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PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

178
577 D1/D2
SERVICE

INSTRUCTION MANUAL

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P.O. Box 500
Beaverton, Oregon 97077

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Product Group 48

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INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tag, or stamped on the chassis. The first number or letter designates the country of manufacture. The last five digits 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 manufacture is identified as follows:

B000000	Tektronix, Inc., Beaverton, Oregon, USA
100000	Tektronix Guernsey, Ltd., Channel Islands
200000	Tektronix United Kingdom, Ltd., London
300000	Sony/Tektronix, Japan
700000	Tektronix Holland, NV, Heerenveen, The Netherlands

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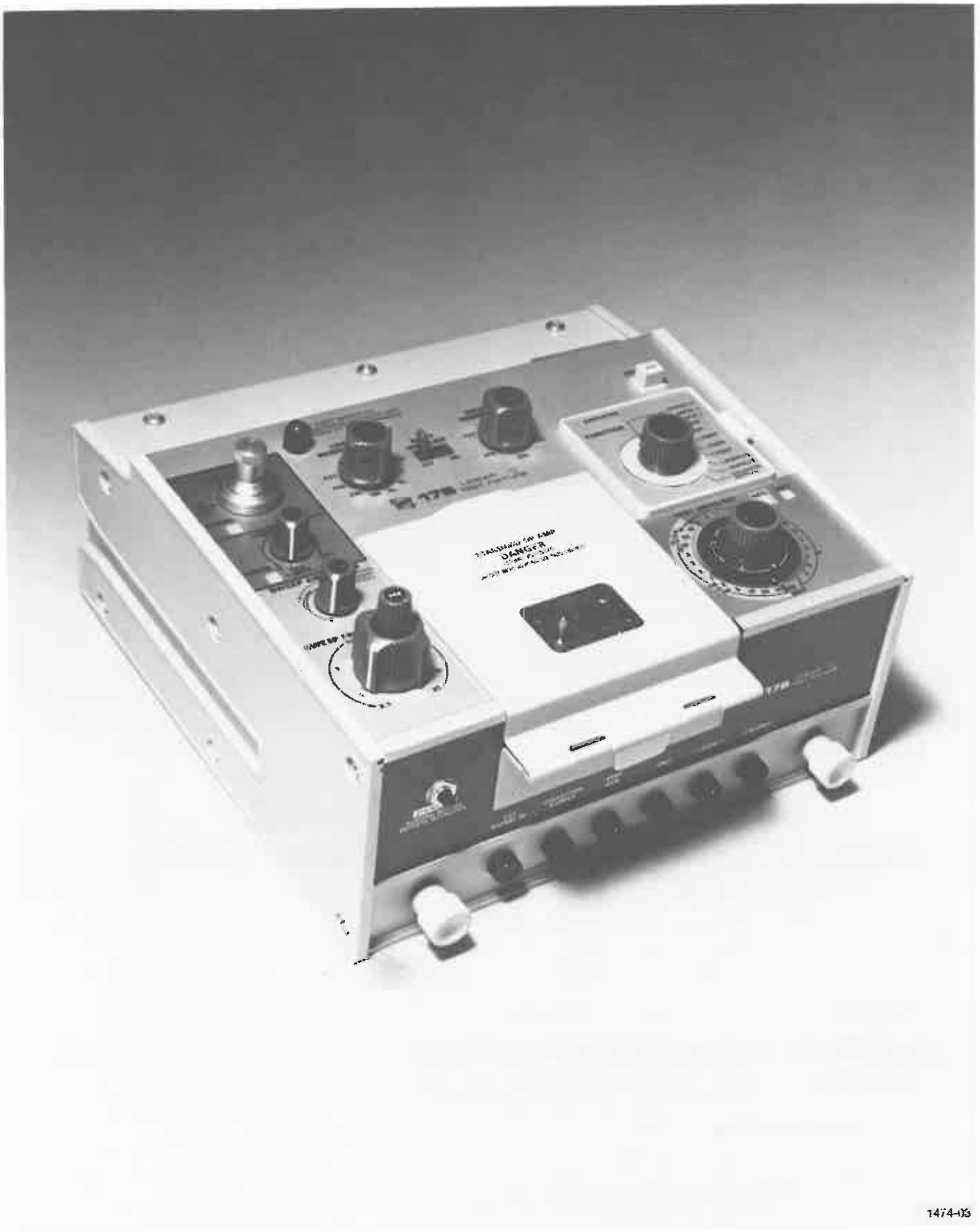


Fig. 1-1. 178 Linear Integrated Circuit Test Fixture.

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 kΩ 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 μ/Div to 50 m/Div can be used for voltage measurements. Any attempt to measure voltage using vertical deflection factors less than 10 μV/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 μV/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.

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[a]	Within ±3% ±50 pA, unmagnified. Within ±4% ±50 pA with 10X magnifier on.	
Voltage[b]	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[a]	Within ±3%, unmagnified; ±4% with 10X magnifier on.	
CMRR Function Accuracy	Within $\pm 3\% + \frac{100K}{Gain - K}\ \% + \frac{150}{K}\ \mu V/V_{cm}$ Within $\pm 4\% + \frac{100\ K}{Gain - K}\ \% \pm \frac{150}{K}\ \mu V/V_{cm}$ with 10X magnifier on (1 μV/DIV to 5 μV/DIV, see footnotes b and c).	
PSRR Function Accuracy	Within $\pm 3\% + \frac{100K}{Gain - K}\ \%$ Within $\pm 4\% + \frac{100\ K}{Gain - K}\ \%$ with 10X magnifier on (1 μV/DIV to 5 μV/DIV; See footnotes b and c).	

[a]Accuracies are the highest percentage of on-screen values.

[b]Vertical magnification is not recommended for .5 mV/DIV through 50 mV/DIV unmagnified settings.

[c]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 μ/Div, and K = 1000 for 50 μV/Div to 10 μV/Div. Vcm = 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[a]	Within ±3% ±1 nA unmagnified; +4% ±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[a]	Within ±3% ±1 nA, unmagnified. ±4% ±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 ±2% ±100 mV.	The −SUPPLY voltage is within ±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 ±5% in calibrated (X1) position.	
Amplitude		
In OFFSET AND GAIN Functions	Adjustable from 0V to 30 V ±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 ±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).

[a]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	4.5 inches (11.4 cm)
Width	7.9 inches (20.1 cm)
Depth	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 Ω (550 Ω 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 Ω, 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 μV/DIV to 50 mV/DIV (μV/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.

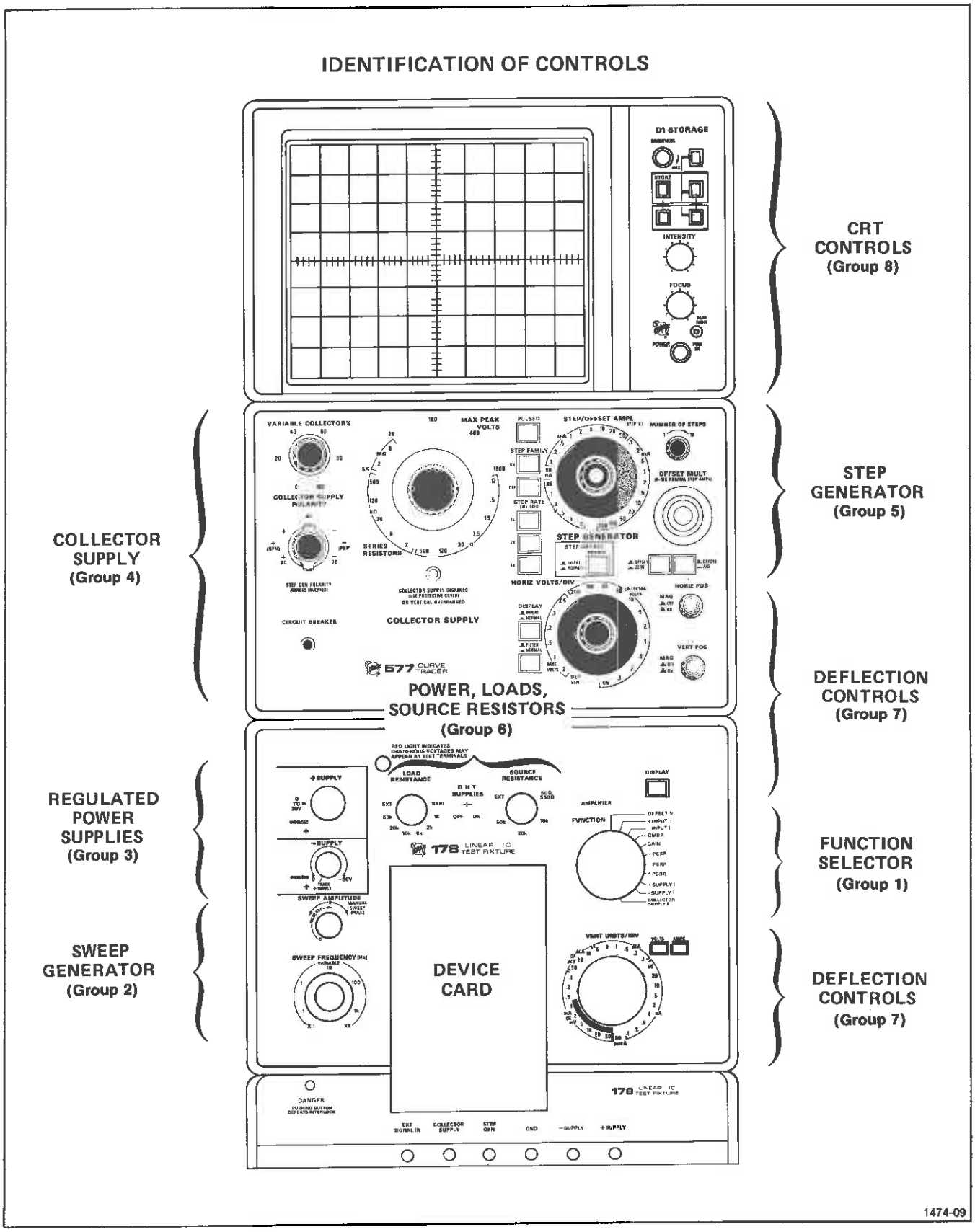


Fig. 2-1. 178 Front-panel controls.

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.

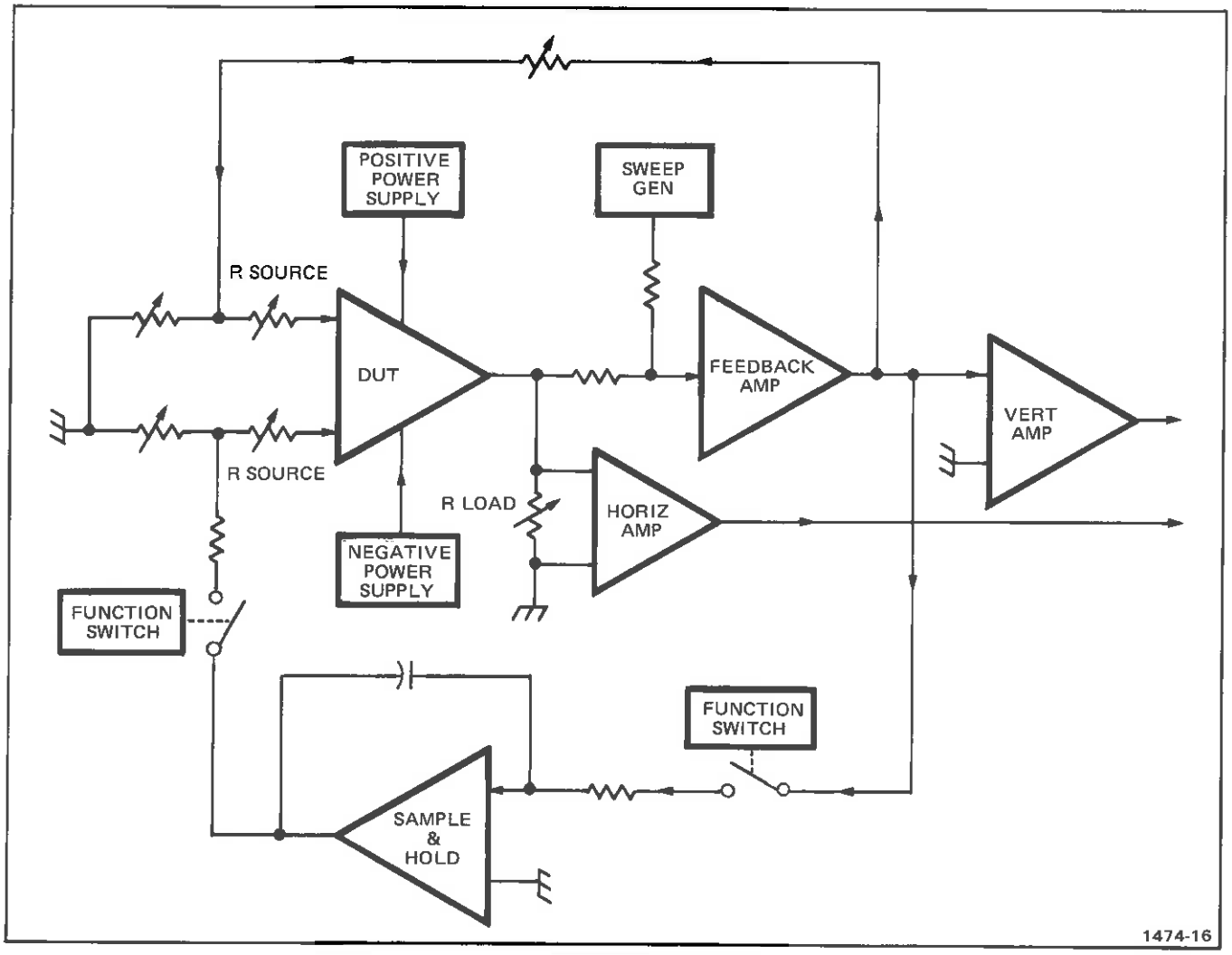


Fig. 3-1. Block diagram of OFFSET V configuration.

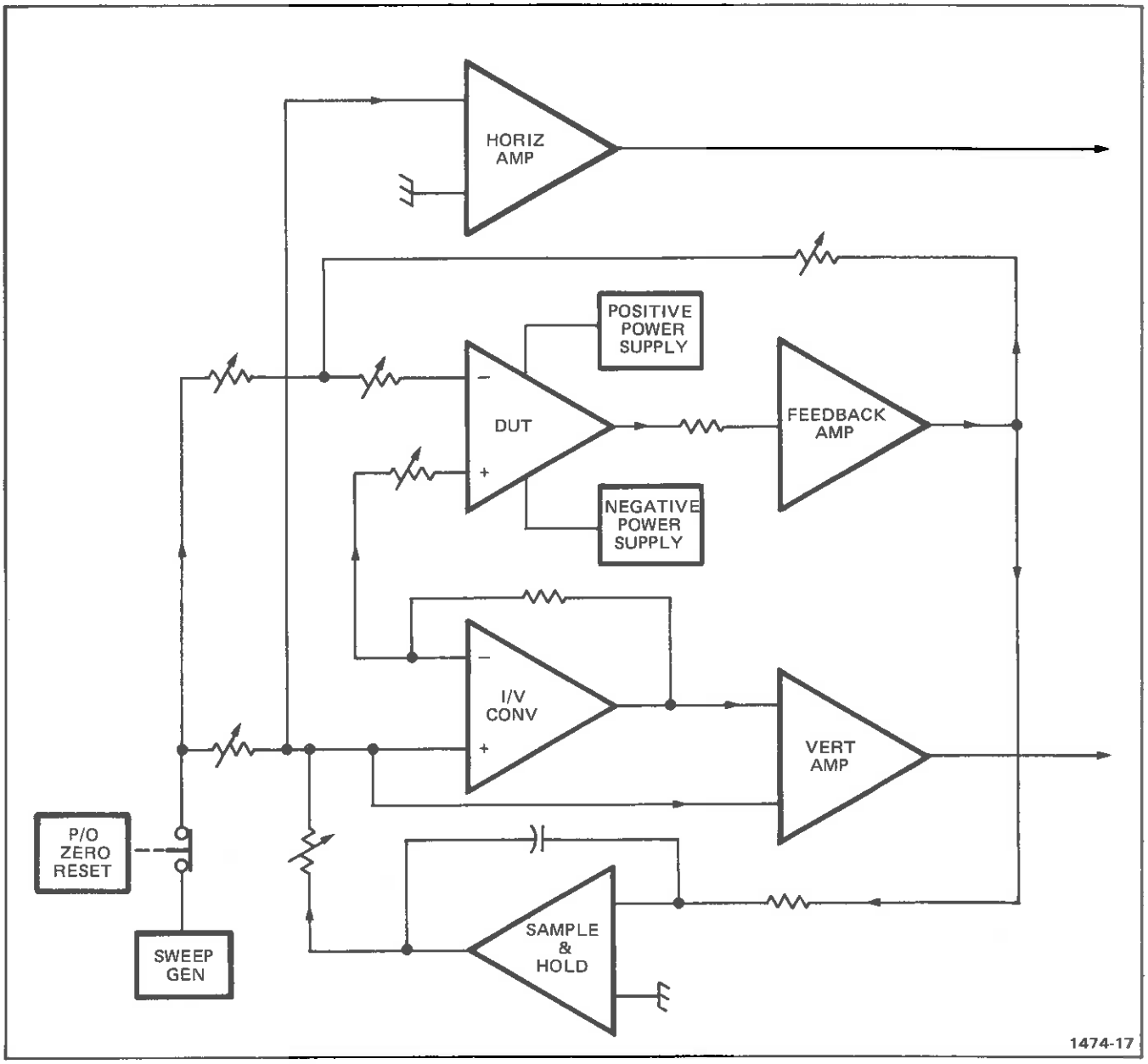


Fig. 3-2. Block diagram of + INPUT I configuration.

+ 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.

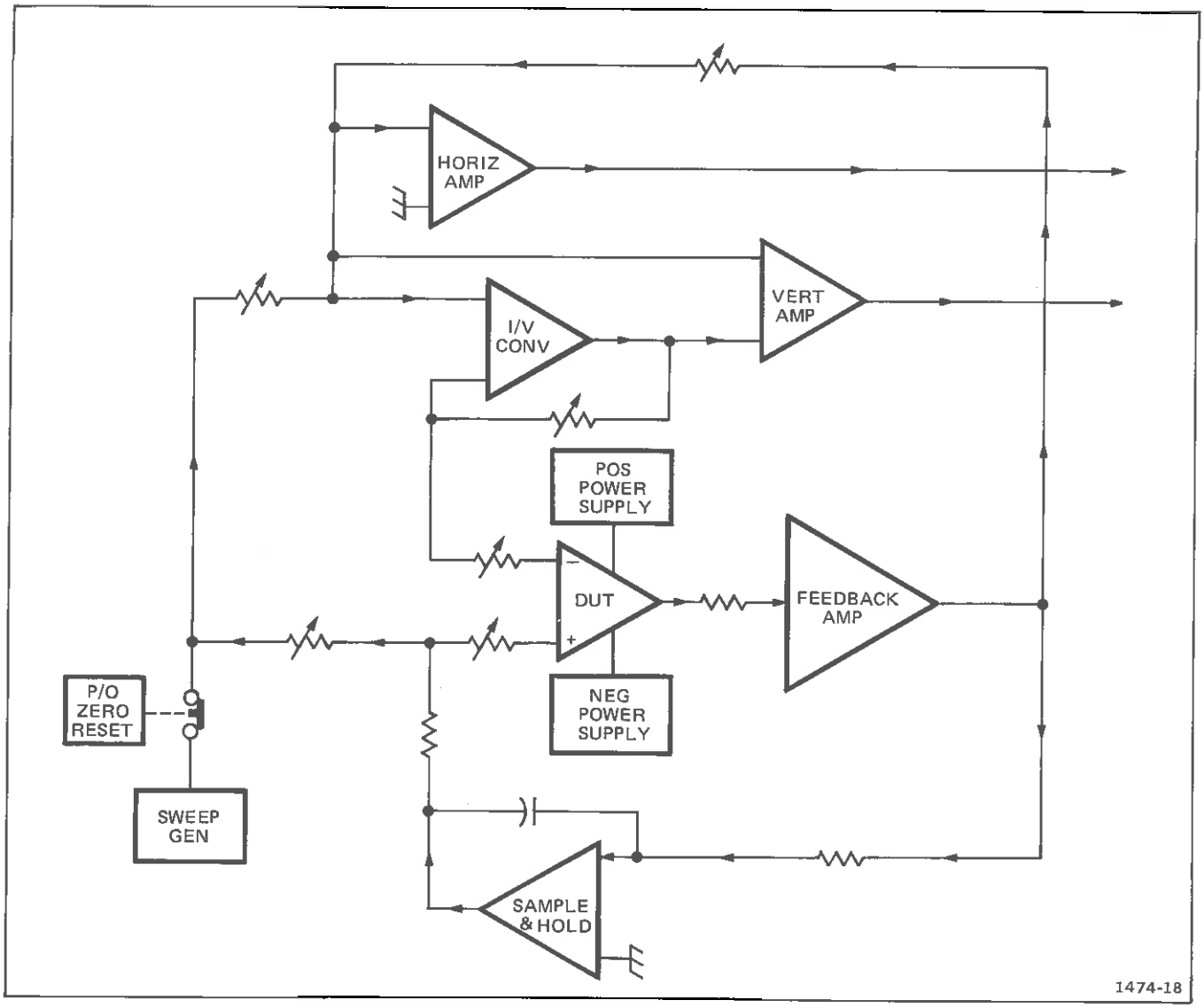


Fig. 3-3. Block diagram of — INPUT I configuration.

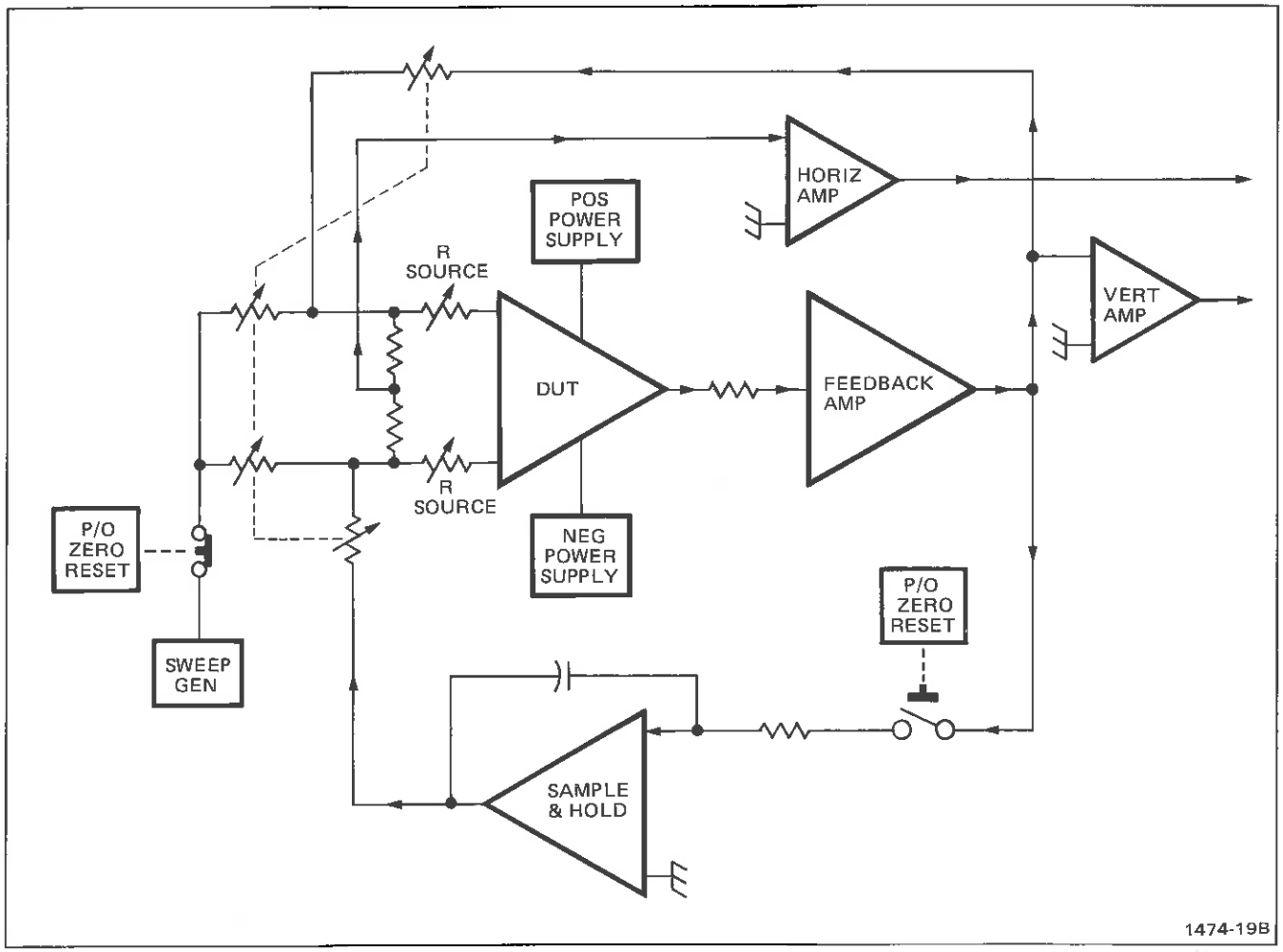


Fig. 3-4. Block diagram of CMRR configuration.

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.

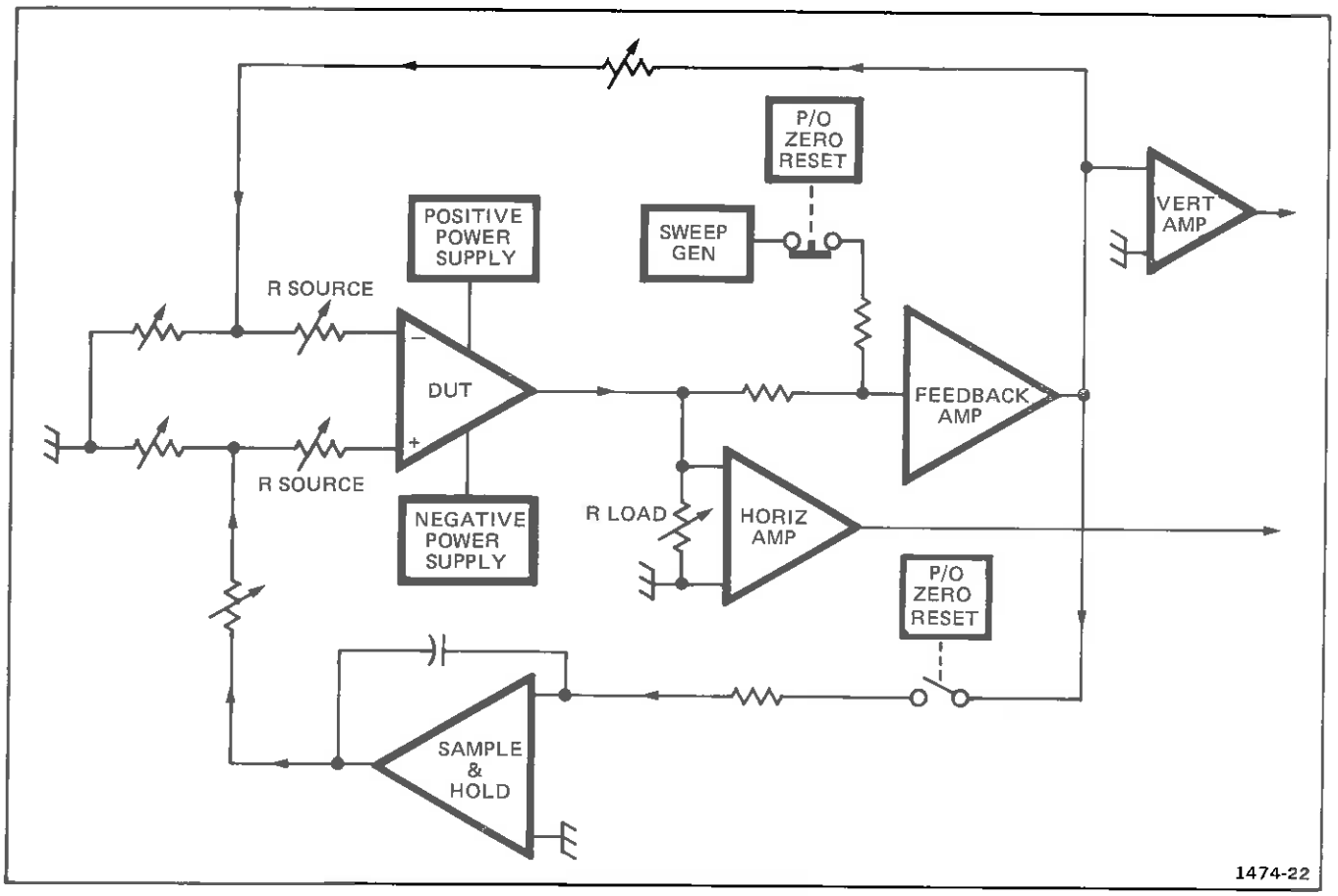


Fig. 3-5. Block diagram of GAIN configuration.

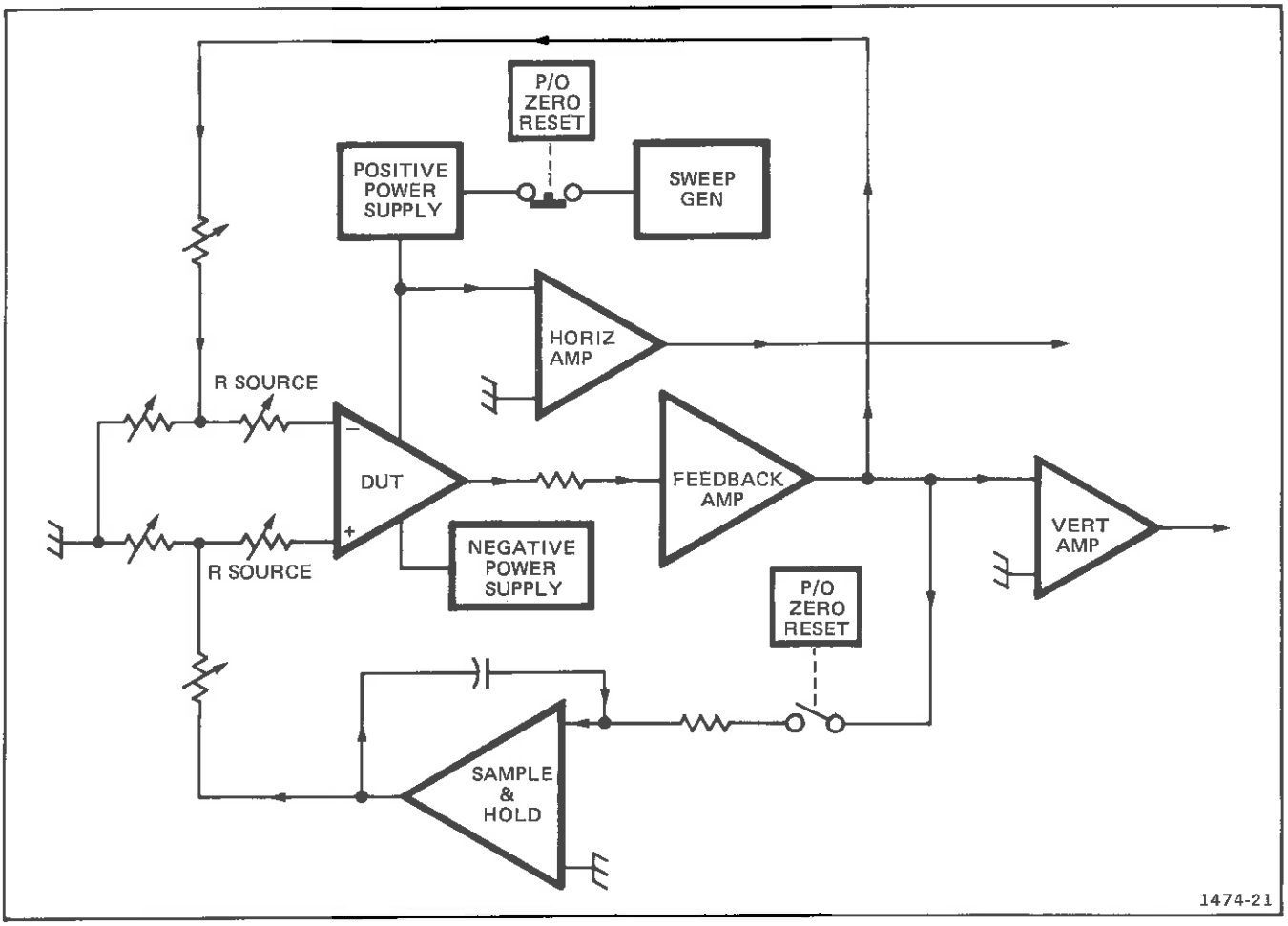


Fig. 3-6. Block diagram of + PSRR configuration.

+ PSRR

Refer to Fig. 3-6. The objective of the + PSRR test is to divide the change in power-supply voltage by the change in input voltage required to hold the output voltage constant. To do this, the Sweep Generator is connected to sweep the positive power supply; the horizontal axis displays this signal. The resultant change is sent to the Vertical Amplifier for display on the vertical axis.

− PSRR

Refer to Fig. 3-7. This test is identical to the + PSRR test, except that the minus supply is swept rather than the plus supply.

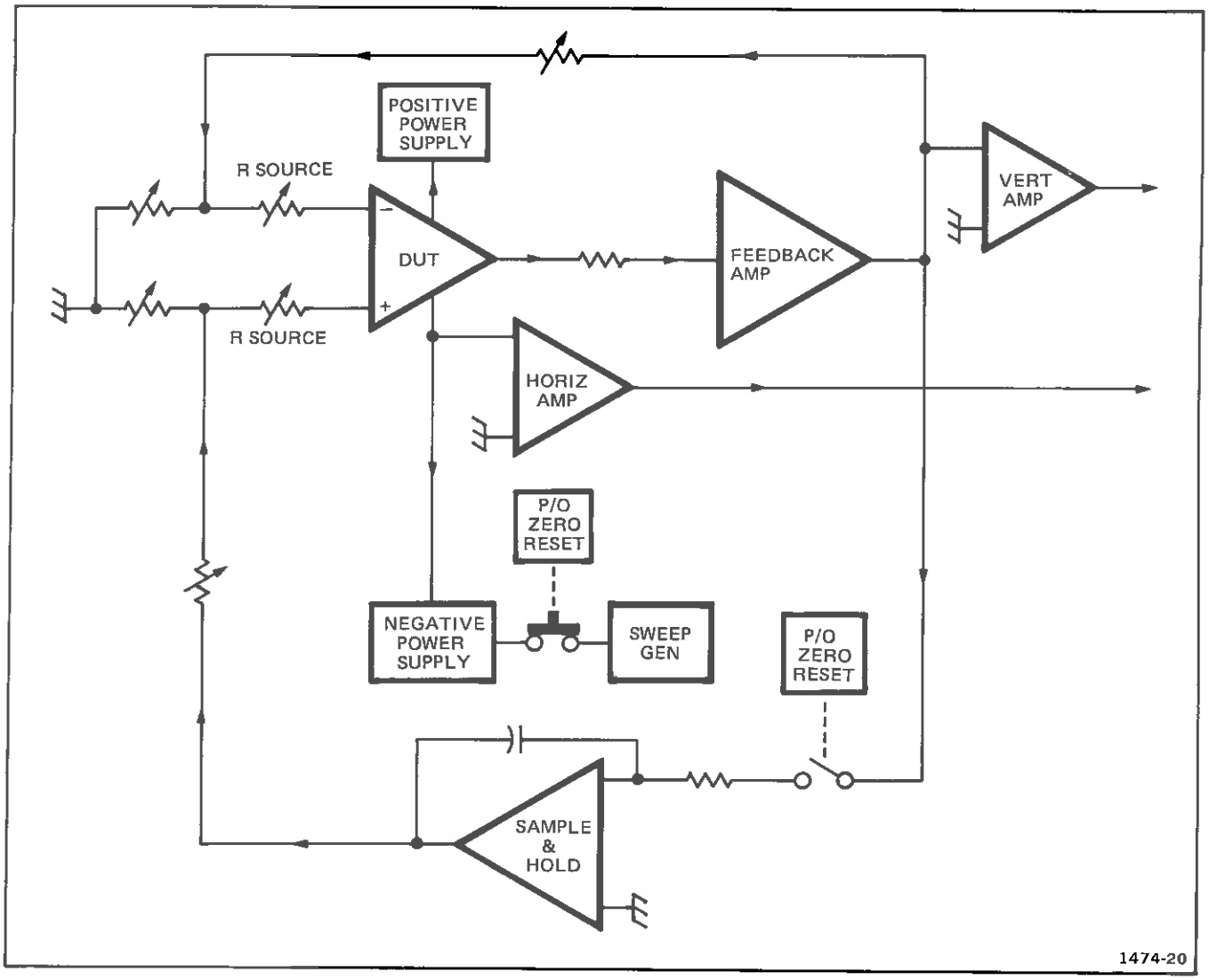


Fig. 3-7. Block Diagram of — PSRR configuration.

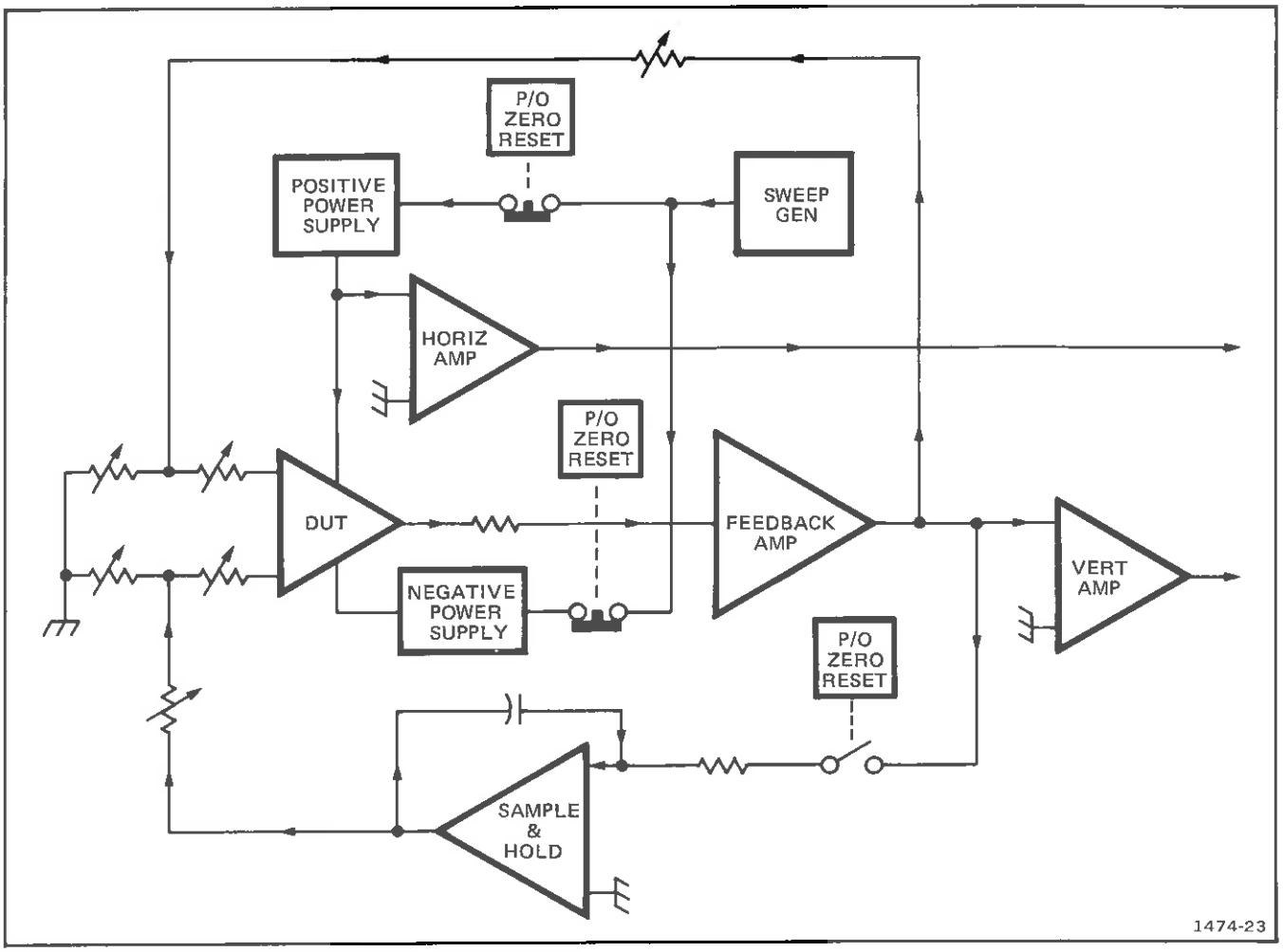


Fig. 3-8. Block diagram of ± PSRR configuration.

± PSRR

Refer to Fig. 3-8. The ± 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.

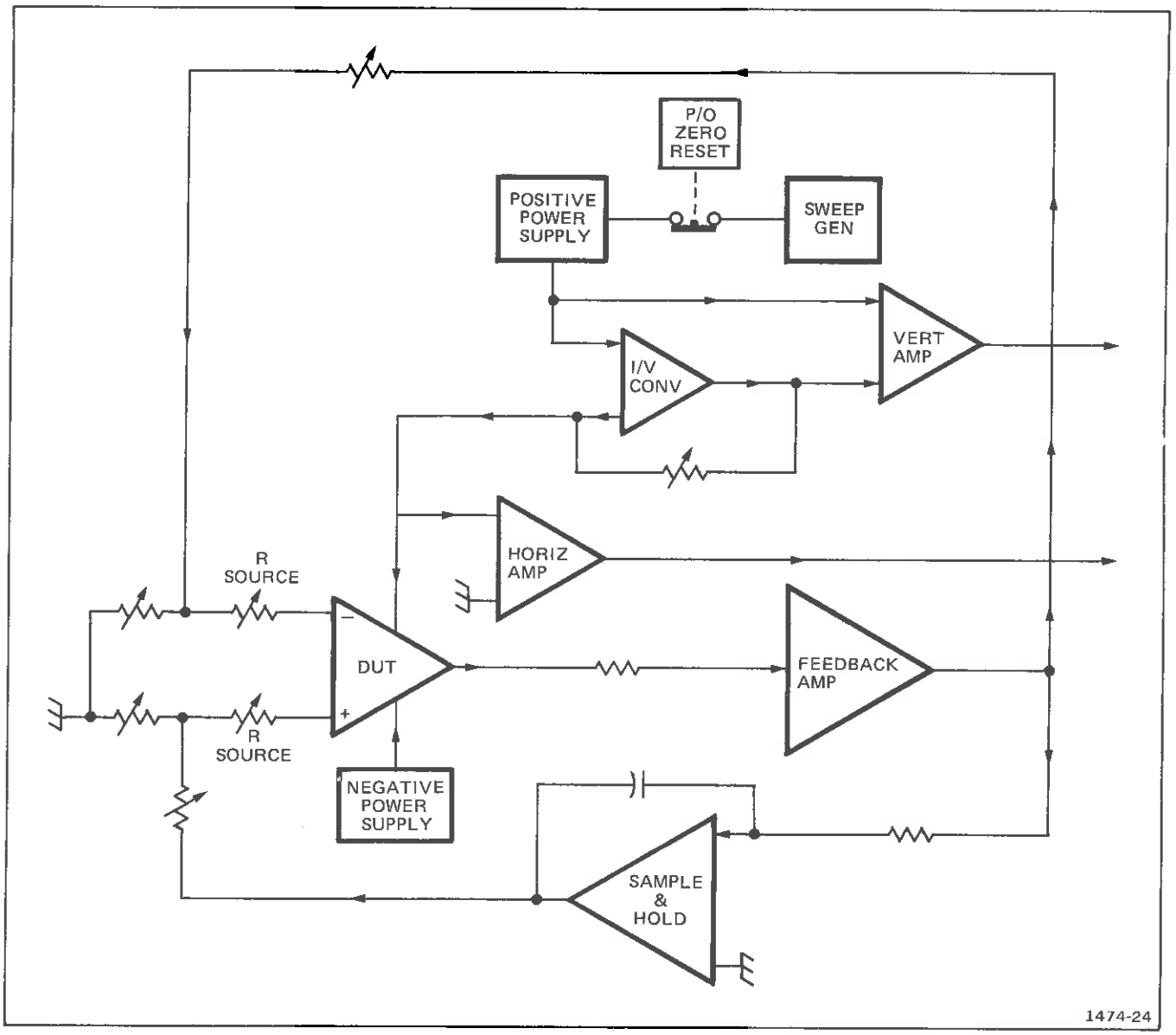


Fig. 3-9. Block diagram of + SUPPLY I configuration.

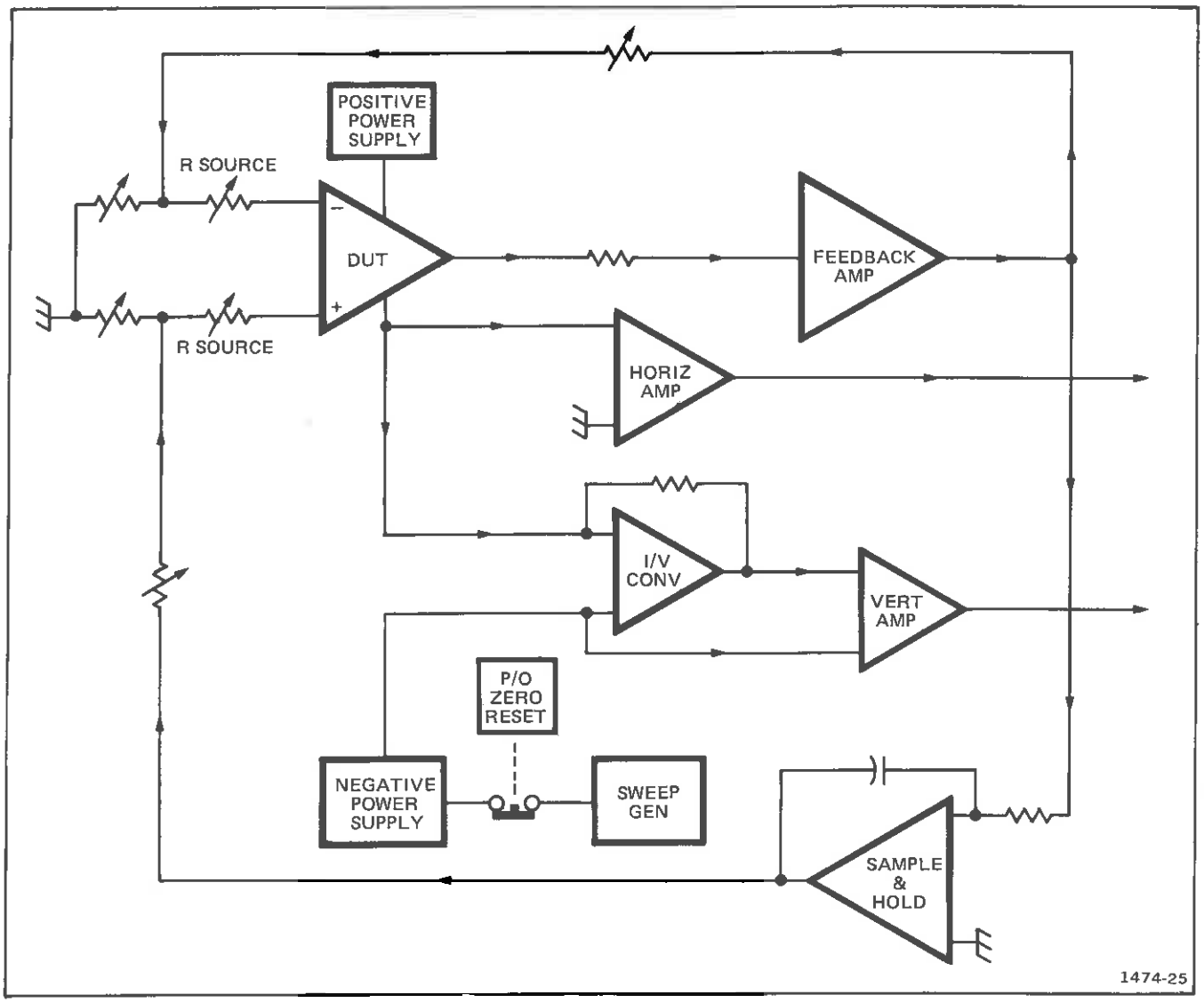


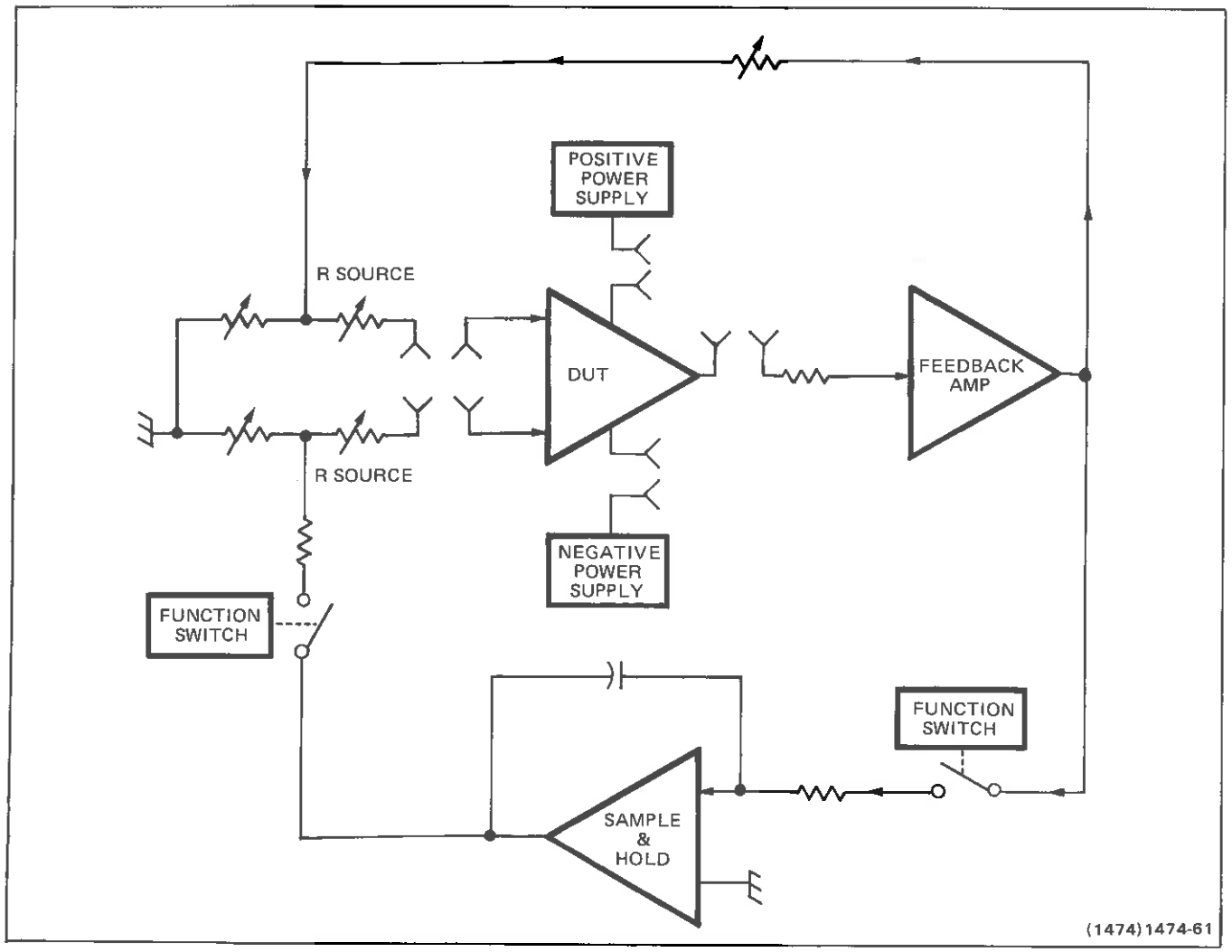
Fig. 3-10. Block diagram of − SUPPLY I configuration.

− 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.



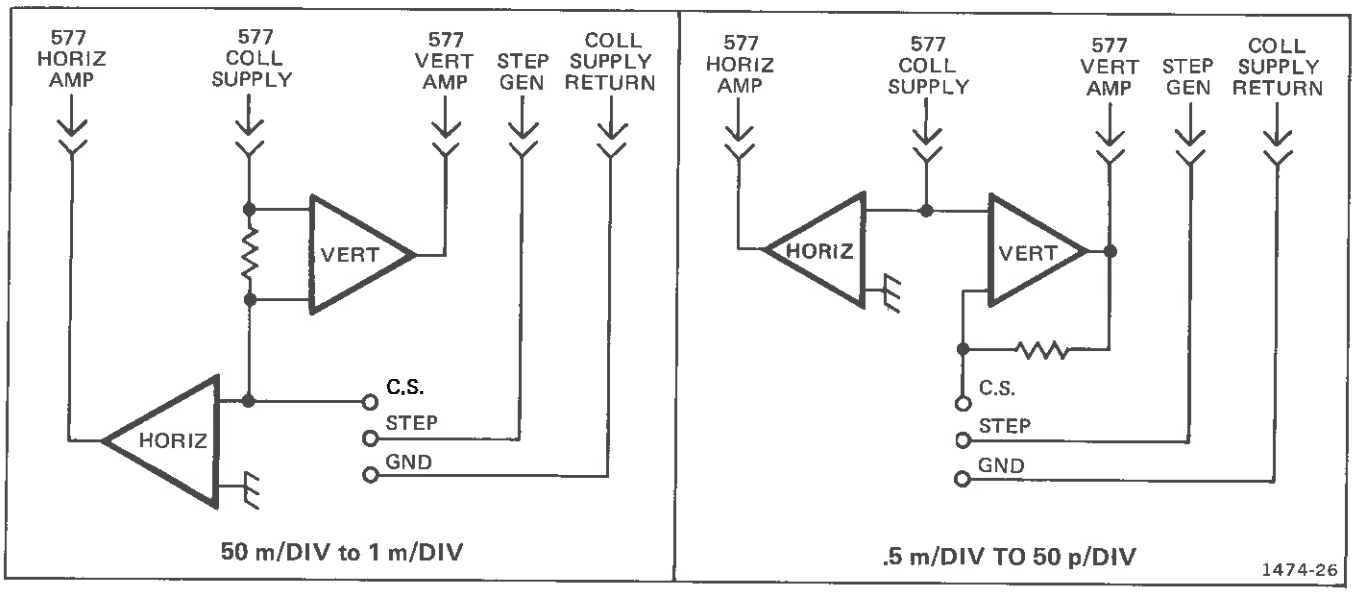


Fig. 3-11. (A) Block diagram of COLLECTOR SUPPLY I configuration; (B) Horizontal and vertical connection for COLLECTOR SUPPLY I configuration.

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 μA 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 μV.

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.

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. Q578 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 overlubricate. 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).

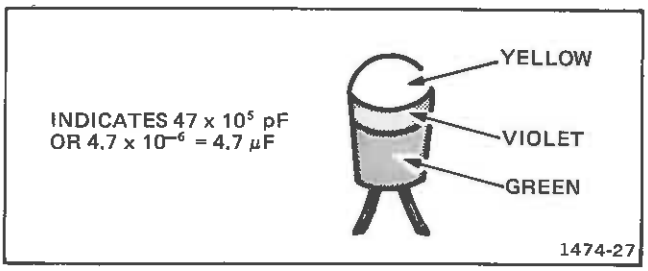


Fig. 4-1. Electrolytic capacitor color code.

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 of 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.

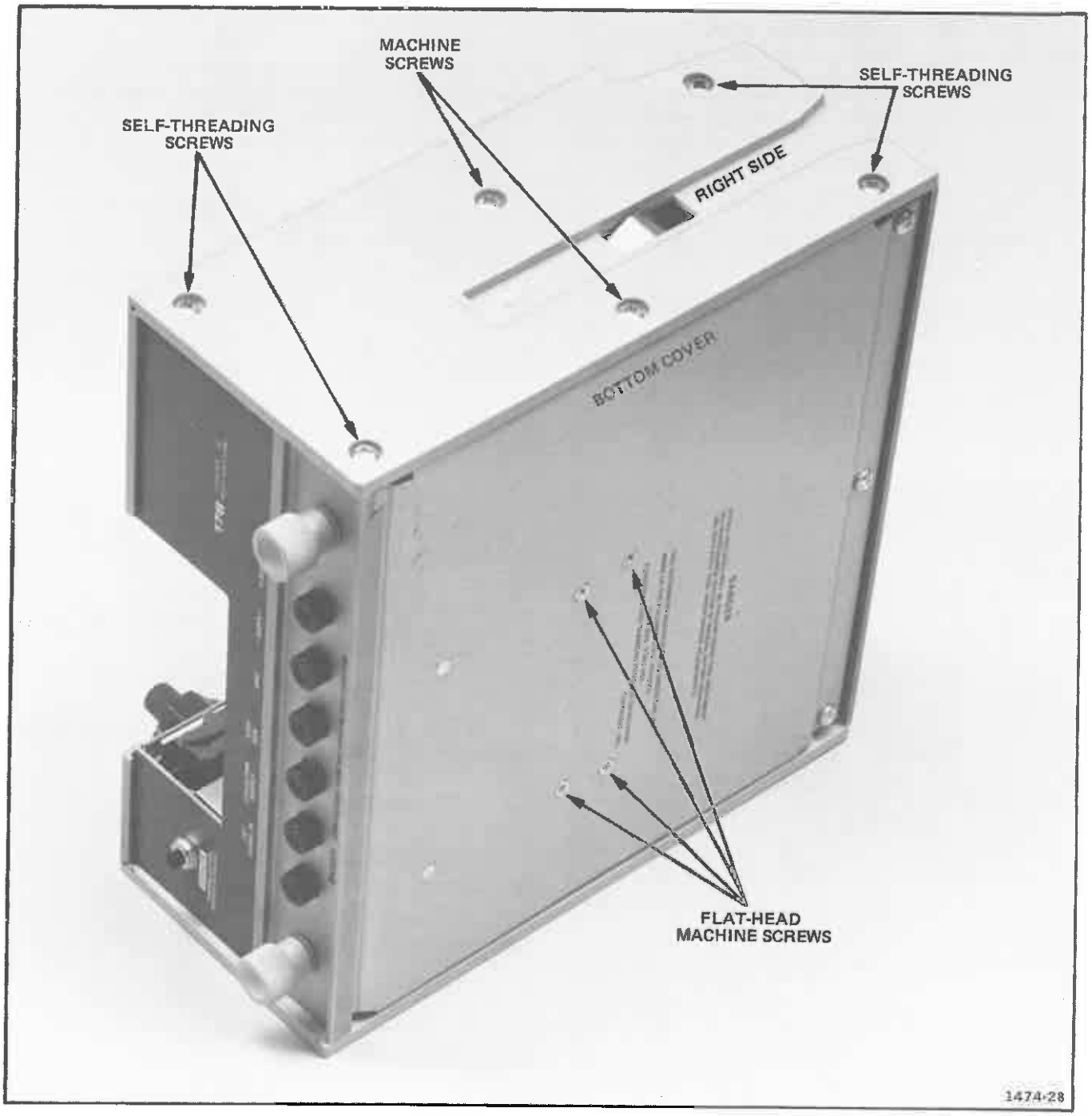


Fig. 4-2. Right-side and bottom panel of the 178.

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.

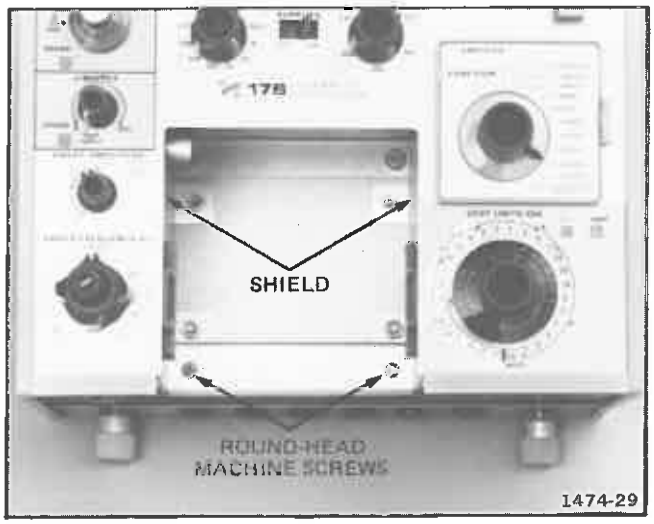


Fig. 4-3. Top view of the 178 showing storage-compartment shields.

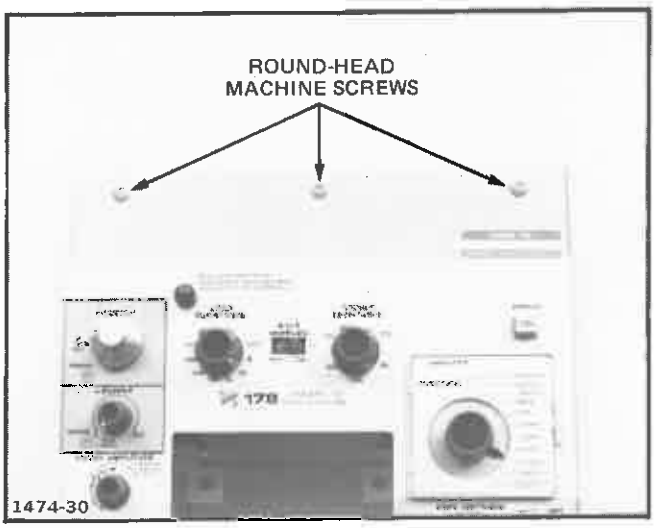


Fig. 4-4. Top view of the 178.

NOTE

The last digit in the number of the circuit-board to which the mulit-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 platic 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.

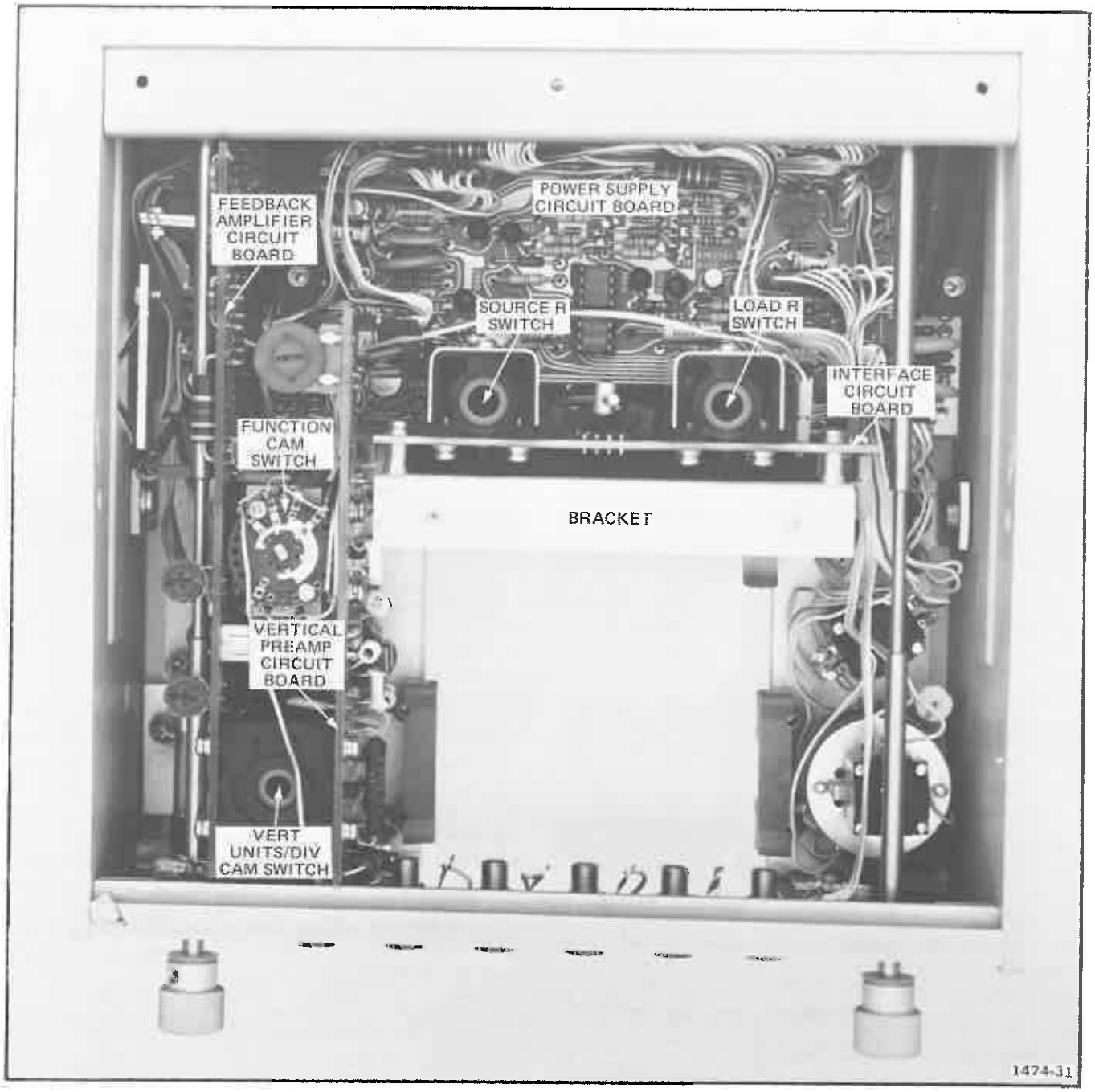


Fig. 4-5. Location of circuit boards in the 178.

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.

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.

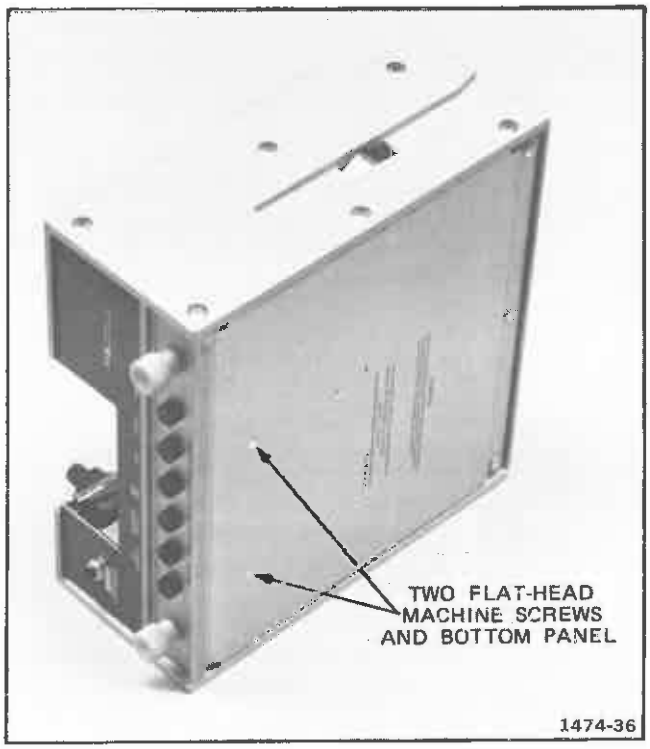


Fig. 4-10. Location of the screws securing the storage compartment shield.

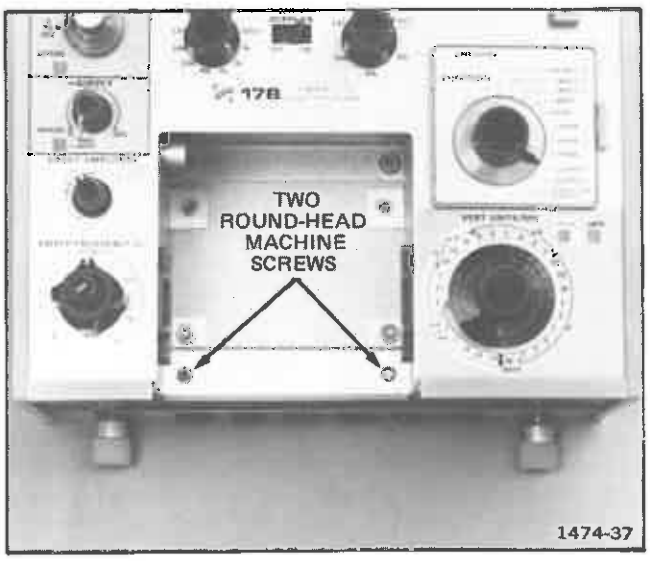


Fig. 4-11. Location of the screws in the storage compartment.

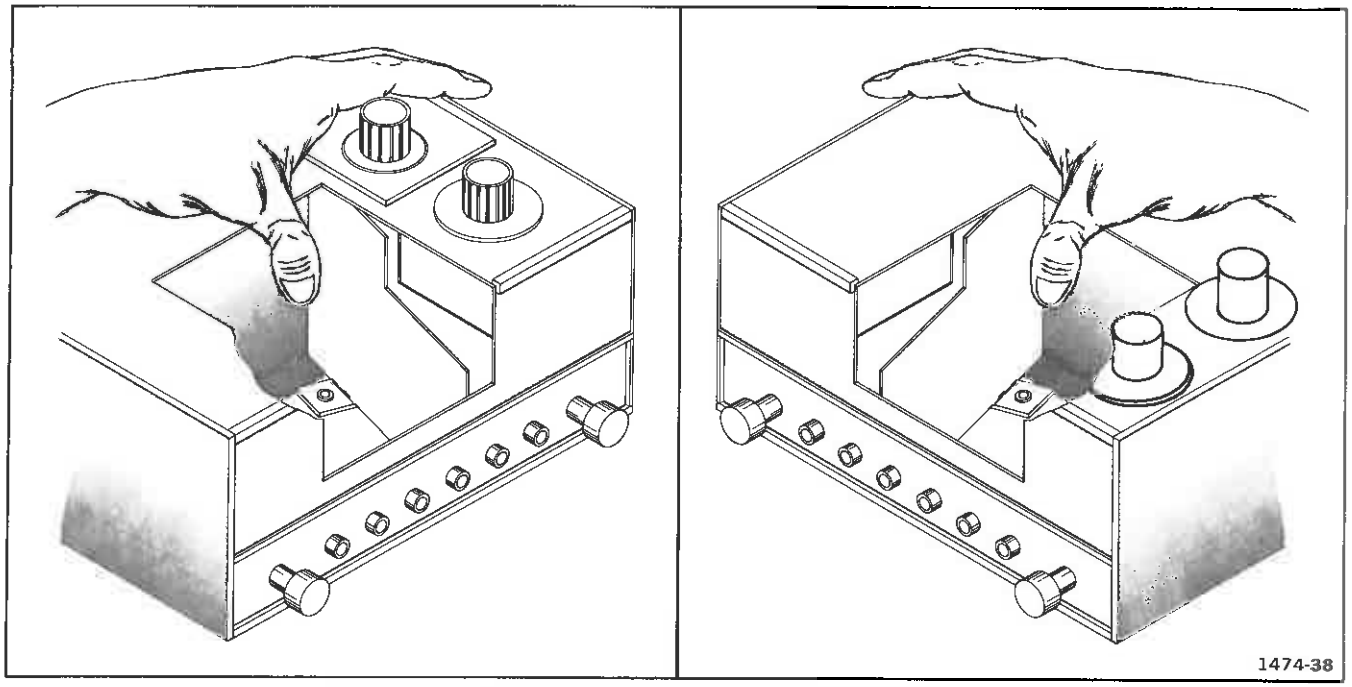


Fig. 4-12. Removing the storage compartment shields.

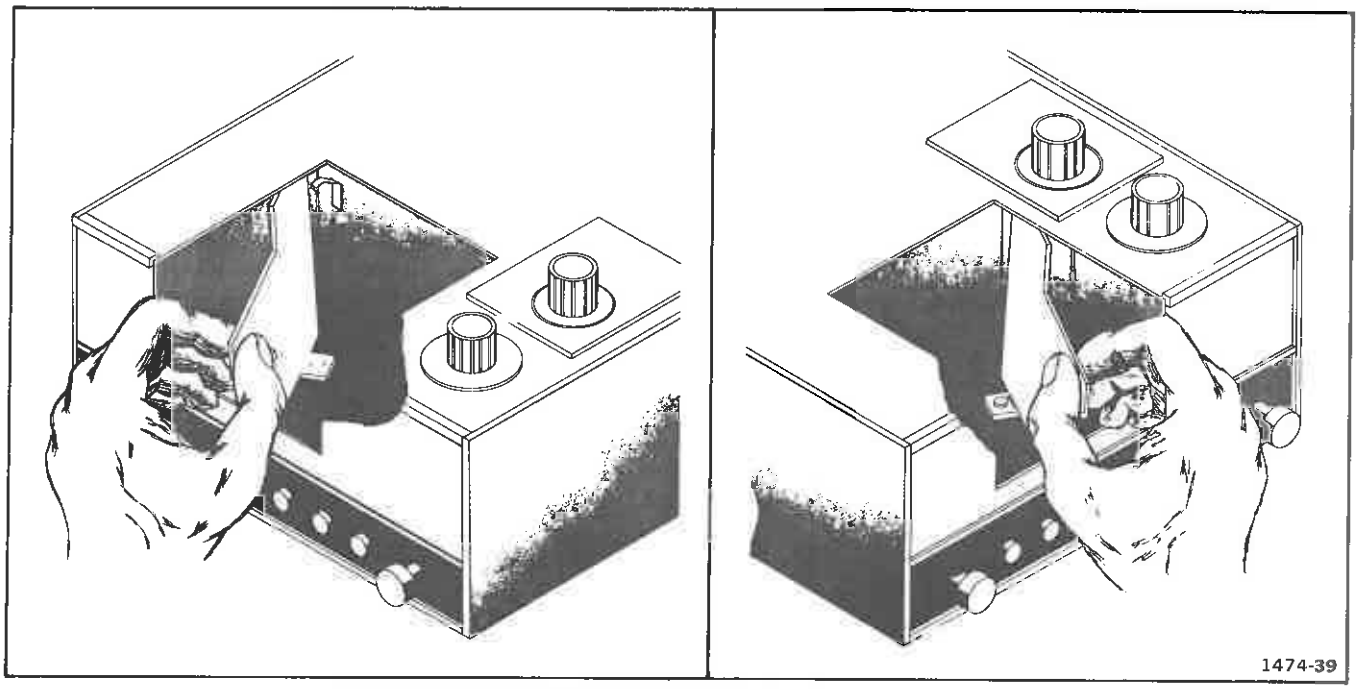


Fig. 4-13. Replacement of the storage compartment shields.

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 Ω through 50 kΩ; accurate within 0.1%.

2. Differential dc Voltmeter: input resistance, 1000 MΩ; 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 μV/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 μV with 50 Ω 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 μV with 50 Ω source resistance; any op amp meeting or exceeding 114 dB measured, such as the Precision Monolithic OP-05EJ, may be used. See CMRR test mehtod 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 Ω, 3 W, 1/4%	1-10 kΩ, 1/4 W, 1/4%
1-10 Ω, 3 W, 1/4%	1-100 kΩ, 1/8 W, 1/4%
1-100 Ω, 1/2 W, 1/4%	1-1 MΩ, 1/8 W, 1/4%
2-200 Ω, 10 W, 1%	1-10 MΩ, 1/8 W, 1/4%
1-1 kΩ, 1/4 W, 1/4%	

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

8. Capacitor. 0.22 μF, 50 volts.

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

2-50 kΩ, 1/4%	1-10 kΩ potentiometer
1-40.2 kΩ, 1%	2-10-volt zener diodes
2-1.5 kΩ, 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[a]	Ohmmeter Reading	Tolerance
50 Ω	1 m	550 Ω	Check for approx
50 Ω	.5 m	50 Ω	value only[b]
10 k	.5 m	10 kΩ	±1%
20 k	.5 m	20 kΩ	±1%
50 k	.5 m	50 kΩ	±1%

[a]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.

[b]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 $-R_S$ 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 $-R_S$ EXT terminal.

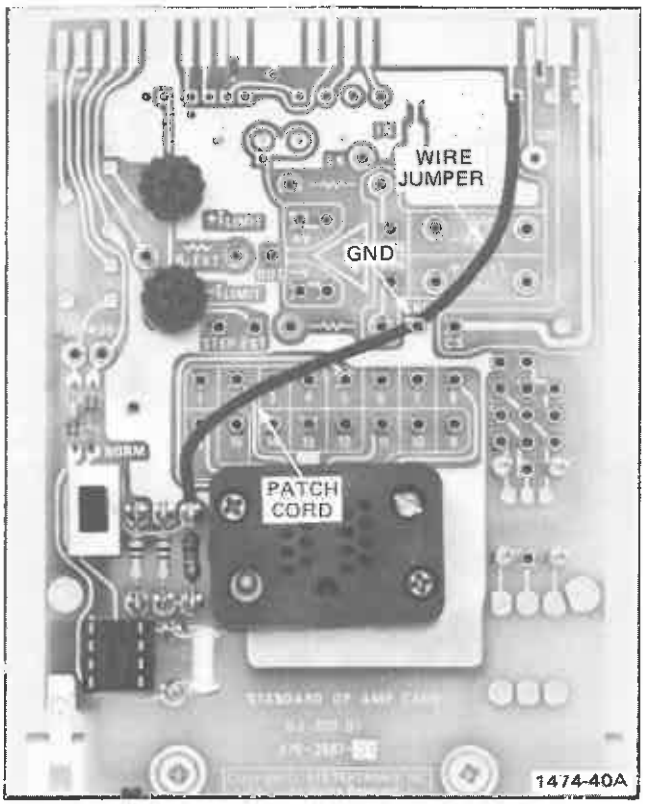


Fig. 5-1. Connections necessary for accurate measurement of source resistance (see Table 5-1, footnote 2).

j. CHECK—The ohmmeter should indicate approximately 50 Ω.

k. Connect the ohmmeter between GND and the right $+R_S$ EXT terminal.

l. CHECK—The ohmmeter should indicate approximately 50 Ω.

m. Connect the ohmmeter between +IN and the left $+R_S$ EXT terminal.

n. CHECK—The ohmmeter should indicate a short circuit.

2. Check Load Resistance Accuracy

a. Set the controls as follows:

577

Power	in (off)

178

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.

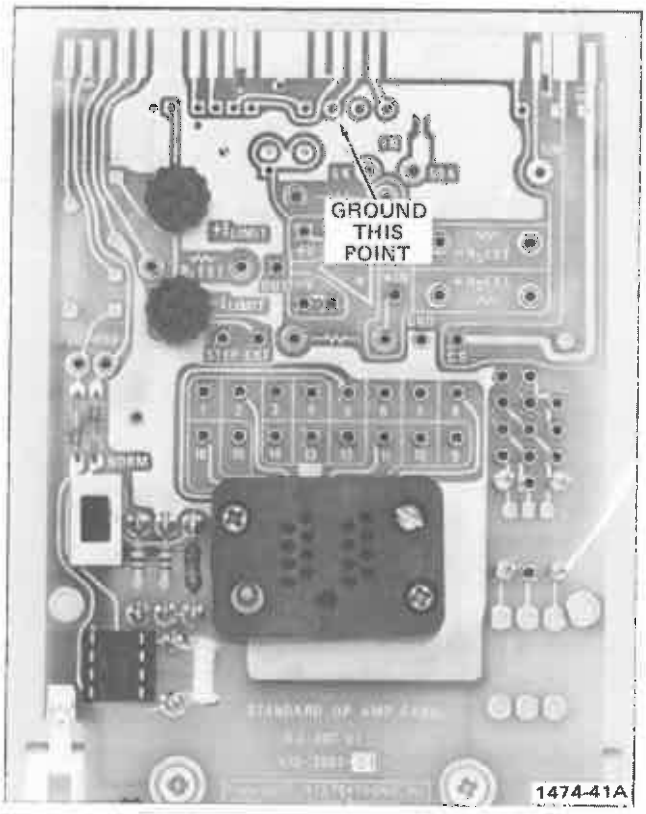


Fig. 5-2. Location of the point to be grounded in Step 2, part b.

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_L 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[a]	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[a]	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

[a]If a dc voltmeter having an input impedance of less than 1000 MΩ is used to measure the voltage accross 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:

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

Where,
V_2 is correct voltage
V_1 is indicated voltage
R_m is meter impedance
R_s is the current-sensing resistor in the table.

Table 5-3 (cont)

Use a differential voltmeter for the remaining measurements (see part j)

VERT UNITS/ DIV	STEP/ OFFSET AMPL	Resistor Value	Meter Reading	Limit (3%)
20 nA	.2 V	10 MΩ[b]	1.60 V	±0.048 V
10 nA	.1 V		0.80 V	±0.024 V
5 nA	.05 V		0.40 V	±0.012 V
2 nA	.2 V	100 MΩ[b]	1.60 V	±0.048 V
1 nA	.1 V		0.80 V	±0.024 V
.5 nA	.05 V		0.40 V	±0.012 V
.2 nA	.05 V		0.16 V	±0.0048 V
.1 nA	.05 V		0.08 V	±0.0024 V
50 pA	.05 V		0.04 V	±0.0012 V

[b]A shielded cable can be used to reduce noise on these measurements. Connect the shield to the Step terminal on the DUT card and to the voltmeter common (do not ground).

j. Connect the resistor between DUT STEP and −IN terminals. Set the Offset Mult dial to 0.00. Zero the differential dc voltmeter.

k. Connect the differential voltmeter common terminal to the DUT STEP terminal and the ±voltmeter terminal to the DUT −IN terminal. This minimizes noise pickup.

l. Adjust the Offset Mult dial for a zero-volt reading on the voltmeter. Opposing the offset aid (Aid button in the out position) may have to be used.

m. Position the spot to the top graticule line.

n. Disconnect the differential voltmeter positive terminal.

o. Adjust the Offset Mult dial to position the spot to the bottom graticule line (in Offset Aid).

p. Reconnect the voltmeter and set the meter dials for a meter null.

q. CHECK—The differential meter should read voltage as indicated in Table 5-3.

r. Continue the tests as described in parts j through p for the remainder of the switch positions.

6. Check Vertical Voltage Accuracy

a. Set the controls as follows:

577

Horiz Volts/Div	5 V, Collector

All Dark Gray Buttons and Knobs in except:

Step Family	Single

178

SWEEP FREQUENCY (Hz)	.1
SWEEP AMPLITUDE	pull
+SUPPLY	15.0 V
−SUPPLY	TRACK +SUPPLY
LOAD RESISTANCE	50 k
SOURCE RESISTANCE	20 k
DUT SUPPLIES	OFF
FUNCTION	GAIN
VERT UNITS/DIV	50 m

b. Connect the test socket on the DUT card for an op amp, such as a 741 or LM301. Place the op amp in the test socket.

c. Connect a 1 MΩ resistor between OUT and −IN. Connect a patch cord between +R, top end, and R_F, top end. Set the External Feedback Amplifier switch, the slide switch on the DUT card, away from the NORM position.

d. Connect a digital voltmeter (dvm) or dc bridge between GND and the patch cord between +R and R_F. Set the DUT SUPPLIES switch to ON. Press the DISPLAY ZERO button. Center the dot with the Vert Pos control.

e. Turn the MANUAL SWEEP control until the spot on the crt is on the bottom graticule line. Note the meter reading.

f. Turn the MANUAL SWEEP control until the spot is on the ninth graticule line, (8 division change). 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 ninth graticule line, (8 division change). 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.

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 Ω

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, ±0.6 volt (1%).

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

g. CHECK—For +30 volts, ±2%, ±100 mV.

h. Set the DUT SUPPLIES switch to OFF. Reconnect the 200 Ω resistor between −V and GND. Switch the DUT SUPPLIES switch to ON. Read the voltage across the 200 Ω.

i. CHECK—For −30 volts, ±2%, ±100 mV.

j. Set the DUT SUPPLIES switch to OFF. Remove the 200 Ω 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
+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, ±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, ±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, ±0.5 div.

i. Set the test oscilloscope for .1 s/Div[1] 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, ±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, ±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[2].

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[2].

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 μF, 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[3].

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, ±7 pulses in one cycle.

10. Check Sweep Amplitude

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

[1]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.

[2]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.

[3]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.

178

+SUPPLY	30.0 V
−SUPPLY	TRACK + SUPPLY
SWEEP AMPLITUDE	0 (fully counterclockwise)
MANUAL SWEEP	UP (pull out)
SOURCE RESISTANCE	50Ω
FUNCTION	CMRR
VERT UNITS/DIV	20 μV
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 ±0.9 V.

11a. Check COMMON-MODE REJECTION RATIO, METHOD 1[4]

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 Ω
FUNCTION	CMRR
VERT UNITS/DIV	.1 m (magnified)

b. Using patch cords, connect the test Op Amp[4] 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 ±3 divisions.

e. Set the VERT UNITS/DIV switch to 10 μV (magnified). Press the DISPLAY ZERO button.

f. CHECK—Vertical deflection of the horizontal trace should not exceed ±3 divisions.

g. Set the VERT UNITS/DIV switch to 1 μV (magnified). Press the DISPLAY ZERO button.

h. CHECK—Vertical deflection of the horizontal trace should not exceed ±3 divisions.

11b. Check COMMON-MODE REJECTION RATION, 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 Ω
+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 ≈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 ccenter. 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 ±1.5 divisions.

g. Set the VERT UNITS/DIV to 10 μV (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 ±1.5 divisions.

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

[4]CMRR of the test op amp must be 150 dB, specified minimum, or must be ≥120 dB, measured. The noise level must be less than 2 μV, using 50 Ω 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.

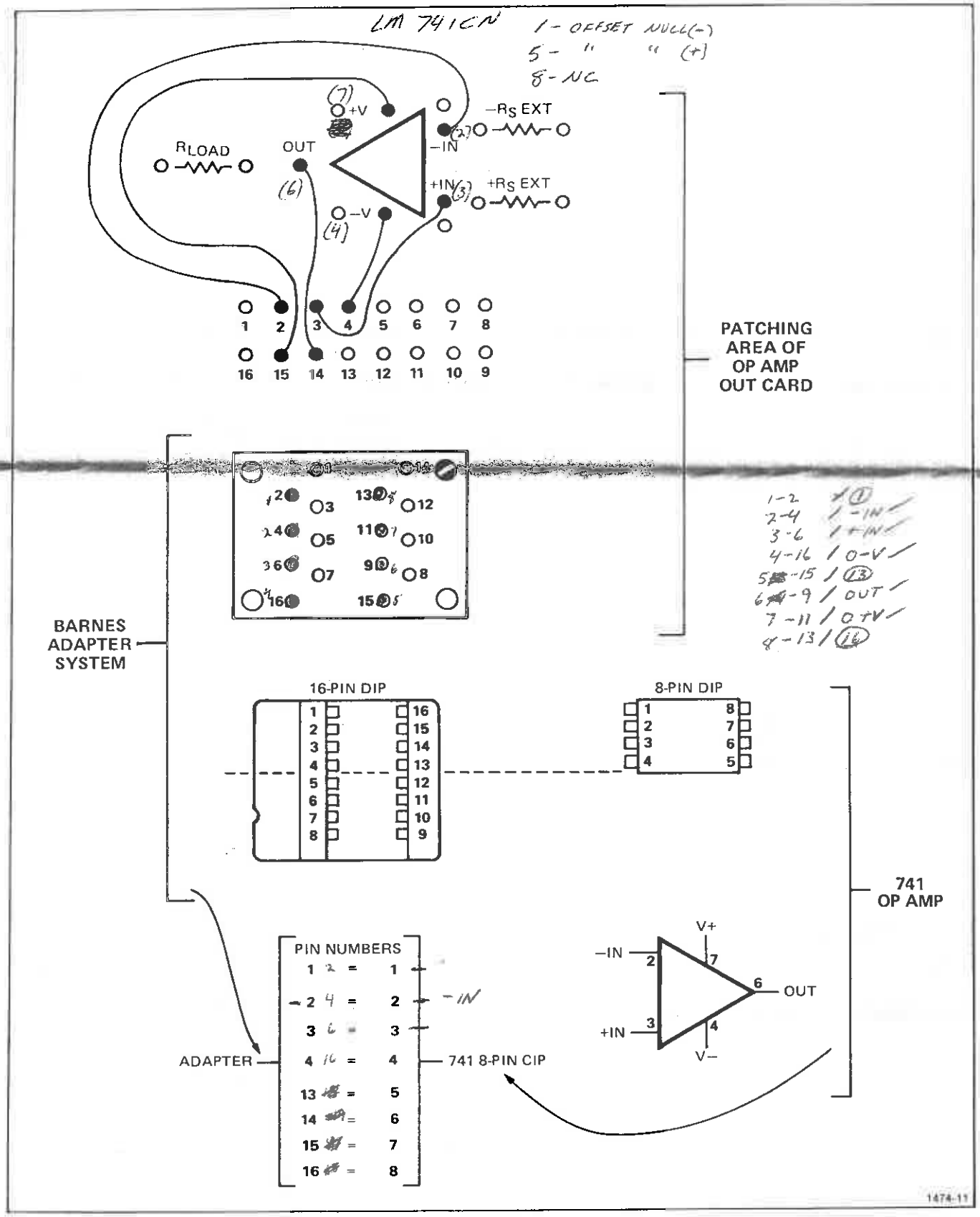


Fig. 2-12. 8-pin DUT plugged into the 16-pin adapter socket.

Initial Control Settings

577

Variable Collector %	0
Collector Polarity	+
Max Peak Volts	6.5 V
Max Peak Power Watts	.15
Step Family	Single
Step Rate	Norm
Step/Offset Ampl	1 V
Step Offset Polarity	in
Number of Steps	1
Offset Mult	0.0
Offset Zero	in
Offset Aid	in
Pulsed 300 μs	out
Step X.1	in
Display Invert	in
Display Filter	in
Horiz Volts/Div	5 collector volts
X10 Horiz Mag	off
X10 Vert Mag	off
Horiz Pos	centered
Vert Pos	centered

178

DUT SUPPLIES	OFF
LOAD RESISTANCE	2 kΩ
SOURCE RESISTANCE	10 kΩ
+SUPPLY	15 V
−SUPPLY	15 V (TRACK +SUPPLY)
SWEEP AMPLITUDE	fully ccw
SWEEP FREQUENCY	.1 Hz
DISPLAY ZERO	press and release
FUNCTION	OFFSET V
VERT UNITS/DIV	2 mV

Standard Op Amp Card (DUT Card)

External Feedback Amplifier switch	Norm
+Current Limit	ccw
−Current Limit	ccw

Patch for the 741 op amp, see Fig. G-1.

Install an AMPHENOL—BARNES 16-pin DIP adapter socket into the DUT Card. Install the eight-pin type 741C Op Amp into the upper half of the adapter socket.

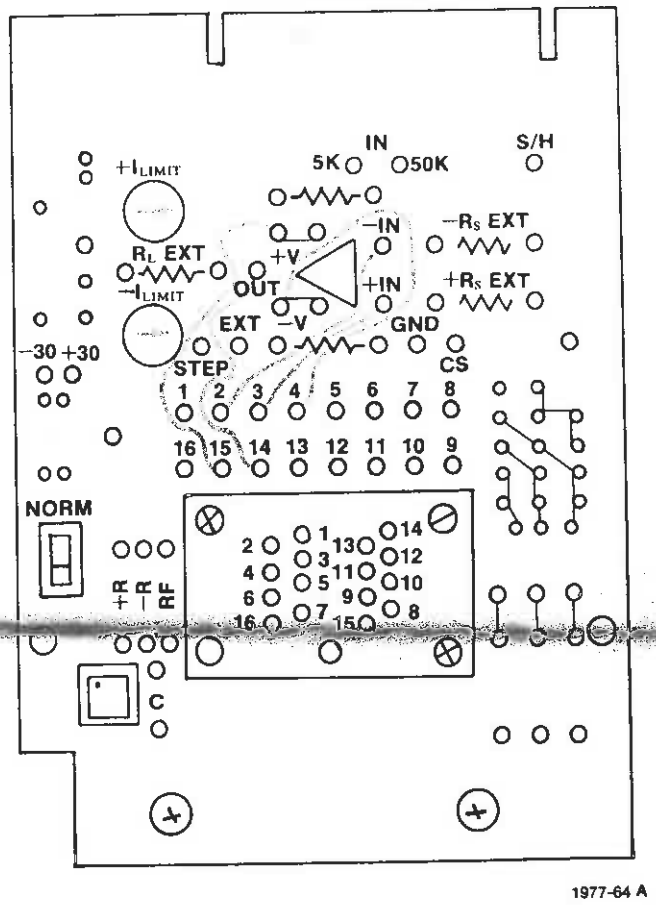


Fig. G-1. Setting up the Standard Op Amp Card for testing the 741. See manufacturer's data sheets for basing.

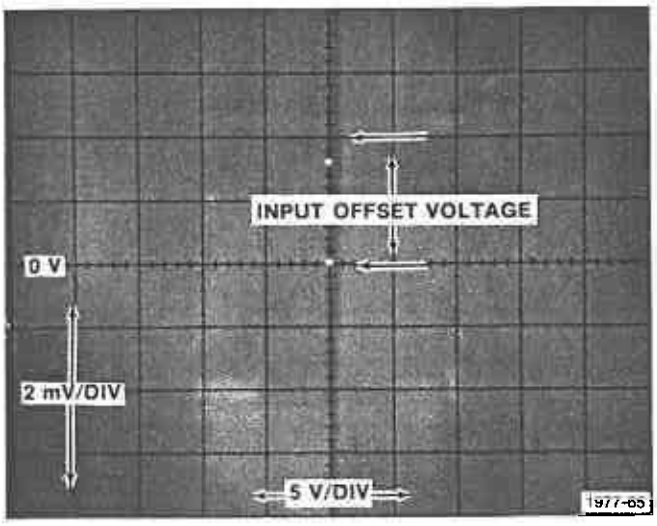


Fig. G-2. Typical display of input offset voltage.

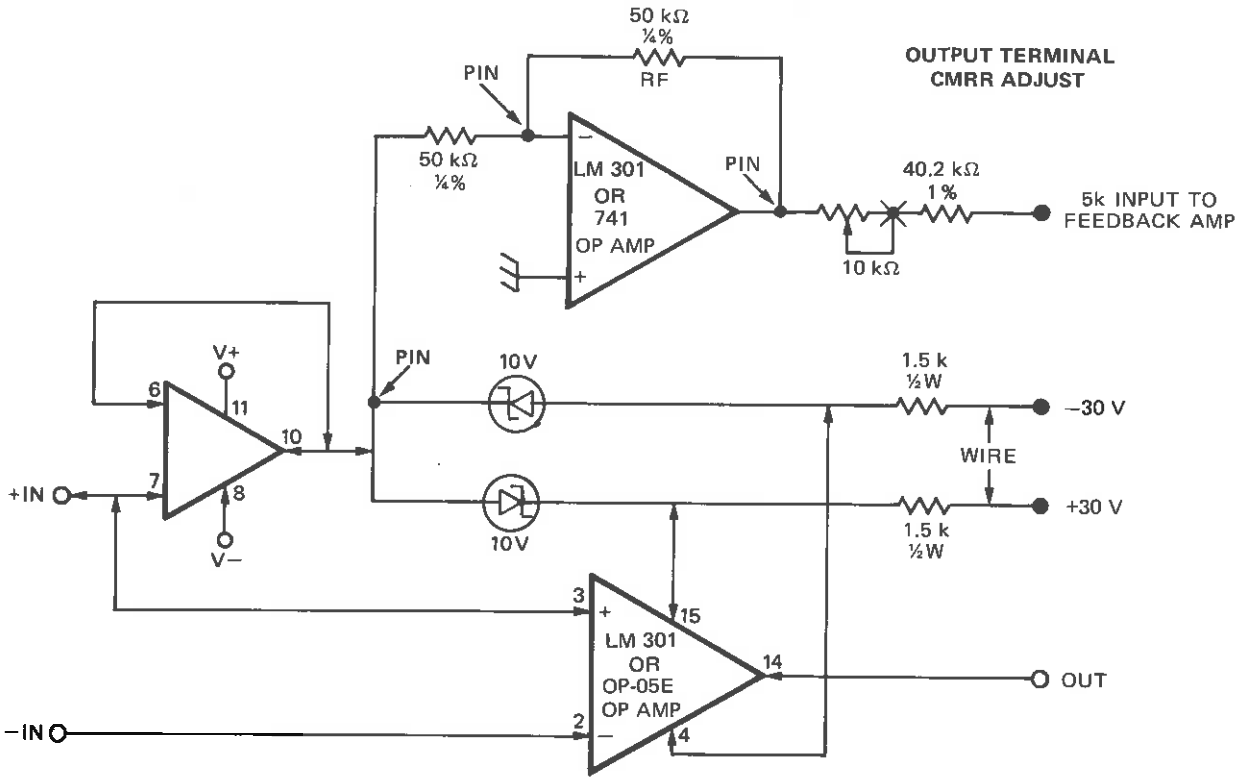
PATCH CORD

PIN — BIFURCATED TERMINAL PIN

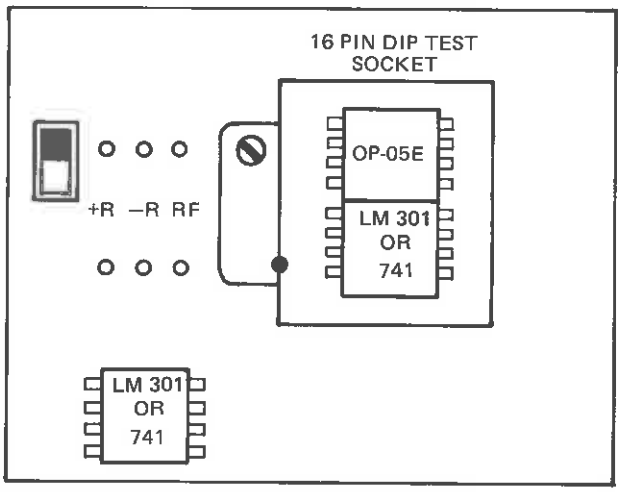
HOLE IN CIRCUIT BOARD (SOLDER)

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 μV OF NOISE IN THIS TEST.



1474-45A

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

j. CHECK—Vertical deflection of the horizontal trace should not exceed ±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:

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	pull (Mag On) centered

178

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:

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	pull (Mag On) centered

178

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:

577

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

178

FUNCTION	CMRR
SOURCE RESISTANCE	50 Ω
+SUPPLY	+15 V
−SUPPLY	TRACK +SUPPLY
SWEEP AMPLITUDE	fully counterclockwise
DUT SUPPLIES Switch	OFF
VERT UNITS/DIV	5 μ (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.

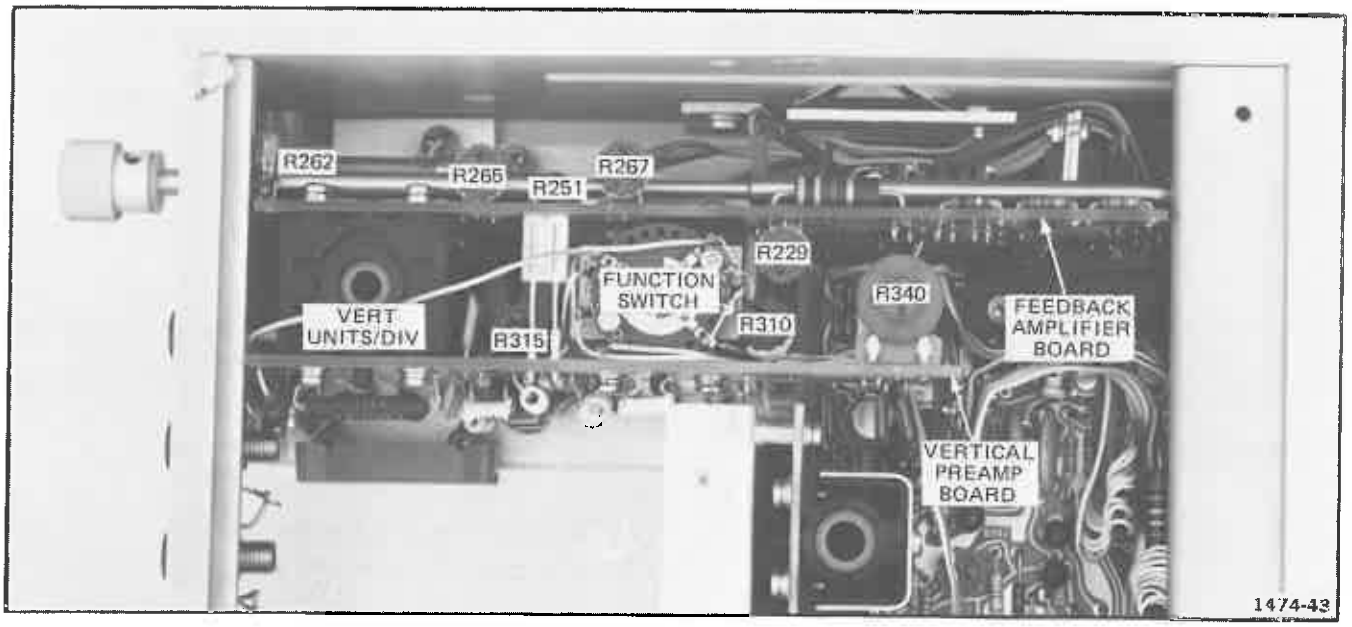


Fig. 5-4. Location of adjustments on the Vertical Preamp and Feedback Amplifier board.

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 ±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.

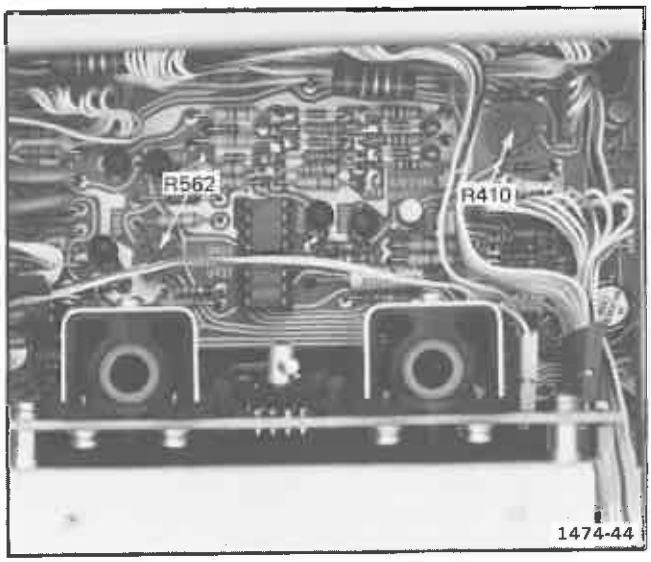


Fig. 5-5. Location of R562 and R410.

5. Adjust Sweep Generator

a. Set the 577-178 controls as follows:

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)	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[5]

a. Set the controls as follows:

577

Horiz Volts/Div	2 V, Collector

All Dark Gray Buttons and Knobs in except:

Vertical Position	pull (Mag On) centered

178

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[5] (test socket terminals) to the op amp terminals on the Standard Op Amp card. Place the test op amp[5] 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.

[5]CMRR of the test op amp must be ≥150 dB, minimum, or must be ≥120 dB, measured. The noise level must be less than 2 μV using 50 Ω 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 μV (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 μV (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 Ω
+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 ≈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 μV (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 μV (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 Ω
FUNCTION	CMRR
VERT UNITS/DIV	.1 m (Mag On)
DUT SUPPLIES Switch	OFF

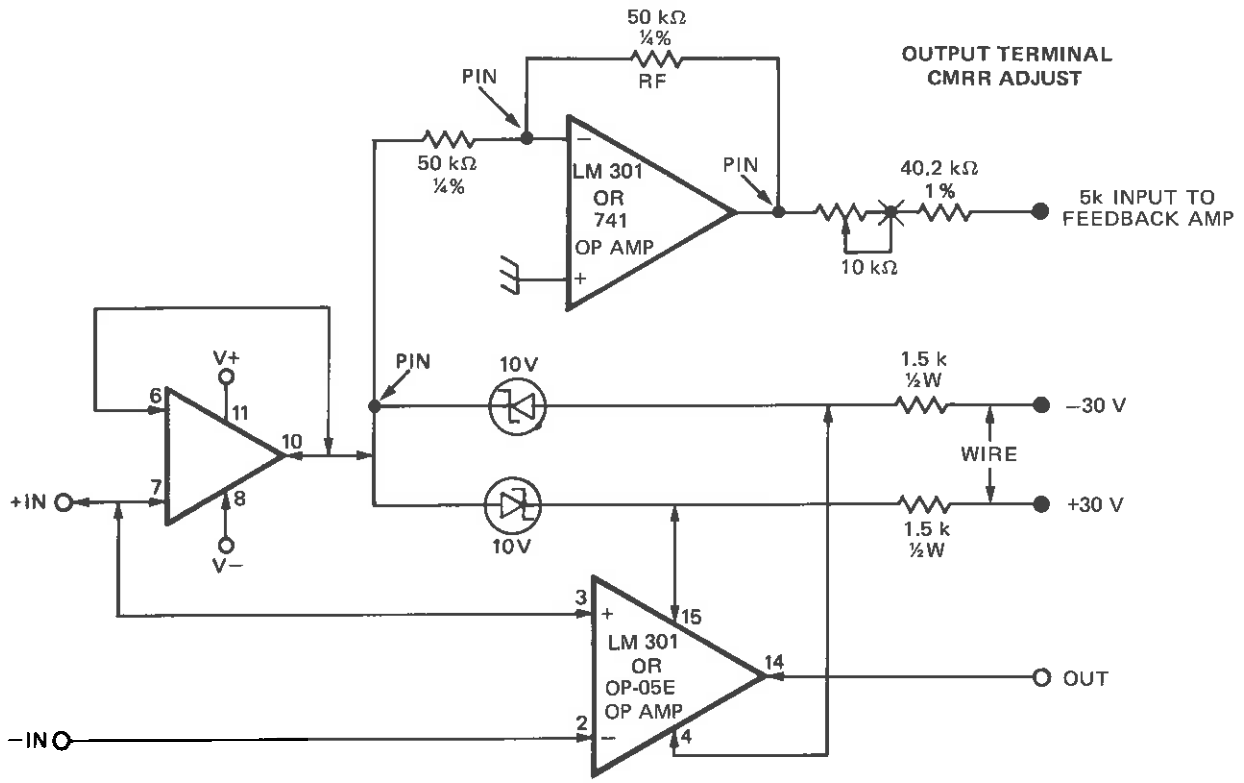
PATCH CORD

PIN — BIFURCATED TERMINAL PIN

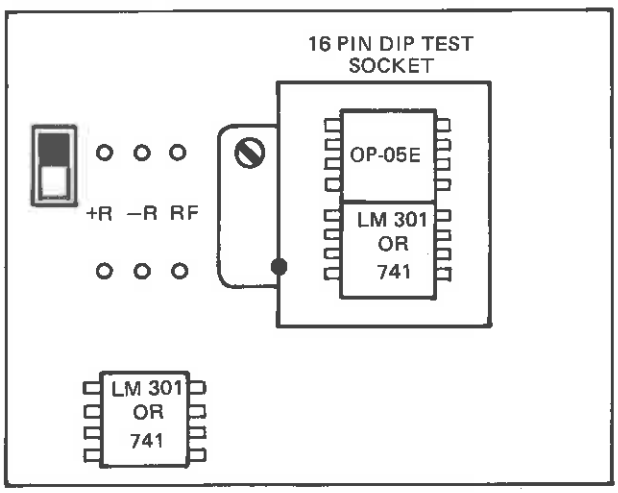
HOLE IN CIRCUIT BOARD (SOLDER)

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 μV 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 μV (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:

178

VERT UNITS/DIV	1 μV (Mag On)
FUNCTION	GAIN
SWEEP AMPIITUDE	fully counterclockwise

Differential Input Test Oscilloscope

Vertical Input	10 μV, 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 μV resolution

j. Connect a lead between the R_F 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 tthe 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 μV, 20 μV, and 10 μV (5 μV, 2 μV, and 1 μV 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 Code
00213	NYTRONICS COMPONENTS GROUP INC SUBSIDIARY OF NYTRONICS INC	ORANGE ST	DARLINGTON SC 29532
01121	ALLEN-BRADLEY CO	1201 SOUTH 2ND ST	MILWAUKEE WI 53204
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
02111	SPECTROL ELECTRONICS CORP SUB OF CARRIER CORP	17070 E GALE AVE P O BOX 1220	CITY OF INDUSTRY CA 91749
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	N GENESEE ST	AUBURN NY 13021
03888	KDI PYROFILM CORP	60 S JEFFERSON RD	WHIPPANY NJ 07981
04099	CAPCO INC	FORESIGHT INDUSTRIAL PARK P O BOX 2164	GRAND JUNCTION CO 81501
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
05397	UNION CARBIDE CORP MATERIALS SYSTEMS DIV	11901 MADISON AVE	CLEVELAND OH 44101
07263	FAIRCHILD CAMERA AND INSTRUMENT CORP SEMICONDUCTOR DIV	464 ELLIS ST	MOUNTAIN VIEW CA 94042
07716	TRW INC TRW ELECTRONICS COMPONENTS TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
08806	GENERAL ELECTRIC CO MINIATURE LAMP PRODUCTS DEPT	NELA PK	CLEVELAND OH 44112
10389	ILLINOIS TOOL WORKS INC	1714 N DAMEN AVE	CHICAGO IL 60647
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
22229	SOLITRON DEVICES INC SEMICONDUCTOR GROUP SAN DIEGO OPERS	8808 BALBOA AVE	SAN DIEGO CA 92123
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701
31433	UNION CARBIDE CORP ELECTRONICS DIV	PO BOX 5928	GREENVILLE SC 29606
31918	ITT SCHADOW INC	8081 WALLACE RD	EDEN PRAIRIE MN 55343
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507
52763	STETTNER ELECTRONICS INC	6135 AIRWAYS BLVD PO BOX 21947	CHATTANOOGA TN 37421
54583	TDK ELECTRONICS CORP	755 EASTGATE BLVD	GARDEN CITY NY 11530
55292	LEDCO DIV WILBRECHT ELECTRONICS INC	240 E PLATO BLVD	ST PAUL MN 55107
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
59660	TUSONIX INC	2155 N FORBES BLVD	TUCSON, ARIZONA 85705
59821	CENTRALAB INC SUB NORTH AMERICAN PHILIPS CORP	7158 MERCHANT AVE	EL PASO TX 79915
71400	MCGRAW-EDISON CO BUSSMANN MFG DIV	502 EARTH CITY PLAZA P O BOX 14460	ST LOUIS MO 63178
71450	CTS OF ELKHART	905 N WEST BLVD	ELKHART IN 46514
75042	TRW INC TRW ELECTRONIC COMPONENTS IRC FIXED RESISTORS PHILADELPHIA DIV	401 N BROAD ST	PHILADELPHIA PA 19108
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
81073	GRAYHILL INC	561 HILLGROVE AVE P O BOX 373	LA GRANGE IL 60525
91637	DALE ELECTRONICS INC	P O BOX 609	COLUMBUS NE 68601
TK0965	MANCO TECHNICAL SALES INC (DIST)	705 W 16TH ST	COSTA MESA CA 92627

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1	670-2568-00			CIRCUIT BD ASSY:INTERFACE	80009	670-2568-00
A2	670-2569-00			CIRCUIT BD ASSY:VERTICAL PREAMP	80009	670-2569-00
A3	670-2566-00			CIRCUIT BD ASSY:FEEDBACK AMPLIFIER	80009	670-2566-00
A4	670-2565-00	B010100	B029999	CIRCUIT BD ASSY:POWER SUPPLY	80009	670-2565-00
A4	670-2565-01	B030000	B039999	CIRCUIT BD ASSY:POWER SUPPLY	80009	670-2565-01
A4	670-2565-02	B040000		CIRCUIT BD ASSY:POWER SUPPLY	80009	670-2565-02
A5	----- -----			(CKT BOARD ASSY:STANDARD OP AMPL) (PART OF 013-0149-XX)		
C15	281-0536-00	B030710		CAP,FXD,CER DI:1000PF,10%,500V	52763	2RDPLZ007 1N00MO
C23	283-0110-00			CAP,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C25	283-0110-00			CAP,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C131	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C141	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C205	281-0526-00			CAP,FXD,CER DI:1.5PF,+/-0.5PF,500V	52763	2RDPLZ007 1P500S
C208	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C227	281-0504-00			CAP,FXD,CER DI:10PF,+/-1PF,500V	54583	TCC20CH2H100FYA
C254	285-0898-00			CAP,FXD,PLASTIC:0.47UF,10%,100V	04099	TEK13-9
C263	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C291	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C293	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C295	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C306	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C315	283-0119-00			CAP,FXD,CER DI:2200PF,5%,200V	59660	855-XXXY5E0222J
C318	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C320	281-0518-00			CAP,FXD,CER DI:47PF,+/-9.4PF,500V	52763	2RDPLZ007 47P0MU
C322	281-0536-00			CAP,FXD,CER DI:1000PF,10%,500V	52763	2RDPLZ007 1N00MO
C324	281-0523-00			CAP,FXD,CER DI:100PF,20%,350V	52763	2RDPLZ007 100PMU
C342	281-0512-00			CAP,FXD,CER DI:27PF,+/-2.7PF,500V	52763	2RDPLZ007 27P0KC
C352	281-0504-00			CAP,FXD,CER DI:10PF,+/-1PF,500V	54583	TCC20CH2H100FYA
C359	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C361	281-0546-00			CAP,FXD,CER DI:330PF,10%,500V	52763	2RDPLZ007 330PMO
C371	283-0059-00			CAP,FXD,CER DI:1UF,+80-20%,50V	31433	C330C105M5R5CA
C373	283-0059-00			CAP,FXD,CER DI:1UF,+80-20%,50V	31433	C330C105M5R5CA
C406	281-0543-00			CAP,FXD,CER DI:270PF,10%,500V	52763	2RDPLZ007 27P0MO
C424	295-0158-00			CAP SET,MATCHED:1UF,0.001UF,MATCHED 2%	80009	295-0158-00
C425	----- -----			(INDIVIDUAL TIMING CAPACITORS IN THIS ASSEMBLY MUST BE ORDERED BY THE 9-DIGIT PART NUMBER, LETTER SUFFIX AND TOLERANCE PRINTED ON THE TIMING CAP TO BE REPLACED. THE LETTER SUFFIX AND TOLERANCE SHOULD BE SAME FOR ALL OF THE TIMING CAPS IN THE ASSEMBLY.EXAMPLE: 285-XXXX-XX F -)		
C442	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C452	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C472	281-0549-00			CAP,FXD,CER DI:68PF,10%,500V	52763	2RDPLZ007 68P0KU
C475	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
C476	283-0111-00			CAP,FXD,CER DI:0.1UF,20%,50V	05397	C330C104M5U1CA
C482	283-0010-00			CAP,FXD,CER DI:0.05UF,+80-20%,50V	04222	SR305E503ZAA
C484	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
C521	281-0580-00			CAP,FXD,CER DI:470PF,10%,500V	52763	2RDPLZ007 470PMO
C542	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C549	281-0518-00			CAP,FXD,CER DI:47PF,+/-9.4PF,500V	52763	2RDPLZ007 47P0MU
C562	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C566	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C574	281-0523-00			CAP,FXD,CER DI:100PF,20%,350V	52763	2RDPLZ007 100PMU
C575	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
C576	283-0111-00			CAP,FXD,CER DI:0.1UF,20%,50V	05397	C330C104M5U1CA
C582	283-0010-00			CAP,FXD,CER DI:0.05UF,+80-20%,50V	04222	SR305E503ZAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C584	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
CR14	152-0243-00			SEMICOND DVC,DI:ZEN,SI,15V,5%,0.4W,DO-7	04713	SZ13203 (1N9658)
CR18	152-0243-00			SEMICOND DVC,DI:ZEN,SI,15V,5%,0.4W,DO-7	04713	SZ13203 (1N9658)
CR151	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR152	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR211	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR226	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR282	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR306	152-0367-00			SEMICOND DVC,DI:SM,SI,30V,0.1A	07263	FSA1544
CR307	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR321	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR322	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR402	152-0141-02	B030000		SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR404	152-0141-02	B030000		SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR406	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR443	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR444	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR445	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR453	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR454	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR455	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR472	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR482	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR484	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR492	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR493	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR494	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR520	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR532	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR533	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR572	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR582	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR584	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR592	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR593	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR594	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
DS236	150-0075-00			LAMP,INCAND:10V,0.013A,#21490,WIRE LD	TK0965	OL 1869TPL
DS268	150-0075-00			LAMP,INCAND:10V,0.013A,#21490,WIRE LD	TK0965	OL 1869TPL
DS281	150-0048-00			LAMP,INCAND:5V,0.06A,#683,WIRE LEAD	08806	683
DS284	150-0048-00			LAMP,INCAND:5V,0.06A,#683,WIRE LEAD	08806	683
DS286	150-0048-00			LAMP,INCAND:5V,0.06A,#683,WIRE LEAD	08806	683
DS441	150-0133-00			LAMP,CARTRIDGE:14V,80MA,RED DOME LENS	55292	70106-02
DS478	150-0048-00			LAMP,INCAND:5V,0.06A,#683,WIRE LEAD	08806	683
DS578	150-0048-00			LAMP,INCAND:5V,0.06A,#683,WIRE LEAD	08806	683
F236	159-0083-00			FUSE,CARTRIDGE:3AG,0.15A,250V,0.25SEC	71400	AGC-CM-15/100
F268	159-0083-00			FUSE,CARTRIDGE:3AG,0.15A,250V,0.25SEC	71400	AGC-CM-15/100
J40	136-0140-00			JACK,TIP:BANANA,CHARCOAL GRAY	80009	136-0140-00
J50	136-0140-00			JACK,TIP:BANANA,CHARCOAL GRAY	80009	136-0140-00
J60	136-0140-00			JACK,TIP:BANANA,CHARCOAL GRAY	80009	136-0140-00
J70	136-0140-00			JACK,TIP:BANANA,CHARCOAL GRAY	80009	136-0140-00
J80	136-0140-00			JACK,TIP:BANANA,CHARCOAL GRAY	80009	136-0140-00
J90	136-0140-00			JACK,TIP:BANANA,CHARCOAL GRAY	80009	136-0140-00
Q214	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q222	151-0367-00			TRANSISTOR:NPN,SI,X-55	04713	SPS 8811
Q226	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q252	151-1037-00			TRANSISTOR:FET,N-CHAN,SI,TO-71	22229	FD1553
Q280	151-0301-00			TRANSISTOR:PNP,SI,TO-18	04713	ST898
Q284	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q286	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
Q310	151-1077-00			TRANSISTOR:FET,N-CHAN,SI	80009	151-1077-00
Q402	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q404	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q406	151-0126-00			TRANSISTOR:NPN,SI,TO-18	04713	ST1046
Q408	151-0126-00			TRANSISTOR:NPN,SI,TO-18	04713	ST1046
Q442	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q452	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
Q462	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q472	151-0126-00			TRANSISTOR:NPN,SI,TO-18	04713	ST1046
Q478	151-0301-00			TRANSISTOR:PNP,SI,TO-18	04713	ST898
Q484	151-0373-00			TRANSISTOR:PNP,SI,TO-127	04713	SJE925
Q492	151-0103-00			TRANSISTOR:NPN,SI,TO-5	04713	SM1307
Q520	151-1059-00			TRANSISTOR:FET,N-CHAN,TO-106	04713	ORDER BY DESCR
Q536	151-0432-00			TRANSISTOR:NPN,SI,TO-106	04713	SP58512
Q538	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q546	151-0462-00			TRANSISTOR:PNP,SI,TO-220	04713	SJE491
Q548	151-0464-00			TRANSISTOR:NPN,SI,TO-220	04713	SJE412
Q572	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q578	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q584	151-0349-00			TRANSISTOR:NPN,SI,SELECTED,TO-127	04713	SJE924
Q592	151-0235-00			TRANSISTOR:PNP,SI,TO-5	04713	SS4353
R10	311-1568-00			RES,VAR,NONWW:TRMR,50 OHM,0.5W	32997	3352T-1-500
R14	315-0104-00	B030710		RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R15	315-0102-00	B030710		RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R16	315-0102-00	B030710		RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R20	311-1568-00			RES,VAR,NONWW:TRMR,50 OHM,0.5W	32997	3352T-1-500
R111	308-0545-00			RES,FXD,WW:100 OHM,0.5%,5W,TC=30PPM	00213	1250SA-100-0.5
R113	308-0507-00			RES,FXD,WW:1K OHM,1%,3W,TC=30PPM	00213	1240S 1000-1
R115	308-0759-00			RES,FXD,WW:2.08K OHM,1%,3W	00213	1240S-2080-1
R116	321-0339-00			RES,FXD,FILM:33.2K OHM,1%,0.125W,TC=T0	07716	CEA033201F
R117	322-0264-00			RES,FXD,FILM:5.49K OHM,1%,0.25W,TC=T0	75042	CEBT0-5491F
R119	321-0298-00			RES,FXD,FILM:12.4K OHM,1%,0.125W,TC=T0	07716	CEA012401F
R121	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R131	321-0289-01			RES,FXD,FILM:10.0K OHM,0.5%,0.125W,TC=T0	07716	CEA010001D
R132	321-0318-02			RES,FXD,FILM:20.0K 0.5%,0.125W,TC=T2	19701	5033RC20K000
R133	321-0756-01			RES,FXD,FILM:50K OHM,0.5%,0.125W,TC=T0	07716	CEA 50KOHM 0.5%
R141	321-0289-01			RES,FXD,FILM:10.0K OHM,0.5%,0.125W,TC=T0	07716	CEA010001D
R142	321-0318-02			RES,FXD,FILM:20.0K 0.5%,0.125W,TC=T2	19701	5033RC20K000
R143	321-0756-01			RES,FXD,FILM:50K OHM,0.5%,0.125W,TC=T0	07716	CEA 50KOHM 0.5%
R202	321-0260-01			RES,FXD,FILM:4.99K OHM,0.5%,0.125W,TC=T0	07716	CEA0 499000
R204	321-0692-00			RES,FXD,FILM:49.9K OHM,0.5%,0.125W,TC=T0	91637	MFF1816G49901D
R205	321-0692-00			RES,FXD,FILM:49.9K OHM,0.5%,0.125W,TC=T0	91637	MFF1816G49901D
R206	321-0356-00			RES,FXD,FILM:49.9K OHM,1%,0.125W,TC=T0	19701	5033ED49K90F
R208	316-0472-00			RES,FXD,CMPSN:4.7K OHM,10%,0.25W	01121	CB4721
R214	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
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%,0.25	01121	CB1521
R223	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
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,FILM:160 OHM,5%,0.25W	57668	NTR25J-E 160E
R228	316-0102-00			RES,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R229	311-1562-00			RES,VAR,NONWW:TRMR,2K OHM,0.5W	32997	3352T-0Y7-202
R231	325-0162-00			RES SET,MATCHED:45K&44.8K OHM,0.1%,0.25W	03888	AF30T35
R232	----- -----			(PART OF R231)		
R233	325-0165-00			RES SET,MATCHED:4.5&4.478K OHM,0.1%,0.25W	03888	A30T38
R234	----- -----			(PART OF R233)		
R235	325-0164-00			RES SET,MATCHED:450&446 OHM,0.1%,0.25W	03888	A30T37
R236	----- -----			(PART OF R235)		

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R238	325-0163-00			RES SET,MATCHED:(2) 50 OHM,0.1%,0.25W	03888	A3DT36
R239	----- -----			(PART OF R238)		
R251	311-1566-00			RES,VAR,NONWW:TRMR,200 OHM,0.5W	32997	3352T-1-201
R252	321-0297-00			RES,FXD,FILM:12.1K OHM,1%,0.125W,TC=T0	07716	CEAD12101F
R253	321-0297-00			RES,FXD,FILM:12.1K OHM,1%,0.125W,TC=T0	07716	CEAD12101F
R254	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
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,NONWW:TRMR,500 OHM,0.5W	32997	3352T-DY7-501
R263	316-0180-00			RES,FXD,CMPSN:18 OHM,10%,0.25W	01121	CB1801
R265	311-1568-00			RES,VAR,NONWW:TRMR,50 OHM,0.5W	32997	3352T-1-500
R267	311-1594-00			RES,VAR,NONWW:TRMR,10 OHM,0.5W	32997	3352T-1-100
R271	321-0618-00			RES,FXD,FILM:250K OHM,1%,0.125W,TC=T0	19701	5043ED250K0F
R272	321-0618-00			RES,FXD,FILM:250K OHM,1%,0.125W,TC=T0	19701	5043ED250K0F
R280	316-0332-00			RES,FXD,CMPSN:3.3K OHM,10%,025W	01121	CB3321
R281	316-0332-00			RES,FXD,CMPSN:3.3K OHM,10%,025W	01121	CB3321
R284	316-0152-00			RES,FXD,CMPSN:1.5K OHM,10%,0.25	01121	CB1521
R286	316-0152-00			RES,FXD,CMPSN:1.5K OHM,10%,0.25	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,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
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	00213	1200S 50-0.5
R305	321-0756-01			RES,FXD,FILM:50K OHM,0.5%,0.125W,TC=T0	07716	CEA 50KOHM 0.5%
R306	302-0334-00			RES,FXD,CMPSN:330K OHM,10%,0.5W	01121	EB 3341
R307	316-0393-00			RES,FXD,CMPSN:39K OHM,10%,0.25W	01121	CB3931
R309	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R310	311-1559-00			RES,VAR,NONWW:TRMR,10K OHM,0.5W	32997	3352T-1-103
R311	321-0995-00			RES,FXD,FILM:549K OHM,1%,0.125W,TC=T0	24546	NA55D5493F
R312	321-0995-00			RES,FXD,FILM:549K OHM,1%,0.125W,TC=T0	24546	NA55D5493F
R313	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R315	311-1554-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3352T-1-204
R316	316-0126-00			RES,FXD,CMPSN:12W OHM,10%,0.25W	01121	CB1261
R317	316-0126-00			RES,FXD,CMPSN:12W OHM,10%,0.25W	01121	CB1261
R318	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R321	308-0537-00			RES,FXD,WW:1K OHM,0.5%,5W,TC=30PPM	00213	1250SA-1000-0.5
R322	322-0707-03			RES,FXD,FILM:100.1K OHM,0.25%,0.25W,TC=T2	19701	5043RC100K1C
R323	307-0430-00			RES,FXD,CMPSN:11.1W OHM,1%,0.5W	03888	FL1/2 11.1W 1%
R324	307-0429-00			RES,FXD,CMPSN:100W OHM,1%,1W PLATE	80009	307-0429-00
R329	321-0991-03			RES,FXD,FILM:18K OHM,0.25%,0.125W,TC=T2	24546	NC55C1802C
R331	321-0222-03			RES,FXD,FILM:2.0K OHM,0.25%,0.125W,TC=T2	19701	5033RC2K000C
R333	315-0107-00			RES,FXD,FILM:100W OHM,5%,0.25W	01121	CB1075
R340	311-1136-00			RES,VAR,NONWW:TRMR,100K OHM,0.25W	71450	YA5536
R341	316-0225-00			RES,FXD,CMPSN:2.2W 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,TC=T2	07716	CEA 200KOHM 0.25
R344	321-1609-03			RES,FXD,FILM:2.02K OHM,0.25%,0.125W,TC=T2	24546	NC55C2021C
R345	321-1610-03			RES,FXD,FILM:22.22K OHM,0.25%,0.125W,TC=T2	19701	5033RC22K22D
R351	321-0289-03			RES,FXD,FILM:10.0K OHM,0.25%,0.125W,TC=T2	07716	CEAC10001C
R352	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R361	321-0756-01			RES,FXD,FILM:50K OHM,0.5%,0.125W,TC=T0	07716	CEA 50KOHM 0.5%
R362	321-0756-01			RES,FXD,FILM:50K OHM,0.5%,0.125W,TC=T0	07716	CEA 50KOHM 0.5%
R363	321-0631-03			RES,FXD,FILM:12.5K OHM,0.25%,0.125W,TC=T2	19701	5033RC12K500C
R401	321-0334-00			RES,FXD,FILM:29.4K OHM,1%,0.125W,TC=T0	07716	CEAD2940 1F
R402	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R403	316-0102-00			RES,FXD,CMPSN:1K OHM,10%,0.25W	01121	CB1021
R404	315-0303-00			RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R408	316-0103-00			RES,FXD,CMPSN:10K OHM,10%,0.25W	01121	CB1031

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R409	321-0287-00			RES,FXD,FILM:9.53K OHM,1%,0.125W,TC=T0	19701	5033ED9K530F
R410	311-1558-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W	32997	3352T-1-203
R411	321-0155-00			RES,FXD,FILM:402 OHM,1%,0.125W,TC=T0	07716	CEAD402R0F
R415	311-0555-00			RES,VAR,NONWW:PNL,10K OHM,1W	01121	10W985
R421	307-0381-00			RES,FXD,FILM:4.99 MEG OHM,1%,0.5W	03888	FL1/2 4.99M +-1%
R422	321-0452-00			RES,FXD,FILM:499K OHM,1%,0.125W,TC=T0	19701	5043ED499K0F
R423	321-0353-00			RES,FXD,FILM:46.4K OHM,1%,0.125W,TC=T0	07716	CEAD46401F
R424	321-0449-00			RES,FXD,FILM:464K OHM,1%,0.125W,TC=T0	19701	5043ED464K0F
R426	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R431	321-0463-00			RES,FXD,FILM:649K OHM,1%,0.125W	19701	5033ED649K0F
R432	321-0367-00			RES,FXD,FILM:64.9K OHM,1%,0.125W,TC=T0	07716	CEAD64901F
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,TC=T0	07716	CEAD10700F
R442	321-0284-00			RES,FXD,FILM:8.87K OHM,1%,0.125W,TC=T0	19701	5043ED8K870F
R443	321-0160-00			RES,FXD,FILM:453 OHM,1%,0.125W,TC=T0	19701	5033ED453R0F
R444	321-0188-00			RES,FXD,FILM:887 OHM,1%,0.125W,TC=T0	07716	CEAD887R0F
R445	321-0197-00			RES,FXD,FILM:1.10K OHM,1%,0.125W,TC=T0	07716	CEAD11000F
R446	321-0612-00			RES,FXD,FILM:500 OHM,1%,0.125W,TC=T0	07716	CEAD500R0F
R447	321-0263-00			RES,FXD,FILM:5.36K OHM,1%,0.125W,TC=T0	07716	CEAD53600F
R448	321-0320-00			RES,FXD,FILM:21.0K OHM,1%,0.125W,TC=T0	19701	5033ED21K00F
R449	321-0370-00			RES,FXD,FILM:69.8K OHM,1%,0.125W,TC=T0	07716	CEAD69801F
R451	321-0284-00			RES,FXD,FILM:8.87K OHM,1%,0.125W,TC=T0	19701	5043ED8K870F
R452	321-0196-00			RES,FXD,FILM:1.07K OHM,1%,0.125W,TC=T0	07716	CEAD10700F
R453	321-0160-00			RES,FXD,FILM:453 OHM,1%,0.125W,TC=T0	19701	5033ED453R0F
R454	321-0188-00			RES,FXD,FILM:887 OHM,1%,0.125W,TC=T0	07716	CEAD887R0F
R455	321-0197-00			RES,FXD,FILM:1.10K OHM,1%,0.125W,TC=T0	07716	CEAD11000F
R460	311-1310-00			RES,VAR,NONWW:PNL,20K OHM,1W,4PST SWITCH (PART OF S460)	01121	10W654
R461	315-0514-00			RES,FXD,FILM:510K OHM,5%,0.25W	19701	5043CX510K0J
R463	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R464	321-0306-00			RES,FXD,FILM:15.0K OHM,1%,0.125W,TC=T0	19701	5033ED15J00F
R467	321-0289-00	8010100	8019999	RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R467	321-0288-00	8020000		RES,FXD,FILM:9.76K OHM,1%,0.125W,TC=T0	19701	5033ED9K760F
R468	321-0268-00			RES,FXD,FILM:6.04K OHM,1%,0.125W,TC=T0	19701	5043ED6K040F
R469	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R471	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R472	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R473	308-0291-00			RES,FXD,MM:2K OHM,5%,3W	00213	1240S 2000-5
R474	316-0822-00			RES,FXD,CMPSN:8.2K OHM,10%,0.25W	01121	CB8221
R475	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R476	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R477	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R478	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R479	301-0111-00			RES,FXD,FILM:110 OHM,5%,0.50W	19701	5053CX110R0J
R481	321-0756-03			RES,FXD,FILM:50K OHM,0.25%,0.125W	07716	CEAC 50001C
R482	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R483	315-0150-00			RES,FXD,FILM:15 OHM,5%,0.25W	19701	5043CX15R00J
R484	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R485	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R486	308-0764-00			RES,FXD,MM:2.7 OHM,5%,2W	75042	BWF 2.7 OHM +-5%
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,TC=T0	19701	5033ED49K90F
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,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R536	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R537	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25M	57668	NTR25J-E 100E
R538	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25M	57668	NTR25J-E01K5
R541	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25M	57668	NTR25J-E02K4
R542	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25M	57668	NTR25J-E24K0
R546	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25M	57668	NTR25J-E200E
R548	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25M	57668	NTR25J-E200E
R549	321-0452-00			RES,FXD,FILM:499K OHM,1%,0.125M,TC=T0	19701	5043ED499K0F
R551	321-0356-00	B010100	B019999	RES,FXD,FILM:49.9K OHM,1%,0.125M,TC=T0	19701	5033ED49K90F
R551	321-0756-01	B020000		RES,FXD,FILM:50K OHM,0.5%,0.125M,TC=T0	07716	CEA 50KOHM 0.5%
R552	321-0631-00			RES,FXD,FILM:12.5K OHM,1%,0.125M,TC=T0	91637	MFF1816G12501F
R554	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125M,TC=T0	19701	5033ED10K0F
R560	311-1150-00			RES,VAR,NM:PNL,10K OHM,1M	02111	533-4
R562	311-1559-00			RES,VAR,NONWM:TRMR,10K OHM,0.5M	32997	3352T-1-103
R563	321-0354-00			RES,FXD,FILM:47.5K OHM,1%,0.125M,TC=T0	19701	5043ED47K50F
R565	311-1518-00			RES,VAR,NONWM:PNL,10K OHM,1M,W/SW (PART OF S565)	01121	11W-324
R566	321-0198-00			RES,FXD,FILM:1.13K OHM,1%,0.125M,TC=T0	07716	CEA011300F
R567	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125M,TC=T0	19701	5033ED4K990F
R570	321-0364-00	B010100	B019999	RES,FXD,FILM:60.4K OHM,1%,0.125M,TC=T0	19701	5043ED60K40F
R570	321-0720-03	B020000		RES,FXD,FILM:60K OHM,0.125%,0.125M,TC=T2	07716	CEA 60 KOHM 0.25
R571	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125M,TC=T0	19701	5033ED10K0F
R572	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25M	57668	NTR25J-E05K1
R573	308-0291-00			RES,FXD,WM:2K OHM,5%,3M	00213	1240S 2000-5
R574	321-0289-03			RES,FXD,FILM:10.0K OHM,0.25%,0.125M,TC=T2	07716	CEAC10001C
R575	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25M	19701	5043CX51R00J
R576	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25M	57668	NTR25J-E200E
R577	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25M	19701	5043CX51R00J
R578	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25M	57668	NTR25J-E05K1
R579	301-0111-00			RES,FXD,FILM:110 OHM,5%,0.50M	19701	5053CX110R0J
R581	321-0720-03			RES,FXD,FILM:60K OHM,0.125%,0.125M,TC=T2	07716	CEA 60 KOHM 0.25
R582	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25M	57668	NTR25J-E05K1
R583	315-0150-00			RES,FXD,FILM:15 OHM,5%,0.25M	19701	5043CX15R00J
R584	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25M	57668	NTR25J-E200E
R585	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25M	57668	NTR25J-E150E
R586	308-0764-00			RES,FXD,WM:2.7 OHM,5%,2M	75042	BWF 2.7 OHM +-5%
R592	316-0123-00			RES,FXD,CMPSN:12K OHM,10%,0.25M	01121	CB1231
S30	260-1641-00			SWITCH,SLIDE:DPDT,0.5A,125VAC	10389	23-021-114
S120	263-1027-00			SW CAM ACTR AS:LOAD RESISTANCE	80009	263-1027-00
S130	263-1026-00			SW CAM ACTR AS:SOURCE RESISTANCE	80009	263-1026-00
S140	105-0467-00			ACTUATOR,SWITCH:OUT SUPPLY ON,OFF	80009	105-0467-00
S200	260-1310-00			SWITCH,PUSH:1 BUTTON,4 POLE,EXTERNAL	31918	ORDER BY DESCR
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:FREQUENCY RANGE	80009	260-1529-00
S441	260-0247-00			SWITCH,PUSH:SPST,1A,115VAC	81073	30YY1009
S460	311-1310-00			RES,VAR,NONWM:PNL,20K OHM,1M,4PST SWITCH (PART OF R460)	01121	10M654
S565	311-1518-00			RES,VAR,NONWM:PNL,10K OHM,1M,W/SW (PART OF R565)	01121	11W-324
U16	156-0067-00	B010100	B030709	MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
U16	156-0105-00	B030710		MICROCKT,LINEAR:OPNL AMPL	01295	LM301AP
U250	156-0400-00			MICROCKT,LINEAR:OPNL AMPL	04713	MC1436CG
U340	156-0158-00			MICROCKT,LINEAR:DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U350	156-0158-00			MICROCKT,LINEAR:DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U424	156-0200-00			MICROCKT,LINEAR:OPNL AMPL	04713	MC1456P1
U432	156-0158-00			MICROCKT,LINEAR:DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U460	156-0158-00			MICROCKT,LINEAR:DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U476	156-0400-00			MICROCKT,LINEAR:OPNL AMPL	04713	MC1436CG
U540	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
U576	156-0400-00			MICROCKT,LINEAR:OPNL AMPL	04713	MC1436CG
VR121	152-0243-00			SEMICOND DVC,DI:ZEN,SI,15V,5%,0.4W,DO-7	04713	SZ13203 (1N9658)
VR238	152-0278-00			SEMICOND DVC,DI:ZEN,SI,3V,5%,0.4W,DO-7	04713	SZG35009K20
VR239	152-0278-00			SEMICOND DVC,DI:ZEN,SI,3V,5%,0.4W,DO-7	04713	SZG35009K20
VR268	152-0278-00			SEMICOND DVC,DI:ZEN,SI,3V,5%,0.4W,DO-7	04713	SZG35009K20
VR269	152-0278-00			SEMICOND DVC,DI:ZEN,SI,3V,5%,0.4W,DO-7	04713	SZG35009K20
VR281	152-0508-00			SEMICOND DVC,DI:ZEN,SI,12.6V,5%,0.4W,DO-7	04713	SZ13Z94RL
VR472	152-0280-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	1N753A
VR572	152-0280-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	1N753A

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.

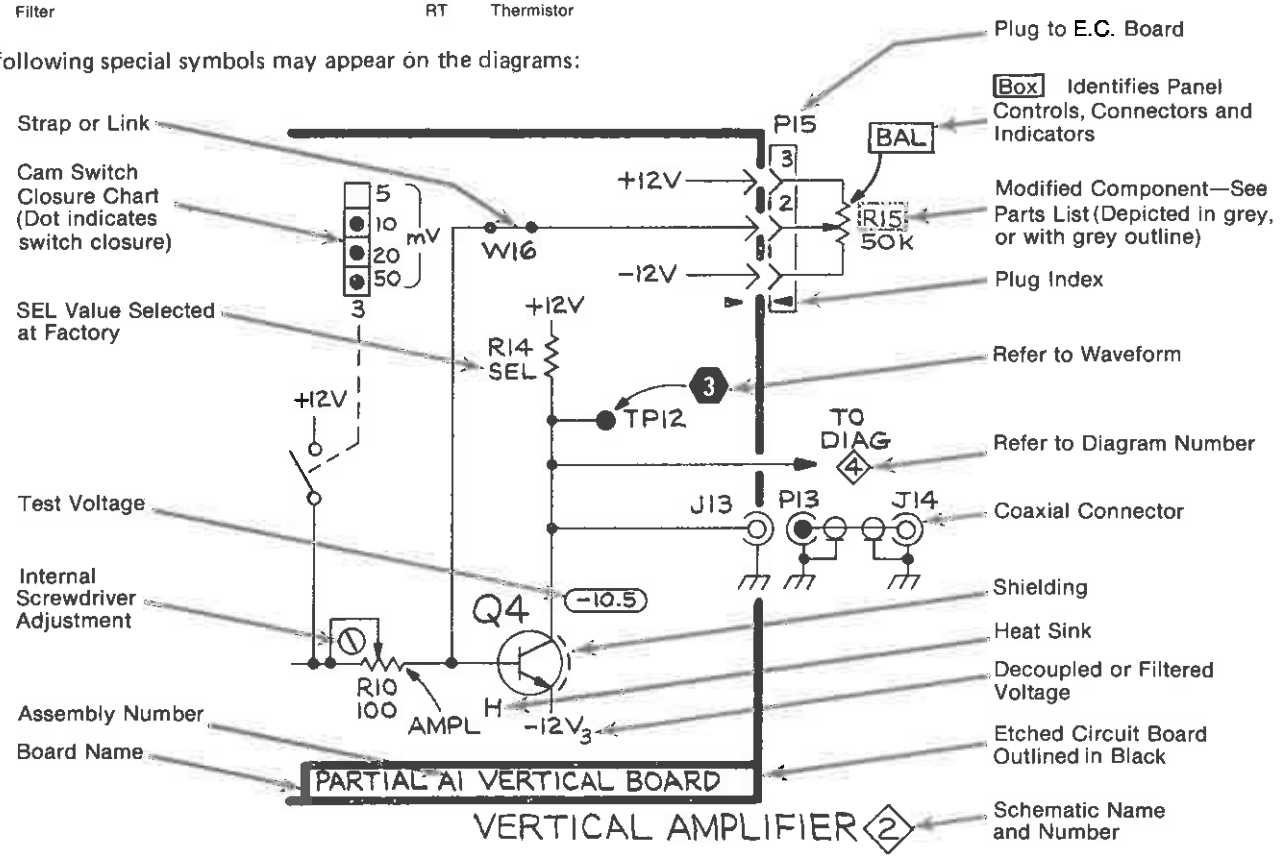
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

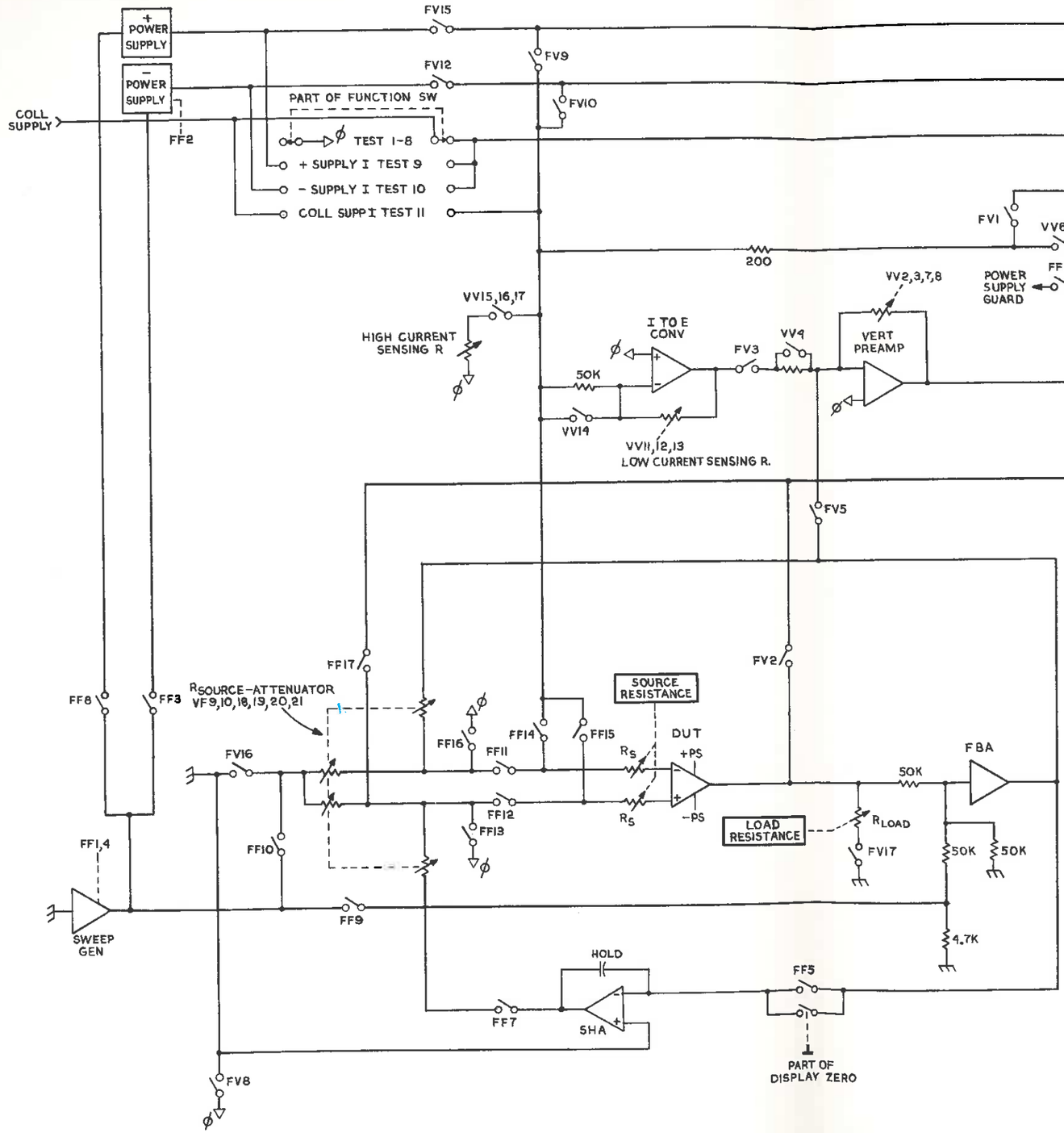
Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

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:

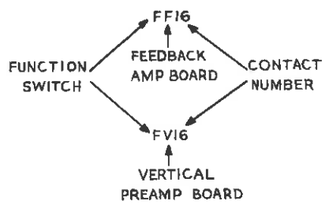


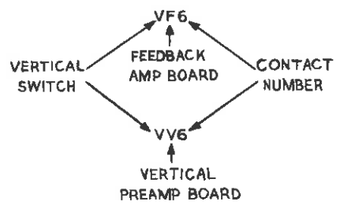


NOTES:

Ø – 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 SWICHING DIAGRAM

178 LINEAR TEST FIXTURE

1474-57
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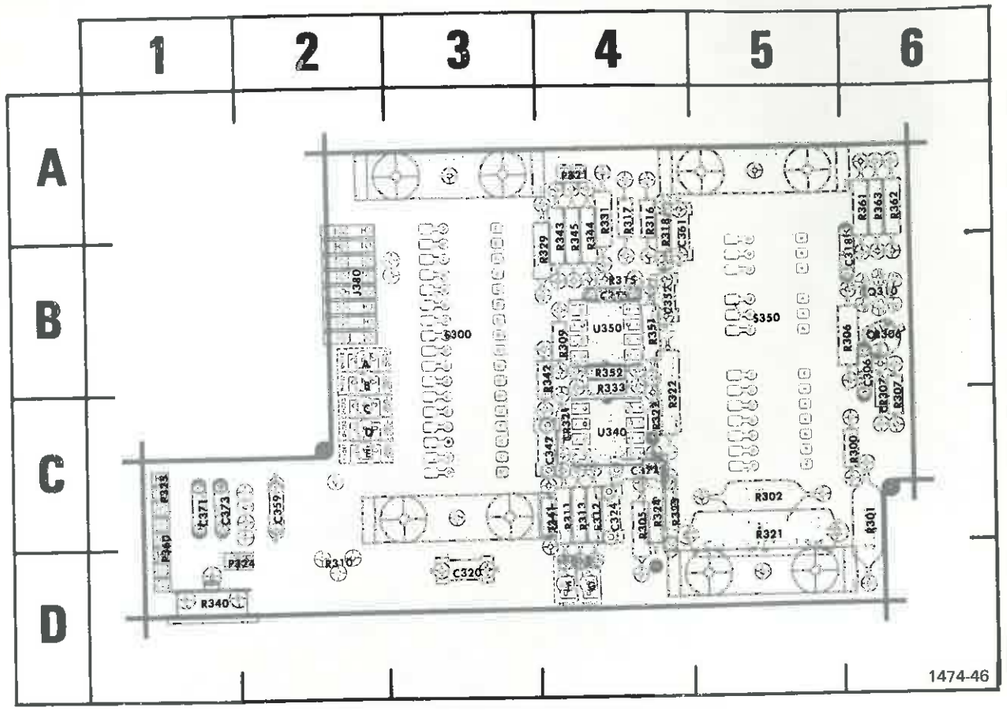
SWITCHING BLOCK DIAGRAM
(WITH STANDARD OP-AMP CARD)

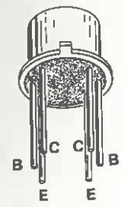
P.S 8-8-73



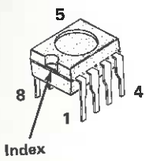
1474-46

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		



METAL-CASED TRANSISTORS



INTEGRATED CIRCUITS

1 VOLTAGE AND WAVEFORM CONDITIONS

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

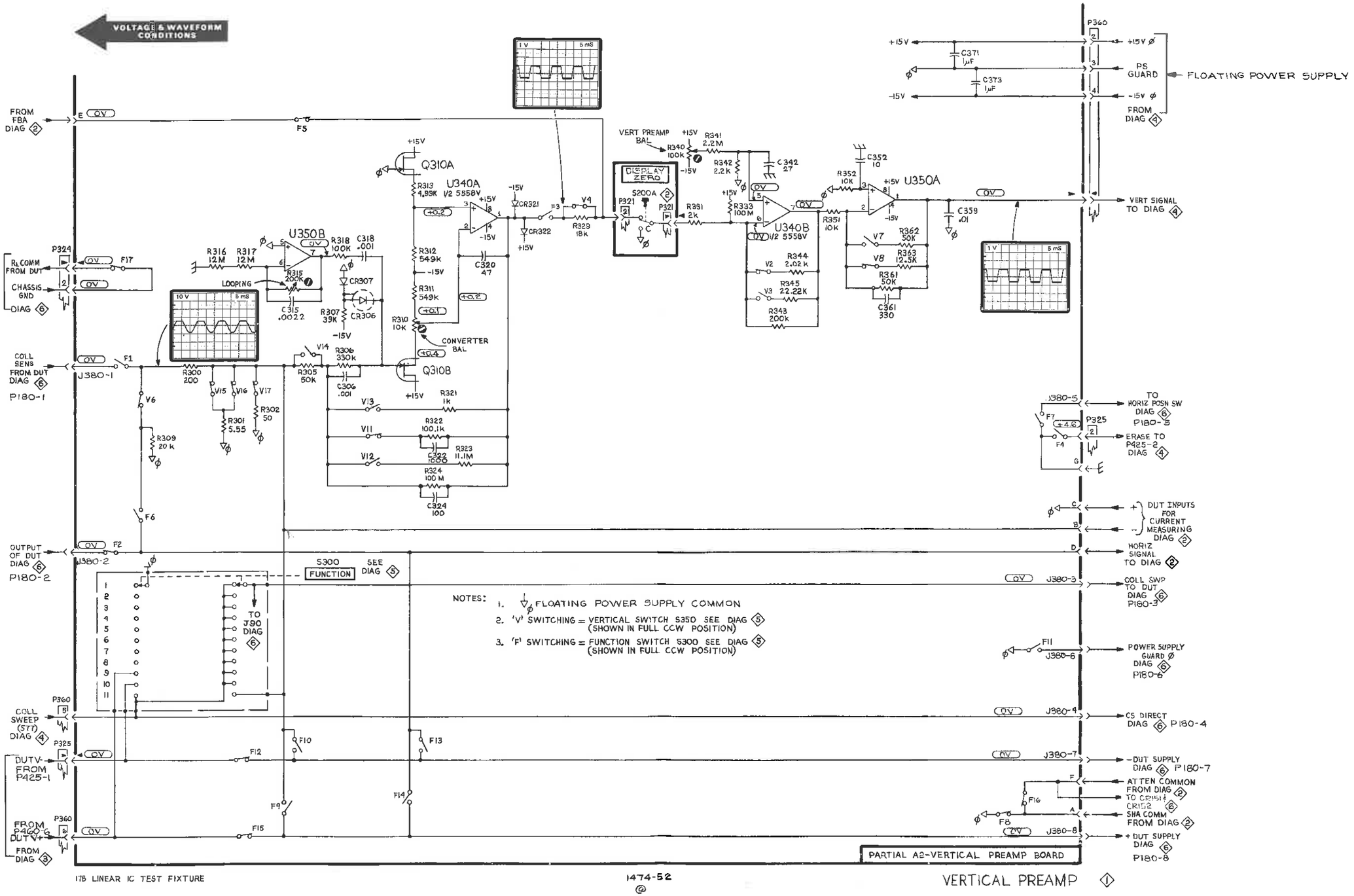
577

Variable Collecter %	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
FUNCTION	−INPUT I
VERT UNITS/DIV	2 mV

VOLTAGE & WAVEFORM CONDITIONS



178 LINEAR IC TEST FIXTURE

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VERTICAL PREAMP 1

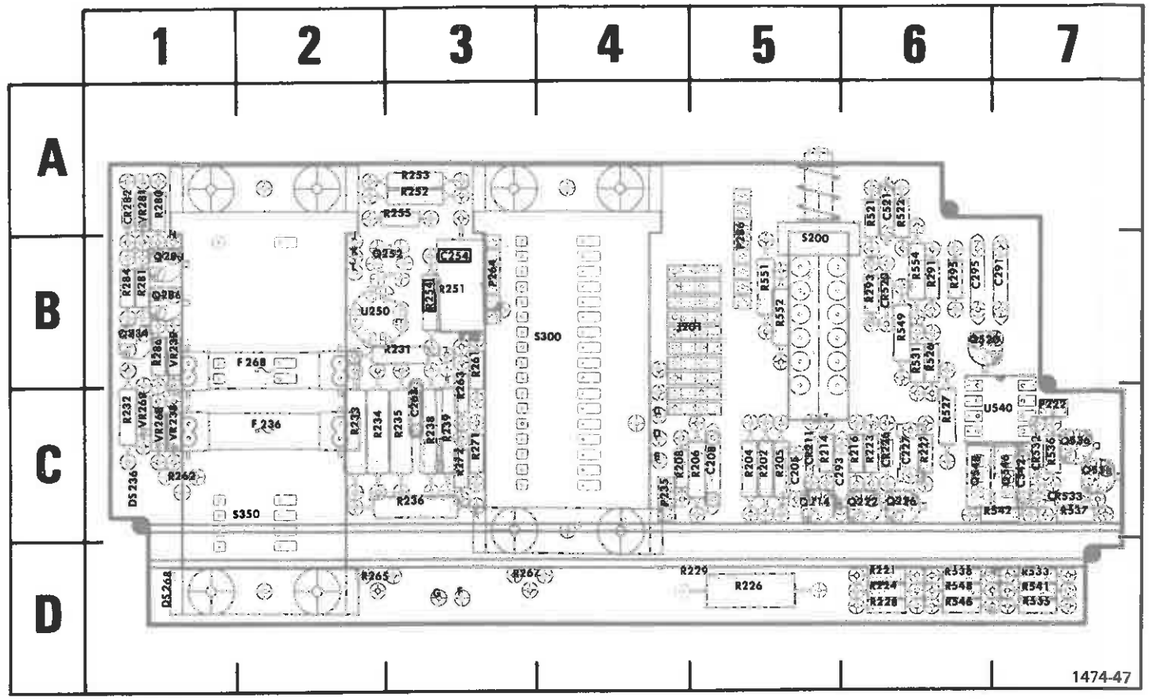
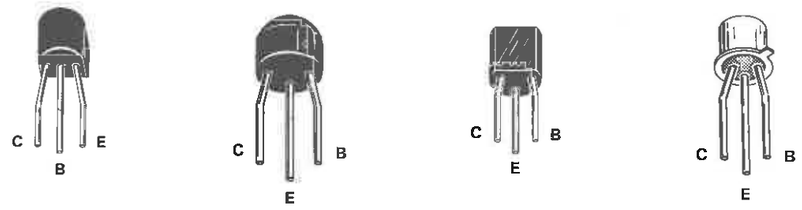


Fig. 7-2. A3—Feedback Amplifier circuit board.

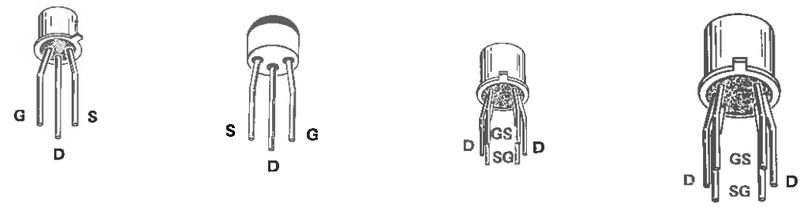
ASSEMBLY A3

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		
C227	6C			Q286	1B	R226	5D	R261	3B	R526	6B	S200	5B
C254	3B	F236	2C	Q520	6B	R227	6C	R262	1C	R527	6C	S300	4B
C263	3C	F268	2B	Q536	7C	R228	6D	R263	3B	R531	6B	S350	2C
C291	7B			Q538	7C	R229	5D	R265	2D	R533	7D		
C293	5C	J201	5B	Q546	7C	R231	3B	R267	3D	R535	7D	U250	2B
C295	6B			Q548	6C	R232	1C	R271	3C	R536	7C	U540	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
CR211	5C	P286	5B	R205	5C	R236	3C	R284	1B	R542	7C	VR268	1C
CR226	6C			R206	5C	R238	3C	R286	1B	R546	6D	VR269	1C
CR250	6B	Q214	5C	R208	4C	R239	3C	R291	6B	R548	6D	VR281	1A
CR282	1A	Q222	6C	R214	5C	R251	3B	R293	6B	R549	6B		
CR532	7C	Q226	6C	R216	6C	R252	3A	R295	6B	R551	5B		
CR533	7C	Q252	3B	R221	6D	R253	3A	R521	6A	R552	5B		

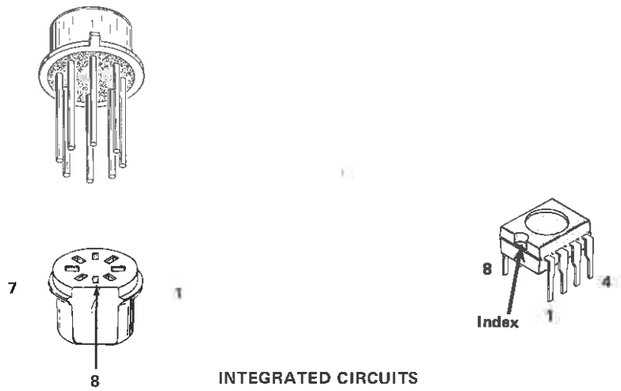
@



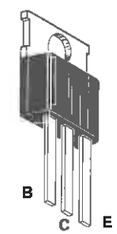
TRANSISTORS



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

PARTIAL A3-FEEDBACK AMPLIFIER BOARD

+5V

VERT MAG FROM DIAG 4

DS284 VOLTS

DS286 AMPS

DS281 VERT SENS X10

Q284 Q286 Q280

R286 1.5K

R284 1.5K

CR282

R280 3.3K -12V

V1

+5.11 -4.75

4 NOISY GND FROM P439-2

F6

VR281 12.6V

R281 3.3K

P286 2 COLL SWEEP DISABLE TO DIAG 4

OV J201-2 DUT SWP GEN TO DIAG 6 P101-2

SWP SIG FROM Q546 DIAG 3

F9 F10

R208 4.7K C208 .01

CHASSIS GND

R206 49.9k

C205 1.5

R214 5.1k

R221 1.5k

R224 150

CR226

Q222 Q226

R216 150

C227 10

R223 62

R227 160

R228 1K

R226 330

P235 P235

TO DUT CARD DIAG 7

SAMPLE & HOLD

F E 2 ATTEN COM OUT TO DIAG 1

OV E FBA OUT TO DIAG 1

DUT OUT FROM P101-3 J201-3

R205 49.9K

CR211 Q214

DIAG 6

5K FBA IN FROM P101-4 J201-4

R202 4.99k

R204 49.9K

50K FBA IN FROM P101-5 J201-5

FEEDBACK BAL R229 2K

FEEDBACK AMPLIFIER

Q252B

SAMPLE HOLD BAL R251 200

R252 12.1K R253 12.1K

R254 100 Q252A

R255 1K F5

C254 0.47

U250

R263 18 C263 .01

R261 10K

R232 44.8K

X1000 CMRR R262 500

V10

R234 4.478K

X100 CMRR R265 50

X10 CMRR R267 10

V21

DS268

R236 446

V20 F268

VR268 VR269

R239 50

R271 250K

F12 F13 F14

J201-8

R272 250K F11

J201-7

F16 F17

OV J201-6 SHA OUT TO DIAG 6 P101-6

F7

R231 45k V9

R233 4.5k V18

R235 450 DS236 F236

V19

R238 50 VR238 VR239

J201-10 F15

GUARD TO DIAG 6 P101-10

Rs DUT SEE DIAG 6 P101-9 P101-8

GUARD TO DIAG 6 P101-7

TO VERT CURRENT MEASURING DIAG 1

TO P321-1 TO P321-2 DIAG 1

P286 6 HORIZ AMP ATTEN TO DIAG 4

SHA COMMON TO DIAG 1

DISPLAY ZERO S200A ALSO 3 AND 1

P264

+30V +12V +5V -12V -30V -40V UNREG +40V UNREG

R291 5.6 C291 0.1 +12V (DCPL)

R293 5.6 C293 0.1 +5V (DCPL)

C295 0.1 R295 5.6 -12V (DCPL)

DIAG 4

HORIZ SIG FROM DIAG 1

DIVIDER SW FROM P101-1 DIAG 6

J201-1 OV

178 LINEAR IC TEST FIXTURE

NOTES:

1. ∇_1 NOISY GROUND
2. ∇_2 ATTENUATOR COMMON
3. 'V' SWITCHING = VERTICAL SWITCH S350 SEE DIAG 5 (SHOWN IN FULL CCW POSITION)
4. 'F' SWITCHING = FUNCTION SWITCH S300 SEE DIAG 5 (SHOWN IN FULL CCW POSITION)

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FEEDBACK AMPLIFIER 2
373

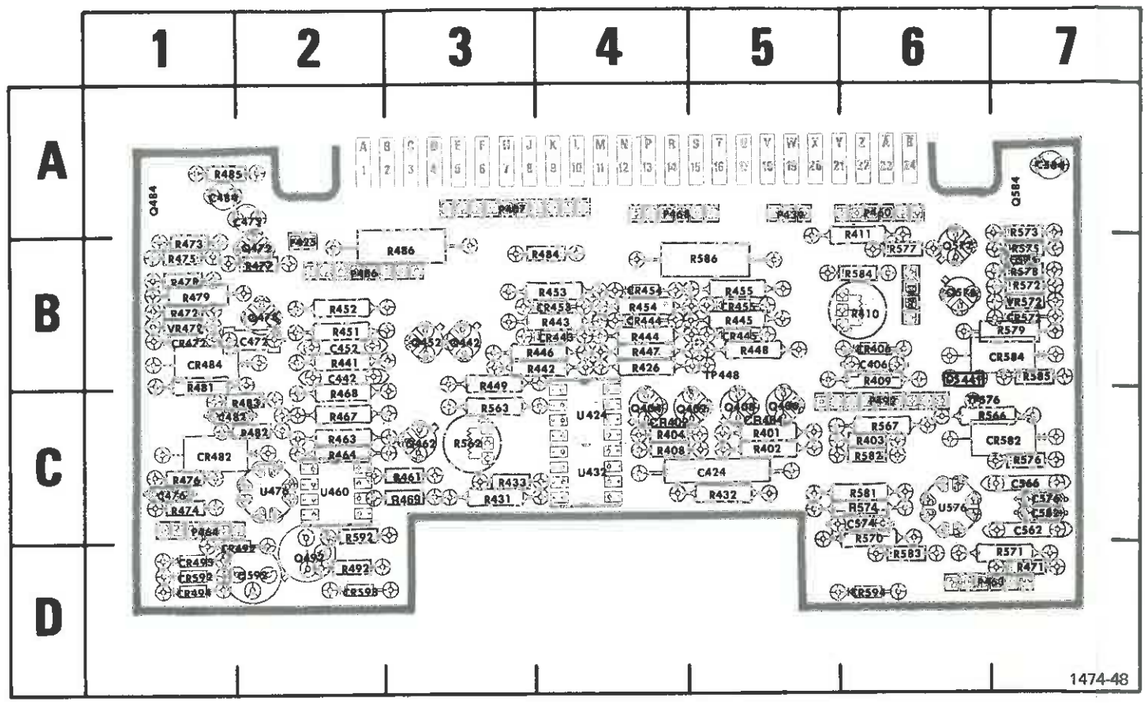
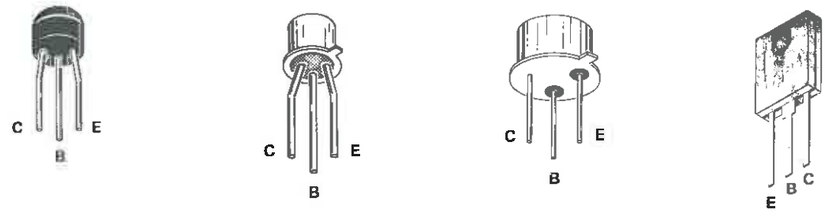
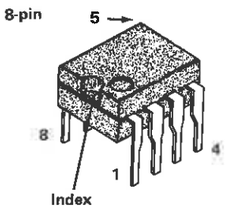


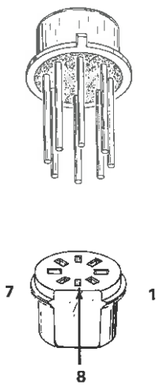
Fig. 7-3. A4—Power Supply circuit board.

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
C406	6B	CR453	4B	P463	6D	R401	5C	R452	2B	R484	4B	R585	7B
C424	5C	CR454	4B	P464	1C	R402	5C	R453	4B	R485	1A	R586	5B
C442	2B	CR455	5B	P468	4A	R403	6C	R454	4B	R486	3B	R592	2C
C452	2B	CR472	1B	P486	2B	R404	4C	R455	5B	R492	2D		
C472	2B	CR482	1C	P492	6C	R408	4C	R461	3C	R562	3C	TP448	5B
C475	2A	CR484	1B			R409	6B	R463	2C	R563	3C	TP576	6C
C476	1C	CR492	2D	Q402	5C	R410	6B	R464	2C	R566	7C		
C482	1C	CR493	1D	Q404	4C	R411	6A	R467	2C	R567	6C	U424	4C
C484	1A	CR494	1D	Q406	5C	R426	4B	R468	2C	R570	6C	U432	4C
C562	7C	CR572	7B	Q408	5C	R431	3C	R469	3C	R571	7D	U460	2C
C566	7C	CR582	7C	Q442	3B	R432	5C	R471	7D	R572	7B	U476	2C
C574	6C	CR584	7B	Q452	3B	R433	3C	R472	1B	R573	7A	U576	6C
C575	7B	CR593	2D	Q462	3C	R441	2B	R473	1B	R574	6C		
C576	7C	CR592	1D	Q472	2B	R442	4B	R474	1C	R575	7B	VR472	1B
C582	7C	CR594	6D	Q478	2B	R443	4B	R475	1B	R576	7C	VR572	7B
C584	7A	DS441	6B	Q484	1A	R444	4B	R476	1C	R577	6B		
CR404	5C			Q492	2D	R445	5B	R477	2B	R578	7B		
CR402	4C	P407	3A	Q572	6B	R446	4B	R478	1B	R579	7B		
CR406	6B	P425	2B	Q578	6B	R447	4B	R479	1B	R581	6C		
CR443	4B	P439	5A	Q584	7A	R448	5B	R481	1B	R582	6C		
CR444	4B	P441	6B	Q592	2D	R449	3B	R482	2C	R583	6D		
CR445	5B	P460	6A			R451	2B	R483	2C	R584	6B		



TRANSISTORS





INTEGRATED CIRCUITS

ASSEMBLY A4

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

VOLTAGE & WAVEFORM CONDITIONS

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

NOTES:
1. ⏚ ATTENUATOR COMMON
2. ⏚ NOISY GROUND
3. ✳ MATCHED PAIR
4. ≠ REPLACE ONLY WITH SPECIAL RESISTOR

CAUTION
R486 & R586 ARE FLAME-PROOF, FUSIBLE AND MUST BE REPLACED WITH THE SAME TYPE.

PARTIAL A3 - FEEDBACK AMPLIFIER BOARD

PARTIAL A4 - POWER BOARD

POWER SUPPLY ③

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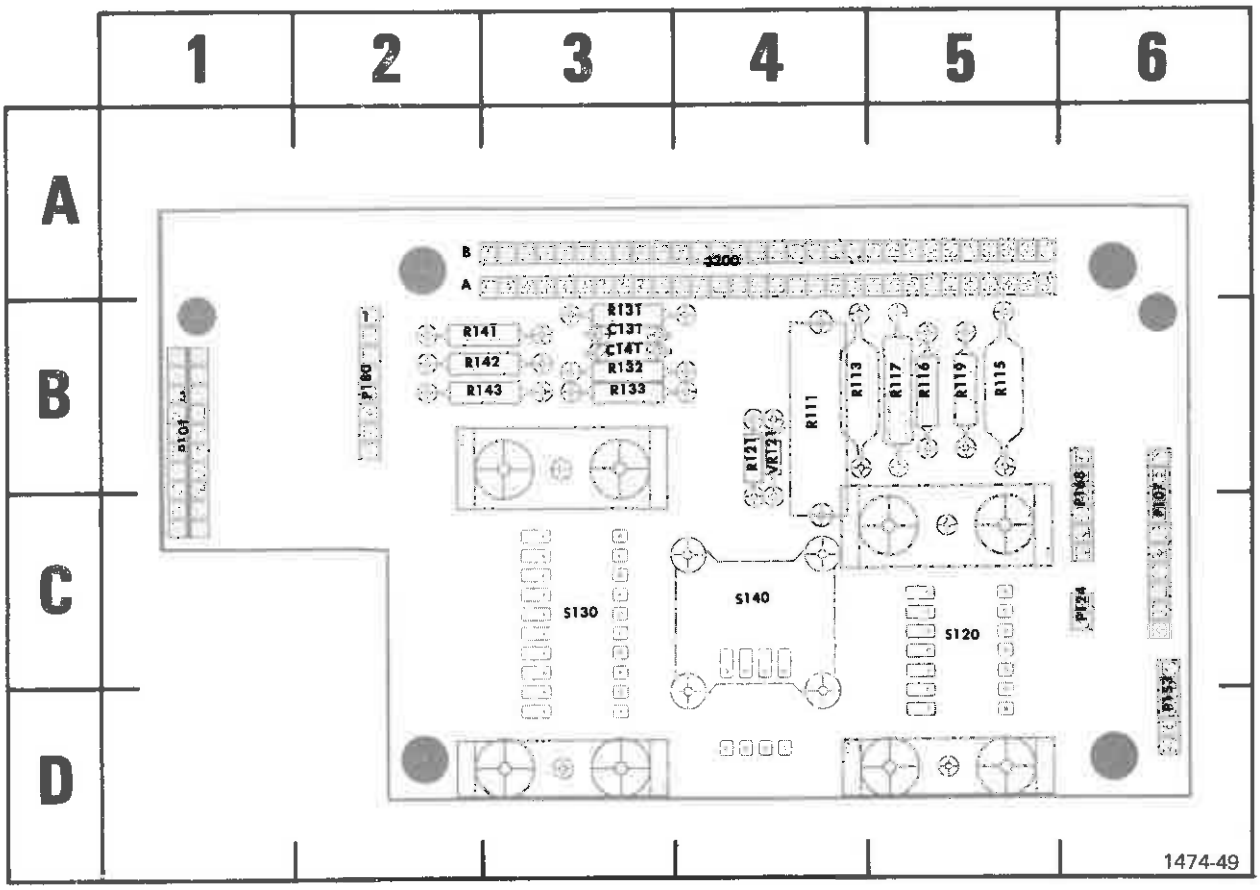
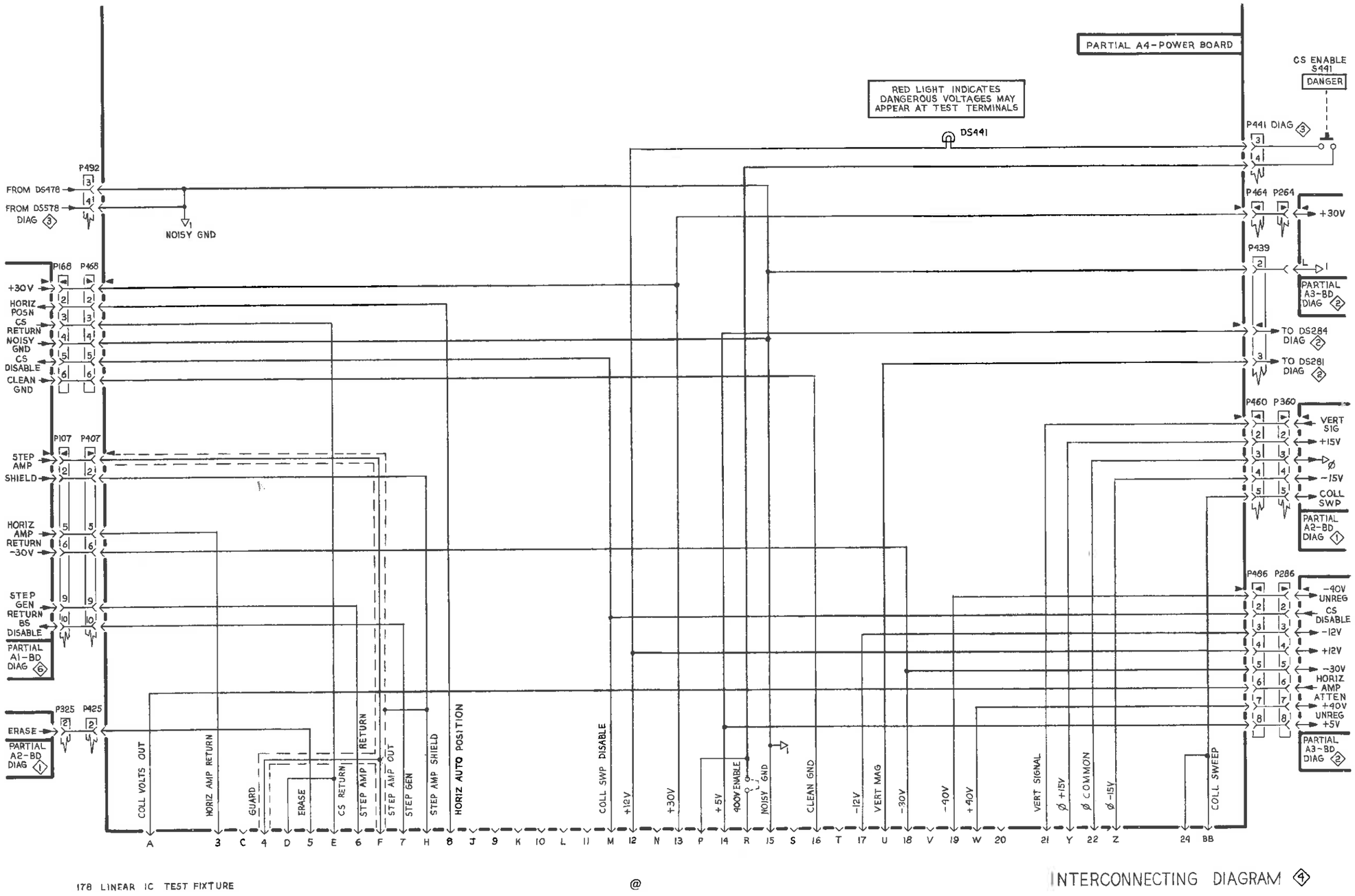


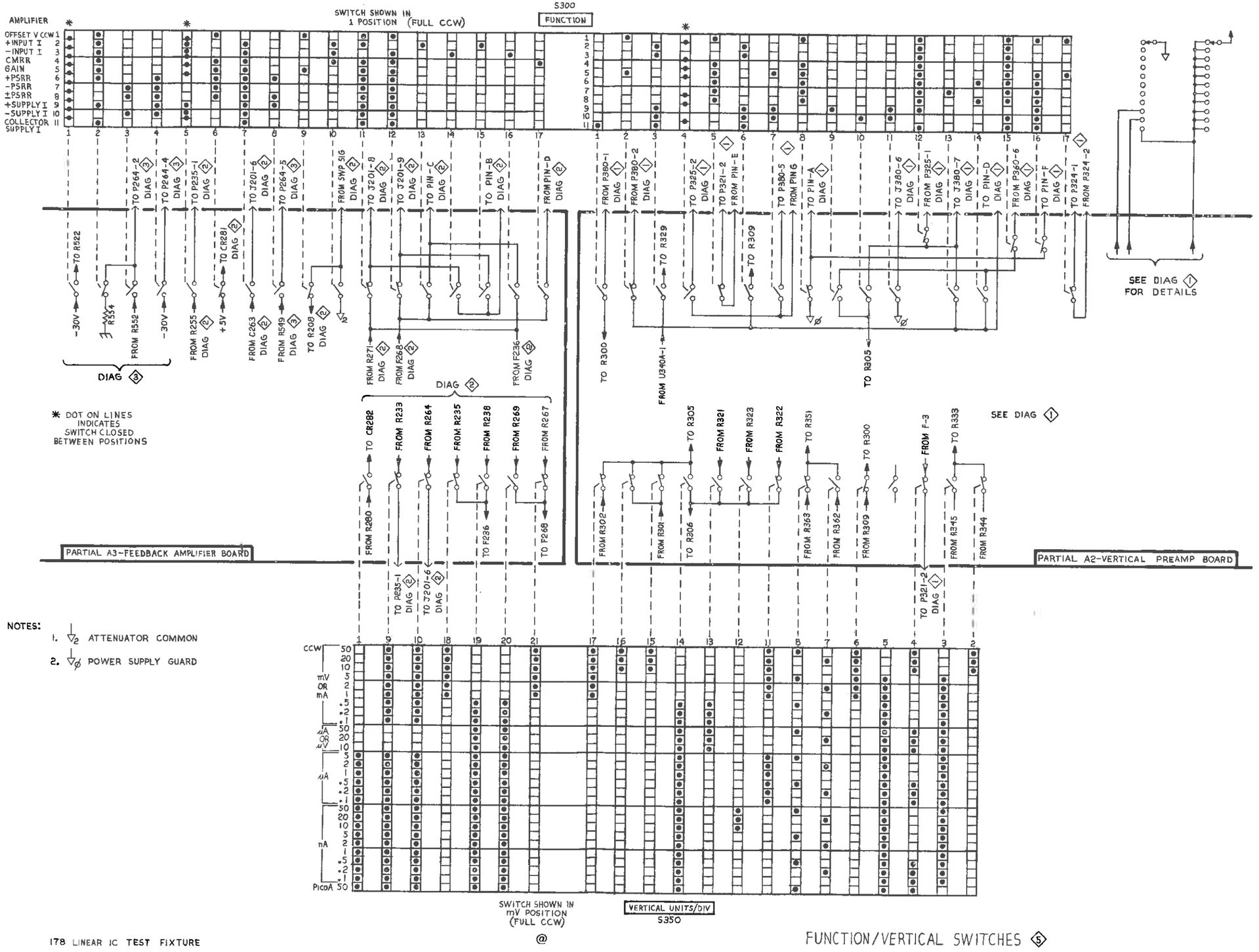
Fig. 7-4. A1—Interface circuit board.

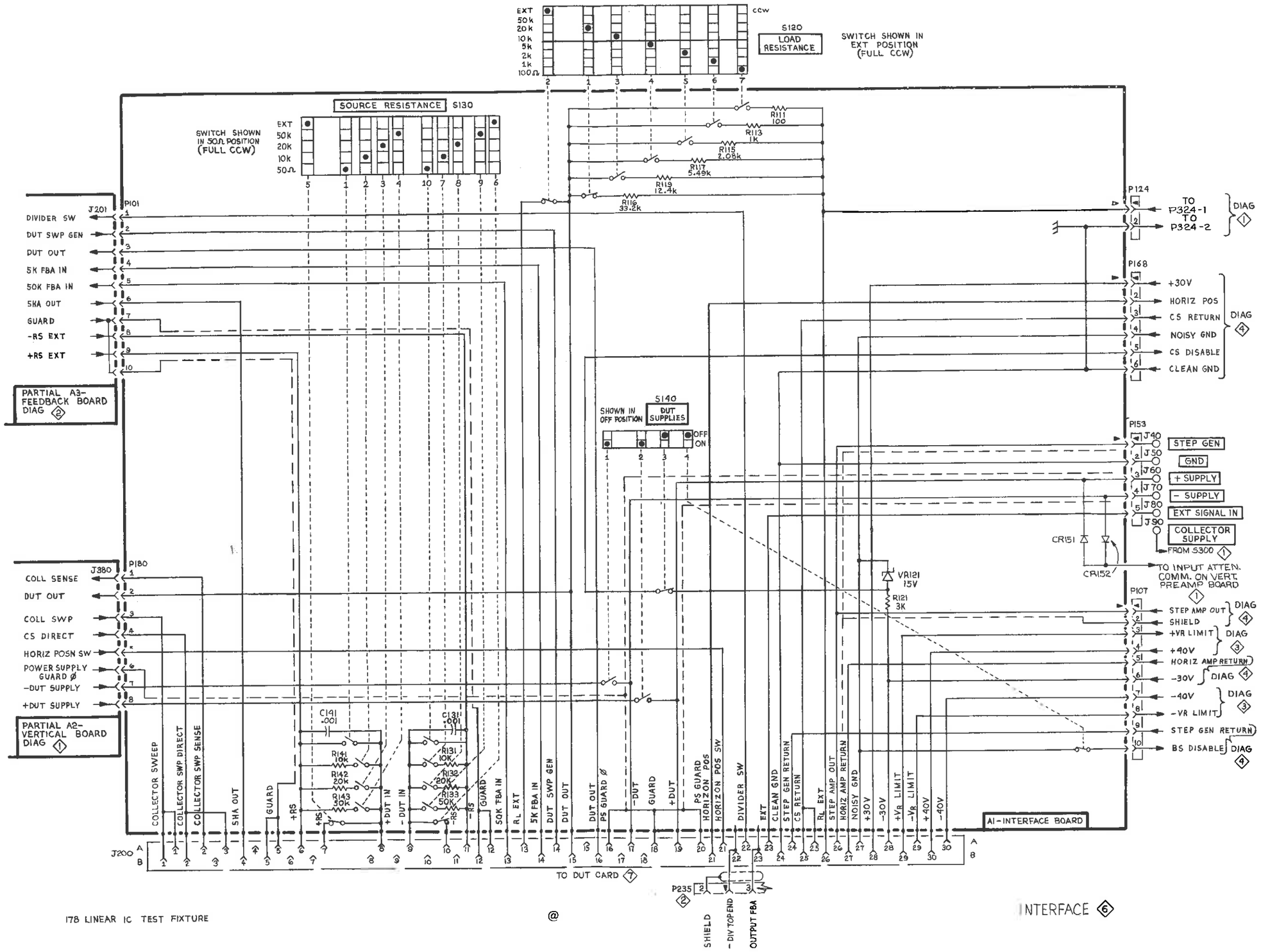
CKT NO	GRID LOC	CKT NO	GRID LOC
C131	3B	R115	5B
C141	3B	R119	5B
		R121	4B
J200	4A	R131	3B
		R132	3B
P101	1B	R133	3B
P107	6C	R141	2B
P124	6C	R142	2B
P153	6D	R143	2B
P168	6C		
P180	2B	S120	5C
		S130	3C
R111	4B	S140	4C
R113	4B		
R116	5B	VR121	4B
R117	5B		

@



178 LINEAR IC TEST FIXTURE @ INTERCONNECTING DIAGRAM 4





178 LINEAR IC TEST FIXTURE @

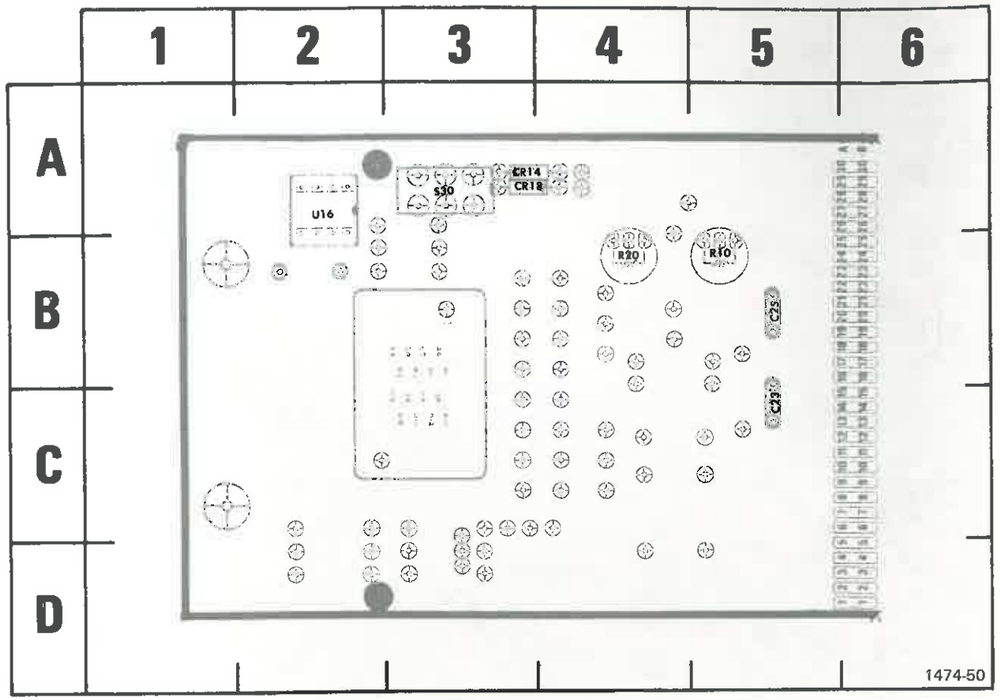
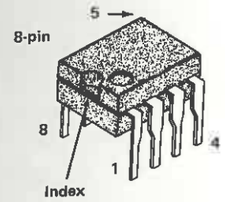
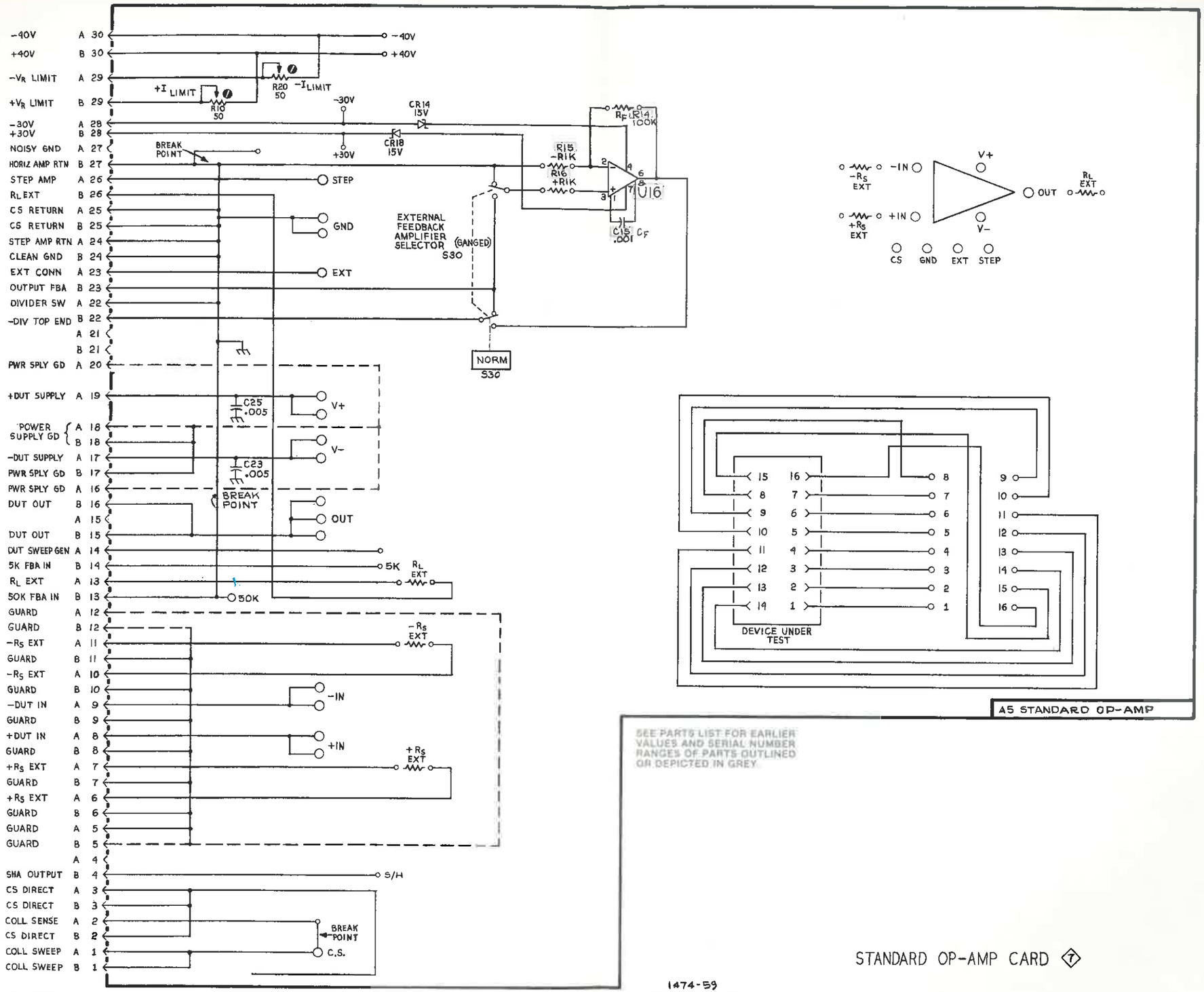


Fig. 7-5. A5—Standard Op Amp Card circuit board.

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



INTEGRATED CIRCUITS



178 LINEAR IC TEST FIXTURE

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

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P.S. 6-3-73

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

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
05129	KILO ENGINEERING CO	2015 D	LA VERNE CA 91750
05574	VIKING CONNECTORS INC	21001 NORDHOFF ST	CHATSWORTH CA 91311
06090	RAYCHEM CORP	300 CONSTITUTION DRIVE	MENLO PARK CA 94025
08261	SPECTRA-STRIP AN ELTRA CO	7100 LAMPSON AVE	GARDEN GROVE CA 92642
09422	PLASTIC STAMPING CORP	2216 W ARMITAGE AVE	CHICAGO IL 60647
09772	WEST COAST LOCKWASHER CO INC	16730 E JOHNSON DRIVE P O BOX 3588	CITY OF INDUSTRY CA 91744
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
11535	LORANGER INTL CORP	12-38 CLARK ST	WARREN PA 16365
12327	FREEWAY CORP	9301 ALLEN DR	CLEVELAND OH 44125
12360	ALBANY FASTENERS INC DIV OF PNEUMO CORP	145 WOODWARD AVE	SOUTH NORWALK CT 06854
15849	LITTON INDUSTRIES USECO DIVISION	13536 SATICOY ST	VAN NUYS CA 91409
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
27238	BRISTOL INDUSTRIES	630 E LAMBERT RD P O BOX 630	BREA CA 92621
29587	BUNKER RAMO CORP AMPHENOL INDUSTRIAL DIV	1830 S 54TH AVE	CHICAGO IL 60650
31918	ITT SCHADOW INC	8081 WALLACE RD	EDEN PRAIRIE MN 55343
70485	ATLANTIC INDIA RUBBER WORKS INC	571 W POLK ST	CHICAGO IL 60607
71159	BRISTOL SOCKET SCREW CO		WATERBURY CT
71279	MIDLAND-ROSS CORP CAMBION DIV	ONE ALEWIFE PLACE	CAMBRIDGE MA 02138
71785	TRW INC TRW CINCH CONNECTORS	1501 WORSE AVE	ELK GROVE VILLAGE IL 60007
73743	FISCHER SPECIAL WFG CO	446 WORGAN ST	CINCINNATI OH 45206
74445	HOLO-KROME CO	31 BROOK ST	WEST HARTFORD CT 06110
76854	OAK SWITCH SYSTEMS INC SUB OF OAK TECHNOLOGY INC	100 S MAIN ST	CRYSTAL LAKE IL 60014
77900	SHAKEPROOF DIV OF ILLINOIS TOOL WORKS	SAINT CHARLES RD	ELGIN IL 60120
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIVISION	ST CHARLES ROAD	ELGIN IL 60120
79136	WALDES KOHINOOR INC	47-16 AUSTEL PLACE	LONG ISLAND CITY NY 11101
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
81073	GRAYHILL INC	561 HILLGROVE AVE P O BOX 373	LA GRANGE IL 60525
83385	MICRODOT MANUFACTURING INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
86928	SEASTROM WFG CO INC	701 SONORA AVE	GLENDALE CA 91201
91500	ASHEVILLE-SCHOONMAKER MICA CO	910 JEFFERSON AVE P O BOX 318	NEWPORT NEWS VA 23607
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61101
97464	INDUSTRIAL RETAINING RING CO	57 CORDIER ST	IRVINGTON NJ 07111
TK0392	NORTHWEST FASTENER SALES INC	7923 SW CIRRUS DRIVE	BEAVERTON OR 97005
TK0435	LEWIS SCREW CO	4114 S PEORIA	CHICAGO IL 60609

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	390-0359-00	B010100	B041599	1	PANEL,PL-IN HSG:BOTTOM	80009	390-0359-00
	390-0359-01	B041600		1	PANEL,PL-IN HSG:BOTTOM,0.063,AL	80009	390-0359-01
					(ATTACHING PARTS)		
-2	211-0504-00			3	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
-3	211-0101-00			2	SCREW,MACHINE:4-40 X 0.25,FLH,100 DG,STL	TK0435	ORDER BY DESCR
-4	211-0105-00			2	SCREW,MACHINE:4-40 X 0.188,FLH,100 DEG	TK0435	ORDER BY DESCR
-5	210-0586-00			2	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
					(END ATTACHING PARTS)		
-6	390-0227-02			1	PANEL,PL-IN HSG:RIGHT SIDE	80009	390-0227-02
					(ATTACHING PARTS)		
-7	213-0146-00			4	SCREW,TPG,TF:6-20 X 0.312,TYPE B,PNH,STL	83385	ORDER BY DESCR
-8	211-0504-00			2	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-9	390-0228-01			1	PANEL,PL-IN HSG:LEFT SIDE	80009	390-0228-01
					(ATTACHING PARTS)		
-10	213-0146-00			4	SCREW,TPG,TF:6-20 X 0.312,TYPE B,PNH,STL	83385	ORDER BY DESCR
-11	211-0504-00			2	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-12	337-1963-00			1	SHIELD,ELEC:SWITCH CKT BD	80009	337-1963-00
					(ATTACHING PARTS)		
-13	211-0007-00			1	SCREW,MACHINE:4-40 X 0.188,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-14	337-1962-00			1	SHIELD,ELEC:FEEDBACK AMP CKT BD	80009	337-1962-00
					(ATTACHING PARTS)		
-15	211-0007-00			1	SCREW,MACHINE:4-40 X 0.188,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-16	337-1961-00			1	SHIELD,ELEC:JACK	80009	337-1961-00
-17	260-0247-00			1	SWITCH,PUSH:SPST,1A,115VAC	81073	30YY1009
					(ATTACHING PARTS)		
-18	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-19	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
-20	210-0046-00			1	WASHER,LOCK:0.261 ID,INTL,0.018 THK,STL	77900	1214-05-00-0541C
					(END ATTACHING PARTS)		
-21	333-1731-00			1	PANEL,FRONT:	80009	333-1731-00
-22	366-0125-00			2	KNOB:AL,0.189 ID X 0.563 OD X 0.625 H	80009	366-0125-00
	213-0004-00			2	.SETSCREW:6-32 X 0.188,STL	74445	ORDER BY DESCR
-23	210-0894-00			2	WASHER,FLAT:0.19 ID X 0.438 OD X 0.031	09422	ORDER BY DESCR
	162-0530-00	B041680		AR	INSUL SLVG,ELEC:HT SHRINK,0.188 ID	06090	VERSAFIT
-24	384-0900-00			2	PIN,STR,THD:0.188 OD X 0.255 L,10-24,SST	80009	384-0900-00
					(ATTACHING PARTS)		
-25	354-0025-00			2	RING,RETAINING:EXTERNAL,U/D 0.187 DIA SFT	79136	5555-18
					(END ATTACHING PARTS)		
-26	136-0140-00			6	JACK,TIP:BANANA,CHARCOAL GRAY	80009	136-0140-00
					(ATTACHING PARTS)		
-27	210-0583-00			6	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-28	210-0223-00	B010100	B041509	6	TERMINAL,LUG:0.26 ID,LOCKING,BRZ TIN PL	86928	5441-37
	210-0223-01	B041510		6	TERMINAL,LUG:0.26 ID,LOCKING,BRS TINNED	86928	ORDER BY DESCR
-29	210-0465-00			6	NUT,PLAIN,HEX:0.25-32 X 0.375,BRS CD PL	73743	3095-402
-30	210-0895-00			6	WSHR,SHLDR:0.255 ID X 0.375 OD X 0.105 THK	80009	210-0895-00
					(END ATTACHING PARTS)		
-31	426-1024-00			1	FRAME SECT,CAB.:FRONT	80009	426-1024-00
					(ATTACHING PARTS)		
-32	211-0541-00			2	SCREW,MACHINE:6-32 X 0.25,FLH,100 DEG,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-33	366-1023-02			1	KNOB:GY,VAR,0.127 ID X 0.392 OD X 0.531 H	80009	366-1023-02
	213-0246-00			1	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-34	366-1037-00			1	KNOB:GY,0.252 ID X 0.925 OD X 0.67 H	80009	366-1037-00
	213-0153-00			2	.SETSCREW:5-40 X 0.125,STL	27238	ORDER BY DESCR
-35	366-1207-00			2	KNOB:GY,0.127 ID X 0.5 OD X 0.531 H	80009	366-1207-00
	213-0153-00			2	.SETSCREW:5-40 X 0.125,STL	27238	ORDER BY DESCR
-36	331-0373-00			1	DIAL,CONTROL:3 TURN,LEFT SIDE READOUT	05129	771-S 6
-37	366-1190-00			2	KNOB:GY,0.252 ID X 0.706 OD X 0.6 H	80009	366-1190-00
	213-0153-00			4	.SETSCREW:5-40 X 0.125,STL	27238	ORDER BY DESCR
-38	366-1508-00			1	KNOB:GY,0.252 ID X 1.125 OD X 0.75 H	80009	366-1508-00
	213-0153-00			2	.SETSCREW:5-40 X 0.125,STL	27238	ORDER BY DESCR
-39	333-1770-00			1	PANEL,FUNCT SW:	80009	333-1770-00
-40	352-0251-00			1	HOLDER,SCALE:2.14 SQ X 0.146,SIL GY PC	80009	352-0251-00

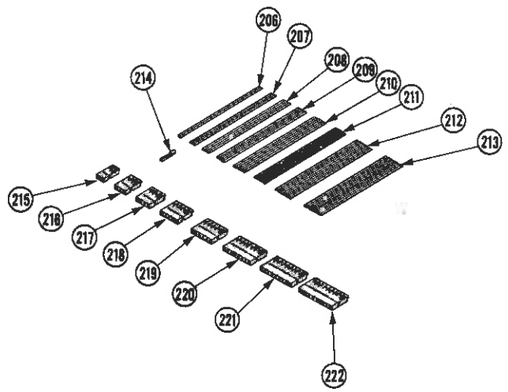
Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-41	366-1501-00			1	KNOB:GY,0.252 ID X 1.475 OD X 0.57	80009	366-1501-00
	213-0153-00			2	.SETSCREW:5-40 X 0.125,STL	27238	ORDER BY DESCR
-42	----- -----			1	RES.,VARIABLE:(SEE R415 REPL) (ATTACHING PARTS)		
-43	210-0590-00			2	NUT,PLAIN,HEX:0.375-32 X 0.438 BRS CD PL	73743	28269-402
-44	210-0012-00			1	WASHER,LOCK:0.384 ID,INTL,0.022 THK,STL (END ATTACHING PARTS)	09772	ORDER BY DESCR
-45	384-1210-00			1	EXTENSION SHAFT:1.875 L X 0.125 OD,SST (ATTACHING PARTS)	80009	384-1210-00
-46	376-0014-00			1	CPLG,SHAFT,FLEX:SST WIRE,VARIABLE RESISTOR (END ATTACHING PARTS)	80009	376-0014-00
-47	260-1529-00			1	SWITCH,ROTARY:FREQUENCY RANGE (ATTACHING PARTS)	80009	260-1529-00
-48	210-0590-00			1	NUT,PLAIN,HEX:0.375-32 X 0.438 BRS CD PL	73743	28269-402
-49	210-0978-00			1	WASHER,FLAT:0.375 ID X 0.5 OD X 0.024,STL (END ATTACHING PARTS)	12327	ORDER BY DESCR
-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,BRS CD PL	73743	2X-20319-402
-53	210-0940-00			2	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL (END ATTACHING PARTS)	12327	ORDER BY DESCR
-54	----- -----			1	RES.,VARIABLE:(SEE R560 REPL) (ATTACHING PARTS)		
-55	210-0046-00			1	WASHER,LOCK:0.261 ID,INTL,0.018 THK,STL (END ATTACHING PARTS)	77900	1214-05-00-0541C
-56	----- -----			1	LAMP:(SEE DS441 REPL) (ATTACHING PARTS)		
-57	348-0004-00			1	GROMMET,RUBBER:BLACK,ROUND,0.281 ID (END ATTACHING PARTS)	70485	763
-58	366-1489-37			1	PUSH BUTTON:SIL GY,ZERO	80009	366-1489-37
-59	426-0681-00			1	FRAME,PUSH BTN:	80009	426-0681-00
-60	358-0029-05			2	BSHG,MACH THD:0.375-32 X 0.5HEX,BRS,0.438L (ATTACHING PARTS)	80009	358-0029-05
-61	210-0590-00			2	NUT,PLAIN,HEX:0.375-32 X 0.438 BRS CD PL	73743	28269-402
-62	210-0012-00			2	WASHER,LOCK:0.384 ID,INTL,0.022 THK,STL	09772	ORDER BY DESCR
-63	210-0978-00			2	WASHER,FLAT:0.375 ID X 0.5 OD X 0.024,STL (END ATTACHING PARTS)	12327	ORDER BY DESCR
-64	390-0358-00			1	PANEL,FRONT:TOP PLUG-IN	80009	390-0358-00
-65	351-0380-00			2	GUIDE,CKT BOARD:GRAY DELRIN,1.5 L (ATTACHING PARTS)	80009	351-0380-00
-66	211-0038-00			4	SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG (END ATTACHING PARTS)	TK0435	ORDER BY DESCR
-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,FLH,82 DEG,STL	TK0435	ORDER BY DESCR
-69	210-0001-00			2	WASHER,LOCK:#2 INTL,0.013 THK,STL	77900	1202-00-00-0541C
-70	210-0405-00			2	NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL (END ATTACHING PARTS)	73743	12157-50
-71	386-2569-00			1	DIFFUSER,LIGHT:SWITCH ILLUM,ACRYLIC	80009	386-2569-00
-72	352-0157-00			1	LAMPHOLDER:(1)T-2 UNBASED,WHITE	80009	352-0157-00
-73	200-0935-00			1	BASE,LAMPHOLDER:0.29 OD X 0.19 L,BK PLSTC	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 0.250,PNH,STL (END ATTACHING PARTS)	TK0435	ORDER BY DESCR
-76	352-0157-00			4	LAMPHOLDER:(1)T-2 UNBASED,WHITE	80009	352-0157-00
-77	200-0935-00			4	BASE,LAMPHOLDER:0.29 OD X 0.19 L,BK PLSTC	80009	200-0935-00
-78	378-0635-00			4	LENS,LIGHT:WHITE	80009	378-0635-00
-79	131-0942-00			1	CONTACT,ELEC:GROUNDING,PH BRZ CU-SN-ZN PL (ATTACHING PARTS)	80009	131-0942-00
-80	213-0138-00			1	SCREW,TPG,TF:4-24 X 0.188,TYPE B,PNH,STL (END ATTACHING PARTS)	TK0435	ORDER BY DESCR
-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:TYPE E EXT,U/O 0.156 OD SFT	97464	1000-15-ZD

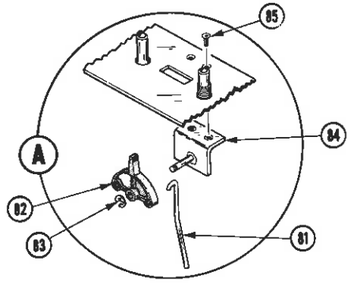
Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-					(END ATTACHING PARTS)		
-84	407-1297-00			1	BRACKET,ANGLE:SWITCH,ALUMINUM	80009	407-1297-00
					(ATTACHING PARTS)		
-85	211-0101-00			2	SCREW,MACHINE:4-40 X 0.25,FLH,100 DG,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-86	441-1149-00			1	CHAS,PL-IN UNIT: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	80009	426-1023-01
					(ATTACHING PARTS)		
-88	211-0101-00			4	SCREW,MACHINE:4-40 X 0.25,FLH,100 DG,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-89	166-0353-00	B010100	B030929	1	SLEEVE,LOCKING:0.32 DIA X 0.457 L W/0.25-32 THD,BLUE NYLON	80009	166-0353-00
	166-0345-00	B030930		1	SLEEVE,LOCKING:0.32 DIA X 0.457 L W/0.25-32	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	83385	ORDER BY DESCR
-92	210-0071-00			2	WASHER,SPR TNSN:0.148 ID X 0.025 THK	78189	4706-05-01-0531
-93	210-0407-00			2	NUT,PLAIN,HEX:6-32 X 0.25,BRS CD PL	73743	3038-402
					(END ATTACHING PARTS)		
-94	342-0136-00			2	INSLTR,WSHR:0.191D X 0.0025THK,MICA,0.812	91500	B52600F013
-95	407-1298-00			2	BRACKET,ELEC SM:POWER SUPPLY	80009	407-1298-00
					(ATTACHING PARTS)		
-96	211-0116-00			4	SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP	77900	ORDER BY DESCR
					(END ATTACHING PARTS)		
-97	----- -----			1	CKT BOARD ASSY:POWER SUPPLY(SEE A4 REPL)		
-98	131-0589-00			6	.TERMINAL,PIN:0.46L X 0.025 SQ PH BRZ GLD	22526	48283-029
	131-0608-00			54	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-99	136-0252-04			3	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-100	136-0183-00			2	.SKT,PL-IN ELEK:TRANS,3 CONTACT,PCB MT	80009	136-0183-00
-101	136-0220-00	B010100	B030909	11	.SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT	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	.SKT,PL-IN ELEK:SEMICOND DVC,8 CONT,PCB MT	71785	133-98-12-062
-103	136-0514-00	B010100	B042389	3	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B042390		3	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
	136-0403-00	B040000		4	.SKT,PL-IN ELEK:MICROCIRCUIT TEST,16 DIP	29587	623-01011-161
-104	214-0579-00			3	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-105	214-0720-01			1	CONTACT,ELEC:GROUNDING,CU BE	80009	214-0720-01
					(ATTACHING PARTS)		
-106	210-0586-00			1	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
					(END ATTACHING PARTS)		
	672-0070-00			1	CIRCUIT BD ASSY:INTERFACE	80009	672-0070-00
					(ATTACHING PARTS)		
-107	211-0116-00			2	SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP	77900	ORDER BY DESCR
-108	211-0154-00	B010100	B049999	2	SCR,ASSEM WSHR:4-40 X 0.562,DOUBLE SEMS	83385	
	211-0152-00	B050000		2	SCR,ASSEM WSHR:4-40 X 0.625,PNH,BRS,NP,POZ	78189	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
	263-1026-00			1	.SM CAM ACTR AS:SOURCE RESISTANCE	80009	263-1026-00
					.(ATTACHING PARTS)		
-109	211-0116-00			4	.SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP	77900	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.ACTUATOR ASSY INCLUDES:		
-110	200-0995-00			1	..COVER,CAM SM:10 ELEMENTS	80009	200-0995-00
					..(ATTACHING PARTS)		
-111	211-0022-00			2	..SCREW,MACHINE:2-56 X 0.188,PNH,STL	TK0435	ORDER BY DESCR
-112	210-0001-00			2	..WASHER,LOCK:#2 INTL,0.013 THK,STL	77900	1202-00-00-0541C
					..(END ATTACHING PARTS)		
-113	210-0405-00			1	..NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL	73743	12157-50
-114	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-115	214-1126-00			1	..SPRING,FLAT:0.7 X 0.125,CU BE GOLD CLR	80009	214-1126-00
	214-1126-02			1	..SPRING,FLAT:0.7 X 0.125,CU BE RED CLR	80009	214-1126-02
-116	214-1127-00			1	..ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-117	401-0058-00			1	..BEARING,CAM SM:FRONT,0.454 DIA CAM	80009	401-0058-00
					..(ATTACHING PARTS)		
-118	354-0219-00			1	..RING,RETAINING:EXT,CRESCENT,U/0 0.25 DIA	79136	5103-25-S-ZD-R
					..(END ATTACHING PARTS)		

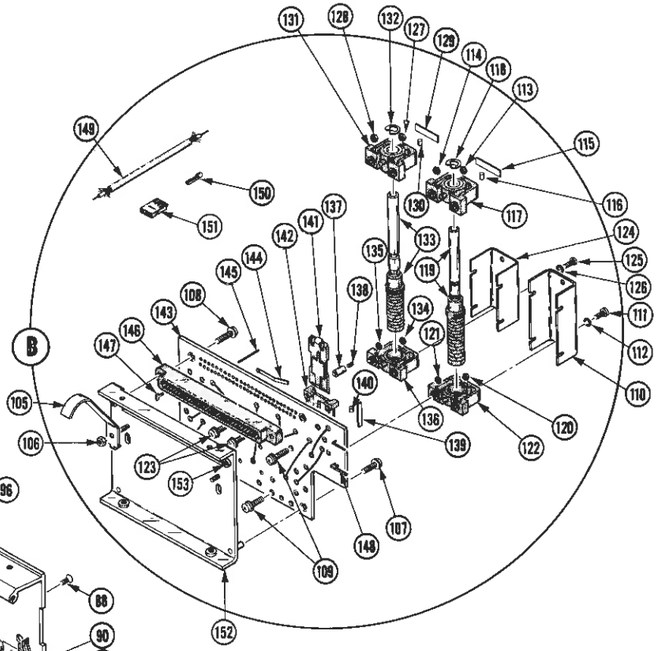
Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-119	105-0460-00			1	..ACTUATOR,CAM SM:SOURCE	80009	105-0460-00
-120	210-0405-00			1	..NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL	73743	12157-50
-121	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-122	401-0061-00			1	..BEARING,CAM SM:REAR OR CENTER,0.454 DIA	80009	401-0061-00
	263-1027-00			1	.SM CAM ACTR AS:LOAD RESISTANCE	80009	263-1027-00
					.(ATTACHING PARTS)		
-123	211-0116-00			4	.SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP	77900	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.ACTUATOR ASSY INCLUDES:		
-124	200-1033-00			1	..COVER,CAM SM:7 ELEMENTS	80009	200-1033-00
					..(ATTACHING PARTS)		
-125	211-0022-00			2	..SCREW,MACHINE:2-56 X 0.188,PNH,STL	TK0435	ORDER BY DESCR
-126	210-0001-00			2	..WASHER,LOCK:#2 INTL,0.013 THK,STL	77900	1202-00-00-0541C
					..(END ATTACHING PARTS)		
-127	210-0405-00			1	..NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL	73743	12157-50
-128	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-129	214-1126-00			1	..SPRING,FLAT:0.7 X 0.125,CU BE GOLD CLR	80009	214-1126-00
	214-1126-02			1	..SPRING,FLAT:0.7 X 0.125,CU BE RED CLR	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 SM:FRONT,0.454 DIA CAM	80009	401-0058-00
					..(ATTACHING PARTS)		
-132	354-0219-00			1	..RING,RETAINING:EXT,CRESCENT,U/O 0.25 DIA	79136	5103-25-S-ZD-R
					..(END ATTACHING PARTS)		
-133	105-0459-00			1	..ACTUATOR,CAM SM:LOAD R	80009	105-0459-00
-134	210-0405-00			1	..NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL	73743	12157-50
-135	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-136	401-0061-00			1	..BEARING,CAM SM:REAR OR CENTER,0.454 DIA	80009	401-0061-00
	105-0467-00			1	.ACTUATOR,SWITCH:OUT SUPPLY ON,OFF	80009	105-0467-00
-137	376-0142-00			1	..ADAPTER,SM ACTR:SLIDE TO SHAFT	80009	376-0142-00
					..(ATTACHING PARTS)		
-138	213-0048-00			1	..SETSCREW:4-40 X 0.125,STL	TK0392	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-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:SLIDE,ON/OFF	80009	105-0478-00
-142	351-0355-00			1	..GUIDE,SLIDE SM:GRAY POLYCARBONATE	80009	351-0355-00
-143	----- -----			1	.CKT BOARD ASSY:INTERFACE(SEE A1 REPL)		
-144	131-0604-00			21	..CONTACT,ELEC:CKT BD SM,SPR,CU BE	80009	131-0604-00
-145	131-0608-00			23	..TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
	131-0787-00			8	..TERM,PIN:0.64 L X 0.025 SQ PH BRZ GOLD	22526	47359-000
-146	131-1228-00			1	..CONN,RCPT,ELEC:EDGECARD,30/60 CONT,0.1 SP	05574	000201-5421
-147	214-1458-00			1	..KEY,CONN PLZN:CKT BOARD	05574	091-0071-000
-148	131-1261-00			10	..CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
-149	175-0072-00			AR	.CABLE,SP,ELEC:2,26 AWG TM PR,SHLD,VINYL	80009	175-0072-00
-150	131-0707-00			3	.CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
-151	352-0161-05			1	.HLDR,TERM CONN:3 WIRE,GREEN	80009	352-0161-05
-152	386-2570-00			1	SUPPORT,CKT BD:INTERFACE	80009	386-2570-00
					(ATTACHING PARTS)		
-153	210-0586-00			2	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
					(END ATTACHING PARTS)		
-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,PNH,BRS,NP	77900	ORDER BY DESCR
-156	211-0168-00			2	SCREW,MACHINE:4-40 X 0.25,PNH,BRS,NP	12360	ORDER BY DESCR
-157	210-1002-00			2	WASHER,FLAT:0.125 ID X 0.25 OD X 0.022	86928	5714-147-20N
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-158	131-0593-00			7	.TERM,PIN:1.15 L X 0.025 SQ BRS TIN PL	80009	131-0593-00
-159	352-0274-00			1	.HOLDER,TERMINAL:8 SQUARE PINS	80009	352-0274-00
-160	131-0604-00			24	.CONTACT,ELEC:CKT BD SM,SPR,CU BE	80009	131-0604-00
-161	131-0608-00			19	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-162	136-0252-04			6	.SOCKET,PIN TERM:U/M 0.016-0.018 DIA PINS	22526	75060-007
-163	136-0220-00	B010100	B030909	9	.SKT,PL-IN ELEK:TRANSISTOR 3 CONTACT	71785	133-23-11-034
	136-0252-04	B030910		27	.SOCKET,PIN TERM:U/M 0.016-0.018 DIA PINS	22526	75060-007
-164	136-0237-00			1	.SKT,PL-IN ELEK:SEMICOND DVC,8 CONT,PCB MT	71785	133-98-12-062
-165	136-0514-00	B010100	B042389	1	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B042390		1	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108

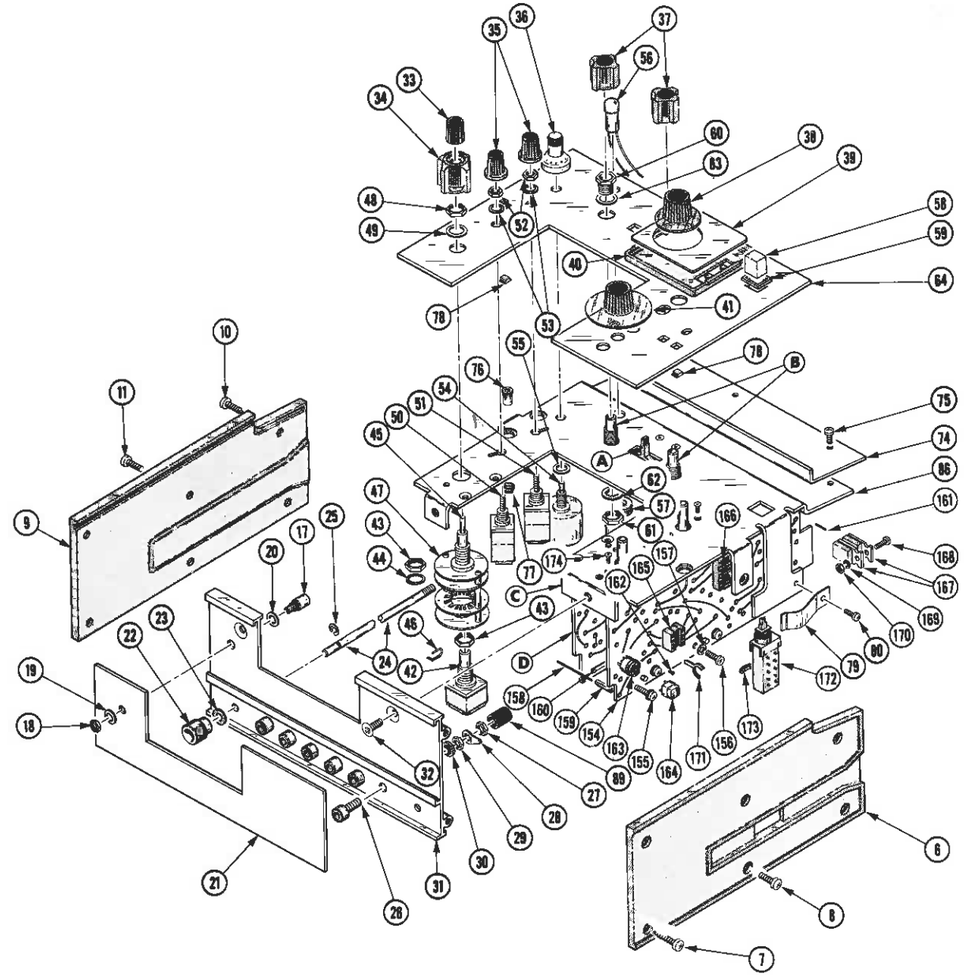
Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-166	136-0499-10			1	.CONN,RCPT,ELEC:CKT BD,1 X 10,0.1 SP,TIN	00779	4-380949-0
-167	----- -----			2	.TRANSISTOR:(SEE Q546,Q548 REPL)		
					.(ATTACHING PARTS)		
-168	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-169	210-0004-00			2	.WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
-170	210-0406-00			2	.NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
					.(END ATTACHING PARTS)		
-171	344-0154-00			4	.CLIP,ELECTRICAL:FUSE,CKT BD MT,CU BE CU	80009	344-0154-00
-172	260-1310-00			1	.SWITCH,PUSH:1 BUTTON,4 POLE,EXTERNAL	31918	ORDER BY DESCR
-173	361-0384-00			2	.SPACER,PB SW:0.133 L,RED POLYCARBONATE	80009	361-0384-00
	672-0413-00			1	CIRCUIT BD ASSY:FDBK/VPREAMP	80009	672-0413-00
					(ATTACHING PARTS)		
-174	211-0030-00			4	SCREW,MACHINE:2-56 X 0.25,FLH,82 DEG,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
	263-1024-00			1	.SW CAM ACTR AS:VERTICAL UNITS/DIV	80009	263-1024-00
					.(ATTACHING PARTS)		
-175	211-0116-00			4	.SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP	77900	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.ACTUATOR ASSY INCLUDES:		
-176	214-1139-02			1	..SPRING,FLAT:0.885 X 0.156 CU BE GRN CLR	80009	214-1139-02
	214-1139-03			1	..SPRING,FLAT:0.885 X 0.156 CU BE RED CLR	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,BRS CD PL	73743	12161-50
	105-0482-00			1	..STOP,DETENT:	80009	105-0482-00
-179	354-0391-00			1	..RING,RETAINING:EXT,U/O 0.438 DIA SFT	80009	354-0391-00
-180	401-0081-01			1	..BEARING,CAM SW:M/THREADED BUSHING	80009	401-0081-01
-181	105-0461-00			1	..ACTUATOR,CAM SW:VERTICAL SENSITIVITY	80009	105-0461-00
-182	210-0406-00			4	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-183	401-0115-00			1	..BEARING,CAM SW:CNTR,0.83 DIA CAM,DBL BD	80009	401-0115-00
	263-1025-00			1	.SW CAM ACTR AS:FUNCTION	80009	263-1025-00
					.(ATTACHING PARTS)		
-184	211-0116-00			4	.SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP	77900	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.ACTUATOR ASSY INCLUDES:		
-185	214-1139-03			2	..SPRING,FLAT:0.885 X 0.156 CU BE RED CLR	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,BRS CD PL	73743	12161-50
-188	354-0391-00			1	..RING,RETAINING:EXT,U/O 0.438 DIA SFT	80009	354-0391-00
-189	401-0081-01			1	..BEARING,CAM SW:M/THREADED BUSHING	80009	401-0081-01
-190	105-0462-00			1	..ACTUATOR,CAM SW:FUNCTION	80009	105-0462-00
-191	263-0519-00			1	..SW SECTION,RTRY:FUNCTION,178	76854	4-2542-619
					..(ATTACHING PARTS)		
-192	211-0181-00			2	..SCREW,MACHINE:2-56 X 0.375,PNH,BRS	80009	211-0181-00
-193	210-0053-00			2	..WASHER,LOCK:#2 SPLIT,0.02 THK STL	78189	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-194	386-2877-00			1	..PLATE,SW MTG:FUNCTION	80009	386-2877-00
					..(ATTACHING PARTS)		
-195	211-0022-00			2	..SCREW,MACHINE:2-56 X 0.188,PNH,STL	TK0435	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-196	210-0406-00			4	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-197	401-0146-01			1	..BEARING,CAM SW:M/INSERT	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 BRZ GLD PL	22526	48283-036
-201	136-0252-04			10	..SOCKET,PIN TERM:U/M 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:U/M 0.025 SQ PIN	22526	75377-001
-203	136-0499-08			1	..CONN,RCPT,ELEC:CIRCUIT BD,8 CONTACTS	00779	30380949-8
-204	136-0514-00	B010100	B042389	2	..SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B042390		2	..SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
	136-0263-03	B010100	B030699	7	..SOCKET,PIN TERM:U/M 0.025 SQ PINS	00779	85864-2
	136-0263-04	B030700		7	..SOCKET,PIN TERM:U/M 0.025 SQ PIN	22526	75377-001
-205	175-0825-00			AR	.CABLE,SP,ELEC:2,26 AWG,STRD,PVC JKT,RBN	80009	175-0825-00
-206	175-0825-00			AR	CABLE,SP,ELEC:2,26 AWG,STRD,PVC JKT,RBN	80009	175-0825-00
-207	175-0826-00			AR	CABLE,SP,ELEC:3,26 AWG,STRD,PVC JKT,RBN	80009	175-0826-00
-208	175-0827-00			AR	CABLE,SP,ELEC:4,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-954

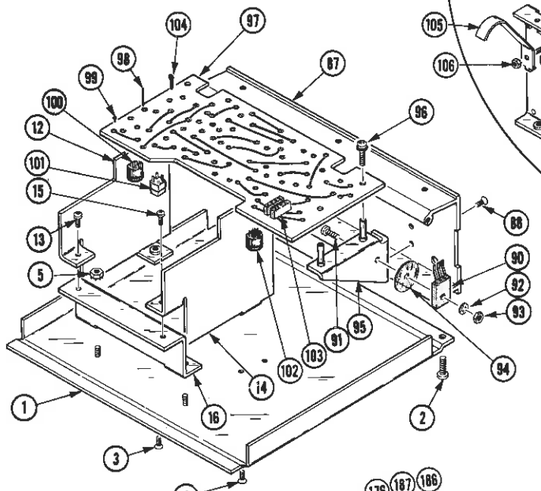
Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
1-209	175-0828-00			AR		CABLE,SP,ELEC:5,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-955
-210	175-0829-00			AR		CABLE,SP,ELEC:6,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-973
-211	175-0831-00			AR		CABLE,SP,ELEC:8,26 AWG,STRD,PVC INSUL,RBN	08261	111-2699-971
-212	175-0832-00			AR		CABLE,SP,ELEC:9,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-956
-213	175-0833-00			AR		CABLE,SP,ELEC:10,26 AWG STRD,PVC JKT,RBN	08261	111-2699-970
-214	131-0707-00			109		CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
-215	352-0169-02			1		HLDR,TERM CONN:2 WIRE,RED	80009	352-0169-02
	352-0169-04			2		HLDR,TERM CONN:2 WIRE,YELLOW	80009	352-0169-04
	352-0169-05			2		HLDR,TERM CONN:2 WIRE,GREEN	80009	352-0169-05
-216	352-0161-09			1		HLDR,TERM CONN:3 WIRE,WHITE	80009	352-0161-09
-217	352-0162-01			1		HLDR,TERM CONN:4 WIRE,BROWN	80009	352-0162-01
-218	352-0163-03			1		HLDR,TERM CONN:5 WIRE,ORANGE	80009	352-0163-03
-219	352-0164-00			2		HLDR,TERM CONN:6 WIRE,BLACK	80009	352-0164-00
	352-0164-03			1		HLDR,TERM CONN:6 WIRE,ORANGE	80009	352-0164-03
	352-0164-04			2		HLDR,TERM CONN:6 WIRE,YELLOW	80009	352-0164-04
	352-0164-08			2		HLDR,TERM CONN:6 WIRE,GRAY	80009	352-0164-08
-220	352-0166-06			2		HLDR,TERM CONN:8 WIRE,BLUE	80009	352-0166-06
-221	352-0167-02			1		HLDR,TERM CONN:9 WIRE,RED	80009	352-0167-02
-222	352-0168-07			2		HLDR,TERM CONN:10 WIRE,VIOLET	80009	352-0168-07

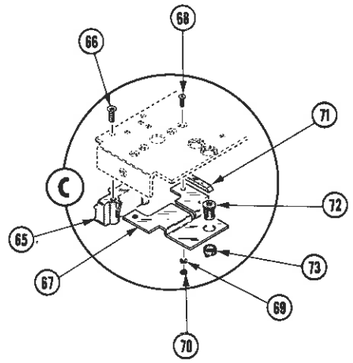


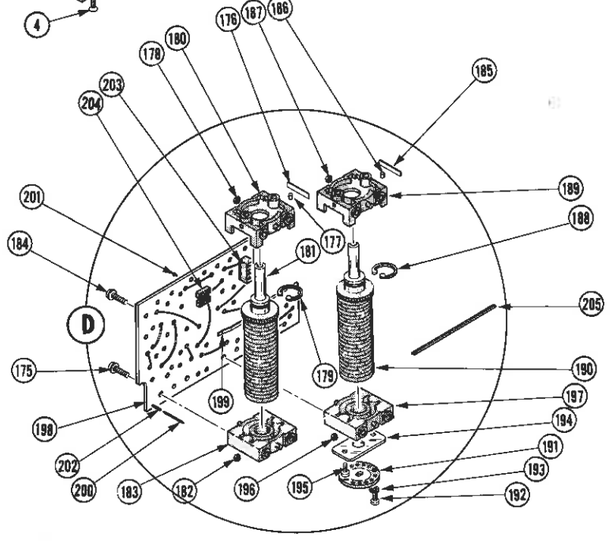




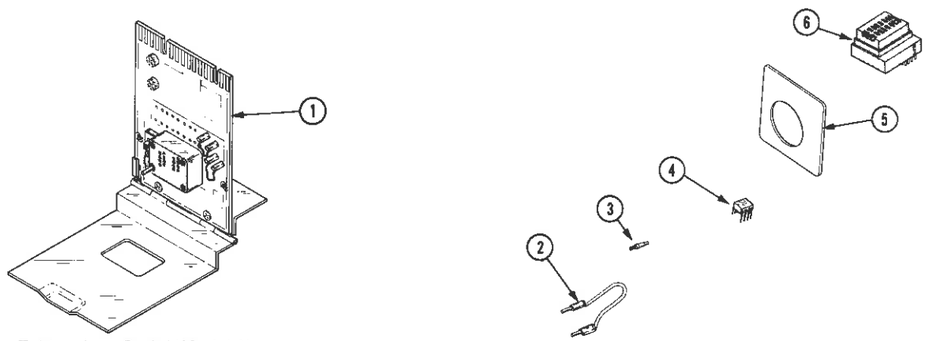








STANDARD ACCESSORIES



Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
-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

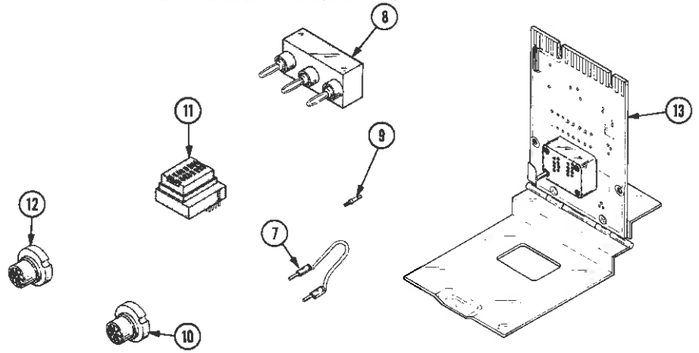


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
-7	012-0200-00			1		LEAD,TEST:2.0 L	71279	3705-1-0312
-8	013-0070-01			1		ADAPTER,TEST:3 TERMINAL,TRANSISTOR	80009	013-0070-01
-9	131-1497-00			1		CONTACT,ELEC:0.04 DIA PIN 1 END	88245	15409
-10	136-0441-00			1		SOCKET,PLUG-IN:XSTR,10 LEAD TO TO-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 TO-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

MANUAL CHANGE INFORMATION

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

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

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

CHANGE INFORMATION

PRODUCT: 178 577 D1/D2 DATE: 6/25/86 CHANGE REF.: M60744

TEXT CHANGES (CONT.)

SECTION 5 - PERFORMANCE CHECK/ADJUSTMENT

Add the following note after Performance Check procedure steps 11a part c and 11b part d.

NOTE

If spikes are visible at the ends of the 10 cm trace, refer to step 6A, 6B, or 6C in the Adjustment procedure for component selection information.

Add the following note after Adjustment procedure steps 6A part b, 6B part d, and 6C part c.

NOTE

If spikes are visible at the ends of the 10 cm trace, they may be eliminated by selecting another capacitance value for C406 on the A4 Power Supply circuit board assembly. See ***Component Selection Criteria*** *in* ***Section 4 - Maintenance*** *for selection information.*

DIAGRAM CHANGES

POWER SUPPLY ◇3

Change C406 from 270 pF to SEL (for selectable). C406 is located in the upper left corner of the schematic diagram.

Tektronix MANUAL CHANGE INFORMATION

COMMITTED TO EXCELLENCE

Manual Insert for Product Group 48

PRODUCT: 178 577 D1/D2 DATE: 7/1/86

CHANGE REFERENCE: M57358 MANUAL PART NO.: 070-1978-00

These changes are effective at serial number B042858.

REPLACEABLE MECHANICAL PARTS LIST CHANGES

CHANGE TO:

Fig. & Index No.	Tektronix Part No.	Qty	12345	Name & Description
Fig. 1-100	136-0252-07	6		.SOCKET,PIN CONN:W/O DIMPLE
Fig. 1-101	136-0252-07	33		.SOCKET,PIN CONN:W/O DIMPLE
Fig. 1-102	136-0252-07	16		.SOCKET,PIN CONN:W/O DIMPLE
Fig. 1-162	136-0252-07	6		.SOCKET,PIN CONN:W/O DIMPLE
Fig. 1-163	136-0252-07	27		.SOCKET,PIN CONN:W/O DIMPLE
Fig. 1-164	136-0252-07	8		.SOCKET,PIN CONN:W/O DIMPLE

DIAGRAM CHANGES

FIG. 1 EXPLODED

Items 100, 101, 102, 163, and 164 are no longer multi-leg transistor sockets but individual pin sockets.

Tektronix®
COMMITTED TO EXCELLENCE

MANUAL CHANGE INFORMATION

Date: 9/2/86 Change Reference: M59639

Product: 178 Manual Part No.: 070-1978-00

DESCRIPTION PG 48

THESE CHANGES ARE EFFECTIVE AT SN B042872

REPLACEABLE ELECTRICAL PARTS LIST CHANGES

CHANGE TO:

R286	315-0152-00	RES,FXD,FILM:1.5kΩ,5%,0.25W
R307	315-0393-00	RES,FXD,FILM;39kΩ,5%,0.25W
R316	315-0136-01	RES,FXD,CMPSN:13MΩ,5%,0.25W
R317	315-0136-01	RES,FXD,CMPSN:13MΩ,5%,0.25W
R341	315-0225-00	RES,FXD,FILM:2.2MΩ,5%,0.25W
R342	315-0222-00	RES,FXD,FILM:2.2kΩ,5%,0.25W