INSTRUCTION MANUAL

Serial Number B020414

2620 STIMULUS ISOLATOR

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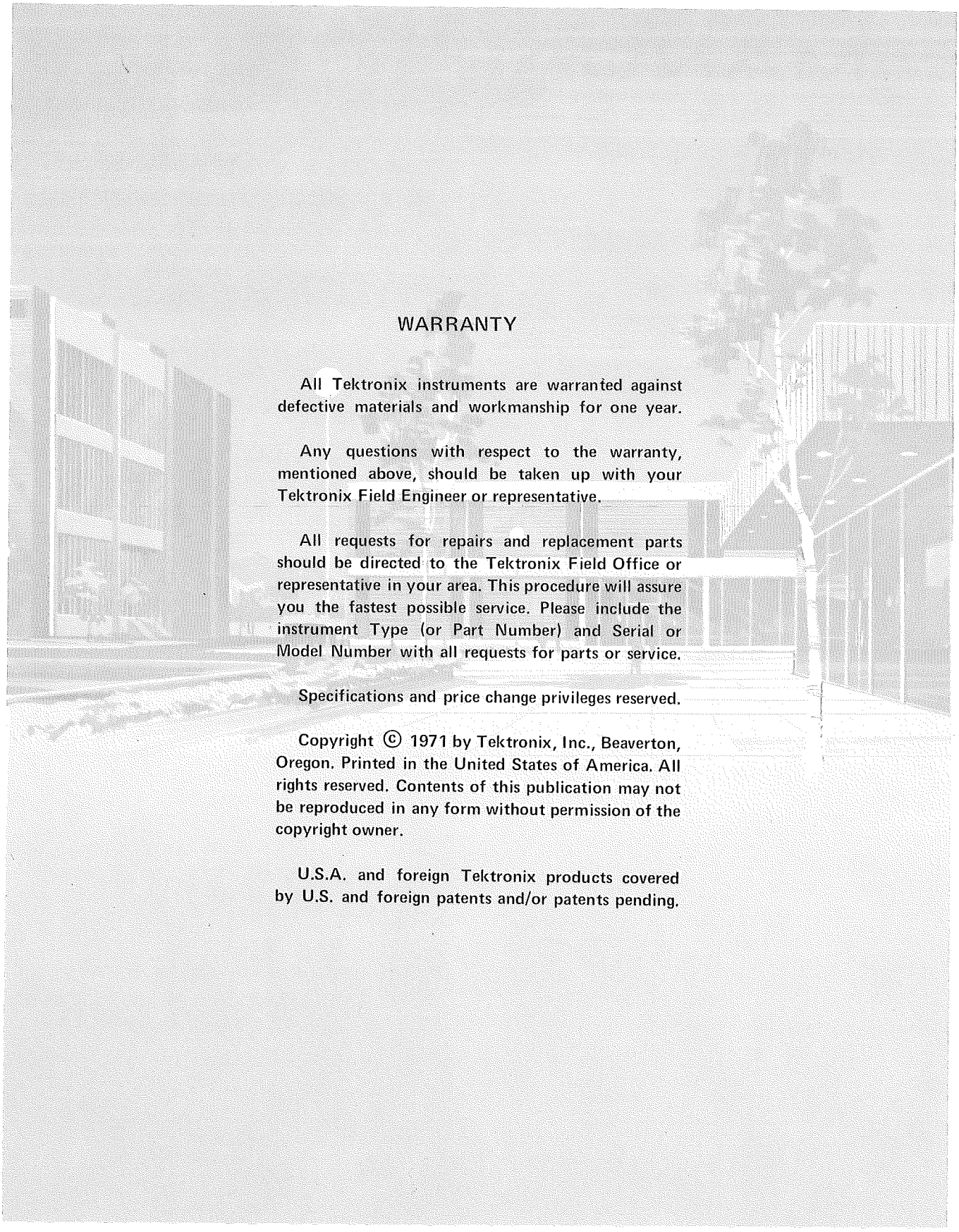
070-1118-00



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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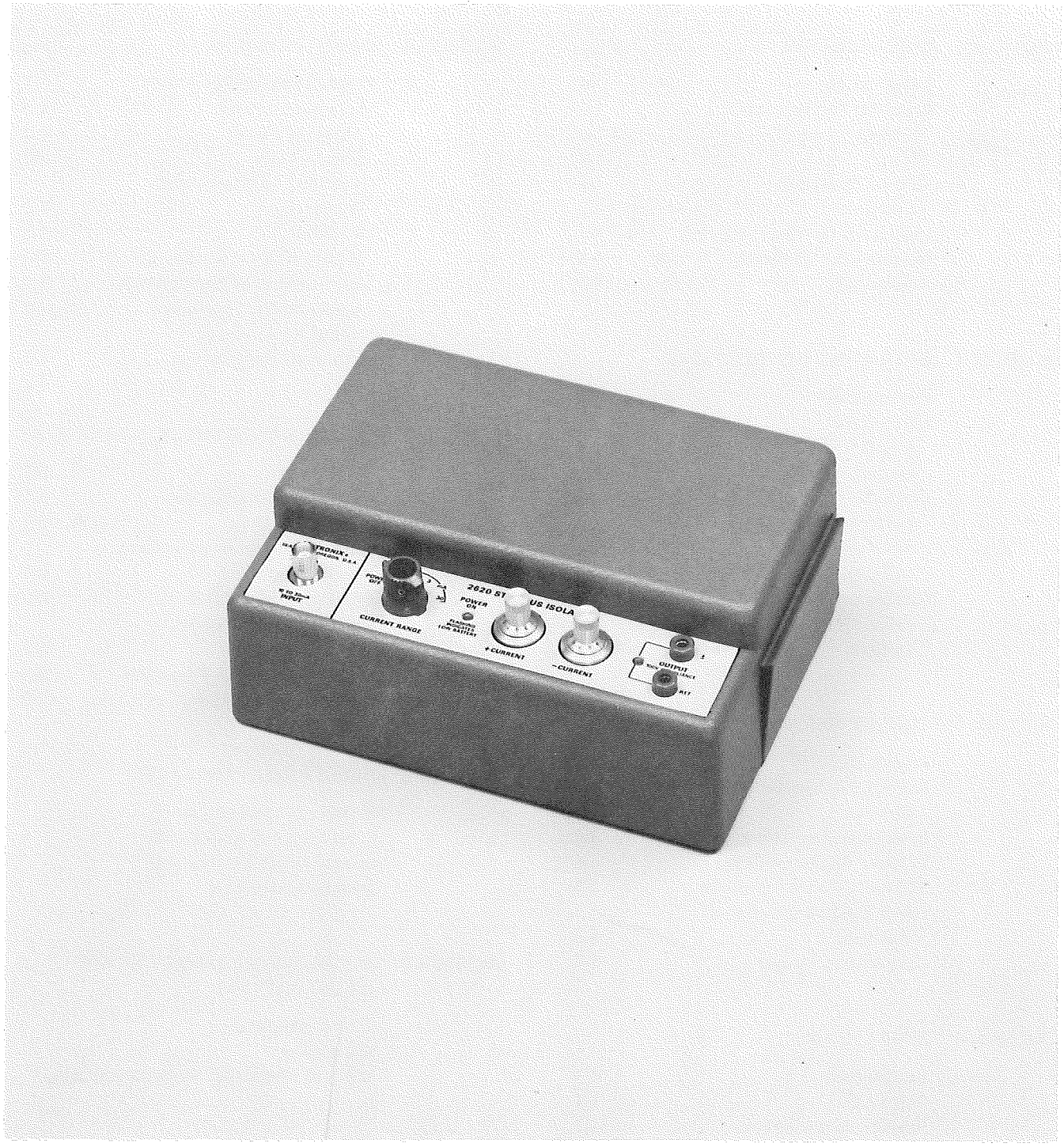


Fig. 1-1. 2620 Stimulus Isolator.

SECTION 1
2620 SPECIFICATION

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

Introduction

The 2620 Stimulus Isolator is a tri-stable pulse generator designed to provide positive or negative stimulus current for biophysical applications. The output is highly isolated, conductively and capacitively, from generators with ground reference connected to the Isolator input, thus permitting true differential tissue stimulation.

Pulse polarity and timing are determined by the input signal via an optical coupler at the input, and may be supplied from the 2600-System or other suitable source. The output pulse amplitudes are controlled independently at the Isolator control panel.

Power is provided by two nickel-cadmium "D" cells, operating a DC to DC converter. Recharging is provided by an external charger.

CAUTION

Operation with cells other than those supplied with the instrument is not recommended, and may cause damage to the instrument.

The 2620 will perform to the specifications listed in this section within an ambient temperature range from +10°C to +40°C. No warmup time is required. The performance check information, Section 5, provides a convenient means of checking the performance of the 2620.

Electrical Characteristics

OUTPUT

Characteristic	Performance Requirement	Supplemental Information
Current		
Range	0 to ±.3 mA 0 to ±3 mA 0 to ±30 mA	
Accuracy[1]		
.3 mA	Within 4% of indicated current ±6 μA	
3 mA	Within 3% of indicated current ±60 μA	
30 mA	Within 3% of indicated current ±600 μA	
Off-State		Less than 10 nA at 25°C ambient, following on-state currents to 3 mA.
Risetime-Falltime[1]		Less than 2 μs, where R_{load} is 3.3 kΩ or less
Delay After Activating Signal[1]		Less than 3 μs, where R_{load} is 3.3 kΩ or less
Voltage Compliance	At least 100 V	
R and C		Greater than 10 MΩ, shunted by 25 pF (typical).

[1] Valid only for output currents between 10% and 100% of full scale amplitude on each range.

INPUT

Characteristic	Performance Requirement	Supplemental Information
Current		
For +Output Activation		Within +10 mA to +20 mA
For −Output Activation		Within −10 mA to −20 mA
Non-Function Level		1 mA or less
Maximum Safe Input		60 mA
Voltage		1.2 V at 20 mA, typical at 25°C

POWER SOURCE

Characteristic	Performance Requirement	Supplemental Information
Operating Time, (Based on 4 AH Rated NiCd Cells).		10 hours, typical, at idle 8 hours, typical at maximum output and 5% duty factor 1.5 hours, typical, at maximum output and 100% duty factor

ISOLATION

Characteristic	Performance Requirement	Supplemental Information
Output to Input		
R and C	10 GΩ or greater shunted by 10 pF or less	
Maximum Voltage		500 V (DC + peak AC)
Output to Space		
Capacitance		10 pF, typical

Environmental Characteristics

Characteristic	Performance Requirement	Supplemental Information
Temperature		
Operating	+10°C to +40°C	
Storage		−40°C to +60°C

Physical Characteristics

Length	≈ 5 7/8 inches
Width	≈ 8 3/16 inches
Height	≈ 3 15/32 inches
Weight (including Battery)	≈ 2 3/4 pounds

NOTES

SECTION 2
OPERATING INSTRUCTIONS

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

WARNING

The maximum voltage and current capability of this instrument (up to 110 V and 35 mA) is high enough to be a potentially lethal hazard to human and animal subjects. Therefore, only the operator can be responsible for proper precautionary measures.

The 2620 was designed to be highly reliable but it was not possible to provide completely fail-safe circuitry. If components fail, output current can exceed that selected by the operator.

Introduction

The 2620 Stimulus Isolator is a tristable pulse generator designed to provide positive or negative stimulus current for biophysical applications. The output is highly isolated, conductively and capacitively, from ground-reference generators connected to the input, thus permitting true differential tissue stimulation.

Pulse polarity and timing are determined by the input signal via an optical coupler and may be supplied from a 2600-Series pulse generator or other suitable source. The output pulse amplitudes are controlled independently at the Isolator control panel.

Power is provided by two nickel-cadmium "D" cells, operating a DC-to-DC converter. Recharging is provided by an external charger.

The 2620 Stimulus Isolator may be operated with any activating signal source capable of supplying the necessary current to the input.

This section describes the functions and features of the controls, connectors and indicators.

CONNECTORS

Input

The Input signal must swing from the 1 mA level into the 10 to 20 mA region in order for Output rise, fall, and delay time specifications to be met.

Output may be activated in the region between the 1 mA and 10 mA levels but transient specifications may not be met in this region. See Fig. 2-1.

Any voltage triggering source can be used to activate the 2620 provided the total source resistance falls within the limits shown in Fig. 2-2. Add series resistance to the signal source as needed to bring the total source resistance within the limits illustrated in Fig. 2-3.

Output

Provides output current at ±OUTPUT Connector (with respect to REF Connector). Polarity and timing of the OUTPUT current are the same as the input signal.

CONTROLS

Current Range

Selects the range of OUTPUT current:

POWER OFF
0 to .3 mA
0 to 3 mA
0 to 30 mA

+Current

Provides continuously variable control of OUTPUT +Current level (within the range selected by the CURRENT RANGE switch). Clockwise rotation increases output current.

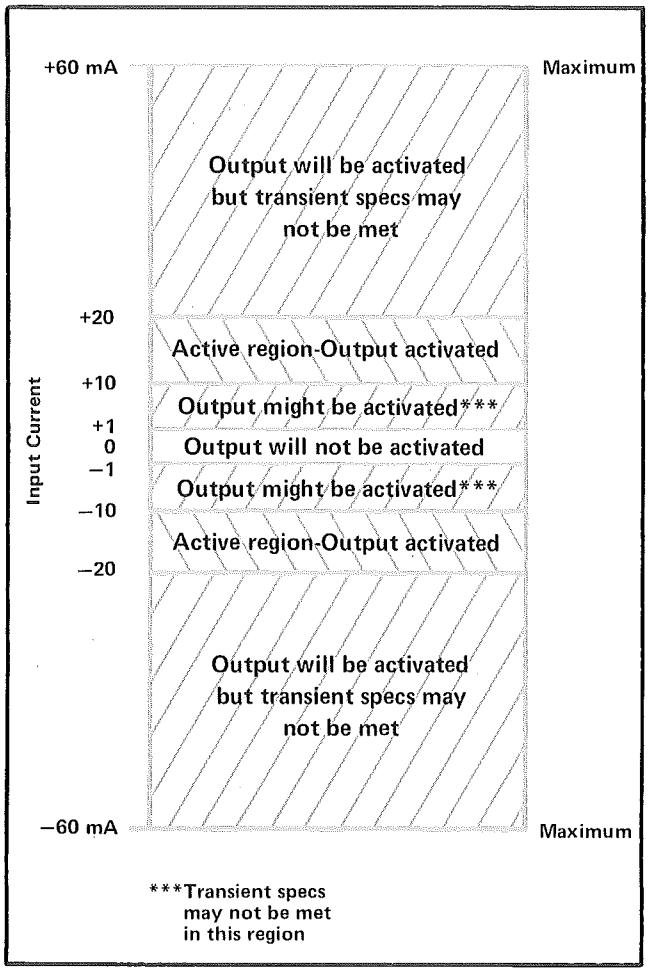


Fig. 2-1. Input signal requirements for output conditions.

—Current

Provides continuously variable control of OUTPUT —Current level (within the range selected by the CURRENT RANGE switch). Clockwise rotation increases output current.

INDICATORS

Power ON

When power is on (CURRENT RANGE switch in a position other than POWER OFF), the lighted POWER ON lamp indicates proper instrument operation.

Flashing lamp warns that battery is nearly discharged, although calibrated operation is still assured.

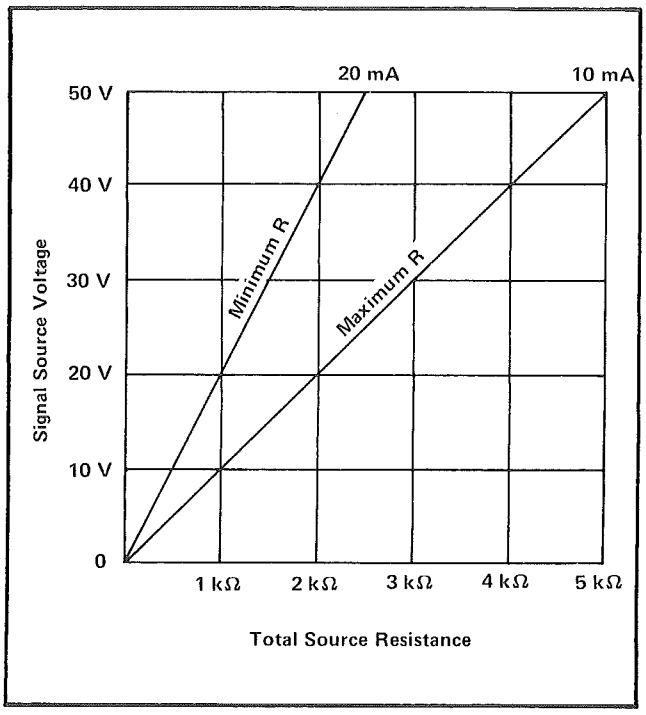


Fig. 2-2. Total Voltage Triggering Source Resistance.

Extinguished lamp (with power on) indicates that battery is too low for proper instrument operation and has been internally disconnected. CURRENT RANGE switch must be returned to POWER OFF position to reset low battery cutout circuit.

Output

Indicates the presence of an output signal. Regardless of input trigger duration, the lamp indicates for a minimum of 100 ms.

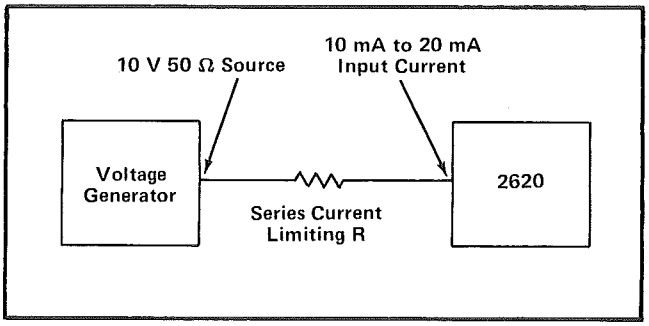


Fig. 2-3. Method of connecting the 2620 to a voltage triggering source.

SECTION 3
CIRCUIT DESCRIPTION

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

Introduction

This section of the manual contains a description of the circuits in the 2620.

Simplified drawings are provided where necessary to illustrate the description. Complete schematic diagrams are included in the Diagrams section. These diagrams should be referred to throughout the detailed description.

Symbols used on the schematic diagrams are explained on the first foldout in the Diagrams section.

Input, Switching and Output Circuits

This description is based on a positive-going Input trigger signal. When a negative going trigger is applied, the circuit function is identical except that a different set of components is activated and the current in the load is reversed. See Fig. 3-1.

U120 (U160 in the negative input), the +Integrated circuit, is a light-emitting diode and photo-transistor combination.

Bias for the transistor is provided by the resistance network R110 and R111. R112 (+Trigger Sens) sets the Photo-transistor light sensitivity.

With no input signal, the transistor is turned off. When +10 mA to +20 mA is applied to the input connector, the light-emitting diode emits light in the infra-red region. The emitted light causes the transistor to turn on.

C140 and associated circuitry in the input circuit provide compensation for input common-mode signals caused by capacitive coupling between the light-emitting diode and the base of the transistor in integrated circuits U120 and U160.

Common-mode signal current is converted to voltage in the Inverter-Differentiator circuit Q146, C146, and divider R116-R156. This voltage drives R115-R155 in the base circuits of U120 and U160 (see Fig. 3-2), providing a path for stray capacitive current and thus cancelling common-mode signal.

Initially (with no signal in) Q125 and Q165 are turned on, Q132 and Q172 are turned on and the bases of Q270 and Q275 are at about −1 volt, holding Q270 and Q275 on. The bases of Q180 and Q190 are at about −7.5 volts, holding Q180 and Q190 turned on. Since Q180 and Q190 are on, Q182 and Q192 are turned off.

With Q270 conducting, Q210 is turned off. Therefore, Q200 and Q202 are turned off, and Q255 is turned off via CR270.

With Q275 conducting, Q230 is turned off. Therefore, Q220 and Q222 are turned off and Q250 is turned off via CR275.

CR271 (CR277) prevents Q270 (Q275) collector from going any more negative than −0.6 volt.

Since there is no current path through Q255, Q250, Q202, and Q222, the levels at OUTPUT ± and REF are both at approximately +110 volts (through R202 and R222 to the +110 volt supply).

Since Q230 and Q210 are turned off, Q282 and Q280 are also off and there is no current to the Output Indicator lamp circuit.

When a +Input pulse arrives (10 mA to 20 mA) the transistor in U120 turns on. Q125 starts to turn off, turning Q132 and Q125 off with a regenerative action which assures fast switching when the threshold level is reached.

As Q132 turns off, Q180 base level drops to about −9 volts, turning on Q182, allowing Q182 to conduct at zero bias. Q182 conduction provides a low resistance (approx. 2 kΩ) path from the current level control to Q260 base. The voltage set by +CURRENT control, R3, now sets the level at TP7. At the same time, Q270 base level drops from −1 volt to about −6 volts, turning Q270 off.

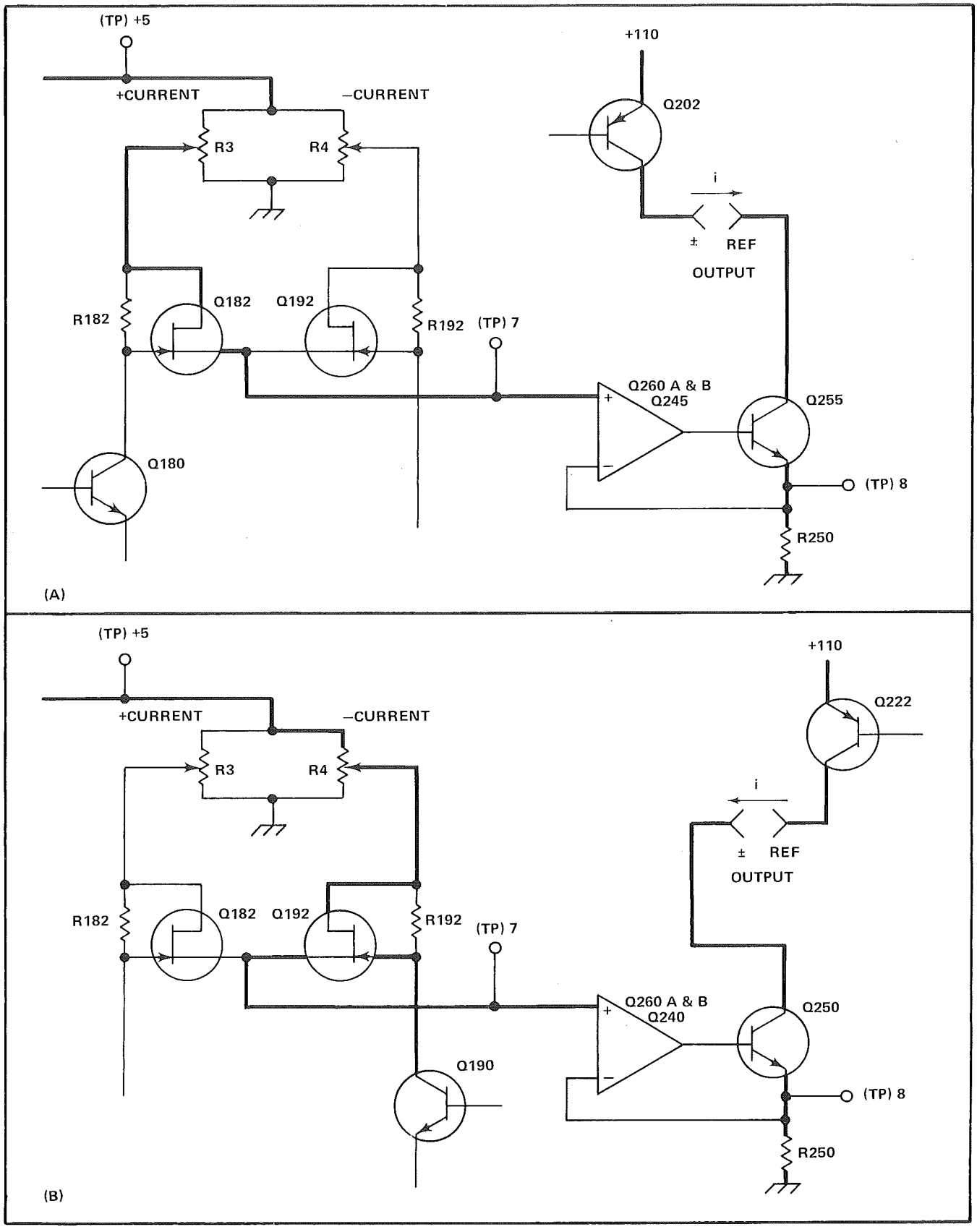


Fig. 3-1. Output Current and Current Level Setting Paths when activated by (A) +Activating Signal and (B) —Activating Signal.

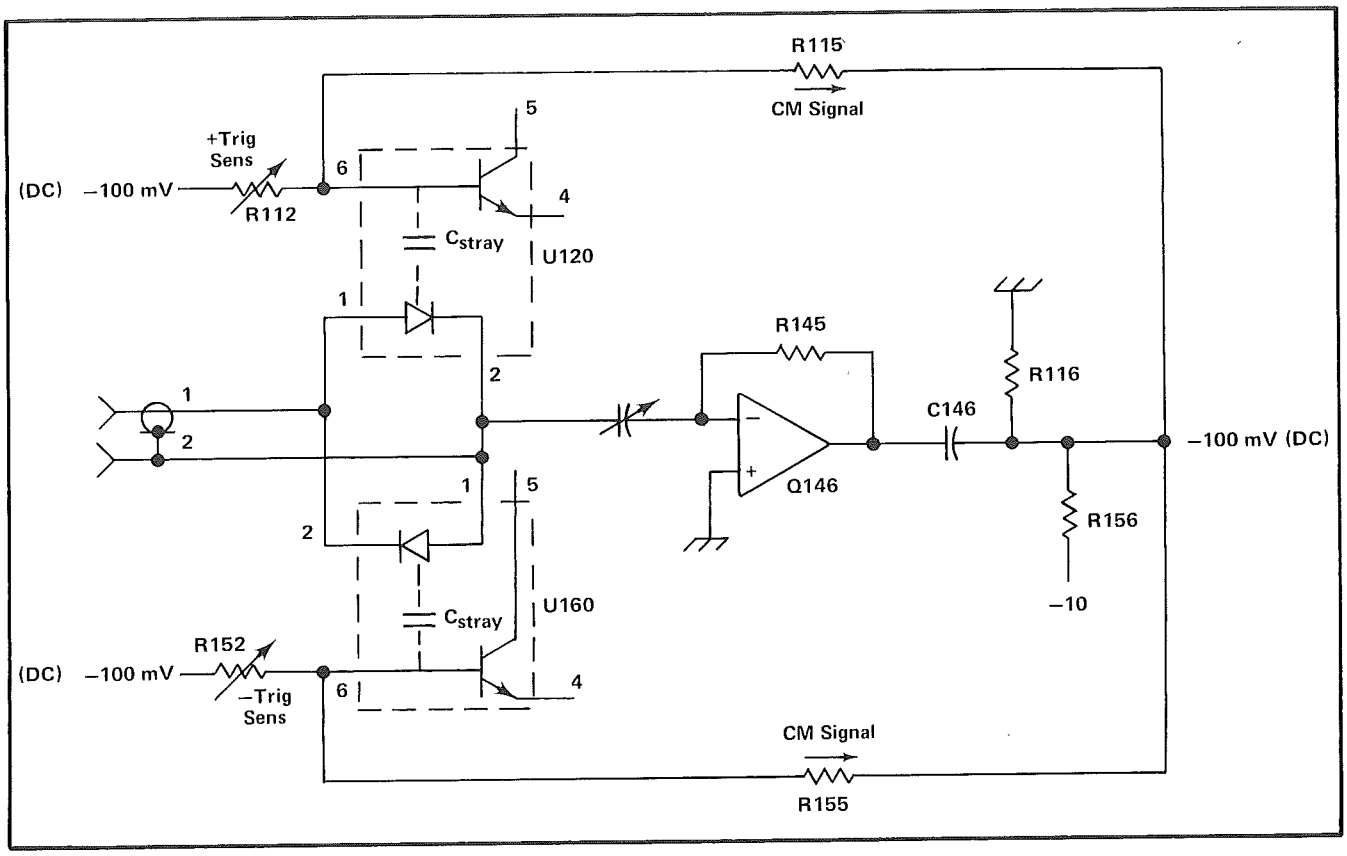


Fig. 3-2. Input common-mode compensation.

When Q270 turns off, its collector goes positive allowing Q255 base level to rise, turning on Q255. Simultaneously, Q210 turns on, turning on Q200 and Q202 (a Darlington pair).

With Q255 turned on, there is now a feedback amplifier (follower) consisting of Q260 A and B, Q245, and Q255 with the voltage at TP8 at the same level as that set at TP7.

Q255 current passes through one of the sense resistors, R250, R253, R255, by way of the CURRENT RANGE switch. With CURRENT RANGE switch, S2, in the 30 mA position and TP8 at 5 volts (set by the +CURRENT control) the OUTPUT current will be 30 mA (5 volts across R250). The current path is: +110 volts, through Q202, through the load at terminals ± and REF, through Q255 to R250.

The voltage at the ±OUTPUT can go to within two junctions (1.2 V) of +110 volts. As the voltage at the ±OUTPUT reaches approximately 108.8 volts (two junctions from 110 V) CR202 starts to turn on, stealing current from Q200 base, limiting the voltage at the ± terminal. CR202, along with CR200, prevents Q200-Q202 from saturating, improving the turn-off time.

As the voltage at TP8 is varied, the current through the output is varied, and therefore the voltage across the load is varied (see Fig. 3-2).

When Q210 turns on, Q280 is biased into conduction, providing about 0.5 mA to drive the OUTPUT Indicator lamp circuit.

The OUTPUT indicator lamp (in the Output circuit) provides visual indication when the instrument is producing an output signal (either positive or negative).

When either output polarity is activated, about 0.5 mA is provided via Q280 or Q282, to turn on Q290.

When Q290 turns on, C294 discharges through CR292 and Q292, turning Q292 off (in about 1 μs) causing Q295 to turn on, supplying current to the OUTPUT indicator.

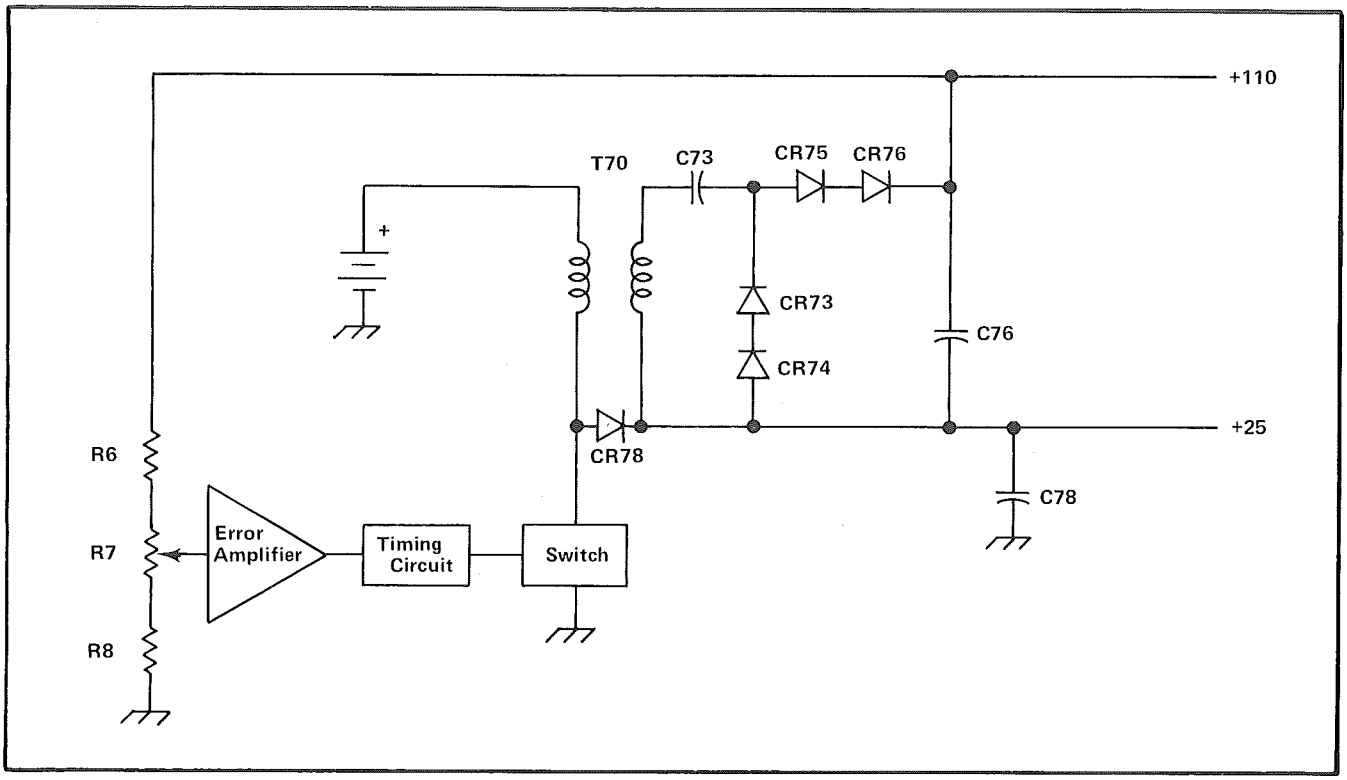


Fig. 3-3. Basic Converter circuit.

When the output pulse terminates, Q280 or Q282 turns off, turning off Q290. C294 now starts charging through R294 toward +10 volts. As C294 charges, the gate of Q292 rises. After a period of approximately 100 ms, Q292 turns on, turning Q295 off, and extinguishes the OUTPUT lamp.

As Q182 (or Q192) turns off when the input activating signal terminates, Q195 turns on, assuring rapid fall of Q160A base.

The voltage source for the +CURRENT, –CURRENT adjustments consists of VR310, CR310 (temperature compensation for VR310), the divider R310, R312, R313, and R314, and operational amplifier (follower) U310.

R313 is the calibration adjustment to set TP+5 to 5 volts.

Basic Converter Operation (see Fig. 3-3)

Assume that the switch is on. Linear current rise in T70 primary builds up a field. The voltage induced in T70 secondary charges C73 through CR73-CR74. Now assume that the switch turns off. The collapsing field in T70 primary adds to the battery voltage, forward biasing CR78, charging C78. The decreasing current in T70 primary causes an opposite voltage to be induced in T70 secondary. This secondary voltage reverse biases CR73-CR74. The charge stored on C73, plus the secondary induced voltage charge C76 through CR75-CR76. The total output is the sum of the voltages on C76 and C78.

The timing circuit holds the switch off for a fixed 1.5 μs regardless of load requirements, and holds the switch on long enough during each cycle so that over many cycles duration, the output voltage is held at +110 volts. The error amplifier senses any deviation from the set voltage and modifies the average "on" time accordingly.

Detailed Converter Operation

A sample of the +110 volt DC output is fed back to the input amplifier, Q3-Q13 via divider R6-R7-R8. The "divided down" voltage is compared to 6.2 volts set by VR13, controlling the timing circuit Q20, C38, and R38.

If the supply battery voltage is normal (greater than 2.2 volts) Q40 is held on by Q320, providing bias for Q50 (Q50 can be turned off by saturating Q35, or by turning off Q40).

Assume that the voltage at TP11 is 1.0 volt. In this condition, the voltage across Q30-Q35 (an SCS type circuit) is such that Q30 and Q35 are saturated. C38 is now charg-

ing through the base-emitter junction of Q30, through R35, giving a time constant which determines the time that Q50 will be turned off (Q50 base-emitter shorted by the saturation of Q35). Q50, turned off, keeps the switch turned off (Q70-Q75 through Q60).

C38 charges to about 1.7 volts in approximately 1.5 µs. Due to the voltage increase at TP11 (as C38 charges) the holding current in Q30-Q35 is decreasing. When TP11 reaches 1.7 volts, Q30 and Q35 switch rapidly to the off state. With Q35 off, Q50 is allowed to turn on, turning the switch (Q70-Q75) on, building up the field in T70 primary.

C38 now starts to discharge through R38. Q20, whose conduction is directly related to the output voltage (+110 volts) helps to determine the amount of time required to discharge C38 back down to the 1.0 volt level. If the average supply voltage (+110) over several cycles is low, Q20 presents (under control of Q3-Q13) a high value of resistance in parallel with C38, increasing RC time constant, and T70 primary field is allowed to build for a longer time.

If the average output voltage is high, Q20 resistance decreases due to increased conduction and C38 discharges faster, allowing T70 primary field to build for a shorter interval.

CR15 ensures Q20 turnoff during the fixed 1.5 µs period in which Q50 is turned off (Q30-Q35 turned on), removing Q20 as a shunting path around C38.

In this manner the level of output voltage determines how long the magnetic field is allowed to build, regulating the output voltage.

The switch in T70 primary consists of Q70 and Q75 in parallel, driven by Q60. When Q70 and Q75 turn off, Q55 turns off and Q65 turns on to drain off the stored base charge on Q70 and Q75.

CR70 and CR71 prevent circulating current in the 2-3 terminal section of T70 during light output loads. When terminal 3 swings negative with respect to terminal 2, there is a tendency for Q70 and Q75 to conduct through their collector-base junctions, causing Q60 to conduct heavily. CR70 and CR71 provide base drive-limiting in Q60, minimizing the circulating current.

+10 and −10 Volt Supplies

Pin 2 of transformer T70 provides voltage to the peak detector circuit, C81, C82, CR81, CR82, and CR86.

Each excursion in the positive direction at pin 2 charges C82 (+10 volts) through CR82-CR81, and each negative excursion at pin 2 charges C86 (−10 volts).

POWER ON-Low Battery Indicator

When the CURRENT RANGE switch is moved away from the POWER OFF position, the POWER ON lamp indicates that the instrument is turned on. A steady lamp indicates that battery voltage is normal (greater than 2.3 volts) and a flashing lamp indicates low battery voltage (2.3 volts or less).

With battery terminal voltage greater than 2.3 volts, current for the lamp is supplied by Q345-Q340A and +110 volts. If the battery voltage drops to 2.3 volts or less, Q340 steals current from Q345 and the lamp. R345 now provides current and DS3, C345-R345 act as a relaxation oscillator and the lamp flashes, indicating low battery voltage.

Low Battery Cutout

The battery terminal voltage is compared to a fixed 2.2 volts in the comparator, Q320 A and B.

When the terminal voltage is greater than 2.2 volts, Q320 B is turned on, holding Q40 in the converter circuit on, allowing the converter to function normally.

As the battery voltage drops, Q320B turns off, turning off Q40. As Q40 turns off, Q50 no longer has operating bias. Q50 turns off, turning off Q70 and Q75, shutting down the converter. C320 causes Q320 to switch regeneratively, so that once shutdown has begin, complete turn-off is assured. C320 also functions during instrument turn-on to supply Q40 base drive until the power supply voltages are normal and Q320 is operating.

NOTES

SECTION 4
MAINTENANCE

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

Introduction

This section of the manual contains maintenance information for use in preventive or corrective maintenance and troubleshooting of the 2620.

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 2620 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 Aids

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

Circuit Boards. A tint band outlines each circuit board 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 in the photograph by its circuit number.

Voltages. Often the defective components can be located by checking for the correct voltage in the circuit. Some 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. Table 4-1 lists the voltage tolerances of the power supplies in the 2620. If a power supply voltage is 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	Voltage
+5	+5, within 10 mV
−10	−10, −10%, +20%
+10	+10, −10%, +20%
+25	+25, ±10%
+110	+110, ±3%

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 2620.

1. Semiconductor Tester. Some means of testing the transistors and diodes used in the instrument is helpful. Since many 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.

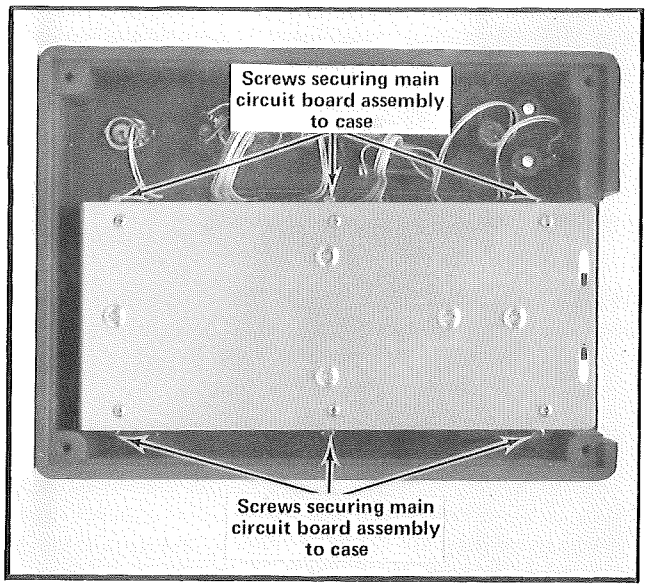


Fig. 4-1. Screws holding chassis-circuit board assembly to case.

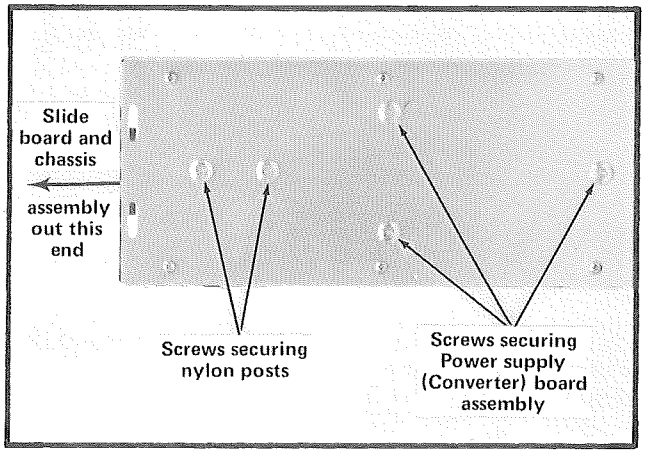


Fig. 4-2. Removing Converter board.

REPLACEMENT PARTS

Standard Parts

NOTE

All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the instrument performance.

All polarized capacitors are solid tantalum. Do NOT substitute.

Refer to the Parts Ordering Information preceding Electrical Parts List and Mechanical Parts List sections.

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.

ASSEMBLY AND COMPONENT REPLACEMENT

General

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

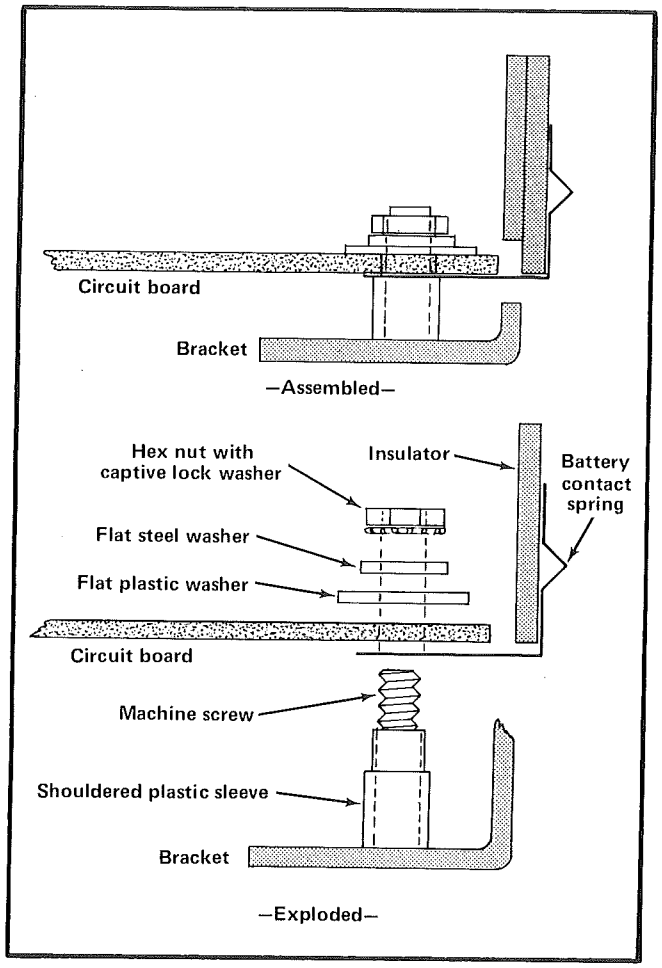
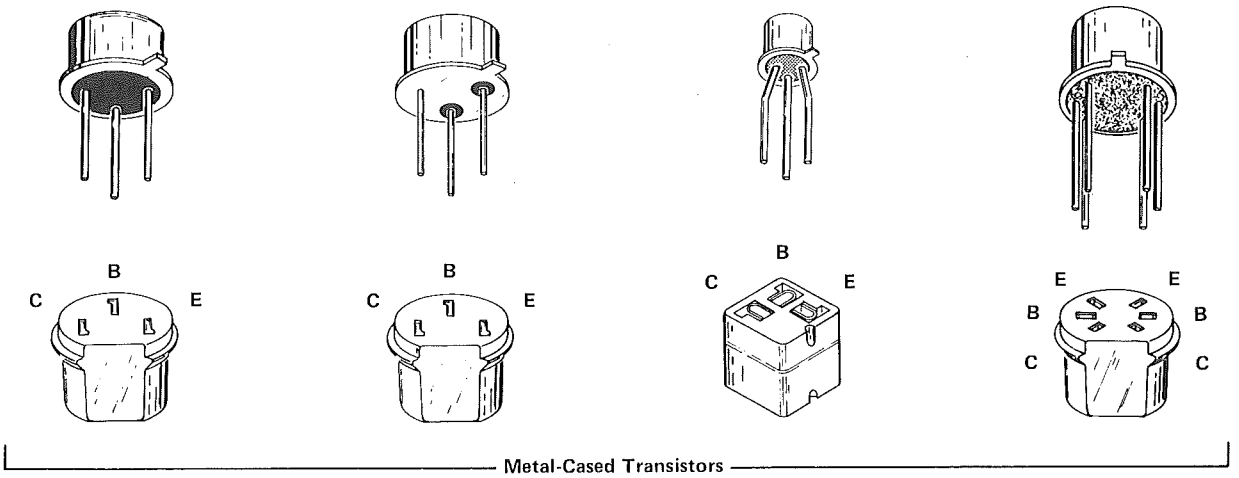
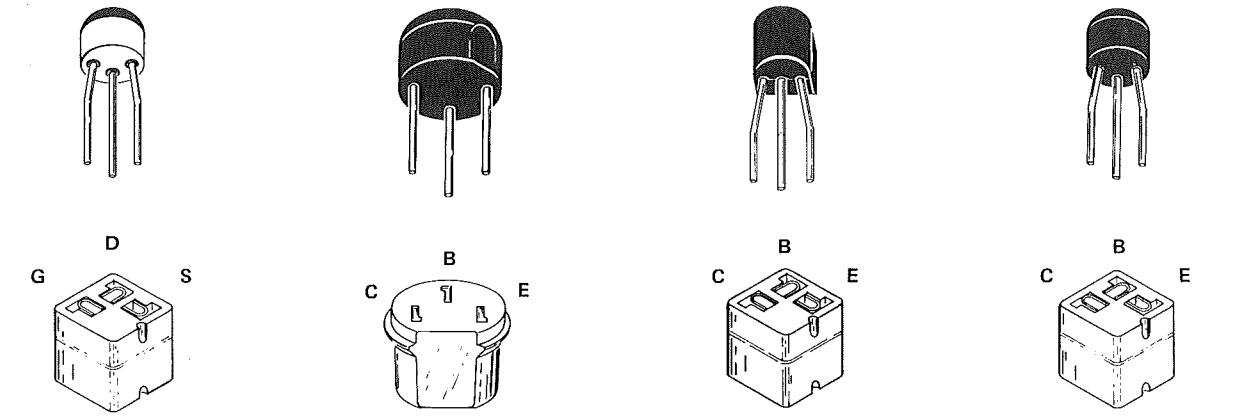


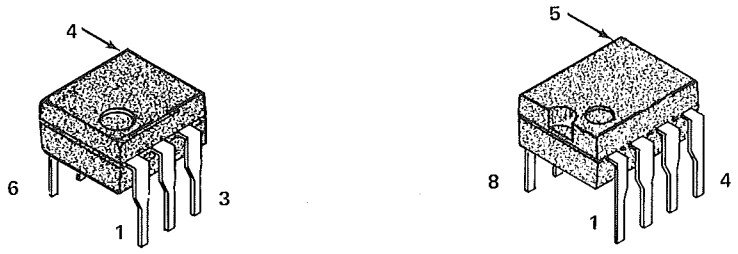
Fig. 4-3. Converter Board-Battery Contact Assembly.



Metal-Cased Transistors



Plastic-Cased Transistors



Integrated Circuits

See Fig. 4-5 for Transistors mounted in Temperature Equalizer

Fig. 4-4. Semiconductor lead configuration.

Removal of Circuit Boards

1. Remove the two "D" cells from the instrument.

2. Remove the instrument bottom cover.

3. Remove the six machine screws through the edge of the main circuit board. See Fig. 4-1.

4. Lift the circuit board assembly away from the cabinet.

If access to the converter board is necessary, proceed as follows:

1. Remove the 8-pin connector from the converter board (through the opening at the end of the chassis).

2. Remove the two machine screws (Fig. 4-2) securing the nylon posts. Remove the posts.

3. Remove the three machine screws (Fig. 4-2) and slide the converter board out through the open end of the battery compartment.

If the converter board must be removed from the bracket, see Fig. 4-3 for assembly details.

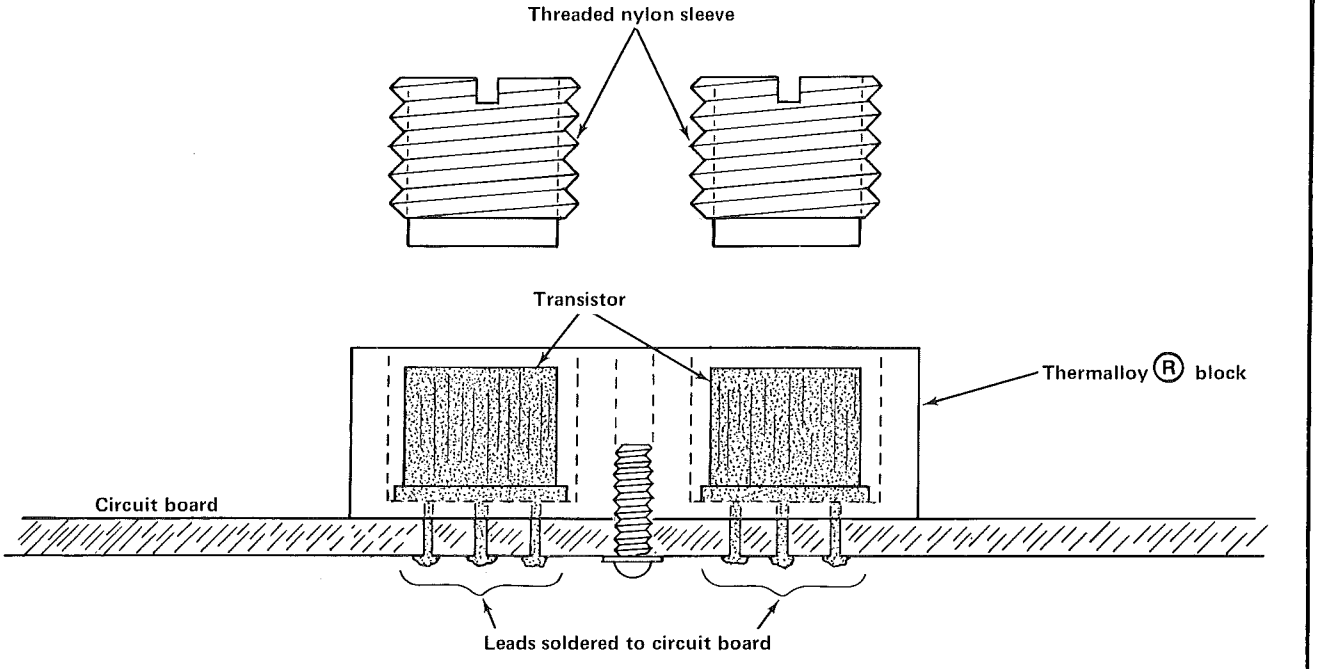
Semiconductor Replacement

Replacement semiconductors should be of the original type or a direct replacement. Fig. 4-4 shows the lead configuration of the semiconductors used in this instrument. Some plastic cased transistors may have lead configurations which do not agree with those 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.

Q70 and Q75 are soldered to the circuit board in a temperature equalizing sink. See Fig. 4-5 for details. Use a vacuum desoldering tool to remove solder for transistor removal.

Lead-End Pin Connectors

The pin connectors are grouped together and mounted in a plastic holder to serve as a multi-pin connector. To provide correct orientation of this multi-pin connector, an arrow is stamped on the circuit board and a matching arrow is molded into the plastic connector body. Replace the



Transistors may be removed separately through the threaded hole without removing the Thermalloy Ⓡ block from the circuit board.

Fig. 4-5. Q70-Q75 Heat-Sink Temperature Equalizer Assembly.

connector with the arrows aligned. If individual lead-end pin connectors are removed from the plastic body, note the individual wire color.

Lamp Replacement (OUTPUT Indicator, POWER ON)

The lamp housing is a two-piece assembly with the lamp soldered to the cap. To remove the lamp, lift the cap away from the sleeve as shown in Fig. 4-6.

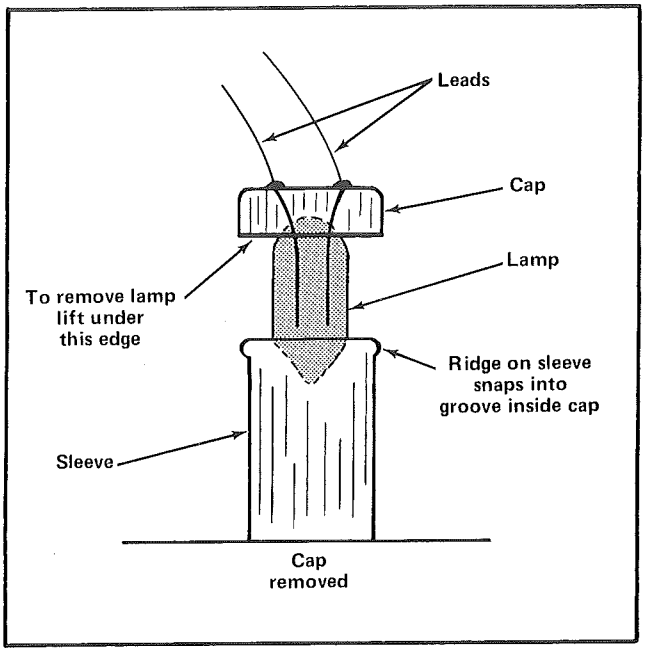


Fig. 4-6. Details of Lamp Assembly.

INSTRUMENT REPACKAGING

If the 2620 is to be shipped over long distances by commercial transportation, it is recommended that the instrument be repackaged in the original manner for maximum protection. Repackaging information and/or new shipping carton may be obtained from Tektronix Inc. Contact the nearest Tektronix Field Office or Representative. See Fig. 2, Repackaging (Pullout, Mechanical Parts List, Section 7).

NOTES

SECTION 5
PERFORMANCE CHECK/ADJUSTMENT

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.

As an aid to checking the performance of the 2620, a Short-Form Procedure is given prior to the complete procedure. To facilitate instrument checkout, the Short-Form Procedure lists the check and applicable tolerances. This Procedure also includes the step number and title as listed in the complete Performance Check, and the page number on which each step begins. The Short-Form Procedure also provides spaces to record performance data or to check off steps as they are completed.

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

Following the Performance Check is a complete ADJUSTMENT Procedure. Completion of the Adjustment Procedure 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. All waveforms shown in this 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 or adjustment of the 2620. 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. See Table 5-1 for list of Test Equipment.

In addition to the test equipment listed in Table 5-1, the following items are necessary to connect the equipment:

1. Coaxial Cable Assembly (2 required); 50 Ω with BNC connectors. Tektronix Part Number 012-0057-00.

2. Patchcord (2 required); 40-mil pin jack to 40-mil pin jack, 12 inch. Tektronix Part Number 012-0202-00.

3. Dual Banana Plug (supplied with instrument). Tektronix Part Number 103-0142-00.

SHORT-FORM PERFORMANCE CHECK

2620 Serial Number_____

Date_____

By_____

1. Check Off-State Current

   Not more than 10 nA

2. Check Output Voltage Compliance

   At least 100 Volts

3. Check Current Range Accuracy

   .3 mA Range, 4% of indicated current ±6 μA.

   3 mA Range, 3% of indicated current ±60 μA.

   30 mA Range, 3% of indicated current ±600 μA.

4. Check Output to Input Isolation Resistance

   10 GΩ or greater

TEST EQUIPMENT REQUIRED

Equipment	Minimum Specs	Use	P*	A**	Examples of Applicable Equipment
Test Oscilloscope					
Indicator		All Tests	X	X	Tektronix 7504 Oscilloscope with 7A13 Diff Comparator 7B50 Time Base OR
Differential Comparator[1]	Deflection Factor 5 mV/Div to 10 V/Div	Current Range Accuracy	X		Tektronix 561B, 564B, etc. with 3A7 Diff Comparator 2B67 or 3B3 Time Base OR
		Adjust Trig Sens		X	
	Bandwidth, 10 MHz	Off-State Current	X		
	Comparison Voltage Range, 0 to +110 V	DC Voltage Levels		X	
		Output-Input Isolation	X		
Time Base	Time/Div from 10 μs to 2 ms	All Tests			Tektronix 535A, 545B, 547, etc. with W Diff Comparator
Probes					
(2) 1X	1 MΩ	Supply Voltage Levels		X	
		Off-State Current	X		
(1) 10X	10 MΩ	Current Range Accuracy	X		(2) Tektronix P6052 (1X, 10X Selectable Attenuation) or equivalent
		Off-State Current	X		
		Trig Sens		X	
Signal Source (Square Wave)	10 μs and 500 ms pulses,	Current Range Accuracy	X		Tektronix 2600-System including 2601 Mainframe 26G1 Rate/Ramp Gen 26G3 Pulse Gen 26A1 Operational Amplifier
	0 to 20 mA	Off-State Current	X		
		Output-Input Isolation			
Operational Amplifier		Output-Input Isolation	X		

*P = Performance Check A** = Adjustment

[1] Any precision voltmeter may be used to measure the DC supply levels.

SHORT-FORM ADJUSTMENT

1. Adjust +110-volt Supply

ADJUST R7 for +110 volts within 0.5 volt.

2. Adjust +5-volt Supply

ADJUST R313 for +5 volts, within 10 mV.

3. Adjust Common-Mode Signal Compensation

ADJUST C140 half way between points of waveform distortion.

4. Adjust Trigger Sensitivity

ADJUST R112 for 150 mV pulse at TP1.

ADJUST R152 for 150 mV pulse at TP2.

PERFORMANCE CHECK PROCEDURE

General

The following procedure is arranged to check the 2620 with the least reconnection of equipment.

NOTE

Control titles which are printed on the front panel of the 2620 are capitalized in this procedure (e.g., +CURRENT). Associated equipment controls are initial capitalized only (e.g., Output).

The procedure uses the equipment listed under Test Equipment Required. If other equipment is substituted, control settings or checking setups 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 instruction manual for the test equipment if more information is required.

NOTE

The performance of this instrument may be checked at any temperature from +10°C to +40°C provided that the instrument was adjusted within an ambient range of +20°C to +30°C.

1. Check Off-State Current

a. Connect a 5 mA diode (any low reverse leakage type Tektronix Part Number 152-0246-00, or equivalent) across the OUTPUT terminals with the cathode toward the REF terminal.

b. Bridge the diode with a 0.01 μF disc capacitor.

c. Set the 2620 CURRENT RANGE to 3 mA and +CURRENT to 3.0.

d. Trigger the 2620 with a +10 mA pulse of 500 ms duration at a repetition rate of 1 second.

e. Monitor the 2620 OUTPUT (across the diode) with a Differential Amplifier. Measure differentially with two 1X probes.

f. CHECK—Off state current should not exceed 10 nA (20 mV across the 2 MΩ of two 1X probes used differentially).

2. Check Output Voltage Compliance

a. Bridge the 2620 OUTPUT terminals with a 3.9 kΩ, 3 watt resistor.

b. Set the 2620 CURRENT RANGE to 30 mA and +CURRENT and −CURRENT to 3.0.

c. Trigger the 2620 with a +10 mA pulse of 1 ms duration at a 1 kHz repetition rate.

d. Monitor the OUTPUT (across the resistor) with the Test Oscilloscope and probe Vertical deflection factor set at 20 V/Div.

e. CHECK—for at least 5 divisions (100 volts) of vertical display.

f. Trigger the 2620 with a −10 mA pulse of 1 ms duration at a 1 kHz repetition rate.

g. Monitor the OUTPUT with the Test Oscilloscope Vertical deflection factor set at 20 V/Div.

h. CHECK—for at least 5 divisions of vertical display.

3. Check Current Range Accuracy

a. Bridge the 2620 OUTPUT terminals with a 3.333 kΩ resistor (three 10 kΩ, 0.25%, 1 watt, resistors in parallel or select from standard values to give 3.333 kΩ) at 3 watts.

b. Set the 2620 CURRENT RANGE to .3 mA and +CURRENT to 3.0.

c. Trigger the 2620 with a +10 mA pulse as in step 2c.

d. Using the Differential Comparator, set to measure approximately 1 volt, measure the Output voltage across the 3.333 kΩ resistor.

e. CHECK—for Output voltage between 0.94 and 1.06.

f. Reset +CURRENT as detailed in Table 5-1.

g. CHECK—That the voltages are within the limits listed in Table 5-1.

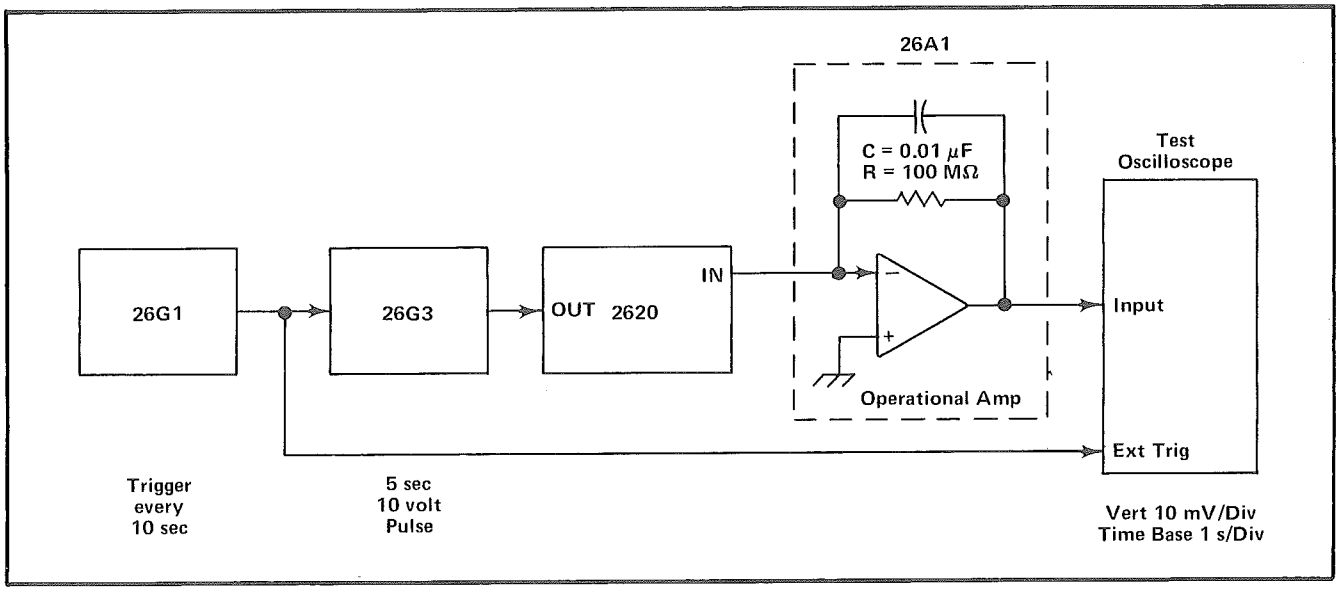


Fig. 5-1. Test setup for Step 4.

h. Switch CURRENT RANGE to 3 mA and +CURRENT to 3.0.

i. CHECK–for Output voltages within the limits shown in Table 5-1.

j. Switch CURRENT RANGE to 30 mA and +CURRENT to 3.0.

k. CHECK–for Output voltages within the limits shown in Table 5-1.

l. Trigger the 2620 with a –10 mA pulse.

m. CHECK–that the Output voltage limits of the negative Output pulse are within the limits shown in Table 5-1 for each set of conditions.

TABLE 5-1

Dial Setting	Output Voltage Range Across 3.333 kΩ		
	.3 mA Range	3 mA Range	30 mA Range
3.0	0.94 to 1.06 V	9.5 to 10.5 V	95 to 105 V
1.8	0.556 to 0.664 V	5.62 to 6.38 V	56.2 to 63.8 V
.3	0.076 to 0.124 V	0.77 to 1.23 V	7.7 to 12.3 V

4. Check Output to Input Isolation Resistance

a. Set up a Trigger Generator, Pulse Generator, Operation amplifier, the 2620 Stimulus Isolator, and a Test Oscilloscope as illustrated in Fig. 5-1.

b. Adjust Test Oscilloscope trigger for a stable display similar to that shown in Fig. 5-2.

c. Select a value of capacitance across the 100 MΩ feedback resistor in the operational amplifier to provide great enough time constant to eliminate most of the stray 60 Hz pickup in the leads, yet small enough to display the signal changes properly. C should equal approximately 0.01 μF.

d. Calculate the Isolation Resistance as follows:

$$R_{isolation} = \frac{R_f\, e_i}{e_o} = \frac{100 \times 10^6\ 10\ V}{e_o}$$

e. CHECK–e_o should not exceed 100 mV.

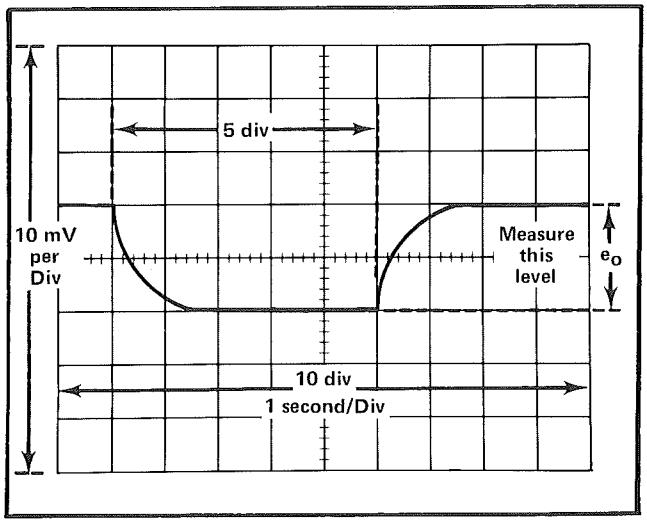


Fig. 5-2. Idealized waveform for checking isolation resistance.

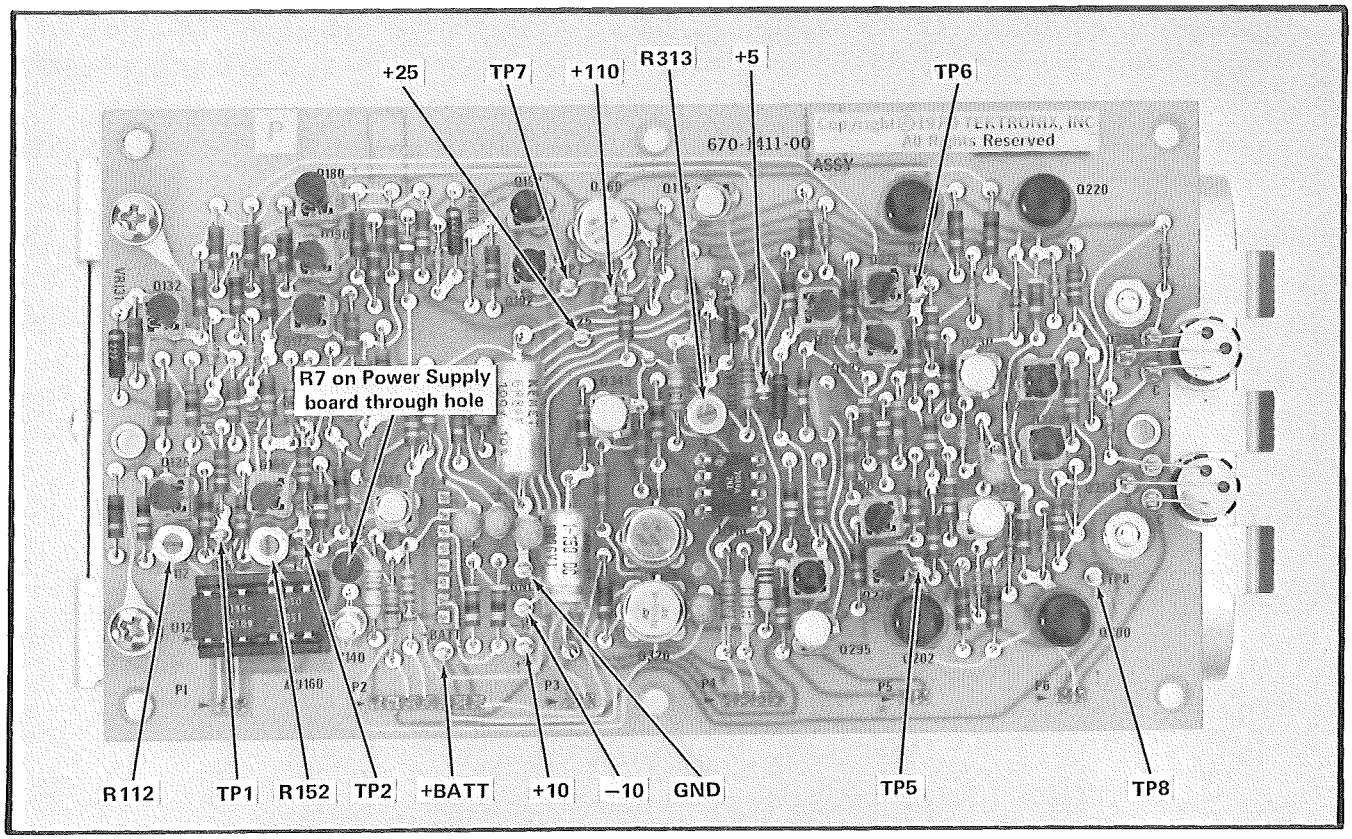


Fig. 5-3. Location of controls and test points.

ADJUSTMENT PROCEDURE

With no signal in:

1. Adjust +110-Volt Supply (R7)

a. Monitor TP+110 (see Fig. 5-3 for location) using a Differential Comparator or DVM.

b. ADJUST—R7 for +110 volts, within 0.5 volt.

c. CHECK the voltages as listed in Table 5-2.

TABLE 5-2

Voltage	Limits
−10	−10 V, within −10%, +20%
+10	+10 V, within −10%, +20%
+25	+25 V, within 10%

2. Adjust +5 Volts (R313)

a. Monitor TP+5 (see Fig. 5-3 for location) using a Differential Comparator or DVM.

b. ADJUST—R313 for +5 volts, within 10 mV.

3. Adjust Common-Mode Signal Compensation (C140)

a. Feed a 10 µs, +10 mA pulse at 1 kHz repetition rate from a Pulse Generator to the 2620 INPUT.

b. Set the 2620 Trig Sens controls (internal adjustments; see Fig. 5-3) fully clockwise.

c. Bridge the 2620 OUTPUT terminals with a 3.3 kΩ, 3 watt resistor and monitor the OUTPUT with a Test Oscilloscope and 10X probe.

d. Set the 2620 CURRENT RANGE to 30 mA and +CURRENT to 3.0.

e. ADJUST—C140 as follows: Turn C140 clockwise until the waveform starts to distort; turn C140 counterclockwise until the waveform again starts to distort. Reset C140 half way between the two points of distortion.

4. Adjust Trigger Sensitivity (R112 and R152)

a. Feed a +10 mA pulse from Pulse Generator (26G3) to 2620 INPUT.

b. Monitor TP1 (see Fig. 5-3 for location) with Test Oscilloscope and 10X probe.

c. ADJUST–R112 for a 150 mV pulse at TP1.

d. Feed a –10 mA pulse from Pulse Generator to 2620 INPUT.

e. Monitor TP2 with Test Oscilloscope and 10X probe.

f. ADJUST–R152 for a 150 mV pulse at TP2.

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

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

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

CHASSIS

Battery

BT70	146-0005-00			Battery, 2.5 V

Bulbs

DS3	150-0035-00			Neon AID T2
DS4	150-0035-00			Neon AID T2

Connectors

J1	131-0955-00			Receptacle, electrical, BNC
J2	136-0139-00			Banana Jack Assembly
J3	136-0139-00			Banana Jack Assembly

Transistors

Q225	*153-0593-00		Silicon NPN	Selected from 2N3440
Q250	*153-0593-00		Silicon NPN	Selected from 2N3440

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R3	311-1150-00			10 kΩ, Var
R4	311-1150-00			10 kΩ, Var

Switch

	Wired or Unwired			
S2	260-1233-00		Rotary	CURRENT RANGE

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A1 MAIN Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
	*670-1411-00			Complete Board		
				Capacitors		
Tolerance ±20% unless otherwise indicated.						
C140	281-0064-00			0.25-1.5 pF, Var	Plastic	
C146	283-0111-01			0.1 μF	Cer 50 V	
C272	290-0517-00			6.8 μF	Elect. 35 V	
C294	283-0110-00			0.005 μF	Cer 150 V	
C301	290-0486-00			6.8 μF	Elect. 100 V	10%
C303	290-0517-00			6.8 μF	Elect. 35 V	
C306	290-0512-00			22 μF	Elect. 15 V	
C308	290-0512-00			22 μF	Elect. 15 V	
C310	290-0512-00			22 μF	Elect. 15 V	
C312	290-0512-00			22 μF	Elect. 15 V	
C320	290-0512-00			22 μF	Elect. 15 V	
C345	290-0164-00			1 μF	Elect. 150 V	
				Semiconductor Device, Diodes		
CR133	*152-0185-00			Silicon	Replaceable by 1N4152	
CR173	*152-0185-00			Silicon	Replaceable by 1N4152	
CR180	*152-0185-00			Silicon	Replaceable by 1N4152	
CR190	*152-0185-00			Silicon	Replaceable by 1N4152	
CR200	*152-0185-00			Silicon	Replaceable by 1N4152	
CR202	*152-0061-00			Silicon	Tek Spec	
CR220	*152-0185-00			Silicon	Replaceable by 1N4152	
CR222	*152-0061-00			Silicon	Tek Spec	
CR242	*152-0185-00			Silicon	Replaceable by 1N4152	
CR243	*152-0185-00			Silicon	Replaceable by 1N4152	
CR244	*152-0185-00			Silicon	Replaceable by 1N4152	
CR250	*152-0185-00			Silicon	Replaceable by 1N4152	
CR255	*152-0185-00			Silicon	Replaceable by 1N4152	
CR270	*152-0185-00			Silicon	Replaceable by 1N4152	
CR271	*152-0185-00			Silicon	Replaceable by 1N4152	
CR272	*152-0185-00			Silicon	Replaceable by 1N4152	
CR275	*152-0185-00			Silicon	Replaceable by 1N4152	
CR276	*152-0185-00			Silicon	Replaceable by 1N4152	
CR277	*152-0185-00			Silicon	Replaceable by 1N4152	
CR292	152-0246-00			Silicon	Low leakage 250 mW	
CR310	*152-0185-00			Silicon	Replaceable by 1N4152	
VR131	152-0227-00			Zener	1N753A 400 mW, 6.2 V, 5%	
VR171	152-0227-00			Zener	1N753A 400 mW, 6.2 V, 5%	
VR180	152-0227-00			Zener	1N753A 400 mW, 6.2 V, 5%	
VR310	152-0227-00			Zener	1N753A 400 mW, 6.2 V, 5%	

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A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
		Inductor		
L301	108-0240-00			820 μH
		Transistors		
Q125	151-0190-00			Silicon NPN TO-92 2N3904
Q132	151-0188-00			Silicon PNP TO-92 2N3906
Q146	151-0230-00	B010100	B010129	Silicon NPN TO-105 Selected from RCA 40235
Q146	*151-0198-00	B010130		Silicon NPN TO-92 Replaceable by MPS 918
Q165	151-0190-00			Silicon NPN TO-92 2N3904
Q172	151-0188-00			Silicon PNP TO-92 2N3906
Q180	151-0190-00			Silicon NPN TO-92 2N3904
Q182	151-1004-00			Silicon FET N Channel, junction type
Q190	151-0190-00			Silicon NPN TO-92 2N3904
Q192	151-1004-00			Silicon FET N Channel, junction type
Q195	151-0230-00	B010100	B010129	Silicon NPN TO-105 Selected from RCA 40235
Q195	151-0190-00	B010130		Silicon NPN TO-92 2N3904
Q200	*151-0228-00			Silicon PNP TO-5 Tek Spec
Q202	*151-0228-00			Silicon PNP TO-5 Tek Spec
Q210	151-0250-00	B010100	B010129	Silicon NPN TO-104 2N5184
Q210	151-0292-00	B010130		Silicon NPN TO-92 TIS100
Q220	*151-0228-00			Silicon PNP TO-5 Tek Spec
Q222	*151-0228-00			Silicon PNP TO-5 Tek Spec
Q230	151-0250-00	B010100	B010129	Silicon NPN TO-104 2N5184
Q230	151-0292-00	B010130		Silicon NPN TO-92 TIS100
Q240	151-0220-00			Silicon PNP TO-18 2N4122
Q245	151-0220-00			Silicon PNP TO-18 2N4122
Q260	151-0232-00			Silicon NPN TO-78 Dual
Q270	151-0190-00			Silicon NPN TO-92 2N3904
Q275	151-0190-00			Silicon NPN TO-92 2N3904
Q280	151-0188-00			Silicon PNP TO-92 2N3906
Q282	151-0188-00			Silicon PNP TO-92 2N3906
Q290	*151-0195-00			Silicon NPN TO-92 Replaceable by MPS 6515
Q292	151-1004-00			Silicon FET N Channel, junction type
Q295	151-0250-00	B010100	B010129	Silicon NPN TO-104 2N5184
Q295	151-0292-00	B010130		Silicon NPN TO-92 TIS100
Q320	*151-0261-00			Silicon PNP TO-78 Tek Spec, Dual
Q340	151-0232-00			Silicon NPN TO-78 Dual
Q345	151-0250-00	B010100	B010129	Silicon NPN TO-104 2N5184
Q345	151-0292-00	B010130		Silicon NPN TO-92 TIS100
		Resistors		
Resistors are fixed, composition, $\pm$10% unless otherwise indicated.				
R110	316-0102-00			1 kΩ 1/4 W
R111	316-0104-00			100 kΩ 1/4 W
R112	311-0613-00			100 kΩ, Var
R115	316-0563-00			56 kΩ 1/4 W
R116	316-0103-00			10 kΩ 1/4 W

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
			Resistors (cont)		
R123	316-0103-00		10 kΩ	1/4 W	
R125	316-0822-00		8.2 kΩ	1/4 W	
R127	316-0680-00		68 Ω	1/4 W	
R128	315-0153-00		15 kΩ	1/4 W	5%
R131	316-0182-00		1.8 kΩ	1/4 W	
R135	315-0182-00		1.8 kΩ	1/4 W	5%
R136	315-0752-00		7.5 kΩ	1/4 W	5%
R138	315-0302-00		3 kΩ	1/4 W	5%
R140	316-0222-00		2.2 kΩ	1/4 W	
R143	316-0392-00		3.9 kΩ	1/4 W	
R145	316-0223-00		22 kΩ	1/4 W	
R150	316-0102-00		1 kΩ	1/4 W	
R151	316-0104-00		100 kΩ	1/4 W	
R152	311-0613-00		100 kΩ, Var		
R155	316-0563-00		56 kΩ	1/4 W	
R156	316-0105-00		1 MΩ	1/4 W	
R163	316-0103-00		10 kΩ	1/4 W	
R165	316-0822-00		8.2 kΩ	1/4 W	
R167	316-0680-00		68 Ω	1/4 W	
R168	315-0153-00		15 kΩ	1/4 W	5%
R171	316-0182-00		1.8 kΩ	1/4 W	
R175	315-0182-00		1.8 kΩ	1/4 W	5%
R176	315-0752-00		7.5 kΩ	1/4 W	5%
R178	315-0302-00		3 kΩ	1/4 W	5%
R182	316-0153-00		15 kΩ	1/4 W	
R184	315-0132-00		1.3 kΩ	1/4 W	5%
R185	315-0152-00		1.5 kΩ	1/4 W	5%
R192	316-0153-00		15 kΩ	1/4 W	
R194	315-0132-00		1.3 kΩ	1/4 W	5%
R200	316-0472-00		4.7 kΩ	1/4 W	
R201	316-0272-00		2.7 kΩ	1/4 W	
R202	315-0107-00		100 MΩ	1/4 W	5%
R210	316-0223-00		22 kΩ	1/4 W	
R211	316-0473-00		47 kΩ	1/4 W	
R215	316-0103-00		10 kΩ	1/4 W	
R216	316-0103-00		10 kΩ	1/4 W	
R220	316-0472-00		4.7 kΩ	1/4 W	
R221	316-0272-00		2.7 kΩ	1/4 W	
R222	315-0107-00		100 kΩ	1/4 W	5%
R230	316-0223-00		22 kΩ	1/4 W	
R231	316-0473-00		47 kΩ	1/4 W	
R235	316-0103-00		10 kΩ	1/4 W	
R236	316-0103-00		10 kΩ	1/4 W	
R240	316-0183-00		18 kΩ	1/4 W	
R243	315-0274-00		270 kΩ	1/4 W	5%

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
R245	316-0183-00			18 kΩ	1/4 W	
R250	321-0117-00			162 Ω	1/8 W	Prec 1%
R253	321-0213-00			1.62 kΩ	1/8 W	Prec 1%
R255	321-0308-00			15.8 kΩ	1/8 W	Prec 1%
R263	315-0473-00			47 kΩ	1/4 W	5%
R272	316-0103-00			10 kΩ	1/4 W	
R273	315-0332-00			3.3 kΩ	1/4 W	5%
R274	315-0432-00			4.3 kΩ	1/4 W	5%
R276	315-0682-00			6.8 kΩ	1/4 W	5%
R278	315-0332-00			3.3 kΩ	1/4 W	5%
R279	315-0432-00			4.3 kΩ	1/4 W	5%
R290	316-0103-00			10 kΩ	1/4 W	
R292	316-0104-00			100 kΩ	1/4 W	
R294	316-0336-00			33 MΩ	1/4 W	
R296	316-0104-00			100 kΩ	1/4 W	
R298	316-0224-00			220 kΩ	1/4 W	
R303	316-0101-00			100 Ω	1/4 W	
R306	316-0470-00			47 Ω	1/4 W	
R308	316-0470-00			47 Ω	1/4 W	
R310	316-0153-00			15 kΩ	1/4 W	
R312	321-0271-00			6.49 kΩ	1/8 W	Prec 1%
R313	311-0633-00			5 kΩ, Var		
R314	321-0322-00			22.1 kΩ	1/8 W	Prec 1%
R320	316-0102-00			1 kΩ	1/4 W	
R325	315-0682-00			6.8 kΩ	1/4 W	5%
R340	315-0272-00			2.7 kΩ	1/4 W	5%
R343	315-0303-00			30 kΩ	1/4 W	
R345	316-0335-00			3.3 MΩ	1/4 W	5%
R346	321-0234-00			2.67 kΩ	1/8 W	Prec 1%
R347	321-0097-00			100 Ω	1/8 W	Prec 1%
R348	321-0227-00			2.26 kΩ	1/8 W	Prec 1%

Integrated Circuits

U120	156-0109-00	Optoelectronic isolator, replaceable by Monsanto MCT-2
U160	156-0109-00	Optoelectronic isolator, replaceable by Monsanto MCT-2
U310	156-0067-00	Op amp., replaceable by Fairchild μA741C

A2 CONVERTER Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
	*670-1410-00			Complete Board			
				Capacitors			
Tolerance ±20% unless otherwise indicated.							
C38	285-0598-00			0.01 μF	PTM	100 V	5%
C57	290-0512-00			22 μF	Elect.	15 V	
C70	290-0425-00			100 μF	Elect.	20 V	
C73	290-0517-00			6.8 μF	Elect.	35 V	
C76	290-0486-00			6.8 μF	Elect.	100 V	10%
C78	290-0517-00			6.8 μF	Elect.	35 V	
C81	290-0512-00			22 μF	Elect.	15 V	
C82	290-0512-00			22 μF	Elect.	15 V	
C85	290-0512-00			22 μF	Elect.	15 V	
C86	290-0512-00			22 μF	Elect.	15 V	
				Semiconductor Device, Diodes			
CR15	152-0079-00	B010100	B019999	Germanium	HD1841		
CR15	152-0075-00	B020000		Germanium	ED48 or GD238		
CR70	152-0333-00			Silicon	High speed and conductance		
CR71	152-0333-00			Silicon	High speed and conductance		
CR73	152-0333-00			Silicon	High speed and conductance		
CR74	152-0333-00			Silicon	High speed and conductance		
CR75	152-0333-00			Silicon	High speed and conductance		
CR76	152-0333-00			Silicon	High speed and conductance		
CR78	152-0333-00			Silicon	High speed and conductance		
CR81	152-0333-00			Silicon	High speed and conductance		
CR82	152-0333-00			Silicon	High speed and conductance		
CR85	152-0333-00			Silicon	High speed and conductance		
CR86	152-0333-00			Silicon	High speed and conductance		
VR13	152-0227-00			Zener	1N753A 400 mW, 6.2 V, 5%		
				Transistors			
Q3	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q13	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q20	151-0223-00			Silicon	NPN	TO-18	2N4275
Q30	151-0223-00			Silicon	NPN	TO-18	2N4275
Q35	*151-0199-00			Silicon	PNP	TO-92	Replaceable by MOT MPS 3640
Q40	151-0190-00			Silicon	NPN	TO-92	2N3904
Q50	151-0164-00			Silicon	PNP	TO-5	2N5447
Q55	151-0223-00			Silicon	NPN	TO-18	2N4275
Q60	151-0260-00			Silicon	NPN	TO-39	2N5189
Q65	151-0260-00			Silicon	NPN	TO-39	2N5189

A2 CONVERTER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Transistors (cont)			
Q70	*151-0338-00			Silicon	NPN	Selected from 2N3553	
Q75	*151-0338-00			Silicon	NPN	Selected from 2N3553	
				Resistors			
Resistors are fixed, composition, ±10% unless otherwise indicated.							
R6	321-0434-00			324 kΩ	1/8 W	Prec	1%
R7	311-0633-00			5 kΩ, Var			
R8	321-0312-00			17.4 kΩ	1/8 W	Prec	1%
R10	316-0562-00			5.6 kΩ	1/4 W		
R13	316-0562-00			5.6 kΩ	1/4 W		
R15	316-0271-00			270 Ω	1/4 W		
R30	316-0682-00			6.8 kΩ	1/4 W		
R31	316-0102-00			1 kΩ	1/4 W		
R35	316-0390-00			39 Ω	1/4 W		
R38	316-0472-00			4.7 kΩ	1/4 W		
R40	315-0122-00			1.2 kΩ	1/4 W		5%
R42	316-0102-00			1 kΩ	1/4 W		
R50	316-0682-00			6.8 kΩ	1/4 W		
R53	316-0100-00			10 Ω	1/4 W		
R56	316-0271-00			270 Ω	1/4 W		
R57	307-0103-00			2.7 Ω	1/4 W		5%
R58	316-0151-00			150 Ω	1/4 W		
				Transformer			
T70	*120-0712-00			Power Pot Core			

SECTION 7

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

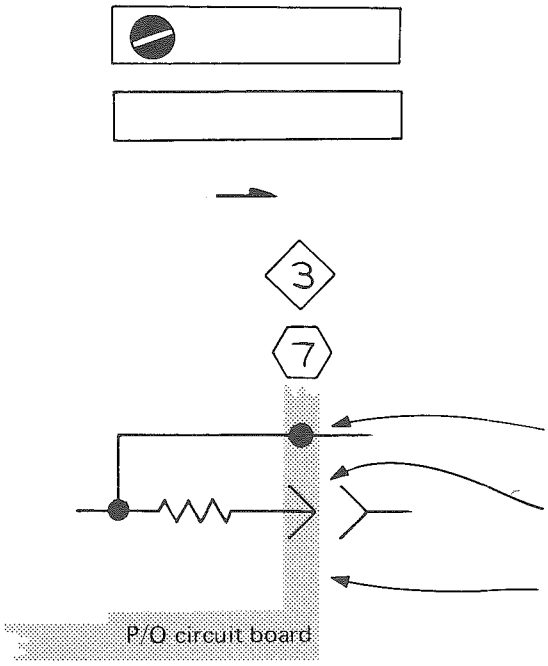
Electrical components shown on the diagrams are in the following units unless noted otherwise:

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

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

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

The following special symbols are used on the diagrams:



External Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

Refer to waveform number indicated in hexagon.

Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

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

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

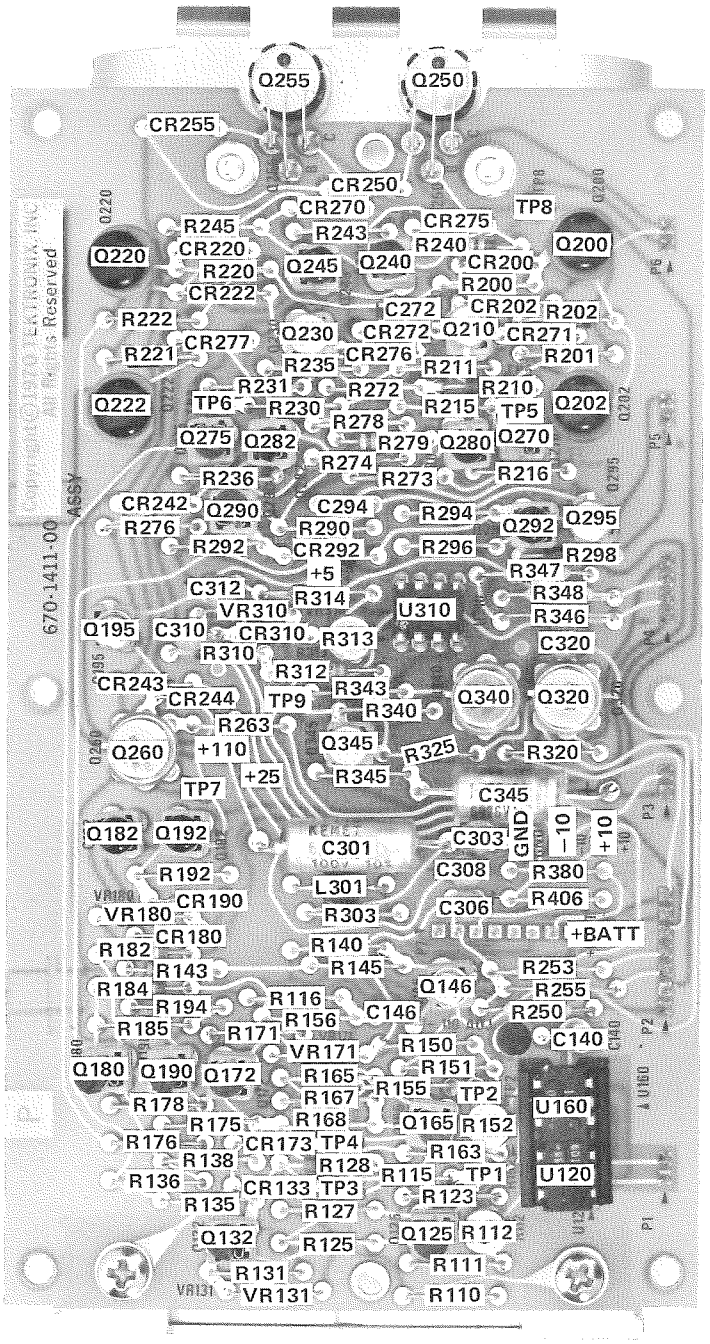
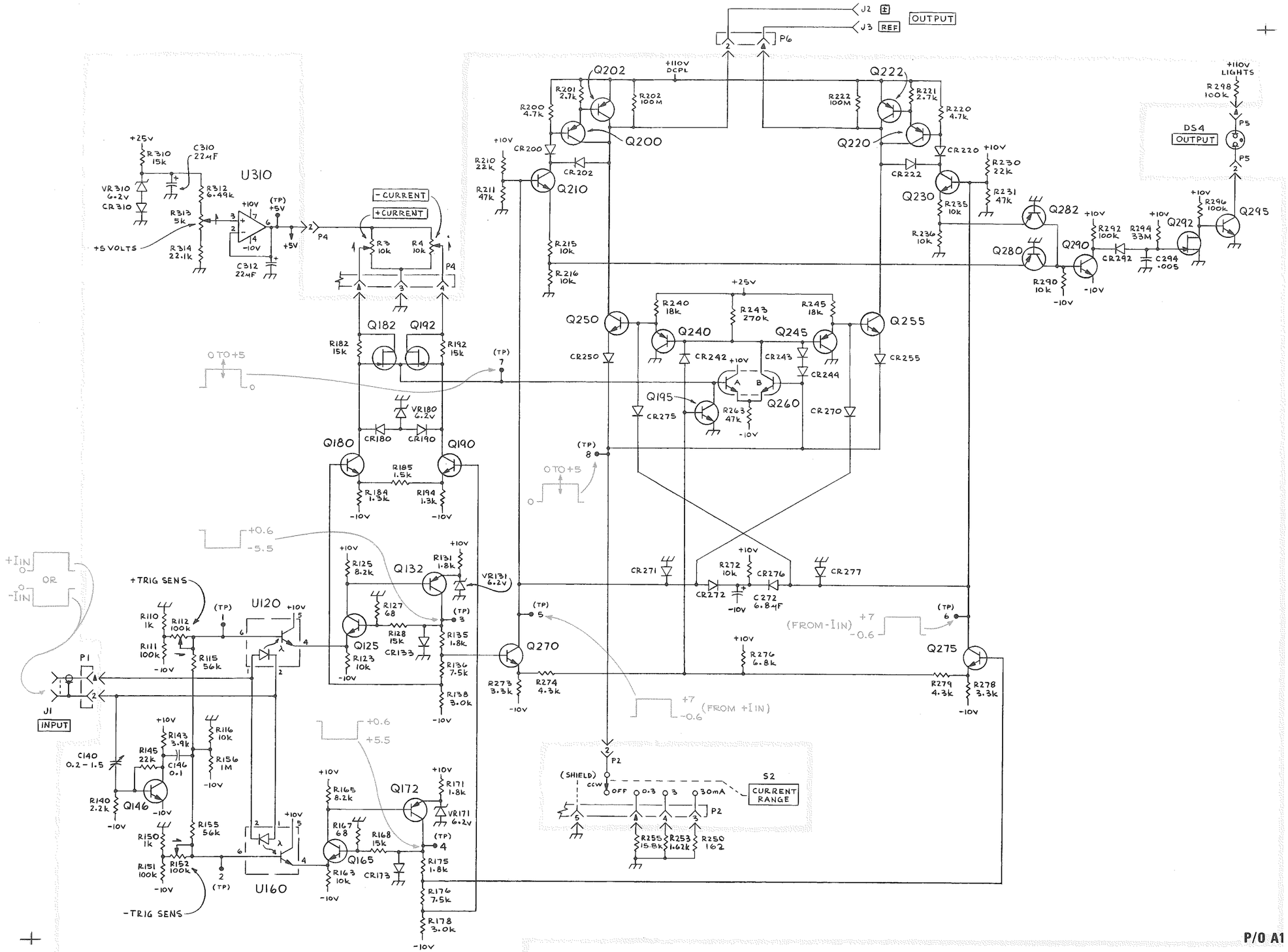


Fig. 7-1. A1. Main circuit board.



P/O A1

ISOLATOR 1

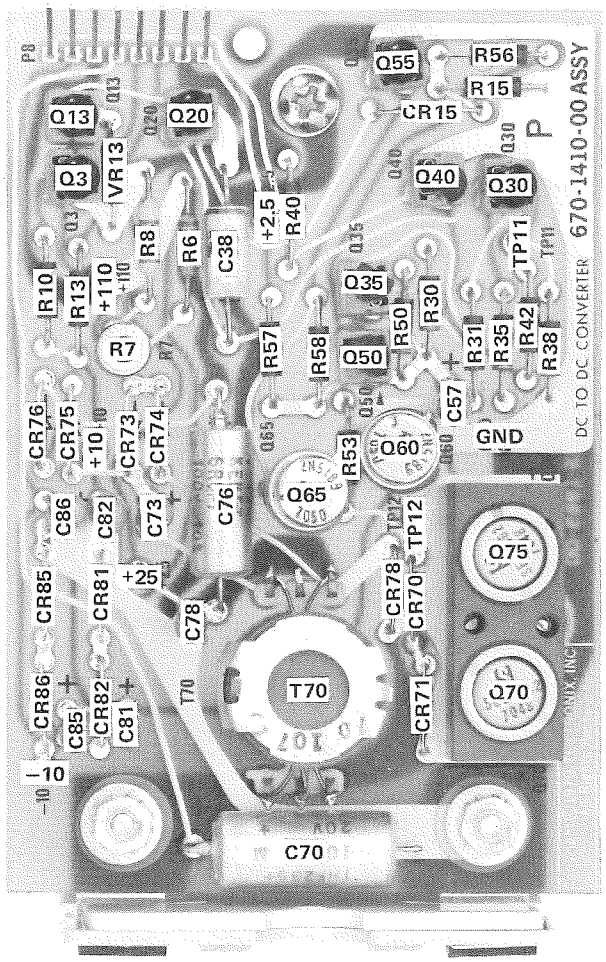
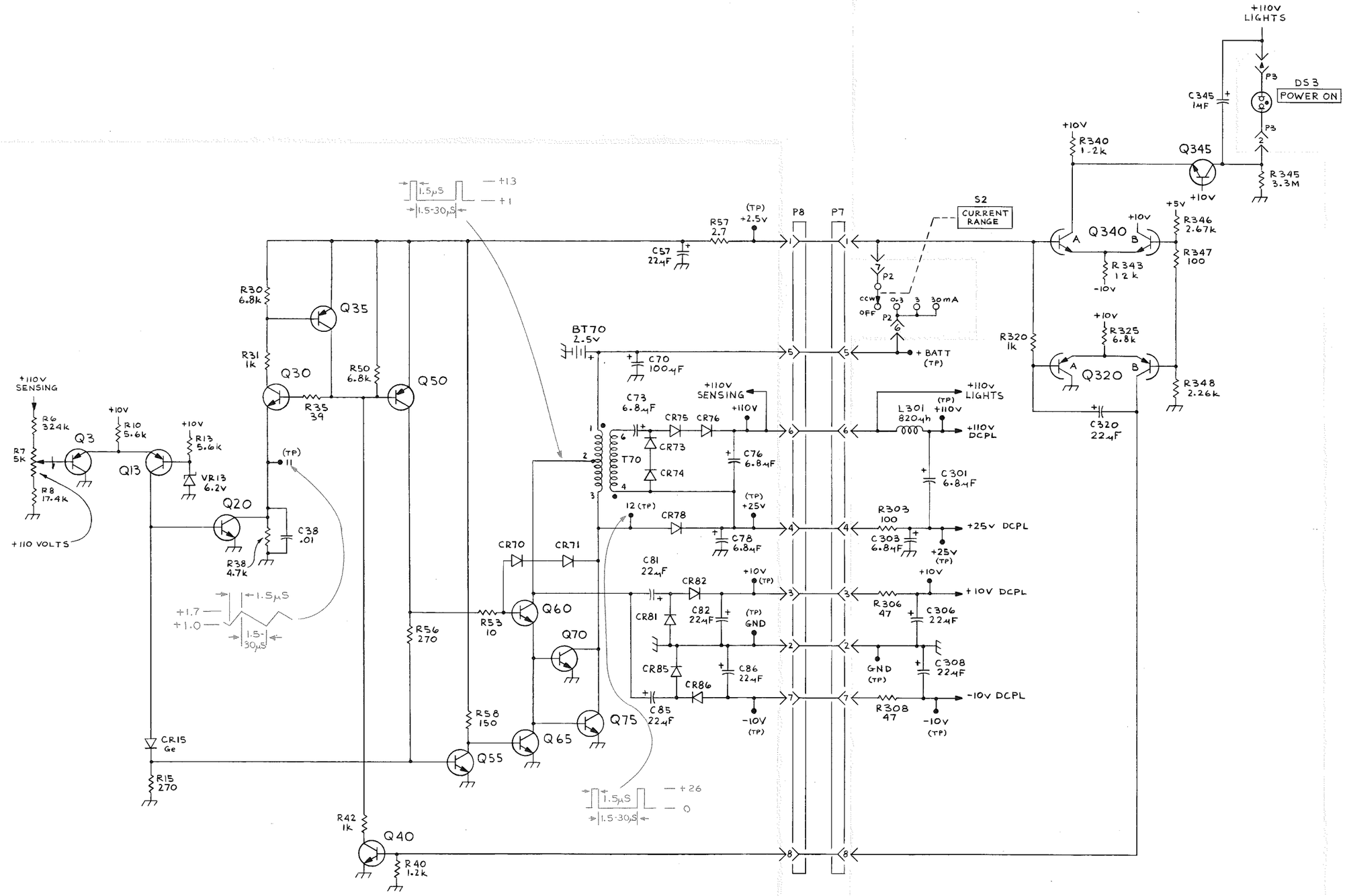


Fig. 7-2. A2. Power Supply circuit board.



A2

P/O A1

POWER SUPPLY

2

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 indicate 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

SECTION 8
MECHANICAL PARTS LIST

FIGURE 1 EXPLODED & STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-1	200-1216-00			1		DOOR, access
	131-1096-00			1		CONTACT-RETAINER ASSEMBLY
	- - - - - -			-		contact-retainer assembly includes:
-2	210-0701-00			2		RIVET, plastic, 0.125 x 0.245 inch long
-3	131-1053-00			1		CONTACT, electrical
-4	342-0079-00			1		INSULATOR, plate, plastic
-5	386-1950-00			1		PLATE, battery retainer
	- - - - - -			-		mounting hardware: *(not included w/contact-retainer assembly)*
-6	211-0025-00			4		SCREW, 4-40 x 0.375 inch, 100° csk, FHS
-7	146-0005-00			2		BATTERY, size D, 1.25 volts
-8	390-0198-00			1		CABINET BOTTOM
	- - - - - -			-		mounting hardware: *(not included w/cabinet bottom)*
-9	348-0048-00			4		FOOT, cabinet
-10	670-1411-00			1		CIRCUIT BOARD ASSEMBLY—MAIN A1
	- - - - - -			-		circuit board assembly includes:
	388-1966-00			1		CIRCUIT BOARD
-11	131-0608-00			27		TERMINAL, pin, 0.365 inch long
-12	136-0252-04			116		SOCKET, pin connector
-13	214-0579-00			16		PIN, test point
-14	131-0639-00			6		CONTACT, electrical
-15	386-1556-00			2		SUPPORT, circuit board
	- - - - - -			-		mounting hardware: *(not included w/circuit board assembly)*
-16	211-0008-00			6		SCREW, 4-40 x 0.25 inch, PHS
-17	352-0270-00			1		HOLDER, battery
	- - - - - -			-		mounting hardware: *(not included w/holder)*
-18	210-0407-00			2		NUT, hex., 6-32 x 0.25 inch
-19	210-0055-00			2		WASHER, lock, split, 0.145 ID x 0.253 inch OD
-20	210-0801-00			2		WASHER, flat, 0.14 ID x 0.281 inch OD
-21	166-0031-00			2		TUBE, spacer
-22	105-0236-00			1		CATCH, retainer plate

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

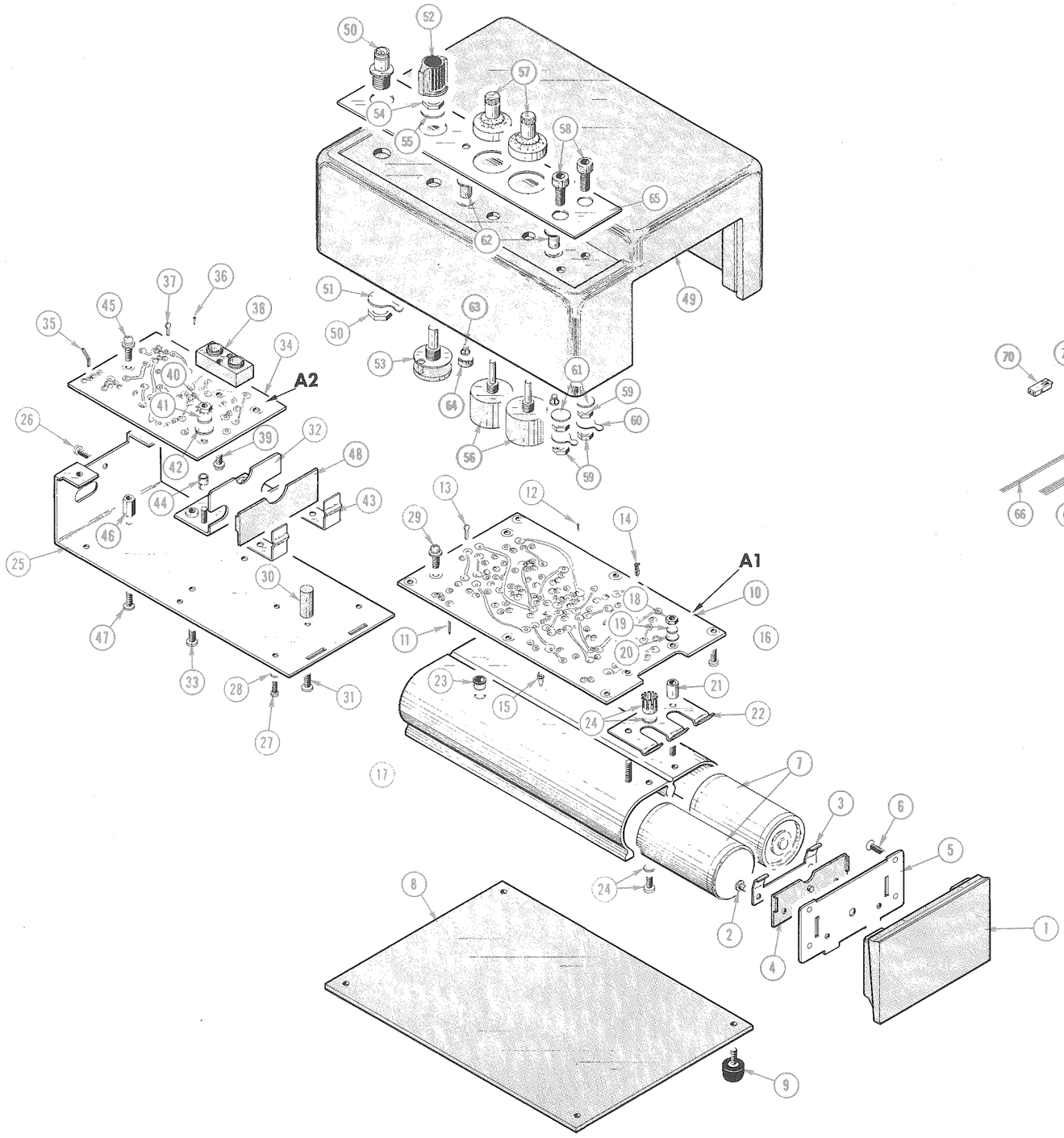
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
1-23	348-0055-00			1		GROMMET, plastic, 0.25 inch diameter
-24	214-0757-00			2		HEAT SINK, transistor, *w/hardware*
-25	426-0746-00			1		FRAME
	- - - - - -			-		mounting hardware: *(not included w/frame)*
-26	211-0008-00			1		SCREW, 4-40 x 0.25 inch, PHS
-27	211-0001-00			6		SCREW, 2-56 x 0.25 inch, RHS
-28	210-0001-00			6		WASHER, lock, internal, 0.092 ID x 0.18 inch OD
-29	211-0601-00			2		SCREW, sems, 6-32 x 0.312 inch, PHB
-30	385-0013-00			2		ROD, plastic, 6-32 x 0.75 inch long
	- - - - - -			-		mounting hardware for each: *(not included w/rod)*
-31	211-0565-00			1		SCREW, 6-32 x 0.25 inch, THS
-32	407-0911-00			1		BRACKET, angle
	- - - - - -			-		mounting hardware: *(not included w/bracket)*
-33	211-0565-00			2		SCREW, 6-32 x 0.25 inch, THS
-34	670-1410-00			1		CIRCUIT BOARD ASSEMBLY—CONVERTER A2
	- - - - - -			-		circuit board assembly includes:
	388-1965-00			1		CIRCUIT BOARD
-35	131-0589-00			8		TERMINAL, pin, 0.50 inch long
-36	136-0252-04			30		SOCKET, pin connector
-37	214-0579-00			8		PIN, test point
-38	214-1580-00			1		HEAT SINK, transistor, dual
	- - - - - -			-		mounting hardware: *(not included w/heat sink)*
-39	211-0116-00			2		SCREW, sems, 4-40 x 0.312 inch, PHB
	- - - - - -			-		mounting hardware: *(not included w/circuit board assembly)*
-40	210-0586-00			2		NUT, keps, 4-40 x 0.25 inch
-41	210-0851-00			2		WASHER, flat, 0.119 ID x 0.375 inch OD
-42	210-0894-00			2		WASHER, plastic, 0.19 ID x 0.438 inch OD
-43	131-1054-00			2		CONTACT, electrical, battery
-44	361-0009-00			2		SPACER, plastic, 0.25 inch diameter
-45	211-0601-00			1		SCREW, sems, 6-32 x 0.312 inch, PHB
-46	385-0079-00			1		ROD, 6-32 x 0.25 x 0.375 inch long
-47	211-0565-00			1		SCREW, 6-32 x 0.25 inch, THS
-48	342-0079-00			1		INSULATOR, plate, plastic
-49	390-0197-01			1		CABINET
-50	131-0955-00			1		CONNECTOR, receptacle, BNC, *w/hardware*
	- - - - - -			-		mounting hardware: *(not included w/connector)*
-51	210-0255-00			1		LUG, solder, 0.375 inch, SE

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-52	366-1028-00			1		KNOB, gray—CURRENT RANGE
	- - - - - -			-		knob includes:
	213-0153-00			2		SETSCREW, 5-40 x 0.125 inch, HSS
-53	260-1233-00			1		SWITCH, rotary—CURRENT RANGE, unwired
	- - - - - -			-		mounting hardware: *(not included w/switch)*
-54	210-0590-00			1		NUT, hex., 0.375-32 x 0.438 inch
-55	210-0978-00			1		WASHER, flat, 0.375 ID x 0.50 inch OD
-56	- - - - - -			2		RESISTOR, variable
	- - - - - -			-		mounting hardware for each: *(not included w/resistor)*
-57	331-0280-00			1		DIAL, control, 3 turn
-58	136-0139-00			2		SOCKET, banana jack
	- - - - - -			-		mounting hardware for each: *(not included w/socket)*
-59	210-0465-00			2		NUT, hex., 0.25-32 x 0.375 inch
-60	210-0223-00			1		LUG, solder, 0.25 inch, SE
-61	210-0046-00			1		WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-62	352-0084-01			2		HOLDER, lamp
-63	378-0541-00			2		FILTER, lens
-64	200-0609-00			2		CAP, lamp holder
-65	333-1416-00			1		PANEL, front
-66	175-0825-00			ft		WIRE, electrical, 2 wire ribbon, 1.336 feet
-67	175-0827-00			ft		WIRE, electrical, 4 wire ribbon, 0.334 foot
-68	175-0830-00			ft		WIRE, electrical, 7 wire ribbon, 0.334 foot
	175-0831-00			ft		WIRE, electrical, 8 wire ribbon, 0.375 foot *(not shown)*
-69	131-0707-00			35		CONNECTOR, terminal
-70	352-0169-00			4		HOLDER, terminal connector, 2 wire *(black)*
-71	352-0162-00			1		HOLDER, terminal connector, 4 wire *(black)*
-72	352-0165-00			1		HOLDER, terminal connector, 7 wire *(black)*
	352-0166-00			2		HOLDER, terminal connector, 8 wire *(black) (not shown)*

STANDARD ACCESSORIES

	103-0142-00			1		PLUG, tip *(not shown)*
	146-0005-00			2		BATTERY, size D, 1.25 volts *(not shown)*
	070-1118-00			1		MANUAL, instruction *(not shown)*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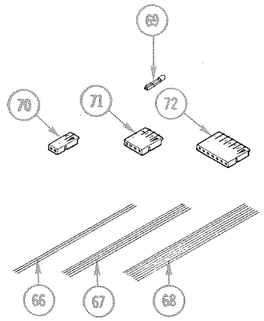

FIG. 2 REPACKAGING

CARTON ASSEMBLY
(Part No. 065-0153-00)

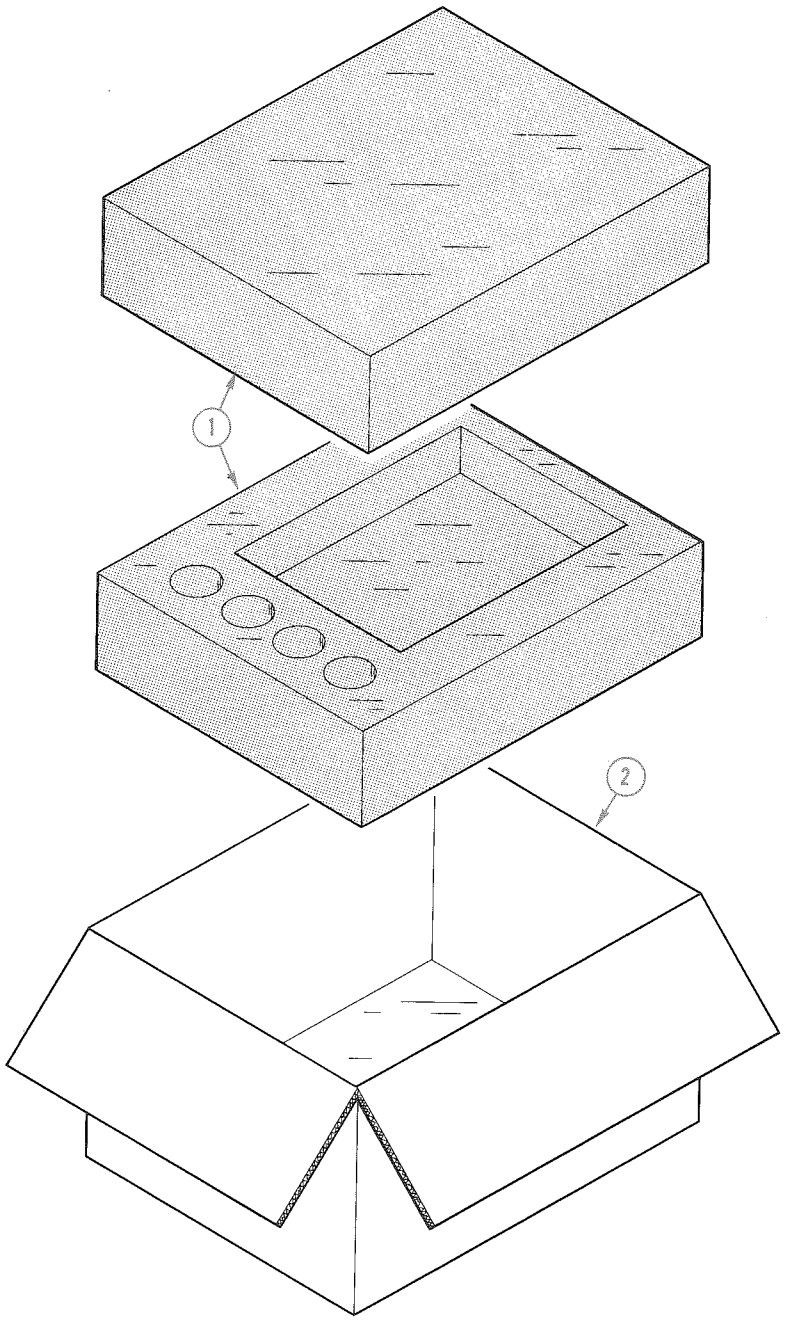

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-	065-0153-00			1		CARTON ASSEMBLY
	- - - - - -			-		carton assembly includes:
-1	004-0283-00			2		PAD
-2	004-0409-00			1		CARTON

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.