INSTRUCTION MANUAL

Serial Number _____

26A1 OPERATIONAL AMPLIFIER

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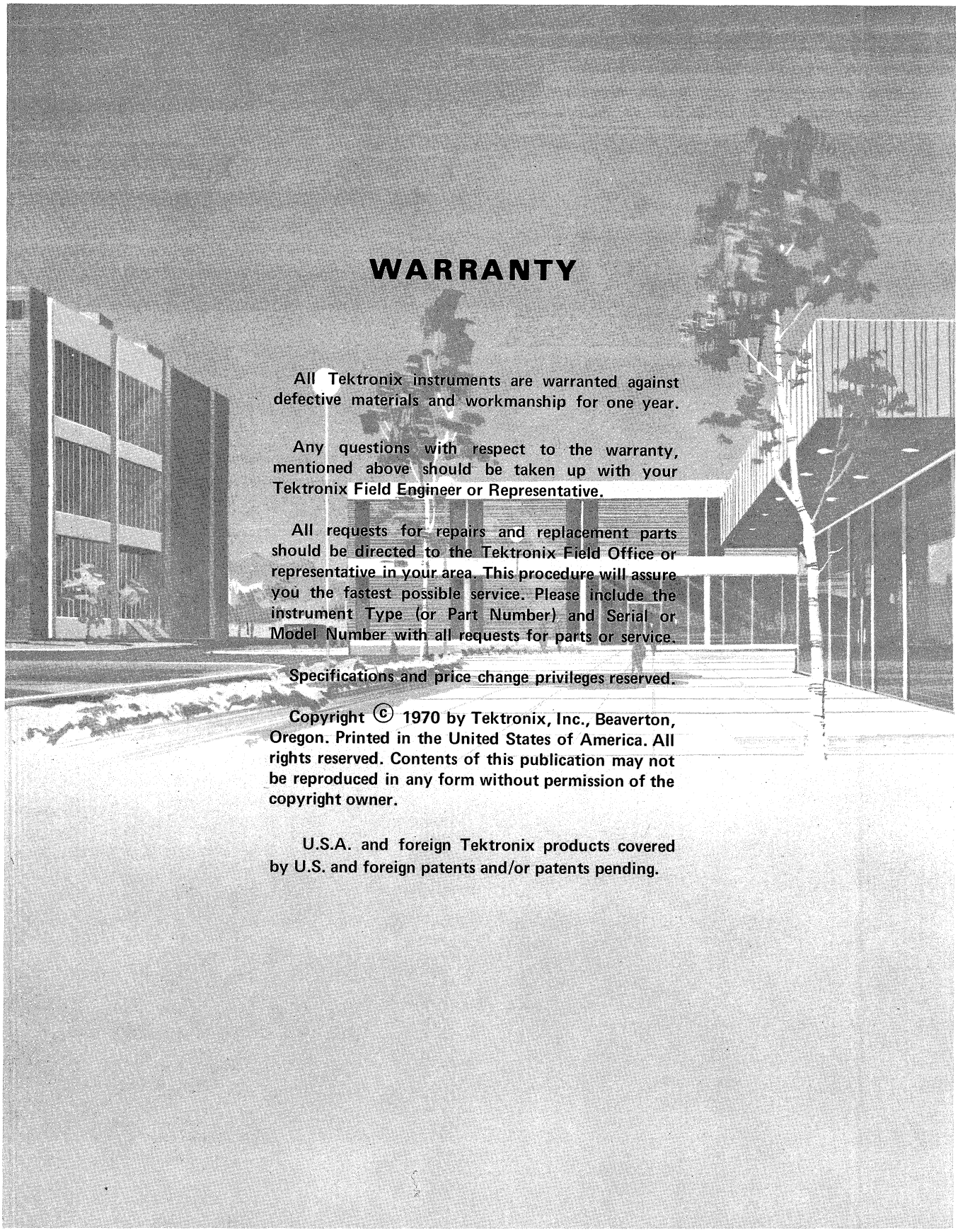

WARRANTY

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

Any questions with respect to the warranty, mentioned above should be taken up with your Tektronix Field Engineer or Representative.

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type (or Part Number) and Serial or Model Number with all requests for parts or service.

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	CHANGE INFORMATION	

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

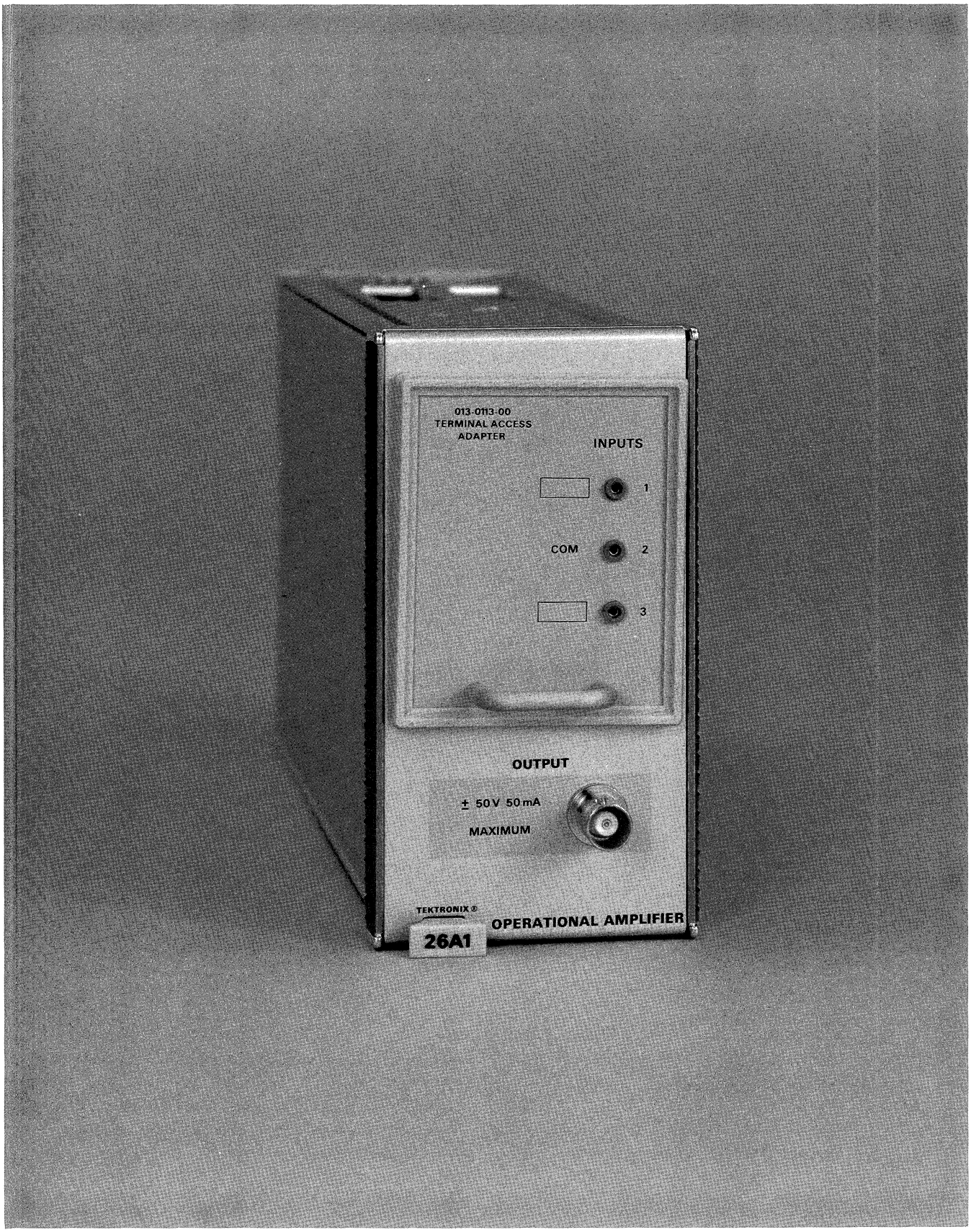


Fig. 1-1. 26A1 Operational Amplifier.

SECTION 1
SPECIFICATION

Change information if any, affecting this section will be found at the rear of the manual.

Introduction

The 26A1 is a high power operational amplifier plug-in unit designed for use with 2600-Series Mainframes. The unit has a wide output voltage swing, centered at zero, high common-mode range, and a high slewing rate. The unit is suitable for final processing of signals generated in the 2600-Series System.

The Terminal Access Adapter, which plugs into the plug-in unit, can be wired by the user for any operational amplifier function. The adapter provides access to the front-panel connectors, regulated +15 and −15 volt supplies, and the amplifier inputs and outputs. The adapter also provides clips and jacks for connecting electrical components into the input and output circuits.

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Gain, Open Loop	At least 10,000 into a 1 kΩ load	
Common-Mode Rejection Ratio	At least 10,000:1 at 60 Hz	
Unity Gain Bandwidth	At least 5 MHz into a 1 kΩ load	
Input		
Maximum Safe Differential Input		100 V
Common-Mode Input Voltage Range		At least + and −50 V
Input Leakage Current	300 pA or less at 25°C increasing to 1.5 nA at 50°C	
Equivalent Input Drift		100 µV/°C or less
Equivalent Input Noise		10 µV RMS or less
Slew Rate	50 V/µs or greater into a 1 kΩ load	
Output		
Voltage Range	At least + and −50 V	
Current Limit		+ and −50 mA or greater
Resistance		150 Ω or less
Maximum Current to Terminal Access Adapter		
+15 V		20 mA
+5 V		50 mA
−15 V		20 mA

Accessories

An illustrated list of Standard and Optional Accessories for the 26A1 will be found at the end of the Mechanical Parts List pullout pages.

NOTE

The pin jacks on the Terminal Access Adapter front panel and circuit board are based upon a standard 40-mil (0.40 inch or ≅1 mm) pin diameter. These items are manufactured by Cambion (Cambridge Thermionic Corp.) and others. Allied Radio Shack catalogs the basic elements of this 40-mil system.

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The 26A1 Operational Amplifier is one of a series of plug-in modules and mainframes in the 2600 system. The 26A1 and other units in the series may also be plugged into 7000-Series Oscilloscopes using an adapter.

To use the 26A1 effectively, the operation and capabilities of the instrument should be understood. This section describes the function of the Input and Output connectors and the Terminal Access Adapter.

Inputs

The three 40-mil pin jacks on the Terminal Access Adapter front panel are connected to the points marked 1, 2 (COM), and 3 on the Terminal Access Adapter circuit board. Each of these points is also bused through to the rear edge connector, through the interface board wiring (mainframe) to terminals 1, 2, and 3 on the interconnection board (M1, M2... corresponding to the plug-in compartment occupied by the 26A1).

Output

The single BNC front-panel OUTPUT connector provides access to the Operational Amplifier via the Terminal access Adapter PANEL JACK and AMP OUT pin jacks and clips.

The bandwidth of the amplifier may be reduced, if desired, by adding capacitance at Test Points 1 and 2 (see Fig. 2-1).

If more than a foot or two of coaxial cable is to be used at the output, an isolation resistor equal to cable impedance should be connected between the Amplifier output and the OUTPUT connector to prevent excessive ringing due to capacitive loading. This can be done conveniently on the Terminal Access Adapter. Feedback components must be connected ahead of the isolation resistor.

Terminal Access Adapter

The Terminal Access Adapter circuit board provides convenient access to the Operational Amplifier inputs and output. The circuit board component mounting clips and pin jacks, as well as the regulated +15 volts, −15 volts, and COM are arranged to give maximum interconnection flexibility.

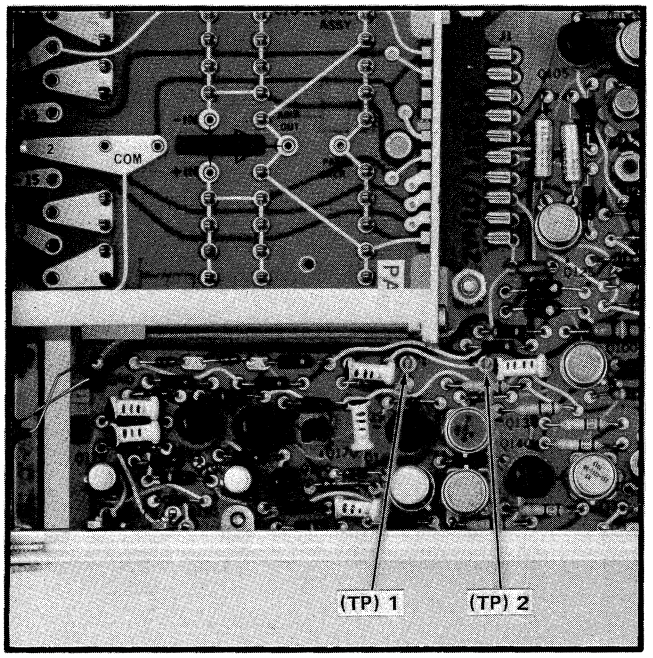


Fig. 2-1. Location of Test Points 1 and 2 (Optional Bandwidth Limiting).

The component kit included with the 26A1 contains several resistors and capacitors of values suitable for commonly used operational amplifier circuits.

Some examples of these configurations are shown in Figs. 2-2 through 2-5.

Also shown Fig. 2-6 is a more complex circuit, using an integrated operational amplifier (mounted on the Terminal Access Adapter circuit board) to provide X5 gain with ±50 volt variable offset capability.

An optional accessory to the 26A1, the Terminal Access Adapter Kit, (013-0114-00) is convenient for the construction of this and other custom adapter circuits. The kit contains a blank front panel, a circuit board with a 0.1 x 0.1-inch grid of pads and plated through holes, and necessary assembly hardware.

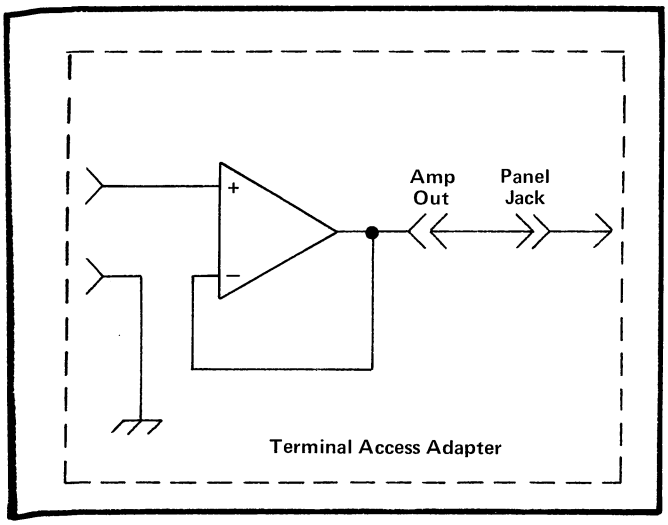


Fig. 2-2. X1 Non-inverting amplifier (follower).

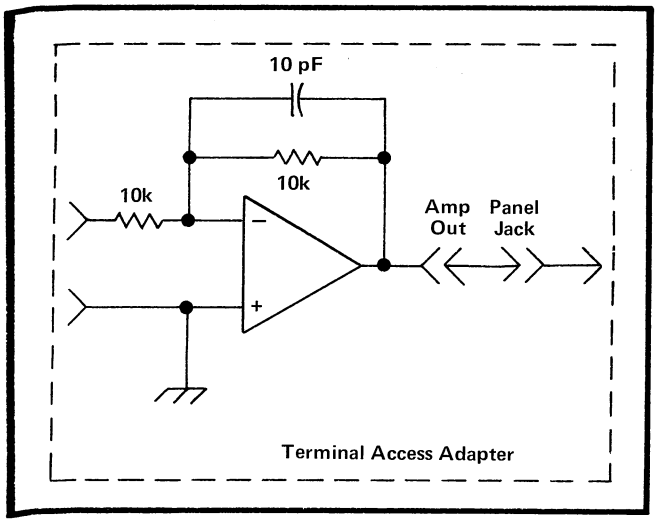


Fig. 2-3. X1 Inverting amplifier.

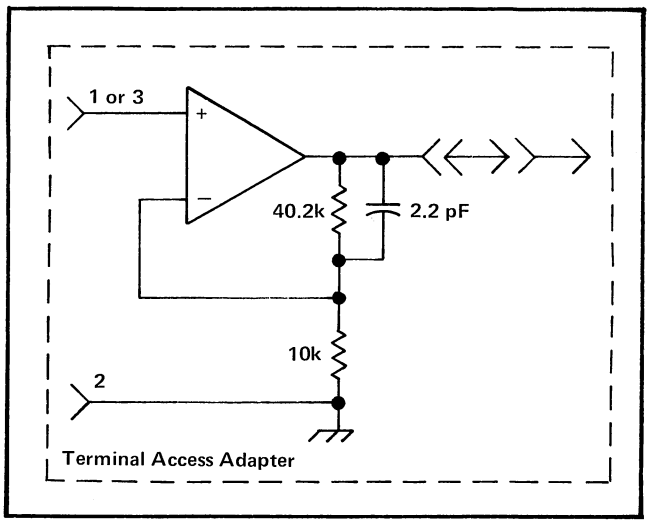


Fig. 2-4. X5 Non-inverting amplifier.

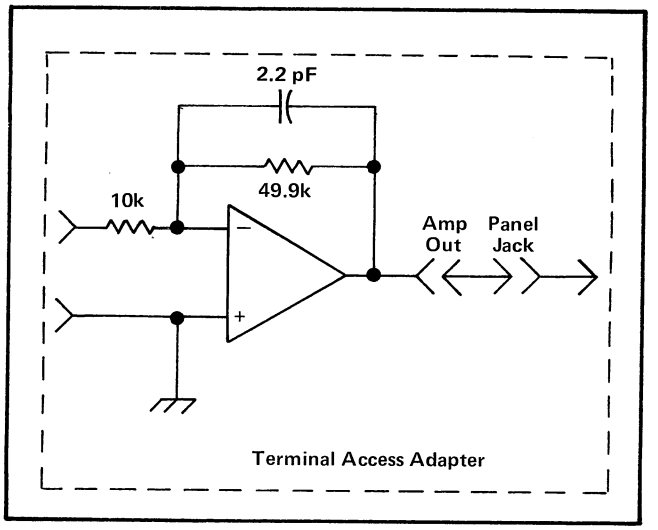


Fig. 2-5. X5 Inverting amplifier.

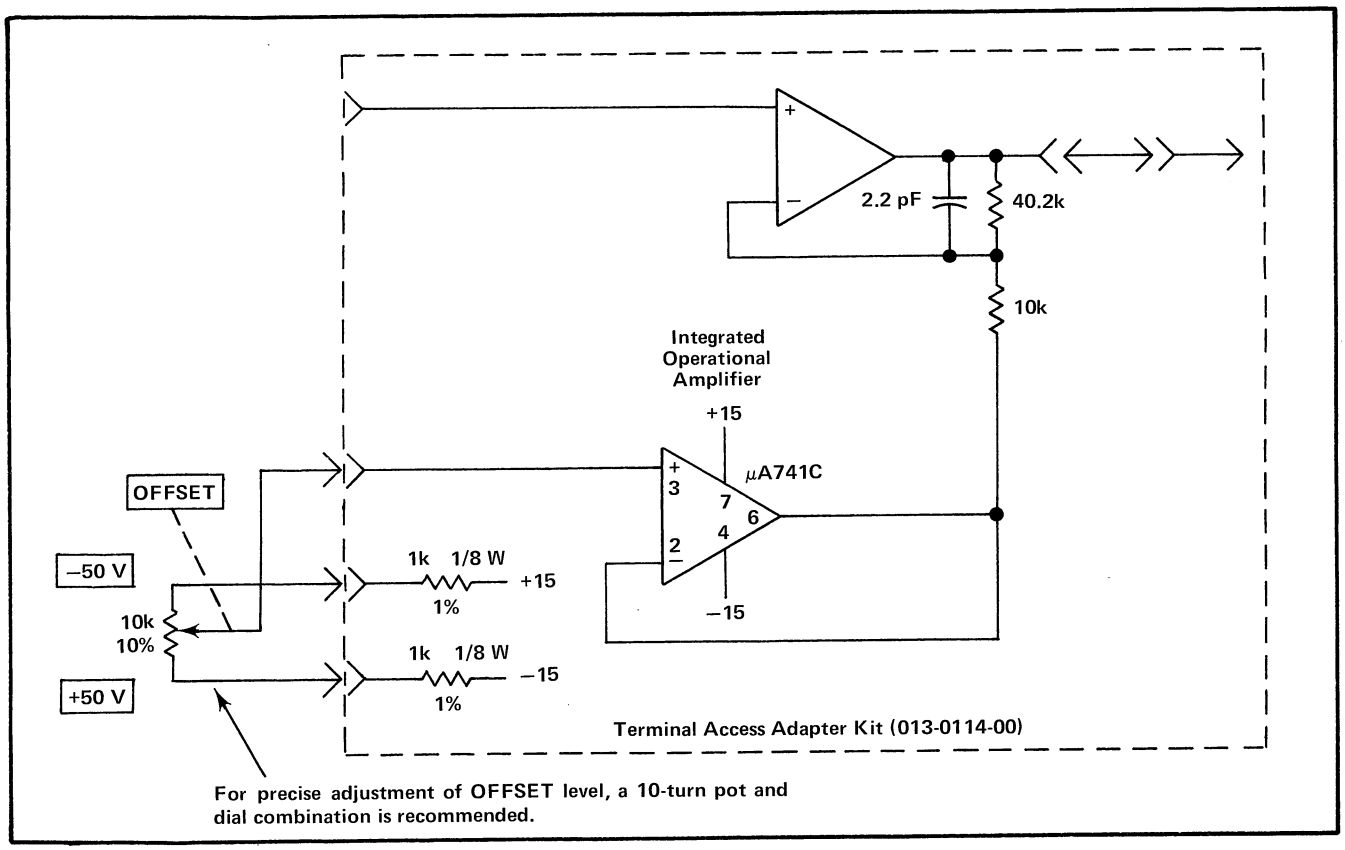


Fig. 2-6. X5 Amplifier with offset.

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains a description of the circuits in the 26A1.

Simplified drawings are provided where necessary for easier understanding. Complete schematics are included in the Diagrams Section. The diagrams should be referred to throughout the detailed circuit description.

Symbols used on the schematics diagrams are explained on the first foldout diagram in the Schematic Diagrams Section.

General

The 26A1 plug-in unit is a feedback amplifier having low output impedance, high overall gain, high output voltage and current capabilities and excellent stability.

The high gain section of the amplifier consists of the input FETs with their current sources, and the output current sources, which serve as high impedance loads for the FETs. The gain is G_mR_o where G_m is the transconductance of the input FETs, and R_o is the impedance of the feedback amplifiers used as signal current sources at the output.

The Output stage is a unity gain amplifier having a very high input impedance and low output impedance. The output stage is capable of ±50 volts at 50 mA.

Input Amplifier

The input FETs use a conventional current source, Q125, that provides a constant current, fixed by the divider R101, R102, R126 and VR126.

The source-to-drain voltage of the input FETs is maintained at a constant value by VR110 and Q110, so that even through the common-mode input level may change, the FET characteristics remain constant.

CR100 and R100 provide impedance at Q120 (+Input) drain equivalent to the impedance at −Input drain.

Q105 is the current source for VR110. Q125 provides about 6 mA and Q105 needs about 2 mA. This leaves about 4 mA for Q120. Thus, when Q120 is balanced, each side of Q120 has 2 mA.

VR126 and R101, R012, R105, R125, and R126 set a relationship between current sources Q105 and Q125 so that any current change in one is matched by an equal change in the other. This keeps Q120 total current constant, and thus maintains amplifier stability with temperature and supply variations.

The 2 mA flows in common base stage Q100, providing 2 mA to the controlled signal current source Q130-Q135.

The same condition exists in the Q115-Q140 side of the amplifier, supplying 2 mA to Q145-Q150.

Differences in characteristics of the active components can be balanced out using the Offset Null control, R122.

The feedback amplifier, Q130-Q135 and its counterpart, Q145-Q150, acting as signal current sources, make possible wide voltage swings at the collectors, providing current change out equal to current in; and present very high impedance loads to the input FET drain current.

The voltage at the base of Q135 sets the bases of Q130A and Q130B at the same level. Since the bases are at the same levels the emitter currents will be equal. Therefore, whatever current is seen in Q130A will be duplicated in Q130B and Q135. The result is that for a given current in, the output current remains essentially constant with respect to the output voltage. The effective load impedance, seen by the input FET drain signal current is ≅10 MΩ. This configuration provides a single voltage amplification point, a single RC amplitude vs. frequency rolloff, which is desirable to prevent oscillation when using 100% feedback.

CR130 and CR135 (CR140-CR145) prevent Q135 (Q145) saturation when full differential voltage is applied at the input.

VR135 and VR140 limit the voltage at the common output point to a maximum of 52 volts, preventing saturation in the output amplifier.

CR137 is a voltage dropping diode used to compensate for an inequality in junction drops from side to side in the output amplifier.

No harm can be done to the input, even if the input drive is maximum (+50 V and −50 V). The range of the amplifier will have been exceeded (it will be locked up at one end), but as the gate-to-drain breakdown of Q120 is reached, the current limiting diode CR120 (CR124) limits the input current to 1 mA, protecting the FET. Below this point, CR120 (CR124) behaves as a low value resistor, ≅1-2 kΩ.

C118 and R119 prevent oscillation at the higher frequency limits. C116 improves the slewing rate during high common-mode voltage swings. The bandwidth may be reduced, if desired, by the addition of capacitance at Test Points 1 and 2.

Output Amplifier

The output amplifier is a unity-gain voltage-follower impedance-transforming amplifier.

Q170 is an emitter follower, having a current source Q165, feeding two successive emitter followers, Q172 and Q175.

Q180 is an emitter follower, having a current source Q190, feeding a unity-gain feedback amplifier, Q182 and Q185.

The sum of the diode and base-emitter drops around the loop starting at Q185 collector (Q182 emitter) and progressing clockwise to Q175 emitter is slightly greater than zero, and is impressed across R175 and R185 to set the standing current in the output transistors.

With the input FET gates tied together, the output voltage (at the junction of R175-R185) is zero.

R168-R193 are part of a current-limiting circuit. As the load current increases to a value near the limit, the drop across R168 causes CR165 to turn on, stealing emitter current from the current source, Q165. When the load current reaches its limit, enough current is diverted from Q165 to shut off Q170 and prevent the output from moving any further positive.

The same current limiting occurs in the other direction (negative swing at the output). R193 senses the load current, CR190 turns on, stealing current from Q190, preventing the negative driving signal from driving the output too far negative.

CR175-CR185 prevent Q170-Q180 from reaching base emitter reverse breakdown during conditions of output overload or short circuit.

C175-R186 prevent oscillation when the output is capacitively loaded.

DC to DC Converter (+60 and −60 volts)

The DC to DC converter is a conventional two transistor square wave switching type converter with some variations. Q10 and Q40 get switched on and off alternately, except that there is a built-in delay which prevents one side switching on until the other side has been off for a brief interval. This action allows the transformer voltages to swing at their resonant frequency.

Assuming that Q10 is switched on, transformer pin 9 is positive, reinforcing the on state of Q10. Transformer pin 7 is negative, holding Q20 off until charging of C21 through R21 allows the base of Q20 to go positive. As Q20 base goes positive, Q20 turns on, turning Q10 off. The feedback cycle starts as transformer pin 1 starts positive and pin 7 starts to go positive. Pin 7 will now start to supply base drive to Q40, except that C30 must charge before Q40 can turn on. This action assures that Q40 will not turn on until Q10 has been off for a short period. As pin 9 goes negative, Q30 is turned off and can't come on until C29 can charge through R29. When Q30 base rises to the conduction point, the switch again restores the circuit to the original state.

Since both Q20 and Q30 turn on when power is applied, the switching action is not self-starting. To start the switching action at turn-on, or after the 60-volt output is short-circuited, the starting circuit functions.

With the 60-volt output at zero, the bottom of R27 is zero and the top of R26 is at +15 volts. The voltage at Q25 anode is initially zero and will rise toward approximately +7 volts as C27 charges. When Q25 (a programmable unijunction transistor) anode reaches +0.6 volt, Q25 conducts at a very low impedance, pulling the junction of R21, R29 to approximately −15 volts. Q20 and Q30 turn off, the base of Q15 goes negative, Q15 turns on, providing base current for Q10, starting the switching action. As the −60-volt output rises (toward −60) Q25 anode drops below −15 V, Q25 shuts off, Q15 turns off and the converter operates normally, Q15 and Q25 will remain turned off as long as the converter produces 60-volt output.

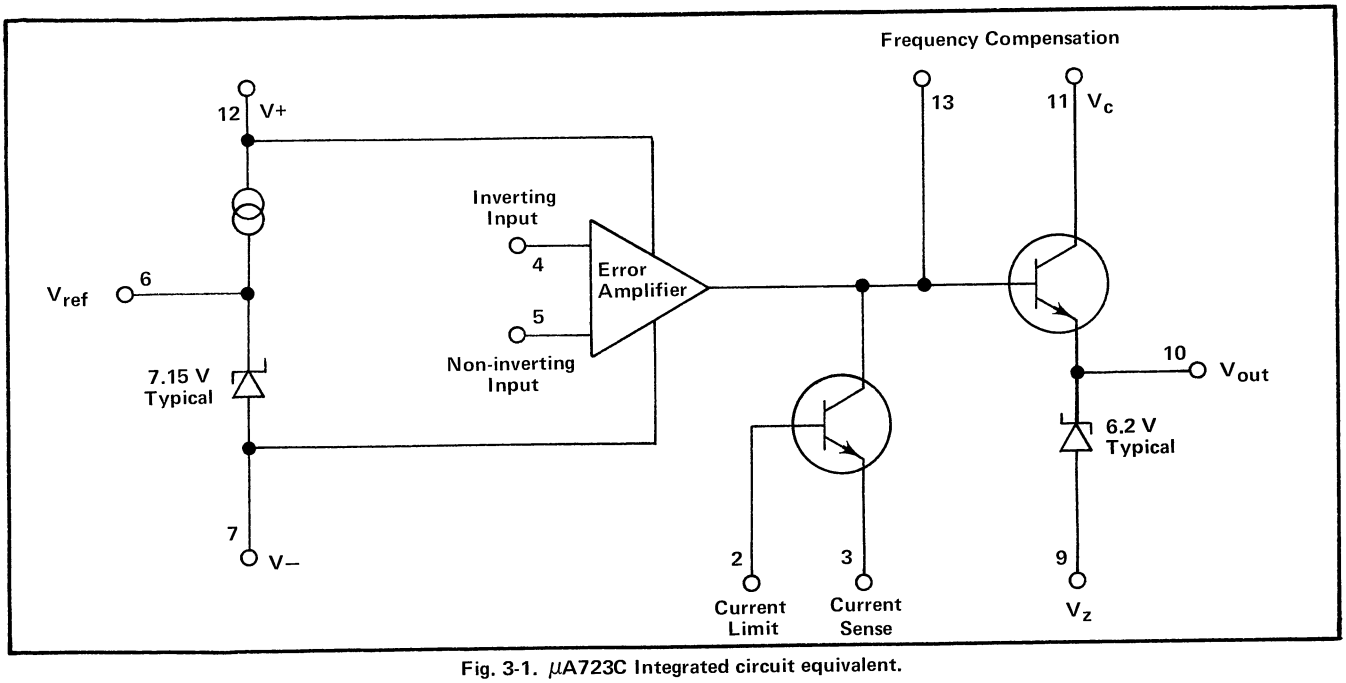


Fig. 3-1. μA723C Integrated circuit equivalent.

The staring circuit will attempt to restart the switching action. If the output does not come up for any reason, the starting circuit will attempt approximately once each second to restart the converter.

CR1, CR2, CR3, and CR4 rectify the transformer secondary voltage. The DC output of the rectifiers is filtered by C1, C2, C3, C4, L1 and L3.

Low Voltage Power Supply

The regulated DC is supplied in two stages, (1) preregulation of the transformer primary in the mainframe and (2) regulation in the 26A1 of the three individual voltages supplied by the mainframe power supply (transformer secondary).

Each of the three mainframe supplies (−17 V, +7 V, and +17 V) is rectified and filtered in the mainframe and supplied to the 26A1 unit via the rear connector.

The heart of each regulator is a μA723C integrated precision voltage regulator containing a feedback amplifier, reference voltage, current limiter, and output emitter follower. Fig. 3-1 shows an equivalent circuit of the μA723C.

R230 and R232 (with the temperature compensated Zener in the μA723C) provide the reference voltage for the −15-volt supply. −15 volts is the reference for the +5-volt and +15-volt supplies.

VR215 provides negative operating voltage for the +5- and +15-volt supplies.

Q200, Q210, and Q220 are series-pass transistors for the +15-, +5-, and −15-volt supplies, respectively, and R205, R211, and R222 establish μA723C output transistor current.

R207, together with the transistor (pins 2 and 3 on μA723C) limits the base drive to Q200, allowing Q205 to limit output current.

R200 is a shunt path to protect Q200 during excessive loads on the +15-volt supply. R203, in parallel with R204, senses load current, turning Q205 on to divert base current from Q200 on heavy output overloads or short circuit. This circuit protects the series pass transistor as well as limiting current from the preregulated +17-volt supply.

R210 senses the +5-volt supply load current. During output current overload, the potential developed across R210 reduces the current drive to Q210, thus limiting output current.

R221 protects Q220 during excessive loads on the −15-volt supply. R223, in parallel with R224, senses load current, turning on transistor in the μA723C which diverts base drive current from Q220, limiting the output current to a safe value.

Error voltage is fed back to the −Input from the dividers, R201-R202, R212-R213, and R220-R225-R226 (R225 being the −15-volt adjust).

C207, C215, and C225 prevent oscillation in the feedback loop.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains maintenance information for use in preventive or corrective maintenance and troubleshooting of the 26A1.

Cleaning

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

Semiconductor Checks

Periodic checks of the semiconductors in the 26A1 are not recommended. The best check of semiconductor performance is actual operation in the instrument.

Recalibration

A calibration check is recommended after each 1000 hours of operation or every year if used infrequently. Replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in the Performance Check/Adjust section.

TROUBLESHOOTING

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 7. The circuit number and electrical value of each component are given on the diagrams. Important voltages are also shown.

Circuit Boards. The circuit boards used in the 26A1 are outlined with a tint band on the Schematic Diagram, and a photograph of each board is shown to the left of the diagram. Each board-mounted electrical component is identified on the photograph by its circuit number.

Voltages and Waveforms. Often the defective components can be located by checking for the correct voltage or waveform in the circuit. Typical voltages are given on the Schematic diagrams. These voltages are not absolute, and may vary slightly from instrument to instrument. To obtain operating conditions similar to those used to take the reading, see the instructions in the Schematic Diagrams section.

Power Supply Voltage and Ripple. Table 4-1 lists the voltage and ripple tolerance of the power supplies in the 26A1. If a power supply voltage and ripple are within the listed tolerance, the supply can be assumed to be working properly. If outside the tolerance, the supply may be misadjusted or operating incorrectly.

TABLE 4-1

Supply	Ripple	Voltage
−15	3 mV, p-p	−15 V, ±40 mV
+5	2 mV, p-p	+5 V, ±50 mV
+15	3 mV, p-p	+15 V, ±150 mV
+60	100 mV, p-p	+60 V, −1 V, +3 V
−60	100 mV, p-p	−60 V, +1 V, −3 V

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 26A1.

1. Semiconductor Tester. Some means of testing the transistors and diodes used in the instrument is helpful. Since most of the semiconductor devices are used in a digital function, probably the most convenient check is that of measuring the junction resistance. For more complete tests, the Tektronix Type 576 is recommended. The most convenient method of integrated circuit check is substitution.

2. DC Voltmeter and Ohmmeter. For most applications a 20,000 ohms/volt VOM can be used to check voltages and resistance, if allowance is made for the circuit loading when making voltage measurements at high impedance points.

3. Test Oscilloscope. A test oscilloscope is required to check circuit waveforms. An oscilloscope having a DC to 10 MHz frequency response and 1 mV/Div to 10 V/Div vertical deflection factor is suggested. A 10X probe should be used where circuit loading is critical.

REPLACEMENT PARTS

Standard Parts

All electrical and mechanical parts replacements for the 26A1 can be obtained through your local Tektronix Field Office or Representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before buying or ordering replacement parts, check the parts lists for value, tolerance, rating and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the instrument performance.

CAUTION

Multi-layer circuit boards require extra care when replacing soldered components. Excess heat can cause the board laminations to separate and conductors to release. Many components have clinched leads which should be straightened before removal so as not to damage the plated through-holes. Such damage may result in irreparable loss of connection to an inner layer conductor.

Special Parts

Some parts are manufactured or selected by Tektronix, Inc. to satisfy particular requirements, or are manufactured for Tektronix, Inc. to our specifications. These special parts are indicated in the parts lists by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., refer to the Parts Ordering Information and Special Notes and Symbols on the page immediately preceding the Electrical Parts List section. Include the following information:

1. Instrument Type (26A1)

2. Instrument Serial Number

3. A description of the part (if electrical, include the circuit number).

4. Tektronix Part Number

COMPONENT REPLACEMENT

General

The exploded-view drawings associated with the Mechanical Parts Lists (Fig. 1, pullout page) may be helpful when disassembling or reassembling individual components or sub-assemblies.

Circuit Board Replacement

The circuit board can be easily removed using the following procedure:

1. Remove the four machine screws holding the rear plastic connector-guide assembly to the top and bottom rails.

2. Remove the connector-guide assembly. See Fig. 4-1.

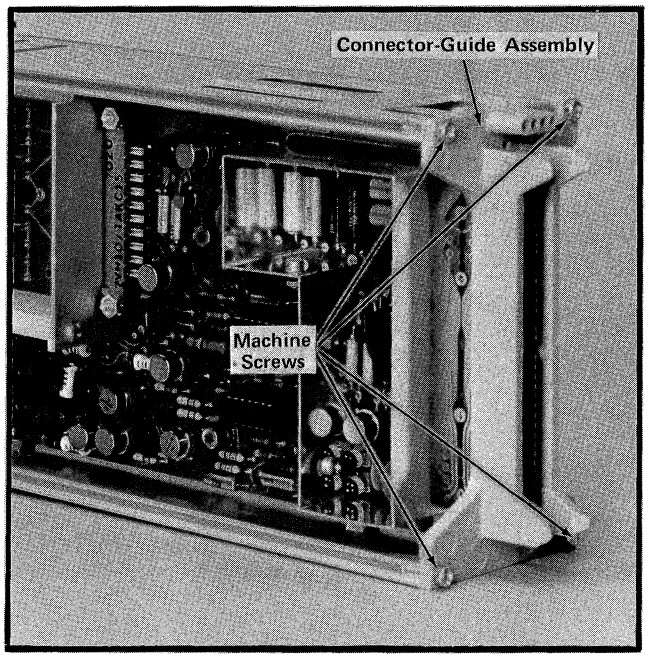


Fig. 4-1. Circuit board replacement.

3. Remove the flat-head machine screw holding each of the flat-pack transistors Q175 and Q185 (front of the bottom rail). See Fig. 4-2.

4. Unsolder the Output and Gnd leads at the BNC connector.

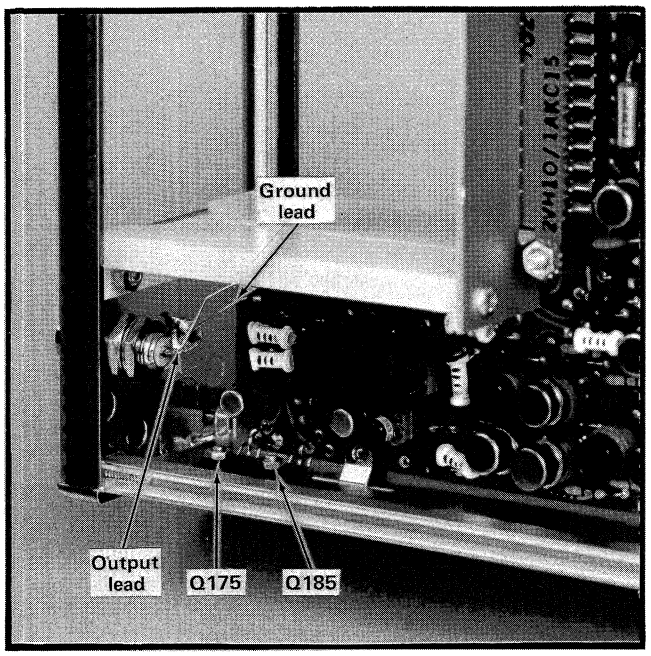


Fig. 4-2. Component locations pertinent to circuit board removal.

5. Remove the three machine screws which hold the circuit board to the top and bottom rail brackets.

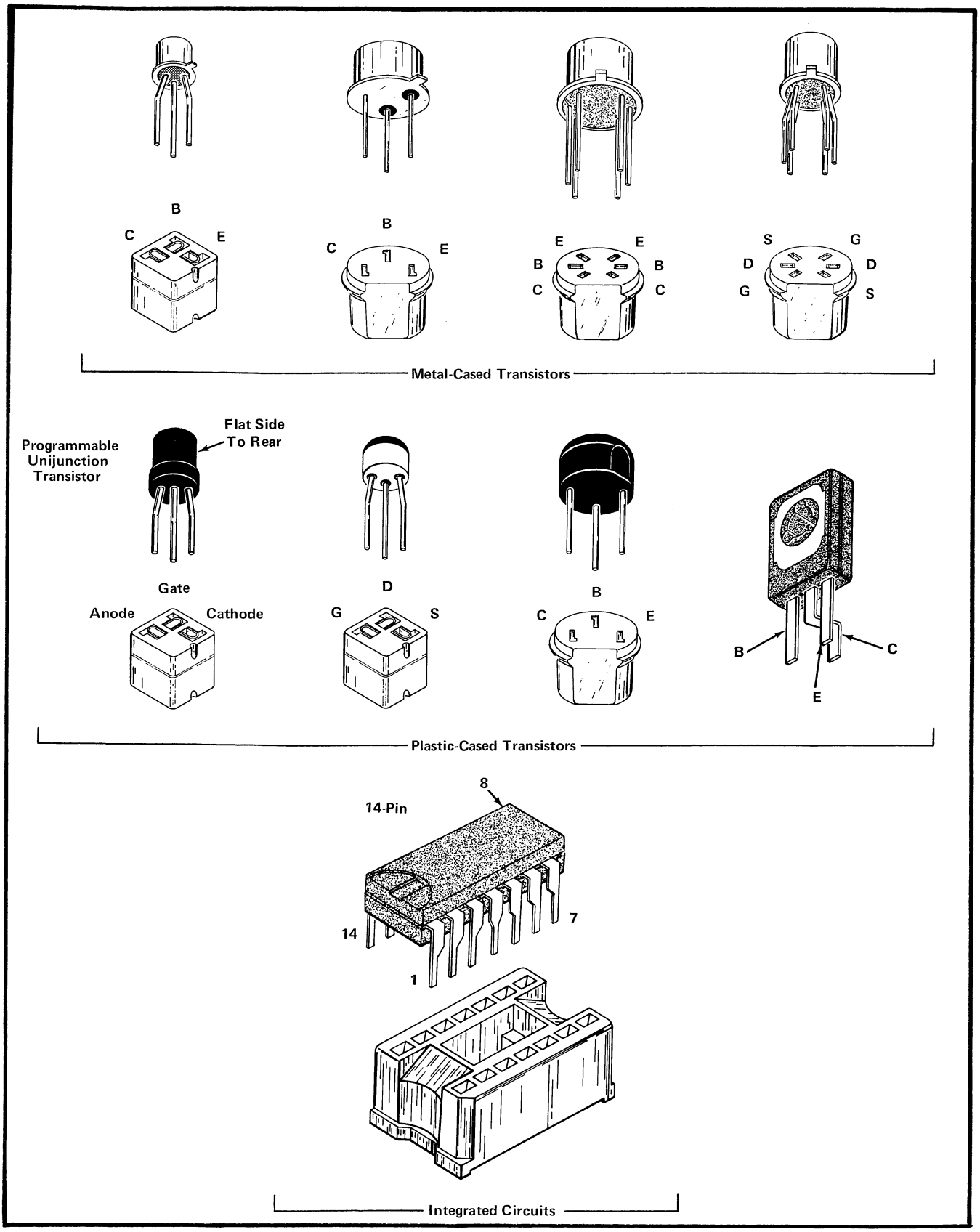
6. Slide the circuit board to the rear.

Semiconductor Replacement

Replacement semiconductors should be of the original type or a direct replacement. Fig. 4-3 shows the lead configuration of the semiconductors used in this instrument. Some plastic case transistors may have lead configurations which do not agree with these shown here. If a replacement transistor is made by a manufacturer other than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the standard basing as used for metal-cased transistors.

An extracting tool should be used to remove the 14-pin integrated circuits to prevent damage to the pins. A removing tool is available from Tektronix, Inc., as Part Number 003-0619-00. If an extracting tool is not available for removal of integrated circuits, pull evenly on both ends of the device. Avoid having one end of the package disengage from the socket ahead of the other.

NOTES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Plastic-Cased Transistors
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1
Integrated Circuits

Fig. 4-3.

SECTION 5
PERFORMANCE CHECK /ADJUST

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

A calibration check is recommended every 1000 hours of operation, or every year if used infrequently. Before complete calibration, the instrument should be cleaned and inspected as outlined in the Maintenance section.

The Performance Check can be used to check instrument performance without making any internal adjustments.

Following the Performance Check is an Adjustment Procedure. Completion of the Adjustments insures that the instrument meets the electrical specifications given in Section 1.

NOTE

Limits, tolerances and waveforms in the Adjustment Procedure are given as calibration guides and should not be interpreted as instrument specifications except as specified in Section 1. Any waveforms shown in the procedure were taken with a Tektronix Oscilloscope Camera system.

TEST EQUIPMENT REQUIRED

General

The following Test Equipment and accessories, or equivalent, are required for complete check and adjustment of the 26A1.

Specifications given are the minimum necessary for accurate check or adjustment. Some of the recommended equipment may have specifications that exceed those given. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

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

Test Equipment

1. Sine Wave Generator. Frequency range, 60 Hz to at least 1 kHz; Amplitude to at least 2 volts, peak to peak. The General Radio GR1310A Oscillator is recommended.

2. Constant Amplitude Signal Generator, Frequency range to at least 5 MHz; Output amplitude, to at least 1 volt, peak to peak. The Tektronix Type 191 Constant Amplitude Signal Generator is recommended.

3. Square Wave Generator. Repetition Rate, 1 kHz; Output amplitude to 10 volts, peak to peak. The Tektronix Type 106 is recommended.

4. Test Oscilloscope, consisting of Indicator, Differential Amplifier, Differential Comparator, and Time Base.

Differential Amplifier. Deflection factor from .2 V/Div to 20 μV/Div.

Differential Comparator. Comparison voltage range from zero volts to −15 volts. Deflection factor, 10 mV/Div to 1 V/Div.

Time Base. Time/Div from 20 ms to 1 μs with 10X magnification.

The Oscilloscope recommended is the Tektronix 7504 with the following plug-in units.

7A22 Differential Amplifier
7A13 Differential Comparator
7B50 Time Base

5. 2600-Series Mainframe, to provide operating power for the 26A1.

6. Plug-in Extender. To provide access to the adjustment and test points in the 26A1.

7. Adapter. 40-mil pin to BNC cable (2 required). Tektronix Part Number 175-1178-00.

8. Coaxial Cable Assembly. 50 Ω with BNC connectors (2 required). Tektronix Part Number 012-0057-01.

9. Attenuator. 50 Ω; 10X attenuation. Tektronix Part Number 011-0059-01.

10. Attenuator. 50 Ω; 5X attenuation. Tektronix Part Number 011-0060-01.

11. Termination. 50 Ω, 2 Watt, GR to BNC. Tektronix Part Number 017-0083-00.

12. 1X Probe, with BNC connector. Tektronix Type P6011 is recommended.

13. 10X Probe, with BNC connector. Tektronix Type P6006 is recommended.

14. Resistors and capacitors as called out in the procedures.

PERFORMANCE CHECK PROCEDURE

General

The Performance Check procedure requires placement of components on the Terminal Access Adapter for each test. A schematic diagram is given for each test setup showing component values and test equipment connections.

Preceding each step is a test equipment control setting procedure.

The procedure uses the equipment listed under Test Equipment required. If other equipment is substituted, control settings or checking setup may need to be altered to meet the requirements of the equipment used. Operating instructions for the test equipment are not given in this procedure. Refer to the test equipment instruction manuals if more information is required.

NOTE

The performance of this instrument may be checked at any temperature from 0°C to +50°C, provided that the instrument was adjusted within an ambient range of +20°C to +30°C.

Set the Test Equipment controls as follows:

Sine Wave Generator	
Frequency	60 Hz
Output Level	1 volt
Test Oscilloscope	
Differential Amplifier	
Volts/Div	.2 V
+Input	DC
−Input	Gnd
HF 3 dB Point	1 kHz
LF 3 dB Point	DC
Time Base	
Time/Div	20 ms
Triggering	
Mode	Auto
Source	Int
Coupling	AC
Display Mode	Time Base

NOTES

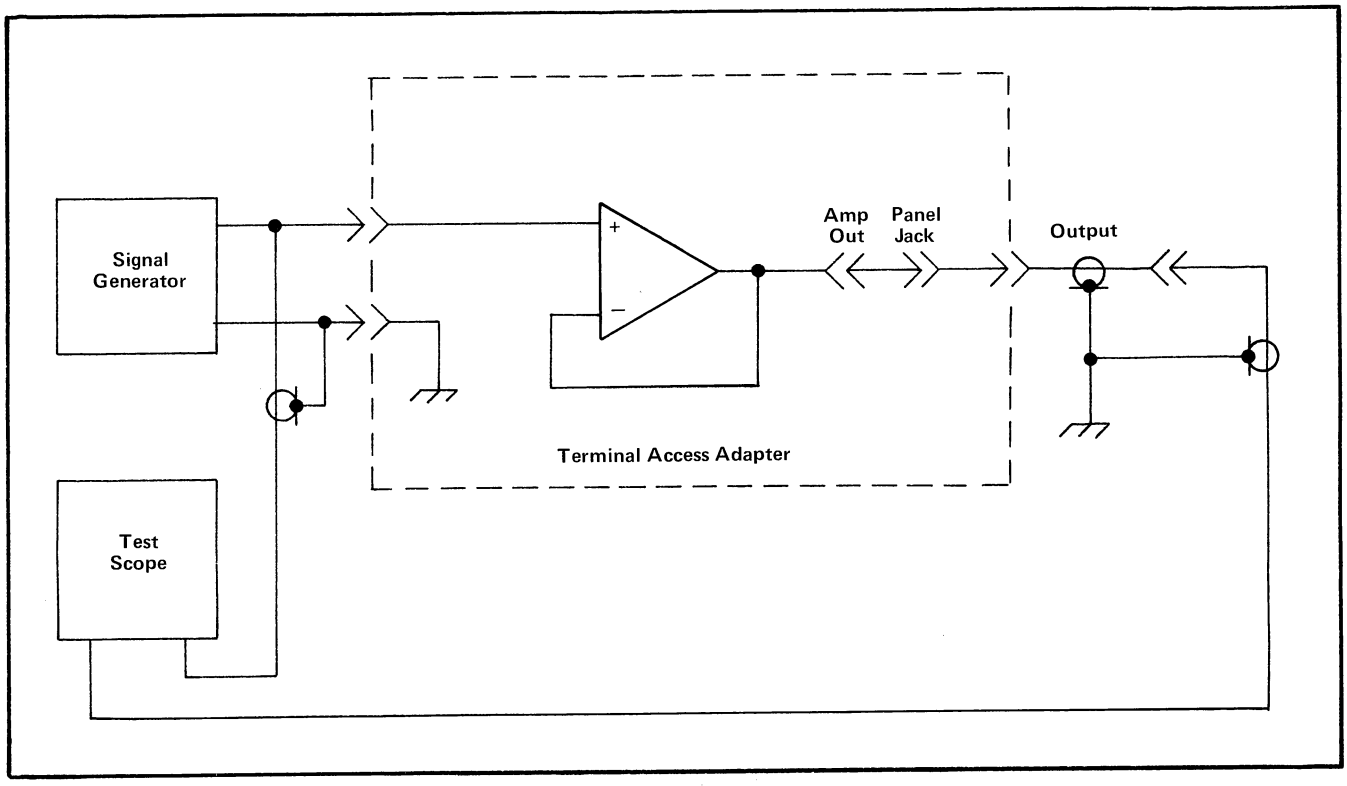

Fig. 5-1. Setup for measuring Common-Mode Rejection Ratio.

1. Check Common-Mode Rejection Ratio

a. Connect the Terminal Access Adapter as diagramed in Fig. 5-1.

b. Connect the Sine-Wave Generator Output to the Differential Amplifier +Input and to the 26A1 INPUT 1 and 2 (COM).

c. Connect the 26A1 OUTPUT to the Differential Amplifier −Input.

d. Set the Sine Wave Generator Output to exactly 5 divisions on the Test Scope.

e. Switch Differential Amplifier −Input to DC.

f. Set Differential Amplifier Volts/Div to 20 μV.

g. CHECK—That the display amplitude is ≤5 divisions. (Calculate the common-mode rejection ratio from

$$CMRR = \frac{e_{in}}{e_{difference}} :1, \frac{1\ V}{100\ \mu V} = 10{,}000:1.$$

Set the Test Equipment controls as follows:

Signal Generator	
Frequency	1 kHz
Test Oscilloscope	
Vertical	
Volts/Div	1 V
Input	DC
Time Base	
Time/Div	2 ms
Magnifier	X1
Triggering	
Mode	Auto
Coupling	AC
Source	Int

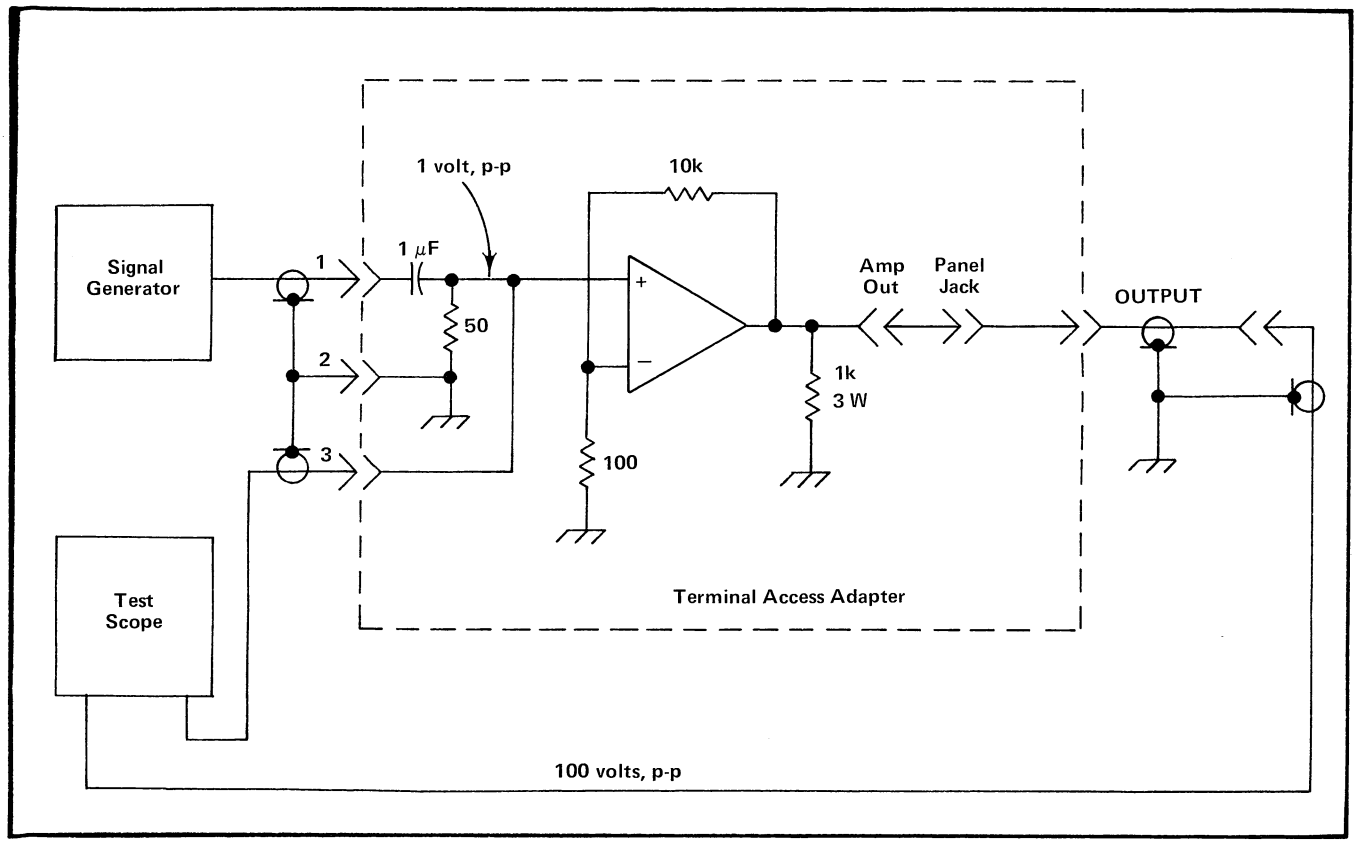

Fig. 5-2. Setup for checking Output Voltage Range.

2. Check Output Voltage Range

a. Connect components on the Terminal Access Adapter as diagramed in Fig. 5-2.

b. Connect Signal Generator Output via 40-mil pin to BNC Adapter cable to Terminal Access Adapter jacks 1 and 2 (COM).

c. Connect Terminal Access Adapter jacks 3 and 2 (COM) to Test Scope Vertical Input via 40-mil pin to BNC Adapter cable.

d. Adjust Signal Generator Output Amplitude to set the input level to the Operational Amplifier +Input to exactly 1 volt (1 division).

e. Reconnect the Test Scope Vertical Input via a 10X probe to the 26A1 OUTPUT.

f. CHECK–That the Output amplitude Range is ±50 volts (5 divisions with center at zero volts).

Set the Test Equipment controls as follows:

Sine-Wave Generator	
Frequency	100 Hz
Test Oscilloscope	
Volts/Div	2 V
Input Coupling	DC
Time/Div	1 ms
Triggering	Internal AC

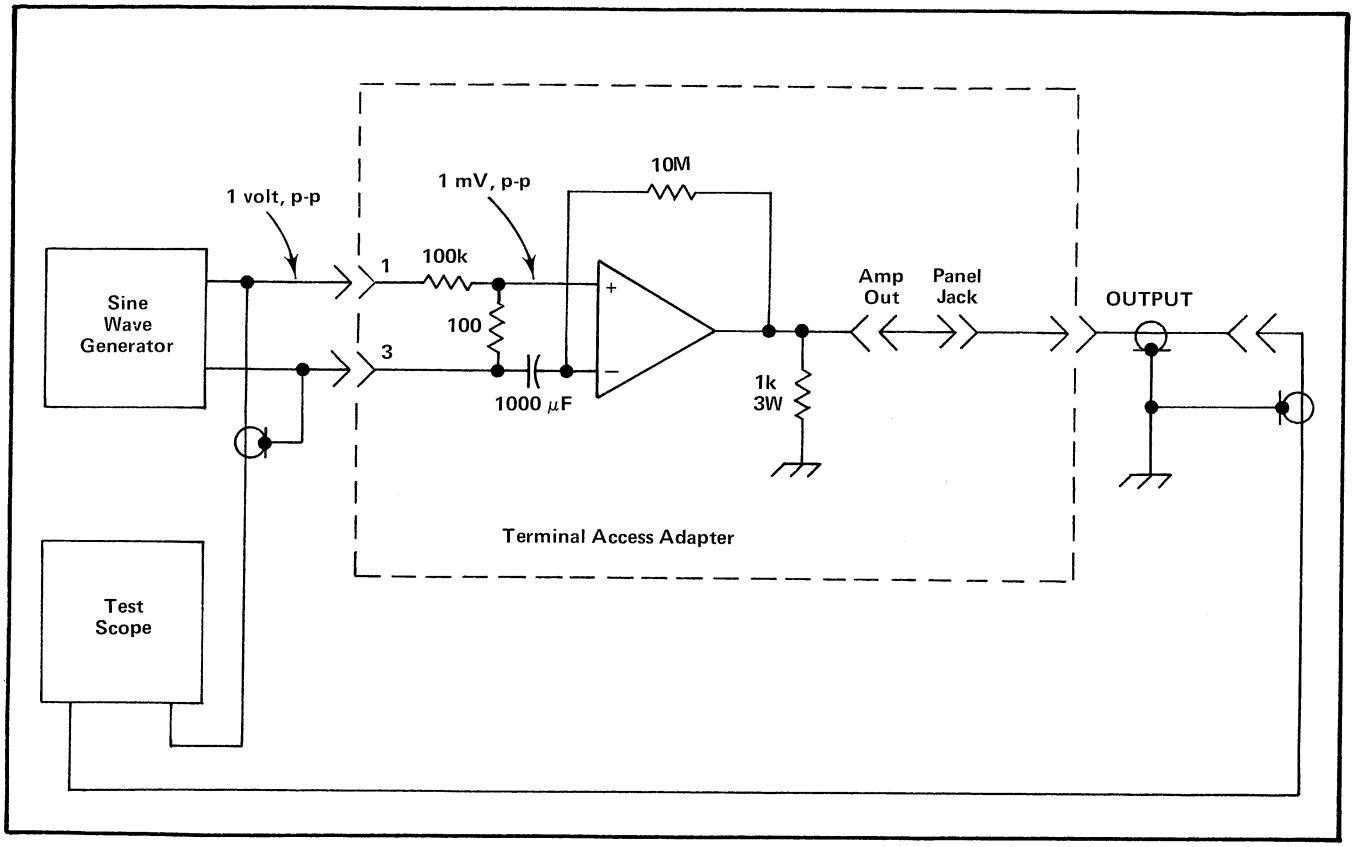

Fig. 5-3. Setup for checking Open Loop Gain.

3. Check Open Loop Gain

a. Connect the components on the Terminal Access Adapter circuit board as diagramed in Fig. 5-3.

b. Connect a Sine-Wave Generator to Terminal Access Adapter Input Terminals 1 and 3.

c. Set the input signal level (pins 1 and 3) to exactly 1 volt, peak to peak (1 mV into Operational Amplifier +Input).

d. CHECK–That the signal amplitude at the OUTPUT connector is at least 10 volts, peak to peak.

$$\text{Open Loop Gain} = \frac{e_{out}}{e_{in}} = \frac{10\text{ V}}{1\text{ mV}} = 10{,}000.$$

Set the Test Equipment controls as follows:

Constant Amplitude Signal Generator	
Frequency	5 MHz
Output Amplitude	1 V
Test Oscilloscope	
Vertical	
Volts/Div	.2 V
Input Coupling	DC
Time Base	
Time/Div	1 μs
Triggering	
Mode	Auto
Coupling	AC
Source	Int
Display Mode	Time Base

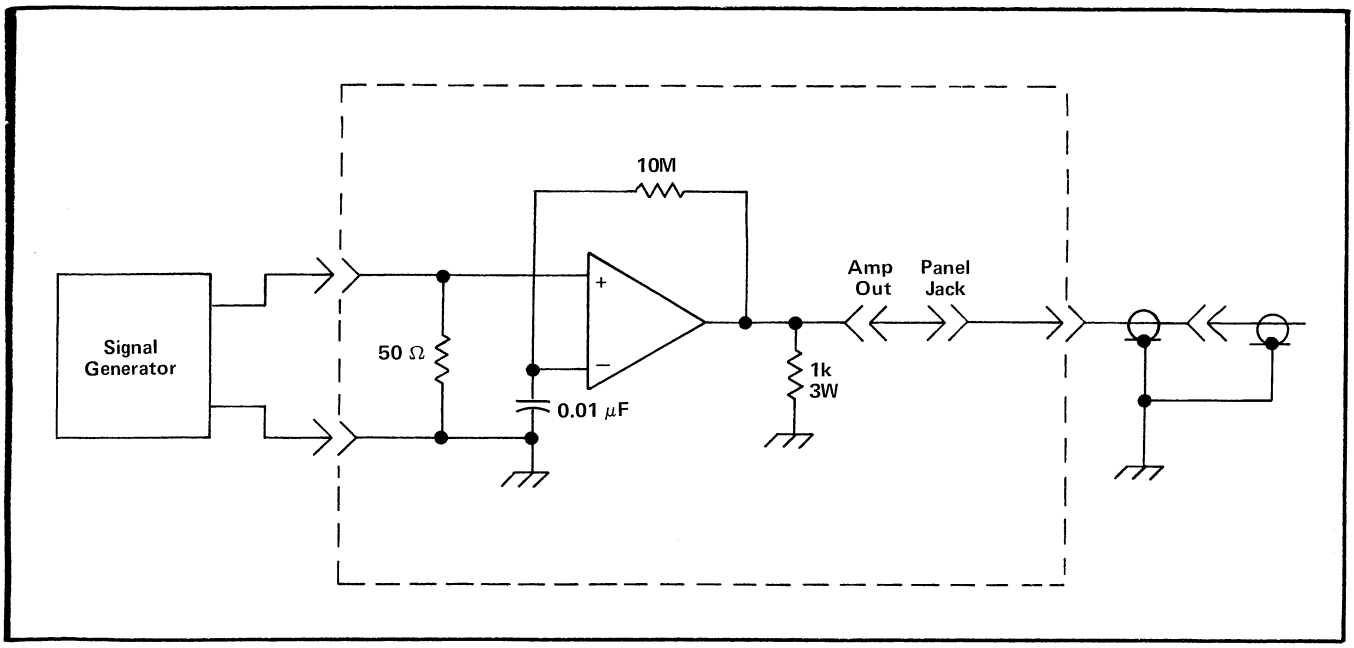

Fig. 5-4. Setup for checking Unity Gain Bandwidth.

4. Check Unity Gain Bandwidth

a. Connect the Terminal Access Adapter as diagramed in Fig. 5-4.

b. Connect the Signal Generator through a 50 Ω BNC cable to Test Scope Vertical Input.

c. Set the Signal Generator Amplitude to display exactly 5 divisions (1 volt) on the Test Scope.

d. Connect the signal through a 40-mil pin to BNC Adapter cable to the Terminal Access Adapter Input 1 and 2 (COM).

e. Connect the 26A1 OUTPUT to the Test Scope Vertical Input.

f. Increase the Signal Generator frequency until the 26A1 output amplitude decreases to exactly 5 divisions (1 volt).

g. CHECK—That the frequency setting on the Signal Generator is ≥5 MHz.

Set the Test Equipment controls as follows:

Square Wave Generator	
Hi Amplitude-Fast Rise	Hi Amplitude
Amplitude	Counterclockwise
Symmetry	Midrange
Repetition Rate Range	1 kHz
Multiplier	1
Test Oscilloscope	
Vertical	
Volts/Div	2 V
Input	DC
Time Base	
Time/Div	1 μs
Magnifier	X10
Triggering	
Mode	Auto
Coupling	AC
Source	Ext

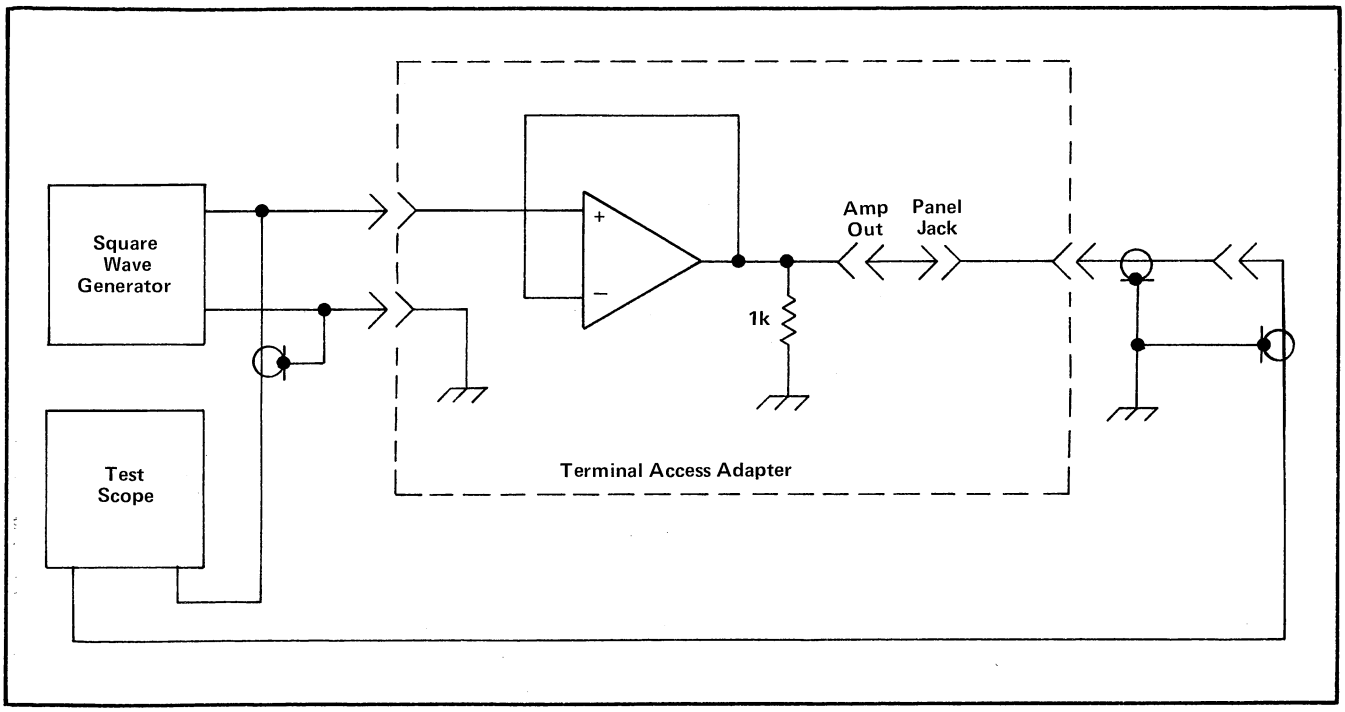

Fig. 5-5. Setup for checking Slew Rate.

5. Check Slew Rate

a. Connect the Terminal Access Adapter as diagramed in Fig. 5-5.

b. Connect the Square Wave Generator through a 50 Ω, 2 watt Termination to a 40-mil pin to BNC Adapter cable, to the Terminal Access Adapter Input 1 and 2 (COM) and to the Test Scope Vertical input.

c. Connect the Square Wave Generator Trigger Output to Test Scope Time Base Ext Trig In.

d. Adjust the Square Wave Generator Amplitude control to display 10 volts (5 divisions) on the Test Scope.

e. Reconnect the Test Scope Input to display the 26A1 OUTPUT (see Fig. 5-6).

f. CHECK—That the center 5 volts of the display occurs within 0.1 µs (50 volts/µs).

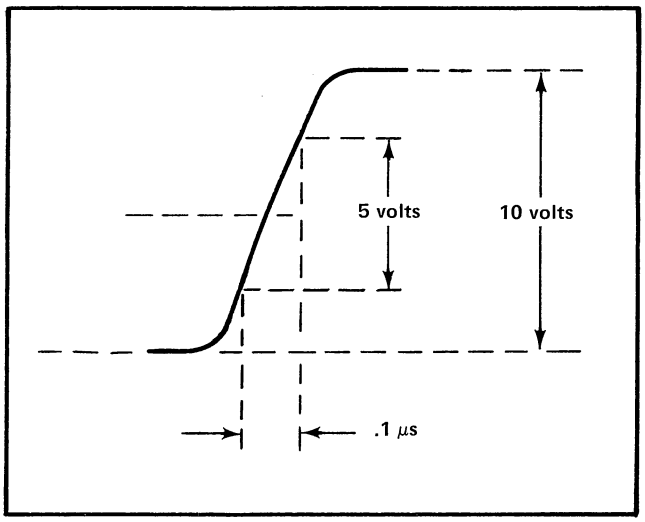

Fig. 5-6. Optimized representation of Slew Rate display.

Set the Test Equipment controls as follows:

Differential Amplifier	
Volts/Div	.1 V
HF 3 dB Point	1 kHz
LF 3 dB Point	DC Offset
+Input	DC
–Input	Gnd
Time Base	
Time/Base	.1 ms
Magnifier	X1
Triggering	
Mode	Auto
Coupling	AC
Source	Int
Display Mode	Time Base

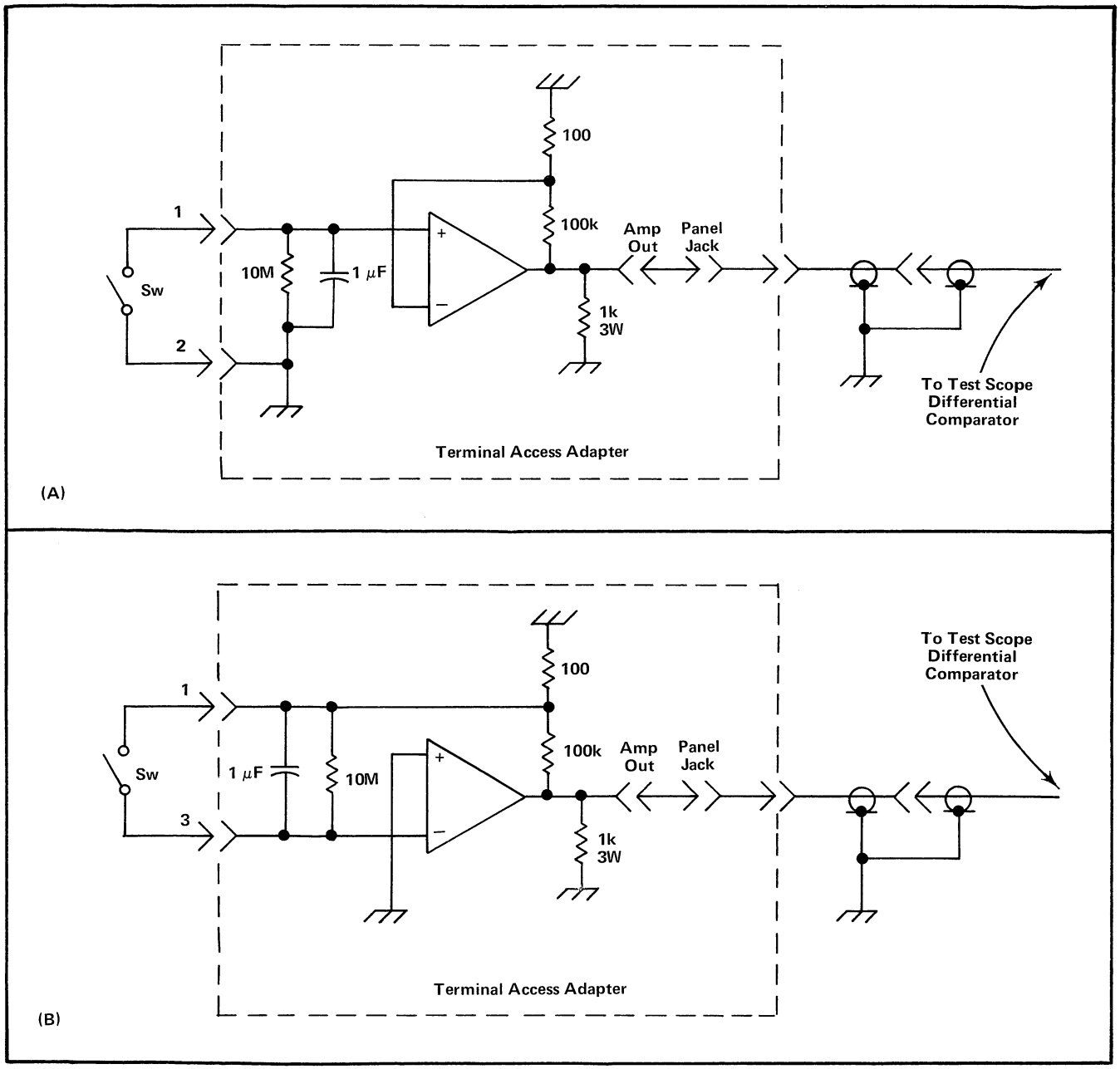

Fig. 5-7. Setups for checking Input Leakage Current (A) +Input, (B) —Input.

6. Check Input Leakage Current (+Input)

a. Connect components on the Terminal Access Adapter as diagramed in Fig. 5-7A.

b. Connect the 26A1 OUTPUT to Differential Amplifier +Input.

c. With the front-panel switch closed, measure the OUTPUT DC level.

d. Open the front-panel switch, and again measure the OUTPUT DC level.

e. Calculates the leakage current from

$$I = \frac{E_{\text{short circuit}} - E_{\text{open}}}{10\ \text{M}\Omega \times 1000}$$

f. CHECK—That the leakage current is ≤300 pA.

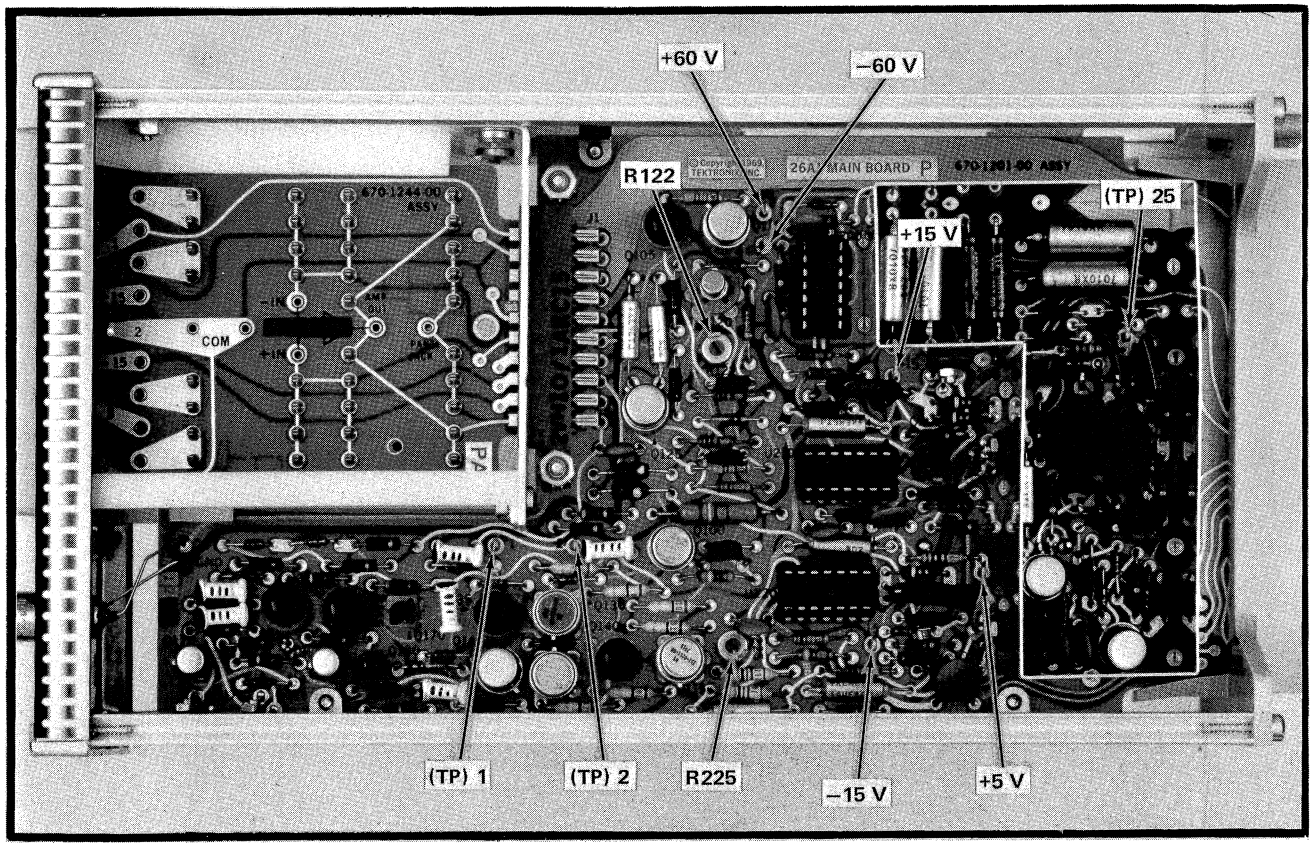

Fig. 5-8. Locations of Controls and Test Points.

7. Check Leakage Current (—Input)

a. Connect components on the Terminal Access Adapter as diagramed in Fig. 5-7B.

b. With front-panel switch closed measure the OUTPUT DC level.

c. Open the front-panel switch and again measure the OUTPUT DC level.

d. Calculate the leakage current as in step 6e.

e. CHECK—That the leakage current is ⩽300 pA.

ADJUSTMENT PROCEDURE

Test Instrument control settings:

Differential Comparator	
+Input	Gnd
—Input	Gnd
Comparison Voltage	−15.00 V
Volts/Div	10 mV
Time Base	
Time/Div	1 ms
Triggering	
Mode	Auto
Coupling	AC
Source	Int
Display Mode	Time Base

Install 26A1 on plug-in extender.

1. Adjust —15-volt Supply (R225)

a. Connect a 1X probe from Differential Comparator +Input to —15-volt Test Point (see Fig. 5-8 for location).

b. Vertically position the trace to graticule center (Differential Comparator Position control).

c. Switch +Input to DC.

d. Switch —Input to V_C.

e. ADJUST—R225 to position the trace to graticule center.

f. Check the +5 volt and +15 volt supplies in the manner detailed above (+5 volts, ±50 mV, and +15 volts, ±150 mV).

Set Test Scope controls as follows:

Differential Comparator

Volts/Div	1 V
+Input	Gnd
—Input	Gnd

On Terminal Access Adapter Circuit Board:

Connect Operational AMP OUT to PANEL JACK
Connect + and — Inputs to COM (2)

2. Adjust Offset Null (R122)

a. Connect the 26A1 Output Jack to the Differential Comparator +Input.

b. Position Test Scope trace vertically to graticule center.

c. Switch +Input to DC.

d. ADJUST—R122 to set the trace as close as possible to zero volts (graticule center). See Fig. 5-8 for location of R122.

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
inc	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
P/O	part of
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
S or SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

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

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

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

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

INDEX OF ELECTRICAL PARTS LIST

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A1 MAIN Circuit Board Assembly	6-1

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description

CHASSIS

Connector

J10	131-0955-00			Receptacle, electrical, female BNC		

Transistors

Q175	151-0311-01			Silicon	NPN	MOT-77 MJE 340
Q185	151-0311-01			Silicon	NPN	MOT-77 MJE 340

A1 MAIN Circuit Board Assembly

	*670-1201-00			Complete Board		

Capacitors

Tolerance ±20% unless otherwise indicated.

C1	290-0270-00			8.2 μF	Elect.	60 V
C2	290-0270-00			8.2 μF	Elect.	60 V
C3	290-0270-00			8.2 μF	Elect.	60 V
C4	290-0270-00			8.2 μF	Elect.	60 V
C5	290-0261-00			6.8 μF	Elect.	35 V
C20	283-0003-00			0.01 μF	Cer	150 V
C21	283-0065-00			0.001 μF	Cer	100 V 5%
C27	283-0194-00			4.7 μF	Cer	50 V
C29	283-0065-00			0.001 μF	Cer	100 V 5%
C30	283-0003-00			0.01 μF	Cer	150 V
C50	290-0135-00			15 μF	Elect.	20 V
C55	290-0135-00			15 μF	Elect.	20 V
C100	283-0000-00			0.001 μF	Cer	500 V
C105	283-0000-00			0.001 μF	Cer	500 V
C116	281-0628-00			15 pF	Cer	600 V 5%
C118	281-0504-00			10 pF	Cer	500 V 10%
C125	283-0000-00			0.001 μF	Cer	500 V
C165	281-0504-00			10 pF	Cer	500 V 10%
C167	281-0549-00			68 pF	Cer	500 V 10%
C175	283-0032-00			470 pF	Cer	500 V 5%

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
			Capacitors (cont)			
C190	281-0504-00		10 pF	Cer	500 V	10%
C192	281-0549-00		68 pF	Cer	500 V	10%
C200	290-0135-00		15 μF	Elect.	20 V	
C207	283-0047-00		270 pF	Cer	500 V	5%
C212	290-0135-00		15 μF	Elect.	20 V	
C215	283-0047-00		270 pF	Cer	500 V	5%
C220	290-0135-00		15 μF	Elect.	20 V	
C225	283-0047-00		270 pF	Cer	500 V	5%
C232	290-0135-00		15 μF	Elect.	20 V	
C250	283-0003-00		0.01 μF	Cer	150 V	
C255	283-0003-00		0.01 μF	Cer	150 V	
C260	283-0003-00		0.01 μF	Cer	150 V	
			Semiconductor Device, Diodes			
CR1	*152-0061-00		Silicon	Tek Spec		
CR2	*152-0061-00		Silicon	Tek Spec		
CR3	*152-0061-00		Silicon	Tek Spec		
CR4	*152-0061-00		Silicon	Tek Spec		
CR12	*152-0185-00		Silicon	Replaceable by 1N4152		
CR40	*152-0185-00		Silicon	Replaceable by 1N4152		
CR100	*152-0185-00		Silicon	Replaceable by 1N4152		
CR120	152-0460-00		Silicon	1N5297 100 V, 1 mA, 10%		
CR124	152-0460-00		Silicon	1N5297 100 V, 1 mA, 10%		
CR130	*152-0185-00		Silicon	Replaceable by 1N4152		
CR135	*152-0061-00		Silicon	Tek Spec		
CR137	*152-0185-00		Silicon	Replaceable by 1N4152		
CR140	*152-0061-00		Silicon	Tek Spec		
CR145	*152-0185-00		Silicon	Replaceable by 1N4152		
CR165	*152-0185-00		Silicon	Replaceable by 1N4152		
CR175	*152-0185-00		Silicon	Replaceable by 1N4152		
CR185	*152-0185-00		Silicon	Replaceable by 1N4152		
CR190	*152-0185-00		Silicon	Replaceable by 1N4152		
CR200	*152-0107-00		Silicon	Replaceable by 1N647		
CR206	*152-0185-00		Silicon	Replaceable by 1N4152		
CR211	*152-0107-00		Silicon	Replaceable by 1N647		
CR212	*152-0107-00		Silicon	Replaceable by 1N647		
CR218	*152-0185-00		Silicon	Replaceable by 1N4152		
VR110	152-0175-00		Zener	1N752A 400 mW, 5.6 V, 5%		
VR126	152-0195-00		Zener	1N751A 400 mW, 5.1 V, 5%		
VR135	152-0195-00		Zener	1N751A 400 mW, 5.1 V, 5%		
VR140	152-0175-00		Zener	1N752A 400 mW, 5.6 V, 5%		
VR215	152-0168-00		Zener	1N963A 400 mW, 12 V, 5%		
VR222	152-0243-00		Zener	1N965B 500 mW, 15 V, 5%		

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A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				Connector
J1	131-0821-00			Receptacle, electrical, right-angle
				Inductors
L1	*108-0237-00			80 μH
L3	*108-0237-00			80 μH
L50	108-0226-00			100 μH
L55	108-0226-00			100 μH
LR5	*108-0089-00			15 μH (wound on a 2.2 kΩ resistor)
LR6	*108-0089-00			15 μH (wound on a 2.2 kΩ resistor)
				Transistors
Q10	151-0290-00		Silicon NPN	TO-5 2N4895
Q15	151-0188-00		Silicon PNP	TO-92 2N3906
Q20	151-0190-00		Silicon NPN	TO-92 2N3904
Q25	151-0508-00		Silicon PNPN	TO-98 Prog unijunction D13T1
Q30	151-0190-00		Silicon NPN	TO-92 2N3904
Q40	151-0290-00		Silicon NPN	TO-5 2N4895
Q100	151-0279-00		Silicon NPN	TO-39 SE7056
Q105	151-0228-00		Silicon PNP	TO-5 Tek Spec
Q110	151-0279-00		Silicon NPN	TO-39 SE7056
Q115 A, B	*151-0261-00		Silicon PNP	Dual, Tek Spec
Q120 A, B	151-1010-00		Silicon FET	N channel, dual, junction type
Q125	151-0279-00		Silicon NPN	TO-39 SE7056
Q130 A, B	*151-0261-00		Silicon PNP	Dual, Tek Spec
Q135	*151-0228-00		Silicon PNP	TO-5 Tek Spec
Q140	*151-0228-00		Silicon PNP	TO-5 Tek Spec
Q145	151-0279-00		Silicon NPN	TO-39 SE7056
Q150 A, B	151-0232-00		Silicon NPN	TO-77 Dual
Q165	*151-0228-00		Silicon PNP	TO-5 Tek Spec
Q170	151-0188-00		Silicon PNP	TO-92 2N3906
Q172	151-0250-00		Silicon NPN	TO-104 2N5184
Q180	151-0190-00		Silicon NPN	TO-92 2N3904
Q182	*151-0228-00		Silicon PNP	TO-5 Tek Spec
Q190	151-0250-00		Silicon NPN	TO-104 2N5184
Q200	151-0324-00		Silicon PNP	MOT-77 MJE371
Q205	151-0188-00		Silicon PNP	TO-92 2N3906
Q210	151-0323-00		Silicon NPN	MOT-77 MJE521
Q220	151-0323-00		Silicon NPN	MOT-77 MJE521

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A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors			
Resistors are fixed, composition, ±10% unless otherwise indicated.							
R10	316-0151-00			150 Ω	1/4 W		
R12	316-0122-00			1.2 kΩ	1/4 W		
R15	316-0223-00			22 kΩ	1/4 W		
R21	315-0243-00			24 kΩ	1/4 W		5%
R22	316-0123-00			12 kΩ	1/4 W		
R23	316-0182-00			1.8 kΩ	1/4 W		
R25	316-0821-00			820 Ω	1/4 W		
R26	316-0274-00			270 Ω	1/4 W		
R27	316-0334-00			330 kΩ	1/4 W		
R29	315-0243-00			24 kΩ	1/4 W		5%
R30	316-0151-00			150 Ω	1/4 W		
R100	321-0168-00			549 Ω	1/8 W	Prec	1%
R101	321-0212-00			1.58 kΩ	1/8 W	Prec	1%
R102	323-0360-00			54.9 kΩ	1/2 W	Prec	1%
R105	321-0202-00			1.24 kΩ	1/8 W	Prec	1%
R115	321-0164-00			499 Ω	1/8 W	Prec	1%
R116	321-0164-00			499 Ω	1/8 W	Prec	1%
R119	316-0102-00			1 kΩ	1/4 W		
R120	321-0289-00			10 kΩ	1/8 W	Prec	1%
R122	311-0607-00			10 kΩ, Var			
R124	321-0289-00			10 kΩ	1/8 W	Prec	1%
R125	321-0202-00			1.24 kΩ	1/8 W	Prec	1%
R126	321-0212-00			1.58 kΩ	1/8 W	Prec	1%
R130	321-0164-00			499 Ω	1/8 W	Prec	1%
R132	321-0164-00			499 Ω	1/8 W	Prec	1%
R150	321-0164-00			499 Ω	1/8 W	Prec	1%
R152	321-0164-00			499 Ω	1/8 W	Prec	1%
R165	315-0302-00			3 kΩ	1/4 W		5%
R167	315-0242-00			2.4 kΩ	1/4 W		5%
R168	315-0510-00			51 Ω	1/4 W		5%
R170	315-0114-00			110 kΩ	1/4 W		5%
R171	316-0681-00			680 Ω	1/4 W		
R172	316-0183-00			18 kΩ	1/4 W		
R175	316-0220-00			22 Ω	1/4 W		
R183	316-0331-00			330 Ω	1/4 W		
R185	316-0220-00			22 Ω	1/4 W		
R186	316-0471-00			470 Ω	1/4 W		
R190	315-0302-00			3 kΩ	1/4 W		5%
R192	315-0242-00			2.4 kΩ	1/4 W		5%
R193	315-0510-00			51 Ω	1/4 W		5%

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description			
				Resistors (cont)			
R200	308-0431-00			120 Ω	3 W	WW	5%
R201	321-0603-07			15 kΩ	1/8 W	Prec	1/10%
R202	321-0603-07			15 kΩ	1/8 W	Prec	1/10%
R203	307-0105-00			3.9 Ω	1/4 W		5%
R204	307-0105-00			3.9 Ω	1/4 W		5%
R205	316-0681-00			680 Ω	1/4 W		
R206	316-0103-00			10 kΩ	1/4 W		
R207	316-0470-00			47 Ω	1/4 W		
R210	307-0108-00			6.8 Ω	1/4 W		5%
R211	316-0681-00			680 Ω	1/4 W		
R212	321-0816-07			5 kΩ	1/8 W	Prec	1/10%
R213	321-0603-07			15 kΩ	1/8 W	Prec	1/10%
R218	316-0103-00			10 kΩ	1/4 W		
R220	321-0223-00			2.05 kΩ	1/8 W	Prec	1%
R221	308-0431-00			120 Ω	3 W	WW	5%
R222	316-0681-00			680 Ω	1/4 W		
R223	307-0105-00			3.9 Ω	1/4 W		5%
R224	307-0105-00			3.9 Ω	1/4 W		5%
R225	311-0634-00			500 Ω, Var			
R226	321-0274-00			6.98 kΩ	1/8 W	Prec	1%
R228	316-0103-00			10 kΩ	1/4 W		
R230	321-0239-00			3.01 kΩ	1/8 W	Prec	1%
R232	321-0239-00			3.01 kΩ	1/8 W	Prec	1%
				Transformer			
T1	120-0686-00			Pot core			
				Integrated Circuits			
U200	156-0071-00			Volt reg. Replaceable by Fairchild μA723C			
U210	156-0071-00			Volt reg. Replaceable by Fairchild μA723C			
U220	156-0071-00			Volt reg. Replaceable by Fairchild μA723C			

SECTION 7

DIAGRAMS, CIRCUIT BOARDS, MECHANICAL AND REPACKAGING PARTS ILLUSTRATIONS

Symbols and Reference Designators

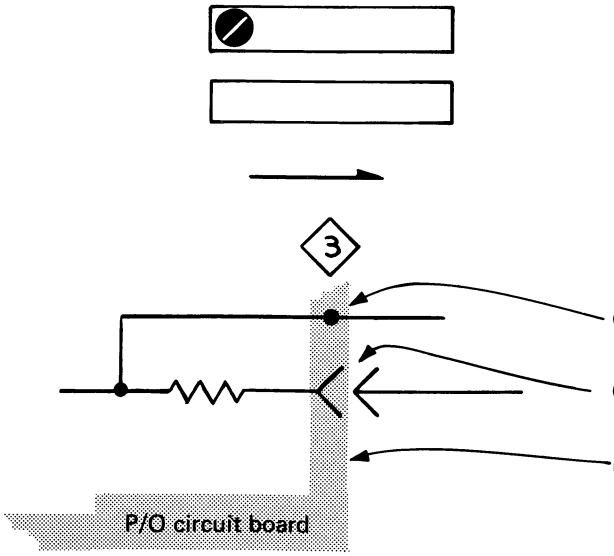
Electrical components shown on the diagrams are in the following units unless noted otherwise:

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

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

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

The following special symbols are used on the diagrams:



External screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

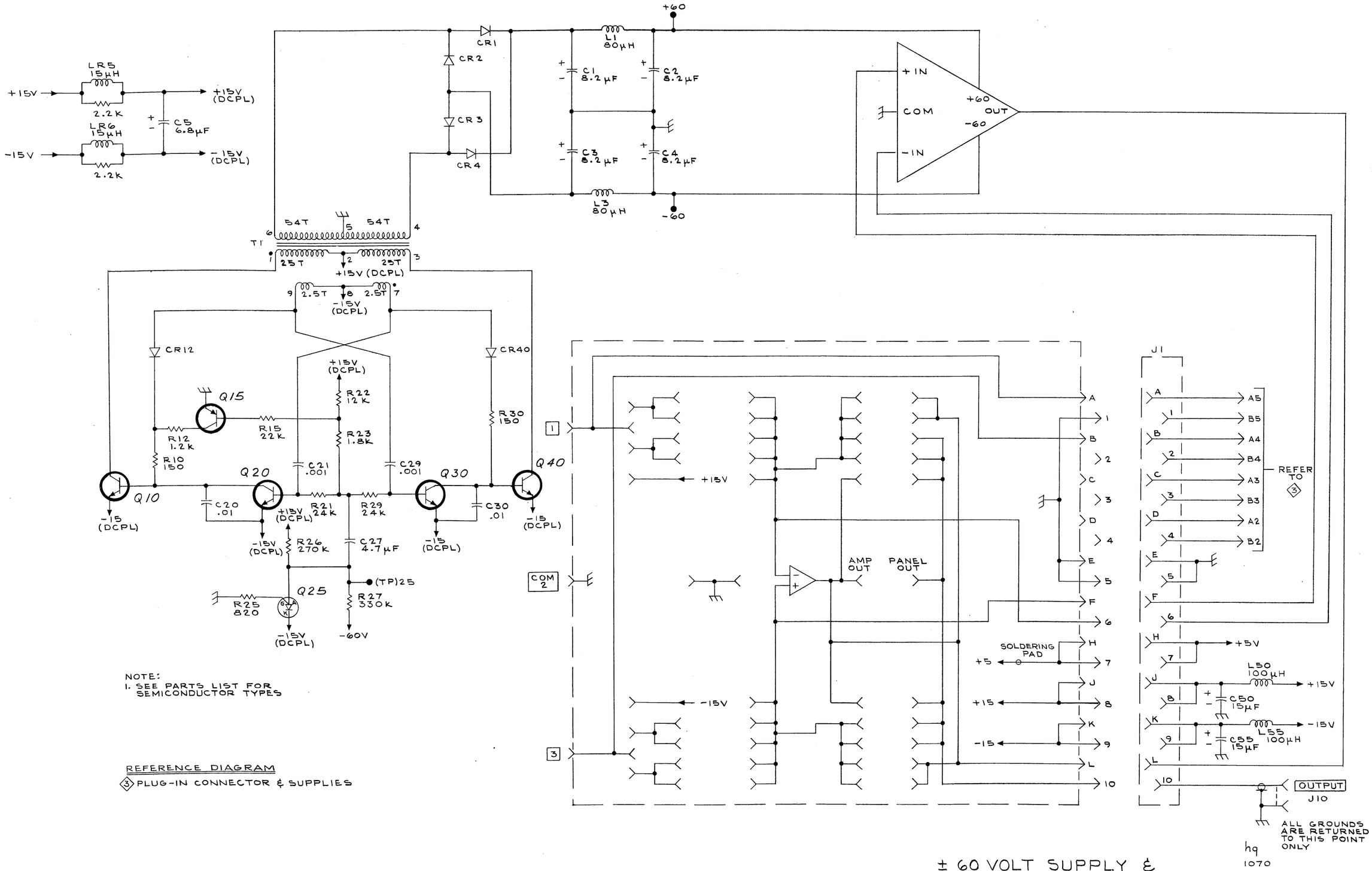
Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

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

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

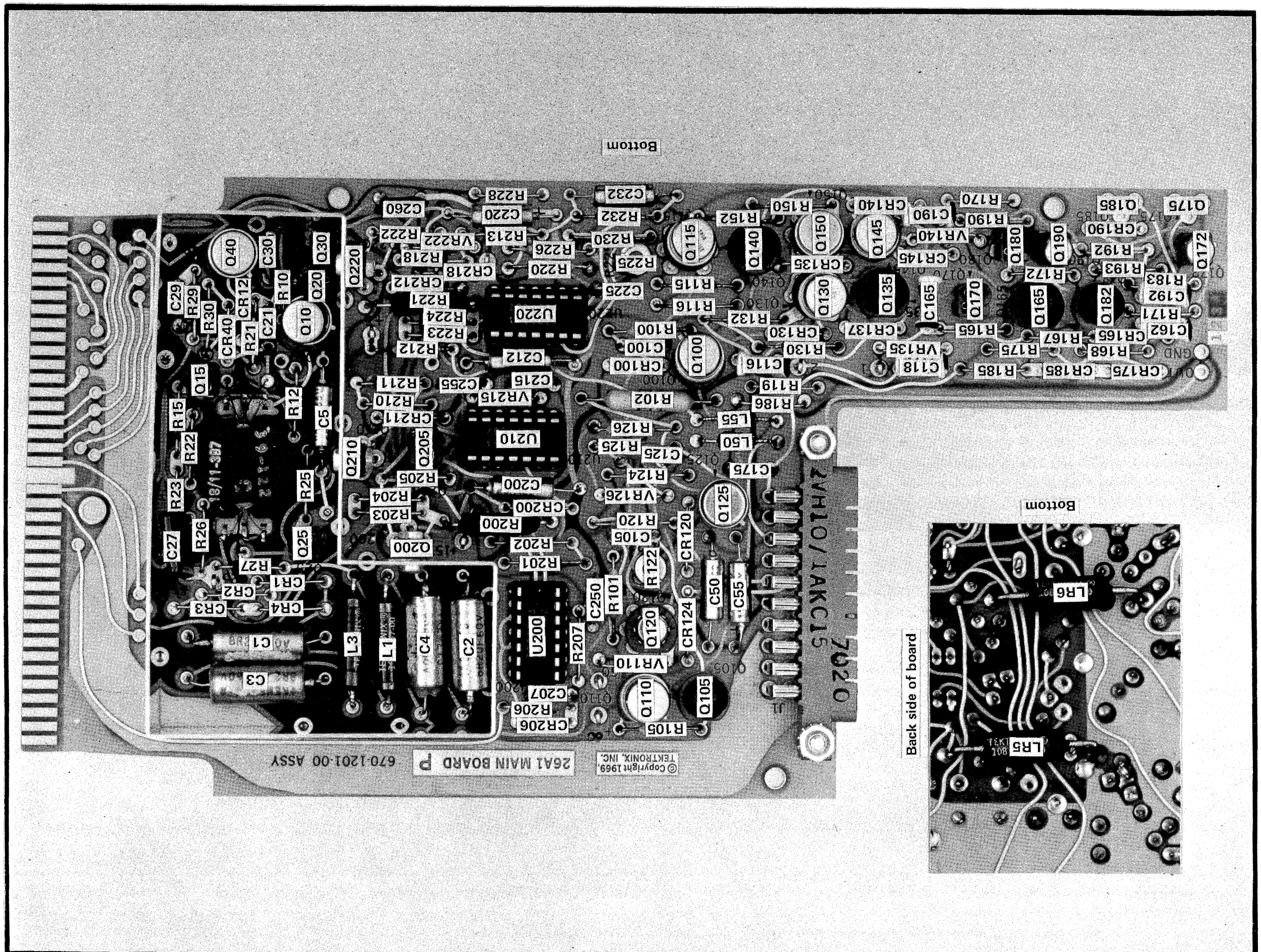


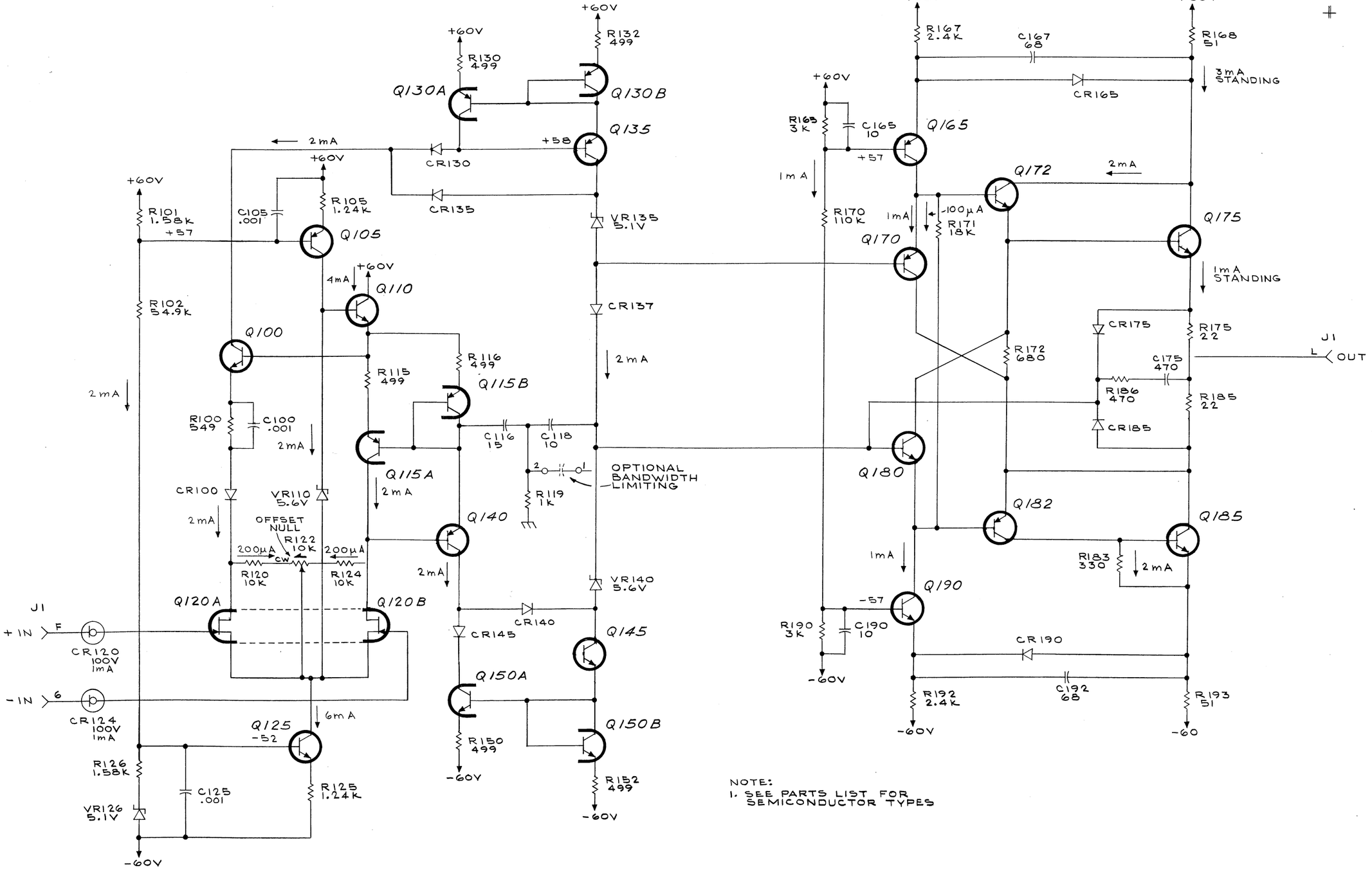
NOTE:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAM
3 PLUG-IN CONNECTOR & SUPPLIES

hq 1070

± 60 VOLT SUPPLY & TERMINAL ACCESS ADAPTER 1


26A1 MAIN BOARD P
670-1201-00 ASSY
© Copyright 1969, TEKTRONIX, INC.
Bottom
Back side of board
Bottom



NOTE:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

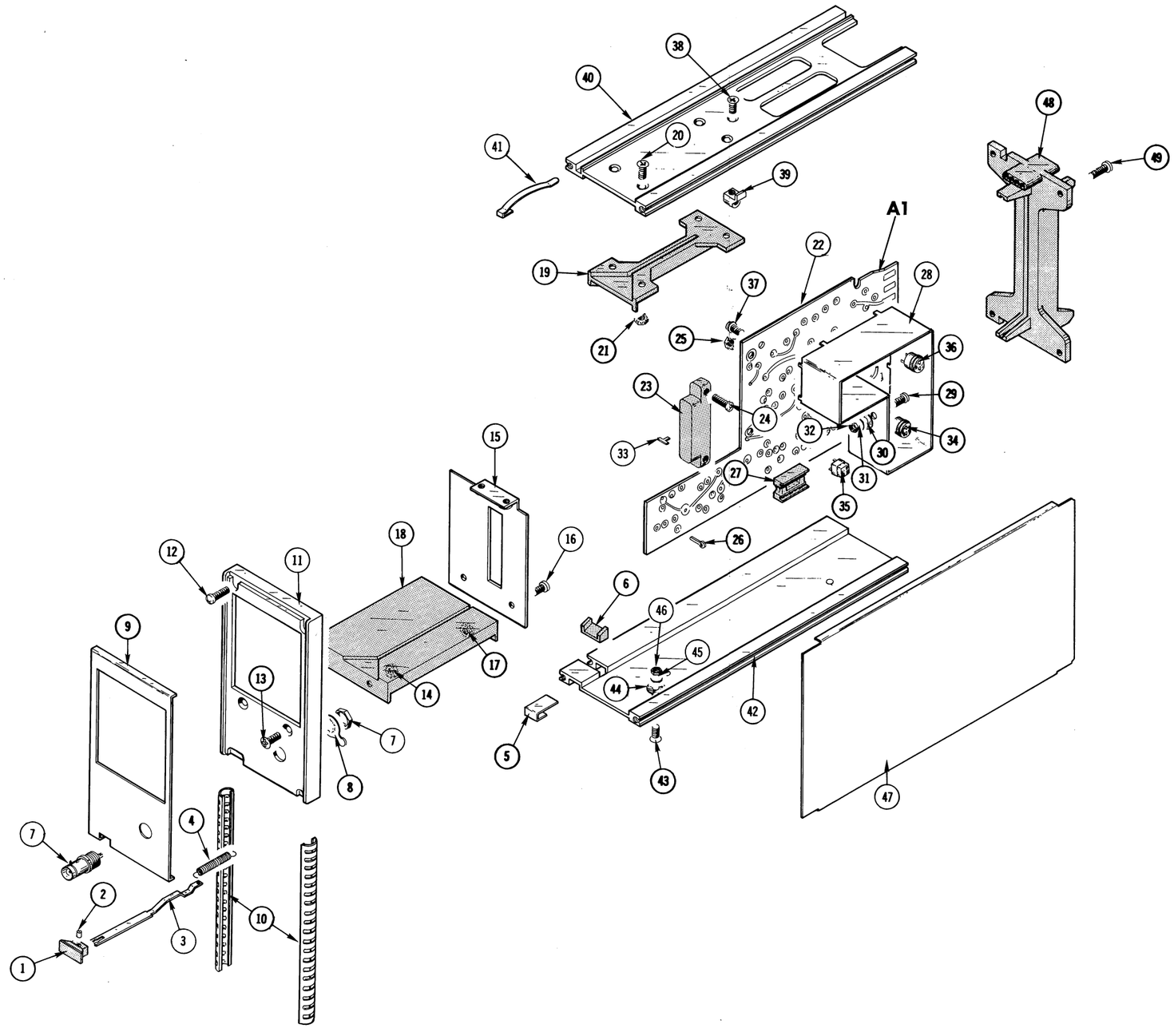
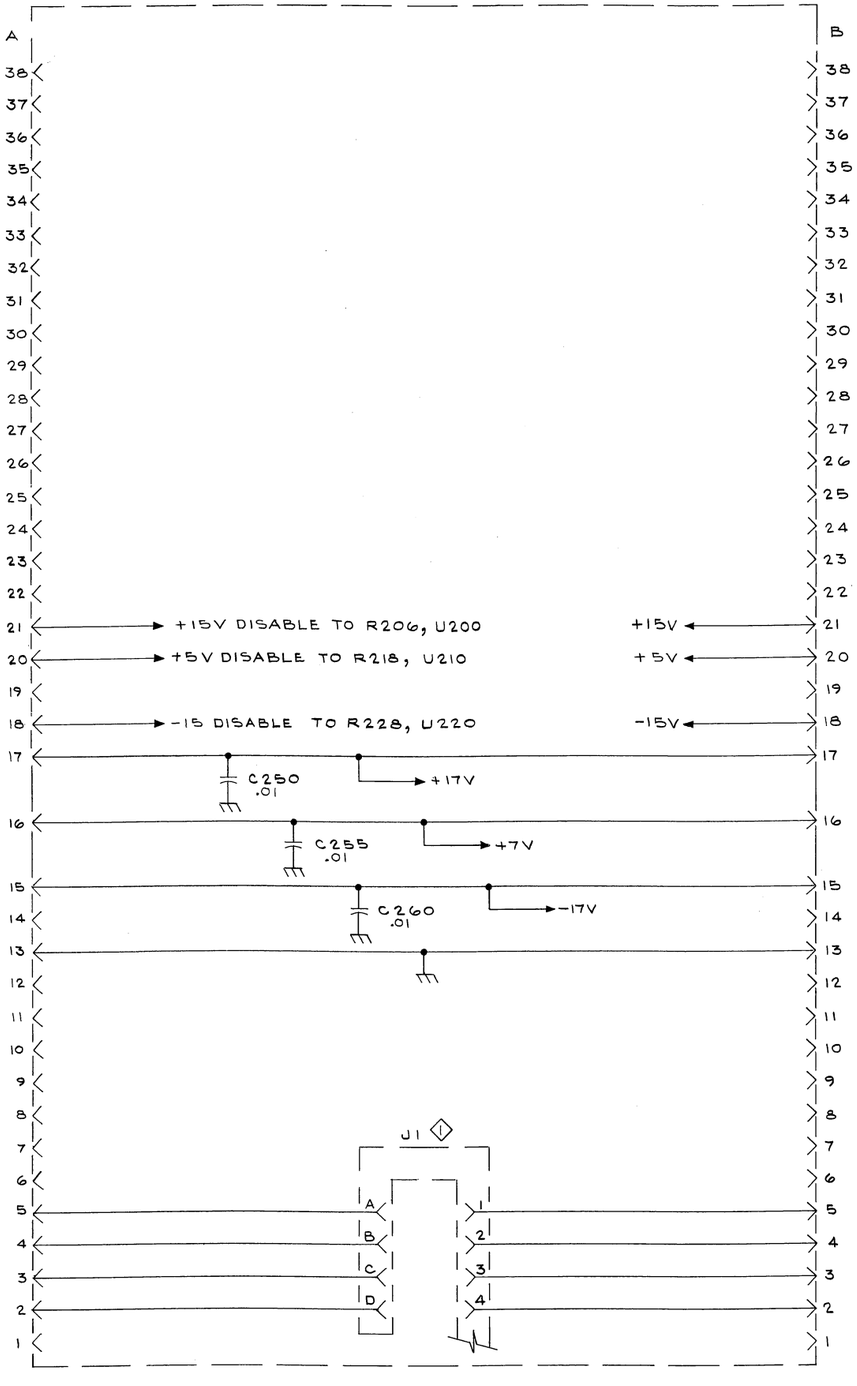


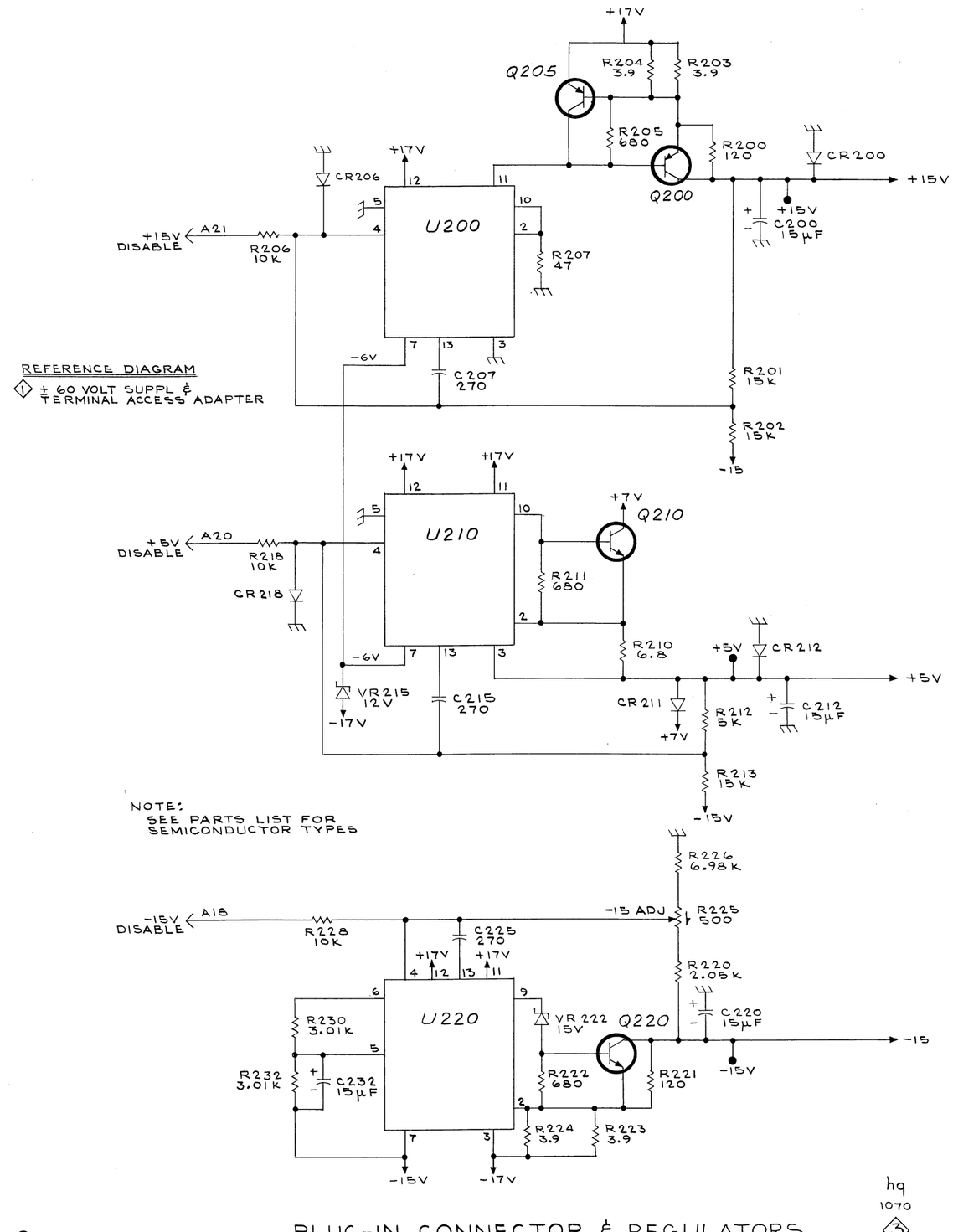
FIG. 1 EXPLODED

26A1 OPERATIONAL AMPLIFIER



26A1

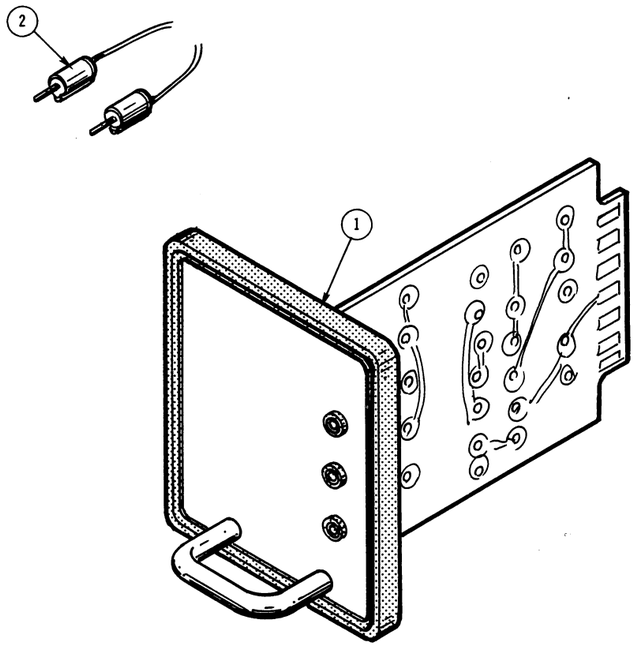
Ⓐ



PLUG-IN CONNECTOR & REGULATORS

hq
1070
3

STANDARD ACCESSORIES



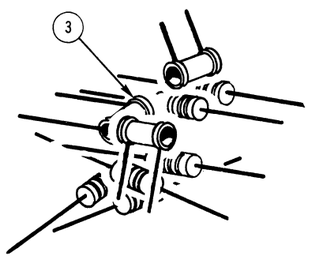


FIG. 2 STANDARD ACCESSORIES & REPACKAGING

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description	Ⓐ
2-1	013-0113-00			1		TERMINAL ACCESS ADAPTER	
-2	012-0200-00			3		PATCH CORD, pinjack to pinjack *(red)*	
-3	020-0039-00			1		RESISTOR-CAPACITOR PACKAGE	
	070-1068-00			1		MANUAL, instruction *(not shown)*	

26A1 OPERATIONAL AMPLIFIER Ⓐ

CARTON ASSEMBLY (Part No. 065-0138-00)

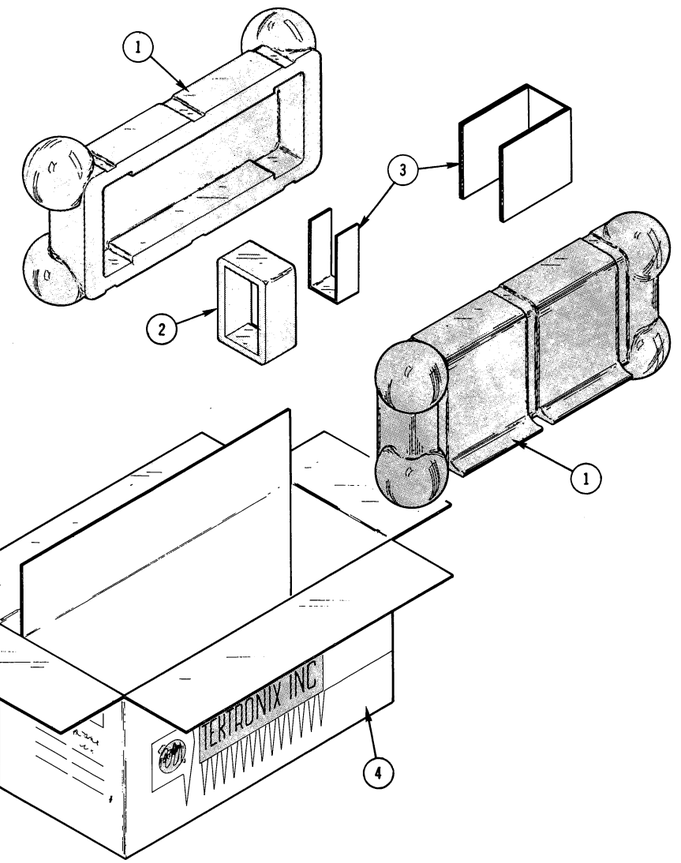


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description	Ⓐ
2-	065-0138-00			1		CARTON ASSEMBLY	
	- - - - - -			-		carton assembly includes:	
-1	004-0241-00			2		CASE HALF	
-2	004-0243-00			1		END CAP, front	
-3	004-1079-00			1		PAD SET, 2 piece	
-4	004-0748-00			1		CARTON	

Ⓐ +

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

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

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears 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.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

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

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

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

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

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

Title	Location (reverse side of)
Figure 1 Exploded	Operational Amplifier Diagram
Figure 2 Std. Access. & Repackaging	Plug-In Conn & Power Supplies Diagram

SECTION 8
MECHANICAL PARTS LIST

FIGURE 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-1	366-1058-20			1	KNOB, latch
	- - - - - -			-	mounting hardware: *(not included w/knob)*
-2	214-1095-00			1	PIN, spring, split
-3	105-0075-00			1	RELEASE BAR, latch
-4	214-1280-00			1	SPRING, helical compression
-5	214-1054-00			1	SPRING, latch detent
-6	105-0076-00			1	BOLT, latch, plastic
-7	131-0955-00			1	CONNECTOR, receptacle, female BNC, *w/hardware*
	- - - - - -			-	mounting hardware: *(not included w/connector)*
-8	210-0255-00			1	LUG, solder, 0.375 inch, SE
-9	333-1309-00			1	PANEL, front
-10	348-0235-00			2	SHIELDING GASKET, electrical
-11	386-1447-43			1	SUBPANEL, front
	- - - - - -			-	mounting hardware: *(not included w/subpanel)*
-12	213-0192-00			4	SCREW, thread forming, 6-32 x 0.50 inch, Fil HS
-13	211-0038-00			2	SCREW, 4-40 x 0.312 inch, 100° csk, FHS
-14	210-0586-00			2	NUT, keps, 4-40 x 0.312 inch
-15	386-1795-00			1	SUPPORT, plug-in guide
	- - - - - -			-	mounting hardware: *(not included w/support)*
-16	211-0008-00			2	SCREW, 4-40 x 0.25 inch, PHS
-17	210-0586-00			2	NUT, keps, 4-40 x 0.25 inch
-18	351-0259-00			1	GUIDE, slide, plastic
-19	351-0257-00			1	GUIDE, slide, plastic
	- - - - - -			-	mounting hardware: *(not included w/guide)*
-20	211-0038-00			4	SCREW, 4-40 x 0.312 inch, 100° csk, FHS
-21	210-0586-00			2	NUT, keps, 4-40 x 0.25 inch

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
-22	670-1201-00			1		CIRCUIT BOARD ASSEMBLY—MAIN A1
	- - - - - -			-		circuit board assembly includes:
	388-1550-00			1		CIRCUIT BOARD
-23	131-0821-00			1		CONNECTOR, receptacle, right angle mounting
	- - - - - -			-		mounting hardware: *(not included w/connector)*
-24	211-0016-00			2		SCREW, 4-40 x 0.625 inch, RHS
	210-1092-00			2		WASHER, flat, 0.147 ID x 0.312 inch OD
-25	210-0586-00			2		NUT, keps, 4-40 x 0.25 inch
-26	214-0579-00			8		PIN, test point
-27	136-0269-00			3		SOCKET, integrated circuit, 14 pin
-28	337-1337-00			1		SHIELD, electrical, circuit board
-29	211-0008-00			3		SCREW, 4-40 x 0.25 inch, PHS
-30	210-0921-00			3		WASHER, mica, 0.125 ID x 0.50 inch OD
-31	210-1122-00			3		WASHER, lock, dished, 0.12 ID x 0.375 inch OD
-32	210-0406-00			3		NUT, hex., 4-40 x 0.188 inch
-33	214-0702-00			1		KEY, connector polarizing
-34	136-0235-00			4		SOCKET, transistor, 6 pin
-35	136-0220-00			9		SOCKET, transistor, 3 pin, square
-36	136-0183-00			11		SOCKET, transistor, 3 pin
	- - - - - -			-		mounting hardware: *(not included w/circuit board assembly)*
-37	211-0116-00			3		SCREW, sems, 4-40 x 0.312 inch, PHB
-38	211-0105-00			3		SCREW, 4-40 x 0.188 inch, 100° csk, FHS
-39	220-0547-01			3		NUT BLOCK
-40	426-0648-00			1		FRAME SECTION, top
-41	214-1061-00			1		SPRING, flat, sliding ground
-42	426-0636-00			1		FRAME SECTION, bottom
-43	211-0038-00			2		SCREW, 4-40 x 0.312 inch, 100° csk, FHS
-44	210-0921-00			2		WASHER, mica, 0.125 ID x 0.50 inch OD
-45	210-1122-00			2		WASHER, lock, dished, 0.12 ID x 0.375 inch OD
-46	210-0406-00			2		NUT, hex., 4-40 x 0.188 inch
-47	337-1316-00			2		SHIELD, electrical
-48	386-1402-00			1		PANEL, rear
	- - - - - -			-		mounting hardware: *(not included w/panel)*
-49	213-0192-00			4		SCREW, thread forming, 6-32 x 0.50 inch, Fil HS

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. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. 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 in this section, your manual is correct as printed.