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AT THE REAR OF THIS MANUAL.**

# **178 577 D1/D2 SERVICE**

## INSTRUCTION MANUAL

**Tektronix, Inc.**  
**P.O. Box 500**  
**Beaverton, Oregon 97077**


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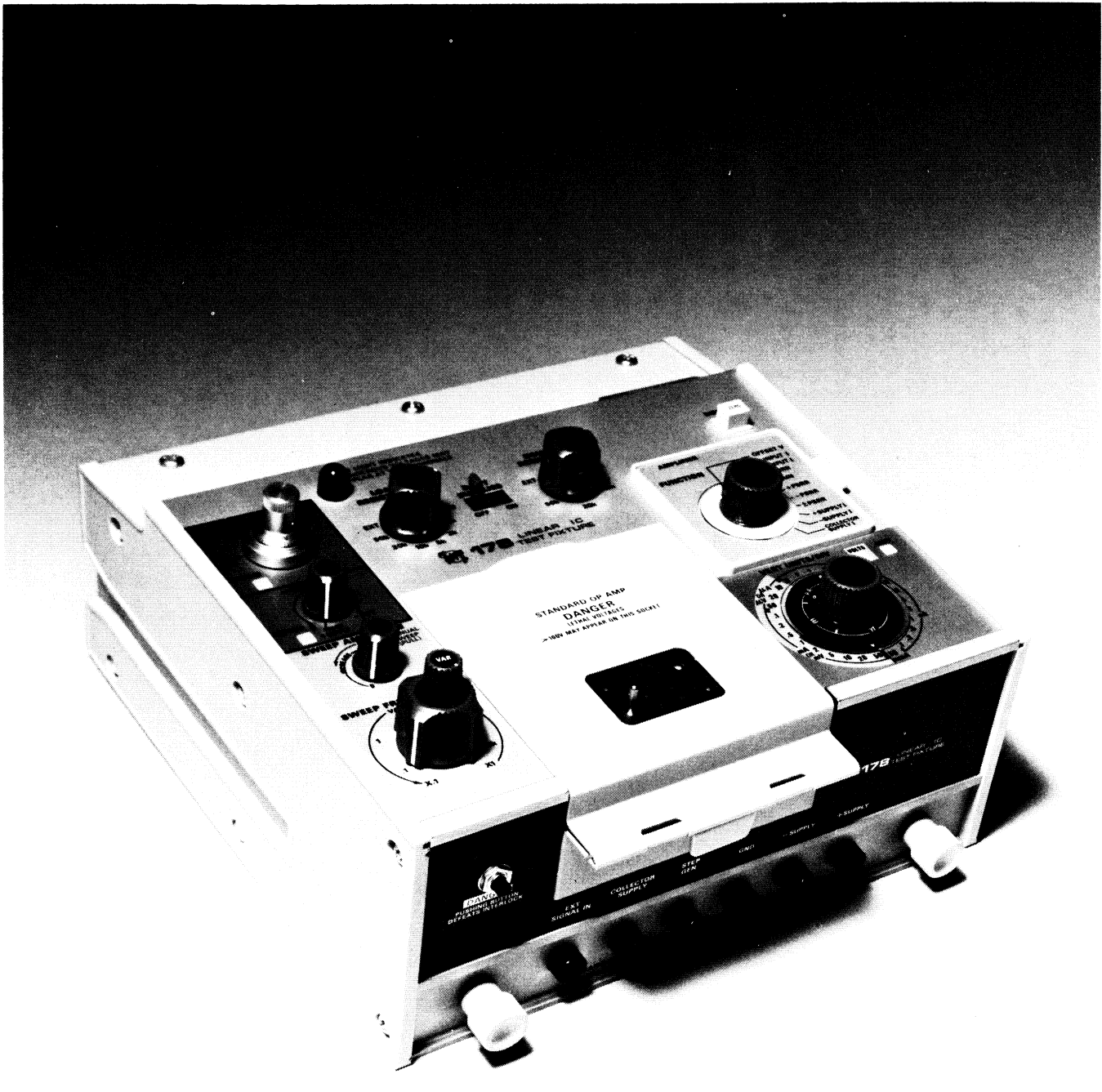
### INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tag,  
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of the serial number are assigned sequentially and are  
unique to each instrument. Those manufactured in the  
United States have six unique digits. The country of  
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Fig. 1-1. 178 Linear Integrated Circuit Test Fixture.

# SPECIFICATION

## Introduction

The 178 Linear IC Test Fixture is a plug-in device for use with the 577-D1 or 577-D2 Curve Tracer Systems. The 577-178 combination, with the D1 Display Unit module, is designed to measure the parameters of operational amplifiers, comparators, differential amplifiers, and regulators. The D2 Display Unit may be used, but lacking display storage, the results may not be satisfactory because of the low frequencies necessary to test many devices.

The 178 Linear IC Test Fixture features a sweep generator, positive and negative supplies, part of the vertical measuring system, a feedback loop for the Device Under Test (DUT), and switching capabilities to facilitate testing of various parameters under diverse conditions.

The sweep generator provides a variable frequency, 0.01 Hz to 1 kHz sinusoidal output. This output is used to force the DUT output or the positive and negative supplies (either in-phase or out-of-phase), or to sweep the DUT inputs.

The dc voltage levels of both positive and negative supplies are independently adjustable from 0 to 30 volts. The negative supply amplitude can be made to track (have the same absolute value as) the positive supply amplitude. The maximum current capability of the positive and negative supplies can be limited by potentiometers on the DUT card. If the load current attempts to exceed the set limits, the supply current limits and a lamp for each supply indicates the condition.

Any pair (of four pairs) of internal source resistors can be used in series with the amplifier inputs. Any value of external source resistance can be added to the DUT card. The DUT output can be loaded with one of seven values of internal load resistance. Any value of external load resistance can be added to the DUT card in parallel with the 50 k $\Omega$  of resistance provided on the card.

The vertical measurement system is capable of measuring either voltage or current. The choice of voltage or current measurement is determined by the position of the FUNCTION switch and is indicated by the AMPS or VOLTS lamp.

The vertical deflection factor switch has 28 positions ranging from 50 p/Div to 50 m/Div (unmagnified) in a 1-2-5 sequence. All 28 positions are used for current measurements, but only the range from 10  $\mu$ /Div to 50 m/Div can be used for voltage measurements. Any attempt to measure voltage using vertical deflection factors less than 10  $\mu$ V/Div (unmagnified) causes the VOLTS indicator light to turn off, indicating an unusable switch position.

Vertical deflection factor is increased by ten when the Vertical POSITION X10 VERT MAG knob on the 577 is pulled to the outward position; the increase is indicated by the lamp behind the VERT UNITS/DIV knob skirt. This lamp also turns off if an unusable switch position is selected.

A FUNCTION selector switch provides eleven test positions. All positions are useful to test operational amplifiers.

Horizontal deflection factors range from 50 mV/Div to 200 V/Div (unmagnified), and are selected from the COLLECTOR VOLTS segment of the 577 HORIZ VOLTS/DIV switch.

The Standard Op Amp card can be used to test single, dual, and quad operational amplifiers. It can also be used to test single and dual comparators and differential amplifiers. Regulator cards are used to test three-terminal regulator parameters. These regulator cards are optional accessories and are covered on separate data sheets. IC socket-pin configurations must be connected to the cards by using adapter sockets and patch cords.

An offset ZERO button provides a zero crt display reference and nulls offset voltage for certain measurements that would otherwise be off screen. Offset is usually reset automatically when the setting of the FUNCTION switch is changed. Offset must be reset manually when switching between 1 and .5 mV/DIV and between .1 mV and 50  $\mu$ V/DIV.

The stored display on the D1 Display Unit is erased whenever the FUNCTION switch is changed, except when switching between +INPUT I and -INPUT I, +PSRR and -PSRR, and +SUPPLY I and -SUPPLY I.

**Specification—178 Service**

The electrical characteristics in the following table are valid only if the instrument has been calibrated at an ambient temperature between +20°C and +30°C, and the instrument is operating at an ambient temperature between 0°C and +50°C (unless otherwise noted).

Items listed in the Performance Requirements column of the Electrical Characteristics are verified by completing the Performance Check in this manual. Items listed in the Supplemental Information column are not verified in this manual; they are either explanatory notes or performance characteristics for which no limits are specified.

**Table 1-1  
ELECTRICAL CHARACTERISTICS**

Characteristic	Performance Requirement	Supplemental Information
Vertical Deflection Factors		
Input Current (In +Input I and -Input I Functions)	50 pA/DIV to .2 mA/DIV in a 1-2-5 sequence, unmagnified.  5 pA/DIV to 20 μA/DIV with 10X magnifier on.	
Accuracy <sup>a</sup>	Within ±3% ±50 pA, unmagnified. Within ±4% ±50 pA with 10X magnifier on.	
Voltage <sup>b</sup>	10 μV/DIV to 50 mV/DIV in a 1-2-5 sequence, unmagnified.  1 μV/DIV to 5 mV/DIV with 10X magnifier on.	
GAIN and OFFSET V Functions Accuracy <sup>a</sup>	Within ±3%, unmagnified; ±4% with 10X magnifier on.	
CMRR Function Accuracy	Within ±3% + $\frac{100K}{\text{Gain} - K} \% + \frac{150}{K} \mu\text{V}/V_{\text{cm}}$  Within ±4% + $\frac{100 K}{\text{Gain} - K} \% \pm \frac{150}{K} \mu\text{V}/V_{\text{cm}}$  with 10X magnifier on (1 μV/DIV to 5 μV/DIV, see footnotes b and c).	
PSRR Function Accuracy	Within ±3% + $\frac{100K}{\text{Gain} - K} \%$  Within ±4% + $\frac{100 K}{\text{Gain} - K} \%$ with 10X magnifier on (1 μV/DIV to 5 μV/DIV; See footnotes b and c).	

<sup>a</sup>Accuracies are the highest percentage of on-screen values.

<sup>b</sup>Vertical magnification is not recommended for .5 mV/DIV through 50 mV/DIV unmagnified settings.

<sup>c</sup>DUT gain with small voltage signal out near zero with 50 kΩ load: K = 10 for 50 mV/Div to 1 mV/Div, K = 100 for .5 mV/Div to 100 μV/Div, and K = 1000 for 50 μV/Div to 10 μV/Div. V<sub>cm</sub> = Common-mode voltage.

Table 1-1 (cont)

## ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Power Supply		
Current	1 nA/DIV to 50 mA/DIV in a 1-2-5 sequence, unmagnified. 0.1 nA/DIV to 5 mA/DIV with 10X magnifier on.	
Current Mode Accuracy <sup>a</sup>	Within $\pm 3\% \pm 1$ nA unmagnified; $+4\% \pm 1$ nA with 10X magnifier on.	
Collector Supply		
Current	1 nA/DIV to 50 mA/DIV in a 1-2-5 sequence, unmagnified. 0.1 nA/DIV to 5 mA/DIV with 10X magnifier on.	
Current Mode Accuracy <sup>a</sup>	Within $\pm 3\% \pm 1$ nA, unmagnified. $\pm 4\% \pm 1$ nA with 10X magnifier on.	
Positive and Negative Supplies		
Voltage	Adjustable from 0 to 30 V.	Both supplies can be adjusted from the +SUPPLY control. Negative supply can be independently adjusted using the uncalibrated -SUPPLY control.
Accuracy	Within $\pm 2\% \pm 100$ mV.	The -SUPPLY voltage is within $\pm 1\%$ (absolute) of the +SUPPLY voltage when the -SUPPLY control is in the TRACK +SUPPLY position.
Current	At least 150 mA	Adjustable current limiting.
Sweep Generator		
Frequency	0.1 Hz to 1 kHz, sinusoidal signal. Five ranges, 0.1, 1, 10, 100, and 1000 Hz with X.1 to X1 variable.	Ranges overlap at X.1 end of variable.
Accuracy	Within $\pm 5\%$ in calibrated (X1) position.	
Amplitude		
In OFFSET AND GAIN Functions	Adjustable from 0V to 30 V $\pm 3\%$ maximum peak	Adjustable, depends on function. The voltage should be limited to the output capability of the DUT.
Common-mode Voltage in INPUT I and CMRR Functions	0 V to 30 V $\pm 3\%$ maximum peak. In the 1 mV/DIV to 50 mV/DIV ranges, the values are 10% lower.	Limited to the power supply voltages (clipped)
Power Supply Voltage in PSRR and SUPPLY I Functions		See Positive and Negative Supplies
Manual Sweep		The Generator output may be manually set to any dc level (uncalibrated) within its amplitude range (depends on the setting of the FUNCTION switch).

<sup>a</sup>Accuracies are the highest percentage of on-screen values.

Table 1-1 (cont)

**ELECTRICAL CHARACTERISTICS**

Characteristics	Performance Requirement	Supplemental Information
Source Resistance		
Resistances		Four pairs; 50 Ω, 10 kΩ, 20 kΩ, and 50 kΩ.  When the VERT UNITS/DIV switch is set to 1 mV/DIV through 50 mV/DIV, the indicated values increase by 500 Ω. External resistors can be used.
Tolerance		±1% ±10 Ω.
Load Resistance		
Resistances		Seven Resistances; 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, and 50 kΩ.
Tolerance		±3% except when using the 50 mV, 20 mV, and 10 mV positions of the VERT UNITS/DIV switch. The tolerance for the 50 kΩ then becomes ±30%, for the 20 kΩ ±14%, 10 kΩ ±7%, and 5 kΩ ±3% when the DUT output voltage swing is 2.5 V or less. The maximum tolerance decreases exponentially as the output swing is increased and is less than ±3% when the output is swinging ±30 volts.

Table 1-2

**ENVIRONMENTAL CHARACTERISTICS**

Characteristic	Performance Requirement	Supplemental
Temperature		
Specified Operating		+10° C (+50° F) to +40° C (+104° F)
Useful Operating		0° C (+32° F) to +50° C (+120° F)
Non-operating		-40° C (-40° F) to +65° C (+149° F).
Altitude		
Operating		To 10,000 feet (3000 metres)
Transportation		12-inch (30 cm) package drop. Qualified under the National Safe Transit Committee procedure 1A.



**Table 1-3**  
**PHYSICAL CHARACTERISTICS**

Dimensions  Height Width Depth	4.5 inches (11.4 cm) 7.9 inches (20.1 cm) 7.8 inches (19.8 cm)
Weight  Net	3.3 pounds (1.5 kg)

**STANDARD ACCESSORIES**

Refer to the Replaceable Mechanical Parts list for a listing of the standard accessories.



# OPERATING INFORMATION

## Introduction

The 178 Test Fixture operates with a TEKTRONIX 577 Curve Tracer and the D1 or D2 Display Unit as a system.

This section of the manual gives a brief functional description of the front-panel controls of the 178. See the 577—178—D1 or D2 Operators Manual for a complete operating procedure.

## Preliminary

For initial preparation, refer to the Operating Instructions section of the 577—178—D1 or D2 Operators Manual. The Operators Manual contains operating instructions, as well as general and specific application information.

## CONTROLS

This is a brief description of the functions of the front-panel controls. More detailed information is given in the Operators Manual.

### FUNCTION Selector

The eleven-position FUNCTION switch selects the points to be monitored by the vertical and horizontal display axes, and selects the point driven by the Sweep Generator.

### SWEEP FREQUENCY

Adjusts the Sweep Generator frequency from .01 Hz to 1 kHz. Five calibrated frequency steps, .1, 1, 10, 100, and 1 kHz, are provided. The VARIABLE control provides continuous adjustment from .1 to 1.0 times the selected decade value.

### SWEEP AMPLITUDE

Adjusts the Sweep Generator amplitude from zero volts to its maximum value (which depends on the function being swept by the Sweep Generator).

### +SUPPLY, -SUPPLY

There are two adjustable, regulated supplies, one positive and one negative, in the 178. The adjustment range is 0 to 30 volts, with 150 mA current capability. Adjustable current limiting for each supply is provided on the Device Card. Overload lamps in the supply-control area indicate when the current limit is reached.

### SOURCE RESISTANCE

This switch selects one pair of four input resistors pairs: 50  $\Omega$  (550  $\Omega$  when VERT UNITS/DIV is in the 1 mV to 50 mV/DIV range), 10 k, 20 k, or 50 k. External resistances may be selected in the EXT position.

### LOAD RESISTANCE

This switch selects one of seven load resistors: 100  $\Omega$ , 1 k, 2 k, 5 k, 10 k, 20 k, or 50 k. External resistance may be selected in the EXT position.

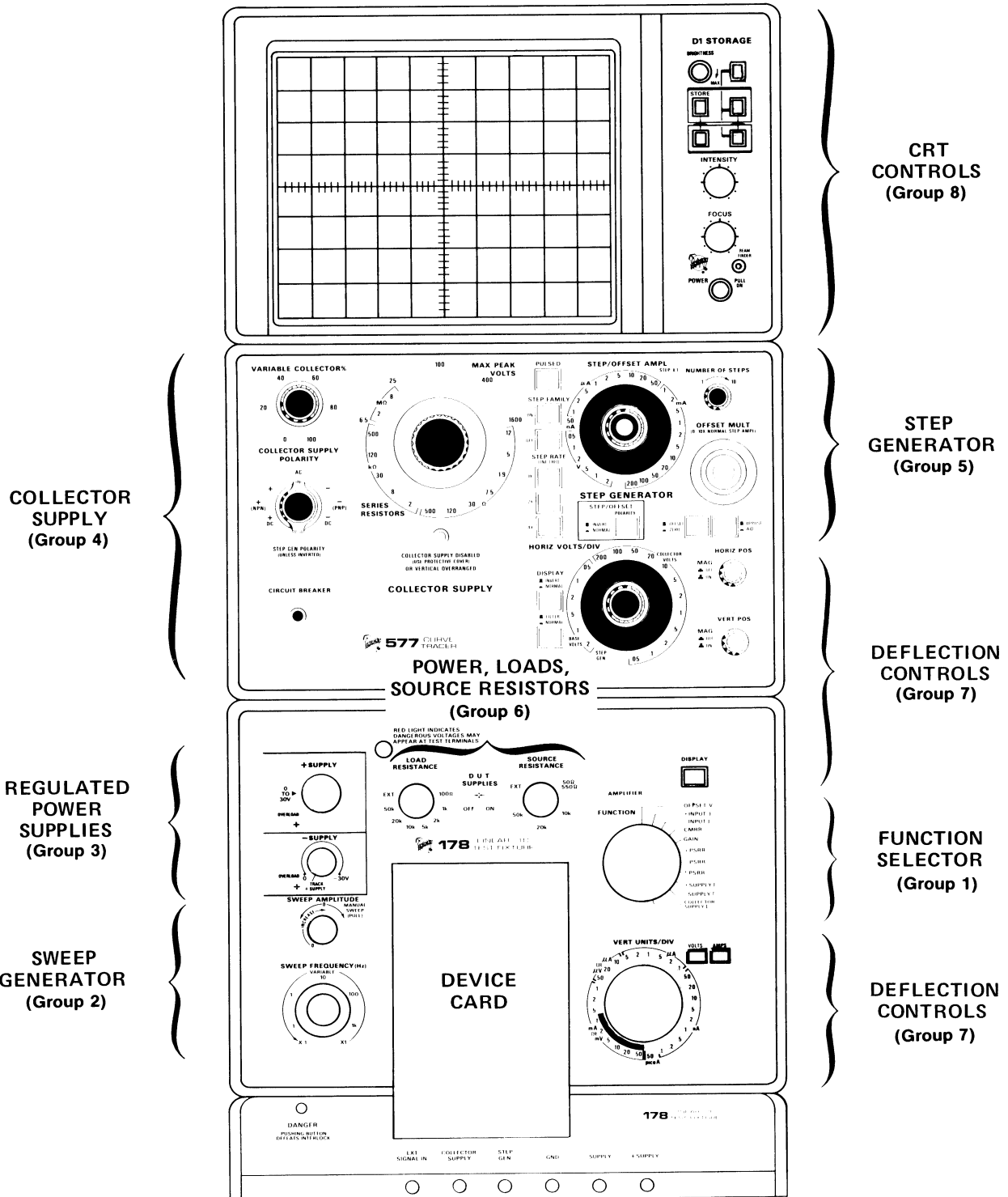
### VERT UNITS/DIV

This switch selects the vertical deflection factor. The deflection factor is either voltage or current per division, depending on the FUNCTION switch position. Indicator lamps show either VOLTS or AMPS. The voltage measurement range is 10  $\mu$ V/DIV to 50 mV/DIV ( $\mu$ V/DIV with X10 vertical magnifier on). The current measurement range is 50 pA/DIV to 50 mA/DIV (5 pA/DIV with X10 vertical magnifier on).

### DEVICE CARD

The Device Card provides test configurations most suited to several classes of devices. Device Cards provide a means of making electrical connections to the DUT (device under test), and in most cases, also provide some circuitry.

IDENTIFICATION OF CONTROLS



CRT CONTROLS (Group 8)

STEP GENERATOR (Group 5)

DEFLECTION CONTROLS (Group 7)

FUNCTION SELECTOR (Group 1)

DEFLECTION CONTROLS (Group 7)

Fig. 2-1. 178 Front-panel controls.

# CIRCUIT DESCRIPTION

This section of the 178 Service Manual contains the description of the 178 Linear Test Fixture. While using this description, refer to the illustrations within this section, and to the Switching Block Diagram and the circuit diagrams in the foldout pages at the rear of this manual.

The 178 Linear Test Fixture is designed to perform a multiplicity of tests, some of which differ widely. As a result, the circuit description is divided into two major parts, the Function Description and the Detailed Circuit Description. In the first, the 178 is described, for each function switch position, in the way the major circuits work together. In the second, each of the major circuits is described in detail.

## FUNCTION DESCRIPTION

### OFFSET VOLTS

Refer to Fig. 3-1. In this test, the Sweep Generator is fed in at the input of the Feedback Amplifier, forcing the Device Under Test (DUT) output. This is fed to and displayed by the Horizontal Amplifier. At the same time, the Vertical Amplifier displays the resultant differential voltage at the input terminals of the DUT. Note that the Sample & Hold Amplifier is not connected in the circuit; otherwise, the Sample & Hold circuit would have compensated for the differential voltage.

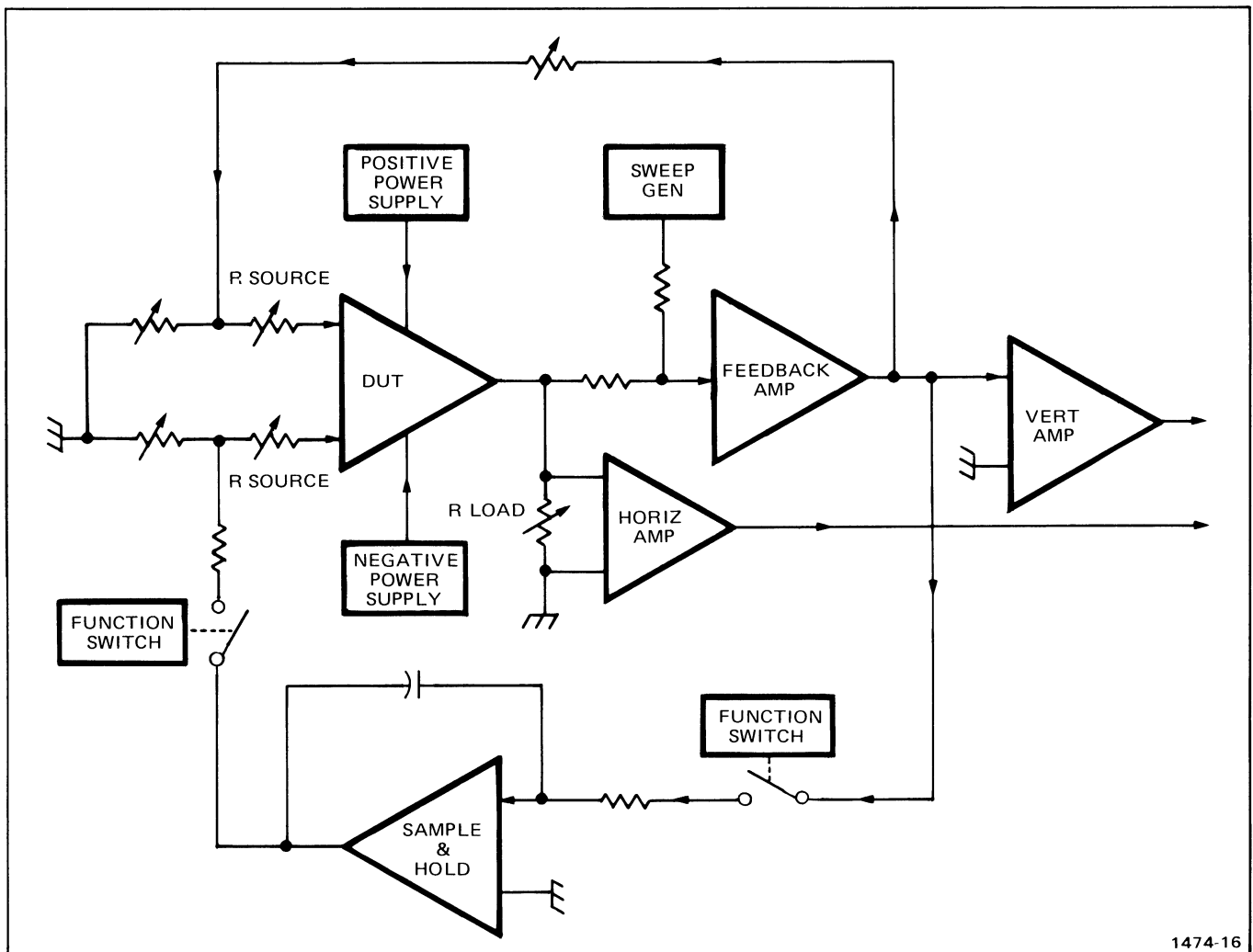
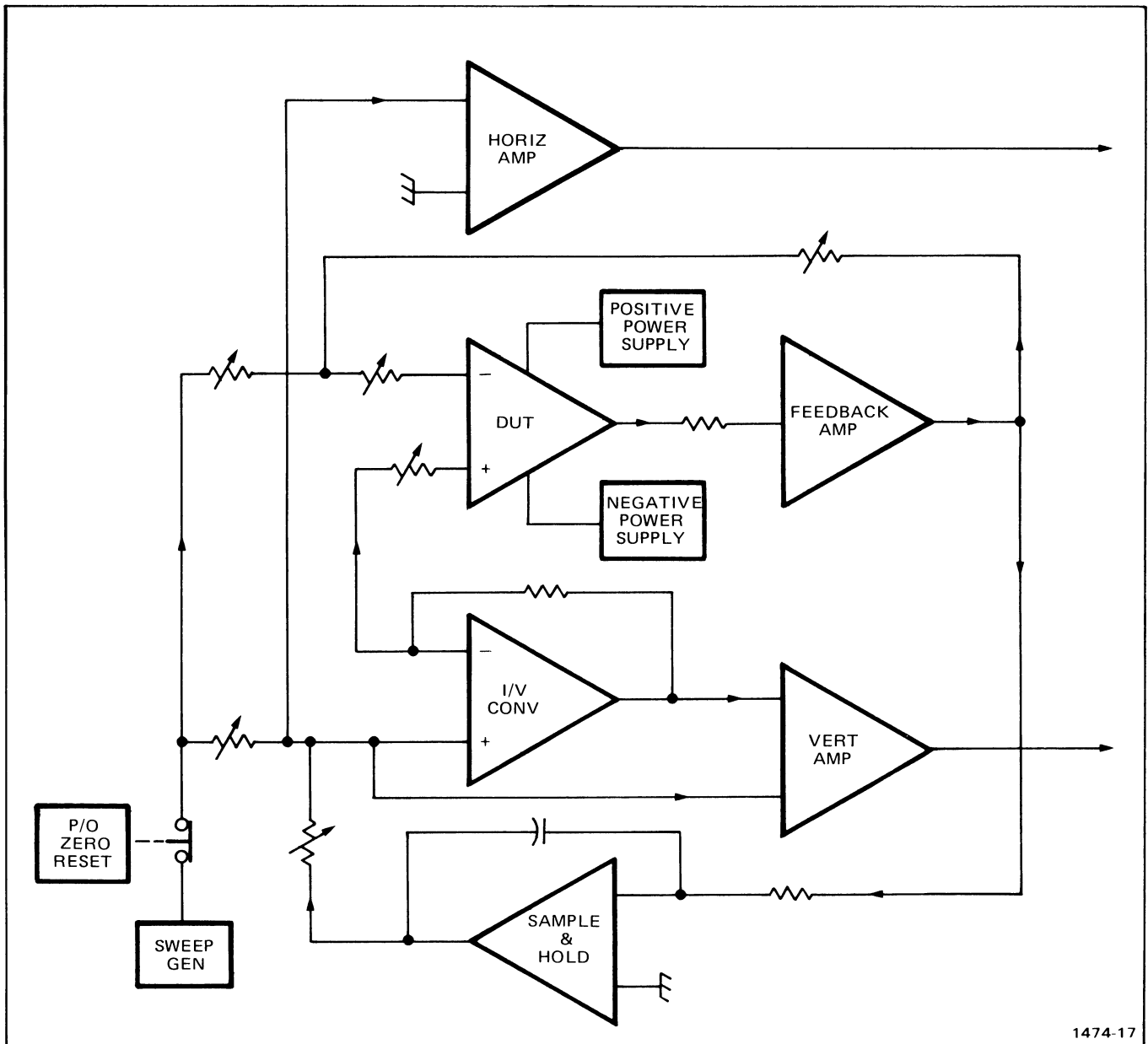


Fig. 3-1. Block diagram of OFFSET V configuration.

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Fig. 3-2. Block diagram of + INPUT I configuration.

**+ INPUT I**

Refer to Fig. 3-2. In this test, the Sweep Generator provides a voltage to sweep the input of the DUT, while the input current to the DUT is measured. The swept voltage is displayed by the Horizontal Amplifier, and the resultant input current is first processed by the I/V Converter, then applied to the Vertical Amplifier for display on the vertical axis.

**– INPUT I**

Refer to Fig. 3-3. This test is exactly the same as the one for + INPUT I, except that the I/V Converter is tied to the opposite DUT input, permitting the measurement of the current at the minus input.



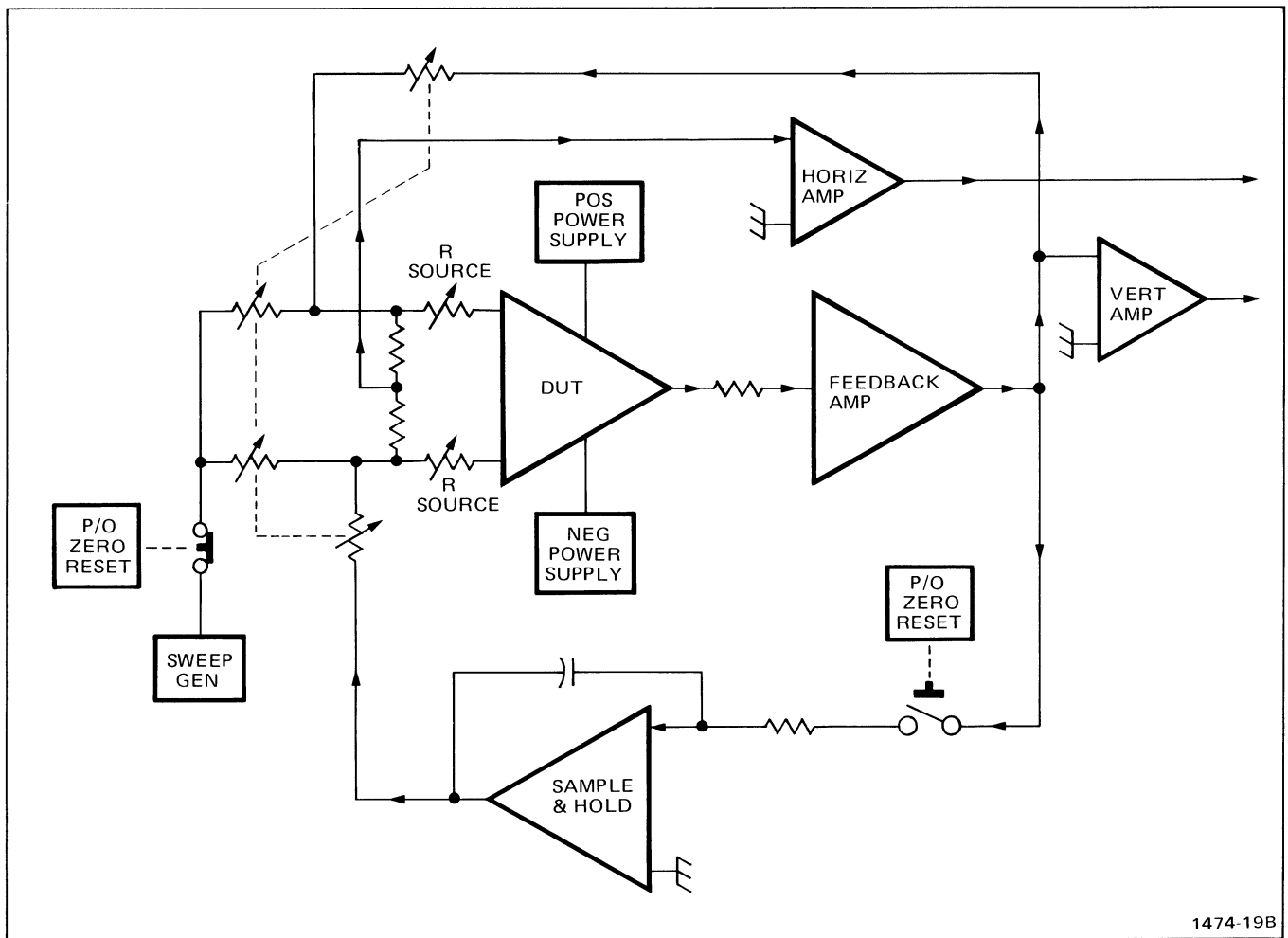


Fig. 3-4. Block diagram of CMRR configuration.

### CMRR

Refer to Fig. 3-4. In the CMRR mode, the DUT inputs are tied together through attenuators, then a voltage is applied to the common junction of the attenuators from the Sweep Generator. The sweeping voltage is displayed on the horizontal axis. The resultant differential voltage that is fed back to the inputs from the Feedback Amplifier is displayed on the vertical axis.

### GAIN

Refer to Fig. 3-5. The GAIN measurement configuration is similar to the OFFSET VOLTS configuration described earlier, except for the inclusion of the Sample & Hold Circuit. The Sweep Generator output is used to force the DUT output, which in turn is fed to the Horizontal Amplifier for display on the horizontal axis. The resultant differential voltage is fed to the vertical amplifier for display on the vertical axis.



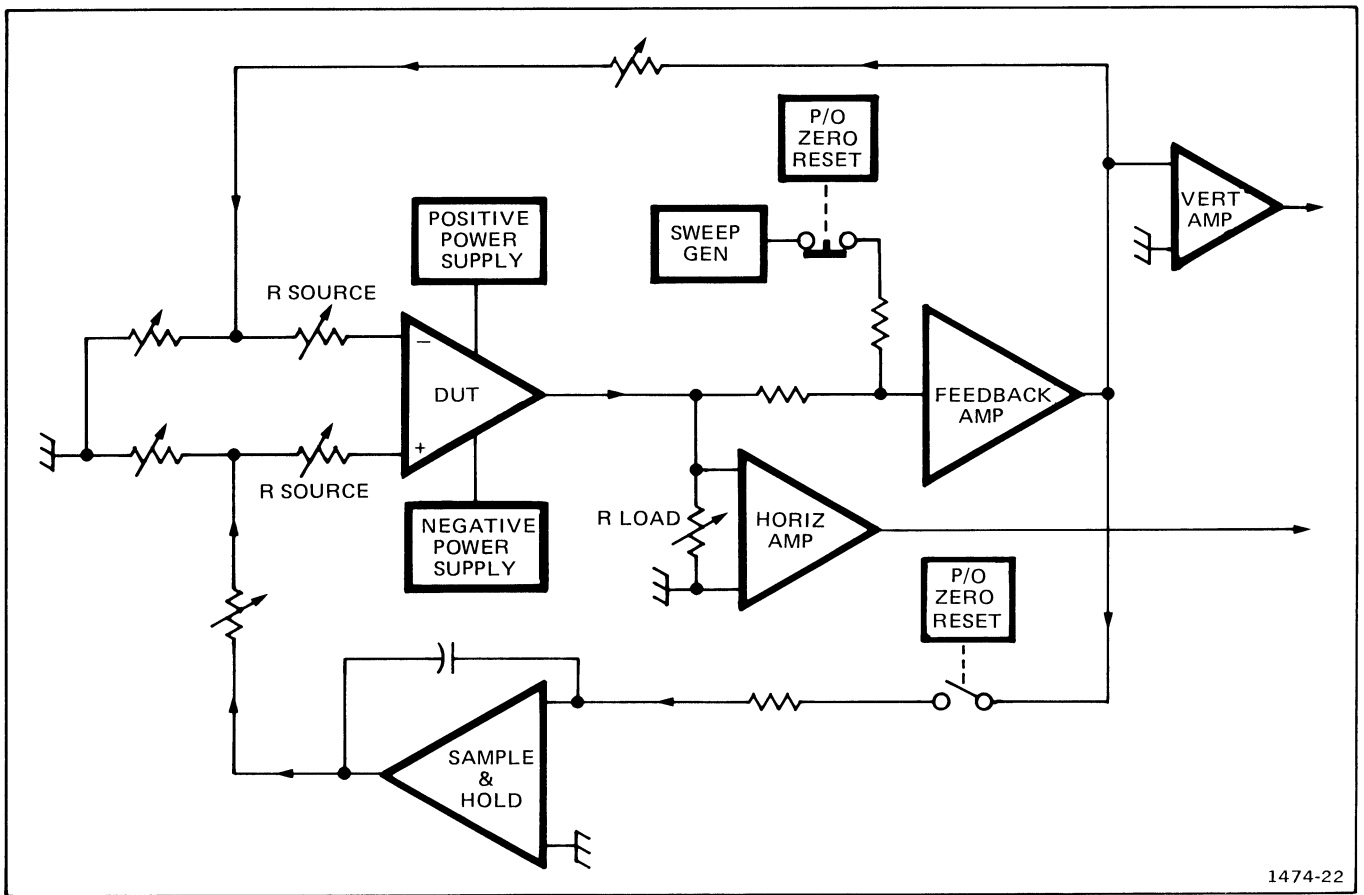
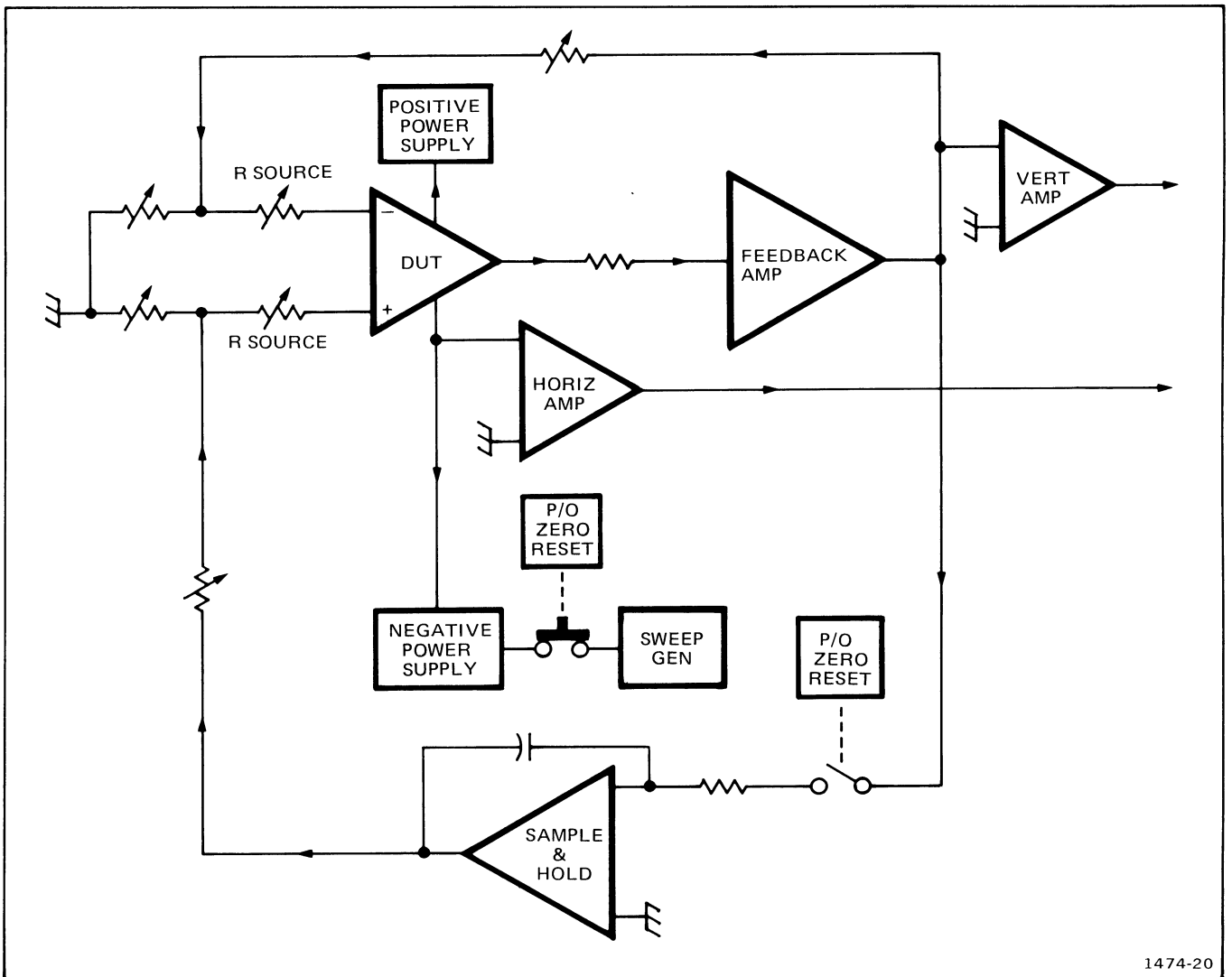


Fig. 3-5. Block diagram of GAIN configuration.





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Fig. 3-7. Block Diagram of - PSRR configuration.

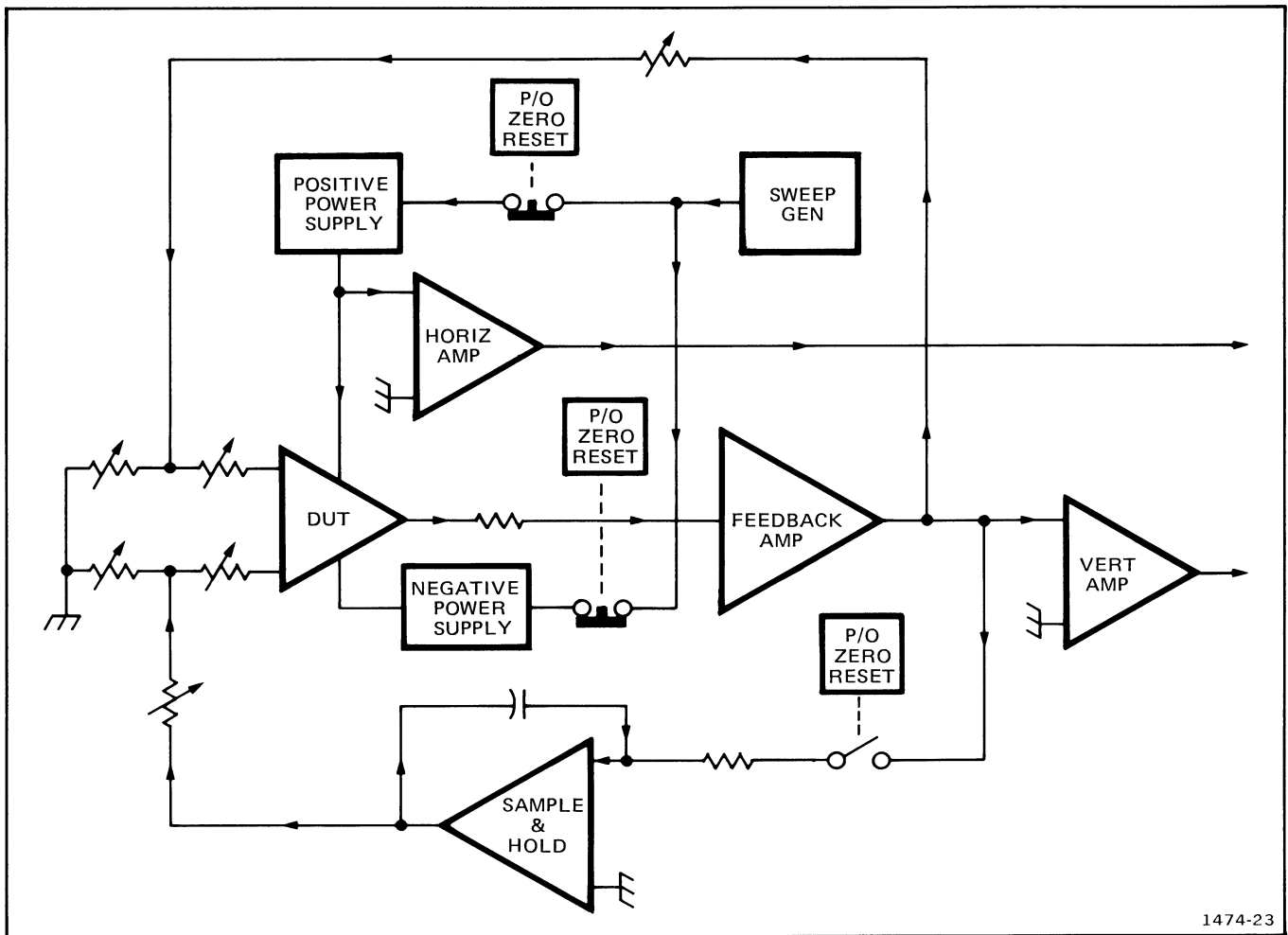


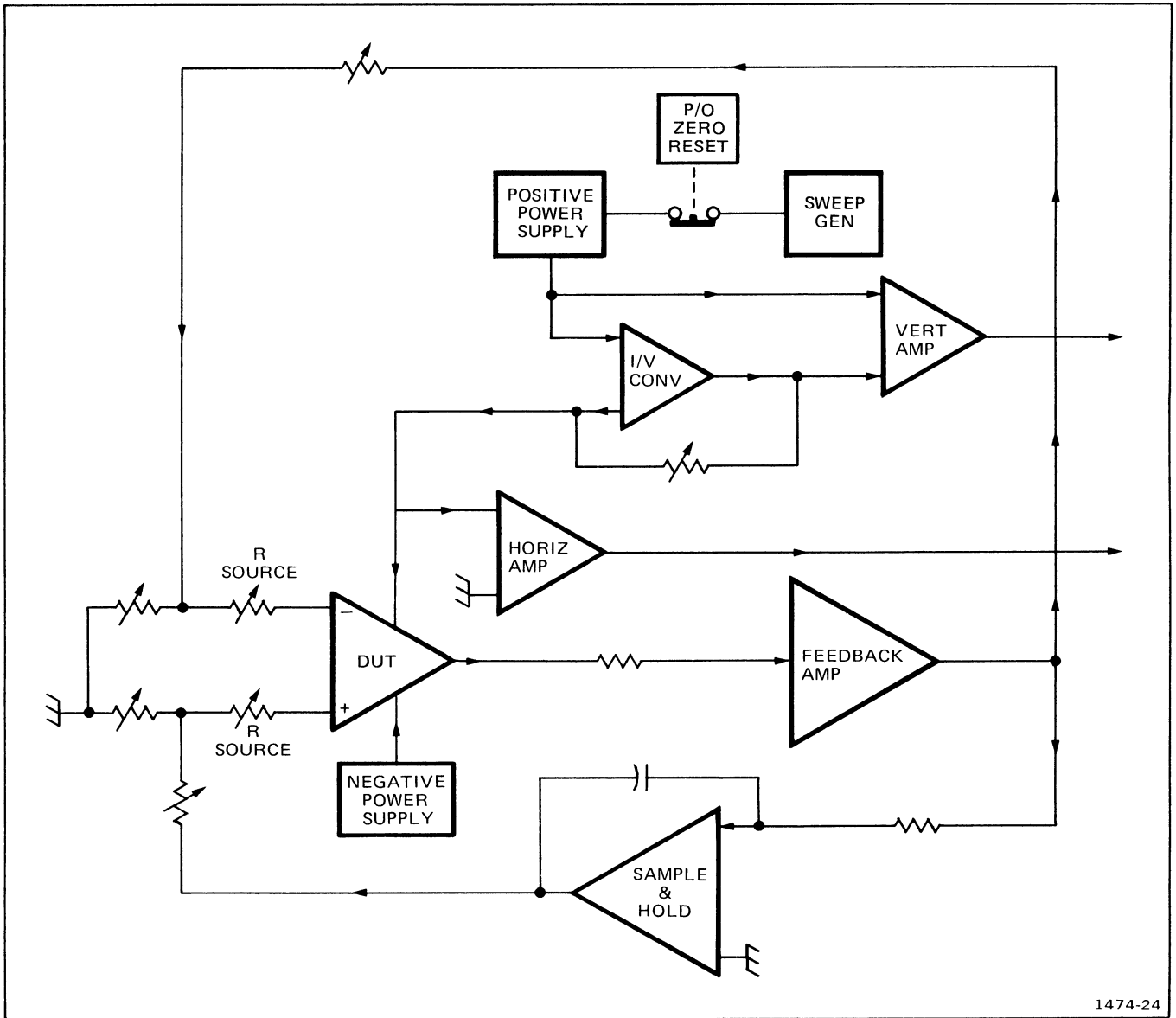
Fig. 3-8. Block diagram of  $\pm$  PSRR configuration.

**$\pm$  PSRR**

Refer to Fig. 3-8. The  $\pm$  PSRR configuration is similar to the previous two tests, except that the Sweep Generator output is applied to both the plus and minus supplies, and they are swept in opposite directions. The output of the positive supply is displayed on the horizontal axis, and the differential input voltage to the DUT is displayed on the vertical axis.

**+ SUPPLY I**

Refer to Fig. 3-9. The power supply voltage is swept by the output of the Sweep Generator in this configuration. The output of the positive power supply is fed through the I/V Converter, then the Vertical Amplifier for display of the power supply current. The Horizontal Axis displays the swept power supply voltage.



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Fig. 3-9. Block diagram of + SUPPLY I configuration.

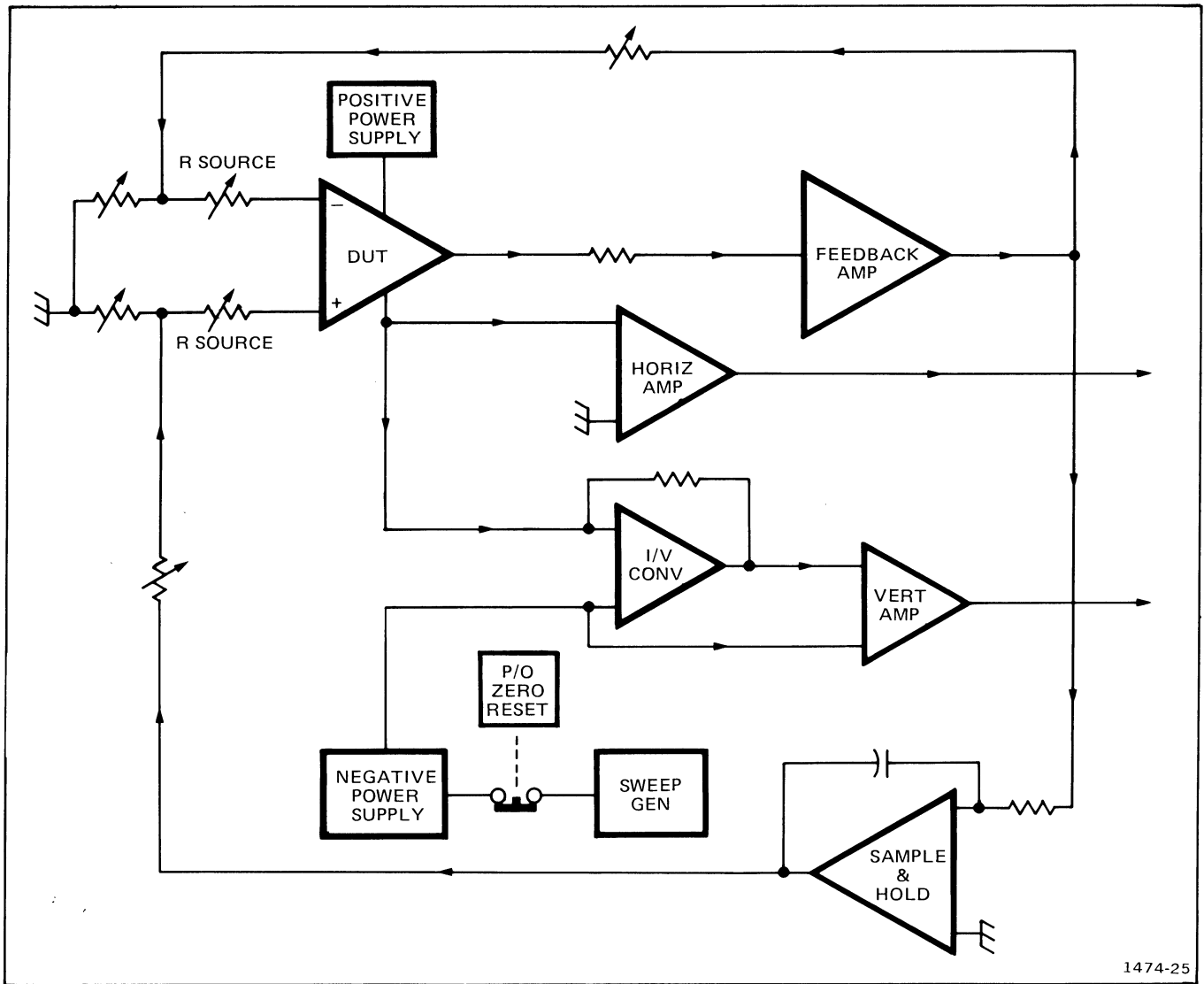


Fig. 3-10. Block diagram of - SUPPLY I configuration.

**- SUPPLY I**

Refer to Fig. 3-10. This configuration is identical to the + SUPPLY I configuration, except that the minus power supply voltage is swept and both current and voltage are displayed.

**COLLECTOR I**

Refer to Fig. 3-11. This is the "standard" curve-tracer configuration. The collector supply is connected to the Horizontal Amplifier, and by way of the I/V Converter, to the Vertical Amplifier. The configuration not only permits the operator to use the 178 and 577 as a standard curve tracer, but also permits using the collector supply to replace either of the DUT power supplied (+ or -). The collector supply can also be patched to any other points on the DUT card as required by a particular test where current vs voltage measurements of the collector supply are required.

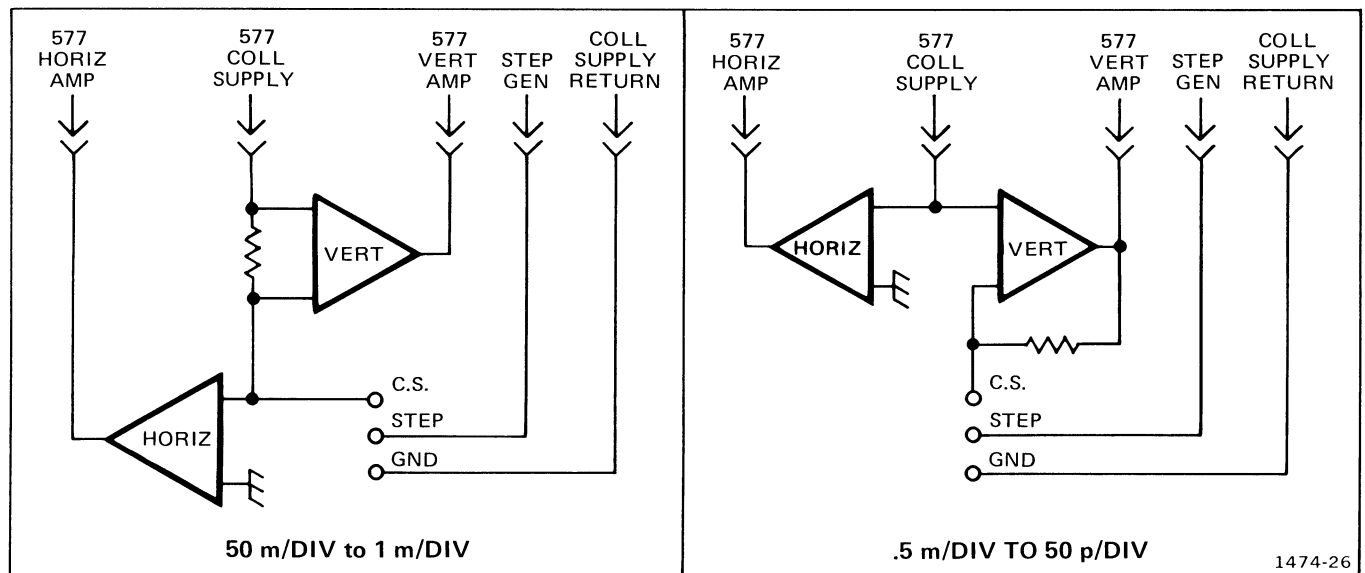
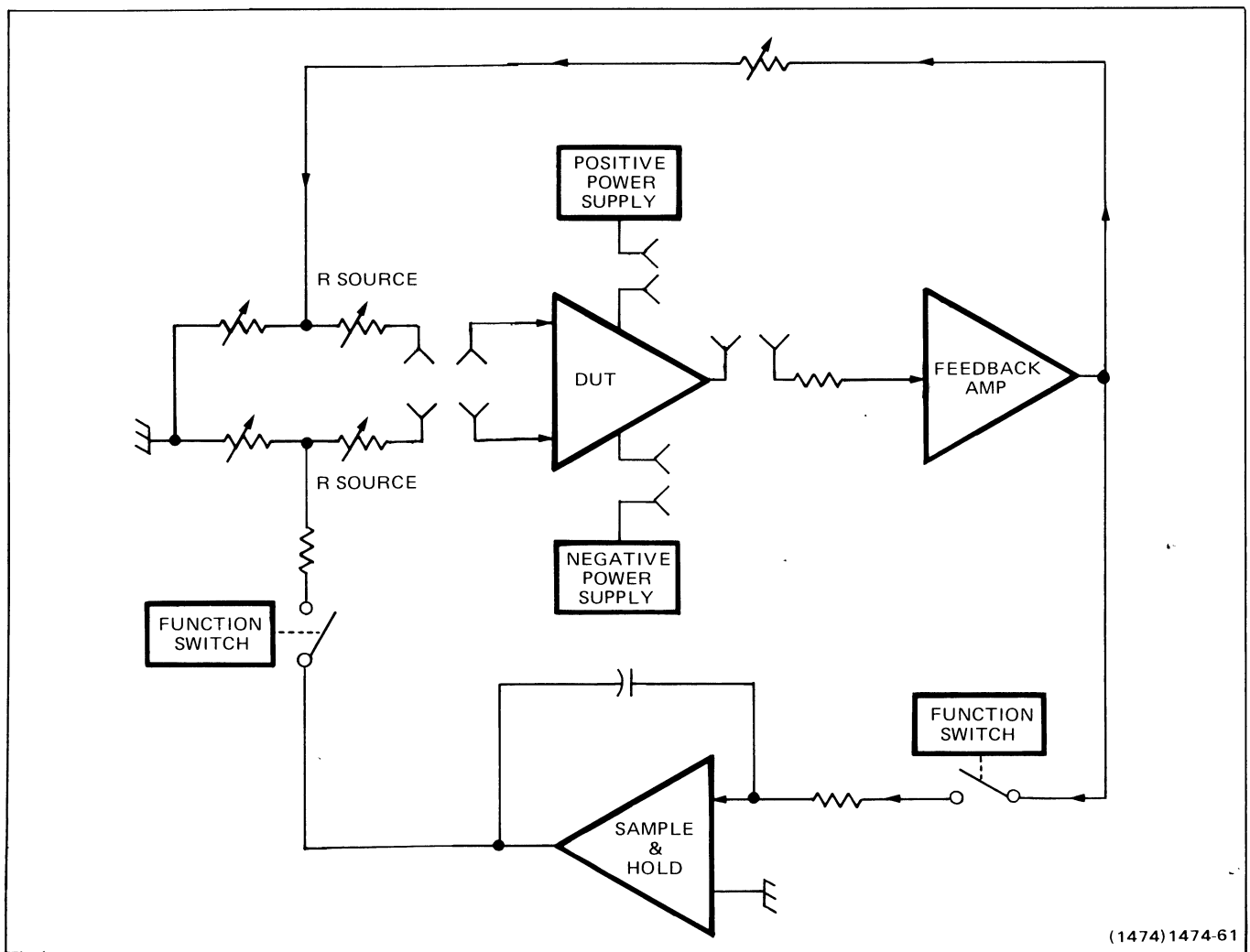


Fig. 3-11. (A) Block diagram of COLLECTOR SUPPLY I configuration; (B) Horizontal and vertical connection for COLLECTOR SUPPLY I configuration.

## DETAILED CIRCUIT DESCRIPTION

### Vertical Preamplifier

Refer to Diagram 1. The vertical preamplifier consists of three major circuits, the preamplifier circuit, the I/V Converter, and the Looping Compensation Amplifier.

**Preamplifier.** This circuit consists of two operational amplifiers, U340B and U350A, plus related components. The first, U340B, has a nominal gain of 1, 10, or 100, depending on which of the three feedback resistors is selected. R331 is the input resistance of the amplifier. The plus input of U340B is controlled by the level adjusted by R340, VERT PREAMP BAL, which is adjusted for the least vertical display shift between vertical sensitivity settings. The second amplifier, U350A, has a nominal gain of 1, 2.5, or 5, depending on the setting of the vertical sensitivity switch. R351 is the input resistor. Display Zero switch S200A is used to connect the minus input to the floating power supply common (to which the plus input of each amplifier is returned) in order to establish a reference point on the display. The preamp receives signals from the feedback amplifier or the I/V Converter; the first is used in the display of voltage on the vertical axis, and the second is used for current displays on the vertical axis.

**I/V Converter.** The current-to-voltage converter (I/V Converter) consists of operational amplifier U340A and dual FET Q310, plus surrounding components. Feedback resistors R321, R322, and R323 are switched in parallel with R324 to select the gain of the amplifier for various vertical units/div settings.

In all but the six highest current settings of the vertical units/div switch, the I/V Converter operates in the "virtual ground" method. This is a case in which there is effectively no input resistance to the amplifier.

When the vertical units/div switch is set to one of the six highest settings, the converter operates in a more conventional voltage amplifier mode. Resistor R305 is switched into the minus input to operate as the input resistance to the amplifier, and R301 and R302 are placed across the plus and minus inputs; the input current is applied to and voltage is developed across the two resistors. Converter Bal adjustment R310 is adjusted to match the output of the converter to the input of the Vertical Preamp.

The I/V Converter is switched in or out of the input path of the vertical preamp by the function switch; it is in the path when the INPUT I, SUPPLY I, and COLLECTOR SUPPLY I functions are selected. Otherwise, the output of the feedback amplifier is connected directly to the input of the vertical preamplifier.

**Looping Compensation.** Amplifier U350B compares chassis ground, through an extremely high resistance (R316-R317), with the floating power supply common. Looping adjustment R315 is connected across the amplifier to act as the feedback resistor for the amplifier. The resistor, and thus the gain of the amplifier, is adjusted to reduce looping of the display that occurs during high-sensitivity current measurements.

### Feedback Amplifier Circuits

Refer to Diagram 2. This diagram depicts the Feedback Amplifier, the Sample & Hold circuit, and the indicator drive circuits. The Feedback Amplifier and related components form the network that amplifies the DUT output and feeds it back to cancel the original driving signal at the minus input of the DUT. The Sample and Hold amplifier performs essentially the same function at the plus input of the DUT, to compensate for the differential offset voltage between inputs.

**Feedback Amplifier.** Transistors Q214, Q222, and Q226 form a non-inverting operational amplifier. Inputs to the amplifier are fed through equal-value summing resistors to reduce dc input shift. The gain of the stage is approximately three, as set by R223 and R227. Feedback Bal adjustment R229 is set for zero dc level change from input to output of the stage.

Resistors R231, R233, R235, and R238 form the feedback string that passes the output signal to the DUT minus input. Vertical units/div switch contacts include or exclude resistors in the string to allow for different sensitivities.

The reader should note that the output of the Feedback Amplifier, through P235 pins 1 and 2, is illustrated far less complex than it actually appears in the circuit. The output signal from Q226 passes through P235 pin 3, through the Interface connector (see Diagram 6), through pin B22 of the Standard Op Amp Card (see Diagram 7) through switch S30. This switch permits the use of an externally connected feedback amplifier in line with the internal circuitry of the 178. From the switch, the signal passes through pin B23, back through the interface connector, through pin 1 of P235 and to the divider string shown on Diagram 2. As noted above, the circuit is drawn as shown for clarity of illustration, since the normal mode of operation is without the external feedback amplifier.

**Sample and Hold Amplifier.** Dual FET Q252 and amplifier U250 form the Sample and Hold Amplifier. The amplifier is used to force the plus input of the DUT to whatever level that will allow the minus input to reach zero volts.



The X1000 CMRR, X100 CMRR, and X10 CMRR adjustments (R262, R265, and R267, respectively) are used to compensate for slight variations in the values of the resistors used in the output divider string. The vertical units/div switch selects combinations of resistance in the output divider string to allow for different sensitivity selections.

**Indicator Drive Circuits.** Transistors Q284 and Q286 energize the front-panel volts and amps indicators, respectively. The two conduct exclusively; that is, when Q284 is conducting, it prevents Q286 from conducting. Likewise, when Q284 is cut off, base current for Q286 is furnished through the VOLTS lamp, and the transistor conducts. Emitter current is furnished for both transistors through Q280.

Control for the drive circuits comes from the FUNCTION switch (F6), the VERTICAL UNITS/DIV switch (V1), and the Vertical Mag switch in the 577. When the Function switch is set to any of the current measurement positions, contact F6 is open, cutting Q284 off, and permitting Q286 to conduct. If the Vertical Units/Div switch is set to 5  $\mu$ A or less, contact V1 is closed, which cuts off Q280. This in turn cuts off both transistors, since no voltage measurements are made below 10  $\mu$ V.

### Power Supply Circuits

See Diagram 3. The Power Supply consists of the Sweep Generator, Sweep Amplifier, Plus and Minus Supply Regulators, Current Limit circuits, and the Current Overload Indicator circuits. The circuits depicted furnish plus and minus dc and swept voltages to the supply terminals of the DUT, and a sine-wave signal to sweep the Feedback Amplifier.

**Sine-Wave Generator.** This circuit consists of a square-wave generator, an integrator-shaper circuit, and an amplifier. The Generator first generates a square wave, integrates it to form a triangle wave, then shapes the triangle wave into a sine wave. The sine wave is then amplified and sent to the Sweep Amplifier circuits.

Comparator Q402-Q404, along with Q408 and Q406, form the square-wave generator. Sweep frequency is controlled by the position of S420, which selects different resistance values for each frequency range. Variable frequency control is accomplished by R415. The calibration of the front-panel frequency controls is performed by adjusting R410.

The signal from the emitter of Q408, which swings from about +29 volts to about -29 volts, is coupled through the frequency-selected network to the input of U424. This amplifier, in conjunction with C424 and C425, integrates

the square wave into a triangle waveshape. The outputs of U424 and Q408 are summed through R402 and R401 and applied to the comparator input. This causes the comparator to switch when the output of U424 is at about 5 volts. The triangle wave is fed through R426 to the shaper network.

The shaper network consists of two main sections: Q442, CR443, CR444, and CR445 act upon the negative half of the input triangle wave; Q452, CR453, CR454, and CR455 shape the positive half of the triangle wave. Since the two sections act upon the input signal in the same way, only the upper (Q442) half will be discussed.

Voltage divider R441-R442 holds the base of Q442 at about -3.2 volts. Q442 is conducting, so its emitter rests at about -2.5 volts. All three diodes are back-biased with no signal applied, so the anode of CR443 is at about -2.5 volts, CR444 is at about -2 volts, and CR445 is at about -1.1 volts. Thus, as the triangle wave is applied to the shaper circuit, the level at the cathode of CR445 drops until the diode begins to conduct, changing the effective load at the output of the integrator. As the applied signal continues to drop, CR444, then CR443 conduct, further changing the load on the integrator. The resultant output seen at TP448 is a sinusoidal waveshape that is applied to the amplifier.

Amplifier U432A is used to isolate the shaping circuit from the impedance changes that occur when the SWEEP AMPLITUDE control is changed. The stage has a gain of approximately one, as determined by the ratio of R432 to R449. During power supply rejection ratio and supply current tests, -30 volts is connected through R431 to the input of U432A. Through divider action, this offsets the output of the amplifier by about three volts. This action is used in tests in which the sweep signal must vary in only one direction from zero.

**Manual Sweep.** Normally, in automatic sweep operation, SWEEP AMPLITUDE control R460 is connected across ground and the output of U432A. When MANUAL SWEEP is selected, R460 is connected across the output of U460A and U460B. The voltage applied to the input of U460A varies from zero to about -6 volts, depending on the setting of R560, the + SUPPLY control. R562, the Supply Cal adjustment, is set for 60 volts (with R560, + SUPPLY control, set to 30 V) across the front-panel SUPPLY jacks; this places + 5 volts at the output of U432B.

In the three PSRR and two SUPPLY I positions of the FUNCTION switch, contact F4 is closed, connecting -30 volts to R461 and saturating Q462. The collector of Q462 is at ground, holding the input and output of voltage follower U460B at ground. In manual sweep, then, the bottom of R460 is held at ground for the above-mentioned functions.

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U432B is also a voltage follower, so the voltage tapped off R560 is also that appearing at the output of U432B. This potential, about  $-5$  volts, is applied through R467 to the input of U460A, which has a gain of about 0.6. The voltage at the output of U460A (about  $+3$  volts) is applied to the top end of R460; thus, in the PSRR and SUPPLY I positions of the FUNCTION switch, about three volts maximum is applied across R460 when manual sweep operation is selected.

When the 178 is operated in the functions other than the PSRR and SUPPLY I tests, switch contact F4 is open, and Q462 is cut off. The voltage from the output of U432A is divided across R463 and R464, applying about 60% to the input of U460B. The output level of U460B, about  $-3$  volts, is applied to the bottom end of R460. (The  $+3$  volts from U460A is still applied to the top of R460.) Thus, for functions other than PSRR and SUPPLY I, approximately twice the voltage is applied across R469.

**Sweep Amplifier.** The Sweep Amplifier consists of Field Effect Transistor Q520, Integrated operational amplifier U540, and four bipolar transistors, Q536, Q538, Q546, and Q548. The amplifier is fundamentally an inverting operational amplifier having a gain of ten; the ratio of R527 and R549 set the gain of the stage. Q520, by means of the F1 contact of the FUNCTION switch (closes between positions of the switch) or contact B of the DISPLAY ZERO switch, disconnects the input signal from the Sweep Amplifier. The output of the stage is applied to the  $+$  Supply through contact F8, the  $-$  Supply through contact F3, and to the DUT via J201-2 (Diagram 2). The sweep amplifier output is connected to the DUT power supplies to sweep the supplies in PSRR and SUPPLY I modes, and forces the DUT inputs in CMRR and INPUT I modes. The FUNCTION switch is used to select the desired mode.

**Supplies and Regulators.** The sweep amplifier sine-wave output signal is applied to the  $+$  DUT supply via switch contact F8, divided through R570-R571, and applied to U576, which sets both the output voltage of Q584 and the  $+$  DUT voltage out.

The sine-wave output from the Sweep Amplifier is also applied to the  $-$  DUT supply, through divider R551-R552, contact F3, then to the input of U476, which sets both the output voltage of Q484 and the  $-$  DUT voltage out.

The  $+$  SUPPLY dc level is set by U432B and R560. This dc level is applied to pin 2 of U576. The result of the dc level on pin 2 of U576 and a sine wave on pin 3 is a dc level at the output, pin 6, swept at the sine-wave rate.

The  $-$  SUPPLY dc level is set by R565 (through switch S565) when it is out of the detent (fully counterclockwise) position in the same manner as the  $+$  SUPPLY dc level is set. The  $-$  SUPPLY can be swept by the sweep generator at the sine-wave rate.

When the  $-$  SUPPLY control is in the detent position (TRACK  $+$  SUPPLY), both supplies have the same absolute value of voltage out and are under control of precision  $+$  SUPPLY control R560.

The Output amplifiers, U476 and U576, can furnish no more than about 20 mA to the load; thus, Q484 and Q584 are used as series-pass transistors to drive the DUT inputs.

**Current Limiting and Overload Indication.** The resistors on the DUT card that are marked  $+$  I LIMIT and  $-$  I LIMIT control the voltage across the base-emitter junction of the current limiter transistors, Q572 and Q472, respectively. Since the circuits are identical, only the plus supply is discussed here.

The  $+$  I LIMIT potentiometer is adjusted by the operator to limit the current to be furnished by the supply. The combination of R586, R584, and the  $+$  I LIMIT resistor can vary the current limit point from about 1 mA to about 150 mA. Assume that the  $+$  I LIMIT resistor is set to limit at 50 mA. Its resistance, plus that of R586, is set at about six ohms. If the collector current of Q584 exceeds 50 mA, the base of Q572 is pulled negative sufficiently to cause it to conduct. Q572 is immediately biased on, lighting the (+) OVERLOAD indicator lamp. Also, the minus input of U576 is pulled positive, which in turn causes its output to move negative. This change is coupled to the base of Q584, reducing its conduction and limiting the current supplied to the DUT.

# MAINTENANCE

## Introduction

This section of the manual contains information for use in preventive and corrective maintenance, with some aids to troubleshooting.

## PREVENTIVE MAINTENANCE

### General

Preventive maintenance consists of cleaning, visual inspection, lubrication, etc. Preventive maintenance performed on a regular basis improves instrument reliability. The severity of the environment in which the instrument is used determines the frequency of maintenance.

### Cleaning

The 178 Test Fixture should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause leakage current and component breakdown, especially in a humid atmosphere.

**Exterior.** Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or a small paint brush. The paint brush is particularly useful for dislodging loose dust on and around the front-panel controls. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should be avoided.

**Interior.** Dust in the interior of the instrument should be removed occasionally to prevent electrical conduction in high-humidity environments. Using dry, low-velocity air, blow out accumulated dust. Remove any remaining dirt with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning circuit boards.

### CAUTION

*Avoid the use of chemical cleaning agents that might damage the plastics used in the instrument. Do not use chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.*

## Lubrication

The reliability of potentiometers, rotary switches, and other moving parts can be maintained if they are kept properly lubricated. Use a cleaning-type lubricant on rotary switch contacts. Lubricate switch detents with heavier grease (such as Tektronix Part No. 006-0219-00). Do not lubricate cam switches.

### NOTE

*Shaft bushings of potentiometers that are not sealed should be lubricated with a lubricant that will not affect the electrical characteristics. Do not over-lubricate. A lubrication kit (Tektronix Part No. 003-0342-01) is available.*

## Visual Inspection

The 178 Test Fixture should be inspected occasionally for such defects as broken connections, loose pin connections, improperly seated transistors, damaged circuit boards and heat damaged parts.

The corrective procedure for most visible defects is obvious. However, particular care must be taken if heat damaged components are found. Overheating usually indicates other trouble in the instrument. It is, therefore, important that the cause of overheating be corrected to prevent recurrence of the damage.

## Transistors and Integrated Circuits

Periodic checks of individual transistors and integrated circuits are not recommended. The best check is their operation in the equipment as reflected by performance. Sub-standard performance is normally detected during a performance check or calibration procedure.

## Recalibration

To ensure accurate measurements, check the instrument calibration after each 1000 hours (approximately) of operation, or if the instrument is used infrequently, every year. Replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in the Performance Check/Adjustment section. The Performance Check/Adjustment procedure can also be helpful in locating troubles.

## TROUBLESHOOTING

### Introduction

The following information is provided to facilitate troubleshooting the 178. Information contained in other sections of this manual should be used with the following information to aid in locating circuit defects (see Operating and Circuit Description sections).

### Troubleshooting Equipment

The following equipment is useful for troubleshooting the 178.

**1. Semiconductor Tester.** Some means of testing the transistors, diodes, FETs, and linear op amps used in the instrument is helpful. A curve tracer, such as the Tektronix 575, 576, or 577-177 (577-178 for linear op amps) gives the most complete information.

**2. DC Voltmeter and Ohmmeter.** A voltmeter for checking circuit voltages and an ohmmeter for checking resistances and diodes are required. For most applications, a 20,000 ohms/volt VOM can be used if allowances are made for circuit loading when measuring voltage at high impedance points.

**3. Test Oscilloscope.** An oscilloscope with a DC to 1 MHz bandwidth and 10 mV/Div to 10 V/Div vertical deflection factor is suggested. A 10X probe should be used to reduce circuit loading.

### Troubleshooting Aids

**Diagrams.** Circuit diagrams are located on foldout pages in the Diagrams section near the rear of the manual. The component number and electrical value of each component is shown. See the first page of the Diagrams section for definition of the symbols used to identify components.

An overall block diagram (SWITCH CONFIG BLOCK DIAGRAM) is provided in the DIAGRAMS section. This block relates the circuits to the FUNCTION and VERTICAL UNITS/DIV switch contact numbers.

**Circuit Description.** The Circuit Description, Section 3, contains a brief description of the theory of circuit operation. The circuit configuration for each function switch position is shown in the series of block diagrams, Figures 3-1 through 3-11. Also, refer to the schematic diagrams in the pullout diagrams section.

**Transistors and Integrated Circuit Lead Configurations.** The lead configurations of the transistors and ICs in the 178 Test Fixture are shown on the schematic diagram introduction page.

**Voltages and Waveforms.** Important voltages and waveform are shown on the diagrams.

**Capacitor Values.** Values of disc capacitors are marked on the capacitor body and electrolytic capacitor values are marked either on the capacitor body or are color coded (see Fig. 4-1).

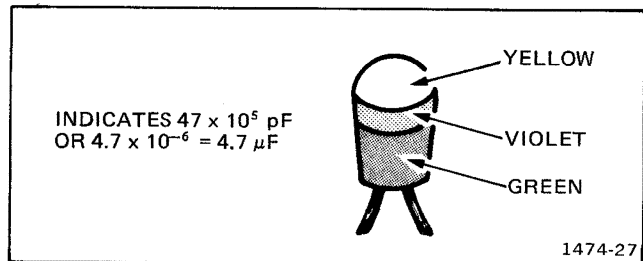


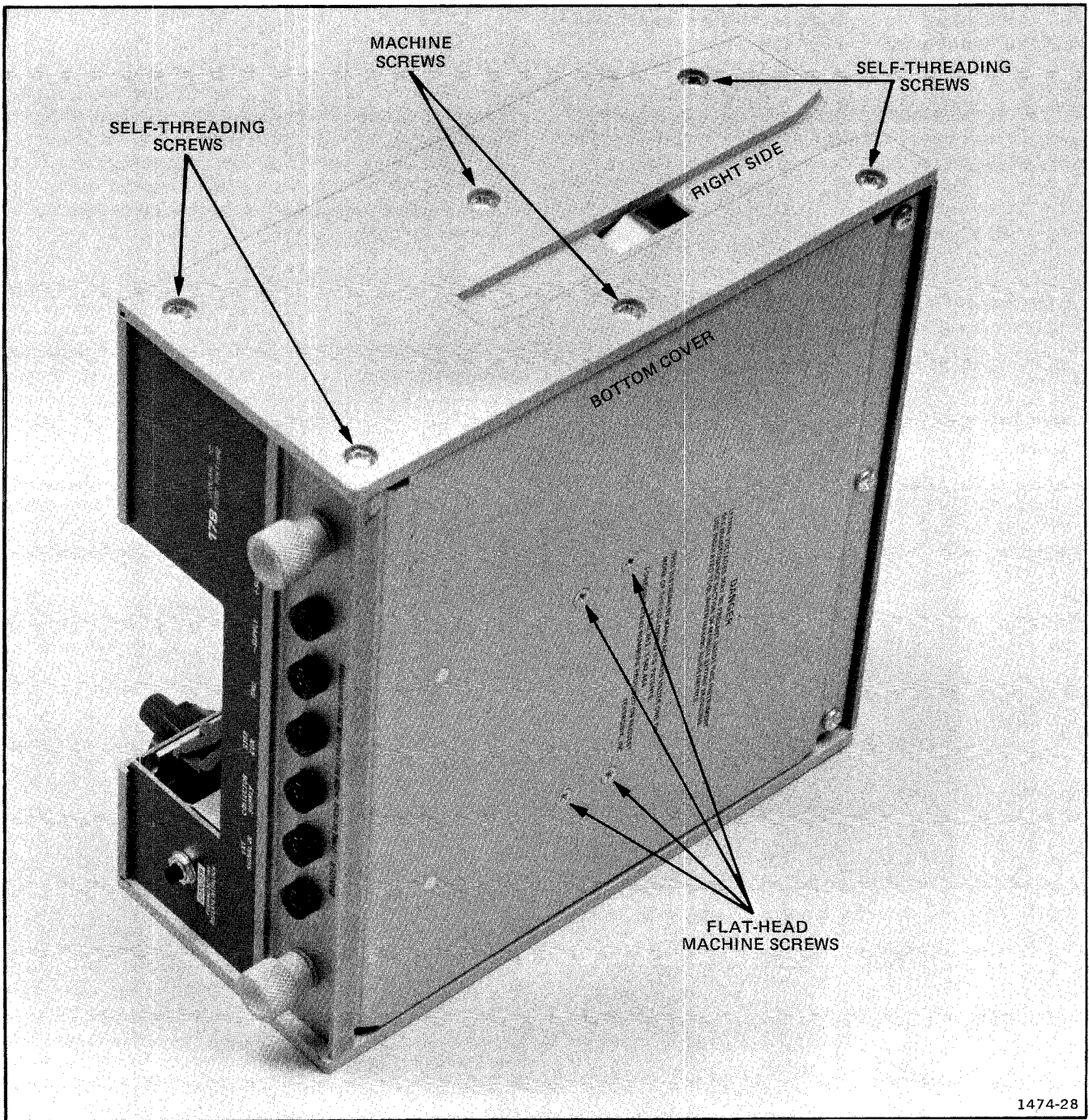
Fig. 4-1. Electrolytic capacitor color code.

**Diode Color Code.** The cathode end of each glass enclosed diode is indicated by a stripe, a series of stripes, or a dot. For diodes using a series of stripes, the color code identifies either the Tektronix part number or the JEDEC number. This code follows the standard color code except that a pink first band indicates a Tektronix part number, i.e., pink-brown-grey-green, indicates Tektronix Part No. 152-0185-00.

**Circuit Boards.** A depiction of each circuit board that relates to the circuit diagram with circuit components identified, is included on the back of the preceding circuit diagram. Each circuit board photo is sectioned by a grid system to facilitate rapid location of components by component number.

### Access to Circuit Boards in the 178

1. Remove the side panels.
  - a. Remove the six screws on each side (note the two screw types: self-threading and machine).
2. Remove the bottom panel.
  - a. Remove the three pan-head machine screws from the bottom panel (see Fig. 4-2).
  - b. Remove the four flat-head machine screws from the bottom panel.



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Fig. 4-2. Right-side and bottom panel of the 178.

## Maintenance—178 Service

- c. Remove the two pan-head machine screws from inside the storage compartment (see Fig. 4-3).
- d. Remove the two shields that form the side of the storage compartment. See Fig. 4-3. (The front shield held in place with two hex nuts, Fig. 4-3, need not be removed).
- e. Remove the bottom panel.

### Removing the Vertical Preamplifier and Feedback Amplifier Boards from the 178

1. Remove the Power Supply circuit board as follows:
  - a. Remove the eleven multi-pin connectors from the Power Supply circuit board. See Fig. 4-5 for circuit-board location.

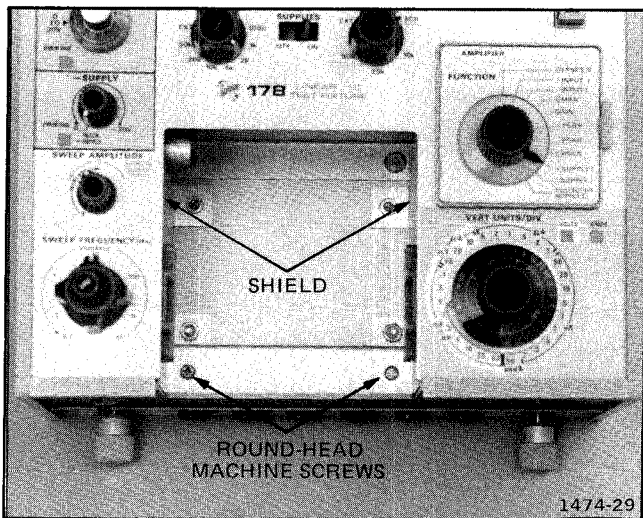


Fig. 4-3. Top view of the 178 showing storage-compartment shields.

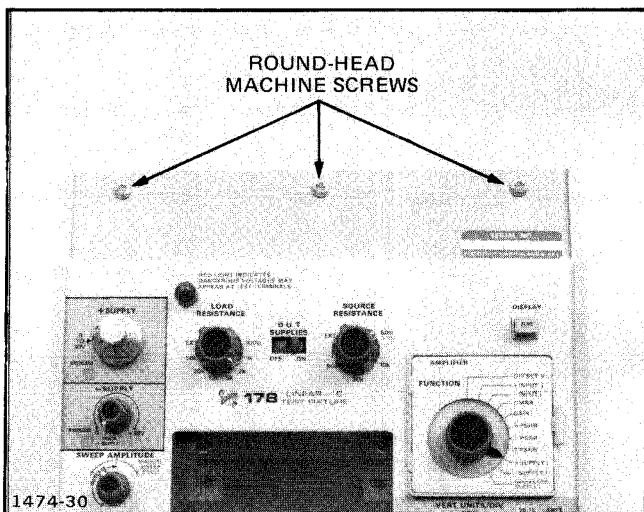


Fig. 4-4. Top view of the 178.

### NOTE

The last digit in the number of the circuit-board to which the multi-pin connector is mated indicates the color of the connector body. The standard color code is used. For example, the connector body color for P473 is orange. An arrow on the circuit board indicates pin number one on the board. Pin number one is marked with an arrow on the plug. Align the arrows for correct position.

- b. Remove the red connector (P222) from the rear of the Feedback Amp board. Lift the pair of wires (attached to the red connector) away from the Power Supply circuit board.

- c. Remove the three round-head machine screws from the top-rear of the instrument (Fig. 4-4).

- d. Slide the Power Supply circuit board and rear-panel assembly away from the instrument far enough to unsolder the two black panel-lamp leads.

- e. Remove the circuit board and rear-panel assembly.

2. Remove the Vertical Preamp, Feedback Amp, and Interface Boards (remove as a unit) as follows:

- a. Remove the six multi-pin connectors (color coded as previously detailed).

- b. Lift the three-lamp holder caps away from the plastic sleeves (see Fig. 4-6).

- c. Note the positions of the VERT UNITS/DIV and FUNCTION switches and remove the switch knobs.

- d. Note the positions of the SOURCE RESISTANCE and LOAD RESISTANCE knobs and remove the knobs.

- e. Remove the hex nut and washer from the SOURCE RESISTANCE, LOAD RESISTANCE, and FUNCTION switch shafts.

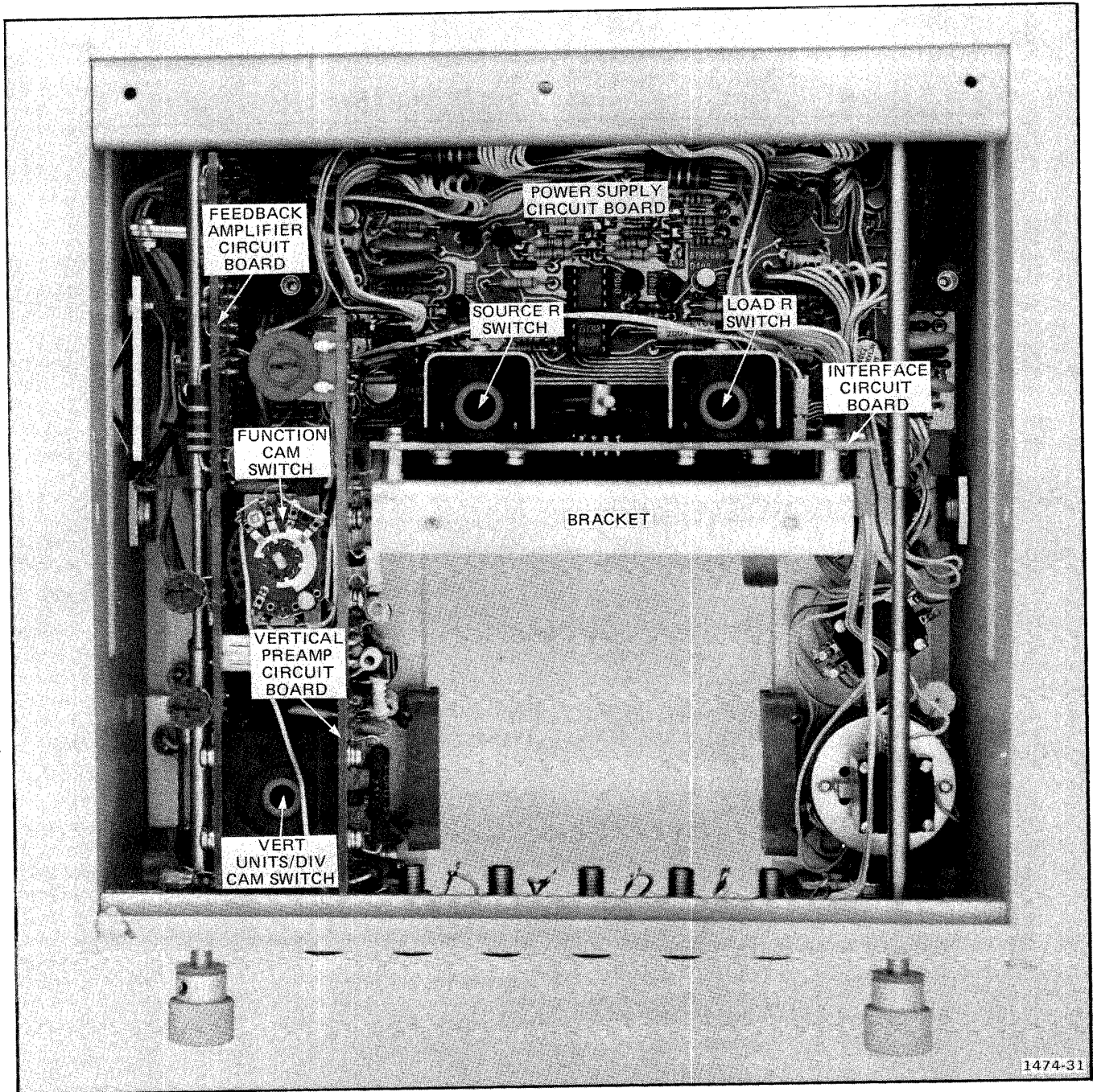


Fig. 4-5. Location of circuit boards in the 178.

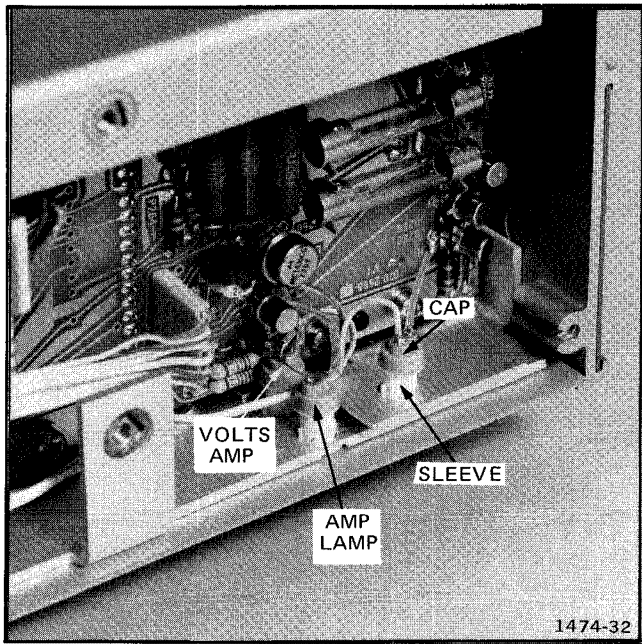


Fig. 4-6. Location and assembly details of indicator lamps.

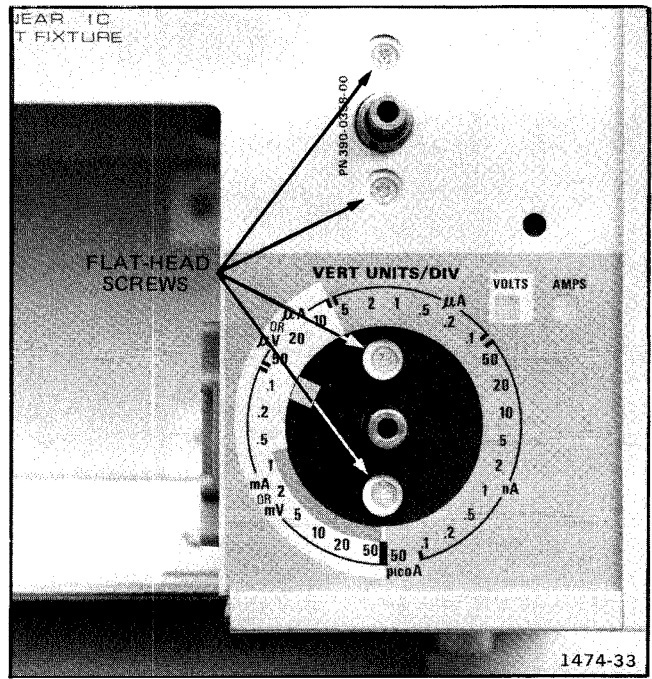


Fig. 4-7. Location of the flat-head machine screws under FUNCTION and VERT UNITS/DIV switches.

f. Remove the four flat-head screws (visible through the front-panel openings, see Fig. 4-7) at the VERT UNITS/DIV and FUNCTION switches.

g. Loosen the socket-head screw from the DUT SUPPLIES switch arm (see Fig. 4-8).

h. Remove the three multi-pin connectors from the Interface circuit board.

i. Remove the DUT card-grounding clip (see Fig. 4-9).

j. Remove the two hex nuts (that hold the bracket to the main chassis) near the 60-pin interface connector.

k. Lift the Vertical Preamp, Feedback Amp, and Interface circuit boards away from the instrument, as a unit.

l. Separate the two board assemblies lying at right angles by pulling the Interface board away from the double-board assembly.

### Removing and Replacing the Feedback and Vert Preamp Boards from the Cam-Switch Assembly

If the two boards (Feedback Amplifier and Vertical Preamp) common to the FUNCTION and VERTICAL UNITS/DIV switches must be separated, remove only one board at a time from the cam switch drum-and-bearing assembly. The drum-and-bearing assembly is precisely aligned at the factory. If both boards are removed from this assembly, the alignment is destroyed. If both boards must be removed, do not disassemble until the replacement boards are obtained. Replace one board at a time to preserve the alignment.

### Cam Switch Repair and Replacement

A cam switch is actually an assembly consisting of a cam rotated by a front panel control and a set of contacts on an adjacent circuit board.

If the cam in the cam-switch drum-and-bearing assembly must be replaced, do not remove the assembly from the circuit boards until the replacement cam assembly is obtained. An alignment fixture and installation instructions are included with the replacement cam assembly.



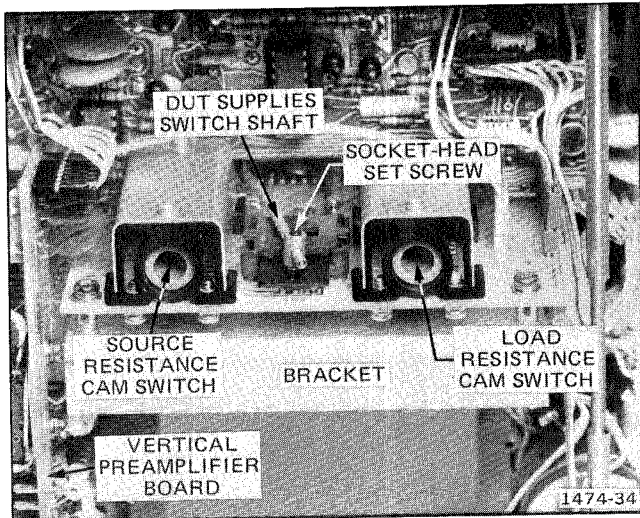


Fig. 4-8. Location of the DUT SUPPLIES switch arm.

**CAUTION**

Repair of cam switches should be undertaken only by experienced repair personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance in repair of the cam switches, contact your local Tektronix Field Office or representative.

**Cleaning.** If the contact is not obviously damaged, try cleaning it before replacing. Follow the cleaning procedures in the order given; the first ones are the easiest.

**CAUTION**

When cleaning cam switch contacts:

1. Don't use cleaners, detergents, or lubricants which leave a residue. The residue can interfere with the high-frequency response of the contact. Also, the residue will attract dust and cause the contact to require frequent cleaning.
2. Don't use any cleaners which contain fluorocarbons. These will damage the cam portion of the switch. Fluorocarbons also damage the circuit board material used in some instruments.
3. Don't use anything that could snag the contact, like a cotton swab.

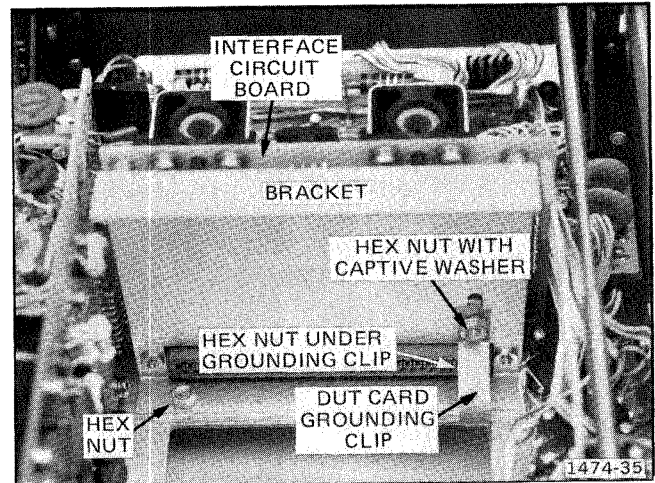


Fig. 4-9. Location of the DUT card grounding clip.

4. Don't scrape the pad. If the gold is removed from the pad, the pad will oxidize and cause future problems.

5. Don't bend the contacts. This may temporarily fix the problem. However, bending the contact damages its self-cleaning action and causes problems in the future.

Use the following procedures to clean the contacts:

1. Operate the switch several times. The wiping action may clean the contacts.
2. Blow low pressure air in the area of the contact while operating the switch.
3. Flush the contact with isopropyl alcohol and blow dry with low-pressure air. Isopropyl alcohol is flammable; avoid its use near open flame or other potential sources of ignition.

If the above procedures don't work, replace the contact strip. If cleaning the switch restores continuity, check to ensure that the contact wipes across the pad. If the contact does not wipe, replace the contact strip.

**Contact Replacement.** Cam Switch contacts in this instrument are part of a contact strip assembly. Refer to the mechanical parts list for ordering information.

If you do not have a replacement contact strip assembly, bend the contact for a temporary repair. If you do bend the contact, make note of its location and the symptom it causes. This will speed repair if the contact fails before you can make permanent repair.

### Removal of Storage Compartment Shields

#### Preliminary

1. Remove the two flat-head machine screws (Fig. 4-10) from the bottom panel.
2. Remove the two round-head machine screws (Fig. 4-11) at the front of the storage compartment.

#### Removal-Right Shield

1. Press lightly at the point on the shield indicated in Fig. 4-12.

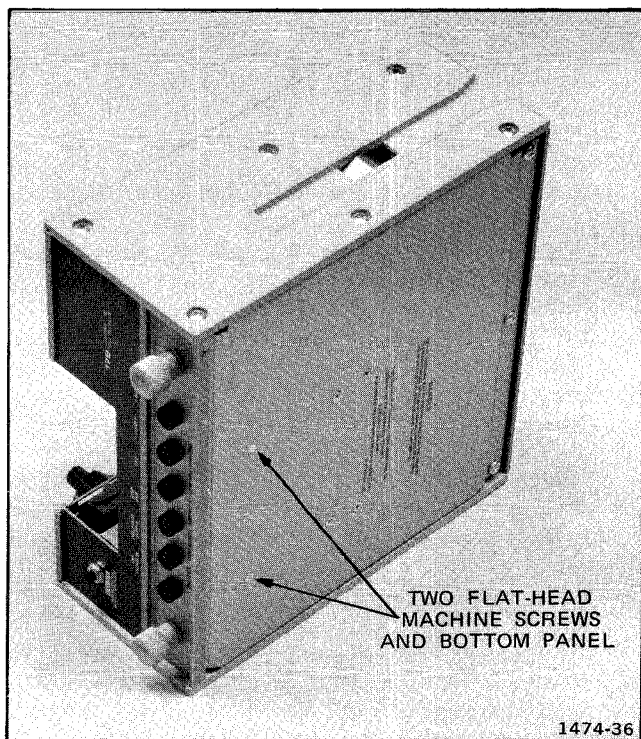


Fig. 4-10. Location of the screws securing the storage compartment shield.

2. Grasp the upper-right corner of the shield and tilt the top of the shield toward the center of the instrument while lifting the shield upward.

3. When the bottom of the shield clears the hex nut on the bottom panel, swing the front of the shield toward the instrument center, and lift the shield away from the instrument.

#### Removal-Left Shield

1. Press lightly at the point on the shield indicated in Fig. 4-12.
2. Grasp the upper-left corner of the shield and tilt the top of the shield slightly toward the instrument center while lifting the shield to clear the hex nut on the bottom panel.
3. Swing the front of the shield toward the center while pulling forward on the shield, until the shield clears the grounding clip (Fig. 4-12).
4. Lift the shield from the instrument.

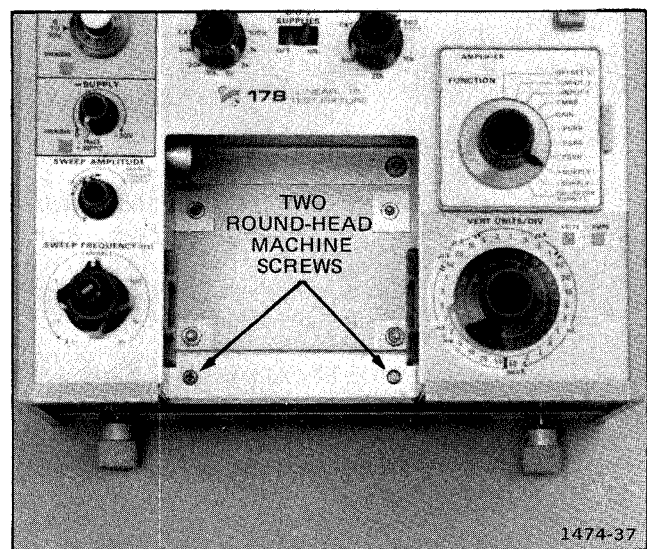
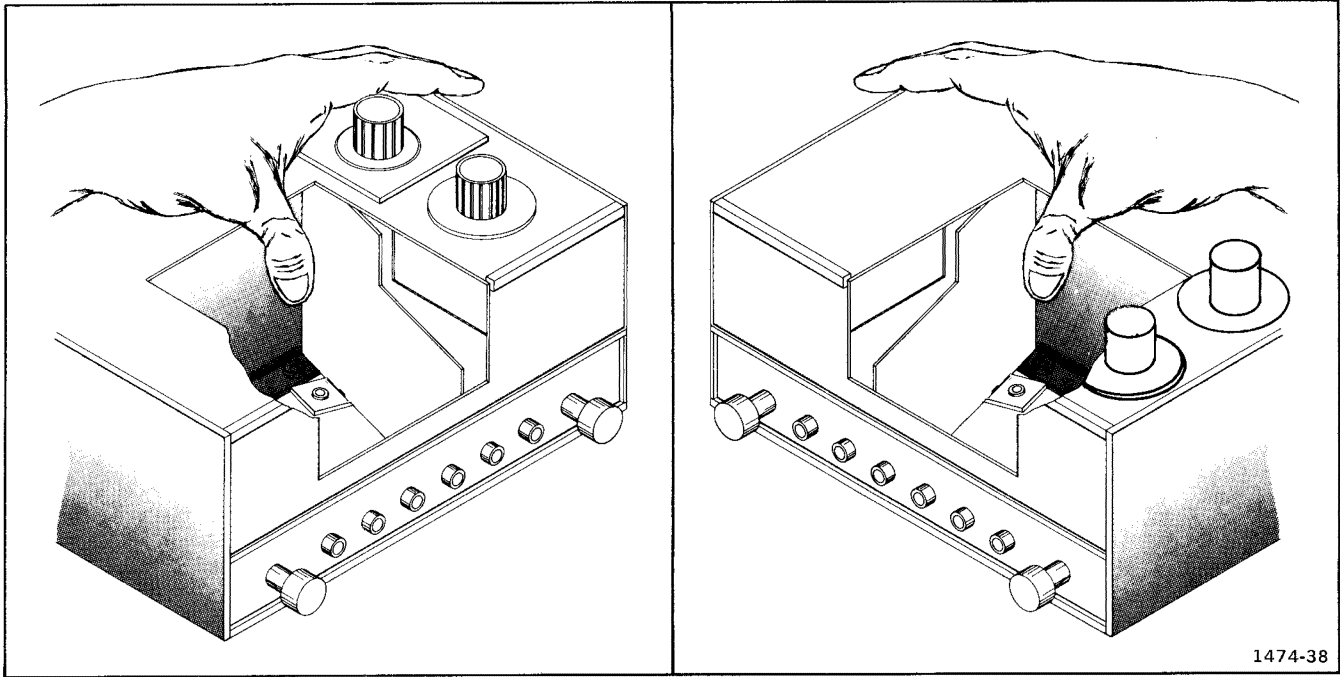
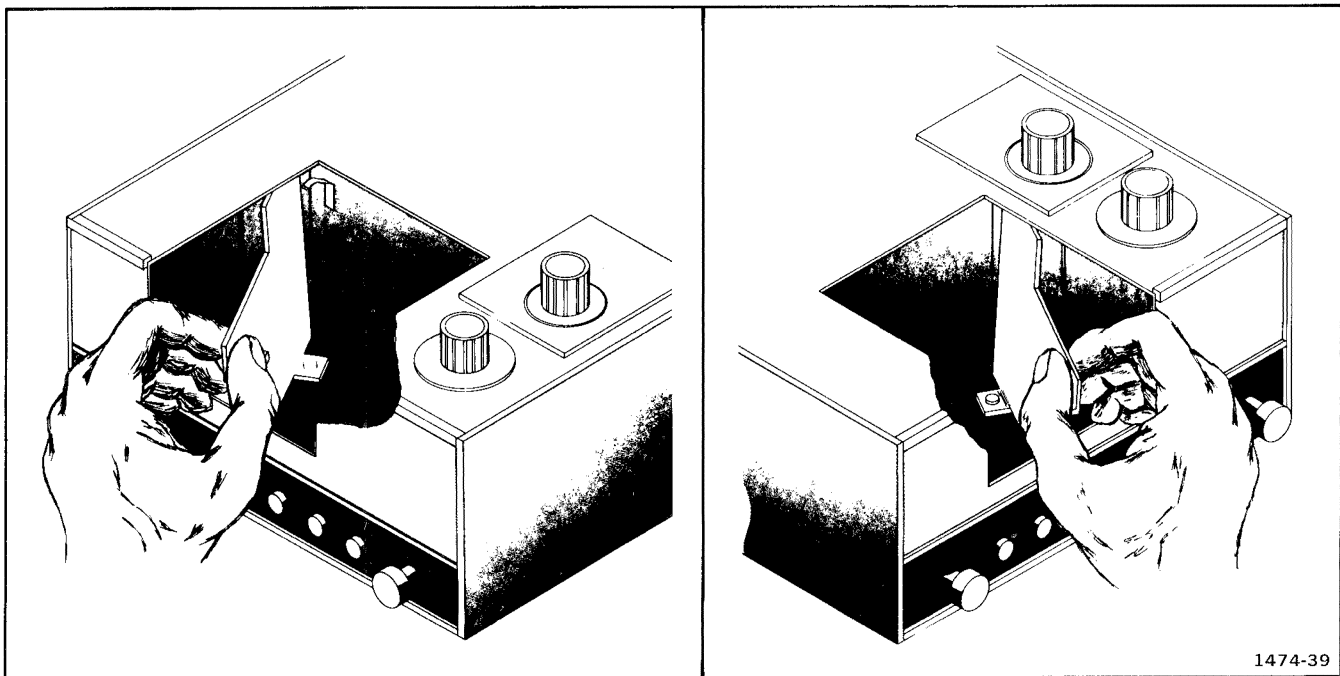


Fig. 4-11. Location of the screws in the storage compartment.



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Fig. 4-12. Removing the storage compartment shields.



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Fig. 4-13. Replacement of the storage compartment shields.

### Replacement of Storage Compartment Shield-Left Side

1. Place the shield in the instrument as shown in Fig. 4-13, with the back edge to the left of the grounding clip.

2. Tilt the top of the shield slightly toward the instrument center, while swinging the front of the shield toward its final position.

3. When the bottom of the shield clears the hex nut on the bottom panel, slide the shield into position and place the round-head machine screw through the front tab, but do not tighten.

4. Replace the flat-head screw through the bottom panel into the shield and tighten. Tighten the round-head machine screw at the front of the compartment.

**Replacement of Storage Compartment Shield-Right Side**

1. Place the shield into the compartment as shown in Fig. 4-13.

2. Grasp the upper-left corner of the shield and tilt the top of the shield slightly toward the instrument center.

3. Keeping the shield tilted, swing the front end of the shield toward its final position, lifting slightly to clear the hex nut on the bottom panel.

4. Place the round-head screw through the front tab, Fig. 4-13, but do not tighten.

5. Replace the flat-head machine screw through the bottom panel into the shield and tighten. Tighten the round-head machine screw at the front of the compartment.

# PERFORMANCE CHECK/ADJUSTMENT PROCEDURE

## Introduction

This section of the manual contains separate check and adjustment procedures. The Check procedure is provided to check the instrument operation against the instrument specification. The adjustment procedure is used to return the instrument to the original performance capabilities. Adjustment is generally required after a repair has been made, or after a long time interval in which normal aging of components may affect instrument accuracy.

## Services Available

Tektronix, Inc. provides complete instrument repair and calibration service at local field service centers and field offices. Contact your local Tektronix Field Office or representative for further information.

## Test Equipment Required

The following test equipment, or equivalent, is required for a complete check or adjustment of the 178 Linear IC Test Fixture. All test equipment is assumed to be correctly calibrated and operating within the listed specifications.

1. Digital Ohmmeter or Resistance Bridge: range, 50  $\Omega$  through 50 k $\Omega$ ; accurate within 0.1%.
2. Differential dc Voltmeter: input resistance, 1000 M $\Omega$ ; range, 0 through 4 volts; accurate within 0.1%. A digital voltmeter may be used for some of the measurements in these procedures. Use the differential voltmeter where indicated.
3. Test Oscilloscope: dual input, dc coupled; time/div, .1 ms through 1 s; deflection factor, from .5 V/Div. (10  $\mu$ V/Div, differential input, for CMRR test method 3, optional.)
4. Time Mark Generator: markers at 1 ms, .1 s, 1 s, and 5 s. The TEKTRONIX TG 501 Time Mark Generator is recommended.

5. Test Op Amp: CMRR 150 dB specified minimum or 120 dB measured; noise level less than 2  $\mu$ V with 50  $\Omega$  source resistance; Tektronix calibration fixture 067-0756-00 is recommended. See CMRR test method 1 in the procedure.

Or, CMRR 110 dB specified minimum; noise level less than 2  $\mu$ V with 50  $\Omega$  source resistance; any op amp meeting or exceeding 114 dB measured, such as the Precision Monolithic OP-05EJ, may be used. See CMRR test method 2 in the procedure.

6. Two LM301 IC operational amplifiers. One is supplied as a standard accessory.

7. Resistor Kit (Tektronix Calibration Fixture 067-0691-00). Same as the calibration resistor kit for the 177.

1-1 $\Omega$ , 3 W, 1/4%	1-10 k $\Omega$ , 1/4 W, 1/4%
1-10 $\Omega$ , 3 W, 1/4%	1-100 k $\Omega$ , 1/8 W, 1/4%
1-100 $\Omega$ , 1/2 W, 1/4%	1-1 M $\Omega$ , 1/8 W, 1/4%
2-200 $\Omega$ , 10 W, 1%	1-10 M $\Omega$ , 1/8 W, 1/4%
1-1 k $\Omega$ , 1/4 W, 1/4%	

Order if needed, for the 178, one-100 M $\Omega$ , 1 W, 1/4% resistor (Tektronix Calibration Fixture 067-0705-00).

8. Capacitor. 0.22  $\mu$ F, 50 volts.

9. Other components, for building CMRR test circuit for method 2:

2-50 k $\Omega$ , 1/4%	1-10 k $\Omega$ potentiometer
1-40.2 k $\Omega$ , 1%	2-10-volt zener diodes
2-1.5 k $\Omega$ , 5%	

10. Extender cable (to permit making adjustments to the 178 without removing the 577 bottom panel). Tektronix Part No. 067-0721-00.

## PERFORMANCE CHECK

### 1. Check Source Resistance Accuracy

a. With the 178 removed from the 577, set the 178 controls as follows:

FUNCTION	OFFSET V
VERT UNITS/DIV	1 m
SOURCE RESISTANCE	50 Ω

b. Connect an ohmmeter or resistance bridge (accuracy .1%) between the +IN and GND terminals on the Standard Op Amp DUT card. Set the SOURCE RESISTANCE and VERT UNITS/DIV switches to the first settings in Table 5-1.

c. CHECK—The resistance and tolerance should be as shown in Table 5-1.

d. Switch to the next settings in Table 5-1.

e. CHECK—The resistance value for each of the SOURCE RESISTANCE and VERT UNITS/DIV settings should be within the tolerances shown.

Table 5-1

SOURCE RESISTANCE	VERT UNITS/DIV <sup>a</sup>	Ohmmeter Reading	Tolerance
50 Ω	1 m	550 Ω	Check for approx
50 Ω	.5 m	50 Ω	value only <sup>b</sup>
10 k	.5 m	10 kΩ	±1%
20 k	.5 m	20 kΩ	±1%
50 k	.5 m	50 kΩ	±1%

<sup>a</sup>When the VERT UNITS/DIV switch is in the 1 m/DIV to 50 m/DIV positions, add 500 Ω to the SOURCE RESISTANCE indicated.

<sup>b</sup>The measured resistance varies, depending upon the ohmmeter and resistance range used, because of the Source Resistance protection circuit in the 178. Use the highest range possible consistent with good resolution.

If a more accurate measurement is required, use the following method:

Connect the points on the DUT card, shown in Fig. 5-1, to GND and slide the EXT Feedback Amp switch away from the NORM position. Measure the resistance as in parts b through e. Return the slide switch to NORM and remove the connecting leads.

#### NOTE

Using this method a zero ohm reading is normal when measuring from + to ground in the 50Ω source resistor position.

f. Connect the ohmmeter or resistance bridge between -IN and GND on the Op Amp card and repeat steps a through e.

g. Connect the ohmmeter between -IN and the left -R<sub>s</sub> EXT terminal. Set the SOURCE RESISTANCE switch to EXT.

h. CHECK—The meter should indicate a short circuit.

i. Connect the ohmmeter between GND and the right -R<sub>s</sub> EXT terminal.

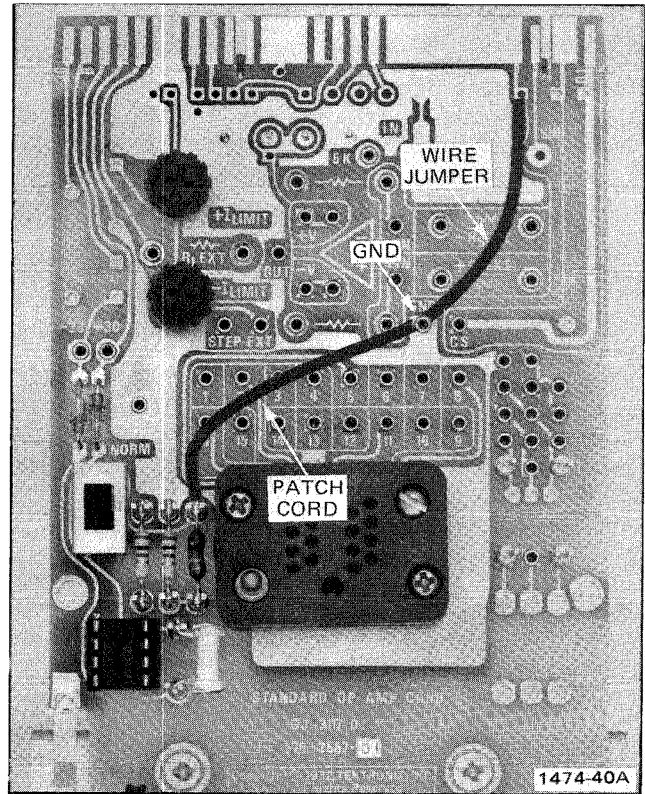


Fig. 5-1. Connections necessary for accurate measurement of source resistance (see Table 5-1, footnote 2).

- j. CHECK—The ohmmeter should indicate approximately 50 Ω.
- k. Connect the ohmmeter between GND and the right +R<sub>s</sub> EXT terminal.
- l. CHECK—The ohmmeter should indicate approximately 50 Ω.
- m. Connect the ohmmeter between +IN and the left +R<sub>s</sub> EXT terminal.
- n. CHECK—The ohmmeter should indicate a short circuit.

**2. Check Load Resistance Accuracy**

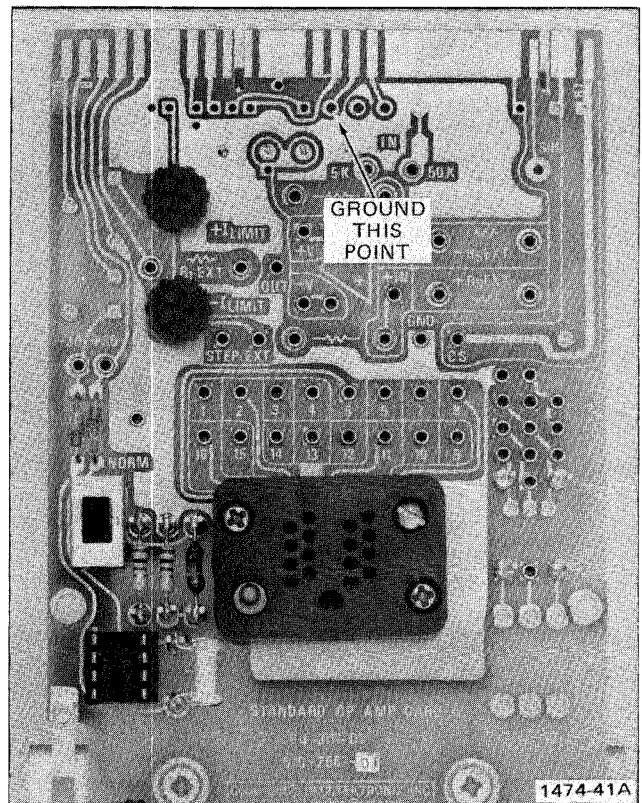
a. Set the controls as follows:

	<b>577</b>	
Power		in (off)
	<b>178</b>	
FUNCTION		OFFSET V
LOAD RESISTANCE		100 Ω
SWEEP AMPLITUDE		
+SUPPLY		0.0 (zero)
-SUPPLY		Track +Supply

b. Connect a lead from GND to the sixth hole to the left from the upper-right corner of the Standard Op Amp card. See Fig. 5-2.

**NOTE**

*Grounding this point permits measuring these resistors without removing the right-side cover. The resistance measured is higher (on the higher ranges) than indicated on the LOAD RESISTANCE switch. This difference is shown in Table 5-2.*



**Fig. 5-2.** Location of the point to be grounded in Step 2, part b.

- c. Place the Standard Op Amp card (DUT card) in the 178 and plug the 178 into the 577.
- d. Connect the ohmmeter between GND and OUT on the DUT card.
- e. Switch the FUNCTION switch to each of its positions.
- f. CHECK—The meter reads 100 Ω only on the OFFSET V and GAIN positions. All other positions should read approximately 50 kΩ.
- g. Return the FUNCTION switch to OFFSET V.
- h. CHECK—Using Table 5-2, read the value of resistance for each setting of the LOAD RESISTANCE switch.

Table 5-2

LOAD RESISTANCE Switch Setting	Resistance in Ohms	Tolerance
100 Ω	100	±3 Ω
1 k	1.001 k	±30 Ω
2 k	2.006 k	±60 Ω
5 k	5.039 k	±150 Ω
10 k	10.156 k	±302 Ω
20 k	20.60 k	±606 Ω
50 k	54.20 k	±1.54 kΩ
EXT	54.20 k	±1.54 kΩ

i. Set the LOAD RESISTANCE switch to EXT.

j. CHECK—With the Ohmmeter connected between OUT and the right end of R<sub>L</sub> EXT on the DUT card; the meter should read a short circuit.

k. Remove the ground lead from the Standard Op Amp card.

### 3. Check Vertical Preamp Balance

a. Set the controls as follows:

577

Max Peak Volts	6.5
Variable Collector %	0
Series Resistors	.12
Horiz Volts/Div	200 V, Collector
Horizontal Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Display Filter Norm	out
Vertical Position	out (Mag On) centered
Power	on

178

FUNCTION	—INPUT I
VERT UNITS/DIV	5 m (magnified)
SWEEP FREQUENCY (Hz)	.1
SWEEP AMPLITUDE	ccw

b. Press and hold the DISPLAY ZERO button. Position the spot to near the graticule center and note the spot position.

c. Release the DISPLAY ZERO button.

d. CHECK—The spot should shift not more than 2 divisions, ±50 pA (from the position noted in part b) when switched through all vertical ranges.

### 4. Check Vertical Looping (Optional)

a. Set the controls as follows:

577

Max Peak Volts	25
Variable Collector %	100
Collector Supply Polarity	AC
Horiz Volts/Div	10 V, Collector
Horizontal Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	out (Magnified) centered

178

FUNCTION	COLLECTOR SUPPLY I
VERT UNITS/DIV	2 mA (magnified)
DUT SUPPLIES Switch	ON

b. CHECK—Typically vertical separation (looping) of the trace is less than 1 division on the .1 mA to 50 mA ranges.

### 5. Check Vertical Current-Mode Accuracy

a. Set the controls as follows:

577

Max Peak Volts	6.5
Variable Collector %	0
Series Resistors	.12
Horiz Volts/Div	200 V, Collector
Collector Supply Polarity	AC



All Dark Gray Buttons and Knobs in except:

Display Filter	
Norm	out
Step Family	Single
Horizontal Position	centered
Vertical Position	centered
Offset Mult	
Zero (button)	in
Aid (button)	in
Step/Offset Ampl	50 mA
Offset Mult (dial)	0.00

**178**

FUNCTION	COLLECTOR SUPPLY I
VERT UNITS/DIV	50 m
SWEEP FREQUENCY (Hz)	1 k
SWEEP AMPLITUDE	fully counterclockwise
DUT SUPPLIES Switch	ON
SOURCE RESISTANCE	50 Ω

b. Connect the 10 Ω, 1/4%, 3-watt resistor (shown in Table 5-3) between STEP and CS terminals on the Op Amp DUT card. Connect a digital dc voltmeter across the 10 Ω resistor. The meter must float (meter common to the STEP terminal). See footnotes a and b for Table 5-1.

c. Note the digital voltmeter reading. Vertically and horizontally position the spot to top-center graticule lines.

d. Push to release the Offset Zero button to the out position. Set the Offset Mult dial to position the spot to the bottom graticule line.

e. CHECK—The dc voltmeter should indicate within 4.00 volts (±3%) of the voltage noted in part c.

f. Set the VERT UNITS/DIV and Step/Offset Ampl to the next settings in Table 5-3. Push the Offset Zero button in and repeat steps c and d.

g. CHECK—The voltmeter reading should be within the voltage limits set in column 4 (with the voltage noted in part c as the reference).

h. Continue the tests using Table 5-3, using the resistor values shown in column 3, through 50 nA/DIV.

i. Starting with 20 nA/DIV, use a differential dc voltmeter. Set the FUNCTION Selector to -INPUT I.

**Table 5-3**

VERT UNITS/DIV	STEP/OFFSET AMPL	Resistor Value	Meter Reading	Limit (3%)
50 mA	50 mA	10 Ω	4.00 V	±0.12 V
20 mA	20 mA		1.60 V	±0.048 V
10 mA	10 mA		0.80 V	±0.024 V
5 mA	5 mA	100 Ω	4.00 V	±0.12 V
2 mA	2 mA		1.60 V	±0.048 V
1 mA	1 mA		0.80 V	±0.024 V
.5 mA	.5 mA	1 kΩ	4.00 V	±0.12 V
.2 mA	.2 mA		1.60 V	±0.048 V
.1 mA	.1 mA		0.80 V	±0.024 V
50 μA	50 μA	10 kΩ	4.00 V	±0.12 V
20 μA	20 μA		1.60 V	±0.048 V
10 μA	10 μA		0.80 V	±0.024 V
5 μA	5 μA	100 kΩ <sup>a</sup>	4.00 V	±0.12 V
2 μA	2 μA		1.60 V	±0.048 V
1 μA	1 μA		0.80 V	±0.024 V
.5 μA	.5 μA	1 MΩ <sup>a</sup>	4.00 V	±0.12 V
.2 μA	.2 μA		1.60 V	±0.048 V
.1 μA	.1 μA		0.80 V	±0.024 V
50 nA	50 nA		0.40 V	±0.012 V

<sup>a</sup>If a dc voltmeter having an input impedance of less than 1000 MΩ is used to measure the voltage across the 100 kΩ and 1 MΩ resistors, the reading will be in error depending on the meter impedance. To calculate the correct voltage, use the formula:

$$V_2 = V_1 \frac{R_m}{R_m + R_s}$$

Where,  
**V<sub>2</sub>** is correct voltage  
**V<sub>1</sub>** is indicated voltage  
**R<sub>m</sub>** is meter impedance  
**R<sub>s</sub>** is the current-sensing resistor in the table.



f. Turn the MANUAL SWEEP control until the spot is on the top graticule line. Note the meter reading.

g. CHECK—The sum of the readings noted in parts e and f should be as shown in Table 5-4, column 3.

h. Switch the VERT UNITS/DIV switch to 20 m and SOURCE RESISTANCE to 10 k.

i. Press the DISPLAY ZERO button. Turn the MANUAL SWEEP control to set the spot to the bottom graticule line. Note the voltage reading.

j. Turn the MANUAL SWEEP control to set the spot to the top graticule line. Note the voltage reading.

k. CHECK—The sum of the readings noted in parts i and j should be as shown in Table 5-4, column 3.

Table 5-4

VERT UNITS/DIV	SOURCE RESISTANCE	Sum of the Voltages	Accuracy
50 m	20 k	4.00 V	±120 mV
20 m	10 k	1.60 V	± 40 mV

l. Replace the 1 MΩ resistor on the DUT card with a 10 MΩ resistor.

m. CHECK—Using Table 5-5 and the procedure in parts i and j, check the accuracy at the VERT UNITS/DIV settings in column 1.

Table 5-5

VERT UNITS/DIV	SOURCE RESISTANCE	Sum of the Voltages	Accuracy
10 m	50 k	0.8 V	±24 mV
5 m	20 k	0.4 V	±12 mV
2 m	10 k	0.16 V	±4.8 mV
1 m	10 k	0.08 V	±2.4 mV

n. Remove the patch cords and resistors, then set the External Feedback Amplifier switch to NORM.

7. Check Sample and Hold Offset Voltage Range

a. Set the controls as follows:

577

Variable Collector %	0
Max Peak Volts	100
Collector Supply Polarity	AC
Series Resistors	2 M
Step/Offset Ampl	.5 V
Offset Mult (dial)	1.00
AID	IN

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Offset Zero	out
Horizontal Position	pull (X10 Mag) centered
Pulsed 300 μs	out
Vertical Position	centered
Horiz Volts/Div	10 mV, Collector (Mag on)

178

VERT UNITS/DIV	10 μA
FUNCTION	COLLECTOR SUPPLY I
SOURCE RESISTANCE	50 Ω
DUT SUPPLIES	OFF

b. Connect a patch cord between OUT and STEP on the Standard Op Amp card. Connect a patch cord between +IN and CS.

c. Switch DUT SUPPLIES switch to ON.

d. Press and hold the DISPLAY ZERO button and position the spot approximately to horizontal graticule center. Note the spot position and release the DISPLAY ZERO button.

e. CHECK—The spot should shift ≥2.5 divisions to the left of the position noted in part d.

f. Release the AID button on the 577 to the Oppose position.

g. Press the DISPLAY ZERO button.

h. CHECK—The spot should shift ≥2.5 divisions to the right of the position noted in part d.

i. Remove the patch cords from the Standard Op Amp card.

## Performance Check/Adjustment—178 Service

### 8. Check Power Supplies

a. Set the controls as follows:

#### 577

Horiz Volts/Div                    10 V, Collector  
Vertical Position                    centered

All Dark Gray Buttons and Knobs in except:

Step Family                    Single

#### 178

FUNCTION                    OFFSET V  
+SUPPLY                    fully counterclockwise  
-SUPPLY                    TRACK +SUPPLY  
SWEEP AMPLITUDE            fully counterclockwise  
SWEEP FREQUENCY (Hz)    .1  
VERT UNITS/DIV            50 mV  
DUT SUPPLIES Switch       ON  
SOURCE RESISTANCE  
Switch                    50  $\Omega$

#### Standard Op Amp Card

Limits                    fully clockwise

b. Connect the dvm between +SUPPLY and GND on the front panel. Read the voltage on the dvm.

c. CHECK—The +SUPPLY dial should indicate approximately the voltage read on the dvm in part b.

d. Reconnect the dvm between +SUPPLY and -SUPPLY on the front panel. Set +SUPPLY dial to 30.0.

e. CHECK—The voltage should be 60.0 volts,  $\pm 0.6$  volt (1%).

f. Set the DUT SUPPLIES switch to OFF. Connect a 200  $\Omega$ , 10 watt, 1% resistor from +V to GND on the Standard Op Amp card. Connect the dvm across the 200  $\Omega$  resistor and set the DUT SUPPLIES switch to ON.

g. CHECK—For +30 volts,  $\pm 2\%$ ,  $\pm 100$  mV.

h. Set the DUT SUPPLIES switch to OFF. Reconnect the 200  $\Omega$  resistor between -V and GND. Switch the DUT SUPPLIES switch to ON. Read the voltage across the 200  $\Omega$ .

i. CHECK—For -30 volts,  $\pm 2\%$ ,  $\pm 100$  mV.

j. Set the DUT SUPPLIES switch to OFF. Remove the 200  $\Omega$  resistor. Patch from +V to GND on the Standard Op Amp card. Set the FUNCTION switch to +SUPPLY I. Set the DUT SUPPLIES switch to ON.

k. Press the DISPLAY ZERO button and position the spot to the graticule bottom center (zero reference). Release the DISPLAY ZERO button and set the DUT SUPPLIES switch to ON.

l. CHECK—For approximately 4 divisions of vertical shift from the zero reference (approximately 200 mA). Note that the +SUPPLY OVERLOAD lamp is lighted.

m. CHECK—That when the +I Limit control (on the Standard Op Amp card) is turned counterclockwise, the +Supply current decreases (spot moves toward the zero reference).

n. Set the DUT SUPPLIES switch to OFF. Move the patch cord from +V to -V. Set the FUNCTION switch to -SUPPLY I.

o. Press the DISPLAY ZERO button and position the spot to the graticule top center (zero reference). Release the DISPLAY ZERO button and set the DUT SUPPLIES switch to ON.

p. CHECK—For approximately 4 divisions of vertical shift from the zero reference (approximately 200 mA). Note that the -SUPPLY OVERLOAD lamp is lighted.

q. CHECK—That when the -I Limit control is turned counterclockwise, the -Supply current decreases (spot moves toward the zero reference). Remove the jumper.

### 9. Check Sweep Generator

a. Set the 577-178 controls as follows:

#### 577

Horiz Volts/Div                    5 V, Collector  
Horizontal Position                centered  
Vertical Position                    centered

All Dark Gray Buttons and Knobs in except:

Step Family                    Single

178

FUNCTION	+ SUPPLY I
+ SUPPLY	30.0
- SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	midrange
SWEEP FREQUENCY (Hz)	1 k
VARIABLE	fully clockwise (X1)
DUT SUPPLIES	OFF
VERT UNITS/DIV	.5 mA

**Test Oscilloscope**

Vert Mode	Alt
CH 1 DC	5 V/Div
CH 2 DC	.5 V/Div
Position CH 1 and 2	centered
Time/Div	.1 ms
Trigger Mode	Norm
Slope	+
Coupling	DC

**Time Mark Generator**

Marker Selector	1 ms
-----------------	------

b. Connect the time mark generator to CH 2 of the test oscilloscope. Connect +V on the Standard Op Amp card to CH 1 of the oscilloscope. Set the DUT SUPPLIES switch to ON. Trigger the test oscilloscope for a stable display.

c. Position the first time mark to the left graticule line on the test oscilloscope. Note the point at which the sine wave from the 178 crosses the time mark from the time mark generator.

d. CHECK—That the sine wave crosses the right-most time mark at the same point as noted in part c,  $\pm 0.5$  major horizontal division.

e. Set the SWEEP FREQUENCY to 100 Hz and the test oscilloscope Horizontal to 1 ms/Div.

f. CHECK—For 1 cycle in 10 time marks,  $\pm 0.5$  div.

g. Set the SWEEP FREQUENCY to 10 Hz. Set the time mark generator to .1 s. Set the test oscilloscope to 10 ms/Div.

h. CHECK—For 1 cycle in 1 time mark,  $\pm 0.5$  div.

i. Set the test oscilloscope for .1 s/Div<sup>1</sup> and the time mark generator to 1 s. Set the test oscilloscope to CH 2 only and check the display for 1 time mark/10 horizontal divisions. If not 1 time mark/10 divisions, adjust the horizontal Variable for 1 mark/10 divisions.

j. Set the test oscilloscope vertical to CH 1. Set the 178 SWEEP FREQUENCY control to 1 s.

- k. CHECK—For 1 cycle in 10 divisions,  $\pm 0.5$  division.
- l. Set the oscilloscope to 1 s/Div (use variable if necessary). Switch the test oscilloscope vertical to CH 2. Set the time mark generator to 1 s and check the time base for 10 s in 10 divisions.
- m. Set the test oscilloscope vertical to CH 1. Set the 178 SWEEP FREQUENCY to .1.
- n. CHECK—For 1 cycle in 10 divisions,  $\pm 0.5$  division.
- o. Set the test oscilloscope horizontal to 2 s/Div. Set the SWEEP FREQUENCY to 1 and the SWEEP FREQUENCY VARIABLE TO X.1.
- p. CHECK—The sine wave on the test oscilloscope for 5 divisions, +0.25 to 2 divisions.
- q. Set the SWEEP FREQUENCY to 10 Hz. Set the test oscilloscope horizontal for .2 s/Div. Set the test oscilloscope horizontal variable to Cal.

r. CHECK—Display for 1 cycle in 5 divisions, +0.25 to +2 divisions, minus the test scope accuracy<sup>2</sup>.

s. Set the SWEEP FREQUENCY to 100 Hz. Set the test oscilloscope horizontal for 20 ms/Div.

t. CHECK—The display for 1 cycle in 5 divisions, +0.25 to +2 divisions, minus the test oscilloscope accuracy<sup>2</sup>.

u. Set SWEEP FREQUENCY to 1 k and test oscilloscope horizontal to 2 ms/Div and repeat part t.

v. Set SWEEP FREQUENCY to .1. Set the time mark generator to 5 s. Disconnect the test oscilloscope. Connect the time mark generator through a .22  $\mu$ F, 50 V capacitor to +V on the Standard Op Amp card. Set the 178 VERT UNITS/DIV to .1 mA. Position the trace on screen<sup>3</sup>.

w. Turn on the storage. When the trace is at about midsweep (approximately 15 V) erase the trace and count the number of time marks in one full sine-wave cycle.

x. CHECK—For 21 pulses,  $\pm 7$  pulses in one cycle.

**10. Check Sweep Amplitude**

a. Set the controls as follows:

	<b>577</b>	
Horiz Volts/Div		2 V, Collector
All Dark Gray Buttons and Knobs in except:		
Step Family		Single
Vertical Position		Pull (Mag On) centered

<sup>1</sup>If the test oscilloscope goes to only .5 s, use the Horizontal Variable and the time mark generator at 1 s and calibrate the crt for 1 time mark/division.

<sup>2</sup>The test oscilloscope accuracy can be checked with the time mark generator. If the sine wave is off the graticule to the right, move the right time mark 2 divisions to the left with the horizontal position control.

<sup>3</sup>Another method of checking part v is to use a stop watch or a watch with a sweep second hand and check for 100 seconds/cycle.

## Performance Check/Adjustment—178 Service

### 178

+SUPPLY	30.0 V
–SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	0 (fully counterclockwise)
MANUAL SWEEP	UP (pull out)
SOURCE RESISTANCE	50 $\Omega$
FUNCTION	CMRR
VERT UNITS/DIV	20 $\mu$ V
DUT SUPPLIES Switch	OFF

b. Connect the DVM between -IN and ground on the Standard Op Amp card.

c. Turn the DUT SUPPLIES Switch to ON.

d. CHECK—the voltage should be  $+30 \pm 0.9$  V.

### 11a. Check COMMON-MODE REJECTION RATIO, METHOD 1<sup>4</sup>

a. Set the controls as follows:

#### 577

Horiz Volts/Div 2 V, Collector

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	Pull (Mag On) centered

#### 178

SWEEP FREQUENCY (Hz)	1
VARIABLE	X1 (clockwise)
+SUPPLY	15.0 V
–SUPPLY	TRACK +SUPPLY
DUT SUPPLIES Switch	OFF
SOURCE RESISTANCE	50 $\Omega$
FUNCTION	CMRR
VERT UNITS/DIV	.1 m (magnified)

b. Using patch cords, connect the test Op Amp<sup>4</sup> on the Standard Op Amp card. Set the DUT SUPPLIES switch ON. Press the DISPLAY ZERO button.

c. Set the SWEEP AMPLITUDE control for 10 divisions of horizontal display.

d. CHECK—Vertical deflection of the horizontal trace should not exceed  $\pm 3$  divisions.

e. Set the VERT UNITS/DIV switch to 10  $\mu$ V (magnified). Press the DISPLAY ZERO button.

f. CHECK—Vertical deflection of the horizontal trace should not exceed  $\pm 3$  divisions.

<sup>4</sup>CMRR of the test op amp must be 150 dB, specified minimum, or must be  $\geq 120$  dB, measured. The noise level must be less than 2  $\mu$ V, using 50  $\Omega$  source resistance. Tektronix calibration fixture 067-0756-00 is recommended. Precision Monolithics SS725 also meets the 120 dB requirement. Compensate the SS725 for X1 gain according to manufacturer's specification.

g. Set the VERT UNITS/DIV switch to 1  $\mu$ V (magnified). Press the DISPLAY ZERO button.

h. CHECK—Vertical deflection of the horizontal trace should not exceed  $\pm 3$  divisions.

### 11b. Check COMMON-MODE REJECTION RATIO, METHOD 2

a. Set the controls as follows:

#### 577

Horiz Volts/Div	2 V, Collector
Horizontal Position	centered
Power Switch	in (off)

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	pull (Mag On) centered

#### 178

FUNCTION	CMRR
SOURCE RESISTANCE	50 $\Omega$
+SUPPLY	15.0 V
–SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
SWEEP FREQUENCY (Hz)	10
VARIABLE	X1 (clockwise)
VERT UNITS/DIV	.1 m (magnified)
DUT SUPPLIES Switch	OFF

b. Construct the circuit of Fig. 5-3 on the Standard Op Amp card. This method uses an op amp having good cmrr and drives its terminals common mode, thereby improving the op amp cmrr to  $\approx 160$  to 180 dB.

c. Plug the Standard Op Amp card into the 178. Pull the 577 Power switch.

d. Set the 178 DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button and position the spot to graticule center. Turn the SWEEP AMPLITUDE control clockwise to display 10 divisions of horizontal trace.





e. Adjust the Output Terminal cmrr control (on the test circuit) for no trace looping.

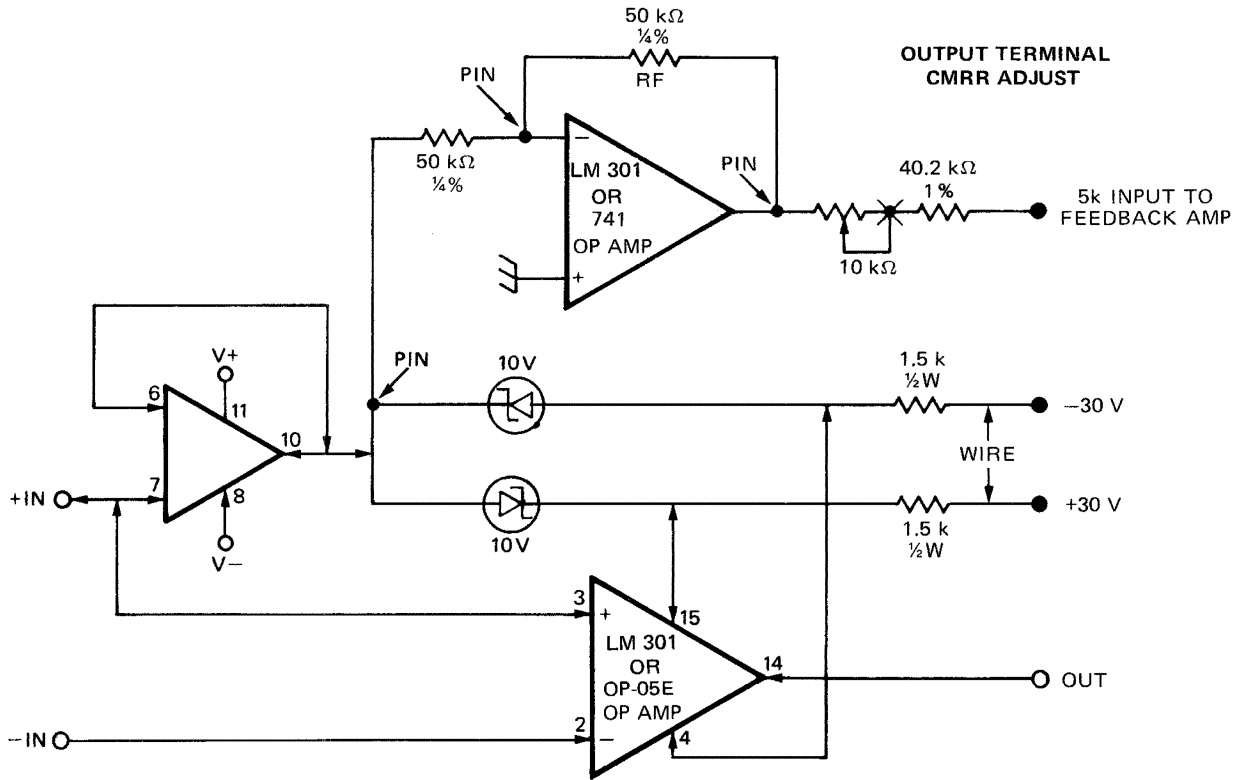
f. CHECK—Vertical deflection of the horizontal trace should not exceed  $\pm 1.5$  divisions.

g. Set the VERT UNITS/DIV to 10  $\mu$ V (Mag On) and press the DISPLAY ZERO button. Adjust the Output Terminal CMRR control for no trace looping.

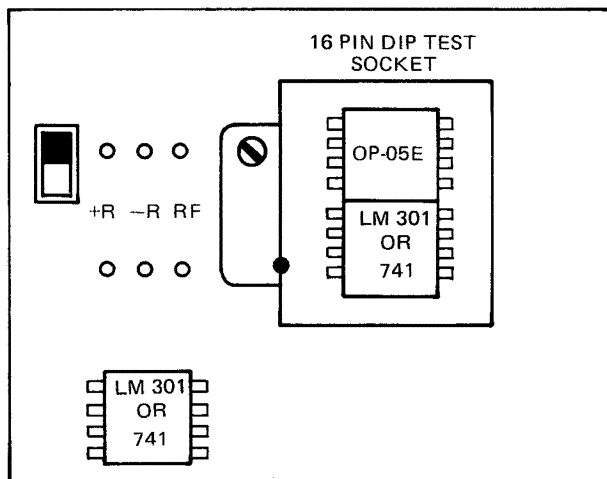
h. CHECK—Vertical deflection of the horizontal trace should not exceed  $\pm 1.5$  divisions.

i. Set the VERT UNITS/DIV switch to 1  $\mu$ V (Mag On) and press the DISPLAY ZERO button. Adjust the Output Terminal CMRR control for no trace looping.

   	<p>PATCH CORD</p> <p>BIFURCATED TERMINAL PIN</p> <p>HOLE IN CIRCUIT BOARD (SOLDER)</p> <p>WIRED CONNECTION (SOLDER)</p>	<p>THE SOCKET PIN NUMBERS SHOWN ARE TEST SOCKET NUMBERS FOR THE OP AMPS SHOWN. IF OTHER TYPES ARE USED, THE SOCKET NUMBERS MAY BE DIFFERENT.</p>
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THE OP-05E OP AMP USED IN THIS TEST IS A LOW NOISE DEVICE HAVING A MINIMUM SPEC OF 110 dB. ANY OP AMP MEETING OR EXCEEDING 114 dB MAY BE USED. ALL WIRING SHOWN IS IN ADDITION TO THAT ON THE STANDARD OP AMP CARD. IF OTHER THAN A LOW NOISE DEVICE IS USED, THERE MAY BE CONSIDERABLE JOHNSON NOISE. THE OP-05E TYPICALLY DISPLAYS 1 TO 2  $\mu$ V OF NOISE IN THIS TEST.



1474-45A

Fig. 5-3. Test circuit for CMRR adjust.

**Performance Check/Adjustment—178 Service**

j. CHECK—Vertical deflection of the horizontal trace should not exceed  $\pm 1.5$  divisions.

k. Remove patch cords and components from the Standard Op Amp card.

**ADJUSTMENT PROCEDURE**

**1. Adjust Vertical Preamplifier Balance**

a. Set the controls as follows:

	<b>577</b>	
Max Peak Volts		6.5
Variable Collector %		0
Series Resistors		.12
Horiz Volts/Div		200 V, Collector
Horizontal Position		centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Display Filter Norm	out
Vertical Position	pull (Mag On) centered

	<b>178</b>	
FUNCTION		COLLECTOR SUPPLY I
VERT UNITS/DIV		5 m (magnified)
SWEEP FREQUENCY (Hz)		.1
SWEEP AMPLITUDE		0

b. Press and hold the DISPLAY ZERO button. Position the spot to or near to graticule center and note the spot position.

c. Set the VERT UNITS/DIV to 5 pA and press and hold the DISPLAY ZERO button.

d. ADJUST—R340, Vertical Preamp Balance, for no spot movement while switching between 5 mA and 5 pA. See Fig. 5-4 for location of R340.

e. Release the DISPLAY ZERO button. Set the VERT UNITS/DIV switch to 5 pA. Wait 15 seconds.

f. ADJUST—R310, Converter Balance, to position the spot to the point noted in part b.

**2. Adjust Vertical Looping**

a. Set the controls as follows:

	<b>577</b>	
Max Peak Volts		25
Variable Collector %		100
Collector Supply Polarity		AC
Horiz Volts/Div		10 V, Collector
Horizontal Position		centered
All Dark Gray Buttons and Knobs in except:		
Step Family		Single
Vertical Position		pull (Mag On) centered

	<b>178</b>	
FUNCTION		COLLECTOR SUPPLY I
VERT UNITS/DIV		2 mA (magnified)
DUT SUPPLIES Switch		ON

b. ADJUST—R315, Vertical Looping, for minimum vertical trace separation (looping). See Fig. 5-4 for location of R315.

**3. Adjust Feedback Amplifier and Sample and Hold**

a. Set the controls as follows:

	<b>577</b>	
Horiz Volts/Div		5 V, Collector
Horizontal Position		centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	Pulled and centered
Display Filter	out

	<b>178</b>	
FUNCTION		CMRR
SOURCE RESISTANCE		50 $\Omega$
+SUPPLY		+15 V
-SUPPLY		TRACK +SUPPLY
SWEEP AMPLITUDE		fully counterclockwise
DUT SUPPLIES Switch		OFF
VERT UNITS/DIV		5 $\mu$ (magnified)

b. Press and hold the DISPLAY ZERO button. Adjust Vertical POSITION to position the spot to graticule center. Release the DISPLAY ZERO button.

c. Patch GND to OUT on the Standard Op Amp card.

d. ADJUST—R229, Feedback Bal, to position the spot to graticule center.



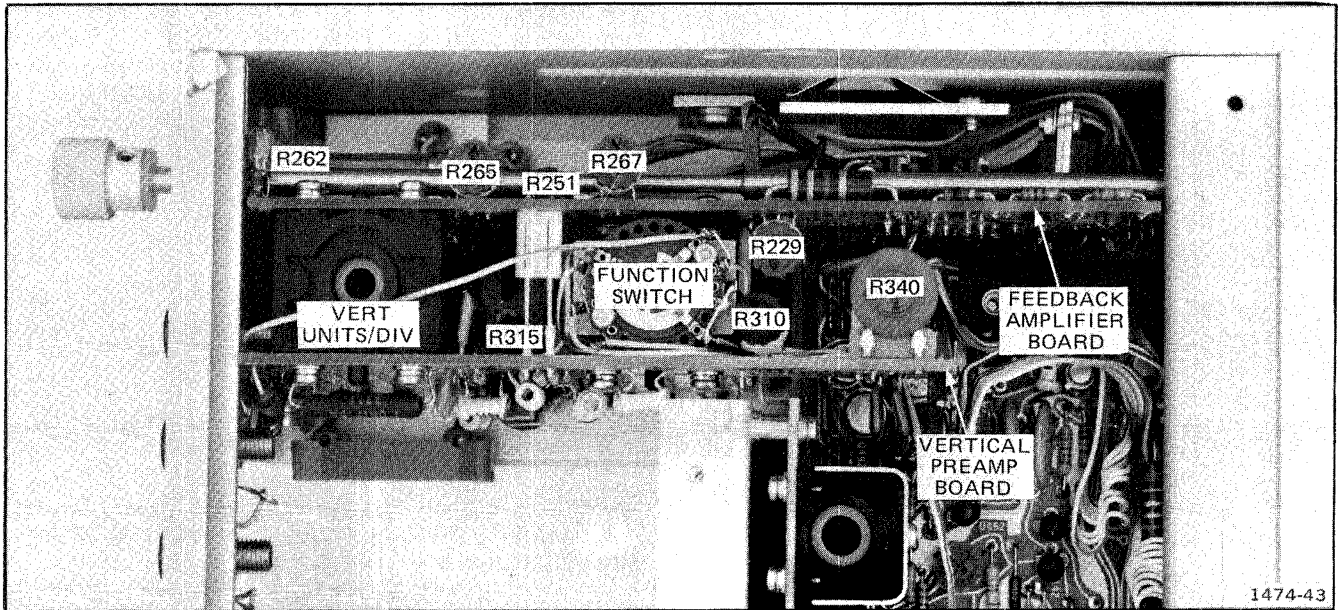


Fig. 5-4. Location of adjustments on the Vertical Preamp and Feedback Amplifier board.

e. Remove the patch cord from GND. Patch the test socket terminals to the Op Amp terminals on the Standard Op Amp card for a 741 Op Amp. (Refer to the operator's manual for instructions.) Place the 741 in the test socket.

f. Set the DUT SUPPLIES switch to ON.

g. Press the DISPLAY ZERO button. Note the spot position and release the button.

h. ADJUST—R251, Sample and Hold Bal, to locate the spot to the position noted in part g. Repeat parts g and h until there is no spot movement while pressing and releasing the DISPLAY ZERO button.

i. Remove the patch cords and 741 op amp.

#### 4. Adjust Power Supplies

a. Set the controls as follows:

577

Horiz Volts/Div	10 V, Collector
Vertical Position	centered

All Dark Gray Buttons and Knobs in except:

Step Family	Single
-------------	--------

178

FUNCTION	OFFSET V
+SUPPLY	fully counterclockwise
-SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
SWEEP FREQUENCY (Hz)	.1
VERT UNITS/DIV	50 mA
DUT SUPPLIES Switch	ON

#### Standard Op Amp Card

Limits	fully clockwise
--------	-----------------

b. Connect the dvm between the +SUPPLY and GND banana jacks on the front panel. Note the voltage on the dvm, approximately  $\pm 0.1$  V or less.

c. Mechanically (loosen +SUPPLY knob set-screw) position the knob to the voltage noted in part b (voltage indicated on knob when the shaft is in the fully counterclockwise position).

d. Reconnect the dvm between +SUPPLY and -SUPPLY on the front panel. Set the +SUPPLY knob to 30.0.

e. ADJUST—R562, Supply Cal, for 60.0 volts. See Fig. 5-5 for location.

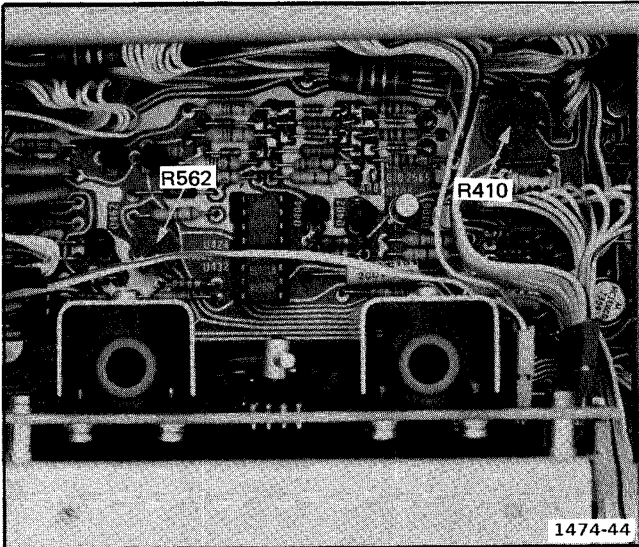


Fig. 5-5. Location of R562 and R410.

**5. Adjust Sweep Generator**

a. Set the 577-178 controls as follows:

<b>577</b>	
Horiz Volts/Div	5 V, Collector
Horizontal Position	centered
Vertical Position	centered
All Dark Gray Buttons and Knobs in except:	
Step Family	Single
<b>178</b>	
FUNCTION	+SUPPLY I
+SUPPLY	30.0
-SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	midrange
SWEEP FREQUENCY (Hz)	100
VARIABLE	fully clockwise (X1)
DUT SUPPLIES	OFF
VERT UNITS/DIV	.5 mA

**Test Oscilloscope**

Vert Mode	Add
Trigger Source	CH 1
CH 1	5 V/Div
CH 2	.5 V/Div
Coupling (both)	DC
Position CH 1 and 2	centered
Time/Div	10 ms
Triggering	Norm, +slope, DC coupling, internal

**Time Mark Generator**

Marker Selector	10 ms
-----------------	-------

b. Connect the +V on the Standard Op Amp card to CH 1 of the test oscilloscope. Set the DUT SUPPLIES switch to ON. Trigger the test oscilloscope for a stable display. Note: CH 1 may have to be readjusted to obtain a better display.

c. Adjust Sweep Freq Adj. R410, for one cycle per division. See Fig. 5-5 for location.

d. Connect the time mark generator to CH 2 of the test oscilloscope.

e. Set the oscilloscope Time/Div to 2 ms.

f. ADJUST—R410, Sweep Freq, for minimum horizontal drift between the time mark and the sine wave.

g. Disconnect all cables.

**6A. Adjust Common-Mode Rejection Ratio, Method 1<sup>5</sup>**

a. Set the controls as follows:

<b>577</b>	
Horiz Volts/Div	2 V, Collector
All Dark Gray Buttons and Knobs in except:	
Vertical Position	pull (Mag On) centered
<b>178</b>	
SWEEP FREQUENCY (Hz)	1
VARIABLE	X1 (clockwise)
+SUPPLY	+15.0
-SUPPLY	TRACK +SUPPLY
DUT SUPPLIES Switch	OFF
SOURCE RESISTANCE	50 Ω
FUNCTION	CMRR
VERT UNITS/DIV	.1 m (magnified)
SWEEP AMP	midrange

b. Using patch cords, patch the test op amp<sup>5</sup> (test socket terminals) to the op amp terminals on the Standard Op Amp card. Place the test op amp<sup>5</sup> in the test socket. Set the DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button. Set the SWEEP AMPLITUDE control for a 10-division trace.

<sup>5</sup>CMRR of the test op amp must be  $\geq 150$  dB, minimum, or must be  $\geq 120$  dB, measured. The noise level must be less than  $2 \mu V$  using  $50 \Omega$  source resistance. Precision Monolithics SS725 meets the 120 dB specification. Compensate the SS725 for X10 gain according to manufacturers specification.

c. ADJUST—R267, X10 CMRR (see Fig. 5-4 for location), for no vertical deflection of the horizontal trace.

d. Set the VERT UNITS/DIV switch to 10  $\mu$ V (Mag on) and press the DISPLAY ZERO button.

e. ADJUST—R265, X100 CMRR, for no vertical deflection of the horizontal trace.

f. Set the VERT UNITS/DIV to .1 m (Mag On) and press the DISPLAY ZERO button and repeat parts c through f until there is no vertical deflection of the horizontal trace.

g. Set the VERT UNITS/DIV to 1  $\mu$ V (Mag On) and press the DISPLAY ZERO button.

h. ADJUST—R262, X1000 CMRR for no vertical deflection of the horizontal display.

**6B. Adjust Common-Mode Rejection Ratio, Method 2**

a. Set the controls as follows:

**577**

Horiz Volts/Div	2 V, Collector
Horizontal Position	centered
Power Switch	in (off)

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	pull (Mag On) centered

**178**

FUNCTION	CMRR
SOURCE RESISTANCE	50 $\Omega$
+SUPPLY	15.0 V
-SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
SWEEP FREQUENCY (Hz)	10
VARIABLE	X1 (clockwise)
VERT UNITS/DIV	1. m (magnified)
DUT SUPPLIES Switch	OFF

b. Construct the circuit of Fig. 5-6 on the standard Op Amp card. This method uses an op amp having good CMRR and drives its terminals common mode, thereby improving the op amp cmrr to  $\approx$ 160 to 180 dB.

c. Plug the Standard Op Amp card into the 178. Pull the 577 Power switch.

d. Set the 178 DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button and position the spot to graticule center. Turn the SWEEP AMPLITUDE control clockwise to display 10 divisions of horizontal trace.

e. Adjust the Output Terminal CMRR control (on the test circuit) for no trace looping.

f. ADJUST—R267, X10 CMRR (see Fig. 5-4) for no vertical deflection of the horizontal trace.

g. Set the VERT UNITS/DIV to 10  $\mu$ V (magnified) and press the DISPLAY ZERO button. Adjust the Output Terminal CMRR control for no trace looping.

h. ADJUST—R265, X100 CMRR, for no vertical deflection of the horizontal trace.

i. Set the VERT UNITS/DIV to .1 mV and press the DISPLAY ZERO button. Repeat parts e through i until there is no vertical deflection.

j. Set the VERT UNITS/DIV to 1  $\mu$ V (magnified) and press the DISPLAY ZERO button. Adjust the Output Terminal CMRR Adjust for no looping.

k. ADJUST—R262, X1000 CMRR, for no vertical deflection of the horizontal trace.

**6C. Adjust Common-Mode Rejection Ratio, Method 3**

a. Set the controls as follows:

**577**

Horiz Volts/Div	2 V, Collector
-----------------	----------------

All Dark Gray Buttons and Knobs in except:

Step Family	Single
Vertical Position	pull (Mag On) centered

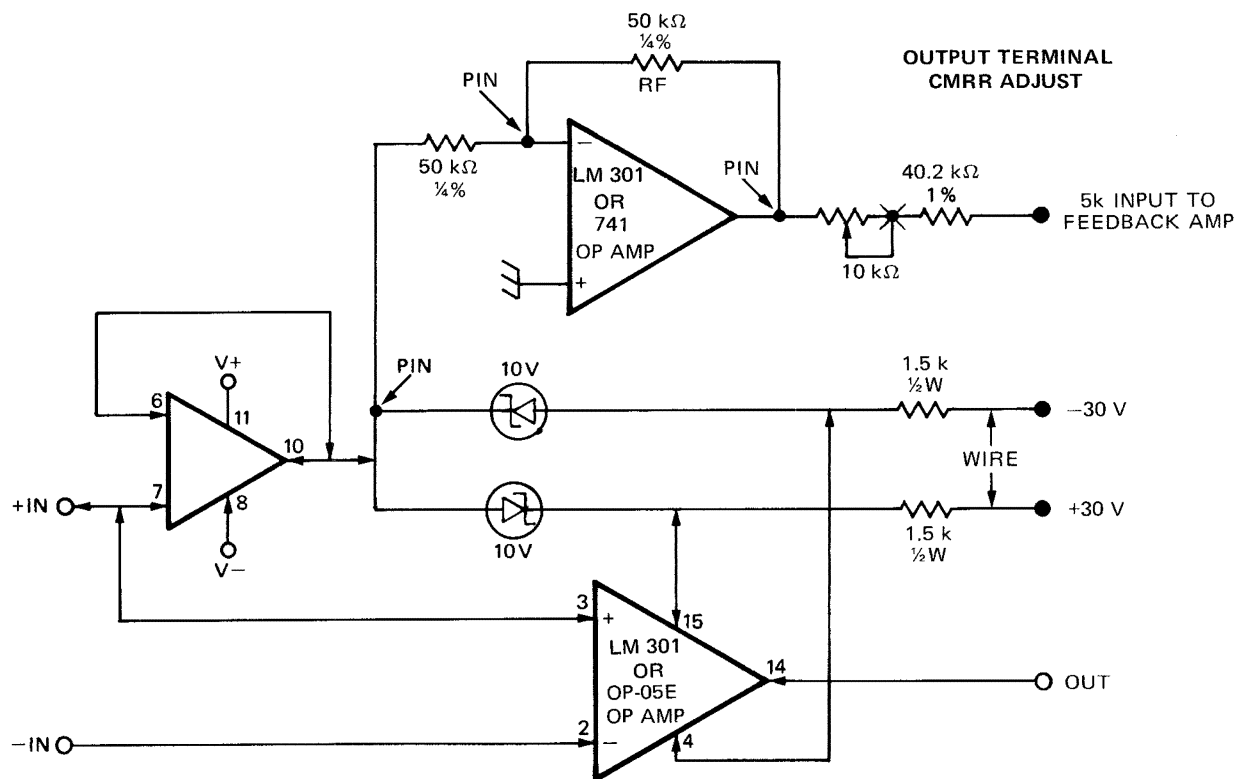
**178**

SWEEP FREQUENCY (Hz)	1
VARIABLE	X1 (fully clockwise)
+SUPPLY	15.0 V
-SUPPLY	TRACK +SUPPLY
SOURCE RESISTANCE	50 $\Omega$
FUNCTION	CMRR
VERT UNITS/DIV	.1 m (Mag On)
DUT SUPPLIES Switch	OFF

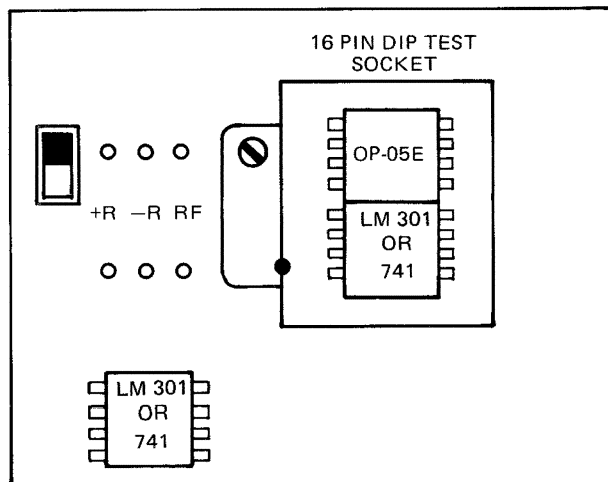
Performance Check/Adjustment—178 Service

- ↔ PATCH CORD
- ← PIN BIFURCATED TERMINAL PIN
- HOLE IN CIRCUIT BOARD (SOLDER)
- × WIRED CONNECTION (SOLDER)

THE SOCKET PIN NUMBERS SHOWN ARE TEST SOCKET NUMBERS FOR THE OP AMPS SHOWN. IF OTHER TYPES ARE USED, THE SOCKET NUMBERS MAY BE DIFFERENT.



THE OP-05E OP AMP USED IN THIS TEST IS A LOW NOISE DEVICE HAVING A MINIMUM SPEC OF 110 dB. ANY OP AMP MEETING OR EXCEEDING 114 dB MAY BE USED. ALL WIRING SHOWN IS IN ADDITION TO THAT ON THE STANDARD OP AMP CARD. IF OTHER THAN A LOW NOISE DEVICE IS USED, THERE MAY BE CONSIDERABLE JOHNSON NOISE. THE OP-05E TYPICALLY DISPLAYS 1 TO 2  $\mu$ V OF NOISE IN THIS TEST.



1474-45A

Fig. 5-6. Test circuit for CMRR adjust.

b. Using patch cords, patch the test op amp (test socket terminals) to the op amp terminals on the Standard Op Amp card. Place the test op amp in the test socket. Set the DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button.

c. Set the SWEEP AMPLITUDE to display 10 divisions of horizontal deflection.

d. ADJUST—R267, X10 CMRR (see Fig. 5-4 for location), for no vertical deflection of the horizontal trace.

e. Set the VERT UNITS/DIV switch to 10  $\mu$ V (Mag On) and press the DISPLAY ZERO button.

f. ADJUST—R265, X100 CMRR, for no vertical deflection of the horizontal trace.

g. Set the VERT UNITS/DIV switch to .1 mV (Mag On). Press the DISPLAY ZERO button and repeat parts d through f until there is no vertical deflection of the horizontal trace. If the cmrr is not 120 dB, but is a known (recorded) value, adjust the cmrr to the known value.

h. Remove the test op amp from the Standard Op Amp card.

i. Reset the controls as follows:

	<b>178</b>	
VERT UNITS/DIV		1 $\mu$ V (Mag On)
FUNCTION		GAIN
SWEEP AMPLITUDE		fully counterclockwise

**Differential Input Test Oscilloscope**

Vertical Input	10 $\mu$ V, DC
Horizontal Time/Div	5 ms
Trigger	Auto
Probes	X1, identical lead length

or

In lieu of a test scope, use a dvm having 1  $\mu$ V resolution

j. Connect a lead between the R<sub>F</sub> terminal (upper end) and the third hole from the left of the upper-right corner of the DUT card. Keep the lead short.

k. Press the DISPLAY ZERO button. Switch the External Feedback selector (to the left of the test socket, see Fig. 5-6), away from the NORM position.

l. Connect both test oscilloscope probes (or the DVM) to -IN on the DUT card, using a bifurcated pin terminal. Twist the probe leads together to minimize noise.

m. Note the dc voltage level. Connect one of the probes (or one of the dvm leads) to the +IN terminal on the DUT card.

n. ADJUST—R262, X1000 CMRR, for the dc level noted in part m.

**NOTE**

*Performing parts i through n calibrate the 50  $\mu$ V, 20  $\mu$ V, and 10  $\mu$ V (5  $\mu$ V, 2  $\mu$ V, and 1  $\mu$ V with magnifier on) ranges. If the X10 CMRR or X100 CMRR controls are re-adjusted, the X1000 range is no longer calibrated and parts i through n must be repeated.*

o. This completes the Adjustment Procedure.



# REPLACEABLE ELECTRICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number

00X Part removed after this serial number

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00213	NYTRONICS, COMPONENTS GROUP, INC., SUBSIDIARY OF NYTRONICS, INC.	ORANGE STREET	DARLINGTON, SC 29532
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03888	KDI PYROFILM CORPORATION	60 S JEFFERSON ROAD	WHIPPANY, NJ 07981
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
10389	CHICAGO SWITCH, INC.	2035 WABANSIA AVE.	CHICAGO, IL 60647
14298	AMERICAN COMPONENTS, INC., AN INSILCO COMPANY	8TH AVE. AT HARRY STREET	CONSHOHOCKEN, PA 19428
14552	MICRO SEMICONDUCTOR CORP.	2830 E FAIRVIEW ST.	SANTA ANA, CA 92704
15238	ITT SEMICONDUCTORS, A DIVISION OF INTER NATIONAL TELEPHONE AND TELEGRAPH CORP.	P.O. BOX 168, 500 BROADWAY	LAWRENCE, MA 01841
17856	SILICONIX, INC.	2201 LAURELWOOD DRIVE	SANTA CLARA, CA 95054
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
55292	LEDCO DIV., WILBRECHT ELECTRONICS, INC.	240 EAST PLATO BLVD.	ST. PAUL, MN 55107
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
71400	BUSSMAN MFG., DIVISION OF MCGRAW- EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71450	CTS CORP.	905 N. WEST BLVD	ELKHART, IN 46514
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76854	OAK INDUSTRIES, INC., SWITCH DIV.	S. MAIN ST.	CRYSTAL LAKE, IL 60014
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81073	GRAYHILL, INC.	561 HILLGROVE AVE., PO BOX 373	LA GRANGE, IL 60525
91418	RADIO MATERIALS COMPANY, DIV. OF P.R. MALLORY AND COMPANY, INC.	4242 W BRYN MAWR	CHICAGO, IL 60646
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601



Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-2568-00			CKT BOARD ASSY:INTERFACE	80009	670-2568-00
A2	670-2569-00			CKT BOARD ASSY:VERTICAL PREAMPL	80009	670-2569-00
A3	670-2566-00			CKT BOARD ASSY:FEEDBACK AMPL	80009	670-2566-00
A4	670-2565-00	B010100	B029999	CKT BOARD ASSY:POWER SUPPLY	80009	670-2565-00
A4	670-2565-01	B030000	B039999	CKT BOARD ASSY:POWER SUPPLY	80009	670-2565-01
A4	670-2565-02	B040000		CKT BOARD ASSY:POWER SUPPLY	80009	670-2565-02
A5	670-2567-00			CKT BOARD ASSY:STANDARD OP AMPL	80009	670-2567-00
C15	281-0536-00	XB030710		CAP.,FXD,CER DI:1000PF,10%,500V	72982	301000 X 5P0102K
C23	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	56289	19C242B
C25	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	56289	19C242B
C131	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C141	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C205	281-0526-00			CAP.,FXD,CER DI:1.5PF,+/-0.5PF,500V	04222	7001-1313
C208	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	91418	SP103Z151-4R9
C227	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	59660	301-055C0G0100F
C254	285-0898-00			CAP.,FXD,PLSTC:0.47UF,10%,100V	56289	LP66A1B474K
C263	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	91418	SP103Z151-4R9
C291	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C293	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C295	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C306	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C315	283-0119-00			CAP.,FXD,CER DI:2200PF,5%,200V	59660	855-536Y5E0222J
C318	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C320	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	59660	301-000U2J0470M
C322	281-0536-00			CAP.,FXD,CER DI:1000PF,10%,500V	72982	301000 X 5P0102K
C324	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C342	281-0512-00			CAP.,FXD,CER DI:27PF,+/-2.7PF,500V	59660	308-000C0G0270K
C352	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	59660	301-055C0G0100F
C359	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	91418	SP103Z151-4R9
C361	281-0546-00			CAP.,FXD,CER DI:330PF,10%,500V	04222	7001-1380
C371	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	72982	8131N031Z5U0105Z
C373	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	72982	8131N031Z5U0105Z
C406	281-0543-00			CAP.,FXD,CER DI:270PF,10%,500V	72982	301055X5P271K
C424}	295-0158-00			CAP.,SET,MTCHD:0.001UF,1UF	80009	295-0158-00
C425}	-----			(C424,C425, INDIVIDUAL TIMING CAPACITORS IN THIS ASSEMBLY MUST BE ORDERED BY THE 9-DIGIT PART NUMBER, LETTER SUFFIX AND TOLERANCE PRINTED ON THE TIMING CAPACITOR TO BE REPLACED. THE LETTER SUFFIX AND THE TOLERANCE SHOULD BE THE SAME FOR ALL OF THE TIMING CAPACITORS IN THE ASSEMBLY. EXAMPLE: 285-XXXX-XX F -)		
C442	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C452	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C472	281-0549-00			CAP.,FXD,CER DI:68PF,10%,500V	59660	301-000U2J0680K
C475	290-0522-00			CAP.,FXD,ELCLTLT:1UF,20%,50V	56289	196D105X0050HA1
C476	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C482	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C484	290-0522-00			CAP.,FXD,ELCLTLT:1UF,20%,50V	56289	196D105X0050HA1
C521	281-0580-00			CAP.,FXD,CER DI:470PF,10%,500V	04222	7001-1374
C542	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-519-Y5P-102P
C549	281-0518-00			CAP.,FXD,CER DI:47PF,+/-9.4PF,500V	59660	301-000U2J0470M
C562	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C566	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	91418	MX104Z2504R0
C574	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C575	290-0522-00			CAP.,FXD,ELCLTLT:1UF,20%,50V	56289	196D105X0050HA1
C576	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C582	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C584	290-0522-00			CAP., FXD, ELCTLT: 1UF, 20%, 50V	56289	196D105X0050HA1
CR14	152-0243-00			SEMICON DEVICE: ZENER, 0.4W, 15V, 5%	14552	TD3810983
CR18	152-0243-00			SEMICON DEVICE: ZENER, 0.4W, 15V, 5%	14552	TD3810983
CR151	152-0242-00			SEMICON DEVICE: SILICON, 225V, 200MA	07263	FDH5004
CR152	152-0242-00			SEMICON DEVICE: SILICON, 225V, 200MA	07263	FDH5004
CR211	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR226	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR282	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR306	152-0367-00			SEMICON DEVICE: SILICON, 20V, 20PA	80009	152-0367-00
CR307	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR321	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR322	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR402	152-0141-02	XB030000		SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR404	152-0141-02	XB030000		SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR406	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR443	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR444	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR445	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR453	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR454	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR455	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR472	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR482	152-0040-00			SEMICON DEVICE: SILICON, 600V, 1A	15238	LG109
CR484	152-0040-00			SEMICON DEVICE: SILICON, 600V, 1A	15238	LG109
CR492	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR493	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR494	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR520	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR532	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR533	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR572	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR582	152-0040-00			SEMICON DEVICE: SILICON, 600V, 1A	15238	LG109
CR584	152-0040-00			SEMICON DEVICE: SILICON, 600V, 1A	15238	LG109
CR592	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR593	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
CR594	152-0141-02			SEMICON DEVICE: SILICON, 30V, 150MA	01295	1N4152R
DS236	150-0075-00			LAMP, INCAND: 19V, 0.0126 TO 0.0154A	08806	2149D
DS268	150-0075-00			LAMP, INCAND: 19V, 0.0126 TO 0.0154A	08806	2149D
DS281	150-0048-00			LAMP, INCAND: 5V, 60MA	08806	683
DS284	150-0048-00			LAMP, INCAND: 5V, 60MA	08806	683
DS286	150-0048-00			LAMP, INCAND: 5V, 60MA	08806	683
DS441	150-0133-00			LAMP, CARTRIDGE: 14V, 80MA, RED DOME LENS	55292	70106-02
DS478	150-0048-00			LAMP, INCAND: 5V, 60MA	08806	683
DS578	150-0048-00			LAMP, INCAND: 5V, 60MA	08806	683
F236	159-0083-00			FUSE, CARTRIDGE: 0.15A, 250V, FAST-BLOW	71400	AGC 15/100
F268	159-0083-00			FUSE, CARTRIDGE: 0.15A, 250V, FAST-BLOW	71400	AGC 15/100
J40	136-0140-00			JACK, TIP: BANANA STYLE, CHARCOAL GRAY CA	80009	136-0140-00
J50	136-0140-00			JACK, TIP: BANANA STYLE, CHARCOAL GRAY CA	80009	136-0140-00
J60	136-0140-00			JACK, TIP: BANANA STYLE, CHARCOAL GRAY CA	80009	136-0140-00
J70	136-0140-00			JACK, TIP: BANANA STYLE, CHARCOAL GRAY CA	80009	136-0140-00
J80	136-0140-00			JACK, TIP: BANANA STYLE, CHARCOAL GRAY CA	80009	136-0140-00
J90	136-0140-00			JACK, TIP: BANANA STYLE, CHARCOAL GRAY CA	80009	136-0140-00
Q214	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K 2N3906
Q222	151-0367-00			TRANSISTOR: SILICON, NPN, SEL FROM 3571TP	01295	SKA6516
Q226	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K 2N3906

151-0777-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q252A,B	151-1037-00			TRANSISTOR:SILICON,FET,N-CHANNEL	80009	151-1037-00
Q280	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q284	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487 <i>2N2222A</i>
Q286	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q310A,B	151-1077-00			TRANSISTOR:SILICON,JFE N- CHANNEL,DUAL	17856	DN1332 <i>2N5908</i>
Q402	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q404	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q406	151-0126-00			TRANSISTOR:SILICON,NPN	04713	ST1046 <i>2N2484</i>
Q408	151-0126-00			TRANSISTOR:SILICON,NPN	04713	ST1046
Q442	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q452	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
Q462	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q472	151-0126-00			TRANSISTOR:SILICON,NPN	04713	ST1046
Q478	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q484	151-0373-00			TRANSISTOR:SILICON,PNP	80009	151-0373-00
Q492	151-0103-00			TRANSISTOR:SILICON,NPN	80009	151-0103-00
Q520	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00 <i>MSPF 789</i>
Q536	151-0432-00			TRANSISTOR:SILICON,NPN	27014	ST07391D
Q538	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q546	151-0462-00			TRANSISTOR:SILICON,PNP	04713	TIP30C
Q548	151-0464-00			TRANSISTOR:SILICON,NPN	04713	SJE412
Q572	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
Q578	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q584	151-0349-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE2801	04713	SJE924
Q592	151-0235-00			TRANSISTOR:SILICON,PNP	80009	151-0235-00
R10	311-1568-00			RES.,VAR, NONWIR:50 OHM,20%,0.50W	73138	91-90-0
R14	315-0104-00	XB030710		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R15	315-0102-00	XB030710		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R16	315-0102-00	XB030710		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R20	311-1568-00			RES.,VAR, NONWIR:50 OHM,20%,0.50W	73138	91-90-0
R111	308-0545-00			RES.,FXD,WW:100 OHM,0.5%,5W	00213	1250S-100R0D
R113	308-0507-00			RES.,FXD,WW:1K OHM,1%,3W	91637	RS2B-B10000F
R115	308-0759-00			RES.,FXD,WW:2.08K OHM,1%,3W	91637	RS2B-B20800F
R116	321-0339-00			RES.,FXD,FILM:33.2K OHM,1%,0.125W	91637	MFF1816G33201F
R117	322-0264-00			RES.,FXD,FILM:5.49K OHM,1%,0.25W	75042	CEBTO-5491F
R119	321-0298-00			RES.,FXD,FILM:12.4K OHM,1%,0.125W	91637	MFF1816G12401F
R121	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R131	321-0289-01			RES.,FXD,FILM:10K OHM,0.5%,0.125W	91637	MFF1816G10001D
R132	321-0318-02			RES.,FXD,FILM:20K OHM,0.5%,0.125W	91637	CMF55116D20001D
R133	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R141	321-0289-01			RES.,FXD,FILM:10K OHM,0.5%,0.125W	91637	MFF1816G10001D
R142	321-0318-02			RES.,FXD,FILM:20K OHM,0.5%,0.125W	91637	CMF55116D20001D
R143	321-0756-01			RES.,FXD,FILM:50K OHM,0.5%,0.125W	24546	NA55D5002D
R202	321-0260-01			RES.,FXD,FILM:4.99K OHM,0.5%,0.125W	91637	MFF1816G49900D
R204	321-0692-00			RES.,FXD,FILM:49.9K OHM,0.5%,0.125W	91637	MFF1816G49901D
R205	321-0692-00			RES.,FXD,FILM:49.9K OHM,0.5%,0.125W	91637	MFF1816G49901D
R206	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R208	316-0472-00			RES.,FXD,CMPSN:4.7K OHM,10%,0.25W	01121	CB4721
R214	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R216	316-0151-00			RES.,FXD,CMPSN:150 OHM,10%,0.25W	01121	CB1511
R221	316-0152-00			RES.,FXD,CMPSN:1.5K OHM,10%,0.25W	01121	CB1521
R223	315-0620-00			RES.,FXD,CMPSN:62 OHM,5%,0.25W	01121	CB6205
R224	316-0151-00			RES.,FXD,CMPSN:150 OHM,10%,0.25W	01121	CB1511
R226	304-0331-00			RES.,FXD,CMPSN:330 OHM,10%,1W	01121	GB3311
R227	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R228	316-0102-00			RES.,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R229	311-1562-00		RES.,VAR, NONWIR: 2K OHM, 20%, 0.50W	73138	91-84-0
R231	325-0162-00		RES. SET, MTCHD: 45K/44.8K OHM, 0.1%, 0.125W	91637	SPTF-30
R232					
R233	325-0165-00		RES. SET, MTCHD: 50/50 OHM, 0.1%, 0.25W	03888	A3DT38
R234					
R235	325-0164-00		RES. SET, MTCHD: 450/446 OHM, 0.1%, 0.25W	03888	A3DT37
R236					
R238	325-0163-00		RES. SET, MTCHD: 4.5K/4.478K OHM, 0.1%, 0.25W	14298	EE 1/4 (MP)
R239					
R251	311-1566-00		RES.,VAR, NONWIR: 200 OHM, 20%, 0.50W	73138	91-88-0
R252	321-0297-00		RES.,FXD, FILM: 12.1K OHM, 1%, 0.125W	91637	MFF1816G12101F
R253	321-0297-00		RES.,FXD, FILM: 12.1K OHM, 1%, 0.125W	91637	MFF1816G12101F
R254	321-0097-00		RES.,FXD, FILM: 100 OHM, 1%, 0.125W	91637	MFF1816G100R0F
R255	316-0102-00		RES.,FXD, CMPSN: 1K OHM, 10%, 0.25W	01121	CB1021
R261	316-0103-00		RES.,FXD, CMPSN: 10K OHM, 10%, 0.25W	01121	CB1031
R262	311-1564-00		RES.,VAR, NONWIR: TRMR, 500 OHM, 0.5W	73138	91-86-0
R263	316-0180-00		RES.,FXD, CMPSN: 18 OHM, 10%, 0.25W	01121	CB1801
R265	311-1568-00		RES.,VAR, NONWIR: 50 OHM, 20%, 0.50W	73138	91-90-0
R267	311-1594-00		RES.,VAR, NONWIR: 10 OHM, 20%, 0.50W	73138	91-93-0
R271	321-0618-00		RES.,FXD, FILM: 250K OHM, 1%, 0.125W	91637	MFF1816G25002F
R272	321-0618-00		RES.,FXD, FILM: 250K OHM, 1%, 0.125W	91637	MFF1816G25002F
R280	316-0332-00		RES.,FXD, CMPSN: 3.3K OHM, 10%, 0.25W	01121	CB3321
R281	316-0332-00		RES.,FXD, CMPSN: 3.3K OHM, 10%, 0.25W	01121	CB3321
R284	316-0152-00		RES.,FXD, CMPSN: 1.5K OHM, 10%, 0.25W	01121	CB1521
R286	316-0152-00		RES.,FXD, CMPSN: 1.5K OHM, 10%, 0.25W	01121	CB1521
R291	307-0107-00		RES.,FXD, CMPSN: 5.6 OHM, 5%, 0.25W	01121	CB56G5
R293	307-0107-00		RES.,FXD, CMPSN: 5.6 OHM, 5%, 0.25W	01121	CB56G5
R295	307-0107-00		RES.,FXD, CMPSN: 5.6 OHM, 5%, 0.25W	01121	CB56G5
R300	315-0201-00		RES.,FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R301	308-0754-00		RES.,FXD, WW: 5.55 OHM, 0.5%, 3W	91637	RS2B-D5R550D
R302	308-0720-01		RES.,FXD, WW: 50 OHM, 0.5%, 3W	91637	RS2B-B50R00D
R305	321-0756-01		RES.,FXD, FILM: 50K OHM, 0.5%, 0.125W	24546	NA55D5002D
R306	302-0334-00		RES.,FXD, CMPSN: 330K OHM, 10%, 0.50W	01121	EB3341
R307	316-0393-00		RES.,FXD, CMPSN: 39K OHM, 10%, 0.25W	01121	CB3931
R309	315-0203-00		RES.,FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R310	311-1559-00		RES.,VAR, NONWIR: 10K OHM, 20%, 0.50W	73138	91-81-0
R311	321-0995-00		RES.,FXD, FILM: 549K OHM, 1%, 0.125W	24546	NA55D5493F
R312	321-0995-00		RES.,FXD, FILM: 549K OHM, 1%, 0.125W	24546	NA55D5493F
R313	321-0260-00		RES.,FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
R315	311-1554-00		RES.,VAR, NONWIR: 200K OHM, 20%, 0.50W	73138	91-76-0
R316	316-0126-00		RES.,FXD, CMPSN: 12M OHM, 10%, 0.25W	01121	CB1261
R317	316-0126-00		RES.,FXD, CMPSN: 12M OHM, 10%, 0.25W	01121	CB1261
R318	315-0104-00		RES.,FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R321	308-0537-00		RES.,FXD, WW: 1K OHM, 0.5%, 5W	91637	RS2A-B10000D
R322	322-0707-03		RES.,FXD, FILM: 100.1K OHM, 0.25%, 0.25W	91637	MFF1421D10012C
R323	307-0430-00		RES.,FXD, CMPSN: 11.1M OHM, 1%, 0.5W	03888	FLO.5-D11104F
R324	307-0429-00		RES.,FXD, CMPSN: 100M OHM, 1%, 1W	03888	FL-1-F10005F
R329	321-0991-03		RES.,FXD, FILM: 18K OHM, 0.25%, 0.125W	24546	NC55C1802C
R331	321-0222-03		RES.,FXD, FILM: 2K OHM, 0.25%, 0.125W	91637	MFF1816D20000C
R333	315-0107-00		RES.,FXD, CMPSN: 100M OHM, 5%, 0.25W	01121	CB1075
R340	311-1136-00		RES.,VAR, NONWIR: 100K OHM, 30%, 0.25W	71450	201-YA5536
R341	316-0225-00		RES.,FXD, CMPSN: 2.2M OHM, 10%, 0.25W	01121	CB2251
R342	316-0222-00		RES.,FXD, CMPSN: 2.2K OHM, 10%, 0.25W	01121	CB2221
R343	321-0414-03		RES.,FXD, FILM: 200K OHM, 0.25%, 0.125W	24546	NC55C2003C
R344	321-1609-03		RES.,FXD, FILM: 2.02K OHM, 0.25%, 0.125W	24546	NC55C2021C
R345	321-1610-03		RES.,FXD, FILM: 22.22K OHM, 0.25%, 0.125W	91637	MFF1816D22221C
R351	321-0289-03		RES.,FXD, FILM: 10K OHM, 0.25%, 0.125W	91637	MFF1816D10001C

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R352	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R361	321-0756-01			RES., FXD, FILM: 50K OHM, 0.5%, 0.125W	24546	NA55D5002D
R362	321-0756-01			RES., FXD, FILM: 50K OHM, 0.5%, 0.125W	24546	NA55D5002D
R363	321-0631-03			RES., FXD, FILM: 12.5K OHM, 0.25W, 0.125W	91637	MFF1816D12501C
R401	321-0334-00			RES., FXD, FILM: 29.4K OHM, 1%, 0.125W	91637	MFF1816G29401F
R402	321-0260-00			RES., FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
R403	316-0102-00			RES., FXD, CMPSN: 1K OHM, 10%, 0.25W	01121	CB1021
R404	315-0303-00			RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R408	316-0103-00			RES., FXD, CMPSN: 10K OHM, 10%, 0.25W	01121	CB1031
R409	321-0287-00			RES., FXD, FILM: 9.53K OHM, 1%, 0.125W	91637	MFF1816G95300F
R410	311-1558-00			RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	73188	91-80-0
R411	321-0155-00			RES., FXD, FILM: 402 OHM, 1%, 0.125W	91637	MFF1816G402R0F
R415	311-0555-00			RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	01121	10M985
R421	307-0381-00			RES., FXD, FILM: 4.99M OHM, 1%, 0.5W	03888	FLYZ 4.99M+/-1%
R422	321-0452-00			RES., FXD, FILM: 499K OHM, 1%, 0.125W	91637	MFF1816G49902F
R423	321-0353-00			RES., FXD, FILM: 46.4K OHM, 1%, 0.125W	91637	MFF1816G46401F
R424	321-0449-00			RES., FXD, FILM: 464K OHM, 1%, 0.125W	91637	MFF1816G46402F
R426	321-0260-00			RES., FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
R431	321-0463-00			RES., FXD, FILM: 649K OHM, 1%, 0.125W	91637	MFF1816G64902F
R432	321-0367-00			RES., FXD, FILM: 64.9K OHM, 1%, 0.125W	91637	MFF1816G64901F
R433	316-0333-00			RES., FXD, CMPSN: 33K OHM, 10%, 0.25W	01121	CB3331
R441	321-0196-00			RES., FXD, FILM: 1.07K OHM, 1%, 0.125W	91637	MFF1816G10700F
R442	321-0284-00			RES., FXD, FILM: 8.87K OHM, 1%, 0.125W	91637	MFF1816G88700F
R443	321-0160-00			RES., FXD, FILM: 453 OHM, 1%, 0.125W	91637	MFF1816G453R0F
R444	321-0188-00			RES., FXD, FILM: 887 OHM, 1%, 0.125W	91637	MFF1816G887R0F
R445	321-0197-00			RES., FXD, FILM: 1.1K OHM, 1%, 0.125W	91637	MFF1816G11000F
R446	321-0612-00			RES., FXD, FILM: 500 OHM, 1%, 0.125W	91637	MFF1816G500R0F
R447	321-0263-00			RES., FXD, FILM: 5.36K OHM, 1%, 0.125W	91637	MFF1816C53600F
R448	321-0320-00			RES., FXD, FILM: 21K OHM, 1%, 0.125W	91637	MFF1816G21001F
R449	321-0370-00			RES., FXD, FILM: 69.8K OHM, 1%, 0.125W	91637	MFF1816G69801F
R451	321-0284-00			RES., FXD, FILM: 8.87K OHM, 1%, 0.125W	91637	MFF1816G88700F
R452	321-0196-00			RES., FXD, FILM: 1.07K OHM, 1%, 0.125W	91637	MFF1816G10700F
R453	321-0160-00			RES., FXD, FILM: 453 OHM, 1%, 0.125W	91637	MFF1816G453R0F
R454	321-0188-00			RES., FXD, FILM: 887 OHM, 1%, 0.125W	91637	MFF1816G887R0F
R455	321-0197-00			RES., FXD, FILM: 1.1K OHM, 1%, 0.125W	91637	MFF1816G11000F
R460	311-1310-00			RES., VAR, NONWIR: 20K OHM, 20%, 1W	01121	10M654
	-----			(R460, FURNISHED AS A UNIT WITH S460)		
R461	315-0514-00			RES., FXD, CMPSN: 510K OHM, 5%, 0.25W	01121	CB5145
R463	321-0289-00			RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R464	321-0306-00			RES., FXD, FILM: 15K OHM, 1%, 0.125W	91637	MFF1816G15001F
R467	321-0289-00	B010100	B019999	RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R467	321-0288-00	B020000		RES., FXD, FILM: 9.76K OHM, 1%, 0.125W	91637	MFF1816G97600F
R468	321-0268-00			RES., FXD, FILM: 6.04K OHM, 1%, 0.125W	91637	MFF1816G60400F
R469	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R471	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R472	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R473	308-0291-00			RES., FXD, WW: 2K OHM, 5%, 3W	91637	CW2B-20000J
R474	316-0822-00			RES., FXD, CMPSN: 8.2K OHM, 10%, 0.25W	01121	CB8221
R475	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R476	315-0201-00			RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R477	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R478	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R479	301-0111-00			RES., FXD, CMPSN: 110 OHM, 5%, 0.50W	01121	EB1115
R481	321-0756-03			RES., FXD, FILM: 50K OHM, 0.25%, 0.125W	91637	MFF1816D50001C
R482	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R483	315-0150-00			RES., FXD, CMPSN: 15 OHM, 5%, 0.25W	01121	CB1505
R484	315-0201-00			RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015

Replaceable Electrical Parts—178

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R485	315-0151-00			RES., FXD, CMPSN:150 OHM, 5%, 0.25W	01121	CB1515
R486	308-0764-00			RES., FXD, WW:2.7 OHM, 5%, 2W	75042	BWF-2R700J
R492	316-0123-00			RES., FXD, CMPSN:12K OHM, 10%, 0.25W	01121	CB1231
R521	316-0106-00			RES., FXD, CMPSN:10M OHM, 10%, 0.25W	01121	CB1061
R522	316-0222-00			RES., FXD, CMPSN:2.2K OHM, 10%, 0.25W	01121	CB2221
R526	316-0224-00			RES., FXD, CMPSN:220K OHM, 10%, 0.25W	01121	CB2241
R527	321-0356-00			RES., FXD, FILM:49.9K OHM, 1%, 0.125W	91637	MFF1816G49901F
R531	316-0473-00			RES., FXD, CMPSN:47K OHM, 10%, 0.25W	01121	CB4731
R533	316-0473-00			RES., FXD, CMPSN:47K OHM, 10%, 0.25W	01121	CB4731
R535	315-0152-00			RES., FXD, CMPSN:1.5K OHM, 5%, 0.25W	01121	CB1525
R536	315-0101-00			RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
R537	315-0101-00			RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
R538	315-0152-00			RES., FXD, CMPSN:1.5K OHM, 5%, 0.25W	01121	CB1525
R541	315-0242-00			RES., FXD, CMPSN:2.4K OHM, 5%, 0.25W	01121	CB2425
R542	315-0243-00			RES., FXD, CMPSN:24K OHM, 5%, 0.25W	01121	CB2435
R546	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R548	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R549	321-0452-00			RES., FXD, FILM:499K OHM, 1%, 0.125W	91637	MFF1816G49902F
R551	321-0356-00	B010100	B019999	RES., FXD, FILM:49.9K OHM, 1%, 0.125W	91637	MFF1816G49901F
R551	321-0756-01	B020000		RES., FXD, FILM:50K OHM, 0.5%, 0.125W	24546	NA55D5002D
R552	321-0631-00			RES., FXD, FILM:12.5K OHM, 1%, 0.125W	91637	MFF1816G12501F
R554	321-0289-00			RES., FXD, FILM:10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R560	311-1150-00			RES., VAR, WW:10K OHM, 5%	73138	7381-1-0
R562	311-1559-00			RES., VAR, NONWIR:10K OHM, 20%, 0.50W	73138	91-81-0
R563	321-0354-00			RES., FXD, FILM:47.5K OHM, 1%, 0.125W	91637	MFF1816G47501F
R565	311-1518-00			RES., VAR, NONWIR:10K OHM, 20%, 1W (R565, FURNISHED AS A UNIT WITH S565)	01121	11M-324
R566	321-0198-00			RES., FXD, FILM:1.13K OHM, 1%, 0.125W	91637	MFF1816G11300F
R567	321-0260-00			RES., FXD, FILM:4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
R570	321-0364-00	B010100	B019999	RES., FXD, FILM:60.4K OHM, 1%, 0.125W	91637	MFF1816G60401F
R570	321-0720-03	B020000		RES., FXD, FILM:60K OHM, 0.25%, 0.125W	91637	MFF1816D60001C
R571	321-0289-00			RES., FXD, FILM:10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R572	315-0512-00			RES., FXD, CMPSN:5.1K OHM, 5%, 0.25W	01121	CB5125
R573	308-0291-00			RES., FXD, WW:2K OHM, 5%, 3W	91637	CW2B-20000J
R574	321-0289-03			RES., FXD, FILM:10K OHM, 0.25%, 0.125W	91637	MFF1816D10001C
R575	315-0510-00			RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
R576	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R577	315-0510-00			RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
R578	315-0512-00			RES., FXD, CMPSN:5.1K OHM, 5%, 0.25W	01121	CB5125
R579	301-0111-00			RES., FXD, CMPSN:110 OHM, 5%, 0.50W	01121	EB1115
R581	321-0720-03			RES., FXD, FILM:60K OHM, 0.25%, 0.125W	91637	MFF1816D60001C
R582	315-0512-00			RES., FXD, CMPSN:5.1K OHM, 5%, 0.25W	01121	CB5125
R583	315-0150-00			RES., FXD, CMPSN:15 OHM, 5%, 0.25W	01121	CB1505
R584	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R585	315-0151-00			RES., FXD, CMPSN:150 OHM, 5%, 0.25W	01121	CB1515
R586	308-0764-00			RES., FXD, WW:2.7 OHM, 5%, 2W	75042	BWF-2R700J
R592	316-0123-00			RES., FXD, CMPSN:12K OHM, 10%, 0.25W	01121	CB1231
S30	260-1641-00			SWITCH, SLIDE:DPDT, 0.5A, 125VAC	10389	23-021-114
S120	263-1027-00			CAM SW ACTR AS:LOAD RESISTANC	80009	263-1027-00
S130	263-1026-00			SW CAM ACTR AS:SOURCE RESISTANCE	80009	263-1026-00
S140	105-0467-00			ACTUATOR, SWITCH:DUT SUPPLY ON, OFF	80009	105-0467-00
S200A, B	260-1310-00			SWITCH, PUSH:4PDT MOMENTARY	71590	2KAA0010000-437
S300	263-1025-00			SW CAM ACTR AS:FUNCTION	80009	263-1025-00
S350	263-1024-00			SW CAM ACTR AS:VERTICAL UNITS/DIV	80009	263-1024-00
S420	260-1529-00			SWITCH, ROTARY:	76854	5-18252-142
S441	260-0247-00			SWITCH, PUSH:SPST, 1A, 115VAC	81073	30YY1009

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
S460	311-1310-00			RES.,VAR, NONWIR:20K OHM,20%,1W (S460, FURNISHED AS A UNIT WITH R460)	01121	10M654
S565	311-1518-00			RES.,VAR, NONWIR:10K OHM,20%,1W (S565, FURNISHED AS A UNIT WITH R565)	01121	11M-324
U16	156-0067-00	B010100	B030709	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP
U16	156-0105-00	B030710		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM301AN
U250	156-0400-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
U340	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U350	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U424	156-0200-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1456P1
U432	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U460	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U476	156-0400-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
U540	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP
U576	156-0400-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
VR121	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	14552	TD3810983
VR238	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR239	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR268	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR269	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR281	152-0508-00			SEMICOND DEVICE:ZENER,0.4W,12.6V,5%	80009	152-0508-00
VR472	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR572	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00





# DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

## 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).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

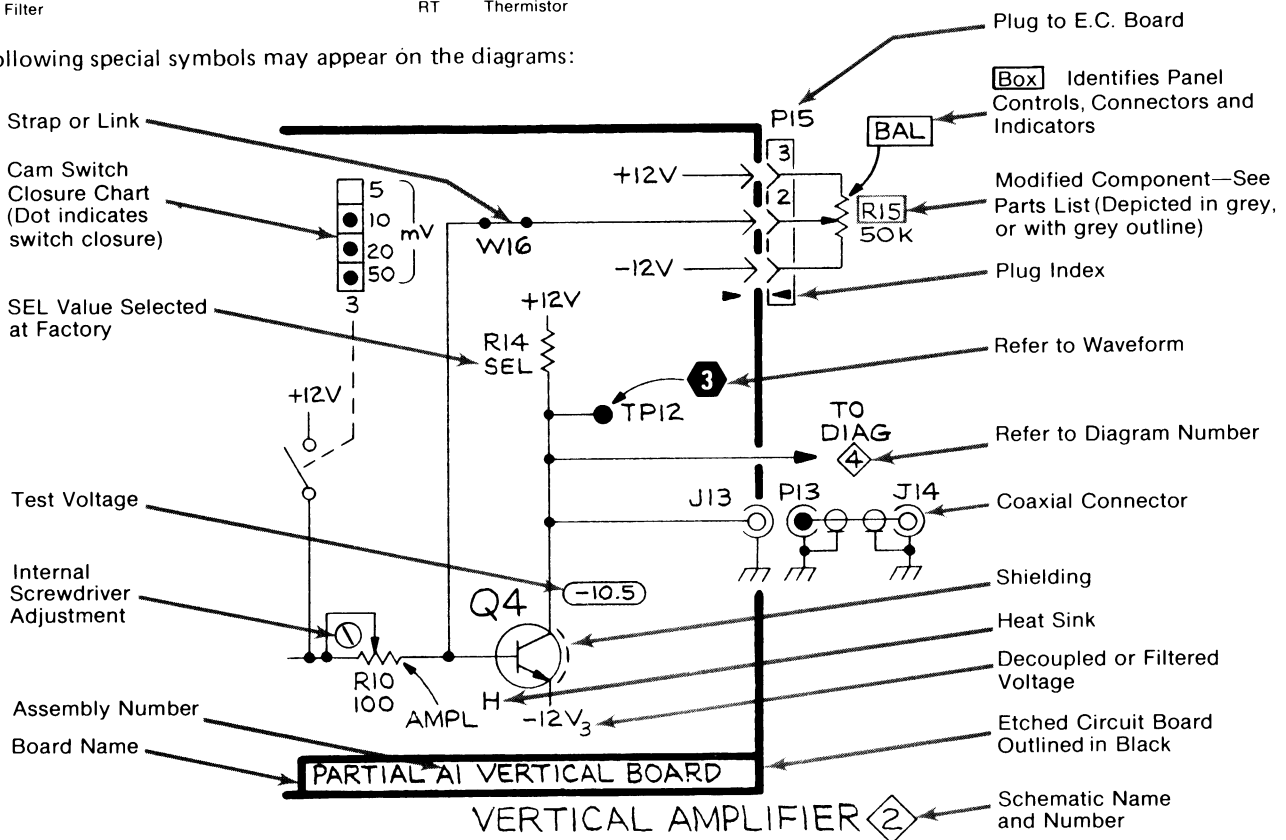
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

- Y14.15, 1966 Drafting Practices.
- Y14.2, 1973 Line Conventions and Lettering.
- Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

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)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode, signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc.)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	Q	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

The following special symbols may appear on the diagrams:



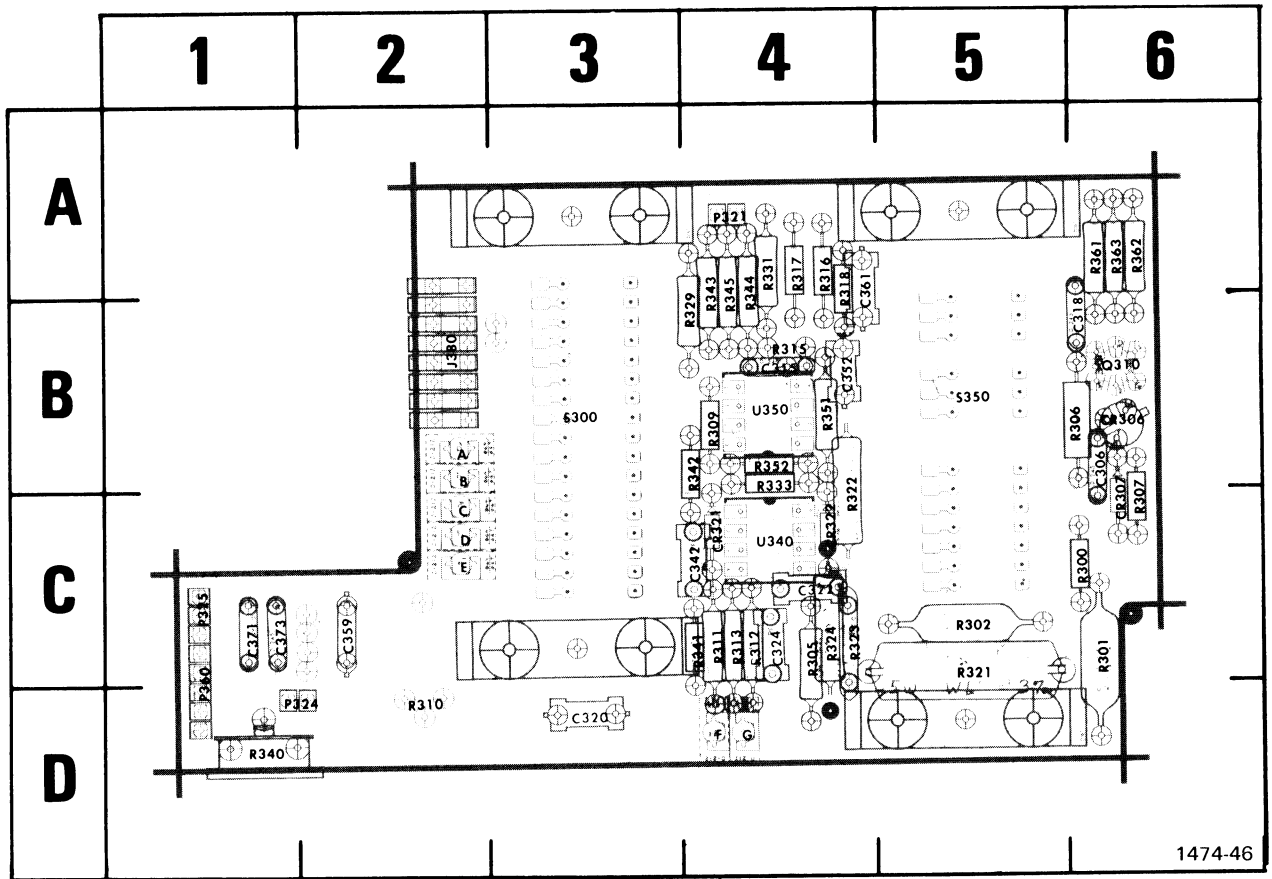
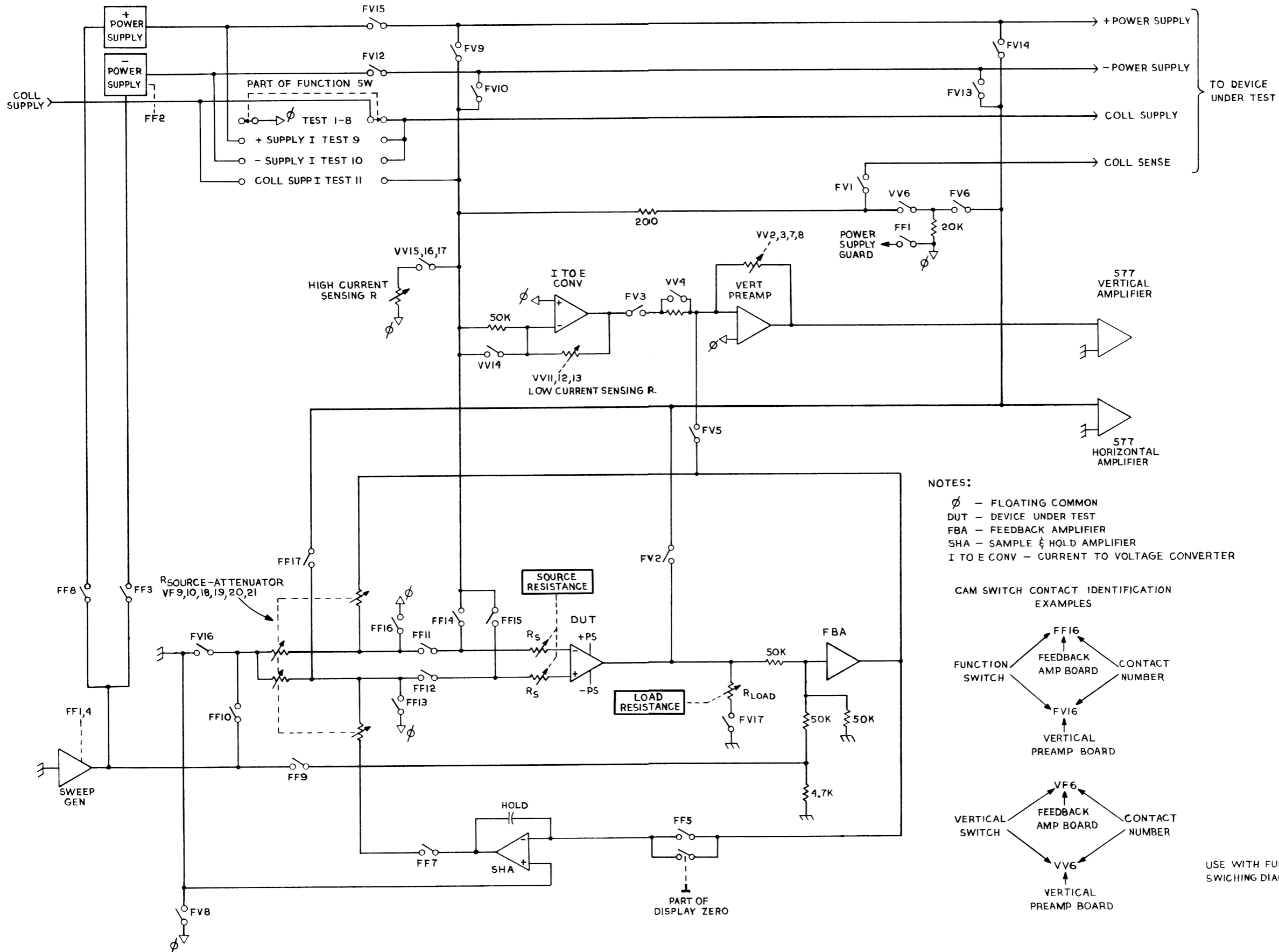


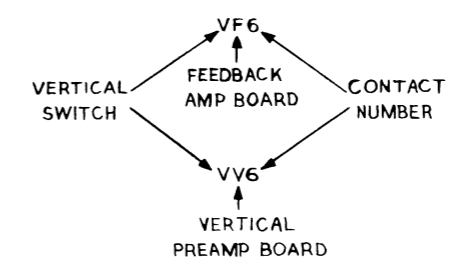
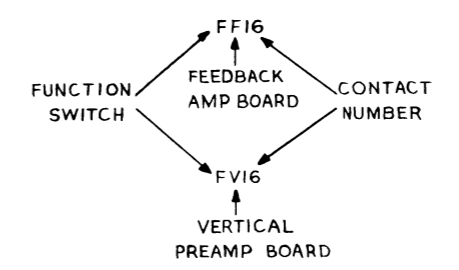
Fig. 7-1. A2-Vertical Preamp circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C306	6B	CR306	6B	R300	6C	R317	4A	R344	4A
C315	4B	CR307	6C	R301	6C	R318	4A	R345	4A
C318	6B	CR321	4C	R302	5C	R321	5C	R351	4B
C322	4C	CR322	4C	R305	4C	R322	4C	R352	4B
C320	3D	J380	2B	R306	6B	R323	4C	R361	6A
C324	4C	P321	4A	R307	6C	R324	4C	R362	6A
C342	4C	P324	1D	R309	4B	R329	4B	R363	6A
C352	4B	P325	1C	R310	2D	R331	4A	S300	3B
C359	2C	P360	1C	R311	4C	R333	4B	S350	5B
C361	4A	Q310	6B	R312	4C	R340	1D	U340	4C
C371	1C			R313	4C	R341	4C	U350	4B
C373	1C			R315	4B	R342	4B		
				R316	4A	R343	4A		



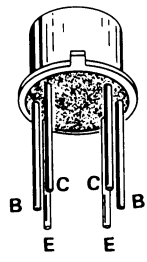
NOTES:  
 ∅ - FLOATING COMMON  
 DUT - DEVICE UNDER TEST  
 FBA - FEEDBACK AMPLIFIER  
 SHA - SAMPLE & HOLD AMPLIFIER  
 I TO E CONV - CURRENT TO VOLTAGE CONVERTER

CAM SWITCH CONTACT IDENTIFICATION EXAMPLES

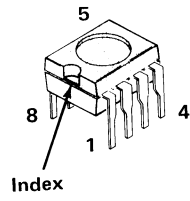


USE WITH FUNCTION/VERTICAL SWITCHING DIAGRAM →

SWITCHING BLOCK DIAGRAM



METAL-CASED TRANSISTORS



INTEGRATED CIRCUITS

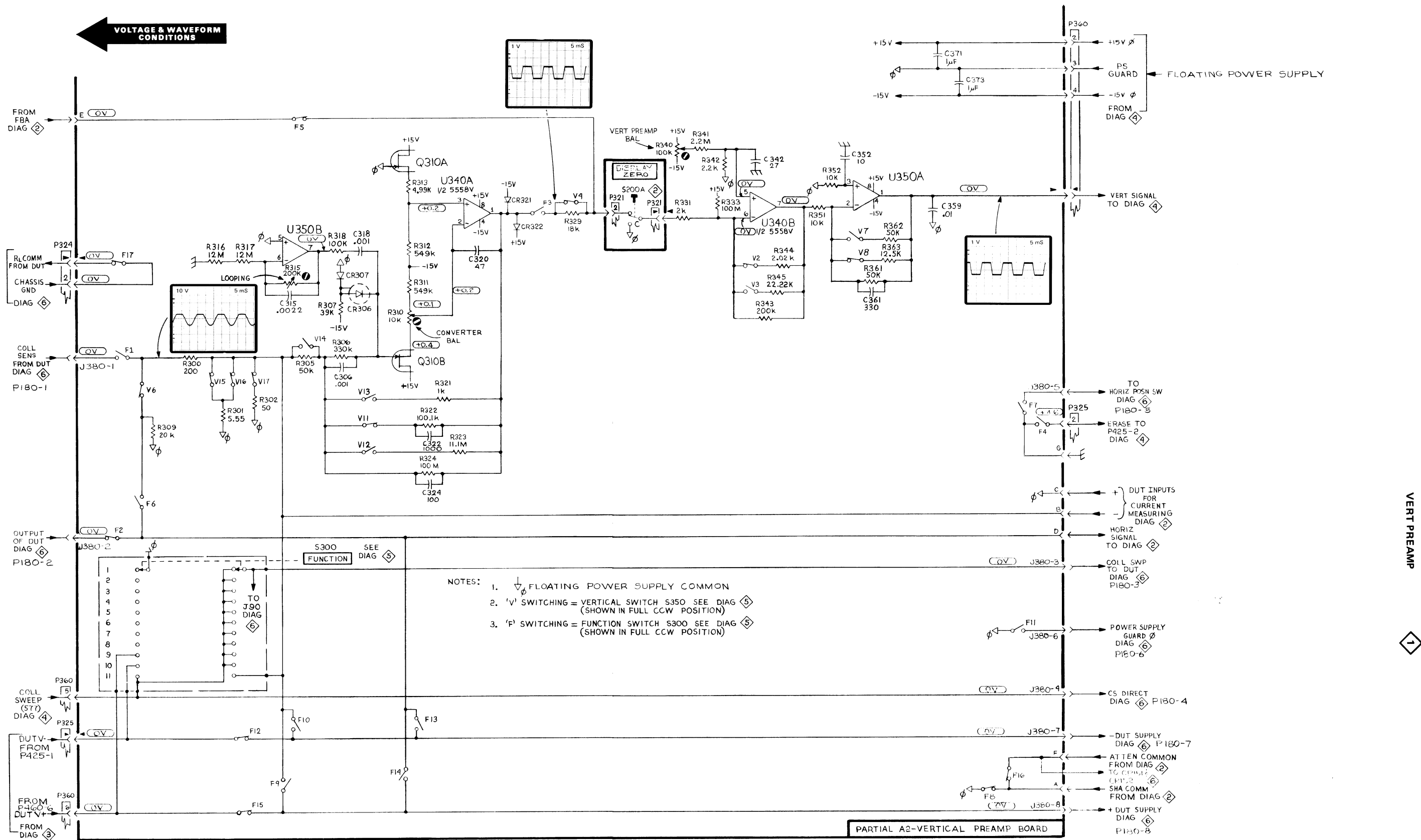


## VOLTAGE AND WAVEFORM CONDITIONS

The waveforms shown were obtained with the controls initially set as follows:

	<b>577</b>	
Variable Collector %		0
Max Peak Volts		6.5
Max Peak Power Watts		.15
Intensity		ccw
All other controls		any position

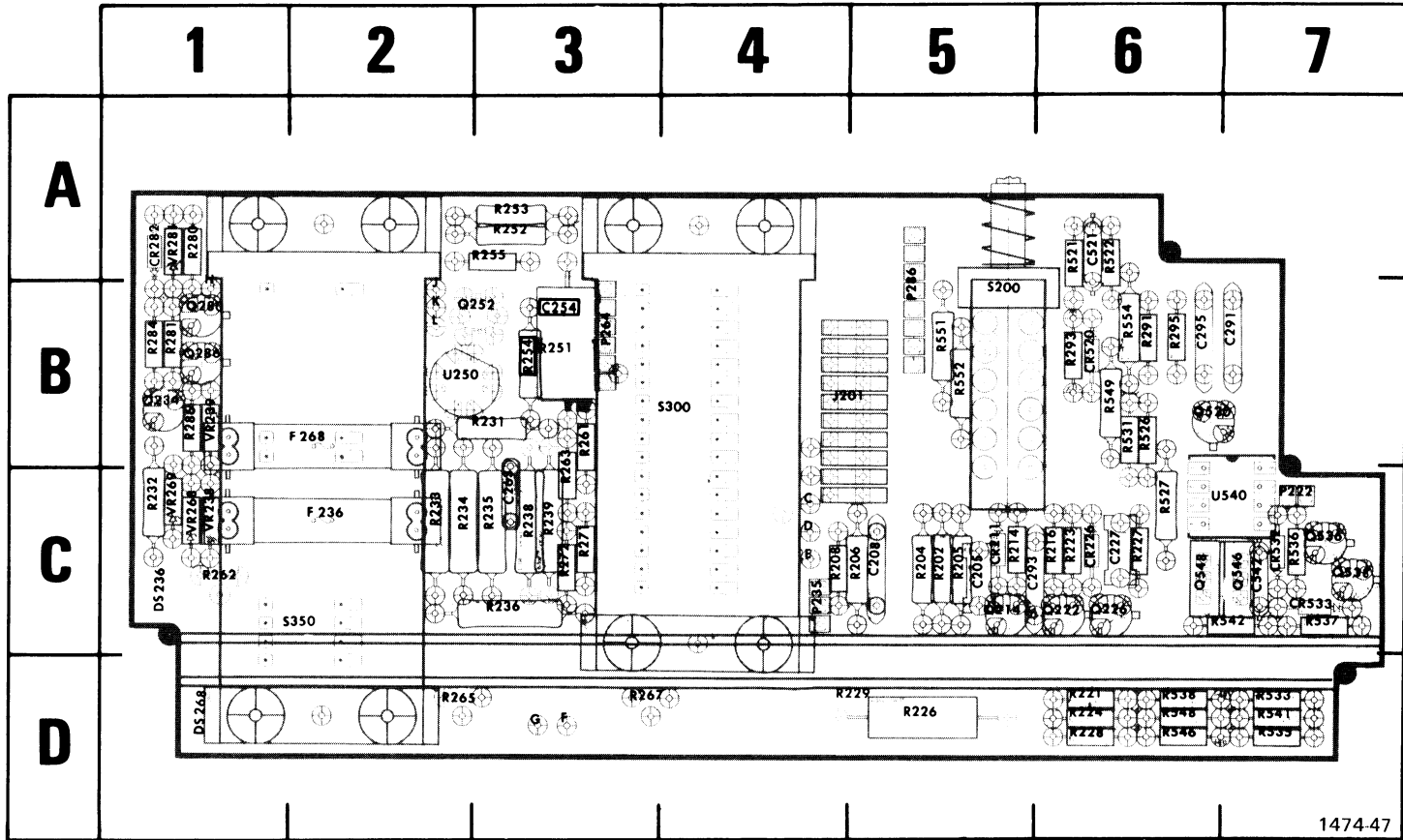
	<b>178</b>	
DUT SUPPLIES		ON
LOAD RESISTANCE		ccw
SOURCE RESISTANCE		ccw
⊕ SUPPLY		0.0
SUPPLY		TRACK ⊕ SUPPLY
SWEEP AMPLITUDE		set for 6 volts peak-to-peak at TP448
SWEEP FREQUENCY		100 Hz
Vernier		midrange
FUNCTION		INPUT 1
VERT UNITS/DIV		2 mV



- NOTES:
1.  $\phi$  FLOATING POWER SUPPLY COMMON
  2. 'V' SWITCHING = VERTICAL SWITCH S350 SEE DIAG 5 (SHOWN IN FULL CCW POSITION)
  3. 'F' SWITCHING = FUNCTION SWITCH S300 SEE DIAG 5 (SHOWN IN FULL CCW POSITION)

VERT PREAMP

1

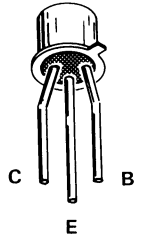
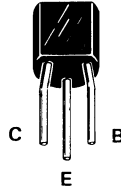
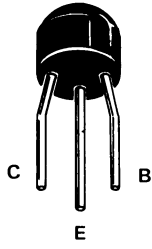
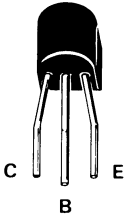


1474.47

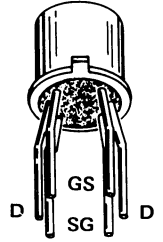
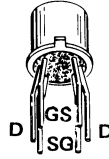
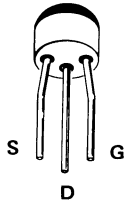
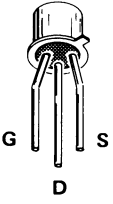
Fig. 7-2. A3—Feedback Amplifier circuit board.

ASSEMBLY A3

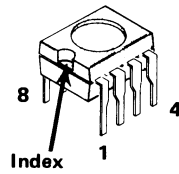
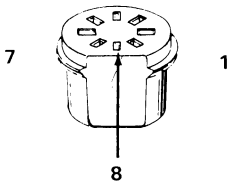
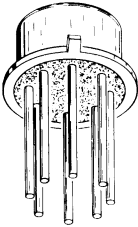
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C205	5C	DS236	1C	Q280	1B	R223	6C	R254	3B	R522	6A	R554	6B
C208	5C	DS268	1D	Q284	1B	R224	6D	R255	3A	R525	5B	S200	5B
C227	6C			Q286	1B	R226	5D	R261	3B	R526	6B	S300	4B
C254	3B	F236	2C	Q520	6B	R227	6C	R262	1C	R527	6C	S350	2C
C263	3C	F268	2B	Q536	7C	R228	6D	R263	3B	R531	6B		
C291	7B			Q538	7C	R229	5D	R265	2D	R533	7D	U250	2B
C293	5C	J201	5B	Q546	7C	R231	3B	R267	3D	R535	7D	U540	7C
C295	6B			Q548	6C	R232	1C	R271	3C	R536	7C		
C521	6A	P222	7C			R233	2C	R272	3C	R537	7C		
C542	7C	P235	4C	R202	5C	R234	2C	R280	1A	R538	6D	VR238	1C
		P264	3B	R204	5C	R235	3C	R281	1B	R541	7D	VR239	1B
		P286	5B	R205	5C	R236	3C	R284	1B	R542	7C	VR268	1C
CR211	5C			R206	5C	R238	3C	R286	1B	R546	6D	VR269	1C
CR226	6C			R208	4C	R239	3C	R291	6B	R548	6D	VR281	1A
CR250	6B	Q214	5C	R214	5C	R251	3B	R293	6B	R549	6B		
CR282	1A	Q222	6C	R216	6C	R252	3A	R295	6B	R551	5B		
CR532	7C	Q226	6C	R216	6C	R252	3A	R295	6B	R552	5B		
CR533	7C	Q252	3B	R221	6D	R253	3A	R521	6A				



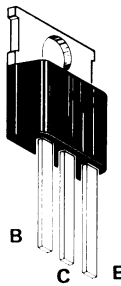
### TRANSISTORS



### FIELD EFFECT TRANSISTORS



### INTEGRATED CIRCUITS



### POWER TRANSISTORS





## VOLTAGE AND WAVEFORM CONDITIONS

The waveforms shown were obtained with the controls initially set as follows:

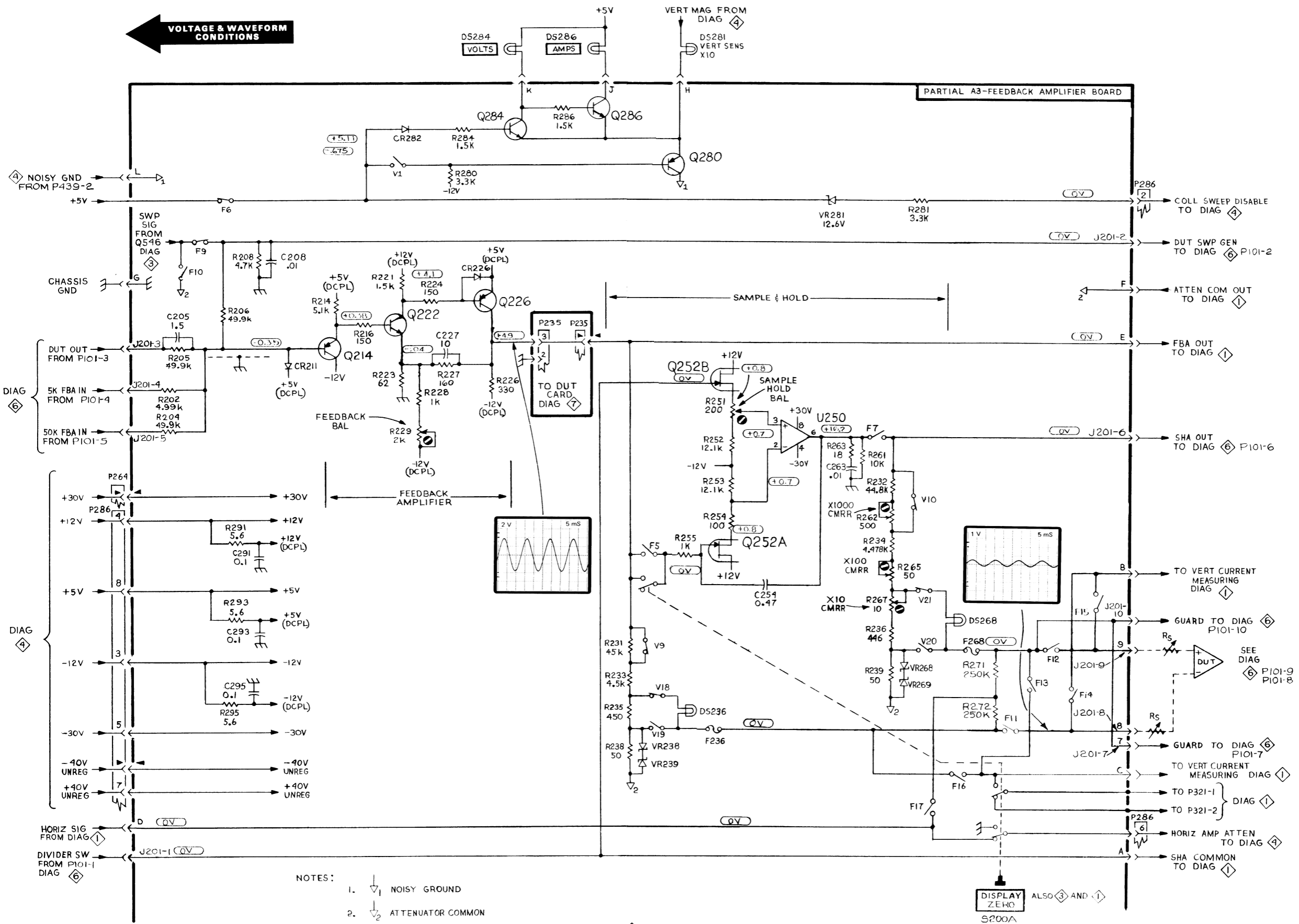
### 577

Variable Collector %	0
Max Peak Volts	6.5
Max Peak Power Watts	.15
Intensity	ccw
All other controls	any position

### 178

DUT SUPPLIES	ON
LOAD RESISTANCE	ccw
SOURCE RESISTANCE	ccw
+SUPPLY	0.0
-SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	set for 6 volts peak-to-peak at TP488
SWEEP FREQUENCY	100 Hz
Vernier	midrange
FUNCTION	OFFSET V
VERT UNITS/DIV	2 mV

**VOLTAGE & WAVEFORM CONDITIONS**



- NOTES:
1.  $\nabla_1$  NOISY GROUND
  2.  $\nabla_2$  ATTENUATOR COMMON
  3. 'V' SWITCHING = VERTICAL SWITCH S350 SEE DIAG (SHOWN IN FULL CCW POSITION)
  4. 'F' SWITCHING = FUNCTION SWITCH S300 SEE DIAG (SHOWN IN FULL CCW POSITION)

178 LINEAR IC TEST FIXTURE

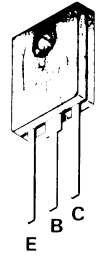
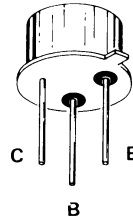
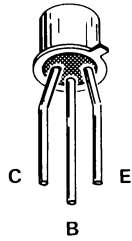
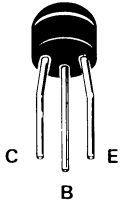
1474-53  
REV SEP 1981

FEEDBACK AMPLIFIER 2  
313

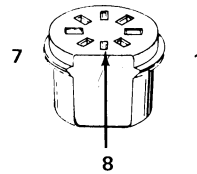
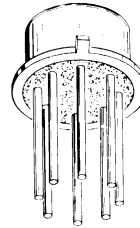
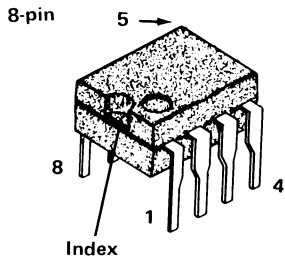
FEEDBACK AMP

2





## TRANSISTORS



## INTEGRATED CIRCUITS



## VOLTAGE AND WAVEFORM CONDITIONS

The waveforms shown were obtained with the controls initially set as follows:

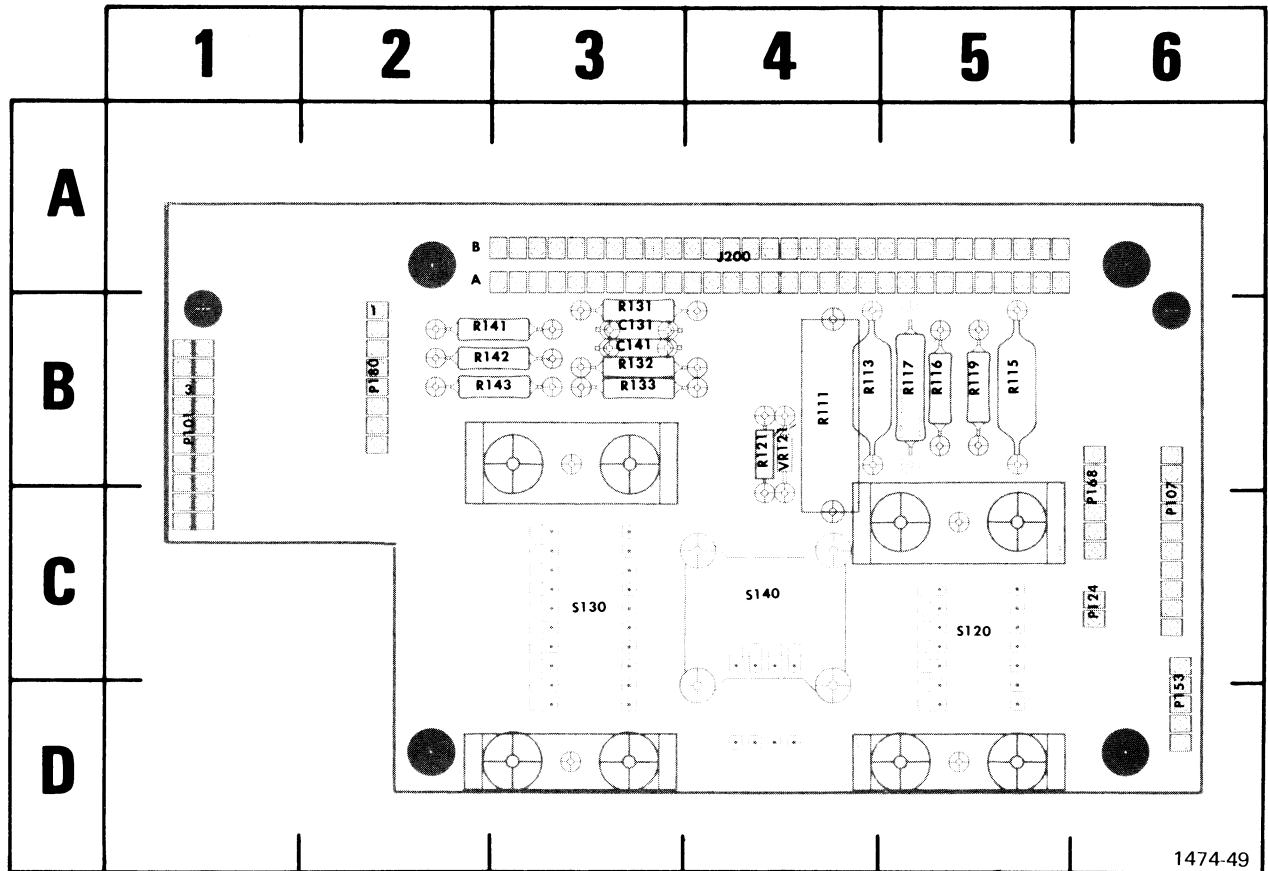
### 577

Variable Collector %	0
Max Peak Volts	6.5
Max Peak Power Watts	.15
Intensity	ccw
All other controls	any position

### 178

DUT SUPPLIES	ON
LOAD RESISTANCE	ccw
SOURCE RESISTANCE	ccw
+SUPPLY	0.0
-SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	set for 6 volts peak-to-peak at TP448
SWEEP FREQUENCY	100 Hz
Vernier	midrange
VERT UNITS/DIV	2 mV

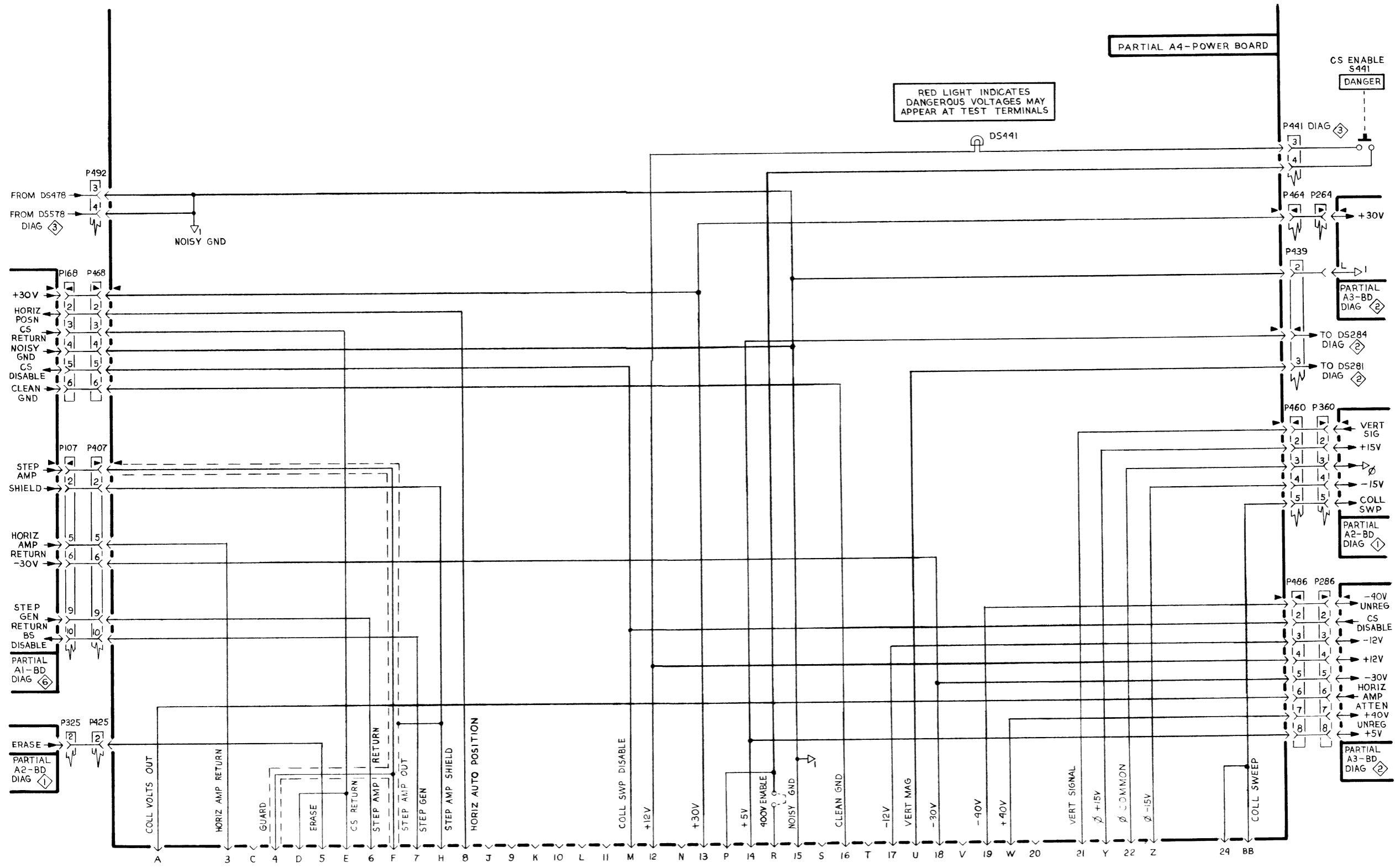




1474-49

Fig. 7-4. A1—Interface circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC
C131	3B	R115	5B
C141	3B	R119	5B
J200	4A	R121	4B
P101	1B	R131	3B
P107	6C	R132	3B
P124	6C	R133	3B
P153	6D	R141	2B
P168	6C	R142	2B
P180	2B	R143	2B
R111	4B	S120	5C
R113	4B	S130	3C
R116	5B	S140	4C
R117	5B	VR121	4B



RED LIGHT INDICATES  
DANGEROUS VOLTAGES MAY  
APPEAR AT TEST TERMINALS

PARTIAL A4-POWER BOARD

CS ENABLE  
5441  
DANGER

INTERCONNECTION

4

PARTIAL  
A2-BD  
DIAG

PARTIAL  
A3-BD  
DIAG

P492  
FROM DS478  
FROM DS578  
DIAG

P168 P468  
+30V  
HORIZ POSN  
CS  
RETURN  
NOISY GND  
CS  
DISABLE  
CLEAN GND

P107 P407  
STEP AMP  
SHIELD  
HORIZ AMP  
RETURN  
-30V

STEP GEN  
RETURN  
BS  
DISABLE  
PARTIAL  
A1-BD  
DIAG

P325 P425  
ERASE  
PARTIAL  
A2-BD  
DIAG

P441 DIAG  
3  
4

P464 P264  
+30V  
P439  
2

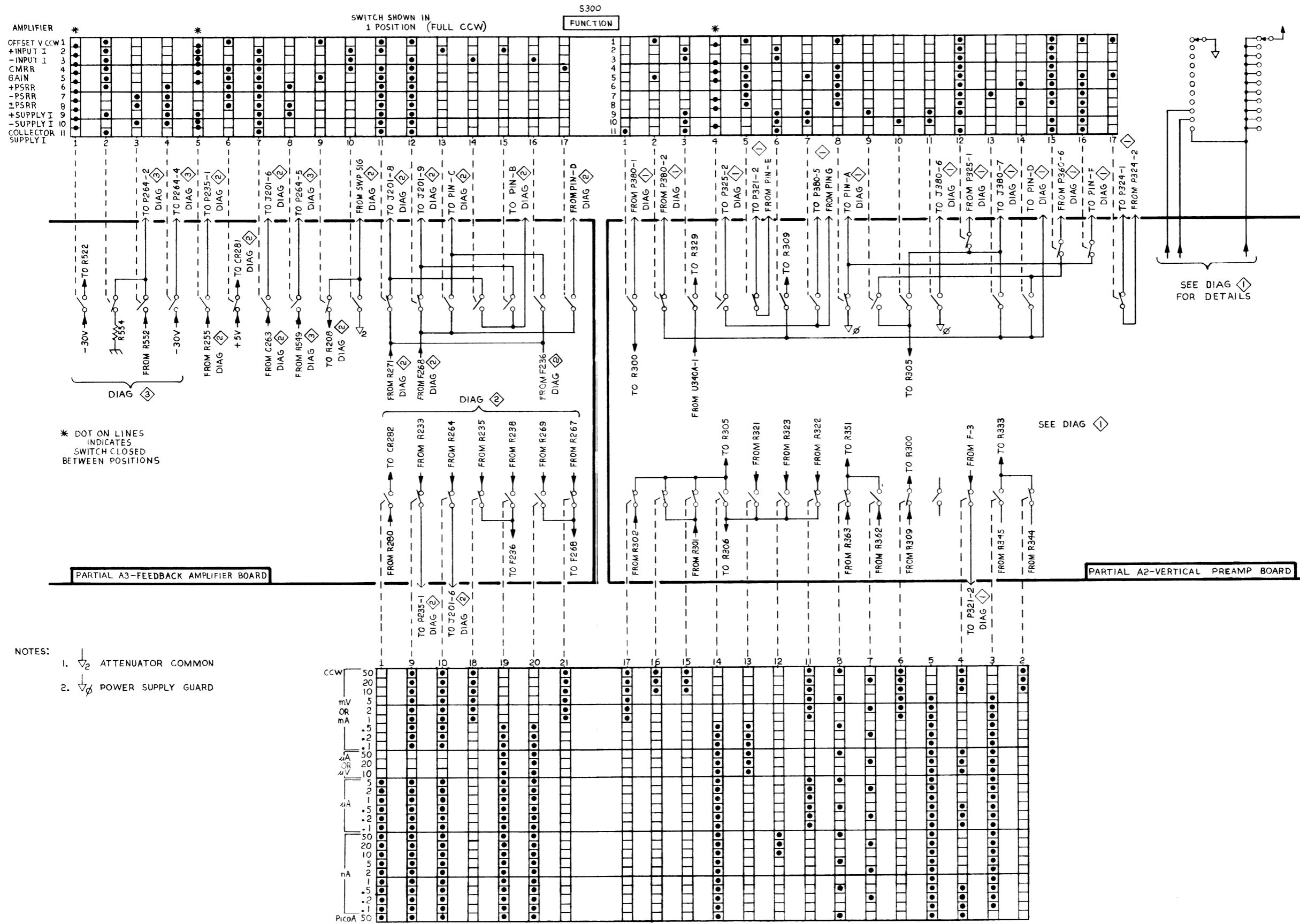
TO DS284  
DIAG  
3  
TO DS281  
DIAG

P460 P360  
VERT SIG  
+15V  
-15V  
COLL SWP  
PARTIAL  
A2-BD  
DIAG

P406 P286  
-40V UNREG  
CS  
DISABLE  
-12V  
+12V  
-30V  
HORIZ  
AMP  
ATTEN  
+40V UNREG  
+5V  
PARTIAL  
A3-BD  
DIAG

A 3 C 4 D 5 E 6 F 7 H 8 J 9 K 10 L 11 M 12 N 13 P 14 R 15 S 16 T 17 U 18 V 19 W 20 21 Y 22 Z 24 BB





\* DOT ON LINES INDICATES SWITCH CLOSED BETWEEN POSITIONS

- NOTES:
- ATTENUATOR COMMON
  - POWER SUPPLY GUARD

PARTIAL A3-FEEDBACK AMPLIFIER BOARD

PARTIAL A2-VERTICAL PREAMP BOARD

SEE DIAG FOR DETAILS

SEE DIAG

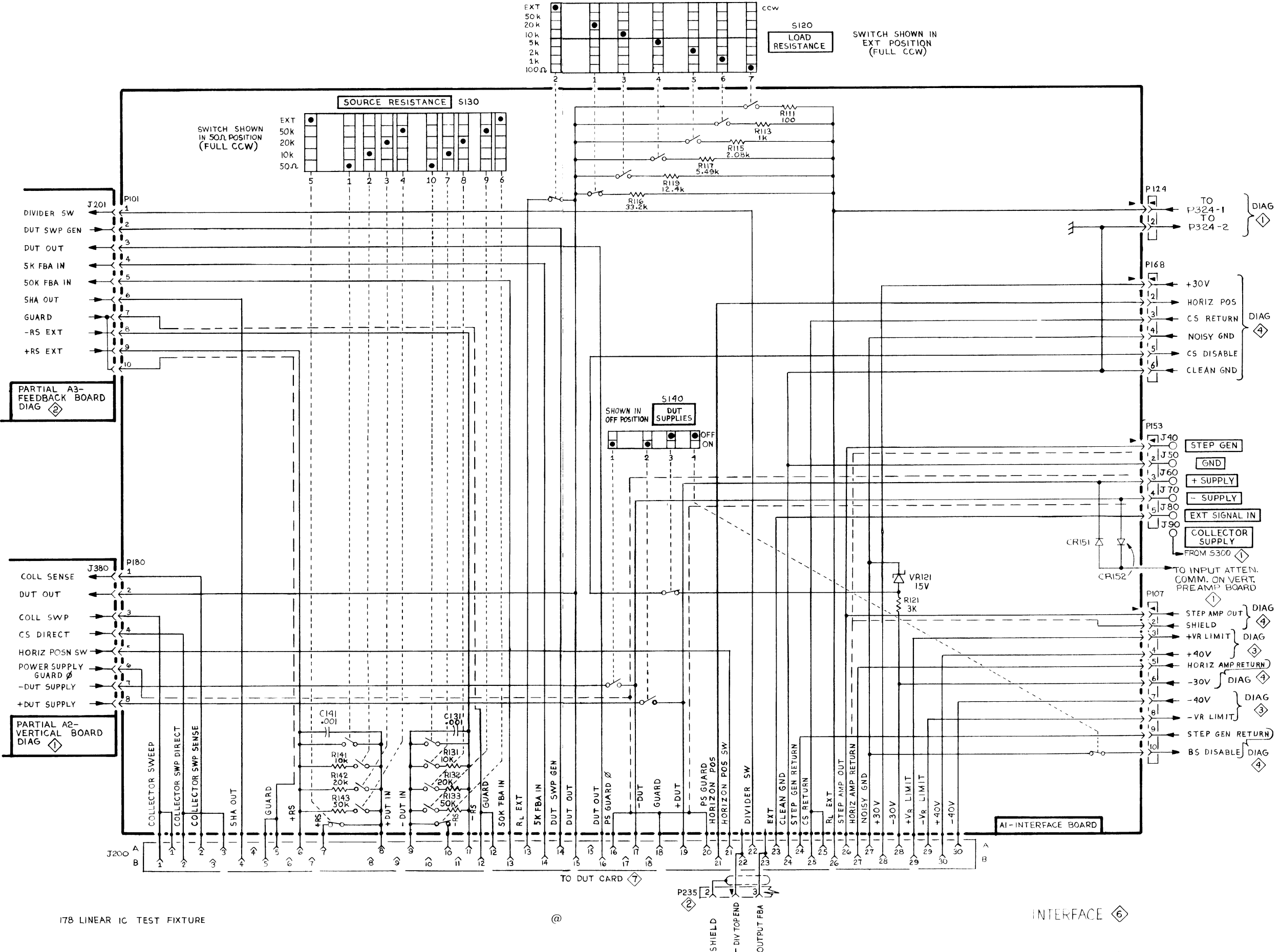
SWITCH SHOWN IN VERTICAL UNITS/DIV S350

SWITCH SHOWN IN FULL CCW

FUNCTION/VERTICAL SWITCHES

FUNCTION/VERTICAL SWITCHES

5



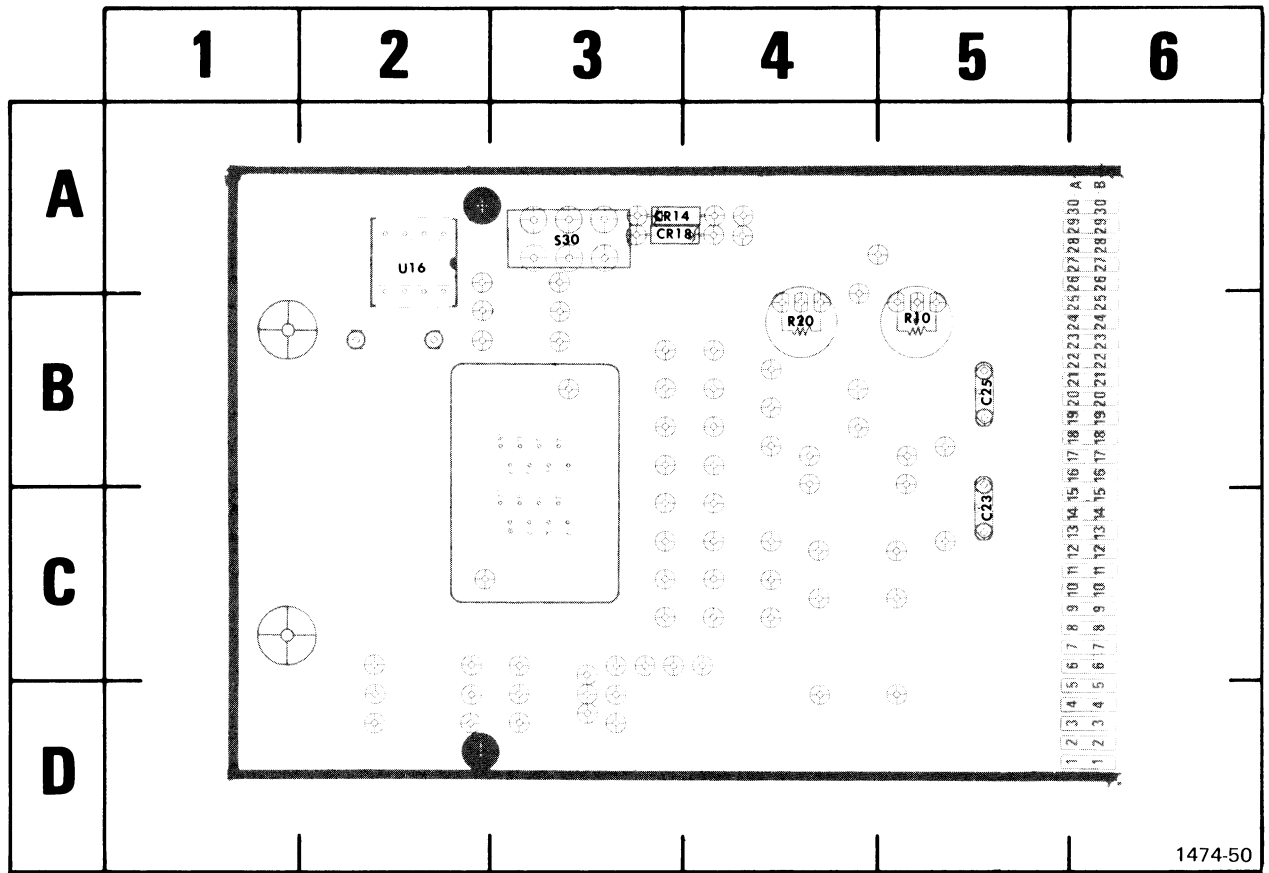
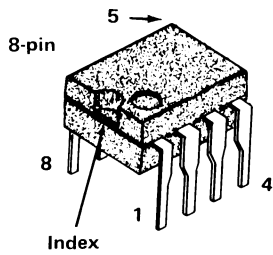
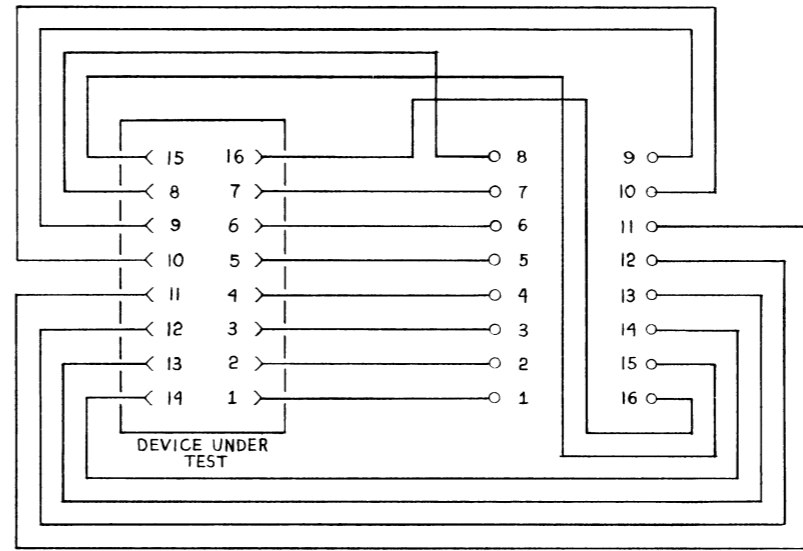
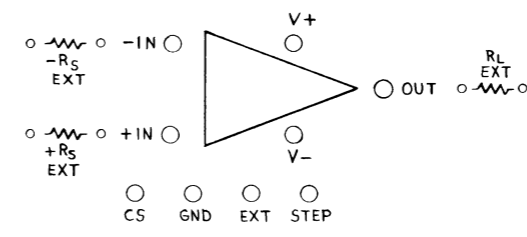
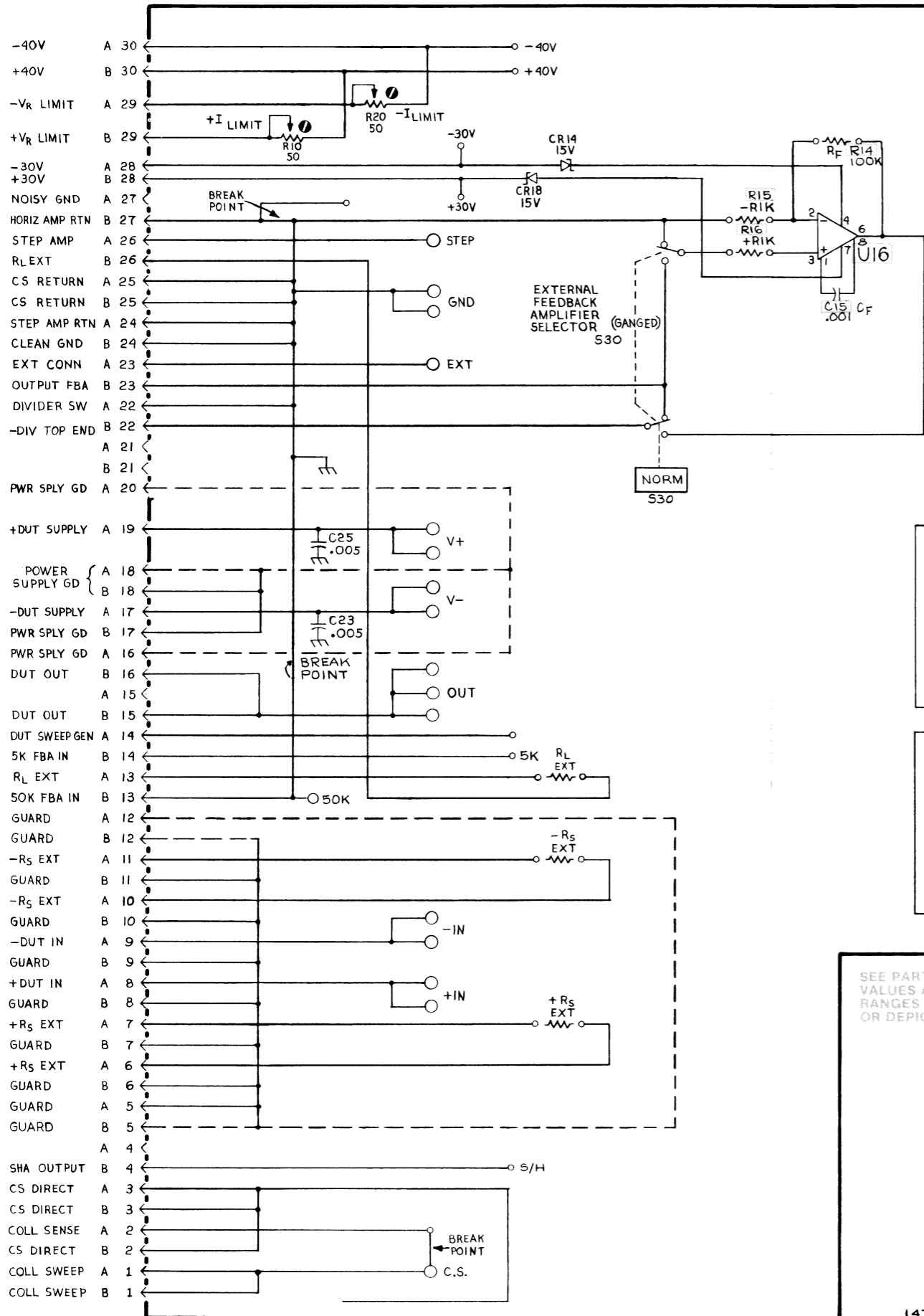


Fig. 7-5. A5—Standard Op Amp Card circuit board.



INTEGRATED CIRCUITS

CKT NO	GRID LOC
C23	5C
C25	5B
CR14	3A
CR18	3A
R10	5B
R20	4B
S30	3A
U16	2A



A5 STANDARD OP-AMP

SEE PARTS LIST FOR EARLIER  
VALUES AND SERIAL NUMBER  
RANGES OF PARTS OUTLINED  
OR DEPICTED IN GREY.

STANDARD OP-AMP CARD 7

# REPLACEABLE MECHANICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number  
00X Part removed after this serial number

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

## INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5           Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
    --- * ---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
    --- * ---
Parts of Detail Part
Attaching parts for Parts of Detail Part
    --- * ---

```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol --- \* --- indicates the end of attaching parts.

**Attaching parts must be purchased separately, unless otherwise specified.**

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

#	INCH NUMBER SIZE	ELCTR	ELECTRON	IN	INCH	SE	SINGLE END
ACTR	ACTUATOR	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ADPTR	ADAPTER	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICON	SEMICONDUCTOR
ALIGN	ALIGNMENT	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
AL	ALUMINUM	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
ASSEM	ASSEMBLED	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSY	ASSEMBLY	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ATTEN	ATTENUATOR	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
AWG	AMERICAN WIRE GAGE	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
BD	BOARD	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BRKT	BRACKET	FLTR	FILTER	OB	ORDER BY DESCRIPTION	SO	SQUARE
BRS	BRASS	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRZ	BRONZE	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BSHG	BUSHING	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
CAB	CABINET	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAP	CAPACITOR	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CER	CERAMIC	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CHAS	CHASSIS	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CKT	CIRCUIT	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
COMP	COMPOSITION	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
CONN	CONNECTOR	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
COV	COVER	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COPLG	COUPLING	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CRT	CATHODE RAY TUBE	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
DEG	DEGREE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DWR	DRAWER	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
		IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000BK	STAUFFER SUPPLY	105 SE TAYLOR	PORTLAND, OR 97214
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OR 97005
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
05129	KILO ENGINEERING COMPANY	2015 D	LA VERNE, CA 91750
05574	VIKING INDUSTRIES, INC.	21001 NORDHOFF STREET	CHATSWORTH, CA 91311
06090	RAYCHEM CORPORATION	300 CONSTITUTION DRIVE	MENLO PARK, CA 94025
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
09422	PLASTIC STAMPING CORPORATION	2216 W. ARMITAGE AVE.	CHICAGO, IL 60647
11535	LORANGER MFG. CORP.	12-38 CLARK ST.	WARREN, PA 16365
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
12360	ALBANY PRODUCTS CO., DIV. OF PNEUMO DYNAMICS CORPORATION	145 WOODWARD AVENUE	SOUTH NORWALK, CT 06586
19613	TEXTPOOL PRODUCTS, INC.	1410 W PIONEER DRIVE	IRVING, TX 75061
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71159	BRISTOL SOCKET SCREW, DIV. OF AMERICAN CHAIN AND CABLE CO., INC.	P O BOX 2244, 40 BRISTOL ST.	WATERBURY, CT 06720
71279	CAMBRIDGE THERMIONIC CORP.	445 CONCORD AVE.	CAMBRIDGE, MA 02138
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
76854	OAK INDUSTRIES, INC., SWITCH DIV.	S. MAIN ST.	CRYSTAL LAKE, IL 60014
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
78471	TILLEY MFG. CO.	900 INDUSTRIAL RD.	SAN CARLOS, CA 94070
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81073	GRAYHILL, INC.	561 HILLGROVE AVE., PO BOX 373	LA GRANGE, IL 60525
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
88245	LITTON SYSTEMS, INC., USECO DIV.	13536 SATICOY ST.	VAN NUYS, CA 91409
97464	INDUSTRIAL RETAINING RING CO.	57 CORDIER ST.	IRVINGTON, NJ 07111

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	390-0359-00	B010100	B041599	1		PANEL, PLUG-IN: BOTTOM, 0.063, AL	80009	390-0359-00
	390-0359-01	B041600		1		PANEL, PLUG-IN: BOTTOM, 0.063, AL (ATTACHING PARTS)	80009	390-0359-01
-2	211-0504-00			3		SCREW, MACHINE: 6-32 X 0.25 INCH, PNH STL	83385	OBD
-3	211-0101-00			2		SCREW, MACHINE: 4-40 X 0.25, 100 DEG, FLH STL	83385	OBD
-4	211-0105-00			2		SCREW, MACHINE: 4-40 X 0.188, 100 DEG, FLH STL	83385	OBD
-5	210-0586-00			2		NUT, PL, ASSEM WA: 4-40 X 0.25, STL - - - * - - -	83385	OBD
-6	390-0227-02			1		PNL, PLUG-IN HSG: RIGHT SIDE (ATTACHING PARTS)	80009	390-0227-02
-7	213-0146-00			4		SCR, TPG, THD FOR: 6-20 X 0.313 INCH, PNH STL	83385	OBD
-8	211-0504-00			2		SCREW, MACHINE: 6-32 X 0.25 INCH, PNH STL - - - * - - -	83385	OBD
-9	390-0228-01			1		CABINET SIDE: LEFT (ATTACHING PARTS)	80009	390-0228-01
-10	213-0146-00			4		SCR, TPG, THD FOR: 6-20 X 0.313 INCH, PNH STL	83385	OBD
-11	211-0504-00			2		SCREW, MACHINE: 6-32 X 0.25 INCH, PNH STL - - - * - - -	83385	OBD
-12	337-1963-00			1		SHLD, ELECTRICAL: CIRCUIT CARD (ATTACHING PARTS)	80009	337-1963-00
-13	211-0007-00			1		SCREW, MACHINE: 4-40 X 0.188 INCH, PNH STL - - - * - - -	83385	OBD
-14	337-1962-00			1		SHLD, ELECTRICAL: CIRCUIT CARD (ATTACHING PARTS)	80009	337-1962-00
-15	211-0007-00			1		SCREW, MACHINE: 4-40 X 0.188 INCH, PNH STL - - - * - - -	83385	OBD
-16	337-1961-00			1		SHIELD, JACK:	80009	337-1961-00
-17	260-0247-00			1		SWITCH, PUSH: SPST, 1A, 115VAC (ATTACHING PARTS)	81073	30YY1009
-18	210-0583-00			1		NUT, PLAIN, HEX: 0.25-32 X 0.312 INCH, BRS	73743	2X20317-402
-19	210-0940-00			1		WASHER, FLAT: 0.25 ID X 0.375 INCH OD, STL	79807	OBD
-20	210-0046-00			1		WASHER, LOCK: 0.261 ID, INTL, 0.018 THK, BRS - - - * - - -	78189	1214-05-00-0541C
-21	333-1731-00			1		PANEL, FRONT:	80009	333-1731-00
-22	366-0125-00			2		KNOB: KNURLED SECURING	80009	366-0125-00
	213-0004-00			2		. SETSCREW: 6-32 X 0.188 INCH, HEX. SOC STL	74445	OBD
-23	210-0894-00			2		WASHER, NONMETAL: 0.19 ID X 0.438" OD, PLSTC	09422	OBD
	162-0530-00	XB041680		FT		INSUL SLVG, ELEC: HT SHRINK, 0.188 ID, PVC, BLK	06090	VERSAFIT
-24	384-0900-00			2		ROD, SECURING: 0.188 DIA X 8.25 INCH LONG (ATTACHING PARTS)	80009	384-0900-00
-25	354-0025-00			2		RING, RETAINING: 0.181 INCH FREE ID - - - * - - -	79136	5555-18
-26	136-0140-00			6		JACK, TIP: BANANA STYLE, CHARCOAL GRAY CA (ATTACHING PARTS)	80009	136-0140-00
-27	210-0583-00			6		NUT, PLAIN, HEX: 0.25-32 X 0.312 INCH, BRS	73743	2X20317-402
-28	210-0223-00	B010100	B041509	6		TERMINAL, LUG: 0.25 INCH DIA, SE	86928	A313-136
	210-0223-01	B041510		6		TERMINAL, LUG: 0.25 INCH DIA, SE, 60 DEG BEND	86928	OBD
-29	210-0465-00			6		NUT, PLAIN, HEX.: 0.25-32 X 0.375 INCH BRS	73743	3095-402
-30	210-0895-00			6		WSHR, SHOULDERED: 0.375 OD X 0.105 INCH THK - - - * - - -	80009	210-0895-00
-31	426-1024-00			1		FRAME PNL, CAB.: FRONT (ATTACHING PARTS)	80009	426-1024-00
-32	211-0541-00			2		SCREW, MACHINE: 6-32 X 0.25" 100 DEG, FLH STL - - - * - - -	83385	OBD
-33	366-1023-02			1		KNOB: GRAY--VAR	80009	366-1023-02
	213-0246-00			1		. SETSCREW: 5-40 X 0.093 ITL BK OXD, HEX SKT	71159	OBD
-34	366-1037-00			1		KNOB: GRAY	80009	366-1037-00
	213-0153-00			2		. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX SKT	000CY	OBD
-35	366-1207-00			2		KNOB: GRAY	80009	366-1207-00
	213-0153-00			2		. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX SKT	000CY	OBD
-36	331-0373-00			1		DIAL, CONTROL:	05129	771-S-6
-37	366-1190-00			2		KNOB: GRAY	80009	366-1190-00
	213-0153-00			4		. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX SKT	000CY	OBD
-38	366-1508-00			1		KNOB: GRAY, WITH SKIRT	80009	366-1508-00
	213-0153-00			2		. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX SKT	000CY	OBD

Replaceable Mechanical Parts—178

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-39	333-1770-00		1		PANEL,FUNCT SW:178	80009	333-1770-00
-40	352-0251-00		1		HOLDER,SCALE:2.14 INCH SQ,PLASTIC	80009	352-0251-00
-41	366-1501-00		1		KNOB:GRAY,WITH SKIRT	80009	366-1501-00
	213-0153-00		2		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX SKT	000CY	OBD
-42	-----		1		RES.,VARIABLE:(SEE R415 REPL) (ATTACHING PARTS)		
-43	210-0590-00		2		NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-44	210-0012-00		1		WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL - - - * - - -	78189	1220-02-00-0541C
-45	384-1210-00		1		EXTENSION SHAFT:1.875 L X 0.125 INCH OD (ATTACHING PARTS)	80009	384-1210-00
-46	376-0014-00		1		CPLG,SHAFT,FLEX:SST WIRE - - - * - - -	76854	22675-001
-47	260-1529-00		1		SWITCH,ROTARY:SWEEP FREQUENCY(S420) (ATTACHING PARTS)	76854	5-18252-142
-48	210-0590-00		1		NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-49	210-0978-00		1		WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL - - - * - - -	78471	OBD
-50	-----		1		RES.,VARIABLE:(SEE R460/S460 REPL)		
-51	-----		1		RES.,VARIABLE:(SEE R565/S565 REPL) (ATTACHING PARTS)		
-52	210-0583-00		2		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-53	210-0940-00		2		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL - - - * - - -	79807	OBD
-54	-----		1		RES.,VARIABLE:(SEE R560 REPL) (ATTACHING PARTS)		
-55	210-0046-00		1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS - - - * - - -	78189	1214-05-00-0541C
-56	-----		1		LAMP:(SEE DS441 REPL) (ATTACHING PARTS)		
-57	348-0004-00		1		GROMMET,RUBBER:0.281 ID X 0.563 INCH OD - - - * - - -	70485	763
-58	366-1489-37		1		PUSH BUTTON:GRAY PLASTIC	80009	366-1489-37
-59	426-0681-00		1		FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0681-00
-60	358-0029-05		2		BSHG,MACH THD:0.274 ID X 0.438"L,NP BRS (ATTACHING PARTS)	80009	358-0029-05
-61	210-0590-00		2		NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-62	210-0012-00		2		WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
-63	210-0978-00		2		WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL - - - * - - -	78471	OBD
-64	390-0358-00		1		CABINET, TOP:	80009	390-0358-00
-65	351-0380-00		2		GUIDE,CKT CARD:PLASTIC (ATTACHING PARTS)	80009	351-0380-00
-66	211-0038-00		4		SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG - - - * - - -	83385	OBD
-67	407-1296-00		1		BRACKET,ANGLE:INDICATOR LIGHTS (ATTACHING PARTS)	80009	407-1296-00
-68	211-0030-00		2		SCREW,MACHINE:2-56 X 0.25"82 DEG,FLH STL	83385	OBD
-69	210-0001-00		2		WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
-70	210-0405-00		2		NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS - - - * - - -	73743	12157-50
-71	386-2569-00		1		DIFFUSER,LIGHT:SWITCH ILLUM,ACRYLIC	80009	386-2569-00
-72	352-0157-00		1		LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-73	200-0935-00		1		BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-74	386-2658-00		1		PLATE,TRIM:REAR (ATTACHING PARTS)	80009	386-2658-00
-75	211-0504-00		3		SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL - - - * - - -	83385	OBD
-76	352-0157-00		4		LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-77	200-0935-00		4		BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-78	378-0635-00		4		LENS,LIGHT:WHITE	80009	378-0635-00
-79	131-0942-00		1		CONTACT,ELEC:GROUNDING (ATTACHING PARTS)	80009	131-0942-00
-80	213-0138-00		1		SCR,TPG,TF:4-24 X 0.188 INCH,PNH STL - - - * - - -	83385	OBD



Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-81	384-1202-00			1		EXTENSION SHAFT:LEVER SWITCH	80009	384-1202-00
-82	214-1770-00			1		LEVER,SLIDE SW: (ATTACHING PARTS)	80009	214-1770-00
-83	354-0165-00			1		RING,RETAINING:0.114 FREE IDX 0.025 INCH - - - * - - -	97464	1000-15
-84	407-1297-00			1		BRACKET,ANGLE:SWITCH,ALUMINUM (ATTACHING PARTS)	80009	407-1297-00
-85	211-0101-00			2		SCREW,MACHINE:4-40 X 0.25,100 DEG,FLH STL - - - * - - -	83385	OBD
-86	441-1149-00			1		CHAS,ELEC EQPT:MAIN	80009	441-1149-00
-87	426-1023-00	B010100	B039999	1		FRAME SECT,CAB.:REAR	80009	426-1023-00
	426-1023-01	B040000		1		FRAME SECT,CAB.:REAR (ATTACHING PARTS)	80009	426-1023-01
-88	211-0101-00			4		SCREW,MACHINE:4-40 X 0.25,100 DEG,FLH STL - - - * - - -	83385	OBD
-89	166-0353-00	B010100	B030929	1		SLEEVE,LOCKING:0.32 DIA X 0.57 INCH LONG	80009	166-0353-00
	166-0345-00	B030930		1		SLEEVE,LOCKING:0.32 DIA X 0.457 INCH L,NYLON	80009	166-0345-00
-90	-----			2		TRANSISTOR:(SEE Q484,Q584 REPL) (ATTACHING PARTS)		
-91	211-0510-00			2		SCREW,MACHINE:6-32 X 0.375,PNH,STL,CD PL	83385	OBD
-92	210-0071-00			2		WASHER,SPR TNSN:0.146 ID X 0.323" OD,STL	78189	4706-05-01-0531
-93	210-0407-00			2		NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS - - - * - - -	73743	3038-0228-402
-94	342-0136-00			2		INSULATOR,WSHR:0.812 OD X 0.0025 INCH THK	04713	OBD
-95	407-1298-00			2		BRACKET,ANGLE:CIRCUIT BOARD MTG (ATTACHING PARTS)	80009	407-1298-00
-96	211-0116-00			4		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS - - - * - - -	83385	OBD
-97	-----			1		CKT BOARD ASSY:POWER SUPPLY(SEE A4 REPL)		
-98	131-0589-00			6		. TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
	131-0608-00			54		. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-99	136-0252-04			3		. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-100	136-0183-00			2		. SOCKET,PLUG-IN:3 PIN,ROUND	80009	136-0183-00
-101	136-0220-00	B010100	B030909	11		. SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
	136-0252-04	B030910		36		. SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-102	136-0237-00			2		. SOCKET,PLUG-IN:8 CONTACT,ROUND	71785	133-98-12-062
-103	136-0514-00	B010100	B042389	3		. SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0727-00	B042390		3		. SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
	136-0403-00	XB040000		4		. SOCKET,PLUG-IN ELEK:MICKRT TEST(NOT SHOWN)	80009	136-0403-00
-104	214-0579-00			3		. TERM,TEST POINT:BRZ CD PL	80009	214-0579-00
-105	214-0720-01			1		SPRING,GROUND: (ATTACHING PARTS)	80009	214-0720-01
-106	210-0586-00			1		NUT,PL,ASSEM WA:4-40 X 0.25,STL - - - * - - -	83385	OBD
	672-0070-00			1		CKT BOARD ASSY:CAM SWITCH (ATTACHING PARTS)	80009	672-0070-00
-107	211-0116-00			2		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
-108	211-0154-00	B010100	B049999	2		SCR,ASSEM WSHR:4-40 X 0.562 INCH,PNH BRS	83385	OBD
	211-0152-00	B050000		2		SCR,ASSEM WSHR:4-40 X 0.625 INCH,PNH BRS - - - * - - -	83385	OBD
	-----			-		CKT BOARD ASSY CAM SWITCH INCLUDES:		
	263-1026-00			1		. SW CAM ACTR AS:SOURCE RESISTANCE (ATTACHING PARTS)	80009	263-1026-00
-109	211-0116-00			4		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS - - - * - - -	83385	OBD
	-----			-		. ACTUATOR ASSY INCLUDES:		
-110	200-0995-00			1		. . COVER,CAM SW: (ATTACHING PARTS)	80009	200-0995-00
-111	211-0022-00			2		. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-112	210-0001-00			2		. . WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL - - - * - - -	78189	1202-00-00-0541C
-113	210-0405-00			1		. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
-114	210-0406-00			2		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-115	214-1126-00			1		. . SPRING,FLAT:GOLD COLORED	80009	214-1126-00
	214-1126-02			1		. . SPRING,FLAT:RED COLORED	80009	214-1126-02
-116	214-1127-00			1		. . ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00

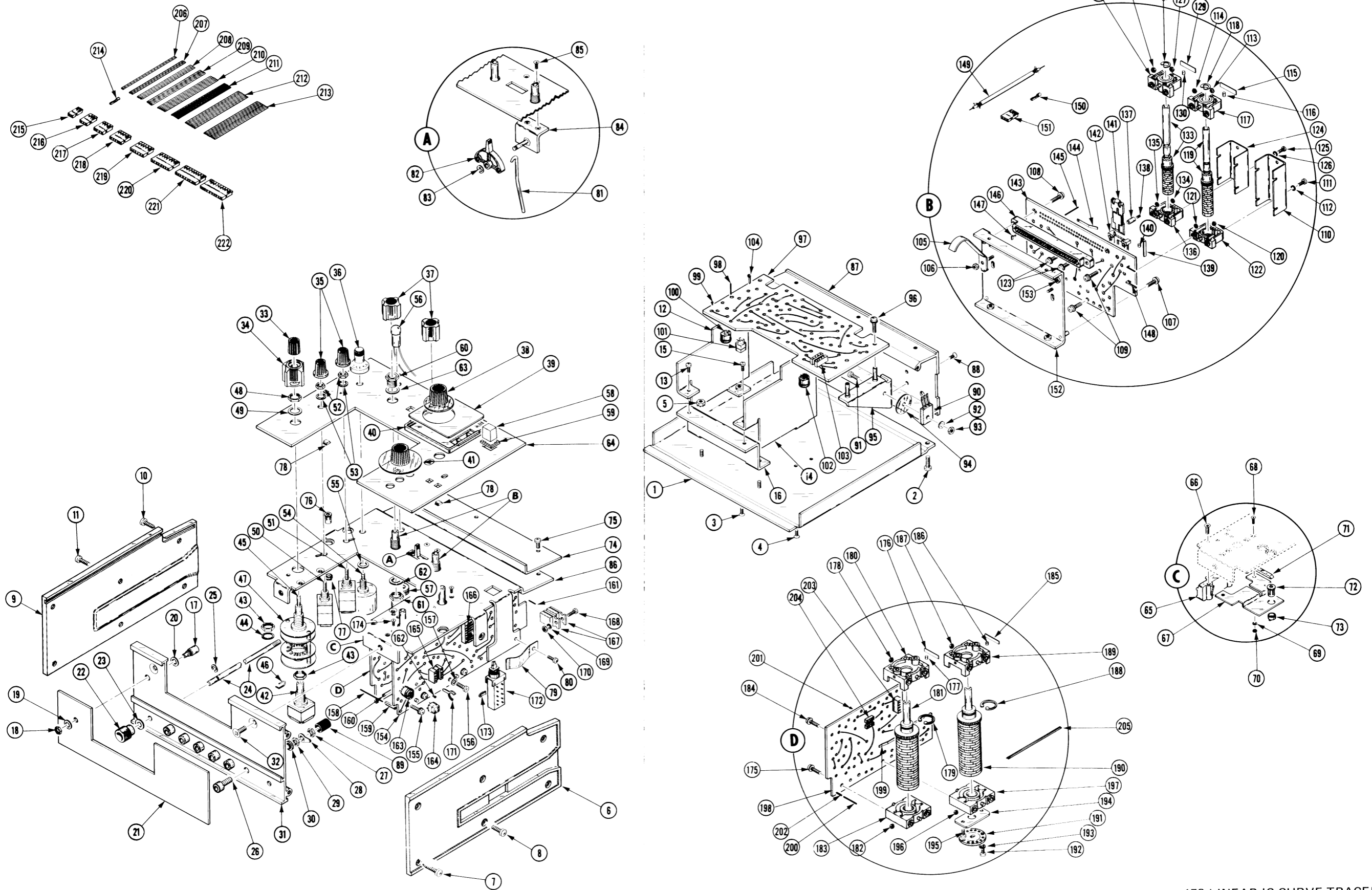
Replaceable Mechanical Parts—178

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
1-117	401-0058-00		1	.	.	.	.	.	BEARING,CAM SW:FRONT (ATTACHING PARTS)	80009	401-0058-00
-118	354-0219-00		1	.	.	.	.	.	RING,RETAINING:FOR 0.25 INCH SHAFT - - - * - - -	79136	5103-25-MD-R
-119	105-0460-00		1	.	.	.	.	.	ACTUATOR,CAM SW:	80009	105-0460-00
-120	210-0405-00		1	.	.	.	.	.	NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
-121	210-0406-00		2	.	.	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-122	401-0061-00		1	.	.	.	.	.	BEARING,CAM SW:REAR	80009	401-0061-00
	263-1027-00		1	.	.	.	.	.	CAM SW ACTR AS:LOAD RESISTANC (ATTACHING PARTS)	80009	263-1027-00
-123	211-0116-00		4	.	.	.	.	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS - - - * - - -	83385	OBD
-124	200-1033-00		1	.	.	.	.	.	ACTUATOR ASSY INCLUDES: COVER,CAM SW:7 ELEMENTS (ATTACHING PARTS)	80009	200-1033-00
-125	211-0022-00		2	.	.	.	.	.	SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-126	210-0001-00		2	.	.	.	.	.	WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL - - - * - - -	78189	1202-00-00-0541C
-127	210-0405-00		1	.	.	.	.	.	NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
-128	210-0406-00		2	.	.	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-129	214-1126-00		1	.	.	.	.	.	SPRING,FLAT:GOLD COLORED	80009	214-1126-00
	214-1126-02		1	.	.	.	.	.	SPRING,FLAT:RED COLORED	80009	214-1126-02
-130	214-1127-00		1	.	.	.	.	.	ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-131	401-0058-00		1	.	.	.	.	.	BEARING,CAM SW:FRONT (ATTACHING PARTS)	80009	401-0058-00
-132	354-0219-00		1	.	.	.	.	.	RING,RETAINING:FOR 0.25 INCH SHAFT - - - * - - -	79136	5103-25-MD-R
-133	105-0459-00		1	.	.	.	.	.	ACTUATOR,CAM SW:	80009	105-0459-00
-134	210-0405-00		1	.	.	.	.	.	NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	12157-50
-135	210-0406-00		2	.	.	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-136	401-0061-00		1	.	.	.	.	.	BEARING,CAM SW:REAR	80009	401-0061-00
	105-0467-00		1	.	.	.	.	.	ACTUATOR,SWITCH:SLIDE ASSY,ON-OFF(S140)	80009	105-0467-00
-137	376-0142-00		1	.	.	.	.	.	ADPT,SHAFT,CPLG:SLIDE TO SHAFT (ATTACHING PARTS)	80009	376-0142-00
-138	213-0048-00		1	.	.	.	.	.	SETSCREW:4-40 X 0.125 INCH,HEX SOC STL - - - * - - -	74445	OBD
-139	214-1126-01		2	.	.	.	.	.	SPRING,FLAT:0.7 X 0.125,CU BE GRN CLR	80009	214-1126-01
-140	214-1127-00		2	.	.	.	.	.	ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-141	105-0478-00		1	.	.	.	.	.	ACTUATOR,SWITCH:	80009	105-0478-00
-142	351-0355-00		1	.	.	.	.	.	GUIDE,SLIDE SW:	80009	351-0355-00
-143	-----		-	.	.	.	.	.	CKT BOARD ASSY:INTERFACE(SEE A1 REPL)		
-144	131-0604-00		21	.	.	.	.	.	CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-145	131-0608-00		23	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	131-0787-00		8	.	.	.	.	.	CONTACT,ELEC:0.64 INCH LONG	22526	47359
-146	131-1228-00		1	.	.	.	.	.	CONNECTOR,RCPT,:CKT BD,30/60 CONTACTS	05574	000201-5421
-147	214-1458-00		1	.	.	.	.	.	KEY,CONN PLZN:CKT BOARD	05574	091-0071-000
-148	131-1261-00		10	.	.	.	.	.	CONTACT,ELEC:F-SHAPED	00779	1-380953-0
-149	175-0072-00		FT	.	.	.	.	.	CABLE,RF:2 CONDUCTOR	80009	175-0072-00
-150	131-0707-00		3	.	.	.	.	.	CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	47439
-151	352-0161-05		1	.	.	.	.	.	CONN BODY,PL,EL:3 WIRE GREEN	80009	352-0161-05
-152	386-2570-00		1	.	.	.	.	.	SUPPORT,CKT BD:INTERFACE (ATTACHING PARTS)	80009	386-2570-00
-153	210-0586-00		2	.	.	.	.	.	NUT,PL,ASSEM WA:4-40 X 0.25,STL - - - * - - -	83385	OBD
-154	-----		1	.	.	.	.	.	CKT BOARD ASSY:FEEDBACK AMPL(SEE A3 REPL) (ATTACHING PARTS)		
-155	211-0116-00		6	.	.	.	.	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
-156	211-0168-00		2	.	.	.	.	.	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	12360	OBD
-157	210-1002-00		2	.	.	.	.	.	WASHER,FLAT:0.125 ID X 0.25 INCH OD,BRS - - - * - - -	12327	OBD
-158	131-0593-00		7	.	.	.	.	.	CKT BOARD ASSY INCLUDES: CONTACT,ELEC:1.15 INCH LONG	22526	47354
-159	352-0274-00		1	.	.	.	.	.	HOLDER,TERMINAL:FOR 8 SQUARE PINS	80009	352-0274-00
-160	131-0604-00		24	.	.	.	.	.	CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00

Fig. & Index No.	Tektronix Part No.	Serial/Model-No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-161	131-0608-00		19	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-162	136-0252-04		6	.	SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-163	136-0220-00	B010100 B030909	9	.	SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT,PCB MT	71785	133-23-11-034
	136-0252-04	B030910	27	.	SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-164	136-0237-00		1	.	SOCKET,PLUG-IN:8 CONTACT,ROUND	71785	133-98-12-062
-165	136-0514-00	B010100 B042389	1	.	SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0727-00	B042390	1	.	SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	D1LB8P-108
-166	136-0499-10		1	.	CONNECTOR,RCPT,:10 CONTACT	00779	4-380949-0
-167	-----		2	.	TRANSISTOR:(SEE Q546,Q548 REPL) (ATTACHING PARTS)		
-168	211-0008-00		2	.	SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
-169	210-0004-00		2	.	WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	000BK	OBD
-170	210-0406-00		2	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS - - - * - - -	73743	12161-50
-171	344-0154-00		4	.	CLIP,ELECTRICAL:FUSE,CKT BD MT	80009	344-0154-00
-172	260-1310-00		1	.	SWITCH,PUSH:4PDT MOMENTARY	71590	2KAA0010000-437
-173	361-0384-00		2	.	SPACER,PB SW:0.133 INCH LONG	80009	361-0384-00
	672-0413-00		1	.	CKT BOARD ASSY:CAM SWITCH (ATTACHING PARTS)		
-174	211-0030-00		4	.	SCREW,MACHINE:2-56 X 0.25"82 DEG,FLH STL - - - * - - -	83385	OBD
	-----		-	.	CKT BOARD ASSY INCLUDES:		
	263-1024-00		1	.	SW CAM ACTR AS:VERTICAL UNITS/DIV (ATTACHING PARTS)	80009	263-1024-00
-175	211-0116-00		4	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS - - - * - - -	83385	OBD
	-----		-	.	ACTUATOR ASSY INCLUDES:		
-176	214-1139-02		1	.	SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	214-1139-03		1	.	SPRING,FLAT:RED COLORED	80009	214-1139-03
-177	214-1127-00		2	.	ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-178	210-0406-00		4	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
	105-0482-00		1	.	STOP,DETENT:	80009	105-0482-00
-179	354-0391-00		1	.	RING,RETAINING:0.395"FREE ID X 0.025" STL	97464	3100-43-CD
-180	401-0081-01		1	.	BEARING,CAM SW:WITH THREADED INSERTS	80009	401-0081-01
-181	105-0461-00		1	.	ACTUATOR,CAM SW:	80009	105-0461-00
-182	210-0406-00		4	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-183	401-0115-00		1	.	BEARING,CAM SW:CENTER	80009	401-0115-00
	263-1025-00		1	.	SW CAM ACTR AS:FUNCTION (ATTACHING PARTS)	80009	263-1025-00
-184	211-0116-00		4	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS - - - * - - -	83385	OBD
	-----		-	.	ACTUATOR ASSY INCLUDES:		
-185	214-1139-03		2	.	SPRING,FLAT:RED COLORED	80009	214-1139-03
-186	214-1127-00		2	.	ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-187	210-0406-00		4	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-188	354-0391-00		1	.	RING,RETAINING:0.395"FREE ID X 0.025" STL	97464	3100-43-CD
-189	401-0081-01		1	.	BEARING,CAM SW:WITH THREADED INSERTS	80009	401-0081-01
-190	105-0462-00		1	.	ACTUATOR,CAM SW:	80009	105-0462-00
-191	263-0519-00		1	.	SW SECTION,RTRY:FUNCTION (ATTACHING PARTS)	76854	4-2542-619
-192	211-0181-00		2	.	SCREW,MACHINE:2-56 X 0.375 INCH,PNH BRS	12360	OBD
-193	210-0053-00		2	.	WASHER,LOCK:INTL,0.092 ID X 0.175"OD,STL - - - * - - -	83385	OBD
-194	386-2877-00		1	.	PLATE,SW MTG:FUNCTION (ATTACHING PARTS)	80009	386-2877-00
-195	211-0022-00		2	.	SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL - - - * - - -	83385	OBD
-196	210-0406-00		4	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-197	401-0146-01		1	.	BEARING,CAM SW:CENTER	80009	401-0146-01
-198	-----		1	.	CKT BOARD ASSY:VERT PREAMPL(SEE A2 REPL)		
-199	131-0604-00		30	.	CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-200	131-0608-00		10	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-201	136-0252-04		10	.	SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-202	136-0327-01	B010100 B030699	7	.	SOCKET,PIN TERM:0.067 INCH DIA	00779	86281-2
	136-0263-04	B030700	7	.	SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001

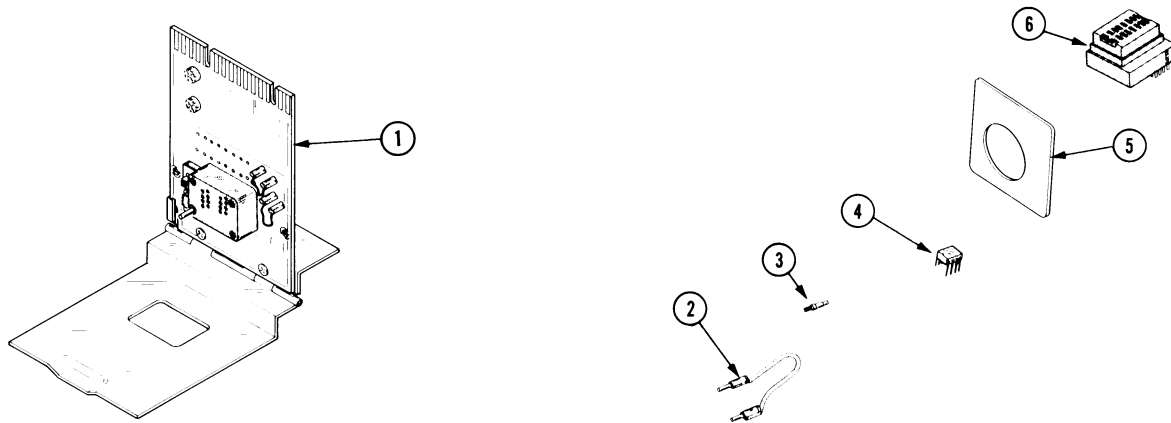
Replaceable Mechanical Parts—178

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-203	136-0499-08			1	. .	CONNECTOR,RCPT,:8 CONTACT	00779	30380949-8
-204	136-0514-00	B010100	B042389	2	. .	SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0727-00	B042390		2	. .	SKT,PL-IN ELEC:MICROCKT,8 CONTACT	09922	DILB8P-108
	136-0263-03	B010100	B030699	7	. .	SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	00779	85864-2
	136-0263-04	B030700		7	. .	SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-205	175-0825-00			FT	. .	WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
-206	175-0825-00			FT	. .	WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
-207	175-0826-00			FT	. .	WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
-208	175-0827-00			FT	. .	CABLE,SP,ELEC:4,26 AWG,STRD.PVC JKT,RBN	08261	SS04267(1061)0C
-209	175-0828-00			FT	. .	WIRE,ELECTRICAL:5 WIRE RIBBON	08261	SS-0526-710610C
-210	175-0829-00			FT	. .	WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
-211	175-0831-00			FT	. .	WIRE,ELECTRICAL:8 WIRE RIBBON	08261	SS-0826-710610C
-212	175-0832-00			FT	. .	WIRE,ELECTRICAL:9 WIRE RIBBON	08261	SS-0926(1061)0C
-213	175-0833-00			FT	. .	WIRE,ELECTRICAL:10 WIRE RIBBON	08261	SS-1026-7
-214	131-0707-00			109		CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	47439
-215	352-0169-02			1		CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	352-0169-04			2		CONN BODY,PL,EL:2 WIRE YELLOW	80009	352-0169-04
	352-0169-05			2		CONN BODY,PL,EL:2 WIRE GREEN	80009	352-0169-05
-216	352-0161-09			1		CONN BODY,PL,EL:3 WIRE WHITE	80009	352-0161-09
-217	352-0162-01			1		CONN BODY,PL,EL:4 WIRE BROWN	80009	352-0162-01
-218	352-0163-03			1		CONN BODY,PL,EL:5 WIRE ORANGE	80009	352-0163-03
-219	352-0164-00			2		CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00
	352-0164-03			1		CONN BODY,PL,EL:6 WIRE ORANGE	80009	352-0164-03
	352-0164-04			2		CONN BODY,PL,EL:6 WIRE YELLOW	80009	352-0164-04
	352-0164-08			2		CONN BODY,PL,EL:6 WIRE GRAY	80009	352-0164-08
-220	352-0166-06			2		CONN BODY,PL,EL:8 WIRE BLUE	80009	352-0166-06
-221	352-0167-02			1		CONN BODY,PL,EL:9 WIRE RED	80009	352-0167-02
-222	352-0168-07			2		CONN BODY,PL,EL:10 WIRE VIOLET	80009	352-0168-07



178 LINEAR IC CURVE TRACER

## STANDARD ACCESSORIES



Index No.	Tektronix Part No.	Serial/Model No.		Qty						Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont		1	2	3	4	5			
-1	013-0149-00	B010100	B030709	1						ADAPTER,CKT BD:OP AMPLIFIER	80009	013-0149-00
	013-0149-01	B030710	B042069	1						ADAPTER,CKT BD:OP AMPLIFIER	80009	013-0149-01
	013-0149-02	B042070		1						ADAPTER,CKT BD:OP AMPLIFIER	80009	013-0149-02
-2	012-0200-00			10						. LEAD,TEST:2.0 L	71279	3705-1-0312
-3	131-1497-00	B010100	B030709	12						. CONTACT,ELEC:0.04 DIA PIN 1 END	88245	15409
	131-1497-00	B030710		14						. CONTACT,ELEC:0.04 DIA PIN 1 END	88245	15409
	136-0388-00	XB030710		1						. SOCKET,PIN TERM:U/W 0.04 DIA PIN	71279	450-3704-01-0300
-4	156-0067-00			1						. MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	02735	85145
-5	333-1770-00			1						PANEL,FUNCT SW:	80009	333-1770-00
-6	136-0442-00			1						SOCKET,PLUG-IN:MICROCIRCUIT,16 CONTACT	11535	2748-161-1221
	070-1978-00			1						MANUAL,TECH:SERVICE	80009	070-1978-00
	070-1977-00			1						MANUAL,TECH:OPERATORS(NOT SHOWN)	80009	070-1977-00

## OPTIONAL ACCESSORIES

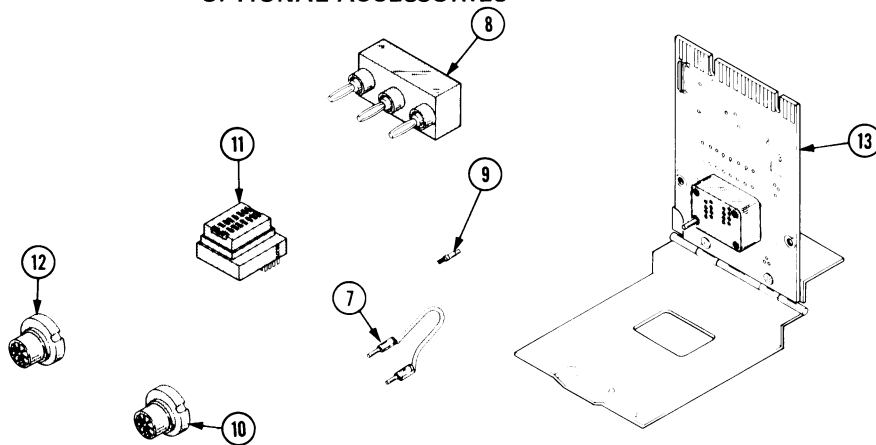


Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty						Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont		1	2	3	4	5			
-7	012-0200-00			1						LEAD,TEST:2.0 L	71279	3705-1-0312
-8	013-0070-01			1						ADAPTER,TEST:3 TERMINAL,TRANSISTOR	80009	013-0070-01
-9	131-1497-00			1						CONTACT,ELEC:0.04 DIA PIN 1 END	88245	15409
-10	136-0441-00			1						SOCKET,PLUG-IN:XSTR,10 LEAD TO T0-5	11535	2767-101-1221/SA
-11	136-0443-00			1						SOCKET,PLUG-IN:MICROCIRCUIT,14 CONTACT	11535	2748-141-1221SAT
-12	136-0444-00			1						SOCKET,PLUG-IN:XSTR,10 LEAD TO T0-5	11535	27678101221/SATP
-13	013-0150-01	B010100	B042069	1						ADAPTER,CKT BD:OPTIONAL AMPL HARDWARE	80009	013-0150-01
	013-0150-02	B042070		1						ADAPTER,CKT BD:OPTIONAL AMPL HARDWARE	80009	013-0150-02
	013-0147-00			1						TEST UNIT,RGLTR:3 TERM POS	80009	013-0147-00
	013-0148-00			1						TEST UNIT,RGLTR:NEGATIVE REGULATOR	80009	013-0148-00