16

TEKTRONIX®

INSTRUCTION MANUAL

INSTRUCTION MANUAL

DUAL POWER SUPPLY

PS 503

Serial Number _____

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

070-1303-00

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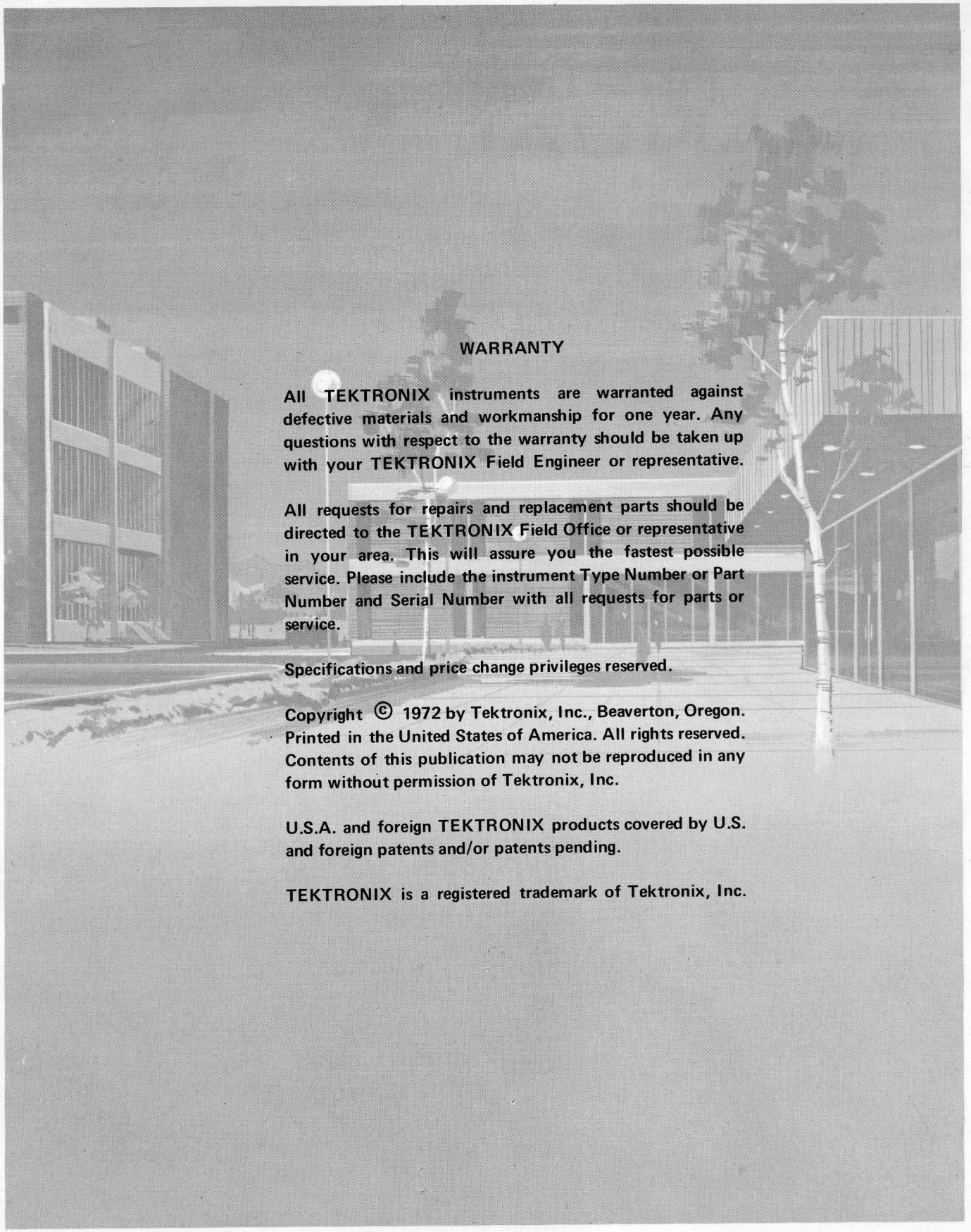

WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty 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 will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

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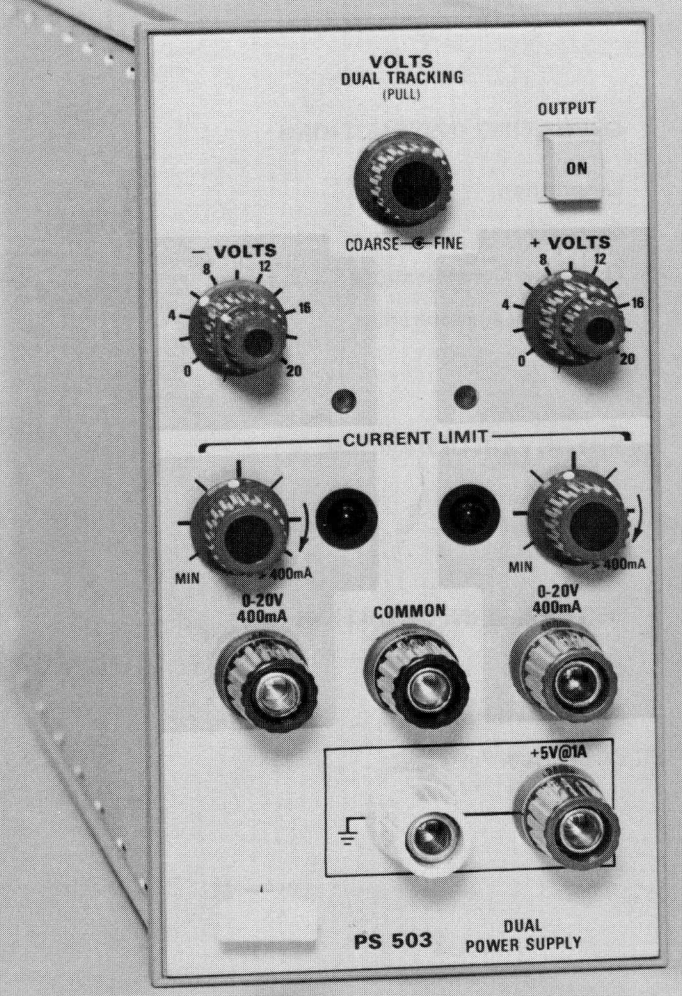
TABLE OF CONTENTS


VOLTS
DUAL TRACKING
(PULL)
OUTPUT
ON
COARSE
FINE
– VOLTS
+ VOLTS
0
4
8
12
16
20
CURRENT LIMIT
MIN
400mA
0-20V
400mA
COMMON
+5V@1A
PS 503
DUAL
POWER SUPPLY

Ⓐ

OPERATING INSTRUCTIONS

DESCRIPTION

The PS 503 is a dual 0 to 20 V DC constant-voltage, current-limited, floating power supply that plugs into a TM 500 Series Power Module. The supply is designed for conveniently powering complementary and linear integrated circuits such as operational and differential amplifiers as well as differential comparators. A ground-referenced +5 V auxiliary supply is also included which is suitable for bipolar logic, light-emitting diodes, incandescent displays and similar applications. With the floating supply available for powering discrete interface circuits and level shifting, the PS 503 can be used for many digital/analog applications.

The plus and minus outputs from the dual floating power supplies are independently variable or both variable at a constant ratio by a common control. Each supply provides a plus and a minus 0 to 20 VDC with respect to the common terminal. By connecting across the + and — terminals the PS 503 can also provide 0 to 40 VDC. Either terminal may be grounded or floated to 350 V (DC + peak AC). Each supply also features continuously variable current limiting from 0 to 400 mA at both 20 V and 40 V output.

The presence and variability of output voltages is verified by voltage indicator lights on the front panel. The brightness of these lights varies with output voltage.

A panel-mounted light-emitting diode indicates when the PS 503 goes into current-limiting. Hard limiting is indicated by maximum brightness of the light-emitting diode as well as a dimming of the voltage indicator light. These functions are easily evaluated by momentarily shorting the output of the supply.

OPERATION

Preparation

The PS 503 is calibrated and ready for use when received. It is designed to operate in any compartment of a TM 500 Series Power Module. Refer to the Power Module Instruction Manual for line voltage requirements and Power Module operation.

Functions of front-panel controls, indicators and connectors are described on a foldout page at the rear of this manual.

NOTE

It is recommended that the Power Module be turned off before inserting or removing the PS 503. Arcing at the connector terminals can reduce connector life. However, no internal damage will result if the supply is inserted into a live Power Module.

1. Install the PS 503 by aligning the upper and lower rails of the plug-in with the Power Module tracks and inserting until the plug-in panel is flush with the Power Module panel. To remove, pull the release latch to disengage the PS 503 from the Power Module.

2. Press the OUTPUT button to apply power to the PS 503 . Observe that the + and — VOLTS indicator lights come on (the lights will be very dim at low voltages).

NOTE

Before using the PS 503 for the first time read the Operating Considerations in this section regarding certain precautions and proper techniques for connecting various loads.

Single Supply Operation (±20 V Maximum)

1. Set the + and — VOLTS controls for approximately 2 V.

2. Turn the CURRENT LIMIT controls fully ccw (to protect the ammeter). Connect an ammeter between the common terminal and the + or — terminal and adjust the appropriate CURRENT LIMIT control for the maximum desired current output.

3. Remove the ammeter. Connect the load between the common terminal and the + or — terminal. Adjust the + or — VOLTS control for the desired output.

Combined Supply Operation (40 V Maximum)

1. Set the + and — VOLTS control for approximately 2 V and turn the CURRENT LIMIT controls fully ccw (to protect the ammeter).

2. Connect an ammeter between the + and – terminals. First adjust one CURRENT LIMIT control for the maximum desired current output; then adjust the other CURRENT LIMIT control until the CURRENT LIMIT indicator just reaches maximum brightness, i.e. both supplies at the same CURRENT LIMIT setting.

3. Remove the ammeter. Connect the load between the + and – terminals and set the + and – VOLTS controls so that both settings added together equal the desired output voltage. (See Dual-Tracking Operation for varying the output with the VOLTS DUAL TRACKING control.)

Dual-Tracking Operation

When pulled out, the VOLTS DUAL TRACKING control varies the output of both supplies at a constant ratio from zero to the value set on the + and – VOLTS controls. For example, if the + and – VOLTS controls are set for maximum output (approximately 20 volts), both outputs can be varied from zero to 20 volts with the VOLTS DUAL TRACKING control (1:1 ratio). Likewise, if one supply is set for 10 volts and the other for 20 volts, each 1 volt change in the 10 volt output will result in a 2 volt change in the 20 volt output (2:1 ratio).

Note also that no matter where the VOLTS DUAL TRACKING control is set, the outputs will return to the voltage selected by the + and – VOLTS controls when the VOLTS DUAL TRACKING control is pushed in. Therefore, rapid selection of two preset outputs from each supply is achieved by merely switching the VOLTS DUAL TRACKING control in or out.

When the + and – supplies are connected as described under Combined Supply Operation, the VOLTS DUAL TRACKING control will vary the output from zero to the value selected by the + and – VOLTS controls added together.

Stair-Step Operation

The PS 503 can be operated to provide a "stair-step" output characteristic by choosing certain load limits and control settings. For example, Fig. 1-1 shows the stair-step output from the PS 503 when a variable load (R_L) is connected between the + and – output terminals. With each supply set for maximum voltage and current (40 V, 400 mA) the output voltage remains constant from open circuit (∞) until the load reaches approximately 100 Ω as illustrated by the solid line in Fig. 1-1. At this crossover point, the output voltage decreases with the load and the output current is limited at 400 mA. Therefore, below approximately 100 Ω, both supplies act as current sources with output voltage variable with the load. Since both supplies are set for the same output voltage, each supply

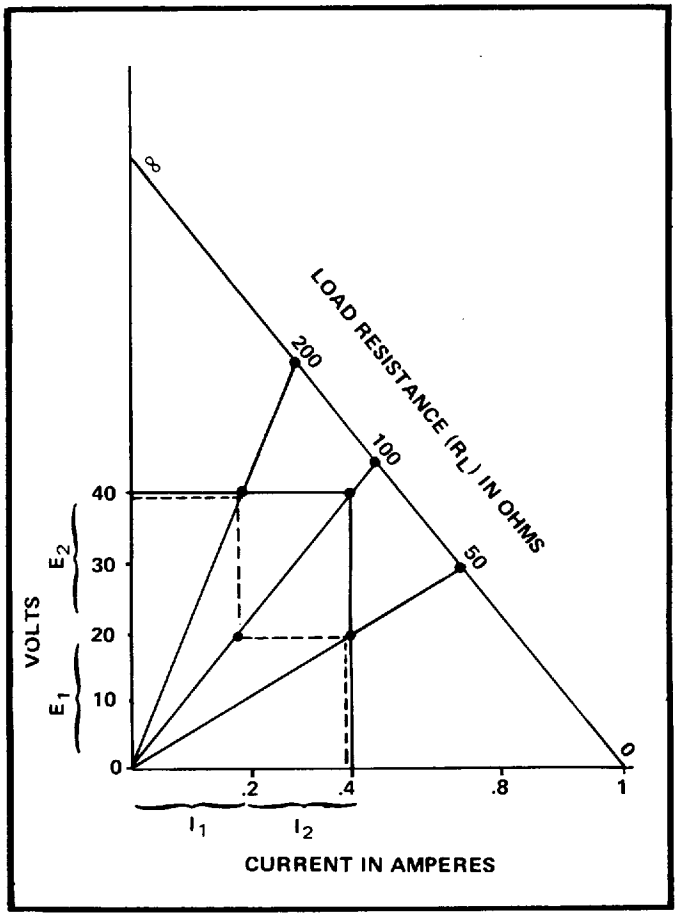


Fig. 1-1. Stair-step output characteristics with various currents, voltages, and loads.

shares equally in the power output (I^2R). If one supply is set for a lower output voltage than the other, output power is shared at the same ratio as the output voltage.

Now, by setting supply E_2 for a current limit of 200 mA and varying the load over the same range, the supplies act as constant voltage sources until the load reaches approximately 200 Ω. At that crossover point, the supply set for 200 mA (E_2) becomes a current source and its output voltage decreases with the load. At approximately 100 Ω and 20 V, supply E_2 no longer contributes to the power output. Subsequently, supply E_1 supplies all the output power and operates as a constant voltage source with output current variable with the load. Then, at approximately 50 Ω, supply E_1 crosses over and becomes a current source at its maximum output of 400 mA. Thus, by choosing the appropriate load limits and control settings, any of the four operating characteristics is possible.

A second stair-step output can be preselected and switched in or out with the VOLTS DUAL TRACKING control (see Dual-Tracking Operation for details on the function of the VOLTS DUAL TRACKING control).

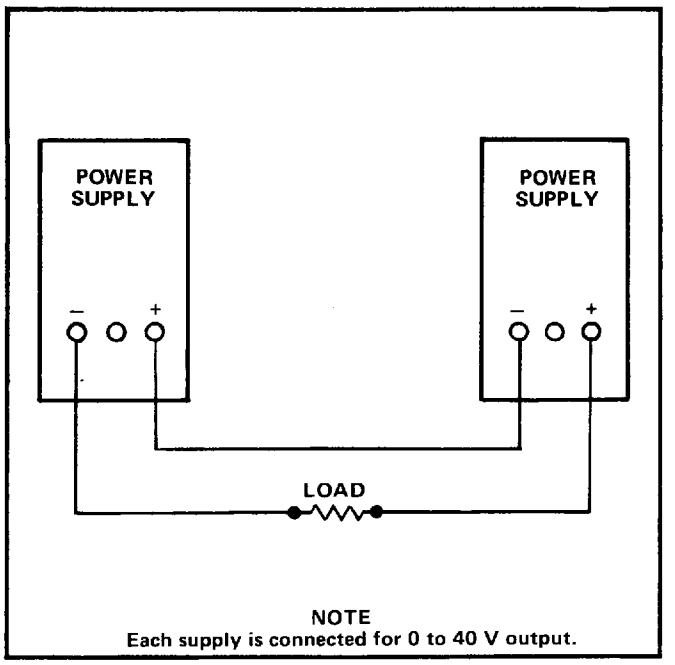


Fig. 1-2. Supplies series-connected to provide 80 V, 400 mA output.

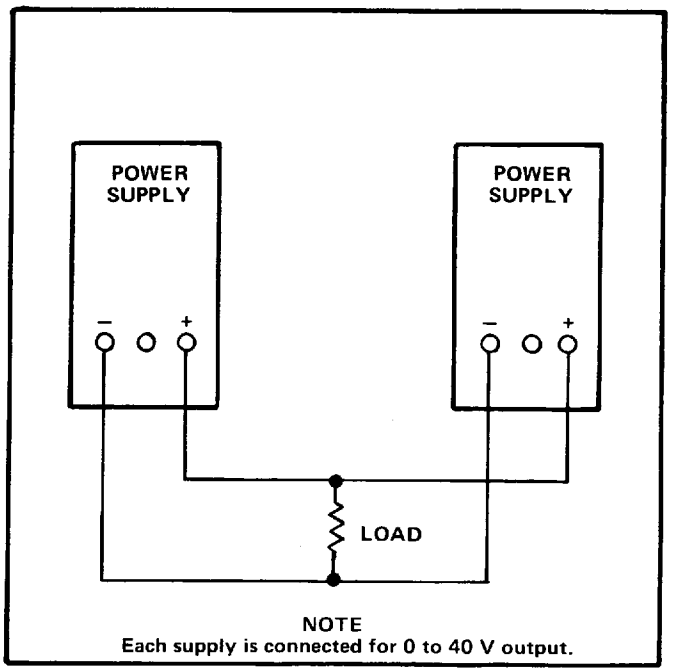


Fig. 1-3. Supplies parallel-connected to provide 40 V, 800 mA output.

Series-Connected Supplies

The outputs of two or more PS 503 's can be connected in series as shown in Fig. 1-2 to obtain an output voltage equal to the sum of the output voltages from each supply. Each supply must be adjusted individually to obtain the desired output voltage (see Dual-Tracking Operation for varying the output of both supplies with the VOLTS DUAL TRACKING control).

NOTE

The PS 503 has internal diodes connected across the output to protect the series-connected supplies against reverse polarity if the load is shorted, or one of the supplies is not on.

Parallel-Connected Supplies

The outputs of two or more PS 503 's can be connected in parallel as shown in Fig. 1-3 to obtain an output current equal to the sum of the output currents from each supply (800 mA maximum). Each supply must be adjusted individually to obtain the desired output current.

NOTE

The + and — supplies are internally connected in series. Therefore, the + and — supplies cannot be externally connected in parallel to obtain an output current equal to the sum of the currents from each supply.

One supply should be set for the desired output voltage and the other for a slightly higher voltage. The supply set for the desired voltage will then become a constant voltage source, while the supply with the higher voltage output becomes a current source (due to automatic crossover) which results in their output voltage decreasing to that of the supply with the lowest output voltage.

OPERATING CONSIDERATIONS

Overheating

The PS 503 is designed to operate at an ambient temperature from 0°C to +50°C. However, when operating several power supplies in a multi-plug-in Power Module, especially at low output voltages, or when operating close to other heat-producing equipment, internal temperature may exceed safe limits and actuate a thermal cutout in the Power Module. Refer to the Power Module Instruction Manual for more complete information.

Load and Monitor Connections

Improper connections between the power supply output and the load(s) and/or monitoring device(s) are a common cause of errors. Multiple loads or monitoring devices must be connected directly to the output terminals with separate pairs of leads as shown in Fig. 1-4. Avoid using clip leads, since their contact resistance can exceed the output impedance of the PS 503 and cause significant measurement error.

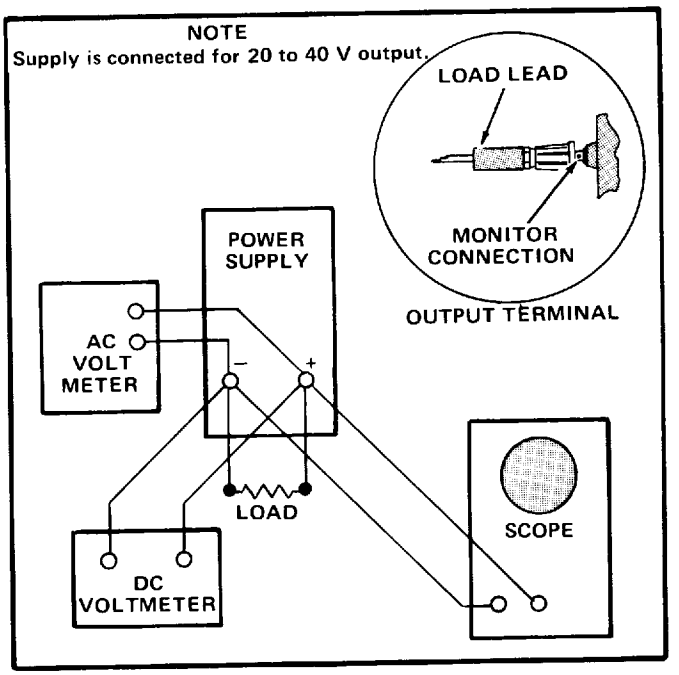


Fig. 1-4. Monitor and load connections.

Grounded and Floating Operation

The PS 503 is a "floating" supply since no internal connections are made to either the chassis or ground. The supply can thus be used as a positive or negative supply by simply connecting between the common and the negative or positive output terminal. However, there may be undesirable effects caused by grounding the supply to the chassis while the load is grounded at some point removed from the supply chassis. For example, if a remote load is connected as shown in Fig. 1-5, ground currents containing the power line frequency could result and create excessive noise and ripple in series with the load. Thus, floating operation is recommended to insure against problems caused by undesirable ground currents.

Reverse Current Loading

In some bias supply and digital circuitry applications the load might behave as a current source for part of its operating cycle. Since the output circuit of a series regulated supply is unidirectional, current will not pass in the opposite direction except through undesirable paths. The internal reverse-current diodes conduct only when the PS 503 terminal voltage reverses and therefore will not work when the voltage is correctly polarized. Connecting a shunt resistor (R_S) as shown in Fig. 1-6 provides an external reverse current path so the power supply sources or delivers current only.

Overvoltage

The PS 503 is not protected from overvoltage conditions. Component failure in the PS 503 could result in load damage if external protection is not provided. Likewise, if the load (or other instruments connected to the load) produce a voltage across the PS 503 terminals which is the same polarity but of greater amplitude, damage may result depending on the amount of overvoltage and the impedance of the load.

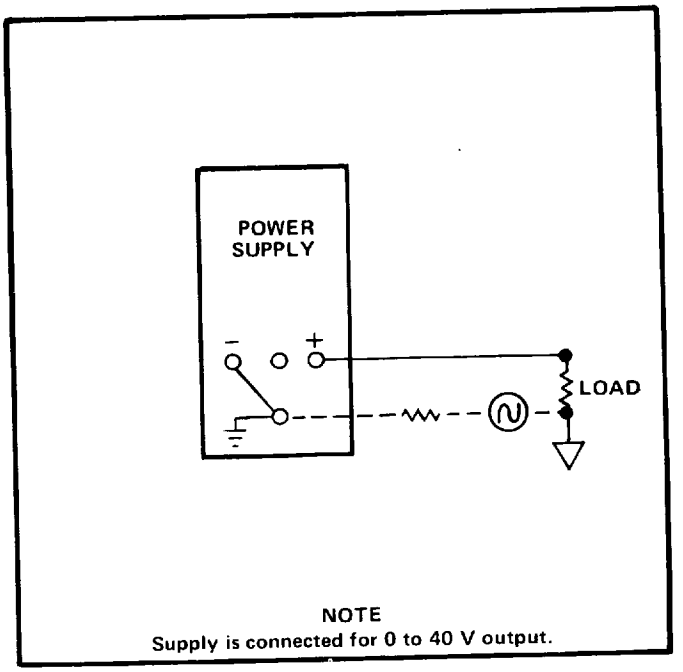


Fig. 1-5. Ground loop created by grounded remote load.

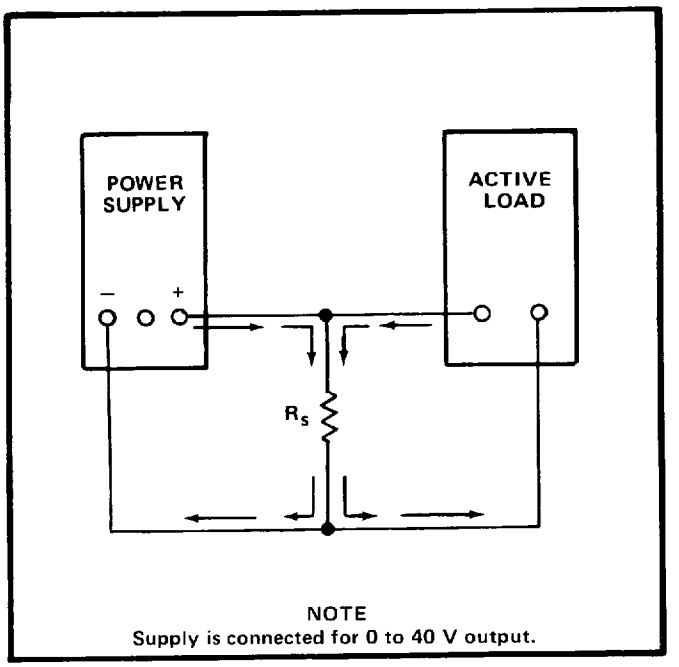


Fig. 1-6. Reverse current shunt (R_S) with active load.

ELECTRICAL CHARACTERISTICS

Performance Conditions

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

20 V Floating Supplies

OUTPUTS: 0 to at least 20 VDC with respect to the common terminal or 0 to 40 VDC across the plus and minus terminals. Outputs either independently variable or both variable at a constant ratio by a common control. Both supplies insulated for 350 V (DC + peak AC) above ground. Each supply has continuously variable current-limiting from 0 to at least 400 mA.

MINIMUM RESOLUTION: 10 mV.

LOAD REGULATION: Within 1 mV with a 400 mA load change.

LINE REGULATION: Within 5 mV for a ±10% line voltage change.

RIPPLE AND NOISE: 0.5 mV P-P or less. 0.1 mV RMS or less.

TEMPERATURE COEFFICIENT: 0.01%/°C or less.

STABILITY: 0.1% + 5 mV or less drift in 8 hours at constant line, load and temperature.

TRANSIENT RECOVERY TIME: 20 μs or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400 mA change in output current.

+5 V Ground-Referenced Supply[1]

OUTPUT (+20°C to +30°C): 4.8 VDC to 5.2 VDC at 1 A.

LOAD REGULATION: Within 100 mV with a 1 A load change.

LINE REGULATION (+20°C to +30°C): Within 50 mV for a ±10% line voltage change.

RIPPLE AND NOISE (1 A): 5 mV P-P or less. 100 μV RMS or less.

STABILITY: 0.5% or less drift.

OVERLOAD PROTECTION: Automatic current limiting and over-temperature shutdown.

[1] **For additional information refer to National Semiconductor Corp. specifications for the LM309K 5 V Regulator Integrated Circuit.**

THEORY OF OPERATION

Introduction

This section contains a discussion of the operating modes of the PS 503 Dual Power Supply. Circuit operation for obtaining constant voltage, current-limited output with automatic crossover, line and load regulation and 5 V ground-referenced output are described. The negative and positive supplies operate identically. The two supplies are internally connected in series with a common front-panel VOLTS DUAL TRACKING control for varying the output of both supplies at a constant ratio. Therefore, except for Dual Tracking operation, this discussion will cover only the positive supply.

Dual Tracking

The VOLTS DUAL TRACKING control R30/S30 is in parallel with + and − VOLTS potentiometers R32 and R132. When the VOLTS DUAL TRACKING knob is pulled out, S30A/B disconnects R32 and R132 and connects R30A/B which then selects the non-inverting reference level to pin 3 of U40 and U140. R30A and R30B are ganged to vary the reference levels to pin 3 of U40 and U140 at a constant ratio.

Automatic Crossover

The positive supply employs two operational amplifiers; U40 and U70. Amplifier U40 controls output voltage while U70 controls output current. For any value of load resistance the power supply acts either as a constant-voltage source or a current source — but never both. Automatic crossover is accomplished by combining the outputs from pin 6 of U40 and U70 in a negative-true, "OR" gate configuration (see Fig. 2-1). The amplifier with the lower output voltage at pin 6 will cause its associated diode

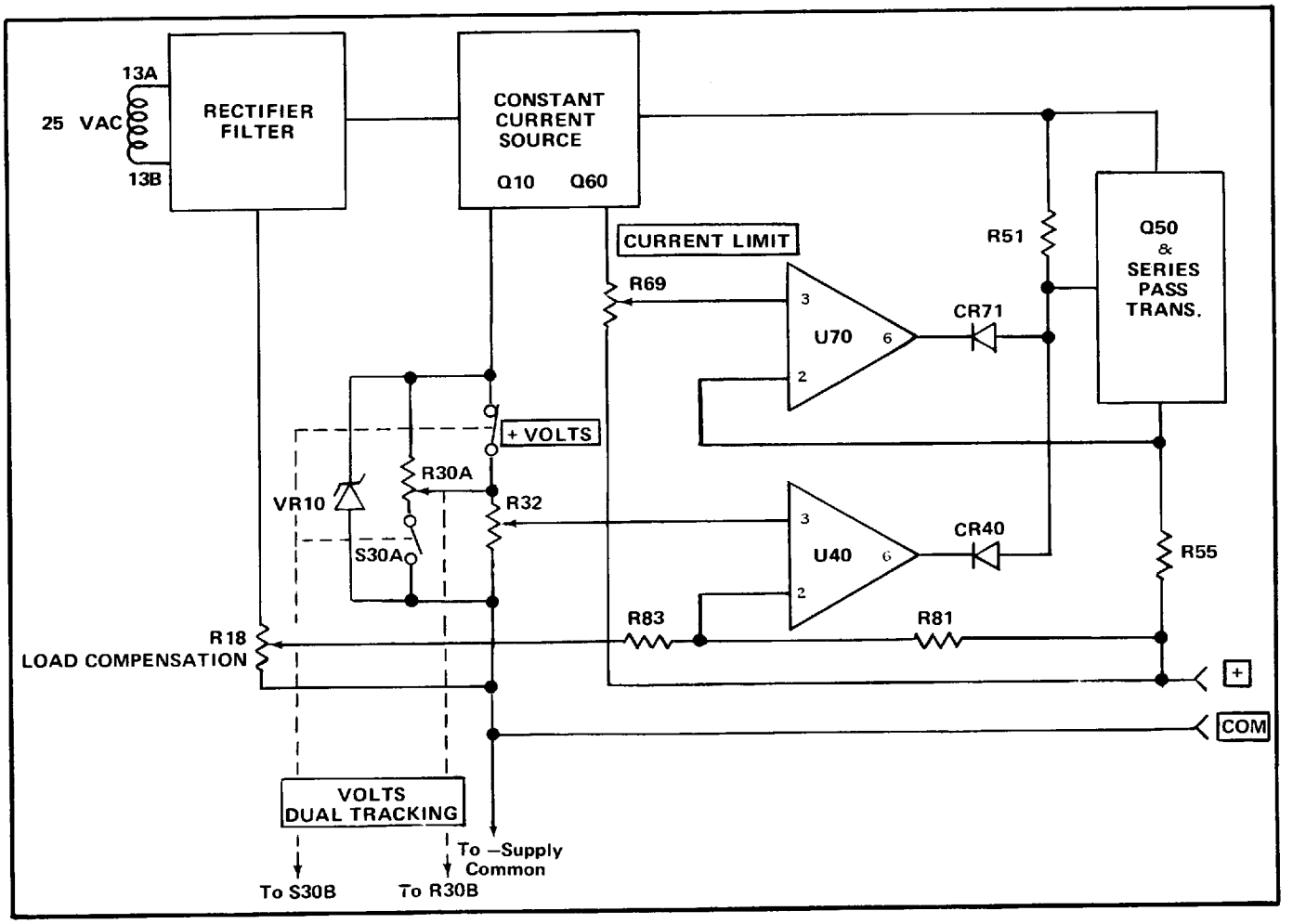


Fig. 2-1. Simplified block diagram of PS 503 .

(CR40 or CR71) to conduct, which eventually reverse biases the other diode. A portion of the current available from R51 is then diverted away from the base of Q50 and to the amplifier with the lower output. The remainder of the current drives the base of Q50 which, in turn controls the current through the series-pass transistor in the Power Module to the load.

Constant Voltage/Current Limited Output

Output current or voltage varies when an imbalance occurs between the comparison voltage at pin 2 and 3 of either U40 or U70. This imbalance is caused by a change in the load resistance or in the reference voltage selected by R69, the front-panel CURRENT LIMIT potentiometer, or by R32, the front-panel + VOLTS potentiometer. Fig. 2-2 illustrates the output characteristics of the power supply with various currents, voltages and loads.

Voltage and current references are generated from two constant-current sources. Q10 and Zener diode VR10 provide constant-current to + VOLTS potentiometer R32 which then establishes the non-inverting reference input to pin 3 of U40, the voltage-controlling amplifier. The collector of Q60 provides constant current to CURRENT LIMIT potentiometer R69 which establishes the non-inverting reference input to pin 3 of U70, the current-controlling amplifier.

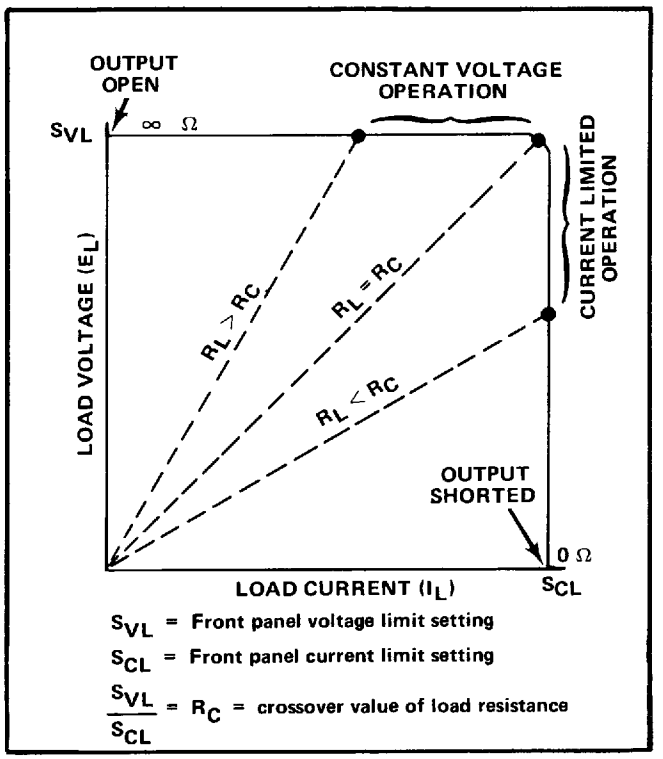


Fig. 2-2. Operating characteristics with various voltages, currents, and loads.

With no load connected to the output terminals, $R_L = \infty$, $I_L = 0$ and $E_L = S_{VL}$, the front-panel voltage limit setting (see Fig. 2-2). When a load is connected to the power supply output terminal, output current increases which results in an increase in the voltage drop across current-sensing resistor R55. This drop provides the inverting input to pin 2 of U70. If the voltage at pin 2 exceeds the reference voltage at pin 3, then the voltage at pin 6 drops to a level where CR71 turns on, and CR40 is reverse biased; thus, control crosses over to U70, the current controlling amplifier. U70 holds the voltage at pin 2 to that set at pin 3 by R69, the CURRENT LIMIT potentiometer (S_{CL}). The supply is now in current-limited operation (see Fig. 2-2).

Load Regulation

With no load connected to the output terminals all of the output current flows through feedback divider R81/R83 (approximately 1 mA/V) and back to the minus side of C10. When a load is connected to the output terminals, output current must increase to maintain the output voltage.

An increase in output current cannot occur unless the drive to the base of Q50 and the series-pass transistor is also increased. The increase in the voltage differential between pin 2 and 3 of U40 necessary to drive Q50 and the series-pass transistor (refer to the discussion of constant voltage/current limited operation) is obtained by applying a small negative voltage developed by the load current through R15 in parallel with Load Compensation resistor R18. By adjusting R18, the proper feedback is developed through divider R81/R83 to increase the output current and subsequently hold the output voltage constant regardless of the load.

Line Regulation

Resistors R13 and R14 enhance the stability of zener reference VR10 by establishing the zener current at approximately 7.5 mA. R12 stabilizes the zener current with respect to the line voltage. VR11 and R11 provide a reference voltage to constant current source Q10.

If the line voltage varies, a corresponding voltage change occurs across C10. This voltage change would normally affect the collector current through Q10. However, the self-bias generated across R13 and R14 partially stabilizes the collector current; further stabilization occurs when the current through R12 is added to the self-bias from R13 and R14. The nearly constant voltage drop across R14 provides bias for constant current source Q60, while CR66 provides temperature compensation.

+5 V Ground-Referenced Supply

The Power Module supplies +11.5 V through pins 2A and 3A on the plug-in rear connector to pin 1 and 3 of integrated circuit U2. U2 provides a regulated +5 V output limited at 1 ampere from pin 2 and 3 to output connectors J5 and J6 on the front panel.

SERVICING INFORMATION

Contents

This section of the manual contains information necessary to service the PS 503. Calibration procedures are provided with supporting illustrations that show internal adjustment locations and describe front-panel control functions (see foldout page). Also included is the electrical parts list with an illustration (see foldout page) that shows the physical location of components on the etched circuit board with an alpha-numeric grid keyed to the electrical parts list (see Grid Loc column). A schematic diagram is located opposite both the electrical parts list and the circuit board illustration to further facilitate the location of components. Table 3-1 on the inside of the first foldout page lists the rear connector pin assignments.

Mechanical parts are listed at the rear of this section with an exploded view of the instrument. A list of standard accessories and a carton assembly drawing are on the back of the exploded view foldout page.

Maintenance

General system maintenance procedures are provided in the Power Module instruction manual, i.e., preventive maintenance, troubleshooting aids, part removal and replacement procedures, parts ordering information, etc.

Service Available

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

CALIBRATION

Introduction

The following calibration procedure is intended to return the circuits of the PS 503 within their designed operating capabilities. Calibration is generally required after a repair has been made, or after long time intervals in which normal aging of components may affect instrument accuracy. Before calibration, verify instrument operation by performing the procedures described under Preparation in Section 1.

Test Equipment Required

The following test equipment and accessories, or the equivalent, are required for complete calibration of the PS 503. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed may be less rigorous than the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within their listed specifications.

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

1. 5100-Series Oscilloscope System. For this procedure, a 5103N/D10 with a 5B10N time-base and 5A15N amplifier plug-in is used.

2. Differential DC voltmeter. 10 V to 20 V within 0.1%. For example, John Fluke Model 825A.

3. 1X passive probe. TEKTRONIX P6060 Passive Probe.

4. Plug-in extension for the 5100-Series Oscilloscope System. TEKTRONIX Calibration Fixture 067-0645-01 (not mandatory for this procedure).

5. Load resistor, 50 Ω, 8 W, 5%.

Preliminary Considerations

Read the Operating Considerations in Section 1 before calibrating the PS 503.

This instrument should be calibrated at an ambient temperature between +20°C and +30°C (+68°F and +86°F) for best accuracy.

Do not preset internal controls unless they are known to be significantly out of adjustment, or unless repairs have been made in the circuit. In these instances, the internal adjustments can be set to midrange.

Preparation

1. Remove the cover from the left side of the PS 503 and, if necessary, blow off accumulated dust with low-pressure compressed air.

2. Insert the PS 503 into the left compartment if a multi-plug-in Power Module is used. (Note: It may be convenient to use the plug-in extender, part no. 067-0645-01, to make internal adjustments without inserting the PS 503 into the Power Module. However, it is not mandatory for this procedure.)

3. If the extender is not used, remove the Power Module cabinet cover to gain access to the PS 503 internal adjustment.

4. Apply power to the Power Module and press the OUTPUT button on the PS 503.

5. Refer to the first foldout page in this section for front-panel control and internal adjustment locations.

ADJUSTMENT PROCEDURE

NOTE

If a malfunction is detected during calibration, refer to system maintenance in the Power Module instruction manual for troubleshooting techniques, parts removal and replacement procedures, parts ordering information, etc.

Zero Volts (R38/R138)

1. Connect the Differential Voltmeter to the PS 503 output terminals.

2. Set the front-panel + and – VOLTS control for 0 volts (fully ccw).

3. Adjust R38/R138 (Zero Volts) for 00.000 volts output.

4. Remove the Differential Voltmeter.

Load Compensation (R18/R28)

1. Connect the 50 Ω, 8 W Load Resistor across the PS 503 output terminals.

2. AC couple the Test Oscilloscope to the PS 503 output terminals and turn the front-panel + and – VOLTS and CURRENT LIMIT controls fully cw. Note the displayed level on the Test Oscilloscope. Remove the Load Resistor and note the shift in the displayed level.

WARNING

If the Load Resistor is left connected for an extended period it may become hot. If necessary, replace with a higher wattage resistor.

3. Adjust R18/R28 (Load Compensation) for no shift in displayed level with or without the Load Resistor connected. Remove the test equipment.

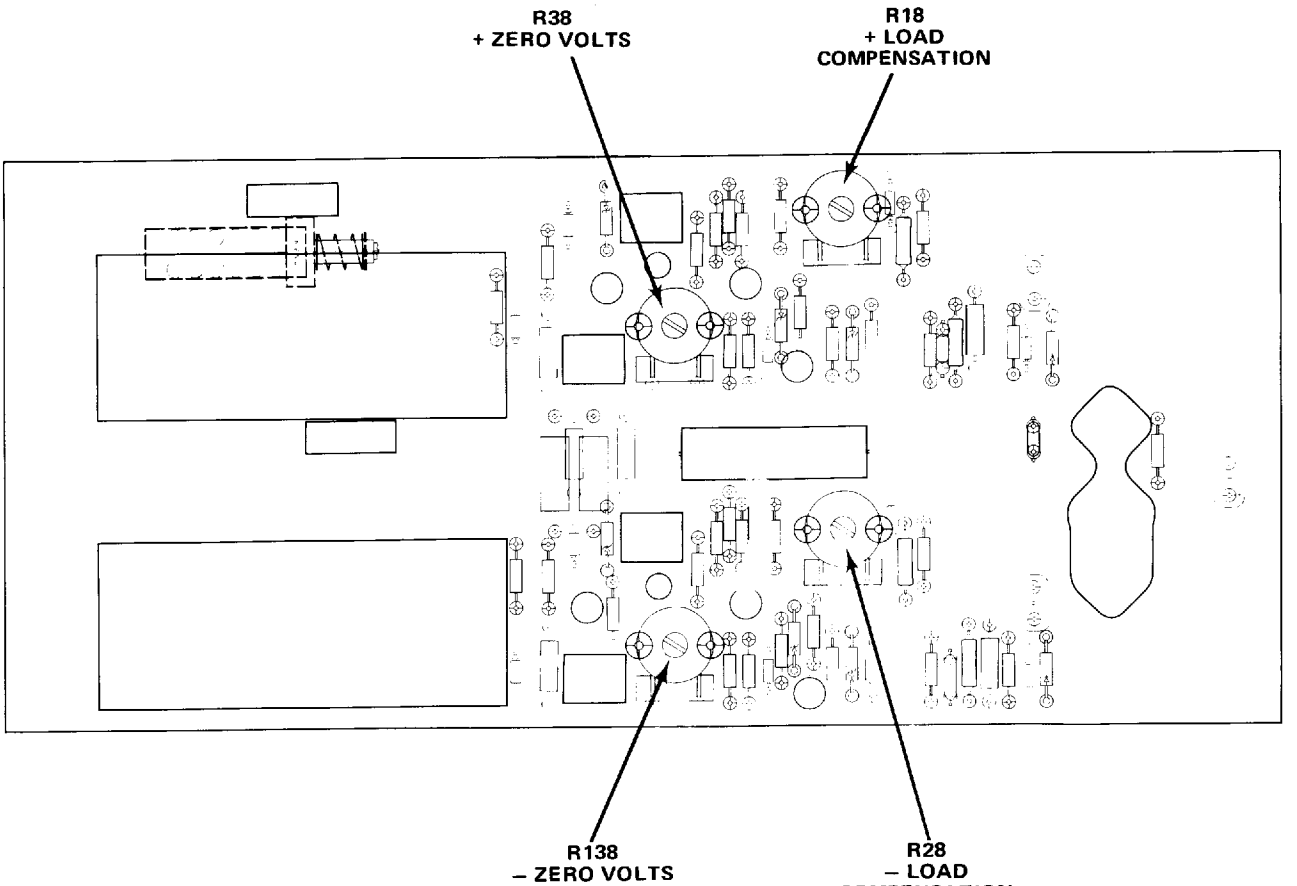
This completes the PS 503 adjustment.

TABLE 3-1

Rear Connector Pin Assignments

Pin No.	Left (A)[1]	Right (B)[1]
27 and 28	No Connection	No Connection
26	–Non-Inverting Input to U170	+Non-Inverting Input to U70
25	–Non-Inverting Input to U140 via R135	+Non-Inverting Input to U40 via R35
24	Reference Common	Reference Common
23	+Sense (R81)	–Sense (R181)
22	+Output (J50)	–Output (J150)
21	+Common	–Common
20	No Connection	No Connection
19	Emitter of PNP Series-Pass Transistor	Emitter of NPN Series-Pass Transistor
14 through 18	No Connection	No Connection
13	25 V RMS	25 V RMS
12	+30.5 V Unregulated	+30.5 V Unregulated
11	Base of PNP Series-Pass Transistor	Collector of PNP Series-Pass Transistor
10	Emitter of PNP Series-Pass Transistor	Transformer Shield
9	30.5 V Unregulated Common	30.5 V Unregulated Common
8	–30.5 V Unregulated	–30.5 V Unregulated
7	Emitter of NPN Series-Pass Transistor	Collector of NPN Series-Pass Transistor
6	Base of NPN Series-Pass Transistor	No Connection
5	17.5 V RMS	17.5 V RMS
3 and 4	9 V Unregulated Common	9 V Unregulated Common
2	+9 V Unregulated	+9 V Unregulated
1	25 V RMS	25 V RMS

[1] The left (A) and right (B) sides of the rear connector are as viewed from the front of the plug-in. Pins are numbered from the bottom of the connector.



INTERNAL ADJUSTMENTS

5-way
nals
to 2
betw
mina
nal.
outp
the +

VOLTS DUAL TRACKING Control

When pulled out, varies both the + and – outputs from 0 volts to the value set on the + and – VOLTS controls. The ratio between the + and – outputs is maintained throughout the range of the VOLTS DUAL TRACKING control.

VOLTS Controls and Indicators

Continuously variable coarse and fine controls that select + or – 0 to 20 volts. Indicator lights when power is applied to the PS 503 (OUTPUT button pressed). Brightness varies with the output voltage.

OUTPUT Pushbutton

When pressed, applies power from the Power Module to the PS 503.

CURRENT LIMIT Controls and Indicators

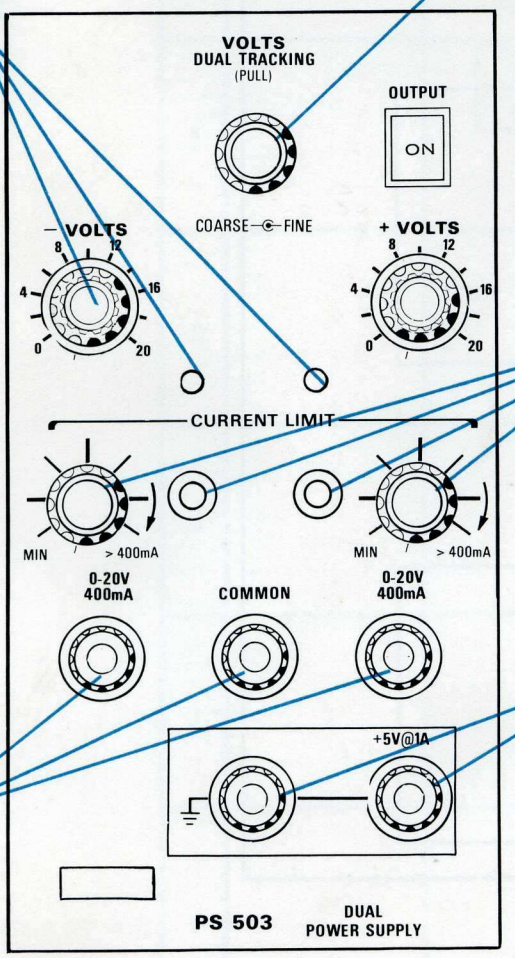
Continuously variable controls that select the + and – output current limit from 0 to at least 400 mA. Light-emitting diode indicates when hard limiting occurs.

+5 Ground-Referenced Output Terminals

5-way binding-post terminals that provide a ground-referenced +5 V, 1 A, fixed output.

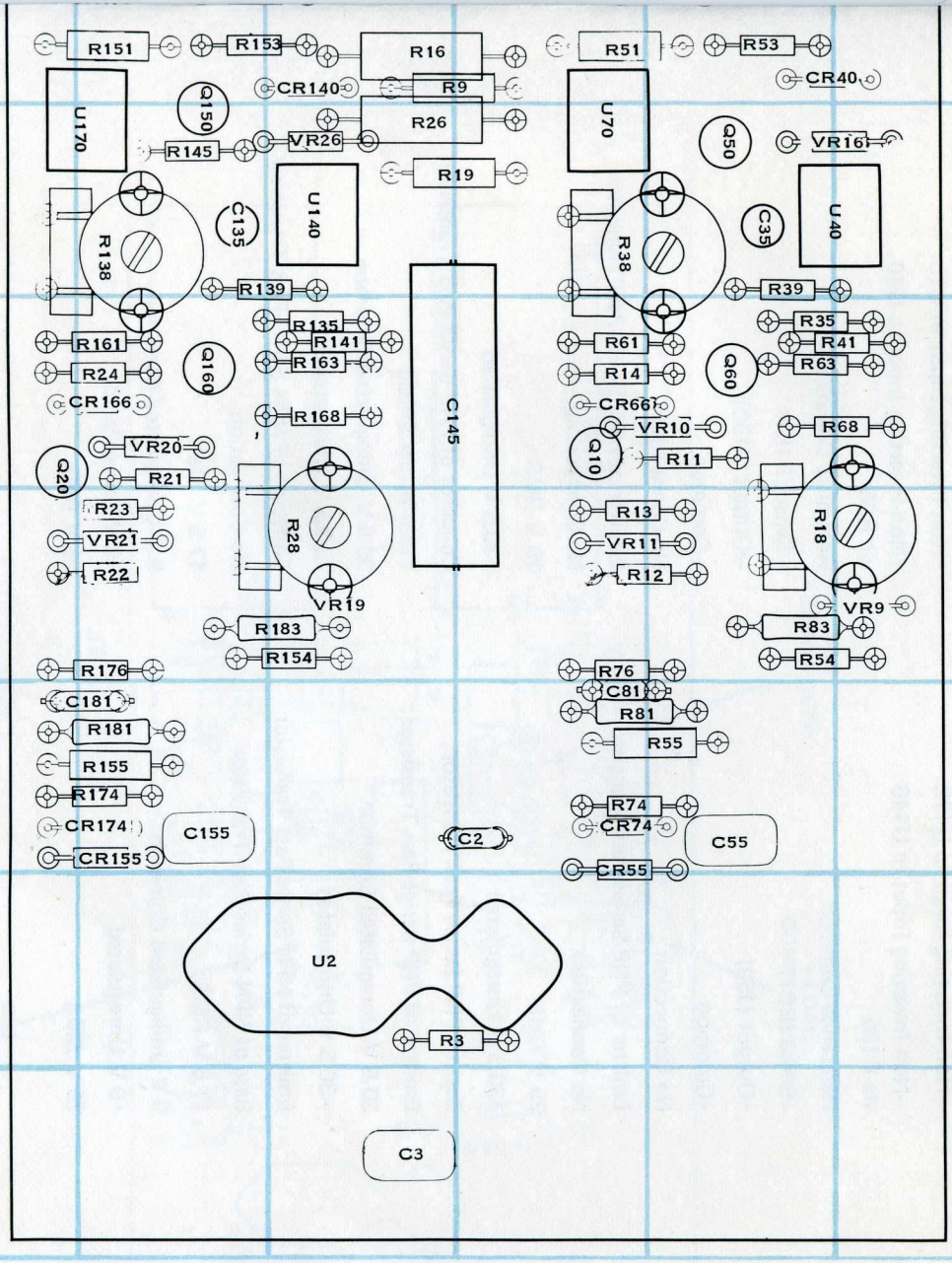
Floating Output Terminals

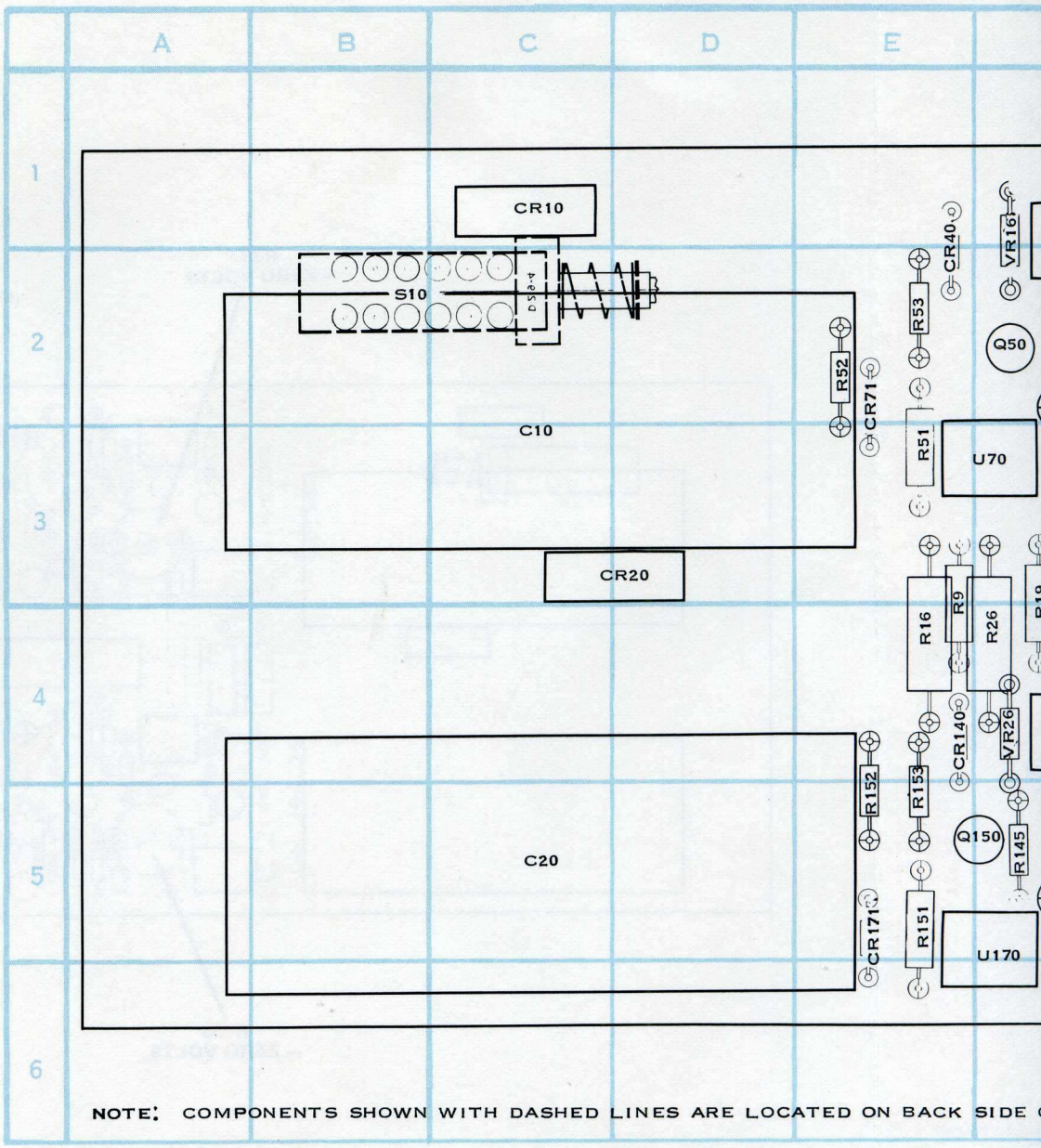
5-way binding-post terminals that provides + or – 0 to 20 V, 400 mA output between the COMMON terminal and the + or – terminal. 0 to 40 V, 400 mA output is obtained between the + and – terminals.



FRONT PANEL CONTROLS, INDICATORS AND CONNECTORS

N BACK SIDE OF BOARD.





PS 503 COMPONENT LOCATIONS

ELECTRICAL PARTS LIST

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

ABBREVIATIONS AND REFERENCE DESIGNATORS

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

Ckt. No.		Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY					
A1		670-2013-00			MAIN Circuit Board Assembly
CAPACITORS					
C2	J3	283-0198-00			0.22 µF, Cer, 50 V, 20%
C3	K4	290-0531-00			100 µF, Elect., 10 V, 20%
C10	C3	290-0520-00	B010100	B039999	4500 µF, Elect., 40 V, +100%-10%
C10	C3	290-0509-00	B040000		3000 µF, Elect., 50 V, +100%-10%
C20	C5	290-0520-00	B010100	B039999	4500 µF, Elect., 40 V, +100%-10%
C20	C5	290-0509-00	B040000		3000 µF, Elect., 50 V, +100%-10%
C35	F2	290-0524-00			4.7 µF, Elect., 10 V, 20%
C55	I2	290-0519-00			100 µF, Elect., 20 V, 20%
C81	I3	290-0517-00	B010100	B010265	6.8 µF, Elect., 35 V, 20%
C81	I3	283-0111-00	B010266		0.1 µF, Cer, 50 V
C135	F5	290-0524-00			4.7 µF, Elect., 10 V, 20%
C145	G4	290-0307-00			100 µF, Elect., 40 V, 20%
C155	I5	290-0519-00			100 µF, 20 V, 20%
C181	I5	290-0517-00	B010100	B010265	6.8 µF, Elect., 35 V, 20%
C181	I5	283-0111-00	B010266		0.1 µF, Cer, 50 V
DIODES					
CR10	C1	152-0488-00			Silicon, rectifier bridge
CR20	D3	152-0488-00			Silicon, rectifier bridge
CR40	E2	152-0141-02			Silicon, replaceable by 1N4152
CR55	J3	152-0066-00			Silicon, selected from 1N3194
CR66	G3	152-0185-00			Silicon, selected from 1N4152
CR70	Chassis	150-1001-00			Light emiting diode
CR71	E2	152-0141-02			Silicon, replaceable by 1N4152
CR74	I3	152-0141-02			Silicon, replaceable by 1N4152
CR140	E4	152-0141-02			Silicon, replaceable by 1N4152
CR155	I5	152-0066-00			Silicon, selected from 1N3194
CR166	G5	152-0185-00			Silicon, selected from 1N4152
CR170	Chassis	150-1001-00			Light emiting diode

ELECTRICAL PARTS LIST (cont)

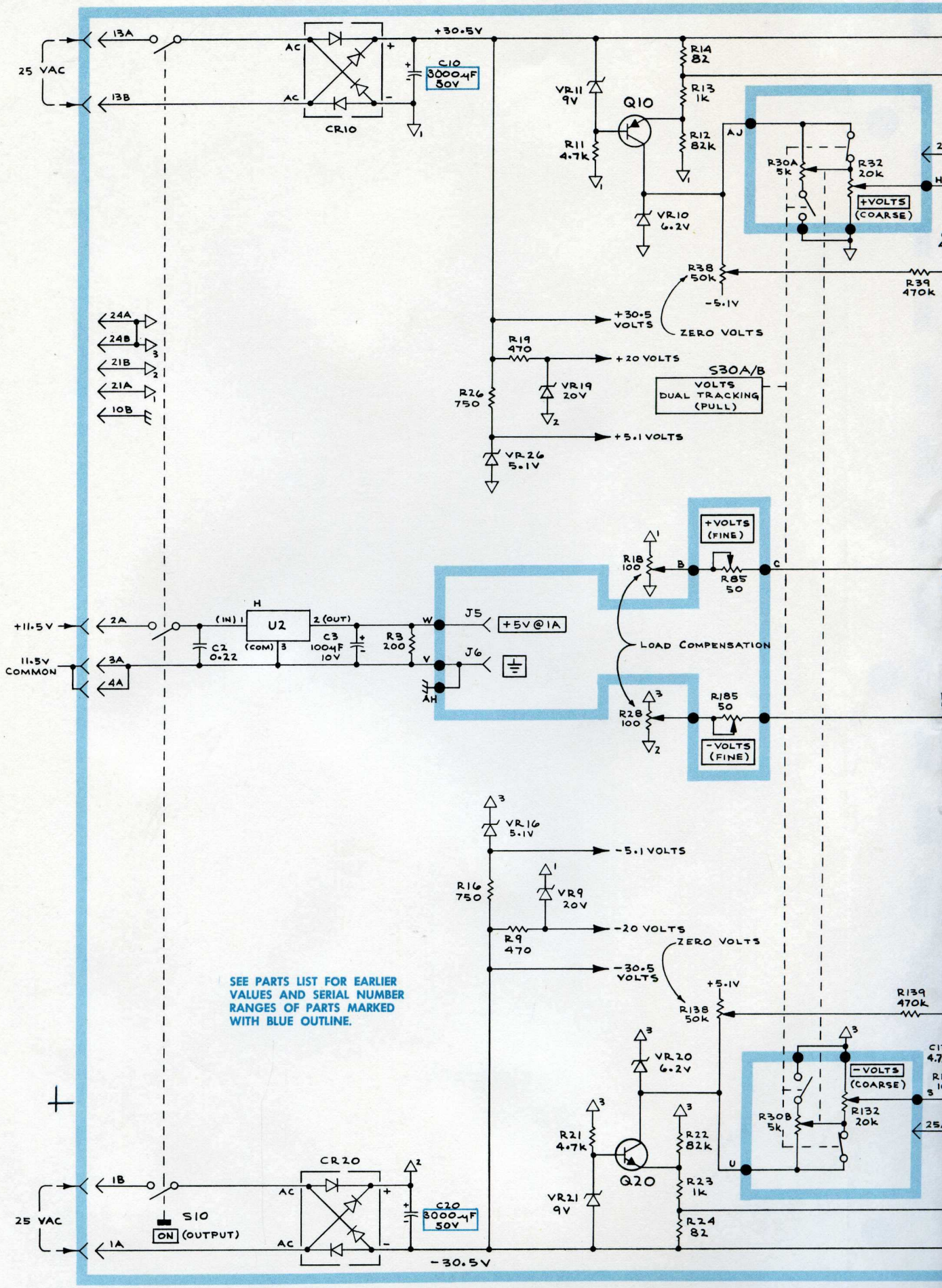
Ckt No.	Grid Loc	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
DIODES (cont)					
CR171	E5	152-0141-02			Silicon, replaceable by 1N4152
CR174	I5	152-0141-02			Silicon, replaceable by 1N4152
VR9	H1	152-0304-00			Zener, replaceable by 1N968B, 0.4 W, 20 V, 5%
VR10	G2	152-0461-00			Zener, replaceable by 1N821, 0.4 W, 6.2 V, 5%
VR11	H3	152-0212-00			Zener, selected from 1N936, 0.5 W, 9 V, 5%
VR16	F1	152-0279-00			Zener, replaceable by 1N751A, 0.4 W, 5.1 V, 5%
VR19	H4	152-0304-00			Zener, replaceable by 1N968B, 0.4 W, 20 V, 5%
VR20	G5	152-0461-00			Zener, replaceable by 1N821, 0.4 W, 6.2 V, 5%
VR21	H5	152-0212-00			Zener, selected from 1N936, 0.5 W, 9 V, 5%
VR26	F4	152-0279-00			Zener, replaceable by 1N751A, 0.4 W, 5.1 V, 5%
BULBS					
DS70	Chassis	150-0107-00			Incandescent, 0.04 A
DS170	Chassis	150-0107-00			Incandescent, 0.04 A
CONNECTORS					
J5	Chassis	129-0064-01			Post, binding, red
J6	Chassis	129-0064-02			Post, binding, white
J50	Chassis	129-0064-01			Post, binding, red
J100	Chassis	129-0064-00			Post, binding, charcoal
J150	Chassis	129-0064-03			Post, binding, green
TRANSISTORS					
Q10	G3	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q20	G6	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q50	F2	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q60	G2	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q150	F5	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q160	G5	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
RESISTORS					
R3	J4	315-0201-00			200 Ω, 1/4 W, 5%
R9	E3	301-0471-00			470 Ω, 1/2 W, 5%
R11	G2	315-0472-00			4.7 kΩ, 1/4 W, 5%
R12	H3	315-0823-00			82 kΩ, 1/4 W, 5%
R13	H3	315-0102-00			1 kΩ, 1/4 W, 5%
R14	G3	315-0820-00			82 Ω, 1/4 W, 5%
R16	E4	303-0751-00			750 Ω, 1 W, 5%
R18	H1	311-1120-00			100 Ω, Var
R19	F3	301-0471-00			470 Ω, 1/2 W, 5%
R21	G5	315-0472-00			4.7 kΩ, 1/4 W, 5%
R22	H5	315-0823-00			82 kΩ, 1/4 W, 5%
R23	H5	315-0102-00			1 kΩ, 1/4 W, 5%
R24	G5	315-0820-00			82 Ω, 1/4 W, 5%
R26	F4	303-0751-00			750 Ω, 1 W, 5%
R28	H4	311-1120-00			100 Ω, Var
R30A,B[1]	Chassis	311-1367-00			2 x 5 kΩ, Var
R32[2]	Chassis	311-1343-00			20 kΩ, Var
R35	G2	315-0103-00			10 kΩ, 1/4 W, 5%
R38	F3	311-1363-00			50 kΩ, Var
R39	G2	315-0474-00			470 kΩ, 1/4 W, 5%

[1]Furnished as a unit with S30.
[2]Furnished as a unit with R85.

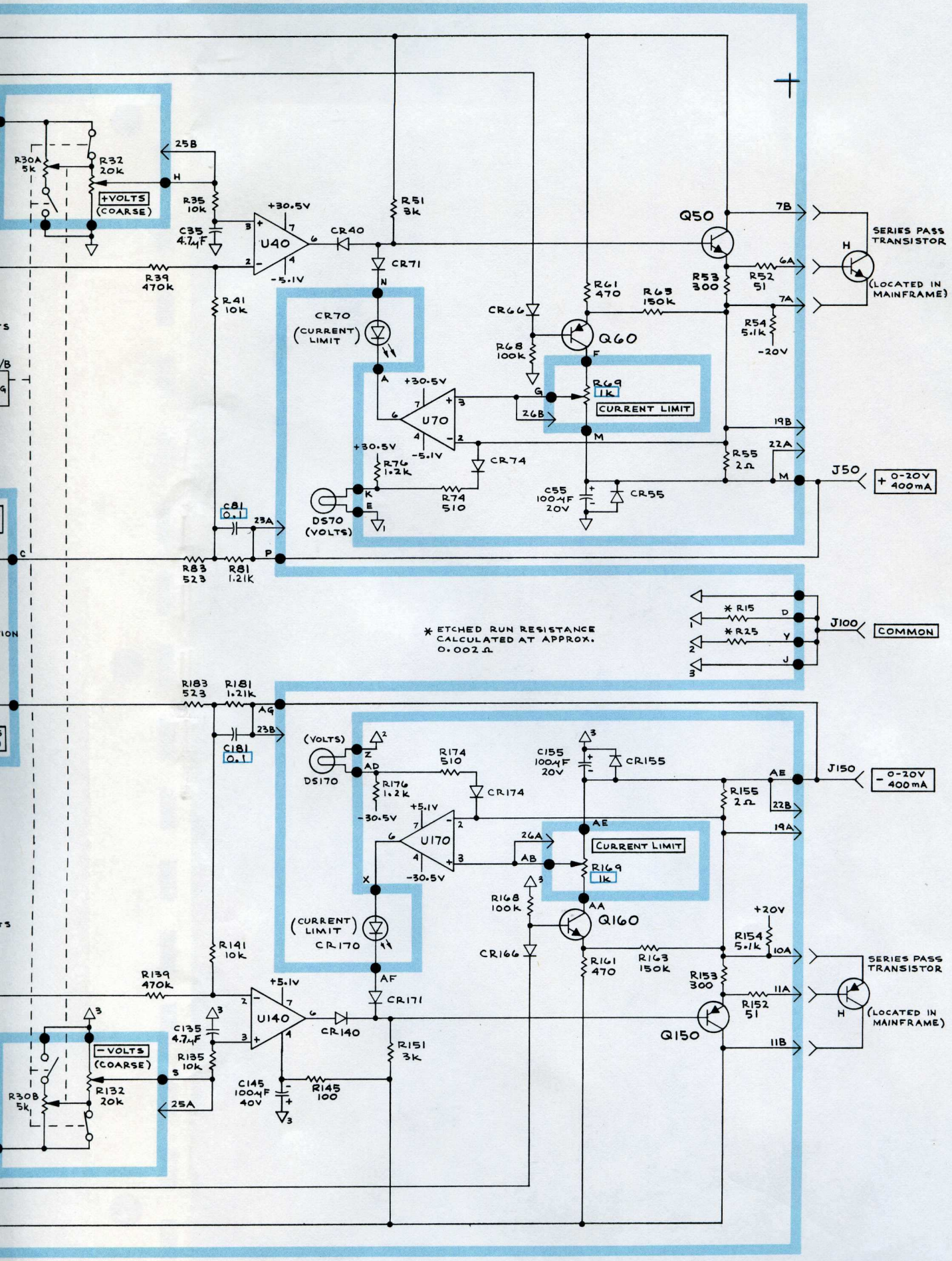
ELECTRICAL PARTS LIST (cont)

Ckt No.	Grid Loc	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)					
R41	G1	315-0103-00			10 kΩ, 1/4 W, 5%
R51	E3	301-0302-00			3 kΩ, 1/2 W, 5%
R52	E2	315-0510-00			51 Ω, 1/4 W, 5%
R53	E2	315-0301-00			300 Ω, 1/4 W, 5%
R54	H2	315-0512-00			5.1 kΩ, 1/4 W, 5%
R55	I2	308-0240-00			2 Ω, 3 W, WW, 5%
R61	G3	315-0471-00			470 Ω, 1/4 W, 5%
R63	G2	315-0154-00			150 kΩ, 1/4 W, 5%
R68	G2	315-0104-00			100 kΩ, 1/4 W, 5%
R69	Chassis	311-1311-00	B010100	B019999	1 kΩ, Var
R69	Chassis	311-1369-00	B020000		1 kΩ, Var
R74	I3	315-0511-00			510 Ω, 1/4 W, 5%
R76	H3	315-0122-00			1.2 kΩ, 1/4 W, 5%
R81	I3	321-0201-00			1.21 kΩ, 1/8 W, 1%
R83	H2	321-0166-00			523 Ω, 1/8 W, 1%
R85[1]	Chassis	311-1343-00			50 Ω, Var
R132[2]	Chassis	311-1343-00			20 kΩ, Var
R135	G4	315-0103-00			10 kΩ, 1/4 W, 5%
R138	F5	311-1363-00			50 kΩ, Var
R139	F5	315-0474-00			470 kΩ, 1/4 W, 5%
R141	G4	315-0103-00			10 kΩ, 1/4 W, 5%
R145	F5	315-0101-00			100 Ω, 1/4 W, 5%
R151	E5	301-0302-00			3 kΩ, 1/2 W, 5%
R152	E5	315-0510-00			51 Ω, 1/4 W, 5%
R153	E5	315-0301-00			300 Ω, 1/4 W, 5%
R154	H4	315-0512-00			5.1 kΩ, 1/4 W, 5%
R155	I5	308-0240-00			2 Ω, 3 W, WW, 5%
R161	G5	315-0471-00			470 Ω, 1/4 W, 5%
R163	G4	315-0154-00			150 kΩ, 1/4 W, 5%
R168	G4	315-0104-00			100 kΩ, 1/4 W, 5%
R169	Chassis	311-1311-00	B010100	B019999	1 kΩ, Var
R169	Chassis	311-1369-00	B020000		1 kΩ, Var
R174	I5	315-0511-00			510 Ω, 1/4 W, 5%
R176	H5	315-0122-00			1.2 kΩ, 1/4 W, 5%
R181	I5	321-0201-00			1.21 kΩ, 1/8 W, 1%
R183	H4	321-0166-00			523 Ω, 1/8 W, 1%
R185[3]	Chassis	311-1343-00			50 Ω, Var
SWITCHES					
S10	B2	260-1209-00			Push, ON
S30[4]	Chassis				Push-pull, VOLTS DUAL TRACKING
INTEGRATED CIRCUITS					
U2	J4	156-0176-00			Single voltage regulator, replaceable by LM309K
U40	F2	156-0067-00	B010100	B010210	Operational amplifier, replaceable by UA741C
U40	F2	156-0067-06	B010211		Operational amplifier, replaceable by UA741C
U70	F3	156-0067-00	B010100	B010210	Operational amplifier, replaceable by UA741C
U70	F3	156-0067-06	B010211		Operational amplifier, replaceable by UA741C
U140	F4	156-0067-00	B010100	B010210	Operational amplifier, replaceable by UA741C
U140	F4	156-0067-06	B010211		Operational amplifier, replaceable by UA741C
U170	F5	156-0067-00	B010100	B010210	Operational amplifier, replaceable by UA741C
U170	F5	156-0067-06	B010211		Operational amplifier, replaceable by UA741C

[1]Furnished as a unit with R32.
[2]Furnished as a unit with R185.
[3]Furnished as a unit with R132.
[4]Furnished as a unit with R30A,B.



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



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MECHANICAL PARTS LIST

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

ABBREVIATIONS

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

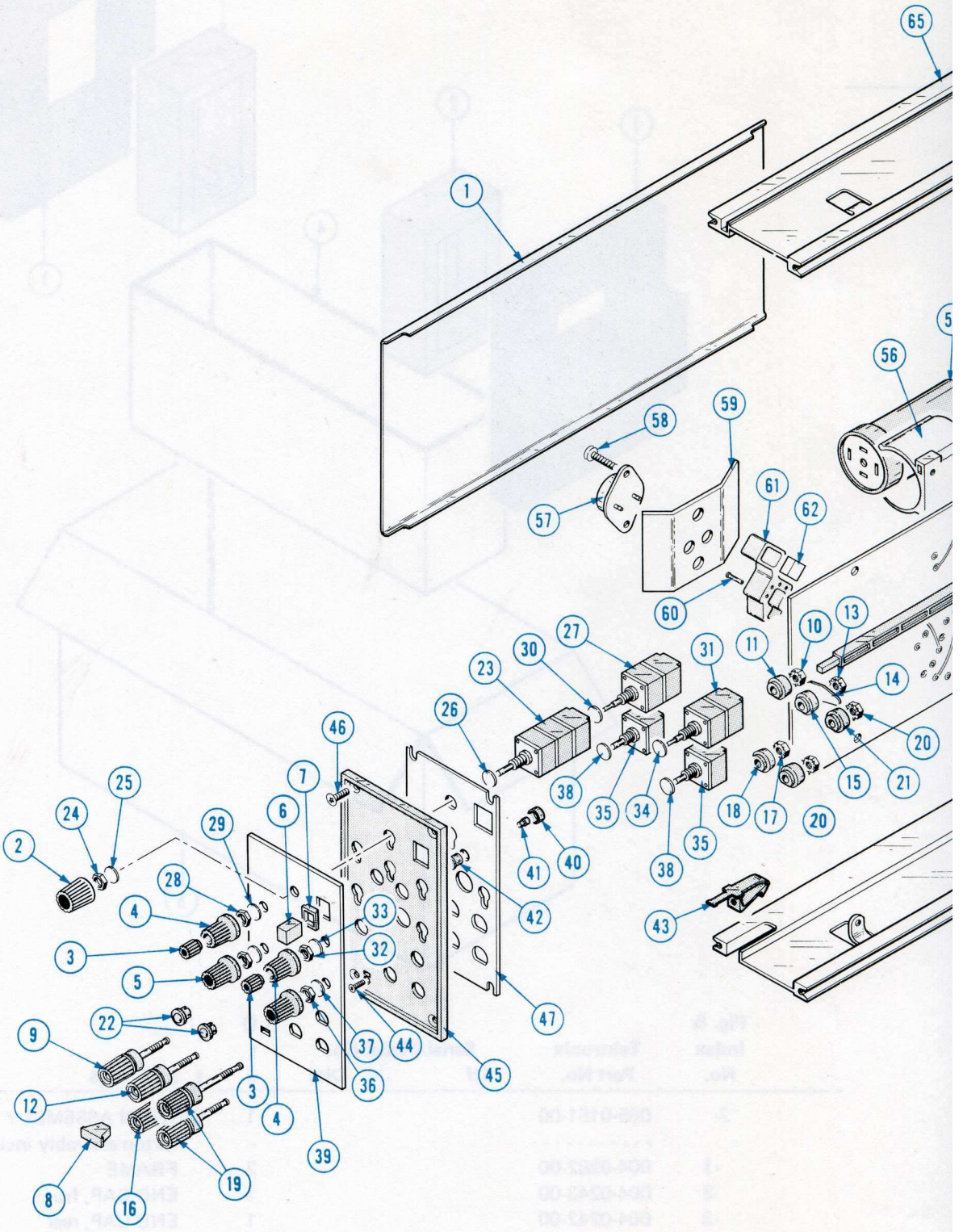
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-1	337-1399-00			2	SHIELD, electrical, side
-2	366-0497-00			1	KNOB, gray--VOLTS DUAL TRACKING
	- - - - - -			-	knob includes:
	213-0153-00			1	SETSCREW, 5-40 x 0.125 inch, HSS
-3	366-1319-00			2	KNOB, gray--VOLTS (fine)
	- - - - - -			-	each knob includes:
	213-0239-00			1	SETSCREW, 3-48 x 0.062 inch, HSS
-4	366-1077-00			2	KNOB, gray--VOLTS (coarse)
	- - - - - -			-	each knob includes:
	213-0153-00			1	SETSCREW, 5-40 x 0.125 inch, HSS
-5	366-0494-00			2	KNOB, gray--CURRENT LIMIT
	- - - --- -			-	each knob includes:
	213-0153-00			1	SETSCREW, 5-40 x 0.125 inch, HSS
-6	366-1257-74			1	PUSHBUTTON--ON
-7	426-0681-00			1	FRAME, pushbutton
-8	366-1422-00	B010100	B019999	1	KNOB, latch
	366-1422-01	B020000		1	KNOB, latch
	214-1840-00	XB020000		1	PIN, knob securing
-9	129-0064-03			1	POST, binding, green (J150)
	- - - - - -			-	mounting hardware: (not included w/post)
-10	210-0457-00			1	kUT, keps, 6-32 x 0.312 inch
-11	- - - - - -			1	INSULATOR, bushing, green (included w/post)
-12	129-0064-00			1	POST, binding, charcoal (J100)
	- - - - - -			-	mounting hardware: (not included w/post)
-13	210-0457-00			1	NUT, keps, 6-32 x 0.312 inch
-14	210-0204-00			1	TERMINAL, lug, 0.146 inch diameter, DE
-15	358-0181-00			1	INSULATOR, bushing, gray
-16	129-0064-02			1	POST, binding, white (J6)
	- - - - - -			-	mounting hardware: (not included w/post)
-17	210-0457-00			1	NUT, keps, 6-32 x 0.312 inch
-18	- - - - - -			1	INSULATOR, bushing, white (included w/post)

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-19	129-0064-01			2	POST, binding, red (J50 & J5)
	- - - - - -			-	mounting hardware for each: (not included w/post)
-20	210-0457-00			1	NUT, keps, 6-32 x 0.312 inch
-21	358-0181-01			1	INSULATOR, bushing, red
-22	- - - - - -			2	LAMP, LED (See CR70 & CR170 electrical list)
-23	- - - - - -			1	RESISTOR, variable (See R30A, R30B & S30 electrical list)
	- - - - - -			-	mounting hardware: (not included w/resistor)
-24	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-25	210-0940-00			1	WASHER, flat, 0.25 ID x 0.375 inch OD
-26	210-0046-00			1	WASHER, loct, internal, 0.261 ID x 0.40 inch OD
-27	- - - - - -			1	RESISTOR, variable (see R85 & R32 electrical list)
	- - - - - -			-	mounting hardware: (not included w/resistor)
-28	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-29	210-0940-00			1	WASHER, flat, 0.25 ID x 0.375 inch OD
-30	210-0046-00			1	WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-31	- - - - - -			1	REIISTOR, variable (See R185 & R132 electrical list)
	- - - - - -			-	mounting hardware: (not included w/resistor)
-32	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-33	210-0940-00			1	WASHER, flat, 0.25 ID x 0.375 inch OD
-34	210-0046-00			1	WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-35	- - - - - -			2	RESISTOR, variable (See R69 & R169 electrical list)
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-36	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-37	210-0940--0			1	WASHER, flat, 0.25 ID x 0.312 inch OD
-38	210-0046-00			1	WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-39	333-1562-00			1	PANEL, front
-40	200-0935-00			2	CAP, lampholder
-41	378-0602-01			2	LENS, indicator light, amber
-42	352-0157-00			2	LAMPHOLDER
-43	214-1513-00	B010100	B019999	1	LATCH, plug-in retainer
	214-1513-01	B020000		1	LATCH, plug-in retainer
	- - - - - -			-	mounting hardware: (not included w/latch)
-44	213-0254-00			1	SCREW, thread forming, 2-56 x 0.25 inch, 100° csk, FHS
-45	386-2232-00			1	SUBPANEL, front
	- - - - - -			-	mounting harfware: (not included w/subpanel)
-46	213-0229-00			4	SCREW, thread forming, 6-20 x 0.375 inch, 100° csk, FHS

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description
1-47	337-1638-00			1	SHIELD, subpanel rear
-48	384-1058-00			1	SHAFT, extension, 7.781 inches long
-49	- - - - - -			1	CIRCUIT BOARD ASSEMBLY--MAIN (See A1 electrical list)
	- - - - - -			-	circuit board assembly includes:
-50	136-0252-04			50	SOCKET, pin connector
-51	260-1209-00			1	SWITCH, push-ON (S10)
-52	361-0384-00	B010100	B029999	2	SPACER, switch, red, 0.133 inch long
	361-0385-00	B030000		2	SPACER, switch, green 0.164 inch long
-53	- - - - - -			2	CAPACITOR (See C10 & C20 electrical list)
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-54	211-0534-00			2	SCREW, sems, 6-32 x 0.312 inch, PHS
-55	210-0407-00			2	NUT, keps, 6-32 x 0125 inch
-56	352-0332-00			1	HOLDER, capacitor
-57	- - - - - -			1	INTEGRATED CIRCUIT (See U2 electrical list)
	- - - - - -			-	mounting hardware: (not included w/integrated circuit)
-58	211-0510-00	B010100	B019999	2	SCREW, 6-32 x 0.375 inch, PHS
	211-0511-00	B020000		2	SCREW, 6-32 x 0.500 inch, PHS
-59	214-1713-00			1	HEATSINK
-60	136-0384-00			2	SOCKET,pin terminal
-61	136-0361-00			1	SOCKET, transistor
-62	131-0847-00			2	TERMINAL, post
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
-63	213-0146-00			4	SCREW, thread forming, 6-20 x 0.312 inch, PHS
-64	426-0724-00			1	FRAME SECTION, bottom
-65	426-0725-00			1	FRAME SECTION, top
-66	179-1766-00			1	WIRING HARNESS
	214-1061-00			1	SPRING, ground flat (not shown)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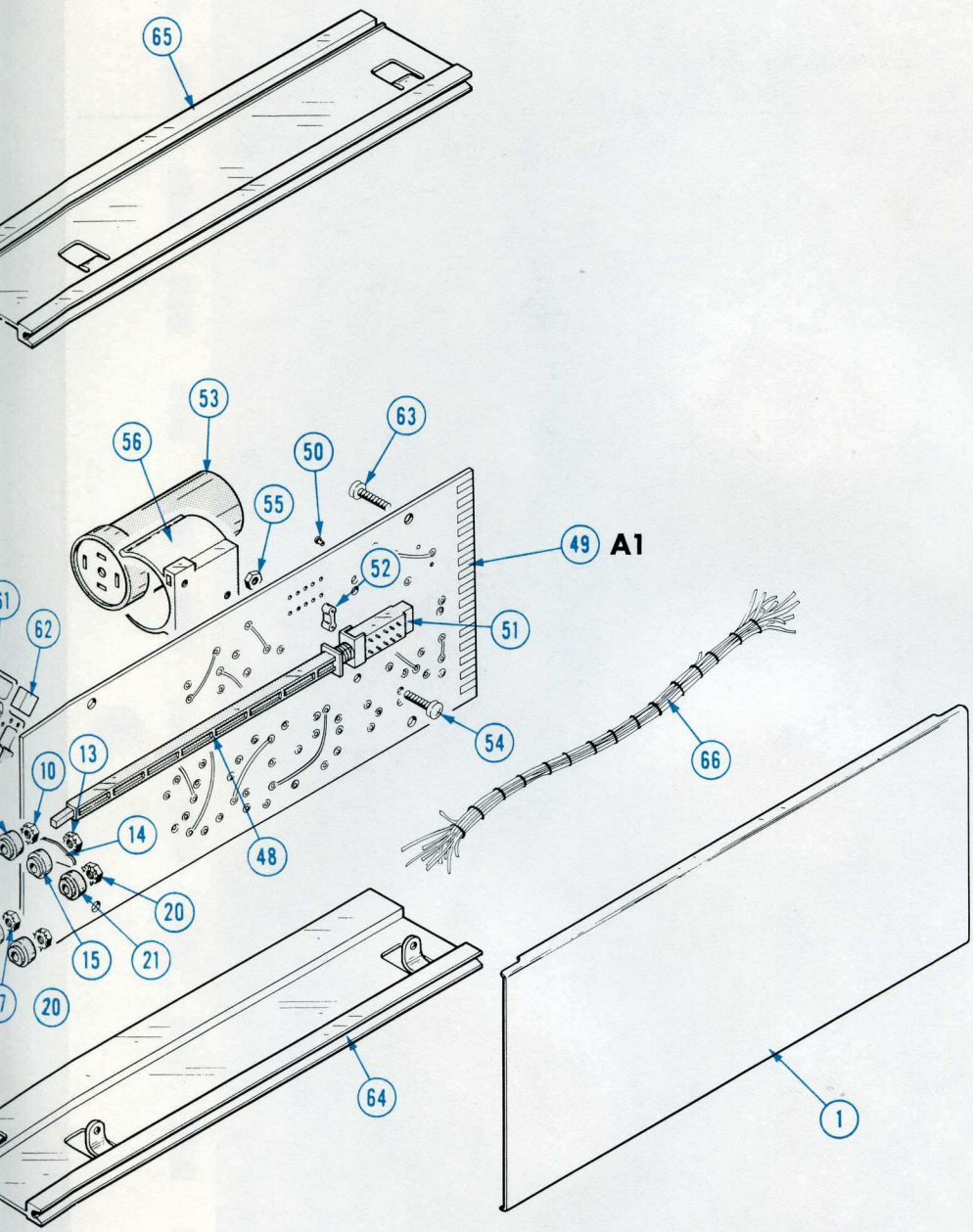
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CARTON ASSEMBLY
(Part No. 065-0151-00)

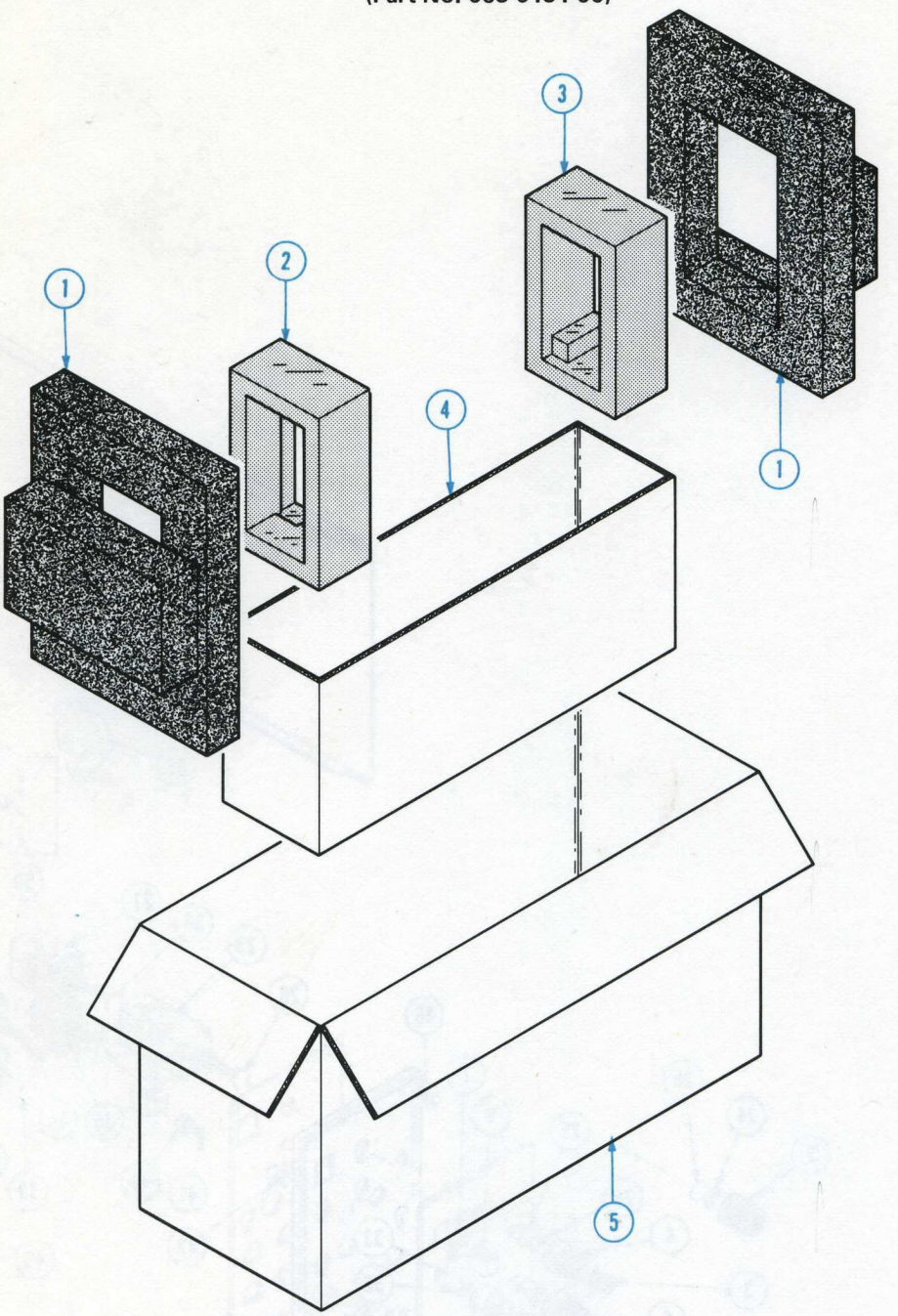

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
2-	065-0151-00			1		CARTON ASSEMBLY
	- - - - - - - - - -			-		carton assembly includes:
-1	004-0282-00			2		FRAME
-2	004-0243-00			1		END CAP, front
-3	004-0242-00			1		END CAP, rear
-4	004-1093-00			1		PAD
-5	004-0612-00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

/FIG. 2 STANDARD ACCESSORIES & REPACKAGING

STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-	070-1303-00			1		MANUAL, instruction (not shown)

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.

PS 503 EFF SN B050000-up

ELECTRICAL PARTS LIST CHANGE

CHANGE TO:

CR40	152-0141-02	Silicon, replaceable by 1N4152
CR140	152-0141-02	Silicon, replaceable by 1N4152