CHAPTER 5

HARMONIC FILTER

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INTRODUCTION

1. The Harmonic Filter comprises six elliptic function filters and a reflectometer circuit.

CIRCUIT DESCRIPTION

FILTERS

2. The filters which operate over the following frequency bands:

(a)	A Filter	–	1,6 MHz	to	2,5 MHz
(b)	B Filter	–	2,6 MHz	to	4,1 MHz
(c)	C Filter	–	4,2 MHz	to	6,8 MHz
(d)	D Filter	–	6,9 MHz	to	11,2 MHz
(e)	E Filter	–	11,3 MHz	to	18,4 MHz
(f)	F Filter	–	18,5 MHz	to	29,9 MHz

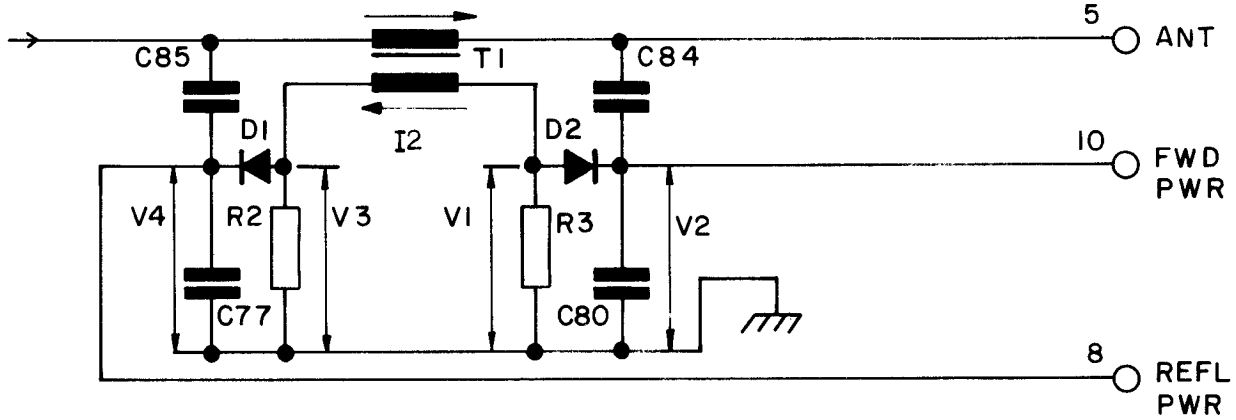
are connected, individually, in series with the antenna to ensure that transmitted signals are free from harmonics. The filter connected is selected by relays RLS to RLM. These relays are operated by signals from the Control Logic PCB.

3. Relay RLN, which is also operated from the Control Logic PCB, control the routing of signals to the antenna from the PA and from the antenna to the reciter.

REFLECTOMETER

4. The function of the reflectometer circuit is to provide information to the reciter front panel meter and to act as a protective device should the v.s.w.r. increase to a dangerous level.

5. The circuit design is of a conventional reflectometer, the operational principle of which is described below:



Transformer T1 is a current transformer. Capacitors C85, C77 and C84, C80 are capacitive dividers. Resistors R2 and R3 are load resistors.

Matched Conditions

(i) The r.f. signal flows via T1 primary to the antenna feeder.

(ii) Voltage V1 is developed across R3 via T1 secondary and voltage V2 developed across C80 via the feeder and C84.

(iii) V1 and V2 are equal in amplitude (as determined by the values of R3, R2, T1 secondary, C80 and C84), but differ 180° in phase due to phase shift in T1.

(iv) The phase difference is detected by D2, which conducts each time V1 is positive with respect to V2. The resultant d.c. voltage is smoothed and passed on to a comparator in the power amplifier via terminal 10 (FWD PWR).

(v) Voltage V3 is developed across R2 via the secondary of T1 and voltage V4 developed across C77 via the feeder and C85.

(vi) V3 and V4 are equal in amplitude (as determined by the values of R2, R3, T1 secondary, C85 and C77) and also in phase.

(vii) No phase difference can be detected by D1, thus the output of D1 is 0V. D1 output is passed to the comparator in the power amplifier via terminal 8 (REFL. PWR).

(viii) The voltages appearing at FWD PWR and REFL PWR terminals are:

(a)	FWD PWR	=	V2 + I2R3	=	2V
(b)	REFL PWR	=	V4 − I2R2	=	0V
	where V2	=	Voltage developed across C80.		
	I2	=	Current through T1 secondary, R2 and R3.		
	V4	=	Voltage developed across C77.		

Mismatched Conditions

(a) Short Circuit

(i) If a short circuit of the antenna feeder occurs, the voltage and current components comprising the r.f. signal flowing through T1 primary differ in phase.

(ii) T1 only senses the r.f. signal current component, therefore voltage V3 differs from voltage V4 in phase.

(iii) The phase difference is detected by D1, which conducts each time V3 is positive with respect to V4. The resultant d.c. voltage is smoothed and passed on to the comparator in the power amplifier via terminal 8 (REFL PWR).

(iv) The voltage appearing at the FWD PWR and REFL PWR terminals are:

(a) FWD PWR = V2 + I2 R3
(b) REFL PWR = V4 + I2 R2
Note: Under full short cct conditions V2 and V4 = 0V, thus voltages at FWD PWR and REFL PWR terminals = I2 R3 and I2 R2 respectively.

(v) Under short circuit conditions voltages therefore appear at both the REFL PWR and FWD PWR terminals.

(b) Open Circuit

(i) If an open circuit of the antenna circuit occurs, no r.f. current flows through T1 primary, thus voltages are not developed across R2 and R3.

(ii) Voltages V2 and V4, however, are still developed across C80 and C77. These voltages are equal in amplitude and are passed to the comparator in the power amplifier via terminals 8 and 10 (REFL PWR and FWD PWR) respectively.

6. If the voltages applied to the comparator via REFL PWR and FWD PWR are equal, as for short circuit or open circuit conditions, then protection circuits in the power amplifier are initiated in order to prevent damage being caused to the power amplifier.

7. When the AM mode is selected, transistor TR1 on the Harmonic Filter PCB is switched into the circuit by + 9V on the AM TX line. TR1 together with C76 changes the time delay of the ALC detector circuit, on the PA PCB, so that it operates on an average instead of a peak value.

SERVICING AND TEST INSTRUCTIONS

8. The following paragraphs detail the procedure used to test the Harmonic Filter Unit. There are no electrical adjustments given as the performance of the module is dependent on the inductance and capacitance of the filter elements. Inductors L1 to L18 are preset during manufacture.

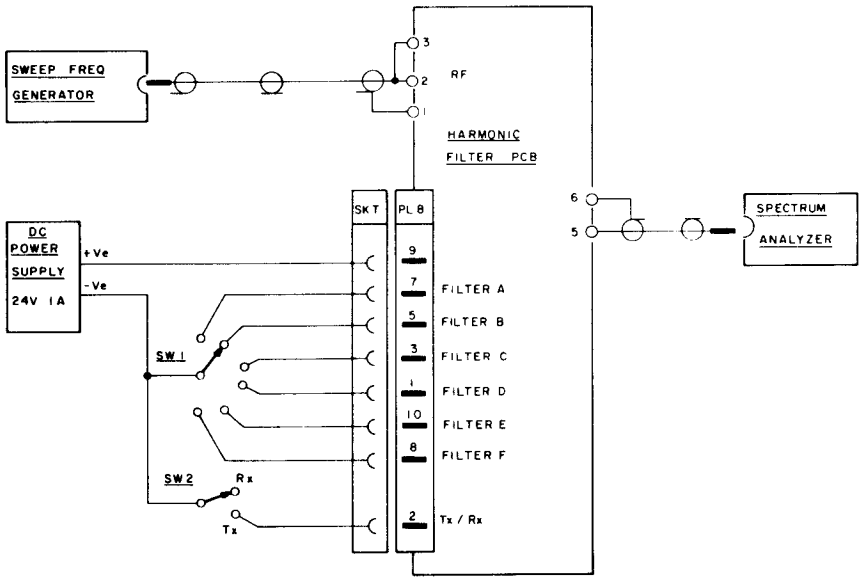
9. The test procedure does not provide for testing of the automatic level control circuit as this forms an integral part of the power amplifier circuit.

10. The following items of test equipment are required:

(a)	Power Supply	:	24V d.c., 1A with current limiting.
(b)	Spectrum Analyzer and)	:	1 to 110MHz
(c)	Tracking Generator)		
(d)	Switches S1 and S2 as illustrated.		

PRELIMINARY OPERATIONS

11. Connect the Harmonic Filter PCB, test equipment and switches as illustrated below. Coaxial leads, which should be as short as possible, must be soldered to the p.c.b. pins.



12. The sweep generator and spectrum analyser must be connected to the Harmonic Filter PCB with 50 ohm coaxial cable.

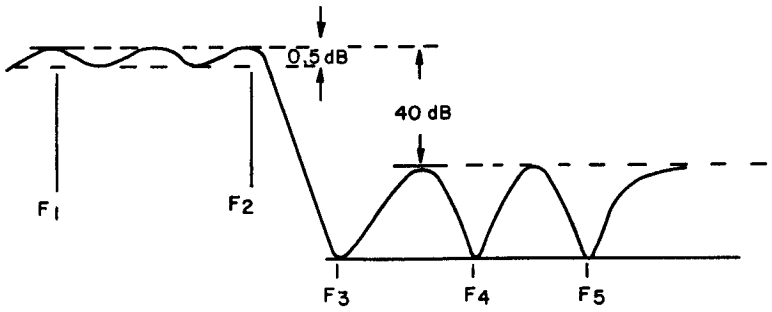
13. Set the d.c. power supply to +24V and the current limit to 500mA.

TEST PROCEDURE

14. The test procedure is as follows:

(1) Switch on the PSU, Frequency Analyser and Tracking Generator.
Set the Tracking Generator output to 100mV.

(2) Set switch S1 to position 'A' (1,6 – 2,5MHz) adjust the analyser so that the filter response is shown on the screen. This should be as indicated below.



The ripple within the filter passband, f1 to f2, should be less than ±0,5dB.
The stopband, f3 to f4, must be at least 40dB lower than the passband.

(3) Switch S2 from RX to TX and check that the same response is displayed.

(4) Repeat steps 2 to 3 for filters B to F.

NOTE

The ripple in the stopband will vary with filter selections but the ripple peak must never be less than –40dB.

15. Table 1 below lists frequencies f1 to f5 for each filter.

TABLE 1 FILTER FREQUENCIES (MHz)

FILTER	F1	F2	F3	F4	F5
A	1,6	2,6	3,24	3,622	5,665
B	2,6	4,2	5,2	5,95	9,35
C	4,2	6,9	8,4	9,62	15,1
D	6,9	11,3	13,8	15,82	24,83
E	11,3	18,5	22,6	25,9	40,66
F	18,5	30,0	37,0	41,89	65,75

PARTS LIST

16. The component tolerances and ratings given in this 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.

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

HARMONIC FILTER PCB

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
		1300-0866		PCB	HARMONIC FILTER	
				Capacitors		
	C1	2600-5094			Mica, 75pF 2p.c. 500V	
	C2	2600-6783			Mica, 820pF 2,5p.c. 500V	
	C3	2600-5582			Mica, 180pF 2p.c. 500V	
	C4	2600-4782			Mica, 39pF 2p.c. 500V	
	C5	2600-4942			Mica, 51pF 2p.c. 500V	
	C6	2600-6490			Mica, 470pF 2p.c. 500V	
	C7	2600-4396			Mica, 24pF ±1pF 500V	
	C8	2600-5293			Mica, 110pF 2p.c. 500V	
	C9	2600-5688			Mica, 200pF 2p.c. 500V	
	C10	2600-5386			Mica, 120pF 2p.c. 500V	
	C11	2600-4942			Mica, 51pF 2p.c. 500V	
	C12	2600-4683			Mica, 33pF 2p.c. 500V	
	C13	2600-5688			Mica, 200pF 2p.c. 500V	
	C14	2600-4942			Mica, 51pF 2p.c. 500V	
	C15	2600-5092			Mica, 68pF 2p.c. 500V	
	C16	2600-4683			Mica, 33pF 2p.c. 500V	
	C17	2600-4942			Mica, 51pF 2p.c. 500V	
	C18	2600-4382			Mica, 20pF 2p.c. 500V	
	C19	2600-6984			Mica, 1300pF 2p.c. 500V	
	C20	2600-5293			Mica, 110pF 2p.c. 500V	
	C21	2600-6783			Mica, 820pF 2,5p.c. 500V	
	C22	2600-6285			Mica, 330pF 2p.c. 500V	
	C23	2600-6783			Mica, 820pF 2,5p.c. 500V	
	C24	2600-4942			Mica, 51pF 2p.c. 500V	

HARMONIC FILTER PCB (Cont.)

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION				NO/UNIT
	C25	2600-6296			Mica,	430pF	2p.c.	500V	
	C26	2600-5983			Mica,	270pF	2p.c.	500V	
	C27	2600-5841			Mica,	240pF	2p.c.	500V	
	C28	2600-6082			Mica,	300pF	2p.c.	500V	
	C29	2600-6298			Mica,	440pF	2p.c.	500V	
	C30	2600-6285			Mica,	330pF	2p.c.	500V	
	C31	2600-4396			Mica,	24pF	±1pF	500V	
	C32	2600-5841			Mica,	240pF	2p.c.	500V	
	C33	2600-5688			Mica,	200pF	2p.c.	500V	
	C34	2600-5501			Mica,	160pF	2p.c.	500V	
	C35	2600-5296			Mica,	100pF	1p.c.	400V	
	C36	2600-4984			Mica,	56pF	2p.c.	500V	
	*C37	2600-3897			Mica,	47pF	5p.c.	2kV	
	C38				Mica,	390pF	2p.c.	500V	
	C39	2600-6783			Mica,	820pF	2,5p.c.	500V	
	C40	2600-6721			Mica,	750pF	2p.c.	500V	
	C41	2600-5386			Mica,	120pF	2p.c.	500V	
	C42	2600-6721			Mica,	750pF	2p.c.	500V	
	C43	2600-5841			Mica,	240pF	2p.c.	500V	
	C44	2600-6082			Mica,	300pF	2p.c.	500V	
	C45	2600-6292			Mica,	390pF	2p.c.	500V	
	C46	2600-5092			Mica,	68pF	2p.c.	500V	
	C47	2600-6082			Mica,	300pF	2p.c.	500V	
	C48	2600-4683			Mica,	33pF	2p.c.	500V	
	C49	2600-5501			Mica,	160pF	2p.c.	500V	
	C50	2600-5386			Mica,	120pF	2p.c.	500V	
	C51	2600-5296			Mica,	100pF	1p.c.	400V	
	C52	2600-5296			Mica,	100pF	1p.c.	400V	
	C53	2600-5521			Mica,	170pF	2p.c.	500V	
	C54	2600-5296			Mica,	100pF	1p.c.	400V	

Note: C37 = 2 x 47pF Caps. connected in parallel.

HARMONIC FILTER PCB (Cont.)

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION				NO/UNIT
	C55	2600-4396			Mica,	24pF	±1pF	500V	
	C56	2600-4692			Mica,	36pF	2p.c.	500V	
	C57	2600-5296			Mica,	100pF	1p.c.	400V	
	C58	2600-5094			Mica,	75pF	2p.c.	500V	
	C59	2600-6082			Mica,	300pF	2p.c.	500V	
	C60	2600-5601			Mica,	190pF	2p.c.	500V	
	C61	2600-5501			Mica,	160pF	2p.c.	500V	
	C62	2600-5296			Mica,	100pF	1p.c.	400V	
	C63	2600-5296			Mica,	100pF	1p.c.	400V	
	C64	2600-4942			Mica,	51pF	2p.c.	500V	
	C65	2600-5293			Mica,	110pF	2p.c.	500V	
	C66				Not Used				
	C67				Not Used				
	C68	2600-3292			Monolithic	100nF	10p.c.	50V	
	C69	2600-3292			Monolithic	100nF	10p.c.	50V	
	C70	2600-3292			Monolithic	100nF	10p.c.	50V	
	C71	2600-3292			Monolithic	100nF	10p.c.	50V	
	C72	2600-3292			Monolithic	100nF	10p.c.	50V	
	C73	2600-3292			Monolithic	100nF	10p.c.	50V	
	C74	2600-3292			Monolithic	100nF	10p.c.	50V	
	C75	2600-3292			Monolithic	100nF	10p.c.	50V	
	C76	2500-6064			Tantalum	1uF	20p.c.	35V	
	C77	2700-2216			Polystyrene	250pF	5p.c.	63V	
	C78	2600-3374			Monolithic	1nF	10p.c.	200V	
	C79	2600-3292			Monolithic	100nF	10p.c.	50V	
	C80	2700-2216			Polystyrene	250pF	5p.c.	63V	
	C81	2600-3266			Monolithic	10nF	10p.c.	100V	
	C82	2600-3292			Monolithic	100nF	10p.c.	50V	
	C83	2600-3374			Monolithic	1nF	10p.c.	200V	

HARMONIC FILTER PCB (Cont.)

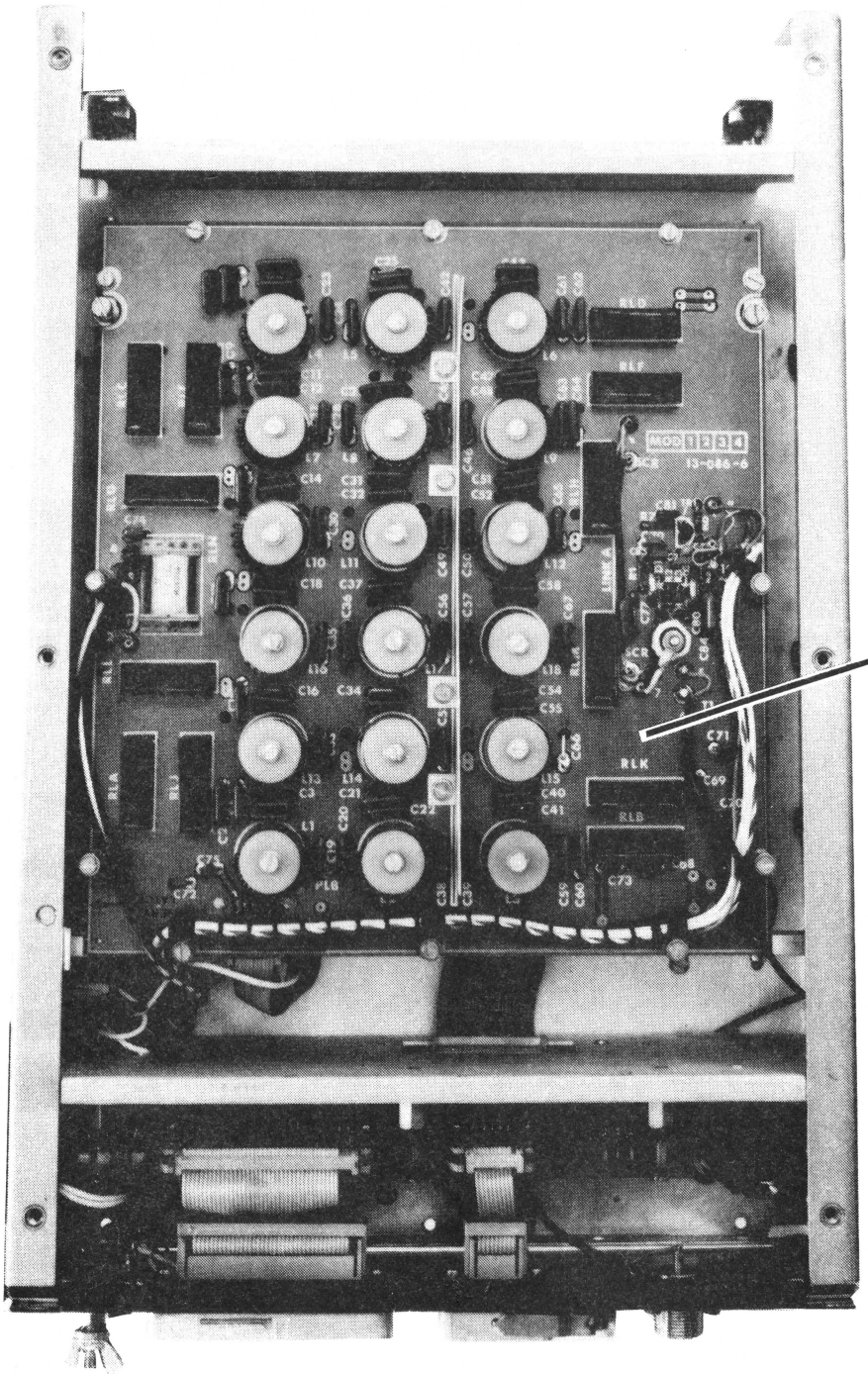
FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
	C84	2600-3996			Mica, 8pF 2p.c. 500V	
	C85	2600-3996			Mica, 8pF 2p.c. 500V	
				Connector		
	PL8	3300-1588			Plug, Right Angle, 609-1002M, 10-way	
				Diodes		
	D1	3600-0404			Diode IN4153	
	D2	3600-0404			Diode IN4153	
				Inductors		
	L1	3100-0756			Coil Assembly	
	L2	3100-0757			Coil Assembly	
	L3	3100-0758			Coil Assembly	
	L4	3100-0759			Coil Assembly	
	L5	3100-0760			Coil Assembly	
	L6	3100-0761			Coil Assembly	
	L7	3100-0762			Coil Assembly	
	L8	3100-0763			Coil Assembly	
	L9	3100-0764			Coil Assembly	
	L10	3100-0765			Coil Assembly	
	L11	3100-0766			Coil Assembly	
	L12	3100-0767			Coil Assembly	
	L13	3100-0768			Coil Assembly	
	L14	3100-0769			Coil Assembly	
	L15	3100-0770			Coil Assembly	

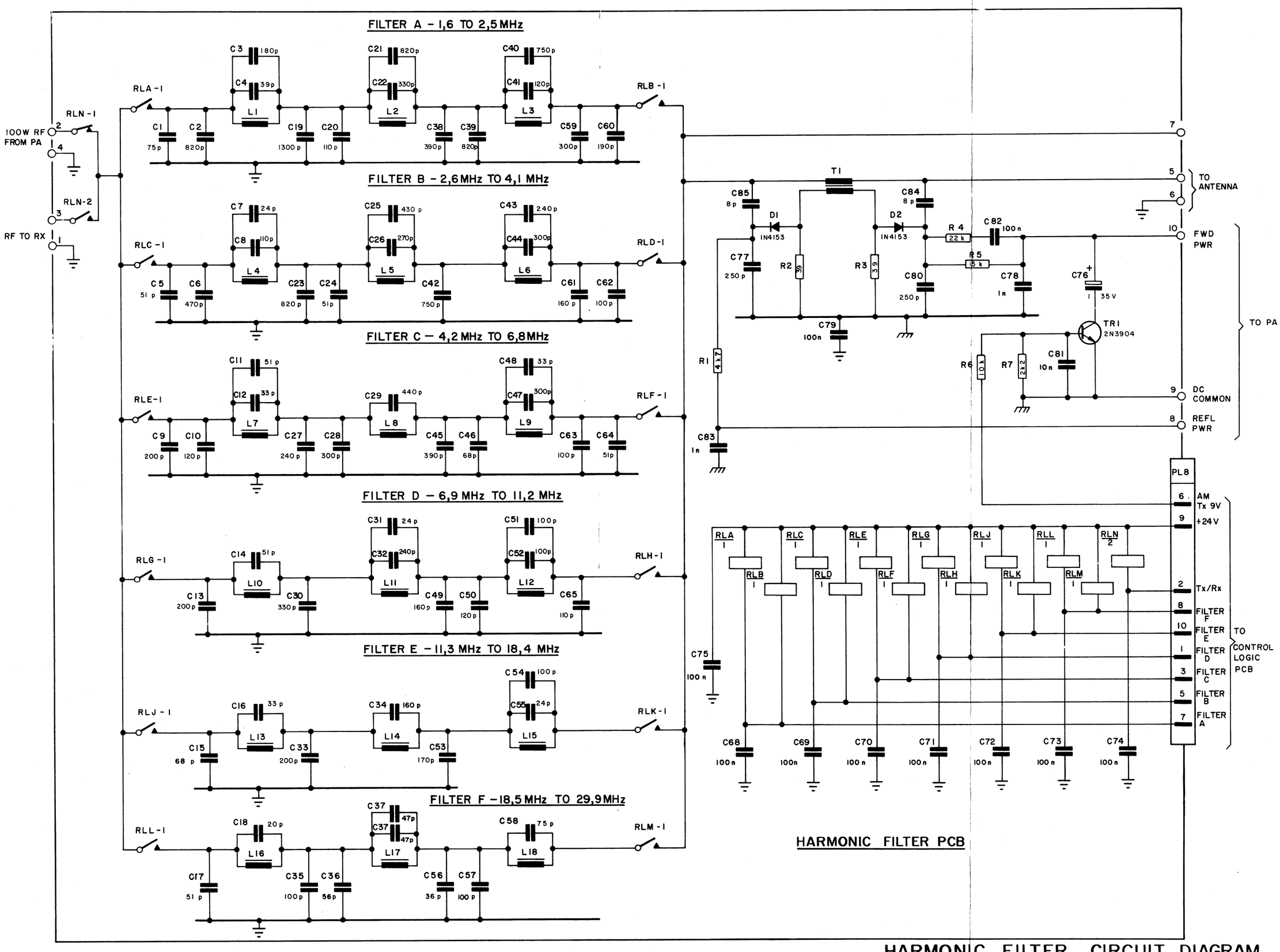
HARMONIC FILTER PCB (Cont.)

FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
	L16	3100-0771			Coil Assembly	
	L17	3100-0772			Coil Assembly	
	L18	3100-0773			Coil Assembly	
				Relays		
	RLA	3400-0169			Reed, SP, 24V	
	RLB	3400-0169			Reed, SP, 24V	
	RLC	3400-0169			Reed, SP, 24V	
	RLD	3400-0169			Reed, SP, 24V	
	RLE	3400-0169			Reed, SP, 24V	
	RLF	3400-0169			Reed, SP, 24V	
	RLG	3400-0169			Reed, SP, 24V	
	RLH	3400-0169			Reed, SP, 24V	
	RLJ	3400-0169			Reed, SP, 24V	
	RLK	3400-0169			Reed, SP, 24V	
	RLL	3400-0169			Reed, SP, 24V	
	RLM	3400-0169			Reed, SP, 24V	
	RLN	3400-0170			Reed, SP, 24V	
				Resistors		
	R1	2000-1925			Metal film, 4k7 2p.c. 0,25W	
	R2	2000-0320			Carbon 39 ohm 5p.c. 0,25W	
	R3	2000-0320			Carbon 39 ohm 5p.c. 0,25W	
	R4	2000-0353			Carbon 22k 5p.c. 0,25W	
	R5	2000-0351			Carbon 15k 5p.c. 0,25W	
	R6	2000-0349			Carbon 10k 5p.c. 0,25W	
	R7	2000-0341			Carbon 2k2 5p.c. 0,25W	
				Transformer		
	T1	3100-0697				

HARMONIC FILTER PCB (Cont.)

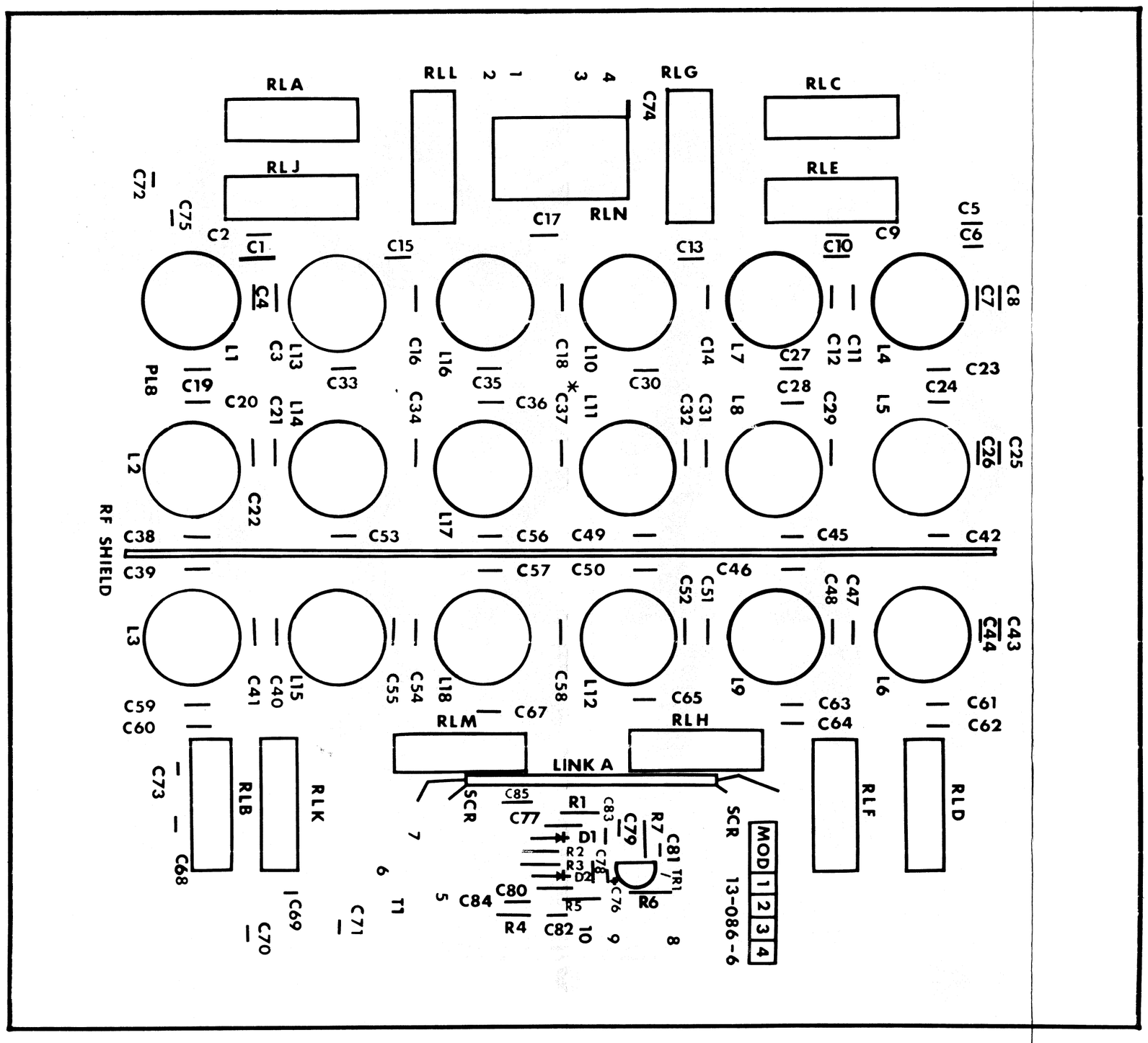
FIG. NO.	REF.	ORDER NO.	CODIFICATION	ITEM	DESCRIPTION	NO/UNIT
				Transistor		
	TR1	3600-0185			2N3904, Si, NPN	


HARMONIC
FILTER PCB



HARMONIC FILTER CIRCUIT DIAGRAM

FIG. 2



NOTE:- *C37 = 2x CAPS CONNECTED IN PARALLEL

TRACK SIDE:

HARMONIC FILTER PCB
COMPONENT LOCATION