INSTRUCTION MANUAL

Serial Number ____________

5CT1N CURVE-TRACER

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

070-1246-00

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WARRANTY

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

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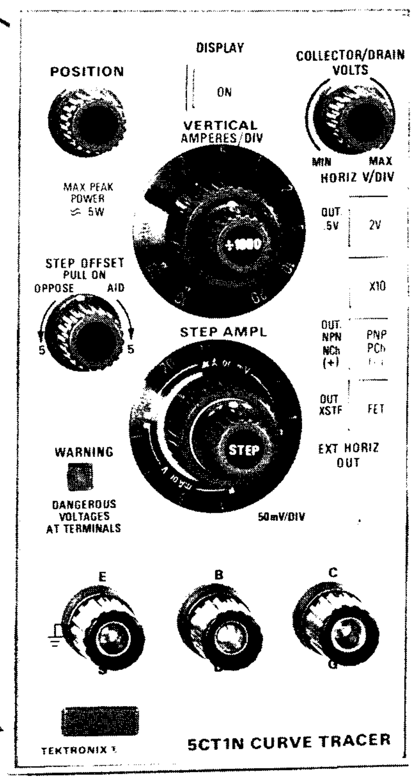

Fig. 1-1. 5CT1N Curve Tracer.

SECTION 1

OPERATING INSTRUCTIONS

Introduction

This section of the manual gives a general description of the 5CT1N, installation instructions, a functional description of the front-panel controls and connectors, a basic operation procedure, application notes and the instrument characteristics.

GENERAL DESCRIPTION

The 5CT1N is a curve tracer plug-in unit for the 5100-Series Modular Instrument System (see Fig. 1-1). It is to be used to make quick checks of the operation of small-signal semiconductor devices, particularly transistors and FET's. It features a variable collector or drain voltage supply with a maximum peak voltage of at least 240 volts and a base or gate step generator which produces calibrated current or voltage steps. The ranges of step amplitudes available are from 1 μA/step to 1 mA/step for current steps, and from 1 mV/step to 1 V/step for voltage steps. The maximum power which can be supplied to a device is limited to about 0.5 watt. In addition, the unit has a vertical display amplifier for measuring collector or drain currents from about 5 nA to 160 mA and a horizontal display amplifier for measuring collector-emitter or drain-source voltages ranging from about 0.2 V to 200 V. Either a vertical or horizontal plug-in unit installed in the horizontal plug-in location of the mainframe is required to display the horizontal portion of the waveforms.

INSTALLATION

The 5CT1N is calibrated and ready for use upon arrival. For proper operation, it should be installed in the center plug-in location of the 5100-series Power Supply/Amplifier module with either a horizontal or vertical plug-in unit installed in the right plug-in location. (The 5CT1N can also be operated in the left plug-in location.)

To install, align the upper and lower rails of the 5CT1N with the plug-in tracks of the mainframe and slide it in until its front panel is flush with the mainframe front panel. To remove, pull the release latch to disengage the 5CT1N from the mainframe.

When the 5CT1N has been installed, connect the EXT HORIZ OUT cable to an external input connector on the plug-in installed in the right plug-in compartment. Then set the deflection factor of the right plug-in to 50 mV/division and press the DISPLAY ON pushbutton on the 5CT1N.

NOTE

The Power Supply/Amplifier module is designed so that if DISPLAY ON logic levels are absent from the vertical plug-ins, it will display the output of the left plug-in unit.

CONTROLS AND CONNECTORS

This is a description of the function and operation of the front-panel controls and connectors (see Fig. 1-2). More information is given under Basic Operation.

DISPLAY ON	Enables or disables the plug-in.
POSITION	Positions the display vertically.
COLLECTOR/DRAIN VOLTS	Varies the collector-drain supply output voltage within the range set by the .5 V - 2 V and X10 pushbuttons.
.5 V - 2 V and X10 Pushbuttons	Selects the horizontal deflection factor and the range of the collector-drain supply output. Table 1-1 shows the deflection factors and voltage ranges for the various states of the pushbuttons.

TABLE 1-1

Collector-Drain Supply Output Ranges and Horizontal Deflection Factors

X10 Pushbutton	.5 V – 2 V Pushbutton	Collector-Drain Supply Range	Horizontal Deflection Factor
Out	Out	0 V to 7.5 V	0.5 V/Div
Out	In	0 V to 30 V	2 V/Div
In	Out	0 V to 75 V	5 V/Div
In	In	0 V to 300 V	20 V/Div

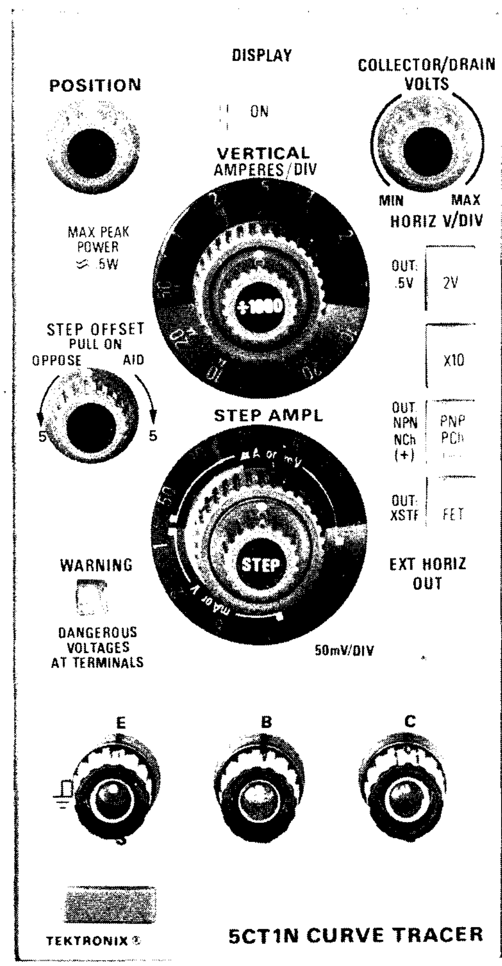

Fig. 1-2. 5CT1N front-panel.

VERTICAL — Selects the vertical deflection factor. The range of the switch is from 10 μA/division to 20 mA/division in a 1-2-5 sequence, with the ÷ 1000 pushbutton in; and from 10 nA/division to 20 μA/division in a 1-2-5 sequence with the pushbutton out.

÷ 1000 — When out, the sensitivity of the vertical display amplifier is increased 1000 times for making leakage current measurements. Also, when out, the collector-drain supply is changed from a sweeping output to a DC (non-looping) output.

STEP AMPL — Selects the step amplitude of the base-gate step generator output. When the XSTR-FET pushbutton is out, the step amplitude range is from 1 μA/step to 1 mA/step in a 1-2-5 sequence; when the pushbutton is in, the step amplitude range is from 1 mV/step to 1 V/step in a 1-2-5 sequence.

STEP — Continuously variable control which determines the number of steps in the base-gate step generator output. The number of steps ranges from 0 to at least 10 steps.

STEP OFFSET — When pulled out, the control provides continuously variable offset of the base-gate step generator output from at least 5 steps of opposing offset (control fully counterclockwise) to at least 5 steps of aiding offset (control fully clockwise). When the control is pushed in, zero offset is obtained.

NPN, N CH - PNP, P CH Pushbutton — Selects the polarity of the collector-drain supply output and the base-gate step generator output. When the pushbutton is out, the collector-drain supply output is positive and the base-gate step generator steps are either positive-going for current steps or negative-going for voltage steps. When the pushbutton is in, the collector-drain supply output is negative and the base-gate step generator steps are negative-going for current steps and positive-going for voltage steps. The XSTR-FET pushbutton determines whether the base-gate step generator output is current or voltage steps. The NPN, N CH - PNP, P CH pushbutton also determines the position of the display. When the pushbutton is out, the zero position of the display is located in the lower left corner of the display unit CRT; when in, the zero position is in the upper right corner of the CRT. The positioning accuracy is within 0.3 division.

XSTR-FET Pushbutton — Selects whether the base-gate step generator output is current steps or voltage steps. When the pushbutton is out, the base-gate step generator output is current steps in the same direction as the collector-drain supply output; when the pushbutton is in, the output is voltage steps in the opposite direction to the collector-drain supply output. This pushbutton also selects which device testing jacks the collector-drain supply output and the base-gate step generator output are connected to (see Table 1-2).

WARNING Light — Light flashes when X10 pushbutton is in to indicate that a dangerous voltage may be present at the device testing jacks.

Device Testing Jacks — Three binding posts on the front of the unit permit connection of devices to be tested to the curve tracer unit. The collector-drain supply output and the base-gate step generator output are connected either to the B or D (base or drain) or C or G (collector

TABLE 1-2

Connection of Collector-Drain Supply Output and Base-Gate Step Generator Output to Device Testing Jacks

B or D	C or G	XSTR-FET
Step Generator	Collector-Drain Supply	Out
Collector-Drain Supply	Step Generator	In

	or gate) binding post, depending on the state of the XSTR-FET pushbutton (see Table 1-2). The E or S (emitter or source) binding post is always connected to ground.
EXT HORIZ OUT Cable	Connects the horizontal display amplifier output to the external input of a vertical or horizontal plug-in unit installed in the horizontal location of the mainframe.

BASIC OPERATION

Familiarization Procedure

This procedure will familiarize the user with the operation of the 5CT1N, and show how to obtain the basic characteristic curves for a diode, bipolar transistor and field effect transistor (FET). Applications are given at the end of this section. This procedure may also be used as an operational check. For a performance check of the instrument, see Section 3.

1. Install the 5CT1N in the mainframe as described in the beginning of this section. Turn on the oscilloscope system and press the 5CT1N **DISPLAY ON** button.

DIODE CHECK

2. Set the 5CT1N controls as follows:

POSITION	Centered
COLLECTOR/DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V - 2 V	Pushbutton out
VERTICAL	1 mA/Div
÷ 1000	Pushbutton in
STEP AMPL	No effect for diode check
STEP	No effect for diode check
STEP OFFSET	No effect for diode check
NPN, N CH - PNP, P CH	Pushbutton out
XSTR-FET	Pushbutton out

3. Position the spot to the lower left corner of the CRT graticule using the **5CT1N POSITION** control and the Position control of the plug-in installed in the right plug-in compartment.

CAUTION

Occasionally, a single spot may be displayed on the CRT. In such cases, avoid high spot intensity to prevent burning the CRT phosphor. This precaution is especially important when using a display module with storage.

4. Connect a silicon diode between the C or G (anode) and E or S (cathode) binding posts of the 5CT1N. The transistor-FET adapter supplied with the 5CT1N may be used for this purpose.

5. Turn the **COLLECTOR/DRAIN VOLTS** control clockwise and obtain a display of the forward current versus voltage characteristic of the diode (see Fig. 1-3A).

6. Press the **NPN, N CH-PNP, P CH** pushbutton. The polarity of the collector-drain supply output voltage is now negative, providing a display of the reverse current versus voltage characteristic of the diode. Note also that the zero portion of the display has been repositioned to the upper right corner of the CRT. If the mainframe display amplifiers are properly adjusted, the position of the zero portion of the display should be within ±0.3 division of the upper right corner of the CRT graticule. This positioning capability can thus be used to check the accuracy of the vertical and horizontal display amplifiers.

7. Turn the COLLECTOR/DRAIN VOLTS control fully counterclockwise and set the **.5 V - 2 V** and **X10** pushbuttons for a new collector-drain supply range and horizontal deflection factor (see Table 1-1).

CAUTION

Always turn the COLLECTOR/DRAIN VOLTS control counterclockwise before changing the collector-drain supply range, to avoid damage to the device under test.

Note that when the X10 pushbutton is in, the **WARNING** light flashes.

WARNING

A flashing warning light indicates that a potentially hazardous voltage may be present on the device testing terminals.

Set the VERTICAL switch to 10 μA/Div and turn the COLLECTOR/DRAIN VOLTS control clockwise until the

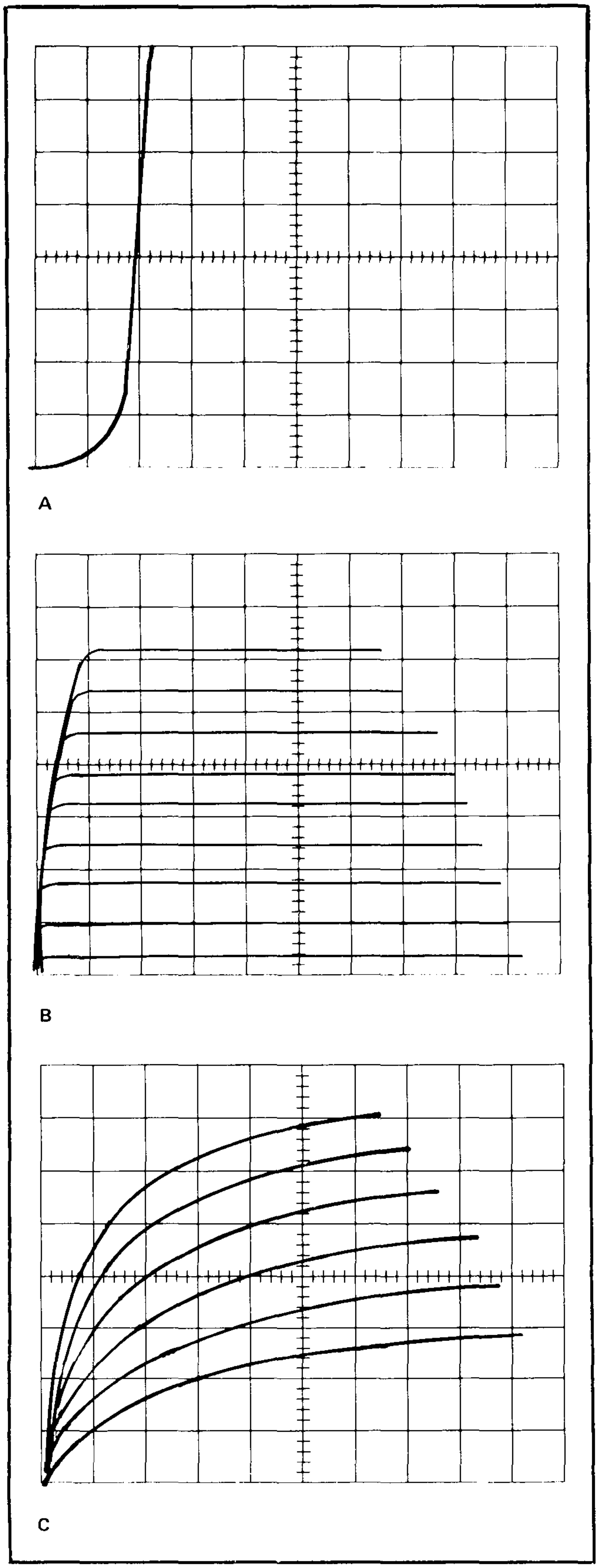

Fig. 1-3. Characteristic curves: (A) Diode; (B) Bipolar transistor; (C) Field effect transistor.

reverse voltage breakdown of the diode is obtained. If the device does not break down within the display window of the CRT, select a higher collector-drain supply range.

TRANSISTOR CHECK

8. Set the 5CT1N controls as follows:

POSITION	Centered
COLLECTOR/DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V - 2 V	Pushbutton in
VERTICAL	1 mA/DIV
÷ 1000	Pushbutton in
STEP AMPL	1 μA/STEP
STEP	Fully clockwise
STEP OFFSET	Pull-switch in
NPN, N CH - PNP, P CH	Pushbutton out
XSTR-FET	Pushbutton out

9. Position the spot to the lower left corner of the CRT graticule.

10. Connect the transistor-FET adapter, which is supplied with the 5CT1N, to the device testing jacks. Install an NPN transistor (with the following suggested characteristics: β of 50 to 100, BV_{CEO} at least 30 V, I_{Cmax} at least 20 mA) in one of the test sockets.

11. Turn the COLLECTOR/DRAIN VOLTS control clockwise until a trace of about 5 divisions (V_{CE} = 10 V) is obtained. Turn the STEP AMPL switch clockwise until a family of curves similar to that shown in Fig. 1-3B is obtained. This set of curves is a display of the I_C vs. V_{CE} for a transistor operated in a common-emitter configuration. With the XSTR-FET pushbutton out, the step generator output is current steps. The setting of the STEP AMPL switch indicates the increment of current added to each step (or the step amplitude).

12. Turn the **VERTICAL** switch throughout its range and note the change in vertical deflection factor.

13. Turn the **STEP** control fully counterclockwise. Note that the number of steps decreases to zero. With the STEP control fully counterclockwise, the base current of the transistor is essentially zero. (For a true open base condition, disconnect the base lead from the test socket.)

14. Release the ÷ **1000** pushbutton and note that the collector-drain supply output becomes a DC voltage (a spot) rather than a sweeping voltage (a trace). Turn the

VERTICAL switch clockwise to obtain a measurable display of leakage current (in this case I_{CEO}). The vertical deflection factor with the ÷ 1000 pushbutton out is the setting of the VERTICAL switch divided by 1000. Before measuring leakage current, remove the transistor from the test socket and vertically position the spot to the bottom horizontal graticule line (top line for PNP transistors). Repositioning of the spot compensates for leakage current in the transistor-FET adapter and 5CT1N. (As in part 13, the best measurement of I_{CEO} is obtained when the base lead is disconnected from the test socket).

FIELD EFFECT TRANSISTOR CHECK

15. Set the 5CT1N controls as follows:

POSITION	Centered
COLLECTOR/DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V - 2 V	Pushbutton in
VERTICAL	1 mA/DIV
÷ 1000	Pushbutton in
STEP AMPL	1 mV/STEP
STEP	Fully clockwise
STEP OFFSET	Pull-Switch in
NPN, N CH - PNP, P CH	Pushbutton out
XSTR-FET	Pushbutton in

16. Position the spot to the lower left corner of the CRT graticule.

17. Install an N channel FET in one of the test sockets. The lead configuration of most FET's should match the sockets on the transistor-FET adapter. Information on the side of the adapter indicates which terminals of the socket the leads of the FET should be connected to.

18. Turn the COLLECTOR/DRAIN VOLTS control and the STEP AMPL switch clockwise until a family of curves similar to those shown in Fig. 1-3A is obtained. This set of curves is a display of I_C vs. V_{DS} for an FET operated in the depletion region. With the **XSTR-FET** pushbutton in, the step generator output is voltage steps. The setting of the STEP AMPL switch indicates the increment of voltage added to each step (or the step amplitude). Turn the STEPS control fully counterclockwise. The step generator output is now zero volts and the curve displayed on the CRT is the zero gate-voltage curve.

19. Turn the STEP control clockwise and pull the **STEP OFFSET** control out. Turn the STEP OFFSET control fully clockwise and note that the curves are offset further into the depletion region of the device toward pinch-off. Turn the control fully counterclockwise and note that the family of curves is offset into the enhancement region of the device. When an FET is operated in its enhancement region, the 1 kΩ output impedance of the step generator protects the device. As gate current increases, the voltage steps are compressed, limiting the gate voltage. Push in the STEP OFFSET control to obtain the zero offset condition.

Device Adapters

A transistor-FET device testing adapter (Tektronix Part No. 013-0128-00) for TO-5 and TO-18 type cases is supplied as a standard accessory with the 5CT1N. A number of other adapters, which may be used with the 5CT1N, are available from Tektronix. Table 1-3 lists the adapters available at the time of printing of this manual and their uses.

TABLE 1-3

Test Fixture Adapters Which May Be Used With the 5CT1N

Tektronix Part Number	Case Type
013-0072-00	Diodes with axial leads
013-0069-00	Devices with long leads
013-0070-01	TO-3 and TO-66
013-0074-00	Transistors with stud leads
013-0110-00	Diodes with stud leads; DO-4/DO-5
013-0112-00	TO-36

APPLICATIONS

The following section describes how to use the 5CT1N to make some common checks and measurements of diodes, transistors and FET's. These checks may range from checking if a device is operating or not (go, no-go) to checking manufacturer-specified parameters. Before reading this section, it is suggested that a user go through the preceding Familiarization Procedure to acquaint himself with the 5CT1N.

Diodes

General. Most signal, Zener and tunnel diodes can be tested with the 5CT1N. The maximum I_F which can be measured is about 160 mA and the maximum V_R is about 200 V. Care should be taken when testing diodes which are sensitive to current, especially tunnel diodes.

Controls Settings. Set the 5CT1N controls initially as follows:

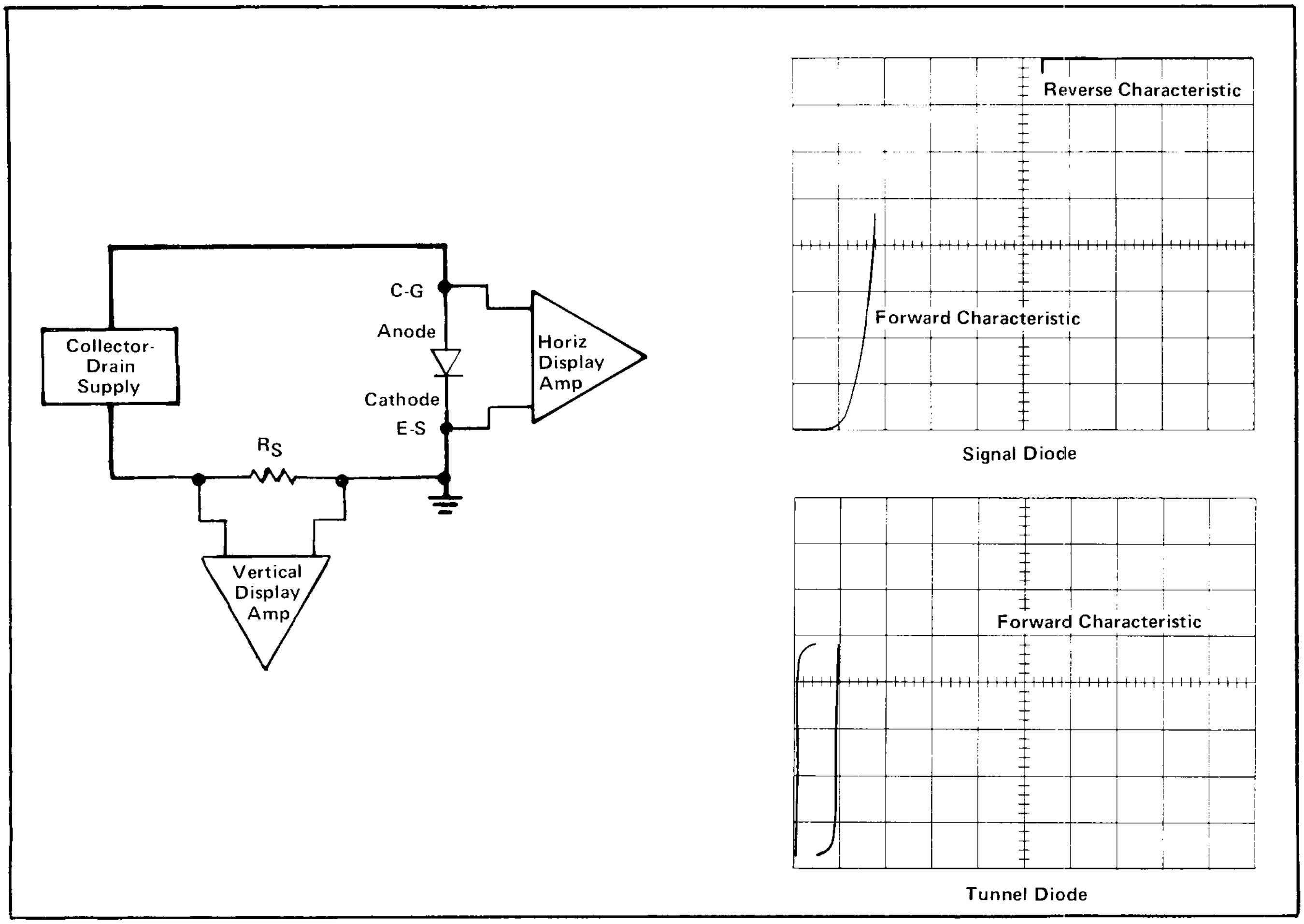

Fig. 1-4. Simplified diagram illustrating connection of diode to 5CT1N and typical displays.

POSITION	Centered
COLLECTOR/DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V - 2 V	Pushbutton out
VERTICAL	As desired
÷ 1000	Pushbutton in
STEP AMPL	No effect for Diode Check
STEP	No effect for Diode Check
STEP OFFSET	No effect for Diode Check
NPN, N CH - PNP, P CH	Pushbutton out
XSTR-FET	Pushbutton out

Installation. Connect the diode to the device testing jacks as shown in Fig. 1-4. The device may be connected either directly to the jacks or through the transistor-FET adapter included with the 5CT1N. Special diode adapters are also available from Tektronix (see Table 1-3).

Checks and Measurements. Use the following instructions to make checks and measurements of a diode once the controls have been set and the diode has been installed as described previously.

Go, No-Go	Turn the COLLECTOR/DRAIN VOLTS control clockwise to obtain a display of the forward conduction characteristic of the diode. Fig. 1-4 shows typical displays for a rectifier type diode and a tunnel diode.
I_F and V_F	Turn the COLLECTOR/DRAIN VOLTS control clockwise to obtain a display of the forward conduction characteristic of the diode. Measure the turn-on voltage on the horizontal axis of the CRT graticule and measure the forward current on the vertical axis. Measure the peak and valley currents and voltages of a tunnel diode in the same manner.

I_R (leakage) and V_R or V_Z Press the NPN, N CH - PNP, P CH pushbutton. Turn the COLLECTOR/DRAIN VOLTS control clockwise until Zener or avalanche breakdown voltage is obtained. If breakdown is not obtained, select a higher collector-drain supply output voltage. Measure V_R or V_Z on the horizontal axis. Release the ÷ 1000 pushbutton to measure leakage current. With the ÷ 1000 pushbutton out, divide the VERTICAL switch setting by 1000 to obtain the vertical deflection factor. Before measuring leakage current, momentarily disconnect the diode from the test socket and vertically position the spot to the zero current line (normally the top horizontal graticule line).

Bipolar Transistors

General. All bipolar transistors can be tested with the 5CT1N. The maximum I_C which can be measured is 160 mA.

Controls Settings. Set the 5CT1N controls initially as follows:

POSITION	Centered
COLLECTOR/DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V - 2 V	Pushbutton in
VERTICAL	As desired
÷ 1000	Pushbutton in
STEP AMPL	1 μA/DIV
STEP	Fully clockwise
STEP OFFSET	Pull-Switch in
NPN, N CH – PNP, P CH	Pushbutton out (NPN Devices) Pushbutton in (PNP Devices)
XSTR-FET	Pushbutton out

Installation. Connect the transistor to the device testing jacks through the transistor-FET adapter which is included with the 5CT1N. This adapter accepts TO-5 and TO-18 type cases. For devices which do not match this adapter, connect the leads to the jacks as shown in Fig. 1-5.

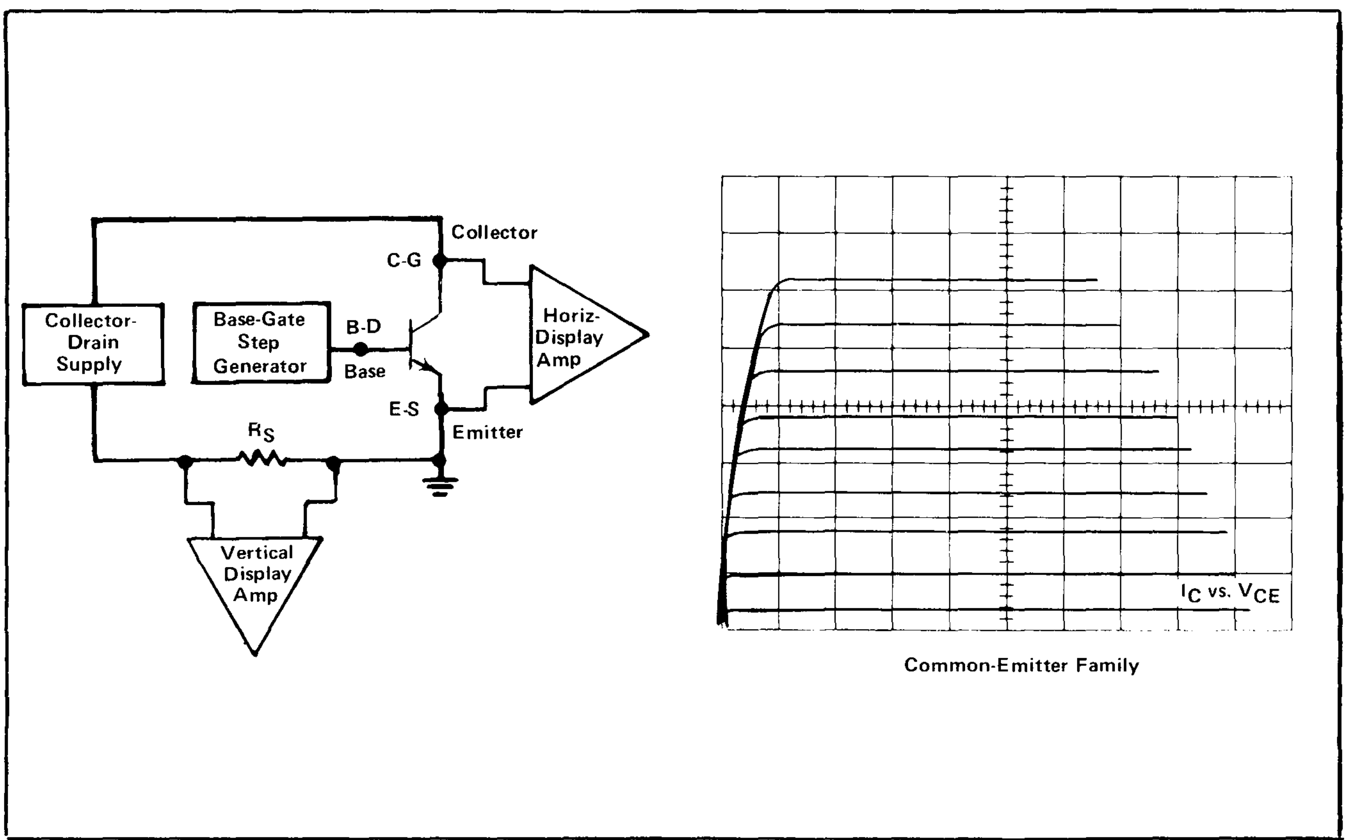

Fig. 1-5. Simplified diagram showing connection of Bipolar transistor to 5CT1N and a typical display.

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Checks and Measurements. Use the following instructions to make checks and measurements of a transistor once the controls have been set and the diode has been installed as described previously.

Go, No-Go — Turn the COLLECTOR/DRAIN VOLTS control clockwise to obtain a horizontal trace of about 5 divisions. Turn the STEP AMPL switch clockwise until a display similar to that shown in Fig. 1-5 is obtained.

β (small-signal) — The small-signal short-circuit forward current transfer ratio (emitter grounded), β or h_{fe}, is $\Delta I_C/\Delta I_B$. To measure β, obtain a display of I_C vs. V_{CE} as described for the go, no-go check. Set the STEP AMPL switch and VERTICAL switch for the I_C at which β is specified. I_C is measured on the vertical axis. The VERTICAL switch sets the deflection factor. When the desired display is obtained, calculate a value for β/division by dividing the VERTICAL switch setting by the setting of the STEP AMPL switch. Next, measure the vertical distance between two curves in the vicinity of the I_C at which β is specified. Offset may be used to position the curves for more convenient measurement. Multiply this distance by the β/division previously calculated to determine β.

V_{CE} (Sat.) — Obtain a display of I_C vs. V_{CE} as described for the go, no-go check. Release the .5 V - 2 V pushbutton and adjust the COLLECTOR/DRAIN VOLTS control for a display of the saturation region of the curves. The saturation region is usually defined as the non-linear or "knee" region of a curve.

V_{BE} (Sat.) — Obtain a display of V_{CE} (Sat.) and measure the base voltage on the device, using a probe from a vertical unit in the oscilloscope system.

I_{CEO} and BV_{CEO} — Disconnect the base lead from the test socket. Turn the COLLECTOR/DRAIN VOLTS control clockwise until the transistor breaks down. If breakdown does not occur, select a higher collector-drain supply range. Collector-emitter breakdown voltage with the base open is measured on the horizontal axis. Collector-emitter leakage current with the base open is measured on the vertical axis. To make this measurement, release the ÷ 1000 pushbutton and adjust the COLLECTOR/DRAIN VOLTS control for the V_{CE} at which the leakage current is specified. Before measuring I_{CEO}, momentarily disconnect the transistor from the test socket and position the spot to the zero current line (the bottom horizontal graticule line for NPN transistors, and the top horizontal graticule line for PNP transistors).

I_{CES} and BV_{CES} — Collector-emitter leakage current and collector-emitter breakdown voltage (base shorted to emitter) are measured the same as I_{CEO} and BV_{CEO}, except that the base lead of the device is shorted to the emitter lead.

I_{CER} and BV_{CER} — Collector-emitter leakage current and collector-emitter breakdown voltage (with a specified resistance between the base terminal and the emitter terminal) are measured the same as I_{CES} and BV_{CES}, except that a specified resistance is connected between the base lead and the emitter lead.

$\propto$ (small-signal) — The small-signal short-circuit forward current transfer ratio (base grounded), h_{fb}, cannot be measured conveniently with the 5CT1N. It can, however, be calculated from β with the following equation: $\propto = \beta/(1 + \beta)$.

I_{CBO} and BV_{CBO} — Collector-base leakage current and collector-base breakdown voltage (emitter open) is measured the same as I_{CEO} and BV_{CEO}, except that the base lead is connected to the E or S terminal, and the emitter lead is left open (or connected to the B or D terminal.

I_{EBO} and BV_{EBO} — Emitter-base leakage current and emitter-base breakdown voltage (collector open) are measured the same as I_{CEO} and BV_{CEO}, except that the emitter lead is connected to the C or G terminal, the base lead is connected to the E or S terminal, and the collector lead is left open (or connected to the B or D terminal).

Field Effect Transistors

General. All Field Effect Transistors including junction FET's and MOS-FET's can be tested with the 5CT1N.

Control Settings. Set the 5CT1N controls initially as follows:

POSITION	Centered
COLLECTOR/DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V - 2 V	Pushbutton in
VERTICAL	As desired
÷ 1000	Pushbutton in
STEP AMPL	1 mV/STEP
STEP	Fully clockwise
STEP OFFSET	Pull-Switch in
NPN, N CH - PNP, P CH	Pushbutton out (N channel) Pushbutton in (P channel)
XSTR-FET	Pushbutton in

Installation. Connect the FET to the device testing jacks through the transistor-FET adapter which is included with the 5CT1N. This adapter is wired to accept devices with gate-drain-source configurations. If the adapter can not be conveniently used, connect the leads directly to the device testing jacks as shown in Fig. 1-6.

Checks and Measurements. Use the following instructions to make checks and measurements of an FET once the controls have been set and the FET has been installed as previously described.

Go, No-Go — Turn the COLLECTOR/DRAIN VOLTS control clockwise to obtain a horizontal trace of about 5 divi-

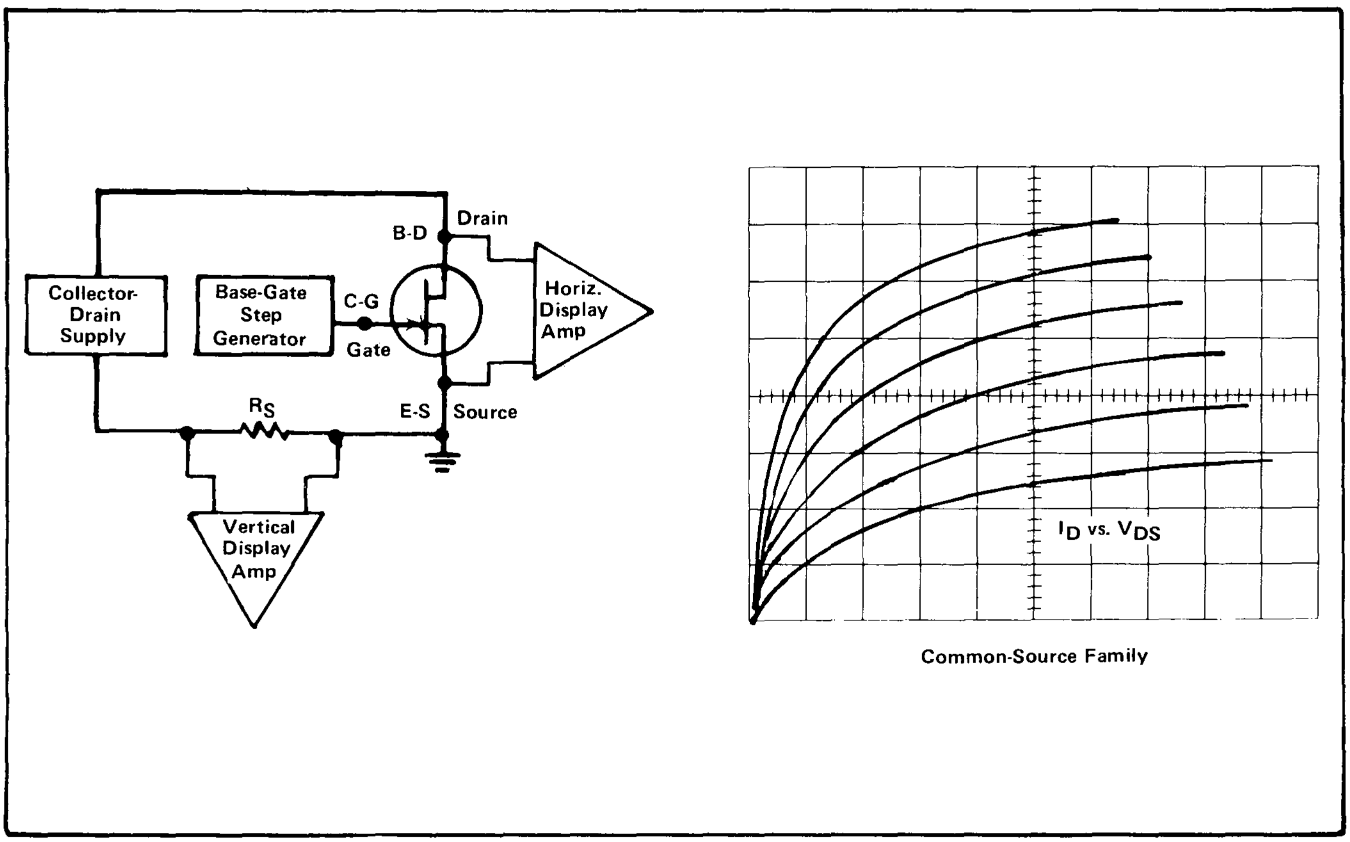

Fig. 1-6. Simplified diagram showing connection of FET to 5CT1N and typical display.

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sions. Turn the STEP AMPL switch clockwise until a display similar to that shown in Fig. 1-6 is obtained.

g_m (small-signal)

The small-signal transconductance (source grounded) is $\Delta I_D/\Delta V_{GS}$. To measure g_m, obtain a display of I_D vs. V_{DS} as is described for the go, no-go check. Set the STEP AMPL switch and VERTICAL switch for the I_D at which g_m is specified. I_D is measured on the vertical axis. The VERTICAL switch sets the deflection factor. When the desired display is obtained, calculate a value for g_m/division by dividing the VERTICAL switch setting by the setting of the STEP AMPL switch. Next measure the vertical distance between two curves in the vicinity of the I_D at which g_m is specified. Offset may be used to position the curves for convenient measurement. Multiply this distance by the g_m/division previously calculated to determine g_m.

I_{DSS}

Obtain a display of I_D vs. V_{DS} as described for the go, no-go check. Turn the STEPS control fully counterclockwise. Drain-source current with zero V_{GS} is the current level of the single curve measured above the knee.

Pinch-Off Voltage (V_p)

Obtain the display of I_D vs. V_{DS} as described for the go, no-go check. Pinch-off voltage is measured by increasing the gate-source depletion voltage, using the STEP AMPL switch and the STEPS control, until the specified pinch-off current is obtained. V_p is then the gate-source voltage required to reach pinch-off current. Multiply the number of steps required to reach pinch-off current by the setting of the STEP AMPL switch to obtain a value for V_p. For a more accurate measurement of V_p, use the STEP OFFSET control. Since the STEP OFFSET control is not calibrated, some reference point must be established on the CRT graticule. For example, the level of the 10th step could be marked on the CRT graticule before the STEP OFFSET control is pulled out.

BV_{GSS}

Install the device in the test socket with the gate lead connected to the E or S jack and the source and drain leads shorted together and connected to the B or D jack. Turn the COLLECTOR/DRAIN VOLTS control clockwise until the gate-source breakdown voltage is obtained. **This measurement should not be made on insulated gate devices.**

SPECIFICATION

This specification lists the electrical performance limits and physical requirements of the 5CT1N. A procedure for checking the electrical performance limits is given in the Performance Check/Adjust section.

Collector-Drain Supply

Polarity: + or –.

Voltage Ranges: (No Load)

0 V to 7.5 V.

0 V to 30 V.

0 V to 75 V.

0 V to 300 V.

Maximum Voltage Limit: Within 20%

Peak Current: (Short Circuit)

240 mA in 7.5 V range.

60 mA in 30 V range.

24 mA in 75 V range.

6 mA in 300 V range.

Peak Current Limit: Within 30%

Base-Gate Step Generator

Step Polarity: Positive-going or negative-going

Number of Steps: From 0 to at least 10.

Step Accuracy:

Absolute: (Eighth step) within 5%.

Incremental: Within 3%.

Zero Step Level: Within 0.3 step.

Step Offset:

Aiding: At least 5 steps (or 13 V for voltage steps).

Opposing: At least 5 steps.

Display Amplifiers

Vertical:

Ranges: Normal and Leakage.

Accuracy: Within 5% + 0.2 nA/V.

Horizontal Accuracy: Within 5%

Positioning Accuracy: Within 3% using NPN, N CH - PNP, P CH pushbutton.

General

Temperature:

Operating: 0°C to +50°C.

Storage: –40°C to +70°C.

Altitude:

Operating: To 15,000 feet.

Storage: To 50,000 feet.

Vibration Range: To 0.015 inch total displacement at 50 Hz.

Shock Range: 30 g's, 1/2 sine, 11 ms duration.

Transportation: Qualified under National Safe Transit Committee Test Procedure 1A, Category II.

Standard Accessories:

1 Instruction Manual 070-1246-00

1 Transistor, FET Adapter, TO-5 and TO-18.

SUPPLEMENTARY INFORMATION

This section lists additional information about the 5CT1N which may be useful in using or maintaining the instrument.

Collector-Drain Supply

Modes: Normal sweeping output or DC output (for leakage current measurements).

Sweep Waveform: Triangular.

Sweep Frequency: ≈110 Hz.

Peak Power: ≈0.5 watt. Limited by internal series resistors. Reduced in higher sensitivity positions of VERTICAL switch.

Warning Light: Flashes when collector-drain supply is in either of two highest voltage ranges to indicate a dangerous voltage may appear at the device testing terminals.

Base-Gate Step Generator

Modes: Current steps for testing bipolar transistors, and voltage steps for testing field effect transistors.

Step Rate: 1 step per cycle of the collector-drain supply.

Ranges:

Current Mode: 1 μA/step to 1 mA/step in a 1-2-5 sequence.

Voltage Mode: 1 mV/step to 1 V/step in a 1-2-5 sequence.

Limits—Current Mode:

Maximum Current:

Aiding: 15 times the STEP AMPL switch setting.

Opposing: 5 times the STEP AMPL switch setting.

Maximum Voltage:

Aiding: ±13 V.

Opposing: ±15 V.

Limits—Voltage Mode:

Maximum Voltage:

Aiding: 15 times the STEP AMPL switch setting or ±13 V, whichever is less.

Opposing: 5 times STEP AMPL switch setting.

Maximum Current: Limited by output impedance of 1 kΩ (aiding or opposing).

Display Amplifiers

Vertical Ranges:

Normal: 10 μA/divisions to 20 mA/division in 1-2-5 sequence.

Leakage: 10 nA/division to 20 μA/division in 1-2-5 sequence.

Horizontal Ranges: .5 V/division, 2 V/division, 5 V/division and 20 V/division through plug-in with 50 mV/division deflection factor.

SECTION 2
CIRCUIT DESCRIPTION

BLOCK DIAGRAM DESCRIPTION

The 5CT1N is divided into a stimulus section which provides voltages and currents for application to the device under test, and a measurement section which measures the effects of the stimulus. The stimulus section consists of the collector-drain supply (see Fig. 2-1) and the base-gate step generator. The measurement section consists of the vertical and horizontal display amplifiers.

The collector-drain supply produces a voltage which is connected to the collector of a bipolar transistor, the drain of an FET, or the anode of a diode. This voltage can be either a sweeping voltage or a DC voltage. The sweeping voltage has a triangular waveshape.

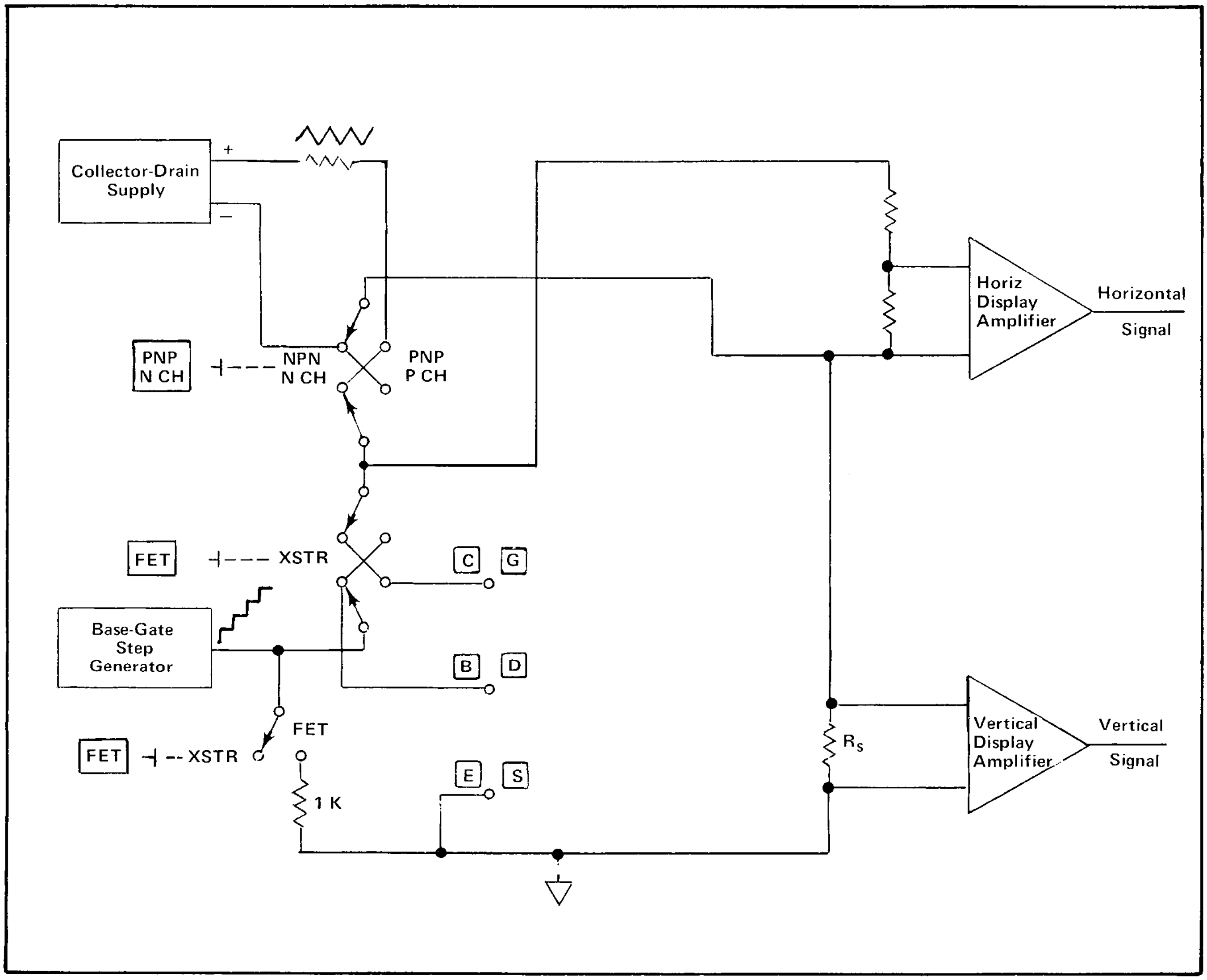


Fig. 2-1. Simplified block diagram of the 5CT1N.

The base-gate step generator produces current steps for application to the base of a bipolar transistor or voltage steps for application to the gate of an FET. The steps occur at a rate of one step per cycle of the collector-drain supply.

The vertical display amplifier measures current for display on the vertical axis of the display unit CRT. A resistor in the return path to the collector-drain supply is used to sense current.

The horizontal display amplifier measures voltage for display on the horizontal axis of the display unit CRT. The voltage measured is V_{CE} for a bipolar transistor, V_{DS} for an FET or anode-cathode voltage for a diode.

CIRCUIT DESCRIPTION

Collector-Drain Supply

The sweep generator (see the Block Diagram in the diagrams section) produces a triangular waveform which is the basis for the collector-drain supply output. The signal is generated at a rate of about 55 Hz with a peak-to-peak amplitude of about 10 V. To produce the triangular waveform (see the circuit diagram), C11 is charged and discharged with constant current conducted through R11. Q2 and Q4 form a Schmitt trigger circuit which determines when C11 is charged and discharged.

The sweep generator output is transmitted through variable attenuator R20, the COLLECTOR/DRAIN VOLTS control, to the sweep amplifier. The sweep amplifier amplifies the triangular wave-form about five times.

From the sweep amplifer, the triangular wave-form is transmitted through collector supply transformer T39. T39 has four taps which determine the four ranges of the collector-drain supply. CR52 full-wave rectifies the output of the transformer secondary, producing the collector-drain sweep output. The sweep output is thus a positive or negative triangular wave-form produced at twice the rate of the unrectified waveform, or 110 Hz.

The collector-drain supply voltage is applied to the device under test through S70C, controlled by the PNP, P CH pushbutton, and S75B, controlled by the FET pushbutton. The path of collector or drain current (see the Block Diagram) is from one side of the rectifier, through the device under test, through the current sensing resistor, and back to the other side of the rectifier. S70C determines the polarity of the collector-drain supply sweep applied to the device under test, and thus the direction of current through the device under test.

R56 and R57 are series limiting resistors which limit the power dissipated by the device under test. The VERTICAL switch determines when these resistors are in the circuit.

C52 and C53, or C54 are connected between the two outputs of the collector-drain supply rectifier when the ÷ 1000 pushbutton is released. These capacitors filter the collector-drain sweep voltage, producing a DC voltage.

Base-Gate Step Generator

The zero crossing detector produces a positive-going pulse each time the output of the sweep generator crosses 0 volts. When the sweep generator output crosses 0 volts going positive, Q82 is turned on and Q84 is turned off, causing a positive pulse to be transmitted through CR86 to the base of Q92. When the output crosses zero going negative, Q84 turns on, Q82 turns off and a positive pulse is transmitted through CR88 to the base of Q92.

The step generator produces a DC voltage which increases by one increment (or step) each time the zero crossing detector produces a positive pulse. The output of the step generator is, thus, a positive-going staircase. The staircase voltage increases until it reaches a level set by the STEP control. At this time the step generator output returns to 0 volts and a new staircase begins.

C114 is charged in increments to produce the step generator output voltage. Quiescently, C96 is charged to about 5 volts as set by R90, the V/STEP CAL adjustment. When a positive-going pulse from the zero crossing detector is applied to the base of Q92, its collector goes to ground, causing a negative-going pulse to be conducted through CR97. This negative pulse causes C114 to be charged by an amount proportional to the initial charge on C96. R90 thus determines the step amplitude at the step generator output. When C96 has discharged, CR97 turns off, holding the charge on C114 constant.

C114 will continue to charge in this manner until the step generator output voltage becomes high enough to turn on Q104. R100, the STEP control, determines the voltage required to turn on Q104. When Q104 turns on, Q108 turns on, which turns on Q114. With Q114 on, C114 is discharged. When Q108 turns on, Q92 is also turned on, keeping C96 discharged until the step generator output returns to 0 volts.

The offset circuit allows the DC level of the step generator staircase to be shifted either positive (aiding) or negative (opposing). R120, the STEP OFFSET control, controls the output voltage of the offset circuit.

The step amplifier amplifies the step generator output 1.5 times and converts the voltage steps into current steps. Q132 and Q136 form an emitter-coupled amplifier. The output of this amplifier is at the collector of Q132. Q142 and Q148 conduct constant current. Q144 and Q146 conduct varying current as determined by the collector of Q132. To obtain positive current steps (current steps conducted into the device under test), the base of Q136 is grounded and positive-going voltage steps from the step generator are applied to the base of Q132. The resulting negative-going voltage steps at the collector of Q132 cause the current conducted by Q144 and Q146 to increase in step increments. Since Q142 and Q148 conduct constant current, the additional current conducted by Q144 and Q146 is conducted into the device under test.

To obtain negative-going current steps (current steps conducted out of the device under test), the base of Q132 is grounded and the step generator output is applied to the base of Q136. In this case, the voltage steps at the collector of Q132 are positive-going, causing the current conducted by Q144 and Q146 to be reduced in step increments. Since Q142 and Q148 are still conducting constant current, current will have to be conducted out of the device under test to make up for the reduced current conducted by Q144 and Q146.

When voltage steps are desired, R169 is switched into the circuit. The current produced by the step amplifier is then conducted through R169 to produce voltage steps. The accuracy of the voltage steps is dependent on the amount of current R169 conducts. If the voltage steps are applied to the gate of an FET being operated in its enhancement region, the steps will be compressed due to the gate current conducted by the device. This voltage limiting protects the gate from excessive current in such cases.

R139, the 1-5 μA BAL adjustment sets the current conducted by emitter-coupled amplifier Q132 and Q136. It thus sets the overall balance of the step amplifier. R158, R155 and R152 (the 10-50 μA, 100-500 μA and 1 mA BAL adjustment, respectively) set the balance of the step amplifier for their respective positions of the STEP AMPL switch. These four controls are adjusted for zero current when no steps are being generated.

Display Amplifiers

The vertical display amplifier measures the voltage across a current sensing resistor and transmits the output to the vertical display amplifier in the mainframe. The size of the current sensing resistor is changed to obtain the decade ranges of the vertical deflection factor. The size of the feedback resistor across the vertical amplifier determines the 1-2-5 multiplier of the vertical deflection factor. When the ÷ 1000 pushbutton is released, a different set of current sensing resistors is used to increase the sensitivity of the vertical amplifier and allow leakage currents to be measured. R194, the VERT AMP BAL adjustment, adjusts the balance of U194 so that there is no DC shift in the output when the VERTICAL AMPERES/ DIV switch position is changed.

The horizontal display amplifier measures the output voltage of the collector-drain supply, which is essentially the voltage between the C-G and E-S jacks, when the XSTR-FET pushbutton is out, and the B-D and E-S jacks, when the pushbutton is in. The output of the horizontal display amplifier is transmitted to the EXT HORIZ OUT connector. From this connector the output is transmitted to the horizontal output amplifier in the mainframe through another plug-in unit.

Since the current sensing resistors are in series with the device under test (see Fig. 2-1), the voltage measured by the horizontal display amplifier is not exactly the voltage across the device under test. This error is only significant for the 0.5 V/div horizontal deflection factor. In this case, divider R171-R172 compensates for the error introduced by the current sensing resistor.

SECTION 3 PERFORMANCE CHECK/ ADJUSTMENT PROCEDURE

GENERAL

Introduction

This section contains a procedure for checking the performance capabilities of the 5CT1N and, when necessary, for making internal adjustments to bring the instrument performance within specified limits. The basic operation procedure in Section 1 verifies instrument operation, but does not check its performance to specified limits.

Instrument Maintenance

Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section of the Oscilloscope System manual. The system manual also contains information for general maintenance of this instrument.

Services Available

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

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or the equivalent, are required for complete calibration of the 5CT1N. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed here may be less rigorous than the performance capabilities of the test equipment. All test equipment is assumed to be operating within the listed specifications.

Special Calibration Fixtures

Special Tektronix calibration fixtures are used in this procedure only where they facilitate instrument calibration. These special calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Calibration Equipment Alternatives

If other test equipment is substituted, control settings or calibration setup may need altering to meet the requirements of the equipment used. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instructions manual for the test equipment if more information is needed.

Test Equipment

1. 5100N-Series Oscilloscope System, including a 5103N mainframes with any display module, one vertical amplifier and one time-base. The measurement accuracies of the vertical amplifier and time-base must be within 3%.

2. Voltage Source. A voltage source with DC voltages (or pulse amplitudes) of 500 mV, 5 V, 20 V, 50 V and 100 V, accuracy within 1%. A Tektronix Standard Amplitude Calibrator is suggested (Tektronix Part No. 067-0502-01).

3. The following precision resistors checked to within 1/2% accuracy: 100 Ω, 1 KΩ, 10 KΩ, 20 KΩ, 50 KΩ, 100 KΩ, 200 KΩ, 2 MΩ and 20 MΩ (all 1/8 watt or greater).

Accessories

1. Patch cords (2). 12 to 18 inches long with standard banana plug connectors. (Tektronix Part No. 012-0031-00 or 012-0039-00.)

2. Connector adapter. BNC male-to-dual binding post (Tektronix Part No. 103-0035-00).

3. Plug-in extender (optional). Tektronix Part No. 103-0035-00. Used for adjustments only.

NOTE

The display amplifiers in the oscilloscope mainframe should be calibrated before performing this procedure.

TABLE 3-1

Check/Adjust Procedure Index and Record

Step	Title	Adjustments	Page
1	Check Horizontal Display Amplifier		3-2
2	Check/Adjust Vertical Display Amplifier	R194	3-3
3	Check/Adjust Base-Gate Step Generator	R139, R152, R155, R158, R100	3-4
4	Check Collector-Drain Supply		3-6

Preliminary Procedure

1. Install the 5CT1N in the 5100-Series Oscilloscope System.

a. (Performance Check Only)—Install in center plug-in location.

b. (Performance Check and/or Adjustment)—Remove the left dust cover from the 5CT1N and install in the center plug-in location through a plug-in extender. If a plug-in extender is not available, install in the left plug-in location and also remove the left dust cover from the mainframe. The plug-in extender is required for rack-mounted oscilloscope systems.

2. Connect the oscilloscope system and Standard Amplitude Calibrator to a suitable power source and turn on the instruments. Allow 5 minutes warmup before starting the procedure.

NOTE

The performance of this instrument can be checked at any ambient temperature within the 0°C to +50°C range. If adjustments are to be made, the ambient temperature should be 25°C ±5°C, for best overall accuracy.

1. Check Horizontal Display Amplifier

a. Set the 5CT1N, oscilloscope system and standard amplitude calibrator controls as follows:

5CT1N

POSITION	Centered
COLLECTOR/ DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V–2 V	Pushbutton out
VERTICAL	20 mA/DIV
÷1000	Pushbutton in
STEP AMPL	1 mA/STEP
STEP	Fully counterclockwise
STEP OFFSET	Pull-switch in
NPN, N CH - PNP, P CH	Pushbutton out
XSTR—FET	Pushbutton out

Oscilloscope System

Vertical Display	Off
Horizontal Display	Alternate
Horizontal Position	Control Centered
Horizontal Seconds/Div or Volts/Div	50 mV/Div

Standard Amplitude Calibrator

Mode	Square Wave
Amplitude	5 Volts

CAUTION

Occasionally while using this procedure, a single spot may be displayed on the CRT. In such cases, avoid high spot intensity to prevent burning the CRT phosphor. This precaution is especially important when using a display module with storage.

b. Connect the 5CT1N EXT HORIZ OUT cable to the external input to the time-base unit. Connect the square wave output of the Standard Amplitude Calibrator to the C or G jack on the 5CT1N and the ground to the E or S jack. It is suggested that a BNC male to dual binding post adapter and two patch cords with banana plug connectors be used.

c. Horizontally position the display so that both spots are visible on the CRT graticule.

d. CHECK FOR—Horizontal separation of spots as shown in Table 3-2 ±0.5 division (±0.25 division for the 20 V/div deflection factor) for all the settings of the

 Ⓐ

TABLE 3-2

Check Horizontal Display Amplifier Accuracy

X10 Pushbutton	.5 V-2 V Pushbutton	Horiz. Deflection Factor	Standard Amplitude Calibrator	Horizontal Separation
Out	Out	.5 V/Div	5 V	9.8 divisions
Out	In	2 V/Div	20 V	9.8 divisions
In	Out	5 V/Div	50 V	9.8 divisions
In	In	20 V/Div	100 V	5.0 divisions

.5 V-2 V and X10 pushbuttons. Note that for the 0.5,V/div, 2 V/div and 5 V/div deflection factors, the 5CT1N loads the Standard Amplitude Calibrator, causing the spot separation to be reduced 0.2 division.

e. Calibrate the CRT horizontal deflection for 5 V over the center 8 divisions. This is done by setting the Standard Amplitude Calibrator for 5 V and the 5CT1N horizontal deflection factor for 0.5 V/division. Then adjust the time-base unit Cal control for a spot separation of 7.8 divisions.

f. Disconnect the Standard Amplitude Calibrator from the 5CT1N.

2. Check/Adjust Vertical Display Amplifier

a. Set the 5CT1N and Oscilloscope System controls as follows:

5CT1N

POSITION	Centered
COLLECTOR/ DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V-2 V	Pushbutton out
VERTICAL	50 μA/DIV
÷1000	Pushbutton in
STEP AMPL	1 mA/STEP
STEP	Fully counterclockwise
STEP OFFSET	Pull-switch in
NPN, N CH-PNP, P CH	Pushbutton out
XSTR-FET	Pushbutton out

Oscilloscope System

Vertical Display	Off
Horizontal Display	Alternate
Horizontal Position	Control Centered
Horizontal Seconds/Div or Volts/Div	50 mV/Div

b. Center the spot on the CRT both horizontally and vertically.

c. Switch the VERTICAL switch back and forth between the 50 μA/DIV and 100 μA/DIV positions.

d. ADJUST—R194, the VERT AMP BAL adjustment (see Fig. 3-1), for no vertical shift in spot between the two positions of the VERTICAL switch.

e. Turn the COLLECTOR/DRAIN VOLTS control fully clockwise and set the VERTICAL switch to one of the positions shown in Table 3-3. Connect the resistor shown in the table for that switch position between the C or G and the E or S jacks. Position the left end of the trace at the intersection of the second vertical graticule line on the left of the CRT and the second horizontal graticule line from the bottom of the CRT.

TABLE 3-3

Check Vertical Display Amplifier Accuracy

VERTICAL	÷1000	Resistor Value
10 mA/DIV	In	100 Ω
1 mA/DIV	In	1 kΩ
100 μA/DIV	In	10 kΩ
50 μA/DIV	In	20 kΩ
20 μA/DIV	In	50 kΩ
10 μA/DIV	In	100 kΩ
10 μA/DIV	Out	100 kΩ
5 μA/DIV	Out	200 kΩ
500 nA/DIV	Out	2 MΩ
50 nA/DIV	Out	20 MΩ

f. CHECK FOR—Trace slope, 5 divisions ±0.25 division, for 8 divisions (5 volts) of horizontal movement. (The top of the trace should intersect the second vertical graticule line from the right and the third horizontal graticule line from the top.

g. Repeat parts e and f for all the non-leakage (÷1000 pushbutton in) positions of the VERTICAL switch.

h. Release the ÷1000 pushbutton and repeat parts e and f for all the leakage positions of the VERTICAL switch.

When measuring leakage current, a spot is displayed, rather than a trace. The COLLECTOR/DRAIN VOLTS control must, therefore, be turned counterclockwise until the spot can be positioned onto the intersection of the second vertical and horizontal graticule lines from the left and bottom, respectively. Once the position of the spot has been established, the COLLECTOR/DRAIN VOLTS control can be turned clockwise to obtain the current at 5 volts. The spot may be shaped like an X. In such cases make measurements from the top right of the display.

i. Remove the resistor connected to the device testing jacks.

3. Check/Adjust Base-Gate Step Generator

a. Set the 5CT1N and Oscilloscope System Controls as follows:

5CT1N

POSITION	Fully Clockwise
COLLECTOR/ DRAIN VOLTS	Fully Counterclockwise
X10	Pushbutton Out
.5 V-2 V	Pushbutton Out
VERTICAL	20 mA/DIV
÷1000	Pushbutton In
STEP AMPL	5 mV/STEP
STEPS	Fully counterclockwise
STEP OFFSET	Pull-switch In
NPN, N CH- PNP, P CH	Pushbutton In
XSTR-FET	Pushbutton In

Oscilloscope System

Vertical Display	On
Vertical Input Coupling	Ground
Vertical Volts/Div	5 mV/Div
Horizontal Display	Chop
Horizontal Position	Control Centered
Horizontal Seconds/Div or Volts/Div	5 ms/Div
Triggering	Auto, +Slope

b. Connect a cable between the C or G jack of the 5CT1N and the external input to the vertical unit in the Oscilloscope System.

c. Vertically position the trace to the center horizontal graticule line and release the ground pushbutton on the vertical unit.

d. CHECK FOR—Vertical shift in the trace within ±0.3 division. If noise makes this check difficult, a probe or coaxial cable can be used in place of the patch cord.

e. ADJUST—R139, the 1-5 μA BAL adjustment (see Fig. 3-1), to move the trace to the center horizontal gracitule line.

f. Press the ground pushbutton on the vertical unit and repeat parts c through e for the other adjustments in Table 3-4. Note that the 5CT1N STEP AMPL switch and the vertical unit volts/div switch will have to be changed for each adjustment.

TABLE 3-4

Adjust Zero Step Level

STEP AMPL	Volts/Div	Adjustment
50 mV/STEP	50 mV/Div	R158 (10-50 μA BAL)
.5 V/STEP	0.5 V/Div	R155 (100-500 μA BAL)
1 V/STEP	1 V/Div	R152 (1 mA BAL)

g. Turn the 5CT1N STEP control fully clockwise. Trigger the display and position the zero step to the bottom horizontal graticule line.

h. CHECK FOR—Eighth step on the top horizontal graticule line ±0.4 division (one step per vertical division).

i. ADJUST—R90, the V/STEP CAL adjustment (see Fig. 3-1), so that the eighth step is on the top horizontal graticule line.

j. Set the vertical unit volts/div switch to .2 volts/div.

k. CHECK FOR—Step increments of 5 divisions ±0.15 division for the first three steps. (Additional steps can be checked by using the STEP OFFSET control.)

l. Set the 5CT1N STEP AMPL and vertical unit volts/div switch as shown in Table 3-5. For each setting of the STEP AMPL switch, position the zero step on the bottom horizontal graticule line.

m. CHECK FOR—Eighth step on the top horizontal graticule line ±0.4 division for each setting on the STEP AMPL switch in Table 3-5. Noise received through the unshielded patch cord may cause measurement difficulty

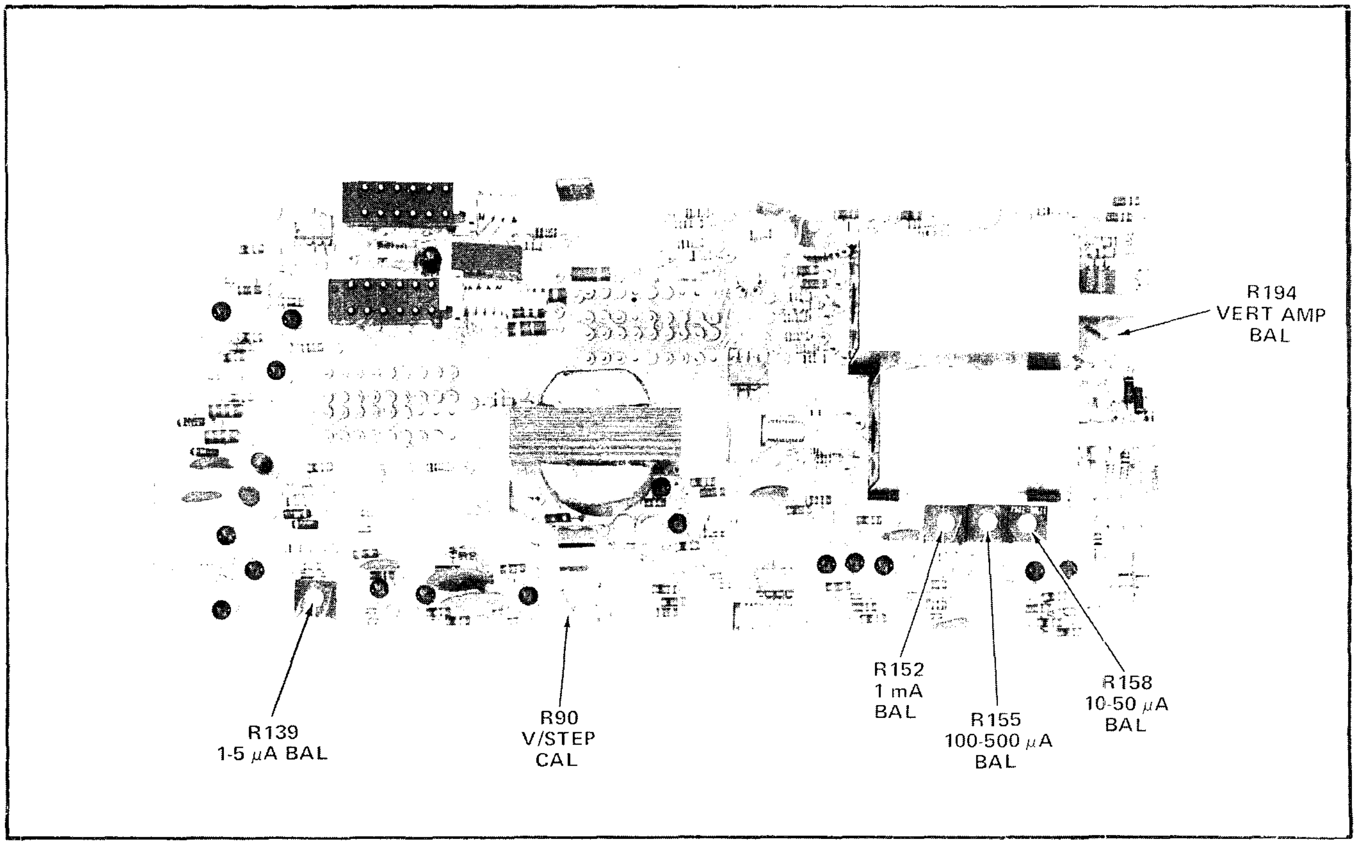


Fig. 3-1. Location of internal adjustments for the 5CT1N.

for the lower voltage steps. In such cases, replace the patch cord with a shielded cable.

TABLE 3-5

Check Step Amplitude Accuracy

STEP AMPL	Volts/Div
1 mV/STEP	1 mV/Div
2 mV/STEP	2 mV/Div
5 mV/STEP	5 mV/Div
10 mV/STEP	10 mV/Div
20 mV/STEP	20 mV/Div
50 mV/STEP	50 mV/Div
.1 V/STEP	0.1 V/Div
.2 V/STEP	0.2 V/Div
.5 V/STEP	0.5 V/Div

n. Set the 5CT1N STEP AMPL switch to 1 volt/step and the vertical unit volts/div switch to 2 volts. Vertically center the zero step on the CRT graticule. Pull the 5CT1N STEP OFFSET pull-switch and turn it throughout its range.

o. CHECK FOR—At least 2.5 divisions of offset both above and below the center horizontal graticule line.

p. CHECK FOR—At least 10 steps in the display.

q. Push in the 5CT1N STEP OFFSET pull-switch and release the NPN, N CH-PNP, P CH pushbutton.

r. CHECK FOR—Negative-going steps (the Oscilloscope System may have to be retriggered).

s. Disconnect the 5CT1N from the input to the vertical unit.

4. Check Collector-Drain Supply

a. Set the 5CT1N and Oscilloscope System controls as follows:

5CT1N

POSITION	Centered
COLLECTOR/ DRAIN VOLTS	Fully counterclockwise
X10	Pushbutton out
.5 V-2 V	Pushbutton out
VERTICAL	20 mA/DIV
÷1000	Pushbutton in
STEP AMPL	1 mA/STEP
STEP	Fully counterclockwise
STEP OFFSET	Pull-switch in
NPN, N CH-PNP, P CH	Pushbutton out
XSTR-FET	Pushbutton out

Oscilloscope System

Vertical Display	Off
Horizontal Display	Alternate
Horizontal Position	Centered
Horizontal Seconds/Div or Volts/Div	50 mV/Div

TABLE 3-6

Check Collector-Drain Supply Peak Current

X10 Pushbutton	.5 V-2 V Pushbutton	VERTICAL Switch
Out	In	5 mA/DIV
In	Out	2 mA/DIV
In	In	.5 mA/DIV

b. Position the spot to the first vertical graticule line on the left. Turn the COLLECTOR/DRAIN VOLTS control clockwise to obtain a trace 10 divisions long, then adjust the time-base unit Cal control to reduce the trace length to 5 divisions. (Reposition the left end of the trace to the left of the CRT graticule.) Turn the COLLECTOR/DRAIN VOLTS control fully clockwise.

c. CHECK FOR—Trace length of 7.5 divisions ±1.5 divisions (±20%).

d. Set the .5 V-2 V and X10 pushbuttons for the other 3 collector-drain supply ranges and repeat part c for each range.

e. Reset the following 5CT1N controls as follows:

COLLECTOR/ DRAIN VOLTS	Fully Counterclockwise
.5 V-2 V	Pushbutton Out
X10	Pushbutton Out

f. Connect a short between the C or G and the E or S jacks. Position the spot to the center of the bottom horizontal graticule line. Turn the COLLECTOR/DRAIN VOLTS control clockwise to obtain a vertical trace of 8 divisions.

g. CHECK FOR—Trace tilt less than 0.4 division horizontally, over total length of trace.

h. Vertically position the top of the trace to the bottom horizontal graticule line and turn the COLLECTOR/DRAIN VOLTS control fully clockwise.

i. CHECK FOR—End of trace on the center horizontal graticule line ±3.6 divisions (±30%).

j. Set the .5 V-2 V and X10 pushbuttons and the VERTICAL switch as shown in Table 3-6 for the other 3 collector-drain supply ranges. Repeat part i for each range.

k. Turn the COLLECTOR/DRAIN VOLTS control fully counterclockwise, remove the short and reposition the spot to the lower left corner of the CRT graticule. (Reset the time-base unit Cal control to its calibrated position.) Press the NPN, N CH-PNP, P CH pushbutton.

l. CHECK FOR—Spot moving to the top right corner of the CRT graticule within 0.3 division vertically and horizontally. (The display amplifiers in the oscilloscope mainframe must be properly adjusted to perform this check.)

m. Turn the COLLECTOR/DRAIN VOLTS control fully clockwise.

n. CHECK FOR—Trace extending right to left, indicating that the polarity of the collector-drain supply voltage has been switched to negative.

This completes the 5CT1N Check/Adjust procedure.

SECTION 4

DIAGRAMS AND PARTS LISTS

Symbols and Reference Designators

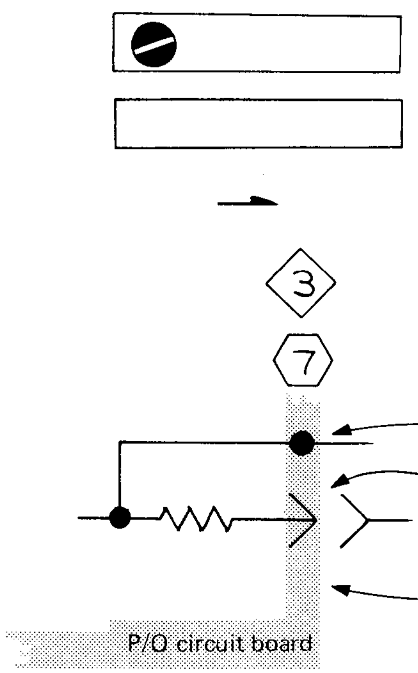
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



External Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

Refer to waveform number indicated in hexagon.

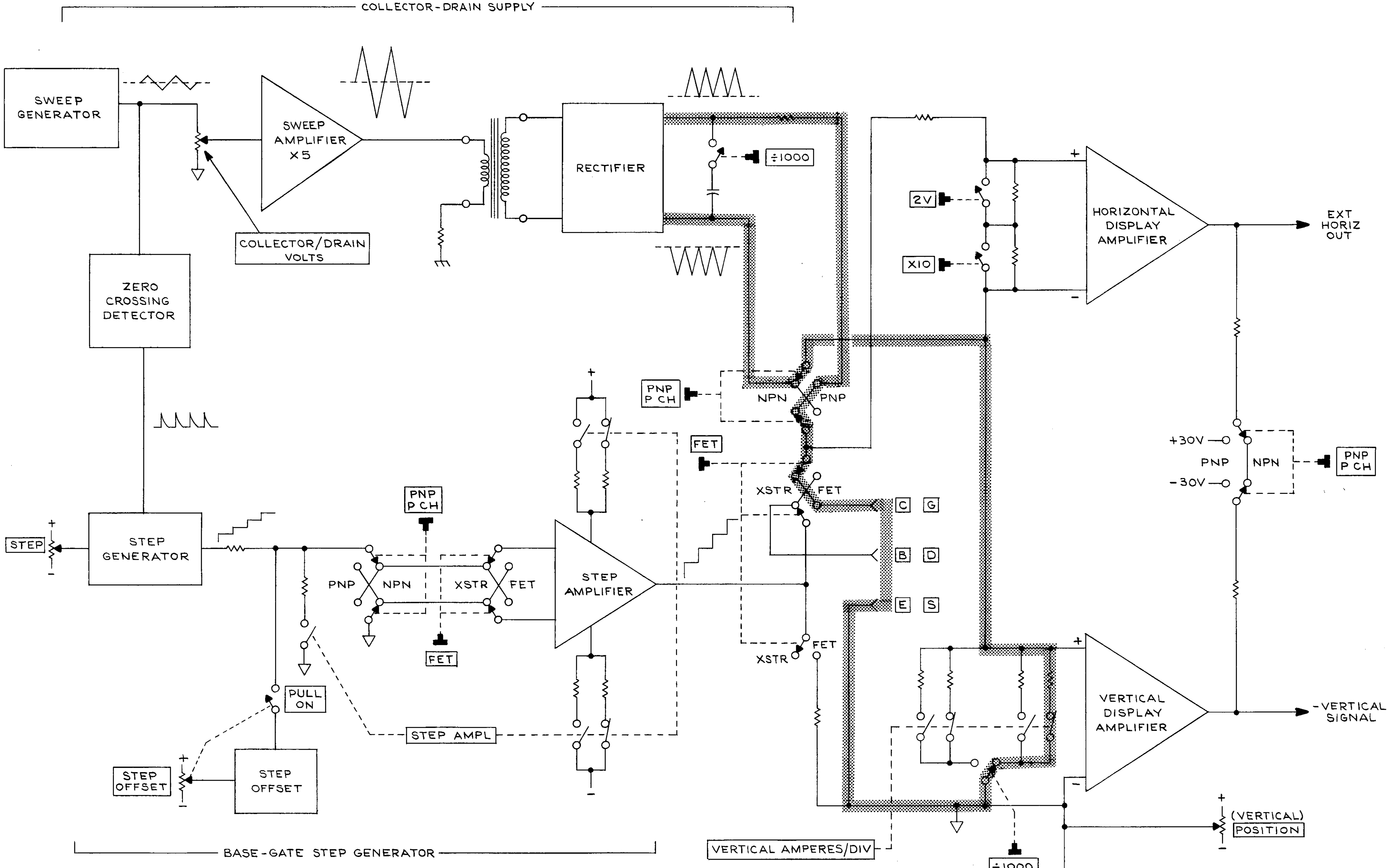
Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

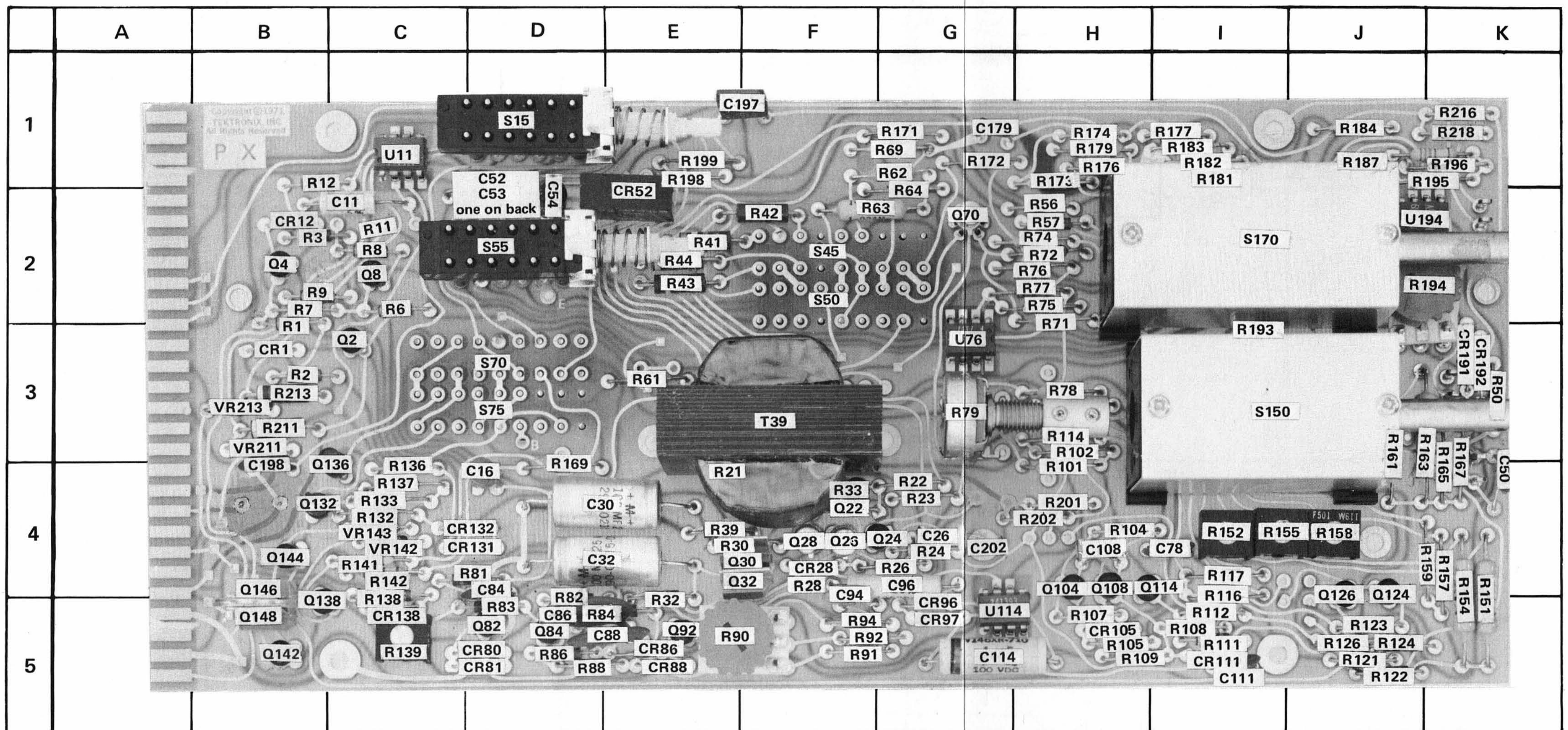
A	Assembly, separable or repairable (circuit board, etc.)
AT	Attenuator, fixed or variable
B	Motor
BT	Battery
C	Capacitor, fixed or variable
CR	Diode, signal or rectifier
DL	Delay line
DS	Indicating device (lamp)
F	Fuse
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc.)
HR	Heater
J	Connector, stationary portion
K	Relay
L	Inductor, fixed or variable
LR	Inductor/resistor combination
M	Meter
Q	Transistor or silicon-controlled rectifier
P	Connector, movable portion
R	Resistor, fixed or variable
RT	Thermistor
S	Switch
T	Transformer
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
V	Electron tube
VR	Voltage regulator (zener diode, etc.)
Y	Crystal



COLLECTOR-DRAIN SUPPLY CURRENT PATH WITH PNP P CH & FET PUSHBUTTONS OUT

BLOCK DIAGRAM

MAIN CIRCUIT BOARD LOCATION GRID



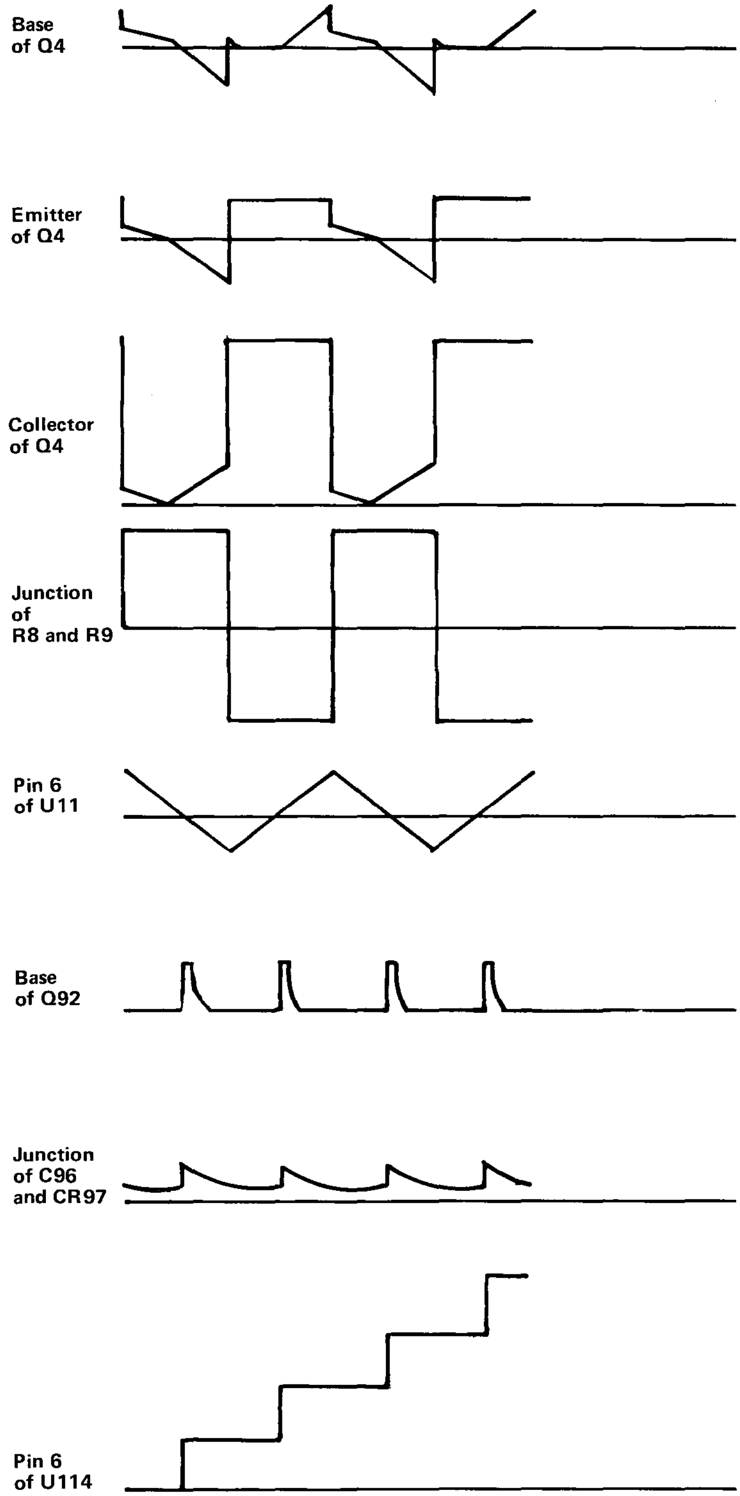
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C11	C2	CR1	B3	Q2	C3	R1	B2	R57	H2	R102	H3	R152	I4	R195	K1	S15	D1	T39	F3	U11	C1
C16	D4	CR12	B2	Q4	B2	R2	B3	R61	E3	R104	H4	R154	K5	R196	K1	S45	F2			U76	G3
C26	G4	CR28	F4	Q8	C2	R3	B2	R62	G1	R105	H5	R155	I4	R197	K1	S50	F2			U114	G5
C30	D4	CR52	E2	Q22	F4	R6	C2	R63	F2	R107	H5	R157	K4	R198	E1	S55	D2			U194	K2
C32	D4	CR80	D5	Q24	G4	R7	B2	R64	G2	R108	I5	R158	J4	R199	E1	S70	D3				
C50	K4	CR81	D5	Q26	F4	R8	C2	R69	G1	R109	H5	R159	K4	R201	H4	S75	D3				
C52	D2	CR86	E5	Q28	F4	R9	B2	R71	H2	R111	I5	R161	J3	R202	H4	S150	I3				
C53	D2	CR88	E5	Q30	F4	R11	C2	R72	H2	R112	I5	R163	J3	R211	B3	S170	J2				
C54	D2	CR96	G5	Q32	F4	R12	B1	R74	H2	R114	H3	R165	K4	R213	B3						
C78	I4	CR97	G5	Q70	G2	R21	E4	R75	H2	R116	I5	R167	K4	R216	K1						
C84	D4	CR105	H5	Q82	D5	R22	G4	R76	H2	R117	I4	R169	D4	R218	K1						
C86	D5	CR111	I5	Q84	D5	R23	G4	R77	H2	R121	J5	R171	G1								
C88	E5	CR131	D4	Q92	E5	R24	G4	R78	H3	R122	J5	R172	G1								
C94	F5	CR132	D4	Q104	H4	R26	G4	R79	G3	R123	J5	R173	H1								
C96	G4	CR138	C5	Q108	H4	R28	F4	R81	D4	R124	J5	R174	H1								
C108	H4	CR191	K3	Q114	H4	R30	E4	R82	D5	R126	J5	R176	H1								
C111	I5	CR192	K3	Q124	J5	R32	E5	R83	D5	R132	C4	R177	I1								
C114	G5	VR142	C4	Q126	J5	R33	F4	R84	E5	R133	C4	R179	H1								
C179	G1	VR143	C4	Q132	B4	R39	E4	R86	D5	R136	C4	R181	I1								
C197	E1	VR211	B3	Q136	C4	R41	E2	R88	D5	R137	C4	R182	I1								
C198	B4	VR213	B3	Q138	B5	R42	F2	R90	E5	R138	C4	R183	I1								
C202	G4			Q142	B5	R43	E2	R91	F5	R139	C5	R184	J1								
				Q144	B5	R44	E2	R92	F5	R141	C4	R187	J1								
				Q146	B4	R50	K3	R94	F5	R142	C4	R193	I3								
				Q148	B4	R56	H2	R101	H4	R151	K5	R194	J1								

Instruments with Serial No.
B010100 – B010159

R21 and R28 on back of board.

Positions of R33 and Q22 reversed.

C202 located between R23 and R201.


Base of Q4
Emitter of Q4
Collector of Q4
Junction of R8 and R9
Pin 6 of U11
Base of Q92
Junction of C96 and CR97
Pin 6 of U114

ELECTRICAL PARTS LIST

Replacement parts should be ordered from the Tektronix Field Office or Representative in your area. Changes to Tektronix products give you the benefit of improved circuits and components. Please include the instrument type number and serial number with each order for parts or service.

ABBREVIATIONS AND REFERENCE DESIGNATORS

A	Assembly, separable or repairable	FL	Filter	PTM	paper or plastic, tubular molded
AT	Attenuator, fixed or variable	H	Heat dissipating device (heat sink, etc.)	R	Resistor, fixed or variable
B	Motor	HR	Heater	RT	Thermistor
BT	Battery	J	Connector, stationary portion	S	Switch
C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A1	670-1893-00			MAIN Circuit Board Assembly
CAPACITORS				
C11	285-0683-00			0.022 μF, PTM, 100 V, 5%
C16	290-0530-00			68 μF, Elect., 6 V, 20%
C26	281-0525-00			470 pF, Cer, 500 V, 20%
C30	290-0215-00			100 μF, Elect., 25 V
C32	290-0215-00			100 μF, Elect., 25 V
C50	283-0211-00	B010100	B020452	0.1 μF, Cer, 200 V, 10%
C50	290-0480-00	B020453		0.5 μF, Elect., 200 V
C52	290-0480-00			0.5 μF, Elect., 200 V
C53	290-0480-00			0.5 μF, Elect., 200 V
C54	290-0528-00			15 μF, Elect., 50 V, 20%
C78	283-0003-00			0.01 μF, Cer, 150 V, +80%-20%
C84	283-0003-00			0.01 μF, Cer, 150 V, +80%-20%
C86	283-0092-00			0.03 μF, Cer, 200 V, +80%-20%
C88	283-0092-00			0.03 μF, Cer, 200 V, +80%-20%
C94	283-0023-00			0.1 μF, Cer, 10 V, +80%-20%
C96	285-0683-00			0.022 μF, PTM, 100 V, 5%
C108	281-0525-00			470 pF, Cer, 500 V, 20%
C111	283-0110-00	B010100	B010194	0.005 μF, Cer, 150 V
C111	283-0080-00	B010195		0.022 μF, Cer, 25 V, +80%-20%
C114	285-0703-00			0.1 μF, PTM, 100 V, 5%
C179	283-0203-00			0.47 μF, Cer, 50 V, 20%
C197	283-0164-00			2.2 μF, Cer, 25 V, 20%
C198	283-0003-00			0.01 μF, Cer, 150 V, +80%-20%
C202	283-0003-00			0.01 μF, Cer, 150 V, +80%-20%

Electrical Parts List (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
SEMICONDUCTOR, DIODES				
CR1	152-0141-02			Silicon, replaceable by 1N4152
CR12	152-0141-02			Silicon, replaceable by 1N4152
CR28	152-0141-02			Silicon, replaceable by 1N4152
CR52	152-0488-00			Silicon, rectifier bridge
CR80	152-0141-02			Silicon, replaceable by 1N4152
CR81	152-0141-02			Silicon, replaceable by 1N4152
CR86	152-0141-02			Silicon, replaceable by 1N4152
CR88	152-0141-02			Silicon, replaceable by 1N4152
CR96	152-0141-02			Silicon, replaceable by 1N4152
CR97	152-0141-02			Silicon, replaceable by 1N4152
CR105	152-0141-02			Silicon, replaceable by 1N4152
CR111	152-0141-02			Silicon, replaceable by 1N4152
CR131	152-0141-02			Silicon, replaceable by 1N4152
CR132	152-0141-02			Silicon, replaceable by 1N4152
CR138	152-0141-02			Silicon, replaceable by 1N4152
CR191	152-0246-00			Silicon, replaceable by CD12676 or FD3375
CR192	152-0246-00			Silicon, replaceable by CD12676 or FD3375
VR142	152-0243-00			Zener, replaceable by 1N965B, 400 mW, 15 V, 5%
VR143	152-0243-00			Zener, replaceable by 1N965B, 400 mW, 15 V, 5%
VR211	152-0243-00			Zener, replaceable by 1N965B, 400 mW, 15 V, 5%
VR213	152-0243-00			Zener, replaceable by 1N965B, 400 mW, 15 V, 5%
BULBS				
DS50	150-0111-00			Neon, AIC, 1.2 mA
DS150	150-0111-00			Neon, AIC, 1.2 mA
DS170	150-0111-00			Neon, AIC, 1.2 mA
CONNECTOR				
P79	195-0095-00			Lead, test, BNC
TRANSISTORS				
Q2	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q4	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q8	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q22	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q24	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q26	151-0347-00			Silicon, NPN, replaceable by 2N5551
Q28	151-0347-00			Silicon, NPN, replaceable by 2N5551
Q30	151-0365-00			Silicon, NPN, replaceable by D42C8
Q32	151-0364-00			Silicon, PNP, replaceable by D43C8
Q70 A,B	151-1054-00			Silicon, FET, N channel
Q82	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q84	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q92	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q104	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q108	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q114	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q124	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q126	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q132	151-0254-00			Silicon, NPN, replaceable by 2N5308
Q136	151-0254-00			Silicon, NPN, replaceable by 2N5308
Q138	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q142	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q144	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q146	151-0364-00			Silicon, PNP, replaceable by D43C8
Q148	151-0365-00			Silicon, NPN, replaceable by D42C8

Electrical Parts List (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS				
R1	315-0303-00			30 kΩ, 1/4 W, 5%
R2	315-0623-00			62 kΩ, 1/4 W, 5%
R3	315-0912-00			9.1 kΩ, 1/4 W, 5%
R6	315-0391-00			390 Ω, 1/4 W, 5%
R7	315-0822-00			8.2 kΩ, 1/4 W, 5%
R8	315-0391-00			390 Ω, 1/4 W, 5%
R9	315-0303-00			30 kΩ, 1/4 W, 5%
R11	321-0481-00			1 MΩ, 1/8 W, 1%
R12	315-0103-00			10 kΩ, 1/4 W, 5%
R20	311-1220-00			20 kΩ, Var
R21	316-0562-00			5.6 kΩ, 1/4 W, 10%
R22	315-0103-00			10 kΩ, 1/4 W, 5%
R23	316-0222-00			2.2 kΩ, 1/4 W, 10%
R24	315-0471-00			470 Ω, 1/4 W, 5%
R26	315-0303-00			30 kΩ, 1/4 W, 5%
R28	316-0102-00			1 kΩ, 1/4 W, 10%
R30	315-0241-00			240 Ω, 1/4 W, 5%
R32	315-0241-00			240 Ω, 1/4 W, 5%
R33	316-0473-00			47 kΩ, 1/4 W, 10%
R39	316-0270-00			27 Ω, 1/4 W, 10%
R41	301-0393-00			39 kΩ, 1/2 W, 5%
R42	301-0222-00			2.2 kΩ, 1/2 W, 5%
R43	301-0241-00			240 Ω, 1/2 W, 5%
R44	307-0023-00			4.7 Ω, 1/2 W, 10%
R50	316-0335-00			3.3 MΩ, 1/4 W, 10%
R56	315-0912-00			9.1 kΩ, 1/4 W, 5%
R57	316-0222-00			2.2 kΩ, 1/4 W, 10%
R61	321-0677-00			30.4 kΩ, 1/8 W, 1/2%
R62	321-0386-00			102 kΩ, 1/8 W, 1%
R63	322-0684-09			1.024 MΩ, 1/4 W, 1/2%
R64	321-0432-00			309 kΩ, 1/8 W, 1%
R69	321-0243-00			3.32 kΩ, 1/8 W, 1%
R71	321-0347-00			40.2 kΩ, 1/8 W, 1%
R72	321-0355-00			48.7 kΩ, 1/8 W, 1%
R74	321-0347-00			40.2 kΩ, 1/8 W, 1%
R75	321-0355-00			48.7 kΩ, 1/8 W, 1%
R76	321-0358-00			52.3 kΩ, 1/8 W, 1%
R77	321-0358-00			52.3 kΩ, 1/8 W, 1%
R78	321-0612-02			500 Ω, 1/8 W, 1/2%
R79	321-0685-00			30 kΩ, 1/8 W, 1/2%
R81	316-0562-00			5.6 kΩ, 1/4 W, 10%
R82	316-0222-00			2.2 kΩ, 1/4 W, 10%
R83	316-0153-00			15 kΩ, 1/4 W, 10%
R84	316-0222-00			2.2 kΩ, 1/4 W, 10%
R86	315-0103-00			10 kΩ, 1/4 W, 5%
R88	315-0103-00			10 kΩ, 1/4 W, 5%
R90	311-1154-00			1 kΩ, Var
R91	316-0332-00	B010100	B019999	3.3 kΩ, 1/4 W, 10%
R91	315-0202-00	B020000		2 kΩ, 1/4 W, 5%
R92	316-0102-00			1 kΩ, 1/4 W, 10%
R94	316-0101-00			100 Ω, 1/4 W, 10%

Electrical Parts List (cont)

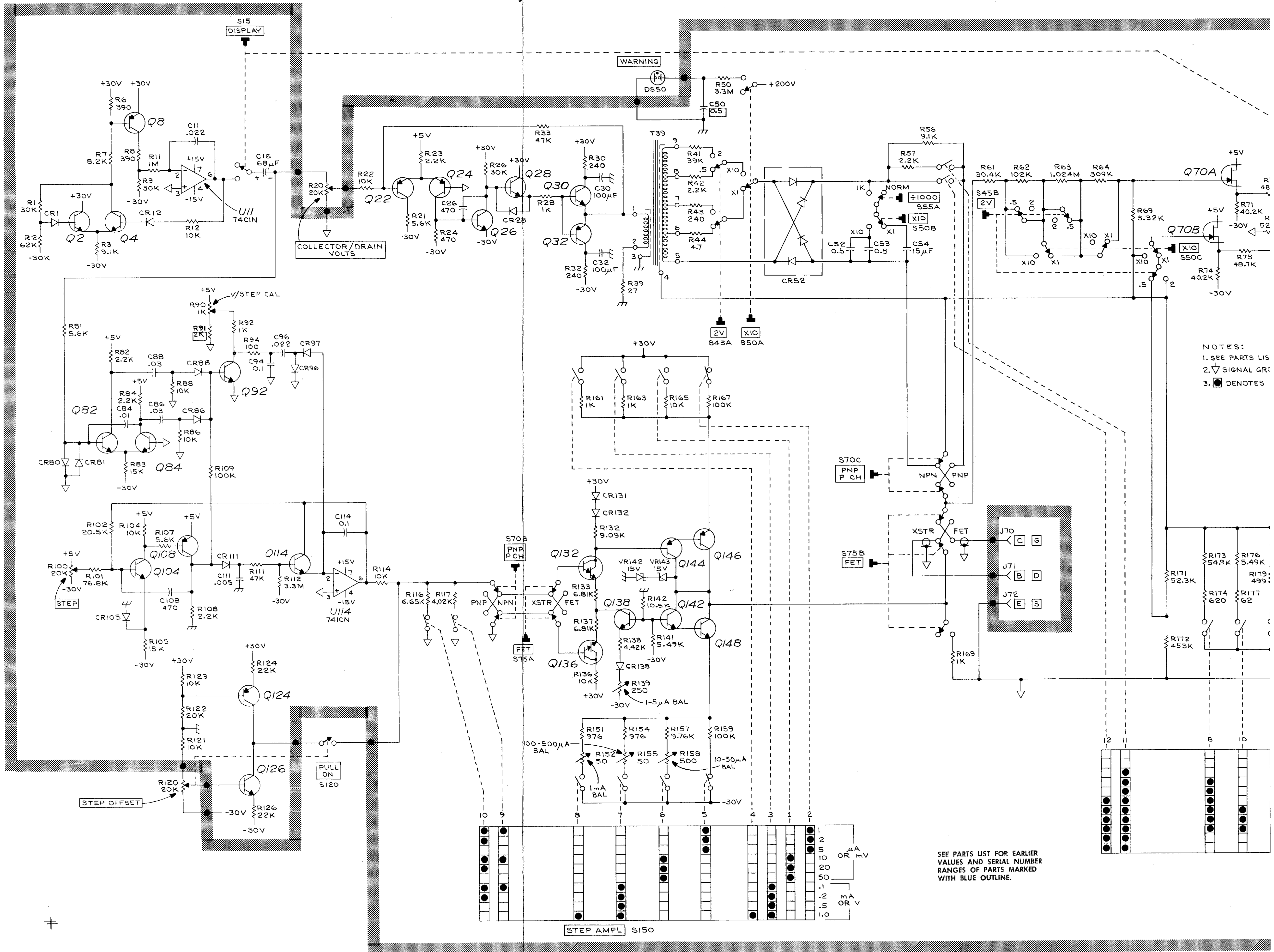
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R100	311-1220-00			20 kΩ, Var
R101	321-0374-00			76.8 kΩ, 1/8 W, 1%
R102	321-0319-00			20.5 kΩ, 1/8 W, 1%
R104	315-0103-00			10 kΩ, 1/4 W, 5%
R105	316-0153-00			15 kΩ, 1/4 W, 10%
R107	316-0562-00			5.6 kΩ, 1/4 W, 10%
R108	316-0222-00			2.2 kΩ, 1/4 W, 10%
R109	316-0104-00			100 kΩ, 1/4 W, 10%
R111	316-0473-00			47 kΩ, 1/4 W, 10%
R112	316-0335-00			3.3 MΩ, 1/4 W, 10%
R114	321-0289-00			10 kΩ, 1/4 W, 1%
R116	321-0272-00			6.65 kΩ, 1/8 W, 1%
R117	321-0251-00			4.02 kΩ, 1/8 W, 1%
R120[1]	311-1310-00			20 kΩ, Var
R121	315-0103-00			10 kΩ, 1/4 W, 5%
R122	315-0203-00			20 kΩ, 1/4 W, 5%
R123	315-0103-00			10 kΩ, 1/4 W, 5%
R124	315-0223-00			22 kΩ, 1/4 W, 5%
R126	315-0223-00			22 kΩ, 1/4 W, 5%
R132	321-0285-00			9.09 kΩ, 1/8 W, 1%
R133	321-0273-00			6.81 kΩ, 1/8 W, 1%
R136	315-0103-00			10 kΩ, 1/4 W, 5%
R137	321-0273-00			6.81 kΩ, 1/8 W, 1%
R138	321-0255-00			4.42 kΩ, 1/8 W, 1%
R139	311-1223-00			250 Ω, Var
R141	321-0264-00			5.49 kΩ, 1/8 W, 1%
R142	321-0291-00			10.5 kΩ, 1/8 W, 1%
R151	323-0192-00			976 Ω, 1/2 W, 1%
R152	311-1221-00			50 Ω, Var
R154	323-0192-00			976 Ω, 1/2 W, 1%
R155	311-1221-00			50 Ω, Var
R157	321-0288-00			9.76 kΩ, 1/8 W, 1%
R158	311-1224-00			500 Ω, Var
R159	321-0645-00			100 kΩ, 1/8 W, 1/2%
R161	323-0193-01			1 kΩ. 1/2 W, 1/2%
R163	323-0193-01			1 kΩ, 1/2 W, 1/2%
R165	321-0289-01			10 kΩ, 1/8 W, 1/2%
R167	321-0645-00			100 kΩ, 1/8 W, 1/2%
R169	321-0193-00			1 kΩ, 1/8 W, 1%
R171	321-0358-00			52.3 kΩ, 1/8 W, 1%
R172	321-0448-00			453 kΩ, 1/8 W, 1%
R173	321-0360-00			54.9 kΩ, 1/8 W, 1%
R174	315-0621-00			620 Ω, 1/4 W, 5%
R176	321-0264-00			5.49 kΩ, 1/8 W, 1%
R177	315-0620-00			62 Ω, 1/4 W, 5%
R179	321-0164-00			499 Ω, 1/8 W, 1%
R181	321-0005-00			11 Ω, 1/8 W, 1%
R182	321-0005-00			11 Ω, 1/8 W, 1%

[1]Furnished as a unit with S120.

Electrical Parts List (cont)

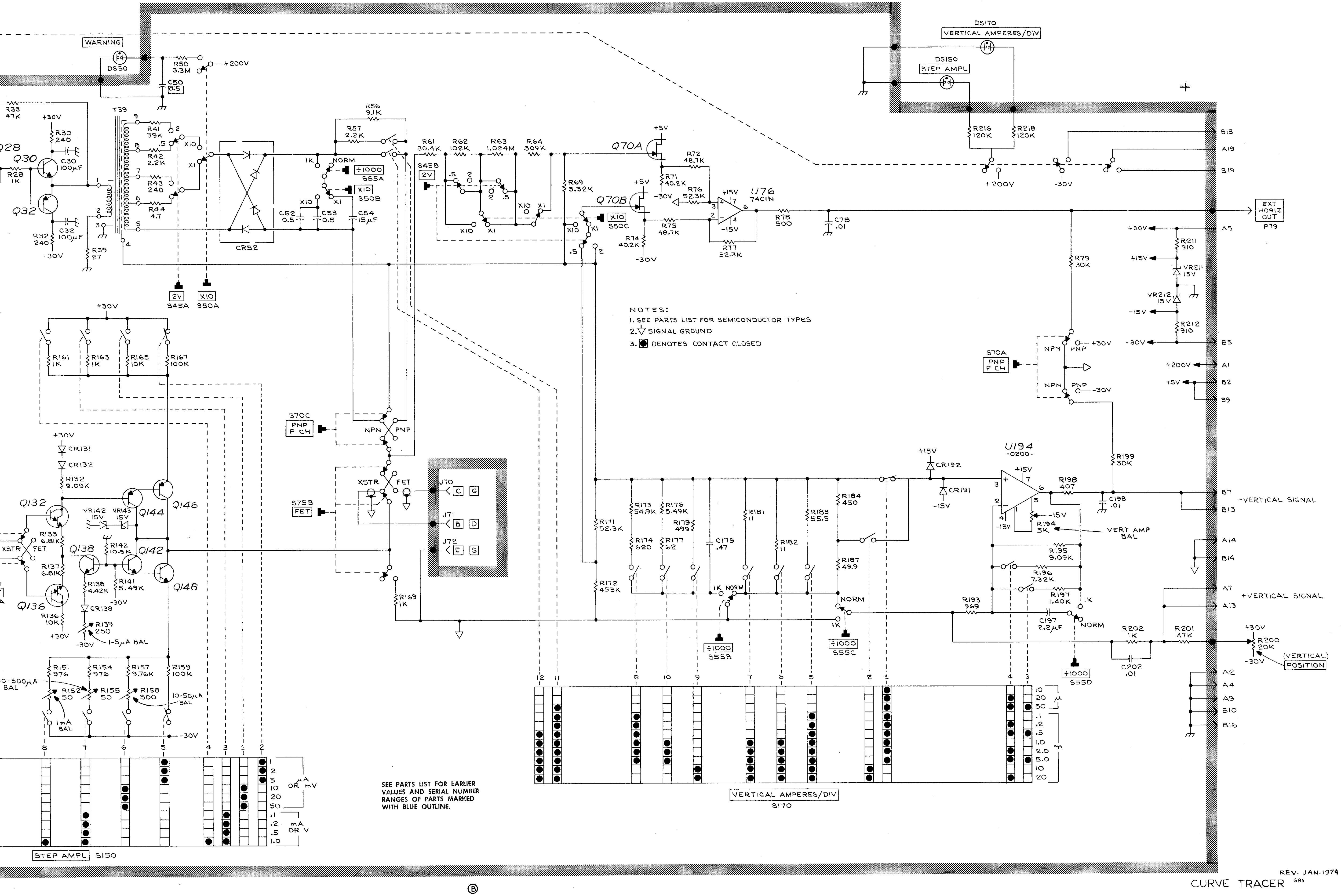
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R183	321-0750-06			55.5 Ω, 1/8 W, 1/4%
R184	321-0749-06			450 Ω, 1/8 W, 1/4%
R187	321-0068-00			49.9 Ω, 1/8 W, 1%
R193	321-0765-01			969 Ω, 1/8 W, 1/2%
R194	311-1153-00			5 kΩ, Var
R195	321-0285-00			9.09 kΩ, 1/8 W, 1%
R196	321-0276-00			7.32 kΩ, 1/8 W, 1%
R197	321-0207-00			1.4 kΩ, 1/8 W, 1%
R198	321-1155-02			407 Ω, 1/8 W, 1/2%
R199	321-0685-00			30 kΩ, 1/8 W, 1/2%
R200	311-1220-00			20 kΩ, Var
R201	316-0473-00			47 kΩ, 1/4 W, 10%
R202	316-0102-00			1 kΩ, 1/4 W, 10%
R211	301-0911-00			910 Ω, 1/2 W, 5%
R213	301-0911-00			910 Ω, 1/2 W, 5%
R216	316-0124-00			120 kΩ, 1/4 W, 10%
R218	316-0124-00			120 kΩ, 1/4 W, 10%
SWITCHES				
S15	260-1209-00			Pushbutton, DISPLAY
S45 S50	260-1356-00			Pushbutton, 2 V X10
S55	260-1209-00			Push-push, ÷1000
S70 S75	260-1356-00			Pushbutton, PNP, P CH FET
S120[1]				PULL ON
S150	105-0308-00			Cam, STEP AMPL
S170	105-0307-00			Cam, VERTICAL AMPERES/DIV
TRANSFORMER				
T39	120-0756-00			Collector sweep
INTEGRATED CIRCUITS				
U11	156-0067-00			Operational amplifier, replaceable by UA741C
U76	156-0067-00			Operational amplifier, replaceable by UA741C
U114	156-0067-00			Operational amplifier, replaceable by UA741C
U194	156-0200-00			Operational amplifier, replaceable by N5556V

[1]Furnished as a unit with R120.


NOTES:
1. SEE PARTS LIS
2. SIGNAL GRO
3. DENOTES
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
STEP AMPL S150
STEP OFFSET
COLLECTOR/DRAIN VOLTS
S15 DISPLAY
WARNING

5CT1N

Scan by Zenith



NOTES:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
2. ▽ SIGNAL GROUND
3. ● DENOTES CONTACT CLOSED

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

CURVE TRACER

REV. JAN. 1974

CURVE TRACER

MECHANICAL PARTS LIST

Replacement parts should be ordered from the Tektronix Field Office or Representative in your area. Changes to Tektronix products give you the benefit of improved circuits and components. Please include the instrument type number and serial number with each order for parts or service.

ABBREVIATIONS

BHB	binding head brass	h	height or high	OHB	oval head brass
BHS	binding head steel	hex.	hexagonal	OHS	oval head steel
CRT	cathode-ray tube	HHB	hex head brass	PHB	pan head brass
csk	countersunk	HHS	hex head steel	PHS	pan head steel
DE	double end	HSB	hex socket brass	RHS	round head steel
FHB	flat head brass	HSS	hex socket steel	SE	single end
FHS	flat head steel	ID	inside diameter	THB	truss head brass
Fil HB	fillister head brass	lg	length or long	THS	truss head steel
Fil HS	fillister head steel	OD	outside diameter	w	wide or width

FIGURE 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-1	366-0494-00			1	KNOB, charcoal--POSITION
	- - - - - -			-	knob includes:
	213-0153-00			1	SETSCREW, 5-40 x 0.125 inch, HSS
-2	366-0494-00			1	KNOB, charcoal--COLLECTOR/DRAIN VOLTS
	- - - - - -			-	knob includes:
	213-0153-00			1	SETSCREW,5-40 x 0.125 inch, HSS
-3	366-0494-00			1	KNOB, charcoal--STEP OFFSET
	- - - - - -			-	knob includes:
	213-0153-00			1	SETSCREW,5-40 x 0.125 inch, HSS
-4	366-1382-00			1	KNOB, gray--1000
	- - - - - -			-	knob includes;
	213-0153-00			1	SETSCREW, 5-40 x 0.125 inch, HSS
-5	366-1375-00			1	KNOB, charcoal--VERTICAL
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-6	366-0494-02			1	KNOB, charcoal--STEP
	- - - - - -			-	knob includes:
	213-0153-00			1	SETSCREW, 5-40 x 0.125 inch, HSS
-7	366-1376-00			1	KNOB, charcoal--STEP AMPL
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-8	366-1286-00	B010100	B019999	1	KNOB, latch
	366-1286-03	B020000		1	KNOB, latch
	- - - - - -			-	knob includes:
	214-1840-00	B020000		1	PIN, securing
-9	366-1257-14			1	PUSHBUTTON--ON
-10	366-1257-88			1	PUSHBUTTON--2 V
-11	366-1257-87			1	PUSHBUTTON--X10
-12	366-1257-76			1	PUSHBUTTON-PNP PCH-1
-13	366-1257-86			1	PUSHBUTTON--FET
-14	426-0681-00			5	FRAME, pushbutton
-15	195-0095-00			1	LEAD, test, BNC
-16	343-0144-00			1	CLAMP, cable, plastic, 0.125 inch diameter
	- - - - - -			-	mounting hardware: (not included w/clamp)
-17	211-0121-00			1	SCREW, sems, 4-40 x 0.438 inch, PHB

FIGURE 1 EXPLODED

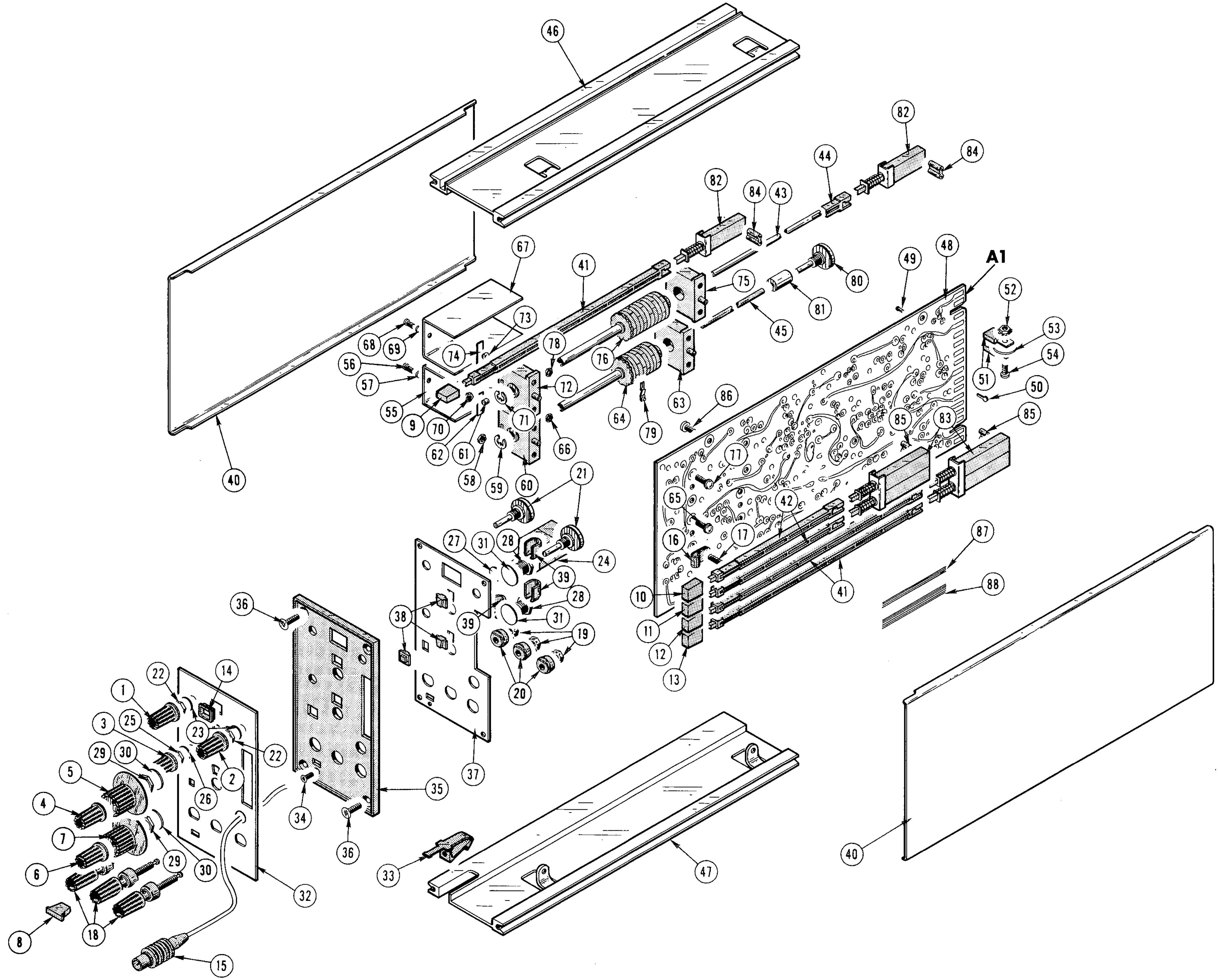
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-18	129-0064-00			3	POST, binding, charcoal
	------			-	mounting hardware for each: (not included w/post)
-19	210-0457-00			1	NUT, keps, 6-32 x 0.312 inch
-20	358-0181-00			1	BUSHING, plastic, charcoal
-21	------			2	RESISTOR, variable
	------			-	mounting hardware for each: (not included w/resistor)
-22	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-23	210-0940-00			1	WASHER, flat, 0.25 ID x 0.375 inch OD
-24	------			1	RESISTOR, variable
	------			-	mounting hardware: (not included w/resistor)
-25	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-26	210-0940-00			1	WASHER, flat, 0.25 ID x 0.375 inch OD
-27	210-0048-00			1	WASHER, lock, internal, 0.320 ID x 0.425 inch OD
-28	358-0029-00			2	BUSHING, 0.375-32 x 0.50 inch
	------			-	mounting hardware for each: (not included w/bushing)
-29	210-0590-00			1	NUT, hex., 0.375-32 x 0.50 inch
-30	210-0978-00			1	WASHER, flat, 0.375 ID x 0.50 inch OD
-31	210-0012-00			1	WASHER, lock, internal, 0.384 ID x 0.50 inch OD
-32	333-1501-00			1	PANEL, front
-33	214-1513-00	B010100	B019999	1	LATCH, plug-in retaining
	------			-	mounting hardware: (not included w/latch)
	214-1515-01	B020000		1	LATCH, plug-in retaining
	------			-	mounting hardware: (not included w/latch)
-34	213-0254-00			1	SCREW, thread forming, 2-56 x 0.25 inch, 100 deg csk, FHS
-35	386-2108-00			1	SUBPANEL, front
	------			-	mounting hardware: (not included w/subpanel)
-36	213-0229-00			4	SCREW, thread forming, 6-20 x 0.375 inch, 100° csk, FHS
-37	337-1525-00			1	SHIELD, electrical, front subpanel
-38	378-0703-00			3	LENS-HOLDER, indicator light
-39	337-1430-00			3	SHIELD, light
-40	337-1399-00			2	SHIELD, electrical side
-41	384-1059-00			3	SHAFT, extension, 6.581 inches long
-42	384-1061-00			2	SHAFT, extension, 3.981 inches long
-43	384-1125-00			1	SHAFT, extension, push-push switch
-44	103-0161-00			1	ADAPTER
	376-0051-00			1	COUPLER (not shown)
-45	384-0496-00			1	SHAFT, extension, plastic, 4.82 inches long
-46	426-0725-00			1	FRAME SECTION, top
-47	426-0724-00			1	FRAME SECTION, bottom
-48	670-1893-00			1	CIRCUIT BOARD ASSEMBLY--MAIN A1
	------			-	Circuit board assembly includes:
	388-2453-00			1	CIRCUIT BOARD
-49	136-0252-04			28	SOCKET, pin connector
-50	214-0579-00			6	PIN, test point
-51	------			2	TRANSISTOR
	------			-	mounting hardware: (not included w/transistor)
-52	210-0586-00			1	NUT, keps, 4-40 x 0.25 inch
-53	210-1061-00			1	WASHER, flat, 0.203 ID x 0.265 inch OD
-54	211-0008-00			1	SCREW, 4-40 x 0.25 inch, PHS

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
	105-0307-00			1	CAM SWITCH ASSEMBLY--VERTICAL
	- - - - - - -			-	cam switch assembly includes:
-55	200-1193-00			1	COVER, cam switch
	- - - - - - -			-	mounting hardware: (not included w/cover)
-56	211-0022-00			2	SCREW, 2-56 x 0.188 inch, RHS
-57	210-0001-00			2	WASHER, lock, internal, 0.092 ID x 0.18 inch OD
-58	210-0405-00			2	NUT, hex., 2-56 x 0.188 inch
-59	354-0219-00			1	RING, retaining
-60	401-0057-00			1	BEARING, front, w/bushing
-61	214-1127-00			1	ROLLER, detent
-62	214-1139-00[1]			-	SPRING, flat, gold
	214-1139-02[1]			-	SPRING, flat, green
	214-1139-03[1]			-	SPRING, flat, red
-63	401-0056-00			1	BEARING, rear
-64	105-0306-00			1	DRUM ASSEMBLY
	- - - - - - -			-	mounting hardware: (not included w/cam switch assembly)
-65	211-0116-00			3	SCREW, sems, 4-40 x 0.312 inch, PHB
-66	210-0406-00			4	NUT, hex., 4-40 x 0.188 inch
	105-0308-00			1	CAM SWITCH ASSEMBLY--BASE GATE DRIVE
	- - - - - - -			-	cam switch assembly includes:
-67	200-1010-00			1	COVER, cam switch
	- - - - - - -			-	mounting hardware: (not included w/cover)
-68	211-0022-00			2	SCREW, 2-56 x 0.188 inch, RHS
-69	210-0001-00			2	WASHER, lock, internal, 0.092 ID x 0.18 inch OD
-70	210-0405-00			2	NUT, hex., 2-56 x 0.188 inch
-71	354-0219-00			1	RING, retaining
-72	401-0057-00			1	BEARING, front, w/bushing
-73	214-1127-00			1	ROLLER, detent
-74	214-1139-00[1]			-	SPRING, flat, gold
	214-1139-02[1]			-	SPRING, flat, green
	214-1139-03[1]			-	SPRING, flat, red
-75	401-0056-00			1	BEARING, rear
-76	105-0305-00			1	DRUM ASSEMBLY
	- - - - - - -			-	mounting hardware: (not included w/cam switch)
-77	211-0116-00			4	SCREW, sems, 4-40 x 0.312 inch, PHB
-78	210-0406-00			4	NUT, hex., 4-40 x 0.188 inch
-79	131-0604-00			22	CONTACT, electrical
-80	- - - - - - -			1	Resistor, variable
	- - - - - - -			-	mounting hardware: (not included w/resistor)
-81	376-0029-00			1	COUPLING, shaft
	- - - - - - -			-	coupling includes:
	213-0075-00			2	SETSCREW, 4-40 x 0.094 inch, HSS
-82	260-1209-00			2	SWITCH, push-push--DISPLAY. 1000
-83	260-1356-00			2	SWITCH, push-push--2V, PNP, PCH X10, FET
-84	361-0383-00			4	SPACER, gray, plastic
-85	361-0385-00			8	SPACER, green, plastic
	- - - - - - -			-	mounting hardware: (not included w/circuit board assy)
-86	213-0146-00			4	SCREW, thread forming, 6-20 x 0.312 inch, PHS
-87	175-0826-00			ft	WIRE, electrical, 3 wire ribbon, 14 inches long
-88	175-0828-00			ft	WIRE, electrical, 5 wire ribbon, 5 inches long

[1] Replace only with part bearing the same color as the original part in your instrument

FIG. 1 EXPLODED



STANDARD ACCESSORIES

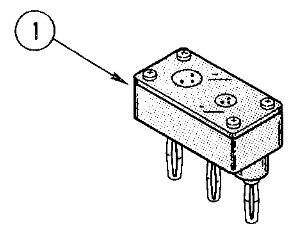


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-1	013-0128-00			1	TEST ADAPTER (see data sheet)
	070-1246-00			1	MANUAL, instruction (not shown)

CARTON ASSEMBLY
(Part No. 065-0151-00)

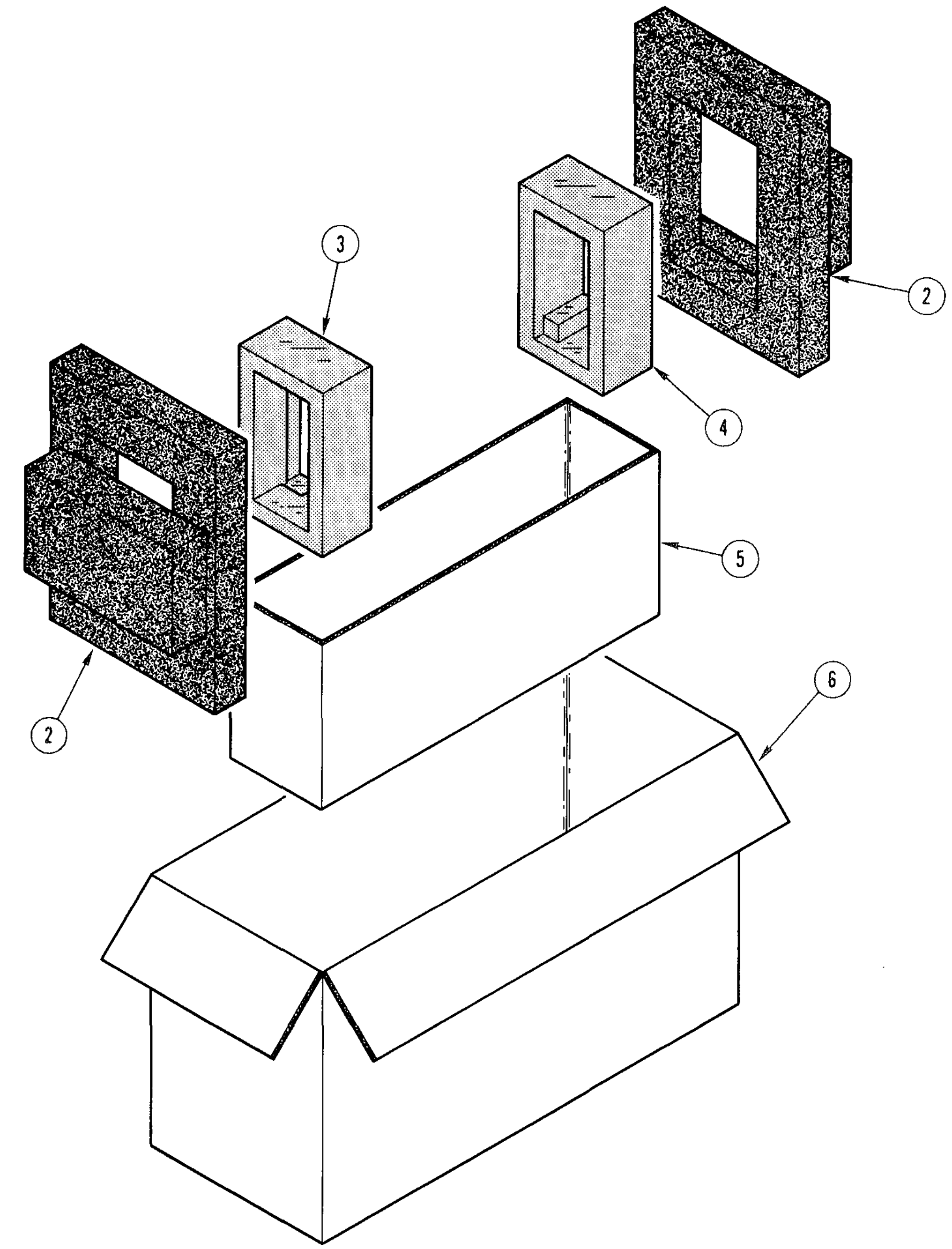


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-	065-0151-00			1	CARTON ASSEMBLY
	----------			-	carton assembly includes:
-2	004-0282-00			2	FRAME
-3	004-0243-00			1	END CAP, front
-4	004-0242-00			1	END CAP, rear
-5	004-1093-00			1	PAD SET, 1 piece
-6	004-0612-00			1	CARTON

TEKTRONIX®
committed to technical excellence

MANUAL CHANGE INFORMATION

PRODUCT 5CT1N
EFF SN B020808-up

CHANGE REFERENCE M23,269
DATE 1-14-75

CHANGE:	DESCRIPTION

070-1246-00

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGE

ADD:

L198	276-0507-00	Core, ferramic suppressor

DIAGRAM CURVE TRACER

L198 is added in series with C198 at the junction with vertical output line to B7 and B13 on MAIN circuit board assembly.