



**VOLTAGE REGULATOR CARD
MODEL 69351B**



**OPERATING AND SERVICE MANUAL FOR CARDS DESIGNATED
SERIAL 1546A-00101 AND ABOVE ***

*** For serials above 1546A-00101
a change page may be included.**

**(A schematic and parts list for the Model 69351A
Voltage Regulator Card is included as Appendix A.)**

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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from date of delivery, or in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

SECTION I GENERAL INFORMATION

1-1 INTRODUCTION

1-2 This manual contains operating and service instructions for the Model 69351B Voltage Regulator Card. This card is designed for use in 6940A or 6940B Multiprogrammers and in 6941A or 6941B Multiprogrammer Extenders to provide the isolated sources of $\pm 15V$ dc power required when Model 69321B D/A Voltage Converter Cards, Model 69370A D/A Current Converter Cards, or Model 69421A Voltage Monitor Cards are used in a multiprogrammer system.

1-3 A voltage regulator card must be installed in slot 600 of each multiprogrammer or extender mainframe in which one or more D/A converter or voltage monitor cards are used.

1-4 DESCRIPTION

1-5 The 69351B Voltage Regulator Card contains four isolated ± 15 -volt regulator circuits. One of them has a 750mA output capability and the other three can each provide up to 150 milliamps. Each of these regulators receives ± 20 -volt power through the backplane of the mainframe from bridge rectifiers and capacitive filters on the mainframe's main power supply board and supplies its regulated output through the backplane to any D/A or voltage monitor cards that might be installed. Jumpers on each D/A or voltage monitor card can be positioned to select which of the four regulated supplies is used by that card.

1-6 The positive and negative unregulated dc input lines to each regulator are equipped with individual fuses which plug into the board. The 750mA regulators also contain current limiting circuits which insure that the series regulator transistors are protected until the fuses blow if the output terminals are shorted. The positive and negative output voltages of each regulator are individually adjustable.

1-7 The Model 69351B Voltage Regulator is fabricated on a $4\frac{1}{2}'' \times 11''$ printed circuit card. The inner end of the card contains a dual 24-pin (48-pin total) printed circuit plug that mates with the connector in multiprogrammer slot 600. The unregulated input and regulated output voltage connections are made through the slot 600 connector.

1-8 SPECIFICATIONS

1-9 Table 1-1 provides detailed specifications for the Model 69351B.

1-10 INTERFACING

1-11 The four ± 15 -volt regulated outputs of the 69351B are wired to all fifteen 400-series slot connectors in the mainframe. Any one of these four outputs can be selected by positioning jumpers on each D/A converter card, and two must be selected by positioning jumpers on each voltage monitor card. Some combinations of cards cannot use a common supply. Detailed instructions are provided in Section III.

1-12 ORDERING ADDITIONAL MANUALS

1-13 One manual is shipped with each order for 69351B voltage regulator cards. Additional manuals may be purchased from your local Hewlett-Packard field office (see list at the rear of this manual for addresses). Specify the card model number and the HP Part Number shown on the title page.

Table 1-1. Model 69351B Specifications

DC OUTPUTS

Regulator A1:

$\pm 15V \pm 0.5\%$ at currents up to 750 milliamps maximum.

Regulators A2-A4:

$\pm 15V \pm 0.5\%$ at currents up to 150 milliamps maximum.

LOAD EFFECT (Load Regulation): Less than 75 millivolts output change for a change in load from zero to 750 milliamps on regulator A1 or from zero to 150 milliamps on regulators A2 through A4.

PARD (Ripple and Noise):

All outputs: Less than 25 millivolts peak-to-peak.

SECTION II INSTALLATION

2-1 INITIAL INSPECTION

2-2 Before shipment, the 69351B Voltage Regulator Card was inspected and found free of mechanical and electrical defects. As soon as the card is received, proceed as instructed in the following paragraphs.

2-3 Mechanical Check

2-4 If external damage to the shipping carton is evident, ask the carrier's agent to be present when the card is unpacked. Check the card for signs of physical damage. If it is damaged, file a claim with the carrier's agent and notify the Hewlett-Packard Sales and Service Office as soon as possible. If it appears to be undamaged, perform the electrical check referenced in the following paragraph.

2-5 Electrical Check

2-6 Check the electrical performance of the card as soon as possible after receipt. Section V of this manual contains checkout procedures that will verify operation of the card. Refer to the inside front cover of this manual for certification and warranty statements.

2-7 REPACKING FOR SHIPMENT

2-8 When shipping a voltage regulator card, it is recommended that the package designed for it be used. The original packaging material is reusable. If it is not available,

contact your local Hewlett-Packard field office to obtain the materials. This office will also furnish the address of the nearest office to which the card can be shipped. Be sure to attach a tag to the card specifying the owner, the model number, and the service required for a brief description of the trouble.

2-9 CARD INSTALLATION

2-10 The voltage regulator card is installed in slot 600 of a multiprogrammer mainframe. To install the card, proceed as follows:

CAUTION

Always turn off the power to the multiprogrammer before installing or removing the voltage regulator card. If power is not removed, it is possible to cause damage by shorting components in the multiprogrammer.

1. Turn the recessed screw within the knurled handle counterclockwise to unlatch and open the hinged front panel of the multiprogrammer.

2. With the extractor handle at the top and the card's components to the right, slide the card into slot 600 and seat it firmly in the connector. (Voltage regulator cards are slotted between pins 6 and 7, and the slot 600 connector is keyed between the same pins.)

SECTION III OPERATING INSTRUCTIONS

3-1 GENERAL

3-2 When the 69351B Voltage Regulator Card is installed in slot 600, it receives unregulated ± 20 -volt input power from four isolated supplies on the multiprogrammer's main power supply board and returns four regulated ± 15 -volt outputs through the backplane wiring to the fifteen 400-series connectors. Figure 3-1 shows the input and output connections made through the slot 600 connector.

3-3 LOAD CONNECTIONS

3-4 The 69351B Voltage Regulator Card powers those circuits on digital-to-analog converter cards and voltage monitor cards that require an isolated ± 15 -volt input. Supply No. 1 has a 750mA capacity; supplies 2, 3, and 4 can each supply 150 milliamps. Jumper connections on the card being powered select one of these isolated supplies for each 69321B Voltage Converter Card or 69370A Current Converter Card and select two of these isolated supplies for each 69421A Voltage Monitor Card. The following paragraphs discuss some special considerations for choosing these jumpers for each type of card. Simplified circuit diagrams of the load circuits of these digital-to-analog and analog-to-digital converter cards are given in Figure 3-2.

3-5 69321B Voltage Converter Cards

3-6 Each 69321B card requires 47 milliamps at ± 15 volts. Up to fifteen cards can be powered from 750mA supply No. 1, and up to three cards can be powered from each of the three 150mA supplies. All 69321B cards are shipped from the factory with jumpers installed selecting the 750mA supply. The LO side of the 69321B card's analog voltage output is tied to the common connection of its ± 15 V supply. Because the LO side of a 69370A card's analog current output is tied to its -15 V supply input, 69321B and 69370A cards should not be powered from the same ± 15 V supply unless the external circuits connected to the outputs of the two types of cards are isolated from each other. Another limitation to combining 69321B cards with others on the same ± 15 V supply occurs when a 69421A card's digital output common line is grounded externally. Combining 69321B cards and the digital output circuits of 69421A cards will ground the 69321B card's LO output. In applications where the output signal common of a 69321B card must be isolated from the input or output signal common lines of any other D/A or A/D converter cards, separate ± 15 V supplies must be selected.

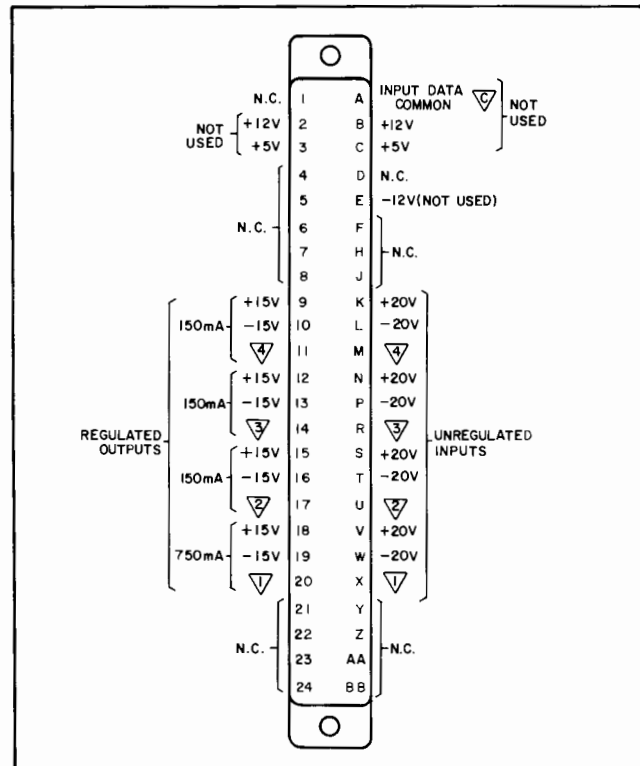


Figure 3-1. Multiprogrammer Slot 600 Connector

3-7 69370A Current Converter Cards

3-8 Each 69370A card requires 47 milliamps at ± 15 volts. Up to fifteen cards can be powered from 750mA supply No. 1, and up to three cards can be powered from each of the three 150mA supplies. All 69370A cards are shipped from the factory with jumpers installed selecting the 750mA supply. The LO side of the 69370A card's analog current output is tied to the -15 V line of its ± 15 V supply. This makes it impractical to combine either 69321B cards or 69421A cards on the same power supply with 69370A cards unless the external circuits connected to the differing cards are isolated from each other.

3-9 69421A Voltage Monitor Cards

3-10 Each 69421A card requires two isolated ± 15 -volt supplies. One powers the analog input circuits and has its common line connected to the LO side of the card's analog input, and the other powers the digital output circuits and generally has its common line grounded externally through the common line of the card's digital output. The analog circuits require 3 milliamps and the digital circuits require

47 milliamps. All 69421A cards leave the factory with their analog input circuits jumpered to 150mA supply No. 2 and their digital output circuits jumpered to 150mA supply No. 3. If more than three voltage monitor cards are to be used in the same mainframe, supply current limitations dictate that the digital output circuits of no more than three cards can be left connected to $\pm 15V$ supply No. 3. The additional cards can either be powered from supply No. 1 or supply No. 4, or else all can be powered from supply No. 1. Since the LO side of the analog input to the card is tied to the common line of its $\pm 15V$ power supply, and the common line of the card's digital output grounds the common line of its $\pm 15V$ power supply, other cards connected to the same power supplies as a voltage monitor card will have their outputs referenced to the common side of its analog input or to ground. Cards must be operated from separate supplies whenever their inputs or outputs must be isolated from each other.

3-11 FUSE REPLACEMENT

3-12 All of the positive and negative unregulated input lines to the four regulators are fused; the 750mA supply is fused at 1 amp and the 150mA supplies are fused at 1/4 amp. The fuses plug into sockets on the printed circuit board. Because of its small size, it is usually difficult to determine the condition of a fuse visually. Use an ohmmeter if in doubt.

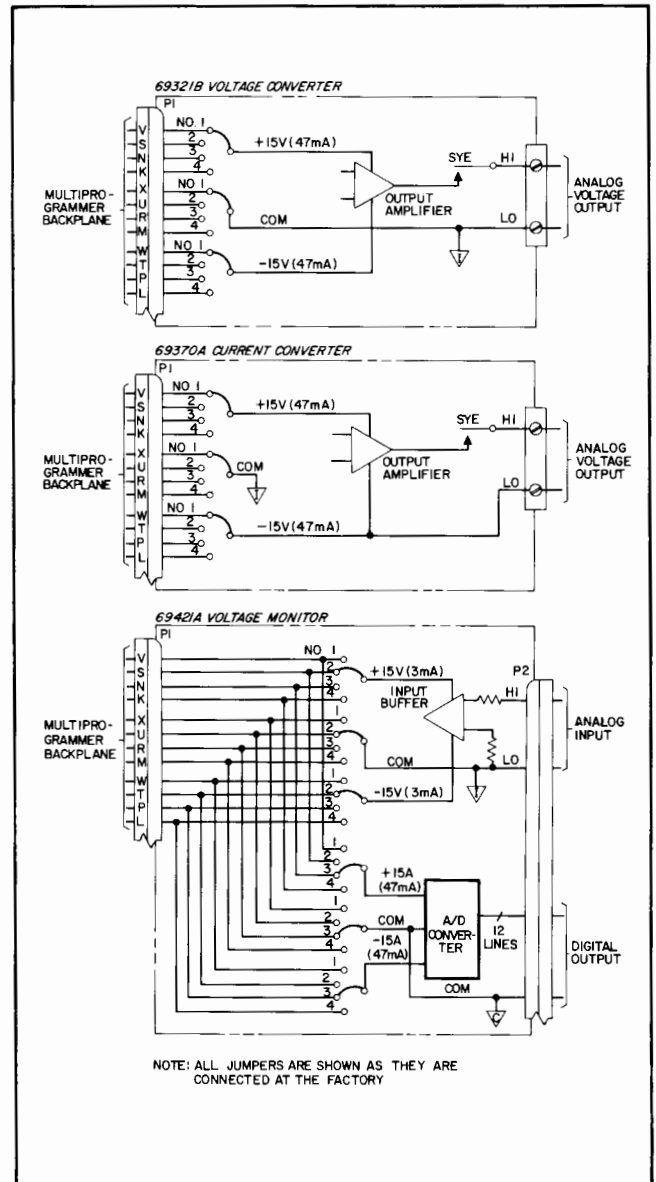


Figure 3-2. $\pm 15V$ Load Circuits — Simplified Circuit Diagram

SECTION IV PRINCIPLES OF OPERATION

4-1 INTRODUCTION

4-2 The 69351B Voltage Regulator Card contains four ± 15 -volt regulator circuits designated A1 through A4. The A1 circuit has a 750mA output capacity, and the A2 through A4 circuits, which are identical to one another, can each supply 150 milliamps.

4-3 THEORY OF OPERATION

4-4 Voltage Regulator A1

4-5 Voltage regulator A1 (Fig. 7-1) consists of two regulator circuits, one for its positive and one for its negative 15-volt output. These two circuits are independent of each other and function similarly. To regulate opposite-polarity outputs, each regulator circuit uses diodes connected with opposite polarity and transistors of complementary polarity to those of the other in an identical circuit arrangement. Because of the similarity of the two circuits, only the positive regulator is described in detail.

4-6 The +15-volt 750mA regulator is composed of comparison amplifier Q3, driver Q5, series regulator Q1, and current limiter Q7. The driver, and in turn the series regulator, is biased off through R5 and biased on through the conduction of comparison amplifier Q3. Since, at turn-on, the initial state of the driver and of the series regulator is nonconducting until Q3 begins to conduct, and Q3 cannot begin to conduct until its base voltage exceeds 0.7 volts, it is necessary for the voltage divider composed of R1 and R3 to apply an initial bias to Q3's base. Once Q3 begins to conduct, Q1 and Q5 turn on, raising the regulator's output voltage. The output voltage immediately increases to 15 volts, at which time the regulator's feedback loop takes control. Once the regulator is in operation, the increased base voltage on Q3 reverse biases CR1, essentially removing it from the circuit.

4-7 Comparison amplifier Q3 compares a sample of the

regulated output voltage across R7 and part of R17 to the constant voltage developed across reference zener diode VR1. VR1 holds Q3's emitter at a constant voltage relative to the regulator's positive output line while any fluctuations in the output are seen at Q3's base. A tendency for the output voltage to rise decreases Q3's conduction. This reduces the turn-on bias to Q5 and Q1 and increases the voltage drop across the series regulator, thus maintaining the output voltage relatively constant. A tendency for the output voltage to decrease is counteracted through the opposite action of the circuit.

4-8 The current limiter circuit includes R13, R15, and Q7. The voltage drop across R13 is proportional to the regulator's input current. As long as this input current remains below approximately 1.2 amps, the voltage across R13 is insufficient to forward bias Q7. If the current rises above this value, Q7 begins to conduct, shunting the base-emitter circuit of transistors Q5 and Q1 to limit their conduction.

4-9 Voltage Regulators A2, A3, and A4

4-10 Because the circuits that regulate the positive and negative outputs of each of the three 150mA outputs are also similar to each other but complementary, only the positive regulator of the A2 circuit is described.

4-11 In the +15-volt 150mA regulator, driver Q3 drives series regulator Q1 and is driven by a two-transistor differential amplifier composed of Q5 and Q7. This differential amplifier compares the voltage of reference zener VR1 to the sample of the output voltage developed across R13 and part of R11. A tendency for the regulator's output voltage to increase is sensed at Q5's base and coupled to Q7's emitter, decreasing Q7's conduction and reducing the turn-on bias to Q3 and Q1 to maintain a constant output voltage. The starting circuit composed of R1, R3, and CR1 operates similarly to the one in regulator A1. The 150mA regulators are equipped with fuses but do not have current limiter circuits.



SECTION V MAINTENANCE

5-1 INTRODUCTION

5-2 This section contains preventive maintenance instructions, checkout procedures, and troubleshooting procedures for the 69351B Voltage Regulator Card.

5-3 TEST EQUIPMENT REQUIRED

5-4 The multiprogrammer mainframe provides unregulated ± 20 volt inputs to the 69351B. It is assumed that the multiprogrammer mainframe is functioning properly at the outset of testing. The general purpose test instruments required for maintenance of the 69351B are listed in Table 5-1.

5-5 PREVENTIVE MAINTENANCE

5-6 The only preventive maintenance necessary is to keep the printed-circuit connector contact fingers clean. A nonabrasive eraser, such as a "Pink Pearl" or plastic eraser, should be lightly rubbed over the contact fingers to remove any film or foreign material.

5-7 CHECKOUT AND TROUBLESHOOTING

5-8 The procedures in Table 5-2 can be used to check

the operation of voltage regulator cards when they are initially received and as an aid in isolating trouble if a malfunction is noted during operation. The procedures are performed with the voltage regulator card plugged into an extender card and the extender card plugged into slot 600 of a multiprogrammer.

NOTE

Remove all digital-to-analog converter and voltage monitor cards from the mainframe while checking or troubleshooting the 69351B Voltage Regulator Card.

5-9 REPLACING HEAT DISSIPATORS

5-10 The heat dissipators used on the series regulator transistors should fit snugly on the transistor cases and a thin film of silicone grease, such as Dow Corning DC-5, should be used for good thermal transfer. The springs on the heat dissipators may be bent for tighter holding action if necessary.

Table 5-1. Test Equipment Required

TYPE	CHARACTERISTICS	USE	RECOMMENDED MODEL
Digital Multi-Function Meter	Voltage Accuracy: $\pm 0.003\%$ of reading. Resistance Accuracy: $\pm 0.01\%$ of reading $+0.01\%$ of range.	Voltage and resistance measurements.	HP Model 3450A with Option 002.
Oscilloscope	Bandwidth: dc to 50MHz Sensitivity: 20mV/div.	Ripple measurements.	HP Model 180A with 1801A and 1821A plug-ins.
Resistor	20 Ω , 20W, $\pm 5\%$.	Load regulation tests of 750mA regulator	
Resistor	100 Ω , 5W, $\pm 5\%$.	Load regulation tests of 150mA regulators.	

Table 5-2. Checkout and Troubleshooting Procedures

Step No.	Test Equipment Connections	Instructions	Normal Indication	Evaluation
1	Connect voltmeter across test points ① (common ∇) and ② of 750mA regulator. (See Section VII for schematic diagram and locations of test points and components.)	Energize the multiprogrammer system and, if necessary, adjust A1R17 for a voltmeter reading of $+15 \pm 0.075$ volts.	$+15 \pm 0.075$ volts dc.	a. If indication is 0 volts, check for open F1, R13, Q1, Q3, Q5, and CR1, and for shorted Q7, C1, and VR1. b. If indication is $+20$ volts, check for shorted Q1, Q3, Q5, and CR1, and for open VR1.
2	Retain step 1 voltmeter connections.	Connect 20Ω 20W resistor across test points ① and ② and observe voltmeter indication.	Voltage changes by no more than 75mV from step 1 indication.	If regulation is poor, monitor the voltage between test points ① and ⑬ while changing load from 20Ω to open circuit. If voltage does not change, check Q3 and VR1. If voltage does change, check Q1 and Q5.
3	Connect oscilloscope across test points ① and ②.	Observe oscilloscope display with 20Ω load connected.	Ripple voltage no more than 25mV peak-to-peak.	Check capacitor C1.
4	Connect voltmeter across test points ① and ③.	Observe voltmeter indication and adjust A1R18 for a reading of -15 ± 0.075 volts if necessary.	-15 ± 0.075 volts dc.	a. If indication is 0 volts, check for open F2, R14, Q2, Q4, Q6, and CR2, and for shorted Q8, C2, and VR2. b. If indication is -20 volts, check for shorted Q2, Q4, Q6, and CR2, and for open VR2.
5	Retain step 4 voltmeter connections.	Connect 20Ω 20W resistor across test points ① and ③ and observe voltmeter indication.	Voltage changes by no more than 75mV from step 4 indication.	If regulation is poor, monitor the voltage between test points ① and ⑭ while changing load from 20Ω to open circuit. If voltage does not change, check Q4 and VR2. If voltage does change, check Q2 and Q6.
6	Connect oscilloscope across test points ① and ③.	Observe oscilloscope display with 20Ω load connected.	Ripple voltage no more than 25mV peak-to-peak.	Check capacitor C2.
7	Connect voltmeter across test points ④ and ⑤.	Observe voltmeter indication and adjust A2R11 for a reading of $+15 \pm 0.075$ volts if necessary.	$+15 \pm 0.075$ volts dc.	a. If indication is 0 volts, check for open F1, R5, Q1, Q3, Q7, and CR1, and for shorted Q5, VR1, and C3.

Table 5-2. Checkout and Troubleshooting Procedures (continued)

Step No.	Test Equipment Connections	Instructions	Normal Indication	Evaluation
7 (cont)				<p>b. If indication is +20 volts, check for shorted Q1, Q3, and Q7, and for open Q5 and VR1.</p> <p>c. If adjustment range of A2R11 is approximately 10 to 14 volts and regulation and ripple are poor, check for shorted CR1.</p>
8	Retain step 7 voltmeter connections.	Connect 100Ω 5 W resistor across test points ④ and ⑤ and observe voltmeter indication.	Voltage changes by no more than 75mV from step 7 indication.	If regulation is poor, monitor the voltage between test points ④ and ⑮ while changing load from 100Ω to open circuit. If voltage does not change, check Q5, Q7, and VR1. If voltage does change, check Q1 and Q3.
9	Connect oscilloscope across test points ④ and ⑤ .	Observe oscilloscope display with 100Ω load connected.	Ripple voltage no more than 25mV peak-to-peak.	Check capacitor C3.
10	Connect voltmeter across test points ④ and ⑥ .	Observe voltmeter indication and adjust A2R12 for a reading of -15 ± 0.075 volts if necessary.	-15 ± 0.075 volts dc.	<p>a. If indication is 0 volts, check for open F2, R6, Q2, Q4, Q8, and CR2, and for shorted Q6, VR2, and C4.</p> <p>b. If indication is -20 volts, check for shorted Q2, Q4, and Q8, and for open Q6 and VR2.</p> <p>c. If adjustment range of A2R12 is approximately 10 to 14 volts and regulation and ripple are poor, check for shorted CR2.</p>
11	Retain step 10 voltmeter connections.	Connect 100Ω 5W resistor across test points ④ and ⑥ and observe voltmeter indication.	Voltage changes by no more than 75mV from step 10 indication.	If regulation is poor, monitor the voltage between test points ④ and ⑯ while changing load from 100Ω to open circuit. If voltage does not change, check Q6, Q8, and VR2. If voltage does change, check Q2 and Q4.

Table 5-2. Checkout and Troubleshooting Procedures (continued)

Step No.	Test Equipment Connections	Instructions	Normal Indication	Evaluation
12	Connect oscilloscope across test points ④ and ⑥ .	Observe oscilloscope display with 100Ω load connected.	Ripple voltage no more than 25mV peak-to-peak.	Check capacitor C4.
13		Repeat steps 7 through 12 for 150mA regulators A3 and A4.	Same as steps 7 through 12.	Same as steps 7 through 12.

SECTION VI REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts. Table 6-4 lists parts in alpha-numeric order by reference designators and provides the following information:

- a. Reference Designators. Refer to Table 6-1.
- b. Description. Refer to Table 6-2 for abbreviations.
- c. Total Quantity (TQ). Given only the first time the part number is listed except in instruments containing many sub-modular assemblies, in which case the TQ appears the first time the part number is listed in each assembly.
- d. Manufacturer's Part Number or Type.
- e. Manufacturer's Federal Supply Code Number.

Refer to Table 6-3 for manufacturer's name and address.

- f. Hewlett-Packard Part Number.
- g. Recommended Spare Parts Quantity (RS) for complete maintenance of one instrument during one year of isolated service.

h. Parts not identified by a reference designator are listed at the end of Table 6-4 under Mechanical and/or Miscellaneous. The former consists of parts belonging to and grouped by individual assemblies; the latter consists of all parts not immediately associated with an assembly.

6-3 ORDERING INFORMATION

6-4 To order a replacement part, address order or inquiry to your local Hewlett-Packard sales office (see lists at rear of this manual for addresses). Specify the following information for each part: Model, complete serial number, and any Option or special modification (J) numbers of the instrument; Hewlett-Packard part number; circuit reference designator; and description. To order a part not listed in Table 6-4, give a complete description of the part, its function, and its location.

Table 6-1. Reference Designators

A = assembly	E = miscellaneous
B = blower (fan)	electronic part
C = capacitor	F = fuse
CB = circuit breaker	J = jack, jumper
CR = diode	K = relay
DS = device, signaling (lamp)	L = inductor
	M = meter

Table 6-1. Reference Designators (Continued)

P = plug	V = vacuum tube,
Q = transistor	neon bulb,
R = resistor	photocell, etc.
S = switch	VR = zener diode
T = transformer	X = socket
TB = terminal block	Z = integrated circuit or network
TS = thermal switch	

Table 6-2. Description Abbreviations

A = ampere	mod. = modular or modified
ac = alternating current	mtg = mounting
assy. = assembly	n = nano = 10^{-9}
bd = board	NC = normally closed
bkt = bracket	NO = normally open
$^{\circ}$ C = degree Centigrade	NP = nickel-plated
cd = card	Ω = ohm
coef = coefficient	obd = order by description
comp = composition	OD = outside diameter
CRT = cathode-ray tube	p = pico = 10^{-12}
CT = center-tapped	P.C. = printed circuit
dc = direct current	pot. = potentiometer
DPDT = double pole, double throw	p-p = peak-to-peak
DPST = double pole, single throw	ppm = parts per million
elect = electrolytic	pvr = peak reverse voltage
encap = encapsulated	rect = rectifier
F = farad	rms = root mean square
$^{\circ}$ F = degree Fahrenheit	Si = silicon
fxd = fixed	SPDT = single pole, double throw
Ge = germanium	SPST = single pole, single throw
H = Henry	SS = small signal
Hz = Hertz	T = slow-blow
IC = integrated circuit	tan. = tantalum
ID = inside diameter	Ti = titanium
incnd = incandescent	V = volt
k = kilo = 10^3	var = variable
m = milli = 10^{-3}	ww = wirewound
M = mega = 10^6	W = Watt
μ = micro = 10^{-6}	
met. = metal	
mfr = manufacturer	

Table 6-3. Code List of Manufacturers

CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS
56289	Sprague Electric Co.	North Adams, Mass.	91637	Dale Electronics, Inc.	Columbus, Neb.
01295	Texas Instruments, Inc.		19701	Electra/Midland Corp.	Mineral Wells, Texas
	Semiconductor-Components Div.	Dallas, Texas	75042	IRC Div. of TRW, Inc.	Philadelphia, Pa.
71400	Bussmann Mfg. Div. of McGraw & Edison Co.	Orange, N. J.	84048	IRC Div. of TRW,	St. Petersburg, Fla.
04713	Motorola Semiconductor Prod. Inc.	Phoenix, Arizona	12954	Dickson Electronics Corp.	8700 E. Thomas Rd. P. O. Box 1390, Scottsdale, Arizona
02735	Radio Corp. of America, Solid State and Receiving Tube Div.	Somerville, N. J.	28480	Hewlett-Packard Co.	Palo Alto, Calif.
27014	National Semiconductor Corp.	Santa Clara, Calif.	03508	G. E. Semiconductor Products Dept.	Syracuse, N. Y.
01121	Allen Bradley Co.	Milwaukee, Wis.	07716	IRC Div. of TRW, Inc.	Burlington Plant Burlington, Iowa
			75915	Littlefuse, Inc.	Des Plaines, Ill.
			13103	Thermalloy, Co.	Dallas, Texas

Table 6-4. Replaceable Parts, Model 69351B

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
69351B-A6	Voltage Regulator Card					
A6A1	750mA Regulator					
C1, 2	fxd, elect. 1.0 35V	2	150D105X9035A2	56289	0180-0291	1
CR1, 2	diode, Si 200mA 180V	8	1N485B	01295	1901-0033	6
F1, 2	fuse, 1A 125V	3	GMW-1	71400	2110-0047	10
Q1	power, PNP, Si	1	2N3740	04713	1853-0052	1
Q2	power, NPN, Si	1	40250	02735	1854-0224	1
Q3	SS, NPN, Si.	12	2N4141 *	27014	1854-0071	7
Q4, 5	SS, PNP, Si	12	2N2907A	56289	1853-0099	7
Q6	SS, NPN, Si.		2N4141 *	27014	1854-0071	
Q7	SS, PNP, Si		2N2907A	56289	1853-0099	
Q8	SS, NPN, Si.		2N4141 *	27014	1854-0071	
R1, 2	fxd, comp 4.3k 5% 1/2W	2	EB4325	01121	0686-4325	1
R3, 4	fxd, comp 750 5% 1/2W	2	EB7515	01121	0686-7515	1
R5, 6	fxd, comp 1.5k 5% 1/2W	2	EB1525	01121	0686-1525	1
R7, 8	fxd, film 6.2k 1% 1/8W	2	CMF-55-1, T-1	91637	0698-5087	1
R9, 10	fxd, film 4.75k 1% 1/8W	2	MF4C-1	19701	0757-0437	1
R11, 12	fxd, film 600 1% 1/8W	2	MF4C-1	19701	0757-1100	1
R13, 14	fxd, ww, 0.51 5% 2W	2	BWH	75042	0811-0929	1
R15, 16	fxd, film 3k 1% 1/8W	8	MF4C-1	19701	0757-1093	2
R17, 18	var, 1k	8	CT-100-4	84048	2100-1773	2
VR1, 2	diode, zener 9.4V ±2%	2	1N2163A	12954	1902-0763	2
A6A2	150mA Regulator					
C1, 2	fxd, polyester .01μF 200V	6	292P10392-PTS	56289	0160-0161	2

* This commercial transistor type is not an exact replacement for the listed HP part but may be used with a high probability of success.

Table 6-4. Replaceable Parts, Model 69351B (Continued)

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
C3, 4	fxd, elect. 22 μ F 35V	6	150D226X0035R2	56289	0180-0160	2
CR1, 2	diode, Si. 200mA 180V		1N485B	01295	1901-0033	
F1, 2	fuse, 0.25A, 125V	7	GMW-1/4	71400	2110-0089	15
Q1	SS, PNP, Si	3	38640	02735	1853-0041	3
Q2	SS, NPN, Si.	3	2N1711A *	27014	1854-0244	3
Q3	SS, PNP, Si.		2N2907A	56289	1853-0099	
Q4, 5	SS, NPN, Si.		2N4141 *	27014	1854-0071	
Q6	SS, PNP, Si.		2N2907A	56289	1853-0099	
Q7	SS, NPN, Si.		2N4141 *	27014	1854-0071	
Q8	SS, PNP, Si.		2N2907A	56289	1853-0099	
R1, 2	fxd, comp. 1k 5% 1/2W	12	EB1025	01121	0686-1025	3
R3, 4	fxd, film 330 1% 1/8W	6	MF4C-1	19701	0698-5663	2
R5, 6	fxd, comp 10 5% 1/2W	6	EB1005	01121	0686-1005	2
R7, 8	fxd, comp 1k 5% 1/2W		EB1025	01121	0686-1025	
R9, 10	fxd, film 4.32k 1% 1/8W	6	MF4C-1	19701	0757-0436	2
R11, 12	var, 1k		CT-100-4	84048	2100-1773	
R13, 14	fxd, film 3k 1% 1/8W		MF4C-1	19701	0757-1093	
R15, 16	fxd, film 1.21k 1% 1/8W	6	MF4C-1	19701	0757-0274	2
R17, 18	fxd, film 2.37k 1% 1/8W	6	MF4C-1	19701	0698-3150	2
VR1, 2	diode, zener 6.2V	6	1N825	04713	1902-1221	2
A6A3, A6A4	Same as A6A2					
	Mechanical Parts					
	heatsink (A6A1Q1, Q2)	2		28480	5000-9316	
	heat dissipator (A6A2Q1, Q2; A6A3Q1, Q2; A6A4Q1, Q2)	6		28480	1205-0206	
	transistor mounting pad (A6A2Q1, Q2; A6A3Q1, Q2; A6A4Q1, Q2)	6		28480	0340-0453	
	card extractor handle with roll pin	1		28480	5081-4918	
	spare 1A fuse		GMW-1	71400	2110-0047	
	spare 0.25A fuse		GMW-1/4	71400	2110-0089	

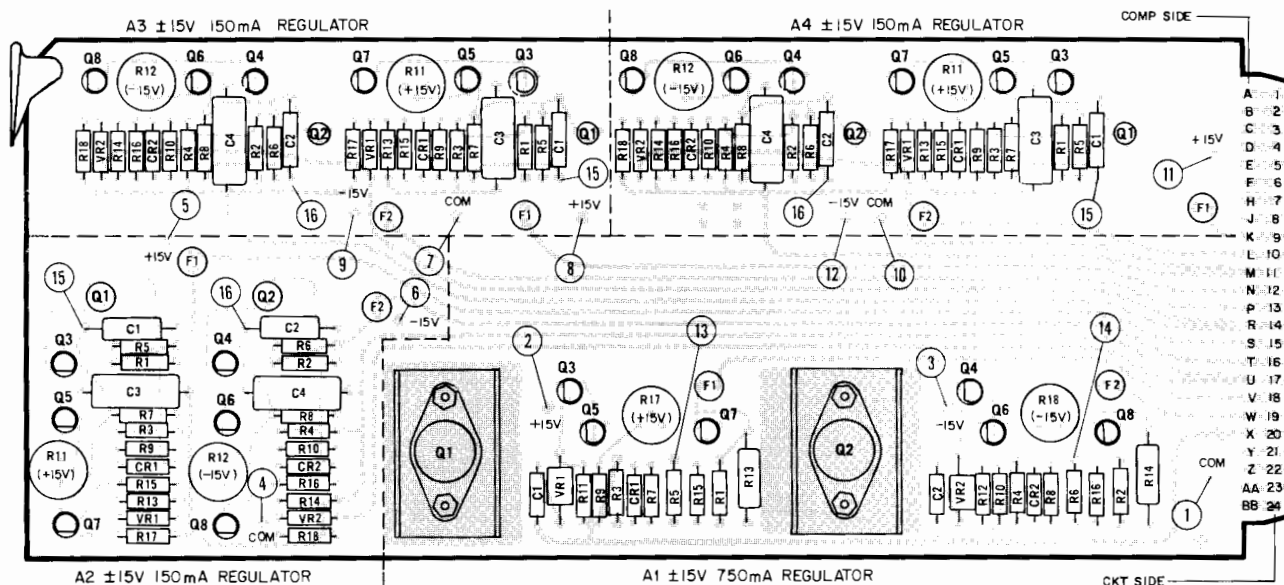
SECTION VII CIRCUIT DIAGRAMS

7-1 COMPONENT LOCATION DIAGRAM

7-2 The drawing below shows the physical locations and reference designations of parts mounted on the printed circuit card.

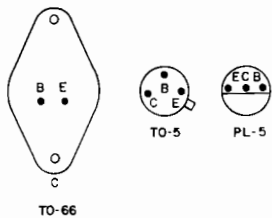
7-3 SCHEMATIC DIAGRAM

7-4 The schematic diagram of the Model 69351B is given in Figure 7-1. The circled test points shown on the schematic correspond to those on the component location diagram.



Model 69351B Voltage Regulator Card, Component Locations

- NOTES**
1. ALL RESISTORS ARE 1/4, 1/8W UNLESS OTHERWISE INDICATED.
 2. ALL CAPACITORS IN MICROFARADS
 3. PIN LOCATIONS FOR TRANSISTORS ARE AS FOLLOWS:



(ALL TOP VIEWS)

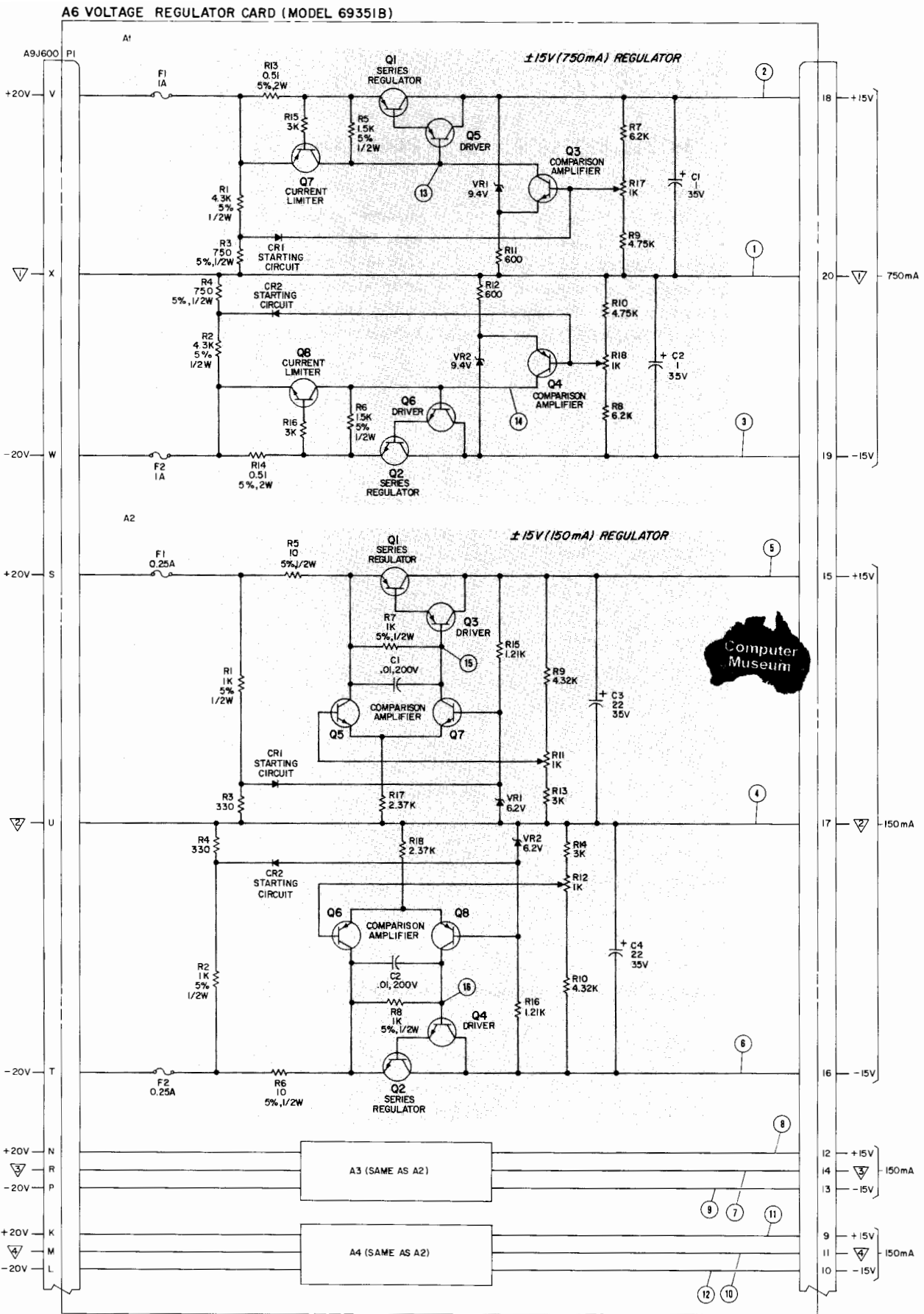


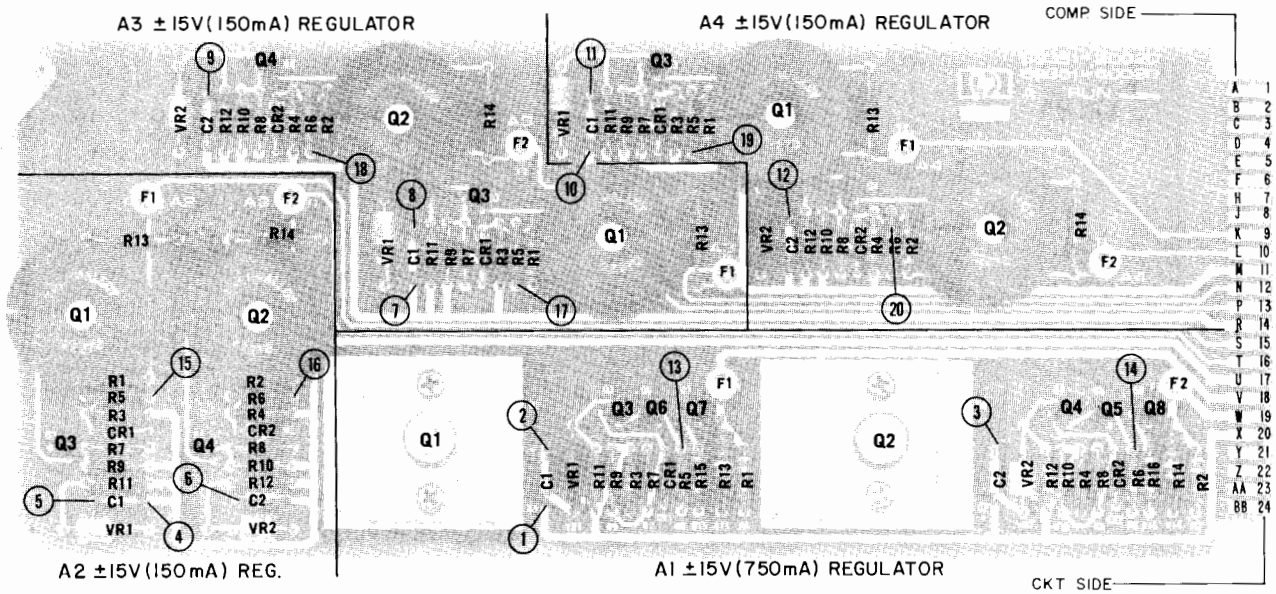
Figure 7-1. Model 69351B Voltage Regulator Card, Schematic Diagram

APPENDIX A MODEL 69351A VOLTAGE REGULATOR CARD

A-1 INTRODUCTION

A-2 This appendix includes a replaceable parts table, a component location diagram, and a circuit schematic for the Model 69351A Voltage Regulator Card. The Model 69351A has been superseded by the Model 69351B to

improve regulation and to provide adjustable output voltages. The maximum ripple of the Model 69351A is 25mV peak-to-peak at any output current within rating. The rated output voltages and currents and the connector pin configurations of the two cards are identical, making both models of voltage regulator cards interchangeable.

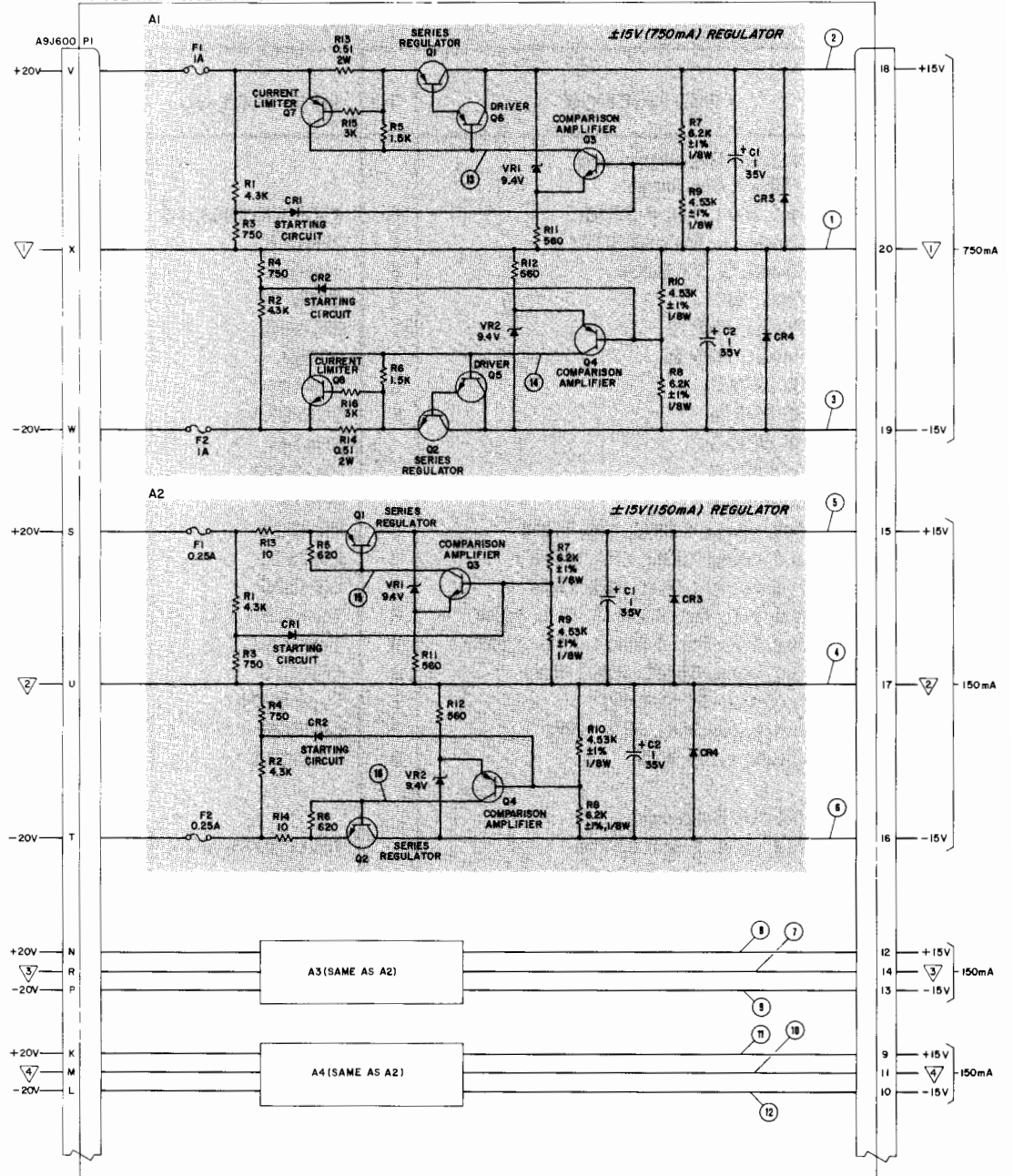
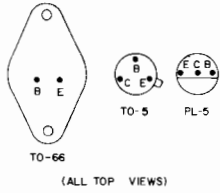


Model 69351A Voltage Regulator Card, Component Locations

A6 VOLTAGE REGULATOR CARD (MODEL 69351A)

NOTES

1. ALL RESISTORS ARE 1/2W, ±5% UNLESS OTHERWISE INDICATED
2. ALL CAPACITORS IN MICROFARADS, UNLESS OTHERWISE INDICATED
3. PIN LOCATIONS FOR TRANSISTORS ARE AS FOLLOWS:



Model 69351A Voltage Regulator Card, Schematic Diagram

Appendix A
Replaceable Parts, Model 69351A

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
69351A-A6 A6A1	Voltage Regulator Card 750mA Regulator					
C1, 2	fxd, elect. 1.0 μ F 35Vdc	8	150D105X9035A2	56289	0180-0291	2
CR1, 2	Diode, Si. 250mW 200V	8	1N485B	01295	1901-0033	6
CR3, 4	Diode, Si. 1A 200V	8	1N5059	03508	1901-0327	6
F1, 2	Fuse, 1A	2	GMW-1	71400	2110-0047	10
Q1	Power, PNP Si	1	2N3740	04713	1853-0052	1
Q2	Power, NPN Si.	1	40250	02735	1854-0224	1
Q3	SS NPN Si.	6	2N4141 *	27014	1854-0071	6
Q4	SS PNP Si.	6	2N2907A	56289	1853-0099	6
Q5	SS NPN Si.		2N4141 *	27014	1854-0071	
Q6, 7	SS PNP Si.		2N2907A	56289	1853-0099	
Q8	SS NPN Si.		2N4141 *	27014	1854-0071	
R1, 2	fxd, comp. 4.3k Ω , \pm 5% 1/2W	8	EB-4325	01121	0686-4325	2
R3, 4	fxd, comp 750 Ω , \pm 5% 1/2W	8	EB-7515	01121	0686-7515	2
R5, 6	fxd, comp 1.5k Ω , \pm 5% 1/2W	2	EB-1525	01121	0686-1525	1
R7, 8	fxd, met. film 6.20k Ω , \pm 1%, 1/8W	8	Type CEA T-0	07716	0698-5087	2
R9, 10	fxd, met. film 4.53k Ω , \pm 1%, 1/8W	8	Type CEA T-0	07716	0698-4443	2
R11, 12	fxd, comp 560 Ω , \pm 5% 1/2W	8	EB-5615	01121	0686-5615	2
R13, 14	fxd, ww, .51 \pm 5% 2W	2	Type BWH	07716	0811-1666	1
R15, 16	fxd, comp 3k Ω , \pm 5% 1/2W	2	EB-3025	01121	0686-3025	1
VR1, 2	Diode, zener 9.4V	8	1N2163A	12954	1902-0763	3
A6A2	150mA Regulator					
C1, 2	fxd, elect. 1.0 μ F 35Vdc		150D105X9035A2	56289	0180-0291	
CR1, 2	Diode, Si. 250mW 200V		1N485B	01295	1901-0033	
CR3, 4	Diode, Si. 1A 200V		1N5059	03508	1901-0327	
F1, 2	Fuse, 1/4A	6	GMW - 1/4	75915	2110-0089	15
Q1	SS PNP Si.	3	38640	02735	1853-0041	3
Q2	SS NPN Si.	3	2N1711A *	27014	1854-0244	3
Q3	SS NPN Si.		2N4141 *	27014	1854-0071	
Q4	SS PNP Si.		2N2907A	56289	1853-0099	
R1, 2	fxd, comp 4.3k Ω , \pm 5% 1/2W		EB-4325	01121	0686-4325	
R3, 4	fxd, comp 750 Ω , \pm 5% 1/2W		EB-7515	01121	0686-7515	
R5, 6	fxd, comp 620 Ω , \pm 5% 1/2W	6	EB-6215	01121	0686-6215	2
R7, 8	fxd, met. film 6.2k Ω , \pm 1% 1/8W		Type CEA T-0	07716	0698-5087	
R9, 10	fxd, met. film 4.53k Ω , \pm 1% 1/8W		Type CEA T-0	07716	0698-4443	
R11, 12	fxd, comp 560 Ω , \pm 5% 1/2W		EB-5615	01121	0686-5615	
R13, 14	fxd, comp 10 Ω , \pm 5% 1/2W	6	EB-1005	01121	0686-1005	2
VR1, 2	Diode, zener 9.4V		1N2163A	12954	1902-0763	
A6A3, A6A4	Same as A6A2					
	MECHANICAL PARTS					
	Heat Sink (A6A1Q1, Q2)	2		28480	5000-9316	
	Heat Dissipator (A6A2Q1, Q2; A6A3Q1, Q2; A6A4Q1, Q2)	6	2227-B	13103	1205-0206	2
	Extractor Handle with Roll Pin	1		28480	5081-4918	
	Shipping Carton, Corrugated	1		28480	9211-0418	

* This commercial transistor type is not an exact replacement for the listed HP part but may be used with a high probability of success.

MANUAL CHANGES
 Model 69351B Voltage Regulator Card
 Manual HP Part No. 69351-90002

Make all corrections in the manual according to errata below, then check the following table for your card's serial number and enter any listed change(s) in the manual.

SERIAL		MAKE CHANGES
Prefix	Number	
1639A	00381-00890	1
1639A	00891-02313	1, 2
1818A	02314-02638	1, 2, 3
1837A	02639- up	1,2,3,4

ERRATA:

On page 3-1, change the second sentence of paragraph 3-8 to read: "All 69370A cards are shipped from the factory with jumpers installed selecting the 150mA 4 supply."

On page 3-2, (Figure 3-2), for the 69370A Current Converter Card, remove the jumpers to supply no. 1 ($\pm 15V$, 750mA) and connect them to supply no. 4 ($\pm 15V$, 150mA) as follows:

Remove From	Connect To
P1-V	P1-K
P1-X	P1-M
P1-W	P1-L

Add the following notice to paragraph 1-13: "Effective December 1, 1975, extra manuals may be obtained by ordering Option 910 when ordering your instrument. The number of extra manuals depends on the number of Option 910's ordered.

CHANGE 1:

All multiprogrammer plug-in cards are now being marked with serial numbers to keep better control of units out in the field. The serials assigned to this model are given in the table. For an explanation of the serial prefix, see paragraph 1-44 in the multiprogrammer mainframe manual.

ERRATA:

Model 69321B D/A Converter Cards have an increased power requirement beginning with card serial 1708A-01291. Change Fig. 3-2 to show a loading of 75mA on the +15V input and 35mA on the -15V input for these newer cards. Also change the first two sentences of par. 3-6 to: Up to ten 69321B cards can be powered from the 750mA supply, and up to two cards can be powered from each of the 150mA supplies.

CHANGE 2:

In the parts list and on the Fig. 7-1 schematic, change voltage trimmers A1R17 and A1R18 to 2k ohms, 5%, HP Part No. 2100-1774.

ERRATA:

In the parts list, delete the packing carton or corrugated tray listed and add the part number of the carton with foam liner now used for shipping multiprogrammer cards. Its number is 9211-2603.

CHANGE 3:

Change resistor - trimmers A1R17, A1R18 to 2k, 10%, HP Part No. 2100-0567.

Change resistor - trimmers A1-A4R11, A2-A4R12 to 1k, 10%, HP Part No. 2100-3211.

► CHANGE 4:

Change zener diodes A1VR1 and A1VR2 to 9V, HP Part No. 1902-0785. Changed fixed resistor A1R11 and A1R12 to 787 Ω , 1/8W, HP Part No. 0698-4014.

9-27-78

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