

# POWER *TEN*

*3103A Series*  
DC Power Supply

***Operation and Maintenance***  
***Manual***

**Model:**

**2000**

**\* REFERENCE ONLY \***

***\* OBSOLETE SERIES, NO LONGER SUPPORTED \****

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**WARNING**

Hazardous voltage (greater than 50 volts) may be present when cover is removed and could cause injury to personnel. Authorized personnel only should remove the cover.

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# CHAPTER 1

## DESCRIPTION OF EQUIPMENT

### 1-1. INTRODUCTION

The Power Ten, Inc. Series 3103, Model 2000 general purpose power supply is designed specifically for laboratory test and systems applications requiring a variable dc source with good ripple and regulation characteristics. This all solid-state constant voltage/current limiting supply provides independent dual range, dual outputs of up to 20 V/0.6 amps or 40 V/ 0.3 amps. This highly versatile supply with its auto-parallel and auto-series capability permits extension of operation to 20 V/1.2 amps, 40 V/0.6 amps or 80 V/0.3 amps. In addition, opposite polarity voltages of +/-20 V, +/-40 V are obtainable when using the supply's auto tracking capability.

The Series 3103 is completely self-contained in a single chassis. Front panel controls include ten turn output voltage controls, volt/ampere meters, meter function/range switches and front and rear output terminals. Range switch allows for the selection of either a high or low output voltage range. This unit is designed for continuous operation with built in filtering, regulation, and protection circuitry.

### 1-2. TECHNICAL CHARACTERISTICS

The following paragraphs contain physical, electrical and environmental data for the Model 2000.

a. Physical Characteristics. Figure 1-1 shows a front view of the Model 2000, while Table 1-1 lists its physical characteristics.

b. Electrical Characteristics. Table 1-1 lists the electrical characteristics of the Model 2000.

c. Environmental Characteristics. Table 1-1 lists the environmental characteristics of the Model 2000.

Table 1-1. Technical Characteristics of Model 2000

#### Physical Characteristics

Width . . . . .	8.50 in. (21.59 cm)
Depth . . . . .	12.625 in. (32.07 cm)
height. . . . .	3.50 in. (8.89 cm)
weight. . . . .	8 lbs.

Table 1-1. Technical Characteristics - Continued

Electrical Characteristics

Input Power

Voltage . . . . . 115 V ac +/-10%  
 Frequency . . . . . 48-440 Hz

Output Power

Dual Range/  
 Dual Output . . . . . 0-20 V/0.6 amps,  
 0-40 V/0.3 amps  
 Series/Parallel  
 Mode . . . . . 20 V/1.2 amps,  
 40 V/0.6 amps,  
 80 V/0.3 amps

Regulation

Line . . . . . 0.01% + 4 mV  
 Load . . . . . 0.01% + 4 mV

PARD (Noise & Ripple)

rms/p-p . . . . . 200 uV/1 mV (20 Hz  
 to 20 MHz)

Protection Circuitry . . . . . 1. Reverse Voltage  
 Protection  
 2. Overload Protec-  
 tion  
 3. AC input line pro-  
 tected with 1 amp  
 thermal circuit  
 breaker.

Stability . . . . . 0.1% + 5 mV/degree C

Operating Modes . . . . . Constant Voltage

Remote Programming

Resistance

Constant Voltage . . . . . 200 ohms/V

Voltage

Constant Voltage . . . . . 1 V/V

Table 1-1. Technical Characteristics - Continued

Environmental Characteristics

Ambient Temperature  
Requirements:

Operating . . . . . 0 to 55 degrees C  
Storage . . . . . -40 to +75 degrees C

Cooling . . . . . Convection

## CHAPTER 2

### INSTALLATION

#### 2-1. INSPECTION

Inspect the shipping carton for possible damage before unpacking the unit. Carefully unpack the equipment. Save all packing materials until inspection is complete. Verify that all items listed on the packing slips have been received. Visually inspect all exterior surfaces. External damage may be an indication of internal damage. If any damage is evident, immediately contact the carrier that delivered the unit and submit a damage report. Failure to do so could invalidate future claims.

#### 2-2. INPUT/OUTPUT CONNECTORS

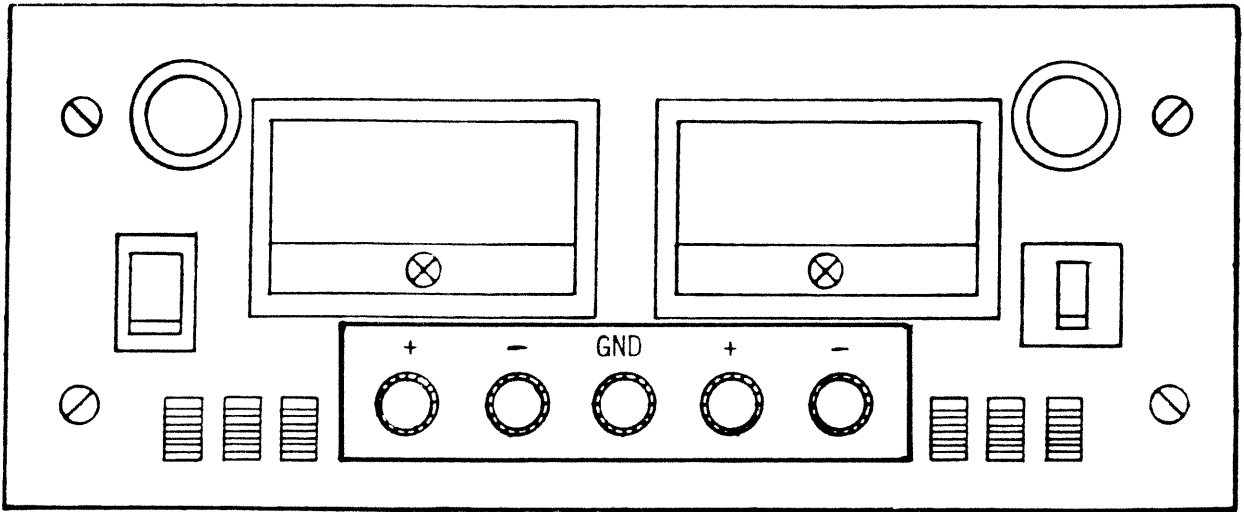
Figures 2-1 and 2-2 show the front and rear panel connector locations for the Model 2000. Table 2-1 lists all external connectors for the Model 2000.

#### 2-3. LOCATION AND MOUNTING

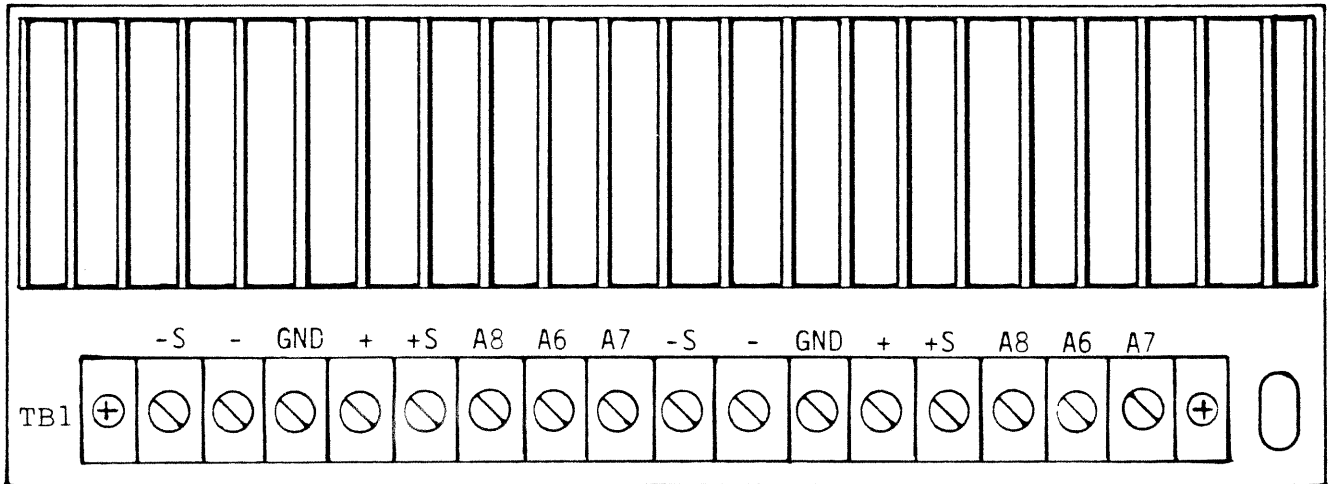
The Model 2000 is intended for workbench applications and no further hardware is required for mounting.

#### 2-4. CHECKOUT AND PRELIMINARY ADJUSTMENTS

Follow the instructions in paragraph 3-2 for setup and operation of the equipment.



Front Panel



Rear Panel

Figure 2-1. Model 2000 Front and Rear Panel Connectors

Table 2-1. Model 2000 Front Panel Output Connectors

CONNECTOR	FUNCTION	CONNECTS TO
+	0-12 W Output - Section A	Load
-	0-12 W Output - Section A	Load
GND	Chassis Ground	
+	0-12 W Output - Section B	Load
-	0-12 W Output - Section B	Load

Table 2-2. Model 2000 Rear Panel Output Connectors

CONNECTOR	FUNCTION	CONNECTS TO
	Section A	
-S	(-) Voltage Sensing	See Chapter 3 for operating configurations and strapping requirements
-	(-) Output (for local sensing)	
GND	Chassis Ground	
+	(+) Output (for local sensing)	
+S	(+) Voltage Sensing	
A6	Voltage Control	
A7	Voltage Program	
A8	Voltage Set	
	Section B	
-S	(-) Voltage Sensing	See Chapter 3 for operating configurations and strapping requirements
-	(-) Output (for local sensing)	
GND	Chassis Ground	
+	(+) Output (for local sensing)	
+S	(+) Voltage Sensing	
A6	Voltage Control	
A7	Voltage Program	
A8	Voltage Set	

CHAPTER 3

OPERATING INSTRUCTIONS

3-1. CONTROLS AND INDICATORS

The front panel controls and indicators for the Model 2000 are shown in figure 3-1 with index numbers keyed to Table 3-1. Table 3-1 provides a description of all operator controls and indicators.

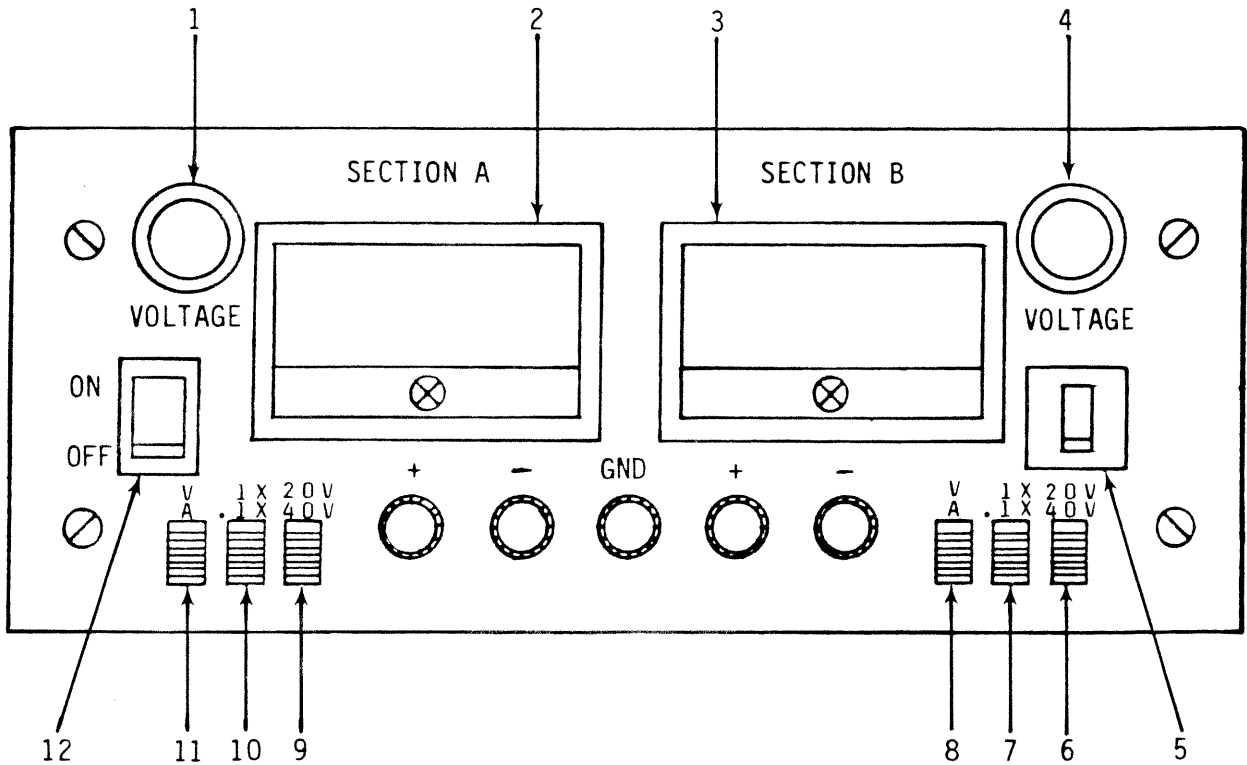


Figure 3-1. Model 2000 Controls and Indicators

Table 3-1. Model 2000 Controls and Indicators

FIGURE & INDEX NO.	CONTROL/INDICATOR	FUNCTION
3-1 -1	Voltage Output Control	Adjusts voltage output of Section A to the desired level.

Table 3-1. Model 2000 Controls and Indicators - Continued

FIGURE & INDEX NO.	CONTROL/INDICATOR	FUNCTION
-2	Voltage/Current Meter	Measures voltage or current output of Section A as determined by V/A switch (Index No. 11) and 1X/.1X switch (Index No. 10).
-3	VOLTAGE/CURRENT Meter	Measures voltage or current output of Section B as determined by V/A switch (Index No. 8) and 1X/.1X switch (Index No. 7).
-4	Voltage Output Control	Adjusts voltage output of Section B to the desired level.
-5	Circuit Breaker	Provides protection in the event of an internal power supply fault.
-6	20V/40V Range Control	Sets output voltage range of Section B power supply.
-7	1X/.1X Meter Control	Selects change of scale reading for Section B VOLTAGE/CURRENT meter (Index No. 3).
-8	V/A (Volts/Amps) Control	Selects parameter (voltage or amps) to be measured by the Section B VOLTAGE/CURRENT meter (Index No. 3).
-9	20V/40V Range Control	Sets output voltage range of Section A power supply.

Table 3-1. Model 2000 Controls and Indicators - Continued

FIGURE & INDEX NO.	CONTROL/INDICATOR	FUNCTION
-10	1X/.1X Meter Control	Selects change of scale reading for Section A VOLTAGE/CURRENT meter (Index No. 2).
-11	V/A (Volts/Amps) Control	Selects parameter (voltage or amps) to be measured by the Section A VOLTAGE/CURRENT meter (Index No. 2).
-12	Power Switch	Applies AC line power to the unit.

### 3-2. SETUP AND OPERATING INSTRUCTIONS

The following paragraphs provide setup and operating procedures for the Model 2000.

a. Setup. The Model 2000 may be configured for different operating configurations: local and remote voltage programming, normal series, auto-series and auto-parallel connections. The use and operations requirements of each configuration are provided in the following paragraphs.

(1) Local operation. The unit is shipped from the factory configured for local voltage control and local voltage sensing. This configuration is used for applications where the IR drip of the load wires is insufficient to degrade performance at the load. The strapping pattern is provided in figure 3-1. Prior to turning the unit on, rotate the voltage and potentiometers to minimum output. Then, press the power switch to the ON position and adjust the voltage to desired output.

(2) Remote Voltage Programming. The remote voltage programming configuration is used for applications that require the output voltage be programmed (controlled) from a remote source. An external resistance or external floating voltage source may be used as a programming device. When using remote voltage programming, a shielded twisted pair hookup wire is recommended to prevent noise interference with programming signals.

(a) External Resistance Programming. The resistance coefficient for remote voltage programming is 200 ohms/volt. The programming current from terminal TB1-A7 is factory set to -5.00 mA. If multi-pole switches or relays are used to program different levels, make-before-break contacts are recommended. See figure 3-2 for strapping requirements.

(b) External Voltage Programming. The voltage coefficient for external voltage programming is 1 volt/volt. To program voltage slightly above the rated output will not damage the unit, but degraded performance may result. See figure 3-3 for strapping requirements.

#### Note

The following modes of operation are used for applications requiring greater output current or voltage than is available from a single power supply. To meet the requirements for greater output, two or more supplies may be connected in parallel or in series.

(3) Normal Parallel Operation. The normal parallel operating configuration uses two or more power supplies connected in parallel, each independently controllable at the front panel or remote programming source. In this mode, the supply with the highest voltage setting will supply all the load current until the current limit circuit activates. This will cause the voltage to decrease to the voltage level set on the parallel connected supply, which will then supply current up to its maximum rating. See figure 3-4 for strapping requirements.

(4) Auto-Parallel Operation. The auto-parallel operation with two or more supplies establishes a master/slave(s) configuration. The output voltage of the slaves(s) is controlled by the master and will automatically track the master. See figure 3-5 for strapping requirements.

(5) Normal Series. This mode of operation provides output voltage control by front panel voltage controls on either series connected power supply. Current output from each supply will be equal. See figure 3-6 for strapping requirements.

(6) Auto-Series Operation. In the auto-series operation, a master/slave configuration is established. With two or more supplies connected in series, one is established as master and the remaining units as slave. In this mode the slave will track the master. The percentage of voltage tracking is determined by the slave front panel voltage control. See figure 3-7 for strapping requirements.

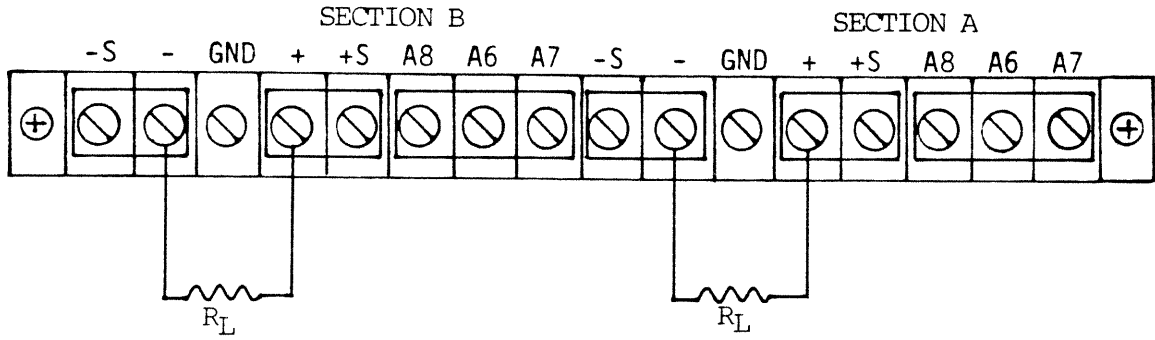


Figure 3-1. Local Operation Strapping

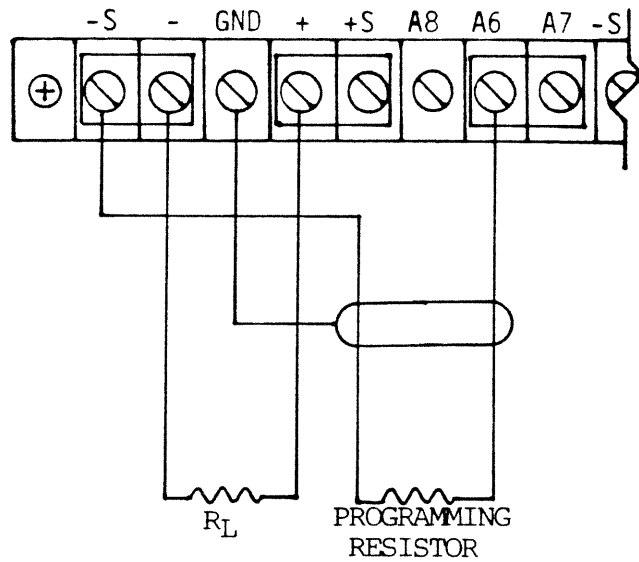


Figure 3-2. Remote Resistance Programming Strapping

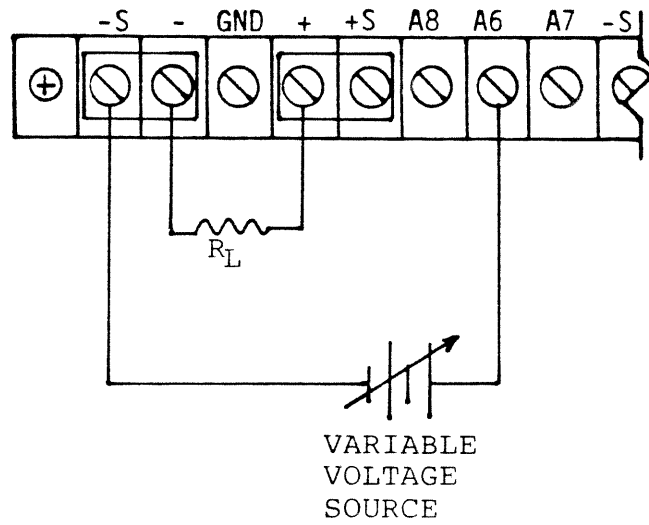


Figure 3-3. Remote Volt/Volt Programming Strapping

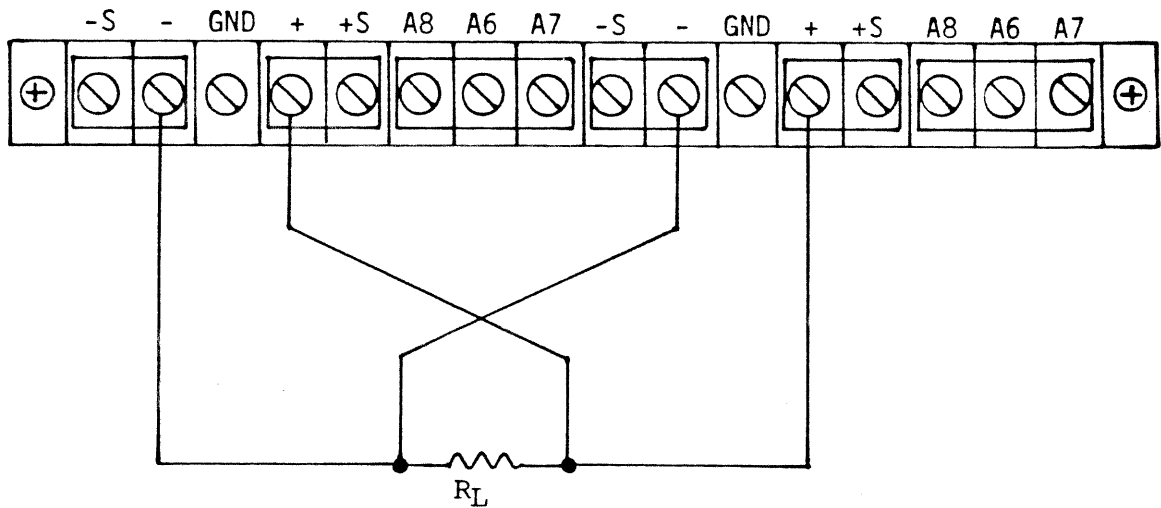


Figure 3-4. Normal Parallel Strapping

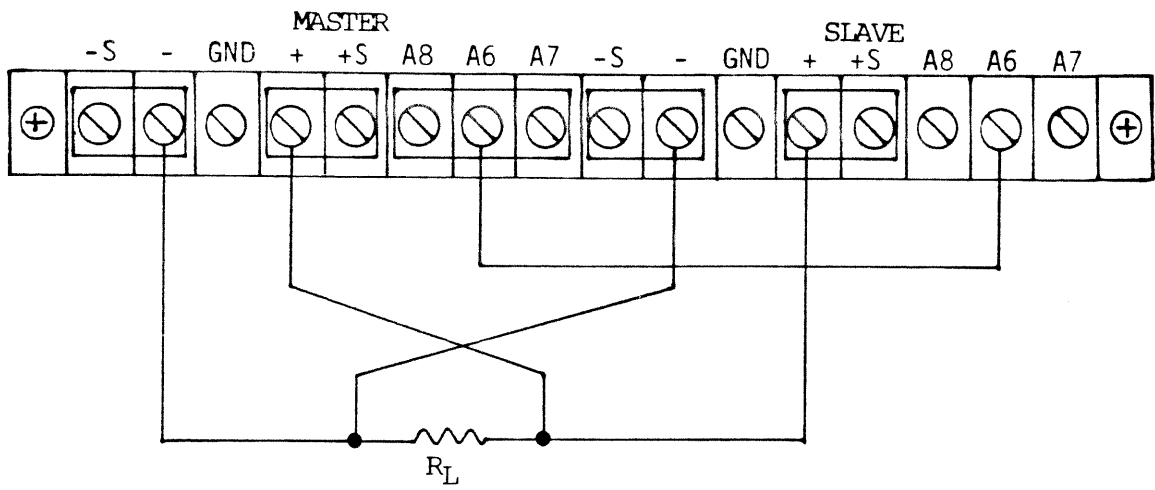


Figure 3-5. Auto-Parallel Stopping

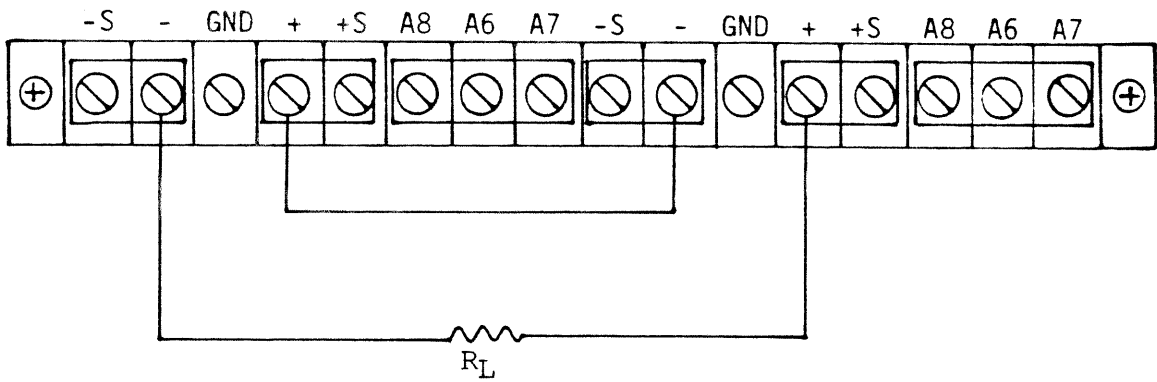


Figure 3-6. Normal Series Stopping

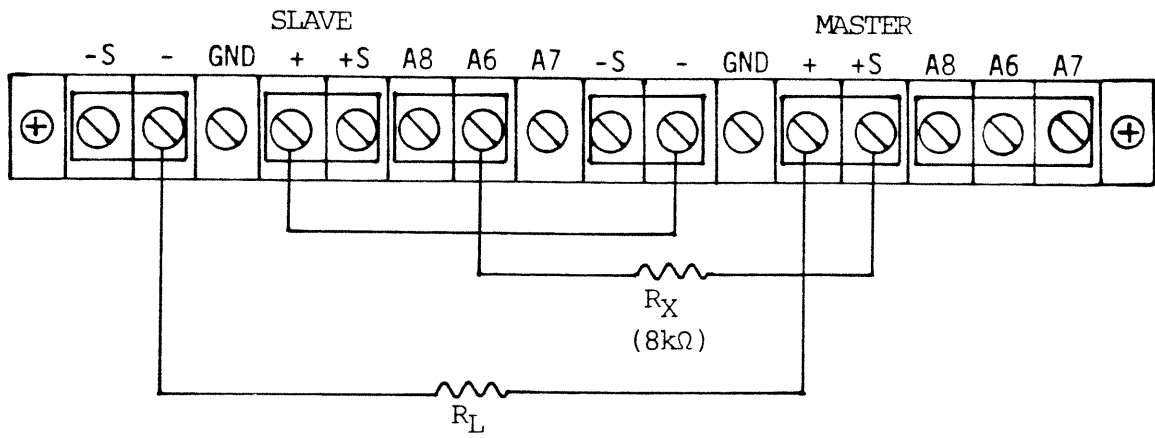


Figure 3-7. Auto-Series Stepping

## CHAPTER 4

### PRINCIPLES OF OPERATION

#### 4-1. INTRODUCTION

This chapter provides a functional block diagram description and a detailed circuit description of the Model 2000. A detailed block diagram of the unit is shown in figure 4-1.

#### 4-2. FUNCTIONAL DESCRIPTION

The front panel controls and indicators contain all necessary controls for local operation. Included are the power switch, circuit breaker, voltage adjustment controls, voltage/current meters, voltage range select switches, volt/amp meter select switches, 1X/.1X meter range select switches, and power output binding posts.

The power transformer provides input/output isolation with four output windings: two for power output, the other two internal power supply bias. The rectifier filter is used to convert the ac power secondary winding of the power transformer to an unregulated dc power for the linear regulator. The bias supplies derive power from the power transformer, rectify, filter, and regulate +/-12 volt bias power for internal power supply circuitry.

The unregulated DC voltage from the rectifier filter is regulated linearly and filtered by capacitors to provide the regulated output dc voltages.

#### 4-3. DETAILED CIRCUIT DESCRIPTION

The following paragraphs provide a more detailed explanation of how some circuits work and what components are used. In addition to the block diagram, figure 4-1, reference the schematics in chapter 7.

a. Unregulated DC Input Power. The high power secondary winding of T1 is rectified by bridge BR1 and filtered by C1 to provide a nominal 60 V dc unregulated to the linear regulator element Q1. Switch S2 (20 V/40 V) will reduce the 60 V dc level, by approximately one-half when the switch is in the 20 V position. This is accomplished by bypassing one-half of the rectifier bridge BR1.

b. Bias Power. The low power secondary provides a nominal 32 V ac center tapped to the regulator circuit which consists of rectifier bridge BR2, capacitors C2, C4 and the voltage regulators U1 and U2.

c. Meter Circuit. The voltage current meter is a 1 milliamp meter with full-scale movement and reading of 50 V/0.75 amps. With the use of switch S4 (1X/.1X), full-scale readings can be reduced to 5 V /75 mA. Drive for the meter is derived from the voltage/current sense amplifier U5. Sensing of voltage or current is provided by double

pole switch S3. U5 provides the current drive for the meter. CR4 serves as a slight voltage drop to prevent overdriving of the meter.

d. Voltage/Regulator Control. Operational amplifier U3 is the error amplifier used to control regulating element Q1. U3, pin 3, is the input control signal from either local or remote operation. Resistor R5 and capacitor C9 serve to stabilize the loop. Regulator pass transistor Q1 will respond accordingly. Capacitors C7 and C8 are used to minimize high frequency effects.

e. Current Limit. This circuit works in conjunction with current sensing element R14. Operational amplifier U4 compares the output current sensed by R14 to a set limit at U4, pin 3, determined by resistor R9 or parallel combination of R9 and R10. Should the output current exceed the level at U5, pin 3, the output at pin 6 will go low forward biasing CR2 and thus reducing basedrive to Q1 and limiting the dc voltage output. Current limit level is set by S2 for a nominal 0.64 amps or 0.33 amps at 20 V or 40 V position, respectively.

f. DC Output Power. DC output voltage is filtered mainly by C13, but C17 serves as a high frequency noise bypass. Output power is routed to both front and rear connectors. Rectifier diode CR3 serves as protection against an accidental reverse connections in an auto-series, auto-parallel configurations.

g. Voltage Reference. Reference diode VR1, R2 and R3 make up a stable reference that is used for voltage control.

## CHAPTER 5

### LIST OF MATERIALS

#### 5-1. INTRODUCTION

The repair parts list contains the major parts required to maintain the Model 2000. To ensure accurate procurement of replacement parts, the information contained in the parts list columns must be used effectively. The following paragraphs describe the parts list format and include an explanation of the information presented in each of the columns.

The ITEM column contains the part number Power Ten has assigned to items both purchased and Power Ten manufactured. The SEQUENCE column contains the sequence number in ascending order. The DESCRIPTION column contains the standard identifying noun or item name. The QUANTITY column contains the quantity required for each unit. The REFERENCE column contains the reference designations of the electrical components.

BILL OF MATERIALS WITHOUT BURDEN  
POWER TEN INC.

FOR ASSEMBLY 3103-2000

ITEM	SEQ.	DESCRIPTION	QTY	REFERENCE
10-010-052-00	4	ASSY, DUAL OUTPUT/RANGE P	1.000	A1
11-070-027-00	6	CIRCUIT BREAKER, .25A	1.000	CB1
09-050-000-03	9	BINDING POST, BLACK	2.000	
09-050-000-04	10	BINDING POST, GREEN	1.000	
09-050-000-05	11	BINDING POST, RED	2.000	
11-050-011-00	13	METER, DUAL RANGE 0-50VDC/	2.000	M1,2
09-020-016-00	15	CONN. FEMALE 16 PIN	1.000	P1
09-020-022-00	16	CONN. FEMALE 6 POS	2.000	P2
09-100-014-00	17	CONN. COVER 16 PIN	1.000	
09-100-017-00	18	CONN. COVER 6 POS	2.000	
03-500-002-00	19	RES. POT., 10K	2.000	R25
12-180-007-00	20	KNOB	2.000	
06-030-000-40	21	XFMR. 50-400HZ, 115VAC (31	1.000	T1
05-051-003-00	23	SWITCH, ROCK. DPDT, MINI P	1.000	S1
11-041-001-00	25	POWER CORD, 115 V	1.000	W1
12-170-002-00	26	STRAIN RELIEF	1.000	
12-070-050-00	28	CHASSIS, BASE (3103-2000)	1.000	
12-070-051-00	29	CHASSIS, COVER (3103-2000)	1.000	
12-330-022-00	31	PANEL, FRONT FAB. ASSY.	1.000	
12-070-049-00	32	HEATSINK (3103-2000)	1.000	
15-100-440-04	33	SCREW, PPH, 4-40 X 1/4"SS	5.000	
15-100-632-06	34	SCREW, PPH, 6-32 X 3/8"SS	10.000	
15-420-400-00	35	WASHER, LOCK #4, SS	13.000	
15-420-600-00	36	WASHER, SPLIT #6, SS	10.000	
15-400-600-00	37	WASHER, FLAT #6, SS ROD	6.000	
15-300-632-00	38	NUT, HEX 6-32, SS	2.000	
15-100-440-06	39	SCREW, PPH, 4-40 X 3/8"SS	8.000	
15-110-440-06	40	SCREW, PFH, 4-40 X 3/8"SS	4.000	
09-040-000-02	41	LUGS, TERM. FEMALE 22/18G	2.000	CB1
09-040-000-36	42	LUGS, TERM. SNAP SPADE 22	4.000	M1, M2
09-040-000-50	43	DISCONNECT, NYLON .110X.03	4.000	
09-090-003-00	45	JUMPER, OVER BARRIER	10.000	
11-030-000-01	48	WIRE, BLACK, 22GA	0.800	
11-030-000-14	49	WIRE, BRN, 22GA	0.800	
11-030-000-17	50	WIRE, RED, 22GA	0.800	
11-030-000-12	51	WIRE, ORANGE, 22GA	0.800	
11-030-000-11	52	WIRE, YELLOW, 22GA	0.800	
11-030-000-15	53	WIRE, GRN, 22GA	0.800	
11-030-000-10	54	WIRE, BLUE, 22GA	0.800	
11-030-000-16	55	WIRE, VIOLET, 22GA	0.800	
11-030-000-07	56	WIRE, WHITE, 22GA	0.800	
11-030-000-18	57	WIRE, WH/BLK, 22GA	0.800	
11-030-000-05	58	WIRE, WH/YEL, 22GA	0.800	
11-030-000-03	59	WIRE, WH/RED, 22GA	0.800	
11-030-000-04	60	WIRE, WH/ORG, 22GA	0.800	
11-030-000-06	61	WIRE, WH/GRN, 22GA	0.800	
11-030-000-19	62	WIRE, WH/BLU, 22GA	0.800	
09-040-000-46	63	LUGS, TERM. SPRING SPADE	5.000	

BILL OF MATERIALS WITHOUT BURDEN  
POWER TEN INC.

FOR ASSEMBLY 10-010-052-00

ITEM	SEQ.	DESCRIPTION	QTY	REFERENCE
10-010-052-10	2	PCB FABRICATION	1.000	-
12-050-004-00	4	BRACKET, HEATSINK (3103-2	1.000	-
07-040-019-00	5	BRIDGE, RECT. 2A, 100V	4.000	BR1, 2
01-022-735-00	8	CAP. ELEC 220UF, 35V, 20%	4.000	C2, 4
01-147-550-00	9	CAP. TANT 4.7UF, 50V	6.000	C3, 5, 20
01-210-310-10	10	CAP. CER .01UF, 100V, 10%	6.000	C6, 10, 14
01-010-763-00	11	CAP. ALUM 100UF, 63V, 20%	2.000	C13
01-022-880-00	12	CAP. ELEC 2200UF, 80V, 20%	2.000	C1
01-210-450-00	13	CAP. CER .1UF, 50V	18.000	C7, 8, 11, 12, 15-19
01-210-120-10	14	CAP. CER 100PF, 200V	2.000	C9
07-030-004-00	16	DIODE, RECT. 1A, 100V	2.000	CR3
07-080-002-00	17	DIODE, SIG. 100MA, 75V	6.000	CR1, 2, 4
09-010-014-00	19	CONN. MALE 16 PIN HEADER	1.000	J1
09-010-020-00	20	CONN. MALE 6 PIN HEADER	2.000	J2
07-010-000-23	21	XSTR. NPN. 8A, 80V	2.000	Q1
03-104-711-00	23	RES. C.F., 470, 1/4W, 5%	2.000	R1
03-101-021-00	24	RES. C.F., 1K, 1/4W, 5%	2.000	R3
03-101-031-00	25	RES. C.F., 10K, 1/4W, 5%	8.000	R4, 5, 11, 22
03-103-021-00	26	RES. C.F., 3K, 1/4W, 5%	2.000	R6
03-102-021-00	27	RES. C.F., 2.0K, 1/4W, 5%	4.000	R7, 12
03-101-011-00	28	RES. C.F., 100, 1/4W, 5%	4.000	R8, 23
03-106-811-00	29	RES. C.F., 680, 1/4W, 5%	4.000	R9, 10
03-101-231-00	30	RES. C.F., 12K, 1/4W, 5%	2.000	R13
03-310-084-00	31	RES. W.W., 1, 2.5W, 1%	2.000	R14
03-249-921-00	32	RES. M.F., 49.9K, 1/4W, 1%	2.000	R24
03-264-901-00	33	RES. M.F., 649, 1/4W, 1%	2.000	R16
03-245-321-00	34	RES. M.F., 45.3K, 1/4W, 1%	2.000	R17
03-210-021-00	35	RES. M.F., 10K, 1/4W, 1%	4.000	R19, 21
03-290-921-00	36	RES. M.F., 90.9K, 1/4W, 1%	2.000	R20
03-500-013-00	37	RES. TRIMPOT, 500, 1/2W	2.000	R2
03-500-001-01	38	RES. TRIMPOT, 200, 1/2W	2.000	R15
03-500-003-01	39	RES. TRIMPOT, 10K, 1/2W	2.000	R18
05-070-004-00	41	SWITCH, P.P. DPDT, BLACK	6.000	S2-4
09-030-019-00	42	BARRIER STRIP, 16 POS W/A	1.000	TB1
07-070-000-26	44	I.C. REG. .1A, +12V	2.000	U1
07-070-000-25	45	I.C. REG. .1A, -12V	2.000	U2
07-050-000-23	46	I.C. J-FET INPUT OP. AMP	6.000	U3-5
07-060-000-14	48	DIODE, ZEN. 6.2V	2.000	VR1
11-030-000-08	50	WIRE, BUS, #22 TINNED COPP	1.000	W2-19
07-100-000-03	52	INSUL. WASHER, MICA, TO-3	2.000	VR1
15-100-440-08	55	SCREW, PPH, 4-40 X 1/2" SS	4.000	
15-400-400-00	56	WASHER, FLAT #4, SS	8.000	
15-420-400-00	57	WASHER, LOCK #4, SS	4.000	
15-300-440-00	58	NUT, HEX 4-40, SS	4.000	
15-520-000-00	59	SPACER, NYLON .2500D X .18	4.000	

CHAPTER 6  
ILLUSTRATIONS

6-1 INTRODUCTION

This chapter contains schematic diagrams for the top assembly and printed circuit board of the Model 2000.

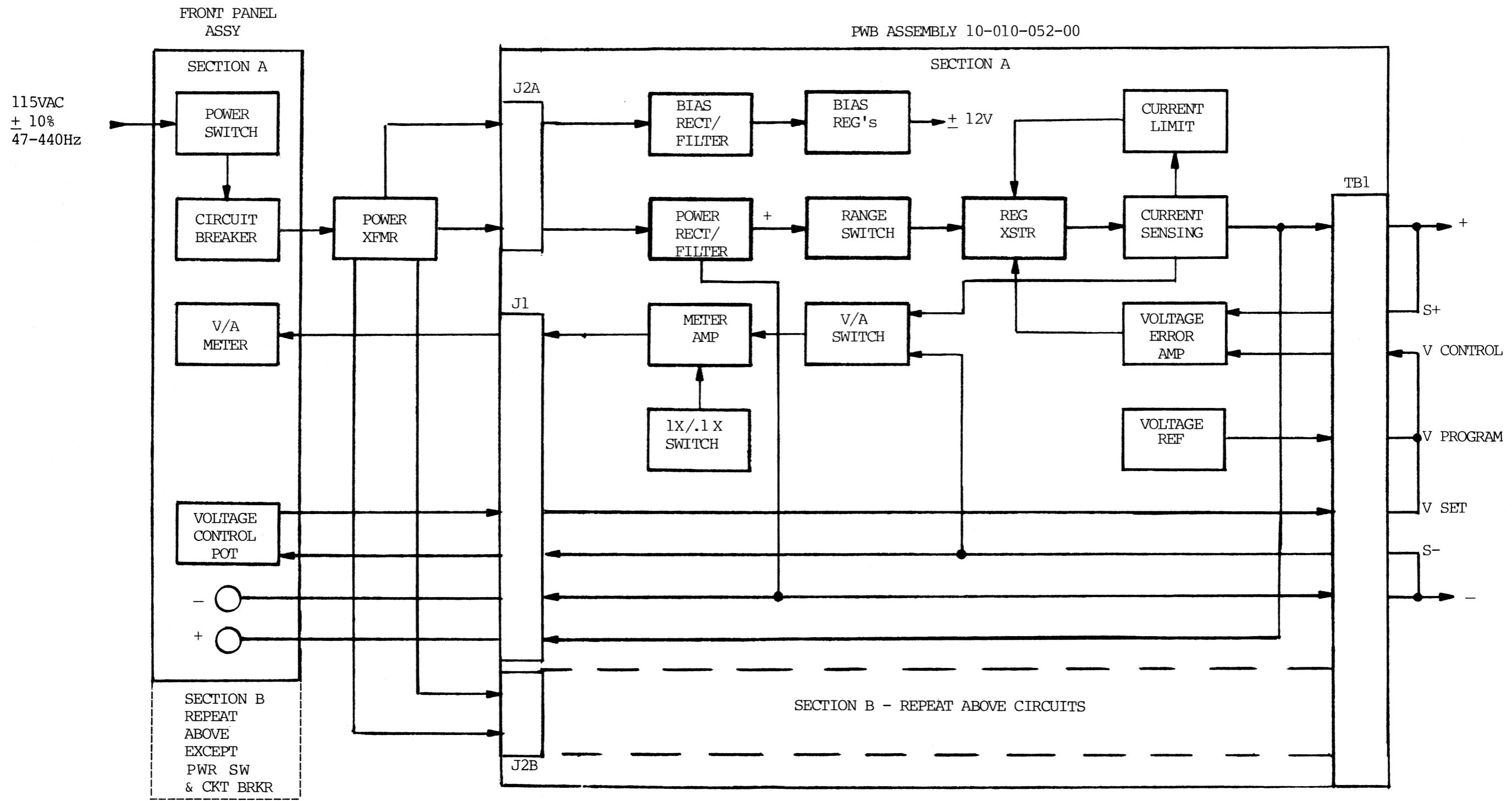


Figure 6-1. Dual Power Supply Block Diagram

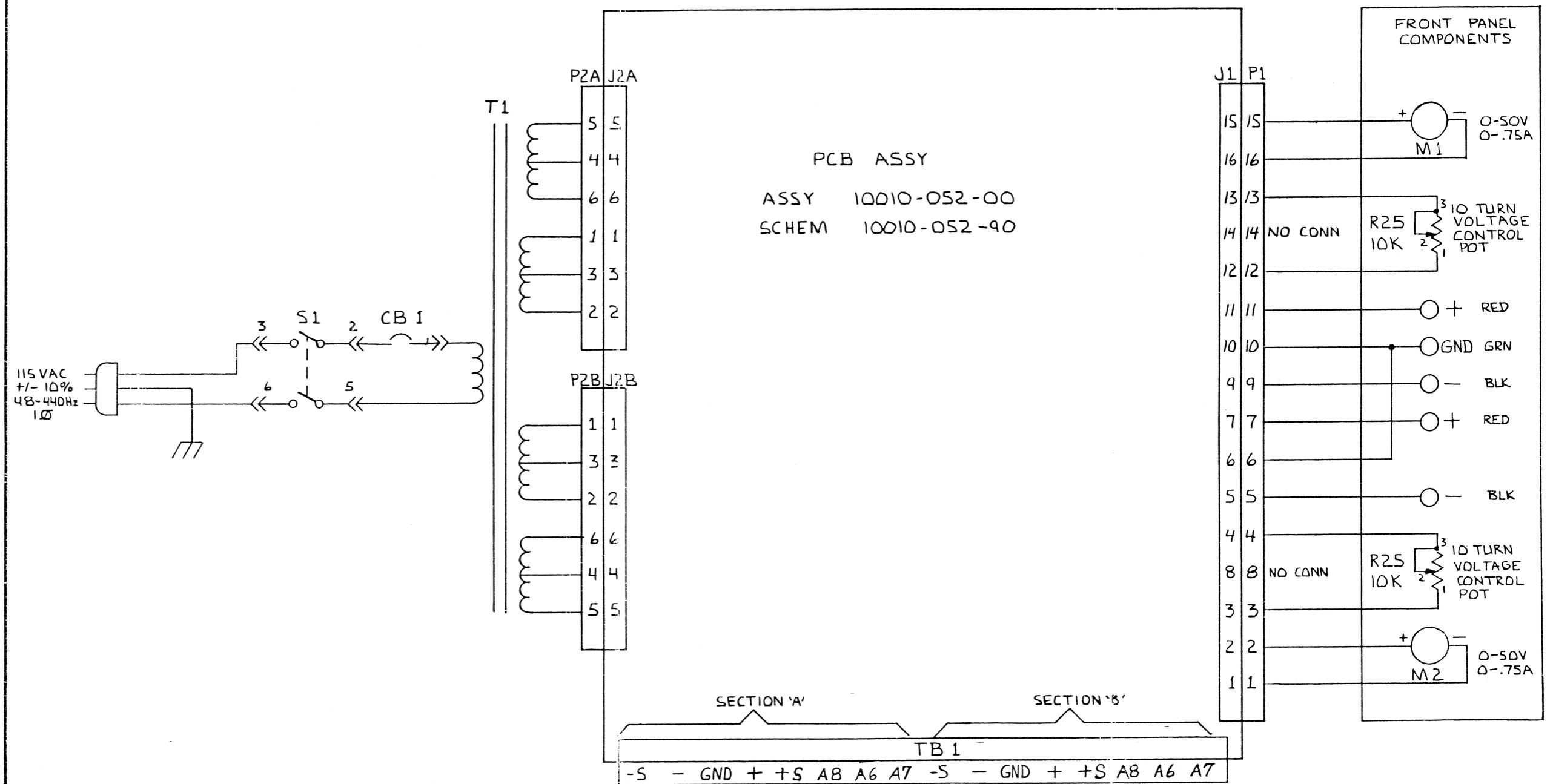
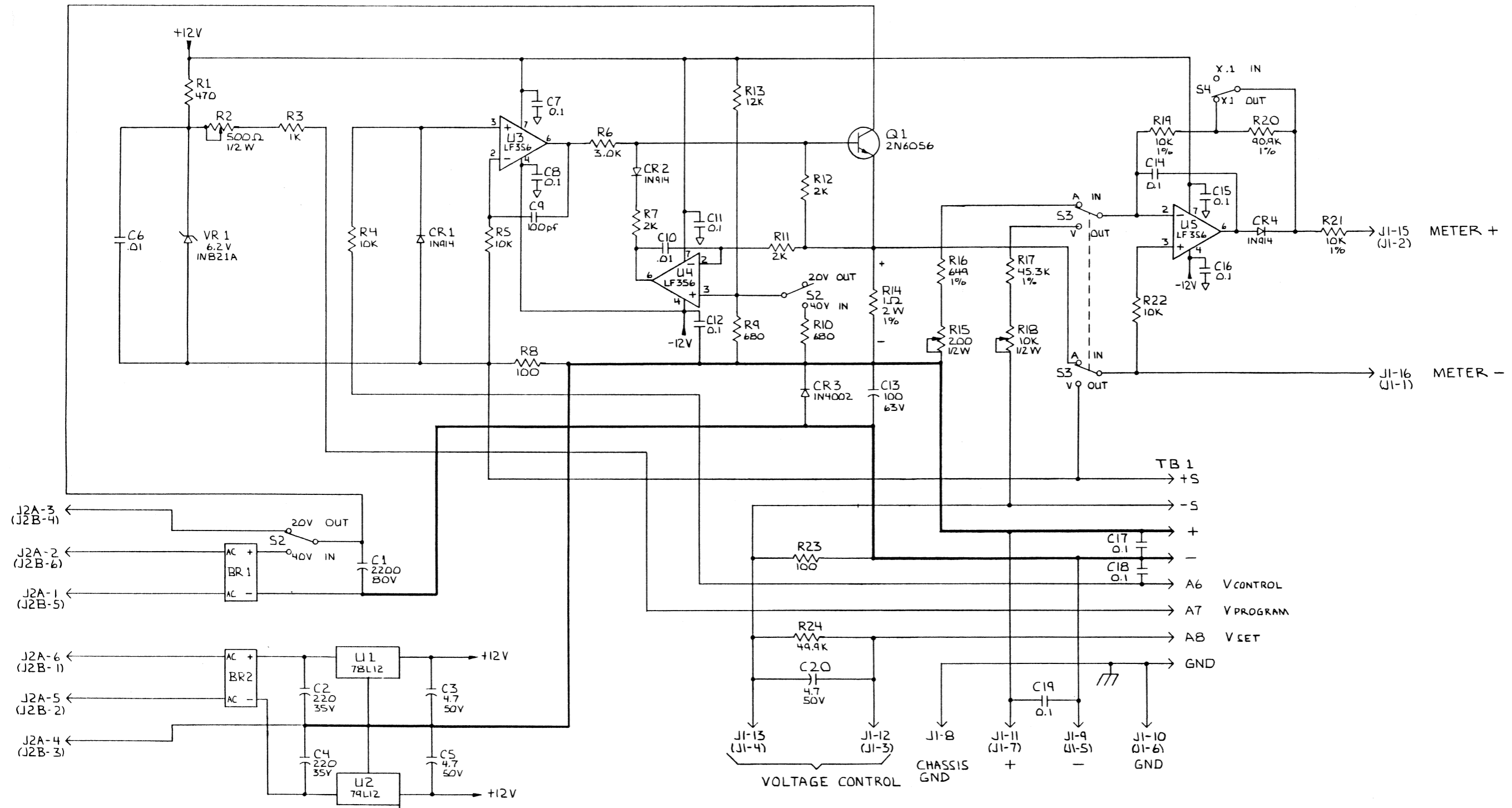


Figure 6-2. Power Supply Schematic for the Top Assembly of Model 2000.



- NOTES: UNLESS OTHERWISE SPECIFIED
1. CONNECTIONS ENCLOSED BY PARENTHESES INDICATE SECTION 'B' CONNECTORS.
  2. SCHEMATIC FOR SECTION 'B' IS IDENTICAL AS ABOVE.
  3. ALL RESISTANCES ARE IN OHMS
  4. ALL CAPACITANCES ARE IN MICROFARADS

Figure 6-3. Power Supply Schematic for the Printed Circuit Board of Model 2000.