Instrumentation

Instruction Manual for

Model 6200 B

Transistor Curve Tracer

FAIRCHILD

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MARCH 1967

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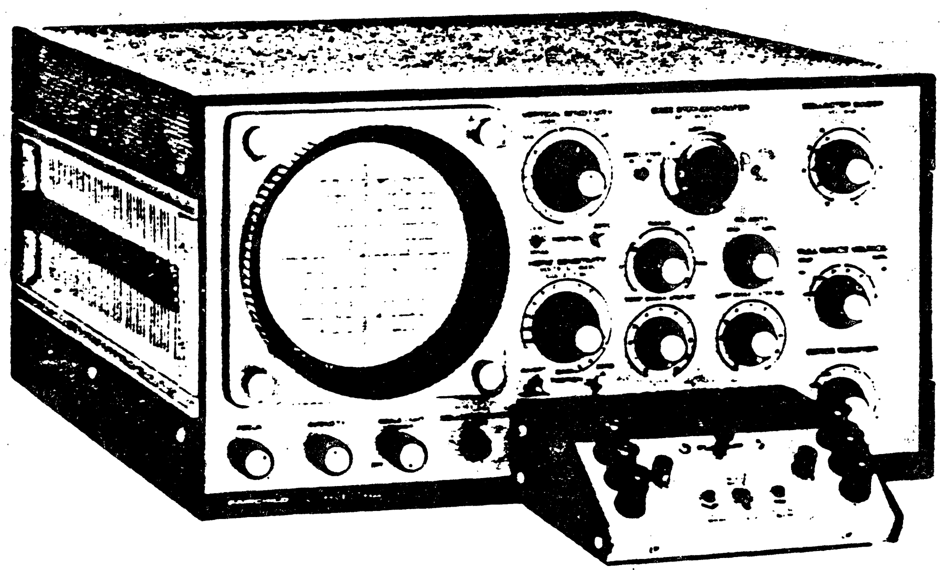

SERIAL NUMBER

Transistor Curve Tracer

FAIRCHILD INSTRUMENTATION

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INSTRUMENTATION

ERRATA SHEET
MODEL 6200B
TRANSISTOR CURVE TRACER
March 1967

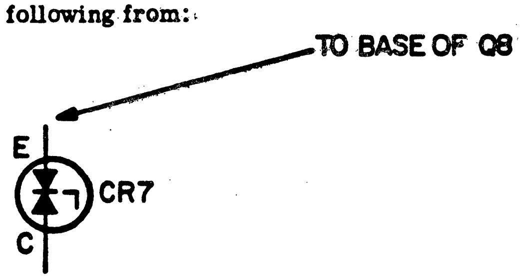
Page 3-3, figure 3-1, definition of switch positions. Change "17 VERTICAL position control positions trace vertically on CRT." to: 17 VERTICAL POSITION control positions trace vertically on screen.

Page 3-3, figure 3-1, definition of switch positions. Change "21 HORIZ. position control positions trace vertically on CRT." to: 21 HORIZ. POSITION control positions trace vertically on screen.

Page 3-7/3-8, Exhibit 3-1, column 2, line 7. Change "figure 1" to: figure 2.

Page 3-7/3-8, Exhibit 3-1, Figure 2. Change "Horizontal: 0.1 mA/div" to: Horizontal: 0.1 V/div.

Page 5-17, Figure 5-8. Change the following from:



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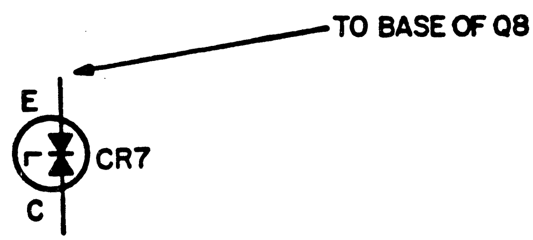
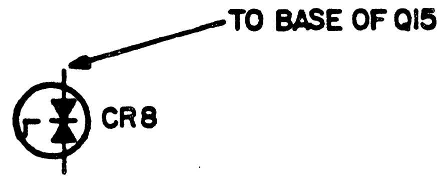


Page 5-17, Figure 5-8. Change the following from:



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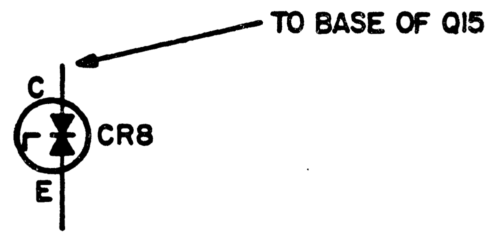
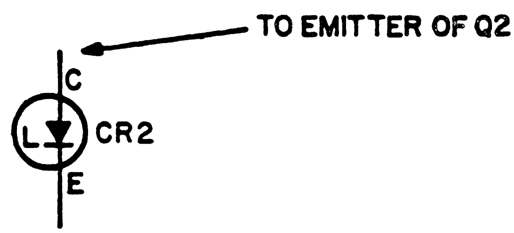


Page 5-19, figure 5-10. Change the following from:



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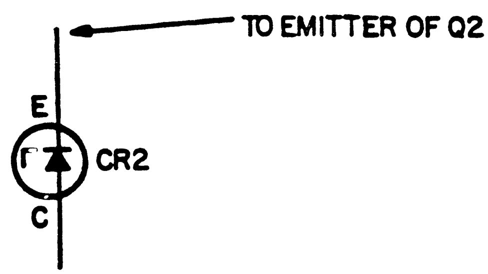

Page 5-37, figure 5-28. Add a tiepoint between the emitter of Q3 and the base of Q1.

Page 5-37, figure 5-28. Change "R5 2M" at the tiepoint of Q3 and Q1 to: R5 FACTORY SELECTED.

Page 5-39, figure 5-30. Change C12 from "150pf" to: 120pf.

Page 5-39, figure 5-30. Change R33 from "1K" to: 5.1 K.

Page 5-39, figure 5-30. Change R34 from "1K" to: 5.1 K.

Insert latest changed pages, destroy superseded pages.

LIST OF EFFECTIVE PAGES.

MODEL 6200B

TOTAL NUMBER OF PAGES IN THIS MANUAL IS 112, CONSISTING OF THE FOLLOWING:

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Additional copies of this publication may be obtained from

Fairchild Instrumentation, 475 Ellis St., Mountain View, California.

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FAIRCHILD INSTRUMENTATION EQUIPMENT WARRANTY

Seller warrants equipment of its manufacture against defective materials or workmanship for a period of one year from date of shipment.

The liability of Seller under this warranty is limited, at Seller's option, solely to repair, replacement with equivalent Fairchild equipment, or an appropriate credit adjustment not to exceed the original equipment sales price, of equipment returned to the Seller provided that:

a. Seller is promptly notified in writing by Buyer upon discovery of defects,

b. The defective equipment is returned to Seller, transportation charges prepaid by Buyer, and,

c. Seller's examination of such equipment discloses to its satisfaction that defects were not caused by negligence, misuse, improper installation, accident, or unauthorized repair or alteration by the Buyer.

This warranty does not include mechanical parts failing from normal usage nor does it cover limited life electrical components which deteriorate with age such as vacuum tubes, chopper, lamps, etc. In the case of accessories, i.e., card punches, typewriters, etc., not manufactured by the Seller, but which are furnished with the Seller's equipment, Seller's liability is limited to whatever warranty is extended by the manufacturers thereof and transferable to the Buyer.

This warranty is applicable to the original Buyer only and constitutes the sole and exclusive warranty of Seller. No other warranty is made, expressed or implied.

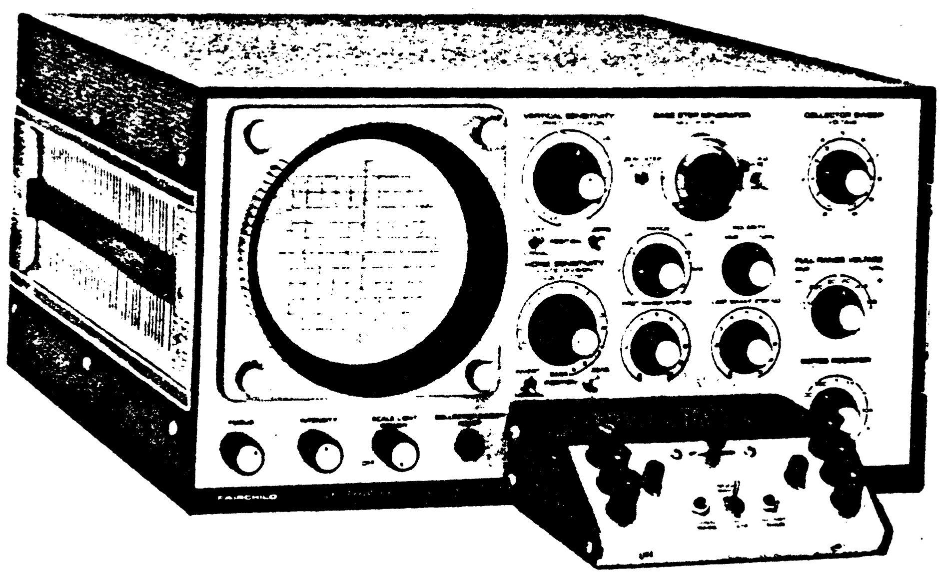


Figure 1-1. Model 6200B Curve Tracer

Section I
General Information

1-1. INTRODUCTION

1-2. This manual provides operating and maintenance information for the Fairchild Model 6200B Curve Tracer. Sections II and III provide installation and operating information. The theory of operation is described in Section IV. Section V outlines maintenance and trouble shooting procedures, and includes schematic diagrams for the instrument. Section VI is a table of replaceable parts and recommended spares.

1-3. GENERAL DESCRIPTION

1-4. The Fairchild Model 6200B Curve Tracer (figure 1-1) is a self-contained, portable instrument that displays the characteristics of two and three terminal semiconductor devices. The unit can be benchtop or rack mounted. It is a flexible unit useful in laboratory, production, and quality control operations. Components to be tested are easily connected to the test panel. Desired checks then are performed through the use of simple front panel controls. A visual display of parameters being checked is presented on the screen.

1-5. The curve tracer consists of two synchronized power supplies and a cathode ray tube monitor. The base step generator provides current or voltage to the input of the device under test in adjustable increments. The base step generator is discretely adjustable for the first and last steps, allowing the operator to select pertinent curves. The collector sweep generator provides collector voltage sweep from zero to full-range voltage. A calibrated oscilloscope display monitors collector volts or base volts on the horizontal scale, and collector current on the vertical scale. This provides a family of curves for analysis.

1-6. ACCESSORIES FURNISHED

1-7. TEST FIXTURE (P/N 811414): The test fixture supplied with the Model 6200B has two inputs and a comparison switch. When it is used, the dynamic characteristics of two semiconductor devices may be compared, which facilitates the selection of a matched pair.

1-8. ELECTRICAL SPECIFICATIONS

1-9. Table 1-1 contains a list of electrical specifications for the Model 6200B Curve Tracer.

1-10. DIMENSIONS AND WEIGHT

1-11. Figure 1-2 is an outline drawing of the Model 6200B. The principal dimensions are in inches and centimeters. The instrument's weight, with the test fixture attached, is 45 pounds (20.4 kilograms).

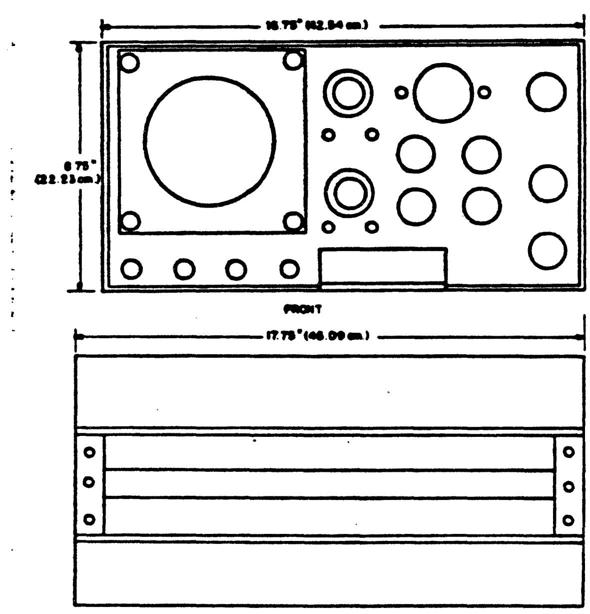


Figure 1-2. Outline Drawing Model 6200B

Table 1-1. Specifications

CATHODE RAY TUBE DISPLAY

VERTICAL (Collector Current)

Range:	1 μA/div to 500 mA/div in 1-2-5 sequence, 18 calibrated steps.
Accuracy:	±3% of reading on all ranges.
Display Mode:	Normal or inverted as set at front panel toggle switch.

HORIZONTAL (Collector Voltage)

Range:	10 mV/div to 100 V/div in 1-2-5 sequence.
Accuracy:	±3% of reading on all ranges.
Display Mode:	Normal or inverted as set at front panel toggle switch.

HORIZONTAL (Base Voltage)

Range:	100 mV/div, 200 mV/div, and 500 mV/div.
Accuracy:	±3% of reading on all ranges.
Display Mode:	Normal or inverted as set at front panel toggle switch.

SWEEP GENERATOR (Collector Voltage)

Sweep Voltage:	Variable at front panel control as follows: 0 to ± 20 V. 0 to ± 200 V. 0 to ±1000 V.
Repetition Range:	100 Hz to 120 Hz dependent on line frequency.
Sweep Currents:	20 V range . . . 0 to 5 A. 200 V range. . . 0 to 500 mA. 1000 V range . . 0 to 100 mA.
Sweep Voltage Polarity:	Positive or negative selectable at front panel.
Overload Protection:	Magnetic breaker.

BASE GENERATOR (Staircase Generator)

Repetition Rate:	100 Hz to 120 Hz, dependent on line frequency.
Number of Steps:	0 to 10 with independent programing of first and last steps at front panel controls.

STEP FUNCTIONS (Current or Voltage)

Current or Voltage

Current Mode:	Ranges 0.1 μA/step, 1 μA/step 10 μA/step, 100 μA step, 1 mA/step, 10 mA/step.
Voltage Mode:	Ranges 10 mV, 100 mV, and 1 V per step.
Multiplier Range:	Multiplies by 1 to 11, adjustable at front panel.
Accuracy:	±3% on all ranges.
Maximum Current:	500 mA.
Maximum Voltage:	35 V.

PULSED BASE MODE

Applies power to base for approximately 800 μsec during peak of collector voltage; this reduces duty cycle to device under test to about 10%.

ZERO STEP OFFSET

Less than 5% of first step x multiplier.

POWER REQUIREMENTS

Voltage Inputs:	105 V minimum to 125 V maximum, 50 Hz to 60 Hz.
Power Inputs:	200 W maximum.

Section II
Installation

2-1. INTRODUCTION

2-2. This section outlines procedures for inspection and initial installation. Reshipment instructions are included in case the instrument must be returned to Fairchild Instrumentation.

2-3. UNPACKING AND INSPECTION

2-4. Before accepting the instrument from the shipper, inspect the crated instrument for external damage. Any sign of external damage must be noted by both customer and shipper, and should be called to the attention of the insurance investigator.

2-5. As soon as the equipment is unpacked, inspect the instrument for damage in shipment, check for scratches or dents and damaged knobs or connectors. Remove top cover plate, and make sure that all plug-in boards are seated firmly in their sockets. If damage is noted, do not use the instrument unless instructed by the insuring agency.

2-6. POWER REQUIREMENTS

2-7. The Model 6200B is designed to operate off 115 V, 50 to 60 Hz, 2-wire single phase power. Do not connect the instrument to a power source with incorrect voltage or inadequate current rating.

2-8. The Model 6200B is equipped with a three-conductor power cable that grounds the instrument when the connector is plugged into an appropriate receptacle. To preserve this safety feature when operating with a two-contact outlet, use an adapter and connect the pigtail on the adapter to a suitable ground.

2-9. RACK MOUNT CONVERSION

2-10. The Fairchild Model 6200B Curve Tracer is shipped as a bench instrument when purchased as a single unit. Detailed instructions for converting the Model 6200B to optional rack mounting configuration are shown in figure 2-1. Information for ordering the rack mounting kit is included in section VI.

2-11. OPERATION CHECK

2-12. The following preliminary operation check may be used to insure that all components and circuits are in operating condition when the instrument is first installed. The procedure provides a quick check for proper functioning, but does not check specifications completely. For complete performance check, refer to paragraph 5-6.

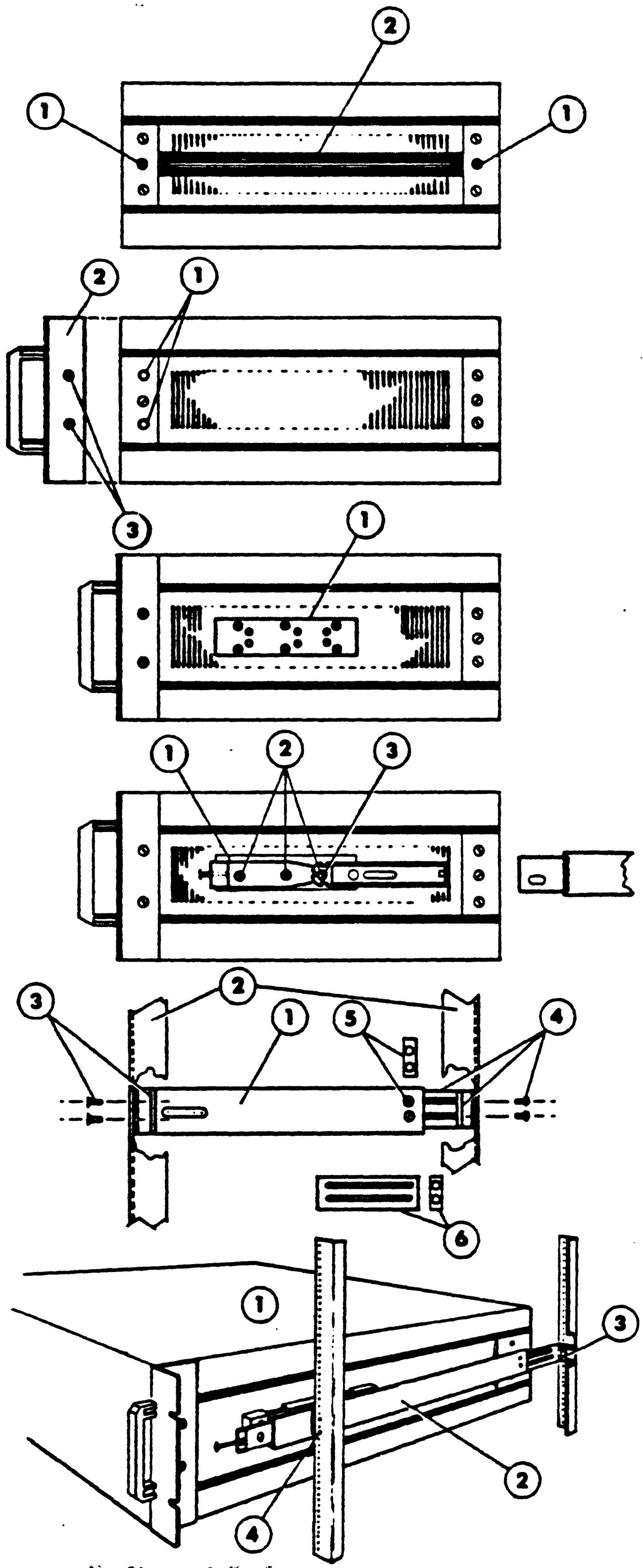
a. Connect instrument to ac power source. Turn power ON with SCALE LIGHT/POWER switch. Scale on CRT screen should glow.

b. Allow one minute warmup; spot should appear on CRT screen. If a spot cannot be located, push and hold horizontal and vertical ZERO switches while rotating vertical and horizontal POSITION potentiometers until beam spot is found.

2-13. RESHIPMENT

2-14. When an instrument is damaged in shipment, do not return it to Fairchild Instrumentation without specific instructions from the insuring agency. Neither the customer nor Fairchild is required to assume responsibility for reshipment.

2-15. When an undamaged instrument is to be returned for service or repair, contact your nearest Fairchild Instrumentation engineering representative for shipping instructions.



a. Remove screws (1) and handle strap (2). Replace screws.

b. Remove screws (1) from front of instrument. Place rack handle (2) in position and replace screws with flat head screws.

c. Mount adapter (1) using six no. 4 screws. Note spacing on detail.

d. Remove center section (1) from slides. Mount adapter in lower set of holes using shoulder screws (2). Use screw with longer shoulder for pivot point (3).

e. Mount front of slide with flat head screws and bar nut (3). Mount angle bracket (4) using binder head screws and bar nut (5). If additional length is required use expander plate (6). Do not secure screws tightly at this time.

f. Place instrument (1) in rack (2) and insert fully into rack. Tighten screws (3) at rear. Withdraw instrument approximately six inches and adjust rack until it is level. Secure screws (4) on front.

Figure 2-1. Rack Mounting Instructions

Section III
Operation

3-1. INTRODUCTION

3-2. There are many diverse applications of the Model 6200B. This instrument may be used to test any device that is responsive to curve trace analysis, and it is well suited to testing low-power devices. Simple-to-operate controls are arranged in logical order on the front panel. This section discusses each control, its function, and some of the instrument's applications.

3-3. CONTROLS

3-4. Figure 3-1 (in two parts) is a photograph with callouts of the Model 6200B front panel. Figure 3-2, also a photograph with callouts, shows the rear panel controls.

3-5. OPERATING INSTRUCTIONS

3-6. Instructions follow for the testing of unknown devices and for the conduct of typical tests.

3-7. Testing Unknown Devices

3-8. Caution must be taken to protect a device of unknown characteristics when it is tested on the Model 6200B. For instance the operator must be careful that the transistor's collector dissipation and current ratings are not exceeded while displaying the curves to be interpreted. Also he must take care that collector-to-emitter voltage ratings are not exceeded.

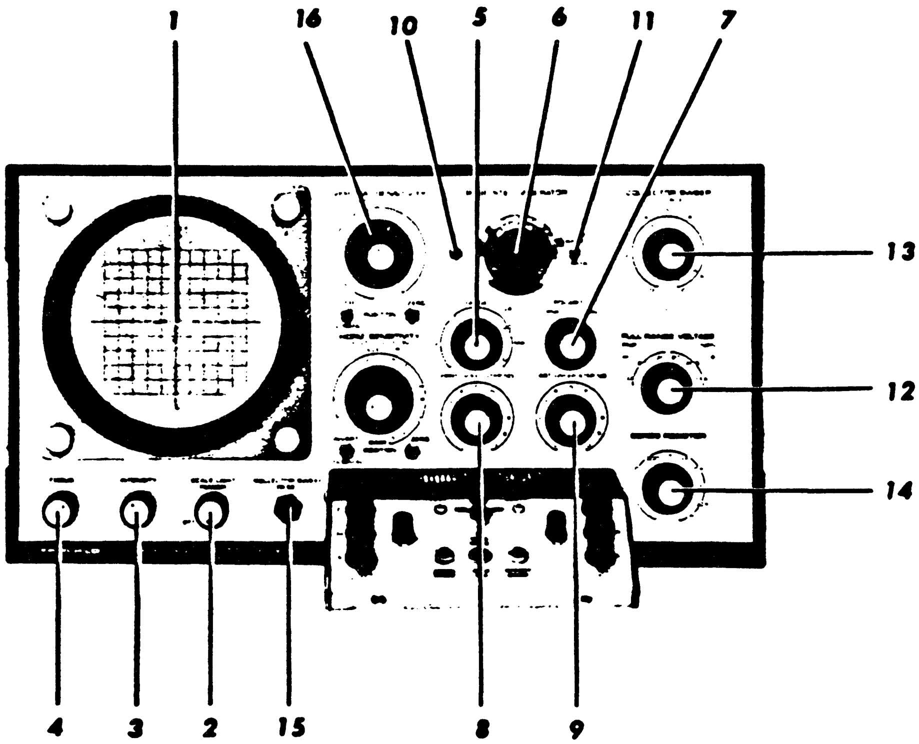
3-9. The procedure for testing unknown devices is outlined in figure 3-3. It is assumed that the operator is aware of whether the device is PNP or NPN.

3-10. Typical Tests

3-11. Semiconductor devices normally tested on the Model 6200B Curve Tracer fall into six basic categories: diodes, conventional PNP and NPN bipolar transistors, junction field effect transistors, metal oxide semiconductor field effect transistors, silicon controlled rectifiers, and unijunction transistors. In the exhibits which follow for each device group, general instructions are given on how to use the Model 6200B to exhibit the characteristics of these devices. Waveforms obtained from tests on typical units in each category are also shown.

3-12. PRODUCTION TEST FORM

3-13. Form 8320-52 (see figure 3-4) is a production aid provided by the Marketing Services Department to assist production workers in setting up tests on the customer's Model 6200B. Pads of Form 8320-52 are available at a nominal cost by writing to Fairchild Instrumentation.



1 Cathode ray tube screen and graticule.

2 SCALE LIGHT/POWER control:

a. Applies primary power to instrument.

b. Controls intensity of trace.

3 INTENSITY control adjusts brightness of trace.

4 FOCUS control adjusts clarity of trace.

5 RANGE switch:

a. Sets basic current value-per-step of base step generator. Step values are .1, 1, 10, and 100 μA; 1 and 10 mA.

b. Sets basic voltage value-per-step of base step generator. Step values are .01, .1 and 1 V.

6 BASE STEP GENERATOR MULTIPLIER control, used in conjunction with RANGE switch, programs base step generator value-per-step. The multiplier is graduated from 1 to 11.

7 POLARITY switch selects polarity of base step generator.

8 FIRST SWEEP STEP NO. switch selects first step of base step generator.

9 LAST SWEEP STEP NO. switch selects last step of base step generator.

10 ZERO STEP ADJUST preset control sets zero step of base step generator.

11 PULSED BASE/NORMAL switch:

a. Selects continuous base drive in NORMAL position.

b. In BASE PULSED position limits base drive to time when collector sweep voltage is near maximum. This produces a duty cycle of less than 10%.

12 FULL RANGE VOLTAGE switch selects polarity and full scale value of collector sweep voltage.

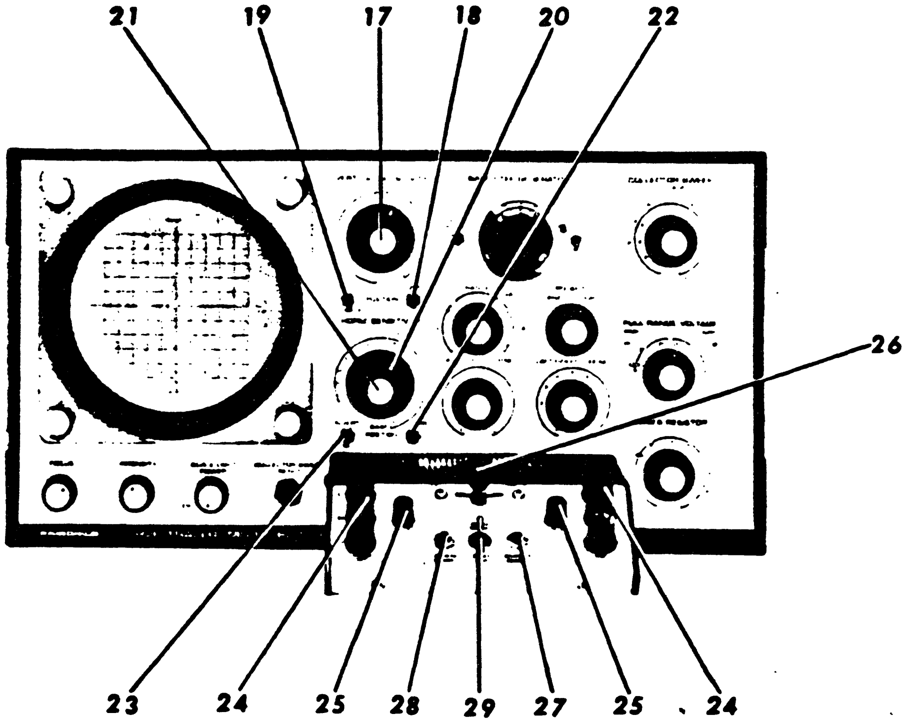
13 COLLECTOR SWEEP VOLTAGE control sets collector voltage value to any level between 0% and 100% of FULL SCALE VOLTAGE setting.

14 SERIES RESISTOR switch selects value of current limiting resistor in collector circuit.

15 COLLECTOR SWEEP RESET switch controls collector sweep overload circuit breaker.

16 VERTICAL SENSITIVITY switch selects sensitivity of Y-axis presentation showing collector current. Sensitivity settings per graticule division run in a 1-2-5 sequence from 1 μA to 500 mA.

Figure 3-1. Front Panel Controls



17 VERTICAL position control positions trace vertically on CRT.

18 ZERO switch grounds vertical amplifier input.

19 NORMAL/INVERT switch:

a. Provides normal display of vertical presentation in NORMAL position.

b. Inverts vertical display in INVERT position.

20 HORIZ. SENSITIVITY switch:

a. COLLECTOR positions set sensitivity of X-axis presentation, showing voltage applies to collector of transistor under test. Sensitivity settings per graticule division run in 1-2-5 sequence from .01 to 100 volts.

b. BASE positions set sensitivity of X-axis presentation, showing voltage applied to base of transistor under test. Sensitivity settings per graticule division are: 0.1, 0.2, and 0.5 V.

21 HORIZ. position control positions trace vertically on CRT.

22 ZERO switch grounds input of horizontal amplifier.

23 NORMAL/INVERT switch:

a. Provides normal display of vertical presentation in NORMAL position.

b. Inverts horizontal display in INVERT position.

24 C-B-E terminals permit device under test to be connected to instrument.

25 Test sockets permit transistors to be connected for test.

26 LEFT-RIGHT switch:

a. LEFT position connects left-hand C-B-E terminals and test socket to instrument.

b. RIGHT position connects right-hand C-B-E terminals and test socket to instrument.

c. Center position disconnects both inputs.

27 OPEN BASE switch opens base lead of device under test when depressed.

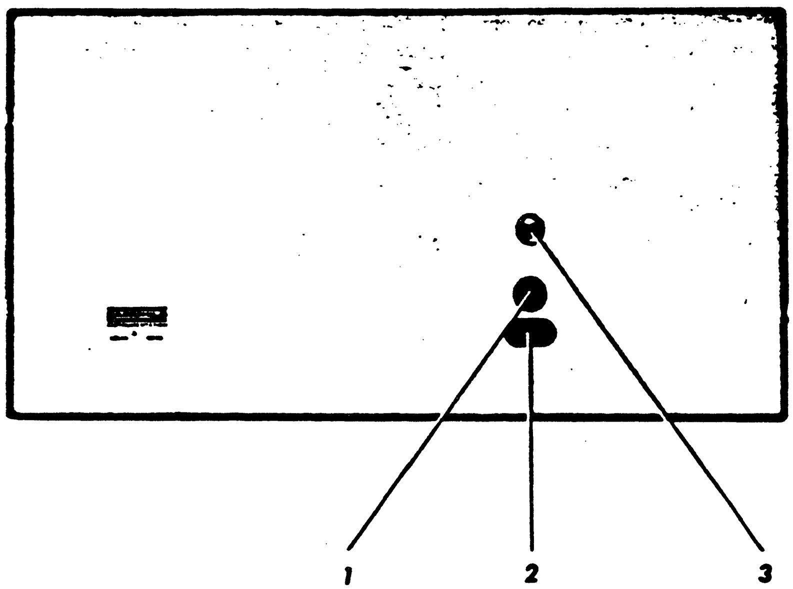
28 SHORT BASE switch shorts base lead of device under test to ground when depressed.

29 GND EM/GND BASE switch:

a. Grounds emitter of transistor under test in GND EM position.

b. Grounds base of transistor in GND BASE position.

Figure 3-1. Front Panel Controls (Cont)

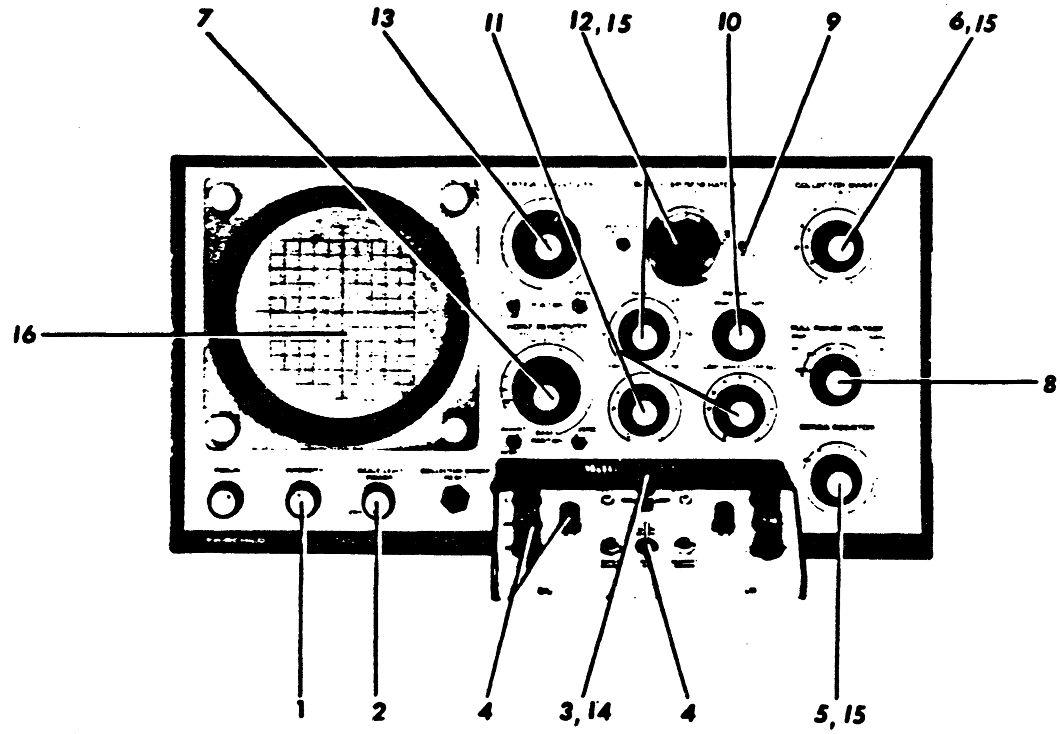


1 Fuse in ac input circuit. Replacement value is 2 amp slow-blow.

2 Ac input connector.

3 Astigmatism control adjusts clarity of trace.

Figure 3-2. Rear Panel Controls



1 Turn INTENSITY control to mid-scale. This prevents damage to the screen when power is applied.

2 Turn POWER ON. Allow instrument to warm up.

3 Center LEFT-RIGHT switch to isolate voltages or currents from test sockets.

4 Set GND BASE/GND EM switch to GND EM if test fixture is being used and a common-emitter configuration is desired.

5 Set SERIES RESISTOR to 1 MΩ.

6 Turn COLLECTOR SWEEP VOLTAGE control to 0 V (fully counter-clockwise).

7 Set HORIZ. SENSITIVITY control to 2 V/div.

8 Set FULL RANGE VOLTAGE amplitude to 20 V, appropriate polarity.

9 Set PULSED BASE/NORMAL switch to NORMAL.

10 Set POLARITY switch to appropriate position for NPN or PNP transistor.

11 Select FIRST SWEEP STEP NO. and LAST SWEEP STEP NO. as required.

12 Set RANGE and MULTIPLIER adjustments to minimum.

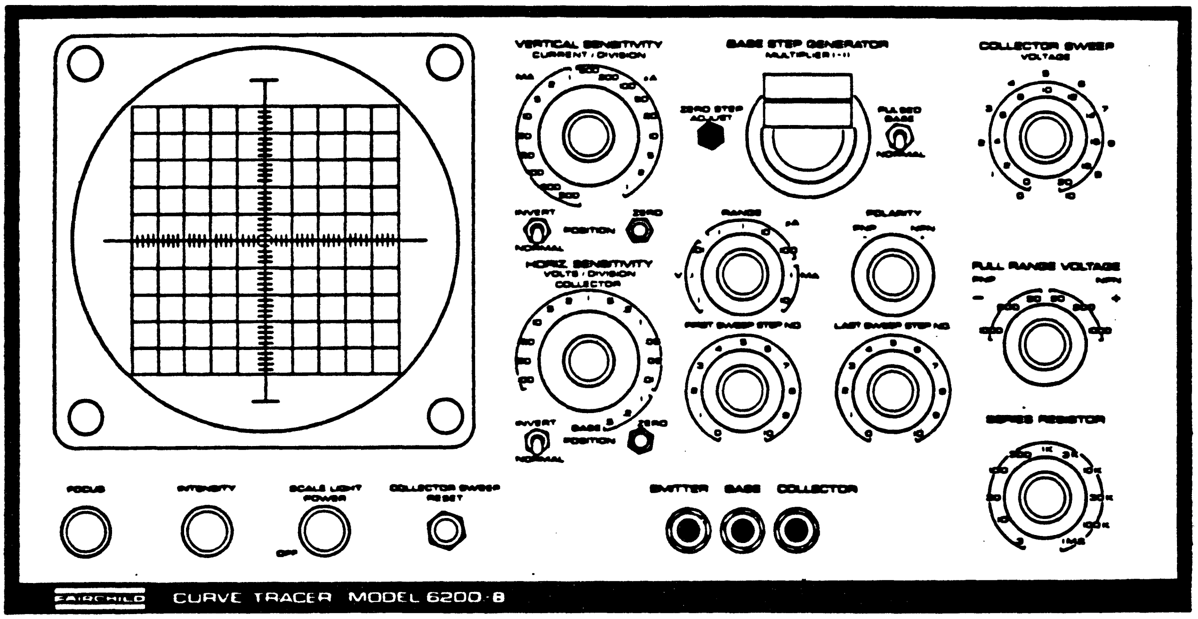
13 Set VERTICAL SENSITIVITY to 1 mA/div.

14 Place transistor to be tested in test socket or terminal posts on one side of test panel, and set comparison switch to corresponding position.

15 Observe display and adjust controls one at a time, increasing COLLECTOR SWEEP VOLTAGE and Base RANGE and MULTIPLIER controls while reducing Collector SERIES RESISTOR. It may be necessary to readjust VERTICAL and HORIZ. SENSITIVITIES to obtain desired display.

16 A family of curves should now be displayed on CRT screen. The controls can be adjusted one at a time.

Figure 3-3. Unknown Device Test



Test Type: ______________________

____

Test Condition: ______________________

____

Test Limits: ______________________

____

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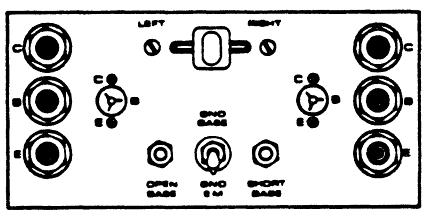


FORM 85

Figure 3-4. Production Test Form

TEST

Display the forward and reverse conduction characteristics of an FD300 silicon diode.

TECHNIQUE:

To make the diode conduct in the forward direction, bias with the sweep generator in the 6200B, (see figure 1) selecting the generator polarity that gives conventional current flow through the diode. Insert collector series resistor to limit current through the diode. The forward voltage drop across the diode will be in the range of 0.2 to 2.0 V, depending on the current through it. To measure how much voltage can be applied across the diode in the reverse direction before it breaks down, reverse the diode physically in the test socket, or reverse the polarity of the sweep generator. The reverse breakdown voltage is generally 25 to 500 V. However, higher voltage units are available.

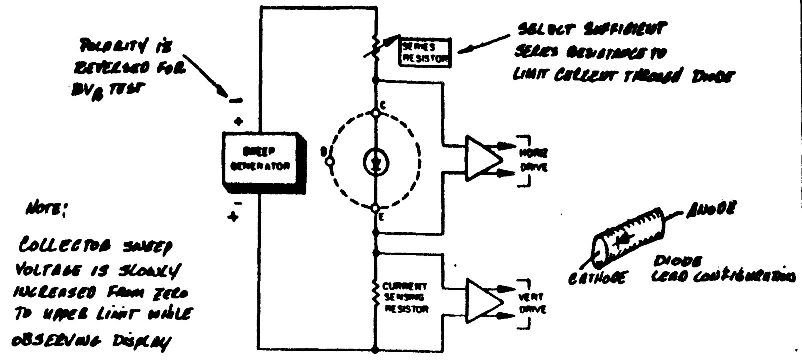
RESULTS:

The forward conduction characteristic of an FD300 silicon diode is shown in figure 1. For this particular device,

V_F = .70 V at I_F = 5 mA.

Figure 3 shows the reverse breakdown characteristic for the particular FD300 silicon diode under test. It is clear that:

BV = 260 V at I_R = 100 µA.



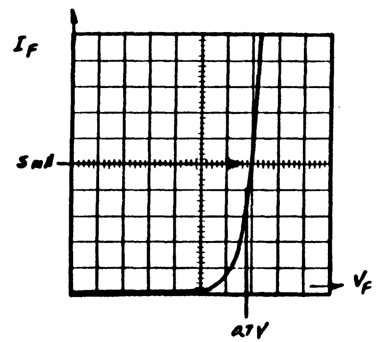
Full Range Voltage: +20

Full Range Voltage: +1000

Figure 1. Curve Tracer Setup for Testing Forward Conduction of a Diode

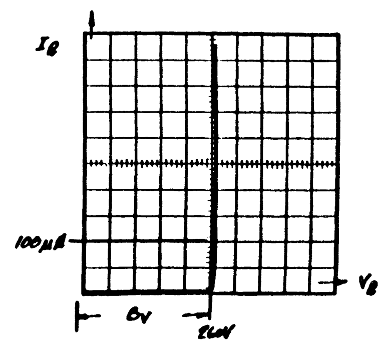
Table I. Manufacturer's Specifications: FD300 Silicon Diode (25°C Free Air Temperature)

SYMBOL	CHARACTERISTIC	MINIMUM	TYPICAL	MAXIMUM	TEST CONDITIONS
V_F	Forward Voltage			.75 V	I_F = 5 mA
BV	Breakdown Voltage	150 V			I_R = 100 µA



Vertical: 1 mA/div (inverted)
Horizontal: 0.1 mA/div

Figure 2. Forward Conduction Characteristic of an FD300 Silicon Diode



Vertical: 50µA/div (inverted)
Horizontal: 50 V/div

Figure 3 Reverse Breakdown in an FD300 Silicon Diode

Exhibit 3-1. Diode Tests

TEST:

Measure h_{FE}, $V_{CE(Sat)}$, and breakdown voltages BV_{CEO} and BV_{CES} for a 2N2905 PNP transistor.

TECHNIQUE

The test setup for measuring h_{FE} and $V_{CE(Sat)}$ in a PNP transistor is given in figure 1. Note that polarities of both generator outputs are negative in the PNP test setup.

The common emitter forward current transfer ratio (h_{FE}) is defined as:

$$h_{FE} = \frac{I_C}{I_B} \qquad \text{(at specified } V_{CE}\text{).}$$

To derive h_{FE} (dc current gain), measure the collector current produced by a base current at the specified collector voltage. This characteristic is shown in figure 2.

Saturation voltage $V_{CE(Sat)}$ is defined as the collector voltage at which collector current becomes essentially independent. To measure saturation voltage select the appropriate scale factor for horizontal collector volts. The saturation region is clearly defined in the bending area of the curve in figure 3.

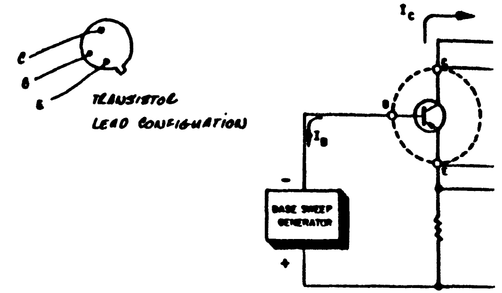
The method of testing breakdown voltage such as BV_{CEO} (the collector to emitter breakdown voltage with base open) is similar to that discussed for testing a diode. See figure 4. Typical breakdown voltage curves for a 2N2905 transistor are shown in figure 5. Note that both breakdown voltage characteristics are shown in one photograph. This was accomplished using a double exposure technique with a scope camera.

RESULTS:

h_{FE} = 167.
$V_{(Sat)}$ = -.22 V at I_C = 150 mA, I_B = 15 mA.
BV_{CEO} = 58 V at I_C = 10 mA, I_B = 0.
BV_{CES} = 64 V at 5 mA.

Table I. Manufacturer's Specifications: 2N2905 PNP Transistor

SYMBOL	CHARACTERISTIC	MINIMUM	TYPICAL	MAXIMUM	TEST CONDITIONS
h_{FE}	DC Current Gain	75			I_C = 10 mA V_{CE} = -10 V
$V_{CE(Sat)}$	Collector Saturation Voltage			-0.4 V	I_C = 150 mA I_B = 15 mA
BV_{CEO}	Collector to Emitter Breakdown Voltage (Base Open)	-40 V			I_C = 10 mA I_B = 0
BV_{CES}	Collector to Emitter Breakdown Voltage (Base Shorted to Emitter)				I_C = 5 mA V_{BE} = 0

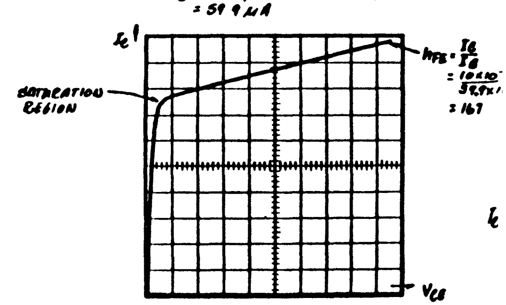


COLLECTOR
Full Range Voltage: 20 - PNP
Collector Sweep Voltage: 10

BASE
Range: 10 μA/step
Multiplier: 5.99
First Step: 0
Last Step: 1

Figure 1. PNP T

I_B = 10μA/step × 5.99 × 1 step = 59.9 μA



Vertical: 1 mA/div (inverted)
Horizontal: 1 V/div (inverted)

Figure 2. Collector Characteristic

and breakdown voltages
a 2N2905 PNP transistor.

ing h_{FE} and $V_{CE(Sat)}$ in a
a figure 1. Note that pol-
outputs are negative in the

ard current transfer ratio

(at specified V_{CE}).

gain), measure the col-
by a base current at the
. This characteristic is

is defined as the collector
rrent becomes essentially

independent. To measure saturation voltage select the appropriate scale factor for horizontal collector volts. The saturation region is clearly defined in the bending area of the curve in figure 3.

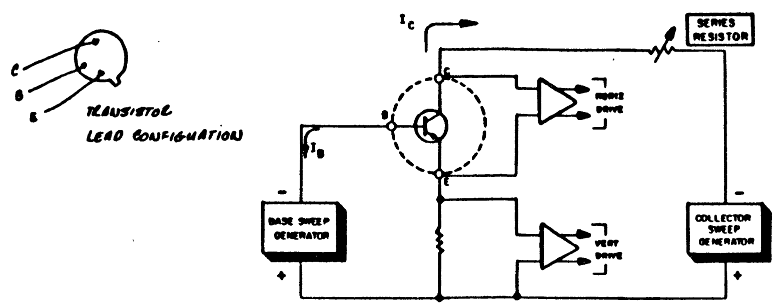
The method of testing breakdown voltage such as BV_{CEO} (the collector to emitter breakdown voltage with base open) is similar to that discussed for testing a diode. See figure 4. Typical breakdown voltage curves for a 2N2905 transistor are shown in figure 5. Note that both breakdown voltage characteristics are shown in one photograph. This was accomplished using a double exposure technique with a scope camera.

RESULTS:

h_{FE} = 167.
$V_{(Sat)}$ = -.22 V at I_C = 150 mA.
I_B = 15 mA.
BV_{CEO} = 58 V at I_C = 10 mA.
I_B = 0.
BV_{CES} = 64 V at 5 mA.

ble I. Manufacturer's Specifications: 2N2905 PNP Transistor

ACTERISTIC	MINIMUM	TYPICAL	MAXIMUM	TEST CONDITIONS
Gain	75			I_C = 10 mA V_{CE} = -10 V
aturation Voltage			-0.4 V	I_C = 150 mA I_B = 15 mA
Emitter Breakdown se Open)	-40 V			I_C = 10 mA I_B = 0
Emitter Breakdown se Shorted to				I_C = 5 mA V_{BE} = 0



COLLECTOR
Full Range
Voltage: 20 - PNP

Collector
Sweep
Voltage: 10

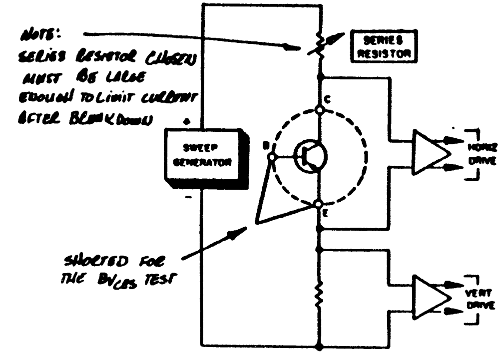
BASE
Range: 10 µA/step
Multiplier: 5.99
First Step: 0
Last Step: 1

COLLECTOR
Full Range
Voltage: 20 - PNP

Collector
Sweep
Voltage: 10

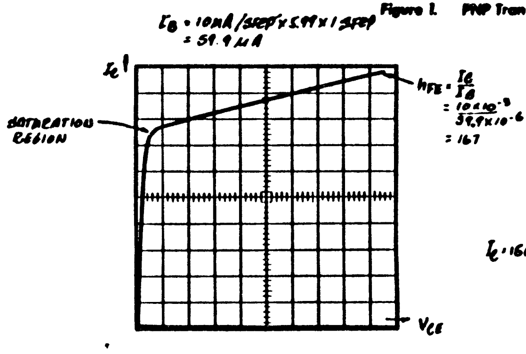
BASE
Range: 10 mA/step
Multiplier: 1.5
First Step: 1
Last Step: 1

Figure 1. PNP Transistor Test Setup



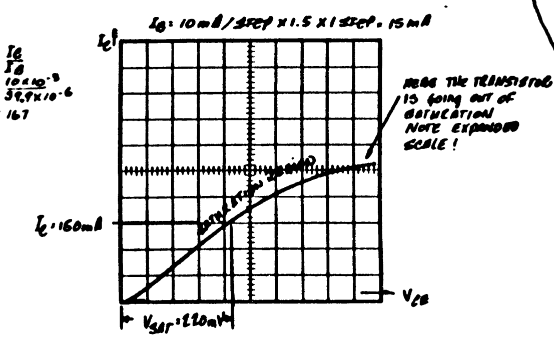
Full Range
Voltage: +20

Figure 4. BV_{CEO} Test, PNP Transistor



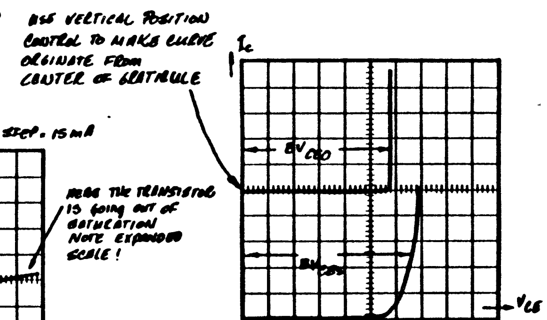
Vertical: 1 mA/div (inverted)
Horizontal: 1 V/div (inverted)

Figure 2. Collector Characteristic



Vertical: 50 mA/div (inverted)
Horizontal: 0.05 V/div (inverted)

Figure 3. Saturation in a 2N2905



Top: BV_{CEO}
Vertical: 2 mA/div
Horizontal: 10 V/div

Bottom: BV_{CES}
Vertical: 2 mA/div
Horizontal: 10 V/div

Figure 5. Breakdown Voltage Characteristics

Exhibit 3-2. Transistor Tests

TEST:

Measure exact values of:

a) drain current at zero-gate voltage (I_{DSS}).

b) gate-source pinch-off voltage (V_p).

c) gate-source breakdown voltage (BV_{GSS}) for a U1283 P-channel junction field effect transistor.

TECHNIQUE:

Figure 1 shows the test setup for a P-channel depletion type junction field effect transistor.

I_{DSS} is the current that flows through a depletion type junction field effect transistor with 0 V applied to gate.

Figure 2 shows I_D versus V_{DS} for 10 steps of gate voltage. The highest curve corresponds to I_{DSS}.

Pinch off-voltage (V_p) of an FET is the gate-to-source voltage that must be applied to reduce the drain current to zero. The lowest curve on figure 3 corresponds to approximately pinch-off.

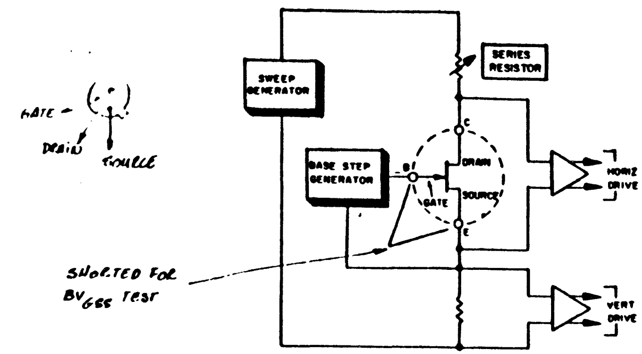
Both the horizontal and vertical axes have been inverted. This allows displaying the U1283, which is a P-channel FET, from the lower-left-hand corner of the screen.

RESULTS:

BV_{GSS} = 86 V at I_G = 10 µA

I_{DSS} = .5 mA at V_{DS} = 5 V, V_{GS} = 0 V

V_P = 2.03 V at V_{DS} = 0 V, I_D = 1µA



NOTE:
INCREASE COLLECTOR SWEEP VOLTAGE SLOWLY FROM 0 TO UPPER LIMIT WHILE OBSERVING DISPLAY

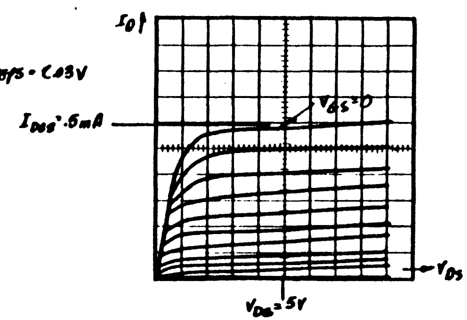
Collector
Sweep Voltage: -200

Range: 0.1 V/step
Multiplier: 2.03
Polarity: (-)
First Step: 0
Last Step: 10

Collector
Sweep Voltage: -1000

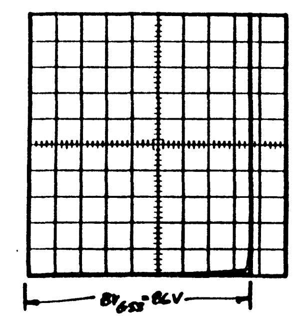
Figure 1. Test Setup for a Junction Field Effect Transistor

V_p = 0.1V/step X 2.03 X 10 steps = 2.03V



Vertical: 100 µA/div (inverted)
Horizontal: 1 V/div (inverted)

Figure 2. Conduction Characteristics



Vertical: 10 µA/div (inverted)
Horizontal: 10 V/div (inverted)

Figure 3. Gate-Source Breakdown Voltage

Table I. Manufacturer's Specifications: U1283 P-Channel Junction Field Effect Transistor

SYMBOL	CHARACTERISTIC	MINIMUM TYPICAL MAXIMUM	TEST CONDITIONS
I_{DSS}	Drain Current at Zero Gate Voltage	.5 mA	V_{DS} = -5.0 V, V_{GS} = 0 V
V_p	Gate-Source Pinch-off Voltage	2.5 V	V_{DS} = 5.0 V, I_D = 1.0 µA
BV_{GSS}	Gate-Source Breakdown Voltage	30 V	I_G = 10 µA, V_{DS} = 0 V

Exhibit 3-3. FET Tests

TEST:

Verify the following parameter specifications given for an FI 100 MOS FET.

TECHNIQUE:

The MOS FET is connected as shown in figure 1. Note that the substrate is connected to the source. As shown in figure 2, the characteristic curves originate in the lower left hand corner of the graticule even though the FI100 is a P-type device. This is possible by using the horizontal and vertical INVERT switches on the Model 6200B.

Y_{fs}, gate to Drain Transconductance, is defined as:

$$Y_{fs} = \frac{\Delta I_D}{\Delta V_{GS}} \text{ at constant V.}$$

Figure 2 shows that when $V_{DS} = V_{GS} = -10$ V, a 1 V change causes a 340 μA change in I_D.

Therefore:

$$Y_{fs} = \frac{340}{1} \times 10^{-6} = 340 \ \mu\text{mhos.}$$

The gate threshold voltage, V_{GST}, is reached when the gate voltage level (with respect to the source voltage) becomes great enough to allow conventional current to flow from the source to the drain lead. The characteristic shown in figure 3 was obtained by shorting the gate to the drain and applying one step of base voltage barely sufficient to drive the device into conduction. The threshold is reached when V_{GS} = 4.78.

RESULTS:

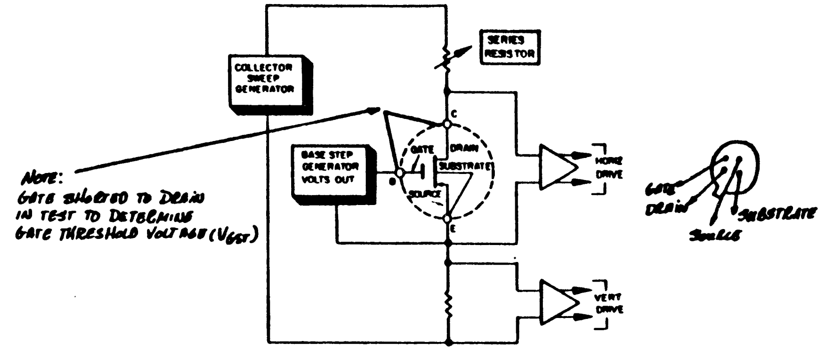
Y_{fs} = 340 μmhos.

V_{GS} = 4.78 V.

$\Delta V_{GS} = 1, \Delta I_D = 340\mu A$
$\therefore Y_{fs} = \frac{340 \times 10^{-6}}{1} = 340 \mu$ MHOS

Table I. Manufacturer's Specifications: FI 100 MOS FET (25°C Free Air Temperature)

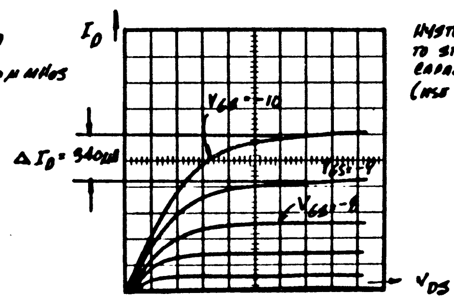
SYMBOL	CHARACTERISTIC	MINIMUM	TYPICAL	MAXIMUM	TEST CONDITIONS
Y_{fs}	Gate to Drain Transconductance	300 μmhos		600 μmhos	$V_{GS} = V_{DS} = -10$ V
V_{GST}	Gate Threshold Voltage	-2.5 V	-4.5 V	-6.0 V	V_{GD} = 0, I_D = 10 μA



COLLECTOR		BASE	
Full Range Voltage:	-20	Range:	1 V/step
		Polarity:	(-)
		Multiplier:	1.0
		First Step:	5
		Last Step:	10

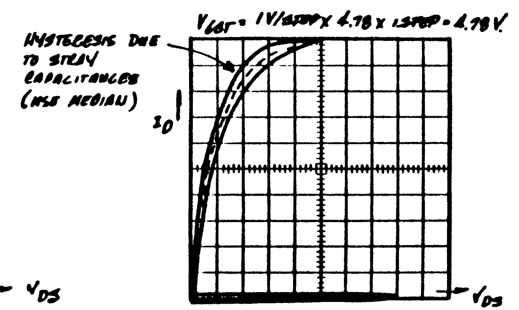
COLLECTOR		BASE	
Full Range Voltage:	-20	Range:	1 V/step
		Polarity:	(-)
		Multiplier:	4.78
		First Step:	0
		Last Step:	1

Figure 1. MOS FET Test Setup



Vertical: 200 μA/div (inverted)
Horizontal: 1 V/div (inverted)

Figure 2. Conduction Characteristics



Vertical: 1 μA/div (inverted)
Horizontal: 0.2 V/div (inverted)

Figure 3. Gate Threshold Voltage

Exhibit 3-4. MOS FET Tests

TEST:

Verify the specifications listed below for a 2N3276 SCR.

TECHNIQUE:

Forward and reverse breakdown characteristics are measured with the SCR's gate lead open. The anode of the device is connected to the COLLECTOR terminal and the cathode is connected to the EMITTER terminal. The collector sweep voltage then is increased until breakdown is observed on the CRT display. Forward and reverse breakdown characteristics are both shown in figure 1. Display of both characteristics on one photo was made possible by a double exposure technique using a scope camera. To determine V_{GT} at rated voltage from anode to cathode, the SCR is connected to the test setup shown in figure 2. The collector sweep voltage is turned up to 400 volts. First and last step numbers are set to 0 and 1 respectively; then the base step RANGE is set to approximately the correct range.

The MULTIPLIER adjustment is cranked up then until just enough gate voltage is applied to fire the device. The exact gate firing voltage for the device being tested is V_{GT} = RANGE x MULT x STEP NUMBER.

Figure 3 shows the device being triggered into conduction. Note in the lower left hand of the photo that the particular device under test turns off when anode current drops below 6 mA. Therefore, the holding current is: I_H = 6 mA. Without the pulse capability of the Model 6200B, it is impossible to make this measurement accurately on a curve tracer. In the normal display mode, the gate drive, which is applied during the entire collector sweep, produces an erroneous reading. The ON voltage is measured across the anode-cathode terminals of the device while it is under conduction. ON voltage at 2.2 A is shown in figure 4.

RESULTS:

V_{FX} = 75 V V_{RO} = 475

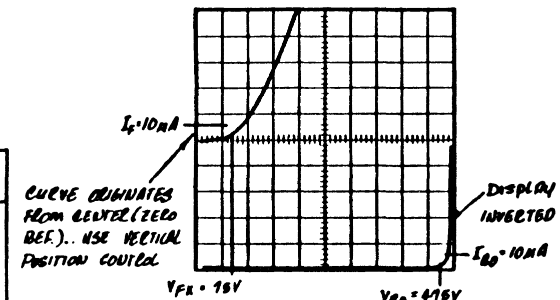
V_{GT} = .54 V I_H = 6 mA

V_F = 1.2 V at I_F = 2.2 A

GATE IS LEFT — UNCONNECTED WHEN MEASURING FORWARD AND REVERSE BLOCKING VOLTAGES

TOP: V_{FX}
Full Range Voltage: +1000

BOTTOM: V_{RO}
Full Range Voltage: -1000



Vertical: 20 μA/div
Horizontal: 50 V/div

Figure 1. Forward and Reverse Blocking Voltages

Table I. Manufacturer's Specifications: 2N3276 SCR

SYMBOL	CHARACTERISTIC	MINIMUM	TYPICAL	MAXIMUM	TEST CONDITIONS
V_{FX}	Forward Blocking Voltage	400 V			I_{FX} = 10 μA
V_{RO}	Reverse Blocking Voltage	400 V			I_{RO} = 10 μA I_G = 0
V_{GT}	Gate Trigger Voltage	0.1 V	0.3 V		V_{AK} = 400 V
I_H	Holding Current		0.7 mA	2.0 mA	I_G = 0 R_K = 1 K
V_F	On Voltage		1.5 V	1.8 V	I_F = 2.2 A

for a 2N3276
teristics are
The anode of
'OR terminal
MITTER ter-
is increased
CRT display.
teristics are
characteris-
by a double
a. To deter-
to cathode,
up shown in
is turned up
rs are set to
ep RANGE is

l up then until
e the device.
device being
EP NUMBER.

Figure 3 shows the device being triggered into conduction. Note in the lower left hand of the photo that the particular device under test turns off when anode current drops below 6 mA. Therefore, the holding current is: I_H = 6 mA. Without the pulse capability of the Model 6200B, it is impossible to make this measurement accurately on a curve tracer. In the normal display mode, the gate drive, which is applied during the entire collector sweep, produces an erroneous reading. The ON voltage is measured across the anode-cathode terminals of the device while it is under conduction. ON voltage at 2.2 A is shown in figure 4.

RESULTS:

V_{FX} = 75 V V_{RO} = 475

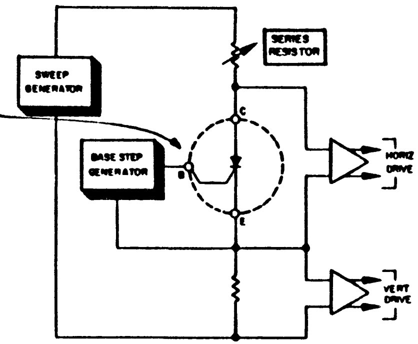
V_{GT} = .54 V I_H = 6 mA

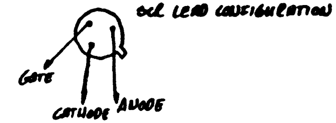
V_F = 1.2 V at I_F = 2.2 A

Manufacturer's Specifications: 2N3276 SCR

	MINIMUM	TYPICAL	MAXIMUM	TEST CONDITIONS
	400 V			I_{FX} = 10 µA
	400 V			I_{RO} = 10 µA, I_G = 0
	0.1 V	0.3 V		V_{AK} = 400 V
		0.7 mA	2.0 mA	I_G = 0, R_K = 1 K
		1.5 V	1.8 V	I_F = 2.2 A

GATE IS LEFT UNCONNECTED WHEN MEASURING FORWARD AND REVERSE BLOCKING VOLTAGES





TOP: V_{FX}
Full Range Voltage: +1000

BOTTOM: V_{RO}
Full Range Voltage: -1000

SWEEP GENERATOR

Full Range Voltage: +1000

Collector Sweep Voltage: 400

STEP GENERATOR

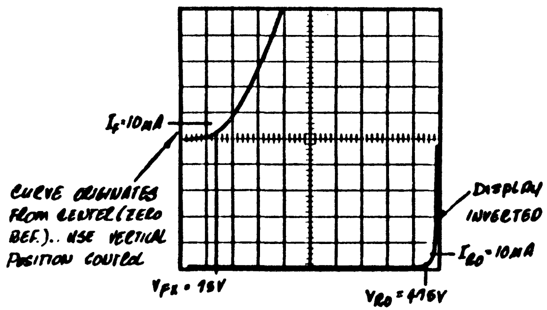
Range: 100 mV/step
Polarity: (+)
Multiplier: 5.40
First Step: 0
Last Step: 1
Mode: Pulsed

Full Range Voltage: +1000 V

Series Resistor: 100Ω

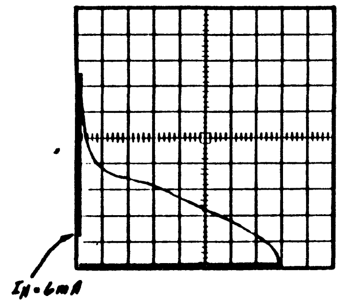
THRU COLLECTOR SWEEP VOLTAGE CONTROL C.W. JUST ENOUGH TO OBTAIN DISPLAY

Figure 2. SCR Test Setup



Vertical: 20 µA/div
Horizontal: 50 V/div

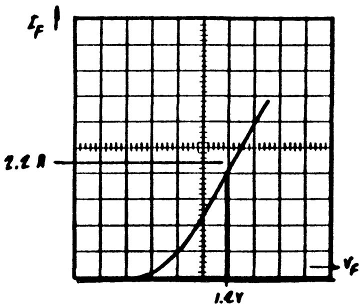
Figure 1. Forward and Reverse Blocking Voltages



V_{GT} = 100mV/STEP X 5.40 X 1 STEP
= 540 mV

Vertical: 5 mA/div
Horizontal: 50 V/div

Figure 3. Firing Characteristics



Vertical: 500 mA/div
Horizontal: 0.2 V/div

Figure 4. Conduction Characteristics

Exhibit 3-5. SCR Tests

TEST:
Measure the parameters listed below to verify the manufacturer's specifications for a 2N2646 unijunction transistor.

TECHNIQUE:
Test configuration for measuring interbase resistance is shown in figure 1.

The emitter lead is left unconnected, and the sweep generator is used to establish V_{BB}.

The conduction characteristics of the unijunction are measured by connecting the device to the Model 6200B as shown in figure 3.

Notice that the bias between Base 1 and Base 2 of the unijunction is supplied by the base step generator in the curve tracer. With the 6200B, one single step can be selected by use of the multiplier and range switches. Any bias level up to 33 V can be applied. The amount of bias can be adjusted at the front panel of the 6200B. The dc bias across the 2N2646 in figure 4 is 1 V/step x 2.5 x 10 steps = 25 V.

The peak-point emitter voltage is the maximum voltage that can be applied between Base 2 and the emitter of the unijunction before the device goes into conduction. This value is clearly indicated on the horizontal axis of figure 4 for the condition of 25 Vdc bias between Base 1 and Base 2.

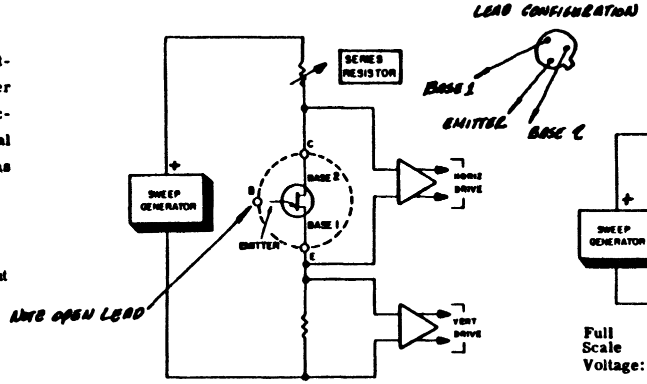
V_V and I_V are the minimum voltage and current that will keep the unijunction turned on.

RESULTS:

R_{BB} = 8.88 kΩ at V_{BB} = 3 V.
I_E = 0
η = .64 at V_{BB} = 25 V.
V_P = 16 at V_{BB} = 25 V.
V_V = 5 at V_{BB} = 25 V.
I_V = 7 mA at V_{BB} = 25 V.

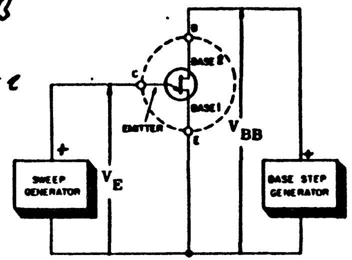
Table I. Manufacturer's Specifications: 2N2646 Unijunction Transistor

SYMBOL	CHARACTERISTIC	MINIMUM	TYPICAL	MAXIMUM	TEST CONDITIONS
R_{BB}	Interbase Resistance	4.7 kΩ		9.1 kΩ	V_{BB} = 3 V, I_E = 0
η	Intrinsic Stand-off Ratio	.56		.75	V_{BB} = 25 V
V_P	Peak Point Emitter Voltage		10 V		V_{BB} = 25 V
V_V	Valley Voltage		2.5 V		V_{BB} = 25 V
I_V	Valley Current		5 mA		V_{BB} = 25 V



Full Range Voltage: 20 + NPN
Collector Sweep Voltage: 5

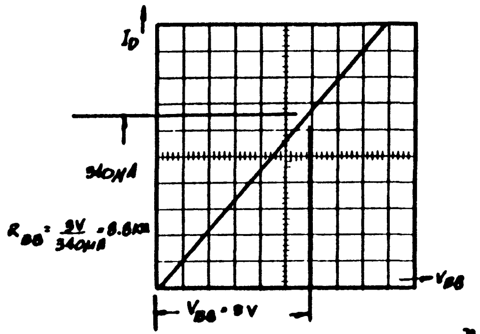
Figure 1. Test Setup for Measuring Interbase Resistance



Full Scale Voltage: 20 + NPN
Collector Sweep Voltage: 5

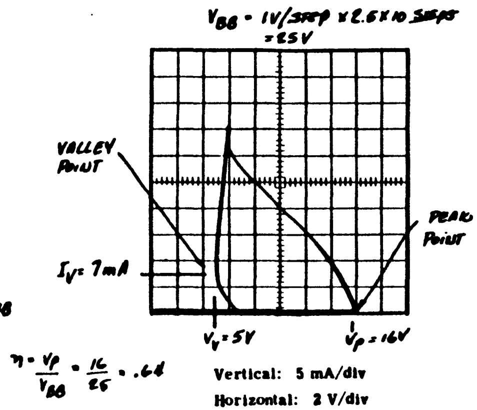
First Step: 10
Last Step: 10
Range: 1 V
Multiplier: 2.50
Mode: Normal

Figure 3. Test Setup for Measuring Conduction Characteristics



Vertical: 50 µA/div
Horizontal: 0.5 V/div

Figure 2. Interbase Resistance Characteristics



Vertical: 5 mA/div
Horizontal: 2 V/div

Figure 4. Conduction Characteristics

Exhibit 3-6. Unijunction Transistor Tests

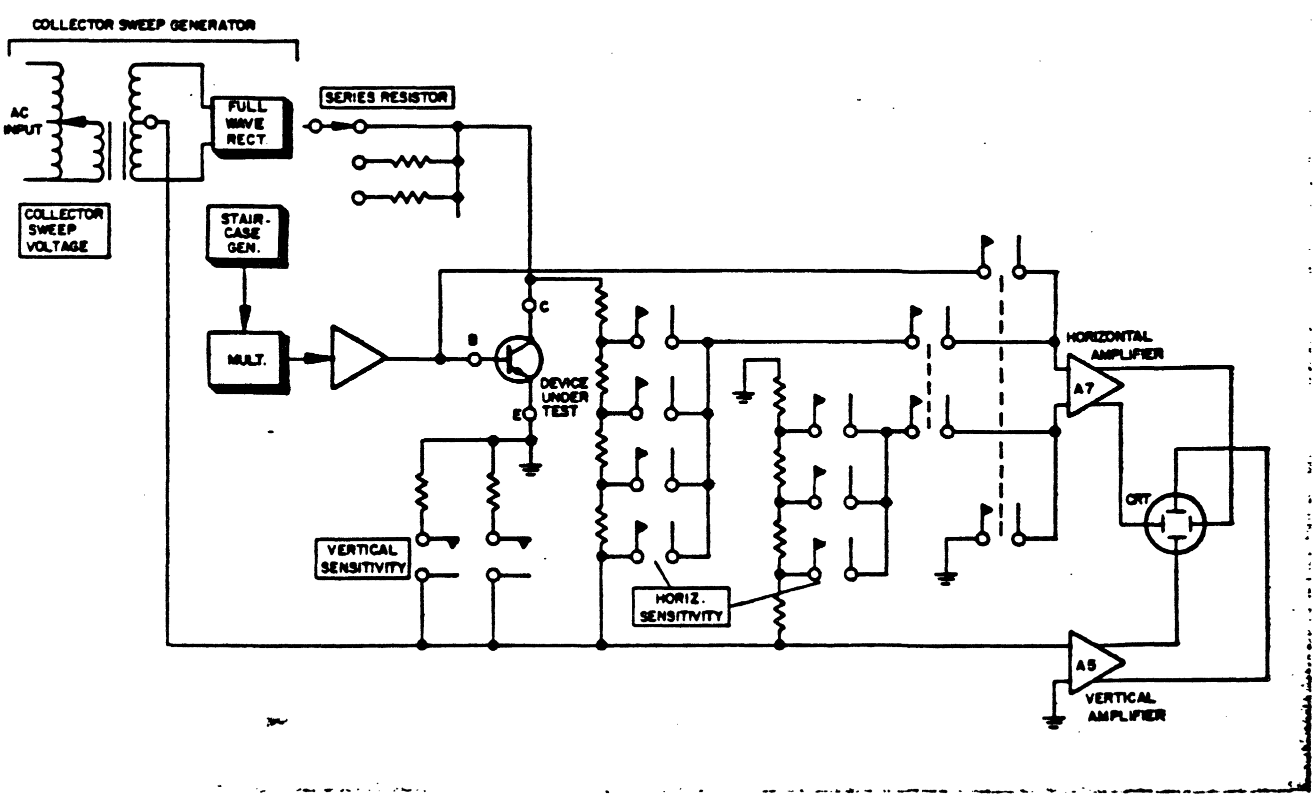


Figure 4-1. Model 6200B Curve Tracer Block Diagram

Section IV
Theory of Operation

4-1. INTRODUCTION

4-2. This section contains a discussion of the design and operating principles of the Fairchild Model 6200B Curve Tracer. Theory of operation is discussed first at block diagram level and then at detailed circuit level. Complete schematic diagrams of circuits discussed in this section are included in section V of this manual.

4-3. BASIC OPERATING PRINCIPLES

4-4. The Model 6200B Curve Tracer is a single chassis, self-contained unit operated from 50 to 60 Hz primary power. The semiconductor under test is inserted into a common emitter circuit, or common base if desired (see figure 4-1). A sweep voltage is applied to the collector while a step voltage or current is applied to the base. Collector volts sweep from zero to full range. The ranges are ±20, ±200, ±1000 volts. Sweep voltages are produced by the sweep generator.

4-5. The base step generator applies a selected number of steps, from zero to ten to the base of the device to produce a sequence of curves. The incremental value of the steps is controlled by a front panel RANGE switch and a variable MULTIPLIER.

4-6. Step and sweep voltages are time synchronized so that the step voltage applied to the base is held constant while the collector voltage sweeps from zero to full value. The step voltage level then is increased for the next sweep. Each sequence of steps produces one family of curves.

4-7. The current/voltage values taken from the collector and base in the transistor test circuit are used for vertical and horizontal deflection signals to deflect an electron beam within the cathode ray tube. When the undeflected beam strikes the coated screen of the tube, the electrical energy is converted to light and is seen as a small luminous spot. As the beam is deflected across the screen under control of the two time-synchronized voltages applied to the vertical and horizontal deflection plates, the moving spot gives the illusion of a continuous line or trace. The deflection of the beam is proportional to the voltage applied to the deflection plates.

4-8. Two standard displays are available:

a. collector current (I_C) versus collector voltage (V_C) as function of base input-current or voltage.
b. collector current (I_C) versus base voltage (V_B) as function of base input-current or voltage.

Selection of desired standard display is accomplished with front panel RANGE and HORIZ. SENSITIVITY controls.

4-9. COLLECTOR SWEEP

4-10. The function of the collector sweep circuit is to provide a voltage to the collector of the device under test. Full range collector voltage is selected at the front panel and the voltage sweeps from zero to full range at double the frequency of the primary power source. The collector current that results from the collector sweep voltage simultaneously with the base input is the vertical trace signal on the CRT. Since the base input remains fixed during each collector voltage sweep (figure 4-2), each vertical trace signal reflects the collector current at all points

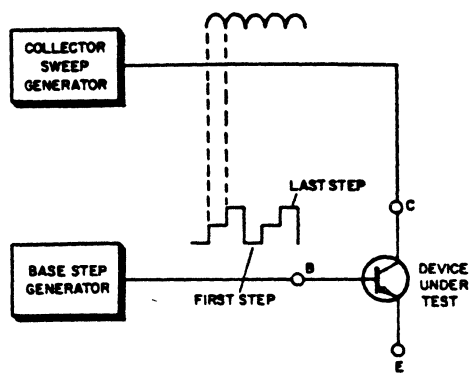


Figure 4-2. Synchronized Output Waveforms of Base Step and Collector Sweep Generators

from zero collector voltage to full range for one base input. To aid in curve analysis, the collector sweep voltage is calibrated in CRT divisions. In the 1 V/div range, for example, each division on the horizontal trace represents an increase of 1 V in the collector sweep voltage. Each division on the vertical trace represents a selected current value.

4-11. Collector Sweep Voltage Controls

4-12. The front panel controls, COLLECTOR SWEEP VOLTAGE and FULL RANGE VOLTAGE, are used to establish the voltage value of the collector sweep (figure 4-3). The COLLECTOR SWEEP VOLTAGE control operates autotransformer T2 whose input is 115 Vac primary power, and whose output is applied across circuit breaker CR1 to the primary winding of T3. The secondary windings of T3 are connected to a full wave rectifier that provides dc outputs of ±20 V, ±200 V, and ±1000 V. FULL RANGE VOLTAGE switch selects the level.

4-13. SERIES RESISTORS

4-14. Output of the collector sweep generator is connected through a front panel selectable series resistance to the collector of the device under test. The series resistor acts as a current limiting device. Resistance values of 3 Ω, 10 Ω, 30 Ω, 100 Ω, 300 Ω, 1 kΩ, 3 kΩ, 10 kΩ, 30 kΩ, 100 kΩ, and 1 MΩ are available to change collector load characteristics. The 3 Ω resistance is the output impedance of the collector sweep generator.

4-15. HORIZONTAL AMPLIFIER

4-16. The amplifier converts the single ended output of the collector sweep circuit into the push-pull configuration needed to drive the horizontal deflection plates of the cathode ray tube. Figure 4-4 is a simplified schematic of the horizontal amplifier.

4-17. Two N-type field effect transistors (FET's) are source followers. A7Q2 is connected to ground across compensation resistors A6R11 through A6R20; and A7Q1 is connected to the collector voltage source through input attenuator A6R1 through A6R10.

4-18. Horizontal balance potentiometer A7R5

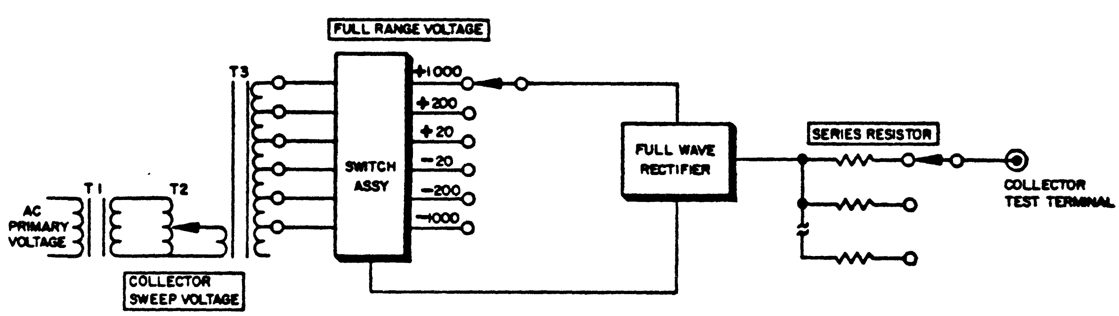


Figure 4-3. Collector Voltage Control

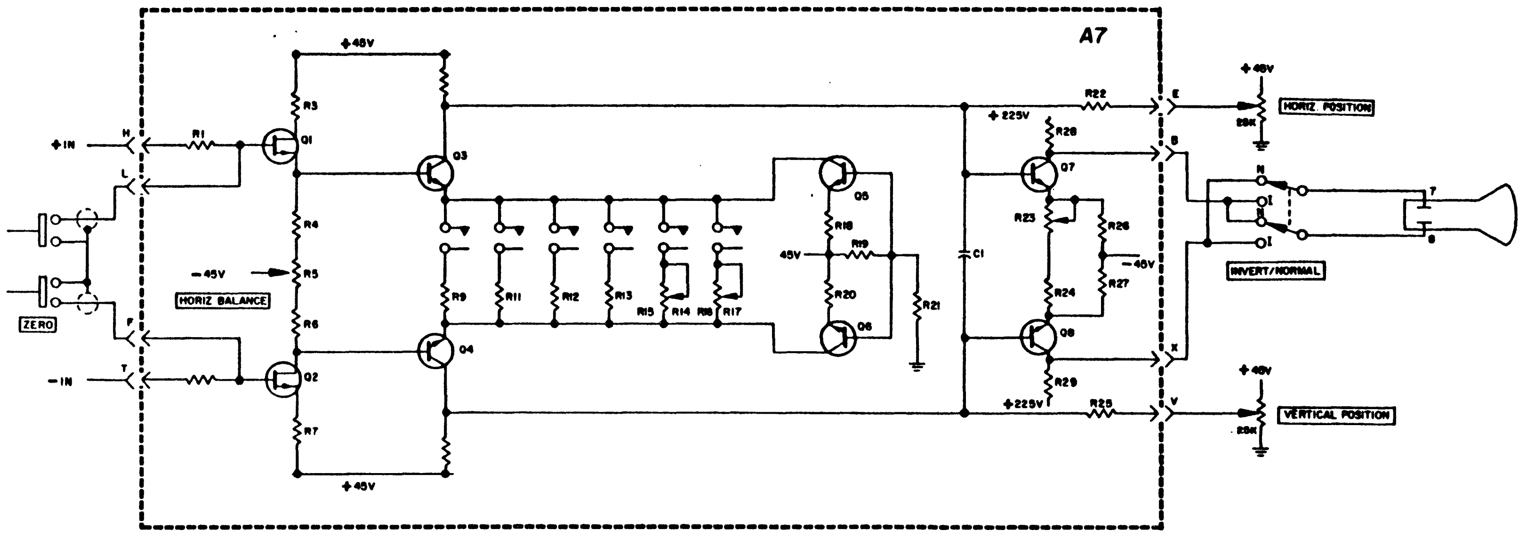


Figure 4-4. Horizontal Amplifier Simplified Schematic

adjusts the source currents to make the source/gate voltages equal (dc balance control). This adjustment ensures that there is no horizontal movement when HORIZ. SENSITIVITY switch S8 is operated.

4-19. ZERO switch S11 provides ground reference to both FET stages to allow setting zero reference on the CRT.

4-20. Transistors A7Q3, A7Q4 comprise a differential amplifier. The emitter currents are supplied by A7Q5 and A7Q6 which serve as constant current sources. Gain of the amplifier is controlled by the emitter resistance selected. For a sensitivity of 100 mV per screen division K1 is closed; for collector voltage ranges requiring a sensitivity of 10, 20, and 50 mV per screen division K6, K5, and K4 are closed. For base voltage range sensitivities of 200 mV and 500 mV per screen division, K2 and K3 are closed.

4-21. Horizontal position potentiometers R232 and R233 (both chassis mounted) unbalance the collector voltages of A7Q3 and A7Q4 to provide an adjustable dc level on the CRT deflection plates. A7Q7 and A7Q8 comprise a differential pair with the gain controlled by A7R23 and A7R24. Potentiometer A7R23 is used for calibration purposes. Output from the horizontal amplifier is taken from the collectors of A7Q7 and A7Q8 and applied respectively to the plus and minus horizontal deflection plates of the CRT.

4-22. HORIZONTAL SENSITIVITY

4-23. The horizontal sensitivity is controlled by two relay-operated attenuators. The relays in turn are enabled by front panel HORIZ. SENSITIVITY VOLTS/DIVISION switch S8. Each range setting on the control pulls in a resistor value that is combined with the gain control to give the desired sensitivity to the horizontal trace. In the base voltage configuration, the attenuators are dropped out, and the sensitivity control operates gain control relays A7K1, A7K2, A7K3 in the horizontal amplifier.

4-24. The upper end of the plus attenuator is connected to the collector sweep source in series with the series resistor. The upper end of the minus attenuator is connected to ground at the emitter of the device under test. The lower end of both attenuators is connected to the center tap of T3.

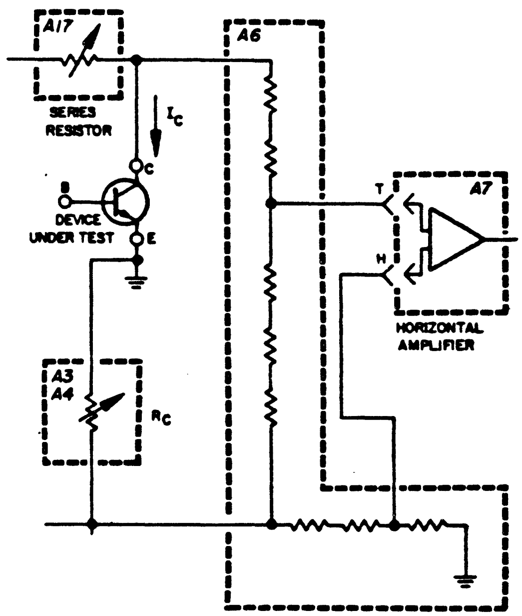


Figure 4-5. Horizontal Sensitivity Circuit

4-25. Figure 4-5 is a simplified diagram of the horizontal circuits. The voltage at point T, with respect to ground, contains the algebraic sum of collector voltage plus the product of collector current times resistor R. The voltage at point H contains only the collector current times R. The combined inputs to the horizontal amplifier are +T and -H. Since T - H leaves a difference of only the collector voltage component, the horizontal amplifier responds only to collector voltage.

4-26. VERTICAL AMPLIFIER

4-27. As mentioned previously, the vertical input to the CRT is proportional to collector current (I_C). Referring to figure 4-6, collector current is sensed by the vertical amplifier by sampling the voltage drop across sensing resistors located on A3 and A4. (The

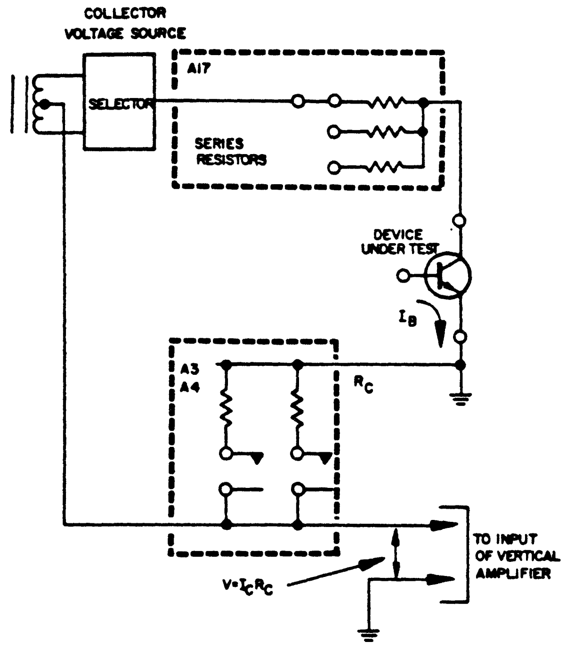


Figure 4-6. Collector Current Sensing Resistors, Simplified Schematic

sensing resistors are shown simply as R_C.) These resistors, selected by relays, are enabled by front panel VERTICAL SENSITIVITY CURRENT/DIVISION switch S7.

4-28. Since I_C is the only current flowing through R_C, input to the vertical amplifier is directly proportional to the values of I_C and R_C. R_C is a precision resistor resulting in a calibrated collector current sensitivity or deflection. The current sensing resistor is connected to the grounded emitter of the device under test and the center tap of the collector sweep transformer.

4-29. As in the horizontal amplifier, two N-type field effect transistors are used as source followers. A5Q1 is connected to the grounded emitter of the device under test. The other input gate A5Q2 is connected across the sensing resistors to provide an input directly proportional to collector current.

4-30. Vertical balance potentiometer A5R5 is used as a dc balance control, adjusting the source currents to make the source/gate voltages equal.

4-31. Transistors A5Q3 and A5Q4 comprise a differential amplifier with A5Q5 and A5Q6 acting as current sources. Gain of the amplifier is controlled by the emitter resistance selected by VERTICAL SENSITIVITY control.

4-32. Transistors A5Q7 and A5Q8 are a differential pair. Their push-pull output is applied to the vertical deflection plates of the CRT, completing the vertical signal path.

4-33. BASE STEP GENERATOR

4-34. The base step generator produces a staircase waveform of current or voltage to the control terminal of the device under test. This current or voltage drive is increased in discrete steps and may be initiated or terminated at any level intermediate to the extremes. Any single step can be selected by setting the first and last steps equally. The increments (steps) can be supplied continuously (NORMAL mode) or in narrow pulses (PULSED mode). The duty cycle of a device being tested under pulsed conditions in the 6200B Curve Tracer is reduced to less than 10%. The purpose of the PULSED mode is to characterize small signal devices at high current levels without destroying them. A detailed block diagram of the base step generator is shown in figure 4-7. The key circuit is a staircase generator capable of producing a staircase waveform of ten calibrated steps. FIRST SWEEP STEP NO. and LAST SWEEP STEP NO. switches are provided to start and terminate the drive level at any desired step.

4-35. The four flip-flops, the last step switch, the reset generator, and first step switch all operate in a closed loop to give a continuous repetition of the staircase waveform.

4-36. Front panel RANGE and MULTIPLIER adjustments provide amplitude control of the base drive. RANGE selector provides large incremental adjustment of the base drive level, while the MULTIPLIER allows continuous variation over the entire range with essentially infinite resolution:

Increments = RANGE x MULTIPLIER

4-37. The height of any particular step in the staircase is determined as follows:

Amplitude = RANGE x MULTIPLIER x Number of Step.

For example, the amplitude of the tenth step when the base step generator is in its 1 V/step range and the multiplier is at 3.33 is:

Amplitude = 1 V/step x 3.33 x 10 steps = 33 V.

4-38. A zero step amplifier offsets the output of the staircase generator so that with no voltage in, the front panel CRT screen indicates zero base drive.

4-39. The base step amplifier raises the signal level for application to the base of the transistor under test.

4-40. Base Step Counter

4-41. Input to the base drive circuits is a primary ac power sine wave. The trigger circuit pulses as the sine wave passes zero; therefore the trigger rate is twice the frequency of the primary power input.

4-42. The waveforms are differentiated and applied to the first of four cascaded flip-flops. Each successive pulse advances the count output of the flip-flops. One output of each flip-flop is connected across coded resistors to the multiplier circuit. Thus count output is presented as a calibrated current. The count-proportional current (staircase waveform) is presented at the output for application to the multiplier circuit.

4-43. First Step Selection

4-44. Selection of the first step is made with front panel FIRST SWEEP STEP NO. switch S3. This control is a rotary switch with four ganged wafers. Each wafer consists of two sets of ten contacts. The set and reset inputs of one flip-flop in the counter are controlled by one set of contacts on each rotary switch. When the control is turned to the selected first step number, the coded rotary switches set and reset four flip-flops to start the sweep at the indicated point.

4-45. Last Step Selection

4-46. Selection of the last step is made with front panel LAST SWEEP STEP NO. switch. This control is connected by one contact to a string of resistors serving as a voltage divider. The other contact is connected to a comparator. Outputs of the flip-flops are connected to the other input of the comparator. (See figure 4-7.) When the output of the flip-flops matches the value selected on the voltage divider, the comparator pulses the reset generator that returns the first step decoder to the condition selected for the first step.

4-47. Range

4-48. Either current or voltage steps can be applied to the base circuit shown in figure 4-8. Programed resistances are selected at the front panel RANGE switch to set mode and range. When current is selected to be applied to the base, the programed resistances give six ranges of I_B: 0.1 μA, 1 μA, 10 μA, 100 μA, 1 mA, and 10 mA.

4-49. When the generator is used to apply a selected base voltage, a 100 Ω resistor is connected (through A10K1) across the BASE input to provide a low impedance voltage source. Three ranges are available: 0.01 V, 0.1 V, and 1.0 V.

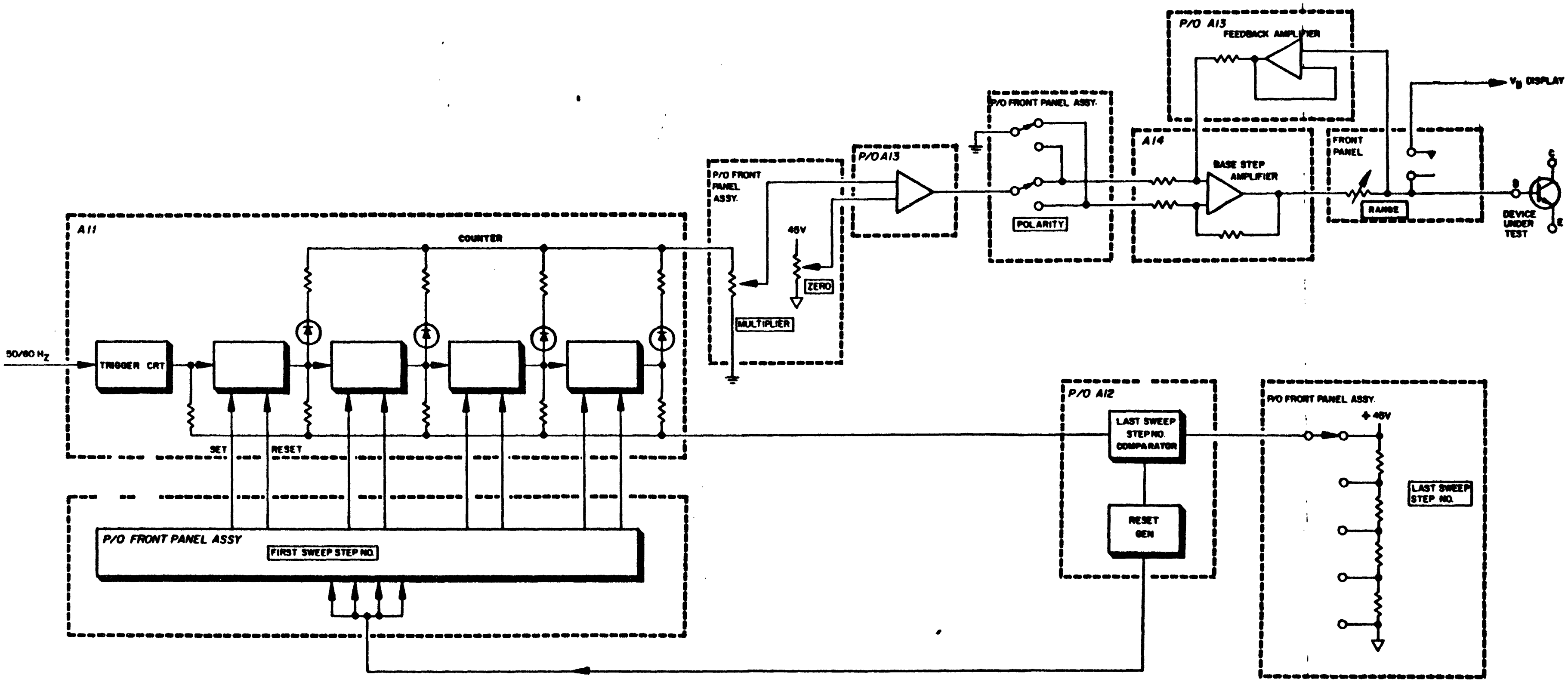


Figure 4-7. Base Step Generator Block Diagra

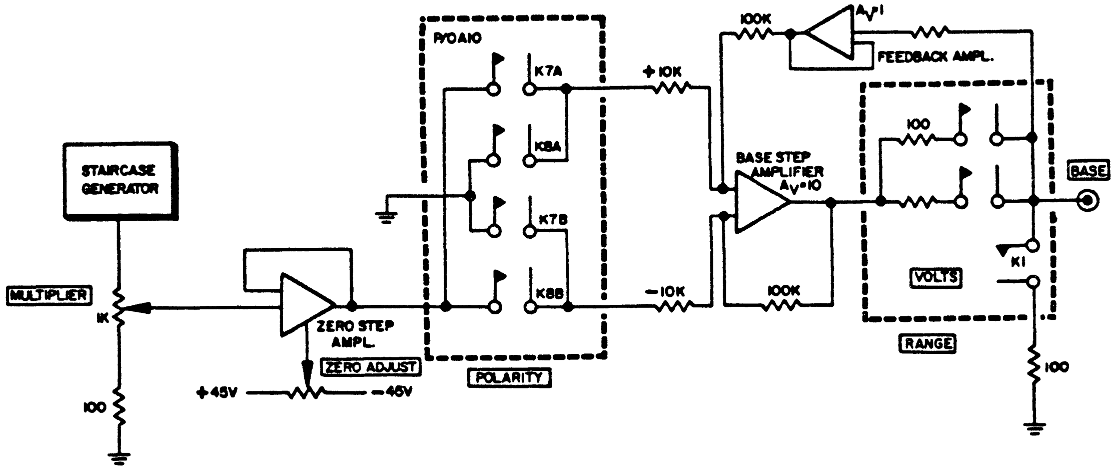


Figure 4-8. Current/Voltage Base Input Block Diagram

4-50. Multiplier

4-51. The MULTIPLIER circuit (refer to figure 4-8) is a potentiometer that may be set at the front panel. Current is fed through the multiplier circuit constituting a calibrated voltage. The movable arm on the MULTIPLIER potentiometer taps the voltage at a desired level and provides an input path to the zero step amplifier.

4-52. Zero Step Amplifier

4-53. With zero input from the BASE STEP COUNTER, it is desirable for accuracy that the trace on the screen of the CRT register zero also. The function of the zero step amplifier is to provide a means to set the trace to zero, maintaining an accurately calibrated reference.

4-54. Input to the zero step amplifier is taken from the movable arm on the MULTIPLIER potentiometer, and applied to the base of A13Q7A. A13Q7A and A13Q7B are a differential pair. A13Q7B is biased with ZERO STEP potentiometer mounted on the front panel. The ZERO STEP control biases the circuit so that the level at the collector of A13Q8 (input to the POLARITY switch) is approximately zero when the circuit is quiescent.

4-55. An input at the base of A13Q7A appears at the collector of A13Q8 as the difference between the input value and the zero adjustment value in the same phase. A13Q8 serves as an inverting amplifier that furnishes a signal directly proportional to the input to A13Q7A and of sufficient amplitude to drive the base step generator.

4-56. Base Step Amplifier

4-57. Inputs to this amplifier are selected by front panel POLARITY switch S5 and relays A10K7, A18K8. The polarity switch grounds the unused side of the amplifier. The + inputs are applied to A14Q4B, which is the noninverting side of the amplifier. The - inputs are applied to the inverting side A14Q4A. A feedback loop is provided from the single-end output of the amplifier to the inverting side.

4-58. Feedback Amplifier

4-59. Adding the base of the device under test to the output of the base step generator introduces an error in the generator's output that is directly proportional to the impedance of the device. Compensation must be added to the generator output to supply the additional voltage to keep the generator current at the programed level. This is the function of feedback amplifier.

4-60. Input to the feedback amplifier is taken from the base input as shown in figure 4-8. In current tests, the resistance of the base and the resistance of the ranging resistor form a voltage divider with voltage drop being the error introduced. Input to the feedback amplifier is the programed current plus the current drawn by the device. This input is applied to the non-inverting side of the amplifier which is clamped by the feedback to a gain of 1. The output of the feedback amplifier is applied to the non-inverting input of base step amplifier through a 100 k attenuating resistor. This drives the base step amplifier to increase its output voltage until the error is overcome and the circuit stabilizes.

4-61. POWER SUPPLIES

4-62. The power supplies for the Model 6200B include: +45 V and -45 V supplies for control reference, and timing functions; 225 V supply used as a reference for the CRT supply; 2500 V regulated supply used as accelerating voltage source for the CRT; and single function supplies used for filament power and pulse timing purposes.

4-63. ± 45 Volt Supplies

4-64. The +45 V and -45 V supplies are mounted on board A1. The two circuits operate identically except that one supply puts out a positive voltage while the other produces a negative supply voltage.

4-65. Input source to the +45 V supply is a 50 Vac rms secondary. Output regulation is accomplished by a chassis-mounted series regulating transistor. Variable resistor A1R36 provides precision adjustment of output level. Zener diode A1CR8 is formed by the emitter-collector junction of a 2N3073 transistor. It provides a stable reference for the supply.

4-66. Constant current generator A1Q15 holds the current through A1R34 very nearly constant. Output variations are sensed across A1R34, and the small voltage variation is detected at the base of A1Q14. As the output voltage tends to decrease due to an applied load, the drive to A1Q14 is reduced and it conducts less current.

4-67. A1Q11 is a constant current generator whose current is diverted partially into the base of A1Q12. A1Q12 conducts providing drive to A1Q13 which, in turn, drives the series regulator. The series regulator conducts harder to raise the output level, thus compensating for the original drop and accomplishing regulation.

4-68. A1CR9 acts as a reference for the constant current generator. A1Q10 is a clamping circuit that limits the output of the constant current generator.

4-69. Resistors A1R20 and A1R24 provide current limiting for the supply.

4-70. Resistor A1R25 provides negative current limiting when output current reaches a set level.

4-71. ± 225 Volt Supply

4-72. The 225 V supply, shown in figure 4-9, is comprised of: full-wave bridge rectifier A2CR1, series regulator A2Q4, with which A2Q1 forms a Darlington configuration; sensing resistor A2R9; reference zener diode A2CR2; simple amplifier circuit A2Q2; and constant current generator A2Q3.

4-73. Output is sensed across resistor A2R9 and regulation is initiated by voltage variations detected at the base of A2Q2. For instance, a drop in output voltage reduces the voltage level at the collector of A2Q3. This, in turn, reduces drive to A2Q2, which causes A2Q2 to conduct less, allowing a rise in potential at the base of A2Q1 which then conducts more. The potential at the base of A2Q4 is increased, A2Q4 conducts harder, and the voltage drop is compensated for.

4-74. Diode A2CR2 maintains constant voltage at the emitter of A2Q2 so that no matter how hard A2Q2

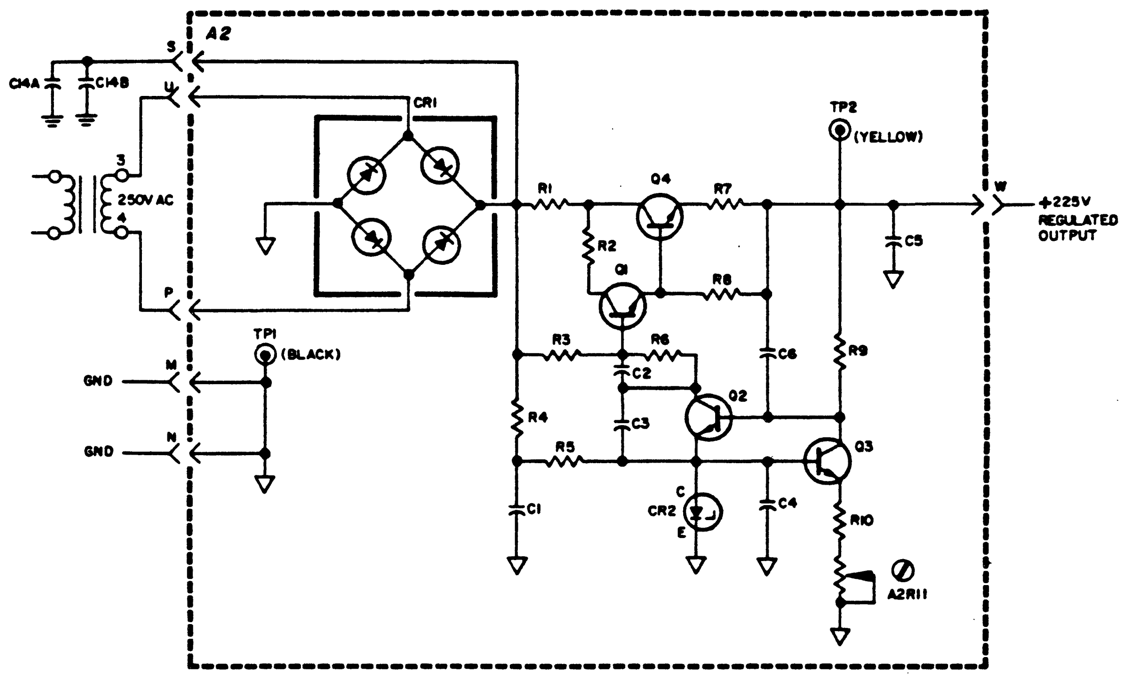


Figure 4-9. 225 Volt Regulated Power Supply Simplified Schematic

conducts, the voltage is maintained constant at the base of A2Q3.

4-75. Current through A2R9 is maintained essentially constant by use of constant current generator is provided by A2CR2. The constant current in R9 forces the change in output voltage to be the same as the voltage change at the input to the sensing amplifier, thus giving better regulation and lower output impedance.

4-76. High Voltage Power Supply

4-77. The 2500 V supply provides operating potentials for the cathode ray tube. Transistor A15Q1 (see figure 5-2) and transformer A15T1 comprise a 50 kc oscillator and step-up-circuit that has an output of approximately 2200 V rms. Diode A15CR2 rectifies this signal and capacitor C6 filters the rectified output. The dc potential across C6 is approximately -2500 V.

4-78. INTENSITY and FOCUS voltages for the CRT are obtained from a voltage divider network connected between C6 and the 225 V supply. INTENSITY potentiometer R241 and FOCUS potentiometer R242 are chassis mounted.

4-79. The high voltage output is regulated by a differential amplifier circuit (A15Q2, A15Q3) that controls the output of the RF oscillator A15Q1. The amplifier compares a portion of the output signal derived from the voltage divider and a -22.5 V reference derived from voltage divider A15R10 and A15R11 connected between the -45 V supply and ground.

4-80. In operation, when the output voltage drops, the voltage at the base of A15Q3B increases, and the differential amplifier increases its output to return the supply output to its original level.

4-81. The rear panel ASTIGMATISM potentiometer R14 (chassis mounted) is connected between the 225 V supply and ground.

4-82. Filament Supply

4-83. The 6.3 Vac filament supply for the CRT is derived directly from the secondary of the power transformer at terminals 13 and 14. Filament pins on the CRT are numbers 1 and 14.

Section V
Maintenance

5-1. INTRODUCTION

5-2. This section contains information for calibration, maintenance, and troubleshooting of the Model 6200B. A list of test equipment required for procedures outlined in this section is included.

5-3. TEST EQUIPMENT REQUIRED

5-4. Table 5-1 lists test equipment required for performance check, troubleshooting, and adjustment. If the recommended equipment is not available, equipment with equivalent specifications may be substituted.

5-5. In procedures involving accurate dc voltage or resistance measurements, care must be taken to ensure consistent results. Working standards should be referred to primary standards on a regular basis. Particular care should be taken with resistance standards that are subject to long-term drift due to aging.

Table 5-1. Required Test Equipment

EQUIPMENT TYPE	REQUIRED SPECIFICATIONS	RECOMMENDED MODEL
Oscilloscope	5 mV vertical sensitivity	Fairchild 767 H
Digital Voltmeter	0.01% accuracy	Fairchild 7100A
Voltmeter	4000 V probe 1000 kΩ/V	Simpson Model 269

5-6. PERFORMANCE CHECK

5-7. The performance check outlined in the following paragraphs is used to verify the specifications of the Model 6200B. It can be used upon receipt of a new instrument, for routine preventive maintenance, and following repair.

5-8. If a failure is indicated at any time during this check, proceed immediately to the calibration procedure.

a. Turn power ON with SCALE LIGHT/POWER switch. Allow one minute warmup. Then adjust beam on CRT screen for optimum focus and intensity. If a spot cannot be located on the CRT, push and hold HORIZ. SENSITIVITY and VERTICAL SENSITIVITY ZERO switches while rotating vertical and horizontal POSITION potentiometers until beam spot is found. Position spot in approximate center of screen. A slight adjustment of astigmatism may be necessary for minimum distortion. This control is located on rear panel of instrument.

b. Make the following control settings:

COLLECTOR SWEEP VOLTAGE	fully CCW
FULL RANGE VOLTAGE	+ 20 NPN
SERIES RESISTOR	1 K
PULSED BASE/NORMAL	NORMAL
POLARITY	+ NPN
LAST SWEEP STEP NO.	10
MULTIPLIER	1
RANGE	.1 V
FIRST SWEEP STEP NO.	0
VERTICAL SENSITIVITY	1 mA
HORIZ. SENSITIVITY	0.1 VOLTS BASE
INVERT/NORMAL switches	NORMAL

c. Press and hold HORIZ. SENSITIVITY ZERO switch and position CRT beam to left side of screen; align on first vertical line of graticule. POSITION control is concentric knob on HORIZ. SENSITIVITY switch.

d. Press and hold VERTICAL SENSITIVITY ZERO switch and position CRT beam to bottom of screen; align on first horizontal line of graticule. POSITION control is concentric knob on VERTICAL SENSITIVITY switch.

5-9. Observe a series of eleven dots on CRT, each occurring at one large division of the screen.

a. Allow a 15 minute warmup before proceeding with next test.

b. Set HORIZ. SENSITIVITY to 0.2 V BASE. Adjust BASE STEP GENERATOR MULTIPLIER dial until all eleven dots again coincide with each large graticule division. Reading on MULTIPLIER dial should be 2.00 ±3%, or 2.06 maximum and 1.94 minimum.

c. Set HORIZ. SENSITIVITY to 0.5 V COLLECTOR. Jumper BASE terminal to COLLECTOR terminal. Adjust BASE STEP GENERATOR MULTIPLIER dial until all eleven dots again coincide with each large graticule division. Reading on MULTIPLIER dial should be 5.00 ±3%, or 5.15 maximum and 4.85 minimum.

d. Set HORIZ. SENSITIVITY to 2 V COLLECTOR. Set BASE STEP GENERATOR RANGE to 1 V. Adjust BASE STEP MULTIPLIER unitl dots again coincide with large graticule divisions. Reading on MULTIPLIER dial should be 2.00 ±3%, or 2.06 maximum, 1.94 minimum. Remove BASE to COLLECTOR short.

e. Attach a 2 kΩ, ±5%, 1/2 W resistor between COLLECTOR and EMITTER terminals. Set COLLECTOR SWEEP VOLTAGE to 100%. A 45° trace should now be observed on CRT screen, corresponding to 20 V full scale ±1 small division, and 20 mA full scale ±1 small division.

f. Remove the 2 kΩ resistor.

5-10. The unit is in operating order if all the foregoing checks have been met.

5-11. CALIBRATION PROCEDURE

5-12. The paragraphs following state the alignment procedure used to calibrate the Model 6200B Curve Tracer. The procedure must be followed in the order given because there is interaction between adjustments. Refer to figure 5-1 for location of test points and adjustment controls.

5-13. Initial Control Settings and Warm-Up

CAUTION

WHILE THE INSTRUMENT IS REACHING OPERATING TEMPERATURE, TURN INTENSITY CONTROL FULLY COUNTER CLOCKWISE AND PULL OUT COLLECTOR SWEEP RESET SWITCH AS A PRECAUTION.

5-14. Make the initial control settings listed below and then turn the SCALE LIGHT/POWER switch 1/4 turn C.W. to the ON power position. Allow at least a thirty minute warm-up period for unit to stabilize before attempting calibration.

COLLECTOR SWEEP VOLTAGE	0
FULL RANGE VOLTAGE	+ 20 NPN
SERIES RESISTOR	1 MΩ
Horizontal POSITION	1/2 turn C.W.
Vertical POSITION	1/2 turn C.W.
VERTICAL SENSITIVITY	50 mA/div
HORIZ. SENSITIVITY	.1 V/div COLLECTOR
FIRST SWEEP STEP NO.	0
LAST SWEEP STEP NO.	0

RANGE	.1 V
MULTIPLIER	1
POLARITY	+ NPN
PULSED BASE/NORMAL switch	NORMAL
Vertical INVERT/NORMAL switch	NORMAL
Horiz. INVERT/NORMAL switch	NORMAL

5-15. ±45 Volt and + 225 Volt Power Supply Adjustments

5-16. To check and calibrate ±45 V and +225 V power supplies, perform following steps:

a. Remove top cover from instrument.

b. Connect digital voltmeter between test points listed in table 5-2 and check that all outputs are within tolerance. Make adjustments where necessary.

c. Check 120 Hz ripple and HF noise with oscilloscope. Results should be below maximum figures given in table 5-2.

5-17. - 2500 Volt Supply Check

WARNING

LETHAL VOLTAGES ARE PRESENT IN THE 2500 VOLT SUPPLY. OBSERVE PROPER PRECAUTIONS WHEN MAKING MEASUREMENTS.

5-18. This supply is referenced to the +225 V supply and the output is not adjustable. To check output proceed as follows:

a. Connect positive terminal of voltmeter (100 kΩ/V input impedance) to front panel EMITTER terminal.

b. Using 4000 V probe, connect negative terminal of voltmeter to terminal 3 of front panel INTENSITY control R241. The voltmeter should read -2500 V, ±25 V.

c. Remove voltmeter.

5-19. Horizontal Amplifier Adjustment

5-20. To check DC Balance Adjustment, proceed as follows:

a. Connect a jumper between front panel COLLECTOR and EMITTER terminals. Increase intensity until a dot appears on the CRT screen.

b. Push COLLECTOR SWEEP RESET button In.

c. Position dot in center of screen with horizontal POSITION control.

d. Switch HORIZ. SENSITIVITY from 0.1 V/div to 0.01 V/div and note direction of travel of trace.

Table 5-2. ±45 Volt and +225 Volt Supply Specifications

POWER SUPPLY	TEST POINTS	OUTPUT	ADJUSTMENT	TOLERANCE	MAXIMUM 120 Hz RIPPLE	MAXIMUM HF NOISE
+45 V	A1TP1 (+) A1TP2 (GND)	+45 V	A1R36	+50 mV - 0 mV	10 mV p.p.	5 mV
-45 V	A1TP2 (GND) A1TP3 (-)	-45 V	A1R18	+50 mV - 0 mV	10 mV p.p.	5 mV
+225 V	A2TP2 (+) A2TP1 (GND)	+225 V	A2R11	+1 V -0 V	50 mV p.p.	25 mV

e. Move trace back to center of CRT with DC Balance Adjustment A7R5.

f. Set HORIZ. SENSITIVITY back to .1 V/div.

g. Repeat steps c, d, e, and f until there is no movement between range changes.

h. Remove jumper from COLLECTOR and EMITTER terminals.

5-21. Horizontal Amplifier Gain Adjustment is performed in the following manner:

a. Connect a jumper between front panel COLLECTOR and BASE terminals.

b. Connect DVM across COLLECTOR and EMITTER terminals.

c. Set POLARITY to + NPN.

d. Set FIRST and LAST SWEEP STEP NO. switches to 10.

e. Set HORIZ. SENSITIVITY to .1 V/div. Adjust multiplier dial until voltmeter reads 1.000 V ±1 mV.

f. Press HORIZ. ZERO button and position beam spot precisely on first left vertical graticule with horizontal POSITION control. Release ZERO button.

g. Adjust A7R23 until spot coincides with first right vertical graticule.

h. Repeat steps f and g until dot falls on both the left and right graticule lines.

i. Set RANGE switch to .01 V and the HORIZ. SENSITIVITY to .02 V/div.

j. Adjust MULTIPLIER dial until the voltmeter reads 0.2000 V ±100 μV.

k. Repeat step f.

l. Adjust A7R14 until dot again coincides with first right vertical graticule.

m. Repeat steps k and l until dot falls on both left and right graticule lines.

n. Set HORIZ. SENSITIVITY to 0.01 V/div and adjust MULTIPLIER dial until the voltmeter reads .1000 V ±100 μV.

o. Repeat step f.

p. Adjust A7R16 until dot coincides with first right graticule.

q. Press HORIZ. ZERO pushbutton and check that dot still aligns with first left graticule. Repeat steps p and q if necessary.

r. Set RANGE to 1 V and HORIZ. SENSITIVITY to 1 V/div.

s. Adjust MULTIPLIER dial until the voltmeter reads 10.000 V ±10 mV.

t. Repeat step f.

u. Check that the dot falls directly on the first right graticule line ±1 1/2 small divisions.

v. This completes Horizontal Amplifier Adjustment. Remove DVM and the COLLECTOR to BASE short.

5-22. Vertical Amplifier Adjustment

5-23. To check DC Balance Adjustment, proceed as follows:

a. Press vertical ZERO pushbutton and position beam spot behind center line on extreme left vertical graticule line with vertical POSITION control.

b. Switch VERTICAL SENSITIVITY from 50 mA/div to 20 mA/div note direction of vertical spot movement.

c. Move spot back to center of CRT with DC Balance Adjustment A5R5.

d. Repeat step b. Continue to adjust A5R5 until there is no vertical spot movement between range changes.

5-24. Vertical Amplifier Gain Adjustment is performed in the following manner:

a. Make the following settings:

HORIZ. SENSITIVITY	0.1 V/div
VERTICAL SENSITIVITY	1 mA/div
SERIES RESISTOR	3 Ω
FULL RANGE VOLTAGE	20 + NPN

b. Connect a 100 Ω 1/2 W ±1% resistor across COLLECTOR and EMITTER terminals.

c. Position beam spot precisely behind lower left corner of graticule.

d. Rotate COLLECTOR SWEEP VOLTAGE control until trace crosses extreme right vertical graticule line.

e. Adjust A5R16 (vertical amplifier gain) until trace crosses from the center of lower left corner to the center of upper right corner of graticule, i.e. a 45° slope. (Reposition trace if necessary as adjustment is being made). Decrease COLLECTOR SWEEP VOLTAGE.

f. Remove the 100 Ω resistor and connect a 10 Ω, 1/2 W, 1% resistor.

g. Change HORIZ. SENSITIVITY to 0.2 V/div and VERTICAL SENSITIVITY to 20 mA/div.

h. Rotate COLLECTOR SWEEP VOLTAGE control until trace just crosses extreme right vertical graticule line. Check that trace again crosses from lower left to upper right corners ±1.5 minor division. Decrease COLLECTOR SWEEP VOLTAGE.

i. Remove the 10 Ω resistor and connect a 10 kΩ ±1% resistor across COLLECTOR and EMITTER terminals.

j. Change HORIZ. SENSITIVITY to .05 V/div and VERTICAL SENSITIVITY to 5 μA/div.

k. Rotate COLLECTOR SWEEP VOLTAGE control clockwise and check again that trace is from lower left corner to upper right corner ±1.5 minor division.

l. This completes the vertical calibration procedure. Remove the 10 kΩ resistor between the COLLECTOR and EMITTER terminals.

5-25. Base Step Generator Alignment

5-26. The Base Step Generator Alignment is checked and aligned as follows:

a. Connect jumper between EMITTER and BASE terminals.

b. Connect DVM to A13TP1. Use front panel EMITTER terminal for GND.

c. Adjust A13R8 until DVM reads less than 100 μV.

d. Remove EMITTER to BASE jumper and replace with a voltmeter.

e. Set FIRST SWEEP STEP NO. to 1 and LAST SWEEP STEP NO. to 1.

f. Switch BASE POLARITY from + NPN to - PNP and adjust A14R10 until the voltmeter reads the same voltage ±1 mV in both polarities.

g. Set FIRST and LAST SWEEP STEP NO. to 10 and MULTIPLIER dial to 10.

NOTE

If 10th step cannot be obtained, carry out the procedure detailing in paragraph 5-27 before proceeding.

h. Adjust A12R21 until the voltmeter reads 10.000 V ±10 mV.

i. Set FIRST and LAST STEP switches to 1 and adjust MULTIPLIER potentiometer to 1.

j. Adjust ZERO STEP ADJUST (located on front panel) until DVM reads +0.1000 V ±1.5 mV.

k. It is recommended that all ranges be spot checked for accuracy.

l. This completes calibration of the Base Step Generator. Remove Voltmeter.

5-27. Pulsed Base Adjustment

5-28. The Pulsed Base circuitry is adjusted as follows:

a. Make the following control settings:

BASE STEP RANGE	0.1 V
POLARITY	+ NPN
MULTIPLIER	1.0
FIRST SWEEP STEP	0
LAST SWEEP STEP	1
PULSED/NORMAL	PULSED
FULL RANGE VOLTAGE	+20 NPN
SERIES RESISTOR	1 KΩ
COLLECTOR SWEEP VOLTAGE	20

b. Connect channel A of a dual trace oscilloscope to the COLLECTOR terminal. Observe output of BASE terminal on channel B. Check that signal on channel B consists of pulses of 100 mV amplitude alternately occurring with a 120 Hz 20 V collector pulse observed on channel A.

c. Adjust A12R6 until Base Step Pulse occurs at peak of collector waveform. Width of pulse is to be 750 μsec ±100 μsec.

5-29. Hysteresis Adjustment

5-30. Hysteresis can be reduced to a minimum by using the following procedure:

NOTE

This adjustment should be necessary only when a test fixture is used with the instrument. The test fixture (even of it is the test socket supplied with the instrument) may introduce stray capacitances through the front panel COLLECTOR, BASE, and EMITTER terminals, resulting in a distorted trace on the screen of the CRT. This procedure provides compensation for these capacitances, and it must be repeated whenever the test socket is removed or changed.

a. Make the following control settings:

VERTICAL SENSITIVITY	1 μA
SERIES RESISTOR	3 Ω
HORIZ. SENSITIVITY	2 V/div
FULL RANGE VOLTAGE	+ 20 NPN
COLLECTOR SWEEP VOLTAGE	fully clockwise

b. Adjust C5 for minimum reading on CRT screen. See figure 5-1 for location of adjustment curves.

c. Change FULL RANGE VOLTAGE to -20 PNP. Adjust C4 for minimum reading on CRT screen.

d. Set controls as follows:

HORIZ. SENSITIVITY	20 V
FULL RANGE VOLTAGE	+200 PNP

e. Adjust C15 for minimum reading.

f. Change FULL RANGE VOLTAGE to -200 NPN. Adjust C12 for a minimum reading on CRT screen.

g. Set controls as follows:

HORIZ. SENSITIVITY	100 V
FULL RANGE VOLTAGE	+1000 NPN

i. Adjust C9 for minimum reading. Change FULL RANGE VOLTAGE to -1000 PNP. Adjust C6 for a minimum reading on CRT screen.

j. This completes the checkout and calibration procedure for the Model 6200B.

5-31. Periodic Maintenance

5-32. The Model 6200B required little periodic maintenance. The procedure in the following paragraphs may be used when maintenance is performed on a regular basis.

5-33. Inspection

5-34. Remove top and bottom covers from instrument. Inspect the chassis and mounted components for damage, signs of overheating, etc. Remove circuit boards and inspect for damage or signs of failure. Using low pressure, dry, compressed air, blow out any dust accumulation.

5-35. Rotate front-panel controls through full range, noting any binding or rough action.

5-36. Following inspection, replace all circuit boards and covers. Make performance check detailed in paragraphs 5-6 through 5-10.

5-37. COMPONENT LOCATION AND SCHEMATIC DIAGRAMS

5-38. Figures 5-2 through 5-37 show location of components on circuit boards and schematic diagrams.

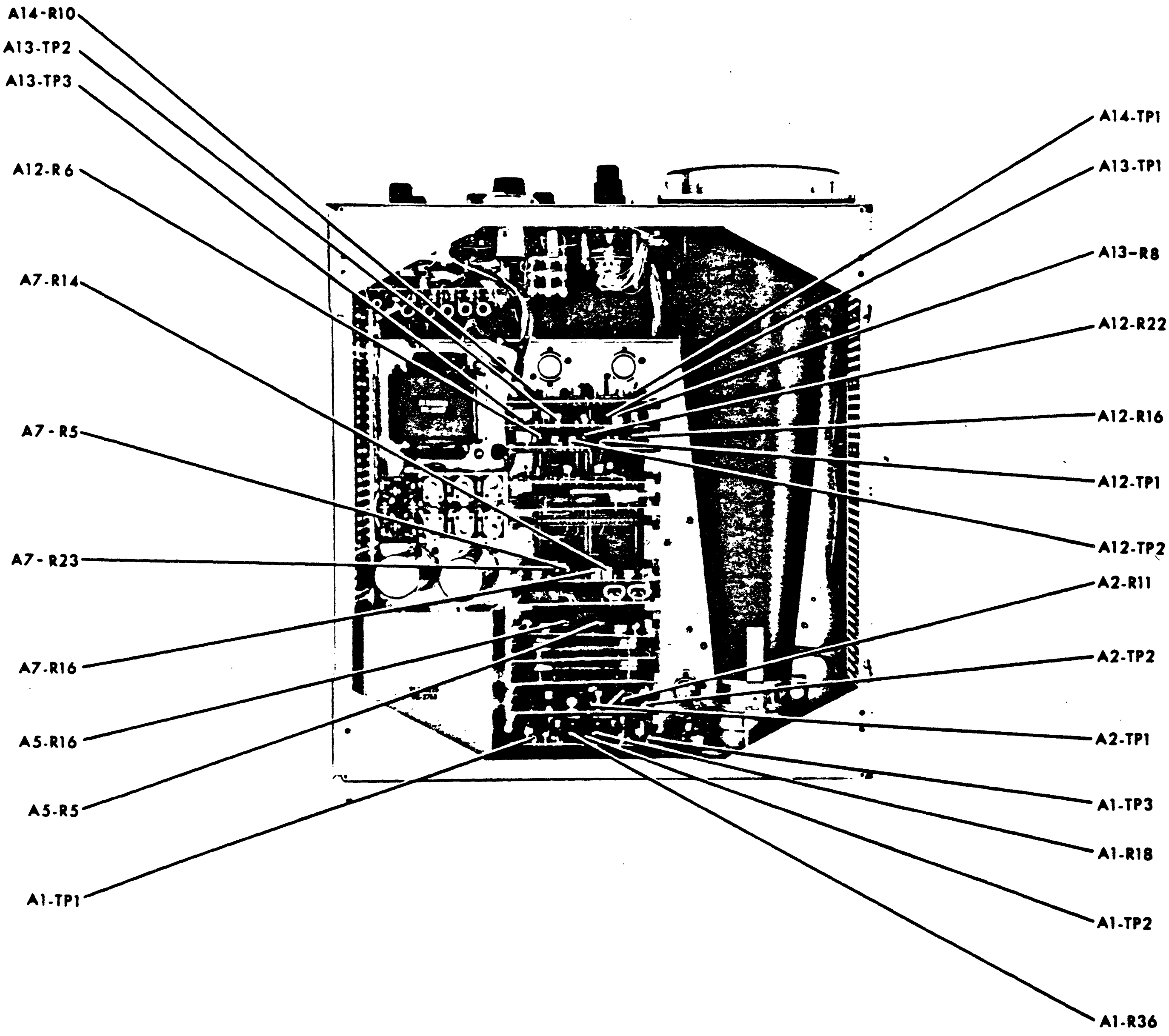


Figure 5-1 Adjustment Controls

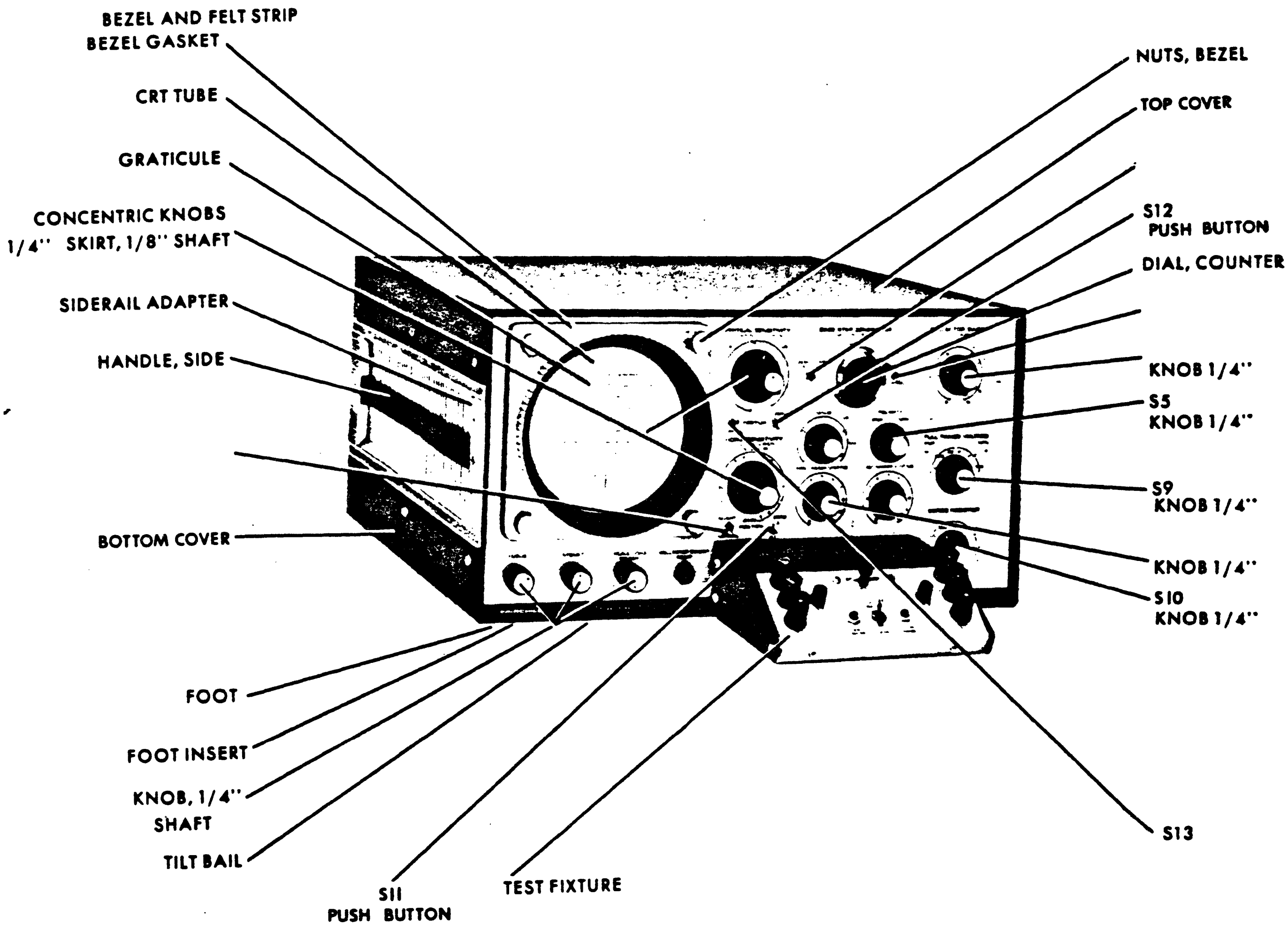


Figure 5-2 Component Location, Front Panel

on V
re 5-3

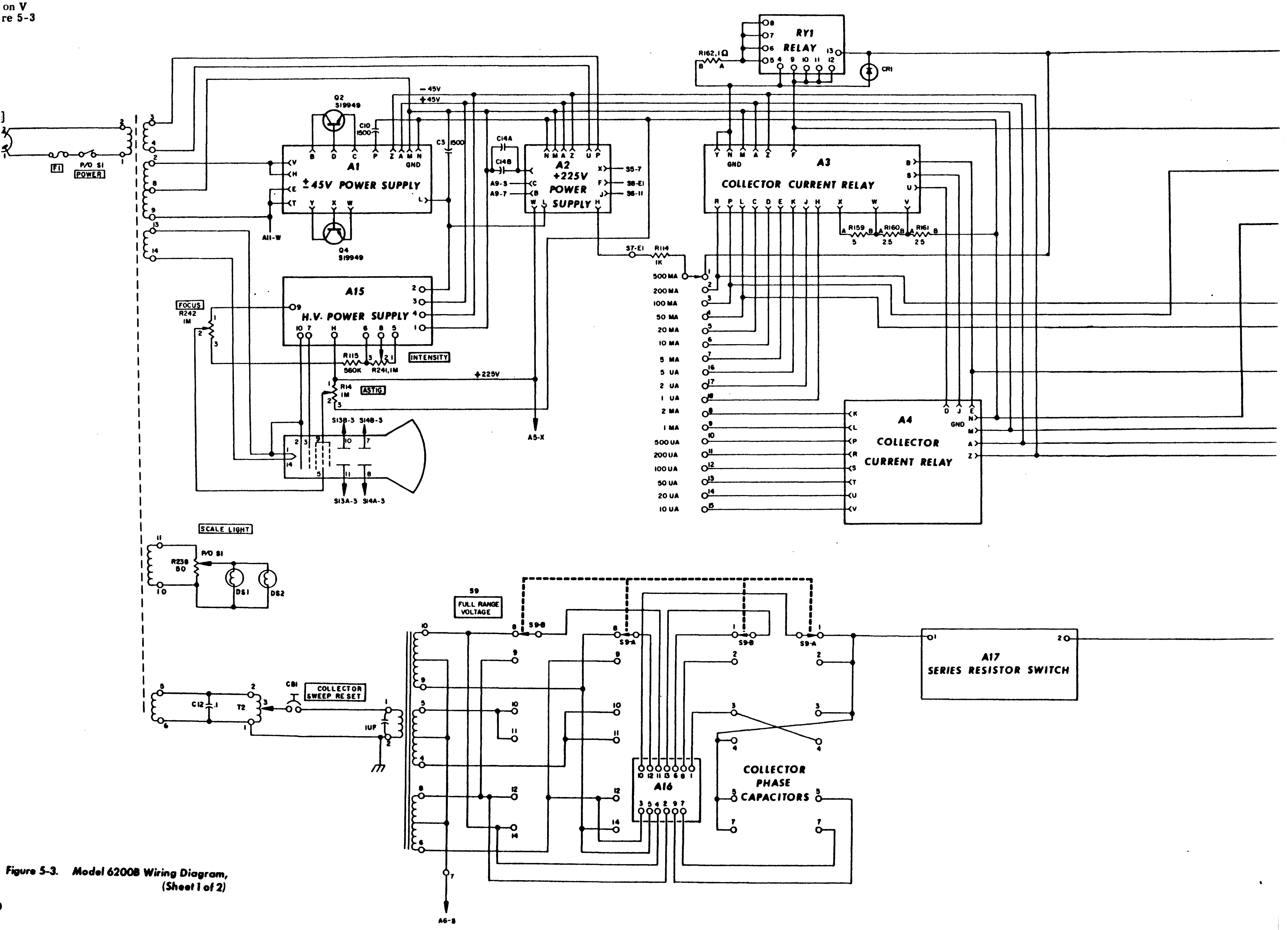
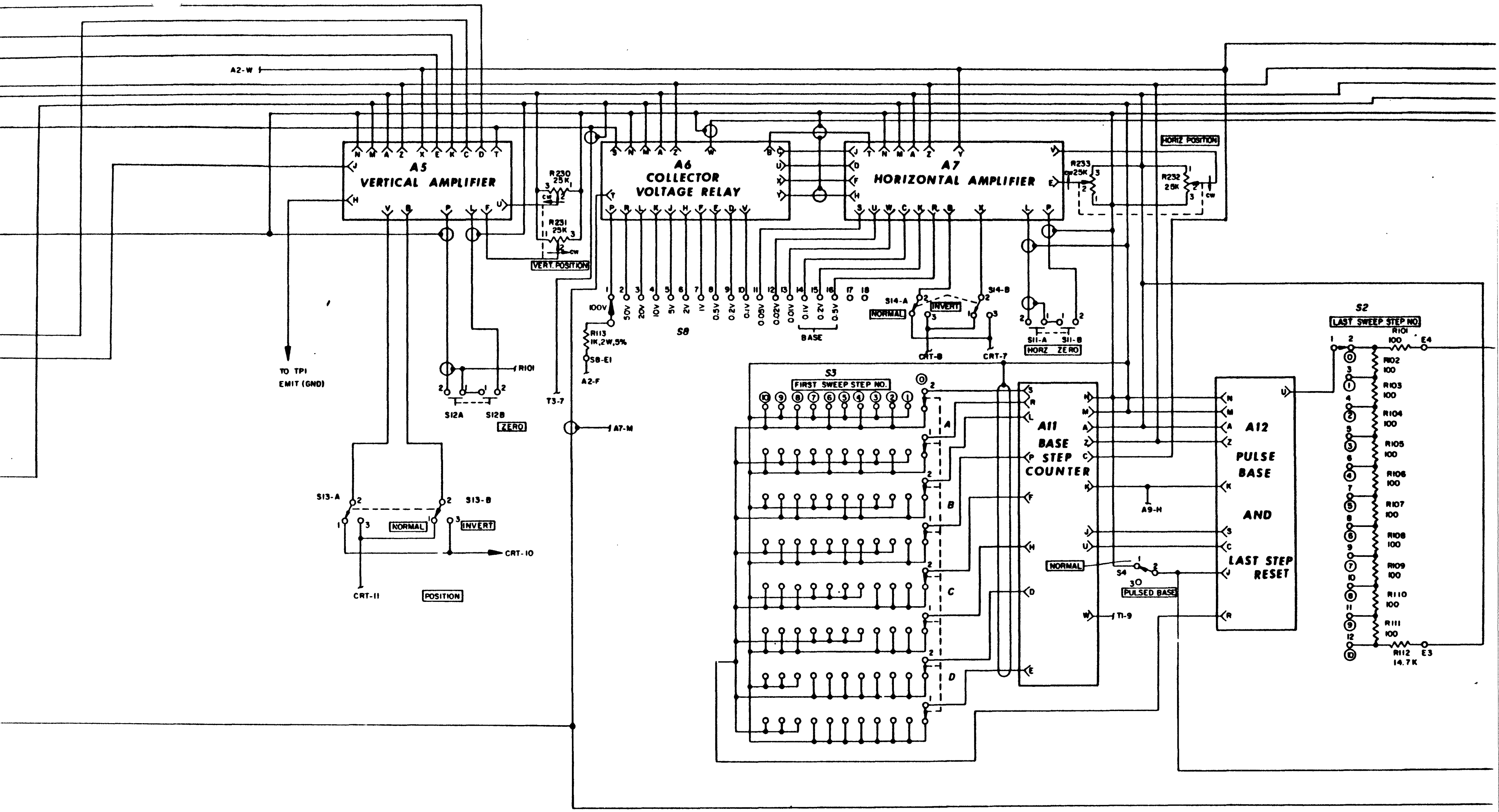


Figure 5-3. Model 6200B Wiring Diagram, (Sheet 1 of 2)


A5
VERTICAL AMPLIFIER
A6
COLLECTOR
VOLTAGE RELAY
A7
HORIZONTAL AMPLIFIER
A11
BASE
STEP
COUNTER
A12
PULSE
BASE
AND
LAST STEP
RESET
S8
S3
FIRST SWEEP STEP NO.
S2
LAST SWEEP STEP NO.
VERT. POSITION
HORIZ POSITION
HORZ ZERO
ZERO
NORMAL
INVERT
POSITION
PULSED BASE
BASE
TO TP1
EMIT (GND)
CRT-10
CRT-11
CRT-7
CRT-8
A2-W
A2-F
A7-M
A9-H
T3-7
T1-9
R230
25K
R231
25K
R232
25K
R233
25K
R113
1K, 2W, 5%
S8-E1
R101
100
R112
14.7K
E3
E4
S11-A
S11-B
S12A
S12B
S13-A
S13-B
S14-A
S14-B
S4
100V
50V
20V
10V
5V
2V
1V
0.5V
0.2V
0.1V
0.05V
0.02V
0.01V

.511 · 1 2 -

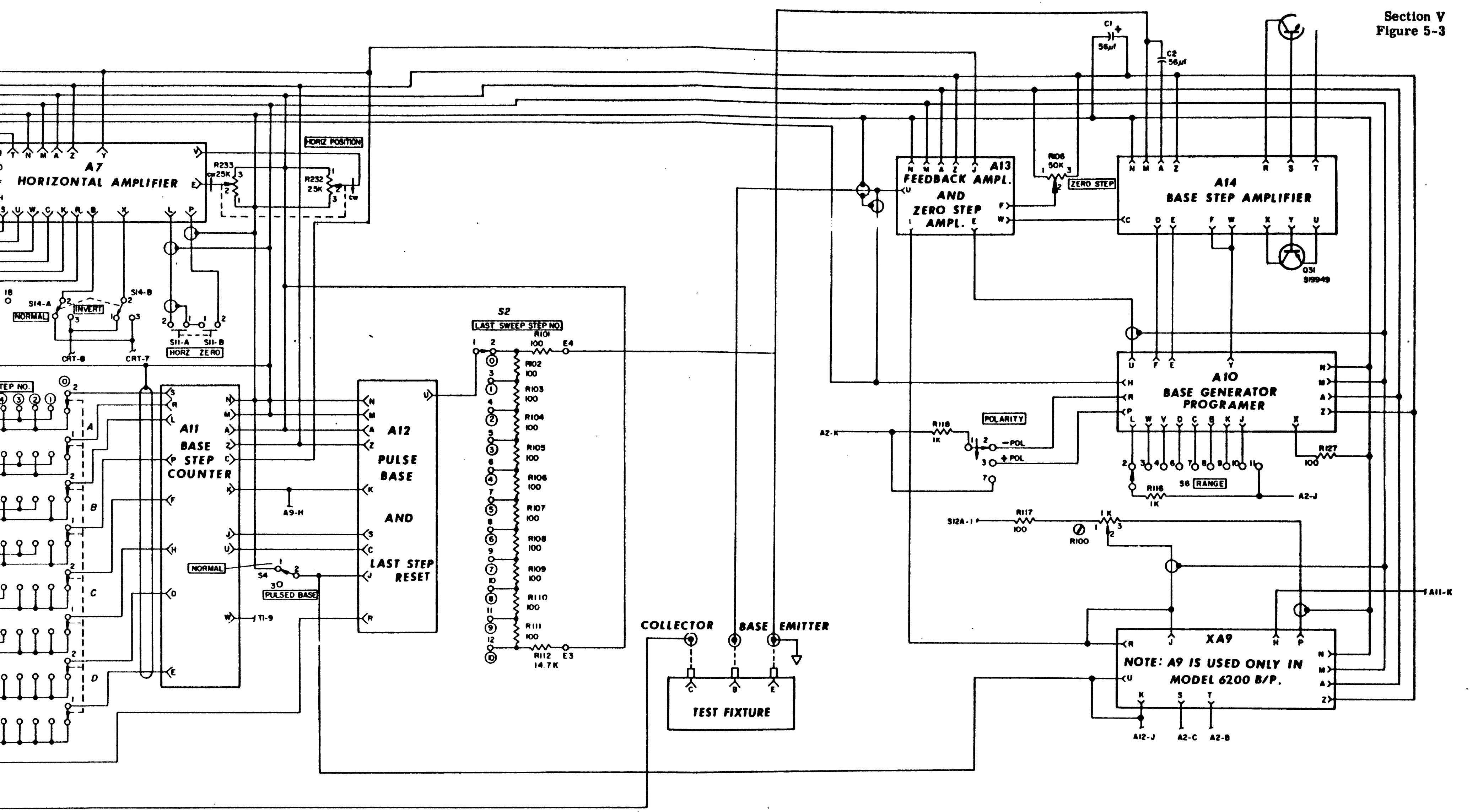


Figure 5-3. Model 6200B Wiring Diagram (Cont.), (Sheet 2 of 2)

S11-A1

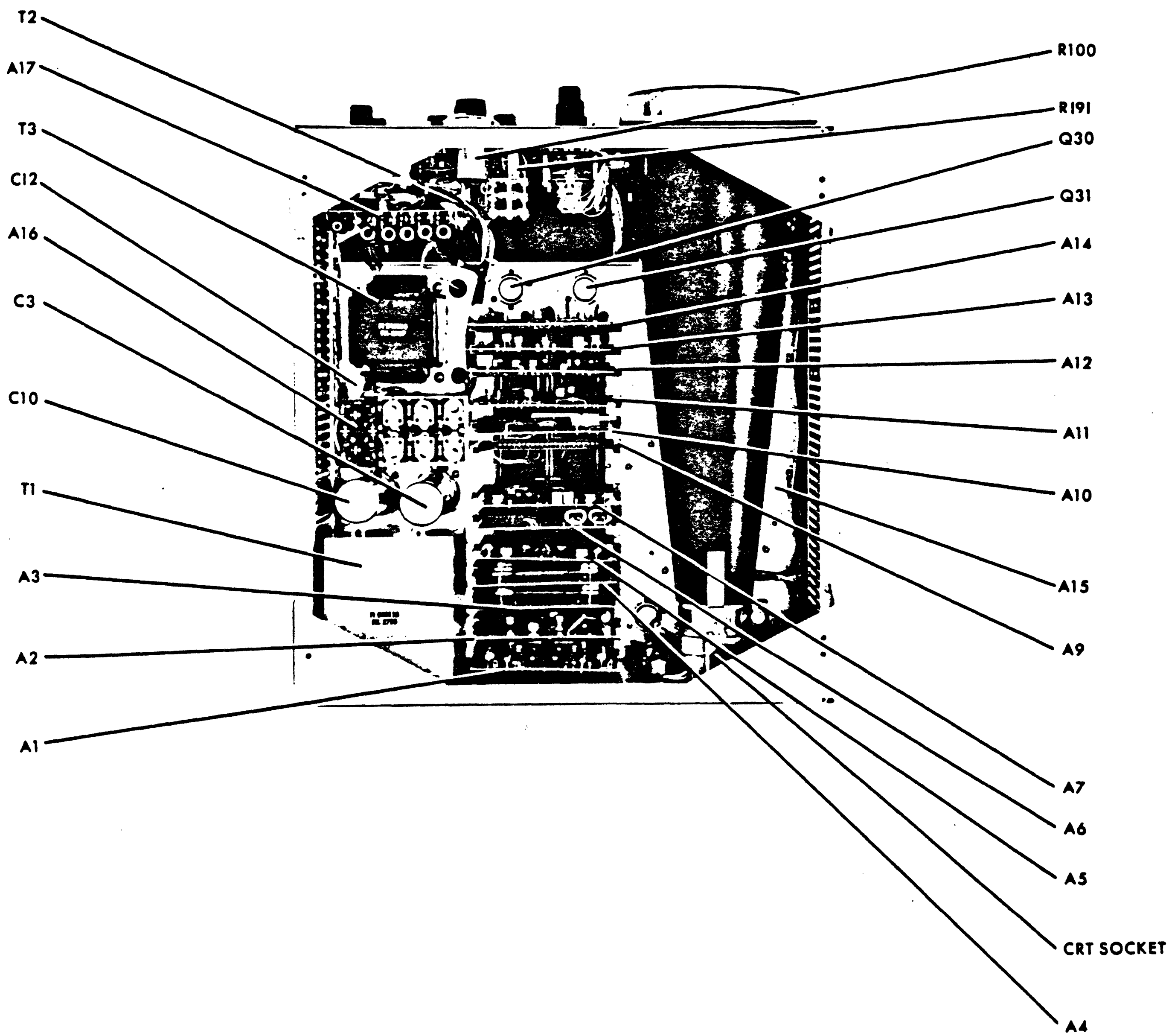


Figure 5-4. Assembly and Component Location, Main Frame, Top View

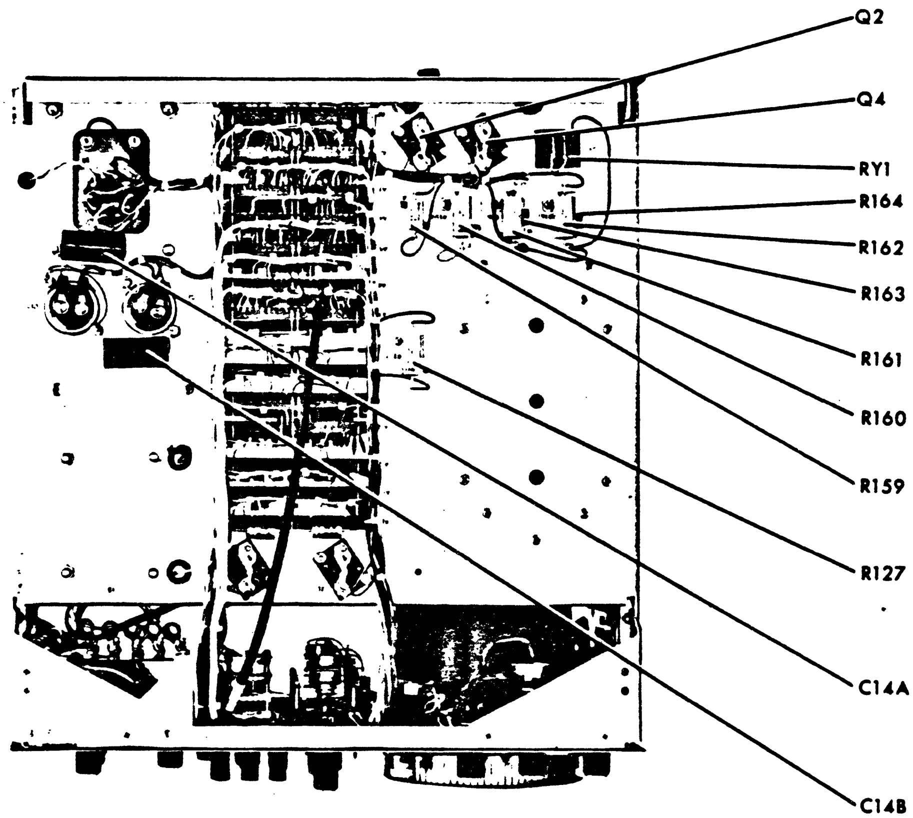


Figure 5-5. Component Location, Main Frame, Bottom View

5-14 A1

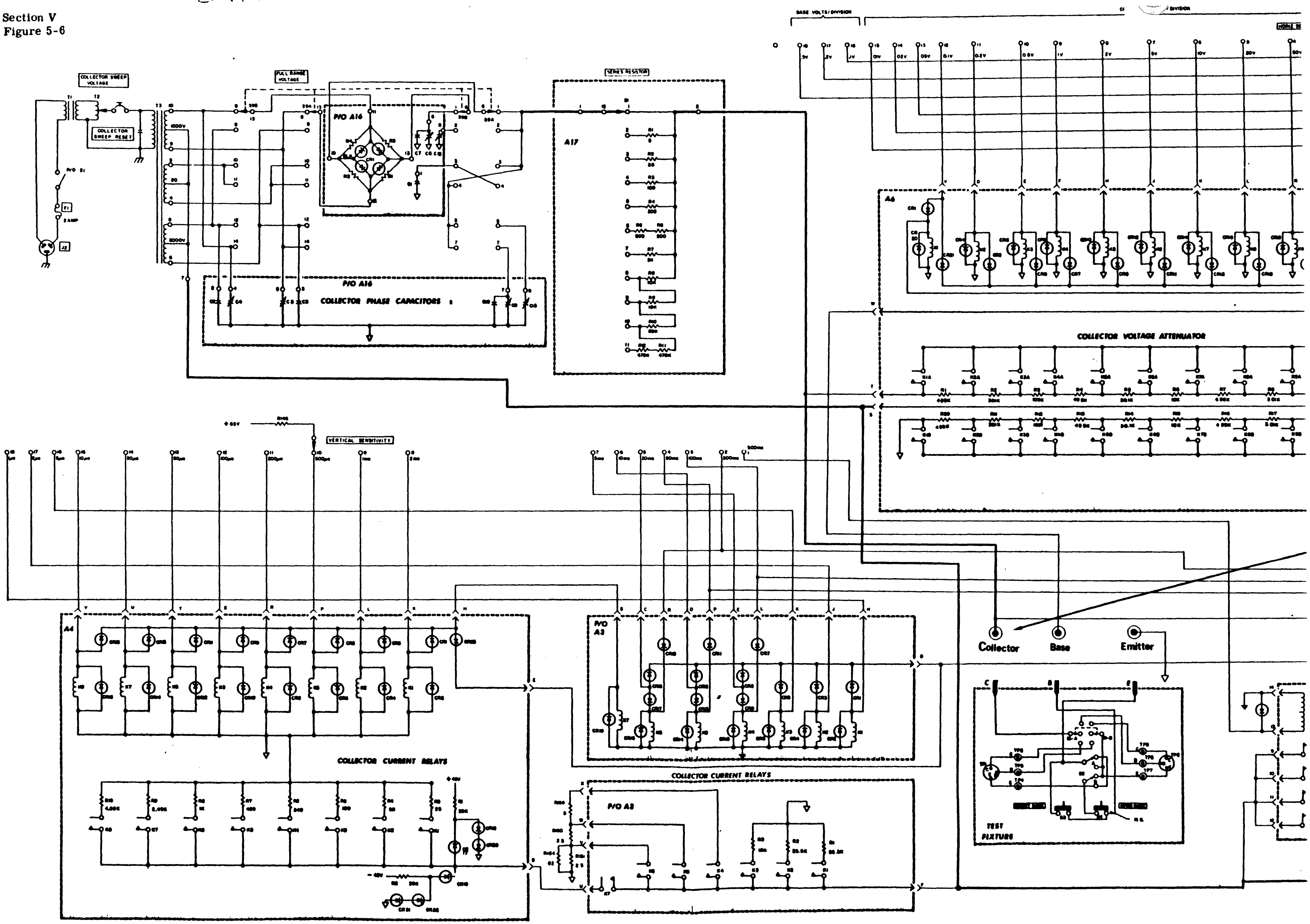
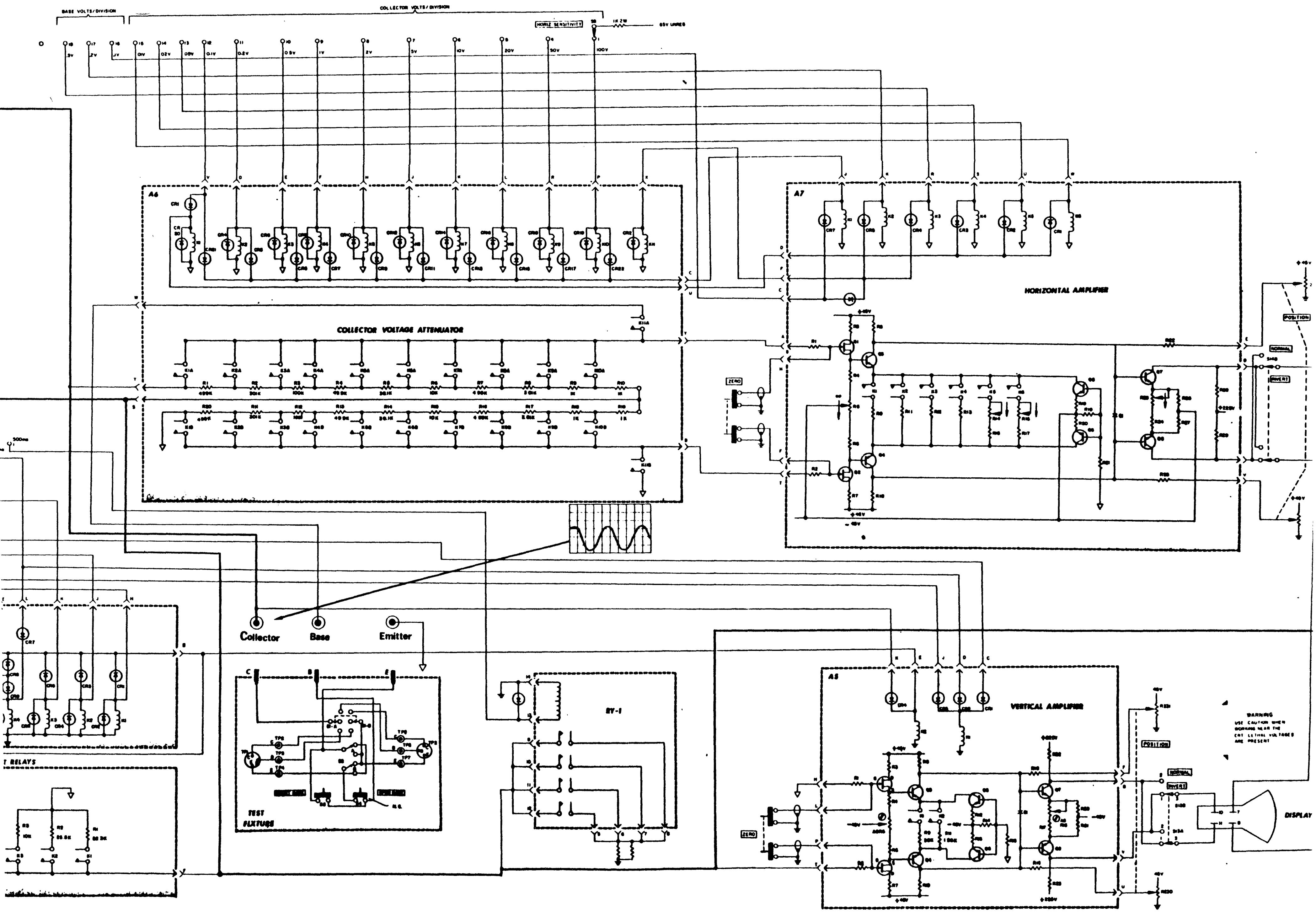
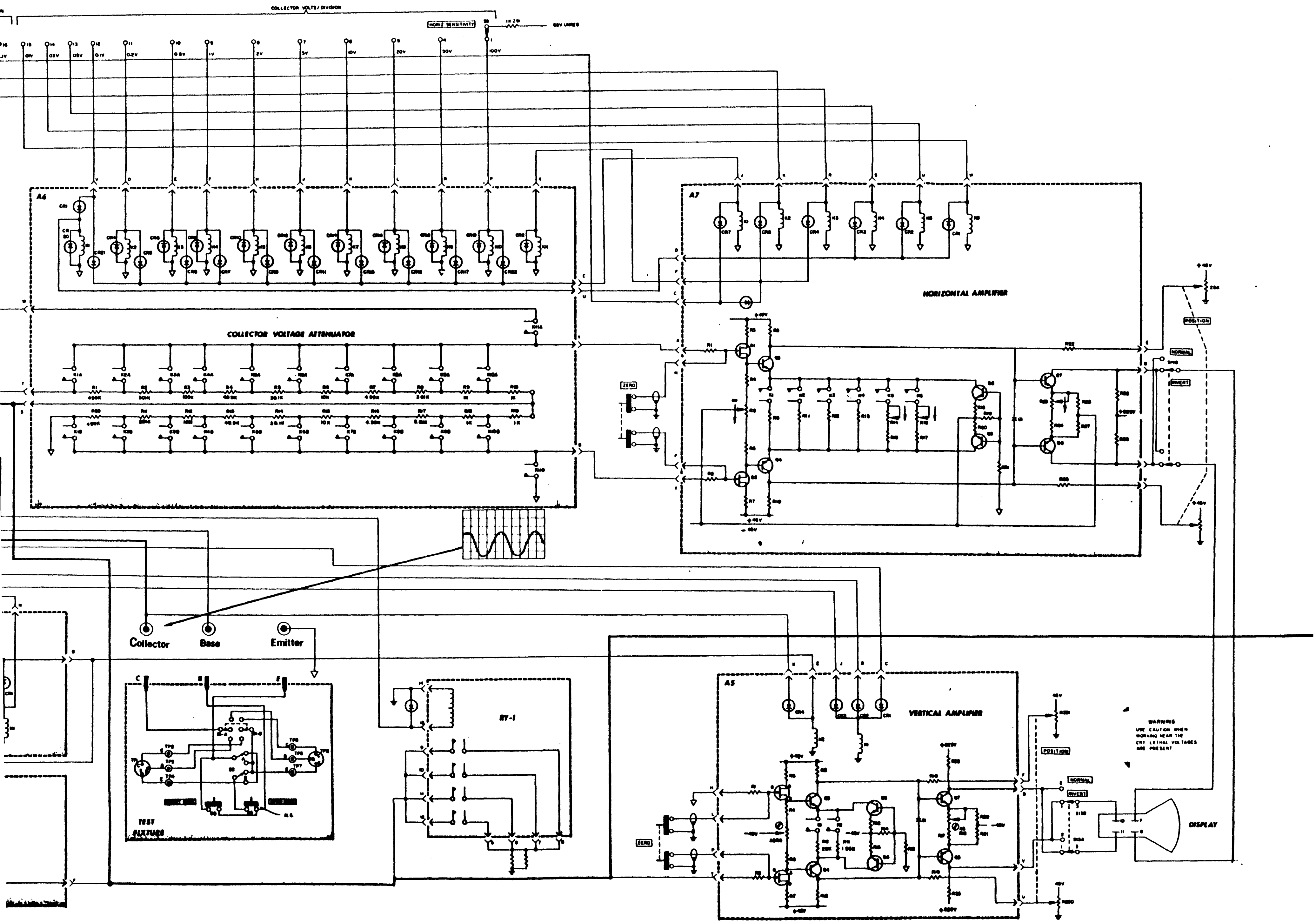


Figure 5-6. Model 6200B Simplified Schematic (Sheet 1 of 2)

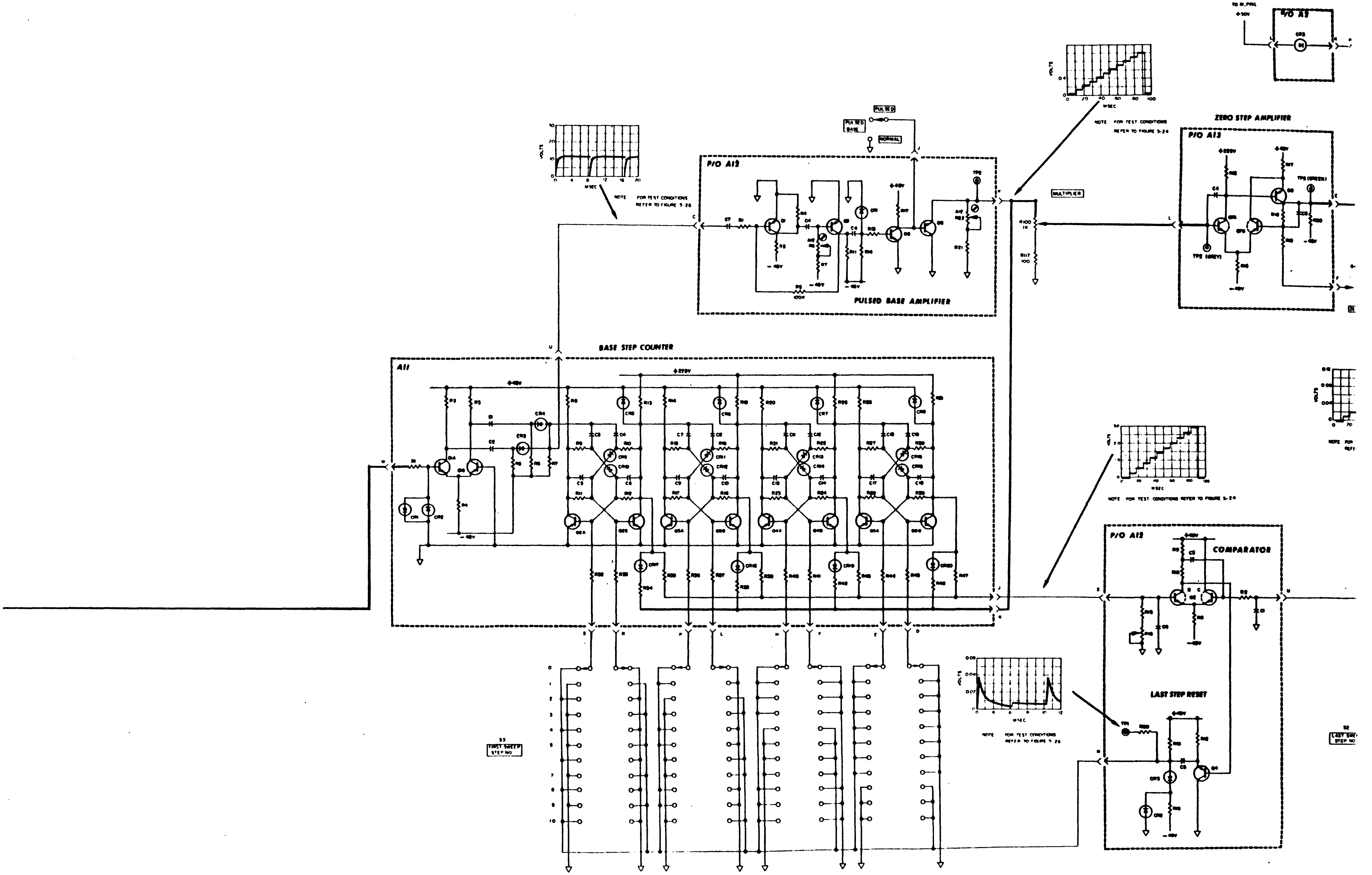
S-14 A2


BASE VOLTS/DIVISION
COLLECTOR VOLTS/DIVISION
HORIZ SENSITIVITY
A6
COLLECTOR VOLTAGE ATTENUATOR
A7
HORIZONTAL AMPLIFIER
POSITION
NORMAL
INVERT
ZERO
Collector
Base
Emitter
TEST FIXTURE
RY-1
A5
VERTICAL AMPLIFIER
RELAYS
DISPLAY

14 A3


COLLECTOR VOLTS/DIVISION
HORIZ SENSITIVITY
A6
COLLECTOR VOLTAGE ATTENUATOR
A7
HORIZONTAL AMPLIFIER
ZERO
POSITION
NORMAL
INVERT
Collector
Base
Emitter
TEST FIXTURE
RY-1
A5
VERTICAL AMPLIFIER
WARNING
USE CAUTION WHEN WORKING NEAR THE CRT LETHAL VOLTAGES ARE PRESENT
DISPLAY

5-15 A1


P/O A12
PULSED BASE AMPLIFIER
PULSED
NORMAL
MULTIPLIER
P/O A13
ZERO STEP AMPLIFIER
A11
BASE STEP COUNTER
P/O A12
COMPARATOR
LAST STEP RESET
FIRST SWEEP STEP NO
VOLTS
MSEC

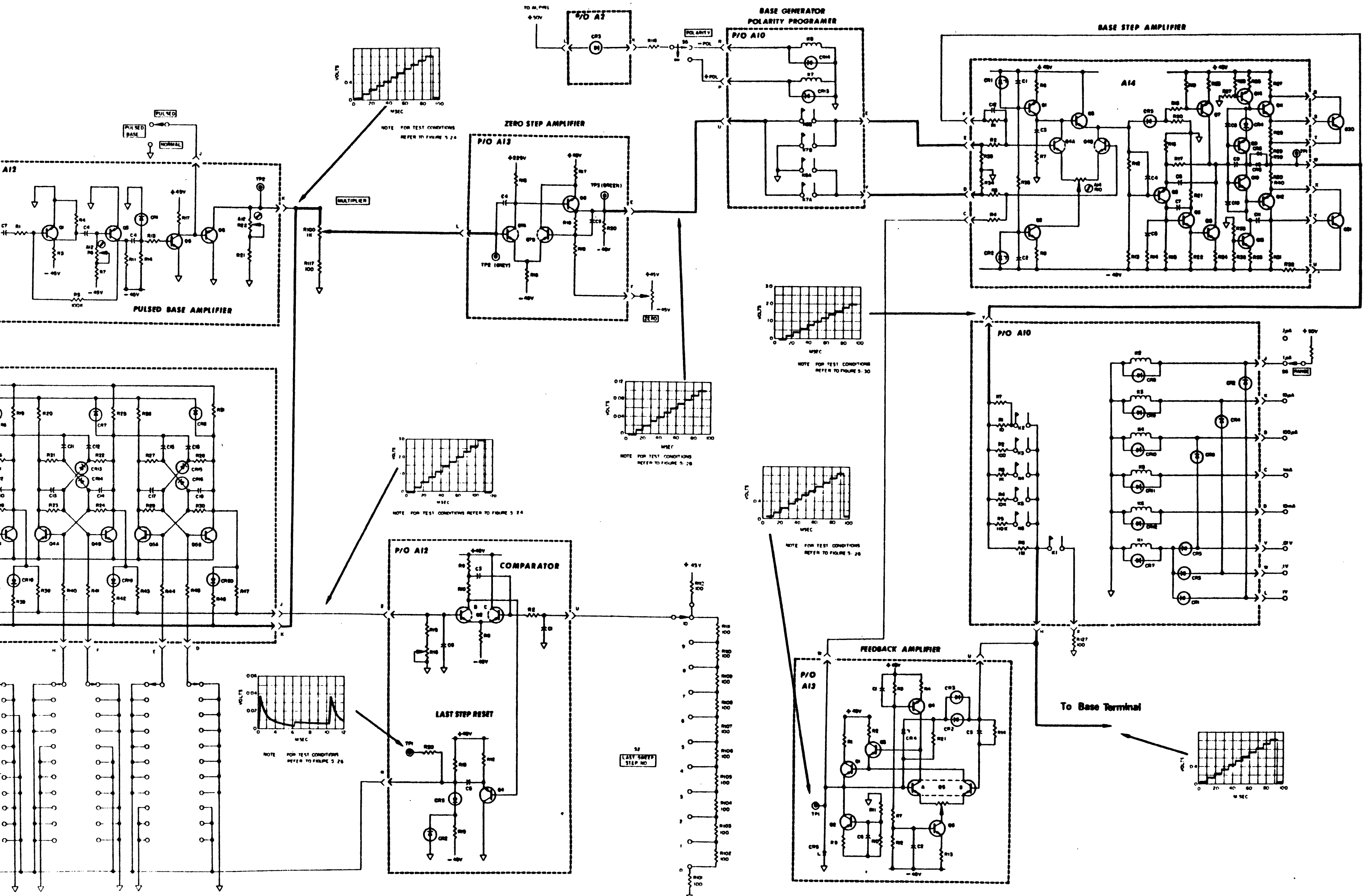


Figure 5-6. Model 6200B Simplified Schematic, (Sheet 2 of 2)

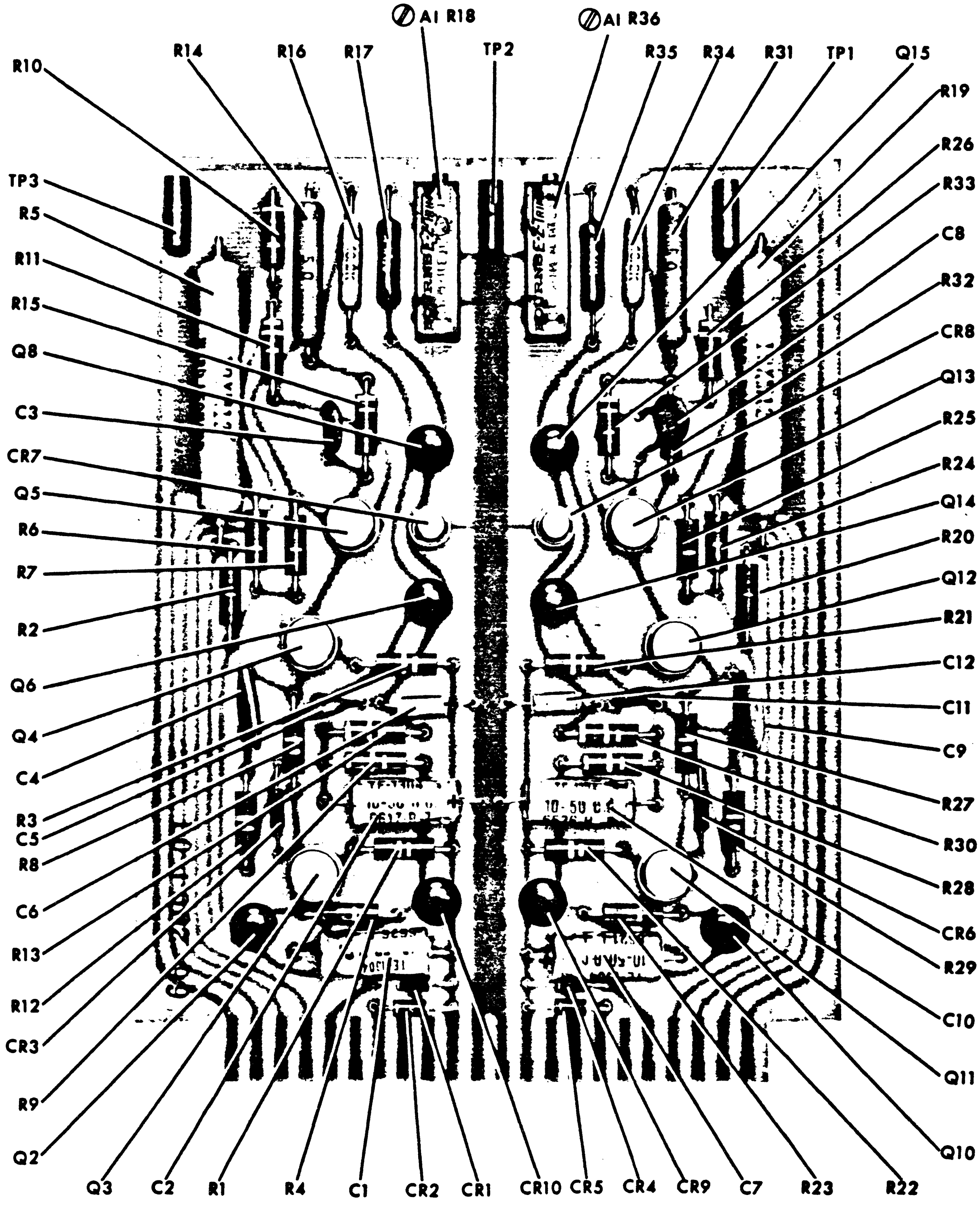


Figure 5-7. Parts Location, Assembly A1

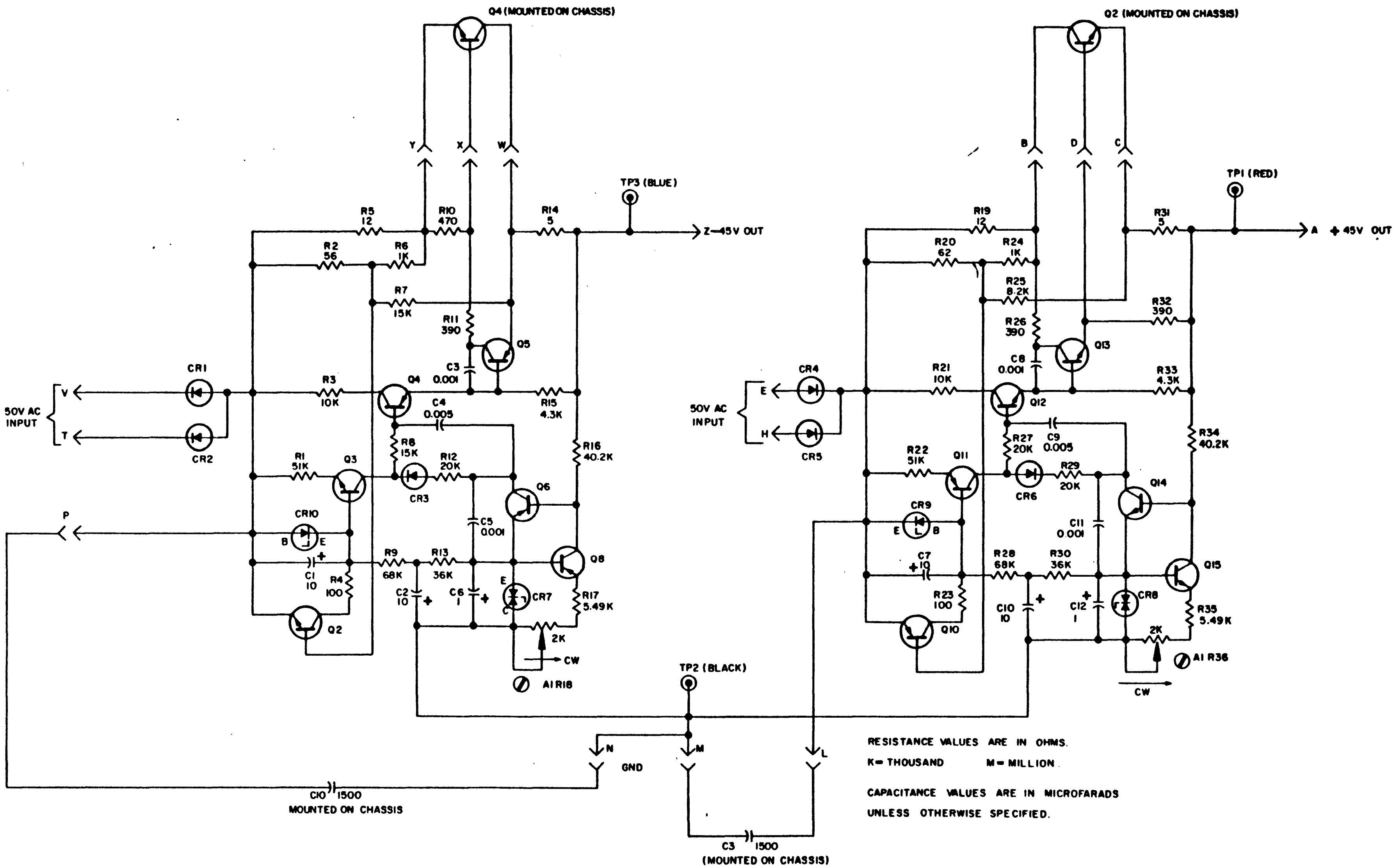


Figure 5-8. Schematic, 45 Volt Power Supply Assembly A1

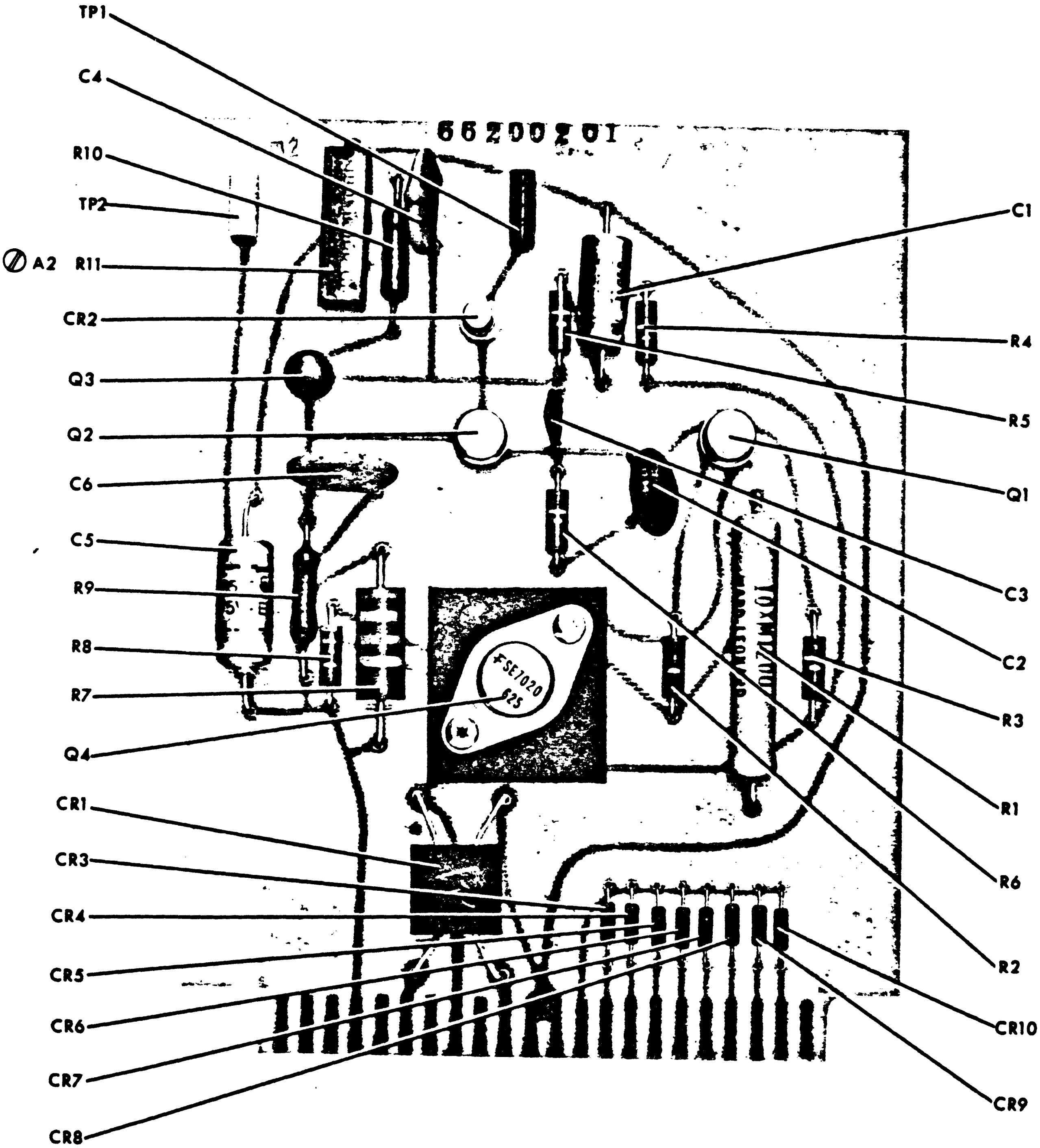


Figure 5-9. Parts Location, Assembly A2

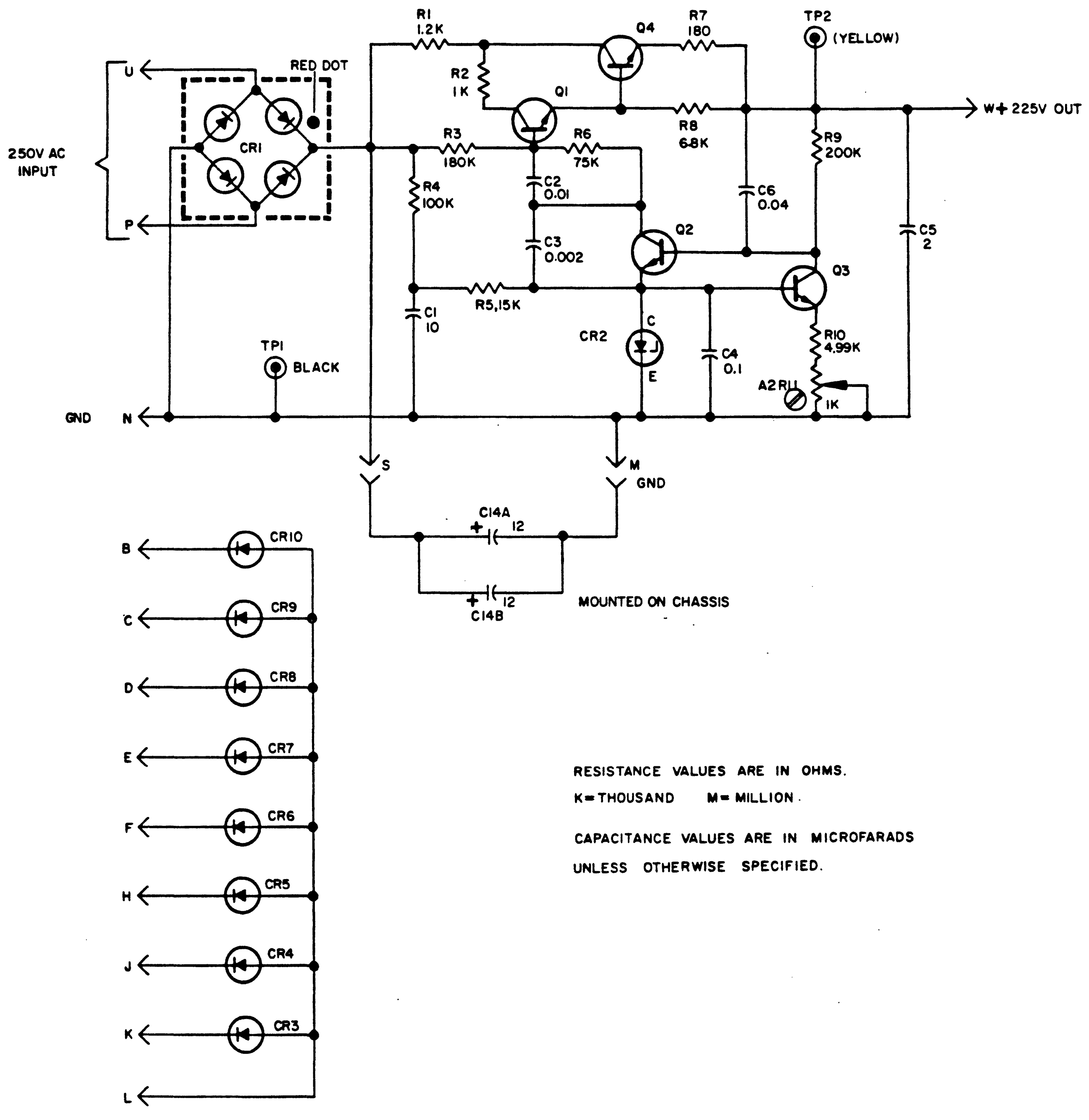


Figure 5-10. Schematic, 225 Volt Power Supply Assembly A2

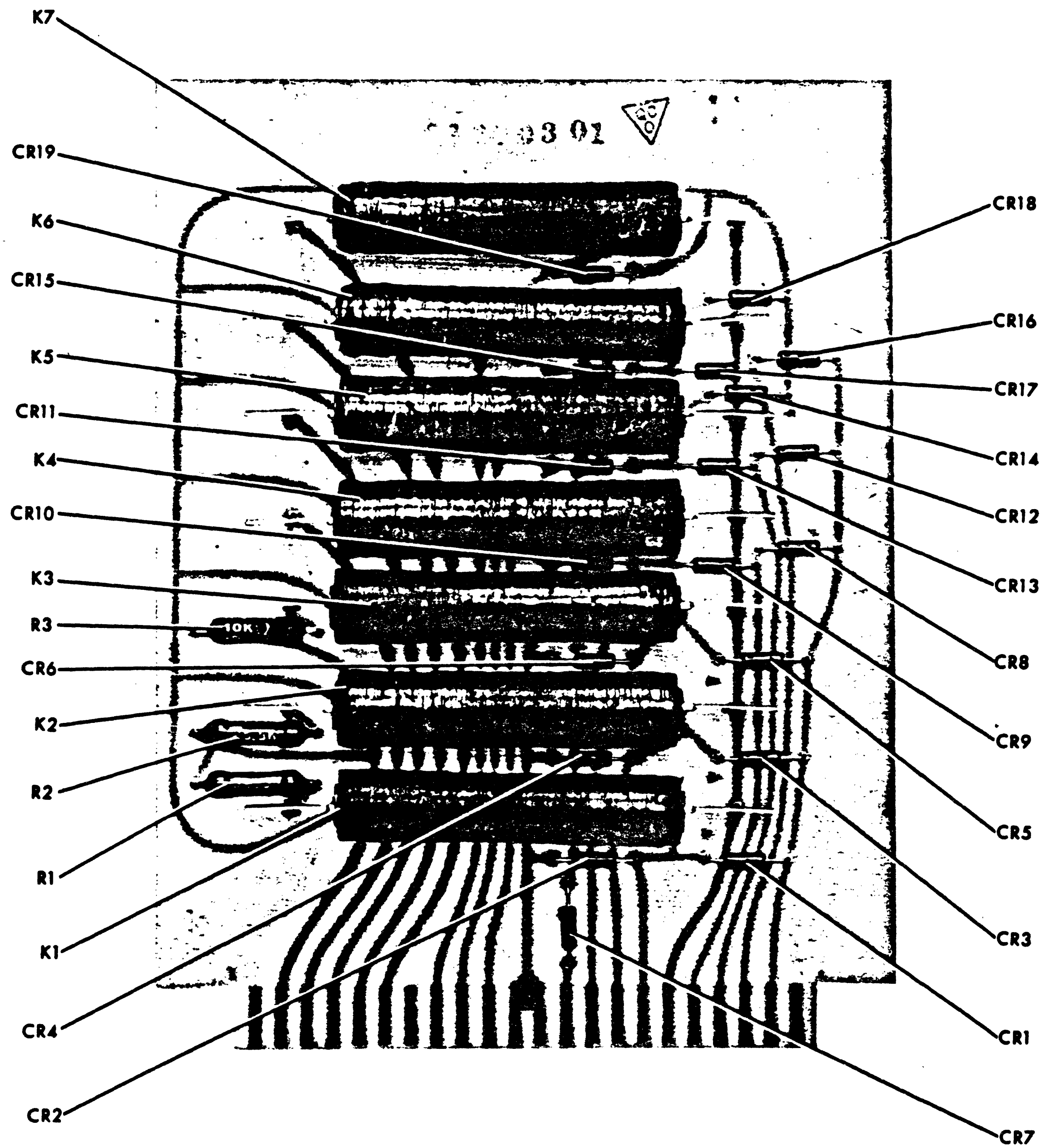


Figure 5-11. Parts Location, Assembly A3

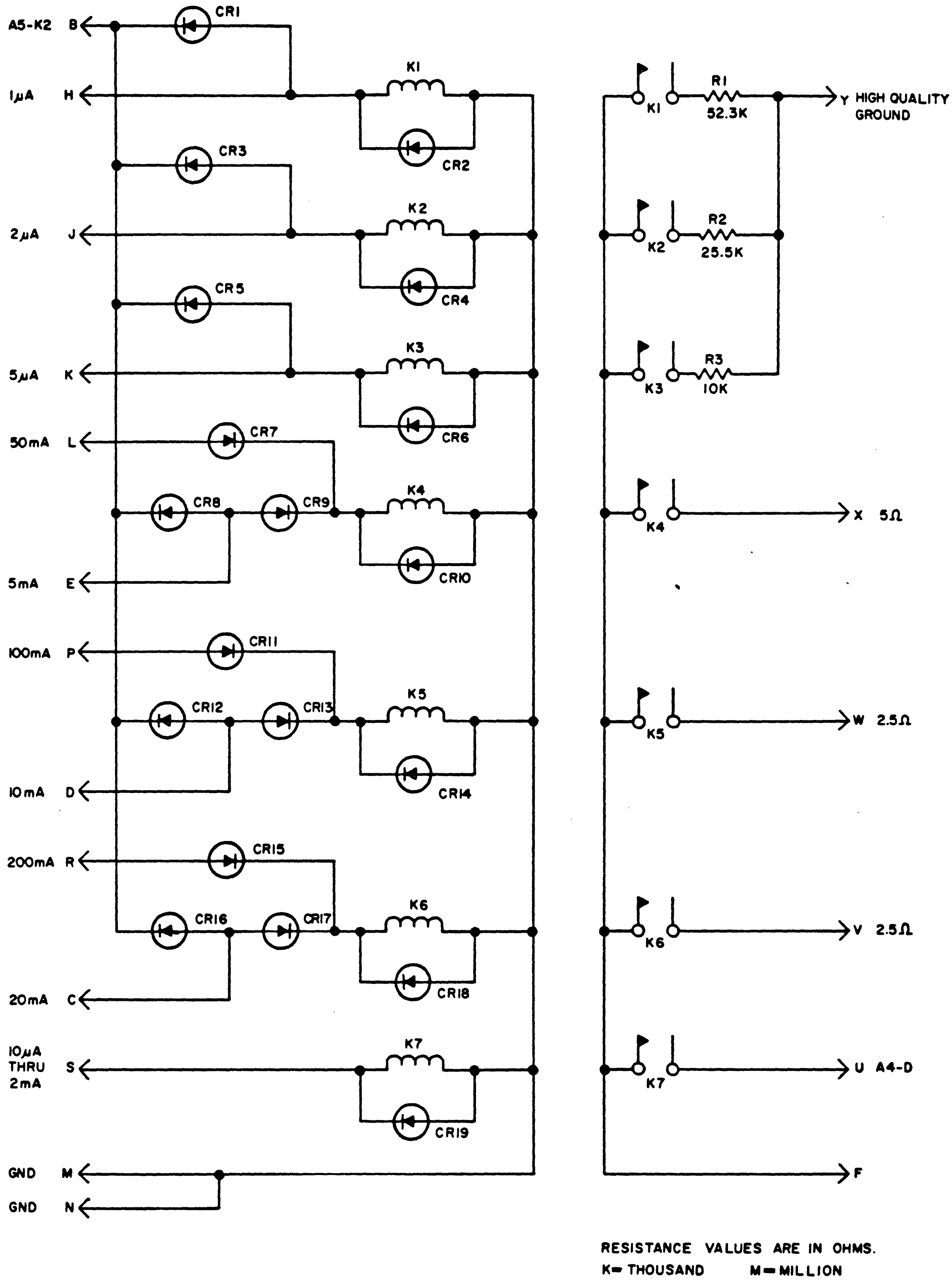


Figure 5-12. Schematic, Collector Current Relay Assembly A3

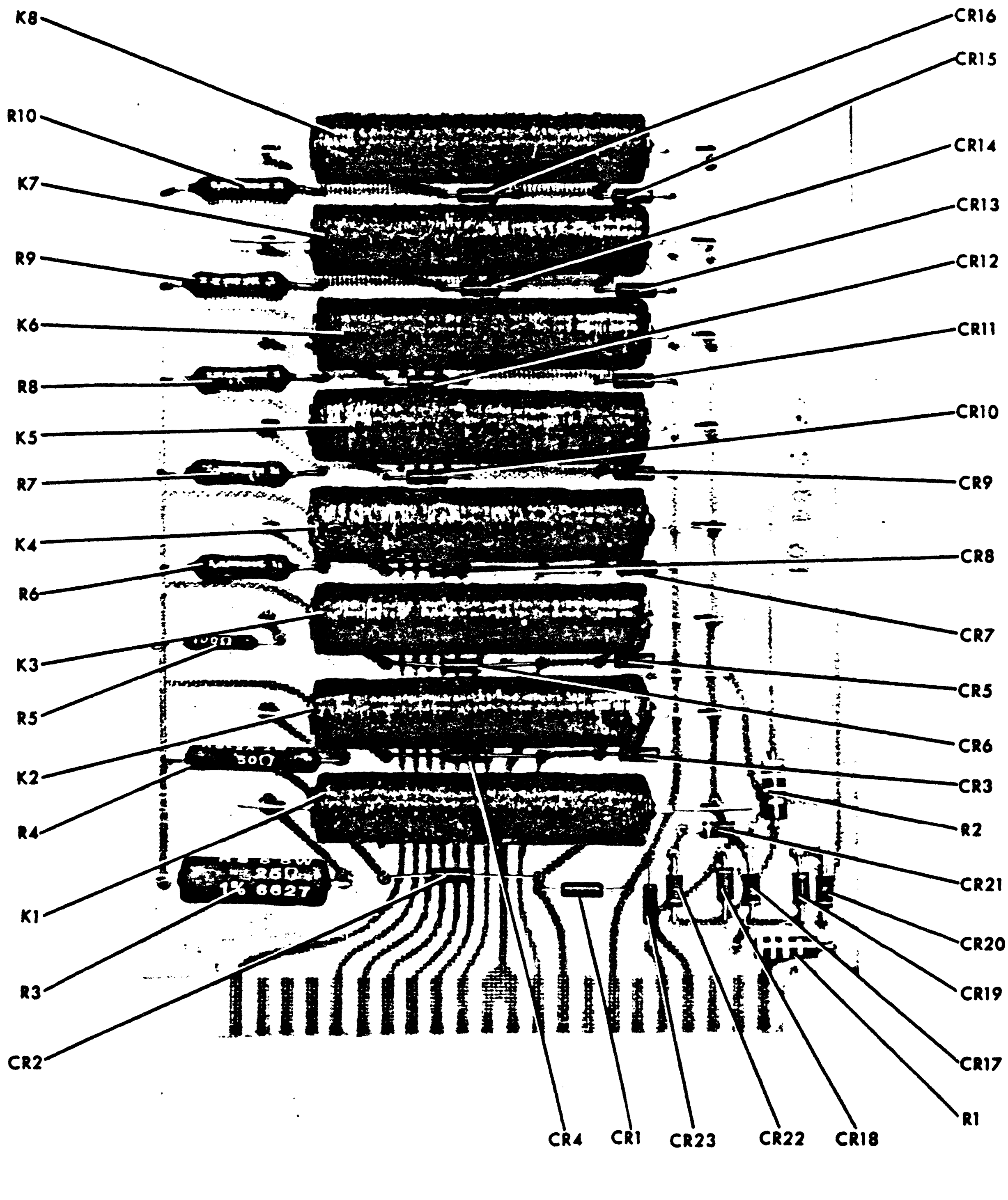


Figure 5-13. Parts Location, Assembly A4

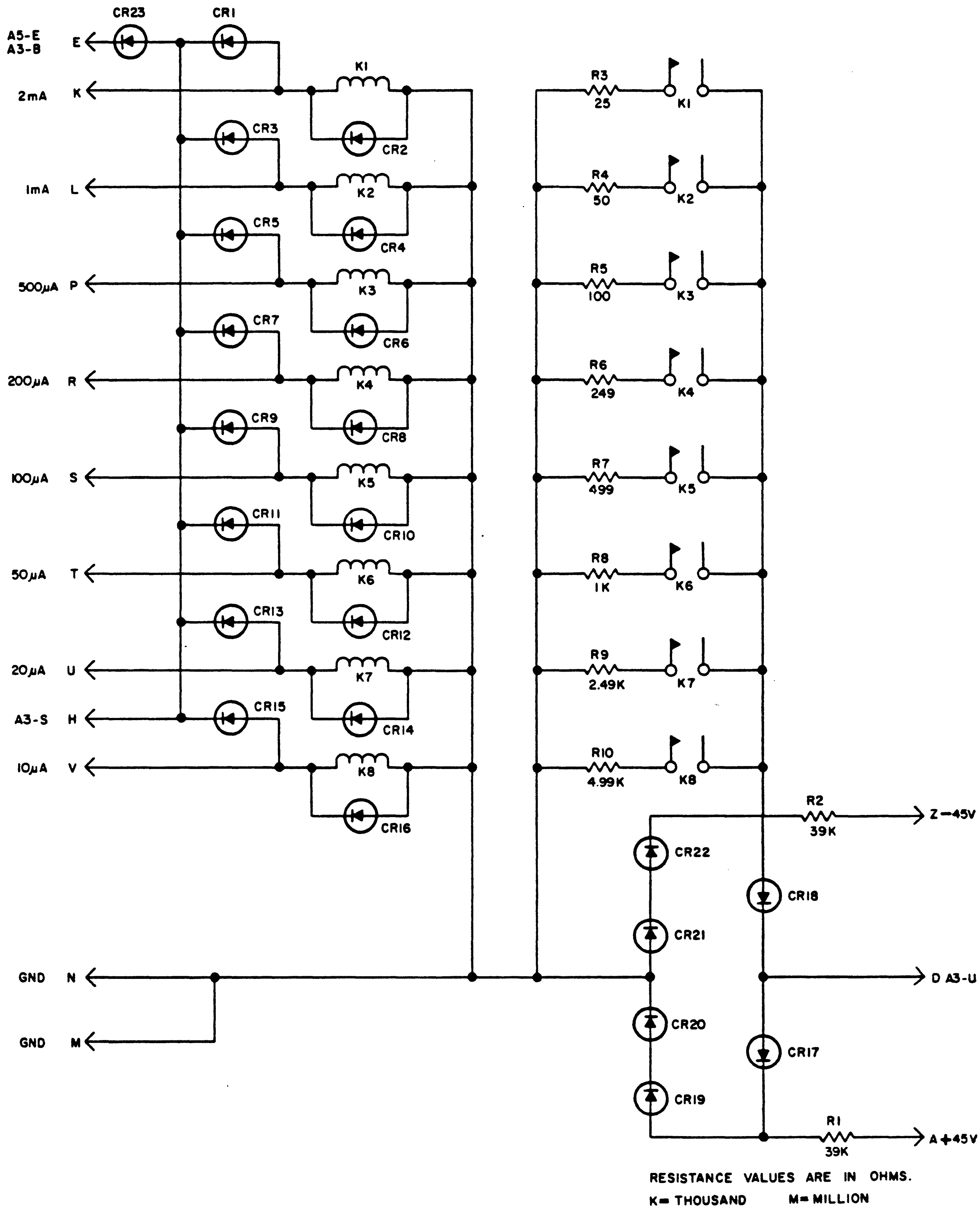


Figure 5-14. Schematic, Collector Current Relay Assembly A4

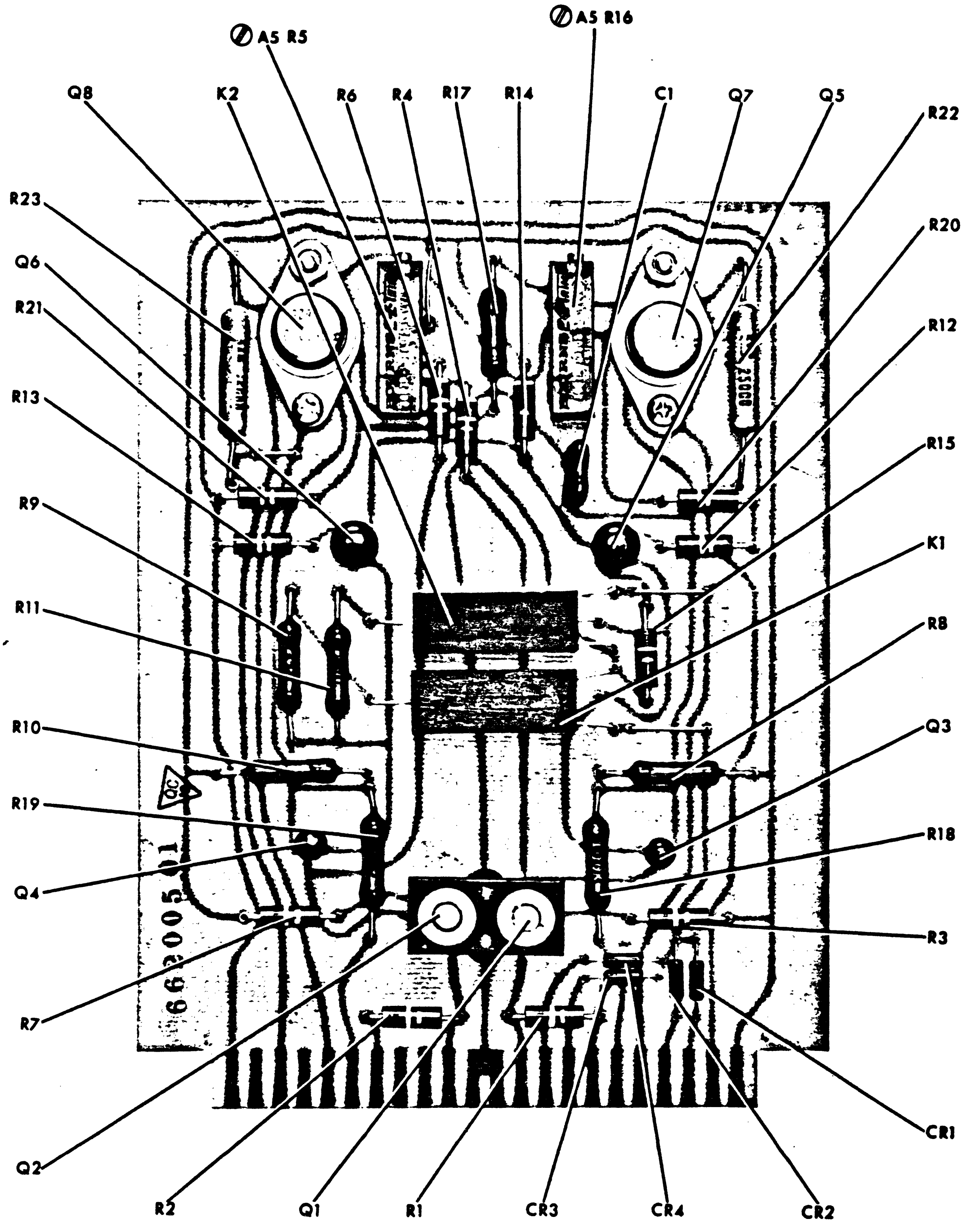
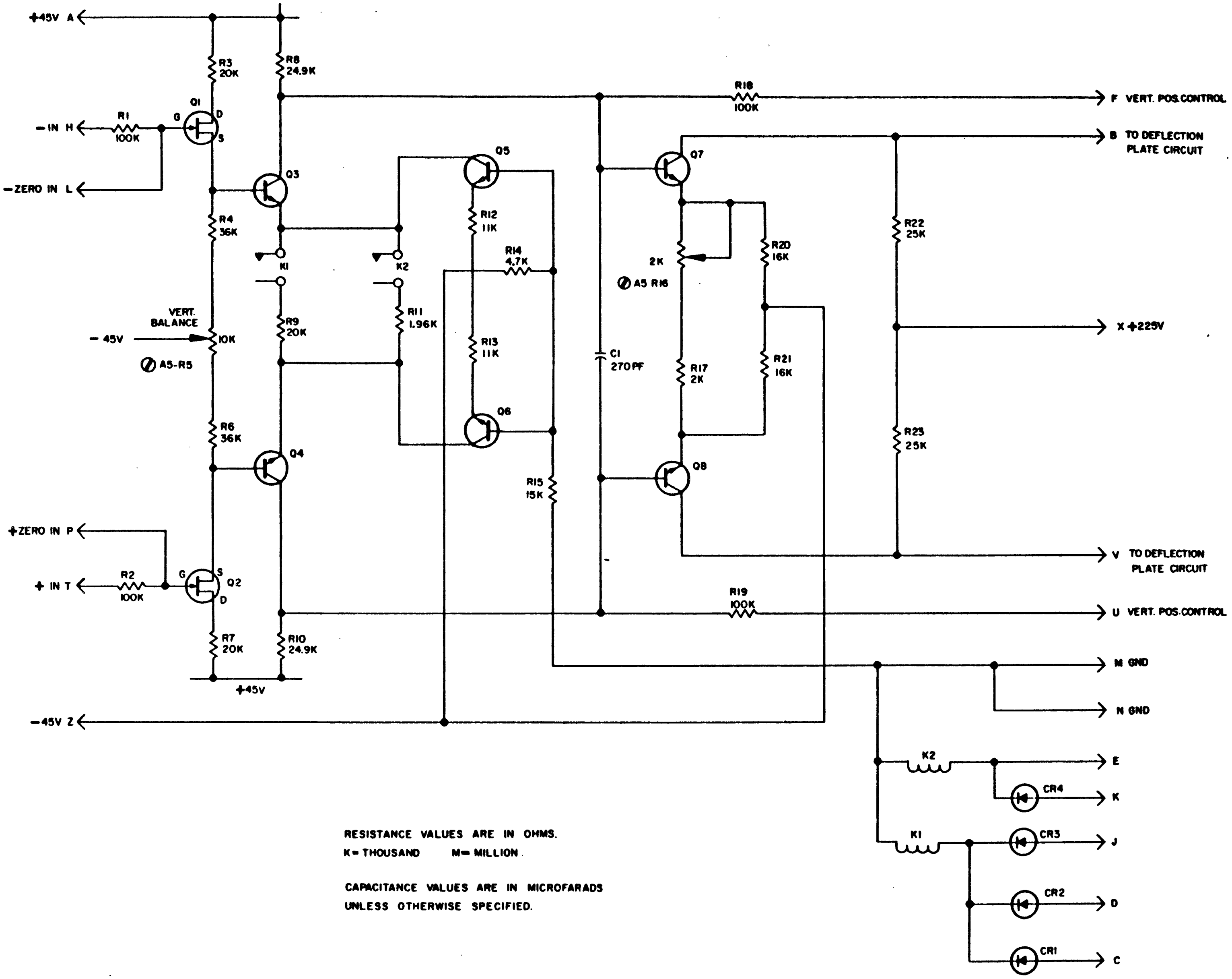


Figure 5-15. Parts Location, Assembly A5



RESISTANCE VALUES ARE IN OHMS.
K= THOUSAND M= MILLION.

CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Figure 5-16. Schematic and Typical Waveform, Vertical Amplifier Assembly A5

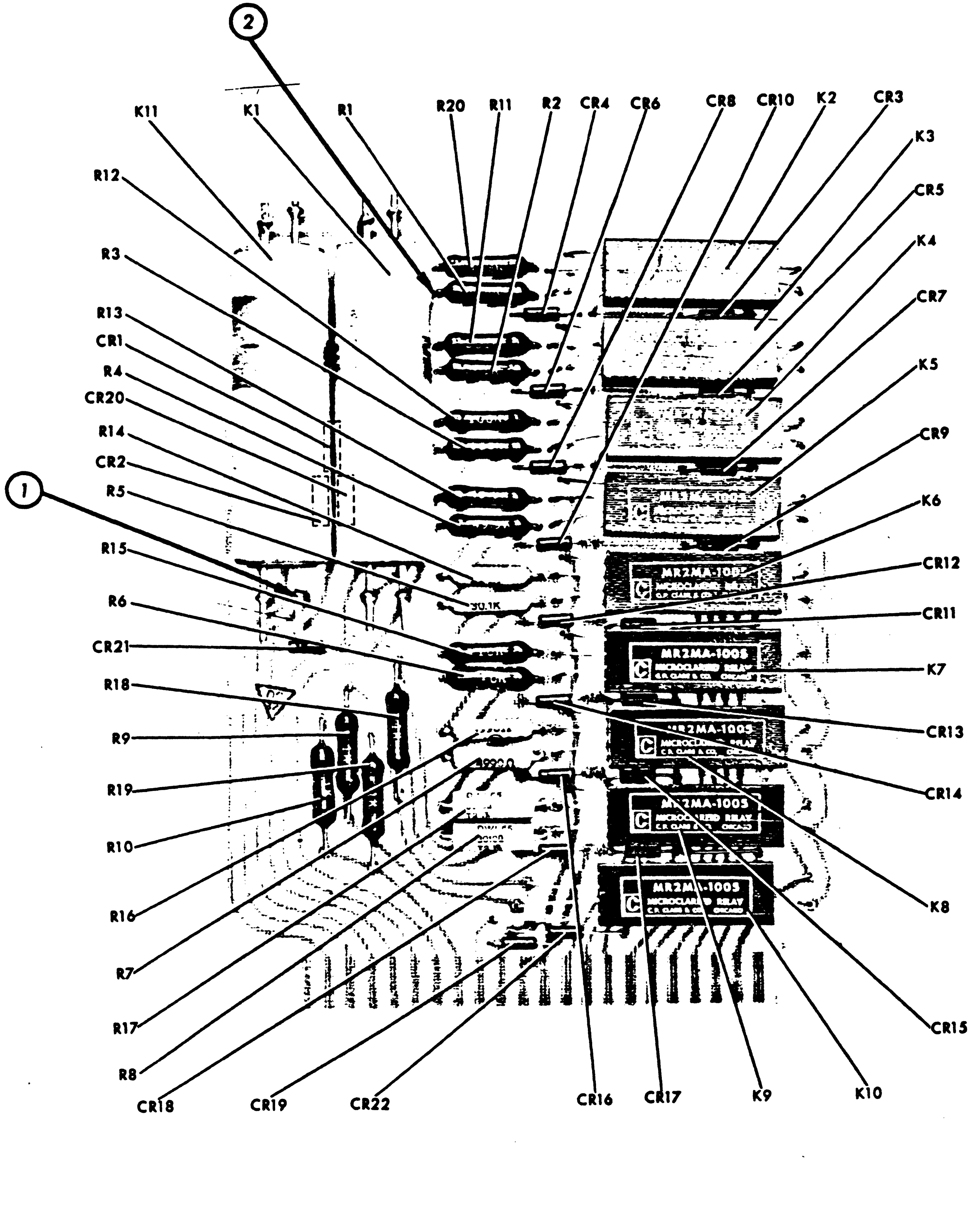
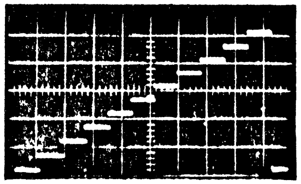


Figure 5-17. Parts Location, Assembly A6

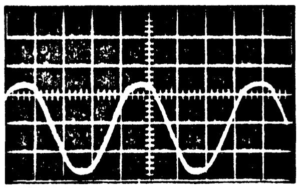
5-27 A1



VERTICAL: .2V/DIV , HORIZONTAL: 10msec/DIV

TEST CONDITIONS

CURVE TRACER SETTINGS	OSCILLOSCOPE SETTINGS
RANGE: .01V	HORIZONTAL SENSITIVITY: 10 msec/div
MULTIPLIER: 10	VERTICAL SENSITIVITY: 0.2V/div
FIRST STEP: 0	DC COUPLED
LAST STEP: 10	



VERTICAL: .2V/DIV. , HORIZONTAL: 2m sec/DIV.

TEST CONDITIONS

CURVE TRACER SETTINGS	OSCILLOSCOPE SETTINGS
FULL RANGE VOLTAGE: +200	HORIZONTAL SENSITIVITY: 2 msec/div
COLLECTOR SWEEP VOLTAGE: FULLY CCW	VERTICAL SENSITIVITY: 0.2V/div
SERIES R: 1MΩ	DC COUPLED

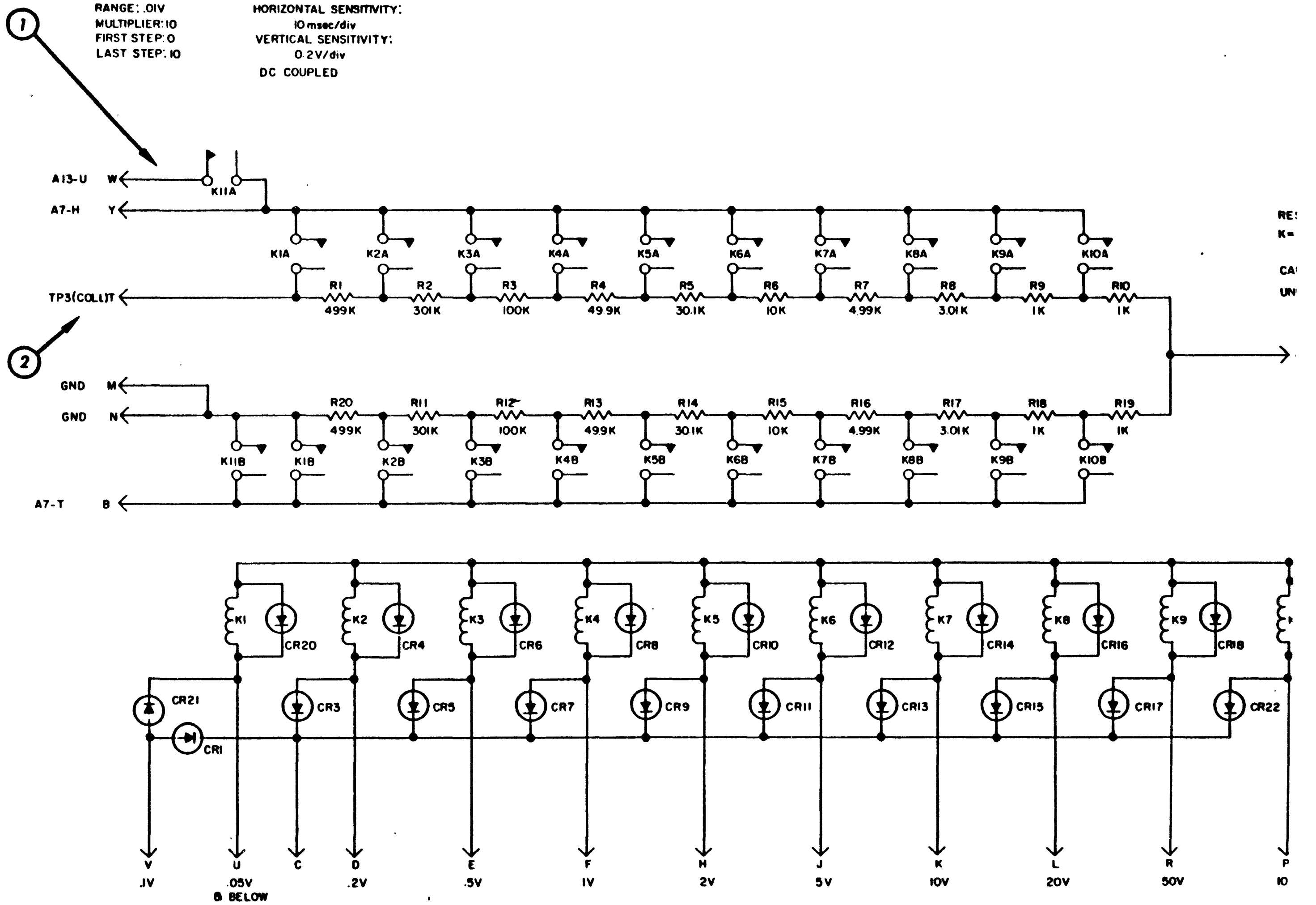
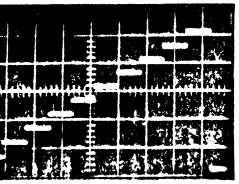
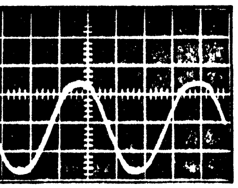


Figure 5-18 Collector



: .2V/DIV , HORIZONTAL : 10msec/DIV



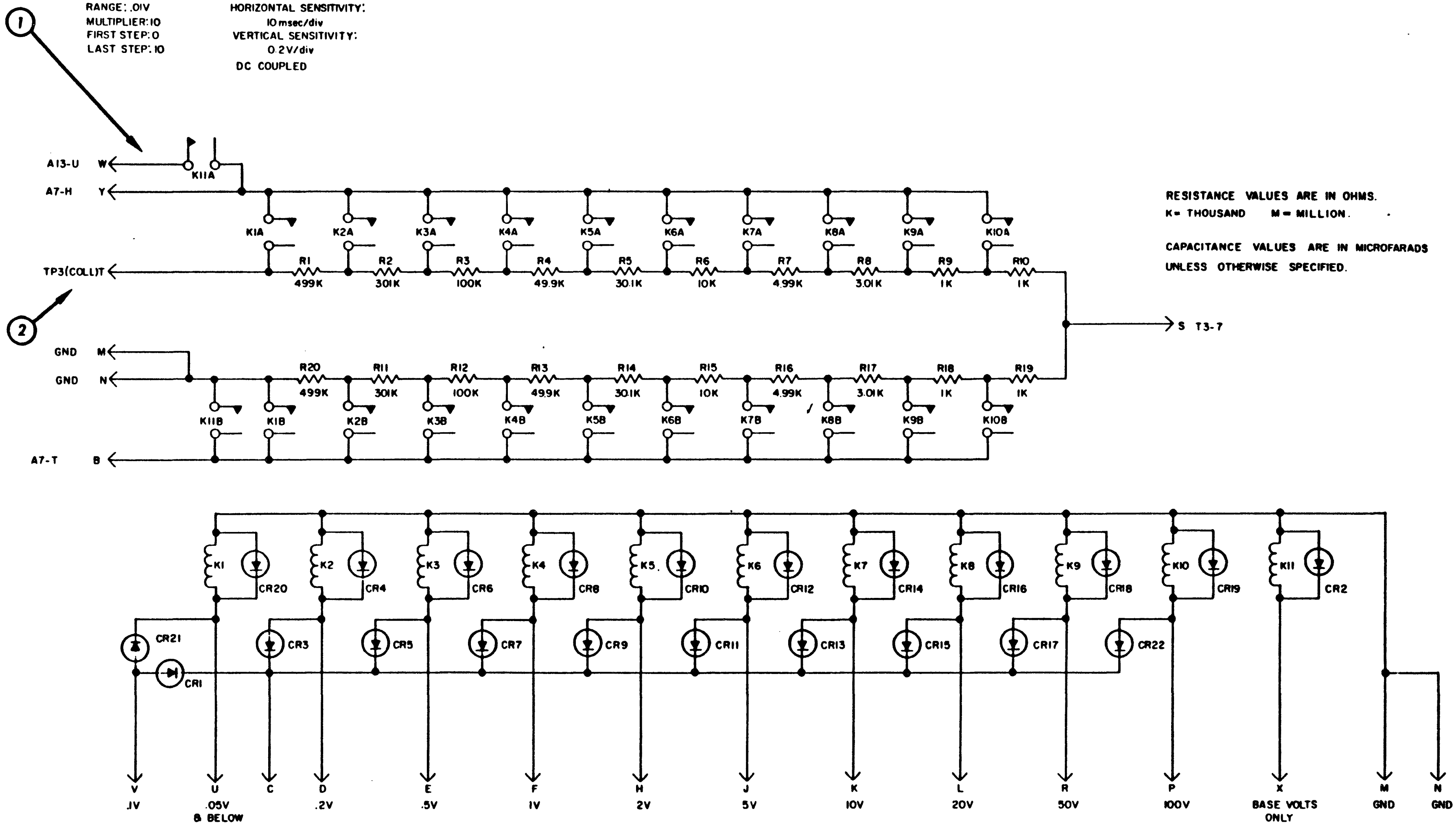
.2V/DIV. , HORIZONTAL : 2msec/DIV

TEST CONDITIONS

CER	OSCILLOSCOPE
S	SETTINGS
	HORIZONTAL SENSITIVITY:
	2 msec/div
	VERTICAL SENSITIVITY:
	0.2V/div
: FULLY CCW	DC COUPLED

TEST CONDITIONS

CURVE TRACER SETTINGS	OSCILLOSCOPE SETTINGS
RANGE: .01V	HORIZONTAL SENSITIVITY:
MULTIPLIER: 10	10 msec/div
FIRST STEP: 0	VERTICAL SENSITIVITY:
LAST STEP: 10	0.2V/div
	DC COUPLED



RESISTANCE VALUES ARE IN OHMS.
K= THOUSAND M= MILLION.

CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Figure 5-18. Schematic and Typical Waveform, Collector Voltage Attenuator Assembly A6

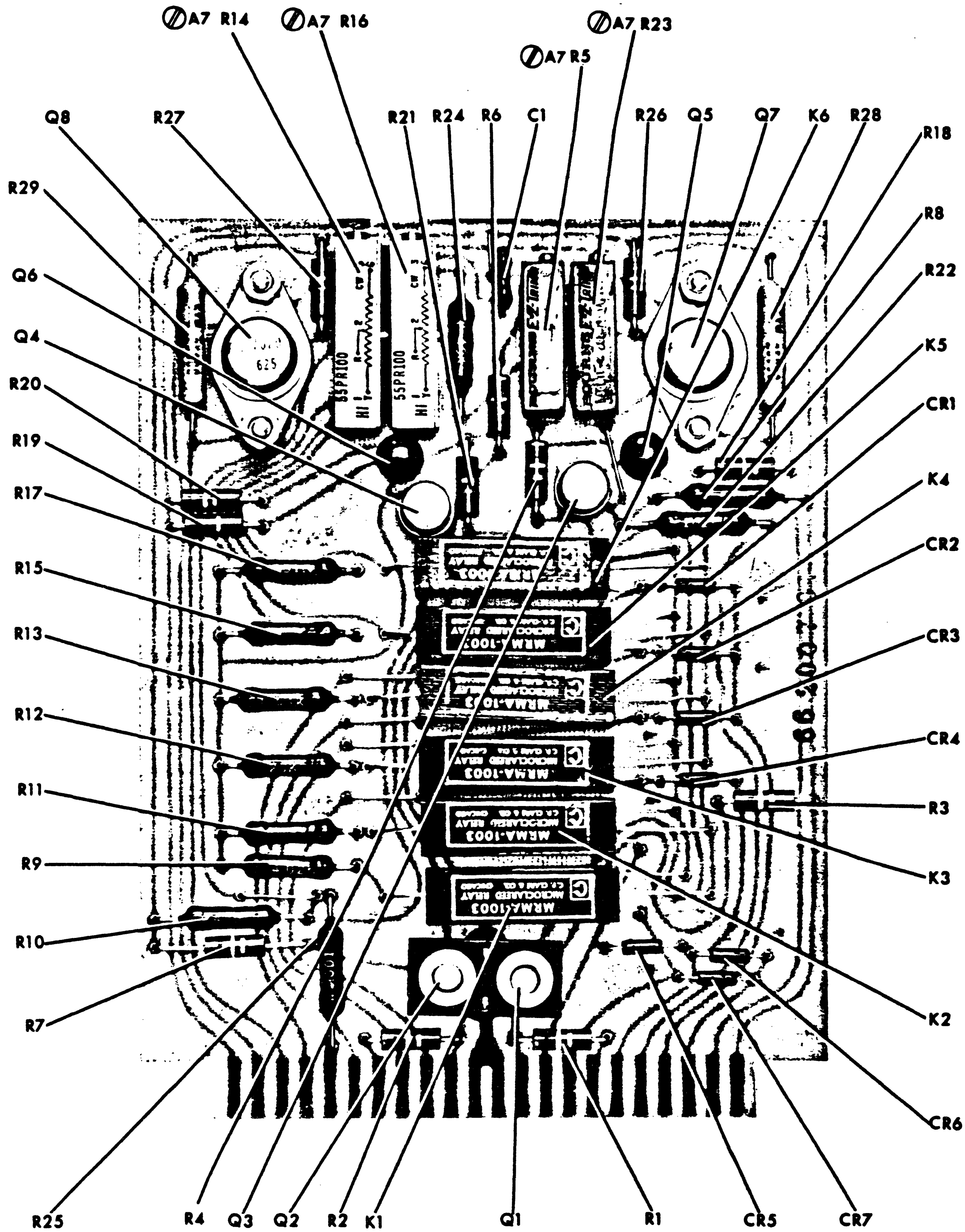


Figure 5-19. Parts Location, Assembly A7

RESISTANCE VALUES ARE IN OHMS.
K = THOUSAND M = MILLION

CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

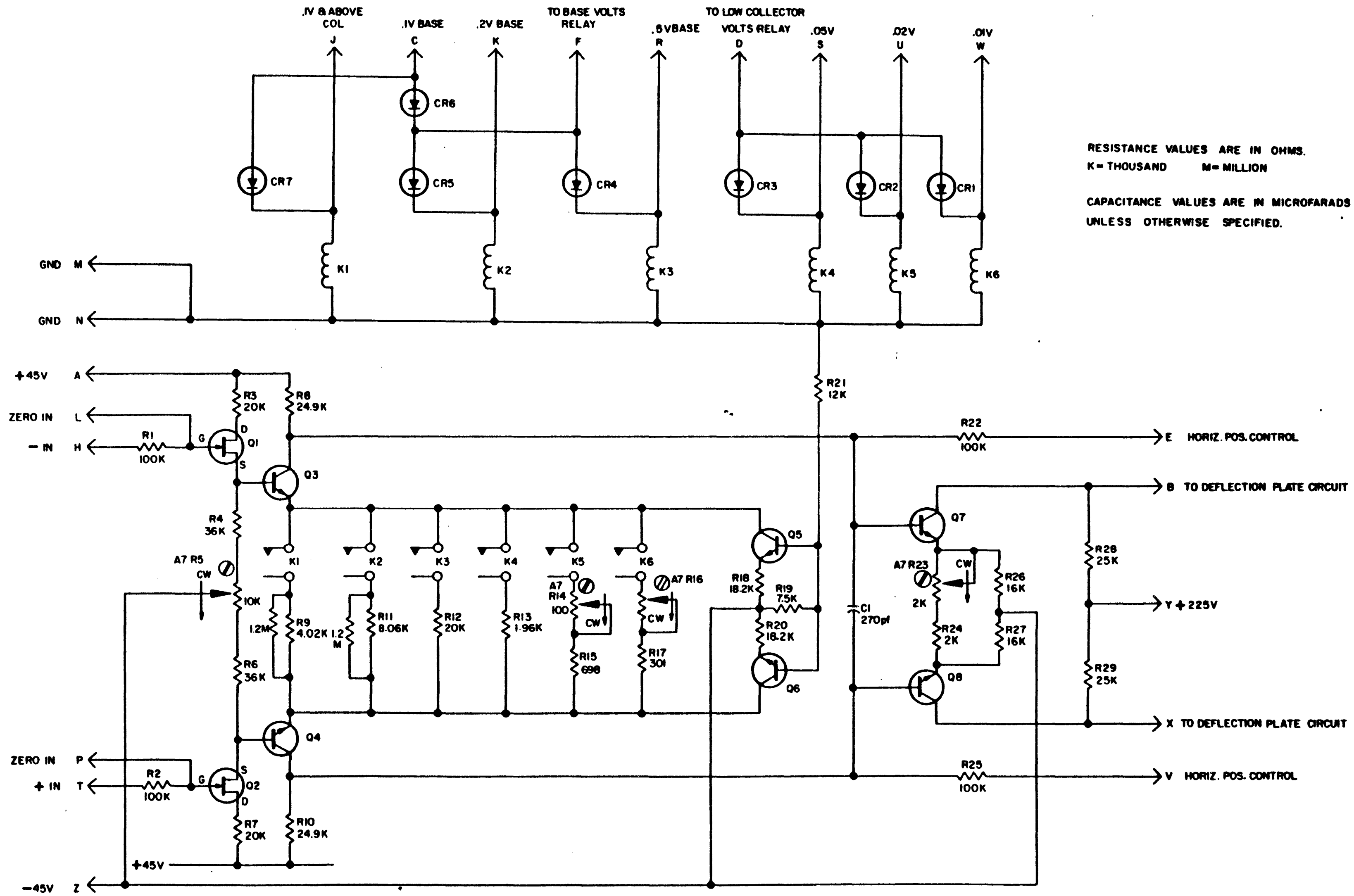


Figure 5-20. Schematic, Horizontal Amplifier Assembly A7

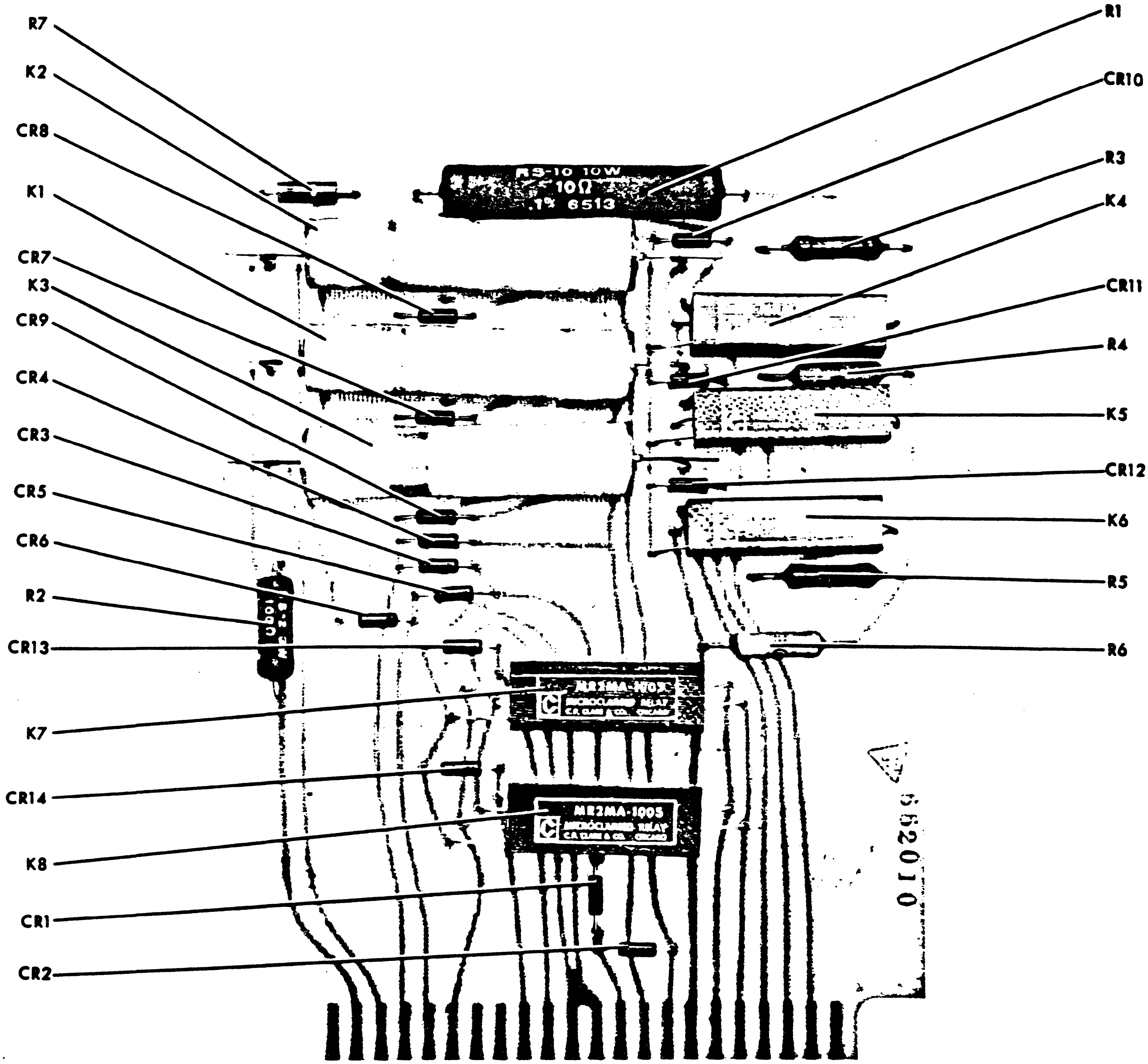
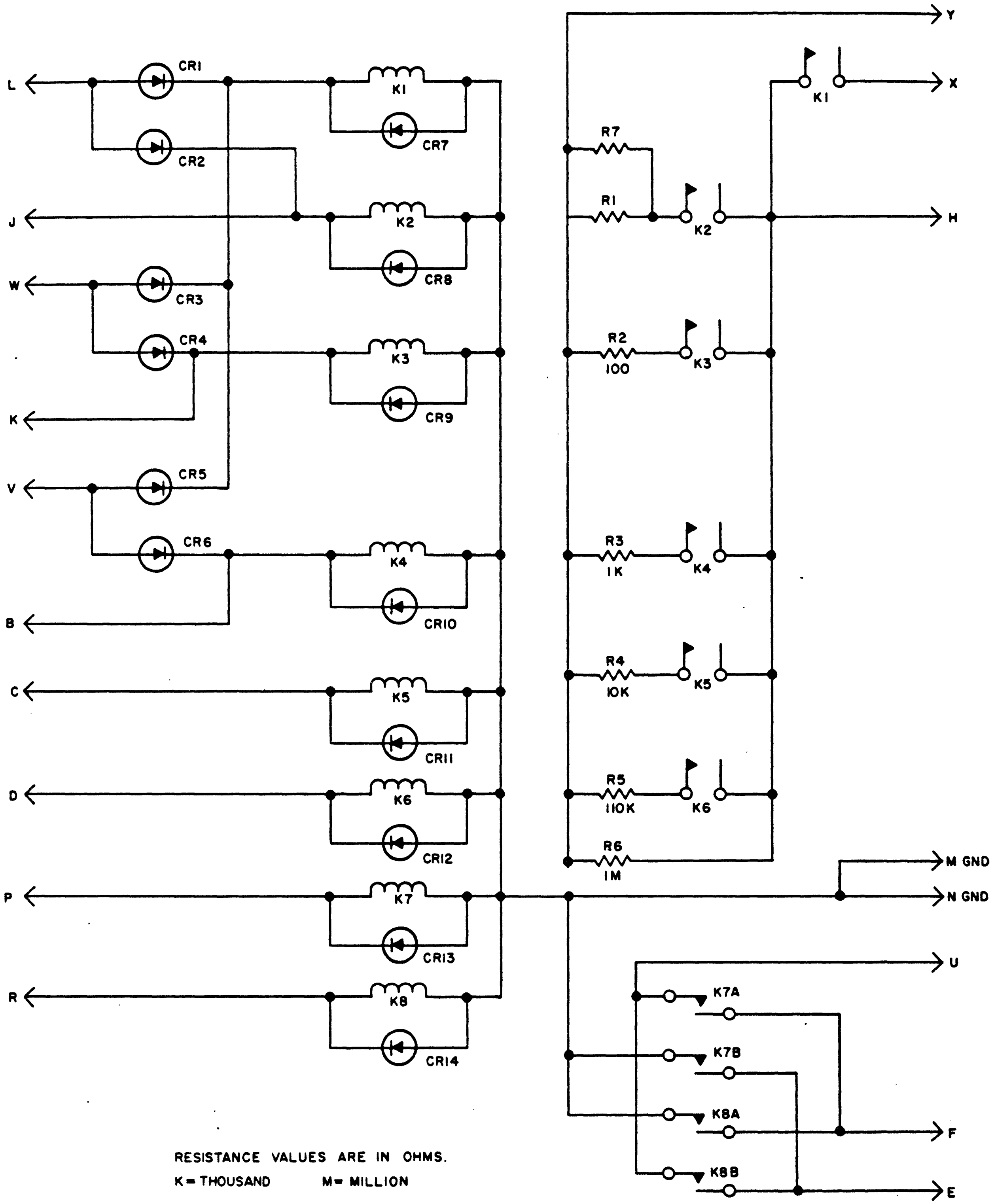


Figure 5-21. Parts Location, Assembly A10



RESISTANCE VALUES ARE IN OHMS.
K = THOUSAND M = MILLION

Figure 5-22. Schematic, Base Generator Programmer, Assembly A10

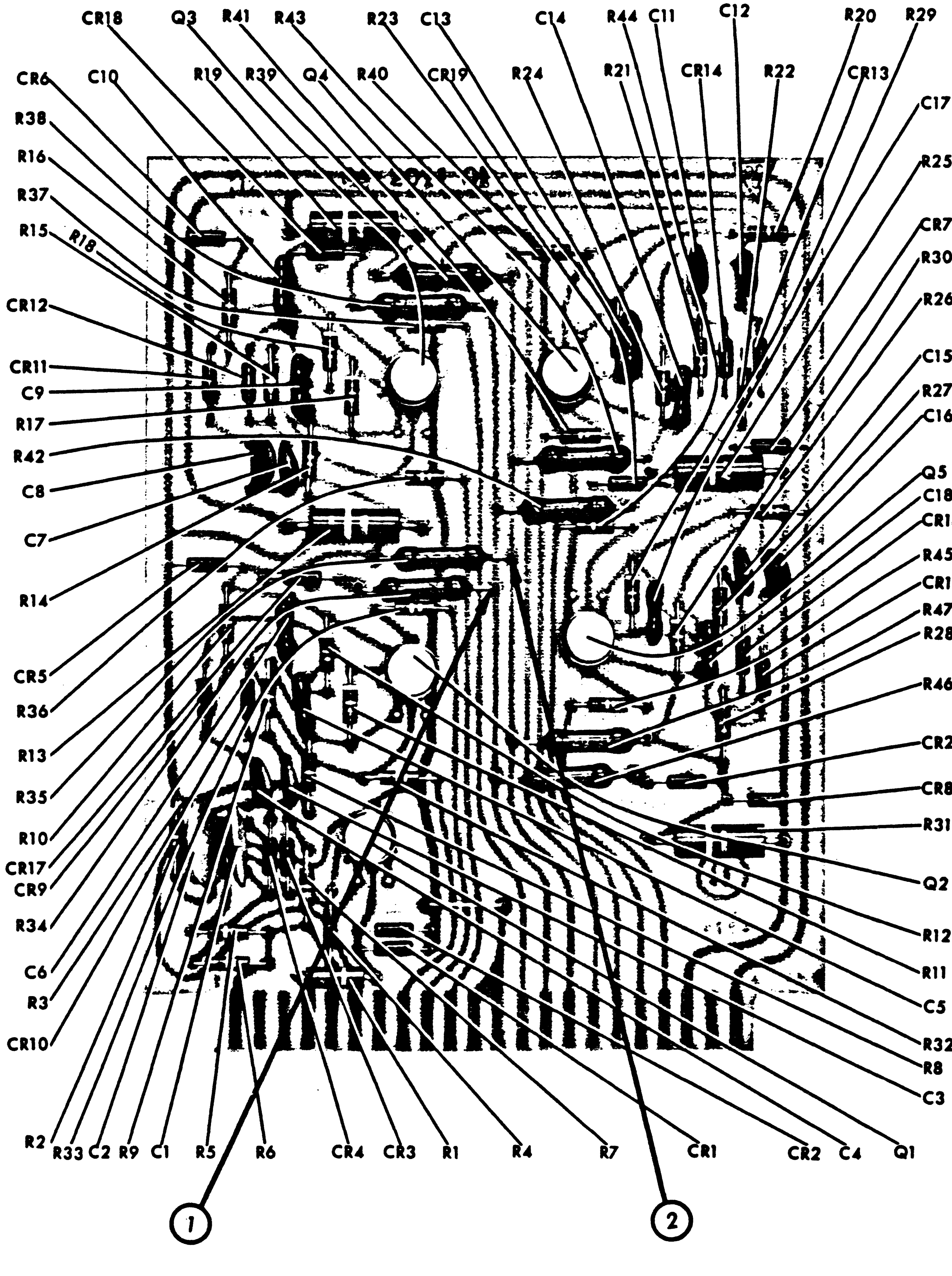
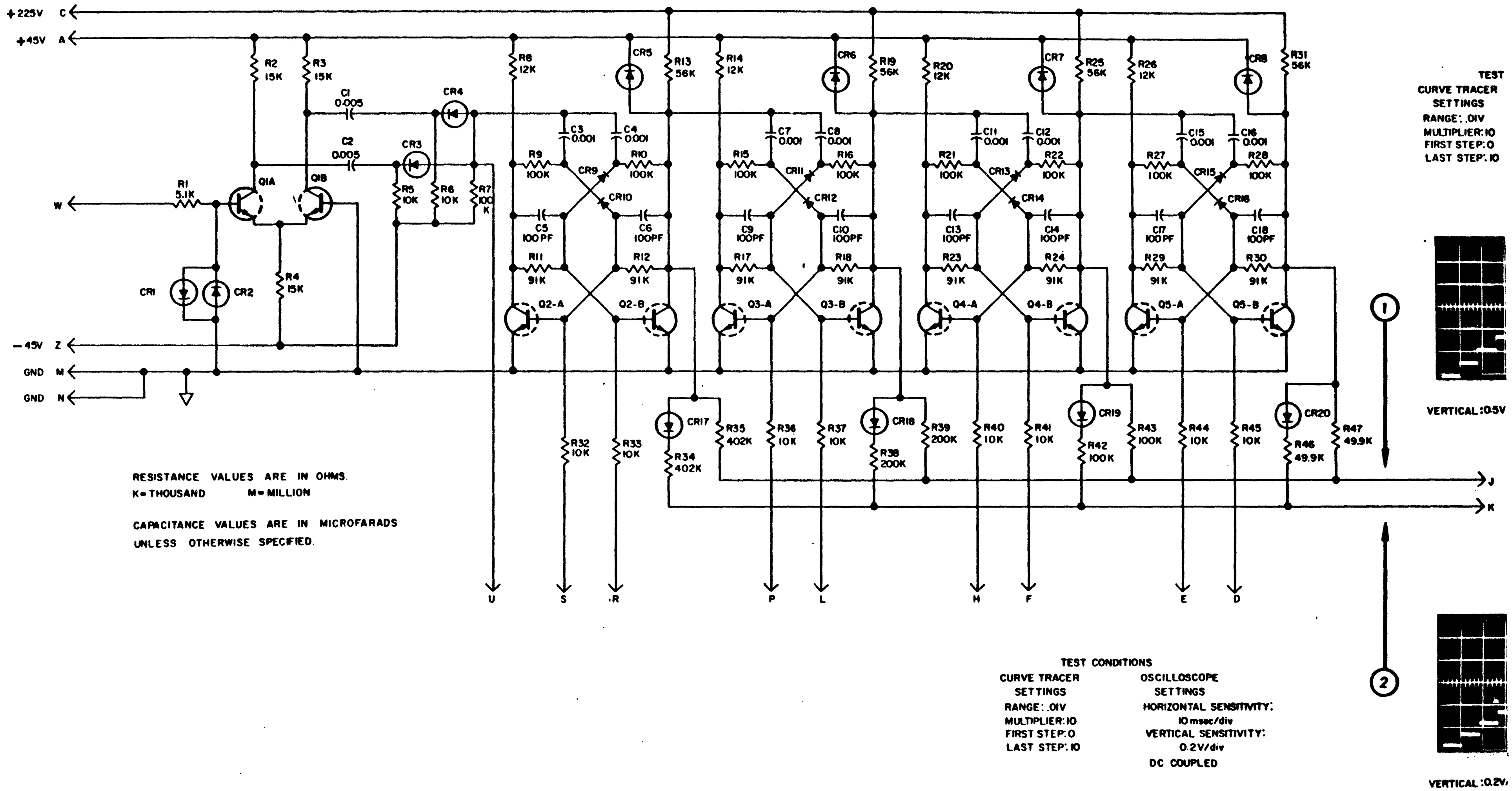


Figure 5-23. Parts Location Assembly A11

5-33 A1



RESISTANCE VALUES ARE IN OHMS.
K=THOUSAND M=MILLION

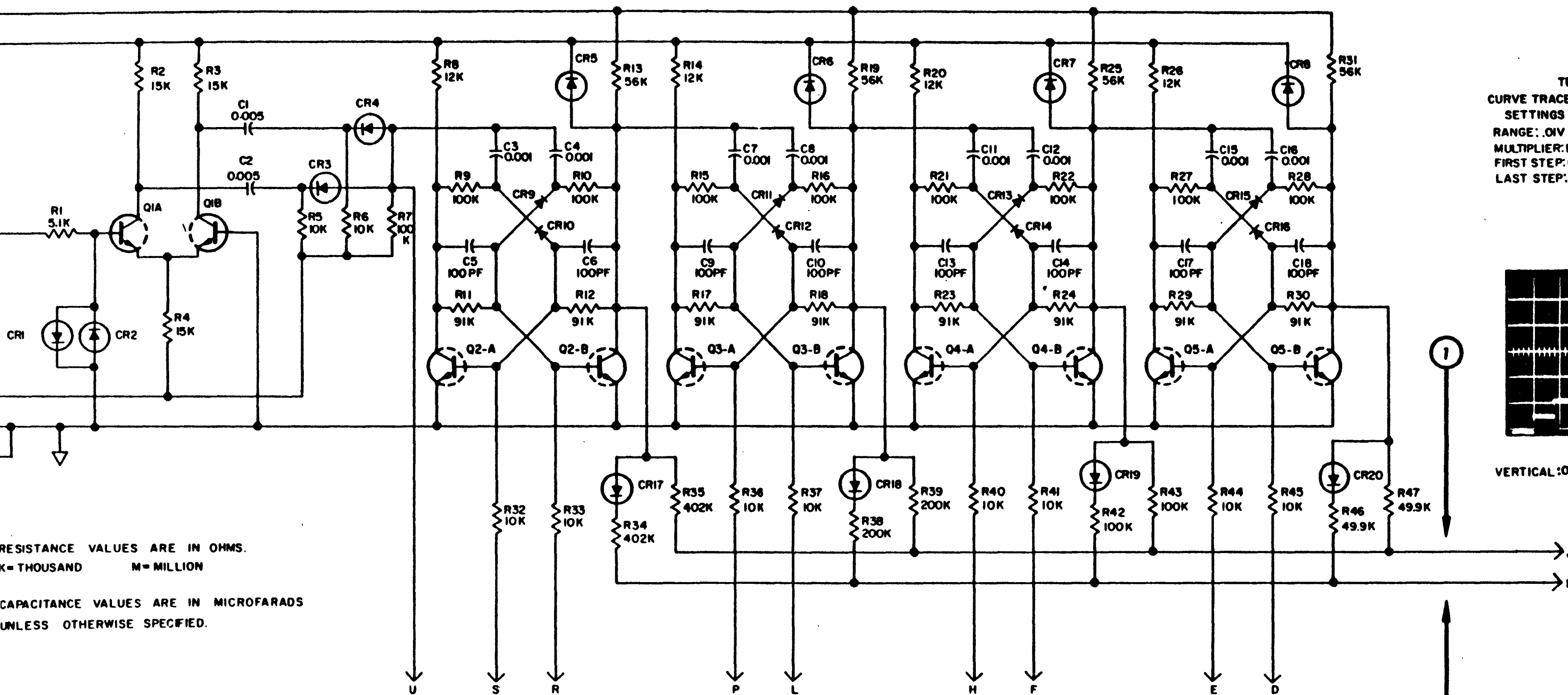
CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

TEST CONDITIONS

CURVE TRACER SETTINGS	OSCILLOSCOPE SETTINGS
RANGE: .01V	HORIZONTAL SENSITIVITY: 10 msec/div
MULTIPLIER: 10	VERTICAL SENSITIVITY: 0.2V/div
FIRST STEP: 0	DC COUPLED
LAST STEP: 10	

Figure 5-24. Schemati
Base Step Counte

5-33 A2

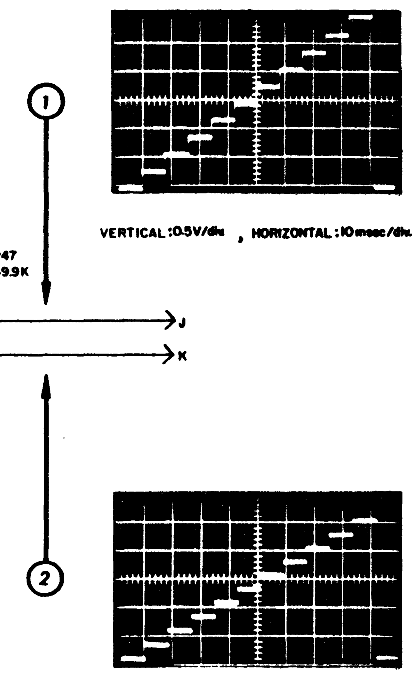


RESISTANCE VALUES ARE IN OHMS.
K = THOUSAND M = MILLION

CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

TEST CONDITIONS

CURVE TRACER SETTINGS	OSCILLOSCOPE SETTINGS
RANGE: .01V	HORIZONTAL SENSITIVITY: 10 msec/div
MULTIPLIER: 10	VERTICAL SENSITIVITY: 0.5 V/div
FIRST STEP: 0	DC COUPLED
LAST STEP: 10	



VERTICAL: 0.5V/div , HORIZONTAL: 10 msec/div.

TEST CONDITIONS

CURVE TRACER SETTINGS	OSCILLOSCOPE SETTINGS
RANGE: .01V	HORIZONTAL SENSITIVITY: 10 msec/div
MULTIPLIER: 10	VERTICAL SENSITIVITY: 0.2V/div
FIRST STEP: 0	DC COUPLED
LAST STEP: 10	

VERTICAL: 0.2V/div , HORIZONTAL: 10 msec/div.

Figure 5-24. Schematic and Typical Waveforms, Base Step Counter Assembly A11

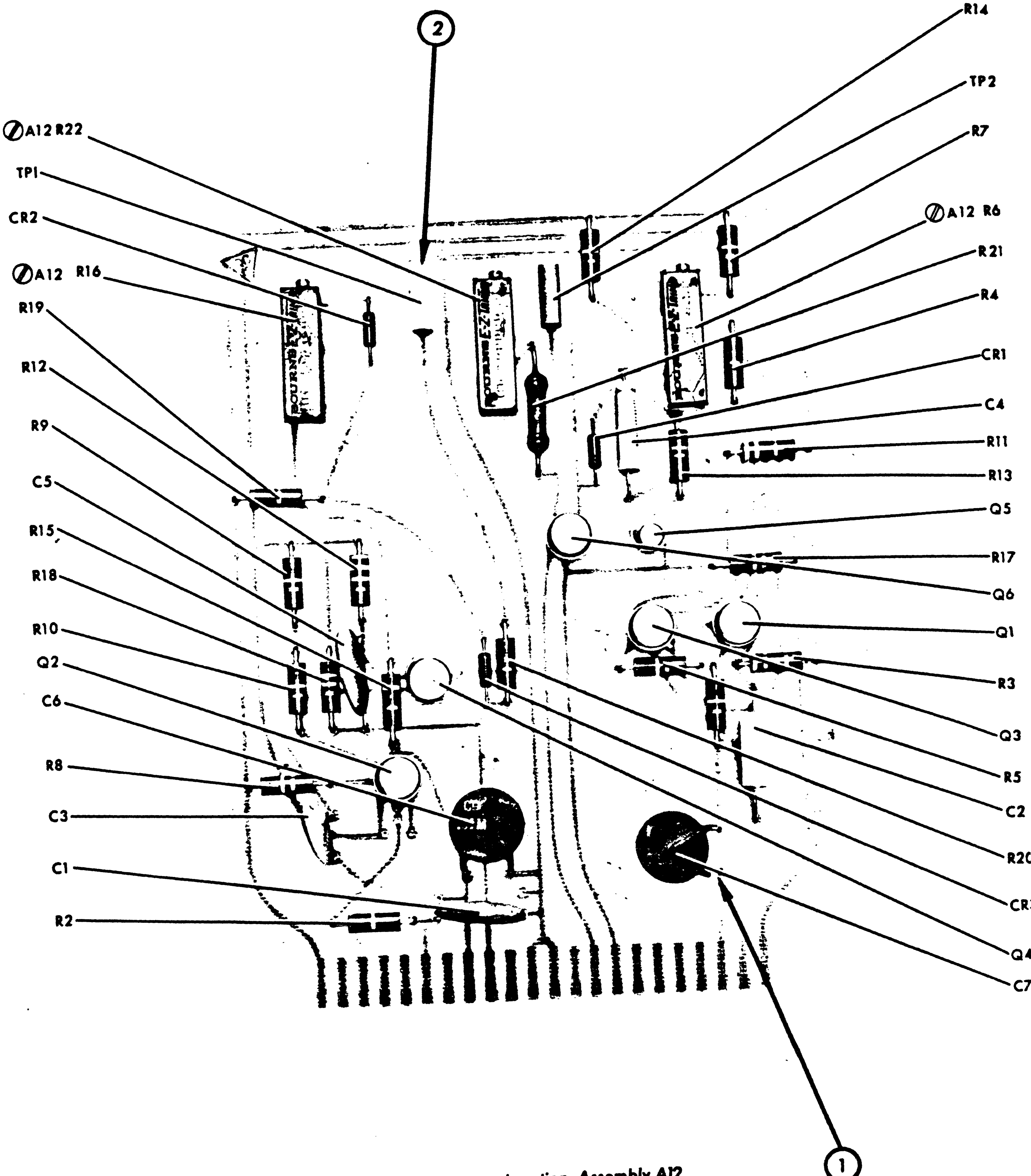
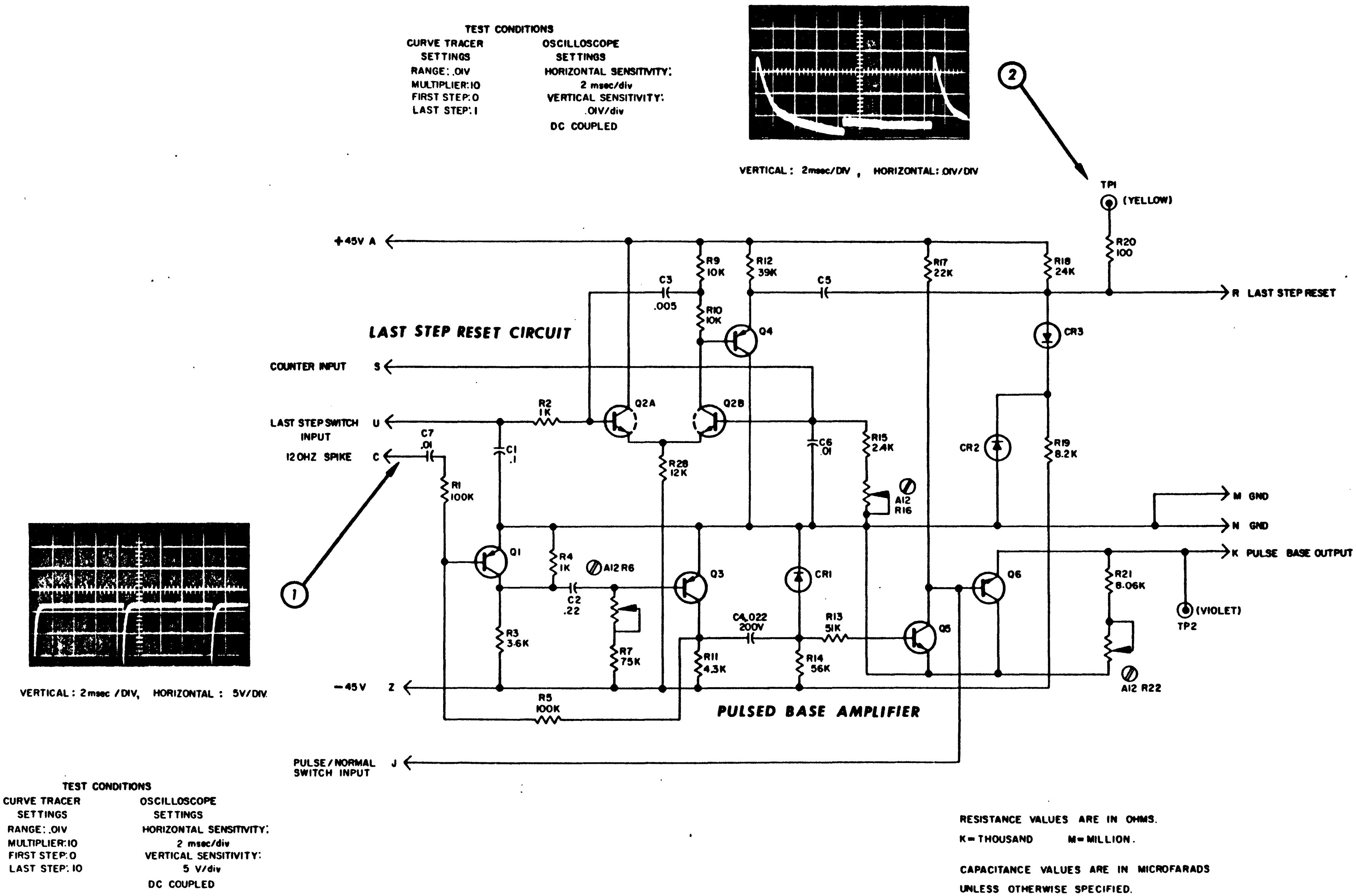


Figure 5-25. Parts Location, Assembly A12



RESISTANCE VALUES ARE IN OHMS.

K = THOUSAND M = MILLION.

CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Figure 5-26. Schematic and Typical Waveforms, Pulse Base and Last Step Reset Assembly A12

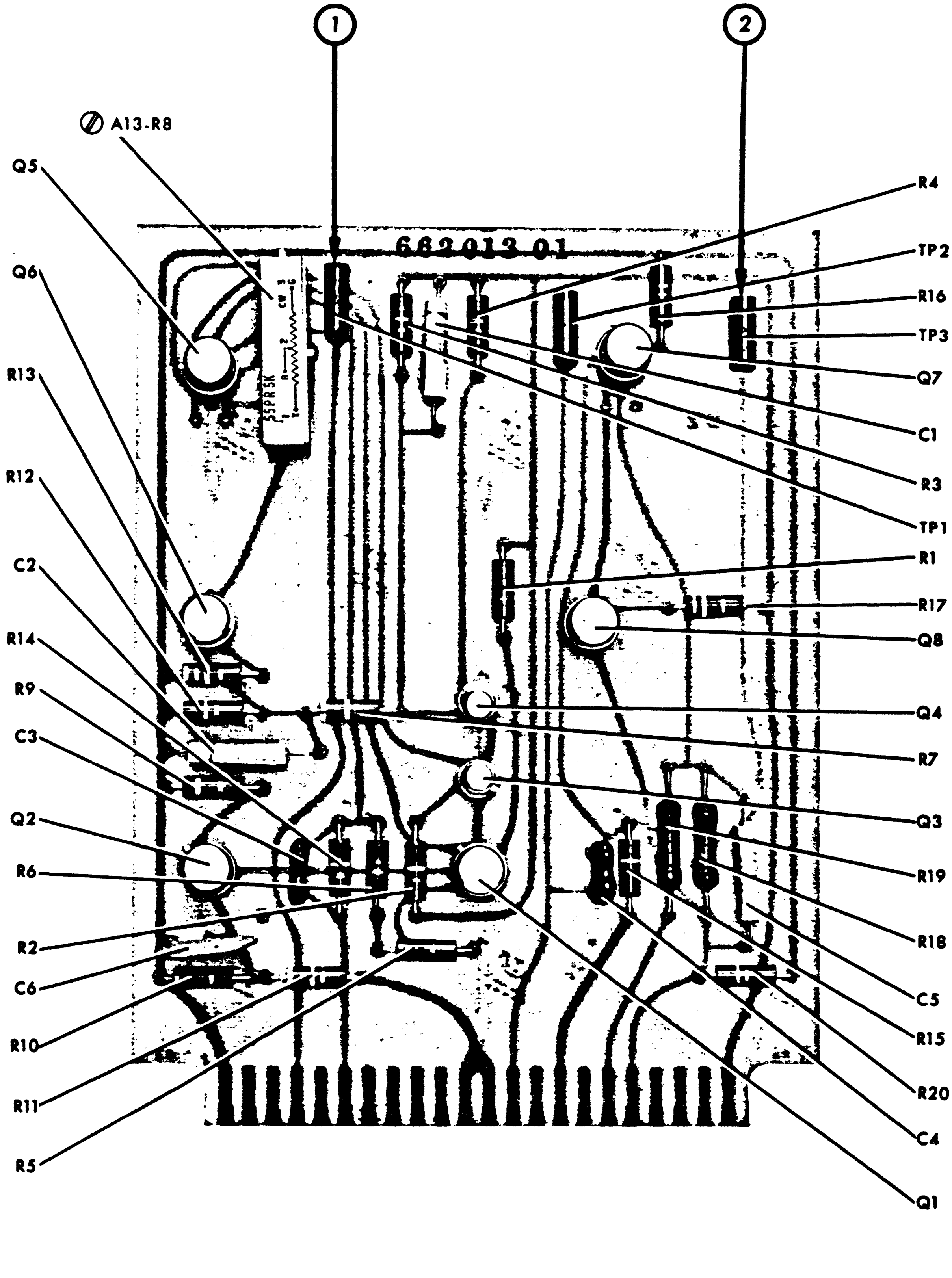
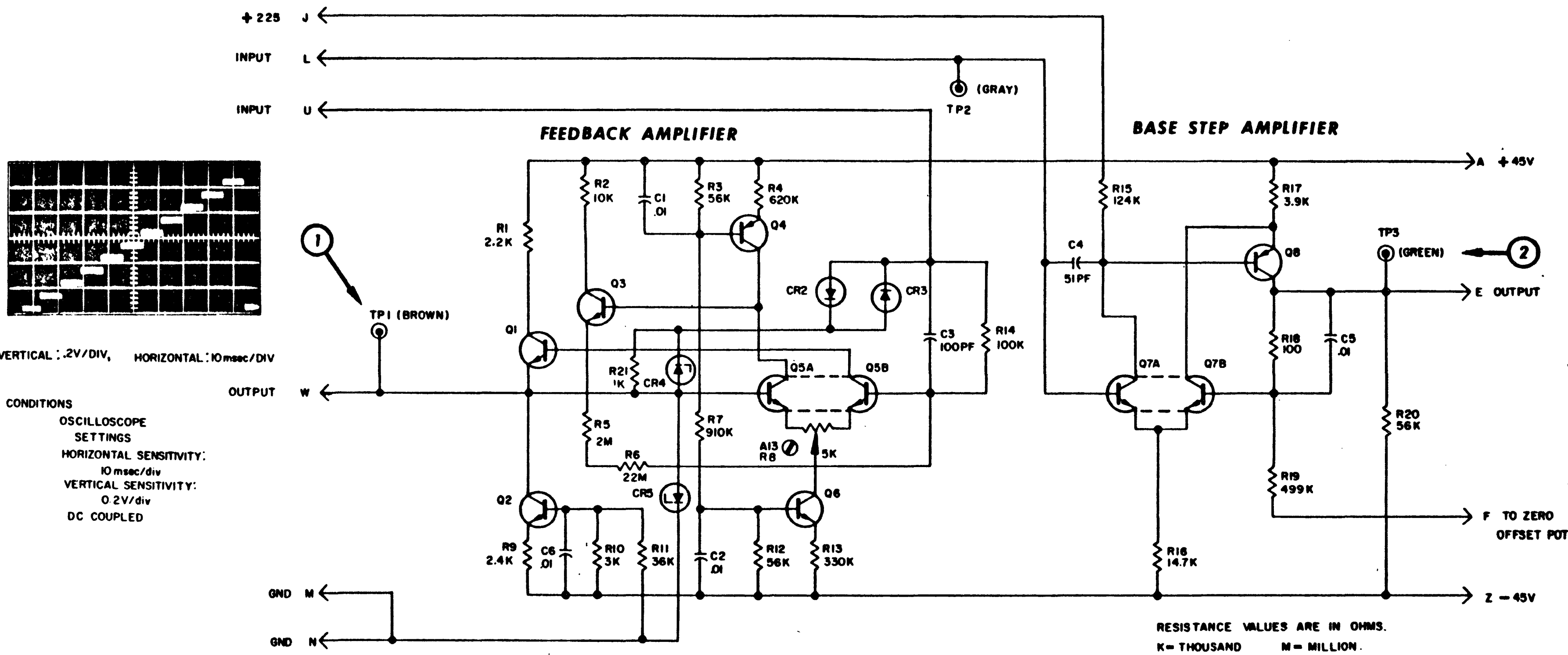


Figure 5-27. Parts Location, Assembly A13

S-37 A1



VERTICAL: .2V/DIV, HORIZONTAL: 10msec/DIV

TEST CONDITIONS

CURVE TRACER SETTINGS
RANGE: .01V
MULTIPLIER: 10
FIRST STEP: 0
LAST STEP: 10

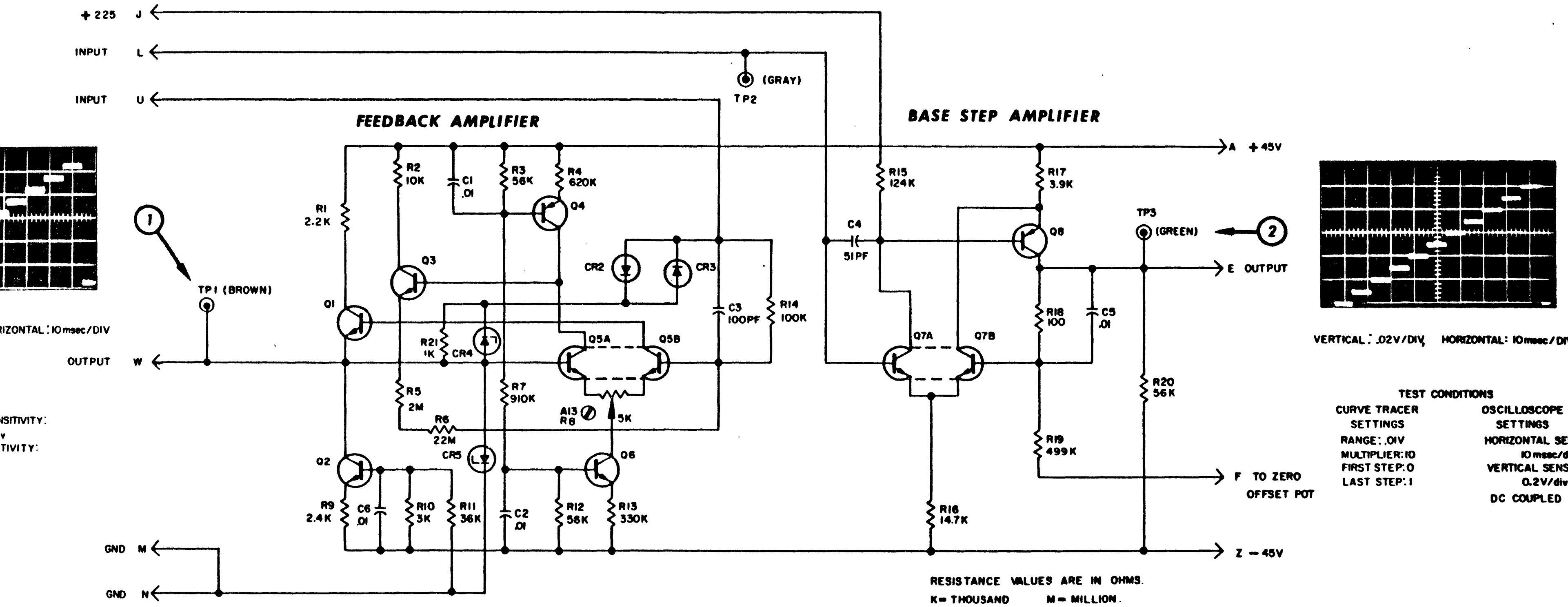
OSCILLOSCOPE SETTINGS
HORIZONTAL SENSITIVITY: 10 msec/div
VERTICAL SENSITIVITY: 0.2V/div
DC COUPLED

RESISTANCE VALUES ARE IN OHMS.
K= THOUSAND M= MILLION.

CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Figure 5-

5-37 A2



TEST CONDITIONS

CURVE TRACER SETTINGS
RANGE: .01V
MULTIPLIER: 10
FIRST STEP: 0
LAST STEP: 1

OSCILLOSCOPE SETTINGS
HORIZONTAL SENSITIVITY: 10 msec/div
VERTICAL SENSITIVITY: 0.2V/div
DC COUPLED

RESISTANCE VALUES ARE IN OHMS.
K= THOUSAND M= MILLION.

CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Figure 5-28. Schematic, Feedback Amplifier and Zero Step Assembly A13

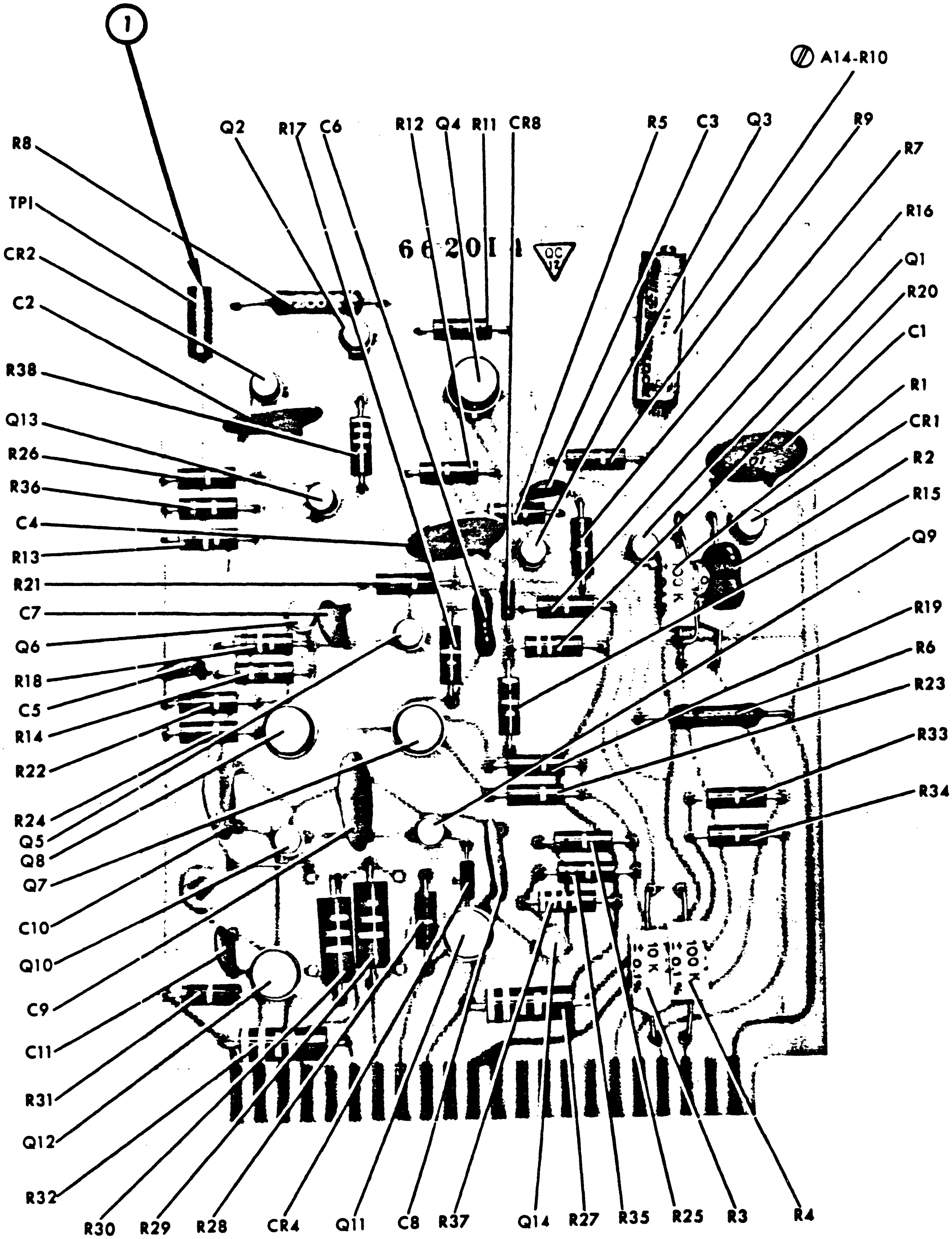
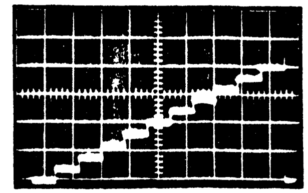


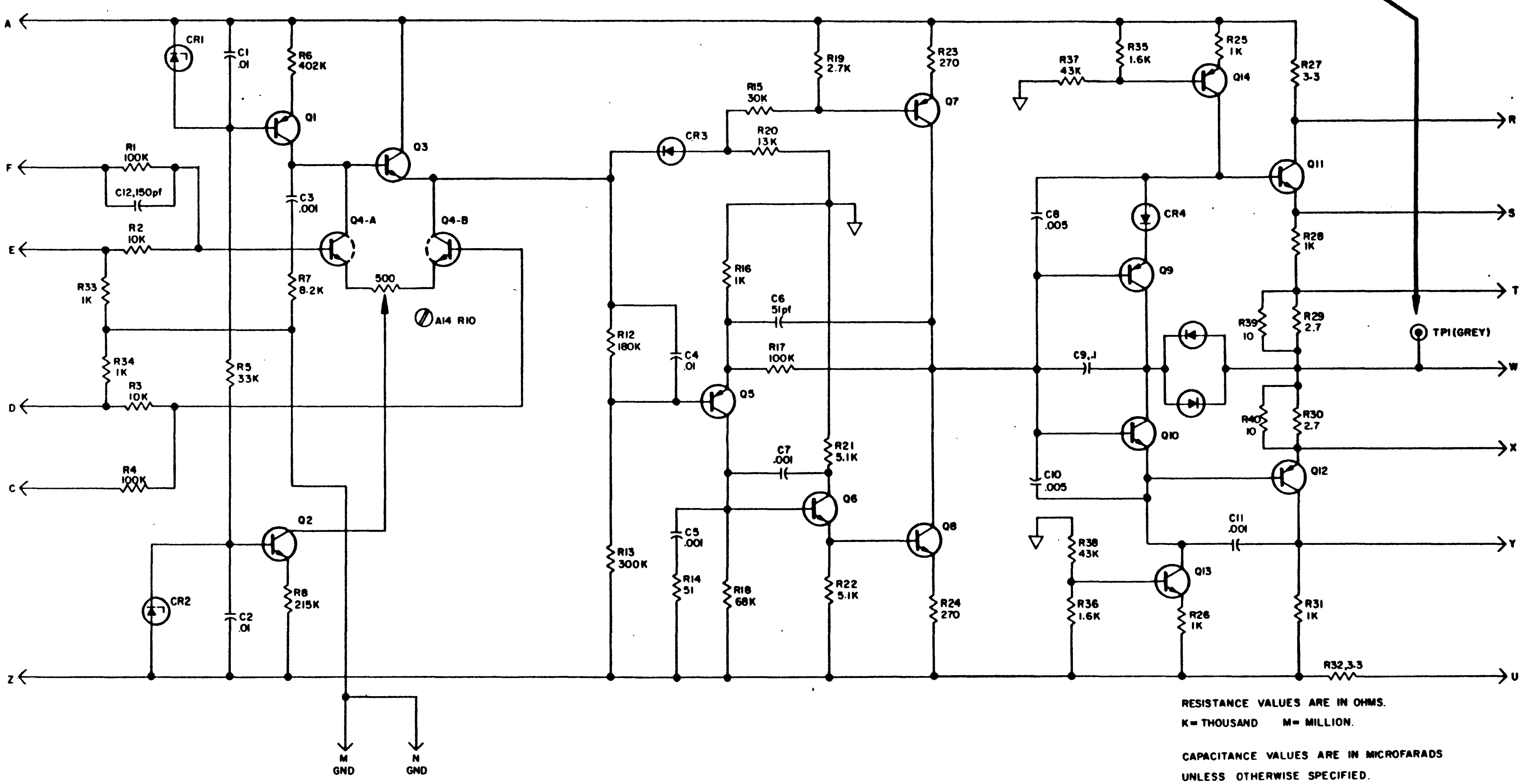
Figure 5-29. Parts Location, Assembly A14

TEST CONDITIONS

CURVE TRACER SETTINGS	OSCILLOSCOPE SETTINGS
RANGE: .01V	HORIZONTAL SENSITIVITY: 10 msec/div
MULTIPLIER: 10	VERTICAL SENSITIVITY: 0.5 V/div
FIRST STEP: 0	DC COUPLED
LAST STEP: 10	



VERTICAL: 0.5V/div HORIZONTAL: 10 msec./div



RESISTANCE VALUES ARE IN OHMS.
K= THOUSAND M= MILLION.

CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Figure 5-30. Schematic and Typical Waveform, Base Step Amplifier Assembly A14

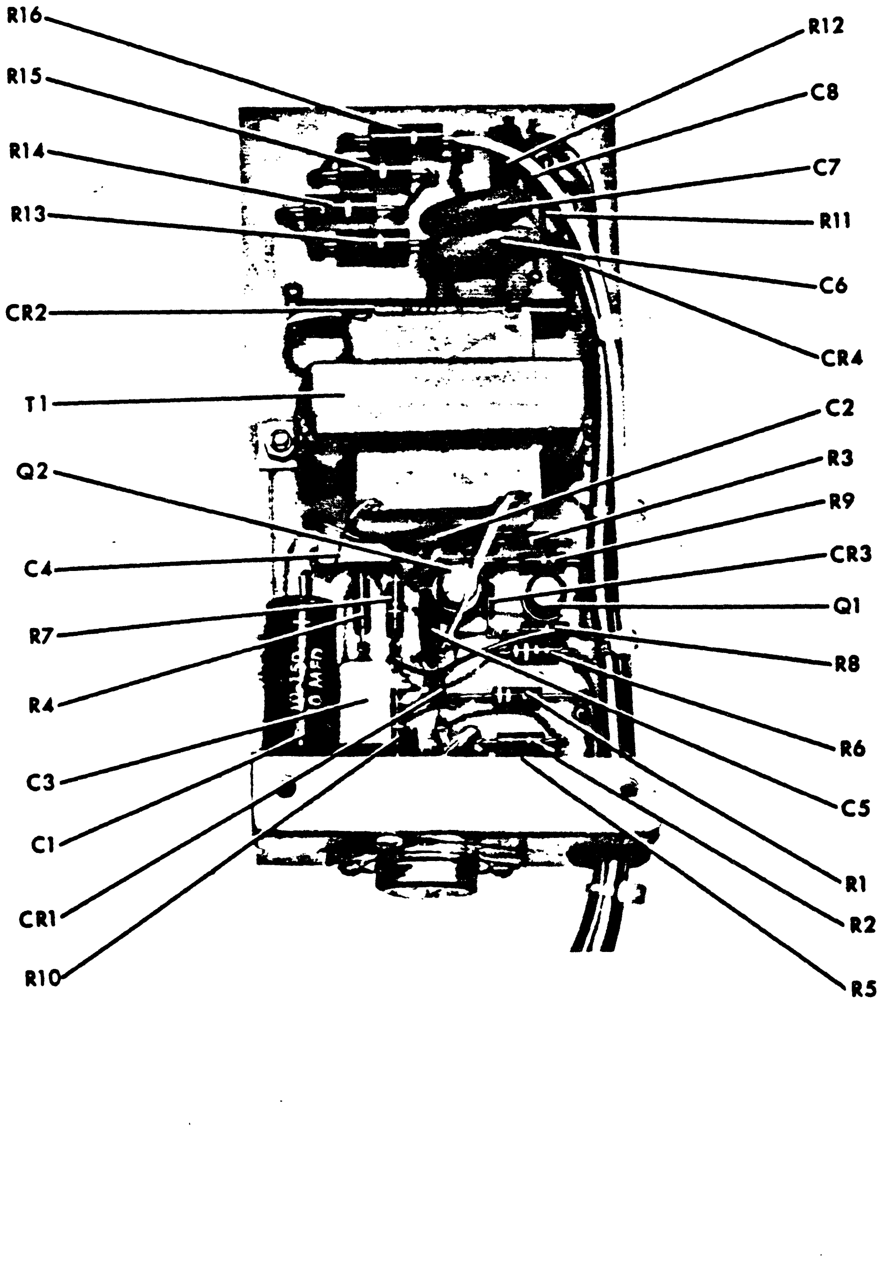
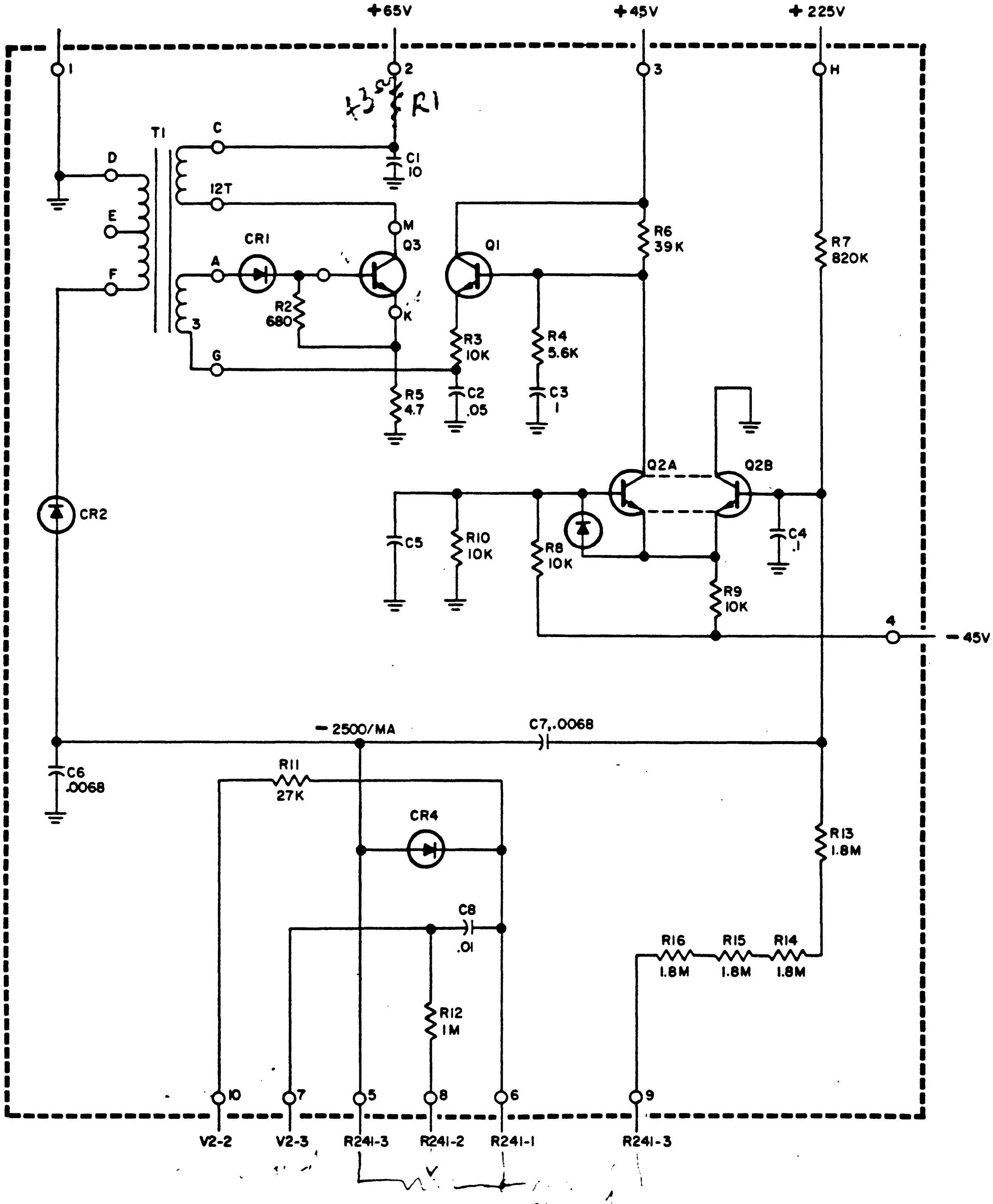


Figure 5-31. Parts Location, Assembly A15



CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

RESISTANCE VALUES ARE IN OHMS. K= THOUSAND M= MILLION

Figure 5-32. High Voltage Power Supply Assembly A15

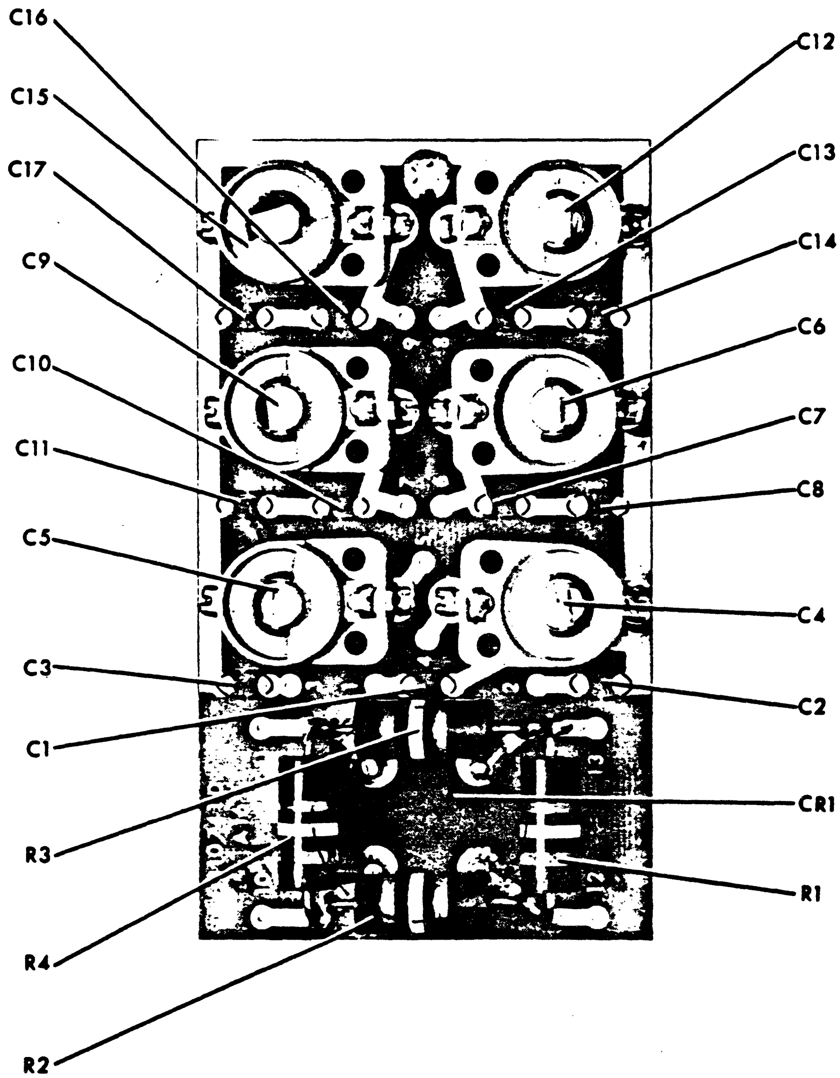


Figure 5-33. Parts Location, Assembly A16

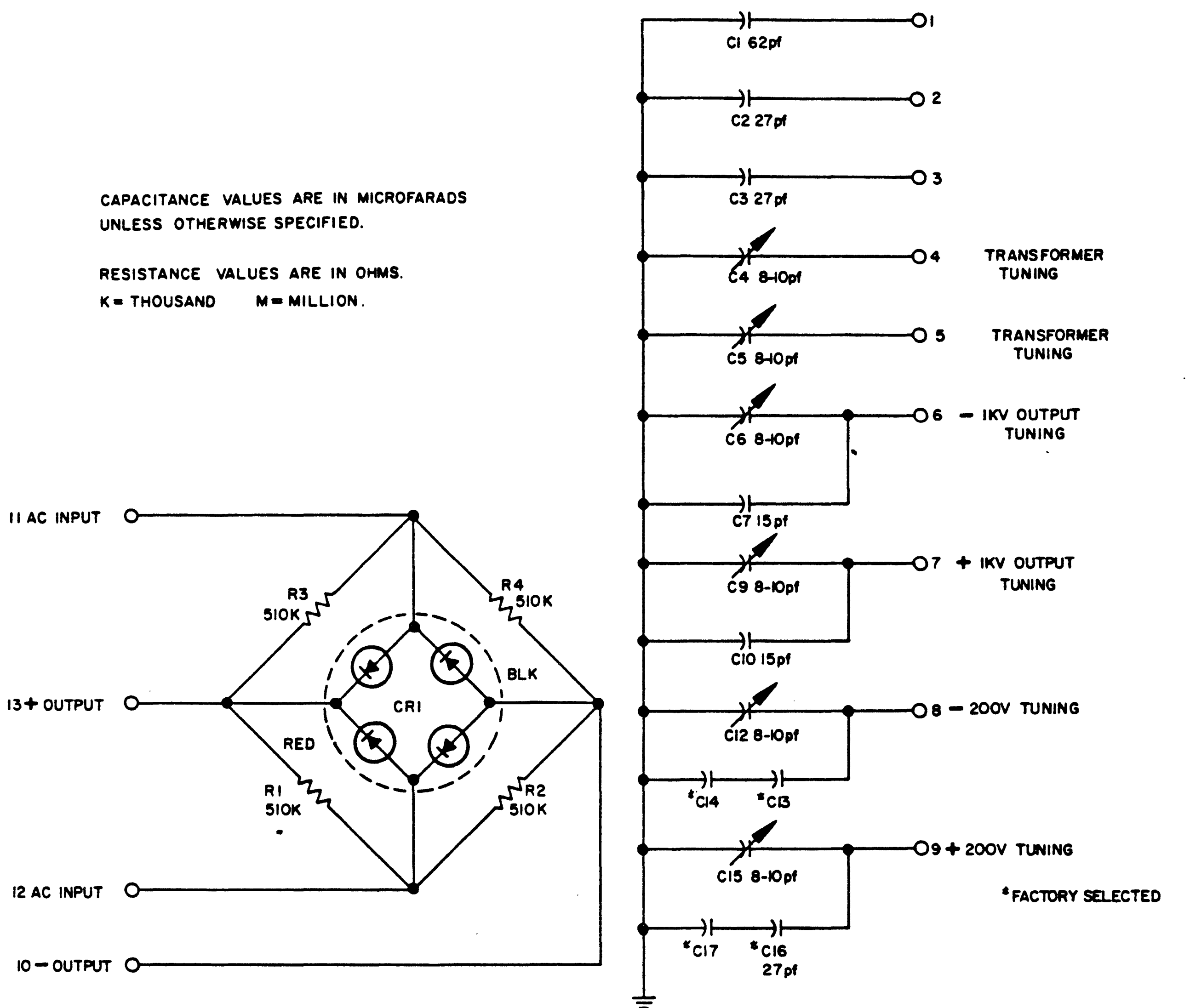


Figure 5-34. Schematic, Collector Phase Capacitor Assembly A16

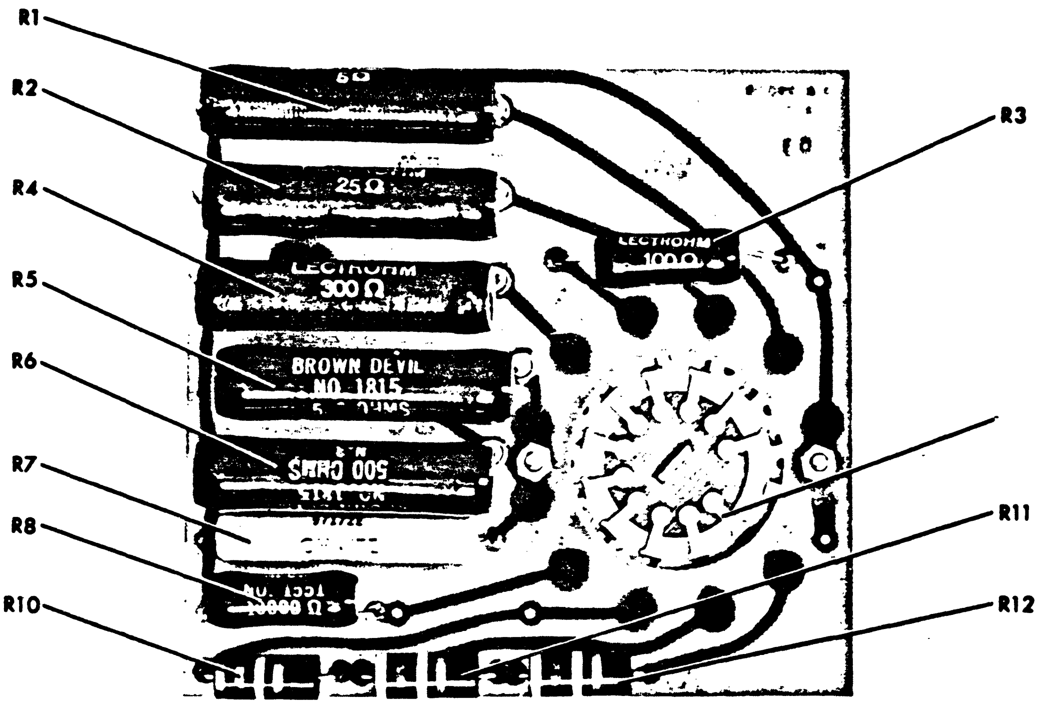


Figure 5-35. Parts Location, Assembly A17

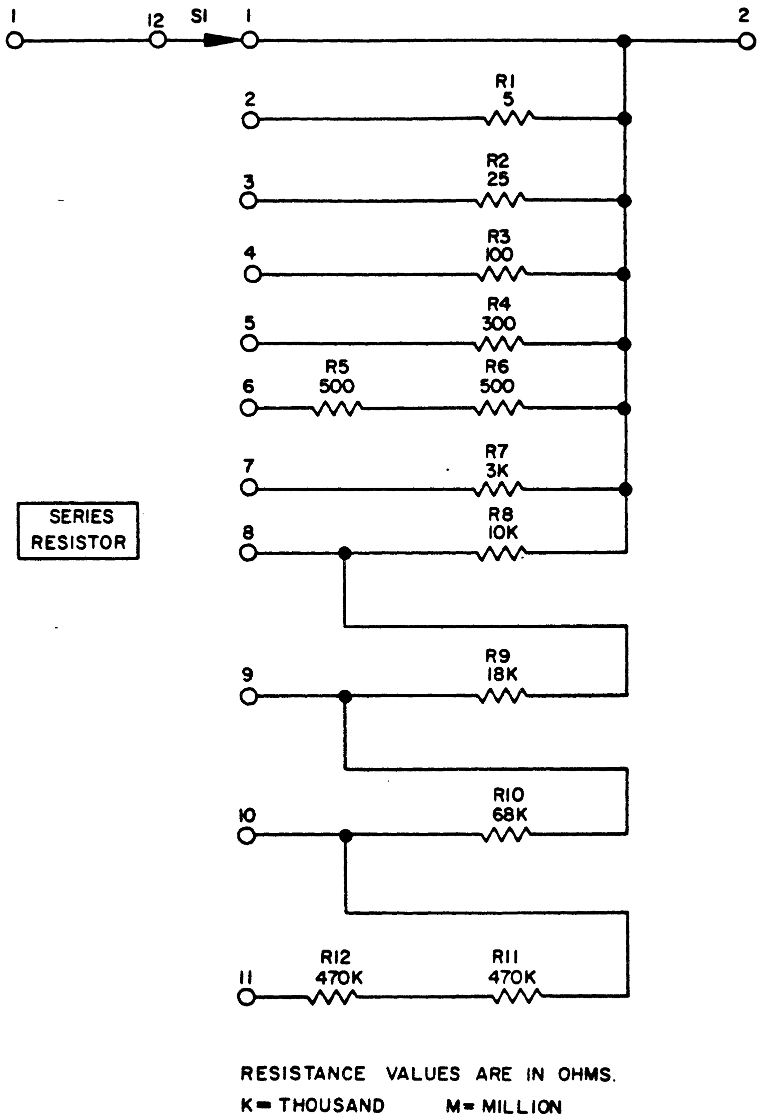


Figure 5-36. Schematic, Collector Resistor Switch Assembly A17

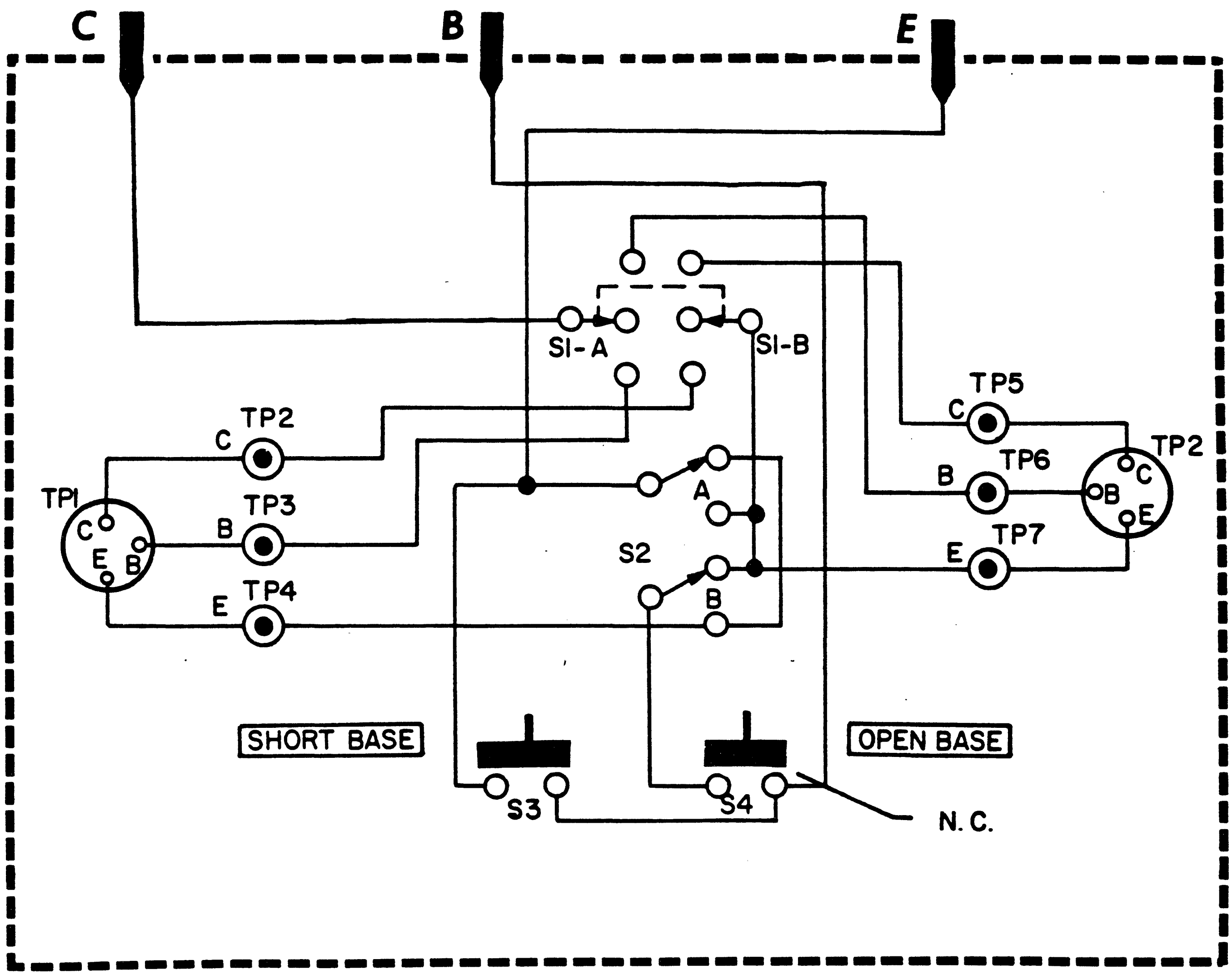


Figure 5-37. Schematic, Test Socket Adapter

Section VI
Replacement Parts

6-1. GENERAL

6-2. Tables 6-1 through 6-17 contain information for ordering replacement parts and list: circuit reference, description, manufacturer, and Fairchild Instrumentation part number. Physical location of electrical components and mechanical items are called out in section V and are cross-referenced with the parts list through the circuit reference numbers.

6-3. ORDERING INFORMATION

6-4. To order a replacement part, address the order to an authorized Fairchild Instrumentation sales representative, or to: 475 Ellis Street, Mountain View, California.

6-5. Specify the following for each part:

a. Model and serial number of instrument.

b. Fairchild Instrumentation part number.

c. Circuit reference designation, assembly number, or complete description.

6-6. To order a part not listed in tables 6-1 through 6-17, provide a complete description of the part, including function and location.

ABBREVIATIONS

AB	Allen-Bradley Co.
Aerovox	Aerovox Corp., HI-Q Div.
Amperex	Amperex Electronic Corp.
Amphenol	Amphenol-Borg Electronics
Arco	Arco Electronics, Inc.
Bourns	Bourns, Inc., Trimpot Div.
Continental	Continental-Wirt Electronics Corp.
CRL	Centralab Div. of Globe-Union Inc.
Elmenco	The Electro Motive Mfg. Co.
Fansteel	Fansteel Metallurgical Corp.
F. I.	Fairchild Instrumentation
F. S.	Fairchild Semiconductor
Goodall	Good All Mfg. Co.
Hamlin	Hamlin, Inc.
Helipot	Helipot Div. of Beckman Inst.
Hopkins	Hopkins Engineering Co.
IRC	International Resistance Co.
Kelvin	Kelvin
Littelfuse	Littelfuse, Inc.
Mallory	Mallory Capacitor Co.
Marco	Marco-Oak Industries
Metohm	
Motorola	Motorola Semiconductor Products
RBM	RBM Controls Div., Essex Wire Corp.
Rich	Rich Industries
Rotron	Rotron Mfg. Co.
Sprague	Sprague Electric Co.
TEC	Transistor Electronics Corp.
TRW	TRW Capacitor Div.
Tower	Tower Mfg. Corp.
Vishay	Vishay Inst. Inc.
Welwyn	Welwyn International

Table 6-1. Model 6200B Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
A1	Assembly, ±45 V P.S., (ref. table 6-2)	FI	6620-01
	Connector, P.C., 22 pin	Elco	6123-69
A2	Assembly, 225 V, P.S., (ref. table 6-3)	FI	6620-02
	Connector, P.C., 22 pin	Elco	6123-69
A3	Assembly, Collector Current Relay (ref. table 6-4)	FI	6620-03
	Connector, P.C., 22 pin	Elco	6123-69
A4	Assembly, Collector Current Relay (ref. table 6-5)	FI	6620-04
	Connector, P.C., 22 pin		
A5	Assembly, Vertical Amplifier (ref. table 6-6)	FI	6620-05
	Connector, P.C., 22 pin	Elco	6123-69
A6	Assembly, Collector Voltage Relay (ref. table 6-7)	FI	6620-06
	Connector, P.C., 22 pin	Elco	6123-69
A7	Assembly, Horizontal Amplifier (ref. table 6-8)	FI	6620-07
	Connector, P.C., 22 pin	Elco	6123-69
A8	Not assigned		
A9	Not assigned		
A10	Not assigned		
A11	Assembly, Base Step Counter (ref. table 6-9)	FI	6620-11
	Connector, P.C., 22 pin	Elco	6123-69
A12	Assembly, Pulse Base and Last Step Reset (ref. table 6-10)	FI	6620-12
	Connector, P.C., 22 pin	Elco	6123-69
A13	Assembly, Feedback Amplifier and Zero Step (ref. table 6-11)	FI	6620-13
	Connector, P.C., 22 pin	Elco	6123-69
A14	Assembly, Base Step Amplifier (ref. table 6-12)	FI	6620-14
	Connector, P.C., 22 pin	Elco	6123-69
A15	Assembly, High Voltage P.S. (ref. table 6-13)	FI	6620-15
	Connector, P.C., 22 pin	Elco	6123-69
A16	Assembly, Collector Phase Capacitor (ref. table 6-14)	FI	6620-16
	Connector, P.C., 22 pin	Elco	6123-69
A17	Assembly, Collector Resistor Switch (ref. table 6-15)	FI	6620-17
	Connector, P.C., 22 pin	Elco	6123-69
C1	Capacitor, 56 μF, 75 V		5303-56
C2	Same as C1		

Table 6-1. Model 6200B Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
C3	Capacitor, 1500 μF, 75 V	Mallory	5303-48
C4	Not assigned		
C5	Not assigned		
C6	Not assigned		
C7	Not assigned		
C8	Not assigned		
C9	Not assigned		
C10	Same as C3		
C11	Not assigned		
C12	Capacitor, 1 μF, 200 V		
C13	Not assigned		
C14A	Capacitor, 12 μF, 350 V		5303-96
C14B	Same as C14A		
CB1	Circuit Breaker	Klixon	5705-93
CR1	Diode		
CR2	Diode, 1N4003		
CR3	Same as CR2		
CR4	Diode, 1N2992		5161-33
CR5	Same as CR4		
DS1	Lamp (Scale light intensity)		
DS2	Same as DS1		
F1	Fuse, 2 A	Littelfuse	5700-39
J2	Connector, ac	Tower	6124-47
Q1	Not assigned		
Q2	Transistor, S19949	Delco	5155-11
Q3	Not assigned		
Q4	Same as Q2		
Q5	Not assigned		
Q6	Not assigned		
Q7	Not assigned		

Table 6-1. Model 6200B Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
Q8	Not assigned		
Q9	Not assigned		
Q10	Not assigned		
Q11	Not assigned		
Q12	Not assigned		
Q13	Not assigned		
Q14	Not assigned		
Q15	Not assigned		
Q16	Not assigned		
Q17	Not assigned		
Q18	Not assigned		
Q19	Not assigned		
Q20	Not assigned		
Q21	Not assigned		
Q22	Not assigned		
Q23	Not assigned		
Q24	Not assigned		
Q25	Not assigned		
Q26	Not assigned		
Q27	Not assigned		
Q28	Not assigned		
Q29	Not assigned		
Q30	Same as Q2		
Q31	Same as Q2		
R1	Not assigned		
R2	Not assigned		
R3	Not assigned		
R4	Not assigned		
R5	Not assigned		
R6	Not assigned		
R7	Not assigned		
R8	Not assigned		
R9	Not assigned		

Table 6-1. Model 6200B Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R10	Not assigned		
R11	Not assigned		
R12	Not assigned		
R13	Not assigned		
R14	Resistor, variable, 1 M (Astigmatism Control)		
R15	Not assigned		
R16	Not assigned		
R17	Not assigned		
R18	Not assigned		
R19	Not assigned		
R20	Not assigned		
R21	Resistor, fixed, 1 k ±5%, 1/2 W		
R100	Resistor, variable, 1 k, 10 turn		5292-07
R101	Resistor, fixed, 100 Ω, 1/4 W		
R102	Same as R101		
R103	Same as R101		
R104	Same as R101		
R105	Same as R101		
R106	Same as R101		
R107	Same as R101		
R108	Same as R101		
R109	Same as R101		
R110	Same as R101		
R111	Same as R101		
R112	Resistor, fixed, 14.7 k ±1%, 1/2 W		
R113	Resistor, fixed, 1 k ±5%, 2 W		
R114	Same as R113		
R115	Resistor, fixed, 560 k		
R116	Same as R113		
R117	Resistor, fixed, 100 Ω ±1%, 1/2 W		

Table 6-1. Model 6200B Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R118	Same as R113		
R159	Resistor, fixed, 5 Ω ±1%, 10 W	Dale	5219-66
R160	Resistor, fixed, 2.5 Ω ±1%, 25 W	Dale	5219-67
R161	Same as R160		
R162	Resistor, fixed, 1 Ω ±1%, 25 W	Dale	5219-61
R163	Resistor, fixed, 39 Ω ±5%, 1/2 W		
R164	Resistor, fixed, 82 Ω ±5%, 5 W		
R165	Not assigned		
R166	Not assigned		
R167	Not assigned		
R168	Not assigned		
R169	Not assigned		
R170	Not assigned		
R171	Not assigned		
R172	Not assigned		
R173	Not assigned		
R174	Not assigned		
R175	Not assigned		
R176	Not assigned		
R177	Not assigned		
R178	Not assigned		
R179	Not assigned		
R180	Not assigned		
R181	Not assigned		
R182	Not assigned		
R183	Not assigned		
R184	Not assigned		
R185	Not assigned		
R186	Not assigned		

Table 6-1. Model 6200B Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R187	Not assigned		
R188	Not assigned		
R189	Not assigned		
R190	Not assigned		
R191	Resistor, variable, 50 k 25 turn (ZERO STEP adjust)	Bourns	5291-79
R230	Resistor, variable, 25 k (Vertical POSITION control)		
R231	Same as R230		
R232	Resistor, variable, 25 k (Horizontal POSITION control)		
R233	Same as R232		
R234	Not assigned		
R235	Not assigned		
R236	Not assigned		
R237	Not assigned		
R238	Resistor, variable, 5 Ω (SCALE LIGHT control)	Ohmite	5290-03
R239	Not assigned		
R240	Not assigned		
R241	Resistor, variable, 1 M, 2 W	AB	5291-82
R242	Same as R241 (FOCUS control)		
RY1	Relay, KHP17011	P and B	5603-95
S1	Switch (POWER ON/OFF)	Ohmite	5604-78
S2	Switch (LAST SWEEP STEP NO.)		
S3	Same as S2 (FIRST SWEEP STEP NO.)		
S4	Switch, Toggle (PULSED BASE/NORMAL)	Control Switch	5603-04
S5	Switch, 2 position rotary (POLARITY)		
S6	Switch (RANGE)		
S7	Switch (VERTICAL SENSITIVITY)		
S8	Switch (HORIZ. SENSITIVITY)		

Table 6-1. Model 6200B Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
S9	Switch, Assembly (FULL RANGE VOLTAGE)	FI	6620-24
S10	Switch (SERIES RESISTOR)		
S11	Switch, pushbutton (HORIZ. SENSITIVITY, ZERO)		
S12	Same as S11 (VERTICAL SENSITIVITY, ZERO)		
S13	Switch, toggle (VERTICAL SENSITIVITY, INVERT/NORMAL)		
S14	Switch, toggle (HORIZ. SENSITIVITY, NORMAL/INVERT)		
T1	Transformer	Tranex	5401-15
T2	Transformer, variable	Standard Elec.	5401-16
T3	Transformer	Tranex	5401-14
TP1	Post, Emitter binding (Blk)	H. H. Smith	6130-44
TP2	Same as TP1, Base binding post		
TP3	Same as TP1, Collector binding post		
	MICELLANEOUS		
	Bail, tilt		6500-69
	Bezel	Dumont	6511-22
	Bezel, gasket (blk)		6202-32
	Bezel, nuts	Dumont	3429-37
	Bezel, stud	Dumont	6202-
	Bushing, panel 1/4		6207-04
	CRT, tube (5AOPIA)	Dumont	5100-04
	CRT, felt strip	Dumont	6202-55
	CRT, graticule		6510-06
	CRT, neck clamp	Dumont	6202-43
	CRT, shield	Dumont	6202-42
	CRT, socket	Dumont	6140-25
	Cover, bottom	FI	6507-56
	Cover, top	FI	6507-57
	Cover, H. V. Power Supply	FI	6507-43
	Dial, counter (MULTIPLIER control)	Beckman	5291-80
	Foot		6500-41
	Foot, insert	A. I. R.	6202-59
	Handle, side	Phil. Handle	6206-52

Table 6-1. Model 6200B Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
	Knob, 1/4" shaft (used with POWER/SCALE LIGHT, FOCUS, and INTENSITY controls).	Natl. Radio	6205-04
	Knob, 1/4" shaft, skirt (used with SERIES RESISTOR, FULL RANGE VOLTAGE, FIRST and LAST SWEEP STEP NO. COLLECTOR SWEEP VOLTAGE, RANGE, and POLARITY controls).	Natl. Radio	6204-65
	Knob, concentric 1/8" shaft (used with VERTICAL and HORIZ. SENSITIVITY).	Natl. Radio	6205-01
	Knob, concentric 1/4" skirt (used with VERTICAL and HORIZ. SENSITIVITY).	Natl. Radio	6205-03
	Rack Mount Conversion Kit	FI	6950-26
	Siderail Adapter	FI	6511-22

Table 6-2. ± 45 Volt Power Supply Al Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, 10 μF,50 V	CD	5300-24
C2	Same as C1		
C3	Capacitor, fixed, .001 μF, 600 V	CRL	5301-15
C4	Capacitor, fixed, .005 μF, 1 kV	CRL	5301-19
C5	Same as C3		
C6	Capacitor, fixed, 1 μF, 35 V	CD	5303-02
C7	Same as C1		
C8	Same as C3		
C9	Same as C4		
C10	Same as C1		
C11	Same as C3		
C12	Same as C6		
CR1	Diode, 1N4003	Motorola	5152-71
CR2	Same as CR1		
CR3	Diode, FD100	FS	5151-37
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR3		
CR7	Transistor, 2N3073	FS	5154-16
CR8	Same as CR7		
CR9	Transistor, S1201	FS	5154-09
CR10	Same as CR9		
Q1	Not assigned		
Q2	Transistor, S1201	FS	5154-09
Q3	Transistor, 2N3114	FS	5152-75
Q4	Transistor, 2N3072	FS	5152-84
Q5	Same as Q4		
Q6	Transistor, 2N3638		5154-82
Q7	Not assigned		
Q8	Same as Q6		
Q9	Not assigned		
Q10	Same as Q6		

Table 6-2. ± 45 Volt Power Supply A1 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
Q11	Same as Q4		
Q12	Same as Q3		
Q13	Same as Q3		
Q14	Same as Q2		
Q15	Same as Q2		
R1	Resistor, fixed, 51 k ±5%, 1/2 W	AB	5215-94
R2	Resistor, fixed, 56 Ω ±5%, 1/2 W		
R3	Resistor, fixed, 10 k ±5%, 1/2 W	AB	5215-76
R4	Resistor, fixed, 100 Ω ±5%, 1/2 W	AB	5215-26
R5	Resistor, fixed, 12 Ω ±5%, 10 W	Ohmite	5250-05
R6	Resistor, fixed, 1 k ±5%, 1/2 W	AB	5215-51
R7	Resistor, fixed, 15 k ±5%, 1/2 W	AB	5215-73
R8	Same as R7		
R9	Same as R1		
R10	Resistor, fixed, 470 Ω ±5%, 1/2 W	AB	5215-43
R11	Resistor, fixed, 390 Ω ±5%, 1/2 W	AB	5215-41
R12	Same as R8		
R13	Same as R3		
R14	Resistor, fixed, 5 Ω ±2%, 5 W	Sprague	5250-94
R15	Resistor, fixed, 4.3 k ±5%, 1/2 W	AB	5215-67
R16	Resistor, fixed, 40.2 k ±1% 1/2 W	IRC	5209-15
R17	Resistor, fixed, 5.49 k ±1%, 1/2 W	Metohm	5209-84
R18	Resistor, variable, 2 k, 5 W	Bourns	5290-62
R19	Same as R5		
R20	Same as R2		
R21	Same as R3		
R22	Same as R1		
R23	Same as R4		
R24	Same as R6		
R25	Same as R7		
R26	Same as R11		
R27	Same as R8		
R28	Same as R1		

Table 6-2. ± 45 Volt Power Supply A1 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R29	Same as R8		
R30	Same as R3		
R31	Same as R14		
R32	Same as R11		
R33	Same as R15		
R34	Same as R16		
R35	Same as R17		
R36	Same as R18		

Table 6-3. + 225 Volts Power Supply A2 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, 10 μF, 50 V	CD	5300-24
C2	Capacitor, fixed, 0.01 μF, 600 V	CD	5301-20
C3	Capacitor, fixed, 0.002 μF, 1 kV	CD	5301-16
C4	Capacitor, fixed, .1 μF, 75 V	CRL	5303-91
C5	Capacitor, fixed, 2 μF, 250 V	Siemens	5303-90
C6	Capacitor, fixed, 0.04 μF, 600 V	CD	5301-23
CR1	Rectifier, MDA-942-5	Motorola	5152-49
CR2	Transistor, 2N3073	FS	5154-16
CR3 - CR10	Diode, FD100	FS	5151-37
Q1	Transistor, 2N3114	FS	5152-75
Q2	Same as Q1		
Q3	Transistor, S1201	FS	5154-09
Q4	Transistor, SE7020		5154-90
R1	Resistor, fixed, 1.2 k, 10 W	Ohmite	5250-60
R2	Resistor, fixed, 1 k ±5%, 1/2 W	AB	5215-51
R3	Resistor, fixed, 180 k ±5%, 1/2 W	AB	5216-09
R4	Resistor, fixed, 100 k ±5%, 1/2 W	AB	5216-02
R5	Resistor, fixed, 15 k ±5%, 1/2 W	AB	5215-81
R6	Resistor, fixed, 75 k ±5%, 1/2 W	AB	5215-98
R7	Resistor, fixed, 180 Ω ±5%, 2 W	AB	5240-18
R8	Resistor, fixed, 6.8 k ±5%, 1/2 W	AB	5215-72
R9	Resistor, fixed, 200 k ±1%, 1/2 W	IRC	5209-27
R10	Resistor, fixed, 4.99 k ±1%, 1/2 W	Dale	5210-78
R11	Resistor, variable, 1 k, 1/2 W	Bourns	5290-57

Table 6-4. Collector Current Relay A3 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
CR1	Diode, FD100	FS	5151-37
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
CR8	Same as CR1		
CR9	Same as CR1		
CR10	Same as CR1		
CR11	Same as CR1		
CR12	Same as CR1		
CR13	Same as CR1		
CR14	Same as CR1		
CR15	Same as CR1		
CR16	Same as CR1		
CR17	Same as CR1		
CR18	Same as CR1		
CR19	Same as CR1		
K1 through K7	Relay, Coil, DBS1	Turbo Jet	5604-91
K1 through K7	Reed, relay	CP Clare	5602-24
R1	Resistor, fixed, 10 k ±1%, 2 W	Dale	5219-70
R2	Resistor, fixed, 25.5 k ±1% 1/2 W	IRC	5209-43
R3	Resistor, fixed, 10 k ±1%, 2 W	Dale	5219-70

Table 6-5. Collector Current Relay A4 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
CR1	Diode, FD100	FS	5151-37
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
CR8	Same as CR1		
CR9	Same as CR1		
CR10	Same as CR1		
CR11	Same as CR1		
CR12	Same as CR1		
CR13	Same as CR1		
CR14	Same as CR1		
CR15	Same as CR1		
CR16	Same as CR1		
CR17	Diode, 1N4003	Motorola	5152-71
CR18	Same as CR17		
CR19	Same as CR17		
CR20	Same as CR17		
CR21	Same as CR17		
CR22	Same as CR17		
CR23	Same as CR1		
K1 through K8	Relay, coil, DBS1	Turbo-Jet	5604-91
K1 through K8	Reed, relay - 1 form A 15 Vac	Clare	5602-24
R1	Resistor, fixed, 39 k ±5%, 1/2 W	AB	5215-91
R2	Same as R1		
R3	Resistor, fixed, 25 Ω ±1%, 5 W	Dale	5219-32
R4	Resistor, fixed, 50 Ω ±1%, 2 W	Dale	5219-31

Table 6-5. Collector Current Relay A4 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R5	Resistor, fixed, 100 Ω ±1%, 1 W	Dale	5219-36
R6	Resistor, fixed, 249 Ω ±1%, 1/2 W	IRC	5209-40
R7	Resistor, fixed, 499 Ω ±1%, 1/2 W	TI	5209-51
R8	Resistor, fixed, 1 k ±1%, 1/2 W	IRC	5209-02
R9	Resistor, fixed, 2.49 k ±1%, 1/2 W	IRC	5209-05
R10	Resistor, fixed, 4.99 k ±1%, 1/2 W	IRC	5209-07

Table 6-6. Vertical Amplifier A5 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, 270 pF	Elemco	5300-78
CR1	Diode, FD100	FS	5151-37
CR2	Same as CR1		
CR3	Same as CR1		
K1	Relay, MRMA 1003	Clare	5605-03
K2	Same as K1		
Q1	Transistor, U1283 N FET		5154-14
Q2	Same as Q1		
Q3	Transistor, S17395		5154-10
Q4	Same as Q3		
Q5	Transistor, S1201	FS	5154-09
Q6	Same as Q5		
Q7	Transistor, TCU0300		5154-90
Q8	Same as Q7		
R1	Resistor, fixed, 100 k ±5%, 1/2 W	AB	5216-02
R2	Same as R1		
R3	Resistor, fixed, 20 k ±5%, 1/2 W	AB	5215-84
R4	Resistor, fixed, 30 k ±5%, 1/2 W	AB	5215-88
R5	Resistor, variable, 20 k	Bourns	5291-75
R6	Same as R4		
R7	Same as R3		
R8	Resistor, fixed, 2.49 k ±1%, 1/2 W	IRC	5209-05
R9	Resistor, fixed, 20 k ±1%, 1/2 W	IRC	5209-12
R10	Same as R8		
R11	Resistor, fixed, 2 k ±1%, 1/2 W	IRC	5209-04
R12	Resistor, fixed, 11 k ±5%, 1/2 W	AB	5215-77
R13	Same as R12		
R14	Resistor, fixed, 4.7 k ±5%, 1/2 W	AB	5215-68
R15	Resistor, fixed, 15 k ±5%, 1/2 W	AB	5215-79
R16	Resistor, variable, 2.5 k	Bourns	5290-62
R17	Same as R8		

Table 6-6. Vertical Amplifier A5 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R18	Resistor, fixed, 100 k %1%, 1/2 W	IRC	5209-24
R19	Same as R18		
R20	Resistor, fixed, 16 k ±5%, 1/2 W	AB	5215-82
R21	Same as R20		
R22	Resistor, fixed, 25 k 5 W		5240-96
R23	Same as R22		

Table 6-7. Collector Voltage Attenuator A6 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
CR1	Diode, FD100	FS	5151-37
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
CR8	Same as CR1		
CR9	Same as CR1		
CR10	Same as CR1		
CR11	Same as CR1		
CR12	Same as CR1		
CR13	Same as CR1		
CR14	Same as CR1		
CR15	Same as CR1		
CR16	Same as CR1		
CR17	Same as CR1		
CR18	Same as CR1		
CR19	Same as CR1		
CR20	Same as CR1		
CR21	Same as CR1		
K1	Reed, relay HV		5604-87
K1	Coil, relay dual TBJ192		5604-56
K2	Relay, MR2MA-1005		5605-04
K3	Same as K2		
K4	Same as K2		
K5	Same as K2		
K6	Same as K2		
K7	Same as K2		
K8	Same as K2		
K9	Same as K2		
K10	Same as K2		
K11	Same as K1		

Table6-7. Collector Voltage Attenuator A6 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R1	Resistor, fixed, 499 k ±1%, 1/2 W	IRC	5209-31
R2	Resistor, fixed, 301 k ±1%, 1/2 W	IRC	5209-47
R3	Resistor, fixed, 100 k ±1%, 1/2 W	IRC	5209-24
R4	Resistor, fixed, 49.9 k ±1%, 1/2 W	IRC	5209-18
R5	Resistor, fixed, 30.1 k ±1%, 1/2 W	IRC	5209-14
R6	Resistor, fixed, 10 k ±1%, 1/2 W	IRC	5209-09
R7	Resistor, fixed, 4.99 k ±1%, 1/2 W	IRC	5209-07
R8	Resistor, fixed, 3 k ±1%, 1/2 W		5209-78
R9	Resistor, fixed, 1 k ±1%, 1/2 W	IRC	5209-02
R10	Same as R9		
R11	Same as R2		
R12	Same as R3		
R13	Same as R4		
R14	Same as R5		
R15	Same as R6		
R16	Same as R7		
R17	Same as R8		
R18	Same as R9		
R19	Same as R9		
R20	Same as R1		

Table 6-8. Horizontal Amplifier A7 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, 270 pF, 300 V	Elmenco	5300-78
CR1	Diode, FD100	FS	5151-37
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
K1	Relay, MRMA 1003	Clare	5605-03
K2	Same as K1		
K3	Same as K1		
K4	Same as K1		
K5	Same as K1		
K6	Same as K1		
Q1	Transistor, U1283	Amelco	5154-14
Q2	Same as Q1		
Q3	Transistor, 2N3114		
Q4	Same as Q3		
Q5	Transistor, S1201	FS	5154-09
Q6	Same as Q5		
Q7	Transistor, TCU03301SE7020	FS	5154-90
Q8	Same as Q7		
R1	Resistor, fixed, 100 k ±5%, 1/2 W	AB	5216-02
R2	Same as R1		
R3	Resistor, fixed, 20 k ±5%, 1/2 W	AB	5215-84
R4	Resistor, fixed, 36 k		
R5	Resistor, variable, 10 k ±10%, 1/2 W	Bourns	5290-59
R6	Same as R4		
R7	Same as R3		
R8	Resistor, fixed, 24.9 k ±1%, 1/2 W	IRC	5209-13
R9	Resistor, fixed, 4.02 k ±1%, 1/2 W	IRC	5209-06

Table 6-8. Horizontal Amplifier A7 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R10	Same as R8		
R11	Resistor, fixed, 8.06 ±1%, 1/2 W	IRC	5209-58
R12	Resistor, fixed, 20 k ±1%, 1/2 W	IRC	5209-12
R13	Resistor, fixed, 1.96 k ±1%, 1/2 W	IRC	5209-59
R14	Resistor, variable, 100 Ω ±10%, 1.5 W	Helipot	5291-66
R15	Resistor, fixed, 698 Ω ±1%, 1/2 W	IRC	5209-60
R16	Same as R14		
R17	Resistor, fixed, 301 Ω ±1%, 1/2 W	IRC	5209-61
R18	Resistor, fixed, 18 k ±5%, 1/2 W	AB	5215-83
R19	Resistor, fixed, 7.5 k ±5%, 1/2 W	AB	5215-73
R20	Same as R18		
R21	Resistor, fixed, ±5%, 1/2 W	AB	5215-78
R22	Resistor, fixed, 100 k ±1%, 1/2 W	IRC	5209-24
R23	Resistor, variable, 2 k ±10%, 1/2 W	Bourns	5290-62
R24	Resistor, fixed, 2.49 k ±1%, 1/2 W	IRC	5209-05
R25	Same as R22		
R26	Resistor, fixed, 16 k ±5%, 1/2 W	AB	5215-82
R27	Same as R26		
R28	Resistor, fixed, 25 k ±5%, 5 W	Sprague	5240-96
R29	Same as R28		

Table 6-9. Base Generator Programer Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
CR1	Diode, FD100	FS	5151-37
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
CR8	Same as CR1		
CR9	Same as CR1		
CR10	Same as CR1		
CR11	Same as CR1		
CR12	Same as CR1		
CR13	Same as CR1		
CR14	Same as CR1		
K1	Reed, relay		5602-24
K2	Same as K1		
K3	Same as K1		
K1	Coil, relay		5604-33
K2	Same as K1		
K3	Same as K1		
K4	Relay, MRMA 1003	Clare	5605-03
K5	Same as K4		
K6	Same as K4		
K7	Relay, MR2MA 1005	Clare	5605-04
K8	Same as K7		
R1	Resistor, fixed 10 Ω ±1%, 10 W	Dale	5218-59
R2	Resistor, fixed, 100 Ω ±1%, 3 W	Dale	5218-20
R3	Resistor, fixed, 1 kΩ ±1%, 1/2 W	IRC	5209-02
R4	Resistor, fixed, 10 kΩ ±1%, 1/2 W		5209-09
R5	Resistor, fixed, 110 kΩ ±1%, 1/2 W	IRC	5209-46
R6	Resistor, fixed, 1 MΩ ±1%, 1/2 W		5209-33
R7	To be selected in test.		

Table 6-10. Base Step Counter All Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, 0.005 μF, 1 kV	CD	5301-19
C2	Same as C1		
C3	Capacitor, fixed, 0.001 μF, 600 V	CD	5301-15
C4	Same as C3		
C5	Capacitor, fixed, 100 pF, 300 V	Elmenco	5300-67
C6	Same as C5		
C7	Same as C3		
C8	Same as C3		
C9	Same as C5		
C10	Same as C5		
C11	Same as C3		
C12	Same as C3		
C13	Same as C5		
C14	Same as C5		
C15	Same as C3		
C16	Same as C3		
C17	Same as C5		
C18	Same as C5		
CR1	Diode, FD100	FS	5151-37
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
CR8	Same as CR1		
CR9	Same as CR1		
CR10	Same as CR1		
CR11	Same as CR1		
CR12	Same as CR1		
CR13	Same as CR1		
CR14	Same as CR1		
CR15	Same as CR1		

Table 6-10. Base Step Counter A11 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
CR16	Same as CR1		
CR17	Same as CR1		
CR18	Same as CR1		
Q1	Transistor, FSP-30	FS	
Q2	Same as Q1		
Q3	Same as Q1		
Q4	Same as Q1		
Q5	Same as Q1		
R1	Resistor, fixed, 5.1 k ±5%, 1/4 W	AB	5230-76
R2	Resistor, fixed, 15 k ±5%, 1/4 W	AB	5230-87
R3	Same as R2		
R4	Same as R2		
R5	Resistor, fixed, 10 k ±5%, 1/4 W	AB	5230-83
R6	Same as R5		
R7	Resistor, fixed, 100 k ±5%, 1/4 W	AB	5231-07
R8	Resistor, fixed, 12 k ±5%, 1/4 W	AB	5230-85
R9	Same as R7		
R10	Same as R7		
R11	Resistor, fixed, 91 k ±5%, 1/4 W	AB	5231-06
R12	Same as R11		
R13	Resistor, fixed, 56 k ±5%, 1 W	AB	5225-76
R14	Same as R8		
R15	Same as R7		
R16	Same as R7		
R17	Same as R11		
R18	Same as R11		
R19	Same as R13		
R20	Same as R8		
R21	Same as R7		
R22	Same as R7		
R23	Same as R11		
R24	Same as R11		
R25	Same as R13		

Table 6-10. Base Step Counter All Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R26	Same as R8		
R27	Same as R7		
R28	Same as R7		
R29	Same as R11		
R30	Same as R11		
R31	Same as R13		
R32	Same as R5		
R33	Same as R5		
R34	Resistor, fixed, 402 k ±1%, 1/2 W	IRC	5209-57
R35	Same as R34		
R36	Same as R5		
R37	Same as R5		
R38	Resistor, fixed, 200 k ±1%, 1/2 W	IRC	5209-27
R39	Same as R38		
R40	Same as R5		
R41	Same as R5		
R42	Resistor, fixed, 100 k ±1%, 1/2 W	IRC	5209-24
R43	Same as R42		
R44	Same as R5		
R45	Same as R5		
R46	Resistor, fixed, 49.9 k ±1%, 1/2 W	IRC	5209-18
R47	Same as R46		

Table 6-11. Pulse Base and Last Step Reset A12 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, 0.1 μF ±20% 75 V	CRL	5303-91
C2	Capacitor, fixed, .22 μF ±20%, 50 V	Electro	5302-68
C3	Capacitor, fixed, .005 μF, 1kV, ±20%	CD	5301-19
C4	Capacitor, fixed, .022 μF, 200 V, ±10%	TRW	5302-10
C5	Same as C1		
C6	Capacitor, fixed, .01 μF, 600 V, ±20%	CR	5301-20
C7	Same as C6		
CR1	Diode, FD100	FS	5151-37
CR2	Same as CR1		
CR3	Same as CR1		
Q1	Transistor, 2N3072	FS	5152-84
Q2	Transistor, 2N2060	FS	5151-78
Q3	Same as Q1		
Q4	Same as Q1		
Q5	Transistor, 2N708	FS	5151-36
Q6	Transistor, 2N2297	FS	5151-21
R1	Resistor, fixed, 100 k ±5%, 1/2 W	AB	5216-02
R2	Resistor, fixed, 1 k ±5%, 1/2 W	AB	5215-51
R3	Resistor, fixed, 3.6 k ±5%, 1/2 W	AB	5215-65
R4	Same as R2		
R5	Same as R1		
R6	Resistor, variable, 50 k ±10%, 5 W	Bourns	5290-64
R7	Resistor, fixed, 75 k ±5%, 1/2 W	AB	5215-98
R8	Resistor, fixed, 12 k ±5%, 1/2 W	AB	5215-78
R9	Resistor, fixed, 10 k ±5%, 1/2 W	AB	5215-76
R10	Same as R9		
R11	Resistor, fixed, 4.3 k ±5%, 1/2 W	AB	5215-67
R12	Resistor, fixed, 39 k ±5%, 1/2 W	AB	5215-91
R13	Same as R7		
R14	Same as R1		
R15	Resistor, fixed, 2.4 k ±5%, 1/2 W	AB	5215-61

Table 6-11. Pulse Base and Last Step Reset A12 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R16	Resistor, variable, 1 k, 5 W		
R17	Resistor, fixed, 22 k ±5%, 1/2 W	AB	5215-85
R18	Resistor, fixed, 24 k ±5%, 1/2 W	AB	5215-86
R19	Resistor, fixed, 8.2 k ±5%, 1/2 W	AB	5215-74
R20	Resistor, fixed, 100 Ω ±5%, 1/2 W	AB	5215-26

Table 6-12. Feedback Amplifier and Zero Step A13 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, .01 μF, 300 V, ±10%	TRW	5302-08
C2	Same as C1		
C3	Capacitor, fixed, 100 pF, ±5%, 300 V	Elmenco	5300-67
C4	Capacitor, fixed, 51 pF, ±5%, 300 V	Elmenco	5300-60
C5	Same as C1		
C6	Capacitor, fixed, .01 μF, ±10%, 200 V	TRW	5302-08
CR1	Not assigned		
CR2	Diode, 1N4003		
CR3	Same as CR2		
CR4	Diode, 1N2992		
CR5	Same as CR4		
Q1	Transistor, 2N3114	FS	5152-75
Q2	Same as Q1		
Q3	Same as Q1		
Q4	Transistor, S16986	FS	5154-68
Q5	Transistor, 2N2920	FS	5154-06
Q6	Same as Q1		
Q7	Same as Q5		
Q8	Transistor, S16986		
R1	Resistor, fixed, 2.2 k ±5%, 1/2 W	AB	5215-60
R2	Resistor, fixed, 10 k ±5%, 1/2 W	AB	5215-76
R3	Resistor, fixed, 56 k ±5%, 1/2 W	AB	5215-95
R4	Resistor, fixed, 620 k ±5%, 1/2 W	AB	5216-22
R5	Resistor; factory selected		
R6	Resistor, fixed 15 MΩ ±5%, 1/2 W		
R7	Resistor, fixed, 910 k ±5%, 1/2 W	AB	5216-26
R8	Resistor, variable, 5 k	Helipot	5291-28
R9	Resistor, fixed, 2.4 k ±5%, 1/2 W	AB	5215-61
R10	Resistor, fixed, 3 k ±5%, 1/2 W	AB	5215-63
R11	Resistor, fixed, 36 k ±5%, 1/2 W	AB	5215-90
R12	Same as R3		
R13	Resistor, fixed, 330 k ±5%, 1/2 W	AB	5215-90

Table 6-12. Feedback Amplifier and Zero Step A13 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R14	Resistor, fixed, 100 k ±5%, 1/2 W	AB	5216-02
R15	Resistor, fixed, 124 k ±1%, 1/2 W		
R16	Resistor, fixed, 14.7 k ±5%, 1/2 W		
R17	Resistor, fixed, 3.9 k ±5%, 1/2 W	AB	5215-66
R18	Resistor, fixed, 100 Ω ±1%, 1/2 W	IRC	5209-39
R19	Resistor, fixed, 499 k ±1%, 1/2 W	IRC	5209-31
R20	Same as R3		
R21	Resistor, fixed, 1 k ±5%, 1/2 W	AB	5215-51

Table 6-13. Base Step Amplifier A14 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, .01 μF, 600 V ±20%	CD	5301-20
C2	Same as C1		
C3	Capacitor, fixed, .001 μF, 100 V ±10%	Aerovox	5301-01
C4	Same as C1		
C5	Same as C3		
C6	Capacitor, fixed, 51 pF, 300 V ±5%	Elmenco	5300-60
C7	Same as C3		
C8	Capacitor, fixed, .005 μF		
C9	Capacitor, fixed, .1 μF, 75 V, ±20%	CRL	5303-91
C10	Same as C8		
C11	Same as C3		
C	Capacitor, fixed, 150 pF		
CR1	Transistor, 2N3073	FS	5154-16
CR2	Same as CR1		
CR3	Diode, FD100	FS	5151-37
CR4	Same as CR3		
CR	Same as CR3		
CR	Same as CR3		
Q1	Transistor, S16986	FS	5154-68
Q2	Transistor, 2N2484	FS	5154-44
Q3	Same as Q2		
Q4	Transistor, 2N2920	FS	5154-06
Q5	Same as Q1		
Q6	Same as Q2		
Q7	Transistor, TCX0054		5154-89
Q8	Transistor, 2N3114	FS	5152-75
Q9	Transistor, 2N2696	FS	5152-19
Q10	Transistor, 2N956	FS	5152-27
Q11	Same as Q8		
Q12	Same as Q7		
Q13	Same as Q2		
Q14	Same as Q5		

Table 6-13. Base Step Amplifier A14 Parts List (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R1	Resistor, fixed, 100 k ±.1%, 1/4 W	Rich	5217-33
R2	Resistor, fixed, 10 k ±.1%, 1/4 W	Rich	5217-22
R3	Same as R2		
R4	Same as R1		
R5	Resistor, fixed, 33 k ±5%, 1/2 W	AB	5215-89
R6	Resistor, fixed, 402 k ±1%		
R7	Resistor, fixed, 8.2 k ±5%, 1/2 W	AB	5215-74
R8	Resistor, fixed, 200 k ±1%, 1/2 W	Dale	5211-29
R9	Not assigned		
R10	Resistor, variable, 500 Ω ±10%, 1.5 W	Helipot	5219-54
R11	Not assigned		
R12	Resistor, fixed, 180 k ±5%, 1/2 W	AB	5216-09
R13	Resistor, fixed, 300 k ±5%, 1/2 W	AB	5216-14
R14	Resistor, fixed, 51 Ω ±5%, 1/2 W	AB	5215-19
R15	Resistor, fixed, 30 k ±5%, 1/2 W	AB	5215-88
R16	Resistor, fixed, 1 k ±5%, 1/2 W	AB	5215-51
R17	Resistor, fixed, 100 k ±5%, 1/2 W	AB	5216-02
R18	Resistor, fixed, 68 k ±5%, 1/2 W	AB	5215-97
R19	Resistor, fixed, 2.7 k ±5%, 1/2 W	AB	5215-62
R20	Resistor, fixed, 13 k ±5%, 1/2 W	AB	5215-79
R21	Resistor, fixed, 5.1 k ±5%, 1/2 W	AB	5215-69
R22	Same as R21		
R23	Resistor, fixed, 270 Ω ±5%, 1/2 W	AB	5215-37
R24	Same as R23		
R25	Same as R16		
R26	Same as R16		
R27	Resistor, fixed, 3.3 Ω ±5%, 1 W	AB	5225-03
R28	Same as R16		
R29	Resistor, fixed, 2.7 Ω ±5%, 1 W	AB	5225-01
R30	Same as R29		
R31	Same as R16		
R32	Same as R27		
R33	Same as R16		

Table 6-13. Base Step Amplifier A14 Parts List Co (Cont)

Circuit Reference	Description	Manufacturer	FI Part Number
R34	Same as R16		
R35	Resistor, fixed, 1.6 k ±5%, 1/2 W	AB	5215-57
R36	Same as R35		
R37	Resistor, fixed, 43 k ±5%, 1/2 W	AB	5215-92
R38	Same as R37		
R39	Resistor, fixed, 10 Ω, ±5%, 1/2 W		
R40	Same as R39		
RX	Resistor, factory selected		
RY	Resistor, factory selected		

Table 6-14. High Voltage Power Supply A15 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, fixed, 10 μF, 150 V	CD	5300-03
C2	Capacitor, fixed, .1 μF	Hopkins	5302-70
C3	Capacitor, fixed, .05 μF	Sprague	5301-24
C4	Capacitor, fixed, .1 μF	Hopkins	5302-67
C5	Capacitor, fixed, .02 μF	CRL	5301-22
C6	Capacitor, fixed, .0068, 3 kV	Sprague	5302-80
C7	Same as C6		
C8	Capacitor, fixed, 10 pF, 150 V	CD	5300-03
CR1	Diode, FD100	FS	5151-37
CR2	Diode, HVG3R102H	Edal	5161-19
CR3	Same as CR1		
CR4	Diode, 1N982	FS	5152-67
Q1	Transistor, 2N1893	FS	5151-92
Q2	Transistor, 2N2920	FS	5151-92
R1	Resistor, fixed, 43 Ω ±5%, 1/2 W	AB	5215-17
R2	Resistor, fixed, 680 Ω ±5%, 1/2 W	AB	5215-47
R3	Resistor, fixed, 10 k ±5%, 1/2 W	AB	5215-76
R4	Resistor, fixed, 5.6 k ±5%, 1/2 W	AB	5215-70
R5	Resistor, fixed, 4.7 Ω ±5%, 1 W	AB	5225-05
R6	Resistor, fixed, 39 k ±5%, 1/2 W	AB	5215-91
R7	Resistor, fixed, 820 k ±5%, 1/2 W	AB	5216-25
R8	Same as R3		
R9	Same as R3		
R10	Same as R3		
R11	Resistor, fixed, 27 k ±5%, 1/2 W	AB	5215-76
R12	Resistor, fixed, 1 M ±5%, 1/2 W	AB	5216-27
R13	Resistor, fixed, 1.8 M ±5%, 1 W	AB	5626-02
R14	Same as R13		
R15	Same as R13		
R16	Same as R13		
T1	Transformer H.V.		5401-32

Table 6-15. Collector Phase Capacitor A16 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
C1	Capacitor, 62 pF		5300-62
C2	Capacitor, 27 pF		5300-52
C3	Same as C2		
C4	Capacitor, trimmer, 8-50 pF	CRL	5302-48
C5	Same as C4		
C6	Same as C4		
C7	Capacitor, 15 Pf, 1 k Vdc		
C8	Not assigned		
C9	Same as C4		
C10	Same as C7		
C11	Not assigned		
C12	Same as C4		
C13	Same as C1		
C14	Same as C1		
C15	Same as C4		
C16	Same as C1		
C17	Same as C1		
CR1	Rectifier, bridge		5151-67
R1	Resistor, fixed, 510 k ±5%, 2 W	AB	5240-67
R2	Same as R1		
R3	Same as R1		
R4	Same as R1		

Table 6-16. Collector Resistor Switch A17 Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
R1	Resistor, fixed, 5 Ω ±5%, 20 W	Ohmite	5251-01
R2	Resistor, fixed, 25 Ω ±5%, 20 W	Ohmite	5251-04
R3	Resistor, fixed, 100 Ω ±5%, 5 W	Ohmite	5250-93
R4	Resistor, fixed, 300 Ω ±5%, 20 W	Ohmite	5251-09
R5	Resistor, fixed, 500 Ω ±5%, 20 W	Ohmite	5251-11
R6	Same as R5		
R7	Resistor, fixed, 3 k ±5%, 10 W	Ohmite	5250-35
R8	Resistor, fixed, 10 k ±5%, 5 W	Ohmite	5250-94
R9	Resistor, fixed, 18 k ±5%, 2 W	AB	5240-46
R10	Resistor, fixed, 68 k ±5%, 2 W	AB	5240-55
R11	Resistor, fixed, 470 k ±5%, 2 W	AB	5240-65
R12	Same as R11		
S1	Switch, POL, 2 Pos.	Centralab	5604-75

6-17. Test Socket Adapter Parts List

Circuit Reference	Description	Manufacturer	FI Part Number
S1	Switch, lever	CRL	5600-45
S2	Switch, toggle DPDT	Alco	5602-04
S3	Switch, pushbutton No.	Grayhill	5604-88
S4	Switch, pushbutton Minia.	Grayhill	5600-54
TP1	Socket, transistor	Textool	6141-02
TP2	Post, binding, blk.	Gen. Radio	6130-44
TP3	Same as TP2		
TP4	Same as TP2		
TP5	Same as TP2		
TP6	Same as TP2		
TP7	Same as TP2		
TP8	Same as TP1		
	Banana Plugs	Johnson	6130-23
	Bottom	FI	6507-48
	Cover	FI	6507-46
	Handle, switch	Davies	6204-28
	Rear Bracket	FI	6507-49
	Top	FI	6507-47

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