Heathkit® Manual

for the

TRI-POWER SUPPLY

Model IP-2718

595-1840-07

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

TABLE OF CONTENTS

PARTS LIST

Check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for.

The key numbers correspond to the numbers on the "Parts Pictorial" in the separate "Illustration Booklet."

Each circuit part in this kit has its own "Circuit Component Number" (R1, C11, D21, etc.). This is a specific number for only that one part. The purpose of these numbers is to help you easily identify the same part in each section of the Manual. These numbers will appear:

- In the Parts List.
- At the beginning of each step where a component is installed.
- In some illustrations.
- In the sections at the rear of the Manual.

To order a replacement part: Always include the PART NUMBER. Use the Parts Order Form furnished with the kit. If one is not available, see "Replacement Parts" inside the rear cover of the Manual. Your Warranty is located inside the front cover. For price information, refer to the separate "Heath Parts Price List."

RESISTORS

1/2-Watt Resistors

Notes:

1. All resistors are 10% tolerance unless otherwise noted.
2. A fourth color band of silver indicates 10% tolerance; a fourth band of gold indicates 5% tolerance.
3. The resistors may be packed in more than one envelope. Open all the resistor envelopes in this pack before you check them against the Parts List.

KEY No.	PART No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-470	2	47Ω (yellow-violet-black)	R5, R6
A1	6-391	2	390Ω (orange-white-brown)	R115, R215
A1	6-471	4	470Ω, 5% (yellow-violet-brown)	R108, R117, R208, R217
A1	6-821	2	820Ω (gray-red-brown)	R104, R204

Resistors (cont'd.)

KEY No.	PART No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-202	4	2000 Ω, 5% (red-black-red)	R111, R112, R211, R212
A1	6-242	2	2400 Ω, 5% (red-yellow-red)	R119, R219
A1	6-392	2	3900 Ω (orange-white-red)	R103, R203
A1	6-472	2	4700 Ω (yellow-violet-red)	R102, R202
A1	6-103	2	10 kΩ (brown-black-orange)	R114, R214
A1	6-333	6	33 kΩ (orange-orange orange)	R101, R118, R121, R201, R218, R221
A1	6-473	1	47 kΩ (yellow-violet-orange)	R1
A1	6-623	2	62 kΩ, 5% (blue-red-orange)	R122, R222

1-Watt Resistors

KEY No.	PART No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A2	6-102-1	2	1000 Ω (brown-black-red)	R106, R206
A2	1-19-1	1	220 Ω (red-red-brown)	R2
A2	1-56-1	2	1200 Ω (brown-red-red)	R113, R213
A2	1-22-1	2	1500 Ω (brown-green-red)	R105, R205

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Precision Resistors				
A3	2-94	1	0.1 Ω, 1%, 1/2-watt	R4
A4	6-1500-12	1	150 Ω, 1%, 1/4-watt (brown-green-black-black-brown)	R3
A4	6-5550-12	2	555 Ω, 1%, 1/4-watt (green-green-green-black-brown)	R107, R207
A4	6-5001-12	2	5000, 1%, 1/4-watt (green-black-black-brown-brown)	R124, R224
A4	6-5491-12	1	5490, 1%, 1/4-watt (green-yellow-white-brown-brown)	R12
A4	6-1222-12	2	12.2 kΩ, 1%, 1/4-watt (brown-red-red-red-brown)	R123, R223
A4	6-1992-12	2	19.9 kΩ, 1%, 1/4-watt (brown-white-white-red-brown)	R11, R13
Other Resistor				
A5	3-8-1	2	1.1 Ω, 1-watt, 3%, wire-wound	R109, R209
CONTROLS				
B1	10-918	2	500Ω	R116, R216
B2	10-281	1	10 kΩ	R7
B3	12-156	1	Dual 10 kΩ control	R8, R9
CAPACITORS				
Disc Capacitors				
C1	21-9	2	100 pF	C106, C206
C1	21-173	1	.0022 μF	C3
C1	21-72	1	.005 μF, 1.4 KV	C1
C1	21-16	3	.01 μF	C5, C6, C7
C1	21-48	2	.05 μF	C107, C207
C1	21-99	1	.2 μF	C4
Electrolytic Capacitors				
C2	25-283	4	10 μF	C105, C109, C205, C209
C2	25-868	4	47 μF, 50 V	C104, C108, C204, C208
C3	25-883	2	47 μF vertical electrolytic	C102, C202
C4	25-878	2	2200 μF	C103, C203
C5	25-822	1	12000 μF	C2
Mylar* Capacitor				
C6	27-47	2	.1 μF Mylar	C101, C201

*Registered Trademark, DuPont Corp.

KEY No.	PART No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
DIODES-TRANSISTORS-INTEGRATED CIRCUIT				
Diodes				
D1	56-637	2	Zener diode (6.8V)	ZD109, ZD209
D1	56-50	2	DO-7 zener diode	ZD104, ZD204
D1	56-57	2	1N716A zener diode	ZD108, ZD208
D1	57-42	2	3A1 diode	D1, D2
D1	57-65	14	1N4002 diode	D101, D102, D103, D105, D106, D107, D110, D201, D202, D203, D205, D206, D207, D210
Transistors and Integrated Circuit				
D2	417-201	4	X29A829 transistor	Q102, Q106, Q202, Q206
D2	417-258	4	TIS87 transistor	Q107, Q108, Q207, Q208
D2	417-294	2	MPSA42 transistor	Q103, Q203
D2	417-801	6	MPSA20 transistor	Q101, Q104, Q105, Q201, Q204, Q205
D3	417-282	2	MJ2841 transistor	Q1, Q2
D3	442-30	1	UA309K integrated circuit (IC)	IC1
SWITCHES-KNOBS-INSERTS				
E1	60-2	2	Slide switch	SW1, SW3
E2	60-54	1	Line switch	SW2
E3	63-1257	1	Rotary switch	SW4
E4	462-363	1	Red knob	
E5	462-361	1	Round knob (with center hole)	
E6	462-920	2	Round knob	
E7	455-52	1	Short knob insert	
E8	455-51	1	Small-center knob insert	
E9	455-619	2	Large-center knob insert	

NOTE: Transistors and integrated circuits may be marked for identification in any of the following four ways:

1. Part number.
2. Type number (on integrated circuits, this refers only to the numbers; the letters may be different or missing).
3. Part number and type number.
4. Part number with a type number other than the one listed.

HEATHKIT®

KEY No.	PART No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.

PLASTIC PARTS-INSULATORS

F1	75-17	6	Black binding post base
F1	75-197	6	Red binding post base
F1	75-198	1	Green binding post base
F2	73-47	1	1" × 1" foam pad
F3	75-52	1	Switch insulator
F4	75-60	3	Transistor insulator (between two pieces of cardboard)
F5	75-142	3	Transistor cover
F6	75-734	3	Circuit board mount
F7	75-736	1	Strain relief
F8	100-16-2	3	Black binding post cap
F8	100-16-18	3	Red binding post cap
F8	100-699	1	Green binding post cap
F9	261-34	4	Foot
F10	354-7	2	Capacitor tie
F11	413-10	1	Red lens

METAL PARTS

G1	90-1168-1	1	Cabinet top
G2	200-1257-1	1	Chassis
G3	204-2162	1	Meter bracket
G4	207-612	1	Capacitor clamp
G5	215-84	2	Heat sink
G6	427-3	7	Binding post
G7	259-10	1	Control solder lug

HARDWARE

NOTE: Hardware packets are marked to show the size of the hardware they contain (HDW #4, or, HDW #2 & #6, etc.). You may have to open more than one packet — in this pack — to locate all the hardware of any one size (#6, for example). (Hardware is shown actual size.)

#6 Hardware

H1	250-369	6	#6 × 1/4" black sheet metal screw
H2	250-381	9	6-32 × 3/8" black screw
H3	250-162	14	6-32 × 1/2" screw
H4	252-3	24	6-32 nut
H5	254-1	17	#6 lockwasher
H6	254-6	1	#6 external lockwasher
H7	259-1	8	#6 solder lug
H8	254-27	1	Binding post lockwasher

KEY No.	PART No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.

Other Hardware

J1	250-330	4	10-32 × 3/8" screw
J2	252-5	4	10-32 nut
J3	254-3	4	#10 lockwasher
J4	252-7	3	Control nut
J5	253-10	3	Control flat washer
J6	254-4	5	Control lockwasher
J7	252-32	1	Push-on nut

WIRE HARNESS-WIRE-SLEEVING

134-951	1	Wire harness
344-2	36"	Black stranded wire
344-3	6"	Red stranded wire
344-50	30"	Solid black wire
344-52	19"	Solid red wire
346-1	8"	Sleeving
89-54	1	Line cord

MISCELLANEOUS

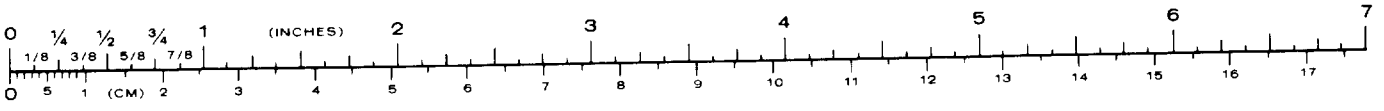
	54-918	1	Power transformer	T1
	85-1750-3	1	Circuit board	
	407-718	1	Meter	M1
K1	412-15	1	Neon lamp	PL1
K2	421-1	1	1-1/2-ampere fuse	F1
K3	352-13	1	Silicone grease	
K4	422-1	1	Fuseholder	
K5	431-5	1	4-lug terminal strip	
K6	434-336	3	Transistor socket	
K7	490-5	1	Nut starter	
			Solder	

PRINTED MATERIAL

K8	391-34	1	Blue and white label

NOTE: Be sure you refer to the numbers on the blue and white label in any communications you may have about this kit with Heath Company. You may want to write the model and series numbers in this sample for future convenience.

K9	390-1255	1	Fuse label
	597-260	1	Parts Order Form
		1	Technical Correspondent letter
		1	Assembly Manual (See front cover for part number.)



TESTS AND ADJUSTMENTS

Refer to Figure 1 (In the "Illustration Booklet") and study the descriptions and functions of the front panel controls.

NOTES:

1. Do not apply power to the Tri-Power Supply until you are instructed to do so.
2. Power leads or cables are not supplied with your kit; you may wish to assemble several short jumper leads with banana plugs on both ends, as well as longer leads, to apply the output power from the Supply to other equipment.
3. A volt-ohmmeter is required for the following tests and adjustments.
4. If, during the following resistance and voltage tests, you do not obtain the desired results, refer to the "In Case of Difficulty" section of the Manual, starting on Page 40.

RESISTANCE TESTS

( ) Connect the ohmmeter common lead to the front panel green binding post (chassis gnd).

( ) Using the positive ohmmeter lead, check each of the six red and black front panel binding posts. Each of these measurements must be 1 megohm or greater.

( ) Refer to Figure 2 (in the "Illustration Booklet"). Using the positive meter lead, check the collector (C) of transistors Q1 and Q2 and the case (C) of IC1. Each of these measurements must exceed 1 megohm.

( ) Using the positive meter lead, check both **flat** prongs on the line cord plug. Each reading must exceed 10 megohms with the POWER switch ON and with the switch OFF.

( ) In the same manner, check the large, round prong on the line cord plug. The reading must indicate 0 (zero) on the ohmmeter.

( ) Disconnect the common ohmmeter lead from the chassis ground post.

( ) One at a time, connect the ohmmeter common lead to each of the front panel black binding posts. Check each of the remaining two black binding posts with the positive meter lead. In each case, the ohmmeter reading should exceed 1 megohm.

( ) In the same manner, connect the ohmmeter common lead to each of the front panel red binding posts. Check the two remaining red binding posts with the ohmmeter positive lead. In each case, the ohmmeter readings must exceed 1 megohm.

VOLTAGE TESTS

( ) Refer to Figure 2 and turn controls R116 and R216 (on the top of the circuit board) to the centers of their rotation.

( ) Refer to the inset drawing on Figure 1. On the underside of the chassis, using the tip of a screwdriver, set Line switch SW2 so the exposed numbers agree with the voltage in your area; either "120" or "240."

( ) Refer to Figure 1 and preset the front panel controls as follows:

1. METER switch to A VOLTS.
2. SUPPLY A control fully counterclockwise.
3. Both inner and outer controls, ○ SUPPLY B and ● A TRACKING B, fully counterclockwise.
4. MODE SWITCH to INDEPENDENT.
5. POWER switch OFF.

NOTE: When you apply power to the Tri-Power Supply in the following step, carefully watch for any symptoms of trouble. These may be indicated by an erratic movement of the meter, some unusual noise, or indications of excessive heat. Should any of these occur, immediately turn the POWER switch OFF, remove the line cord from the AC outlet, and then refer to the "In Case of Difficulty" portion of the Manual on Page 40.

( ) Plug the line cord into an AC outlet.

( ) Turn the POWER switch ON. At this time, the meter pointer should indicate zero and the pilot light should glow.

WARNING: Avoid touching any components or leads in the "High Voltage" areas as shown in Figure 10 on Page 41.

( ) Turn the METER switch counterclockwise to each of the following positions; note the meter reading at each position:

Set METER Switch To:	Meter Reading
A AMPS	0 (Zero)
B VOLTS	0 (Zero)
B AMPS	0 (Zero)
5V VOLTS	5 (plus or minus 1/4 volt)
5V AMPS	0 (Zero)

( ) Set the METER switch to A VOLTS.

( ) Slowly turn the SUPPLY A control clockwise as you observe the meter. The meter pointer should move upscale.

( ) Turn the SUPPLY A control fully counterclockwise.

( ) Set the METER switch to B VOLTS.

( ) Slowly turn the dual ○ SUPPLY B / ● A TRACKING B dual controls clockwise as you observe the meter. The meter pointer should move upscale.

( ) Turn the dual controls fully counterclockwise.

( ) Set the METER switch to A VOLTS.

( ) Set the MODE switch to TRACKING.

( ) Slowly turn the dual control knobs clockwise as you observe the meter. The meter pointer should move upscale.

( ) Turn the dual controls fully counterclockwise.

( ) Turn the dual control knobs to obtain a 1-volt indication on the meter 0-20 volt scale.

( ) Set the METER switch to A AMPS.

( ) Briefly short the OUTPUT A negative (−) black binding post to the positive (+) red binding post as you observe the meter. The pointer should move upscale to indicate greater than 5 on the lower meter scale.

( ) Set the METER switch to B AMPS.

( ) Briefly short the OUTPUT B negative (−) and positive (+) binding posts together as you observe the meter. The pointer should move upscale to indicate greater than 5 on the lower meter scale.

( ) Set the METER switch to 5V AMPS.

( ) Briefly short the 5 VOLT SUPPLY negative (−) and positive (+) binding posts together as you observe the meter. The meter pointer should indicate a lower scale reading of more than 1.5 amperes, and the pointer may even go to its upper limit. NOTE: If this short between the binding posts is held for a short period of time, the pointer will begin to drift downward.

( ) Set the POWER switch to OFF.

CALIBRATION

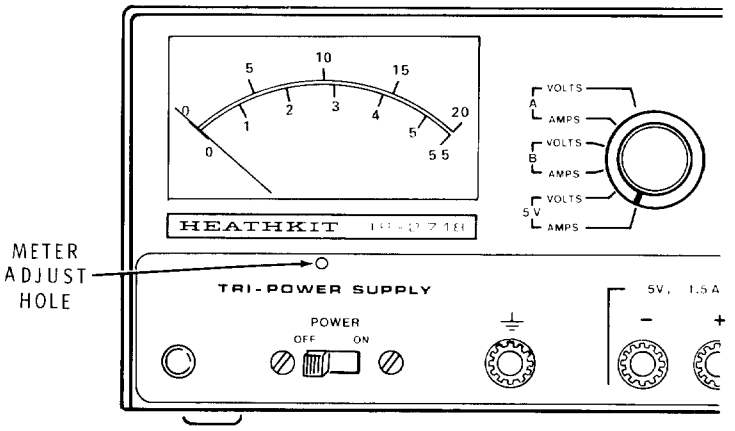


Figure 3

( ) Preset the front panel controls and switches as follows:

METER switch: B VOLTS.

SUPPLY A control: Fully clockwise.

SUPPLY B and A TRACKING B controls: Fully clockwise.

MODE switch: TRACKING.

NOTE: Refer to Figure 3 and perform the following step only if the meter pointer is **not** directly over the "0" (zero) on the meter scale.

( ) Locate the small hole in the front panel, directly under the center of the meter. Using a small screwdriver, carefully and slowly turn the small meter adjust screw through the small hole until the pointer is positioned directly over the "0" at the left side of the meter scale.

( ) Set the POWER switch to ON.

( ) Refer to Figure 2 and adjust circuit board control R216 until the pointer is directly over "20" on the upper meter scale.

( ) Turn the METER switch to A VOLTS.

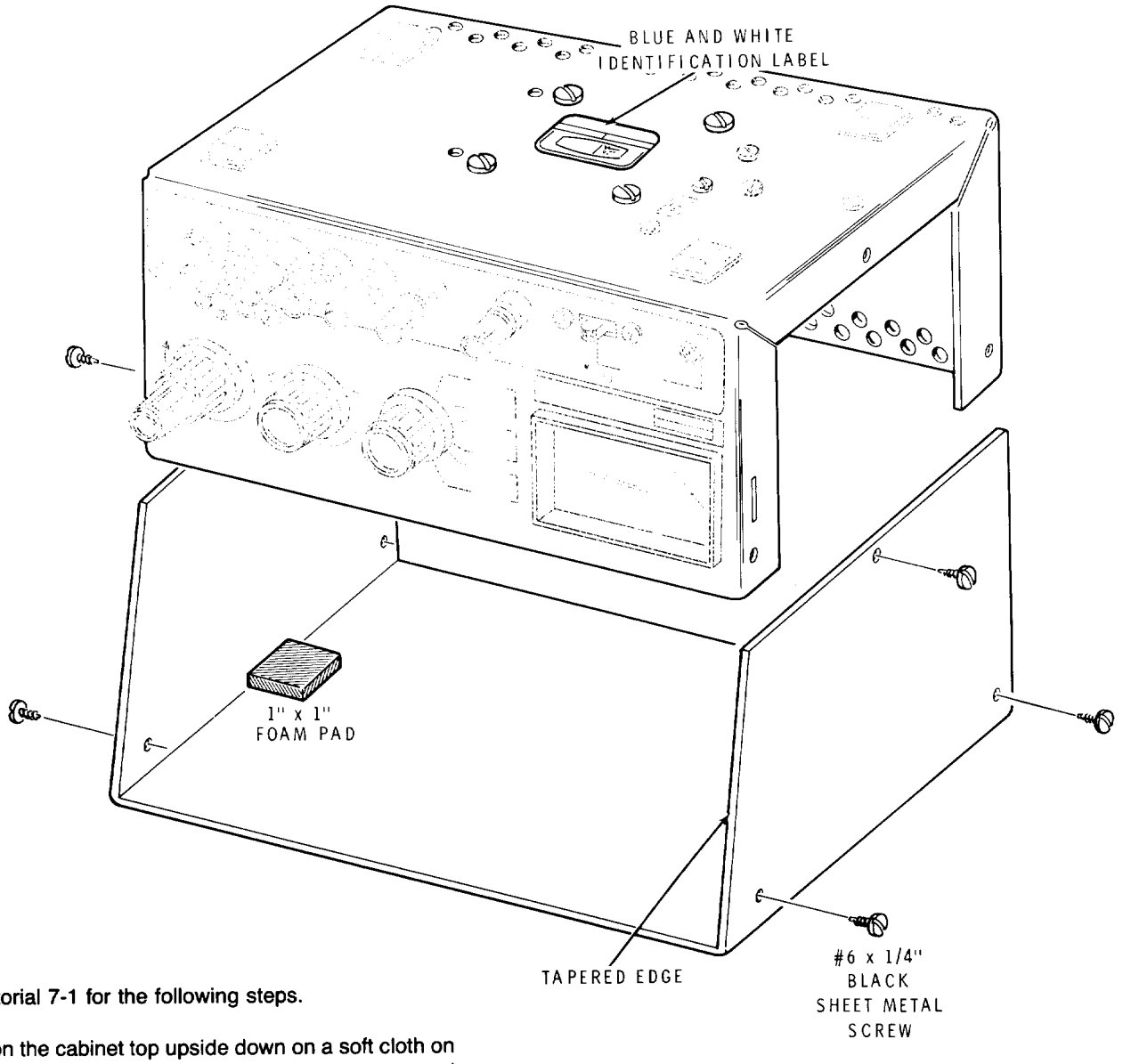
( ) On the circuit board, adjust control R116 until the pointer is directly over "20" on the upper meter scale.

( ) Set the Mode switch to INDEPENDENT. The pointer should now indicate between 19 and 21 on the upper scale.

( ) Turn the POWER switch OFF and remove the line cord plug from its socket.

This completes the "Calibration" of your Power Supply.

FINAL ASSEMBLY



PICTORIAL 7-1

Refer to Pictorial 7-1 for the following steps.

( ) Position the cabinet top upside down on a soft cloth on your work area so the tapered front edges are toward you.

( ) Remove the paper backing from the 1" × 1" foam pad and press the pad in place on the underside of the cabinet top. Center the pad from front to rear, close to the left side as shown in the Pictorial.

( ) Turn the chassis assembly upside down and position it downward into the inverted cabinet top. Then secure the top to the chassis with six #6 × 1/4" black sheet metal screws.

( ) Remove the paper backing from the blue and white label and press the label in place on the underside of the chassis as shown. NOTE: Refer to the model and series numbers on the blue and white label in any correspondence you have with the Heath Company about this kit.

This completes the assembly of your Tri-Power Supply.

OPERATION

Refer to Figure 1 in the "Illustration Booklet."

Before you use your Tri-Power Supply, you should become entirely familiar with its capabilities, characteristics, and its features. Study Figure 1 to learn each control and switch function as you read this portion of the Manual.

CONTROL AND SWITCH FUNCTIONS

LINE AND POWER SWITCHES (SW2 and SW1)

Line switch SW2 is located on the underside of the chassis. If the line voltage in your area is 100-135 volts AC, use a screwdriver tip to push the switch slide to expose the "120" on the slide. If the line voltage in your area is 200-270 volts AC, push the switch slide to expose the "240."

The POWER switch on the front panel is a simple slide switch that applies the line voltage to the primary circuit of the power transformer when you push the switch to the ON position. At the same time, power is applied to the pilot light to indicate that power has been applied to the unit.

METER SWITCH (SW4)

It is important that you know that METER switch (SW4) does **not** switch any output voltage or current. The switch permits you to observe any of the Power Supply outputs on the meter, whether voltage or current. The METER switch thus allows you to monitor any of the variable outputs and to set them accurately to any desired levels.

METER

Note that the meter scales are printed in two colors. The lower scale, in red, corresponds to each of the METER switch functions that also are lettered in red: "A-AMPS" (current flowing to a load from the output of the A supply); "B-AMPS" (current flowing to a load from the output of the B supply); and, "5V-VOLTS" (the voltage available at the output of the 5-volt supply).

The upper meter scale, in black, corresponds to the following METER switch functions, also printed in black: "A-VOLTS" (the voltage at the output of the A supply); "B-VOLTS" (the voltage at the output of the B supply); and, "5V-AMPS" (current flowing to a load from the output of the 5-volt supply).

SUPPLY A CONTROL (R7)

When you turn this control clockwise from its "0" position, the output of front panel jacks J4 and J5 (OUTPUT A) will increase from zero to any level up to 20 volts and a load current up to 500 milliamperes. Read these levels on the meter when the METER switch is either at "A-VOLTS" or at "A-AMPS." NOTE: In the TRACKING mode of operation, Supply A control R7 is disabled; control of the 20-volt A-supply is transferred to • A TRACKING B control R8 (the small red knob at the right side of the front panel, which operates as a clutched control with ○ SUPPLY B control R9).

○ SUPPLY B CONTROL (R9)

Control R9 is half of the dual control at the right side of the front panel. The other half of this control is turned with the small red knob and is labeled "• A TRACKING B" in red lettering above the two control knobs. The two controls are "clutched" together so that both controls will turn when either knob is turned. Note that black knob R9 corresponds to the black letters ("○ SUPPLY B") on the panel just above the control.

Control R9 adjusts the voltage at OUTPUT B jacks J6 and J7. This control will vary the B supply voltage from zero to 20 volts DC and a load current up to 500 milliamperes. Read the output levels on the meter when the METER switch is turned to B-VOLTS and to B-AMPS.

• A TRACKING B CONTROL (R8)

Control R8 is "clutched" to "O SUPPLY B" control R9. At any time either control is turned, the other will turn with it. Since it is a friction action, either control may be operated independently of the other, providing the other control is grasped and held in place. Control R8 is enabled only when MODE switch SW3 is in the TRACKING position. In this manner, the A 20-volt supply is disabled at SUPPLY A control R7, and is controlled by the small red knob at R8. At no time are the electrical and electronic circuits of the A and B 20-volt power supplies connected together internally.

MODE SWITCH (SW3)

In the INDEPENDENT mode of operation, the 20-volt A supply is connected to SUPPLY A control R7 through the contacts of the Mode switch. In this mode, control R9 (small red knob) is disconnected from the circuit. When MODE switch SW3 is in the TRACKING mode, control R7 is removed from the circuit, and control R9 is enabled and the A-supply will track with the B-supply through the clutch action of the dual control knobs.

OUTPUT JACKS (J1-J7)

Output jack J1 is a chassis ground connection. If, at any time, you wish to reference any of the three supplies to ground, external connections from the appropriate supply jacks may be connected to J1.

Jacks J2 and J3 are the connections for the fixed 5-volt, 1.5-ampere power supply.

Jacks J4 and J5 are the connections for the variable 20-volt, 500 milliampere A power supply.

Jacks J6 and J7 are the connections for the variable 20-volt, 500 milliampere B power supply.

OPERATING PROCEDURES

Two modes of operation are provided at the output jacks on the front panel. These are the "Independent" and the "Tracking" modes. Each will be discussed under separate headings.

INDEPENDENT MODE

Each of the three power supplies in the Tri-Power supply may be operated independently from one another, either floating or referenced to another AC or DC source, or referenced to the Tri-Power Supply ground connection at J1. In addition, any of the separate supplies may be connected in series with external jumpers to provide up to 45 volts DC, referenced to any external or internal level. NOTE: External references may not exceed 200 volts.

TRACKING MODE

In the TRACKING mode of operation, the 20-volt A and B supplies are clutched together at the front panel dual control R8/R9. As either of the controls is turned, the other will turn in the same manner. To adjust the controls, the voltage output must be observed on the meter for each 20-volt supply, and the level of each set by controls R8 and R9. For example, if you wish to have the A-supply referenced 5 volts greater than the variable B-supply, you should proceed as follows: Turn dual controls R8 and R9 fully counterclockwise. Grasp the black knob at R9 and turn it until some voltage is read on the meter. Then, as you hold the black knob, turn the small red knob on R8 until A-VOLTS on the meter indicates +5 volts more than shown for the B supply. Release the red knob. As you turn the black knob, the A supply voltage will track the B supply voltage, always at a potential of 5 volts (±5%) higher than produced by the B supply.

In the TRACKING mode, the A and B supplies may be operated as a tracking pair of output voltages, referenced to a voltage not exceeding 200 volts. As in the INDEPENDENT mode, the three supplies may be connected as any combination in series, to supply up to 45 volts total, at any desired reference.

APPLICATIONS

The following sections of the Manual will show you a number of examples of how you can use your Power Supply. The variety of uses is extensive, however, so only a few examples are given.

NOTE: Since 5 volts is used extensively in TTL logic applications, it is incorporated into the Tri-Power Supply as a fixed output. This 5 volts DC may be referenced to any other voltage up to 200 volts, or to the Power Supply front panel GND jack at J1.

INDEPENDENT MODE APPLICATIONS

INDEPENDENT FLOATING SUPPLIES

Refer to Figure 4 as you read the following information.

Figure 4 illustrates each of the three Power Supply outputs connected to separate loads. Each of the supplies may be floated at a level up to 200 volts from ground, or from each other. In this example; the MODE switch is at INDEPENDENT, SUPPLY A control R7 controls the output level of one 0-20 volt circuit, and SUPPLY B (black) control R9 controls the output of the other 0-20 volt circuit.

Each of the supplies has fixed current limiting in all modes of operation at slightly above the rated current output. This provides short-circuit protection to the Power Supply.

NOTE: Each circuit output has a .01 μF capacitor connected from its negative terminal to chassis ground. This must be taken into consideration with many applications; such as where earth (power line) ground loops might be a problem, or where the Power Supply is used for floating operation in high-impedance circuits.

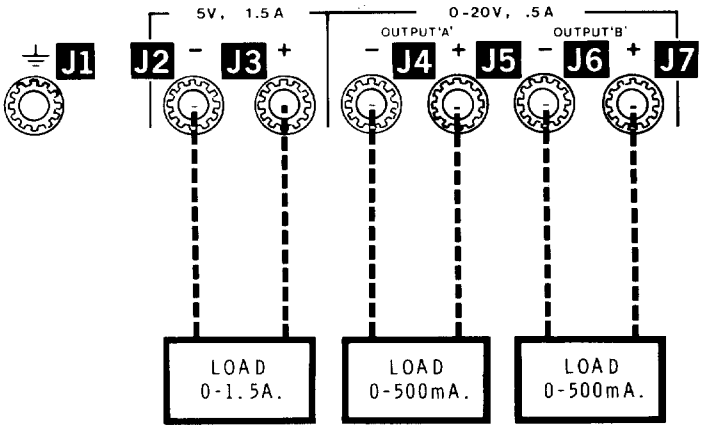


Figure 4

INDEPENDENT GROUND-REFERENCED SUPPLIES

Any of the output terminals, whether + or − may be connected to ground, and in any combination. The following chart lists many of the possible voltage combinations using chassis ground as a reference.

5-Volt Supply	A-Supply	B-Supply
+5 volts, fixed	0 to +20 volts	0 to +20 volts
+5 volts, fixed	0 to +20 volts	0 to −20 volts
+5 volts, fixed	0 to −20 volts	0 to +20 volts
+5 volts, fixed	0 to −20 volts	0 to −20 volts
−5 volts, fixed	0 to +20 volts	0 to +20 volts
−5 volts, fixed	0 to +20 volts	0 to −20 volts
−5 volts, fixed	0 to −20 volts	0 to +20 volts
−5 volts, fixed	0 to −20 volts	0 to −20 volts

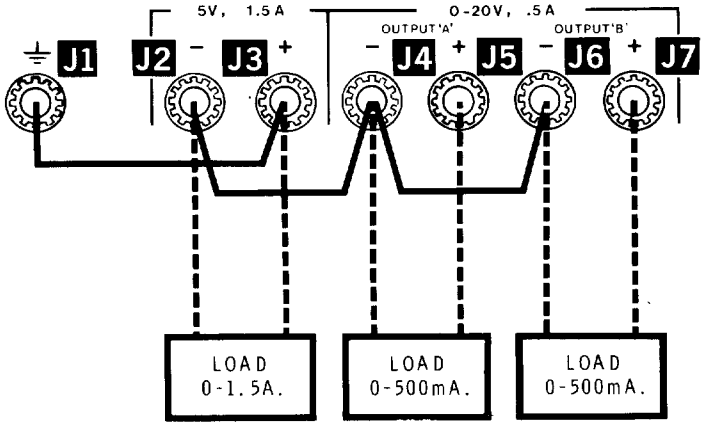


Figure 5

Figure 5 illustrates an example of a circuit in which the +5 volt terminal is referenced to ground, and both the 0 to +20-volt A and B supplies are referenced to −5 volts. Thus, each of the positive-going 20-volt supplies can be varied from −5 to +15 volts (+20 volts, overall).

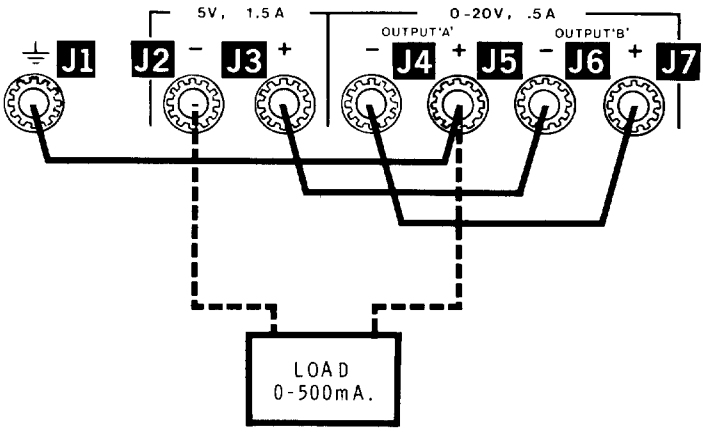


Figure 6

Figure 6 is an example of a circuit in which the three outputs of the circuit are connected in series, with a ground reference at the high end of the circuit. Thus the output to the load is variable from −5 to −45 volts. Load current is limited to 500 mA by the A and B-supply limiters.

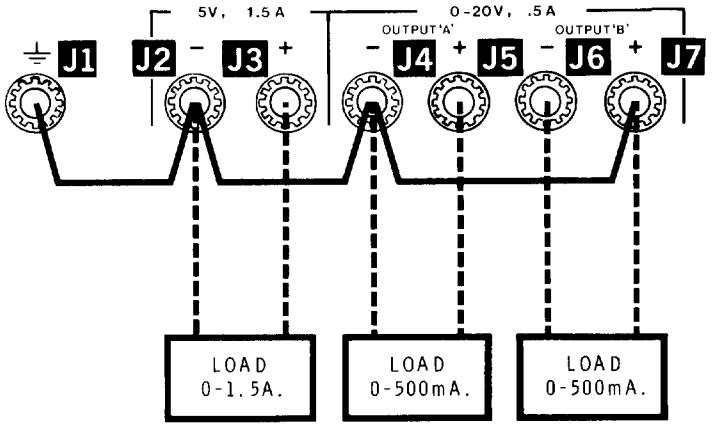


Figure 7

Figure 7 illustrates the Tri-Power Supply connected to produce separate outputs of +5 volts, fixed, the A-supply variable from 0 to +20 volts, and the B-supply variable from 0 to −20 volts.

TRACKING MODE APPLICATIONS

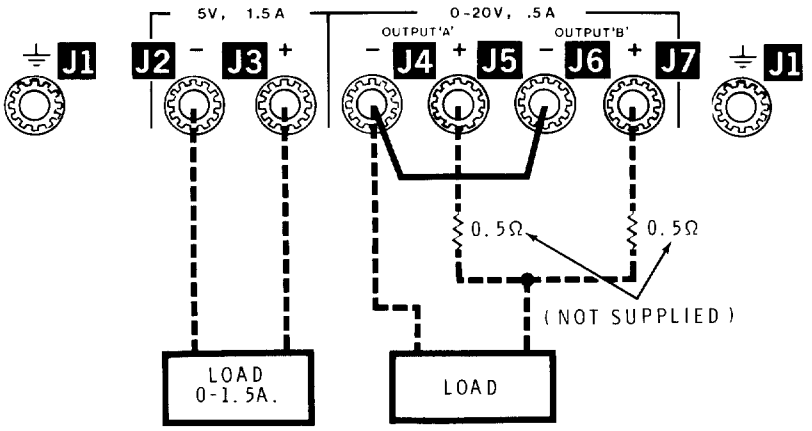


Figure 8

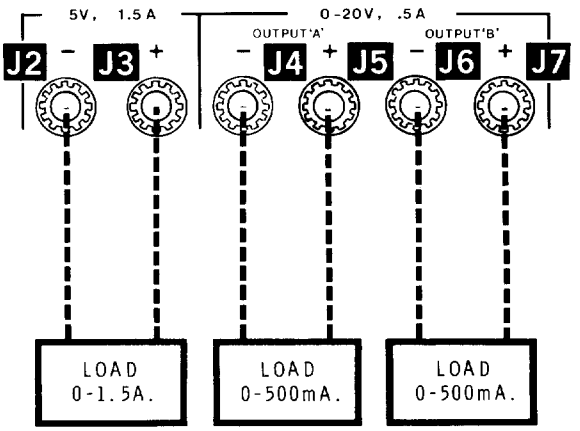


Figure 9

NOTE: In the Tracking Mode of operation, as previously described, A-supply control is clutched to the B-supply control at R8/R9.

PARALLEL OPERATION

The purpose of connecting the two 20-volt power supplies in parallel is to provide higher current through the load. Figure 8 shows a typical Power Supply-to-load connection in which up to 1 ampere of current is available to the load. Note that 0.5 ohm current-sharing resistors (not supplied) are used in the output connections. The output voltage of the circuit is reduced by the IR voltage drop across these equalizing resistors. Each supply is short-circuit and overload protected; either 20-volt supply may current-limit slightly before the other.

TRACKING-FLOATING CIRCUITS

NOTE: Each of the three power supplies is connected to a separate load as shown in Figure 9. Each supply is floating, and independent of reference levels. In this configuration, the MODE switch must be in TRACKING to produce the following outputs: 5 volts, fixed and floating, B-supply 0 to +20 volts floating with the A-supply output floating, and tracking the B supply at any predetermined voltage differential. To create a tracking ± supply, the A+ terminal may be connected to the B− terminal, for example. The Power Supply may be wired in any manner of series connections of A, B, and 5-volt outputs in the Tracking Mode.

IN CASE OF DIFFICULTY

This part of the Manual will help you locate and correct any difficulty which might occur in your Power Supply. The information is divided into three sections. The first section "General," contains suggestions of a general nature in the following areas:

A. Visual checks and inspection.

B. Bench-testing precautions.

C. Repair techniques.

The second section consists of a "Troubleshooting Chart." It calls out specific problems that may occur and lists one or more conditions or components that could cause each difficulty. Capacitor C-numbers, transistor Q-numbers, etc., are identified in this chart by the same numbers that are used on the Schematic diagram. A "Circuit Board X-Ray View" (on Page 48) is also provided to help you locate the components. Refer to the "Chassis Assembly" steps to locate chassis-mounted parts.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

GENERAL

VISUAL CHECKS

1. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many difficulties by a careful inspection of connections to make sure they are soldered as described in the "Soldering" section of the "Assembly Notes" on Page 6 of this Manual. Reheat any doubtful connections and be sure all the wires are connected.

2. Check the circuit board to be sure there are no solder bridges between adjacent connections. Remove any solder bridges that may exist. Compare the circuit board foil pattern with the "Circuit Board X-Ray View" on Page 48.

3. Be sure each transistor and integrated circuit is in the proper location (correct part number and type number). Be sure that each transistor lead is positioned properly and has a good solder connection to the foil. Check the integrated circuit for proper positioning and good connections.

4. Check capacitor values carefully. Be sure the proper part is wired into the circuit at each capacitor location. For example, it would be easy to mistake a .001 μF capacitor for a 100 pF capacitor. Always check the polarity of electrolytic and tantalum capacitors to be sure the "+" lead is installed at the correct location. Where required, insure that the banded end of a Mylar capacitor is at the correct location.

5. Check each resistor carefully. It would be easy, for example, to install a 1200 Ω (brown-red-red) resistor where a 220 Ω (red-red-brown) resistor is called for. A resistor that is discolored, cracked, or shows any sign of bulging would indicate that it is faulty and should be replaced.

6. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.

7. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work; someone who is not familiar with the unit may notice something you have consistently overlooked.

8. Check all component leads connected to the circuit board. Make sure the leads do not extend through the circuit board and make contact with other connections or parts.

BENCH TESTING

WARNING: The full AC line voltage and high voltage DC is present at several points in the Power Supply. Be careful to avoid personal shock when you work on the Power Supply. Refer to Figure 10.

- Be cautious when you test the transistors and integrated circuits. Although they have almost unlimited life when used properly, they are more susceptible to damage from excessive voltage and current than are other circuit components.
- Be careful so you do not short any terminals to ground when you make voltage measurements. If the probe should slip, for example, and short out a bias or voltage supply point, it may damage one or more components.
- Do not remove any components while the Power Supply line cord is connected to the AC outlet.
- When you make repairs to the Power Supply, make sure you eliminate the cause as well as the effect of the trouble. If, for example, you should find a damaged resistor, be sure you find out what caused the resistor to become damaged. If the cause is not eliminated, the replacement resistor may also become damaged when the Power Supply is put back into operation.
- Refer to the X-Ray View, on Page 48 and the fold-in "Schematic" to locate the various components.
- Use a high impedance-input voltmeter to make any voltage measurements.

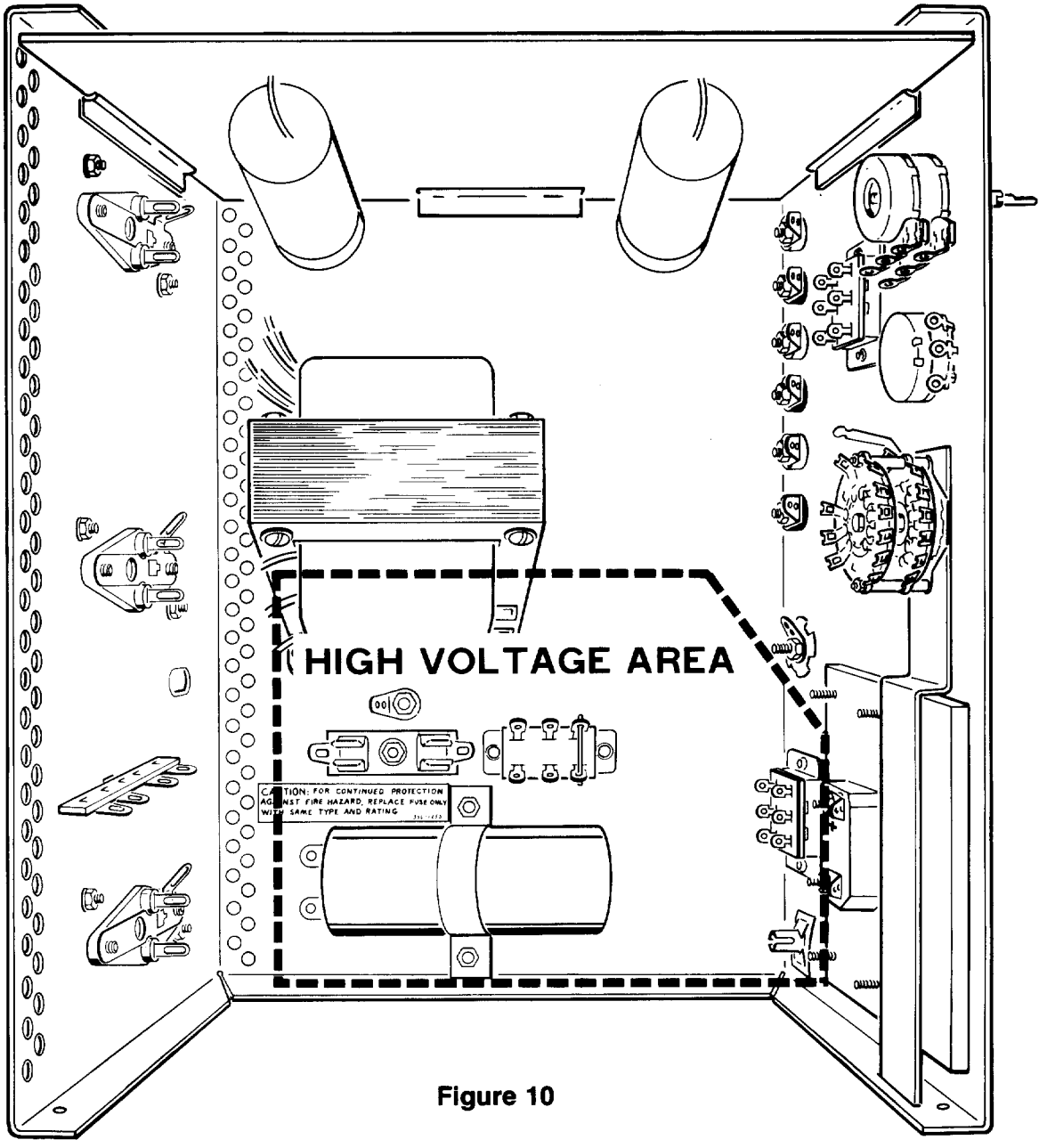


Figure 10

REPAIR TECHNIQUES

Components

Faulty resistors or capacitors should first be clipped from their leads to the circuit board. Heat the solder on the foil-side and allow the clipped lead to fall out of the hole. Preshape the leads of the replacement part and insert them into the holes in the circuit board. Solder the leads to the foil and cut off the excess lead lengths.

Transistors can be removed in the same manner as previously described. The replacement transistor must be installed with its leads in the proper holes. Then quickly solder the leads to avoid heat damage. Cut off the excess lead lengths.

CAUTION: On several areas of the circuit board, the foil patterns are quite narrow. When you unsolder a part for checking or replacement, avoid excessive heat while removing the part. A suction-type desoldering tool will make part removal easier.

Foil Repair

A break in a circuit board foil can be bridged by soldering across the break. Large gaps in the foil should be bridged with a length of bare wire. Lay the wire across the gap and solder each end to the foil.

Troubleshooting Chart

GENERAL

CONDITION	POSSIBLE CAUSE
Power Supply dead.	1. Fuse blown. 2. Bad solder connection, power transformer primary wiring. 3. Power switch SW1. 4. Line switch SW2.
Fuse blows.	1. Power or Line switches incorrectly wired. 2. Power transformer secondary incorrectly wired. 3. Integrated circuit IC1. 4. Capacitors C2, C103, C203, C108, or C208 incorrectly installed or faulty.

5-VOLT SUPPLY

CONDITION	POSSIBLE CAUSE
No Output.	1. Diodes D1 or D2. 2. Resistor R4. 3. Integrated circuit IC1.
Output greater than 5.25 volts DC.	1. Integrated circuit IC1.
Unable to get 1.5 amperes of current from supply.	1. Integrated circuit IC1 loosely installed or defective. 2. Resistor R4 wrong value.
Excessive ripple at output jacks.	1. Integrated circuit IC1. 2. Diodes D1 or D2. 3. Capacitor C2.
5-Volt supply not floating. Resistance from either output jack to chassis is less than 1 MΩ.	1. Wiring error. 2. Integrated circuit IC1 case contacting chassis. 3. Capacitor C5.

20-VOLT A OR B SUPPLIES

NOTE: Since both of the 20-volt supplies are identical, troubleshooting for both supplies is the same. If one of the 20-volt supplies operates correctly, you may be able to compare in-circuit voltages to identify a problem. All 100-series components are in the A-supply; all 200-series components are in the B-supply.

CONDITION	POSSIBLE CAUSE
No output from 20-volt supply.	1. Diodes D101, D102, D103, or diodes D201, D202, D203 open. 2. Resistors R101, R103, R109, or resistors R201, R203, R209 open. 3. Transistors Q101, Q102, Q103, Q107, or transistors Q201, Q202, Q203, or Q207 open. 4. Capacitors C102, C109, or capacitors C202, C209, shorted or reversed. 5. Zener diodes ZD104, ZD108, ZD109, or zener diodes ZD204, ZD208, ZD209 shorted or reversed. 6. Transistors Q104, Q105, Q106, Q108, or transistors Q204, Q205, Q206, Q208 shorted or incorrectly installed.*
Output too high, cannot be adjusted.	1. Transistors Q102, Q103, Q1, Q107, or transistors Q202, Q203, Q2, Q207 shorted. 2. Diodes D105, D110, or diodes D205, D210 open. 3. Zener diodes ZD108, ZD109, or zener diodes ZD208, ZD209 open. 4. Transistors Q106, Q108, or transistors Q206, Q208 open.
Output current too low.	1. Resistor R109 or resistor R209 open or incorrect value. 2. Transistor Q104 or transistor Q204 faulty.*
Output current does not limit.	1. Solder bridge A or solder bridge B open. 2. Transistor Q104 or transistor Q204 faulty. 3. Resistor R108, R109 or resistor R208, R209 wrong value.
Excessive ripple in output voltages.	1. Diodes D101, D102 or diodes D201, D202 open or faulty. 2. Capacitors C101, C103, C104, C105, C108 or capacitors C201, C203, C204, C205, C208 open or faulty.
Supply not floating. Resistance from either output jack to chassis is less than 1 MΩ.	1. Transistor Q1 or transistor Q2 case shorted to chassis. 2. Capacitor C6 or capacitor C7 faulty.

*NOTE: To check transistors Q104, Q105, Q204, and Q205, proceed as follows:

1. Disconnect the Power Supply from the AC outlet.
2. Unsolder Bridge A if the problem is in the A supply, and Bridge B if the problem is in the B supply. (See Pictorial 6-2 on Page 30.)

CAUTION: Current limiting protection will be disabled in the following steps; do not short together the terminals of either 20-volt supply as you perform these steps.

3. Turn on the Power Supply. Turn the voltage control fully clockwise. Observe the meter, and if the meter indicates a full-scale reading, transistor Q104 (or transistor Q204) is shorted.
4. Refer to Page 11, Pictorial 1-2, right column, 6th step. Temporarily unsolder the indicated jumper wire.
5. Turn on the Power Supply. Observe the meter. If it indicates a full-scale reading (pegged at upper limit), transistors Q105 (or Q205), Q106 (Q206), or Q108 (Q208) are shorted.
6. If necessary, replace the faulty component(s). Then resolder the Bridges and the jumper wires previously opened.

SPECIFICATIONS

Outputs	
5-Volt Supply	5 volts DC ±5% at 1.5 amperes.
'A' -Supply	0-20 volts DC at 0.5 ampere, continuously adjustable.
'B' -Supply	0-20 volts DC at 0.5 ampere, continuously adjustable.
Regulation	
Load	Less than 0.1% (20 mv) variation from no load to full load on 20-volt supplies. Less than 3% (150 mv) variation from no load to full load on 5-volt supply.
Line	20-Volt Supplies: Less than 0.2% (40 mv) for a line voltage change of 10 volts. 5-Volt Supply: Less than 0.2% (10 mv) for a line voltage change of 10 volts.
Ripple and Noise	Less than 5 mv RMS.
Current Limiting	Limiting for each supply fixed slightly above rated current to provide short-circuit protection.
Tracking Range	2 to 18 volts.
Tracking Error	Less than 1 volt.
Series Operation	All three supplies may be connected in series.
Parallel Operation	20-volt supplies may be operated in parallel by adding 0.5 Ω current-equalizing resistors (not supplied).

Voltage-Current Monitor Accuracy	5% of full scale.
Meter Ranges	Voltages, 0-20 and 0-5.5. Current, 0-550 mA and 0-2A.
Power Requirements	100-135 VAC or 200-270 VAC, 50/60 Hz, 100 watts at full load.
Power Switching Overshoot (On-Off)	None.
Voltage Control, 20-Volt Supplies 'A' and 'B'	Continuously variable, 0-20 volts.
Dimensions	4-1/2" high × 10-3/4" wide × 9" deep (11.43 cm × 27.3 cm × 22.86 cm).
Weight	10 lbs (3.73 kg).

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (in the "Illustration Booklet") while you read this "Circuit Description." The part numbers on the Schematic are arranged in the following groups to help you locate specific parts on the Schematic, chassis, and circuit boards:

1- 99	Parts mounted on the chassis.
101-199	Parts mounted on the circuit board, and in the 20-volt 'A' Supply.
201-299	Parts mounted on the circuit board, and in the 20-volt 'B' Supply.

The five principle sections of the Tri-Power Supply are the power primary circuit, the 5-volt supply, the 20-volt 'A' Supply, the 20-volt 'B' Supply, and the metering circuit.

PRIMARY CIRCUIT

The primary circuit of the Tri-Power Supply includes; hash-filter capacitor C1 across the line cord input, fuse F1, Power switch SW1, pilot lamp PL1 and dropping resistor R1, Line switch SW2, and transformer T1. The purpose of the Line switch is to allow you to switch from 120-VAC operation to 240-VAC operation without rewiring the primary circuit of power transformer T1. To change from 120-VAC operation to 240-VAC operation, for example, you need only to push the slide of switch SW2 to indicate the voltage that agrees with the local AC service. CAUTION: Be sure never to have switch SW2 at "120" during 240-volt operation; this could damage the Power Supply. Three transformer secondary windings provide separate voltage sources for the three voltage regulators of the 5-volt supply and the two 20-volt supplies.

5-VOLT SUPPLY

One secondary winding on transformer T1 provides a voltage to rectifier diodes D1 and D2. The rectified DC voltage is filtered by capacitor C2. Resistor R4 is a current shunt for the metering circuit. Resistor R2 is a bleeder resistor.

Regulation in the 5-volt circuit is accomplished in integrated circuit IC1. The output voltage is fixed at 5 volts. The IC provides internal overload, short-circuit, and high temperature protection. Capacitor C3 stabilizes the IC-regulator, and capacitor C4 lowers the high-frequency output impedance. Capacitor C5 provides an AC path to chassis ground for voltages induced when the 5-volt supply is used in the floating mode of operation.

20-VOLT 'A' AND 'B' SUPPLIES

NOTE: In the description of the 20-volt supplies, the "A" and "B" circuits are identical. One circuit will be described in this text which applies to either supply. Component callouts (R101, C111, Q103, etc.) in the 100-series are in the A-supply; component callouts in the 200-series are in the B-supply.

RECTIFIER-FILTER CIRCUIT

One transformer secondary winding provides an AC voltage to full-wave rectifier diodes D101 and D102. The rectified voltage is routed through blocking diode D103 and is filtered by capacitor C103. Resistor R105 is a bleeder resistor to discharge C103 when the Power Supply is turned off.

A negative voltage is derived through rectifier diodes D106 and D107. This voltage is filtered by capacitor C105, and is then routed to the voltage regulator.

CURRENT SOURCE

Current flows through zener diode ZD104, through resistor R103, to transistor Q101. The voltage drop across R104 is fixed at a constant value by ZD104 and the constant base-to-emitter voltage of transistor Q102. Thus, the current through R104 is constant. Since the collector current of Q102 is very nearly equal to its emitter current, the collector current will also be constant.

Transistor Q101 acts as a switch, to turn on quickly when the power supply is turned on. However, Q101's turn-off is delayed by the action of capacitor C101 to eliminate transients on the output of the supply when power is switched off.

OUTPUT AMPLIFIER

The output amplifier of the 20-volt supply consists of power transistor Q1, which is driven by transistor Q103 in a Darlington connection. Resistor R5 stabilizes the output amplifier at higher operating temperatures.

VOLTAGE REGULATOR

The reference voltage for the regulator circuit is derived from zener diode ZD109. Constant current for ZD109 is provided by resistor R115 and zener diode ZD108. ZD108 and resistor R106 are a pre-regulator for the reference source.

Differential transistors Q107 and Q108 compare a portion of the reference voltage as set by control R7 with a portion of the output voltage sampled between resistors R123 and R124.

An example of the action of this regulator circuit is as follows: If the output voltage rises due to a reduction in the load, the base voltage of transistor Q108 will increase. The collector voltage of Q108 will drop, causing an increase in the base current of transistor Q106. This causes an increase in the base current of transistor Q105 and its collector current will also increase. Since transistor Q102 provides a constant output current which is present both at Q103 and Q105, any increase in Q105 collector current will cause a reduction in Q103 base current. As Q103 base current decreases, its emitter current and that of transistor Q1, will also decrease. This decrease in the current from Q1 decreases the current from the Supply and will lower the output voltage to the correct level. The regulator circuit is designed to hold the output constant within a few millivolts for a full range of loads at the output terminals.

Diode D105, capacitors C102 and C104, with diode D110 and capacitor C108 eliminate overshoot during turn-on and turn-off of the Supply. Resistor R113 sets a negative bias current through current-metering resistor R109 equal to the positive current drawn by the regulator. This allows the meter to indicate the true supply output current when the Meter switch is correctly positioned.

CURRENT LIMITER

Transistor Q104 senses the voltage drop across resistor R109. This resistor carries the output current. As the voltage across R109 reaches approximately .55 volts, Q104 starts to conduct taking some of the current from the output of driver transistor Q103. As the voltage across R109 increases further, Q104 will conduct fully, taking all of the current from source transistor Q102. This causes transistors Q103 and Q1 to turn off. In this manner, output current limiting can be maintained indefinitely.

METERING CIRCUIT

Switch SW4 selects any of the six output functions to be monitored by the meter. NOTE: This switch function does **not** select or affect any of the outputs at the front terminals of the Tri-Power Supply.

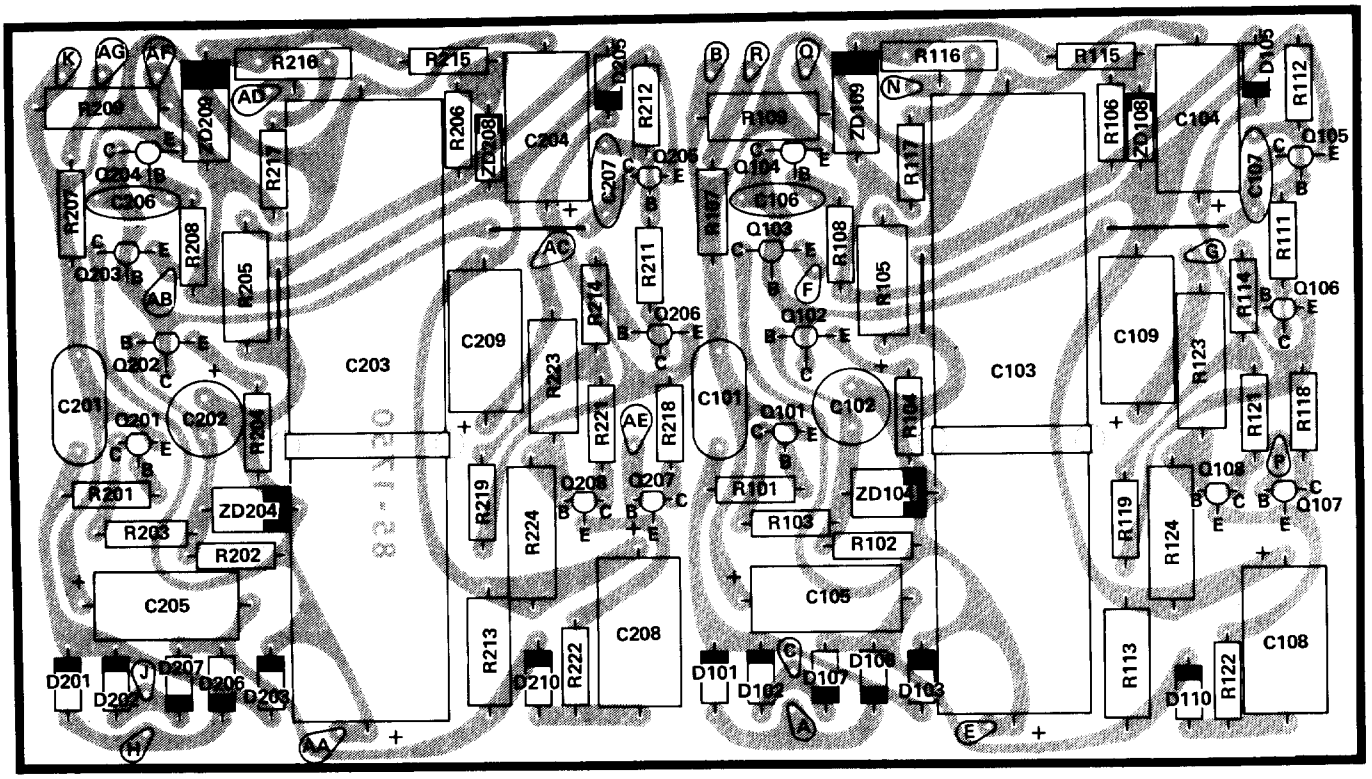
CIRCUIT BOARD X-RAY VIEW

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R5, C3, etc.) on the X-Ray View or "Chassis Photograph."

B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.

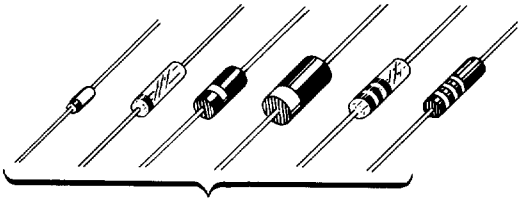
C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



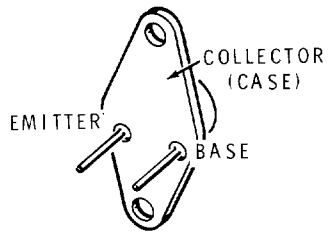
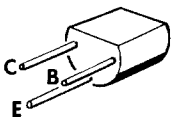
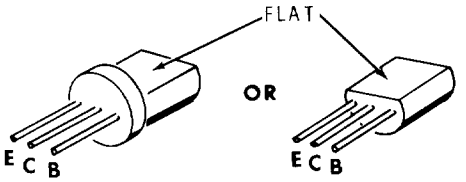
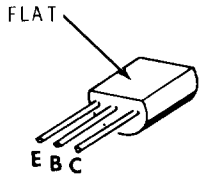
(Shown from component side)

SEMICONDUCTOR IDENTIFICATION CHARTS

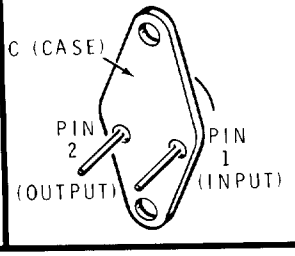
DIODES

COMPONENT	PART NO.	MAY BE REPLACED WITH	IDENTIFICATION
ZD109, ZD209	56-637	PS18775	**IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.**  **BANDED END**
ZD104, ZD204	56-50	DO-7	
ZD108, ZD208	56-57	IN716A	
D1, D2	57-42	3A1	
D101, D102, D103, D105, D106, D107, D110, D201, D202, D203, D205, D206, D207, D210	57-65	IN4002	

TRANSISTORS

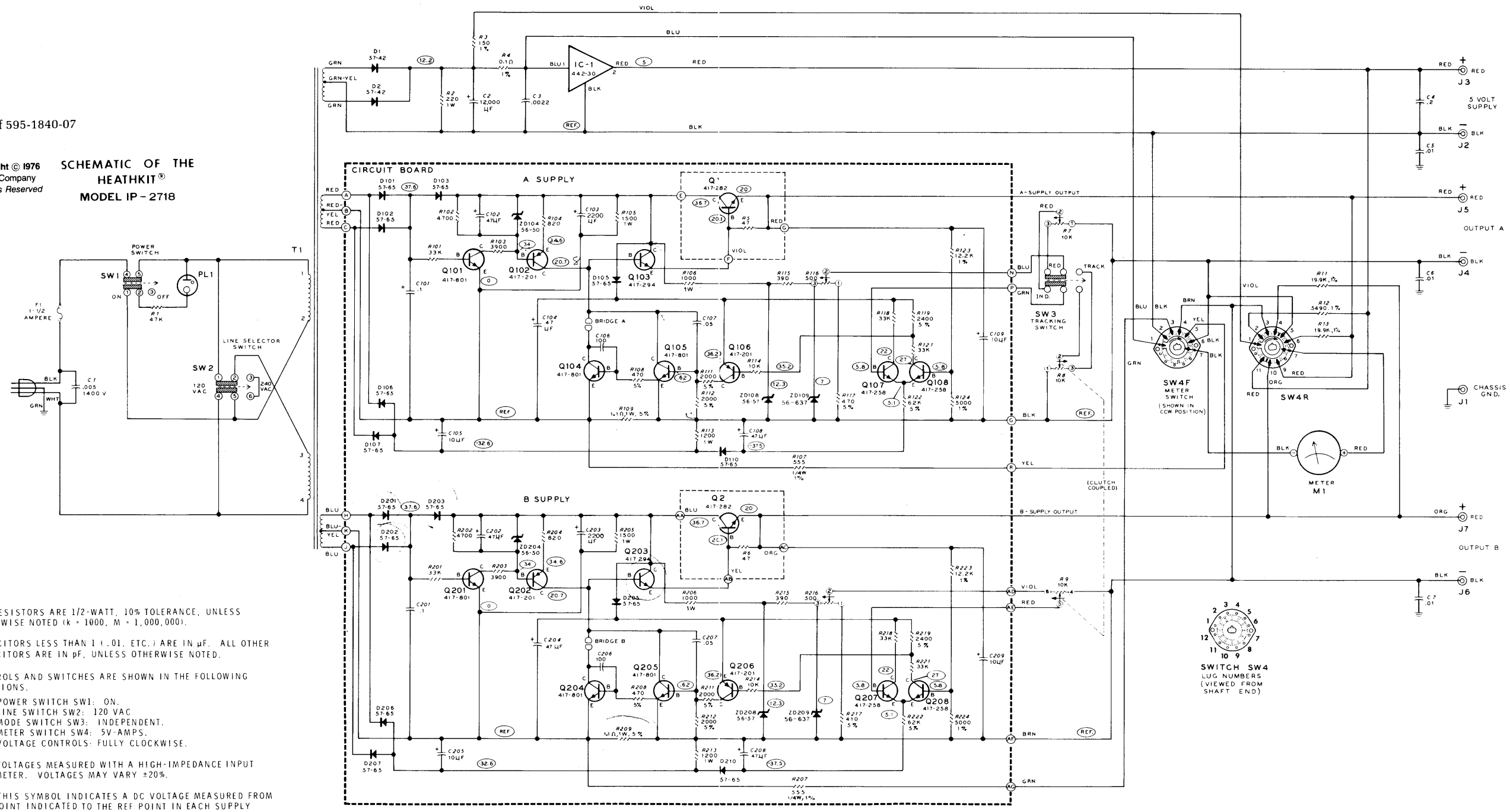
COMPONENT	HEATH PART NO.	MAY BE REPLACED WITH	IDENTIFICATION
Q1, Q2	417-282	MJ2841	
Q107, Q108 Q207, Q208	417-258	TIS87	
Q102, Q106, Q202, Q206	417-201	X29A829	
Q103, Q203	417-294	MPSA42	
Q101, Q104, Q105, Q201, Q204, Q205,	417-801	MPSA20	

INTEGRATED CIRCUIT

COMPONENT	HEATH PART NO.	MAY BE REPLACED WITH	IDENTIFICATION
IC1	442-30	UA309K	

Part of 595-1840-07

SCHEMATIC OF THE HEATHKIT® MODEL IP-2718



NOTES:

1. ALL RESISTORS ARE 1/2-WATT, 10% TOLERANCE, UNLESS OTHERWISE NOTED (k = 1000, M = 1,000,000).
2. CAPACITORS LESS THAN 1 (.01, ETC.) ARE IN µF. ALL OTHER CAPACITORS ARE IN pF, UNLESS OTHERWISE NOTED.
3. CONTROLS AND SWITCHES ARE SHOWN IN THE FOLLOWING POSITIONS.
   - POWER SWITCH SW1: ON.
   - LINE SWITCH SW2: 120 VAC
   - MODE SWITCH SW3: INDEPENDENT.
   - METER SWITCH SW4: 5V-AMPS.
   - VOLTAGE CONTROLS: FULLY CLOCKWISE.
4. ALL VOLTAGES MEASURED WITH A HIGH-IMPEDANCE INPUT VOLTMETER. VOLTAGES MAY VARY ±20%.
5. (36.7) THIS SYMBOL INDICATES A DC VOLTAGE MEASURED FROM THE POINT INDICATED TO THE REF POINT IN EACH SUPPLY SECTION.
6. ⏚ THIS SYMBOL INDICATES CHASSIS GROUND.
7. LETTER-NUMBER DESIGNATIONS FOR RESISTORS, CAPACITORS, ETC., ARE IN THE FOLLOWING GROUPS:
   - 1-99 CHASSIS MOUNTED PARTS.
   - 101-199 PARTS IN THE 20-VOLT A SUPPLY.
   - 201-299 PARTS IN THE 20-VOLT B SUPPLY.