NOTE

A nomenclature change has been introduced for the 5000 Series products. The 5403/D41 is now called the 5441 Storage Oscilloscope.

This composite manual incorporates the 5403 and D41 manuals, formerly bound under separate cover.

TEKTRONIX®

5441 STORAGE OSCILLOSCOPE

INSTRUCTION MANUAL

Tektronix, Inc.
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Serial Number _____

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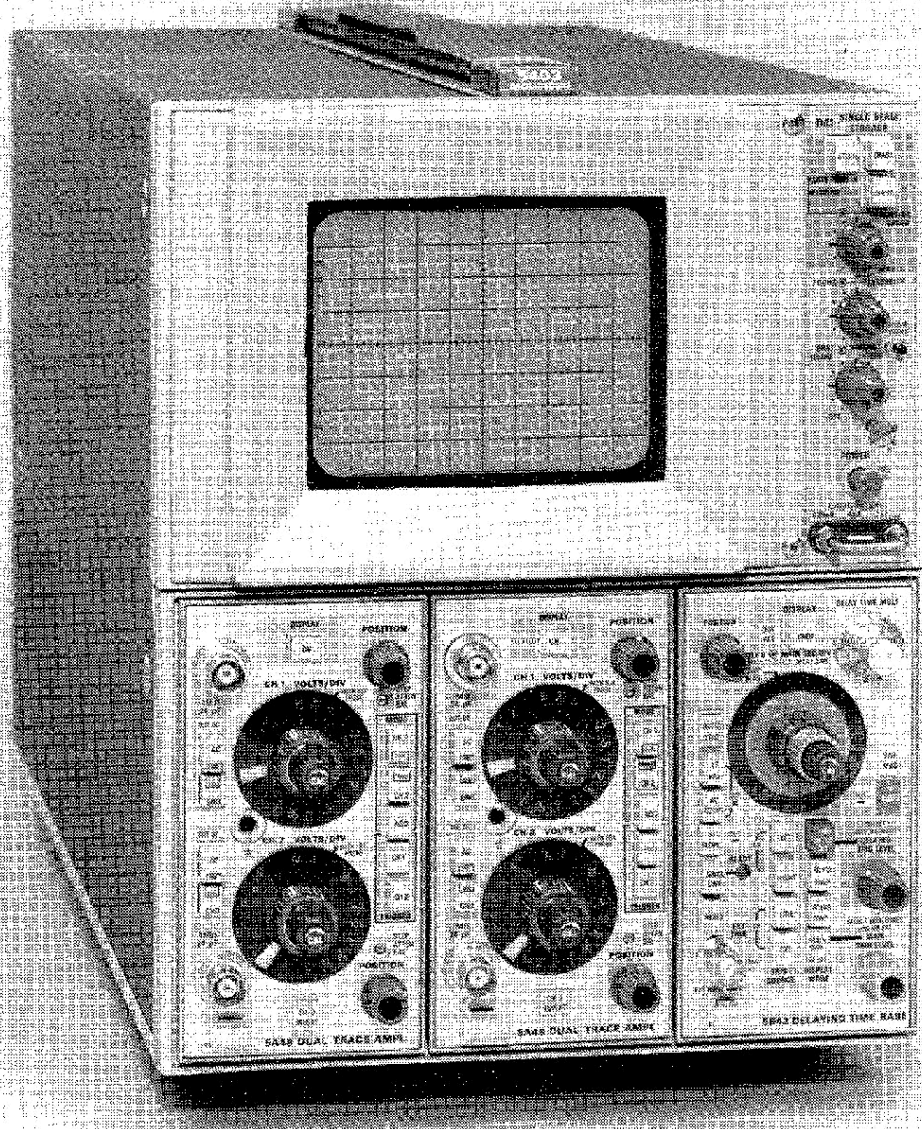

5A48 DUAL TRACE AMPL
5A48 DUAL TRACE AMPL
5B43 DELAYING TIME BASE

THEORY OF OPERATION

Z-AXIS AMPLIFIER AND CRT CIRCUIT

The CRT circuit produces the high voltage potentials and provides the control circuits necessary for operation of the cathode-ray tube (CRT). The Z-Axis amplifier circuit is included with the CRT circuit discussion, since it sets the intensity of the CRT display.

Z-Axis Amplifier

The Z-Axis amplifier is a current driven, shunt-feedback operational amplifier with a voltage output. The amplifier consists of Q345, Q352, and Q356. The feedback path is from the Q352-Q356 collectors through C350-R349-R350 to the summing point at the base of Q345. Q352 and Q356 are connected as a collector-coupled complementary amplifier that provides a fast linear output signal while consuming minimum quiescent power. Q356 acts as the pull-up transistor and Q352 acts as the pull-down transistor for the amplifier. The output voltage from the amplifier provides the drive signal to control the CRT intensity level through the control-grid supply.

The output voltage level of the Z-Axis amplifier is determined by the voltage drop across R349 and R350 in reference to the voltage level at the summing point for the amplifier (base of Q345). The current through R349-R350 is determined by the input current from any combination of several sources, such as INTENSITY control, plug-in interface (unblanking, readout unblanking), and from Q320 and Q335. Q320 is an operational amplifier that sets the EXT INTENSITY INPUT connector signal to a level suitable for proper Z-Axis amplifier response. Q335 acts as an electronic switch to cause the CRT display intensity to increase when the BEAM FINDER switch is pushed. Q340 acts as an impedance-matching and bias-setting transistor for the Z-Axis amplifier. CR352 and current limiting resistor R352 act as a protection circuit for the Z-Axis amplifier in case of a high-voltage short.

High-Voltage Regulator

High-Voltage Primary. A repetitive, sinusoidal signal is produced by a regenerative feedback oscillator in the primary of T410 and induced into the secondary. Current drive for the primary winding is furnished by Q410.

The conduction of Q410 is controlled by the collector voltage of Q400.

High-Voltage Regulation. Regulation is accomplished by sampling the −1.5 kV across voltage divider R395A-R395B. If the output level of the cathode supply goes above the nominal −1.5 kV (goes more negative), the input base of Darlington transistor Q390 goes negative from its quiescent 0 V. The output of Q390 goes more positive, reducing the conduction of Q400 and Q410. This reduces the peak-to-peak sinusoidal signal amplitude, resulting in a reduced voltage in the secondary of T410. Conversely, if the output decreases below −1.5 kV (goes more positive), Q410 will conduct more, i.e., have a larger sinusoidal signal amplitude. CR395 and C395 form a delay turn-on circuit to prevent the CRT beam from coming on immediately at instrument turn-on. The delay time is controlled by the time it takes the (+) end of C395 to charge to +30.6 V through R392 from the +200 V power supply. At the moment the top of C395 reaches +30.6 V, diode CR395 will turn on and clamp the CR395-C395-R397-R395A junction at +30.6 V. R402 and C402 limit the bandwidth of the regulator to prevent oscillations.

High-Voltage Outputs

The secondary winding of T410 provides the negative and positive accelerating potentials for the CRT and the bias voltage for the control grid.

Positive accelerating voltage for the CRT screen is supplied by voltage doubler U410. The applied voltage to the input of U410 from the T410 secondary winding is about +1.5 kV peak-to-peak. The output voltage of U410 is about +7 kV at the CRT anode. The negative accelerating voltage for the CRT cathode is also obtained from the T410 secondary winding. CR412 half-wave rectifies the transformer output and supplies the −1.5 kV to the CRT cathode. R419 connects the CRT cathode voltage to the CRT filament to prevent cathode-to-filament breakdown.

Diodes CR420 and CR422 provide the rectified negative control voltage for the CRT control grid. The output level of this supply is set by the Intens Range adjustment R435. Diodes CR428 and CR430 clip the CRT grid bias voltage from the T410 secondary, to determine the operating level at the control grid. CR428 limits the negative excursion of the bias voltage, depending upon the output voltage of the Z-Axis amplifier. The positive clipping level at the cathode of CR430 is set by the Intens Range adjustment. CR420 acts as a DC restorer and CR422 as a rectifier. This results

in a DC level across R422 equal to the peak-to-peak excursion at the anode of CR430.

CRT Control Circuits

In addition to the INTENSITY control discussed previously, front-panel FOCUS and internal astigmatism controls have been incorporated for arriving at an optimum CRT display. FOCUS control R440 provides the correct voltage for the second anode in the CRT. Proper voltage for the third anode is obtained by adjusting Astig control R370. In order to obtain optimum spot size and shape, both the FOCUS and Astig controls are adjusted to provide the proper electrostatic lens configuration in the CRT.

The Geom adjustment R365 varies the positive level on the horizontal deflection plate shields to control the overall geometry of the display. The trace rotation control, R375, permits adjustment of the DC current through beam-rotation coil L375 to align the display with the horizontal graticule lines.

HORIZONTAL AMPLIFIER

The horizontal amplifier amplifies the push-pull horizontal deflection signal from the interface circuit board and applies it to the horizontal deflection plates of the CRT.

Input Amplifier

The horizontal signal from the interface circuit board is connected to the bases of Q200 and Q215. Under no-signal conditions, the bases of Q200 and Q215 are within 150 mV of ground. Resistive network R205-R207-R210-R212-R213, between the emitters of Q200 and Q215, controls the emitter degeneration of this stage. R212 provides a means of adjusting the emitter degeneration of the input amplifier and thereby controls the gain of the horizontal amplifier, within ±10%.

To compress an off-screen display so that it may be viewed on the CRT, the BEAM FINDER reduces the dynamic range of the input amplifier. This is done by disconnecting CR208 in the emitter circuitry of Q200-Q215, and supplying a reduced current through current setting resistors R205, R208, and R213.

Resistors R202 and R217 provide thermal compensation for the input amplifier, while R222 provides a means of correcting for differential unbalance in the amplifier or CRT.

Output Amplifier

Transistors Q240-Q244-Q250 and Q270-Q274-Q280 are connected as two separate current-driven feedback amplifiers. Input transistor Q240 (in the left output amplifier) is an NPN transistor for better response to positive-going signals, while input transistor Q270 (in the right output amplifier) is a PNP transistor for better negative-going signal response.

Negative feedback is provided from the collectors of output transistors Q244-Q250-Q274-Q280 to the base of input transistors Q240 and Q270 through feedback networks C242-R242 and C272-R272. Variable capacitors C242 and C272 adjust the transient response of the feedback networks to provide good linearity at fast sweep rates. The Zener diode-fast switching series diode, CR242-VR240 and CR272-VR270 (across each of the feedback networks in the output amplifier), turn on when the sweep passes the right edge of the CRT. This action stops the collectors of the output transistors and shunts out the feedback networks, thus current limiting the output amplifier. Capacitors C240, C250, and C280 are speed-up capacitors to improve the amplifier response to fast changes. Diodes CR246 and CR274 prevent Q244 and Q274 from going into saturation.

VERTICAL AMPLIFIER

The vertical amplifier provides the final amplification for the vertical signal before it is applied to the vertical deflection plates of the CRT. The vertical amplifier circuitry includes the delay line and part of the beam finder circuit, which reduces the final drive to compress an over-scanned display to within the viewing area of the CRT.

Delay Line

Delay line DL100 provides approximately 140 ns of delay for the vertical signal. This allows the time-base circuits time to initiate a sweep before the vertical signal reaches the CRT deflection plates. This delay of the vertical signal allows the leading edge of the signal originating the trigger pulse to be displayed when using internal triggering.

The delay line has a characteristic input impedance of about 75 ohms, or about 150 ohms from side-to-side.

Amplifier

The vertical amplifier consists of a high bandpass three-stage paraphase amplifier having an input sensitivity of approximately 35 mV/division and a voltage gain of about 115. The amplifier is differentially driven at the bases of Q100 and Q125 by the input signal from the delay line. R100 and R125 terminate the delay line.

The first amplifier stage consists of Q100, Q106, Q125, and Q130. The gain of this stage is determined by the ratio of the feedback resistors R104-R103 or R128-R129 and the emitter resistor R111. The networks parallel to the emitter resistor compensates for the signal losses in the delay line. R135 acts as a DC centering control, which compensates for resistive tolerance errors and CRT electrical center error in the vertical amplifier, and allows the mainframe input to be standardized.

The next stage of amplification consists of Q148, Q170, Q165, and Q172. Thermistor RT157 resistor R157 varicap CR146 and capacitor C160 between the emitters of Q148 and Q165 comprise a thermal compensation network to correct for frequency loss with temperature changes. The two RC networks (R151-C156 and R155-C153-C155) in the emitters of Q148 and Q165, and the RCL network in the collectors of Q148 and Q165 provide high frequency compensation.

The final amplifier stage consists of Q180, Q188, Q182, and Q190. R175 provides a means of adjusting the vertical amplifier gain within a ±20% range.

Pushing the BEAM FINDER compresses an off-screen display to determine its location. This is accomplished by turning off Q140, when the BEAM FINDER is pushed, which reduces the standing current in the second amplifier stage. This lowers the voltage drop across R172 and R176, which lowers the standing current in the final amplifier stage. The lower final amplifier stage standing current reduces the possible scan on the CRT.

STORAGE CIRCUIT

The cathode-ray tube is a transmission halftone storage tube. The collector mesh is a coarse mesh, which accelerates electrons toward the target area. The target (storage mesh) is a fine mesh with a highly insulative dielectric layer deposited on it. It is in the dielectric layer that storage occurs. The flood guns cover the entire storage target with a continuous stream of low velocity electrons; these electrons are prevented from reaching the phosphor screen unless a display has been written on the storage mesh.

The collimation bands (electrodes) are used as a lens which uniformly distributes flood-gun electrons over the storage target area. In the non-store mode, the collimation bands have no control over the CRT.

Switching from the non-store mode to the store mode is done by pushing in the STORE pushbutton. When changing modes from non-storage to storage operation, an erase cycle is generated automatically.

Flood-Gun Filaments

The flood-gun filament supply for the CRT consists of VR690-VR691 and emitter follower Q690. The power to heat the filaments is derived from the −20 V power supply. VR690-VR691 sets the base voltage of Q690 and provides regulation.

Flood-Gun Cathode

The flood-gun cathode is switched either on or off by switching transistors Q675, Q680 and Q685. Two signals control whether the flood-gun cathode is turned on; they are:

a. The STORE switch pushed in signal turns on the flood-gun cathode.

b. The SAVE pushbutton, S675, when depressed either turns the flood-gun cathode completely off (PERSIST control fully clockwise), or if the PERSIST control is turned away from its fully clockwise position, allows the flood-gun cathode to be pulsed at a low duty factor.

When the D41 power is turned off, in less than a microsecond Q700 turns off. This eliminates the negative voltage that would result from the slow decay of the power supply filter capacitors, leaving only the positive voltage present at the base of Q675. Q675 is turned on causing Q680 and Q685 to be off. This prevents damage to any stored information if the save mode is being utilized, since there is not any flood-gun cathode current available.

Flood-Gun Anode

The flood-gun anode circuit consists of operational amplifier Q670-Q672. The operational amplifier is used as a

current-to-voltage conversion amplifier. A composite erase pulse is supplied to the base of Q670 to hold the flood-gun anode high during the erase cycle.

Collimation Electrodes (CE)

The CE 1 and 2, and the CE 3 circuits consist of an emitter follower, Q655 and Q600, with base-emitter reverse voltage protection furnished by CR655 or CR600. R655, CE 1 and R600, CE 3 adjustments control the voltage level of the CE 1 and 2, and CE 3 respectively. CE 1 and 2 voltage varies between store and non-store modes of operation. R655, CE 1 adjustment sets the CE 1 and 2 level in the store mode, while R654 and VR655 sets the CE 1 and CE 2 level in the non-store mode. R655-R657 divider is allowed to float in the non-store mode.

Collector Mesh

Emitter follower Q595, base-emitter reverse voltage protection diode CR595 and Zener diode VR595 make up the collector mesh circuitry. VR595 sets the base voltage for Q595.

Storage Mesh

Q580, Q575 and Q585 form an operational amplifier that is used as a current-to-voltage conversion amplifier. Internal adjustments, R572, Prep Level, and R590, Op Level, set the quiescent operating levels for the CRT in the storage mode. R585, WRITING SPEED control, allows a small adjustment to be made in the operate level, which increases the CRT's ability to store a fast waveform. During the erase cycle the storage mesh is made a high positive for 50 ms, returned to its operate level for 10 ms, then made a slightly positive level for 440 ms. The two positive-going erase signals (see Fig. 2-1) are supplied to the storage mesh by the collectors of Q515 (50 ms) and Q555 (440 ms).

Erase Generator

Pushing the ERASE pushbutton creates a negative pulse at the base of Q510. R665-R500-C500 is a contact bounce remover network for the ERASE pushbutton with R500 used to dampen any ringing. Q510 and Q515 form a 50 ms monostable multivibrator; C514 and R507 are the timing components. Coupling capacitor C528 couples the 50 ms multivibrator to the input of the 10 ms monostable multivibrator consisting of Q530-Q535. The timing components for Q530-Q535 are C534 and R530. The output from the 10 ms multivibrator is coupled to the input of the 440 ms monostable multivibrator by C538. Q550-Q555, along with timing components C554 and R545 form the 440 ms monostable multivibrator. The monostable multivibrators are cascaded to provide a sequential pulse train. Diodes CR560, CR562 and CR564 make up an OR gate to supply a composite erase signal to the flood-gun anode circuit.

The signal available from the collector of Q550 is used to retrigger the erase generator when the ERASE pushbutton is held depressed.

Variable Persistence and Save

Q625 and Q640 form a monostable multivibrator that is triggered by the output of the 10 ms pulse generator consisting of programmable unijunction transistor Q610. The timing components for the monostable multivibrator are C625, R622 and R620 PERSIST control. The 10 ms pulse generator timing components are C610, R608 and R609. Q635 acts as a switch for R620 PERSIST control.

When S610 STORE pushbutton is pushed in, the 10 ms pulse generator feeds pulses to the storage mesh to increase the background level slightly for better storage and to the Q625-Q640 monostable multivibrator for triggering.

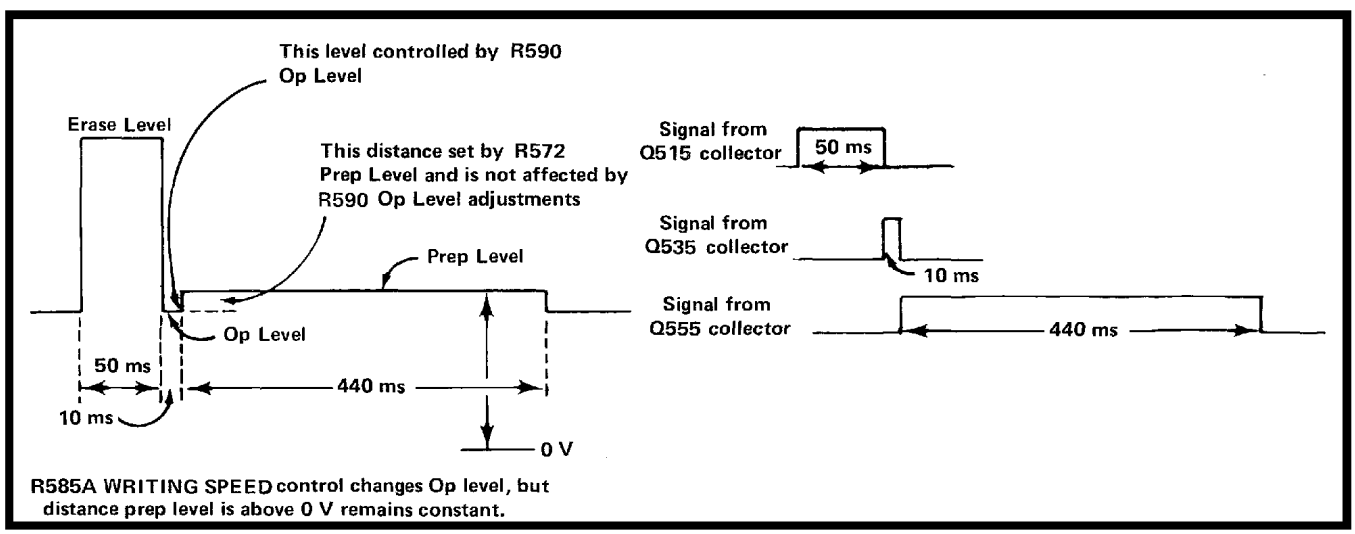


Fig. 2-1. Erase cycle waveform as seen at the storage mesh-connection to the crt.

If S675 SAVE pushbutton is not pushed in (out position), then the output of Q640 (Fig. 2-2) is supplied via CR640 to the storage mesh.

When S675 SAVE pushbutton is pushed in, then the output of Q640 (Fig. 2-2) is supplied to the flood-gun cathode. Pushing S675 in forward-biases CR650 and holds pins 16A and 17A of the time-base plug-in high, preventing a sweep.

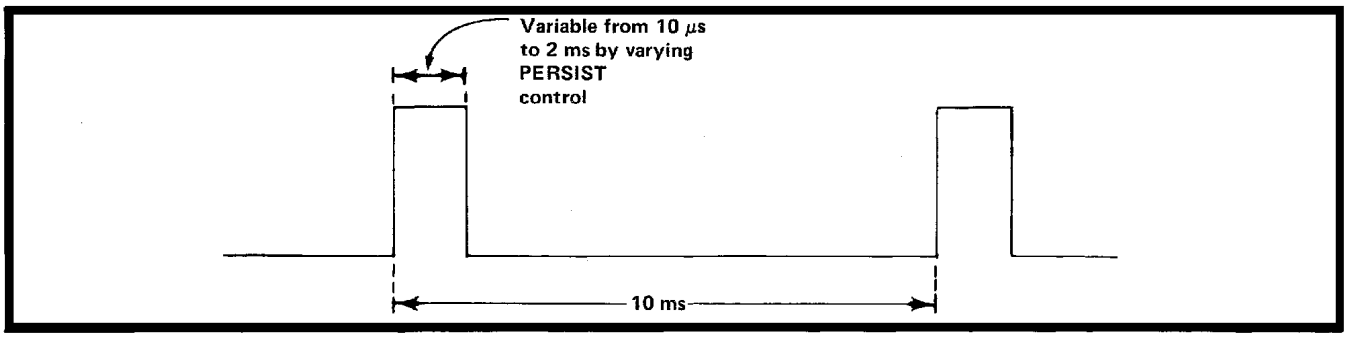


Fig. 2-2. Variable Persistence and Save circuit output waveform.

CONTROLS AND CONNECTORS

STORE Pushbutton

A push-push button that selects storage operation of the CRT. Button out position selects normal operation without storage.

ERASE Pushbutton

Momentary pushbutton that initiates erasure of the displayed information stored on the CRT screen.

SAVE Pushbutton

A push-push button that when pushed prevents accidental erasure or damage to the stored information. The pushed position also allows the stored information to be retained for long periods of time.

WRITING SPEED Control

Controls the writing speed and brightness of the stored displays.

FOCUS Control

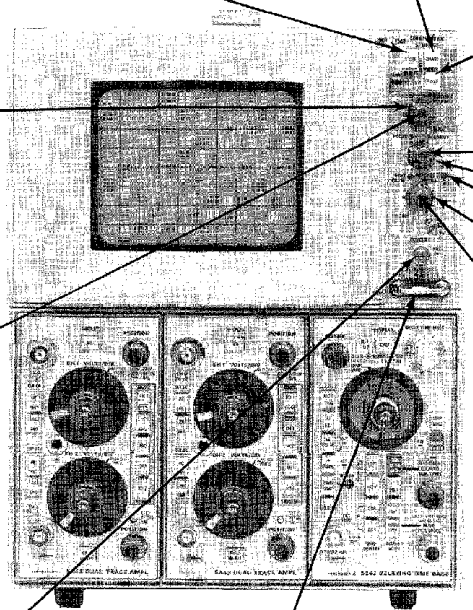
Provides adjustment to obtain a well-defined display.

INTENSITY Control

Controls display brightness.

VARIABLE PERSIST Control

Controls the display only when the instrument is operating in the storage mode. If the SAVE pushbutton is in its out position, the control operates as a persistence control to determine the retention of the stored display (full counterclockwise is maximum retention). With the SAVE pushbutton pushed in, the control operates as a save-time control to extend the retention time longer than is available with the normal storage mode. The fully clockwise position (maximum retention) does not allow viewing the stored display.



BEAM FINDER Pushbutton

Brings beam on-screen; limits display to area inside graticule and intensifies beam.

READOUT INTENS Control

Controls brightness of the readout portion of the CRT display. In the fully counterclockwise position, the readout system is inoperative.

GRAT ILLUM Control

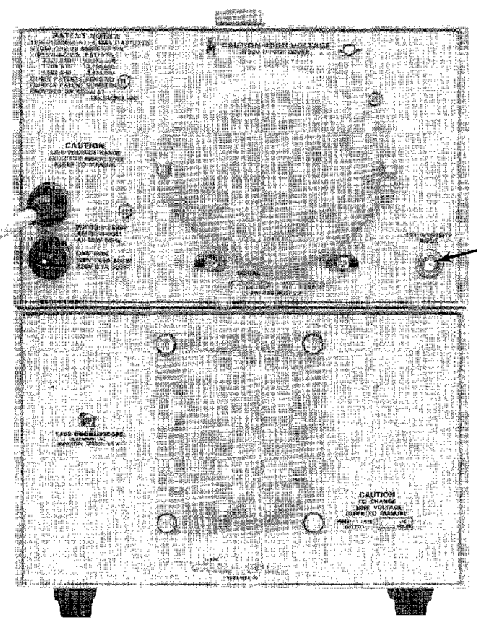
Controls Graticule illumination.

POWER Switch

Turns instrument power on or off.

CALIBRATOR Loop

Provides positive-going accurate 400-millivolt and 4-milliampere squarewave at a frequency of twice the line frequency for calibration and probe compensation.



EXT INTENSITY INPUT Connector

Permits application of Z-axis signals to the CRT (DC coupled). Positive-going signal increases intensity.

ADJUSTMENTS

Adjustment is generally required after a repair has been made, or after long time intervals in which normal aging of components may affect instrument accuracy. For initial inspection to verify instrument operation, the basic operation procedure in section 1 should be used (the instrument is checked with its covers on, using a minimum of peripheral equipment).

Before complete adjustment, thoroughly clean and inspect this instrument as outlined in the service section of the 5403 manual. Also, the system manual contains information for general maintenance of this instrument, including preventive maintenance, component identification and replacement, etc.

Services Available

Tektronix, Inc., provides complete instrument repair and adjustment at local Field Service Centers and at the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

Equipment Required

1. Time-base plug-in unit.

2. Two vertical plug-in units, both of which must be dual-trace units.

3. Sinewave generator with a variable 0-6 volt signal amplitude at 1 kHz and 60 MHz.

Preliminary Procedure

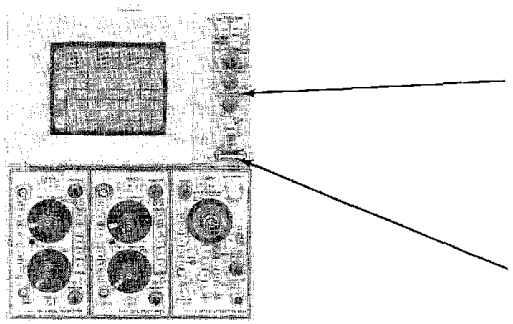
NOTE

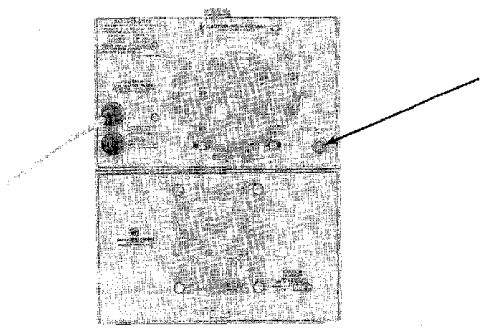
The performance of this instrument can be checked at any temperature within the 0°C to +50°C range. Make any adjustments at a temperature of +25°C, ±5°C.

a. Install a vertical dual-trace plug-in in the left plug-in compartment and a time-base plug-in in the right plug-in compartment.

b. Check that the correct nominal line-selector block has been installed on the line-selector pins and that the regulating range selected includes the input line voltage, see Installation section for complete instructions.

c. Connect the 5403-D41 to the line voltage source and pull the POWER switch out to turn the instrument on.





1. Check Trigger Amplifier

Connect a properly terminated 60 MHz[1] signal to channel 1 on the vertical plug-in. Set the time-base sec/div switch to .1 μ. Set the vertical and time-base plug-in triggering controls to trigger on + slope, channel 1, and left plug-in compartment signal.

Adjust the output amplitude of the sine-wave generator for exactly 1 major graticule division of signal. Check that a stable display can be obtained.

2. Check Beam Finder

Using the signal established in step 1 press the BEAM FINDER pushbutton. Check that the display intensity increases and that the signal cannot be positioned out of the viewing area as long as the BEAM FINDER pushbutton is depressed.

Disconnect the signal.

3. Check Calibrator

Connect the signal from the front-panel CALIBRATOR loop to channel 1 on the vertical plug-in. Set the time-base sec/div switch to 5 m and the vertical channel 1 volts/div to .1. Adjust the time-base triggering controls for a stable display. Check for a display four major graticule divisions high.

Disconnect the signal.

4. Check Z-Axis Amplifier

Connect a 5-volt, 1-kHz sine-wave signal to the EXT INTENSITY INPUT connector. Also, use the sine-wave signal to externally trigger the time-base plug-in. Set the time-base plug-in controls for an external, automatic, triggered 1 ms sweep. Check that bright spots occur at regular intervals along the trace. It may be necessary to reduce the trace brightness to observe the Z-axis modulation.

Disconnect the signal.

5. Check Chop and Alternate

Set the time-base sec/div switch to 50 m and push the chop pushbutton in. Set the vertical plug-in for dual-trace operation. Check for two spots, one above the other, going across the CRT.

Install a second dual-trace plug-in in the center plug-in compartment and set its controls for dual-trace operation. Set the time-base chop pushbutton to its out position. Check for two sweeps for the left plug-in (one for each channel), then two sweeps for the center plug-in, alternately.

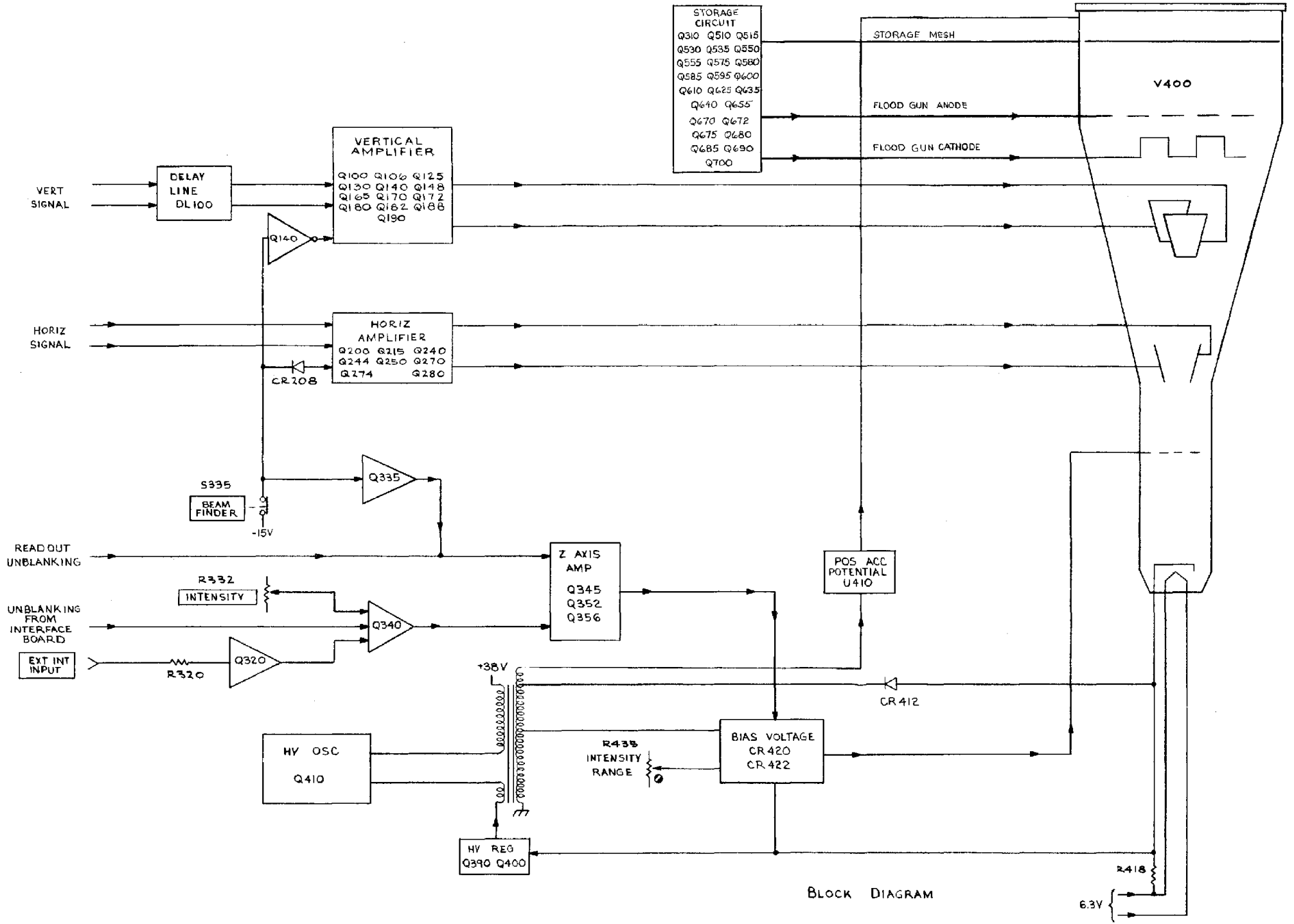
6. Orthogonality—R364

Connect 1 ms markers from the time marker generator to the vertical plug-in input connector using a coaxial cable.

Set the time base controls for a 1 ms/Div sweep with auto triggering. Position the trace to the horizontal center line of the graticule.

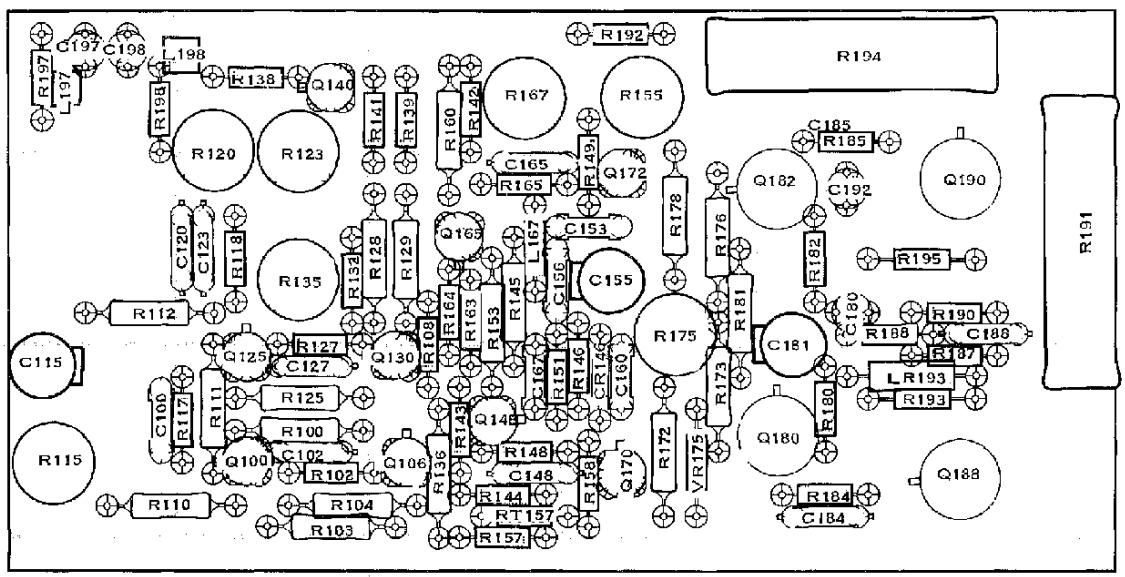
Adjust R364 so that the vertical time markers make a 90° angle with the trace as observed at the graticule center. The adjustment of R364 may have to be compromised to make the angle as closely as possible to the desired 90°.

[1] A 5A48 Dual Trace Amplifier and a 5B42 Delaying Time Base plug-in units were used for this check. If other plug-in units are used the trigger amplifier bandpass will depend on the vertical plug-in unit bandpass and the triggering capabilities of the time-base plug-in unit.



Block Diagram

PARTS LOCATION GRID



Located on back of board
C173

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C100	A3	C184	E3	CR146	D3	Q100	B3	R100	B3	R129	C2	R157	C3	R187	F2
C102	B3	C185	E1			Q106	C3	R102	B3	R132	B2	R158	D3	R188	E2
C115	A2	C188	F2	L167	C2	Q125	B2	R103	B3	R135	B2	R160	C1	R190	F2
C120	B2	C192	E2	L197	A1	Q130	C2	R104	B3	R136	C3	R163	C2	R191	F2
		C197	A1	L198	A1	Q140	B1	R108	C2	R138	B1	R164	C2	R192	D1
C123	B2	C198	A1			Q148	C3	R110	A3	R139	C1	R165	C2	R193	E3
C127	B3			LR193	E3	Q165	C2	R111	B3	R141	C1	R167	C1	R194	E1
C148	C3					Q170	D3	R112	A2	R142	C1	R172	D3	R195	E2
C153	D2					Q172	D1	R115	A3	R143	C3	R173	D3	R197	A1
C155	D2					Q180	E3	R117	B3	R144	C3	R175	D2	R198	A1
C156	D2					Q182	E2	R118	B2	R145	C2	R176	D2		
C160	D3					Q188	F3	R120	B1	R146	D3	R178	D2	RT157	C3
C165	C1					Q190	F2			R148	C3	R180	E3		
C167	C3							R123	B1	R149	D1	R181	D2	VR175	D3
C180	E2							R125	B3	R151	D3	R182	E2		
C181	E2							R127	B2	R153	C2	R184	E3		
								R128	C2	R155	D1	R185	E1		

ADJUSTMENTS

Equipment Required

1. Time-base plug-in unit with a triggered sweep rate of at least 0.1 μs. For example, a Tektronix 5B42 Delaying Time Base or any time base that is compatible with the Tektronix 5403-D41 Oscilloscope.

2. Special Tektronix Calibration Fixure 067-0680-00.

3. Sine-wave generator with output frequencies of 3 MHz and 100 MHz.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to +50°C range. Make any adjustments at a temperature of +25°C, ±5°C.

a. Remove the cabinet panels covering the D41.

b. Install the 067-0680-00 Calibration Fixture in the left plug-in compartment and a time-base plug-in in the right plug-in compartment.

c. Check that the correct nominal line-selector block has been installed on the line-selector pins and that the regulating range selected includes the input line voltage, see Installation section for complete instructions.

d. Connect the 5403-D41 to the line voltage source and pull the POWER switch out to turn the instrument on.

VERTICAL AMPLIFIER

1. Vertical Centering, R135

Install the 067-0680-00 Calibration Fixture in left plug-in compartment. Set the 067-0680-00 test switch to com mode. Adjust R135 to center the trace vertically on the graticule.

Remove the Calibration Fixture from the left plug-in compartment and install it into the center plug-in compartment. Trace position should be within 0.5 major divisions of vertical graticule center.

2. Vertical Gain, R175

Move the 067-0680-00 from the center to the left plug-in compartment. Set the test switch of the Calibration Fixture to vert or horiz gain and depress the 1 kHz rep rate switch. Position the bright trace to the center of the graticule with the position control of the 067-0680-00.

Adjust R175 so that the horizontal traces coincide with the horizontal graticule lines, one trace per division. Place the first and last trace of the center seven traces exactly on their respective graticule lines.

3. Vertical Compensation

Flat Top, R120, R123

Set the test switch of the 067-0680-00 Calibration Fixture to vert or horiz + step resp and depress the 100 kHz rep rate switch. Center the square-wave signal, then increase its amplitude to 6 major divisions with the amplitude control of the 067-0680-00.

Change the sweep rate of the time-base plug-in to 1 μs and adjust R120 for a flat waveform top. Change the sec/div switch of the time-base plug-in to 0.5 μs sweep rate and adjust R123 for optimum level top of the signal. Repeat as necessary to obtain optimum flat top on the waveform.

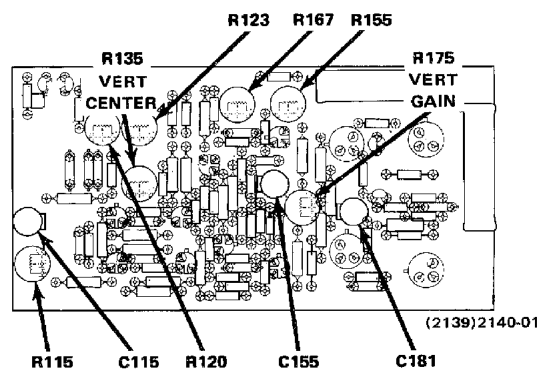
Square Front Corner, C115, R115, C155, R155, R167, and C181.

Depress the 1 MHz rep rate switch on the 067-0680-00 Calibration Fixture. Set the main sec/div switch of the time-base plug-in to 0.1 μs, and adjust the main trig level for a stable step function display.

Adjust C637 (this adjustment located on interface board between vertical components, SN B061533 - up), C115, R115, C155, R155, R167, and C181 for a square front corner. There is direct interaction between C115 and R115 and between C155 and R155. Best results are usually obtained by setting R115 fully cw, then adjusting C115.

Adjust R155 and R167 for minimum ringing of front corner. Adjust C637 (on interface board between vertical compartments, SN B061533 - up), C155 and C115 for a level front corner. After other front corner adjustments have been made, adjust C181 for optimum rise-time and minimum front corner spike.

Position effect: Using a 6 division square-wave, position it down so 3 divisions remain on screen. The front corner aberrations should not exceed 0.36 division (6%).



Change the STEP RESP. to — and position the 6 division squarewave up so 3 divisions remain on screen. The front corner aberrations should not exceed 0.36 division.

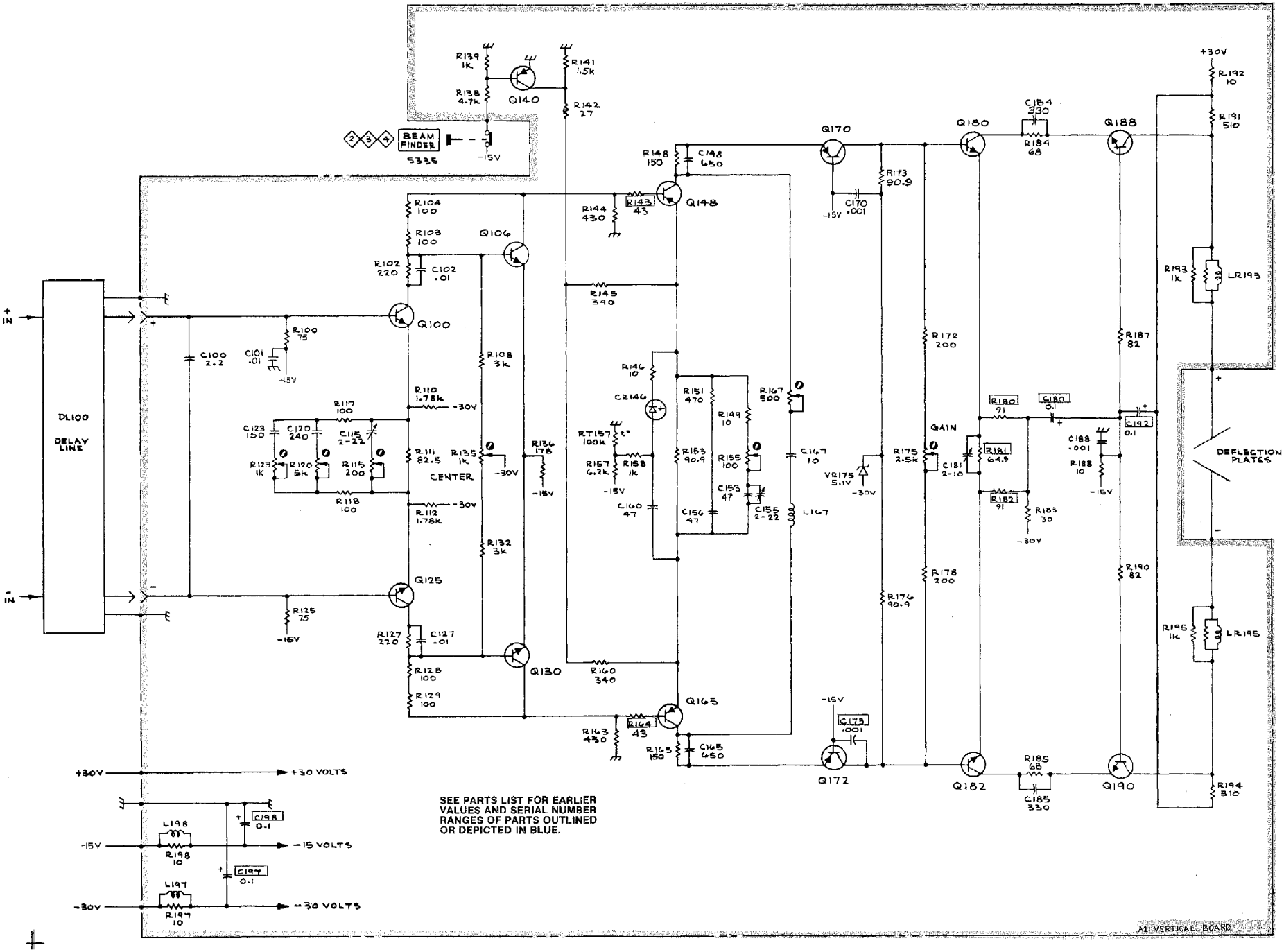
Install Calibration fixture into right plug-in compartment and repeat checks.

4. Check Vertical Bandwidth

Set the 067-0680-00 test switch to vert or horiz freq resp. Connect a 3 MHz sine wave from a 50 Ω source to the 067-0680-00 aux in cw in (freq resp) connector. Adjust the output amplitude of the sine-wave generator to obtain a vertical CRT display of six major graticule divisions.[1] (Green light must go on.)

Change the sine-wave frequency to 90 MHz. Check that the vertical CRT display is still at least 4.2 major graticule divisions.

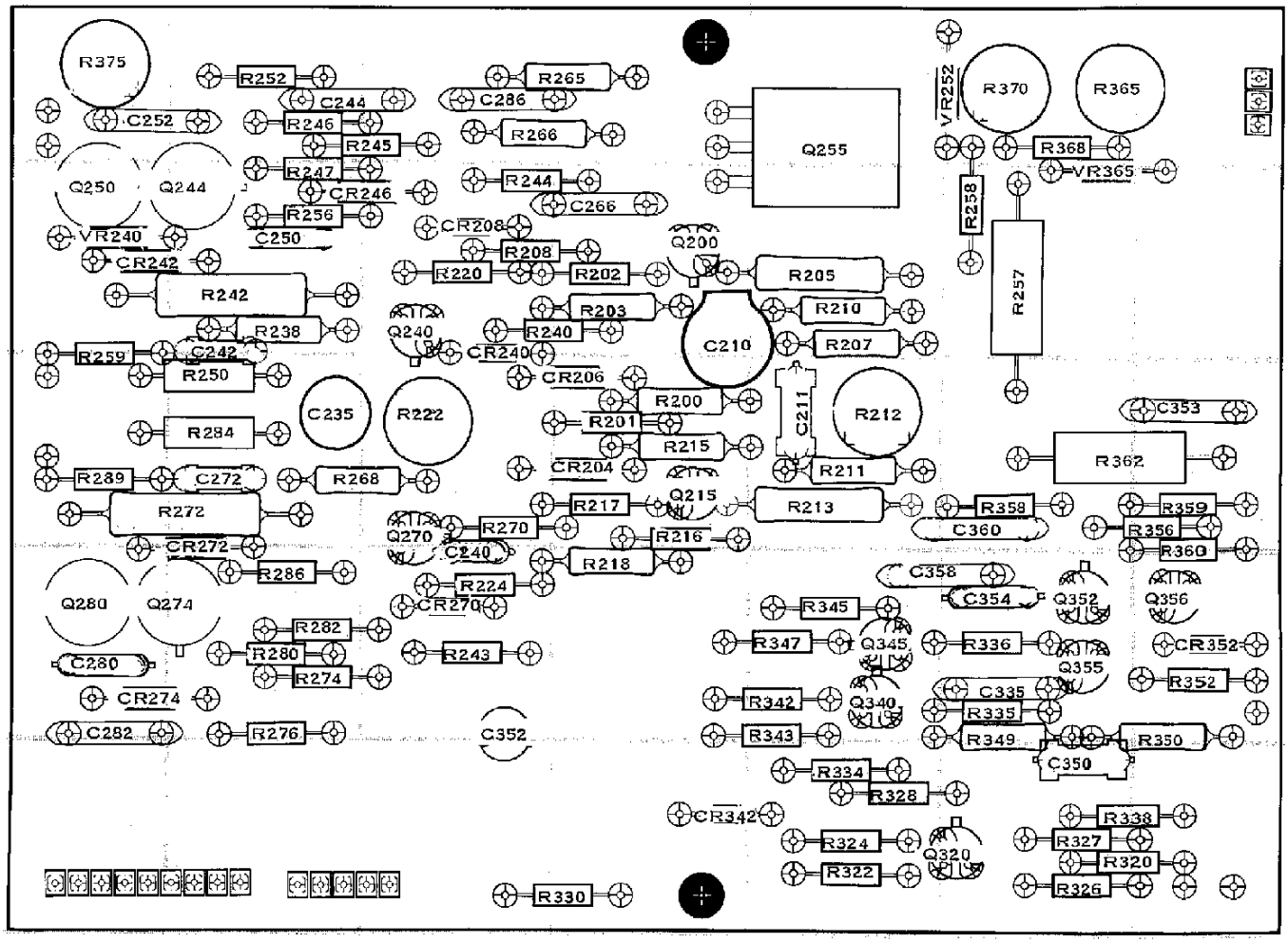
[1] Refer to the 067-0680-00 Calibration Fixture manual for how to get a leveled sine-wave output.



REV. D, MARCH 1977

VERTICAL AMPLIFIER ◇1 DEM 1174

PARTS LOCATION GRID



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C210	E2	C353	G3	CR204	D3	Q200	D2	R200	D3	R242	B2	R289	A3	R352	G4
C211	E3	C358	E4	CR206	D3	Q215	D3	R201	D3	R243	C4	R320	F5	R356	G3
C235	B3	C360	F3	CR208	C2	Q240	C2	R202	D2	R250	B3	R322	E5	R358	F3
C240	C3			CR240	C2	Q244	B2	R203	D2	R252	B1	R324	E5	R359	G3
C242	B2			CR242	A2	Q250	A2	R205	E2	R256	B2	R326	F5	R360	G3
C244	B1			CR246	C2	Q255	E1	R207	E2	R257	F2	R327	F5	R362	F3
C250	B2			CR270	A4	Q270	C3	R208	C2	R258	F2	R328	E5	R365	F1
C252	A1			CR272	B3	Q274	B4	R210	E2	R259	A2	R330	D5	R368	F1
C266	D2			CR274	B4	Q280	A4	R211	E3	R265	C1	R334	E5	R370	F1
C272	B3			CR342	D5	Q320	E5	R212	E3	R266	C1	R335	F4	R375	A1
C282	H-4			CR352	G4	Q340	E4	R213	E3	R268	C3	R336	F4		
C280	A4					Q345	E4	R215	D3	R270	C3	R338	F5		
C282	A4					Q352	F4	R216	D3	R272	B3	R342	E4	VR240	A2
C286	C1					Q355	F4	R217	D3	R274	B4	R343	E4	VR252	F1
C335	F4					Q356	G4	R218	D4	R276	B4	R345	E4	VR270	B4
C350	F5							R220	C2	R280	B4	R347	E4	VR365	F1
C352	C4							R222	C3	R282	B4	R349	F4		
C354	F4							R224	C4	R284	B3	R350	G4		
								R238	B2	R286	B4				
								R240	C2						

ADJUSTMENTS

Equipment Required

1. Vertical plug-in unit.

2. Time-base plug-in unit.

3. Special Tektronix calibration fixture 067-0680-00.

4. Time-marker generator having 10 ns and 1 ms markers.

5. Sinewave generator with output frequencies of 50 kHz and 2 MHz.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to +50°C range. Make any adjustments at a temperature of +25°C, ±5°C.

a. Remove the cabinet panels covering the D41.

b. Install a vertical plug-in in the left plug-in compartment and a time-base plug-in in the right plug-in compartment.

c. Check that the correct nominal line-selector block has been installed on the line-selector pins and that the regulating range selected includes the input line voltage, see Installation section for complete instructions.

d. Connect the 5403-D41 to the line voltage source and pull the POWER switch out to turn the instrument on.

HORIZONTAL AMPLIFIER

1. Astig, R370

Set the time-base main sec/div switch to amp. Turn the FOCUS control fully clockwise, then adjust R370 for a nearly round spot on the CRT. Adjust the FOCUS control for smallest spot.

2. Trace Rotation, R375

Set the time-base controls for a 1 ms/div sweep with auto triggering. Adjust R375 to make the trace parallel to the horizontal graticule lines.

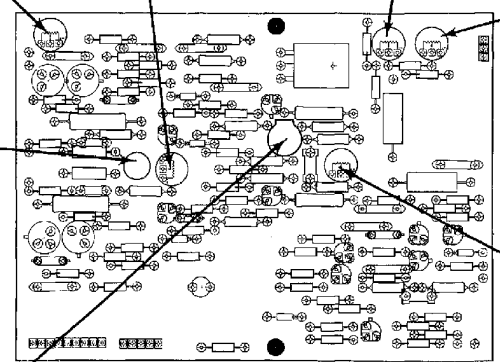
3. Horizontal Centering, R222

Remove the vertical plug-in from the left plug-in compartment and install the time-base plug-in in its place. Install the 067-0680-00 calibration fixture in the right plug-in compartment.

Set the 067-0680-00 test switch to com mode. Adjust R222 to center the trace horizontally on the graticule.

4. Geom, R365

Set the 067-0680-00 (located in the right plug-in compartment) test switch to vert or horiz gain and depress the 1 MHz rep rate switch. Position bright vertical trace to center graticule line. Adjust R365 for minimum bow or tilt of vertical trace, using graticule as reference. Check that the bowing or tilting does not exceed one-half minor graticule division. The adjustment of R365 may have to be a compromise to bring all points within the tolerance.



5. Horiz Gain, R212

Adjust R212 for exactly eight major graticule divisions between the second and eighth vertical traces. Check for a display of one vertical line per major graticule division within one-quarter minor division.

8. 5 ns Timing, C235

DO NOT make this ADJUSTment unless a time-base plug-in having a 5 ns sweep is available.

Connect 5 ns markers from the time-marker generator to the 067-0680-00, aux in cw in (freq resp) connector, using a coaxial cable. Adjust the 067-0680-00 amplitude control for a marker height of about five major divisions.

Set the time-base main sec/div switch to .05 and push the mag pushbutton in. Adjust the time-base triggering controls for a stable display.

Adjust C235 for one 5 ns marker per division over the center eight major graticule divisions. Check linearity (±6 1/2%) of entire sweep, excluding the first three and the last ten major divisions.

C235 and C210 interact with each other. It therefore may be necessary to recheck step 7 and this step.

7. 10 ns Timing, C210

Interchange the 067-0680-00 and time-base plug-ins (a 5B42 plug-in or a time-base plug-in having a 10 ns sweep must be used), i.e., 067-0680-00 in left plug-in compartment and time-base in right plug-in compartment. Set 067-0680-00 test switch to aux in. Connect 10 ns markers from the time-marker generator to the 067-0680-00, aux in cw in (freq resp) connector, using a coaxial cable. Adjust the 067-0680-00 amplitude control for a marker height of about five major divisions.

Set the time-base main sec/div switch to .1 and push the mag pushbutton in. Adjust the time-base triggering controls for a stable display.

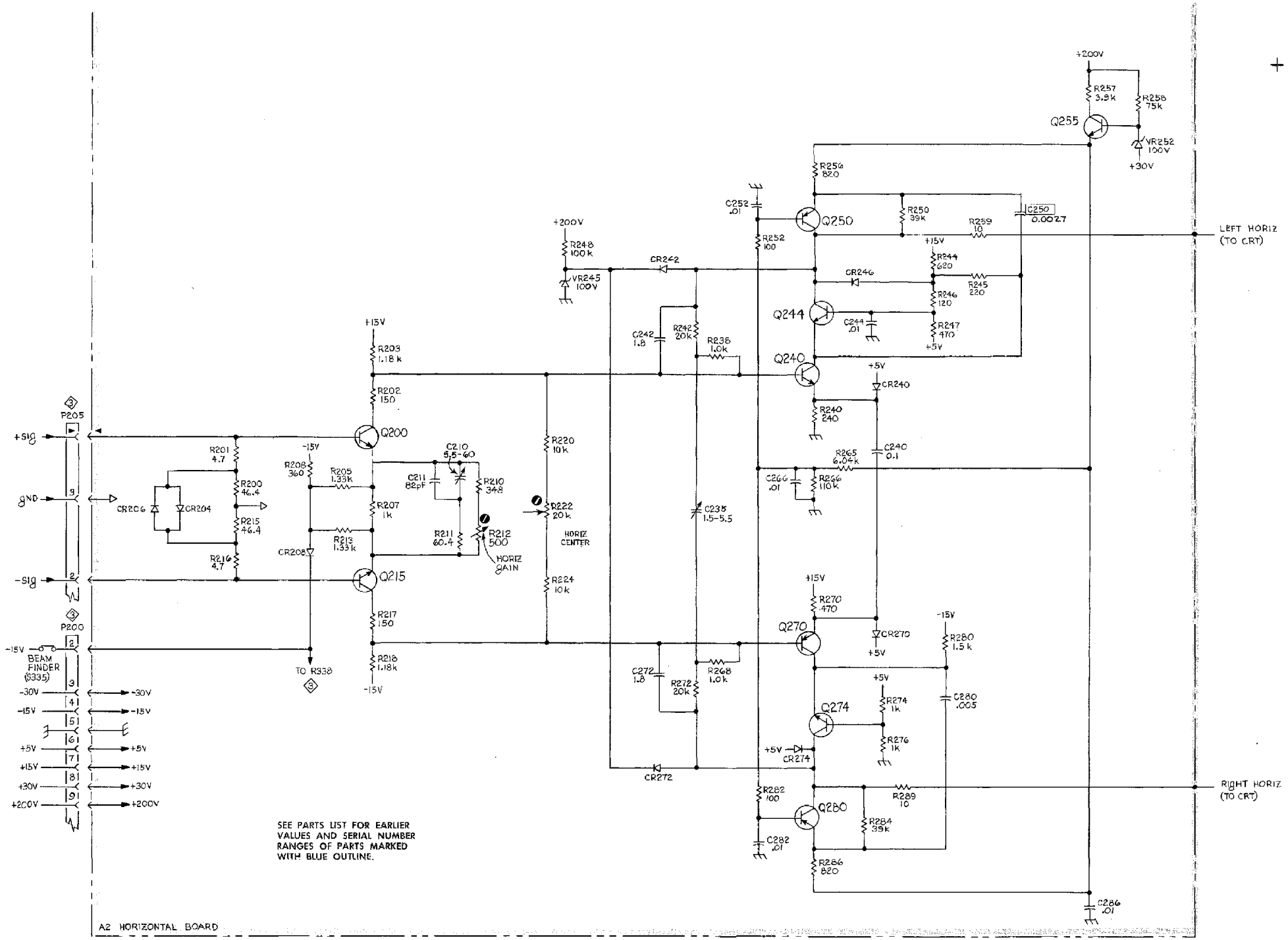
Adjust C210 for one 10 ns marker per division over the center eight major graticule divisions. Check linearity (±6 1/2%) of entire sweep, excluding the first three and the last ten major divisions.

6. Check Horizontal Bandwidth

Set the 067-0680-00 test switch to aux in. Connect a correctly terminated 50 kHz sine wave to the 067-0680-00 aux in cw in (freq resp) connector. Adjust the output amplitude of the sine-wave generator to obtain a horizontal CRT display of six major graticule divisions.[1]

Change the input sine-wave frequency to the 067-0680-00 to 2 MHz. Check that the horizontal CRT display is still at least 4.2 major graticule divisions.

[1] Refer to the 067-0680-00 Calibration Fixture manual for how to get a leveled sine-wave output.


+200V
R257 3.9k
R258 75k
Q255
VR252 100V
+30V
R256 820
C252 .01
Q250
R250 39k
R259 10
C250 0.0027
LEFT HORIZ (TO CRT)
+200V
R248 100k
VR245 100V
CR242
R252 100
+15V
R244 620
CR246
R245 220
R246 120
Q244
C244 .01
R247 470
+5V
C242 1.8
R242 20k
R236 1.0k
Q240
+5V
CR240
R240 240
C240 0.1
R265 6.04k
C266 .01
R266 110k
+15V
R203 1.18 k
R202 150
Q200
P205
+SIG
GND
-SIG
P200
-15V
BEAM FINDER (S335)
-30V
-15V
+5V
+15V
+30V
+200V
R201 4.7
R200 46.4
R215 46.4
R216 4.7
CR206
CR204
-15V
R208 360
R205 1.33k
R207 1k
R213 1.33k
CR208
C211 82pF
C210 5.5-60
R210 348
R211 60.4
R212 500
HORIZ GAIN
Q215
R217 150
R218 1.18k
-15V
TO R338
R220 10k
R222 20k
HORIZ CENTER
R224 10k
C235 1.5-5.5
+15V
R270 470
CR270
+5V
Q270
-15V
R280 1.5 k
C280 .005
C272 1.8
R272 20k
R268 1.0k
+5V
R274 1k
Q274
R276 1k
+5V
CR274
CR272
R282 100
Q280
R284 39k
R289 10
RIGHT HORIZ (TO CRT)
C282 .01
R286 820
C286 .01
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
A2 HORIZONTAL BOARD

ADJUSTMENTS
HIGH VOLTAGE
POWER SUPPLY CIRCUIT BOARD

Equipment Required

For intensity range adjustment a vertical plug-in is required.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to +50°C range. Make any adjustments at a temperature of +25°C, ±5°C.

a. Remove the cabinet panels covering the D41.

b. Install a vertical plug-in in the right plug-in compartment.

c. Check that the correct nominal line-selector block has been installed on the line-selector pins and that the regulating range selected includes the input line voltage, see Installation section for complete instructions.

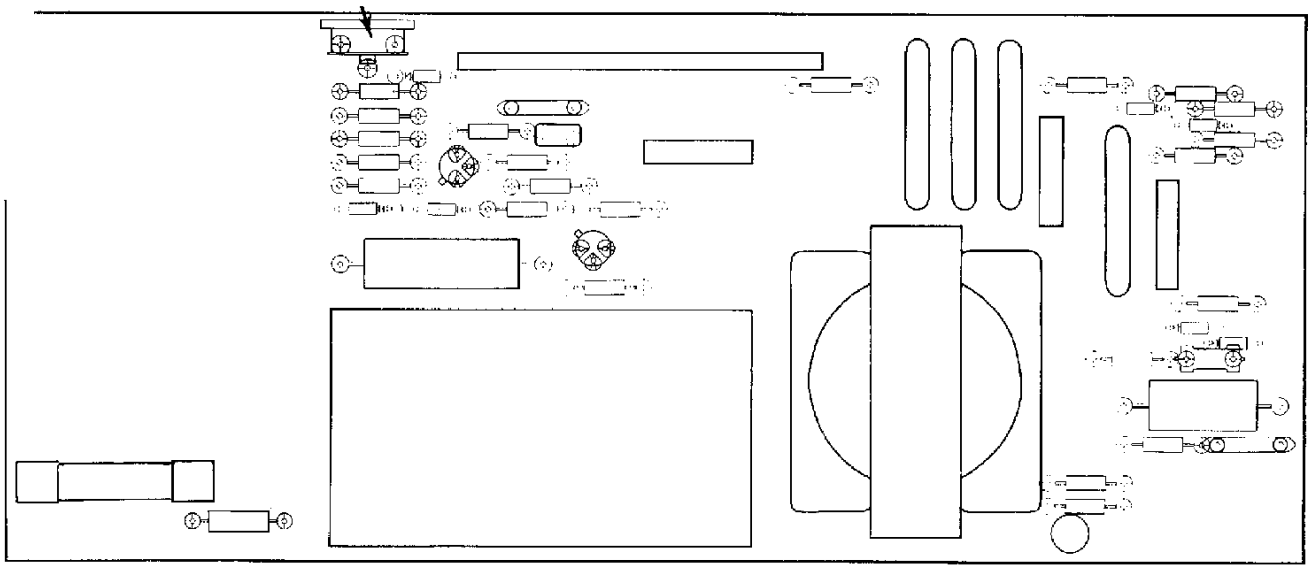
d. Connect the 5403-D41 to the line voltage source and pull the POWER switch out to turn the instrument on.

NOTE

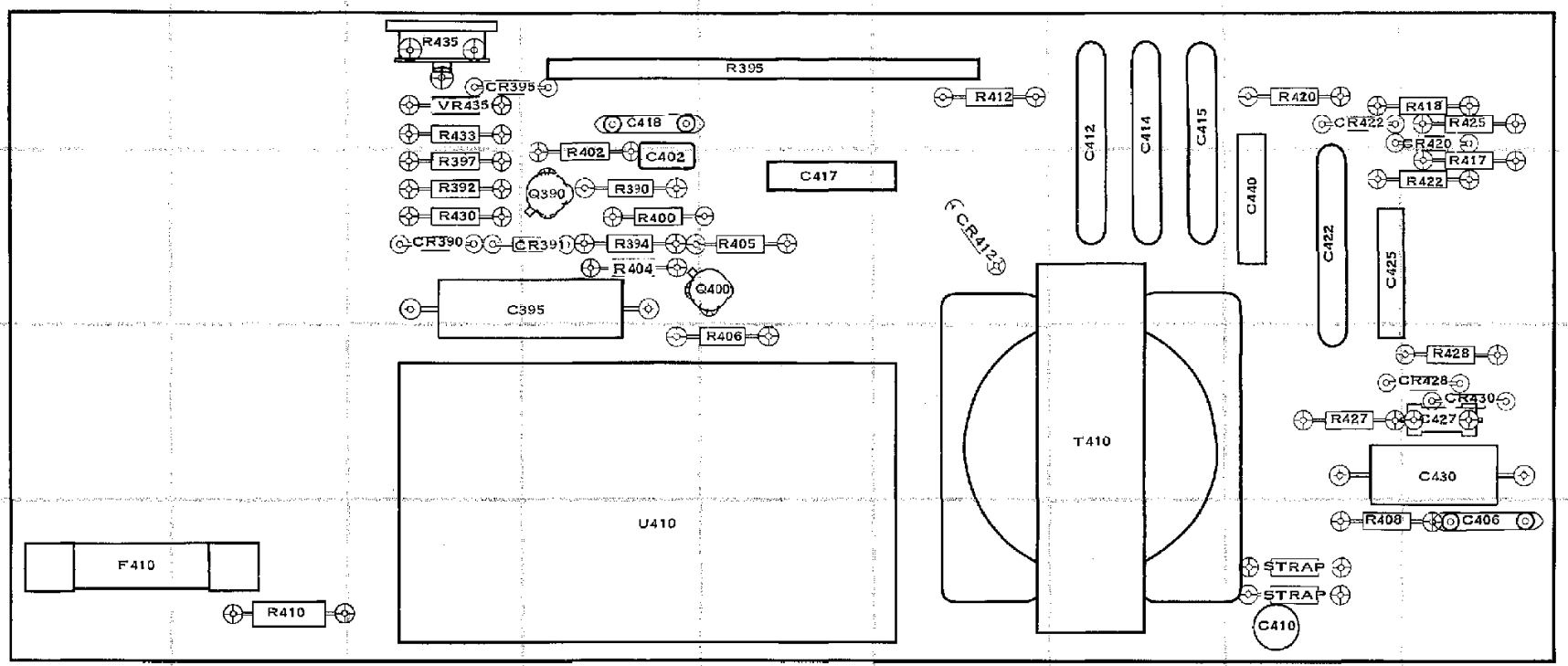
This adjustment need only be made if the CRT was changed.

1. Intensity Range, R435

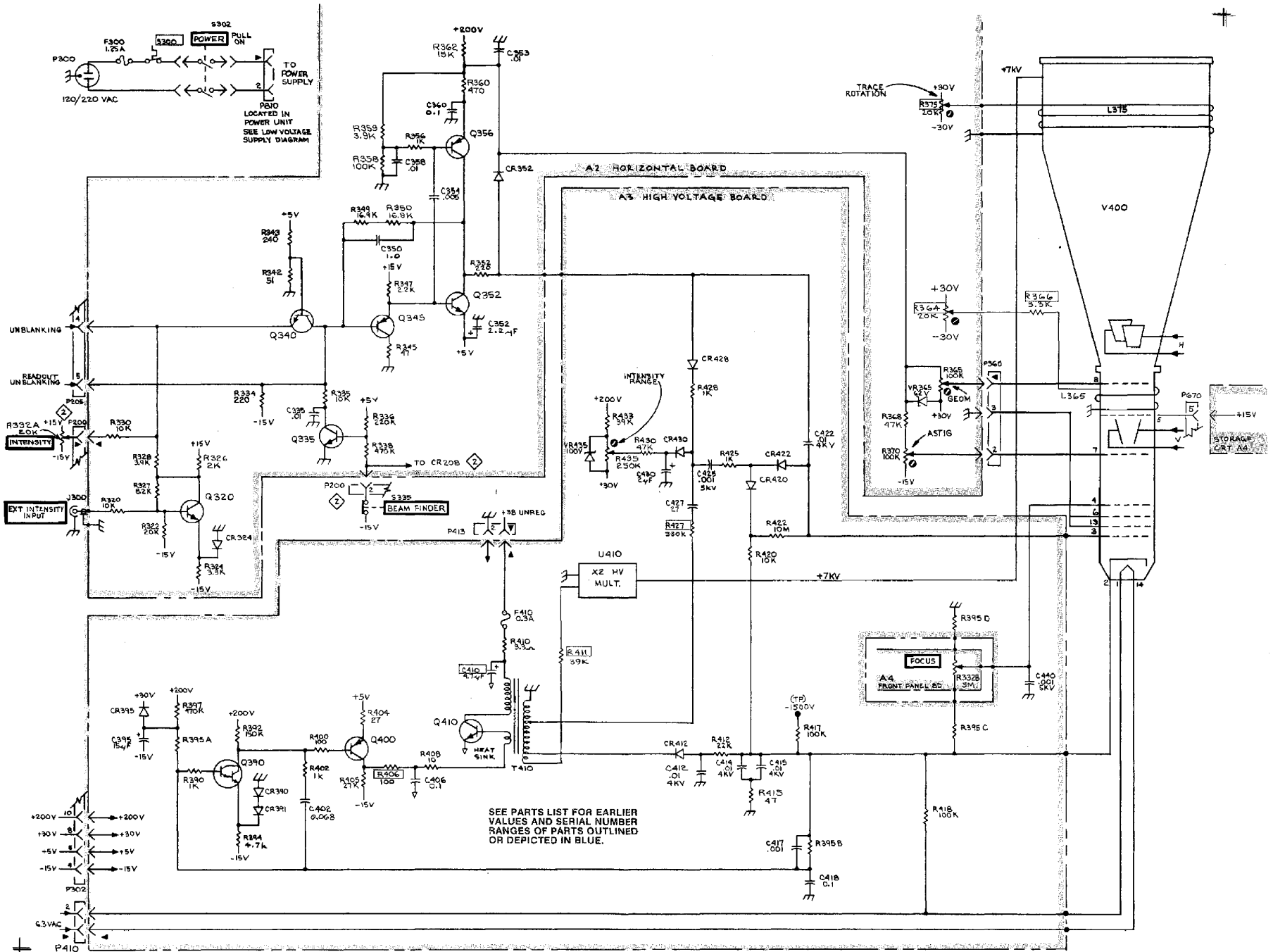
Turn INTENSITY control fully counterclockwise. Adjust R435, through the hole in the high-voltage shield, so spot is just extinguished. Turn INTENSITY control clockwise and note that visible spot appears when INTENSITY control is between its 8 and 11 o'clock positions.



PARTS LOCATION GRID



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C395	C2	CR390	C2	F410	B4	Q390	D2	R390	D2	R420	H1	T410	G3	U410	D4	VR435	C1
C402	D1	CR391	D2			Q400	E2	R392	C2	R422	I2						
C406	I4	CR395	C1					R394	D2	R425	I1						
C410	H4	CR412	F2					R395	E1	R427	H3						
C412	G1	CR420	I1					R397	C1	R428	I3						
C414	G1	CR422	H1					R400	D2	R430	C2						
C415	G1	CR428	I3					R402	D1	R433	C1						
C417	E2	CR430	I3					R404	D1	R435	C1						
C418	D1							R405	E2								
C422	H2							R406	E2								
C425	H2							R408	H4								
C427	I3							R410	B4								
C430	I3							R412	F1								
C440	H2							R417	I1								
								R418	I1								



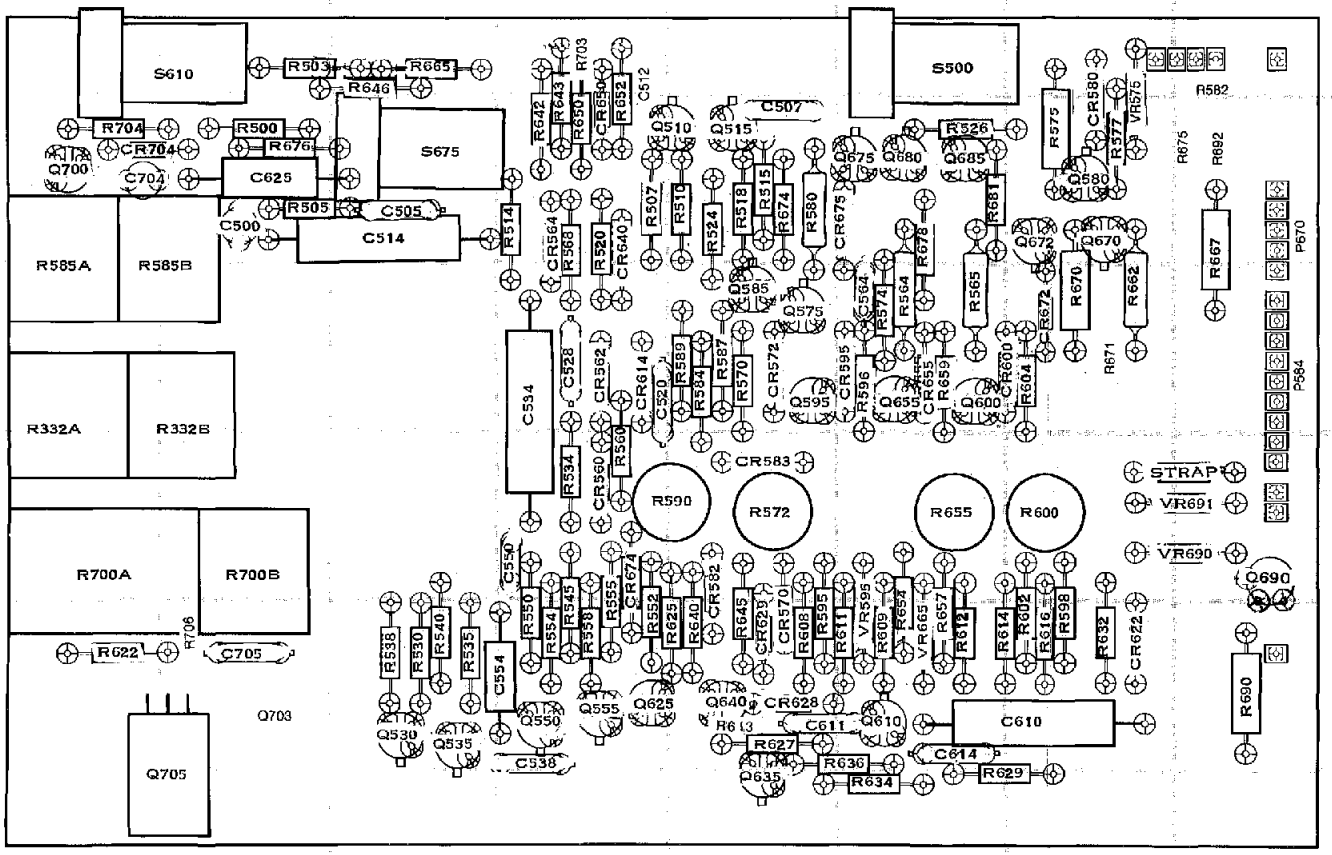
D41

REV. E, MARCH 1977

Z AXIS AMPLIFIER AND CRT CIRCUIT (3)

CJH 2174

PARTS LOCATION GRID



*See Parts List for serial number ranges.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C500	B2	Q672	G2	R612	F5
C505	C2	Q675	F2	R613*	E5
C507	E2	Q680	F2	R614	G5
C512*	D2	Q685	F2	R616	G5
C514	C2	Q690	H4	R622	A5
C520	E3	Q700	A2	R625	E4
C528	D3	Q703*	B5	R627	E5
C534	D3	Q705	B5	R629	F5
C538	D5			R632	G5
C550	D4	R332A	A3	R634	F5
C554	D5	R332B	B3	R636	F5
C564	F3	R500	B2	R640	E4
C610	G5	R503	B1	R642	D2
C611	E5	R505	B2	R643	D2
C614	F5	R507	D2	R645	E4
C625	B2	R510	E2	R646	C1
C704	A2	R514	D2	R650	D2
C705	B5	R515	E2	R652	D2
		R518	E2	R654	F4
CR560	D4	R520	D2	R655	F4
CR562	D3	R524	E2	R657	F4
CR564	D2	R526	F2	R659	F3
CR570	E4	R530	C5	R662	G3
CR572	E3	R534	D4	R665	C1
CR580	G2	R535	C5	R667	H2
CR582	E4	R538	C5	R670	G3
CR583	E4	R540	C5	R671*	G3
CR595	F3	R545	D4	R672	G3
CR600	G3	R550	D4	R674	E2
CR614	D3	R552	D4	R675*	H2
CR622	G5	R554	D5	R676	B2
CR628	E5	R555	D4	R678	F2
CR629	E4	R558	D5	R681	F2
CR640	D2	R560	D4	R690	H5
CR650	D2	R564	F3	R692*	H2
CR655	F3	R565	F3	R700A	A4
CR674	D4	R568	D2	R700B	B4
CR675	F2	R570	E3	R703*	D1
CR704	A2	R572	E4	R704	A2
		R574	F3	R706*	B5
Q510	E2	R575	G2		
Q515	E2	R577	G2	S500	F1
Q530	C5	R580	E2	S610	B1
Q535	C5	R582*	H1	S675	C2
Q550	D5	R584	E3		
Q555	D5	R585A	A2	VR575	G2
Q575	E2	R585B	B2	VR595	F4
Q580	G2	R587	E3	VR665	F4
Q585	E2	R589	E3	VR690	H4
Q595	E2	R590	E4	VR691	H4
Q600	F3	R595	E4		
Q610	F5	R596	F3		
Q625	D5	R598	G4		
Q635	E5	R600	G4		
Q640	E5	R602	G4		
Q655	F3	R604	G3		
Q670	G2	R608	E5		
		R609	F5		
		R611	F5		

ADJUSTMENTS

STORAGE

Equipment Required

1. Vertical plug-in unit.

2. Time-base plug-in unit.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature with the 0°C to +50°C range. Make any adjustments at a temperature of +25°C, ±5°C.

a. Remove the cabinet panels covering the D41.

b. Install a vertical plug-in in the left plug-in compartment and a time-base plug-in in the right plug-in compartment.

c. Check that the correct nominal line-selector block has been installed on the line-selector pins and that the regulating range selected includes the input line voltage, see Installation section for complete instructions.

d. Connect the 5403-D41 to the line voltage source and pull the POWER switch out to turn the instrument on.

2. Op Level and Prep Level, R590 and R572.

Turn the Prep Level, R572 and Op Level, R590 adjustments to their fully counterclockwise position.

Slowly turn the Op Level, R590 clockwise in small increments until the storage area no longer increases in brightness. Press the ERASE pushbutton after each increment of Op Level adjustment. When the proper operate level has been obtained, the storage area brightness should be the same as the stored trace.

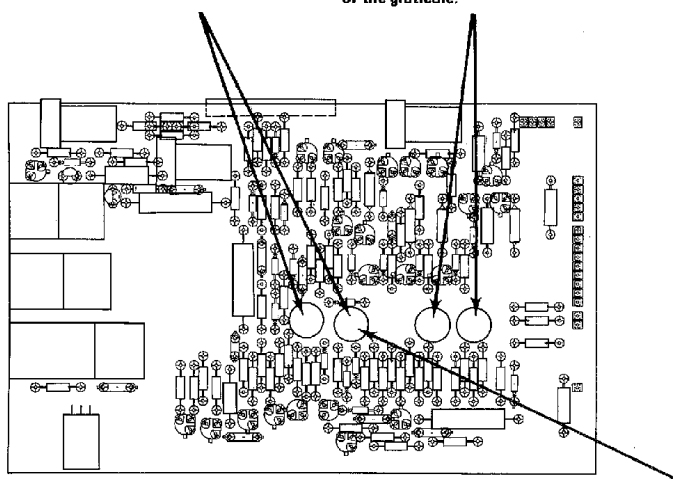
Slowly rotate the Prep Level, R572 clockwise in small increments until the background level of the storage area is just visible. Press the ERASE pushbutton after each increment of Prep Level adjustment.

1. CE 1 and CE 3, R655 and R600

Set both the WRITING SPEED and the PERSIST controls fully clockwise. Set the SAVE pushbutton to its out position and the STORE pushbutton to its pushed-in position.

Using the time-base plug-in controls, obtain a trace. Slowly position the trace over the complete storage area of the CRT until a brightened display (storage area flooded) has been stored. If there is trouble in storing the trace, a slight adjustment can be made to the Op Level, R590, to permit storage.

Adjust CE 1, R655 and CE 3, R600 alternately until the brightened storage area just fills the area of the graticule.



3. Storage Functional Checks

Refer to the operating Instructions section of this manual.

4. Check Writing Speed

Turn the INTENSITY control cw until excessive spreading of the display just starts to occur, the FOCUS control should be adjusted for a well focused display. Set the WRITING SPEED control to its fully cw position.

Set the time base plug-in for a 0.2 μs/div sweep rate and for single-sweep operation. Rotate the time base main trigger level control from one extreme to its other extreme to cause a sweep.

If a stored trace is not visible, adjust R572 Prep Level slightly cw, then repeat this step.

ADJUSTMENTS

STORAGE

Equipment Required

1. Vertical plug-in unit.

2. Time-base plug-in unit.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature with the 0°C to +50°C range. Make any adjustments at a temperature of +25°C, ±5°C.

a. Remove the cabinet panels covering the D41.

b. Install a vertical plug-in in the left plug-in compartment and a time-base plug-in in the right plug-in compartment.

c. Check that the correct nominal line-selector block has been installed on the line-selector pins and that the regulating range selected includes the input line voltage, see Installation section for complete instructions.

d. Connect the 5403-D41 to the line voltage source and pull the POWER switch out to turn the instrument on.

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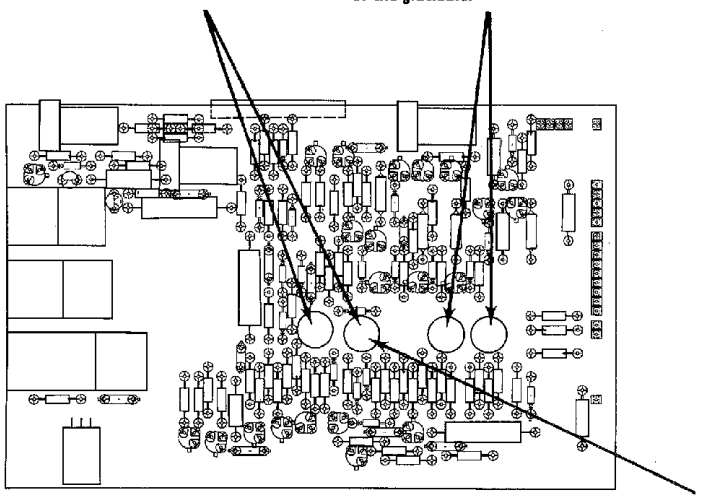
Slowly rotate the Prep Level, R572 clockwise in small increments until the background level of the storage area is just visible. Press the ERASE pushbutton after each increment of Prep Level adjustment.

1. CE 1 and CE 3, R655 and R600

Set both the WRITING SPEED and the PERSIST controls fully clockwise. Set the SAVE pushbutton to its out position and the STORE pushbutton to its pushed-in position.

Using the time-base plug-in controls, obtain a trace. Slowly position the trace over the complete storage area of the CRT until a brightened display (storage area flooded) has been stored. If there is trouble in storing the trace, a slight adjustment can be made to the Op Level, R590, to permit storage.

Adjust CE 1, R655 and CE 3, R600 alternately until the brightened storage area just fills the area of the graticule.



3. Storage Functional Checks

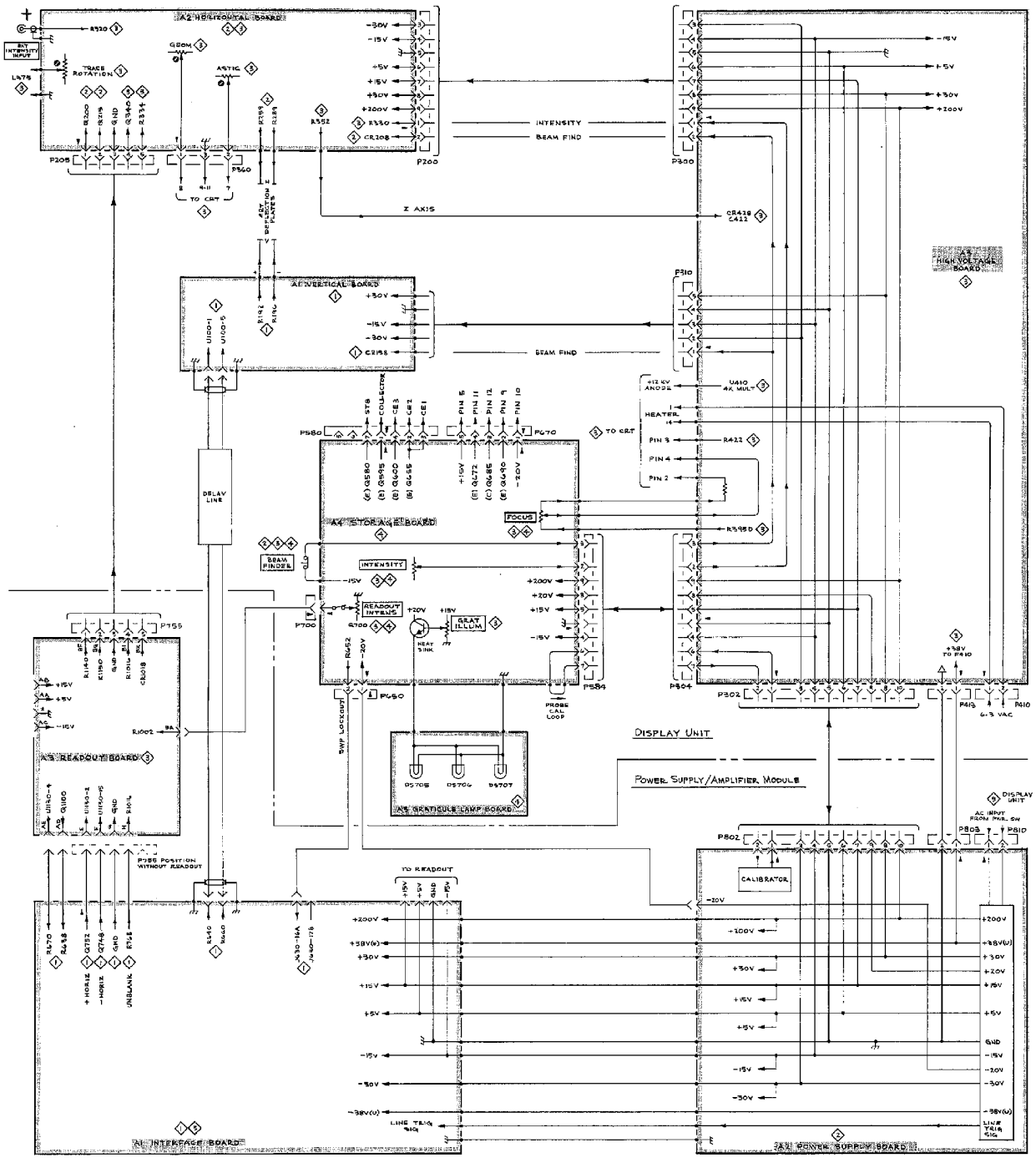
Refer to the operating Instructions section of this manual.

4. Check Writing Speed

Turn the INTENSITY control cw until excessive spreading of the display just starts to occur, the FOCUS control should be adjusted for a well focused display. Set the WRITING SPEED control to its fully cw position.

Set the time base plug-in for a 0.2 μs/div sweep rate and for single-sweep operation. Rotate the time base main trigger level control from one extreme to its other extreme to cause a sweep.

If a stored trace is not visible, adjust R572 Prep Level slightly cw, then repeat this step.



INTERCONNECT AND VOLTAGE DISTRIBUTION 5 DEC 1974

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

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MANUAL CHANGE INFORMATION

PRODUCT 5440/R & 5441/R
070-2139-01 & 070-2140-00

CHANGE REFERENCE M30734

DATE 11-8-77

CHANGE:	DESCRIPTION

EFF SN B074125 (5440/R) EFF SN B062200 (5441/R)

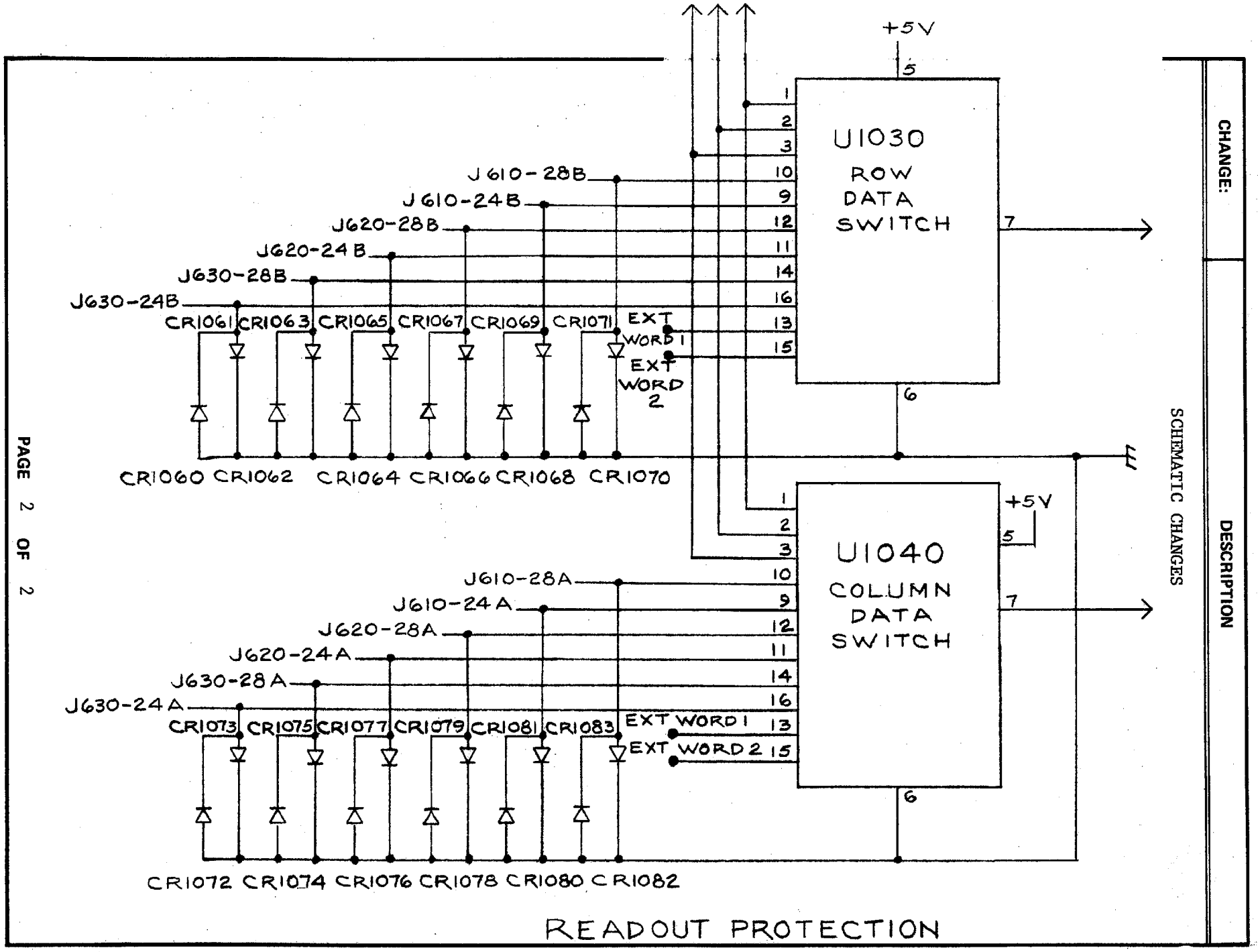
ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

A2	670-2335-04	CKT BOARD ASSY:INTERFACE

ADD:

	670-5035-00	CKT BOARD ASSY:READOUT PROTECTION
CR1060 thru CR1083	152-0333-00	SEMICOND DEVICE:SILICON,55V,200MA,1N461D



PRODUCT 5440/R, 5441/R CHANGE REFERENCE M30734 DATE 11-8-77

CHANGE: DESCRIPTION

SCHEMATIC CHANGES

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MANUAL CHANGE INFORMATION

PRODUCT 5440 & 5441

CHANGE REFERENCE M30792

DATE 3-17-77

CHANGE:	DESCRIPTION

EFF SN B073789 (5440) 070-2139-01

EFF SN B061967 (5441) 070-2140-00

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

DL100	119-0693-00	DELAY LINE,ELEC:

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MANUAL CHANGE INFORMATION

PRODUCT 5440/R & 5441/R

CHANGE REFERENCE M24,547

DATE 10-8-76

CHANGE:	DESCRIPTION

EFF SN B033100-up (5440) 070-2139-01

EFF SN B021497-up (5441) 070-2140-00

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

C180	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V
C192	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V
C197	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V
C198	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V

The parts listed above are located on the VERTICAL circuit board assembly and shown on diagram 1 VERTICAL AMPLIFIER.

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MANUAL CHANGE INFORMATION

PRODUCT 5441
070-2140-00

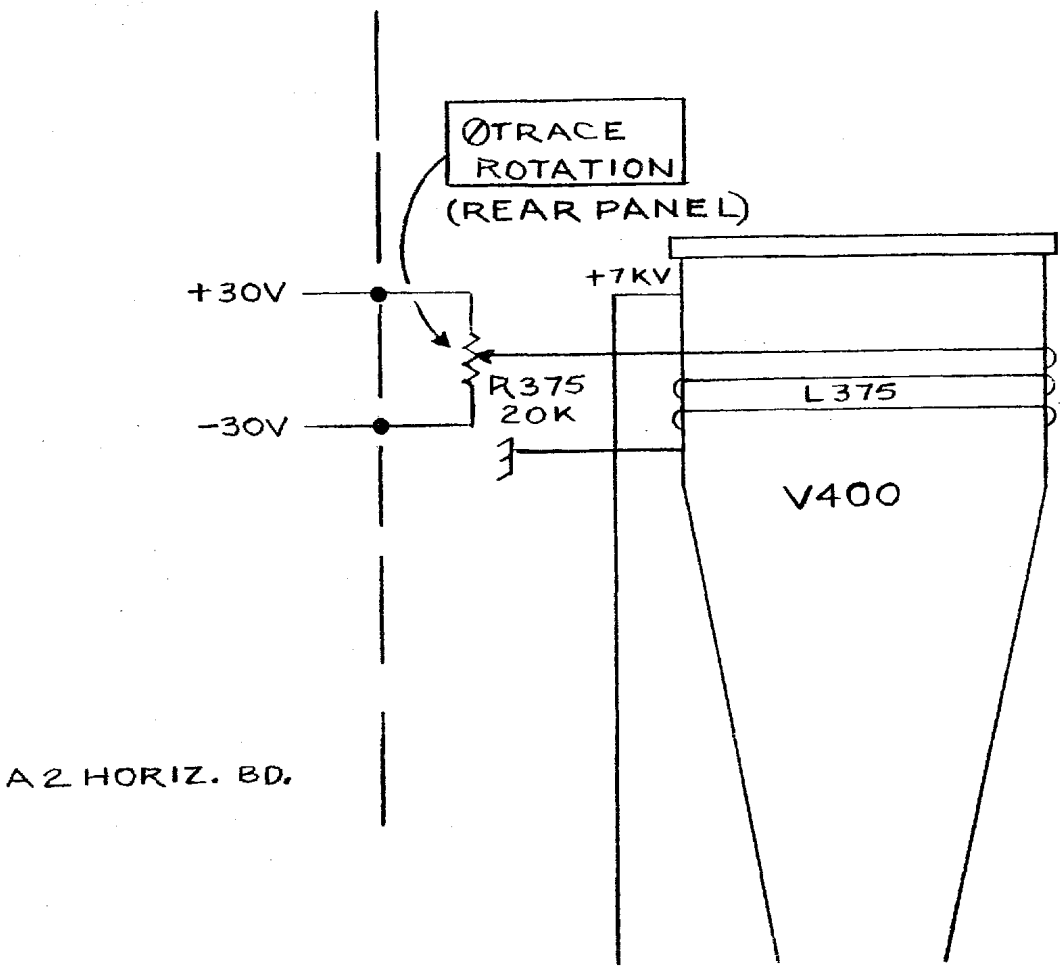
CHANGE REFERENCE M22400
DATE 8-3-77 REV.

CHANGE:	DESCRIPTION

EFF SN B020000

The Trace Rotation pot R375 is moved from the HORIZONTAL AMPLIFIER circuit board to the top right corner of rear panel. See schematic sketch below.

DIAGRAM ◇2◇ Z-AXIS AMPLIFIER & CRT CIRCUIT



MANUAL CHANGE INFORMATION

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PRODUCT 5440/R & 5441/R
070-2139-01 & 070-2140-00

CHANGE REFERENCE M24973
DATE 5-24-77 REV. 8-15-77

CHANGE:	DESCRIPTION

EFF SN B080000-up MECHANICAL PARTS LIST CHANGES

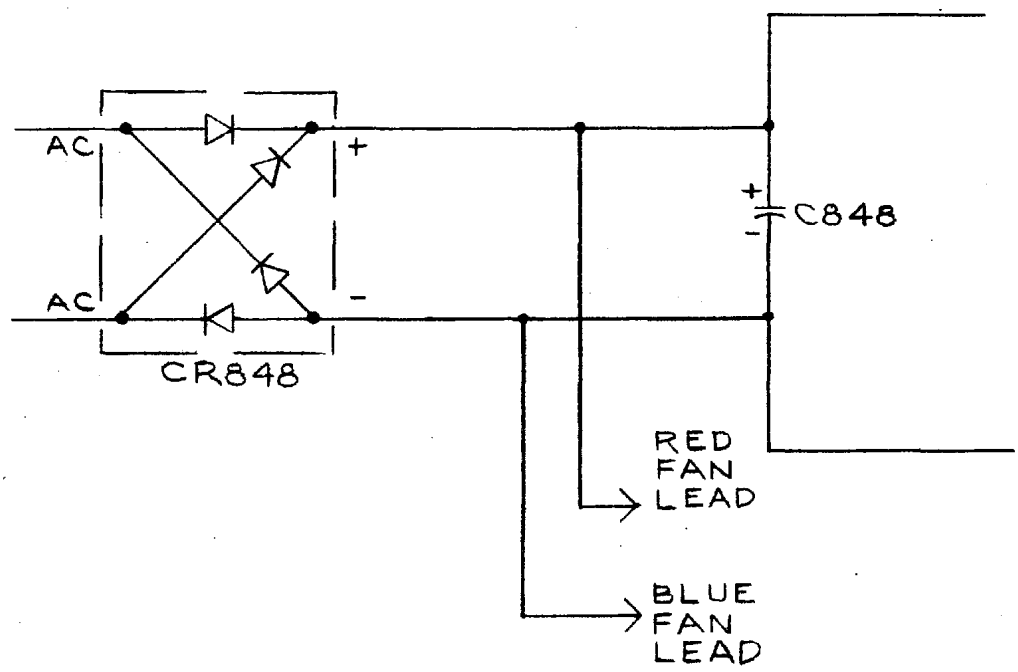
CHANGE TO:

Fig. 2-45	333-1833-02	1	PANEL,REAR
Fig. 2-56	426-0934-01	1	FRAME ASSY,CABINET
	426-0719-24	1	FRAME SECTION
	390-0469-01	2	CABINET SIDE
	390-0470-01	1	CABINET BOTTOM
	390-0502-01	1	CABINET SIDE
	390-0503-01	1	CABINET SIDE
	390-0505-01	2	CABINET BOTTOM

ADD:

333-1889-01	1	PANEL,REAR
119-0830-00	1	FAN
378-2027-01	1	FAN,GRILL
211-0018-00	2	SCREW,MACHINE:4-40 X 0.875",PNH
211-0144-00	4	SCREW,MACHINE:4-40 X 1.312.PNH
380-0490-00	1	HOUSING,FAN
407-1889-00	1	BRACKET,FAN
210-0994-00	4	WASHER,FLAT

DIAGRAM (2) LOW-VOLTAGE SUPPLY AND CALIBRATOR - Partial



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MANUAL CHANGE INFORMATION

PRODUCT 5440/R & 5441/R
070-2139-01 & 070-2140-00

CHANGE REFERENCE M31308
DATE 4-5-77

CHANGE:	DESCRIPTION

EFF SN B073840 (5440/R)

EFF SN B062000 (5441/R)

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

VR245	152-0428-00	SEMICOND DEVICE:ZENER,0.4W,120V,5%

VR245 is located on the HORIZONTAL AMPLIFIER board and shown on diagram 4 in the 5440 manual and diagram 2 in the 5441 manual.