179999	1 Contact, female
J2	131-0126-00	B180000		1 Contact, BNC
J50	131-0081-00	B010100	B179999	1 Contact, female
J50	131-0126-00	B180000		1 Contact, BNC
J51	131-0081-00	B010100	B179999	1 Contact, female
J51	131-0126-00	B180000		1 Contact, BNC
J120	131-0081-00	B010100	B179999	1 Contact, female
J120	131-0126-00	B180000		1 Contact, BNC
J121	131-0081-00	B010100	B179999	1 Contact, female
J121	131-0126-00	B180000		1 Contact, BNC
J310	131-0081-00	B010100	B179999	1 Contact, female
J310	131-0126-00	B180000		1 Contact, BNC
J311	131-0081-00	B010100	B179999	1 Contact, female
J311	131-0126-00	B180000		1 Contact, BNC
J330	131-0372-00			Coaxial
J340	131-0372-00			Coaxial
J1210	131-0081-00	B010100	B019999	1 Contact, female
J1210	131-0302-00	B020000	B069999	UHF
J1210	131-0320-00	B070000	B179999	UHF
J1210	131-0274-00	B180000		BNC
J1500	131-0171-00			Motor Base, 3 wire
J1620	210-0652-00			Eyelet

Inductors

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
L1	*108-0527-00	XB180000		100 nH
L46	114-0234-00			10-20 μH, Var Core not replaceable
L51	*108-0527-00	XB180000		100 nH
L76	276-0507-00			Core, Ferramic Suppressor
L220	*114-0247-00			30-85 μH, Var Core 276-0540-00
L221	*114-0246-00			0.7-1.1 μH, Var Core 276-0506-00
L272	114-0235-00			6-12 μH, Var Core not replaceable
L279	114-0235-00			6-12 μH, Var Core not replaceable
L331	*114-0250-00			15-30 μH, Var Core not replaceable
L332	*114-0249-00			27-60 μH, Var Core not replaceable
L401	*108-0360-00	XB150000		46 μH
L402	*108-0200-01	B010100	B149999X	40 μH
L411	*108-0360-00	XB150000		46 μH
L412	*108-0200-01	B010100	B149999X	40 μH
L453	108-0317-00			15 μH
L454	*108-0443-00			25 μH
L455	*108-0472-00			160 μH
L456	108-0249-00	XB200000		12 μH
L457	*108-0200-01	B010100	B239999	40 μH
L457	*108-0200-00	B240000		40 μH
L545	114-0209-00			28-60 μH, Var Core not replaceable
L547	114-0209-00			28-60 μH, Var Core not replaceable
L548	276-0507-00			Core, Ferramic Suppressor
L556	*108-0474-00			2 μH
L558	*108-0111-01	B010100	B239999	5.5 μH
L558	*108-0111-00	B240000		5.5 μH
L559	*120-0286-00			Toroid, 2 turns, bifilar
L566	*108-0111-01	B010100	B239999	5.5 μH
L566	*108-0111-00	B240000		5.5 μH
L569	*108-0474-00			2 μH
L601	*114-0238-00			300-470 μH, Var Core 276-0506-00
L602	*114-0237-00			120-185 μH, Var Core 276-0506-00
L606	*114-0238-00			300-470 μH, Var Core 276-0506-00
L607	*114-0237-00			120-185 μH, Var Core 276-0506-00
L610	*114-0239-00			6-15 μH, Var Core not replaceable
L611	*114-0240-00			14-35 μH, Var Core not replaceable
L612	*114-0241-00			23-64 μH, Var Core not replaceable
L613	*114-0242-00			29-80 μH, Var Core not replaceable
L614	*114-0243-00			40-118 μH, Var Core not replaceable
L615	*114-0243-00			40-118 μH, Var Core not replaceable
L616	*114-0244-00			50-143 μH, Var Core not replaceable
L617	*114-0244-00			50-143 μH, Var Core not replaceable
L618	*114-0245-00			80-182 μH, Var Core not replaceable
L838	*114-0248-00			500-800 μH, Var Core 276-0506-00
L858	*114-0248-00			500-800 μH, Var Core 276-0506-00
L958	*114-0248-00			500-800 μH, Var Core 276-0506-00
L978	*114-0248-00			500-800 μH, Var Core 276-0506-00
L1420	*108-0020-01	B010100	B239999	7.1 μH
L1420	*108-0020-00	B240000		7.1 μH
L1422	*108-0473-00			150 μH
L1426	*108-0288-00			1.2 μH
L1440	108-0205-00			1 mH
L1470	*108-0227-00			Beam Rotator
L1474	*108-0295-00			Y-Axis Alignment

Inductors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
LR150	*108-0288-00			1.2 μH (wound on a 6.2 Ω resistor)
LR152	*108-0288-00			1.2 μH (wound on a 6.2 Ω resistor)
LR295	*108-0111-01	B010100	B239999	5.5 μH (wound on a 15 Ω resistor)
LR295	*108-0111-00	B240000		5.5 μH (wound on a 15 Ω resistor)
LR296	*108-0111-01	B010100	B239999	5.5 μH (wound on a 15 Ω resistor)
LR296	*108-0111-00	B240000		5.5 μH (wound on a 15 Ω resistor)

Transistors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
Q30	151-0188-00			Silicon	2N3906
Q40	151-0190-00			Silicon	2N3904
Q41	151-0188-00			Silicon	2N3906
Q80	*151-0192-00			Silicon	Replaceable by MPS 6521
Q81	*151-0192-00			Silicon	Replaceable by MPS 6521
Q85	151-0188-00			Silicon	2N3906
Q90	*151-0192-00			Silicon	Replaceable by MPS 6521
Q91	*151-0192-00			Silicon	Replaceable by MPS 6521
Q95	151-0188-00			Silicon	2N3906
Q140	151-0188-00			Silicon	2N3906
Q141	151-0190-00			Silicon	2N3904
Q200	151-0190-00			Silicon	2N3904
Q205	151-0190-00			Silicon	2N3904
Q220	151-0190-00			Silicon	2N3904
Q225	151-0188-00			Silicon	2N3906
Q230	151-0190-00	B010100	B249999	Silicon	2N3904
Q230	*151-0230-00	B250000		Silicon	Selected from RCA 40235
Q236	*151-0230-00	XB250000		Silicon	Selected from RCA 40235
Q238	151-0190-00	XB250000		Silicon	2N3904
Q250	151-1015-00			Silicon	FET
Q255	*151-0192-00			Silicon	Replaceable by MPS 6521
Q260	151-0190-00			Silicon	2N3904
Q270	151-0190-00			Silicon	2N3904
Q275	151-0188-00			Silicon	2N3906
Q280A	151-0188-00			Silicon	2N3906
Q280B	151-0188-00			Silicon	2N3906
Q285	*151-0136-00			Silicon	Replaceable by 2N3053
Q291	151-0190-00			Silicon	2N3904
Q295	*151-0136-00			Silicon	Replaceable by 2N3053
Q320	151-0190-00			Silicon	2N3904
Q325	151-0190-00			Silicon	2N3904
Q340	151-0190-00			Silicon	2N3904
Q345	151-0190-00			Silicon	2N3904
Q420	151-0188-00			Silicon	2N3906
Q421	151-0190-00			Silicon	2N3904
Q425	151-0188-00			Silicon	2N3906
Q430	151-0190-00			Silicon	2N3904
Q432	151-0190-00	XB150000		Silicon	2N3904
Q435	151-0190-00			Silicon	2N3904
Q440	*151-0192-00			Silicon	Replaceable by MPS 6521
Q442	151-0190-00	XB150000		Silicon	2N3904
Q445	*151-0192-00			Silicon	Replaceable by MPS 6521
Q450	151-0188-00			Silicon	2N3906
Q460	151-0188-00			Silicon	2N3906
Q470	*151-0198-00			Silicon	Replaceable by MPS 918
Q471	*151-0198-00	B010100	B149999	Silicon	Replaceable by MPS 918

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Transistor *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc		Description
Q471	151-0188-00	B150000		Silicon	2N3906
Q480	151-0190-00			Silicon	2N3904
Q490	151-0190-00			Silicon	2N3904
Q491	*151-0195-00			Silicon	Replaceable by MPS 6515
Q495	151-0188-00			Silicon	2N3906
Q500A, Q500B	*153-0547-00			Silicon	(matched pair) MPS 918
Q505A	*151-0198-00	B010100	B149999	Silicon	Replaceable by MPS 918
Q505B	*151-0198-00	B010100	B149999	Silicon	Replaceable by MPS 918
Q505A, Q505B	*153-0547-00	B150000		Silicon	(matched pair) MPS 918
Q515	*151-0198-00			Silicon	Replaceable by MPS 918
Q516	*151-0198-00			Silicon	Replaceable by MPS 918
Q530	*151-0198-00			Silicon	Replaceable by MPS 918
Q540	*151-0192-00			Silicon	Replaceable by MPS 6521
Q550	151-0190-00			Silicon	2N3904
Q560	151-0190-00			Silicon	2N3904
Q565	*151-0195-00			Silicon	Replaceable by MPS 6515
Q570	151-0190-00			Silicon	2N3904
Q571	151-0190-00			Silicon	2N3904
Q575	151-0190-00			Silicon	2N3904
Q576	151-0190-00			Silicon	2N3904
Q580	151-0188-00			Silicon	2N3906
Q590A, Q590B	*153-0547-00			Silicon	(matched pair) MPS 918
Q595A	*151-0198-00	B010100	B149999	Silicon	Replaceable by MPS 918
Q595B	*151-0198-00	B010100	B149999	Silicon	Replaceable by MPS 918
Q595A, Q595B	*153-0547-00	B150000		Silicon	(matched pair) MPS 918
Q620	*151-0192-00			Silicon	Replaceable by MPS 6521
Q630	*151-0192-00			Silicon	Replaceable by MPS 6521
Q640	*151-0192-00			Silicon	Replaceable by MPS 6521
Q650	*151-0192-00			Silicon	Replaceable by MPS 6521
Q660	151-0190-00			Silicon	2N3904
Q670	151-1005-00			Silicon	FET
Q680	151-0188-00			Silicon	2N3906
Q690	151-0190-00			Silicon	2N3904
Q691	151-0190-00			Silicon	2N3904
Q700	151-0188-00			Silicon	2N3906
Q710	151-0188-00			Silicon	2N3906
Q720	151-0188-00			Silicon	2N3906
Q730	151-0188-00			Silicon	2N3906
Q740	151-0188-00			Silicon	2N3906
Q750	151-0188-00			Silicon	2N3906
Q760	151-0188-00			Silicon	2N3906
Q770	151-0190-00			Silicon	2N3904
Q780	151-0188-00			Silicon	2N3906

Transistor *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Q800	151-0190-00			Silicon	2N3904
Q810	151-0190-00			Silicon	2N3904
Q820	151-1005-00			Silicon	FET
Q830	151-0190-00			Silicon	2N3904
Q835	151-0190-00			Silicon	2N3904
Q836	151-0169-00			Silicon	2N3439
Q840	151-0190-00			Silicon	2N3904
Q855	151-0190-00			Silicon	2N3904
Q856	151-0169-00			Silicon	2N3439
Q860	151-0188-00			Silicon	2N3906
Q870A } Q870B }	*153-0558-00			Silicon	(matched pair) 2N3906
Q890	151-0190-00			Silicon	2N3904
Q900	151-0190-00			Silicon	2N3904
Q910	151-0190-00			Silicon	2N3904
Q920	151-1005-00			Silicon	FET
Q930	151-0188-00			Silicon	2N3906
Q950	151-0190-00			Silicon	2N3904
Q955	151-0190-00			Silicon	2N3904
Q956	151-0169-00			Silicon	2N3439
Q960	151-0190-00			Silicon	2N3904
Q975	151-0190-00			Silicon	2N3904
Q976	151-0169-00			Silicon	2N3439
Q980A } Q980B }	*153-0558-00			Silicon	(matched pair) 2N3906
Q1010	151-0190-00			Silicon	2N3904
Q1100	151-0188-00			Silicon	2N3906
Q1101	151-0190-00			Silicon	2N3904
Q1110	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1115	151-0188-00	XB150000		Silicon	2N3906
Q1120	151-0190-00			Silicon	2N3904
Q1121	151-0190-00			Silicon	2N3904
Q1130	151-0190-00			Silicon	2N3904
Q1140	151-0190-00			Silicon	2N3904
Q1150	*151-0126-00	B010100	B149999X	Silicon	Selected from 2N2484
Q1150A,B	151-1011-00	XB150000		Silicon	Dual FET
Q1151	*151-0126-00	B010100	B149999X	Silicon	Selected from 2N2484
Q1160	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1161	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1162	151-0190-00			Silicon	2N3904
Q1170	151-0190-00			Silicon	2N3904
Q1180	151-0190-00			Silicon	2N3904
Q1190	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1200	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1210	151-0190-00			Silicon	2N3904

Transistor *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Q1220	151-0150-00			Silicon	2N3440
Q1230	151-0190-00			Silicon	2N3904
Q1250	151-0190-00			Silicon	2N3904
Q1255	151-0190-00			Silicon	2N3904
Q1260	151-0190-00			Silicon	2N3904
Q1265	151-0190-00			Silicon	2N3904
Q1270	151-0188-00			Silicon	2N3906
Q1280	151-0190-00			Silicon	2N3904
Q1285	151-0190-00			Silicon	2N3904
Q1290	151-0190-00			Silicon	2N3904
Q1300	151-0190-00			Silicon	2N3904
Q1400	151-0188-00			Silicon	2N3906
Q1410	*151-0195-00			Silicon	Replaceable by MPS 6515
Q1420	151-0140-00			Silicon	2N3055
Q1510	151-0150-00			Silicon	2N3440
Q1515	151-0150-00			Silicon	2N3440
Q1520	151-0149-00			Silicon	2N3441
Q1540	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1541	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1545	151-0150-00			Silicon	2N3440
Q1550	151-0149-00			Silicon	2N3441
Q1560	*151-0148-00			Silicon	Selected 40250 (RCA)
Q1570A	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1570B	*151-0192-00			Silicon	Replaceable by MPS 6521
Q1590	*151-0183-00			Silicon	Selected from 2N2192
Q1600	*151-0183-00			Silicon	Selected from 2N2192
Q1610	*151-0195-00			Silicon	Replaceable by MPS 6515
Q1620	*151-0195-00			Silicon	Replaceable by MPS 6515
Q1630	151-0140-00			Silicon	2N3055

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R2[3]	*312-0648-00			15 kΩ	1/8 W	Prec	1%
R3	315-0392-00			3.9 kΩ	1/4 W		5%
R4	321-0412-00			191 kΩ	1/8 W	Prec	1%
R5	315-0103-00			10 kΩ	1/4 W		5%
R13	315-0392-00			3.9 kΩ	1/4 W		5%
R14	321-0409-00	B010100	B149999	178 kΩ	1/8 W	Prec	1%
R14	321-0410-00	B150000		182 kΩ	1/8 W	Prec	1%
R17[3]	*312-0648-00			15 kΩ	1/8 W	Prec	1%
R18	321-0306-00			15 kΩ	1/8 W	Prec	1%
R33	315-0334-00			330 kΩ	1/4 W		5%

[3]Matched pair, furnished as a unit.

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R34	315-0105-00			1 MΩ	1/4 W		5%
R36	315-0223-00			22 kΩ	1/4 W		5%
R37	315-0220-00			22 Ω	1/4 W		5%
R38	315-0103-00			10 kΩ	1/4 W		5%
R39	315-0101-00			100 Ω	1/4 W		5%
R40	315-0152-00			1.5 kΩ	1/4 W		5%
R42	315-0820-00			82 Ω	1/4 W		5%
R44	315-0331-00			330 Ω	1/4 W		5%
R45	311-0462-00	B010100	B319999	1 kΩ, Var			
R45	311-1225-00	B320000		1 kΩ, Var			
R46	321-0231-00			2.49 kΩ	1/8 W	Prec	1%
R47	321-0231-00			2.49 kΩ	1/8 W	Prec	1%
R48	315-0151-00			150 Ω	1/4 W		5%
R49	315-0751-00			750 Ω	1/4 W		5%
R52[4]	*312-0648-00			15 kΩ	1/8 W	Prec	1%
R53	315-0392-00			3.9 kΩ	1/4 W		5%
R54	321-0412-00			191 kΩ	1/8 W	Prec	1%
R55	315-0103-00			10 kΩ	1/4 W		5%
R60	321-0127-00			205 Ω	1/8 W	Prec	1%
R63	315-0392-00			3.9 kΩ	1/4 W		5%
R64	321-0409-00	B010100	B149999	178 kΩ	1/8 W	Prec	1%
R64	321-0410-00	B150000		182 kΩ	1/8 W	Prec	1%
R66	321-0306-00			15 kΩ	1/8 W	Prec	1%
R67[4]	*312-0648-00			15 kΩ	1/8 W	Prec	1%
R74	315-0470-00			47 Ω	1/4 W		5%
R75	315-0470-00			47 Ω	1/4 W		5%
R80	321-0335-00			30.1 kΩ	1/8 W	Prec	1%
R81	321-0306-00			15 kΩ	1/8 W	Prec	1%
R82	301-0152-00			1.5 kΩ	1/2 W		5%
R84	303-0183-00			18 kΩ	1 W		5%
R85	315-0390-00	B010100	B149999	39 Ω	1/4 W		5%
R85	315-0270-00	B150000		27 Ω	1/4 W		5%
R87	301-0152-00			1.5 kΩ	1/2 W		5%
R88	321-0155-00	B010100	B239999	402 Ω	1/8 W	Prec	1%
R88	321-0151-00	B240000		365 Ω	1/8 W	Prec	1%
R89	315-0152-00			1.5 kΩ	1/4 W		5%
R90	321-0335-00			30.1 kΩ	1/8 W	Prec	1%
R91	321-0306-00			15 kΩ	1/8 W	Prec	1%
R92	301-0152-00			1.5 kΩ	1/2 W		5%
R94	303-0183-00			18 kΩ	1 W		5%
R95	315-0390-00	B010100	B149999	39 Ω	1/4 W		5%
R95	315-0270-00	B150000		27 Ω	1/4 W		5%
R97	301-0152-00			1.5 kΩ	1/2 W		5%
R98	321-0155-00	B010100	B239999	402 Ω	1/8 W	Prec	1%
R98	321-0151-00	B240000		365 Ω	1/8 W	Prec	1%
R99	315-0152-00			1.5 kΩ	1/4 W		5%
R101	315-0332-00			3.3 kΩ	1/4 W		5%
R102	315-0105-00			1 MΩ	1/4 W		5%

[4]Matched pair, furnished as a unit.

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Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R105	315-0222-00			2.2 kΩ	¼ W		5%
R106	315-0182-00			1.8 kΩ	¼ W		5%
R109	315-0362-00			3.6 kΩ	¼ W		5%
R111	315-0222-00			2.2 kΩ	¼ W		5%
R112	315-0182-00			1.8 kΩ	¼ W		5%
R114	315-0105-00			1 MΩ	¼ W		5%
R116	315-0332-00			3.3 kΩ	¼ W		5%
R120	315-0563-00			56 kΩ	¼ W		5%
R121	315-0752-00			7.5 kΩ	¼ W		5%
R124	315-0392-00			3.9 kΩ	¼ W		5%
R126	315-0105-00			1 MΩ	¼ W		5%
R128	315-0822-00			8.2 kΩ	¼ W		5%
R130	315-0392-00			3.9 kΩ	¼ W		5%
R132	315-0105-00			1 MΩ	¼ W		5%
R134	315-0822-00			8.2 kΩ	¼ W		5%
R136	315-0682-00			6.8 kΩ	¼ W		5%
R140	315-0332-00	B010100	B239999	3.3 kΩ	¼ W		5%
R140	321-0252-00	B240000		4.12 kΩ	⅛ W	Prec	1%
R141	315-0302-00			3 kΩ	¼ W		5%
R142	321-0260-00	XB240000		4.99 kΩ	⅛ W	Prec	1%
R143	315-0103-00			10 kΩ	¼ W		5%
R144	315-0102-00	XB240000		1 kΩ	¼ W		5%
R145	315-0100-00			10 Ω	¼ W		5%
R146	315-0153-00			15 kΩ	¼ W		5%
R147	315-0100-00			10 Ω	¼ W		5%
R148	301-0471-00	B010100	B239999	470 Ω	½ W		5%
R148	301-0271-00	B240000		270 Ω	½ W		5%
R149	315-0510-00			51 Ω	¼ W		5%
R201	315-0222-00			2.2 kΩ	¼ W		5%
R203	315-0330-00			33 Ω	¼ W		5%
R205	315-0330-00			33 Ω	¼ W		5%
R206	315-0152-00			1.5 kΩ	¼ W		5%
R208	315-0472-00			4.7 kΩ	¼ W		5%
R209	315-0271-00			270 Ω	¼ W		5%
R210	315-0333-00			33 kΩ	¼ W		5%
R211	315-0103-00			10 kΩ	¼ W		5%
R216	321-0093-00			90.9 Ω	⅛ W	Prec	1%
R220	315-0101-00			100 Ω	¼ W		5%
R221	315-0151-00			150 Ω	¼ W		5%
R222	315-0101-00			100 Ω	¼ W		5%
R224	301-0433-00			43 kΩ	½ W		5%
R226	315-0682-00			6.8 kΩ	¼ W		5%
R227	321-0289-00	B010100	B189999	10 kΩ	⅛ W	Prec	1%
R227	321-0239-00	B190000		3.01 kΩ	⅛ W	Prec	1%
R228	315-0242-00			2.4 kΩ	¼ W		5%
R229	315-0330-00			33 Ω	¼ W		5%
R231	315-0104-00	B010100	B249999	100 kΩ	¼ W		5%
R231	321-0391-00	B250000		115 kΩ	⅛ W	Prec	1%
R232	315-0562-00	B010100	B249999	5.6 kΩ	¼ W		5%
R232	321-0265-00	B250000		5.62 kΩ	⅛ W	Prec	1%
R234	315-0102-00	B010100	B249999X	1 kΩ	¼ W		5%
R235	317-0101-00	XB280000		100 Ω	⅛ W		5%
R236	315-0330-00			33 Ω	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R237	321-0180-00	XB250000		732 Ω	1/8 W	Prec	1%
R238	315-0681-00			680 Ω	1/4 W		5%
R239	321-0280-00	XB250000		8.06 kΩ	1/8 W	Prec	1%
R242	321-1485-00			1.11 MΩ	1/8 W	Prec	1%
R243	311-0508-00	XB150000	B319999	50 kΩ, Var			
R243	311-1234-00	B320000		50 kΩ, Var			
R244	321-1485-00			1.11 MΩ	1/8 W	Prec	1%
R246	321-0274-00	XB250000		6.98 kΩ	1/8 W	Prec	1%
R248	315-0302-00	XB250000		3 kΩ	1/4 W		5%
R250	311-0463-00	B010100	B319999	5 kΩ, Var			
R250	311-1227-00	B320000		5 kΩ, Var		Prec	1%
R251	321-0261-00			5.11 kΩ	1/8 W		
R252	321-0321-00			21.5 kΩ	1/8 W	Prec	1%
R254	316-0336-00			33 MΩ	1/4 W		
R255	315-0303-00	B010100	B149999	30 kΩ	1/4 W		5%
R255	315-0623-00	B150000		62 kΩ	1/4 W		5%
R256	315-0104-00			100 kΩ	1/4 W		5%
R257	315-0202-00	XB230000		2 kΩ	1/4 W		5%
R258	315-0104-00			100 kΩ	1/4 W		5%
R264	315-0473-00			47 kΩ	1/4 W		5%
R265	315-0473-00			47 kΩ	1/4 W		5%
R268	315-0153-00			15 kΩ	1/4 W		5%
R270	315-0103-00			10 kΩ	1/4 W		5%
R271	315-0512-00			5.1 kΩ	1/4 W		5%
R272	315-0512-00			5.1 kΩ	1/4 W		5%
R273	315-0101-00			100 Ω	1/4 W		5%
R275	315-0681-00			680 Ω	1/4 W		5%
R276	315-0151-00			150 Ω	1/4 W		5%
R277	315-0510-00			51 Ω	1/4 W		5%
R279	315-0301-00			300 Ω	1/4 W		5%
R280A, R280B, R280C, R280D [5]							
R282	315-0332-00			3.3 kΩ	1/4 W		5%
R283	315-0152-00			1.5 kΩ	1/4 W		5%
R287	315-0133-00			13 kΩ	1/4 W		5%
R289	304-0392-00			3.9 kΩ	1 W		
R290	304-0153-00			15 kΩ	1 W		
R292	315-0394-00			390 kΩ	1/4 W		5%
R294	315-0332-00			3.3 kΩ	1/4 W		5%
R297	315-0182-00			1.8 kΩ	1/4 W		5%
R299[5]							
R301	315-0752-00			7.5 kΩ	1/4 W		5%
R302	315-0103-00			10 kΩ	1/4 W		5%
R304	315-0105-00			1 MΩ	1/4 W		5%
R305	315-0332-00			3.3 kΩ	1/4 W		5%
R306	315-0392-00			3.9 kΩ	1/4 W		5%
R311	315-0153-00			15 kΩ	1/4 W		5%
R312	315-0103-00			10 kΩ	1/4 W		5%
R314	315-0105-00			1 MΩ	1/4 W		5%
R316	315-0392-00			3.9 kΩ	1/4 W		5%
R320	315-0103-00			10 kΩ	1/4 W		5%
R321	315-0512-00			5.1 kΩ	1/4 W		5%

[5]Furnished as a unit with partial Oven Assembly (*205-0083-01).

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R323	301-0182-00			1.8 kΩ	½ W		5%
R327	315-0100-00			10 Ω	¼ W		5%
R329	315-0330-00			33 Ω	¼ W		5%
R331	321-0220-00			1.91 kΩ	⅛ W	Prec	1%
R333	321-0097-00			100 Ω	⅛ W	Prec	1%
R335	311-0169-00			100 Ω, Var			
R337	321-0220-00			1.91 kΩ	⅛ W	Prec	1%
R340	315-0330-00			33 Ω	¼ W		5%
R341	315-0303-00			30 kΩ	¼ W		5%
R342	315-0331-00			330 Ω	¼ W		5%
R343	315-0682-00			6.8 kΩ	¼ W		5%
R344	315-0682-00			6.8 kΩ	¼ W		5%
R345	315-0470-00			47 Ω	¼ W		5%
R346	315-0330-00			33 Ω	¼ W		5%
R347	315-0332-00			3.3 kΩ	¼ W		5%
R349	315-0470-00			47 Ω	¼ W		5%
R354[6]							
R358[6]							
R364[7]							
R368[7]							
R401	321-0128-00			210 Ω	⅛ W	Prec	1%
R402	311-0608-00	B010100	B259999	2 kΩ, Var			
R402	311-1079-00	B260000		2 kΩ, Var			
R403[8]	311-0685-00			100 Ω, Var			
R404	321-0039-00	B010100	B239999	24.9 Ω	⅛ W	Prec	1%
R404	321-0010-00	B240000		12.4 Ω	⅛ W	Prec	1%
R405	321-0160-00			453 Ω	⅛ W	Prec	1%
R406	321-0130-00	B010100	B239999	221 Ω	⅛ W	Prec	1%
R406	321-0126-00	B240000		200 Ω	⅛ W	Prec	1%
R407	321-0135-00			249 Ω	⅛ W	Prec	1%
R409	321-0253-00			4.22 kΩ	⅛ W	Prec	1%
R411	321-0128-00			210 Ω	⅛ W	Prec	1%
R412	311-0608-00	B010100	B259999	2 kΩ, Var			
R412	311-1079-00	B260000		2 kΩ, Var			
R413[9]	311-0685-00			100 Ω, Var			
R414	321-0039-00	B010100	B239999	24.9 Ω	⅛ W	Prec	1%
R414	321-0010-00	B240000		12.4 Ω	⅛ W	Prec	1%
R415	321-0160-00			453 Ω	⅛ W	Prec	1%
R416	321-0130-00	B010100	B239999	221 Ω	⅛ W	Prec	1%
R416	321-0126-00	B240000		200 Ω	⅛ W	Prec	1%
R417	321-0135-00			249 Ω	⅛ W	Prec	1%
R419	321-0253-00			4.22 kΩ	⅛ W	Prec	1%
R420	315-0472-00			4.7 kΩ	¼ W		5%
R421	315-0132-00			1.3 kΩ	¼ W		5%

[6]Furnished as a unit with CH A Goniometer (*119-0133-00).

[7]Furnished as a unit with CH B Goniometer (*119-0133-00).

[8]Furnished as a unit with SW403.

[9]Furnished as a unit with SW413.

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R422	315-0153-00			15 kΩ	¼ W		5%
R423	315-0153-00			15 kΩ	¼ W		5%
R424	321-0239-00			3.01 kΩ	⅛ W	Prec	1%
R425	315-0472-00			4.7 kΩ	¼ W		5%
R426	315-0132-00			1.3 kΩ	¼ W		5%
R427	315-0472-00			4.7 kΩ	¼ W		5%
R428	315-0122-00			1.2 kΩ	¼ W		5%
R429	321-0239-00			3.01 kΩ	⅛ W	Prec	1%
R431	315-0562-00			5.6 kΩ	¼ W		5%
R432	315-0103-00			10 kΩ	¼ W		5%
R433	321-0224-00	XB150000		2.1 kΩ	⅛ W	Prec	1%
R434	321-0224-00	XB150000		2.1 kΩ	⅛ W	Prec	1%
R435	315-0562-00			5.6 kΩ	¼ W		5%
R436	315-0103-00			10 kΩ	¼ W		5%
R437	315-0105-00	XB150000		1 MΩ	¼ W		5%
R438	315-0472-00	XB150000		4.7 kΩ	¼ W		5%
R439	315-0682-00	XB150000		6.8 kΩ	¼ W		5%
R440	315-0101-00			100 Ω	¼ W		5%
R441	321-0224-00	XB150000		2.1 kΩ	⅛ W	Prec	1%
R442	321-0253-00	B010100	B149999	4.22 kΩ	⅛ W	Prec	1%
R442	321-0224-00	B150000		2.1 kΩ	⅛ W	Prec	1%
R443	315-0222-00			2.2 kΩ	¼ W		5%
R444	321-0253-00			4.22 kΩ	⅛ W	Prec	1%
R445	315-0105-00	XB150000		1 MΩ	¼ W		5%
R446	315-0152-00	B010100	B149999	1.5 kΩ	¼ W		5%
R446	301-0152-00	B150000		1.5 kΩ	½ W		5%
R447	315-0472-00	XB150000		4.7 kΩ	¼ W		5%
R448	303-0183-00			18 kΩ	1 W		5%
R449	315-0470-00	B010100	B149999	47 Ω	¼ W		5%
R449	315-0682-00	B150000		6.8 kΩ	¼ W		5%
R450	315-0101-00	XB150000		100 Ω	¼ W		5%
R452	321-0193-00			1 kΩ	⅛ W	Prec	1%
R453	321-0164-00			499 Ω	⅛ W	Prec	1%
R455	321-0164-00			499 Ω	⅛ W	Prec	1%
R461	315-0152-00			1.5 kΩ	¼ W		5%
R463	315-0203-00	B010100	B149999	20 kΩ	¼ W		5%
R463	315-0333-00	B150000		33 kΩ	¼ W		5%
R465	315-0393-00			39 kΩ	¼ W		5%
R470	315-0303-00			30 kΩ	¼ W		5%
R471	315-0222-00			2.2 kΩ	¼ W		5%
R472	315-0430-00	XB150000		43 Ω	¼ W		5%
R473	321-0279-00	B010100	B149999	7.87 kΩ	⅛ W	Prec	1%
R473	315-0622-00	B150000		6.2 kΩ	¼ W		5%
R474	321-0226-00	B010100	B199999	2.21 kΩ	⅛ W	Prec	1%
R474	321-0224-00	B200000	B239999	2.1 kΩ	⅛ W	Prec	1%
R474	321-0219-00	B240000		1.87 kΩ	⅛ W	Prec	1%
R475	315-0511-00	B010100	B149999X	510 Ω	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R476	315-0271-00	XB150000		270 Ω	¼ W		5%
R482	315-0242-00			2.4 kΩ	¼ W		5%
R484	315-0472-00			4.7 kΩ	¼ W		5%
R485	315-0751-00			750 Ω	¼ W		5%
R486	315-0512-00			5.1 kΩ	¼ W		5%
R488	315-0242-00			2.4 kΩ	¼ W		5%
R489	315-0222-00	XB260000		2.2 kΩ	¼ W		5%
R490	315-0101-00	B010100	B259999	100 Ω	¼ W		5%
R490	315-0221-00	B260000		220 Ω	¼ W		5%
R491	315-0102-00			1 kΩ	¼ W		5%
R492	315-0472-00			4.7 kΩ	¼ W		5%
R493	315-0331-00			330 Ω	¼ W		5%
R494	315-0471-00			470 Ω	¼ W		5%
R495	315-0911-00	B010100	B149999	910 Ω	¼ W		5%
R495	315-0561-00	B150000		560 Ω	¼ W		5%
R496	315-0224-00			220 kΩ	¼ W		5%
R497	315-0223-00			22 kΩ	¼ W		5%
R498	311-0614-00			30 kΩ, Var			
R500	321-0187-00			866 Ω	⅛ W	Prec	1%
R501	311-0607-00			10 kΩ, Var			
R502	321-0229-00			2.37 kΩ	⅛ W	Prec	1%
R503	315-0223-00			22 kΩ	¼ W		5%
R504	321-0170-00	B010100	B149999	576 Ω	⅛ W	Prec	1%
R504	321-0135-00	B150000		249 Ω	⅛ W	Prec	1%
R505	315-0153-00			15 kΩ	¼ W		5%
R506	321-0216-00	B010100	B149999	1.74 kΩ	⅛ W	Prec	1%
R506	321-0192-00	B150000		976 Ω	⅛ W	Prec	1%
R508	321-0216-00	B010100	B149999	1.74 kΩ	⅛ W	Prec	1%
R508	321-0192-00	B150000		976 Ω	⅛ W	Prec	1%
R509	315-0153-00			15 kΩ	¼ W		5%
R511	315-0183-00	B010100	B149999	18 kΩ	¼ W		5%
R511	315-0153-00	B150000		15 kΩ	¼ W		5%
R512	315-0272-00			2.7 kΩ	¼ W		5%
R515	315-0822-00			8.2 kΩ	¼ W		5%
R516	315-0471-00			470 Ω	¼ W		5%
R517	315-0822-00			8.2 kΩ	¼ W		5%
R518	315-0471-00			470 Ω	¼ W		5%
R519	315-0822-00			8.2 kΩ	¼ W		5%
R521	315-0562-00			5.6 kΩ	¼ W		5%
R525	315-0562-00			5.6 kΩ	¼ W		5%
R527	315-0752-00			7.5 kΩ	¼ W		5%
R528	315-0622-00			6.2 kΩ	¼ W		5%
R529	315-0682-00			6.8 kΩ	¼ W		5%
R530	315-0513-00			51 kΩ	¼ W		5%
R532	315-0202-00			2 kΩ	¼ W		5%
R533	315-0202-00			2 kΩ	¼ W		5%
R535	315-0152-00			1.5 kΩ	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R540	315-0473-00			47 kΩ	¼ W		5%
R541	315-0103-00			10 kΩ	¼ W		5%
R543	315-0242-00	B010100	B149999	2.4 kΩ	¼ W		5%
R543	315-0302-00	B150000		3 kΩ	¼ W		5%
R545	315-0153-00			15 kΩ	¼ W		5%
R546	315-0152-00	B010100	B149999	1.5 kΩ	¼ W		5%
R546	315-0272-00	B150000		2.7 kΩ	¼ W		5%
R550	315-0220-00			22 Ω	¼ W		5%
R551	315-0272-00			2.7 kΩ	¼ W		5%
R552	315-0152-00			1.5 kΩ	¼ W		5%
R553	315-0470-00			47 Ω	¼ W		5%
R554	315-0104-00			100 kΩ	¼ W		5%
R555	315-0220-00			22 Ω	¼ W		5%
R556	315-0911-00			910 Ω	¼ W		5%
R557	315-0132-00			1.3 kΩ	¼ W		5%
R560	315-0331-00			330 Ω	¼ W		5%
R562	315-0472-00			4.7 kΩ	¼ W		5%
R564	315-0471-00			470 Ω	¼ W		5%
R566	315-0202-00			2 kΩ	¼ W		5%
R568	315-0220-00			22 Ω	¼ W		5%
R570	301-0303-00			30 kΩ	½ W		5%
R572	315-0152-00			1.5 kΩ	¼ W		5%
R574	315-0152-00			1.5 kΩ	¼ W		5%
R575	301-0303-00			30 kΩ	½ W		5%
R576	315-0113-00			11 kΩ	¼ W		5%
R577	315-0392-00			3.9 kΩ	¼ W		5%
R578	315-0562-00			5.6 kΩ	¼ W		5%
R579	315-0222-00			2.2 kΩ	¼ W		5%
R580	315-0103-00			10 kΩ	¼ W		5%
R582	321-0212-00	B010100	B289999	1.58 kΩ	⅛ W	Prec	1%
R582	321-0216-00	B290000		1.74 kΩ	⅛ W	Prec	1%
R583	311-0634-00	B010100	B289999	500 Ω, Var			
R583	311-0605-00	B290000		200 Ω, Var			
R585	321-0175-00			649 Ω	⅛ W	Prec	1%
R586	321-0175-00			649 Ω	⅛ W	Prec	1%
R587	315-0104-00			100 kΩ	¼ W		5%
R588	311-0361-00			500 kΩ, Var			
R590	321-0187-00			866 Ω	⅛ W	Prec	1%
R592	321-0225-00			2.15 kΩ	⅛ W	Prec	1%
R594	321-0170-00	B010100	B149999	576 Ω	⅛ W	Prec	1%
R594	321-0135-00	B150000		249 Ω	⅛ W	Prec	1%
R595	315-0153-00			15 kΩ	¼ W		5%
R596	321-0216-00	B010100	B149999	1.74 kΩ	⅛ W	Prec	1%
R596	321-0192-00	B150000		976 Ω	⅛ W	Prec	1%
R598	321-0216-00	B010100	B149999	1.74 kΩ	⅛ W	Prec	1%
R598	321-0192-00	B150000		976 Ω	⅛ W	Prec	1%
R599	315-0153-00			15 kΩ	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R608	307-0103-00			2.7 Ω	¼ W		5%
R609	315-0100-00			10 Ω	¼ W		5%
R621	321-0193-00			1 kΩ	⅛ W	Prec	1%
R622	315-0470-00			47 Ω	¼ W		5%
R624	311-0510-00	B010100	B319999	10 kΩ, Var			
R624	311-1228-00	B320000		10 kΩ, Var			
R625	315-0183-00			18 kΩ	¼ W		5%
R626	311-0496-00	B010100	B319999	2.5 kΩ, Var			
R626	311-1226-00	B320000		2.5 kΩ, Var			
R627	321-0284-00			8.87 kΩ	⅛ W	Prec	1%
R630	315-0683-00			68 kΩ	¼ W		5%
R632	315-0153-00			15 kΩ	¼ W		5%
R633	315-0753-00			75 kΩ	¼ W		5%
R635	315-0101-00			100 Ω	¼ W		5%
R637	315-0152-00			1.5 kΩ	¼ W		5%
R641	321-0193-00			1 kΩ	⅛ W	Prec	1%
R642	315-0470-00			47 Ω	¼ W		5%
R644	311-0510-00	B010100	B319999	10 kΩ, Var			
R644	311-1228-00	B320000		10 kΩ, Var			
R645	315-0183-00			18 kΩ	¼ W		5%
R646	311-0496-00	B010100	B319999	2.5 kΩ, Var			
R646	311-1226-00	B320000		2.5 kΩ, Var			
R647	321-0283-00			8.66 kΩ	⅛ W	Prec	1%
R648	311-0486-00			500 Ω, Var			
R650	315-0683-00			68 kΩ	¼ W		5%
R652	315-0153-00			15 kΩ	¼ W		5%
R653	315-0753-00			75 kΩ	¼ W		5%
R655	315-0101-00			100 Ω	¼ W		5%
R657	315-0152-00			1.5 kΩ	¼ W		5%
R660	315-0102-00			1 kΩ	¼ W		5%
R661	315-0100-00			10 Ω	¼ W		5%
R662	315-0101-00			100 Ω	¼ W		5%
R664	315-0302-00			3 kΩ	¼ W		5%
R671	315-0623-00			62 kΩ	¼ W		5%
R672	311-0465-00	B010100	B319999	100 kΩ, Var			
R672	311-1235-00	B320000		100 kΩ, Var			
R673	301-0333-00			33 kΩ	½ W		5%
R676	321-0164-00			499 Ω	⅛ W	Prec	1%
R678	321-0121-00			178 Ω	⅛ W	Prec	1%
R682	315-0472-00			4.7 kΩ	¼ W		5%
R684	315-0820-00			82 Ω	¼ W		5%
R685[10]	311-0656-00	B010100	B259999	5 kΩ, Var			
R685[10]	311-1080-00	B260000		5 kΩ, Var			
R686	321-0175-00			649 Ω	⅛ W	Prec	1%
R687	321-0137-00			261 Ω	⅛ W	Prec	1%
R688	321-0184-00			806 Ω	⅛ W	Prec	1%
R690	315-0471-00	XB150000		470 Ω	¼ W		5%
R691	315-0511-00			510 Ω	¼ W		5%
R692	315-0102-00			1 kΩ	¼ W		5%
R693	315-0153-00	XB150000		15 kΩ	¼ W		5%
R694	321-0239-00			3.01 kΩ	Selected (nominal value)		

[10]Furnished as a unit with SW685.

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R695	315-0222-00			2.2 kΩ	¼ W		5%
R697	315-0682-00			6.8 kΩ	¼ W		5%
R698	315-0123-00			12 kΩ	¼ W		5%
R702	315-0303-00			30 kΩ	¼W		5%
R703	315-0303-00			30 kΩ	¼W		5%
R705[11]	*312-0647-00			4.99 kΩ	⅛ W	Prec	1%
R706	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R712	315-0303-00			30 kΩ	¼ W		5%
R713	315-0303-00			30 kΩ	¼ W		5%
R715[11]	*312-0647-00			4.99 kΩ	⅛ W	Prec	1%
R716	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R718	321-0283-00			8.66 kΩ	⅛ W	Prec	1%
R722	315-0303-00			30 kΩ	¼ W		5%
R723	315-0303-00			30 kΩ.	¼ W		5%
R725[11]	*312-0647-00			4.99 kΩ	⅛ W	Prec	1%
R726	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R728	321-0259-00			4.87 kΩ	⅛ W	Prec	1%
R732	315-0303-00			30 kΩ	¼ W		5%
R733	315-0303-00			30 kΩ	¼ W		5%
R735[11]	*312-0647-00			4.99 kΩ	⅛ W	Prec	1%
R736	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R742	315-0303-00			30 kΩ	¼ W		5%
R743	315-0303-00			30 kΩ	¼ W		5%
R745	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R746	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R752	315-0303-00			30 kΩ	¼ W		5%
R753	315-0303-00			30 kΩ	¼ W		5%
R755	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R756	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R762	315-0303-00			30 kΩ	¼ W		5%
R763	315-0303-00			30 kΩ	¼ W		5%
R765	321-0178-00	B010100	B149999	698 Ω		Selected (nominal value)	
R765	321-0193-00	B150000	B189999	1 kΩ	⅛ W	Prec	1%
R765	321-0191-00	B190000	B239999	953 Ω	⅛ W	Prec	1%
R765	321-0192-00	B240000		976 Ω	⅛ W	Selected (nominal value)	
R766	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R770	321-0244-00			3.4 kΩ	⅛ W	Prec	1%
R771	321-0262-01			5.23 kΩ	⅛ W	Prec	½%
R773	315-0683-00			68 kΩ	¼ W		5%
R775	315-0912-00			9.1 kΩ	¼ W		5%
R778	315-0474-00			470 kΩ	¼ W		5%
R782	321-0194-00			1.02 kΩ	⅛ W	Prec	1%
R784	315-0472-00			4.7 kΩ	¼ W		5%
R786	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R788	323-0356-00			49.9 kΩ	½ W	Prec	1%
R806	315-0124-00			120 kΩ	¼ W		5%
R807	315-0243-00			24 kΩ	¼ W		5%

[11] R705, R715, R725 and R735 matched to 0.1%, furnished as a unit.

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R809	315-0275-00			2.7 MΩ	¼ W		5%
R813	315-0153-00			15 kΩ	¼ W		5%
R816	315-0124-00			120 kΩ	¼ W		5%
R817	315-0243-00			24 kΩ	¼ W		5%
R822	315-0104-00			100 kΩ	¼ W		5%
R826	315-0153-00			15 kΩ	¼ W		5%
R830	321-0251-00	B010100	B029999	4.02 kΩ	⅛ W	Prec	1%
R830	321-0247-00	B030000		3.65 kΩ	⅛ W	Prec	1%
R832	301-0363-00			36 kΩ	½ W		5%
R834	315-0362-00			3.6 kΩ	¼ W		5%
R835	315-0153-00			15 kΩ	¼ W		5%
R837	308-0461-00			16 kΩ	4 W	WW	1%
R838	315-0912-00			9.1 kΩ	¼ W		5%
R840	321-0193-00			1 kΩ	⅛ W	Prec	1%
R841	321-0235-00			2.74 kΩ	⅛ W	Prec	1%
R843	323-0176-00	B010100	B149999	665 Ω	½ W	Prec	1%
R843	323-0164-00	B150000		499 Ω	½ W	Prec	1%
R846	321-0116-00	B010100	B149999	158 Ω	⅛ W	Prec	1%
R846	321-0104-00	B150000		118 Ω	⅛ W	Prec	1%
R847	321-0116-00	B010100	B149999	158 Ω	⅛ W	Prec	1%
R847	321-0126-00	B150000		200 Ω	⅛ W	Prec	1%
R848	311-0496-00	B010100	B319999	2.5 kΩ, Var			
R848	311-1226-00	B320000		500 Ω, Var			
R849	311-0480-00	B010100	B319999	500 Ω, Var			
R849	311-1224-00	B320000		500 Ω, Var			
R855	303-0183-00	XB150000		18 kΩ	1 W		5%
R857	308-0461-00			16 kΩ	4 W	WW	1%
R858	315-0912-00			9.1 kΩ	¼ W		5%
R860A } R860B }	311-0694-00			50 kΩ, Var 10 kΩ, Var			
R861	315-0474-00			470 kΩ	¼ W		5%
R862	315-0155-00			1.5 MΩ	¼ W		5%
R863	315-0335-00			3.3 MΩ	¼ W		5%
R864	315-0223-00			22 kΩ	¼ W		5%
R865	315-0753-00			75 kΩ	¼ W		5%
R867	315-0204-00			200 kΩ	¼ W		5%
R868	315-0114-00			110 kΩ	¼ W		5%
R873	321-0334-00			29.4 kΩ	⅛ W	Prec	1%
R874	315-0563-00			56 kΩ	¼ W		5%
R875	311-0463-00	B010100	B319999	5 kΩ, Var			
R875	311-1227-00	B320000		5 kΩ, Var			
R876	323-0414-00			200 kΩ	½ W	Prec	1%
R877	315-0392-00			3.9 kΩ	¼ W		5%
R878	321-0262-01			5.23 kΩ	⅛ W	Prec	½%
R880	311-0329-00			50 kΩ, Var			
R881	315-0474-00			470 kΩ	¼ W		5%
R883	321-0331-00			27.4 kΩ	⅛ W	Prec	1%
R884	315-0563-00			56 kΩ	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R886	323-0414-00			200 kΩ	½ W	Prec	1%
R887	315-0392-00			3.9 kΩ	¼ W		5%
R889	323-0354-00			47.5 kΩ	½ W	Prec	1%
R890	321-0203-00			1.27 kΩ	⅛ W	Prec	1%
R892	321-0181-00			750 Ω	⅛ W	Prec	1%
R896	315-0102-00			1 kΩ	¼ W		5%
R901	315-0103-00			10 kΩ	¼ W		5%
R902	315-0622-00			6.2 kΩ	¼ W		5%
R903	315-0393-00			39 kΩ	¼ W		5%
R904	315-0333-00			33 kΩ	¼ W		5%
R905	311-0510-00	B010100	B319999	10 kΩ, Var			
R905	311-1228-00	B320000		10 kΩ, Var			
R906	315-0124-00			120 kΩ	¼ W		5%
R907	315-0243-00			24 kΩ	¼ W		5%
R909	315-0275-00			2.7 MΩ	¼ W		5%
R912	315-0103-00			10 kΩ	¼ W		5%
R913	315-0512-00			5.1 kΩ	¼ W		5%
R915	315-0153-00			15 kΩ	¼ W		5%
R916	315-0124-00			120 kΩ	¼ W		5%
R917	315-0243-00			24 kΩ	¼ W		5%
R922	315-0104-00			100 kΩ	¼ W		5%
R926	315-0153-00			15 kΩ	¼ W		5%
R930	315-0102-00			1 kΩ	¼ W		5%
R932	315-0224-00			220 kΩ	¼ W		5%
R934	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R936	315-0303-00			30 kΩ	¼ W		5%
R937	315-0303-00			30 kΩ	¼ W		5%
R939	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R940	321-0368-00			66.5 kΩ	⅛ W	Prec	1%
R944	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R946	323-0356-00			49.9 kΩ	½ W	Prec	1%
R950	321-0251-00	B010100	B029999	4.02 kΩ	⅛ W	Prec	1%
R950	321-0247-00	B030000		3.65 kΩ	⅛ W	Prec	1%
R952	301-0363-00			36 kΩ	½ W		5%
R954	315-0362-00			3.6 kΩ	¼ W		5%
R955	315-0153-00			15 kΩ	¼ W		5%
R957	308-0461-00			16 kΩ	4 W	WW	1%
R958	315-0912-00			9.1 kΩ	¼ W		5%
R960	321-0193-00			1 kΩ	⅛ W	Prec	1%
R961	321-0235-00			2.74 kΩ	⅛ W	Prec	1%
R963	323-0176-00	B010100	B149999	665 Ω	½ W	Prec	1%
R963	323-0164-00	B150000		499 Ω	½ W	Prec	1%
R966	321-0116-00	B010100	B149999	158 Ω	⅛ W	Prec	1%
R966	321-0104-00	B150000		118 Ω	⅛ W	Prec	1%
R967	321-0116-00	B010100	B149999	158 Ω	⅛ W	Prec	1%
R967	321-0126-00	B150000		200 Ω	⅛ W	Prec	1%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R968	311-0496-00	B010100	B319999	2.5 kΩ, Var			
R968	311-1226-00	B320000		2.5 kΩ, Var			
R969	311-0480-00	B010100	B319999	500 Ω, Var			
R969	311-1224-00	B320000		500 Ω, Var			
R975	303-0183-00	XB150000		18 kΩ	1 W		5%
R977	308-0461-00			16 kΩ	4 W	WW	1%
R978	315-0912-00			9.1 kΩ	¼ W		5%
R980A } R980B }	311-0694-00			10 kΩ, Var / 50 kΩ, Var			
R981	315-0623-00			62 kΩ	¼ W		5%
R982	315-0244-00			240 kΩ	¼ W		5%
R983	321-0334-00			29.4 kΩ	⅛ W	Prec	1%
R984	315-0563-00			56 kΩ	¼ W		5%
R985	311-0463-00	B010100	B319999	5 kΩ, Var			
R985	311-1227-00	B320000		5 kΩ, Var			
R986	323-0414-00			200 kΩ	½ W	Prec	1%
R987	315-0392-00			3.9 kΩ	¼ W		5%
R988	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R993	321-0330-00			26.7 kΩ	⅛ W	Prec	1%
R994	315-0563-00			56 kΩ	¼ W		5%
R996	323-0414-00			200 kΩ	½ W	Prec	1%
R997	315-0392-00			3.9 kΩ	¼ W		5%
R999	323-0354-0			47.5 kΩ	½ W	Prec	1%
R1000	315-0474-00			470 kΩ	¼ W		5%
R1002	311-0329-00			50 kΩ, Var			
R1012	315-0224-00			220 kΩ	¼ W		5%
R1016	315-0104-00			100 kΩ	¼ W		5%
R1017	315-0303-00			30 kΩ	¼ W		5%
R1101	315-0243-00			24 kΩ	¼ W		5%
R1102	315-0222-00			2.2 kΩ	¼ W		5%
R1103	315-0104-00			100 kΩ	¼ W		5%
R1105	315-0682-00			6.8 kΩ	¼ W		5%
R1108	315-0274-00			270 kΩ	¼ W		5%
R1110	301-0333-00			33 kΩ	½ W		5%
R1111	315-0471-00	XB150000		470 Ω	¼ W		5%
R1112	301-0333-00			33 kΩ	½ W		5%
R1114	315-0433-00			43 kΩ	¼ W		5%
R1116	315-0243-00			24 kΩ	¼ W		5%
R1118	315-0822-00			8.2 kΩ	¼ W		5%
R1120	315-0273-00			27 kΩ	¼ W		5%
R1122	315-0821-00			820 Ω	¼ W		5%
R1124	315-0472-00			4.7 kΩ	¼ W		5%
R1126	315-0302-00			3 kΩ	¼ W		5%
R1127	315-0103-00			10 kΩ	¼ W		5%
R1128	315-0182-00			1.8 kΩ	¼ W		5%
R1129	315-0133-00			13 kΩ	¼ W		5%
R1131	315-0100-00			10 Ω	¼ W		5%
R1133	315-0513-00			51 kΩ	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R1134	315-0751-00			750 Ω	¼ W		5%
R1135	315-0333-00			33 kΩ	¼ W		5%
R1138	315-0682-00			6.8 kΩ	¼ W		5%
R1140	315-0100-00			10 Ω	¼ W		5%
R1141	315-0470-00			47 Ω	¼ W		5%
R1142	315-0101-00	B010100	B149999X	100 Ω	¼ W		5%
R1143	315-0224-00			220 kΩ	¼ W		5%
R1145	315-0104-00			100 kΩ	¼ W		5%
R1150	315-0204-00	B010100	B149999	200 kΩ	¼ W		5%
R1150	315-0473-00	B150000		47 kΩ	¼ W		5%
R1151	315-0106-00	B010100	B149999	10 MΩ	¼ W		5%
R1151	315-0154-00	B150000		150 kΩ	¼ W		5%
R1152	315-0243-00	B010100	B149999	24 kΩ	¼ W		5%
R1152	315-0823-00	B150000		82 kΩ	¼ W		5%
R1153	315-0241-00			240 kΩ	¼ W		5%
R1154	315-0333-00	XB150000		33 kΩ	¼ W		5%
R1155	321-0289-00			10 kΩ	⅛ W	Prec	1%
R1156	321-0363-00	B010100	B149999	59 kΩ	⅛ W	Prec	1%
R1156	321-0335-00	B150000		30.1 kΩ	⅛ W	Prec	1%
R1157	321-0332-00	B010100	B149999	28 kΩ	⅛ W	Prec	1%
R1157	321-0353-00	B150000		46.4 kΩ	⅛ W	Prec	1%
R1158	311-0170-00			20 kΩ, Var			
R1159	321-0350-00	B010100	B149999	43.2 kΩ	⅛ W	Prec	1%
R1159	317-0107-00	B150000		100 MΩ	⅛ W		5%
R1160	321-0696-00			40.2 kΩ	⅛ W	Prec	½%
R1161	321-0677-00			30.4 kΩ	⅛ W	Prec	½%
R1162	315-0151-00	XB150000		150 Ω	¼ W		5%
R1163	321-0258-00			4.75 kΩ	⅛ W	Prec	1%
R1164	321-0289-00			10 kΩ	⅛ W	Prec	1%
R1165	321-0391-00			115 kΩ	⅛ W	Prec	1%
R1166	315-0331-00			330 Ω	¼ W		5%
R1167	321-0258-00			4.75 kΩ	⅛ W	Prec	1%
R1168	301-0102-00			1 kΩ	½ W		5%
R1169	315-0332-00			3.3 kΩ	¼ W		5%
R1172	315-0100-00			10 Ω	¼ W		5%
R1174	315-0392-00			3.9 kΩ	¼ W		5%
R1176	315-0103-00			10 kΩ	¼ W		5%
R1180	315-0223-00			22 kΩ	¼ W		5%
R1184	315-0222-00			2.2 kΩ	¼ W		5%
R1186	315-0183-00			18 kΩ	¼ W		5%
R1188	315-0272-00			2.7 kΩ	¼ W		5%
R1190	321-0353-01	B010100	B149999	46.4 kΩ	⅛ W	Prec	½%
R1190	321-0345-00	B150000		38.3 kΩ	⅛ W	Prec	1%
R1192	315-0470-00			47 Ω	¼ W		5%
R1194	301-0473-00			47 kΩ	½ W		5%

Resistors (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R1196	315-0362-00			3.6 kΩ	¼ W		5%
R1198	315-0391-00			390 Ω	¼ W		5%
R1201	315-0100-00			10 Ω	¼ W		5%
R1203	304-0152-00			1.5 kΩ	1 W		
R1204	315-0222-00			2.2 kΩ	¼ W		5%
R1206	315-0562-00			5.6 kΩ	¼ W		5%
R1208	315-0103-00			10 kΩ	¼ W		5%
R1209	315-0472-00	XB150000		4.7 kΩ	¼ W		5%
R1212	315-0223-00			22 kΩ	¼ W		5%
R1213	315-0103-00			10 kΩ	¼ W		5%
R1216	315-0472-00			4.7 kΩ	¼ W		5%
R1218	315-0103-00			10 kΩ	¼ W		5%
R1220	315-0472-00			4.7 kΩ	¼ W		5%
R1222	315-0332-00			3.3 kΩ	¼ W		5%
R1224	305-0223-00			22 kΩ	2 W		5%
R1225	305-0223-00			22 kΩ	2 W		5%
R1227	315-0473-00			47 kΩ	¼ W		5%
R1228	311-0465-00	B010100	B319999	100 kΩ, Var			
R1228	311-1235-00	B320000		100 kΩ, Var			
R1230	321-0447-00			442 kΩ	⅛ W	Prec	1%
R1232	315-0393-00			39 kΩ	¼ W		5%
R1233	315-0124-00			120 kΩ	¼ W		5%
R1234	303-0203-00			20 kΩ	1 W		5%
R1236	315-0684-00			680 kΩ	¼ W		5%
R1238	315-0105-00			1 MΩ	¼ W		5%
R1239	315-0472-00			4.7 kΩ	¼ W		5%
R1251	315-0102-00			1 kΩ	¼ W		5%
R1253	315-0393-00			39 kΩ	¼ W		5%
R1254	315-0154-00			150 kΩ	¼ W		5%
R1256	301-0333-00			33 kΩ	½ W		5%
R1258	315-0222-00			2.2 kΩ	¼ W		5%
R1259	316-0825-00			8.2 MΩ	¼ W		
R1261	315-0133-00			13 kΩ	¼ W		5%
R1263	315-0332-00			3.3 kΩ	¼ W		5%
R1264	315-0624-00	B010100	B149999X	620 kΩ	¼ W		5%
R1265	315-0105-00	B010100	B149999	1 MΩ	¼ W		5%
R1265	315-0125-00	B150000		1.2 MΩ	¼ W		5%
R1266	315-0393-00			39 kΩ	¼ W		5%
R1268	315-0752-00			7.5 kΩ	¼ W		5%
R1270	315-0102-00			1 kΩ	¼ W		5%
R1273	315-0512-00			5.1 kΩ	¼ W		5%
R1275	315-0752-00			7.5 kΩ	¼ W		5%
R1283	315-0332-00	B010100	B149999	3.3 kΩ	¼ W		5%
R1283	315-0132-00	B150000		1.3 kΩ	¼ W		5%
R1285	315-0105-00			1 MΩ	¼ W		5%
R1286	315-0393-00	B010100	B149999	39 kΩ	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
R1286	317-0393-00	B150000		39 kΩ	⅛ W	5%
R1288	315-0752-00	B010100	B149999	7.5 kΩ	¼ W	5%
R1288	315-0302-00	B150000		3 kΩ	¼ W	5%
R1289	315-0222-00	B010100	B149999	2.2 kΩ	¼ W	5%
R1289	315-0152-00	B150000		1.5 kΩ	¼ W	5%
R1291	315-0132-00			1.3 kΩ	¼ W	5%
R1292	315-0472-00	B010100	B149999	4.7 kΩ	¼ W	5%
R1292	315-0332-00	B150000		3.3 kΩ	¼ W	5%
R1300	315-0562-00			5.6 kΩ	¼ W	5%
R1302	315-0103-00			10 kΩ	¼ W	5%
R1304	315-0223-00			22 kΩ	¼ W	5%
R1306	315-0103-00			10 kΩ	¼ W	5%
R1307	315-0562-00			5.6 kΩ	¼ W	5%
R1310	315-0392-00	B010100	B149999	3.9 kΩ	¼ W	5%
R1310	317-0103-00	B150000		10 kΩ	⅛ W	5%
R1312	315-0392-00	B010100	B149999	3.9 kΩ	¼ W	5%
R1312	317-0103-00	B150000		10 kΩ	⅛ W	5%
R1314	315-0472-00	B010100	B149999	4.7 kΩ	¼ W	5%
R1314	317-0103-00	B150000		10 kΩ	⅛ W	5%
R1316	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1319	315-0752-00	XB150000		7.5 kΩ	¼ W	5%
R1320	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1322	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1324	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1326	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1330	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1332	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1334	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1336	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1340	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1342	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1344	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1346	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1350	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1352	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1354	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1356	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1370	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1372	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1374	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1376	317-0103-00	XB150000		10 kΩ	⅛ W	5%
R1401	315-0105-00			1 MΩ	¼ W	5%
R1402	315-0472-00			4.7 kΩ	¼ W	5%
R1404	315-0221-00			220 Ω	¼ W	5%
R1405	301-0100-00			10 Ω	½ W	5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R1410	315-0393-00			39 kΩ	¼ W		5%
R1412	315-0123-00			12 kΩ	¼ W		5%
R1414	315-0392-00			3.9 kΩ	¼ W		5%
R1420	308-0245-00			0.6 Ω	2 W	WW	5%
R1426	308-0245-00			0.6 Ω	2 W	WW	5%
R1430	315-0561-00			560 Ω	¼ W		5%
R1432	315-0103-00			10 kΩ	¼ W		5%
R1433	315-0183-00			18 kΩ	¼ W		5%
R1436	315-0101-00			100 Ω	¼ W		5%
R1453	301-0223-00			22 kΩ	½ W		5%
R1460	303-0685-00			6.8 MΩ	1 W		5%
R1461	315-0103-00	XB150000		10 kΩ	¼ W		5%
R1462	305-0825-00	B010100	B019999	8.2 MΩ	2 W		5%
R1462	305-0755-00	B020000		7.5 MΩ	2 W		5%
R1463	305-0825-00			8.2 MΩ	2 W		5%
R1464	305-0825-00			8.2 MΩ	2 W		5%
R1465	311-0647-00			5 MΩ, Var			
R1467	303-0395-00	B010100	B019999	3.9 MΩ	1 W		5%
R1467	303-0475-00	B020000		4.7 MΩ	1 W		5%
R1468	316-0105-00			1 MΩ	¼ W		
R1469	311-0314-01			2 MΩ, Var			
R1470	311-0086-00			2.5 kΩ, Var			
R1472	311-0366-00			500 kΩ, Var			
R1474	311-0475-00			5 kΩ, Var			
R1476	311-0366-00			500 kΩ, Var			
R1478	311-0357-00			10 kΩ, Var			
R1480	316-0474-00			470 kΩ	¼ W		
R1483	308-0459-00			1.1 Ω	3 W	WW	5%
R1484	316-0104-00			100 kΩ	¼ W		
R1485	316-0103-00			10 kΩ	¼ W		
R1490	316-0105-00			1 MΩ	¼ W		
R1492	316-0105-00			1 MΩ	¼ W		
R1502	304-0393-00			39 kΩ	1 W		
R1510	301-0623-00			62 kΩ	½ W		5%
R1511	301-0823-00			82 kΩ	½ W		5%
R1513	304-0101-00			100 Ω	1 W		
R1515	306-0393-00			39 kΩ	2 W		
R1522	323-0369-00			68.1 kΩ	½ W	Prec	1%
R1524	323-0345-00			38.3 kΩ	½ W	Prec	1%
R1532	304-0153-00			15 kΩ	1 W		
R1534	315-0100-00			10 Ω	¼ W		5%
R1540	305-0433-00			43 kΩ	2 W		5%
R1542	315-0182-00			1.8 kΩ	¼ W		5%
R1543	308-0460-00			56 Ω	3 W	WW	5%
R1545	315-0390-00			39 Ω	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R1547	306-0223-00			22 kΩ	2 W		
R1552	323-0328-00			25.5 kΩ	½ W	Prec	1%
R1554	321-0249-00			3.83 kΩ	⅛ W	Prec	1%
R1560	302-0270-00			27 Ω	½ W		
R1562	315-0103-00			10 kΩ	¼ W		5%
R1563	308-0405-00			70 Ω	3 W	WW	5%
R1564	311-0632-00			2 kΩ, Var			
R1572	315-0821-00			820 Ω	¼ W		5%
R1573	315-0471-00			470 Ω	¼ W		5%
R1574	315-0181-00			180 Ω	¼ W		5%
R1576	315-0101-00			100 Ω	¼ W		5%
R1578	315-0621-00			620 Ω	¼ W		5%
R1582	315-0101-00			100 Ω	¼ W		5%
R1584	321-0211-00			1.54 kΩ	⅛ W	Prec	1%
R1585	321-0193-00			1 kΩ	⅛ W	Prec	1%
R1587	315-0512-00			5.1 kΩ	¼ W		5%
R1588	311-0510-00	B010100	B319999	10 kΩ, Var			
R1588	311-1228-00	B320000		10 kΩ, Var			
R1590	305-0203-00			20 kΩ	2 W		5%
R1592	315-0202-00			2 kΩ	¼ W		5%
R1594	315-0470-00			47 Ω	¼ W		5%
R1600	315-0101-00			100 Ω	¼ W		5%
R1604	308-0388-00			47 Ω	3 W	WW	5%
R1610	315-0911-00			910 Ω	¼ W		5%
R1614	301-0821-00			820 Ω	½ W		5%
R1622	321-0202-00			1.24 kΩ	⅛ W	Prec	1%
R1624	321-0219-00			1.87 kΩ	⅛ W	Prec	1%

Switches

Ckt. No.	Unwired or Wired	Description	
SW5	*260-0916-00	Push	CH A
SW55	*260-0917-00	Push	CH B
SW130	260-0583-01	Slide	SYNC
SW510 [12]	260-0880-00	3 Function Button	A ϕ
SW515			B ϕ
SW520			A ϕ/B ϕ ALT
SW210	260-0893-00	5 Function Button (Bottom)	Line Sweep
SW530			dA
SW550			I
SW552			Q
SW570			d ϕ
SW30	260-0892-00	5 Function Button (Top)	VECTOR
SW700			G
SW710			R
SW720			B
SW730			Y

[12]Furnished as a unit with SW1310, SW1312 and SW1314.

Switches *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
SW305	260-0642-00			Toggle	ϕ REF
SW403[13]	311-0685-00				
SW405	260-0894-00	B010100	B149999	Lever	CH A 100%-75%-MAX GAIN
SW405	260-0894-01	B150000		Lever	CH A 100%-75%-MAX GAIN
SW413[14]	311-0685-00				
SW415	260-0894-00	B010100	B149999	Lever	CH B 100%-75%-MAX GAIN
SW415	260-0894-01	B150000		Lever	CH B 100%-75%-MAX GAIN
SW685[15]	311-0656-00	B010100	B259999		
SW685[15]	311-1080-00	B260000			
SW1305	260-0583-01			Slide	FIELD
SW1310 [16]					VITS 18
SW1312 [16]	260-0880-00			3 Function Button	VITS 19
SW1314 [16]					FULL FIELD
SW1500	260-0834-00			Toggle	POWER ON
SW1502[17]					
SW1503[17]					

Thermal Cutout

TK280[18]					

Test Points

TP41	*214-0579-00			Pin, Test Point	
TP49	*214-0579-00			Pin, Test Point	
TP80	*214-0579-00			Pin, Test Point	
TP85	*214-0579-00			Pin, Test Point	
TP90	*214-0579-00			Pin, Test Point	
TP95	*214-0579-00			Pin, Test Point	
TP110	*214-0579-00			Pin, Test Point	
TP130	*214-0579-00			Pin, Test Point	
TP140	*214-0579-00			Pin, Test Point	
TP141	*214-0579-00			Pin, Test Point	
TP205	*214-0579-00	B010100	B249999	Pin, Test Point	
TP205	131-0633-00	B250000		Terminal, Pin	
TP212	*214-0579-00			Pin, Test Point	
TP220	*214-0579-00			Pin, Test Point	
TP222	*214-0579-00			Pin, Test Point	
TP230	*214-0579-00			Pin, Test Point	
TP250	*214-0579-00			Pin, Test Point	
TP252	*214-0579-00			Pin, Test Point	
TP255	*214-0579-00			Pin, Test Point	
TP270	*214-0579-00			Pin, Test Point	
TP275	*214-0579-00			Pin, Test Point	

[13]Furnished as a unit with R403.

[14]Furnished as a unit with R413.

[15]Furnished as a unit with R685.

[16]Furnished as a unit with SW510, SW515 and SW520.

[17]See Mechanical Parts List. Line Voltage Selector (*204-0279-00).

[18]Furnished as a unit with partial Oven Assembly (*205-0083-01).

Test Points *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TP285	*214-0579-00			Pin, Test Point
TP295	*214-0579-00			Pin, Test Point
TP320	*214-0579-00			Pin, Test Point
TP325	*214-0579-00			Pin, Test Point
TP340	*214-0579-00			Pin, Test Point
TP345	*214-0579-00			Pin, Test Point
TP450	*214-0579-00			Pin, Test Point
TP460	*214-0579-00			Pin, Test Point
TP471	*214-0579-00			Pin, Test Point
TP502	*214-0579-00			Pin, Test Point
TP510	*214-0579-00			Pin, Test Point
TP514	*214-0579-00			Pin, Test Point
TP515	*214-0579-00			Pin, Test Point
TP530	*214-0579-00			Pin, Test Point
TP565	*214-0579-00			Pin, Test Point
TP575	*214-0579-00			Pin, Test Point
TP576	*214-0579-00			Pin, Test Point
TP583	*214-0579-00	XB150000		Pin, Test Point
TP590	*214-0579-00			Pin, Test Point
TP598	*214-0579-00	B010100	B149999X	Pin, Test Point
TP620	*214-0579-00			Pin, Test Point
TP630	*214-0579-00			Pin, Test Point
TP640	*214-0579-00			Pin, Test Point
TP650	*214-0579-00			Pin, Test Point
TP660	*214-0579-00			Pin, Test Point
TP670	*214-0579-00			Pin, Test Point
TP680	*214-0579-00			Pin, Test Point
TP690	*214-0579-00			Pin, Test Point
TP691	*214-0579-00			Pin, Test Point
TP770	*214-0579-00			Pin, Test Point
TP772	*214-0579-00			Pin, Test Point
TP774	*214-0579-00			Pin, Test Point
TP776	*214-0579-00			Pin, Test Point
TP805	*214-0579-00			Pin, Test Point
TP820	*214-0579-00			Pin, Test Point
TP830	*214-0579-00			Pin, Test Point
TP835	*214-0579-00			Pin, Test Point
TP870	*214-0579-00			Pin, Test Point
TP880	*214-0579-00			Pin, Test Point
TP890	*214-0579-00			Pin, Test Point
TP900	*214-0579-00			Pin, Test Point
TP905	*214-0579-00			Pin, Test Point
TP913	*214-0579-00			Pin, Test Point
TP920	*214-0579-00			Pin, Test Point
TP950	*214-0579-00			Pin, Test Point

Test Points (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TP955	*214-0579-00			Pin, Test Point
TP980	*214-0579-00			Pin, Test Point
TP990	*214-0579-00			Pin, Test Point
TP1101	*214-0579-00			Pin, Test Point
TP1120	*214-0579-00			Pin, Test Point
TP1130	*214-0579-00			Pin, Test Point
TP1140	*214-0579-00			Pin, Test Point
TP1152	*214-0579-00			Pin, Test Point
TP1153	*214-0579-00			Pin, Test Point
TP1162	*214-0579-00			Pin, Test Point
TP1164	*214-0579-00			Pin, Test Point
TP1170	*214-0579-00			Pin, Test Point
TP1190	*214-0579-00			Pin, Test Point
TP1200	*214-0579-00			Pin, Test Point
TP1205	*214-0579-00			Pin, Test Point
TP1215	*214-0579-00			Pin, Test Point
TP1216	*214-0579-00			Pin, Test Point
TP1220	*214-0579-00			Pin, Test Point
TP1230	*214-0579-00	B010100	B149999X	Pin, Test Point
TP1260	*214-0579-00			Pin, Test Point
TP1265	*214-0579-00			Pin, Test Point
TP1270	*214-0579-00			Pin, Test Point
TP1280	*214-0579-00			Pin, Test Point
TP1285	*214-0579-00			Pin, Test Point
TP1289	*214-0579-00			Pin, Test Point
TP1290	*214-0579-00			Pin, Test Point
TP1405	*214-0579-00			Pin, Test Point
TP1410	*214-0579-00			Pin, Test Point
TP1412	*214-0579-00			Pin, Test Point
TP1430	*214-0579-00			Pin, Test Point
TP1432	*214-0579-00			Pin, Test Point
TP1510	*214-0579-00			Pin, Test Point
TP1515	*214-0579-00			Pin, Test Point
TP1540	*214-0579-00			Pin, Test Point
TP1545	*214-0579-00			Pin, Test Point
TP1570	*214-0579-00			Pin, Test Point
TP1580	*214-0579-00			Pin, Test Point
TP1590	*214-0579-00			Pin, Test Point
TP1600	*214-0579-00			Pin, Test Point
TP1610	*214-0579-00			Pin, Test Point
TP1620	*214-0579-00			Pin, Test Point

Transformers

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
T45	*120-0528-00			Toroid, two 22 turn windings
T205	*120-0525-00			Toroid, 7 turns, quadfilar
T235	*120-0529-00			Toroid, 24 turns, trifilar
T355[19]				
T365[20]				

[19]Furnished as a unit with CH A Goniometer (*119-0133-00).
[20]Furnished as a unit with CH B Goniometer (*119-0133-00).

Transformers *(Cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
T500	*120-0527-00			Toroid, 12 turns, bifilar
T508	*120-0526-00			Toroid, 12 turns, quadfilar
T590	*120-0526-00			Toroid, 12 turns, quadfilar
T598	*120-0526-00			Toroid, 12 turns, quadfilar
T695	*120-0524-00			Toroid, 12 turns, quadfilar
T1140	*120-0525-00			Toroid, 7 turns, quadfilar
T1450	*120-0523-00			H.V. Power
T1501	*120-0498-00			L.V. Power

Integrated Circuits

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
U510	156-0012-00			Clocked J-K Flipflop Replaceable by Fairchild µL923
U511	156-0012-00			Clocked J-K Flipflop Replaceable by Fairchild µL923
U1310	156-0012-00			Clocked J-K Flipflop Replaceable by Fairchild µL923
U1320	156-0012-00			Clocked J-K Flipflop Replaceable by Fairchild µL923
U1330	156-0012-00			Clocked J-K Flipflop Replaceable by Fairchild µL923
U1340	156-0012-00			Clocked J-K Flipflop Replaceable by Fairchild µL923
U1350	156-0012-00			Clocked J-K Flipflop Replaceable by Fairchild µL923
U1370	156-0012-00	XB150000		Clocked J-K Flipflop Replaceable by Fairchild µL923

Electron Tube

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
V1470	*154-0513-00			T5201-31-4 CRT Standard Phosphor

Crystals

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
Y40	158-0038-00			3.59 MHz
Y260	158-0036-00			3.59 MHz

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
  Detail Part of Assembly and/or Component
  mounting hardware for Detail Part
    Parts of Detail Part
    mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

SECTION 8
MECHANICAL PARTS LIST

FIG. 1 FRONT

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-1	333-1011-01			1	PANEL, front
	- - - - - - -			-	mounting hardware: (not included w/panel)
-2	213-0055-00			4	SCREW, thread forming, 2-32 x 3/16 inch, PHS
-3	333-1010-00			1	PANEL, right insert
	- - - - - -			-	mounting hardware: (not included w/panel)
-4	211-0507-00			3	SCREW, 6-32 x 5/16 inch, PHS
-5	333-1009-00			1	PANEL, left insert
	- - - - - -			-	mounting hardware: (not included w/panel)
	211-0507-00			4	SCREW, 6-32 x 5/16 inch, PHS
-6	200-0797-01	B010100	B039999	1	BEZEL, graticule
	200-0797-03	B040000	B319999	1	BEZEL, graticule
	200-0797-07	B320000		1	BEZEL, graticule
	- - - - - -			-	bezel includes:
	348-0131-00	B010100	B199999X	4	PAD, cushioning
-7	355-0120-01	B010100	B039999X	4	STUD, snap fastener
	- - - - - -			-	mounting hardware for each: (not included w/stud)
-8	213-0173-00	B010100	B039999X	1	SCREW, thread forming, #6 x 3/8 inch, PHS
-9	378-0581-00			1	FILTER, light, smokey gray
-10	331-0190-00			1	GRATICULE
-11	331-0191-00	B010100	B199999	1	MASK, graticule
	331-0191-01	B200000		2	MASK, graticule
-12	386-1303-00			1	LIGHT CONDUCTOR, graticule illumination
-13	136-0265-01	B010100	B039999	4	SOCKET, snap fastener
	213-0190-00	B040000		4	THUMBSCREW, 1/4-20 x 1.369 inch long
-14	366-0479-00			1	KNOB, pushbutton—CH A
-15	366-0470-00			1	KNOB, pushbutton—VITS 18
-16	366-0472-00			1	KNOB, pushbutton—FULL FIELD
-17	366-0469-00			1	KNOB, pushbutton—VITS 19
-18	366-0478-00			1	KNOB, pushbutton—CH B
-19	366-0461-00			1	KNOB, pushbutton—A CAL
-20	366-0467-00			1	KNOB, pushbutton—Aϕ
-21	366-0468-00			1	KNOB, pushbutton—Aϕ Bϕ ALT.
-22	366-0466-00			1	KNOB, pushbutton—Bϕ
-23	366-0462-00			1	KNOB, pushbutton—B CAL
-24	366-0480-00			1	KNOB, pushbutton—VECTOR
-25	366-0474-00			1	KNOB, pushbutton—Y
-26	366-0473-00			1	KNOB, pushbutton—R
-27	366-0475-00			1	KNOB, pushbutton—G
-28	366-0477-00			1	KNOB, pushbutton—B
-29	366-0465-00			1	KNOB, pushbutton—DIFF PHASE
-30	366-0464-00			1	KNOB, pushbutton—DIFF GAIN
-31	366-0463-00			1	KNOB, pushbutton—Q
-32	366-0476-00			1	KNOB, pushbutton—I
-33	366-0471-00			1	KNOB, pushbutton—LINE SWEEP
-34	366-0435-00	B010100	B089999	1	KNOB, gray—CALIBRATED PHASE
	366-1024-00	B090000		1	KNOB, gray—CALIBRATED PHASE
	- - - - - -			-	knob includes:
	213-0153-00			2	SCREW, set, 5-40 x 1/8 inch HSS

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-35	119-0152-00			1	ASSEMBLY, precision phase shifter
	- - - - - -			-	assembly includes:
-36	331-0189-00			1	LENS, tape, dial
	- - - - - -			-	mounting hardware: (not included w/lens)
-37	211-0105-00			2	SCREW, 4-40 x 3/16 inch, FHS
-38	386-1290-00			1	PLATE, mounting
-39	407-0386-00			1	BRACKET, dial mounting
	- - - - - -			-	mounting hardware: (not included w/bracket)
-40	211-0139-00			1	SCREW, 5-40 x 4 13/16 inches, RHS
-41	211-0138-00			2	SCREW, 5-40 x 2 9/16 inches, RHS
-42	361-0165-00			3	SPACER, sleeve, 0.155 OD x 7/8 inch long
-43	361-0167-00			3	SPACER, sleeve, 0.155 OD x 1 3/8 inches
-44	361-0166-00			1	SPACER, sleeve, 0.155 OD x 2 1/4 inches long
-45	210-0449-00			3	NUT, hex., 5-40 x 1/4 inch
-46	331-0188-00			1	DIAL, tape
-47	401-0042-00			2	BEARING, sleeve
	- - - - - -			-	mounting hardware for each: (not included w/bearing)
-48	210-1043-00			1	WASHER, plastic, 0.253 IDx 5/8 inch OD
-49	386-1299-00			1	PLATE, retaining
	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD
-50	354-0233-00			1	RING, retaining
-51	384-0678-00			1	SHAFT, 1/4 OD x 1.45 inches long
-52	214-0953-00			1	GEAR, spur
	- - - - - -			-	gear includes:
	213-0075-00			4	SCREW, set, 4-40 x 3/32 inch
-53	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-54	211-0065-00			2	SCREW, 4-40 x 3/16 inch, PHS
	358-0042-00	XB020000		1	BUSHING, plastic
	210-0269-00	XB020000		1	LUG, terminal
-55	- - - - - -			2	COIL, w/mounting hardware
	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-56	131-0372-00			2	CONNECTOR, coaxial, w/hardware
-57	441-0751-00			1	CHASSIS
-58	337-0957-00			1	SHIELD
	- - - - - -			-	mounting hardware: (not included w/shield)
-59	213-0055-00			8	SCREW, thread forming, 2-32 x 3/16 inch, PHS
-60	129-0098-00			2	POST, hex., 1/4 inch diameter x 0.406 inch long
	- - - - - -			-	mounting hardware for each: (not included w/post)
-61	210-0004-00			1	LOCKWASHER, internal #4
-62	211-0008-00			1	SCREW, 4-40 x 1/4 inch, PHS
	- - - - - -			-	mounting hardware: (not included w/assembly)
	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-63	210-0978-00			1	WASHER, flat, 3/8 ID x 1/2 inch OD
-64	210-0590-00			1	NUT, hex., 3/8-32 x 7/16 inch

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-65	366-0429-00			1	KNOB, gray—HORIZ POSITION
-66	366-0429-00			1	KNOB, gray—VERT POSITION
-67	366-0429-00			1	KNOB, gray—BURST FLAG TIMING
-68	366-0429-00			1	KNOB, gray—FOCUS
-69	260-0583-01			1	SWITCH, slide—FIELD
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0001-00			2	SCREW, 2-56 x 1/4 inch, RHS
	210-0405-00			2	NUT, hex., 2-56 x 3/16 inch
	210-0001-00			2	LOCKWASHER, internal #2
-70	260-0583-01			1	SWITCH, slide—SYNC
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0001-00			2	SCREW, 2-56 x 1/4 inch, RHS
	210-0405-00			2	NUT, hex., 2-56 x 3/16 inch
	210-0001-00			2	LOCKWASHER, internal #2
-71	366-0436-00	B010100	B089999	1	KNOB, gray—SCALE ILLUM
	366-0497-00	B090000		1	KNOB, gray—SCALE ILLUM
	- - - - - -			-	knob includes:
	213-0153-00			2	SCREW, set, 5-40 x 1/8 inch, HSS
-72	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-73	361-0143-00			1	SPACER, ring, 0.281 ID x 0.562 inch OD
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-74	260-0834-00			1	SWITCH, toggle—POWER ON
	- - - - - -			-	mounting hardware: (not included w/switch
-75	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0562-00			1	NUT, hex., 1/4-40 x 5/16 inch
-76	136-0223-00			1	SOCKET, light w/hardware
	- - - - - -			-	mounting hardware: (not included w/socket)
	210-0562-00			1	NUT, hex., 1/4-40 x 5/16 inch
	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-77	366-0435-00	B010100	B089999	1	KNOB, gray—INTENSITY
	366-1024-00	B090000		1	KNOB, gray—INTENSITY
	- - - - - -			-	knob includes:
	213-0153-00			2	SCREW, set, 5-40 x 1/8 inch, HSS
-78	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-79	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-80	210-0978-00			1	WASHER, flat, 3/8 ID x 1/2 inch OD
-81	210-0590-00			1	NUT, hex., 3/8-32 x 7/16 inch

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-82	200-0745-00			1	COVER, plastic, variable resistor
-83	366-0431-00			1	KNOB, gray—LUMINANCE GAIN
	- - - - - -			-	knob includes:
	213-0076-00			2	SCREW, set, 2-56 x 1/8 inch, HSS
-84	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-85	210-0583-00			2	NUT, hex., 1/4-32 x 5/16 inch
-86	407-0375-00			3	BRACKET, angle
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
-87	220-0413-00			2	NUT, hex., 4-40 x 3/16 x 0.562 inch long
-88	366-0482-00	B010100	B089999	1	KNOB, gray—PHASE (CH B)
	366-0498-00	B090000		1	KNOB, gray—PHASE (CH B)
	- - - - - -			-	knob includes:
	213-0153-00			2	SCREW, set, 5-40 x 1/8 inch, HSS
	- - - - - -			-	mounting hardware: (not included w/knob)
	210-1106-00	X272150		1	WASHER, spring tension
	210-0894-00	X272150		1	WASHER, plastic, 0.19 ID x 0.438 inch, OD
-89	119-0133-00			2	GONIOMETER, w/hardware
	- - - - - -			-	mounting hadware for each: (not included w/goniometer)
	220-0576-00	X272150		1	NUT, hex., 0.312-32 x 0.438 inch
-90	366-0482-00	B010100	B089999	1	KNOB, gray—PHASE (CH A)
	366-0498-00	B090000		1	KNOB, gray—PHASE (CH A)
	- - - - - -			-	knob includes:
	213-0153-00			2	SCREW, set, 5-40 x 1/8 inch, HSS
-91	366-0215-02			1	KNOB, gray—100% (CH A)
-92	260-0894-00	B010100	B149999	1	SWITCH, lever—100% (CH A)
	260-0894-01	B150000		1	SWITCH, lever—100% (CH A)
	- - - - - -			-	mounting hardware: (not included w/switch)
-93	220-0413-00			2	NUT, hex., 4-40 x 3/16 x 0.562 inch long
-94	366-0215-02			1	KNOB, gray—100% (CH B)
-95	260-0894-00	B010100	B149999	1	SWITCH, lever—100% (CH B)
	260-0894-01	B150000		1	SWITCH, lever—100% (CH B)
	- - - - - -			-	mounting hardware: (not included w/switch)
-96	220-0413-00			2	NUT, hex., 4-40 x 3/16 x 0.562 inch long
-97	366-0431-00			1	KNOB, gray—GAIN (CH A)
	- - - - - -			-	knob includes:
	213-0076-00			2	SCREW, set, 2-56 x 1/8 inch, HSS
-98	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-99	366-0431-00			1	KNOB, gray—GAIN (CH B)
	- - - - - -			-	knob includes:
	213-0076-00			2	SCREW, set, 2-56 x 1/8 inch, HSS

FIG. 1 FRONT (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5 Description
1-100	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-101	260-0916-00			1	SWITCH, pushbutton
	- - - - - -			-	mounting hardware: (not included w/switch)
-102	211-0541-00			1	SCREW, 6-32 x 1/4 inch, FHS
-103	260-0880-00			2	SWITCH, pushbutton
	- - - - - -			-	mounting hardware for each: (not included w/switch)
	211-0541-00			2	SCREW, 6-32 x 1/4 inch, FHS
-104	260-0917-00			1	SWITCH, pushbutton
	- - - - - -			-	mounting hardware: (not included w/switch)
-105	211-0541-00			1	SCREW, 6-32 x 1/4 inch, FHS
-106	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch, HHS
-107	260-0892-00			1	SWITCH, pushbutton
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0541-00			2	SCREW, 6-32 x 1/4 inch, FHS
-108	260-0893-00			1	SWITCH, pushbutton
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0541-00			2	SCREW, 6-32 x 1/4 inch, FHS
-109	124-0206-00			2	STRIP, trim, blue (Type 520 only)
-110	407-0377-01	B010100	B319999	2	BRACKET, handle (Type R520 only)
	407-0377-03	B320000		2	BRACKET, handle (Type R520 only)
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
-111	212-0560-00			2	SCREW, 10-32 x 5/16 inch, FHS
-112	333-1038-00	B010100	B319999	1	PANEL, front, right (Type R520 only)
	333-1630-00	B320000		1	PANEL, front, left (Type R520 only)
-113	367-0076-00			2	HANDLE, carrying (Type R520 only)
	- - - - - -			-	mounting hardware for each: (not included w/handle)
-114	212-0506-00			2	SCREW, 10-32 x 3/8 inch, FHS
-115	333-1039-00	B010100	B319999	1	INSERT, front panel, blank (Type R520 only)
	333-1630-00	B320000		1	INSERT, front panel, blank (Type R520 only)
-116	367-0073-00	B010100	B209999	1	HANDLE, carrying (Type 520 only)
	367-0073 01	B210000	B219999	1	HANDLE, carrying (Type 520 only)
	367-0073-02	B220000		1	HANDLE, carrying (Type 520 only)
	- - - - - -			-	mounting hardware: (not included w/handle)
-117	213-0155-00			4	SCREW, 10-32 x 0.40 inch long, machine (Type 520 only)
-118	386-1283-00			2	PLATE, plastic, mounting (Type 520 only)
-119	200-0728-00			2	COVER, plastic, handle (Type 520 only)
-120	386-1260-01	B010100	B319999	1	SUB-PANEL, front
	386-1260-04	B320000		1	SUB-PANEL, front

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-121	200-0761-01	B010100	B169999	2	DOOR, access panel
	200-0873-00	B170000		2	DOOR, access panel
-122	426-0370-00	B010100	B169999X	2	FRAME, door guide
	- - - - - -			-	mounting hardware for each: (not included w/frame)
	211-0507-00	B010100	B169999X	2	SCREW, 6-32 x 5/16 inch, PHS
-123	351-0136-00	B010100	B169999	2	GUIDE, door
	- - - - - -			-	mounting hardware for each: (not included w/guide)
-124	211-0007-00	B010100	B169999	1	SCREW, 4-40 x 3/16 inch, PHS
	351-0148-00	B170000		2	TRACK, top right, bottom left
	351-0149-00	B170000		2	TRACK, top left, bottom right
-125	105-0067-00	B010100	B169999X	2	CATCH, friction
-126	214-0239-00			2	FASTENER, thumb screw (Type R520 only)
	- - - - - -			-	mounting hardware for each: (not included w/fastener)
-127	210-0917-00			2	WASHER, plastic, 0.191 ID x 0.625 inch OD
-128	354-0025-00			1	RING, snap
-129	358-0301-00			2	BUSHING, plastic, gray
-130	407-0394-00			1	BRACKET, angle
	- - - - - -			-	mounting hardware: (not included w/bracket)
	212-0518-00			2	SCREW, 10-32 x 5/16 PHS
-131	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-132	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-133	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-134	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-135	337-0972-00			2	SHIELD, light
-136	260-0642-00			1	SWITCH, toggle—ϕ REF
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
	210-0490-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0562-00			1	NUT, hex., 1/4-40 x 3/16 inch

FIG. 2 CRT SHIELD, HIGH VOLTAGE & CHASSIS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
2-1	441-0741-00	B010100	B269999	1	CHASSIS, main
	441-0741-01	B270000		1	CHASSIS, main
	- - - - - -			-	mounting hardware: (not included w/chassis)
	212-0043-00			4	SCREW, 8-32 x 1/2 inch, FHS
	212-0070-00			8	SCREW, 8-32 x 5/16 inch, FHS
-2	407-0370-00			1	BRACKET, capacitor
	- - - - - -			-	mounting hardware: (not included w/bracket)
-3	212-0001-00			6	SCREW, 8-32 x 1/4 inch, PHS
-4	344-0118-00			6	CLIP, capacitor mounting
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-5	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-6	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-7	386-1259-00			1	PLATE, chassis support
	- - - - - -			-	mounting hardware: (not included w/plate)
	212-0004-00			3	SCREW, 8-32 x 5/16 inch, PHS
	212-0040-00			2	SCREW, 8-32 x 3/8 inch, FHS
-8	210-0458-00			5	NUT, keps, 8-32 x 11/32 inch
-9	348-0063-00			5	GROMMET, plastic, 1/2 inch diameter
-10	348-0050-00			2	GROMMET, plastic, 3/4 inch diameter
-11	348-0031-00			1	GROMMET, plastic, 3/32 inch diameter
-12	348-0055-00			1	GROMMET, plastic, 1/4 inch diameter
-13	348-0141-00			1	GROMMET, plastic, "U" shaped
-14	344-0143-00			40	CLIP, circuit board mounting
	- - - - - -			-	mounting hardware for each: (not included w/clip)
-15	213-0088-00			1	SCREW, thread forming, #4 x 1/4 inch, PHS
-16	- - - - - -			4	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-17	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-18	358-0075-00			1	BUSHING, panel
-19	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-20	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-21	358-0075-00			1	BUSHING, panel
-22	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer)
-23	212-0515-00			4	SCREW, 10-32 x 2 1/4 inches, HHS
-24	210-0812-00			4	WASHER, fiber, 3/16 ID x 3/8 inch OD
-25	220-0410-00			4	NUT, keps, 10-32 x 3/8 inch

FIG. 2 CRT SHIELD, HIGH VOLTAGE & CHASSIS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
2-26	337-0888-00			1	SHIELD, high voltage box
-27	621-0430-00			1	ASSEMBLY, high voltage
	- - - - - -			-	assembly includes:
-28	380-0115-00			1	HOUSING, high voltage
-29	670-0543-00			1	ASSEMBLY, circuit board—H.V. #2
	- - - - - -			-	assembly includes:
	388-0883-00			1	BOARD, circuit
	- - - - - -			-	mounting hardware: (not included w/assembly)
-30	211-0097-00	B010100	B080559	4	SCREW, 4-40 x 5/16 inch, PHS
	211-0040-00	B080560		4	SCREW, 4-40 x 1/4, BH plastic
-31	361-0137-00			4	SPACER, 1/4 OD x 1.39 inches long
-32	670-0542-00			1	ASSEMBLY, circuit board—H.V. #1
	- - - - - -			-	assembly includes:
	388-0887-00			1	BOARD, circuit
	- - - - - -			-	mounting hardware: (not included w/assembly)
-33	211-0097-00	B010100	B080559	4	SCREW, 4-40 x 5/16 inch, PHS
	211-0040-00	B080560		4	SCREW, 4-40 x 1/4, BH plastic
-34	166-0319-00			3	SLEEVE, plastic
-35	166-0368-00			1	SLEEVE, plastic, anode lead
-36	200-0714-00			1	COVER, plastic, high voltage
	- - - - - -			-	mounting hardware: (not included w/cover)
-37	211-0537-00			1	SCREW, 6-32 x 3/8 inch, THS
-38	211-0545-00			2	SCREW, 6-32 x 1 1/4 inches, THS
-39	136-0272-00			1	CABLE HARNESS, CRT
	- - - - - -			-	cable harness includes:
-40	136-0202-00			1	SOCKET, CRT, 14 pin
-41	179-1218-00			1	CABLE HARNESS, high voltage
	- - - - - -			-	mounting hardware: (not included w/assembly)
-42	211-0507-00			3	SCREW, 6-32 x 5/16 inch, PHS
-43	200-0616-00			1	COVER, plastic, CRT socket
-44	337-0945-01			1	SHIELD, cathode ray tube
	- - - - - -			-	mounting hardware: (not included w/shield)
-45	211-0537-00			4	SCREW, 6-32 x 3/8 inch, THS
	211-0596-00			2	SCREW, 6-32 x 3/8 inch, PHB
	210-0803-00			6	WASHER, flat, 0.150 ID x 3/8 inch OD
-46	348-0085-00			1	GROMMET, plastic, "U" shaped
-47	343-0131-00			1	CLAMP, coil form
	- - - - - -			-	mounting hardware: (not included w/clamp)
-48	211-0534-00			2	SCREW, sems, 6-32 x 5/16 inch, PHS
-49	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-50	352-0091-01			2	HOLDER, CRT retainer
	- - - - - -			-	mounting hardware for each: (not included w/holder)
-51	211-0590-00			2	SCREW, 6-32 x 1/4 inch, PHS

FIG. 2 CRT SHIELD, HIGH VOLTAGE & CHASSIS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-52	343-0123-00			2	CLAMP, CRT retainer
-53	211-0600-00			1	SCREW, 6-32 x 2 inches, FIL HS
-54	220-0444-00			1	NUT, square, 6-32 x 1/4 inch
-55	343-0124-00			1	CLAMP, plastic, retainer
	- - - - - -			-	mounting hardware: (not included w/clamp)
-56	211-0599-00			1	SCREW, 6-32 x 3/4 inch, FIL HS
-57	220-0444-00			1	NUT, square, 6-32 x 1/4 inch
-58	343-0122-01			2	CLAMP, CRT shield
	- - - - - -			-	mounting hardware for each: (not included w/clamp)
	211-0537-00			1	SCREW, 6-32 x 3/8 inch, THS
	210-0949-00			2	WASHER, flat, 9/64 ID x 1/2 OD x 1/16 inch thick
-59	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-60	136-0035-00			4	SOCKET, graticule lights
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-61	211-0534-00			1	SCREW, sems, 6-32 x 5/16 inch, PHS
-62	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD
-63	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-64	136-0264-00			2	SOCKET, light
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	211-0116-00			1	SCREW, sems, 4-40 x 5/16 inch, PHS
	210-0801-00			1	WASHER, flat, 0.140 ID x 0.281 inch OD
-65	210-0586-00			1	NUT, keps, 4-40 x 1/4 inch
-66	- - - - - -			1	COIL, beam rotating
	- - - - - -			-	mounting hardware: (not included w/coil)
-67	213-0088-00			1	SCREW, thread forming, 4-40 x 1/4 inch, PHS
-68	354-0321-00			1	RING, CRT shockmount
-69	179-1221-00	B010100	B149999	1	CABLE HARNESS, main chassis
	179-1221-01	B150000		1	CABLE HARNESS, main chassis
-70	179-1220-00	B010100	B149999	1	CABLE HARNESS, power
	179-1220-01	B150000		1	CABLE HARNESS, power
-71	344-0111-00			2	CLIP, plastic deflection plate
-72	179-0588-00			1	WIRE, CRT lead, striped orange white, 5 1/2 inch w/connector
	179-0641-00			1	WIRE, CRT lead, striped brown, 3 inch w/connector
	179-0642-00			1	WIRE, CRT lead, striped blue, 4 inch w/connector
	179-0705-00			1	WIRE, CRT lead, striped green, 6 inch w/connector
	179-0706-00			1	WIRE, CRT lead, striped red, 5 inch w/connector
-73	210-0201-00			1	LUG, solder, SE #4
	- - - - - -			-	mounting hardware: (not included w/lug)
	213-0004-00			1	SCREW, thread forming, 5-32 x 3/16 PHS
-74	200-0174-00			1	COVER, plastic, screw
-75	343-0088-00			2	CLAMP, plastic, small
-76	343-0089-00			5	CLAMP, plastic, large

FIG. 3 CIRCUIT BOARDS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
3-	670-0353-00	XB250000	B279999	1	ASSEMBLY, circuit board—SCR LIMITER
	670-0353-01	B280000		1	ASSEMBLY, circuit board—SCR LIMITER
	- - - - - -			-	assembly includes:
	388-1685-00	B250000	B279999	1	BOARD, circuit
	388-1685-01	B280000		1	BOARD, circuit
	131-0589-00			2	TERMINAL, pin, 0.50 inch long
	136-0220-00			2	SOCKET, transistor, 3 pin, square
	136-0263-03	B250000	B279999	4	SOCKET, connector pin
	136-0327-01	B280000		4	SOCKET, connector pin
-1	670-0544-00	B010100	B149999	1	ASSEMBLY, circuit board—SCR
	670-0544-01	B150000	B249999	1	ASSEMBLY, circuit board—SCR
	670-0544-02	B250000		1	ASSEMBLY, circuit board—SCR
	- - - - - -			-	assembly includes:
	388-0878-00	B010100	B149999	1	BOARD, circuit
	388-0878-01	B150000	B249999	1	BOARD, circuit
	388-0878-02	B250000		1	BOARD, circuit
-2	352-0125-00			1	HOLDER, plastic, toroid, clear
-3	352-0134-00			1	HOLDER, plastic, toroid, black
-4	334-0143-00			4	CLIP, plastic, mounting
	- - - - - -			-	mounting hardware for each: (not included w/clip)
-5	211-0097-00			1	SCREW, 4-40 x 5/16 inch, PHS
	210-0589-00			1	NUT, hex., locking, 4-40 x 1/4 inch
-6	337-0950-00			1	SHIELD, electrical
-7	136-0220-00			10	SOCKET, transistor, 3 pin
-8	136-0235-00			1	SOCKET, transistor, 6 pin
-9	136-0183-00			2	SOCKET, transistor, 3 pin
-10	214-0269-00			2	HEAT SINK
-11	214-0506-00	B010100	B149999	26	PIN, test point
	214-0506-00	B150000		24	PIN, test point
-12	214-0579-00			14	PIN, connector, male
-13	131-0557-00	B010100	B14999	14	CONNECTOR, post
	131-0591-00	B150000		14	TERMINAL, pin
	119-0151-00			1	ASSEMBLY, crystal oven
	- - - - - -			-	assembly includes:
-14	200-0770-00			1	COVER, oven, outer
	- - - - - -			-	mounting hardware: (not included w/cover)
-15	210-0589-00			2	NUT, hex., locking, 6-32 x 5/16 inch
-16	214-0952-00			1	INSULATOR, oven, thermal
-17	200-0769-00			1	COVER, oven, liner
-18	348-0126-00			1	PAD, cushioning
-19	205-0083-01			1	ASSEMBLY, heater winding
-20	214-0951-00			1	INSULATOR, oven, thermal
-21	670-0548-00			1	ASSEMBLY, circuit board—oven mounting
	- - - - - -			-	assembly includes:
	388-0902-00			1	BOARD, circuit
-22	136-0263-00	B010100	B050389	14	SOCKET, pin connector
	136-0263-01	B050390		14	SOCKET, pin connector
-23	670-0547-00			1	ASSEMBLY, circuit board—CRYSTAL OVEN
	- - - - - -			-	assembly includes:
	388-0880-00	B010100	B229999	1	BOARD, circuit
	388-0880-02	B230000		1	BOARD, circuit
-24	136-0220-00			3	SOCKET, transistor, 3 pin
-25	136-0234-00			2	SOCKET, crystal
-26	214-0506-00			3	PIN, connector, male

FIG. 3 CIRCUIT BOARDS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
3-27	670-0537-00			1	ASSEMBLY, circuit board—OUTPUT AMPLIFIER
	- - - - - -			-	assembly includes:
	388-0890-00			1	BOARD, circuit
-28	136-0183-00			4	SOCKET, transistor, 3 pin
-29	136-0220-00			27	SOCKET, transistor, 3 pin
-30	136-0235-00			2	SOCKET, transistor, 6 pin
-31	214-0506-00			36	PIN, connector, male
-32	214-0579-00			19	PIN, test point
-33	214-0269-00			4	HEAT SINK, transistor
-34	670-0538-00			1	ASSEMBLY, circuit board—INPUT SYNC
	- - - - - -			-	assembly includes:
	388-0889-00			1	BOARD, circuit
	388-0889-00	B010100	B279999	1	BOARD, circuit
	388-0889-01	B280000		1	BOARD, circuit
-35	136-0220-00			6	SOCKET, transistor, 3 pin
-36	214-0506-00			45	PIN, connector, male
-37	214-0579-00			11	PIN, test point
-38	337-0950-00			2	SHIELD, electrical
-39	670-0539-00	B010100	B0149999	1	ASSEMBLY, circuit board—DEMODULATOR
	670-0539-01	B150000	B259999	1	ASSEMBLY, circuit board—DEMODULATOR
	670-0539-02	B260000	B289999	1	ASSEMBLY, circuit board—DEMODULATOR
	670-0539-03	B290000		1	ASSEMBLY, circuit board—DEMODULATOR
	- - - - - -			-	assembly includes:
	388-0877-00	B010100	B149999	1	BOARD, circuit
	388-0877-01	B150000		1	BOARD, circuit
	131-0557-00	XB150000	B160869	7	CONTACT, electrical
	131-0591-00	B160870		7	TERMINAL, pin
	344-0143-00	XB150000		2	CLIP, circuit board
	211-0597-00	XB150000		2	SCREW, 4-40 x 0.312 inch, PHS
	210-0589-00	XB150000		2	NUT, locking, 4-40 x 0.250 inch
-40	136-0220-00	B010100	B149999	27	SOCKET, transistor, 3 pin
	136-0220-00	B150000		29	SOCKET, transistor, 3 pin
-41	136-0235-00			4	SOCKET, transistor, 6 pin
-42	136-0237-00			2	SOCKET, transistor, 8 pin
-43	214-0506-00	B010100	B149999	49	PIN, connector, male
	214-0506-00	B150000		51	PIN, connector, male
-44	214-0579-00			13	PIN, test point
-45	337-0950-00			1	SHIELD, electrical
-46	352-0125-00			2	HOLDER, toroid
	352-0134-00			2	HOLDER, toroid
	337-1031-00	XB080000	B169999X	1	SHIELD, circuit board
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0504-00			2	SCREW, 6-32 x 0.25 inch, PHS
-47	670-0540-00	B010100	B149999	1	ASSEMBLY, circuit board—INPUT AMPLIFIER
	670-0540-01	B150000		1	ASSEMBLY, circuit board—INPUT AMPLIFIER
	- - - - - -			-	assembly includes:
	388-0888-00			1	BOARD, circuit
-48	136-0220-00			9	SOCKET, transistor, 3 pin
-49	352-0096-00			1	HOLDER, crystal
-50	214-0506-00			22	PIN, connector, male
-51	214-0579-00			6	PIN, test point
-52	337-0950-00			2	SHIELD, electrical
-53	352-0134-00			1	HOLDER, toroid
-54	136-0234-00			2	SOCKET, crystal

FIG. 3 CIRCUIT BOARDS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
3-55	670-0533-00	B010100	B149999	1	ASSEMBLY, circuit board—SWEEP
	670-0533-01	B150000	B259999	1	ASSEMBLY, circuit board—SWEEP
	670-0533-02	B260000	B289999	1	ASSEMBLY, circuit board—SWEEP
	670-0890-01	B290000		1	ASSEMBLY, circuit board—SWEEP
	- - - - - -			-	assembly includes:
	388-0882-00	B010100	B149999	1	BOARD, circuit
	388-0882-01	B150000		1	BOARD, circuit
	131-0566-00	XB150000		2	LINK, terminal
	136-0235-00	XB150000		1	SOCKET, transistor, 6 pin
-56	136-0183-00			1	SOCKET, transistor, 3 pin
-57	136-0220-00	B010100	B149999	24	SOCKET, transistor, 3 pin
	136-0220-00	B150000		26	SOCKET, transistor, 3 pin
-58	136-0237-00	B010100	B149999	5	SOCKET, transistor, 8 pin
	136-0237-00	B150000		6	SOCKET, transistor, 8 pin
-59	214-0506-00	B010100	B149999	68	PIN, connector, male
	214-0506-00	B150000		72	PIN, connector, male
-60	214-0579-00	B010100	B149999	24	PIN, test point
	214-0579-00	B150000		23	PIN, test point
-61	337-0950-00			1	SHIELD, electrical
-62	352-0125-00			1	HOLDER, toroid
-63	670-0536-00	B010100	B149999	1	ASSEMBLY, circuit board—DRIVER AMPLIFIER
	670-0536-01	B150000	B199999	1	ASSEMBLY, circuit board—DRIVER AMPLIFIER
	670-0536-02	B200000		1	ASSEMBLY, circuit board—DRIVER AMPLIFIER
	- - - - - -			-	assembly includes:
	388-0896-00	B010100	B189999	1	BOARD, circuit
	388-0896-01	B190000	B199999	1	BOARD, circuit
	388-0896-02	B020000	B209999	1	BOARD, circuit
	388-0896-03	B210000	B272069	1	BOARD, circuit
	388-0896-04	B272070		1	BOARD, circuit
-64	136-0220-00			9	SOCKET, transistor, 3 pin
-65	214-0506-00	B010100	B069999	31	PIN, connector, male
	214-0506-00	B070000		32	PIN, connector, male
-66	214-0579-00			9	PIN, test point
-67	352-0125-00			1	HOLDER, toroid
-68	670-0532-00	B010100	B269999	1	ASSEMBLY, circuit board—LOW VOLTAGE POWER SUPPLY
	670-0532-01	B270000		1	ASSEMBLY, circuit board—LOW VOLTAGE POWER SUPPLY
	- - - - - -			-	assembly includes:
	388-0879-00			1	BOARD, circuit
-69	136-0183-00			5	SOCKET, transistor, 3 pin
-70	136-0220-00			4	SOCKET, transistor, 3 pin
-71	136-0235-00			1	SOCKET, transistor, 6 pin
-72	210-0652-00			1	EYELET, gold plated
-73	214-0506-00			41	PIN, connector, male
-74	214-0579-00			10	PIN, test point
	- - - - - -			-	mounting hardware: (not included w/assembly)
	211-0116-00	XB270000		4	SCREW, sems, 4-40 x 0.312 inch, PHB

FIG. 3 CIRCUIT BOARDS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
3-75	670-0541-00			1	ASSEMBLY, circuit board—RECTIFIER
	- - - - - -			-	assembly includes:
	388-0881-00			1	BOARD, circuit
-76	214-0506-00			25	PIN, connector, male
-77	352-0031-00			3	HOLDER, fuse
	- - - - - -			-	mounting hardware for each: (not included w/holder)
-78	211-0012-00			1	SCREW, 4-40 x $^3/_8$ inch, PHS
	210-0994-00			1	WASHER, flat, #4
	210-0586-00			1	NUT, keps, 4-40 x $^1/_4$ inch
-79	670-0535-00			1	ASSEMBLY, circuit board—R-Y B-Y FILTER
	- - - - - -			-	assembly includes:
	388-0891-00			1	BOARD, circuit
-80	214-0506-00			8	PIN, connector, male
-81	670-0534-00			1	ASSEMBLY, circuit board—LUMINANCE FILTER
	- - - - - -			-	assembly includes:
	388-0876-00			1	BOARD, circuit
-82	214-0506-00			4	PIN, connector, male
-83	670-0613-00	XB150000		1	ASSEMBLY, circuit board—FEED BACK
	- - - - - -			-	assembly includes:
	388-1014-00			1	BOARD, circuit
-84	136-0263-00			1	SOCKET, connector pin
-85	337-0896-00			1	SHIELD

FIG. 4 REAR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5 Description
4-1	386-1252-00	B010100	B069999	1	PLATE, rear sub-panel
	386-1252-01	B070000		1	PLATE, rear sub-panel
	- - - - - -			-	mounting hardware: (not included w/plate)
-2	212-0069-00			10	SCREW, 8-32 x 1/4 inch, THS
-3	386-1254-00			2	PLATE, trim
	- - - - - -			-	mounting hardware for each: (not included w/plate)
-4	212-0506-00			2	SCREW, 10-32 x 3/8 inch, FHS
-5	426-0326-03			1	FRAME, section, cabinet, left rear
-6	426-0325-03			1	FRAME, section, cabinet, right rear
-7	124-0201-00			2	STRIP, trim, blue
-8	361-0159-00			1	SPACER, frame, right
-9	361-0160-00			1	SPACER, frame, left
-10	426-0373-00			1	FRAME, section, cabinet bottom
	- - - - - -			-	mounting hardware: (not included w/frame)
	212-0506-00			4	SCREW, 10-32 x 3/8 inch, FHS
-11	426-0374-00			1	FRAME, section, cabinet top
	- - - - - -			-	mounting hardware: (not included w/frame)
-12	212-0506-00			4	SCREW, 10-32 x 3/8 inch, FHS
-13	124-0188-00			1	STRIP, trim, blue (Type R520 only)
-14	441-0742-00			1	CHASSIS, Input Sync
	- - - - - -			-	mounting hardware: (not included w/chassis)
-15	211-0504-00			3	SCREW, 6-32 x 1/4 inch, PHS
	211-0537-00			3	SCREW, 6-32 x 3/8 inch, THS
-16	344-0143-00	B010100	B269999	6	CLIP, circuit board mounting
	344-0143-00	B270000		2	CLIP, circuit board mounting
	- - - - - -			-	mounting hardware for each: (not included w/clip)
-17	213-0088-00			1	SCREW, thread forming, #4 x 1/4 inch, PHS
-18	131-0171-00			1	CONNECTOR, motor base
	- - - - - -			-	mounting hardware: (not included w/connector)
	211-0542-00			2	SCREW, 6-32 x 5/16 inch, THS
	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
	210-0202-00			2	LUG, solder, SE #6
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-19	204-0279-00			1	BODY, line voltage selector
	- - - - - -			-	mounting hardware: (not included w/body)
-20	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
	210-0006-00			2	LOCKWASHER, internal #4
-21	200-0762-00			1	COVER, line voltage selector
	- - - - - -			-	cover includes:
-22	352-0102-00			2	HOLDER, fuse
	- - - - - -			-	mounting hardware for each: (not included w/holder)
-23	213-0088-00			2	SCREW, thread cutting, 4-40 x 1/4 inch

FIG. 4 REAR *(cont)*

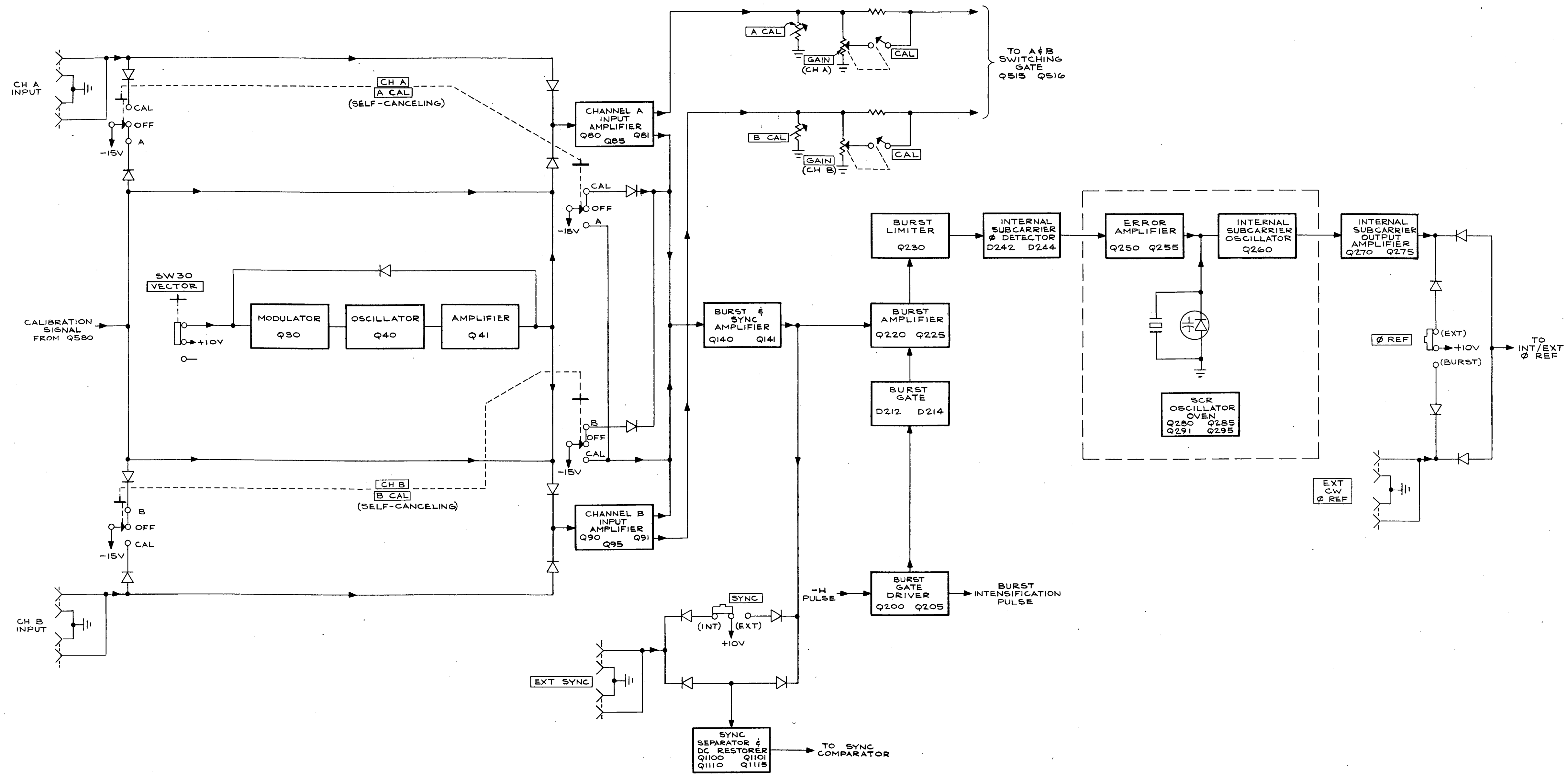
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
4-24	200-0777-00			1	COVER, CRT socket access
-25	- - - - - -			3	TRANSISTOR
	- - - - - -			-	mounting hardware for each: (not included w/transistor)
-26	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
-27	211-0511-00			1	SCREW, 6-32 x 1/2 inch, PHS
-28	200-0669-00			1	COVER, transistor
-29	386-0143-00			1	PLATE, insulating, mica
-30	210-0975-00			2	WASHER, shouldered, 0.140 ID x 3/8 inch OD
-31	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
-32	210-0202-00			1	LUG, solder, SE #6
-33	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-34	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
-35	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
	211-0513-00			1	SCREW, 6-32 x 5/8 inch, PHS
-36	200-0692-00			1	COVER, transistor
-37	386-0978-00			1	PLATE, insulating, mica
-38	210-0975-00			2	WASHER, shouldered, 0.140 ID x 3/8 inch OD
-39	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
-40	210-0202-00			1	LUG, solder, SE #6
-41	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-42	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
-43	210-0510-00			2	SCREW, 6-32 x 3/8 inch, PHS
-44	386-0978-00			1	PLATE, insulating, mica
	210-0975-00			2	WASHER, shouldered, 0.140 ID x 3/8 inch OD
	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
	210-0202-00			1	LUG, solder, SE #6
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-45	200-0805-00	B010100	B029999	1	COVER, transistor shield
	200-0500-00	B030000		1	COVER, transistor, black plastic
	- - - - - -			-	mounting hardware: (not included w/cover)
-46	211-0061-00			2	SCREW, 4-40 x 1/2 inch, FIL HS
-47	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-48	- - - - - -			3	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-49	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-50	210-0421-00			1	NUT, hex., 3/8-32 x 1/2 x 7/16 inch
-51	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-52	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-53	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
-54	210-0421-00			1	NUT, hex., 3/8-32 x 1/2 x 7/16 inch

FIG. 4 REAR *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
4-55	131-0081-00	B010100	B179999	5	CONNECTOR, 1 contact, UHF w/hardware
	131-0126-00	B180000		5	CONNECTOR, 1 contact, BNC w/hardware
-56	131-0081-00	B010100	B019999	4	CONNECTOR, 1 contact, UHF w/hardware
	131-0081-00	B020000	B179999	3	CONNECTOR, 1 contact, UHF w/hardware
	131-0126-00	B180000		4	CONNECTOR, 1 contact, BNC w/hardware
	- - - - - -			-	mounting hardware for each: (not included w/connector)
-57	210-0241-00			1	LUG, solder connector
	131-0302-00	B020000	B069999	1	CONNECTOR, 1 contact, UHF
	131-0320-00	B070000	B179999	1	CONNECTOR, 1 contact, UHF w/hardware
	131-0274-00	B180000		1	CONNECTOR, 1 contact, BNC w/hardware
	- - - - - -			-	mounting hardware: (not included w/connector)
	210-0207-00	B020000		1	LUG, solder, 3/8 inch
	210-0814-00	B020000		1	WASHER, fiber, 3/8 ID x 5/8 inch OD
	210-0865-00	B020000		1	WASHER, fiber, shouldered, 3/8 ID x 5/8 inch OD
	210-0255-00	B020000		1	LUG, solder, 3/8 inch
	210-0840-00	B020000		1	WASHER, flat, 0.390 ID x 9/16 inch OD
-58	200-0776-00			1	COVER, connector access
	- - - - - -			-	mounting hardware: (not included w/cover)
-59	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-60	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-61	385-0018-00			2	ROD, plastic, 5/16 x 1 1/4 inches
	- - - - - -			-	mounting hardware for each: (not included w/rod)
-62	211-0542-00			1	SCREW, 6-32 x 5/16 inch, THS
-63	343-0005-00			2	CLAMP, cable, 7/16 inch plastic
	- - - - - -			-	mounting hardware for each: (not included w/clamp)
-64	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD
-65	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-66	129-0006-00			3	POST, connecting, insulated
	- - - - - -			-	mounting hardware for each: (not included w/post)
-67	210-0401-00			1	NUT, cap, hex., 6-32 x 5/16 inch
-68	337-0993-00			1	SHIELD, electrical
-69	367-0073-00	B010100	B209999	1	HANDLE, carrying (Type 520 only)
	367-0073-01	B210000	B219999	1	HANDLE, carrying (Type 520 only)
	367-0073-02	B220000		1	HANDLE, carrying (Type 520 only)
	- - - - - -			-	mounting hardware: (not included w/handle)
-70	213-0155-00			4	SCREW, 10-32 x 0.40 inch long, machine (Type 520 only)
-71	386-1352-00			2	PLATE, plastic, mounting (Type 520 only)
-72	200-0728-00			2	COVER, plastic, handle (Type 520 only)
-73	179-1217-00			1	CABLE HARNESS, line voltage selector
-74	343-0088-00			1	CLAMP, plastic, small
-75	343-0089-00			1	CLAMP, plastic, large

FIG. 5 CABINET & FRAME

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
5-1	390-0010-00			1	CABINET, top
	- - - - - -			-	cabinet includes:
-2	214-0812-00			4	ASSEMBLY, latch
	- - - - - -			-	each assembly includes:
-3	214-0603-01			1	PIN, securing
-4	214-0604-00			1	SPRING
-5	386-0227-00			1	PLATE, plastic, index
-6	386-0226-00			1	PLATE, locking
-7	390-0011-00			1	CABINET, bottom
	- - - - - -			-	cabinet includes:
-8	214-0812-00			4	ASSEMBLY, latch
	- - - - - -			-	each assembly includes:
-9	214-0603-01			1	PIN, securing
-10	214-0604-00			1	SPRING
-11	386-0227-00			1	PLATE, plastic, index
-12	386-0226-00			1	PLATE, locking
-13	426-0372-00			1	FRAME, section, right
	- - - - - -			-	mounting hardware: (not included w/frame)
	212-0506-00			4	SCREW, 10-32 x 3/8 inch, FHS
-14	426-0371-00			1	FRAME, section, left
	- - - - - -			-	mounting hardware: (not included w/frame)
-15	212-0506-00			4	SCREW, 10-32 x 3/8 inch, FHS
-16	351-0104-00			1	SLIDE, section tilt type, 1 pair, (Type R520 only)
	- - - - - -			-	mounting hardware: (not included w/slide)
	212-0068-00			3	SCREW, 8-32 x 5/16 inch, THS
-17	348-0080-01			4	FOOT, plastic, (Type 520 only)
	- - - - - -			-	mounting hardware for each: (not included w/foot)
-18	211-0511-00			1	SCREW, 6-32 x 1/2 inch, PHS
-19	210-0006-00			1	LOCKWASHER, internal #6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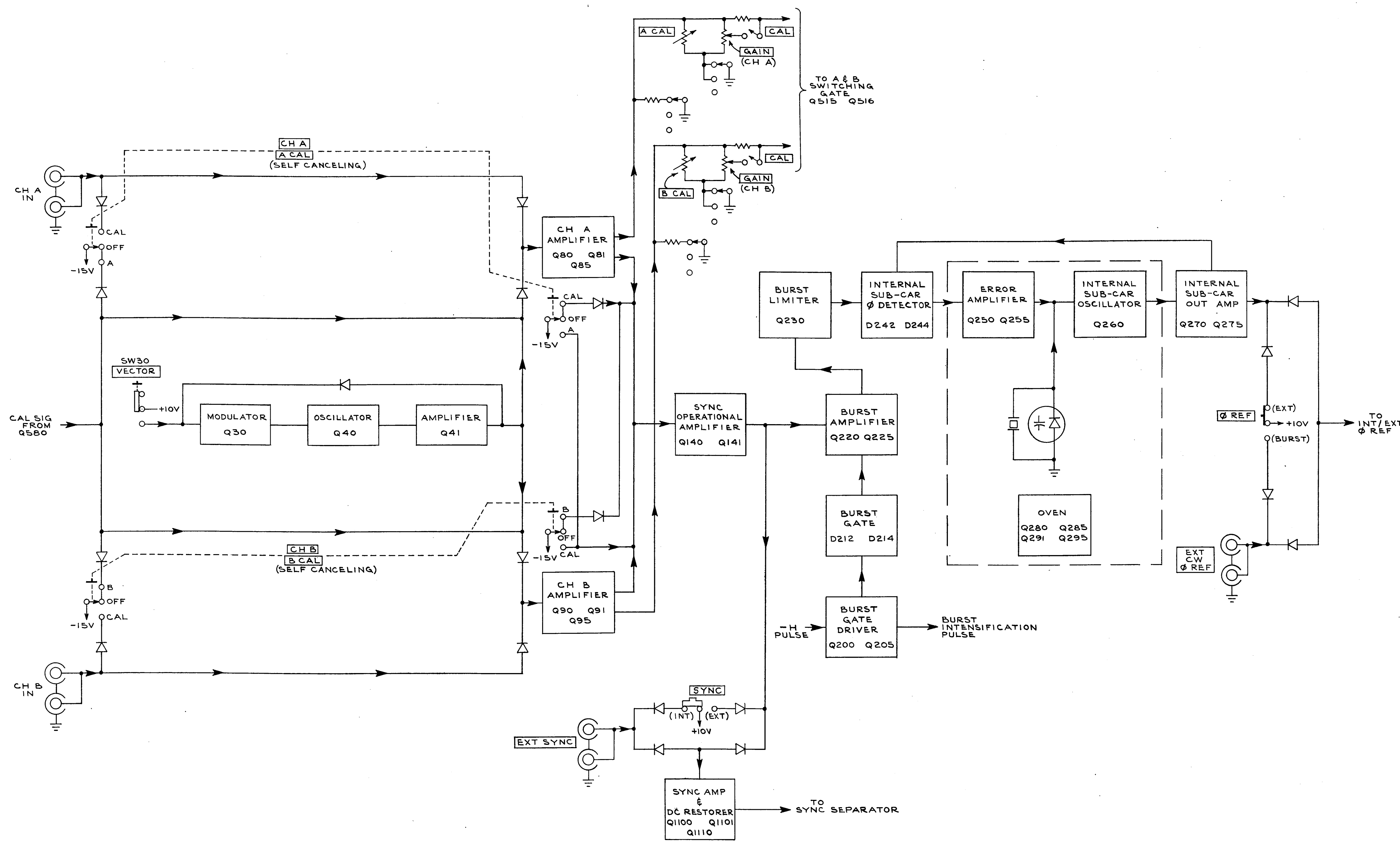
CH A
A CAL
(SELF-CANCELING)
CAL
OFF
A
-15V
A CAL
GAIN (CH A)
CAL
TO A & B SWITCHING GATE Q515 Q516
B CAL
GAIN (CH B)
CAL
CHANNEL A INPUT AMPLIFIER Q80 Q81 Q85
CAL
OFF
-15V
A
SW30 VECTOR
+10V
CALIBRATION SIGNAL FROM Q580
MODULATOR Q30
OSCILLATOR Q40
AMPLIFIER Q41
B
OFF
CAL
-15V
CH B
B CAL
(SELF-CANCELING)
B
OFF
CAL
-15V
CHANNEL B INPUT AMPLIFIER Q90 Q91 Q95
CH B INPUT
BURST & SYNC AMPLIFIER Q140 Q141
BURST LIMITER Q230
BURST AMPLIFIER Q220 Q225
BURST GATE D212 D214
BURST GATE DRIVER Q200 Q205
-H PULSE
BURST INTENSIFICATION PULSE
INTERNAL SUBCARRIER Ø DETECTOR D242 D244
ERROR AMPLIFIER Q250 Q255
INTERNAL SUBCARRIER OSCILLATOR Q260
SCR OSCILLATOR OVEN Q280 Q285 Q291 Q295
INTERNAL SUBCARRIER OUTPUT AMPLIFIER Q270 Q275
Ø REF
(EXT)
+10V
(BURST)
TO INT/EXT Ø REF
EXT CW Ø REF
SYNC
(INT)
(EXT)
+10V
EXT SYNC
SYNC SEPARATOR & DC RESTORER Q1100 Q1101 Q1110 Q1115
TO SYNC COMPARATOR

868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CH A
A CAL
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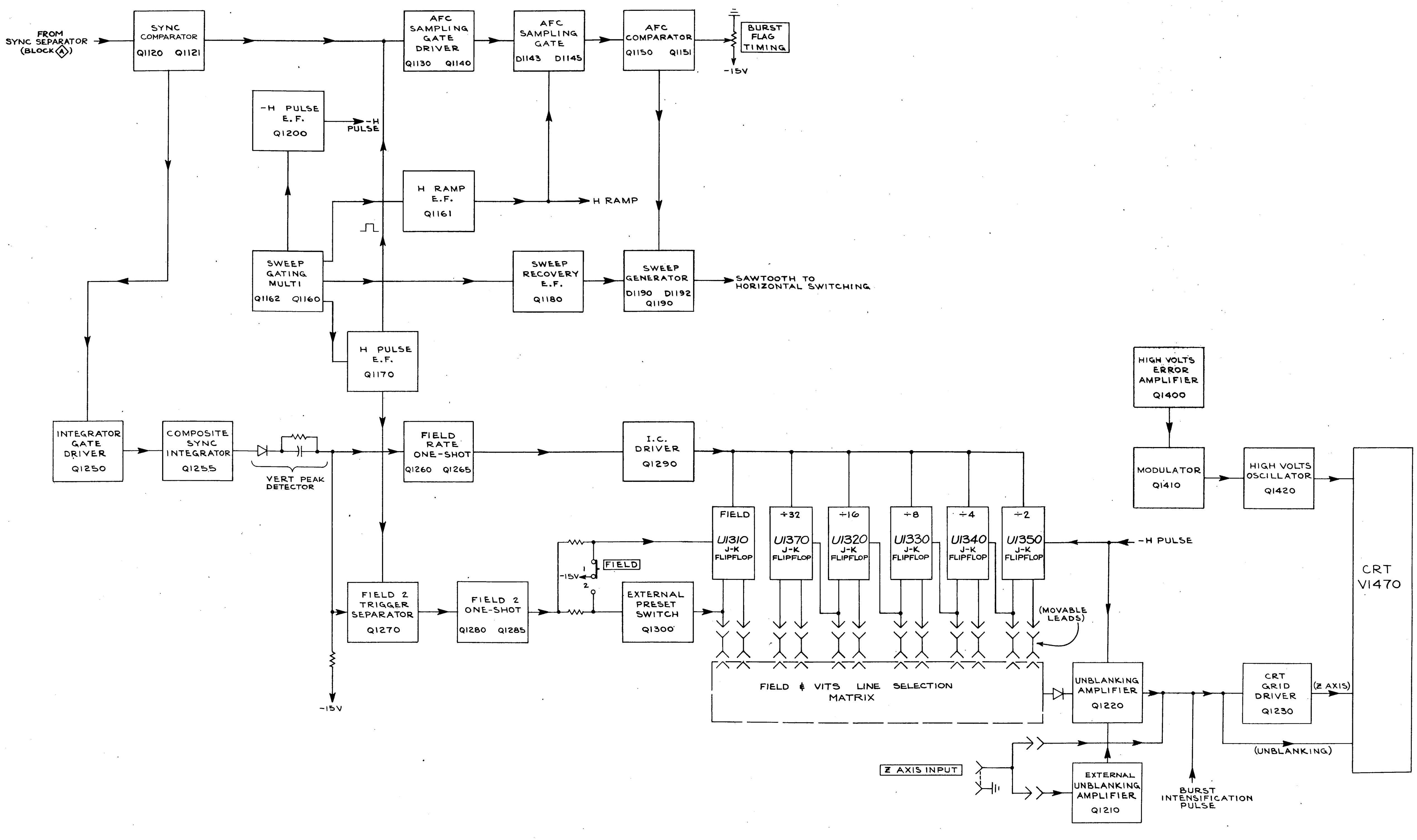
CAL
OFF
A
-15V
SW30
VECTOR
+10V
CAL SIG FROM Q580
MODULATOR Q30
OSCILLATOR Q40
AMPLIFIER Q41
CH B
B CAL
(SELF CANCELING)
B
OFF
CAL
CH B IN
CH A AMPLIFIER Q80 Q81 Q85
CH B AMPLIFIER Q90 Q91 Q95
A CAL
CAL
GAIN (CH A)
B CAL
GAIN (CH B)
TO A & B SWITCHING GATE Q515 Q516
SYNC OPERATIONAL AMPLIFIER Q140 Q141
BURST LIMITER Q230
INTERNAL SUB-CAR Ø DETECTOR D242 D244
ERROR AMPLIFIER Q250 Q255
INTERNAL SUB-CAR OSCILLATOR Q260
INTERNAL SUB-CAR OUT AMP Q270 Q275
BURST AMPLIFIER Q220 Q225
BURST GATE D212 D214
BURST GATE DRIVER Q200 Q205
-H PULSE
BURST INTENSIFICATION PULSE
OVEN Q280 Q285 Q291 Q295
Ø REF
(EXT)
+10V
(BURST)
TO INT/EXT Ø REF
EXT CW Ø REF
SYNC
(INT)
(EXT)
+10V
EXT SYNC
SYNC AMP & DC RESTORER Q1100 Q1101 Q1110
TO SYNC SEPARATOR



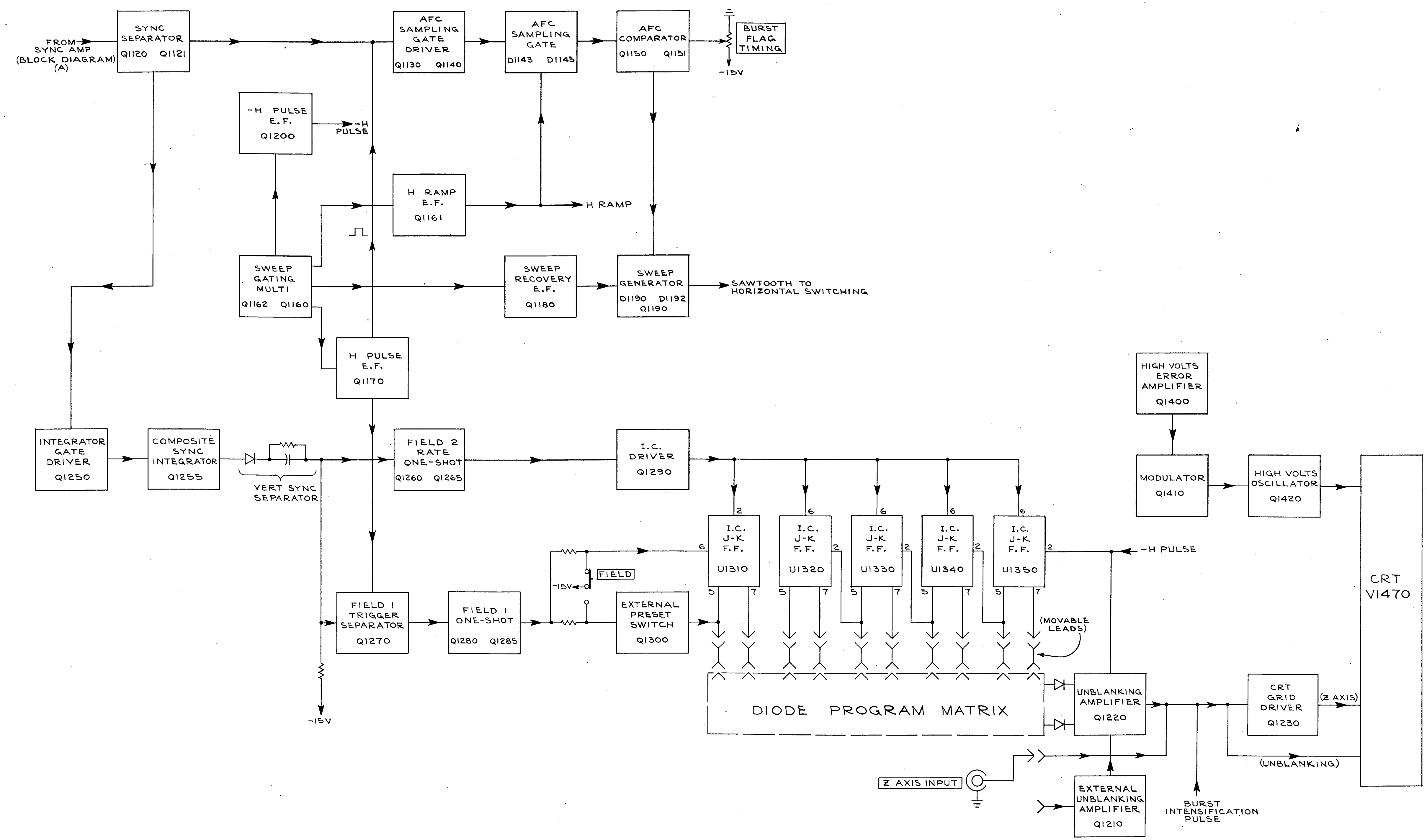
TYPE 520/R520 NTSC VECTORSCOPE

A

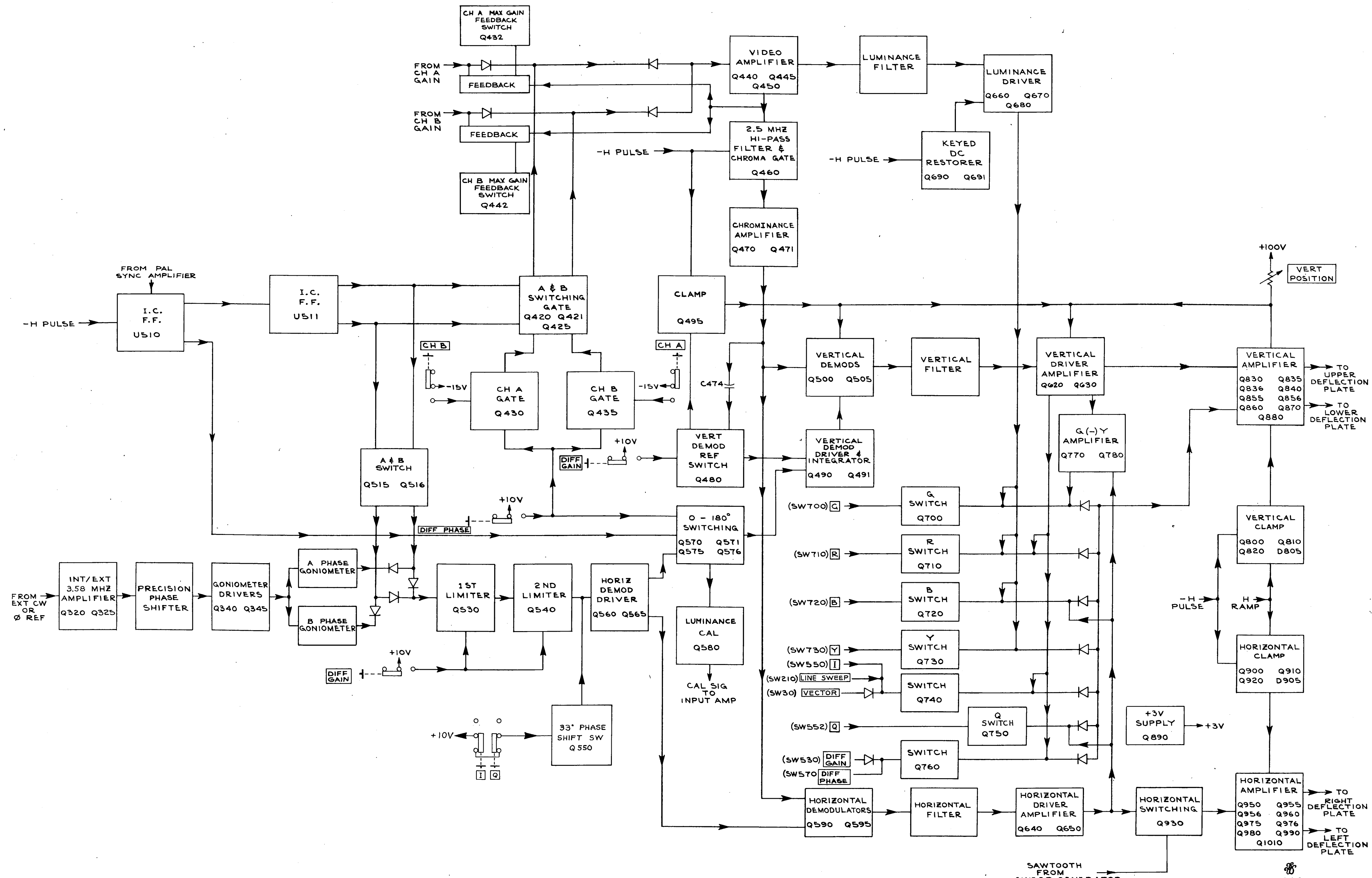
BLOCK DIAGRAM (B)
(S/N B150100-UP)

868

BLOCK DIAGRAM (B)
(SN B150100-up)



BLOCK DIAGRAM (B)
(SN B010100 - B149999)

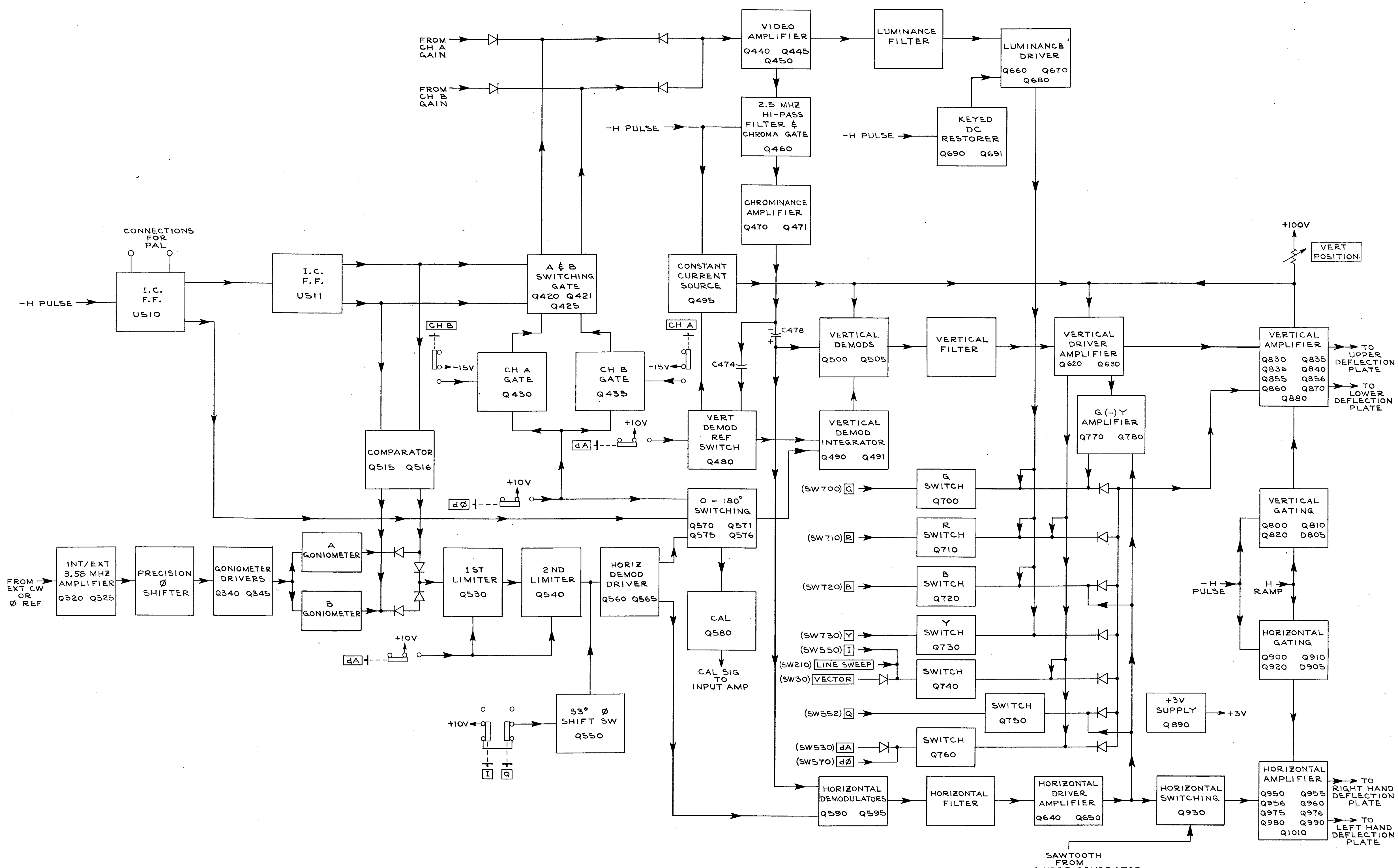


TYPE 520/R520 NTSC VECTORSCOPE

A

BLOCK DIAGRAM ⓒ
(S/N B150100-UP)

BLOCK DIAGRAM
(SN B150100 up) ⓒ



TYPE 520/R520 NTSC VECTORSCOPE

B

BLOCK DIAGRAM (C)
(S/N B010100-B149999)

PLM 868

BLOCK DIAGRAM
(SN B010100 - B149999)
(C)

VOLTAGE AND WAVEFORM CONDITIONS

Circuit voltages measured with a 20,000 Ω/volt VOM, All reading in volts. Voltages are measured with respect to chassis ground unless otherwise noted. Numbers contained in parenthesis are the peak to peak voltage value of the reference subcarrier.

Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule.

Voltages and waveforms on the diagrams (shown in blue) are not absolute and may vary between instruments because of differing component tolerances, internal calibration or front-panel control settings.

The test oscilloscope used had the following characteristics: deflection factor, 1 mV/cm to 50 V/cm; frequency response, DC to 8 MHz; sweep rates, 0.1 μs/cm to 5 s/cm; DC input coupling was used unless otherwise specified.

Chassis ground was used for all voltage readings and as probe ground for all waveforms taken.

A standard color bar signal was connected to channel A input of the Type R520 for all waveforms and voltage readings unless otherwise specified.

The trigger source for the test oscilloscope is specified on the individual diagrams.

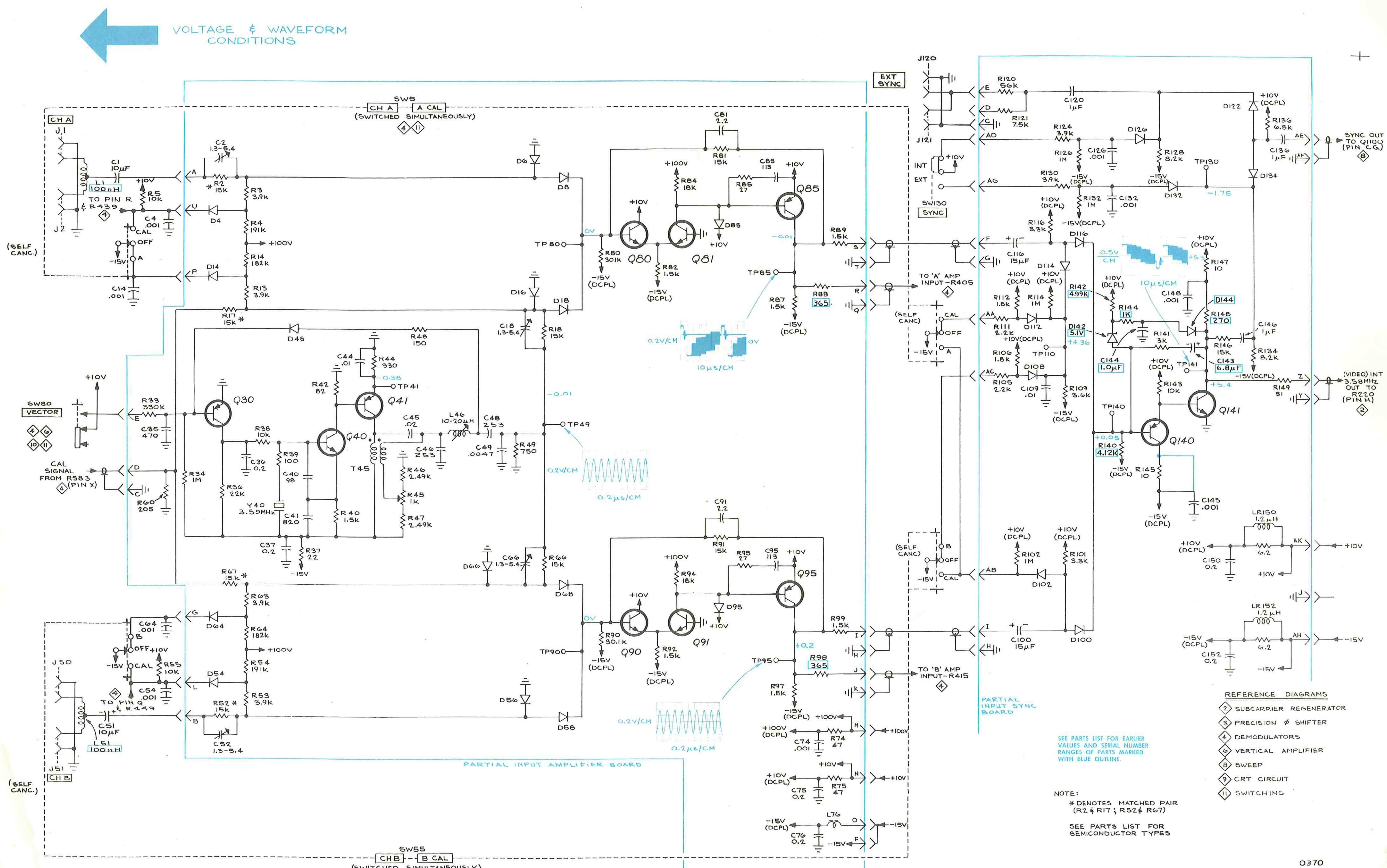
Type R520 Controls

For all front and rear panel screwdriver adjustments refer to the calibration section of this manual.

POWER	ON
SCALE ILLUM	As desired
INTENSITY	As desired
FOCUS	A well defined display
CH A and CH B GAIN	CAL
100%-75%-MAX GAIN	75%
Signal Selector	CH A, B CAL, FULL FIELD and AΦ/BΦ ALT
A PHASE	Position Burst to the 180° position on the vector graticule.
B PHASE	No affect
Φ REF	BURST
Display Selector	VECTOR
CALIBRATED PHASE	0
LUMINANCE GAIN	CAL
FIELD	2
SYNC	INT
BURST FLAG TIMING	As set forth in operating instructions, First-Time Operating Procedure.

WARNING

"Ground lugs" and shield braids are not always at ground potential. Check the schematic before using such connections as a ground for the voltmeter test prod or oscilloscope probe. Some transistor cases may be elevated from 0 to 275 V. This warning note also applies to recessed screws that hold the low voltage power supply transistors to the rear panel.



NOTE:
* DENOTES MATCHED PAIR (R2 & R17; R52 & R67)
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS
- 2 SUBCARRIER REGENERATOR
- 3 PRECISION Ø SHIFTER
- 4 DEMODULATORS
- 6 VERTICAL AMPLIFIER
- 8 SWEEP
- 9 CRT CIRCUIT
- 11 SWITCHING

VOLTAGES and WAVEFORMS obtained under conditions given on this diagram, except as follows: Test oscilloscope is triggered internally on + slope.

TYPE 520/R520 NTSC VECTORSCOPE

0370

INPUT AMPLIFIER & SYNC INPUT 1
(S/N B150100-UP)

INPUT AMP & SYNC INPUT (SN B150100 up) 1

VOLTAGE AND WAVEFORM CONDITIONS

Circuit voltages measured with a 20,000 Ω/volt VOM, All reading in volts. Voltages are measured with respect to chassis ground unless otherwise noted. Numbers contained in parenthesis are the peak to peak voltage value of the reference subcarrier.

Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule.

Voltages and waveforms on the diagrams (shown in blue) are not absolute and may vary between instruments because of differing component tolerances, internal calibration or front-panel control settings.

The test oscilloscope used had the following characteristics: deflection factor, 1 mV/cm to 50 V/cm; frequency response, DC to 8 MHz; sweep rates, 0.1 μs/cm to 5 s/cm; DC input coupling was used unless otherwise specified.

Chassis ground was used for all voltage readings and as probe ground for all waveforms taken.

A standard color bar signal was connected to channel A input of the Type R520 for all waveforms and voltage readings unless otherwise specified.

The trigger source for the test oscilloscope is specified on the individual diagrams.

Type R520 Controls

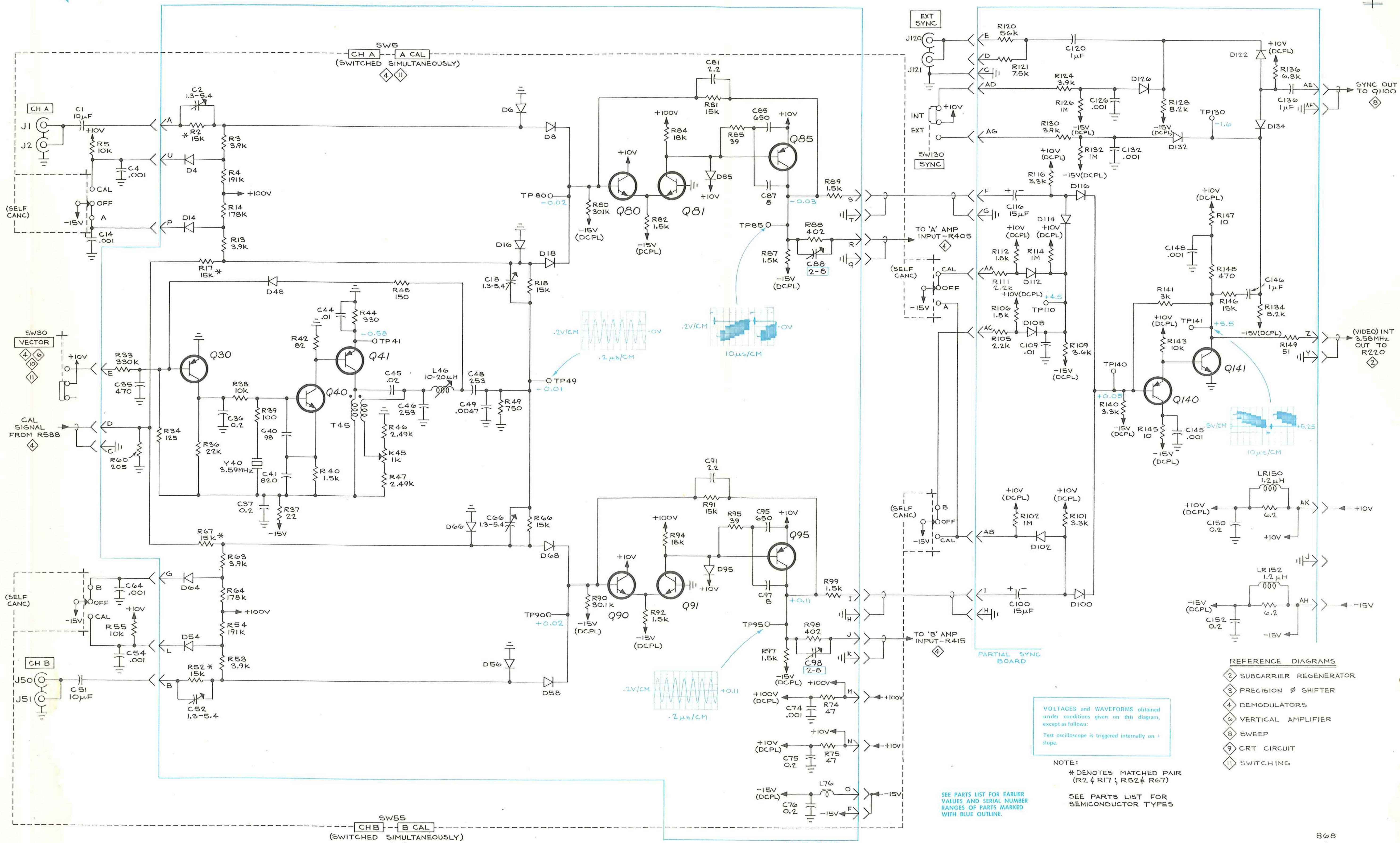
For all front and rear panel screwdriver adjustments refer to the calibration section of this manual.

POWER	ON
SCALE ILLUM	As desired
INTENSITY	As desired
FOCUS	A well defined display
CH A and CH B GAIN	CAL
100%-75%-MAX GAIN	75%
Signal Selector	CH A, B CAL, FULL FIELD and AΦ/BΦ ALT
A PHASE	Position Burst to the 180° position on the vector graticule.
B PHASE	No affect
Φ REF	BURST
Display Selector	VECTOR
CALIBRATED PHASE	0
LUMINANCE GAIN	CAL
FIELD	2
SYNC	INT
BURST FLAG TIMING	As set forth in operating instructions, First-Time Operating Procedure.

WARNING

"Ground lugs" and shield braids are not always at ground potential. Check the schematic before using such connections as a ground for the voltmeter test prod or oscilloscope probe. Some transistor cases may be elevated from 0 to 275 V. This warning note also applies to recessed screws that hold the low voltage power supply transistors to the rear panel.

VOLTAGE & WAVEFORM CONDITIONS



VOLTAGES and WAVEFORMS obtained under conditions given on this diagram, except as follows:

Test oscilloscope is triggered internally on + slope.

NOTE:

* DENOTES MATCHED PAIR (R2 & R17; R52 & R67)

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

REFERENCE DIAGRAMS

- 2 SUBCARRIER REGENERATOR
- 3 PRECISION φ SHIFTER
- 4 DEMODULATORS
- 6 VERTICAL AMPLIFIER
- 8 SWEEP
- 9 CRT CIRCUIT
- 11 SWITCHING

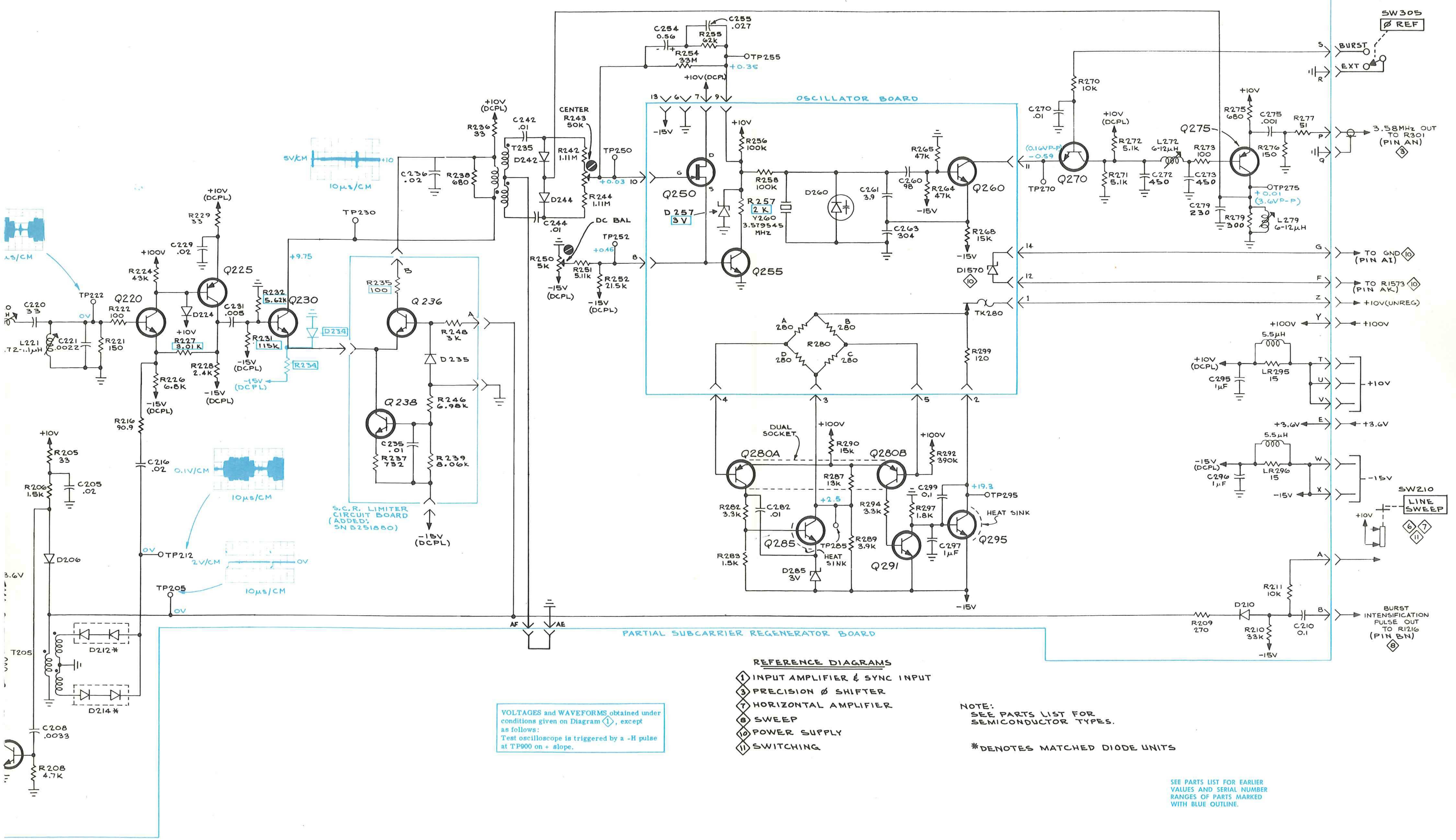
868

TYPE 520/R520 NTSC VECTORSCOPE

C1

INPUT AMPLIFIER & SYNC INPUT 1

(S/N B010100-B149999)



REFERENCE DIAGRAMS

1 INPUT AMPLIFIER & SYNC INPUT
3 PRECISION Ø SHIFTER
7 HORIZONTAL AMPLIFIER
8 SWEEP
10 POWER SUPPLY
11 SWITCHING

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 1, except as follows:
Test oscilloscope is triggered by a -H pulse at TP900 on + slope.

NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

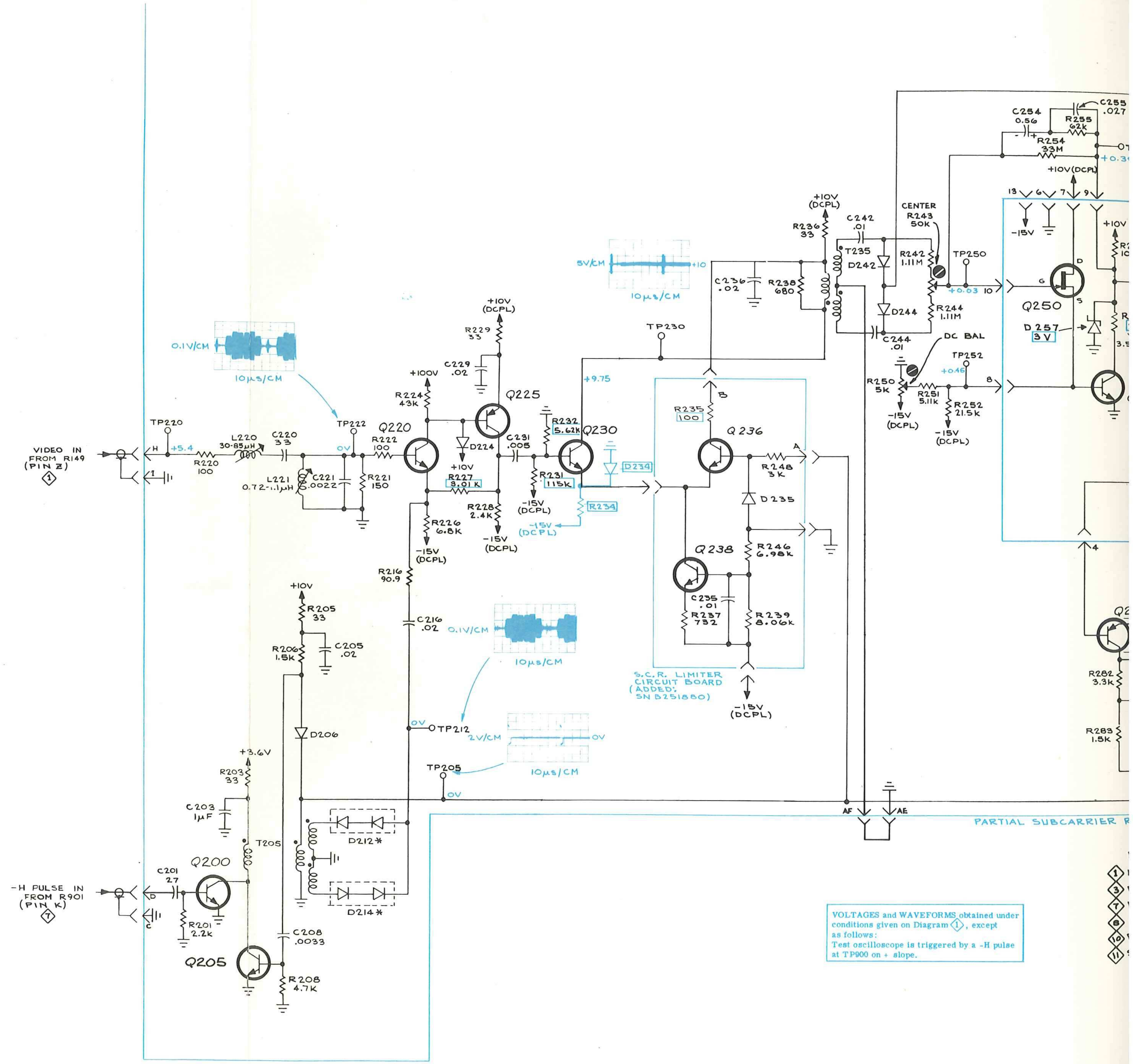
*DENOTES MATCHED DIODE UNITS

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

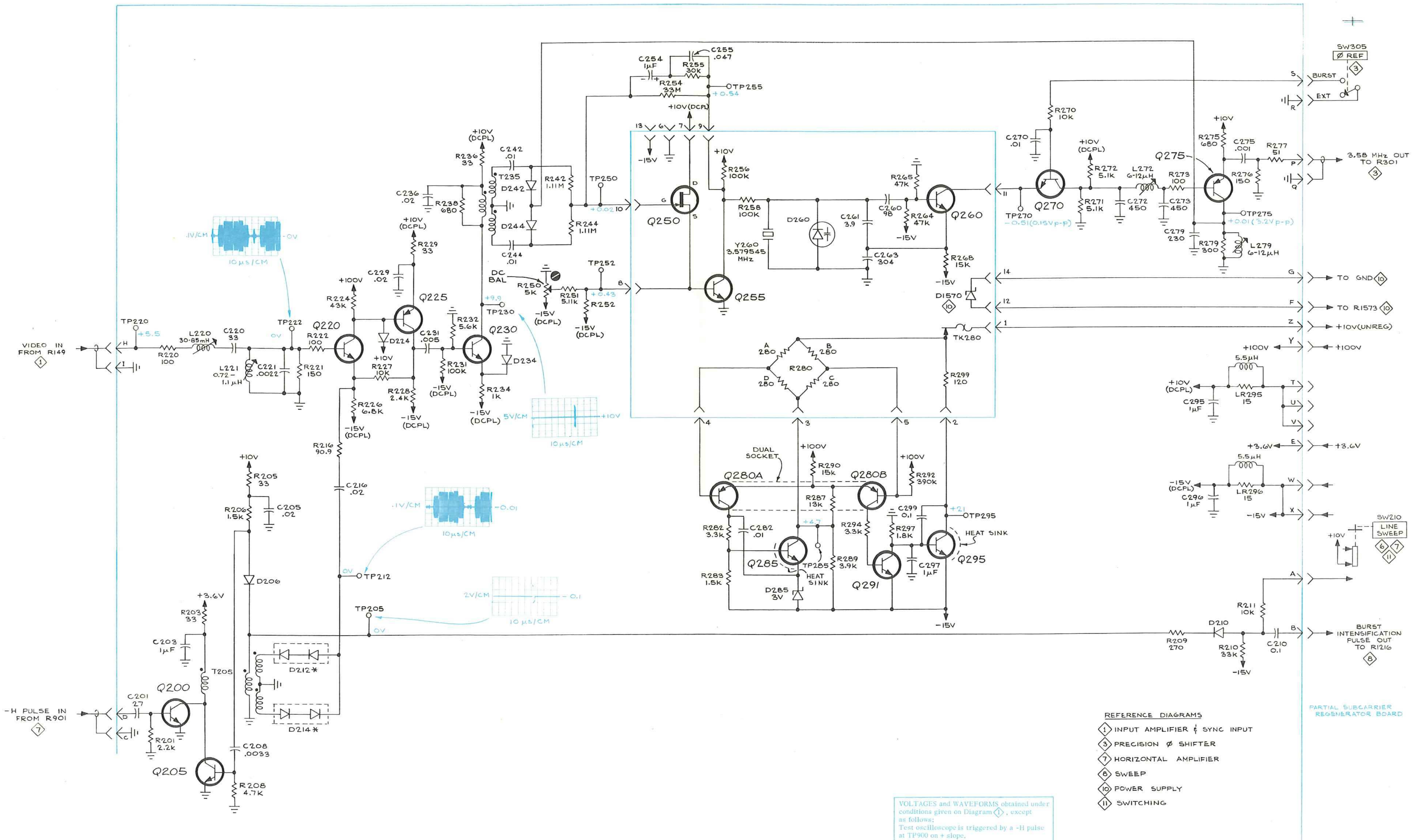
0271

E

SUBCARRIER REGENERATOR 2
(S/N B150100-UP)



TYPE 520/R520 NTSC VECTORSCOPE



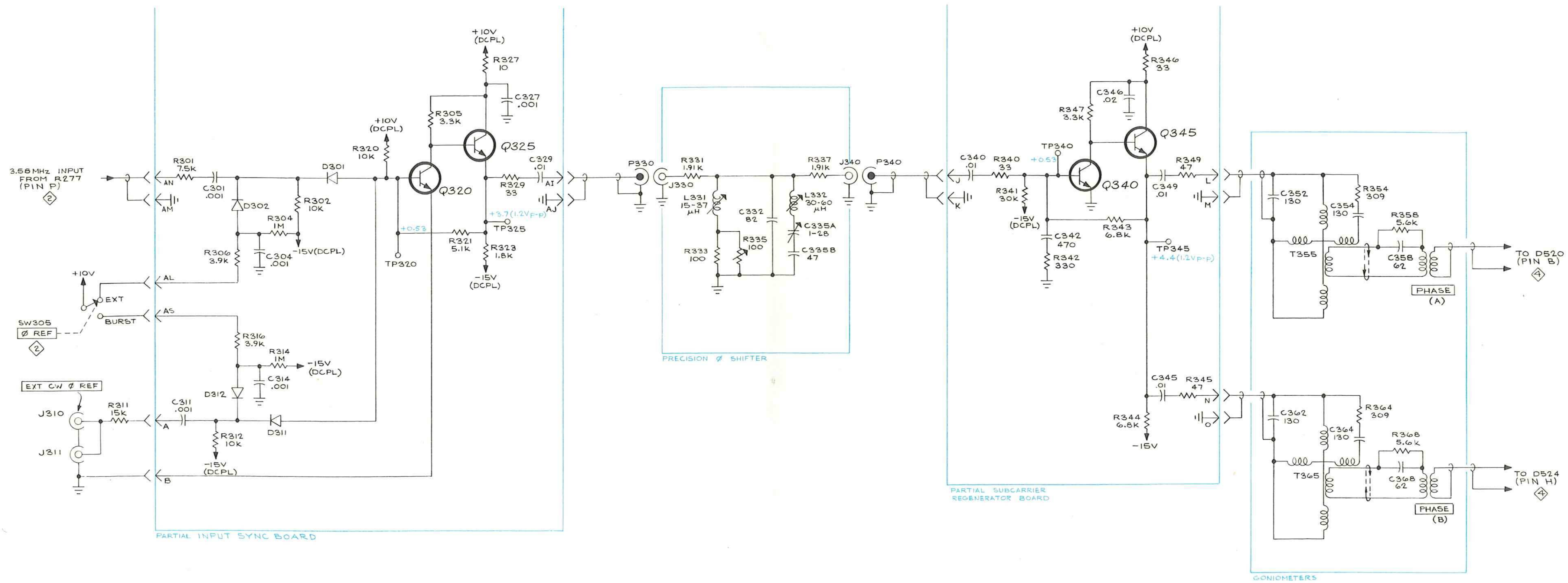
TYPE 520/R520 NTSC VECTORSCOPE

B

NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
* DENOTES MATCHED DIODE UNITS

868

SUBCARRIER REGENERATOR (2)
(S/N B010100-B149999)



REFERENCE DIAGRAMS
- ① INPUT AMPLIFIER & SYNC INPUT
- ② SUBCARRIER REGENERATOR
- ④ DEMODULATORS
- ⑨ CRT CIRCUIT

NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

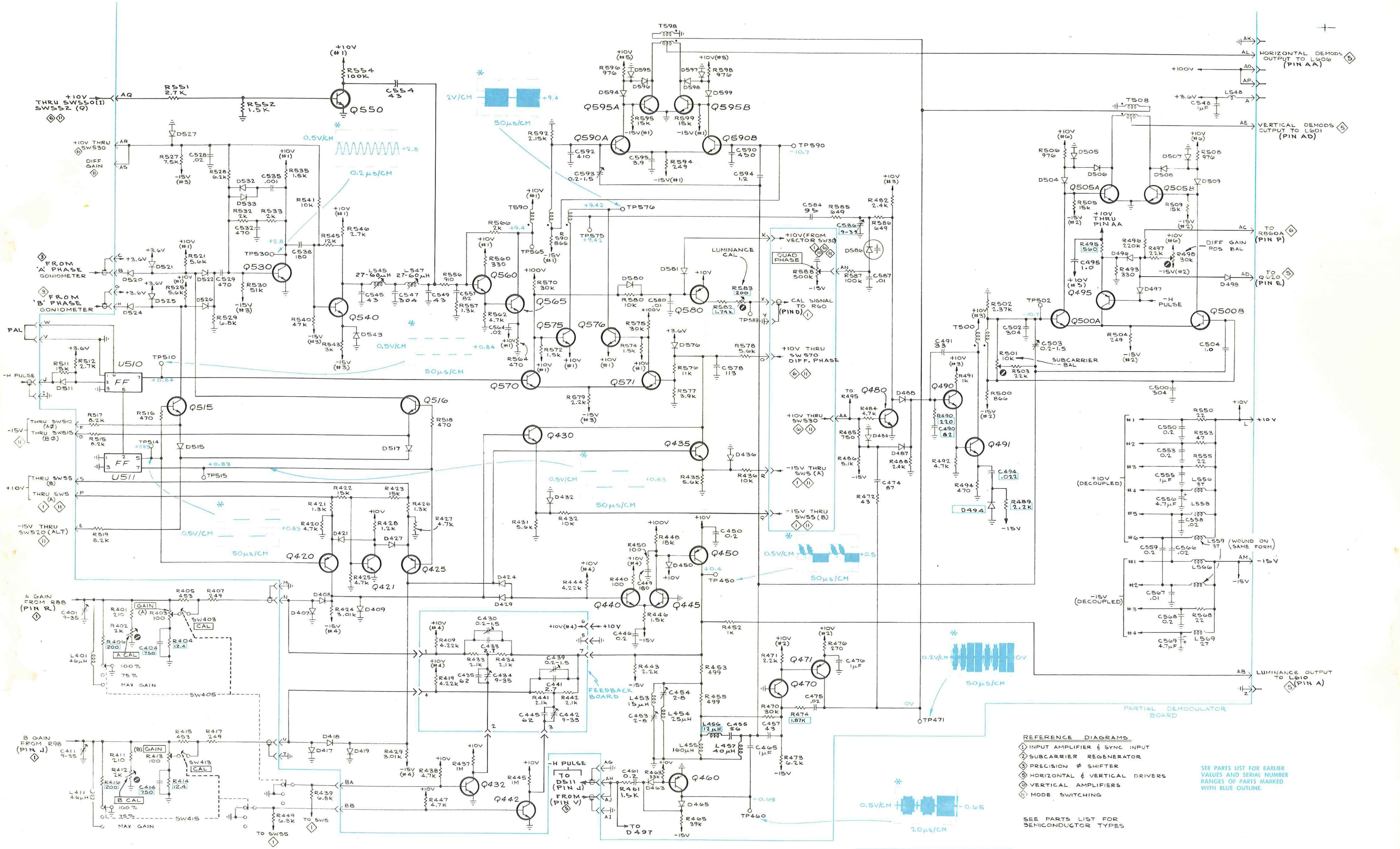
VOLTAGES obtained under conditions given on Diagram ①.

1067

TYPE 520/R520 NTSC VECTORSCOPE

A₂

PRECISION Ø SHIFTER ③



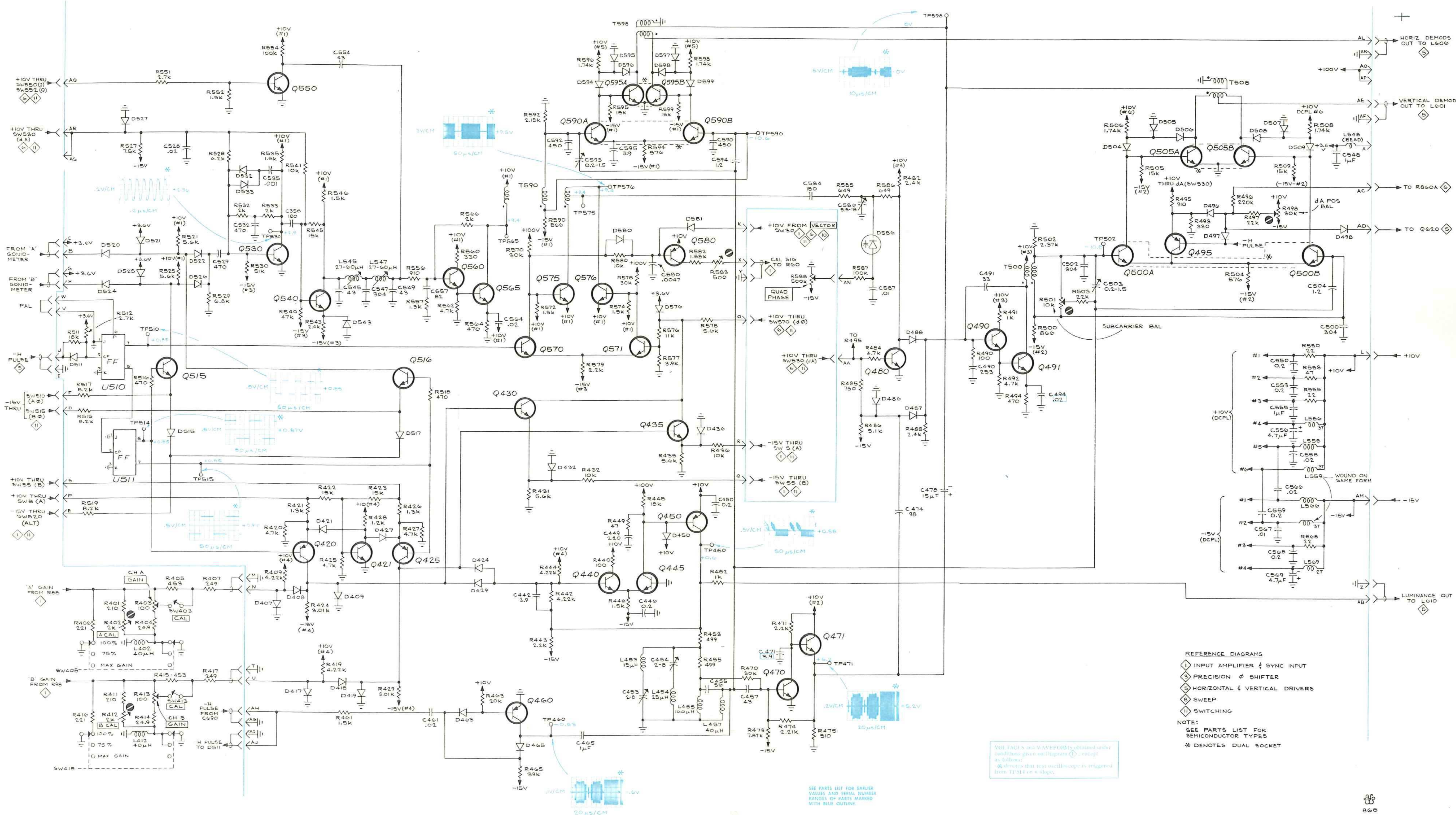
TYPE 520/R520 NTSC VECTORSCOPE

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 1, except as follows:
* denotes that test oscilloscope is triggered from TP514 on + slope.

1071

DEMODULATORS 4
(S/N B150100-UP)

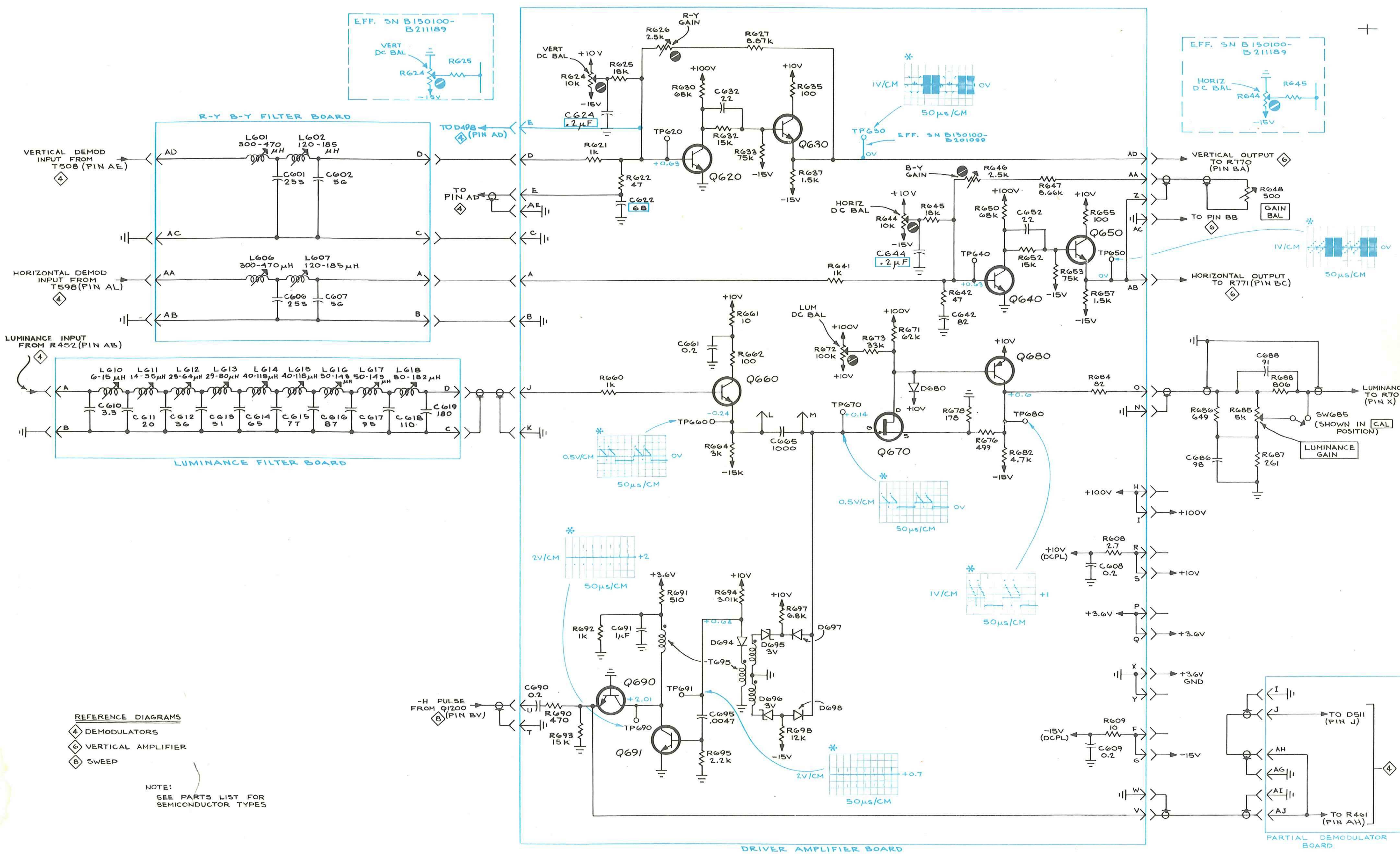
DEMODULATOR (SN B150100 up) 4



TYPE 520/R520 NTSC VECTORSCOPE

DEMODULATORS 4
(S/N B010100-B149999)

DEMODULATOR
(SN B010100 - B149999) 4



REFERENCE DIAGRAMS
- 4 DEMODULATORS
- 6 VERTICAL AMPLIFIER
- 8 SWEEP

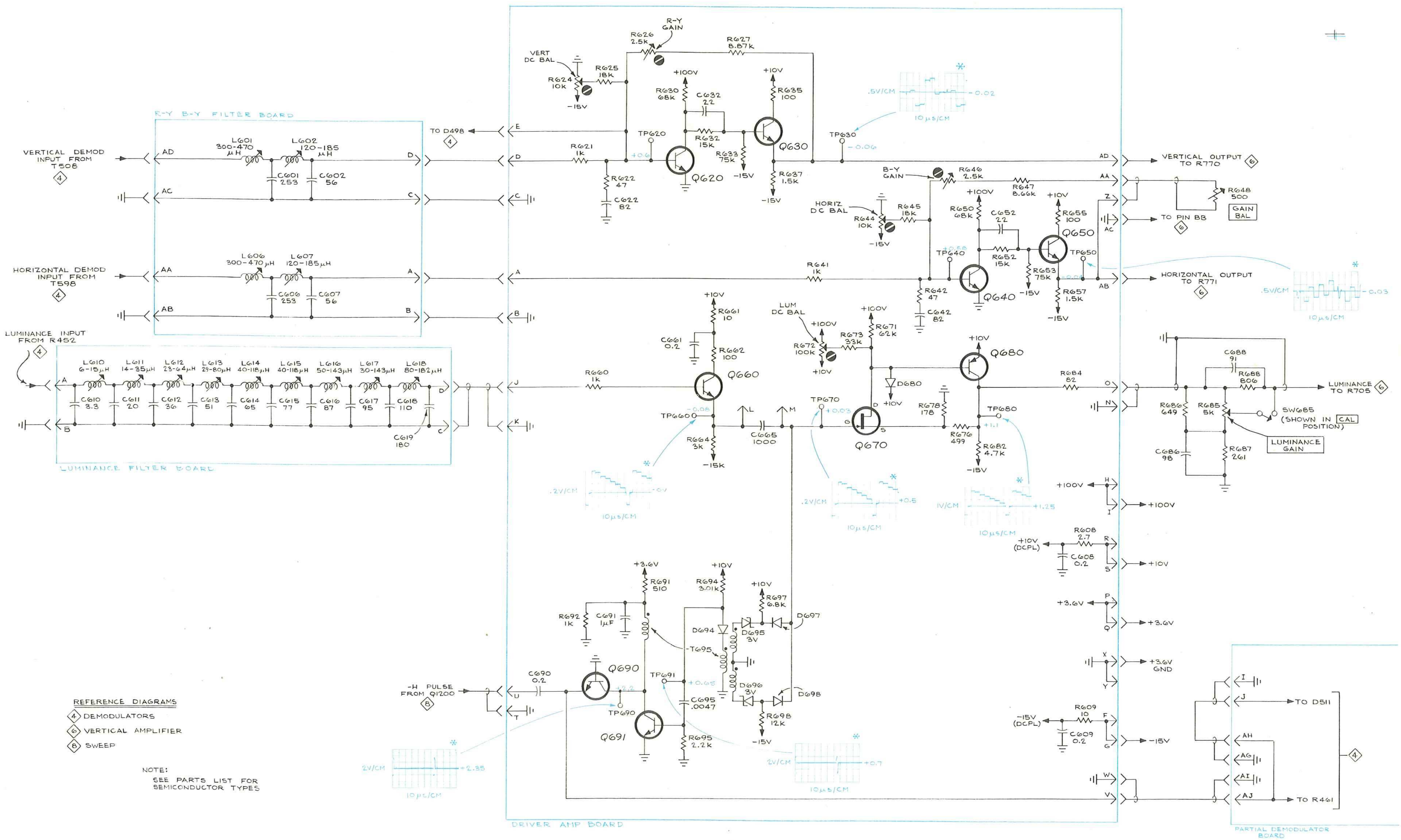
NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 1, except as follows:
* denotes that test oscilloscope is triggered from TP 514 on + slope.

1069

TYPE 520/R520 NTSC VECTORSCOPE

HORIZONTAL & VERTICAL DRIVERS 5
(S/N B150100-UP)



REFERENCE DIAGRAMS
4 DEMODULATORS
6 VERTICAL AMPLIFIER
8 SWEEP

NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 1, except as follows:
* denotes that test oscilloscope is triggered from TP914 on + slope.

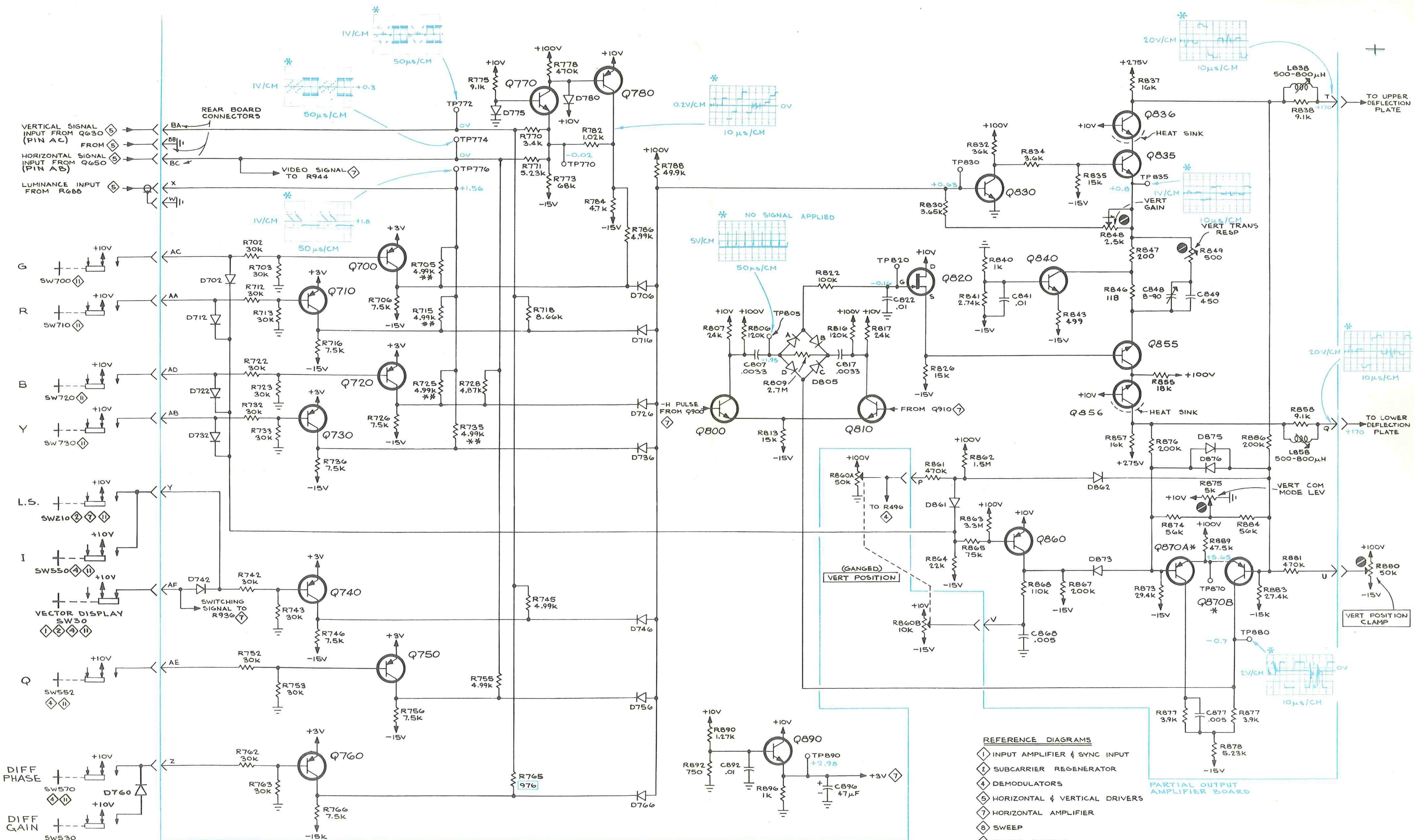
TYPE 520/R520 NTSC VECTORSCOPE

B,

868

HORIZONTAL & VERTICAL DRIVERS 5
(S/N B010100-B149999)

HORIZ & VERT DRIVERS (SN B010100 - B149999) 5



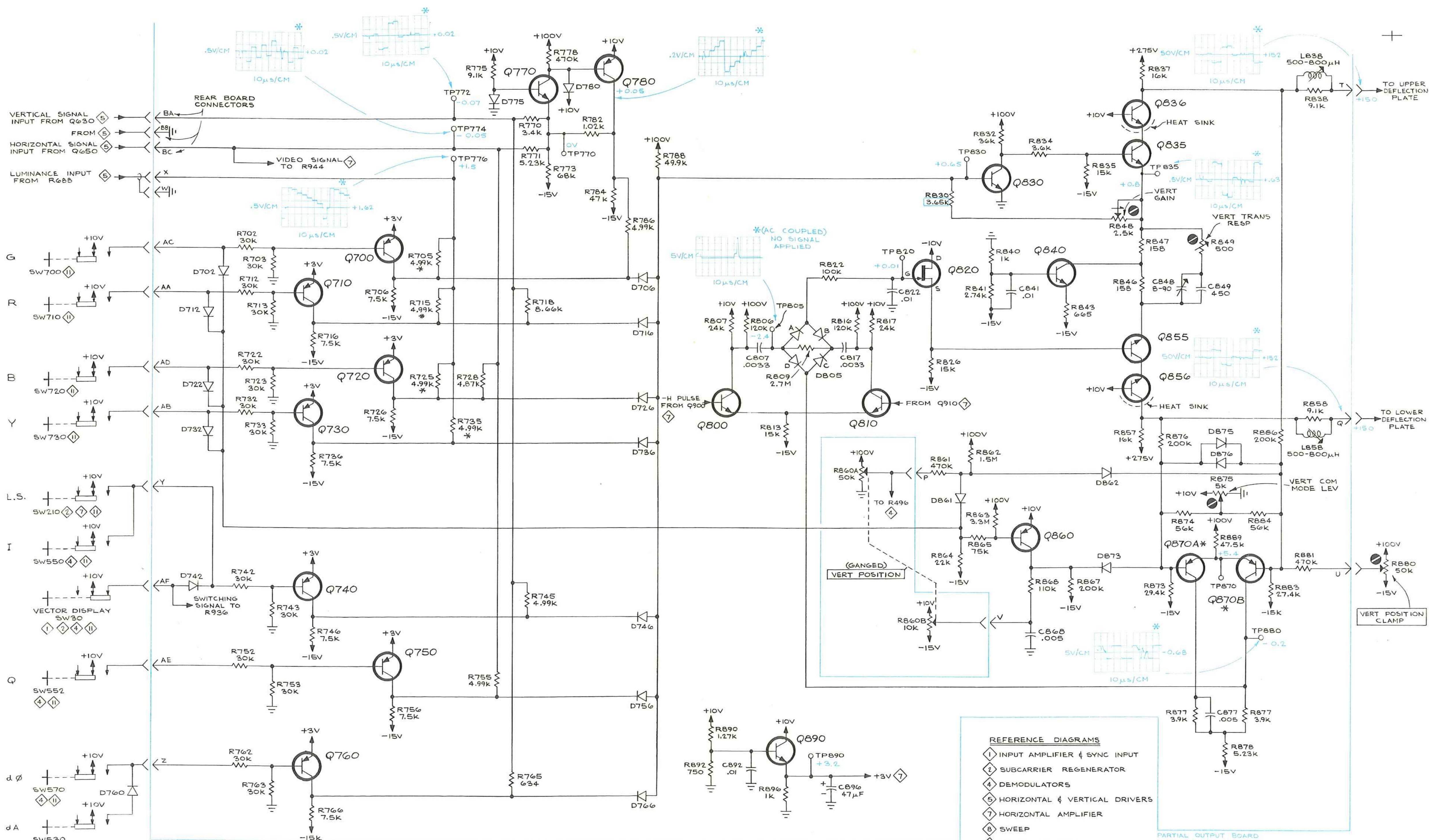
NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
* DENOTES MATCHED COMPONENTS MOUNTED ON A DUAL SOCKET
** MATCHED TO WITHIN 0.1%

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram ①, except as follows:
* denotes that test oscilloscope is triggered from TP 514 on + slope.

0270

TYPE 520/R520 NTSC VECTORSCOPE

VERTICAL AMPLIFIER ⑥
(S/N B150100-UP)



REFERENCE DIAGRAMS
① INPUT AMPLIFIER & SYNC INPUT
② SUBCARRIER REGENERATOR
④ DEMODULATORS
⑤ HORIZONTAL & VERTICAL DRIVERS
⑦ HORIZONTAL AMPLIFIER
⑧ SWEEP
⑩ POWER SUPPLY
⑪ SWITCHING

NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
* DENOTES MATCHED COMPONENTS MOUNTED ON A DUAL SOCKET

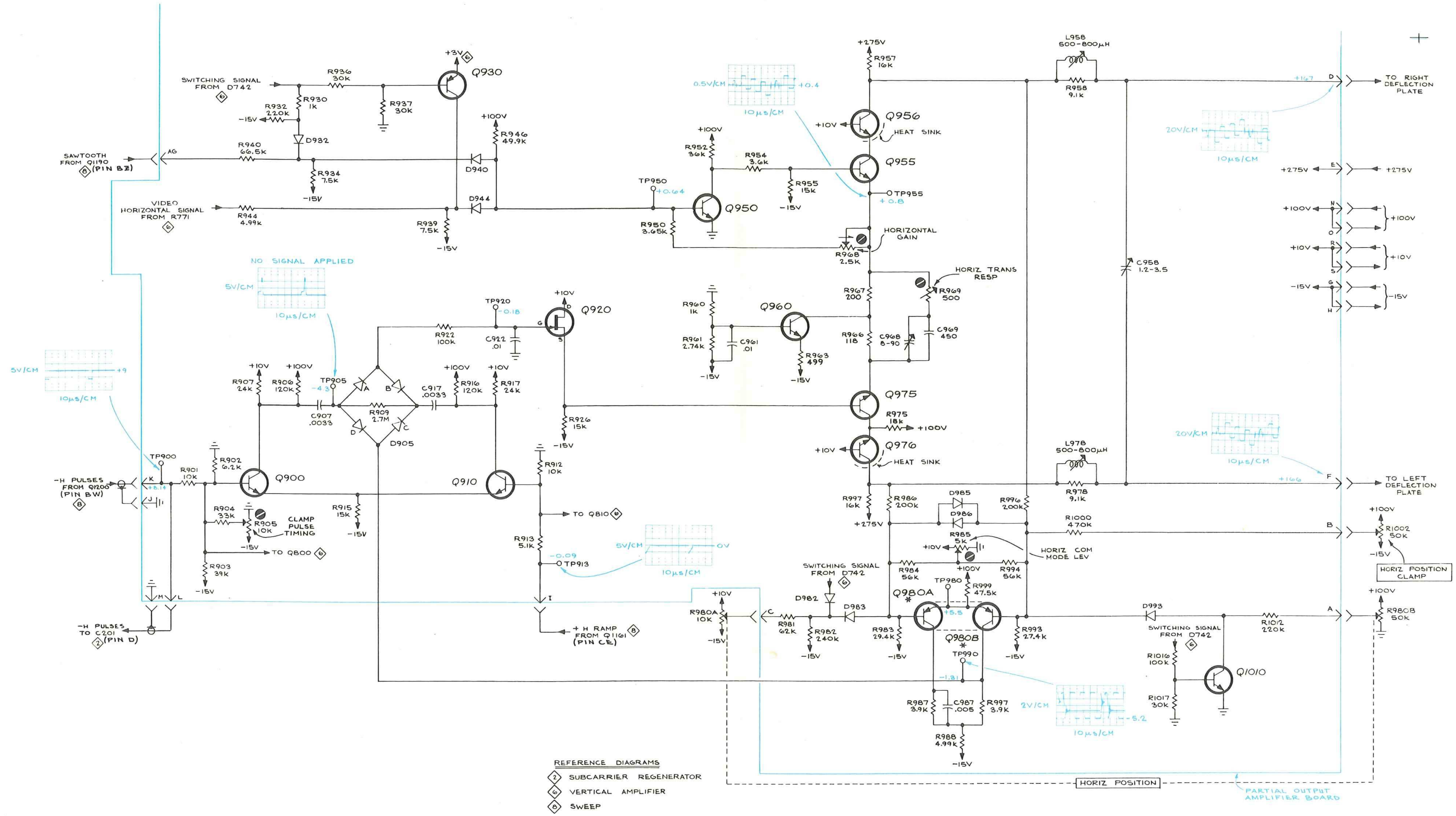
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram ①, except as follows:
* denotes that test oscilloscope is triggered from TP514 on + slope.

868

TYPE 520/R520 NTSC VECTORSCOPE

VERTICAL AMPLIFIER ⑥
(S/N B010100-B149999)



REFERENCE DIAGRAMS

⟨2⟩ SUBCARRIER REGENERATOR

⟨6⟩ VERTICAL AMPLIFIER

⟨8⟩ SWEEP

NOTE:
SEE PARTS LIST FOR SEMICONDUTOR TYPES
* DENOTES MATCHED PAIR MOUNTED ON A COMMON SOCKET

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram ⟨1⟩.

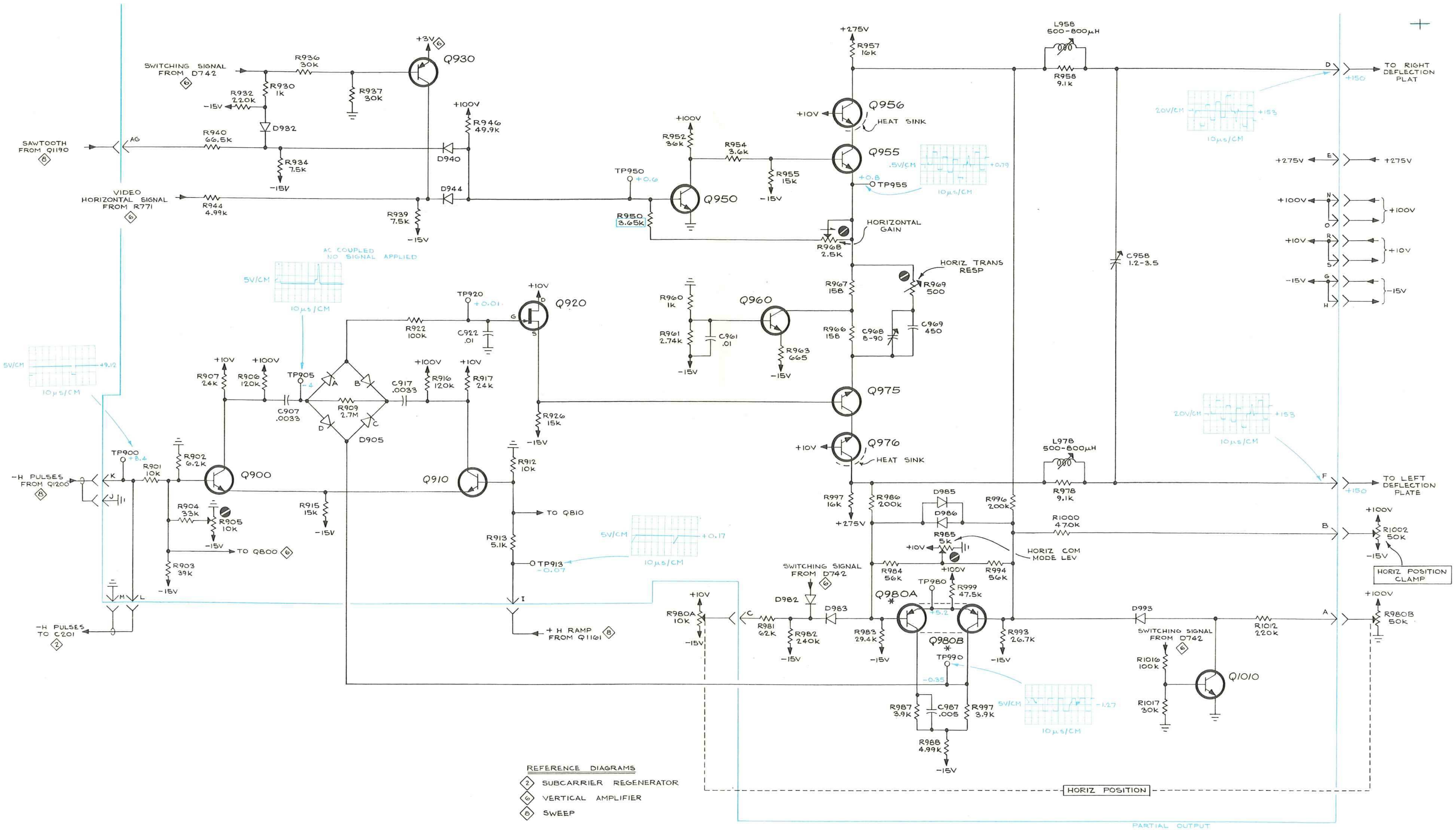
868

TYPE 520/R520 NTSC VECTORSCOPE

A

HORIZONTAL AMPLIFIER ⟨7⟩
(S/N B150100-UP)

HORIZONTAL AMPLIFIER (SN B150100 up) ⟨7⟩



REFERENCE DIAGRAMS
- (2) SUBCARRIER REGENERATOR
- (6) VERTICAL AMPLIFIER
- (8) SWEEP

NOTE:
SEE PARTS LIST FOR SEMICONDUTOR TYPES
* DENOTES MATCHED PAIR MOUNTED ON A COMMON SOCKET

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram (1).

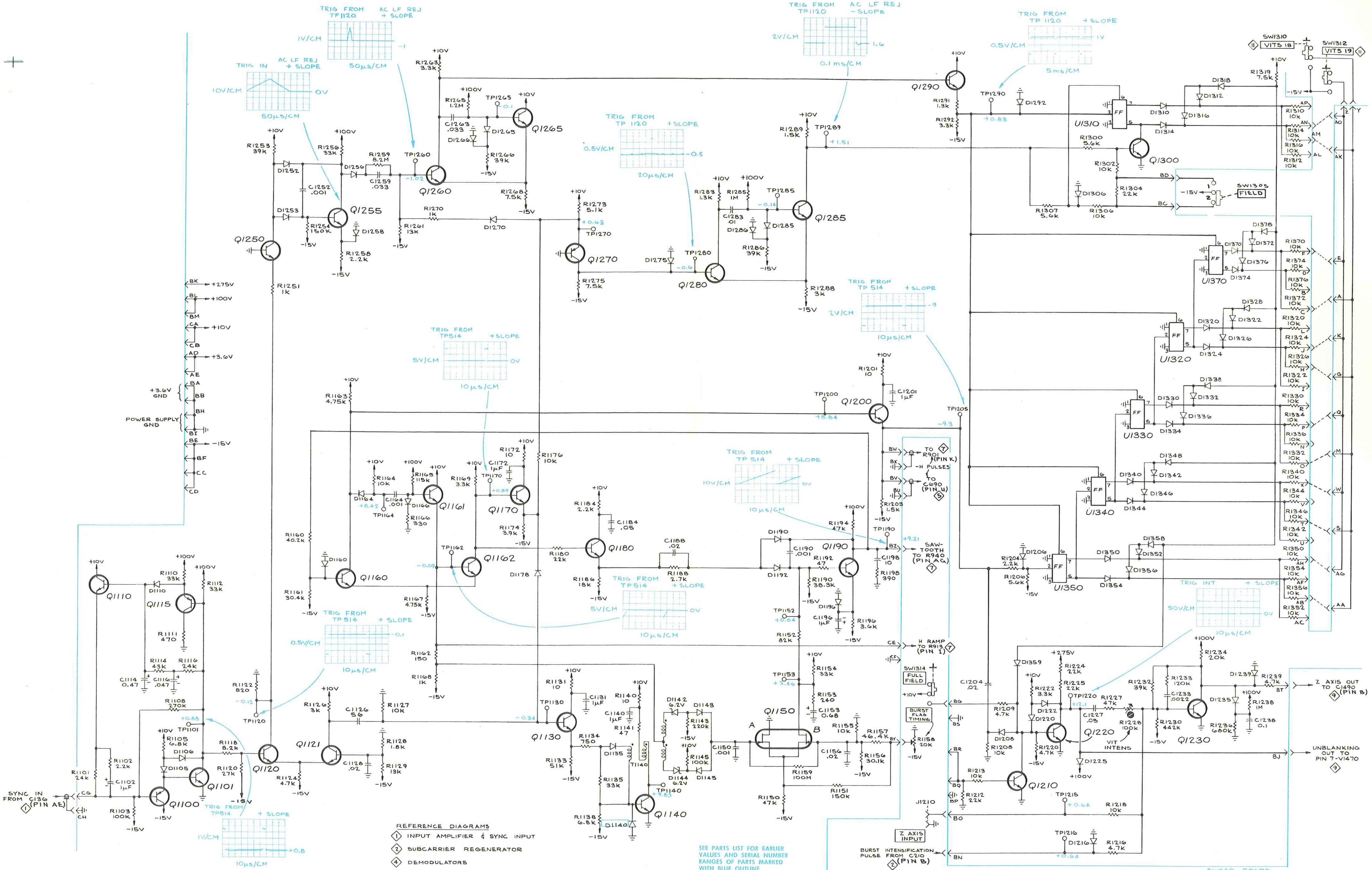
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

868

TYPE 520/R520 NTSC VECTORSCOPE

C

HORIZONTAL AMPLIFIER (7)
(S/N B010100-B149999)



REFERENCE DIAGRAMS

1. INPUT AMPLIFIER & SYNC INPUT
2. SUBCARRIER REGENERATOR
4. DEMODULATORS
5. HORIZONTAL & VERTICAL DRIVERS
7. HORIZONTAL AMPLIFIER
9. CRT CIRCUIT
11. SWITCHING

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram (1), except as noted on individual waveforms.

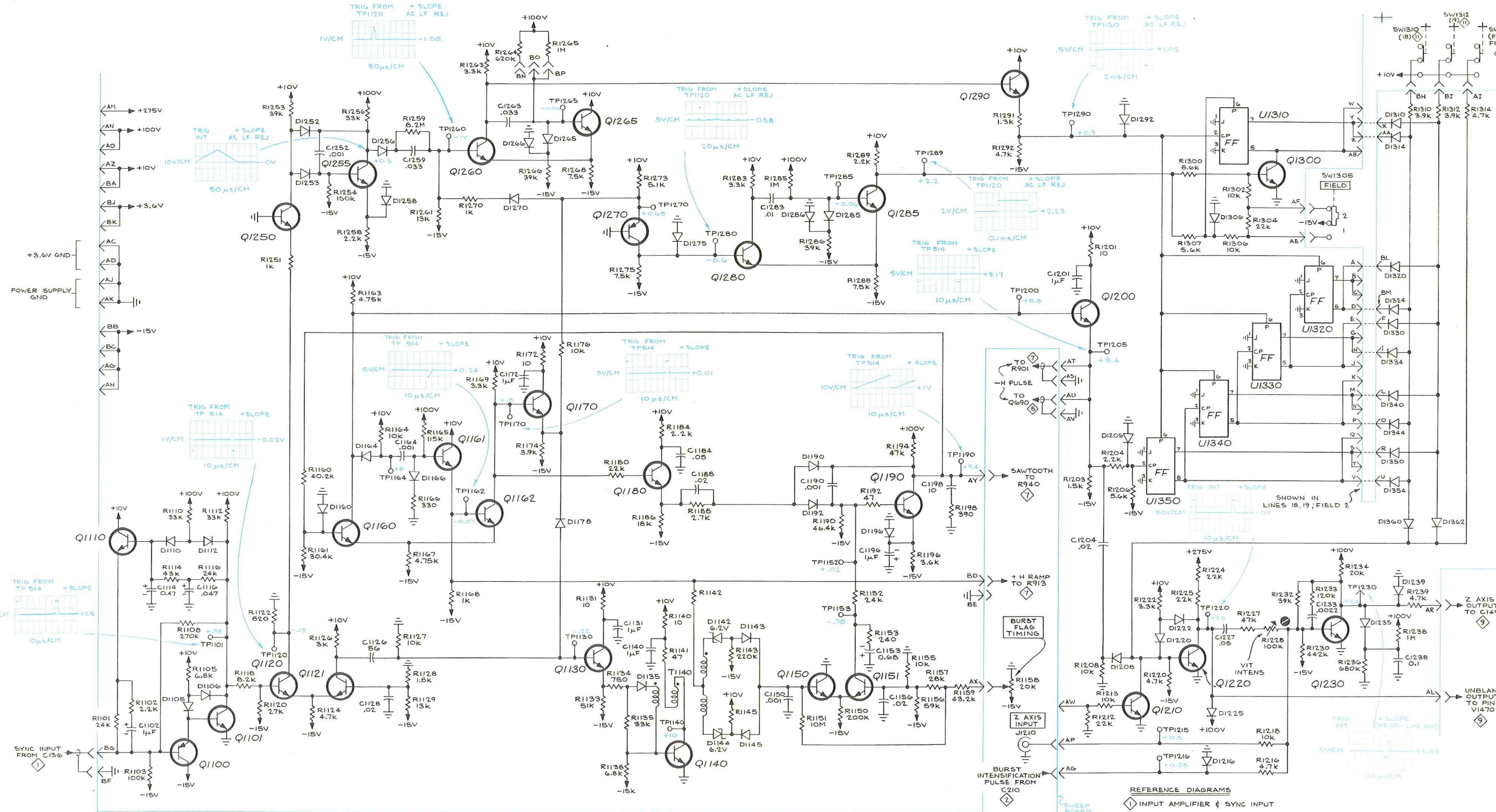
TYPE 520/R520 NTSC VECTORSCOPE

B

0870

SWEEP (8)
(S/N B150100-UP)

SWEEP (SN B150100 up) (8)



NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE ⟨4⟩ FOR IC POWER DETAILS

REFERENCE DIAGRAMS
⟨1⟩ INPUT AMPLIFIER & SYNC INPUT
⟨2⟩ SUBCARRIER REGENERATOR
⟨4⟩ DEMODULATORS
⟨5⟩ HORIZONTAL & VERTICAL DRIVERS
⟨7⟩ HORIZONTAL AMPLIFIER
⟨9⟩ CRT CIRCUIT
⟨11⟩ SWITCHING

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram ⟨1⟩, except as noted on individual waveforms.

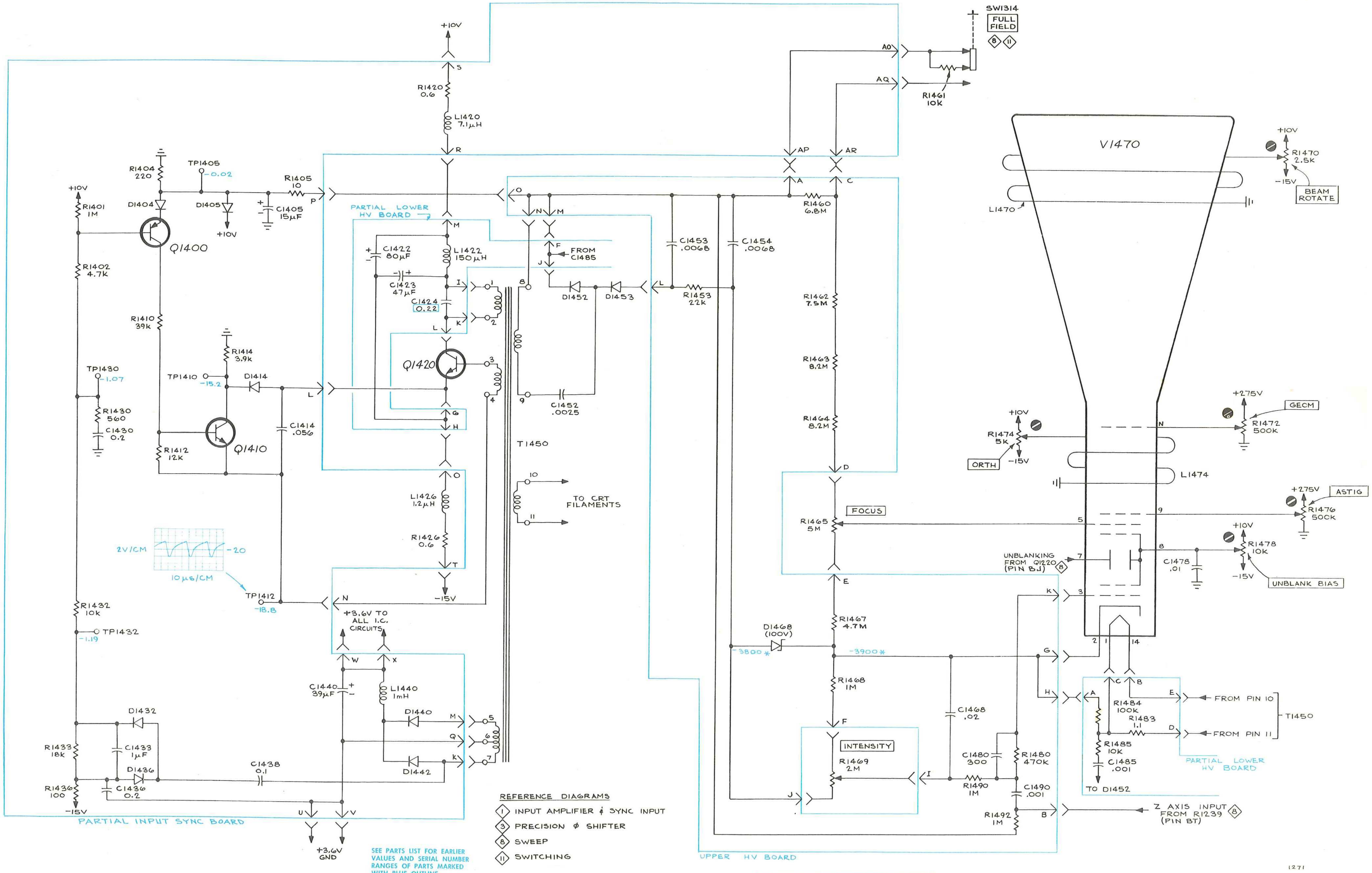
TYPE 520/R520 NTSC VECTORSCOPE

B

868

SWEEP ⟨8⟩
(S/N B010100-B149999)

SWEEP (SN B010100 - B149999) ⟨8⟩



TYPE 520/R520 NTSC VECTORSCOPE

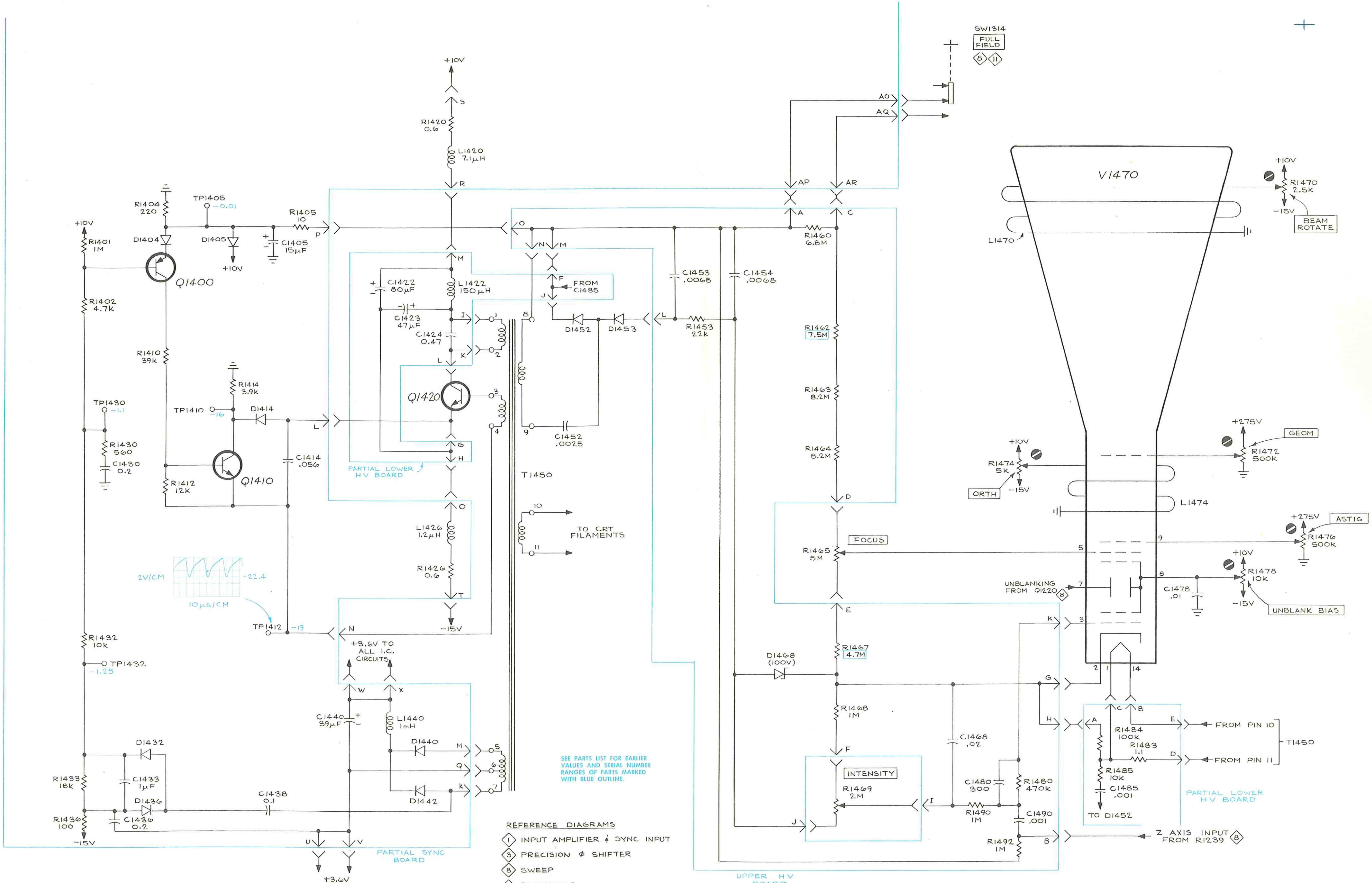
VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 1, except as follows:
Test oscilloscope is triggered internally on + slope. VECTOR switch is depressed.

* DENOTES METER LOADING

1271

CRT CIRCUIT 9
(S/N B150100-UP)

CRT CIRCUIT (SN B150100 up) 9



REFERENCE DIAGRAMS

1. INPUT AMPLIFIER & SYNC INPUT
3. PRECISION ϕ SHIFTER
8. SWEEP
11. SWITCHING

TYPE 520/R520 NTSC VECTORSCOPE

C2

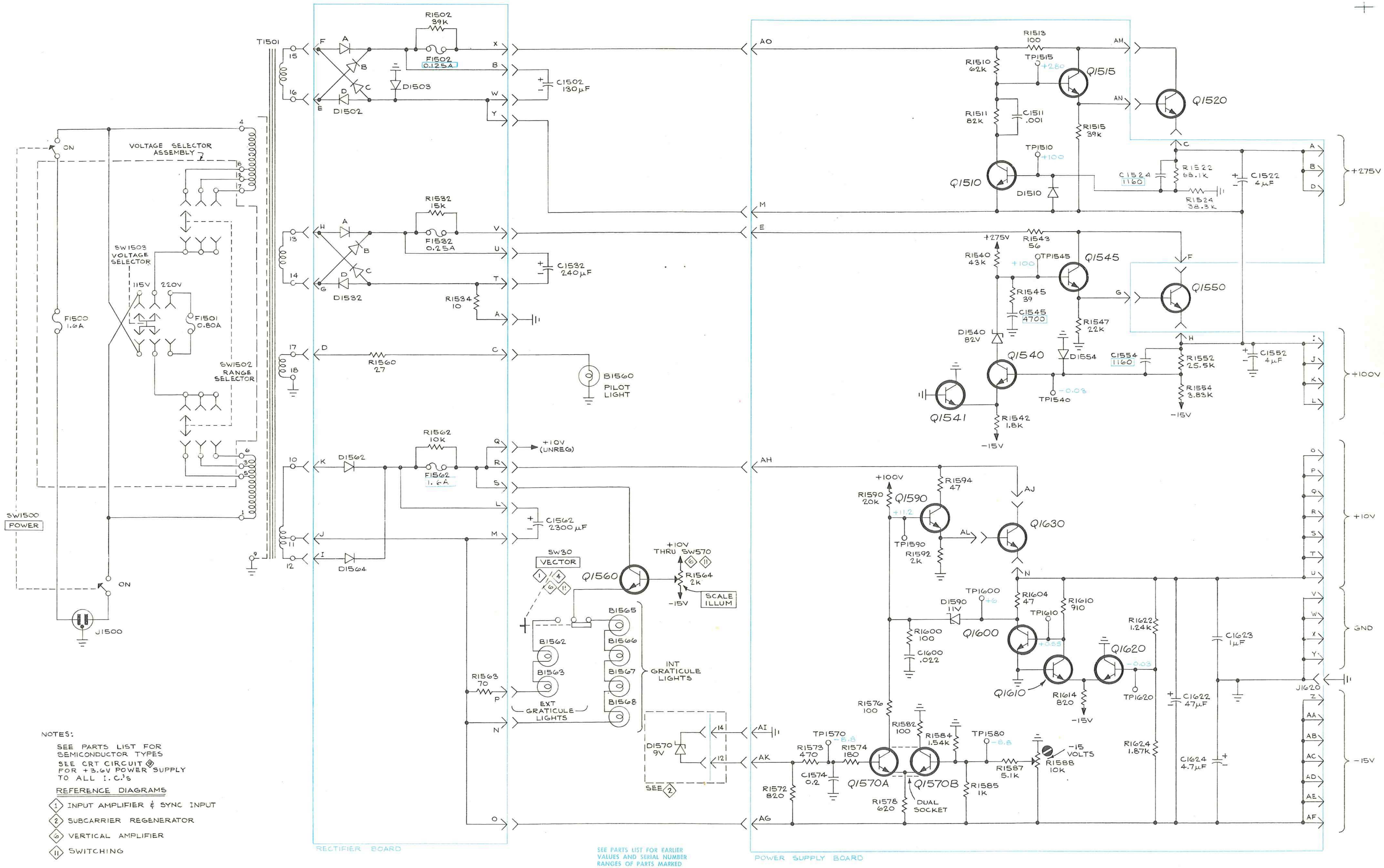
VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 1, except as follows:
Test oscilloscope is triggered internally on +slope. VECTOR switch is depressed.

868

CRT CIRCUIT 9
(S/N B010100-B149999)

CRT CIRCUIT
(SN B010100 - B149999)

9



NOTES:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE CRT CIRCUIT ⟨9⟩ FOR +3.6V POWER SUPPLY TO ALL I.C.'S

REFERENCE DIAGRAMS
⟨1⟩ INPUT AMPLIFIER & SYNC INPUT
⟨2⟩ SUBCARRIER REGENERATOR
⟨6⟩ VERTICAL AMPLIFIER
⟨11⟩ SWITCHING

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

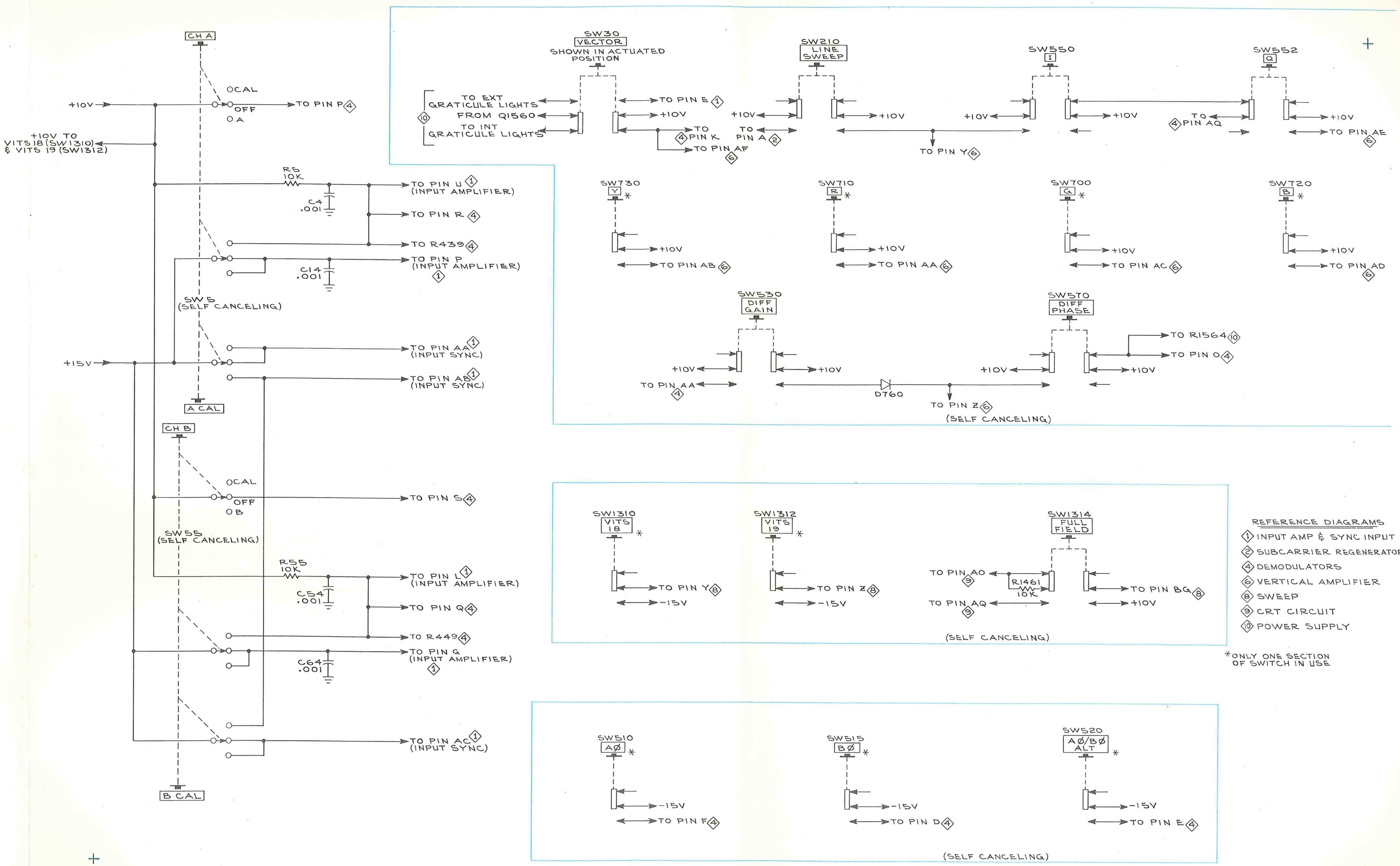
VOLTAGES obtained under conditions given on Diagram ⟨1⟩.

472

TYPE 520/R520 NTSC VECTORSCOPE

D

POWER SUPPLY ⟨10⟩



TYPE 520/R520 NTSC VECTORSCOPE

A1

MODE SWITCHING 11
(S/N B150100-UP)

868

MODE SWITCHING (SN B150100 up) 11

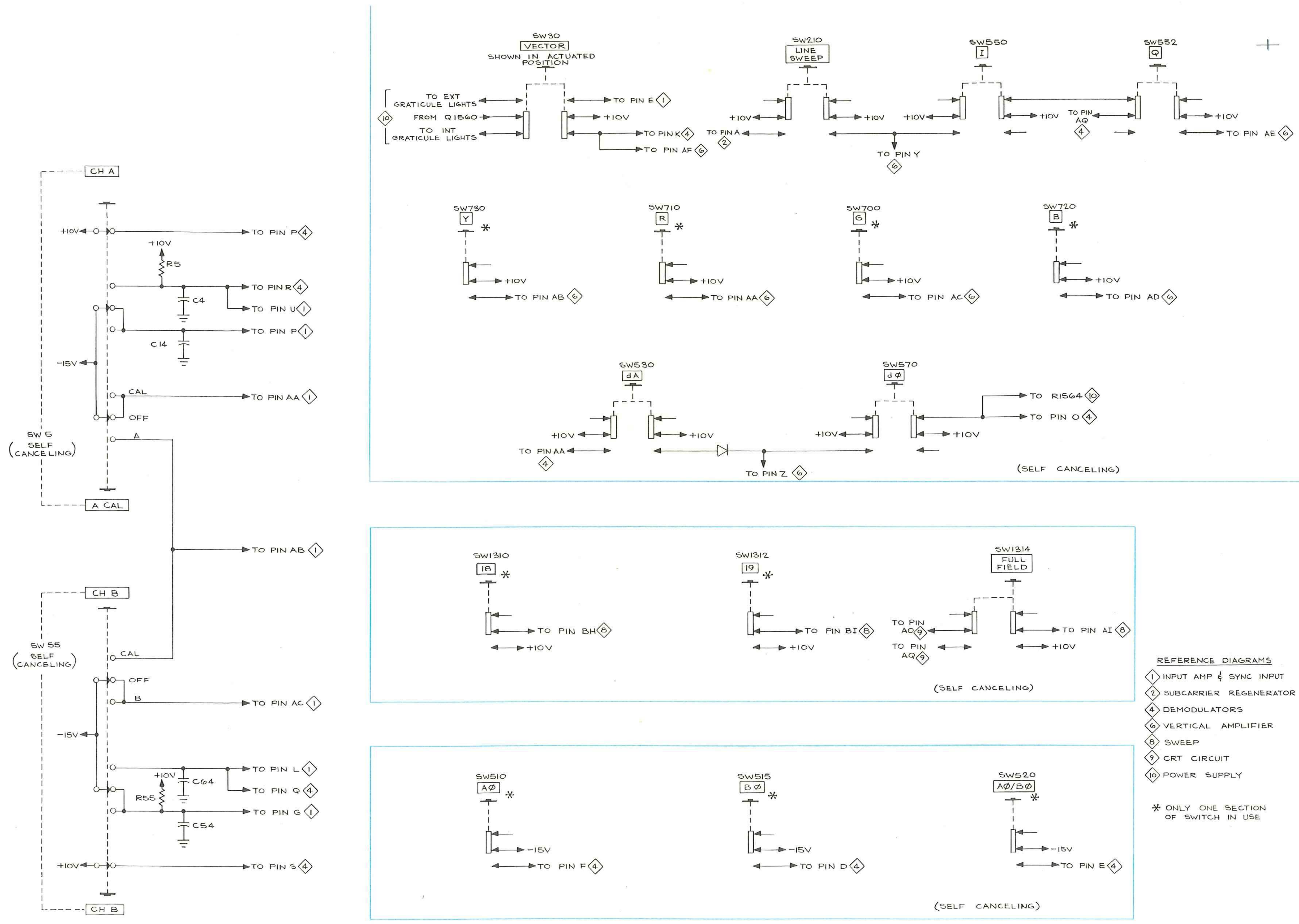

SW30
VECTOR
SHOWN IN ACTUATED POSITION
TO EXT GRATICULE LIGHTS
FROM Q1560
TO INT GRATICULE LIGHTS
TO PIN E
+10V
TO PIN K
TO PIN AF
SW210
LINE SWEEP
TO PIN A
TO PIN Y
SW550
I
SW552
Q
TO PIN AQ
TO PIN AE
SW730
Y
TO PIN AB
SW710
R
TO PIN AA
SW700
G
TO PIN AC
SW720
B
TO PIN AD
SW530
dA
TO PIN AA
TO PIN Z
SW570
dØ
TO R1564
TO PIN O
(SELF CANCELING)
CH A
TO PIN P
+10V
R5
TO PIN R
C4
TO PIN U
TO PIN P
C14
-15V
CAL
TO PIN AA
OFF
SW 5
SELF
(CANCELING)
A
A CAL
TO PIN AB
CH B
SW 55
SELF
(CANCELING)
CAL
OFF
B
TO PIN AC
TO PIN L
C64
TO PIN Q
R55
TO PIN G
C54
TO PIN S
CH B
SW1310
18
TO PIN BH
SW1312
19
TO PIN BI
SW1314
FULL FIELD
TO PIN AQ
TO PIN AI
(SELF CANCELING)
SW510
AØ
-15V
TO PIN F
SW515
BØ
TO PIN D
SW520
AØ/BØ
TO PIN E
(SELF CANCELING)
REFERENCE DIAGRAMS
1 INPUT AMP & SYNC INPUT
2 SUBCARRIER REGENERATOR
4 DEMODULATORS
6 VERTICAL AMPLIFIER
8 SWEEP
9 CRT CIRCUIT
10 POWER SUPPLY
* ONLY ONE SECTION OF SWITCH IN USE

Fig. 1 FRONT

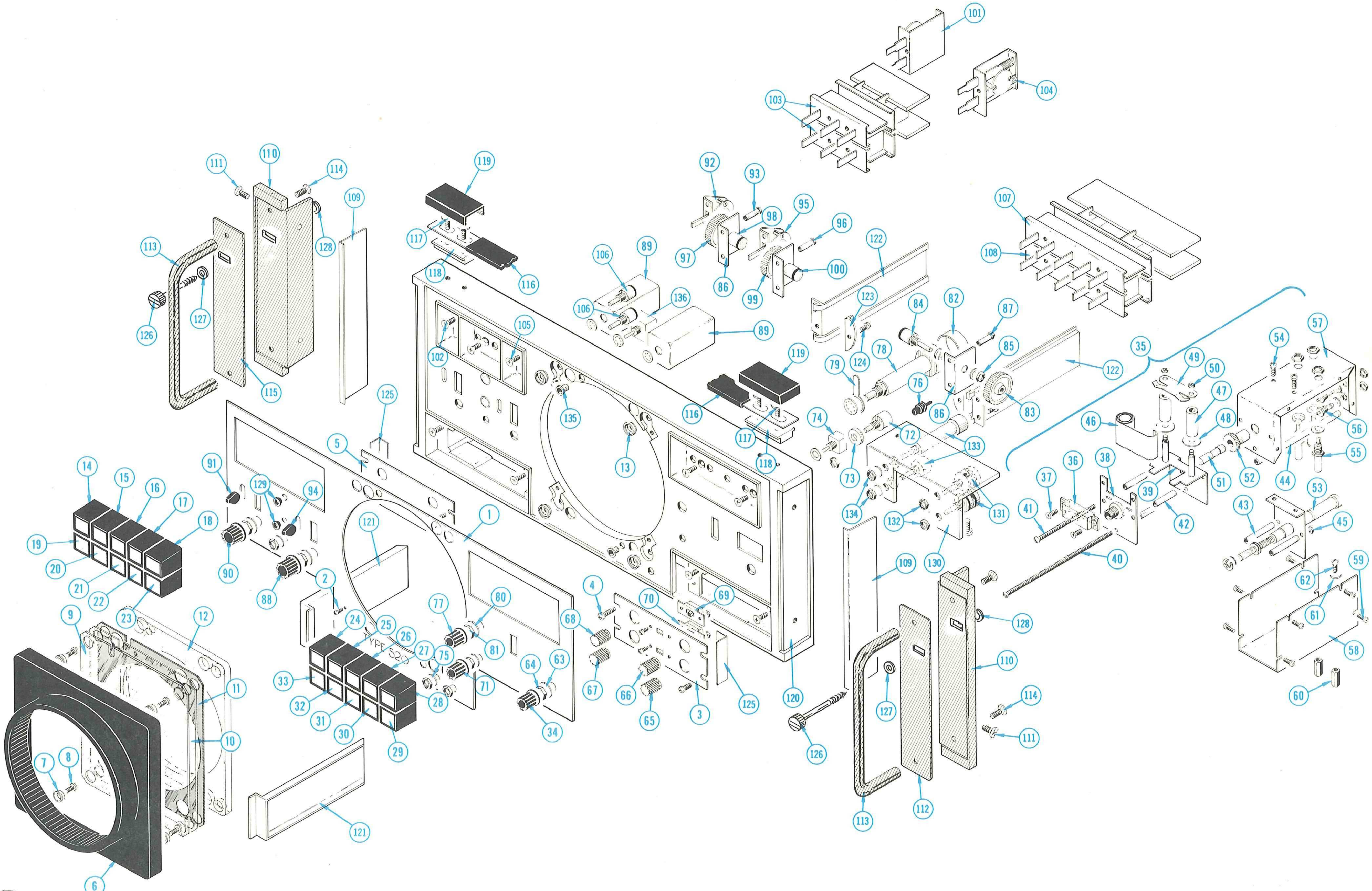


Fig. 2 CRT SHIELD, HIGH VOLTAGE & CHASSIS

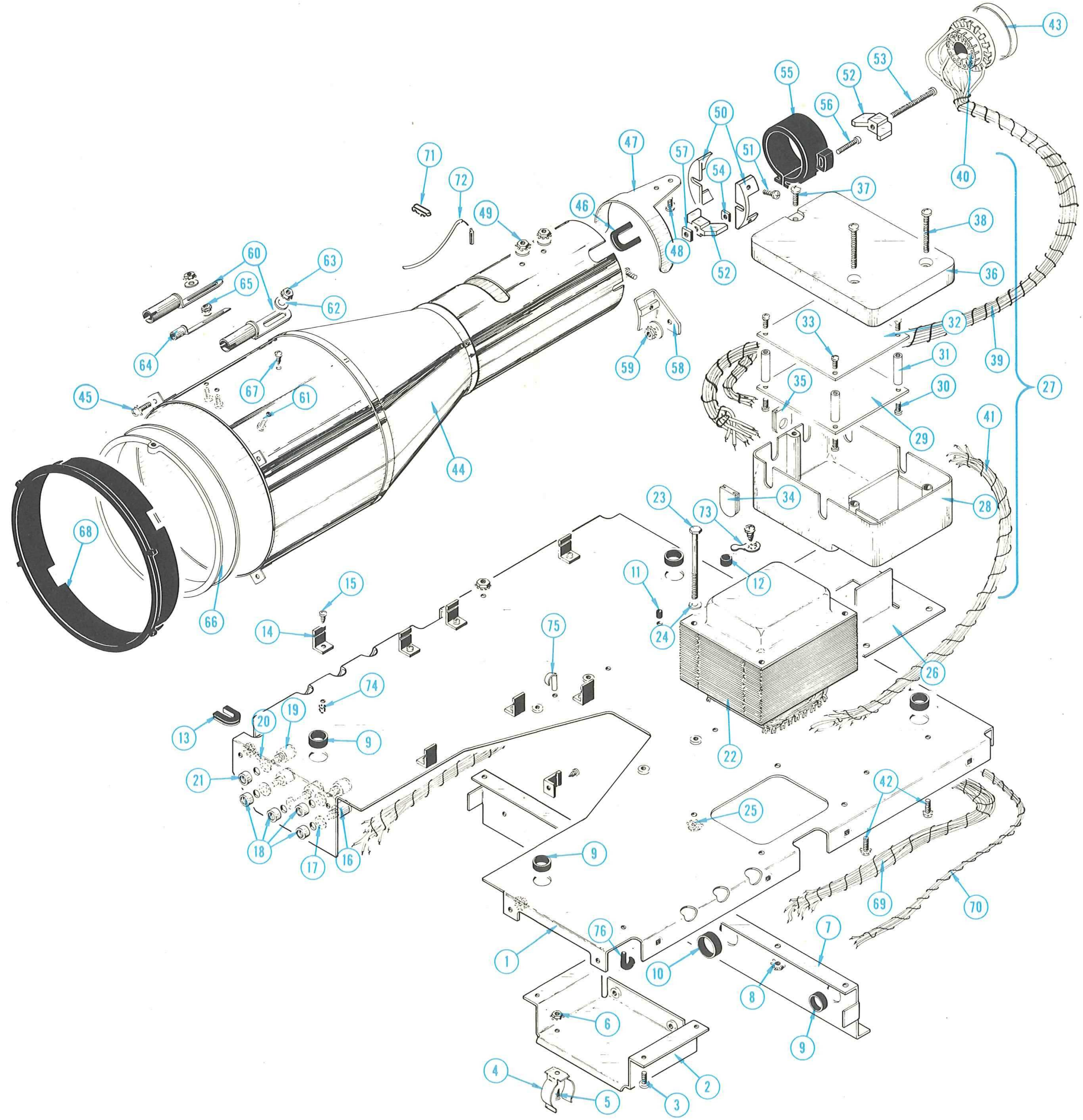


Fig. 3 CIRCUIT BOARDS

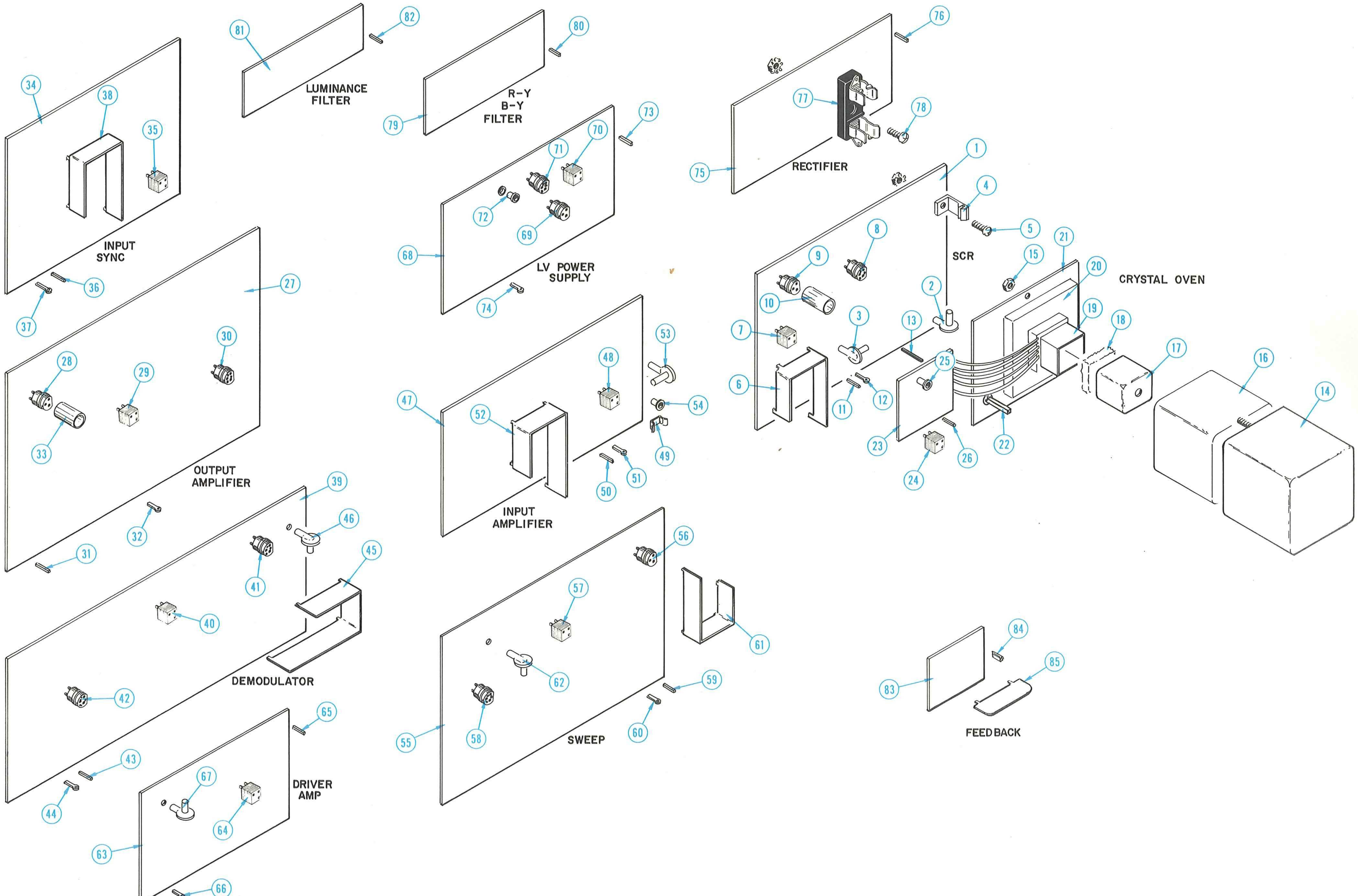
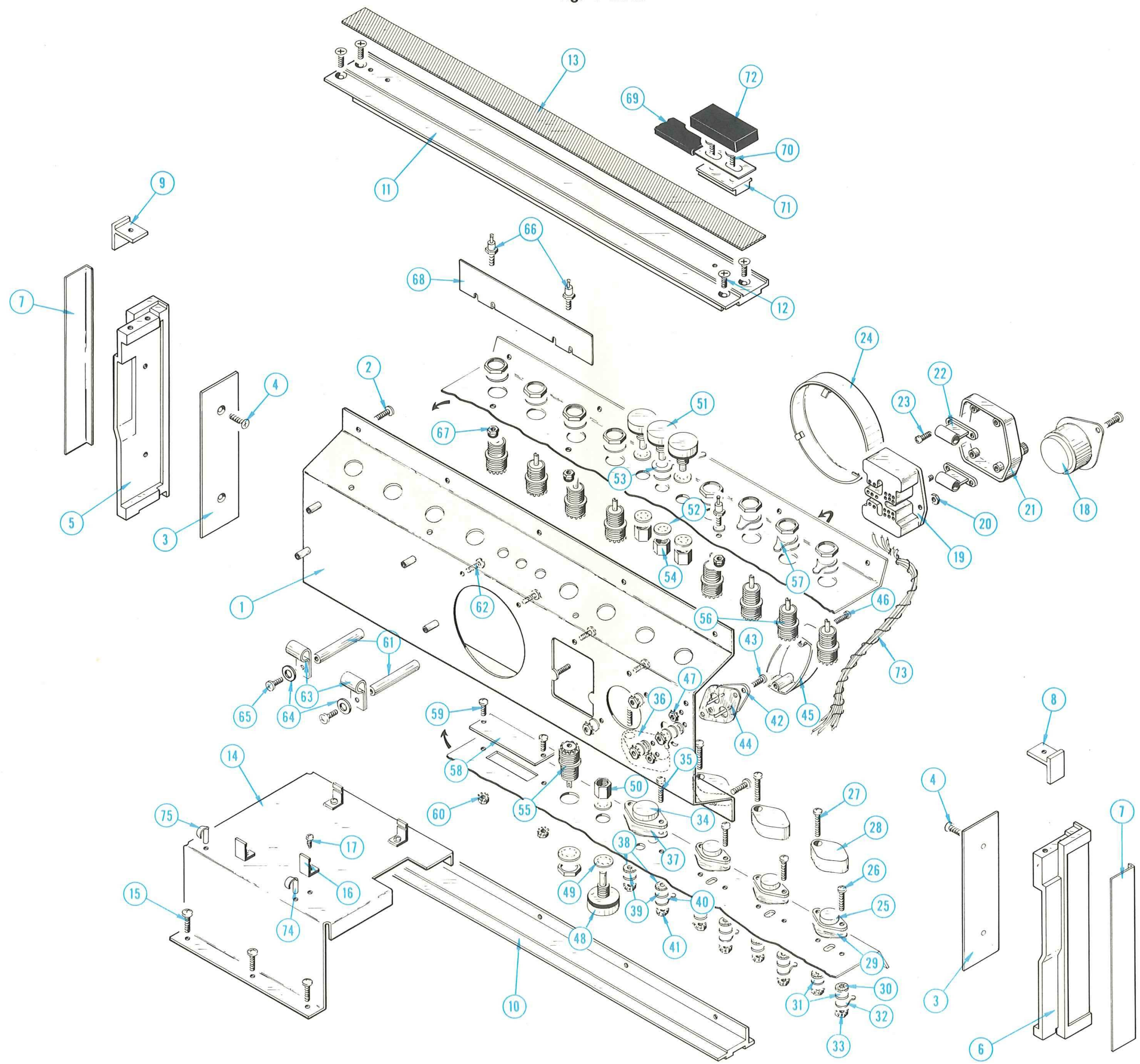


Fig. 4 REAR



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75

A

Fig. 5 CABINET & FRAME

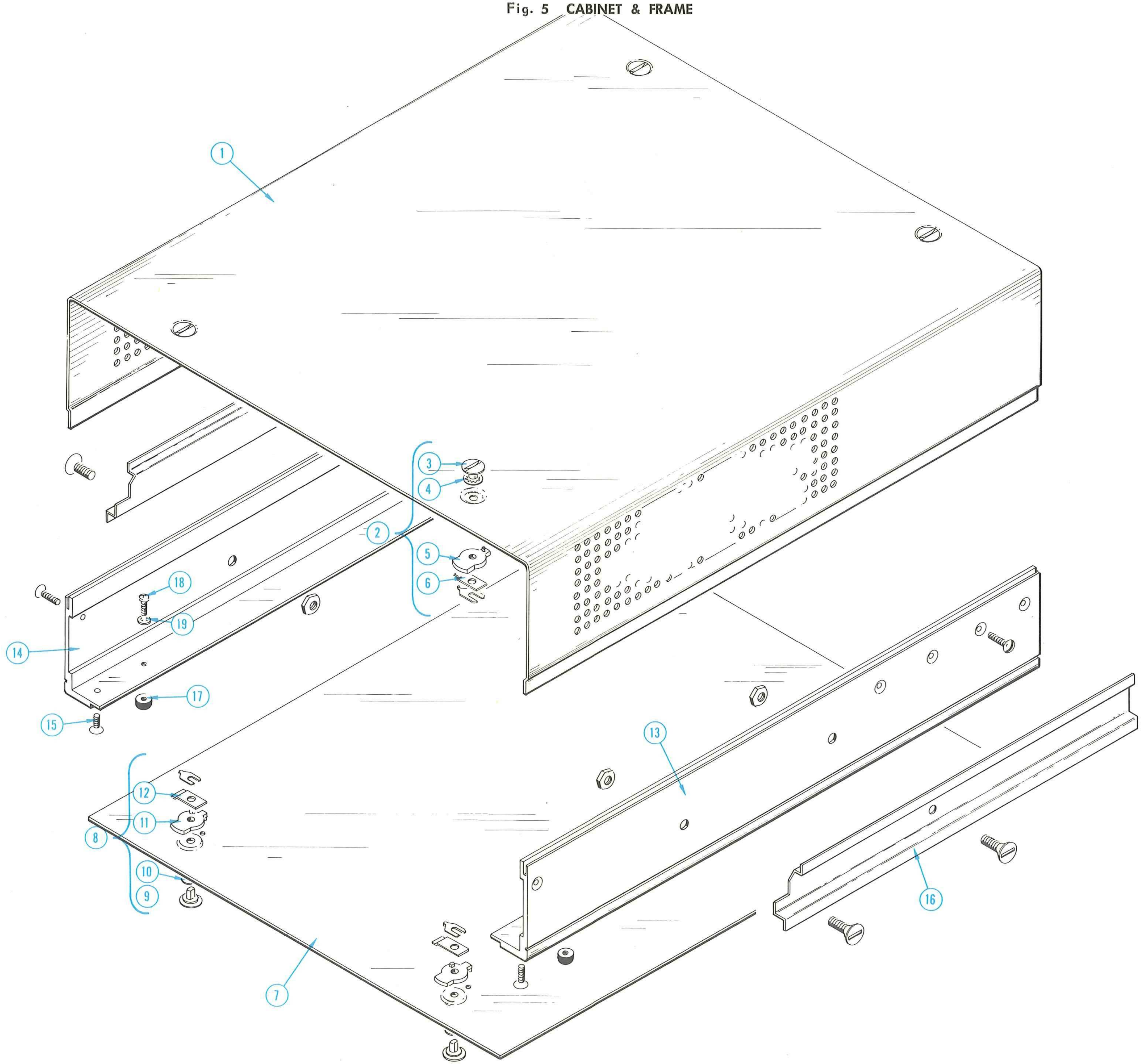


Fig. 6 STANDARD ACCESSORIES

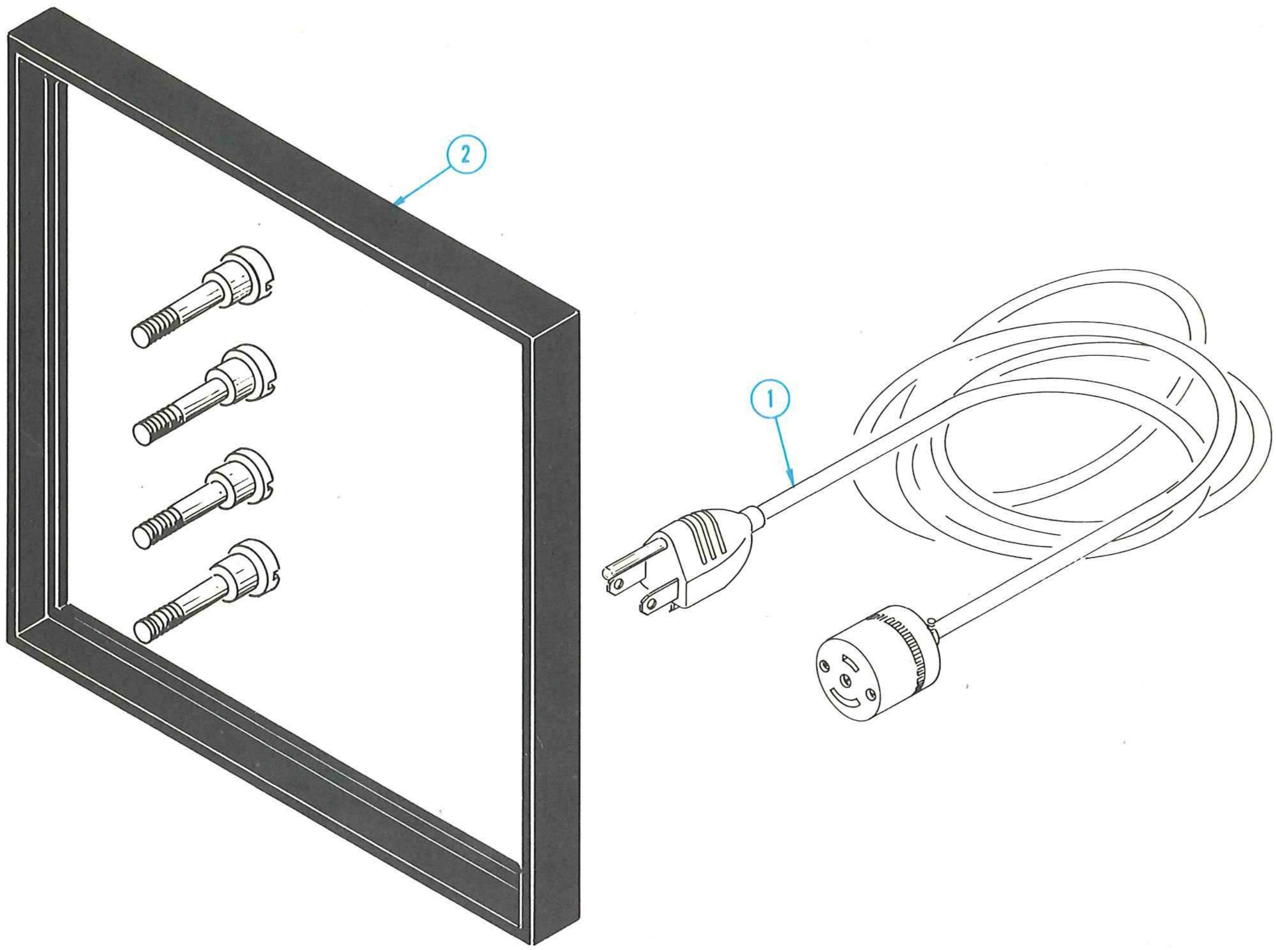


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Q t y	1 2 3 4 5 Description
6-1	161-0036-00			1	CABLE ASSEMBLY, power 7 feet 6 inches long
-2	016-0114-00			1	KIT, light seal & screws
	070-0639-01			1	MANUAL, instruction (not shown)

OTHER PARTS FURNISHED W/R520 ONLY

	351-0101-00	B010100	B199999	1	SLIDE chassis track, 1 pair (not shown)
	351-0195-00	B200000		1	SLIDE chassis track, 1 pair (not shown)

SECTION 10
RACKMOUNTING

Introduction

This section of the manual contains information for field converting the rackmount model of the Vectorscope into a bench model and vice versa. There is also some information about 3-3/8-inch wide Tilt-Lock Slideout Track availability, and rackmounting installation instructions using the 1¾-inch wide slideout tracks in a non-tilt installation.

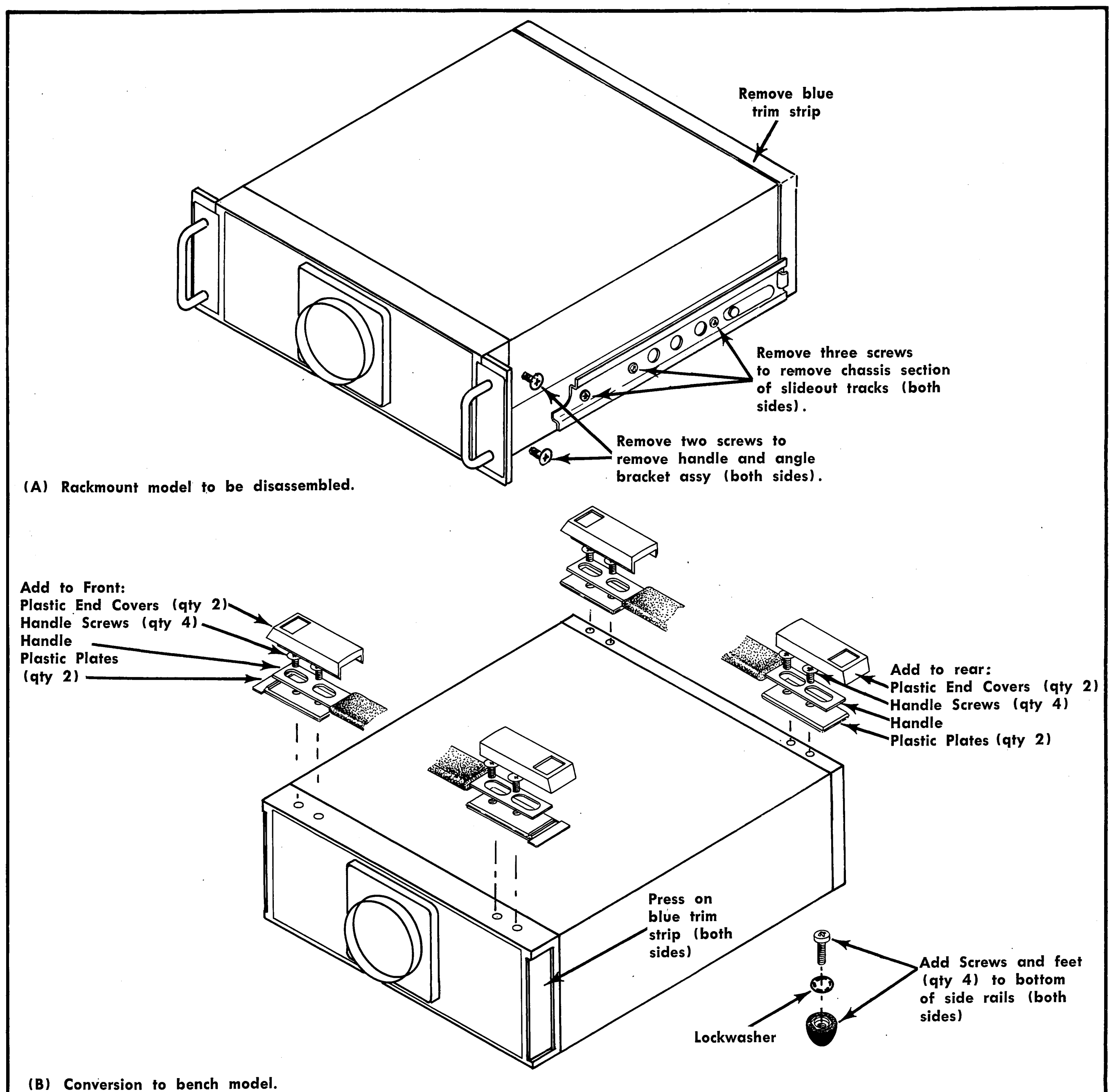


Fig. 10-1. Converting a rackmount Vectorscope into a bench model.

RACKMOUNT-TO-BENCH CONVERSION

Converting the Vectorscope From a Rackmount Model (Type R520) to a Bench Model (Type 520).

Remove these parts (see Fig. 10-1A):

1. Adhesive-backed blue trim strip from top rear-portion of the instrument.

2. Remove the chassis section of the slideout tracks (both sides).

3. Remove two screws from each angle bracket (both sides of the instrument) to remove the handle and angle bracket assembly as a unit.

Add these parts (see Fig. 10-1B):

1. Mount the front handle on the instrument by first laying the front plastic plates in line with the holes on the top edge of the front casting. Then, align the handle over the plates and fasten these parts to the instrument using the 10-32 x 0.40 inch screws.

2. Mount the rear handle on the instrument by first laying the rear plastic plates in line with holes on the top of the rear casting. Then, align the handle over the plates and fasten these parts to the instrument using the 10-32 x 40 inch screws.

3. Lay the plastic end cover over the handle screws. Apply finger pressure to snap the cover into place. Repeat this procedure to install all four covers.

4. Peel the paper backing from the adhesive side of the blue trim strips. Press the blue strips into place at the left and right sides of the instrument where the rackmount angle brackets have been removed.

5. Remove the bottom from the instrument and install the four feet. Each foot can be easily installed by holding the screw in the hole and threading the foot onto the screw. Repeat this procedure for all four feet.

6. Install the bottom cover.

BENCH-TO-RACKMOUNT CONVERSION

Converting a Bench Model (Type 520) to a Rackmount Model (Type R520).

Remove the parts that were added in Fig. 10-1B and described in the previous procedure. Add the parts that were removed in the previous procedure and illustrated in Fig. 10-1A. To install the blue trim strip, remove the paper backing and press the trim strip into place where the rear handle was removed.

NOTE

Before mounting the rackmount handles on the instrument, the parts for the handle and angle bracket assembly may be pre-assembled as shown in the Fig. 10-2 illustration. Use appropriate size retaining ring pliers to install the retaining ring on the thumb screw shaft.

When mounting the chassis sections of the slideout tracks, the pivot screw and tilt stop hardware supplied by the slideout track manufacturer are not used. Instead, use the 8-32 x 5/16-inch screws (212-0068-00) to mount the chassis sections to the sides of the instrument for a non-tilt installation.

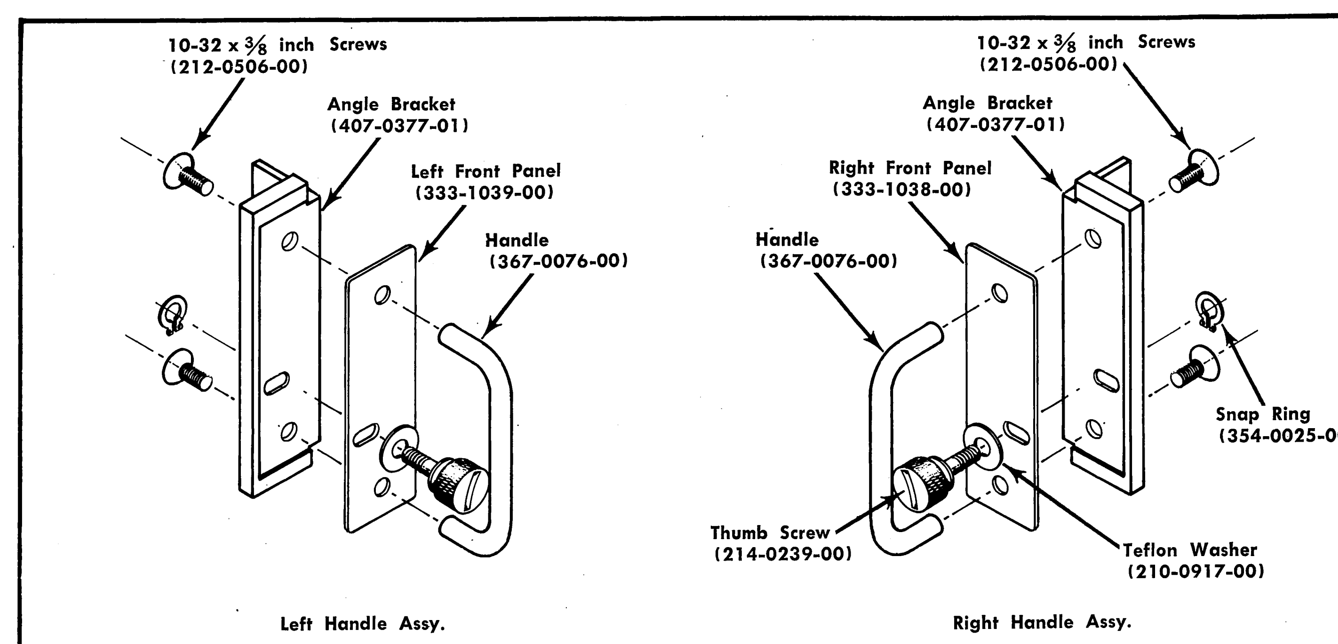


Fig. 10-2. Assembling the handles for the rackmount model.

MECHANICAL PARTS LIST FOR RACKMOUNT MODEL

Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty.	Description
				Parts for Handle Assembly (left & right)
407-0377-01			2	Bracket, angle (mounting hardware for bracket is shown in Fig. 10-2)
367-0076-00			2	Handle (mounting hardware for handle is shown in Fig. 10-2)
333-1039-00			1	Panel, left front
333-1038-00			1	Panel, right front
212-0506-00			4	Screw, 10-32 x 3/8 inch, FHS (holds handle & panel to angle bracket)
212-0560-00			4	Screw, 10-32 x 5/16 inch, FHS (mounts handle assembly to chassis)
214-0239-00			2	Screw, knurled thumb, fastener
210-0917-00			2	Washer, teflon
354-0025-00			2	Ring, retaining
124-0188-00			1	Strip, trim, blue, 16.3 x 0.876 inches
				Parts for Slideout Tracks
351-0104-00			1 pr.	Chassis section
212-0068-00			6	Screw, 8-32 x 5/16 inch, THS (mounts chassis sections to chassis)
351-0101-00	B010100	B199999	1 pr.	Intermediate & stationary section with mounting hardware
351-0195-00	B200000		1 pr.	Intermediate & stationary section with mounting hardware

MECHANICAL PARTS LIST FOR BENCH MODEL

Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty.	Description
386-1283-00			2	Plate, plastic (for front handle)
386-1352-00			2	Plate, plastic (for rear handle)
367-0073-00			2	Handle, blue
200-0728-00			4	Cover, handle end, plastic, blue
213-0155-00			8	Screw, 10-32 x 0.40 inch (mounts plates & handles to instruments)
124-0201-00			2	Strip, trim, blue (covers rackmount handle bracket holes)
348-0080-01			4	Feet, black, vinyl
210-0006-00			4	Lockwasher, internal, #6
211-0511-00			4	Screw, 6-32 x 1/2 inch, PHS (mounts feet to bottom of side rails)

TILT-LOCK SLIDEOUT TRACKS

On special order, the Type R520 can be equipped with premounted side-rail extrusions that accept 3 3/8-inch wide Tilt-Lock Slideout Tracks. The chassis sections of the slideout tracks are also premounted at the factory. These tracks permit the instrument to be tilted up or down when fully extended from the rack. In the fully extended position, the instrument can be locked into one of seven positions: horizontal; 45°, 90°, or 105° above or below the horizontal position. For further details, contact your Tektronix Field Engineer or Field Office.

RACKMOUNTING INSTRUCTIONS

Mounting Method (Figs. 10-3, 10-4 and 10-7)

This instrument will fit most commercial consoles and most 19-inch wide racks whose front and rear rail holes conform to Universal hole spacing. An extra hole in each rail must be drilled (and tapped, if desired) to permit mounting the Type R520 in a rack having EIA/RETMA/Western Electric hole spacing (see Fig. 10-7A).

Fig. 10-3 shows the instrument installed in a cabinet type rack with 1 3/4-inch wide slideout tracks for a non-tilt installation. The instrument is secured into the rack by means of two knurled thumb screws. When the thumb screws on the front panel are loosened to release the instrument, the instrument can be pulled out of the rack like a drawer to its fully extended position (see Fig. 10-4). This position permits many routine maintenance functions to be performed without completely removing the instrument from the rack.

The slideout tracks easily mount to the cabinet rack front and rear vertical mounting rails if the inside distance between the front and rear rails is within 10 9/16 inches to 24 3/8 inches. Some means of support (for example, make extensions for the rear mounting brackets) is needed to support the rear ends of the slideout tracks if the tracks are going to be installed in a cabinet rack whose inside dimension between front and rear rails is not the proper distance (10 9/16 inches to 24 3/8 inches).

Instrument Dimension

The last pullout page in this section shows dimensional drawings exclusive of the power cord and cables.

Rack Dimensions

Width—A standard 19-inch rack may be used. The dimension or opening between the front rails must be at least $17\frac{5}{8}$ inches (see Fig. 10-4) for a cabinet rack in which the front lip of the stationary section is mounted behind an untapped front rail as shown in Fig. 10-7B. If the front rails are tapped and the stationary section is mounted in front of the front rail as shown in Fig. 10-7C, the dimension between the front rails should be at least $17\frac{3}{4}$ inches. These dimensions allow room on each side of the instrument for the slideout tracks to operate so the instrument can move freely in and out of the rack.

Depth—For proper circulation of cooling air, allow at least 2 inches clearance behind the rear of the instrument and any enclosure on the rack (see dimensional drawing). If it is sometimes necessary or desirable to operate the Type R520 in the fully extended position, use cables that are long enough to reach from the signal source to the instrument.

Rackmounting in a Cabinet Rack

General Information—The slideout tracks for the instrument consist of two assemblies, one for the left side of the instrument and one for the right side. Each assembly consists of three sections as illustrated in Fig. 10-5. The stationary section attaches to the front and rear rails of the rack with inside dimensions as indicated in Fig. 10-4, the chassis section attaches to the instrument and is installed at the factory; the intermediate section fits between the other two sections to allow the instrument to fully extend out of the rack.

The small hardware components included with the slideout track assemblies are shown in Fig. 10-6. The hardware shown in Fig. 10-6 is used to mount the slideout tracks to the rack rails having this compatibility:

(a) Front and rear rail holes must be large enough to allow inserting a 10-32 screw through the rail mounting holes if the rails are untapped (see Fig. 10-7B).

(b) Or, front and rear rail holes must be tapped to accept a 10-32 screw if Fig. 10-7C mounting method is used. Note in Fig. 10-7C right hand illustration that a #10 washer (not supplied) may be added to provide increased bearing surface for the slideout track stationary section front flange.

(c) Front and rear rail holes must be located on Universal spacing, that is the sequence for the hole spacing is: $\frac{5}{8}$ inch, $\frac{1}{2}$ inch, $\frac{5}{8}$ inch, $\frac{1}{2}$ inch, etc.

Because of the above compatibility, there will be some small parts left over.

The stationary and intermediate sections for both sides of the rack are shipped as a matched set and should not be separated. The matched sets for both sides including hardware are marked 351-0195-00 on the package for instruments SN B200000 and up. To identify the assemblies, note that the automatic latch and intermediate section stop are both located near the top of the matched set.

Mounting Procedure—Use the following procedure to mount both sets. See Fig. 10-7 for installation details.

1. To mount the instrument directly above or below another instrument in the cabinet rack, select the appropriate holes in the front rack rails for the stationary sections using Fig. 10-7A as a guide.

2. Mount the stationary slideout track sections to the front rack rails using either of these methods:

(a) If the front flanges of the stationary sections are to be mounted **behind the front rails** (rails are countersunk or not tapped), mount the stationary sections as shown in Fig. 10-7B right-hand illustration. Note that the bar nut is positioned so the $\frac{1}{2}$-inch spaced holes are located near the top so the upper-most threaded hole will accept the thumb screw when the Type R520 is fully installed.

(b) If the front flanges of the stationary sections are to be mounted **in front of** the front rails (rails are tapped for 10-32 screws), mount the stationary sections as shown in Fig. 10-7C righthand illustration. To provide increased bearing surface for the screw head to securely fasten the front flange to the rail, a flat washer (not suppled) may be added under the screw head. However, consider that using this mounting method, the front panel will not fit flush against the front rail because of the stationary section and washer thickness. If a flush fit is preferred, method 2 (a) should be used.

3. Mount the stationary slideout track sections to the rear rack rails using either of these methods:

(a) If the rear rack rail holes are **not tapped** to accept 10-32 machine screws, mount the left stationary section with hardware provided as shown in the left-hand or center illustration of Fig. 10-7B. Note that the rear mounting bracket can be installed either way so the slideout tracks will fit a deep or shallow cabinet rack. Use Fig. 10-7B as a guide for mounting the right stationary section. Make sure the stationary sections are horizontally aligned so they are level and parallel with each other.

(b) If the rear rack rail holes are **tapped** to accept 10-32 machine screws, mount the left stationary section with hardware provided as shown in the left-hand or center illustration of Fig. 10-7C. Note that the rear mounting bracket can be installed either way so the slideout tracks will fit a deep or shallow cabinet rack. Use Fig. 10-7C as a guide for mounting the right stationary section. Make sure the stationary sections are horizontally aligned so they are level and parallel with each other.

Adjustments

To adjust the slideout tracks for smooth operation, proceed as follows:

1. Insert the instrument into the rack as shown in Fig. 10-8.

2. Adjust the slideout tracks for proper spacing as shown in Fig. 10-9.

Maintenance

The slideout tracks require no lubrication. The special dark gray finish on the sliding parts is a permanent lubrication.

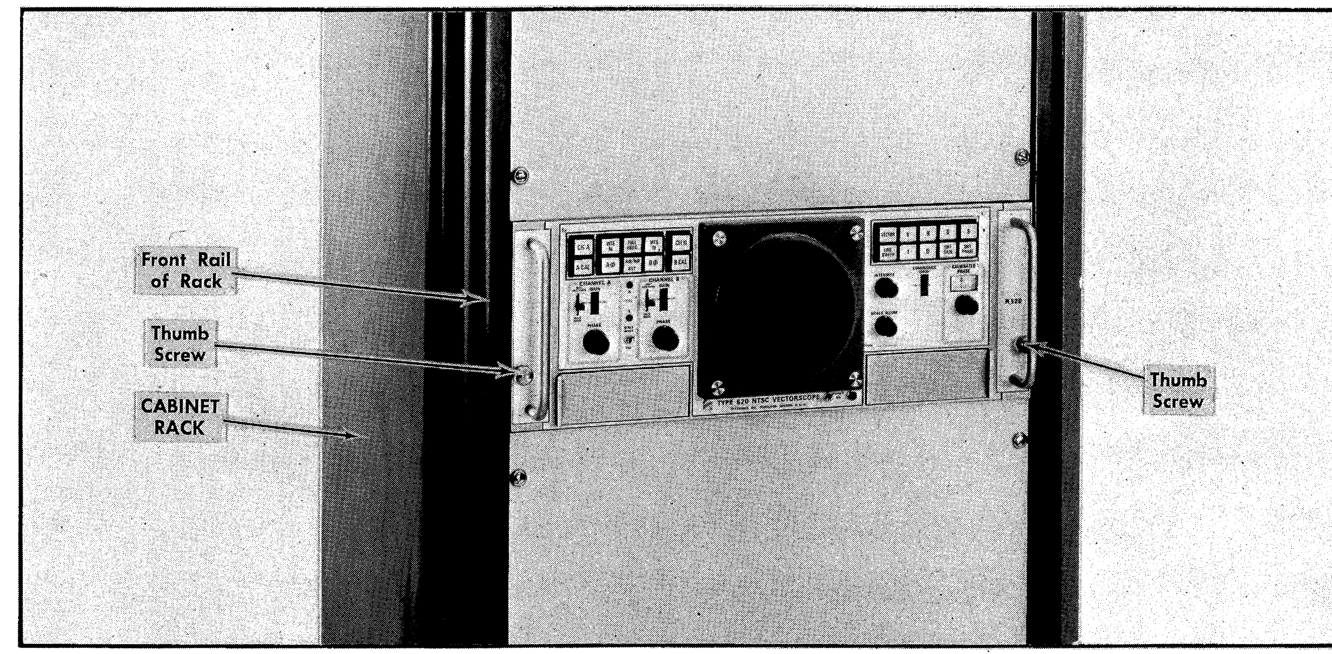


Fig. 10-3. The Type R520 installed in a cabinet type rack.

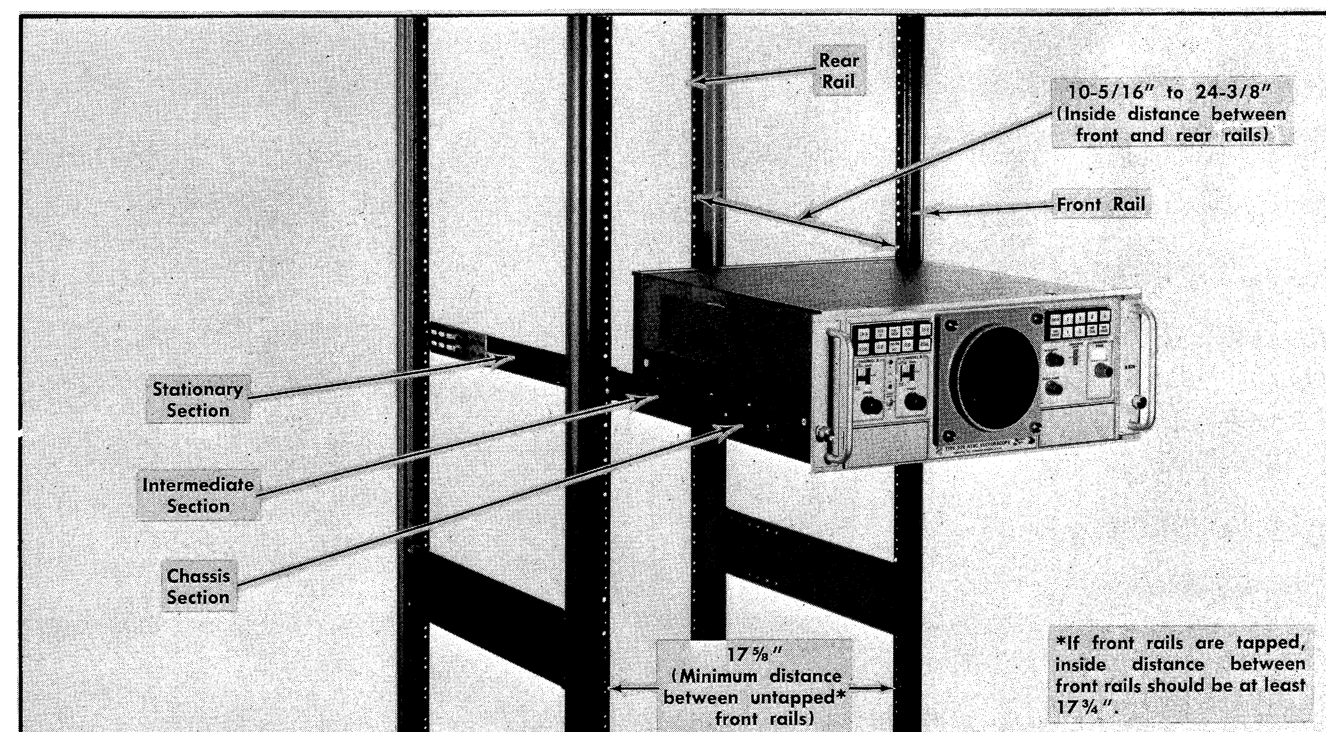


Fig. 10-4. The Type R520 shown in the fully extended position. The cabinet sides have been removed from the rack to show mounting details.

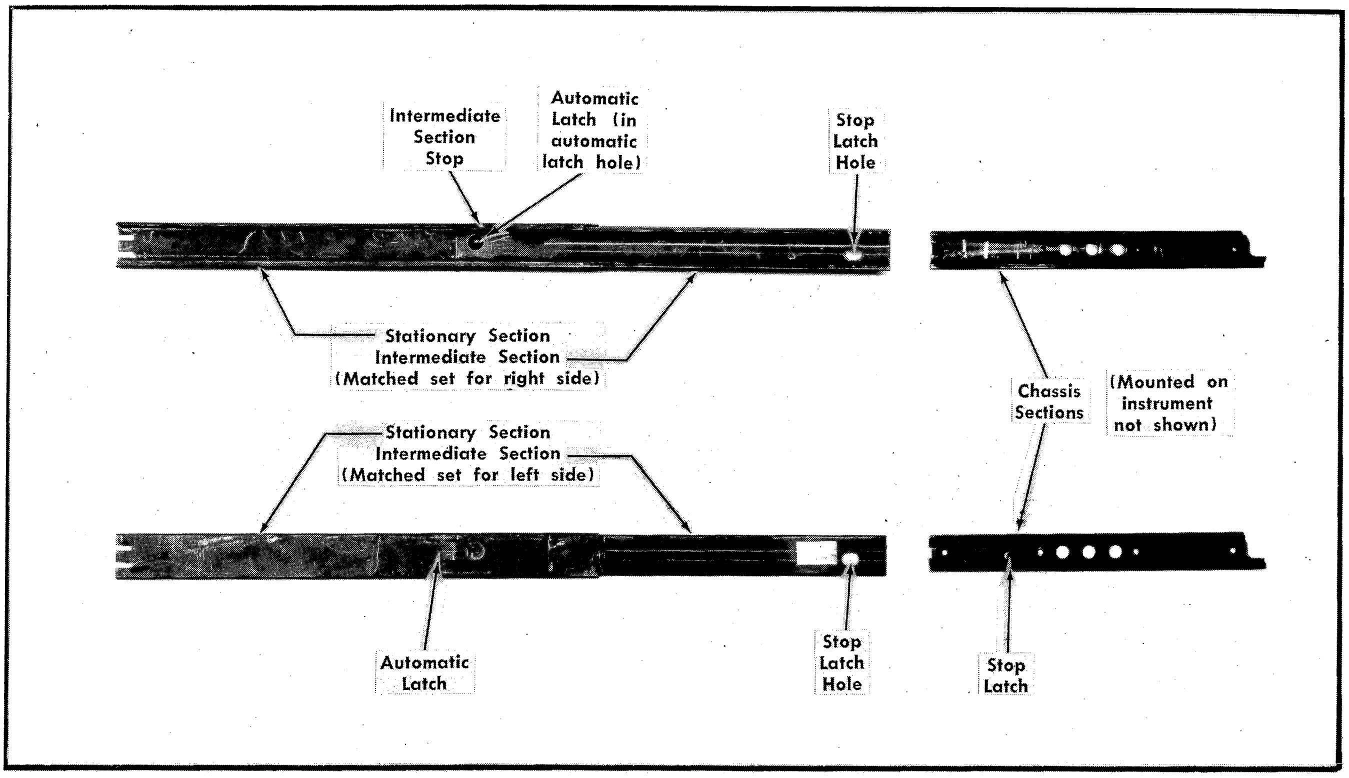


Fig. 10-5. Illustrations showing the 1 3/4-inch wide slideout track assemblies.

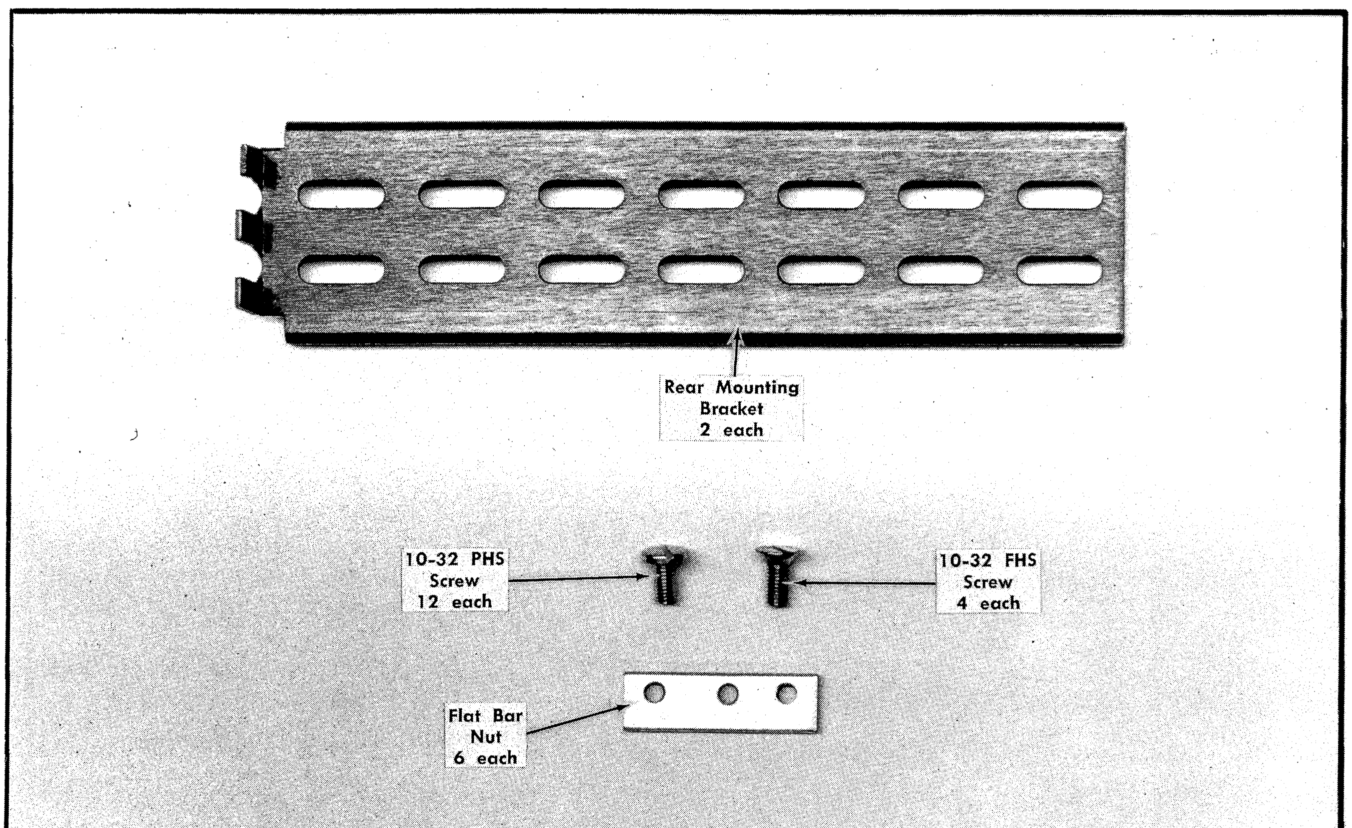
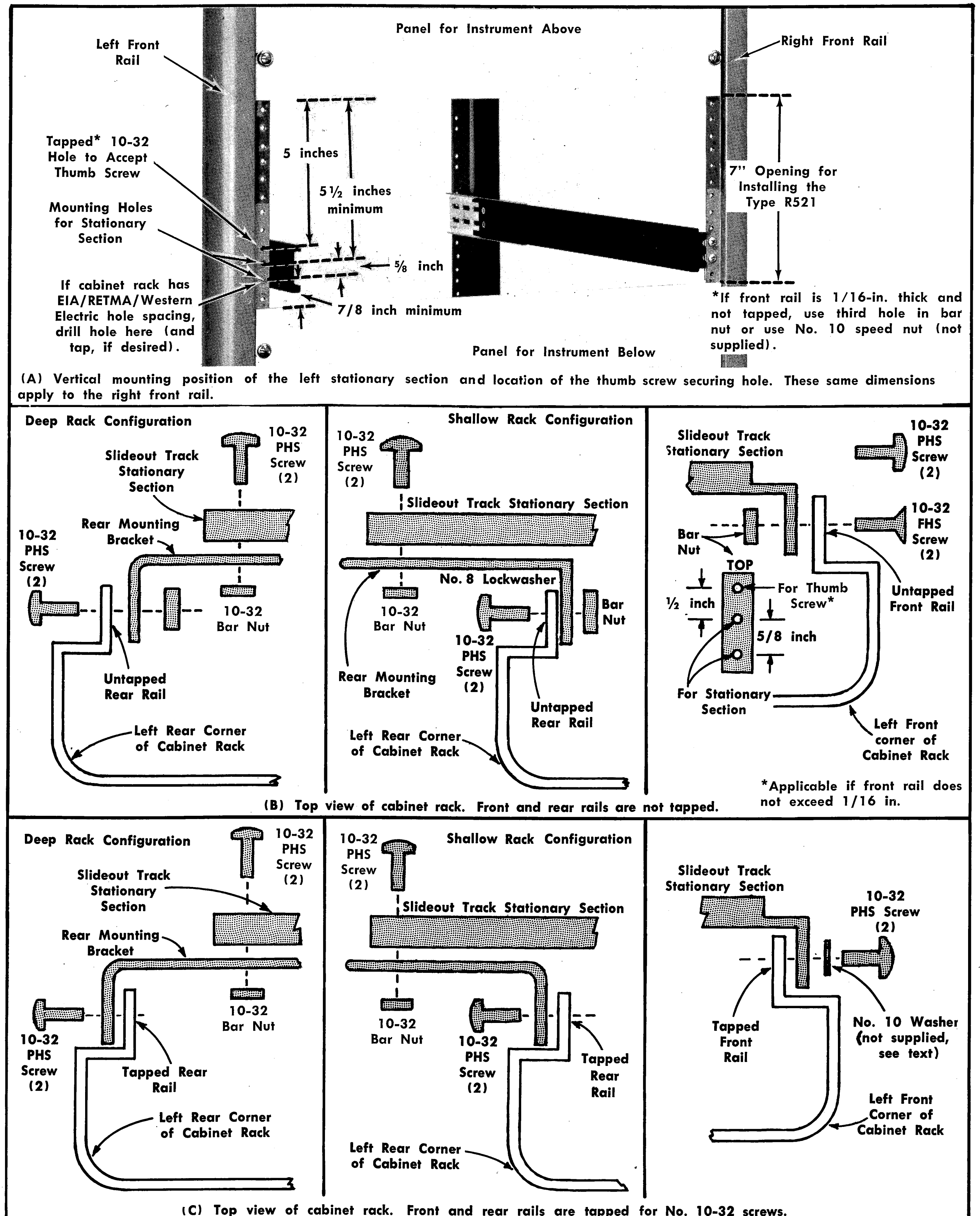


Fig. 10-6. Small hardware components for mounting the stationary sections to the rack rails.



(A) Vertical mounting position of the left stationary section and location of the thumb screw securing hole. These same dimensions apply to the right front rail.

(B) Top view of cabinet rack. Front and rear rails are not tapped.

(C) Top view of cabinet rack. Front and rear rails are tapped for No. 10-32 screws.

Fig. 10-7. Mounting the left stationary section (with its matched intermediate section, not shown in illustrations B and C) to the rack rails.

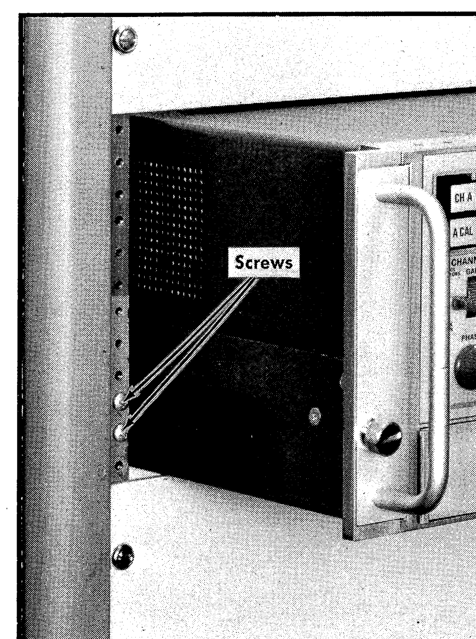
TO INSTALL

1. Pull the slideout track intermediate sections out to the fully extended position.
2. Insert the instrument chassis sections into the intermediate sections.
3. Press stop latches and push instrument toward rack until the latches snap into their holes.
4. Again press stop latches and push instrument into rack.
5. Secure the instrument in place with the front-panel thumb screws.

TO REMOVE

1. Loosen the front panel thumb screws.
2. Pull instrument outward until the stop latches snap into the holes.
3. Press stop latches and remove the instrument.

Fig. 10-8. Installing and removing the instrument.



1. Loosen screws on both sides.
2. Allow slides to seek proper width.
3. Center instrument.
4. Retighten screws.

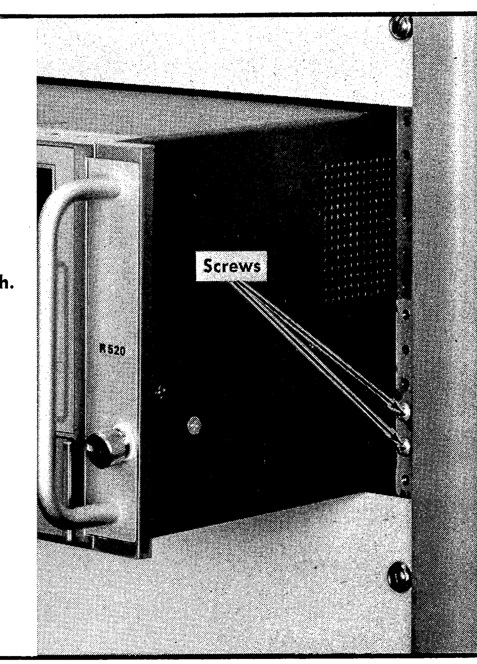
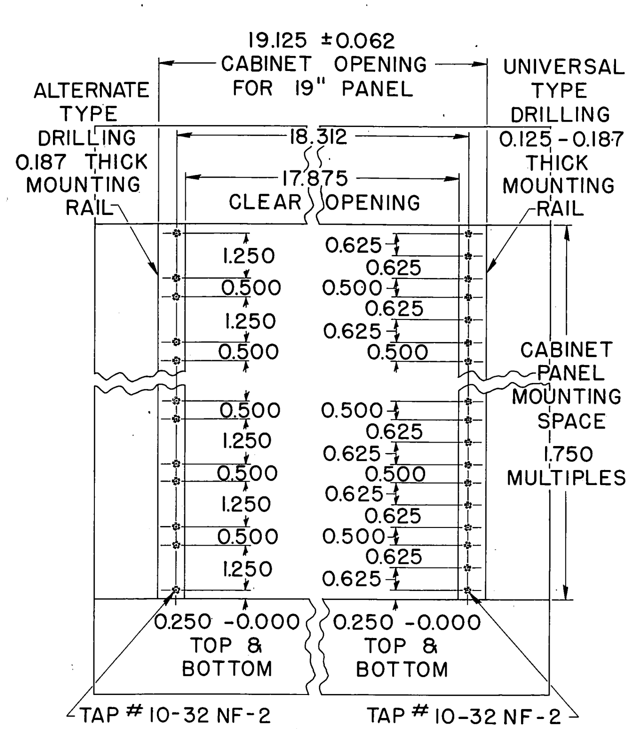
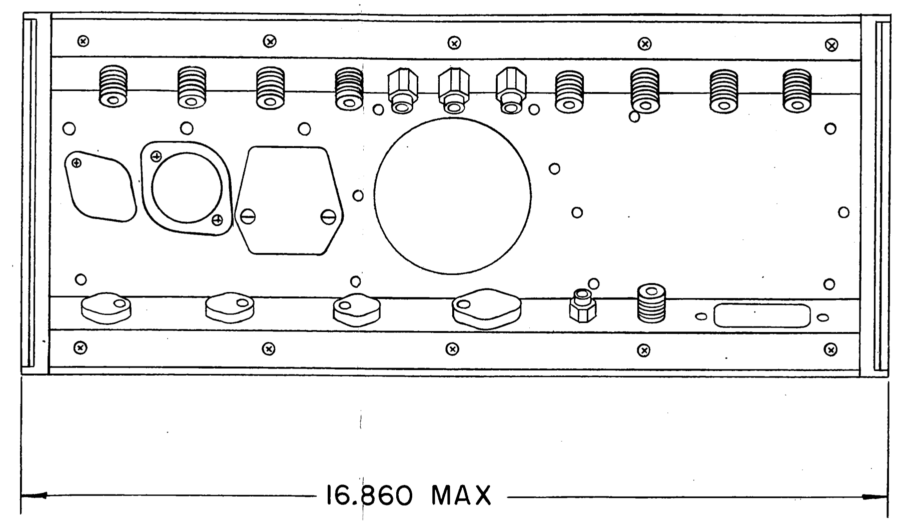


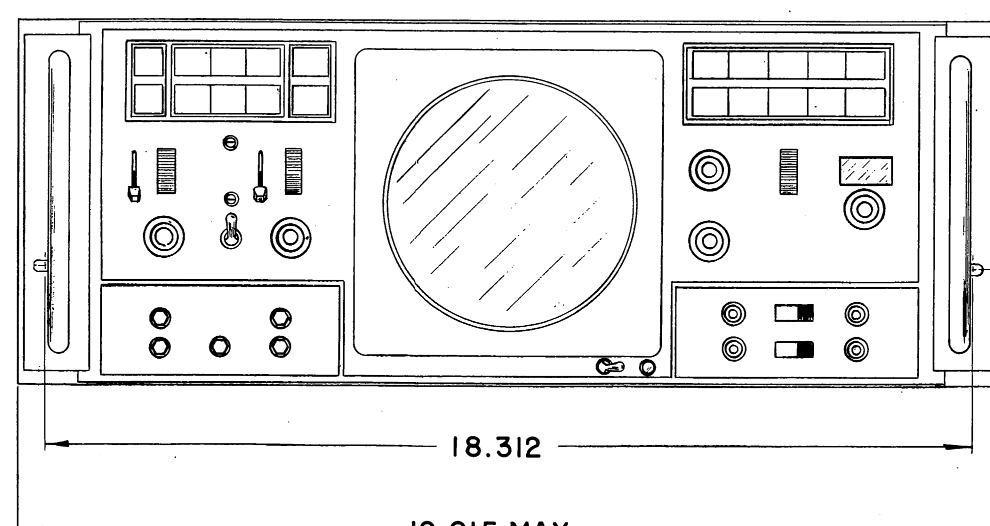
Fig. 10-9. Adjusting the slideout tracks for smooth sliding action.

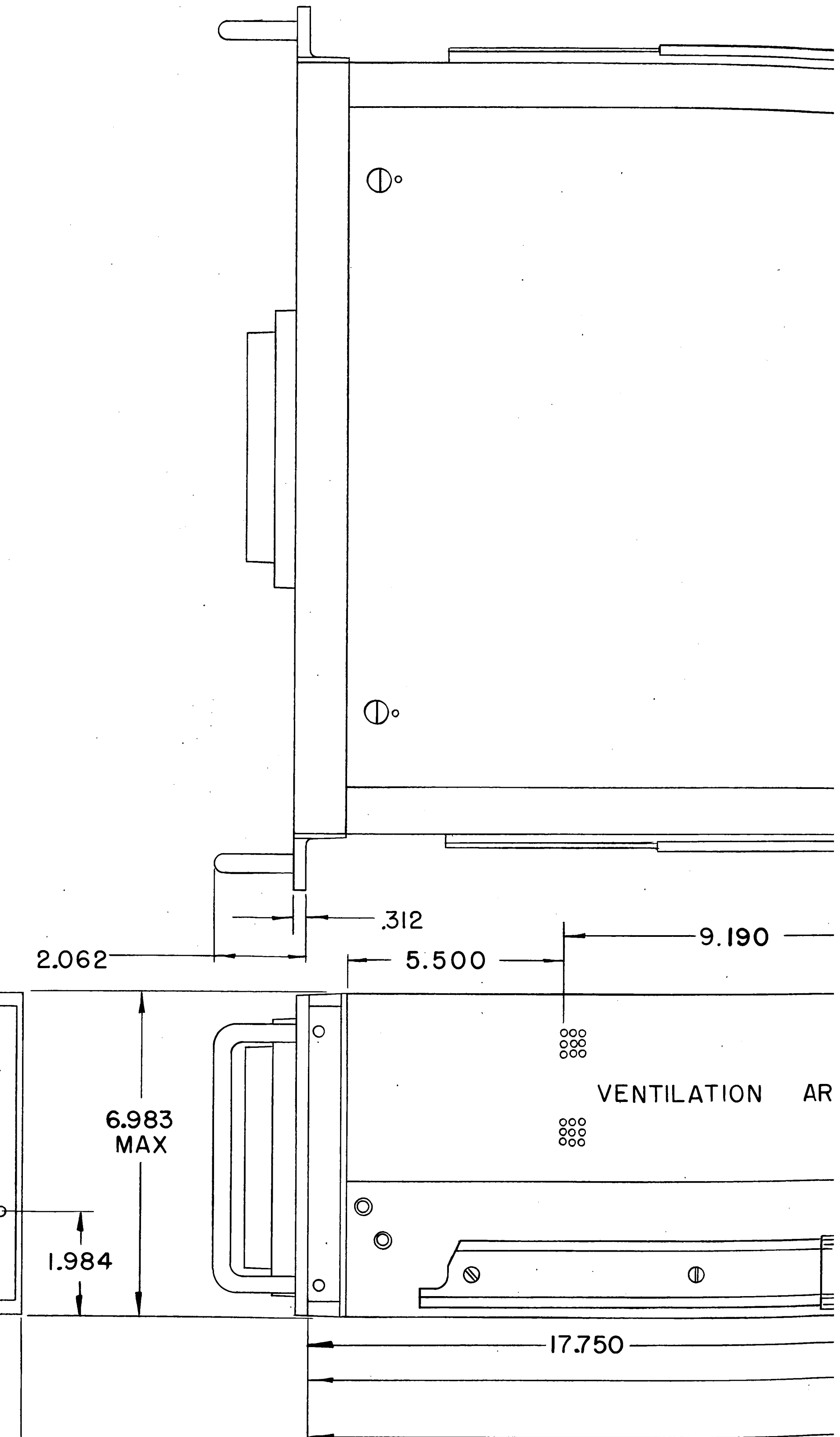
RACKMOUNTING

RACK RAIL TYPES

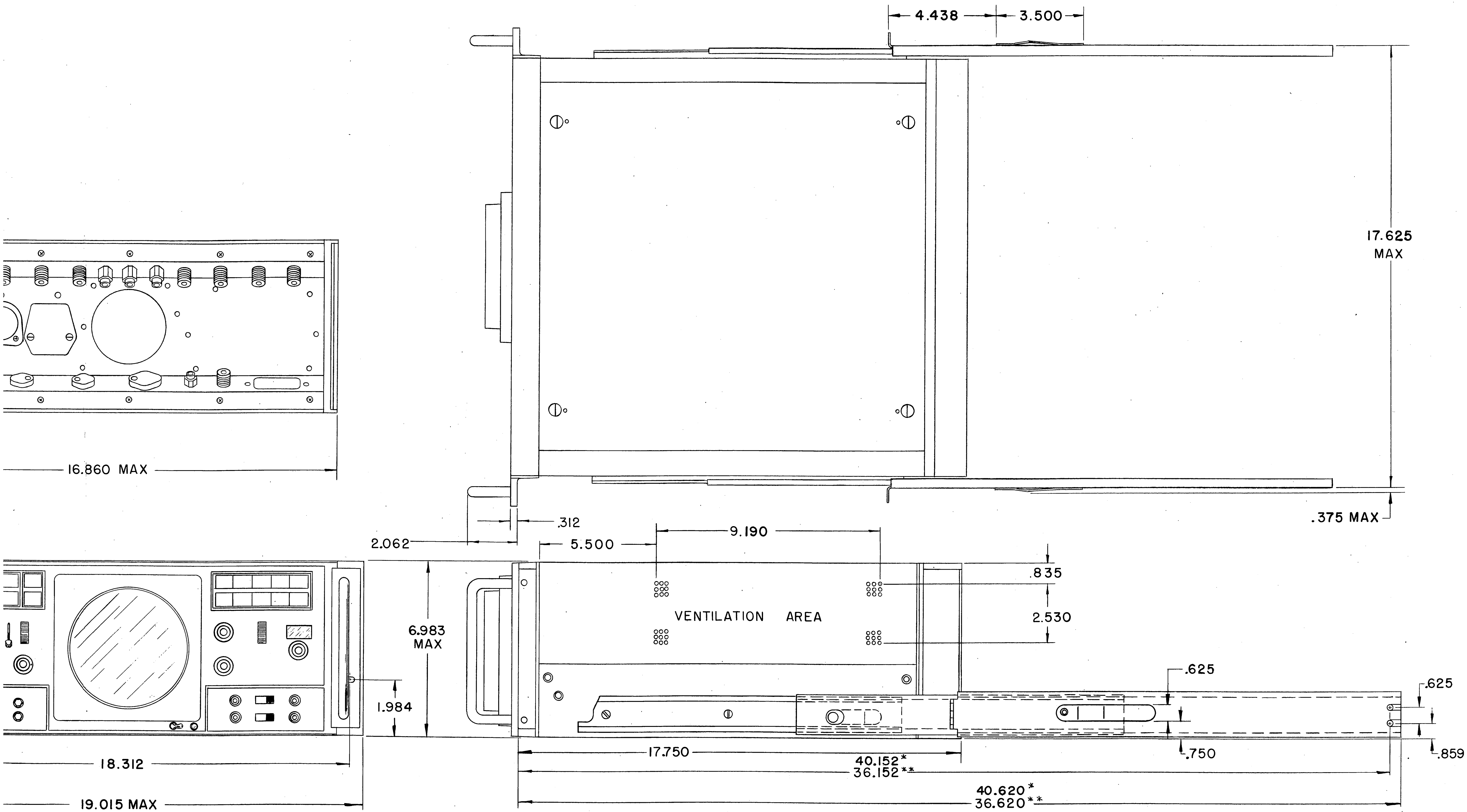








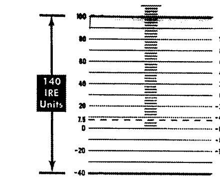
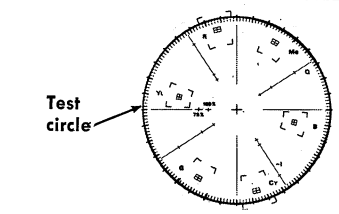
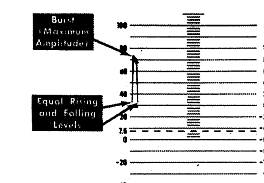
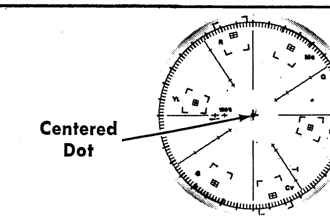
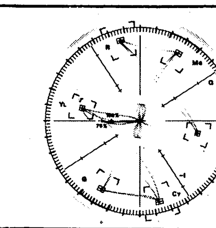
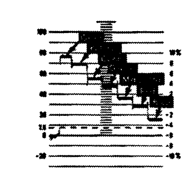
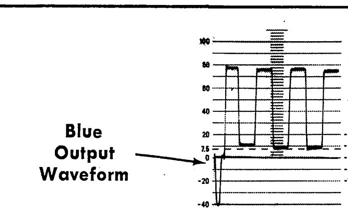
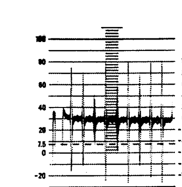
* FOR INSTRUMENTS SNB
** FOR INSTRUMENTS BELO

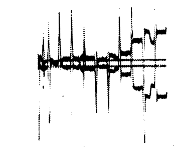
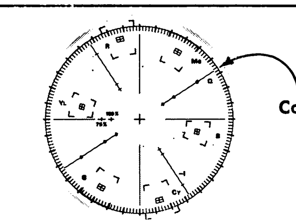
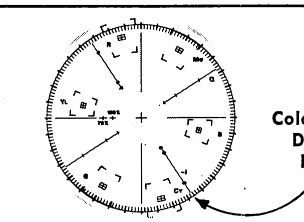
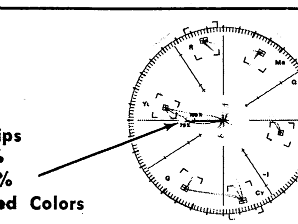


* FOR INSTRUMENTS SN B200000-UP
** FOR INSTRUMENTS BELOW SN B200000

TYPE R520 NTSC VECTORSCOPE

DIMENSION DRAWING

Display No.	Type of Check or Display Using the Vectorscope	Signal Applied to Vectorscope Rear-Panel Connector	Buttons Depressed: Signal Selector	Buttons Depressed: Display Selector	Other Pertinent Control Settings	Measurement Information	Display
1	Luminance amplitude calibration	None required	A CAL, FULL FIELD, Aϕ (or Bϕ)	Y	Ch A 100%-75%-MAX GAIN: 75%. Ch A GAIN: CAL. LUMINANCE GAIN: CAL.	Display amplitude should be 140 IRE units (see Fig. 2-14). If not, go to step 12 in the First-Time Operation procedure.	
2	Test circle calibration	None required	A CAL, FULL FIELD, Aϕ (or Bϕ)	VECTOR	Ch A 100%-75%-MAX GAIN: 75%. Ch A GAIN: CAL. ϕ REF: BURST.	Vectorscope is properly calibrated if test circle coincides with vector graticule guide circle (see Fig. 2-15A). If not, refer to step 13 in the First-Time Operation procedure.	
3	Unstable display (due to misadjusted BURST FLAG TIMING adjustment)	Composite color video to CH A	CH A, FULL FIELD, Aϕ (or Bϕ)	LINE SWEEP	SYNC: INT Ch A 100%-75%-MAX GAIN: 75%. Ch A GAIN: CAL. ϕ REF: BURST. A PHASE: Adjust for maximum burst amplitude.	Adjust BURST FLAG TIMING control for equal rising and falling intensified portions on burst waveform (see Fig. 2-12A and step 9 in First-Time Operation procedure).	
4	Vector reference point calibration	None.	FULL FIELD, Aϕ (or Bϕ)	VECTOR	ϕ REF: BURST.	Reference dot should be located at center of vector graticule guide circle; if not, go to Display No. 2 in this table.	
5	Normal color vector display	Color-bar signal to CH A	CH A, FULL FIELD, Aϕ (or Bϕ)	VECTOR	SYNC: INT. Ch A 100%-75%-MAX GAIN: 75% Ch A GAIN: CAL. ϕ REF: BURST. A PHASE: Adjusted so burst coincides with 180° position.	Normal display: Burst tip at 75% mark and color vector dots in inner boxes (see Fig. 2-17A). If not, refer to topic, "Vector Displays".	
6	Normal luminance amplitude display of color bar signal	Color-bar signal to CH A	CH A, FULL FIELD, Aϕ (or Bϕ)	Y	SYNC: INT. Ch A 100%-75%-MAX GAIN: 75%. Ch A GAIN: CAL. ϕ REF: BURST. LUMINANCE GAIN: CAL.	Display will appear similar to that shown in Fig. 2-17B in the First-Time Operation procedure.	
7	Displaying the red, green, or blue waveform of a color bar test signal.	Color-bar signal to Ch A	A CAL, FULL FIELD, Aϕ (or Bϕ)	VECTOR	SYNC: INT. Ch A 100%-75%-MAX GAIN: 75%. Ch A GAIN: CAL. ϕ REF: BURST. Aϕ: Adjusted so burst coincides with 180° position.	First, obtain a normal vector display as described in Display No. 5. Next, depress the Function Selector R, G or B button to display the desired output waveform.	
8	Differential gain	Subcarrier modulated staircase signal to CH A	CH A, FULL FIELD, Aϕ (or Bϕ)	DIFF GAIN	SYNC: INT. Ch A 100%-75%-MAX GAIN: MAX GAIN. Ch A GAIN: CAL. ϕ REF: BURST.	Straight line display indicates no differential gain. Vertical-amplitude variations indicate stairsteps are non-linear (differential gain). Horizontally positioning the desired step to graticule center scale facilitates measurement.	

9.	Differential phase	Subcarrier modulated staircase signal to CH A	CH A, FULL FIELD, Aϕ (or Bϕ)	DIFF PHASE	SYNC: INT. Ch A 100%-75%-MAX GAIN: MAX GAIN. Ch A GAIN: CAL. ϕ REF: BURST. A PHASE: Adjusted to center the display.	Two straight parallel traces indicate no differential phase. Vertical-amplitude variations in the traces indicate presence of differential phase (see Fig. 2-18E and F, step 23 in the First-Time Operation procedure).	
10.	Color VITS on line 18 of field 2	Color VITS to CH A	CH A, VITS 18, Aϕ (or Bϕ)	See Column 7	SYNC: INT. Ch A 100%-75%-MAX GAIN: See column 7. Ch A GAIN: CAL. ϕ REF: BURST. LUMINANCE GAIN: CAL. FIELD: 2.	Exact nature of this signal to be defined by the National Television Committee.	
11.	Subcarrier modulated staircase VITS: on line 19 of field 2	Composite video with staircase VITS to CH A	CH A, VITS 19, Aϕ (or Bϕ)	DIFF GAIN DIFF PHASE	Same as Display No. 8 with FIELD switch set to 2. Same as Display No. 9 with FIELD switch set to 2.		
12.	Color encoder Q component	Composite color bars with 1 component of the color bars turned off to CH A	CH A, FULL FIELD, Aϕ (or Bϕ)	VECTOR	SYNC: INT. Ch A 100%-75%-MAX GAIN: 75%. Ch A GAIN: CAL. ϕ REF: BURST.	Associated color vector dots are displayed along the Q axis (see Fig. 2-2D). Lack of dot coincidence with Q-axis marks indicate gain or linearity troubles (refer to topic, "Color Encoder").	 Color Vector Dots on Q Axis
13.	Color encoder I component	Composite color bars with Q component of the color bars turned off to CH A	CH A, FULL FIELD, Aϕ (or Bϕ)	VECTOR	Same as Display No. 12.	Same as Display No. 12 except associated color vector dots are displayed along the I axis. (Refer to topic, "Color Encoder").	 Color Vector Dots on I Axis
14.	Color encoder subcarrier imbalance	Encoder output with subcarrier (Y, I and Q signals of the color bars turned off) to CH A DIFF PHASE	CH A, FULL FIELD, Aϕ (or Bϕ)	VECTOR DIFF PHASE	SYNC: INT. Ch A 100%-75%-MAX GAIN: 75%. Ch A GAIN: CAL. ϕ REF: BURST.	VECTOR MODE: Dot should be centered if subcarrier is balanced and Display No. 2 conditions are fulfilled. If dot is not centered, imbalance exists. DIFF PHASE MODE: Allows precise measurement of inbalance and permits accurate balancing of subcarrier component.	
15.	Dual displays for matching outputs from two color cameras	Reference color camera signal to CH A; other signal to CH B.	CH A, CH B, FULL FIELD, Aϕ/Bϕ ALT	VECTOR	SYNC: INT. Ch A & B 100%-75%-MAX GAIN: 75%. Ch A & B GAIN: CAL. ϕ REF: BURST. A & B PHASE: Adjusted so burst coincides with 180° position.	If Ch B color vectors do not match Ch A color vector locations, adjust the Ch B color camera for proper matching to Ch A signal.	
16.	Color Saturation	Composite color video to CH A	CH A, FULL FIELD, Aϕ (or Bϕ)	VECTOR	SYNC: INT. Ch A GAIN: CAL. ϕ REF: BURST. A PHASE: Adjusted so burst coincides with 180° position.	Set the Ch A 100%-75%-MAX GAIN switch to a position (100% or 75%) that will cause the color vector dots to appear in the target area. Note the location of the burst tips. If located at the 75% vector graticule markings, the colors are 75% saturated; if located at the 100% marking, the colors are 100% saturated. The Ch A 100%-75%-MAX GAIN switch position will also correspond to the burst tip locations.	Burst Tips at 75% for 75% Saturated Colors 

OPERATING DISPLAYS II

17	Phase vs time delay	Composite color video camera signals to CH A and CH B. Assume CH A signal is the reference.	CH A, FULL FIELD, Aφ	VECTOR	SYNC: INT. Ch A & B 100%-75%-MAX GAIN: 75%. Ch A & B GAIN: CAL. φ REF: BURST. A PHASE: Adjusted so burst coincides with 180° position.	Obtain a normal Ch A vector display as described in Display No. 5. Depress the Ch B button to obtain a time-shared dual display. Note the Ch B vector display locations compared to Ch A. Any phase difference can be converted to time delay by noting that 360° is equal to 280 nanoseconds of time; hence, 1° equals 0.8 nanoseconds or 8 inches of cable length if the cable has a delay of 1.2 ns/foot. Adjust cable lengths for one camera to match the displays.	
18	Line intensification	Composite color video to CH A	CH A, FULL FIELD, Aφ (or Bφ)	Y	SYNC: INT. Ch A 100%-75%-MAX GAIN: 75%. Ch A GAIN: CAL. φ REF: BURST. LUMINANCE GAIN: CAL.	Check that the Z axis input lead is connected to pin BO on the Sweep board. Apply the negative-going intensifying pulse to the Z AXIS INPUT connector. Turn the INTENSITY to a level such that the intensified line will appear as a bright display on the CRT. The non-intensified lines will appear dim. Instruments below SN B150100: Z axis input lead is connected to pin AP on the Sweep board.	

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

520A EFF ALL Serial Numbers

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

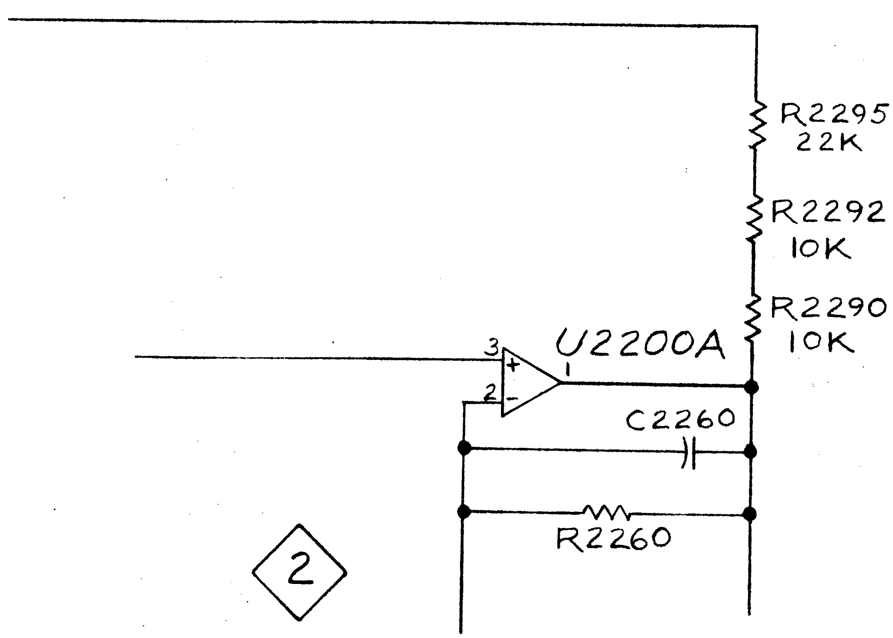
R2290	315-0103-00	10 kΩ	1/4 W	5%

ADD: (to EPL only)

R2098	315-0224-00	220 kΩ	1/4 W	5%

ADD:

R2292	315-0103-00	10 kΩ	1/4 W	5%



PARTIAL-
SUBCARRIER
REGENERATOR

TEXT CORRECTION

SECTION 2 Operating Instructions

Page 2-11 TABLE 2-3

CHANGE as follows:

TABLE 2-3

Resistor Circuit Number	Description			Tektronix Part Number
	Resistance	Wattage	Tolerance	
R301	3.9 kΩ	1/4	5%	315-0392-00
R320	7.5 kΩ	1/4	5%	315-0752-00
R321	10 kΩ	1/4	5%	315-0103-00

TEXT CORRECTION

When reference is made to a "75% saturated color bar signal", the text should be changed to read, "100% saturated, 75% amplitude color bar signal". Similarly, when reference is made to colors that are "75% saturated", the text should read, "75% amplitude".

A reference to "100% saturated color bar signal" should be changed to read "100% saturated, 100% amplitude color bar signal". Colors that are "100% saturated" should be changed to read "100% amplitude".

TEXT CORRECTION

SECTION 6 Calibration

Pages 6-16, 6-17, 6-18 and 6-19

For proper sequence of calibration steps, move steps 16 and 17 so that they follow step 20 (Adjust Channel B Gain).

CHANGE to read as follows:

16. Adjust Luminance Calibrator

16A. Adjust Luminance Calibrator

17. Adjust Channel A Gain

18. Adjust Channel B Gain

19. Adjust Test Circle Oscillator

20. Adjust Test Circle Oscillator Compensation

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

Q420	151-0221-00	Silicon	PNP	2N4258
Q425	151-0221-00	Silicon	PNP	2N4258

R520A EFF SN B350000-up

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

SW1316	260-1460-01	LINE SELECTOR

R520A EFF SN B360000-up

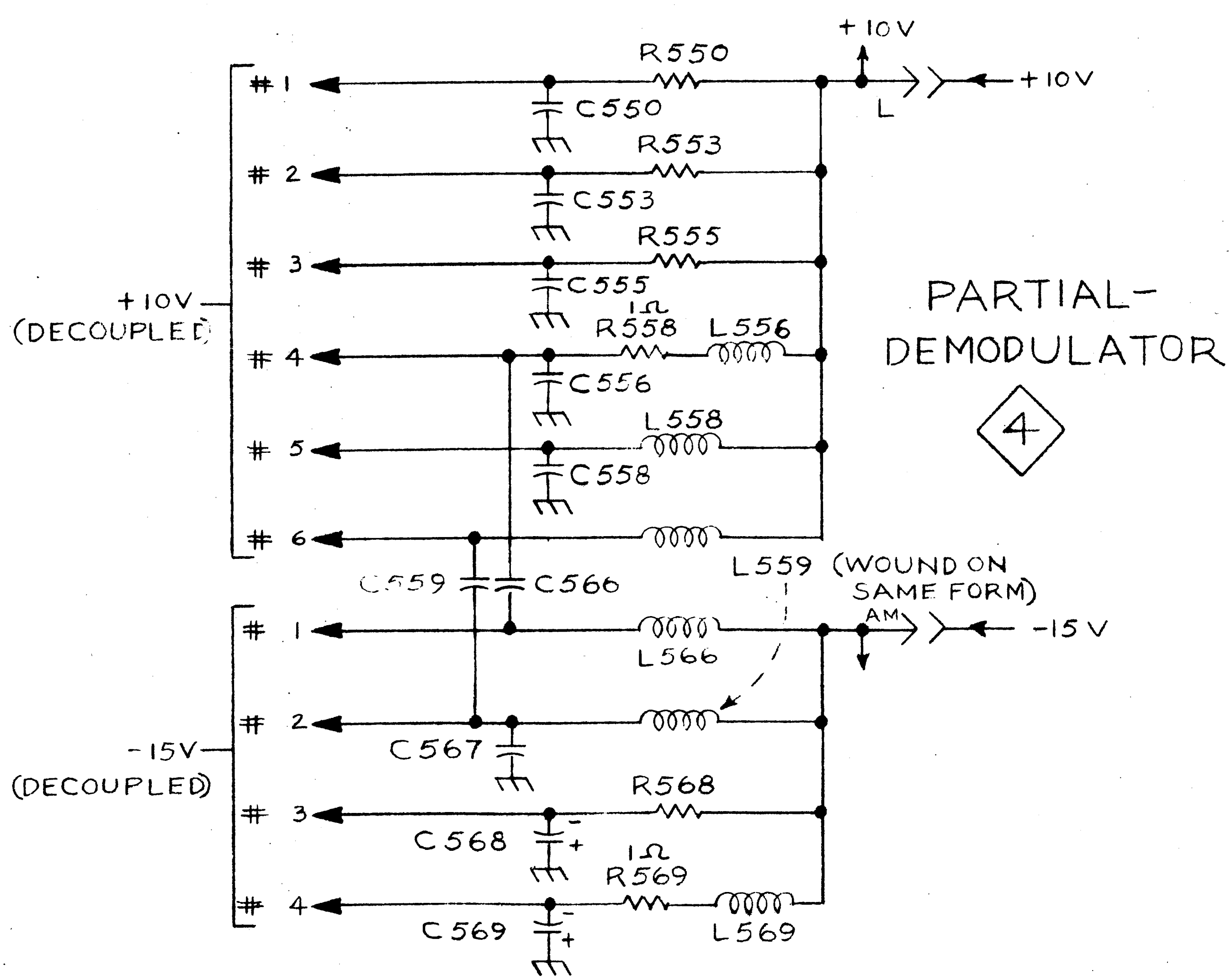
R521A EFF SN B160000-up

R522A EFF SN B090000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

ADD:

R558	308-0433-00	1 Ω	1/4 W	10%
R569	308-0433-00	1 Ω	1/4 W	10%



R520A EFF SN B360000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

C584	283-0616-00	75 pF (nominal value) Selected

M20,366/673

520A/R EFF SN B343460
521A/R EFF SN B151100
522A/R EFF SN B090210

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

DRIVER AMPLIFIER Circuit Board Assembly

CHANGE TO:

R694	321-0247-00	3.65 kΩ	Selected	(nominal value)