AIR PUBLICATION

116T-1202-1

OSCILLOSCOPE TYPE RM529

GENERAL, AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

(Ministry of Defence)

FOR USE IN THE

ROYAL AIR FORCE

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The inclusion of references to items of equipment does not constitute authority for demanding the items.

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◀ The reference number of this publication was altered from A.P. 101S-0202-1, Cover 5 to A.P. 116T-1202-1 by A.L. action in Feb. 69. ▶

DANGER-HIGH VOLTAGE

LEARN THESE SAFETY RULES

1. ELECTRICAL SYSTEM. Voltages in excess of 100 volts, a.c. or d.c. can be extremely dangerous in certain circumstances. Personnel should therefore ensure that the electrical system is electrically safe before any servicing is attempted. Where it is essential for tests or adjustments to be made with the electrical power switched on, the greatest care must be exercised.

2. SHOCK. Learn how to deal with cases of electric shock.

APPARATUS IS SAFE - ONLY IF YOUR APPROACH IS CORRECT

INSTRUCTION MANUAL

Serial Number 5788

MODIFICATION INSERT

TYPE RM529
MOD 188A

This insert has been written to supplement the Instruction Manual furnished with this modified instrument. The information given in this insert will supersede that given in the manual.

TYPE RM529

MOD 188A

Tektronix, Inc.
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03077

ds

TYPE RM529
MOD 188A

This manual insert describes the special features of the Type RM529, MOD 188A which has been modified for use with the CCIR, 625/50 system. The following changes have been made to this instrument:

Vertical Deflection System - Frequency Response

HIGH PASS - The center frequency has been changed from 3.58 MHz to 4.43 MHz. At 3.93 MHz and at 5.13 MHz, 60 mV produces not more than 85% nor less than 65% full screen deflection. At 4.43 MHz, 60 mV produces full screen deflection. The gain of the amplifier is X2 in the HIGH PASS position.

BAND PASS - The response is down not more than 1 dB (89.3 IEEE units) at 0.9 and 1.3 MHz referred to 1.096 MHz center frequency, and not less than -18 dB (12 IEEE units) at 200 kHz. Sensitivity is 60 mV full scale at 1.096 MHz. The gain of the amplifier is X2 in the BAND PASS position.

LOW PASS - (unchanged) - 12 dB or 75% down or more at 500 kHz.

IEEE - Rolloff extends to 4.43 MHz.

FLAT - (unchanged) Within ±1%, 60 Hz to 5 MHz; within ±3% to 8 MHz (DC Restorer off).

Calibrator

The F.S. (Full Scale) position of the CALIBRATOR remains the same. The .714 F.S. position has been changed to .700 F.S.

Horizontal

The sweep rates for the 2 LINE and 2 FIELD positions of the Horizontal DISPLAY switch have been changed to correspond with the 625/50 CCIR System.

The nomenclature on the Horizontal DISPLAY switch has been changed as follows:

- .25 H/CM changed to .1 H/CM
- .125 H/CM changed to 10 μS/CM

In the Line Selector positions:

- .25 H/CM changed to .2 H/CM
- .125 H/CM changed to .1 H/CM

The sweep-time relationships are shown by the table on the following page, which replaces Table 2-1 in the manual.

(HORIZONTAL) MAG	DISPLAY Switch Settings .1 H/CM	.2 H/CM	10 μS/CM
X1	.1 H/cm	.2 H/cm	10 μs/cm
	6.4 μs/cm	12.8 μs/cm	10 μs/cm
X5	.02 H/cm	.04 H/cm	2 μs/cm
	1.28 μs/cm	2.56 μs/cm	2 μs/cm
X25	.004 H/cm	.008 H/cm	.4 μs/cm
	.256 μs/cm	.512 μs/cm	.4 μs/cm

Graticule

Display Area - 7 cm high by 10cm wide. Two types of graticules are furnished with this modified instrument. They are: (a) Composite CCIR video, 0-100 IEEE units with 30-unit blanking level (331-0184-00), installed; and (b) Composite CCIR video, $\sin^2$ and K factor: ruled 0-100 IEEE units with 30-unit blanking level, 2 and 4% K factor for 0.1 μs T pulse and 0.2 μs 2T pulse (331-0185-00), added to the accessory kit.

Power Supplies - Transformer Wiring

The Type RM529, MOD 188A is wired for 230-volt operation, unless otherwise specified.

Trace Rotation

The locations of the GAIN control, R814, normally on the front panel, and the CRT BEAM ROTATOR (TRACE ROTATION) control, R655, have been interchanged. The TRACE ROTATION control is now on the front panel.

CALIBRATION

The following changes and additions should be made to the Calibration section of the manual.

1. The .714 F.S. position of the CALIBRATOR has been changed to .700 F.S. - Check for 7 major divisions of signal. R885 and R886 have been changed to set this level (±1%).

2. Check Vertical Amplifier High-Frequency Response

(a) Set the RESPONSE switch to FLAT and follow the procedure as described in Table 5-4 in the manual.

(b) Change to IEEE and follow the table (IRE), extending the check to 4.43 MHz. At 4.43 MHz the deflection should be 2-5 IEEE units.

(c) Change to LOW PASS and follow the procedure in the table.

(d) Change to BAND PASS. The sensitivity is 60 mV full scale at 1.096 MHz (X2 gain in this position). The response should be down not more than 1 dB (89.3 IEEE units) at 0.9 and 1.3 MHz, and down 18 dB (12 IEEE units) or more at 200 kHz.

Connect a 2 Hz to 2 MHz constant amplitude signal generator to A VIDEO INPUT; switch RESPONSE to FLAT; VOLTS FULL SCALE to 0.2; and VARIABLE to the CALIB position. Set the signal generator frequency to 1.096 MHz and adjust amplitude for 50 IEEE units. Then change to BAND PASS and adjust L136, C140B, and C140H (in the 1.09 MHz filter for the center frequency and X2 gain - see Response Switch diagram in this insert) for 100 IEEE units. Check the upper and lower limits for not less than 89.3 IEEE units at 0.9 and 1.3 MHz. (A slight readjustment may be necessary to set the two limits.) Change frequency to 200 kHz and check response for 12 IEEE units or less.

(e) Change to HIGH PASS. The sensitivity is 60 mV full scale at 4.43 MHz (X2 gain in this position). At 3.93 MHz and at 5.13 MHz, 60 mV produces not more than 85% nor less than 65% full scale deflection.

Connect a modulated stairstep signal of 10 steps with 4.43 MHz burst superimposed to A VIDEO INPUT; switch RESPONSE to FLAT; VOLTS FULL SCALE to 0.2; and VARIABLE to the CALIB position. Externally, adjust the amplitude of the signal for 50 IEEE units. Change to HIGH PASS position. In this position, the filter in the RESPONSE switch strips the stairstep providing bandpass filtering centered at 4.43 MHz with X2 gain. Adjust C140C and C140G for 100 IEEE units with best waveform response. There is interaction between C140C and C140G.

Check the upper and lower limits, using a constant amplitude signal generator set to 4.43 MHz; 3.93 MHz; and 5.13 MHz. 60 mV produces not more than 85% nor less than 65% of full scale deflection by adjusting C140C and C140G for gain.

3. Horizontal Amplifier (Omit this step if 625/50 is available). The sweep rates have been changed to correspond with the 625/50 CCIR system. Apply composite 525/60 video signal to Vertical and set Horizontal DISPLAY switch to 2 FIELD. Adjust Horiz. Gain (R568) for 8.33 cm display of video, ±5%. Then change DISPLAY switch to 10μS/CM and apply 10μsec from 180A to Vertical and Ext. Trigger. Adjust C481 for 10μsec/cm. Change Horizontal DISPLAY switch to .1H/CM and readjust Horiz. Gain for 63.5μsec, or one horizontal line in 10cm of video. (Measure from trailing edge to trailing edge only.) Recheck 10μS/CM range.

4. Horizontal Amplifier (Using Conrac Generator for 625/50 clock). Apply composite sync from Conrac to Vertical and set Horizontal DISPLAY switch to 2 FIELD. Adjust Horiz. Gain (R568) for 10.2 cm of sweep, ±5%. Turn Horizontal DISPLAY switch to 10μS/CM and adjust C481 for 6.4 cm between trailing edges of successive horizontal sync pulses. Turn Horizontal DISPLAY switch to .1H/CM and check for 1 horizontal line in 10 cm (trailing edge to trailing edge). MAG switch in X1 for above checks.

5. The sweep length will increase in the Line Mode operation, to approximately 11 cm (Spec. is 10.5 cm min.).

6. Adjust X25 MAG (C523) .4μsec/cm.
Set for 5MHz from 180A, Ext Sync, and adjust C523 for 2 cycles/cm or 20 pulses in 10 cm, ±7%.

7. Check X5 MAG 2μsec/cm.
Set for 1μsec from 180A, Ext Sync, should be 20 pulses in 10 cm.

8. Change Horizontal DISPLAY to .1H/CM (This is only a check. If out of tollerance, readjust C523 in 10μS/CM position). With MAG switch in X1, display 1 and 5μsec markers. Check for 13 markers counting the first marker of 5μsec markers plus 4 ea 1μsec marker in 10 cm (64μsec ±2%). With MAG switch in X5, display 1μsec markers. Check for 13.8 markers in 10 cm counting the first marker, ±3%. With MAG switch in X25, display 5MHz markers. Check for 13.8 markers in 10 cm counting the first marker, ±7%.

9. Adjust Field Sync (R360).
The FIELD switch states ONE or TWO. This is referring to the start of the sweep, not the center of the sweep that is viewed on the screen. The procedure for setting this up is the same as standard, except that the 625/50 system uses only five equalizing pulses. Therefore, R360 should be adjusted for only 5 pulses instead of 6 (reset Conrac for 5 pulses).

9. (cont.) Set the FIELD switch to ONE. Determine that only 1/2 line of video precedes the Vertical Unblanking Pulse appearing in center screen (use X25 MAG). Compare line and 1/2 line, looking at adjacent horizontal sync pulses.

NOTES

When setting the VIT Line Sel Range potentiometer (R458), set the LINE SELECTOR switch to line 19, although the actual line, according to the CCIR System of counting, is line 12.

When checking the brightening pulse set the LINE SELECTOR switch to VARIABLE and rotate the VARIABLE throughout its range. The brightening pulse must cover at least one field.

The locations of the GAIN control, R814, and the CRT BEAM ROTATOR have been interchanged. The Vertical GAIN is now adjusted through the hole in the dust cover (at the left of the CRT), and the TRACE ROTATION is now on the front panel.

PARTS LIST

The following parts have been added to this modified instrument. When ordering replacement parts, specify instrument type, serial number, and MOD number. Include the circuit number, part number, and description of the desired item.

CAPACITORS

C132	Add	281-0594-00	150pF	100V		cer
C134	Delete					
C135	Delete					
C136	Change	283-0602-00	53pF	300V		mica
C137	Delete					
C140A	Add	283-0602-00	53pF	300V		mica
C140B	Add	281-0092-00	9-35pF		var	
C140C	Add	281-0091-00	2-8pF		var	
C140D	Add	281-0577-00	14pF	500V		cer
C140E	Add	281-0577-00	14pF	500V		cer
C140F	Add	281-0504-00	10pF	500V		cer
C140G	Add	281-0093-00	5.5-18pF		var	
C140H	Add	281-0091-00	2-8pF		var	
C205	Add	283-0002-00	.01μF	500V		cer
C232	Add	281-0594-00	150pF	100V		cer
C236	Change	283-0602-00	53pF	300V		mica
C237	Delete					
C482	Change	283-0604-00	304pF	300V	2%	mica
C452	Change	281-0543-00	270pF		10%	cer

INDUCTORS

L132	Add	037-2036-00	72μH	
L133	Add	108-0360-00	46μH	
L134	Add	037-2037-00	36μH	
L136	Add	037-2038-00	364μH	var
L137	Change	037-2036-00	72μH	
L232	Add	037-2036-00	72μH	
L233	Add	108-0360-00	46μH	
L237	Add	037-2036-00	72μH	

RESISTORS

R122	Change	321-0265-00	5.62k	1/8w	1%	film
R124	Add	321-0184-00	806Ω	1/8w	1%	film
R135	Delete					
R362	Change	323-0498-00	1.5M	1/2w	1%	film
R453	Change	303-0273-00	27k	1w	5%	comp
R467	Add	316-0562-00	5.6k	1/4w	10%	comp
R468	Change	323-0394-00	124k	1/2w	1%	film
R481	Change	321-0417-00	215k	1/8w	1%	film
R482	Change	321-0417-00	215k	1/8w	1%	film
R483	Change	321-0427-00	274k	1/8w	1%	film
R484	Delete					
R492	Change	321-0335-00	30.1k	1/8w	1%	film
R834	Change	323-0465-00	681k	1/2w	1%	film
R885	Change	321-0143-00	301Ω	1/8w	1%	film
R886	Change	321-0178-00	698Ω	1/8w	1%	film

SWITCHES

SW135	Change	031-0045-00	Vertical RESPONSE
SW430	Change	031-0005-00	Horizontal DISPLAY

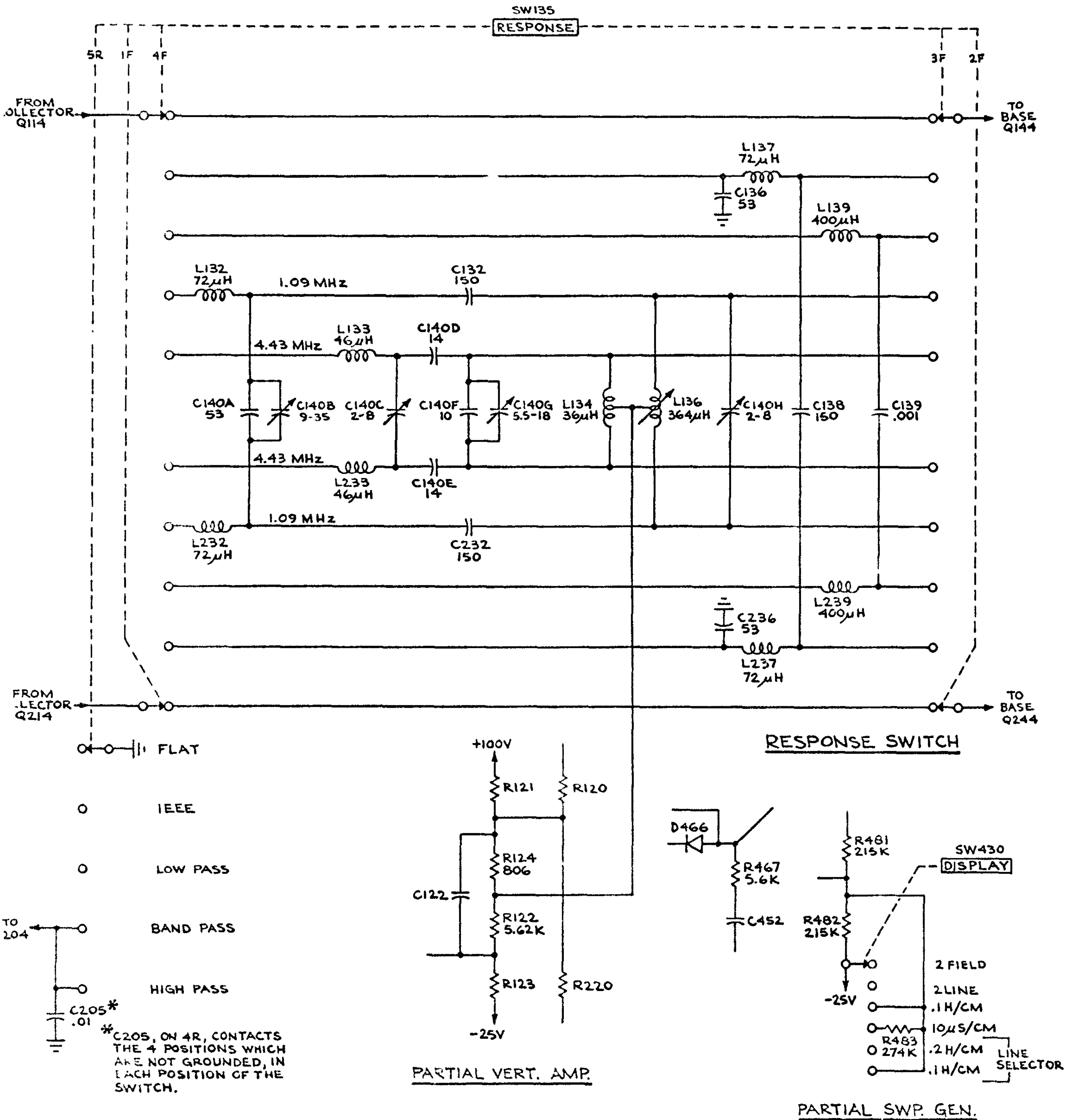
TRANSFORMERS

T135	Delete

MECHANICAL

DUST COVER, Top	Change	1	386-1097-01
ETCHED CIRCUIT BOARD, Film #937X	Add	1	037-6007-00
GRATICULE, 7 x 10 cm (Installed)	Change	1	331-0184-00*
GRATICULE, 7 x 10 cm (In Accessories)	Change	1	331-0185-00*
PANEL, Front, Film #3703	Change	1	034-0169-00
ROD, Aluminum, Hex, 1/4 x 7/16	Add	3	385-0080-00

* See page 2 of this insert for GRATICULE descriptions.


SW135
RESPONSE
5R 1F 4F
3F 2F
FROM COLLECTOR Q114
TO BASE Q144
L137 72μH
C136 53
L139 400μH
L132 72μH
1.09 MHz
C132 150
4.43 MHz
L133 46μH
C140D 14
C140A 53
C140B 9-35
C140C 2-8
C140F 10
C140G 5.5-18
L134 36μH
L136 364μH
C140H 2-8
C138 150
C139 .001
4.43 MHz
L233 46μH
C140E 14
1.09 MHz
L232 72μH
C232 150
L239 400μH
C236 53
L237 72μH
FROM COLLECTOR Q214
TO BASE Q244
RESPONSE SWITCH
FLAT
IEEE
LOW PASS
TO 204
BAND PASS
HIGH PASS
C205* .01
*C205, ON 4R, CONTACTS THE 4 POSITIONS WHICH ARE NOT GROUNDED, IN EACH POSITION OF THE SWITCH.
+100V
R121
R120
R124 806
C122
R122 5.62K
R123
R220
-25V
PARTIAL VERT. AMP.
D466
R467 5.6K
C452
R481 215K
SW430
DISPLAY
R482 215K
-25V
2 FIELD
2 LINE
.1H/CM
10μS/CM
R483 274K
.2H/CM
.1H/CM
LINE SELECTOR
PARTIAL SWP. GEN.

INSTRUCTION MANUAL

Serial Number ____________

TYPE RM 529 OSCILLOSCOPE

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0466-01

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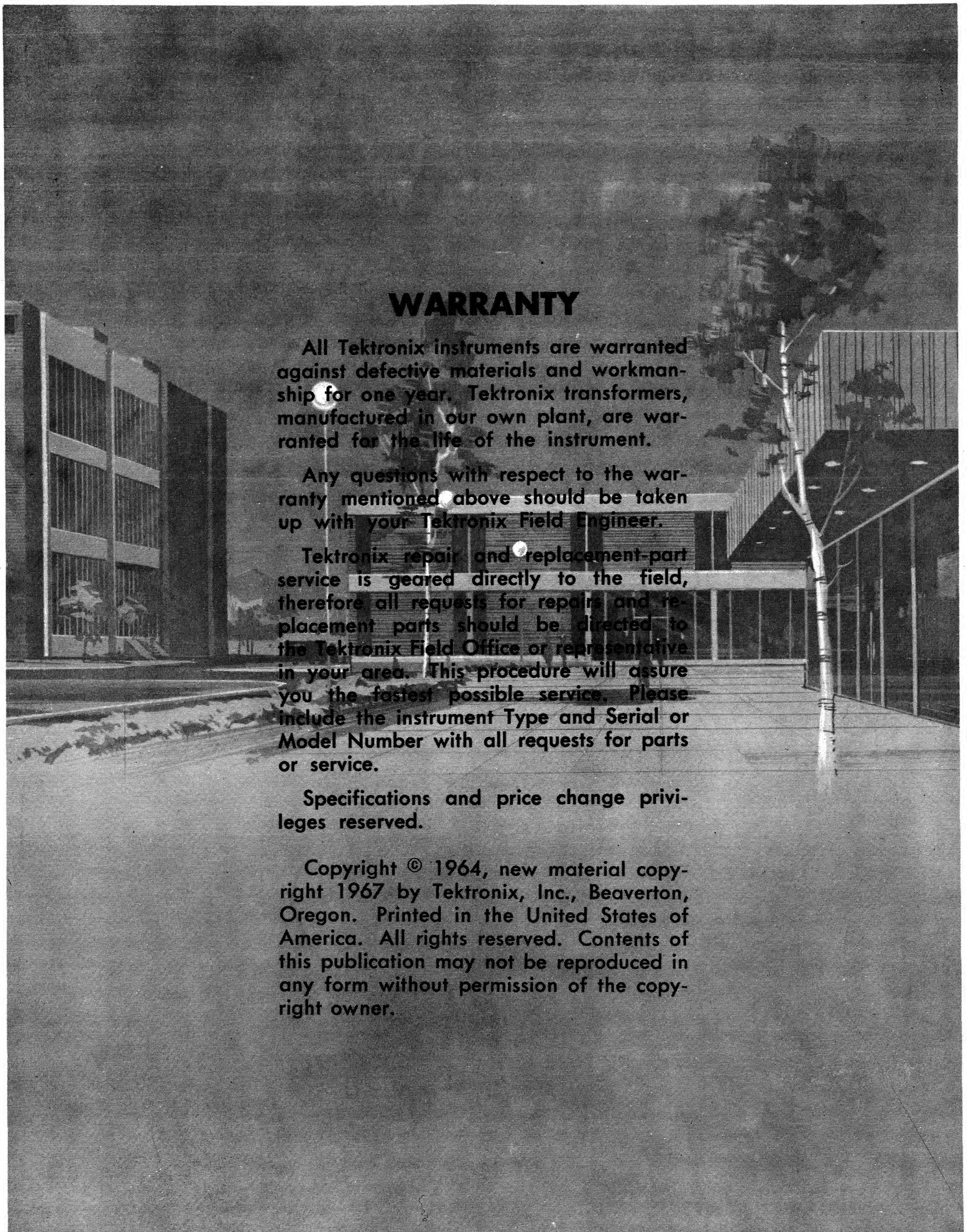


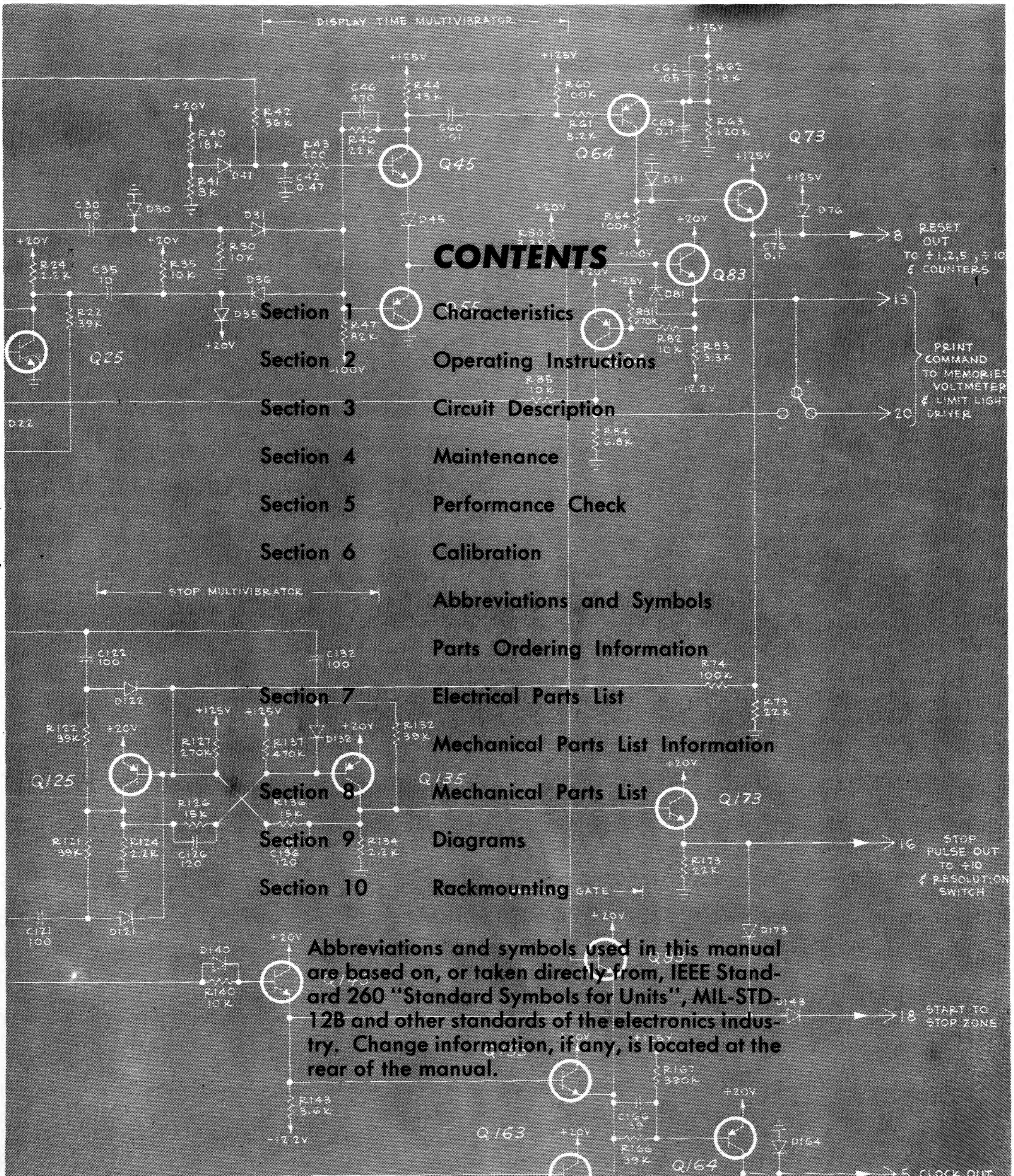
WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

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.



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.

SECTION 1
CHARACTERISTICS

General Information

The Tektronix Type RM529 Waveform Monitor is a self-contained cathode-ray oscilloscope specifically designed for video-waveform monitoring at television transmitters and studio facilities. With this monitor, any portion of the television-signal waveform can be displayed on a 5-inch rectangular cathode-ray tube.

A frequency-response switch is included which enables the selection of several frequency-response characteristics including that characteristic recommended by the IEEE Standards Committee for standardized pulse-level measurements.

An internal 30-kHz amplitude calibrator provides 0.714-volt or 1.0-volt pulses for calibrating the vertical amplifier. The sweep system provides calibrated sweeps which eliminates the need for time markers.

The following characteristics apply over an ambient temperature range of 0° C to 50° C. Warm-up time for the given accuracies is 20 minutes at 25° C, ±5° C.

The performance requirements throughout this manual are stated in either percentage or IEEE units. The compatible dB point is also inserted using the formula: $dB = 20 \log \frac{E1}{E2}$.

NOTE

On instruments with the Serial Numbers below 400, the following control names and labels are used:

1. The HIGH PASS position of the RESPONSE switch is labeled CHROMA.
2. The IEEE position of the RESPONSE switch is labeled IRE.
3. The VOLTS FULL SCALE switch is labeled MAG.
4. The 1.0, 0.5 and 0.2 positions of the VOLTS FULL SCALE switch are labeled X1, X2 and X5 respectively.
5. The FULL SCALE position of the CALIBRATION switch is labeled F. S.
6. The FIELD switch is labeled FIELD SHIFT.
7. The ONE and TWO positions of the FIELD switch are labeled EVEN and ODD respectively.
8. The LINE SELECTOR variable control is labeled DELAY.
9. The LINE SELECTOR .125 H/CM and LINE SELECTOR .25 H/CM positions of the DISPLAY switch are labeled DELAYED LINE .125 H/CM and DELAYED LINE .25 H/CM respectively.

VERTICAL DEFLECTION SYSTEM

Characteristic	Performance Requirement	Supplemental Information
Frequency Response FLAT (1 V gain sensitivity)	Flat to within +0%, −1% (0.1 dB) from 50 Hz to 6 MHz. Flat to within +0%, −3% (0.3 dB) from 6 MHz to 8 MHz.	
FLAT (0.2 and 0.5 gain sensitivities)	Flat to within +0%, −1% (0.1 dB) from 50 Hz to 6 MHz.	
LOW PASS	Down not less than 80% (14 dB) at 500 kHz or above.	
HIGH PASS	3.58 MHz center frequency 15% to 35% down in amplitude + and − 400 kHz.	
IEEE	See Fig. 1-2.	
Transient Response		
High Frequency	T/2 pulse must be between 94 and 100 IEEE units high for 100 IEEE units of bar signal amplitude applied and have less than or equal to 3 IEEE units of overshoot.	Any ringing as observed on the test oscilloscope (Type 547 with 1A1 plug-in used for check) must be added to the overshoot tolerance.
Middle Frequency	Top of bar signal must be flat within ± ½ IEEE unit.	Flatness measured at +100 IEEE unit graticule line.
Gain Sensitivity	1 V—Adjustable to 1 V. 0.2 V—Adjustable to 0.2 V. 0.5 V—less than ±3% error.	
Variable Gain Sensitivity	Must attenuate the gain by a ratio of at least 2.5:1.	Ratio of maximum amplitude to minimum amplitude.

HORIZONTAL DEFLECTION SYSTEM

Characteristics	Performance Requirement	Supplemental Information
Calibrated Sweep Rates		
×1	Adjustable to 0.125 H/CM.	
×5	Should be within ±3% of 0.025 H/CM.	
×25	Should be within ±3% of 0.005 H/CM.	
Staircase (RGB-BW) Relay	When relay K501 is energized, sweep will be at either line or field rate (depends on DISPLAY switch setting), and 2.5 cm or less in length.	
Line Selector (Variable)		
Minimum Delay	Line selection will start on or before the 15th line of either field.	
Discrete Line Selector (SN 2997-up)	Sweep will start on the line indicated by the LINE SELECTOR (switch) position on both fields.	
Field Selector		
ONE	Sweep is triggered by field one.	
TWO	Sweep is triggered by field two.	

TRIGGERING

External Trigger	Stable triggering must be obtained on an input composite video signal ≤ 250 mV to ≥ 1 V in amplitude.	
Internal Trigger	Stable triggering must be obtained on an input composite video signal ≤ 200 mV to ≥ 1 V in amplitude.	

AMPLITUDE CALIBRATOR

Signal Accuracy		
.714 FS	Adjustable to 0.714 V.	
FULL SCALE	Within ±1% of 1 V.	
Frequency		Approximately 30 kHz.

POWER SUPPLY

Power Source	115 VAC, ±10%, 50 to 60 Hz.	Can be connected for 230-VAC operation.
Power Source Fuse	Type 3AG, 1.25 A slow-blowing.	Type 3 AG, 0.6 A slow blowing for 230-VAC operation.

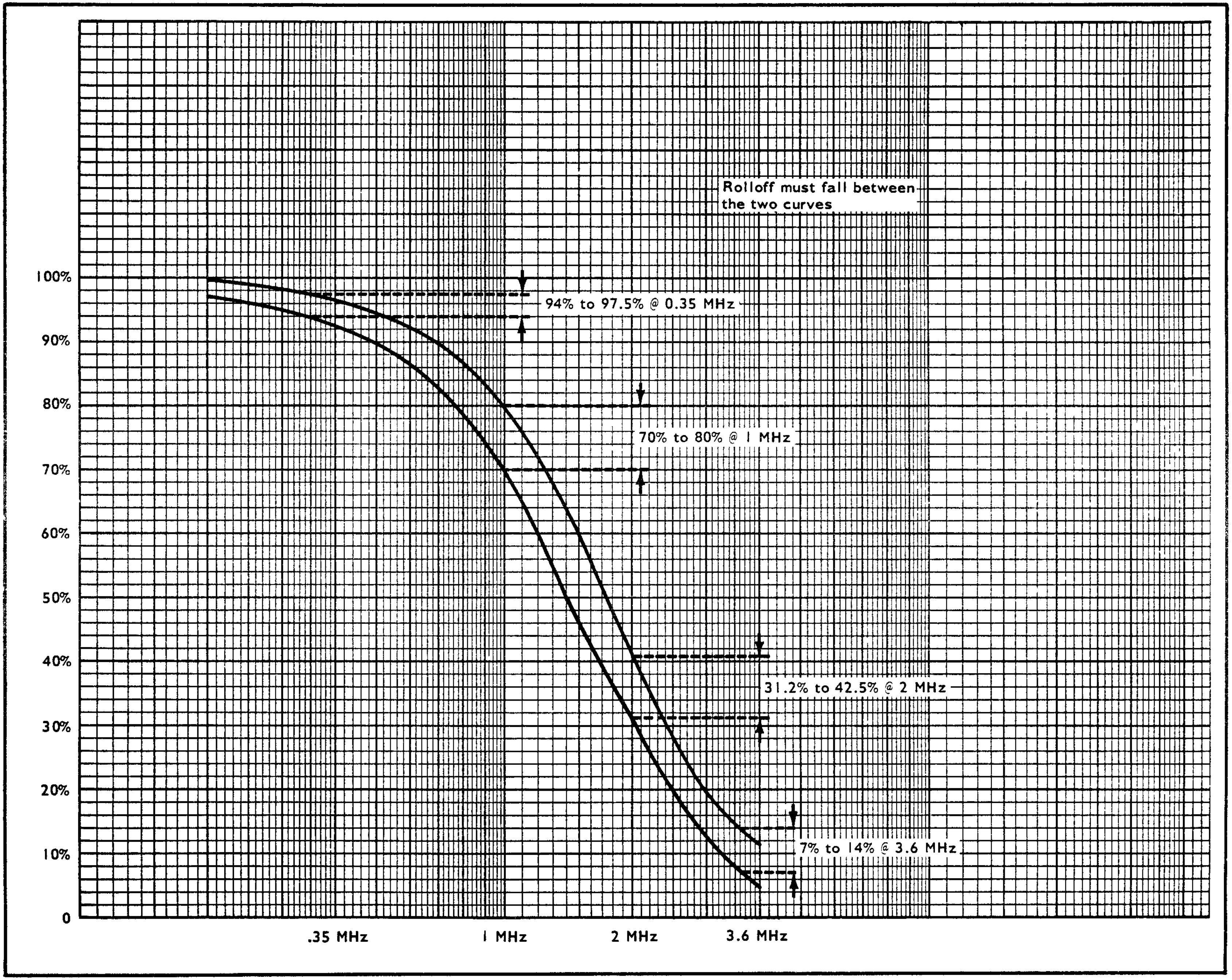


Fig. 1-2. IEEE 1958 Standard 23s-1.

CATHODE-RAY TUBE

Characteristics	Information
Tube Type	T5290-31 rectangular, glass envelope.
Phosphor	P31 standard. Others available on special order.
Accelerating Potential	Approximately 5300 V.
Graticule Type	External. See Standard Accessories list for graticules.
Scan Area	The equivalent of 7 or more centimeters of vertical area and the equivalent of 10 or more centimeters of horizontal area.
Graticule Illumination	Variable edge lighting.
Unblanking	DC used on all sweep rates with AC coupled brightening pulses for line Selector modes of operation.
CRT Beam Rotator	Electrical. Will vary the beam across horizontal by 1° in either direction (total range is equal to or greater than 6°).

MECHANICAL CHARACTERISTICS

Characteristics	Information
Construction	Aluminum-alloy chassis and panel.
Finish	Anodized panel.
Overall Dimensions (measured at maximum points)	5¼ inches high, 19 inches wide, 20 inches long (includes front panel knobs).

Standard Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

SECTION 2
OPERATING INSTRUCTIONS

General

This section of the manual provides general operating information. Included is a brief description of the Type RM529 controls and a suggested first-time operating procedure.

Power Requirements

The regulated power supplied in the Type RM529 will operate with line voltages from 103.5 to 126.5 VAC (115 VAC, ±10%) or from 207 to 253 VAC (230 VAC, ±10%). The line-voltage operating range for which your instrument is wired at the factory is indicated on a metal tag fastened to the rear panel near the power receptacle.

The power transformer is wound with two 115-volt primaries, connected in parallel for 115-volt operation or in series for 230-volt operation. Fig. 2-1 shows the connections for both voltages. When the transformer connections are changed, the metal tag should be turned around so the back side becomes the front. The unmarked side can then be marked with a pencil for the new operating voltage.

For maximum dependability and long life, the line voltage applied to the Type RM529 should be near the voltage indicated on the tag. If the line voltage exceeds the operating limits, or has a poor waveform (distorted sine waves), unstable power-supply operation may result. Check for proper line voltage and waveform before checking for other causes of unstable operation.

Cooling

The Type RM529 is cooled by convection air flow through the instrument. If possible, allow two inches clearance at the sides and rear of the instrument for proper air circulation. Temperature of the circulating air should not exceed 50° C (122° F) for safe operation.

Radiation

To prevent high-voltage power-supply radiation of 30-kHz fundamental and harmonic frequencies from affecting the Type RM529 display and adjacent instruments in the rack, it is important to keep the top and bottom dust covers in place.

FUNCTIONS OF FRONT-PANEL CONTROLS AND CONNECTORS

VERTICAL Controls

INPUT

Four-position switch to select one of four input signals: internal calibrator, input A, input B or A-B differential.

POSITION

Positions the trace vertically on the CRT.

RESPONSE

Four-position switch to select the amplifier frequency-response characteristics as listed in Section 1 of this manual.

VOLTS FULL SCALE

Three-position switch to select the calibrated vertical gain settings of 1.0, 0.5 and 0.2.

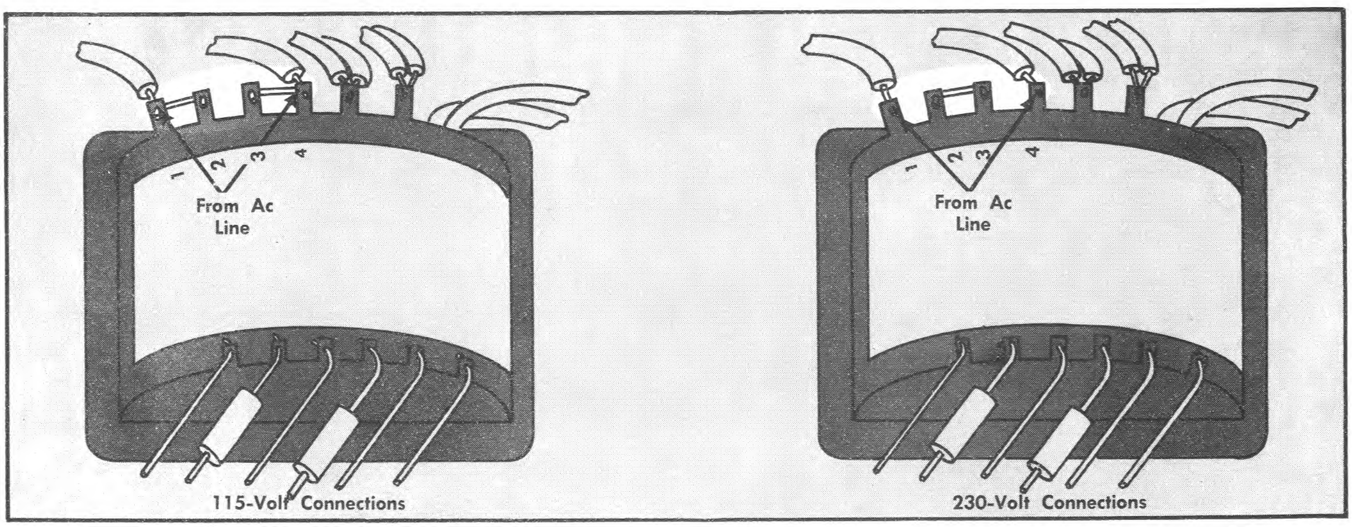


Fig. 2-1. Power transformer connections for 115- and 230-volt operation.

zontal sync pulses, or the time from the start of one horizontal line to the start of the next line). When the (HORIZ) MAG switch is set to ×1, one complete horizontal line is displayed in a sweep length of 8 cm (see Fig. 2-2). In addition, refer to Table 2-1 which lists the sweep-time relationship between H/cm and μs/cm.

For pulse measurements at .125 H/CM, one cm equals 0.125 H. For example, in the NTSC (National Television Standards Commission) signal specifications, 0.125 H is the minimum time interval between the leading edge of the horizontal sync pulse and the end of the color burst.

If the (HORIZ) MAG switch is set to ×5 when the DISPLAY switch is at .125 H/CM, the time-base sweep rate is 0.025 H/cm. This sweep rate is used, for example, to make horizontal sync-pulse waveform measurements such as those shown in Fig. 2-2B.

If the (HORIZ) MAG switch is set to ×25 when the DISPLAY switch is at the .125 H/CM position, the sweep rate is 0.005 H/CM. This sweep rate is useful for measuring the risetime and falltime of the horizontal sync pulses, to count the cycles of color burst (see Fig. 2-2C) and to examine portions of a complete line.

The .25 H/CM position of the DISPLAY switch is another calibrated sweep rate which is useful for making horizontal line- and sync-pulse waveform measurements. In the ×1 position of the (HORIZ) MAG switch approximately 2½ horizontal lines are displayed. Table 2-1 lists the sweep-time relationship between H/cm and μs/cm for each MAG switch position.

When the DISPLAY switch is set to either of the LINE SELECTOR positions and the LINE SELECTOR control is used, it is possible to range into the top of the picture to examine any one or two lines, depending on whether the DISPLAY switch is set to the .125 H/CM LINE SELECTOR or .25 H/CM LINE SELECTOR position. Also, the LINE SELECTOR control can be set so the portion of the vertical blanking pulse which may contain vertical-interval test signals can be examined in detail. The .25 H/CM LINE SELECTOR position, in particular, is useful for observing $\sin^2$ (sine-squared) pulses.

The range of the LINE SELECTOR control is such that any portion of field 1 or field 2 can be examined. Either field 1 or field 2 is selected by means of the FIELD switch. A special bright-up circuit in the Type RM529 increases the CRT wiriting rate in either of the two LINE SELECTOR positions.

MAG

Three-position switch to select sweep magnification ratios of the ×1, ×5 and ×25 for all positions of the DISPLAY switch.

LINE SELECTOR

Ten-turn variable control (and a seven position switch, SN 2997-up) for starting the sweep at the beginning of any selected line in the field so that a particular line can be examined in detail. Used in conjunction with all positions of the (HORIZ) MAG and FIELD switches when the DISPLAY switch is set to LINE SELECTOR .125 H/CM or .25 H/CM

FIELD

Two-position level switch to select either field 1 or field 2. Used in conjunction with the LINE SELECTOR and 2 FIELD positions of the DISPLAY switch.

SYNC

Two-position lever switch to select either internal or external sync sources.

REAR-PANEL CABLE CONNECTIONS

VIDEO INPUTS A, VIDEO INPUTS B

Two pairs of signal-input coaxial connectors are provided. These are VIDEO INPUTS A and VIDEO INPUTS B. These video inputs are designed for high-impedance loop-through, compensated for 75-ohm systems. Bridging capacitance is approximately 20 pF.

If the second connector of each pair is not used, it can either remain unused, or it can be used for terminating the line with a 75-ohm termination.

EXT NEG SYNC INPUT

A pair of coaxial connectors marked EXT NEG SYNC INPUT is provided on the rear panel to couple external sync signals to the Type RM529. This input is a high-impedance loop-through connector and is compensated for 75-ohm systems. Bridging capacitance is about 20 pF. To select external sync, set the SYNC switch to the EXT position.

EXT CAL INPUT

The pair of connectors marked EXT CAL INPUT, located on the rear panel, is provided to couple external calibration signals to the instrument. The connectors are connected in parallel to couple the signal in and out of the instrument. To select the external calibration signal, set the INPUT switch to CAL and the CALIBRATOR switch to EXT.

VIDEO OUTPUT

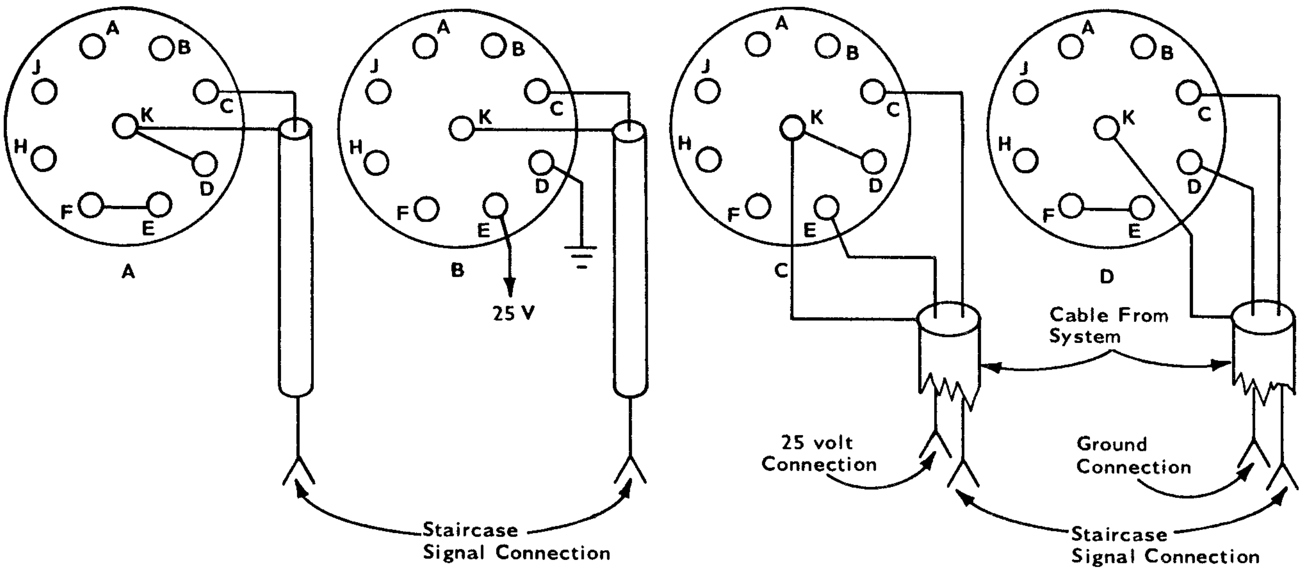
A single VIDEO OUTPUT connector is provided for driving a picture or line monitor. It is important that the VIDEO OUTPUT connector be terminated into 75 ohms to ensure correct frequency response of the vertical amplifier. When properly terminated, the signal available at this connector is approximately the same amplitude as the signal applied to the Type RM529.

Added to the VIDEO OUTPUT signal is a line intensifying pulse. This pulse is approximately 0.1 volt in amplitude or about 10% of the VIDEO OUTPUT signal when the input video signal is 1 volt.

The line intensifying pulse is generated only when the DISPLAY switch is set to LINE SELECTOR .125 H/CM or LINE SELECTOR .25 H/CM. The LINE SELECTOR control is used to select the line(s) to be examined in detail on the Type RM529 CRT and the picture monitor. The line intensifying pulse brightens the selected line(s) on the picture monitor for easy identification.

J501 Connector

A 9-pin female connector (J501) is provided to connect an external staircase signal to the Type RM529. Fig. 2-3 shows how to connect the signal and remotely actuate relay K385.



To energize relay K385 in instruments below SN 787 it is necessary to only ground pin D of the 9-pin plug connector, i.e., no connection is made to either pins F or E of the 9-pin connector. To energize part C of the figure it will be necessary to install an external switch between pins D and K of the 9-pin plug connector.

Fig. 2-3. Front view of 9-pin plug connector. (Tektronix Part No. 134-0049-00) showing jumper wire connections to: (A) Cause relay K385 to be energized whenever the plug is in place. (B) Energize the relay when an external voltage and ground connection are used. (C) Energize the relay when a GE system is connected. (D) Energize the relay when a RCA system is connected.

When K385 is actuated and the DISPLAY switch is set to any position, the sweep length is reduced to about 2½ cm (3 cm, SN 100-786). Thus, when a 20-Hz staircase signal of correct amplitude (about 12 volts overall amplitude) is applied through pin C of J501, the display is positioned in accordance with the staircase output from a color processor.

FIRST-TIME OPERATION

NOTE

It is necessary to check and adjust the VERT GAIN control (internal adjustment) each time the type of graticule is changed.

To place the instrument in operation for the first time, the following procedure is suggested:

1. Connect the instrument to a source of power specified by the metal tag located near the power connector.

2. Set the front-panel controls as follows:

POWER and SCALE ILLUM	2/3 clockwise
FOCUS	Centered
INTENSITY	2/3 rotation clockwise
VERTICAL Controls	
INPUT	CAL
POSITION	Centered
RESPONSE	FLAT
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE	CALIB
DC RESTORER	ON
CALIBRATOR	FULL SCALE
HORIZONTAL Controls	
POSITION	Centered (five full turns from either end)
DISPLAY	2 LINE
MAG	×1
LINE SELECTOR	As is
FIELD	One or Two
SYNC	INT

3. After the instrument has warmed up for a few minutes, adjust the INTENSITY control for adequate brightness of the square-wave calibrator waveform.

4. Adjust the (VERTICAL) POSITION control to center the display.

5. Adjust the FOCUS control to obtain a sharply defined display.

6. To observe other waveforms, connect a video signal to either the VIDEO INPUTS A or B connector and set the INPUT switch to the appropriate position.

To observe an external calibration waveform, connect the calibration signal from the external source to the EXT CAL connector. Place the INPUT switch to CAL and set the CALIBRATOR switch to EXT.

CRT Beam Rotator

If the trace does not coincide with the graticule lines, the CRT BEAM ROTATOR (R655) needs to be adjusted. To adjust the control, proceed as follows:

1. Perform steps 1 through 5 in the First-Time Operation procedure.

2. Set the CALIBRATOR switch to .714 F. S., and the DISPLAY switch to 2 FIELD.

3. Adjust the CRT BEAM ROTATOR control so the bottom trace of the calibrator pulses coincides with the 0 IEEE graticule line. Location of the control can be found by referring to Fig. 6-7 in the Calibration section of this manual.

GAIN Adjustment

A front-panel GAIN screwdriver adjustment is provided to correct for long-term change in the high-voltage supply. A change in the supply voltage will affect both the vertical and horizontal calibration.

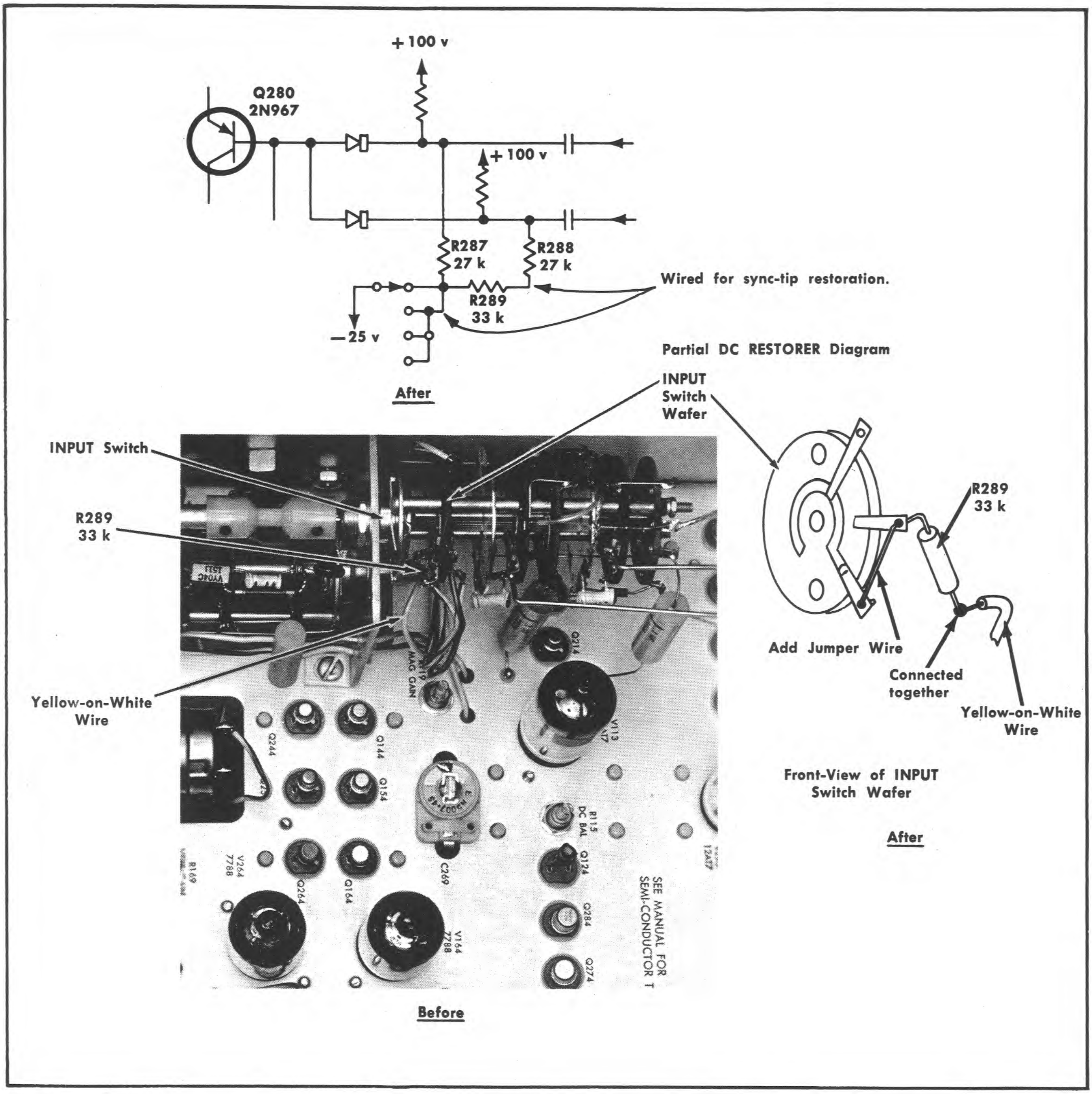


Fig. 2-4. Modification for sync-tip restoration.

To check calibration, check the vertical-amplifier calibration first as follows:

1. Perform steps 1 through 5 in the First-Time Operation procedure.

2. Check that vertical deflection is 140 IEEE units. If the deflection is not 140 IEEE units, adjust the GAIN control to obtain proper deflection.

3. If desired, the horizontal calibration can be checked by performing steps 15 through 18 in the Calibration section of this manual. If the HORIZ GAIN R568 or C481 are adjusted, then steps 17 and 18 should also be performed to fully calibrate the horizontal sweep rates.

MODIFICATIONS

Introduction

Four modifications are available to make the Type RM529 satisfy certain studio conditions. The first three can be made in the field, but the last one is more complex and, therefore, is normally done at the factory.

1. Changing to Sync-Tip Restoration

To change the Type RM529 circuitry so sync-tip restoration can be used instead of back-porch clamping.

a. Unsolder the yellow-on-white wire (refer to Fig. 2-4) and R289 from the INPUT switch contact. Leave the wire and resistor leads connected together.

b. Solder a jumper wire between the two contacts on wafer 1F of the INPUT switch as shown in Fig. 2-4.

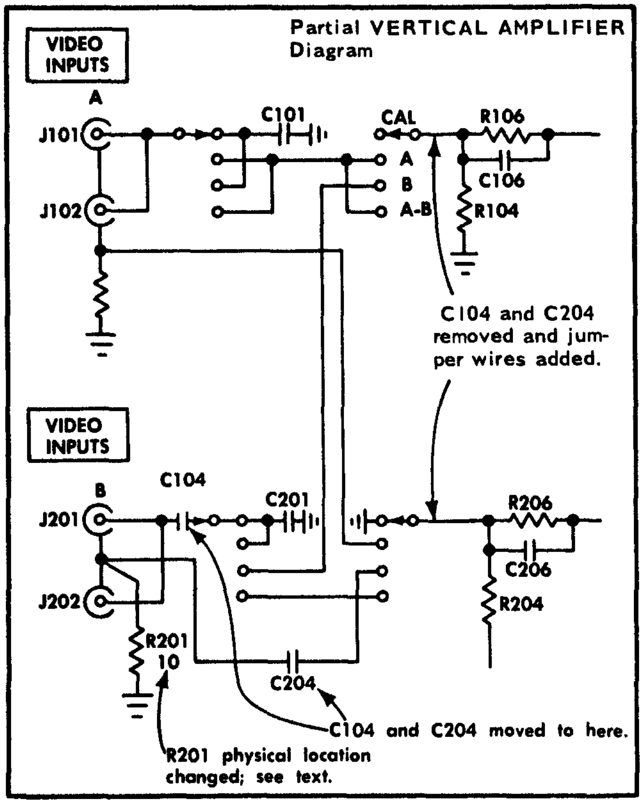


Fig. 2-5. Modification to DC couple VIDEO INPUTS A.

2. Changing to DC Input Coupling

Sometimes it is necessary to observe the demodulated output from a television transmitter using a DC-coupled oscilloscope. For this purpose the Type RM529 can be DC coupled, using VIDEO INPUTS A, as follows:

a. Refer to the Vertical Amplifier diagram at the back of this manual and the partial diagram shown in Fig. 2-5.

b. Remove C104 and C204 and solder jumper wires in their place.

c. Disconnect the ground lead that connects from the J201/J202 connector outer conductor to the INPUT switch contact.

d. Remove R201 from its location on the INPUT switch. Connect R201 between J201/J202 connector outer conductor and ground.

e. Connect one of the removed capacitors between J201/J202 connector outer conductor and the INPUT switch contact (where one end of R201 was formerly connected).

f. Locate the jumper wire going from J201 connector center conductor to the INPUT switch contact. Disconnect this jumper at J201 and cut off about 2 inches to shorten it. Connect the second capacitor in series between the shortened end of the jumper lead and the center conductor of J201.

NOTE

After completing this modification, the DC RESTORER is automatically off when the INPUT switch is set to A.

3. Changing the Sweep Repetition Rate

Since the field rate in some countries differs from the 30 Hz rate used in the United States, the Type RM529 must be modified to operate at the different rate.

To modify the instrument to operate at a longer time per field (slower sweep-repetition rate) than 30 Hz, increase the value of C483. For less time per field (faster sweep-repetition rate), decrease the value of C483 by substituting a smaller value. Refer to the base circuit of Q483 on the Sweep Generator diagram at the back of the manual to locate C483 on the diagram.

4. Changing to 4.4-MHz Chroma Response

In countries using a 4.4-MHz color-burst frequency, the Type RM529 must be modified and adjusted to pass this center frequency when the RESPONSE switch is set to HIGH PASS. This modification is much more complex and is, therefore, normally performed in the factory at the request of the purchaser at the time the instrument is ordered.

When the factory modification is made, prepared insert sheets showing the changes are inserted in the manuals accompanying the modified instrument. For this reason, no further information is provided in this section of the manual.

SECTION 3
CIRCUIT DESCRIPTION

General Information

The Type RM529 Waveform Monitor circuits contain both vacuum tubes and transistors. Portions of both the vertical and horizontal systems contain amplifiers with special feedback for gain stability independent of tubes or transistors. Several multivibrators in the trigger and horizontal systems provide precise display triggering. Refer to the block and circuit diagrams at the back of this manual during the following circuit descriptions.

All connectors are rear-panel mounted. Four of the input circuits are 75-ohm coaxial loop-through; two VIDEO INPUTS, EXT NEG SYNC INPUT and EXT CAL INPUT. The Staircase Input (J501) is a special nine-pin socket (see Staircase Input discussion in Section 2 for mating connector). The VIDEO OUTPUT coaxial jack has a 75-ohm unbalanced output impedance.

BLOCK DIAGRAM

The (VERTICAL) INPUT switch selects either of two video signals, or the A signal minus the B signal, or the CALIBRATOR signal, (the calibrator signal can be from an external source) and applies it to the input of the preamplifier. The preamplifier and magnifier supplies the signal to both the response filters and the sync amplifier. The response filter passes the signal on to the output amplifier and to the CRT deflection plates. The output amplifier also supplies the signal to the keyed DC restorer circuit. The sync amplifier supplies an AC-coupled signal to the VIDEO OUTPUT jack (with an open circuit gain of 2, and 75-ohm loaded gain of 1 referred to the video input), and an AC-coupled signal to the sync separator.

The sync separator regenerates the horizontal sync pulses so their shape and amplitude is always the same. Plus and minus regenerated horizontal sync pulses are available for operating the keyed DC restorer circuit. Minus H pulses are used when displaying video, and plus H pulses are used when displaying the calibrator.

The keyed DC restorer circuit holds the display steady at the video back-porch level or the negative level of the internal calibrator. The circuit operates by controlling the DC level of the preamplifier and magnifier minus input. The video input signals are AC coupled, but the preamplifier and magnifier, response filters, and output amplifier are DC coupled. The DC-restorer circuit virtually eliminates display shift with change in signal amplitude, but response time is slow enough for hum or tilt to be observed.

The sync separator —H signal is used by the trigger selector matrix, when the display is of a line nature (undelayed). The +H signal does not go directly to the trigger selector matrix, but to the vertical sync separator, and then to both the field 1 recognition circuit and the field trigger generator (Q375-Q385). The field trigger generator triggers the sweep gating multivibrator via the trigger selector matrix for field displays (undelayed), and triggers the sweep gating multivibrator through the delay generator and trigger selector matrix for delayed field displays.

The sweep gating multivibrator and sweep generator triggering source and sweep rate is set by the front-panel DISPLAY switch. Triggers are received by the sweep gating multivibrator, which allows the sweep generator to run and drives the unblanking amplifier to turn on the CRT beam at the time of the sweep. The unblanking amplifier also sends a brightening pulse to the CRT and the VIDEO OUTPUT jack during delayed line modes. The sweep generator drives both the horizontal amplifier and the staircase amplifier. The staircase amplifier is inserted between the sweep generator and the horizontal amplifier when external control (through J501) switches the sweep generator function to read the red, blue, green (and black-white SN787-up) portions of a color studio camera.

The high voltage supply contains the CRT high-voltage power supply. A portion of the power-supply circuit forms the calibrator signal at the $\simeq$ 30 kHz rate of the high-voltage oscillator. An external calibrator signal can be substituted for the internal signal.

VERTICAL AMPLIFIER

The video input circuits of the vertical amplifier are shown in simplified form in Fig. 3-1. The 10-ohm resistor in Fig. 3-1A is optional, but necessary in the event there is any AC potential difference between the input coaxial cable and the Type RM529 chassis. It presents any cable-to-chassis signal differentially to the vertical amplifier so the signal will not become part of the display. (Any signal on the outside of the braid of a coaxial cable is also on the center conductor, but with the same polarity. The equal signals are applied to the + and — input terminals, and cancelled by the differential rejection characteristics of the vertical amplifier.) The A-B input of Fig. 3-1B does not use the 10-ohm resistors because the cables are likely to have the same unwanted information. Since the unwanted information appears on both center conductors, it is presented to the vertical amplifier in differential form and cancelled.

Operating With the DC Restorer Circuit Off

Operation of the vertical amplifier will be described first with the DC restorer circuit turned off.

The input signals are AC coupled to both the + and — input grids of V113 and through C104 and C204, see 1 megohm return to ground. The rest of the vertical amplifier is DC coupled.

Preamplifier. The preamplifier consists of two input cathode followers (V113A and V113B), and two-transistor amplifiers Q114 and Q214. The preamplifier is shown in simplified form in Fig. 3-2A. The cathodes of V113 return to the same constant-current circuit to which the emitters of Q114-Q214 return. The VOLTS FULL SCALE control between emitters of Q114 Q214 couples the signal between emitters, causing both sides of the amplifier to have an output signal when only one input receives a signal.

The tubes serve basically as impedance transformers, changing the 1-megohm input resistance to about 400 ohms to drive

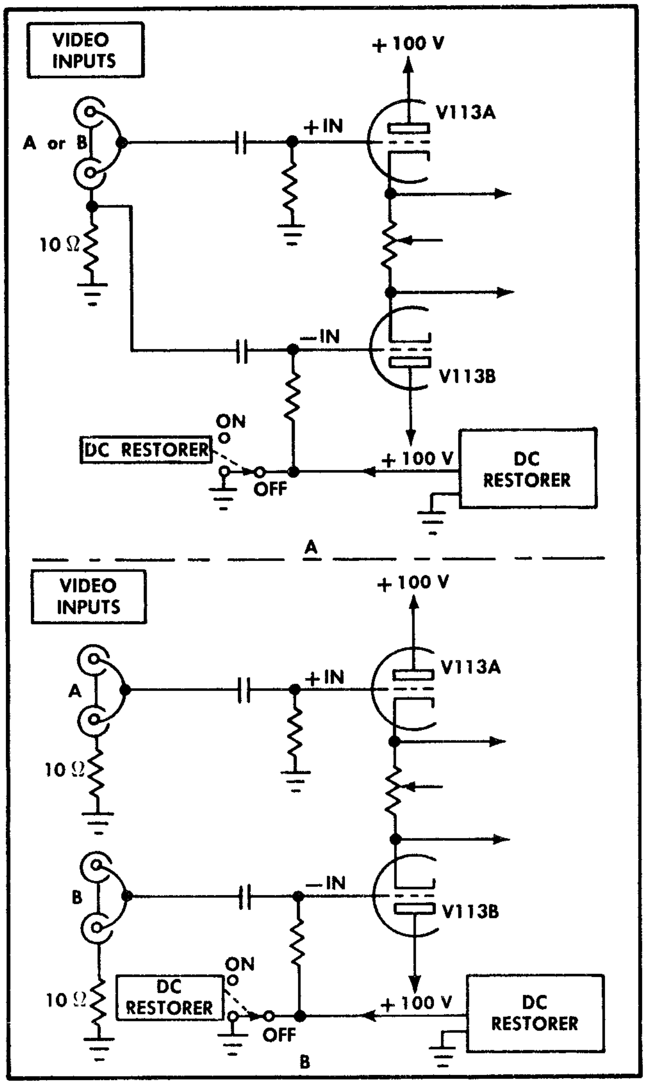


Fig. 3-1. Simplified vertical amplifier input circuits.

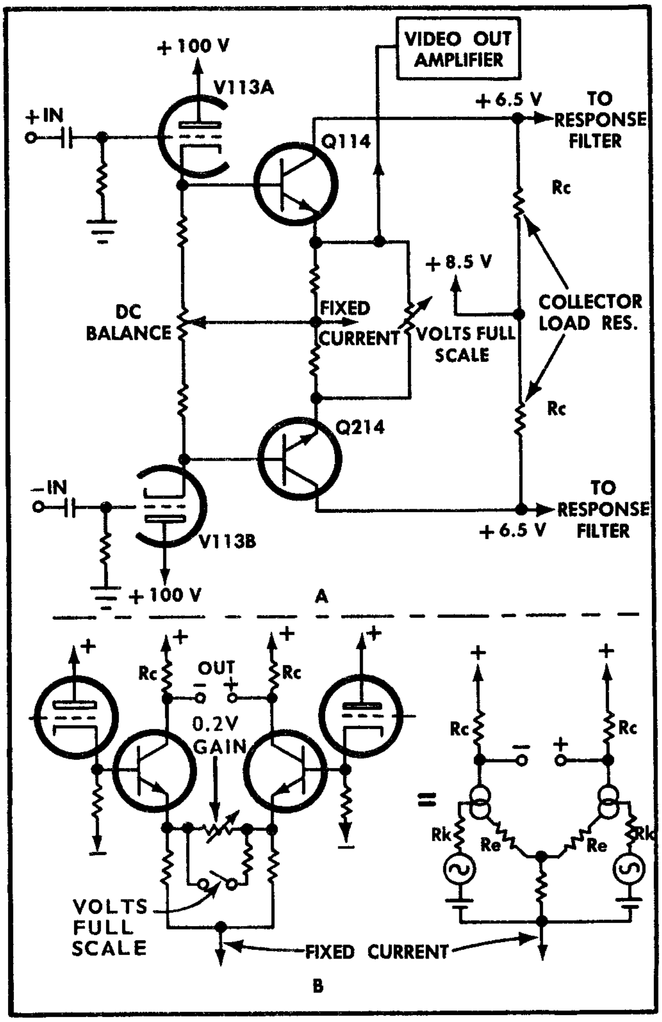


Fig. 3-2. Simplified circuit (SN 1600-up). Some circuit values are different in earlier SN instruments.

each transistor base. The cathode-return resistors have a value about 20 times the cathode-follower output impedance; therefore, do not attenuate the signal significantly. Each cathode follower passes about 93% of the input signal to the following transistor base.

The emitter resistors would normally cause considerable degenerative effect, and would thus keep the stage gain very low. However, the VOLTS FULL SCALE resistance between the two emitters also couples the signal from one side to the other. Fig. 3-2B shows a simplified concept of the VOLTS FULL SCALE control signal path. If, in this theoretical circuit, the VOLTS FULL SCALE resistor were made zero ohms, the input signal to one transistor base would divide equally between the two halves of the stage. Fig. 3-2B shows the internal emitter resistance in series. Thus, VOLTS FULL SCALE equal to zero ohms degeneration on one side of the amplifier is the emitter resistance of the other side. This causes both sides of the amplifier to have gain. The emitter return resistors are many times greater than the emitter internal resistance, and, therefore, do not attenuate the signal when the VOLTS FULL SCALE resistance is low. The actual minimum VOLTS FULL SCALE resistance is about 590 to 600 ohms between emitters setting the push-pull output signal equal to about 2 times the single-ended input signal.

A typical single input signal will cause the following action (assume the VOLTS FULL SCALE resistance to be 600 ohms): Q114 base is driven in the positive direction 1 volt and its emitter follows it nearly 1 volt. The 600-ohm resistor allows the emitter current to increase and the emitter voltage to follow the base voltage nearly one volt. The increased forward bias of Q114 is about 0.02 volt. The signal current is essentially 1.66 mA greater than the static current. The only source for the signal current is the emitter of Q214; therefore, both transistors receive the same amount of signal current (but of opposite polarity) for a single input signal. The result is that both collector resistors have a 1.66 mA signal current. The collector of Q114 goes negative, and the collector of Q214 goes positive producing a push-pull output signal about 2.2

volts peak to peak. Since the collector load resistors have equal and opposite current changes, the voltage at their center does not change. A common-mode signal reaching the preamplifier would change the voltage at the junction of the collector load resistors, and degrade the common-mode rejection of the amplifier except for presence of the constant current stage.

The high-frequency gain of the preamplifier is adjusted to equal the low-frequency gain by making the RC time constant of the emitter circuit equal to the RC time constant of the collector circuit. The cathode followers' output impedance allows the Miller capacitance of the transistors to affect the high-frequency response. To minimize the Miller effect, the transistor stage is neutralized by C113 and C213. The variable capacitors (C118B and C118C) across the VOLTS FULL SCALE resistors R118B and R118C permit the preamplifier frequency response to be properly adjusted. There is no need for a variable capacitor across R118A, due to wiring stray capacitance.

In the event of minor differences in bias of the input cathode followers, (and the resultant output voltage difference) the DC BAL control (R115) is set to create a compensating change in current in the cathode return circuit. The DC BAL control final setting is correct if the trace does not shift when changing the VOLTS FULL SCALE switch position (with the DC RESTORER OFF).

The high impedance of the preamplifier transistor collectors allows the output voltage to be varied a slight amount without significant change in current. The VAR DC BAL control slightly alters the voltage balance of the preamplifier output to allow the output amplifier VARIABLE control (between emitters of Q144-Q244) to be adjusted without shifting the trace position.

Constant Current Stage. The constant current stage cancels any push-pull output from the preamplifier in the event both input leads receive equal amplitude-equal polarity signals. The circuit causes the voltage of the constant current leads of Fig. 3-2 to shift and follow any common-mode input voltages. (The high collector resistance of Q114 and Q214 prevents any change in the preamplifier output voltage.) Fig. 3-3 shows simplified connections between the constant current stage and the preamplifier. Assume both input leads to be positive. The result is that both collector-load resistors receive an increase in current. The increased current pulls down on R121. R122 divides the change to the base of Q124. Q124 base goes negative and causes its collector to go positive an amount equal to the original common-mode signal. This cancels its effect and returns the current in the collector-load resistors to the original value. The input cathode followers' negative supply is the same as Q114-Q214 negative supply, to assure signal linearity in the event of common-mode signal cancellation by Q124.

The principal reason for keeping the common-mode currents out of the preamplifier is that even though the currents may be equal, the collector load resistors may not be precisely equal, and equal currents would generate unequal output voltages. The circuit does stop the preamplifier output from moving positive or negative with common-mode signals.

Response Filters. The frequency response of the overall monitor is altered for special purposes by the RESPONSE switch and its filters.

The FLAT position of the RESPONSE switch gives the widest bandwidth, with a direct connection from the preamplifier to the output amplifier.

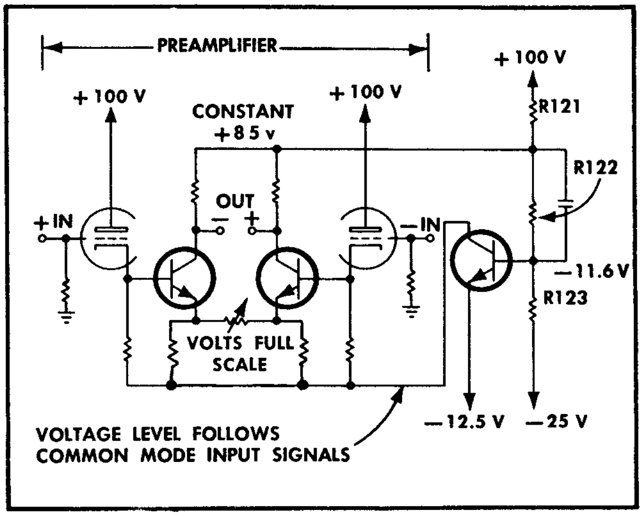


Fig. 3-3. Simplified constant current stage connections on preamplifier.

The IEEE position of the RESPONSE switch inserts components that cause the overall monitor bandwidth to be low-pass to agree with 1958 Standard 23S-1.

The LOW PASS position of the RESPONSE switch inserts components that alter the overall response so that it is about 12-dB down at 500 kHz.

The HIGH PASS position of the RESPONSE switch inserts a critically-coupled transformer between the preamplifier and the output amplifier, making the overall monitor bandpass about 800 kHz centered at 3.58 MHz. The DC level at the input of the output amplifier is maintained by connecting the center of the primary and secondary windings together at a cold RF point.

Output Amplifier. The output amplifier includes two sets of push-pull amplifiers, each with variable emitter coupling to vary the gain. The first amplifier is Q144-Q154 and Q244-Q254. The second amplifier is driven by the first, and is a combination of transistors and tubes giving a large voltage output swing.

The driver portion of the amplifier has negative feedback from the collector of Q154 to the emitter of Q144 (and from Q254 to Q244). The negative feedback makes the input impedance at the base of Q144 very high and the output impedance at the collector of Q154 quite low. The high input impedance prevents loading of the response filters. The low, output impedance is needed to drive the base of Q164 (and Q264). R154 is the negative feedback path and is also the collector load resistor for Q154 (see Fig. 3-4).

The VARIABLE gain control (concentric with the VOLTS FULL SCALE switch) varies the emitter-to-ground degeneration between Q144 and Q244 to vary the overall vertical amplifier gain by a 2.5:1 ratio. The VARIABLE control mechanically switches R241 into the circuit in the CALIB position, and out of the circuit (SW240 closed) when not in the CALIB position. If the VARIABLE control is counterclockwise at lower than cali-

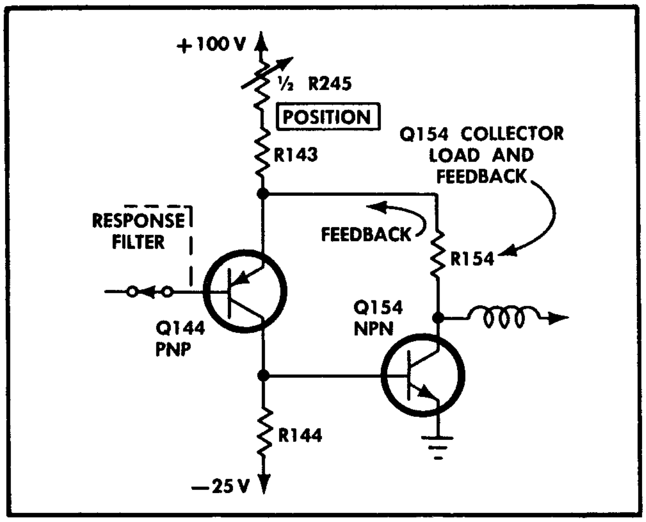


Fig. 3-4. Simplified one-half output driver stage.

brated gain, clockwise rotation can increase the monitor gain so it is greater than normal. Then, as the clockwise end of rotation is reached and the control is rotated to snap into the CALIB position, the overall gain drops about 70% as R241 is switched into the circuit. At the same time a second part of SW240 closes and turns on the front-panel CALIB neon lamp.

The output driver signal is coupled to the base of Q164 (Q264) of the output cascode amplifier. The combination of a transistor (supplying cathode drive) and a tube not only gives stable gain but also gives the wide voltage output swing. This amount of swing can only be obtained by a cascode amplifier consisting of a tube and transistor. The output cascode stage also has emitter-to-emitter degeneration used to adjust the overall vertical amplifier gain to match the CRT deflection factor. The emitter circuit also contains the HF COMP capacitors that permit the output stage high-frequency gain to be adjusted a bit higher than the low-frequency gain. This adjustment helps make the bandpass correct for the FLAT position of the RESPONSE switch.

While reading the following description of the cascode stage operation, keep in mind that (1) a transistor's emitter follows its base, just as a tube's cathode follows its grid—if the return circuit is a higher impedance than the internal emitter or cathode impedance, and (2) a transistor's collector has quite a high impedance, as high as the plate impedance of some triode tubes.

A signal that drives the base of Q164 in the positive direction causes several simultaneous circuit changes. The emitter voltage of Q164 follows the base voltage, with emitter voltage change about 2 percent less than base voltage change, offset by normal silicon transistor bias. The positive swing of Q164 base drives the grid voltage of V164 positive the same amount, and the cathode of V164 follows, lagging its grid about 20 percent. The 20 percent positive bias occurring in V164 as a result of cathode-follower action increases plate current, and the consequent plate current increase causes the output plate voltage to drop in the negative direction an amount determined by R162 and Ohm's Law.

Push-pull signals that drive the bases of Q164-Q264 drive the two halves of the output stages equally. (The degenerative action of the resistors between emitters is one half what it would be if only one base received a signal). The signal voltages at Q164-Q264 bases cause plate-current changes of V164 and V264 to be about 3.3 mA per centimeter of spot deflection each, producing a push-pull voltage output to the CRT deflection plates of about 20 volts per centimeter. The peaking coils in each plate circuit compensate for deflection-plate capacitance, and aid in obtaining flat frequency response of the vertical amplifier.

Positioning the CRT display (with DC RESTORER OFF) is by current injection into the emitter circuits of Q144-Q244 through R143 and R243. The POSITION control (R245) sends current toward the cascode output stage bases, but this current does not affect the display position so long as the DC restorer is off. Voltage changes at the bases of Q164 and Q264 do not significantly affect the positioning circuit because of two germanium diodes D271-D272, which limit the voltage difference between R149-R249 junctions with R148-R248. The two diodes appear on the DC restorer diagram.

Operation With DC RESTORER ON

The DC restorer circuit provides an automatic DC positioning voltage to the −input grid of V113B. The source of DC positioning voltage is the signal in the base circuit of the output cascode stage. The signal is usually composite video (sometimes it is the calibrator). The DC restorer circuit positions the CRT display firmly around the level of the composite video horizontal sync pulse back porch. Because of these facts, the restorer must look at the video only at the correct time. The DC restorer circuit is keyed by the horizontal trigger system to sample the video back porch for about 0.4 μs, and remember the DC level until the next horizontal sync pulse occurs.

When the DC restorer circuit is on, a current injection path through R148 and R248 into the input of the DC restorer Comparator permits the POSITION control to operate. The positioning current changes the DC level of the composite video at the point where it is looked at by the restorer.

Video Output Amplifier. The video output amplifier receives its signal from the emitter of Q114. The input impedance of Q174 is greater than 50 kΩ due to the large amount of emitter degeneration, which loads Q114 lightly. Q174 produces an inverted current drive to the feedback amplifier Q184-Q193 of essentially 1 mA per 1 volt. The emitter impedance of Q174 is R172-R173 in parallel, or 1.06 kΩ. Since the collector current of Q174 changes linearly with base-voltage drive, the signal-source resistance of Q184 base is 1.05 kΩ. Then, the voltage gain of Q184-Q193 (set by the feedback resistance divided by the input resistance) is 2.2 kΩ/1.06 kΩ or about 2.06. Assuming 3% signal loss in the preamplifier, the gain from input to Q193 collector is 2. R198 in series with a 75-ohm load makes the overall gain 1. The feedback (R192) makes the video output amplifier have a very low output impedance. Thus, the amplifier is matched to the output coaxial line by inserting a series 75-ohm resistor (R198). The reactance of C198 is so low at the frequencies passed by the circuit that it does not increase the output resistance over that of R198. R199 assures that C198 is properly charged.

The video output amplifier also serves as an internal trigger amplifier. The output lead to the sync clamping amplifier (diagrammed with the sync separator) rests at −5 volts.

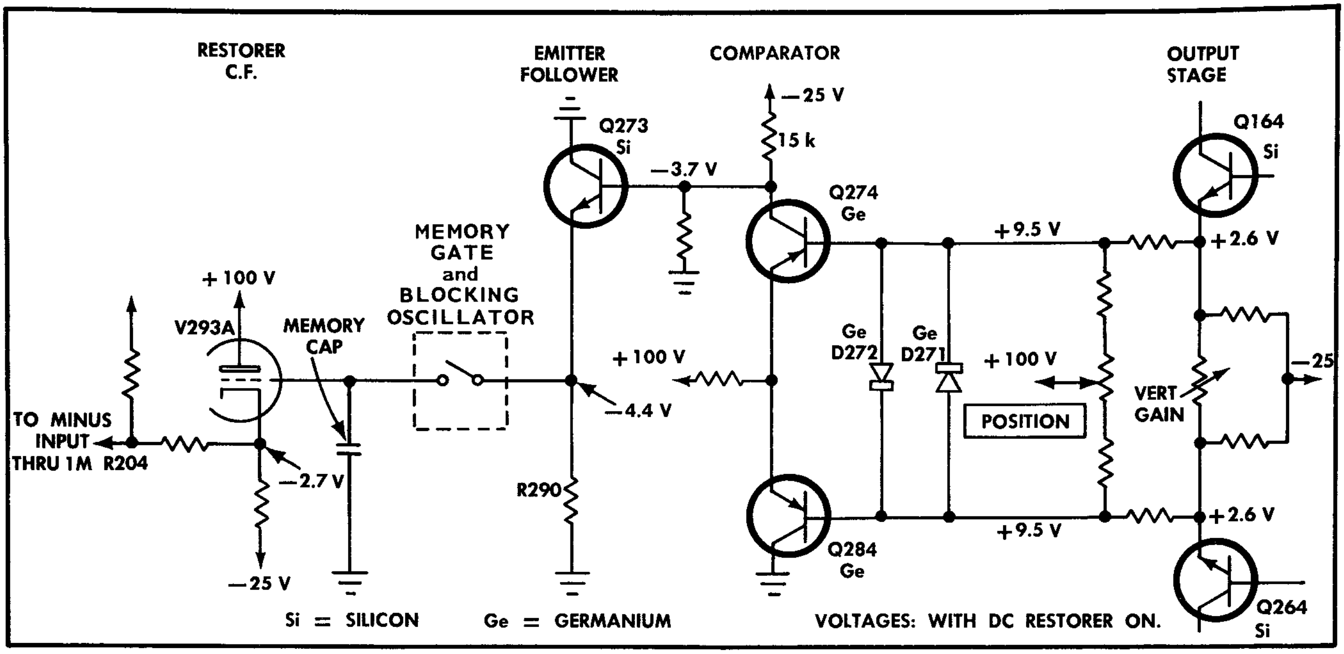


Fig. 3-5. Simplified keyed DC Restorer circuit.

The sweep generator applies a positive pulse to the video output jack when operating in a line selector mode. The intensifying pulse amplitude is about 0.2 volt at the video output jack (0.1 volt when loaded with 75 ohms). The value of the pulse is set by current from a +100-volt pulse in the sweep generator unblanking circuit applied through R476 diagrammed near the unblanking amplifier with the sweep generator to the 75-ohm output resistor R198. The very low output impedance of the video output amplifier prevents the intensifying pulse from disturbing the internal triggering signal.

Keyed DC Restorer

The keyed DC Restorer circuit includes the DC restorer Comparator, the blocking oscillator, and the restorer cathode follower. Voltages and waveforms on the DC restorer diagram were taken with the DC restorer circuit on. The simplified diagrams of Fig. 3-5, 3-7 and 3-8, and waveforms of Fig. 3-6 will help during the following discussion of the DC restorer circuit operation.

The DC restorer comparator is a dual-input single output amplifier that amplifies a small part of the composite video which is normally near the CRT screen center. The signal peaks are limited by parallel back-to-back germanium diodes D271-D272 (see Fig. 3-5). One of the two diodes conducts whenever the voltage across them exceeds 0.2 to 0.3 volt. When the diodes are not conducting, the comparator bases are fed push-pull signals from the two bases of the output amplifier cascode stages. When a diode is conducting, the two bases of the comparator amplifier are essentially shorted together, and there is no gain. When the signal at the base of Q274 goes negative (and the signal at the base of Q284 goes positive) D271 conducts. The opposite polarity signal causes D272 to conduct. The peak-to-peak signal input to the comparator is, therefore, limited to about 0.45 volt. The comparator output signal is typically 4.2 volts peak-to-peak at the emitter of the emitter follower (Q273). The comparator functions in the same manner as the differential preamplifier previously described, except there is just one output lead. Fig. 3-6 shows the signal as it enters the memory gate. The other waveforms of Fig. 3-6 are discussed with the blocking oscillator below.

Blocking Oscillator. The blocking oscillator is normally biased to cutoff by current through R282 and D282. A negative pulse applied to the base of Q280 will cause it to conduct and go through one cycle of oscillation. The negative pulse arrives at the base of Q280 through a diode switching network from the sync regenerator (diagrammed with the sync separator).

Assume the vertical INPUT switch is at A, as shown in Fig. 3-7. The diode switching circuit then reverse biases D285 about 45 volts and reverse biases D286 about 1 volt. Regenerated horizontal sync pulses arriving at C285 and C286 have a peak-

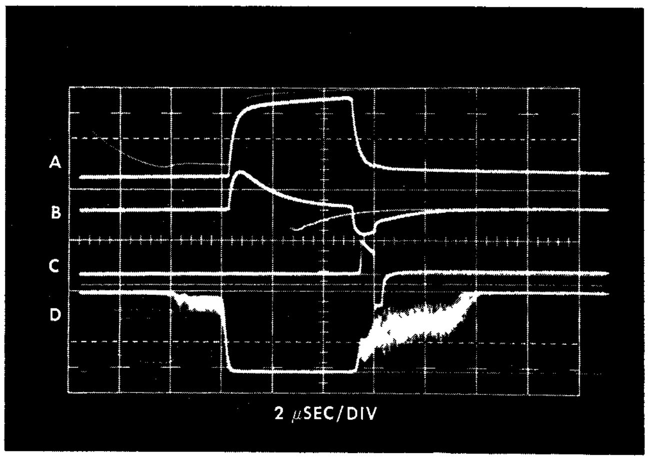


Fig. 3-6. Time-coincident waveforms of keyed DC Restorer.

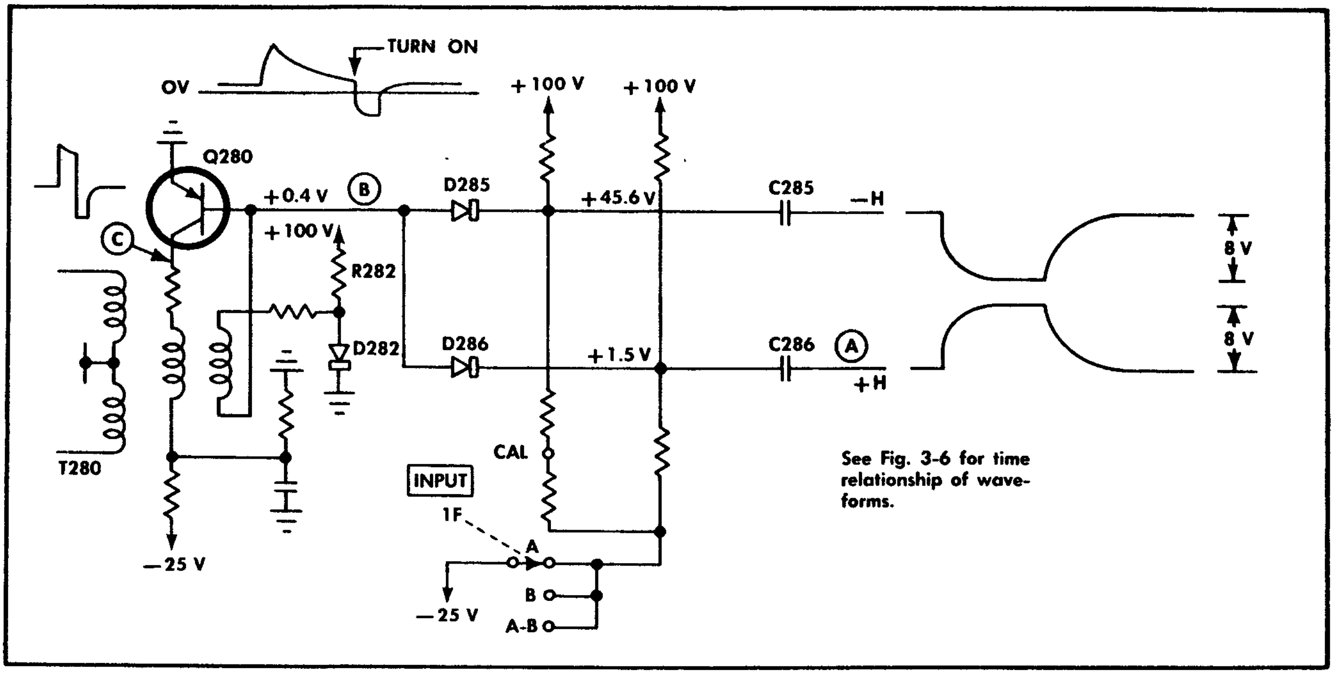


Fig. 3-7. Operation of Diode switch feeding Blocking Oscillator.

to-peak amplitude of about 8 volts. Thus, the —H pulse will not cause D285 to conduct, but the +H pulse will cause D286 to conduct at the end of the pulse as it goes negative. C286 charges almost the full 8 volts of the +H pulse rise, and then causes the cathode of D286 to fall about 7 volts. The base of Q280 does not fall as much as 8 volts because of the low base-to-emitter impedance at the time of turn on.

The blocking oscillator turns on at the time the composite video horizontal sync pulse ends and starts toward the back-porch level. The back-porch level occurs about 0.25 μs later, so the blocking oscillator does not sample the video at the time of turn-on. As Q280 conducts, the L/R time constant of the collector circuit inductance and resistance keeps Q280 conducting for about 0.6 μs before the base drive decays. As Q280 regenerative base turn-on drive is stopped, the collector current drops rapidly. Dropping collector current is transformer-coupled back to the base of Q280 as a fast turn-off signal. The collector voltage waveform is shown in Fig. 3-6. Changing collector current is also transformer-coupled to the tapped secondary that drives the memory gate.

Memory Gate. The memory gate consists of the center-tapped secondary of T280 with its DC level set by the emitter follower, two parallel RC circuits and two silicon diodes. As Q280 is turned on, the secondary voltage of T280 reverse biases D292 and D293 and no current flows. As Q280 stops conducting, the secondary of T280 drives D292 and D293 into conduction and at the same time charges both C292 and C293 to about 7 volts. (The energy for charging the two capacitors comes from the core of T280.) D292 and D293 are computer diodes with equal forward drop at the time they conduct, making the voltage at their junction with C294 equal to the voltage at the center of T280 secondary. Thus, during the backswing time of T280, the voltage at the center of T280 secondary appears at C294. The backswing lasts for about 0.4 μs, which is plenty of time to fully charge C294 to the voltage of the emitter follower. During each backswing, C292 and C293 are recharged to replace the small amount of voltage discharged by the resistors R292 and R293. The time constant of the two RC circuits is 1 ms each, many times longer than the 63.5 μs between sampling times.

Memory Circuit. The memory circuit includes the memory capacitor C294 and the grid of V293A. Since D292-D293 are silicon diodes with very high reverse leakage, the memory capacitor charge is essentially constant between samples.

The four waveforms of Fig. 3-6 (taken with a four-channel oscilloscope) show the time-coincidence of the DC restorer circuit. Note that some of the color burst is seen by the memory gate and memory capacitor. The reactance of the memory capacitor is about 440 ohms at 3.58 MHz; and the sampling diodes are turned on hard by T280 secondary so there is no color-burst rectification. Thus, the DC restorer circuit acts upon the average voltage of the color burst, keeping the display at the same stable position with or without the color burst.

Restorer Cathode Follower. The restorer cathode follower acts as an impedance transformer that couples the sampled and stored voltage into the vertical amplifier minus input grid. The two resistors, R298 and R299, offset the DC level of V293A cathode to the correct value for the minus input, setting the minus grid to essentially ground voltage when the system is correctly balanced.

Restorer Operation on Calibrator Signal. This mode of restorer operation uses the —H regenerated horizontal sync pulse to fire the blocking oscillator. The —H signal starts negative at the same time calibrator signal goes negative. The blocking oscillator fires as the —H signal goes negative, causing the DC restorer circuit to sample the signal voltage about 0.88 μs after the beginning of the calibrator negative

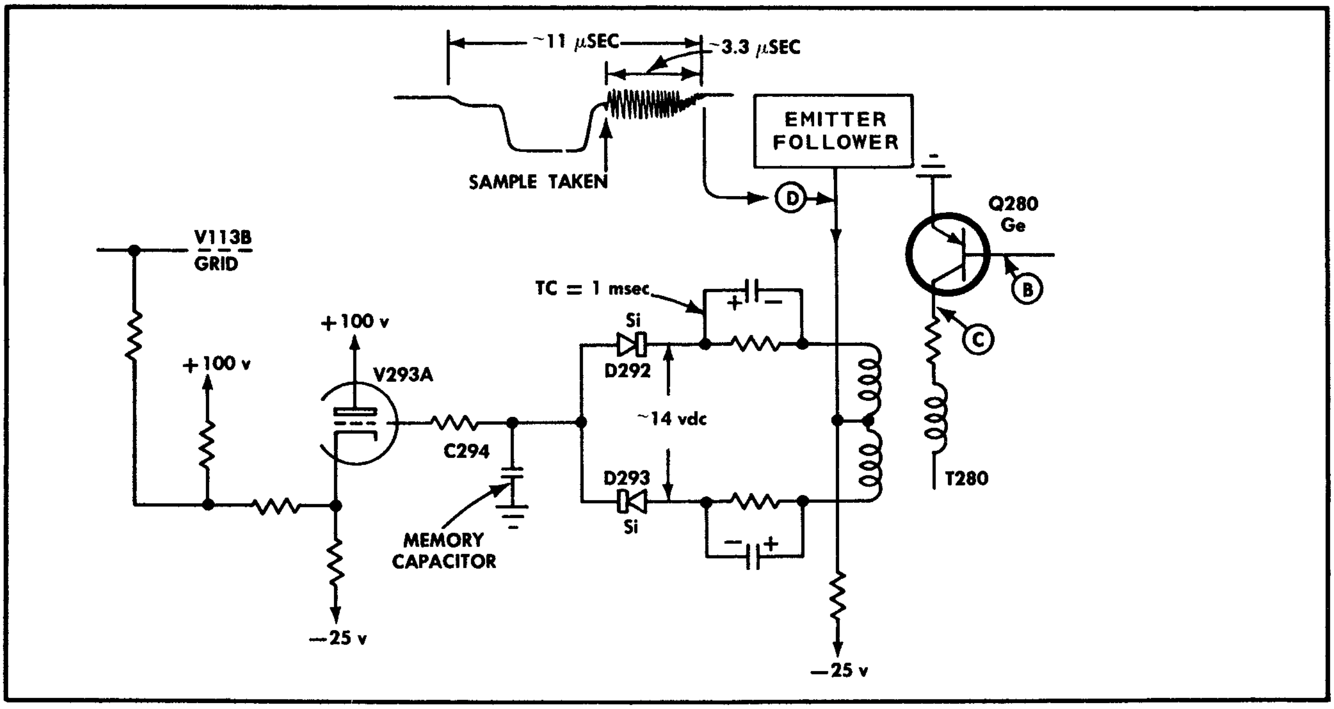


Fig. 3-8. Sampling and memory portions of DC Restorer circuit.

half-cycle. Thus, the display is stabilized at the bottom of the calibrator signal and held in the same position as the back porch.

Sync Separator

The sync separator processes composite video so the sweep generator is triggered properly for the various modes of the DISPLAY switch.

The input to the sync clamping amplifier can be from one of two sources; the internal trigger signal from the video output amplifier or an external sync input, usually composite video. The selection of source is made by the SYNC switch. Source switching is by diodes, and the actual SYNC switch is isolated from the video leads by R305. When the SYNC switch is set to INT, D301 is back biased and D304 is forward biased. The signal passes through forward-biased D304 into the grid of V293B. When the SYNC switch is set to EXT, D304 is back biased and D301 is forward biased, so the signal passes through D301. The internal-external sync selection can be made from the front panel for all vertical input modes except when viewing the calibrator signal. When the vertical INPUT switch is at CAL, the sync input is automatically switched over to internal.

Sync Clamping

The sync clamping amplifier has two feedback loops. One is a normal type consisting of R315, with the gain of Q314 set by R315 and the transconductance of V293B.

A feedback amplifier of the type in the sync clamping amplifier, shown in Fig. 3-9, has low input impedance called virtual ground, and a low output impedance. The virtual ground is easy to visualize when we find equal and opposite currents in the input resistor (R_i) and the feedback resistor (R_f). Assume R_f of Fig. 3-9 to be 22 kΩ and R_i to also be 22 kΩ. A one-volt IN signal will cause 0.045 mA to flow in R_i. The transistor collector will change voltage level (also 1 volt) until an opposite 0.045 mA flows in R_f at which time the input signal is balanced, so none is left for the base. When $R_i = R_f$ the voltage gain is unity.

V293B cathode output impedance is approximately equal to 1/Gm or typically $1/0.001\ S^1 = 1000\ \Omega$. (Normal range of

[1]siemens = mho

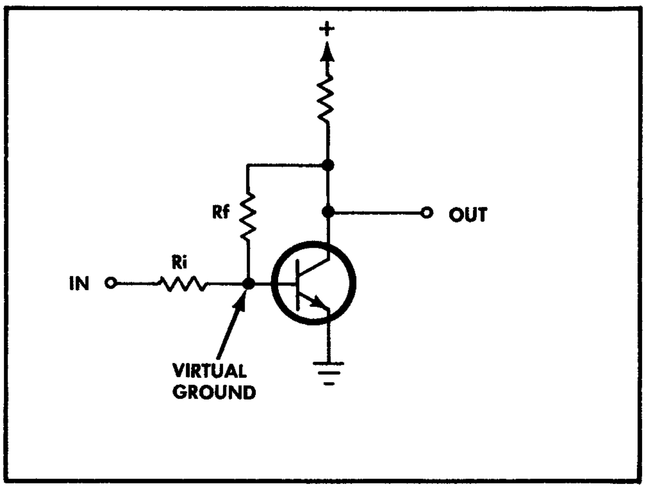


Fig. 3-9. Simplified Feedback amplifier.

output resistance between tubes will be from about 600 to 1200 Ω). The cathode-follower output resistance can be considered directly in series with the input grid for calculating signal current to the base of Q314. Thus, the typical voltage gain of Q314 is $\frac{22\ k\Omega}{1\ k\Omega} = 22$.

A second feedback loop around the Sync Clamping Amplifier is composed of R317, R318 and C317. This loop acts as a DC restorer for signals into the rest of the triggering circuitry. Negative-going composite video at the grid of V293B causes the collector of Q314 to go positive. As each negative-going sync tip occurs, C304 charges slightly positive, then as the collector voltage of Q314 falls, C317 gains a negative charge that is the average of the input signal amplitude. C304 thus receives a charge as each sync tip occurs, then discharges through R317 to C317 at all other times. The discharge current for C304 is approximately proportional to video level. The effect of the action just described is that C304 acts as a DC restorer for the Sync Clamping Amplifier for a wide range of signal levels. Restorer action thus holds the Sync Clamping Amplifier output (at the sync pulse tips) at a stable level of about —0.5 volt.

Any large noise pulses riding on the negative-going composite video will cause the collector of Q314 to go positive enough to back bias D318; while at the same time, the large negative going pulse at the grid of V293B will cause D317 to be forward biased. Forward biased D317 will now cause the charge rate of C304 to be limited by R319.

Video stripping occurs in the Sync Clamping Amplifier as the input signal goes positive, because available Q314 collector current through R314 is all taken by the feedback resistor R315. As V293B cathode applies positive-signal turn-off current to the base of Q314, Q314 collector goes negative until the current in R315 equals the current in from V293B cathode. At that point, the collector voltage stops going negative and the remaining positive signal input to V293B grid is not amplified. Thus, the DC-restored sync tips out of the Sync Clamping Amplifier have a maximum peak amplitude of about 13 volts with the video information removed from large signals.

Sync Regenerator

The Sync Regenerator is a Schmitt multivibrator whose operation is bistable due to the DC coupled input signal from Q314 collector. Q335 conducts when the base of Q325 is near ground, and Q325 conducts when the input is more negative than about —4 volts. Output signals are each about 8 or 9 volts peak to peak. The TRIG MULTI BIAS control is adjusted for proper triggering on low-level video sync signals in case the Sync Regenerator input signal is less than normal.

Assume Q325 is conducting. As the input signal goes positive, current in Q325 is reduced, allowing its emitter to go positive and its collector to go negative. Q325 emitter is coupled to Q335 emitter and Q325 collector is coupled to Q335 base. Initially the back bias at the base-emitter junction of Q335 prevented it from conducting. As Q335 bias reaches the point of conduction, regenerative action flips the conduction from Q325 to Q335 rapidly. As long as a sync tip holds the base of Q325 up near ground, Q335 will conduct. As Q325 base starts negative, Q325 begins to conduct and a second regenerative action switches Q335 off and Q325 on. The regenerative path is between the emitters of Q325-Q335 and from the collector of Q325 to the base of Q335.

Both the +H and —H signals are available for the keyed DC Restorer circuit previously described, and for the rest of the triggering circuitry.

FIELD SELECTOR

The Field Selector circuit includes the Vertical Sync Separator, the Field 1 Recognition circuit and the Field Trigger Generator.

Vertical Sync Separator. The Vertical Sync Separator is primarily a differentiator and an amplifier biased off about 3 volts. The differentiator, C341-R341, shifts the signal output DC level depending on the pulse duty cycle. If the incoming square-wave signal negative peaks are of longer duration than the positive peaks, the output will be more positive than negative. Likewise, if the incoming signal positive peaks are of longer duration that the negative peaks (vertical sync), the output will be more negative than positive. During the time C341 receives only regenerated horizontal sync pulses, the signal at the base of 344 shifts between about 2 volts negative and 6.5 volts positive and Q344 does not conduct. As the vertical sync group occurs, the signal at the base of Q344 shifts to between about 6 volts negative and 2.5 volts positive, turning Q344 on hard each time the signal goes below about —3.5 volts.

Both the Field 1 Recognition circuit and the Field Trigger Generator require a single pulse, the first of the vertical sync pulses. The parallel combination of R346-D346 and the capacitance of C347 allow only the first vertical pulse to pass through. As the collector of Q344 rises positive 20 volts, D346 passes the whole pulse to C347 (and C351). C347 charges to more than half the peak voltage of the first pulse. The very high reverse resistance of D346 and the resistance of R346 let C347 keep its charge. The second vertical sync pulse is, thus, not able to be coupled on since the cathode of D346 is already several volts more positive than it was before the arrival of the first pulse. (Some of the second pulse gets through the coupling capacitors, but does not affect the following circuits.) R346 discharges C347 (and C351) before the next vertical pulse arrives.

Field 1 Recognition. The field 1 recognition circuit is a one-shot multivibrator (mono-stable) with two input paths. The single vertical sync pulse that arrives through C351 to the base of Q355 turns Q355 on and Q365 off. The switching action is regenerative due to emitter coupling, and coupling from Q355 collector to Q365 base. C360 was initially charged to about 13 volts. As Q355 collector falls, the base of Q365 is taken about 11 volts negative. The FIELD 1 SYNC control (R360), in series with R361, starts the base of Q365 back toward ground, discharging C360. As the voltage at the base of Q365 nears a value that would cause Q365 to turn on, a positive pulse coupled to the base through C361 will turn it on and reset the multi. The time constant of C360 and R360-R361 is set such that the multi is reverted at the end of the last vertical equalizer pulse. (The waveform near the collector of Q365 on the diagram at the back of this manual shows capacitively-coupled pulses that pass through C361 and the base-to-collector capacitance of Q365. This is normal and does not indicate Q365 to be defective). As Q365 collector goes negative at the end of the last equalizing pulse, C364 and R368 form a negative pulse that ramps up for a period of 50 to 55 μs. C370 couples differentiated —H pulses and adds them to the ramp at the junction of R369 and D370. If a horizontal pulse occurs during the time the ramp is running up, the output through D370 is more negative than at any other time. A two-field interlace horizontal sync pulse occurs in the middle of every other ramp.

All the other negative pulses at the junction of R369-D370 charge C371 (through R372) to an essentially stable DC voltage (R371 does not appreciably discharge C371 between pulses). As a field 2 occurs, the more negative pulse that coincides with the field 1 recognition ramp is coupled through D371 to the base of Q375, flipping the field trigger generator so that Q375 conducts.

Field Trigger Generator. The field trigger generator is a bistable multivibrator that changes state each time a positive pulse arrives through C347 from the vertical sync separator. The triggering pulse is coupled to the bases of Q375-Q385 through diodes D374-D384 and the RC networks of C375-C385. The positive-polarity pulse turns off the conducting transistor regardless of which is conducting. The pulses arrive at a 60-hertz output rate, causing the field trigger generator to have a 30-hertz output rate at each collector.

If Q375 is off when the negative-going field 1 signal from the field 1 recognition circuit arrives at the base of Q375, Q375 will be turned on. A positive signal from the sync separator to each collector at the start of each field, and a negative pulse to Q375 base at each field 1 assures that the field trigger generator output is always related to field 1 and field 2 of the composite video. The collector of Q375 always goes positive (toward ground) at the beginning of each field 1. The collector of Q385 always goes positive at the beginning of each field 2.

Field shift switching is the selection of the correct field trigger generator output pulse by a dual input single output diode switch. Positive-going trigger pulses are needed by the sweep generator and by the delay generator. Thus, to trigger on a field 1, the field shift switch causes Q375 collector signal to be coupled on, and for a field 2, Q385 collector signal to be coupled on.

Assume a field 2 trigger is selected. The CRT display will start the sweep on a field 2 and show the field 1 at center screen. The FIELD switch (set at TWO) applies a negative bias to D377 anode, assuring that it cannot conduct the signal from Q375 collector to the following circuits. D387 will pass the positive portion of the differentiated Q385 collector signal. Differentiation of Q385 collector signal is by C384 and the parallel resistance of R388 and R379-R389. As Q385 collector rises, C384 couples the first of the full step through to D387 and the rest of the circuit. C384 soon charges, dropping the voltage at the cathode of D387 back to ground level. As Q385 collector falls, D387 disconnects the signal from the rest of the circuit and R388 recharges C384 for the next positive pulse. The contacts of K385 are described with the staircase amplifier later in this section.

Line Selector (SN 1910-up)

The line selector circuit includes the delay generator and the line pickoff circuit. The selected line-trigger pulses occur once each field, at an adjustable time interval after each vertical sync pulse.

Delay Generator. The delay generator is normally biased so Q405 is conducting and Q415 is cut off. Q415 collector rests at +24 volts because of the voltage divider R414, R415, R418 and Q420. (The LINE SELECTOR variable control current from —25 volts through R428 to the junction of R419-C419 will not take the junction significantly below ground, because a 24-volt drop exists across R415 and another of up to 25 volts across R428). Q405 collector rests at —1 volt, holding Q415 base of about —2.6 volts by the drop across R405-R406. Q414 is saturated (collector voltage pulled down very near emitter voltage) due to base current through R417. Thus, the emitter and collector current of Q405 is set by R419 and the —24 volts at Q414 collector. The delay generator will remain in this condition until a positive trigger pulse arrives at the base of Q415.

As a positive pulse turns on Q415, the current through Q414-R419 shifts to Q415, and Q405 turns off. As Q415 collector starts negative, C417 couples the voltage change into the base of Q414 in a direction to reduce its collector current. As the base of Q414 is taken far enough negative to almost turn off its collector current, the drop in Q415 collector voltage is nearly eliminated until the current through R417 discharges C417. As C417 discharges a bit, the base voltage of Q414 turns on a bit more current. The current of Q414 is also the current in Q415, which again pulls down on C417. The result of the feed-back just described is that C417 is discharged in a very linear manner by current through R417. The voltage at the junction of C417-R417 remains essentially constant while the collector of Q415 pulls the other side of C417 negative at a rate set by the current through R417.

When the collector voltage of Q415 reaches ground level and stops going negative, current through R417 raises the base voltage of Q414 and increases its current. Increased current in Q414 pulls both Q415 emitter and base elements negative, allowing the collector to go negative also. The common emitter-to-emitter lead of Q405-Q415 drops negative until Q405 again turns on. The collector voltage of Q405 drops and quickly turns Q415 off, letting its collector voltage rise in the positive direction as R414 charges C417 to its original state. (C414 cancels Q415 initial negative collector surge caused by shifting Q414 current from about 5 mA in Q405 to about 0.27 mA in Q415. Without C414, the collector voltage of Q415 would drop sharply negative at the time Q415 was triggered into conduction.) C417 charging current is limited only by R414 since the negative end of the capacitor is tied to —25 volts through Q414 base-emitter junction.

Line Selector (SN 100-1909)

The line selector circuit includes the delay generator and the line pickoff circuit (blocking oscillator). The selected line-trigger pulses occur once each field, an adjustable amount of time after each vertical sync pulse.

Delay Generator. The delay generator is normally biased so Q405 is conducting and Q415 is cut off. Q415 collector rests at +24 volts because of the voltage divider R414, R415-D415. The LINE SELECTOR variable control current from —25 volts through R428 to the junction of R415-D415 will not take the junction significantly below ground because a 24 volt drop exists across R415 and another of up to 25 volts across R428.) Q405 collector rests at —1 volt, holding Q415 base at about —2.6 volts by R405-R406. Q414 is saturated (collector voltage pulled down very near emitted voltage) due to base current through R417. Thus the emitter and collector current of Q405 is set by R419 and the —24 volts at Q414 collector. The delay generator will remain in this condition until a positive trigger pulse arrives at the base of Q415.

As a positive pulse turns on Q415, the current through Q414-R419 shifts to Q415 and Q405 turns off. As Q415 collector starts negative, C417 couples the voltage change into the base of Q414 in a direction to reduce its collector current. As the base of Q414 is taken far enough negative to almost turn off its collector current, the drop in Q415 collector voltage is nearly eliminated until the current through R417 discharges C417. As C417 discharges a bit, the base voltage of Q414 turns on a bit more current. The current of Q414 is also the current in Q415 which again pulls down on C417. The result of the feed-back just described is that C417 is discharged very linearly by current through R417. The voltage at the junction of C417-R417 pulls the other side of C417 negative at a rate set by the current of R417.

When the collector voltage of Q415 reaches ground level and stops going negative, current through R417 raises the base voltage of Q414 and increases its current. Increased current in Q414 pulls both Q415 emitter and base elements negative, allowing the collector to go negative also. The common emitter-to-emitter lead of Q405-Q415 drops negative until Q405 again turns on. The collector voltage of Q405 drops and quickly turns Q415 off, letting its collector voltage rise in the positive direction as R414 charges C417 to its original state. (C414 cancels Q415 initial negative collector surge caused by shifting Q414 current from about 5 mA in Q405 to about 0.27 mA in Q415. Without C414, the collector voltage of Q415 would drop sharply negative at the time Q415 was triggered into conduction.) C417 charging current is limited only by R414 since the capacitors negative end is tied to —25 volts through Q414 base-emitter junction.

The blocking oscillator section of the delay generator and its signals are shown in Fig. 3-10. The knee of waveform C where D415 stops conducting is adjustable by the LINE SELECTOR variable control. The knee is the point at which R415-R428 voltage division of the sawtooth output waveform causes the voltage at the blocking oscillator input to start negative. Negative differentiated horizontal sync pulses (waveform B, with their positive peaks removed by D427) are added to the sawtooth so that the blocking oscillator will fire at the time of a horizontal sync pulse. As the base of Q420 is pulsed far enough negative to cause it to conduct, transformer regenerative feedback turns it on hard. The collector is held stable for a short period of time by C424, causing the emitter to go sharply negative until it is more negative than the base. This turns off the drive and T420 aids in quickly turning off the pulse. R420 helps dissipate base winding inductive energy and D420 helps dissipate emitter winding energy so a second ringing type pulse is not generated. The negative emitter pulse is coupled to the trigger selector switch through R436-C436.

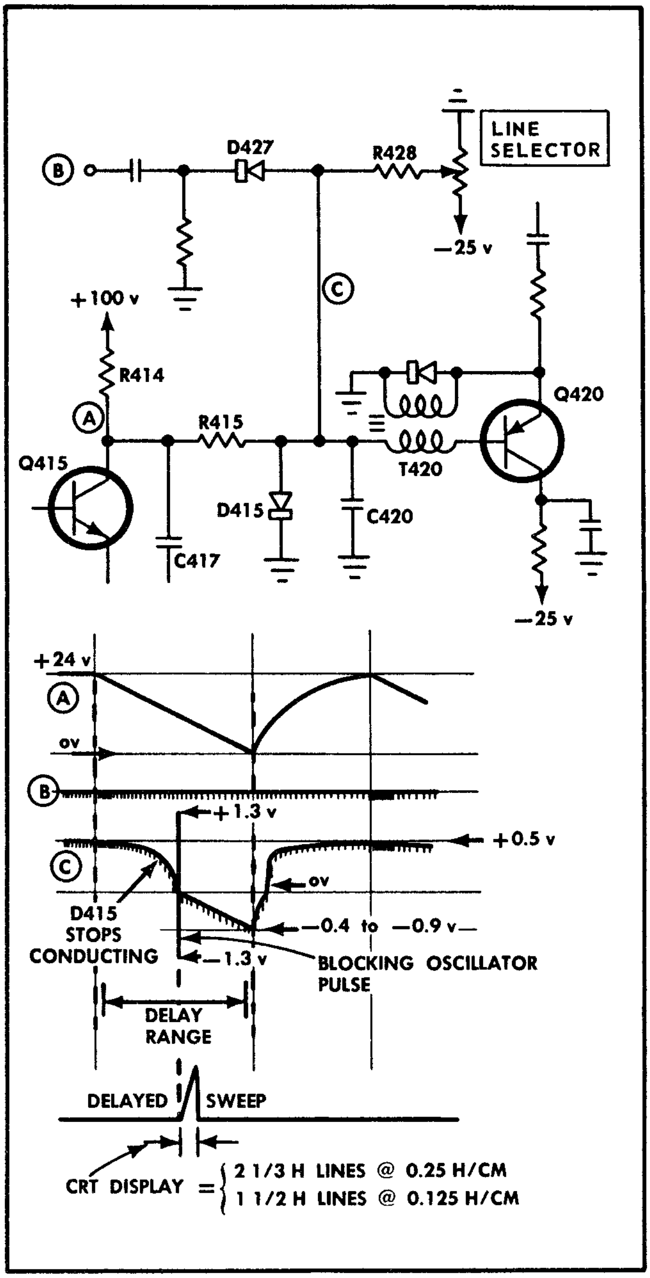


Fig. 3-10. Blocking oscillator section of the Delay Generator (SN 100-1909) and waveforms.

Sweep Generator (SN 2997-up)

The sweep generator is a triggered sweep system for all positions of the DISPLAY switch except the 2 FIELD position, at which it is a recurring synchronized sweep. Positive field-trigger pulses prevent the sweep from operating in 2 FIELD and both LINE SELECTOR positions (LINE SELECTOR set to a line, lines 16 through 21). Negative line-trigger or selected line pulses start the sweep in all other modes of operation. The sweep rate at 2 LINE permits viewing the interlacing of the color burst. The sweep rate at 0.125 H/cm permits a look at

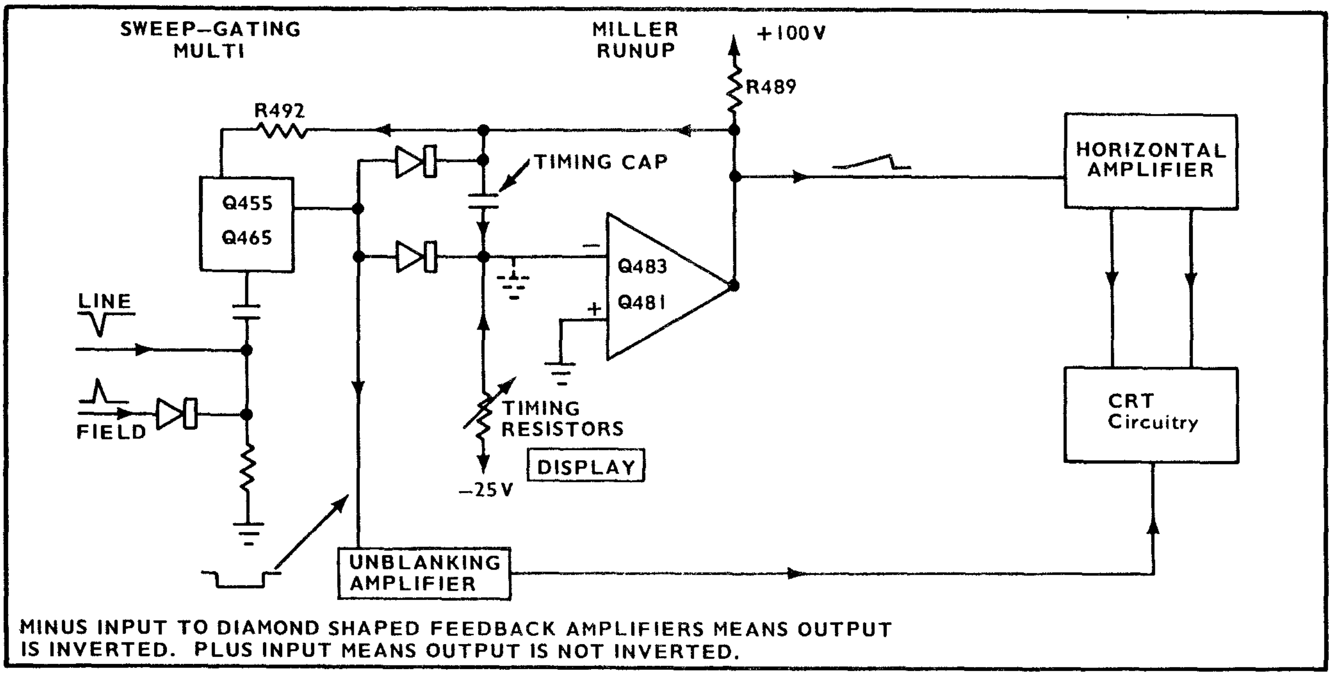


Fig. 3-11. Simplified Sweep Generator.

every other horizontal line displaying a non-interlaced color burst. Refer to the simplified sweep generator diagram of Fig. 3-11 and the complete diagram at the back of this manual during the following circuit description.

Trigger Selector Matrix

Selection of recurrent negative line trigger pulses at the beginning of each horizontal line, or of selected line pulses, is made in a diode switching network of the DISPLAY switch.

When the DISPLAY switch is at a LINE SELECTOR position and the LINE SELECTOR switch is set to a line (lines 16 through 21) position, both D430 and D436 are reverse biased so that no negative triggers get to the sweep gating multi. At the same time, D452 is forward biased through R450 so positive field triggers are available to the sweep gating multi.

When the DISPLAY switch is at its LINE SELECTOR positions and the LINE SELECTOR switch is set to VARIABLE, the cathode of D430 is raised about 9.5 volts positive and the diode is reverse biased so it cannot conduct negative line triggers to the sweep gating multi. D436 does conduct negative selected line pulses to the sweep gating multi.

When the DISPLAY switch is at 2 FIELD, both D430 and D436 are reverse biased, so that no negative triggers get to the sweep gating multi. At the same time, D452 is forward biased through R450 so positive field triggers are available to the sweep gating multi.

Sweep Gating Multi

The sweep generator is operated in two basically different modes of operation as suggested earlier. The sweep gating multi operation is altered from a triggered system for 2 LINE, .25 H/CM, .125 H/CM and both LINE SELECTOR positions of the DISPLAY switch with the LINE SELECTOR switch set to VARIABLE to a stopped-sweep system for both LINE SELECTOR positions of the DISPLAY switch when LINE SELECTOR switch is set to a line (lines 16 through 21), and to a free-running stopped-sweep systems for 2 FIELD displays.

2 LINE DISPLAY. (Vertical INPUT switch at A, DISPLAY switch at 2 LINE.) The sweep generator is held in one state by the sweep gating multi until the arrival of a negative trigger pulse. Before receipt of a trigger pulse, the following conditions exist:

a. Q455 is conducting, Q465 is in a state of non-conduction.

b. Both disconnect diodes are conducting. D482 is applying positive turn-on current from R468 to the miller runup input base, while D481 is limiting the turn-on current, as the collector of Q481 pulls down and takes some of the current flow from R468.

c. Q481 collector voltage is at about +1 volt, so that essentially no current is delivered through R520 (see horizontal amplifier diagram) to the horizontal amplifier.

d. The unblanking amplifier output is near ground, turning off the CRT beam.

e. The CRT horizontal deflection plates hold the blanked beam at the left side of the CRT (depending upon the setting of the POSITION control).

Q455 is held in conduction by current through the series resistors R464-R465 and D466, limited by R470 current into the base-emitter junction of Q474. The base turn-on current to

Q455 is enough to saturate it; however, D455 bypasses some of the intended base current when the collector voltage drops slightly below D466 anode voltage. This prevents the transistor from saturating. (If Q455 were to saturate, the base-emitter junction would hold so many carriers that the transistor could not be turned off quickly.) The fact that Q455 collector voltage is near ground assures that no current reaches the base of Q465, and Q465 remains cut off.

As the negative-going line trigger pulse arrives at the base of Q455 through C452, Q455 is turned off. The voltage rise at the collector of Q455 is coupled to the base of Q465, turning it on. As the current begins to flow in Q465, its collector voltage drop aids in turning Q455 off and the switching action takes place very rapidly. (Consider the emitter of Q465 as grounded; the components in its emitter circuit are used in 2 FIELD and LINE SELECTOR operation when LINE SELECTOR switch is set to a line, line 16 through 21 and are of no importance in 2 LINE operation.)

Miller Runup

As Q465 collector voltage falls below about +1.3 volts, D464 conducts and takes the anodes of the disconnect diodes toward ground. Both D481 and D482 stop conducting. The timing resistor current that had been flowing through D482 is immediately transferred to the base of Q483. The current that had been flowing in D481 through Q481 is cancelled by a slight drop in voltage at the base of Q481. As Q483 base starts negative, the base of Q481 also starts negative and reduces its collector current, causing its collector voltage to start positive. The timing capacitor couples the positive voltage of Q481 collector back to Q483 base, essentially stopping its negative travel. The result is that the timing capacitor receives a charge at a rate set by the timing resistor, creating a very linear positive-going sawtooth voltage at the collector of Q481. The miller runup circuit can be defined as a feedback amplifier, with the feedback element a timing capacitor, and the input resistor a timing resistor; the input signal is the —25-volt supply (see Fig. 3-9 and associated text for description of a feedback amplifier).

The sweep voltage rises positive until R492 raises the base voltage of Q455 far enough to revert the sweep gating multi. As Q455 conducts, the collector voltage of Q465 raises in the positive direction. D464 stops conducting and R468 raises the base voltage of Q483 positive through D482. This causes collector current in Q481 to increase rapidly. This collector current discharges the timing capacitor at a linear rate set by R468. As Q481 collector voltage approaches the voltage at the base of Q483, D481 takes some of the R468 current and stops the rundown. (D486 offsets the base voltage of Q481 in a direction to limit the quiescent current in D481, permitting the next sweep runup to start linearly.) The rate of rundown is slow enough that the sweep is triggered every other horizontal sync pulse, presenting a non-interlaced color burst. The sweep generator then waits for another negative line-trigger pulse to turn off Q455 and start the cycle over again.

2 FIELD DISPLAY. Operation of the sweep gating multivibrator is changed from a state where a trigger is required to start the sweep, to a condition where the sweep starts automatically, and is stopped by a trigger pulse. If the sweep is not running when the DISPLAY switch is set to 2 FIELD, Q465 of the sweep gating multi is not conducting. The DISPLAY switch connects R461A to the —25-volt supply and the emitter voltage starts negative. D461 is reverse biased, and the rate of fall is set by the time constant of R461A-C463. Approximately 1 millisecond after Q465 emitter voltage starts negative, the sweep gating multi switches so that Q465 is on and Q455 off. The sweep voltage runs up as described for 2 LINE operation.

The DISPLAY switch also changes the output of the trigger selector matrix, forward biasing D452 through R450 so that positive pulses will come through D452, and will turn on Q455 to stop the sweep. The positive pulse that turns Q455 on occurs at every other vertical sync pulse. The sweep is stopped, runs down very rapidly (due to additional rundown current from R453 in parallel with R468), waits 1 millisecond and automatically starts again, just before the video portion of the next field.

In the event vertical input composite video stops, the sweep will continue to cycle, but instead of positive pulses stopping the sweep, Q455 is turned on by sweep voltage feedback through R491-R492 in the same manner as described for 2 line operation. Thus, the Type RM529 Monitor will show a sweep without vertical information when the DISPLAY switch is set to 2 FIELD, but requires a trigger signal from the sweep to operate in all other positions of the DISPLAY switch.

With the INPUT switch set to CAL, R469 is placed in parallel with R468 so the rundown rate will be rapid enough to prepare the sweep to run again at the next calibrated signal transition. This assures a cleanly triggered calibrator display without the possible jitter caused by a longer rundown.

The runup rate of the miller runup circuit is slowed by adding C483 across the timing capacitor used in 2 LINE operation. C483 does not affect the sweep voltage peak value, but changes only the rate at which the spot moves across the CRT. Television systems with different time per field than the 30-hertz U. S. A. rate require a change in the value of C483 to change the sweep rate. For longer time per field, increase C483 value; for less time per field, decrease C483 value. Modification of C483 is normally made at the factory at time of purchase.

The miller runup circuit drives the horizontal amplifier and staircase amplifier.

LINE SELECTOR DISPLAY. Operation of the sweep gating multivibrator is changed from a state where a trigger is required to start the sweep, to a condition where the sweep gating multivibrator starts automatically, runs until a —H pulse latches it and causes it to switch and start the sweep voltage running up. After the sweep voltage has run up, the sweep gating multivibrator is reset by a field selected frame rate trigger pulse. If the sweep is not running when the DISPLAY switch is set to the LINE SELECTOR position (LINE SELECTOR switch set to line 21), Q465 of the sweep gating multi is not conducting. The DISPLAY switch connects R461A to the —25-volt supply through R461B, R461C, R461D, R461E, R461F and R461G (if FIELD switch is set to 2) and the emitter voltage starts negative. D461 is reverse biased, and the rate of fall is set by the time constant of C463-R461A, R461B, R461C, R461D, R461E, R461F and R461G. At a time which is determined by the setting of the LINE SELECTOR switch and the FIELD switch, after Q465 emitter voltage starts negative, it will be negative enough to be latched by one of the —H pulses applied through C462 to the emitter of Q465. The latching by the —H pulse causes the sweep gating multi to switch so that Q465 is on and Q455 off. The sweep voltage runs up as described for 2 LINE operation. After the sweep voltage has run up, the sweep gating multi is reset by a field selected frame rate trigger pulse.

Since the VIT LINE SEL RANGE control, R458, varies the base voltage of Q465 only a small amount, it is used to set the exact time that Q465 will turn on.

The DISPLAY switch also changes the output of the trigger selector matrix, forward biasing D452 through R450 so that positive pulses will come through D452, and will turn on Q455 to stop the sweep. The positive pulse that turns Q455 on occurs at every other vertical sync pulse. The sweep is stopped, runs down, waits for the time set by the LINE SELECTOR switch and the FIELD switch, then automatically starts again, just before the desired horizontal line.

Unblanking Amplifier

The unblanking amplifier (Q474) responds to the sweep gating multi (Q465) collector signal. When there is no sweep, the CRT beam is pulled away from the deflection plates and phosphor screen, preventing any spot from being seen. Q474 collector is near ground at the time of no sweep, turning off the CRT beam. As the sweep gating multi switches states to start a sweep, Q474 is biased to cutoff and its collector rises to +101 volts, limited by conduction of D474 and D475.

The unblanking amplifier provides two more output signals during line selector sweep operation. One is the video output intensification discussed with the vertical amplifier description. The other increases the CRT beam current to intensify the CRT trace for the short duration of the line selector sweeps.

The collector signal of Q474 does not pull down on the trace intensification line; rather, that line is pulled down by R476 and the —5 volts of the video output amplifier circuit between sweeps when the DISPLAY switch is set to either Line Selector position. The collector voltage of Q474 is near ground most of the time in line selector modes, because of the short-duration sweeps recurring at the 30-hertz rate (once every 33.3 ms). The trace intensification line (at R477-R478 junction) drops to +5 volts in about 2.6 ms as the combination of R476-R477 discharges C478 and changes the charge on C477.

As the sweep starts, Q474 collector rises quickly, sending an integrated pulse to the CRT grid circuit. R478 permits the step to rise abruptly to +22 volts, then continue to rise at an RC rate. The rising signal to the CRT grid is required to keep the cathode current constant during the intensification period, assuring a uniform CRT intensity throughout each sweep.

R476 also conducts current into the 75 ohms of the VIDEO OUTPUT connector, adding about 0.1 volt to the video output to intensify a line of the studio monitor, identifying which line the Type RM529 Monitor is viewing.

Sweep Generator (SN 100-2996)

The sweep generator is a triggered sweep system for all positions of the DISPLAY switch except the 2 FIELD position, at which it is a recurring synchronized sweep. Positive field-trigger pulses stop the sweep in 2 FIELD operation. Negative line-trigger or selected line pulses start the sweep in all other modes of operation. The sweep rate at 2 LINE permits viewing the interlacing of the color burst. The sweep rate at 0.125 H/cm permits a look at every other horizontal line displaying a noninterlaced color burst. Refer to the simplified sweep generator diagram of Fig. 3-11 and the complete diagram at the back of this manual during the following circuit description.

Trigger Selector Matrix

Selection of recurrent negative line trigger pulses at the beginning of each horizontal line, or of selected line pulses, is made in a diode switching network of the DISPLAY switch.

When the DISPLAY switch is at either of its LINE SELECTOR positions, the cathode of D430 is raised about 9.5 volts positive and the diode is reverse biased so it cannot conduct negative line triggers to the sweep gating multi. D436 does conduct negative selected line pulses to the sweep gating multi.

When the DISPLAY switch is at 2 LINE, .25 H/CM, or .125 H/CM, D436 cathode is reverse biased about +29 volts to prevent selected line pulses from getting to the sweep gating multi. D430 does conduct negative line-trigger pulses to the sweep gating multi.

When the DISPLAY switch is at 2 FIELD, both D430 and D436 are reverse biased so that no negative triggers get to the sweep gating multi. At the same time, D452 is forward biased through R450 so positive field triggers are available to the sweep gating multi.

Sweep Gating Multi

The sweep generator is operated in two basically different modes of operation as suggested earlier. The sweep gating multi operation is altered from a triggered system for line displays to a free-running stopped-sweep system for 2 field displays.

2 LINE DISPLAY. (Vertical INPUT switch at A, DISPLAY switch at 2 LINE.) The sweep generator is held in one state by the sweep gating multi until the arrival of a negative trigger pulse. Before receipt of a trigger pulse, the following conditions exist:

a. Q455 is conducting, Q465 is in a state of nonconduction.

b. Both disconnect diodes are conducting. D482 is applying positive turn-on current from R468 to the miller runup input base, while D481 is limiting the turn-on current, as the collector of Q481 pulls down and takes some of the current flow from R468.

c. Q481 collector voltage is at about +1 volt, so that essentially no current is delivered through R520 (see horizontal amplifier diagram) to the horizontal amplifier.

d. The unblanking amplifier output is near ground, turning off the CRT beam.

e. The CRT horizontal deflection plates hold the blanked beam at the left side of the CRT (depending upon the setting of the POSITION control).

Q455 is held in conduction by current through the series resistors R464-R465 and D466, limited by R470 current into the base-emitter junction of Q474. The base turn-on current to Q455 is enough to saturate it; however, D455 bypasses some of the intended base current when the collector voltage drops slightly below D466 anode voltage, which prevents the transistor from saturating. (If Q455 were to saturate, the base-emitter junction would hold so many carriers that the transistor could not be turned off quickly.) The fact that Q455 collector voltage is near ground assures that no current reaches the base of Q465, and Q465 remains cut off.

As the negative-going line trigger pulse arrives at the base of Q455 through C452, Q455 is turned off. The voltage rise at the collector of Q455 is coupled to the base of Q465, turning it on. As current begins to flow in Q465, its collector voltage aids in turning Q455 off and the switching action takes place very rapidly. (Consider the emitter of Q465 as grounded; the three components in its emitter circuit are used in 2 FIELD operation and are of no importance in 2 LINE operation.)

Miller Runup

As Q465 collector voltage falls below about +1.3 volts, D464 conducts, and takes the anodes of the disconnect diodes toward ground. Both D481 and D482 stop conducting. The timing resistor current that had been flowing through D482 is immediately transferred to the base of Q483. The current that had been flowing in D481 through Q481 is cancelled by a slight drop in voltage at the base of Q481. As Q483 base starts negative, the base of Q481 also starts negative and reduces its collector current, causing its collector voltage to start positive. The timing capacitor couples the positive voltage of Q481 collector back to Q483 base, essentially stopping its negative travel. The result is that the timing capacitor receives a charge at a rate set by the timing resistor, creating a very linear positive-going sawtooth voltage at the collector of Q481. The miller runup circuit can be defined as a feedback amplifier, with the feedback element a timing capacitor, and the input resistor a timing resistor; the input signal is the —25-volt supply (see Fig. 3-9 and associated text for description of a feedback amplifier.)

The sweep voltage rises positive until R492 raises the base voltage of Q455 far enough to revert the sweep gating multi. As Q455 conducts, the collector voltage of Q464 rises in the positive direction. D464 stops conducting and R468 raises the base voltage of Q483 positive through D482. This causes collector current in Q481 to increase rapidly. This collector current discharges the timing capacitor at a linear rate set by R468. As Q481 collector voltage approaches the voltage at the base of Q483, D481 takes some of the R468 current and stops the rundown. (D486 offsets the base voltage of Q481 in a direction to limit the quiescent current in D481, permitting the next sweep runup to start linearly.) The rate of rundown is slow enough that the sweep is triggered every other horizontal sync pulse, presenting a non-interlaced color burst. The sweep generator then waits for another negative line-trigger pulse to turn off Q455 and start the cycle over again.

2 FIELD DISPLAY. Operation of the sweep gating multivibrator is changed from a state where a trigger is required to start the sweep, to a condition where the sweep starts automatically, and is stopped by a trigger pulse. If the sweep is not running when the DISPLAY switch is set to 2 FIELD, Q465 of the sweep gating multi is not conducting. The DISPLAY switch connects R461 to the —25-volt supply and the emitter voltage starts negative. D461 is reverse biased, and the rate of fall is set by the time constant of R461-C461. Approximately 1 millisecond after Q465 emitter voltage starts negative, the sweep gating multi switches so that Q465 is on and Q455 off. The sweep voltage runs up as described for 2 LINE operation.

The DISPLAY switch also changes the output of the trigger selector matrix, forward biasing D452 through R450 so that positive pulses will come through D452, and will turn on Q455 to stop the sweep. The positive pulse that turns Q455 on occurs every other vertical sync pulse. The sweep is stopped, runs down very rapidly due to additional rundown current from R453 in parallel with R468, waits 1 millisecond and automatically starts again, just before the video portion of the next field.

In the event vertical input composite video stops, the sweep will continue to cycle, but instead of positive pulses stopping the sweep, Q455 is turned on by sweep voltage feedback through R491-R492 in the same manner as described for 2 line operation. Thus, the Type RM529 Monitor will show a sweep without vertical information when the DISPLAY switch is set to 2 FIELD, but requires a trigger signal for the sweep to operate in all other positions of the DISPLAY switch.

With the INPUT switch set to CAL, R469 is placed in parallel with R468 so the rundown rate will be rapid enough to prepare the sweep to run again at the next calibrator signal transition. This assures a cleanly triggered calibrator display without the possible jitter caused by a longer rundown.

The runup rate of the miller runup circuit is slowed by adding C483 across the timing capacitor used in 2 LINE operation. C483 does not affect the sweep voltage peak value, but changes only the rate at which the spot moves across the CRT Television systems with different time per field than the 30-hertz U.S.A. rate require a change in the value of C483 to change the sweep rate. For longer time per field, increase C483 value; for less time per field, decrease C483 value. Modification of C483 is normally made at the factory at time of purchase.

The miller runup circuit drives both the horizontal amplifier and the staircase amplifier.

Unblanking Amplifier

The unblanking amplifier (Q474) responds to the sweep gating multi (Q465) collector signal. When there is no sweep, the CRT beam is pulled away from the deflection plates and phosphor screen, preventing any spot from being seen. Q474 collector is near ground at the time of no sweep, turning off the CRT beam. As the sweep gating multi switches states to start a sweep, Q474 is biased to cutoff. Its collector rises to +101 volts, limited by conduction of D474 and D475.

The unblanking amplifier provides two more output signals during line selector sweep operation. One is the video output intensification discussed with the vertical amplifier description. The other increases the CRT beam current to intensify the CRT trace for the short duration of the line selector sweeps.

The collector signal of Q474 does not pull down on the trace intensification line; rather, that line is pulled down by R476 and the —5 volts of the video output amplifier circuit between sweeps when the DISPLAY switch is set to either Line Selector position. The collector voltage of Q474 is near ground most of the time in line selector modes, because of the short-

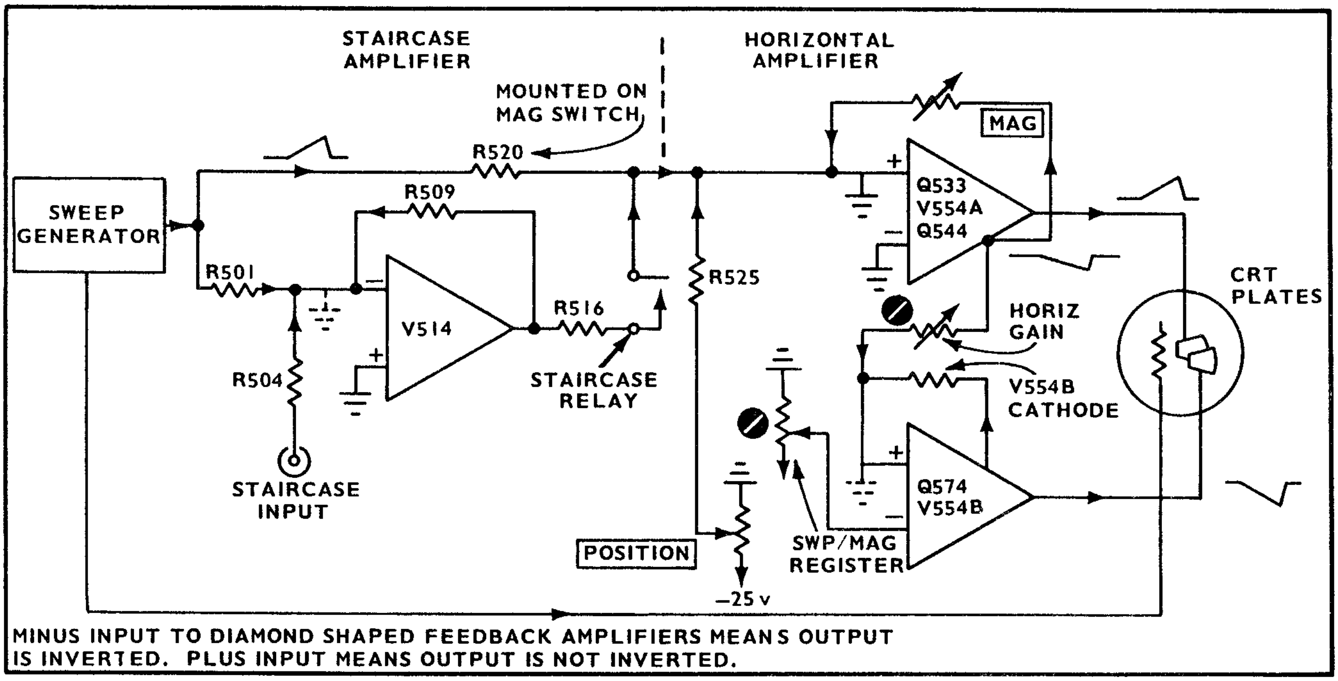


Fig. 3-12. Simplified Horizontal Amplifier.

duration sweeps recurring at a 30-hertz rate (once every 33.3 ms). The trace intensification line (at R477-R478 junction) drops to —5 volts in about 2.6 ms as the combination of R476-R477 discharges C478 and changes the charge on C477.

As the sweep starts, Q474 collector rises quickly, sending an integrated pulse to the CRT grid circuit. R478 permits the step to rise abruptly to +22 volts, then continue to rise at an RC rate. The rising signal to the CRT grid is required because the high-voltage power supply does not follow the increased current immediately, and the increasing grid signal turns on the CRT at about the same rate as the supply current decreases, assuring a steady CRT intensity throughout each sweep.

R476 also conducts current into the 75 ohms of the VIDEO OUTPUT connector, adding about 0.1 volt to the video output to intensify a line of the studio monitor, identifying which line the Type RM529 Monitor is viewing.

Horizontal Amplifier

The horizontal amplifier circuit includes the horizontal amplifier and the staircase amplifier. Refer to the simplified horizontal amplifier diagram of Fig. 3-12 and the complete diagram at the back of this manual during the following circuit description.

Horizontal Amplifier. The horizontal amplifier is a combination of feedback and paraphase amplifier. The base of Q533 is the virtual ground summing input terminal to the whole amplifier. Voltage gain of the overall amplifier is the ratio of the MAG resistance to the input resistance of R520. The DC level of the output (positioning) is through R525 to the base of Q533. The input to a feedback amplifier can have several input resistors and signals. The gain of each is the ratio of feedback resistor to input resistor. Feedback is from V544A cathode to the base of Q533. V544A cathode is also the signal source for the inverting half of the amplifier, through the HORIZ GAIN control R558-R568 to the base of Q574. Feedback in the inverting half of the amplifier is the cathode resistance of V554B to the base of Q574. The SWP/MAG REGIS control sets the DC balance of cathode voltages of V544A/V554B so the display center does not shift as the MAG switch is changed.

The sweep sawtooth enters through R520. Q533 is an emitter follower and current-gain transistor, driving the inverting amplifier Q544. Q544 signal output receives current gain in the cathode of V544A, assuring linear feedback from a low impedance. The plate of V554A provides a +150-volt swing that would be impossible to achieve with transistors. It acts in a normal vacuum tube fashion, with the input grid signal appearing inverted at the plate output.

The HORIZ GAIN resistance is degenerative to V554A, and is the signal coupling path to Q574. The signal from V554A cathode to Q574 base runs negative, increasing the current in Q574 collector. The collector voltage of Q574 becomes less negative and drives the grid of V554B to increase V554B current, raising the cathode to the level it had before the signal started negative. Note that the base of Q574 acts as a virtual ground for signals. V544B grid swings about 6.6 volts, turning on plate current so the plate swings about —150 volts.

Staircase Amplifier (SN 787-up)

V514 is a feedback amplifier with two input resistors to sum the sawtooth and studio color camera staircase voltages. When 25 volts is applied between pins D and E of J501, K385 causes R516 to become the third input to the horizontal amplifier. V514 inverts the sawtooth voltage so that the summed sawtooth signal to Q533 base is one-fourth its normal amplitude. The external input negative staircase signal is also inverted by V514.

With the staircase most positive, the sweep runs for the period of 1 field, and is reverted by a vertical sync trigger. At the time the sweep is reverted, the staircase drops negative to its second level. The sweep starts again, but begins one-fourth of the way across the CRT due to the staircase positioning signal. Again the sweep runs for 1 field, is reverted and the staircase drops to its third level. Once again the sweep starts, but one-half of the way across the CRT. Again the sweep runs for 1 field, is reverted and the staircase drops to its fourth level. Once again the sweep starts, but three-fourths of the way across the CRT. Thus, the three-color and black-white camera signals can all be viewed in one CRT display.

The staircase level shift takes about 800 μs. With the sweep gating multi operating in 2 FIELD, the sweep restarts in about 1 millisecond, so the change in staircase is not seen because the CRT beam is blanked off at the same time.

Closing the staircase relay also changes the timing resistor of the sweep generator so the sweep rate is twice as fast as that for 2 FIELD operation. The relay also changes the operation of the field selector to put out a positive pulse at each vertical sync pulse time instead of at every other one. Thus, the sweep recurs at a 60-hertz rate, taking four sweeps to get across the CRT.

Staircase Amplifier (SN 100-786)

V514 is a feedback amplifier with two input resistors to sum the sawtooth and studio color camera staircase voltages. When the control lead, pin D of J501, is externally grounded, K385 causes R516 to become the third input to the horizontal amplifier. V514 inverts the sawtooth voltage so that the summed sawtooth signal to Q533 base is one-third of its normal amplitude. The external input negative staircase signal is inverted by V514.

With the staircase most positive, the sweep runs for the period of one field, and is reverted by a vertical sync trigger. At the time the sweep is reverted, the staircase drops negative to its second level. The sweep starts again, but begins one-third of the way across the CRT due to the staircase positioning signal. Again the sweep runs for one field, is reverted and the staircase drops to its third level. Once again the sweep starts, but two-thirds of the way across the CRT. Thus, the three color camera signals can all be viewed on one CRT display.

The staircase level shift takes about 800 μs. With the sweep gating multi operating in 2 FIELD, the sweep restarts in about 1 ms, so the change in staircase is not seen because the CRT beam is blanked off at the same time.

Closing the staircase relay also changes the timing resistor so the sweep rate is twice as fast as that for 2 FIELD operation. The relay also changes the operation of the field trigger generator to put out a positive pulse at each vertical sync pulse time instead of at every other one. Thus the sweep recurs at a 60-hertz rate, taking three sweeps to get across the CRT.

Power Supply

The low-voltage power supply provides regulated −25 volts, +100 volts, and unregulated +360 volts to the circuits of the Type RM529. The −25 volt supply is the reference voltage for the +100-volt supply and the calibrator circuit.

The Type RM529 is powered by a dual primary power transformer for operation on either 115 or 230 volt 50-60 hertz line. Refer to the Operating Instructions section of this manual for converting from one supply voltage to the other.

−25-Volt Supply

Voltage for the −25-volt power supply comes from the full-wave rectifier system of D610-D611 and C610. Voltage across C610 is nominally 35 volts.

The −25-volt regulator consists of a comparator that compares a portion of −25 volts (divided by R624-R626 and the −25 VOLTS/CAL AMPL control R620) against the voltage of a precision zener diode D614. D614 zener voltage is about 9.1 volts. The comparator output at Q616 collector is inverted and amplified by Q634, which drives the series transistor Q637 in a direction to compensate for changes in the output voltage.

Assume the −25-volt supply level decreases and the voltage goes slightly positive. Q626 turns on harder, reducing the current in Q616 so its collector goes positive. Q634 turns on harder and pulls Q637 base in the negative direction, causing it to conduct harder, raising the output voltage back to its proper negative level. Since the collector of Q637 is grounded, the whole supply is moved by the emitter of Q637 to make the correction. R617-C617 at the base of Q634 reduce the feedback loop high-frequency gain for more stable operation with high-frequency load transients. C620 and C626 aid in reducing the high-frequency output impedance of the supply.

The −25-volt supply is the voltage source for the heaters of V113 and V293. R621 across V293 heater compensates the heater voltage for current taken by the constant current stage of the vertical preamplifier.

The value of the −25-volt supply directly sets the peak-to-peak amplitude of the calibrator signal; therefore the control used to adjust the supply is labeled −25 VOLTS/CAL AMPL. See the Calibration procedure for adjustment.

+100-Volt Supply

Voltage for the +100-volt supply is provided by the full-wave bridge rectifiers D640A-B-C-D and C640. The voltage across C640 is nominally 130 volts.

The +100-volt regulator compares a portion of the +100 volts (referenced to the −25-volt supply through the divider R641-R642) to ground at the emitter of Q644. Q643 is an emitter follower acting as an impedance transfer device to raise the base impedance of Q644 base to prevent loading the divider. Q644 amplifies and inverts any change at the base of Q643 and applies the change directly to the base of Q647. Q644 collector current is the total base current of Q647. Q647 emitter voltage follows the inverted correction signals, changing the level of the whole supply when needed.

Assume that the load increases, taking the +100 volts slightly negative. Q643 drives Q644 base negative, increasing its collector current. Increased Q644 collector current means increased base current in Q647, raising the emitter positive the correct amount to restore the output voltage.

Fuse F648 protects Q647 from accidental short circuit of the +100-volt supply bus. R648 discharges C640 if the fuse is blown, but only after the AC power is turned off.

C649 and C644 aid in reducing the supply high-frequency impedance. R644 limits the peak current through C644 to the base of Q643 in case the supply is accidentally shorted.

R646-C646 decouple the +100-volt bus for peak current of the CRT unblanking circuit.

+360-Volt Supply

Voltage for the +360-volt unregulated supply is provided by the full-wave bridge rectifiers D650A-B-C-D and C650A (C650 below SN 787). The voltage across C650A (C650 below SN 787) is nominally 255 volts, which is added to the +100-volt supply. The supply is used by the CRT high-voltage supply and the vertical output stage, whose current passes through the beam rotator coil.

Beam Rotator Coil. The rectangular CRT is not easily rotated physically. Also, the trace changes its alignment with the graticule slightly, depending upon the monitor's relation to the earth's magnetic field. Thus, a coil is included around the CRT proper, allowing the operator to adjust the trace alignment with the graticule.

CRT Circuit and Calibrator

The Type T5290 (V859) cathode-ray tube is a rectangular, flat-faced, mono-accelerator, deflection-blanked type, designed especially for the Type RM529 Waveform Monitor. Acceleration voltage is 5500 volts with —5300 V at the cathode, and nominally +200 volts at the deflection plates. The phosphor is aluminized, permitting bright displays and preventing any chance of phosphor damage at any position of the INTENSITY control.

The beam is blanked between sweeps by special deflection plates (located in the focus gun area of the tube) that pull all electrons away from the screen. Special intensifying circuits described with the sweep generator automatically brighten selected line displays for easy viewing of fast sweeps at low-repetition rates.

High-Voltage Power Supply and Calibrator

High-Voltage Power Supply. The high-voltage supply is actually a cathode-modulated amplifier with positive feedback sustaining oscillation. The cathode modulation is voltage feedback from the high-voltage output that controls the level of oscillation. The calibrator transistor Q874 is directly in the feedback path that sustains oscillation.

As the monitor is turned on, V800B is turned off due to its cold heater. The voltage divider of R875-R876 turns on Q874 so its collector voltage is about —10 volts. Q874 collector is directly connected to the grid of V800B. V800B will conduct with its grid at —10 volts. As V800B warms up and pulls plate current, Q874 collector receives a transformer-coupled turn-off signal and its collector voltage turns on V800B even more. The secondary of T801 is a tank circuit, resonant at about 30 kHz. Thus, Q874 first receives a turn-off pulse, and then as T801 secondary swings through a cycle, Q874 is turned on full, turning V800B completely off. The cycle of oscillation repeats, heating the cathodes of V822 and V832. As they conduct, high voltage is developed that soon reduces current in V800A and Q804 to limit the current of V800B. Any further changes in output high voltage will change the conduction level of V800B to correct and restore the supply voltage.

V822 and V832 are the diodes of a half-wave voltage doubler with C837 and C848, the main filter capacitors. C837 also couples fast output voltage changes to the control tube V800A.

The multiple-resistor bleeder of R834 through R847 also provides voltage division for the INTENSITY and FOCUS controls. C849 assures that there is no voltage ripple between the cathode and grid of the CRT, which would otherwise intensity-modulate the trace.

Neon bulbs placed across the ASTIG control assure that the voltage of the astigmatism element remains constant to the average voltage of the vertical defective plates, which also use the unregulated +360-volt supply.

Calibrator. The calibrator voltage is a secondary benefit of the high-voltage oscillator. Q874 collector voltage swings between about ground and the —25-volt supply, providing a stable square wave. D881 sets the ground level, and the —25-volt supply sets the negative level. R881, R885 and R886 divide the 25-volt swing for use in the vertical amplifier when the VOLTS FULL SCALE control is at 1.0. As the gain of the vertical amplifier is increased with the VOLTS FULL SCALE switch, R882 and/or R883 reduce the calibrator output amplitude to keep the display on the CRT screen.

External calibrator signals see a 1-megohm load when the switch is set to EXT.

SECTION 4
MAINTENANCE

Visual Inspection

If trouble occurs in the Type RM529, make sure the associated equipment is operating and the controls are properly set. If it is determined that the trouble is definitely in the Type RM529, a visual check may reveal the cause. Defects such as loose or broken connections, frayed or broken cables, damaged connectors, burned components, and broken switches can generally be detected by a visual inspection. Except for heat-damaged components, the remedy for such defects is obvious. Overheating of components is usually a symptom of other, less apparent, troubles in the circuit. For this reason, it is essential to determine the actual cause of overheating before the damaged parts are replaced; otherwise, the damage may be repeated.

Parts Removal and Replacement

Whenever a part is replaced, check and adjust the instrument calibration as necessary. Most parts in the Type RM529 can be replaced without detailed instructions. Some, however, are best removed and replaced by using definite procedures contained in the following paragraphs. (Parts ordering information is located on the back of the Abbreviations And Symbols page which immediately precedes Section 7 of this manual.)

CAUTION

Turn AC power off before removing tubes or transistors from their sockets.

Transistor Replacement. Transistors should not be replaced unless they are actually defective. Transistor defects usually take the form of the transistor opening, shorting, or developing excessive leakage. To check a transistor for these and other defects, use a transistor curve display instrument such as a Tektronix Type 575. However, if a good transistor checker is not readily available, a defective transistor can be found by signal-tracing, by making in-circuit voltage checks, by measuring the transistor forward-to-back resistance using proper ohmmeter resistances, or by using the substitution method. The locations of all transistors are silk-screened on the chassis next to each socket.

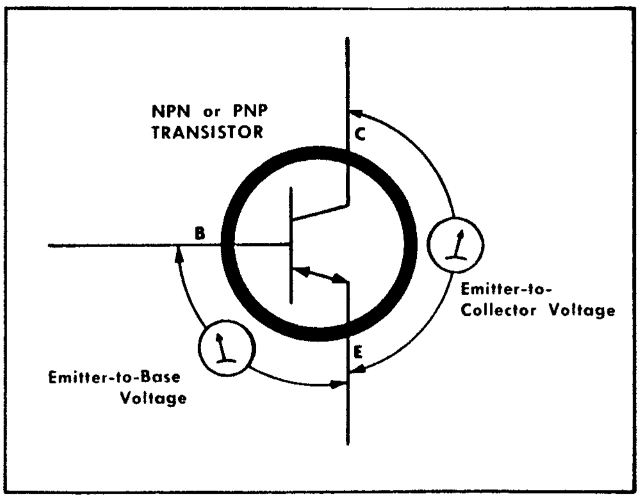


Fig. 4-1. In-circuit voltage checks NPN or PNP transistors.

To check transistors using a voltmeter, measure the emitter-to-base and emitter-to-collector voltages and determine whether the voltages are consistent with the normal resistances and currents in the circuit (see Fig. 4-1).

To check a transistor using an ohmmeter, know your ohmmeter ranges, the currents they deliver, and the internal battery voltage(s). If your ohmmeter does not have sufficient resistance in series with its internal voltage source, excessive current will flow through the transistor under test. Excessive current and/or high internal source voltage may permanently damage the transistor.

NOTE

As a general rule, use the R X 1 k range where the current is usually limited to less than 2 mA and the internal voltage is usually 1 ½ volts. You can quickly check the current and voltage by inserting a multimeter between the ohmmeter leads and measuring the current and voltage for the range you intend to use.

When you know which ohmmeter ranges will not harm the transistor, use those ranges to measure the resistance with the ohmmeter connected both ways as given in Table 4-1.

TABLE 4-1

Transistor Resistance Checks

Ohmmeter Connections[1]	Resistance Readings That Can Be Expected Using the R X 1 k Range
Emitter-Collector	High readings both ways (about 60 kΩ to around 500 kΩ).
Emitter-Base	High reading one way (about 200 kΩ or more). Low reading the other way (about 400 Ω to 2.5 kΩ).
Base-Collector	High reading one way (about 500 kΩ or more). Low reading the other way (about 400 Ω to 2.5 kΩ).

[1]**Test prods from the ohmmeter are first connected one way to the transistor leads and then reversed (connected the other way). Thus, the effects of the polarity reversal of the voltage applied from the ohmmeter to the transistor can be observed.**

If there is doubt about whether the transistor is good or not, substitute a new transistor; but, first be certain the circuit voltages applied to the transistor are correct before making the substitution. If a transistor is substituted without first checking out the circuit, the new transistor may immediately be damaged by some defect in the circuit.

Replacement of either Q637 or Q647 requires removal of only the transistor mounting bolts.

Remove the mounting bolts and pull the transistor and its leads a short distance away from the rear panel. Note the wire color code for correct resoldering to the leads of the new transistor. Unsolder the defective transistor. Wipe a small amount of non-melting silicone grease such as Dow Corning 4 Compound on the under side of the new transistor.

WARNING

Silicone grease will irritate and may damage eye tissues. Wash your hands thoroughly after this procedure before touching the face.

Solder the leads to the new transistor using long-nose pliers on the transistor lead as a heat sink. Push the transistor into place making sure the leads are separated, and re-install the mounting bolts. Wipe excess silicone grease away from the transistor edge with a disposable tissue.

Tube Replacement. Tester checks on tubes used in the Type RM529 are not recommended. Tube testers sometimes indicate a tube to be defective when that tube is operating satisfactorily in a circuit, or they may fail to indicate tube defects which affect the performance of the circuits. The standard of usability of a tube is whether or not it works properly in the circuit. If it does not, it should be replaced. Unnecessary replacement is not only expensive, but may also cause needless recalibration of the instrument.

Lamp Replacement. The graticule illumination lamps are bayonet Type 47, 6-8 volt bulbs. Remove the four bezel nuts, lift away the graticule, and replace the lamps in the normal manner.

The four neon bulbs just to the left of the CRT (two are not visible through the front panel) are soldered in place. Removal and replacement requires a small iron and long-nose pliers.

Recalibration

To assure accurate measurements, check the calibration of this instrument after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions are given in Section 6.

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, recalibration may reveal and correct minor troubles that do not show up during regular operation.

Cleaning

The Type RM529 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 a possible electrical conduction path.

Loose dust accumulated on the outside of the Type RM529 can be removed with a cloth or small paint brush. The paint brush is particularly useful for dislodging dust on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild solution of water and detergent. Abrasive cleaners should not be used.

The high-voltage circuits, including parts enclosed by the high-voltage shield, should receive special attention. Excessive dust and dirt in these areas may cause high-voltage arcing and result in improper instrument operation.

CAUTION

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

To clean the graticule and the face of the CRT, first remove the four graticule nuts. Then remove the bezel and the graticule. Clean the graticule and the face of the CRT with a soft, lint-free cloth dampened with mild detergent and water. Repeat with a cloth dampened with water only.

Standard Parts

All electrical and mechanical part replacements for the Type RM529 can be obtained through your local Tektronix Field Office or representative. However, since many of the components are standard parts, they can generally be obtained locally in less time than from the factory. Before purchasing replacement parts, consult the Parts Lists for value, tolerance rating and Tektronix Part Number.

Special Parts

In addition to the standard components some special parts are used in the production of the Type RM529. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Textronix, Inc. in accordance with our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your Textronix Field Office or representative. Parts ordering information is located on the Abbreviations and Symbols page which immediately precedes Section 7.

Resistor Coding

The Type RM529 uses a number of very stable metal-film resistors identified by their gray background color and color coding.

If the resistor has three significant figures with a multiplier the resistor will be EIA color coded. If it has four significant figures with a multiplier, the value will be printed on the resistor. For example, a 333-kΩ resistor will be color coded, but a 333.5-kΩ resistor will have its value printed on the resistor body.

The color-coding sequence is shown in Fig. 4-2.

Ceramic Terminal Strip Replacement

A complete ceramic terminal strip assembly is shown in Fig. 4-3. Replacement strips (including studs) and spacers are supplied under separate part numbers. The old spacers may be re-used unless they are damaged.

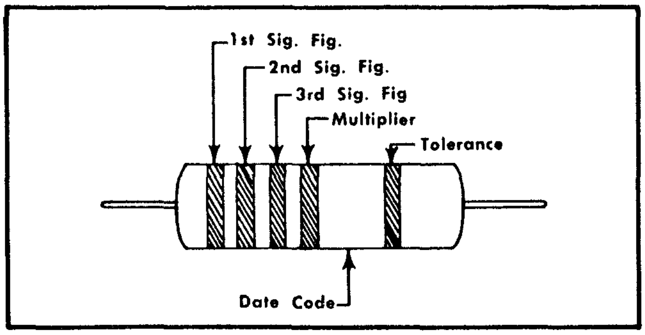


Fig. 4-2. Standard EIA color code for metal-film resistors.

After the damaged strip has been removed, place the undamaged spacers in the chassis holes. Then, carefully press the studs into the spacers until they are completely seated. If necessary, use a soft mallet and tap lightly, directly over the stud area of the strip.

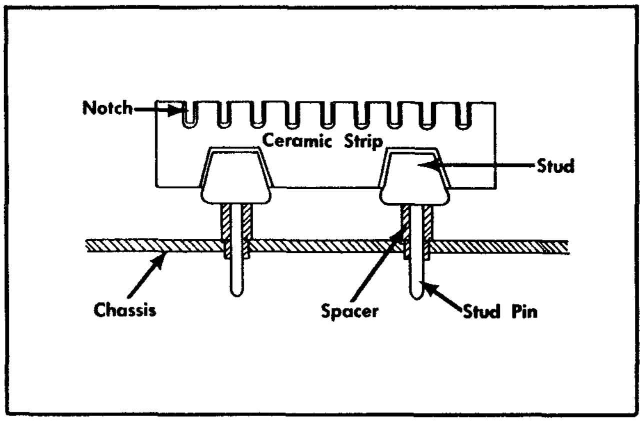


Fig. 4-3. Ceramic terminal strip assembly.

Soldering

Ceramic Terminal Strips. Solder used on the ceramic terminal strips should contain about 3% silver. Ordinary 60/40 solder can be used occasionally without damage to the ceramic terminal strips. Use a 40- to 75-watt soldering iron with a 1/8 inch wide chisel-shaped tip. If ordinary solder is used repeatedly, or if excessive heat is applied, the solder-to-ceramic bond can be broken.

A small supply of solder containing about 3% silver is included on a spool mounted inside this instrument on the rear panel. Additional solder should be available locally, or it can be purchased from Tektronix in one-pound rolls; order by Tektronix Part No. 251-0514-00.

Observe the following precautions when soldering ceramic terminal strips:

1. Use a hot iron for a short time. Apply only enough heat to make the solder flow freely.

2. Maintain a clean, properly tinned tip.

3. Avoid putting pressure on the ceramic terminal strip.

4. Do not attempt to fill the terminal-strip notch with solder; use only enough solder to cover the wires adequately.

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

Observe the following precautions when soldering to metal terminals:

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

2. If a wire extends beyond the solder joint, clip the excess wire close to the joint.

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

Rotary Switches

Individual wafers or mechanical parts of rotary switches are normally not replaced. If a switch is defective, replace the entire assembly. The availability of replacement switches, either wired or unwired, is detailed in the Parts List.

Cathode-Ray Tube

Use the following procedure for removal and replacement of the CRT.

WARNING

Use care when handling a CRT. Avoid striking it on any object that might cause it to crack and implode. Flying glass from an imploding CRT can cause serious injury. Wear safety glasses or a plastic face mask.

1. Disconnect the instrument power.

2. Place the instrument on a level workbench.

3. Remove the graticule.

4. Carefully remove the five neck leads. Use long-nose pliers and slowly pull each clip off its neck pin.

5. Loosen the 6-32 bolt in the white plastic CRT rear neck clamp.

6. Place one hand over the CRT face. With the other hand push gently on the CRT socket until the tube moves slightly forward. Remove the socket and push on the center of the CRT base. Carefully guide the tube out the front, without touching the magnetic shield with the neck pins.

To install a new CRT:

1. Position the tube with the single neck pin at the top, two neck pins at both the side and bottom.

2. Carefully insert the tube into the magnetic shield, being careful not to touch the shield with the neck pins.

3. Extend the finger of one hand into the rear end of the shield to help guide the base into place. Push the CRT the last 1/4 inch with the plastic graticule so the front of the tube is flush with the front panel.

4. Tighten the 6-32 bolt in the plastic clamp until the CRT neck is held firmly. DO NOT OVERTIGHTEN.

5. Use long-nose pliers and carefully install the neck clips to the neck pins; observe the color code as marked on the shield near each opening.

6. If the CRT face is not parallel with the front panel, use a 7/64-inch hexagonal wrench to loosen the two hexagonal headed bolts at the mounting clamp. Raise, lower, or otherwise position the CRT socket so the face is correctly positioned. Tighten the hexagonal headed bolts and check that the neck pins are not grounded.

7. Re-install the graticule and recalibrate the instrument in accordance with the Calibration procedure.

Troubleshooting

In the event of trouble, help with the particular problem may be obtained by reading the Circuit Description. Voltage checks and normal troubleshooting procedures will aid in finding and correcting the trouble.

Power-Supply Problems. The Type RM529 can still present a display and appear to operate if certain problems develop in the power supplies. The following table of symptoms and their related causes may help solve power-supply failures.

TABLE 4-2

Problem	Probable Cause
1. Short sweep, excess high voltage and ripple horizontally.	Q647 or Q644 of +100-volt supply is shorted.
2. Same as No. 1; in addition, calibrator waveform shows considerable hum.	Q637 or Q634 of —25-volt supply is shorted.
3. No trace. No heater flow in two 12AT7 tubes. Power On neon still glows.	Q637 or Q634 of —25-volt supply is open or F637 is blown. Or, if 12AT7 heaters glowing, V833-V832 filaments open; look for their glow.
4. Sweep shorters as INTENSITY control is turned clockwise.	V800A has a short, or V800B has a short, or Q804 is shorted.

SECTION 5
PERFORMANCE CHECK

Introduction

This section of the manual provides a means of rapidly checking the performance of the Type RM529. It is intended to check the calibration of the instrument without the need for performing the complete Calibration procedure. The Performance Check does not provide for the adjustment of any internal controls Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, and the user should refer to the Calibration procedure in this manual.

EQUIPMENT REQUIRED

General

The following equipment, or its equivalent is required for a complete performance check of the Type RM529. Specifications given are the minimum necessary to accurately check the performance of this instrument. All test equipment is assumed to be correctly calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

Special Test Equipment

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed under Equipment Required can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Constant amplitude sine-wave generator. Frequency, 50 kHz and 350 kHz to above 10 MHz; output amplitude, 200 mV to 1 volt adjustable; amplitude accuracy, within ±3% at 50 kHz and 350 kHz to above 10 MHz. Tektronix Type 191 recommended.

2. Test oscilloscope. Bandwidth, DC to 1 MHz; minimum deflection factor, 0.005 volts/division. Tektronix Type 545B Oscilloscope with Type B Plug-In Unit, and Tektronix P6006 and P6028 Probes recommended.

3. Standard amplitude calibrator. Amplitude accuracy, within 0 25%; signal amplitude, 0.2 volt to 2 volts; output frequency, 1 kHz. Tektronix calibration fixture 067-0502-00 recommended.

4. Time-mark generator. Marker outputs of 1 μs, 5 μs, 10 μs, 0 1 ms and 0.1 μs; accuracy, within 0.001%. Tektronix Type 184 recommended.

5. Composite video signal source. Calibrated signal amplitude of 1 volt, variable from 200 mV to 1 volt. For example, Conrac model AU 12C receiver.

6 Square-wave generator. Frequency of 120 hertz; output amplitude variable from 4 to 12 volts. Tektronix Type 105, T e 106, or equivalent.

7. Termination. Impedance, 75 ohms; accuracy, within ±3%; connector, UHF. Tektronix Part No. 011-0023-00.

8. Three cables. Impedance, 75 ohms; Type RG11/U; length 42 inches; connectors, BNC. Tektronix Part No. 012-0074-00.

9. Two adapters. Connectors, BNC female to UHF male. Tektronix Part No. 103-0015-00.

10. One capacitor. 2 μF at 150 WVDC. Tektronix Part No. 290-0121-00.

PERFORMANCE CHECK PROCEDURE

General

In the following procedure, test equipment connections or control settings should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information.

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Remove the oscilloscope from any enclosure, to provide access to rear panel connectors.

2. Check that a 160-IEEE unit 7-cm composite graticule (331-0161-00) is installed and that the VIDEO OUTPUT connector is terminated into 75 ohms.

3. Connect the Type RM529 power cord to a suitable power source.

4. Set the Type RM529 POWER switch to on. Allow at least 20 minutes warm up, for checking the instrument to the given accuracies.

POWER	On
SCALE ILLUM	Fully clockwise
FOCUS	Midrange
INTENSITY	Fully counterclockwise
GAIN	As is
VERTICAL Controls	
RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	EXT
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	ONE
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

1. Check Graticule Illumination

a. Requirement—Graticule illumination must be maximum when the SCALE ILLUM control is fully clockwise. There should be no illumination when the SCALE ILLUM control is fully counterclockwise. The graticule illumination must smoothly change intensity with smooth rotation of the SCALE ILLUM control.

b. With the SCALE ILLUM control fully clockwise, check for maximum graticule illumination.

c. Slowly and smoothly rotate the SCALE ILLUM control counterclockwise, noting that the graticule illumination decreases smoothly as the control is rotated.

d. Check—There is no graticule illumination.

e. Adjust the SCALE ILLUM control for desired graticule illumination.

2. Check CRT Beam Rotator and Horizontal Geometry

a. Requirement—CRT Beam Rotator is adjustable for no horizontal tilt.

Horizontal Geometry: Trace bowing or trace deviation from a straight horizontal line must not exceed 2 mm.

b. Rotate the INTENSITY control clockwise until a trace can be seen.

c. Ground the upper VIDEO INPUTS A connector.

NOTE

The trace should be parallel to the horizontal graticule lines, but due to the different effects of the earth's magnetic field at various locations, it is impossible to state that the trace should be aligned within plus or minus a specific tolerance. If the trace is not parallel to the horizontal graticule lines, it will be necessary to adjust the internal CRT BEAM ROTATOR control until the trace is parallel to the horizontal graticule lines.

d. Position the start of the trace to the left edge of the graticule and vertically position the trace to the +30 IEEE units graticule line.

e. Check—Amount of trace bowing or deviation from a straight line.

f. Remove ground from upper VIDEO INPUTS A connector.

3. Check FOCUS and INTENSITY Controls

a. Requirement—Focus: The FOCUS control must adjust for a well-defined display without being at either end of its adjustment range.

Intensity: With the INTENSITY control fully counterclockwise there must be no display. Clockwise rotation of the control must increase the intensity smoothly with smooth rotation of the control.

b. Reset the following controls:

INPUT	CAL
CAL	.714 F. S.
DISPLAY	2 LINE

c. Adjust the FOCUS control for a well-defined display.

d. Check—FOCUS control should not be at either end of its adjustment range.

e. Rotate the INTENSITY control fully counterclockwise.

f. Check—No display.

g. Slowly and smoothly rotate the INTENSITY control clockwise.

h. Check—For a smooth and constant increase in display brightness.

i. Adjust the INTENSITY control for normal display brightness.

4. Check Vertical Geometry

a. Requirement—Vertical trace bowing and/or tilt must not exceed 2 mm.

b. Reset the following controls:

INPUT	A
SYNC	EXT
DISPLAY	.25 H/cm

c. Connect 5-μs time markers to the upper VIDEO INPUTS A connector using a 75-ohm coaxial cable.

d. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

e. Connect .1 ms time-marker trigger pulses to the upper EXT NEG SYNC INPUT connector using a 75-ohm coaxial cable.

f. Adjust the (VERTICAL) POSITION control and the VOLTS FULL SCALE switch and its VARIABLE control so the time markers over-scan the CRT viewing area.

g. Check—For not more than 2 mm of bowing and/or tilt.

h. Disconnect the time markers from the upper VIDEO INPUTS A connector, and the time-marker trigger pulses from the upper EXT NEG SYNC INPUT connector.

5. Check (VERTICAL) POSITION Control

a. Requirement—Range: POSITION control must be able to position the trace off the top and bottom of the graticule area.

Direction: Clockwise rotation of the control must move the trace up, and counterclockwise rotation must move the trace down.

b. Reset the following controls:

(VERTICAL) POSITION	Fully clockwise
SYNC	INT
DISPLAY	2 FIELD

c. Check—For upward trace movement beyond the graticule viewing area.

d. Rotate the POSITION control fully counterclockwise.

e. Check—For downward trace movement beyond the graticule limits.

6. Check Vertical Gain and Calibrator

a. Requirement—Vertical gain:

1.0 position; 1 volt of square wave from a standard amplitude calibrator must produce 140 IEEE units of deflection, $\pm 1\%$.

0.2 position; 0.2 volt of square wave from a standard amplitude calibrator must produce 140 IEEE units of deflection, $\pm 2\%$.

0.5 position; 0.5 volt of square wave from a standard amplitude calibrator must produce 140 IEEE units of deflection, $\pm 3\%$.

VARIABLE (VOLTS FULL SCALE) ratio must be 2.5:1 or greater.

Calibrator:

FULL SCALE; calibrator deflection must match (1 volt) standard amplitude calibrator deflection (140 IEEE units), $\pm 1\%$.

.714 F.S.; calibrator deflection must be 100 IEEE units, $\pm 1\%$, when FULL SCALE setting of calibrator produces 140 IEEE units of deflection.

b. Connect 1 volt of standard amplitude calibrator square wave through a 75-ohm coaxial cable to the upper VIDEO INPUTS A connector.

c. Set the VOLTS FULL SCALE switch to 1.0.

d. Check—For 140 IEEE units of deflection, $\pm 1\%$.

e. Set the standard amplitude calibrator for a 0.5-volt square wave.

f. Set the VOLTS FULL SCALE switch to 0.5.

g. Check—For 140 IEEE units of deflection, $\pm 3\%$.

h. Set the standard amplitude calibrator for a 0.2-volt square wave.

i. Set the VOLTS FULL SCALE switch to 0.2.

j. Check—For 140 IEEE units of deflection, $\pm 2\%$.

k Set the VOLTS FULL SCALE switch to 1.0.

l. Adjust the VARIABLE (VOLTS FULL SCALE) control to produce maximum signal deflection. Note the amount of deflection.

m. Adjust the VARIABLE (VOLTS FULL SCALE) control to produce minimum signal deflection. Note the amount of deflection.

n. Check—$\dfrac{\text{Maximum signal deflection}}{\text{Minimum signal deflection}}$ = a ratio of 2.5:1 or greater.

o. Reset the following controls:

VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	FULL SCALE

p. Set the standard amplitude calibrator for a 1 volt square-wave signal and note the signal amplitude.

q. Change the INPUT switch to CAL.

r. Check—The calibrator signal amplitude matches the standard amplitude calibrator signal amplitude within 1%. Note any error.

s. Change the CAL switch to .714 F. S.

t. Check—The calibrator signal amplitude is 100 IEEE units $\pm 1\%$, taking into account any error noted in part r of this step.

7. Check External Calibrator Input

a. Requirement—1 volt of standard amplitude calibrator square-wave signal must produce 140 IEEE units of deflection, $\pm 1\%$.

b. Remove the standard amplitude calibrator signal from the upper VIDEO INPUTS A connector and connect it to the right EXT CAL INPUT connector.

c. Set the CAL switch to EXT.

d. Check—For 140 IEEE units of deflection, $\pm 1\%$.

e. Reconnect the standard amplitude calibrator signal to the upper VIDEO INPUTS A connector.

f. Set the INPUT switch to A.

8. Check Compression and Expansion

a. Requirement—Compression and expansion must not exceed one IEEE unit.

b. Change the standard amplitude calibrator to obtain a 0.2-volt square wave.

c. Using the VARIABLE (VOLTS FULL SCALE) and the (VERTICAL) POSITION controls, obtain a signal 40 IEEE units high, centered vertically in the graticule area.

d. Position the top of the display to the top graticule line.

e. Check—For less than one IEEE unit of compression or expansion.

f. Position the bottom of the display to the bottom graticule line.

g. Check—For less than one IEEE unit of compression or expansion.

h. Return the VARIABLE (VOLTS FULL SCALE) control to CALIB.

i. Disconnect the standard amplitude calibrator.

9. Check DC RESTORER Switch

a. Requirement—Reference level must shift no more than ±4 IEEE units for a gain change within the graticule area.

b. Set the DC RESTORER switch to ON.

c. Connect a composite video signal to the upper VIDEO INPUTS A connector.

d. Adjust the amplitude of the incoming composite video signal to obtain a display 30 IEEE units high.

e. Position the 0 IEEE signal level (back porch) to the 0 IEEE graticule line.

f. Rotate the VOLTS FULL SCALE switch through its 0.2 and 0.5 positions.

g. Check—Amount of vertical shift of the 0 IEEE signal level (back porch). It must not exceed ±4 IEEE units.

h. Set the VOLTS FULL SCALE switch to 1.0.

10. Check Horizontal Gain

a. Requirement—See Table 5-1.

TABLE 5-1

DISPLAY Switch	Trace Length	Tolerance
2 FIELD	10.2 div	±5%
2 LINE	10.2 div	±5%
.125 H/CM	10.2 div	±2%
.25 H/CM	10.2 div	±2%

b. Set the DISPLAY switch to each of the positions listed in Table 5-1.

c. Check—For a trace length within the tolerance listed in Table 5-1.

d. Set the DISPLAY switch to .125 H/CM.

e. Disconnect the composite video signal.

11. Check Horizontal Sweep Rates

a. Requirement—See Table 5-2.

TABLE 5-2

DISPLAY Switch	Mag Switch	Time Markers Applied	Markers per 10 Major Divisions	Tolerance
.125 H/CM	×1	5 μs and 10 μs	8	±2%
.125 H/CM	×5	1 μs	16	±3%
.125 H/CM	×25	0.1 μs	32	±5%

b. Connect the output of a time-mark generator through a 75-ohm coaxial cable to the upper VIDEO INPUTS A connector.

c. Connect 0.1 ms time-marker trigger pulses from the time-mark generator through a 75-ohm coaxial cable to the upper EXT NEG SYNC INPUT connector.

d. Set the SYNC switch to EXT.

e. Adjust the VOLTS FULL SCALE switch and the VARIABLE (VOLTS FULL SCALE) control to obtain a display 50 IEEE units high.

f. Set the time-mark generator and Type RM529 controls as listed in Table 5-2.

g. Check—For the proper number of markers for 10 divisions within the tolerance listed in Table 5-2.

12. Check (HORIZONTAL) Position Control

a. Requirement—The trace must move to the right with clockwise rotation of the POSITION control. The trace must move to the left with counterclockwise rotation of the POSITION control.

b. Rotate the POSITION control to its fully clockwise position.

c. Check—That the trace moves to the right.

d. Rotate the POSITION control to its fully counterclockwise position.

e. Check—That the trace moves to the left.

f. Set the (HORIZ) POSITION control to midrange.

g. Disconnect the time-mark generator time markers and time-marker trigger pulses from the Type RM529.

h. Reset the following controls:

SYNC	INT
DISPLAY	2 FIELD

13. Check FIELD Switch

a. Requirement—With the FIELD switch set to ONE, the last horizontal sync pulse will be one-half line (31.75 μs) away from the first equalizing pulse. With the FIELD switch set to TWO, the last horizontal sync pulse will be a full line (63.5 μs) away from the first equalizing pulse.

b. Connect a 1 volt composite video signal to the upper VIDEO INPUTS A connector.

c. Reset the following controls:

DISPLAY	2 FIELD
MAG	×25
FIELD	ONE

d. If vertical sync pulse group is not completely displayed, position it to the horizontal center of the viewing area with the (HORIZ) POSITION control.

e. Check—The position (in time) of the last horizontal sync pulse before the first equalizing pulse. It should be 31.75.

f. Set the FIELD switch to TWO.

g. Check—The position (in time) of the last horizontal sync pulse before the first equalizing pulse. It should be 63.5.

14. Check Triggering

a. Requirement—Must trigger internally on a 200 mV peak-to-peak signal connected to the VIDEO INPUT connectors. Must trigger externally on a 250 mV peak-to-peak signal connected to the EXT NEG SYNC INPUT connectors.

b. Remove the composite video signal from the upper VIDEO INPUTS A connector and connect it to the upper EXT NEG SYNC INPUT connector.

c. Connect a 75-ohm coaxial cable from the lower EXT NEG SYNC INPUT connector to the upper VIDEO INPUTS A connector.

d. Reset the following controls:

VOLTS FULL SCALE	0.2
DISPLAY	2 FIELD

e. Adjust the amplitude of the composite video signal to obtain a display amplitude of 140 IEEE units on the CRT.

f. Check—For a stable display on internal triggering.

g. Set the VOLTS FULL SCALE switch to .5.

h. Adjust the amplitude of the composite video signal to obtain a display amplitude of 70 IEEE units on the CRT

i. Set the SYNC switch to EXT.

j. Check—For a stable display on external triggering.

k. Reset the following controls:

VOLTS FULL SCALE	1.0
SYNC	INT
MAG	×25

l. Position the vertical sync block to the center of the graticule area.

15. Check Line Selector Operation (SN 2997-up)

a. Requirement—Brightening pulse amplitude must be 100 mV or more.

NOTE

The start of the brightening pulse corresponds to the start of the sweep, as observed on the Type RM529 CRT, while the width of the brightening pulse corresponds to the length of the sweep, as observed on the Type RM529 CRT.

With the LINE SELECTOR switch set to VARIABLE and the LINE SELECTOR variable set fully counterclockwise, the brightening pulse must start in the vertical blanking time on or before the fifteenth line; with the LINE SELECTOR variable set fully clockwise, the brightening pulse must start after the first 25% of the second field; the display on the Type RM529 must remain stable throughout the rotation of the LINE SELECTOR variable control.

With the LINE SELECTOR switch set to 16, the brightening pulse must start at the start of line 16; with the LINE SELECTOR switch set to 17, the brightening pulse must start at the start of line 17; with the LINE SELECTOR switch set to 18, the brightening pulse must start at the start of line 18; with the LINE SELECTOR switch set to 19, the brightening pulse must start at the start of line 19; with the LINE SELECTOR switch set to 20, the brightening pulse must start at the start of line 20; with the LINE SELECTOR switch set to 21 the brightening pulse must start at the start of line 21.

b. Connect a 75-ohm coaxial cable from the VIDEO OUTPUT connector of the Type RM529 to the vertical input connector of the test oscilloscope.

c. Set the test oscilloscope controls as follows:

Input Selector	AC
Volts/Div	0.02
Time/Div	2 ms
Triggering Mode	Adjusted for stable display
Trigger Slope	+ External

NOTE

The external triggering signal must be at the video field rate.

d. Set the Type RM529 DISPLAY switch to LINE SELECTOR .125 H/CM and the LINE SELECTOR switch to VARIABLE.

e. Rotate the LINE SELECTOR variable control fully counterclockwise.

f. Check—The position (in time) and the amplitude of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 100 mV high and its start should be on or before the 15th line.

g. Rotate the LINE SELECTOR variable control fully clockwise.

h. Check—The position (in time) and the amplitude of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 100 mV high and its start must occur after the first 25% of the second field.

i. Set the LINE SELECTOR switch to each numbered line position.

j. Check—That the brightening pulse is at least 100 mV high and that it starts at the start of the line to which the LINE SELECTOR switch is set.

k. Set the FIELD switch to ONE and repeat parts d through j.

NOTE

LINE 10 starts at the first horizontal pulse following the last equalizing pulse in both fields (field one and two). Lines 16 through 21 can be found by counting forward from this point of reference.

16. Check Line Selector Operation (SN 100-2997)

a. Requirement—Brightening pulse amplitude must be 100 mV or more. With the LINE SELECTOR control fully counterclockwise, the brightening pulse must start in the vertical blanking time before the sixteenth line. With the LINE SELECTOR control fully clockwise, the brightening pulse must start after the first 25% of the second field. The display on the Type RM529 must remain stable throughout the rotation of the LINE SELECTOR control.

b. Connect a 75-ohm coaxial cable from the VIDEO OUTPUT connector of the Type RM529 to the vertical input connector of the test oscilloscope.

c. Set the test oscilloscope controls as follows:

Input Selector	AC
Volts/Div	0.02
Time/Div	2 ms
Triggering Mode	Adjusted for stable display
Trigger Slope	+ External

NOTE

The external triggering signal must be at the video field rate.

d. Set the Type RM529 DISPLAY switch to LINE SELECTOR .125 H/CM.

e. Rotate the LINE SELECTOR control fully counterclockwise.

f. Check—The position (in time) and the amplitude of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 100 mV high and its start should be before the sixteenth line.

g. Rotate the LINE SELECTOR control fully clockwise.

h. Check—The position (in time) and the amplitude of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 100 mV high and its start must occur after the first 25% of the second field.

i. Remove all connections to the Type RM529.

NOTE

The last equalizing pulse in the vertical blanking time is the ninth line.

17.[1] Check Frequency Response

a. Requirement—See Table 5-3.

b. Connect the output of a constant amplitude sine-wave generator through a 75-ohm coaxial cable to the upper VIDEO INPUTS A connector.

c. To the lower VIDEO INPUTS A connector, connect a 75-ohm termination.

d. Set the Type RM529 controls and apply the indicated signal frequencies as listed in Table 5-3.

e. Check—For the required amount of deflection as listed in Table 5-3.

[1] An optional method of checking high-frequency response of the vertical amplifier will be found in step 18.

TABLE 5-3

Response Switch Set to:	VARIABLE (VOLTS FULL SCALE) Set to:	VOLTS FULL SCALE Set to:	Check or Procedure
FLAT	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
FLAT	CALIB	1.0	Check for flat frequency response from 50 kHz to 6 MHz; within +0%, —1% (—0.1 dB) or 1 IEEE unit.
FLAT	CALIB	1.0	Check for flat frequency response from 6 MHz to 8 MHz; within +0%, —3% (—0.3 dB) or 3 IEEE units.
FLAT	CALIB	0.2	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
FLAT	CALIB	0.2	Check for flat frequency response from 50 kHz to 6 MHz; +0%, —1% (—0.1 dB) or 1 IEEE unit.
FLAT	CALIB	0.5	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 500 kHz.
FLAT	CALIB	0.5	Check for flat frequency response from 500 kHz to 6 MHz; +0%, —1% (—0.1 dB) or 1 IEEE unit.
FLAT	Counter-clockwise	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
FLAT	Counter-clockwise	1.0	Check for flat frequency response from 50 kHz to 6 MHz; +0%, —2% (—0.2 dB) or 2 IEEE units.

TABLE 5-3 (Continued)

Response Switch Set to:	VARIABLE (VOLTS FULL SCALE) Set to:	VOLTS FULL SCALE Set to:	Check or Procedure
LOW PASS	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
LOW PASS	CALIB	1.0	Check for 20 IEEE units (down 14 dB) or less of deflection at 500 kHz.
FLAT	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 3.58 MHz of deflection.
HIGH PASS	CALIB	1.0	Check for 100 IEEE units +0%, −1% (−0.1 dB) (1 IEEE unit) of deflection at 3.58 MHz.
HIGH PASS	CALIB	1.0	Check for 65 to 85 IEEE units of deflection at 3.18 MHz.
HIGH PASS	CALIB	1.0	Check for 65 to 85 IEEE units of deflection at 3.98 MHz.
IEEE	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
IEEE	CALIB	1.0	Check for 94 to 97.5 IEEE units of deflection at 350 kHz.
IEEE	CALIB	1.0	Check for 70 to 80 IEEE units of deflection at 1 MHz.
IEEE	CALIB	1.0	Check for 31.2 to 42.5 IEEE units of deflection at 2 MHz.
IEEE	CALIB	1.0	Check for 7 to 14 IEEE units of deflection at 3.6 MHz.

f. Remove all connections to the Type RM529.

18. Check J501 Staircase Input (SN 787-up)

a. Requirement—Four displays per ten centimeters. Each display should have some separation from neighboring displays.

b. Wire the 9-pin plug connector (Tektronix Part No. 134-0049-00) as shown in Fig. 5-1. Make sure that the 2 μF capacitor is in series between the Type RM529 J501 connector pin C and the output of the square-wave generator.

c. Connect the plug to J501 on the Type RM529.

d. Connect a 12-volt, 120-hertz signal from a square-wave generator to pin C of the plug via the 2 μF capacitor.

e. Connect a test oscilloscope to the monitoring point to measure the output amplitude of the square-wave generator.

f. Apply one volt of composite video to the upper VIDEO INPUTS A connector.

g. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

h. Check—For a display as shown in Fig. 5-2A. Note right-hand display position.

i. Reduce the signal from the square-wave generator to 8 volts.

j. Check—For a display as shown in Fig. 5-2B. Note right-hand display position.

k. Reduce the signal from the square-wave generator to 4 volts.

l. Check—For a display as shown in Fig. 5-2C. Note right-hand display position.

m. Check—That each display has some separation from its neighbors.

19. Check J501 Staircase Input (SN 100-786)

a. Requirement—Three displays per ten centimeters. Each display should have some separation from neighboring displays.

b. Wire the 9-pin plug connector (Tektronix Part No. 134-0049-00) as shown in Fig. 5-1. Make sure that the 2 μF capacitor is in series between the Type RM529 J501 connector pin C and the output of the square-wave generator.

c. Connect the plug to J501 on the Type RM529.

d. Connect a 12 volt, 120 hertz signal from a square-wave generator to pin C of the plug via the 2 μF capacitor.

e. Connect a test oscilloscope to the monitoring point to measure the output amplitude of the square-wave generator.

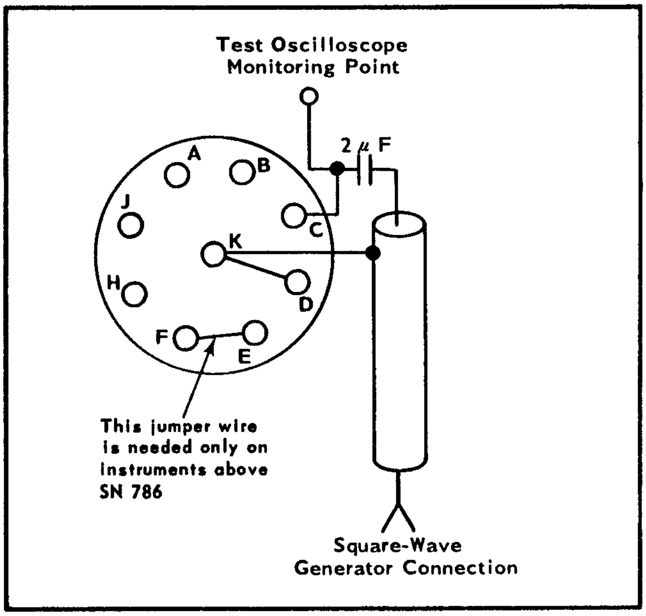


Fig. 5-1. Front view of 9-pin plug connector (Tektronix Part No. 134-0049-00) showing jumper wire connections to cause relay K385 to be energized whenever the plug is in place.

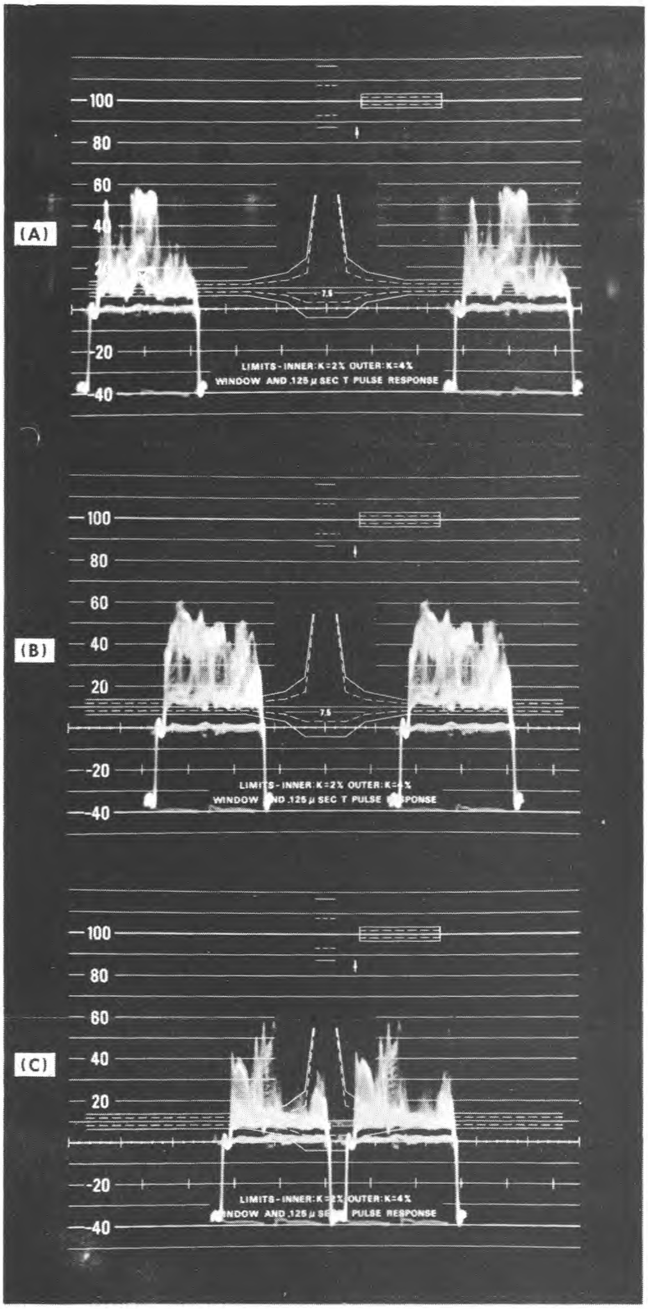


Fig. 5-2. Checking to insure that four displays per 10 centimeters can be obtained.

f. Apply one volt of composite video to the upper VIDEO INPUTS A connector.

g. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

h. Check—For a display as shown in Fig. 5-3A. Note right-hand display position.

i. Reduce the signal from the square-wave generator to 6 volts.

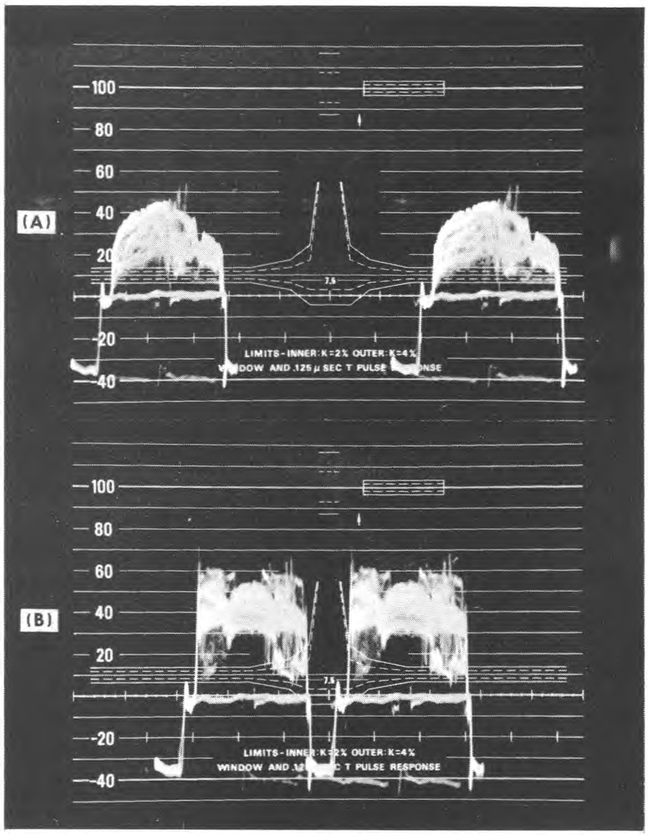


Fig. 5-3. Checking to insure that three displays per 10 centimeters can be obtained.

j. Check—For a display as shown in Fig. 5-3B. Note right-hand display position.

k. Check—That each display has some separation from its neighbors.

20. (Optional Method) Check Frequency Response

a. Set the Type RM529 front-panel controls as follows:

POWER	On
SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjusted for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0

VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	.125 H/CM
FIELD	ONE
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

b. Connect to upper VIDEO INPUTS A connector 1 volt of multi-burst signal.

c. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

d. Check each position of the RESPONSE switch for the display shown in Fig. 5-4.

This completes the performance check procedure for the Type RM529. Disconnect all test equipment. If the instrument has met all performance requirements given in this procedure, it is correctly calibrated and within the specified tolerances.

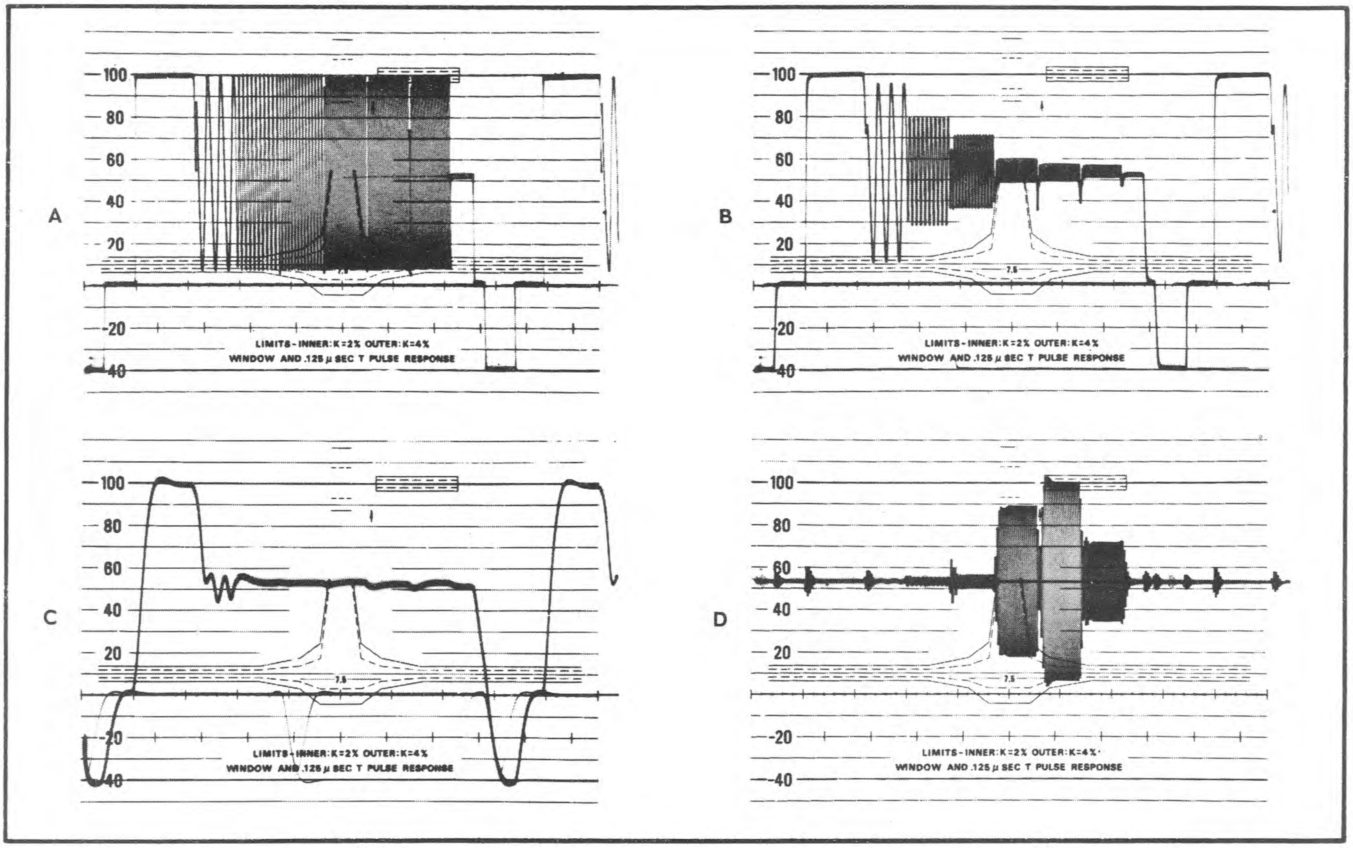


Fig. 5-4. Waveforms showing the display which will result when 1-volt of multi-burst signal is connected to the Type RM529 and the RESPONSE switch is set to (A) FLAT, (B) IEEE, (C) LOW PASS, (D) HIGH PASS.

SECTION 6
CALIBRATION

Introduction

The Type RM529 Waveform Monitor is a stable instrument which will provide many hours of trouble-free operation. However, to insure measurement accuracy, it is suggested that you recalibrate the instrument after each 500 hours of operation, or every six months if used intermittently. It will also be necessary to recalibrate certain sections of the instrument when tubes, transistors or other components that affect the calibration accuracy of the instrument are replaced.

This calibration procedure can be used either for complete calibration of the Type RM529 to return it to original performance, or as an operational check of instrument performance. Completion of every step in this procedure returns the Type RM529 to original factory performance standards. If it is desired to merely touch up the calibration, perform only those steps entitled Adjust . . .

NOTE

The Adjust . . . steps provide a check of instrument performance before the adjustment is made. To prevent recalibration of other circuits when performing a partial calibration, readjust only if the listed tolerance is not met.

General Information

Any needed 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 of this Instruction Manual.

The procedure is arranged in a sequence which allows this instrument to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed out of sequence or a step may be done individually. However, some adjustments affect the calibration of other circuits within the instrument. In this case, 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 will be noted.

The location of test points and adjustments is shown in each step. Waveforms which are helpful in determining the correct adjustment or operation are also shown.

EQUIPMENT REQUIRED

(see Fig. 6-1)

General

The following equipment, or its equivalent, is required for complete calibration of the Type RM529. 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 original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

Special Test Equipment

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed under Equipment Required can be obtained Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. DC voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to within 1% at 25 and 100 volts, and checked to within 3% at 5300 volts. For example, Triplett Model 630 N A.

2. Constant amplitude sine-wave generator. Frequency 50 kHz and 350 kHz to above 10 MHz; output amplitude, 200 mV to 1 volt adjustable; amplitude accuracy, ±3% at 50 kHz and 350 kHz to above 10 MHz. Tektronix Type 191 or equivalent.

3. Test oscilloscope. Bandwidth, DC to 1 MHz; minimum deflection factor, 0.005 volts/division. Tektronix Type 545B Oscilloscope with Type B Plug-In Unit, and Tektronix P6006 and P6028 Probes, or equivalent.

4. Precision DC voltmeter. Accuracy, within ±0.25; meter resolution, 50 μV range, 0.02 to 30 volts. For example, Fluke Model 825A meter.

5. Time-Mark generator. Marker outputs of 1 μs, 5 μs, 10 μs, 0.1 ms and 0.1 μs accuracy, 0.001%. Tektronix Type 184 or equivalent.

6. [1]Variable autotransformer. Must be capable of supplying at least 80 watts to the Type RM529 over a voltage range of 96 to 137 volts (192 to 274 volts for 230-volt normal line). If autotransformer does not have an AC voltmeter to indicate output voltage, monitor output with an AC voltmeter (RMS) with range of at least 137 (or 274) volts. For example, General Radio W10MT3W Metered Variac Autotransformer.

7. Composite video signal source. Calibrated signal amplitude of 1 volt, variable from 200 mV to 1 volts. For example, Conrac model AV 12E receiver.

8. Square-wave generator. Frequency of 120 hertz; output amplitude variable from 4 to 12 volts. Tektronix Type 106, or equivalent.

9. Three Terminations. Impedance 75 ohms; accuracy, ±3%; connector, UHF. Tektronix Part No. 011-0023-00.

10. Two cables. Impedance 75 ohms; type RG11/U; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0074-00.

11. Two adapters. Connectors, BNC female to UHF male. Tektronix Part No. 103-0015-00.

12. Adapter. Connectors, BNC female to female. Tektronix Part No. 103-0028-00.

13. Adapter. Connectors, BNC T with two female and one male. Tektronix Part No. 103-0030-00.

[1]Used only to check power-supply ripple in step 2. May be deleted if this check is not made.

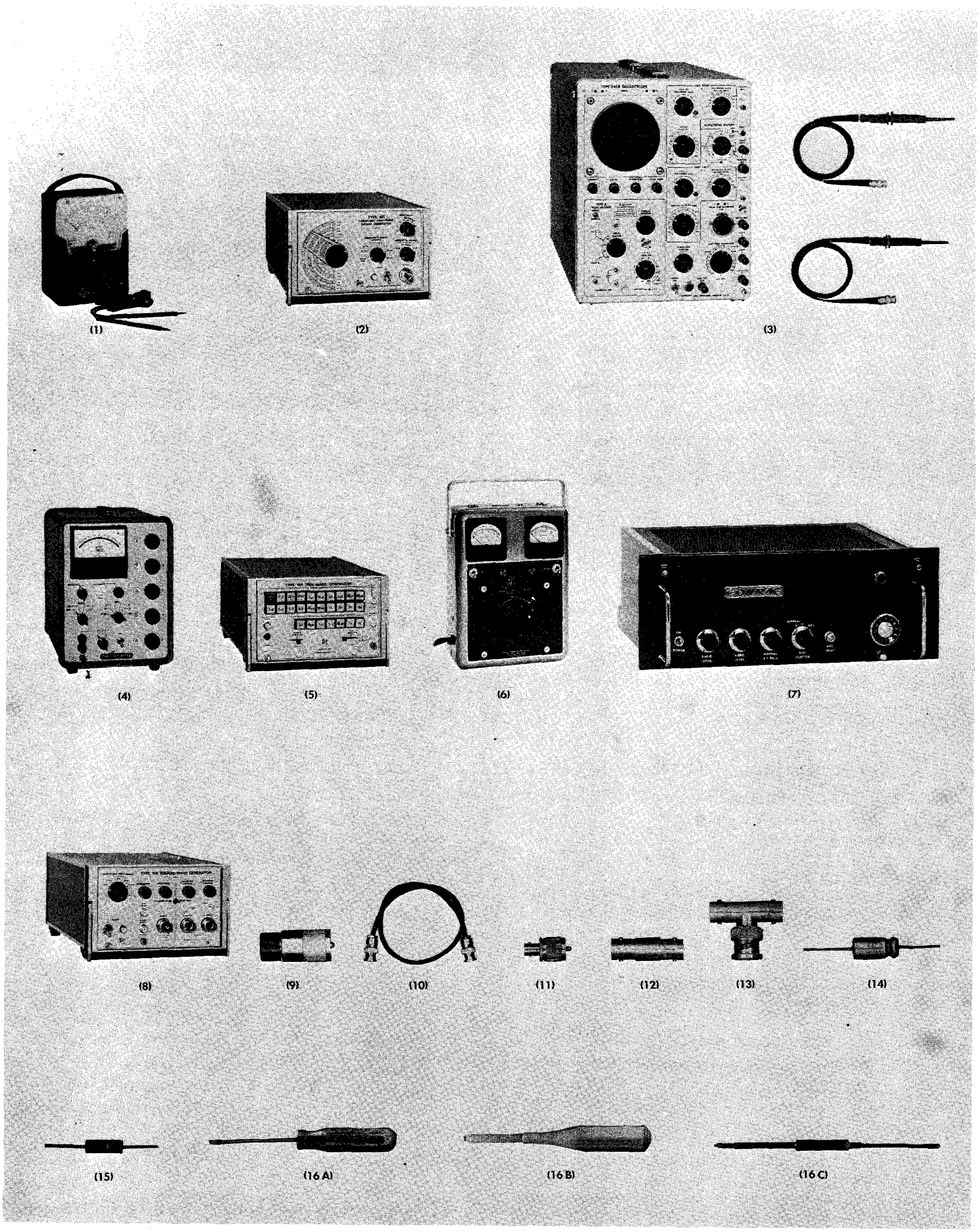


Fig. 6-1. Recommended calibration equipment.

14. One capacitor. 2 μF at 150 WVDC. Tektronix Part No. 290-0121-00.

15. One resistor, 27 kΩ, 1/4 watt. Tektronix Part No. 315-0273-00.

16. Adjustment tools (see Fig. 6-1).

a. Screwdriver, shank about 3 inches long by 3/32-inch wide tip. Tektronix Part No. 003-0192-00.

b. Insulated low-capacitance screwdriver, Jaco No. 125, 1 1/2-inch long shank by 1/8-inch wide metal tip. Tektronix Part No. 003-0000-00.

c. Hexagonal wrench 5 inches long, for 0.100-inch inside diameter powdered-iron hex slug. Tektronix Part No. 003-0301-00.

CALIBRATION RECORD AND INDEX

This abridged calibration procedure is provided to aid in checking the operation of the Type RM529. It may be used as a calibration guide by the experienced calibrator, or it may be used as a calibration record. Since the step numbers and titles used here correspond to those used in the complete Calibration procedure, the following short-form list may serve as an index. Characteristics are those listed in the Calibration section of this Instruction Manual.

Type RM529, Serial No. ______________________

Calibration Date ______________________

☐ 1. Adjust — VOLTS/CAL AMPL (R620). Page 6-5.
—25 volts.

☐ 2. Check Low-Voltage Power-Supply Regulation and Ripple. Page 6-7.
See Table 6-1 and Fig. 6-3A.

☐ 3. Adjust HIGH VOLTAGE (R835). Page 6-8.
—5300 volts.

☐ 4. Check High Voltage Regulation. Page 6-8.
Within ±5% of —5300 volts.

☐ Adjust ASTIG (R864). Page 6-9.
Well-defined display.

☐ 6. Adjust CRT BEAM ROTATOR (R655). Page 6-9.
Trace parallel to horizontal graticule lines.

☐ 7. Adjust DC BAL (R115). Page 6-9.
No vertical trace movement as VOLTS FULL SCALE switch is rotated.

☐ 8. Adjust VAR DC BAL (R130). Page 6-10.
No vertical trace movement as VARIABLE (VOLTS FULL SCALE) control is rotated.

☐ 9 Adjust VERT GAIN (R169). Page 6-11.
1 volt peak to peak of calibrator signal must produce 140 IEEE units of deflection. VOLTS FULL SCALE switch at 1.0.

☐ 10. Adjust Vertical 0.2 VOLTS GAIN (R119). Page 6-12.
Calibrator signal must produce 140 IEEE units of deflection. VOLTS FULL SCALE switch at 0.2.

☐ 11. Check Vertical 0.5 VOLTS FULL SCALE Gain Accuracy Page 6-12.
Calibrator signal must produce 140 IEEE units of deflection ±4%. VOLTS FULL SCALE switch at 0.5.

☐ 12. Adjust TRIG MULTI BIAS (R325). Page 6-13.
Set for stable display.

☐ 13. Check External Sync. Page 6-14.
Stable display with 20 IEEE units of display. VOLTS FULL SCALE switch at 0.2.

☐ 14. Check DC RESTORER Switch. Page 6-14.
Less than ±4 IEEE units of shift as VOLTS FULL SCALE switch is rotated through its settings.

☐ 15. Adjust HORIZ GAIN (R568). Page 6-15.
10.2 cm sweep length.

☐ 16. Adjust Miller Timing Capacitor (C481). Page 6-16.
80 μs of sweep in 10 cm.

☐ 17. Adjust ×25 Horizontal Sweep Magnifier Capacitor (C523, SN 1606-up) (C521, SN 101-1605). Page 6-16.
Thirty-two 0.1 μs time markers per 10 cm.

☐ 18. Check ×5 Magnified Sweep Timing. Page 6-17.
Sixteen 1 μs time markers per 10 cm, ±3%.

☐ 19. Adjust FIELD 1 SYNC (R360). Page 6-18.
Ramp starts after sixth equalizing pulse.

☐ 20. Check FIELD Switch. Page 6-19.
ONE field—31.75 μs between last horizontal sync pulse and first equalizing pulse.

TWO field—63.5 μs between last horizontal sync pulse and first equalizing pulse.

☐ 21. Adjust SWP/MAG REGIS (R575). Page 6-20.
Display in center of graticule does not shift horizontally as MAG switch is changed from ×25 to ×1.

☐ 22. Check Line Selector Brightening Pulse Amplitude. Page 6-22.
At least 100 mV high.

☐ 23. Adjust VIT LINE SEL RANGE (R458); SN 2997-up. Page 6-23.
Set for a DC voltmeter reading which is halfway between the two reading obtained when the brightening pulse just started to jump between the 21st and 22nd lines and the 20th and 21st lines.

☐ 24. Check Line Selector Operation, SN 997-up. Page 6-23.
With LINE SELECTOR switch set to VARIABLE and

VARIABLE fully counterclockwise, brightening pulse must start on or before the 15th line. With VARIABLE (LINE SELECTOR) fully clockwise, brightening pulse must start after the first 25% of the second field.

When LINE SELECTOR switch is set to a numbered position, the brightening pulse must start at the start of that numbered line.

☐ 25. Check Vertical Amplifier High-Frequency Response. Page 6-24.

Refer to Table 6-2.

☐ 26. Adjust Vertical-Amplifier 1.0 Flat-Frequency Response (C269, L162 and L262). Page 6-24.

Flat-frequency response from 500 kHz to 5 MHz, ±1% and flat response from 500 kHz to 8 MHz, ±3%.

☐ 27. Adjust Vertical Amplifier 0.2 Flat-Frequency Response (C118B). Page 6-26.

Flat frequency response from 500 kHz to 5 MHz, ±1%.

☐ 28. Adjust Vertical Amplifier 0.5 Flat-Frequency Response (C118C). Page 6-26.

Flat-frequency response from 500 kHz to 5 MHz, ±1%.

☐ 29. Adjust Common Mode Rejection (SN 930-up). Page 6-26.

Minimum display amplitude of common 2 MHz signal.

☐ 30. Adjust Vertical Amplifier Chroma Frequency Response (T135). Page 6-27.

Set bottom transformer slug for 100 IEEE units of deflection at 3.58 MHz.

Set top transformer slug for 70 to 85 IEEE units of deflection at 3.18 MHz.

Check for 70 to 85 IEEE units of deflection at 3.98 MHz.

☐ 31. Check J501 Staircase Input. Page 6-28.

Four displays in 10 cm (SN 787-up).

Three displays in 10 cm (SN 100-786).

☐ 32. Adjust Bar Response of Pulse and Bar VIT Signal. Page 6-29.

Bar portion of pulse and bar VIT signal should have no tilt.

☐ 33. (Optional Method) Check Vertical Amplifier High-Frequency Response. Page 6-30.

General

In the following calibration procedure, a test equipment setup is shown for each major setup change. Complete control settings are listed below the picture. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

NOTE

When performing a complete recalibration, best performance will be provided if each adjustment is made to the exact setting, even if the Check is within the allowable tolerance.

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Remove the oscilloscope from any enclosure and remove the top and bottom covers to provide access to all internal adjustments and test points, including rear-panel connectors.

2. Check that a 160-IEEE unit 7-cm composite graticule (331-0161-00) is installed and that the VIDEO OUTPUT connector is terminated into 75 ohms.

3. Connect the autotransformer (if used) to a suitable power source.

4. Connect the Type RM529 power cord to the autotransformer output (or directly to the power source).

5. Set the autotransformer to 115 (or 230) volts.

6. Set the Type RM529 POWER switch to on. Allow at least 20 minutes warm up for checking the instrument to the given accuracies.

NOTES

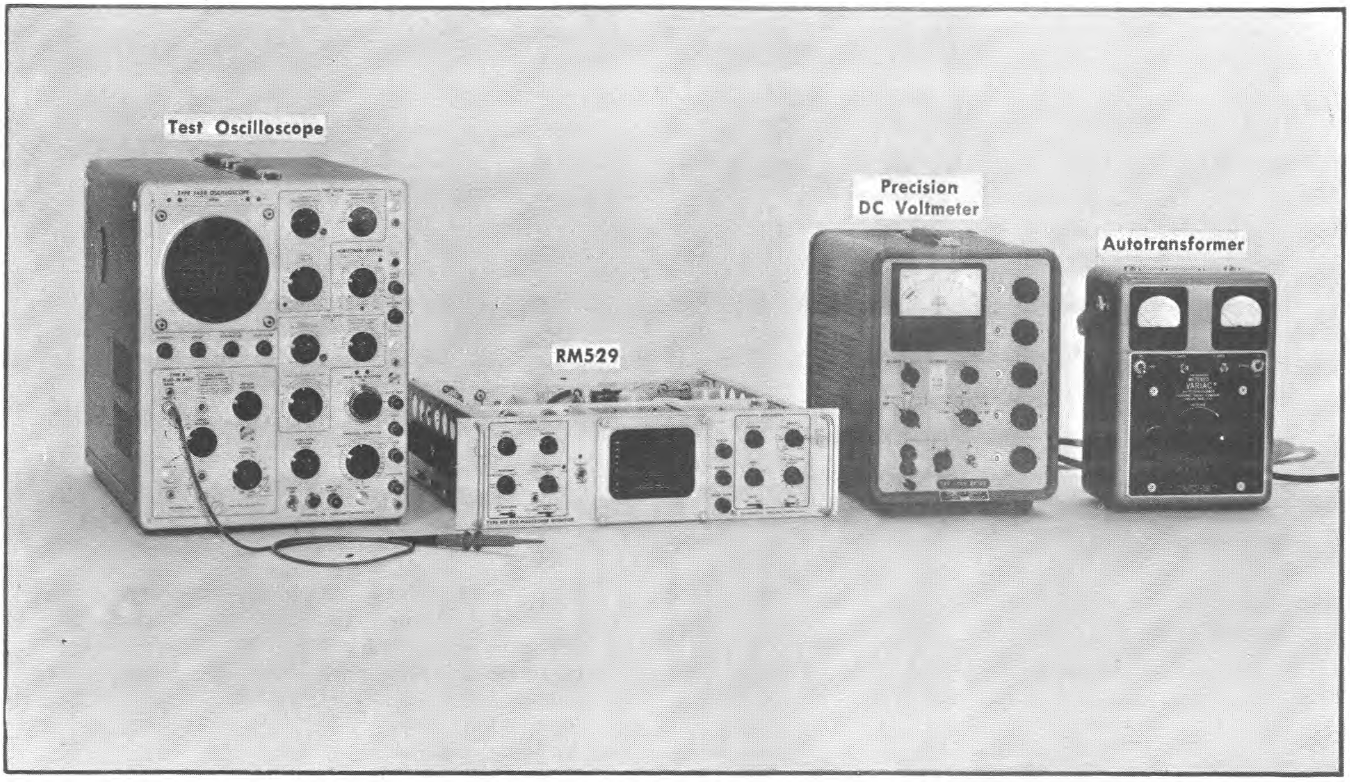


Fig. 6-2. Test equipment setup for steps 1 and 2.

Set Type RM529 controls as follows.

POWER	On
SCALE ILLUM	⅔ clockwise
FOCUS	Midrange
INTENSITY	Fully counterclockwise
GAIN	Midrange

VERTICAL Controls

RESPONSE	Flat
DC RESTORER	OFF
INPUT	CAL
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	FULL SCALE
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

PROCEDURE

1. Adjust —25 VOLTS/CAL AMPL (R620) ❶

NOTE

Do not reset the —25 VOLTS/CAL AMPL (R620) unless the power-supply voltages are actually out of tolerance or you are planning to perform a complete calibration of the instrument.

a. Test equipment setup is shown in Fig. 6-2.

b. Connect a precision DC voltmeter between the —25 V supply and ground. See Fig. 6-3A.

c. Check for a meter reading of —25 volts.

d. Adjust the —25 VOLTS/CAL AMPL control (R620; see Fig. 6-3B) for a meter reading of —25 volts.

e. Disconnect the voltmeter.

f. Turn off the Type RM529 power.

g. Remove Q804 and Q874.

h. Turn on the Type RM529 power.

i. Connect the precision DC voltmeter between the junction of R885-R881 and ground; see Fig. 6-3C.

j. Note the exact meter reading.

k. Turn off the Type RM529 power.

l. Reinstall Q874 and connect a ¼ watt, 27 kΩ resistor between the base of Q874 and ground.

m. Turn the Type RM529 power on.

n. Note the exact meter reading; it will be approximately —0.976 volts.

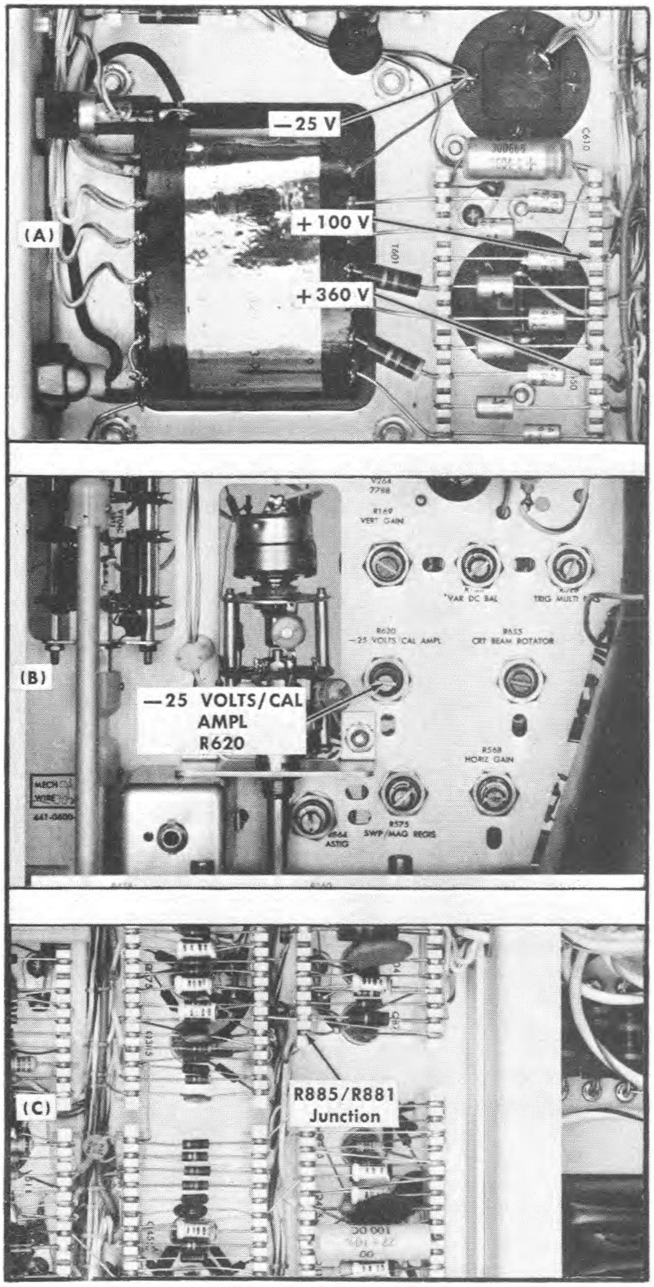


Fig. 6-3. (A) Location of low-voltage power supply test points. (B) Location of —25 VOLTS/CAL AMPL adjustment. (C) Location of R885-R881 junctions.

o. Check that 1.0 volt minus the meter reading noted in part j of this step equals the meter reading noted in part n of this step.

p. Adjust the —25 VOLTS/CAL AMPL control (R620; see Fig. 6-3B) until the meter reading equals 1.0 volt minus the meter reading noted in part j of this step.

NOTE

Without the use of a high input impedance precision DC voltmeter such as item number four in the Equipment Required list, adjustment accuracy within 1% cannot be obtained.

q. Turn off the Type RM529 power.

r. Remove the 27 kΩ resistor from Q874 and re-install Q804.

s. Disconnect the voltmeter.

t. Turn the Type RM529 power on.

u. Interaction—May affect operation of all circuits.

1A. Adjust —25 VOLTS/CAL AMPL (R620) ⓿

(Alternate method of adjusting the —25 VOLTS/CAL AMPL (R620) using a good DC voltmeter.)

NOTE

This method of adjustment may lack some of the accuracy of the method outlined in Step 1. Therefore, it is recommended that a precision voltmeter be used to make this adjustment. Factors affecting the accuracy of this method include the calibration of the DC voltmeter and the calculation of the correction factor for meter loading.

a. Test equipment setup is as shown in Fig. 6-2.

b. Connect a DC voltmeter between the —25 volt supply and ground. See Fig. 6-3A.

c. Check for a meter reading of —25 volts.

d. Adjust the —25 VOLTS/CAL AMPL control (R620; see Fig. 6-3B) for a meter reading of —25 volts.

e. Disconnect the voltmeter.

f. Turn off the Type RM529 power.

g. Remove Q804 and connect a 27 kΩ, ¼ W, 5% resistor from the base of Q874 to ground.

h. Turn the Type RM529 power on.

i. Connect the DC voltmeter between the junction of R885-R881 and ground; see Fig. 6-3C.

j. Note the exact meter reading; it will be approximately —.976 volts.

k. Adjust the —25 VOLTS/CAL AMPL control (R620) for a meter reading of —.97 volts minus the correction factor for meter loading.

Example: a 20,000 ohm/volt voltmeter on the 1.5 volt full scale range has an input resistance of 30,000 ohms and will cause a 3% error in this circuit. ($\frac{\text{Circuit resistance}}{\text{Meter resistance}} = \%$ Loading Error.)

Therefore, the —25 VOLT/CAL AMPL control should be adjusted for a reading of —.94 volts (.97 minus .03 = .94).

2. Check Low-Voltage Power-Supply Regulation and Ripple

a. Test equipment setup is shown in Fig. 6-2.

b. Set the CAL switch to .714 F. S. to display 100 IEEE units of vertical deflection.

c. Vary the autotransformer so the line voltage is set 10% above design center (for 115 V, +10% is 126.5 V) and hold for 1 minute at this voltage extreme. Check voltage regulation and ripple according to the information given in Table 6-1 and Fig. 6-3A.

d. Vary the autotransformer so the line voltage is set 10% below design center (for 115 V, —10% is 103.5 V) and hold for 1 minute at this voltage extreme. Check voltage regulation and ripple as given in Table 6-1 and Fig. 6-3A.

TABLE 6-1

Typical Ripple Amplitudes

Supply	Voltage Deviation[2]	Ripple Amplitude
—25 V	±3% or 0.75	≤ 10 mV
+100 V	±5% or 5 V	≤ 100 mV

[2]Deviation from the voltage reading obtained at design center; for example, if —25 V supply indicates a reading of —25.7 V on the DC voltmeter at design center, deviation should be within the range from —24.95 V to —26.45 V.

e. Set the autotransformer for design center line voltage.

f. Disconnect the DC voltmeter and 1× probe.

NOTES

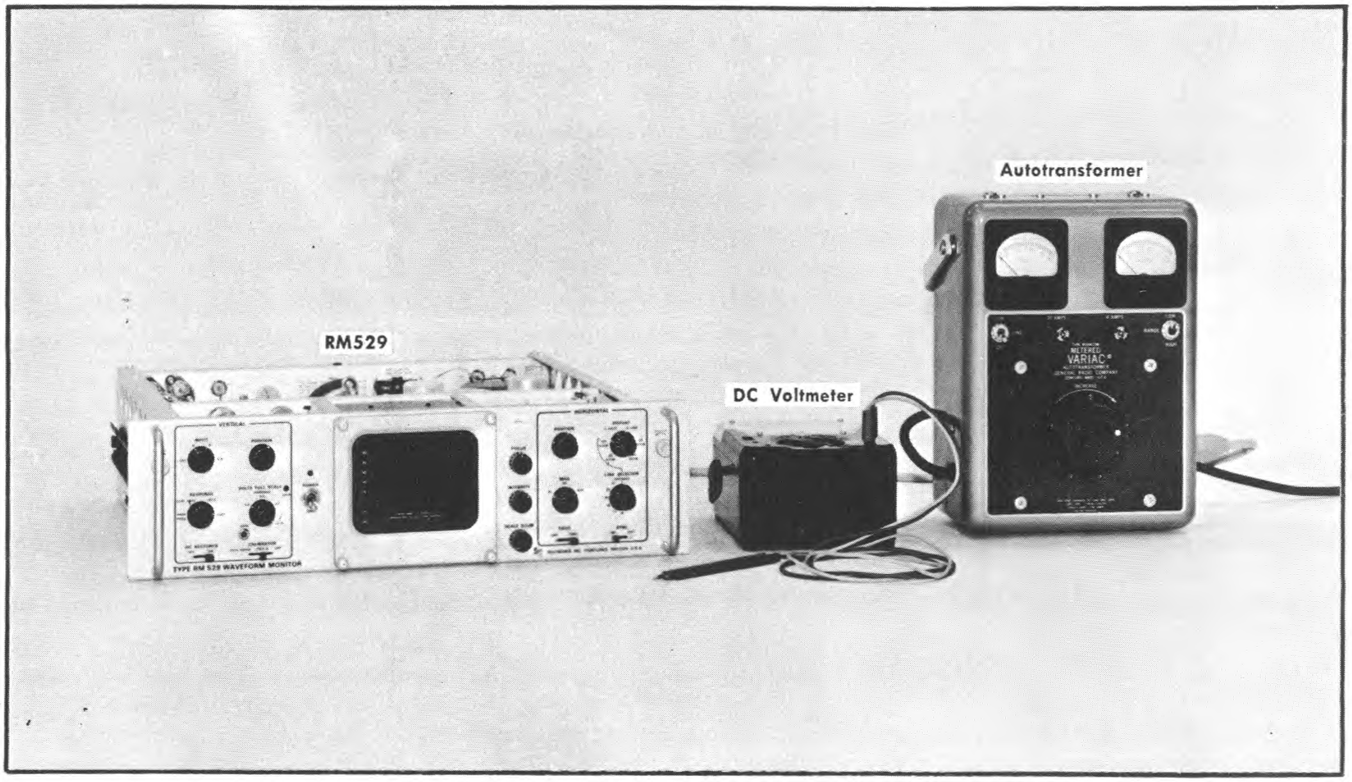


Fig. 6-4. Test equipment required for steps 3 and 4.

POWER	On
SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange
VERTICAL Controls	
RESPONSE	FLAT
DC RESTORER	OFF
INPUT	CAL
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F. S.
POSITION	Midrange
HORIZONTAL Controls	
POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

3. Adjust HIGH VOLTAGE (R835)

a. Test equipment setup is shown in Fig. 6-4.

b. Connect the DC voltmeter between the CRT cathode (see Fig. 6-5) and ground.

c. Rotate the GAIN control from one extreme to the other.

d. Check that the meter reading varies.

e. Set the GAIN control to its midrange position.

f. Check for a meter reading of —5300 V.

g. Adjust the HIGH VOLTAGE control (R835; see Fig. 6-5) to obtain a meter reading of —5300 V.

h. Interaction—May affect operation of all circuits.

4. Check High Voltage Regulation

a. Test equipment setup is shown in Fig. 6-4.

b. Vary the autotransformer so the line voltage is set 10% above design center and hold for 1 minute at this extreme. Check that the high voltage remains essentially constant (within ±5% or 265 volts of the —5300-volt reading).

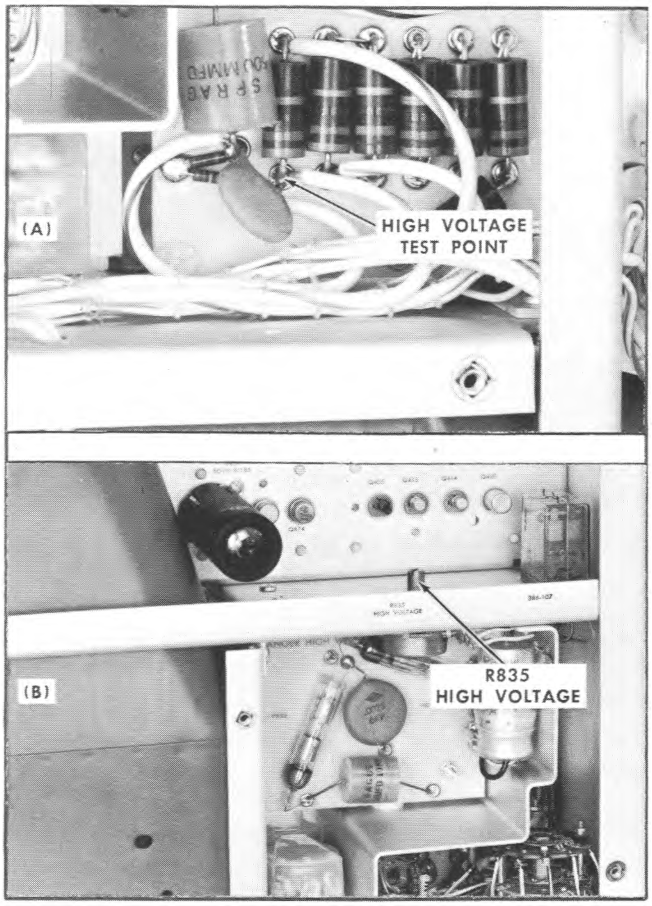


Fig. 6-5. Location of (A) high-voltage test point, (B) HIGH VOLTAGE adjustment.

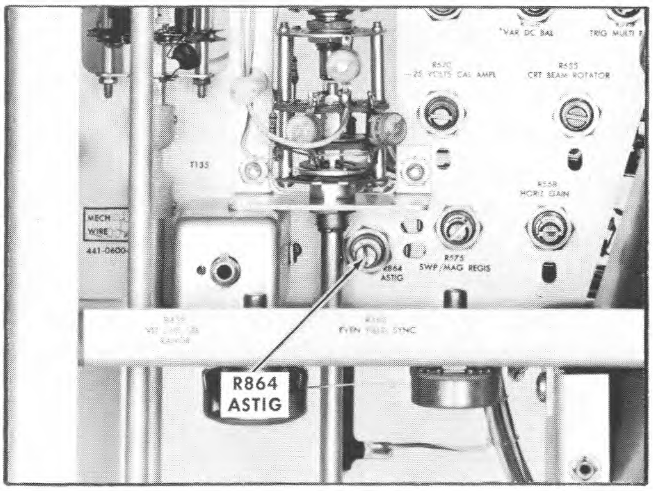


Fig. 6-6. Location of ASTIG adjustment.

c. Vary the autotransformer so the line voltage is set 10% below design center and hold for 1 minute at this extreme.

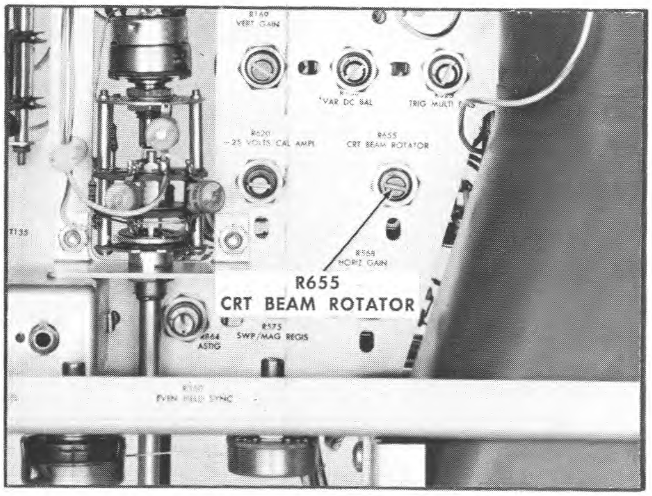


Fig. 6-7. Location of CRT BEAM ROTATOR adjustment.

Check that the high voltage remains essentially constant (within ±5% or 265 volts of the —5300-volt reading).

d. Set the autotransformer for design-center line voltage.

e. Disconnect the DC voltmeter.

5. Adjust ASTIG (R864)

a. Set the DISPLAY switch to 2 LINE.

b. Check for well-defined display with normal brightness.

c. Adjust the FOCUS and ASTIG controls (R864; see Fig. 6-6) to obtain a well-defined display using normal brightness.

6. Adjust CRT BEAM ROTATOR (R655)

a. Set the DISPLAY switch to 2 FIELD.

b. Check that flat bottoms of the calibrator square waves coincide with the graticule line.

c. Adjust the CRT BEAM ROTATOR control (R655; see Fig. 6-7) so the flat bottom of the calibrator square waves coincides with the graticule line.

7. Adjust DC BAL (R115)

a. Set the INPUT switch to A (no signal applied to VIDEO INPUTS A connector).

b. Check for no vertical trace movement as (VERTICAL) VOLTS FULL SCALE switch is changed from 1.0 to 0.2 and 0.5 positions.

c. Adjust the DC BAL control (R115; see Fig. 6-8) for no vertical movement of the trace as (VERTICAL) VOLTS FULL SCALE switch is set to 0.2, to 0.5, and then returned to 1.0. Repeat this procedure, if necessary, to check that the adustment is made properly.

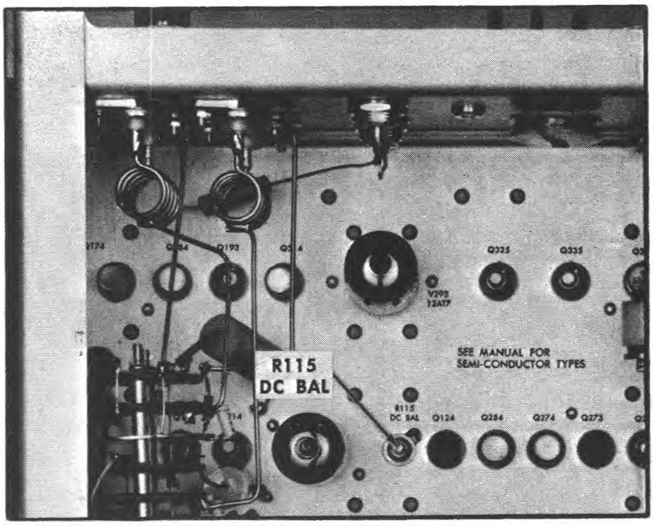


Fig. 6-8. Location of DC BAL adjustment.

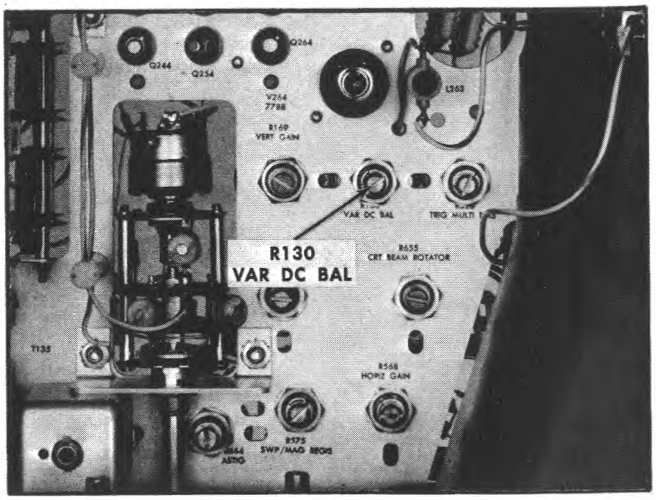


Fig. 6-9. Location of VAR DC BAL adjustment.

8. Adjust VAR DC BAL (R130)

a. Check that the (VERTICAL) VOLTS FULL SCALE switch is set to 1.0.

b. Check for no vertical trace movement as the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control is rotated from extreme to extreme.

c. Adjust the VAR DC BAL control (R130; see Fig. 6-9) for no vertical movement of the trace as the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control is rotated from extreme to extreme.

d. Set the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control to the CALIB position.

e. Interaction—Recheck step 7.

NOTES

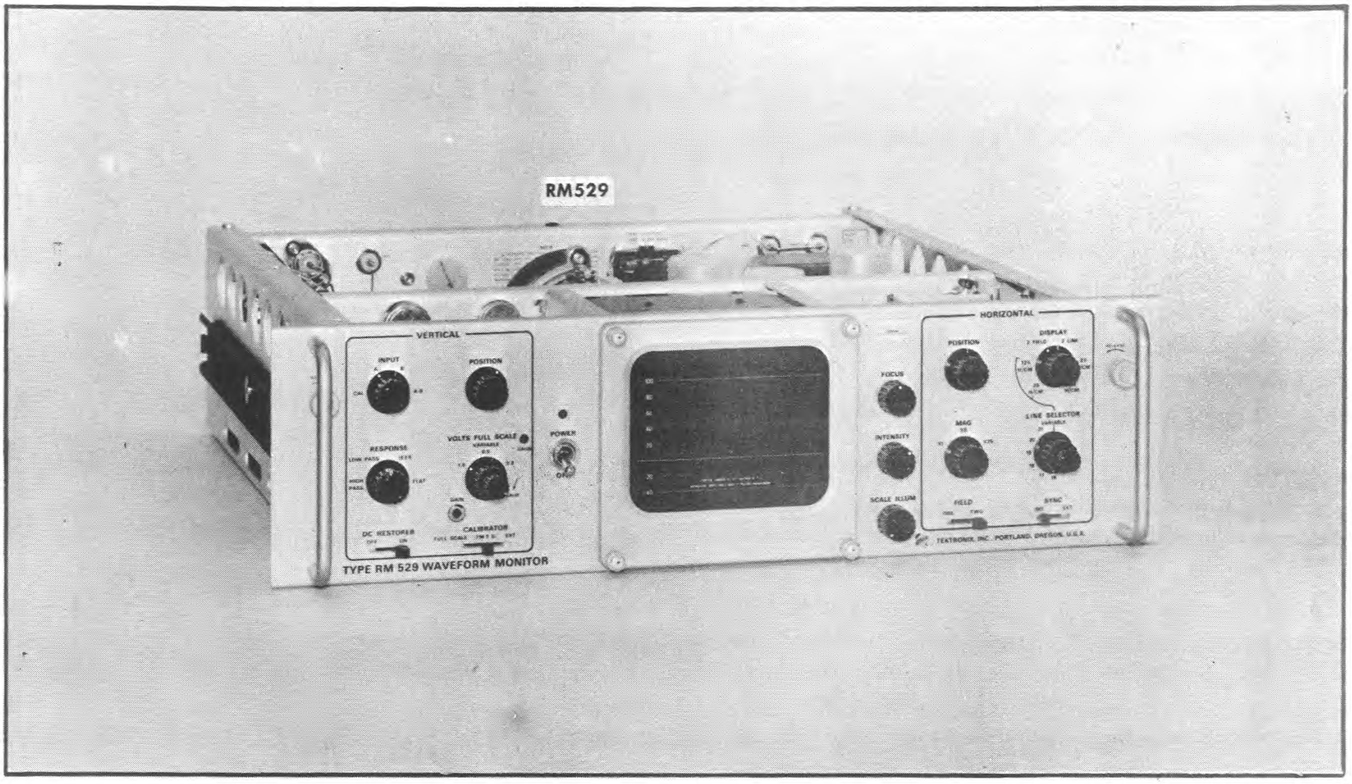


Fig. 6-10. Test equipment required for steps 9 through 11.

Control settings:

POWER	On
SCALE ILLUM	$\frac{2}{3}$ clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	CAL
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	FULL SCALE
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

9. Adjust VERT GAIN (R169)

a. Test equipment setup is shown in Fig. 6-10.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 1.0.

c. Adjust the VERT GAIN control (R169; see Fig. 6-11) to obtain exactly 140 IEEE units of vertical deflection.

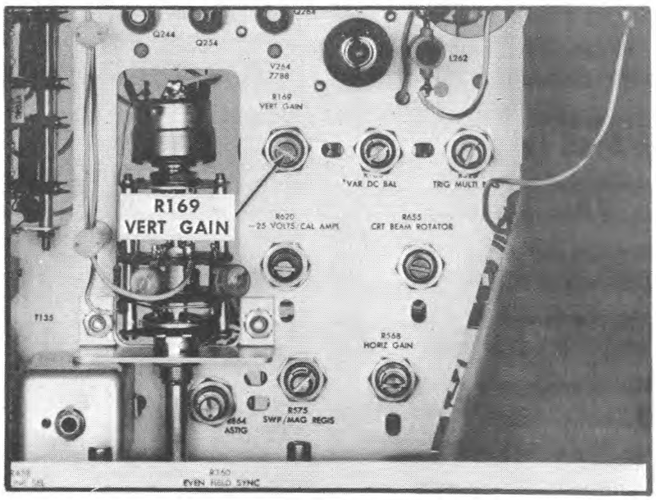


Fig. 6-11. Location of VERT GAIN adjustment.

10. Adjust Vertical 0.2 VOLTS FULL SCALE GAIN (R119)

a. Test equipment setup is given in step 9.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.2.

c. Check for exactly 140 IEEE units of vertical deflection.

d. Adjust the 0.2 VOLTS GAIN control (R119; see Fig. 6-12) for exactly 140 IEEE units of vertical deflection.

11. Check Vertcial 0.5 VOLTS FULL SCALE Gain Accuracy

a. Test equipment setup is given in steps 9 and 10.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

c. Check that the vertical deflection of the display is 140 IEEE units within a tolerance of ±4 IEEE units.

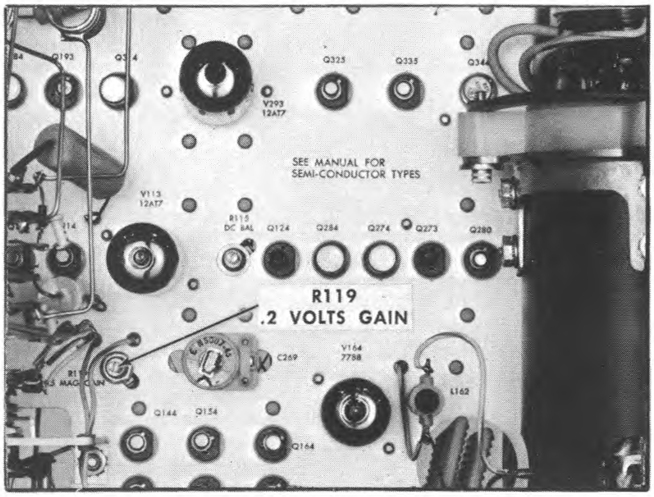


Fig. 6-12. Location of 0.2 VOLTS GAIN adjustment.

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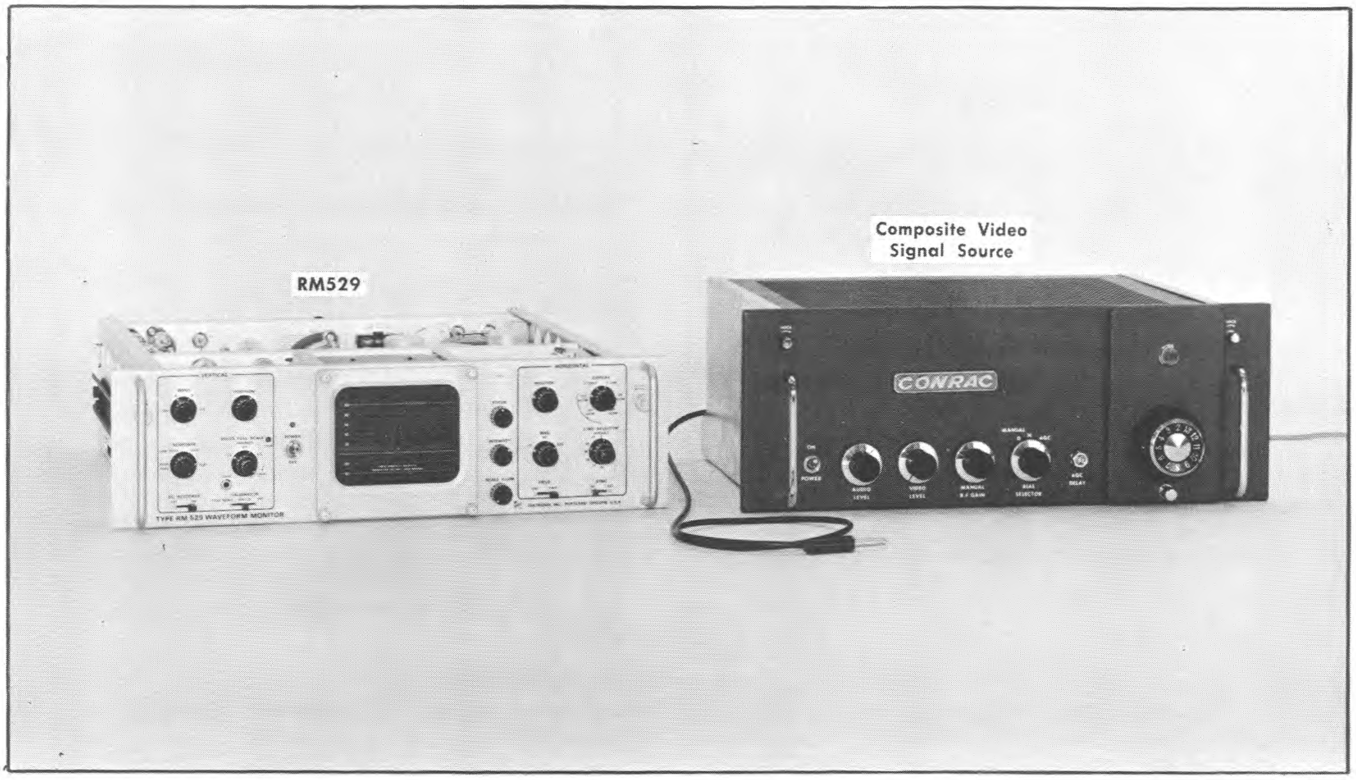


Fig. 6-13. Test equipment required for steps 12, 13 and 14.

Control settings:

POWER	On
SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	0.2
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	FULL SCALE
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

12. Adjust TRIG MULTI BIAS (R325) ◐

a. Test equipment setup is shown in Fig. 6-13.

b. Connect a composite video signal to the lower EXT NEG SYNC INPUT connector.

c. Connect a coaxial cable from the upper EXT NEG SYNC INPUT connector to the upper VIDEO INPUTS A connector.

d. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

e. Adjust the source signal level to produce 140 IEEE units of sync amplitude.

f. Check for a stable display.

g. Adjust by first rotating the TRIG MULTI BIAS control (R325; see Fig. 6-14) full counterclockwise. Then, rotate the control slowly clockwise until the display is synchronized; that is, a stationary display is obtained.

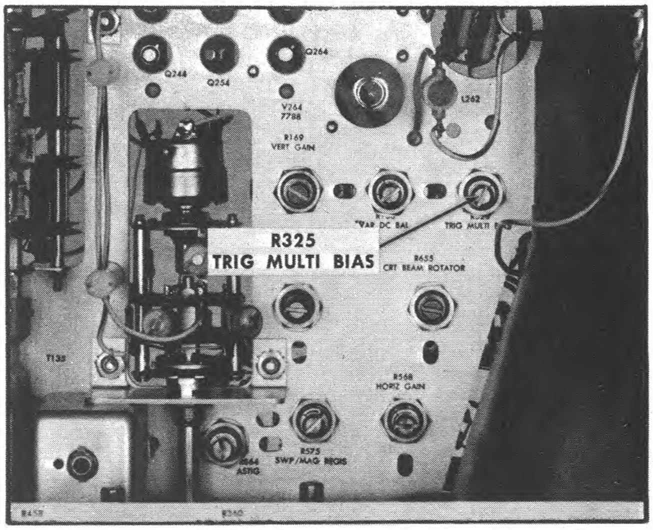


Fig. 6-14. Location of TRIG MULTI BIAS adjustment.

NOTE

If the Type RM529 is used to monitor video signals containing noise, rotate the TRIG MULTI BIAS control about 20° further clockwise from the point where a stable display was first obtained. If the control is turned too far clockwise, a jittery display will be obtained. The control should always be set within the stable display range.

h. As a check that the TRIG MULTI BIAS control is properly adjusted, set the (VERTICAL) VOLTS FULL SCALE switch to 1.0, adjust the source signal level for a larger sync amplitude (up to 140 IEEE units) and check that the display remains synchronized.

13. Check External Sync

a. Test equipment setup is given in step 12.

b. Set the SYNC switch to EXT.

c. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

d. Adjust the video source signal level so the vertical deflection is 70 IEEE units of sync amplitude.

e. Check that a stable display is obtained.

14. Check DC RESTORER Switch

a. Test equipment setup is given in step 12.

b. Set the front-panel controls to these settings:

VOLTS FULL SCALE	1.0
DC RESTORER	ON
INPUT	CAL
CALIBRATOR	.714 F. S.
SYNC	INT

c. Using the (VERTICAL) POSITION control, position the bottom of the calibrator waveform so it coincides with the 0 IEEE graticule line.

d. Set the INPUT switch to A.

e. Check that the back porch level of the video signal coincides with the 0 IEEE graticule line.

f. Set the INPUT switch to CAL.

g. Set the (VERTICAL) VOLTS FULL SCALE switch from 1.0 to 0.2, then to 0.5. Check for ±4 IEEE units or less vertical movement of the calibrator waveform from 0 IEEE.

h. Set the (VERTICAL) VOLTS FULL SCALE switch to 1.0 and DC RESTORER switch to OFF.

i. Disconnect the video signal from the lower EXT NEG SYNC INPUT connector.

j. Disconnect the jumper coaxial cable.

NOTES

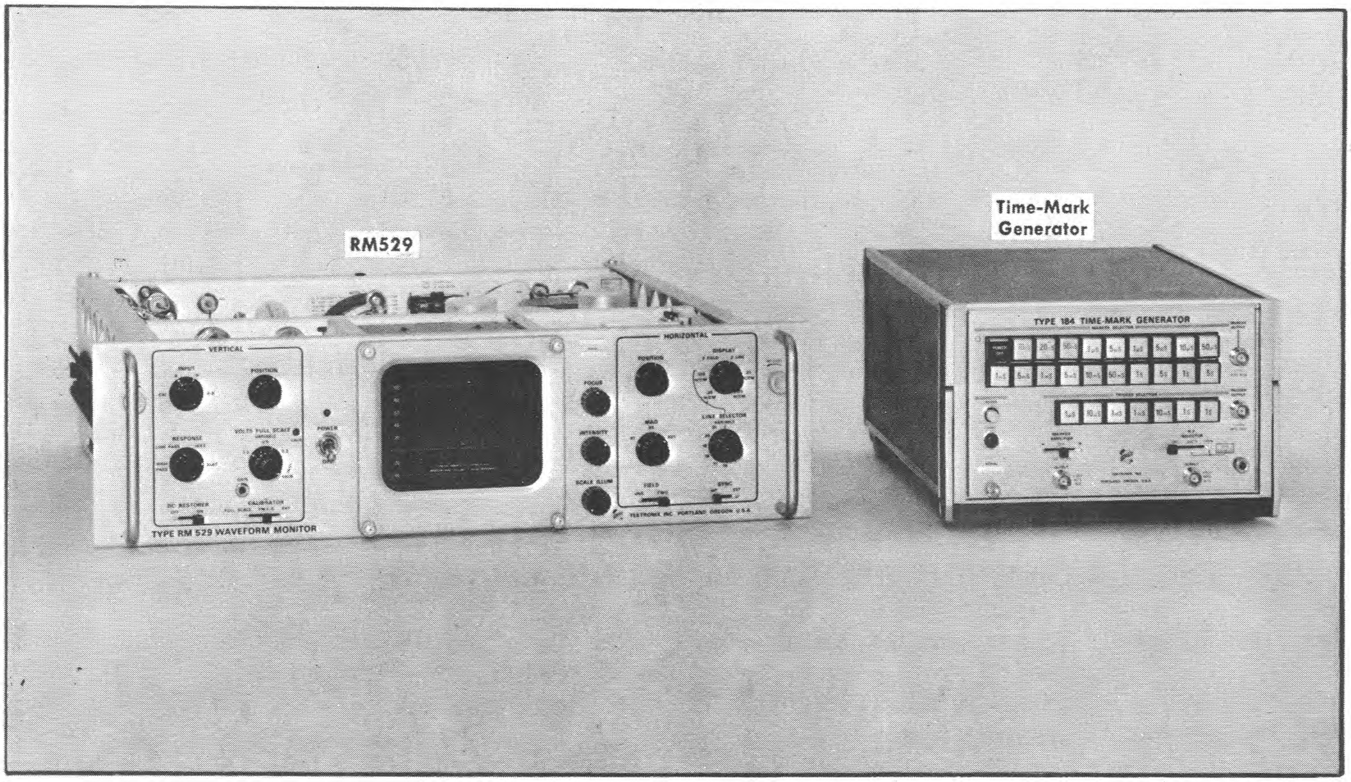


Fig. 6-15. Test equipment required for steps 15 through 18.

Control settings:

POWER	On
SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange
VERTICAL Controls	
RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F. S.
POSITION	Midrange
HORIZONTAL Controls	
POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

15. Adjust HORIZ GAIN (R568)

a. Test equipment setup is shown in Fig. 6-15.

b. Connect 5-μs and 10-μs time markers from the time-mark generator to the upper VIDEO INPUTS A connector.

c. Check that the 75-ohm termination is still connected to the lower VIDEO INPUTS A connector.

d. Apply 100-μs trigger pulses from the time-mark generator to the upper EXT NEG SYNC INPUT connector.

e. Set the SYNC switch to EXT and the DISPLAY switch to .125 H/CM.

NOTE

Use the (VERTICAL) VOLTS FULL SCALE and VARIABLE (VOLTS FULL SCALE) controls to adjust the vertical amplitude of the display in steps 15 through 18.

f. Check for a sweep length of 10.2 cm.

g. Adjust the HORIZ GAIN control (R568; see Fig. 6-16) for a sweep length of 10.2 cm.

h. Interaction—Check step 16.

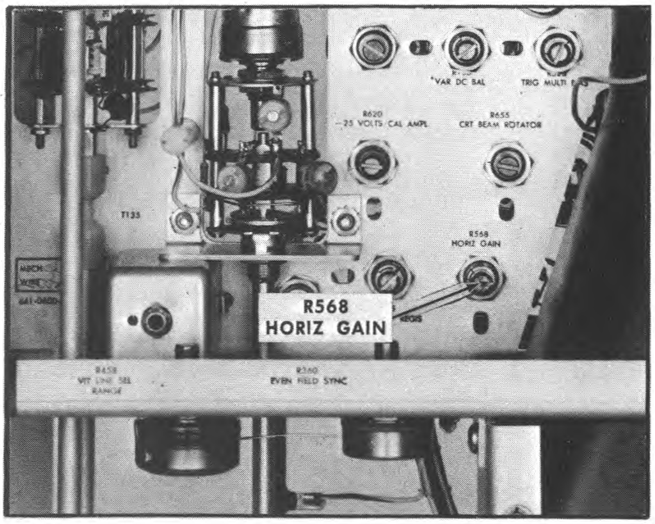


Fig. 6-16. Location of HORIZ GAIN adjustment.

16. Adjust Miller Timing Capacitor (C481) ⓘ

a. Test equipment setup is given in step 15.

b. Check for 80 μs of sweep in 10 cm.

c. Adjust the Miller timing capacitor (C481; see Fig. 6-17) for 80 μs per 10 cm (see Fig. 6-18).

d. Interaction—Check step 15.

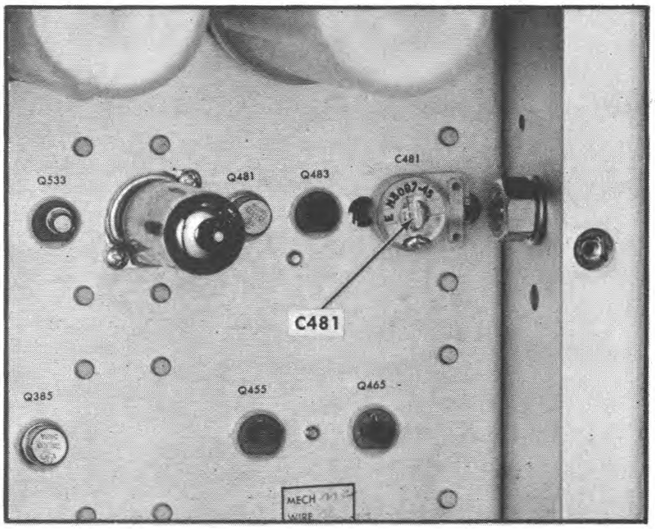


Fig. 6-17. Location of C481 adjustment.

17. Adjust X25 Horizontal Sweep Magnifier Capacitor (C523, SN 1606-up); (C521, SN 101-1605) ⓘ

a. Test equipment setup is given in step 15.

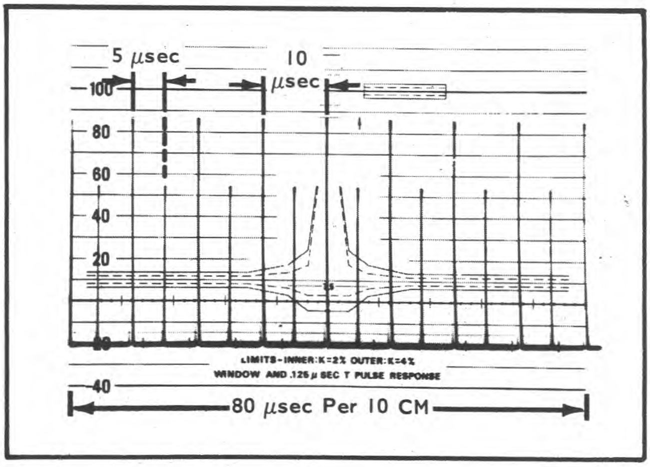


Fig. 6-18. Adjusting C481 for correct ×1 sweep timing.

b. Set the time-mark generator for .1 μs time markers.

c. Set the (HORIZONTAL) MAG switch to ×25.

d. Check for 32 time markers per 10 cm.

e. Adjust the horizontal sweep magnifier capacitor (C523 or C521; see Fig. 6-19), primarily for sweep timing and secondarily for linearity. For correct timing, 32 time markers per 10 cm should be displayed (see Fig. 6-20). For checking linearity, display should show 8 time markers for any 2.5-cm portion of the display.

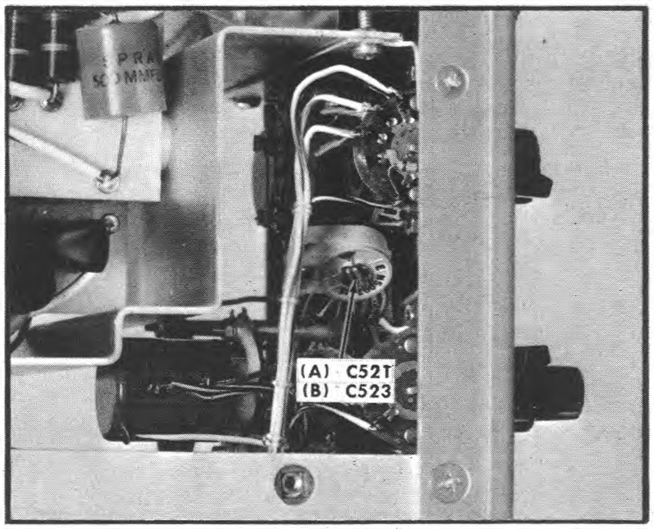


Fig. 6-19. Location of (A) C521 SN 101-1605 (B) C523 SN 1606 and up adjustment.

NOTE

To minimize horizontal jitter, set the time-mark generator trigger rate for 1 ms trigger output. After completing this step, set trigger rate to 0.1 ms.

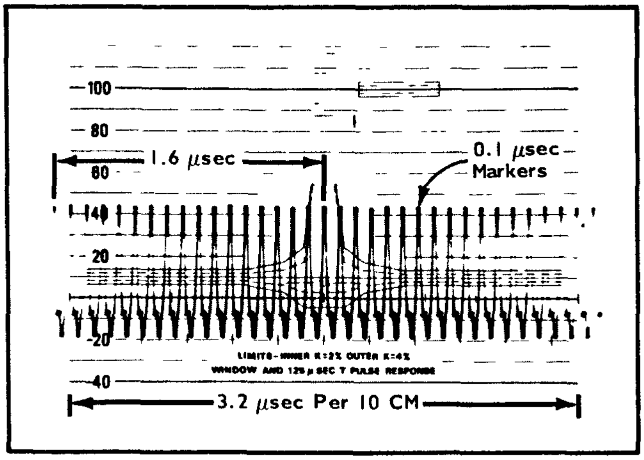


Fig. 6-20. Adjusting C521 for optimum ×25 sweep linearity.

18. Check X5 Magnified Sweep Timing

a. Test equipment setup is given in step 15.

b. Set the time-mark generator output for 1-μs time-marker output and check that the trigger rate is 0.1 ms.

c. Set the (HORIZONTAL) MAG switch to ×5.

d. Check for 16 μs of sweep time per 10 cm (see Fig. 6-21). Sweep-timing tolerance should be within ±3 mm.

e. Disconnect the time markers and external trigger.

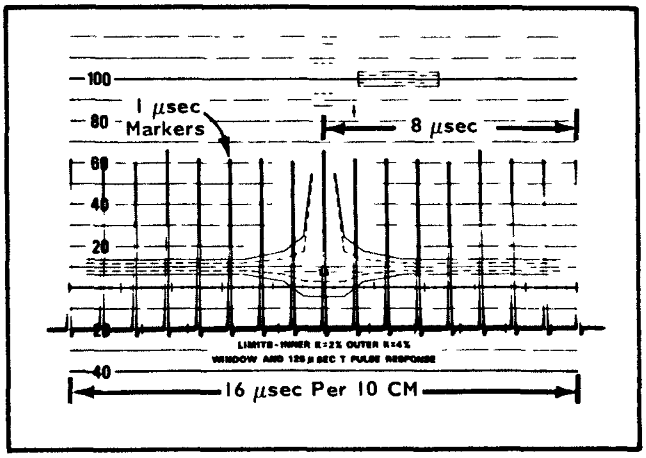


Fig. 6-21. Checking the ×5 sweep timing.

NOTES

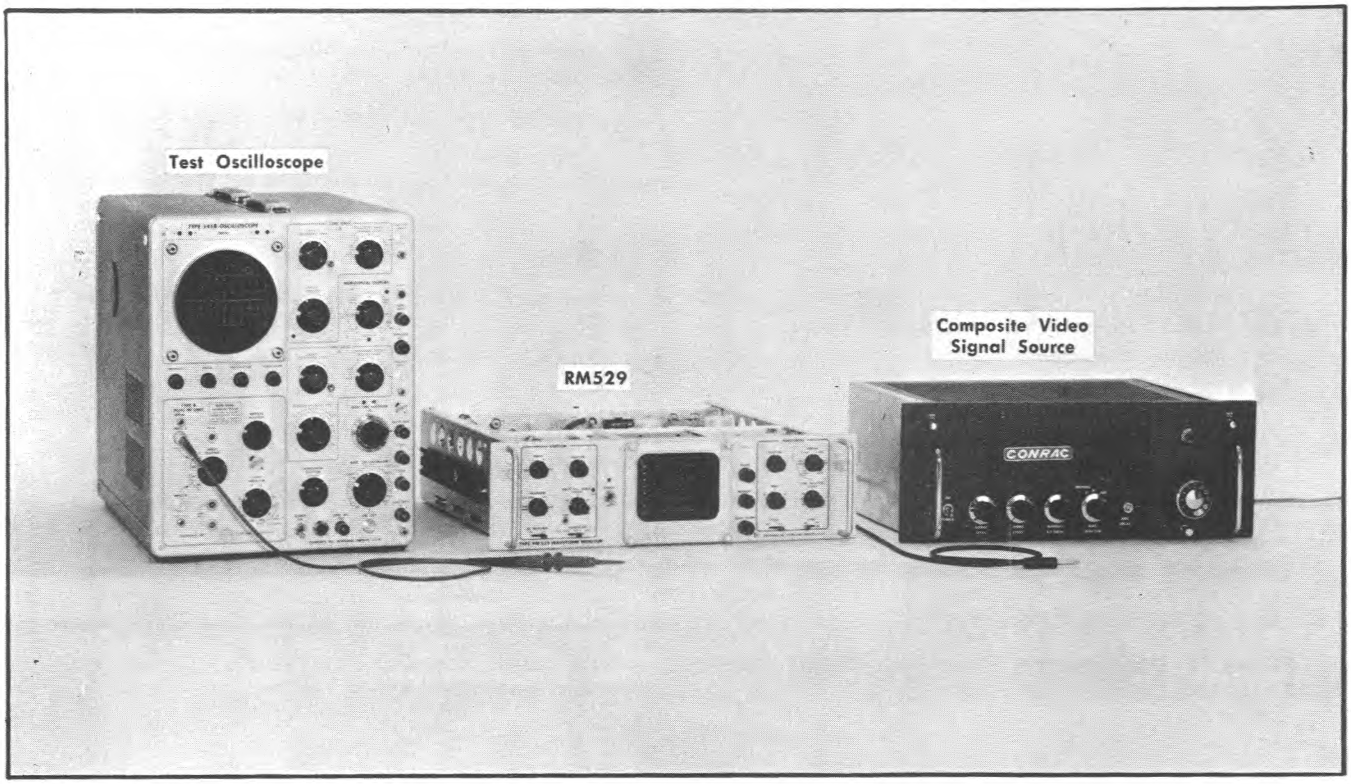


Fig. 6-22. Test equipment required for steps 19 through 21.

Control settings:

POWER	On
SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F. S.
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×25
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

19. Adjust FIELD 1 SYNC (R360)

a. Test equipment setup is shown in Fig. 6-22.

b. Connect a 1-volt composite video signal to the upper VIDEO INPUTS A connector.

c. Check that a 75-ohm termination is connected to the lower VIDEO INPUTS A connector.

d. Set the test oscilloscope controls as follows:

Sweep Rate	50 μs/cm
Triggering	+Ext, AC
Signal Input Coupling	AC
Vertical Deflection Factor (with 10× attenuator probe)	5 Volts/cm

e. Connect the 10× probe from the vertical input connector to the junction of D370 and C370 (see Fig. 6-23).

f. Connect the 1× probe from the external trigger input connector to the collector of Q344.

g. Check that the ramp starts just after the sixth equalizing pulse.

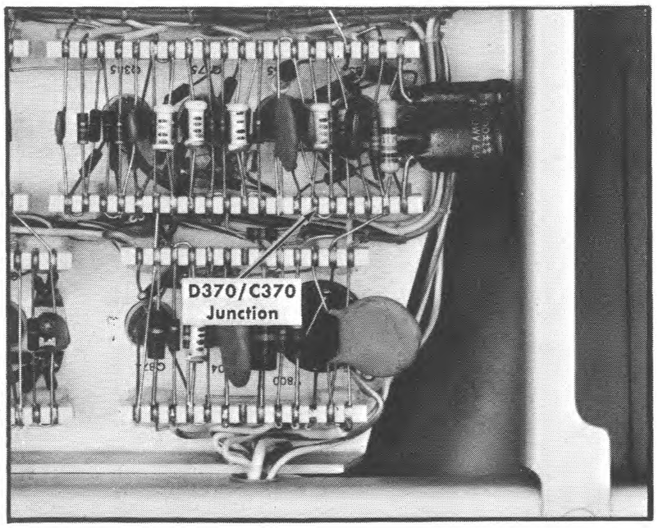


Fig. 6-23. Location of D370/C370 junction.

h. Adjust by first rotating the FIELD 1 SYNC control (R360; see Fig. 6-24) fully counterclockwise. Then, rotate the control slowly in a clockwise direction until the ramp starts just after the sixth equalizing pulse (see Fig. 6-25A). The sixth equalizing pulse is the last pulse in the equalizing-pulse group following the vertical sync pulses. Fig. 6-25B and 6-25C show two possible displays that can be obtained when the control is incorrectly adjusted.

i. Disconnect the 10× and 1× probes.

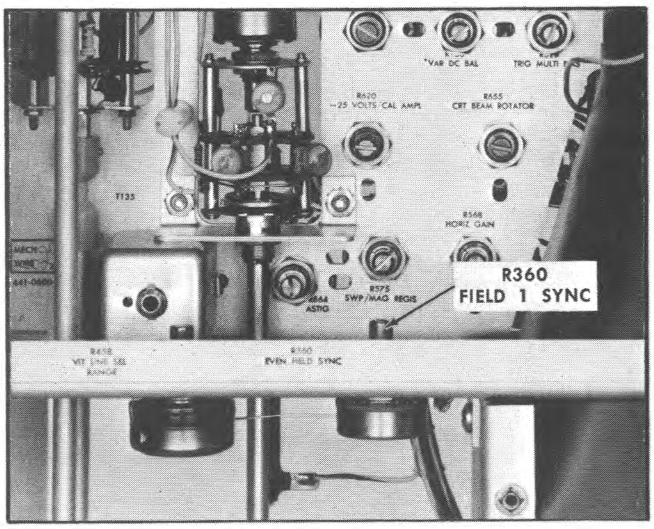
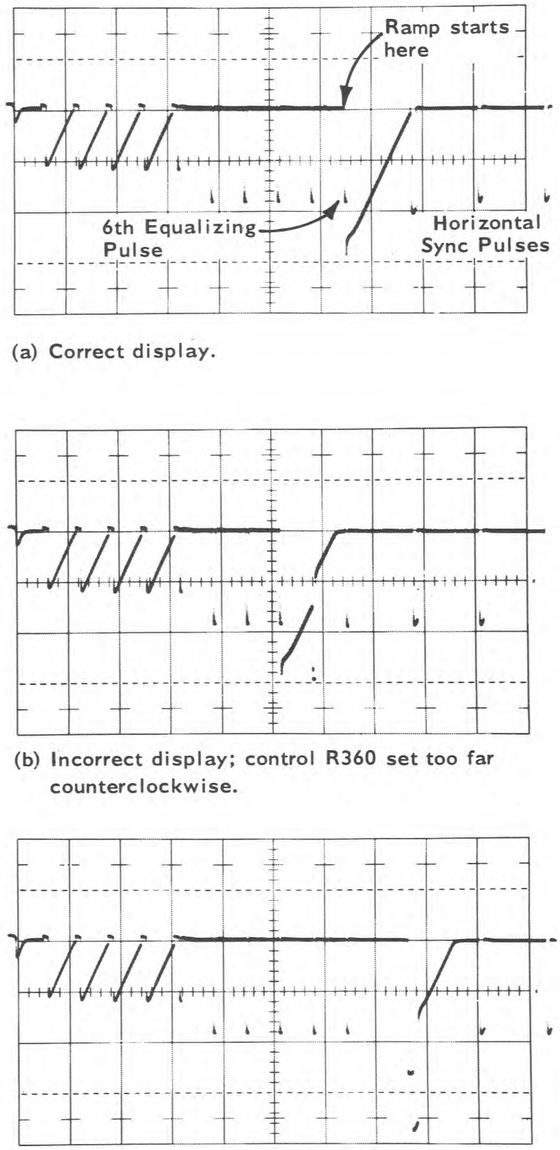


Fig. 6-24. Location of FIELD 1 SYNC adjustment.

20. Check FIELD Switch

a. Test equipment setup is given in step 19.



(a) Correct display.

(b) Incorrect display; control R360 set too far counterclockwise.

(c) Incorrect display; control R360 set too far clockwise.

Fig. 6-25. Adjusting the FIELD 1 SYNC control (R360) for proper triggering. Displays obtained on the test oscilloscope CRT.

b. Set the FIELD switch to TWO.

NOTE

If vertical sync pulse is not completely displayed, position it to the horizontal center of the viewing area with the (HORIZONTAL) POSITION control.

c. Check for a horizontal distance of 1 H (63.5 μs) between the last horizontal sync pulse and the first equalizing pulse (see Fig. 6-26A). This indicates that field one is displayed at the center of the CRT.

d. Set the SYNC switch to EXT and back to INT several times to check that a field display is obtained each time the SYNC switch is returned to the INT position. This is a double check on step 19. A stable display of field one means that R360 is adjusted properly.

e. Set the FIELD switch to ONE.

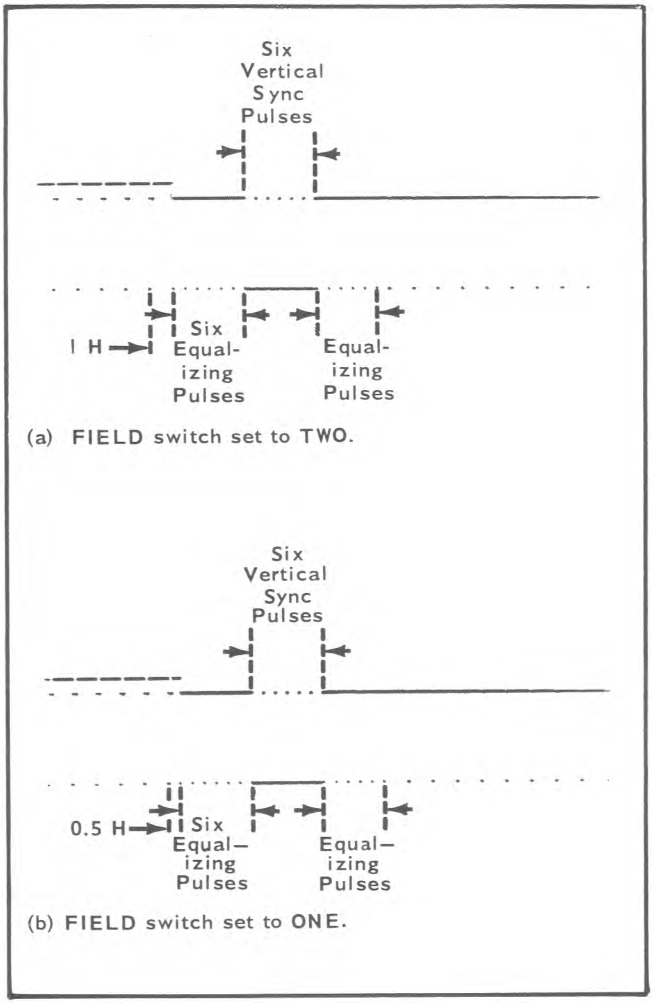


Fig. 6-26. Checking for proper field display when operating the FIELD and SYNC switches.

f. Check for 0.5 H (31.75 μs) horizontal distance between the last horizontal sync pulse and the first equalizing pulse (see Fig. 6-26B). This indicates that field two is displayed at the center of the CRT.

g. Repeat part d, except check that a field two display is obtained each time the SYNC switch is returned to INT.

21. Adjust SWP/MAG REGIS (R575) Pulse Amplitude

a. Test equipment setup is given in step 19.

b. Using the (HORIZONTAL) POSITION control, position the display so the center of the vertical-sync pulse group coincides with graticule center (see Fig. 6-27A).

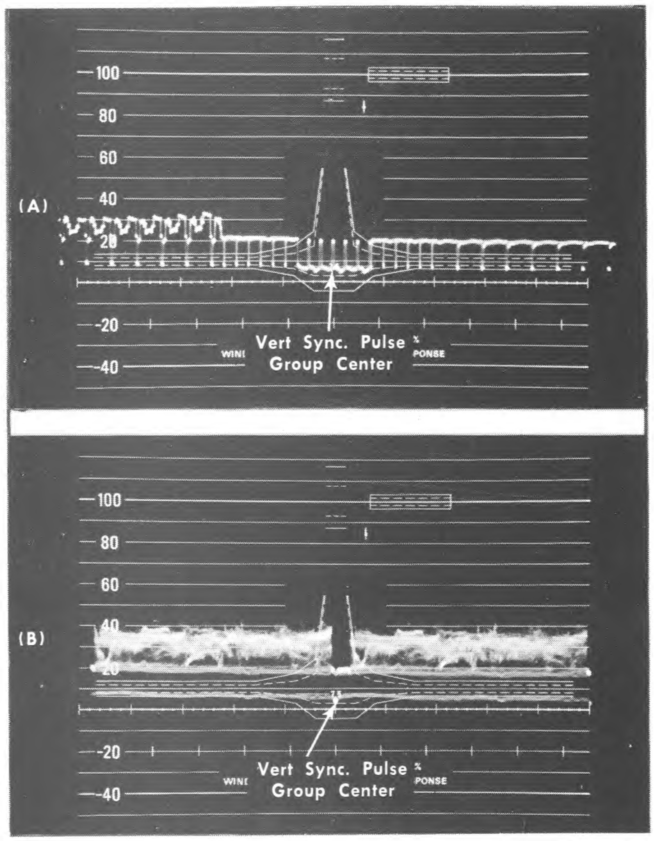


Fig. 6-27. Adjusting the SWP/MAG REGIS control (R575) for proper display registration. The Horizontal MAG switch was set to (A) ×25 (B) ×1.

c. Set the (HORIZONTAL) MAG switch to $\times 1$.

d. Check that the vertical-pulse group coincides with graticule center (see Fig. 6-27B).

e. Adjust the SWP/MAG REGIS control (R575; see Fig. 6-28) so the vertical pulse group coincides with graticule center (see Fig. 6-27B).

f. To check whether the adjustment has been set properly, set the (HORIZONTAL) MAG switch to $\times 25$ and then to $\times 1$. If the display as observed at graticule center shifts horizontally, readjust the SWP/MAG REGIS control (R575) for no horizontal shift of the display when switching from $\times 25$ to $\times 1$.

g. Disconnect the composite video signal.

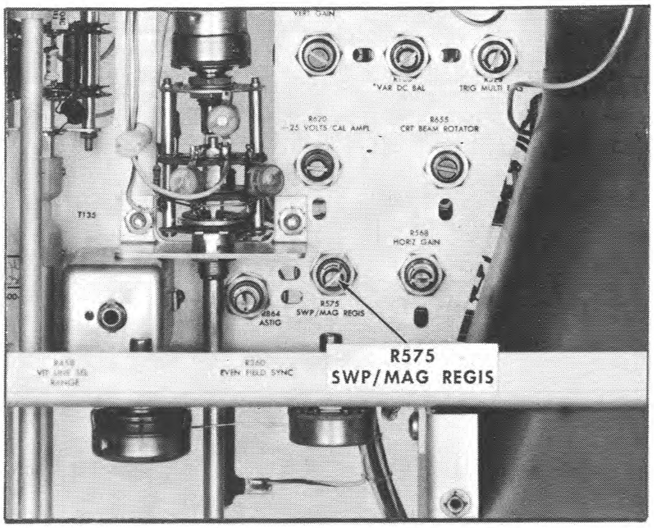


Fig. 6-28. Location of SWP/MAG REGIS adjustment.

NOTES

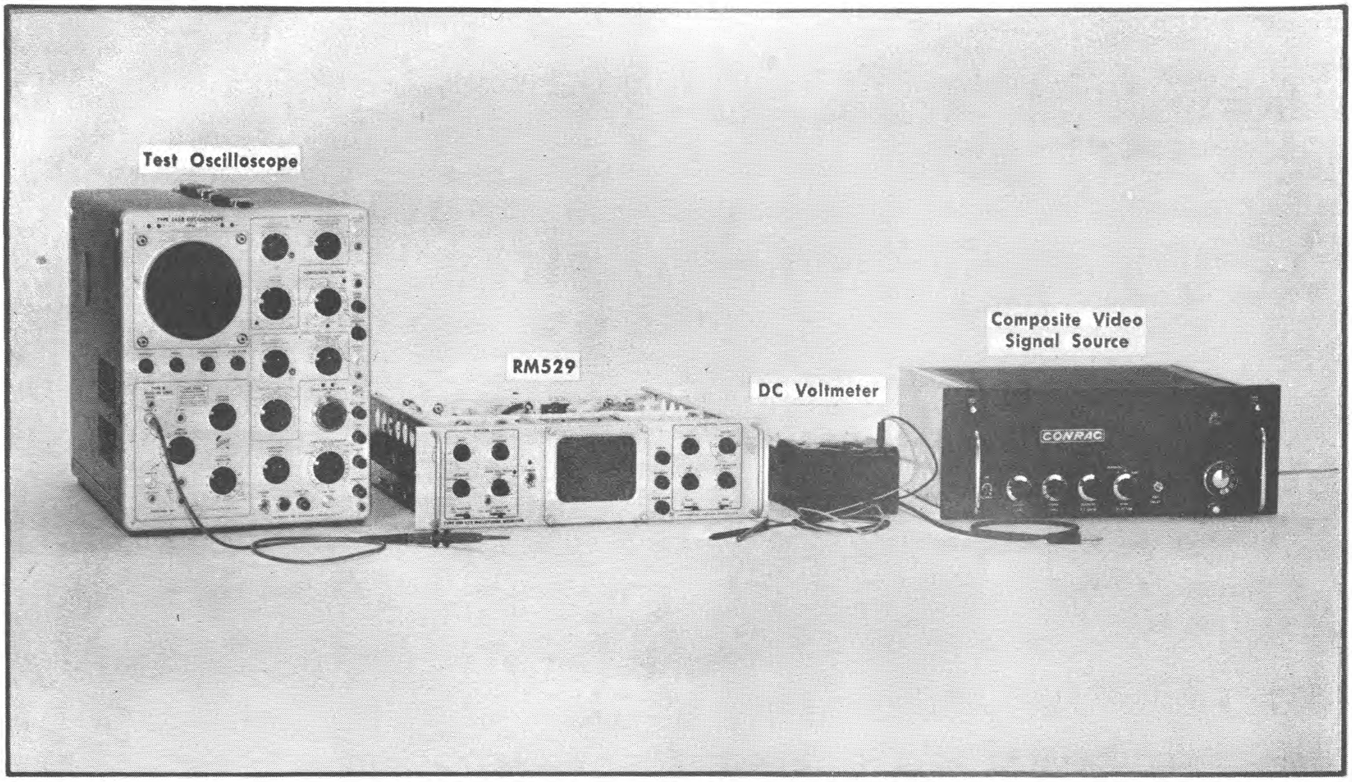


Fig. 6-29. Test equipment required for steps 22 through 24.

Control settings:

POWER	On
SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F. S.
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	LINE SELECTOR .125 H/CM
FIELD	TWO
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	21

22. Check Line Selector Brightening Pulse Amplitude

a. Test equipment setup is shown in Fig. 6-29.

b. Apply one volt of composite video to the upper VIDEO INPUTS A connector.

c. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

d. Connect a 75-ohm coaxial cable from the VIDEO OUTPUT connector of the Type RM529 to the vertical input connector of the test oscilloscope.

e. Connect a 1× probe from the appropriate Trigger Input connector of the test oscilloscope to the junction of D377 and D387 (see Fig. 6-30).

f. Set the test oscilloscope controls as follows:

Input Selector	AC
Volts/Div	0.02
Time/Div	2 ms
Triggering Mode	Adjusted for stable display
Trigger Slope	+ External

NOTE

The external triggering signal must be at the video field rate.

g. Check that the brightening pulse amplitude is at least 100 mV high.

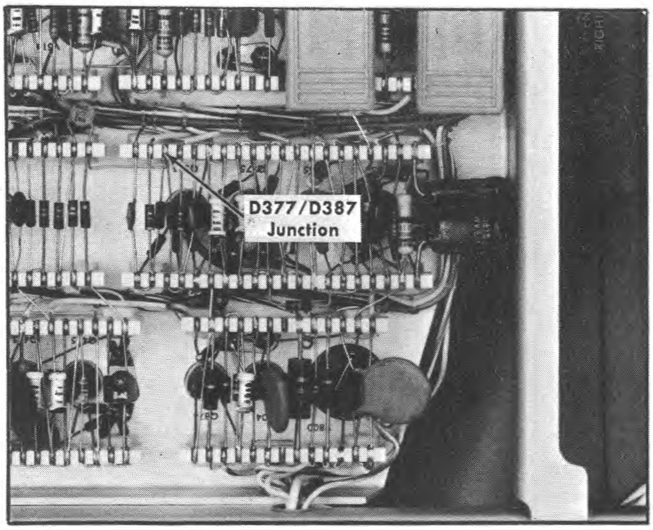


Fig. 6-30. Location of D377/D387 junction.

23. Adjust VIT LINE SEL RANGE (R458); SN 2997-up

a. Test equipment setup is given in step 22.

b. Connect a DC voltmeter between the center arm of R458 and ground.

NOTE

Before proceeding with this step, the position of the LINE SELECTOR should be checked to insure that the knob has not been misaligned.

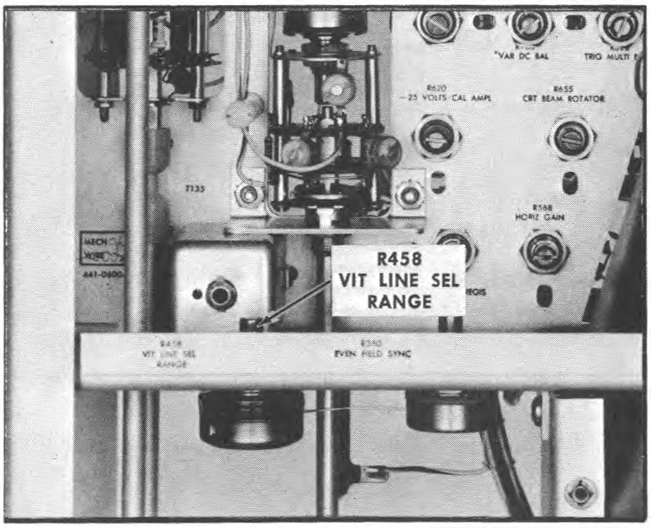


Fig. 6-31. Location of VIT LINE SEL RANGE control (R458).

c. Adjust the VIT LINE SEL RANGE control (R458; see Fig. 6-31) so the brightening pulse just starts to jump between the 21st and 22nd lines as observed on the test oscilloscope.

NOTE

LINE 10 starts at the first horizontal pulse following the last equalizing pulse in both fields (field one and two). Lines 16 through 21 can be found by counting forward from this point of reference.

d. Note the DC voltmeter reading.

e. Adjust the VIT LINE SEL RANGE control (R458) so the brightening pulse just starts to jump between the 21st and 20th lines as observed on the test oscilloscope.

f. Note the DC voltmeter reading.

g. Adjust the VIT LINE SEL RANGE control (R458) for a DC voltmeter reading halfway between the two readings noted in parts d and f of this step.

h. Disconnect the DC voltmeter.

24. Check Line Selector Operation; SN 2997-up

a. Test equipment setup is given in step 22.

b. Set the LINE SELECTOR switch to VARIABLE and rotate the VARIABLE (LINE SELECTOR) control fully counterclockwise.

c. Check the position (in time) of the brightening pulse on the test oscilloscope. The brightening pulse must start on or before the 15th line.

d. Rotate the VARIABLE (LINE SELECTOR) control fully clockwise.

e. Check the position (in time) of the brightening pulse on the test oscilloscope. The brightening pulse must start after the first 25% of the second field.

f. Set the LINE SELECTOR switch to each numbered line position.

g. Check that the brightening pulse starts at the start of the line to which the LINE SELECTOR switch is set.

h. Set the FIELD switch to ONE and repeat parts b through g.

NOTE

LINE 10 starts at the first horizontal pulse following the last equalizing pulse in both fields (field one and two). Lines 16 through 21 can then be found by counting forward from this point of reference.

i. Disconnect the composite video signal and the test oscilloscope from the Type RM529.

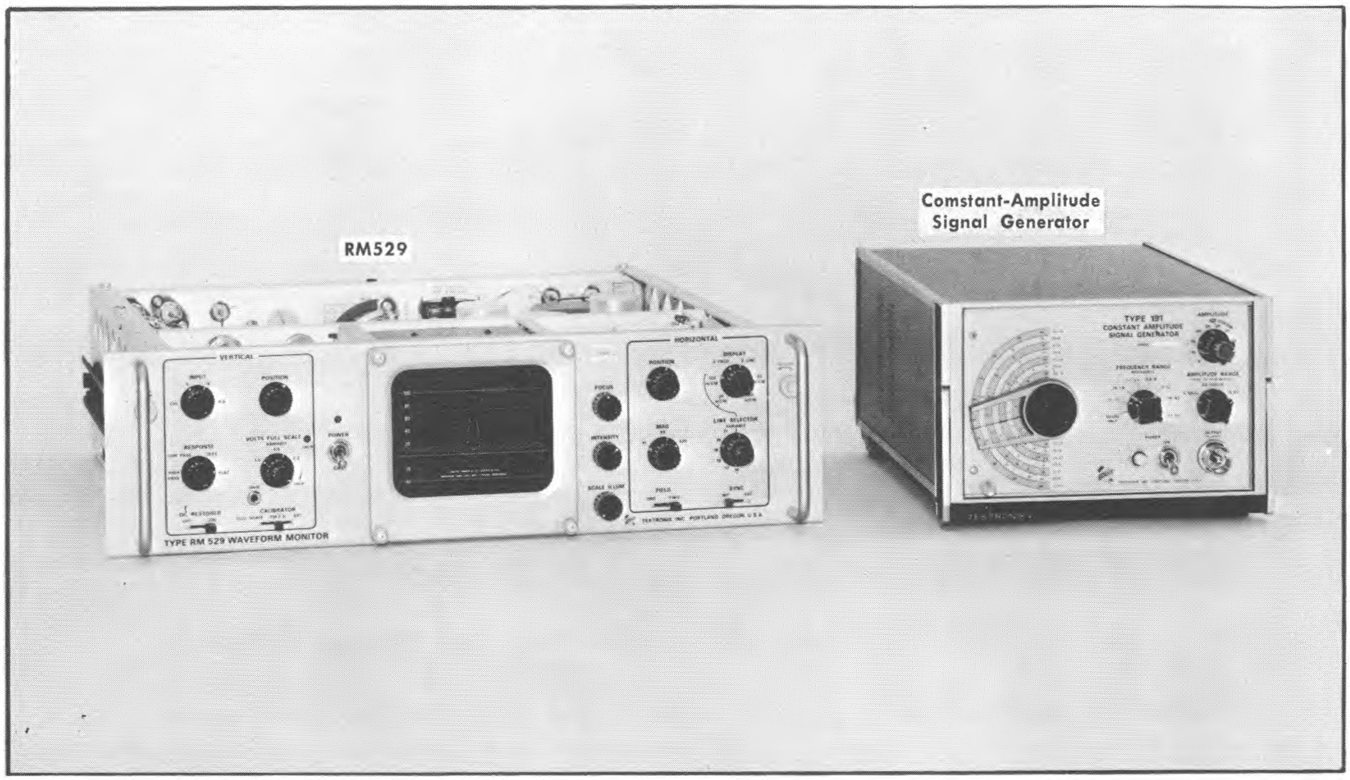


Fig. 6-32. Test equipment required for steps 25 through 30.

Control settings:

POWER	On
SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange
VERTICAL Controls	
RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F. S.
POSITION	Midrange
HORIZONTAL Controls	
POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	ONE
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

25. Check Vertical Amplifier High-Frequency Response[3]

a. Test equipment setup as shown in Fig. 6-32.

b. Apply a 50-kHz sine-wave signal from the constant amplitude sine-wave generator to the VIDEO INPUT A connector.

c. Adjust the constant amplitude sine-wave generator for 100 IEEE units of vertical deflection; this is the reference amplitude.

d. Follow the remaining sequence of instructions given in Table 6-2 to check the vertical-amplifier frequency response and rolloff for all the front-panel control positions listed.

26. Adjust Vertical-Amplifier 1.0 Flat-Frequency Response (C269, L162 and L262)

a. Test equipment setup is given in step 25.

b. Check the vertical-amplifier response from 500 kHz to 8 MHz. It should be flat within ±1% to 5 MHz, ±3% to 8 MHz.

c. Adjust the vertical amplifier components (see Fig. 6-33) as listed in Table 6-3 to obtain flat frequency response from 500 kHz to 8 MHz within ±1% to 5 MHz and flat to within ±3% to 8 MHz.

[3] An optional method of checking high-frequency response of the vertical amplifier will be found in step 33.

TABLE 6-2

Checking Vertical Amplifier Frequency Response

RESPONSE Switch Set To:	Signal[4] To: INPUT Switch Set To:	VARIABLE (VOLTS FULL SCALE) Set To:	(VERTICAL) VOLTS FULL SCALE Switch Set To:	Check or Procedure
FLAT	A	CALIB	1.0	Check the flat frequency response from 500 kHz to 8 MHz[5]; within ±1% (±0.1 dB) or 1 IEEE unit to 5 MHz, ±3% (±0.3 dB) or 3 units to 8 MHz.
			0.2	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
			0.5	
		Fully CCW	1.0	Check for flat frequency response from 500 kHz to 5 MHz[6]; within ±1% (±0.1 dB) or 1 IEEE unit.
	B	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units or reference amplitude at 50 kHz. Check for flat frequency response from 500 kHz to 8 MHz; within ±1% (±0.1 dB) to 5 MHz, ±3% (±0.3 dB) to 8 MHz.
LOW PASS	A	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz. Check for vertical deflection of 25 units or less at 500 kHz.
FLAT	A	CALIB	1.0	[7]Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
HIGH PASS	A	CALIB	1.0	Check for exactly 100 IEEE units of vertical deflection at 3.58 MHz (center frequency); 65 to 85 units at 3.18 MHz and 3.98 MHz.[8]
IEEE	A	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of vertical deflection at 50 kHz. Check high-frequency rolloff at the following points: At 350 kHz—94 to 97.5 units. At 1 MHz—70 to 80 units. At 2 MHz—31.2 to 42.5 units. At 3.6 MHz—7 to 14 units.

NOTE

Adjust C133[9] (see Fig. 6-34) so the frequency response is down approximately 1% from the response at the 5 MHz point.

TABLE 6-3

Vertical Amplifier Flat-Frequency Response Adjustments Shown in Fig. 6-33

Adjustment	Affects Frequency Response in These Frequency Ranges
[9]C133	5 to 8 MHz
C269	2 to 6 MHz, particularly at 2.5 MHz
Physical spacing of R162 and R262	3 to 6 MHz, particularly at 4 MHz
L162 and L262 Slugs	5 to 10 MHz

[4]Apply the signal to the upper VIDEO INPUT connector as indicated in the column and terminate the appropriate lower VIDEO INPUT connector with a 75-ohm termination.

[5]If frequency response cannot be obtained within the tolerance specified, perform step 26 before completing the checks given in the remaining portion of Table 6-2.

[6]If frequency response within the tolerance cannot be obtained for the 0.2 and 0.5 vertical VOLTS FULL SCALE switch position, perform step 27 for the 0.2 position and step 28 for 0.5.

[7]This is a preliminary setup procedure for performing the high-pass frequency-response check that follows.

[8]If this frequency-response characteristic cannot be met, perform step 30.

[9]Adjust C133 as part of this step only if instrument serial number is below SN 930.

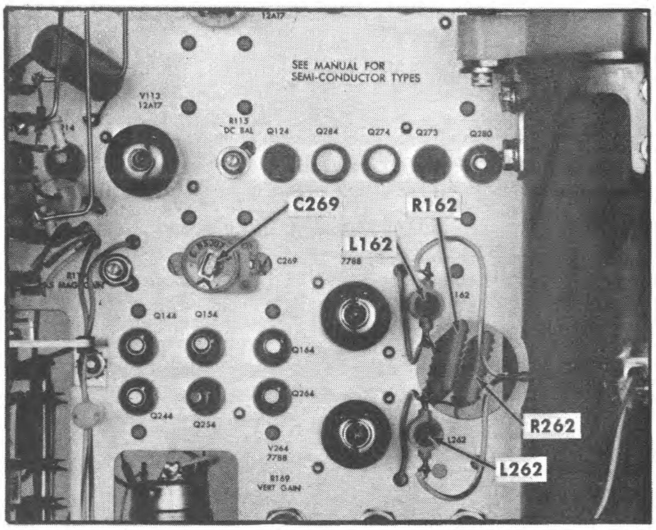


Fig. 6-33. Location of C269, R162, R262, L162 and L262.

d. Recheck the response between 500 kHz and 8 MHz at several points to determine if any of the adjustments in this step need to be readjusted to obtain the desired response.

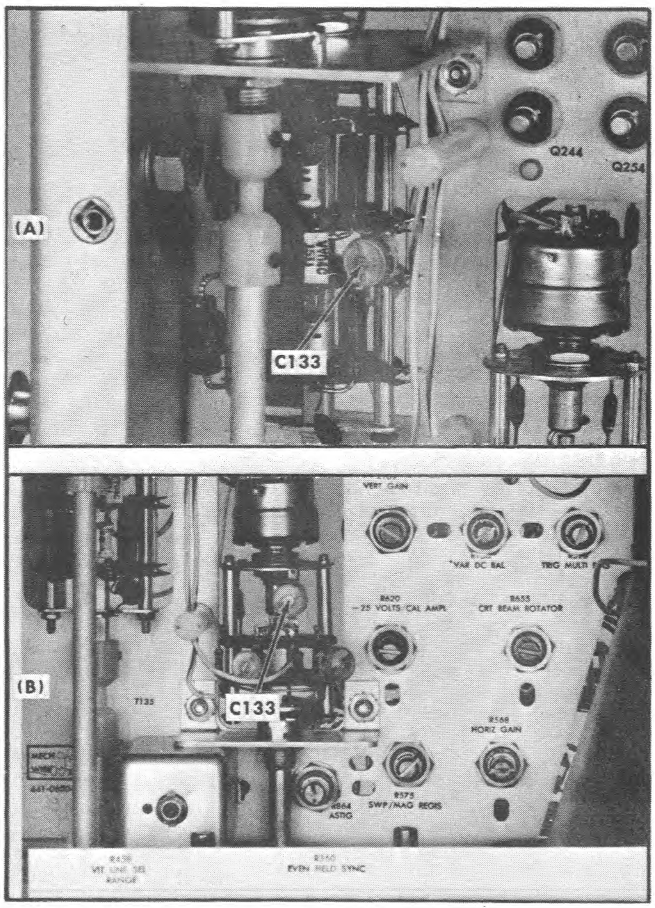


Fig. 6-34. Location of C133 (A) Vertical Response Switch SN 101-929, (B) Vertical Volts Full Scale Switch SN 930 and up.

27. Adjust Vertical-Amplifier 0.2 Flat-Frequency Response (C118B)

a. Test equipment setup is given in step 25.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.2.

c. Set the constant-amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.

d. Check for a flat-frequency response within ±1% from 500 kHz to 5 MHz.

e. Adjust C118B (see Fig. 6-35) to obtain flat-frequency response from 500 kHz to 5 MHz within ±1%.

28. Adjust Vertical-Amplifier 0.5 Flat-Frequency Response (C118C)

a. Test equipment setup is given in step 25.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

c. Set the constant-amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.

d. Check for a flat-frequency response within ±1% from 500 kHz to 5 MHz.

e. Adjust C118C (see Fig. 6-35) to obtain flat-frequency response from 500 kHz to 5 MHz within ±1%.

29. Adjust Common Mode Rejection (SN 930-up)

a. Test equipment setup is given in step 25.

b. Disconnect the constant-amplitude sine-wave generator from the A VIDEO INPUT connector.

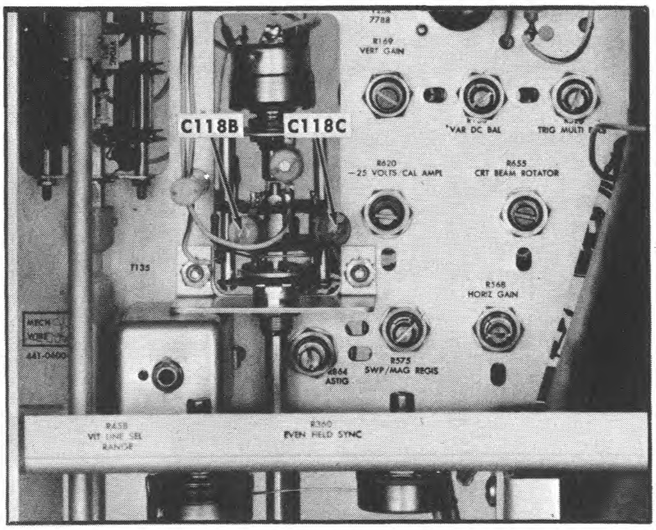


Fig. 6-35. Location of C118B and C118C adjustments.

c. To the constant-amplitude sine-wave generator 50 ohm GR to BNC termination connect a female to female BNC adapter and a BNC T connector to the female to female BNC adapter. Connect a 75-ohm coaxial cable from one end of the T connector to the upper A VIDEO INPUT connector. Connect another 75 ohm coaxial cable from the other end of the T connector to the upper B VIDEO INPUT connector.

d. Connect a 75 ohm termination to the lower B VIDEO INPUT connector.

e. Set the VOLTS FULL SCALE switch to 1.0.

f. Apply 40 IEEE units of 2 MHz signal from the constant-amplitude sine-wave generator to the Type RM529.

g. Set the INPUT switch to A-B.

h. Adjust C133 for minimum display amplitude. If desired, the VOLTS FULL SCALE switch may be set to provide a larger signal.

i. Recheck steps 25 through 28 and this step several times to eliminate any interaction.

j. Remove the female to female BNC adapter, the BNC T connector and the two 75 ohm cables. Remove the 75 ohm termination from the lower B VIDEO INPUT connector and reconnect the constant-amplitude sine-wave generator to the upper A VIDEO INPUT connector.

30. Adjust Vertical-Amplifier Chroma Frequency Response (T135)

a. Test equipment setup is given in step 25.

b. Set the RESPONSE switch to FLAT and the VOLTS FULL SCALE switch to 1.0.

c. Set the constant-amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.

d. Set the constant-amplitude sine-wave generator for an output frequency of 3.58 MHz.

e. Set the RESPONSE switch to HIGH PASS.

f. Check for 100 IEEE units of vertical deflection.

g. Adjust the bottom powdered-iron slug in T135 (see Fig. 6-36) to obtain 100 IEEE units of vertical deflection.

h. Set the constant-amplitude sine-wave generator for an output frequency of 3.18 MHz.

i. Check for 65 to 85 IEEE units of vertical deflection.

j. Adjust the top slug in T135 to obtain 65 to 85 IEEE units of vertical deflection.

k. Set the constant-amplitude sine-wave generator for an output frequency of 3.98 MHz.

l. Check that the vertical deflection of the display is 65 to 85 IEEE units in amplitude. If necessary, repeat steps d through k to obtain proper frequency response characteristics.

m. After completing the adjustment of T135 and the checks in Table 6-2, disconnect the constant-amplitude sine-wave generator from the Type RM529.

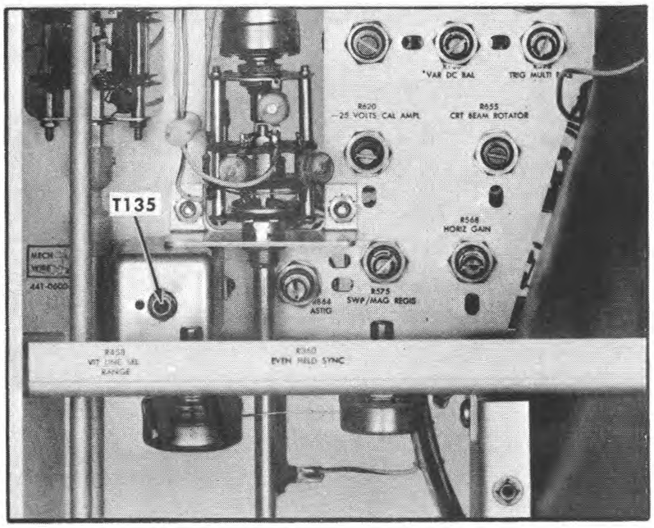


Fig. 6-36. Location of transformer T135.

NOTES

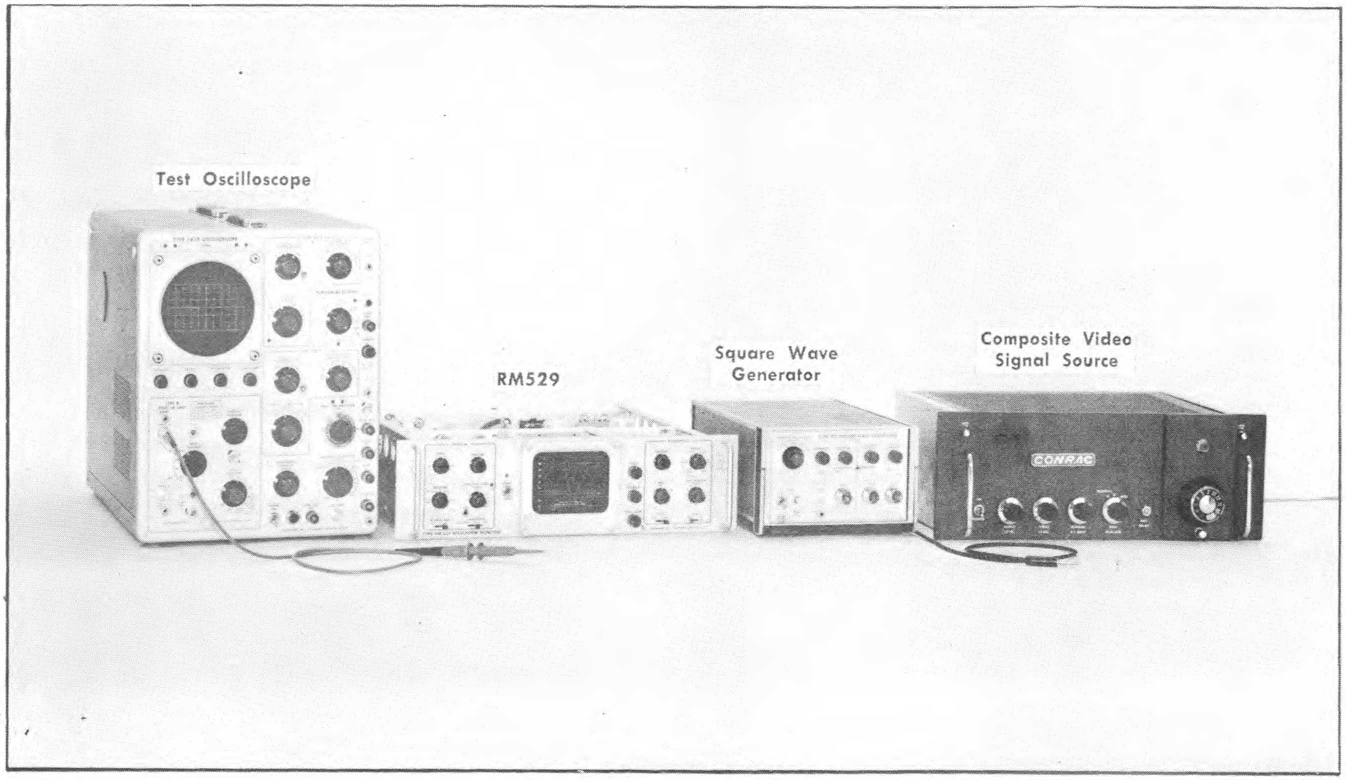


Fig. 6-37. Test equipment required for steps 31 and 32.

Control settings:

POWER	On
SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange
VERTICAL Controls	
RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F. S.
POSITION	Midrange
HORIZONTAL Controls	
POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 LINE
FIELD	ONE
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

31A. Check J501 Staircase Input (SN 787-up)

a. Test equipment setup is shown in Fig. 6-37.

b. Wire the 9-pin plug connector (Tektronix Part No. 134-0049-00) as shown in Fig. 6-38. Make sure that the 2-μF capacitor is in series between the Type RM529 J501 connector pin C

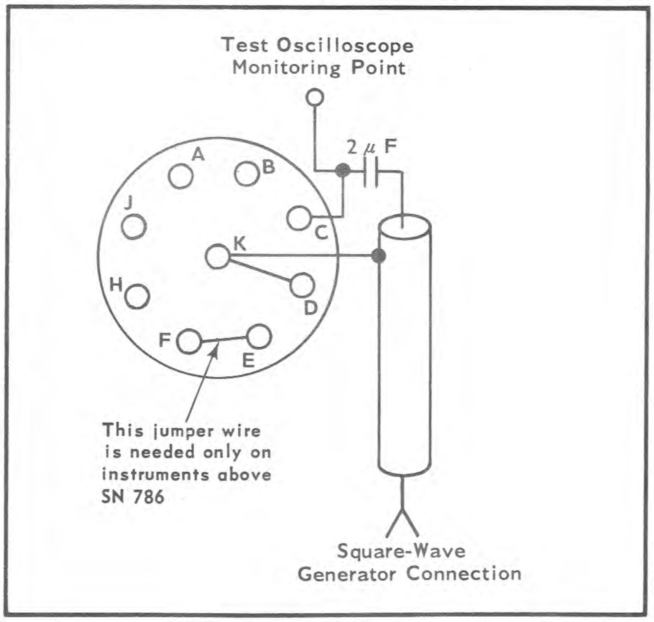


Fig. 6-38. Front view of 9-pin plug connector (Tektronix Part No. 134-0049-00) showing jumper wire connections to cause relay K385 to be energized whenever the plug is in place.

and the output of the square-wave generator.

c. Connect the plug to J501 on the Type RM529.

d. Connect a 12-volt, 120-hertz signal from a square-wave generator to pin C of the plug via the 2-μF capacitor.

e. Connect a test oscilloscope to the monitoring point to measure the output amplitude of the square-wave generator.

f. Apply one volt of composite video to the upper VIDEO INPUTS A connector.

g. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

h. Check for a display as shown in Fig. 6-39A. Note right-hand display position.

i. Reduce the signal from the square-wave generator to 8 volts.

j. Check for a display as shown in Fig. 6-39B. Note right-hand display position.

k. Reduce the signal from the square-wave generator to 4 volts.

l. Check for a display as shown in Fig. 6-39C. Note right-hand display position.

m. Check that each display had some separation from its neighbors.

31B. Check J501 Staircase Input (SN 100-786)

a. Test equipment setup is shown in Fig. 6-37.

b. Wire the 9-pin plug connector (Tektronix Part No. 134-0049-00) as shown in Fig. 6-38. Make sure that the 2-μF capacitor is in series between the Type RM529 J501 connector pin C and the output of the square-wave generator.

c. Connect the plug to J501 on the Type RM529.

d. Connect a 12-volt, 120-hertz signal from a square-wave generator to pin C of the plug via the 2-μF capacitor.

e. Connect a test oscilloscope to the monitoring point to measure the output amplitude of the square-wave generator.

f. Apply one volt of composite video to the upper VIDEO INPUTS A connector.

g. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

h. Check—For a display as shown in Fig. 6-40A. Note right-hand display position.

i. Reduce the signal from the square-wave generator to 6 volts.

j. Check—For a display as shown in Fig. 6-40B. Note right-hand display position.

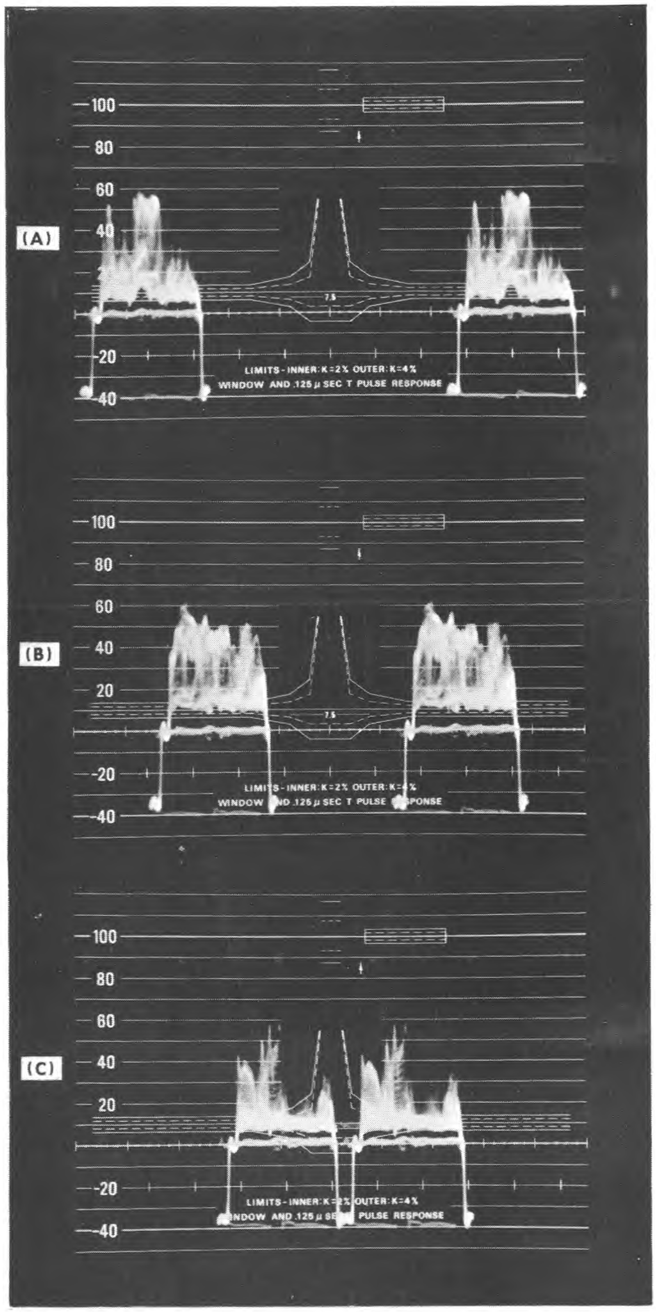


Fig. 6-39. Checking to insure that four displays per 10 centimeters can be obtained.

k. Check—That each display has some separation from its neighbors.

32. Adjust Bar Response of Pulse and Bar VIT Signal (SN 4400-up only)

a. Connect a 1-volt composite video signal to the upper A VIDEO INPUTS connector.

b. Check that a 75-ohm termination is connected to the lower A VIDEO INPUTS connector.

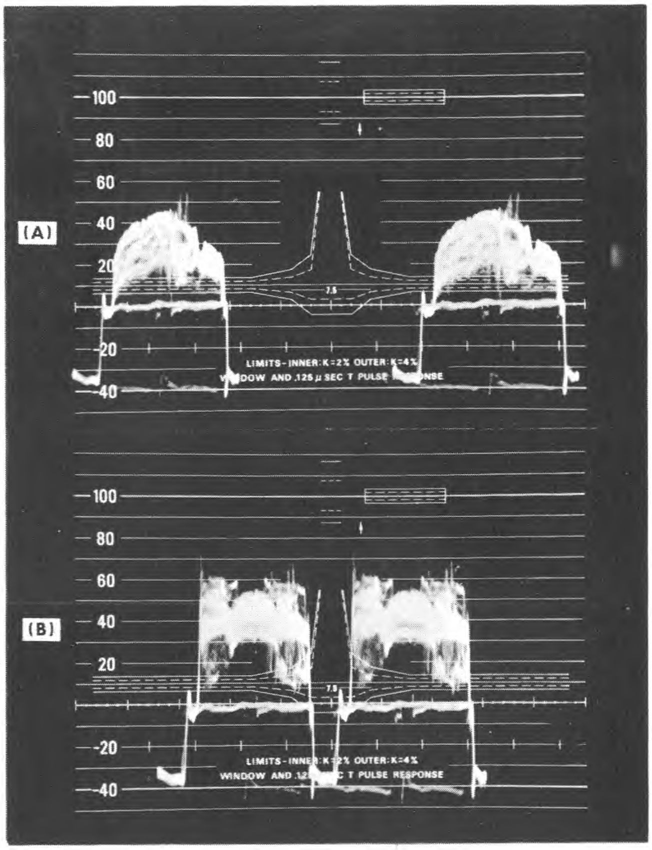


Fig. 6-40. Checking to insure that three displays per 10 centimeters can be obtained.

c. Set the Type RM529 front-panel controls as follows:

POWER	On
SCALE ILLUM	$^2/_3$ clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	As is

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE VARIABLE (VOLTS FULL SCALE)	Adjusted for 100 IEEE units of pulse and bar VIT pulse
CAL	.714 F. S.
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	LINE SELECTOR .125 H/CM
VARIABLE (LINE SELECTOR	Midrange
FIELD LINE SELECTOR switch	Set as required to obtain pulse and bar VIT signal

d. Adjust C167 (see Fig. 6-41) for optimum flat top, i.e., no tilt of bar top, of the bar portion of the pulse and bar VIT signal.

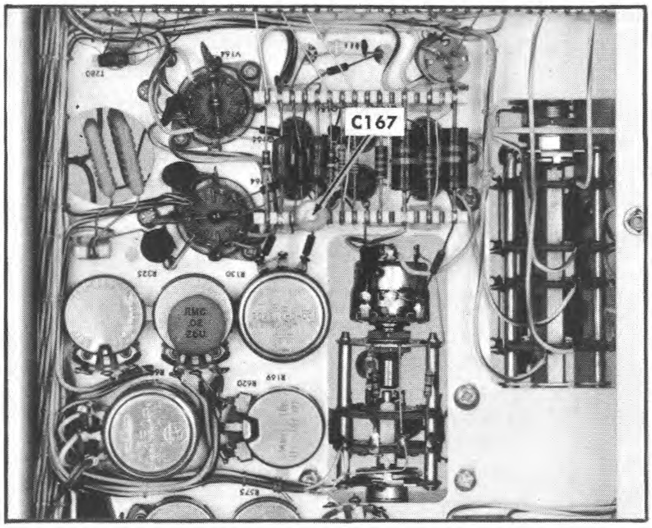


Fig. 6-41. Location of C167.

33. (Optional Method) Check Vertical Amplifier High-Frequency Response

Control settings:

POWER	On
SCALE ILLUM	$^2/_3$ clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

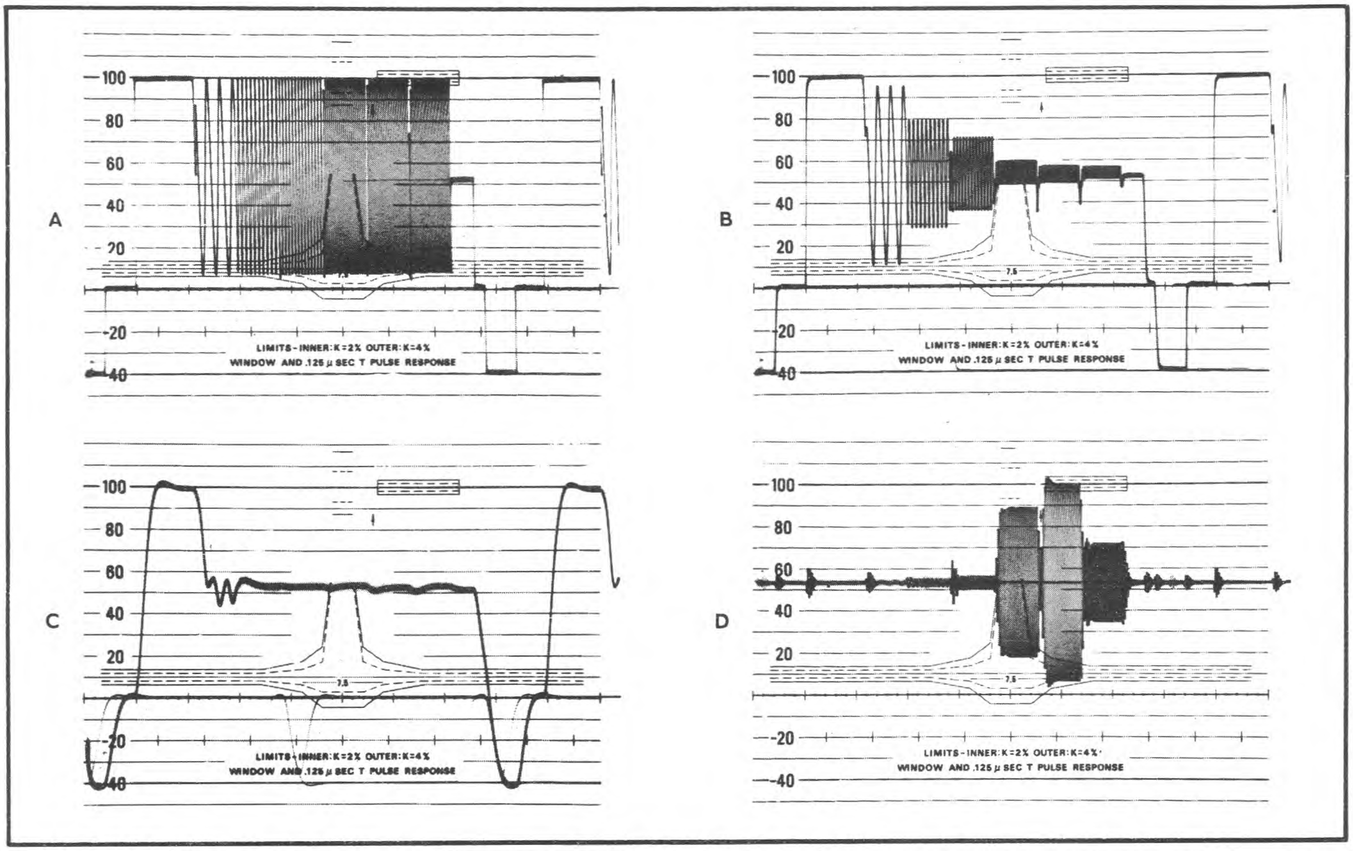


Fig. 6-42. Waveforms showing the display which will result when 1-volt of multi-burst signal is connected to the Type RM529 and the RESPONSE switch is set to (A) FLAT, (B) IEEE, (C) LOW PASS and (D) HIGH PASS.

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F. S.
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	.125 H/CM
FIELD	ONE
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR switch	VARIABLE

a. Connect to upper VIDEO INPUTS A connector 1 volt of multi-burst signal.

b. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

c. Check each position of the RESPONSE switch for the display shown in Fig. 6-42.

This completes the calibration of the Type RM529. Disconnect all test equipment. If the instrument has been completely calibrated to the tolerances given in this procedure, it will perform to the limits given in the Characteristics section of this Instruction Manual.

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
$^\circ$	degrees
$^\circ$C	degrees Celsius (degrees centigrade)
$^\circ$F	degrees Fahrenheit
$^\circ$K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geq$	equal to or greater than
$\leq$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
$+$	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

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.
	Screwdriver adjustment.
	Control, adjustment or connector.

SECTION 7
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description					S/N Range

Bulbs

Ckt. No.	Tektronix Part No.	Description		S/N Range
B242	150-030	Neon, NE-2V	CAL	
B604	150-001	Incandescent, #47	Graticule Light	
B605	150-001	Incandescent, #47	Graticule Light	
B864	150-030	Neon, NE-2V		
B865	150-030	Neon, NE-2V		
B866	150-030	Neon, NE-2V	POWER (ON)	

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description					S/N Range
C101	281-509	15 pf	Cer		500 v	10%	
C104	Use 285-623	0.47 μf	PTM		100 v		
C106	283-001	0.005 μf	Cer		500 v		
C113	Use 281-0604-00	2.2 pf	Cer		500 v	±0.25 pf	
C118B	281-061	5.5-18 pf	Cer	Var			
C118C	281-063	9-35 pf	Cer	Var			
C118D	Use 281-0509-00	15 pf	Cer		500 v	10%	
C122	283-004	0.02 μf	Cer		150 v		
C124	283-003	0.01 μf	Cer		150 v		
C130	283-0006-00	0.02 μf	Cer		500 v		X328-up
C133	281-060	2-8 pf	Cer	Var			
C134	Use 281-0629-00	33 pf	(nominal value)	Selected			
C135	281-620	21 pf	Cer		500 v	1%	
C136	283-600	43 pf	Mica		500 v	5%	
C137	281-503	8 pf	Cer		500 v	±0.5 pf	
C138	281-594	150 pf	Cer		500 v	5%	
C139	283-594	0.001 μf	Mica		100 v	1%	
C144	281-558	18 pf	Cer		500 v		
C160	283-001	0.005 μf	Cer		500 v		
C163	283-000	0.001 μf	Cer		500 v		
C165	283-001	0.005 μf	Cer		500 v		
C167	281-0063-00	9-35 pf	Cer	Var			X4400-up
C198	290-217	250 μf	EMT		12 v		
C201	281-509	15 pf	Cer		500 v	10%	
C204	Use 285-623	0.47 μf	PTM		100 v		
C206	283-001	0.005 μf	Cer		500 v		
C213	Use 281-0604-00	2.2 pf	Cer		500 v	±0.25 pf	
C236	283-600	43 pf	Mica		500 v	5%	
C237	281-503	8 pf	Cer		500 v	±0.5 pf	
C244	281-558	18 pf	Cer		500 v		
C263	283-000	0.001 μf	Cer		500 v		
C265	283-001	0.005 μf	Cer		500 v		
C267	281-512	27 pf	Cer		500 v	10%	
C269	281-012	7-45 pf	Cer	Var			
C281	283-026	0.2 μf	Cer		25 v		

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C285	281-518	47 pf	Cer	500 v		100-929
C285	281-0549-00	68 pf	Cer	500 v	10%	930-up
C286	281-518	47 pf	Cer	500 v		100-929
C286	281-0549-00	68 pf	Cer	500 v	10%	930-up
C292	283-001	0.005 μf	Cer	500 v		
C293	283-001	0.005 μf	Cer	500 v		
C294	281-523	100 pf	Cer	350 v		
C297	283-067	0.001 μf	Cer	200 v	10%	
C301	285-604	0.01 μf	PTM	400 v		100-5519
C301	285-0622-00	0.1 μf	PTM	100 v		5520-up
C302	281-0543-00	270 pf	Cer	500 v	10%	X4480-up
C303	283-0041-00	0.0033 μf	Cer	500 v	5%	X4480-up
C304	283-104	0.002 μf	Cer	500 v		100-4479
C304	283-0596-00	528 pf	Mica	300 v	1%	4480-up
C317	281-525	470 pf	Cer	500 v		100-4479
C317	213-0059-00	1 μf	Cer	25 v	+80%—20%	4480-up
C327	281-521	56 pf	Cer	500 v	10%	100-4479
C327	281-0516-00	39 pf	Cer	500 v	10%	4480-up
C335	281-623	650 pf	Cer	500 v		100-4479
C335	281-0546-00	330 pf	Cer	500 v	10%	4480-up
C341	283-000	0.001 μf	Cer	500 v		
C342	283-001	0.005 μf	Cer	500 v		
C347	281-523	100 pf	Cer	350 v		
C351	281-513	27 pf	Cer	500 v		
C360	285-598	0.01 μf	PTM	100 v	5%	100-4025
C360	283-0593-00	0.01 μf	Mica	100 v	1%	4026-4909
C360	283-0593-01	0.01 μf	Mica	100 v	5%	4910-up
C361	Use 281-0534-00	3.3 pf	Cer	500 v	±0.25 pf	
C364	283-596	528 pf	Mica	300 v	1%	
C370	281-546	330 pf	Cer	500 v	10%	
C371	283-081	0.1 μf	Cer	25 v		
C372	281-0550-00	120 pf	Cer	500 v	10%	X4026-up
C374	283-000	0.001 μf	Cer	500 v		
C375	283-000	0.001 μf	Cer	500 v		100-4025
C375	281-0550-00	120 pf	Cer	500 v	10%	4026-up
C377	283-000	0.001 μf	Cer	500 v		
C379	283-000	0.001 μf	Cer	500 v		
C384	283-000	0.001 μf	Cer	500 v		
C385	283-000	0.001 μf	Cer	500 v		100-4025
C385	281-0550-00	120 pf	Cer	500 v		4026-up
C387	283-000	0.001 μf	Cer	500 v		
C409	281-0519-00	47 pf	Cer	500 v	10%	X4480-up
C410	283-000	0.001 μf	Cer	500 v		
C414	283-001	0.005 μf	Cer	500 v		
C417	285-633	0.22 μf	PTM	100 v	10%	
C418	281-0511-00	22 pf	Cer	500 v	10%	X1910-up
C419	281-0621-00	12 pf	Cer	500 v	1%	X1910-up
C420	281-536	0.001 μf	Cer	500 v	10%	100-1909
C420	281-0546-00	330 pf	Cer	500 v	10%	1910-up
C422	283-0010-00	0.05 μf	Cer	50 v		X1910-up
C423	281-0580-00	470 pf	Cer	500 v	10%	X1910-up
C424	283-001	0.005 μf	Cer	500 v		100-1909X
C425	283-0002-00	0.01 μf	Cer	500 v		X1910-up
C427	281-621	12 pf	Cer	500 v	1%	100-1909X

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C430	281-524	150 pf	Cer		500 v		
C436	281-525	470 pf	Cer		500 v		
C452	281-550	120 pf	Cer		500 v	10%	
C455	281-523	100 pf	Cer		350 v		
C461	283-081	0.1 μf	Cer		25 v		100-2996X
C462	283-0600-00	43 pf	Mica		500 v	5%	X2997-4479
C462	281-0528-00	82 pf	Cer		500 v	10%	4480-up
C463	285-0595-00	0.1 μf	PTM		100 v		X2997-up
C464	281-0551-00	390 pf	Cer		500 v	10%	X1719-up
C465	281-519	47 pf	Cer		500 v	10%	
C470	281-551	390 pf	Cer		500 v	10%	100-2996
C470	281-0523-00	100 pf	Cer		350 v		2997-up
C477	283-096	500 pf	Cer		20000 v		100-5519
C477	281-0556-00	500 pf	Cer		10000 v		5520-up
C478	283-001	0.005 μf	Cer		500 v		
C481	281-012	7-45 pf	Cer	Var			
C482	283-519	360 pf	Mica		500 v	5%	
C483	285-595	0.1 μf	PTM		100 v	1%	
C484	Use 283-0028-00	0.0022 μf	Cer		50 v		
C501	281-0616-00	6.8 pf	Cer		200 v		X787-up
C509	281-609	1 pf	Cer		200 v	10%	100-786
C509	281-0613-00	10 pf	Cer		200 v	10%	787-up
C517	283-000	0.001 μf	Cer		500 v		
C519	281-0558-00	18 pf	Cer		500 v		X1606-1718
C519	281-0504-00	10 pf	Cer		500 v	10%	1719-up
C521	281-010	4.5-25 pf	Cer	Var			100-1605
C521	281-0546-00	330 pf	Cer		500 v	10%	1606-1718X
C522	281-0518-00	47 pf	Cer		500 v		X1606-up
C523	281-0012-00	7-45 pf	Cer	Var			X1606-up
C553	283-0000-00	0.0001 μf	Cer		500 v		X1606-1718
C553	283-0003-00	0.01 μf	Cer		150 v		1719-up
C558	285-0627-00	0.0033 μf	PTM		100 v	5%	X1606-1718X
C575	283-081	0.1 μf	Cer		25 v		100-1605
C575	283-0026-00	0.2 μf	Cer		25 v		1606-1718
C575	283-0059-00	1 μf	Cer		25 v	+80%—20%	1719-up
C579	283-079	0.01 μf	Cer		250 v		X150-up
C610	290-0122-00	1000 μf	EMC		50 v		
C617	283-002	0.01 μf	Cer		500 v		
C620	290-145	10 μf	EMT		50 v		
C626	283-003	0.01 μf	Cer		150 v		
C640	290-0180-00	300 μf	EMC		250 v		
C644	283-079	0.01 μf	Cer		250 v		
C646	283-057	0.1 μf	Cer		200 v		
C649	290-149	5 μf	EMT		150 v		
C650	290-0179-00	125 μf	EMC		250 v		100-786
C650A,B	290-0059-00	160-10 μf	EMC		350 v		787-up
C800	290-213	10 μf	EMT		450 v		
C801	283-0111-00	0.1 μf	Cer		50 v		X1600-up
C804	283-004	0.02 μf	Cer		150 v		100-205X
C822	283-036	0.0025 μf	Cer		6000 v		
C832	281-556	500 pf	Cer		10000 v		

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C834	283-006	0.02 μf	Cer	500 v		
C837	281-556	500 pf	Cer	10000 v		
C848	283-096	500 pf	Cer	20000 v		100-5519
C848	281-0556-00	500 pf	Cer	10000 v		5520-up
C849	283-006	0.02 μf	Cer	500 v		
C850	281-0543-00	270 pf	Cer	500 v	10%	X1660-up
C875	281-0513-00	27 pf	Cer	500 v		X860-up
C876	283-032	470 pf	Cer	500 v	5%	

Diodes

Ckt. No.	Tektronix Part No.	Description		S/N Range
D109	*152-0185-00	Silicon	Replaceable by 1N3605	X1606-up
D209	*152-0185-00	Silicon	Replaceable by 1N3605	X1606-up
D271	*152-075	Germanium	Tek Spec	
D272	*152-075	Germanium	Tek Spec	
D282	*152-061	Silicon	Tek Spec	
D285	*152-185	Silicon	Replaceable by 1N3605	
D286	*152-185	Silicon	Replaceable by 1N3605	
D292	*152-185	Silicon	Replaceable by 1N3605	
D293	*152-185	Silicon	Replaceable by 1N3605	
D301	*152-185	Silicon	Replaceable by 1N3605	
D304	*152-185	Silicon	Replaceable by 1N3605	
D314	*152-185	Silicon	Replaceable by 1N3605	
D315	*152-0185-00	Silicon	Replaceable by 1N3605	X5520-up
D317	*152-185	Silicon	Replaceable by 1N3605	
D318	*152-185	Silicon	Replaceable by 1N3605	
D323	*152-0185-00	Silicon	Replaceable by 1N3605	X4480-up
D333	*152-0185-00	Silicon	Replaceable by 1N3605	X4480-up
D346	*152-185	Silicon	Replaceable by 1N3605	
D351	*152-185	Silicon	Replaceable by 1N3605	X4026-up
D362	*152-185	Silicon	Replaceable by 1N3605	
D363	*152-185	Silicon	Replaceable by 1N3605	X4026-up
D368	*152-185	Silicon	Replaceable by 1N3605	
D370	*152-185	Silicon	Replaceable by 1N3605	
D371	*152-185	Silicon	Replaceable by 1N3605	
D374	*152-185	Silicon	Replaceable by 1N3605	
D377	*152-185	Silicon	Replaceable by 1N3605	
D384	*152-185	Silicon	Replaceable by 1N3605	
D387	*152-185	Silicon	Replaceable by 1N3605	
D410	*152-185	Silicon	Replaceable by 1N3605	
D411	*152-185	Silicon	Replaceable by 1N3605	
D415	*152-185	Silicon	Replaceable by 1N3605	100-1909X
D416	*152-0185-00	Silicon	Replaceable by 1N3605	X1910-up
D417	*152-0185-00	Silicon	Replaceable by 1N3605	X1910-up
D418	Use *152-0075-00	Germanium	Tek Spec	X1910-up
D420	*152-185	Silicon	Replaceable by 1N3605	100-1909X
D427	*152-185	Silicon	Replaceable by 1N3605	100-1909X
D430	*152-185	Silicon	Replaceable by 1N3605	
D436	*152-185	Silicon	Replaceable by 1N3605	
D452	*152-185	Silicon	Replaceable by 1N3605	
D455	*152-185	Silicon	Replaceable by 1N3605	

Diodes *(cont)*

Ckt. No.	Tektronix Part No.		Description	S/N Range
D456	*152-0185-00	Silicon	Replaceable by 1N3605	X2997-up
D461	*152-075	Germanium	Tek Spec	100-2996
D461	*152-0185-00	Silicon	Replaceable by 1N3605	2997-up
D462	*152-0185-00	Silicon	Replaceable by 1N3605	X2997-up
D463	*152-0075-00	Germanium	Tek Spec	X2997-up
D464	*152-075	Germanium	Tek Spec	
D466	*152-185	Silicon	Replaceable by 1N3605	
D470	152-0142-00	Zener	1N972A 0.4 w, 30 v, 10%	X2997-up
D471	*152-0061-00	Silicon	Tek Spec	X2997-up
D472	*152-0185-00	Silicon	Replaceable by 1N3605	X2997-up
D473	*152-0185-00	Silicon	Replaceable by 1N3605	X2997-up
D474	*152-061	Silicon	Tek Spec	
D475	*152-061	Silicon	Tek Spec	
D481	*152-185	Silicon	Replaceable by 1N3605	
D482	*152-185	Silicon	Replaceable by 1N3605	
D486	*152-185	Silicon	Replaceable by 1N3605	
D553	152-0142-00	Zener	1N972A 0.4 w, 30 v, 10%	X1719-up
D556	*152-0185-00	Silicon	Replaceable by 1N3605	X1606-up
D571	*152-0185-00	Silicon	Replaceable by 1N3605	X1606-up
D610	152-066	1N3194		
D611	152-066	1N3194		
D614	152-123	Zener	1N935A 0.4 w, 9.1 v, 5%	
D640A,B,C,D	152-066	1N3194		
D643	*152-0185-00	Silicon	Replaceable by 1N3605	X5179-up
D649	152-0066-00	Silicon	1N3194	X5179-up
D650A,B,C,D	152-066	1N3194		
D881	*152-185	Silicon	Replaceable by 1N3605	

Fuses

F601	159-041	1.25 Amp, 3AG, Slo-Blo, 115 v operation
F601	159-043	0.6 Amp, 3AG, Slo-Blo, 230 v operation
F637	159-031	0.4 Amp, 3AG, Slo-Blo
F648	159-030	0.3 Amp, 3AG, Fast-Blo

Relay

K385	148-024	4 PDT 24 v

Inductors

L101	*108-326	150 nh		
L137	*108-109	60 μh		
L139	*108-214	400 μh		
L159	*108-260	0.1 μh		
L162	*114-182	58-90 μh	Var	Core 276-511 (2)
L201	*108-326	150 nh		
L237	*108-109	60 μh		
L239	*108-214	400 μh		
L259	*108-260	0.1 μh		
L262	*114-182	58-90 μh	Var	Core 276-511 (2)
L655	*108-285	CRT Beam Rotator		

Transistors

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q114	*151-108	Replaceable by 2N2501	
Q124[1]	*151-154	Replaceable by 2N2924	
Q144	*151-133	Selected from 2N3251	
Q154	*151-108	Replaceable by 2N2501	
Q164	*151-127	Selected from 2N2369	
Q174	Use 151-0063-00	2N2207	
Q184	Use 151-063	2N2207	
Q193	151-080	2N706	
Q214	*151-108	Replaceable by 2N2501	
Q244	*151-133	Selected from 2N3251	
Q254	*151-108	Replaceable by 2N2501	
Q264	*151-127	Selected from 2N2369	
Q273[2]	*151-153	Replaceable by 2N2923	
Q274	Use 151-063	2N2207	
Q280	151-107	2N967	
Q284	Use 151-063	2N2207	
Q314	Use 151-063	2N2207	
Q325	Use *151-0133-00	Selected from 2N3251	
Q335	Use *151-0133-00	Selected from 2N3251	
Q344	151-041	2N1303	
Q355[3]	*151-154	Replaceable by 2N2924	100-4025
Q355	151-0190-00	2N3904	4026-up
Q365[3]	*151-154	Replaceable by 2N2924	100-4025
Q365	151-0190-00	2N3904	4026-up
Q375	151-041	2N1303	
Q385	151-041	2N1303	
Q405[2]	*151-153	Replaceable by 2N2923	
Q414	*151-151	Replaceable by 2N930	
Q415	*151-151	Replaceable by 2N930	
Q420	151-071	2N1305	100-1909
Q420	151-0063-00	2N2207	1910-up
Q455[4]	*151-155	Replaceable by 2N2925	100-2996
Q455	151-0190-00	Silicon, 2N3904	2997-up
Q465[3]	*151-154	Replaceable by 2N2924	100-2996
Q465	151-0190-00	Silicon, 2N3904	2997-up
Q474	*151-096	Selected from 2N1893	
Q481	Use *151-0103-00	Replaceable by 2N2219	
Q483	*151-155	Replaceable by 2N2925	
Q533	Use 151-0063-00	2N2207	100-1605
Q533	*151-0133-00	Selected from 2N3251	1606-up
Q544	Use 151-063	2N2207	100-1605
Q544	*151-0151-00	Replaceable by 2N930	1606-up
Q574	Use 151-063	2N2207	
Q616	*151-151	Replaceable by 2N930	
Q626	*151-151	Replaceable by 2N930	
Q634[2]	*151-153	Replaceable by 2N2923	
Q637	151-137	2N2148	
Q643[5]	151-155	Replaceable by 2N2925	

[1]151-155 may be substituted.

[2]151-154 and 151-155 may be substituted.

[3]151-153 and 151-155 may be substituted.

[4]151-154 may be substituted.

[5]151-153 and 151-154 may be substituted.

Transistors *(cont)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q644	*151-134	Replaceable by 2N2905	
Q647	*151-148	RCA 40250 Selected	
Q804	*151-136	Replaceable by 2N3053	
Q874	151-040	2N1302	100-859
Q874	Use *151-0103-00	Replaceable by 2N2219	860-up

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description					S/N Range
R101	315-100	10 Ω	¼ w			5%	
R104	Use 319-031	1 meg	¼ w		Prec	1%	
R106	316-474	470 k	¼ w				
R110	316-101	100 Ω	¼ w				
R113	316-272	2.7 k	¼ w				100-1599
R113	315-0682-00	6.8 k	¼ w			5%	1600-up
R114	321-227	2.26 k	⅛ w		Prec	1%	
R115	311-310	5 k		Var		DC BAL	100-1599
R115	311-0546-00	10 k		Var		DC BAL	1600-up
R118A	321-247	3.65 k	⅛ w		Prec	1%	
R118B	321-219	1.87 k	⅛ w		Prec	1%	
R118C	321-167	536 Ω	⅛ w		Prec	1%	
R119	311-169	100 Ω		Var		X5 MAG GAIN	
R120	321-175	649 Ω	⅛ w		Prec	1%	
R121	308-212	10 k	3 w		WW	5%	100-1599
R121	308-0334-00	7 k	3 w		WW	3%	1600-up
R122	321-271	6.49 k	⅛ w		Prec	1%	
R123	321-253	4.22 k	⅛ w		Prec	1%	100-1599
R123	321-0250-00	3.92 k	⅛ w		Prec	1%	1600-up
R130	311-224	50 k		Var		VAR DC BAL	
R131	316-273	27 k	¼ w				100-327
R131	315-0823-00	82 k	¼ w			5%	328-up
R135	321-279	7.87 k	⅛ w		Prec	1%	
R141	321-131	226 Ω	⅛ w		Prec	1%	
R143	305-153	15 k	2 w			5%	
R144	321-297	12.1 k	⅛ w		Prec	1%	
R148	301-333	33 k	½ w			5%	
R149	316-392	3.9 k	¼ w				
R154	321-213	1.62 k	⅛ w		Prec	1%	
R160	308-107	1 k	5 w		WW	5%	100-619
R160	308-0017-00	2 k	10 w		WW	5%	620-up
R162	*310-621	3 k	8 w		Prec	1%	
R163	316-104	100 k	¼ w				
R164	316-470	47 Ω	¼ w				
R166	308-077	1 k	3 w		WW		
R167	321-0335-00	30.1 k	⅛ w		Prec	1%	X4400-up
R168	315-910	91 Ω	¼ w			5%	100-929
R168	315-0750-00	75 Ω	¼ w			5%	930-up
R169	311-003	100 Ω		Var		VERT GAIN	
R172	315-112	1.1 k	¼ w			5%	
R173	304-273	27 k	2 w				
R183	316-271	270 Ω	¼ w				

Resistors *(cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R184	316-103	10 k	1/4 w				
R192	316-222	2.2 k	1/4 w				100-4259
R192	315-0242-00	2.4 k	1/4 w			5%	4260-up
R193	316-122	1.2 k	1/4 w				100-4259
R193	304-0122-00	1.2 k	1 w				4260-up
R198	301-750	75 Ω	1/2 w			5%	
R199	316-103	10 k	1/4 w				
R201	315-100	10 Ω	1/4 w			5%	
R204	Use 319-031	1 meg	1/4 w		Prec	1%	
R206	316-474	470 k	1/4 w				
R210	316-101	100 Ω	1/4 w				
R213	316-272	2.7 k	1/4 w				100-1599
R213	315-0682-00	6.8 k	1/4 w			5%	1600-up
R214	321-227	2.26 k	1/8 w		Prec	1%	
R220	321-175	649 Ω	1/8 w		Prec	1%	
R231	316-273	27 k	1/4 w				100-327
R231	315-0823-00	82 k	1/4 w			5%	328-up
R240[6]	311-506	500 Ω		Var		VARIABLE (MAG)	
R241	321-121	178 Ω	1/8 w		Prec	1%	
R242	316-224	220 k	1/4 w				
R243	305-153	15 k	2 w			5%	
R244	321-297	12.1 k	1/8 w		Prec	1%	
R245	311-016	10 k		Var		POSITION (VERT)	
R248	301-333	33 k	1/2 w			5%	
R249	316-392	3.9 k	1/4 w				
R254	321-213	1.62 k	1/8 w		Prec	1%	
R262	*310-621	3 k	8 w		Prec	1%	
R263	316-104	100 k	1/4 w				
R264	316-470	47 Ω	1/4 w				
R266	308-077	1 k	3 w		WW		
R267	316-271	270 Ω	1/4 w				
R268	315-910	91 Ω	1/4 w			5%	100-929
R268	315-0750-00	75 Ω	1/4 w			5%	930-up
R274	315-153	15 k	1/4 w			5%	
R275	315-752	7.5 k	1/4 w			5%	
R276	316-104	100 k	1/4 w				
R280	316-183	18 k	1/4 w				
R281	316-682	6.8 k	1/4 w				
R282	316-105	1 meg	1/4 w				
R283	316-151	150 Ω	1/4 w				
R284	316-150	15 Ω	1/4 w				
R285	315-104	100 k	1/4 w			5%	100-4479
R285	321-0385-00	100 k	1/8 w		Prec	1%	4480-up
R286	315-104	100 k	1/4 w			5%	100-4479
R286	321-0385-00	100 k	1/8 w		Prec	1%	4480-up
R287	315-273	27 k	1/4 w			5%	100-4479
R287	321-0328-00	25.5 k	1/8 w		Prec	1%	4480-up

[6]Furnished as a unit with SW240.

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R288	315-273	27 k	¼ w			5%	100-4479
R288	321-0328-00	25.5 k	⅛ w		Prec	1%	4480-up
R289	316-333	33 k	¼ w				
R290	315-472	4.7 k	¼ w			5%	
R292	315-224	220 k	¼ w			5%	
R293	315-224	220 k	¼ w			5%	
R296	316-101	100 Ω	¼ w				
R297	316-103	10 k	¼ w				
R298	315-472	4.7 k	¼ w			5%	
R299	315-104	100 k	¼ w			5%	
R301	301-564	560 k	½ w			5%	
R302	315-0392-00	3.9 k	¼ w			5%	X4480-up
R303	315-0223-00	22 k	¼ w			5%	X4480-up
R304	315-155	1.5 meg	¼ w			5%	
R305	316-103	10 k	¼ w				
R310	316-101	100 Ω	¼ w				
R312	315-0104-00	100 k	¼ w			5%	X4480-up
R313	316-153	15 k	¼ w				
R314	316-153	15 k	¼ w				100-4479
R314	316-0682-00	6.8 k	¼ w				4480-up
R315	316-223	22 k	¼ w				100-4479
R315	315-0333-00	33 k	¼ w			5%	4480-up
R316	316-103	10 k	¼ w				100-127X
R317	316-106	10 meg	¼ w				100-4479
R317	302-0156-00	15 meg	½ w				4480-up
R318	316-106	10 meg	¼ w				100-4479
R318	316-0103-00	10 k	¼ w				4480-up
R319	316-226	2.2 meg	¼ w				100-127
R319	316-335	3.3 meg	¼ w				128-up
R321	316-224	220 k	¼ w				100-127X
R323	301-393	39 k	½ w			5%	100-1909
R323	323-0346-00	39.2 k	½ w		Prec	1%	1910-up
R324	321-218	1.82 k	⅛ w		Prec	1%	
R325	311-369	100 k		Var		TRIG MULTI BIAS	
R326	301-393	39 k	½ w			5%	100-1909
R326	323-0414-00	200 k	½ w		Prec	1%	1910-up
R327	315-123	12 k	¼ w			5%	100-1909
R327	321-0297-00	12.1 k	⅛ w		Prec	1%	1910-up
R328	321-0387-00	105 k	⅛ w		Prec	1%	X1910-up
R329	315-0333-00	33 k	¼ w			5%	X4480-up
R333	301-393	39 k	½ w			5%	100-1909
R333	323-0346-00	39.2 k	½ w		Prec	1%	1910-up
R334	302-182	1.8 k	½ w				
R335	321-201	1.21 k	⅛ w		Prec	1%	100-4479
R335	321-0189-00	909 Ω	⅛ w		Prec	1%	4480-up
R336	315-0331-00	330 Ω	¼ w			5%	X4480-up
R341	301-682	6.8 k	½ w			5%	
R342	301-272	2.7 k	½ w			5%	
R343	315-183	18 k	¼ w			5%	
R344	302-392	3.9 k	½ w				

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R346	316-226	22 meg	¼ w				
R347	315-103	10 k	¼ w			5%	
R351	315-103	10 k	¼ w			5%	100-4025
R351	321-0289-00	10 k	⅛ w		Prec	1%	4026-up
R352	321-0397-00	133 k	⅛ w		Prec	1%	X4026-up
R354	315-683	68 k	¼ w			5%	
R355	315-103	10 k	¼ w			5%	100-4025
R355	321-0289-00	10 k	⅛ w		Prec	1%	4026-up
R358	315-243	24 k	¼ w			5%	100-4025
R358	321-0327-00	24.9 k	⅛ w		Prec	1%	4026-up
R360	311-183	500 k		Var		EVEN FIELD SYNC	
R361	316-474	470 k	¼ w				100-4025
R361	323-0612-00	950 k	½ w		Prec	1%	4026-up
R362	301-0245-00	2.4 meg	½ w			5%	X4026-up
R363	315-0223-00	22 k	¼ w			5%	X4026-up
R364	315-683	68 k	¼ w			5%	
R365	315-103	10 k	¼ w			5%	100-4025
R365	321-0333-00	28.7 k	⅛ w		Prec	1%	4026-up
R368	Use 323-0493-00	1.33 meg	½ w		Prec	1%	100-4025
R368	321-0452-00	499 k	⅛ w		Prec	1%	4026-up
R369	316-103	10 k	¼ w				100-4025
R369	301-0333-00	33 k	½ w			5%	4026-up
R371	316-336	33 meg	¼ w				
R372	Use 316-472	4.7 k	¼ w				
R373	316-0105-00	1 meg	¼ w				X4026-up
R374	315-103	10 k	¼ w			5%	
R375	316-473	47 k	¼ w				
R376	316-182	1.8 k	¼ w				
R377	316-473	47 k	¼ w				
R378	316-105	1 meg	¼ w				
R379	316-102	1 k	¼ w				
R383	316-0105-00	1 meg	¼ w				X4026-up
R384	315-103	10 k	¼ w			5%	
R385	316-473	47 k	¼ w				
R386	316-182	1.8 k	¼ w				
R387	316-473	47 k	¼ w				
R388	316-105	1 meg	¼ w				
R389	316-104	100 k	¼ w				
R404	315-154	150 k	¼ w			5%	
R405	315-123	12 k	¼ w			5%	
R406	315-154	150 k	¼ w			5%	
R409	315-0472-00	4.7 k	¼ w			5%	X4480-up
R410	316-105	1 meg	¼ w				
R414	Use 323-352	45.3 k	½ w		Prec	1%	
R415	323-302	13.7 k	½ w		Prec	1%	100-1909
R415	323-0304-00	14.3 k	½ w		Prec	1%	1910-3867
R415	323-0304-00	14.3 k	½ w	Selected (nominal value)			3868-up
R417	321-452	499 k	⅛ w		Prec	1%	
R418	323-0443-00	402 k	½ w	Selected (nominal value)			X1910-up
R419	315-472	4.7 k	¼ w			5%	

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R420	316-471	470 Ω	¼ w				100-1909X
R421	316-0471-00	470 Ω	¼ w				X1910-up
R423	316-0223-00	22 k	¼ w				X1910-up
R424	316-823	82 k	¼ w				
R425	316-0101-00	100 Ω	¼ w				X1910-up
R426	315-0563-00	56 k	¼ w			5%	X4252-up
R427	315-472	4.7 k	¼ w			5%	100-1909X
R428	323-308	15.8 k	½ w		Prec	1%	
R429	311-360	5 k		Var		DELAY	100-2996
R429	311-0360-01	5 k		Var		DELAY	2997-up
R430	316-103	10 k	¼ w				
R431	316-104	100 k	¼ w				
R436	316-102	1 k	¼ w				100-1909X
R437	316-104	100 k	¼ w				
R438	316-393	39 k	¼ w				
R445	302-0333-00	33 k	½ w				X2997-up
R448	316-0104-00	100 k	¼ w				X2997-up
R449	316-0104-00	100 k	¼ w				X2997-up
R450	315-104	100 k	¼ w			5%	
R451	315-223	22 k	¼ w			5%	
R452	315-223	22 k	¼ w			5%	
R453	303-303	30 k	1 w			5%	100-2996
R453	311-0026-00	100 k		Var			2997-up
R454	315-623	62 k	¼ w				100-2996
R454	315-0623-00	62 k	¼ w	Selected (nominal value)			2997-3459
R454	315-0563-00	56 k	¼ w	Selected (nominal value)			3460-up
R455	315-472	4.7 k	¼ w			5%	100-2996
R455	321-0258-00	4.75 k	⅛ w		Prec	1%	2997-up
R456	323-320	21 k	½ w		Prec	1%	100-2996
R456	321-0317-00	19.6 k	⅛ w		Prec		2297-up
R457	323-0393-00	121 k	½ w	Selected (nominal value)			X2997-up
R458	311-0026-00	100 k		Var			X2297-up
R460	315-0472-00	4.7 k	¼ w			5%	X4480-up
R461	316-333	33 k	¼ w				100-2996X
R461A	321-0341-00	34.8 k	⅛ w		Prec	1%	X2997-up
R461B	321-0239-00	3.01 k	⅛ w		Prec	1%	X2997-up
R461C	321-0239-00	3.01 k	⅛ w		Prec	1%	X2997-up
R461D	321-0239-00	3.01 k	⅛ w		Prec	1%	X2997-up
R461E	321-0239-00	3.01 k	⅛ w		Prec	1%	X2997-up
R461F	321-0239-00	3.01 k	⅛ w		Prec	1%	X2997-up
R461G	321-0210-00	1.5 k	⅛ w		Prec	1%	X2997-up
R462	315-0272-00	2.7 k	¼ w			5%	X2997-up
R463	315-0471-00	470 Ω	¼ w			5%	X2997-up
R464	301-433	43 k	½ w			5%	
R465	315-113	11 k	¼ w			5%	
R466	321-335	30.1 k	⅛ w		Prec	1%	
R468	301-154	150 k	½ w			5%	100-4251
R468	301-0104-00	100 k	½ w			5%	4252-5048
R468	323-0401-00	147 k	½ w		Prec	1%	5049-up
R469	301-473	47 k	½ w			5%	
R470	315-113	11 k	¼ w			5%	

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R471	316-563	56 k	¼ w				100-2996X
R472	Use 316-0334-00	330 k	¼ w				X2997-up
R473	316-0563-00	56 k	¼ w				X2997-up
R474	*310-614	41.5 k	8 w		Prec	1%	
R475	316-105	1 meg	¼ w				
R476	316-393	39 k	¼ w				
R477	302-273	27 k	½ w				
R478	316-103	10 k	¼ w				
R481	321-409	178 k	⅛ w		Prec	1%	
R482	321-350	43.2 k	⅛ w		Prec	1%	
R483	321-397	133 k	⅛ w		Prec	1%	
R484	321-379	86.6 k	⅛ w		Prec	1%	
R486	316-475	4.7 meg	¼ w				100-1718
R486	316-0334-00	330 k	¼ w			10%	1719-up
R487	316-224	220 k	¼ w				
R488	316-103	10 k	¼ w				
R489	304-183	18 k	1 w				
R491	301-752	7.5 k	½ w			5%	
R492	321-329	26.1 k	⅛ w		Prec	1%	
R493	323-0346-00	39.2 k	½ w		Prec	1%	X2997-up
R501	323-498	1.5 meg	½ w		Prec	1%	100-786
R501	323-0496-00	1.43 meg	½ w		Prec	1%	787-up
R502	321-440	374 k	⅛ w		Prec	1%	100-786
R502	321-0450-00	475 k	⅛ w		Prec	1%	787-up
R504	323-481	1 meg	½ w		Prec	1%	100-786
R504	323-0468-00	732 k	½ w		Prec	1%	787-up
R509	323-481	1 meg	½ w		Prec	1%	
R510	316-101	100 Ω	¼ w				
R514	302-223	22 k	½ w				
R516	321-368	66.5 k	⅛ w		Prec	1%	
R517	321-339	33.2 k	⅛ w		Prec	1%	100-786
R517	321-0351-00	44.2 k	⅛ w		Prec	1%	787-up
R520	323-377	82.5 k	½ w		Prec	1%	
R521	321-249	3.83 k	¼ w		Prec	1%	
R522	321-318	20 k	⅛ w		Prec	1%	100-1605
R522	321-0317-00	19.6 k	⅛ w		Prec	1%	1606-up
R523	321-389	110 k	⅛ w		Prec	1%	100-1605
R523	321-0386-00	102 k	⅛ w		Prec	1%	1606-up
R525	323-373	75 k	½ w		Prec	1%	
R533	316-224	220 k	¼ w				
R534	315-222	2.2 k	¼ w			5%	
R535	315-273	27 k	¼ w			5%	
R544	315-393	39 k	¼ w			5%	100-1605
R544	316-0274-00	270 k	¼ w				1606-up
R551	316-101	100 Ω	¼ w				
R552	315-0104-00	100 k	¼ w			5%	X1606-up
R553	315-0474-00	470 k	¼ w			5%	X1606-1718
R553	316-0102-00	1 k	¼ w				1719-up
R554	*310-614	41.5 k	8 w		Prec	1%	
R556	315-682	6.8 k	¼ w			5%	100-1605

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R556	321-0269-00	6.19 k	⅛ w		Prec		1606-up
R558	Use 322-0123-00	187 Ω	¼ w		Prec	1%	
R561	316-101	100 Ω	¼ w				
R564	*310-614	41.5 k	8 w		Prec	1%	
R566	315-682	6.8 k	¼ w			5%	100-1605
R566	321-0269-00	6.19 k	⅛ w		Prec	1%	1606-up
R568	311-178	200 Ω		Var		HORIZ GAIN	
R571	316-0473-00	47 k	¼ w				X1606-up
R574	315-393	39 k	¼ w			5%	100-1605
R574	316-0273-00	27 k	¼ w				1606-up
R575	311-178	200 Ω		Var		SWP/MAG REGIS	
R576	316-0392-00	3.9 k	¼ w				X1606-up
R579	311-360	5 k		Var		POSITION (HORIZ)	
R605	311-377	25 Ω		Var	WW	SCALE ILLUM	
R614	315-242	2.4 k	¼ w			5%	
R616	315-184	180 k	¼ w			5%	
R617	316-471	470 Ω	¼ w				
R618	315-183	18 k	¼ w			5%	
R620	311-147	10 k		Var		—25 VOLTS CAL AMPL	
R621	302-122	1.2 k	½ w				
R624	321-206	1.37 k	⅛ w		Prec	1%	
R625	315-103	10 k	¼ w			5%	
R626	321-233	2.61 k	⅛ w		Prec	1%	
R634	304-223	22 k	1 w				
R640	307-007	2.7 Ω	1 w				
R641	323-335	30.1 k	½ w		Prec	1%	
R642	321-277	7.5 k	⅛ w		Prec	1%	
R643	316-104	100 k	¼ w				
R644	316-102	1 k	¼ w				
R645	302-0103-00	10 k	½ w				X787-up
R646	316-221	220 Ω	¼ w				
R647	304-120	12 Ω	1 w				
R648	302-103	10 k	½ w				
R649	316-0221-00	220 Ω	¼ w				X5179-up
R650	307-009	4.7 Ω	1 w				
R652	302-0102-00	1 k	½ w				X787-up
R655	311-317	2 x 1 k		Var		CRT BEAM ROTATOR	
R800	302-101	100 Ω	½ w				
R801	302-0100-00	10 Ω	½ w				X1600-up
R802	316-101	100 Ω	¼ w				
R809	316-105	1 meg	¼ w				
R810	316-101	100 Ω	¼ w				
R814	311-184	1 meg		Var		VERTICAL GAIN	
R815	316-335	3.3 meg	¼ w				
R834	316-684	680 k	¼ w				
R835	311-183	500 k		Var		HIGH VOLTAGE	
R837	305-565	5.6 meg	2 w			5%	
R838	305-685	6.8 meg	2 w			5%	
R839	305-565	5.6 meg	2 w			5%	
R841	305-685	6.8 meg	2 w			5%	

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R842	305-565	5.6 meg	2 w			5%	
R843	305-685	6.8 meg	2 w			5%	
R844	311-505	10 meg		Var		FOCUS	
R845	305-685	6.8 meg	2 w			5%	
R846	311-043	2 meg		Var		INTENSITY	
R847	315-184	180 k	¼ w			5%	
R848	315-155	1.5 meg	¼ w			5%	
R849	302-155	1.5 meg	½ w				
R855	311-0183-00	500 k		Var			X5420-up
R856	315-0114-00	110 k	¼ w			5%	X5420-up
R857	315-0223-00	22 k	¼ w			5%	X5420-up
R864	311-184	1 meg		Var		ASTIG	
R865	316-334	330 k	¼ w				100-149
R865	302-824	820 k	½ w				150-619X
R866	316-336	33 meg	¼ w				100-149
R866	302-684	680 k	½ w				150-up
R867	316-0184-00	180 k	¼ w				X620-up
R874	304-273	27 k	1 w				
R875	316-393	39 k	¼ w				
R876	316-471	470 Ω	¼ w				100-859
R876	316-0152-00	1.5 k	¼ w				860-up
R881	321-327	24.9 k	⅛ w		Prec	1%	
R882	321-146	324 Ω	⅛ w		Prec	1%	
R883	321-191	953 Ω	⅛ w		Prec	1%	
R885	321-141	287 Ω	⅛ w		Prec	1%	
R886	321-179	715 Ω	⅛ w		Prec	1%	

Switches

Ckt. No.	Unwired	Wired	Description		S/N Range
SW101	260-658	*262-685	Rotary	VERTICAL INPUT	
SW118	260-654	*262-687	Rotary	VOLTS FULL SCALE	
SW135	260-655	Use *262-0686-01	Rotary	VERTICAL RESPONSE	
SW240†	311-506				
SW290	260-473		Lever	DC RESTORER	
SW305	260-473		Lever	SYNC	
SW380	Use 260-0640-00		Lever	FIELD SHIFT	
SW430	260-657	*262-688	Rotary	HORIZONTAL DISPLAY	100-2996
SW430	260-0657-00	*262-0688-01	Rotary	HORIZONTAL DISPLAY	2997-up
SW461	260-0793-00	*262-0773-00	Rotary	LINE SELECTOR	X2997-up
SW520	260-656	*262-689	Rotary	HORIZONTAL MAG	100-1605
SW520	260-0656-00	*262-0689-01	Rotary	HORIZONTAL MAG	1606-1718
SW520	260-0656-00	*262-0689-02	Rotary	HORIZONTAL MAG	1719-up
SW601	260-199		Toggle	POWER	
SW885	260-490		Lever	CALIBRATOR	

Transformers

Ckt. No.	Tektronix Part No.	Description		S/N Range
T135	120-362	RF 3.58 MC	Center frequency	
T280	*120-365	Toroid	4 windings	
T420	*120-366	Toroid	2 windings	100-1909X
T601	*120-363	Power		
T801	*120-364	High Voltage		

†Furnished as a unit with R240.

Electron Tubes

Ckt No.	Tektronix Part No.	Description		S/N Range
V113	154-0039-01	12AT7		100-4909
V113	*157-0010-00	12AT7	Checked	4910-up
V164	154-420	7788		
V264	154-420	7788		
V293	154-039	12AT7		
V514	154-0022-03	6AU6		100-4019
V514	154-0022-00	6AU6		4020-up
V554	154-187	6DJ8		
V800	154-468	6GV8		
V822	154-051	5642		
V832	154-051	5642		
V859	*154-473	T5290-31 Crt Standard Phosphor		100-5419
V859	*154-0507-00	T5290-31 Crt Standard Phosphor		5420-up

SECTION 8
PARTS LIST and DIAGRAMS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

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 including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

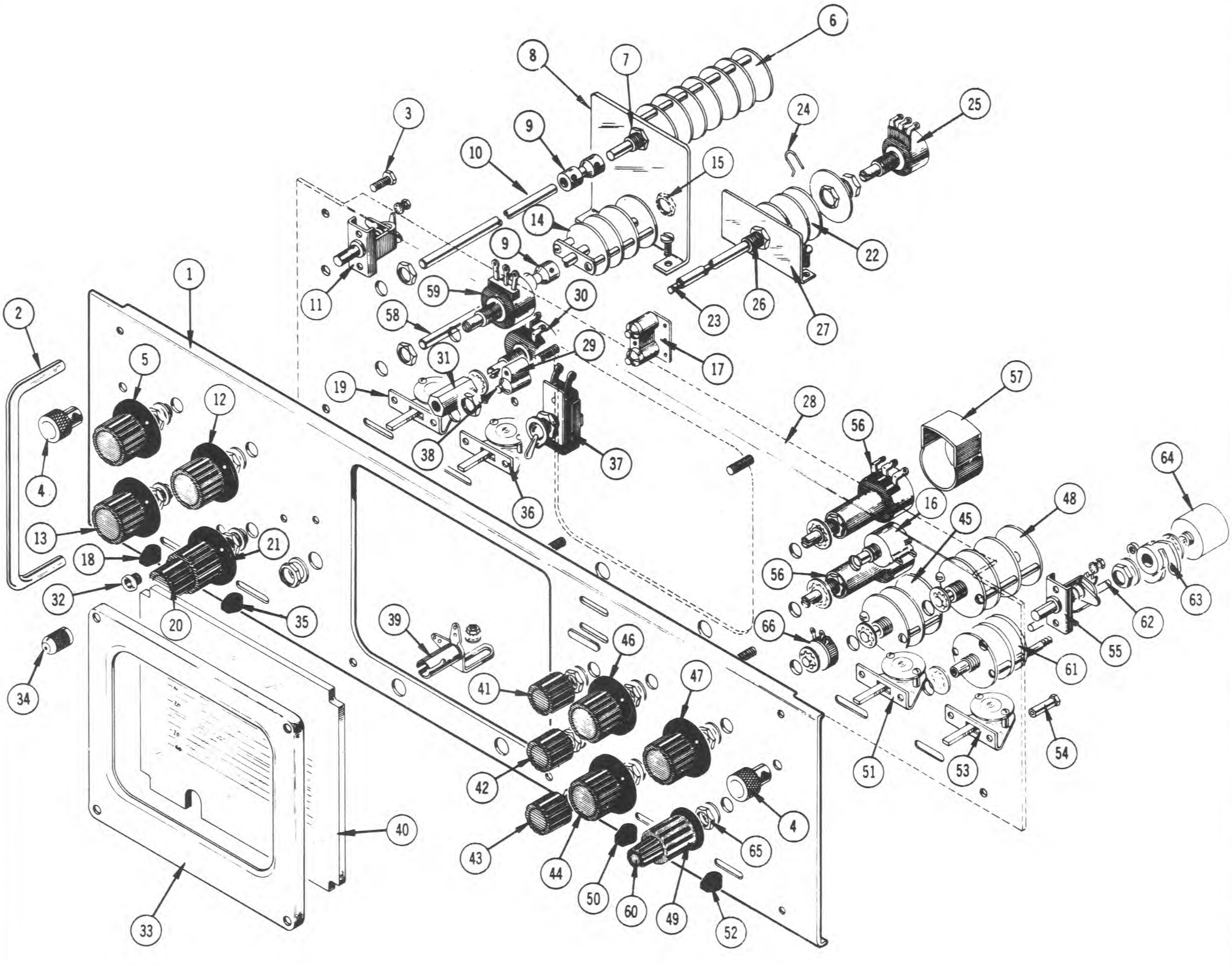
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g. or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

FRONT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FRONT

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	333-0863-00	100	399	1	PANEL, front
	333-0863-01	400	2996	1	PANEL, front
	333-0863-02	2997		1	PANEL, front
2	367-0022-00			2	HANDLE, brass rod
	- - - - - -			-	mounting hardware for each: (not included w/handle)
3	213-0090-00			2	SCREW, 10-32 x 1/2 inch, HHS
4	366-0109-00			2	KNOB, plug-in securing
	- - - - - -			-	each knob includes:
	213-0005-00			1	SCREW, set, 8-32 x 1/8 inch, HSS
5	366-0173-00			1	KNOB, charcoal—VERTICAL INPUT
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
6	262-0685-00			1	SWITCH, wired—VERTICAL INPUT (See Ref. #7)
	- - - - - -			-	switch includes:
	260-0658-00			1	SWITCH, unwired—VERTICAL INPUT
7	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
8	407-0079-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0507-00			1	SCREW, 6-32 x 5/16 inch, BHS
	211-0538-00			2	SCREW, 6-32 x 5/16 inch, FHS phillips
	210-0803-00			1	WASHER, 6L x 3/8 inch
	210-0457-00			3	NUT, keps, 6-32 x 5/16 inch
9	376-0011-00			2	COUPLING, insulating
	- - - - - -			-	each coupling includes:
	213-0048-00			2	SCREW, set, 4-40 x 1/8 inch, HSS
10	384-0342-00			1	ROD, extension
11	214-0425-00			1	FASTENER, left
	- - - - - -			-	mounting hardware: (not included w/fastener)
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
12	366-0173-00			1	KNOB, charcoal—VERTICAL POSITION
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
13	366-0173-00			1	KNOB, charcoal—VERTICAL RESPONSE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS

FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
14	262-0686-00	100	929	1	SWITCH, wired—VERTICAL RESPONSE (see ref. #15)
	262-0686-01	930		1	SWITCH, wired—VERTICAL RESPONSE (see ref. #15)
	- - - - - -			-	switch includes:
	260-0655-00			1	SWITCH, unwired—VERTICAL RESPONSE
15	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, $^3/_8$ x $^1/_2$ inch
	210-0840-00			1	WASHER, .390 ID x $^9/_{16}$ inch OD
	210-0413-00			1	NUT, hex, $^3/_8$-32 x $^1/_2$ inch
16	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0012-00			1	LOCKWASHER, internal, $^3/_8$ x $^1/_2$ inch
	210-0840-00			1	WASHER, .390 ID x $^9/_{16}$ inch OD
	210-0413-00			1	NUT, hex, $^3/_8$-32 x $^1/_2$ inch
17	352-0064-00			1	HOLDER, neon, double
	- - - - - -			-	mounting hardware: (not included w/holder)
	211-0109-00			1	SCREW, 4-40 x $^7/_8$ inch, FHS
	210-0406-00			2	NUT, hex, 4-40 x $^3/_{16}$ inch
18	366-0215-00	100	889	1	KNOB, lever—DC RESTORER
	366-0215-01	890		1	KNOB, lever—DC RESTORER
19	260-0473-00			1	SWITCH, lever—DC RESTORER
	- - - - - -			-	mounting hardware: (not included w/switch)
	220-0413-00			2	NUT, hex, rod, 4-40 x $^3/_{16}$ x .500 inch
20	366-0153-00			1	KNOB, small charcoal—VARIABLE CAL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
21	366-0175-00			1	KNOB, charcoal—VOLTS FULL SCALE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
22	262-0687-00			1	SWITCH, wired—VOLTS FULL SCALE (See Ref. #26)
	- - - - - -			-	switch includes:
	260-0654-00			1	SWITCH, unwired—VOLTS FULL SCALE
23	384-0260-00			1	ROD, extension
24	376-0014-00			1	COUPLING, pot
25	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot alone)
	210-0413-00			2	NUT, hex, $^3/_8$-32 x $^1/_2$ inch
	210-0012-00			1	LOCKWASHER, internal, $^3/_8$ x $^1/_2$ inch
26	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, $^3/_8$ x $^1/_2$ inch
	210-0840-00			1	WASHER, .390 ID x $^9/_{16}$ inch OD
	210-0413-00			1	NUT, hex, $^3/_8$-32 x $^1/_2$ inch

FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
27	407-0078-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, BHS
	210-0803-00			2	WASHER, 6L x 3/8 inch
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
28	386-0112-00			1	PLATE, front sub-panel
29	352-0067-00			2	HOLDER, neon, single
	- - - - - -			-	mounting hardware for each: (not included w/holder)
	211-0109-00			1	SCREW, 4-40 x 7/8 inch, FHS
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
30	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
31	220-0420-00			1	NUT, adapter, hex
32	358-0054-00			1	BUSHING, banana jack
33	200-0272-00			1	COVER, graticule
	- - - - - -			-	mounting hardware: (not included w/cover)
34	210-0434-00			4	NUT, graticule
35	366-0215-00	100	889	1	KNOB, lever—CALIBRATOR
	366-0215-01	890		1	KNOB, lever—CALIBRATOR
36	260-0490-00			1	SWITCH, lever—CALIBRATOR
	- - - - - -			-	mounting hardware: (not includedw/switch)
	220-0413-00			2	NUT, hex, rod, 4-40 x 3/16 x .500 inch
37	260-0199-00			1	SWITCH, toggle—POWER ON
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0414-00			1	NUT, hex, 15/32 x 9/16 inch
	354-0055-00			1	RING, locking, switch
	210-0902-00			1	WASHER, .470 ID x 21/32 inch OD
	210-0473-00			1	NUT, switch, 15/32-32 x 5/64 inch, 12 sided
38	378-0541-00			2	FILTER, lens, neon light
39	136-0112-00			2	SOCKET, graticule lamp
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	211-0534-00			1	SCREW, 6-32 x 5/16 inch, PHS w/lockwasher
	210-0803-00			1	WASHER, 6L x 3/8 inch
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch

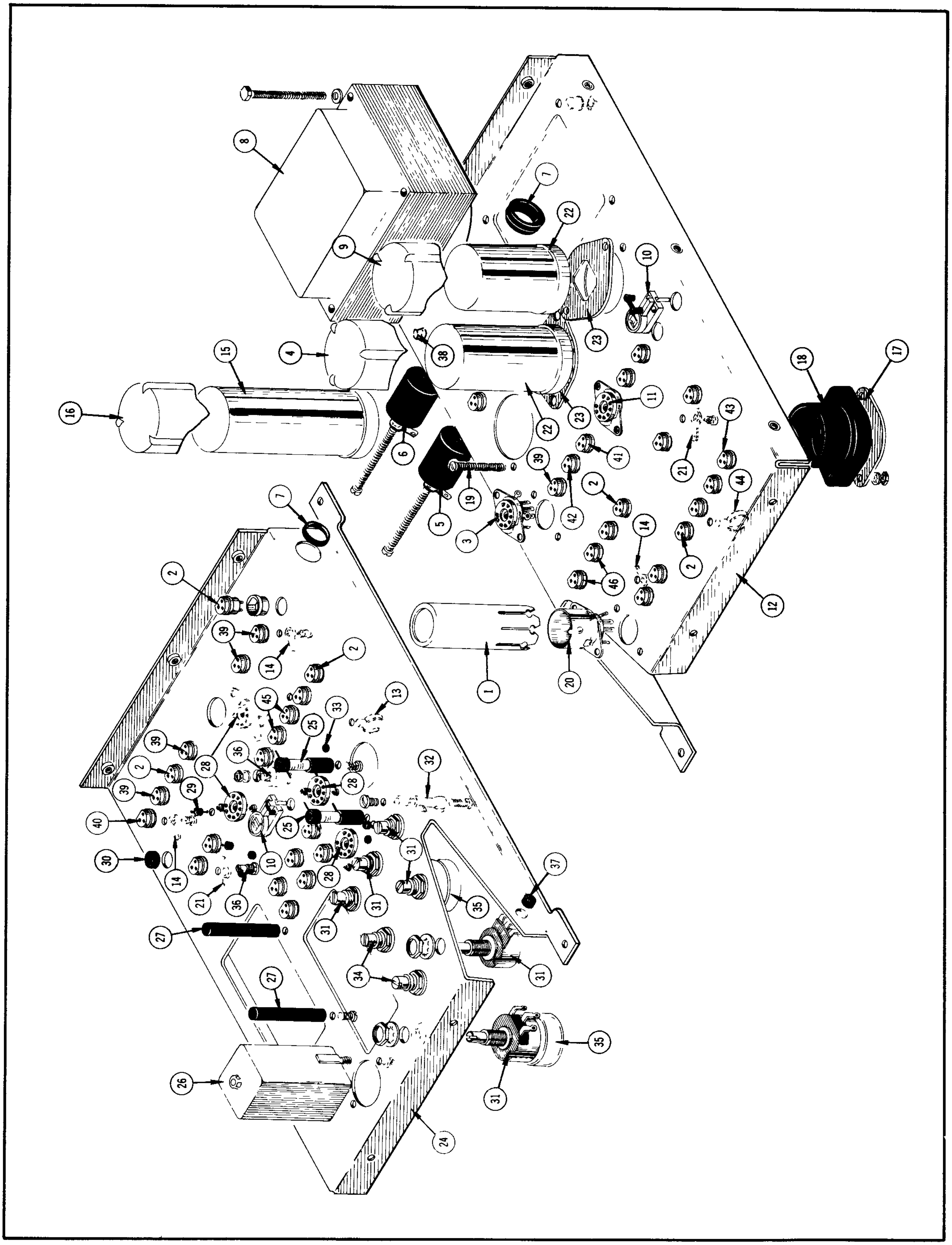
FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
40	- - - - - -			1	SEE STANDARD ACCESSORIES
41	366-0148-00			1	KNOB, small charcoal—FOCUS
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
42	366-0148-00			1	KNOB, small charcoal—INTENSITY
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
43	366-0148-00			1	KNOB, small charcoal—SCALE ILLUM
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
44	366-0173-00			1	KNOB, charcoal—HORIZONTAL MAG
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
45	262-0689-00	100	1605	1	SWITCH, wired—HORIZONTAL MAG
	262-0689-01	1606	1718	1	SWITCH, wired—HORIZONTAL MAG
	262-0689-02	1719		1	SWITCH, wired—HORIZONTAL MAG
	- - - - - -			-	switch includes:
	260-0656-00			1	SWITCH, unwired—HORIZONTAL MAG
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, $^3/_8$ x $^1/_2$ inch
	210-0840-00			1	WASHER, .390 ID x $^9/_{16}$ inch OD
	210-0413-00			1	NUT, hex, $^3/_8$-32 x $^1/_2$ inch
46	366-0173-00			1	KNOB, charcoal—HORIZONTAL POSITION
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
47	366-0173-00			1	KNOB, charcoal—HORIZONTAL DISPLAY
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
48	262-0688-00	100	2996	1	SWITCH, wired—HORIZONTAL DISPLAY
	262-0688-01	2997		1	SWITCH, wired—HORIZONTAL DISPLAY
	- - - - - -			-	switch includes:
	260-0657-00			1	SWITCH, unwired—HORIZONTAL DISPLAY
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, $^3/_8$ x $^1/_2$ inch
	210-0840-00			1	WASHER, .390 ID x $^9/_{16}$ inch OD
	210-0413-00			1	NUT, hex, $^3/_8$-32 x $^1/_2$ inch
49	366-0173-00	100	2996	1	KNOB, charcoal—LINE SELECTOR
	366-0175-00	2997		1	KNOB, charcoal—LINE SELECTOR
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
50	366-0215-00	100	889	1	KNOB, lever—FIELD SHIFT
	366-0215-01	890		1	KNOB, lever—FIELD SHIFT
51	260-0473-00	100	2996	1	SWITCH, lever—FIELD SHIFT
	260-0640-00	2997		1	SWITCH, lever—FIELD SHIFT
	- - - - - -			-	mounting hardware: (not included w/switch)
	220-0413-00			2	NUT, hex, rod, 4-40 x $^3/_{16}$ x .500 inch

FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	Q T Y.	DESCRIPTION
52	366-0215-00	100	889	1	KNOB, lever—SYNC
	366-0215-01	890		1	KNOB, lever—SYNC
53	260-0473-00			1	SWITCH, lever—SYNC
	- - - - - -			-	mounting hardware: (not included w/switch)
54	220-0413-00			2	NUT, hex, rod, 4-40 x 3/16 x .500 inch
55	214-0424-00			1	FASTENER, right
	- - - - - -			-	mounting hardware: (not included w/fastener)
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
56	- - - - - -			2	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0013-00			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
57	200-0269-00			2	COVER, pot
58	384-0030-00			1	ROD, extension
59	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0207-00	X150		1	LUG, solder, 3/8 inch
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
60	366-0153-00	X2997		1	KNOB, charcoal—VARIABLE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
61	262-0773-00	X2997		1	SWITCH, wired—LINE SELECTOR
	- - - - - -			-	switch includes:
	260-0793-00			1	SWITCH, unwired—LINE SELECTOR
62	384-0408-00			1	ROD, extension
63	426-0289-00			1	MOUNT, plastic
	- - - - - -			-	mounting hardware: (not included w/mount)
	210-0801-00			2	WASHER, flat, 5s x 9/32 inch
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
64	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
65	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
66	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0590-00			1	NUT, hex., 3/8-32 x 7/16 inch
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

CHASSIS



CHASSIS

REF. NO	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	337-0491-00			1	SHIELD, tube
2	136-0181-00			30	SOCKET, 3 pin transistor
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket
3	136-0014-00			1	SOCKET, STM9
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread cutting, 5-32 x $^3/_{16}$ inch PHS phillips
4	200-0293-00			1	COVER, capacitor, $2^9/_{16}$ inches
5	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
	211-0503-00	100	1659	1	SCREW, 6-32 x $^3/_{16}$ inch BHS
	211-0587-00	1660		1	SCREW, 6-32 x $^3/_{16}$ inch HSS
	210-0202-00	100	1659	1	LUG, solder, SE #6
	210-0261-00	1660		2	LUG, solder, high voltage
	210-0006-00			1	LOCKWASHER, internal, #6
	211-0504-00			1	SCREW, 6-32 x $^1/_4$ inch BHS
6	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
	211-0503-00	100	1659	1	SCREW, 6-32 x $^3/_{16}$ inch BHS
	211-0587-00	1660		1	SCREW, 6-32 x $^3/_{16}$ inch HSS
	210-0202-00	100	1659	2	LUG, solder, SE #6
	210-0261-00	1660		2	LUG, solder, high voltage
	210-0935-00			2	WASHER, fiber, .140 ID x .375 inch OD
	211-0507-00			1	SCREW, 6-32 x $^5/_{16}$ inch BHS
7	358-0166-00			2	BUSHING, black plastic
8	- - - - - -			1	TRANSFORMER
	- - - - - -			-	transformer includes:
	212-0515-00			4	SCREW, 10-32 x $2^1/_4$ inches HHS
	210-0812-00			4	WASHER, fiber, #10
	220-0410-00			4	NUT, keps, 10-32 x $^3/_8$ inch
9	200-0260-00	100	786	1	COVER, capacitor, $2^1/_{32}$ inches
	200-0258-00	787		1	COVER, capacitor, $3^1/_{32}$ inches
10	- - - - - -			2	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
	214-0153-00			1	FASTENER, snap, double pronged
11	136-0007-00			1	SOCKET, STM7
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread cutting, 5-32 x $^3/_{16}$ inch PHS phillips
12	441-0599-00			1	CHASSIS, horizontal
	- - - - - -			-	mounting hardware: (not included w/chassis)
	212-0004-00			5	SCREW, 8-32 x $^5/_{16}$ inch BHS
	212-0070-00			5	SCREW, 8-32 x $^5/_{16}$ inch FHS phillips
	210-0458-00			2	NUT, keps, 8-32 x $^{11}/_{32}$ inch
13	426-0121-00			1	MOUNT, toroid
	- - - - - -			-	mounting hardware: (not included w/mount)
	361-0007-00			1	SPACER, nylon, .063 inch

CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	Q T Y.	DESCRIPTION
14	210-0201-00			12	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread cutting, 5-32 x $^{3}/_{16}$ inch PHS phillips
15	- - - - - -			1	CAPACITOR (see Ref #19)
	- - - - - -			-	capacitor includes:
16	200-0293-00			1	COVER, capacitor
17	386-0254-00			1	PLATE, fiber, large capacitor
18	432-0048-00			1	BASE, large capacitor
19	- - - - - -			-	mounting hardware: (not included w/capacitor)
	211-0516-00			2	SCREW, 6-32 x $^{7}/_{8}$ inch BHS
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x $^{1}/_{4}$ inch
20	136-0022-00			1	SOCKET, STM9S
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread cutting, 5-32 x $^{3}/_{16}$ inch PHS phillips
21	210-0204-00			3	LUG, solder, DE #6
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread cutting, 5-32 x $^{3}/_{16}$ inch PHS phillips
22	- - - - - -			2	CAPACITOR
	- - - - - -			-	each capacitor includes:
23	386-0254-00			1	PLATE, fiber, large capacitor
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
	211-0543-00			2	SCREW, 6-32 x $^{5}/_{16}$ inch RHS
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x $^{1}/_{4}$ inch
24	441-0600-00			1	CHASSIS, vertical
	- - - - - -			-	mounting hardware for each: (not included w/chassis)
	212-0004-00			5	SCREW, 8-32 x $^{5}/_{16}$ inch BHS
	212-0070-00			5	SCREW, 8-32 x $^{5}/_{16}$ inch FHS phillips
	210-0458-00			2	NUT, keps, 8-32 x $^{11}/_{32}$ inch
25	- - - - -			2	COIL
	- - - - -			-	mounting hardware for each: (not included w/coil)
	213-0054-00			1	SCREW, thread cutting, 6-32 x $^{5}/_{16}$ inch PHS phillips
26	- - - - -			1	COIL
	- - - - -				mounting hardware: (not included w/coil)
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x $^{1}/_{4}$ inch
27	385-0138-00			2	ROD, delrin, $1^{5}/_{8}$ inches
	- - - - -			-	mounting hardware for each: (not included w/rod)
	211-0507-00			1	SCREW, 6-32 x $^{5}/_{16}$ inch BHS

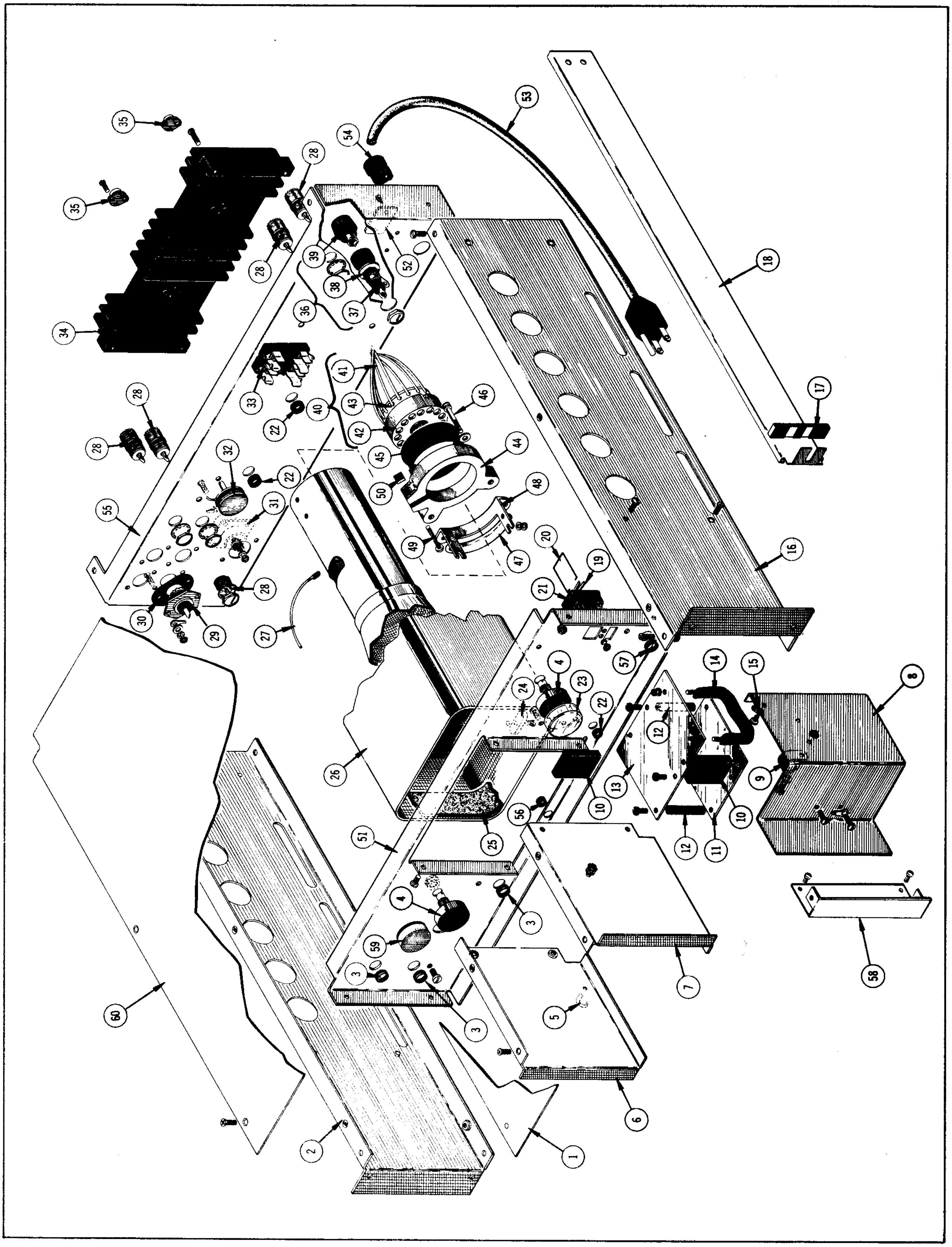
CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC	Q T Y.	DESCRIPTION
28	136-0015-00			4	SOCKET, STM9G
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0044-00			2	SCREW, thread cutting, 5-32 x 3/16 inch PHS phillips
29	131-0183-00			2	CONNECTOR, terminal feed-through
	- - - - -			-	mounting hardware for each: (not included w/connector)
	358-0136-00			1	BUSHING, teflon
30	348-0056-00			1	GROMMET, plastic, 3/8 inch
31	- - - - - -			6	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
32	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included w/resistor)
	211-0544-00	100	619	1	SCREW, 6-32 x 3/4 inch THS phillips
	211-0553-00	620		1	SCREW, 6-32 x 1 1/2 inches RHS phillips
	210-0601-00	X620		1	EYELET, brass
	210-0478-00			1	NUT, hex, resistor mounting
	211-0507-00			1	SCREW, 6-32 x 5/16 inch BHS
33	348-0031-00			5	GROMMET, snap-in
34	- - - - - -			2	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0046-00			1	LOCKWASHER, internal, .400 OD x .261 inch ID
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
35	200-0247-00	100	149X	3	CAP, pot
36	- - - - - -			2	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0207-00			1	LUG, solder, 3/8 inch
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
37	348-0055-00			1	GROMMET, plastic, 1/4 inch
38	200-0385-00	X150	4849X	1	COVER, transistor
39	136-0181-00	100	149	5	SOCKET, 3 pin transistor
	136-0182-00	150		5	SOCKET, 4 pin transistor
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket

CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	Q T Y.	DESCRIPTION
40	136-0181-00	100	559	1	SOCKET, 3 pin transistor
	136-0182-00	560		1	SOCKET, 4 pin transistor
	- - - - - -			-	mounting hardware: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket
41	136-0181-00	100	559	1	SOCKET, 3 pin transistor
	136-0182-00	560	1605	1	SOCKET, 4 pin transistor
	136-0181-00	1606		1	SOCKET, 3 pin transistor
	- - - - - -			-	mounting hardware: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket
42	136-0181-00	100	149	1	SOCKET, 3 pin transistor
	136-0182-00	150	1605	1	SOCKET, 4 pin transistor
	136-0181-00	1606		1	SOCKET, 3 pin transistor
	- - - - - -			-	mounting hardware: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket
43	136-0181-00	100	1909	1	SOCKET, 3 pin transistor
	136-0182-00	1910		1	SOCKET, 4 pin transistor
	- - - - - -			-	mounting hardware: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket
44	426-0121-00	100	1909X	1	MOUNT, toroid
	- - - - - -			-	mounting hardware: (not included w/mount)
	361-0007-00			1	SPACER, nylon, 0.063 inch
45	136-0181-00	100	149	2	SOCKET, 3 pin transistor
	136-0182-00	150	1909	2	SOCKET, 4 pin transistor
	136-0181-00	1910		2	SOCKET, 3 pin transistor
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket
46	136-0181-00	100	4025	2	SOCKET, 3 pin transistor
	136-0182-00	4026		2	SOCKET, 4 pin transistor
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket

REAR



REAR

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	Q T Y.	DESCRIPTION
1	386-0108-00			1	PLATE, dust cover, bottom
	- - - - - -			-	mounting hardware for each: (not included w/plate)
	211-0504-00			6	SCREW, 6-32 x 1/4 inch BHS
2	386-0109-00			1	PLATE, left side
	- - - - - -			-	mounting hardware: (not included w/plate)
	212-0004-00			3	SCREW, 8-32 x 5/16 inch BHS
	212-0070-00			6	SCREW, 8-32 x 5/16 inch FHS
	210-0458-00			9	NUT, keps, 8-32 x 11/32 inch
3	348-0063-00			3	GROMMET, plastic, 1/2 inch
4	- - - - - -	100	5419	2	POT
	- - - - - -	5420		3	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
5	343-0089-00			2	CLAMP, cable
6	407-0081-00			1	BRACKET, crt shield, left
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0538-00			2	SCREW, 6-32 x 5/16 inch FHS
	212-0004-00			2	SCREW, 8-32 x 5/16 inch BHS
	212-0070-00			2	SCREW, 8-32 x 5/16 inch FHS
	210-0458-00			2	NUT, keps, ,8-32 x 11/32 inch
7	407-0080-00			1	BRACKET, crt shield, right
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0538-00			2	SCREW, 8-32 x 5/16 inch FHS
	212-0004-00			2	SCREW, 8-32 x 5/16 inch BHS
	212-0070-00			2	SCREW, 6-32 x 5/15 inch FHS
	210-0458-00			2	NUT, keps, 8-32 x 11/32 inch
8	407-0077-00	100	2996	1	BRACKET, high voltage
	407-0077-01	2997		1	BRACKET, high voltage
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch BHS
	210-0963-00	X2997		2	WASHER, plastic, 0.254 ID x 0.500 inch OD
9	343-0014-00			1	CLAMP, cable, 1 inch
	- - - - - -			-	mounting hardware: (not included w/clamp)
	211-0510-00			1	SCREW, 6-32 x 3/8 inch BHS
	210-0803-00			1	WASHER, 6L x 3/8 inch
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
10	361-0083-00			2	SPACER, high voltage
	- - - - - -			-	mounting hardware for each: (not included w/spacer)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch BHS
11	392-0167-00			1	BOARD, focus & intensity
	- - - - - -			-	mounting hardware: (not included w/board)
	211-0558-00			6	SCREW, 6-32 x 1/4 inch BHS nylon

REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	Q T Y.	DESCRIPTION
12	385-0018-00			2	ROD, nylon
13	392-0166-00			1	BOARD, rectifier
	- - - - - -			-	mounting hardware: (not included w/board)
	211-0558-00			6	SCREW, 6-32 x 1/4 inch BH nylon
14	346-0001-00			1	STRAP, mounting, high voltage transformer
	- - - - - -			-	mounting hardware: (not included w/strap)
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
15	210-0201-00			1	LUG, solder, SE #4
	- - - - - -			-	mounting hardware: (not included w/lug)
	213-0044-00			1	SCREW, thread cutting, 5-32 x 3/16 inch PHS phillips
16	386-0111-00			1	PLATE, right side
	- - - - - -			-	mounting hardware: (not included w/plate)
	212-0004-00			3	SCREW, 8-32 x 5/16 inch BHS
	212-0070-00			6	SCREW, 8-32 x 5/16 inch FHS phillips
	210-0458-00			9	NUT, keps, 8-32 x 11/32 inch
17	- - - - - -			2	SEE STANDARD ACCESSORIES
18	351-0040-00	100	1729	1	SLIDE, chassis track, slide & guide, 1 pair (w/mounting hardware)
	351-0040-01	1730		1	TRACK, guide, 1 pair (w/mounting hardware)
19	214-0538-00			1	SPRING, ground wire
20	214-0539-00			1	SPRING, retainer wire
21	136-0215-00			1	SOCKET, relay
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0008-00			1	SCREW, 4-40 x 1/4 inch BHS
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0406-00			1	NUT, hex, 4-40 x 3/16 inch
22	348-0056-00			4	GROMMET, plastic, 3/8 inch
23	200-0247-00	100	149X	1	CAP, pot
24	352-0044-00			1	HOLDER, crt coil form
	- - - - - -			-	mounting hardware: (not included w/holder)
	211-0011-00			1	SCREW, 4-40 x 5/16 inch BHS
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0406-00			1	NUT, hex, 4-40 x 3/16 inch
25	124-0167-00			1	STRIP, crt shield
26	337-0725-00			1	SHIELD, crt
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0534-00			7	SCREW, 6-32 x 5/16 inch PHS w/lockwasher
	210-0803-00			7	WASHER, 6L x 3/8 inch
	210-0457-00			7	NUT, keps, 6-32 x 5/16 inch
27	175-0585-00			1	WIRE, crt lead, .290 foot, striped brown, w/connector
	175-0588-00	100	149X	1	WIRE, crt lead, .833 foot, striped orange, w/connector
	175-0592-00			1	WIRE, crt lead, .960 foot, striped green, w/connector
	175-0593-00			1	WIRE, crt lead, .333 foot, striped blue, w/connector
	175-0595-00			1	WIRE, crt lead, .960 foot, striped red, w/connector

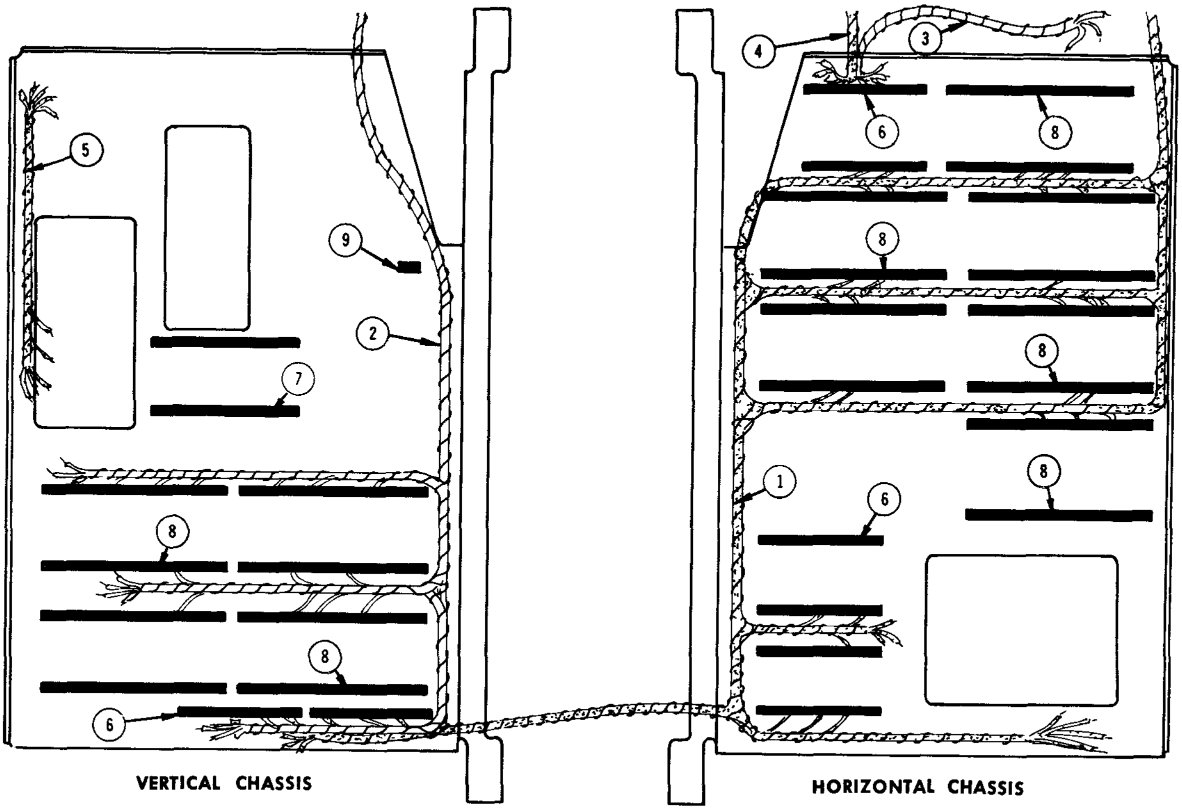
REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
28	131-0081-00			5	CONNECTOR, coaxial, 1 contact, UHF
29	131-0064-00			4	CONNECTOR, coaxial, 1 contact, UHF
	- - - - - -			-	mounting hardware for each: (not included w/connector)
	211-0025-00			2	SCREW, 4-40 x 3/8 inch, FHS
	210-0224-00			1	LUG, solder, #10
	210-0812-00			2	WASHER, fiber, #10
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
30	406-0244-00			1	BRACKET, coaxial insulator
31	136-0089-00			1	SOCKET, 9 pin w/female insert
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0011-00			4	SCREW, 4-40 x 5/16 inch, BHS
	210-0004-00			3	LOCKWASHER, internal, #4
	210-0201-00			1	LUG, solder, SE #4
	210-0406-00			4	NUT, hex, 4-40 x 3/16 inch
32	214-0210-00			1	SPOOL, solder, assembly
	- - - - - -			-	spool assembly includes:
	214-0209-00			1	SPOOL, solder
	- - - - - -			-	mounting hardware: (not included w/spool)
	361-0007-00			1	SPACER, nylon, .063 inch
33	352-0025-00			1	HOLDER, fuse, dual
	- - - - - -			-	mounting hardware: (not included w/holder)
	211-0510-00			2	SCREW, 6-32 x 3/8 inch, BHS
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
34	214-0517-00			1	HEAT SINK
	- - - - - -			-	mounting hardware: (not included w/heat sink)
	212-0033-00			4	SCREW, 8-32 x 3/4 inch, BHS
	210-0458-00			4	NUT, keps, 8-32 x 11/32 inch
35	- - - - - -			2	TRANSISTOR
	- - - - - -			-	mounting hardware for each: (not included w/transistor)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch, BHS
36	352-0002-00			1	HOLDER, fuse, assembly
	- - - - - -			-	holder assembly includes:
37	352-0010-00			1	HOLDER, fuse
38	210-0873-00			1	WASHER, rubber
	- - - - - -			1	NUT, fuse holder
39	200-0582-00			1	CAP, fuse
40	179-0954-00			1	CABLE HARNESS, crt, assembly
	- - - - - -			-	cable harness includes:
41	136-0216-00			1	SOCKET, crt, assembly
	- - - - - -			-	socket assembly includes:
42	136-0202-01	X150		1	SOCKET, crt
	- - - - - -			-	socket includes:
	214-0464-00			14	CONTACT, crt socket
43	200-0616-00	X150		1	COVER, crt socket

REAR *(Cont'd)*

REF. NO	PART NO.	SERIAL/MODEL NO. EFF.	DISC	QTY.	DESCRIPTION
44	354-0249-00			1	RING, crt clamping, assembly
	- - - - - -			-	ring includes:
45	124-0171-00			1	STRIP, liner, crt clamp
	- - - - - -			-	mounting hardware: (not included w/ring)
46	211-0576-00			2	SCREW, 6-32 x 7/8 inch, socket head cap
	210-0949-00			2	WASHER, 9/64 ID x 1/2 inch OD
47	214-0207-00			1	NUT, adjustment, securing
48	406-0730-00			1	BRACKET, adjustment
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0534-00			4	SCREW, 6-32 x 5/16 inch, PHS w/lockwasher
	210-0803-00			4	WASHER, 6L x 3/8 inch
	210-0006-00			4	LOCKWASHER, internal, #6
	210-0407-00			4	NUT, hex, 6-32 x 1/4 inch
49	211-0560-00			1	SCREW, 6-32 x 1 inch, RHS
50	220-0419-00			1	NUT, square, 6-32 x 5/16 inch
51	386-0107-00			1	PLATE, bulkhead
52	334-0904-00			1	TAG, voltage rating
	- - - - - -			-	mounting hardware: (not included w/tag)
	213-0088-00			2	SCREW, thread forming, 4-40 x 1/4 inch, PHS phillips
53	161-0017-00			1	CORD, power
54	358-0025-00			1	BUSHING, strain relief
55	386-0110-00			1	PLATE, rear
56	348-0067-00	100	589	1	GROMMET, delrin, 5/16 inch
	358-0215-00	590		1	BUSHING, plastic, black
57	348-0063-00	100	786	1	GROMMET, delrin, 1/2 inch
	348-0064-00	787		1	GROMMET, delrin, 5/8 inch
58	337-0830-00	X2997		1	SHIELD, high voltage
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
	211-0538-00			2	SCREW, 6-32 x 5/16 inch, FHS
	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
59	- - - - - -	X2997		1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	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
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
60	386-0108-00	100	3798	1	PLATE, dust cover, top
	386-1097-00	3799		1	PLATE, dust cover, top
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0504-00			6	SCREW, 6-32 x 1/4 inch BHS

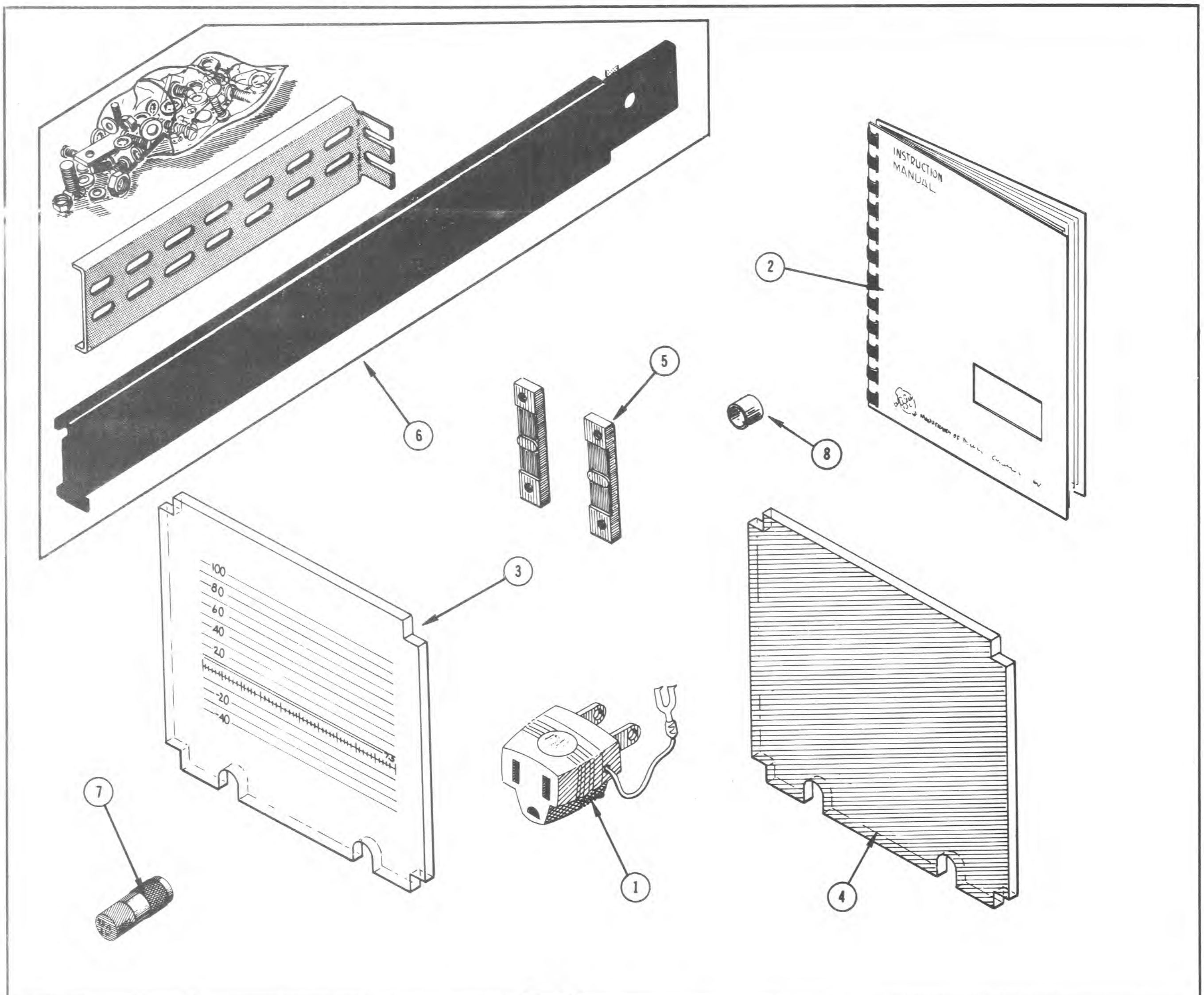
CABLE HARNESS & CERAMIC STRIP DETAIL



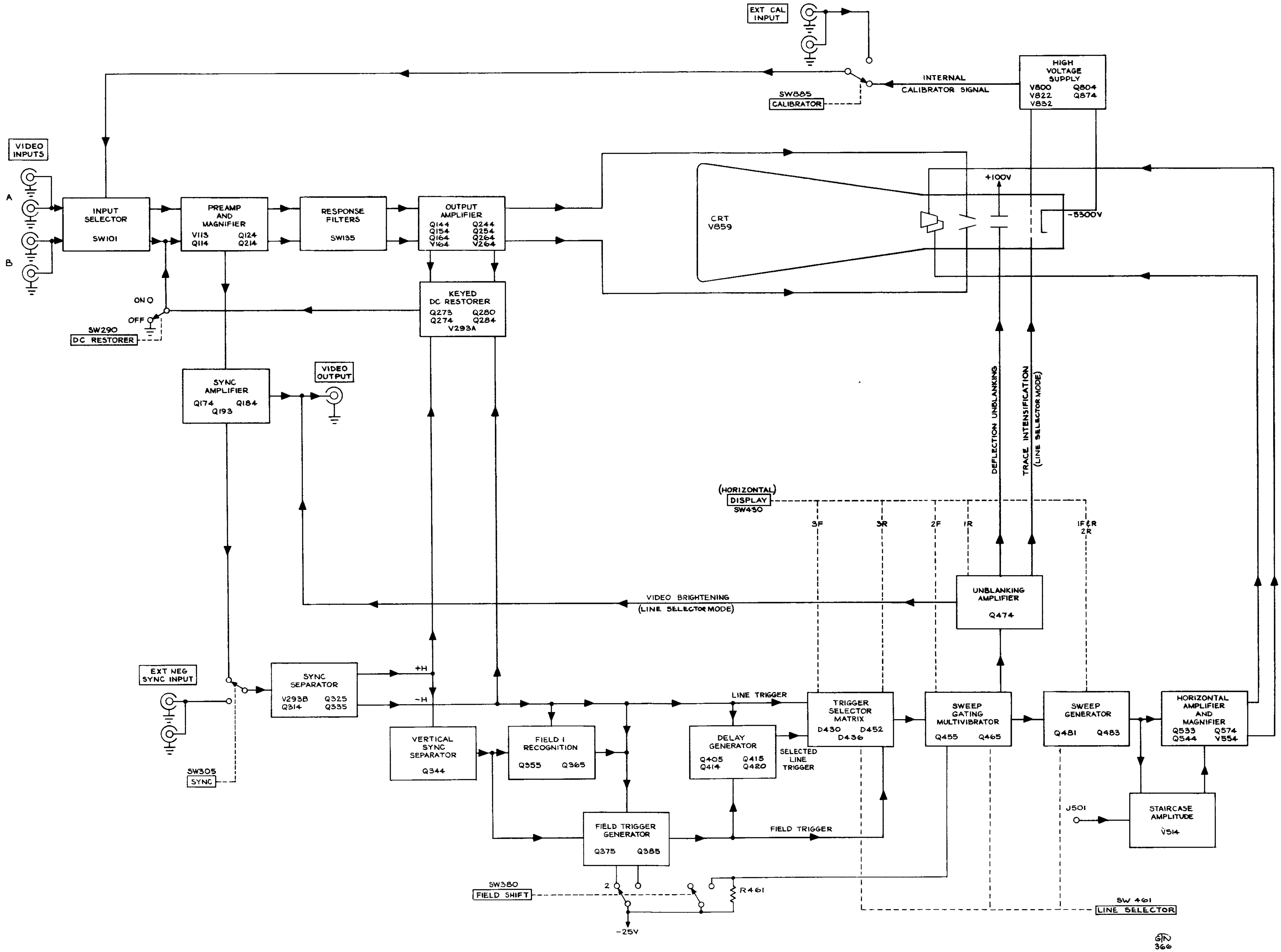
CABLE HARNESS & CERAMIC STRIP DETAIL

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
1	179-0950-00	100	786	1	CABLE HARNESS, horizontal
	179-0950-01	787	1605	1	CABLE HARNESS, horizontal
	179-0950-02	1606	2996	1	CABLE HARNESS, horizontal
	179-0950-03	2997		1	CABLE HARNESS, horizontal
2	179-0951-00	100	619	1	CABLE HARNESS, vertical
	179-0951-01	620	2996	1	CABLE HARNESS, vertical
	179-0951-02	2997		1	CABLE HARNESS, vertical
	- - - - - -			-	cable harness includes:
	175-0590-00	X150		1	WIRE, CRT lead, 1.937 feet, striped orange, w/connector
3	179-0953-00			1	CABLE HARNESS, high voltage
4	179-0956-00			1	CABLE HARNESS, focus & intensity
5	179-0952-00			1	CABLE HARNESS, switch
6	124-0147-00			8	STRIP, ceramic, $^{7}/_{16}$ inch x 13 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, nylon, .313 inch
7	124-0146-00			2	STRIP, ceramic, $^{7}/_{16}$ inch x 16 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, nylon, .313 inch
8	124-0145-00			20	STRIP, ceramic, $^{7}/_{16}$ inch x 20 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, nylon, .313 inch
9	124-0100-00	X620		1	STRIP, ceramic, $^{3}/_{4}$ inch x 1 notch
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, nylon
	- - - - - -			-	mounting hardware: (not included w/strip)
	361-0007-00			1	SPACER, nylon, $^{1}/_{16}$ inch

STANDARD ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
1	103-0013-00			1	ADAPTER, power cord
2	070-0466-00			2	MANUAL, instruction
3	331-0145-00	100	729	1	GRATICULE, composite standard, 140 IRE ruling
	331-0156-00	730	1568	1	GRATICULE, composite, 7 cm
	331-0156-01	1569		1	GRATICULE, composite, 7 cm
	331-0146-00	100	456	1	GRATICULE, 100 IRE ruling
	331-0157-00	457		1	GRATICULE, double scale
	331-0150-00	100	456	1	GRATICULE, combination composite
	331-0161-00	457		1	GRATICULE, plexiglas (installed)
	331-0077-01	X1569		1	GRATICULE, blank
4	378-0525-00	100	1629	1	FILTER, light (installed)
	378-0560-00	1630	5419	1	FILTER, light, smoke gray (installed)
	378-0560-00	5420		1	FILTER, light, smoke gray
5	381-0187-00	X1173		4	BAR, retainer
6	351-0040-02	X1730		1 PR	TRACK, slide, stationary & intermediate sections, (w/mounting hardware)
7	011-0023-00	X4400		1	RESISTOR, terminating, 75 Ω
8	377-0064-00	X150		2	INSERT, graticule light, red



TYPE RM529 WAVEFORM MONITOR

G1

BLOCK DIAGRAM

IMPORTANT

VOLTAGE AND WAVEFORM CONDITIONS

Circuit voltages measured with a 20,000 Ω/volt VOM. All readings in volts. Voltages are measured with respect to chassis ground unless otherwise noted.

Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule.

Voltages and waveforms on the schematics (shown in blue) are not absolute and may vary between instruments.

The test oscilloscope used had the following characteristics: Minimum deflection factor, 0.02 volts/division using a 10X probe; frequency response, dc to 30 MHz; sweep rates, 5 ms to 20 μs; sweep magnification, X1, X20 and X100. AC input coupling was used.

To indicate true time relationship between signals and to obtain stable displays, the test oscilloscope was externally triggered through X1 probe form:

1. Collector of Q325 (-H signal) for all waveforms except those at the junctions of C198 and R198, C364 and R365, C417 and the Collector of Q415.

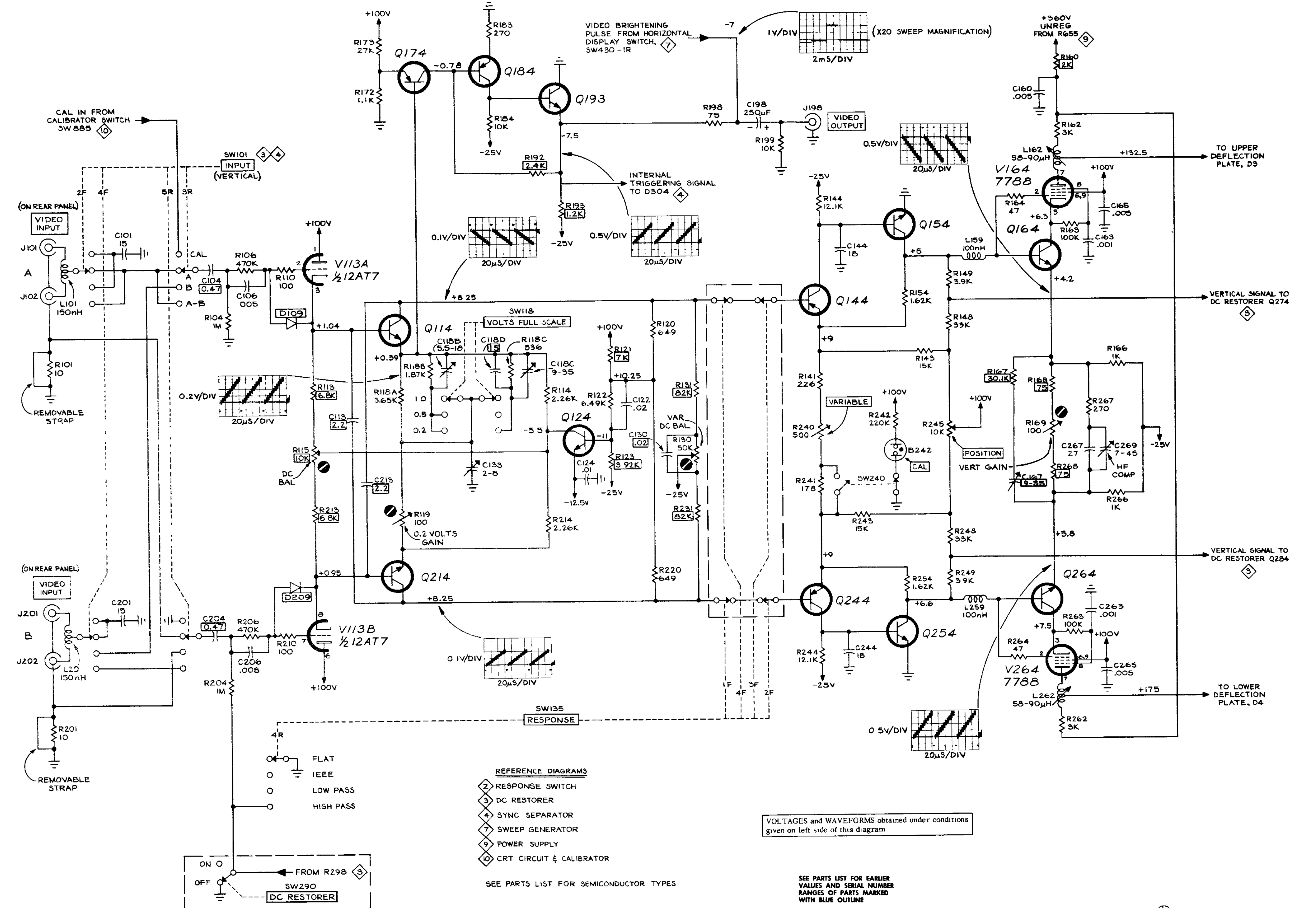
2. Collector of Q344 for waveforms at the junctions of C198 and R198, C364 and R365, C417 and the collector of Q415.

Voltage readings and waveforms were obtained using the following control settings, unless otherwise noted on the individual diagrams.

For waveforms, 1-volt of modulated staircase was connected to the left VIDEO INPUTS A connector. The right VIDEO INPUTS A connector was terminated into 75 ohms.

For voltage readings, no input signal or termination was connected to the instrument.

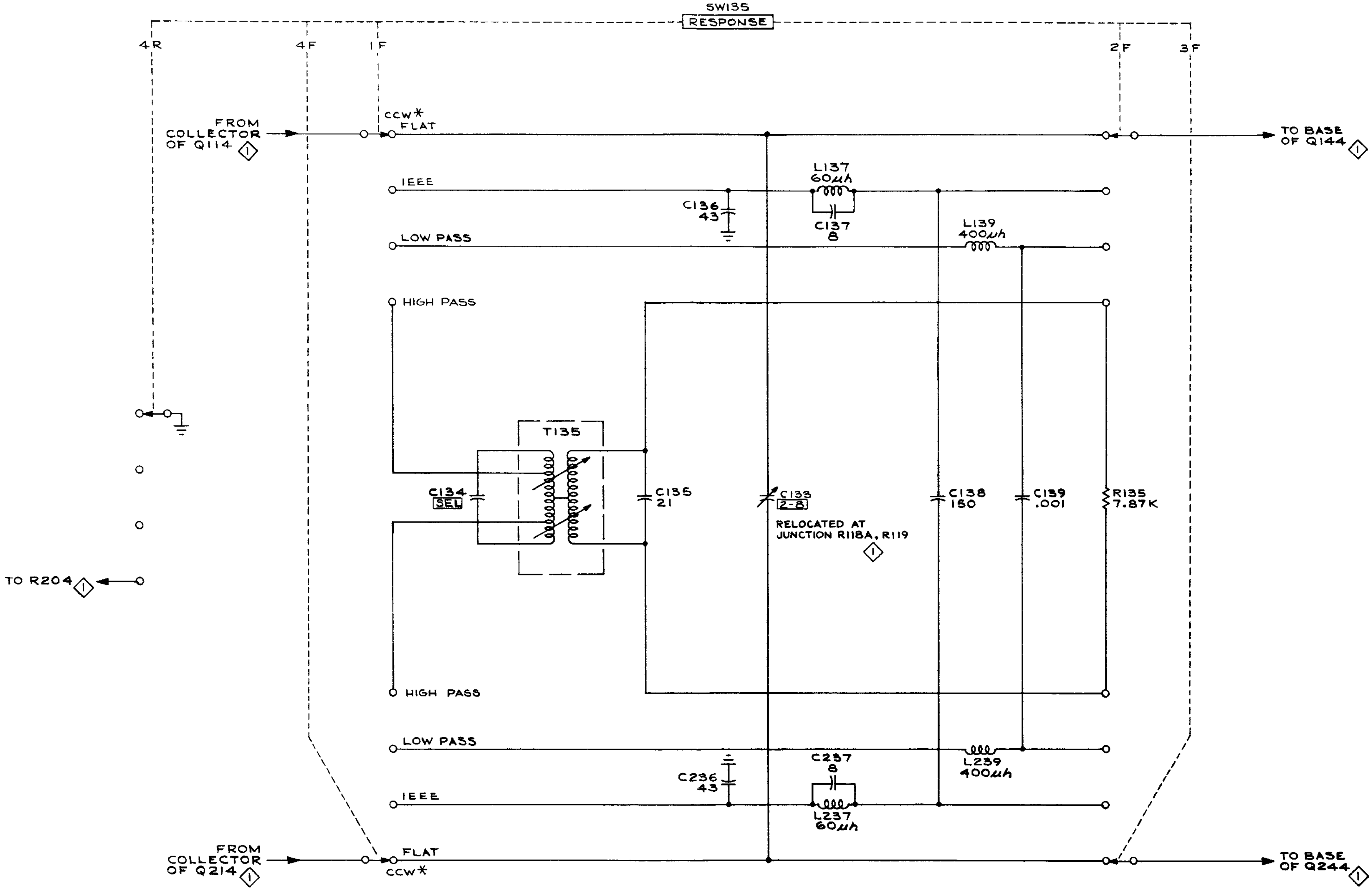
POWER and SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjusted for normal display brightness
GAIN	As is
VERTICAL Controls	
RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange
HORIZ Controls	
POSITION	Midrange
SYNC	INT
MAG	X1
DISPLAY	LINE SELECTOR .25 H/cm
LINE SELECTOR (SWITCH)	Variable
FIELD	TWO
VARIABLE (LINE SELECTOR)	Fully clockwise



TYPE RM529 WAVEFORM MONITOR

H

VERTICAL AMPLIFIER 1



REFERENCE DIAGRAM

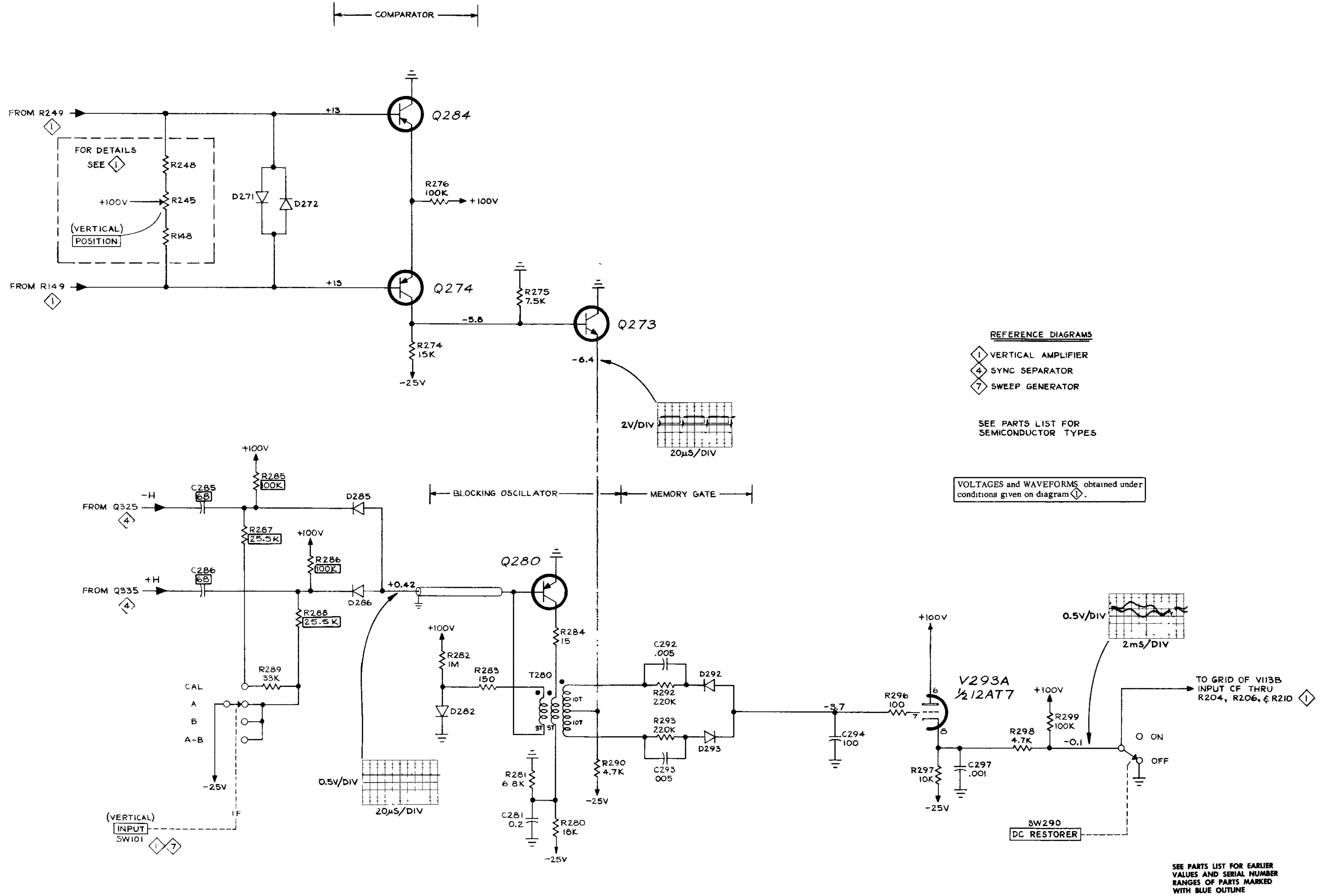
1 VERTICAL AMPLIFIER

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

NOTES:

1. ALL INACTIVE FILTER SECTIONS GROUNDED AT INPUT AND OUTPUT
2. SWITCH IS MOUNTED IN INSTRUMENT WITH WAFER 4 NEAREST FRONT PANEL
3. * SWITCH ROTATION AS VIEWED FROM INDEX END OF SWITCH - THIS POSITION IS CLOCKWISE ON FRONT PANEL

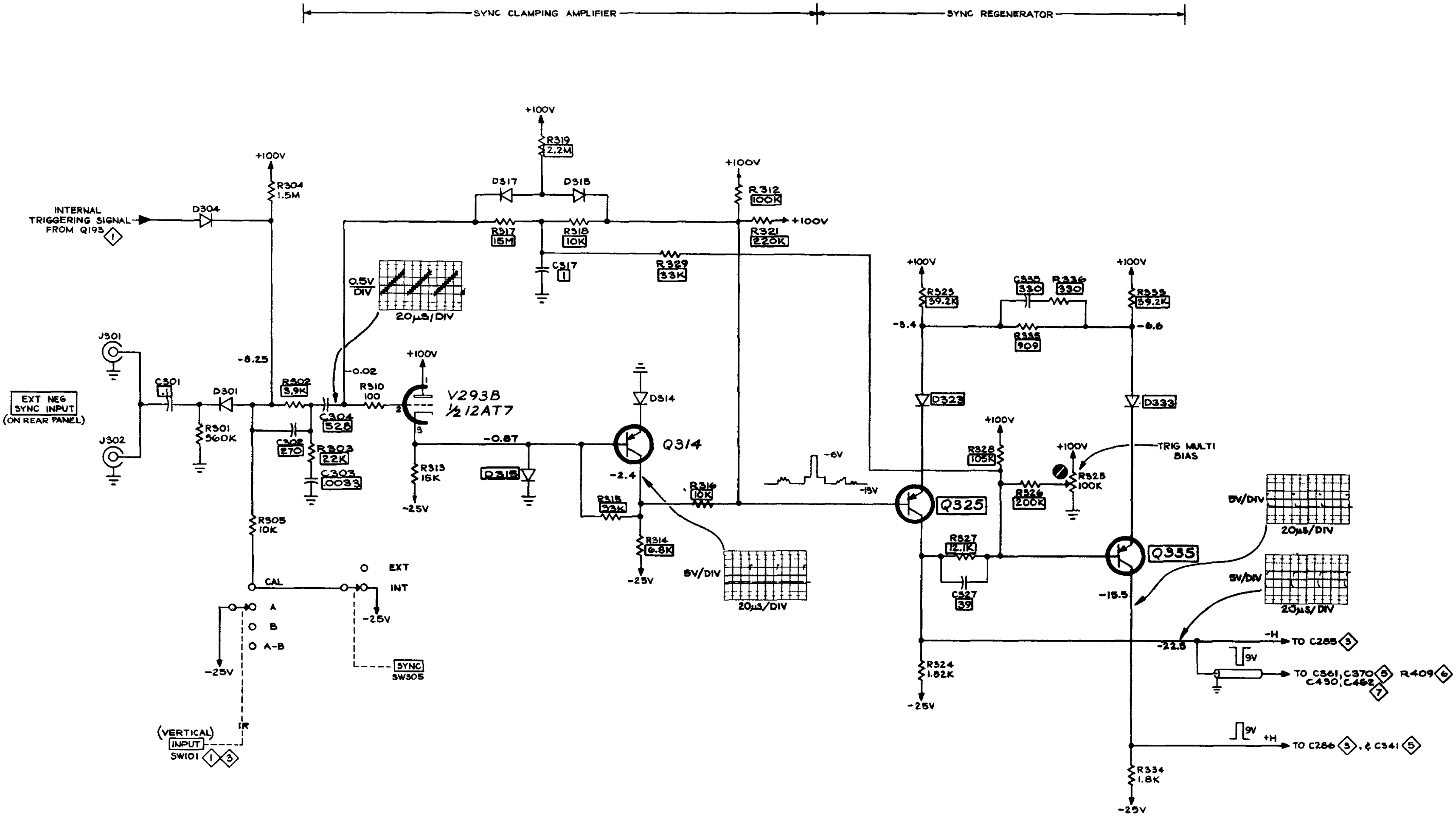
MRH
366



H2

GTN 966

DC RESTORER 3



REFERENCE DIAGRAMS

1. VERTICAL AMPLIFIER
3. DC RESTORER
5. FIELD SELECTOR
6. LINE SELECTOR
7. SWEEP GENERATOR

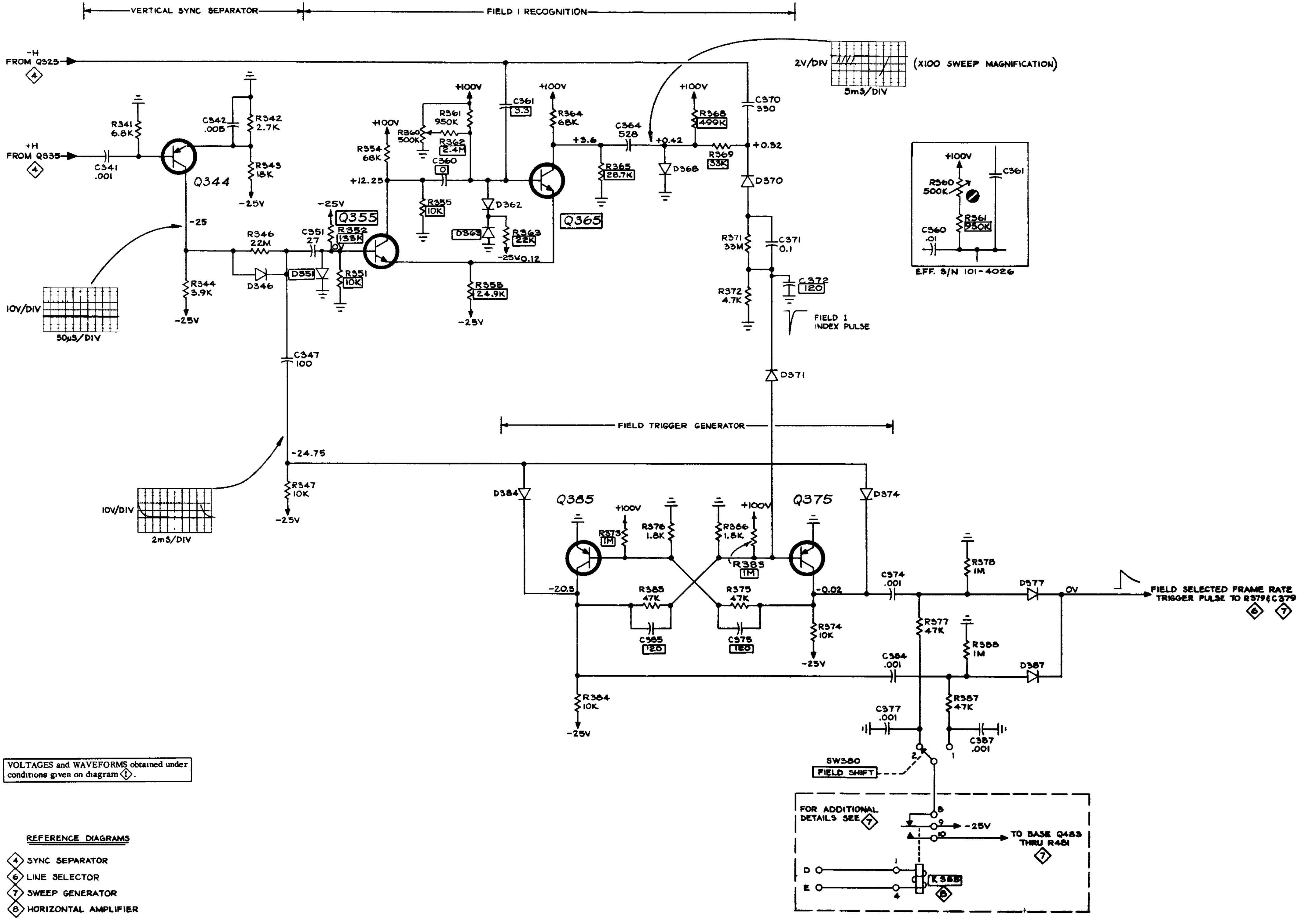
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES and WAVEFORMS obtained under conditions given on diagram 1.

TYPE RM529 WAVEFORM MONITOR

GN 367

SYNC SEPARATOR 4



VOLTAGES and WAVEFORMS obtained under conditions given on diagram 1.

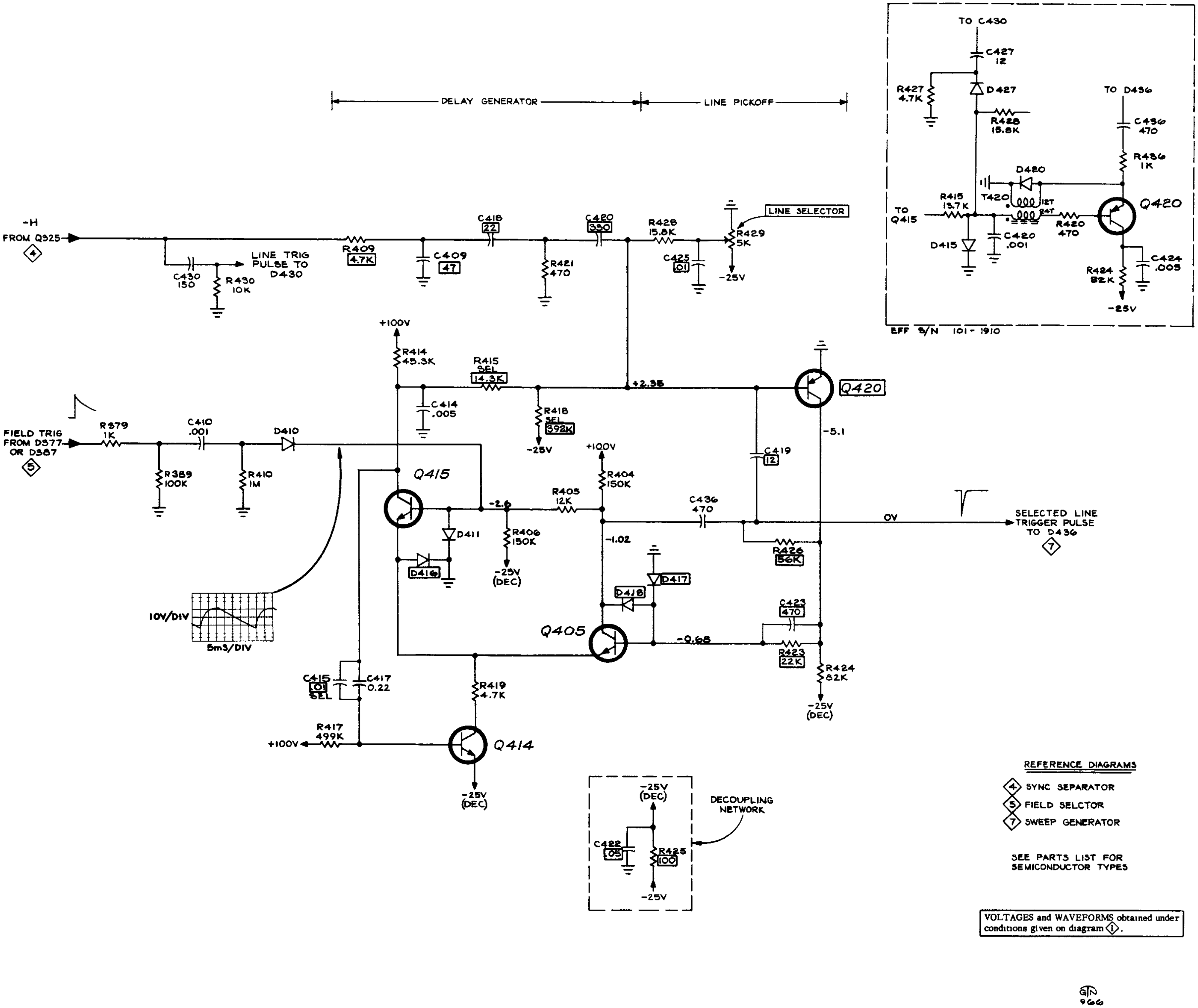
REFERENCE DIAGRAMS

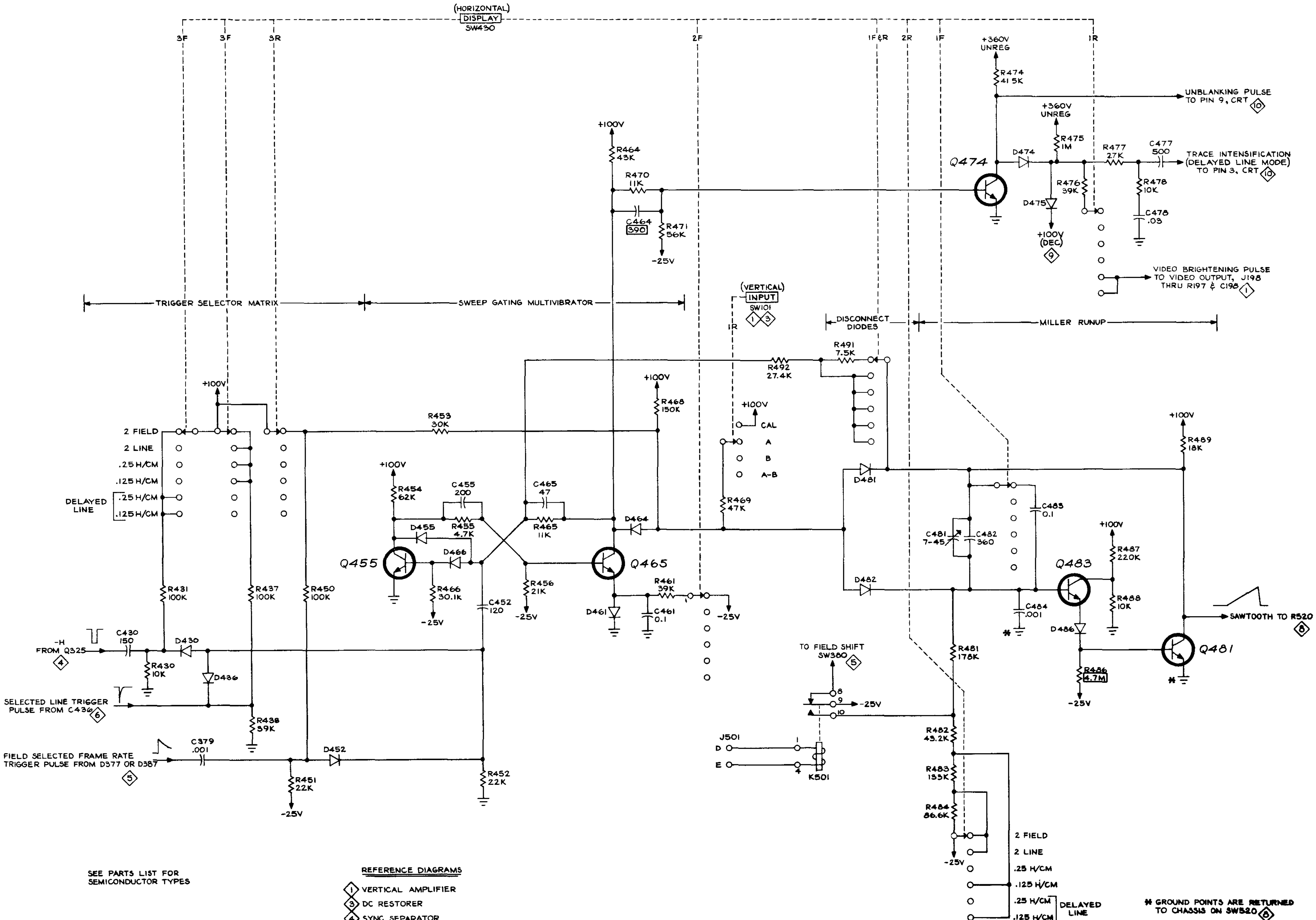
4 SYNC SEPARATOR
6 LINE SELECTOR
7 SWEEP GENERATOR
8 HORIZONTAL AMPLIFIER

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

TYPE RM529 WAVEFORM MONITOR

FIELD SELECTOR 5


DELAY GENERATOR
LINE PICKOFF
-H
FROM Q325
4
LINE TRIG
PULSE TO
D430
C430
150
R430
10K
R409
4.7K
C409
47
C418
22
R421
470
C420
330
R428
15.8K
C425
.01
LINE SELECTOR
R429
5K
-25V
+100V
R414
45.3K
R415
SEL
14.3K
+2.35
C414
.005
R418
SEL
392K
-25V
Q420
-5.1
FIELD TRIG
FROM D377
OR D387
5
R379
1K
C410
.001
D410
R389
100K
R410
1M
Q415
-2.6
R405
12K
+100V
R404
150K
C419
12
C436
470
0V
SELECTED LINE
TRIGGER PULSE
TO D436
7
R426
56K
D411
R406
150K
-25V
(DEC)
D416
-1.02
D417
D418
10V/DIV
5mS/DIV
C423
470
Q405
-0.68
R423
22K
R424
82K
-25V
(DEC)
C415
.01
SEL
C417
0.22
R419
4.7K
R417
499K
+100V
Q414
-25V
(DEC)
TO C430
C427
12
R427
4.7K
D427
R428
15.8K
TO D436
C436
470
R436
1K
D420
T420
12T
24T
TO
Q415
R415
13.7K
R420
470
Q420
D415
C420
.001
R424
82K
C424
.005
-25V
EFF S/N 101-1910
-25V
(DEC)
DECOUPLING
NETWORK
C422
.05
R425
100
-25V
REFERENCE DIAGRAMS
4 SYNC SEPARATOR
5 FIELD SELCTOR
7 SWEEP GENERATOR
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES
VOLTAGES and WAVEFORMS obtained under conditions given on diagram 1.
GTN
966



SEE PARTS LIST FOR SEMICONDUCTOR TYPES

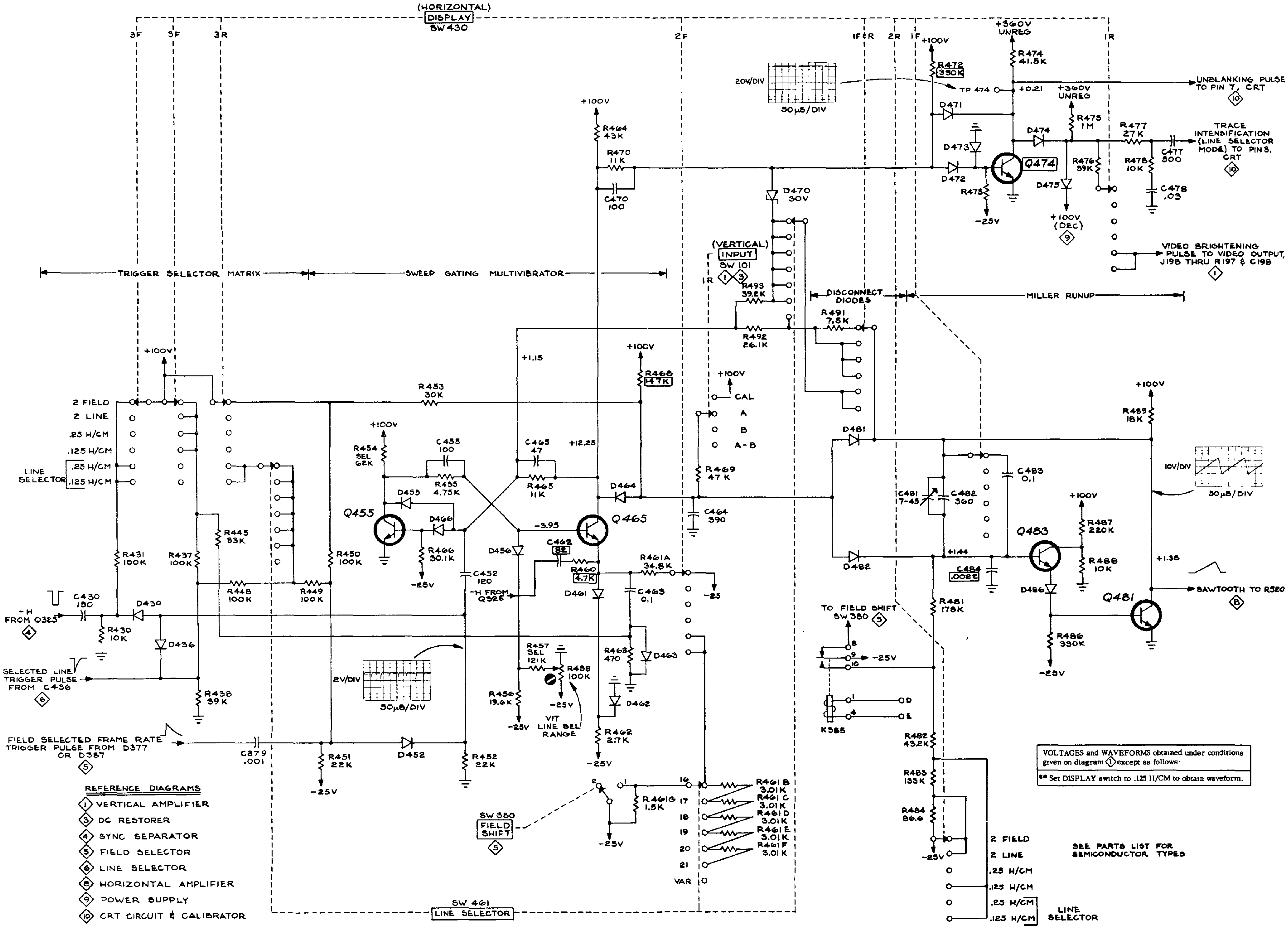
REFERENCE DIAGRAMS

1. VERTICAL AMPLIFIER
3. DC RESTORER
4. SYNC SEPARATOR
5. FIELD SELECTOR
6. LINE SELECTOR
8. HORIZONTAL AMPLIFIER
9. POWER SUPPLY
10. CRT CIRCUIT & CALIBRATOR

TYPE RM529 WAVEFORM MONITOR

SWEEP GENERATOR

S/N 101-2996



TYPE RM529 WAVEFORM MONITOR

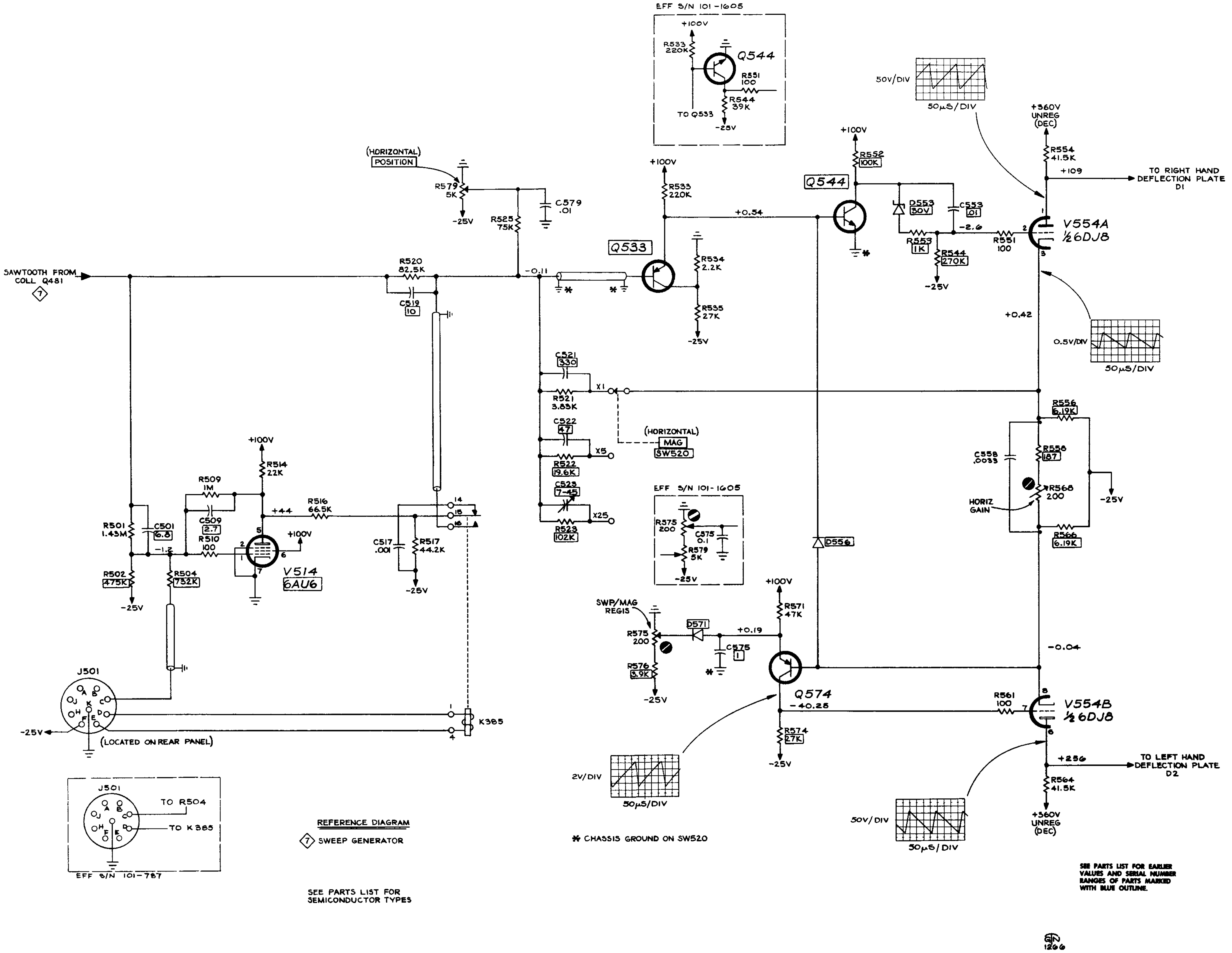
M

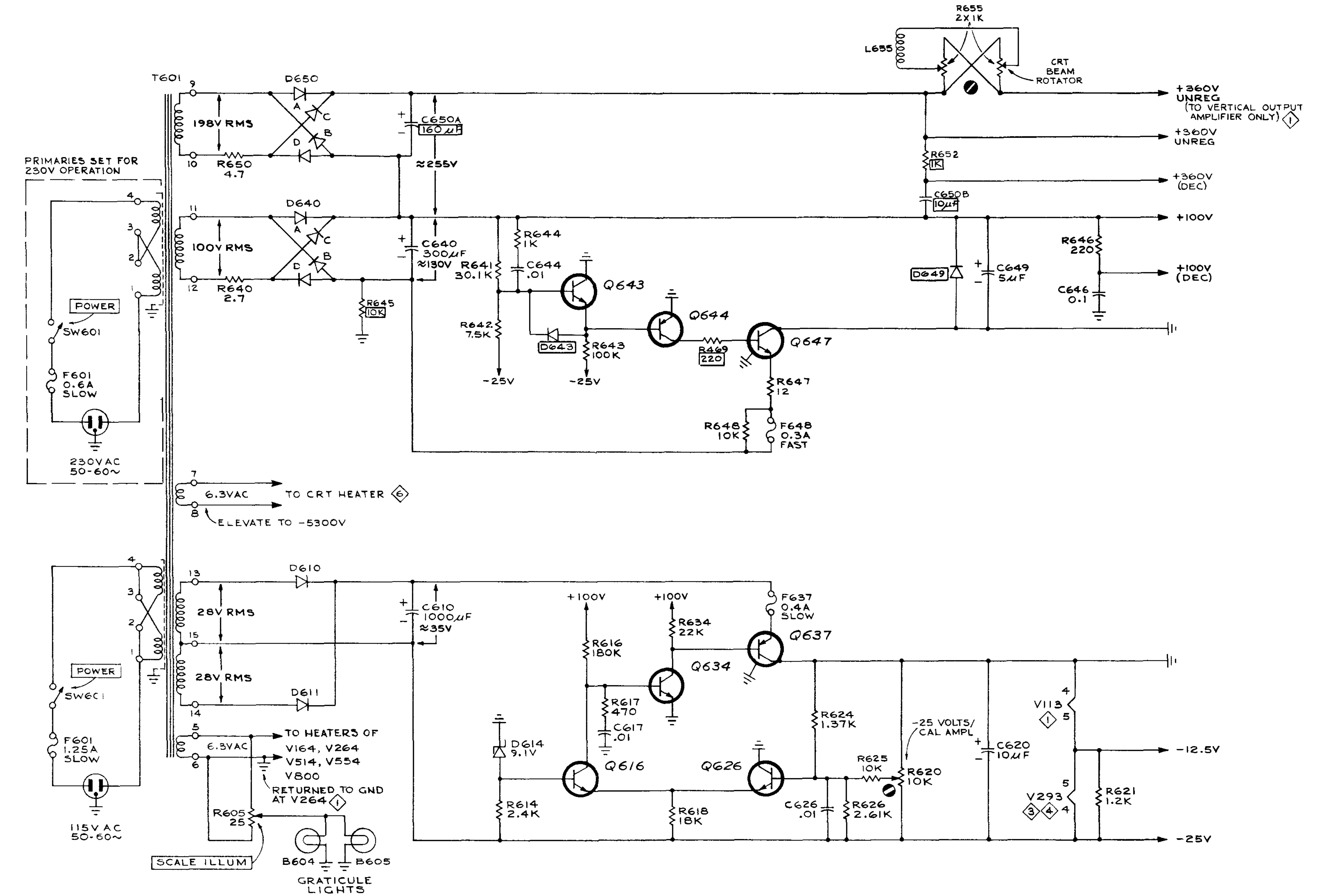
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

SWEEP GENERATOR 7

S/N 2997-UP

567


EFF S/N 101-1605
+100V
R533 220K
Q544
R551 100
R544 39K
TO Q533
-25V
(HORIZONTAL) POSITION
R579 5K
-25V
C579 .01
R525 75K
SAWTOOTH FROM COLL Q481 7
R520 82.5K
C519 10
-0.11
+100V
R533 220K
+0.54
Q533
R534 2.2K
R535 27K
-25V
+100V
R552 100K
Q544
D553 30V
C553 .01
-2.6
R553 1K
R544 270K
-25V
R551 100
50V/DIV
50μS/DIV
+360V UNREG (DEC)
R554 41.5K
+109
TO RIGHT HAND DEFLECTION PLATE D1
V554A ½6DJ8
+0.42
0.5V/DIV
50μS/DIV
C521 330
R521 3.83K
X1
C522 47
R522 19.6K
X5
(HORIZONTAL) MAG SW520
C523 7-45
R523 102K
X25
R556 6.19K
C558 .0033
R558 187
R568 200
HORIZ GAIN
-25V
R566 6.19K
+100V
R514 22K
R509 1M
C509 2.7
+44
R516 66.5K
R501 1.43M
C501 6.8
-1.2
R510 100
+100V
V514 6AU6
C517 .001
R517 44.2K
-25V
R502 475K
R504 732K
-25V
EFF S/N 101-1605
R575 200
C575 0.1
R579 5K
-25V
D556
SWP/MAG REGIS
R575 200
D571
+0.19
C575 1
R576 3.9K
-25V
+100V
R571 47K
Q574
-40.25
R574 27K
-25V
-0.04
R561 100
V554B ½6DJ8
+256
TO LEFT HAND DEFLECTION PLATE D2
R564 41.5K
+360V UNREG (DEC)
J501
-25V
(LOCATED ON REAR PANEL)
K385
2V/DIV
50μS/DIV
50V/DIV
50μS/DIV
J501
TO R504
TO K385
EFF S/N 101-787
REFERENCE DIAGRAM
7 SWEEP GENERATOR
* CHASSIS GROUND ON SW520
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
1266



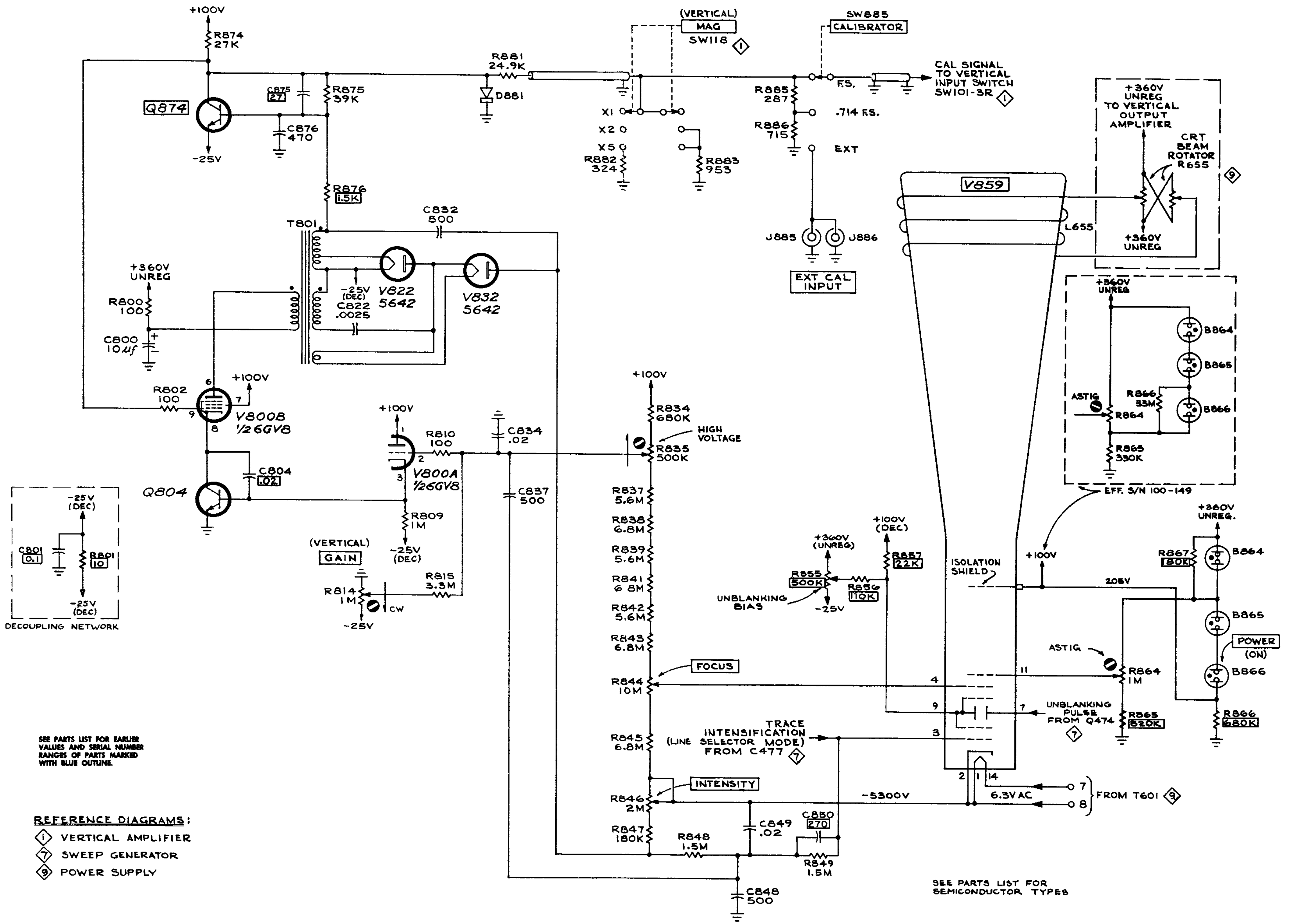
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS:

1 VERTICAL AMPLIFIER
3 DC RESTORER
4 SYNC SEPARATOR

MRH
167



REFERENCE DIAGRAMS:
1. VERTICAL AMPLIFIER
7. SWEEP GENERATOR
9. POWER SUPPLY

367 MRH

SECTION 10
RACKMOUNTING

Mounting Method (Figs. 10-1 and 10-2)

This instrument will fit most commercial consoles and most 19-inch wide racks whose dimensions conform to EIA specifications.

Fig. 10-1 shows the instrument installed in a cabinet type rack with slideout tracks. The instrument is locked into the rack by means of pawl fasteners. When the RELEASE knobs on the front panel are turned to release the instrument, the instrument can be pulled out of the rack like a drawer to its fully extended position (see Fig. 10-2) and then tilted up about 100°. 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 or relay type rack front and rear vertical mounting rails if the inside distance between front and rear rails is within $10\frac{9}{16}$ inches to $24\frac{3}{8}$ 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 ($10\frac{9}{16}$ inches to $24\frac{3}{8}$ inches).

Instrument Dimensions and Weight

The last pullout page in this section shows dimensional drawings exclusive of the power cord and hables.

Rack Dimensions

Width—A standard 19 inch rack may be used. The dimension of opening between the front rails of the rack must be at lease $17\frac{5}{8}$ inches for a cabinet type rack in which the front lip of the stationary section is mounted **behind the front rail** as shown in Fig. 10-5B. This dimension allows room on each side of the instrument for the slideout tracks to operate so the instrument can move freely in and out of he rack.

Depth—For proper circulaion of cooling air, allow at least 2 inches clearance behind the rear of the instrument and any enclosure on the rack (see dimensional drawings). At least that much space is also needed for the coaxial cables (unless 90° adapters are used) so they are not bent too sharply. If it is sometimes necessary or desirable to operate the Type RM529 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 (Fig. 10-2)

General Information

The slideout tracks for the instrument consist of two assemblies, one each for the right and left sides. Each assembly consists of three sections as illustrated in Fig. 10-3. The stationary section attaches to the fron and rear rails of he rack with inside dimensions as shown in Fig. 10-2, the chassis section attaches to the instrument, and the intermediate section 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. 10-4. The hardware shown in Fig. 10-4 is used to mount the slideout tracks to the rack rails having this compatibility; from and rear rail holes must be large enough to allow inserting a #10-32 screw; rail holes must be located on EIA/RETMA/Western Electric or Universal spacing. Because of the above compatibility, there will be some parts left over.

Stationary and Intermediate Sections Installation

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 are marked 351-0042-02 on the packabe. Use the following procedure to mount both sets. See Fig. 10-5 for installation details.

NOTE

If i is desired to mount the rear of the stationary sildeout track sections without the bar nuts, then one hole must be drilled and tapped for a #10-32 screw in each rear rail. To locate the desired hole: mount the front of the stationary slideout track section; level the stationary section and mark the required hole location.

1. If the instrument is to be mounted 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. 10-5C as a guide.

2. Mount the stationary slideout track sections to the front rack rails using Fig. 10-5B as a guide.

3. If the rear rack rail holes have been drilled and tapped as described above for #10-32 machine screws, mount the left stationary section with hardware provided as shown in Fig. 10-5A. Using Fig. 10-5A as a guide, mount the right stationary section in the same manner.

4. If the rear rack rail holes are not drilled and tapped as described above to accept 10-32 machine screws, mount the left stationary section with hardware provided as shown in Fig. 10-5B. Using Fig. 10-5B as a guide, mount the right stationary section in the same manner.

Adjustments

To adjust the slideout tracks for smooth operation, proceed as follows:

1. Insert the instrument into the rack as shown in Fig. 10-6.

2. Adjust the slideout tracks for proper spacing as shown in Fig. 10-7.

Maintenance

The slideout tracks require no lubrication. The special gray finish on the sliding parts is a permanent lubrication.

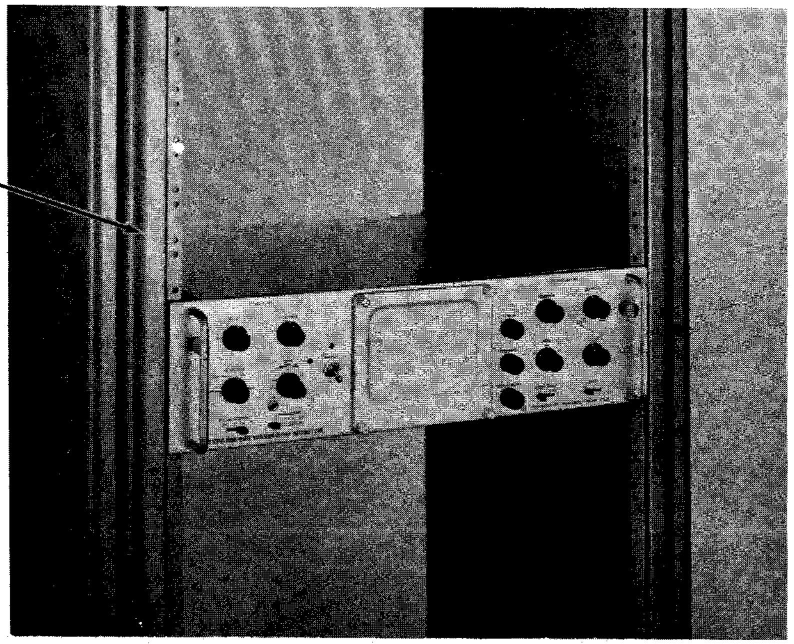


Fig. 10-1. The Type RM529 installed in cabinet type rack.

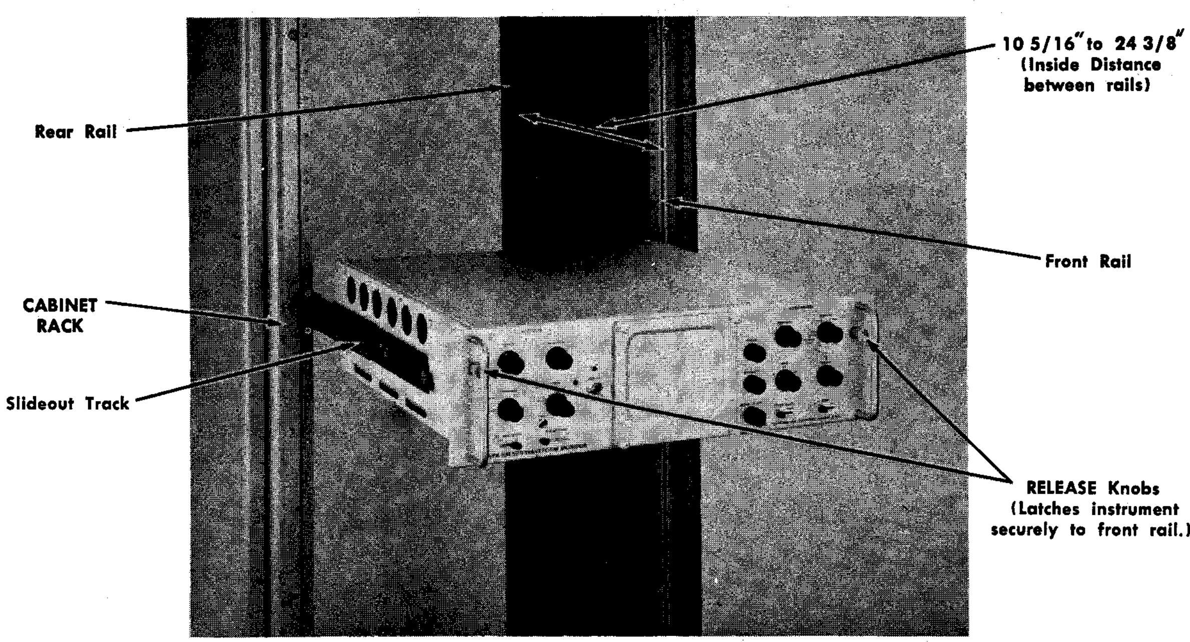


Fig. 10-2. The Type RM529 supported by slideout tracks mounted between front and rear cabinet rack rails.

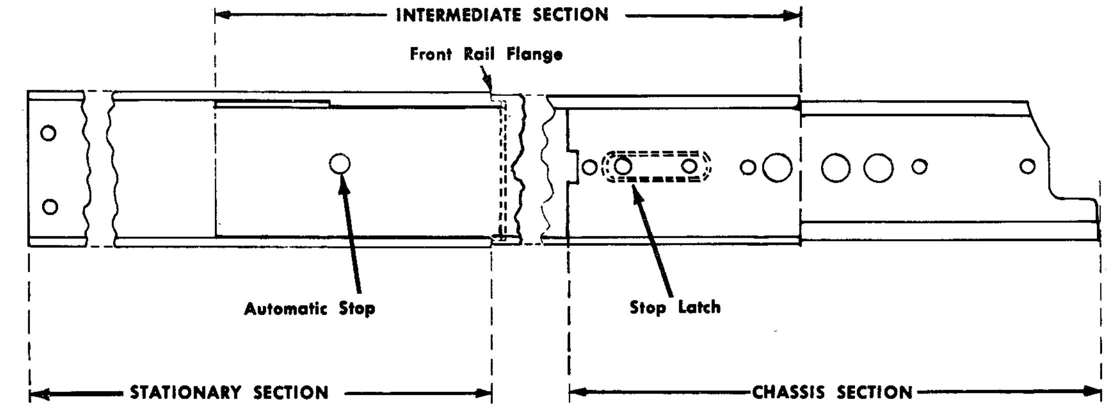


Fig. 10-3. Illustration showing the slideout track assembly for the right side.

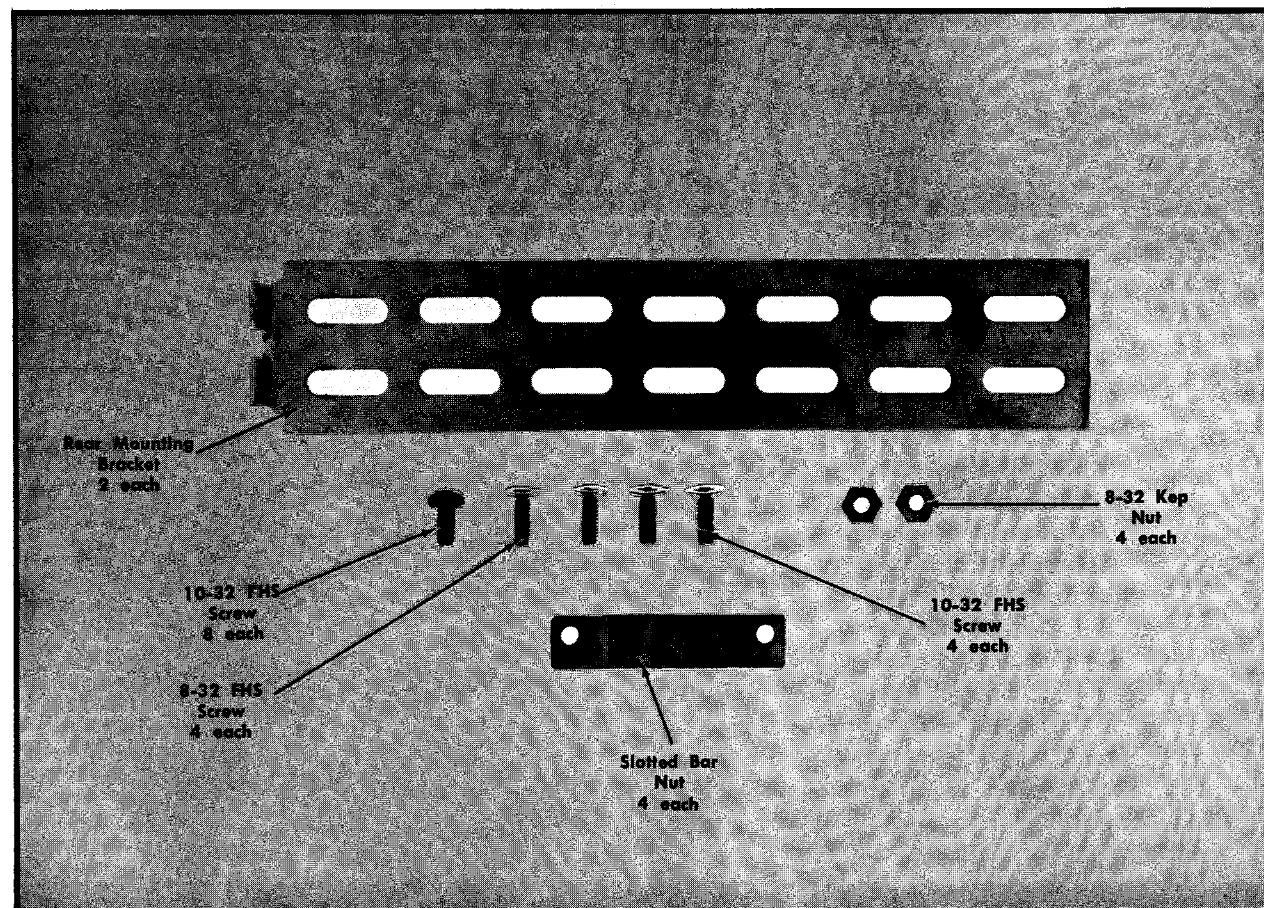
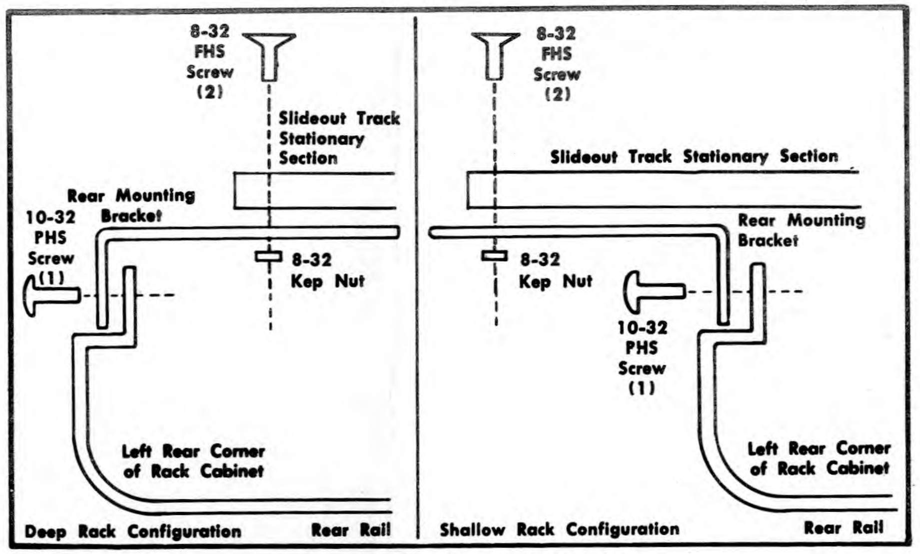
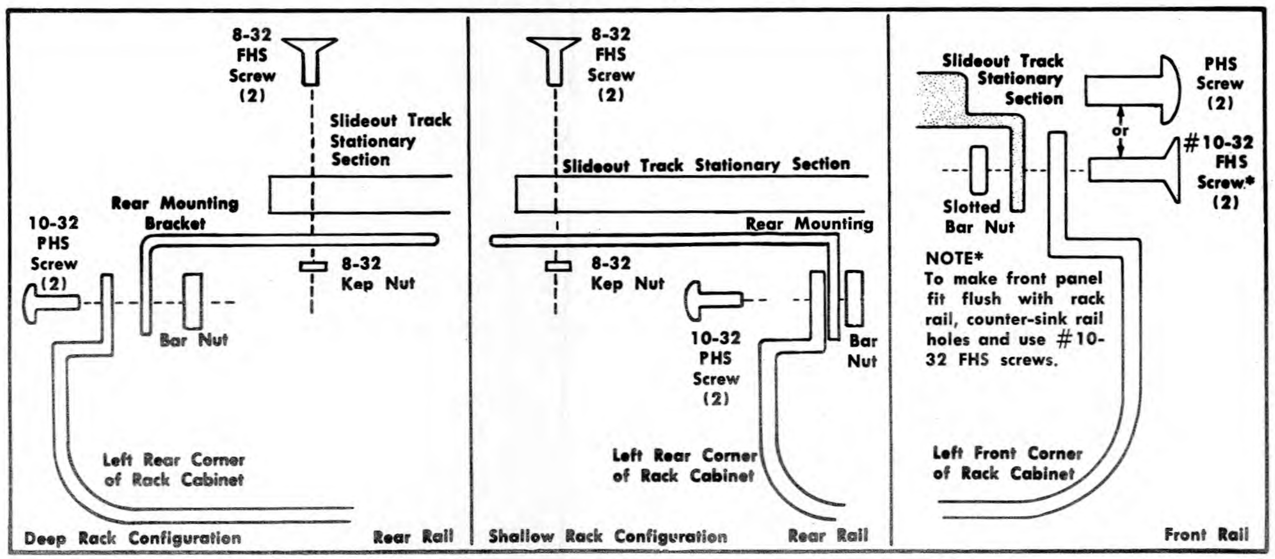


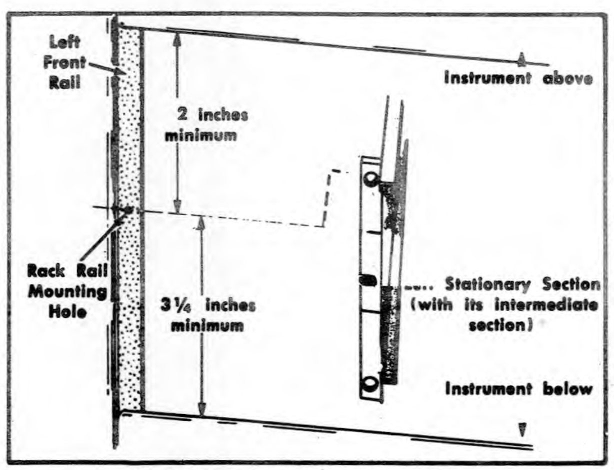
Fig. 10-4. Small hardware components for mounting the stationary sections to the rack rails.



(A) Rear rack rails tapped #10-32.



(B) Rack rails not tapped.



(C) Locating vertical mounting position.

Fig. 10-5. Mounting the left stationary section with its matched intermediate section (not shown) to rack rails.

Rackmounting—Type RM529

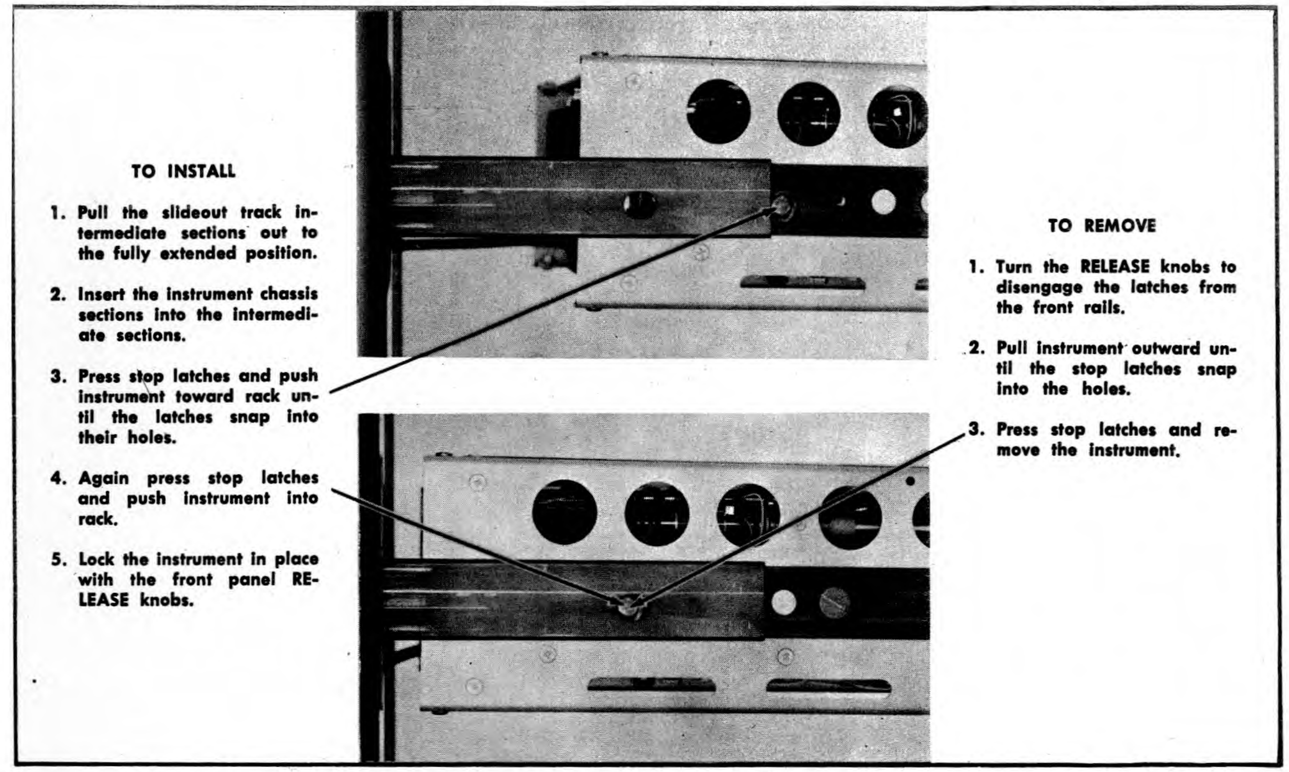


Fig. 10-6. Installing and removing the instrument.

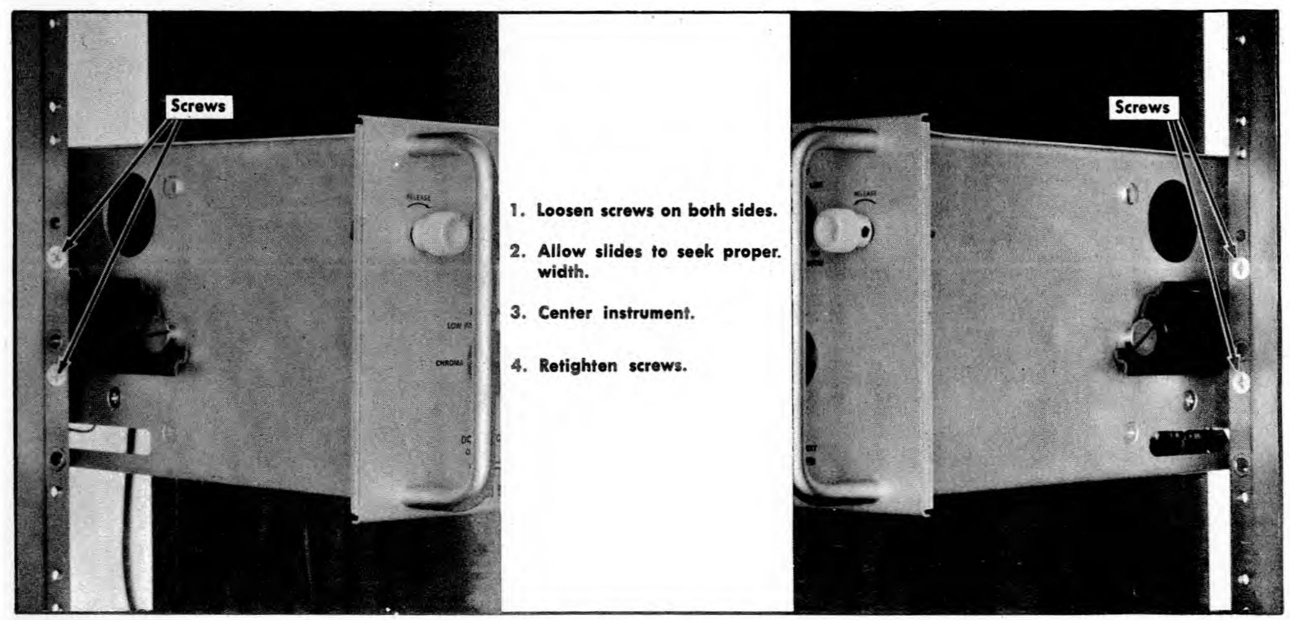
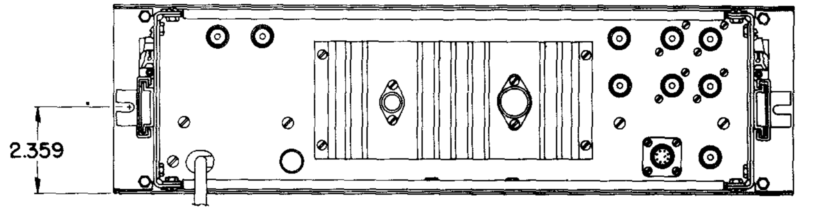
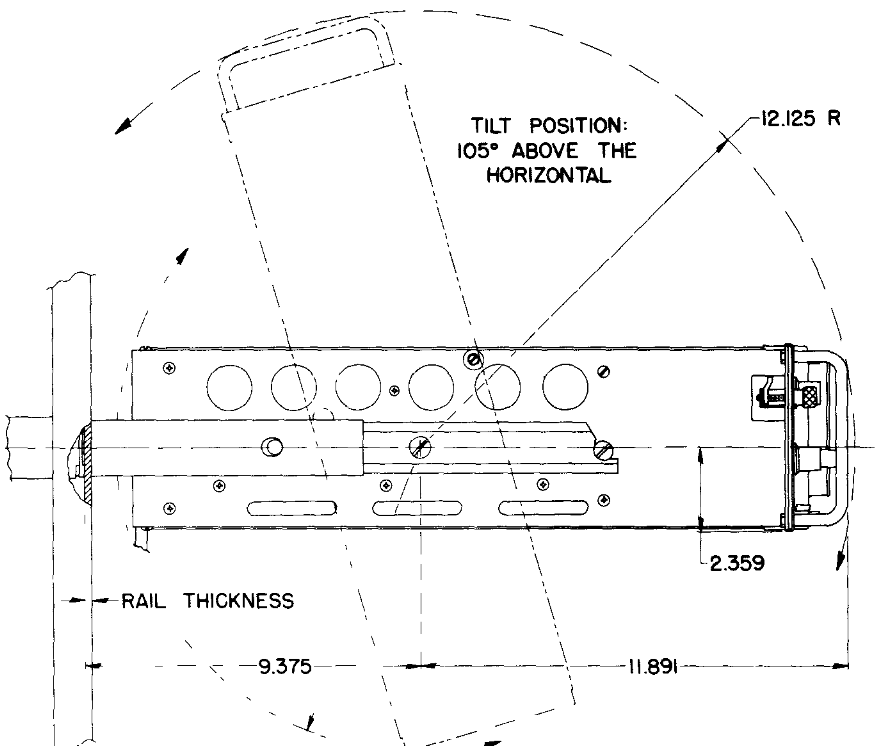
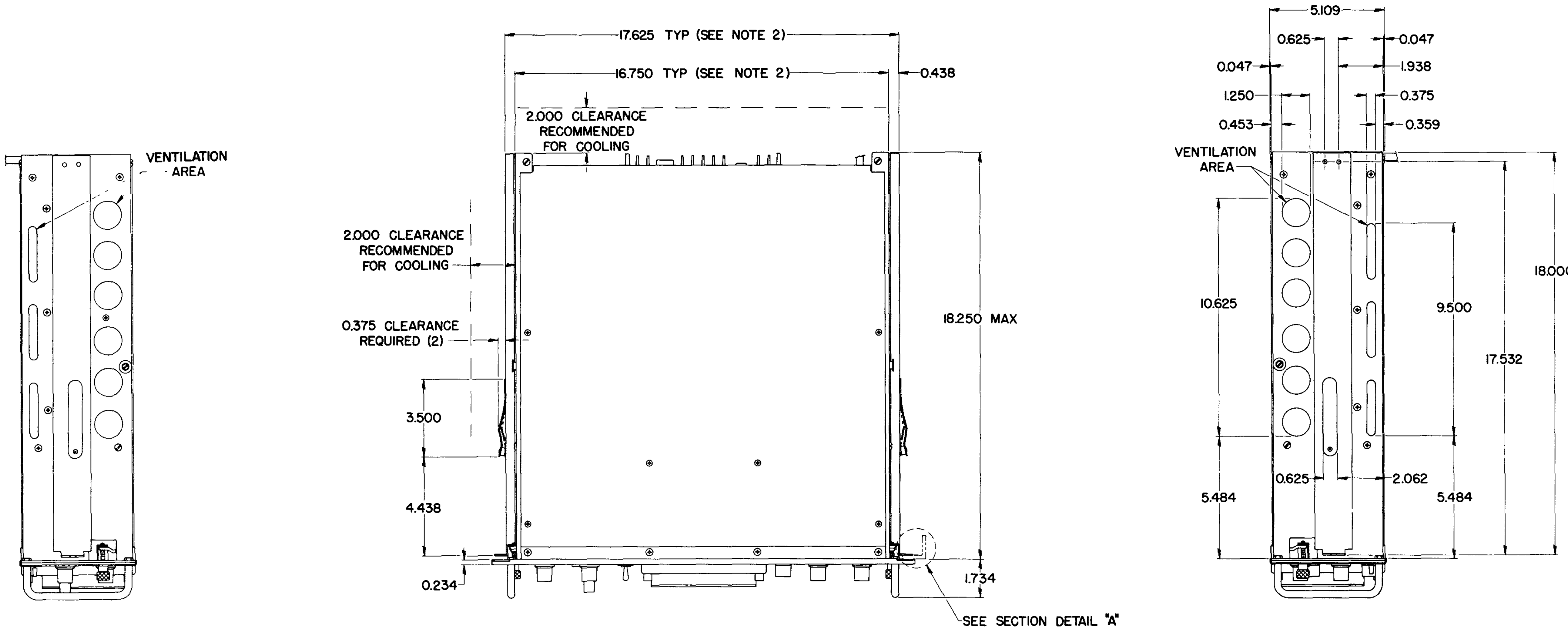


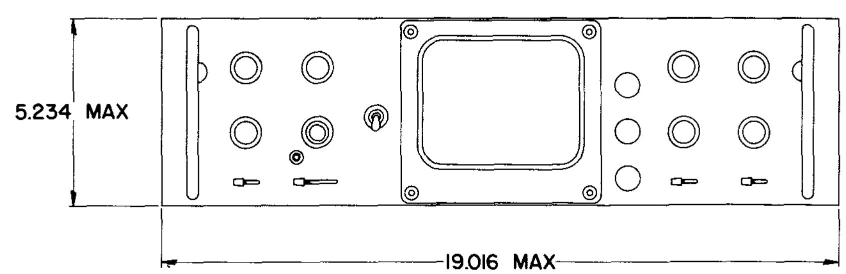
Fig. 10-7. Adjusting the slideout tracks for smooth sliding action.

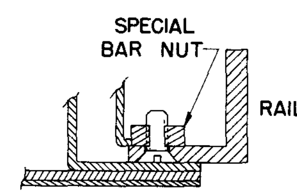

2.359

REAR VIEW


TILT POSITION:
105° ABOVE THE
HORIZONTAL
12.125 R
2.359
RAIL THICKNESS
9.375
11.891
8.453 R
RAIL





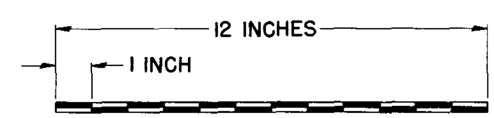


SECTION DETAIL "A"

RECOMMENDED MOUNTING

NOTES:
1. ALL DIMENSIONS ARE REFERENCE DIMENSIONS EXCEPT AS NOTED
2. SUBJECT TO APPROXIMATELY ±0.047 DEVIATION

TYPE RM529



A

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. If it does not, your manual is correct as printed.

TYPE 529 TENT SN 2930

TYPE RM529 TENT SN 6110

PARTS LIST & SCHEMATIC CORRECTION

CHANGE TO:

R478	315-0183-00	18 k	1/4 W	5 %
R847	315-0124-00	120 k	1/4 W	5 %
V859	154-0514-00	CRT, T5291-31	6.4KV	

M12,402/567

TYPE RM529 TENT SN 5420

TEXT CORRECTION

Section 3 Circuit Description

Page 3-17

Sub-Title: CRT Circuit and Calibrator

ADD: After paragraph two;

The bias network consisting of R855, R856 and R857 insures uniform intensity of the CRT horizontal trace. This is accomplished by varying the voltage applied to the fixed unblanking plate.

Section 6 Calibration

Page 6-9

ADD: After step 6, Adjust CRT BEAM ROTATOR R655

6A. Adjust UNBLANKING PLATE BIAS (R855)

a. Set the INPUT switch to A (no signal applied to VIDEO INPUT A connector).

b. Adjust the INTENSITY control so the CRT trace is barely visible.

c. Check for uniform intensity along the horizontal axis.

d. Adjust the UNBLANKING PLATE BIAS (R855) for uniform intensity along the horizontal axis.

TYPE 529 TENT SN 2600

TYPE RM529 TENT SN 5610

PARTS LIST CORRECTION

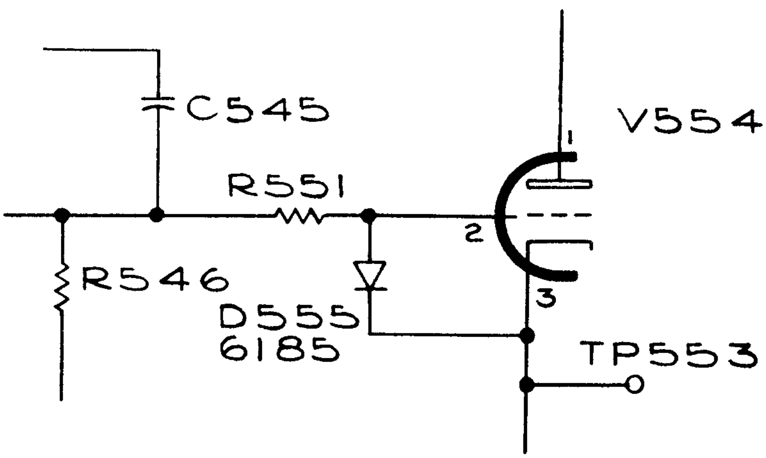
CHANGE TO:

Q544	151-0190-00	Silicon	2N3904

ADD:

D555	152-0185-00	Silicon	6185

SCHEMATIC CORRECTION



PARTIAL HORIZONTAL AMPLIFIER

M12,073/267

TYPE 529	TENT SN 2680
TYPE RM529	TENT SN 5700

PARTS LIST CORRECTION

CHANGE TO:

Q533	151-0188-00	2N3906

TYPE 529	TENT SN 2740
TYPE RM529	TENT SN 5800

PARTS LIST CORRECTION

CHANGE TO:

Q474	151-0150-00	Silicon	2N3440

TYPE RM529 -- TENT SN 6110

PARTS LIST CORRECTION

CHANGE TO:

	Unwired		
SW520	260-0656-01	Rotary	MAG