INSTRUCTION MANUAL

TYPE 3A5

AUTOMATIC/PROGRAMMABLE AMPLIFIER

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070-0500-00 1265

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 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 this manual.

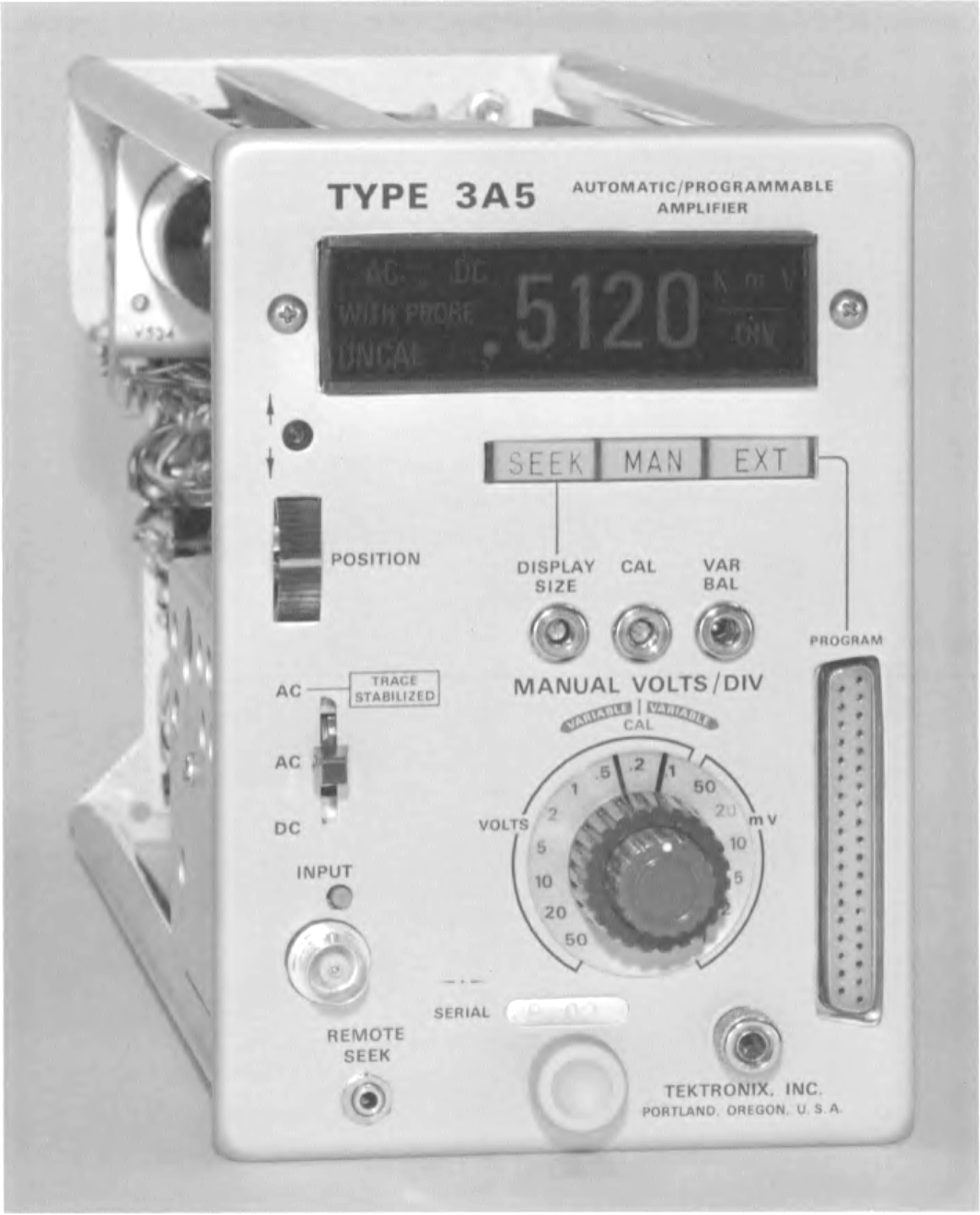

Fig. 1-1. Type 3A5 Automatic/Programmable Amplifier.

SECTION 1
CHARACTERISTICS

Introduction

The Tektronix Type 3A5 Automatic/Programmable Amplifier is a wideband oscilloscope vertical amplifier plug-in unit. Its most distinctive feature is the ability to seek and automatically select an appropriate deflection factor for a usable display of an input signal. The Type 3A5 is designed to operate in Tektronix Types 561A, 564, 565 and 567 oscilloscopes (including rack-mount instruments of the same type number), or in the 4-channel Tektronix Type 129 Plug-In Unit Power Supply. It is most often used in the Type 564 or 561A Oscilloscope, with a Type 3B5 Automatic/Programmable Time Base in the horizontal compartment.

Front-panel operated modes include SEEK: automatic deflection factor seeking; MAN: manually selected deflection factor using the MANUAL VOLTS/DIV switch; and EXT: external programming of the deflection factor and input coupling by external circuit closures. The SEEK mode can also be selected by pressing the SEEK button located on the P6030 10× Probe, or by command through the PROGRAM CONNECTOR.

A front-panel illuminated readout indicates the deflection factor (correctly scaled with or without the Tektronix P6030 10× Probe); the input coupling AC or DC; and uncalibrated deflection factor when the VARIABLE control is not at its detent CAL position. Display amplitude is read from the oscilloscope crt by the operator.

ELECTRICAL CHARACTERISTICS

The following characteristics apply over an ambient temperature range of 0°C to +50°C, except as otherwise stated. These characteristics apply only after an instrument warm-up time of at least 20 minutes.

TABLE 1-1

General Characteristics	Performance Requirements		Supplemental Information
Deflection Factors	1 mV/DIV to 50 V/DIV in 15 calibrated steps selectable by MANUAL VOLTS/DIV switch.		Steps are in 1, 2, 5 sequence.
	10 mV/DIV to 50 V/DIV in 12 calibrated steps selectable by automatic or external circuits.		Steps are in 1, 2, 5 sequence.
			Both ranges are automatically scaled 10× to maximum of 0.5 kV/DIV when P6030 10× Probe is installed on INPUT connector. Other probes will not scale deflection factor.
Deflection Accuracy	±3% of indicated deflection when VARIABLE control is at CAL detent position.		
Variable Deflection Factor	VARIABLE control reduces display size to between 55.5% and 71.5% of calibrated size as it is rotated from CAL to full ccw position. As control rotates from CAL position clockwise, display size increases. Full display size attenuation ratio as control is rotated throughout its range is ≥2.5:1.		Readout V/DIV turns off and red UNCAL turns on when VARIABLE control is at other than CAL.
Input Resistance and Capacitance To Ground	1 MΩ ±0.75% paralleled by 24 pF ±1 pF.		Capacitance measured at 140 kHz.
	Type 3A5 ONLY	With P6030 Probe (Calculated)	
Frequency Response (Amplitude Response not more than —30% from 50 kHz calibrated deflection.)			Response measured at 10 mV/DIV.
10 mV/DIV to 50 V/DIV	DC to ≥15 MHz ≤5 Hz to ≥15 MHz ≤5 Hz to ≥15 MHz	DC to ≥14 MHz ≤5 Hz to ≥14 MHz ≤5 Hz to ≥14 MHz	DC coupled. AC coupled. AC—TRACE STABILIZED.
1 mV/DIV to 5 mV/DIV	DC to ≥5 MHz ≤5 Hz to ≥5 MHz ≤30 Hz to ≥5 MHz	DC to ≥5 MHz ≤5 Hz to ≥5 MHz ≤30 Hz to ≥5 MHz	Response measured at 1 mV/DIV. DC coupled. AC coupled. AC—TRACE STABILIZED. AC—TRACE STABILIZED operation is recommended.

TABLE 1-1 *(Cont'd)*

General Characteristics	Performance Requirements	Supplemental Information
Risetime (Calculated) 10 mV/DIV to 50 V/DIV 1 mV/DIV to 5 mV/DIV	23.2 ns 25 ns 70 ns 70 ns	10% to 90%. Related to sine-wave frequency response at 10 mV/DIV.
Transient Response	$\leq$3% overshoot, rounding, ringing or tilt.	Measured at 10 mV/DIV with centered 4 div fast step display.
Attenuator Compensation	$\leq$3% peak-to-peak overshoot, rounding, ringing or tilt.	Measured at 20 mV/DIV to 50 V/DIV using 1 kHz 10 ns risetime square wave, 4 div display through 24 pF time-constant standardizer.
Position Effect On Transient Response	$\leq\pm$5% overshoot, rounding, ringing or tilt.	While displaying a 400 kHz 6 div step pulse.
Compression or Expansion	$\pm$5% compression or expansion of 2 division display from crt top to bottom.	Measured with test oscilloscope at crt pins.
Position Control Range	$\geq\pm$6 div	AC coupled symmetrical 12 div display top and bottom can be positioned past crt centerline.
Maximum Input Voltage	600 volts combined dc plus peak ac.	500 volts with P6030.
Trace Drift With Line Voltage Change	$\pm$0.5 major div from 105 to 125 volts rms.	At 10 mV/DIV and after one minute at each voltage.
	Automatic Mode Characteristics	
CRT Displayed Size	1. When the DISPLAY SIZE control is adjusted for the oscilloscope in which the Type 3A5 is operating: The CRT display size will be reduced so that top and bottom are $\leq$3.5 div above and below the graticule centerline when the SEEK button is pressed. 2. The crt display size will not be reduced once the deflection factor of 50 V/DIV has been reached.	A dc coupled display peak-to-peak amplitude is dependent upon the signal zero dc level, polarity, amplitude, crt electrical center and the POSITION control. An ac coupled display peak-to-peak amplitude is dependent upon the signal waveshape, crt electrical center and the POSITION control. A typical sine-wave display peak-to-peak amplitude (when the display zero dc level is at the graticule centerline) will be between 2 and 6 DIV.
Automatic Seeking Time	$\leq$200 ms.	With 100 V, 1 kHz signal.
Automatic Cycling Time	2 to 4 seconds.	When SEEK command is continuous. Slightly faster in first 5 seconds.
Automatic Seeking Circuit Will Respond to Signals:	DC and 30 Hz sinewaves to 20 MHz. 30 Hz sinewaves to 20 MHz.	DC coupled. AC coupled. Waveform does not have to be sinusoidal above 60 Hz. Some signals below 60 Hz will allow proper operation depending upon waveform.

OPERATING CHARACTERISTICS

General

All front panel controls of the Type 3A5 (except the POSITION and VARIABLE controls) operate transistor circuits and internal magnetic reed switches that perform the indicated functions. All functions, including positioning (but not the VARIABLE control), can be performed either manually or programmed externally. The following paragraphs describe which functions operate for each mode.

Manual Mode (No external program connected)

The Type 3A5 operates as a normal oscilloscope vertical amplifier in the manual mode whenever the MAN pushbutton is illuminated. The manual mode operates when the MAN button is pressed, or whenever the MANUAL VOLTS/

DIV switch setting is changed. An external mode command through the PROGRAM connector takes priority over all other modes.

The operating functions available in manual mode, and the corresponding readout panel indications are listed in Table 1-2.

TABLE 1-2

Manual mode functions and readout

Functions	Control Used	Readout
Input Coupling	Three position lever switch	
DC		DC
AC		AC
AC-TRACE STABILIZED		AC
Deflection Factor Selection	MANUAL VOLTS/DIV	$1 \frac{mV}{DIV}$ to $50 \frac{V}{DIV}$
Variable Deflection Factor Selection	VARIABLE control	$\frac{V}{DIV}$ extinguishes and red UNCAL turns on
Deflection Factor 10× probe scaling	P6030 Probe mechanically depresses unlabeled 10× scaling switch	WITH PROBE from $10 \frac{mV}{DIV}$ to $.5 \frac{kV}{DIV}$
Display Positioning	POSITION control	None

Automatic Seeking Mode (No external program connected)

Automatic deflection factor selection is obtained by pressing the front panel SEEK pushbutton. Internal circuitry disables the MANUAL VOLTS/DIV switch; the MAN pushbutton lamp goes out; the automatic circuits cycle through the reed switch-operated attenuators to a point determined by the display amplitude; and the SEEK pushbutton is illuminated. Automatic deflection factor seeking is also operated by the P6030 Probe SEEK button whenever the probe is connected to the front panel INPUT and REMOTE SEEK connectors.

The Type 3A5 will recycle to seek a new deflection factor each 2 to 4 seconds when either SEEK button is held closed longer than 5 seconds. The recycle time is slightly faster during the first 5 seconds.

External Mode

Deflection factor selection can be switched to external programming through the Type 3A5 front panel external PROGRAM connector. Also, the mode will change to external when the EXT pushbutton is held depressed. The mode remains external only by permanent command through the PROGRAM connector. The Type 3A5 deflection factor must be programmed instead of automatically selected when operating in the external mode. Deflection factor selection is by external circuit closures through the external PROGRAM connector. An external mode command through the PROGRAM connector has priority over all other modes. Functions that can be externally operated are listed in Table 1-3.

TABLE 1-3

External Operations Through PROGRAM connector

1. SEEK Mode.
2. EXTernal Mode.
3. Deflection factor, including readout.
4. Input coupling, including readout.
5. WITH PROBE 10× scaling, including readout.
6. Vertical position (adds to POSITION control).

External operation disconnects the front panel input coupling selector switch and the probe 10× scaling switch. The oscilloscope —12.2, —100, and +125-volt power supplies are always available through the external PROGRAM connector. See the Operating Instructions for available current.

The external PROGRAM lead voltage and current ratings required of external programming equipment are given at the back of the Operating Instructions section of this manual.

ENVIRONMENTAL CHARACTERISTICS

Storage

Temperature— —40°C to +65°C.

Altitude—to 50,000 feet.

Operating

Operating temperature—0°C to +50°C.

Operating altitude—to 10,000 feet.

MECHANICAL CHARACTERISTICS

Dimensions—16½ inches x 4¼ inches x 6¼ inches.

Weight—5 pounds, net.

Construction—aluminum alloy chassis.

Finish—anodized and silk screened front panel.

ACCESSORIES

Standard Accessories

	Tektronix Part No.
1—P6030 10× Probe with its accessories.	010-0195-00
1—37 pin Connector, male, to mate with PROGRAM connector.	131-0422-00
1—Connector cover, fits 131-0422-00.	200-0660-02
2—Instruction Manuals.	070-0500-00

SECTION 2
OPERATING INSTRUCTIONS

Introduction

The Type 3A5 Automatic/Programmable Amplifier plug-in unit is an internally or externally controlled vertical amplifier for Tektronix oscilloscopes Types 561A, 564, 565 and 567 (including rack-mount instruments of same type number). It will also operate in the Type 129 Plug-In Unit Power Supply. Vertical deflection factor and other functions can be controlled from the Type 3A5 front-panel controls, or through the 37-pin front-panel external PROGRAM connector. The Type 263 Programmer can be connected directly to the Type 3A5 to remotely operate all its functions except the VARIABLE VOLTS/DIV control.

Automatic selection of deflection factor allows the operator to obtain meaningful displays more easily and quickly than is normally possible with hand operated MANUAL VOLTS/DIV control. The instrument deflection factor is always indicated on an illuminated readout panel. A 10× scaling factor is included when the Tektronix P6030 10× Probe is connected to the INPUT connector. The mode of operation is always shown by one of three illuminated pushbuttons.

Connection to the external PROGRAM connector is by a mating male 37-pin connector supplied with the instrument, or by the Tektronix Type 263 programmer. Detailed external programming information is supplied at the back of this section. Should the user build his own external programming equipment, the oscilloscope —100, —12.2 and +125-volt regulated power supplies can provide some current through the PROGRAM connector J-20. Table 2-1 lists the maximum allowable external currents that can be taken through J-20.

TABLE 2-1

J-20 Maximum Power Supply Currents

Supply	Pin	Current
+125-V	18	20 mA
—100-V	19	10 mA
—12.2-V	1	50 mA

VERTICAL AMPLIFIER OPERATION

Manual vs Automatic Selection of Deflection Factor

An oscilloscope's vertical deflection factor is normally selected by manual adjustment of the Volts/Div control. This provides a useful display for a particular input signal, but any sizable change in signal amplitude is likely to require re-adjustment of the Volts/Div control.

With the Type 3A5 this problem is eliminated by pressing the front-panel SEEK pushbutton and letting the plug-in automatically select the correct deflection factor. If using the P6030 10× Probe, pressing the probe SEEK button will also cause the Type 3A5 to automatically select the correct deflection factor. The deflection factor is automatically scaled to include the P6030 Probe 10× attenuation. (Other probes or cables with normal size BNC connectors will not cause the Type 3A5 to scale the deflection factor 10×).

Function of Front Panel Controls and Connectors
(without external program connected)

SEEK	When pressed, causes the unit to automatically select the correct deflection factor. Starts cycle at 10 mV/DIV. If there is no signal, and if crt beam is less than ±2.1 divisions from graticule centerline, the deflection factor remains at 10 mV/DIV. (See discussion of crt display size limits in Table 1-1 and in first time operation later in this section.) Pressing the SEEK button momentarily starts a seek cycle that will be completed in less than 200 ms after the button is pressed. Holding the SEEK button depressed will cause the seek cycle to repeat at between 2- and 4-second intervals after the first five seconds. Cycle time is slightly faster during the first five seconds the SEEK button is held depressed.
REMOTE SEEK	A phone jack for connection of an externally operated SEEK switch. Normally used by the P6030 10× Probe SEEK circuit. When the probe SEEK button is pressed, both the Type 3A5 and the Type 3B5 seek circuits operate.
MAN	When pressed, causes the deflection factor to be controlled by the front-panel MANUAL VOLTS/DIV switch.
EXT	When held depressed, switches the control of all front panel operations (except POSITION and VARIABLE volts/div) to the external PROGRAM connector. EXT button is illuminated when external program commands the mode of operation.
MANUAL VOLTS/DIV	When turned, changes the mode of operation from SEEK to manual, and sets the deflection factor to the value indicated between the two black lines marked on the knob skirt. Operates the Type 3A5 deflection factor from 1 mV/DIV through 50 V/DIV. The MANUAL VOLTS/DIV switch offers a maximum of 10× gain over the minimum automatically selected deflection factors, with a decreased bandwidth of dc to ≥5 MHz.
VARIABLE	Permits uncalibrated plus and minus changes of each fixed calibrated deflection factor. Has at least 2.5:1 range that provides continuous overlap of calibrated deflection factors.

POSITION — Permits the display position to be adjusted. Has at least a 12-division range. (Has about 120-division range when MANUAL VOLTS/DIV switch is at 1, 2, or 5 mV/DIV.)

OVERSCAN LAMP — (Not labeled) Neon lamp that is illuminated if any part of the display is beyond the display size limits, when deflection factor is between 10 mV/DIV and 50 V/DIV. The lamp is located just above the POSITION control. When deflection factor is manually operated to 1, 2 and 5 mV/DIV, the overscan lamp is 1/10 as sensitive and turns on only when display is about 45 divisions off screen.

INPUT COUPLING SWITCH — Three-position lever switch that sets the input coupling circuit when the mode of operation is either MAN or SEEK.

DC: Input connector is directly coupled to the input attenuator circuits.

AC: Input connector is ac coupled through a 0.04 μF capacitor.

AC—TRACE STABILIZED: Input is ac coupled through 0.04 μF capacitor and total vertical amplifier is feedback stabilized. Trace drift normal for dc operation is canceled and display remains at fixed level for long periods.

INPUT CONNECTOR — BNC connector for installing input signal cable or P6030 10× Probe.

PROBE 10× SCALING SWITCH — (Not labeled) Small gray pushbutton located between the input connector and the word INPUT. Special P6030 10× Probe BNC connector presses switch in when probe is installed. This changes readout panel deflection factor indication to agree with the probe 10× attenuation.

DISPLAY SIZE — Screwdriver adjust potentiometer that controls sensitivity of the automatic deflection factor-seeking circuit.

CAL — Screwdriver adjust potentiometer that controls the vertical amplifier gain so Type 3A5 deflection factor can be set to agree with the crt deflection factors when changing crt or oscilloscope.

VAR BAL — Screwdriver adjust potentiometer for varying the vertical amplifier balance so the display zero dc level will remain stationary when turning the VARIABLE control.

EXTERNAL PROGRAM CONNECTOR — 37-pin female connector that permits external programming of (1) Deflection Factor; (2) Readout panel; (3) Input Coupling; (4) With Probe, 10× scaling of deflection factor readout; (5) Changing mode of operation from internal to external; and (6) changing mode of operation from external to internal SEEK. The oscilloscope −12.2, −100, and +125-volt regulated power supplies are also available through the PROGRAM connector. Two leads permit override of the front-panel POSITION control.

Installing the Type 3A5 Into the Oscilloscope

CAUTION

Turn off oscilloscope power while inserting or removing plug-in units.

The Type 3A5 is designed to provide dc to $\geq$15 MHz information to the oscilloscope crt vertical deflection plates. It may be used in either the vertical or the horizontal plug-in compartments of the Type 561A or Type 564. It can be used in the vertical compartment of the Type 565. The Type 3A5 may also be used in the four-channel Type 129 Plug-In Unit Power Supply.

Before inserting the plug-in unit, turn the front-panel knurled aluminum locking knob counterclockwise so the locking dog will clear the lower front panel. Press the unit firmly in place for proper interconnection plug mating, then turn the knurled locking knob a few turns clockwise until it is hand tight.

To remove the plug-in unit, turn the knurled aluminum knob a few turns counterclockwise until the locking dog is obviously clear, then pull the unit straight out of the oscilloscope.

First Time Operation

The following procedure covers a complete first time operation of the Type 3A5 in a Type 561A Oscilloscope. Operation in a Type 564 and Type 565 is essentially the same except for display storage operation of the Type 564.

INSTALLATION

1. Insert the Type 3A5 into the vertical plug-in compartment of the oscilloscope. Set the oscilloscope INTENSITY control fully counterclockwise. Set the Type 3A5 controls as in 2 below, then turn on the oscilloscope power and allow two or three minutes warm up.

2. Set the Type 3A5 front-panel controls as follows:

POSITION	Midrange
Input Coupling	DC
MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Mode	MAN

3. Set the time-base controls for an automatically triggered 5 ms/div sweep. Set the oscilloscope CALIBRATOR control to 50 mVOLTS.

4. Connect a coax with BNC connectors between the CAL OUT connector and the Type 3A5 INPUT connector. Turn the oscilloscope INTENSITY control for a display of normal brilliance. Set the Type 3A5 POSITION control so the display is centered.

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SET *CAL* CONTROL

5. If the Type 3A5 was not calibrated in the oscilloscope in which it is now operating, it is necessary to adjust the CAL control. Vertical deflection accuracies of ±3% are attained only when the reference signal accuracy is ±0.3% or better, and the Type 3A5 has been turned on at least 20 minutes. However, familiarization of the Type 3A5 is possible using the oscilloscope CALIBRATOR. With the display as already obtained, adjust the CAL control for exactly five divisions between peaks of the calibrator signal. Do not include the trace width in the adjustment, but use the top or bottom of the trace when comparing the display amplitude to the graticule markings.

Set *DISPLAY SIZE* Control

6. If the Type 3A5 was not calibrated in the oscilloscope in which is it now operating, it is necessary to adjust the DISPLAY SIZE control.

NOTE

Operate the Type 3A5 for at least 20 minutes before adjusting the DISPLAY SIZE control.

Remove the signal and obtain a free run trace. Position the trace above the graticule centerline until the overscan lamp (the small neon lamp located just above the POSITION control) turns on. Note the trace position. Position the trace below the graticule centerline until the overscan lamp turns on. Note the trace position.

The trace should have moved further from graticule center in one direction than in the other before causing the overscan lamp to light. Position the trace in the direction of the farthest move, and set it exactly 3.5 divisions from graticule center. Using a small screwdriver, adjust the DISPLAY SIZE control so that the overscan lamp blinks periodically. To find the correct DISPLAY SIZE setting, adjust the control so that the overscan lamp lights steadily, then back it off so the lamp blinks.

Position the trace to the opposite half of the graticule, and note the vertical position at which the overscan lamp starts blinking. This position must be no closer than 2.1 divisions from graticule center. This DISPLAY SIZE limit represents maximum allowable error in vertical amplifier balance and crt electrical center. Normally, if the DISPLAY SIZE control is adjusted with the trace 3.5 divisions from center in one half of the graticule, the overscan lamp will blink only when the display is 3 or more divisions from center in the other half. Fig. 2-1 illustrates the worst-case limits of DISPLAY SIZE, in a system which has its electrical center 0.7 division from graticule center. Since this is the maximum allowable deviation in all oscilloscopes with which the Type 3A5 may be operated, Fig. 2-1 applies to all uses of the Type 3A5.

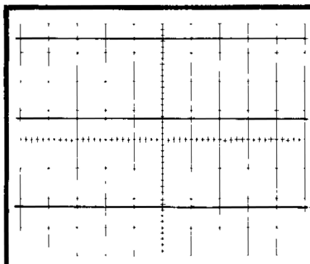


Fig. 2-1. Example of minimum display size when system electrical center is +0.7 division from graticule centerline.

SEEK MODE OPERATION

7. Reconnect the coax from the oscilloscope CALIBRATOR to the Type 3A5 INPUT connector. Press the MAN mode button and obtain a centered, stable 5-division display.

Change the CALIBRATOR control to .1 VOLT then press the SEEK button. Increasing the input signal voltage will deflect the top of the display off the crt screen, then as the SEEK button is pressed, the display will again be five divisions peak to peak, and the readout will indicate a 20-mV/DIV deflection factor.

Position the display top to more than +3.5 divisions from the graticule centerline and press the SEEK button. The display will drop to two divisions peak to peak with an indicated deflection factor of 50 mV/DIV.

Position the display bottom to more than —3.5 divisions from the graticule centerline and press the SEEK button. The display will change to a straight line with an indicated deflection factor of 50 V/DIV. This is true only when the Input Coupling is at DC and the signal displayed is positive going.

Change the Input Coupling switch to AC and position the trace to the graticule centerline. Press the SEEK button and the display will be either almost six or slightly greater than two divisions peak to peak, with an indicated deflection factor of either 20 mV/DIV or 50 mV/DIV. The display and deflection factor obtained are determined by the DISPLAY SIZE limits as previously adjusted and checked.

REMOTE SEEK OPERATION

8. Remove the coax cable from the Type 3A5 INPUT connector and install the P6030 10× Probe. Insert the Probe small phono plug into the REMOTE SEEK jack located just under the INPUT connector.

Remove the coax from the CALIBRATOR output connector and change the CALIBRATOR control to 1 VOLTS.

Touch the P6030 Probe tip to the CAL OUT centerpin and press the probe SEEK button. The display will be the same as at the end of step 7 with the same readout, except that the readout panel WITH PROBE light will be on.

MAN MODE OPERATION

9. With the signal and display as at the end of Step 8, change the MANUAL VOLTS/DIV switch to .1 VOLTS. The mode will change from SEEK to MAN and the display will be slightly greater than one division peak to peak. The readout will not agree with the setting of the MANUAL VOLTS/DIV switch, but will indicate the true deflection factor of 1 V/DIV including the 10× attenuation of the P6030 probe.

Remove the probe tip from the CALIBRATOR output connector.

TRACE STABILIZED OPERATION

10. Set the input coupling to AC and position the trace to the graticule centerline. Touch the probe tip to the CAL OUT centerpin. Press the SEEK button and position the display so the most negative part is —2 divisions from the graticule centerline. Change the input coupling to AC—TRACE STABILIZED. The display will momentarily disappear, and will then return within ±1 division of its previous AC coupled position. Rapidly move the POSITION control to center the display and note the stabilizing circuit affect upon positioning. The display moves with a rather rubbery appearance when the POSITION control is moved rapidly. This shows the presence of the low-pass filter in the stabilizing circuit. The filter permits only dc and very low frequency feedback around the vertical amplifier to cancel any internal drift signals. Therefore, the display will always remain on the crt, regardless of how long the equipment remains in a set up state before use.

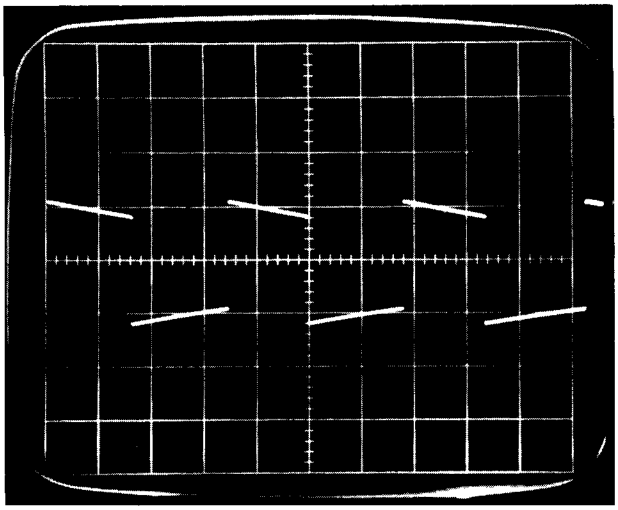
1-, 2-, AND 5-MILLIVOLT SWITCH POSITIONS

11. Remove the P6030 Probe. Set the oscilloscope CALIBRATOR control to 20 mVOLTS, the input coupling to AC—TRACE STABILIZED and the MANUAL VOLTS/DIV switch to 10 mV. Connect a coax with BNC connectors between the CAL OUT and the Type 3A5 INPUT connectors and center the display with the POSITION control.

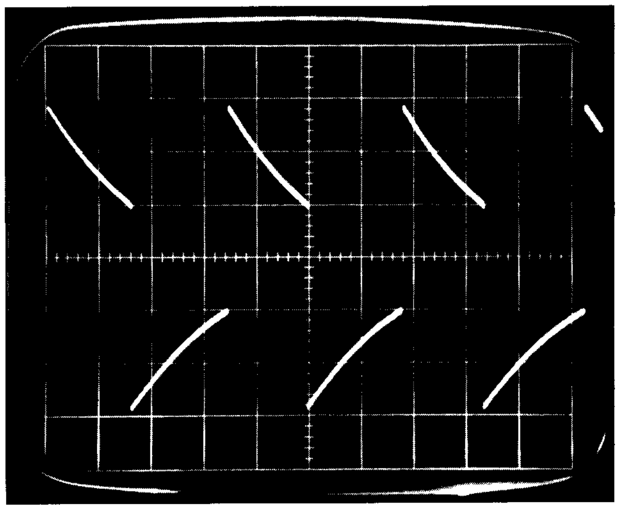
12. Set the MANUAL VOLTS/DIV switch to 5 mV. The display rise and fall will double in amplitude, but the RC decay during the flat portion of the calibrator signal will fall farther than at 10 mV/DIV. See Fig. 2-2.

The increased rate of fall is because the trace stabilizing circuit feedback voltage is now 10 times greater than at 10 mV/DIV with increased low frequency signal attenuation.

DC or AC input coupling at 1, 2, or 5 mV/DIV will sometimes permit the display to drift a little. Thus, make measurements at 1, 2, or 5 mV/DIV with the input AC—TRACE STABILIZED.



a. AC display, 10mV/DIV.



b. AC-TRACE STABILIZED display, 5mV/DIV.

Fig. 2-2. Normal display difference in ac coupled 60-cycle calibrator signal.

FRONT-PANEL ADJUSTMENTS

Three front-panel screwdriver adjust controls offer the operator the ability to ensure a proper display at all times. Simple procedures listed below show the value of the three controls: (1) DISPLAY SIZE, (2) CAL and (3) VAR BAL. Proper operation requires that the VAR BAL control always be properly adjusted before adjusting either the DISPLAY SIZE or the CAL control.

VAR BAL. Turning the front panel VARIABLE control may alter the display zero dc level if the VAR BAL is misadjusted. To adjust the VAR BAL control, use the following procedure.

1. Remove any signal from the Type 3A5 INPUT connector. Set the input coupling to DC and the MANUAL VOLTS/DIV switch to 10 mV. Set the VARIABLE control to its detent CAL position. Set the POSITION control midrange with the red mark near the word POSITION. Free run the time base.

2. If the trace is off screen, turn the VAR BAL control until it comes on screen. Turn the VARIABLE control fully clockwise and bring the trace near screen center with the VAR BAL control.

3. Turn the VARIABLE control counterclockwise and note which direction the trace moves. Return the VARIABLE control fully clockwise. Adjust the VAR BAL control so the trace moves in the same direction it moved due to counterclockwise rotation of the VARIABLE control. Move the trace about 1.5 times as far with the VAR BAL control as it was moved by full rotation of the VARIABLE control. If necessary, use the POSITION control to bring the trace back on the screen.

4. Turn the VARIABLE control counterclockwise and check which way the trace moves and how far. Repeat adjustment of the VAR BAL control following the VARIABLE control until the trace does not move when the VARIABLE control is turned.

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CAL. The front panel CAL control allows the operator to adjust the Type 3A5 overall vertical amplifier gain to calibrate the vertical deflection factors.

Perform the First Time Operation CAL adjust procedure whenever there is doubt about the deflection factor calibration, and always when first placing the plug-in unit into an oscilloscope. The accuracy of the Type 3A5 deflection factors will be related directly to the accuracy of the signal used. In order for the Type 3A5 deflection factors to be within the specified ±3% limits, the calibrating signal must be accurate to within 0.3%. (The Tektronix Standard Amplitude Calibrator, Part No. 067-0502-00 meets the accuracy requirements.)

SIGNAL CONNECTION PRECAUTIONS

To ensure valid measurements, certain precautions should be taken when connecting signals to the Type 3A5 INPUT connector. Table 2-2 lists several practical coupling methods, their advantages, limitations and other data. Not included in Table 2-2 is the Type 3A5 input voltage limit of 600 volts dc plus ac peak. The Type 3A5 input circuit is designed to withstand such signals for a few moments at deflection factor ratings as low as 10 mV/DIV. The input voltage limit is set by input circuit insulation and the voltage rating of the input ac coupling capacitor. The P6030 10× Probe has a maximum voltage limit of 500 volts dc plus ac peak.

TABLE 2-2

Signal Coupling Methods

Method	Advantages	Limitations	Accessories Required	Source Loading	Precautions
1. Open test leads.	Simplicity.	Limited frequency response. Subject to stray pickup that limits use of full sensitivity.	BNC to Banana Jack adapter (103-0033-00) Two test leads.	1 MΩ and 24 pF at input, plus test leads.	Stray pickup.
2. Untermined coax cable.	Full sensitivity.	Limited frequency response. High capacitance of cable.	Coax cable with BNC connectors.	1 MΩ and 24 pF plus cable capacitance.	High capacitive loading.
3. Terminated coax cable. Termination at 3A5 input.	Full sensitivity, total bandwidth. Flat-response, resistive loading. Long cable with uniform response.	Presents R_o (typically 50 Ω) loading at end of coax. May need blocking capacitor to prevent dc loading or damage to termination.	Coax cable with BNC connectors. R_o termination at input. (BNC 50 Ω Termination 011-0049-00)	R_o plus 24 pF at 3A5 end of coax can cause reflections.	Reflection from 24 pF at input. Dc and ac loading on test point. Power limit of termination.
4. Same as 3, with coax attenuator at termination.	Less reflection from 24 pF at termination.	Sensitivity is reduced (increased deflection factor).	BNC coaxial attenuators.	R_o only.	Dc and ac loading on test point. Power limit of attenuator.
5. Tap into terminated coax system. (BNC Tee: UG-274/U at 3A5 input.)	Permits signal to go to normal load. Dc or ac coupling without coaxial attenuators.	24 pF load at tap point.	BNC Tee and BNC connectors on signal cables.	1 MΩ and 24 pF at tap point.	Reflections from 24 pF input.
6. 1× Probe.	Full sensitivity. Less capacitance than equal length 93 Ω coax. Convenient small tip.	Limited frequency response. Voltage derating above 0.5 kHz.	P6011 1× passive probe.	1 MΩ and 52 pF (24 pF of 3A5 + 28 pF of probe).	High capacitance loading.
7. 10×, 10 MΩ probe. 100×, 10 MΩ probe. 1000× 100 MΩ probe.	Reduced resistive and capacitive loading; full bandwidth. 1000×: High voltage measurements. P6030 Remote SEEK. P6015 has ±9% adjustable attenuation.	10× Defl. factor. 100× Defl. factor. 1000× Defl. factor. P6013: 12 kV. P6015: 40 kV. Each probe has certain CW voltage limits.	P6030: 10× P6007: 100× P6013 and P6015: 1000×	P6030: 12 pF, 10 MΩ P6007: ≈ 2.1 pF, 10 MΩ P6013: 3 pF, 100 MΩ P6015: ≈ 2.7 pF, 100 MΩ	Check probe frequency compensation. Use square wave frequency less than 5 kHz, preferably 1 kHz.

TABLE 2-2 Cont'd

8. Current Transformer, or clip-on AC current probe.	Current transformer can be permanent part of test circuit. Less than 2.2 pF to test circuit chassis. Measure signal currents in transistor circuits: CT-1 — 100 A pk, CT-2 — 100 A pk, P6016 — 15 A pk to pk. Is a quick connect probe.	RMS current rating: CT-1 — 0.5 A CT-2 — 2.5 A Sensitivity: CT-1 — 5 mv/mA CT-2 — 1 mv/mA P6016—Slight reduction of 3A5 bandpass. 1 mA/div to 1 A/div.	CT-1: Coax adapter and BNC termination. CT-2: Nothing extra (perhaps additional coax cable for either transformer). P6016 —131 amplifier.	CT-1: Insertion; 1 Ω paralleled by about 5 μH. Up to 1.5 pF. CT-2: insertion; 0.04 Ω paralleled by about 5 μH. Up to 2.2 pF. P6016: Insertion; $\approx$0.04 Ω paralleled $\approx$1 pF.	Transformer is not a quick-connect device. CT-1: low-frequency limit about 75 kHz. CT-2: low-frequency limits about 1.2 kHz and is 1/5th as sensitive as the CT-1. P6016; low frequency limit about 50 Hz.

INPUT COUPLING

To display both the ac and dc components of an applied signal, set the input coupling switch to DC; to display only the ac component of a signal, set the input coupling to AC; to ensure trace stability for long periods of time, set the input coupling to AC—TRACE STABILIZED. In either ac position of the input coupling switch, the dc component of the signal is blocked by a capacitor in the input circuit. The AC coupled low-frequency response (—3 db = 70% of calibrated amplitude) is about 5 Hz when the signal source resistance is low. When using a 10× 10 MΩ probe, the low-frequency response is about 0.5 Hz. The 1, 2, and 5 mV/DIV AC—TRACE STABILIZED low-frequency response is about 30 Hz whether a probe is used or not. Therefore, some low-frequency distortion of 60 Hz signals can be expected at 1, 2 and 5 mV/div when operating AC—TRACE STABILIZED.

DEFLECTION FACTOR

The amount of display vertical deflection produced by a signal is determined by the signal amplitude, the indicated deflection factor, the attenuation factor of any probe other than the P6030, and the setting of the VARIABLE control. Calibrated deflection factors indicated on the readout panel apply only when the VARIABLE control is at its detent CAL position with or without a P6030 10× Probe. When the VARIABLE control is at any other position, the readout V/DIV lamp goes out and the red UNCAL lamp turns on. The VARIABLE control increases the Type 3A5 deflection factor to above 70 V/div.

VOLTAGE MEASUREMENTS

To measure the voltage between two points on a display (such as peak-to-peak ac volts), measure the vertical distance in graticule divisions between the two points and multiply by the readout panel indicated deflection factor. (If the probe is other than the P6030, multiply the indicated deflection factor by the probe attenuation.) Be certain the VARIABLE control is at its detent CAL position.

For example, assume the use of a 100× probe, an indicated deflection factor of 20 mV/DIV, and a vertical display of 4 divisions. In this case, 4 divisions × 0.02 volts/div = 0.08 volts. This voltage times the probe 100× attenuation shows a true peak-to-peak voltage of 8 volts.

To measure the dc level at a given point on a waveform when using the P6030 10× Probe, proceed as follows:

1. Set the input coupling to DC and install the P6030 to the INPUT connector, and the small plug into the REMOTE SEEK jack. Attach the probe ground clip to the chassis of the equipment being checked. Touch the probe tip to the signal source and press the probe SEEK button. Adjust the time base triggering for a valid display.

2. Press the probe PUSH TO GROUND button at the compensating block mounted to the Type 3A5 INPUT connector. Check the zero dc level of the trace (auto or free run time base). If the zero level trace is near the graticule center, position it in a direction away from the ac component polarity and release the grounding button. Again press the probe SEEK button to assure that the automatic circuits offer the largest display within normal limits.

3. Measure the number of divisions between the zero signal trace level and the desired point of the display. Multiply this by the indicated deflection factor to obtain the dc volts of the signal.

VOLTAGE COMPARISON MEASUREMENTS

In some applications, a set of vertical deflection factors other than the calibrated values need to be used. This is convenient for measuring signals that are multiples of fractional voltages with other than the calibrated deflection factor values.

To establish a set of deflection factors based upon some specific voltage, use the following procedure:

1. Apply the new reference voltage signal to the Type 3A5 INPUT connector and set the MANUAL VOLTS/DIV to obtain several divisions of display. Adjust the VARIABLE control until the display is an exact number of graticule divisions peak to peak. Do not move the VARIABLE control through the rest of this procedure.

2. Divide the true voltage amplitude of the reference signal (in volts) by the product of the number of divisions set in step 1 times the setting of the MANUAL VOLTS/DIV switch. The result is the deflection conversion factor.

$$\text{Conversion Factor} = \frac{\text{Amplitude of reference signal (in volts)}}{\text{Div deflection} \times \text{MANUAL VOLTS/DIV setting}}.$$

3. To calculate the true deflection factor at any position of the MANUAL VOLTS/DIV switch, multiply the switch setting by the deflection conversion factor.

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Deflection Factor = MANUAL VOLTS/DIV setting × Conversion Factor.

The new set of deflection factor values applies only as long as the VARIABLE control is not moved.

SPECIAL MEASUREMENTS

Several oscilloscope waveform and time measurements require special uses of the horizontal time-base. Phase measurements made on a Y-T basis use the precision of the time base coupled with the display positioning of the vertical unit. For phase measurements, see the time-base instruction manual, such as the Type 3B5 or Type 3B4.

X-Y operation with the horizontal signal (X-axis) other than a time base can be useful to measure the freuency difference of harmonically-related signals. Use of two Type 3A5 plug-in units for X-Y measurements must be limited to operation in an ambient temperature not over 30°C, and at a line voltage to the oscilloscope not higher than 117 volts rms (or 234 volts rms if the power supply is wired for the higher line voltage). The limits are necessary due to plug-in unit and oscilloscope heating.

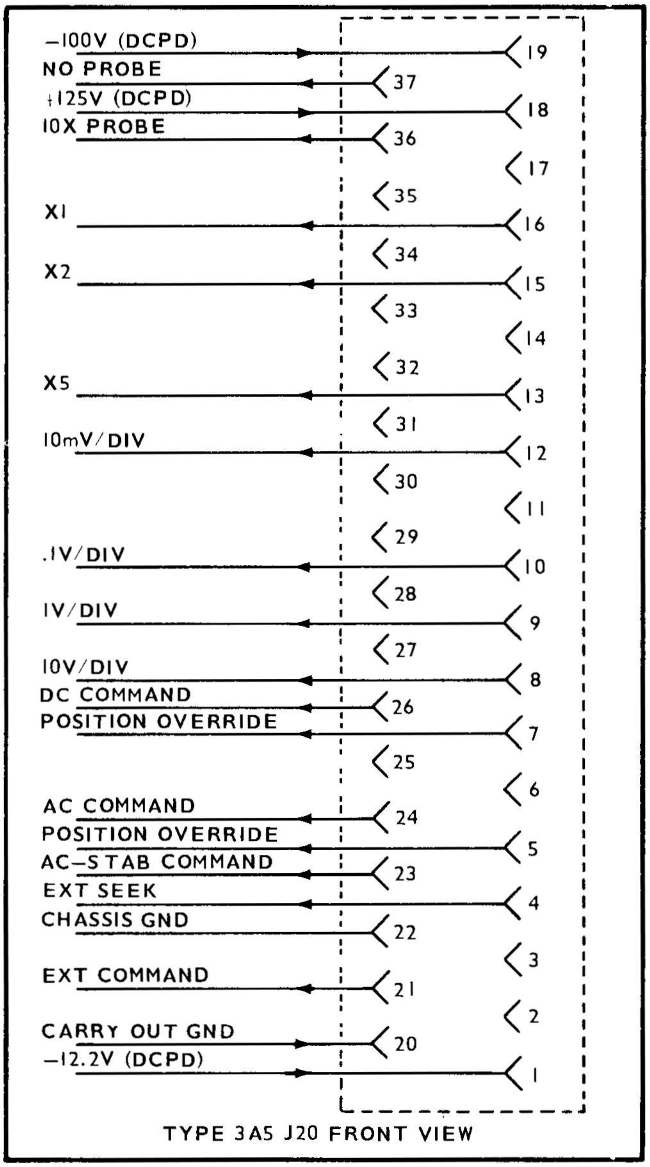

Fig. 2-3. External PROGRAM connector leads labeled in relation to their program function. Blank pins have no internal leads connected.

External Programming

Production pre-testing of subassemblies in either pulse or sine wave systems can be simplified for the operator by use of external programming to the Type 3A5 and the oscilloscope time-base unit. The following section describes what is required for complete programming of the Type 3A5. All functions are included in the Tektronix Type 263 Programmer, including all facilities to program the Type 3B5 Automatic/Programmable Timebase and auxiliary equipment.

EXTERNAL CONNECTIONS

All leads that pass through the front-panel external PROGRAM connector J-20 are shown in Fig. 2-3. Each lead is labeled according to its external program function. The connector pins are shown from the front, which is the same view as normally used for making external connections to the rear of the supplied mating connector.

Terminology of programming used in Fig. 2-3 should aid in making external connections. As an example, to program a deflection factor of 50 mV/DIV, it is necessary to ground pins 37 (no probe), 12 (10 mV/DIV) and 13 (×5). All program ground connections are made through pin 20, the Carry Out GND. The word "carry" indicates that more than one external program can be wired up and connected, and with proper diode isolation (explained below) each program can be switched into operation by one connection to the Carry Out GND lead.

Program logic is of the two state 1/0 type. Each program logic lead is at −12.2 volts for 1 logic, and each lead is at 0 volts for 0 logic. Power supply leads and POSITION control override leads are classified as linear circuits.

External switches must handle current in the 0 logic state. Table 2-2 lists the currents for each pin of J-20.

TABLE 2-2

J-20 Current Ratings

J-20 Pins	Current in mA
4 and 37	17
8-9-10-12-13-15-16	5
21	10
23-24-26-36	75

MULTIPLE PROGRAM DIODE ISOLATION

If more than one external program is to be used with the Type 3A5, diodes must be used to isolate the inactive programs from the program in use. Fig. 2-4 shows three possible external programs, with the required isolation diodes and switching for simple program selection. The germanium diodes must be able to handle the currents listed

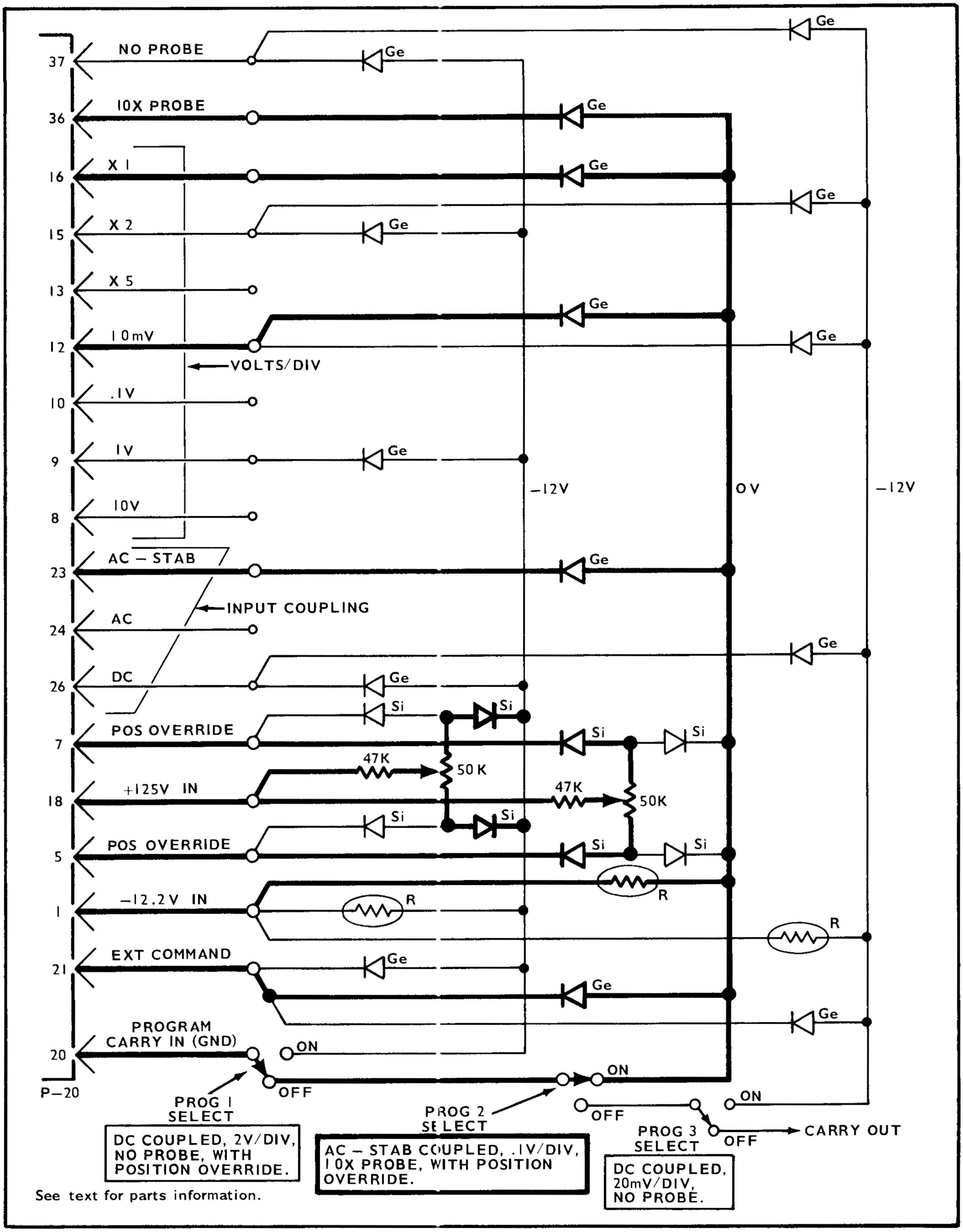

Fig. 2-4. Three external programs with isolation diodes and selection switches.

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in Table 2-2. Diodes are available from your Tektronix Field Office. Order germanium diodes by part number 152-0075-00. Order silicon diodes by part number 152-0185-00. The circled resistors, R, can be either 270 Ω 2-watt composition resistors (Tektronix Part No. 306-0271-00), or indicator lamps, G.E. #2107D (Tektronix Part Number 150-0046-00).

Fig. 2-4 has heavy lines to indicate program current flow, and to aid in understanding how the diodes disconnect the position override resistors of the inactive program. The circled resistors ensure that the position override resistors are disconnected by drawing their current to —12.2 volts and placing the variable position control ends more negative than the nominal —6 volts at pins J-20/5 and J-20/7. The PROG SELECT switches disconnect the carry gnd from succeeding programs. If PROG 1 is on, throwing the PROG SELECT switches of PROG 2 or PROG 3 on will not parallel programs. PROG 1 select switch must be off for PROG 2 or PROG 3 to operate.

J-20/21 is grounded by any PROG SELECT switch in its ON position. This EXT COMMAND circuit ground prevents returning the Type 3A5 operating mode to internal operation by accidentally pressing the MAN or SEEK buttons

Table 2-3 shows which pins of J-20 to ground, to obtain proper VOLTS/DIV and readout with and without a 10X probe. Note that three pins must always be grounded for proper operation. Use of a probe with other than 10X attenuation is the same as NO PROBE for programming purposes. Refer to Fig. 2-3 and Fig. 2-4 for other J-20 leads and programming functions.

TABLE 2-3

J-20 Pins to Be Grounded To Obtain Deflection Factors Listed.

VOLTS/DIV	NO PROBE pin 37 and	10X PROBE pin 36 and
10 mV	12 16	- -
20 mV	12 15	- -
50 mV	12 13	- -
0.1 V	10 16	12 16
0.2 V	10 15	12 15
0.5 V	10 13	12 13
1 V	9 16	10 16
2 V	9 15	10 15
5 V	9 13	10 13
10 V	8 16	9 16
20 V	8 15	9 15
50 V	8 13	9 13
.1 KV	- -	8 16
.2 KV	- -	8 15
.5 KV	- -	8 13

SECTION 3

LOGIC AND CIRCUIT DESCRIPTION

Introduction

The Type 3A5 Automatic/Programmable Amplifier circuits provide several ways to obtain a useful crt display easily. The plug-in includes the normal vertical amplifier circuits needed to deflect the crt beam, plus circuits and controls that allow automatic or external control of the deflection factor, input coupling and mode of operation. This section of the manual describes first the system (through block diagrams), then the circuits of the Type 3A5.

LOGIC AND BLOCK DIAGRAM

The system interconnections of the Type 3A5 are shown fully in the complete block diagram at the back of this manual. The logic description begins with simplified block diagrams that show the general vertical and automatic portions of the instrument. Circuit interconnections for seven operating modes follow the simplified block diagrams. The seven mode block diagrams are drawn with the blocks in the same order as the complete block diagram.

A simplified block diagram of the most basic blocks of the Type 3A5 is shown in Fig. 3-1. The Type 3A5 input attenuators are operated by either the MANUAL VOLTS/DIV control or the automatic circuits. Display size information from the vertical amplifier controls the response of the automatic circuits once they have been put into operation. The two connections between the automatic block and the MANUAL VOLTS/DIV switch block (of Fig. 3-1) are power control lines. The automatic control circuits supply —12.2 volts to the MANUAL VOLTS/DIV switch only during manual mode operation. The MANUAL VOLTS/DIV switch will change the mode of operation from SEEK to manual any time the switch is turned (provided an external programmer is not connected and operating). The +6.8 volts to the automatic block is interrupted as the MANUAL VOLTS/DIV switch travels between detent positions, changing the mode to manual.

Fig. 3-2 block diagram shows more basic interconnections between the automatic circuits and the vertical system. The connections added to those of Fig. 3-1 are: (1) "WITH PROBE" switch for 10× scaling of the readout when operating with P6030 10× Probe; (2) two sets of reed-switched attenuators; (3) the AC—TRACE STABILIZED feedback path around the vertical amplifier, and (4) the Input Coupling switch is shown as feeding information to the readout circuits.

The diodes in the lines to the two sets of reed switched attenuators switch out the Automatic circuits when operation is manual; similarly for automatic operation, the MANUAL VOLTS/DIV switch is diode-switched out of operation.

Automatic circuits is the name thus far given to both the mode control circuits and the circuits that set the deflection factor automatically. Before studying any of the control or automatic deflection factor selection circuits, refer to Fig. 3-3 which shows the complete vertical amplifier block diagram. All the front panel controls that affect the vertical system are shown.

Fig. 3-3 shows that several functions of the vertical amplifier can be controlled in more than one manner. The functions and their source of control are:

Function	Controlled By:
Input Coupling	Front-panel three position switch; or external program.
Deflection Factor	MANUAL VOLTS/DIV switch; or SEEK auto selection circuits; or external program.
With Probe 10× scaling of readout	By P6030 10× Probe connector; or by external program.
VARIABLE	Front-Panel only.
UNCAL to readout	Front-Panel only.
POSITION	Front-Panel; or external program override of front-panel control.
CAL	Front-Panel only.
DISPLAY SIZE	From front-panel only. Display size information controls SEEK auto circuit selection of deflection factor.
1, 2, or 5 mV/DIV Deflection Factors	Front-Panel MANUAL VOLTS/DIV switch only, changes Output Amplifier gain 10×.

The seven major operating modes are block diagrammed in Fig. 3-4 through Fig. 3-10. Each figure has all the circuit blocks laid out in the same order as used on the complete block diagram at the back of this manual. Interconnections and readout are shown for only those leads that are active for each mode. (The INT-EXT switch indicates that the input coupling, and "with probe" switching can be front-panel or externally controlled.)

Fig. 3-4 and Fig. 3-5 show two manual operating modes. The major difference between the two diagrams is the 10× probe, the Input Coupling, and the Output Stage 10× gain. Note that the MANUAL VOLTS/DIV switch receives a 10× readout scaling command when the P6030 10× Probe is used.

Fig. 3-6 shows a simple automatic SEEK mode block diagram with an uncalibrated 10 V/DIV deflection factor, and no probe. Note that the Mode Control provides —12.2 volts to the two Ring Counters and the 1×/10× Readout Scaler. The +6.8-volt lead from the MANUAL VOLTS/DIV switch to the Mode Control circuits is the control lead that will change the mode from SEEK to Manual any time the MANUAL VOLTS/DIV switch position is changed (providing there is no external program in operation). The SEEK mode is obtained by pressing the front-panel SEEK pushbutton, or by momentary grounding of the correct external PROGRAM lead (dashed line). A SEEK command pulse goes to the Advance Gate. (Pressing the P6030 SEEK button causes a REMOTE SEEK command pulse to go to both the Advance Gate and the horizontal unit.) The leading edge of the

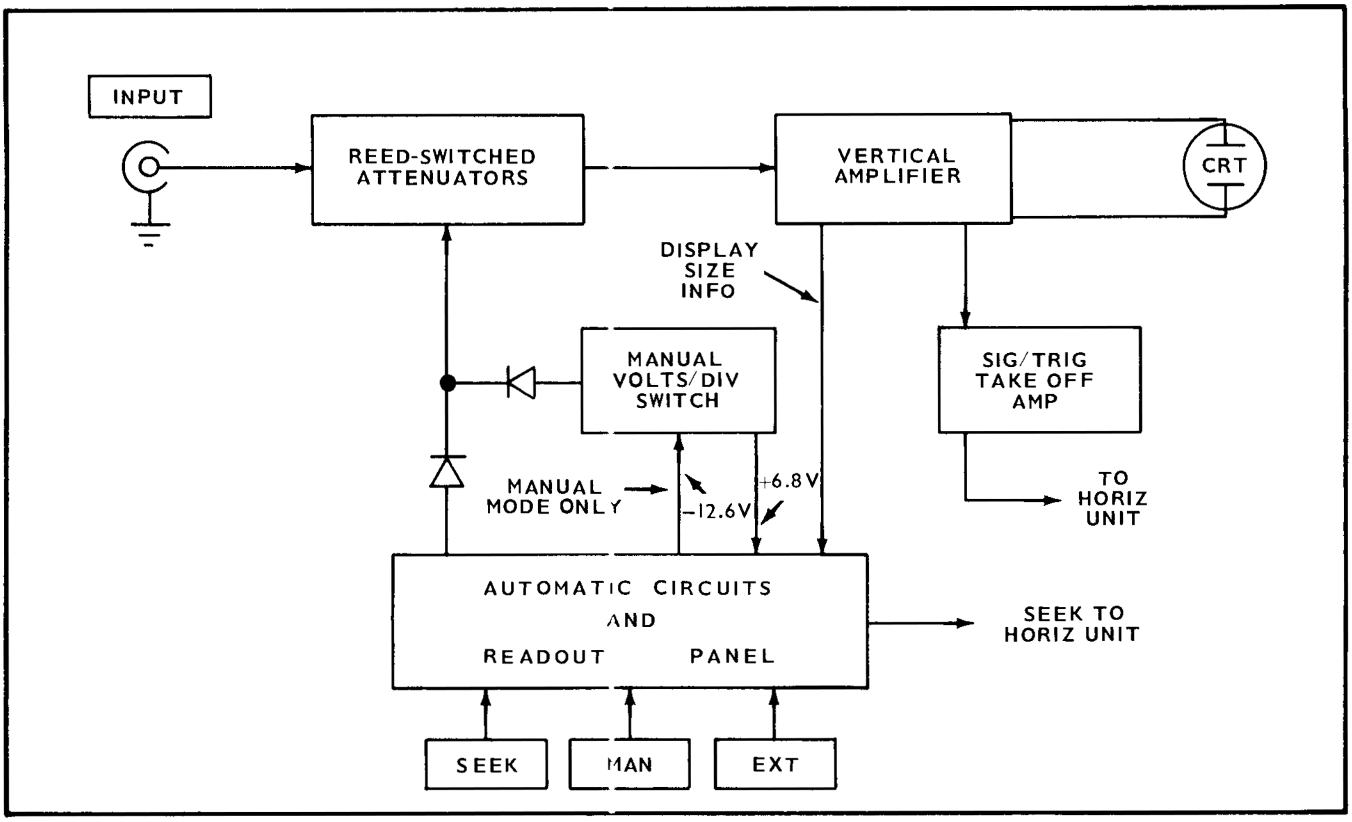

Fig. 3-1. Type 3A5 simplified block diagram.

SEEK command signal is used as a Ring Counter reset pulse to set them both to ÷1. If the vertical signal out of the Driver Amp exceeds the voltage set by the DISPLAY SIZE control, the Display Comparator Multi will send a positive pulse or a series of pulses to the Advance Gate. If the Advance Gate has received a SEEK Command, negative Advance pulses are sent to the ÷3 Ring Counter. Each pulse advances the ÷3 Ring Counter to the next state in its cycle, ÷1 to ÷2 to ÷5, each state corresponding to an input attenuator value. After the ÷3 Ring Counter reaches ÷5, its next step is back to ÷1, and a ÷3 Advance Pulse is sent to the ÷4 Ring Counter. Pulses to the ÷4 Ring Counter advance it one step at a time from ÷1 to ÷10 to ÷100 and to ÷1000. If the Display Comparator Multi sends out enough pulses for the ÷3 Ring Counter to reach ÷5 at the same time the ÷4 Ring Counter reaches ÷1000, a 50 V/DIV Advance Inhibit locks out any more Advance Pulses from leaving the Advance Gate (see Fig. 3-9). If the signal out of the Driver Amp still exceeds the voltage set by the DISPLAY SIZE control, the Display Comparator Multi continues to send out pulses, but they are used only to light the Overscan Lamp. The 10 V/DIV Deflection Factor of Fig. 3-6 required 9 Advance Pulses (after the reset of both ring counters) in order for the Ring Counters to activate the ÷1000 and ÷1 attenuator reed switches.

Fig. 3-7 is a 20 V/DIV SEEK mode WITH PROBE block diagram. The major difference from Fig. 3-6 is the 10× Command to the 1×/10× Readout Scaler, and the ÷1000 and ÷2 attenuators that are activated by the Ring Counters.

Fig. 3-8 connections differ from Fig. 3-7 only in the Input Coupling, and the fact that the VARIABLE control is in its calibrated position. The Deflection Factor is different and shows that the 1×/10× Readout Scaler can turn on more than one readout lamp.

Fig. 3-9 shows signals of the ring counter ÷1000 and ÷5 stages coupled to the Advance Gate at 50 V/DIV. When both Ring Counters reach their maximum count, an inhibit signal to the Advance Gate stops any more Advance Pulses from reaching the ÷3 Ring Counter. If there were no 50 V/DIV inhibit signal, the attenuators next step would be back to 10 mV/DIV (÷1 and ÷1) and the system would not stop cycling until the end of the SEEK command pulse.

Fig. 3-10 is an External Mode block diagram at .5 V/DIV, WITH PROBE, and uncalibrated. Note that the Mode Control sends —12.2 volts to the Ring Counters and the 1×/10× Readout Scaler. Ring Counter input leads are grounded through the External PROGRAM connector, labeled EXT PROGRAM. The Input Coupling is externally controlled, and the 1×/10× Readout Scaler is externally controlled. The POSITION control can receive override current through the PROGRAM connector if desired.

CIRCUIT DESCRIPTION

Attenuators

The attenuators, detailed on diagram number 1, Section 9 are selected by magnetic coil reed switches. Each attenuator

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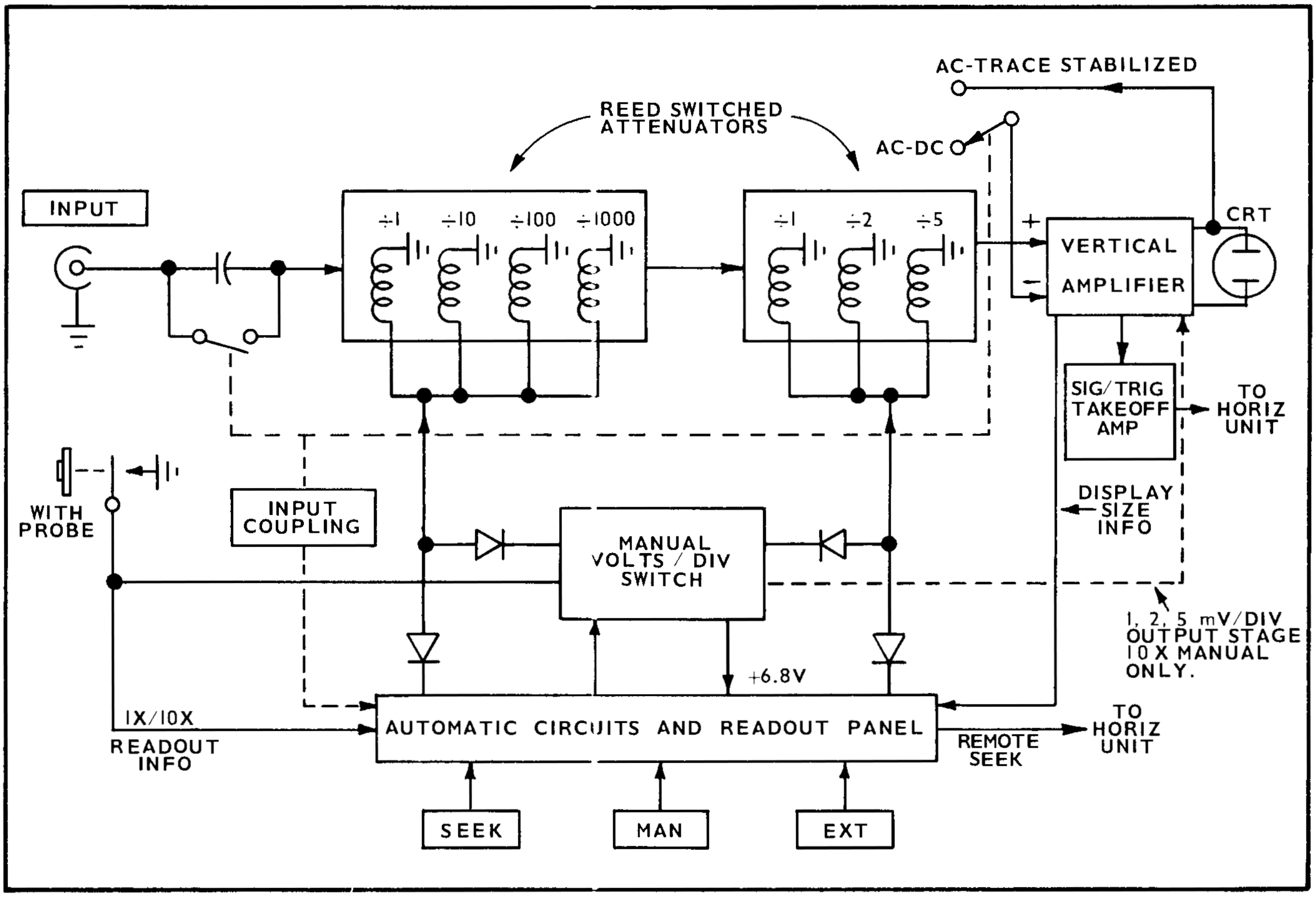

Fig. 3-2. Basic interconnections between vertical system and automatic system.

is a time constant compensated divider that is correctly compensated when its load is 1 MΩ and 24 pF. Fig. 3-11 shows the basic components of an attenuator, assuming no stray capacitance. The output voltage is equal to the input voltage multiplied by the ratio of the resistor values at dc or low frequencies, and by the ratio of the capacitive reactance of the two capacitors at high frequencies. Another way of expressing the same thing is to say the time constant of $R_1 \times C_1$ equals the time constant of $R_2 \times C_2$, and the voltage attenuation is the same for all frequencies.

Fig. 3-12 shows that the ÷2 attenuator output resistor and capacitor (equal to R_2 and C_2 of Fig. 3-11) consist of R55D in parallel with R70, and C70 in parallel with stray load capacitance and the vertical amplifier input capacitance. R55D and R70 in parallel equals 500 kΩ, which, in turn is equal to R55A. This gives the attenuator a ratio of 2 to 1. Capacitors C55A and C55B serve only to bring the ÷2 attenuator input capacitance up to 24 pF. Without C55A and C55B, the system input would be less than 24 pF with the ÷2 attenuator in use.

The number of components between the INPUT connector and the vertical amplifier input changes considerably, depending upon what deflection factor is required. The attenuator components sequence (without component numbers) is shown in Fig. 3-13. Fig. 3-13 indicates that the input resistance and capacitance (at the INPUT connector) remains the same regardless of deflection factor, and the input capacitance of each attenuator input section is adjustable. An attenuator probe such as the P6030 10× Probe can be used with the Type 3A5 without having to change its compensation as different input attenuators are switched into service.

All attenuator switching is done by magnetic reed switches which are operated remotely by the various circuits. Circuits that can operate the reed switches are shown on the block diagram. They include: (1) the MANUAL VOLTS/DIV switch, (2) the ÷3 and ÷4 Ring Counters, and (3) the external PROGRAM. External control lead voltage and current requirements are given in the Operating Instructions under External Programming.

The input circuit to the attenuators includes the reed-relay operated AC coupling capacitor, C1. Resistor R1 is placed in series with the reed switch and C1 to limit the discharge current through the reed switch in the event C1 is charged to a high voltage.

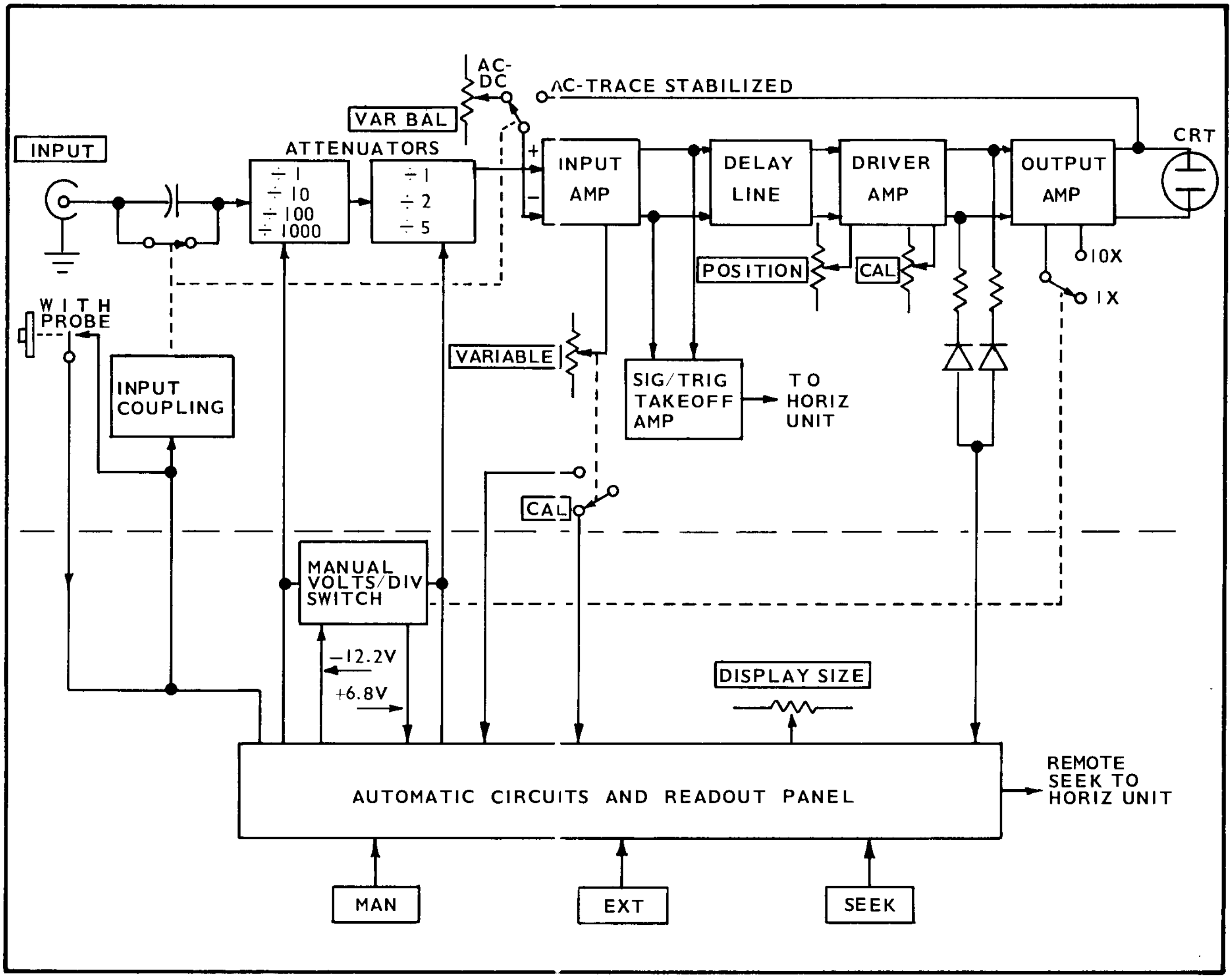

Fig. 3-3. Block diagram of the complete vertical amplifier system with simplified automatic circuits.

Vertical Amplifier

The input grid of the vertical amplifier (at V113) receives a standard signal of 10 mV peak to peak for each major division of vertical deflection. This is true for deflection factors of 10 mV/DIV, through 50 V/DIV. For deflection factors of 1, 2, or 5 mV/DIV, the standard input signal to V113 grid is 1 mV peak to peak for each major division of vertical deflection. The total amplifier is symmetrically balanced, with some sections push-pull and some sections paraphase. The push-pull stages have no common coupling between balanced halves, while the paraphase stages do have common coupling.

Referring to Fig. 3-3 (or the complete block diagram) the Input Amplifier has a single-ended input to push-pull output voltage gain of approximately 9.5 when the VARIABLE control is at CAL. The gain of 9.5 is from the grid of V113 to the two Delay Line input terminals. The gain of the Driver Amplifier is adjustable by the front-panel CAL control. The nominal push-pull voltage gain of the Driver Amplifier (when the crt vertical deflection factor is 20 volts/div) is approximately 5.5. The gain of 5.5 is measured from the two Delay Line output terminals to the two emitters of Q183/Q383. The Output Amplifier push-pull voltage gain is approximately 41 as measured from the emitters of Q183/Q383 to the plates of V524/V534. The total gain from V113 grid to the push-pull output at the crt is approximately 2000.

Input Amplifier. The Input Amplifier consists of five balanced stages. The input is a pair of vacuum tube cathode followers. V113 grid receives the standard signal from the input attenuators. V313 receives either a fixed level dc voltage from the VAR BAL control, or a dc feedback signal from the Output Amplifier at V524 plate. The input tubes have large cathode resistors to the −100-volt supply to stabilize their operation and make their gain nearly unity. R115 and C115 decouple the power supply lead from the input stage cathodes. Since R115 is 47 ohms and C115 is 0.01 μF, the two cathodes have no common signal coupling, and the tubes operate independently.

The cathode output impedance of V113 is not low enough to properly drive the base circuit of Q134, so the second stage is a transistor emitter follower. Q123/Q323 each have relatively large emitter resistors to the decoupled +4.2-volt

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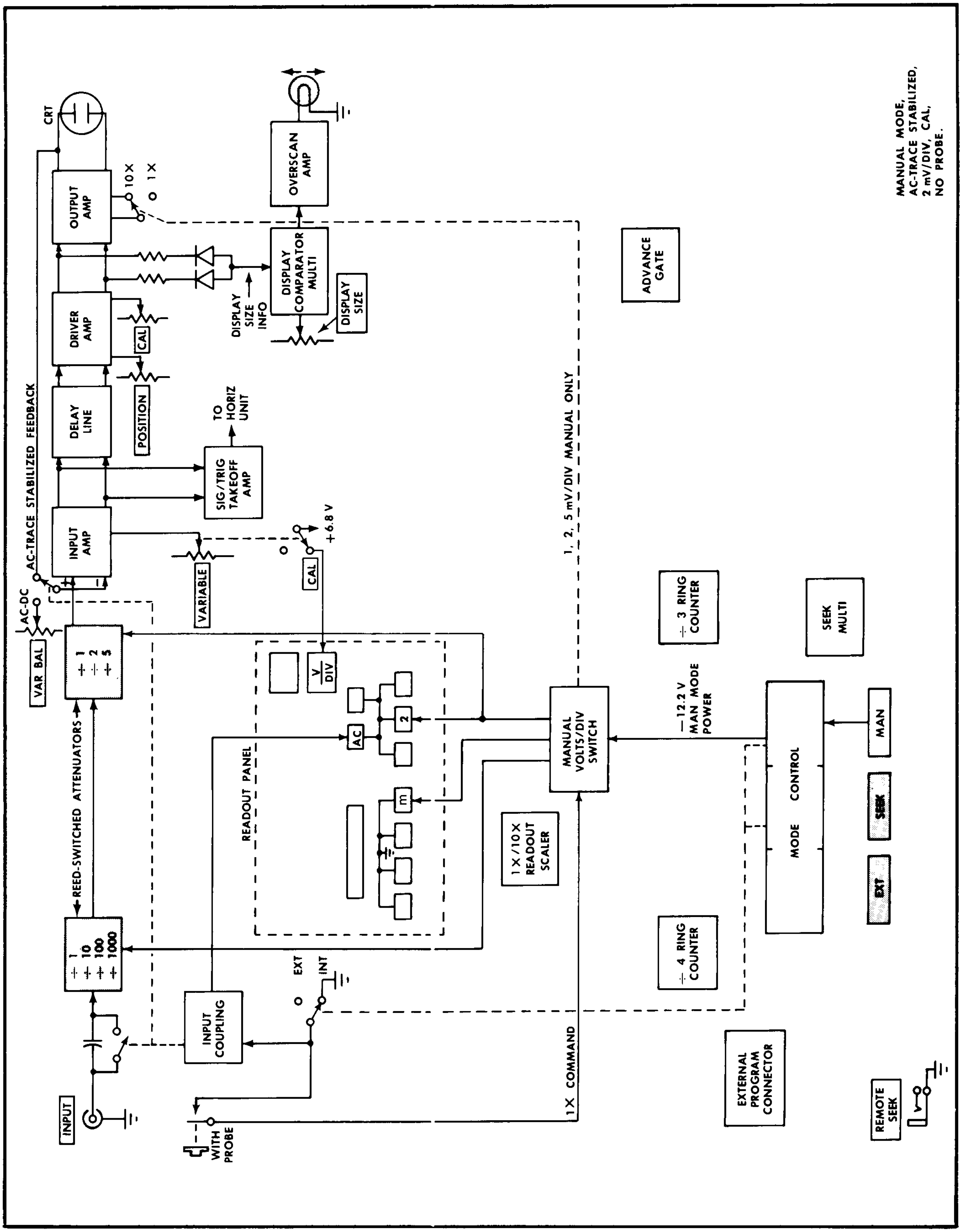
MANUAL MODE, AC-TRACE STABILIZED, 2 mV/DIV, CAL, NO PROBE.
CRT
OUTPUT AMP
10 X
1 X
OVERSCAN AMP
DISPLAY COMPARATOR MULTI
DISPLAY SIZE INFO
DISPLAY SIZE
DRIVER AMP
CAL
POSITION
DELAY LINE
TO HORIZ UNIT
SIG/TRIG TAKEOFF AMP
INPUT AMP
AC-TRACE STABILIZED FEEDBACK
+6.8 V
CAL
VARIABLE
AC-DC
VAR BAL
÷ 1 ÷ 2 ÷ 5
REED-SWITCHED ATTENUATORS
÷ 1 ÷ 10 ÷ 100 ÷ 1000
READOUT PANEL
V/DIV
AC
2
m
1, 2, 5 mV/DIV MANUAL ONLY
ADVANCE GATE
÷ 3 RING COUNTER
SEEK MULTI
MANUAL VOLTS/DIV SWITCH
−12.2 V MAN MODE POWER
MODE CONTROL
MAN
SEEK
EXT
1 X/10 X READOUT SCALER
÷ 4 RING COUNTER
EXT
INT
INPUT COUPLING
INPUT
WITH PROBE
1 X COMMAND
EXTERNAL PROGRAM CONNECTOR
REMOTE SEEK

Fig. 3-4.

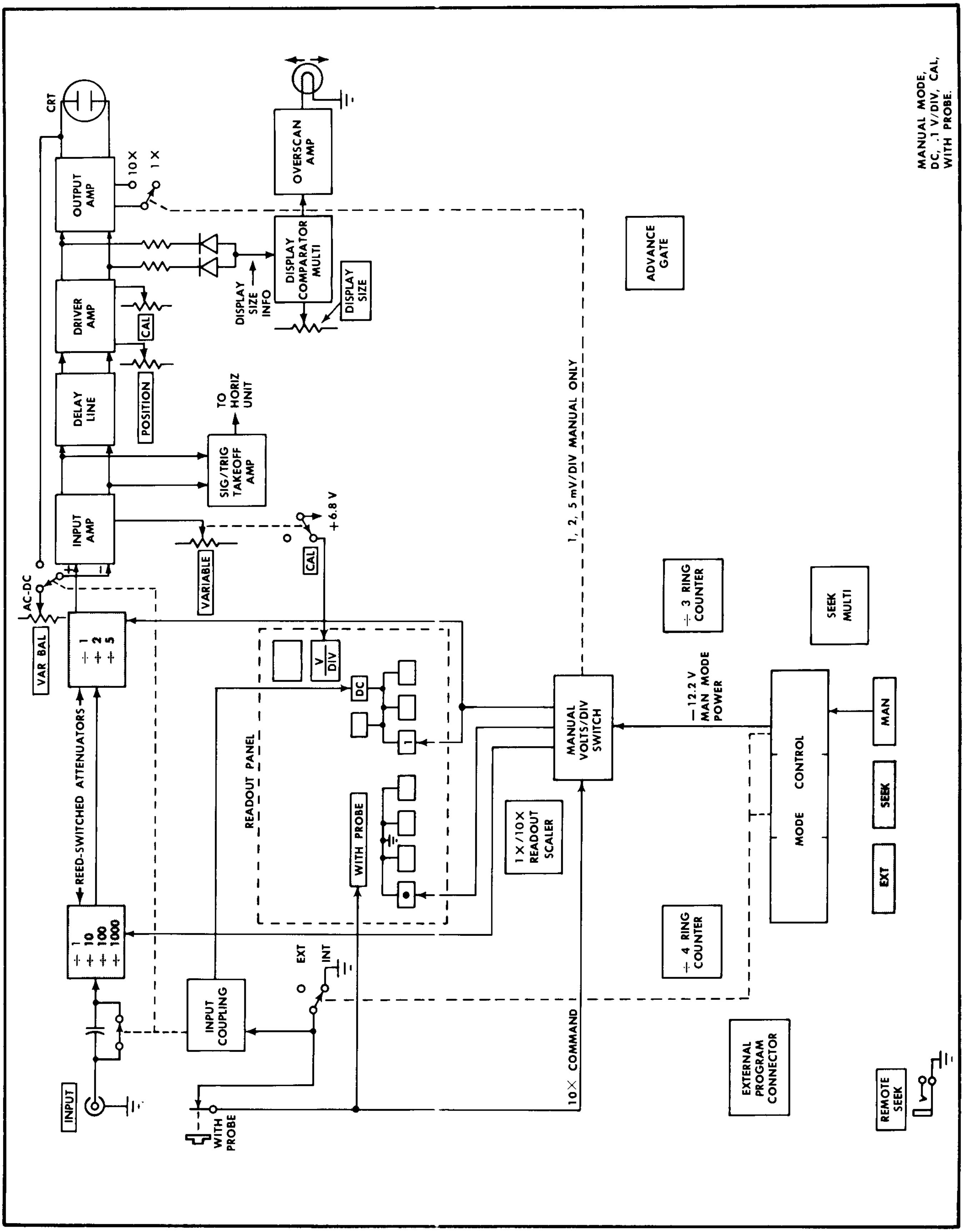
MANUAL MODE, DC, .1 V/DIV, CAL, WITH PROBE.
CRT
OUTPUT AMP
10X
1X
OVERSCAN AMP
DISPLAY COMPARATOR MULTI
DISPLAY SIZE INFO
DISPLAY SIZE
ADVANCE GATE
DRIVER AMP
CAL
POSITION
DELAY LINE
TO HORIZ UNIT
SIG/TRIG TAKEOFF AMP
1, 2, 5 mV/DIV MANUAL ONLY
INPUT AMP
+6.8 V
VARIABLE
CAL
AC-DC
VAR BAL
÷ 1
÷ 2
÷ 5
÷ 3 RING COUNTER
SEEK MULTI
V/DIV
DC
1
READOUT PANEL
REED-SWITCHED ATTENUATORS
MANUAL VOLTS/DIV SWITCH
−12.2 V MAN MODE POWER
MODE CONTROL
MAN
SEEK
EXT
WITH PROBE
1X/10X READOUT SCALER
÷ 1
÷ 10
÷ 100
÷ 1000
÷ 4 RING COUNTER
EXT
INT
INPUT COUPLING
10X COMMAND
EXTERNAL PROGRAM CONNECTOR
INPUT
WITH PROBE
REMOTE SEEK

Fig. 3-5.

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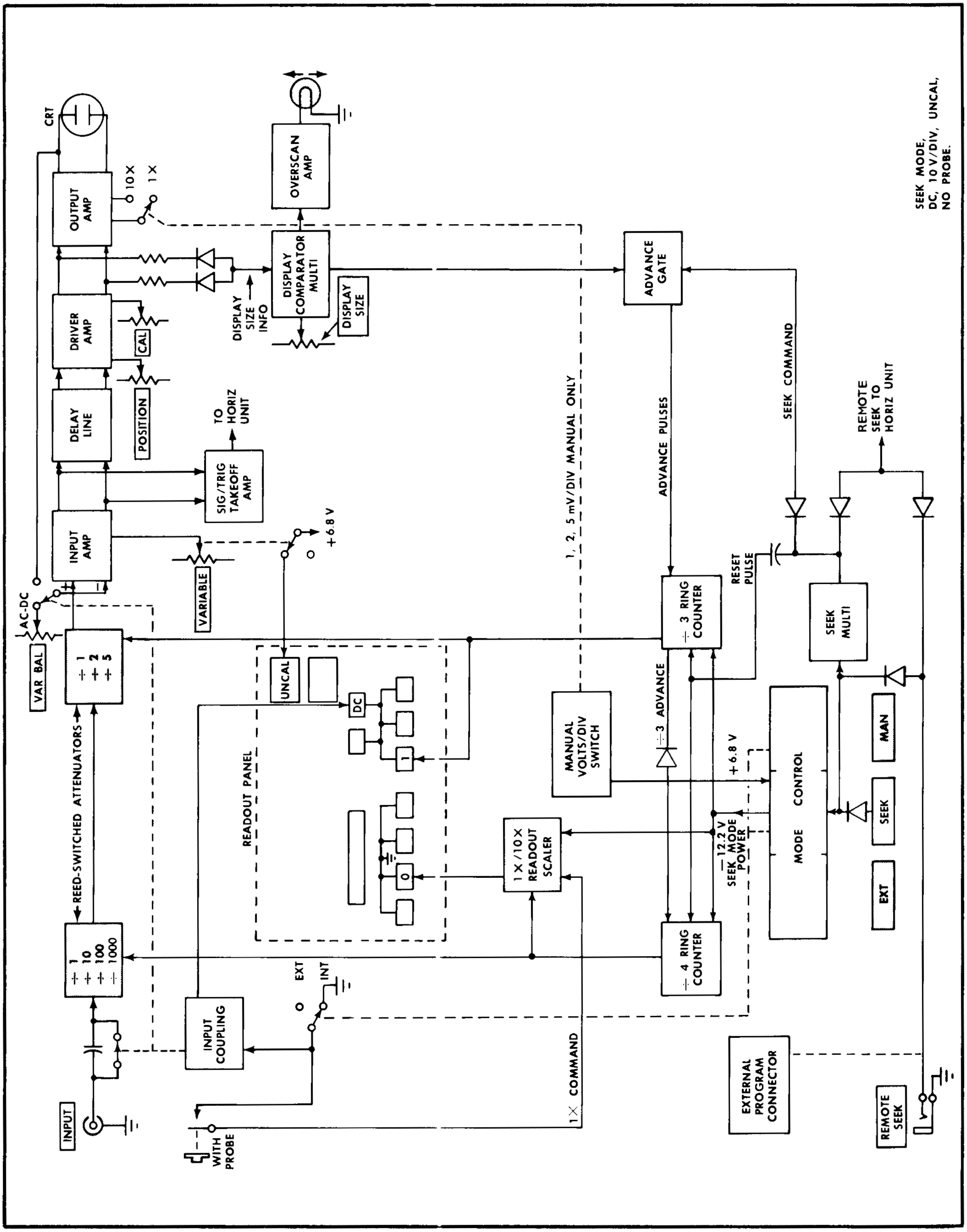
CRT
OUTPUT AMP
10×
1×
DRIVER AMP
CAL
DELAY LINE
POSITION
INPUT AMP
SIG/TRIG TAKEOFF AMP
TO HORIZ UNIT
OVERSCAN AMP
DISPLAY COMPARATOR MULTI
DISPLAY SIZE
DISPLAY SIZE INFO
VARIABLE
+6.8 V
AC-DC
VAR BAL
÷1 ÷2 ÷5
REED-SWITCHED ATTENUATORS
÷1 ÷10 ÷100 ÷1000
INPUT
INPUT COUPLING
EXT
INT
WITH PROBE
1× COMMAND
READOUT PANEL
UNCAL
DC
1
0
1, 2, 5 mV/DIV MANUAL ONLY
MANUAL VOLTS/DIV SWITCH
1×/10× READOUT SCALER
ADVANCE GATE
ADVANCE PULSES
÷3 RING COUNTER
÷3 ADVANCE
÷4 RING COUNTER
+6.8 V
−12.2 V SEEK MODE POWER
RESET PULSE
MODE CONTROL
SEEK COMMAND
SEEK MULTI
REMOTE SEEK TO HORIZ UNIT
MAN
SEEK
EXT
EXTERNAL PROGRAM CONNECTOR
REMOTE SEEK
SEEK MODE, DC, 10 V/DIV, UNCAL, NO PROBE.

Fig. 3-6.

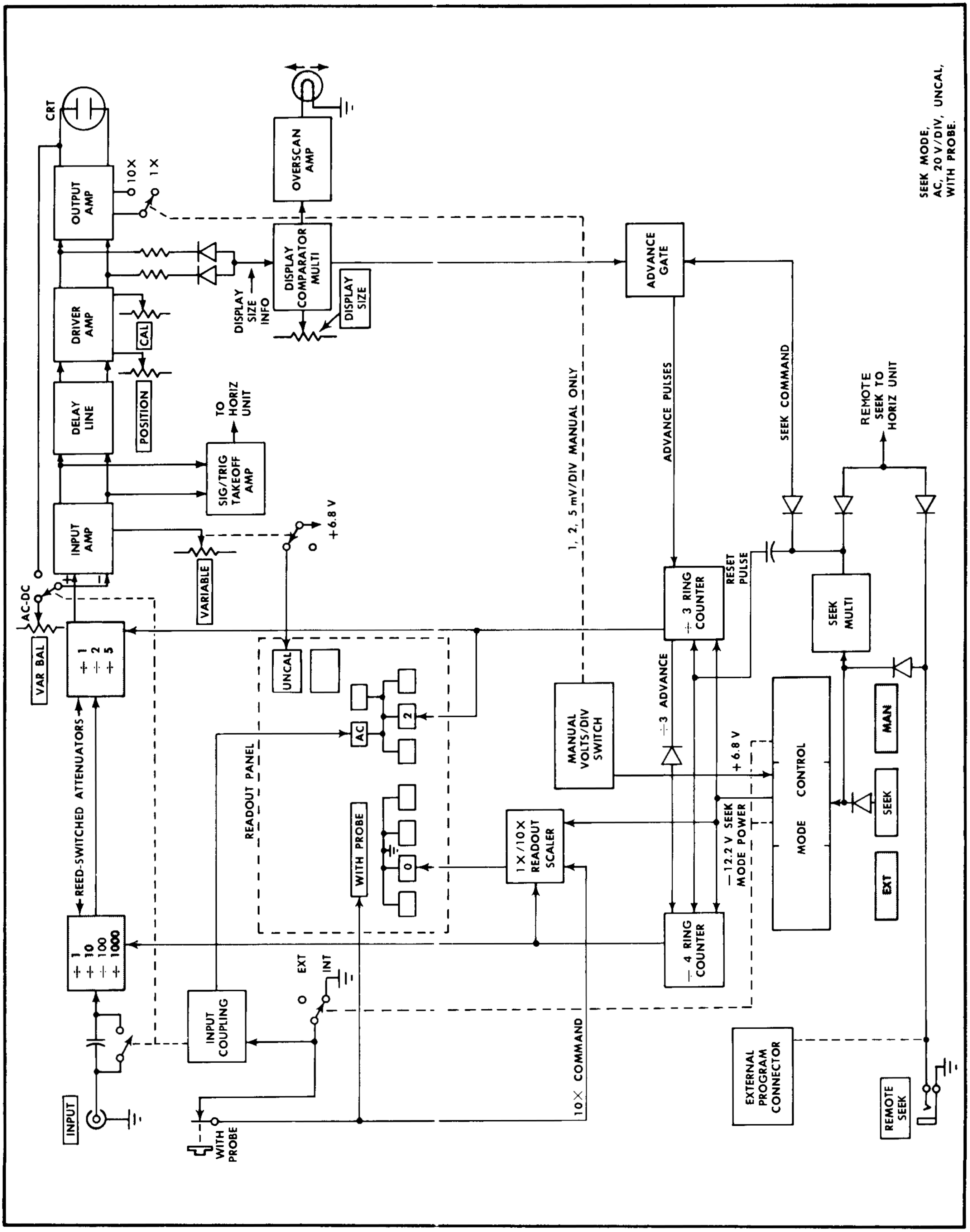
CRT
OUTPUT AMP
10×
1×
OVERSCAN AMP
DISPLAY COMPARATOR MULTI
DISPLAY SIZE INFO
DISPLAY SIZE
DRIVER AMP
CAL
POSITION
DELAY LINE
TO HORIZ UNIT
SIG/TRIG TAKEOFF AMP
INPUT AMP
+6.8 V
VARIABLE
AC-DC
VAR BAL
÷ 1 ÷ 2 ÷ 5
REED-SWITCHED ATTENUATORS
÷ 1 ÷ 10 ÷ 100 ÷ 1000
INPUT
INPUT COUPLING
EXT
INT
WITH PROBE
10× COMMAND
READOUT PANEL
UNCAL
AC
2
0
WITH PROBE
1×/10× READOUT SCALER
1, 2, 5 mV/DIV MANUAL ONLY
MANUAL VOLTS/DIV SWITCH
ADVANCE GATE
ADVANCE PULSES
÷ 3 ADVANCE
÷ 3 RING COUNTER
÷ 4 RING COUNTER
RESET PULSE
+6.8 V
−12.2 V SEEK MODE POWER
MODE CONTROL
SEEK COMMAND
SEEK MULTI
REMOTE SEEK TO HORIZ UNIT
MAN
SEEK
EXT
EXTERNAL PROGRAM CONNECTOR
REMOTE SEEK
SEEK MODE, AC, 20 V/DIV, UNCAL, WITH PROBE.

Fig. 3-7.

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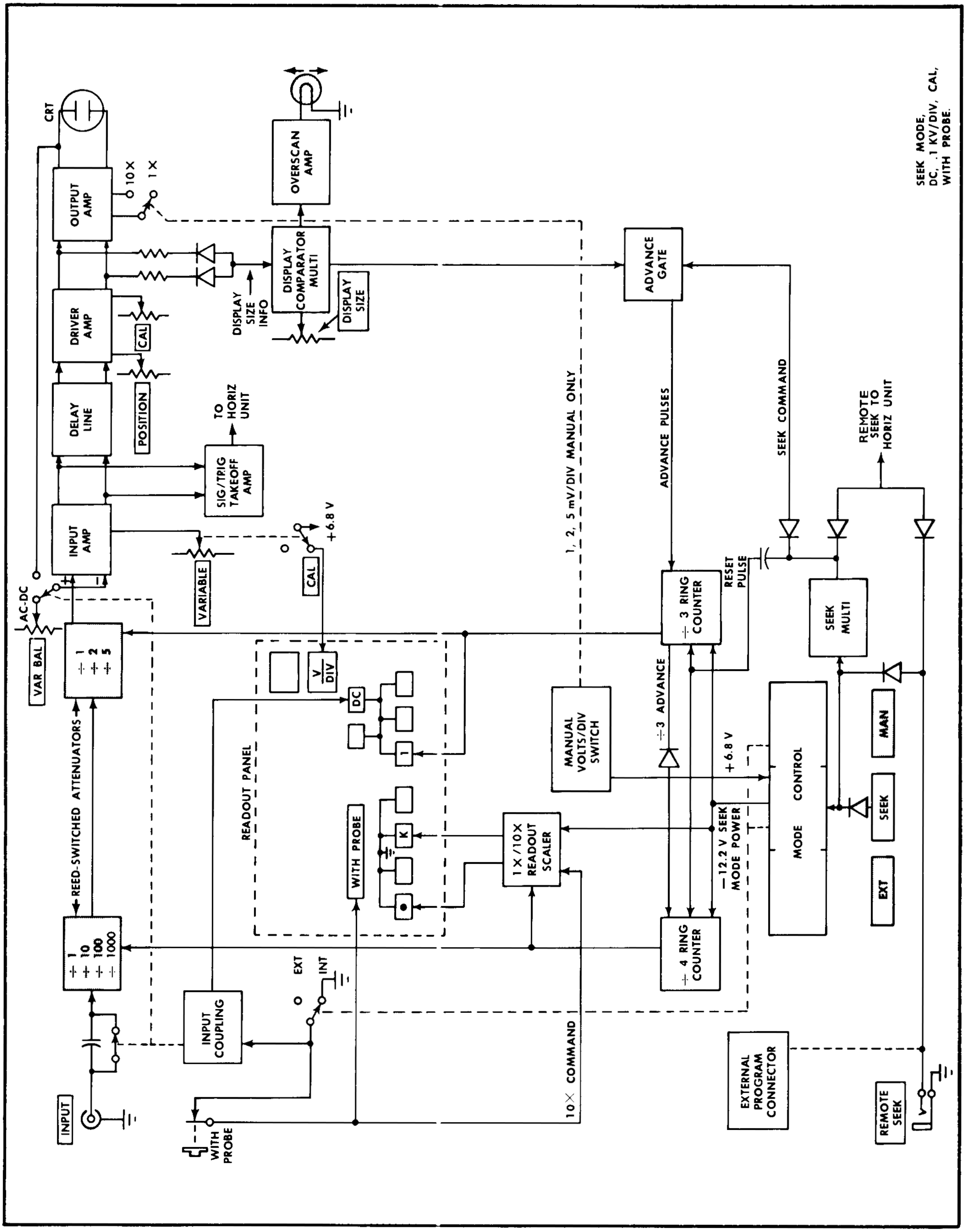
CRT
OUTPUT AMP
10×
1×
OVERSCAN AMP
DISPLAY COMPARATOR MULTI
DISPLAY SIZE INFO
DISPLAY SIZE
ADVANCE GATE
DRIVER AMP
CAL
POSITION
DELAY LINE
TO HORIZ UNIT
SIG/TRIG TAKEOFF AMP
INPUT AMP
+6.8 V
VARIABLE
CAL
AC-DC
VAR BAL
÷ 1 ÷ 2 ÷ 5
REED-SWITCHED ATTENUATORS
READOUT PANEL
V/DIV
DC
K
WITH PROBE
÷ 1 ÷ 10 ÷ 100 ÷ 1000
INPUT
INPUT COUPLING
EXT
INT
WITH PROBE
10× COMMAND
1, 2, 5 mV/DIV MANUAL ONLY
MANUAL VOLTS/DIV SWITCH
1×/10× READOUT SCALER
ADVANCE PULSES
÷ 3 RING COUNTER
÷ 3 ADVANCE
+6.8 V
−12.2 V SEEK MODE POWER
÷ 4 RING COUNTER
RESET PULSE
SEEK COMMAND
SEEK MULTI
MODE CONTROL
REMOTE SEEK TO HORIZ UNIT
MAN
SEEK
EXT
EXTERNAL PROGRAM CONNECTOR
REMOTE SEEK
SEEK MODE, DC, .1 KV/DIV, CAL, WITH PROBE.

Fig. 3-8.

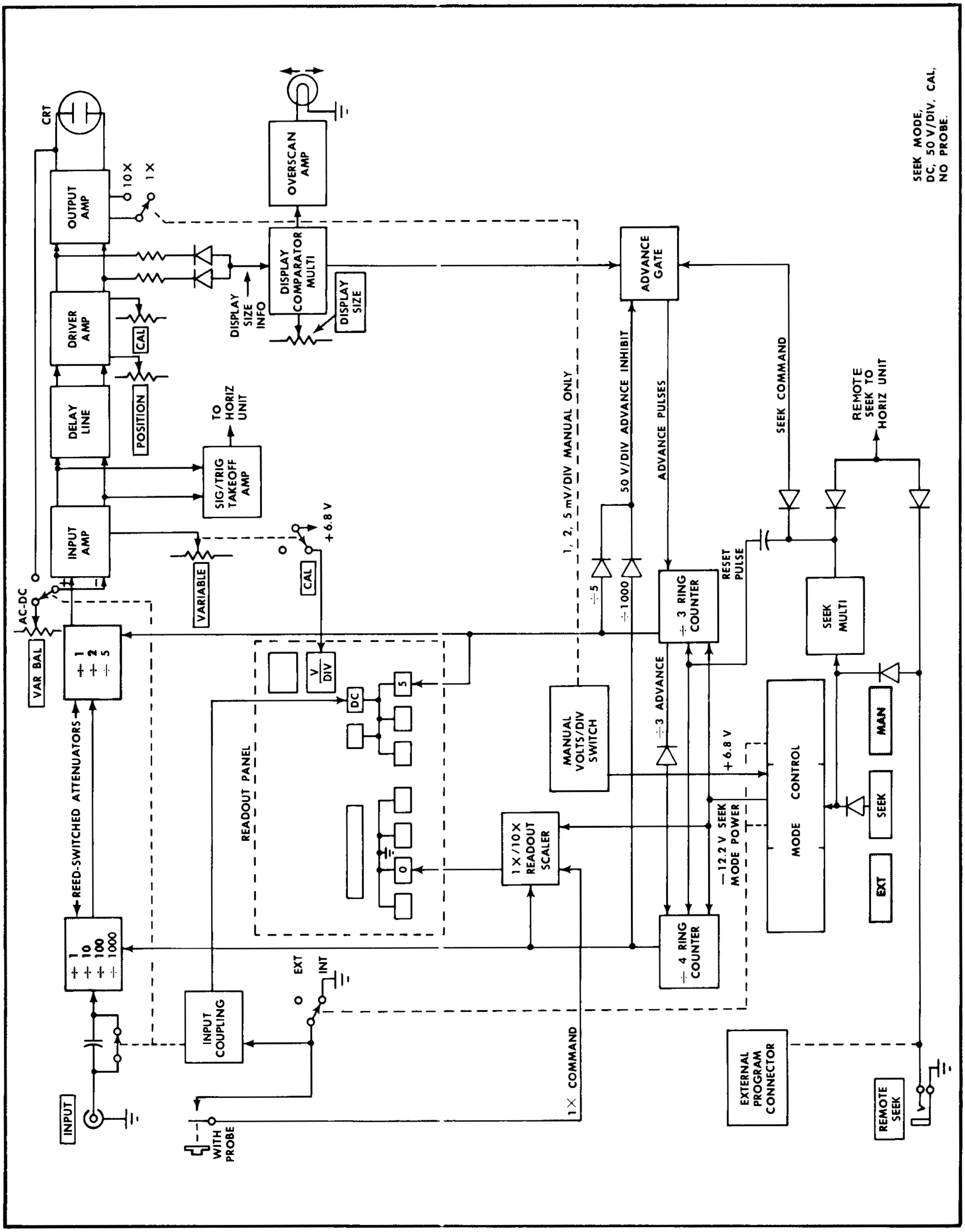
CRT
OUTPUT AMP
10×
1×
OVERSCAN AMP
DISPLAY COMPARATOR MULTI
DISPLAY SIZE INFO
DISPLAY SIZE
ADVANCE GATE
DRIVER AMP
CAL
DELAY LINE
POSITION
TO HORIZ UNIT
SIG/TRIG TAKEOFF AMP
INPUT AMP
+6.8 V
VARIABLE
CAL
AC-DC
VAR BAL
÷1 ÷2 ÷5
REED-SWITCHED ATTENUATORS
÷1 ÷10 ÷100 ÷1000
READOUT PANEL
V/DIV
DC
5
0
INPUT COUPLING
EXT
INT
INPUT
WITH PROBE
1× COMMAND
1, 2, 5 mV/DIV MANUAL ONLY
50 V/DIV ADVANCE INHIBIT
÷5
÷1000
ADVANCE PULSES
÷3 RING COUNTER
÷3 ADVANCE
MANUAL VOLTS/DIV SWITCH
1×/10× READOUT SCALER
÷4 RING COUNTER
RESET PULSE
+6.8 V
−12.2 V SEEK MODE POWER
MODE CONTROL
SEEK COMMAND
REMOTE SEEK TO HORIZ UNIT
SEEK MULTI
MAN
SEEK
EXT
EXTERNAL PROGRAM CONNECTOR
REMOTE SEEK
SEEK MODE, DC, 50 V/DIV, CAL, NO PROBE.

Fig. 3-9.

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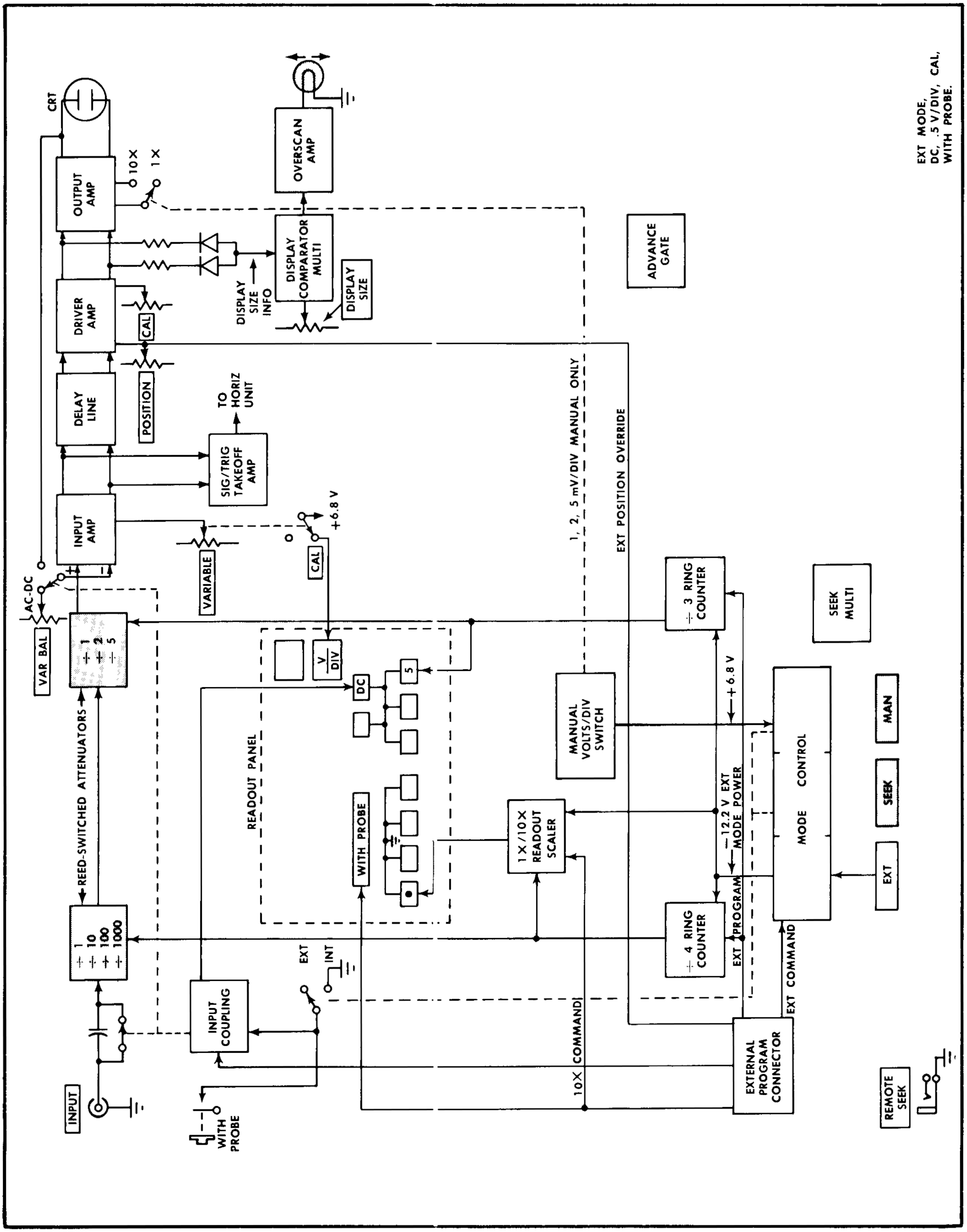
CRT
OUTPUT AMP
10×
1×
OVERSCAN AMP
DISPLAY COMPARATOR MULTI
DISPLAY SIZE INFO
DISPLAY SIZE
DRIVER AMP
CAL
POSITION
DELAY LINE
TO HORIZ UNIT
SIG/TRIG TAKEOFF AMP
INPUT AMP
VARIABLE
CAL
+6.8 V
AC-DC
VAR BAL
÷ 1
÷ 2
÷ 5
REED-SWITCHED ATTENUATORS
÷ 1
÷ 10
÷ 100
÷ 1000
INPUT
INPUT COUPLING
WITH PROBE
EXT
INT
READOUT PANEL
V/DIV
DC
5
WITH PROBE
1×/10× READOUT SCALER
10× COMMAND
1, 2, 5 mV/DIV MANUAL ONLY
EXT POSITION OVERRIDE
ADVANCE GATE
MANUAL VOLTS/DIV SWITCH
÷ 3 RING COUNTER
÷ 4 RING COUNTER
+6.8 V
−12.2 V EXT MODE POWER
EXT PROGRAM
EXT COMMAND
MODE CONTROL
EXTERNAL PROGRAM CONNECTOR
SEEK MULTI
MAN
SEEK
EXT
REMOTE SEEK
EXT MODE, DC, .5 V/DIV, CAL, WITH PROBE.

Fig. 3-10.

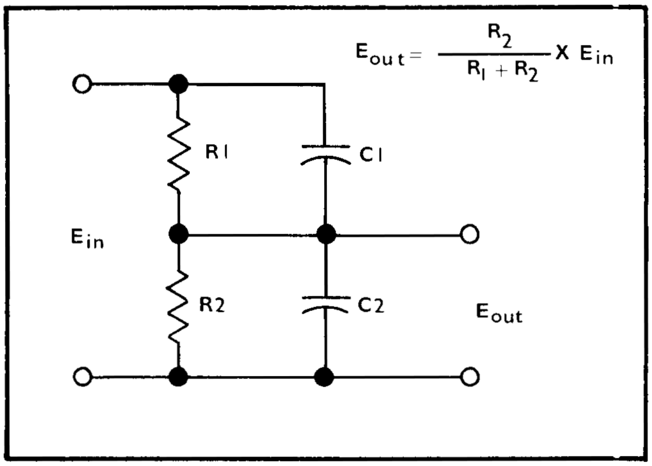

Fig. 3-11. Basic input attenuator.

supply. L122 and C122 decouple the power supply lead from the emitters and provide the low impedance that isolates the emitters. Thus Q123 emitter signal is not coupled to Q323 emitter.

Thus far in the Input Amplifier, signal voltage is applied only to V113 and Q123. There is no signal associated with V313 and Q323. V313 grid is normally fed from the VAR BAL control. The VAR BAL control sets the dc level to V313 grid, which is the minus input to the vertical amplifier. The VAR BAL control adjusts the dc level of Q334 emitter (through V313 and Q323) to exactly the same voltage that is at Q134 emitter. Thus, changing the VARIABLE resistance will not shift the display dc level. The other use of V313/Q323 is discussed under AC-TRACE STABILIZED feedback operation later in this section.

Two diodes located between V313 cathode circuit and Q323 emitter, D315 and D316, protect Q123 and Q134 bases. from large overdrive signals. If V113 cathode voltage rises to about +0.75 volt (about 25 times larger than a normal signal) D316 conducts and places the emitter circuit of Q323 in parallel with V113 cathode. (The output signal of the Input Amplifier reaches its limits before either D316 or D315 conducts.) If V113 cathode voltage falls to about −0.45 volt, D315 conducts and parallels the cathode circuit of V313 across V113 cathode circuit. D315 applies a turn-on signal to Q323 base through R315 (D316 applies a turn-on signal to Q323 emitter) and Q323 then couples some of the overdrive signal to Q334 to limit the unbalanced signal in Q134/Q334 stage.

Q134/Q334 form the first voltage amplifier of the vertical system. The input signal is essentially the same peak-to-peak value through V113/Q123, but is given considerable current gain by the cathode of V113 and the emitter of Q123. Q134/Q334 is a paraphase amplifier with adjustable emitter coupling to allow gain adjustment. The front-panel VARIABLE control is in the signal path between emitters.

As a positive going signal arrives at Q134 base, PNP transistor Q134 conducts less current. Decreased current causes Q134 emitter to go positive and the collector to go negative. As Q134 emitter goes positive, the VARIABLE circuit couples part of the signal to Q334 emitter in a direction to increase its conduction. As Q334 conduction increases, its collector voltage goes positive. Thus the output of Q134/Q334 is push-pull with only single-ended input. Since the VARIABLE circuit attenuates some of the signal from

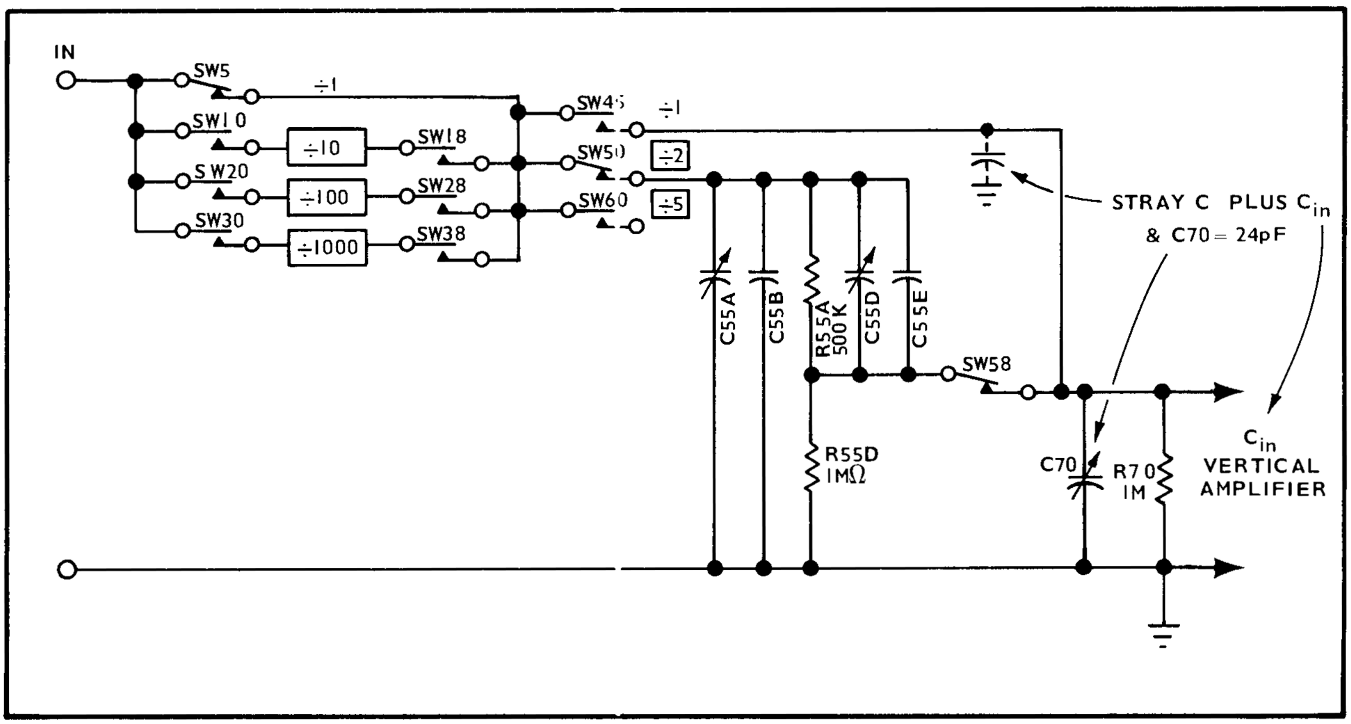

Fig. 3-12. Reed switches and attenuator components at either 2 mV/DIV or 20 mV/DIV.

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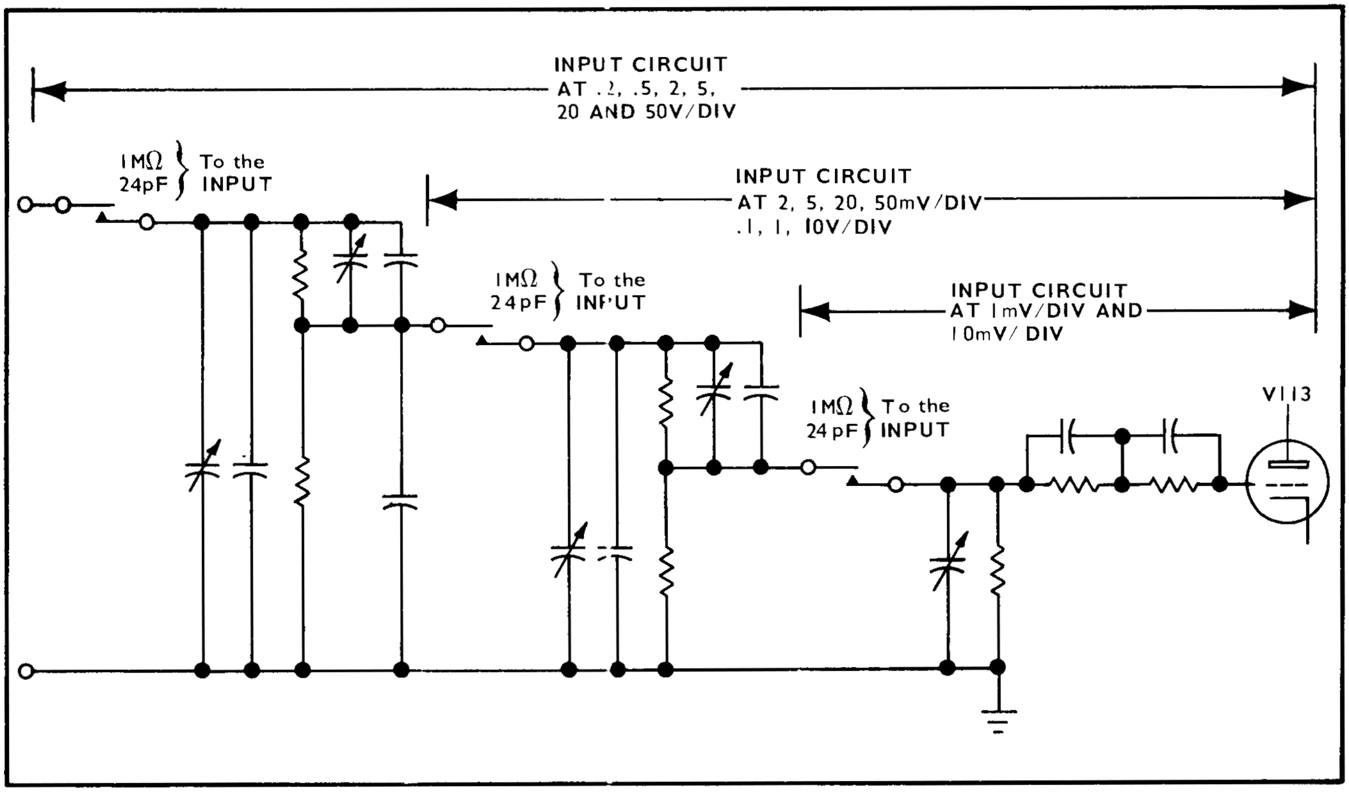

Fig. 3-13. Attenuator sections, single or in cascade, identified for each of the 15 calibrated deflection factors.

Q134 emitter to Q334 emitter, Q334 collector signal amplitude is not quite as great as that of Q134 collector. The difference is not great, because the VARIABLE circuit also provides degeneration to Q134. If the resistance value of the VARIABLE circuit is decreased, the collector signal amplitude of both Q134 and Q334 increases. The two 20 kΩ resistors between Q134/Q334 emitters and the decoupled +125-Volt supply keep the stage current essentially constant. The signal gain is stabilized against transistor β difference by the preceeding stage low driving impedance. Bypassed resistors R124 and R324 in Q134/Q334 collector circuits provide the proper dc and low frequency collector load impedance. R134/R324 allow optimum power dissipation in Q134/Q334 collectors.

C124 and C324 restore the high frequency response that would be lost if pure resistance were placed between the collector (as a signal source) and the next stage base (as a signal load). R140 is a power supply voltage dropping resistor that sets Q143/Q343 base voltage to the correct value.

Q143/Q343 are isolated emitter followers that provide current gain to the signal between Q134/Q334 collector circuits and the bases of amplifier Q154/Q354. These emitter followers are necessary to maintain the overall amplifier high frequency response.

Q154/Q354 is the paraphase output stage of the Input Amplifier. R354 provides dc signal coupling between Q154/Q354 emitters. Several capacitors and series resistance/capacitance networks parallel R354 to provide high frequency compensation to the vertical system. Emitter return resistors R350/R352 assure constant stage current. The collector circuit of Q154/Q354 drives both the Driver Amplifier and the Signal/Trigger Takeoff Amplifier. These amplifiers are driven through power compensating resistors R160/R360. The power compensating resistors keep Q154/Q354 collector junction power dissipation within required limits regardless of signal level.

Delay Line. The delay line is a balanced 186 Ω transmission line. Each end is terminated in 186 Ω. The input end termination is the 186 Ω series value of R194/R394 (at the Signal/Trigger Takeoff Amplifier input) and the low emitter resistance of Q194/Q394. The power compensating resistors, R160/R360 are not in parallel with R194/R394 due to the very high collector resistance of Q154/Q354.

The Delay Line output is terminated by the 186 Ω series resistance of R166/R366 and the virtual ground input resistance of the Driver Amplifier.

Signal/Trigger Takeoff Amplifier. The Signal/Trigger Takeoff Amplifier input is the common-base stage Q194/Q394. The stage effectively isolates the base circuits of paraphase amplifier Q204/Q404 from the delay line input termination, and prevents interaction between the Driver Amplifier and the Signal/Trigger Takeoff Amplifier input.

Q204/Q404 is a non-linear paraphase amplifier that has more gain for low level signals than it does for higher level signals. The stage is designed to have increased low level gain required by the change in standard signal level at V113 input grid. When the deflection factor is 1, 2, or 5 mV/DIV, the Signal/Trigger Takeoff Amplifier receives 1/10 as much signal per crt division as at 10 mV/DIV and up. The stage gain is offset upward at low levels by diodes D204/D404 and C404. Without any signal, D204/D404 are conducting and they place C404 in parallel with the normal emitter signal coupling resistor R202. As a positive 0.5-volt signal is applied to the base of Q204, and a negative 0.5-volt signal the base of Q404, D204 remains in conduction; however, D404 is reverse biased and stops conducting. This is because the charge on C404 takes the cathode of D404 positive while Q404 emitter is going negative. However, if the push-pull signals to the bases of Q204/Q404 are not greater than a total of 0.4 volt, neither diode will cease conducting, and C404 will remain diode-connected across R202, making the stage gain higher than for larger signals.

The collector signal of Q404 is dc coupled to emitter follower Q213. The emitter voltage of Q213 is slightly negative with respect to ground. To bring the output voltage near ground with only small attenuation, R216 and R218 apply a small positive offset to the output signal. C216 couples high frequencies around R216. R214 is a parasitic suppression resistor.

Driver Amplifier. The Driver Amplifier is a paraphase feedback amplifier (usually called an Operational Amplifier) that drives the Output Amplifier and provides Display Size Information to the automatic circuits. The input bases of Q174/Q374 are a virtual signal ground due to negative feedback applied from the output back to the input. The feedback current is nearly equal in magnitude, and is opposite in polarity to the input current. The result is that essentially no signal voltage appears at the input bases, implying a virtual signal ground. Since the input bases are a very low impedance, more than one signal current can be injected or withdrawn to alter the amplifier output voltage. This is done without affecting the amplifier's ability to amplify normal signals. Thus, the POSITION control injects or withdraws current at the Driver Amplifier input to position the crt display.

The input signal current to the Driver Amplifier is applied through the Delay Line and the Delay Line terminating resistors to the base circuit junctions of Q174 and Q374. Assume that a positive voltage signal appears at the Delay Line pin I and a negative voltage signal appears at pin H. Q174 base current increases its collector current. Q374 decreases its collector current. Q174/Q374 emitters are tied directly together to a single return resistor, so the paraphase voltage gain of these two transistors is very high. Q174/Q374 collector signals receive current gain from emitter followers Q183/Q383 and are then metered back to the input base circuit junctions through R179/R183 to Q174, and through R379/R383 to Q374. When the output voltage signal is great enough for the signal current through the feedback resistors to almost equal the input signal current, Q174/Q374 no longer see the signal and they stop changing current. Part of the feedback current is shunted away from Q174/Q374 by the CAL control. The stage gain is adjusted by changing the feedback current by the CAL control which does not change the feedback resistance.

The emitter follower dc return circuit is through R178/R378. These resistors also shunt some of the signal current from the input bases.

Display Size information is diode coupled from the Driver Amplifier output through D188 or D388 to the Display Comparator Multi. Only negative-going signals cause D188 or D388 to conduct; thus, the push-pull Driver Amplifier output signal is converted to single-ended negative-going information. The voltage at which D188 or D388 conduct is set by the Display Size control and the Display Comparator Multi.

Output Amplifier. The Output Amplifier is a combination transistor—vacuum tube amplifier with high voltage gain. The push-pull input signals arrive through T501 to the emitters of common base stages Q504/Q514. T501 assures that the two signals arrive with identical time relationship, even if a minor phase difference exists out of the Driver Amplifier. T501 also inserts a small loss in the signal path, providing parasitic suppression.

Common base amplifiers Q504/Q514 each carry about 17 mA current which passes through the Driver Amplifier output transistors Q183/Q383. Voltage levels are included on the diagram in Section 9. Q504 and Q514 are both feedback amplifiers with feedback applied from the output tube cathodes to the individual transistor bases.

Assume that a negative voltage signal arrives at Q504 and a positive voltage signal arrives at Q514. Q504 reduces its current and Q514 increases its current. As Q504 collector voltage goes negative, the conduction of V524 is reduced. The output voltage to the crt goes positive, and V524 cathode goes negative. V524 cathode is directly coupled to Q504 base, so the negative cathode signal becomes inverse feedback and increases Q504 current again. Q504 current is not increased as much by V524 cathode signal as it was reduced by the Driver Amplifier signal, because the cathode of V524 changes less voltage than the grid changed. Therefore, Q504 receives a turn off signal equal to the difference between its emitter and base voltage changes. D524 (and D534) assure that Q504 (and Q514) have sufficient emitter to collector voltage for proper operation.

V524/V534 are paraphase-connected with about 50 Ω (R518) between cathodes. Thus the Output Stage receives push-pull signals and acts on them in a push-pull balanced fashion. The stage cathode current passes through R521 and R522 to the —12-Volt supply.

When operating at 1, 2, or 5 mV/DIV, the input coupling switch (SW610) causes L515 to close SW515 and parallel less than 3 Ω across R518. Several frequency compensating networks are also placed across R518 to keep the bandwidth as great as possible at the increased gain. SW515 changes the Output Amplifier gain 10X. T524 and T534 are parasitic suppression loss networks.

The plates of V524/V534 include double peaking coils L526 and L536. The plate load resistors are R526 and R536. R528 reduces the +300-Volt supply voltage to limit the plate dissipation in the output tubes. This lowers the output voltage below that which provides proper crt deflection plate voltage (it is low enough to cause defocusing). Therefore, Zener diodes D546 and D556 offset the output voltage (and signal) positively to the required level of about +187 volts at center screen. R546 and R556 provide current to the Zener diodes to assure that they remain at a fixed 62 volts drop. C546 and C556 bypass any Zener diode noise and assure that high frequencies are not attenuated.

AC—TRACE STABILIZED Operation

AC—TRACE STABILIZED operation of the overall vertical amplifier places a dc and low-frequency feedback circuit from the plus output plate circuit of V524 to the minus input grid of V313. The feedback is large in magnitude, causing the whole vertical amplifier to be an operational amplifier with a dc gain much less than unity. Fig. 3-14 is a simplified

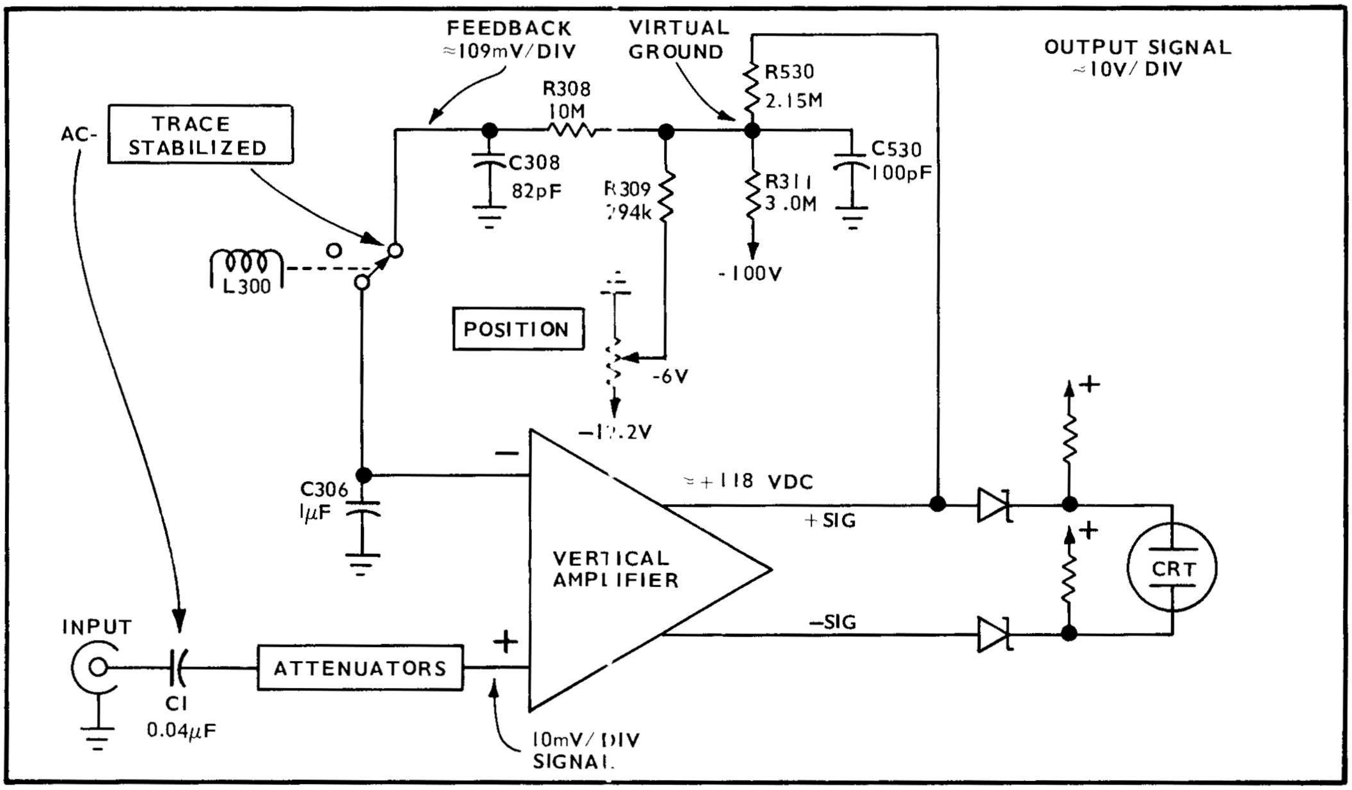

Fig. 3-14. AC-TRACE STABILIZED operational amplifier circuit.

diagram showing the feedback and POSITION control components. Fig. 3-15 shows the circuit connections in greater detail. Feedback resistor R520 is bypassed by C530 to assure that only low frequency signals leave the physical area of the Output Amplifier. The feedback information is cabled to the Control Board for connection with other components. The signal and feedback values included in Fig. 3-14 are for operation at 10 mV/DIV to 50 VOLTS/DIV. Operation at 1 to 5 mV/DIV provides ten times as much feedback due to the Output Amplifier operating at 10× gain.

Feedback current through R530 is equaled by current through R311 and R309 so that their common junction is a virtual signal ground. R308 and C308 in parallel with C306 establish a long time constant to the feedback to assure it is dc and low frequencies only. The feedback network changes the current feedback to about 109 mV/DIV, almost 11 times the standard input signal fed to the amplifier plus input. This amount of feedback would be sufficient to make the overall vertical amplifier dc gain zero, except that the inside loop gain is approximately 2000. Thus the actual dc gain under stabilized feedback conditions is about 0.025 instead of zero. This very low dc gain assures that the crt trace will remain stable for long periods of time regardless of drift signals within the amplifier loop.

With a total vertical amplifier dc closed loop gain of 0.025, normal positioning currents injected at the Driver Amplifier input will not allow control of the crt trace position. Therefore, R309, in addition to opposing R530 feedback signal, also provides offset current to the feedback current so the trace can be positioned. Position affect of the control is approximately one half its normal affect when operation is not feedback-stabilized.

AUTOMATIC CIRCUITS

Some of the automatic circuits have been diagrammed on more than one page of the diagrams in Section 9. The duplication includes interconnections, and is done to help the reader gain understanding of the instrument in the least amount of time.

Mode Control Circuits

The Mode Control Circuits are physically divided between the Automatic Card and the Control board. Drawings Number 4 and 5 in Section 9 show all the control circuits. Number 4 is the MODE CONTROL AND READOUT CONNECTIONS with part of the Control Board and Automatic Card circuits combined in one drawing with the Readout Board bulbs. Number 5 is the complete AUTOMATIC CARD.

The mode of operation is controlled by grounding the proper lead associated with Q624/Q654/Q664 diagrammed on Drawing Number 4. A simplified mode control circuit is shown in Fig. 3-16 joining the physically separated mode control transistors to the proper control relays. The two control relays, L622 and L612 operate as follows:

1. MANUAL operation, both L612 and L622 energized by Q624.

2. SEEK operation, L612 energized by Q664.

3. EXT operation, neither relay energized.

Fig. 3-16 shows that L612/SW612 (the INT-EXT SELECT relay) supplies a ground return circuit for both the Input Coupling switch SW610, and the With Probe switch SW70.

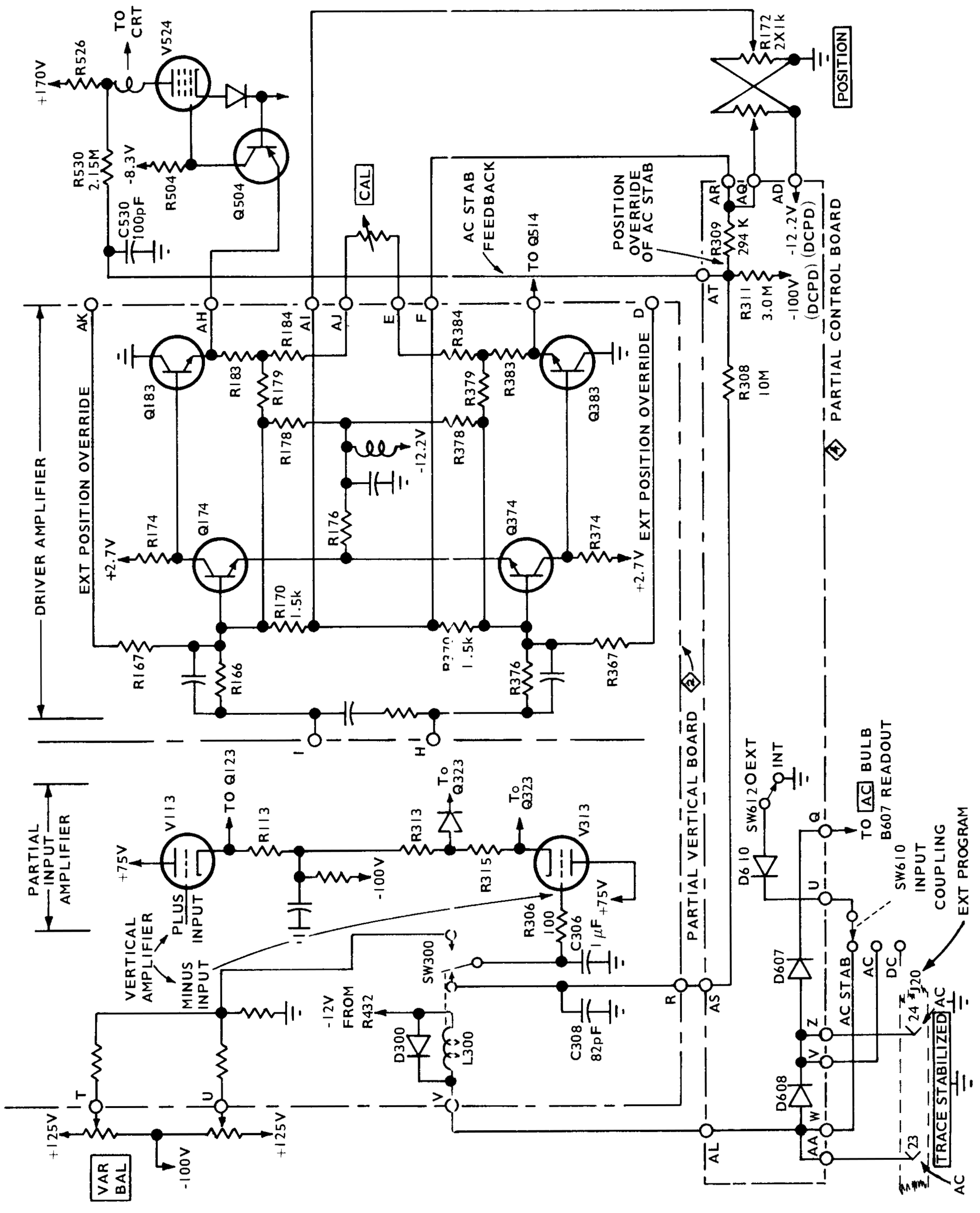

Fig. 3-15. Position control and AC—TRACE STABILIZED connections.

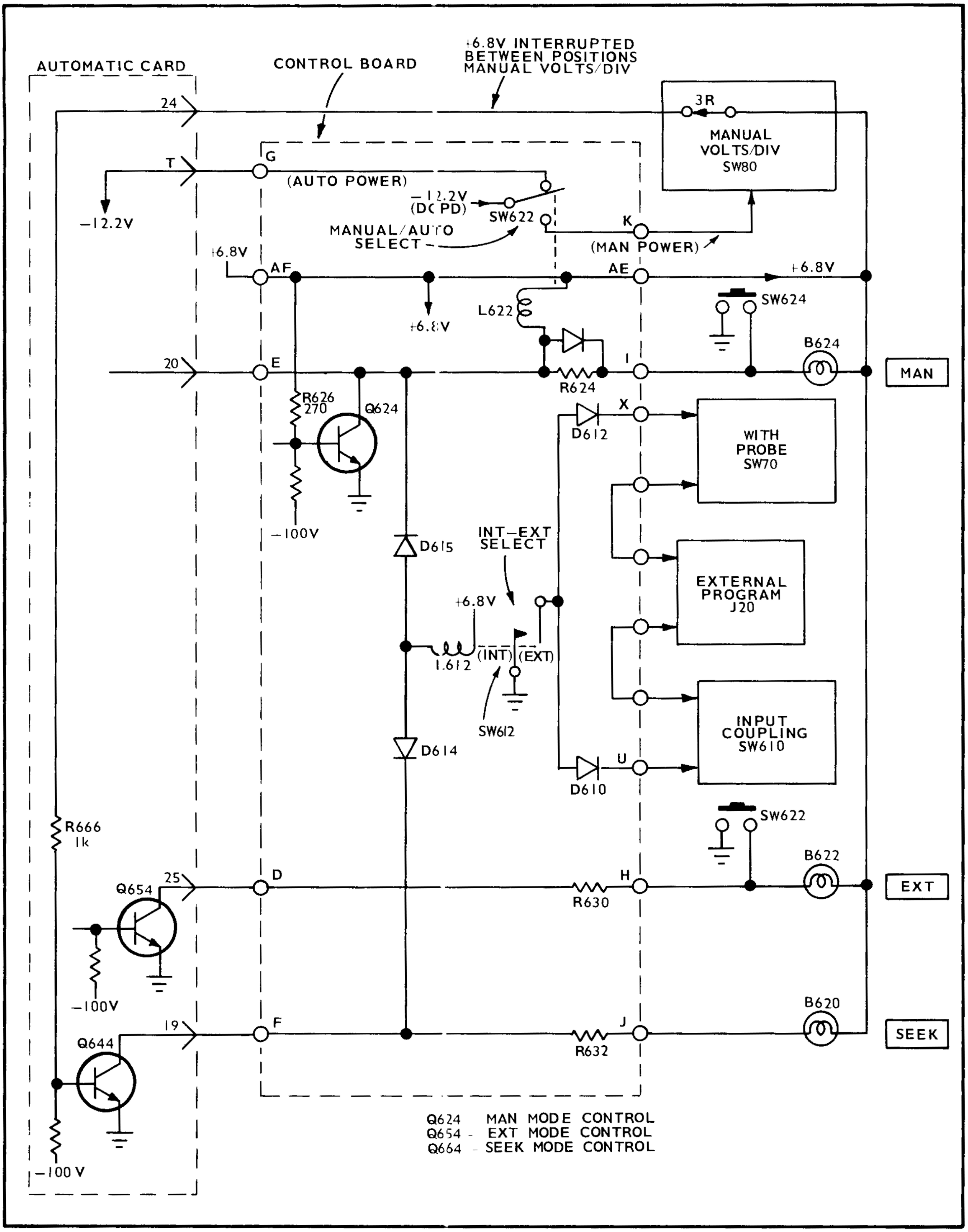

Fig. 3-16. Simplified mode control circuits.

Thus L612 is energized for both SEEK and MAN mode operation. L622/SW622 (the MANUAL POWER or AUTO/EXT POWER relay) supplies —12.2 volts to the MANUAL VOLTS/DIV switch SW80 during MAN mode operation only. It provides —12.2 volts to the Automatic Card for both SEEK and EXT mode operation. Details of each operation mode follow.

SEEK mode operation begins by grounding pin J15-22 or pin J15-21 by either the SEEK button or through the REMOTE SEEK jack or through the external PROGRAM connector J20-34. Momentarily grounding either of these three points will turn Q664 on. See Fig. 3-17. (The same grounding action will operate the SEEK MULTI explained below.) Q664 conducts current through the SEEK bulb and the Internal-External control relay L612, allowing the Input Coupling switch SW610 and the 1×/10× With Probe command switch SW70 to operate normally. Q664 also draws current through the biasing network of Q624 so that Q624 is held cutoff. Q664 is held in saturated conduction by base current through R666/D666/D664; base current is approximately 4.5 mA.

The voltage at the un-operated SEEK button (Fig. 3-17) of —6.0 volts is due to current through the resistance divider R660/R661/R662. As shown, D662 is reverse-biased. Grounding the anode of D661 would let R661/R662 apply turn-on base current to Q664 through D662. Likewise, grounding the anode of D660 will also apply turn-on base current to Q664.

EXT Mode operation requires a continuous ground connection at the base circuit of Q654 through the external PROGRAM connector J20 at pin 21. See Fig. 3-18. Grounding the collector circuit of Q654 (by pressing the EXT pushbutton) allows external mode operation only as long as the button is held depressed. When J20-21 is grounded, Q654 conducts to saturation drawing current through R630 and the EXT readout bulb. Q654 also draws current through R666 and R626 to assure that Q664 and Q624 are held cut off. With only Q654 conducting, neither control relay, L612 nor L622, has any current flow and operation of the Type 3A5 must be controlled through the External PROGRAM connector.

MAN Mode operation begins by first releasing any external program and then grounding the collector circuit of Q624. See Fig. 3-19. Grounding the collector circuit of Q624 is done by pressing the MAN pushbutton. At that time current through D624 and D668 assures that Q664 turns off. With both Q654 and Q664 cut off, Q624 biasing network automatically applies turn-on current to Q624 holding it saturated. Q624 conducts current through the MAN bulb and through both control relays L612 and L622. Q624 also conducts current through R666, biasing Q664 to cutoff. D614 assures that the collector circuit of Q664 is not pulled down by Q624. During internal SEEK operation, MAN MODE operation is assured when changing the MANUAL VOLTS/DIV switch position because its 3R section momentarily interrupts the +6.8-volt power to Q664 biasing network. The result is that Q664 stops conducting and with both Q664/Q654 collector circuits at +6.8 volts (through B620/B621), Q624 is turned on for manual mode operation.

Q664 SEEK Mode bias network is shown in detail in Fig. 3-20. Note that D662 does not conduct when the mode is SEEK and the SEEK button is not pressed. The bias network for Q624 is similar to that shown in Fig. 3-20. D664/D666 provide the necessary voltage drop from the junction of R665/D663 so Q624 conduction assures that Q664 base is reverse biased (Fig. 3-20C).

SEEK Multi

The SEEK multi (See Fig. 3-21) is a monostable multivibrator that drives the Advance Gate and supplies a reset pulse to the Ring Counters. The SEEK multi transistors, Q674 and Q684, do not conduct current in the quiescent state. Quiescent conditions are controlled by six resistors in a multiple divider between ground and minus voltages. Resistors R674/R673/R675/R678 establish —7.5 volts at their junction with germanium diodes D675/D678. D678 conducts 0.42 mA through R679 to the —100-volt supply. D675 conducts 0.933 mA through R676 to the —100-volt supply. The cathode of D678 sets the emitter of Q676 to —7.7 volts, and the cathode of D675 sets the base of Q674 to —7.7 volts. Q674 does not conduct any collector current with the zero bias conditions. Since Q674 does not conduct, R682 in its collector circuit has no voltage drop across it and thus Q684 base emitter junction has zero bias. Q684 does not conduct with the zero bias conditions. All diodes shown in Fig. 3-21 are listed in Table 3-1 with their conduction conditions marked.

TABLE 3-1

SEEK Multi Diode Conduction
(X means conduction)

Diode	Quiescent	SEEK button pressed	Multi conducting	REMOTE SEEK pressed
D660	OFF	OFF	OFF	X
D661	OFF	X	OFF	OFF
D669	X	OFF	OFF	OFF
D672	OFF	X	OFF	X
D673	OFF	X	OFF	X
D674	OFF	OFF	OFF*	OFF
D675	X	OFF	OFF	OFF
D678	X	OFF	OFF	OFF
D684	OFF	X	X	X
D689	OFF	X	OFF	OFF

***D674 protects C674 if Q674 emitter goes positive.**

When either the SEEK button or the REMOTE SEEK button is momentarily pressed, the following action takes place:

1. Q674 base receives turn on current through R671/D672. Q674 collector conducts current and applies several mA of turn on current to Q684 base. Q684 collector rises positive and Q674 base receives regenerative turn on current through R672/R686/C672. Both transistors saturate.

2. Q674 conduction causes its emitter voltage to rise positively and decrease the charge on C674. See Fig. 3-22 and 3-23. As the emitter rises positive, so does the base. C672 signal current to Q674 base increases C672 charge slightly. R672/R686/C672 continue to apply turn on current to Q674 base until Q674 collector voltage rises to about —6.7 volts. (Q674 is still saturated.) At this point the positive side of

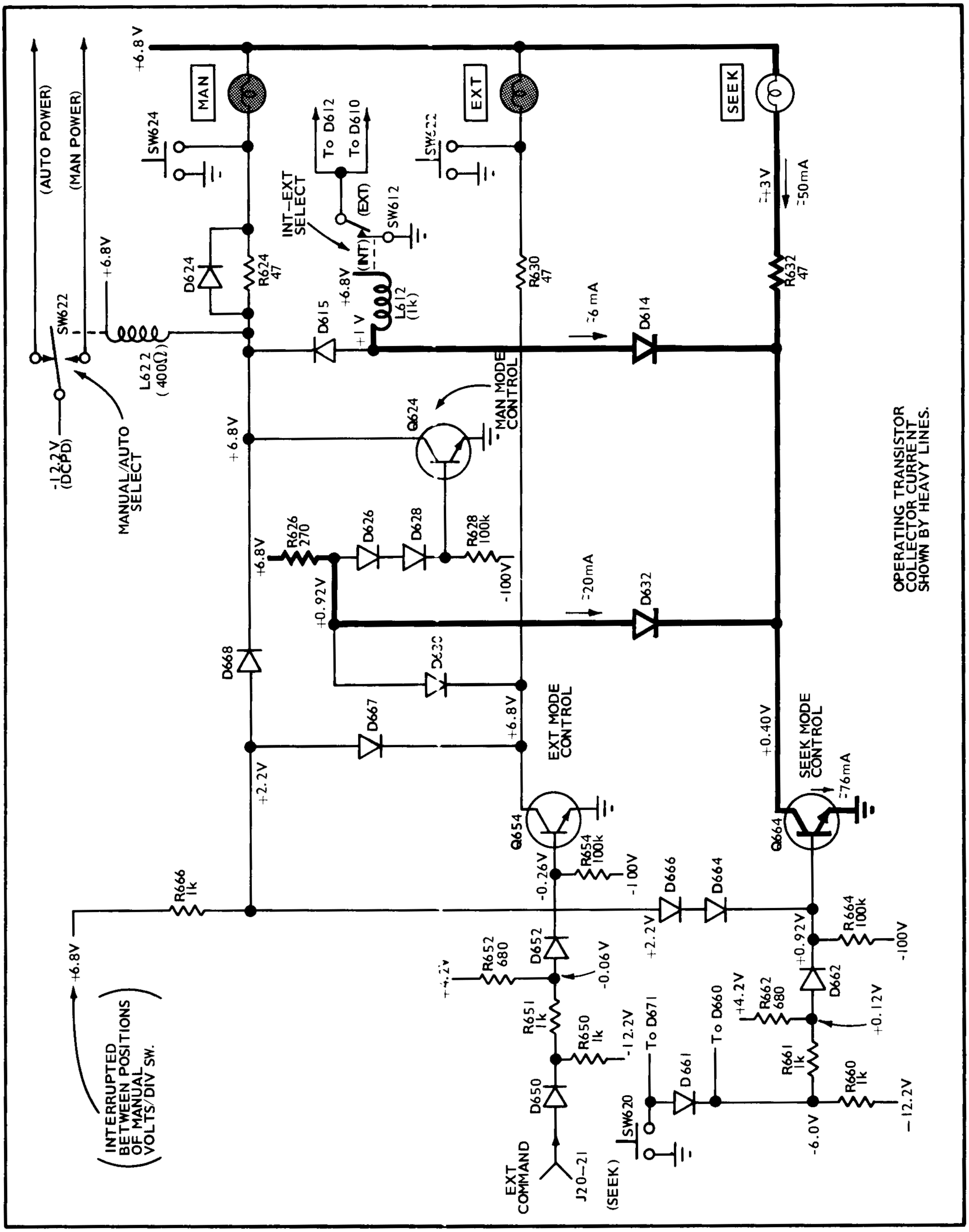

Fig. 3-17. Typical SEEK Mode control circuit conditions.

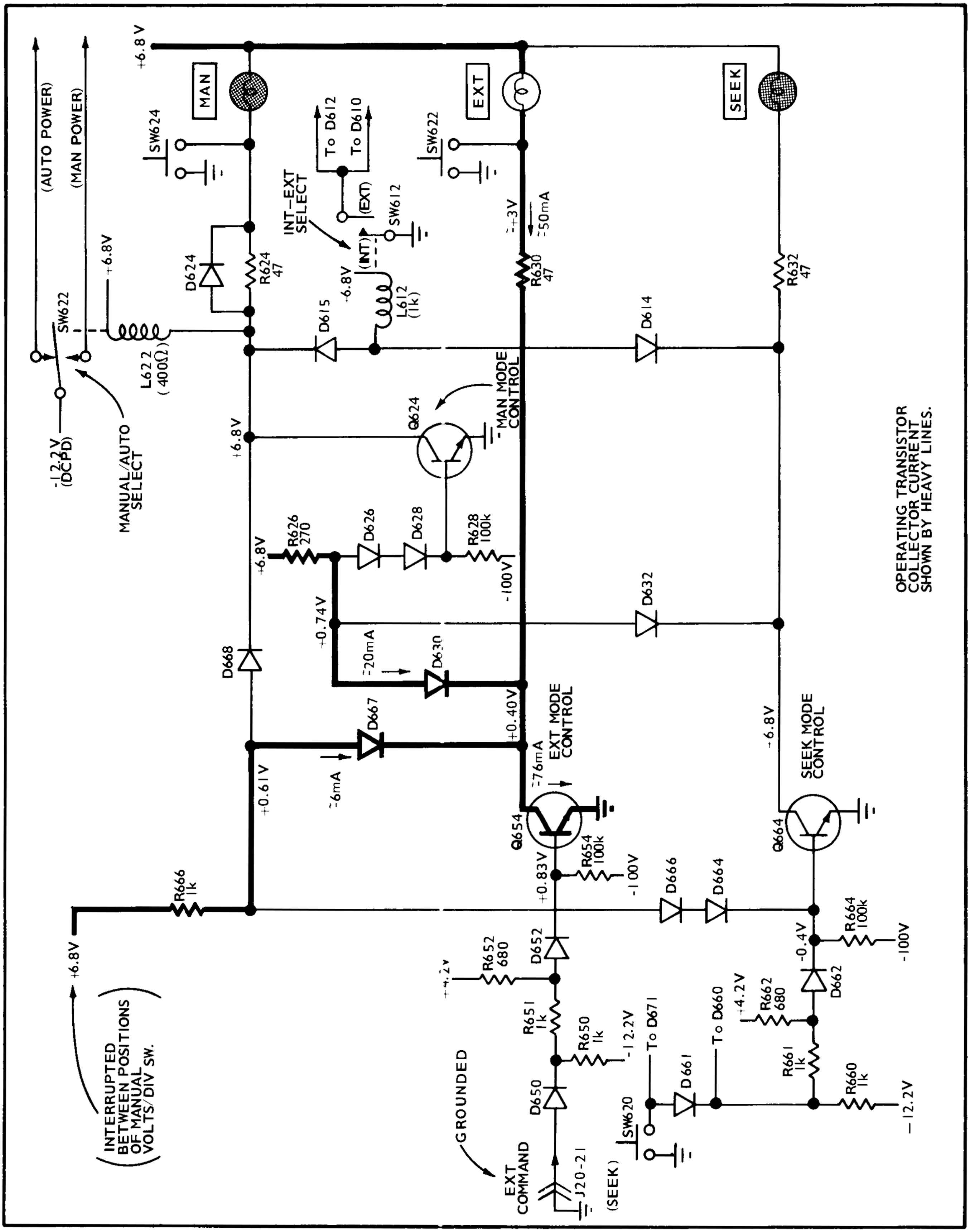

Fig. 3-18. Typical EXT Mode control circuit conditions.

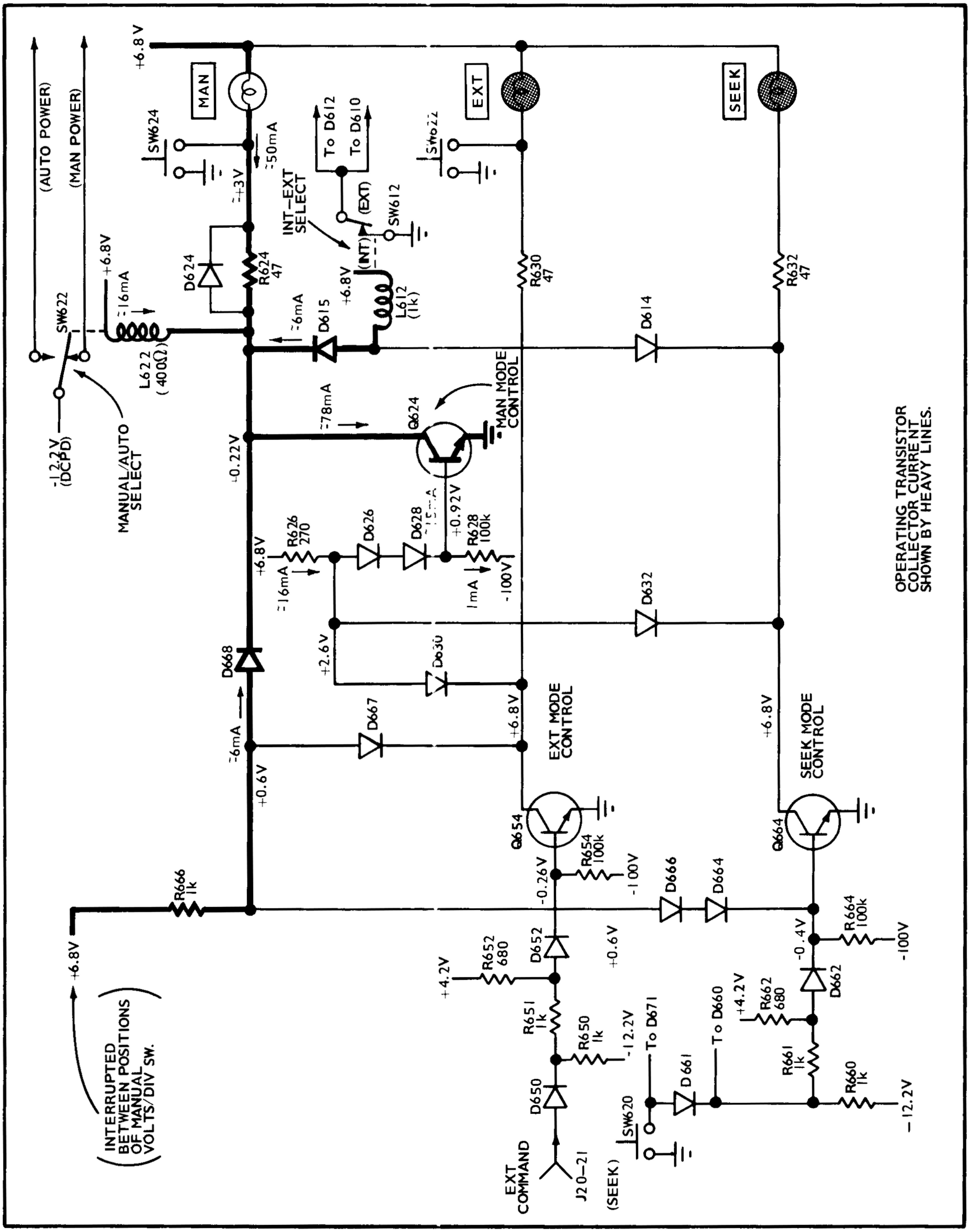

Fig. 3-19. Typical MAN Mode control circuit conditions.

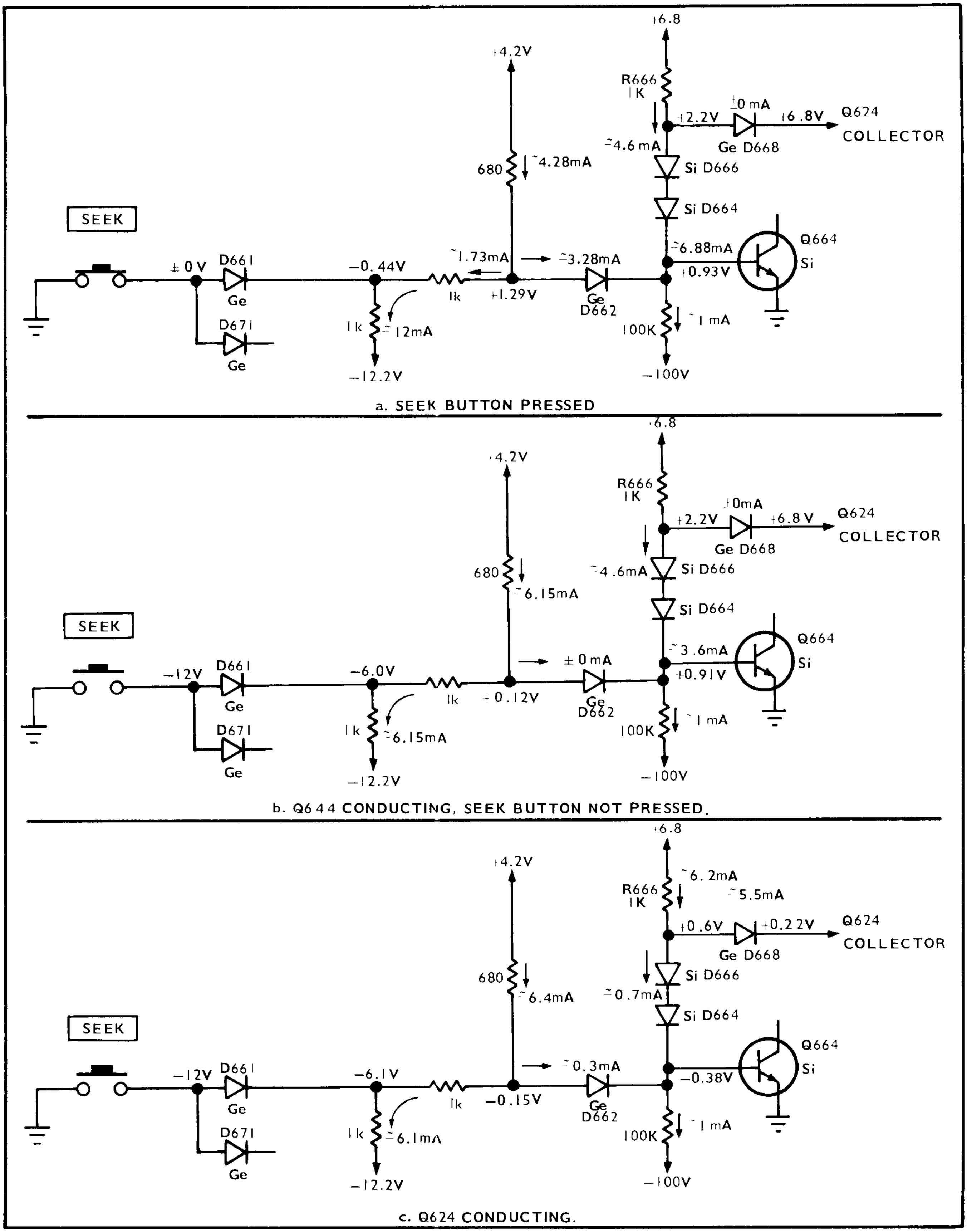

Fig. 3-20. Mode control bias network conditions.

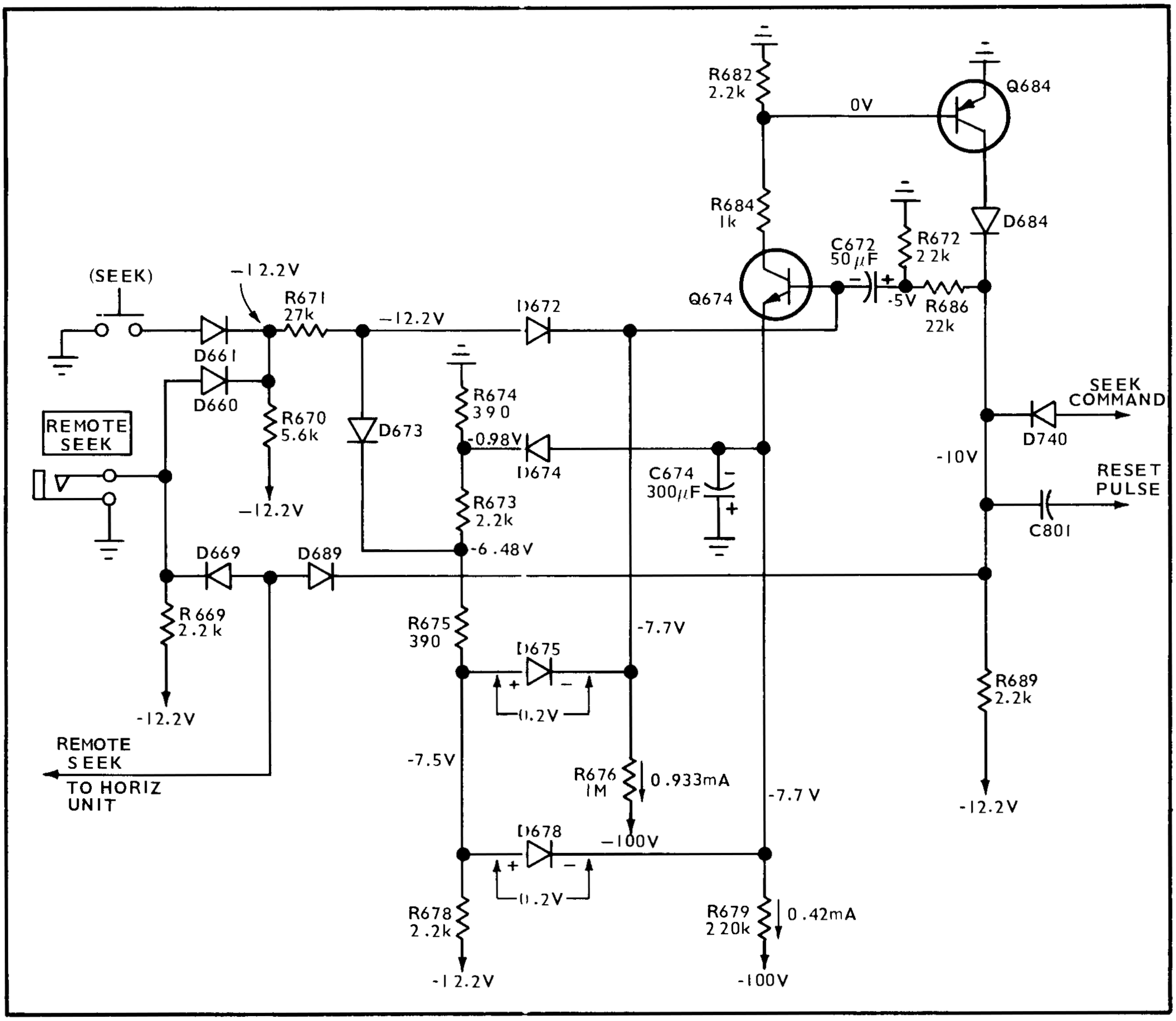

Fig. 3-21. SEEK multivibrator quiescent voltage and current conditions.

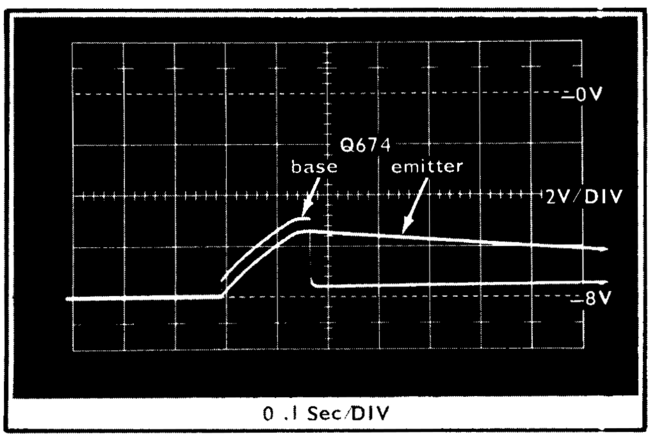

Fig. 3-22. Q674 base and emitter signals when SEEK button is momentarily pressed. (Initial −8-volt level differs from Fig. 3-21 −7.7 volts due to 10X probe loading.)

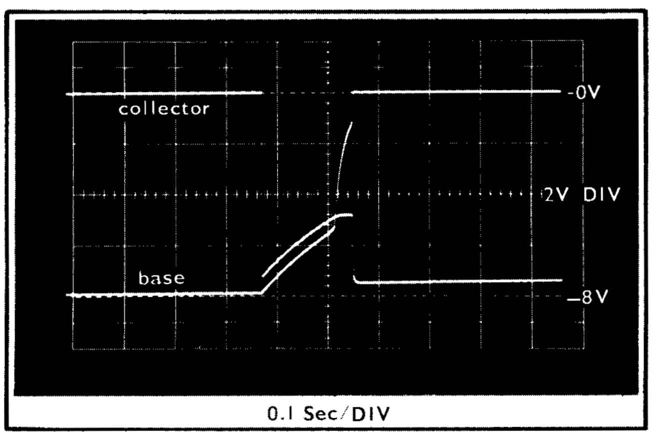

Fig. 3-23. Q674 collector and base signals.

C672 has reached about −1.5 volts and the turn on current to Q674 base through R672/R686 falls below the level where Q674 can remain in saturation.

3. As Q674 comes out of saturation, its collector voltage rises positively until R682/R684 reduce the turn on current to Q684 and it starts to reduce its collector current. As Q684 reduces its current, R689 pulls its collector negative. As the collector goes negative, R686/C672 apply a regenerative turn off signal to Q674 base and both transistors stop conducting.

4. R689 pulls R686/C672 back to their original level and the base of Q675 returns almost to its original level. However, C674 gains its charge back through the large value of R679. This means an interval of about two seconds is required before Q674 emitter returns to its original level, which prevents immediate recycling by the SEEK button. It is the positive signal from Q684 that is the SEEK COMMAND signal to the rest of the automatic circuits.

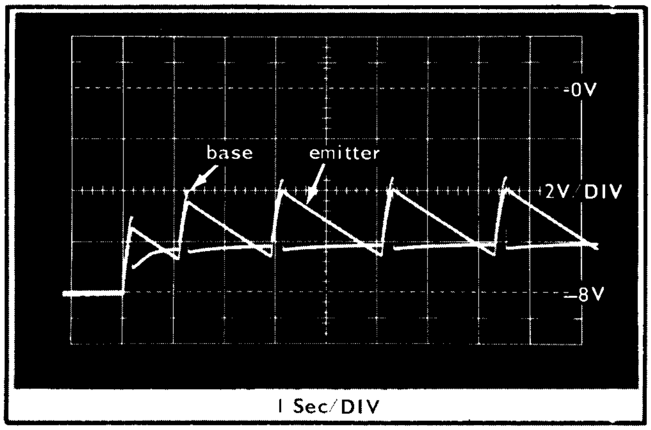

Fig. 3-24. Q674 emitter and base signals over a nine second period. SEEK button was held pressed.

When either the SEEK button or the REMOTE SEEK button is held depressed, the SEEK multi will automatically recycle as shown in Fig. 3-24. Note that the current through R671/D672 causes the base-emitter voltages of Q674 to gradually rise about 2 volts from the single cycle or quiescent values.

Advance Control

The Advance Control circuits are so named because they combine information from several sources to control the number of advance pulses sent to the Ring Counters. When advance pulses are sent to the ring counters from the Advance Control circuits, the reed switched attenuators change the deflection factor.

Sources of information to the Advance Control Circuits

1. SEEK Command pulse from Q684. (See Fig. 3-25 and Diagram 5 in Section 9.)

2. Display Size dc level from the DISPLAY SIZE Control.

3. Display Size information from the vertical Driver Amplifier.

4. 50 V/DIV inhibit signal from the Ring Counter ÷5 and ÷1000 stages.

Quiescent conditions in the circuit are:

1. Q714 and Q724, Display Comparator Multi transistors, are both cut off.

2. The Display Size dc reference level to the Display Comparator Multi is about −2.6 volts at the anode of D706.

3. Q743 emitter follower Advance Gate prevents any signal from turning on Q754 Gated Advance Pulse Amplifier. Q743 is controlled through D740/D743 negative OR gate by either the SEEK Multi or the 50 V/DIV inhibit from the Ring Counters.

4. Q743 Overscan Amplifier is saturated.

5. The Display Size voltage information from the vertical Driver Amplifier depends upon the display. If the crt beam exceeds plus or minus 3.5 divisions from electrical center, the base of Q714 (Display Comparator Multi input) will be taken sufficiently negative to cause Q714 to draw current. The Display Comparator Multi will free run and turn on the Overscan Lamp, but will not pass signals to the Ring Counters until a SEEK Command pulse arrives at Q743. An operation description of each circuit follows:

Display Comparator Multi. The quiescent dc voltage at Q714 emitter is set by current through R714, D705 and D706 and the DISPLAY SIZE control. (See Fig. 3-25.) D706 sets C714 most positive potential, but disconnects the low impedance DISPLAY SIZE control if C714 and the emitter of Q714 try to go more negative than the quiescent level. Both D705 and D706 provide temperature compensation to Q714.

As Q714 starts to conduct current (point #1 of waveforms of Fig. 3-25) its collector voltage begins to rise positive. Q724 base comes out of cutoff after Q714 collector rises about 2 volts. As Q724 starts to conduct, its collector goes negative and couples a negative regenerative turn on signal to Q714 base. Q714 and Q724 both saturate quickly. Q714 remains saturated during the time attenuator reed bounce occurs, and so is insensitive to bounce voltages. Current through R712 and R710 quickly take some of C714 charge and transfer it to C723. As C723 charges, Q714 base becomes reverse biased, and the regenerative action starts in reverse, turning Q714 and Q724 off rapidly. During the time Q714 was conducting, C714 let Q714 emitter fall about −1.5 volts below its quiescent level (point #2 of waveforms of Fig. 3-25). As Q724 collector rises positive to cutoff, C723 drive to Q714 base is limited by D710.

The waveforms of Fig. 3-25 were taken while the Display Comparator Multi was free running. The free run action was caused by positioning the trace 4 divisions from the graticule center. Note that Q714 emitter voltage following point #2 rises slowly and the multi is off longer than it is on. The slow rise is due to C714 charging through R714. As soon as Q714 emitter rises to a level where the base-emitter voltage will again cause it to conduct, the Display Comparator Multi flips and both transistors again saturate.

The Display Comparator Multi thus sends positive pulses to Q754, the Gated Advance Pulse Amplifier.

Overscan Amplifier. The base of Q734, the Overscan Amplifier, is directly coupled to Q724 collector. When Q724 is cut off, R726 applies about 0.125 mA turn-on current to

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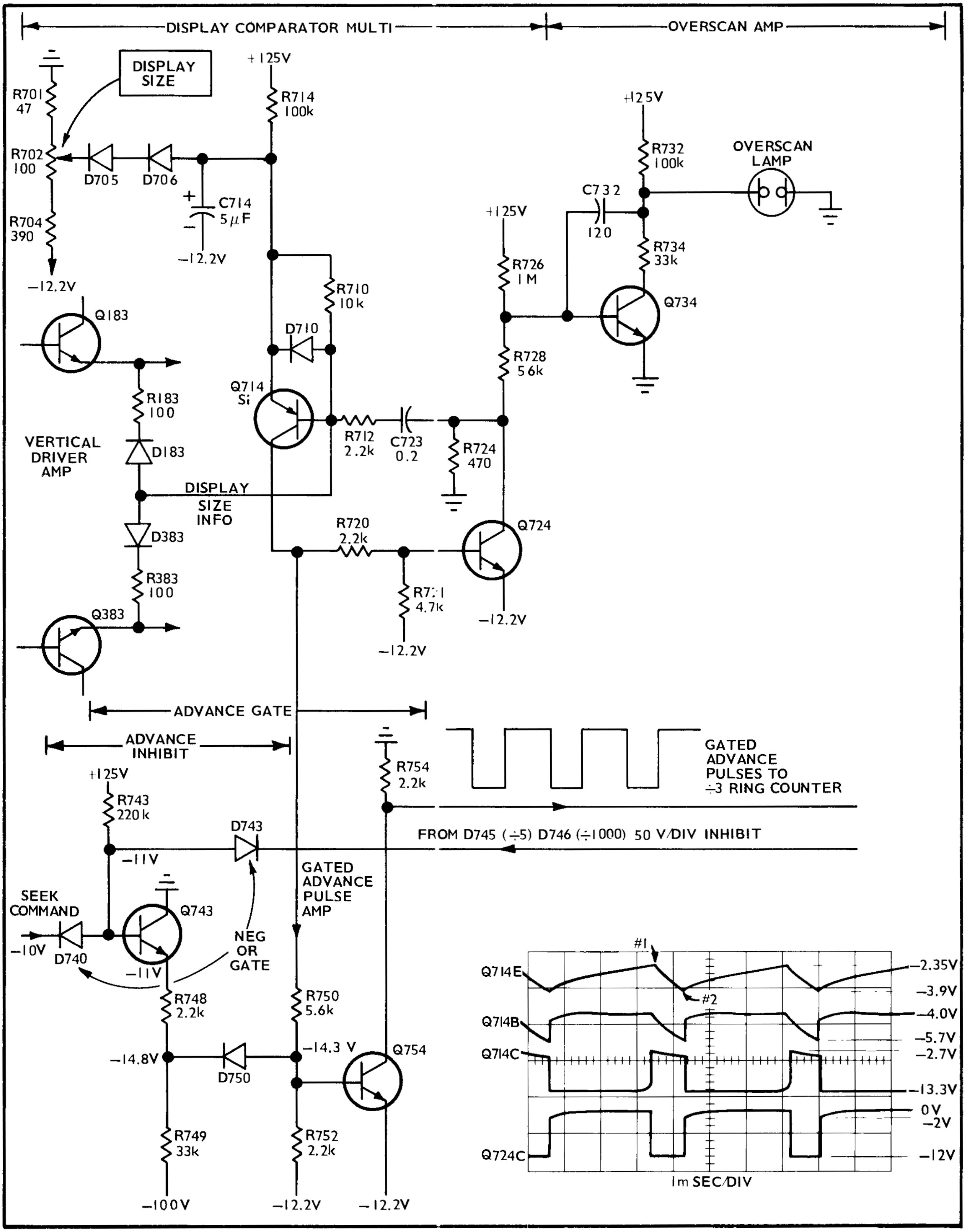

Fig. 3-25. Advance control circuits.

Q734 base. Q734 is thus quiescently saturated. Whenever the Display Comparator Multi develops Advance Pulses, Q734 is turned off during the time Q724 is conducting. The collector circuit of Q734 rises positive toward +125 volts. At about +75 volts B736 the Overscan Lamp fires and immediately returns the voltage level to about +55 volts, the normal holding potential for the neon bulb. C732 couples part of the output voltage back to Q734 base to limit the rate of collector voltage rise, and thus limit high frequency signals from being coupled to the input attenuators. Q734 saturates each time Q724 turns off. Thus the Overscan Lamp is pulsed on and off whenever it is illuminated.

Advance Gate. The Advance Gate (see Fig. 3-26) consists of Q743, Q754 and associated diodes. It is the Advance Gate that permits Advance Pulses to pass to the Ring Counters whenever the SEEK button is pressed.

Assume the deflection factor is 50 V/DIV; that a signal of 10 volts peak to peak is applied to the INPUT connector; and that the input coupling is AC. The display will be 1/5 division peak to peak and cannot be read with any accuracy. Press the SEEK button and the display will change to 5 divisions peak to peak. The sequence of events that takes place to set the deflection factor to 2 V/DIV is:

1. The SEEK multi output step raised the emitter of Q743 from —11 volts to —0.9 volt. The leading edge of the SEEK Command was used as a reset pulse to the Ring Counters, and they changed the deflection factor to 10 mV/DIV. The signal to the vertical amplifier input is now 200 times the value it will be.

2. The Display Comparator Multi changes state immediately. The Overscan Lamp lights. The base of Q754 receives enough turn-on current through R570 to cause it to saturate and send a —12.2 volt Advance Pulse to the ÷3 Ring Counter. The ÷3 Ring Counter does not respond to the first advance pulse because the ac coupled Reset Pulse energy lasts long enough to override the Advance pulse.

3. The Display Comparator Multi and Q754 put out another advance pulse. This time the ÷3 Ring Counter advances to its ÷2 state and actuates the 20 mV/DIV deflection factor. The signal to the vertical amplifier is now 100 times what it will be.

4. The Display Comparator Multi continues to cycle until the ÷3 and ÷4 Ring Counters set the deflection factor to 2 V/DIV. At that time the signal to the vertical amplifier is such that the Display Comparator Multi stops sending pulses to Q754 and the Ring Counters. The SEEK Command remains up for several more milliseconds, and then drops to inhibit Q743/Q754.

50 V/DIV Inhibit. The conditions are slightly different if the display zero dc level is above or below the Display Comparator Multi trip level. If the Display Comparator multi receives a constant turn-on signal it continues to send positive pulses to Q754 and the deflection factor will cycle to 50 VOLTS/DIV whenever the SEEK or REMOTE SEEK buttons are pressed. To prevent advancing the Ring Counters past 50 VOLTS/DIV back to 10 mV/DIV, two Ring Counter output signals are diode-connected back to the Advance Gate through D745 and D746. The signals are the ÷3 Ring Counter ÷5 state output and the ÷4 Ring Counter ÷1000 state output.

The 50 V/DIV Inhibit diode switching operates in the following manner (see Fig. 3-26). When the attenuator ÷1000 and ÷5 coils, L30 and L60, are not energized, D745 and D746 anodes rest at zero volts. A small current (½ mA per diode) flows through them and the coils to the —100-volt supply through R745. If one of the two attenuators is energized, the current through R745 switches to pass 1 mA through one diode and the other diode is reverse-biased. If both attenuators are energized, the anodes of both diodes drop to —12.2 volts and R745 current passes through D743 taking the base of Q743 sufficiently negative to inhibit Q745 from sending any more advance pulses to the ÷3 Ring Counter. Thus D740 and D743 form a negative AND gate such that either diode can couple a turn-off signal to Q743 and inhibit advance pulses.

Another diode, D684 in the collector lead of SEEK Multi transistor Q684 (see Fig. 3-26) assures proper deflection factor selection when there is no signal and the trace is at a position that will not trip the Display Comparator Multi. D684 sets the SEEK COMMAND pulse plus voltage to —0.9 volt. This sets the anode of D740 (by current through R743) and the base of Q743 to —0.3 volt, sufficiently negative that D743 is not turned on. If D743 were to turn on and change the ½ mA current in either D745 or D746, L30 or L60 magnetic flux change would couple enough energy to the attenuator reed switch to be seen by the vertical amplifier and cause the no-signal deflection factor to be 20 mV/DIV instead of 10 V/DIV.

Ring Counters

The ÷3 Ring Counter receives Advance Pulses, changes state, directly energizes attenuator reed coils, and sends a ÷3 Advance Pulse to the ÷4 Ring Counter. The ÷4 Ring Counter directly energizes attenuator reed coils and drives the 1×/10× Readout Scaler. Both ring counters will reset to an initial condition whenever a positive reset pulse arrives through C801 to the base circuits of both Q814 and Q854. See Fig. 3-27 and drawing number 5 during the following discussion.

Each ring counter can be described as a set of saturating transistors that are biased and interconnected in a manner that allows only one to conduct at a time. Coupling circuits allow an incoming negative advance pulse to turn off the conducting transistor. The next transistor is turned on by the collector signal from the turned off transistor. All signals are ac coupled.

A cycle of operation begins with the arrival of a reset pulse, and proceeds as follows:

1. The leading edge of the SEEK command signal is ac coupled through C801 to the base circuits of Q814 and Q854. Both transistors turn on to saturation.

2. An advance Pulse arrives at the ÷3 Ring Counter and tries to turn Q814 off, but the reset pulse lasts long enough to leave Q814 on.

3. Diode D826 turns Q824 off and D836 turns Q834 off in the ÷3 Ring Counter. In the ÷4 Ring Counter, D866 turns Q864 off, D876 turns Q874 off and D886 turns Q884 off.

4. Q814 collector current includes current through D814/L45, R814, D815/R841, D826/R826, D836/R836 and R819 through germanium diode D819 and R812/R816. D819 is

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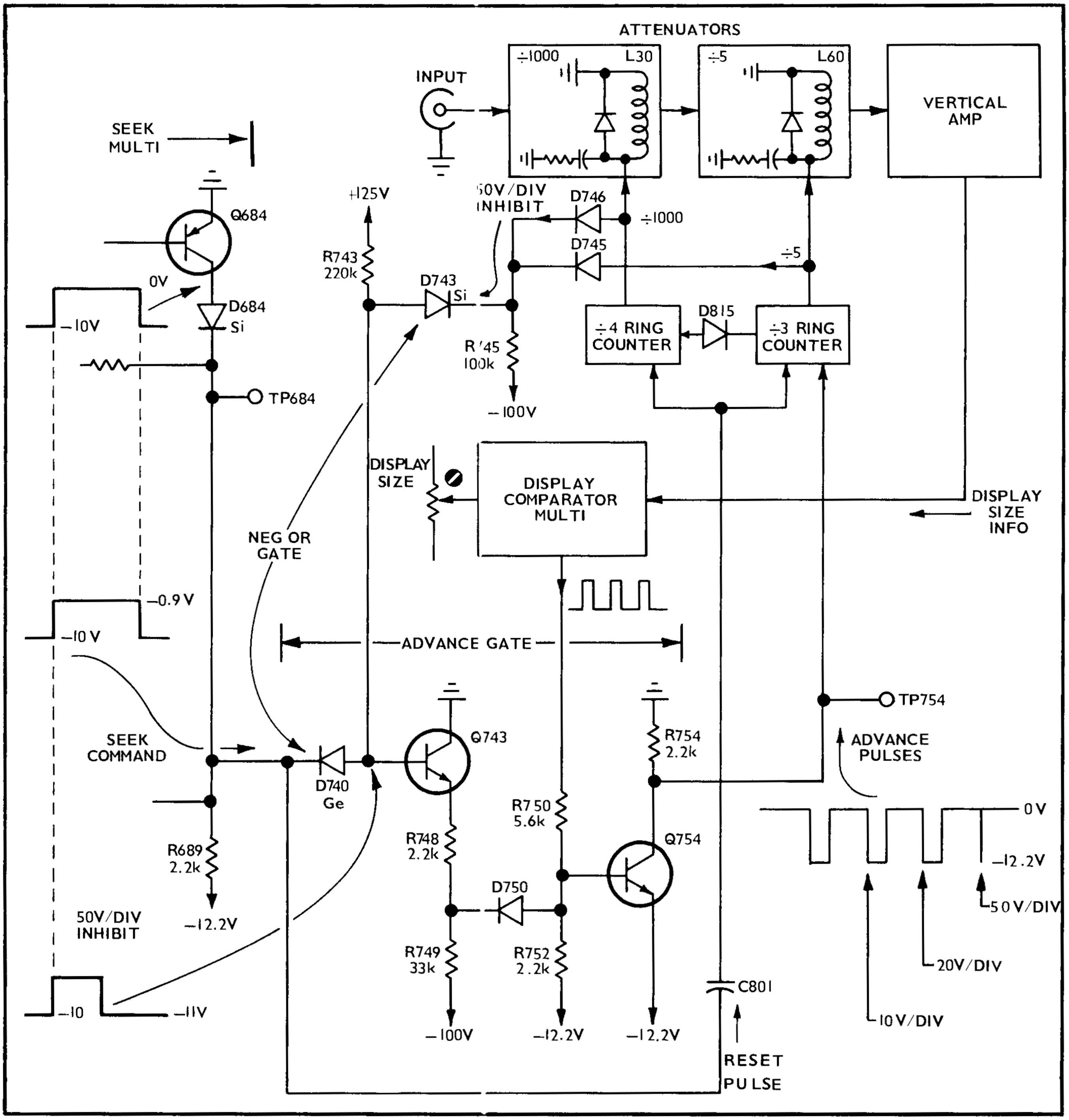

Fig. 3-26. Advance Gate interconnections and signals.

conducting so that the next negative Advance Pulse will turn Q814 off.

5. The base voltage of Q814 is about —11.5 volts; the collector voltage is —12 volts. Base current is through R812/R816. Current through R816 reverse biases D812 and D816. Current through R816 reverse biases D812 and D816. Current through D802/R802 (at reset input) reverse biases D804.

6. The base voltage of the other ÷3 Ring Counter transistors is about —13.3 volts due to Q814 current through D826 and D836. The same conditions exist in the ÷4 Ring Counter. The anode of D826 is at about —11.7 volts; thus, current through R821 and R822 sets Q824 base negative from its emitter and keeps it cut off. With Q824 collector at 0 volts, D829 is reverse biased 13.3 volts so that the —12.2-volt Advance Pulse does not affect Q824 base.

7. After the reset pulse decays, and as the second Advance Pulse arrives, C819 couples the signal to Q814 base and turns it off. As Q814 collector stops conducting current, R814 and L45 pull the collector voltage to ground. D45 clamps L45 inductive backswing. C822 couples the positive going signal to Q824 base and Q824 turns on to saturation. Q824

collector goes to −12 volts and D816 keeps Q814 off and D832 keeps Q834 off.

8. The 3rd Advance Pulse turns Q824 off, and Q824 turns Q834 on.

9. The 4th Advance Pulse turns Q834 off and Q834 turns Q814 on. The signal coupling from Q834 collector to Q814 base is through C812 diagrammed with Q814 biasing network.

10. As Q814 turns on, D815 couples the ÷3 negative Advance signal to Q854 base and turns it off. Q854 then turns Q864 on in the same manner as earlier described when Q814 turned Q824 on.

During manual mode, the MAN/AUTO select switch SW622 turns off the —12.2-volt power to the Ring Counter and the Readout Scaler circuits.

Each Ring Counter transistor can be turned on by external command through the external PROGRAM connector. A positive pulse or a ground connection to the correct pin of J20 will turn on the desired transistor, and thus the desired attenuator. See the Operating Instructions for programming details. The external ground connection applies turn on current to the base of the selected Ring Counter transistors through resistors R810, R820, R830, R850, R860, R870 and R880. External connections must be removed before the Type 3A5 can be operated for the SEEK mode.

Readout Scaler

The Readout Scaler is a set of four saturating emitter follower transistors with diode input control. The emitter followers act as switches to turn on the Readout Board decimal, zero, K and m bulbs. Bulb current is limited by R935 or R939. Whether or not the emitter follower(s) conduct is determined by both the ÷4 Ring Counter and the unlabeled front-panel "with probe" switch SW70.

There are eight possible control conditions shown in Figures 3-28 through 3-35. The figures show the current paths for each possible condition, both bulb current and lockout current. An example of lockout current is shown in Fig. 3-30 where none of the ÷4 Ring Counter current turns on a Readout Scaler emitter follower. All of Q864 is "locked out" and bypasses all scaler emitter followers. When reading Figures 3-27 through 3-34, note that the ÷4 Ring Counter transistors are numbered out of numerical sequence.

Fig. 3-27 is the only figure with voltage included. All other figures will have similar voltages for the portion carrying bulb current, and similar voltages for the portion carrying lockout current.

Power Supplies

Power for the Type 3A5 operation comes from the oscilloscope. Power supply interconnections, and two low voltage supplies within the Type 3A5 are diagrammed on drawing #6 of Section 9.

The oscilloscope power supplies are capable of operating with various current loads, depending upon the plug-in units in use. To keep each supply in regulation, some plug-in units place shunt resistors across the oscilloscope regulator circuits. Diagram #6 indicates which leads of the Type 3A5 are used for supplying regulated current to the Type 3A5 circuits, and which leads are the shunt return circuits for the oscilloscope. P11 pins 10, 15, 16 and 23 are the regulated supply leads to the Type 3A5 circuits. Pins 6, 20 and 22 are the shunt return leads to the oscilloscope power supplies.

Power supply leads that serve more than one part of the Type 3A5 have signal isolation networks to decouple the various circuits. For instance the +125 volt supply enters the Type 3A5 at P11 pin 15, goes directly to the Vertical board and the Output Amplifier. The supply is then cabled to the Control board where R110 and C110 decouple the control and automatic and external circuits from the vertical circuit. R636 is the power supply shunt resistor. The output side of R110/C110, is labeled +125 V (DCPD), indicating the lead is decoupled from the preceding circuits.

Three additional voltages are provided by circuits within the Type 3A5. +75 volts for the Vertical Amplifier Input stage; +6.8 volts for readout lamps, relay coils and some control circuits; and +4.2 volts regulated for the Vertical Amplifier and control circuits.

+75 Volt Regulator. Q108, physically located on the Control board, and diagrammed on drawing #2, is an emitter follower. Q108 collector supply is the +125-volt supply. The base voltage is set at approximately +75 volts by the resistive divider, R106 and R107. Q108 emitter resistance to ground is the plate circuit of V113 and V313. Thus, Q108 emitter provides +75 volts (at a sufficiently low impedance) to the input stage plate circuits.

+6.8-Volt Supply. The +6.8-volt supply is a simple four-diode bridge rectifier and an electrolytic capacitor. D422 A, B, C, and D rectify the oscilloscope 6.3-volt ac voltage, and C422 is the filter capacitor. The supply output voltage is directly related to the power line voltage. It is not regulated, because its major use is for readout lamps and relay coils.

+4.2-Volt Regulator. A stable +4.2 volts is provided by Q423 and Q424 to several of the transistor circuits of the Type 3A5. The regulator source is the unregulated +6.8-volt supply. The circuit consists of an emitter follower (Q423) with an inverse feedback amplifier (Q424). Q423 emitter output voltage is divided by R426 and R427 to provide the feedback signal to Q424 base. The low-voltage end of the divider is the oscilloscope regulated —12.2-volt supply. The —12.2 volts is the reference voltage that sets the +4.2 volts output value.

Assume the circuit to be operating. The load current reduces, causing the output voltage to rise positive. Q424 base receives part of the positive change, Q424 collector current increases changing the voltage drop across R422 and taking Q423 base negative. The negative signal at Q423 base takes the output voltage back to its original value. Thus the supply output voltage remains essentially constant with only a few millivolts of 120 Hz ripple.

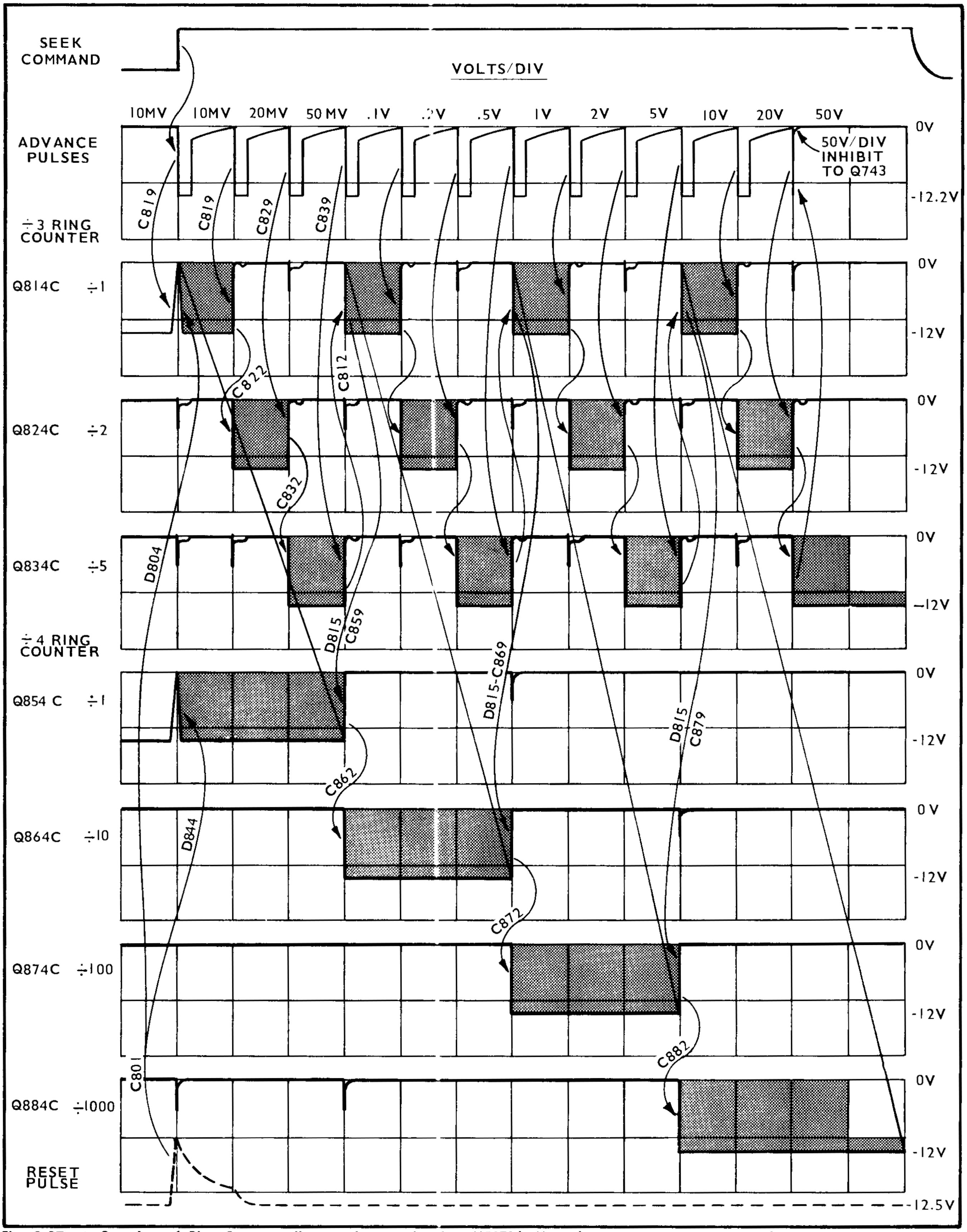

Fig. 3-27. ÷ 3 and ÷ 4 Ring Counter collector voltages related to VOLTS/DIV readout. Coupling sequence and components are identified.

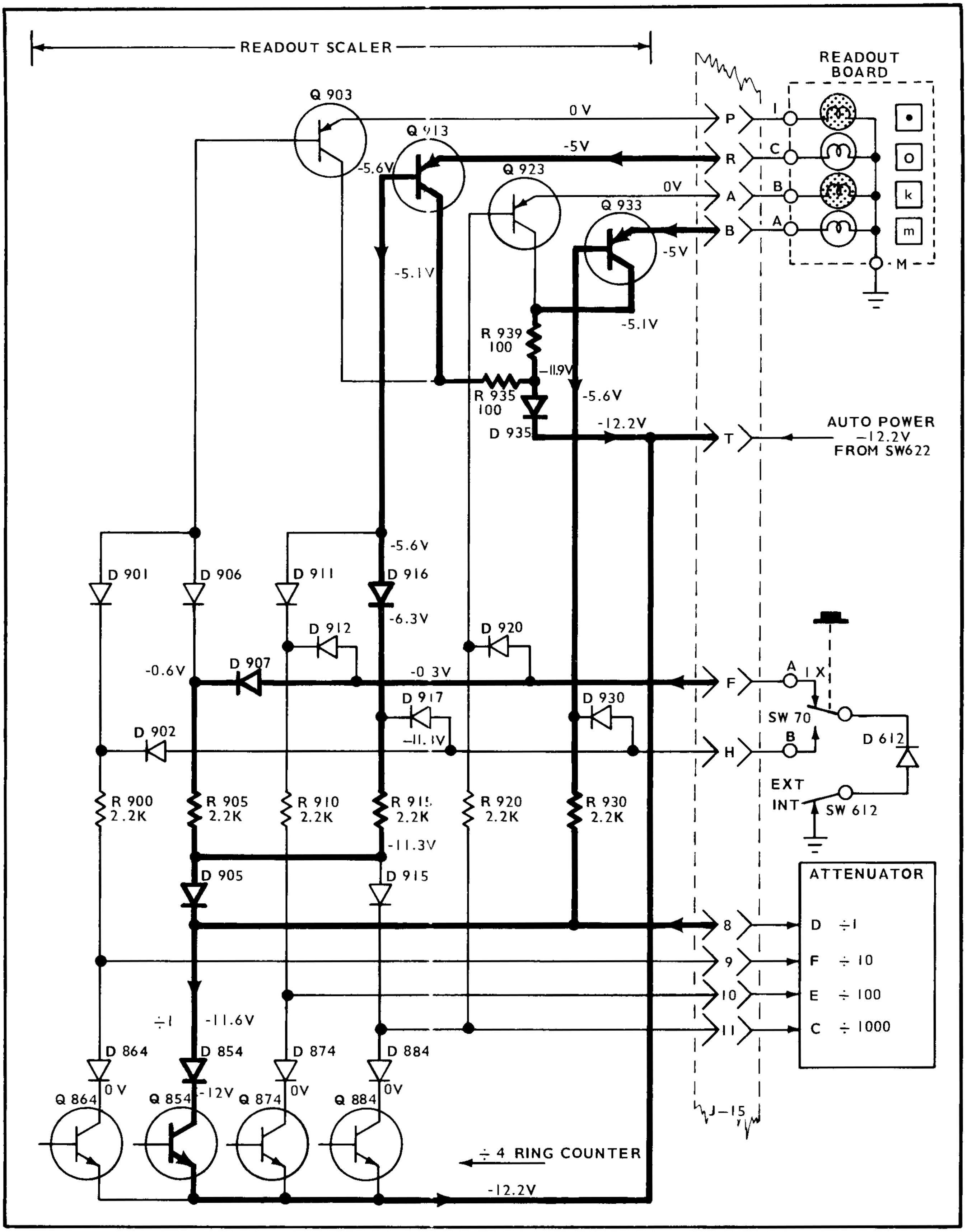

Fig. 3-28. Readout Scaler current paths for 10, 20, 50 mV/DIV, no P6030 Probe.

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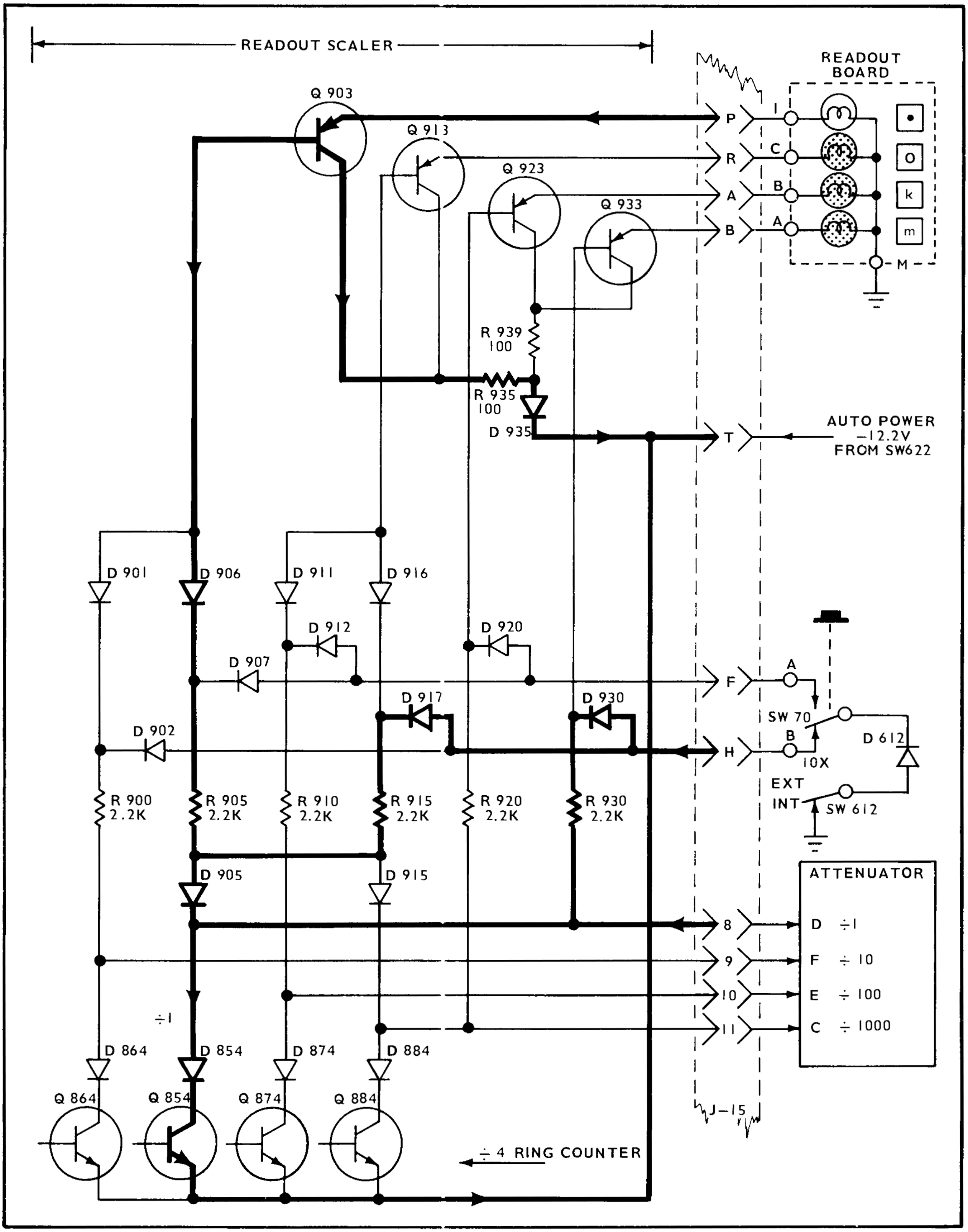

Fig. 3-29. Readout Scaler current paths for .1, .2, .5 V/DIV, with P6030 Probe.

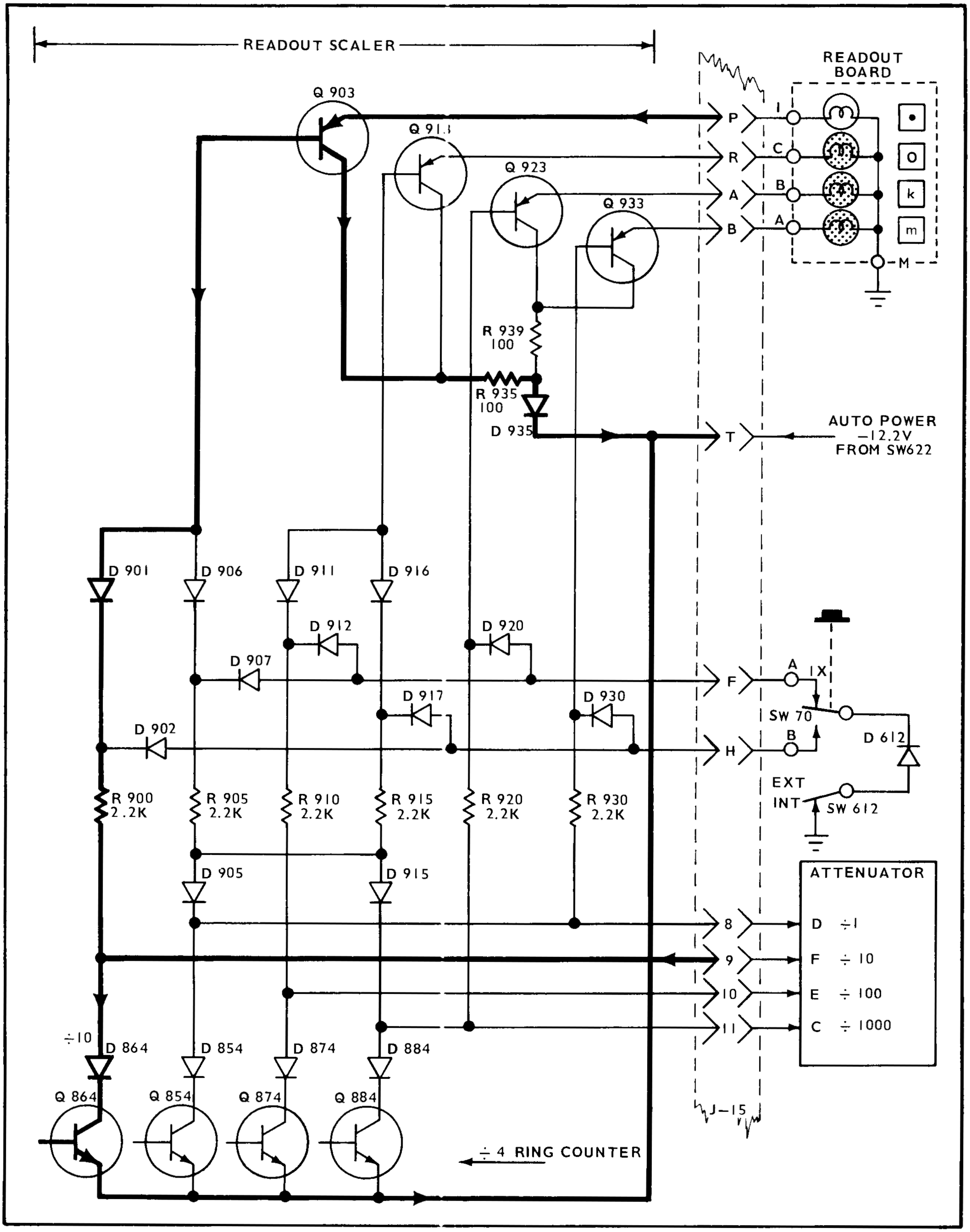

Fig. 3-30. Readout Scaler current paths for .1, .2, .5 V/DIV, no P6030 Probe.

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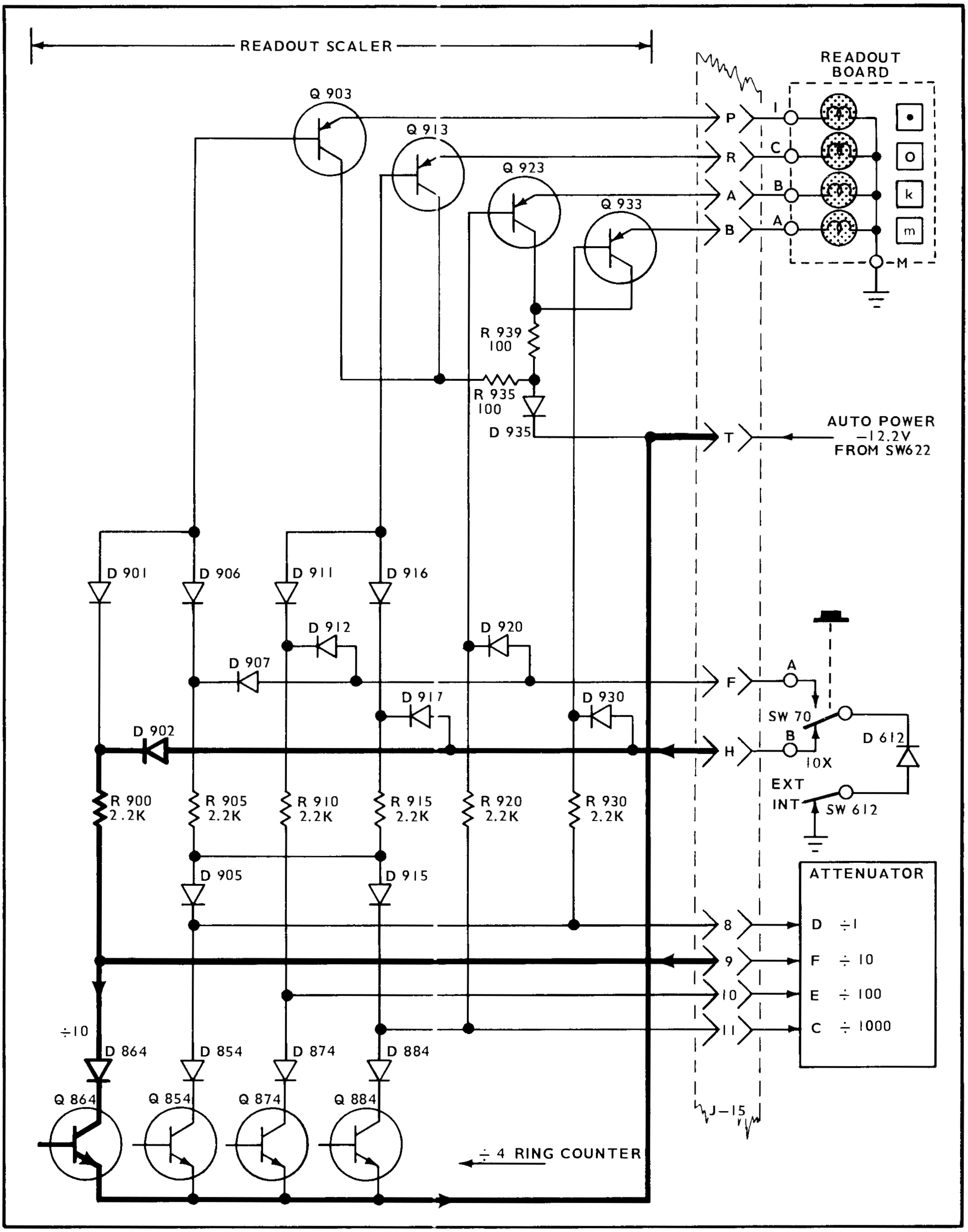

Fig. 3-31. Readout Scaler current paths for 1, 2, 5 V/DIV, with P6030 Probe.

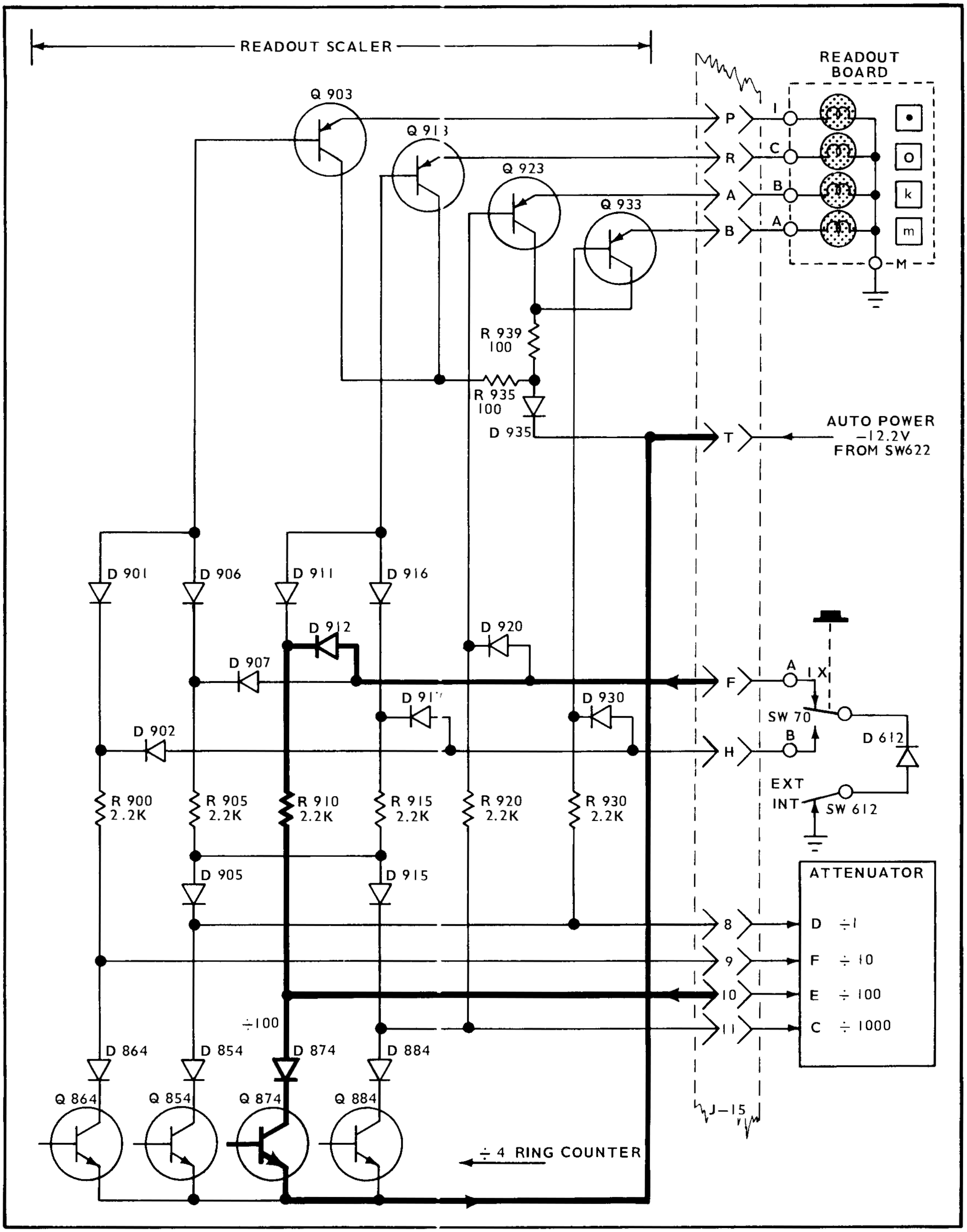

Fig. 3-32. Readout Scaler current paths for 1, 2, 5 V/DIV, no P6030 Probe.

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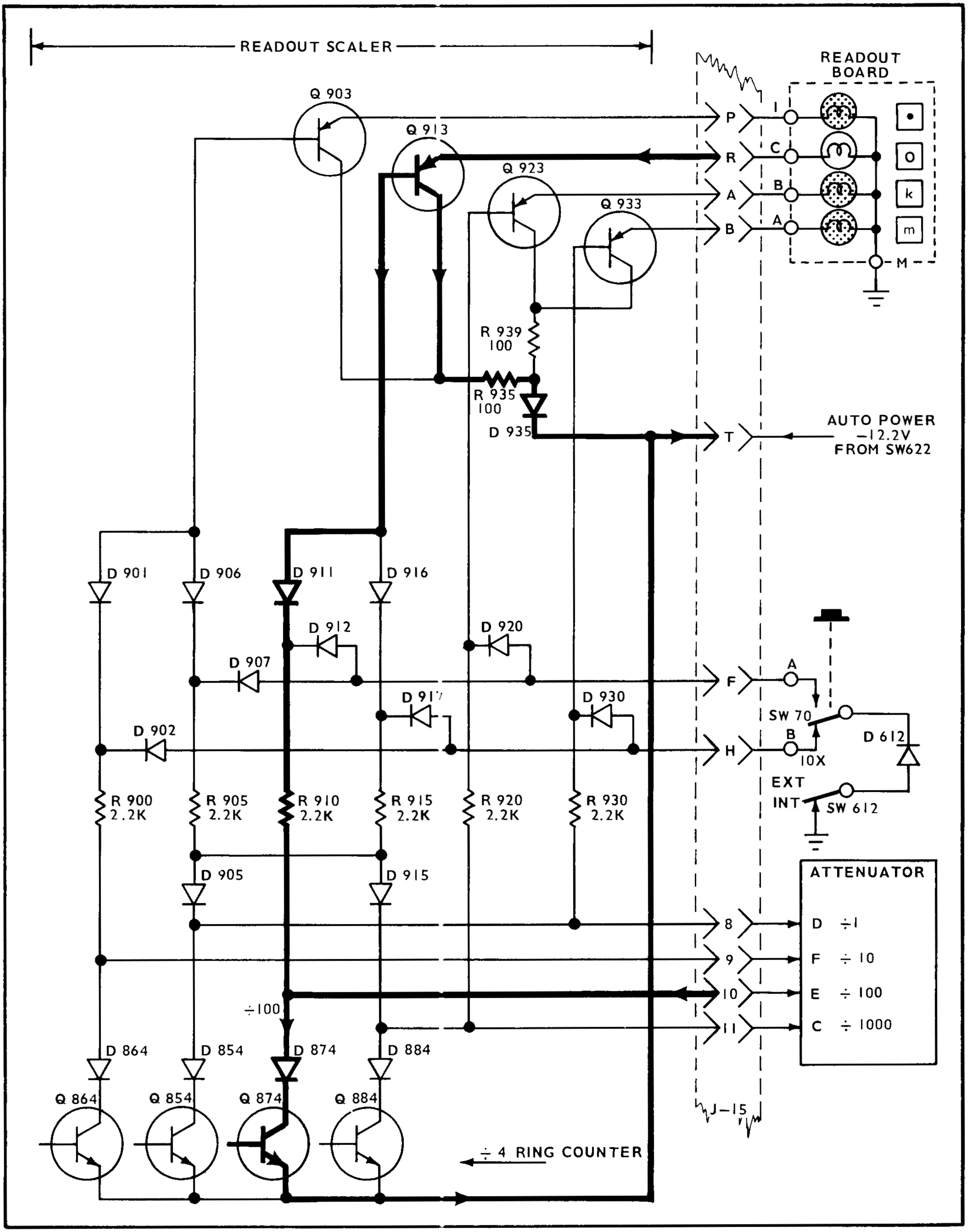

Fig. 3-33. Readout Scaler current paths for 10, 20, 50 V/DIV, with P6030 Probe.

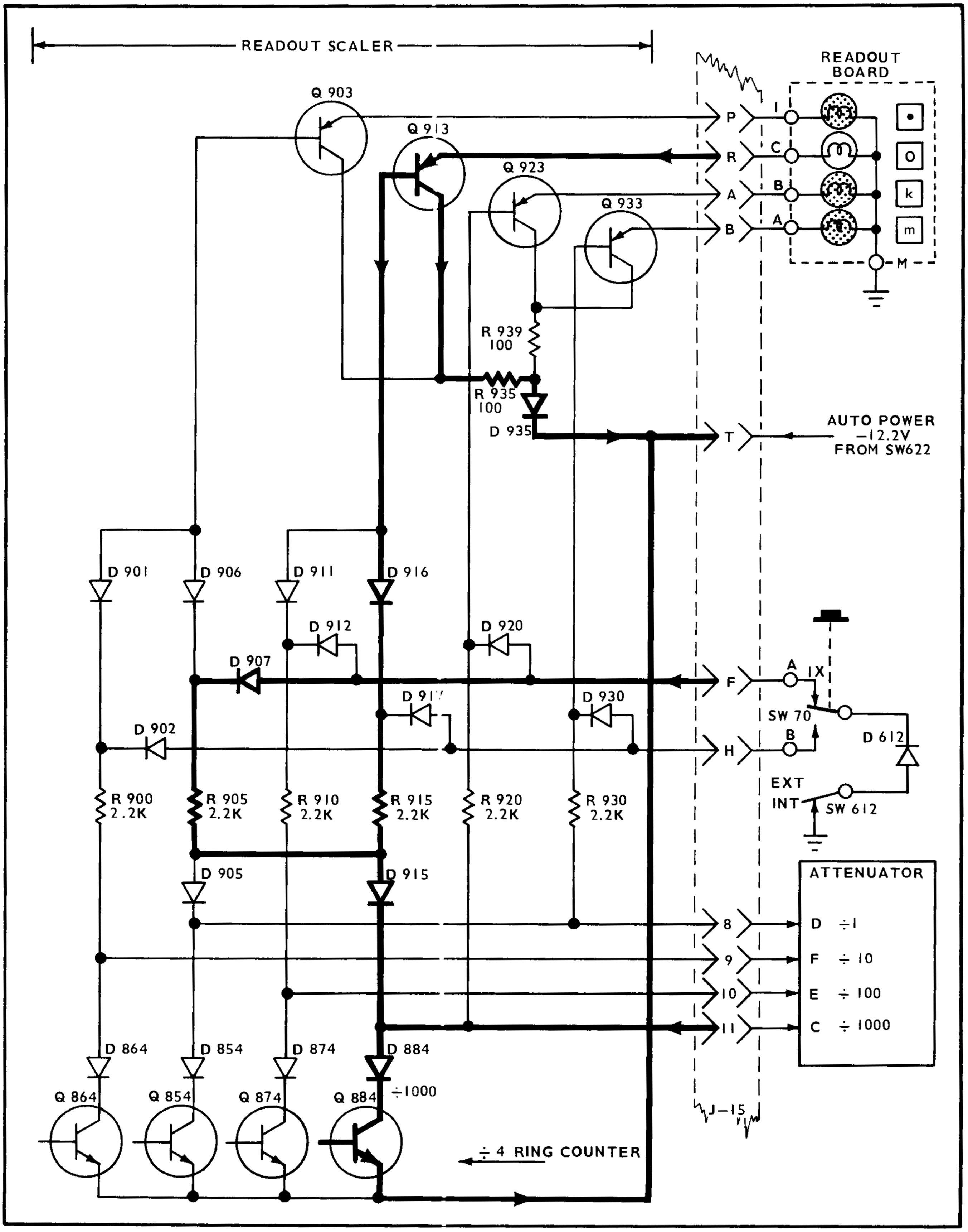

Fig. 3-34. Readout Scaler current paths for 10, 20, 50 V/DIV, no P6030 Probe.

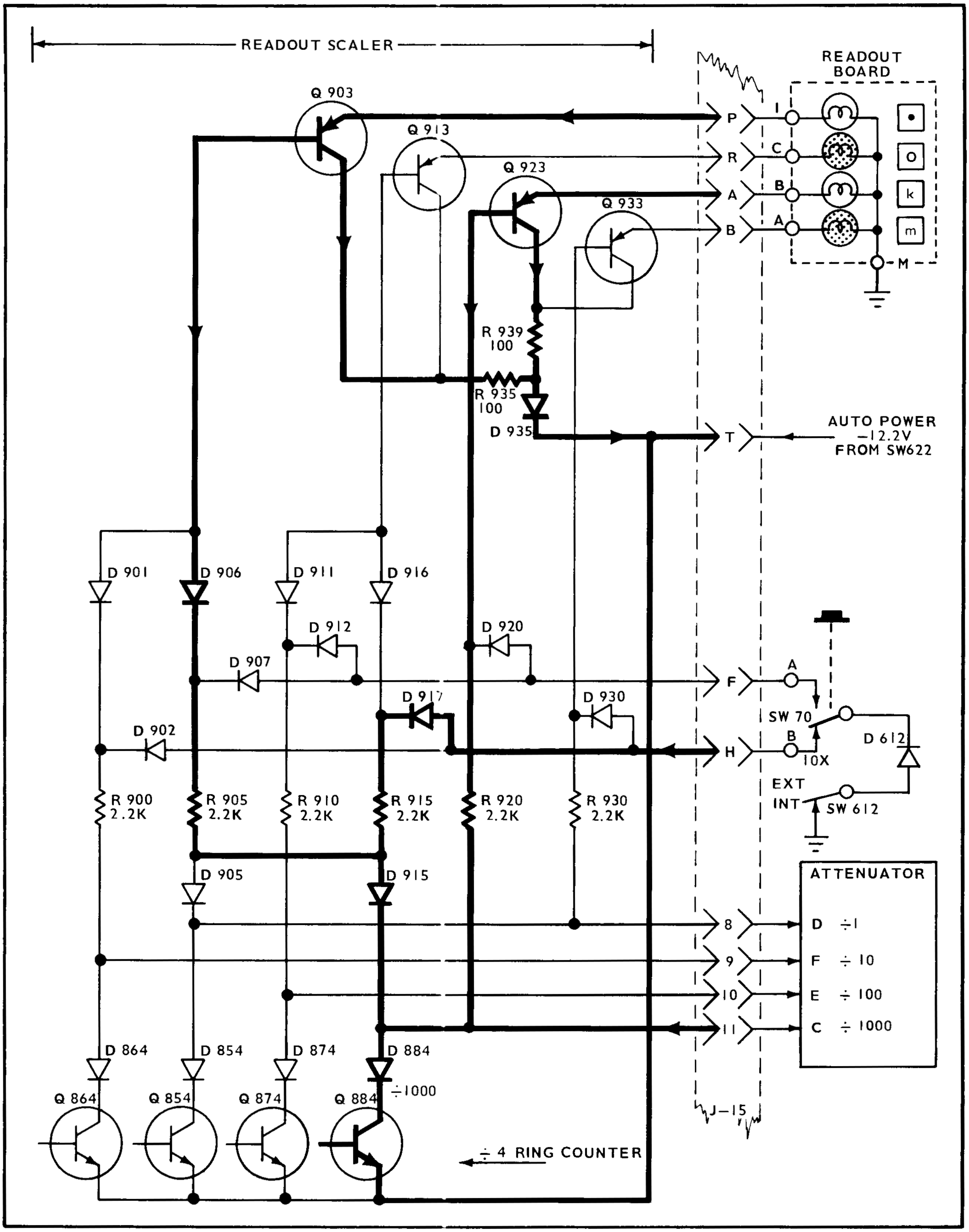

Fig. 3-35. Readout Scaler current paths for .1, .2, .5 kV/DIV, with P6030 Probe.

SECTION 4
MAINTENANCE

Introduction

This section contains maintenance instructions for the Tektronix Type 3A5, and includes preventive maintenance, troubleshooting hints, and corrective maintenance.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, lubrication and, if needed, recalibration. Preventive maintenance is generally more economical than corrective maintenance, since preventive maintenance can usually be done during idle periods at a time convenient to the user. The preventive maintenance schedule established for the instrument should be based on the amount of use and the environment in which the instrument is used.

Cleaning. The Type 3A5 should be cleaned as often as operating conditions require. The oscilloscope side panels provide some protection against dust accumulating in the interior of the instrument, but a small amount of dust is brought in by circulating air. Operation without the side panels in place is not recommended for internal temperature control reasons.

Dirt on the circuit components prevents efficient heat dissipation and may cause component overheating. Clean the instrument by loosening the accumulated dust with a dry, soft paint brush. Remove the loosened dust by vacuum and/or dry, low-pressure compressed air (high-velocity air can damage some components). Hardened dirt and grease may be removed with a cotton-tipped swab or a soft cloth dampened with water and a mild detergent solution (such as Kelite or Spray White). Abrasive cleaners should not be used.

CAUTION

Do not permit water to get inside controls or shaft bushings. Store the instrument in a dust-tight covering when not in use.

Lubrication. The life of potentiometers and rotary switches is lengthened if they are properly lubricated. Use a cleaning type lubricant (such as Cramoline) on shaft bushings, plug-in connector contacts, and switch contacts. Lubricate the switch detents with a heavier grease (Beacon grease No. 325 or equivalent). The necessary materials and instructions for proper lubrication of Tektronix instruments are contained in a component lubrication kit which may be ordered from Tektronix. Order Tektronix Part No. 003-0342-00.

Visual Inspection. After cleaning, the instrument should be carefully inspected for such defects as poor connections, damaged parts, and improperly seated tubes or transistors. The remedy for most visible defects is obvious; however if heat-damaged parts are discovered, determine the cause of overheating before the damaged parts are replaced. Otherwise, the damage may be repeated.

Tube and Transistor Checks. Periodic preventive maintenance checks consisting only of removing the tubes and transistors from the instrument and testing them in a tester are not recommended. The circuits within the instrument provide the only satisfactory means of checking tube and transistor performance. Defective tubes or transistors will usually be detected during recalibration of the instrument. Details of in-circuit tube and transistor checks are given in the troubleshooting procedures later in this section.

Recalibration. To ensure accurate measurements, the instrument calibration should be checked after each 500 hours of operation or every six months if the instrument is used intermittently. The calibration procedure is helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation are frequently revealed and corrected during recalibration. Complete calibration instructions are contained in Section 6.

CORRECTIVE MAINTENANCE

Troubleshooting. If the instrument is not operating, attempt to isolate the trouble by a quick operational and visual check. Make sure that any apparent trouble is actually due to a malfunction within the Type 3A5 and not due to improper control settings or a fault in associated equipment.

Operate the controls to see what effect, if any, they have on the trouble symptoms. The normal or abnormal operation of each control helps in establishing the nature of the trouble. The normal function of each control is listed in Section 2 of this manual.

If the trouble cannot be located by means of front-panel checks, remove the oscilloscope side panel and check voltages and waveforms against those presented in the circuit descriptions and schematics, starting with the power-supply connections.

Trouble Symptoms

Three specific vertical amplifier troubles can be located by their symptoms as viewed on the crt trace.

1. If Q143 and Q343 (see Fig. 4-1) are operating with very low β (between 5 and 10), the crt will exhibit compression of a signal at either or both the crt top and bottom. The POSITION control has limited effect upon the display position. The dc voltages for a centered display are altered for the whole vertical amplifier beginning at Q134 and Q334 collectors.

2. If Q404 in the Signal/Trigger Takeoff Amplifier is shorted, an internal trigger signal of low amplitude is still sent to the time-base. Triggering becomes difficult with one division peak-to-peak signals. The dc voltage of the vertical amplifier are unbalanced for the whole amplifier beginning at Q134 and Q334 collectors.

3. The Output Stage tubes are of frame-grid construction. If a grid wire pops loose and shorts to the screen and suppressor grids, the POSITION control can position a free-run trace from the crt center to either the top only or the bottom only. The two preceding transistors (on the same side of the

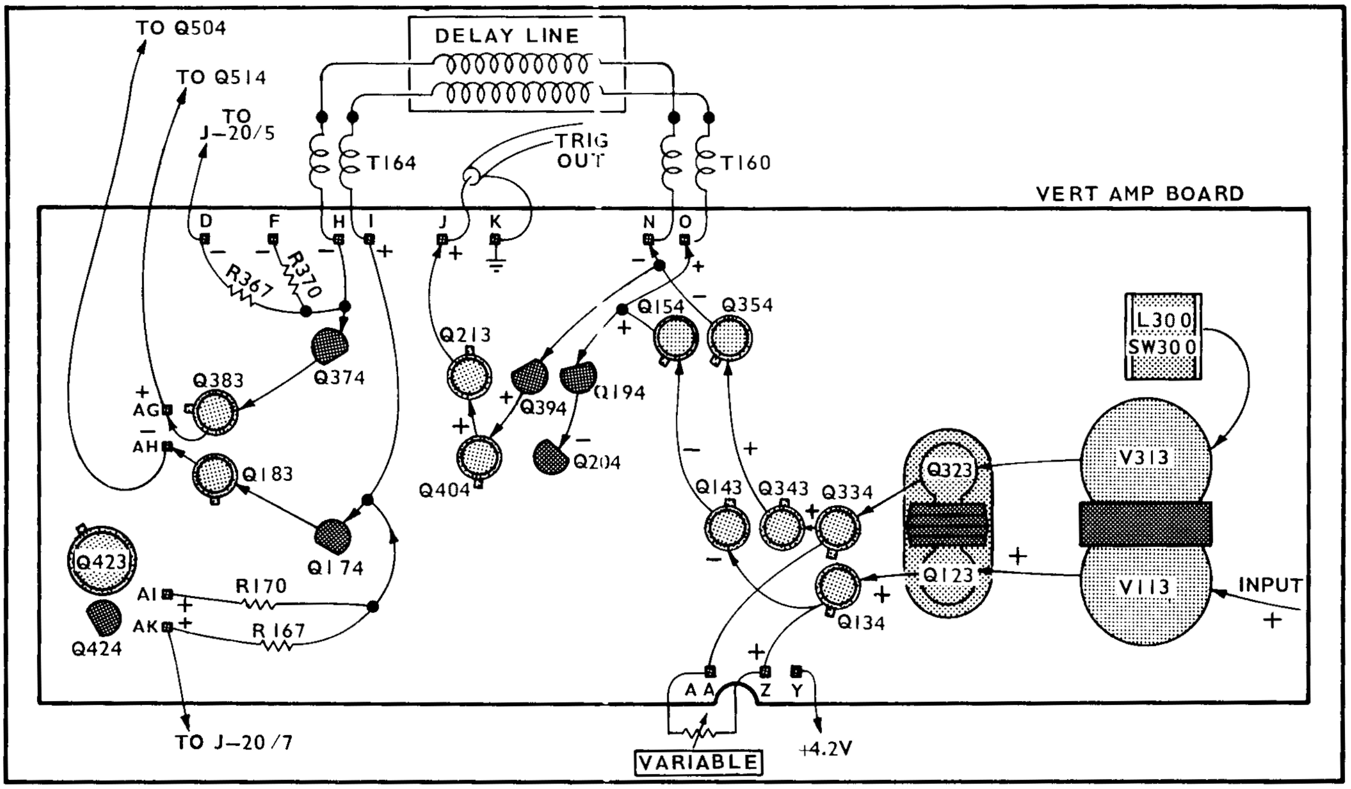

Fig. 4-1. Vertical Amplifier board transistor (and tube) locations with signal flow and phase noted.

amplifier as the bad tube) will probably be either shorted or open. For instance, if V524 fails this way, check and change Q183 and Q504.

Automatic circuit troubles usually fall in the complete failure category and can be located with normal voltage and signal tracing techniques.

Transistor Checks

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 resistance ranges, or by using the substitution method. The location of all transistors is shown in the parts location figures later in this section.

To check transistors using a voltmeter, measure the emitter-to-base and emitter-to-collector voltages and determine if the voltages are consistent with the normal resistances and currents in the circuit (see Fig. 4-2).

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.

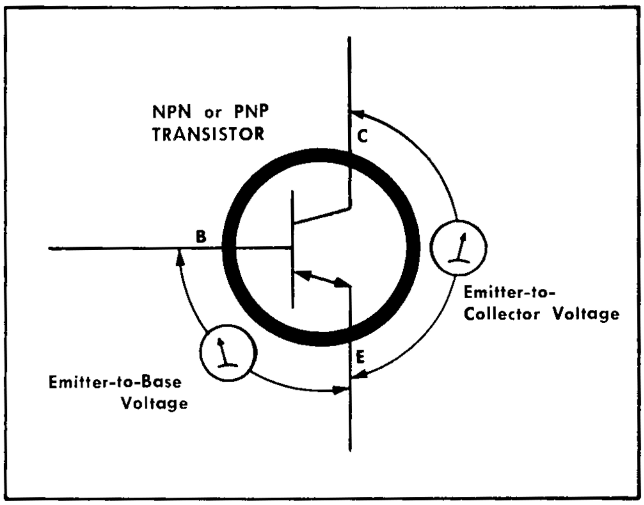

Fig. 4-2. In-circuit voltage checks NPN or PNP transistors.

NOTE

As a general rule, use the R × 1 k range where the current is usually liminted to less than 2 mA and the internal voltage is usually 1½ 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, then use those ranges to measure the resistance

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with the ohmmeter connected both ways as given in Table 4-1.

TABLE 4-1

Transistor Resistance Checks

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

[1]**Test prods from the ohmmeter are first connected one way to the transistor leads and then the test prods are 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, substitute a new transistor; but first, be certain the circuit voltages applied to the transistor are correct before making the substitution.

When checking transistors by substitution, be sure that the voltages on the transistor are normal 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.

CAUTION

Be careful when making measurements on live circuits. The small size and high density of components used in this instrument result in close spacing An inadvertent movement of the test probes, or the use of oversized probes may short between circuits

Parts Identification

Identification of Switch Wafers. Wafers of the MANUAL VOLTS/DIV switch shown on the circuit diagrams are numbered from the first wafer located behind the detent section of the switch to the last wafer. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function. For example, the designation 2R printed by a switch section on a schematic identifies the switch section as being on the rear side of the second wafer when counting back from the front panel.

Wiring Color Code. The wiring in the Type 3A5 is color coded to facilitate circuit tracing. In the case of power-supply leads, the color code indicates the voltage carried, with the widest stripe denoting the first signficant figure. Table 4-2 lists the color combinations and the voltages indicated by the colors.

All leads that clip to the permanently mounted etch-wired circuit boards are color coded. The color code of each lead, and the pin lettering is shown in parts location figures later on in this section.

Resistor Coding. The Type 3A5 uses a number of very stable metal film resistors identified by their gray background color and color coding.

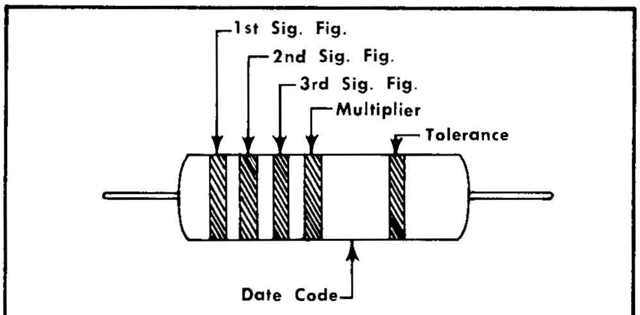
TABLE 4-2

Power Supply Color Coding

Supply	Color Code
+300	Orange/Black/Purple on White
+125	Brown/Red Black on White
−12.2	Brown/Red/Black on Tan
−100	Brown/Black/Brown on Tan

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 k resistor will be color coded, but a 333.5 k resistor will have its value printed on the resistor body.

The color-coding sequence is shown in Fig. 4-3.



Color	1st Sig. Fig.	2nd Sig. Fig.	3rd Sig. Fig.	Multiplier	Tolerance (±) %
Black	0	0	0	1	—
Brown	1	1	1	10	1
Red	2	2	2	100	2
Orange	3	3	3	1,000	—
Yellow	4	4	4	10,000	—
Green	5	5	5	100,000	0.50
Blue	6	6	6	1,000,000	0.25
Violet	7	7	7	10,000,000	0.10
Gray	8	8	8	100,000,000	0.05
White	9	9	9	1,000,000,000	—
Gold				0.1	5
Silver				0.01	—
No Color					10

Fig. 4-3. Standard EIA color code for metal film resistors.

Parts Replacement. All parts used in the Type 3A5 can be purchased directly through your Tektronix Field Office or Representative. However, replacements for standard electronic items can generally be obtained locally in less time than is required to obtain them from Tektronix. Replacements for the special parts used in the assembly of the Type 3A5 should be ordered from Tektronix since these parts are either manufactured or selected by Tektronix to satisfy a particular requirement. Before purchasing or ordering, consult the Electrical Parts List in Section 7 to determine the value, tolerance, and ratings required.

NOTE

When selecting the replacement parts, it is important to remember that the physical size and shape of a component may affect its performance at high frequencies. Parts orientation and lead dress should duplicate those of the original part since many of the components are mounted in a particular way to reduce or control stray capacitance and inductance. After repair, portions of the instrument may require recalibration.

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 Electrical Parts List Section 7.

Replacing Components on Etch-Wired Circuits. Use ordinary electronic grade 60/40 solder and a 35- to 40-watt pencil soldering iron with a 1/8 inch wide chisel tip. The tip of the iron should be clean and properly tinned for best heat transfer in a short time to a soldered connection. A higher wattage soldering iron, if used and applied for too long a time may ruin the bond between the etched wiring and base material by charring the glass epoxy laminate. The step-by-step technique is as follows:

1. To remove a component, cut the leads near the body. This frees the leads for individual unsoldering.

2. Grip the lead with needle-nose pliers. Apply the tinned tip of the soldering iron to the lead between the pliers and the solder joint; then pull gently.

3. When the solder first begins to melt, the lead will come out, leaving a clean hole. If the hole is not clean, use the soldering iron and a toothpick or a piece of enamel wire to open the terminal hole. Do not attempt to drill the solder out since the through-hole plating might be destroyed.

4. Clean the leads on the new component and bend them to the correct shape. Carefully insert the leads into the holes from which the defective component was removed.

5. Hold the leads of diodes with tweezers or pliers to form a heat sink. Apply the iron for a short time at each connection on the side of the board opposite the component to properly seat the component.

6. Apply the iron and a little solder to the connections to finish the solder joint.

7. Clean all flux from the joint, thus avoiding future corrosion.

Replacing Components on Ceramic Terminal Strips. Special silver-bearing solder is used to establish a bond to the ceramic terminal strips used in Tektronix instruments. This bond may be broken by repeated use of ordinary tin-lead solder or by excessive heating. Solder containing about 3% silver is recommended. Silver-bearing solder is usually available locally or may be purchased in one-pound rolls through your Tektronix Field Office or Representative. Order by Tektronix Part No. 251-0514-00.

Because of the shape of the ceramic strip terminals it is recommended that a soldering iron with a wedge-shaped tip be used. A wedge-shaped tip allows the heat to be concentrated on the solder in the terminals. It is important to use as little heat as possible while producing a full-flow joint. The step-by-step technique is as follows:

1. Use long-nose pliers for a heat sink. Attach pliers between the component and the point where heat is applied.

2. Use a 50- to 75-watt soldering iron with a clean tip, properly tinned with solder containing about 3% silver.

3. Apply heat directly to the solder in the terminal without touching the ceramic. Do not twist the iron in the notch as this may chip or break the ceramic strip.

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

5. Do not attempt to fill the notch with solder; instead apply only enough solder to cover the wires adequately and form a small fillet. Overfilling the notches may result in cracked terminal strips. If the lead extends beyond the solder joint, clip off the excess close to the joint.

6. Clean all solder flux from the joint.

7. Remove all wire clippings from the chassis.

Ceramic Strip Replacement. Unsolder all connections, then use a 3/8 inch long plastic or hardwood dowel and a small (2 to 4 oz) mallet to knock the stud pins out of the chassis. Place one end of the dowel on the end of the stud pin protruding through the chassis. Rap the opposite end of the dowel smartly with the mallet. When both studs of the strip to be removed have been loosened in this fashion, the strip is removed as a unit. The spacers will probably come out with the studs. If not, they can be pulled out separately. An alternative method of removing the terminal strip is to use diagonal cutters to cut off the sides of the studs. The ceramic strip is removed and the studs pulled from the chassis with a pair of pliers. Replacement ceramic strips are supplied with studs and spacers, so the old studs need not be salvaged. The ceramic strip and its parts are shown in Fig. 4-4.

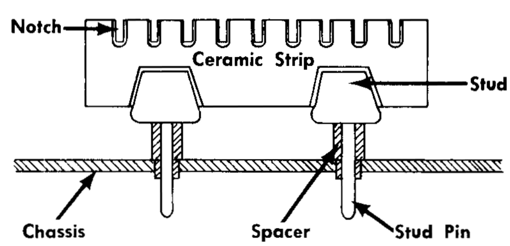


Fig. 4-4. The ceramic strip and its parts.

The only ceramic strips in the Type 3A5 are located under the output amplifier at the rear panel.

Glass Reed Switch Replacement

The glass reed switches used in the Type 3A5 are of high quality and should not need replacement unless broken.

WARNING

Wear safety glasses when replacing the reed switches.

Tools required are a small soldering iron, long nose pliers and diagonal cutters.

Removal. Observe the lead and glass physical position of the old switch and compare it with the new switch before removing the old. If the switch leads go through the etch-wired laminate, cut both switch leads about $^{3}/_{8}$ inch from the laminate (leaving two leads as solder posts) and pull the switch out of the coil with long-nose pliers.

If the switch has two leads on one end, place the pliers on the lead to be unsoldered before applying heat to the junction of lead and pin. Hold the lead just far enough away from the pin to let the molten solder cool, then unsolder the next lead. Use the pliers to pull the old switch out of the coil by the single lead end.

If removing switches from the attenuator board, note the associated component physical positions before unsoldering so all parts can be repositioned the same way after replacement.

Installing the new switch. Start the new two-lead switch into the coil from either end. Start the three-lead switch into the coil so the single lead enters first. Start an attenuator switch into the coil with the small lead first, passing the lead through the variable capacitor lead. Pull the switch into exactly the same physical position as the old switch.

CAUTION

Do not apply side pressure to any lead in a manner that will allow the stress to reach the glass. If necessary to bend a lead, use two long-nose pliers.

Clip the leads to the needed length. Solder them in place using good quality 60/40 solder. Check that all parts are dressed correctly and check the circuit operation.

PARTS LOCATION

Text and illustrations for the remainder of this section are devoted to showing locations of major circuits. Circuit numbers for all parts mounted on etch-wired circuit boards, and color codes for all pin connections are also shown.

Subassembly Removal

Attenuator removal (see Fig. 4-5) requires a small soldering iron, a pair of long-nose pliers, a number 10 ($^{5}/_{16}$ inch) socket wrench, a $^{5}/_{16}$ inch end wrench, a number 6 ($^{3}/_{16}$ inch) socket wrench and a small screwdriver. Remove the attenuator assembly as follows:

1. Remove the Automatic card from the Type 3A5.

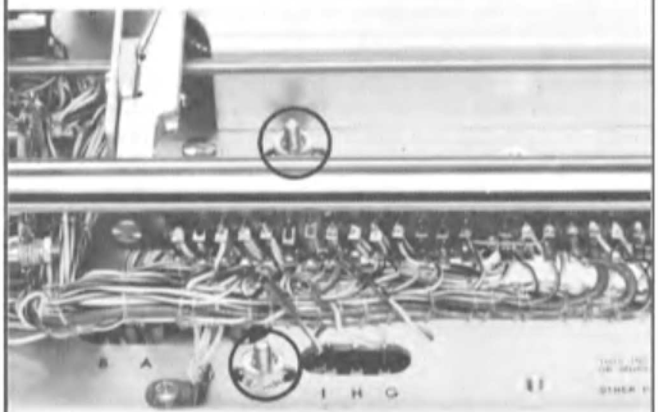
2. Remove the attenuator shield by removing the two 4-40 bolts located on the instrument left side. Then lift the shield free.

3. Unsolder the output lead and disconnect the ground pin from pin W of the vertical board. See Fig. 4-5A.

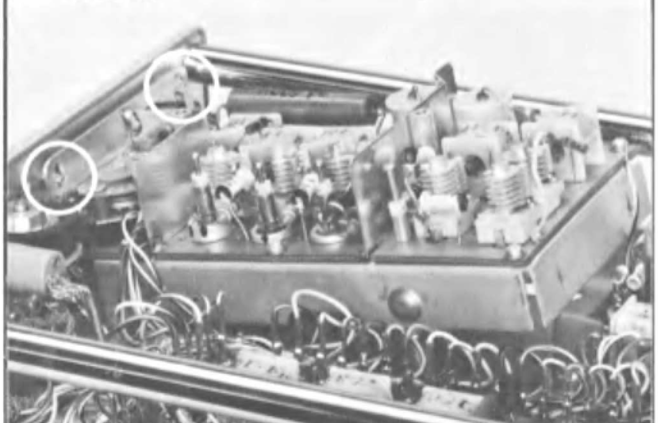
4. Use the long-nose pliers to lift all nine leads from the pins on the attenuator underside. Use the $^{5}/_{16}$ inch end wrench and socket wrench to remove the two nuts shown in Fig. 4-5B.

5. Lay the instrument on its right side with the attenuator up. Use the $^{3}/_{16}$ inch socket wrench to remove the two nuts shown in Fig. 4-5C. Remove the plastic knob from the front of the input coupling switch by pulling it off.

A. Attenuator shield removed and output lead unsoldered.



B. Right side mounting nuts (two) and connections to be removed.



C. Left side panel mounting nuts (two) removed and attenuator partially removed.

Fig. 4-5. Mechanical details for removing attenuator from the Type 3A5.

6. Lift the attenuator rear upward and slide the assembly away from the front panel for removal. If the attenuator needs to be taken more than a few inches from its normal location, lift the input coupling switch wires from the control board.

To replace the attenuator switch:

1. Slide the assembly into the front-panel opening at a slight angle. It may be necessary to watch the probe 10× scaling switch button through the panel hole to align it correctly.

2. Install the two right side nuts, but do not tighten. Install the two front-panel nuts and lockwashers, and tighten. Tighten the right side nuts.

3. Install all removed wires from the attenuator right side, the control board and vertical board pins. The wire color code and pin letters are shown in Fig. 4-9 and Fig. 4-10 at the back of this section. Solder the attenuator output lead in place. Do not apply excess heat or the reed switch may be damaged. Replace the attenuator shield.

Vertical Board removal requires a small soldering iron, a small screwdriver and long-nose pliers. Remove the Vertical board as follows:

1. Remove the attenuator shield and unsolder the attenuator output lead as shown in Fig. 4-5A.

2. Lift all wires from the connecting pins with the long-nose pliers. Pull on the pins, not the wires. Unsolder six leads: H, I, N, O, and the two leads of C422 shown in Fig. 4-6. (Place the removed delay line leads so they can be soldered again in correct order.)

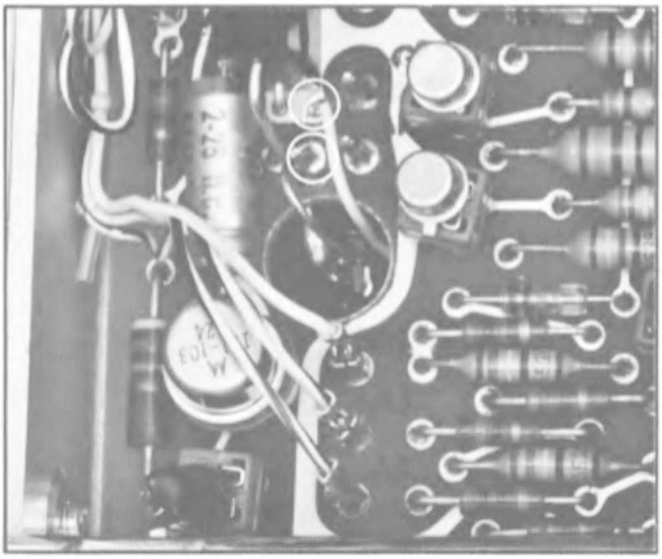


Fig. 4-6. Unsolder two leads of C422 when removing Vertical board.

3. Remove the six mounting bolts (they have captive nuts permanently mounted in the chassis) and lift the board out.

To replace the Vertical board:

1. Gently lower it into place so the positive terminal of C422 comes through its opening. Secure it in place with the six mounting bolts and their split washers.

2. Solder C422 leads and the delay line leads. If the delay line lead orientation is unknown, an ohmmeter (10× scale) will help. The pins H and N connect through the ferrite transformers to the rear delay line terminals. Pins I and O connect through the ferrite transformers to the front delay line terminals.

3. Solder the attenuator output lead in place and install the attenuator shield.

4. Replace all leads to the Vertical board pins following the color coding and pin lettering of Fig. 4-11.

Two tubes and two transistors are mounted on the Vertical board under clamped-down heat sinks. Q123-Q323 heat sink is removed by lifting the black clamp straight away from the board.

To remove V113 and V313 use a sharp pointed tool such as a scribe to unlock the phosphor-bronze clip at the rear side of the heat sink. Pry the clip away from the bottom of the heat sink so it can come out of the mounting hole. Repeat for the front side of the heat sink and remove the clip. Lift the heat sink straight away from the board with a steady pressure. The heat sink will slip slowly off the tubes due to silicone grease lubricant. To remove the tubes DO NOT use long nose pliers, but use either the fingers or a specially shaped tool that will not cave in the tube sides.

Replace the tubes and heat sink in the reverse order. If new tubes are installed, coat them lightly with silicone grease such as Dow Corning DC-4.

WARNING

Do not let the silicone grease touch the face or eyes. Serious damage may result from silicone grease in the eyes. Wash your hands after working with V113-V313 heat sink.

Control Board removal requires only a screwdriver and long nose pliers. Disconnect all leads, remove four mounting screws and lift the board out. To replace the Control board place it so that Q624 is at the instrument top. Color coding of the wires and pin lettering is shown in Fig. 4-12.

Readout Panel removal (see Fig. 4-13) requires only a Phillips number 1 screwdriver and long-nose pliers. Remove the leads, unscrew the two through-panel mounting bolts and lift the board out. Readout lamps can be replaced using a small soldering iron and normal soldering procedures. Use a heat sink on the diode leads when soldering in new diodes.

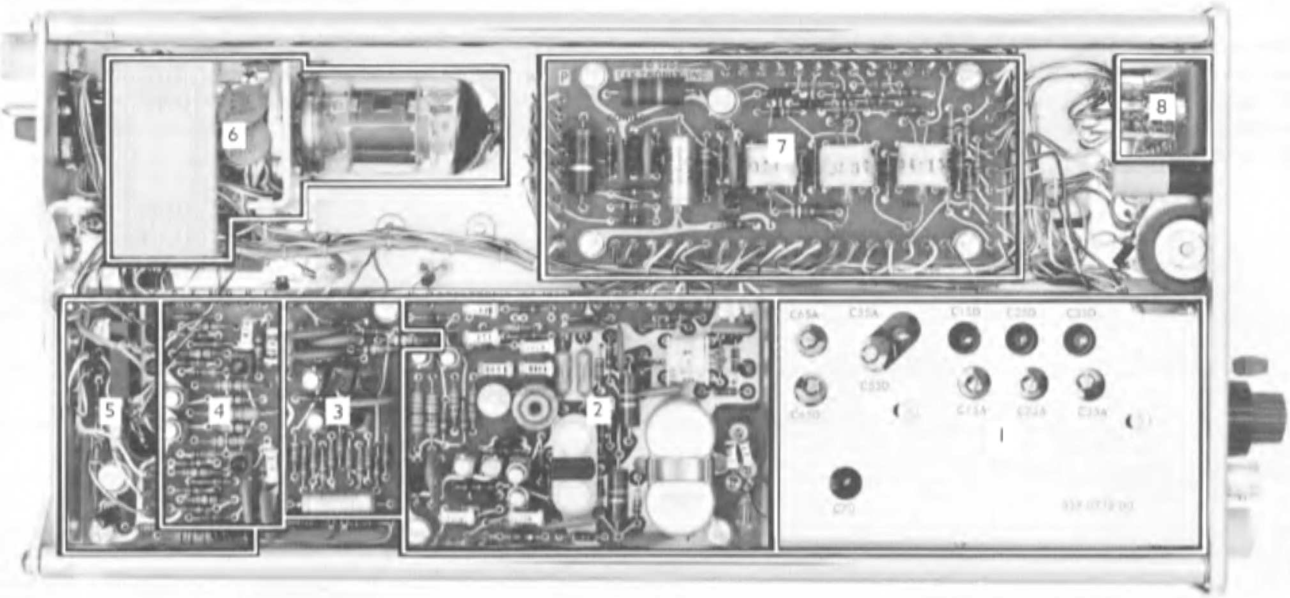
Mode Switches Panel removal (see Fig. 4-13) requires a small soldering iron, long-nose pliers, and a $\frac{1}{4}$ inch box end wrench. Remove the two mounting nuts with the $\frac{1}{4}$ inch wrench, withdraw the board, then unsolder the leads. The leads can be soldered most easily if the board is removed through the instrument left side. Installation is the reverse of removal, and lead color code and pin lettering is shown in Fig. 4-13.

Position Control removal requires a pair of long nose pliers, a No. 6 ($\frac{3}{16}$ inch) end wrench and a small soldering iron. Remove the two special $\frac{1}{2}$ inch long mounting nuts that are located next to each other at the top of the control. Withdraw the control, make a record of lead color coding and placement, then unsolder the leads. Remove the knob with a 0.035 inch Allen wrench.

Re-install the POSITION control with the knob on the shaft, but not screwed tight. Correct knob position is with the red mark positioned out of sight behind the panel and over the top terminal (to which —12.2 volts is connected) when the control is at its counterclockwise end of rotation (instrument lying on its right side). Tighten the knob with a 0.035 inch Allen wrench.

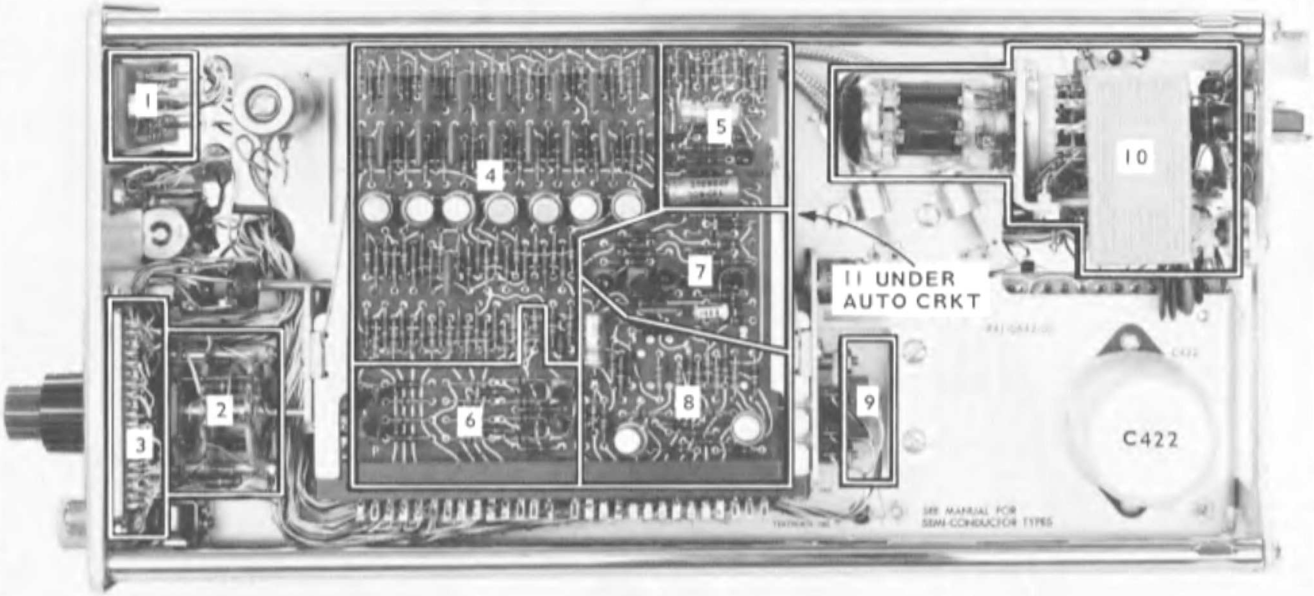
Delay Line removal requires a small soldering iron, a screwdriver and long nose pliers. Unsolder the four delay line leads at the through-chassis terminals. Remove the mounting bolts at the delay line ends. Remove the delay line cover bolt and lift the delay line out.

If the delay line leads develop a short circuit, it will probably be at one end. It may not be necessary to remove the delay line to make the repair. Each end of the delay line can have up to ten turns removed without affecting performance. Thus, if the line is shorted, remove a few turns (equal number for each lead) from the shorted end and resolder the leads to the through-chassis terminals. An ohmmeter (10× scale) will tell you which end is shorted. When soldering the delay line leads, use the pliers as heat sink to prevent the soldering heat from going back into the line and causing a short circuit. The lead orientation must be checked with an ohmmeter before soldering. One side of the line goes to the front terminals and the other side of the line goes to the rear terminals of the two pairs of through-chassis terminals.



1. Reed switched attenuators.
2. Vertical amplifier before delay line.
3. Trigger amplifier.
4. Output stage driver amplifier.
5. +6.8V and +4.2V power supplies.
6. Output amplifier.
7. Control circuits.
8. Readout panel.

Fig. 4-7. Left side major circuit locations.



1. Readout panel.
2. MANUAL VOLTS DIV sw.
3. External PROGRAM connector.

Automatic Circuits:

4. ÷ 3 & ÷ 4 Ring counters.
5. SEEK Multi.
6. 1X 10X Readout Scaler.
7. Advance/Comparator.
8. SEEK & EXT Control.

9. VARIABLE control.
10. Output amplifier.
11. Delay line under Auto Crkts.

Fig. 4-8. Right side major circuit locations.

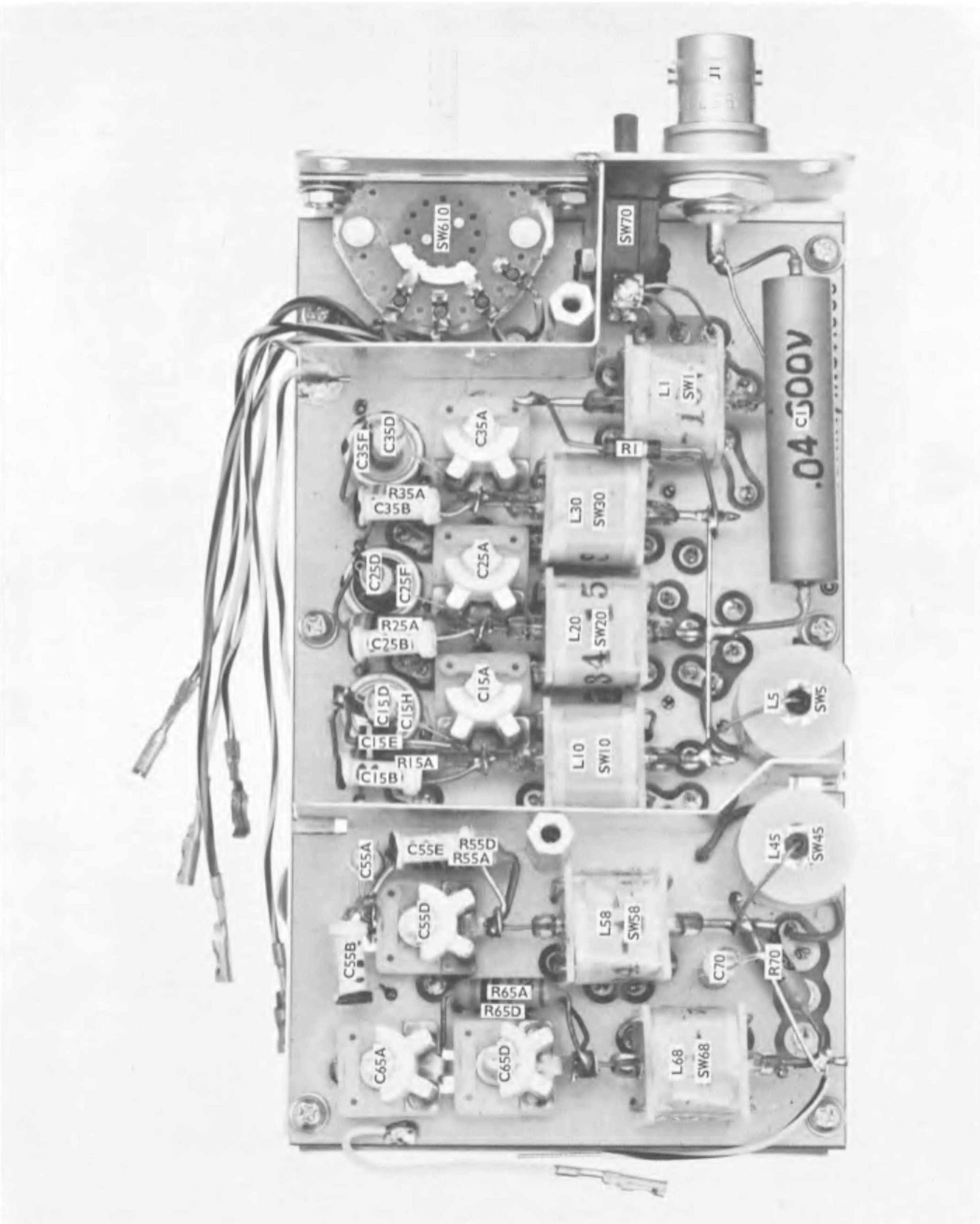


Fig. 4-9. Attenuator left side parts locations and wire color code.

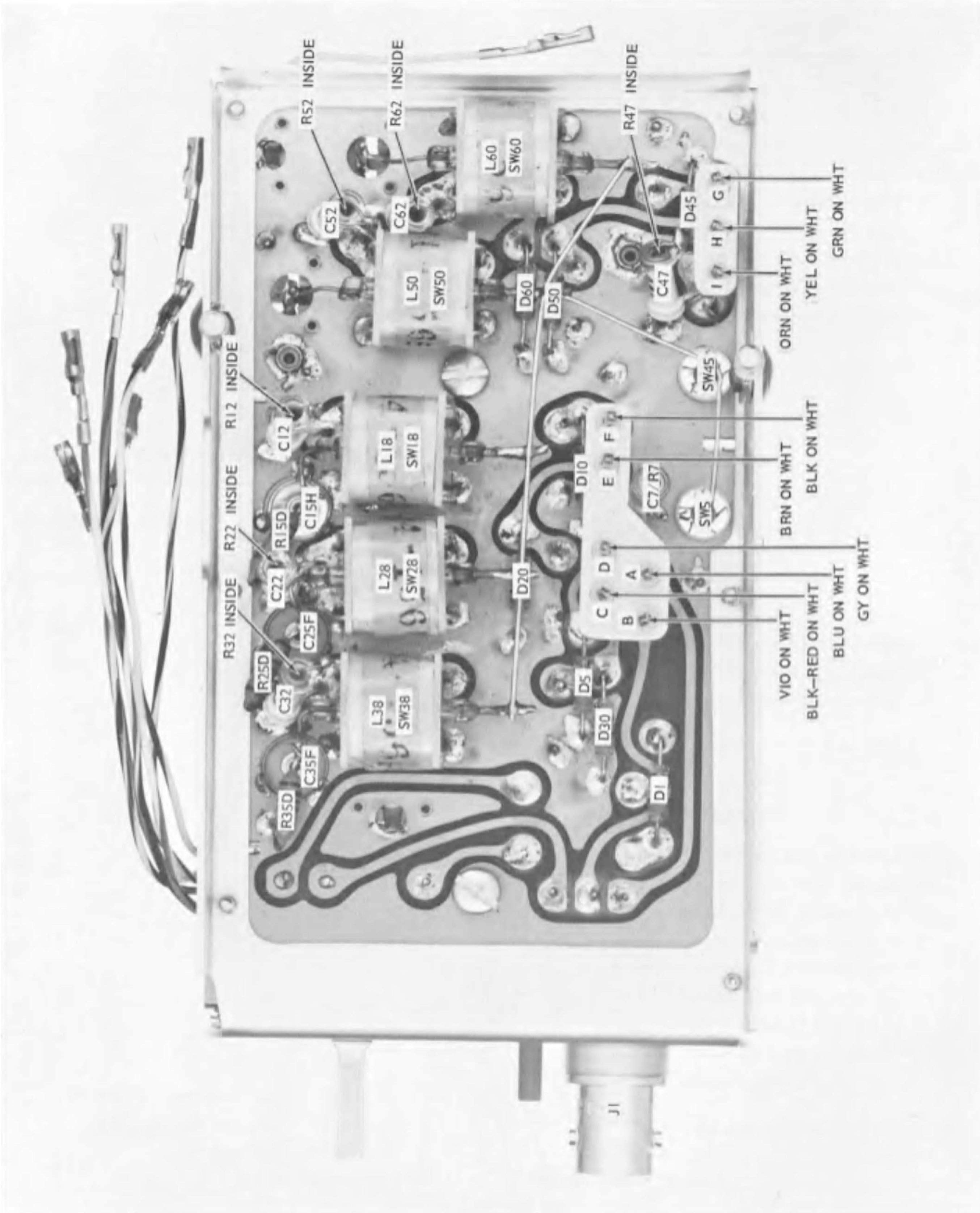


Fig. 4-10. Attenuator right side parts locations and wire color code.

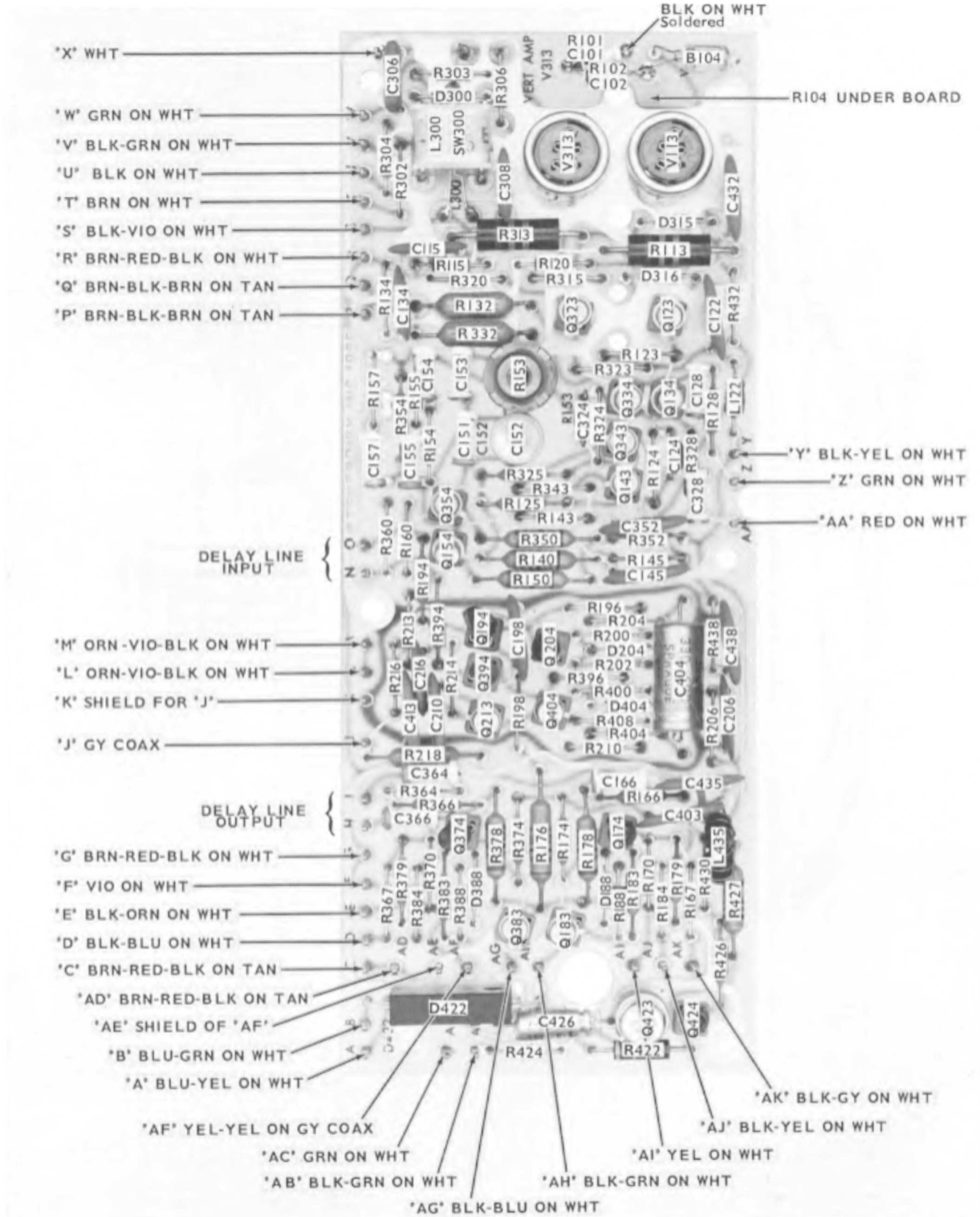


Fig. 4-11. Vertical amplifier board parts locations, and wire color code.

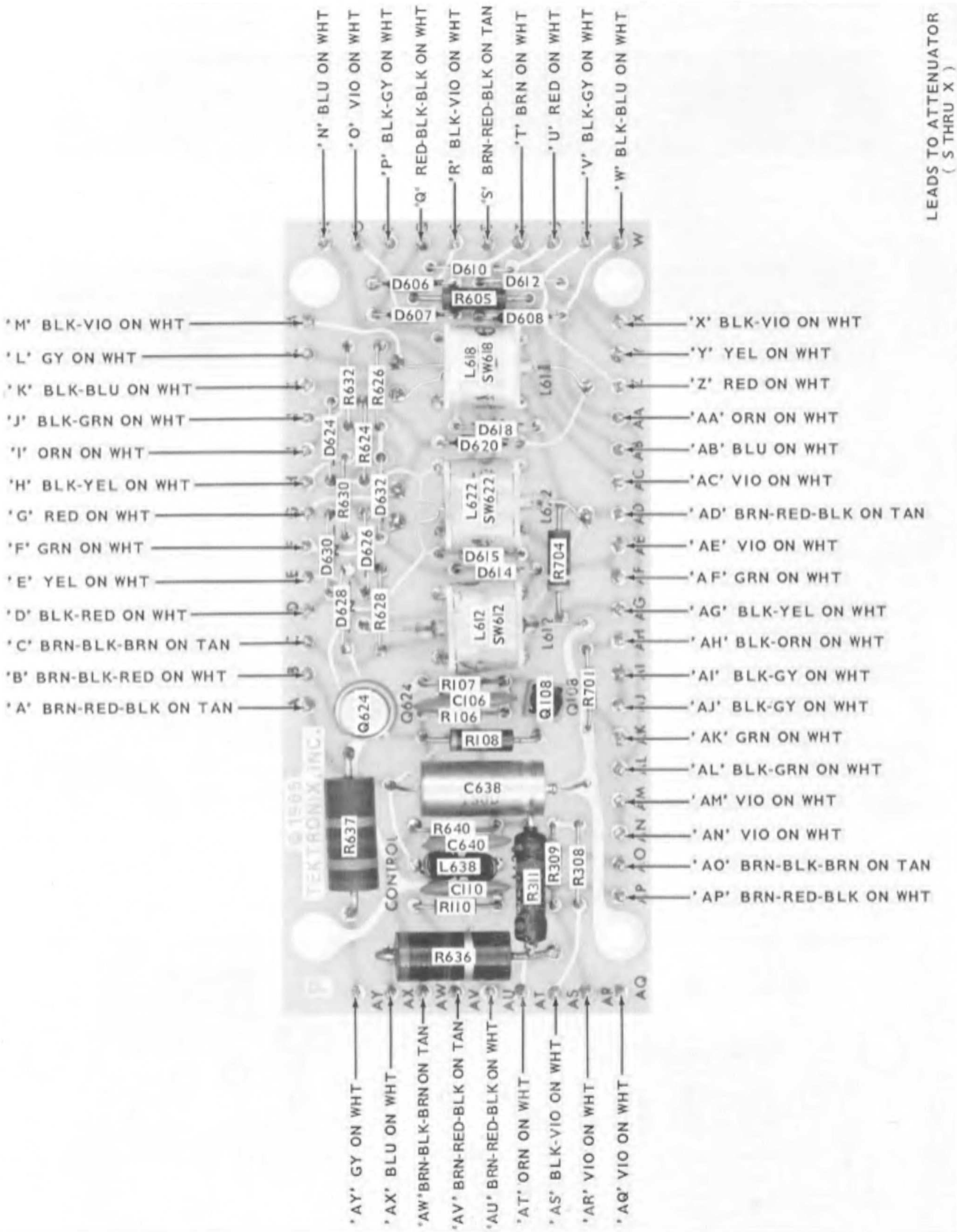
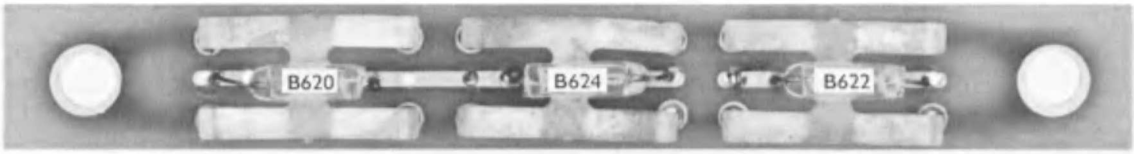
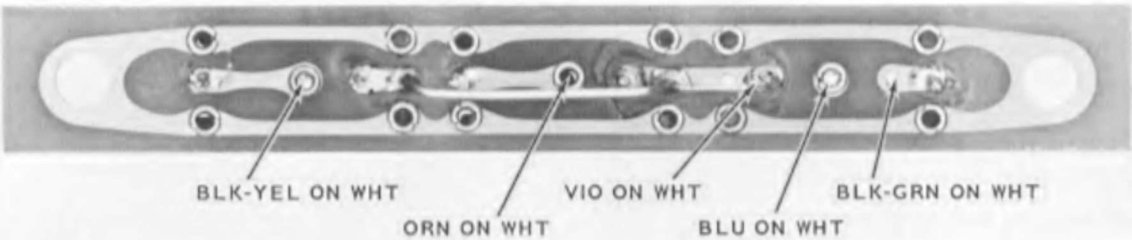


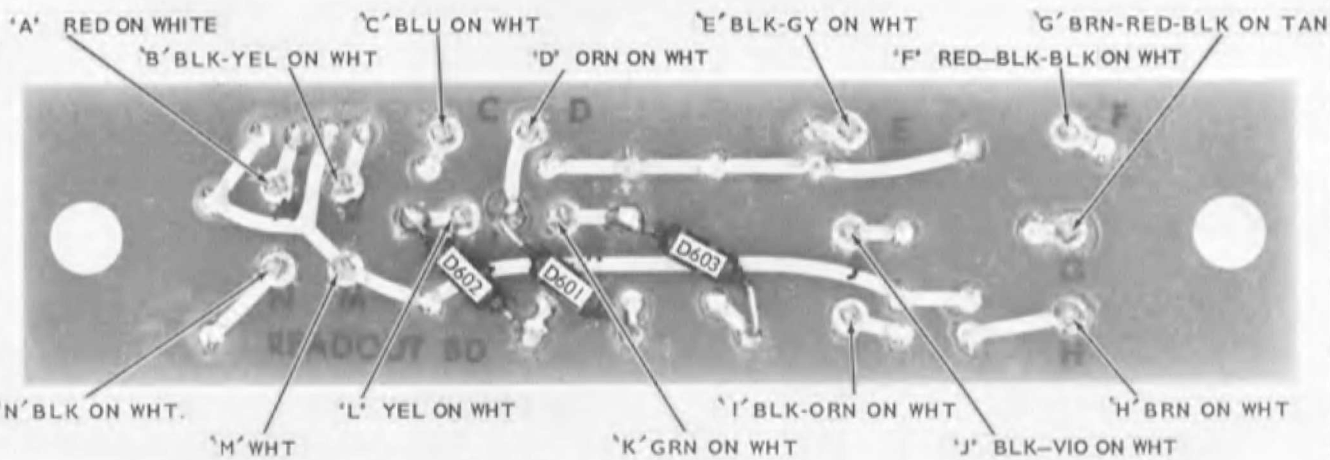
Fig. 4-12. Control circuit board parts locations, and wire color code.



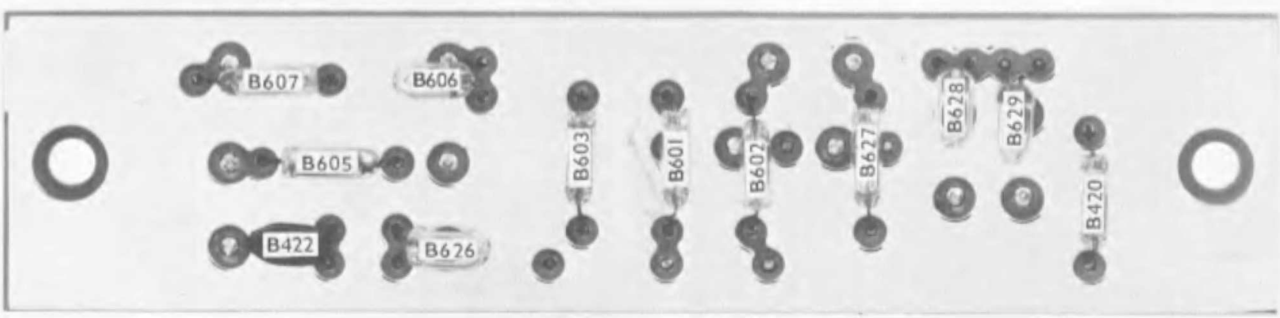
a. Mode switch lamps.



b. Mode switch wiring color code.



c. Readout board diode locations and wiring color code.



d. Readout board lamps.

Fig. 4-13. (A) Mode switch lamps. (B) Mode switch panel wire color code. (C) Readout panel diode locations and wire color code. (D) Readout panel lamps.

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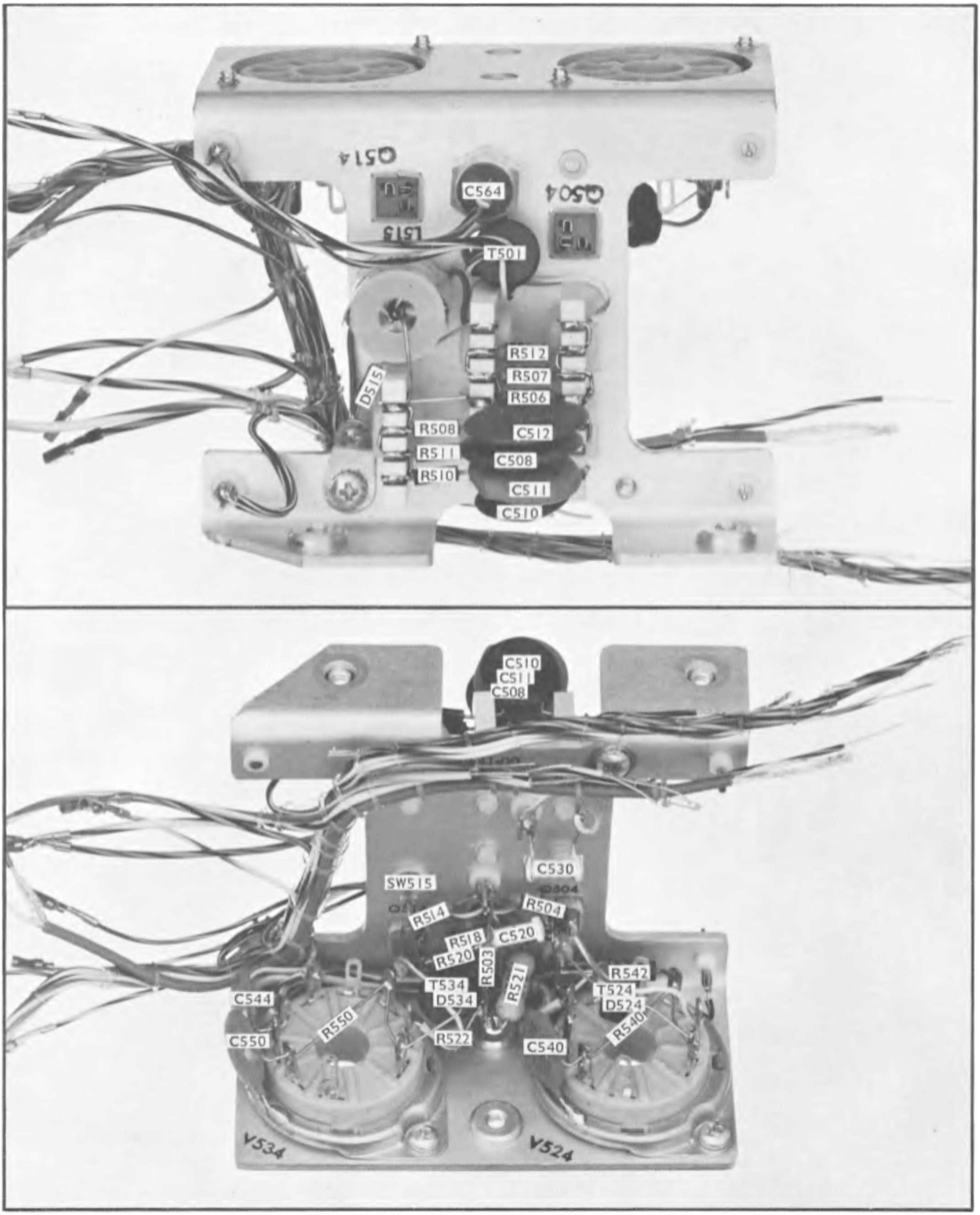


Fig. 4-14. Output amplifier parts locations.

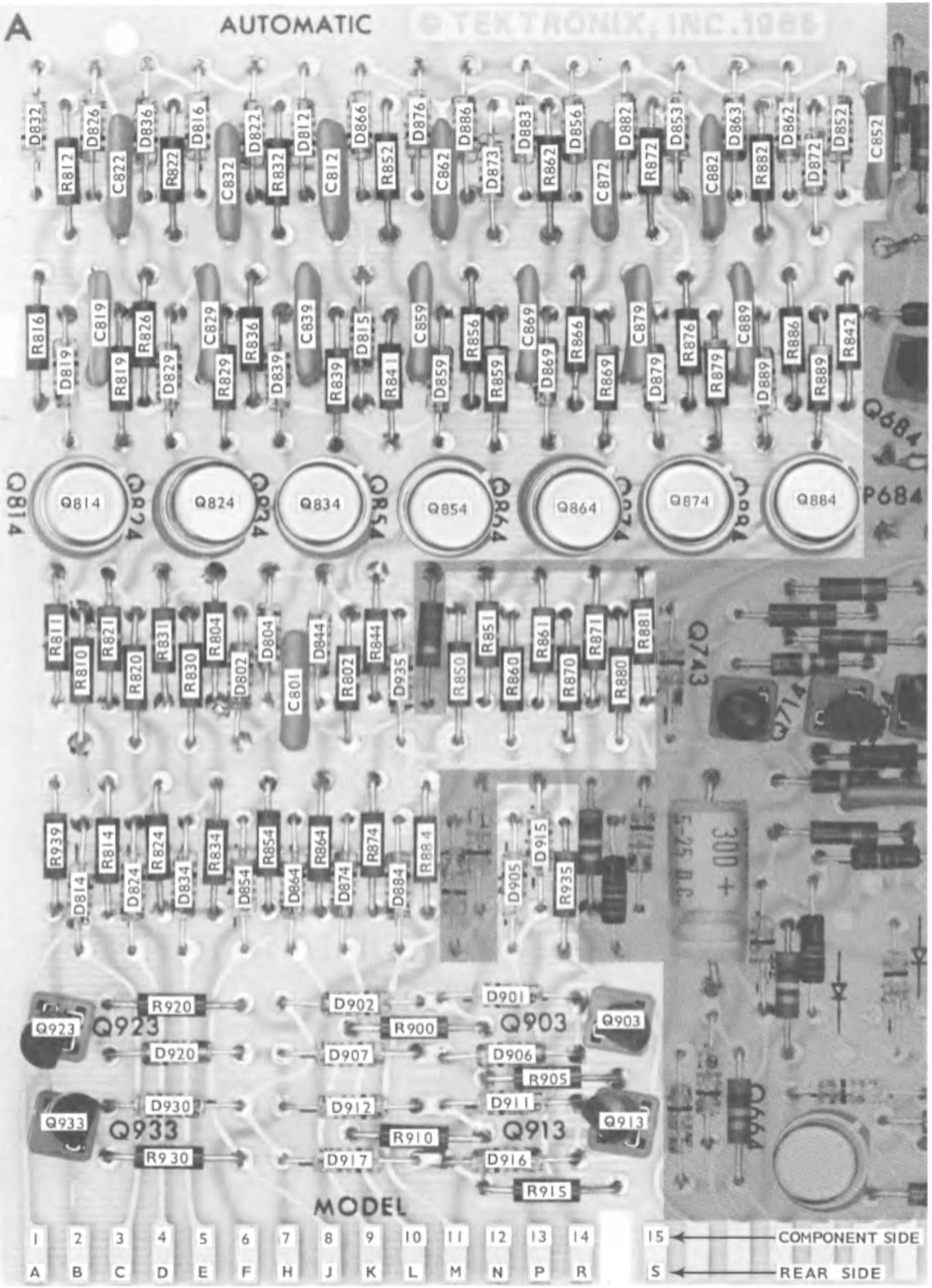


Fig. 4-15. One half automatic card parts locations.

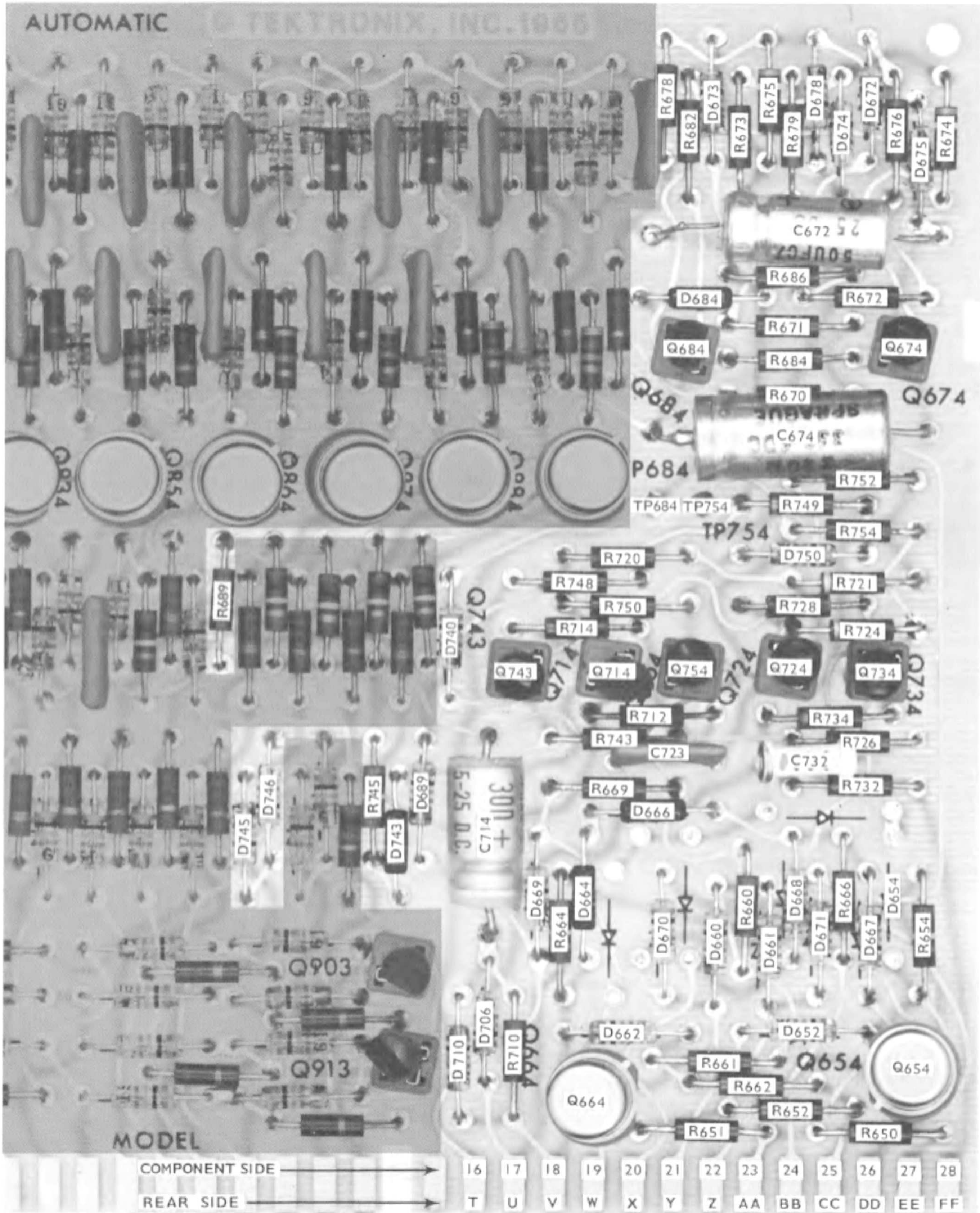


Fig. 4-16. One half automatic card parts locations.

SECTION 5
PERFORMANCE CHECK

Introduction

This performance check procedure is to be performed entirely from the Type 3A5 front panel, without removing the oscilloscope side or bottom panel. The procedure may be used for incoming inspection, quality control after recalibration, and instrument familiarization.

Failure to meet the characteristics and limits given in this procedure indicates that the instrument requires internal checks and/or adjustments. See the Calibration section of this instruction manual.

Recommended Equipment

The following equipment is necessary for a complete performance check of the Type 3A5. If other than the recommended equipment is used, it must meet or exceed the specifications of the recommended equipment.

Special calibration equipment is used in the performance check procedure for obtaining the maximum accuracy and convenience. Some of these items are manufactured specially by Tektronix. Items available from Tektronix are identified by type or nine digit part number. Order by part number from your local Tektronix Field Office or Representative.

1. A Type 561A Oscilloscope, or other oscilloscope in which the Type 3A5 will normally operate. A time-base unit for the oscilloscope, such as a Type 3B5 Automatic/Programmable Time-Base. The Type 3B5 is required to perform one check of the Type 3A5.

2. A sine wave signal generator with constant amplitude control at 50 kHz and from approximately 2 MHz through 25 MHz. Amplitude continuously variable from 5 mV to 10 V peak to peak. Example, Tektronix Type 191 Constant Amplitude Signal Generator.

3. Fast rise pulse generator with amplitude adjustable from 5 mV to 120 V peak-to-peak at a repetition rate of approximately 1 kHz. Risetime of $\leq$2.3 nsec into 50 Ω at 400 kHz and 40 mV peak to peak. Tektronix Type 106 Square-Wave Generator is recommended.

4. A low frequency sine wave oscillator with an output frequency of 10 Hz at an amplitude of 10 mV peak to peak. Example, Heathkit Model IG-72 Audio Generator.

5. An accurate-amplitude signal generator of approximately 1 kHz square-wave repetition rate. Voltage from 0.2 mV to 100 V with accuracy of ±0.25%. Tektronix 067-0502-00 Standard Amplitude Calibrator.

6. A 24 pF Input Time Constant Standardizer with BNC connectors, Tektronix Part No. 011-0067-00.

7. A ±1% 50 Ω termination with BNC connectors, such as Tektronix Part No. 011-0049-00.

8. Two 50 Ω 10:1 attenuators with BNC connectors, such as Tektronix Part No. 011-0059-00.

9. Two (one required, two can be used) GR Type 874 connector to BNC adapters. General Radio 874-QBJA, Tektronix Part No. 017-0063-00.

10. A 50 Ω coax cable about 3 or 4 feet long with BNC connectors. Such as 42 inch cable, Tektronix Part No. 012-0057-00.

11. A BNC to clip lead adapter (if the 10 Hz sine wave generator is the suggested Heath unit), Tektronix Part No. 013-0076-00.

12. Variable line voltage autotransformer, such as the General Radio VARIAC, Type W10MT3W, metered 600 watt rating.

13. Small screwdriver for adjusting front-panel screwdriver controls.

14. A dc resistance bridge of ±0.075% or better accuracy at 1 MΩ.

15. A power line 3-wire to 2-wire adapter.

PROCEDURE

In the following procedure, control settings are listed in complete form just once. Changes required for each step are stated at the time the control is to be changed. Thus, perform the procedure in the order stated without any alterations. Signal connections are listed as required.

Preliminary Checks

1. Check all front-panel controls for proper indexing. Check the variable controls for smooth operation. Check that the POSITION control red mark rests approximately half way between the end of rotation limits. Correct any defects found.

2. Check Input Resistance. This check is required in order to make accurate measurement of input grid current and to assure correct input time constant when compared to a Tektronix input time constant standardizer.

Requirement—Input dc resistance to ground must be 1 MΩ ±0.75%.

a. Lay the Type 3A5 on its right side on the work bench (with the Vertical Amplifier board up). Locate the lead coming out the rear of the attenuator shield (white with black tracer). This lead is connected directly to the 1 MΩ input resistor.

b. Use a dc resistance bridge. Connect its common lead to the Type 3A5 front-panel ground connector and its active lead to the white with black tracer lead located in (a) above. Measure the resistance.

Connections and Control Settings

Place the Type 3A5 into the test oscilloscope. Connect the oscilloscope power cord to the variable line voltage autotransformer. Set the Type 3A5 controls before turning on the power, then turn on the power and adjust the line voltage to 117 volts rms (234 volts rms if the oscilloscope is wired for the higher voltage).

Set the Type 3A5 controls:

POSITION	Midrange
Input Coupling	AC-TRACE STABILIZED
MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Mode	MAN

Set the Time-Base controls:

Position	Midrange
Manual Time/Div	1 msec
Variable	Cal
Trigger Mode	Auto
Coupling	+Int, AC
Trigger Level	Midrange
Magnifier	×1 or Off
Delay	0.00
Mode	Man

Set the oscilloscope controls:

Intensity	Normal brilliance trace
Focus	As required
Calibrator	Off
Power	On

Operation Checks

1. Trace Alignment check

Position the trace to the graticule centerline and adjust the oscilloscope Alignment control so that the trace is parallel with the graticule markings.

2. Check INPUT grid current

Requirement—2 nanoamperes or less grid current after 20 minutes operation.

Set the Input Coupling switch to DC and position the trace to graticule centerline. Short the INPUT connector center conductor to ground and note trace shift. The shift should not be greater than 0.2 division, or 2 nanoamperes. Remove the INPUT short circuit.

3. Check Microphonics

Requirement—No ringing microphonics. No microphonics greater than 0.2 minor division at 10 mV/division.

a. Lightly tap the oscilloscope top front panel area. The trace should show no microphonics of a prolonged ringing nature, and no short-term microphonics of greater amplitude than 2 minor divisions.

4. Check trace drift with change in line voltage

Requirement—Trace does not drift over ±0.5 major division between the line voltages of 105 volts and 125 volts rms after 1 minute at each voltage.

a. Set the line voltage autotransformer to deliver 105 volts rms to the oscilloscope. Wait one minute. Position the trace to the graticule centerline. Change the autotransformer to deliver 125 volts rms to the oscilloscope. After one minute the trace must not have drifted more than ±0.5 major division. Return the autotransformer output to 117 volts.

5. Check Readout Panel Lamps

Requirement—All lamps light in accordance with the following procedure.

a. Set the Input Coupling to AC-TRACE STABLIZED and position the trace to the graticule centerline. The AC lamp must be lighted. Set the Input Coupling to AC and then DC. The AC and then the DC lamps should light. Return the Input Coupling switch to AC-TRACE STABILIZED. Center the trace.

b. Set the MANUAL VOLTS/DIV switch to 1 mV. The VARIABLE control to CAL. The readout should be AC; 1 mV/DIV and the MAN button is lighted. Operate the MANUAL VOLTS/DIV switch through each step up to 50 V/DIV and observe that the readout agrees with the switch position at each step.

c. Press the gray unlabeled 10× probe switch located just above the INPUT connector. Note that the display changes to: WITH PROBE and .5 KV/DIV.

d. While holding the 10× probe switch depressed, operate the MANUAL VOLTS/DIV switch from 50 V/DIV to 1 mV/DIV and note that the readout is 10× each switch position. Release the 10× probe switch.

e. Turn the VARIABLE control first left, then right from its detent CAL position and note that the V/DIV lamp goes out and the red UNCAL lamp turns on. Return the VARIABLE control to CAL. Return the MANUAL VOLTS/DIV switch to 10 mV.

f. Press the SEEK button and note that the display reads AC and 10 mV/DIV, and that the SEEK button is lighted. Turn the MANUAL VOLTS/DIV switch to 20 mV and note that the SEEK button light goes out and the MAN button is lighted. Press and hold the EXT button and note that only the V/DIV lamp comes on. Other lamps may light, but this is normal without an external program connected. Release the EXT button. Set the MANUAL VOLTS/DIV switch to 10 mV.

g. Position the trace to plus four divisions, and then to minus four divisions and note that the unlabeled neon overscan lamp above the POSITION control is lighted in both cases. Set the Input Coupling switch to DC and center the trace.

6. Check Variable Balance

Requirement—Trace does not shift vertically when VARIABLE control is turned. (Drifts slightly with ambient temperature and is considered an operator adjustment prior to any accurate dc or VARIABLE measurements.)

a. Turn VARIABLE control counterclockwise and note any shift of the trace. Return VARIABLE to CAL and shift trace in same direction $1\frac{1}{3}$ times its (VARIABLE) travel by the VAR BAL control. Repeat until trace does not shift vertically throughout full rotation of VARIABLE control. Return VARIABLE to CAL.

7. Check Vertical Amplifier 10 mV/DIV through 50 V/DIV Deflection Accuracy

Requirement—Vertical deflection must be within 3% of VOLTS/DIV indicated deflection factor between 10 mV/DIV and 50 V/DIV.

a. Connect the Standard Amplitude Calibrator right side (signal) OUTPUT connector to the Type 3A5 INPUT connector using a 50 Ω coax.

Set the Type 3A5 VARIABLE control to CAL and the MANUAL VOLTS/DIV switch to 10 mV. Set the Calibrator Amplitude control to 50 mvolts, the Mode control for square wave output, and the Mixed switch up.

NOTE

Determine that the Standard Amplitude Calibrator has been operating at least 15 minutes before proceeding.

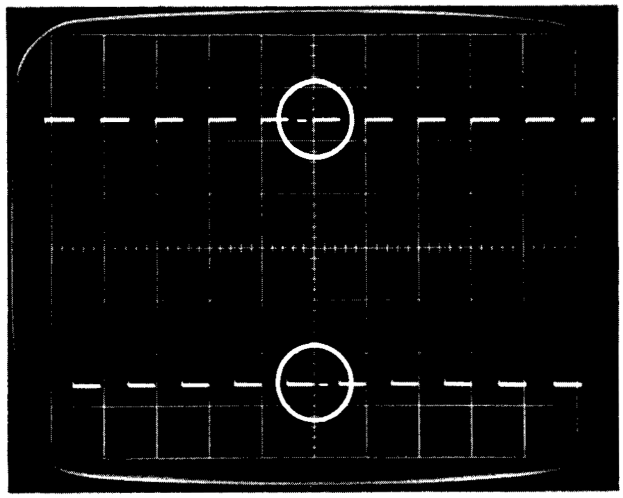
b. If the Type 3A5 was not calibrated in the oscilloscope in which it is now operating, adjust the CAL control to exactly 5 divisions peak-to-peak display.

c. Use Table 5-1 and Figures 5-1, 5-2 and 5-3 to determine the deflection accuracy at each setting of the MANUAL VOLTS/DIV switch between 10 mV/DIV and 50 V/DIV. If any one switch setting causes an out-of-tolerance display, record the amount of error, continue to 50 V/DIV, then return to 10 mV/DIV and adjust the CAL control. Adjust the CAL control to reduce the one error, but not far enough to give any other switch setting an opposite out-of tolerance error. Correct adjustment of the CAL control is complete when all ranges are within 3%, and 10 mV/DIV is not necessarily at ±0%. If one switch position causes a plus error greater than +3% and another causes a minus error greater than —3%, record the error of all switch settings in order to determine which attenuator is in error.

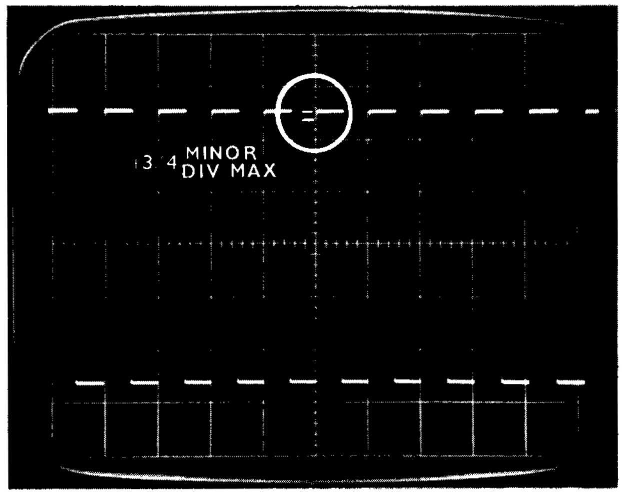
TABLE 5-1

Vertical Deflection Accuracy Check

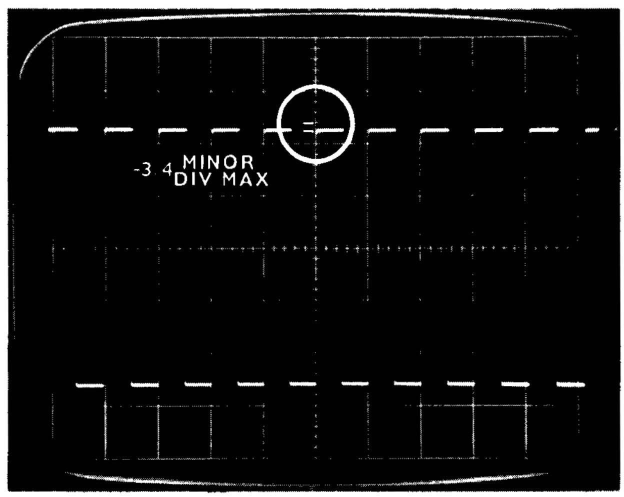
MANUAL VOLTS/DIV Switch Setting	Standard Amplitude Calibrator AMPLITUDE Control	Vertical Deflection In Divisions	% Error, See Fig. 5-1 thru Fig. 5-5
1 mV	5 mV	5	±5%
2 mV	10 mV	5	±5%
5 mV	20 mV	4	±5%
10 mV	50 mV	5	±3%
20 mV	0.1 V	5	±3%
50 mV	0.2 V	4	±3%
.1 V	0.5 V	5	±3%
.2 V	1 V	5	±3%
.5 V	2 V	4	±3%
1 V	5 V	5	±3%
2 V	10 V	5	±3%
5 V	20 V	4	±3%
10 V	50 V	5	±3%
20 V	100 V	5	±3%
50 V	100 V	2	±3%: ±0.3 minor div



a. DEFLECTION ACCURACY ±0%

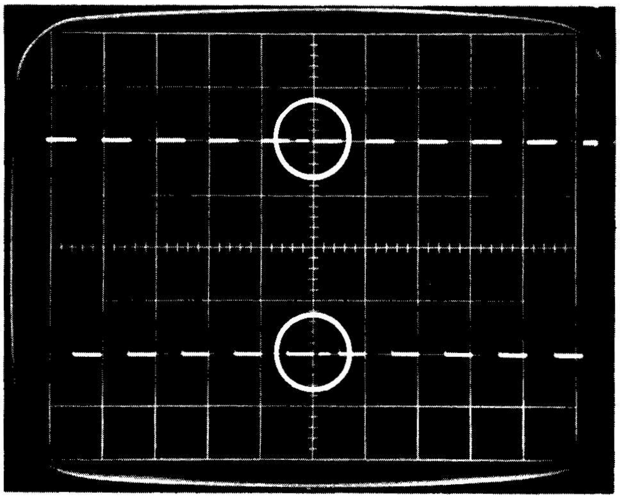


b. DEFLECTION ACCURACY +3% (+3/4 MINOR DIV).

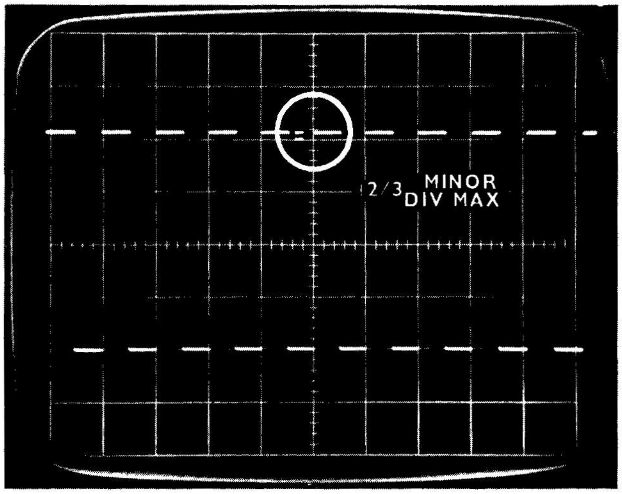


c. DEFLECTION ACCURACY -3% (-3/4 MINOR DIV).

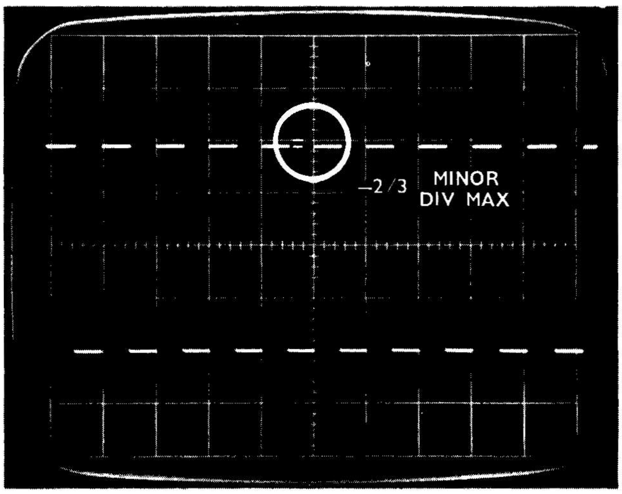
Fig. 5-1. Deflection accuracy limits between 10 mV/DIV and 20 V/DIV when VOLTS/DIV has the number 1 or 2 in it.



a. DEFLECTION ACCURACY ±0%.

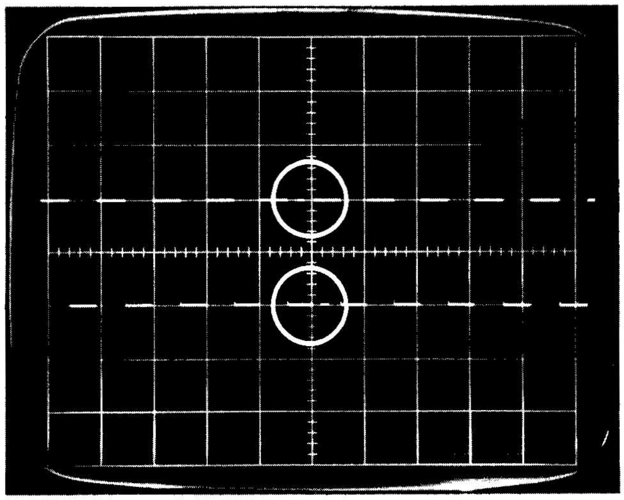


b. DEFLECTION ACCURACY +3% (+2/3 MINOR DIV).

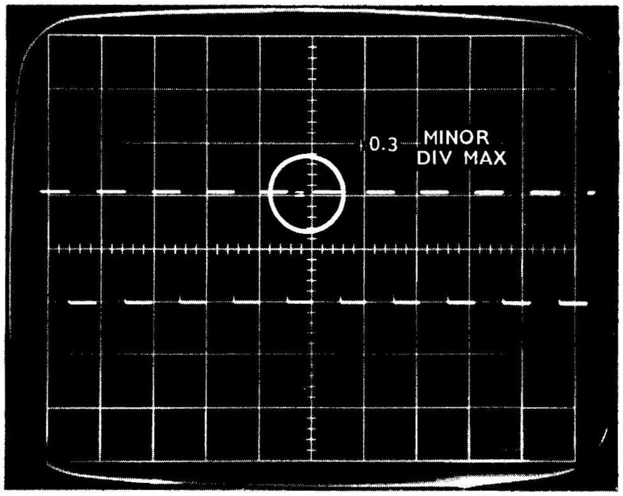


c. DEFLECTION ACCURACY -3% (−2/3 MINOR DIV).

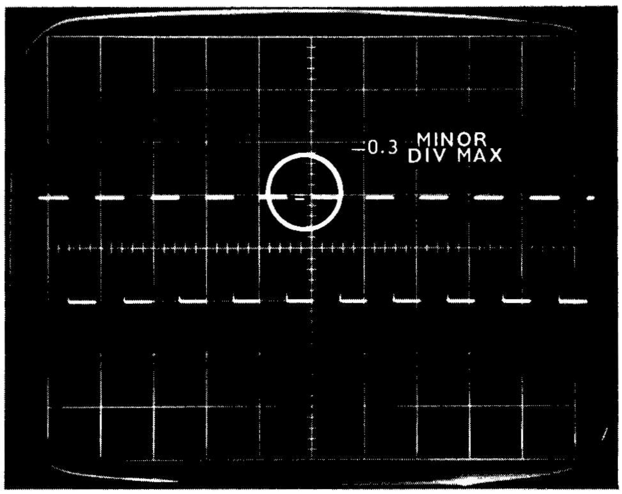
Fig. 5-2. Deflection accuracy limits between 10 mV/DIV and 20 V/DIV when VOLTS/DIV has a number 5 in it.



a. DEFLECTION ACCURACY ±0%



b. DEFLECTION ACCURACY +3% (+0.3 MINOR DIV).



c. DEFLECTION ACCURACY −3% (−0.3 MINOR DIV).

Fig. 5-3. Deflection accuracy limits at 50 V/DIV.

8. Check Vertical Amplifier Manual 1, 2 and 5 mV/DIV Deflection Accuracy

Requirement—Vertical Deflection must be within 5% of VOLTS/DIV indicated deflection factor between 1 mV/DIV and 5 mV/DIV.

a. With the Standard Amplitude Calibrator as connected, set Type 3A5 MANUAL VOLTS/DIV switch to 10 mV. Set the Calibrator Amplitude control to 50 mvolts. Set the Type 3A5 Input Coupling Switch to AC—TRACE STABILIZED and center the display vertically.

b. Set the Calibrator Amplitude control to 5 mvolts and the Type 3A5 MANUAL VOLTS/DIV switch to 1 mV. The display transition must be 5 divisions ±5% as shown in Fig. 5-14. Use Table 5-1 and Figures 5-4 and 5-5 for 1, 2 and 5 mV/DIV checks. If all three checks show the gain to be either high or low, check the Output Amplifier cathode circuit.

9. Check VARIABLE Range

Requirement— ≥2.5:1 overall and from CAL position to full counterclockwise, reduced to between 55% and 71% of display size at CAL detent.

a. Use a 50 Ω coax cable and connect the Standard Amplitude Calibrator Output connector to the Type 3A5 INPUT, connector. Set the Calibrator Amplitude control to 50 mvolts. Set the Type 3A5 MANUAL VOLTS/DIV switch to 10 mV and the Input Coupling Switch to AC.

b. Turn the VARIABLE control fully counterclockwise. The display must be between 2.8 and 3.6 divisions peak to peak. Record the amplitude.

c. Set the Calibrator Amplitude control to 20 mvolts. Turn the Type 3A5 VARIABLE control fully clockwise. The display amplitude must be equal to or greater in amplitude than the display of step b. Set the VARIABLE control to CAL.

10. Check POSITION Range

a. With the Standard Amplitude Calibrator connected as in step 9, set the Amplitude control to 50 mvolts. Adjust the Type 3A5 VARIABLE control for a 6 division display. Change the Calibrator Amplitude control to .1 volts.

b. Position the display as far up screen as possible. The display bottom must be above the graticule centerline.

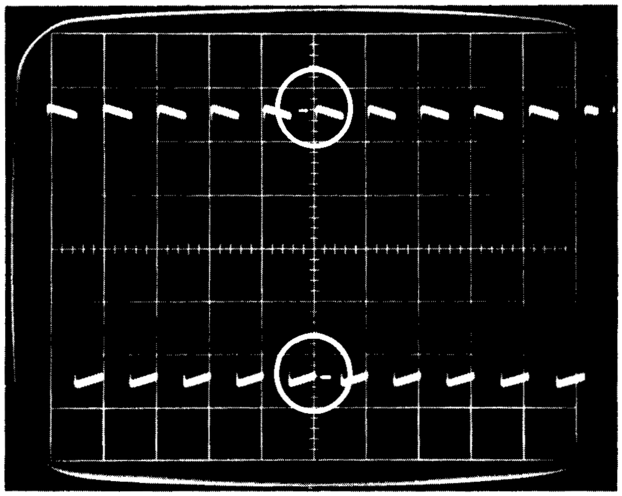
c. Position the display as far down screen as possible. The display top must be below the graticule centerline.

NOTE

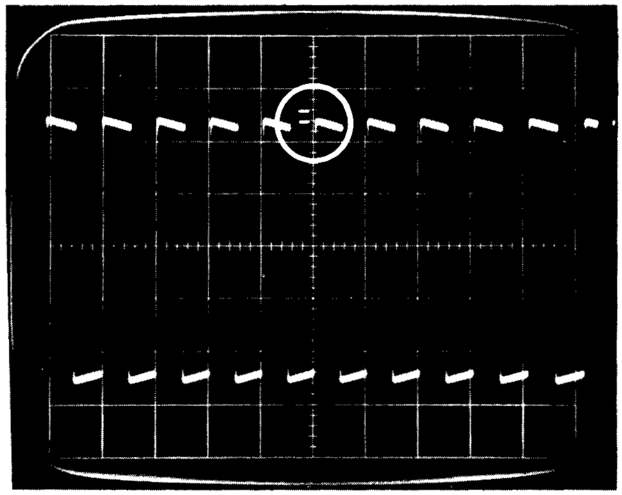
Steps 9 and 10 are checks of the transistors installed in the Driver Amplifier and the Output Amplifier. Less than the required performance could mean one or more of the transistors have inadequate β.

11. Check Input Capacitance and Attenuator Compensations

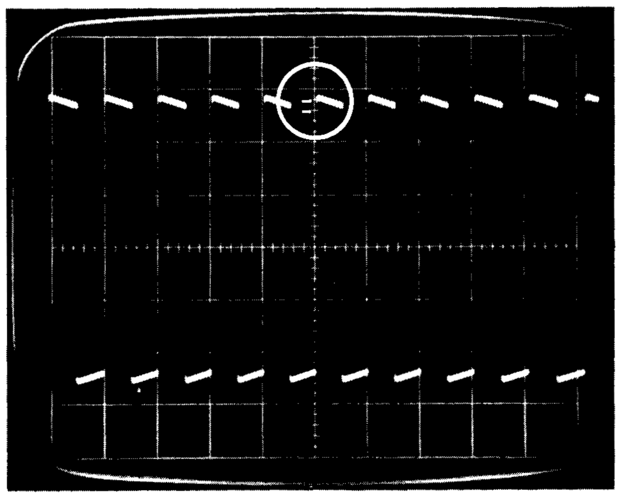
Requirements—Input capacitance must be 24 pF ±1 pF. Square-wave display must not have greater than 3% peak to peak overshoot, rounding, ringing or tilt when driven by a flat-topped square wave, and when using the Input RC Standardizer mentioned in the Equipment Required list.



a. DEFLECTION ACCURACY ±0%.

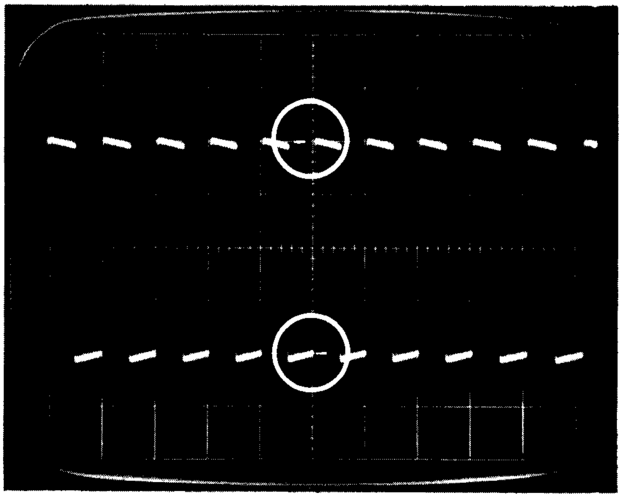


b. DEFLECTION ACCURACY −5% (−1.25 MINOR DIV).

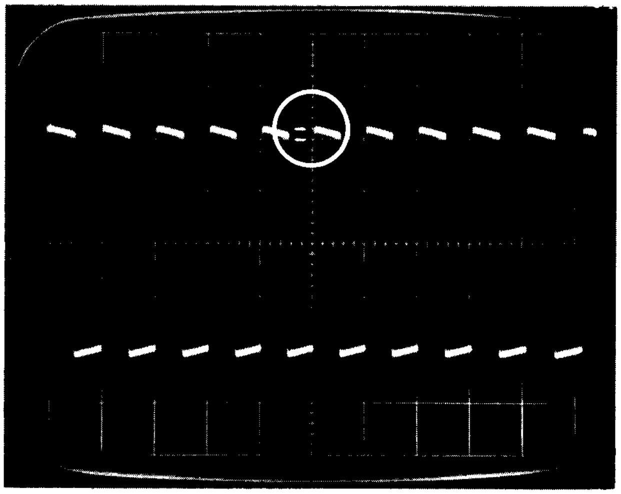


c. DEFLECTION ACCURACY +5% (+1.25 MINOR DIV).

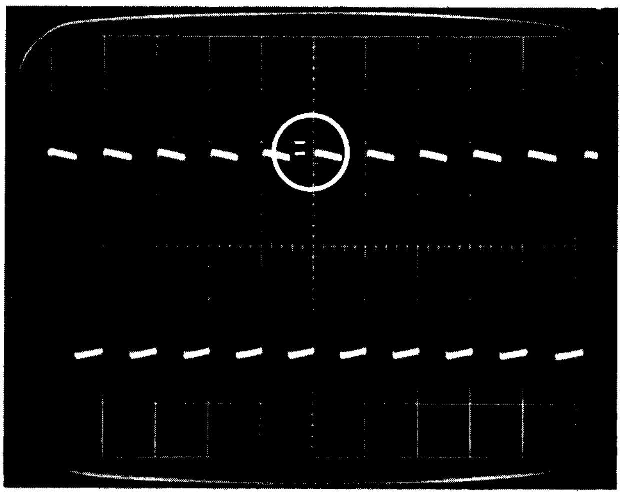
Fig. 5-4. Deflection accuracy limits at 1 and 2 mV/DIV.



a. DEFLECTION ACCURACY ±0%.



b. DEFLECTION ACCURACY +5% (+1 MINOR DIV).



c. DEFLECTION ACCURACY −5% (−1 MINOR DIV).

Fig. 5-5. Deflection accuracy limits at 5 mV/DIV.

a. Install the Input RC Standardizer on the Type 3A5 INPUT connector. Install the BNC 50 Ω termination on the Input RC Standardizer. Connect a 50 Ω BNC connector cable to the termination.

b. The signal generator recommended is the Tektronix Type 106. A Tektronix Type 105 will work equally well, and does not require a connector adapter.

Install one 10× 50 Ω attenuator to the signal generator Output connector. (Use the GR to BNC adapter with the Type 106); attach it to the Hi Amplitude Output connector.)

Set the Type 106 controls:

Repetition Rate Range	1 kHz
Multiplier	Near 2
Symmetry	Midrange
Amplitude	Fully Counterclockwise
Hi Amplitude Fast Rise Switch	Hi Amplitude
Fast Rise Controls	Optional

Set the Type 3A5 controls:

Input Coupling	DC
MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL

Connect the 50 Ω cable to the 10× attenuator and check that the oscilloscope FOCUS control is properly adjusted for a sharply defined display.

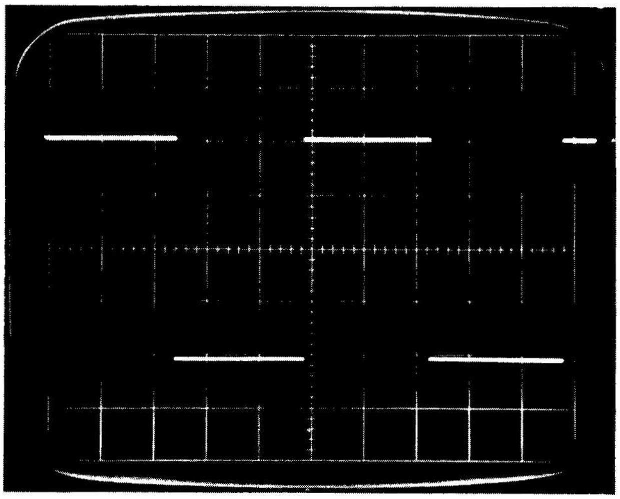
c. Set the Time-Base TIME/DIV control to .1 msec and obtain a stable display. Adjust the square-wave generator Amplitude control for exactly 4 divisions peak to peak.

d. Check the input capacitance by observing any spike or rolloff of the square-wave leading edge for approximately 0.02 msec (or 1 minor horizontal division). 1 pF error of input capacitance will cause approximately 1 minor vertical division spike or rolloff, an error greater than the allowed 3% peak to peak aberration limits of ⅔ minor division. If the Input RC Standardizer being used is different than the Standardizer used in calibration, up to ¼ minor division additional spike or rolloff is allowable due to Standardizer capacitance tolerance. Note the spike or rolloff, and take it into account during the rest of this step.

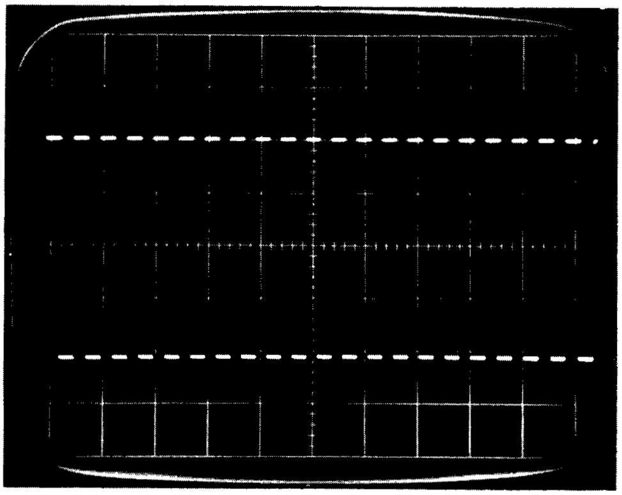
e. Use Table 5-2 and Fig. 5-6 to check the aberration of the input attenuators. Start at 10 mV/DIV and work to 50 V/DIV, adjusting the Calibrator Amplitude control, removing the attenuator, termination and standardizer when it is not possible to obtain four divisions at higher deflection factors.

CAUTION

Maximum full-time peak-to-peak display with the 10× attenuator/50 Ω termination/Standardizer combination is 0.3 volts as displayed on the crt. This keeps the attenuator 50% signal duty cycle power dissipation within its ½ watt rating. Remove the 10× attenuator beginning at .1 V/DIV deflection factor. Maximum full-time peak-to-peak display with the 50 Ω termination/Standardizer combination is 5 volts as displayed on the crt. Thus remove the attenuator beginning at 2 V/DIV deflection factor.



a. DISPLAY FOR CHECKING SHORT TIME CONSTANT SPIKE OR ROLLOFF.



b. DISPLAY FOR CHECKING LONGER TIME CONSTANT TILT OR ROUNDING.

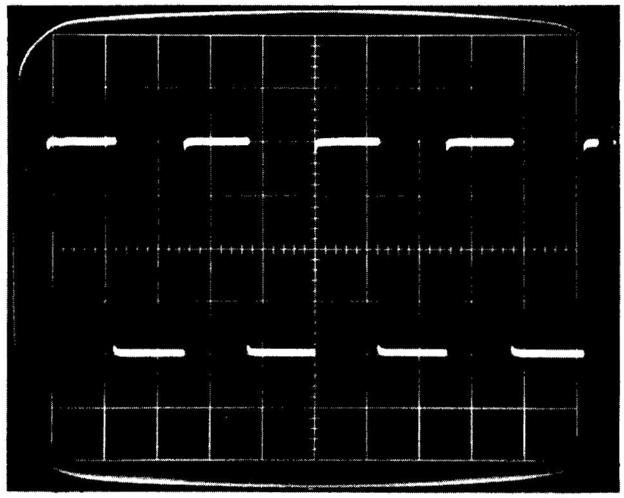
Fig. 5-6. Changes in sweep rate for best displays while checking attenuator compensation. Signal generator repetition rate is the same in both cases.

f. Install the 3-wire to 2-wire power cord adapter at the Type 106 power connector to eliminate 60 Hz ground current signals that may be displayed at 1, 2 and 5 mV/DIV. Install two 10× attenuators to the Type 106 Output and the 50 Ω termination to the Input RC Standardizer. Set the Type 106 Amplitude control fully counterclockwise.

Set the Type 3A5 controls:

MANUAL VOLTS/DIV	10 mV
Input Coupling	DC
POSITION	Vertically centered display

Change the MANUAL VOLTS/DIV switch to 1 mV and position the display to the crt center. Increase the signal amplitude for four divisions display. The display should be similar to Fig. 5-7. The 5% square-wave leading edge rolloff is due to limited high frequency response, and not to the attenuator.



APPROX. 2kHz SIGNAL .2mS/DIV.

Fig. 5-7. Normal square-wave display at 1, 2, or 5 mV/DIV when attenuators are correctly compensated at 10, 20 and 50 mV/DIV.

TABLE 5-2

Step 11 Operating Conditions

MANUAL VOLTS/DIV Switch Setting	Use 10× Atten.	Use 50 Ω Term.	Use RC Stand.	Display Divisions Peak to Peak
10 mV	X	X	X	4
20 mV	X	X	X	4
50 mV	X	X	X	4
.1 V		X	X	4
.2 V		X	X	4
.5 V		X	X	4
1 V		X	X	4
2 V			X	4
5 V			X	4
10 V			X	4
20 V				4
50 V				≈2.2

12. Check AC—TRACE STABILIZED Operation

Requirement—Position control will have approximately one-half normal control at 10 mV/DIV to 50 V/DIV when the Input Coupling is at AC—TRACE STABILIZED. Trace will not drift at 1, 2 and 5 MV/DIV.

a. Set the MANUAL VOLTS/DIV switch to 10 mV. Set the VARIABLE control to CAL. Set the Input Coupling switch to AC.

b. Position the trace to the top graticule line. Change the Input Coupling Switch to AC-TRACE STABILIZED. The

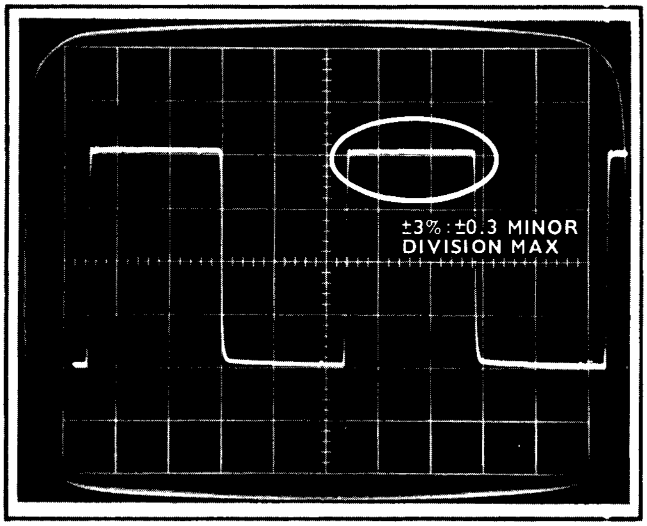


Fig. 5-8. Correct high frequency transient response. ≈400 kHz at 0.5 ms/div and 10 mV/div.

trace must return at least 1 major division toward the graticule centerline.

c. With the Input Coupling at AC—TRACE STABILIZED and the trace position as at the end of step b, change the MANUAL VOLTS/DIV switch to 5 mV. The trace should not change position from its 10 mV/DIV position.

13. Check High Frequency Transient Response

Requirement—Display has no more than ±3% overshoot, rounding, ringing or tilt of a 400 kHz square-wave signal with 10% to 90% risetime of ≤12 nsec. MANUAL VOLTS/DIV switch at 10 mV.

a. Connect the Type 106 Fast Rise +Output connector to the Type 3A5 INPUT connector. Use a BNC 50 Ω termination directly on the INPUT connector, and a GR to BNC adapter on the Type 106 +Output connector. Use a 50 Ω coax between the adapter and termination.

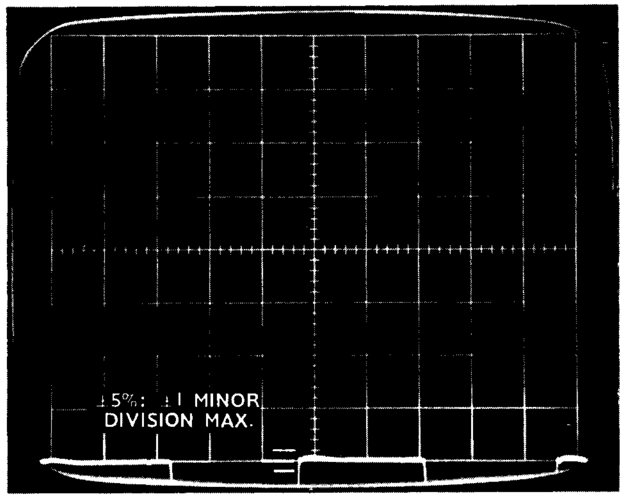
b. Set the Type 106 +Amplitude control fully counterclockwise and the Hi Amplitude/Fast Rise switch to Fast Rise. Obtain a 400 kHz repetition rate signal.

Set the oscilloscope time-base Time/Div switch to .5 μsec and obtain a stable triggered display that is like Fig. 5-8. The display should be the same for all three positions of the Type 3A5 Input Coupling switch.

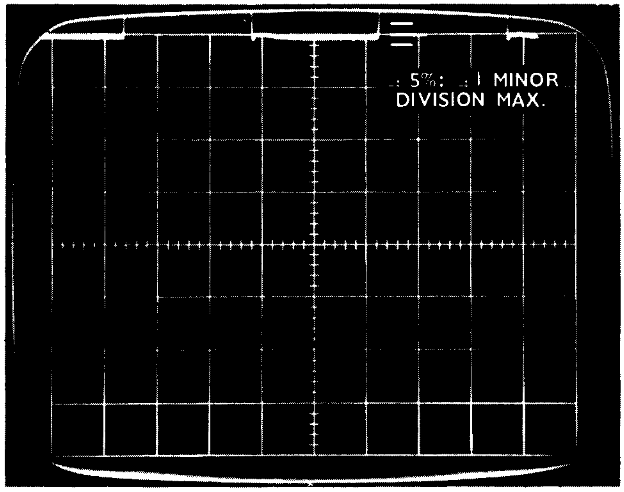
c. If using a Type 105 Square-Wave Generator, put two 10× attenuators on the Output connector and then feed the 50 Ω cable and Type 3A5 50 Ω termination. The display must be the same as Fig. 5-8 with limits as above.

14. Check Display Positioning Effect Upon Transient Response

Requirement—Four division fast-rise signal display will not have more than ±5% overshoot, rounding, ringing or tilt when top of AC coupled display is positioned to bottom of graticule or when bottom of display is positioned to top of graticule.



a. 4 DIVISION DISPLAY POSITIONED DOWN.



b. 4 DIVISION DISPLAY POSITIONED UP.

Fig. 5-9. Position effect upon transient response, step 14.

a. With the display as in step 13, position the display top to the graticule bottom. See Fig. 5-9. The aberrations must not exceed ±5%: ±1 minor division maximum (2 minor divisions peak to peak).

b. Move the Type 106 output cable to the −Output connector. Obtain a centered Ac-coupled four division display. Position the display bottom to the graticule top. See Fig. 5-9. The aberrations must not exceed ±5%: ±1 minor divisions (2 minor divisions peak to peak).

NOTE

Step 14b cannot be performed if using a Type 105 Square-Wave Generator.

15. Check Vertical Amplifier 10% to 90% Risetime

Requirement—10% to 90% risetime must be ≤23 nsec when clean fastrise signal of ≤2.3 nsec risetime drives Type

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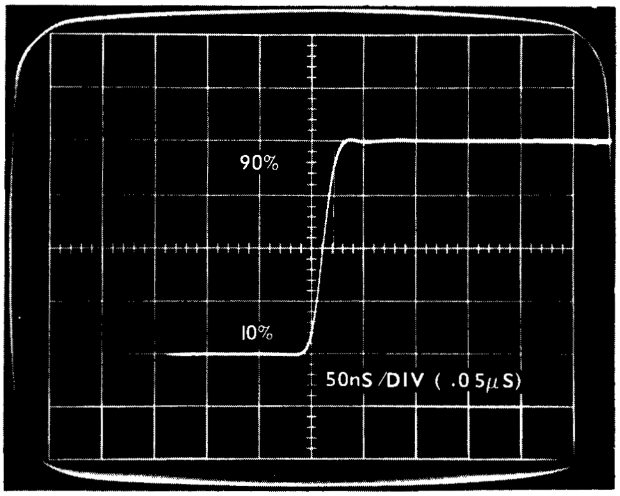
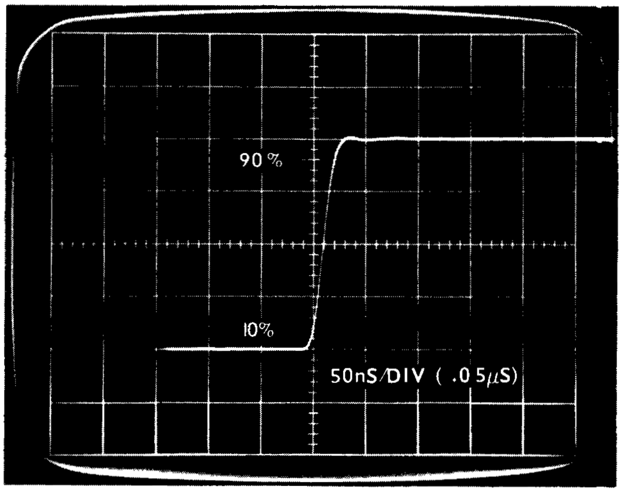


a. RISETIME, 22nS



b. RISETIME, 20nS.

Fig. 5-10. Difference in risetime measurement using Type 105 (A) and Type 106 FAST RISE (B).

3A5 INPUT at 10 mV/DIV. The risetime requirement is rounded off to ≤23 nsec here because of the difficulty of visually resolving 0.2 nsec.

a. Connect the GR to BNC adapter to the Type 106 +Output connector. (50 Ω termination at Type 3A5 INPUT connector.) Obtain a four division 400 kHz display.

b. Increase the sweep rate to at least 0.05 μsec/div (50 nsec/div) and obtain stable triggering on the rising slope of the signal. The display should be similar to Fig. 5-10. Measure the risetime between the 10% and 90% points as shown in Fig. 5-10.

If you are using the recommended Type 106 fast rise signal, read the vertical amplifier risetime directly from the display (as in Fig. 10B).

If you are using a Type 105 Square-Wave Generator (with two 10× 50 Ω attenuators at the Type 105 Output connector) the true amplifier risetime will be essentially 2 nsec faster than that displayed (as in Fig. 5-10A).

16. Check Vertical Amplifier Bandwidth

Requirement—Sine wave high frequency amplitude response at 10 mV/DIV remains no less than 70% of the dc or low frequency sine wave response to at least 15 MHz.

a. Set the Type 191 Constant Amplitude Signal Generator controls:

Amplitude Range	5-50 mV
Amplitude	35
Variable	4 div display
Frequency Range	50 kHz
Frequency Control	Fully Clockwise

Set the Type 3A5 controls:

Input Coupling	AC
MANUAL VOLTS/DIV	10 mV
POSITION	Midrange

Set the time-base controls:

Manual Time/Div	10 msec
Triggering	+Int AC

b. Connect a 50 Ω cable from the Type 191 Output connector (use the GR to BNC adapter) to the Type 3A5 INPUT connector. Use a 50 Ω termination at the Type 3A5 INPUT connector. Obtain a four-division peak-to-peak display as shown in Fig. 5-11A. Fig. 5-11A shows how the bottom "side" of the trace is positioned to the top side of the −2 division graticule line, and then the Type 191 Variable control adjusted to place the same side of the trace to the top side of the +2 division graticule line. This gives an accurately centered four division peak to peak display that does not include the trace thickness.

c. Change the Type 191 Frequency Range control to the 8-18 MHz range. Set the oscilloscope time base for a triggered sweep at .05 μsec/div. Check the display peak-to-peak amplitude and turn the Type 191 frequency adjust control slowly higher in frequency until the display amplitude is 2.8 divisions as in Fig. 5-11B. Position the plus peak of a sine wave to the graticule vertical centerline so the minor divisions can best be used. Record the frequency.

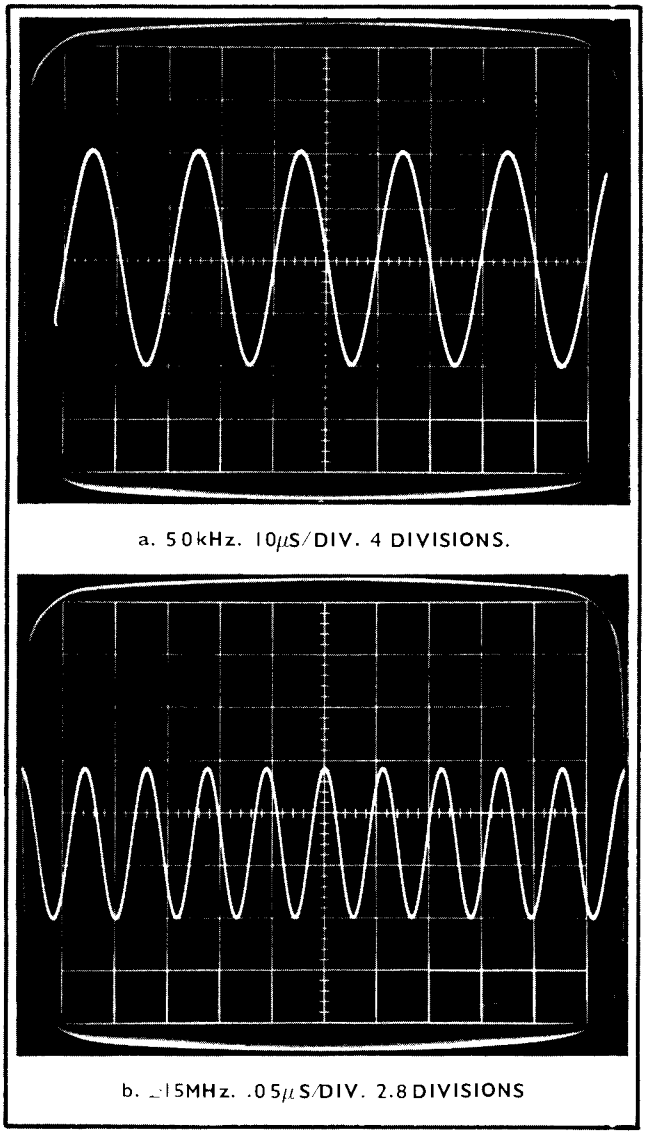
17. Check Automatic Seeking Circuit High Frequency Performance

Requirement—Seek circuit will respond at 20 MHz.

a. With the connections and display as at the end of step 16, set the Type 191 Frequency Range control to the 18-42 MHz range and the frequency control to 20 (MHz). Position the display to be equally balanced at the graticule centerline.

b. Change the Type 191 Amplitude Range switch to 50-500 mV and then press the Type 3A5 SEEK button. The display must first extend to near the graticule limits, then as the SEEK button is pressed the display must return to less than 6 divisions peak to peak.

c. Change the Type 191 Amplitude Range switch to 5-50 mV and then press the Type 3A5 SEEK button. The display



a. 50kHz. 10μS/DIV. 4 DIVISIONS.

b. ≈15MHz. .05μS/DIV. 2.8 DIVISIONS

Fig. 5-11. Bandwidth measurement displays, step 16.

must first become small (or extinguish due to loss of internal trigger) and then as the SEEK button is pressed, return to its original amplitude and a deflection factor of 10 mV/DIV

18. Check Trigger Circuit Output

Requirement—A display can be triggered with a signal of 2 mV peak to peak at 10 mV/DIV deflection factor.

a. With the equipment as connected for steps 16 and 17, install one 50 Ω 10× attenuator in series with the signal coax between the Type 191 and the Type 3A5.

NOTE

If you do not have a Type 191, use the special Standard Amplitude Calibrator without attenuators or termination in this step.

b. Set the Type 191 controls:

Amplitude Range	5-50 mV
Amplitude	20
Variable	Cal
Frequency Control	Fully clockwise
Frequency Range	50 kHz

Set the Type 3A5 MANUAL VOLTS/DIV control to 10 mV, the VARIABLE control to CAL.

Set the oscilloscope time-base controls:

Mode	Manual
Manual Time/Div	10 μsec
Dly'd Swp Mag	Off
Triggering	+Int AC (Not Auto)

c. Adjust the time base Triggering Level control for a stable display.

NOTE

It is assumed here that the time base trigger circuit is calibrated and operating within its specifications. If it is impossible to obtain a stable display, check the controls before assuming that the Type 3A5 trigger circuits are faulty.

19. Check REMOTE SEEK Operation

Requirement—The Type 3A5 and the Type 3B5 will both change mode of operation to SEEK when the Type 3A5 REMOTE SEEK button is pressed.

a. Remove the 50 Ω termination and signal cable from the Type 3A5 INPUT connector. Install the Type P6030 10× Probe to the INPUT connector and the small phono plug into the REMOTE SEEK jack. Compensate the probe.

b. Set the Type 191 controls:

Amplitude Range	50-500 mV
Amplitude	10
Variable	Cal
Frequency Range	50 kHz
Frequency Control	Fully clockwise

Set the Type 3B5 controls:

Manual Time/Div	20 μsec
Variable	Cal
Mode	Man
Mag	Off or ×1
Triggering	+Int AC

c. Connect the P6030 10× Probe ground clip to the Type 191 Output connector edge and touch the probe tip to the connector center conductor. With the Type 3A5 MANUAL VOLTS/DIV switch at 10 mV, the display should be about 2.5 divisions peak to peak and 10 complete cycles.

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d. Set the Type 191 Amplitude Range switch to .5 5 V and press the probe SEEK button. The display will first extend past the top and bottom of the screen and then as the probe SEEK button is pressed, both the vertical amplifier and the time base will respond. The display will be about five divisions peak to peak depending upon the POSITION control affect on the display, and as many cycles as the time base is calibrated to display.

20. Check SEEK Cycle Time

Requirement—Type 3A5 seeks for proper deflection factor once every two to four seconds (after holding SEEK button pressed the preceding five seconds).

a. With the connections and signal as in step 19D, hold the P6030 Probe SEEK button pressed. After the first five seconds, count the number of seconds between times the system seeks for a new deflection factor. (A wrist watch second hand is adequate as a time reference.)

21. Check SEEK Selected DISPLAY SIZE Limits

Requirement—All SEEK selected displays will either bring display limits within 3.5 divisions of the graticule centerline, or will seek to 50 V/DIV and leave all or part of the display outside the limits.

a. With the connections and signal as in Step 20, carefully balance the display to be equally above and below the graticule centerline.

b. Hold the SEEK button depressed and slowly increase the display amplitude with either the signal generator Variable control or the Type 3A5 VARIABLE control until the display size is automatically reduced. Note the display top and bottom points at the time the display size is reduced by slightly reducing the signal with the same Variable control, and then increasing it again and watching the point at which the display size is reduced. Neither the top nor the bottom of the display will extend past 3.5 divisions from the graticule centerline.

c. Holding the SEEK button depressed, slowly position the display up (or down) and note that the display size will continue to be reduced as the display zero level reaches the previously measured limits. The deflection factor will rest at 50 V/DIV as soon as the display zero level has been taken at least $^3/_4$ minor division past either the plus or minus dynamic signal limit.

SECTION 6
CALIBRATION

General

Recalibrate the Type 3A5 after each 500 hours of operation, or every six months if used intermittently. It may also be necessary to recalibrate certain sections of the instrument when tubes, transistors, or other components are replaced. Before recalibrating the instrument, clean it as outlined in Section 4.

NOTE

The performance standards described in this section of the manual are provided strictly as guides to calibration of the Type 3A5 and should not be construed as advertised performance specifications. However, if the Type 3A5 performs within the guide tolerances given in the calibration procedure, it will also perform as listed in the Characteristics section of this manual.

This section of the instruction manual presents a step-by-step calibration procedure. The title of each step identifies the step as adjustment or verification. All adjustments must be completed in the order given and none should be omitted. Proper overall operation of the Type 3A5 is ensured when all steps in the procedure are completed.

Do not set any screwdriver controls to midrange as a preliminary to recalibration. Presetting controls to midrange will only require more time to completely recalibrate the instrument.

Equipment Required

Equipment required for the complete calibration of the Type 3A5 is shown in Fig. 6-1 and Fig. 6-2 and listed below. Alternate equipment may be substituted for that listed, if the performance specifications of the substituted equipment meet the particular requirements of the test. All test equipment must be calibrated and in good working order.

1. Test oscilloscope with a deflection factor of 5 mV/DIV minimum, and bandwidth of at least 25 MHz at 0.02 V/DIV, such as Tektronix Type 543B Oscilloscope with either Type 1A1 or Type L Plug-In Unit.

2. Type 561A Oscilloscope in which to operate the Type 3A5; with Type 3B5, 3B4 or other time-base unit that will normally be used with the Type 3A5.

3. Sine-wave signal generator with constant amplitude continuously variable from 5 mV to 10 V peak to peak. Tektronix Type 191 Constant Amplitude Signal Generator is recommended.

4. Fast-rise pulse generator with amplitude adjustable from 5 mV to 120 V peak to peak at a repetition rate of approximately 1 kHz. Risetime of 2.3 ns or less into 50 Ω at 400 kHz, and 40 mV peak to peak. For example, Tektronix Type 106 Square-Wave Generator.

5. Variable line voltage autotransformer, such as General Radio VARIAC Type W10MT3W, metered, 600 watt rating.

6. Low frequency sine wave oscillator with output frequency of 10 Hz at an amplitude of 10 mV peak to peak. Example, Heathkit Model 1G-72 Audio Generator.

7. Accurate-amplitude signal generator of approximately 1 kHz square-wave repetition rate; voltage from 0.2 mV to 100 V with accuracy of $\pm 0.25\%$. Tektronix Standard Amplitude Calibrator 067-0502-00 recommended.

8. 24 pF Input Time Constant Standardizer with BNC connectors, Tektronix Part No. 011-0067-00.

9. 50 Ω in-line termination ($\pm 1\%$ accuracy) with BNC connectors, Tektronix Part No. 011-0049-00.

10. Two 50 Ω 10:1 attenuators with BNC connectors, Tektronix Part No. 011-0059-00.

11. Two (one required, two can be used) GR Type 874 connector to BNC adapters. General Radio 874-QBJA, Tektronix Part No. 017-0063-00.

12. 50 Ω coaxial cable 3 or 4 feet long with BNC connectors. For example, 42 inch Tektronix cable, Part No. 012-0057-00.

13. Two 10× attenuator probes, such as Tektronix P6006 10× Probe with BNC connector, Part No. 010-0127-00.

14. 1× probe with BNC connector, such as Tektronix P6028, Part No. 010-0074-00.

15. Flexible plug-in extension cable, Tektronix Part No. 012-0066-00.

16. BNC to clip lead adapter (for use with Heath IG-72 Audio Generator), Tektronix Part No. 013-0076-00.

17. Bench multimeter with ohmmeter, such as Simpson 262, 20,000 ohms/volt.

18. Non-metallic capacitor adjusting tool, such as ¼ inch diameter plastic rod, sharpened to a screwdriver point at one end (not shown).

19. Plastic handle capacitor adjusting tool with small metal bit, such as Walsco No. 2519. Tektronix Part No. 003-0003-00.

20. Plastic coil adjusting tool with handle. Tektronix Part No. 003-0307-00.

21. Small screwdriver for adjusting front-panel screwdriver controls. (not shown.)

22. A dc resistance bridge of $\pm 0.075\%$ or better accuracy at 1 MΩ. (Not shown.)

23. A power line 3-wire to 2-wire adapter. (Not shown.)

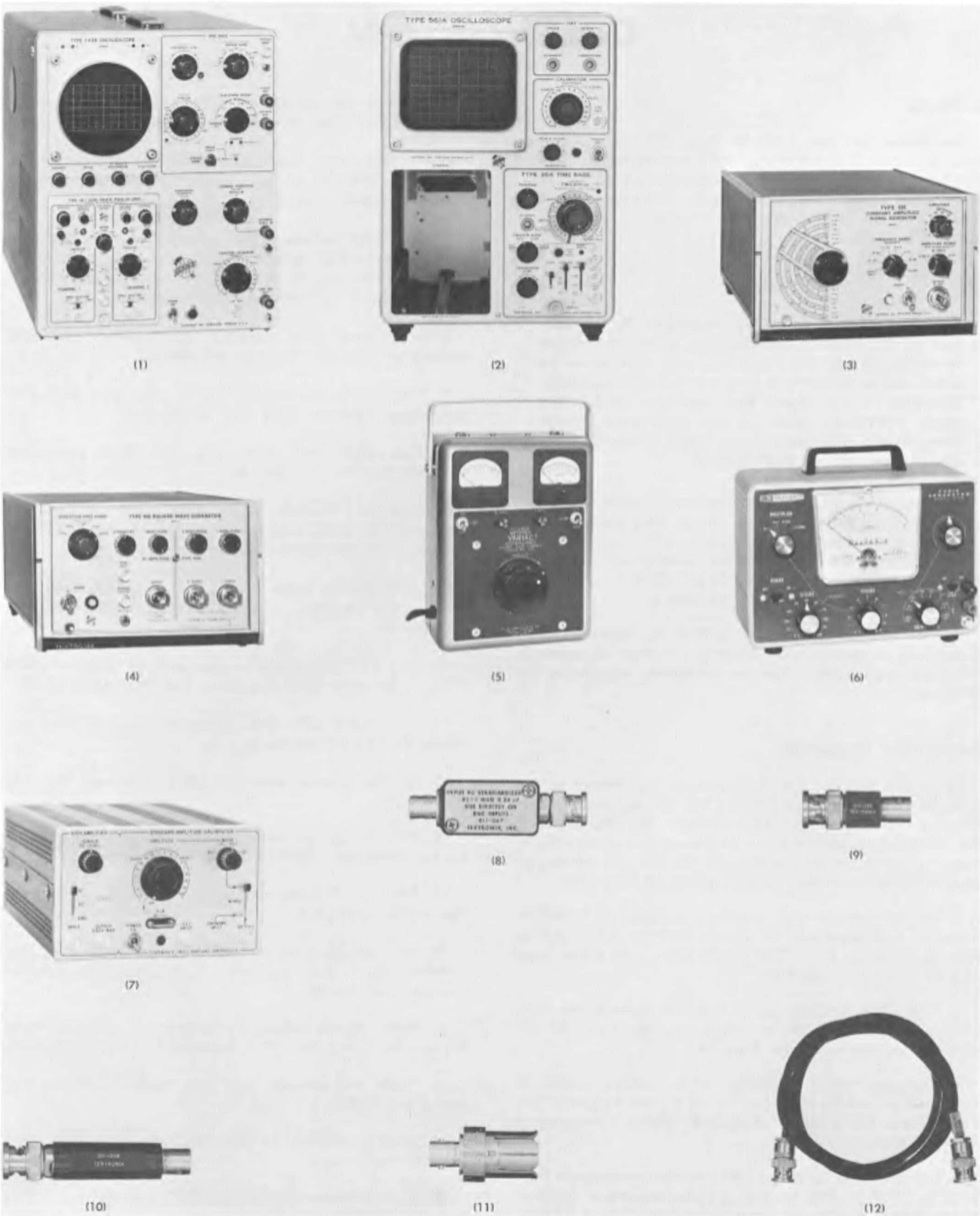

Fig. 6-1. Equipment required for calibration of the Type 3A5.

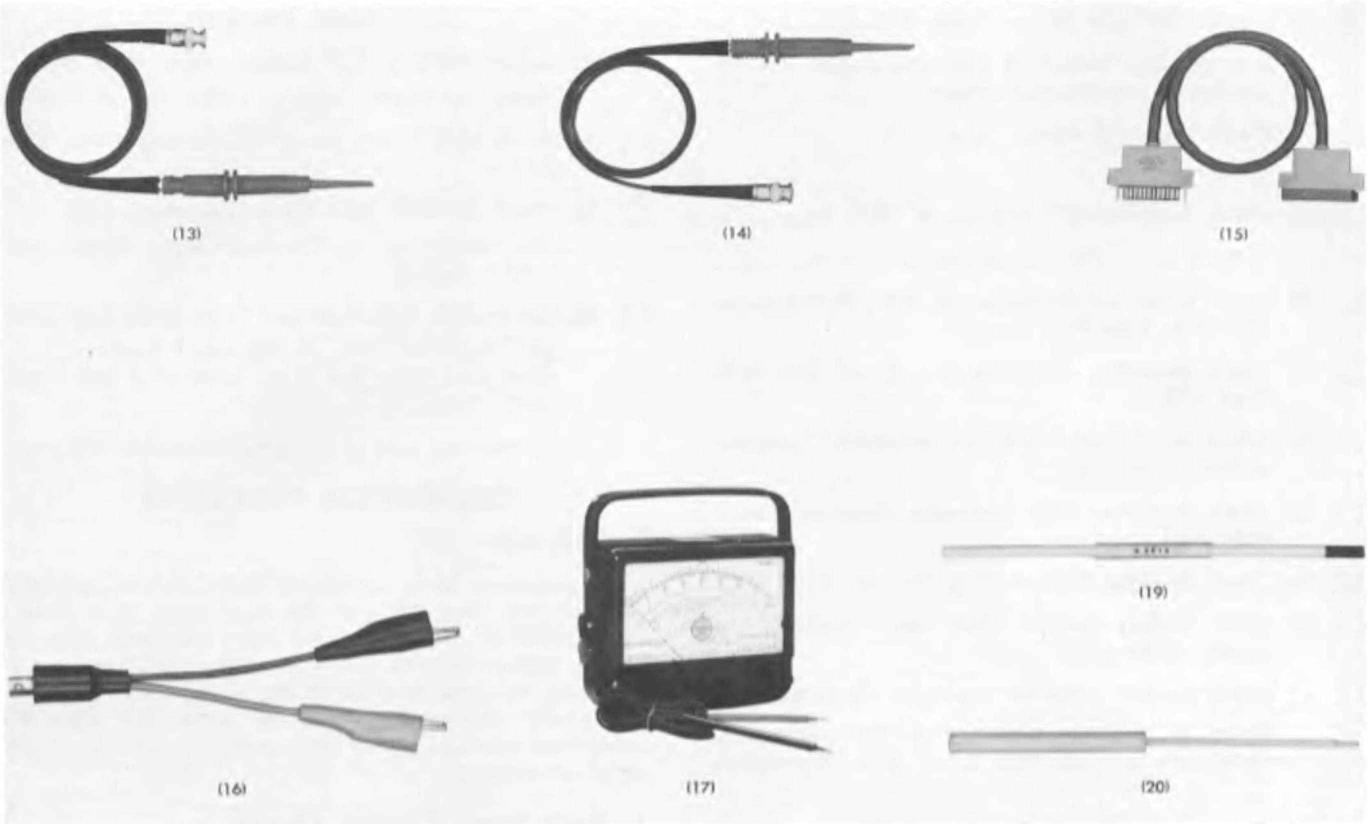

Fig. 6-2. Calibration tools.

CALIBRATION RECORD AND INDEX

This Calibration Record is provided as a convenient check list and record of calibration conditions. The step numbers and title are identical to the complete procedure that follows this check list. This abbreviated procedure may be photocopied without special permission from Tektronix for convenience of use or record keeping in the Calibration Laboratory.

Type 3A5, Serial No.____________________

Calibration Date____________________

☐ 1. Preliminary Control Check. Page 6-4.

☐ 2. Measure Input Resistance. 1 MΩ ±0.75%. Page 6-4.

☐ 3. Oscilloscope Trace Alignment. Page 6-5.

☐ 4. Check Power Supplies. Page 6-7.

Supply	Tolerance	Value	Max Ripple	Value
+6.8 V	6 to 7 V at 117 VAC	——	no spec	
+4.2 V	4.0 to 4.3 V	——	20 mV	——
+75 V	70 to 85 V	——	10 mV	——

☐ 5. Check Readout Lamps (Operating Modes). Page 6-7.

VERTICAL AMPLIFIER

☐ 6. Preliminary Adjust Variable Balance. Page 6-8.

☐ 7. Check Microphonics. Page 6-8.
No Ringing microphonics. ≤ 0.2 DIV max short term microphonics.

☐ 8. Check Amplifier Balance. Page 6-8.

☐ 9. Final Adjust Variable Balance. Page 6-9.

☐ 10. Check Trace Drift. Page 6-9.
≤ 0.4 DIV max after 1 minute at 105 and then 125 VAC.

☐ 11. Check DC Shift. Page 6-9.
≤ 0.1 div after 5 div dc signal applied.

☐ 12. Check AC—TRACE STABILIZED Operation. Page 6-9.

☐ 13. Preliminary Adjust Amplifier Gain. Page 6-10.

☐ 14. Check Input Grid Current. Page 6-10.

☐ 15. Check Amplifier Compression/Expansion. Page 6-13.
≤5% gain change at CRT pins.

☐ 16. Check Amplifier Dynamic Range. Page 6-13.
≥ 185 V Peak to Peak for 10 div centered display. Value ________

☐ 17. Check POSITION Range. Page 6-13.

Both top and bottom of 8-division display can be positioned past graticule center.

☐ 18. Check VARIABLE Range. Page 6-13.

$\geq$ 2.5:1.

☐ 19. Check Amplifier DC Voltage to CRT. Page 6-13.

+165 V to + 190 V at crt center. Value______

☐ 20. Check Deflection Accuracies at 10 mV/DIV through 50 V/DIV. Page 6-13.

☐ 21. Check Deflection Accuracies at 1, 2 and 5 mV/DIV. Page 6-15.

☐ 22. Adjust Input Capacitance and Attenuator Compensations. Page 6-18.

☐ 23. Adjust Amplifier High Frequency Compensations. Page 6-20.

☐ 24. Check Amplifier 10% to 90% Risetime. Page 6-20.

☐ 25. Check Display Position Affect Upon Transient Response. Page 6-21.

☐ 26. Check Vertical Amplifier Bandpass. Page 6-23.

Dc to $\geq$ 15 MHz. Amplifier 15 MHz response at 10 mV/DIV not less than 0.7 dc gain. Frequency: ______ MHz

☐ 27. Check Signal/Trigger Amplifier Dc Output Voltage. Page 6-26. $\leq$ ±1.5 V.

☐ 28. Check Signal/Trigger Amplifier Gain. Page 6-26. At 10 mV/DIV: 2 mV square-wave sig; $\geq$ 0.3 V peak to peak out. Value______

50 mV square-wave sig; $\geq$ 5 V peak to peak out. Value ______

☐ 29. Check Signal/Trigger Amplifier High and Low Frequency Response. Page 6-26.

At 10 mV/DIV: Set display 1 div 50 kHz. Output must not be less than 0.7 of 50 kHz amplitude at 8 MHz. Amplitude:______%

Set display 1 div 10 Hz. Output must be $\geq$ 0.1 V peak to peak. Value ______

AUTOMATIC CIRCUITS

☐ 30. Adjust DISPLAY SIZE Control, R703. Page 6-26.

Trace trip levels: +______DIV, −______DIV.

☐ 31. Check SEEK Operation at 20 MHz and 30 Hz. Page 6-28.

☐ 32. Check REMOTE SEEK Operation. Page 6-28.

SEEK pulse sent to time-base when remote seek button pressed.

☐ 33. Check SEEK Multi Pulse and Cycle Time. Page 6-30.

SEEK Pulse on time: $\geq$ 200 msec. Time ______
Cycle time after first 5 sec, between 2 and 4 seconds. Time ______

System must seek to 50 V/DIV in less than 200 msec.

CALIBRATION PROCEDURE

Preliminary

The deflection factor calibration (Step 21), the attenuator compensation (Step 22) and the input stage grid current measurement all require that the input resistance value be known. Perform the first two steps of this calibration procedure with the Type 3A5 out of the oscilloscope. All other checks and performance limits are valid only after the system has operated for at least twenty minutes at normal room temperature.

1. Preliminary Control Checks

a. Check all front panel controls for proper indexing. Check the variable controls for smooth operation. Check that the micro switch at the rear of the VARIABLE shaft functions at the CAL detent position. Correct any defects found before proceeding.

2. Measure Input Resistance

a. Use a dc resistance bridge to measure the Type 3A5 input resistance.

b. Lay the instrument on its right side, with the Vertical Amplifier board up. Connect the bridge between the chassis (front panel ground terminal) and the white wire with black tracer out the rear of the attenuator shield. Measure and record the resistance value.

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3. Adjust Oscilloscope Trace Alignment ⓿

a. Install the Type 3A5 in the Type 561A vertical compartment and the appropriate time-base in the horizontal compartment. Connect the oscilloscope power cord to the variable autotransformer output. Set the autotransformer for 117 volts output and turn on the oscilloscope power switch.

b. Set the instrument controls as shown under Fig. 6-3 and obtain a trace on the Type 561A crt.

c. Physically orient the Type 561A in the position in which it will remain during this calibration procedure. Adjust the oscilloscope Alignment controls so that the no-signal trace is parallel to the horizontally scribed graticule lines.

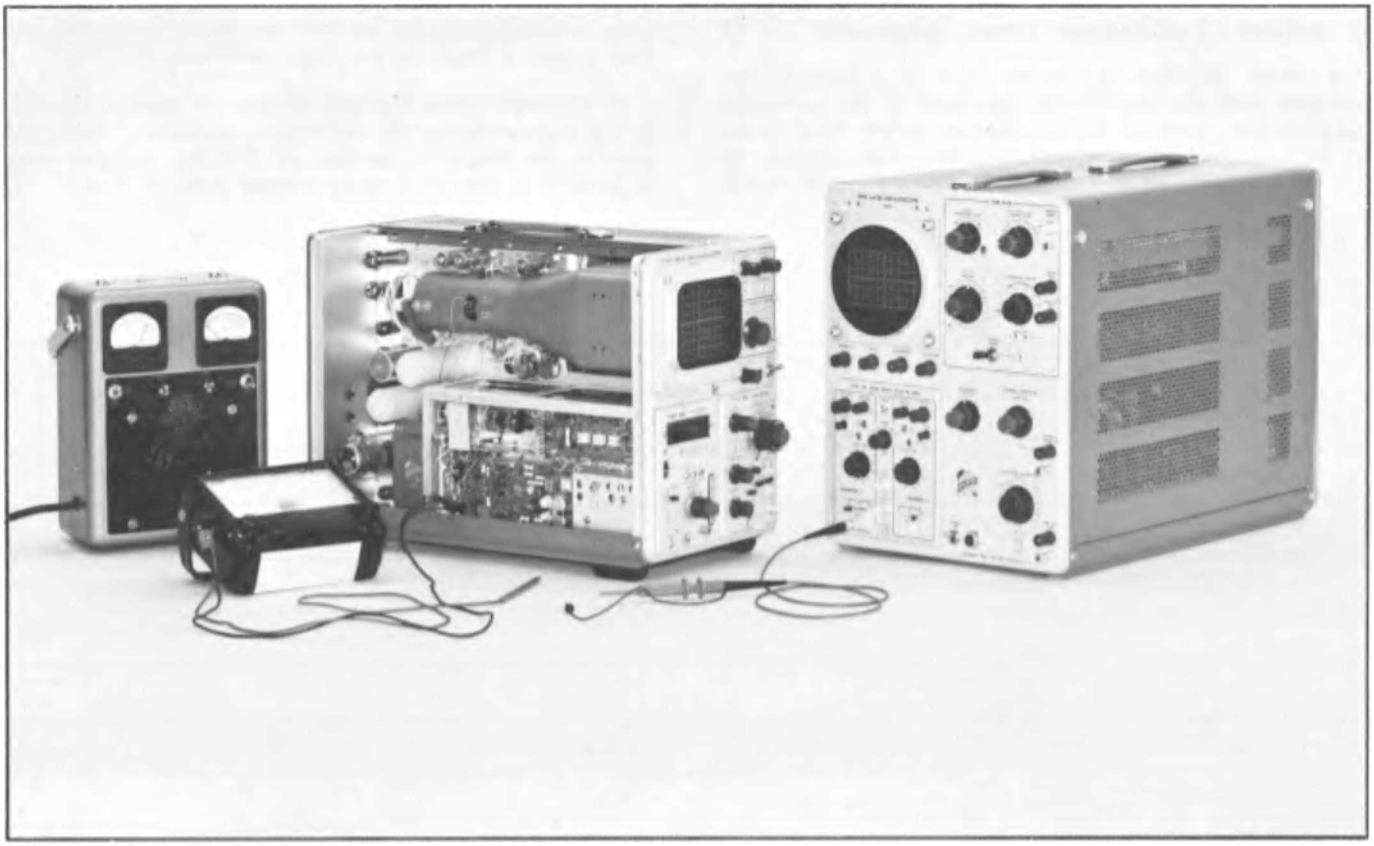

Fig. 6-3. Test setup for checking power supplies.

Control Settings

Type 3A5

POSITION	Midrange
MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	AC
Mode	MAN

Time Base

Position	Midrange
Trigger Mode	Auto
Triggering Level	As required
Time/Div	2 msec
Variable	Cal
Slope	+
Coupling	AC
Source	Int

Type 561A

Power	On
Calibrator	Off
Focus	As required
Intensity	Counterclockwise

Test Oscilloscope

Trigger Slope	+Line
Triggering Mode	AC
Stability	Preset
Triggering Level	Midrange
Horizontal Display	Normal
Sweep Switch	Normal Sweep
Horizontal Position	Midrange
Intensity, Focus,	As Required
Astigmatism, Scale Illum	As Required
Amplitude Calibrator	Off

Type 1A1

Mode	Ch 1
Norm/Invert	Norm
Variable Volts/Cm	Calib
Volts/Cm	.005 Ch 1
Input Selector (both)	AC

Connections

Connect the P6028 1× Probe to the Type 1A1 Channel 1 input connector. Connect the probe ground clip to the Type 3A5 rear panel. Connect the voltmeter negative lead to the ground post on the Type 3A5 front panel.

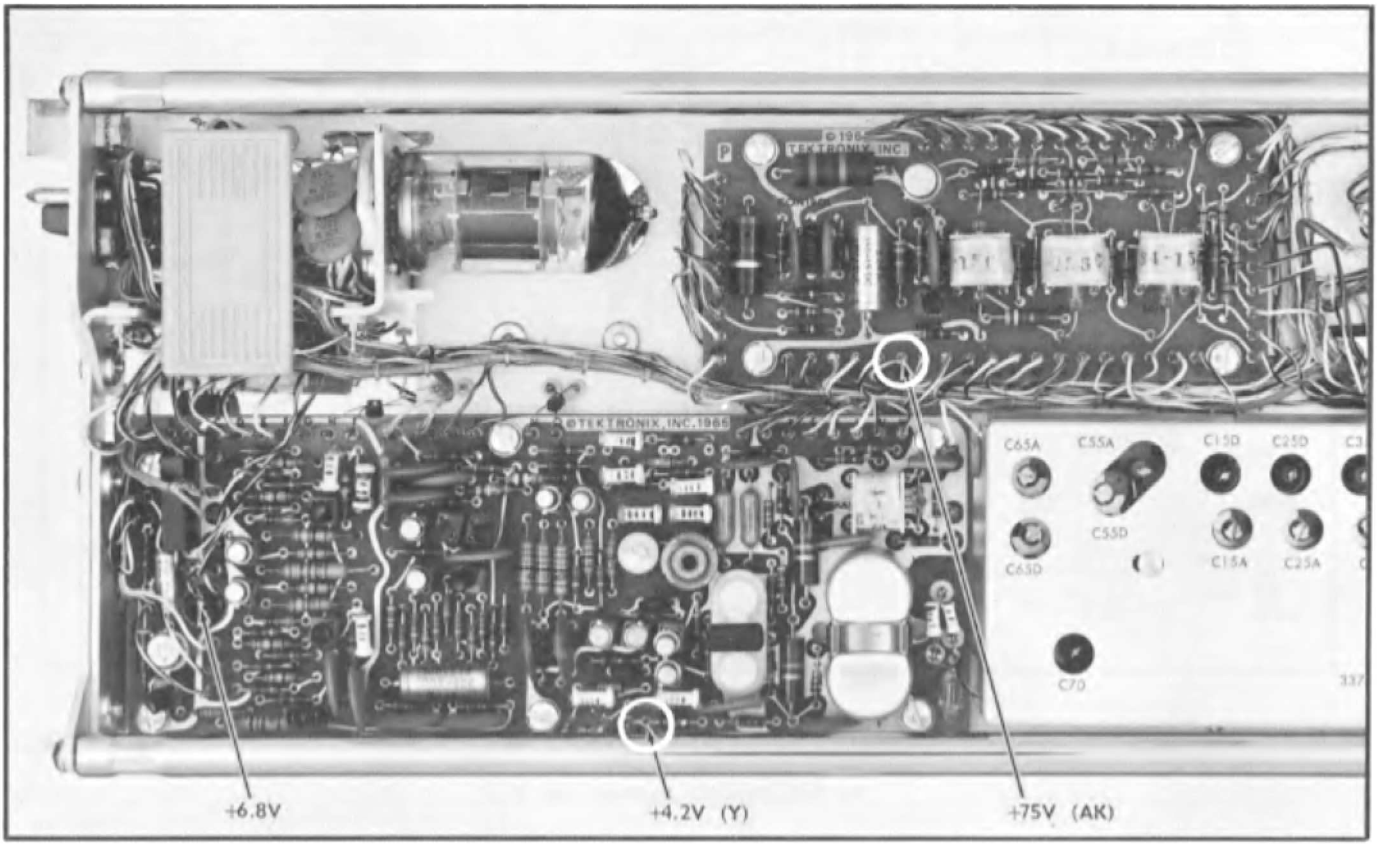

Fig. 6-4. Power Supply test points.

WARNING

Avoid the leads and connections at the bottom end of the large tan-colored 1.05 kΩ resistor. The two lower terminals rest at about +170 volts.

4. Check Power Supplies

a. Change the Time Base Trigger Mode switch to Norm so the trace disappears. Make the power supply check without a sweep running.

b. Measure the voltage at each of the test points shown in Fig. 6-4. The meter must be correct to within ±1%, or have a scale that is corrected to ±1% at the voltages listed. Tolerances are listed in Table 6-1.

TABLE 6-1

Power Supply Tolerances and Ripple

Supply	Tolerance	Maximum Ripple Peak to Peak
+6.8 V	6 to 7 V at 117 VAC	No spec.
+4.2 V	4.0 to 4.3 V ±1% at limits	20 mV
+75 V	70 to 85 V ±1% at limits	10 mV

c. Measure the ripple voltage on the 4.2- and 75-volt supplies with the test oscilloscope and 1X probe. Use the test points shown in Fig. 6-4. 20 mV equals four divisions, and 10 mV equals two divisions on the test oscilloscope crt.

5. Check Readout Lamps (Operating Modes)

a. The test setup remains the same as for Step 4.

b. Set the Time-base Trigger Mode switch to Auto. Obtain a trace. Control settings used in step 4 should cause the following readout lamps to now be lighted: AC, 1, 0, m and V/DIV in the readout panel, and the MAN Mode button.

c. Set the Input Coupling to AC-TRACE STABILIZED and position the trace to the graticule centerline. The AC lamp must be lighted. Set Input Coupling to AC and then to DC. The AC, and then the DC lamps should light. Return the Input Coupling switch to AC-TRACE STABILIZED. Center the trace.

d. Set the MANUAL VOLTS/DIV switch to 1 mV. The readout should now be AC; 1 mV/DIV, and the MAN button should be lighted. Operate the MANUAL VOLTS/DIV switch through each step up to 50 V/DIV and note that the readout agrees with the switch position at each step.

e. Press the gray unlabeled 10× probe switch (SW70) located just above the INPUT connector. Note that the readout changes to WITH PROBE and .5 KV/DIV.

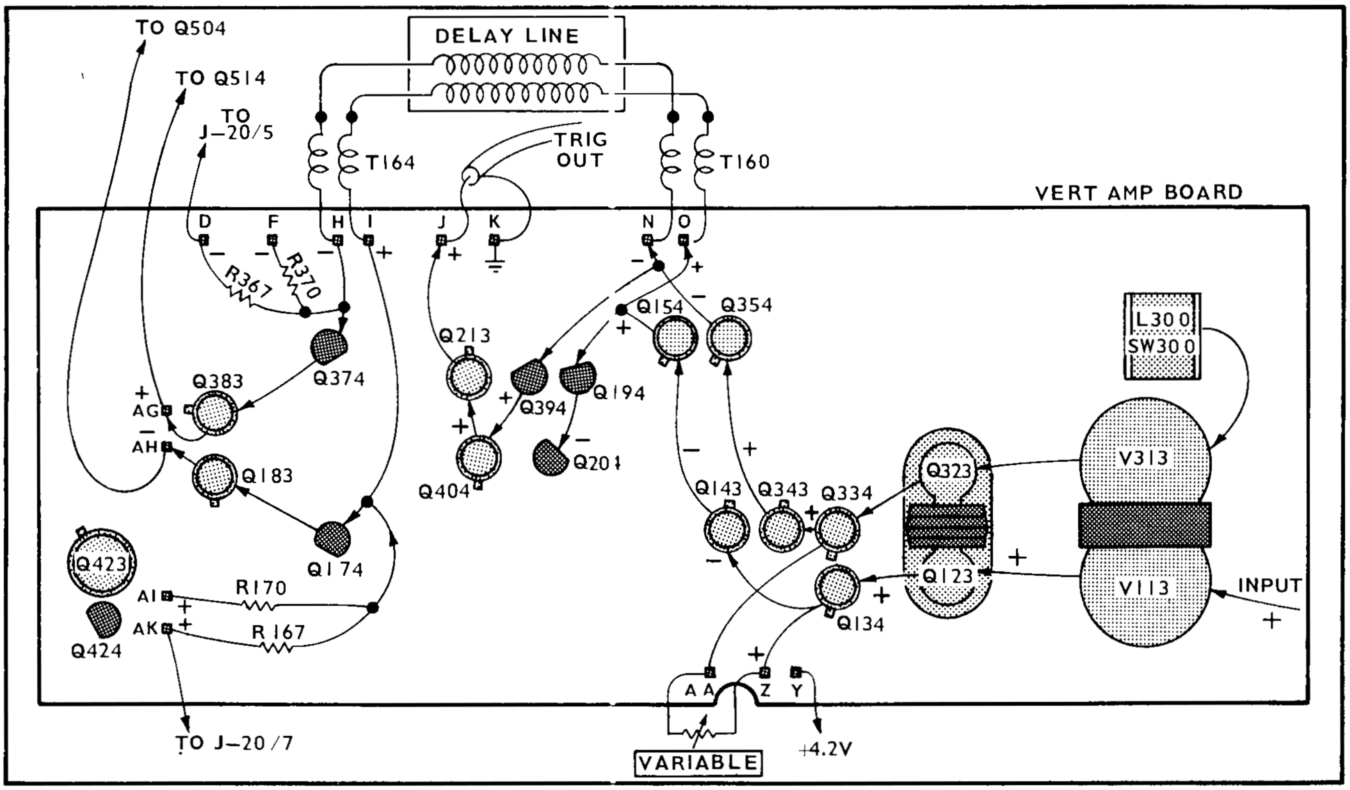

Fig. 6-5. Transistor locations, step 8.

f. While holding the 10× probe switch depressed, operate the MANUAL VOLTS/DIV switch through the positions from 50 V/DIV to 1 mV/DIV. Notice that the readout is 10 times greater than the switch reading at each position. Release the 10× probe switch.

g. Turn the VARIABLE control left, then right from its detent CAL position. Note that the V/DIV lamp goes out and the red UNCAL lamp turns on. Return the VARIABLE control to CAL. Return the MANUAL VOLTS/DIV switch to 10 mV.

h. Press the SEEK button. The display should read AC and 10 mV/DIV, and the SEEK button should light. Turn the MANUAL VOLTS/DIV switch to 20 mV. The SEEK light should go out, and the MAN button should light. Press and hold the EXT button, and note that only the V/DIV lamp comes on. Other lamps may light, or may light only dimly. This does not indicate a problem. Release the EXT button. Set the MANUAL VOLTS/DIV switch to 10 mV, and the Input Coupling switch to AC.

6. Preliminary Adjust Variable Balance VAR BAL, R300 ⓿

a. Test setup remains as in Step 5.

b. Turn the VARIABLE control counterclockwise. Note any shift of the trace. Return the VARIABLE control to CAL, and by use of the VAR BAL control, shift the trace in the same direction about one and one-third times as far as it moved when the VARIABLE control was rotated. Repeat this procedure until there is no vertical shift of the trace throughout the full rotation of the VARIABLE control. Return the VARIABLE control to CAL.

7. Check for Microphonics

a. Test setup remains as in Step 6.

b. Tap the top of the oscilloscope front panel with the fingers of one hand. The trace should show no prolonged ringing-type microphonics, and no short-term microphonics of greater amplitude than 2 minor divisions.

8. Check for Balance

a. Test setup remains the same as in step 7.

b. Set the Input Coupling switch to DC.

c. Note the trace position. Remove both Q134 and Q334 and re-insert the transistors in reverse positions. See Fig. 6-5F or transistor locations. Trace shift as a result of changing the transistors must not be greater than 2 divisions. If the trace shift is more than 2 divisions, replace the transistors one at a time until you have a pair that will cause a trace shift of 2 divisions or less when their positions are reversed. Readjust the VAR BAL control as directed in Step 6.

d. Repeat the procedure of Step c with Q154 and Q354. Again, trace shift must not be more than 2 major graticule divsions when the transistor positions are reversed.

9. Final Adjust Variable Balance VAR BAL, R300

a. Repeat the procedure described in Step 6 until no vertical trace shift occurs when the VARIABLE control is turned throughout its range.

10. Check Trace Drift

a. Test setup remains the same as for Step 8.

b. Set the line voltage autotransformer to deliver 105 volts rms to the oscilloscope. Allow one minute for the trace position to stabilize. Position the trace to the graticule centerline. Change the autotransformer setting to deliver 125 volts rms to the oscilloscope. After one minute, the trace must not have drifted more than 0.5 major graticule division. Return the autotransformer output to 117 volts.

11. Check DC Shift

a. Test setup remains as in Step 10.

b. Set the Type 3A5 MANUAL VOLTS/DIV control to .5 VOLTS. Set the bench multimeter to an ohms range with internal 1.5 volt battery.

c. Connect one ohmmeter lead to the Type 3A5 front panel ground terminal. Touch the other lead to the INPUT connector center conductor and note the direction of trace shift. Remove the lead from the input. Position the trace three divisions in the direction opposite to trace shift, and set the MANUAL VOLTS/DIV switch to .2 VOLTS. Touch the ohmmeter lead to the INPUT center conductor again, and adjust the VARIABLE control for a trace change of 5 divisions from zero input volts. Remove the meter lead from the input and wait one minute.

d. Touch the meter lead to the INPUT center conductor and carefully watch the trace. There should be no more than $\pm 5\%$ slow trace shift after the meter lead is connected. ($5\% = 1.25$ minor division). Remove the meter leads.

NOTE

This step checks the thermal compensations in the amplifier, and can reveal a weak cathode in an output tube.

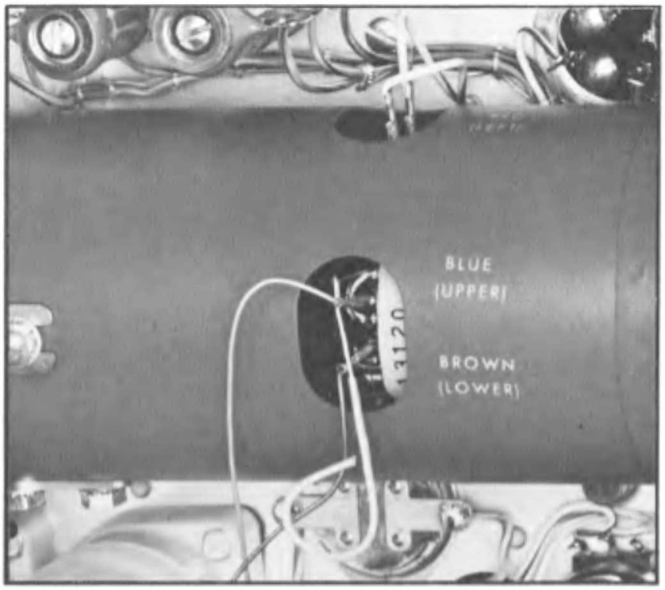

Fig. 6-6. Shorting crt vertical deflection pins, step 12.

12. Check AC—TRACE STABILIZED Operation

a. Test setup remains as in Step 11.

b. Set the Type 3A5 VARIABLE control to CAL and the MANUAL VOLTS/DIV switch to 10 mV.

c. Position the trace to the graticule centerline. Use a non-magnetic tool or wire (with insulation for the hands) and short the crt vertical deflection pins together. See Fig. 6-6. Note the trace position on the crt. This is the crt electrical center.

CAUTION

No not short either pin to ground, or the Output Amplifier may be damaged.

d. Remove the shorting tool and position the trace to the crt electrical center. Change the Input Coupling switch to AC—TRACE STABILIZED. The trace will disappear, but will return quickly. It must return to within one major division of the crt electrical center. Set the Input Coupling to AC.

e. Position the trace to the top graticule line. Change the Input Coupling Switch to AC—TRACE STABILIZED. The trace must return at least one major division toward the graticule centerline.

f. With the Input Coupling at AC-TRACE STABILIZED and the trace position as at the end of Step e, change the MANUAL VOLTS/DIV switch to 5 mV. The trace should not shift from its 10 mV/DIV position.

Fig. 6-7. Test setup for adjusting Vertical Amplifier gain.

Control Settings

TYPE 3A5	
MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	**DC**
Mode	MAN
Time Base	
Time/Div	**1 msec**
Variable	Cal
Trigger Mode	Auto
Triggering Level	Midrange
Slope	+
Coupling	AC
Source	Int
Standard Amplitude Calibrator	
Amplitude	50 mvolts
Mode	Square-wave
Mixed	Up
×100 Amplifier	Optional

Connections

Install a BNC 50 Ω coaxial cable from the calibrator right side Output connector to the Type 3A5 INPUT connector.

NOTE

The Standard Amplitude Calibrator must be turned on for at least fifteen minutes before using it in the following step.

13. Preliminary Adjust Amplifier Gain, CAL Control, R186

a. Set up the equipment and controls as shown in Fig. 6-7.

b. Obtain a square-wave display and adjust the front-panel CAL control for exactly five divisions deflection. Do not include the trace thickness in the adjustment.

14. Check Input Grid Current

a. Leave equipment controls as set, but remove the coax from the Type 3A5 INPUT connector. The Standard Amplitude Calibrator will be used again in step 15.

b. Position the trace to the graticule centerline. Short the INPUT connector center conductor to ground and note any trace shift. The trace must not shift more than 0.2 division, indicating a grid current of ±2 nanoampere maximum.

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c. If the grid current is greater, change V113. Normally grid current decreases with use of V113, so if the grid current is greater than 2 nanoamperes, it can mean the tube will soon fail in other ways also.

d. If V113 is replaced, the Type 3A5 must operate for at least 20 minutes before making the grid current test again. Then, if the new tube grid current is marginally greater than allowed, proceed with the rest of this procedure, and check grid current again after several hours use. Normally, tubes used for V113 will noticeably decrease grid current in the first ten hours of operation in a circuit that allows normal plate current flow.

After V113 selection provides a tube with grid current within limits, recheck for microphonics as in Step 7; readjust the VAR BAL control as in Step 9 and check trace drift as in Step 10.

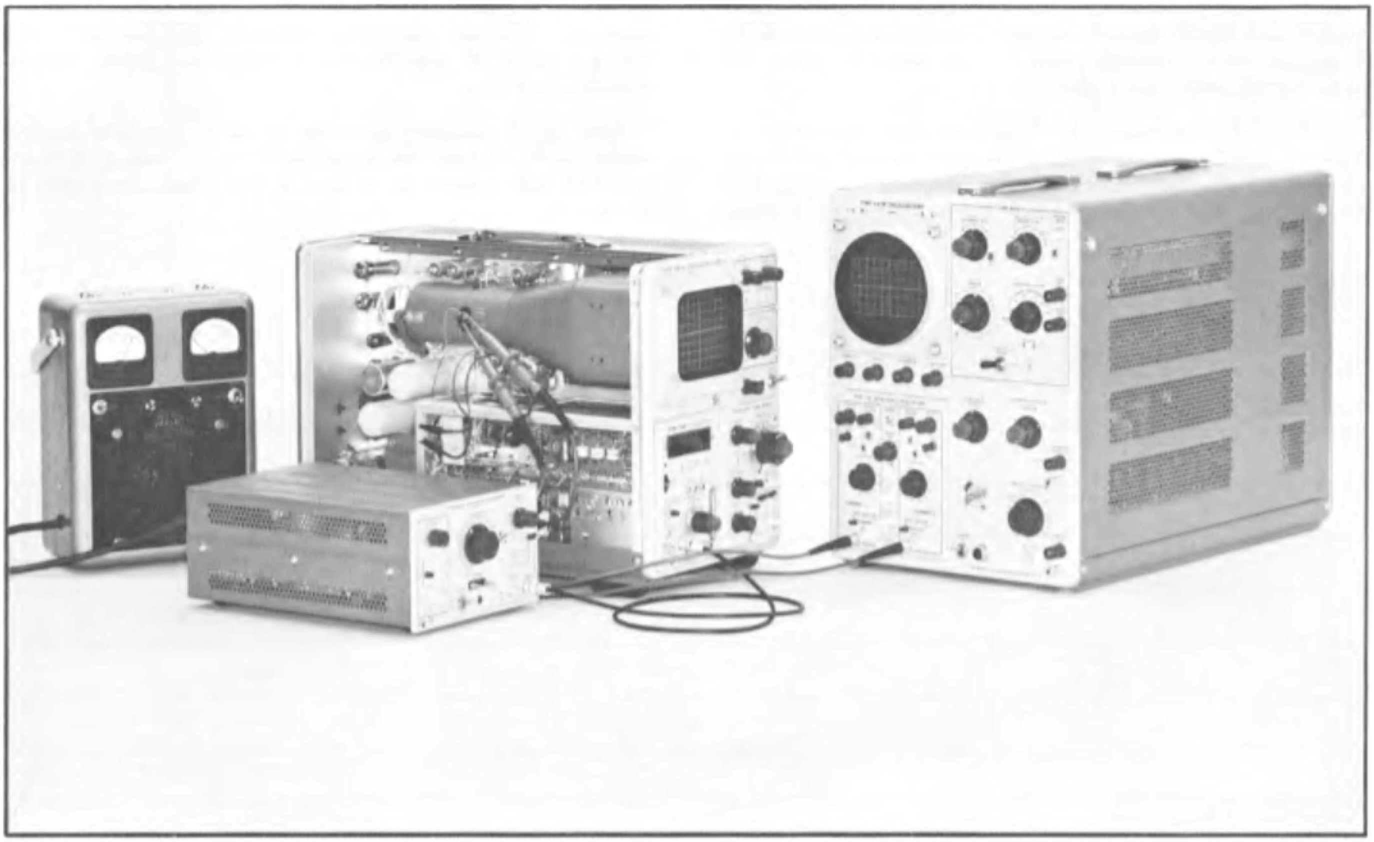


Fig. 6-8. Test setup for checking compression/expansion.

Control Settings

Type 3A5

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Mode	MAN
Input Coupling	**AC**

Time Base

Time/Div	1 msec
Variable	Cal
Trigger Mode	Auto
Triggering Level	Midrange
Slope	+
Coupling	AC
Source	Int

Standard Amplitude Calibrator

Amplitude	**20 mvolts**
Mode	Square-wave
Mixed	Up
×100 Amplifier	Optional

Test Oscilloscope

Trigger Slope	+Int
Triggering Mode	AC
Stability	Preset
Triggering Level	Midrange
Time/Cm	**.5 msec**
Variable	**Calibrated**
Horizontal Display	Normal
Sweep Switch	Normal Sweep
Horizontal Position	Midrange

Type 1A1

Volts/Cm (both)	**1**
Variable Volts/Cm	See Step 15
Channel 1 Norm/Invert	Norm
Channel 2 Norm/Invert	**Invert**
Mode	**Add**
Input Selector (both)	AC

Connections

Connect a 50 ohm (BNC connector) coaxial cable from the Calibrator right side Output connector to the Type 3A5 INPUT connector. Connect two 10× probes to the Type 1A1 input connectors. Compensate both probes, and check that the display gain (.05 V/Cm Gain) control of both channels is properly adjusted. Connect the two probe ground clips to the Type 3A5 chassis, and the probe tips to the crt vertical deflection plate pins. See Fig. 6-8.

CAUTION

Do not let either probe tip touch the crt shield Be careful not to apply unnecessary pressure with the probes to the crt neck pins.

15. Check Amplifier Compression/Expansion

a. Set up test equipment and connections as shown in Fig. 6-8.

b. Obtain a stable, centered two-division display on the Type 561A crt, and a stable 5-division display on the test oscilloscope. (Use Channel 1 Variable Volts/Cm control to set the test oscilloscope display to 5 divisions.)

c. Position the Type 561A display so that the waveform top rests on the top graticule line. After the ac-coupled test oscilloscope display settles down, record its peak-to-peak amplitude, compared to its previously-set 5-division amplitude.

d. Position the Type 561A display so that the waveform bottoms rests at the bottom graticule line. After the ac-coupled test oscilloscope display has settled down, record its peak-to-peak amplitude as compared to the original 5-divisions.

The measurements described above should be made between the end of a positive half-cycle and the beginning of a negative half-cycle, near the test oscilloscope crt center. Compression or expansion of the Type 3A5 vertical amplifier gain as seen on the test oscilloscope must not be greater than 5% (1.25 minor divisions).

Any compression or expansion greater than $\pm 5\%$ can probably be traced to transistor unbalance in step 8, or to unbalance Output Stage tubes or transistors.

16. Check Amplifier Dynamic Range

a. Test equipment setup remains as in step 15. Change the controls as follows:

Standard Amplitude Calibrator

Amplitude	.1 volts

Type 3A5

No change

Type 1A1

Volts/cm (both)	5
Variable Volts/cm (both)	Calib

Type 543B

No change

b. Center the Type 561A two-division display. Change the Standard Amplitude Calibrator AMPLITUDE control to .1 volts. The display will now be approximately 10 divisions peak to peak, and the top and bottom should both be out of sight above and below the crt edges.

c. The test oscilloscope deflection factor is 50 volts/cm. The display should be $\geq$185 volts peak to peak. Remove the 10$\times$ probes from the Type 561A crt neck pins.

17. Check Amplifier POSITION Range

a. Test setup remains as in Step 16. However, the test oscilloscope is not used. Change the Standard Amplitude Calibrator Amplitude control to 50 mvolts. Adjust the Type 3A5 VARIABLE control to obtain a six division peak-to-peak display.

b. Change the Calibrator Amplitude control to .1 volts. The Type 3A5 POSITION control must now be able to position the display bottom above the graticule centerline, and the display top below the graticule centerline.

If the POSITION control cannot position the display sufficiently, check the Driver and Output Stage transistors and tubes.

18. Check VARIABLE Range

a. Test setup remains the same as in Step 17.

Control Settings

Standard Amplitude Calibrator

Amplitude	**50 mvolts**

Type 3A5

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	**DC**

b. Check that the Type 561A crt display is five divisions peak to peak.

c. Turn the VARIABLE control fully counterclockwise. The display must be between 2.8 and 3.6 divisions peak to peak in vertical height. Record the display size.

d. Set the Calibrator Amplitude control to 20 mvolts. Turn the VARIABLE control fully clockwise. Display amplitude must be equal to or greater than the amplitude shown in Step c. Return the VARIABLE control to CAL.

19. Check Amplifier DC Voltage to CRT

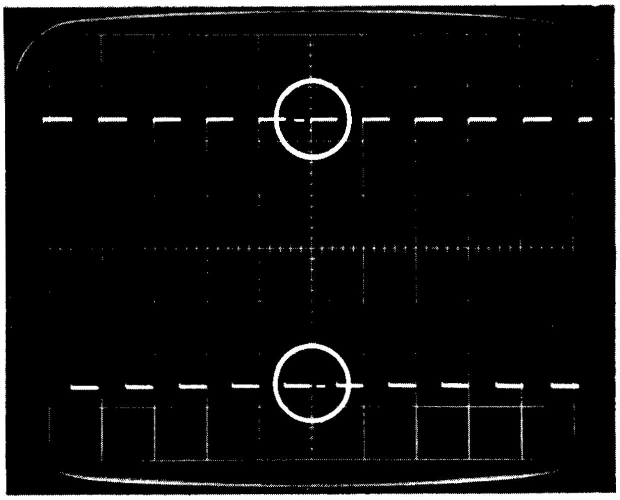
a. Disconnect the 50 Ω coaxial cable from the Type 3A5 INPUT connector. Do not turn off the Standard Amplitude Calibrator, since it will be used again in the next step.

b. Position the trace to the crt electrical center which was located in Step 12.

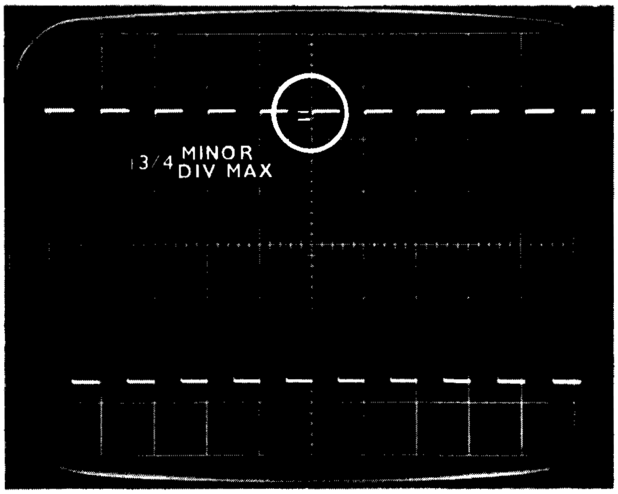
c. Use the 20,000 Ω/V bench multimeter, set to at least a 400 volt range ($\geq$8 MΩ meter resistance) to measure the dc voltage at either crt vertical deflection plate pin. The voltage must be between +165 and +190 volts $\pm 3\%$.

20. Check deflection accuracy at 10 mV/DIV through 50 V/DIV.

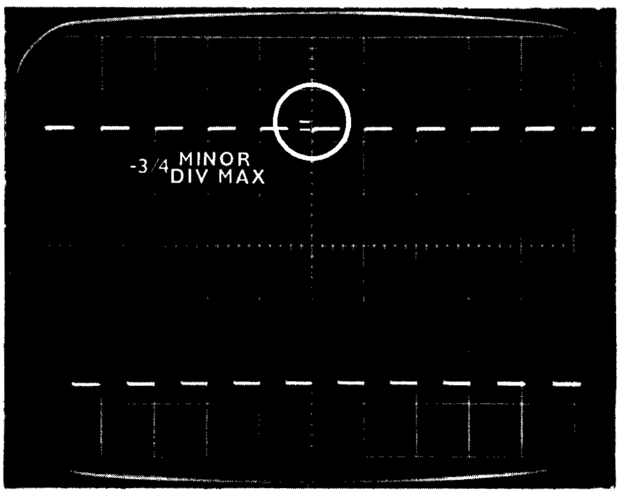
a. Reconnect the Standard Amplitude Calibrator coaxial cable to the Type 3A5 INPUT connector. Set the Calibrator Amplitude control to 50 mvolts.



a. DEFLECTION ACCURACY ±0%

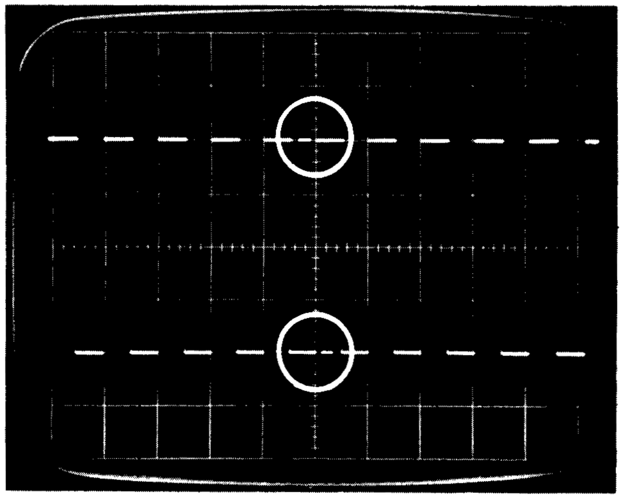


b. DEFLECTION ACCURACY +3% (+3/4 MINOR DIV).

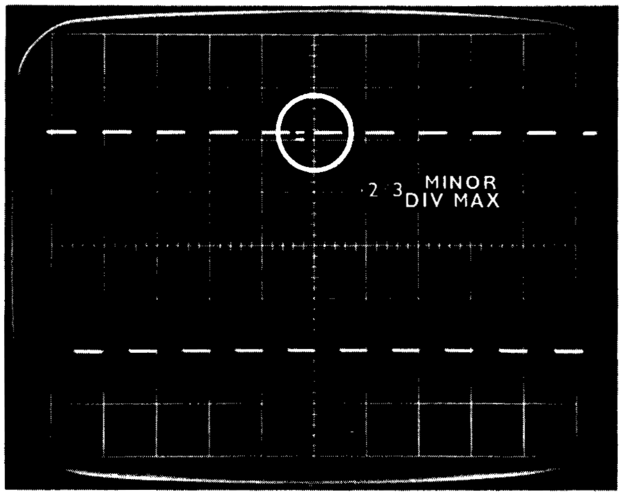


c. DEFLECTION ACCURACY -3% (-3/4 MINOR DIV).

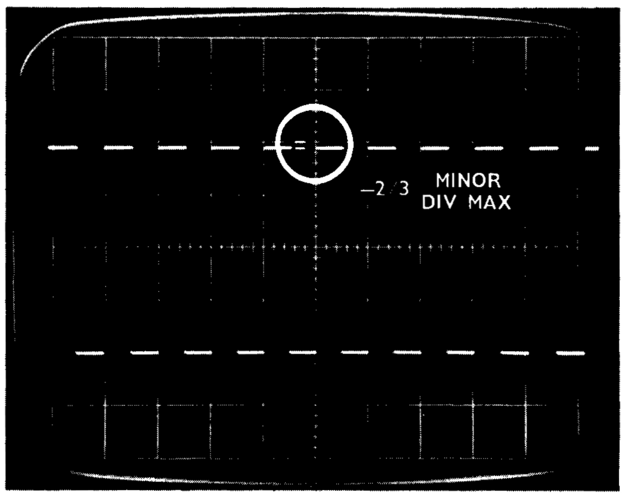
Fig. 6-9. Deflection accuracy limits between 10 mV/DIV and 50 V/DIV when VOLTS/DIV has the number 1 or 2 in it.



a. DEFLECTION ACCURACY ±0%.



b. DEFLECTION ACCURACY +3% (+2/3 MINOR DIV).



c. DEFLECTION ACCURACY -3% (−2/3 MINOR DIV).

Fig. 6-10. Deflection accuracy limits between 10 mV/DIV and 50 V/DIV when VOLTS/DIV has a number 5 in it.

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b. Use Table 6-2 and Figures 6-9, 6-10 and 6-11 to determine the deflection accuracy at each setting of the MANUAL VOLTS/DIV switch between 10 mV/DIV and 50 V/DIV. If any one switch setting causes an out-of-tolerance display, record the amount of error, continue to 50/DIV, then return to 10 mV/DIV and adjust the CAL control. Adjust the CAL control to reduce the one error, but not far enough to give any other switch setting an opposite out-of-tolerance error. The CAL control is correctly adjusted when all ranges are within 3%, and 10 mV/DIV is not necessarily at zero per cent error. If one switch position causes a plus error greater than +3% and another causes a minus error greater than −3%, record the error of all switch settings in order to determine which attenuator requires repair.

TABLE 6-2

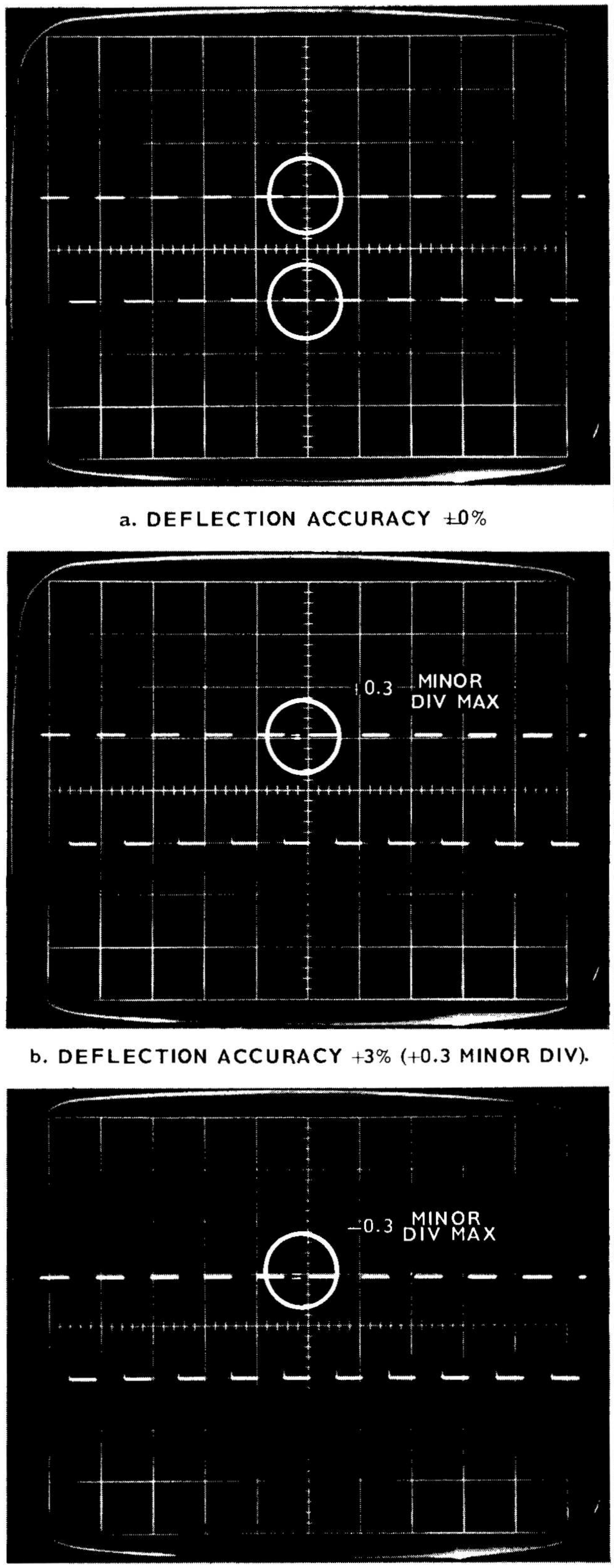
Vertical Deflection Accuracy Check

MANUAL VOLTS/DIV Switch Setting	Standard Amplitude Calibrator AMPLITUDE Control	Vertical Deflection In Divisions	% Error, See Fig 6-9 thru Fig. 6-13
1 mV	5 mV	5	±5%
2 mV	10 mV	5	±5%
5 mV	20 mV	4	±5%
10 mV	50 mV	5	±3%
20 mV	0.1 V	5	±3%
50 mV	0.2 V	4	±3%
.1 V	0.5 V	5	±3%
.2 V	2 V	5	±3%
.5 V	2 V	4	±3%
1 V	5 V	5	±3%
2 V	10 V	5	±3%
5 V	20 V	4	±3%
10 V	50 V	5	±3%
20 V	100 V	5	±3%
50 V	100 V	2	±3%: ±0.3 minor div

21. Check deflection accuracy at 1, 2 and 5 mv/DIV

a. With the Standard Amplitude Calibrator connected, set Type 3A5 MANUAL VOLTS/DIV switch to 10 mV. Set the Calibrator Amplitude control to 50 mvolts. Set the Type 3A5 Input Coupling switch to AC—TRACE STABILIZED and center the display vertically.

b. Set the Calibrator Amplitude control to 5 mvolts, and the Type 3A5 MANUAL VOLTS/DIV switch to 1 mV. The display must be 5 divisions peak to peak ±5% as shown in Fig. 6-12. Use Table 6-2 and Figs. 6-12 and 6-13 for 1, 2 and 5 mV/DIV checks. If all three checks show the gain to be either high or low, check the Output Amplifier cathode circuit.

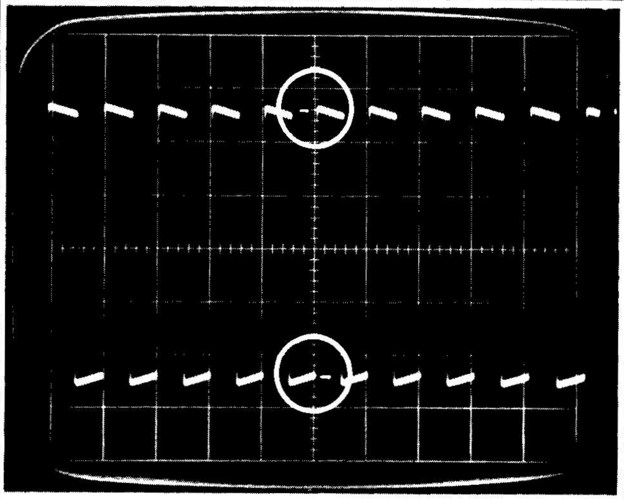


a. DEFLECTION ACCURACY ±0%

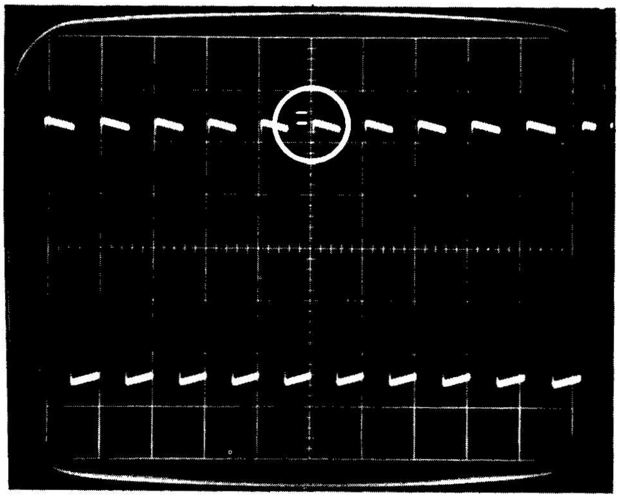
b. DEFLECTION ACCURACY +3% (+0.3 MINOR DIV).

c. DEFLECTION ACCURACY −3% (−0.3 MINOR DIV).

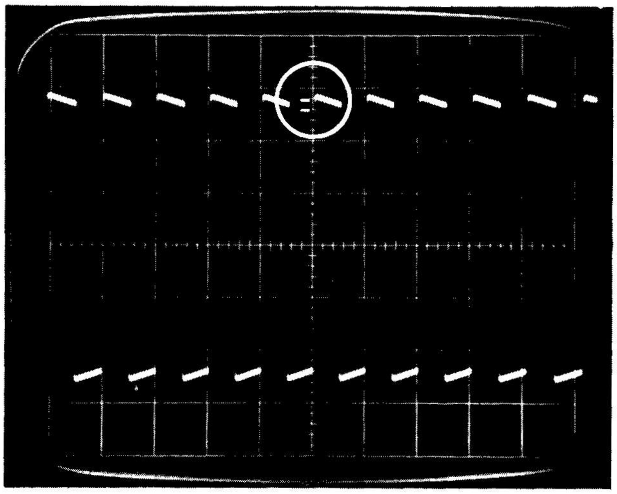
Fig. 6-11. Deflection accuracy limits at 50 V/DIV.



a. DEFLECTION ACCURACY ±0%.

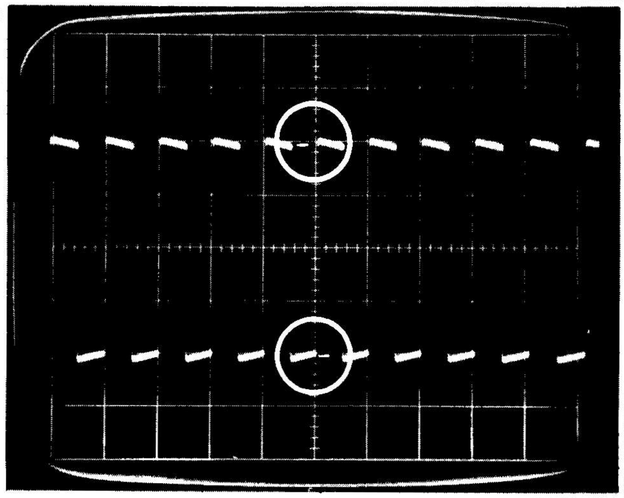


b. DEFLECTION ACCURACY −5% (−1.25 MINOR DIV).

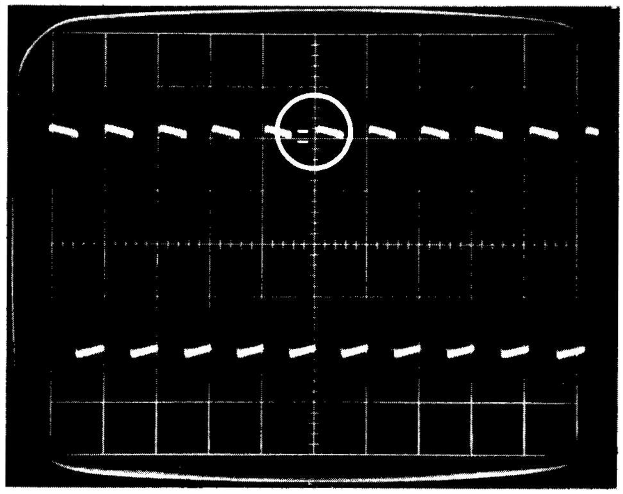


c. DEFLECTION ACCURACY +5% (+1.25 MINOR DIV)

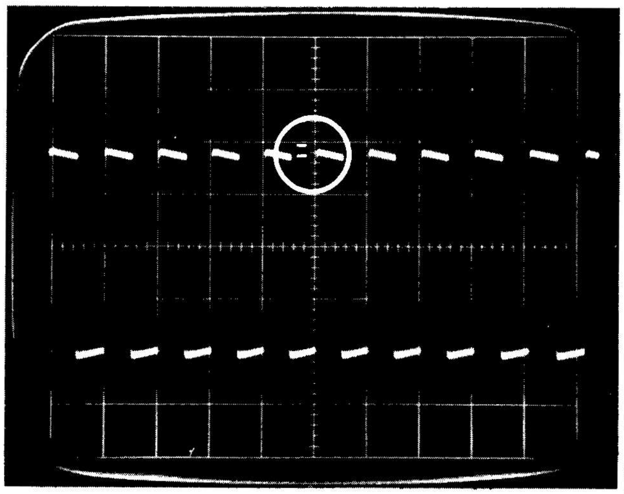
Fig. 6-12. Deflection accuracy limits at 1 and 2 mV/DIV.



a. DEFLECTION ACCURACY ±0%.



b. DEFLECTION ACCURACY +5% (+1 MINOR DIV).



c. DEFLECTION ACCURACY −5% (−1 MINOR DIV).

Fig. 6-13. Deflection accuracy limits at 5 mV/DIV.

Fig. 6-14. Test setup for adjusting input capacitance and attenuator compensations, Step 22.

Control settings

Type 106

Repetition Rate Range	1 kHz
Multiplier	Near 2
Symmetry	Midrange
Amplitude	Fully Counterclockwise
Hi Amplitude Fast Rise Switch	Hi Amplitude
Fast Rise controls	Optional

Type 3A5

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	DC

Time Base

Time/Div	**.1 msec**
Variable	Cal
Trigger Mode	Auto
Triggering Level	Midrange
Slope	+
Coupling	AC
Source	Int

Connections

Install the Input RC Standardizer on the Type 3A5 INPUT connector. Install the BNC 50 Ω termination on the Input RC Standardizer. Connect a 50 Ω BNC cable to the termination. The signal generator recommended is the Tektronix Type 106. A Tektronix Type 105 will work equally well, and does not require a GR to BNC connector adapter.

Install one 10× 50 Ω attenuator on the signal generator high amplitude Output connector. Use the GR to BNC adapter with the Type 106.

Connect the 50 Ω cable to the 10× attenuator and check that the oscilloscope focus control is properly adjusted for a sharply defined display.

22. Adjust Input Capacitance and Attenuator Compensations

a. Make the connections and set the controls as stated under Fig. 6-14. Set the square-wave generator Amplitude control for a display of four divisions peak to peak.

b. Check the input capacitance by observing any spike or rolloff of the square-wave leading edge for approximately 0.02 msec. A difference of 1 pF in input capacitance as compared with the Standardizer capacitance will cause approximately 1 minor vertical division of spike or rolloff —an error greater than the allowed 3% peak-to-peak aberration limits of $^2/_3$ minor division.

c. Use item 19 of Equipment Required, and adjust C70 (attenuator adjustment locations shown in Fig. 6-15) so there is no spike, rounding or rolloff of the display. Use a time base sweep rate of 1 msec/div to obtain a display with the proper resolution. Set the sweep rate back to 0.1 msec/div.

d. Use Table 6-3 and Fig. 6-16 while adjusting the input attenuator compensating capacitors. Start at 10 mV/DIV and work to 50 V/DIV, adjusting the Calibrator Amplitude control and removing the attenuator, termination and standardizer when higher deflection factors make it no longer possible to obtain four divisions of display.

e. Install a 3-wire to 2-wire power cord adapter at the Type 106 power connector, to eliminate 60 Hz ground current signals that may be displayed at 1, 2 and 5 mV/DIV.

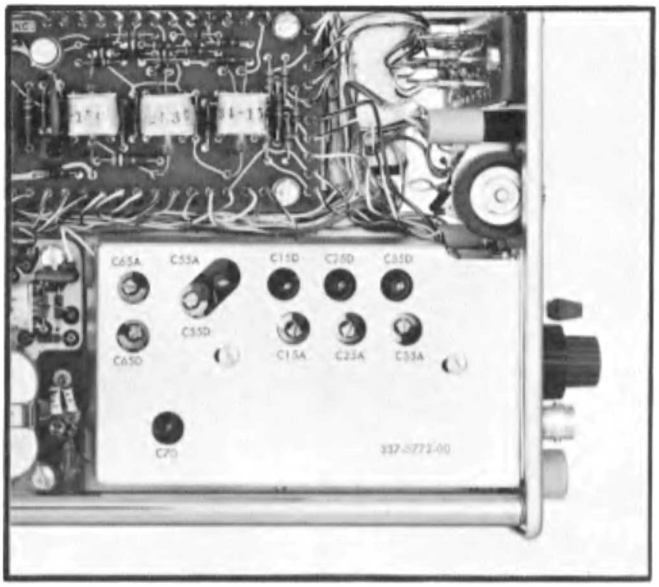


Fig. 6-15. Location of attenuator and input capacitance adjustments.

Install two 10× attenuators to the square-wave generator Output and the 50 Ω termination to the Input RC Standardizer. Set the square-wave generator Amplitude control fully counterclockwise.

TABLE 6-3

Step 22d Operating Conditions

MANUAL VOLTS/ DIV Switch Setting	Use 10× Atten	Use 50 Ω Term	Use RC Stand	Display Divisions Pk-to-pk	Adjust for square corner. Fig. 6-16A/B	Adjust for optimum level. Fig. 6-16C/D
10 mV	X	X	X	4	none	C70
20 mV	X	X	X	4	C55D	C55A
50 mV	X	X	X	4	C65D	C65A
.1 V		X	X	4	C15D	C15A
.2 V		X	X	4	check	check
.5 V		X	X	4	check	check
1 V		X	X	4	C25D	C25A
2 V			X	4	check	check
5 V			X	4	check	check
10 V			X	4	C35D	C35A
20 V				4	check	check
50 V				≈2.2	check	check

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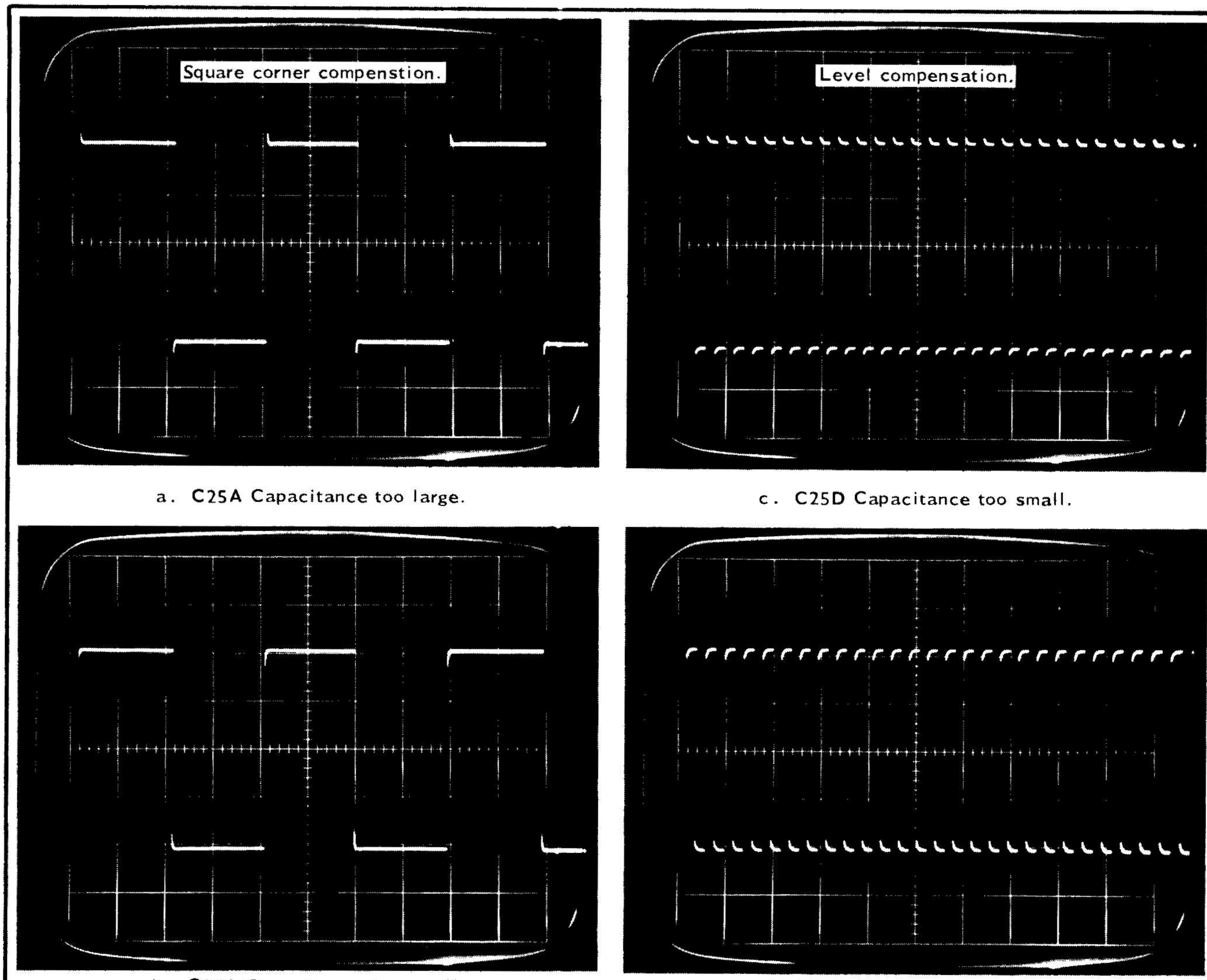


a. C25A Capacitance too large.

c. C25D Capacitance too small.

b. C25A Capacitance too small.
0.1 msec/div.

d. C25D Capacitance too large.
1.0 msec/div.

Fig. 6-16. Examples of sweep rate and display when adjusting attenuator capacitors. Signal ≈2 kHz. Type 3A5 VOLTS/DIV = 1 VOLT/DIV.

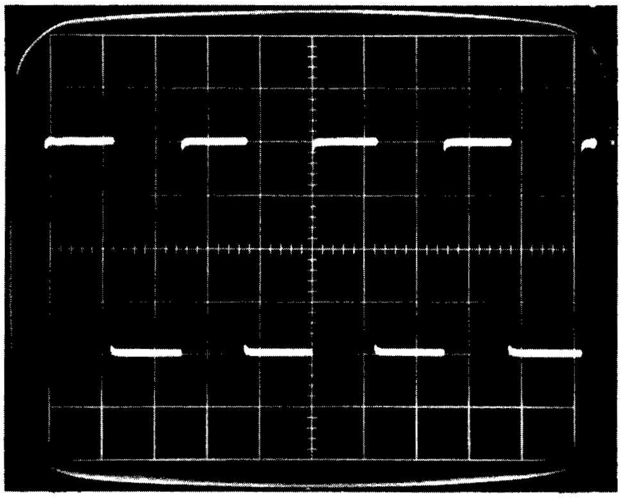
CAUTION

Maximum full-time peak-to-peak display with the 10× attenuator / 50 Ω termination / Standardizer combination if 0.3 volt as displayed on the crt. It will be necessary to remove the attenuator beginning at 2 V/DIV deflection factor.

Set the Type 3A5 controls:

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	DC
POSITION	for vertically centered display

f. Change the MANUAL VOLTS/DIV switch to 1 mV and position the display to the crt center. Increase the signal amplitude to display 4 divisions. The display should be similar to Fig. 6-17. The 5% square-wave leading edge rolloff is due to limited high frequency response, and not to the attenuator.



APPROX. 2kHz SIGNAL .2mS/DIV.

Fig. 6-17. Normal square-wave display at 1, 2, or 5 mV/DIV when attenuators are correctly compensated at 10, 20, and 50 mV/DIV.

23. Adjust Amplifier High Frequency Compensations

a. Test equipment remains the same as in Step 22, with new connections and control settings as listed below:

Control Settings

Type 3A5

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	DC
Mode	**Man**

Type 106

Repetition Rate Range	**100 kHz**
Multiplier	**Near 4**
Symmetry	**Adjust for 50% duty factor**
Amplitude	**Fully counterclockwise**
Hi Amplitude Fast Rise Switch	**Fast Rise**
+Amplitude	**Fully counterclockwise**
—Amplitude	**Fully counterclockwise**

Time Base

Time/Div	**.5 μsec**
Variable	Cal
Trigger Mode	Auto
Triggering Level	Midrange for triggered display
Slope	+
Coupling	AC
Source	Int

Connections

Install the BNC 50 Ω termination directly to the Type 3A5 INPUT connector. Install the GR to BNC adapter to the Type 106 Fast Rise +Output connector. Join the adapter and 50 Ω termination with a 50 Ω coaxial cable.

If a Type 105 is being used in place of the Type 106, install two 10× 50 Ω attenuators on the OUTPUT connector, and connect the 50 Ω cable to the second attenuator output.

b. Adjust the Type 106 +Amplitude control for a display of four divisions peak to peak. Proper transient response is shown in Fig. 6-19. Fig. 6-18 shows the portions of the display affected by the four high-frequency transient response controls; R153, C152, L526 and L536.

c. Before making any adjustments, carefully note the display, then switch the Input Coupling to AC and then to AC—TRACE STABILIZED. The transient response should not be altered. Leave the switch at AC—TRACE STABILIZED.

d. If it is necessary to make any high frequency adjustments, start with C152. C152 will probably be finally adjusted near maximum capacitance, which produces the fastest rise, possibly with a very slight overshoot spike.

e. Next, adjust R153 to remove any severe spike or hump (Fig. 6-18A and B).

f. For final control of the display leading corner, adjust either L526, L536 or both as needed. For correct adjustment, it is important that both ferrite slugs be adjusted to about the same depth within the coils. Final adjustment of transient response controls is complete when the spike, rolloff, rounding or tilt is no greater than ±3% (or ±0.3 minor division maximum) and the 10% to 90% risetime is ≤23 nsec as checked in Step 24.

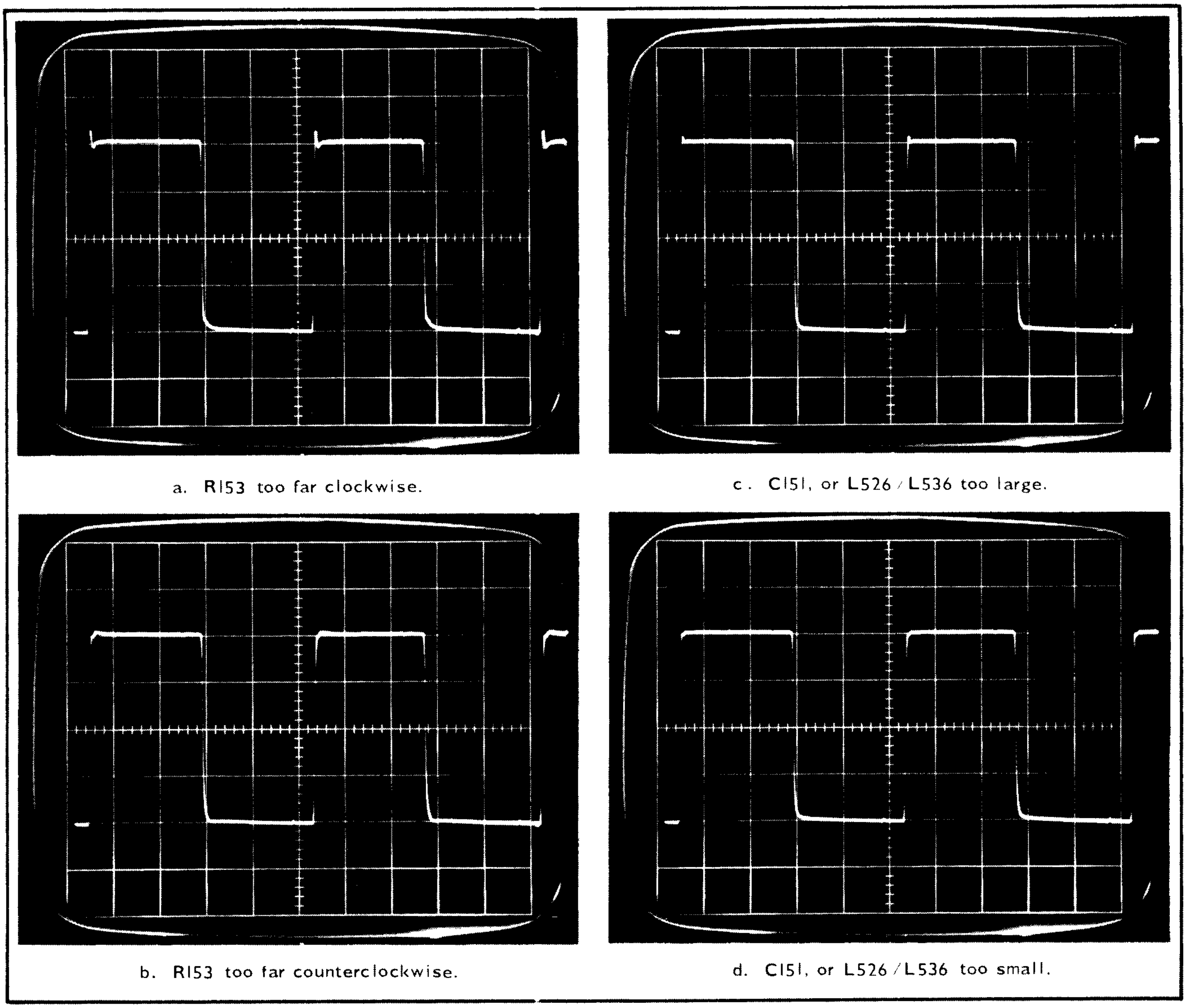
24. Check Amplifier 10% to 90% Risetime

a. Test setup remains as in Step 23.

b. Set Time Base controls

Time/Div	.05 μsec
Position	Display positioned as in Fig. 6-20
Other controls	No change

c. Carefully measure the 10% to 90% rise of the leading edge of the display. The 10% point is two minor divisions up from the display bottom, and the 90% point is two minor divisions down from the display top. If a Type 106 is being used and the risetime is measured to be ≤23 nsec, proceed to Step 25. (≤23 nsec is stated as the limit for calibration, even though in Section 1 risetime is noted as ≤23.2 nsec.



a. R153 too far clockwise.

c. C151, or L526/L536 too large.

b. R153 too far counterclockwise.

d. C151, or L526/L536 too small.

Fig. 6-18. Transient response displays that show which control is misadjusted. Signal: Type 106 Fast Rise at 400 kHz; Type 3A5: 10 mV/DIV; Time Base: 0.5 μSEC/DIV.

This change is because of the difficulty in visually resolving a display time duration of 0.2 nsec). If a Type 105 is being used or the measurement and risetime is found to be $\leq$1.25 nsec, proceed to Step 25. If risetime is too long for either condition just stated, return to Step 23 and adjust L526/L536 for slightly more peaking, and re-adjust C152 to reduce the display peak back to its proper limits. Measure the risetime again. Several repetitions of Step 23 may be necessary before both aberrations and risetime are within proper limits.

25. Check Display Position Affect on Transient Response

a. Test equipment setup remains as in Step 24.

b. Set the Time Base Time/Div control to .5 μsec and the Type 3A5 Input Coupling to AC. All other controls remain at the same settings as in Step 24.

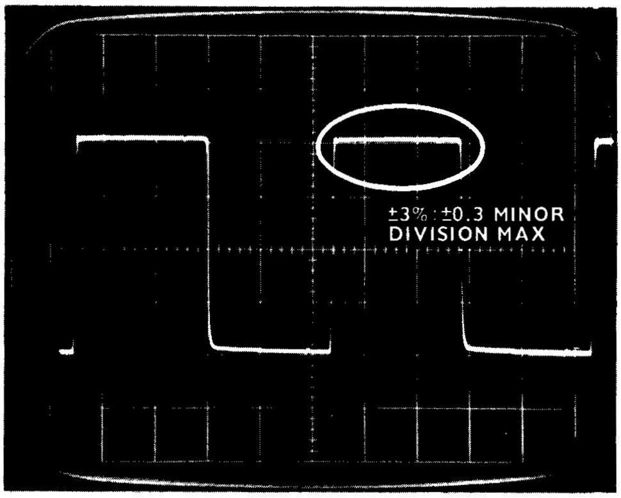
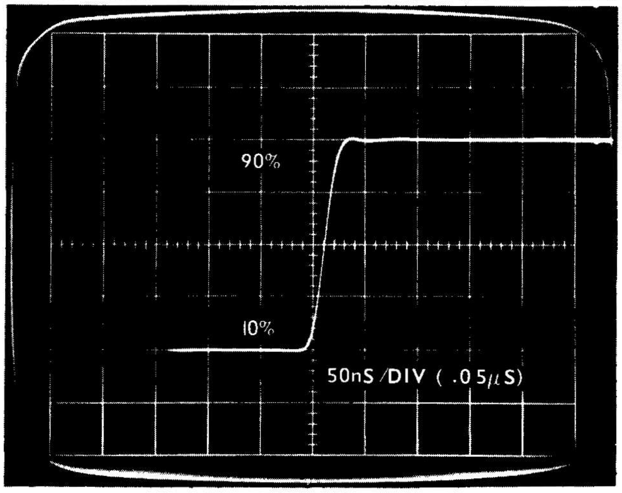
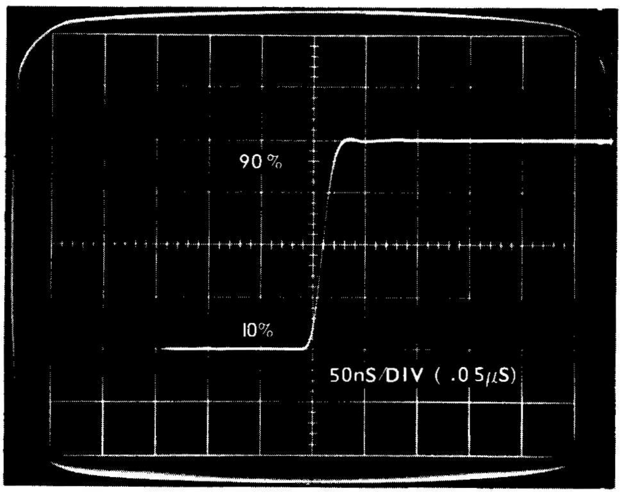


Fig. 6-19. Correct high frequency transient response. ≈400 kHz, at 0.5 μS/div and 10 mV/div.



a. RISETIME, 22n S



b. RISETIME,20 nS.

Fig. 6-20. Difference in risetime measurement using Type 105 (A) and Type 106 FAST RISE (B).

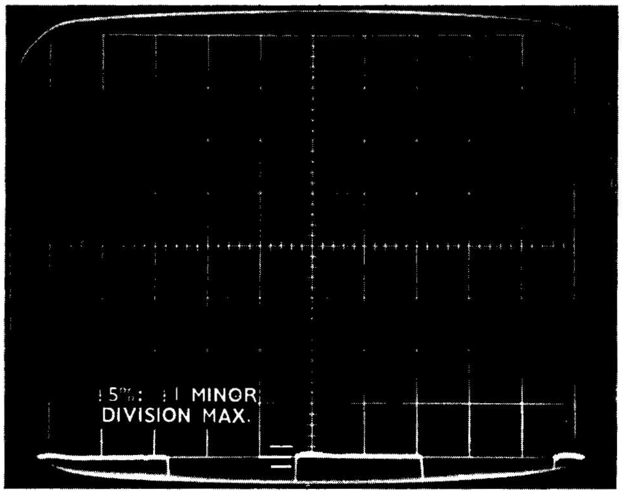
c. Position the top of the display to the bottom graticule line as in Fig. 6-21A. Aberrations must not exceed ±5% or ± 1 minor division (2 minor divisions peak to peak).

NOTE

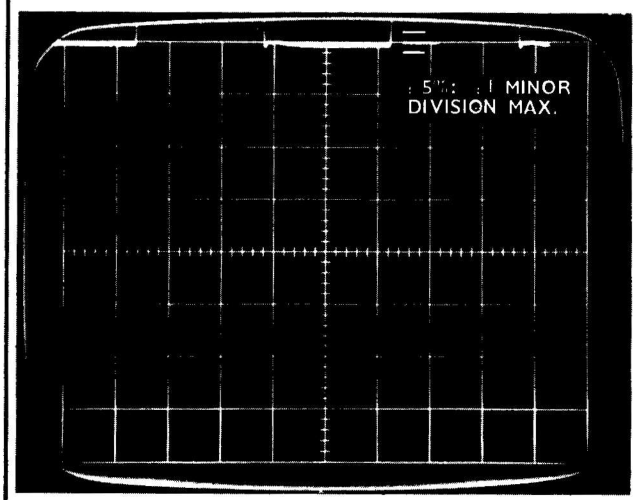
Step 25 d and e cannot be performed if a Type 105 Square-Wave Generator is being used.

d. Position the display back to graticule center. Move the cable from the Type 106 +Output connector to the —Output connector, and adjust the —Amplitude control for a display of 4 major divisions peak to peak.

e. Position the bottom of the display to the top line of the graticule as in Fig. 6-21B. Aberrations must not exceed ±5%.



a. 4 DIVISION DISPLAY POSITIONED DOWN.



b. 4 DIVISION DISPLAY POSITIONED UP.

Fig. 6-21. Position effect upon transient response, step 25.

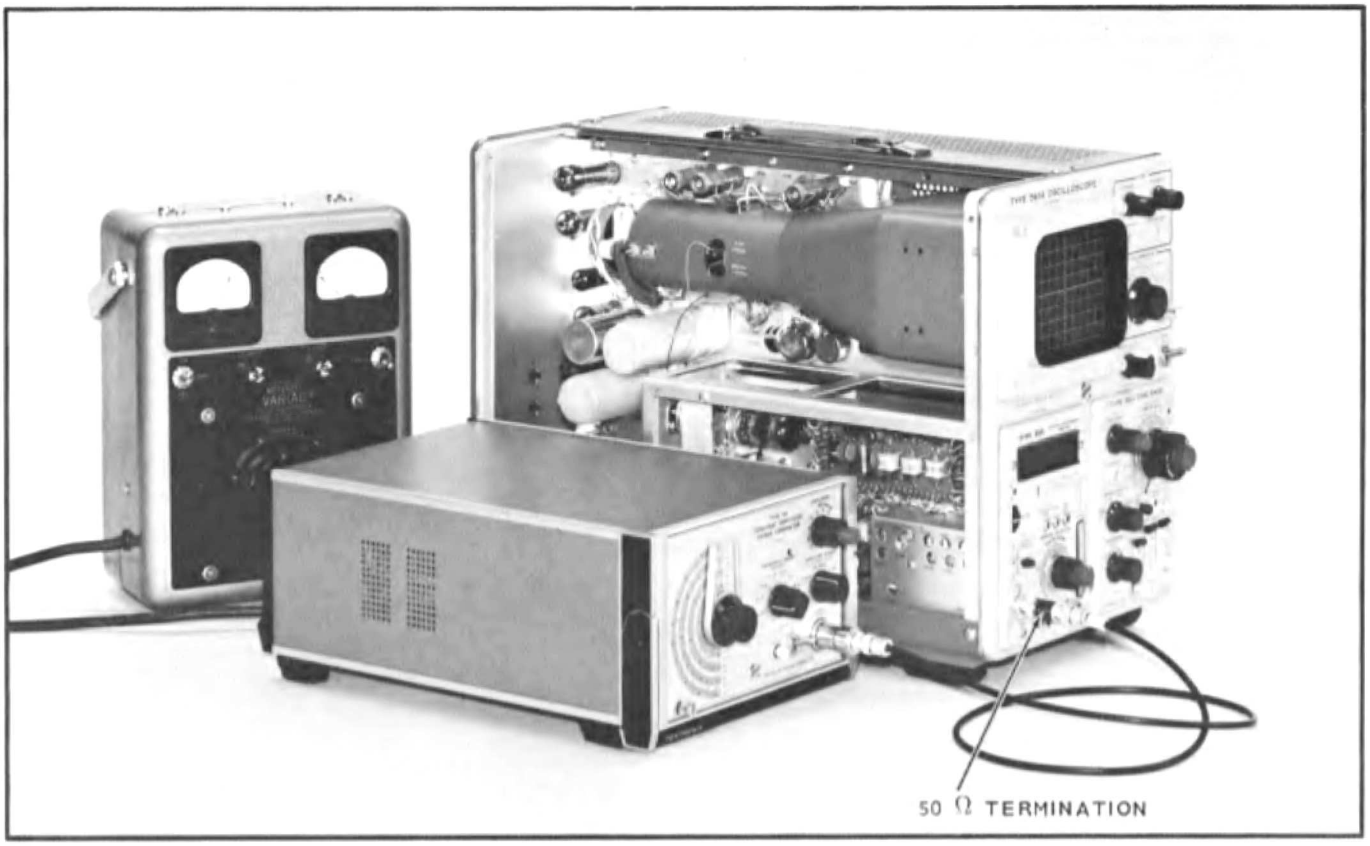


Fig. 6-22. Test setup for checking the Vertical Amplifier bandwidth, 10 mV/DIV.

Control Settings

Type 3A5

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	**AC**
POSITION	**Centered display**

Time Base

Time/Div	**10 μsec**
Variable	Cal
Trigger Mode	Auto
Triggering Level	Midrange for triggered display
Slope	+
Coupling	AC
Source	Int

Type 191

Amplitude Range	**5-50 mV**
Amplitude	**35**
Variable	**4-division display**
Frequency Range	**50 kHz**
Frequency Control	**Fully Clockwise**

Connections

Install a 50 Ω termination on the Type 3A5 INPUT connector. Connect a GR to BNC adapter on the Type 191 Output connector. Join the adapter and termination with a 50 Ω coaxial cable.

26. Check Vertical Amplifier Bandwidth

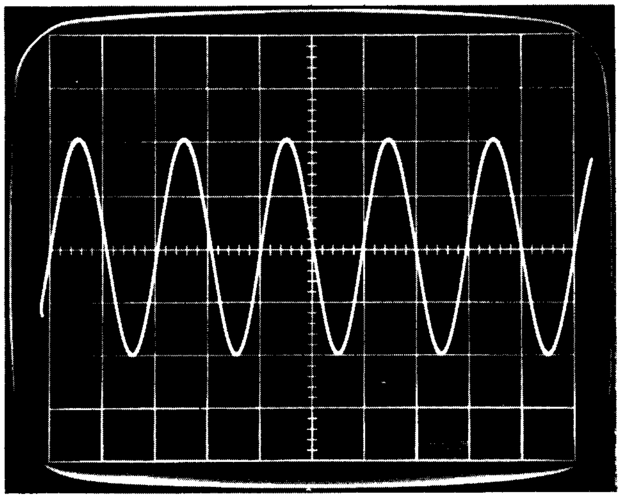
a. Make the connections shown in Fig. 6-22.

b. Obtain a 4-division peak-to-peak display as shown in Fig. 6-23A. Fig. 6-23 illustrates alignment of the top and bottom of a centered 4-division peak-to-peak display, with the same side of the trace referenced to a graticule line at both top and bottom. This makes the amplitude measurement more precise, eliminating error due to trace width.

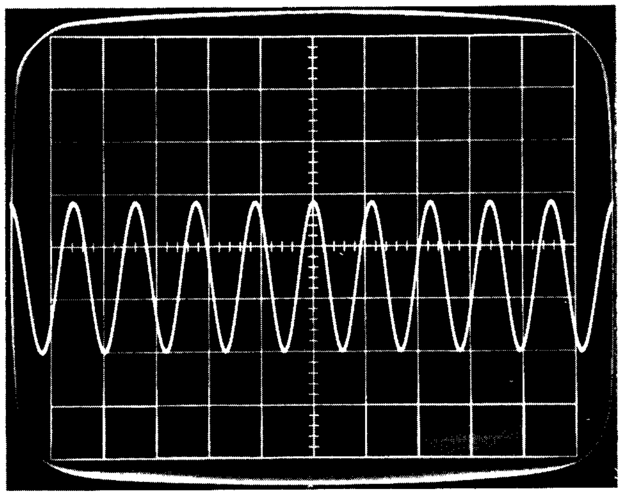
c. Change the Type 191 Frequency Range control to the 8-18 range. Set the oscilloscope Time Base for a triggered sweep at .05 μsec/div. Check the peak-to-peak amplitude of the display. Then turn the Type 191 Frequency Adjust control slowly higher in frequency until the display amplitude is 2.8 divisions, as in Fig. 6-23B. Position the plus peak of a sine wave to the graticule vertical center line for best viewing of the minor divisions of display. Record the frequency. The Type 191 Frequency Adjust dial must be at or above 15 MHz.

d. Insert a 10× attenuator between the GR to BNC adapter and the 50 Ω coax. Set the Type 191 for 50 kHz signal again. Set the Type 3A5 Input Coupling to AC—TRACE STABILIZED and then the MANUAL VOLTS/DIV switch to 1 mV. Obtain a stable triggered four division display at a sweep rate of 10 μSEC. Set the Type 191 VARIABLE control and the Type 3A5 POSITION control for a display like that of Fig. 6-23A.

e. Change the Type 191 Frequency Range control to 3.6-8 and the time-base for a sweep rate of .1 μsec. Turn the Frequency Adjust Control to 5 MHz and check the display amplitude to be 2.8 or more divisions peak to peak. If the display is greater than 2.8 divisions, turn the Frequency Adjust control up in frequency, and record the frequency at which the display is 2.8 divisions peak to peak.



a. 50kHz. 10μS/DIV. 4 DIVISIONS.



b. 15MHz. .05μS/DIV. 2.8 DIVISIONS

Fig. 6-23. Bandpass measurement displays, step 26b and c.

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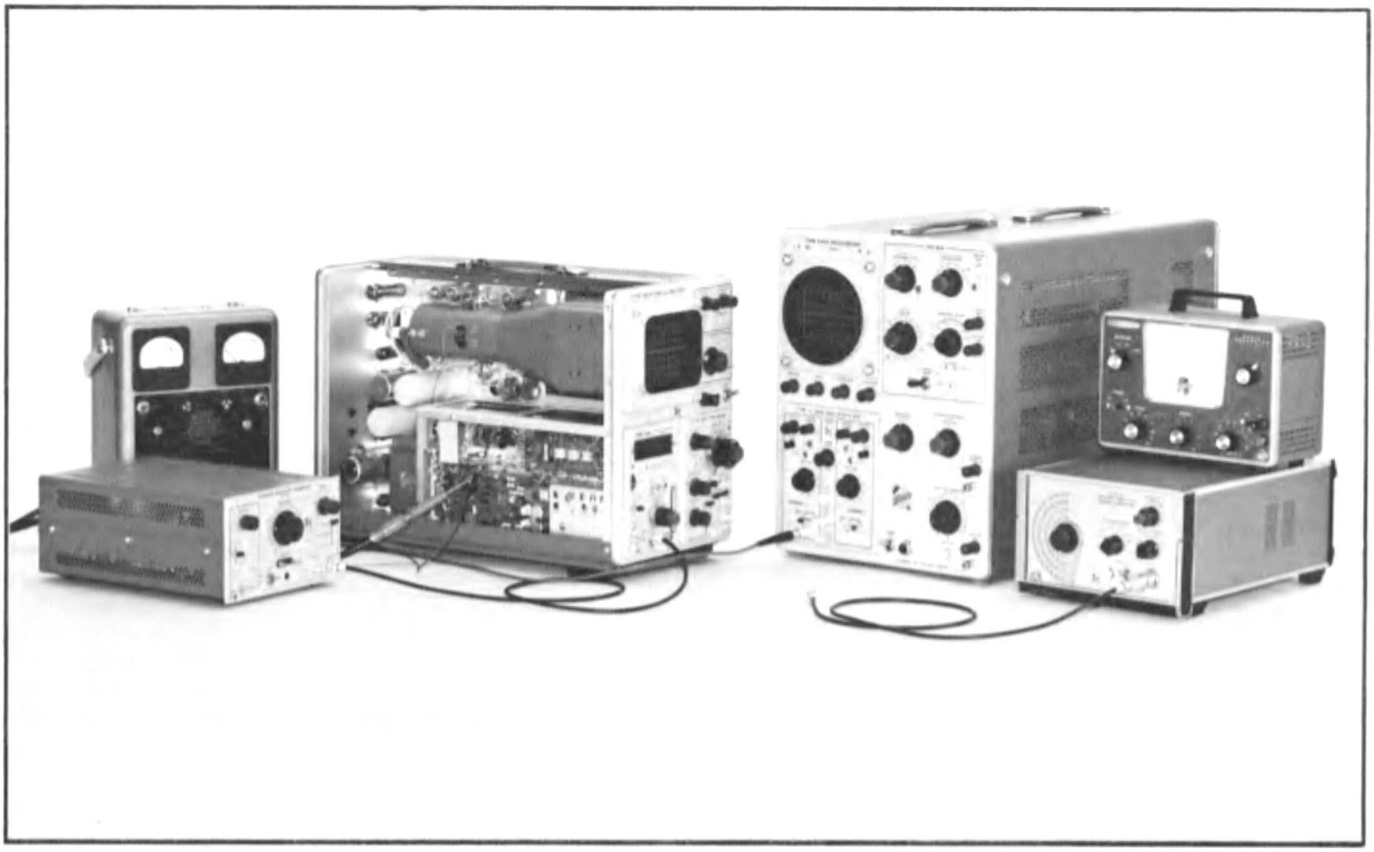

Fig. 6-24. Test setup for checking Signal/Trigger Amplifier.

Control Settings

Type 3A5

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	AC
POSITION	Trace at crt electrical center

Time Base

Time/Div	**.5 msec**
Variable	Cal
Trigger Mode	Auto
Triggering Level	Midrange
Slope	+
Coupling	AC
Source	Int

Type 1A1

Volts/Cm (Ch 1)	**.05**
Mode	**Ch 1**
Variable Volts/Cm	**Calib**
Position	Trace at graticule center-line
Norm/Invert	Norm
Input Selector	**DC**

Type 543B

Trigger Slope	+Int
Triggering Mode	Auto
Stability	Preset
Triggering Level	Midrange
Time/Cm	.5 msec
Variable	Calibrated
Horizontal Display	Normal
Sweep Switch	Normal Sweep
Horizontal Position	Midrange

Standard Amplitude Calibrator

Amplitude	**2 mvolts**
Mode	**Square Wave**
Mixed	**Up**

Type 191

Amplitude Range	5-50 mV
Amplitude	**10**
Variable	**1 division display**
Frequency Range	50 kHz
Frequency Control	**8 of 3.6-8 Range**

IG-72 Audio Generator

Multiplier	×1
Cycles (Left)	10
Cycles (Center)	0
Int/Ext 600 Ω Load Sw	Int
Output Switch	—40/.01
Output Variable	For one division display

Connections

The test setup of Fig. 6-24 applies to the following three steps in the procedure. Install a 10× Probe on the Type 1A1 Channel 1 Input connector. Connect the probe ground clip to the Type 3A5 vertical board, pin K, and the tip to the vertical board, pin J.

27. Check Signal/Trigger Amplifier DC Output Voltage

a. Set up the equipment and make the connections shown in Fig. 6-24.

b. With the Type 561A trace at the crt electrical center, the test oscilloscope trace dc level must be within not more than 3 divisions above or below graticule centerline. The test oscilloscope is set for 0.5 volt per division—so 3 divisions equal 1.5 volts. Thus, the Type 3A5 trigger amplifier output dc level must be $\leq \pm 1.5$ volts as measured with the test oscilloscope.

28. Check Signal/Trigger Amplifier Gain

a. Set the Type 3A5 Input Coupling to AC—TRACE STABILIZED. Set the Standard Amplitude Calibrator controls as stated under Fig. 6-24. Connect a 50 Ω coax from the Calibrator Output (right side) to the Type 3A5 INPUT connector. The Type 561A display should be 0.2 division peak to peak.

b. Change the test oscilloscope Type 1A1 Input Selector to AC and the Volts/Cm switch to .01 (0.1 volt/cm with 10× probe). Adjust the Type 543B triggering controls for a stable display. The Type 543B display amplitude must be $\geq$0.3 volt peak to peak.

c. Change the Type 1A1 Volts/Cm switch to .2. Change the Calibrator Amplitude control to 50 mvolts. The test oscilloscope display must be $\geq$5 volts peak to peak.

d. Change the Type 1A1 Volts/Cm switch to .005. Change the Calibrator Amplitude control to .2 mvolts. Change the Type 3A5 MANUAL VOLTS/DIV switch to 1 mV. The test oscilloscope display must be at least 0.03 volts peak to peak, equal to at least 0.3 major divisions peak to peak.

e. Set the Type 1A1 Volts/Cm switch to .01. Set the Calibrator Amplitude control to 5 mV. The test oscilloscope display must be 0.5 volts or greater peak to peak, equal to 5 major divisions or greater peak to peak.

Leave the test oscilloscope probe as connected. Disconnect the Standard Amplitude Calibrator.

29. Check Signal/Trigger Amplifier High and Low Frequency Response

a. Set the Type 3A5 MANUAL VOLTS/DIV switch to 10 mV, and the Input Coupling to DC. Center the trace.

Set the test oscilloscope Time/Cm switch to 10 μSEC; the Type 1A1 Volts/Cm switch to .02.

Connect a 50 Ω termination to the Type 3A5 INPUT connector. Install a 50 Ω coax between the Type 191 Output connector and the termination. Set the Type 191 controls as stated under Fig. 6-24. The Type 561A crt display should be set to 1 division peak to peak by adjusting the Type 191 Variable control.

b. Adjust the Type 1A1 Variable Volts/Cm control counterclockwise to obtain a test oscilloscope display exactly four divisions peak to peak.

c. Set the Type 191 Frequency Range switch to the 3-8 MHz range. Set the Frequency Adjust control for 8 MHz output. The test oscilloscope display must be $\geq$2.8 divisions peak to peak.

d. Leave the test oscilloscope probe as connected. Disconnect the Type 191. Remove the 50 Ω termination from the Type 3A5 INPUT connector.

e. Set the low frequency audio oscillator for 10 cycles output for a 10 mV peak-to-peak signal. Connect a 50 Ω coax from the signal generator output to the Type 3A5 INPUT connector. If using the Heath IG-72, use item number 16 of Equipment Required between the generator output terminals and the coax. The clip lead to BNC adapter center conductor is the red lead. Adjust the signal generator output for 1 division peak to peak on the Type 561A crt display.

f. Set the Type 1A1 Volts/Cm to .01 and the Variable Volts/Cm to Calib. Set the Type 543B Time/Cm switch to 50 msec. The test oscilloscope display must be $\geq$1 division (0.1 volt) peak to peak.

Disconnect the test oscilloscope probe and the low frequency signal generator.

AUTOMATIC CIRCUITS

30. Adjust DISPLAY SIZE Control, R702

a. Test equipment remains the same as in Fig. 6-24. Remove the test oscilloscope 10× probe from the Type 3A5 circuits. It will be used again in Step 33. Remove any input signal.

Control Settings

Type 3A5

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	**DC**
Mode	**MAN**

Time Base

Time/div	**.5 msec**
Variable	Cal
Trigger Mode	Auto
Triggering Level	Midrange
Slope	+
Coupling	AC
Source	INT

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Standard Amplitude Calibrator

Amplitude	**50 mvolts**
Mode	Square Wave
Mixed	Up

Connections

a. Beginning at Step 30d, use a 50 Ω coax cable and connect the Calibrator right-side OUTPUT connector to the Type 3A5 INPUT connector.

NOTE

This step is written for a DISPLAY SIZE adjustment to match the Characteristics stated in Section 1 of this manual. Other limits may be used at the option of the user.

b. With no input signal, obtain a free run trace. Position the trace above the graticule centerline until the overscan lamp (the small neon lamp located just above the POSITION control) turns on. Note the trace position. Move the trace below the graticule centerline until the overscan lamp turns on. Note the trace position.

The trace should have moved farther from graticule center in one direction than in the other before causing the overscan lamp to light. Position the trace in the direction it moved farthest and set it exactly 3.5 divisions from graticule center. Record the trace position. Using a small screwdriver, adjust the DISPLAY SIZE control so that the overscan lamp blinks periodically. To find the correct DISPLAY SIZE setting, adjust the control so that the overscan lamp lights steadily, then back it off so the lamp blinks.

c. Position the trace to the opposite half of the graticule, and note the vertical position at which the overscan lamp starts blinking. This position must be no closer than 2.1 divisions from graticule center. Record the trace position. This DISPLAY SIZE limit represents maximum allowable error in vertical amplifier balance and crt electrical center. Normally, if the DISPLAY SIZE control is adjusted with the trace 3.5 divisions from center in one half of the graticule, the overscan lamp will blink only when the display is 3 or more divisions from center in the other half.

Fig. 6-25 illustrates the worst-case limits of DISPLAY SIZE in a Type 561A system which has its electrical center 0.7 division from graticule center. Since this is the maximum allowable deviation in all oscilloscopes with which the Type 3A5 may be operated, Fig. 6-25 applies to all uses of the Type 3A5.

d. Make the connection stated in Step 30a.

e. Use Table 6-4 and determine that the automatic seeking circuit will operate the Type 3A5 deflection factor correctly through each attenuator range, starting at 10 mV/DIV. Start by setting the Standard Amplitude Calibrator Amplitude control at 50 mvolts. Hold the SEEK button depressed and advance the Amplitude control one step at a time according to Table 6-4.

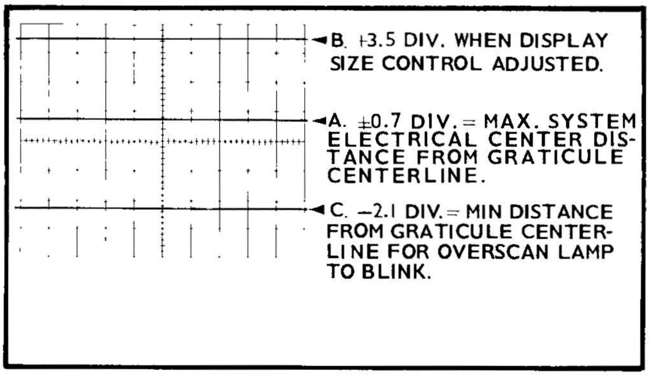


Fig. 6-25. Worst-case DISPLAY SIZE limits.

If all deflection factors presented on the readout board are incorrect or erratic, a problem probably exists in the Display Comparator Multi and Gating circuits. If only one deflection factor readout is in error, or each deflection factor with a common number in its value is in error, the problem is probably in the Ring Counter circuits.

TABLE 6-4

Verification Of Automatic Deflection Factor Selection

Readout Panel Deflection Factor	Standard Amplitude Calibrator AMPLITUDE Control	Vertical Deflection In Divisions	% Error
10 mV	50 mV	5	±3%
20 mV	0.1 V	5	±3%
50 mV	0.2 V	4	±3%
.1 V	0.5 V	5	±3%
.2 V	1 V	5	±3%
.5 V	2 V	4	±3%
1 V	5 V	5	±3%
2 V	10 V	5	±3%
5 V	20 V	4	±3%
10 V	50 V	5	±3%
20 V	100 V	5	±3%
50 V[1]	100 V	2[1]	±3%; ±0.3 minor div.

[1]Obtained by positioning display top upward until deflection factor is changed to 50 V/DIV.

31. Check SEEK Operation At 20 MHz and 60 Hz

a. Disconnect the Standard Amplitude Calibrator.

Control Settings

Type 3A5

MANUAL VOLTS/DIV	10 mV
VARIABLE	CAL
Input Coupling	**AC**
Mode	MAN

Time Base

Time/div	**10 μsec**
All others the same.	

Type 191

Amplitude Range	5-50 mV
Amplitude	**50**
Variable	**Five division display**
Frequency Range	50 kHz
Frequency Control	**20 of 18-42 Range**

Connections

a. Install a 50 Ω termination on the Type 3A5 INPUT connector. Use a 50 Ω coax cable from the Type 191 Output connector to the termination.

b. Obtain a triggered display of five divisions peak to peak.

c. Change the Time Base Time/div control to .05 μsec, and the Type 191 Frequency Range control to the 18-42 MHz range. Obtain a stable display.

d. Position the display + peaks slightly above the trip level recorded in Step 30 b, and press the SEEK button. The mode must change to SEEK, and the deflection factor to 50 mV/DIV. Position the display to center screen and press the SEEK button. The deflection factor must change to 10 mV/DIV.

e. Position the display negative peaks slightly below the trip level recorded in Step 30 c, and press the SEEK button. The deflection factor must change to 50 mV/DIV. Position the display to center screen and press the SEEK button, the deflection factor must change to 10 mV/DIV.

f. Disconnect the Type 191 and remove the 50 Ω termination.

Control Settings

Type 3A5

No Change

Time Base

Time/div	10 msec
No other change.	

IG-72 Audio Generator

Multiplier	×1
Cycles (Left)	**60**
Cycles (Center)	0
Int/Ext 600 Ω Load Sw	Int
Output Switch	**—30/.03**
Output Variable	**For five division display**

Connections

Connect a 50 Ω coax from the Audio Generator output to the Type 3A5 INPUT connector. Use the BNC to clip lead adapter at the Audio Generator output terminals.

g. Obtain a triggered display of the 60 Hz signal at five divisions peak to peak. Position the display positive peaks slightly above the trip level recorded in Step 30 b, and press the SEEK button. The deflection factor must change from 10 mV/DIV to 50 mV/DIV. Position the display to center screen and press the SEEK button. The deflection factor must change to 10 mV/DIV.

h. Position the display negative peaks slightly below the trip level recorded in Step 30 c, and press the SEEK button. The deflection factor must change to 50 mV/DIV. Center the display and press the SEEK button. The deflection factor must change to 10 mV/DIV.

32. Check REMOTE SEEK Operation

NOTE

This step is to be performed only when the companion time-base unit is a Type 3B5 Automatic/Programmable Time Base.

a. Disconnect the signal cable from both the Audio Generator and the Type 3A5. Connect a P6030 10× Probe to the Type 3A5 INPUT connector and the probe small phono plug into the REMOTE SEEK jack. Check the probe compensation. Set the MANUAL VOLTS/DIV switch to 10 mV.

Control Settings

IG-72 Audio Generator

Multiplier	X100
Output Switch	—10/.3
No other change. Frequency is now 6 kHz.	

Type 3B5

MANUAL TIME/DIV	.5 mSEC
VARIABLE	CAL
Mode	MAN
DLY'D SWP MAG	OFF
SLOPE	+
TRIGGER	AC/INT

b. Connect the probe ground clip to the Audio Generator ground terminal and the probe tip to the signal output terminal. Adjust the Type 3B5 LEVEL control for a stable display.

c. Change the Audio Generator OUTPUT switch to 0/1 and press the P6030 Probe SEEK button. The display will first extend past the graticule top and bottom, and then as the P6030 Probe SEEK button is pressed, will reduce in amplitude and show as many cycles as the Type 3B5 is calibrated to display.

The Type 3B5 will not respond when the Type 3A5 front-panel SEEK button is pressed.

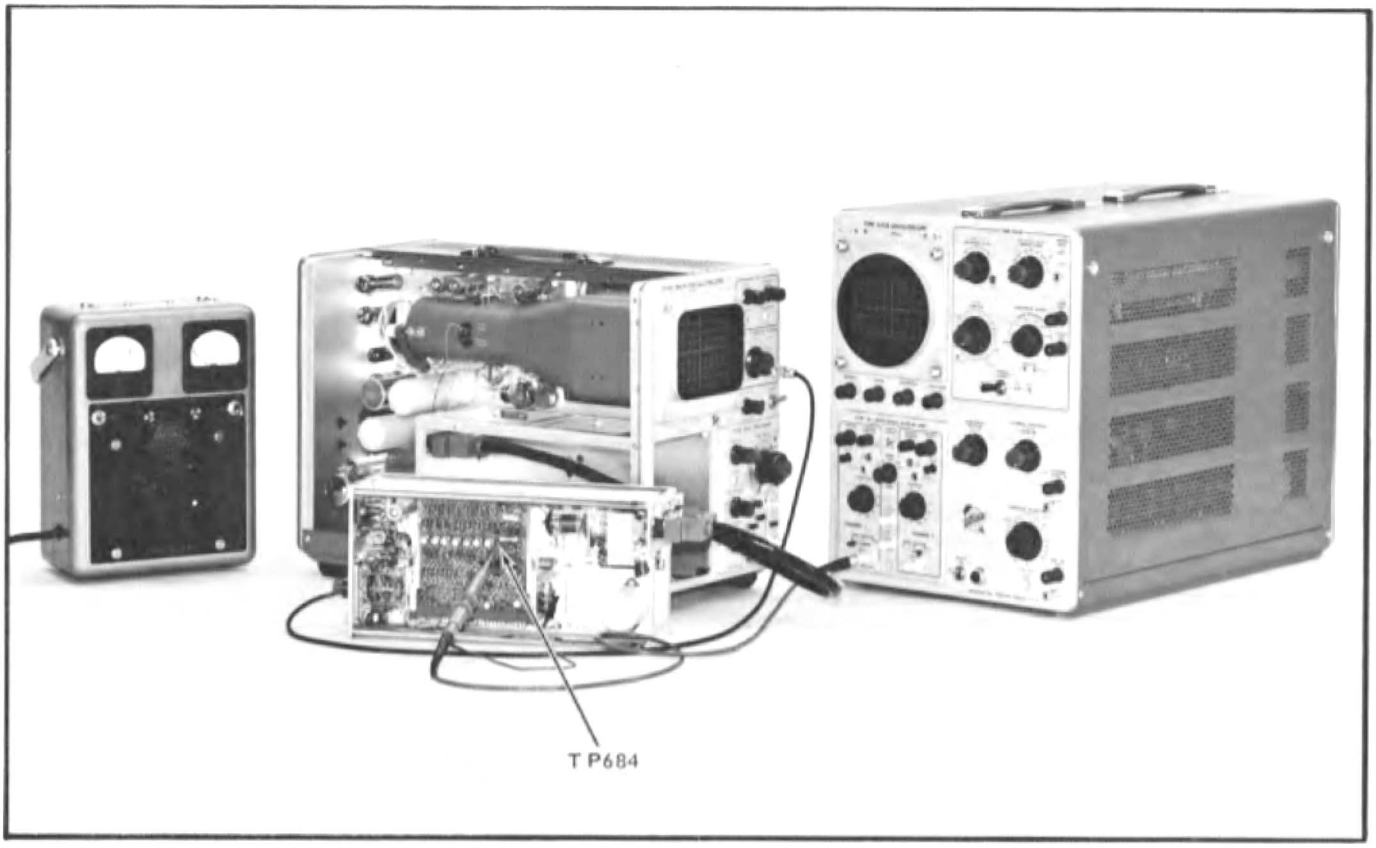


Fig. 6-26. Test equipment setup for checking SEEK multi and Advance pulse times, Step 33.

Control Settings

Type 3A5

MANUAL VOLTS/DIV	**50 V/DIV**
VARIABLE	CAL
Input Coupling	DC
POSITION	**Display zero at −1 division**

Time Base

Time/Div	**5 msec**
Variable	Cal
Trigger Mode	Auto
Triggering Level	Midrange
Slope	+
Coupling	**DC**
Source	**Line**

Type 561A

Calibrator	**100 volts**

Type 1A1

Volts/Cm (Ch 1)	**1**
Mode	Ch 1
Variable Volts/Cm	Calib
Position	Centered display
Norm/Invert	Norm
Input Selector	**AC**

Type 543B

Trigger Slope	+Int
Triggering Mode	**Auto**
Stability	Preset
Triggering Level	Midrange
Time/Cm	**1 sec**
Variable	Calibrated
Horizontal Display	Normal
Sweep Switch	Normal Sweep
Horizontal Position	Midrange

Connections

Install a 10× Probe on the test oscilloscope Channel 1 Input connector. Attach the probe ground clip to the Type 3A5 near the Automatic Card, and the probe tip to Test Point TP684 on the Automatic Card.

Connect the Type 561A Calibrator Cal Out connector to the Type 3A5 INPUT connector with a 50 Ω coax.

33. Check SEEK Multi Pulse and Advance Pulse Times

a. Make the connections and control settings recommended under Fig. 6-26. The display should be 2 divisions peak to peak.

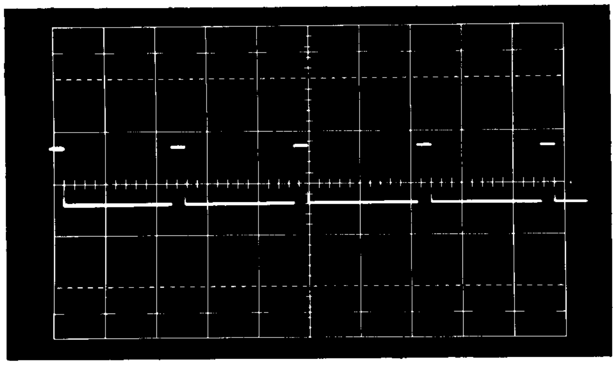
b. Press and hold down the Type 3A5 SEEK button, and obtain a test oscilloscope display similar to Fig. 6-27A. The Type 3A5 deflection factor readout must be 50 V/DIV. The time between test oscilloscope display positive pulses must be between 2 and 4 seconds after the SEEK button has been held down for 5 seconds.

c. Change the test oscilloscope sweep rate to 50 msec/div and the triggering for +Int, AC Mode (not Auto). Press and hold the Type 3A5 SEEK button. The display will now be similar to Fig. 6-27B, and the time the signal is positive must be equal to or greater than 200 msec (more than 4 horizontal divisions).

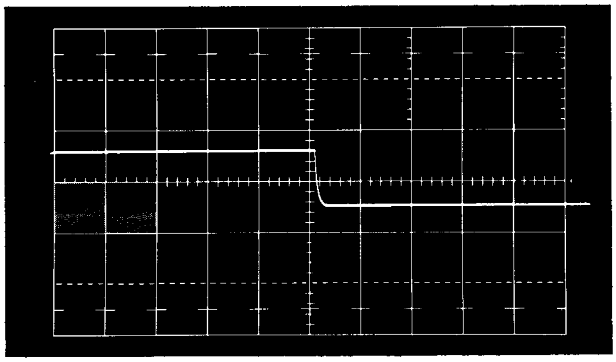
d. Change the test oscilloscope sweep rate to 20 msec/div and for —Int AC triggering. Move the probe tip to Test Point TP754 and press the SEEK button. The series of negative Advance Pulses must be completed in less than 200 msec, or in less than 10 divisions, as in Fig. 6-27C.

EXTERNAL PROGRAMMING

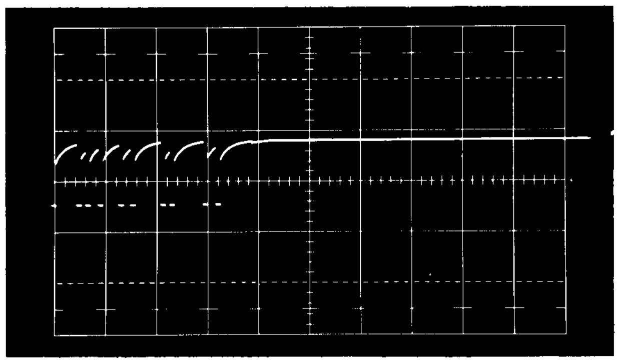
No test procedure is given here, since external operation requires special programming equipment. Each user has different external programming needs, so use your own programmer and check that the system performs as required. If you use the Tektronix Type 263 Programmer, use the checkout procedure in the Type 263 Instruction Manual.



a. I sec/div.



b. 50 msec/div.



c. 20 msec/div.

Fig. 6-27. Step 33 waveforms.

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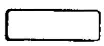
PARTS ORDERING INFORMATION

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.
	Heat sink.

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
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
EMC	electrolytic, metal cased
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
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
λ	lambda—wavelength
$<$	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
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
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference
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
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

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
B104	150-0035-00	Neon, A1D				
B420	150-0049-00	Incandescent, #6835		5 V	60 mA	
B422	150-0054-00	Incandescent, #683	w/red coating tinned leads			
B601	150-0049-00	Incandescent, #6835		5 V	60 mA	
B602	150-0049-00	Incandescent, #6835		5 V	60 mA	
B603	150-0049-00	Incandescent, #6835		5 V	60 mA	
B605	150-0049-00	Incandescent, #6835		5 V	60 mA	
B606	150-0048-00	Incandescent, #683		5 V	60 mA	
B607	150-0049-00	Incandescent, #6835		5 V	60 mA	
B620	150-0049-00	Incandescent, #6835		5 V	60 mA	
B621	150-0049-00	Incandescent, #6835		5 V	60 mA	
B624	150-0049-00	Incandescent, #6835		5 V	60 mA	
B626	150-0048-00	Incandescent, #683		5 V	60 mA	
B627	150-0049-00	Incandescent, #6835		5 V	60 mA	
B628	150-0048-00	Incandescent, #683		5 V	60 mA	
B629	150-0048-00	Incandescent, #683		5 V	60 mA	
B736	150-0055-00	Neon, 5 AB-B				

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description					S/N Range
C1	*285-0708-00	0.04 μF	PTM		600 V	+5% −15%	
C7	281-0536-00	1000 pF	Cer		500 V	10%	
C12	281-0536-00	1000 pF	Cer		500 V	10%	
C15A	281-0102-00	1.7-11 pF	Air	Var			
C15B	281-0544-00	5.6 pF	Cer		500 V	10%	
C15D }	281-0104-00	0.2-1.5 pF	Tub.	Var			
C15H }		0.5 pF	Mica				
C15E	281-0538-00	1 pF	Cer		500 V		
C22	281-0536-00	1000 pF	Cer		500 V	10%	
C25A	281-0102-00	1.7-11 pF	Air	Var			
C25B	281-0544-00	5.6 pF	Cer		500 V	10%	
C25D }	281-0113-00	0.2-1.5 pF	Tub.	Var			
C25F }		100 pF	Mica				
C32	281-0536-00	1000 pF	Cer		500 V	10%	
C35A	281-0102-00	1.7-11 pF	Air	Var			
C35B	281-0572-00	6.8 pF	Cer		500 V	10%	
C35D }	281-0108-00	0.2-1.5 pF	Tub.	Var			
C35F }		1000 pF	Mica				
C47	281-0536-00	1000 pF	Cer		500 V	10%	
C52	281-0536-00	1000 pF	Cer		500 V	10%	

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C55A	281-0064-00	0.2-1.5 pF	Tub.	Var			
C55B	281-0526-00	1.5 pF	Cer		500 V	±0.5 pF	
C55D	281-0102-00	1.7-11 pF	Air	Var			
C55E	281-0572-00	6.8 pF	Cer		500 V	10%	
C62	281-0536-00	1000 pF	Cer		500 V	10%	
C65A	281-0102-00	1.7-11 pF	Air	Var			
C65D	281-0101-00	1.5-9.1 pF	Air	Var			
C70	281-0064-00	0.2-1.5 pF	Tub.	Var			
C101	281-0613-00	10 pF	Cer		200 V	10%	
C102	281-0591-00	5600 pF	Cer		200 V		
C106	283-0092-00	0.03 μF	Cer		200 V	+80% —20%	
C110	283-0079-00	0.01 μF	Cer		250 V		
C115	283-0079-00	0.01 μF	Cer		250 V		
C122	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C124	283-0067-00	0.001 μF	Cer		200 V	10%	
C128	281-0546-00	330 pF	Cer		500 V	10%	
C134	283-0079-00	0.01 μF	Cer		250 V		
C145	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C151	281-0513-00	27 pF	Cer		500 V		
C152	281-0092-00	9-35 pF	Cer	Var			
C153	281-0524-00	150 pF	Cer		500 V		
C154	281-0550-00	120 pF	Cer		500 V	10%	
C155	281-0518-00	47 pF	Cer		500 V		
C157	281-0525-00	470 pF	Cer		500 V		
C164	281-0552-00	25 pF	Cer		500 V		
C166	281-0549-00	68 pF	Cer		500 V	10%	
C176	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C198	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C206	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C210	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C213	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C216	283-0079-00	0.01 μF	Cer		250 V		
C306	283-0059-00	1 μF	Cer		25 V	+80% —20%	
C308	283-0089-00	82 pF	Cer		1000 V	5%	
C324	283-0067-00	0.001 μF	Cer		200 V	10%	
C328	281-0546-00	330 pF	Cer		500 V	10%	
C352	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C366	281-0549-00	68 pF	Cer		500 V	10%	
C404	290-0138-00	330 μF	EMC		6 V		
C422	290-0029-00	2000 μF	EMC		20 V		
C426	290-0121-00	2 μF	EMC		25 V		
C430	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C432	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C438	283-0081-00	0.1 μF	Cer		25 V	+80% —20%	
C508	283-0029-00	0.005 μF	Cer		500 V	5%	

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C510	283-0051-00	0.0033 μF	Cer	100 V	5%	
C511	283-0027-00	0.02 μF	Cer	30 V		
C512	283-0029-00	0.005 μF	Cer	500 V	5%	
C520	281-0516-00	39 pF	Cer	500 V	10%	
C530	281-0523-00	100 pF	Cer	350 V		
C540	283-0079-00	0.01 μF	Cer	250 V		
C544	283-0079-00	0.01 μF	Cer	250 V		
C546	281-0591-00	5600 pF	Cer	200 V		
C550	283-0079-00	0.01 μF	Cer	250 V		
C556	281-0591-00	5600 pF	Cer	200 V		
C564	281-0597-00	2500 pF	Cer	500 V		
C638	290-0248-01	150 μF	EMT	15 V		
C640	283-0079-00	0.01 μF	Cer	250 V		

Diodes

D1	*152-0075-00	Germanium	Tek Spec
D5	*152-0075-00	Germanium	Tek Spec
D10	*152-0075-00	Germanium	Tek Spec
D20	*152-0075-00	Germanium	Tek Spec
D30	*152-0075-00	Germanium	Tek Spec
D45	*152-0075-00	Germanium	Tek Spec
D50	*152-0075-00	Germanium	Tek Spec
D60	*152-0075-00	Germanium	Tek Spec
D80	*152-0107-00	Silicon	Replaceable by 1N647
D82	*152-0107-00	Silicon	Replaceable by 1N647
D84	*152-0107-00	Silicon	Replaceable by 1N647
D90	*152-0107-00	Silicon	Replaceable by 1N647
D92	*152-0107-00	Silicon	Replaceable by 1N647
D96	*152-0107-00	Silicon	Replaceable by 1N647
D188	152-0071-00	Germanium	ED 2007
D204	*152-0075-00	Germanium	Tek Spec
D300	*152-0075-00	Germanium	Tek Spec
D315	152-0071-00	Germanium	ED 2007
D316	152-0071-00	Germanium	ED 2007
D388	152-0071-00	Germanium	ED 2007
D404	*152-0075-00	Germanium	Tek Spec
D422A,B,C,D	152-0199-00	Rectifier bridge MDA 962-3 (Motorola)	
D515	*152-0075-00	Germanium	Tek Spec
D524	152-0141-00	Silicon	1N3605
D534	152-0141-00	Silicon	1N3605
D546 D556	*152-0235-00	Zener, matched pair, 0.4 W, 60 V, 10%	
D601	*152-0107-00	Silicon	Replaceable by 1N647
D602	*152-0107-00	Silicon	Replaceable by 1N647
D603	*152-0107-00	Silicon	Replaceable by 1N647

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description		S/N Range
D606	*152-0107-00	Silicon	Replaceable by 1N647	
D607	*152-0107-00	Silicon	Replaceable by 1N647	
D608	*152-0107-00	Silicon	Replaceable by 1N647	
D610	*152-0107-00	Silicon	Replaceable by 1N647	
D612	*152-0107-00	Silicon	Replaceable by 1N647	
D614	*152-0075-00	Germanium	Tek Spec	
D615	*152-0075-00	Germanium	Tek Spec	
D618	*152-0075-00	Germanium	Tek Spec	
D620	*152-0107-00	Silicon	Replaceable by 1N647	
D624	*152-0075-00	Germanium	Tek Spec	
D626	*152-0185-00	Silicon	Replaceable by 1N3605	
D628	*152-0185-00	Silicon	Replaceable by 1N3605	
D630	*152-0075-00	Germanium	Tek Spec	
D632	*152-0075-00	Germanium	Tek Spec	
D650	*152-0075-00	Germanium	Tek Spec	
D705	*152-0075-00	Germanium	Tek Spec	

Connectors

J1	131-0106-00	Coaxial, 1 contact, female
J670	131-0407-00	Jack, Telephone Spring Leaf

Inductors

L1	*108-0358-00	Coil, Reed Drive		
L5	*108-0356-00	Coil, Reed Drive, Push-In		
L10	*108-0358-00	Coil, Reed Drive		
L18	*108-0358-00	Coil, Reed Drive		
L20	*108-0358-00	Coil, Reed Drive		
L28	*108-0358-00	Coil, Reed Drive		
L30	*108-0358-00	Coil, Reed Drive		
L38	*108-0358-00	Coil, Reed Drive		
L45	*108-0356-00	Coil, Reed Drive, Push-In		
L50	*108-0358-00	Coil, Reed Drive		
L58	*108-0358-00	Coil, Reed Drive		
L60	*108-0358-00	Coil, Reed Drive		
L68	*108-0358-00	Coil, Reed Drive		
L122	108-0226-00	100 μH		
L162	*119-0059-00	Delay Line Assembly		
L176	*108-0359-00	Toroid, 100 μH		
L300	*108-0358-00	Coil, Reed Drive		
L515	*108-0356-00	Coil, Reed Drive, Push-In		
L526	*114-0192-00	12-24 μH	Var	core 276-0506-00
L536	*114-0192-00	12-24 μH	Var	core 276-0506-00
L612	*108-0357-00	Coil, Reed Drive		
L618	*108-0358-00	Coil, Reed Drive		
L622	*108-0357-00	Coil, Reed Drive		
L638	*108-0359-00	Toroid, 100 μH		

Transistors

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q108	151-0179-00	2N3877A	
Q123	151-0162-00	2N3324	
Q134	*151-0142-00	Selected from 2N3546	
Q143	*151-0120-00	Selected from 2N2475	
Q154	151-0107-00	2N967	
Q174	151-0175-00	2N3662	
Q183	*151-0120-00	Selected from 2N2475	
Q194	151-0164-00	2N3702	
Q204	*151-0155-00	Replaceable by 2N2925	
Q213	*151-0120-00	Selected from 2N2475	
Q323	151-0162-00	2N3324	
Q334	*151-0142-00	Selected from 2N3546	
Q343	*151-0120-00	Selected from 2N2475	
Q354	151-0107-00	2N967	
Q374	151-0175-00	2N3662	
Q383	*151-0120-00	Selected from 2N2475	
Q394	151-0164-00	2N3702	
Q404	*151-0127-00	Selected from 2N2369	
Q423	*151-0103-00	Replaceable by 2N2219	
Q424	*151-0155-00	Replaceable by 2N2925	
Q504	*151-0142-00	Selected from 2N3546	
Q514	*151-0142-00	Selected from 2N3546	
Q624	*151-0183-00	Selected from 2N2192	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R1	316-0122-00	1.2 k	¼ W		
R7	317-0200-00	20 Ω	1/10 W		5%
R12	317-0200-00	20 Ω	1/10 W		5%
R15A	322-0658-00	900 k	¼ W	Prec	½%
R15D	321-0712-00	111 k	⅛ W	Prec	½%
R22	317-0200-00	20 Ω	1/10 W		5%
R25A	322-0659-00	990 k	¼ W	Prec	½%
R25D	321-0711-00	10.1 k	⅛ W	Prec	½%
R32	317-0200-00	20 Ω	1/10 W		5%
R35A	322-0629-00	999 k	¼ W	Prec	1%
R35D	321-0193-00	1 k	⅛ W	Prec	1%
R47	317-0200-00	20 Ω	1/10 W		5%
R52	317-0200-00	20 Ω	1/10 W		5%
R55A	322-0610-00	500 k	¼ W	Prec	1%
R55D	322-0481-00	1 meg	¼ W	Prec	1%
R62	317-0200-00	20 Ω	1/10 W		5%
R65A	322-0620-00	800 k	¼ W	Prec	1%
R65D	321-0618-00	250 k	⅛ W	Prec	1%
R70	322-0481-00	1 meg	¼ W	Prec	1%
R90	301-0101-00	100 Ω	½ W		5%

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.	Description					S/N Range
R92	301-0101-00	100 Ω	½ W			5%	
R94	301-0101-00	100 Ω	½ W			5%	
R96	301-0101-00	100 Ω	½ W			5%	
R101	315-0391-00	390 Ω	¼ W			5%	
R102	315-0104-00	100 k	¼ W			5%	
R104	315-0101-00	100 Ω	¼ W			5%	
R106	315-0223-00	22 k	¼ W			5%	
R107	315-0393-00	39 k	¼ W			5%	
R108	301-0332-00	3.3 k	½ W			5%	
R110	315-0470-00	47 Ω	¼ W			5%	
R113	303-0273-00	27 k	1 W			5%	
R115	315-0470-00	47 Ω	¼ W			5%	
R120	307-0106-00	4.7 Ω	¼ W			5%	
R123	315-0471-00	470 Ω	¼ W			5%	
R124	315-0301-00	300 Ω	¼ W			5%	
R125	321-0137-00	261 Ω	⅛ W		Prec	1%	
R128	321-0014-00	13.7 Ω	⅛ W		Prec	1%	
R130	*311-0544-00	100 Ω		Var			
R132	308-0313-00	20 k	3 W		WW	1%	
R134	315-0102-00	1 k	¼ W			5%	
R140	322-0187-00	866 Ω	¼ W		Prec	1%	
R143	315-0182-00	1.8 k	¼ W			5%	
R145	307-0106-00	4.7 Ω	¼ W			5%	
R150	322-0145-00	316 Ω	¼ W		Prec	1%	
R153	311-0480-00	500 Ω		Var			
R154	315-0102-00	1 k	¼ W			5%	
R155	315-0272-00	2.7 k	¼ W			5%	
R157	315-0822-00	8.2 k	¼ W			5%	
R160	315-0820-00	82 Ω	¼ W			5%	
R164	315-0102-00	1 k	¼ W			5%	
R166	321-0093-00	90.9 Ω	⅛ W		Prec	1%	
R167	315-0102-00	1 k	¼ W			5%	
R170	315-0152-00	1.5 k	¼ W			5%	
R172	311-0576-00	2 X 1 k		Var			
R174	321-0146-00	324 Ω	⅛ W		Prec	1%	
R176	323-0122-00	182 Ω	½ W		Prec	1%	
R178	322-0134-00	243 Ω	¼ W		Prec	1%	
R179	321-0115-00	154 Ω	⅛ W		Prec	1%	
R183	321-0115-00	154 Ω	⅛ W		Prec	1%	
R184	315-0270-00	27 Ω	¼ W			5%	
R186	311-0095-00	500 Ω		Var			
R188	315-0101-00	100 Ω	¼ W			5%	
R194	321-0093-00	90.9 Ω	⅛ W		Prec	1%	
R196	315-0221-00	220 Ω	¼ W			5%	
R198	315-0821-00	820 Ω	¼ W			5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R200	315-0181-00	180 Ω	¼ W			5%	
R202	315-0181-00	180 Ω	¼ W			5%	
R204	315-0202-00	2 k	¼ W			5%	
R206	307-0106-00	4.7 Ω	¼ W			5%	
R210	307-0106-00	4.7 Ω	¼ W			5%	
R213	315-0471-00	470 Ω	¼ W			5%	
R214	315-0470-00	47 Ω	¼ W			5%	
R216	315-0302-00	3 k	¼ W			5%	
R218	322-0394-00	124 k	¼ W		Prec	1%	
R300A,B	311-0321-00	2 X 500 k		Var			
R302	315-0335-00	3.3 meg	¼ W			5%	
R303	315-0182-00	1.8 k	¼ W			5%	
R304	315-0274-00	270 k	¼ W			5%	
R306	315-0101-00	100 Ω	¼ W			5%	
R308	316-0106-00	10 meg	¼ W				
R309	321-0430-00	294 k	⅛ W		Prec	1%	
R311	309-0377-00	3 meg	½ W		Prec	1%	
R313	303-0273-00	27 k	1 W			5%	
R315	315-0101-00	100 Ω	¼ W			5%	
R320	307-0106-00	4.7 Ω	¼ W			5%	
R323	315-0471-00	470 Ω	¼ W			5%	
R324	315-0301-00	300 Ω	¼ W			5%	
R325	321-0137-00	261 Ω	⅛ W		Prec	1%	
R328	321-0014-00	13.7 Ω	⅛ W		Prec	1%	
R332	308-0313-00	20 k	3 W		WW	1%	
R343	315-0182-00	1.8 k	¼ W			5%	
R350	322-0145-00	316 Ω	¼ W			5%	
R352	307-0106-00	4.7 Ω	¼ W			5%	
R354	321-0074-00	57.6 Ω	⅛ W		Prec	1%	
R360	315-0820-00	82 Ω	¼ W			5%	
R366	321-0093-00	90.9 Ω	⅛ W		Prec	1%	
R367	315-0102-00	1 k	¼ W			5%	
R370	315-0152-00	1.5 k	¼ W			5%	
R374	321-0146-00	324 Ω	⅛ W		Prec	1%	
R378	322-0134-00	243 Ω	¼ W		Prec	1%	
R379	321-0115-00	154 Ω	⅛ W		Prec	1%	
R383	321-0115-00	154 Ω	⅛ W		Prec	1%	
R384	315-0270-00	27 Ω	¼ W			5%	
R388	315-0101-00	100 Ω	¼ W			5%	
R394	321-0093-00	90.9 Ω	⅛ W		Prec	1%	
R396	315-0221-00	220 Ω	¼ W			5%	
R400	315-0181-00	180 Ω	¼ W			5%	
R404	315-0202-00	2 k	¼ W			5%	
R408	315-0751-00	750 Ω	¼ W			5%	
R422	301-0473-00	47 k	½ W			5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R424	315-0270-00	27 Ω	¼ W			5%	
R426	321-0227-00	2.26 k	⅛ W		Prec	1%	
R427	322-0280-00	8.06 k	¼ W		Prec	1%	
R430	315-0510-00	51 Ω	¼ W			5%	
R432	307-0106-00	4.7 Ω	¼ W			5%	
R438	307-0106-00	4.7 Ω	¼ W			5%	
R503	321-0099-00	105 Ω	⅛ W		Prec	1%	
R504	321-0125-00	196 Ω	⅛ W		Prec	1%	
R506	321-0004-00	10.7 Ω	⅛ W		Prec	1%	
R507	321-0004-00	10.7 Ω	⅛ W		Prec	1%	
R508	315-0101-00	100 Ω	¼ W			5%	
R510	315-0300-00	30 Ω	¼ W			5%	
R511	315-0121-00	120 Ω	¼ W			5%	
R512	321-0001-00	10 Ω	⅛ W		Prec	1%	
R514	321-0125-00	196 Ω	⅛ W		Prec	1%	
R518	323-0626-00	50 Ω	½ W		Prec	1%	
R520	315-0681-00	680 Ω	¼ W			5%	
R521	308-0387-00	178 Ω	3 W		WW	1%	
R522	308-0387-00	178 Ω	3 W		WW	1%	
R526	*310-0629-00	1.05 k	11 W		Prec	1%	
R528	308-0282-00	1.35 k	25 W		WW	5%	
R530	309-0275-00	2.15 meg	½ W		Prec		
R536	*310-0629-00	1.05 k	11 W		Prec	1%	
R540	315-0104-00	100 k	¼ W			5%	
R542	302-0333-00	33 k	½ W				
R544	315-0101-00	100 Ω	¼ W			5%	
R546	301-0823-00	82 k	½ W			5%	
R550	315-0104-00	100 k	¼ W			5%	
R552	302-0333-00	33 k	½ W				
R556	301-0823-00	82 k	½ W			5%	
R605	301-0101-00	100 Ω	½ W			5%	
R624	315-0470-00	47 Ω	¼ W			5%	
R626	315-0271-00	270 Ω	¼ W			5%	
R628	315-0104-00	100 k	¼ W			5%	
R630	315-0470-00	47 Ω	¼ W			5%	
R632	315-0470-00	47 Ω	¼ W			5%	
R636	306-0102-00	1 k	2 W				
R637	305-0562-00	5.6 k	2 W			5%	
R640	315-0470-00	47 Ω	¼ W			5%	
R701	315-0750-00	75 Ω	¼ W			5%	
R702	311-0169-00	100 Ω		Var			
R704	301-0361-00	360 Ω	½ W			5%	

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Switches

Ckt. No.	Tektronix Part No. Unwired	Wired	Description		S/N Range
SW1	260-0722-00		Reed		
SW5	260-0722-00		Reed		
SW10	260-0722-00		Reed		
SW18	260-0722-00		Reed		
SW20	260-0722-00		Reed		
SW28	260-0722-00		Reed		
SW30	260-0722-00		Reed		
SW38	260-0722-00		Reed		
SW45	260-0722-00		Reed		
SW50	260-0722-00		Reed		
SW58	260-0722-00		Reed		
SW60	260-0722-00		Reed		
SW68	260-0722-00		Reed		
SW70	260-0760-00		Micro		
SW80	260-0690-00	*262-0741-00	Rotary	MANUAL VOLTS/DIV	
SW300	260-0721-00		Reed		
SW424	260-0760-00		Micro		
SW515	260-0552-00		Reed		
SW610	260-0621-00		Lever	INPUT COUPLING	
SW612	260-0552-00		Reed		
SW618	260-0721-00		Reed		
SW620†	*670-0096-00		Push-Button	SEEK	
SW621†	*670-0096-00		Push-Button	EXT	
SW622	260-0721-00		Reed		
SW624†	*670-0096-00		Push-Button	MAN	

Transformers

T160	*120-0286-00	Toroid, 2 turns bifilar
T164	*120-0286-00	Toroid, 2 turns bifilar
T501	276-0512-00	Core, Powder Iron
T524	276-0512-00	Core, Powder Iron
T534	276-0512-00	Core, Powder Iron

Electron Tubes

V113	154-0306-00	7586
V313	154-0306-00	7586
V524	154-0361-00	8233
V534	154-0361-00	8233

† Furnished with the Push-Button Board.

AUTOMATIC CARD

Ckt. No.	Tektronix Part No.	Description				Model No.
	*670-0092-00	Complete Card				

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description				Model No.
C672	290-0158-00	50 μF	EMT	25 V	+75% —15%	
C674	*290-0299-00	330 μF	EMT	10 V		
C714	290-0219-00	5 μF	EMT	25 V		
C723	283-0026-00	0.2 μF	Cer	25 V		
C732	281-0536-00	1000 pF	Cer	500 V	±100 pF	
C801	283-0059-00	1 μF	Cer	25 V	+80% —20%	
C812	283-0026-00	0.2 μF	Cer	25 V		
C819	283-0026-00	0.2 μF	Cer	25 V		
C822	283-0026-00	0.2 μF	Cer	25 V		
C829	283-0026-00	0.2 μF	Cer	25 V		
C832	283-0026-00	0.2 μF	Cer	25 V		
C839	283-0026-00	0.2 μF	Cer	25 V		
C852	283-0026-00	0.2 μF	Cer	25 V		
C859	283-0026-00	0.2 μF	Cer	25 V		
C862	283-0026-00	0.2 μF	Cer	25 V		
C869	283-0026-00	0.2 μF	Cer	25 V		
C872	283-0026-00	0.2 μF	Cer	25 V		
C879	283-0026-00	0.2 μF	Cer	25 V		
C882	283-0026-00	0.2 μF	Cer	25 V		
C889	283-0026-00	0.2 μF	Cer	25 V		

Diodes

Ckt. No.	Tektronix Part No.	Description		Model No.
D652	*152-0075-00	Germanium	Tek Spec	
D660	*152-0075-00	Germanium	Tek Spec	
D661	*152-0075-00	Germanium	Tek Spec	
D662	*152-0075-00	Germanium	Tek Spec	
D664	*152-0185-00	Silicon	Replaceable by 1N3605	
D666	*152-0185-00	Silicon	Replaceable by 1N3605	
D667	*152-0075-00	Germanium	Tek Spec	
D668	*152-0075-00	Germanium	Tek Spec	
D669	*152-0075-00	Germanium	Tek Spec	
D670	*152-0075-00	Germanium	Tek Spec	
D671	*152-0075-00	Germanium	Tek Spec	
D672	*152-0075-00	Germanium	Tek Spec	
D673	*152-0075-00	Germanium	Tek Spec	
D674	*152-0075-00	Germanium	Tek Spec	
D675	*152-0075-00	Germanium	Tek Spec	
D678	*152-0075-00	Germanium	Tek Spec	

AUTOMATIC CARD *(Cont'd)*

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description		Model No.
D684	*152-0185-00	Silicon	Replaceable by 1N3605	
D689	*152-0075-00	Germanium	Tek Spec	
D706	*152-0075-00	Germanium	Tek Spec	
D710	*152-0075-00	Germanium	Tek Spec	
D740	*152-0075-00	Germanium	Tek Spec	
D743	*152-0185-00	Silicon	Replaceable by 1N3605	
D745	*152-0075-00	Germanium	Tek Spec	
D746	*152-0075-00	Germanium	Tek Spec	
D750	*152-0075-00	Germanium	Tek Spec	
D802	*152-0075-00	Germanium	Tek Spec	
D804	*152-0075-00	Germanium	Tek Spec	
D812	*152-0075-00	Germanium	Tek Spec	
D814	*152-0107-00	Silicon	Replaceable by 1N647	
D815	*152-0075-00	Germanium	Tek Spec	
D816	*152-0075-00	Germanium	Tek Spec	
D819	*152-0075-00	Germanium	Tek Spec	
D822	*152-0075-00	Germanium	Tek Spec	
D824	*152-0107-00	Silicon	Replaceable by 1N647	
D826	*152-0075-00	Germanium	Tek Spec	
D829	*152-0075-00	Germanium	Tek Spec	
D832	*152-0075-00	Germanium	Tek Spec	
D834	*152-0107-00	Silicon	Replaceable by 1N647	
D836	*152-0075-00	Germanium	Tek Spec	
D839	*152-0075-00	Germanium	Tek Spec	
D844	*152-0075-00	Germanium	Tek Spec	
D852	*152-0075-00	Germanium	Tek Spec	
D853	*152-0075-00	Germanium	Tek Spec	
D854	*152-0075-00	Germanium	Tek Spec	
D856	*152-0075-00	Germanium	Tek Spec	
D859	*152-0075-00	Germanium	Tek Spec	
D862	*152-0075-00	Germanium	Tek Spec	
D863	*152-0075-00	Germanium	Tek Spec	
D864	*152-0075-00	Germanium	Tek Spec	
D866	*152-0075-00	Germanium	Tek Spec	
D869	*152-0075-00	Germanium	Tek Spec	
D872	*152-0075-00	Germanium	Tek Spec	
D873	*152-0075-00	Germanium	Tek Spec	
D874	*152-0075-00	Germanium	Tek Spec	
D876	*152-0075-00	Germanium	Tek Spec	
D879	*152-0075-00	Germanium	Tek Spec	
D882	*152-0075-00	Germanium	Tek Spec	
D883	*152-0075-00	Germanium	Tek Spec	
D884	*152-0075-00	Germanium	Tek Spec	
D886	*152-0075-00	Germanium	Tek Spec	
D889	*152-0075-00	Germanium	Tek Spec	

AUTOMATIC CARD *(Cont'd)*

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description		Model No.
D901	*152-0075-00	Germanium	Tek Spec	
D902	*152-0075-00	Germanium	Tek Spec	
D905	*152-0075-00	Germanium	Tek Spec	
D906	*152-0075-00	Germanium	Tek Spec	
D907	*152-0075-00	Germanium	Tek Spec	
D911	*152-0075-00	Germanium	Tek Spec	
D912	*152-0075-00	Germanium	Tek Spec	
D915	*152-0075-00	Germanium	Tek Spec	
D916	*152-0075-00	Germanium	Tek Spec	
D917	*152-0075-00	Germanium	Tek Spec	
D920	*152-0075-00	Germanium	Tek Spec	
D930	*152-0075-00	Germanium	Tek Spec	
D935	*152-0107-00	Silicon	Replaceable by 1N647	

Transistors

Ckt. No.	Tektronix Part No.	Description
Q654	*151-0183-00	Selected from 2N2192
Q664	*151-0183-00	Selected from 2N2192
Q674	*151-0155-00	Replaceable by 2N2925
Q684	151-0164-00	2N3702
Q714	151-0164-00	2N3702
Q724	*151-0155-00	Replaceable by 2N2925
Q734	151-0179-00	2N3877A
Q743	*151-0155-00	Replaceable by 2N2925
Q754	*151-0155-00	Replaceable by 2N2925
Q814	*151-0183-00	Selected from 2N2192
Q824	*151-0183-00	Selected from 2N2192
Q834	*151-0183-00	Selected from 2N2192
Q854	*151-0183-00	Selected from 2N2192
Q864	*151-0183-00	Selected from 2N2192
Q874	*151-0183-00	Selected from 2N2192
Q884	*151-0183-00	Selected from 2N2192
Q903	151-0164-00	2N3702
Q913	151-0164-00	2N3702
Q923	151-0164-00	2N3702
Q933	151-0164-00	2N3702

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R650	315-0102-00	1 k	¼ W	5%
R651	315-0102-00	1 k	¼ W	5%
R652	315-0681-00	680 Ω	¼ W	5%
R654	315-0104-00	100 k	¼ W	5%

AUTOMATIC CARD *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description		Model No.
R660	315-0102-00	1 k	¼ W	5%	
R661	315-0102-00	1 k	¼ W	5%	
R662	315-0681-00	680 Ω	¼ W	5%	
R664	315-0104-00	100 k	¼ W	5%	
R666	315-0102-00	1 k	¼ W	5%	
R669	315-0222-00	2.2 k	¼ W	5%	
R670	315-0562-00	5.6 k	¼ W	5%	
R671	315-0273-00	27 k	¼ W	5%	
R672	315-0223-00	22 k	¼ W	5%	
R673	315-0222-00	2.2 k	¼ W	5%	
R674	315-0391-00	390 Ω	¼ W	5%	
R675	315-0391-00	390 Ω	¼ W	5%	
R676	315-0105-00	1 meg	¼ W	5%	
R678	315-0222-00	2.2 k	¼ W	5%	
R679	315-0224-00	220 k	¼ W	5%	
R682	315-0222-00	2.2 k	¼ W	5%	
R684	315-0102-00	1 k	¼ W	5%	
R686	315-0223-00	22 k	¼ W	5%	
R689	315-0222-00	2.2 k	¼ W	5%	
R710	315-0103-00	10 k	¼ W	5%	
R712	315-0222-00	2.2 k	¼ W	5%	
R714	315-0104-00	100 k	¼ W	5%	
R720	315-0222-00	2.2 k	¼ W	5%	
R721	315-0472-00	4.7 k	¼ W	5%	
R724	315-0471-00	470 Ω	¼ W	5%	
R726	315-0105-00	1 meg	¼ W	5%	
R728	315-0563-00	56 k	¼ W	5%	
R732	315-0104-00	100 k	¼ W	5%	
R734	315-0333-00	33 k	¼ W	5%	
R743	315-0224-00	220 k	¼ W	5%	
R745	315-0104-00	100 k	¼ W	5%	
R748	315-0222-00	2.2 k	¼ W	5%	
R749	315-0333-00	33 k	¼ W	5%	
R750	315-0562-00	5.6 k	¼ W	5%	
R752	315-0222-00	2.2 k	¼ W	5%	
R754	315-0222-00	2.2 k	¼ W	5%	
R802	315-0104-00	100 k	¼ W	5%	
R804	315-0222-00	2.2 k	¼ W	5%	
R810	315-0222-00	2.2 k	¼ W	5%	
R811	315-0104-00	100 k	¼ W	5%	
R812	315-0222-00	2.2 k	¼ W	5%	
R814	315-0222-00	2.2 k	¼ W	5%	
R816	315-0222-00	2.2 k	¼ W	5%	
R819	315-0103-00	10 k	¼ W	5%	
R820	315-0222-00	2.2 k	¼ W	5%	

AUTOMATIC CARD *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description		Model No.
R821	315-0104-00	100 k	1/4 W	5%	
R822	315-0222-00	2.2 k	1/4 W	5%	
R824	315-0222-00	2.2 k	1/4 W	5%	
R826	315-0222-00	2.2 k	1/4 W	5%	
R829	315-0103-00	10 k	1/4 W	5%	
R830	315-0222-00	2.2 k	1/4 W	5%	
R831	315-0104-00	100 k	1/4 W	5%	
R832	315-0222-00	2.2 k	1/4 W	5%	
R834	315-0222-00	2.2 k	1/4 W	5%	
R836	315-0222-00	2.2 k	1/4 W	5%	
R839	315-0103-00	10 k	1/4 W	5%	
R841	315-0222-00	2.2 k	1/4 W	5%	
R842	315-0222-00	2.2 k	1/4 W	5%	
R844	315-0222-00	2.2 k	1/4 W	5%	
R850	315-0222-00	2.2 k	1/4 W	5%	
R851	315-0104-00	100 k	1/4 W	5%	
R852	315-0222-00	2.2 k	1/4 W	5%	
R854	315-0222-00	2.2 k	1/4 W	5%	
R856	315-0222-00	2.2 k	1/4 W	5%	
R859	315-0473-00	47 k	1/4 W	5%	
R860	315-0222-00	2.2 k	1/4 W	5%	
R861	315-0104-00	100 k	1/4 W	5%	
R862	315-0222-00	2.2 k	1/4 W	5%	
R864	315-0222-00	2.2 k	1/4 W	5%	
R866	315-0222-00	2.2 k	1/4 W	5%	
R869	315-0473-00	47 k	1/4 W	5%	
R870	315-0222-00	2.2 k	1/4 W	5%	
R871	315-0104-00	100 k	1/4 W	5%	
R872	315-0222-00	2.2 k	1/4 W	5%	
R874	315-0222-00	2.2 k	1/4 W	5%	
R876	315-0222-00	2.2 k	1/4 W	5%	
R879	315-0473-00	47 k	1/4 W	5%	
R880	315-0222-00	2.2 k	1/4 W	5%	
R881	315-0104-00	100 k	1/4 W	5%	
R882	315-0222-00	2.2 k	1/4 W	5%	
R884	315-0222-00	2.2 k	1/4 W	5%	
R886	315-0222-00	2.2 k	1/4 W	5%	
R889	315-0473-00	47 k	1/4 W	5%	
R900	315-0222-00	2.2 k	1/4 W	5%	
R905	315-0222-00	2.2 k	1/4 W	5%	
R910	315-0222-00	2.2 k	1/4 W	5%	
R915	315-0222-00	2.2 k	1/4 W	5%	
R920	315-0222-00	2.2 k	1/4 W	5%	
R930	315-0222-00	2.2 k	1/4 W	5%	
R935	302-0101-00	100 Ω	1/2 W	5%	
R939	302-0101-00	100 Ω	1/2 W	5%	

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AUTOMATIC CARD *(Cont'd)*

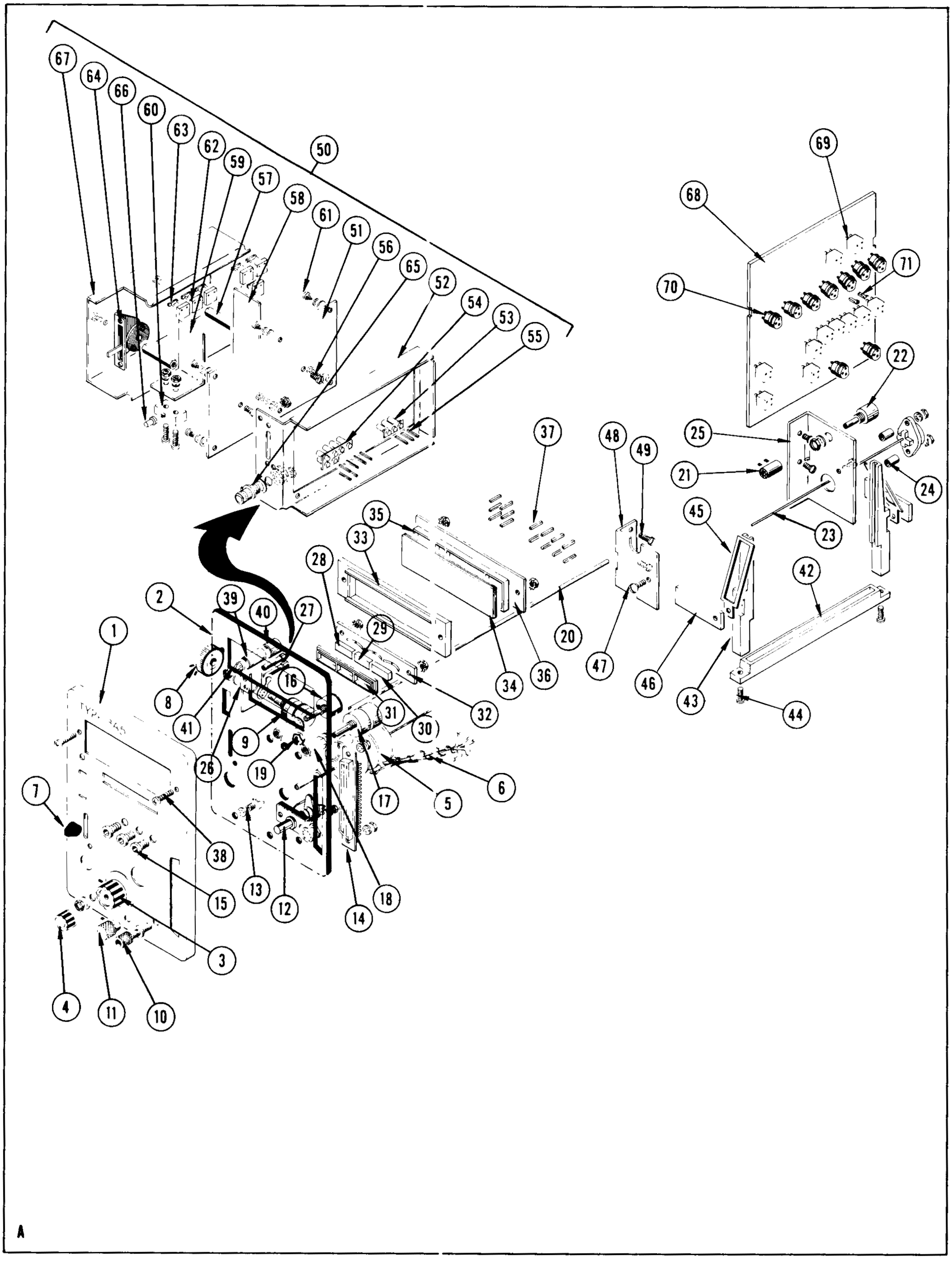
Test Points

Ckt. No.	Tektronix Part No.	Description	Model No.
TP684	*214-0579-00	Pin, Test Point	
TP754	*214-0579-00	Pin, Test Point	

SECTION 8
MECHANICAL PARTS LIST

A list of abbreviations and special symbols in use throughout this manual will be found immediately preceding the Electrical Parts List, Section 7. 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. Parts ordering information is also located immediately preceding Section 7.

FRONT



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FRONT

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	Q T Y.	DESCRIPTION
1	333-0914-00			1	PANEL, front
2	386-0230-00			1	PLATE, front subpanel
3	366-0230-00			1	KNOB, charcoal—MANUAL VOLTS/DIV
	- - - - - -			-	knob, includes:
	213-0004-00			1	SCREW, set 6-32 x $^{3}/_{16}$ inch, HSS
4	366-0081-00			1	KNOB, red—VARIABLE
	- - - - - -			-	knob, includes:
	213-0004-00			1	SCREW, set, 6-32 x $^{3}/_{16}$ inch, HSS
5	262-0741-00			1	SWITCH, wired—MANUAL VOLTS/DIV
	- - - - - -			-	switch includes:
	260-0690-00			1	SWITCH, unwired—MANUAL VOLTS/DIV
6	179-1016-00			1	CABLE HARNESS, switch
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0413-00			1	NUT, hex., $^{3}/_{8}$-32 x $^{1}/_{2}$ inch
7	336-0215-01			1	KNOB, lever—AC—TRACE STABILIZED-AC-DC
8	366-0341-00			1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0076-00			2	SCREW, set, 2-56 x $^{1}/_{8}$ inch, HSS
9	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0583-00			1	NUT, hex., $^{1}/_{4}$-32 x $^{5}/_{16}$ inch
	210-0940-00			1	WASHER, flat, $^{1}/_{4}$ ID x $^{3}/_{8}$ inch OD
	210-0223-00			1	LUG, solder, $^{1}/_{4}$ inch
10	129-0053-00			1	ASSEMBLY, binding post
	- - - - - -			-	assembly includes:
	355-0507-00			1	STEM, binding post
	200-0103-00			1	CAP, binding post
	- - - - - -			-	mounting hardware: (not included w/assembly)
	210-0455-00			1	NUT, hex., $^{1}/_{4}$-28 x $^{3}/_{8}$ inch
	210-0046-00			1	LOCKWASHER, int, .261 ID x .400 inch OD
11	366-0109-00			1	KNOB, aluminum, securing,
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^{3}/_{16}$ inch, HSS
12	214-0052-00			1	FASTENER, pawl right, w/stop
	- - - - - -			-	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
13	131-0407-00			1	JACK, telephone, w/hardware—REMOTE SEEK
14	131-0408-00			1	CONNECTOR, 37 pin, female
	- - - - - -			-	mounting hardware: (not included w/connector)
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex., 4-40 x $^{3}/_{16}$ inch
15	358-0054-00			3	BUSHING, banana jack, $^{1}/_{4}$-32 x $^{13}/_{32}$ inch
16	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0471-00			1	NUT, hex., $^{1}/_{4}$-32 x $^{5}/_{16}$ x $^{19}/_{32}$ inch long
	210-0046-00			1	LOCKWASHER, int, .261 ID x .400 inch OD

FRONT (Cont'd)

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
17	- - - - - - -			1	POT
	- - - - - - -			-	mounting hardware: (not included w/pot)
18	210-0471-00			1	NUT, hex., $\frac{1}{4}$-32 x $\frac{5}{16}$ x $\frac{19}{32}$ inch long
	210-0046-00			1	LOCKWASHER, int, .261 ID x .400 inch OD
	348-0055-00			1	GROMMET, plastic, $\frac{1}{4}$ inch
19	210-0465-00			1	NUT, hex., $\frac{1}{4}$-32 x $\frac{3}{8}$ inch
20	384-0374-00			1	ROD, shaft
21	376-0029-00			1	COUPLING, shaft, $\frac{1}{4}$ diameter x $\frac{1}{2}$ inch long
	- - - - - - -			-	coupling includes:
	213-0075-00			2	SCREW, set, 4-40 x 3/32 inch, HSS
22	- - - - - - -			1	POT
	- - - - - - -			-	mounting hardware: (not included w/pot)
	210-0583-00			1	NUT, hex., $\frac{1}{4}$-32 x $\frac{5}{16}$ inch
	210-0940-00			1	WASHER, flat, $\frac{1}{4}$ ID x $\frac{3}{8}$ inch OD
23	384-0240-00			1	ROD, extension
	213-0022-00			1	SCREW, set, 4-40 x $\frac{3}{16}$ inch, HSS
24	361-0097-00			2	SPACER, pot
	210-0586-00			2	NUT, keps, 4-40 x $\frac{1}{4}$ inch
25	407-0178-00			1	BRACKET
	- - - - - - -			-	mounting hardware: (not included w/bracket)
	211-0504-00			2	SCREW, 6-32 x $\frac{1}{4}$ inch, PHS
26	407-0177-00			1	BRACKET, pot
	- - - - - - -			-	mounting hardware: (not included w/bracket)
27	220-0413-00			2	NUT, hex., $\frac{3}{16}$ x .562 inch long
28	366-0342-03			1	KNOB, pushbutton—SEEK
29	366-0342-02			1	KNOB, pushbutton—MAN
30	366-0342-01			1	KNOB, pushbutton—EXT
31	380-0084-00			1	HOUSING, pushbutton
32	670-0096-00			1	ASSEMBLY, etched wiring board, PUSHBUTTON (Switches)
	- - - - - - -			-	assembly includes:
	388-0657-00			1	BOARD, etched wiring, unwired
	- - - - - - -			-	mounting hardware: (not included w/assembly)
	210-0586-00			2	NUT, keps, 4-40 x $\frac{1}{4}$ inch
33	380-0086-00			1	HOUSING, read out
34	386-0231-00			1	PLATE, vertical read out (set)
35	361-0098-00			1	SPACER, light divider
36	670-0095-00			1	ASSEMBLY, etched wiring board, READ OUT
	- - - - - - -			-	assembly includes:
37	214-0506-00			14	PIN, connector
	388-0655-00			1	BOARD, etched wiring, unwired
	- - - - - - -			-	mounting hardware: (not included w/assembly)
38	211-0094-00			2	SCREW, 4-40 x $\frac{1}{2}$ inch, PHS
	210-0586-00			2	NUT, keps, 4-40 x $\frac{1}{4}$ inch

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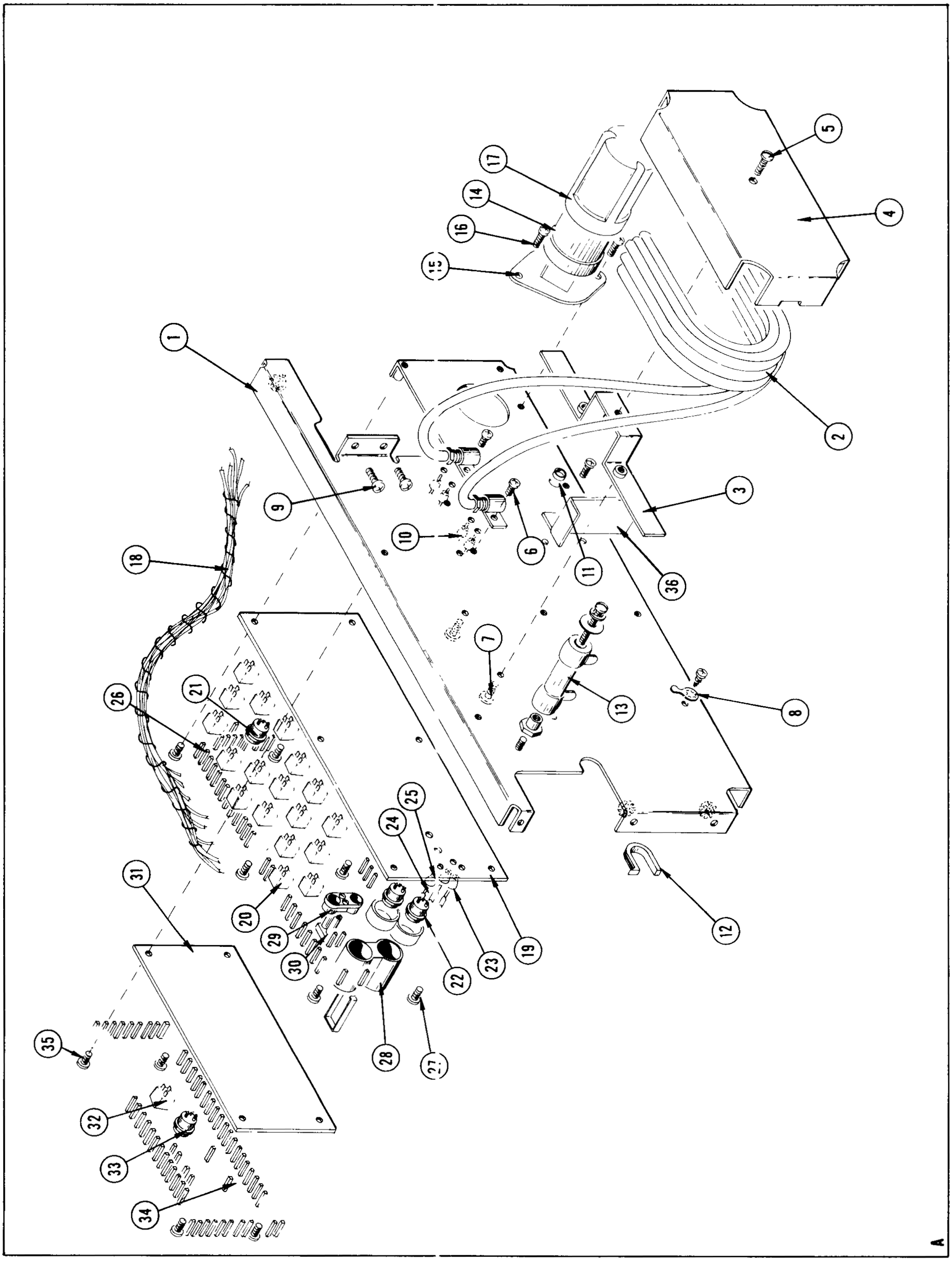
FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
39	352-0084-00			1	HOLDER, neon
40	200-0643-00			1	CAP, lamp holder
41	378-0541-00			1	LENS
42	131-0292-00			1	CONNECTOR, 56 pin contact
43	351-0059-00			2	GUIDE
44	211-0014-00			2	SCREW, 4-40 x $^1/_2$ inch, PHS
45	344-0101-00			2	CLIP, retainer, board
46	407-0180-00			2	BRACKET, connector index
47	211-0510-00			2	SCREW, 6-32 x $^3/_8$ inch
48	407-0179-00			1	BRACKET
	- - - - - -			-	mounting hardware: (not included w/bracket)
49	211-0504-00			2	SCREW, 6-32 x $^1/_4$ inch, PHS
50	670-0097-00			1	ASSEMBLY, ATTENUATOR
	- - - - - -			-	assembly includes:
51	388-0654-00			1	BOARD, etched wiring, unwired
52	441-0640-00			1	CHASSIS
53	407-0175-00			1	BRACKET
	- - - - - -			-	bracket includes:
	214-0321-00			3	FASTENER
54	407-0174-00			1	BRACKET
	- - - - - -			-	bracket includes:
	214-0321-00			6	FASTENER
55	214-0506-01			9	PIN, connector
56	361-0095-00			2	SPACER, cover shield (attenuator)
57	211-0116-00			2	SCREW, 4-40 x $^5/_{16}$ inch, PHB phillips w/lockwasher & flat washer
58	337-0770-00			1	SHIELD, attenuator board (upper)
59	337-0771-00			1	SHIELD, and micro switch bracket
60	- - - - - -			1	SWITCH, mirco
	- - - - - -			-	mounting hardware: (not included w/switch alone)
	211-0089-00			2	SCREW, 2-56 x $^3/_8$ inch, RHS, black
	210-0001-00			2	LOCKWASHER, internal, #2
	210-0405-00			2	NUT, hex., 2-56 x $^3/_{16}$ inch
61	213-0120-00			6	SCREW, 2-32 x $^1/_4$ inch, thread forming, PHS phillips
62	- - - - - -			6	CAPACITOR
63	214-0456-00			6	FASTENER, delrin, w/2 studs
64	- - - - - -			1	SWITCH, lever
	- - - - - -			-	mounting hardware: (not included w/switch alone)
	211-0105-00			2	SCREW, 4-40 x $^3/_{16}$ inch, FHS
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex., 4-40 x $^3/_{16}$ inch
65	131-0106-00			1	CONNECTOR, coax., 1 contact, female, w/hardware
66	385-0188-00			1	ROD, micro switch actuator
	- - - - - -			-	mounting hardware: (not included w/assembly)
	210-0586-00			2	NUT, keps, 4-40 x $^1/_4$ inch
	210-0457-00			2	NUT, keps, 6-32 x $^5/_{16}$ inch
	210-0803-00			2	WASHER, flat, 0.150 ID x $^3/_8$ inch OD
67	337-0772-00			1	SHIELD, attenuator
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0007-00			2	SCREW, 4-40 x $^3/_{16}$ inch, PHS
68	670-0092-00			1	ASSEMBLY, etched wiring card, AUTOMATIC
	- - - - - -			-	assembly includes:
	388-0651-00			1	CARD, etched wiring, unwired
69	136-0220-00			11	SOCKET, transistor
70	136-0183-00			9	SOCKET, transistor
71	214-0579-00			2	PIN, test point

CHASSIS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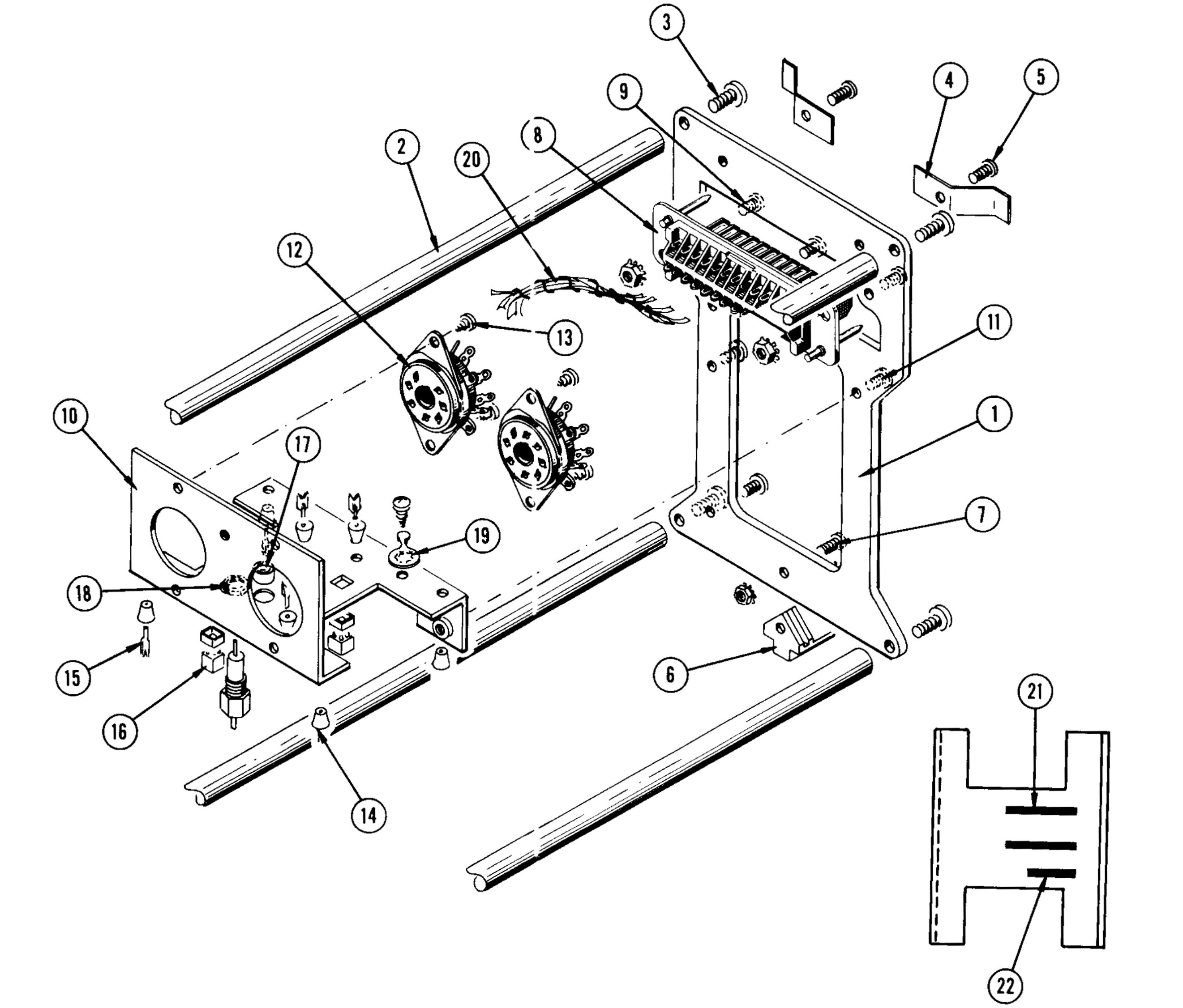
CHASSIS

REF. NO.	PART NO.	SERIAL/MODEL NO.		Q T Y.	DESCRIPTION
		EFF.	DISC.		
1	441-0642-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included with chassis)
	211-0507-00			3	SCREW, 6-32 x 5/16 inch, PHS
	211-0559-00			2	SCREW, 6-32 x 3/8 inch FHS, 100° CSK, phillips
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
	213-0068-00			1	SCREW, 6-32 x 5/16 inch, thread cut, FHS, 100° CSK, phillips
2	- - - - - -			1	ASSEMBLY, DELAY LINE
	- - - - - -			-	assembly includes:
3	343-0121-00			1	CLAMP, delay line
4	380-0085-00			1	HOUSING, delay line
5	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
	- - - - - -			-	mounting hardware: (not included with assembly)
6	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS, phillips
7	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS, phillips
8	210-0201-00			1	LUG, solder, SE #4
	- - - - - -			-	mounting hardware: (not included with lug)
	213-0044-00			1	SCREW, thread forming 5-32 x 3/16 inch, PHS
9	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS, phillips
10	131-0183-00			4	CONNECTOR, terminal feed through
	358-0136-00			1	BUSHING, plastic
11	348-0055-00			1	GROMMET, plastic, 1/4 inch
12	358-0215-00			1	BUSHING, plastic
13	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included with resistor)
	210-0462-00			1	NUT, hex., alum. 8-32 x 1/2 inch
	210-0809-00			1	WASHER, brass, centering
	212-0037-00			1	SCREW, 8-32 x 1 3/4 inch, Fil HS
14	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included with capacitor)
15	386-0254-00			1	PLATE, fiber large
16	211-0597-00			1	SCREW, 6-32 x 1/4 inch, RHS
17	200-0260-00			1	COVER, capacitor, polyethylene
18	179-1014-00			1	CABLE HARNESS, chassis
19	670-0094-00			1	ASSEMBLY, etched wiring board, VERTICAL AMP
	- - - - - -			-	assembly includes:
20	136-0220-00			18	SOCKET, #3 pin
21	136-0183-00			1	SOCKET, 3 pin w/etched circuit contacts
22	136-0125-00			2	SOCKET, 5 pin
23	131-0403-00			1	CONNECTOR, feed through bifurcated teflon
24	131-0309-00			2	CONNECTOR, terminal bifurcated
25	358-0136-00			2	BUSHING, teflon
26	214-0506-00			40	PIN, connector
	388-0653-00			1	BOARD, etched wiring, unwired
	- - - - - -			-	mounting hardware: (not included with assembly)
27	211-0601-00			6	SCREW, 6-32 x 5/16 inch, PHS, w/lockwasher

CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
28	200-0640-01			1	COVER, heat stabilizer
	- - - - - -			-	mounting hardware: (not included with cover)
	344-0121-00			1	CLIP, spring
29	200-0497-00			1	COVER, heat stabilizer
	377-0103-00			2	INSERT, heat stabilizer (not shown)
30	352-0072-00			1	HOLDER, transistor cover
31	670-0093-00			1	ASSEMBLY, etched wiring board, CONTROL
	- - - - - -			-	assembly includes:
32	136-0220-00			1	SOCKET, 3 pin
33	136-0183-00			1	SOCKET, 3 pin w/etched circuit contacts
34	214-0506-00			57	PIN, connector
	388-0652-00			1	BOARD, etched wiring, unwired
	- - - - - -			-	mounting hardware: (not included with assembly)
35	211-0601-00			4	SCREW, 6-32 x $^5/_{16}$ inch, PHS, w/lockwasher

REAR



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REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	Q T Y.	DESCRIPTION
1	387-0647-00			1	PLATE, panel rear
2	384-0615-00			4	ROD, spacer
3	212-0044-00			4	SCREW, 8-32 x 1/2 inch RHS, phillips
4	214-0276-00			2	SPRING, ground
	- - - - - -			-	mounting hardware for each: (not included with spring)
5	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS, phillips
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
6	351-0037-00			1	GUIDE, plug-in, delrin
	- - - - - -			-	mounting hardware: (not included with guide)
7	211-0013-00			1	SCREW, 4-40 x 3/8 inch, RHS, phillips
	210-0586-00			1	NUT, keps, 4-40 x 1/4 inch

REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	Q T Y.	DESCRIPTION
8	131-0149-00			1	CONNECTOR, 24 contact, male
	- - - - - -			-	mounting hardware: (not included with connector)
9	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
10	441-0641-00			1	CHASSIS, output
	- - - - - -			-	mounting hardware: (not included with chassis)
11	211-0504-00			4	SCREW, 6-32 x 1/4 inch, PHS, phillips
12	136-0174-00			2	SOCKET, 9 pin
	- - - - - -			-	mounting hardware for each: (not included with socket)
13	213-0044-00			2	SCREW, 5-32 x 3/16 inch, thread form, PHS, phillips
14	131-0161-00			2	CONNECTOR, terminal feed through
15	131-0235-00			5	CONNECTOR, terminal bifurcated
	- - - - - -			-	mounting hardware for each: (not included with connector)
	358-0136-00			1	BUSHING, teflon
16	136-0218-00			2	SOCKET, 3 pin transistor
	- - - - - -			-	mounting hardware for each: (not included with socket)
	354-0285-00			1	BUSHING
17	348-0055-00			1	GROMMET, plastic, 1/4 inch
18	220-0415-00			2	NUT, hex., 5/16-32 x .093 inch
	210-0048-00			1	LOCKWASHER, internal, 5/16 ID x 0.425 inch OD
19	210-0201-00			2	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included with lug)
	213-0044-00			1	SCREW, 5-32 x 3/16 inch, thread form, PHS phillips
20	179-1015-00			1	CABLE HARNESS, OUTPUT
21	124-0149-00			2	STRIP, ceramic, 7/16 inch x 7 notch
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included with strip)
	361-0007-00			2	SPACER, nylon, 1/16 inch
22	124-0162-00			1	STRIP, ceramic, 7/16 inch x 4 notch
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, nylon
	- - - - - -			-	mounting hardware: (not included with strip)
	361-0007-00			1	SPACER, nylon, 1/16 inch

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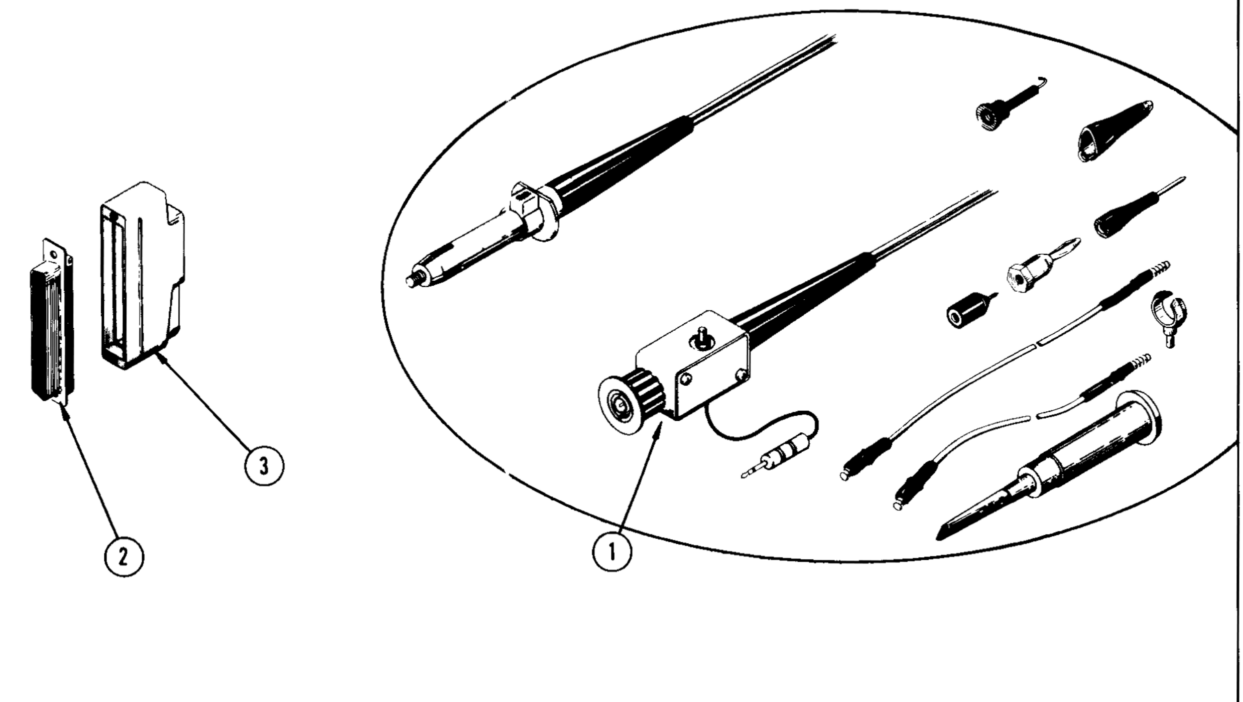
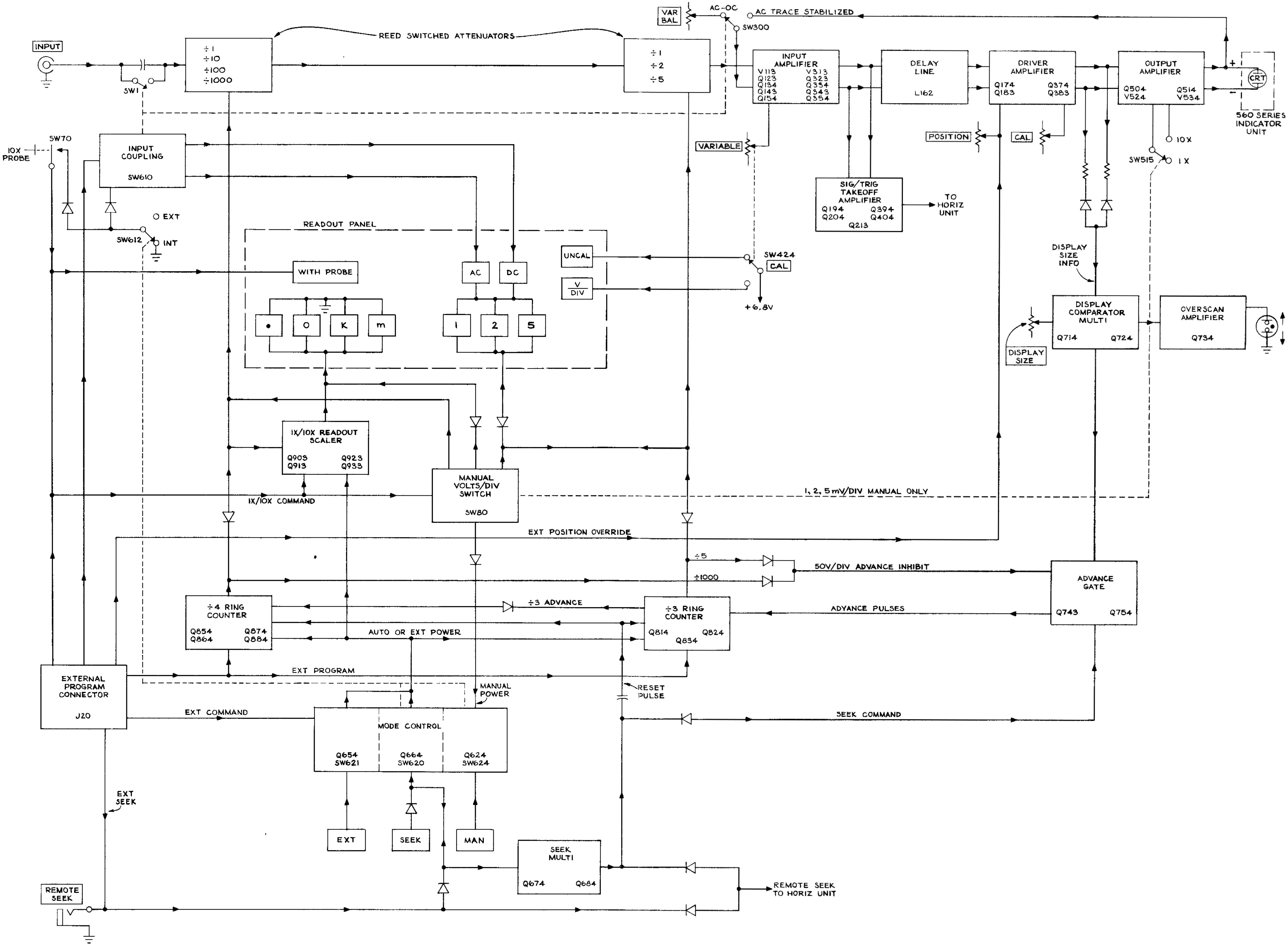
ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	Q T Y.	DESCRIPTION
1	010-0195-00			1	PROBE, package, P6030
2	131-0422-00			1	CONNECTOR, 37 pin, male
	213-0045-00			2	SCREW, thread cutting, 4-40 x $^5/_{16}$ inch, PHS, phillips
3	200-0660-02			1	COVER, connector
	070-0500-00			2	MANUAL, instruction (not shown)



TYPE 3A5

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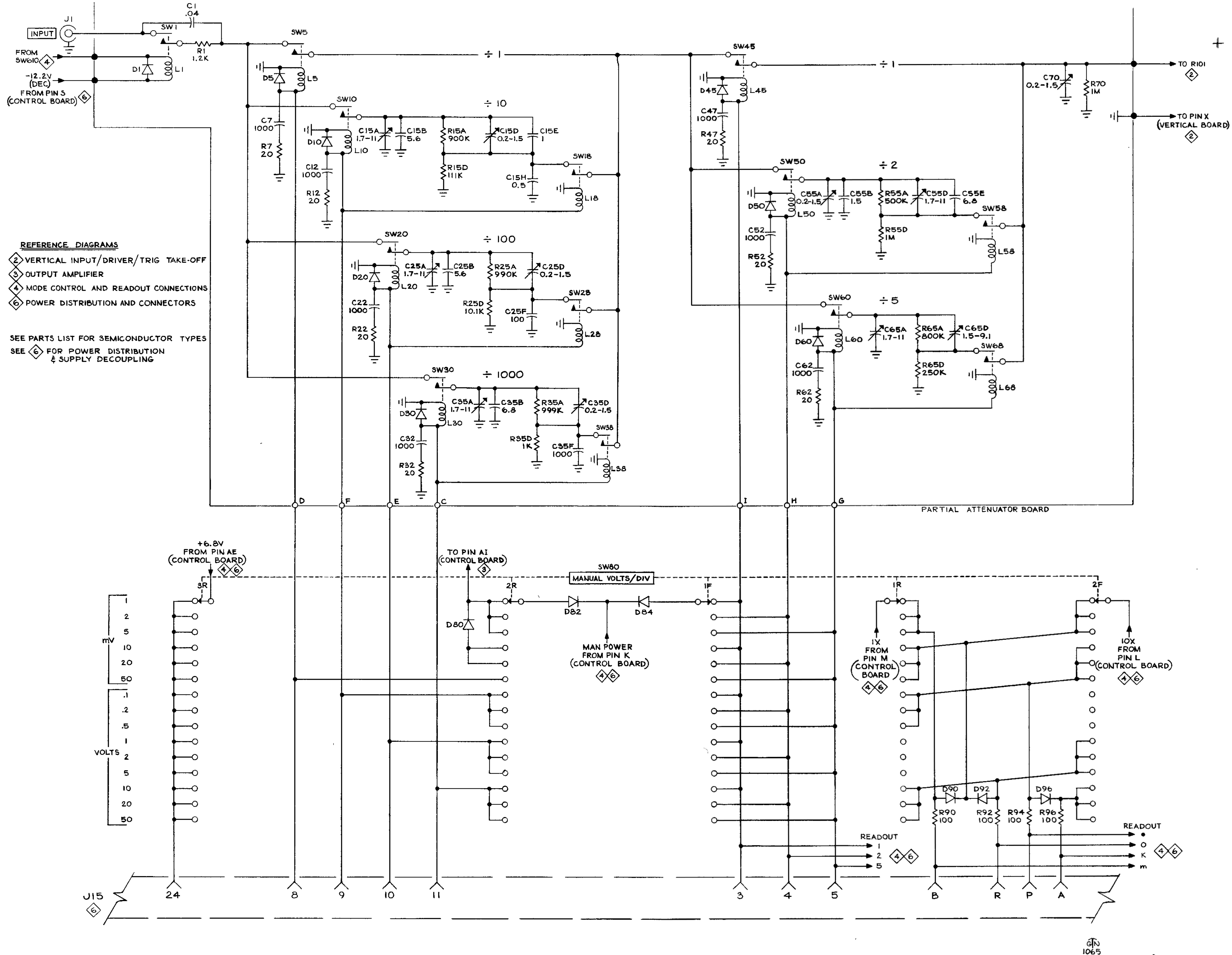
BLOCK DIAGRAM


INPUT
J1
C1 .04
SW1
R1 1.2K
FROM SW610 4
-12.2V (DEC) FROM PIN S (CONTROL BOARD) 6
D1
L1
SW5
D5
L5
C7 1000
R7 20
÷ 1
SW10
÷ 10
D10
L10
C15A 1.7-11
C15B 5.6
R15A 900K
C15D 0.2-1.5
C15E 1
R15D 111K
C15H 0.5
SW18
L18
C12 1000
R12 20
REFERENCE DIAGRAMS
2 VERTICAL INPUT/DRIVER/TRIG TAKE-OFF
3 OUTPUT AMPLIFIER
4 MODE CONTROL AND READOUT CONNECTIONS
6 POWER DISTRIBUTION AND CONNECTORS
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE 6 FOR POWER DISTRIBUTION & SUPPLY DECOUPLING
SW20
÷ 100
D20
L20
C25A 1.7-11
C25B 5.6
R25A 990K
C25D 0.2-1.5
R25D 10.1K
C25F 100
SW28
L28
C22 1000
R22 20
SW30
÷ 1000
D30
L30
C35A 1.7-11
C35B 6.8
R35A 999K
C35D 0.2-1.5
R35D 1K
C35F 1000
SW38
L38
C32 1000
R32 20
SW45
D45
L45
C47 1000
R47 20
C70 0.2-1.5
R70 1M
TO R101 2
TO PIN X (VERTICAL BOARD) 2
SW50
÷ 2
D50
L50
C55A 0.2-1.5
C55B 1.5
R55A 500K
C55D 1.7-11
C55E 6.8
R55D 1M
SW58
L58
C52 1000
R52 20
SW60
÷ 5
D60
L60
C65A 1.7-11
R65A 800K
C65D 1.5-9.1
R65D 250K
SW68
L68
C62 1000
R62 20
D
F
E
C
I
H
G
PARTIAL ATTENUATOR BOARD
+6.8V FROM PIN AE (CONTROL BOARD) 4 6
3R
TO PIN AI (CONTROL BOARD) 3
2R
D80
D82
D84
MAN POWER FROM PIN K (CONTROL BOARD) 4 6
SW80
MANUAL VOLTS/DIV
1F
1R
2F
1X FROM PIN M (CONTROL BOARD) 4 6
10X FROM PIN L (CONTROL BOARD) 4 6
mV
1
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50
VOLTS
.1
.2
.5
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10
20
50
D90
D92
D96
R90 100
R92 100
R94 100
R96 100
READOUT
1
2
5
4 6
READOUT
O
K
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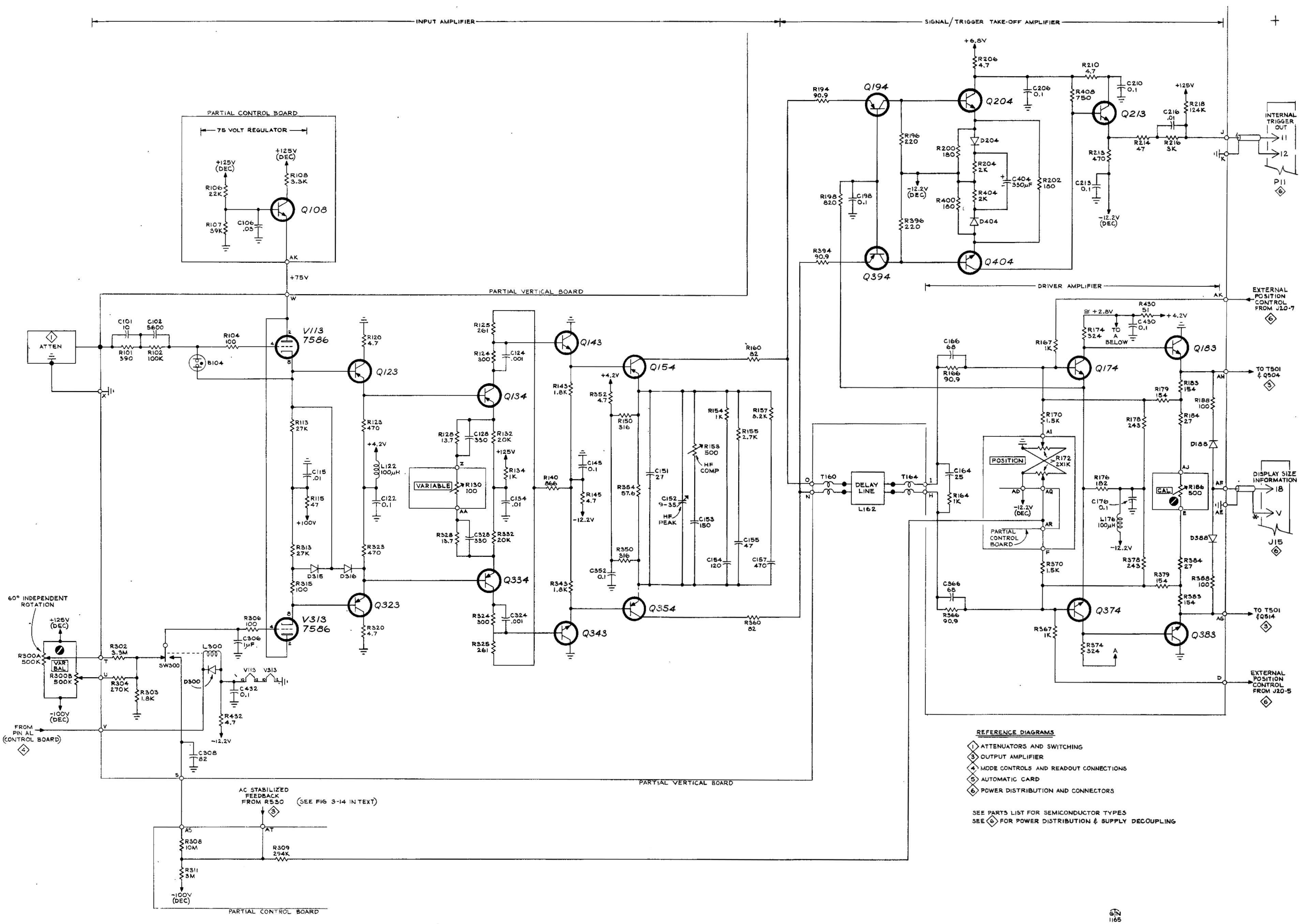
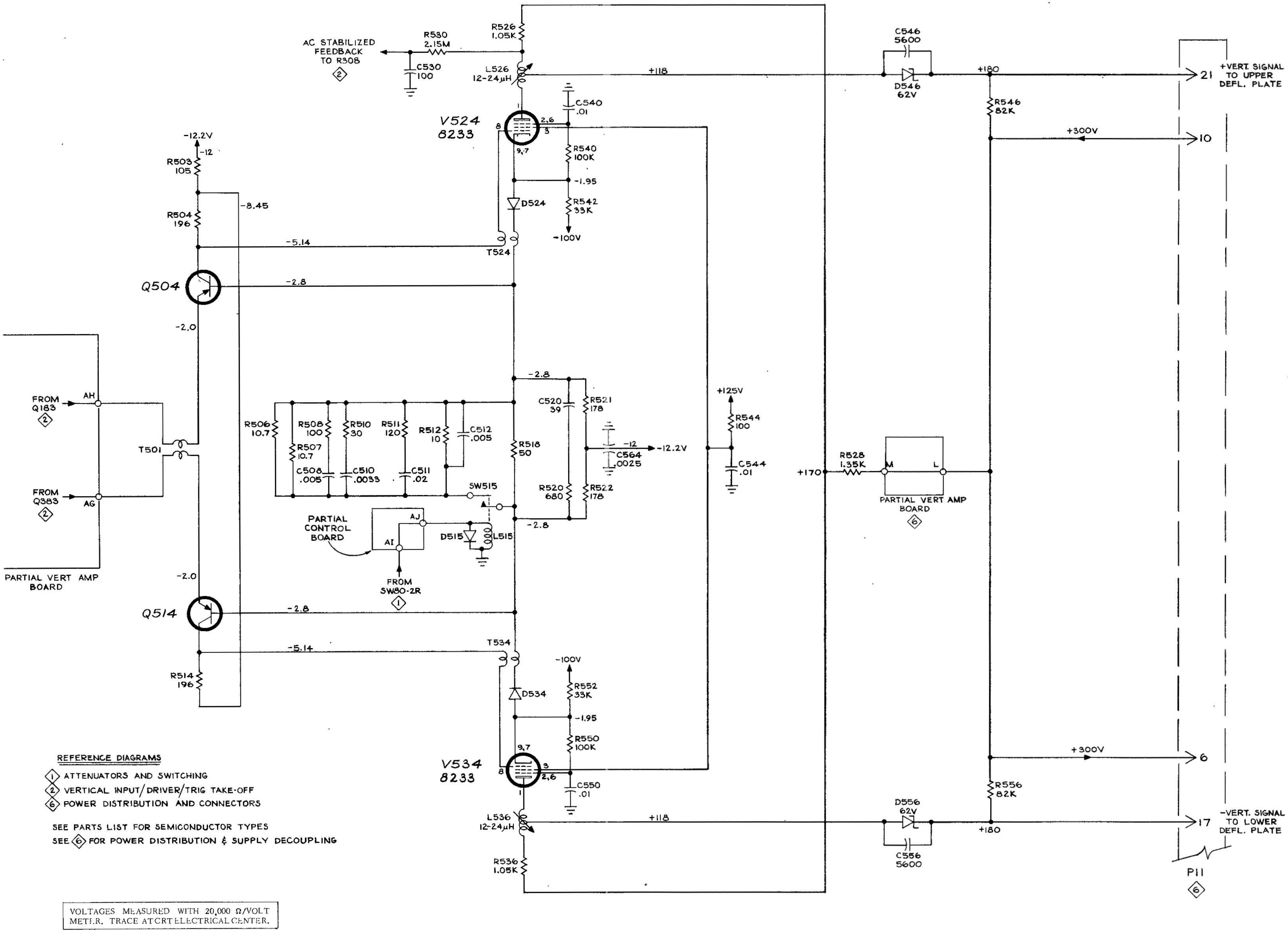


VERTICAL INPUT/DRIVER/TRIGGER TAKE-OFF ②



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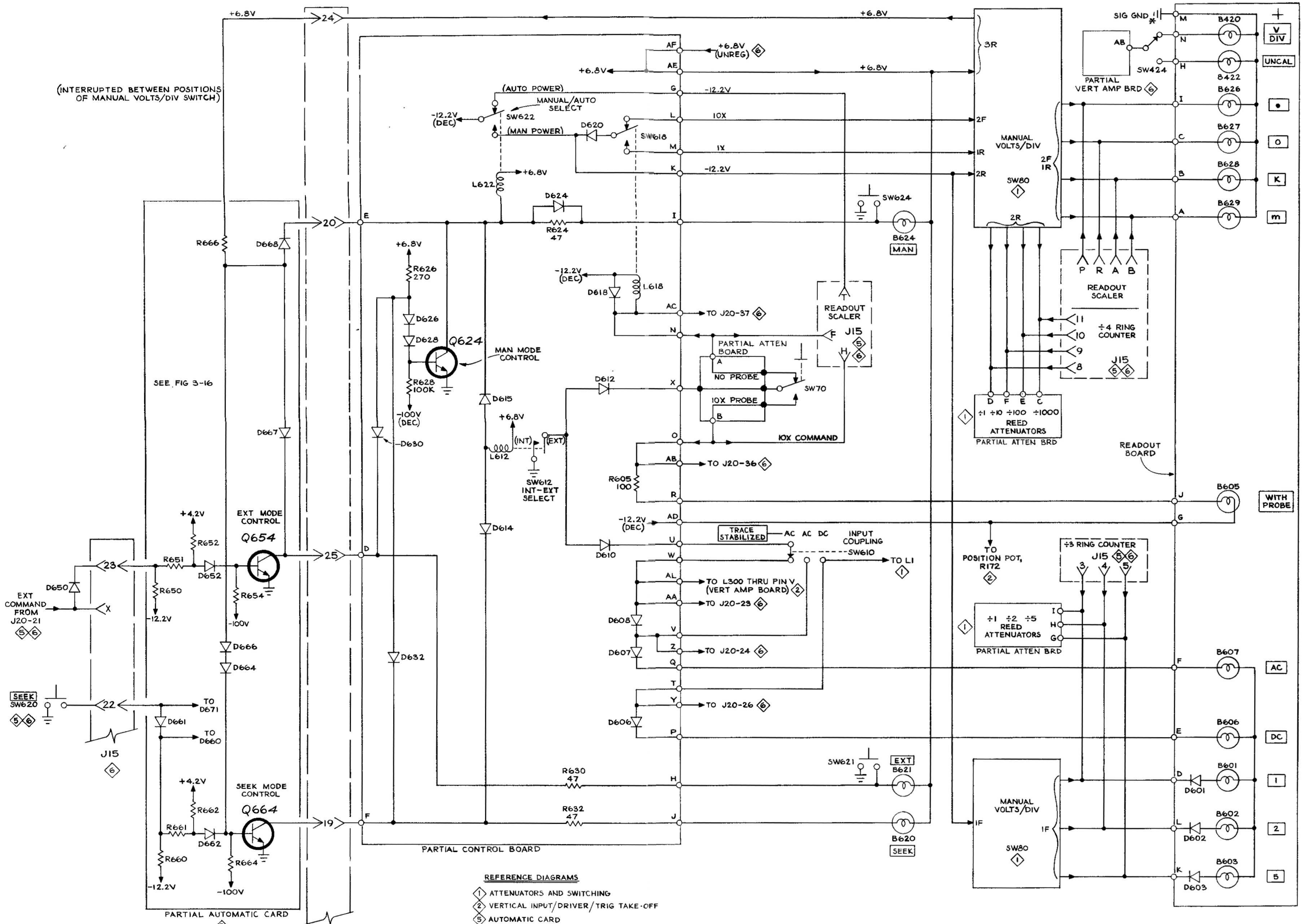
OUTPUT AMPLIFIER 3



REFERENCE DIAGRAMS

1. ATTENUATORS AND SWITCHING
2. VERTICAL INPUT/DRIVER/TRIG TAKE-OFF
5. AUTOMATIC CARD
6. POWER DISTRIBUTION AND CONNECTORS

SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE 6 FOR POWER DISTRIBUTION & SUPPLY DECOUPLING

GTN 1065

TYPE 3A5

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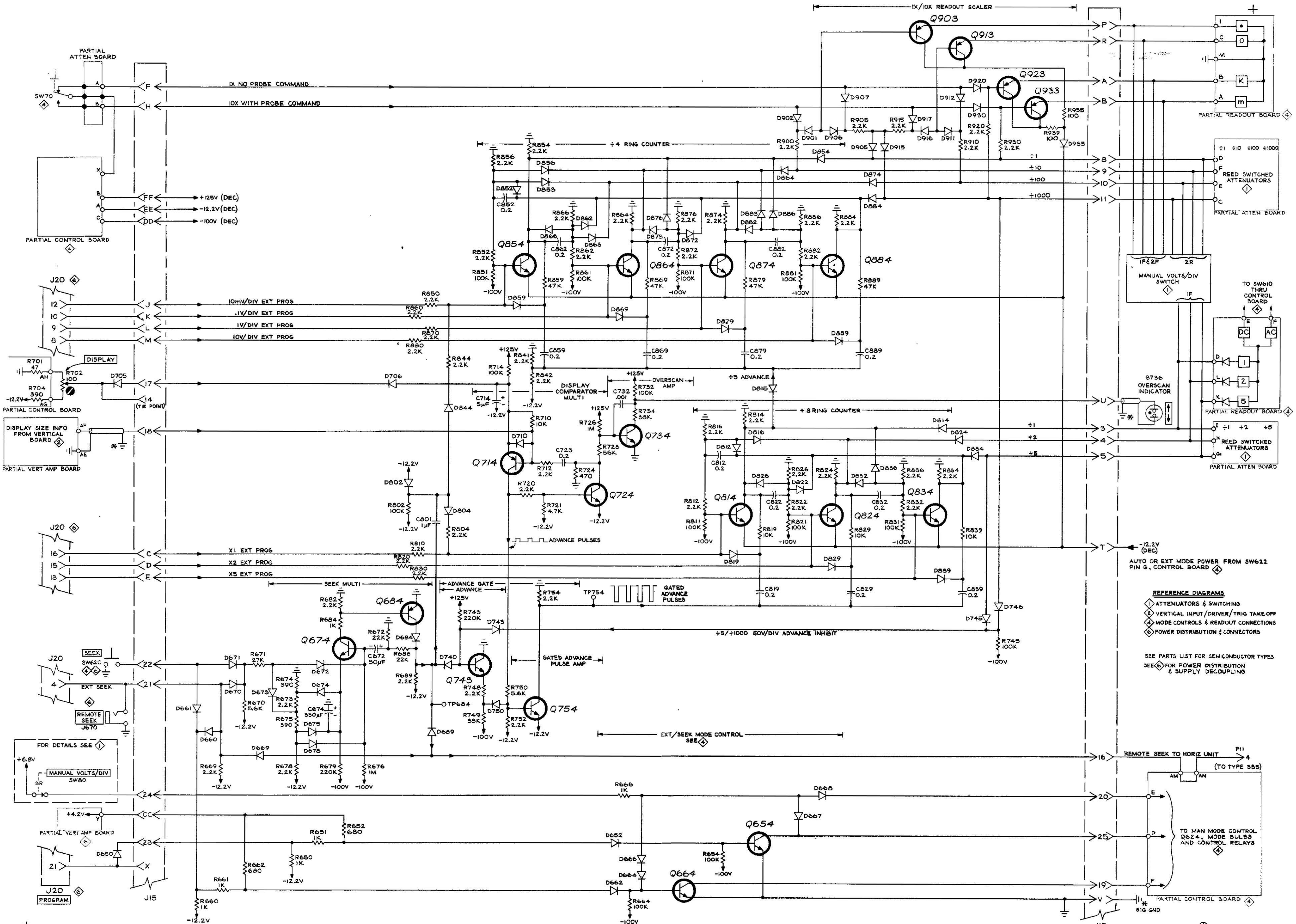
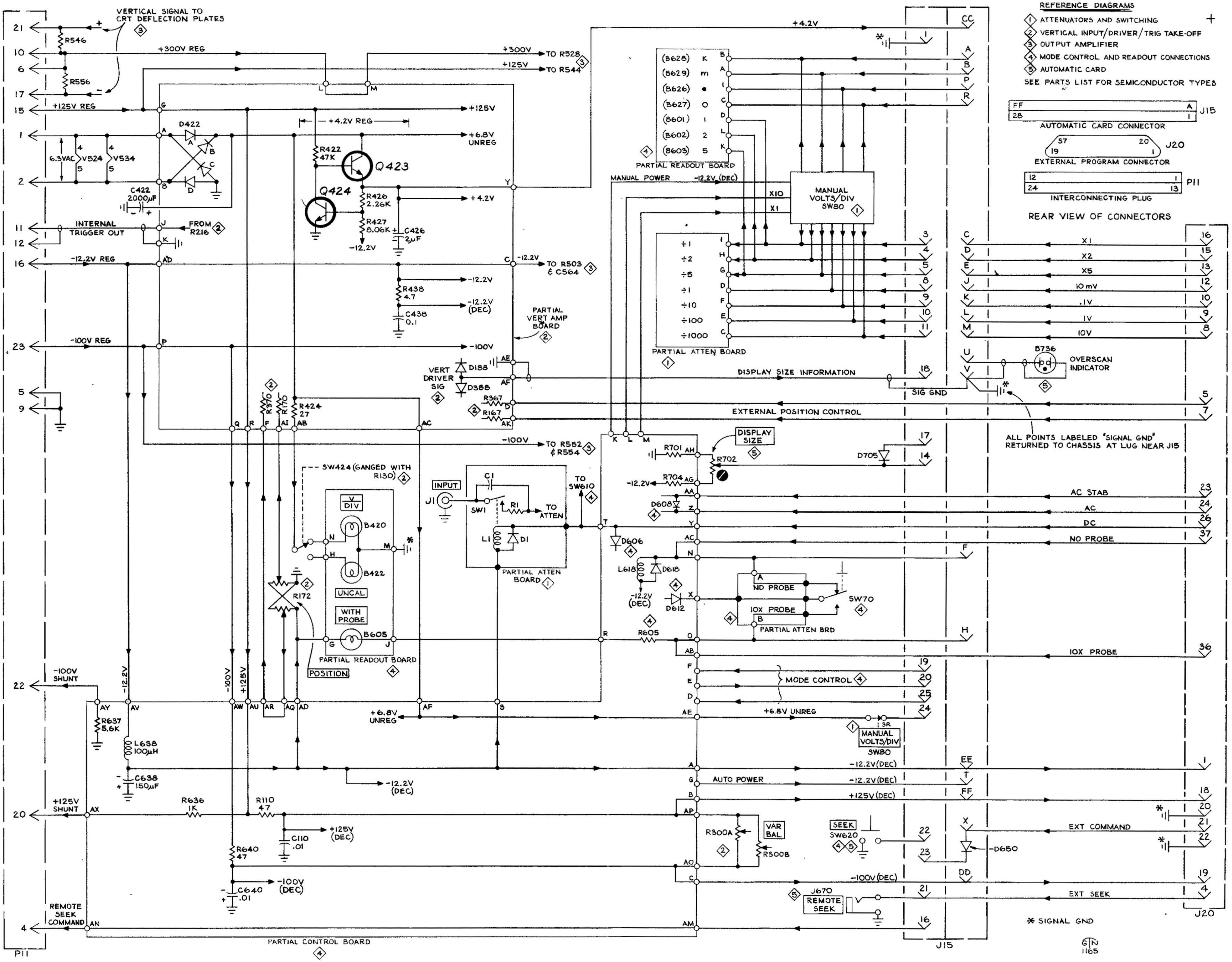
MODE CONTROL AND READOUT CONNECTIONS 4



TYPE 3A5

AUTOMATIC CARD 5



TYPE 3A5

POWER DISTRIBUTION AND CONNECTORS 6

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 3A5

PARTS LIST CORRECTION

CHANGE TO:

Q143	151-0175-00	Replaceable by 2N3662
Q183	151-0108-00	Silicon Replaceable by 2N2501
Q343	151-0175-00	Replaceable by 2N3662
Q383	151-0108-00	Silicon Replaceable by 2N2501
Q903	151-0188-00	Replaceable by 2N3906
Q913	151-0188-00	Replaceable by 2N3906
Q923	151-0188-00	Replaceable by 2N3906
Q933	151-0188-00	Replaceable by 2N3906

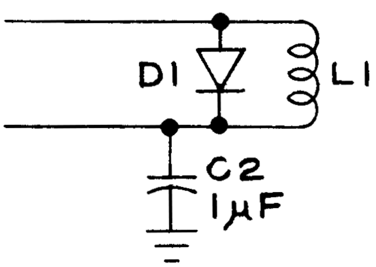
C2/1265

PARTS LIST CORRECTION

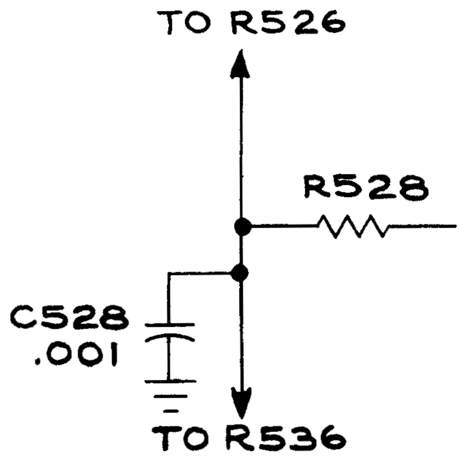
Add:

C2	283-0059-00	1 µF	Cer.	+80% -20%	25 V
C528	283-0078-00	.001	Cer.	±20%	500 V

SCHEMATIC CORRECTION



PART ATTEN. & SWITCHING



PART OUTPUT AMP.

TYPE 3A5

PARTS LIST CORRECTION

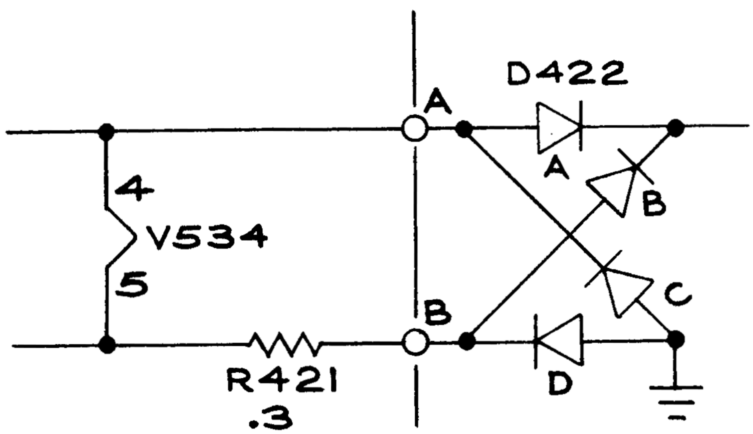
ADD:

R421	308-0244-00	.3 Ω	2W	10%

CHANGE TO:

Q724	151-0108-00	Silicon	Replaceable by 2N2501	
R720	315-0103-00	10 k	1/4 W	5%

SCHEMATIC CORRECTION



PARTIAL PWR. DISTRIBUTION DIAG.