CHAPTER 8

POWER SUPPLY

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INTRODUCTION

1. The Power Supply, which provides an unregulated + 24V d.c. by means of a conventional rectifier circuit and a regulated + 12V d.c. by means of a switch mode power supply also incorporates a battery trickle charger.

2. During normal operation the primary power requirements of the Transceiver (+24V d.c. and +12V d.c.) are derived from an external 230V/115V, 50Hz/60Hz source. Under emergency conditions a + 24V standby battery is automatically switched into circuit to provide power for the equipment.

CIRCUIT DESCRIPTION

3. Refer to Figure 2 for a circuit diagram of the Power Supply.

24V d.c. RECTIFIER

4. The rectifier provides + 24V d.c. at socket SK18 pins 7, 9 and 12, and to pin 1 of 24V/12V Converter p.c.b.

5. Fuse FS1 (5A) protects the primary a.c. source connected via PL16, against PSU failures. RF decoupling is provided for the LINE and NEUTRAL inputs, by toroid X2 and capacitors C1/C2 respectively. The LINE input is connected to transformer T1 via the control panel POWER switch which is open circuited in the OFF position.

6. T1 output, 23V r.m.s. for no load conditions, with 230V or 115V 50Hz input, depending on voltage selection, is applied to the bridge rectifier comprising D1 to D4. A selector switch connects T1 primary windings in series for a 230V input and in parallel for a 115V input. The rectified output is smoothed in the π filter comprising C4, C5, L1, C6 and C7. Transorb D3 limits transient voltage spikes to a maximum of 39V. Bleeder resistor R7 enables the smoothing capacitors to discharge when the POWER switch is set to OFF.

BATTERY SUPPLY

7. Under normal operating conditions the rectifier d.c. voltage output exceeds the battery voltage. Consequently diode D5 is reverse biased and current cannot flow from the battery. In the event of a failure of the external a.c. supply the bridge rectifier output is reduced to zero. D5 is then forward biased and the transceiver is powered from the battery.

BATTERY CHARGING

8. The function of the battery charger circuit, which comprises TR1, TR2, TR3 and associated components, is to provide a current, at a level suitable for a trickle charge via the current limiting resistor R9, when the transceiver is powered from an external a.c. source.

9. When the POWER switch is set to ON, TR3 is switched on from 24V d.c. via R5 to connect TR2 emitter circuit to OV. The charging circuit is then in a standby condition, ready to operate. Transistor TR2 and TR1 conduct, the battery charging current flowing from +24V d.c. via TR1 and R9.

10. Safety features are incorporated to prevent damage occuring to the charging circuit under reverse or faulty battery connected conditions. These are:

(a) Reverse battery connection.
If a battery is incorrectly connected diode D2 is reverse biased. Consequently TR2 and TR1 remain non-conducting. Diode D5 is also reverse biased and the battery terminals are, effectively, open circuited.

(b) Faulty battery.
The charging circuit is only operative if the BATT + ve voltage exceeds D1 zener voltage + D2 forward voltage + TR2 Vbe + TR3 Vce (saturated) — approximately 19,5V. Excessive current in R9 resulting from the connection of a battery with shorted cells is thus prevented.

SWITCH MODE POWER SUPPLY ASSEMBLY

11. The function of the Switch Mode Assembly which is a totally enclosed sub-unit is to provide a + 12V d.c. supply from + 24V d.c.

12. At initial switch on, + 24V is applied to pin 1 of the Switch Mode p.c.b. resulting in a + 12V reference at TR2 base. At the same time TR3 base, connected to the + 12V output circuit via R9 and D4, is at 0V. Current then flows in TR1 and TR2, whilst TR3 and TR4 are cut-off. Consequently TR1 emitter and one side of C2 are at + 24V. Capacitor C1 is charged via R6 across which a low voltage only is developed. A current path therefore exists for the base/emitter junctions of TR7 and TR6 via R10, R11 and R7. Current flowing in this path causes D2 to be reverse biased and TR7 to be switched hard on. The resulting voltage across TR7 being in the order of 100 to 200mV. The current in L1 (initially zero) increases linearly with time to charge C4 and C5. When the potential at TR3 base, via D4 and R9, rises above the + 12V reference at the TR2 base normal multivibrator action occurs so that TR3 and TR4 conduct and TR1 and TR2 are cut-off. TR4 is driven into saturation and D2 is forward biased. The sum of the saturation voltage across TR4 and the D2 forward voltage is less than the Vbe of TR7 and TR6. Consequently TR7 and TR6 are cut-off. The current flowing in L1 then decreases resulting in a back e.m.f. being generated which causes the catch diode D3 (fast recovery type) to become forward biased. This allows L1 to pump the remainder of the energy stored in the inductor into the output circuit in the form of current decreasing linearly with time. TR1 and TR4 then go into normal multivibrator action with TR2 and TR3 adjusting the on/off times by proportioning the discharge rates of C1 and C2 to maintain the average output voltage equal to the 12V reference.

13. When the switch TR6/TR7 is in the on condition L1, which becomes an inductive potential divider with a turns ratio 4,7:1, places TR6 collector approximately 2V below TR7 collector. As TR6 emitter potential is close to the collector potential when operating in the saturated condition, TR6 emitter is approximately 1,3V below TR7 base potential. The drive to TR7 is set by R11. If for any reason TR7 tends to come out of saturation the drive current is automatically increased due the increased voltage across R11. An increase in efficiency is obtained because the drive current also contributes to the load current.

14. An excessive current pulse in TR7 results in a potential across R10 greater than TR5 threshold level, so that TR5 is switched on. The resulting current flow in TR5 is integrated by C3 to produce a rising voltage level at TR3 base. The comparator transistor therefore senses a rising output voltage and adjusts TR7 on periods to decrease the output voltage. This reaction, even when a direct short circuit is applied to the converter, reduces TR7 on time to such a short period that the current in L1 never rises to a level that can destroy TR7.

SERVICING AND TEST INSTRUCTIONS

TEST EQUIPMENT

15. The following items of test equipment are required:

(a) PSU 0–35V d.c., 5A with current limiting.
(b) Variac 0–25V, 10A (fused) incorporating amp and volt meters.
(c) Ammeter 1A–0–1A/5A–0–5A center zero.
(d) Multimeter
(e) Voltmeter 30V–0–30V center zero.
(f) Load 5A (variable 6Ω, 130W)
(g) Load 10A (variable 3Ω, 220W)

(h) Load 1A (variable 33Ω, 30W)
(j) Resistor 6Ω, 25W
(k) Resistor 25Ω, 40W

PRELIMINARY OPERATIONS

16. **Switch Mode Assembly Mechanical Checks.** As the performance of the receiver circuits are adversly effected by faulty screening the following should be checked.

(a) Electrical decoupling
(b) Top and bottom covers of the Assembly must be tightly secured to the aluminium extrusion to form an effective screen.
(c) The Assembly must make good electrical contact with the support bar. In addition a check must be made to ensure the the decoupling capacitors or transistors mounted on the assembly cover do not come into contact with the components mounted on the converter p.c.b.

TEST PROCEDURES

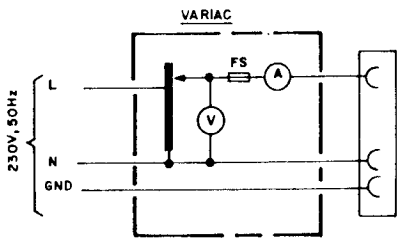
DC Resistance (Safety) Checks.

17. Using the multimeter set to the resistance function, measure as follows:

(1) PL16/B to chassis (set multimeter to lowest range).
This should be 0 to 0,5Ω
(2) PL16/A to chassis (Set multimeter to highest range).
This should be ⩾ 1MΩ – see note below Step (6).
(3) PL16/C to chassis
This should be ⩾ 1MΩ – see note below Step (6).
(4) PL16/C to PL17/2 (voltage selector to 230V and multimeter to lowest range).
This should be 3,4Ω approximately.
(5) PL16/C to PL17/2 (voltage selector to 115V)
This should be 1Ω approximately.
(6) Capacitor Interconnection p.c.b. pin 5 (-ve) to pin 9 (+ve)
This should be 400Ω (select a higher multimeter range if necessary).
NOTE : Allow capacitors time to charge.

Transformer and Diode Bridge Circuit.

18. (1) Remove fuse FS2.
(2) Check that voltage selector is to 230V.
(3) Connect jumper plug (pin 1 connected to pin 2 and pin 5 connected to pin 6) into SK17.
(4) Connect the variac output to the power supply as illustrated below.



(5) Set the variac to the 0V output position.
(6) Switch on the external a.c. supply.
(7) Using the multimeter measure the voltage between the 'live' side of FS2 fuseholder and SK18/1 for 100V a.c. and 230V a.c. variac output voltages. These should be as follows:
(i) 100V a.c.
d.c. output voltage – 8,5V
variac input current – 7mA to 15mA
(ii) 230V a.c.
d.c. output voltage – 21,5V
variac input current – 25mA to 40mA
Note the variac input current. Excessive current indicates wiring faults, reverse diodes, defective insulation etc.
(8) Return the variac to the 0V output position.
(9) Set the voltage selector to 115V.
(10) Repeat Step (7) for 50V and 115V variac outputs.
The d.c. voltage and variac current should be:
(i) 50V a.c.
d.c. output voltage – 8,5V
variac input current – 15mA to 40mA
(ii) 115V a.c.
d.c. output voltage – 21,5V
variac input current – 45mA to 85mA
(11) Return the variac to the 0V output position and the voltage selector to 230V a.c.
(12) Switch off the external a.c. supply.

+24V d.c. Smoothing Circuit

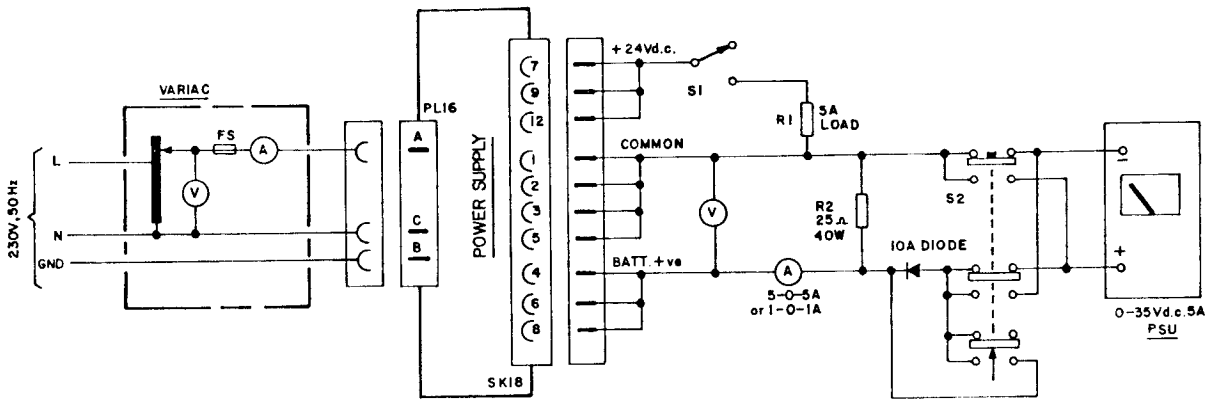
19. (1) Connect the 0 to 35V d.c. PSU, with current limiting set to 100mA, between the output side of FS2 fuse holder (+ve) and SK18/1 , 2, 3 or 5 (-ve)
(2) Switch on the PSU and increase the output voltage to +24V d.c.
Note the PSU output current.
This should not exceed 75mA.
(3) Switch off and remove the PSU.

Rectifier Output Circuit

20. (1) Replace FS2.
(2) Switch on the external a.c. supply.
(3) Increase the variac output voltage to 230V a.c.
(4) Note the rectifier d.c. output and variac input current at 100V and 230V with no load connected. These should be approximately the same as the readings obtained in Paragraph 18, Step (7).
(5) Return the variac to the 0V output position and switch off the external a.c. supply.

Charging Circuit

21. (1) Connect the power supply into the test circuit configuration illustrated opposite. Open switch S1.
(2) Switch on the PSU and set the output voltage to +25V d.c.
(3) Switch on the 230V, 50Hz supply and adjust the variac towards 230V.
Note the current flowing in R2 (as indicated by ammeter when switched to 1–0–1A f.s.d.) and the output voltage (with no load on 24V line) for the following a.c. inputs.
(i) 205V a.c.
Charging current – 100mA
Output voltage – 24,7V d.c.
(ii) 230V a.c.
Charging current – 600mA
Output voltage – 24,9V d.c.



(iii) 250V a.c.
Charging current – 1A
Output voltage – 26,3V d.c.

Mains Fail.

22. (1) Reduce the variac output to 0V.
(2) Close switch S1.
(3) Check that the battery (simulated by 0–35V d.c. PSU) supplies current to R1.
This is indicated by the ammeter (set to 5–0–5A range).
(4) Return the variac to the 230V a.c. output position.

+ve, –ve Lines/Power Supply Chassis Isolation.

23. (1) Connect a 30–0–30V voltmeter (shunted by a 470Ω, 2W resistor) between chassis and the +ve line (SK18 pin 7, 9 or 12).
The voltage reading should not exceed 3V.
(2) Switch off the 230V, 50Hz supply.
(3) Connect the multimeter, set to resistance range 20kΩ, between chassis and SK18 pin 1, 2, 3 or 5.
The resistance measured should not be less than 4k7Ω ± 5%

Battery Reversal

24. (1) Depress switch S2 to simulate reversal of battery connection.
(2) Check that current is not drawn from the battery (0–35V d.c. PSU).

+12V Output

25. (1) Switch on the 230V, 50Hz supply.
(2) Using the multimeter measure the voltage between SK18/10 (+ve) and SK18/1 (-ve).
This should be +12V d.c.

+24V d.c. Line – Regulation and Ripple

26. (1) Connect 1A, 5A and 10A loads between SK18 pins 7, 9, 12 and SK18 pins 1, 2, 3 and 5. Monitor the voltage across each load and the peak-to-peak ripple voltage.
These should be as follows:

Load	O/P	Voltage	Ripple (Vpp)
1A	29,5V	± 0,5V	1,5V/50mV
5A	27V	± 0,5V	1,3V/200mV
10A	24,5V	± 0,5V	1,3V/300mV

(2) Switch off the 230V, 50Hz supply and set the variac to the 0V output position.
(3) Set the power supply voltage selector to 115V.
(4) Switch on the 230V, 50Hz supply and adsjust the variac to give a 115V output.
(5) Repeat Step (1).
The results obtained should be substantially the same as before.
(6) Reset the power supply voltage selector to 230V.

PARTS LIST

27. The component tolerances and ratings given in these parts list are optimum. However if such components are not immediately available, alternatives with closer tolerances and/or higher wattage or voltage ratings may be used in manufacture, or supplied as replacements.

28. When ordering replacements please quote the full description, including the circuit reference and the Order No.

POWER SUPPLY UNIT

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
		1100-0587		**ASSEMBLY**	**POWER SUPPLY UNIT**	
				Sub-Assemblies		
		1300-0155			Mains Decoupling PCB	
		1300-0644			Switch Mode Assembly	
		1300-0645			Capacitor Interconnection PCB	
		1300-0737			Diode Mounting Block	
				Capacitors		
	C4	2400-4446			Electrolytic 10000uF 40V	
	C5	2400-4446			Electrolytic 10000uF 40V	
	C6	2400-4446			Electrolytic 10000uF 40V	
	C7	2400-4446			Electrolytic 10000uF 40V	
	C8	2400-2024			Electrolytic 100uF 25V Axial	
				Choke		
	L1	3000-0062			Choke	
				Diode		
	D6	3600-2013			Transient Voltage Suppressor 1,5kW, 15V	
				Fuses		
	FS1	2900-0051			5A 5 x 20	
	FS2	2900-0441			15A Slow Blow 6.3 x 32	
	FS3	2900-0047			2A 5 x 20	
				Plug		
	PL16	3300-2081			Connector Receptacle 3 pin, Panel Mtg	
				Sockets		
	SK17	3300-0105			Socket, 6–W	
	SK18	3300-0104			Socket, 12–W	

POWER SUPPLY UNIT (Cont.)

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
				Switch		
	S1	3200-0047			Voltage Select 230/115V – Toggle DPDT miniature	
				Toroids		
	X1	4200-0004			Toroid , Ferrite SA601	
	X2	4200-0004			Toroid , Ferrite SA601	
				Transformer		
	T1	3000-0061			Transformer 115/230V	

Mains Decoupling PCB

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
		1300-0155		PCB	Mains Decoupling	
				Capacitors		
	C1	2600-2517			Ceramic 10nF, 750 V d.c.	
	C2	2600-2517			Ceramic 10nF, 750 V d.c.	

Switch Mode Assembly

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
		1300-0644		**Assembly**	**Switch Mode**	
				Sub-Assemblies		
		1300-0657			Switch Mode PCB	
		1300-0683			Top Cover	

Switch Mode PCB

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
		1300-0657		PCB	Switch Mode	
				Capacitors		
	C1	2700-6050			Polyester 2N2 100V 10p.c.	
	C2	2700-6041			Polyester 1nF 100V 10p.c.	
	C3	2600-2535			Ceramic 10nF 200V 10p.c.	
	C4	2500-4014			Tantalum 100uF 16V	
	C5	2500-4014			Tantalum 100uF 16V	
				Diodes		
	D1	3600-0293			12,0V Zener 0,4W BZX 79C12	
	D2	3600-0404			IN4153	
	D3	3600-1335			MR852	
	D4	3600-0404			IN4153	
	D5	3600-0404			IN4153	
				Inductor		
	L1	3100-0705			Storage Inductor	
				Resistors		
	R1	2000-0341			Carbon 2k2 5p.c. 0,25W	
	R2	2000-0343			Carbon 3k3 5p.c. 0,25W	
	R3	2000-0349			Carbon 10k 5p.c. 0,25W	
	R4	2000-0350			Carbon 12k 5p.c. 0,25W	
	R5	2000-0349			Carbon 10k 5p.c. 0,25W	
	R6	2000-0347			Carbon 6k8 5p.c. 0,25W	

Switch Mode PCB (Cont.)

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
	R7	2000-0347			Carbon 6k8 5p.c. 0,25W	
	R8	2000-0325			Carbon 100 ohms 5p.c. 0,25W	
	R9	2000-0337			Carbon 1k 5p.c. 0,25W	
	R10	1300-1213			Special 0,08 ohms	
	R11	2000-0305			Carbon 2,2 ohms 5p.c. 0,25W	
	R12	2000-0337			Carbon 1k 5p.c. 0,25W	
				Transistors		
	TR1	3600-6728			2N3906 Germanium PNP	
	TR2	3600-0185			2N3904 Silicon NPN	
	TR3	3600-0185			2N3904 Silicon NPN	
	TR4	3600-6728			2N3906 Germanium PNP	
	TR5	3600-6728			2N3906 Germanium PNP	
	TR6	3600-0949			BC636/16 TELEFUNKEN PNP	

Top Cover Assembly

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
		1300-0683		**Assembly**	**Top Cover**	
				Sub-Assemblies		
		1300-0684			Decoupling PCB	
				Transistor		
	TR7	3600-0950 or			TIP42A PNP	
		3600-0871			BD244A PNP	
		1300-0684		**Decoupling PCB**		
				Capacitors		
	C6	2600-3421			Chip Ceramic 1uF 50V 20p.c.	
	C7	2600-3421			Chip Ceramic 1uF 50V 20p.c.	
	C8	2600-3421			Chip Ceramic 1uF 50V 20p.c.	
				Resistor		
	R14	2000-1149			Metal Film 22 ohms 1p.c. 0,25W	

Capacitor Interconnection PCB

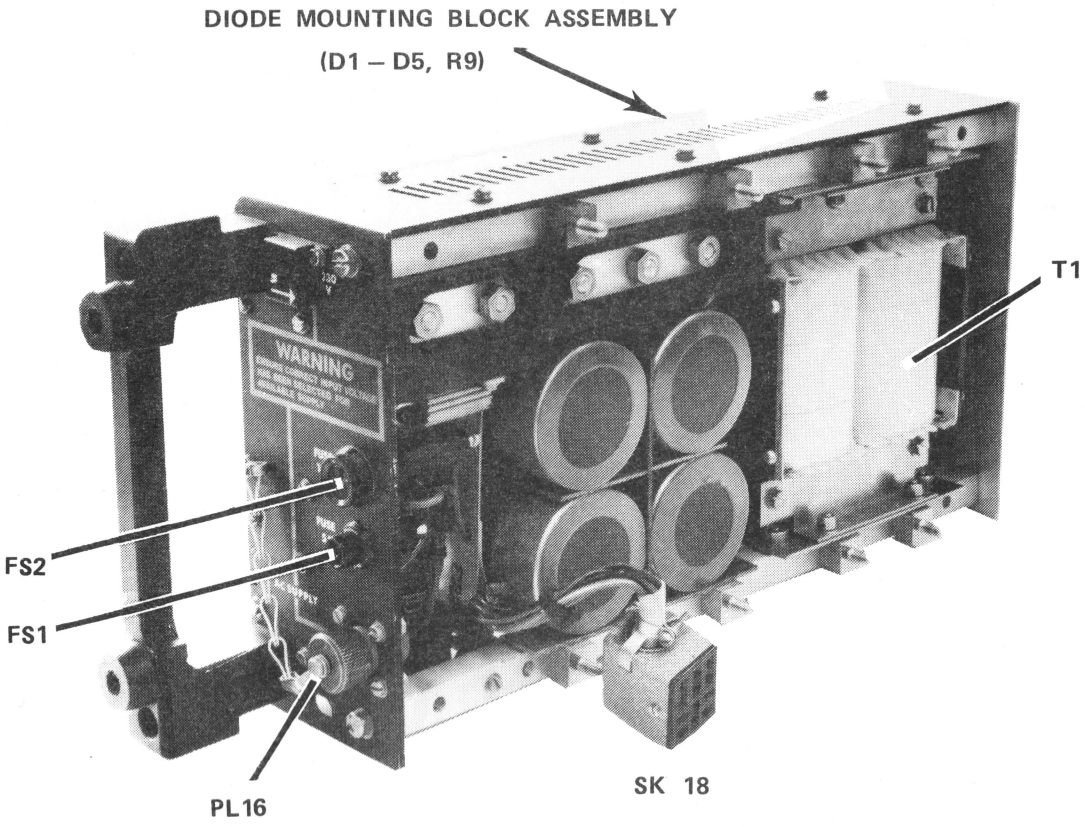
FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
		1300-0645		PCB	Capacitor Interconnection	
				Capacitors		
	C1	2600-3292			Ceramic 100nF 50V 10p.c.	
	C2	2600-3292			Ceramic 100nF 50V 10p.c.	
	C3	2600-3292			Ceramic 100nF 50V 10p.c.	
	C4	)				
	C5	) Mounted				
	C6	) on				
	C7	) Main Assembly				
				Diodes		
	D1	3600-0459			18.0 V Zener 0,5W BZX 83C18	
	D2	3600-0404			IN4153	
	D3	3600-1331			Transorb PF239A	
				Resistors		
	R1	2000-0349			Carbon 10k 5p.c. 0,25W	
	R2	2000-0337			Carbon 1k 5p.c. 0,25W	
	R3	2000-0337			Carbon 1k 5p.c. 0,25W	
	R4	2100-0473			Wirewound 470 ohms 2,5W	
	R5	2000-0353			Carbon 22k 5p.c. 0,25W	
	R6	2000-0349			Carbon 10k 5p.c. 0,25W	
	R7	2100-0473			Wirewound 470 ohms 2,5W	
	R8	2000-0345			Carbon 4k7 5p.c. 0,25W	

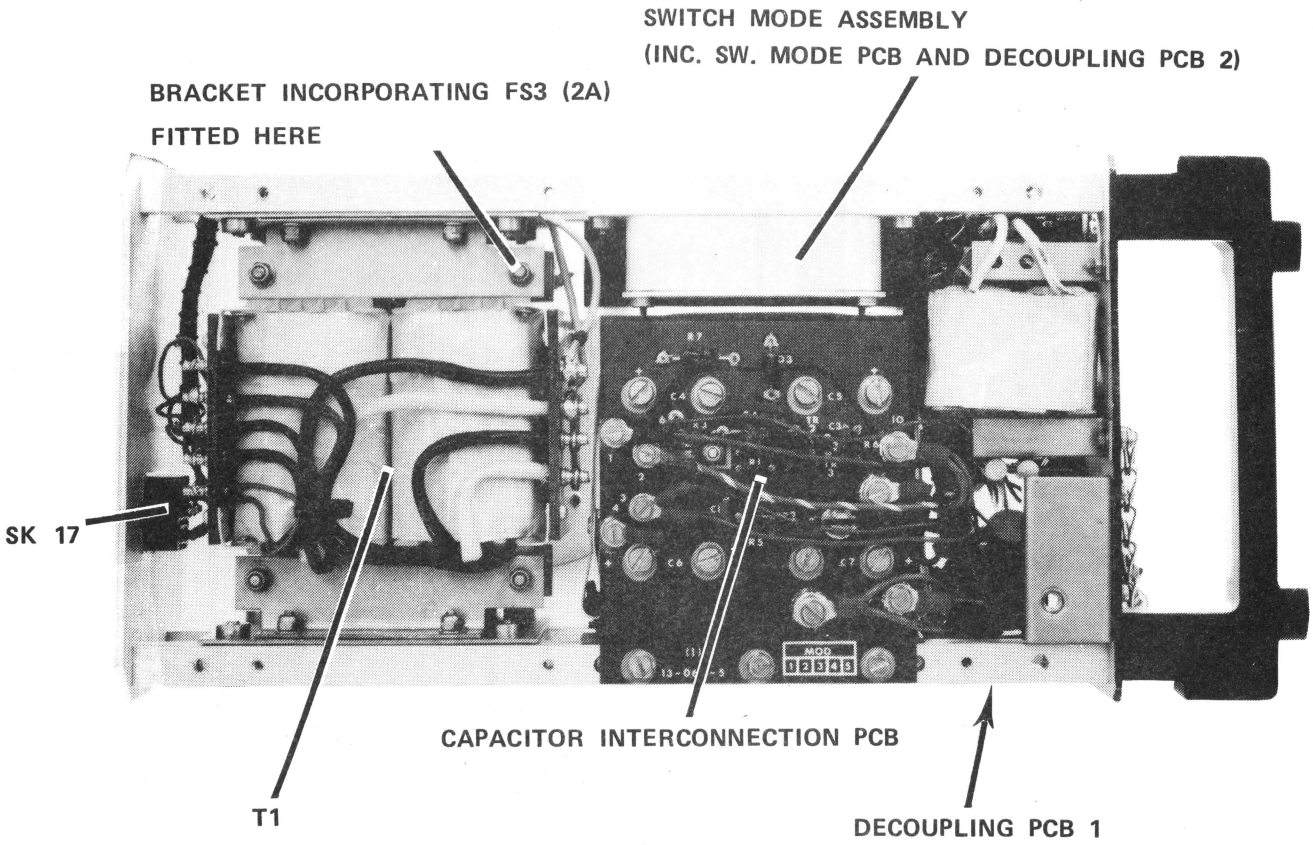
Capacitor Interconnection PCB (Cont.)

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
				Transistors		
	TR1	3600-0905			2N5195 PNP	
	TR2	3600-0185			2N3904 NPN	
	TR3	3600-0185			2N3904 NPN	

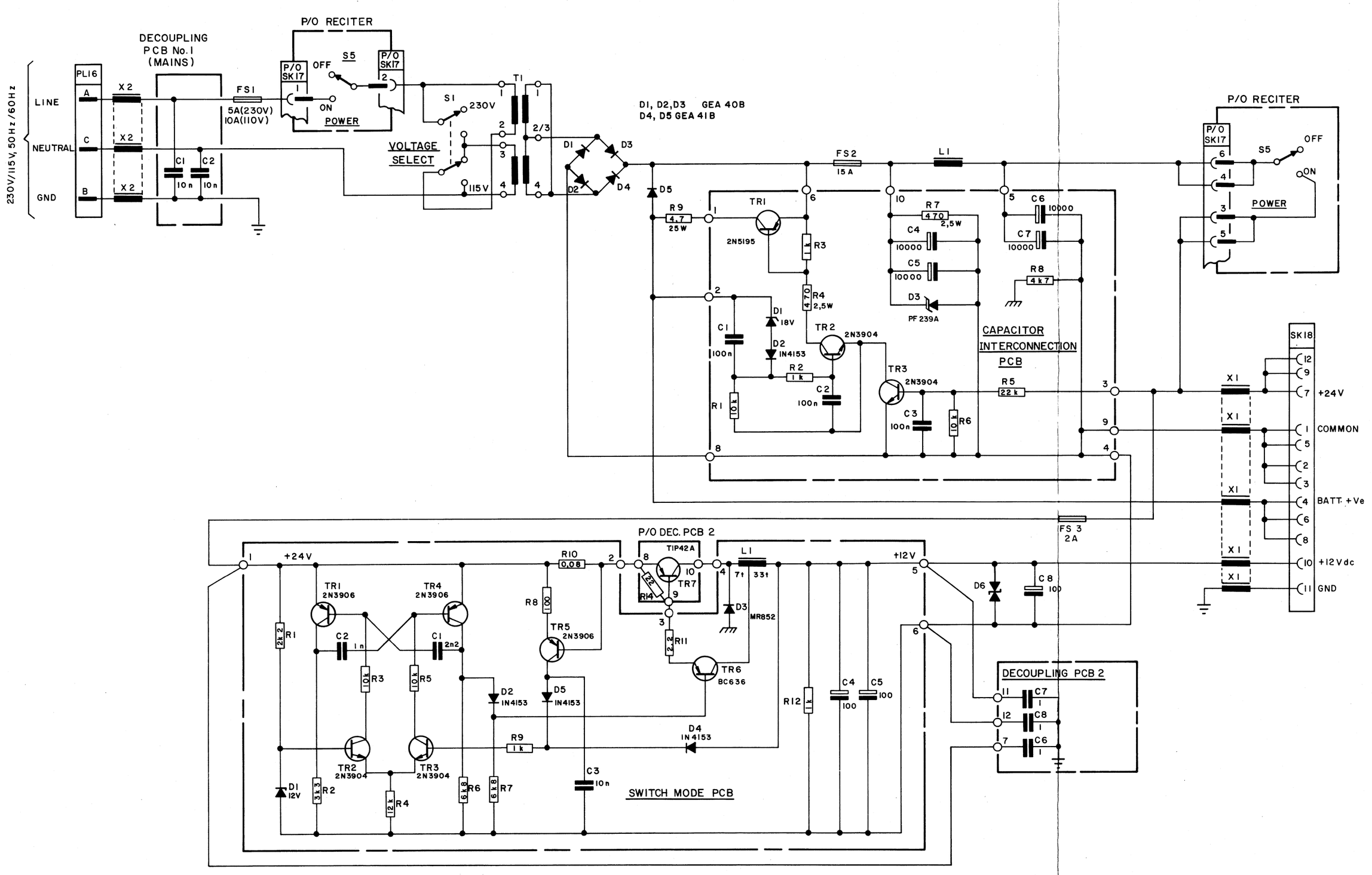
Diode Mounting Block Assembly

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
		1300-0737		Assembly	Diode Mtg Block	
				Diodes		
	D1	3600-1325			A40B Ge. Rect. 20A/200V Stud Anode	
	D2	3600-1325			A40B Ge. Rect. 20A/200V Stud Anode	
	D3	3600-1325			A40B Ge. Rect. 20A/200V Stud Anode	
	D4	3600-1326			A41B Ge. Rect. 20A/200V Stud Cathode	
	D5	3600-1326			A41B Ge. Rect. 20A/200V Stud Cathode	
				Resistor		
	R9	2100-0245			Wirewound 4,7 ohms 3p.c. 25W	





POWER SUPPLY



POWER SUPPLY CIRCUIT DIAGRAM

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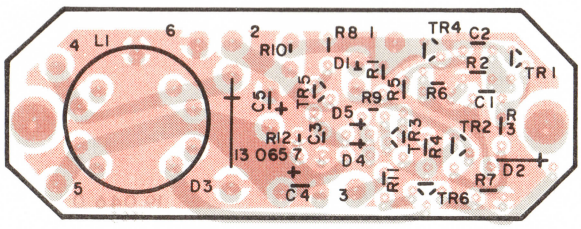
FIG. 2

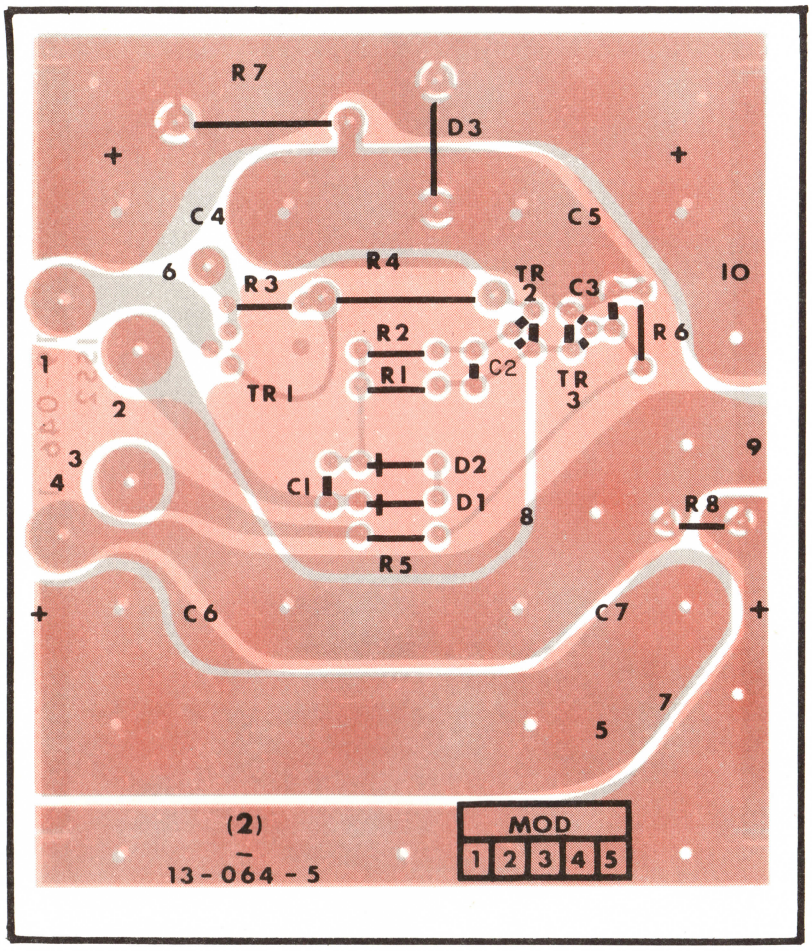


PCB Component Side:

PCB Track Side:

SWITCH MODE PCB

Component Layout



PCB Component Side:

PCB Track Side:

CAPACITOR INTERCONNECTION PCB
Component Layout