TRANSMITTING SETS RADIO, RACAL TYPE TTA.1860A AND TTA.1860S (UK/FRT-618) ALSO DRIVE UNIT TYPE M.1721S

NOTE: SINCE PUBLICATION OF THIS A.P. THE TRANSMITTING SET RADIO TTA.1860A HAS BEEN REMOVED FROM SERVICE AND IS NOW OBSOLETE.

GENERAL AND TECHNICAL INFORMATION
ALSO
REPAIR AND RECONDITIONING INSTRUCTIONS

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence

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WARNINGS

CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH

MAKE SURE YOU KNOW THE SAFETY PRECAUTIONS AND FIRST AID INSTRUCTIONS BEFORE YOU USE A HAZARDOUS SUBSTANCE

READ THE LABEL ON THE CONTAINER IN WHICH THE SUBSTANCE IS SUPPLIED

READ THE DATA SHEET APPLICABLE TO THE SUBSTANCE

OBEY THE LOCAL ORDERS AND REGULATIONS

WARNINGS

(1) LETHAL VOLTAGE. DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. REFER TO JSP 375 VOL 2 AND DEF STAN 61-15 ISS 3 FOR SAFETY PRECAUTIONS

▶ (2) IONIZING RADIATION. THIS EQUIPMENT CONTAINS CLASS 1 RADIOACTIVE VALVES. REFER TO JSP 392 CHPT 30 ◀

(3) BERYLLIUM/BERYLLIA. THIS EQUIPMENT CONTAINS COMPONENTS THAT ARE OF BERYLLIUM/BERYLLIA. REFER TO JSP F 395 100B-10 (RAF) FOR SAFETY PRECAUTIONS

(4) LIFTING/REMOVAL PRECAUTIONS

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

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WARNING

BERYLLIUM/BERYLLIA. THIS EQUIPMENT CONTAINS BERYLLIUM/BERYLLIA MATERIAL AND/OR ITEMS. REFER TO THE BERYLLIUM/BERYLLIA WARNINGS IN THE PRELIMINARY PAGES OF THIS PUBLICATION.

Components in this equipment which are manufactured using beryllium oxide are as follows:

Assembly	Board ref.	Circuit ref.
MS.442	Distribution amplifier PS.319	TR1 to TR4
MS.564	Muting unit PS.565	TR1, TR2
MS.420	Low-level PS.314	TR15,16,17,20,21,22
	or	
	Low-level PS.351	TR15,16,17,20,21,22
MM.420	High-level PS.315	TR1 to TR10
	High-level PS.315	Heatsink washers for TR1 to TR4 and TR7 to TR10

MODIFICATION RECORD

This publication is technically up-to-date in respect of the modifications listed below.

Mod. No.	Strike No.	L.R.U./Sub-Assembly	Description
A5124	1	MA 1004	Publication unaffected
A5345	1	MA 1720A	Addition to PTT circuit to prevent trip-out.
A5426	1	Cabinet	Publication unaffected
A5518	1	MM 320	Change of R32
A5586	2	MA 1004	To improve coarse tune/fine tune switching.
A5836	1	TA 1810	Publication unaffected
A6640	2 & 1	MA 1720A & S	Publication unaffected
A6641	3 & 2	MA 1720A & S	Removal of resistors
A7366	2	MM 320	Addition of 2 resistors
A7455	2	TA 1810	Introduction of VSWR trip circuits
A7536	3	MA 1720S	Change of capacitor value
A7621	4	MA 1720S	Addition of capacitor
A7622	1	MS 440	Addition of capacitor
A7623	3	MM 320	Re-position of capacitor
A7649	5	MA 1720S	Change of resistor value
A7649 (Alt 1)	5	MA 1720S	Change of resistor value
A7773	1	MA 1004	Change of resistor value
A7773 (Alt 1)	3	MA 1004	Change of resistor value
A7885	6	MA 1720S	Change of front panel
A7952	5	MA 1720A	Publication unaffected
A8215	4 & 7	MA 1720A & S	Addition of capacitor
A8508	5	MA 1004	Publication unaffected
A8509	4	MA 1004	Publication unaffected
A8557	13	MA 1720S	Addition of resistor
A8583	8	MA 1720S	Publication unaffected
A8585	10	MA 1720S	Change of resistor values
A8586	11	MA 1720S	Introduction of surge suppressor
A8587	12	MA 1720S	Addition of two resistors
A8608	14	MA 1720S	To reduce crosstalk
A8931	15	MA 1720S	Decrease value of suppression capacitors
A8932	16	MA 1720S	Change of out-of-lock circuit
A8937	6	MA 1004	Introduction of insulating beads
A9003	3	TA 1810	Introduction of solid state relays

Mod. No.	Strike No.	L.R.U./Sub-Assembly	Description
A9004	4	MM 320	To reduce sensitivity of MM 420 current trip
A9005	2	MM 440	Introduction of thermistor
A9016	4	TA 1810	Publication unaffected
A9415	7	MA 1004	Change of resistor values
A9524	5	MM 320	Introduction of alternative RF transistors
A9546	5	TA 1810	Replacement of Relays 1RLA & 1RLB
A9547	6 & 17	MA 1720A & S	Publication unaffected
A9598	7 & 18	MA 1720A & S	Change of resistor values
B0189	6	MM 320	Publication unaffected
B0231	1	MM 420	Addition of R56 on PS 351
B0496	6	TA 1810	Publication unaffected
TC 0032	8	MA 1004	Improve reliability of CSR5
TC 0034	7	TA 1810	To prevent overheating damage to Distribution Amplifier
TC 0077	1	MS 64/1	Change of capacitor values
TC 0078	1	MS 64/1 (Ruggedised)	Change of capacitor values

INTRODUCTION

This Air Publication describes two similar transmitting sets used in different operational circumstances.

The first, TTA.1860A, is used as a 1 kW, h.f. communications transmitter in an air-transportable cabin installation. This transmitter contains a drive unit MA.1720A.

The second, TTA.1860S, is also a 1 kW, h.f. transmitter but used in fixed ground installations. When this transmitter is provided with a second drive unit assembly, it can be employed in a single or dual-drive/frequency configuration.

Hence, both transmitters can be used in 1 kW, h.f. installations. However, when the second drive unit assembly MA.1721S is interconnected with the TTA. 1860S, a dual-drive/frequency system exists where the low-level output from each separately-modulated drive unit (MA.1720S and MA.1721S) is applied to each of two 500W channels; this configuration also allows each drive unit to be tuned to a different carrier frequency.

The two 500W power output signals from the TTA.1860S can be fed to a common antenna or two separate antennas.

◀ The following is a complete list of all sub-assemblies and printed-circuit boards fitted in both the TTA.1860A and TTA.1860S transmitters and also the MA.1721S drive unit assembly.

LIST OF SUB-ASSEMBLIES AND PRINTED CIRCUIT BOARDS

Sub-assy. or p.c.b.	Title	Location
PS.56	Discriminator board	Feeder matching unit MA.1004
PS.57	Power supply board	Feeder matching unit MA.1004
PS.58	Constant-voltage amplifier board	Feeder matching unit MA.1004
PS.59	Tune board	Feeder matching unit MA.1004
PS.60	Range board	Feeder matching unit MA.1004
MS.64	Power supply assy.	1 kW cabinet assy. (TTA.1860A and S)
PS.106	Coarse-tune discriminator	Feeder matching unit MA.1004
PS.108	Servo pre-amplifier board	Feeder matching unit MA.1004
MS.139	Line switching unit	1 kW cabinet assy.and drive unit assy.
PW.178	Control unit motherboard	Feeder matching unit MA.1004
PS.201	Servo power amplifier board	Feeder matching unit MA.1004
PS.251	Protection board	R.F. power module MM.420
MS.265	Servo power amplifier assy.	Feeder matching unit MA.1004
PS.313	Stabilizer board	R.F. power module MM.420
PS.314	Low-level board	R.F. power module MM.420(TTA.1860A only)
PS.315	High-level board	R.F. power module MM.420
PS.316	V.S.W.R. board	R.F. power module MM.420
MM.320	R.F. amplifier assy.	R.F. power module MM.420

Sub-assy. or p.c.b.	Title	Location
PS.337/3	H.F. loop board	Drive unit MA.1720A and MA.1720S
PS.338	Transfer loop board	Drive unit MA.1720A and MA.1720S
PM.341	Low-level board	Drive unit MA.1720A and MA.1720S
PM.342	Mixer and output board	Drive unit MA.1720A and MA.1720S
PM.343	Power supply board	Drive unit MA.1720A and MA.1720S
PM.344	34 MHz generator board	Drive unit MA.1720A and MA.1720S
PM.345	Control board	Drive unit MA.1720A and MA.1720S
PM.346	Noise-immunity board	Drive unit MA.1720A and MA.1720S
PM.349	L.F. loop board	Drive unit MA.1720A and MA.1720S
PS.351	Low-level board	R.F. power module MM.420 (TTA.1860S only)
MS.440	Voltage stabilizer assy.	R.F. power module MM.420
MS.441	Combiner unit	1 kW cabinet assy. (TTA.1860A and S)
MS.442	Distribution amplifier assy.	1 kW cabinet assy. (TTA.1860A and S)
MS.443	Overload unit	1 kW cabinet assy. (TTA.1860A and S)
MS.444	Splitter unit	1 kW cabinet assy. (TTA.1860A and S) and drive unit assembly (MA.1721S)
MS.445	Meter panel assy.	1 kW cabinet assy. (TTA.1860A only)
MS.445/2	Meter panel assy.	1 kW cabinet assy. (TTA.1860S only)
MS.447	V.S.W.R. assy.	1 kW cabinet assy. (TTA.1860A and S) and drive unit assy. (MA.1721S)
MS.448	Power supply assy.	Feeder matching unit MA.1004
MS.449	Discriminator assy.	Feeder matching unit MA.1004
MS.450	Control unit	Feeder matching unit MA.1004
MS.451	Coil, motor and gearbox assy.	Feeder matching unit MA.1004
MS.454	Constant-voltage amplifier assy.	Feeder matching unit MA.1004
MS.560	Combiner unit	Drive unit assy. MA.1721S
MS.564	Muting unit	1 kW cabinet assy. (TTA.1860A and S) and drive unit assy. (MA.1721S)
9400	5 MHz frequency standard assembly	Drive unit MA.1720A only
9420	5 MHz frequency standard assembly	Drive unit MA.1720S only

►

LEADING PARTICULARS

TRANSMITTING SETS, RADIO 5820-99-626-4733 (TTA.1860A) AND UK/FRT-618 (TTA.1860S) ALSO DRIVE UNIT ASSEMBLY 5820-99-631-8614 (MA.1721S)

Because of the close similarity between the above two transmitting sets, the following particulars serve for both; the differences are indicated where relevant.

Function (TTA.1860A)	This transmitting set, radio is a 1 kW solid-state transmitter covering the h.f. range; the equipment is contained in a single cabinet. R.F. power is provided by eight interchangeable plug-in modules, any of which can be withdrawn without interruption of service. Frequency generation is by means of an in-built synthesizer.
Function (TTA.1860S and MA.1721S)...	This transmitting terminal is a 1 kW solid-state transmitter, covering the h.f. range, which is also capable of operating as two 500 W transmitters each emitting a carrier of differing frequency. R.F. power is provided by eight interchangeable plug-in modules, any one of which can be removed without interruption of service.
Frequency range	1.6 MHz to 30 MHz in 100 Hz steps.
Frequency stability (TTA.1860A) ...	With internal frequency standard (Racal Type 9400). (1) ± 1 part in $10^8/^\circ C$ over temperature range $-10^\circ C$ to $+55^\circ C$. (2) Long term stability: ± 5 parts in 10^9 over 24-hour period after 30 days. Provision is also made for the use of an external frequency standard.
Frequency stability (TTA.1860S and MA.1721S)	With internal frequency standard (Racal Type 9420). (1) ± 6 parts in $10^{10}/^\circ C$ over temperature range $-10^\circ C$ to $+55^\circ C$. (2) Long term stability: ± 5 parts in 10^{10} over any 24-hour period after 30 days. Provision is made for the use of an external frequency generating source.

Modes of emission	U.S.B./L.S.B. (A3J, A3A), compatible A.M. (A3H), I.S.B. (A3B), C.W. (A1), M.C.W. (A2H, A2J).
Carrier suppression	Selection by front-panel control for -6 dB,-16 dB,-26 dB,-50 dB (suppressed).
R.F. power output (TTA.1860A) ...	S.S.B.: 1 kW p.e.p. nominal. C.W. : 1 kW nominal (continuous, key down).
R.F. power output (TTA.1860S and MA.1721S)	1 kW p.e.p. or C.W. (single frequency) or 2 x 500 W p.e.p. or C.W. (dual frequency, two antennas) or 2 x 250 W p.e.p. or C.W. (dual frequency, single antenna)
Load impedance	50 ohms; operates for v.s.w.r. up to 3:1.
Intermodulation products	Better than -35 dB from 1.6 to 10 MHz and -25 dB from 10 to 30 MHz relative to either one of two equal tones in a standard two-tone test.
C.W./M.C.W. keying input	Operation by closed loop. A2J or A2H emission achieved by internally generated 1000 Hz tone in selected sideband.
Keying speed	200 bauds max.
Hum	-50 dB relative to p.e.p.
Spurious emissions and harmonics ...	Less than 50 mW at the output of the MA.1004 feeder matching unit.
Unwanted sideband suppression ...	Better than -50 dB relative to p.e.p.
In band noise	-50 dB relative to p.e.p. in a 3.0 kHz bandwidth.
Wideband noise	-100 dB relative to p.e.p. in a 3.0 kHz bandwidth.
Muting	Overall muting -130 dB below rated output.
Audio input level	-30 dBm to +10 dBm into 600 ohms by preset adjustment. Carbon or specified dynamic microphone.
A.F. response	Within 3 dB from 300 Hz to 3400 Hz relative to peak response.
Drive unit audio (a.g.c.)	An audio input variation of ± 10 dB relative input signal between -20 dBm and 0 dBm, will produce a change in output level of less than 2 dB.

Linear amplifier automatic level control (a.l.c.)	A.L.C. is applied to each r.f. module individually and holds the output constant to within ± 1 dB of the nominal value over the whole frequency range.
Power supply	210-250V ± 6 %, 47-65 Hz, single-phase.
Power consumption	6 kVA (max.) at full output.
Cooling system (TTA.1860A and TTA.1860S)	Two built-in air blowers fitted as standard in linear amplifier. Filter fitted in air inlet. Axial fan on rear panel provides cooling for drive unit MA.1720A and MA.1004.
Cooling system (MA.1721S)	Axial fan on rear panel.

Dimensions	Height	Width	Depth
TTA.1860A or S	1585	524	610 mm
MA.1721S*	730	524	615 mm

Weight ...		
	TTA.1860A	275 kg (approx.)
	TTA.1860S	275 kg (approx.)
	MA.1721S*	kg

* including dummy loads.

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Chapter 1-0

FUNCTIONAL DESCRIPTION

TRANSMITTING SET, RADIO 5820-99-626-4733 (TTA.1860A)

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INTRODUCTION

1. The transmitting set, radio 5820-99-626-4733(TTA.1860A) is a locally-controlled h.f. transmitter assembly (fig.1) providing voice and telegraph communication in the frequency range 1.6 MHz to 30 MHz.

2. The operating channels are selected at 100 Hz spacing. The carrier frequencies are generated by frequency synthesis and are referenced to an internal standard frequency source.

3. The following operational modes are provided:-

(1) Upper - sideband telephony (A3A, A3J)

(2) Lower - sideband telephony (A3A, A3J)

(3) Independent sideband telephony (A3B)

(4) Compatible a.m. telephony (A3H)

(5) C.W. telegraphy (A1)

(6) M.C.W. telegraphy (A2H, A2J)

4. Wide-band techniques are used throughout the power amplifying stages; no 'transmitter tuning' is required. The 1 kW r.f. output is provided by the combined outputs from eight sub-units, each delivering 125W (nominal).

5. A feeder matching network provides optimum coupling between the transmitter output and a 50Ω (nominal) antenna load. The network is adjusted automatically whenever the operating frequency is changed.

6. The primary power source for the transmitting set is a 210V to 250V single phase a.c. supply.

CONSTRUCTION

7. The TTA.1860A is housed in a single floor-standing cabinet. It consists of the main units listed in Table 1. The location of these items is given in fig.2.

TABLE 1

List of main units - TTA.1860A

Assembly	Nato No.	Manufacturer's ref.
Transmitter sub-assembly	5820-99-624-5393	1 kW Cabinet assembly
Amplifier-stabilizer	5820-99-626-4730	MM420 (8 off)
Transmitter drive unit	5820-99-624-5395	MA1720A
Adaptor, antenna to transmitter	5820-99-624-5394	MA1004
Line switching unit	5820-99-626-7836	MS139

8. With reference to Table 1, the 1 kW cabinet assembly does not contain the MM420 amplifier-stabilizers. The transmitter sub-assembly is not a functional entity until the eight amplifier-stabilizers have been fitted. It then becomes a 1 kW linear amplifier assembly (TA.1810A) - which is not a replaceable stores item as a whole. The TTA.1860A is formed when the remaining major items have been fitted.

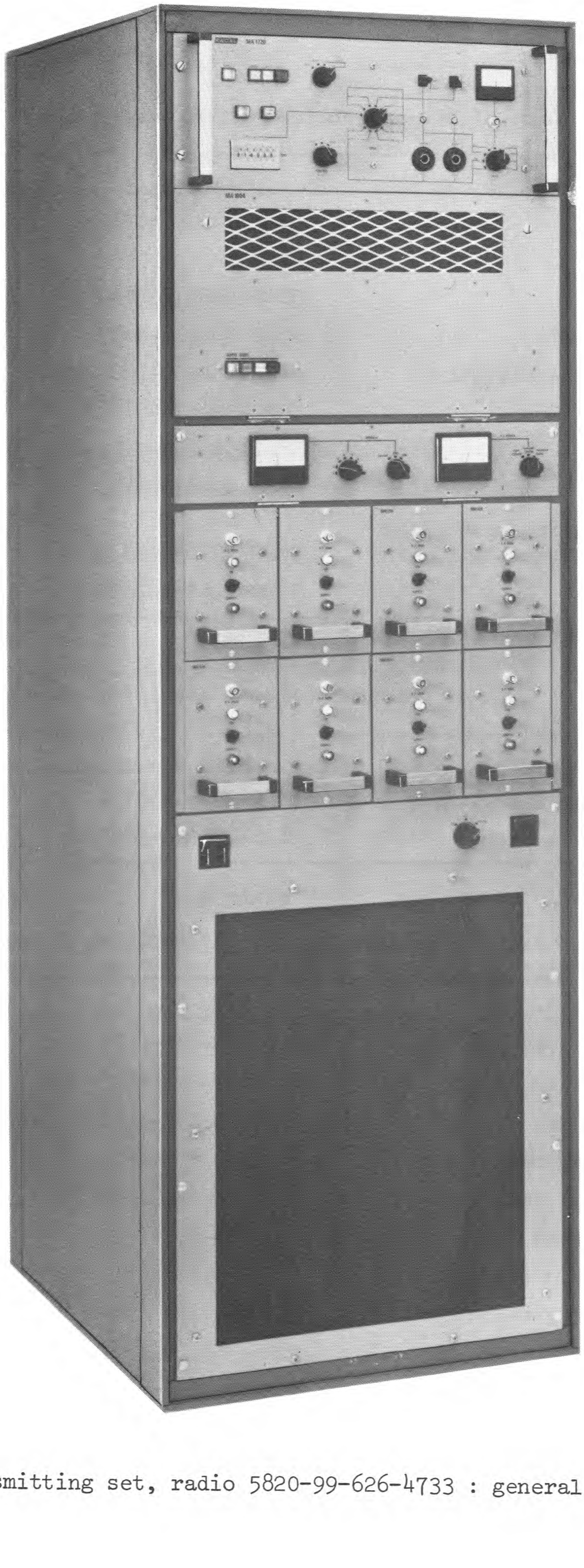


Fig.1 Transmitting set, radio 5820-99-626-4733 : general view

9. The sub-assemblies contained in the main units are listed in Tables 2 to 5. The layout of the transmitter sub-assembly is given in fig.3.

TABLE 2

List of sub-assemblies - transmitter sub-assembly

Sub-assembly	Nato No.	Manufacturer's ref.
Power supply	5820-99-626-4731	MS64/1 (4 off)
or		
Power supply	5820-99-643-6159	MS64/2 (4 off)
Combining unit	5820-99-626-3417	MS441
Distribution amplifier	5820-99-630-7603	MS442 (2 off)
Overload unit	5820-99-630-7604	MS443
Splitter unit	5820-99-630-7605	MS444
Meter panel assembly	6625-99-626-3416	MS445
Voltage standing wave ratio (v.s.w.r.) assembly	5820-99-630-7337	MS447
Muting unit	5820-99-633-2059	MS564

TABLE 3

List of sub-assemblies - amplifier-stabilizer

Sub-assembly	Nato No.	Manufacturer's ref.
Radio frequency amplifier	5820-99-626-4732	MM320
Voltage stabilizer	5820-99-626-3419	MS440

TABLE 4

List of sub-assemblies - transmitter drive unit

Sub-assembly	Nato No.	Manufacturer's ref.
Standard frequency source	5820-99-635-2527	9400
34MHz generator board	5820-99-631-6959	PM344
L.F. loop board	5820-99-633-8778	PM349
Transfer loop board	5820-99-633-8779	PS338
H.F. loop and oscillator board	5820-99-635-9488	PS337
Low level board	5820-99-631-9827	PM341
Mixer and output board	5820-99-631-4957	PM342
Noise immunity board	5820-99-631-6961	PM346
Control board	5820-99-631-6960	PM345
Power supply board	5820-99-631-6958	PM343

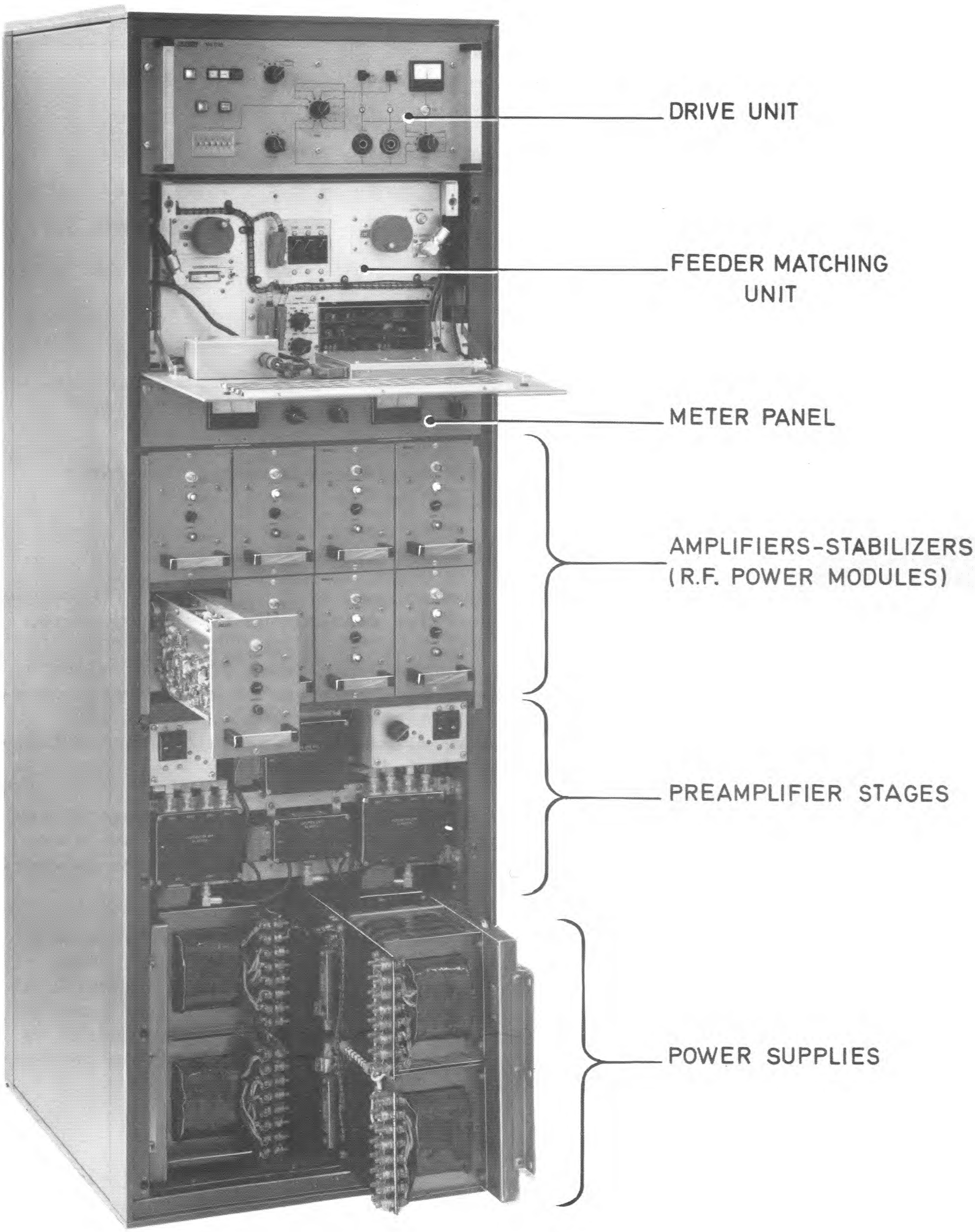


Fig.2 Transmitting set, radio 5820-99-626-4733 : front panel removed

TABLE 5

List of sub-assemblies - feeder matching unit

Sub-assembly	Nato No.	Manufacturer's ref.
Power supply	5820-99-638-3709	MS448
Control unit	-	MS450
Fine-tune discriminator	5820-99-631-9461	MS449
Constant voltage amplifier	5820-99-638-3710	MS454
Servo power amplifier	5820-99-638-3711	MS265(2 off)
Coil, motor and gearbox assembly (L/H and R/H)	5820-99-631-4958/9	MS451 (2 off)

BRIEF FUNCTIONAL DESCRIPTION

10. These paragraphs describe, with the aid of block diagrams, the basic functions of the main units of the transmitting set.

Transmitter drive unit

11. The MA.1720A (fig. 4a) provides, by frequency synthesis, radio frequencies of high stability and of standard accuracy for driving the linear amplifier.

12. Frequency synthesis is a method of generating a range of output signals, each of which bears a precise relationship to a harmonic or sub-harmonic of a standard frequency. In the MA.1720A, the phase-lock loop technique is employed and the output frequencies are presented in a decade scale. A full description of the synthesis process is given in Chap. 2-5-1.

13. The drive unit covers the range 1.6 MHz to 30 MHz; in this range discrete operating frequencies at 100 Hz spacing are selected by six manual switches. Each output has the same stability and accuracy as the in-built 5 MHz standard frequency source.

14. A 1.4 MHz carrier is amplitude-modulated by the audio frequency inputs (channel 1 for s.s.b. and c.w. modes, channels 1 and 2 for i.s.b.). The carrier and sideband components of the modulated signal are then selected, as required by the operating mode, and converted to r.f. signals at the radiated frequency. These signals, at power levels up to 200 mW, are then passed to the linear amplifier assembly. A full description of the modulation process and of the subsequent frequency conversion is given in Chap. 2-5-2.

Linear amplifier

15. As stated in para.8, the linear amplifier assembly TA.1810A (fig.4b) becomes an operational entity when the amplifier-stabilizers MM.420 are fitted into the transmitter sub-assembly.

16. The modulated r.f. output from the drive unit is fed via the muting unit to a splitter network and thence to two distribution amplifiers. Each distribution amplifier provides four identical outputs to drive the amplifier-stabilizers.

17. Each MM.420 delivers 125W (nominal) into 50Ω and, since they are driven in phase, all the MM.420 outputs are in phase. The outputs are combined in pairs (250W level) and then in fours by means of hybrid networks. The resultant 500W outputs are finally combined to provide the 1 kW output.

18. The TA.1810A will continue to function, at reduced power, if one or more amplifier-stabilisers is switched off or removed. Failure of an MM.420 does not disable the transmitter set. The hybrid combining networks provide isolation between individual outputs and the matching to the remaining units is unaffected by the presence - or otherwise - of an unserviceable MM.420.

Amplifier power supplies

19. Two separate power supply systems are incorporated, each system feeding a bank of four amplifier-stabilizers. The distribution amplifiers, splitter unit and other 'common' stages are fed jointly from the two systems. The interconnections between the d.c. supply rails are such that transmission can continue without interruption if one system is disabled.

Feeder matching

20. For optimum performance, the linear amplifier requires a 50Ω non-reactive load. The MA.1004 provides matching between the antenna load impedance, which can have a voltage standing wave ratio (v.s.w.r.) of up to 3:1 relative to the 50Ω nominal value, and the TA.1810A output. The MA.1004 contains a 'T' network which is aligned automatically by means of a servo system.

21. The feeder matching sequence (para. 33) is initiated each time the operating frequency is changed. A low-level signal from the MA.1720A, fed via the MA.1004 coarse-tune circuits, causes the network elements to be set close to their final values. When the full power output of the TA.1810A is subsequently fed via the MA.1004, its fine-tune circuits operate to optimize the settings.

22. The output matching is further improved by means of the line-switching unit. The MS.139 connects the optimum length of coaxial cable between the TA.1810A and the MA.1004. The cable length - one of four - is chosen on a maximum power output basis (para. 41).

DETAILED DESCRIPTION

23. These paragraphs describe, with the aid of interconnecting diagrams, the events occurring between the instant of switch-on and the realization of r.f. power output to the antenna.

Power supply switching

24. The single phase supply to the TTA.1860A (fig.5c) is normally controlled via the MA.1720A, its SUPPLY pushbutton (not shown) becomes the master control. With the supply present at 1 TB1, PL2 on the MA.1720A is permanently 'live'.

25. Assuming the drive unit to be switched on, operation of the STANDBY pushbutton on the MA.1720A applies 12V via 1 TB8 and switch SA (set to REMOTE) to energize relay RLC/1 and in turn operate contactor CON A; airblower BL3 starts and power is applied to the MA.1004. The resultant +30V and -30V supplies feed the servo system and the MS.139.

26. With contact breaker 1CB2 closed (manually) prior to switch-on, airblower BL2 starts and power is applied via surge - limiting resistors R3 and R4 to power supply units 1 and 2. When their +42V and +36V outputs become available, the surge protection circuit energizes relay RLB/1; R3 and R4 are short-circuited and the full supply voltage is applied to PSU1 and PSU2.

27. The power supplies PSU3 and PSU4 and air blower BL1 are controlled in a similiar manner via 1CB1. The distribution of the +42V and +36V supplies is self-evident.

28. Voltage stabilizers in each MM.420 convert the +42V and +36V inputs to +30V and +20V supply rails for the power amplifier stages. The +30V outputs are also fed to the distribution amplifiers and thence to the MS.443, the MS.444 and the MS.564.

Supply monitoring

29. The SUPPLY indicator-lamps on each main unit are self-explanatory.

30. The +30V and +20V supply rails and the power amplifier load currents are measured individually at the MS.445 meter panel (fig.5c).

31. The +36V outputs from all four power units (PSU1-4) are monitored by the MS.443 overload unit (fig. 5b). The absence of any one supply causes pin 10 of 9PL1 to go to +12V and hence the REDUCED POWER lamp on the MA.1720A glows.

32. Absence of either supply (+30V or -30V) in the MA.1004 results in a 0V level at pin 1 of 5PL2 (fig. 5a). This fault signal is fed via the MS.443 (9PL1, pins 6 and 5) to the MA.1720A.

Feeder matching sequence

33. The following events occur during a change of operating frequency and it is assumed that the MA.1004 and MS.139 are both set for automatic operation.

34. When one or more of the frequency-setting switches (thumbwheels) on the MA.1720A is re-set, the synthesizer goes momentarily out-of-lock. This condition causes the MA.1720A control board to effect the following:-

(1) Mute the MA.1720A r.f. output.

(2) Apply the 'mute' command to the TA.1810A. This 0V signal is fed via the MA139 (PL1 pins 7 and 6, fig.5a).

(3) Select the 'tune' signal conditions (c.w. mode).

(4) The RESET lamp glows.

35. The IN-LOCK lamp is also extinguished and, when the synthesizer has locked to the new operating frequency, the lamp is re-lit. Since the locking action is virtually instantaneous, the lamp may just flicker.

Note...

Should the IN-LOCK lamp remain extinguished, a fault condition exists.

36. When the RESET pushbutton on the MA.1720A is pressed:-

(1) The 'coarse-tune initiate' command (+12V at pin 11 of SK6, fig.5c) is applied to the MA.1004.

(2) After a two-second delay, the MA.1720A is de-muted.

(3) The RESET lamp is extinguished.

The low-level 'tune' signal is now available.

37. In the MA.1004, a relay (5RLA) breaks the path between 5PL1 and 5SK1 and connects the 'tune' signal input to the coarse-tune circuits. The presence of the signal activates the servo system and coarse-tuning commences; this sequence is fully described in Chap.5-0.

38. Selection of the coarse-tune condition lights the TUNE lamp on the MA.1004 and provides a 'not ready' signal (+12V) via the MS.139 (PL1 pins 12 and 9) to the MA.1720A; this causes the READY lamp on the MA.1720A to be extinguished.

39. On completion of the coarse-tuning sequence, the servo motors being at rest:-

(1) Relay 5RLA releases and the MA.1720A output is reconnected to the TA.1810A.

(2) The MA.1004 switches to the fine-tune mode; this condition is maintained until a subsequent change in operating frequency.

(3) A 'ready' signal is applied to activate the MS.139.

(4) The MS.139 applies an inhibit to the MA.1004 servo system; this prevents simultaneous operation of the fine-tune circuits whilst the MS.139 is active.

40. The high-power 'tune' signal from the TA.1810A is now fed via the line switching relays (RLD to RLG) to the MA.1004 and thence via the v.s.w.r. unit to the antenna. The presence of the r.f. signal lights the r.f. monitor lamps on each MM.420.

41. Line selection now takes place; the control signals for the MS.139 are provided by the 'forward power' detector of the v.s.w.r. unit. Each of four line lengths - a direct connection, 1.2m, 2m or 3.2m of coaxial cable - is connected in turn and the line length giving maximum power output is selected (fig. 5b). To prevent damage to the relay contacts, the TA.1810A is muted momentarily each time a relay is operated; the r.f. monitor lamps flicker in sympathy.

42. When the optimum line length has been determined:-

(1) The MS.139 rests.

(2) The servo inhibit is removed.

(3) The MA.1004 'fine-tunes', setting the 'T' network to its final values.

43. On completion of fine-tuning:-

(1) A 'ready' signal is applied to the MA.1720A.

(2) The MS.139 re-applies the servo inhibit to the MA.1004.

44. At the MA.1720A, the 'ready' signal effects the following:-

(1) The 'tune' signal is removed.

(2) The drive unit reverts to the selected operational mode.

(3) The READY lamp glows.

45. When feeder matching is performed manually, e.g. during maintenance, the sequence of events is similar to that described above. These procedures are fully described in Chap.1-2.

R.F. monitoring

46. The r.f. output from the MA.1720A is indicated on its front panel meter.

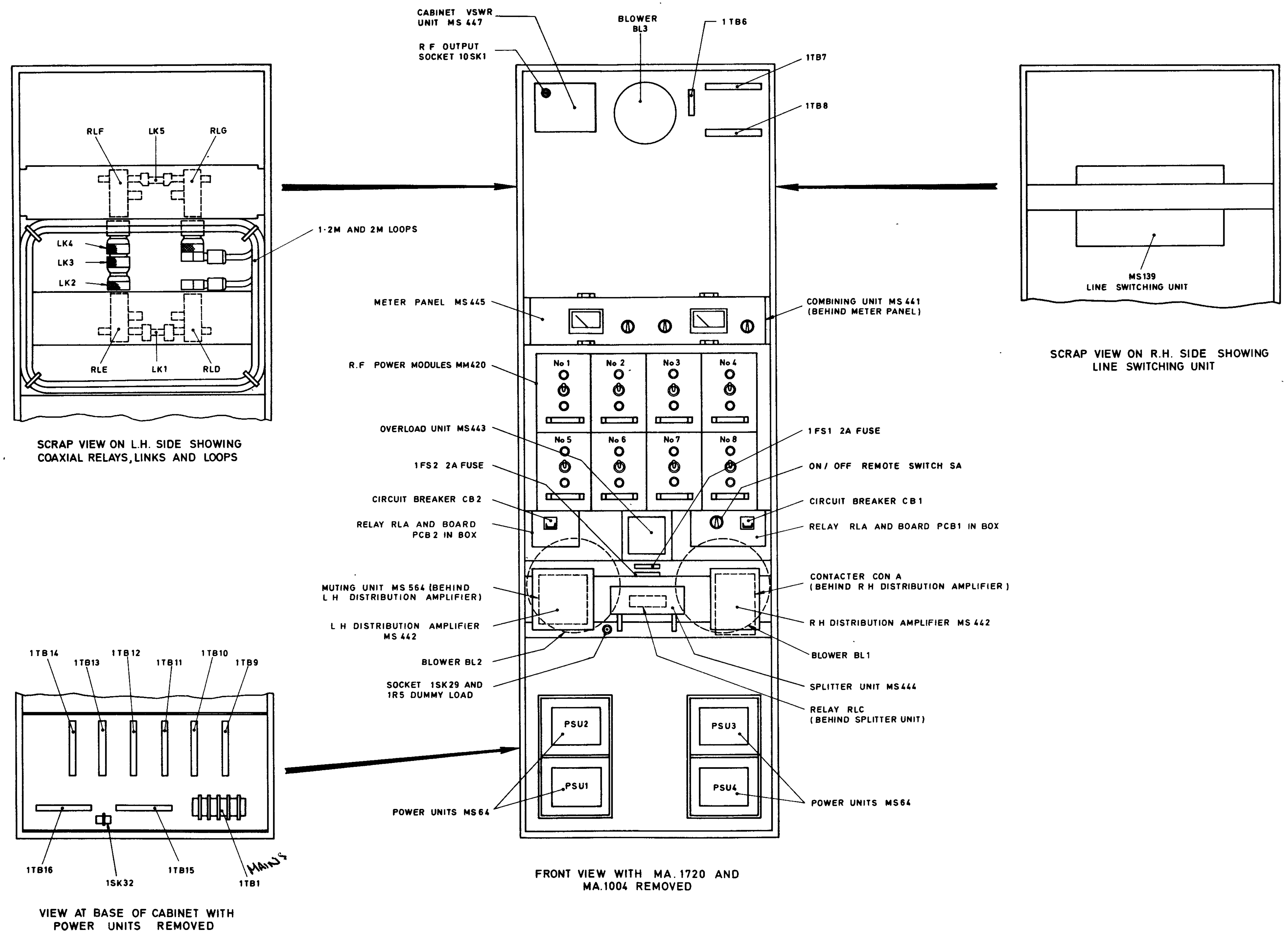
47. The input level to the MS.564, the power output to the antenna and the reflected power (fig. 5b) are measured at the meter panel MM.445.

48. Should the reflected power exceed a predetermined level (v.s.w.r. greater than 3:1), a 'warning' signal is generated in the MS.445; this signal appears at pin 6 of 1TB9.

49. R.F. monitor sockets are provided on each MM.420 and on the hybrid combining networks; these connections provide for r.f. measurements at the 125W, 500W and 1 kW levels.

50. Each MM.420 carries a r.f. monitor lamp. Under normal conditions, all eight lamps glow with equal brilliance and hence a low-power output from one unit is self-evident.

51. If one or more amplifier-stabilizers is giving zero or reduced power output, a 'r.f. unbalanced' signal is generated in the hybrid combining unit (fig. 5b). This signal is fed via the MS.443 to give the 'reduced-power' indication at the MA.1720A.



Transmitter sub-assembly: location of sub-assemblies

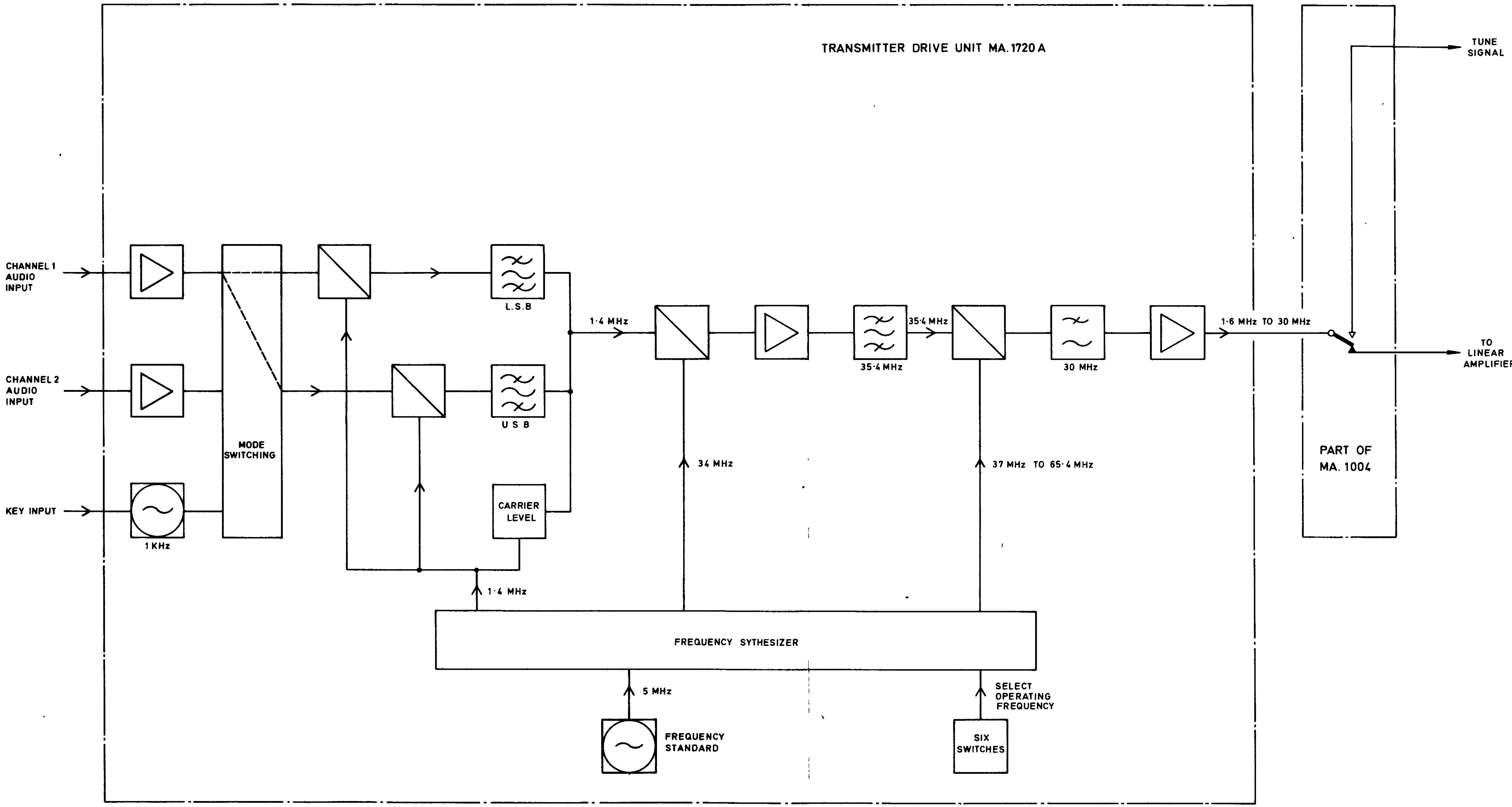


Fig. 4a

Transmitting set, radio: simplified block diagram (Sheet 1 of 2)

Fig.4a

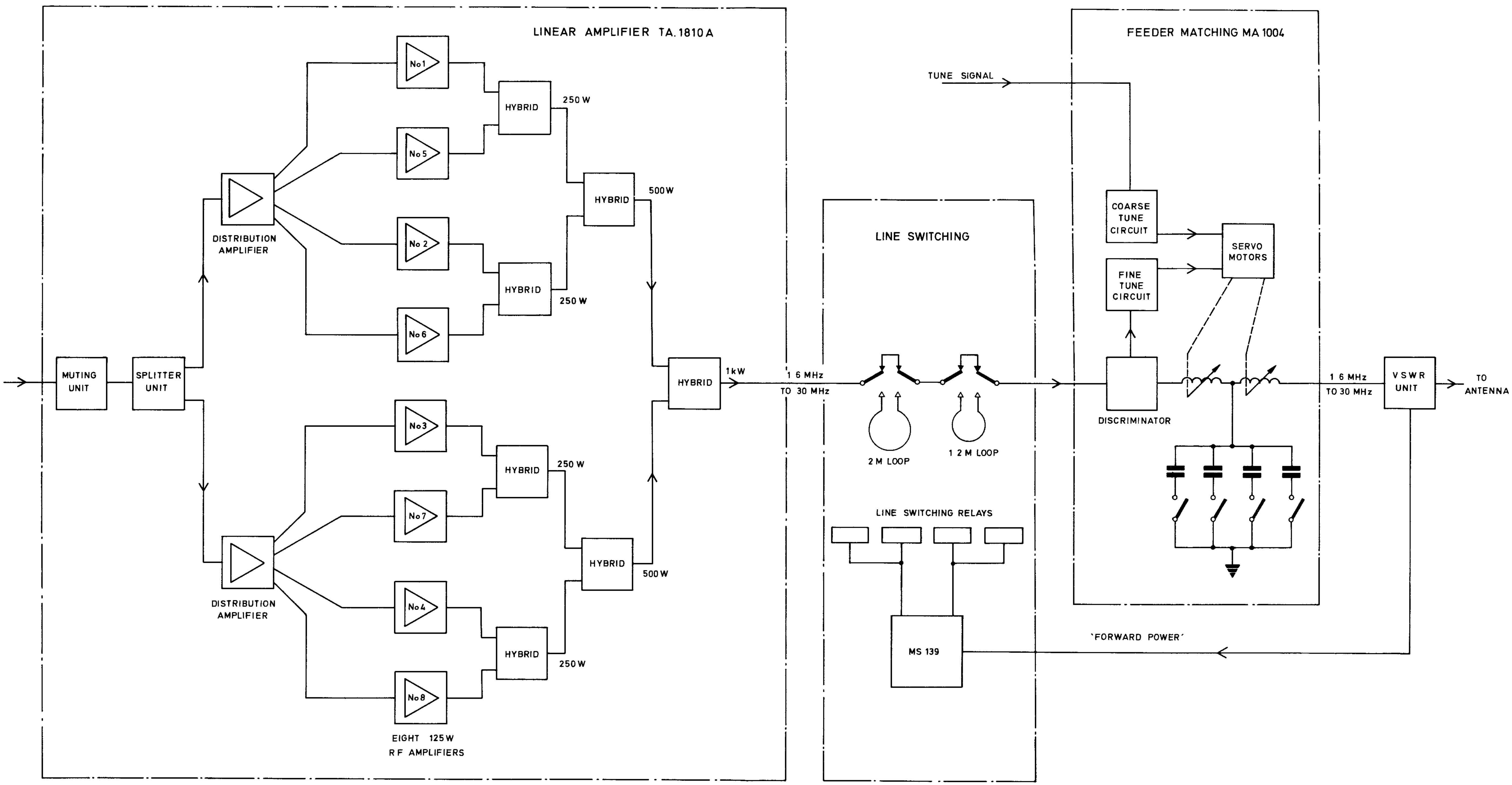


Fig 4b

Transmitting set, radio: simplified block diagram (Sheet 2 of 2)

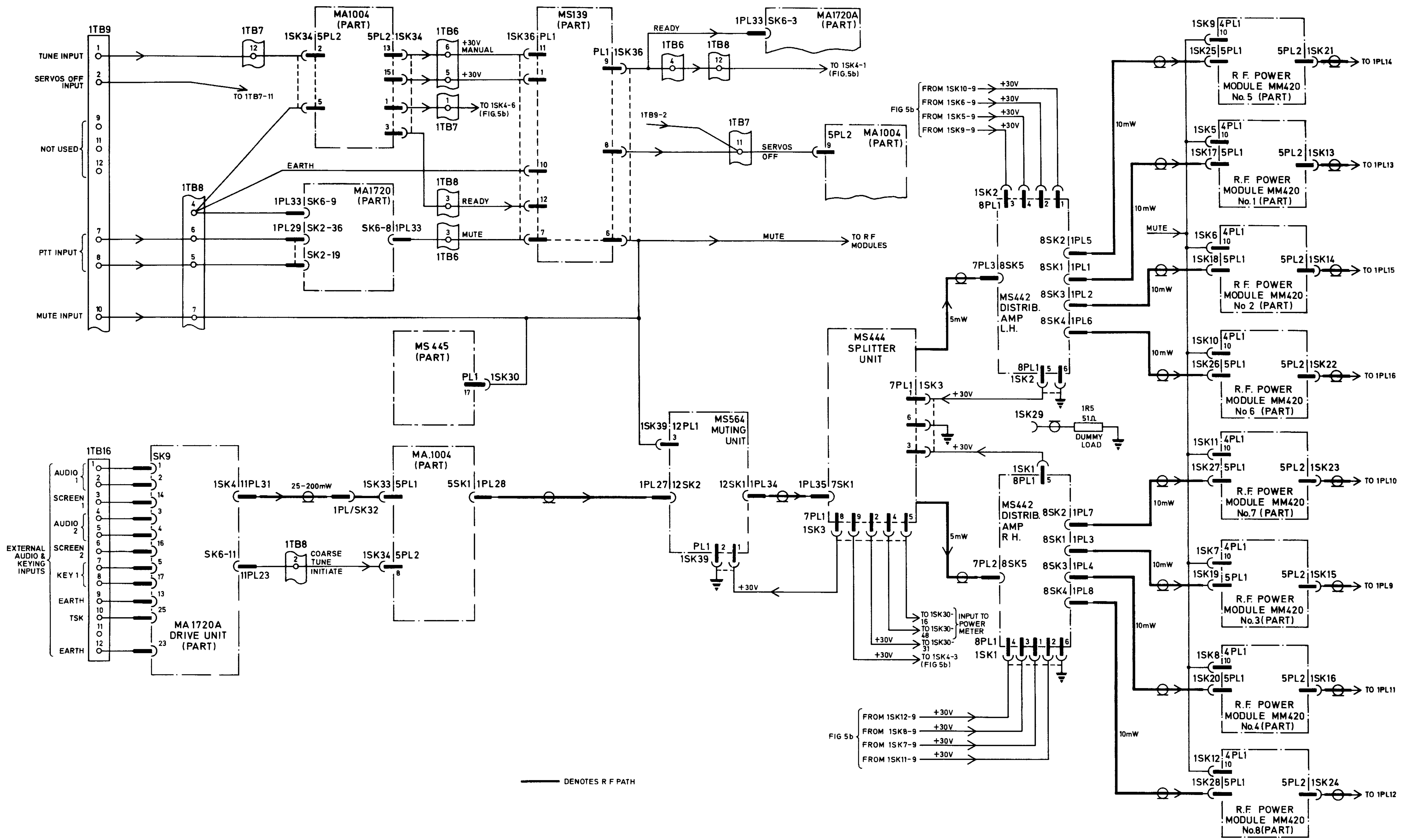


Fig 5a

Transmitting set, radio: interconnecting (functional) diagram (Sheet 1 of 3)

Fig.5a

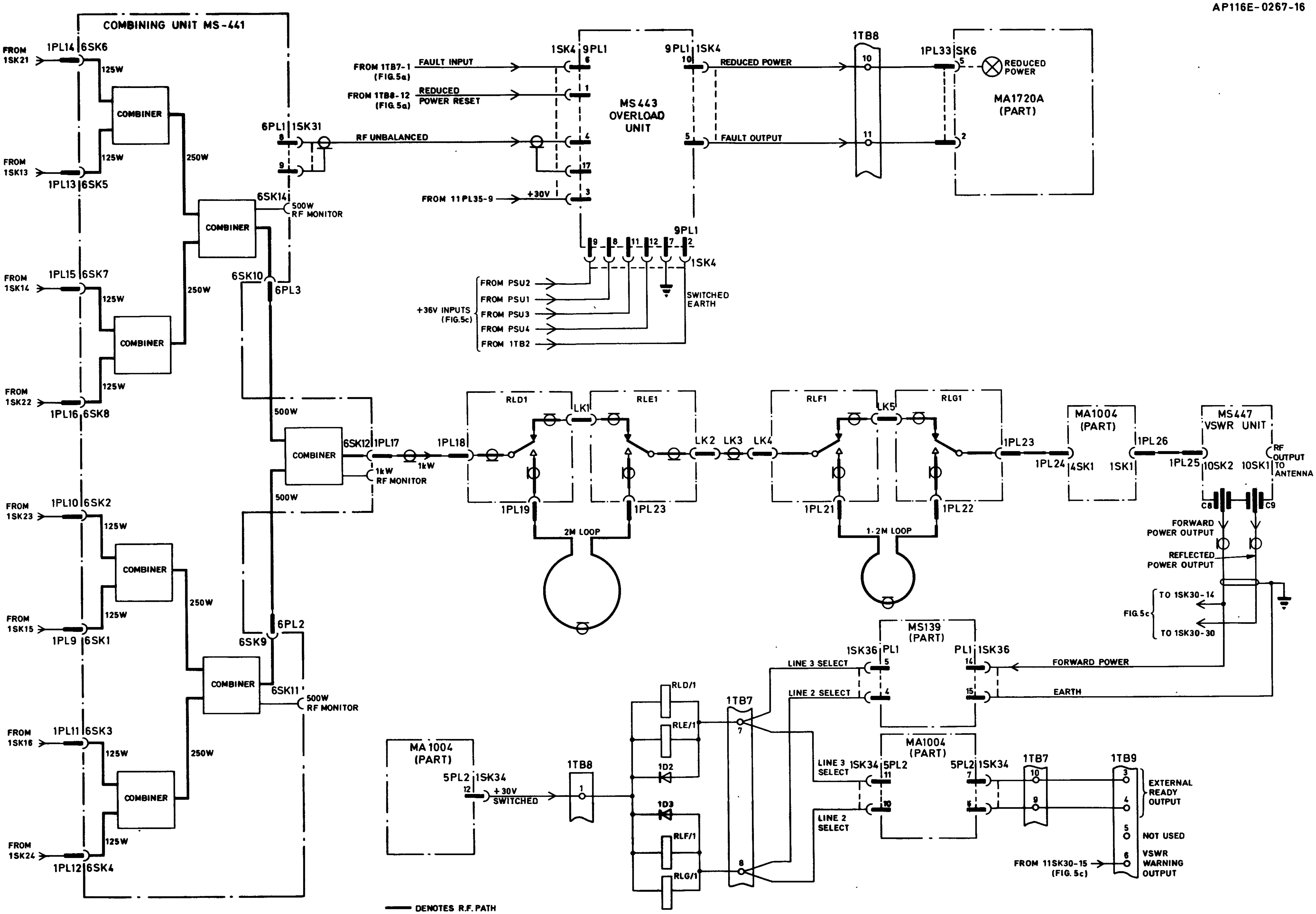


Fig.5b

Transmitting set, radio: interconnecting (functional) diagram (Sheet 2 of 3)

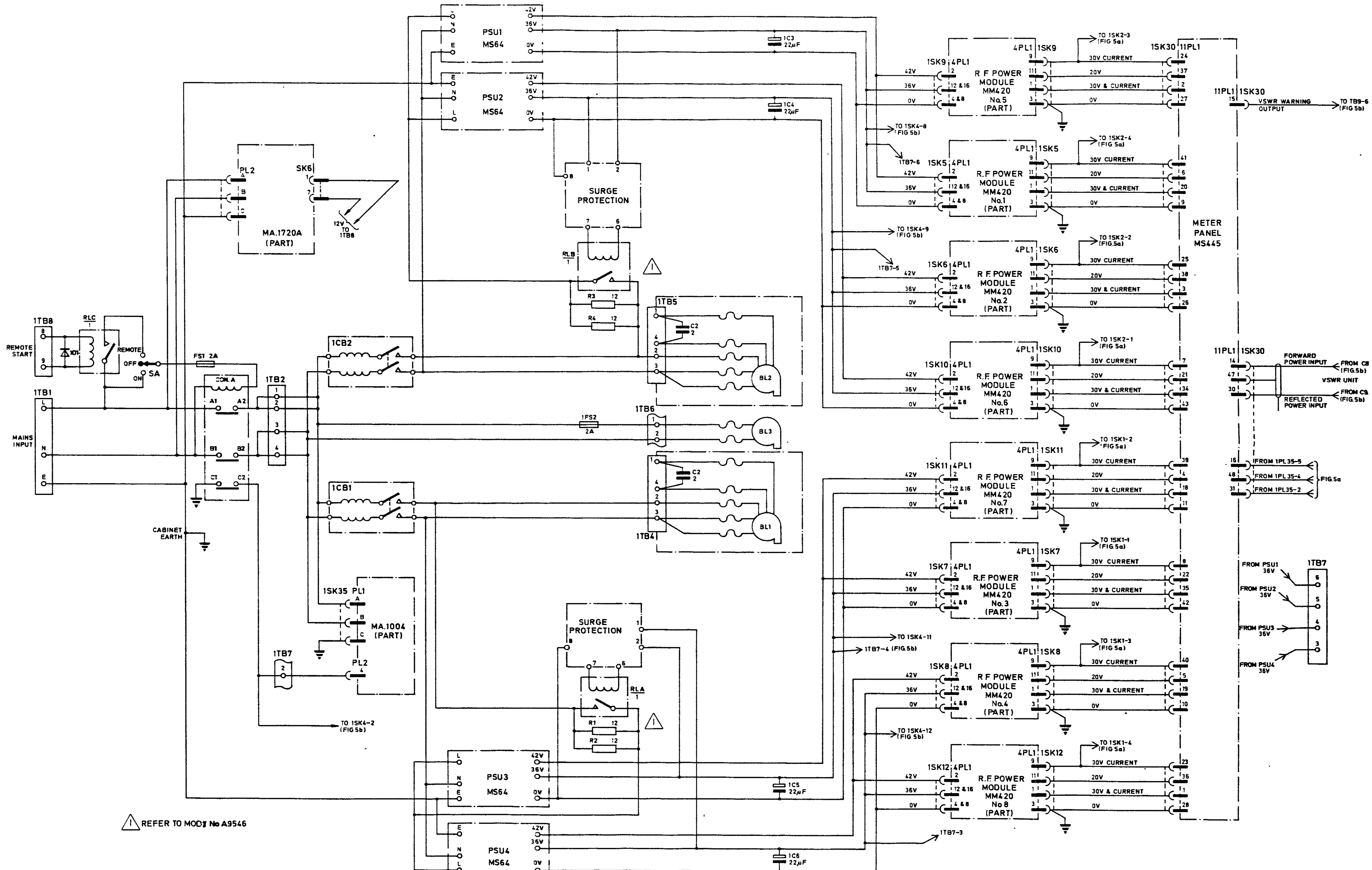


Fig.5c

Transmitting set, radio: interconnecting (functional) diagram (Sheet 3 of 3)

Fig.5c

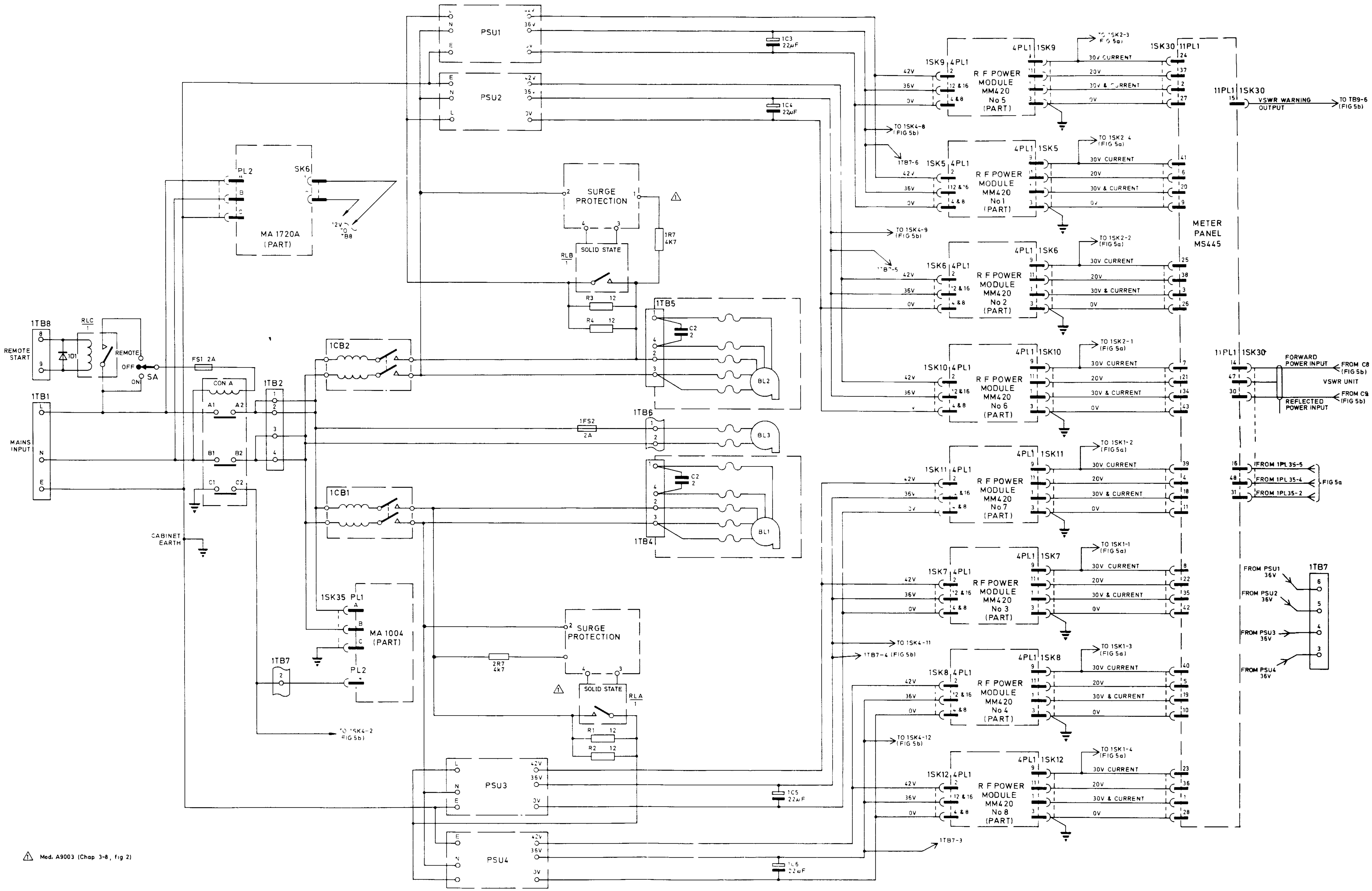


Fig.5d

Transmitting set, radio: interconnecting (functional) diagram (Sheet 3 of 3, Mod. A9003)

Fig.5d

Chapter 1-1

SETTING-UP INSTRUCTIONS

TRANSMITTING SET, RADIO 5820-99-626-4733 (TTA.1860A)

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INTRODUCTION

1. The setting-up procedures are carried out, in the order given, at initial switch-on or after a repair.

2. Certain checks involve the removal of units; the removal instructions are given in Chap.1-3. When re-fitting the units to the cabinet, ensure that all cables are dressed to their correct positions. Where cable connections are disturbed, it is assumed that the connections are re-made following a particular check or adjustment.

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

PRELIMINARY ADJUSTMENTS

3. The location of all operational controls is given in Chap.1-2.

(1) Ensure that the main a.c. supply to the transmitting set is switched OFF.

(2) Set the SUPPLY pushbutton on the MA.1720A to OFF (released).

(3) Set the ON/OFF/REMOTE switch on the power supply front panel to OFF.

(4) Set both main circuit breakers CB1 and CB2 to OFF.

Power supplies

4. (1) Lower the power supply front panel.

(2) Withdraw the left-hand pair of MS.64 power supply units. Check that both mains voltage selectors are set for the local supply voltage. Re-set as necessary and then re-fit the units.

(3) Repeat step (2) for the right-hand pair of units.

Attenuator settings

5. (1) Remove the cover from the muting unit MS.564. Check that the links are set for 6 dB attenuation, i.e. from pin 8 to pin 9 and from pin 12 to pin 13. Re-fit the cover to the unit.

(2) Remove the cover from the splitter unit MS.444. Check that the links are set for 0 dB attenuation, i.e. from pin 9 to pin 10 and from pin 13 to SK1. Re-fit the cover to the unit.

(3) Close the power supply front panel.

Amplifier-stabilizers

6. Set the SUPPLY switches on each MM.420 to ON (total eight switches).

Feeder matching and line switching units

7. (1) Remove the MA.1004 from the cabinet.

(2) Remove the top cover from the MA.1004. Check that the primary connections to the mains transformer are appropriate to the supply voltage; adjust as necessary (soldered connections). Replace the top cover.

(3) Remove the cover plate from the MA.1004 control unit. Check that link LK1 ('servos-off') on the tune board is not connected. Re-fit the board and the cover plate.

(4) Remove the cover from the MS.139 line switching unit. Check that link LK3 is connected. Re-fit the cover.

(5) Re-fit the MA.1004 to the cabinet and secure. Lower the front panel.

(6) On the MA.1004 front sub-panel set the following controls:-

(a) MANUAL switches to AUTO and LINE 1.

(b) DISCRIMINATOR BALANCE switch to OFF.

(c) TUNE/READY switch to READY.

(d) Contact breakers CB1, CB2 and CB3 to ON (up).

(7) Close the front panel and then set the front panel controls as follows:-

(a) SUPPLY pushbutton to OFF.

(b) TUNE pushbutton to OFF.

Drive unit

8. (1) Remove the MA.1720A from the cabinet.

(2) Check that the main voltage selector is set for the local supply voltage; re-set as necessary.

(3) Set the FREQ. STD. switch to INT.

(4) Check that fuse-link FS1 is serviceable and of correct rating (500 mA).

(5) Re-fit the MA.1720A to the cabinet and secure.

(6) Set the front panel controls as follows:-

(a) SUPPLY pushbutton to OFF.

(b) STANDBY pushbutton to OFF.

(c) EHT pushbutton to OFF.

(d) CONTROL switch to LOCAL SYNTH.

(e) MODE switch to SSB SUPP.

(f) Sideband switch to UPPER.

(g) VOX/PTT/TX switch to TX.

(h) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(j) Frequency selection switches to 03.0000 MHz or as required.

SWITCH-ON SEQUENCE

9. Ensure that a suitable dummy load is connected to socket 10 SK1 (ANTENNA).

10. (1) Set the main a.c. supply to ON.

(2) Depress the SUPPLY pushbutton on the MA.1720A and check that the SUPPLY and IN-LOCK lamps glow.

(3) Set the ON/OFF/REMOTE switch to REMOTE.

(4) Depress the STANDBY pushbutton on the MA.1720A. Check that the STANDBY lamp glows, main contactor CON A closes and air blower BL3 operates (audible checks).

(5) Check that the RESET lamp on the MA.1720A is extinguished; if not, depress the RESET pushbutton.

(6) Depress the SUPPLY pushbutton on the MA.1004 and check that the SUPPLY lamp glows.

(7) Set contact breaker CB2 to ON.

(8) Check that airblower BL2 operates and that the SUPPLY lamps on the left-hand bank of amplifier-stabilizers glow (total four lamps).

(9) Set CB2 to OFF. Air blower BL2 will stop and the lamps will be extinguished.

(10) Set contact breaker CB1 to ON.

(11) Check that airblower BL1 now operates and that the SUPPLY lamps on the right-hand bank of four units glow.

(12) Re-set CB2 to ON. All three blowers should now run and all eight lamps should be glowing.

SUPPLY VOLTAGES

11. (1) At the meter panel, measure the supply voltages generated within MM.420 No.1, i.e. set the MODULE switches to 1 and 20V and then to 1 and 30V.

(2) Repeat step (1) using appropriate switch settings for each remaining MM.420.

Note...

The presence of +20V and +30V outputs from each MM.420 indicates that all four MS.64 power supply units are functioning correctly.

(3) Set the METER switch on the MA.1720A to the -7, +5, +12 and +20 VOLTS positions in turn. A meter-reading within the green band should be obtained in each case.

(4) Set contact breakers CB1 and CB2 to OFF.

LINE LEVELS

12. It is assumed for setting-up purposes that test tones of the required line input level, e.g. 0 dBm, are being applied to the AUDIO 1 and AUDIO 2 inputs.

13. (1) Set the METER switch on the MA.1720A to LINE 1 and check that the meter indicates the AUDIO 1 input level e.g. 0 dBm.

(2) Set the METER switch to SET 1.

(3) Adjust the SET LINE 1 preset control until a 0 dBm level is obtained.

(4) Set the METER switch to LINE 2 and check the AUDIO 2 input level.

(5) Set the METER switch to SET 2.

(6) Adjust the SET LINE 2 control until a 0 dBm level is obtained.

SSB modes

14. (1) Set the METER switch to RF.

(2) Check that the meter indicates -3 dB: (100 mW r.f. output) approximately.

(3) Set the sideband selector switch to LOWER and repeat step (2).

ISB mode

15. (1) Re-set the sideband switch to UPPER.

(2) Disable the AUDIO 2 input.

(3) Set the MODE switch to ISB -26.

(4) Check that 25 mW r.f. output (-9 dB on the meter) is obtained.

(5) Disable the AUDIO 1 input.

(6) Re-connect the AUDIO 2 input.

(7) Check that 25 mW output is again obtained.

Note...

If the AUDIO 1 input is now re-connected, a 100 mW p.e.p. output is developed from the dual-tone input. Under these conditions, the meter indicates -6 dB approximately.

SWITCH-OFF SEQUENCE

16. (1) Set the STANDBY pushbutton on the MA.1720A to OFF (released).

(2) Set the TUNE/MUTE/OPERATE switch to MUTE.

(3) Set the ON/OFF/REMOTE switch to OFF.

Notes...

1. Step (1) is sufficient to switch-off the transmitting set. Steps (2) and (3) are safety measures; should the STANDBY pushbutton be depressed inadvertently, the TA.1810A will not be activated and hence transmission cannot take place.

2. The SUPPLY pushbutton on the MA.1720A should be left ON.

Chapter 1-2

OPERATING INSTRUCTIONS

TRANSMITTING SET, RADIO 5820-99-626-4733 (TTA.1860A)

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INTRODUCTION

1. This chapter describes the functions of the controls and indicators followed by the operating procedures. The transmitting set is normally operated using the 'automatic' tuning procedures. The manual tuning procedures are used for maintenance purposes or in the event of failure of the automatic system. Instructions are also given for by-passing the feeder matching equipment and for operation of the TA.1810A at a 500W power level whilst maintenance is in progress (para. 16 and 19).

FUNCTIONS OF CONTROLS AND INDICATORS

2. The following paragraphs describe the functions of all front panel controls and indicators.

Drive unit (fig. 2)

3. (1) SUPPLY pushbutton (with locking action): controls the a.c. supply to the MA.1720A. This switch also acts as the master power control for the TTA.1860A. The a.c. supply is normally kept 'on' to maintain the best stability and ageing characteristics of the frequency standard.

(2) SUPPLY lamp: glows when power is switched on.

(3) STANDBY pushbutton (with locking action): controls the operation of the main supply contactor. This is the normal supply control for the TTA.1860A.

(4) STANDBY lamp: glows when power is applied to the TA.1810A and the MA.1004.

(5) READY pushbutton (not used in the TTA.1860A).

(6) READY lamp: glows when the transmitter is ready to accept traffic i.e. when the feeder matching sequence is completed. (The 'EHT' engraving should be disregarded).

(7) RESET pushbutton (non-locking): initiates the feeder matching sequence. This pushbutton is depressed whenever the MA.1720A is set to a new operating frequency or the MA 1004 is retuned to an existing one.

(8) RESET lamp: glows when either:-

(a) The MA.1720A is muted due to the re-setting of the frequency selector switches.

(b) A fault occurs in the MA.1004.

(c) A complete failure of the TA.1810A power supplies occurs.

(9) IN-LOCK lamp: glows when the synthesizer is locked to the selected frequency.

(10) REDUCED POWER lamp: glows when either:-

(a) One or more r.f. modules is switched off or fails.

(b) A partial failure of the TA.1810A power supplies occurs.

(11) TUNE/MUTE/OPERATE switch (four position):-

(a) TUNE: selects the low-level 'tune' signal for the MA.1004.

(b) MUTE: mutes the drive to the TA.1810A.

(c) OPERATE LOW: selects reduced r.f. output levels (-6 dB approx.) from the MA.1720A.

(d) OPERATE HIGH: selects normal r.f. output levels from the MA.1720A This switch position is the one normally used.

(12) VOX/PTT/TX switch (three position):-

(a) VOX: voice-operated transmit/receive switching.

(b) PTT: manual 'press-to-talk' transmit/receive switching.

(c) TX: continuous transmission.

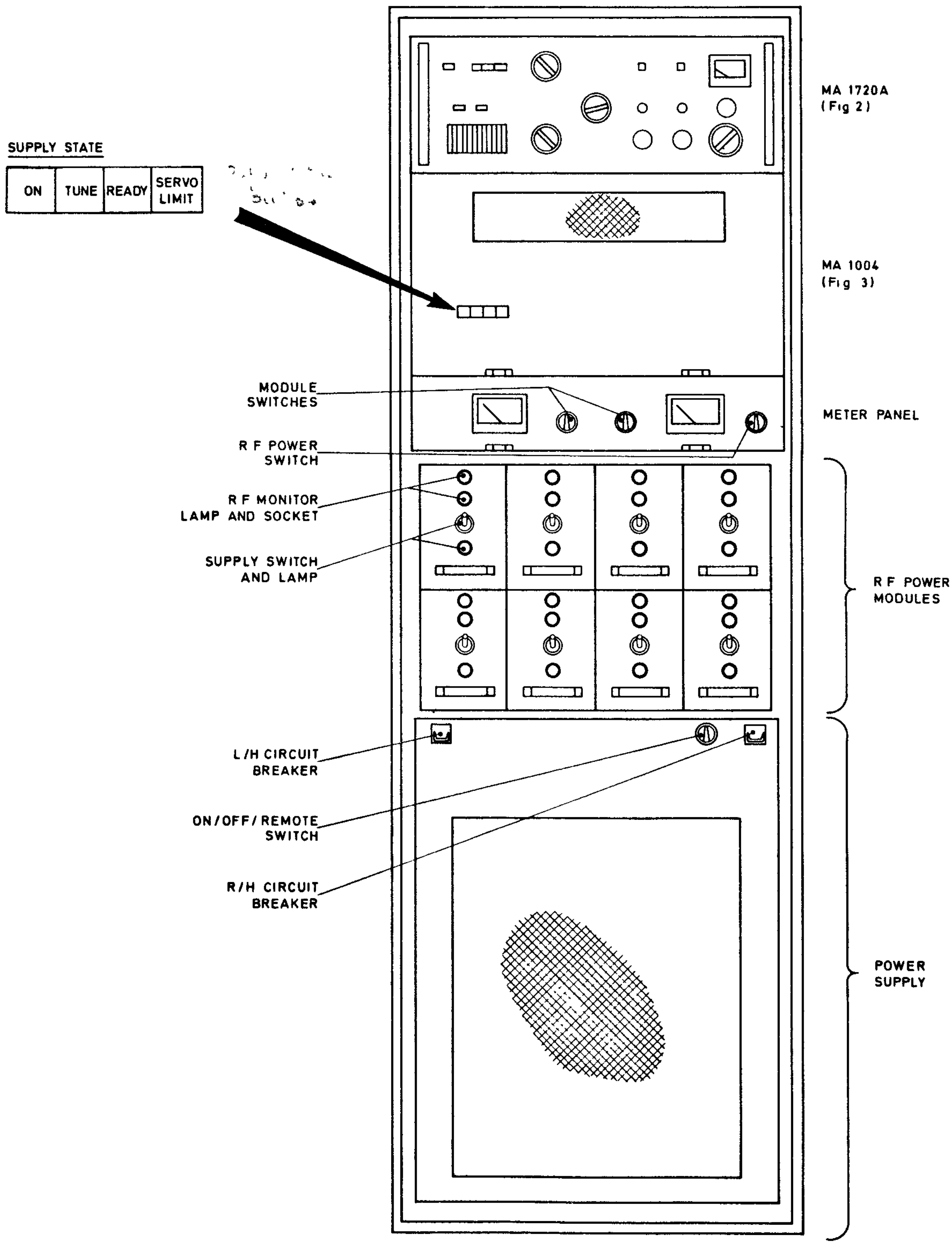


Fig.1 Transmitter sub-assembly : location of controls

(13) Frequency selector switches (six thumbwheels): the function is self-evident. The operating frequency is displayed in decade form.

(14) CONTROL selector switch (four position):-

(a) LOCAL PROG: this position is selected if the operating frequency is set by means of an external pre-programmer unit. (Not used in the TTA.1860A).

(b) LOCAL SYNTH: the normal position of the switch, i.e. with the operating frequency set by the thumbwheel switches.

(c) EXTENDED: control effected via an external control panel. (Not used in the TTA.1860A).

(d) REMOTE: control effected via a remote control system. (Not used in the TTA 1860A).

(15) MODE selector switch (eleven position) and sideband selector switch (two position): selection of the following operational modes:-

(a) CW: continuous wave (keyed carrier) mode. Note that in this mode the frequency selector switches are set to 1 kHz above the required operating frequency.

(b) KEY SUPP: keyed tone in sideband, carrier suppressed.

(c) KEY -6; keyed tone in sideband with -6 dB carrier.

(d) RTTY TEST (not used in the TTA.1860A).

(e) RTTY (not used in the TTA.1860A).

(f) AM-6: compatible a.m. with -6 dB carrier.

(g) SSB-16, UPPER: single sideband with -16 dB carrier.

(h) SSB-16, LOWER: single sideband with -16 dB carrier.

(j) SSB-26, UPPER: single sideband with -26 dB carrier.

(k) SSB-26, LOWER: single sideband with -26 dB carrier.

(l) SSB SUPP, UPPER: single sideband, carrier suppressed.

(m) SSB SUPP, LOWER: single sideband, carrier suppressed.

(n) ISB-26: independent sideband with -26 dB carrier.

(p) ISB-16: independent sideband with -16 dB carrier.

(16) METER switch (nine position): for measuring the following parameters (operating conditions are given in Table 1):-

(a) LINE 2: line 2 audio input level.

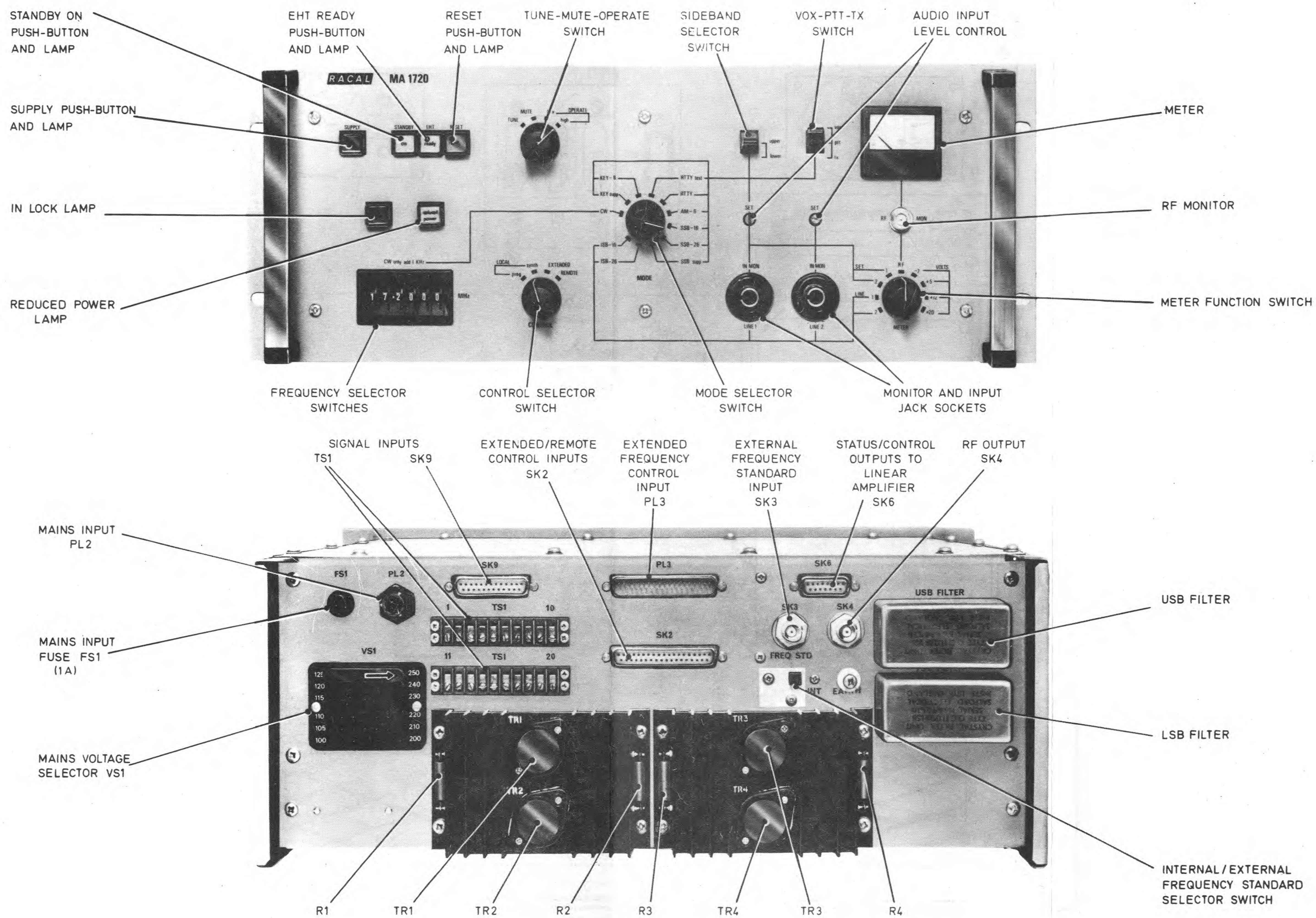
(b) LINE 1: line 1 audio input level.

(c) SET 2: audio input level to line 2 amplifier.

(d) SET 1: audio input level to line 1 amplifier.

(e) RF: r.f. output level to the TA.1810A.

(f) -7 VOLTS)
(g) +5 VOLTS) supply rails.
(h) +12 VOLTS)
(j) +20 VOLTS)



Drive unit : Location of controls

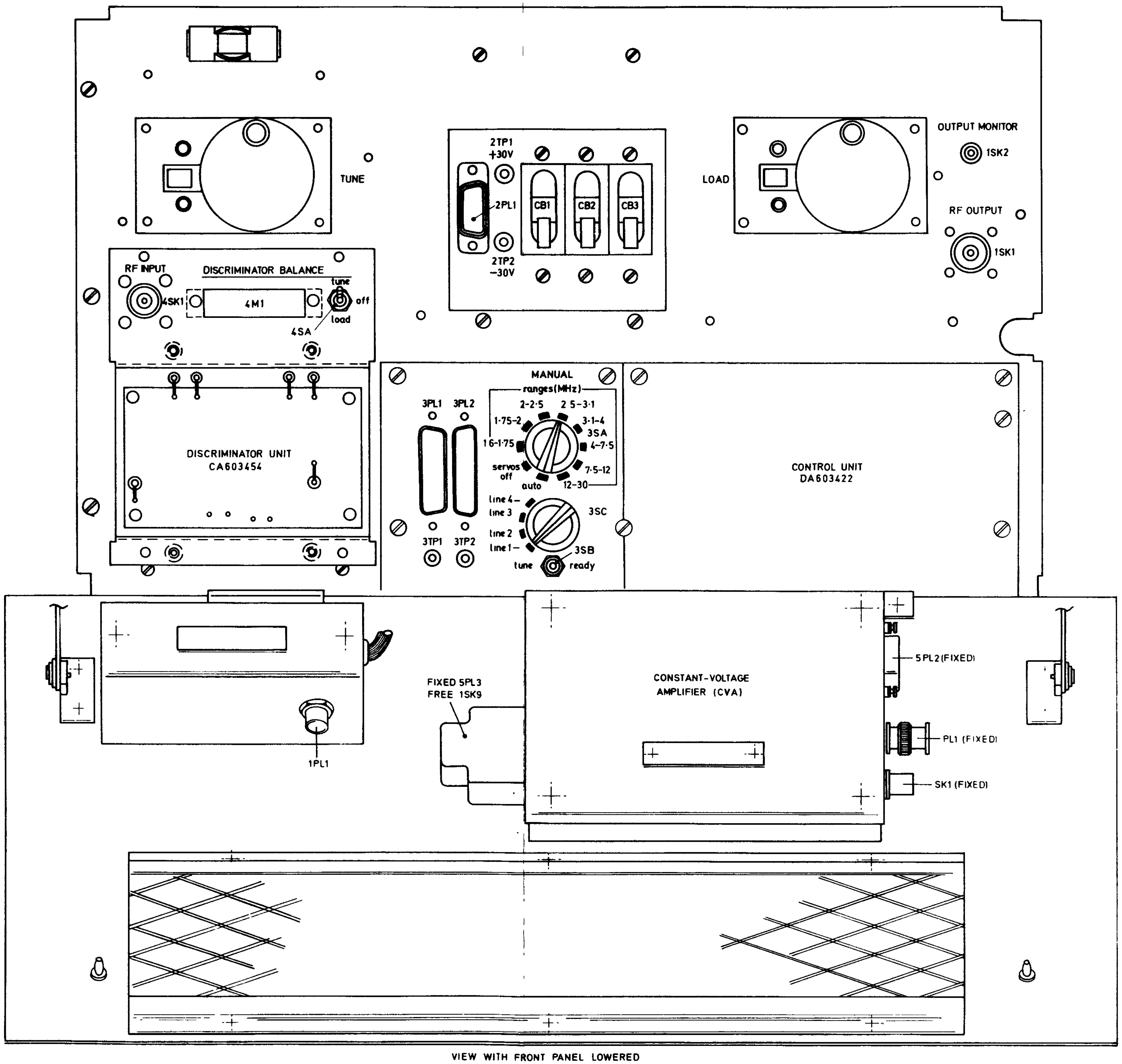


Fig. 3 Feeder matching unit: location of controls Fig. 3

(17) SET LINE 1 (preset): adjusts audio level to line 1 amplifier.

(18) SET LINE 2 (preset): adjusts audio level to line 2 amplifier.

(19) Meter: used in conjunction with METER switch.

4. The following front panel monitoring points are also provided:-

(1) RF MON (coaxial connector): provides a sample of the r.f. output for use with external test equipment e.g. a frequency counter.

(2) IN/MON LINE 1 jack (multiway connector): provides monitoring and signal access to this audio path.

(3) IN/MON LINE 2 jack: as for item (2).

Feeder matching unit (fig. 3)

5. (1) SUPPLY ON pushbutton: controls the a.c. supply input to the MA.1004.

(2) SUPPLY ON lamp: glows when power is switched on.

(3) TUNE pushbutton (not used in the TTA.1860A).

(4) TUNE STATE lamp: glows during the tuning sequence.

(5) READY STATE lamp: glows when the tuning sequence is completed.

(6) SERVO LIMIT STATE lamp: glows when a servo system is driven to an extreme of travel.

6. The following items are located on the sub-front panel:-

(1) Circuit breaker CB1: power supply protection, a.c. supply input. Normally 'on' (toggle up).

(2) Circuit breaker CB2: +30V supply protection. Normally 'on'.

(3) Circuit breaker CB3: -30V supply protection. Normally 'on'.

(4) TUNE control and turns counter: manual adjustment of 'tune' inductor.

(5) LOAD control and turns counter: manual adjustment of 'load' inductor.

(6) DISCRIMINATOR BALANCE switch (three position): measurement of the following:-

(a) TUNE: 'tune' discriminator output.

(b) OFF: self-evident. Normal position of switch.

(c) LOAD: 'load' discriminator output.

(7) Meter, centre zero: used in conjunction with item (6).

(8) MANUAL RANGES switch (ten position):-

(a) AUTO: normal position of switch.

(b) SERVOS OFF: inhibits operation of servo motors.

(c) 1.6 - 1.75 MHz to 12-30 MHz: manual selection of switched capacitors appropriate to each of eight frequency bands.

(9) LINE switch (four position): manual selection of line length (coaxial cables between the TA.1810A and the MA.1004).

(10) TUNE/READY switch (two position):-

(a) TUNE: used during manual tuning sequence.

(b) READY: provides 'ready' signal to the MA.1720A on completion of manual tuning sequence.

Meter panel (fig. 1)

7. (1) MODULE 'selector' switch (eight position) and 'meter range' switch (three position): measurement of the following parameters on each amplifier-stabilizer:-

(a) CURRENT: load current drawn from the +30V supply.

(b) 20V: supply rail.

(c) 30V: supply rail.

(2) RF POWER switch (three position): measurement of the following:-

(a) INPUT 250 mW: drive level from the MA.1720A to the TA.1810A.

(b) FORWARD 1250W: power output to antenna.

(c) REFLECTED 250W: power reflected from antenna. Note that the ratio of the forward and reflected powers is a measurement of the voltage standing wave ratio.

(3) Meter (left-hand): used in conjunction with the MODULE selector switches.

(4) Meter (right-hand): used in conjunction with the RF POWER switch.

Amplifier-stabilizers (fig. 1)

8. Each MM.420 carries the following:-

(1) SUPPLY switch: controls +30V and +20V supplies to the amplifier stages.

(2) SUPPLY lamp: glows when power is switched on.

(3) ON lamp: glows when unit is providing r.f. output. Under normal conditions, all eight ON lamps should glow with equal brilliance. The degree of brilliance is somewhat dependent upon the operating frequency.

(4) RF MON (coaxial connector): provides a sample of the r.f. output for use with external test equipment.

Power supply panel (fig. 1)

9. (1) Circuit breaker CB2 (left-hand): controls the a.c. supply to power supply units PSU 1 and PSU 2.

(2) Circuit breaker CB1 (right-hand): controls the a.c. supply to PSU 3 and PSU 4.

(3) ON/OFF/REMOTE switch (three position):-

(a) ON: operates main contactor, over-riding the action of relay RLC.

(b) OFF: self-evident.

(c) REMOTE: control of main contactor via the MA.1720A. Normal position of switch.

OPERATING PROCEDURES

10. It is assumed that the setting-up procedures (Chap. 1-1) have been completed and that the required audio line inputs are present.

Automatic tuning

11. (1) Check that an antenna of the correct impedance (50-ohm nominal) has been connected to 10 SK1.

(2) Check that the front panel controls are set as follows:-

(a) SUPPLY pushbutton on the MA.1720A to ON i.e. with lamp glowing.

(b) STANDBY pushbutton to OFF.

(c) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(d) CONTROL switch to LOCAL SYNTH.

(e) SUPPLY pushbutton on the MA.1004 to ON.

(f) SUPPLY switch on each MM.420 to ON.

(g) Both circuit breakers on the power supply panel to ON.

(h) ON/OFF/REMOTE switch to REMOTE.

(3) On the MA.1720A set the following controls:-

(a) Frequency selector switches (thumbwheels) to desired operating frequency.

(b) MODE and 'sideband' switches as required.

(c) VOX/PTT/TX switch as required.

(4) Depress the STANDBY pushbutton on the MA.1720A and check that:-

(a) The STANDBY, RESET and IN LOCK lamps glow.

(b) Main contactor CON A closes and all three airblowers operate (audible checks).

(c) The SUPPLY lamp on the MA.1004 glows.

(d) The SUPPLY lamp on each MM.420 glows.

(5) Depress the RESET pushbutton on the MA.1720A and check that the following sequence occurs:-

(a) The RESET lamp is extinguished.

(b) The MA.1004 carries out the feeder matching sequence (audible check and TUNE lamp glows).

(c) The TUNE lamp on the MA.1004 is extinguished and then the READY lamp glows.

(d) The line-selection procedure takes place. At this stage the ON lamp on each MM.420 should glow and a flicker may be observed coincident with the operation of the line selection relays.

(e) The READY lamp on the MA.1720A glows: the TTA.1860A is now tuned and ready to accept traffic.

Change of operating mode or frequency

12. Changes to the operating mode or sideband may be made during normal transmission by re-setting the MODE and 'sideband' switches on the MA.1720A as required.

13. Changes to the operating frequency are made as follows:-

(1) Reset the thumbwheel switches on the MA.1720A to the new frequency.

(2) Depress the RESET pushbutton.

(3) Check that step 11 (5) is repeated.

Manual tuning

14. The following procedures are used for maintenance purposes or in the event of a failure of the MA.1004 servo system.

15. (1) Carry out the procedures given in para.11(1) to 11(4).

(2) Lower the hinged front panel of the MA.1004 and set the sub-front panel controls as follows:-

(a) TUNE/READY switch to TUNE.

(b) MANUAL LINE switch to LINE 1.

(c) MANUAL RANGES switch to suit the operating frequency.

Note...

If the frequency is at end-of-band e.g. 2.5 MHz, either range may be used (2-2.5 MHz or 2.5-3.1 MHz).

(3) Referring to the tuning graph (fig. 4), adjust the TUNE control to give the counter reading appropriate to the operating frequency.

(4) Repeat step (3) using the LOAD control.

(5) Depress the RESET switch on the MA.1720A.

(6) Set the DISCRIMINATOR BALANCE switch to TUNE and adjust the TUNE control to give a centre-zero meter reading.

(7) Set the DISCRIMINATOR BALANCE switch to LOAD and adjust the LOAD control for a centre-zero meter reading.

(8) Repeat steps (6) and (7) alternately for best balance.

Note...

Do not set either the TUNE or the LOAD control below 100 or above 208 counter reading.

(9) Set the R.F. POWER switch on the meter panel to FORWARD 1250W and note the forward power output (right-hand meter).

(10) Set the MANUAL LINE switch on the MA.1004 to LINE 2, 3 and 4 in turn and note the forward power output in each case.

(11) Select the LINE position giving the greatest power output.

(12) Repeat steps (6) to (8).

(13) Set the TUNE/READY switch to READY and the DISCRIMINATOR BALANCE switch to OFF.

◄ (14) Close the MA.1004 front panel.

(15) Check that the READY lamps on the MA.1004 and the MA.1720A are both glowing: the TTA.1860A is now tuned and ready to accept traffic.

(16) To change the operating frequency:-

(a) Set the thumbwheels on the MA.1720A to the new frequency.

(b) Repeat steps (2) to (15).

By-passing of the feeder matching unit

16. The following procedures allow transmission to continue in the event of a failure of the MA.1004. Under these conditions, the harmonic performance will be degraded and, if there is other than unity v.s.w.r. on the antenna feeder, the power output will be reduced. ►

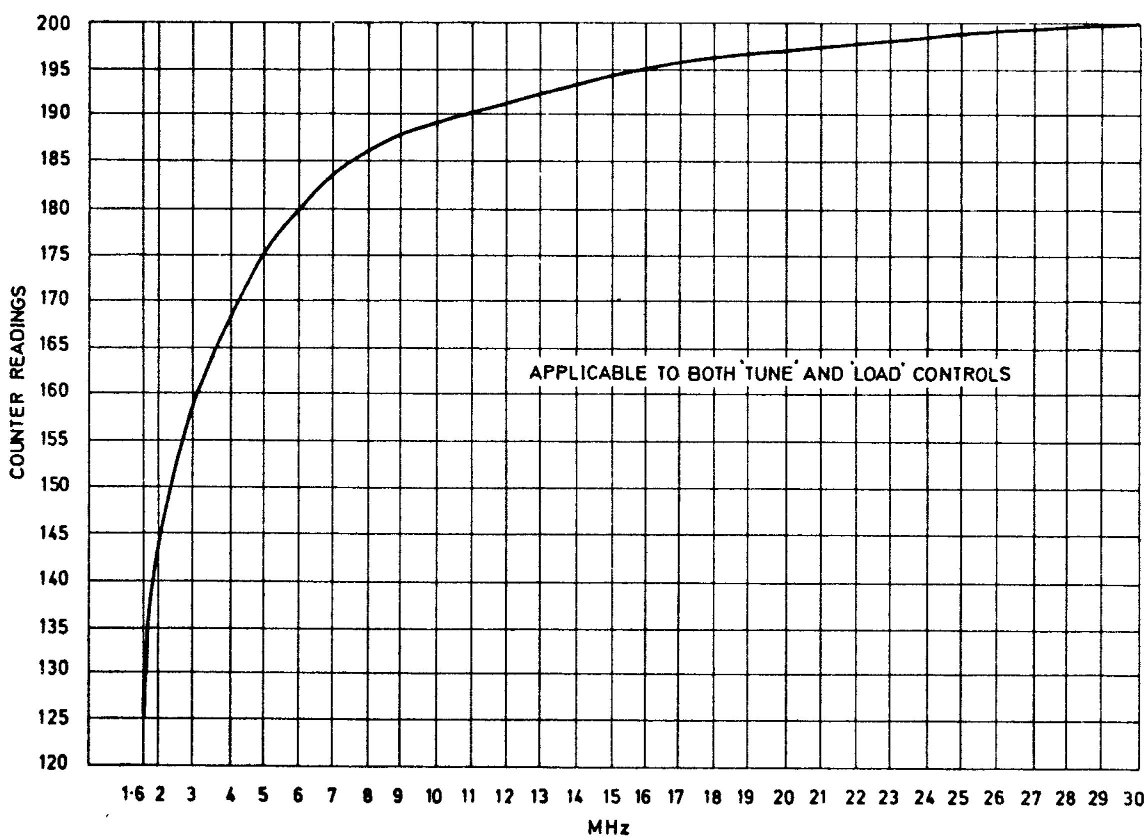


Fig. 4 Feeder matching unit : manual tuning graph

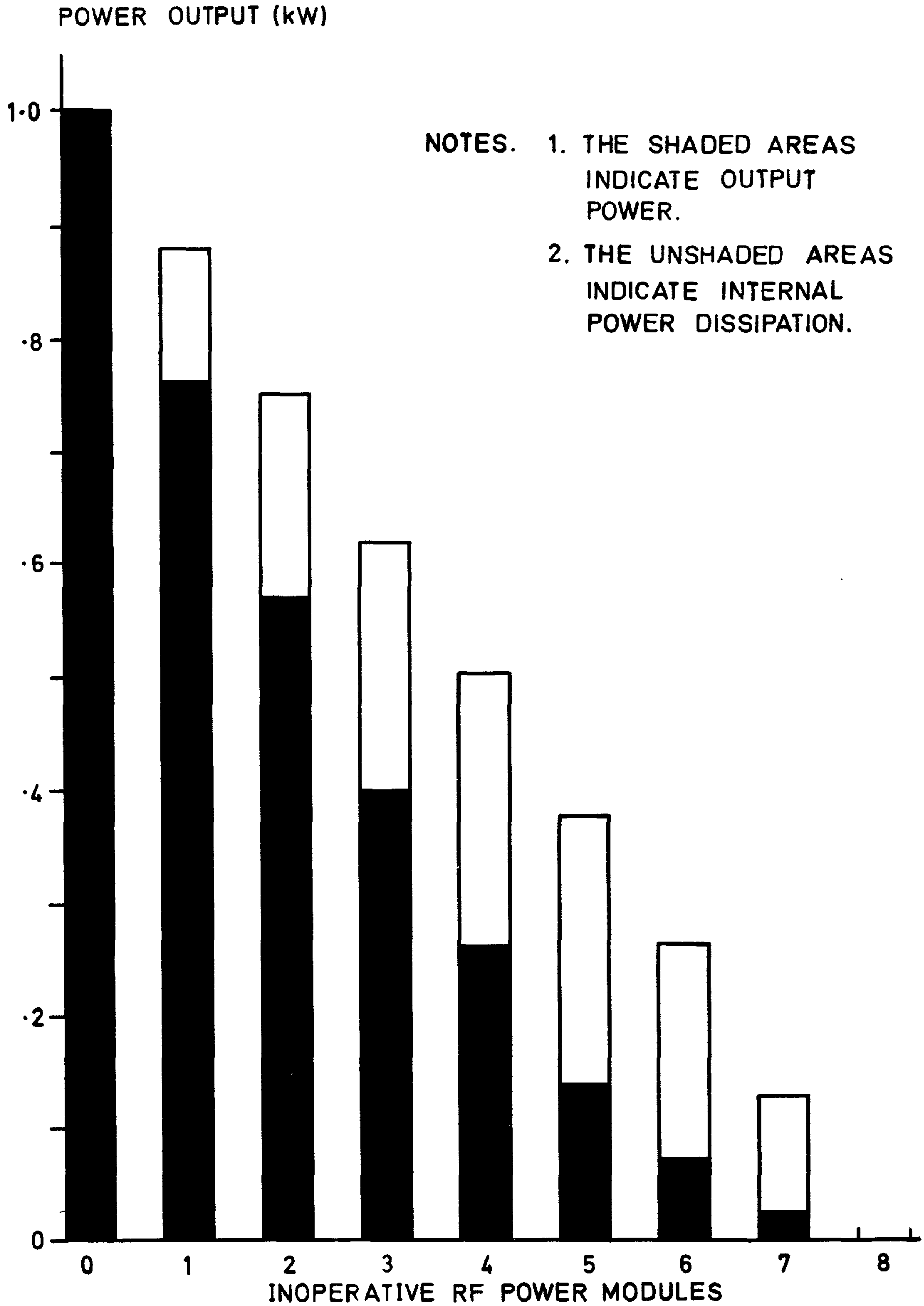


Fig.5 Available - power chart

17. (1) Set the STANDBY switch on the MA.1720A to OFF.

(2) Check that the a.c. supplies are removed from the TA.1810A.

(3) Lower the hinged front panel of the MA.1004.

(4) Disconnect the high-power r.f. cables from the RF INPUT and RF OUTPUT sockets. ► ◄

(5) Disconnect the low-power r.f. cables from 5PL1 and 5SK1 (rear of front panel) and connect them together.

(6) Remove the MA.1004 from the cabinet; the removal instructions are given in Chap. 1-3.

◄ (7) Disengage the multiway connector (1SK36) from the MS.139.

(8) Connect the MS.139 dummy plug (part of accessory kit CA 608) to 1SK36.

(9) Interconnect the high-power r.f. cables using the adaptor provided (located above the TUNE control on the MA.1004).

(10) Interconnect the low-power r.f. cables disconnected at operation (5)

(11) Check that all unused cables are stowed correctly.

(12) Set the STANDBY switch on the MA.1720A to ON. ►

18. Transmission may now be resumed. The operating procedures are similar to those given in para. 11; the difference will be self-evident.

Connection for 500W outputs

19. The following paragraphs describe the connection of the TA.1810A as a dual-500W linear amplifier. This configuration allows transmission to continue, at reduced power output, whilst maintenance is in progress. The procedures assume that the left-hand bank of amplifier-stabilizers feeds the antenna and the right-hand bank is terminated into a dummy load; the alternate connections will be self-evident from figures 5a and 5b, Chap. 1-0.

20. (1) Set the STANDBY switch on the MA.1720A to OFF.

(2) Set the ON/OFF/REMOTE switch to OFF.

(3) Lower the meter panel to its fullest extent, i.e. remove the retaining arm and allow the meter panel to rest gently on its hinges.

(4) Disconnect the r.f. cable (1PL17) from 6SK12 (1 kW output) on the combining unit.

(5) Disconnect the r.f. cable (6PL3) from 6SK10.

(6) Connect 1PL17 to 6SK10.

(7) Disconnect the r.f. cable (6PL2) from 6SK9.

(8) Connect 6SK9 to a suitable dummy load (rating 500W, 50-ohm nominal). Note that an external power indicator is also required.

(9) Check that the unused cables are stowed correctly.

(10) Making due allowance for the r.f. cable connected at step (8), close the meter panel.

(11) Lower the power supply front panel.

(12) Disconnect the r.f. cable (7PL2) from 8SK5 on the right-hand distribution amplifier.

(13) Connect 7PL2 (one of the outputs from the splitter unit)to 1SK29, i.e. to dummy load 1R5.

(14) Connect 8SK5 (right-hand amplifier) to the output of an external signal source (e.g. signal generator).

(15) Close the power supply front panel and set the controls as follows:-

(a) Left-hand circuit breaker to ON.

(b) Right-hand circuit breaker to OFF.

(c) ON/OFF/REMOTE switch to REMOTE.

(16) Set the STANDBY switch on the MA.1720A to ON.

(17) To transmit at a 500W power level, carry out the procedures given in para.11 but with CB1 switched OFF.

(18) To activate the right-hand bank of amplifier-stabilizers:-

(a) Check that the test signal input level is not greater than 100 mV e.m.f.

(b) Set the right-hand circuit breaker to ON.

(c) Switch each MM.420 ON in turn and check its supply rails.

(d) Increase the signal input level until the desired power output level is obtained, as indicated on the external test equipment.

21. It may be noted that when one of the amplifier-stabilizers e.g. No.3 is switched off, the power output falls by more than 1/8 of the total. Part of the output from the companion unit (No. 7) is dissipated in the combining network. If a second MM.420 e.g. No.6 is now switched off, part of No.2 output is also lost. Figure 5 shows how the effect is cumulative down to the last MM.420. Should faults develop in more than two amplifier-stabilizers, and assuming spares are not available, it is advantageous to transfer four serviceable units into one bank and operate the TA.1810A in the 500W configuration.

Note...

Record the original position of each MM.420 affected e.g. 'No.8 temporarily moved to No.5 position'.

MONITORING

22. Monitoring is carried out by means of the front panel meters and indicator lamps (para.2) and by connection of external test equipment to the MONITOR sockets. Typical signal levels are listed in Tables 1 and 2; since the r.f. levels vary according to the frequency and mode of operation, the actual values should be logged at initial installation of the equipment.

TABLE 1

Signal levels - front panel meters

Sub-assembly	Switch position	Normal indication
Drive unit	LINE 2	Dependent upon line input level
	LINE 1	Dependent upon line input level
	SET 2	0 dBm (nominal): adjusted by the appropriate SET control.
	SET 1	0 dBm (nominal): adjusted by the appropriate SET control.
	RF	As logged for each mode.
	-7	Within green band.
	+5	Within green band.
	+12	Within green band.
	+20	Within green band.
Meter panel	CURRENT	Up to 13A (as logged). See Note.
	20V	20V
	30V	30.5V
	INPUT 250 mW	Up to 100 mW (as logged)
	FORWARD 1250W	Up to 1250W (as logged)
	REFLECTED 250W	Up to 250W (as logged)

Note...

The CURRENT, 20V and 30V measurements apply to each amplifier-stabilizer, as selected by the MODULE switch.

TABLE 2

Signal levels - monitor sockets

Sub-assembly and test-point	Instrument	Normal indication
Drive unit		
(a) R.F. MON socket	Oscilloscope	Up to 0.3V p-p (as logged) when terminated in 50Ω.
	Electronic Voltmeter	Up to 0.1V r.m.s. (as logged) when terminated in 50Ω.
(b) IN/MON LINE 1 jack)) (c) IN/MON LINE 2 jack)	A.F. signal source or headphones	See Note 1.

TABLE 2 (cont.)

Sub-assembly and test-panel	Instrument	Normal indication
Feeder matching unit		
OUTPUT MONITOR socket	Oscilloscope	Up to 2V p-p (as logged) when terminated in 50Ω.
	Electronic Voltmeter	Up to 0.7V r.m.s. (as logged) when terminated in 50Ω.
Combining unit		
(a) R.F.MON 1 kW socket	Oscilloscope	Up to 3V p-p (as logged) when terminated in 50Ω.
	Electronic Voltmeter	Up to 1V r.m.s. (as logged) when terminated in 50Ω.
(b) R.F. MON 500W sockets	Oscilloscope	Up to 2V p-p (as logged) when terminated in 50Ω.
	Electronic Voltmeter	Up to 0.7V r.m.s. (as logged) when terminated in 50Ω.
Amplifier stabilizers		
R.F. MON sockets (see Note 2)	Oscilloscope	Up to 10V peak-to-peak when terminated in 50Ω.
	Electronic Voltmeter	Up to 3V r.m.s. when terminated in 50Ω.

Notes...

(1) The jacks provide for the injection of audio test signals to the drive unit or for headphone monitoring of the normal line inputs.

(2) The levels quoted should be obtained at each of the eight sub-assemblies.

Chapter 1-3

TRANSMITTING SET, RADIO 5820-99-626-4733 (TTA 1860A)

SERVICING

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INTRODUCTION

1. This chapter gives a guide to the location of a fault to user-replaceable unit level. Information is also given on routine servicing procedures and for the removal and re-fitting of units.

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN. AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

TEST EQUIPMENT

2. The common test equipment and tools necessary for the maintenance and servicing of the TTA.1860A are listed in Table 1. Authorized equivalent items of test equipment may be used instead of those listed in Table 1, provided that their parameters are at least as good as the equipment they replace.

TABLE 1

List of test equipment

ALTE Item No.	Reference No.	Nomenclature	Remarks
Section 'A' - general purpose electrical engineering test equipment			
A1	5QP/6625-99-105-7049	Multimeter set CT.498A	
A2	10S/6625-99-539-2405	Electronic voltmeter	Marconi TF2603
A3	10S/6625-99-952-0447	Signal generator	Marconi TF2005

TABLE 1 (cont.)

ALTE Item No.	Reference No.	Nomenclature	Remarks
A4a	10S/6625-99-527-1079	Spectrum analyser main-frame 141T	
A4b	10S/6625-99-621-8509	Spectrum analyser r.f. section HP8553B	
A4c	10S/6625-99-621-8508	Spectrum analyser i.f. section HP8552B	
A5	110S/6625-00-649-5070	Wattmeter, directional	Bird 43
A6	110B/9542785	Detecting element 1000W, 2-30 MHz	For use with item 45
A7	10S/6625-99-628-5323	Frequency counter	Racal 9059
A8	10K/6150-99-628-5325	Mains power unit, option 08	For use with item A7
A9	10ZZ/205705	Oscilloscope set CT.588	Tektronix 475
A10	10S/17198	Dummy load 1 kW, 50 ohms	Bird 8890
A11	6625-99-642-5510	Oscilloscope, storage	Tektronix 466

TABLE 1 (cont.)

AIME Item No.	Reference No.	Nomenclature	Remarks
	Section 'D' GSE and special tools		
D1	10H/1142429	'T' connector, coaxial TM.7948	For use with item A2
D2	10H/6625-99-631-9452	Accessory kit CA.607 comprising:- (a) Amplifier module extension lead assembly. (b) Combiner patch lead assembly. (c) Amplifier module blanking panel assembly. (d) Amplifier module mating connectors.	Racal BA 604043 For use with MM.420
D3	10H/6625-99-631-9453	Accessory kit CA.608 comprising:- (a) Servo pre-amp extension board. (b) Tune and range extension board. (c) Mating connectors. ◄ (d) Dummy plug. ►	Racal BA 604044 For use with MA.1004
D4	10A/12783	Brinkley earthing stick	
D5	10W/5905-99-633-3089	Rheostat 5.8 ohms, 20A	Berco SE

ROUTINE SERVICING

3. Routine servicing is carried out at the intervals specified in Topic 45 of this publication.

Air blowers

4. The air blowers BL1 and BL2, which are fitted above the power supply units, employ sealed bearings which require no lubrication.

Extractor fan

5. The extractor fan BL3 is fitted to the top of the cabinet. After a considerable period of use, or after some 12 months storage under tropical conditions without use, it will be found that the oil has migrated from the

grease in the bearings of the rotor. As a result the fan will tend to overheat and will ultimately seize up. To obviate this failure, the fan should be periodically examined and if necessary overhauled and the bearings replaced.

Removal and re-fitting of rotor bearings

6. (1) Remove the extractor fan from the cabinet (para. 72).

(2) Slacken off the hexagon-headed screw retaining the impeller. Remove the impeller and clean off any dust.

(3) Remove any dust from the fan housing.

(4) Remove the two 6BA nuts securing the two through-bolts. Withdraw the through-bolts.

(5) Remove the rear bearing housing.

(6) Remove the rotor with its two bearings.

(7) Examine the rotor and bearings for signs of over-heating. If severely discoloured, (e.g. due to a stalled fan having been left on for a considerable period), the rotor assembly should be replaced. A small amount of discolouration is acceptable.

(8) Remove the bearings using a bearing puller, taking care to avoid damage to the shaft. Discard the bearings.

(9) If the shaft is scored or damaged, restore polish with very fine emery cloth.

(10) Fit the replacement bearings, non-shielded faces outwards. Avoid pressure on the outer race. The new bearings should be a neat fit, not requiring excess force to fit them although the shaft must not slip in the inner race.

(11) A small quantity of XG274 grease should be added to the two-bearing housing after cleaning; this will increase the life of the fan by acting as a reservoir. Excess grease will cause pressure in the bearings and result in over-heating and failure.

(12) Check the field windings for overheating, continuity and insulation to frame. Remove any dust.

(13) Re-fit the rotor with bearings and bearing housings. Secure with the two through-bolts.

(14) Re-fit the impeller, ensuring that the screw seats in the dimple in the shaft.

(15) Connect the fan to a suitable a.c. supply and check for correct operation.

(16) Re-fit the fan assembly to the cabinet.

Main contactor

7. Examine the contacts of the main contactor for burning or pitting; replace as necessary. The contactor is located at the rear of the hinged panel. Access will be self-evident after removal of the contactor cover plates.

Air filters

8. The air filters, one in the power supply front panel and one in the hinged front panel of the MA.1004, should be removed and cleaned using warm soapy water. Ensure that the filters are dry before refitting to the unit.

Coil and gearbox sub-assemblies

9. (1) Remove the MA.1004 from the cabinet (para. 53).

(2) Remove the top cover from the MA.1004 (fourteen screws).

(3) Examine the spur gears of the gearboxes and re-lubricate as required using XG287 grease.

(4) Examine the small insulating wear-strips located at two corners of the rotor (either side of the coil helix) and replace as required. The new items are attached with Evostik 528 adhesive.

(5) Check the backlash between the rotor assembly and shaft of the 'tune' inductor.

(a) Rotate the manual tuning control to bring one corner of the rotor assembly to the top and then hold the handle firmly in this position.

(b) With a suitable tool e.g. a small screwdriver, try to push the corner of the rotor around the helix in either direction. Note the two limits of free movement.

(c) The distance between these positions should not exceed one-eighth inch at the circumference of the coil. If this figure exceeds one-eighth inch, the backlash adjustments should be performed.

(d) Rotate the manual tuning control so that the rotor contacts point to the bottom of the unit. Using a small screwdriver inserted between the coil turns, tighten both of the screws visible in the body of the rotor by one-eighth turn only.

(e) Recheck the backlash and continue adjustment as necessary, ensuring that both screws are turned through the same angle each time. Do not overtighten the adjustment screws.

(6) Repeat operation (5) for the 'load' inductor.

(7) Re-fit the top cover and re-install the unit.

CRYSTAL OSCILLATOR ADJUSTMENT

10. The output frequency of the standard frequency source within the MA.1720A should be adjusted to compensate for crystal ageing.

11. (1) Connect the RF MON socket on the front panel of the MA.1720A to the 'test' input of the frequency counter.

(2) Set the frequency selector switches on the MA.1720A to 29.0000 MHz.

(3) Using a 10s count-time, check that the counter indicates 29.0000 MHz ± 1 Hz.

(4) If the reading is incorrect, withdraw the MA.1720A and remove the top cover. Remove the rubber bung from the hole in the frequency standard module.

(5) Make appropriate adjustments to give the desired counter reading.

(6) Replace the rubber bung and the top cover.

12. If a counter having a range of up to 29.000 MHz is not available, the check can be carried out at a lower frequency; the use of the higher frequency gives greater accuracy of adjustment.

FAULT LOCATION

13. These paragraphs give, with the aid of the interconnecting (functional) diagrams (Chap. 1-0), a guide to the location of a fault to user - replaceable unit level. A thorough understanding of Chap. 1-0 is an essential aid to fault-finding and reference should be made to the relevant paragraphs for details of the 'command' and supervisory signals.

14. The faults are grouped under the following main headings:-

(1) Failure of the drive unit.

(2) Loss of drive to the linear amplifiers.

(3) Zero or reduced output from the linear amplifiers.

(4) Failure of the feeder matching equipment.

(5) Power supply failure.

15. Where a complete set of serviceable spares is available, the substitution method must be used. The tests, which assume an initial 'no-output' condition, must be carried out in the order given.

DRIVE UNIT

16. (1) Set the ON/OFF/REMOTE switch to OFF.

(2) Lower the meter panel and connect the dummy load and directional wattmeter (items A5, A6 and A10 of Table 1) to 6SK12 on the combining unit MS.441. Set the power indicator for 1 kW forward power.

(3) Check that all three circuit breakers on the MA.1004 are set to ON. Set the SUPPLY pushbutton on the MA.1004 to ON.

(4) Set the SUPPLY switch on each MM.420 to ON.

(5) Set both circuit breakers on the power supply panel to ON.

(6) Set the ON/OFF/REMOTE switch to REMOTE.

(7) Set the controls on the MA.1720A as follows:-

(a) SUPPLY pushbutton to ON.

(b) STANDBY pushbutton to ON.

(c) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(d) Control switch to LOCAL SYNTH.

(e) Frequency selector switches (thumbwheels) to the desired test frequency.

(f) MODE switch to AM-6.

(g) VOX/PTT/TX switch to TX.

(8) Check that the SUPPLY, STANDBY, RESET and IN LOCK lamps on the MA.1720A glow.

(9) Check that:-

(a) Main contactor CON A closes and all three airblowers operate (audible checks).

(b) The SUPPLY lamp on each MM.420 glows; if not, refer to para. 23.

(c) The SUPPLY lamp on the MA.1004 glows.

(d) The SERVO LIMIT lamp on the MA.1004 is extinguished; if this lamp glows, refer to para. 33.

(10) Set the METER switch on the MA.1720A to the -7, +5, +12 and +20 VOLTS positions in turn. A meter-reading within the green band should be obtained in each case, if not, carry out the adjustments given in para. 22.

(11) Depress the RESET pushbutton on the MA.1720A and check that the RESET lamp is extinguished.

(12) Set the METER switch to RF and check that the meter indicates the r.f. output level (-6 dB approximately).

(13) Set the MODE switch to each remaining position in turn and check that appropriate c.w. output levels are obtained.

17. (1) Carry out the line level checks given in Chap.1-1, para. 12 to 15.

(2) Disable the test tone inputs.

(3) Re-set the TUNE/MUTE/OPERATE switch to TUNE.

<u>Remedial action</u>

18. (1) If the synthesizer failed to 'lock' at operation 16(8), try several changes in test frequency. If the 'in-lock' condition cannot be obtained, replace the frequency standard in the MA.1720A (para. 52).

Note...

The frequency standard is the only user-replaceable sub-assembly in the drive unit.

(2) If the synthesizer still fails to 'lock', re-fit the original frequency standard and then replace the entire MA.1720A. Having installed the new unit, repeat operations 16(7) to (13). After the installation of a new frequency standard, the adjustments of para. 10 must be carried out <u>before</u> resuming transmission.

19. If no r.f. output is indicated on the meter and the RESET lamp continues to glow, depress the RESET pushbutton for five seconds. If the r.f. output appears for about two seconds and then falls again, a fault condition external to the drive unit may be inhibiting the output. Withdraw the MA.1720A, disengage the multiway connector from socket SK6 and repeat operation 16(10). If the 'no-output' condition persists, replace the entire MA.1720A.

20. If step 19 resulted in the desired r.f. output, re-connect SK6. Lower the hinged front panel of the MA.1004 and disengage the multiway connector from 5PL2 (rear of hinged panel). If the fault symptom re-appears, change the overload unit MS.443; if not, the fault lies in the MA.1004 (para. 34).

21. If the desired output levels are not obtained for either operation 16 (12 16 (13) or 17 (1), replace the entire MA.1720A.

22. If the desired meter readings are not obtained at operation 16 (10):-

(1) Withdraw the MA.1720A.

(2) Remove the bottom cover plate from the power supply board PM.343 (located centre left of chassis, four screws).

(3) Measure the supply rails at tags 1 to 4 of the adjacent terminal strip TB2.

(4) Make appropriate adjustments to the preset controls on the PM.343 to give the following voltages:-

(a) -7V at tag 1: adjust R12.

(b) +5V at tag 2: adjust R9.

(c) +12V at tag 3: adjust R33.

(d) +20V at tag 4: adjust R22.

Note...

If no output is obtained at tag 2, check fuselink FS2.

(5) Remove the multimeter connections and re-fit the bottom cover.

(6) Re-fit the MA.1720A.

If the supply voltages are still incorrect, replace the entire MA.1720A.

23. If the SUPPLY lamp on one particular MM.420 failed to glow at operation 16 (9):-

(1) Re-set its SUPPLY switch to OFF and then remove the suspect r.f. module.

(2) Check that +42V is present at pin 2 of the MM.420 supply socket.

(3) Check that +36V is present at pins 12 and 16.

(4) If the supply inputs are correct, fit the replacement r.f. module.

CAUTION...

The conditions of para. 23 indicate an overload of the MS.440 stabilizer. Do <u>not</u> attempt to re-fit the suspect module to the TTA.1860A until the cause of the overload has been eliminated. The actions of withdrawal and re-fitting of the MM.420 reset the overload-trip circuits and the resultant current surges will cause further damage to the faulty unit.

TRANSMITTER POWER SUPPLIES

24. (1) At the meter panel, measure the supply voltages generated within MM.420 No.1, i.e. set the MODULE switches to 1 and 20V and then to 1 and 30V.

(2) Repeat operation (1) using appropriate switching settings for each remaining MM.420.

Notes...

1. The presence of +20V and +30V outputs from each MM.420 is a good indication that all four MS.64 power supply units are functioning correctly.

2. The failure of any one of the +36V supply rails will result in a REDUCED POWER indication at the MA.1720A.

(3) If the correct meter readings are not obtained for one particular MM.420, transfer the suspect module to a known 'good' position. If the fault symptom now appears at this position, replace the MM.420.

(4) If a pair of modules, e.g. No.1 and No.5 exhibit identical symptoms, the associated MS.64 power supply may be faulty. Check the modules as in operation (1) and, if serviceable, re-fit them to their correct positions. Referring to Chap. 1-0, fig. 5C, measure the outputs from the suspect MS.64; replace as necessary.

(5) Re-fit any modules removed during tests.

25. Measure the +30V supplies to the MS.444 splitter unit and the MS.564 muting unit:-

(1) Remove the power supply front panel.

(2) Remove the two screws securing the hinged panel to the cabinet.

(3) Ease the panel outwards about 2 inches and then disconnect the r.f. cables from the left-hand MS.442 distribution unit. The panel can now swing clear.

(4) Disengage the multiway connector from the MS.444.

(5) Check that +30V is present at both pin 1 and pin 3 of 1SK3.

(6) Re-fit the connector to the MS.444.

(7) Disengage the multiway connector from the MS.564.

(8) Check that +30V is present at pin 1 of 1SK39.

(9) Check that a 0V 'mute' signal is <u>not</u> present at pin 3 of 1SK39.

(10) Re-fit the connector to the MS.564.

(11) Re-connect the r.f. cables and close the hinged panel.

Note...

The +30V outputs from four MM.420 modules are combined in each MS.442. Provided at least one MM.420 is active, the MS.444 and hence the MS.564 receives the required +30V supply input.

<u>TRANSMITTER DRIVE</u>

26. Set the RF POWER switch on the meter panel to INPUT 250 mW. A signal level of about 100 mW should be indicated. If zero or reduced signal level is obtained, a fault exists in either the MA.1004, the MS.564 or the MS.444.

(1) Lower the hinged front panel of the MA.1004. Disconnect the low-power r.f. cables from 5PL1 and 5SK1 and connect them together. If the correct signal level is now obtained, switch OFF and replace the constant voltage amplifier MS.452 (para. 54); if not, re-connect the r.f. cables to 5PL1 and 5SK1. Close the front panel of the MA.1004.

(2) Open the hinged panel (para. 63). Disconnect the r.f. cables from the MS.564 and interconnect them via a BNC adaptor. If the r.f. input signal is now present, the MS.564 is faulty; if not, the fault lies in the MS.444. Replace as necessary.

LINEAR AMPLIFIER OUTPUTS

27. The linear amplifier should now be delivering about 1 kW to the dummy load; measure the actual value. Check that the r.f. monitor lamp on each MM.420 is glowing and that they all glow with approximately equal brilliance.

28. (1) Set the MODULE switches on the meter panel to measure the CURRENT drawn by each MM.420. The actual values should be as logged for the TUNE condition.

(2) If the current drawn by one particular MM.420, e.g. No.1 is less than the expected value, transfer the suspect module to a known 'good' position. If the fault symptom now appears at this position, replace the MM.420.

(3) If operation (2) has no effect upon the current reading, re-fit MM.420 No.1 to its correct position. Release the hinged panel and temporarily transpose the r.f. cables to 8SK1 and 8SK2 on the left-hand distribution amplifier. If the fault symptom now appears at MM.420 No.2, one of the MM.442 outputs is faulty; replace the MM.442. Re-fit the r.f. cables to their correct positions.

Combining unit

29. If all the current readings are correct but zero or reduced r.f. output is obtained, the fault is probably in the combining unit MS.441, and may be located as follows:-

(1) Set the SUPPLY switches on all eight MM.420 modules to OFF.

(2) Transfer the wattmeter connections from 6SK12 to 6SK10.

(3) Switch ON modules No.1 and No.5 only and measure the resultant r.f. power output.

(4) Repeat operation (3) using modules No.2 and No.6 only.

(5) Measure the output from modules No.1, No.2, No.5 and No.6 together.

(6) Repeat operation (1) and then transfer the wattmeter connections to 6SK9.

(7) Repeat operations (3) and (4) using module pairs No.3, No.7 and No.4, No.8.

(8) Repeat operation (5) for the right-hand bank of modules.

(9) The power level at operations (3), (4) and (7) should be 125W approx. in each case. If not, the combiner circuit associated with the reduced power reading is faulty.

(10) The power levels at operations (5) and (8) should each be 500W approx If not, the combiner circuit feeding the relevant output (6SK9 or 6SK10) is faulty.

(11) If the outputs via 6SK9 and 6SK10 are of correct level but that via 6SK12 is not, the final combiner stage is faulty.

If the specified power levels are not obtained, replace the combining unit (para. 69).

OUTPUT TO ANTENNA

30. At this stage the correct r.f. output is available from the linear amplifier. The fault must therefore lie between 6SK12 and the antenna connection.

(1) Set the TUNE/MUTE/OPERATE switch on the MA.1720A to MUTE.

(2) Connect the wattmeter and dummy load to 10SK1 (ANTENNA).

(3) Check that the following r.f. connections have been made. Adjust as necessary:-

(a) 6PL2 to 6SK9.

(b) 6PL3 to 6SK10.

(c) 1PL17 to 6SK12.

(d) 1PL18 to the line switching unit.

(4) Check that all eight r.f. power modules and the MA.1004 are switched ON.

(5) Set the TUNE/MUTE/OPERATE switch to TUNE.

(6) Depress the RESET pushbutton to initiate the automatic tuning sequence. On completion, the power output to the dummy load should be 1 kW approximately.

(7) At the meter panel, measure the actual FORWARD and REFLECTED power levels.

31. If no r.f. output is obtained, a fault exists in either the MA.1004 or the line-switching circuits. By-pass the MA.1004 (Chap.1-2, para. 14). If the r.f. output to the dummy load is now satisfactory, the fault is in the MA.1004 (para. 33); if not, a discontinuity exists either between 1PL17 and 1PL24 (line-switching relays) or between 1PL26 and 10SK1.

32. Having established a continuous signal path to the dummy load, measure the FORWARD power level at the meter panel. If the indicated power is not in agreement with the r.f. wattmeter reading, the v.s.w.r. unit MS.447 may be faulty. Lower the meter panel and check that about 2V is present at pin 1 of the v.s.w.r. warning board PS.446. If it is, re-calibration is required as given in Chap. 1-4; if zero or reduced voltage is obtained at pin 1, replace the MS.447 (para. 70).

Note...

A failure of the 'forward power' signal to the MS.139 will inhibit the automatic line-selection sequence.

FEEDER MATCHING UNIT

▶ 33. At various stages in the previous tests, a fault-symptom within the ◀ MA.1004 was apparent. The following tests localize the fault to one of the direct-exchange sub-assemblies.

Fault signal

34. (1) Re-fit the MA.1004 to the cabinet.

(2) Depress the SUPPLY pushbutton and check that the SUPPLY lamp glows.

(3) Check that the SERVO LIMIT lamp is extinguished.

(4) Lower the hinged front panel and check that:-

(a) All three circuit breakers are ON.

(b) A +30V supply is present at 2TP1.

(c) A -30V supply is present at 2TP2.

(d) The TUNE and LOAD turns counters are not at the limits of their working range.

(5) Set the TUNE/READY switch to TUNE.

35. If the desired results are obtained at operation 34(4), repeat the procedures given in para. 19 and 20. If the 'fault' signal is generated, replace the MS.454 constant voltage amplifier. If the fault condition persists, re-fit the original MS.454 and then replace the entire MA.1004.

CAUTION...

Considerable torque is generated by the servo motors and hence the TUNE and LOAD controls must not be touched during an 'automatic' tuning sequence. Under certain fault conditions, one or both motors may become active during 'manual' tuning; if this condition is suspected, release the control immediately.

Servo limit

36. If the SERVO LIMIT lamp is glowing, set the TUNE/READY switch on the MA.1004 to TUNE. Ascertain whether manual adjustment of the LOAD and LOAD controls is possible; if it is, set each inductor to give a turns-counter reading between 120 and 180. If the SERVO LIMIT lamp remains ON, replace the MS.454.

37. If on attempting to adjust either inductor it self-runs back to the end stop, the associated servo power amplifier is probably faulty; replace the MS.265. If the fault condition persists, re-fit the original MS.265 and then replace the entire MA.1004.

Note...

The supply for the 'tune' MS.265 is obtained via the 'load' MS.265 and hence removal of the 'load' MS.265 will inhibit the operation of the 'tune' servo system.

Manual tuning

38. Carry out the manual tuning procedures given in Chap. 1-2, para. 15.

39. If the desired power output is not obtained, first replace the PS.60 range board (para. 59); if still incorrect, replace the PS.59 tune board also. If the results are now satisfactory, re-fit the original PS.60 and hence localize the fault to either the PS.59 or the PS.60. If replacement of both boards does not rectify the fault, re-fit the original boards and replace the entire MA.1004.

Automatic tuning

40. On satisfactory completion of the manual tuning procedures, automatic tuning may be attempted. Select a different test frequency from that used in para. 38, e.g. change the drive unit settings from 8 MHz to 20 MHz.

41. Carry out the automatic tuning procedures given in Chap. 1-2, para. 11 checking that the following sequence takes place:-

(1) Coarse-tune.

(2) First fine-tune.

(3) Line selection.

(4) Second fine-tune.

42. At operation 41(1), check that the TUNE and LOAD inductors are driven to approximately the settings given in Chap. 1-2, fig. 4. If not, depress the RESET pushbutton the MA.1720A for about five seconds; check that the TUNE lamp on the MA.1004 glows. If still incorrect, depress the TUNE pushbutton on the MA.1004; if coarse-tuning now takes place, a fault exists in the 'coarse-tune-initiate' signal from the drive unit.

43. If neither inductor 'coarse-tunes', first replace the MS.454 constant voltage amplifier; if still incorrect, replace the PS.59 tune board also. If results are now satisfactory, re-fit the original MS.454 and hence localize the fault to either the MS.454 or the PS.59. If replacement of both items does not rectify the fault, re-fit the original items and then replace the entire MA.1004.

44. If one inductor fails to coarse-tune, the fault lies in the relevant servo amplifier stages. A faulty MS.265 could have damaged the associated PS.108 servo pre-amplifier board; it is therefore necessary to replace the MS.265 first. If the inductor still fails to coarse-tune, replace the PS.108 also. If replacement of both items does not rectify the fault, refit the original items and replace the entire MA.1004.

45. The MA.1004 should now carry out the coarse-tune and then the fine-tune actions.

46. If the fine-tune action does not take place, remove the cover from the MS.454 and check that the 'coarse-tune-initiate' signal (+12V) is not present at pin 3 of the printed-wiring board. If +12V is present at pin 3, the fault is probably external to the MA.1004; check the signal level from pin 11 of SK6 on the MA.1720A.

47. If operation 46 is correct but fine-tune action is not obtained, the servo systems may require mechanical re-alignment. Replace the entire MA.1004.

REMOVAL AND RE-FITTING OF UNITS

48. The following conditions are assumed:-

(1) The main a.c. supply to the TTA.1860A has been disconnected.

(2) The ON/OFF/REMOTE switch is set to OFF.

(3) All high-voltage points have been made safe, e.g. capacitors discharged.

49. The re-fitting procedures are in general the reverse of those given for removal; minor differences will be self-evident.

AMPLIFIER/STABILIZERS MM.420

50 (1) Set the SUPPLY switch on the relevant MM.420 to OFF.

(2) Release the dzus fasteners and withdraw the unit.

(3) When re-fitting the unit, ensure that it is correctly located in the guide rails, and then ease into place.

Note ...

It is permissible to remove or re-fit the MM.420 whilst the transmitter is 'live'.

DRIVE UNIT MA.1720A

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

51. (1) Remove the four screws securing the MA.1720A to the cabinet.

(2) Partially withdraw the unit to gain access to the connectors at the rear of the unit.

(3) Release the slidelocks and disengage the multiway connectors.

(4) Disconnect the r.f. cables.

(5) Lift the MA.1720A clear.

Frequency standard

52. (1) Remove the top cover from the MA.1720A (sixteen screws).

(2) Remove the four screws securing the frequency standard mounting plate.

(3) Withdraw the frequency standard sub-assembly from its socket.

(4) Noting its orientation, detach the mounting plate. Re-fit to the new unit.

FEEDER MATCHING UNIT MA.1004

53. (1) Release the dzus fasteners and lower the hinged meter panel.

(2) Lower the hinged front panel of the MA.1004.

(3) Disconnect the high-power r.f. cables from the RF INPUT and RF OUTPUT sockets.

(4) Disconnect the low-power r.f. cables from 5PL1 and 5SK1 (rear of front panel).

(5) Release the slidelocks and disengage the multiway connectors.

(6) Dress the cables to the sides of the cabinet.

(7) Release the side arms and lower the front panel to its fullest extent. Remove the four screws securing the MA.1004 to the cabinet.

(8) Close the front panel and lift the MA.1004 clear (two persons are required).

(9) When re-fitting the unit, check that the cables do not obstruct the movement of the hinged panel or of the manual tuning controls when the panel is raised.

Servo power amplifiers MS.265

54. (1) Remove the MA.1004 from the cabinet.

(2) Remove the bottom cover from the MA.1004 (eleven screws).

(3) Disengage the relevant multiway connector.

(4) Release the four green-painted captive screws.

(5) Lift the unit clear.

Power supply MS.448

55. (1) Remove the MA.1004 from the cabinet (para. 53).

(2) Remove the top cover from the MA.1004 (fourteen screws).

(3) Lower the hinged front panel.

(4) Disengage the multiway connector.

(5) Remove the four screws securing the MS.448 to the sub-front panel.

(6) Remove the two screws securing the rear of the unit.

(7) Disconnect the r.f. cable braid at the side of the MS.448.

(8) Slide the power supply rear-wards and then lift upwards, front first

Constant voltage amplifier MS.452

56. (1) Lower the hinged front panel of the MA.1004.

(2) Disconnect the cables from 5PL1 and 5SK1.

(3) Release the slidelocks and disengage the multiway connectors.

(4) Remove the cover from the amplifier unit (four screws).

(5) Remove the four hexagon pillars.

(6) Lift the unit clear.

Servo pre-amplifier board PS.108

57. (1) Lower the hinged front panel of the MA.1004.

(2) Remove the five screws securing the right-hand front panel of the control unit.

(3) Gently withdraw the printed-wiring board from its socket.

Tune board PS.59

58. As for para. 57.

Range board PS.60

59. As for para. 57.

Power supply units MS.64

60. Power supply units PSU1 to 4 are mounted in two banks of two; the instructions are given for the left-hand bank.

61. (1) Remove the power supply front panel (eight dzus fasteners).

(2) Remove the large Posidrive screw securing the left-hand angle bracket to the front edge of the cabinet.

(3) Withdraw the left-hand bank of power supplies to the full extent of the runners.

(4) Remove the mains shroud.

(5) Using a multimeter, check that a.c. supplies are not present at the transformers.

(6) Disconnect the mains supply cable.

(7) Separate the mains wiring to the two power supplies.

(8) Support the relevant power supply and then remove the three screws securing the bottom of the power supply to the mounting panel.

(9) Loosen but do not remove the three screws securing the top of the power supply.

(10) Lift the power supply from the mounting panel.

CAUTION...

Two or more persons are required when removing a bank of two units from the cabinet.

62. In an emergency, it is permissible to remove a power supply MS.64 whilst transmission is in progress. Set the appropriate circuit breaker (CB1 or CB2) to OFF and then proceed with caution.

Distribution amplifiers MS.442

63. To remove the left-hand MS.442:-

(1) Remove the power supply front panel.

(2) Remove the two screws securing the hinged panel to the cabinet.

(3) Ease the panel outwards about 2 inches and then disconnect the r.f. cables from the left-hand MS.442. The panel can now swing clear.

(4) Disengage the multiway connector from the left-hand MS.442.

(5) Remove the four screws securing the mounting strips to the hinged panel.

(6) As required, detach the mounting strips from the unit (four screws) and re-fit to the new unit.

64. To remove the right-hand MS.442:-

(1) Carry out operations 63 (1) to (3).

(2) Disconnect the r.f. cables from the right-hand unit.

(3) Carry out operations 63 (4) to (6) for the right-hand unit.

Muting unit MS.564

65. (1) Remove the left-hand distribution amplifier (para. 63).

(2) Disconnect the r.f. cables and disengage the multiway connector from the MS.564.

(3) Remove the four screws (front of hinged panel) securing the MS.564 and lift clear.

Splitter unit MS.444

66. (1) Carry out operations 63 (1) to (3).

(2) Disconnect the r.f. cables from the MS.444.

(3) Carry out operations 63 (4) to (6) for the MS.444.

Overload unit MS.443

67. (1) Carry out operations 63(1) to (3).

(2) Disengage the multiway connector on the MS.443.

(3) Remove the cover from the MS.443 (four screws).

(4) Remove the four nuts and bolts securing the MS.443 to the hinged panel and lift clear.

Meter panel assembly MS.445

68. (1) Release the dzus fasteners and lower the meter panel.

(2) Release the slidelock and disengage the multiway connector.

(3) Release the left-hand stay from the slotted member.

(4) Supporting the meter panel assembly, remove the four hinge-retaining screws (a short screwdriver is required) and lift clear.

Combining unit MS.441

69. (1) Remove the MA.1004 (para. 53).

(2) Lower the meter panel.

(3) Disconnect the r.f. connections at the front of the MS.441.

(4) Release the four green-painted captive screws (two either side) securing the MS.441 to the mounting plate.

(5) Remove the two screws securing the rear of the MS.441 to the bearer bar.

(6) Disconnect the four r.f. cables at the left-hand side of the MS.441, noting their positions. Disengage the multiway connector.

(7) Disconnect the four r.f. cables at the right-hand side of the MS.441

(8) Lift the unit upwards and then forwards until clear of the cabinet.

VSWR unit MS.447

70. (1) Remove the MA.1720A from the cabinet (para. 51).

(2) Disconnect the r.f. cable from the MS.447.

(3) Unsolder the twin screened cable and the single screened cable.

(4) Remove the cover from the MS.447 (four screws).

(5) Remove the four nuts securing the unit and lift clear.

Blower units BL1 and BL2

71. The instructions are given for the left-hand blower unit.

(1) Remove all eight amplifier stabilizers (para. 50).

(2) Remove the top left-hand power supply unit MS.64 (para. 61).

(3) Release the hinged panel bearing the distribution amplifiers and swing the panel clear (para. 63).

(4) Remove the mains shroud and disconnect the main supply leads for both blowers.

(5) Remove the mains connector block for the left-hand blower unit.

(6) Provide a suitable support for the blower assembly.

(7) Remove the screws securing the assembly to the mounting frame (acce is provided via apertures at the left-hand edge of the unit).

(8) Lower the assembly clear of the duct and then lift clear.

(9) Disconnect the capacitor and then release from its mounting.

(10) Remove the blower from its mounting frame (seven screws).

Extractor fan BL3

72. (1) Remove the MA.1720A from the cabinet (para.51).

(2) Disconnect the mains supply leads to the fan.

(3) Remove the four Posidriv screws securing the fan assembly and lift clear.

LINE SWITCHING UNIT MS.139

73. (1) Remove the MA.1004 from the cabinet (para. 53).

(2) Disengage the multiway connector from the MS.139.

(3) Remove the cover from the unit (four screws).

(4) Remove the four unit-retaining screws and lift clear.

Chapter 1-4

TRANSMITTING SET, RADIO 5820-99-626-4733 (TTA.1860A)

OVERALL PERFORMANCE CHECKS AND ADJUSTMENTS

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INTRODUCTION

1. The performance checks are carried out in the order given to prove the serviceability of the TTA.1860A.

2. Instructions are also given for the electrical adjustments required following an unsatisfactory performance check.

3. The procedures assume that the setting-up instructions (Chap. 1-1) have been carried out and that the required audio line inputs are present.

FUNCTIONAL CHECKS

FEEDER MATCHING SEQUENCE

4. (1) Connect the dummy load to 10SK1 (ANTENNA).

(2) Disable the AUDIO 1 and AUDIO 2 inputs.

(3) Check that the front panel controls on the TTA.1860A are set as follows:-

(a) SUPPLY pushbutton on the MA.1720A to ON, i.e. with lamp glowing

(b) STANDBY pushbutton to OFF.

(c) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(d) CONTROL switch to LOCAL SYNTH.

(e) SUPPLY pushbutton on the MA.1004 to ON.

(f) SUPPLY switch on each MM.420 to ON.

(g) Both circuit breakers on the power supply panel to ON.

(h) ON/OFF/REMOTE switch to REMOTE.

(4) Depress the STANDBY pushbutton on the MA.1720A and check that:-

(a) The STANDBY, RESET and IN LOCK lamps glow.

(b) Main contactor CON A closes and all three airblowers operate (audible checks).

(c) The SUPPLY lamp on the MA.1004 glows.

(d) The SUPPLY lamp on each MM.420 glows.

(5) On the MA.1720A set the following controls:-

(a) MODE switch to CW.

(b) VOX/PTT/TX switch to TX.

(c) METER switch to RF.

(6) Set the frequency selector switches (thumbwheels) to 2.000 MHz.

(7) Depress the RESET pushbutton on the MA.1720A and check that the following sequence occurs:-

(a) The RESET lamp is extinguished and the 'tune' r.f. output is obtained from the drive unit.

(b) The MA.1004 carries out the feeder matching sequence (audible check and TUNE lamp glows).

(c) The TUNE lamp on the MA.1004 is extinguished and then the line-selection procedure takes place. The ON lamp on each MM.420 should glow and a flicker may be observed coincident with the operation of the line selection relays.

(d) The READY lamp on the MA.1720A glows and the 'tune' signal is removed.

Note...

At this stage, the r.f. power output falls to zero.

(8) Repeat operations (6) and (7) for each of the following test frequencies in turn:-

4 MHz, 6 MHz, 8 MHz, 10 MHz, 12 MHz, 14 MHz, 18 MHz, 20 MHz, 24 MHz, 26 MHz, 28 MHz and 29.9 MHz.

SERVO LIMIT

5. Simulate a 'servo limit' fault condition as follows:-

(1) Set the thumbwheel switches on the MA.1720A to 1.000 MHz, i.e. to a frequency which is <u>not</u> within the working range of the MA.1004.

(2) Depress the RESET pushbutton to initiate the feeder matching sequence.

(3) Check that after a short delay:-

(a) The SERVO LIMIT lamp on the MA.1004 glows.

(b) The RESET lamp on the MA.1720A glows.

(4) Reset the thumbwheel switches to 2.000 MHz.

(5) Depress the RESET pushbutton and check that operation 4 (7) is now repeated.

POWER OUTPUT

6. (1) Set the MA.1720A to the 'c.w. key-down' condition. Link contacts 1 and 13 of the plug provided and insert it into jack JK1 on the MA.1720A; alternatively, interconnect terminals 7 and 8 of 1TB16.

(2) Set the RF POWER switch on the meter panel to FORWARD 1250W. Measure the c.w. power output to the dummy load; at least 820W should be obtained.

(3) Reset the MA.1720A to 'key-up' conditions.

Note...

If the required output is not obtained and it appears that all the r.f. modules are functioning normally, refer to para. 11.

(4) Set the MA.1720A to 4.000 MHz and depress the RESET pushbutton. When the feeder matching sequence is completed, repeat operations (1) to (3).

(5) Repeat operation (4) for each of the remaining test frequencies listed in para. 4(8).

REDUCED-POWER INDICATOR

7. (1) Set the SUPPLY switch on MM.420 No.1 to OFF.

(2) Check that the REDUCED POWER lamp on the MA.1720A glows.

(3) Switch the r.f. module ON again.

(4) Depress the RESET pushbutton on the MA.1720A and check that the REDUCED POWER lamp is extinguished.

(5) Repeat operations (1) to (4) for each remaining r.f. module in turn.

PERFORMANCE CHECKS AND ADJUSTMENTS

8. The following tests can only be carried out by maintenance units having the appropriate test equipment. A list of approved test equipment is given in Table 1 of Chap. 1-3.

CALIBRATION OF R.F. POWER METER

9. (1) Set the STANDBY pushbutton the MA.1720A to OFF (released).

(2) Disconnect the r.f. cable from the dummy load and insert the directional wattmeter (items A5 and A6 of Table 1) at this point.

(3) Set the power indicator on the wattmeter for 1 kW forward power.

(4) Depress the STANDBY pushbutton the MA.1720A.

(5) Set the MODE switch to CW.

(6) Set the MA.1720A to 10.000 MHz and depress the RESET pushbutton.

(7) When the feeder matching sequence is completed, select the c.w. key-down condition (para. 6).

(8) Measure the forward power output using the wattmeter. Note the actual level as a reference value.

(9) Check that the FORWARD power reading on the meter panel is in agreement with that of the wattmeter. If not, lower the meter panel and make the required slight adjustment to preset control 11AR1 (rear of panel). Close the meter panel.

10. (1) Switch OFF r.f. modules No.1, No.2, No.3 ...... in turn until the r.f. power output falls below 250W. Note the actual value.

(2) Lower the meter panel.

(3) Set the NORMAL/CALIBRATE switch to CALIBRATE.

(4) Set the RF POWER switch to REFLECTED 250W.

(5) Adjust preset control 11AR2 until the value noted at operation (1) is indicated on the lower (250W) scale of meter ME2.

(6) Reset the NORMAL/CALIBRATE switch to NORMAL and close the meter panel.

(7) Switch all the r.f. modules ON again.

(8) Depress the RESET pushbutton on the MA.1720A and check that the REDUCED POWER lamp is extinguished.

DISCRIMINATOR ALIGNMENT

11. Re-alignment of the discriminator circuits within the MA.1004 may be required following an unsatisfactory performance check at para. 6.

CAUTION...

These procedures require the use of both 'automatic' and manual adjustment of the MA.1004. Considerable torque is developed by the servo motors. No attempt must be made to manually adjust either the TUNE or the LOAD control whilst 'automatic' conditions prevail.

12. (1) Set the STANDBY pushbutton on the MA.1720A to OFF.

(2) Disconnect the directional wattmeter from the dummy load. Reconnect the dummy load 'direct'.

(3) Lower the hinged front panel of the MA.1004.

(4) Disconnect the high-power r.f. cable from the RF INPUT socket (4SK1) and insert the wattmeter at this point using the minimum length of r.f. cable.

(5) Set the power indicator on the wattmeter for 1 kW forward power.

(6) Depress the STANDBY pushbutton.

(7) Set the MODE switch to CW.

(8) Set the MA.1720A to 10.000 MHz and depress the RESET pushbutton.

(9) When the 'automatic' feeder matching sequence is completed, select the 'c.w. key-down' condition (para. 6).

(10) Check that at least 800W forward power is indicated on the wattmeter.

(11) Set the MA.1720A to the 'key-up' condition. Set the power indicator for reflected power. Re-apply the 'c.w. key-down' condition.

(12) Check that less than 50W reflected power is indicated on the wattmeter.

13. If the above conditions are not obtained:-

(1) Set the TUNE/READY switch on the MA.1004 to TUNE.

(2) Remove the front cover from the discriminator unit (four screws).

(3) Set preset control 4AR16 fully counter-clockwise.

(4) Make small manual adjustments to the TUNE and LOAD controls to give a minimum indication on the wattmeter.

(5) Set the DISCRIMINATOR BALANCE switch to TUNE and check that a centre-zero meter reading is obtained; if not, make a slight adjustment to preset control 4AR4.

(6) Set the DISCRIMINATOR BALANCE switch to LOAD and check that a centre-zero meter reading is obtained; if not, make a lsight adjustment to preset control 4AR10.

(7) Set the STANDBY pushbutton to OFF.

(8) Disconnect the wattmeter from 4SK1. Reconnect the high-power r.f. cable 'direct'.

(9) Depress the STANDBY pushbutton and, after five seconds, the RESET pushbutton.

(10) Check that at least 800W forward power output is obtained; if not, make a slight adjustment to the TUNE control to maximize the power output.

(11) Check that a centre-zero meter reading is obtained; if not, adjust preset control 4AR16 for a centre-zero reading.

(12) Reset the TUNE/READY switch to READY.

(13) Re-fit the front cover to the discriminator unit.

INTERMODULATION PRODUCTS

14. (1) Set the TUNE/MUTE/OPERATE switch to MUTE.

(2) Lower the hinged front panel of the MA.1004.

(3) Connect the 'test' input of the spectrum analyser (item A4 of Table 1) to the OUTPUT MONITOR socket 1SK2 on the MA.1004.

(4) Connect the balanced 600 ohm output of the audio signal generator (item A3) to the AUDIO 1 input of the TTA.1860A.

(5) Set the audio generator for two-tone operation at frequencies of 1100 Hz and 1775 Hz. Set the level of each tone to 0 dBm.

(6) On the MA.1720A set the controls as follows:-

(a) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(b) MODE switch to SSB SUPP.

(c) 'Sideband' switch to UPPER.

(d) VOX/PTT/TX switch to TX.

(7) Set the MA.1720A to 10.000 MHz.

(8) Depress the RESET pushbutton to initiate the feeder matching sequence.

(9) Set the spectrum analyser for operation at the test frequency and adjust to display the wanted tone outputs at the 0 dB reference level.

Note...

The TTA.1860A will now provide about 1 kW p.e.p. output but the r.f. wattmeter will indicate 500W only.

(10) Measure the level of any intermodulation products. These signals, which appear equally-spaced from the wanted tones, should be not less negative than -35 dB relative to the 0 dB reference level.

(11) Set the 'sideband' switch to LOWER and repeat operation (10).

(12) Re-set the 'sideband' switch to UPPER.

(13) Repeat operations (7) to (12) for the following test frequencies:- 4 MHz, 6 MHz and 8 MHz. In each case check that the intermodulation products are within the limits stated at operation (10).

(14) Repeat operations (7) to (12) for the following test frequencies, noting that a limit of -25 dB applies at operation (10):-

12 MHz, 14 MHz, 16 MHz, 18 MHz, 20 MHz, 24 MHz, 26 MHz, 28 MHz and 29.9 MHz.

CARRIER LEVELS

15. (1) Set the MA.1720A to 29.999 MHz.

(2) Set the MODE switch to CW and set for the 'c.w. key-down' condition (para. 6).

(3) Set the METER switch to RF.

(4) Set the TUNE/MUTE/OPERATE switch to OPERATE HIGH and check that an r.f. output level of 0 dB ± 2 dB is obtained. Note the actual value as a reference level.

(5) Set the TUNE/MUTE/OPERATE switch to TUNE. Check that the r.f. level is now within ± 0.5 dB of that noted at operation (5).

16. If the required levels are not obtained:-

(1) Withdraw the MA.1720A and remove the top cover.

(2) Adjust preset control R204 on the low-level board PM.341 until the meter reading reaches a maximum value.

(3) Re-set the TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(4) Adjust preset control R70 on the mixer output board PM.342 to give a 0 dB reading on the MA.1720A meter.

17. (1) Set the MA.1720A to 10.000 MHz.

(2) Set the a.f. generator for single-tone operation at a frequency of 1000 Hz. Set the signal input level to 0 dBm.

(3) Set the MODE switch on the MA.1720A to SSB SUPP.

(4) Set the 'sideband' switch to UPPER.

(5) Adjust the spectrum analyser to display the single-tone output at the 0 dB reference level; this is the reference level for the following tests.

(6) Locate the suppressed carrier signal (if any) spaced 1 kHz from the 'wanted' tone. Check that the level of any signal found is not less negative than -40 dB relative to the 0 dB level.

(7) Set the 'sideband' switch to LOWER and check that the conditions of operation (6) are again satisfied.

(8) Set the MODE switch to SSB-26.

(9) Set the 'sideband' switch to UPPER and LOWER in turn and check that the carrier level is -26 dB ± 1 dB in each case.

(10) Set the MODE switch to SSB-16.

(11) Set the 'sideband' switch to UPPER and LOWER in turn and check that the carrier level is -16 dB ± 1 dB in each case.

(12) Set the MODE switch to AM-6.

(13) Check that the carrier level is -6 dB ± 1 dB and that the 'wanted' tone is also displayed at this level.

(14) Set the MODE switch to CW and check that a single output is present at the 0 dB level.

(15) Set the a.f. signal input to -60 dBm and check that the output noted at operation (14) is removed.

CLOSEDOWN PROCEDURE

18. On completion of testing:-

(1) Release the STANDBY pushbutton on the MA.1720A.

(2) Set the ON/OFF/REMOTE switch to OFF.

(3) Disconnect the test equipment as appriate.

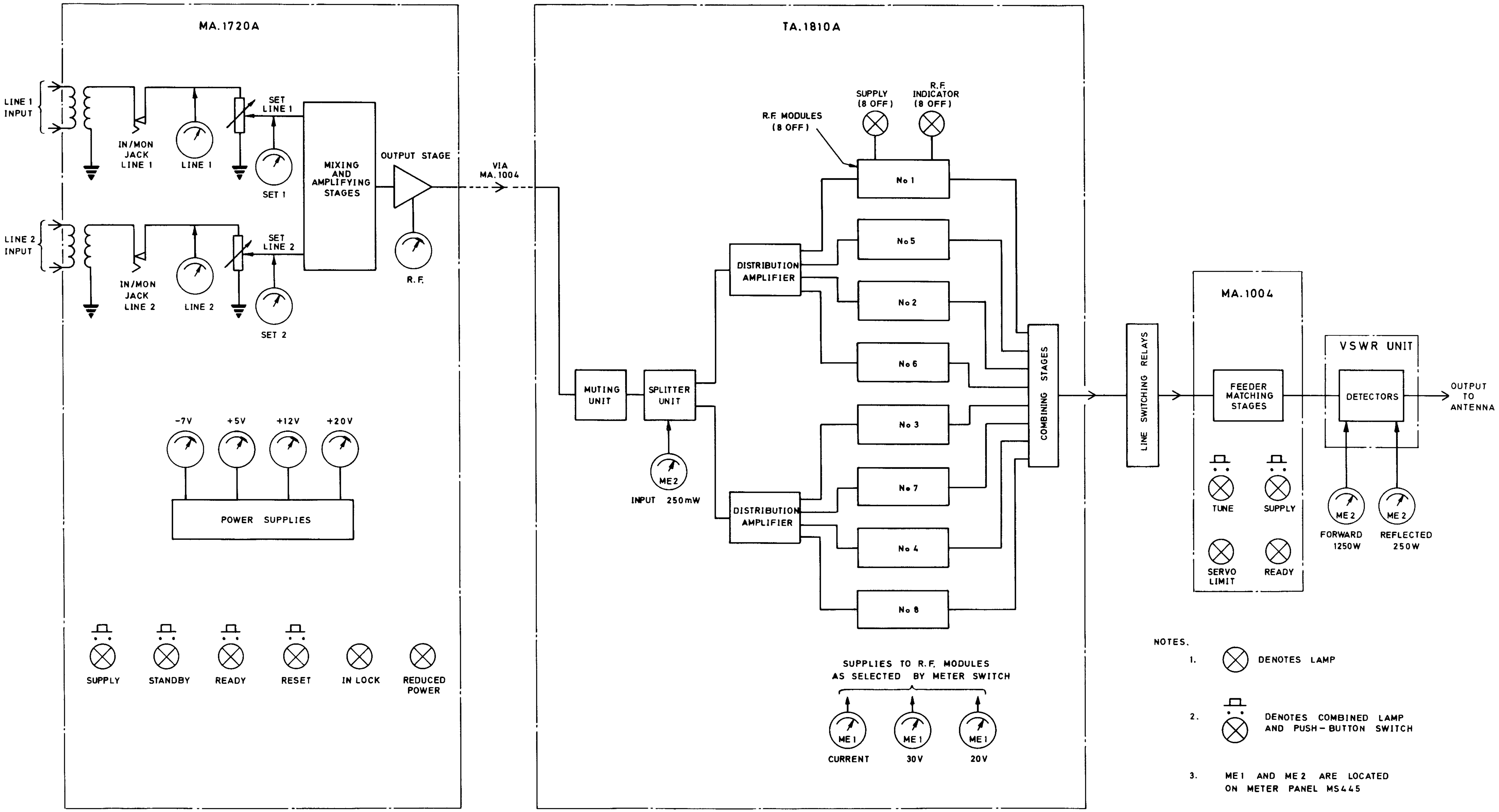

Fig.1

Metering points diagram

Chapter 2-0

FUNCTIONAL DESCRIPTION : DRIVE UNITS, TRANSMITTER 10D/5820-99-624-5395 (MA.1720A) AND 10D/5820-99-631-8611 (MA.1720S)

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INTRODUCTION

1. The drive units MA.1720A and MA.1720S (fig.1) differ in the following respects:

(1) The MA.1720A is fitted with a frequency standard assembly Type 9400.

(2) The MA.1720S is fitted with a frequency standard assembly Type 9420 which has higher stability characteristics than the 9400.

(3) The MA.1720A is fitted with sideband filters having a 3 kHz bandwidth.

(4) The MA.1720S is fitted with sideband filters having a 3.4 kHz bandwidth.

2. The purpose of the drive unit is to provide a low-level (25mW to 200mW) modulated r.f. output in the frequency range 1.6 - 30 MHz (nom.). The internally-generated carrier frequency is produced by a synthesizer which is locked to a high-stability fast-warm-up 5 MHz standard frequency source. The carrier frequency is selected by six thumbwheel switches (front-panel) which enable channel selection to be made in 100 Hz steps over the frequency range 1.6 - 29.9999 MHz. The following points should be noted:

(1) the switch selecting the most significant digit cannot be set to any digit above '2'.

(2) although the frequency range of the drive unit extends down to 1 MHz, the transmitter is not designed to operate below 1.6 MHz.

FACILITIES

▶3. Certain facilities that can be provided by the drive unit are not fitted for either the TTA.1860A or TTA.1860S transmitters; these are as follows: ◀

(1) RTTY operation : hence the RTTY and RTTY TEST positions of the front-panel mode switch are inoperative.

(2) Ancillary units, not forming part of these transmitters, are required to provide the facilities selected by the following three positions of the front-panel LOCAL/EXTENDED/REMOTE switch:

(a) LOCAL (PROG): pre-selection of channel operating frequency.

(b) EXTENDED: local extended control of transmitter.

(c) REMOTE: control of transmitter extended to a remote site via telephone cables or radio link.

4. The facilities provided by the drive unit for the TTA.1860A and TTA.186CS transmitter installations are as follows:

Operational modes

5. (1) Single sideband (upper or lower) with either -16dB, -26dB or fully-suppressed carrier.

(2) Independent sideband with either -16dB or -26dB carrier.

(3) Keyed tone with either -6dB or fully suppressed carrier.

(4) Compatible a.m. with -6dB carrier.

(5) C.W. (lower sideband) with 1 kHz keyed tone.

(6) VOX

(7) P.T.T. : press-to-talk.

(8) Transmit : continuous transmission.

6. The VOX facility is available on the Line 1 audio input, and enables two-way conversation to be carried out without manual switching. Provision is also made for muting an associated receiver.

Monitoring

7. The front-panel jack sockets, LINE 1 (u.s.b.) and LINE 2 (l.s.b.), enable the audio line inputs to the drive unit to be monitored using high-impedance headphones. Contacts are also provided on LINE 1 jack for a press-to-talk line, sidetone output, and connection of an output from an associated receiver.

Inputs

8. Rear panel connectors provide for connection of two 600-ohm balanced line inputs and telegraph keying inputs. The 600-ohm balanced audio inputs may vary between -30dBm and +10dBm (relative to 1mW); two front-panel preset controls enable the input level to be set to the centre of the a.g.c. range. The signal input socket SK9, which is mounted on the rear panel, provides monitor facilities for audio 1 and audio 2 inputs and the output of an associated receiver. The associated receiver output may also be monitored at terminal strip TS1 at the rear of the unit.

9. An r.f. monitor socket mounted on the front panel permits connection of test equipment to monitor the r.f. output of the drive unit.

Metering

10. A front panel meter is used, in conjunction with a meter switch, to indicate the line input levels, line input setting levels, the internal supply voltages and the r.f. output level. A green band on the meter scale indicates the correct setting for audio levels and internal supply voltages.

Frequency standard

11. The 9400 frequency standard, fitted in the MA.1720A, has a nominal stability of 1 part in 10^8 over the temperature range of -10°C to +60°C; the stability of the 9420, fitted in the MA.1720S, is 6 parts in 10^{10} over the same temperature range.

12. A facility is also provided (on the rear of the unit) for connecting and switching to an external 5 MHz standard frequency source.

CONSTRUCTION

13. The unit is housed in a cast alloy chassis which is compartmented (fig.2 and 3) to provide screening between assemblies liable to mutual interference. Printed-circuit boards are mounted on either side of the chassis.

14. Access is gained to assemblies mounted on the top of the chassis by removing the top panel which is secured by screws to the side and rear panels. Assemblies mounted on the underside of the chassis are protected by individual lids which afford easy access to each assembly; all printed-circuit boards are wired-in and, with the exception of the mixer and output board, may be hinged outwards for servicing purposes.

15. The front, side and rear panels are all constructed of steel; the rear panel carries the heat sinks for the power transistors. The front panel is connected to the main cableform via two multi-pin connectors and may be completely detached from the chassis for test purposes.

16. To facilitate cooling, slots in the chassis, the top cover, and compartment lids allow air to flow freely throughout the unit.

BRIEF FUNCTIONAL DESCRIPTION

17. Referring to the simplified block diagram (fig.4) of the drive unit, the main functions are each covered on a printed-circuit board, and are as follows

(1) Low-level board: audio and keying inputs are set-up prior to being applied to balanced modulators; a 1.4 MHz sub-carrier is applied to the modulator and also used for carrier re-insertion purposes.

(2) Mixer and output board: the modulated 1.4 MHz output from the low-level board is passed through two stages of mixing and amplification to provide a 25mW to 200mW r.f. output.

(3) Three synthesizer boards and 34 MHz generator board: the 1.4 MHz sub-carrier and the local-oscillator voltages for the two mixers are produced by the synthesizer.

(4) Control board: contains solid-state switches, initiated by front-panel controls, which select operational modes.

(5) Power supply board: this board, in conjunction with the main chassis-mounted components e.g. mains transformer, produces four low-level, positive, d.c. supply voltages.

A.F. and r.f. stages (fig.4)

18. The principle of operation of the drive unit is apparent from an examination of fig.4.

19. The modulating input signals are applied to the balanced modulator via the automatic gain control amplifiers. The outputs of the a.g.c. amplifiers are switched by reed relays which are controlled by the setting of the front panel mode selector switch in the s.s.b./i.s.b. modes; channel 1 input is used to generate the s.s.b. upper or lower sideband whilst channel 2 input is used to generate the lower sideband in the i.s.b. mode.

20. The audio outputs from the a.g.c. amplifiers are mixed, in the balanced modulators, with the 1.4 MHz output from the frequency synthesizer; the required sidebands are obtained by filtering. The suppressed carrier output from balanced modulator 1 is applied to the l.s.b. filter and the output from balanced modulator 2 is applied to the u.s.b. filter, to compensate for a side band inversion (para.7) which occurs in the final mixer.

21. The 1.4 MHz signal from the synthesizer is also applied to a carrier re-insertion stage where it is attenuated by 6, 16 or 26dB (suppressed carrier greater than -40dB), dependent upon the mode of emission selected. A summing amplifier adds the s.s.b. or i.s.b. signals to the carrier and the resultant signal is mixed with the 34 MHz output from the synthesizer to produce an i.f. of 35.4 MHz. The 35.4 MHz i.f. signal is finally mixed with the 36.4 to 65.4 MHz output from the synthesizer to produce the 1 to 30 MHz r.f. output.

Synthesizer

25. Figure 5 shows that the synthesizer produces the following three outputs

(1) 36.4 to 65.4 MHz as the final mixer injection frequency.

(2) 34 MHz for injection into the first mixer.

(3) 1.4 MHz for injection into the balanced modulators and the carrier re-insertion.

26. The indirect method of frequency synthesis is used where the required output frequencies (with the exception of the 1.4 MHz output) are derived from voltage-controlled oscillators which are phase-locked to an input frequency derived from the 5 MHz standard frequency source. Algebraic equations, for calculating each loop oscillator frequency, are given in para. 39 to 43.

27. 34 MHz generator. The 5 MHz signal is divided by five, on the 34 MHz generator board, and the 1 MHz output fed to the l.f. loop board. This 1 MHz signal is also applied to a phase-locked loop containing a 34 MHz v.c.o. the output from which is fed via a band-pass filter to the first mixer on the mixer and output board (fig.4).

28. L.F. loop. This generates the kHz part of the synthesizer output frequency. The low-frequency loop consists of an 18 to 23 MHz v.c.o., a programmed divider, N1, and a phase-comparator. The phase-comparator compares the phase of the output signal from the programmed divider with that of a 500 Hz reference frequency derived from the frequency standard. Should a phase difference exist, a correction voltage is derived which is fed back to the v.c.o. to eliminate the error.

29. The programmed divider, N1, has a variable division ratio in the range 36001 to 46000, and is controlled by the 100 Hz, 1 kHz, 10 kHz and 100 kHz frequency selector switches. A frequency setting of 9999 sets the division ratio to 36001; a setting of 0000 sets the division ratio to 46000; the division ratio for intermediate frequency settings is given by the expression N1 = 46000 minus the setting of the above four frequency selector switches.

30. The programmed divider N1 is a reversible decade counter programmed to commence a counting sequence at a point dependent on the setting of the four selector switches; a reset operation takes place when the 'count' reaches 46000.

31. Consider a frequency setting of 12.3456 MHz; the required final mixer injection frequency is 12.3456 MHz plus 35.4 MHz i.e. 47.7456 MHz. Ignoring the MHz part of this frequency, the divider N1 is preset to start a counting sequence and count up to 46000; the v.c.o. output frequency for these switch settings is N1 times the input reference frequency to the phase-comparator i.e. 21.272 MHz.

32. The 21.272 MHz main output from the v.c.o. is fed via a divide-by-five stage to the transfer loop. Note that the output frequency from the l.f. loop is in the range 3.6 to 4.6 MHz hence, the actual output is 4.2544 MHz.

33. The 1 MHz input to the l.f. loop is divided by five to produce 200 kHz; a 1.4 MHz crystal filter selects the seventh harmonic and this is amplified to produce a 1.4 MHz injection signal for the balanced modulators.

34. <u>Transfer loop</u>. This loop, in conjunction with the h.f. loop, generates the MHz portion of the output frequency. It consists of a programmed divider, N2, a phase comparator, a mixer and a v.c.o. (h.f. loop board) which covers the frequency range 885 to 947.8 kHz.

35. The programmed divider, N2, has a division ratio from 40 to 69. In contrast to the previously described programmed divider N1, the division ratio of N2 is found by adding 40 to the setting of the MHz switch. This is achieved by first converting the decimal 0 to 29 into a 'nines complement' code before application to the programmed divider which counts from the programmed starting point up to 99, amd then to 39 when the reset occurs. Table 1 gives the conversion from decimal to nines-complement code.

TABLE 1

Decimal to nines-complement b.c.d. conversion

Decimal	BCD				Nines complement				Decimal
	D	C	B	A	D9	C9	B9	A9	
0	0	0	0	0	1	0	0	1	9
1	0	0	0	1	1	0	0	0	8
2	0	0	1	0	0	1	1	1	7
3	0	0	1	1	0	1	1	0	6
4	0	1	0	0	0	1	0	1	5
5	0	1	0	1	0	1	0	0	4
6	0	1	1	0	0	0	1	1	3
7	0	1	1	1	0	0	1	0	2
8	1	0	0	0	0	0	0	1	1
9	1	0	0	1	0	0	0	0	0

36. The output from the l.f. loop is divided by N2 and is then applied as one input of a phase-comparator. The output from the v.c.o. is mixed with the 1 MHz reference frequency, derived from the frequency standard, and the difference frequency output from the mixer is applied as the second input to the phase-comparator. Thus the output voltage from the phase-comparator drives the v.c.o. to a frequency which is equal to 1 MHz minus the output frequency from the programmed divider, N2.

37. The division ratio for the programmed divider, N2, is obtained by adding 40 to the MHz digits of the output frequency. Thus for a frequency of 12.3456 MHz, N2 will be 40 plus 12 which equals 52. The 4.2544 MHz output from the l.f. loop (para.31) is divided by 52 and the result is then subtracted from 1 MHz to give the transfer loop output frequency.

$$\text{Transfer loop output} = 1 - \frac{4.2544}{52}\ \text{MHz}$$

$$= 1 - 0.081815\ \text{MHz}$$

$$= 918.185\ \text{kHz}$$

38. H.F. loop. As stated in para.10, the v.c.o. for the transfer loop is on the h.f. loop board. The output from this v.c.o. is fed via a divide-by-two stage to the h.f. loop containing a programmed divider N2 with the same range of division ratios as for the transfer loop. The output from this loop, which also contains a further divide-by-two stage, is 2N2 times the input frequency to the phase comparator. Hence, the output from the v.c.o. is:

$$918.185/2 \times 2 \times N2$$

$$= 47.7456\ \text{MHz (para.31)}$$

39. Loop equations. The variable output frequency from the synthesizer may be worked out for any frequency setting by using a simple algebraic equation. The following paragraphs show the derivation of this equation.

40. The 1 MHz reference frequency input to the low-frequency loop, designated f1, is expressed as: $f1 = 10^6$ Hz. The output from the l.f. loop (f2) is therefore:

$$f2 = \frac{10^6}{5 \times 400} \times N1 \times \frac{1}{5}\ \text{Hz} \qquad \text{.................. (1)}$$

41. The input to the transfer loop (equation (1)) is initially divided by N2 before being applied to the transfer loop; hence the input to the phase-comparator is:

$$f2 = \frac{10^6}{5 \times 400} \times \frac{N1}{N2} \times \frac{1}{5}\ \text{Hz}$$

$$= \frac{10^6}{10^4} \times \frac{N1}{N2}\ \text{Hz}$$

$$= 100 \times \frac{N1}{N2}\ \text{Hz} \qquad \text{.................. (2)}$$

The transfer loop inverts the frequency range of equations (2) and subtracts it from 1 MHz; the output from the v.c.o. is:

$$f3 = 10^6 - 100 \times \frac{N1}{N2}\ \text{Hz} \qquad \text{.................. (3)}$$

42. The input to the h.f. loop (equation (3)) is divided by a factor of two and applied to the phase-comparator as:

$$\frac{f3}{2} = \frac{10^6}{2} - \frac{100}{2} \times \frac{N1}{N2} \text{ Hz} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

The h.f. loop, which also contains a further divide-by-two stage, provides the following output frequency:

$$f4 = f3 \times 2 \times N2 \text{ Hz}$$

$$= \frac{10^6 \times 2 \times N2}{2} - \frac{100}{2} \times \frac{N1}{N2} \times 2 \times N2 \text{ Hz}$$

$$= 10^6 N2 - 100N1 \text{ Hz} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

43. As shown in fig.5, the division rations N1 and N2 are evolved as follows:

N1 = 46000 minus kHz digits .... (6)

N2 = 40 plus MHz digits .... (7)

44. It will be observed that the equation shown on fig.5 symbolizes the input reference frequency to the l.f. (1 MHz) as f1.

DETAILED FUNCTIONAL DESCRIPTION

45. The following description is primarily concerned with:

(1) the a.f. and keying input paths (fig.6).

(2) the front-panel and solid-state switching (fig.7).

The complete interconnections for the boards within the drive unit are given on sheets 1, 2 and 3 of fig.8.

A.F. input switching and monitoring (fig.6)

46. The flow-circuit in fig.6 is largely self-explanatory, and traces the path of the a.f. and keying inputs from either the rear connectors or front-panel jack sockets through to the low-level board PM341; the detailed description of the low-level modulation process is contained in Chap.2-5-2. Fig.6 also shows the meter monitor circuit and the jack socket monitoring circuits for each input channel; a detailed description of this facility is given in Chap.2-5-3.

47. With reference to the jack sockets JK1 and JK2, the following points should be noted:

(1) the pick-off terminals for the jack plug are those lettered 'a' on the socket diagram.

(2) when a plug is not inserted, there are no breaks in the audio and keying paths for each channel.

(3) the keying input is to channel 1 only; however, this input can also be inserted on either JK1 or JK2 at pin 11.

(4) when a plug is inserted and turned clockwise, the audio (contacts 12) and the keying (contacts 11) line input paths (from rear panel) are broken, and the audio/key input is then derived from the front-panel jack plug. To monitor line inputs without breaking the signal paths to the low-level board, either terminals 2 and 11 (keying input) or 3 and 12 (audio input) must be linked in the jack plug.

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(5) the a.f. output from an associated receiver can be monitored at contact 1a of JK1 only.

(6) the output from a local microphone or key can be connected at terminal 12 of JK1 or JK2 (a.f.) or terminal 11 of JK1 (key).

(7) a sidetone signal can be monitored at contact 5 of JK1 or JK2.

(8) a d.c. supply for a carbon microphone is available at contact 4 of JK1 or JK2.

48. The meter monitoring and setting-up facility utilizes a meter amplifier on the low-level board for the audio lines, and a r.f. detector (not shown) on the mixer and output board for the 200mW r.f. output level measurement. The a.f. meter amplifier circuit is calibrated by R195 on the low-level board. The line input levels are measured in the LINE 1 and 2 positions of the meter switch; these levels are preset by R12 and R11 and measured in the SET 1 and 2 positions of the meter switch.

Front-panel and solid-state switching (fig.7a and 7b)

49. The flow circuit in fig.7 shows all control lines which carry 'command' voltages generated by switches on the front panel; it also shows how these 'command' levels are used, via solid-state switches, to select the mode of operation required from the drive unit.

50. A number of facilities provided by pins in connectors on the rear of the drive unit are not used in the TTA.186CA or TTA.1860S transmitters. The function of all pins on all multi-pin plugs or sockets is given in Tables 2 to 5; those pins which are 'not used' are indicated accordingly.

TABLE 2

Extended frequency control lines : pin functions on PL3
(This facility is not used)

Pin	Function		Remarks
9	1		
10	2		
11	4	x 100 Hz	
12	8		
5	1		
6	2		
7	4	x 1 kHz	Inverted B.C.D.
8	8		
1	1		
2	2		
3	4	x 10 kHz	
4	8		

TABLE 2 (cont.)

Pin	Function	Remarks
21	1	
22	2	Inverted B.C.D.
23	4 x 100 kHz	
24	8	
17	1	
18	2	
19	4 x 1 MHz	
20	8	Inverted Nines Complement B.C.D.
13	1	
	x 10 MHz	
16	8	

TABLE 3

Extended/remote control lines : pin functions on SK2

Pin	Function	Pin	Function
1	Blank	20	Blank
2	Blank	21(not used)	RTTY
3(not used)	I.S.B. control	22(not used)	L.S.B. control
4	Blank	23(not used)	Low power control
5(not used)	High power control	24(not used)	-26dB control
6(not used)	-16dB control	25(not used)	-6dB control
7(not used)	Key supp. control	26(not used)	Key -6dB control
8(not used)	Vox control	27	Blank
9(not used)	Extended 'tx' lamp	28(not used)	Extended 'e.h.t. on'
10(not used)	Extended 'reset'	29(not used)	Extended 'standby on'
11(not used)	Extended 'tune'	30(not used)	Extended 'reset' lamp
12(not used)	Extended 'reduced power' lamp	31(not used)	Extended 'ready' lamp
13(not used)	Extended 'in-lock'	32(not used)	Extended mute
14(not used)	Remote 'on'	33(not used)	Extended 'on'
15(not used)	Extended mode control	34(not used)	Extended p.t.t.
16(not used)	-7V	35(not used)	0V
17(not used)	+5V	36	+12V
18(not used)	+20V	37(not used)	Remote p.t.t.
19	Local p.t.t.		

TABLE 4

Status/control lines to linear amplifier : pin functions on SKT6

Pin	Function	Voltage	Action
1		+12V	
2	Fault	0V = fault +12V = normal	Lights the 'reset' lamp and mutes the MA.1720 under fault condition.
3	Ready	0V = ready +12V = not ready	Lights the 'ready' lamp; the absence of the 'ready' signal reverts the output of the MA.1720 to the 'tune' signal.
4	Reset (coarse-tune-initiate)	0V = normal +12V = reset	When the 'reset' button is depressed, the MA.1720 is de-muted and a coarse-tune-initiate signal is applied to the linear amplifier.
5	Reduced power	0V = lamp 'off' +12V = lamp 'on'	Lights 'reduced power' lamp when the linear amplifier is operating on reduced power.
6 (not used)	E.H.T. 'on'	+12V = 'off' 0V = 'on'	Switches on linear amplifier e.h.t. supplies.
7	Standby	+12V = normal 0V = 'on'	Sets the linear amplifier to 'standby'.
8	Mute	+12V = normal 0V = mute	Mutes linear amplifer.
9		0V	Earth
10 (not used)			
11	Coarse-tune-initiate (reset)	0V = normal +12V = reset	Sets linear amplifier to the coarse-tune-condition.

TABLE 5

Input signals : pin functions on SKT9 and TS1

Pin SKT9	Pin TS1	Function	Pin SKT9	Pin TS1	Function
1) 2)	1, 2	Audio 1 input	25	18	Screen for RTTY input
			15*		Blank
14	3	Screen for audio 1 input	19*		Audio 1 monitor (sidetone)
3) 4)	4, 5	Audio 2 input	20*		Screen for audio 1 monitor
16	6	Screen for audio 2 input	21*		Audio 2 monitor (sidetone)
5	13	KEY input	22*		Screen audio 2 monitor
17	14	Screen for key input	23	19	OV
6*	15	Audio from receiver	24*	20	+12V
18*	16	Screen for audio from receiver			
7*	7	Normally closed (tx condition)			
8*	8	Relay contacts (change-over)			
9*	9	Normally-open			
10*	10	Normally-closed			
11*	11	Relay contacts (change-over)			
12*	12	Normally-open			
13	17	RTTY input			

* not used

51. Initially, the following description of fig.7 presupposes certain conditions set up on the front panel switches; these conditions are as follows:

(1) SUPPLY pushbutton released (out) hence lamp extinguished.

(2) STANDBY pushbutton released (out) hence lamp extinguished.

Note...

The E.H.T. pushbutton is not utilized in the TTA.1860A and TTA.1860S transmitters.

(3) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(4) LOCAL/EXTENDED/REMOTE switch to LOCAL SYNTH.

(5) SIDEBAND switch to LOWER.

(6) VOX/P.T.T./TX switch to TX.

(7) MODE switch to SSB-16.

52. The effect of the remaining positions of the above switches is indicated where appropriate in the following paragraphs. A full description of the PM345 control board is given in Chap.2-5-3; fig.7 includes the complete circuit of the PM345.

Switching-on

53. When the SUPPLY pushbutton (fig.6) is depressed, the mains input voltage is connected via the voltage selector (rear) to the drive unit power supply (Chap.2-5-3) and the low-level d.c. voltages for all the boards in the drive unit are produced.

54. When the STANDBY pushbutton is depressed, a +12V 'command' voltage is applied via SA2F, D2 (front panel) and SF to pin 13 of the control board PM345; this results in a 0V level at pin 14 of the PM345 which energizes the standby relay RLC/1 in the linear amplifier. The linear amplifier can now be switched on in the manner described in Chap.1-0 (TTA.1860A) or Chap.13-0 (TTA.1860S).

Frequency selection

55. It is now assumed that the operating frequency has been selected on the six thumbwheel switches, hence the synthesizer will have gone out-of-lock and then re-locked (IN-LOCK lamp glowing). The effect of the synthesizer momentarily going out-of-lock is to produce a sharp-edged negative-going pulse (logic '0') at pin 9 of G4 (PM345); this causes the latch stage G3/G4 to trip and produce a logic '1' at pin 11 of ML2. This results in the following:

(1) The output of G9 (ML1) changes from logic '0' to logic '1'.

(2) The level at pin 5 (PM345) changes from +12V (nom.) to 0V (nom.).

(3) The RESET lamp glows because TR6 conducts.

(4) The IN-LOCK lamp is momentarily extinguished because TR4 momentarily conducts.

The 0V 'command' at pin 5 (PM345) is applied to pin 12 of the mixer and output board PM342 (Chap.2-5-2) to mute the r.f. output from the drive unit; this 0V 'command' is also applied via pin 11 of SKT6 (rear) to mute the linear amplifier and hence minimise the radiation of noise during a frequency changing action.

56. After the RESET button has been operated, the linear amplifier applies a 'not ready' command, via pin 3 of SKT6 (rear) to pin 8 (PM345). This +12V command, via TR13 and TR14 (PM345), produces a 'tune' voltage (+12V) at pin 11 (PM345) which is routed to pin 27 (PM341) and produces the following actions:

(1) The channel 1 audio path (PM341) is muted, via D28, D12 and R21, by TR1.

(2) The 1.4 MHz carrier is re-inserted, via D29, D41 and R166, by TR49.

(3) The 1.4 MHz re-inserted carrier is attenuated to the 'tune' level, via D29 and R220, by TR61.

(4) The full-power attenuator, for the 1.4 MHz output, is switched in, via D29, D51 and R215, by TR58.

(5) The low-power attenuator, for the 1.4 MHz output, is inhibited, via D29 and R209, by TR59 and TR56.

(6) The READY lamp is extinguished via pin 10 (PM345).

57. The presence of the 'not ready' +12V command at pin 3 of SKT6 also results in an open-circuit, via TR13, TR14, TR17 and TR16, at pin 12 (PM345); this open-circuit is applied via pin 8 of PL1 (front panel) and SA1B to the wipers of the MODE switch SB. Hence, the MODE switch has no 'command' voltage (+12V) at its wipers and, therefore, cannot institute mode changes.

Reset operation

58. Until the RESET pushbutton is depressed, the transmitter remains in the state described in para.55 to 57. When the RESET switch is depressed a +12V 'command' is applied, via SA2F, D3, switch SE (RESET) and pin 3 of PL1 on the front-panel, to pin 29 (PM345); this results in the following actions:

(1) A +12V coarse-tune-initiate command is applied, via TR2, TR1 and pin 30 of the PM345, to the feeder-matching unit.

(2) The monostable ML4 is triggered, via TR2 and G1 (ML2), for 2 seconds to produce a logic '0' output which resets the latch G2/G3 in ML2 (para. 55). Hence, the level at pin 11 of G5 (ML2) reverts to logic '0' which, via G7, G9, TR9 and pin 5 results in a logic '1' being applied to pin 5 (PM342) and the muting 'command' being removed from the drive unit output stage. Hence, the MA.1004 is now fed with an attenuated 1.4 MHz 'tune' signal, and commences the coarse-tune action.

(3) The RESET lamp is extinguished by TR6.

59. When the MA.1004 has completed its tuning process, a 'ready' command (0V) is fed back to pin 3 of SKT6 (rear of drive unit). This is applied to pin 8 (PM345) and results in the following actions:

(1) A 0V command, via TR13 and TR14, appears at pin 11 (PM345) which cancels the 'tune' condition; hence, the states described in (1) to (6) of para.56 are reversed.

(2) A +12V level, via TR13, TR14, TR17, TR16 and pin 12 (PM345) is applied to pin 8 of PL1 (front panel); hence, the MODE switch now has the 'command' level necessary to institute mode changes (para.57) if required.

60. The READY lamp is now glowing and the transmitter is operational for the frequency and mode previously selected.

Mode selection

61. For the lower-sideband SSB-16 mode previously selected (para.51), the following occurs:

(1) Switch wafer SB1F (front panel) applies a +12V command, via pin 17 (SKT1) and pin 23 (PM341), which results in the following:

(a) The 1.4 MHz carrier re-insertion amplifier TR51 being switched on by TR49/TR50/TR52 via D43, D37 and R166.

(b) The 1.4 MHz, -16dB attenuation stage TR60 being activated via D43 and R216.

(c) The channel 1 audio attenuator TR32 being activated via D43 and R116.

(d) The channel 2 audio attenuator TR30 being activated via D43 and R115; this channel is not used in s.s.b. mode.

(2) Switch wafer SB2F open-circuits the +12V command, via pin 33 of PL1, which is reconnected by the SIDEBAND switch (SL) in the LSB position; hence the +12V command is routed via pin 33 of PL1 to pin 30 (PM345) to energize the relay RLA/1. Contact RLA1 changes over to route the channel 1 audio input into the u.s.b. modulator and filter path; a subsequent frequency inversion (PM342) inverts the signal into the l.s.b. path.

62. The effect of a mode change is as follows. Assume that ISB-26 is selected by the MODE switch SB; the operation of the SIDEBAND switch SL becomes ineffective. Switch wafer SB2F applies a +12V command, via pin 18 of SKT1 (front-panel) to pin 29 (PM341) which has the following affects:

(1) The i.s.b. switching relay RLB/1 (PM341) is energized via D31, R92, TR31; hence the audio channels 1 and 2 are switched to the l.s.b. and u.s.b. modulators respectively.

(2) The channel 1 audio attenuator TR28 is activated via D31, D26 and R91.

63. Switch wafer SB1F applies a +12V command, via pin 35 of SKT1 (front-panel), to pin 20 (PM341) which has the following affects:

(1) The 1.4 MHz carrier re-insertion amplifier TR51 is switched on by TR49/TR50/TR52 via D44, D40 and R116.

(2) The 1.4 MHz, -26dB attenuation stage TR53 is activated via D44 and R200.

64. If the MODE switch SB is set to CW, and LSB is still selected by the SIDEBAND switch, wafer SB2F applies a +12V command, via pin 33 of PL1 (front panel) to pin 30 (PM341); this energizes the l.s.b. switching relay RLA/1 (PM341). Contact RLA1 routes the channel 1 audio signal to the u.s.b. modulator. Switch wafer SB1F applies a +12V command, via pin 34 of SKT1 (front panel), to pin 46 (PM341) with the following affects:

(1) The 1 kHz tone oscillator is switched on, via D3 and R24, by TR9 and TR14 (PM341).

(2) The a.g.c. input amplifier of audio channel 1 is turned 'off', via D3, D18, D12 and R21 by TR1 (PM341).

65. The mute-delay stage on the PM341 board provides a OV output, until a key is depressed, which is routed from pin 47 (PM341) to pin 21 (PM345); the key contacts are connected to pins 44 and 43 of the PM341 board. This OV signal is applied to D9 (PM345) of the diode OR gate D14, D16, D9 and D11; this results in the NAND gate G9 (ML1) producing a logic '1' output which is inverted by TR9 to produce a logic '0' muting signal to the drive unit output stage on the PM342 board (pin 12). Hence, the drive unit output is muted until the key is depressed when the level at pin 21 (PM345) rises to +12V and the muting level is removed from pin 5 (PM345). The mute-delay stage introduces a 2 second delay, following the cessation of the keying action, before the drive unit is again muted.

66. The effect of selecting other modes of operation can be deduced from fig.7 in the same manner as previously described.

Fault condition

67. The fault input at pin 2 of SKT6 (Table 4) is normally at +12V but falls to OV when a linear amplifier fault occurs. When a fault occurs, the output from the latch stage ML2 (PM345) rises to logic '1' causing the RESET lamp to glow and, via G7 (ML3), G9 (ML1) and TR9, the transmitter to become muted as described in para.55. When the linear amplifier fault has been cleared, the RESET switch is depressed in order to restore normal operating conditions.

Reduced power

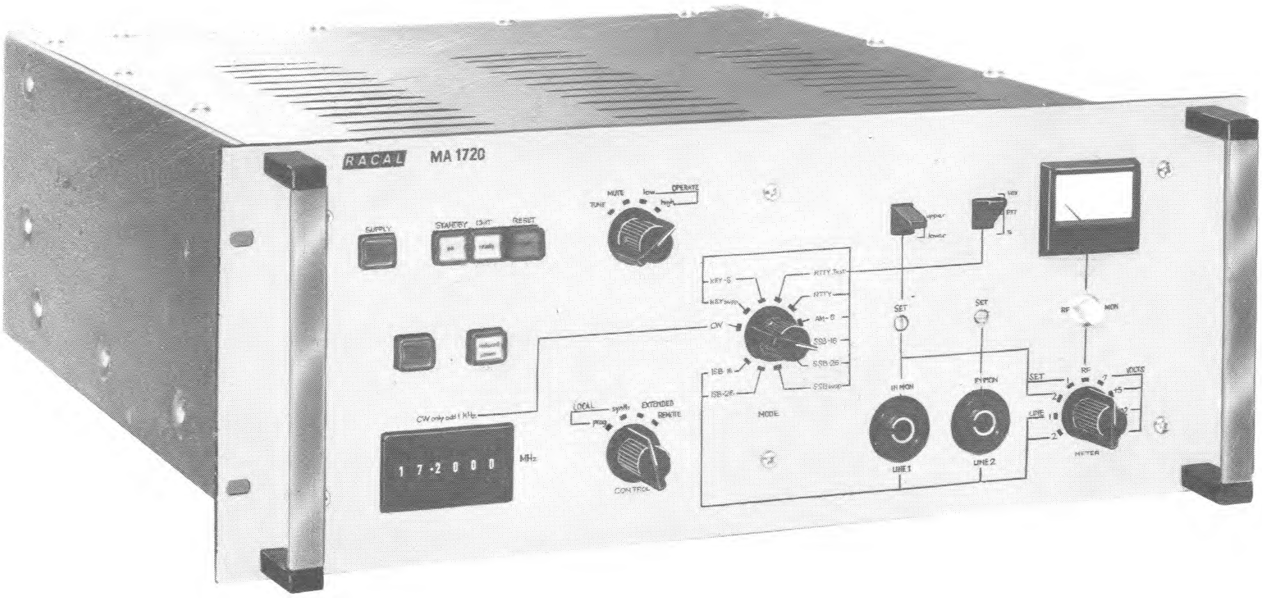
68. The reduced-power input line (pin 5 of SKT6) is normally at OV; when a reduced-power condition prevails, a +12V command is applied to TR10 (PM345) which causes the REDUCED POWER lamp to glow via pin 7 (PM345) and pin 5 of PL1 (front-panel).

P.T.T. input

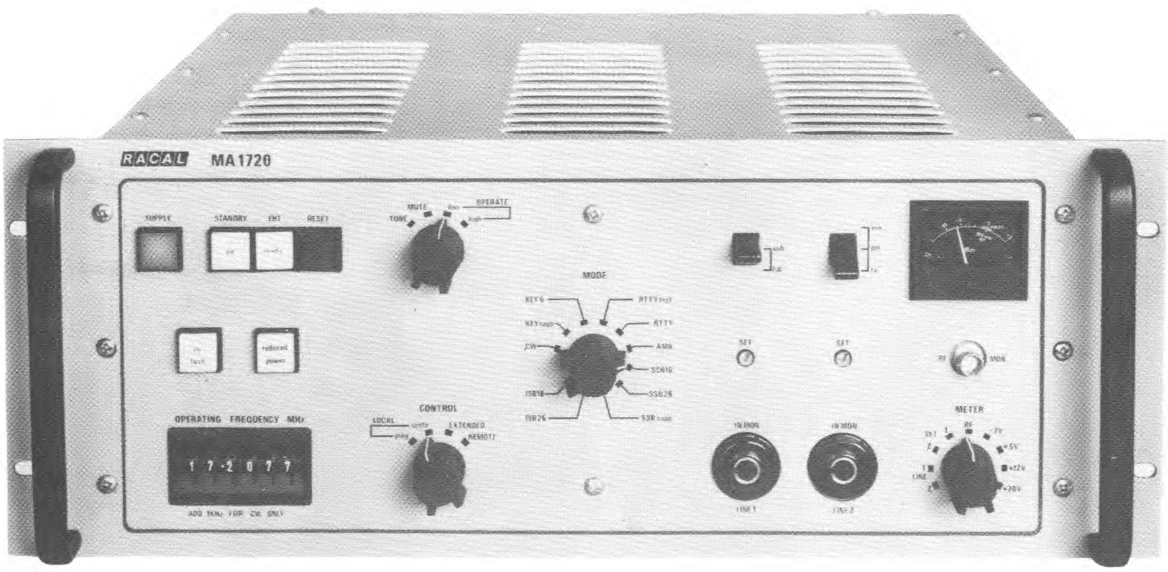
69. The pressel contacts are connected to pins 19 and 36 (+12V) of SKT2 (rear of drive unit); hence, the p.t.t. input appears at pin 19 and is applied, via switch SH (P.T.T. position), switch SA2F, pin 27 of PL1 and pin 19 (PM345) to the diode OR gate referred to in para.65. The action of setting switch SH to P.T.T. is to mute the drive unit, i.e. when the pressel is in the 'normal' (released) position, a logic '1' occurs at the output of G9 (ML1). When it is depressed, the muting action is removed.

VOX input

70. When a 'voice' mode is selected and switch SH is set to VOX, the level at pin 12 (PM341) is OV until a speech signal occurs in channel 1. This OV level is applied, via pin 15 of PL1 (front-panel), switches SH and SA2F, pin 27 of PL1 (front-panel), pin 19 (PM345) and D11, to the diode OR gate (para.65); this results in a mute output (logic '1') from G9 (ML1) which mutes the drive unit output. When an audio signal appears in channel, pin 12 (PM341) rises to +12V and the muting effect is removed.



OLD VERSION



NEW VERSION

Fig.1   Drive unit : front view

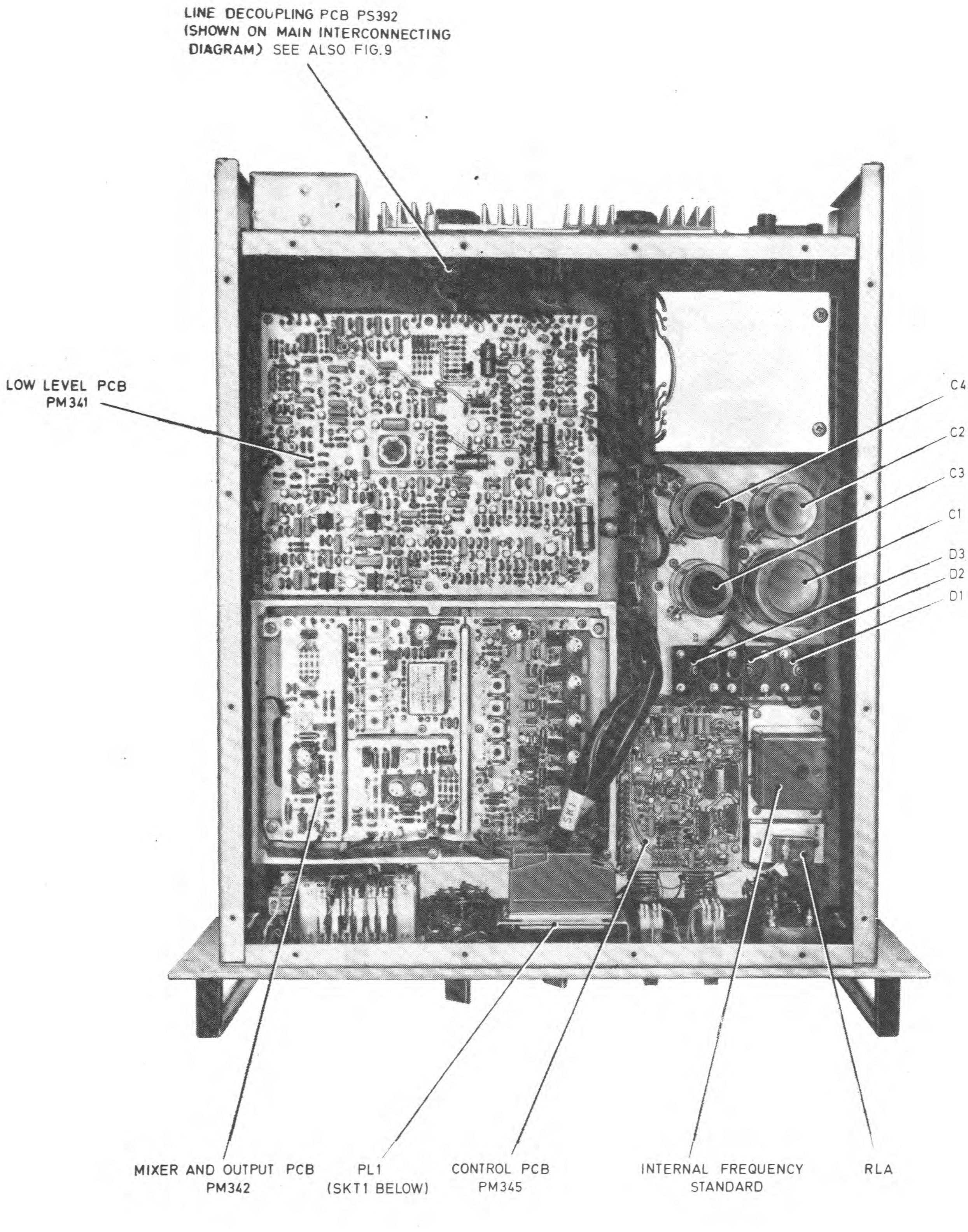


Fig.2 **Drive unit** : chassis top

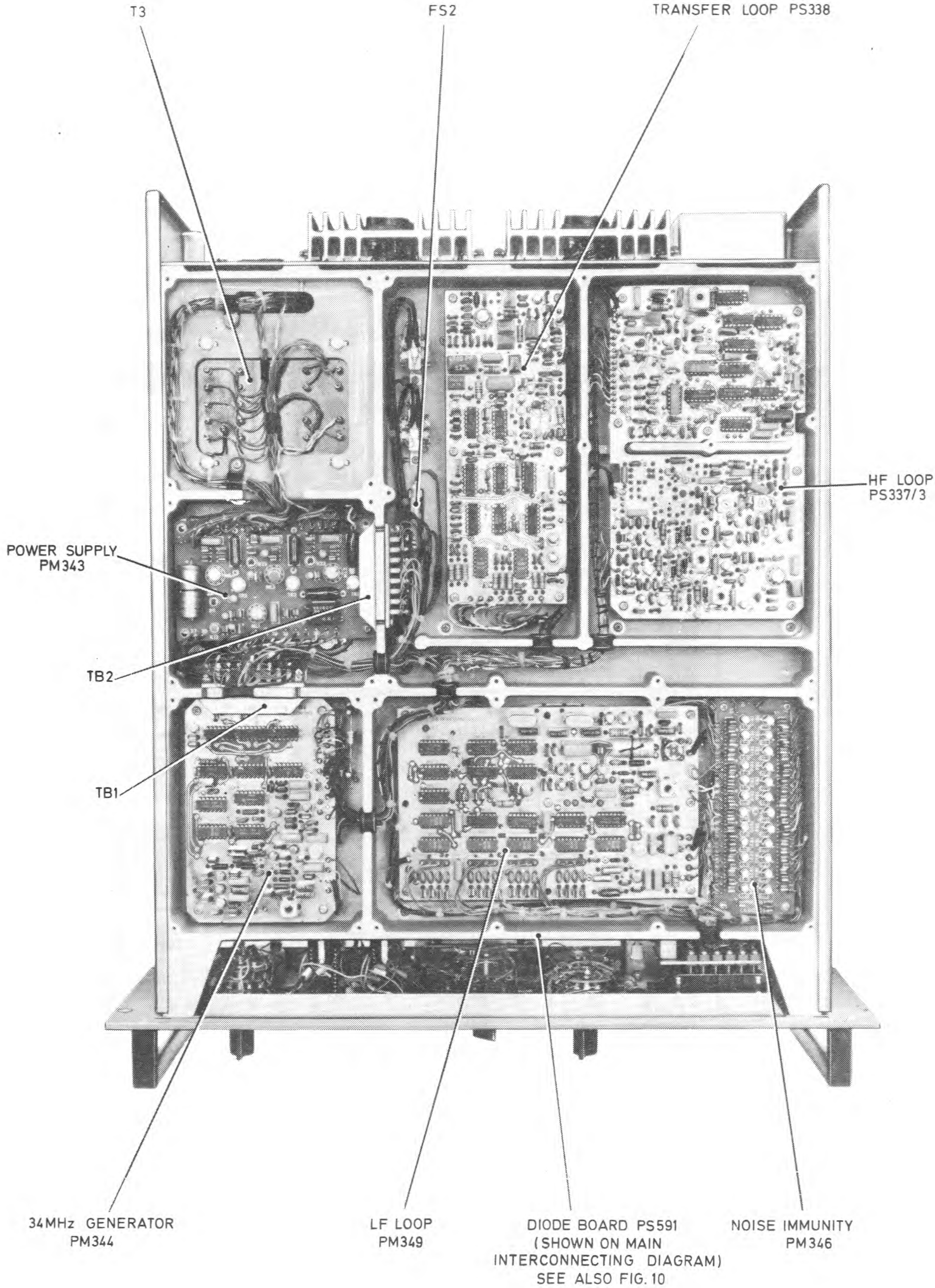


Fig.3 Drive unit : chassis underside

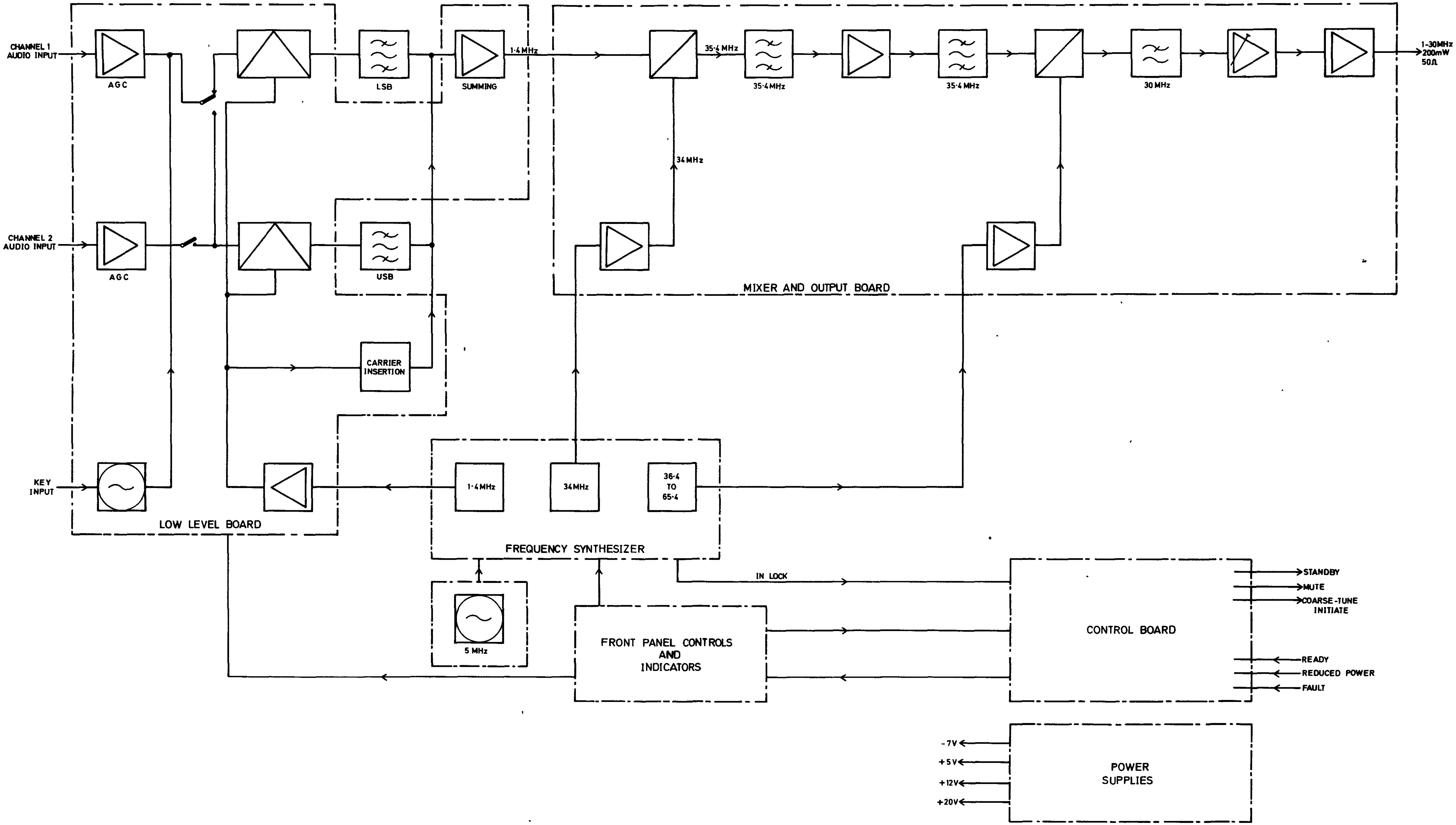


Fig.4 **Drive unit: simplified block diagram** Fig.4

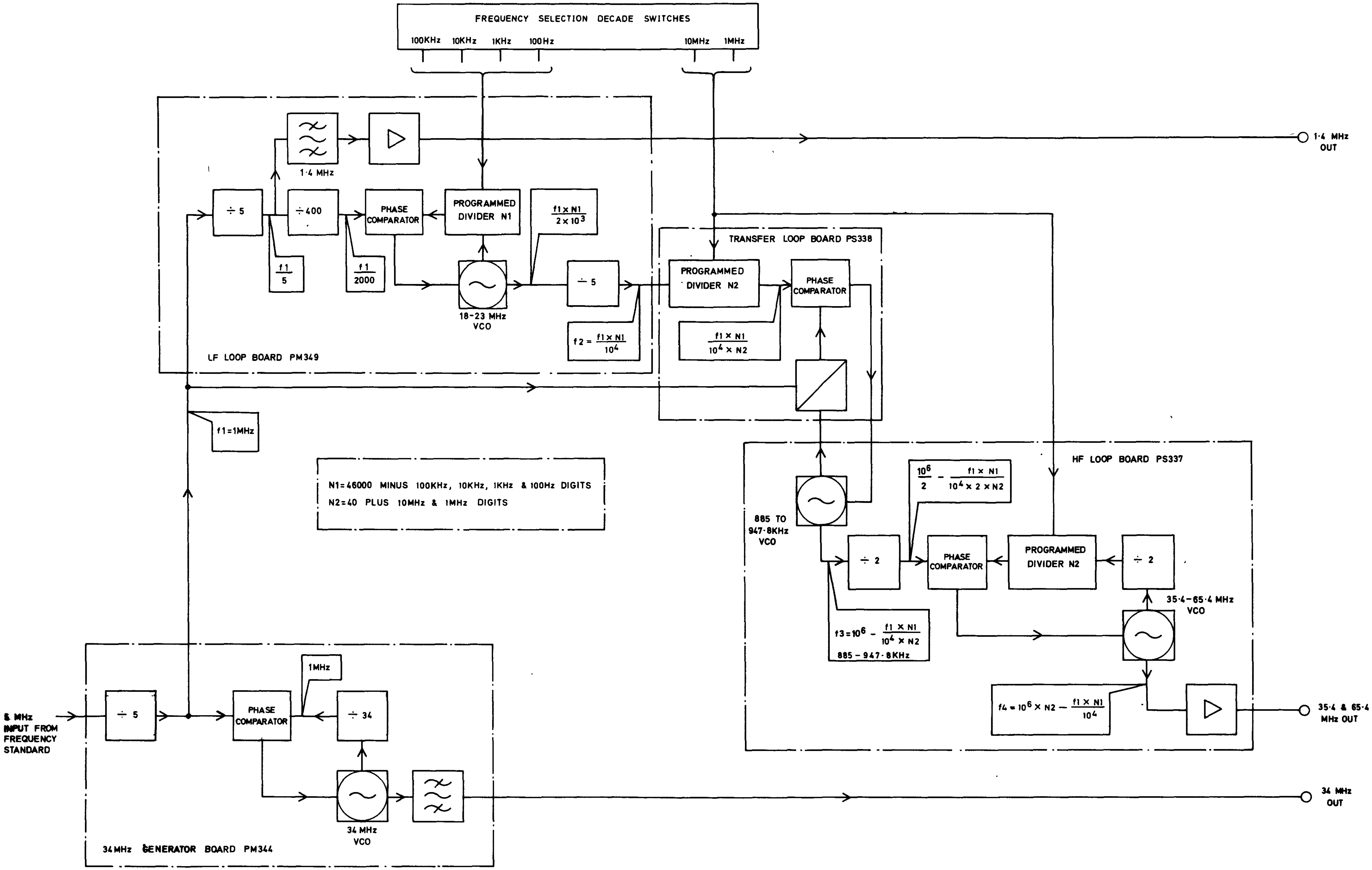


Fig. 5 **Synthesizer: simplified block diagram** Fig. 5

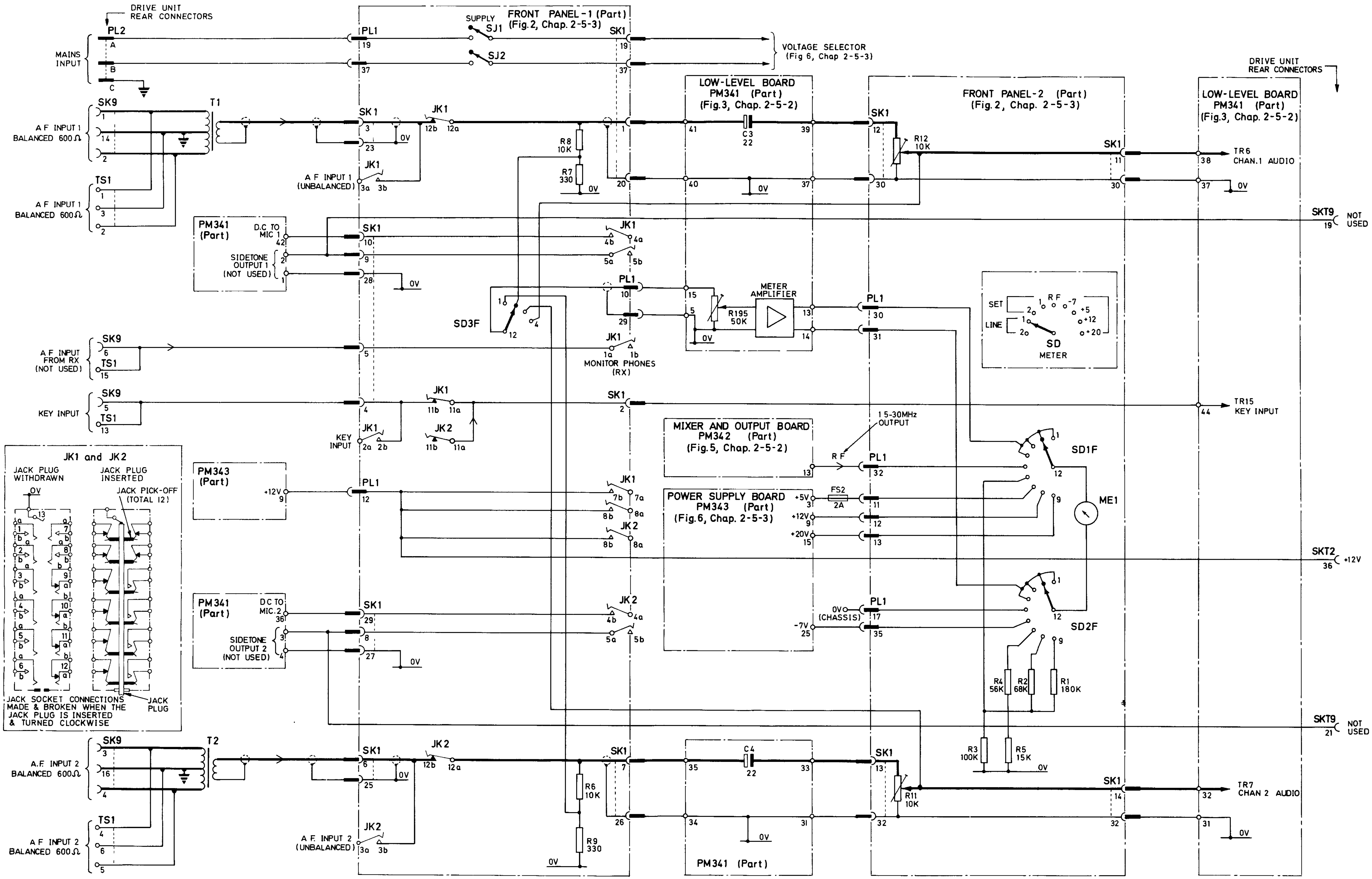
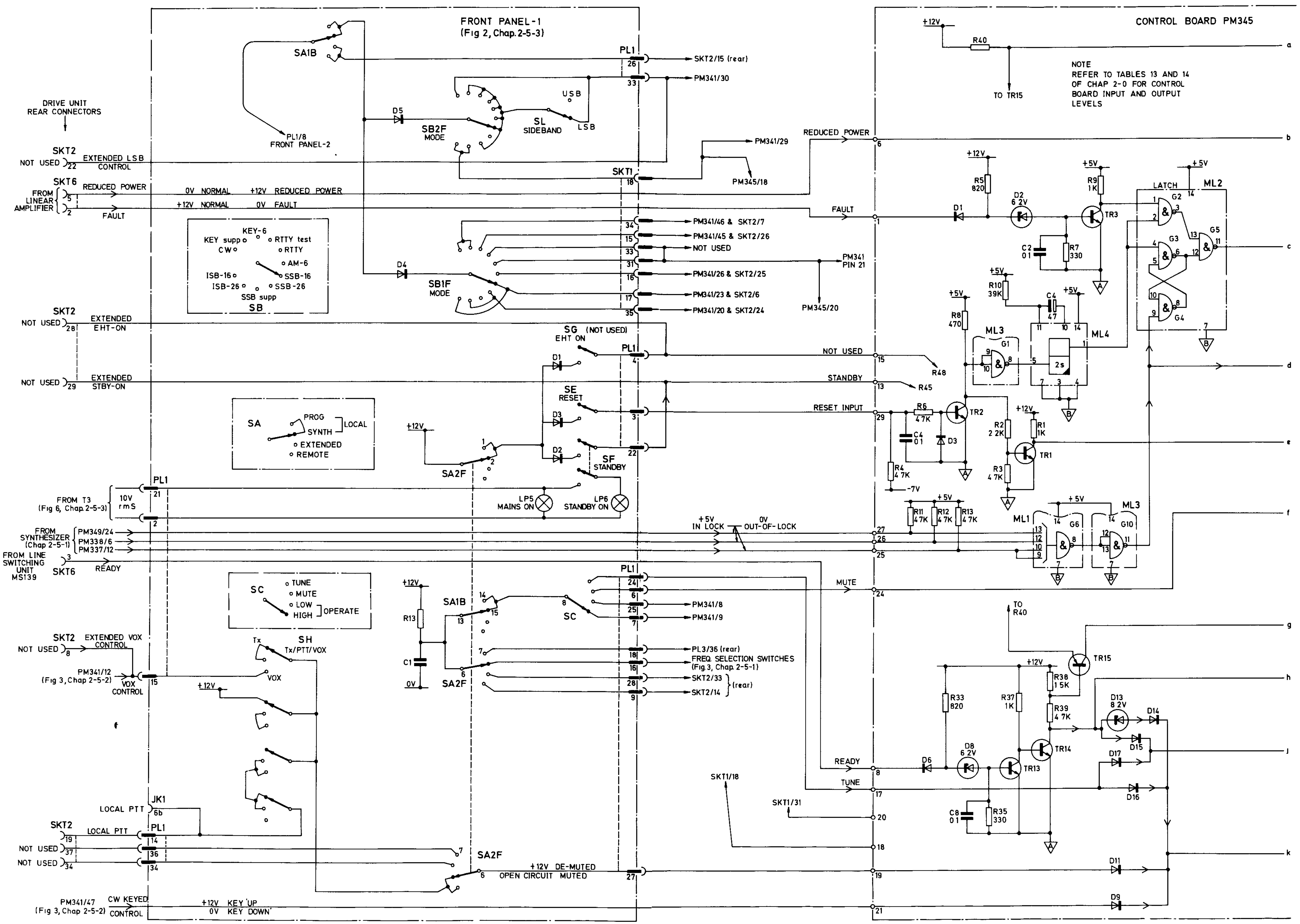
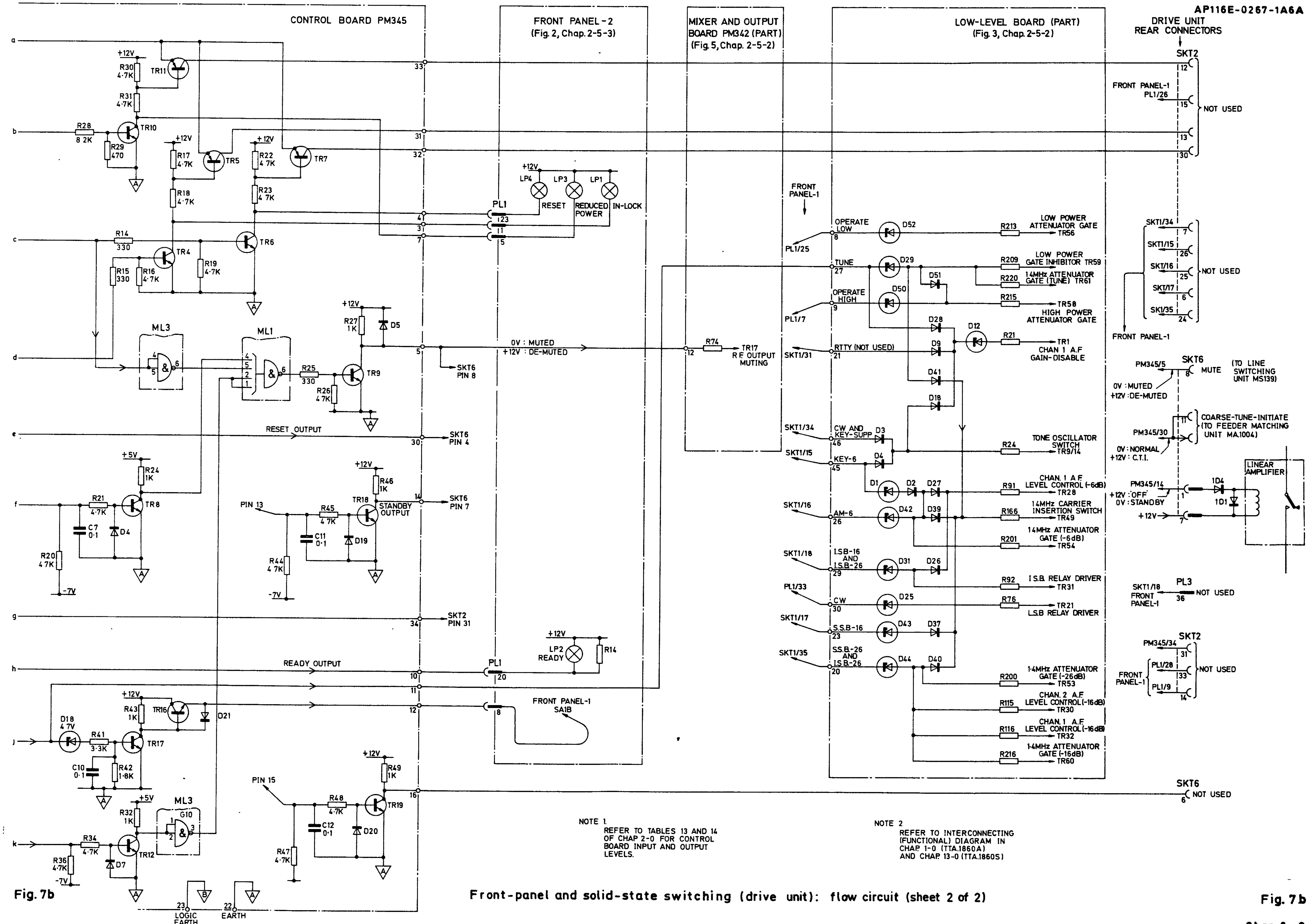


Fig.6

A.F and keying input paths: flow circuit



Front-panel and solid-state switching (drive unit) : flow circuit (sheet 1 of 2)



NOTE 1
REFER TO TABLES 13 AND 14 OF CHAP 2-0 FOR CONTROL BOARD INPUT AND OUTPUT LEVELS.

NOTE 2
REFER TO INTERCONNECTING (FUNCTIONAL) DIAGRAM IN CHAP. 1-0 (TTA.1860A) AND CHAP. 13-0 (TTA.1860S)

Fig. 7b

Front-panel and solid-state switching (drive unit): flow circuit (sheet 2 of 2)

Fig. 7b

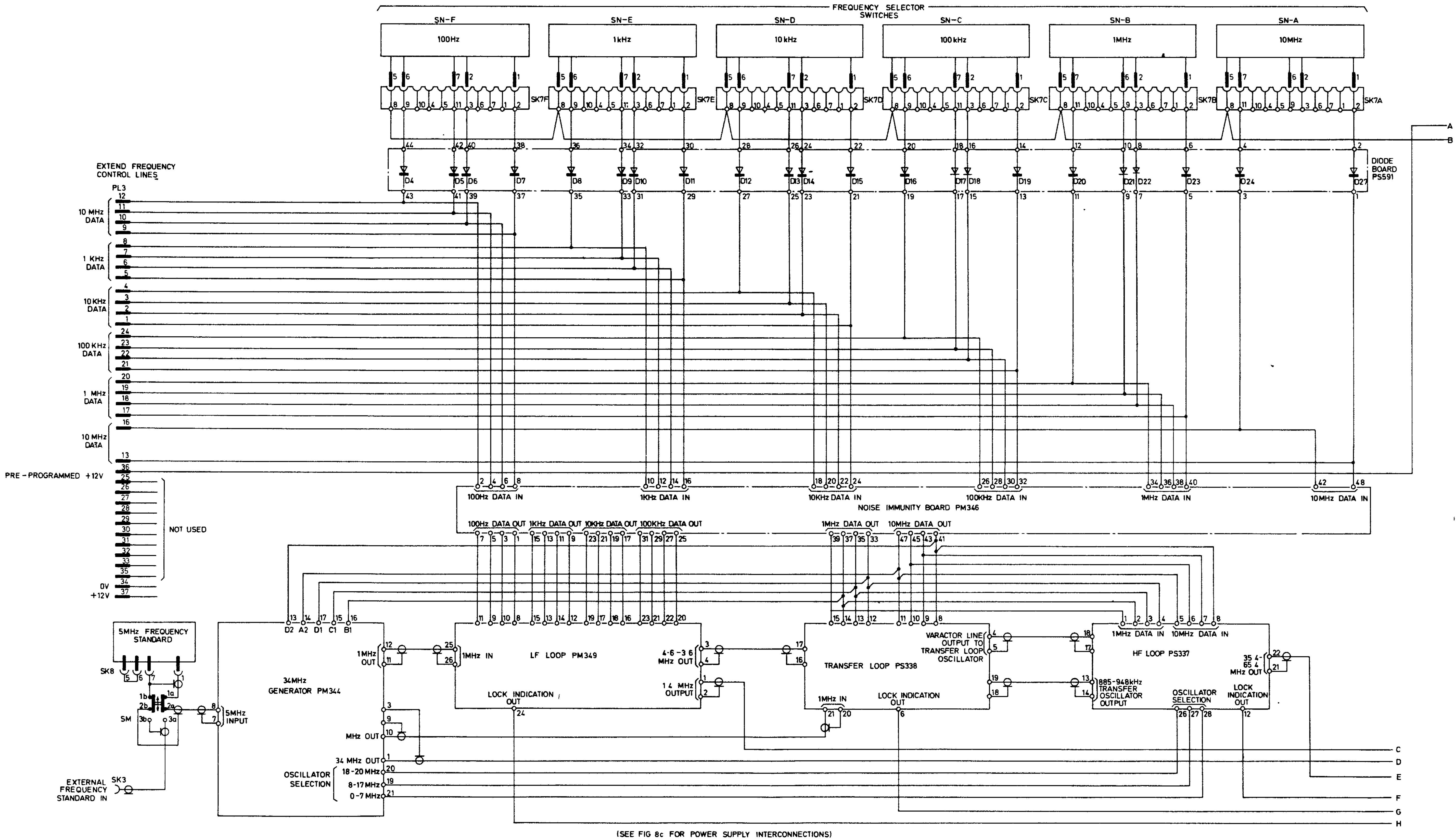
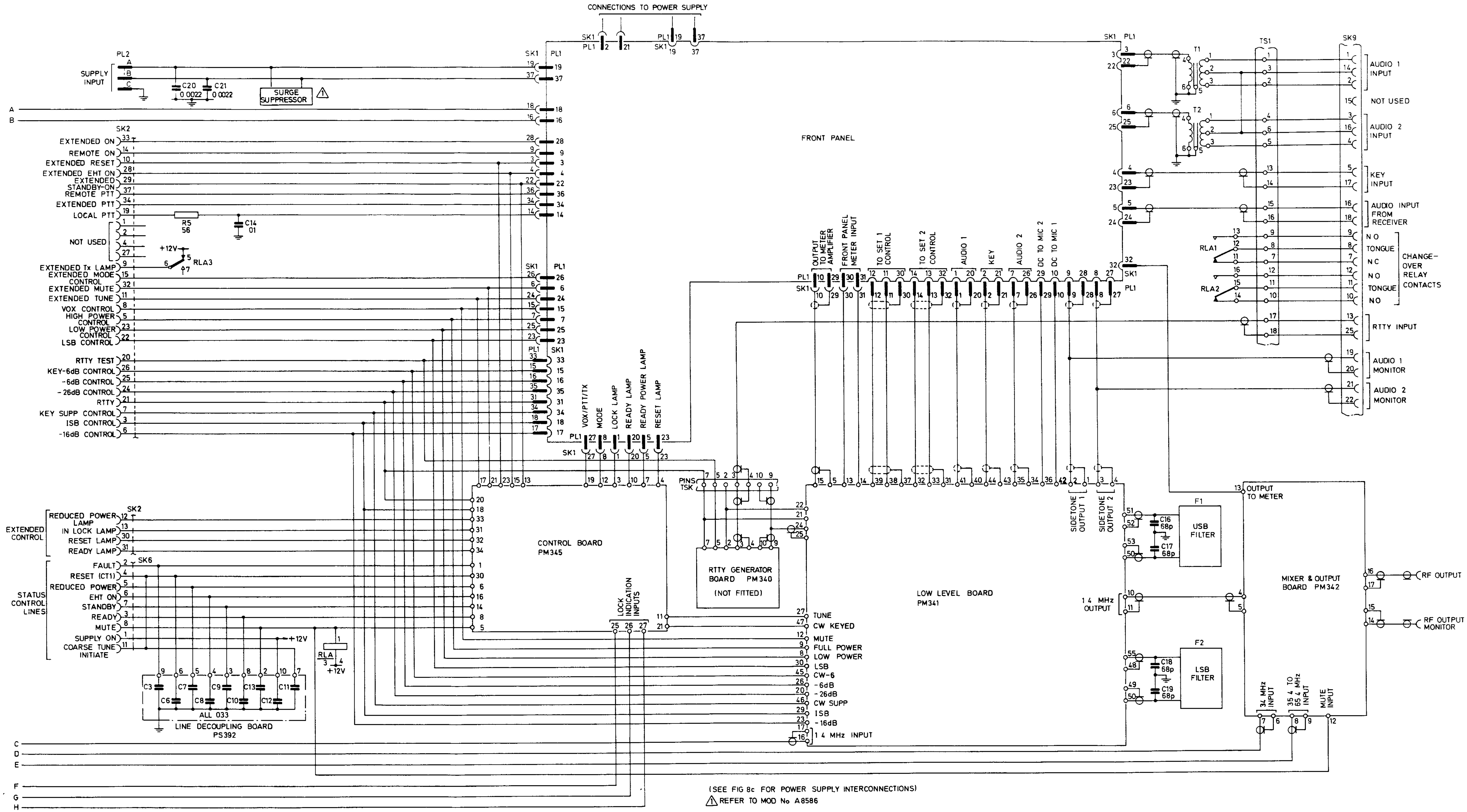


Fig. 8a Drive unit: interconnection diagram (sheet 1 of 3) Fig. 8a



Drive unit: interconnection diagram (sheet 2 of 3)

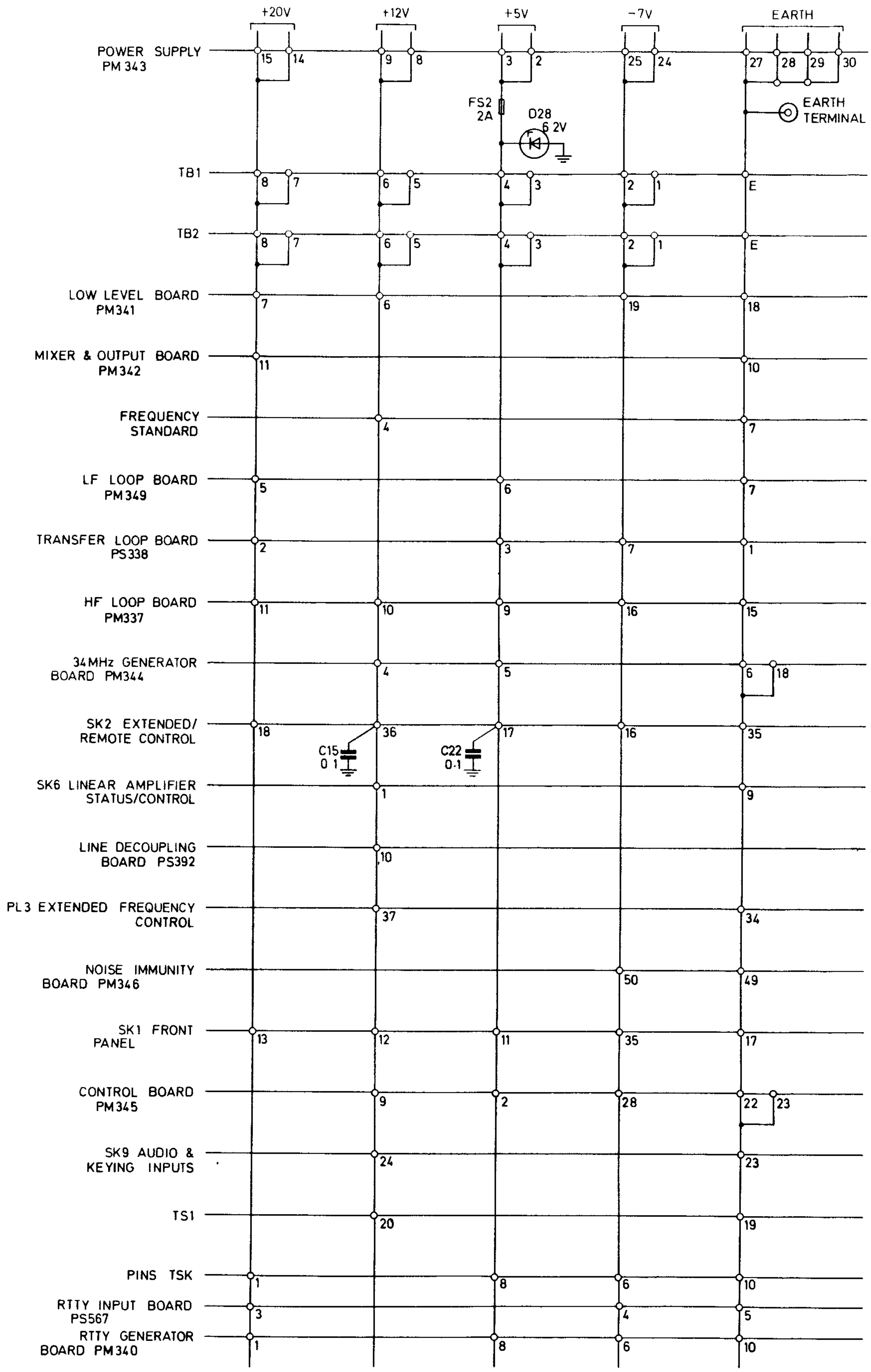
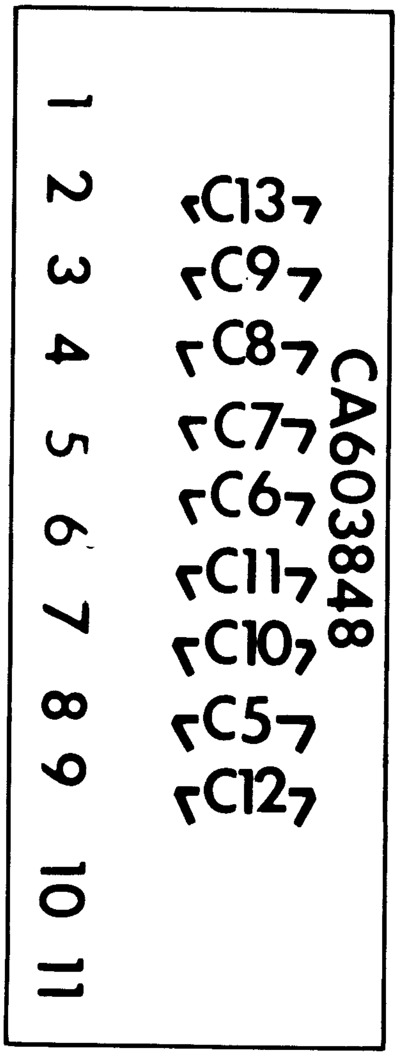
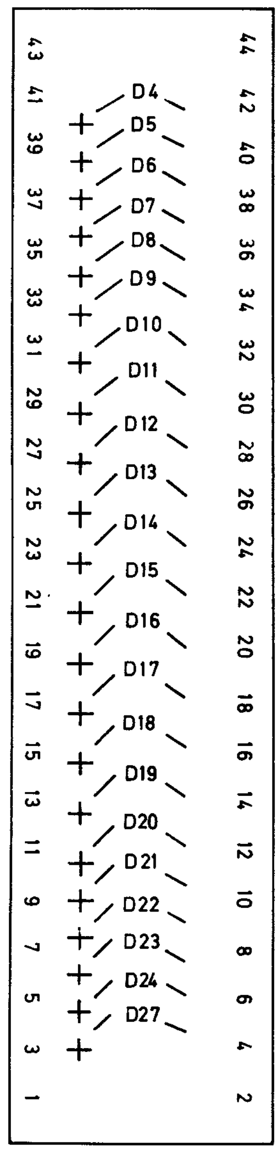


Fig.8c Drive unit: interconnection diagram (sheet 3 of 3)



NOTE: CIRCUIT IS SHOWN ON OVERALL INTERCONNECTING DIAGRAM FIG. 8

Fig.9 Line decoupling board PS392
component layout



NOTE: CIRCUIT IS SHOWN ON OVERALL INTERCONNECTING DIAGRAM FIG 8

Fig.10 Diode board PS591: component layou

Chapter 2-1

SERVICING:

DRIVE UNITS, TRANSMITTER:

10D/5820-99-624-5395 (MA.1720A)

AND

10D/5820-99-631-8611 (MA.1720S)

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INTRODUCTION

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

1. This chapter contains a list of the relevant test equipment required to carry out the fault-finding procedures which follow.

2. The fault-finding procedures are separated under the following headings:

(1) fault-finding to board or sub-assembly level.

(2) fault-finding to component level.

3. In addition to the procedures given in this chapter, the task of fault-finding to board level requires a reference to fig. 6, 7 and 8 and the detailed functional description in Chap.2-0. Fault-finding to component level requires an understanding of the descriptions given in Chap.2-5.

TEST EQUIPMENT

4. The following items of test equipment are required:

(1) Multimeter CT498A.

(2) Oscilloscope CT588.

(3) Microphone with built-in pressel switch.

(4) Electronic voltmeter.

(5) Morse key.

(6) Frequency counter (Racal 9059).

(7) L.F. signal generator (Marconi TF2005R).

FAULT LOCATION

5. As previously stated, the flow-circuits in fig. 6 and 7 of Chap.2-0 function as a useful aid to fault-finding to board level. Initially, a functional check is carried out from which deductions are made as to where the fault might exist. All checks are carried out, unless otherwise stated, with the drive unit on a bench and connected to a mains supply.

FREQUENCY STANDARDS (9400 AND 9420)

6. The frequency standard is a replaceable sub-assembly which, if found to be faulty, is returned to the manufacturer. A performance check and adjustment procedure is given in Chap.2-4.

7. To check that the frequency standard is functioning, ensure that the drive unit has been switched on for at least 30 minutes and connect an oscilloscope to pin 8 on the 34MHz generator board; the amplitude of the displayed waveform should be 800mV p-p. However, although the output level may be correct, a failure in the crystal oven control stages would result in the output frequency shifting up by 125Hz; this can be checked using the frequency counter. A further fault indication is obtained by measuring the current drawn from the +12V d.c. supply. Refer to Table 1 and use the multimeter to make the measurement; unsolder the lead to pin 4 of SKT8 (fig.8, Chap.2-0).

TABLE 1

Frequency standard : supply current

	Supply current	
	Type 9400 (MA.1720A)	Type 9420 (MA.1720S)
Normal	60 to 70mA	120 to 125mA
Fault	25 to 30mA	25 to 30mA

BOARD-LEVEL FAULT-LOCATION

8. It is assumed that no fault exists in the inter-board wiring which can be checked using the interconnecting diagrams (fig. 8) in Chap.2-0. It is also assumed that all lamps and fuses are satisfactory. Before switching on the drive unit, set the front-panel controls as follows:

(1) SUPPLY switch to 'off'.

(2) STANDBY switch to 'off'.

(3) TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(4) MODE switch to C.W.

(5) VOX/PTT/TX switch to TX.

(6) Link pins 13 and 14 of TS1 (rear).

(7) LOCAL/EXTENDED/REMOTE switch to LOCAL SYNTH.

(8) Depress the SUPPLY pushbutton.

Note ...

It is not necessary to depress the STANDBY pushbutton.

(9) Set the METER switch, in turn, to the -7V, +5V, +12V AND +20V positions. Check that, for each position, the meter indication is within the green band; if not, refer to Chap.2-4 for the adjustment procedure. If one or the other of these supply voltages is not present, either a fault exists on the PM.343 board or a short-circuit exists in the wiring within the drive unit.

(10) Observe that the following lamps are glowing:

(a) SUPPLY.

(b) RESET.

(c) IN LOCK.

9. Should the IN LOCK lamp fail to glow, a fault may exist on one or more of the three synthesizer boards PM.349, PS.338 and PS.337 (fig. 3, Chap.2-0). Using the multimeter, monitor in turn pins 12 (PS.337), 6 (PS.338) and 24 (PM.349). A normal reading is +5V (nom.); an abnormal (fault) reading of OV

indicates the faulty board(s). However, a further out-of-lock condition can exist where the IN LOCK lamp continues to glow; in this case, the use of an oscilloscope will display short-duration negative-going pulses on the above affected in-lock line(s).

10. Carry out the following functional checks:

(1) Connect a 50Ω dummy load to the r.f. output socket (SKT4) on the rear of the unit.

(2) Simulate a 'ready' input command from the linear amplifier by linking pin 3 to pin 9 (OV) of SKT6 (rear).

(3) Set the six frequency selector switches to an arbitrary setting.

(4) Depress the RESET pushbutton and observe the following:

(a) the RESET lamp extinguishes following a 2-sec delay.

(b) the IN LOCK lamp momentarily extinguishes; however, this is not discernible.

(5) Set the METER switch to R.F. and check for a meter reading of 200mW approximately.

11. If the meter reading is zero and the lamps are indicating correctly, check that +12V (nom.) exists at pin 5 of the PM.345 board; if not, the PM.345 board may be at fault. Alternatively the muting stage on the PM.342 board may be at fault.

(1) Connect the multimeter between pin 7 (+ve) and pin 9 (OV) of SKT6.

(2) Depress the STANDBY switch and observe that the meter reading drops from +12V to OV. If not, a fault exists on the PM.345 board.

(3) Link pin 2 (+12V) of SKT2 (rear) to pin 5 of SKT6 (rear) in order to simulate a 'reduced-power' input command from the linear amplifier.

(4) Check that the REDUCED POWER lamp glows; if not, a fault exists on the PM.345 board.

(5) Remove the link made in (3) above.

(6) Using the multimeter, check that pin 8 (SKT6) is at +12V.

(7) Set the TUNE/MUTE/OPERATE switch to MUTE and check that the multimeter now reads OV; if not, a fault exists on the PM.345 board.

(8) Reset the TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(9) Connect the multimeter (+12V d.c.) between pin 4 (SKT6) and earth.

(10) Depress and hold the RESET switch and check that the meter reading changes from OV to +12V, and that the RESET lamp glows; if not, a fault exists on the PM.345 board. Release the switch.

(11) Simulate a linear amplifier fault by linking pin 2 to pin 9 (OV) of SKT6. Check that the RESET lamp is glowing and that the r.f. output meter indication has dropped to zero (muted condition).

(12) Depress the RESET switch and observe that, for a period of two seconds, the RESET lamp extinguishes and the r.f. output indication is restored (not-muted condition). If the preceding results are not obtained, a fault may exist in either the PM.345 board or the muting stage of the PM.342 board; the fault is on the PM.342 board if the r.f. output meter indication does not drop to zero when the RESET switch is operated.

(13) Remove the link between pins 2 and 9 of SKT6 and observe that the RESET lamp is extinguished and the r.f. output indication is restored.

(14) Remove the link between pins 13 and 14 of TS1 (rear).

13. The following tests check the operation of the MODE switch, the TUNE/MUTE/OPERATE switch and the VOX/PTT/TX switch; it is assumed that audio input-level-setting has been correctly carried out; refer to Chap.1-1 (TTA.1860A) or Chap. 13-1 (TTA.1860S).

(1) Set the MODE switch to AM-6.

(2) Set the VOX/PTT/TX switch to TX.

(3) Check that the TUNE/MUTE/OPERATE switch is set to OPERATE HIGH.

(4) Check that the r.f. output meter indication is 100mW, approximately, with no audio input to the drive unit.

(5) Set the TUNE/MUTE/OPERATE switch to OPERATE LOW and observe that the r.f. output indication reduces by a further 6dB approximately; if not, a fault exists on the PM.341 board.

(6) Reset to OPERATE HIGH.

(7) Set the MODE switch to SSB SUPP and observe that the r.f. output indication has dropped to zero.

(8) Connect a microphone into the LINE 1 jack socket (JK1, pin 12a); speak into the microphone and observe that a speech-modulated r.f. output indication occurs on the meter. If not, a fault exists in the channel 1 audio stages of the PM.341 board.

(9) Reset the MODE switch to AM-6.

(10) Set the TUNE/MUTE/OPERATE switch to MUTE and check that the r.f. output meter indication is zero.

(11) Speak into the microphone and observe that there is no speech modulated r.f. indication on the meter.

(12) Reset to OPERATE HIGH.

(13) Set the VOX/PTT/TX switch to VOX and check that the r.f. output indication is zero.

(14) Check that an r.f. output indication occurs when speaking into the microphone, and that this indication is sustained for approximately two seconds following the cessation of speech. If not, a fault may exist in either the 'vox' control stages of the PM.341 board or on the PM.345 board. The 'vox' control stages are checked by monitoring pin 12 (PM.341) and observing that the level rises from 0V to +12V when speech occurs; this +12V indication should remain for two seconds following cessation of speech.

(15) Set the VOX/PTT/TX switch to PTT.

(16) If the microphone has a built-in pressel switch, the pressel contacts should be connected to pins 6b and 7b of the jack plug. Alternatively, a pressel action is obtained by temporarily joining pin 19 to pin 36 of SKT2 (rear).

(17) Check that the r.f. output indication is zero.

(18) Operate the microphone pressel and observe that an r.f. output indication occurs. If not, a fault exists on the PM.341 board.

(19) Disconnect the microphone.

(20) Connect an electronic voltmeter across the 50Ω dummy load at the r.f. output socket (SKT4).

(21) With the MODE switch still in the AM-6 position, note the reading on the electronic voltmeter as a reference.

(22) Set the mode switch, in turn, to each of the following positions and note that the voltmeter reading is either 10dB or 20dB, as appropriate, below the reading noted in (21) above: SSB-16, SSB-26, ISB-16 and ISB-26. If not, a fault exists on the PM.341 board.

(23) Connect a morse key to pins 13 and 14 of TS1.

(24) Set the MODE switch, in turn, to C.W., KEY SUPP and KEY-6 and refer to Table 2 for the appropriate r.f. output meter indications.

TABLE 2

C.W., key suppressed and key (-6dB) mode checks

Meter with key:	Mode switch setting		
	C.W.	KEY SUPP	KEY-6
up	0	0	50mW
down	200mW	200mW	100mW (approx.)

COMPONENT-LEVEL FAULT-LOCATION

14. The following information consists mainly of in-situ measurements of voltage levels at specified points on the boards. The location of monitoring points is shown on the component layout diagram in Chap.2-5. With the exception of the mixer and output board, monitoring on the reverse side of all boards is made possible by removing the fixing screws and hinging the board up on the cable harness.

Power supply board PM.343

15. Check the four unregulated input voltages to the board as follows:

(1) +30V d.c. ± 3V at pin 17.

(2) +18V d.c. ± 3V at pin 12.

(3) +10V d.c. ± 2V at pin 6.

(4) +4.5V d.c. ± 1.5V at pin 22.

16. If any one of the above voltages is incorrect, check the associated rectifiers and secondary voltage on T3. If these voltages are correct, the board must be checked as follows.

17. Note that if the +20V supply fails, then the +12V and +5V supplies also fail. Check the board voltage levels, as given in Table 3, using a multimeter the voltages are measured with respect to chassis (OV) unless otherwise stated

TABLE 3

Power supply board : voltage levels

Monitor at:	Measured voltage
ML2, pin 7 or 8	+30V
ML2, pin 4	+7.15V ± 0.5V
ML2, pin 3	+7.0V ± 0.5V
ML2, pin 2	+7.15V ± 0.5V
Board pin 14 or 15	+20V (output)
Board pin 10	+18V ± 3V
ML3, pin 4	+7.15V ± 0.5V
ML3, pin 3	+7.15V ± 0.5V
ML3, pin 7 or 8	+20V
ML3, Pin 6	+14.5V
ML3, pin 2	+7.15V ± 0.5V
Board pin 8 or 9	+12V (output)
Board pin 4	+10V ± 2V
ML4, pin 4	+7.15V ± 0.5V
ML4, pin 3	+5V
ML4, pin 7 or 8	+20V
ML4, pin 6	+8V
Board pin 2 or 3	+5V (output)
Board pin 22	+4.5V ± 1.5V
ML1, pin 4	+7.15V ± 0.5V relative to board pin 25 (approx. OV with respect to earth)
ML1, pin 7 or 8	+4.5V with respect to earth
Board pin 25	-7V

18. Check that the four preset controls R12 (-7V), R22 (+20V), R23 (+12V) and R9 (+5V) effectively adjust the appropriate output voltage level. This latter check, in conjunction with the data in Table 3, should locate the component(s) which have failed.

Mixer and output board PM.342

19. Using a multimeter, refer to Table 4 and check the transistor emitter voltages listed; set the MODE switch to AM-6.

TABLE 4

Mixer and output board : emitter voltages (d.c.)

Transistor	Emitter voltage (d.c.)
TR13	5.8V
TR12	5.6V
TR11	2.8V
TR10	2.6V
TR9	2.6V
TR15	8.0V
TR6	3.2V
TR5	4.0V
TR8	6.0V
TR3	3.2V
TR2	4.0V

20. Using an oscilloscope, refer to Table 5 and check the r.f. voltages at the collectors of the transistors; set the MODE switch to C.W.

TABLE 5

Mixer and output board : collector r.f. voltages

Transistor	Collector voltage (p-p)
TR13	16.0V
TR12	7.5V
TR11	4.0V
TR10	1.6V
TR9	0.8V
TR15	0.3V
TR6	15 to 20V (35 to 60MHz)
TR5	15 to 20V (35 to 60MHz)
TR8	1.0V
TR3	15 to 20V (35.4MHz)
TR2	15 to 20V (35.4MHz)

21. If the board is functioning correctly, the nominal current drawn from the supply is 900mA (d.c.) when +12V d.c. is applied to pin 12 (de-muted condition) and the MODE switch is set to AM-6.

22. If excessive break-through from the 2nd local oscillator is suspected, re-align the 30MHz low-pass filter in accordance with the instructions in Chap.2-3.

23. The levels of the three inputs to the board are as follows:

(1) 1.4MHz (pin 4) at 600mV p-p from the PM.341 board.

(2) 34MHz (pin 7) at OdBm (225mV) from the PM.344 board.

(3) 35.4 to 65.4MHz at OdBm (225mV) from the PS.337/3 board.

Should any of these inputs be at an abnormal level, a fault exists on the board from which it is derived.

Low-level board PM.341

24. Proceed as follows:

(1) Set the mode switch to KEY SUPP and the SIDEBAND switch to LSB.

(2) Link pins 13 and 14 of TS1 (rear). Using an electronic voltmeter, check that the collector of TR14 is at +12V (nom.), and that the collector of TR1 is at -7V (nom). If not, check TR9, TR14 and TR1.

(3) Set the TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(4) Connect an oscilloscope to pin 16 and check that the displayed waveform is approximately 600mV p-p at 1.4MHz. If not, check the 1.4MHz generator on the PM.349 board (para.39).

(5) Using the oscilloscope, monitor at TP5 on the board for a level of 620mV p-p at 1.4MHz. If not, check the 1.4MHz gain-controlled amplifier TR40 and TR43 to TR46.

(6) Using the oscilloscope, check for a squarewave of 4V p-p (nom.) at the collectors of TR41 and TR42.

(7) Using the oscilloscope, check for a sinewave of 1V p-p at the collector of TR57. If not, check TR55 and TR57.

(8) Set the SIDEBAND switch to USB and check (audibly) that relay RLA/1 de-energizes. If not, check TR21.

(9) Set the MODE switch to ISB-16 and check (audibly) that relay RLB/1 energizes. If not, check TR31.

(10) Set the MODE switch to KEY-6 and reset the SIDEBAND switch to LSB.

(11) Using an electronic voltmeter (+12V d.c.), check the voltage levels shown in Table 6.

TABLE 6

Key-6 mode : voltage levels

Monitor at:	Measured voltage
pin 45 on board	+12V nom.
TR14 collector	+12V nom.
TR28 collector	OV nom.
TR50 collector	+5.5V nom.
TR54 collector	OV nom.
TR1 collector	-7V nom.

Check the appropriate transistors if any of the above results are not obtained

(12) Set the MODE switch to SSB-16 and, using an electronic voltmeter, check the levels shown in Table 7.

TABLE 7

SSB-16 mode : voltage levels

Monitor at:	Measured voltage
pin 23 of board	+12V nom.
TR50 collector	+5.5V nom.
TR30 collector	0V nom.
TR32 collector	0V nom.
TR60 collector	0V nom.
TR2 collector	+15V nom.
TR3 collector	-5.6V nom.

If any of the above results are not obtained, check the appropriate transistor(s).

(13) Connect an audio signal generator into the LINE 1 jack socket (JK1, pin 12a).

(14) Adjust the generator output level to 0dBm, using an oscilloscope, at pin 38 of the board. Set the generator frequency to 1kHz. Set the METER switch to SET 1 and adjust the SET LINE 1 control for an indication in the centre of the green band; check that the level on pin 38 is 75mV p-p approximately.

(15) Using an oscilloscope, check the levels shown in Table 8.

TABLE 8

Channel 1 audio levels

Monitor at:	Measured voltage (approx.)
TR12 collector	20mV p-p
TP2 on board	4V p-p

(16) Set the MODE switch to ISB-26 and, using an electronic voltmeter, check the levels shown in Table 9.

TABLE 9

ISB-26 mode : voltage levels

Monitor at:	Measured voltage
pin 20 on board	+12V nom.
pin 29 on board	+12V nom.
TR50 collector	+5.5V

TABLE 9 (contd.)

Monitor at:	Measured voltage
TR53 collector	CV nom.
TR28 collector	OV nom.

If any of the above results are not obtained, check the appropriate transistor.

(17) Transfer the audio signal generator to the LINE 2 jack socket. Set the METER switch to SET 2 and adjust the SET LINE 2 control for an indication in the centre of the green band; check, using an oscilloscope, that the level at pin 32 of the board is still 75mV p-p approximately.

(18) Using an oscilloscope, check the levels shown in Table 10.

TABLE 10

Channel 2 audio levels

Monitor at:	Measured voltage (approx.)
TR13 collector	20mV p-p
TP3 on board	4V p-p

(19) In order to check the meter amplifier, measure the voltages, shown in Table 11, using an oscilloscope.

TABLE 11

Meter amplifier : voltage levels

Monitor at:	Measured voltage (approx.)
pin 15 on board	75mV p-p
TR64 collector	1.5V p-p squarewave

25. To check the 1kHz c.w. oscillator, proceed as follows:

(1) Set the MODE switch to C.W.

(2) Check that pins 13 and 14 of TS1 (rear) are still linked.

(3) Using an oscilloscope, monitor at TP1 on the board; the level of the displayed waveform should be within the limits of 3.0V to 5.0V p-p, limiting on one peak and folding back 1.0V (approx.).

26. Similar checks to the above, for the remaining positions of the MODE switch, can be evolved by a reference to fig. 7 of Chap.2-0 and fig. 3 of Chap.2-5-3.

Control board PM.345

27. The localisation of a fault on the PM.345 board is revealed, to a large extent, by the tests given in para.10 to 13 of this chapter. It is recommended that the board-level tests in these paragraphs be carried out again referring to Table 12 which gives the areas of possible failure on the board.

TABLE 12

Control board : area of failure

Para. reference	Check the following:
11	TR9, ML1(G9), ML3(G7), ML2, ML4, ML3(G1), TR2
12(2)	TR18
12(4)	TR10
12(7)	TR9, ML1(G9), TR8
12(10)	TR1, TR2
12(12)	TR9, ML1(G9), ML3(G7), ML2, TR3
13(14)	TR9, ML1(G9), ML3(G7), ML3(G10), TR12

28. Further tests can be evolved by referring to the technical description (Chap.2-5-3) and fig. 7 of Chap.2-0. Tables 13 and 14 give the input and output pin functions, respectively, together with appropriate voltage levels.

TABLE 13

Control board : input pin functions

Pin	Function	Input levels
6	Reduced power	0V : normal
		+12V : reduced power
1	Fault	+12V : normal
		0V : fault
15	Not used	
29	RESET switch	-4V : released
		+12V : depressed
13	STANDBY switch	-4V : released
		+12V : depressed
27	In-lock	+5V : in-lock
		0V : out-of-lock
26	As for pin 27	
25	As for pin 27	
24	MUTE select	+12V : selected
		-4V : not selected

TABLE 13 (contd.)

Pin	Function	Input levels
8	Ready	0V : ready +12V : not ready
17	TUNE select	+12V : 'tune' selected 0V : 'tune' not selected
21	C.W. mode selected	+12V : key 'down' 0V : key 'up'
19	P.T.T. line (Set to P.T.T.)	+12V : pressel operated 0V : pressel not operated

TABLE 14

Control board : output pin functions

Pin	Function	Output levels
31	Not used	
33	Not used	
32	Not used	
4	RESET lamp	0V : 'on' +12V : 'off'
3	IN LOCK lamp	0V : 'on' +12V : 'off'
7	Reduced power lamp	0V : 'on' +12V : 'off'
5	Mute	0V : drive unit muted +12V : drive unit not muted
30	Coarse-tune-initiate	0V : normal +12V : coarse-tune-initiate
14	Standby switch	0V : depressed +12V : released
16	Not used	
34	Not used	
12	Command level to MODE switch	+12V : 'ready' condition 0V : 'tune' or 'not ready' condition
11	TUNE select	+12V : 'tune' selected 0V : 'tune' not selected
10	READY lamp	0V : 'on' +12V : 'off'

Noise-immunity board PM.346

29. Refer to fig. 3 of Chap.2-5-1 and fig. 8 of Chap.2-0 in order to ascertain the interconnecting points between the frequency selection switches and the PM.346 board. In order to check the PM.346 board, it is necessary to apply either +12V or open-circuit to each input pin and check for an inverted level at each corresponding output pin. This is accomplished by setting the frequency selection switches to certain positions and monitoring, with an electronic voltmeter, at the pins shown in Tables 15 to 20.

TABLE 15

Noise-immunity board check : MHz x 10 switch

Switch Setting MHz x 10	Pin			
	Input	Output	Input	Output
	48	47	42	41
1	+12V	0V	-4V	+5V
2	-4V	+5V	+12V	0V
Suspect transistor	TR24		TR21	

TABLE 16

Noise-immunity board check : MHz x 1 switch

Switch Setting MHz x 1	Pin							
	Input	Output	Input	Output	Input	Output	Input	Output
	40	39	38	37	36	35	34	33
8	-4V	+5V	+12V	0V	+12V	0V	+12V	0V
7	+12V	0V	-4V	+5V	+12V	0V	+12V	0V
5	+12V	0V	+12V	0V	-4V	+5V	+12V	0V
1	+12V	0V	+12V	0V	+12V	0V	-4V	+5V
Suspect transistor	TR20		TR19		TR18		TR17	

TABLE 17

Noise-immunity board check : kHz x 100 switch

Switch Setting kHz x 100	Pin							
	Input	Output	Input	Output	Input	Output	Input	Output
	32	31	30	29	28	27	26	25
1	-4V	+5V	+12V	0V	+12V	0V	+12V	0V
2	+12V	0V	-4V	+5V	+12V	0V	+12V	0V
4	+12V	0V	+12V	0V	-4V	+5V	+12V	0V
8	+12V	0V	+12V	0V	+12V	0V	-4V	+5V
Suspect transistor	TR16		TR15		TR14		TR13	

TABLE 18

Noise-immunity board check : kHz x 10 switch

Switch Setting kHz x 10	Pin							
	Input	Output	Input	Output	Input	Output	Input	Output
	24	23	22	21	20	19	18	17
1	-4V	+5V	+12V	0V	+12V	0V	+12V	0V
2	+12V	0V	-4V	+5V	+12V	0V	+12V	0V
4	+12V	0V	+12V	0V	-4V	+5V	+12V	0V
8	+12V	0V	+12V	0V	+12V	0V	-4V	+5V
Suspect transistor	TR12		TR11		TR10		TR9	

TABLE 19

Noise-immunity board check : kHz x 1 switch

Switch Setting kHz x 1	Pin							
	Input	Output	Input	Output	Input	Output	Input	Output
	16	15	14	13	12	11	10	9
1	-4V	+5V	+12V	0V	+12V	0V	+12V	0V
2	+12V	0V	-4V	+5V	+12V	0V	+12V	0V
4	+12V	0V	+12V	0V	-4V	+5V	+12V	0V
8	+12V	0V	+12V	0V	+12V	0V	-4V	+5V
Suspect transistor	TR8		TR7		TR6		TR5	

TABLE 20

Noise-immunity board check : Hz x 100 switch

Switch Setting Hz x 100	Pin							
	Input	Output	Input	Output	Input	Output	Input	Output
	8	7	6	5	4	3	2	1
1	-4V	+5V	+12V	0V	+12V	0V	+12V	0V
2	+12V	0V	-4V	+5V	+12V	0V	+12V	0V
4	+12V	0V	+12V	0V	-4V	+5V	+12V	0V
8	+12V	0V	+12V	0V	+12V	0V	-4V	+5V
Suspect transistor	TR4		TR3		TR2		TR1	

34MHz generator board PM.344

30. Initially, check that the input at pin 8 of the board is approximately 1V p-p at 5MHz; use an oscilloscope. Carry out the voltage checks given in Table 21.

TABLE 21

34MHz generator board : voltage levels

Monitor at:	Test equipment	Measured voltage
Board pin 10	Oscilloscope	1V p-p, 1MHz squarewave
Board pin 12	Oscilloscope	4V p-p, 1MHz squarewave
TR4, collector	Oscilloscope	2V p-p
ML1, pin 6	Oscilloscope	4V p-p
ML2, pin 8	Oscilloscope	2V p-p, 2:3 mark/space ratio, 1MHz squarewave
ML4, pin 8	Oscilloscope	4V p-p, 3:2 mark/space ratio, 1MHz squarewave
ML6, pin 6	Oscilloscope	4V, 1MHz, negative-going spikes, approx. 30ns width
Board, pin 2	Multimeter	+4V d.c. *
TR5, collector	Oscilloscope	4V p-p, 5MHz squarewave
ML6b, pin 8	Oscilloscope	4V p-p, 1MHz squarewave
Board pin 8	Oscilloscope	1V p-p, 5MHz
TR3, base	Multimeter	+1.7V d.c. approx.
TR3, collector	Oscilloscope	4V p-p (approx.), 5MHz
TR1, emitter	Multimeter	+5V d.c.

* Refer to Chap.2-4 for adjustment procedure.

31. Check the v.c.o. switching stage (para.29) as follows. Set the MHz x 10 and MHz x 1 switches to each 'MHz' setting from 0 to 29 and monitor pins 20, 19 and 21 with a multimeter; refer to Table 22 for the measured results.

TABLE 22

34MHz generator board : v.c.o. switch output check

MHz settings	Output pins		
	21	19	20
0 to 7MHz	0	1	1
8 to 17MHz	1	0	1
18 to 29MHz	1	1	0

Logic '1' = +14V nom.

Logic '0' = 0V nom.

32. If the results in Table 22 are not obtained, check the input levels to the v.c.o. switching stage (fig. 1). Allow for the logic inversion in the noise-immunity board and also refer to fig. 1 of Chap.2-5-1. The frequency settings of particular interest are those at 7MHz, 8MHz, 17MHz and 18MHz; Table 23 gives the input levels for these frequency settings. If these input levels are correct, a fault exists in the v.c.o. switching stage; if not, the fault may be on the noise immunity board or in the inter-wiring.

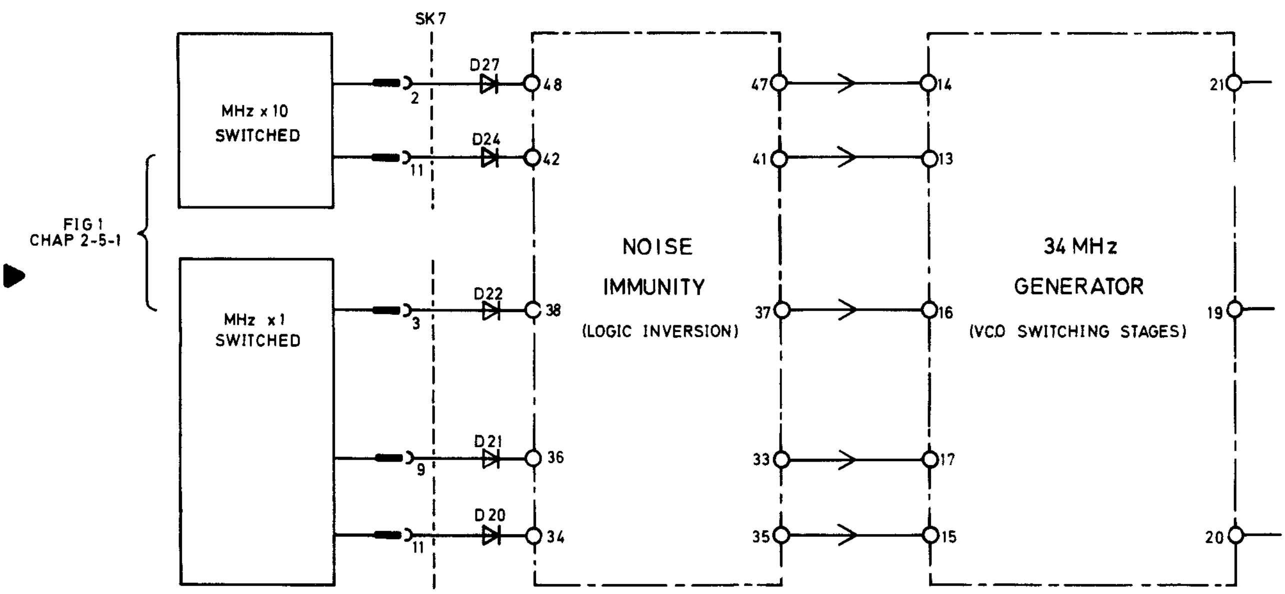

Fig.1 Input paths to v.c.o. switching stage

TABLE 23

34MHz generator board : v.c.o. switch input check

MHz setting	Input pins				
	14	13	16	17	15
7	1	1	1	0	0
8	1	1	0	0	0
17	0	1	1	0	0
18	0	1	0	0	0

Logic '1' = +5V nom.

Logic '0' = 0V nom.

H.F. loop board PS.337/3

33. Set the two MHz thumbwheel switches to the following MHz settings and check that the correct oscillator is being selected by monitoring at the pins shown in Table 24; if not, a fault may exist on the PM.344 board (para.27).

TABLE 24

H.F. loop board : v.c.o. selection

MHz setting	Pin	Multimeter reading
0 to 7MHz	28	0V
8 to 17MHz	27	0V
18 to 29MHz	26	0V

34. Check that the selected v.c.o. is functioning by monitoring, with an oscilloscope, for 3V p-p at TP4 on the h.f. loop board.

35. Carry out the following voltage checks throughout the board; these checks should locate a fault to a stage and, in some instances, a component.

(1) Using a multimeter, set to the 25V d.c. range, monitor the following test points (negative to 0V):-

(a) TP1: MHz switch set to 7MHz : +14V ± 1V.

(b) TP2: MHz switch set to 17MHz : 14V ± 1V.

(c) TP3: MHz switch set to 27MHz : +14V ± 1V.

(2) Set the MHz switches to 27. Use the multimeter to measure the following voltages with respect to chassis (0V); observe the correct polarity.

(a) Emitter TR9: -0.7V d.c.

(b) Base TR10: +2.4V d.c.

(c) Emitter TR10: +1.7V d.c.

(3) Use the oscilloscope to monitor the collector of TR9 for 600mV p-p at 52.4 to 65.4MHz.

(4) Set the kHz controls to 9999. Monitor TP4 using the electronic voltmeter. Step the MHz switches through each position and check that the electronic voltmeter indication is 1V r.m.s. ± 2.5dB.

(5) Monitor at TP5 for 1V r.m.s., using the electronic voltmeter.

(6) Connect a frequency counter, in turn, to TP4 and TP5; check that the frequency at TP5 is one-half that at TP4; the MHz switch setting is arbitrary. The voltage at the collector of TR12 is a squarewave having an excursion from +0.4V to +3V (min.).

(7) Use the oscilloscope to monitor the test points listed below.

(a) TP6: 442 to 474 kpps strobe pulses, negative-going, 3.5V p-p (approx.).

(b) TP7 and TP8: 442 to 474 kpps phase-comparator output pulses, negative-going and in phase with (a), 3.5V p-p (approx.).

(8) Ensure that the kHz controls are set to 9999 and connect the multimeter, set to the 10V d.c. range, between TP10 (positive) and chassis (0V); check for a reading of +3.5V d.c.

(9) Use the oscilloscope to monitor the following:

(a) TP12: 885 to 948kHz, approximate squarewave 4V p-p.

(b) ML12, pin 5: half of transfer oscillator frequency, 4V p-p.

(c) Board pin 13: 885 to 948kHz, 1V p-p.

(d) Board pin 12: logic '1' in-lock; logic '0' out-of-lock.

(10) Use the multimeter to check the voltage at the collector of TR19 which should be between +3V and +14V d.c. when the loop is locked. When TP7 has a pulse of cyclically varying width, the voltage should be approximately +2.3V d.c.; when TP8 has a pulse of cyclically varying width, the voltage should be approximately +19V d.c.

(11) Use the oscilloscope to check the lock indicator. When the loop is locked, TP9 and TP11 should have negative-going pulses of 1.5µs duration at a p.r.f. of approximately 400kHz. When the loop is out-of-lock, the pulse of cyclically varying width at TP7 or TP8 should also appear at TP12 except during the period of the negative-going 1.5µs pulse at TP9 and TP11.

<u>Transfer loop board PS.338</u>

36. The following in-situ checks assume that the transfer loop oscillator, on the h.f. hoop board, is functioning correctly.

37. Use an oscilloscope to check the following levels:

(1) TP1: 4.6 to 3.6MHz squarewave, 5V p-p.

(2) TP2: 115 to 52kHz squarewave, 4V p-p.

(3) TP3: 115 to 52 kpps, negative-going, 4V p-p, pulse width of 50ns approximately.

(4) TP4 and TP5: 115 to 52 kpps, 3 microsecond negative-going, and in phase with (3), 4V p-p.

(5) TP6: 115 to 52 kpps strobe pulse, negative-going, 4V p-p, pulse width of 300ns approximately.

(6) Board pin 21: 1MHz, 750mV p-p.

(7) Collector TR2: 1MHz, 500mV p-p.

(8) Board pin 19: 885 to 948kHz, 1V p-p.

(9) ML3 pin 4: 885 to 948kHz, 1V p-p.

(10) Board pin 17: 4.6 to 3.6MHz, 800mV p-p.

(11) Junction C35/L11: 400mV p-p, 115kHz to 52kHz.

(12) Board pin 6: Logic '1' in-lock; logic '0' out-of-lock.

38. (1) Use the multimeter to check the voltage at board pin 4. In the 'lock' condition, this should be in the range +3V to +8V d.c. When pin 6 of ML8 has a pulse of cyclically varying width, this voltage should be approximately +11V d.c. (out-of-lock condition).

(2) Use the oscilloscope to check the lock indicator. In the 'lock' condition the signals at TP4 and TP5 should be negative-going pulses with an excursion of +3V to +0.4V and a duration of 3μs. In the out-of-lock condition, the pulse of cyclically varying width at TP3, or pin 6 of ML8, should also appear at pin 6 of the transfer loop board except during the period of the negative-going 3μs pulse at TP4 and TP5.

<u>L.F. loop board PM.349</u>

39. Carry out the following voltage checks:

(1) Use the multimeter to check the oscillator supply; the voltage at the emitter of transistor TR1 should measure +5V d.c. ± 0.25V.

(2) Use the oscilloscope to check the oscillator output at TP1 which should be a TTL squarewave signal in the frequency range 18-23MHz.

(3) Use the oscilloscope to check the strobe pulse at TP4 which should be negative-going pulses with a duration of 80-100ns.

(4) Use the oscilloscope to check the strobe pulse at TP2 which should be positive-going pulses of approximately 50ns duration. If the positive-going 50ns pulses are not obtained at TP2, the input and output pins of ML5, ML8, ML13 and ML16 should be monitored to isolate the faulty module in the divider chain.

(5) Use the oscilloscope to check the divide-by-five stage ML2; the TTL signal at pin 2 of ML2 should be in the frequency range 3.6 - 4.6MHz.

(6) Transfer the oscilloscope to pin 12 of ML1 to check the buffer stage, gate G1 of ML1; the signal should be in the frequency range 3.6 - 4.6MHz.

(7) Use the oscilloscope to check the divide-by-2000 stage at TP3; the signal should be a 500Hz squarewave. If the 500Hz squarewave is not obtained at TP3, the input and output pins of ML3, ML4, ML7 and ML10 should be monitored to isolate the faulty module in the divider chain.

(8) Use the oscilloscope to check the phase-comparator outputs. Positive-going pulses of 50ns duration should be obtained at the Q outputs (pin 5 and pin 9) of ML12A and ML12B when the loop is locked. In the out-of-lock condition, pin 5 or pin 9 should have a positive-going 50ns pulse whilst the other pin should have a pulse of cyclically varying width.

(9) Use the multimeter to check the supply to the varactor line driver at the emitter of transistor TR10; the voltage should be +19.5V d.c. ± 0.5V.

(10) Transfer the multimeter to check the varactor line driver at TP5. When the loop is locked, the voltage should be between +3.5V and +15V d.c. depending on the frequency selected. When the Q output (pin 5) of ML12A has the pulse of cyclically varying width, the voltage should be approximately +2V d.c. When the Q output (pin 9) of ML12B has the pulse

of cyclically varying width, the voltage should be approximately +18V d.c.

(11) Use the oscilloscope to check the 1.4MHz generator; the signal at pin 9 of ML3 should be a squarewave with an excursion from +0.4V to at least +3V p-p.

(12) Transfer the oscilloscope to the base of TR3; a sinewave signal of approximately 500mV p-p should be obtained.

(13) Transfer the oscilloscope to pins 1 and 2 of the board. The output of the 1.4MHz generator should be approximately 640mV p-p when the generator is correctly terminated.

Chapter 2-2

REPAIR:
DRIVE UNITS, TRANSMITTER

10D/5820-99-624-5395 (MA.1720A)
AND
10D/5820-99-631-8611 (MA.1721S)

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INTRODUCTION

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

1. The information in this chapter covers the removal and refitting of sub-assemblies and printed-circuit boards; where not obvious, the procedure for removing certain components is also given. It is assumed that the drive unit is placed on a bench.

2. The location of sub-assemblies and printed-circuit boards is shown in fig.2 and 3 of Chap.2-0.

REMOVAL AND REFITTING OF FREQUENCY STANDARD

3. (1) Remove the top cover to the chassis (10 quick-release fasteners).

(2) Remove the four screws securing the plate on which the frequency standard assembly is mounted (fig.2, Chap.2-0).

(3) Withdraw, vertically, the assembly; there is sufficient cable beneath to allow this to be done.

(4) Remove the connector from beneath the mounting plate.

(5) Remove the screws securing the mounting plate to the frequency standard.

(6) Refitting is the reverse of the above procedure.

REMOVAL AND REFITTING OF BOARDS

Mixer and output board PM.342

4. The following transistors are physically mounted in 'cup' type heatsinks secured, and electrically insulated from, the chassis casting; TR2, TR3, TR5, TR6, TR8 to TR13 and TR15. These transistors protrude through holes in the board and are wired to terminals on the board. Any one of the transistors is removed by unsoldering the leads and gently easing the component out of the heat-sink by gripping the leads with pliers.

5. The PM.342 board is removed as follows:

(1) Remove the chassis top cover (10 quick-release fasteners).

(2) Remove the eight board fixing screws.

(3) Unsolder all connecting leads, noting the colour code and board terminal number.

(4) Using a pair of pliers, very carefully ease out of the chassis-mounted heat-sink all the transistors referred to in para.4. This should be progressively carried out, in turn, for all the transistors until the board is free.

(5) Raise the board vertically until it is clear of the webbs in the casting.

CAUTION ...

This board must be handled with care as it may easily be damaged by bending or dropping.

(6) Refitting is the reverse of the above instructions.

Control board PM.345 and low-level board PM.341

6. (1) Remove the chassis top cover (10 quick-release fasteners).

(2) Remove all fixing screws.

(3) Unsolder all connecting leads, noting the colour code and board terminal number.

(4) Remove the board.

(5) Refitting is the reverse of the above instructions.

Power supply board PM.343

7. Refer to fig.3 of Chap.2-0.

(1) Remove the four screws securing the cover.

(2) Loosen the two screws securing the bracket holding TB2, and withdraw TB2.

(3) Unsolder all connecting leads, noting the colour code and board terminal number.

(4) Withdraw the board.

(5) Refitting is the reverse of the above instructions.

Remaining boards

8. The remaining boards are all removed in the same manner. Note that only one screening cover encloses the transfer loop and h.f. loop boards.

(1) Remove the screws securing the cover.

(2) Remove the screws securing the board.

(3) Unsolder all connecting leads, noting the colour code and board terminal number.

(4) Withdraw the board.

CAUTION ...

The h.f. board must be handled with care as it may easily be damaged by bending or dropping.

(6) Refitting is the reverse of the above instructions.

Diode board PS.581

9. Refer to fig.3 of Chap.2-0.

(1) Remove the cover enclosing the l.f. loop and noise-immunity boards.

(2) Remove the board securing screws.

(3) Withdraw the board on its cable harness.

(4) Unsolder all connecting leads, noting the colour code and board terminal number.

(5) Refitting is the reverse of the above procedure.

Line decoupling board PS.392

10. Refer to fig.2 of Chap.2-0.

(1) Remove the chassis top cover (12 securing screws).

(2) Remove the board securing screws.

(3) Unsolder all connecting leads, noting the colour code and board terminal number.

(4) Refitting is the reverse of the above procedure.

Front panel

11. (1) Disconnect SKT1 and PL1 (fig.2, Chap.2-0).

(2) Unsolder the lead to the front-panel R.F. MON. socket.

(3) Remove the four screws securing the front panel to the two chassis side members.

(6) Refitting is the reverse of the above procedure.

Miscellaneous components

12. The method is self-evident for the unsoldering and removal of the various chassis-mounted components. When replacing any one of the power transistors TR1 to TR4, it is necessary to also remove the appropriate heat-sink (chassis rear) before unsoldering leads.

Chapter 2-3

ALIGNMENT

DRIVE UNITS, TRANSMITTER

10D/5820-99-624-5395 (MA.1720A)

AND

10D/5820-99-631-8611 (MA.1720S)

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INTRODUCTION

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A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
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1. This chapter gives alignment procedures for the filters contained within the two drive units. The two filters which it is possible for maintenance units to align are both on the mixer and output board PM.342. Alignment of the two sideband filters is not possible. The following procedures are identical for both drive units, and reference should be made to Chap. 2-5-2 for the component layout and circuit diagrams for the mixer and output board; reference to illustrations in Chap. 2-0 gives the location of the board.

TEST EQUIPMENT

2. Refer to Chap.2-1 for the complete list of test equipment required to service the drive unit. The items required for filter alignment are:

(1) Electronic voltmeter 10S/6625-99-193-4355.

(2) Signal generator (40 MHz) 10S/6257379.

PRELIMINARY REQUIREMENTS

3. It is assumed that the drive unit has been placed on a bench with access to the chassis top, and with the dust cover removed. Both filter alignment procedures are most conveniently carried out in-situ; however, certain links on the board have to be removed and refitted using a soldering iron. It is not necessary to connect the drive unit to a mains voltage supply.

35.4 MHz BAND-PASS FILTER ALIGNMENT

4. (1) Unsolder the wire links between terminals 1 and 2 and terminals 29 and 27 on the mixer and output board.

Note ...

The two lengths of 50-ohm coaxial cable (operations (2) and (3)) required for connecting test equipment must be as short as possible in order to avoid interaction; crocodile clips must not be used for connection to the board terminals.

(2) Using a short length of coaxial cable, and a soldering iron, connect the signal generator (50-ohm output) to terminal 2 (inner) and terminal 3 (screen) on the board.

(3) Using a short length of coaxial cable, and a soldering iron, connect the electronic voltmeter (50-ohm input) to terminal 29 (inner) and terminal 28 (screen) on the board.

(4) Set the signal generator frequency to 35.4 MHz with an output level of 1 volt r.m.s.

(5) Adjust the electronic voltmeter range to obtain a reading.

(6) Adjust the cores of L2 to L7, in turn, for a maximum reading on the electronic voltmeter; repeat until optimum results are obtained.

(7) Ensure that the output indicated on the electronic voltmeter is not more negative than minus 7 dB relative to 1 volt. Note the voltage.

(8) Set the signal generator to 34.0 MHz with an output level of 1 volt r.m.s.

(9) Ensure that the output indicated on the electronic voltmeter is not less negative than minus 55 dB relative to 1 volt.

(10) Set the signal generator to 32.6 MHz with an output level of 1 volt r.m.s.

(11) Ensure that the output indicated on the electronic voltmeter is not less negative than minus 65 dB relative to 1 volt.

(12) Unsolder the coaxial leads and link terminals 1 and 2 and terminals 29 and 27 using bare tin copper wire.

<u>30 MHz LOW-PASS FILTER ALIGNMENT</u>

5. (1) Unsolder the wire links between terminals 30 and 31 and terminals 19 and 20 on the mixer and output board.

Note ...

The two lengths of 50-ohm coaxial cable (operations (2) and (3)) required for connecting test equipment must be as short as possible in order to avoid interaction; crocodile clips <u>must not</u> be used for connection to the board terminals.

(2) Using a short length of coaxial cable, and a soldering iron, connect the signal generator (50-ohm output) to terminal 30 (inner) and terminal 32 (screen) on the board.

(3) Using a short length of coaxial cable, and a soldering iron, connect the electronic voltmeter (50-ohm input) to terminal 20 (inner) and terminal 18 (screen) on the board.

(4) Adjust the electronic voltmeter range to obtain a reading.

(5) Set the signal generator frequency to 37.42 MHz with an output level of 1 volt r.m.s. Adjust the electronic voltmeter range to obtain a reading.

(6) Adjust L9 for minimum meter reading.

(7) Set the signal generator frequency to 35.5 MHz.

(8) Adjust L10 for minimum meter reading.

(9) Set the signal generator frequency to 44.17 MHz.

(10) Adjust L11 for minimum meter reading.

(11) Set the signal generator frequency to 30 MHz; adjust L8 for maximum meter reading.

(12) Repeat operations (5) to (11) twice.

(13) Sweep the signal generator frequency from 1 MHz to 30 MHz. Note the frequency which produces maximum output and note the maximum output level.

(14) Sweep the signal generator frequency from 1 MHz to 30 MHz. Ensure that the output remains within 1 dB of the level noted in operation (13). If necessary re-adjust L8.

(15) Set the signal generator frequency to 35.4 MHz with an output level of 1 volt r.m.s.

(16) Ensure that the output indicated on the electronic voltmeter is not less negative than minus 55 dB relative to the level noted in operation (13).

(17) Sweep the signal generator frequency from 35.4 MHz to 65.4 MHz and ensure that the output remains not less negative than minus 55 dB.

(18) Unsolder the coaxial leads and link terminals 20 and 19 and terminals 30 and 31 using bare tin copper wire.

Chapter 2-4

OVERALL PERFORMANCE TESTS AND ADJUSTMENTS

DRIVE UNITS, TRANSMITTER:

10D/5820-99-624-5395 (MA.1720A)

AND

10D/5820-99-631-8611 (MA.1720S)

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INTRODUCTION

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A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

1. This chapter gives post-repair adjustment procedures and checks for the boards within the drive unit. Folliwing repair work to the drive unit, the appropriate transmitter setting-up procedures given in Chap.1-1 or 13-1 (TTA.1860A or TTA.1860S) and performance checks given in Chap.1-4 or 13-4 (TTA.1860A or TTA.1860S) must be carried out.

ADJUSTMENTS

Preliminary procedure

2. The drive unit must be placed on a bench with its top and bottom covers removed (Chap.2-2).

(1) Connect a 50-ohm dummy load to the .f. output socket (SKT4) on the rear of the unit.

(2) Connect the unit to a suitable mains voltage supply.

(3) Check that both the SUPPLY and STANDBY pushbuttons are released to the 'off' positions.

(4) Set the TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(5) Set the MODE switch to C.W.

(6) Set the VOX/PTT/TX switch to TX.

(7) Link pins 13 and 14 of TS1 (rear).

(8) Set the LOCAL/EXTENDED/REMOTE switch to LOCAL SYNTH.

Regulator board PM343

3. (1) Depress the SUPPLY pushbutton.

Note ...

It is not necessary, under these conditions, to depress the STANDBY pushbutton.

(2) Connect a multimeter to TB2 (Chap.2-0, fig.3) and make the adjustments given in Table 1; refer to Chap.2-5-3, fig.5.

TABLE 1

Regulator board PM343: adjustments

Connect to TB2, pins:	Adjust	Measured voltage
1 or 2 and E	R12	-7V ± 0.25V
3 or 4 and E	R9	+5V ± 0.25V
5 or 6 and E	R23	+12V ± 0.25V
7 or 8 and E	R22	+20V ± 0.25V

(3) Disconnect the multimeter and release the SUPPLY pushbutton.

Frequency standards (9400 and 9420)

4. The conditions of para.2 are to be set up.

(1) Place the drive unit on its side on the bench.

(2) Connect a frequency counter between pin 8 of the 34MHz generator board (Chap.2-5-1, fig.9) and chassis.

(3) Connect an oscilloscope across the counter.

(4) Depress the SUPPLY pushbutton and allow approximately 30 minutes to elapse before making the following measurements.

(5) Check that the oscilloscope displays 800mV p-p.

(6) Set the counter to measure 5MHz; refer to the appropriate publication.

(7) In order to display the least significant digit, utilise the 'overspill' facility.

(8) Check that the displayed count is either 999999 ± 1Hz or 000000 ± 1Hz. If necessary, remove the rubber plug (top of frequency standard unit) and adjust for the correct displayed count.

(9) Release the SUPPLY pushbutton.

L.P. loop board PM349

5. The conditions of para.2 are to be set up.

(1) Depress the SUPPLY pushbutton.

(2) Set the six frequency selector switches to 000000 and depress the RESET pushbutton.

(3) Connect a multimeter between TP5 (+) and chassis; refer to Chap.2-5-1, fig.11.

(4) Adjust L2 on the PM349 board for a multimeter indication of +15V d.c.

(5) Reset the six frequency selector switches to 299999, depress the RESET pushbutton and check that the multimeter indication is +3.5V d.c.

(6) Disconnect the multimeter and release the SUPPLY pushbutton.

H.F. loop board PS337/3

6. The conditions of para.2 are to be set up.

(1) Depress the SUPPLY pushbutton.

(2) Set the six frequency selector switches to an arbitrary setting and depress the RESET pushbutton.

(3) Connect an oscilloscope to TP4; refer to Chap.2-5-1, fig.15.

(4) Adjust R38 on the PS337/3 board for a display of 3V p-p.

(5) Disconnect the oscilloscope.

(6) Connect an electronic voltmeter to pin 22 of the PS337/3 board.

(7) Adjust R44 on the board for a meter indication of 225mV r.m.s. (0dBm into 50 ohms).

(8) Connect the electronic voltmeter to pin 18 of the board.

(9) Set the frequency selector switches to 299999 and depress the RESET pushbutton.

(10) Adjust L20 on the board for a meter indication of +8V d.c.

(11) Connect the electronic voltmeter to the collector of TR19.

(12) Make the adjustments at the given frequency settings shown in Table 2; depress the RESET pushbutton after each change in frequency.

TABLE 2

H.F. loop board PS337/3: adjustments

Frequency setting	Adjust	Measured voltage
069999	L4	+14V d.c.
179999	L5	+14V d.c.
299999	L6	+14V d.c.

(13) Release the SUPPLY pushbutton and disconnect the voltmeter.

Drive unit mode levels

7. The entire following procedure must be carried out after repair and/or replacement of either the low-level board PM341 (Chap.2-5-2, fig.2) or the mixer and output board PM342 (Chap.2-5-2, fig.4). The procedure embraces the following particular adjustments:

(1) R.F. output level of 200mW.

(2) A.F. line input levels.

(3) Channels 1 and 2 a.f. gain.

(4) Vox sensitivity.

(5) A.F. meter sensitivity.

(6) R.F. meter sensitivity.

8. The drive unit must be placed on a bench and the top cover removed.

(1) Connect a 50-ohm dummy load to the r.f. output socket (SKT4) on the rear.

(2) Connect the unit to a suitable mains voltage supply.

(3) Check that both the SUPPLY and STANDBY pushbutton are released to the 'off' positions.

(4) Set the TUNE/MUTE/OPERATE switch to OPERATE HIGH.

(5) Set the MODE switch to AM-6 and the sideband switch to UPPER.

(6) Set the VOX/PTT/TX switch to TX.

(7) Set the LOCAL/EXTENDED/REMOTE switch to LOCAL SYNTH.

(8) Connect an electronic voltmeter across the 50-ohm dummy load at SKT4.

(9) Depress the SUPPLY pushbutton.

9. (1) Adjust T6 on the PM341 board (Chap.2-5-2, fig.2) for a maximum voltmeter indication.

(2) Adjust L2, L3, L4, L6 and L7 on the mixer and output board (Chap.2-5-2, fig.4) for a maximum voltmeter indication.

(3) Adjust R70 on the mixer and output board for a voltmeter indication of 1.6V r.m.s.

(4) Set the front-panel meter switch to R.F. and adjust R64 on the PM342 board for a front-panel meter indication of -6dB.

(5) Set the MODE switch, in turn, to SSB-16 and SSB-26, and check that the voltmeter reading reduces by 10dB ± 1dB and 20dB ± 1dB respectively.

(6) Connect an audio signal generator to the LINE 1 jack socket on the front panel; refer to fig.6, Chap.2-0 for method of connecting to the audio line terminals of the jack plug.

(7) Set the MODE switch to SSB-SUPP.

(8) Adjust the generator output level to 0dBm at 1kHz and 600 ohms.

(9) Set the METER switch to LINE 1.

(10) Adjust R195 on the low-level board (Chap.2-5-2, fig.2) for a front-panel meter indication of 0dBm.

(11) Set the front-panel SET LINE 1 control fully counter-clockwise.

(12) Set the METER switch to SET 1.

(13) Adjust the SET LINE 1 control for a front-panel meter indication of 0dBm.

(14) Set the METER switch to R.F.

(15) Increase the generator output level by 10dB.

(16) Adjust R73 on the low-level board for a front-panel meter reading of 200mW.

(17) Alternate the setting of the SIDEBAND switch between UPPER and LOWER and adjust, in turn, R175 and R176 respectively in order to obtain 200mW meter readings for each switch position.

(18) Decrease the generator output by 20dB and check that the voltmeter reading reduces by not more than 1.5dB.

10. (1) Set the VOX/PTT/TX switch to VOX.

(2) Set R79 on the low-level board to the maximum counter-clockwise position and check that, after 2 seconds, the drive unit output indication is muted to zero.

(3) Turn R79 clockwise until the drive unit de-mutes.

Note ...

For normal speech inputs, the clockwise setting of R79 may have to be increased slightly.

11. (1) Reset the generator output level to 0dB.

(2) Set the VOX/PTT/TX switch to TX.

(3) Set the MODE switch to ISB-26 and check that the output level falls by 6dB.

12. (1) Connect the generator output to the LINE 2 front-panel jack socket.

(2) Set the METER switch to LINE 2 and check that the front-panel meter reading is 0dBm.

(3) Set the METER switch to SET 2 and adjust the SET LINE 2 control for a 0dBm reading on the front-panel meter.

(4) Set the METER switch to R.F.

(5) Increase the generator output level by 10dB.

(6) Adjust R75 on the low-level board for a reading of -6dB relative to the 200mW front-panel meter setting.

(7) Set the TUNE/MUTE/OPERATE switch to TUNE.

(8) Set the MODE switch to C.W.

(9) Adjust R204 on the low-level board for a reading of 6dB below 200mW.

(10) Set the TUNE/MUTE/OPERATE switch to OPERATE LOW.

(11) Adjust R190 on the low-level board until the front-panel meter reading is -6dB relative to 200mW.

(12) Release the SUPPLY pushbutton.

1kHz tone oscillator

13. The conditions of para. 2 are to be set up.

(1) Depress the SUPPLY pushbutton and set the frequency selector switches to 2000000.

(2) Adjust R65 on the low-level board for a front-panel meter reading of 200mW.

(3) Connect a frequency counter across the dummy load at the r.f. output SK4.

(4) The frequency display should be 1.999000MHz; if necessary, adjust T1 on the low-level board.

(5) Release the SUPPLY pushbutton and disconnect the test equipment.

(6) Set the Mode switch to C.W.

(7) Check that pins 13 and 14 of TS1 (rear) are still linked.

(8) Using an oscilloscope, monitor at TP1 on the board; the level of the displayed waveform should be within the limits of 3.0V to 5.0V p-p. limiting on one peak and folding back 1.0V (approx).

(9) Adjust R69, if necessary, to meet the above conditions.

R.F. output level

14. If an r.f. output level of less than 200mW is required, then adjust R70 (low-level board) accordingly.

Chapter 2-5-1

CIRCUIT DESCRIPTION OF SYNTHESIZER

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INTRODUCTION

1. This chapter contains a circuit description of those boards in the drive unit which combine to provide the synthesizer function. The principle of operation of the synthesizer is contained in Chap. 2-0. The synthesizers are identical in the MA.1720A and MA.1720S drive units with the exception of the frequency standard which is a Type 9400 (MA.1720A) or 9420 (MA.1720S); the Type 9420 has higher stability characteristics.

2. The synthesizer consists of the following sub-assemblies:-

(1) Frequency standard (5 MHz).

(2) 34 MHz generator board PM.344.

(3) L.F. loop board PM.349.

► (4) H.F. loop board PS.337/3, or PS.337/4. ◄

(5) Transfer loop board PS.338

(6) Noise immunity board PM.346

The interconnection diagram in Chap. 1 shows the interconnections between all the synthesizer sub-assemblies.

3. The frequency selection switches and the noise immunity board are described in this chapter because they are an essential part of the synthesizer.

FREQUENCY STANDARD

4. The fast-warm-up frequency standard sub-assembly produces a 5 MHz high-stability output which is applied to the 34 MHz generator board.

5. This is a fourth-line repairable unit hence no technical information is given in this publication.

FREQUENCY SELECTION SWITCHES (fig. 6)

6. There are six frequency selection switches each with a +12V input line and four output lines; the output lines are at a level of +12V or open-circuit depending upon the switch settings. The binary-coded decimal output from each switch is nines-complemented and inverted for the MHz x 10 and MHz x 1 switches; an inverted BCD output is provided by the kHz x 100, kHz x 10, kHz x 1 and Hz x 100 switches. Table 1 summarises the logic output levels as related to the switch decimal settings.

7. The switch output lines are routed via a noise immunity board PM.346 to the programmed dividers on the l.f. loop board, the h.f. loop board and the transfer loop board.

TABLE 1

Frequency selection switches: logic output levels

		Switch setting (decimal)*										
		0	1	2	3	4	5	6	7	8	9	
Binary	2^0	0	1	0	1	0	1	0	1	0	1	
	2^1	0	0	1	1	0	0	1	1	0	0	
	2^2	0	0	0	0	1	1	1	1	0	0	
	2^3	0	0	0	0	0	0	0	0	1	1	
Inverted binary (100 Hz, 1 kHz 10 kHz, & 100 kHz switches)	2^0	1	0	1	0	1	0	1	0	1	0	
	2^1	1	1	0	0	1	1	0	0	1	1	
	2^2	1	1	1	1	0	0	0	0	1	1	
	2^3	1	1	1	1	1	1	1	1	0	0	
Inverted 9's complemented binary (1 MHz & 10 MHz switches)	2^0	0	1	0	1	0	1	0	1	0	1	
	2^1	1	1	0	0	1	1	0	0	1	1	) **
	2^2	1	1	0	0	0	0	1	1	1	1	)
	2^3	0	0	1	1	1	1	1	1	1	1	

* Logic 0 = open circuit
Logic 1 = +12V

** Not used in MHz x 10 switch

NOISE IMMUNITY BOARD PM.346 (fig. 8)

8. The function of the noise immunity board is to prevent random operation on any of the 22 frequency selection lines by noise or r.f. signals picked up on the lines.

9. The board contains 22 identical stages (one for each frequency selection line) which accept +12V for 'select' and open-circuit for 'non select'. The input line to each circuit is taken via a 4.7k ohm resistor to the -7V rail (earth clamp diodes in the transistor base circuits prevent reverse base/emitter voltage breakdown) and thus a voltage greater than approximately 8V (relative to -7V) must be applied to the input line before the transistor will conduct.

10. The outputs of the board are taken from the collectors of transistors to the inputs of the three programmed dividers; selection of a line causes the associated transistor to conduct and apply logic '0' to the divider input.

34 MHz GENERATOR BOARD PM.344 (fig. 10)

11. The main function of the 34 MHz generator board is to produce a 34 MHz sinewave output at a level of 0 dBm. The board contains the following stages, and a block diagram is shown in fig. 1.

(1) 34 MHz oscillator with output buffers and filter.

(2) Divide-by-34 stage to produce a nominal 1 MHz squarewave from one of the outputs of (1), for internal use on the board by the phase-comparator.

(3) Amplifier and squarer for the 5 MHz reference frequency input, followed by a divide-by-5 stage and output buffers.

(4) Phase detector circuits to compare the outputs of (2) and (3), produce a control voltage for locking the frequency of (1) accurately on 34 MHz.

12. Also contained on the board are logic circuits that receive inputs from the frequency-setting thumbwheel switches on the front panel, and produce control outputs for application to the appropriate oscillator selector on the h.f. loop board.

34 MHz oscillator

13. TR2, TR4 and associated components form a nominal 34 MHz L-C oscillator. L1, C1 and C3 form the basic tuned circuit; frequency pulling is provided by varactor diode D2. The control voltage for D2, applied via choke L2, is derived from the phase-detector and voltage-control circuit described in para. 19 and 20.

14. The output of the oscillator is buffered by NAND gates G1-G3 in ML1, for which the supply voltage is provided by series regulator TR1 and Zener diode D1. The squarewave output from gate G3 is fed to the low-pass filter including L4 and L5, and the resultant 34 MHz sinewave output is taken off the board at pin 1. The output of gate G2 is applied as the clock input to the divide-by-34 stage.

Divide-by-34 stage

15. The divide-by-34 stage consists of the dual J-K flip-flop ML3, the binary decade counter ML5 (connected as a divide-by-10 stage), and NAND gates G4 and G6 in ML6.

16. The34 MHz output from the buffer G2 in ML1 is applied in parallel to the clock inputs of both halves of ML3; the J1 output is held at logic '1' (+5V). The division factor of 34 is obtained by dividing the first 18 pulses by 3 and the next 16 pulses by 4.

i.e. 18 pulses ÷ 3 = 6

16 pulses ÷ 4 = 4

Therefore, for 34 pulses in, 10 pulses appear at the output of ML3. These 10 pulses are divided by ML5 to provide the 1 MHz output at pin 2 of ML5.

17. Figure 2 illustrates the action of the circuit and shows the logic signals produced at relevant points.

Amplifier and squarer

18. The 5 MHz sinewave output from the frequency standard is fed onto the board at pin 8 and applied to the amplifier and squarer comprising TR3, TR5 and associated components. The output of this circuit is divided by 5 in ML2; the resulting 1 MHz squarewave (0V to +4V p-p) is fed to the inputs of NAND gates G5, G7 and G8 (connected as buffers) in ML4. The output of G5 is taken from the board at pin 10 via a 220 ohm resistor to the transfer loop board PS.338, and the output of G7 is taken via pin 12 to the l.f. loop board PM.349. The output of G8 is applied as the reference frequency to one input of the phase-comparator.

Phase-comparator

19. The phase-comparator consists of the dual D-type flip-flop ML7 and the NAND gate G9 in ML6. The nominal 1 MHz squarewave derived from the 34 MHz oscillator via the divide-by-34 stage is applied as the 'clock' input to one half of ML7; the reference 1 MHz squarewave derived from the 5 MHz frequency standard is applied as the clock input to the other half. Both D inputs are held permanently at logic 1. The Q outputs of both halves are applied to the inputs of NAND gate G9, and the output of G9 is connected back in parallel to the 'clear' inputs of both halves of ML7. The Q outputs are applied as control inputs to the voltage-control stage.

Voltage-control stage

20. The voltage-control stage consists of transistors TR6 and TR8 which together control TR7. The d.c. control voltage is developed across C23 and applied to the varactor diode D2 in the 34 MHz oscillator. R27 and C21 provide decoupling for the control voltage.

V.C.O. switching stages

21. The v.c.o. switching stages consist of NAND gates ML8, NOR gates ML9, ML10, and the inverting output buffers TR9-TR11. Inputs from the frequency selection switches on the front panel, routed via inverting circuits on the noise immunity board, are applied to ML8 and ML9 at pins 13-17. The logic circuits produce control outputs at pins 19-21 which are fed to the h.f. loop board to select one of the three h.f. loop oscillators.

22. A logic '0' is required as output from one (and only one) of pins 19-21 in order to select a particular oscillator; the remaining two pins must be at logic '1'.

TABLE 2

Oscillator selection logic

Input pins					Output pins			Oscillator selected
16	15	17	13	14	21	19	20	
'1' on any pin			1	1	0	1	1	0- 7 MHz
0	0	0	1	1)				8-17 MHz
or '1' on any pin			*	0)	1	0	1	
Any other condition					1	1	0	18-29 MHz

'*' = immaterial

L.F. LOOP BOARD PM.349 (fig. 12)

23. This printed circuit board contains the circuits necessary to generate the 3.6 - 4.6 MHz frequency (f2); these consist of the following:

(1) 18-23 MHz voltage-controlled oscillator.

(2) Programmed divider (N1).

(3) Divide-by-2000 stage to produce the 500 Hz reference frequency from the 1 MHz standard frequency input.

(4) 500 Hz phase-comparator and output circuit for the control voltage.

(5) Divide-by-5 stage to produce the 3.6 - 4.6 MHz output from (1).

24. The board also contains logic circuits to produce an 'out-of-lock' signal when the oscillator is not phase-locked to the reference frequency, and a filter and amplifier to produce a 1.4 MHz output from the 1 MHz standard frequency input. A block diagram is shown in fig. 4.

18-23 MHz oscillator

25. Transistor TR2 and associated components form a variable-frequency L-C oscillator, tunable over the range 18-23 MHz by the bias voltage applied to varactor diode D1 in the oscillatory circuit. The output is buffered by NAND gate G2 in ML1, and applied as the clock input to the divide-by-5 stage ML2. A squarewave output from ML2 is buffered by G1 in ML1 before being applied to the step-down transformer T1 via the low-pass filter L1, C1, C2. The 3.6 - 4.6 MHz sinewave output f2 is taken from the secondary of T1 at pins 3 and 4 of the board. Transistor TR1 forms a series stabilizer for the oscillator circuit.

Programmed divider N1

26. This consists of the presettable decade counters ML5, ML8, ML11, ML13 and ML16, AND gates G5 and G4 of ML6, NAND gates ML15 and the dual J-K flip-flop ML9.

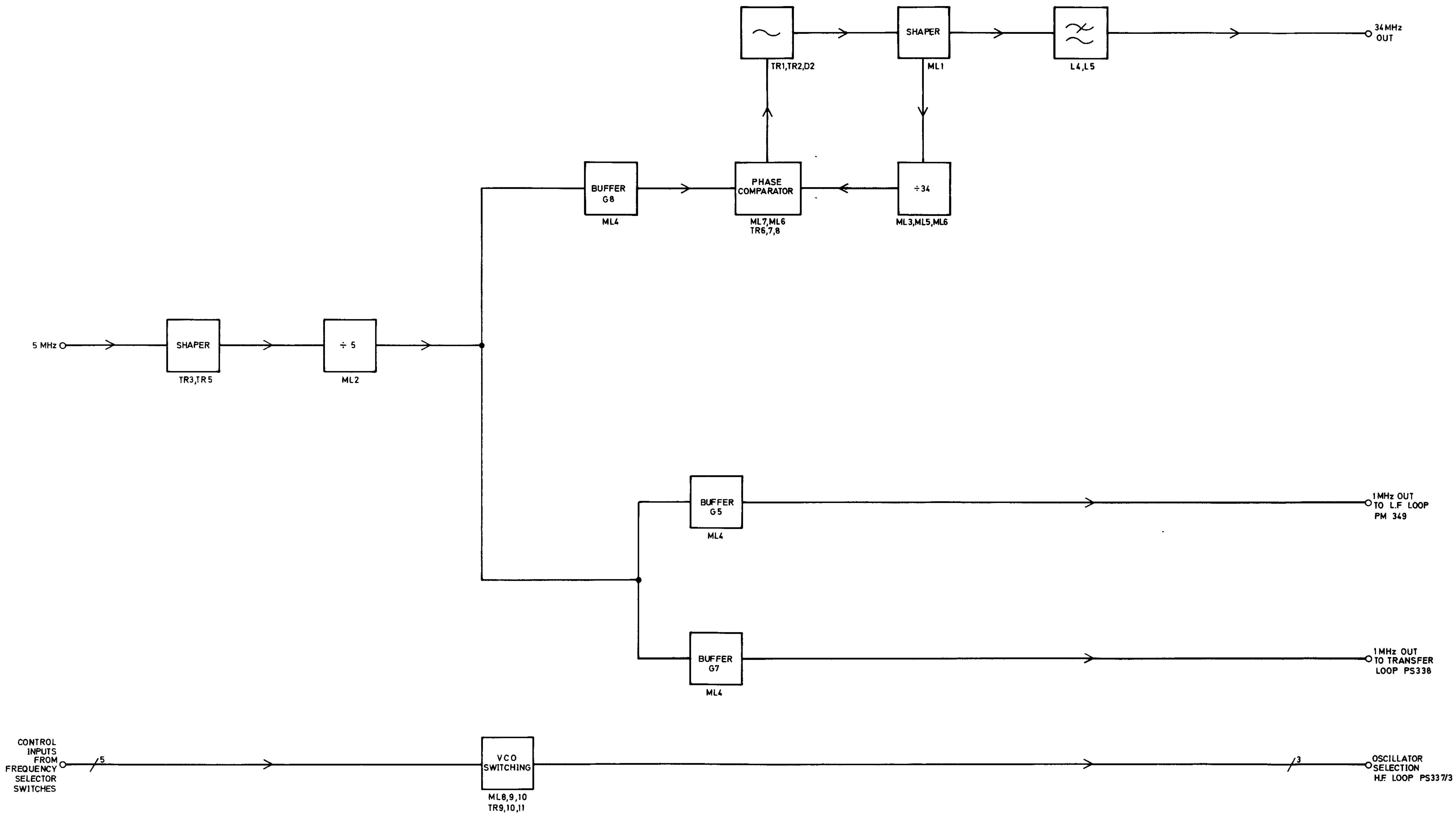


Fig.1

34 MHz generator board PM344: block diagram

Fig. 1

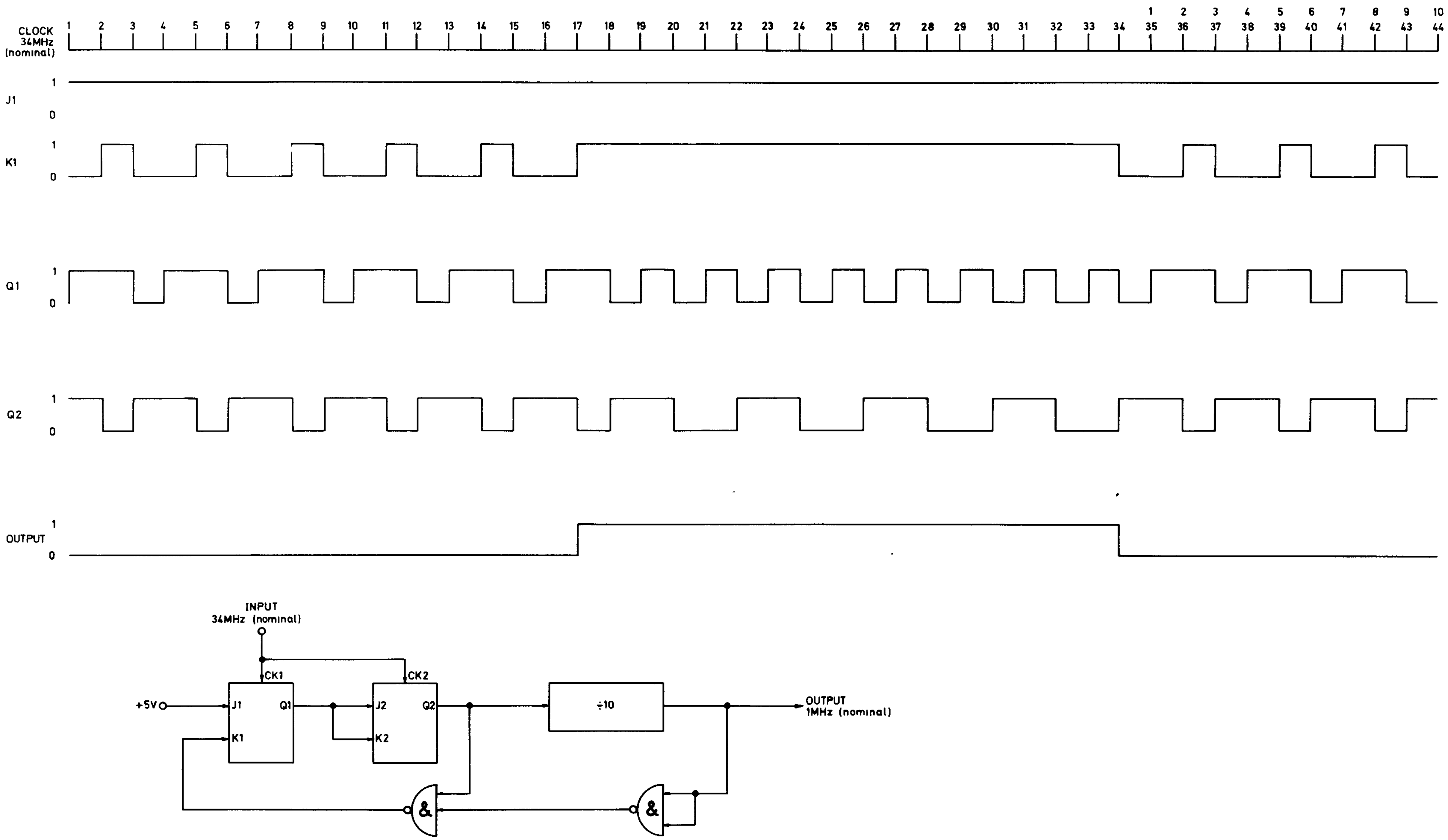


Fig.2

Waveform diagram: divide-by-34 stage

Fig. 2

27. The input to the divider at ML5 pin 8 is the output of the 18-23 MHz oscillator; the output of the divider at ML16 pin 2 is applied as the sample input to one half of the phase-comparator ML12. ML9 is also clocked by the output from the v.c.o.

28. Gates ML6 and ML15 form a decoder, giving an output of logic '1' from ML8 pin 6 when a BCD count of 45997 is detected at the outputs of the counters.

29. The divider is programmable for any division ratio in the range 36001-46000 by the setting of the 'kHz' switches on the front panel; these apply the set figures (in BCD form) to the input lines of the first four counters.

30. The divider operates as follows. Assume an initial state where all counters are at 0, and where 4236 is set in BCD format on the input lines. When the clock input is applied to ML5 pin 8, the counters count up until the decoder gates detect a count of 45997.

31. At this point the J1 input of ML9a goes to logic '1', and three clock pulses later (at a count of 46000) the $\overline{Q1}$ output of ML9a goes to '0'.

32. This is applied as the strobe input to the counters, and 'strobes-in' the data on the input lines. The counters therefore reset to 4236, count up to 46000, and continue cycling in this manner, dividing by a figure of 46000-4236.

33. In general terms, the divider is programmable to divide by 46000-XXXX, where XXXX are the digits set on the 'kHz' switches.

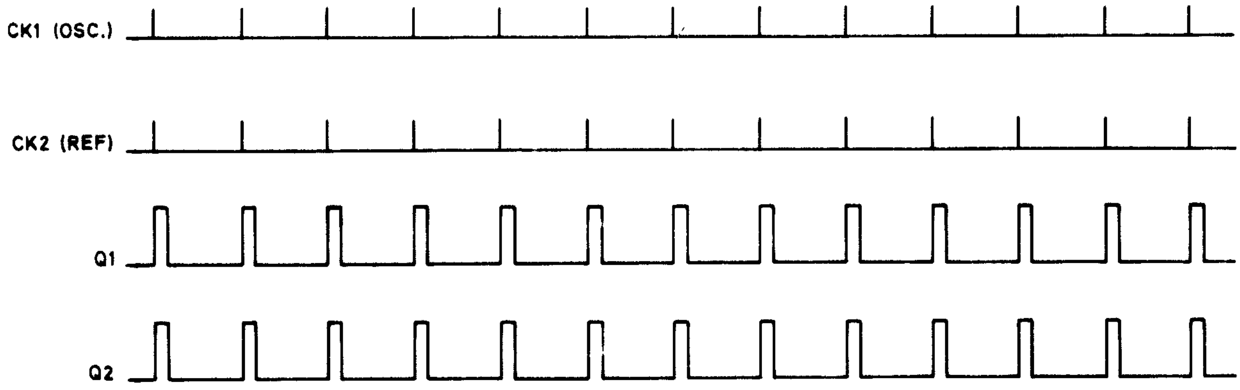
Divide-by-2000 stage

34. This stage consists of the three binary decade counters ML3, ML4 and ML7 connected in cascade, followed by a single divide-by-two stage ML10. The input to the stage at pin 25 is a 1 MHz squarewave (derived from the 5 MHz frequency source) from the 34 MHz generator board pin 12. The 500 Hz output from ML10 (the reference frequency) is applied to one input of the phase-comparator (ML12 and G6 of ML14).

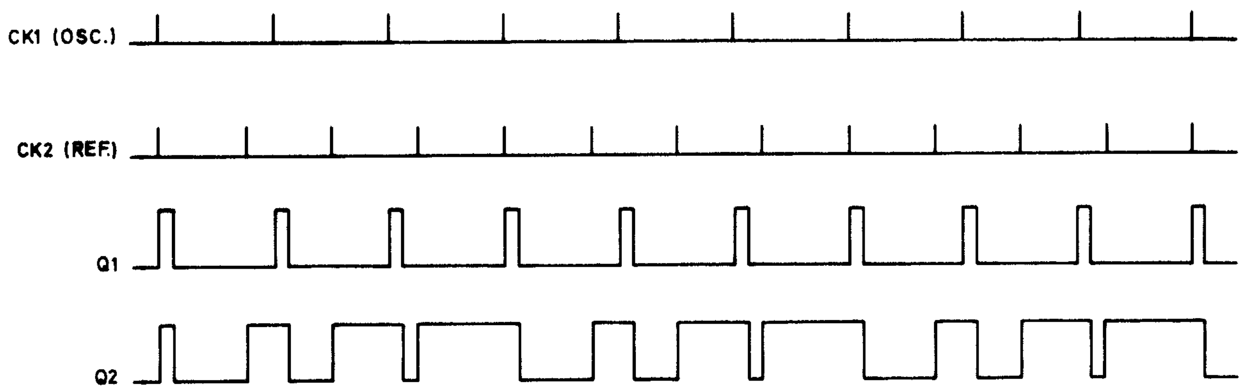
Phase-comparator

35. This consists of the dual D-type flip-flop ML12, NAND gate G6 in ML14, and the voltage-control circuit TR5-TR11 and associated components. The squarewave derived from the 18-23 MHz oscillator via the programmed divider is applied as the clock input to one half of ML12, and the reference 500 Hz squarewave from the 5 MHz frequency standard is applied as the clock input to the other half. Both D inputs are connected to +5V and held permanently at logic 1. The Q outputs of both halves are applied to the inputs of 'nand' gate G6 in ML14, and the output of G6 is connected to the 'clear' inputs of both halves of ML12 via the delay network R26, C25. The Q outputs are applied to the bases of TR5 and TR7 in the voltage-control circuit, and the $\overline{Q}$ outputs are fed to the out-of-lock indicator.

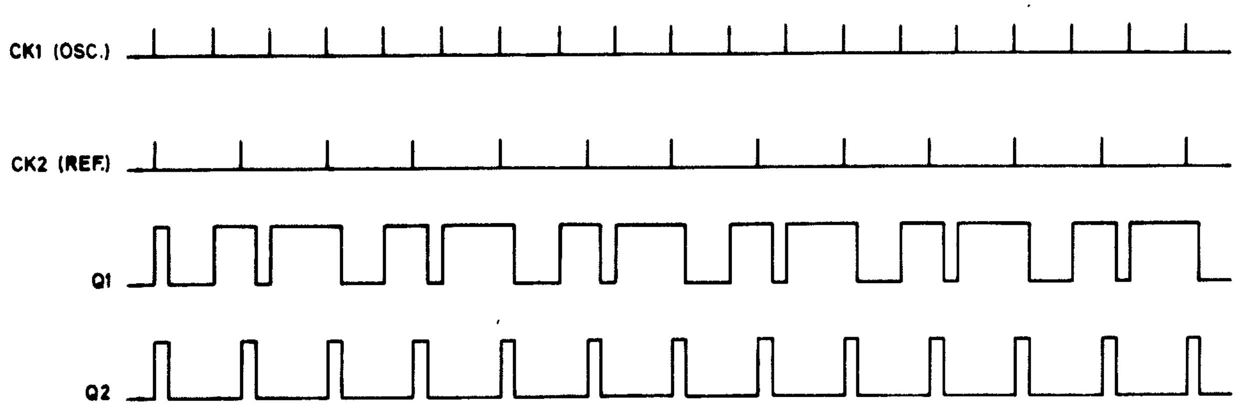
36. The operation of the phase-comparator is as follows. If the inputs are in phase, i.e. if the oscillator frequency is 500 x N1 Hz, the Q1 and Q2 outputs go to '1' simultaneously; gate G1 therefore gives a '0' output which, applied to the 'clear' inputs of ML12, inverts both Q outputs to '0'. The Q1 and Q2 outputs thus both consist of a train of narrow positive-going pulses at a p.r.f. of 500 Hz.



OSCILLATOR AND REFERENCE IN PHASE



OSCILLATOR LAGGING (FREQUENCY LOW)



OSCILLATOR LEADING (FREQUENCY HIGH)

Fig.3 Phase comparator - idealized waveforms

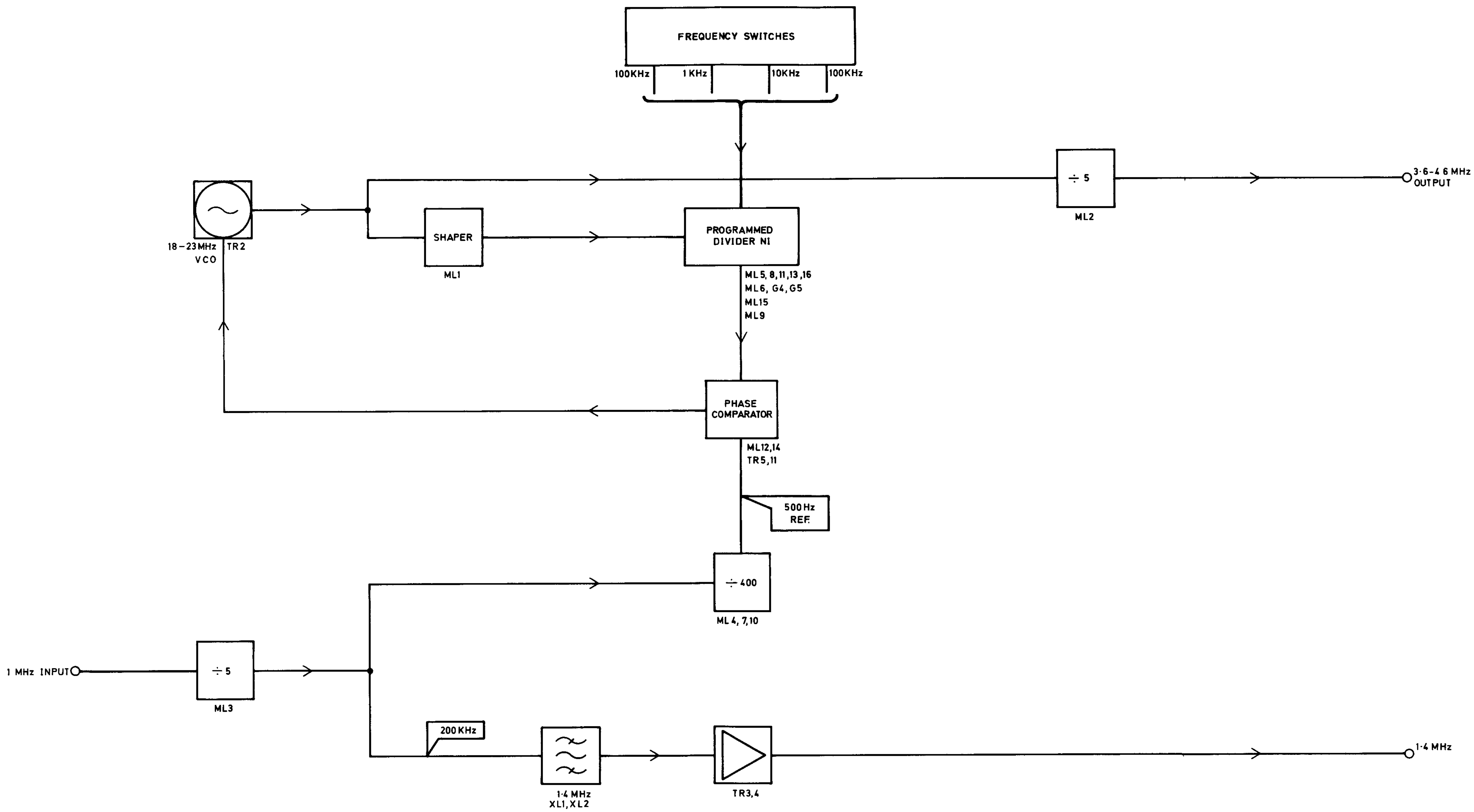


Fig. 4

L.F. loop PM349: block diagram

37. If the oscillator is lagging on the reference, the Q1 output is a train of narrow pulses and the Q2 output is a train of wide pulses. If the oscillator is leading, the Q1 output is a train of wide pulses and the Q2 output is a train of narrow pulses.

38. These three conditions are illustrated by the idealized waveforms in fig.3.

39. The voltage-control circuit consists of transistors TR5 to TR12 and associated components, the control voltage being developed across capacitor C39.

40. If a wide pulse appears at the Q output of ML12A, this is converted by transistor TR7 into a current pulse, which will discharge capacitor C39 via transistor TR8, connected as a diode; similarly a wide pulse at the Q output of ML12B charges C39 via transistors TR5, TR6 and TR9. The voltage on C39 is fed via the source follower TR11 to the varactor diode D1 to complete the phase-lock loop; R34 and C31 ensure the loop is stable. The effect of leakage in TR6, TR7 and the varactor D1 is eliminated by TR8, TR9 and TR11. Transistor TR10 is an a.c. stabilizer to prevent unwanted noise on the +20V d.c. line reaching the varactor line.

Lock indicator

41. The $\overline{Q}$ outputs of the 500 Hz phase-comparator are applied to NAND gates G9 and G10 in ML14; gate G11 on ML17 is connected as a buffer/inverter. The inputs to G10 are delayed by approximately 0.3 µs by R38 and C31, R51 and C44 to ensure correct latching action.

42. In the in-lock condition, a train of negative-going pulses of approximately 50 ns duration will be applied to G9 and G10 in ML14. These inputs will appear as logic '0' and logic '1' inputs to G9 (logic '0' during negative pulse) but, because of the delay caused by R35 and C30, R38 and C31, the negative-going pulses will not appear at the input to G10; therefore in the in-lock condition, pins 4 and 5 of G10 will always be at logic '1'. Pin 6 of G10 will be at logic '0' which will be inverted by gate G11 in ML17 to produce a logic '1' in-lock indication at pin 24 of the board.

43. In the out-of-lock condition, one the $\overline{Q}$ outputs from the phase-comparator will consist of a train of wide negative-going pulses whilst the other output will consist of a train of narrow negative-going pulses (para. 37). Due to the delay caused by R35 and C30 or R38 and C31, the wide negative pulse will still be present at G10 after the input to G9 has returned to logic '1'; this will have the effect of resetting the latch in G9 and G10 producing a logic '1' output at pin 6 of G10. Gate G11 in ML17 will invert this logic '1' output from G10 to produce a logic '0' out-of-lock indication at pin 24 of the board.

44. The output from the out-of-lock indicator is fed via the r.f. filter L7 and C44 to pin 24 of the board.

Crystal filter and amplifier

45. A divide-by-5 output of 200 kHz is taken from pin 9 to ML3 (the first component of the divide-by-2000 stage). This is passed via the 1.4 MHz crystal filter (XL1 and XL2) to the tuned amplifier TR3 and TR4. The 1.4 MHz sinewave output is at pins 1 and 2 of the board.

TRANSFER LOOP BOARD PS.338 AND H.F. LOOP BOARD PS.337/3 (fig. 14 and 16)

46. It is convenient to describe these two boards together because the v.c.o. for the transfer loop is contained on the h.f. loop board. A block diagram is shown in fig. 5.

47. The principal function of these two boards is to generate f4 (35.4 - 65.4 MHz) and f3 (885-947.8 kHz). The frequency f3 is determined by the setting of the thumbwheel frequency selector switch. f4 is phase-locked to f3 via the programmed divider such that f4 = N2 x f3.

Generation of f3

48. The circuits generating f3 are contained on two boards as follows:-

(1) Voltage-controlled oscillator (D19, TR17, TR20 on the h.f. loop board, fig. 16).

(2) Mixer and low-pass filter on the transfer loop board (fig. 14) to produce the frequency 1 MHz-f3.

(3) Programmed divider (N2) on the transfer loop board, producing an output $\frac{f2}{N2}$ for use as the reference frequency.

(4) Phase-comparator on the transfer loop board, to lock the output of (1) at a frequency

$$1 \text{ MHz} - f3 = \frac{f2}{N2}$$

Transfer loop : oscillator (fig. 16)

49. Transistor TR17, TR20 and associated components form a variable-frequency L-C oscillator, tunable by the bias voltage applied to varactor diode D19 in the oscillatory circuit. The output at frequency f3 is applied as the clock input to the divide-by-two stage ML12. A sample of f3 is fed off the board at pin 13 via the buffer amplifier TR21 and applied to the mixer on the transfer loop board.

Transfer loop : mixer and low-pass filter (fig. 14)

50. The mixer comprises the integrated-circuit ML3, together with the input buffer amplifiers TR1, TR2, TR3.

51. The 1 MHz stable signal is fed onto the board at pin 3 and applied to one input of ML3 via the buffer amplifier TR1, TR2. A sample of f3, generated by the oscillator, is applied to the other input of ML3 via pin 19 and buffer TR3, and the combined signal is fed via the low-pass filter L11, L12 to the buffer amplifier TR6. The output frequency at the collector of TR6 is 1 MHz - f3, which is squared and inverted in NAND gate ML7A for application to the phase-comparator.

Transfer loop : programmed divider N2 (fig. 14)

52. This consists of the presettable decade counters ML1, ML2, NAND gates ML4, ML5 and the D-type flip-flop ML6.

53. The input to the divider at pin 17 is the sinewave f2 generated by the v.c.o.; the output of the divider at ML6 pin 5 is the frequency f2/N2, used as the reference frequency in the generation of f3.

54. The input signal is shaped by TR4, TR5, squared and inverted by NAND gate ML4A, and applied as the clock input to the 'units' counter ML1.

55. Gates ML4B and ML5 form a decoder, giving an output of logic '0' when a count of 37 is detected at the outputs of the decade counters. The output at ML5 pin 8 is applied to the data input of ML6, which is clocked by the input frequency f2. The Q output of ML6 is applied:

(1) To one clock-input of the phase-comparator ML8 as the reference frequency.

(2) To the decade counters ML1, ML2 as the strobing signal (logic '0' 'strobes' in the data on the input lines).

56. The divider is programmable for any division ratio in the range 40-69 by the setting of the 'MHz' frequency selection switches on the front panel; these apply the nines-complement of the set figure (in BCD form) via the noise immunity board to the data input lines of the divider (pins 8-15).

57. Table 3 shows the operation of the divider for various representative values of 'MHz' switch setting.

TABLE 3

Operation of divider (transfer loop)

'MHz' setting	BCD input	Clock pulses				
		Count up (100-BCD i/p)	Commence strobe pulse ML6	Fixed count detect	End strobe pulse ML6	Total (= division ratio)
00	99	1	1	37	1	40
07	92	8	1	37	1	47
14	85	15	1	37	1	54
21	78	22	1	37	1	61
29	70	30	1	37	1	69

Transfer loop : phase-comparator (fig. 14)

58. This consists of the dual D-type flip-flop ML8 and the NAND gate ML7B. The squarewave 1 MHz-f3 is applied as the clock input to one half of ML8, and the reference frequency f2/N2 is applied as the clock input to the other half. Both D inputs are connected to +5V and held permanently at logic '1'. The Q outputs of both halves are applied to the inputs of NAND gate ML7B, and the output of ML7B is connected back in parallel to the 'clear' inputs of both halves of ML8. The Q outputs are applied as control inputs to the voltage-control circuit.

Transfer loop : voltage-control stage (fig. 14)

59. The voltage-control stage comprises transistors TR7-TR10 and associated components; the d.c. control voltage at TR10 collector is fed off the board at pin 4, and applied to varactor diode D2 in the oscillator via pin 18 on the h.f. loop board (fig. 16).

Transfer loop : lock indicator and fast lock stage (fig. 14)

60. This stage comprises two monostables, ML9, ML10, a dual D-type flip-flop ML11, and NAND gates ML4C, ML4D. Its purpose is to augment the conduction of TR7 or TR10 in the out-of-lock condition and so obtain a faster return to the locked condition; it also provides a lock-indication output signal. The action of the circuit is as follows.

61. The Q output from the phase-comparator flip-flop (ML8A) is applied to the B input (Schmitt trigger) of the monostable, ML9, and also to the D and 'clear' inputs of a D type flip-flop, ML11A. Similarly, the Q output from ML8B is applied to the B input of the monostable, ML10, and also to the D and 'clear' inputs of a second D-type flip-flop, ML11B. The two monostables, triggered when positive-going signals are applied to the respective B inputs, each produce a negative-going output pulse ($\overline{Q}$), of approximately 1.5 µs duration.

62. At the end of each output pulse, the D inputs of ML11A and ML11B are sampled by their respective clock inputs to produce the appropriate in-lock or out-of-lock $\overline{Q}$ outputs from the flip-flops.

63. In the in-lock condition, the Q outputs from the two flip-flops, ML11A, ML11B are both at logic '1'; these signals do not, however, affect the conduction of the voltage-control transistors, TR7, TR10, due to the presence of the two diodes, D2, D3. The logic '0' output from ML4C is inverted by ML4D to produce a logic '1' in-lock signal at board pin 5.

64. If the output frequency from the mixer is low, the negative excursion of the $\overline{Q}$ output from ML11B will be applied to TR10, via diode D3. The conduction of TR10 will, therefore, be increased rapidly to bring about a fast return to the in-lock condition. The $\overline{Q}$ output from ML11B is also applied to ML4C to produce an alternating '01' out-of-lock signal at board pin 6.

65. Should the out-of-lock condition be due to a high mixer output frequency, the $\overline{Q}$ output from ML11 will cause a rapid return to the in-lock condition by increasing the conduction of TR7; the Q output from ML11A is also applied to ML4C to produce an alternating '01' out-of-lock signal at board pin 6, as before.

H.F. loop : generation of f4 (fig. 16)

66. The circuits generating f4 are contained on the h.f. loop board and consist of the following:

(1) Voltage-controlled oscillator TR1-TR9, with a.g.c. stage TR10, TR13 and output buffer TR14.

(2) Programmed divider N2 consisting of ML3, ML5 and associated components.

(3) Phase-comparator ML7, to lock the output of (1) at a frequency

$$\frac{f1}{2N2} = \frac{f3}{2}$$

H.F. loop : oscillator (fig. 16)

67. The frequency range of the oscillator is 35.4 to 65.4 MHz; this is provided by three switched oscillators each having the following frequency range:

(1) Oscillator No.1 : 52.4 to 65.4 MHz

(2) Oscillator No.2 : 42.4 to 52.4 MHz

(3) Oscillator No.3 : 35.4 to 42.4 MHz

The oscillators are similar in operation, and the required frequency band is selected by the setting of the 'MHz' switches on the front panel. These switches apply a control voltage of 0V to one of the pins 26, 27 or 28 via the logic circuits on the 34 MHz generator board (fig. 10); this input turns on TR3, TR2 or TR1 supplying power to the associated oscillator.

68. Details of the three oscillators are as follows:-

	Selector	Oscillator	O/P buffer
Osc. 1	TR1	TR4, D4, D5, L4	TR7
Osc. 2	TR2	TR5, D6, D7, L5	TR8
Osc. 3	TR3	TR6, D8, D9, L6	TR9

69. The output of the selected oscillator is amplified in TR10 and applied to:

(1) The a.g.c. stage TR13, which controls the oscillator source potential (R38 sets the a.g.c. level).

(2) The squarer stage TR11, TR12.

(3) The output buffer amplifier TR14 (potentiometer R44 sets the stage gain); the output (f4) is available at pin 20.

H.F. loop : programmed divider (fig. 16)

70. This consists of the presettable decade counters ML3, ML5, J-K flip-flops ML2B, ML9, AND gates ML4, and NAND gate ML6. ML3 is the 'units' counter and ML5 the 'tens' counter.

71. The input to the divider at ML3 pin 8 is the squarewave f1/2, derived from the selected oscillator via the squarer stage TR11, TR12 and the divide-by-two pre-scaler ML2A; the output of the divider at ML2B pin 9 is the frequency f1/2N, which is fed to one input of the phase-comparator ML7.

72. Gates ML4 and ML6A form a decoder, giving an output of logic '1' when a count of 35 is detected at the outputs of the decade counters. The output at ML4 pin 6 is applied to the 'J' input of ML2B, which is clocked by the input frequency f1/2; both Q outputs of ML2B are fed to the dual J-K flip-flop ML9 (Q to 'J', Q to 'K'), and the Q output of ML9B is fed back to the 'K' input of ML2B. The effect of this circuit is to stretch the duration of the '1' signal at the Q output of ML2B in order to enable the programmed divider to recognise the input data.

73. The $\overline{Q}$ output of ML2B is applied also to the decade counters ML3, ML5 as the strobing signal (logic '0' strobes-in the data on the input lines).

74. The divider is programmable for any division ratio in the range 40-69 by the setting of the 'MHz' frequency selection switches on the front panel; these apply the nines complement of the set figure (in BCD format), via the noise immunity board, to the data input lines of the divider.

75. Table 4 shows the operation of the divider for various representative values of 'MHz' switch setting.

TABLE 4

Operation of divider (h.f. loop)

'MHz' setting	BCD input	Clock pulses				
		(100-BCD i/p	Reset counters ML2b	Fixed count detect	ML9a and ML9b	Total (± division ratio)
00	99	1	2	35	2	40
07	92	8	2	35	2	47
14	85	15	2	35	2	54
21	78	22	2	35	2	61
29	70	30	2	35	2	69

<u>H.F. loop : phase-comparator</u> (fig. 16)

76. This consists of the dual D-type flip-flop ML7 and the NAND gate ML6A. The squarewave f1/2N from the programmed divider is applied as the clock input to one half of ML7, and the frequency f3/2 (derived from the oscillator via the divide-by-two stage ML12) is applied as the reference to the clock input of the other half. Both D inputs are connected to +5V and held permanently at logic 1. The Q outputs of both halves are applied to the inputs of NAND gate ML6A, and the output of ML6A is connected back in parallel to the 'clear' inputs of both halves of ML7. The $\overline{Q}$ outputs are applied as control inputs to the voltage-control circuit.

<u>H.F. loop : voltage-control stage</u> (fig. 16)

77. The voltage-control stage consists of transistors TR16-TR19 and associated components; the d.c. control voltage at TR19 collector is applied via R82 and r.f. chokes L21, L22, L23 to the varactor diodes D4-D9.

<u>H.F. loop: out-of-lock indicator</u> (fig. 16)

78. The Q outputs of the phase-comparator are applied to the out-of-lock indicator comprising ML8, ML10, ML11, ML12B and associated components. This circuit operates in the same way as that described in paras. 41 to 43; the purpose of ML12B is to lengthen the out-of-lock pulse at board pin 12.

HF LOOP BOARD PS.337/4

79. Some equipments are fitted with an alternative HF Loop Board type PS.337/4, in place of type PS.337/3. The circuits on the alternative board operate, in general, as described for type PS.337/3; the differences will be evident from a comparison of Fig. 16 and 17. The physical differences between the boards are shown in Fig. 15.

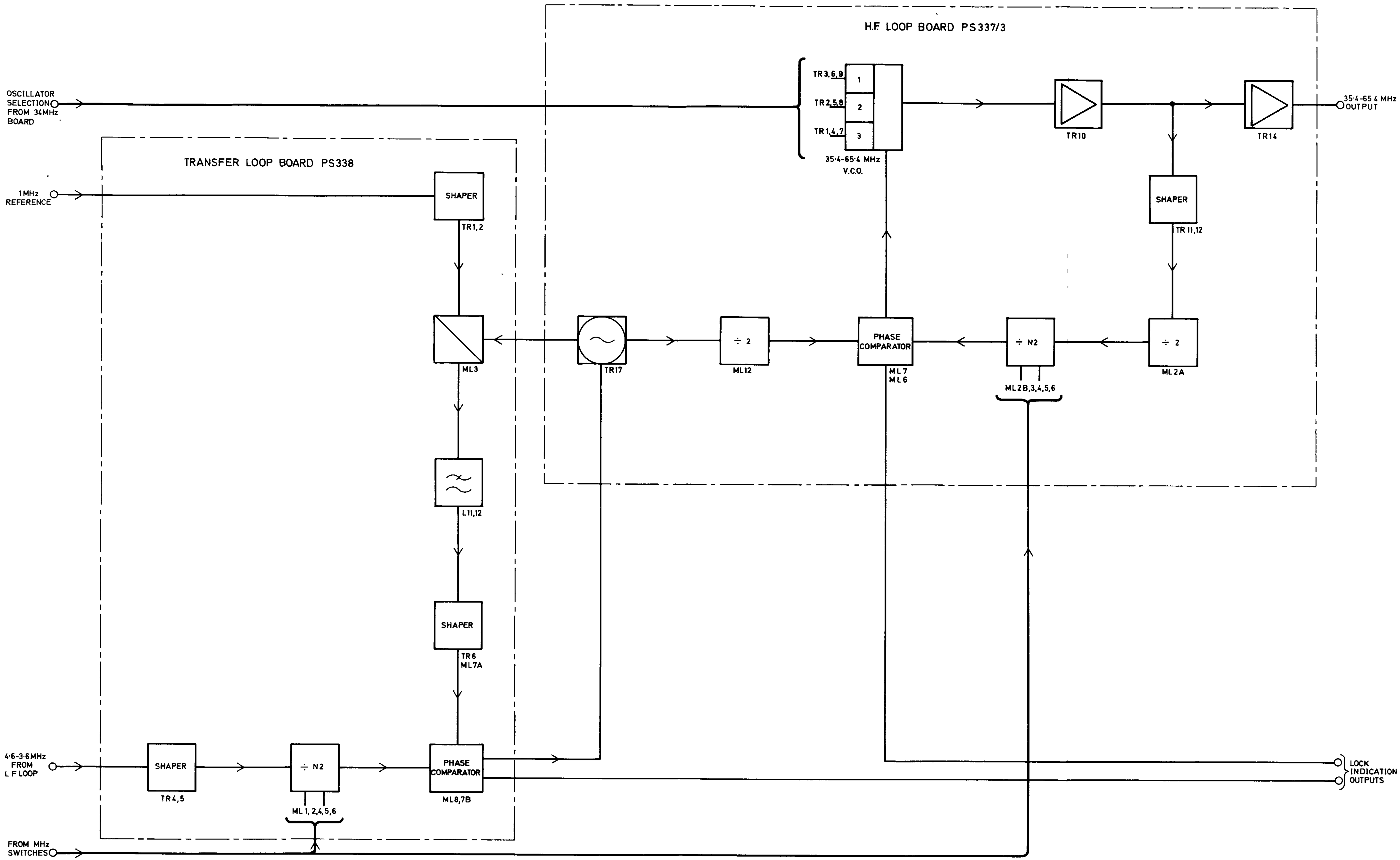


Fig.5

Transfer loop PS338 and h.f. loop PS337/3: block diagram

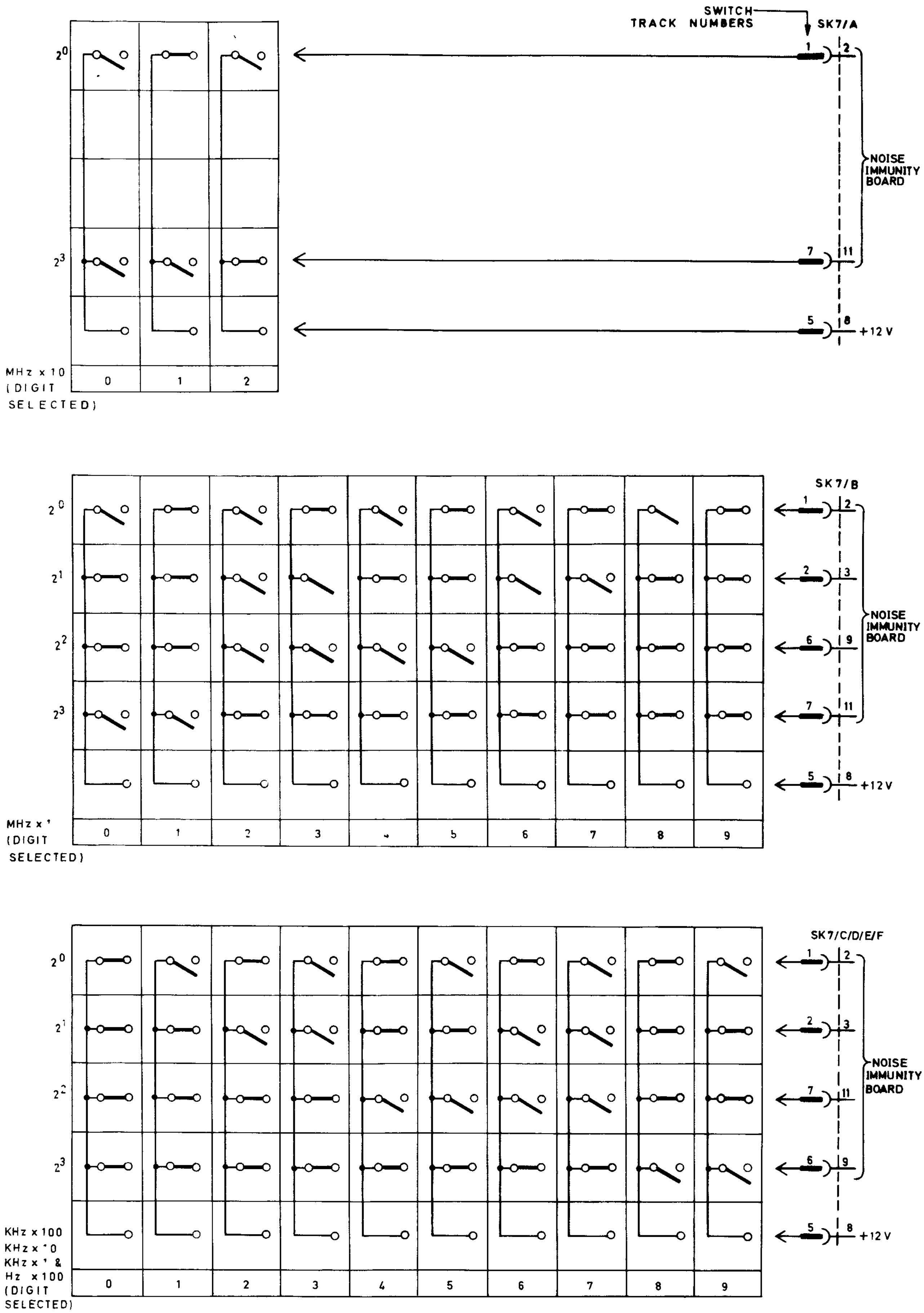


Fig.6 Frequency selection switches: circuit

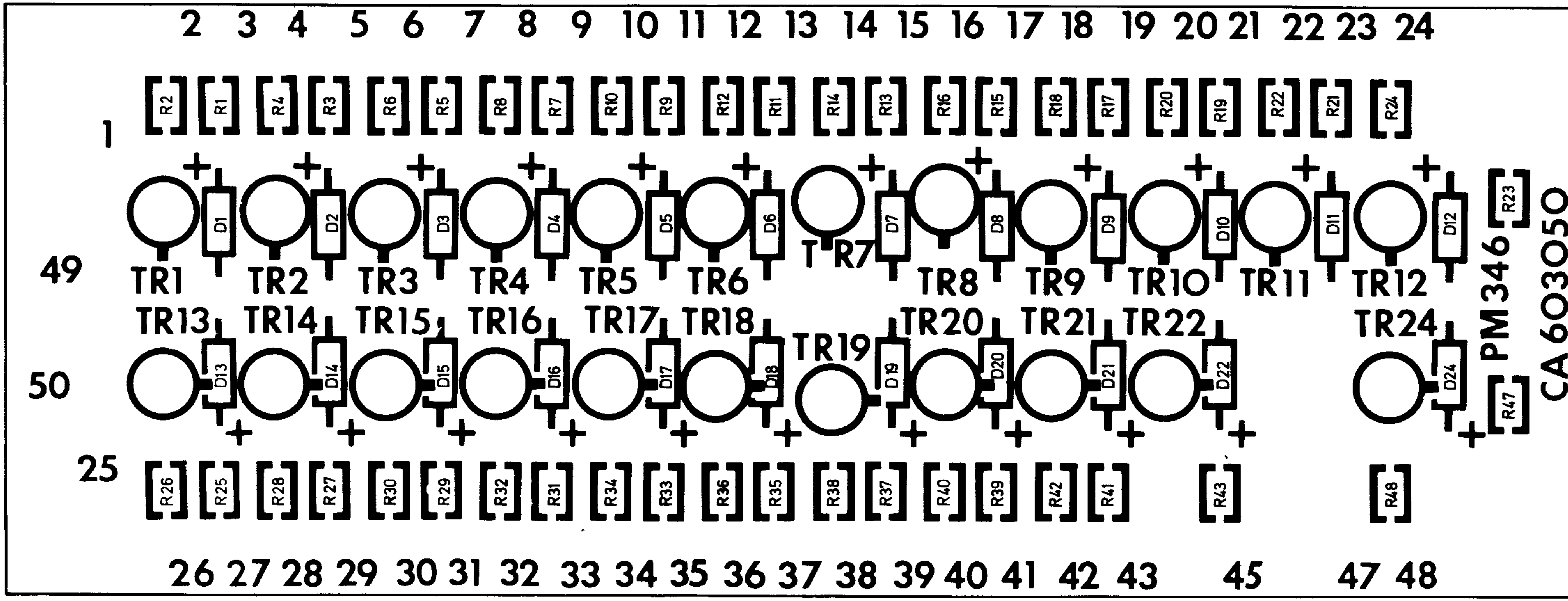


Fig. 7

Noise immunity board PM346: component layout

Fig. 7

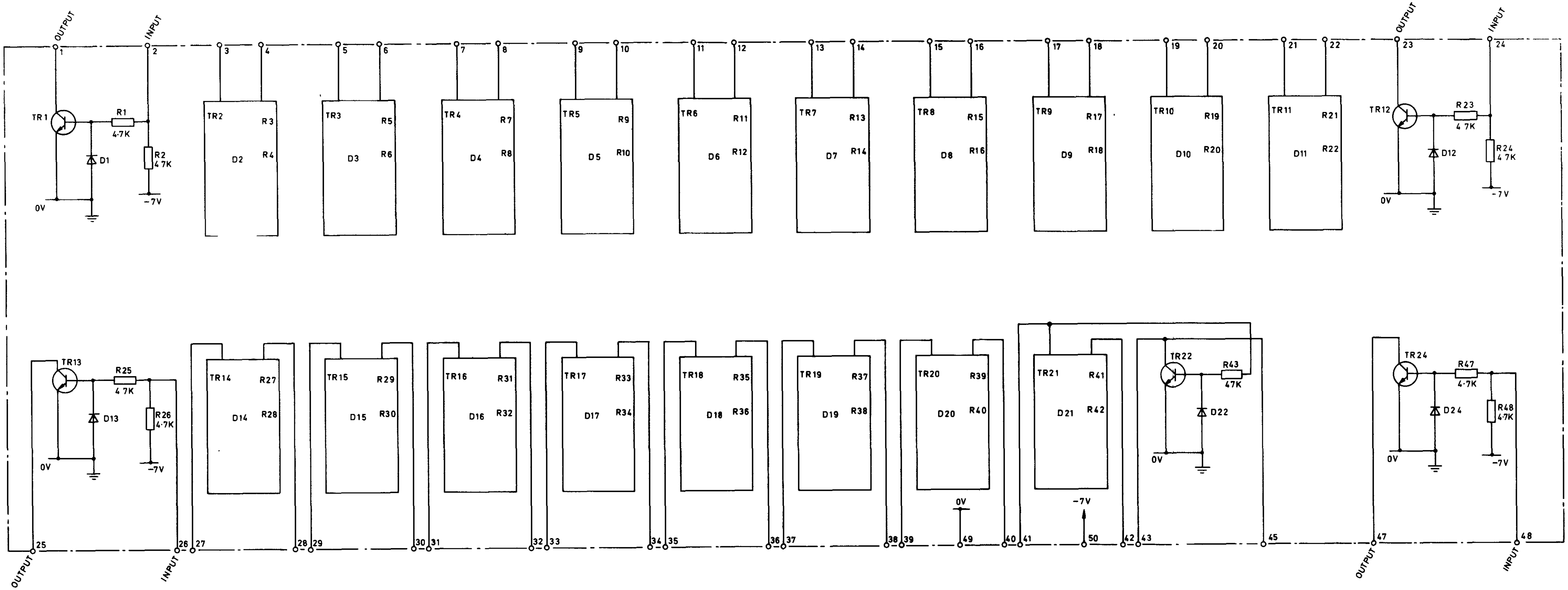


Fig. 8

Noise immunity board PM346: circuit

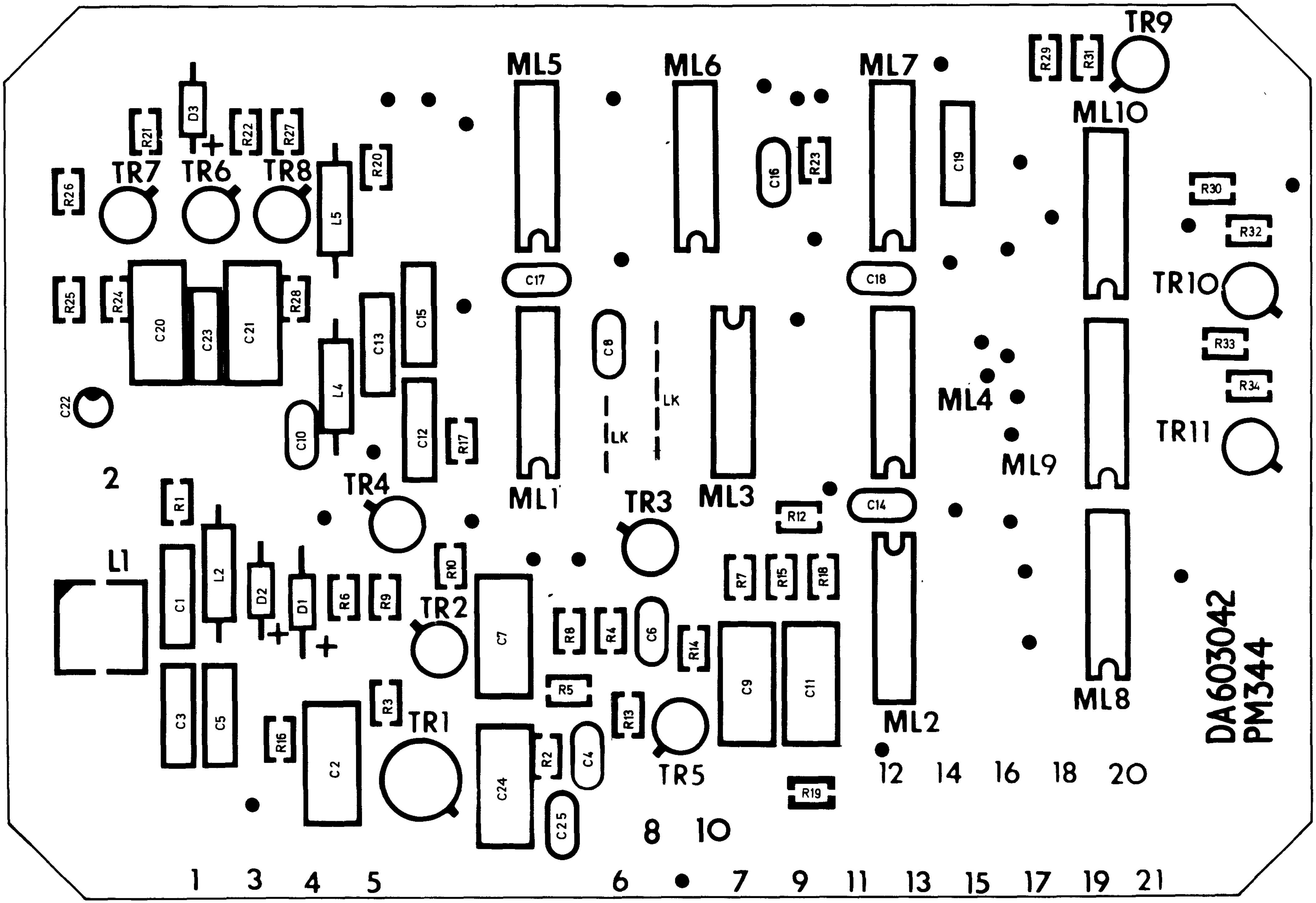


Fig. 9 34MHz generator board PM344: component layout Fig. 9

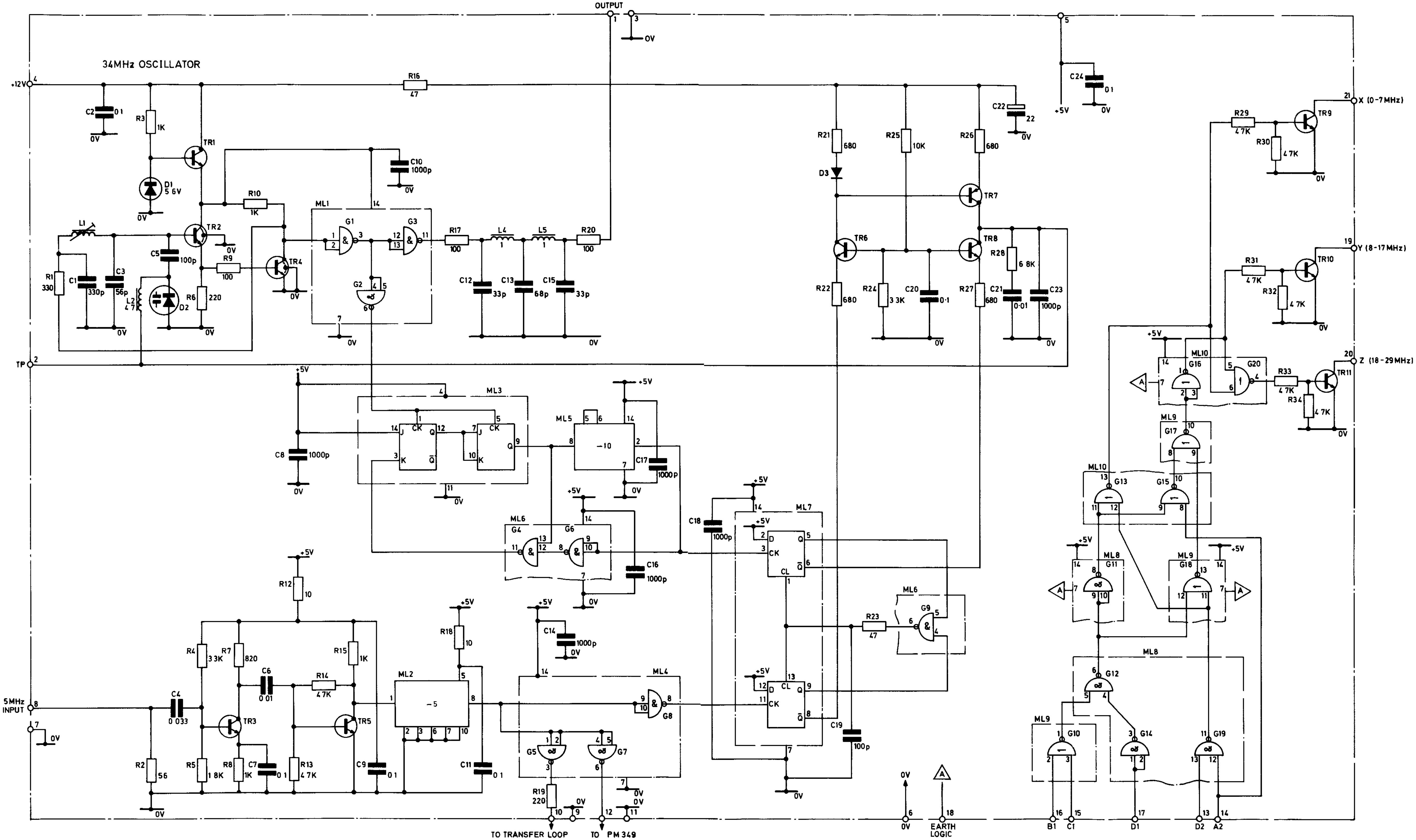


Fig. 10

34MHz generator PM344: circuit

Fig. 10

AL3 April 75

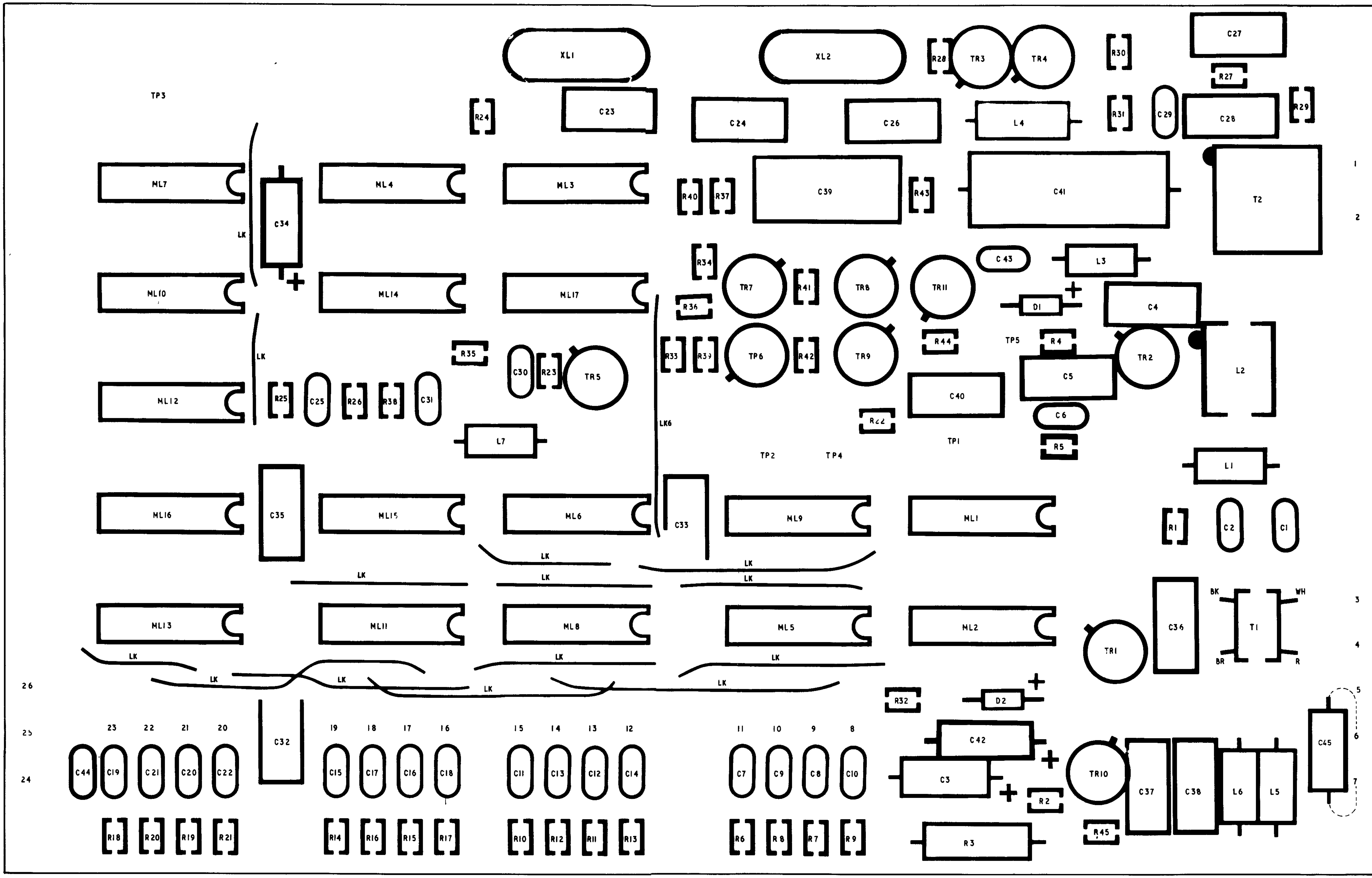
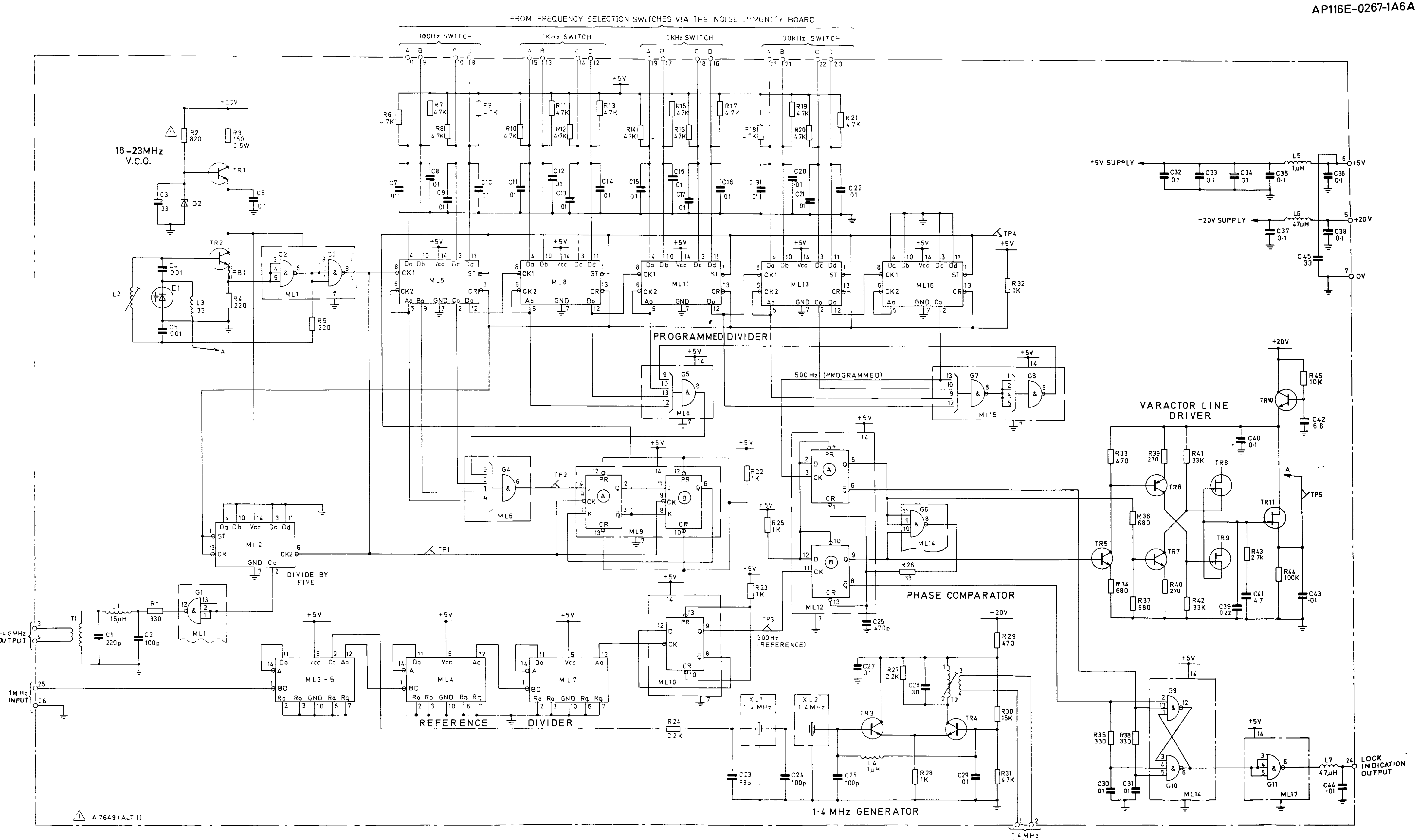
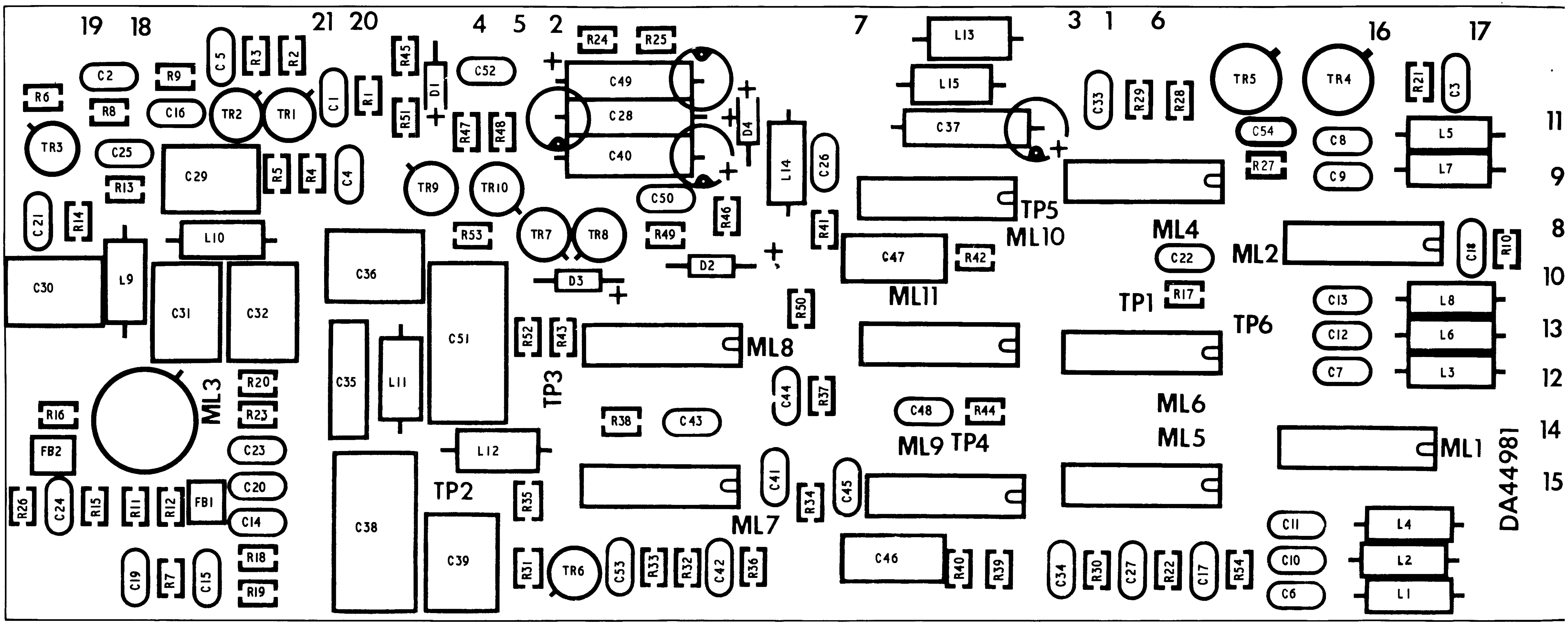


Fig 11 L.F loop board PM349: component layout Fig 11



L.F loop board PM349: circuit



Transfer loop board PS338: component layout

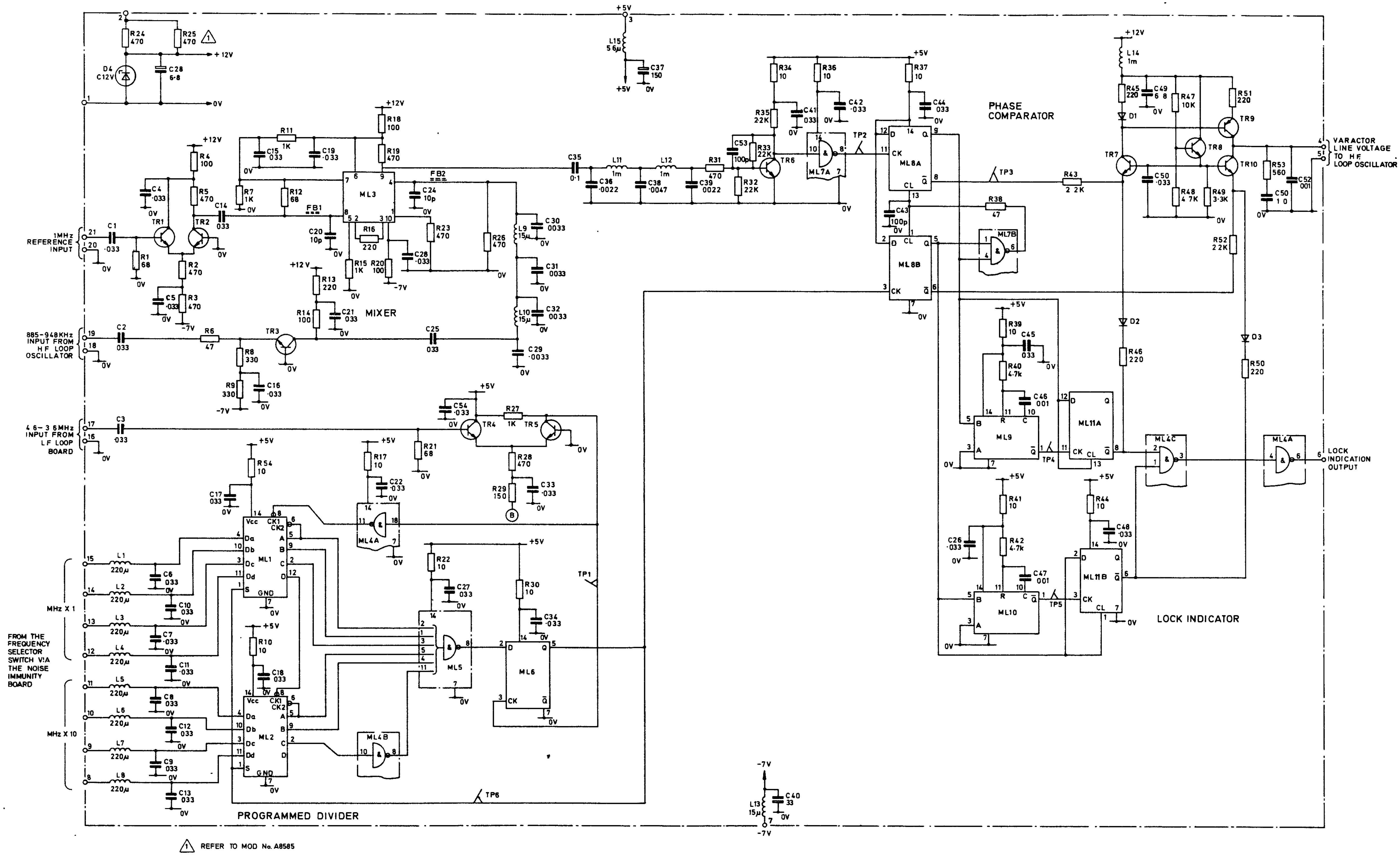


Fig. 14 Transfer loop board PS338 : circuit Fig. 14

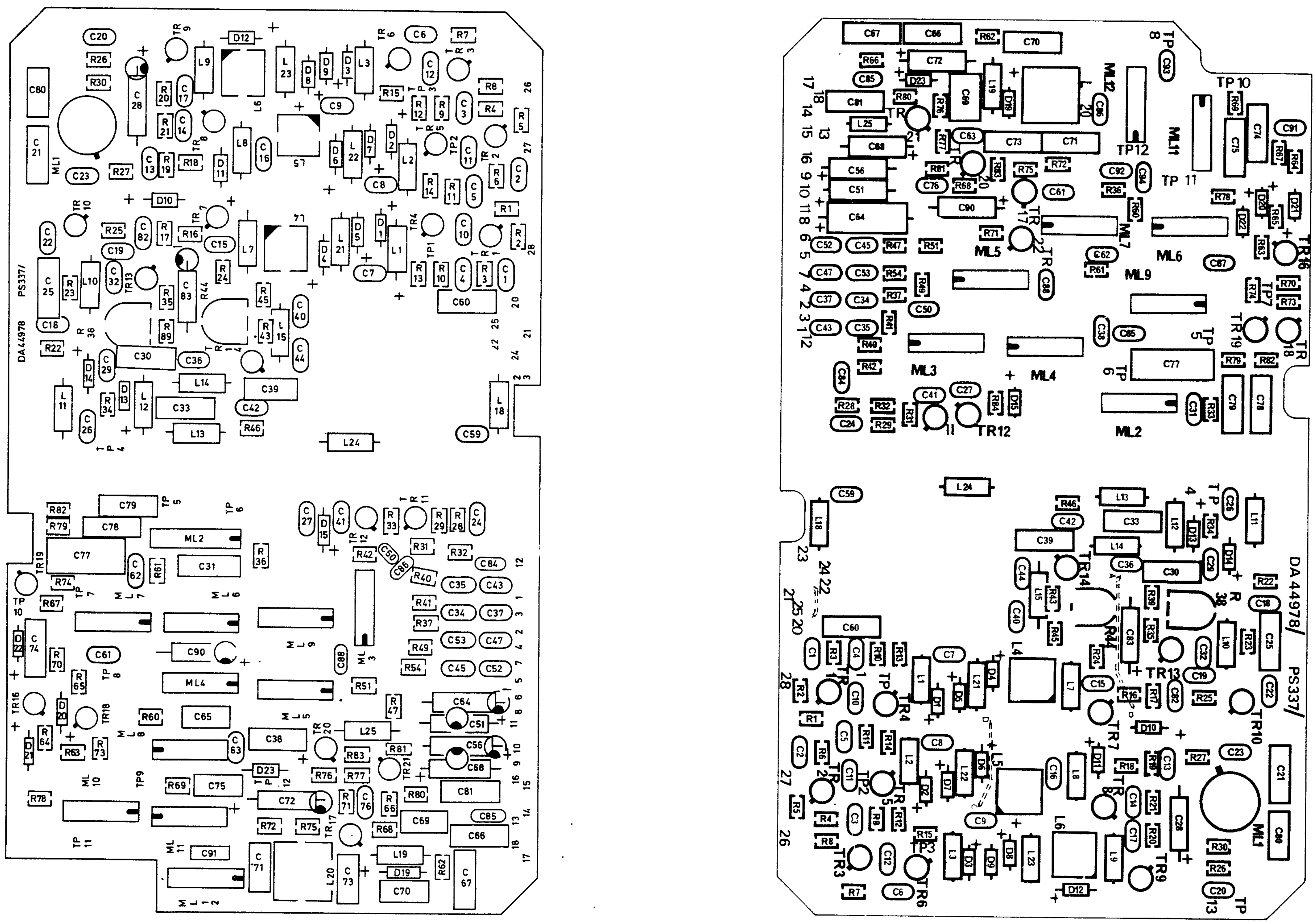


Fig. 15 HF loop boards PS 337/3 and PS337/4: component layouts Fig. 15

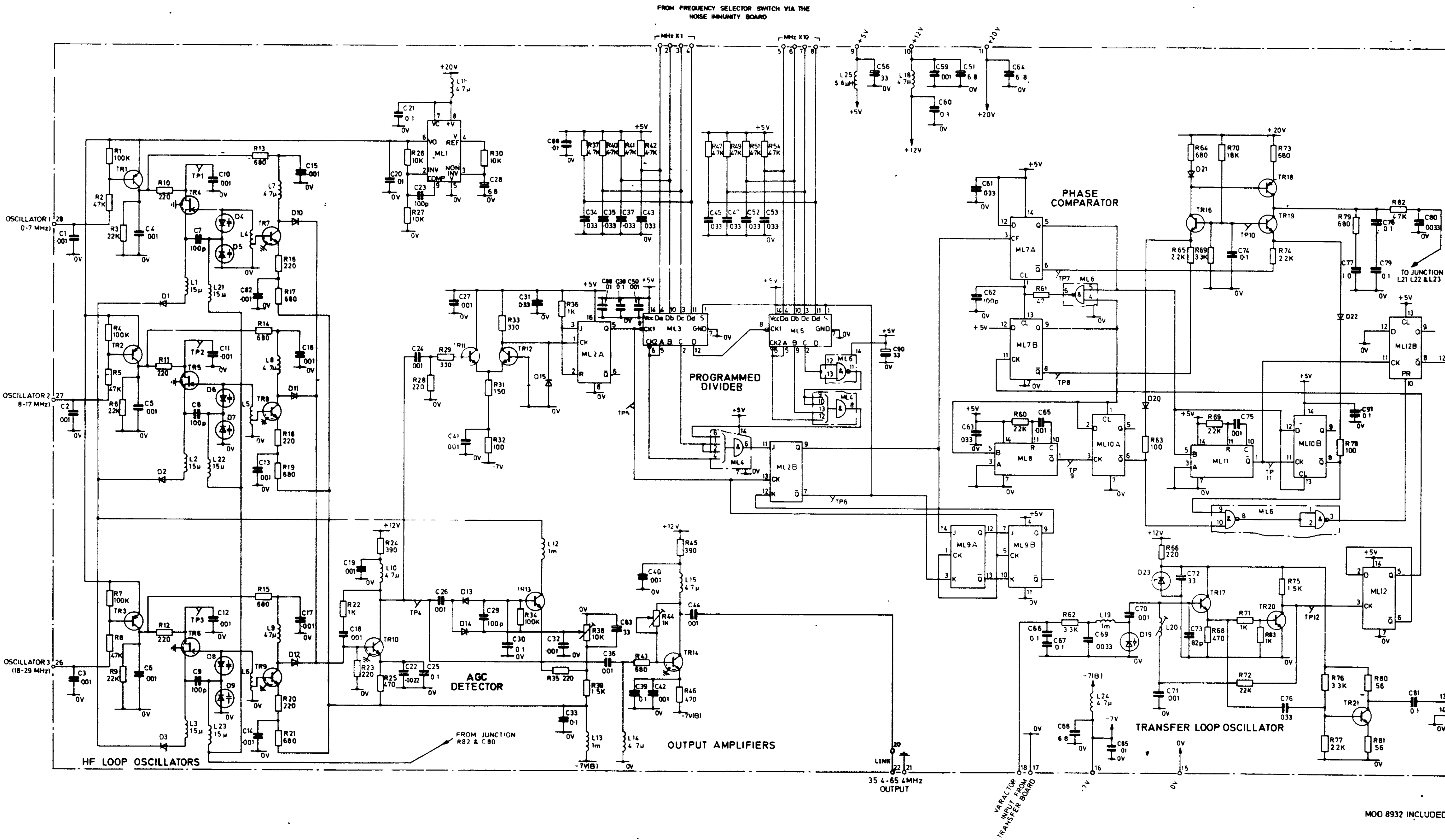


Fig. 16 HF loop board PS337/3: circuit Fig 16

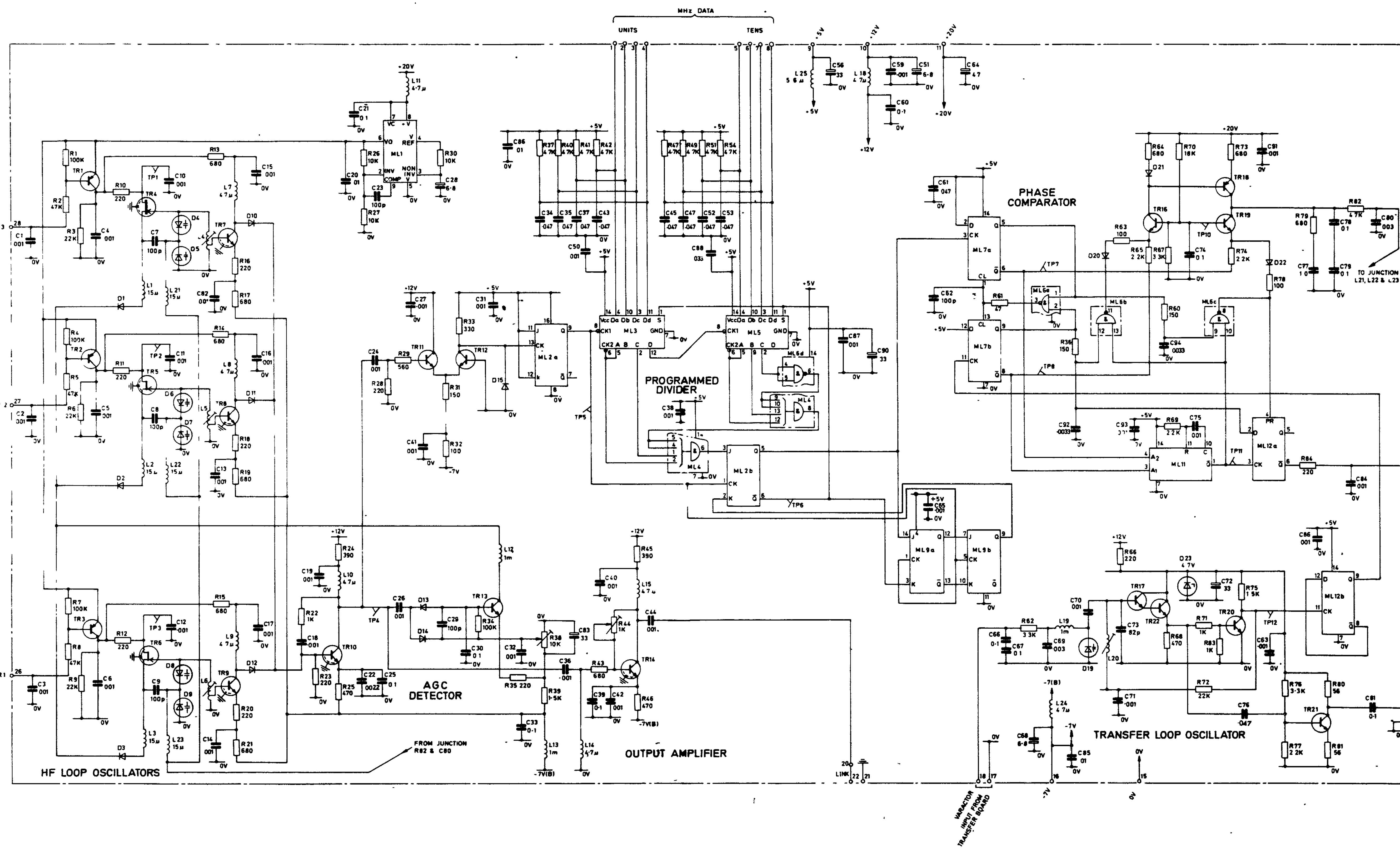


Fig. 17 HF loop board PS 337/4: circuit Fig. 17

Chapter 2-5-2

CIRCUIT DESCRIPTION OF A.F. AND R.F. STAGES:

DRIVE UNITS, TRANSMITTER

10D/5820-99-624-5395 (MA.1720A)

AND

10D/5820-99-631-8611 (MA.1720S)

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INTRODUCTION

WARNING

A. RACAL MA1720 DRIVE UNITS ARE NOT TO BE LIFTED OUT OF THEIR EQUIPMENT RUNNERS UNLESS THE UNIT IS BEING REMOVED FROM THE CABINET AND THEN ONLY BY TWO TRADESMEN.
AFTER EMBODIMENT OF MODIFICATION TC 0088 IT WILL BE NECESSARY TO REMOVE TWO BLANKING PLATES FROM THE RUNNERS TO FACILITATE REMOVAL OF DRIVE UNITS. (RAF LOCKING ONLY).

B. AT NO TIME ARE PERSONNEL TO BE PERMITTED TO WORK BELOW A UK/FRT 618 TRANSMITTER SUB-ASSEMBLY WHICH HAS BEEN WITHDRAWN OUT OF THE CABINET ON ITS EQUIPMENT-RUNNERS, EG. RACAL MA1720 DRIVE UNIT. THIS IS TO MINIMISE THE POSSIBILITY OF THE EXTENDED SUB-ASSEMBLY SLIPPING, FALLING AND INJURING PERSONNEL WORKING BELOW.

C. TRADESMEN ARE TO SATISFY THEMSELVES, BY PHYSICAL EXAMINATION, THAT WHEN A SUB-ASSEMBLY, EG. RACAL MA1720 DRIVE UNIT IS FULLY WITHDRAWN OUT OF ITS UK/FRT 618 TRANSMITTER CABINET, ALL LOCATING-LUGS AT THE SIDE OF THE SUB-ASSEMBLY ARE SECURELY LOCATED IN THE EQUIPMENT RUNNERS.

1. This chapter contains a circuit description of those boards in the drive unit which have the audio amplifier stage, the low-level modulation stage, r.f. mixing and low-level r.f. amplifier stages.

2. The a.f. and r.f. stages are identical in the two drive units but for the sideband filters which have a bandwidth of 3 kHz (MA.1720A) or 3.4 kHz (MA.1720S).

3. The two relevant boards are as follows:

(1) Low-level board PM.341.

(2) Mixer and output board PM.342

4. The remaining ancillary boards in the drive unit are described in Chap. 2-5-3 which includes the control board PM.345 and the front-panel switch and indicator wiring. It may be necessary to make cross-references to this chapter during the course of the following descriptions, and also to the flow circuits and interconnection diagrams contained in Chap. 2-0.

LOW-LEVEL BOARD PM.341 (fig. 1 and 3)

5. The low-level board processes all the audio and key input signals to the drive unit and produces a modulated output of 1.4 MHz which is translated to the final output frequency by the mixer and output board. The board also contains the necessary attenuation circuits and relay drivers for selection of the required sideband filters. The block diagram in fig.1 is largely self-explanatory and is also an aid to understanding fig. 3.

Keyed mode

6. The drive unit generates a keyed output, by keying a 1 kHz oscillator, which is then applied to one of the balanced modulators. When either the key or c.w. position is selected on the front panel, +12V is applied to the board via either pin 45 or 46, thus turning on TR9 and thence TR14, connecting +12V to the tone insertion oscillator. A +12V supply is also connected to TR1 via D18 and D12, turning on TR1 thus switching off the -7V regulator transistor TR3 and muting the channel 1 audio amplifier.

7. The keying input to the board is direct keying on pins 44 and 43; a closed key connects pins 44 and 43 and takes TR15 base to 0V. TR15 collector rises towards +12V, producing the following results:

(1) It switches on TR18, connecting the output of the L-C audio oscillator TR19 into the main audio path via R59, C29.

(2) It operates the mute delay circuit TR20-TR26. In the 'normal' state, C40 is charged to approximately 6.5V and thus TR25 and TR26 are conducting, giving a 0V output to the 'OR' gate on the control board and muting the output. Upon initiation of keying, TR20 and TR22 are turned on, discharging C40 rapidly to 0V via R84; this turns TR25 and TR26 off, allowing the collector to rise to +12V which is applied to the control board to demute the exciter. Upon cessation of keying, TR20 and TR22 are turned off, C40 charges towards +12V via R83, and when the potential on the base of TR25 reaches 6.5V, TR26 turns on taking pin 47 to 0V to mute the exciter. This ensures that so long as keying is not suspended for more than 2 seconds the exciter and any associated equipment remain active, but after this period of time they are automatically muted.

Tone oscillator

8. The tone insertion oscillator (1 kHz) consists of a tuned transformer (T1) coupled oscillator; feedback is provided by R68 and R69 in the emitter circuit of TR19; R69 provides adjustment of the feedback level. Output level adjustment is provided by R65.

RTTY mode

9. The RTTY facility is not incorporated in either the MA.1720A or MA1720S drive units.

Audio mode

10. The audio input is fed onto the board at pins 41 (audio 1) and 35 (audio 2), and is routed to pins 38 (32) via front-panel level-control potentiometers; from there the inputs are applied to similar a.f. amplifiers.

11. The audio 1 input at pin 38 drives the differential amplifier TR10, TR12 via the phase splitter TR6. The output at TR12 collector is applied to amplifier ML1, which has a gain of approximately 200 times; a.g.c. action is provided by TR16 and diodes D13, D17. A sample of the audio output from ML1 is detected by D19, D23 and the resulting signal is used to control the current through TR16 and thus through D13 and D17; as the effective impedance of D13 and D17 is dependent upon the current flowing through them, this controls the overall gain of the amplifier. A potential of -3V is required on TR16 base to turn it on, and to set the output level from the amplifier at approximately 4.5V p-p.

12. The output of ML1 is applied to the level control gates (TR28 and 32) via the 'channel 1 gain' potentiometer R73. The level control gates are brought into operation when reinserted carrier modes are selected in order to reduce the gain of the audio channel, thus preserving a constant p.e.p. level at the output.

13. The audio 2 input is similarly processed in the circuit comprising ML2 and associated components, and is applied to a 16 dB level gate via potentiometer R75.

VOX mode

14. VOX operation is available on channel 1 on single sideband modes. A sample of the output from ML1 is applied via the 'VOX sensitivity' potentiometer R79 to the amplifier TR23, TR24, the output of which operates the Schmitt trigger TR27, TR29. The output of the Schmitt switches TR33 in the mute delay circuit TR33-TR39, which operates in the same fashion as the c.w. mute delay circuit, giving a fast attack, and a 2-seconds decay time.

Production of 1.4 MHz first i.f.

15. The 1.4 MHz signal, derived from the reference oscillator, is fed onto the board at pin 16 at a level of about 0 dBm and applied to the a.g.c. amplifier TR43-TR46, which stabilises it at a level of 250 mV r.m.s. From pin 16 the signal is passed into a variable attenuator formed by R133 and TR40, the output of which is amplified by TR43 and TR44. The signal at the emitter of TR44 is amplified by TR45 and detected by D35 and D36; the resultant d.c. signal is amplified in TR46 and then applied to TR40, thus controlling the overall gain of the amplifier. The output level is adjustable by R149, and

is set to be exactly 250 mV r.m.s. at TP5. The low-impedance output from TR44 emitter is applied in parallel to:-

(1) The balanced modulator stages TR41, D33, TR47 (channel 1) and TR42, D34, TR48 (channel 2).

(2) The 1.4 MHz carrier insertion stage TR49-TR52.

16. The output from channel 1 level gates is amplified in TR34, TR37, and the low-impedance output from TR37 emitter may be applied to either of the balanced modulators according to the state of RLA and RLB. The channel 2 modulating input at TR35 base is amplified in TR35, TR38; the low-impedance output from TR38 is applied to the channel 2 balanced modulator when the i.s.b mode is selected. The gain in channel 2 is set to be 6 dB down on that of channel 1.

17. The outputs of the balanced modulators are routed via band-pass filters to the input of the feedback summing amplifier TR55, TR57 where the 1.4 MHz carrier frequency is re-inserted (via the amplifier and switch TR51) to form the first i.f. of 1.4 MHz; this is fed off the board at pin 10 at a level of 0 dBm. D45, D46, D47 form a limiter circuit arranged to operate when the level on TP6 is about 9V p-p (output level of +2 dBm) to prevent overloading of the following stages.

Attenuation stages

18. Attenuation gates are provided as follows, energized by +12V d.c. inputs to pins 26 (6 dB), 23 (16 dB) and 20 (26 dB).

(1) 6 dB gates:

(a) TR28, shunting the channel 1 modulating input to TR34 (attenuates signal by 6 dB).

(b) TR54, shunting the 1.4 MHz output from TR51.

(2) 16 dB gates:

(a) TR32, shunting the channel 1 modulating input to TR34 (attenuates signal by 1.5 dB).

(b) TR30, shunting the channel 2 modulating input to TR35.

(c) TR60, shunting the 1.4 MHz output from TR51.

(3) 26 dB gate: TR53, shunting the 1.4 MHz output from TR51.

19. The 'tune' attenuator TR61 is energized by +12V d.c. at pin 27, and shunts the 1.4 MHz output from TR51. Its attenuation may be adjusted by means of R204.

20. When any of the above attenuation gates are selected, +12V is applied to the base of TR49 via the appropriate diode in the chain D37-D41 and the base resistor R166. TR49 will switch on, switching off TR50 which will switch on TR52. This action will switch on the 1.4 MHz amplifier TR51, and the 1.4 MHz signal will be applied via the amplifier to the appropriate attenuator gate. The gain of this stage is controlled by R184.

Relay driver stages

21. Relays RLA and RLB are driven by TR21 and TR31 respectively; their contacts control the routing of the modulating inputs to the balanced modulators.

22. When the l.s.b. mode is selected by applying +12V to pin 30, RLA in TR21 collector is energized and contact RLA1 routes the channel 1 input to the channel 2 modulator, the output of which is taken to the u.s.b. filter.

23. When the u.s.b. mode is selected, both relays are de-energized and the channel 1 input is routed via the channel 1 modulator to the l.s.b. filter.

24. When the i.s.b. mode is selected, RLB is energized via TR31; RLA is de-energized, and the channel 1 input therefore generates the upper sideband while the channel 2 input generates the lower sideband.

Auxiliary control inputs

25. The auxiliary control functions are summarised in Table 1.

TABLE 1

Control functions on low level board

Control input	Operation on application of +12V
Full power (pin 9)	Sets the output to maximum by switching on TR58 and setting the gain of the output amplifier to maximum.
Low power (pin 8)	Switches on TR59 and TR56 allowing output level to be adjusted by R190; this enables the output level to be set between 0 dB and -7 dB down on the normal level.
- 6 dB (pin 26)	Turns on 1.4 MHz switch (TR51) via D39; operates 1.4 MHz 6 dB gate (TR54), and 6 dB audio gate (TR28).
-16 dB (pin 23)	Turns on 1.4 MHz switch (TR51) via D37; operates 1.4 MHz 16 dB gate (TR60), and 16 dB audio gates (TR30, TR32).
-26 dB (or -20 dB) (pin 20)	Turns on 1.4 MHz switch (TR51) via D40; operates 1.4 MHz 26 dB gate (TR53).
I.S.B. (pin 29)	Operates RLB (TR31) and 6 dB audio gate via D26.
Tune (pin 27)	Mutes audio by turning off -7V regulator (TR3) via D28. Turns on 1.4 MHz switch (TR51) via D41; operates tune gate (TR61) allowing tune level to be set by R204. Also operates full-power gate (TR58) via D51, and inhibits low-power gate.
L.S.B. (pin 30)	Operates RLA (TR21).
RTTY ON (pin 21)	Not applicable.

TABLE 1 (cont.)

Control input	Operation on application of +12V
C.W.-6 (pin 45)	Switches on the tone-insertion oscillator by turning on TR14 via D4 and D10. Operates 6 dB audio gate (TR28) via D1, D2, D27, and 1.4 MHz switch (TR51) via D1, D2 and D39, and 1.4 MHz 6 dB gate (TR54) via D1, D2. Also mutes audio by turning off -7V regulator (TR3) via D4, D18 and D12.
C.W. supp. (pin 46)	Switches on the tone-insertion oscillator by turning on TR14 via D3 and D10. Mutes audio by turning off -7V regulator (TR3) via D3, D18 and D12.

Meter amplifier

26. Transistors TR62-TR64 form a meter-drive circuit. The amplifier accepts audio inputs at approximately -30 dBm at pin 15 and, with diodes D48, D49 in the feedback network, provides 100 μA d.c. for full-scale deflection of the front-panel meter. R195 is for initial calibration of the meter circuit.

MIXER & OUTPUT BOARD PM.342 (fig. 5)

27. This board contains the following circuits:-

(1) First and second mixer circuits, with associated filters and amplifiers.

(2) Input amplifiers for the 34 MHz fixed and 35.4-65.4 MHz variable frequencies.

(3) Muting circuit.

Mixer and output amplifier stages

28. The 1.4 MHz first i.f. from the low-level board is fed onto the mixer and output board at pin 4 at a level of 0 dBm and into the first mixer stage T1, T2; there it is mixed with the 34 MHz stable frequency from the 34 MHz generator board to produce the second i.f. of 35.4 MHz. Unwanted frequency components are removed by the bandpass L-C filter including C7-C30, which provides 50 dB attenuation of the fundamental and 70 dB image rejection.

29. The signal is then amplified by TR7, TR8, filtered again in the crystal filter, (which reduces wideband noise into the final mixer and has a passband of ± 6 kHz centred on 35.4 MHz), and then fed into the final mixer T8, T10. There it is mixed with a signal in the range 35.4-65.4 MHz derived from the synthesizer boards, and the resulting signals are filtered by the lowpass filter L8-L10 (which has a sharp cut-off above 30 MHz). The output from the filter is a signal in the range 1-30 MHz at a level of -16 dBm; this is applied via the buffer amplifier TR14, TR15, which also incorporates a gain control R67, to the input of the five-stage wideband output amplifier TR9-TR13. The output at a level of +23 dBm is taken off the board at pin 16.

Input amplifier stages

30. The two input amplifiers, for the 34 MHz fixed frequency and the 35.4-65.4 MHz variable frequency, are similar in construction and operation.

31. The 34 MHz signal is fed onto the board via pin 7 at a level of 0 dBm and a.c. coupled into the base of the driver transistor TR1. The output of the push-pull stage TR2, TR3, is a 20V p-p sinewave to the first mixer.

32. The 35.4 - 65.4 MHz signal is fed onto the board via pin 8 at a level of 0 dBm, and a.c. coupled into the base of driver transistor TR4. The output of the push-pull stage TR5, TR6, is a 20V p-p sinewave to the second mixer.

Muting stage

33. The muting circuit TR16, TR17 controls the d.c. supply to the collectors of TR9-TR12 in the output amplifier. Transistor TR17 is normally held on by the +12V d.c. input to pin 12 from pin 5 on the control board, and TR16 is bottomed, applying +20V to the output amplifier. When TR17 base is taken down to 0V, TR16 cuts off and removes the supply to the amplifier.

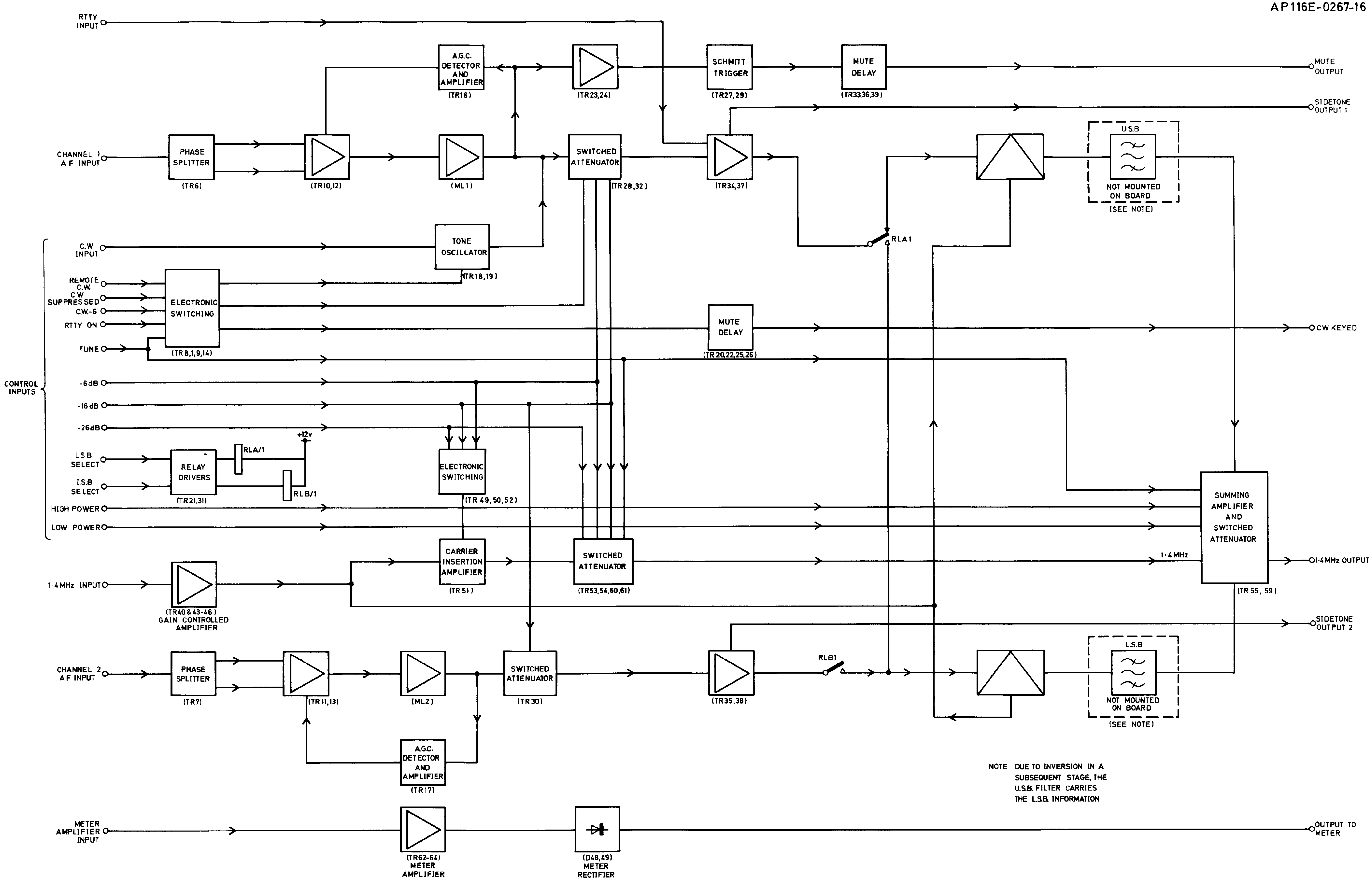
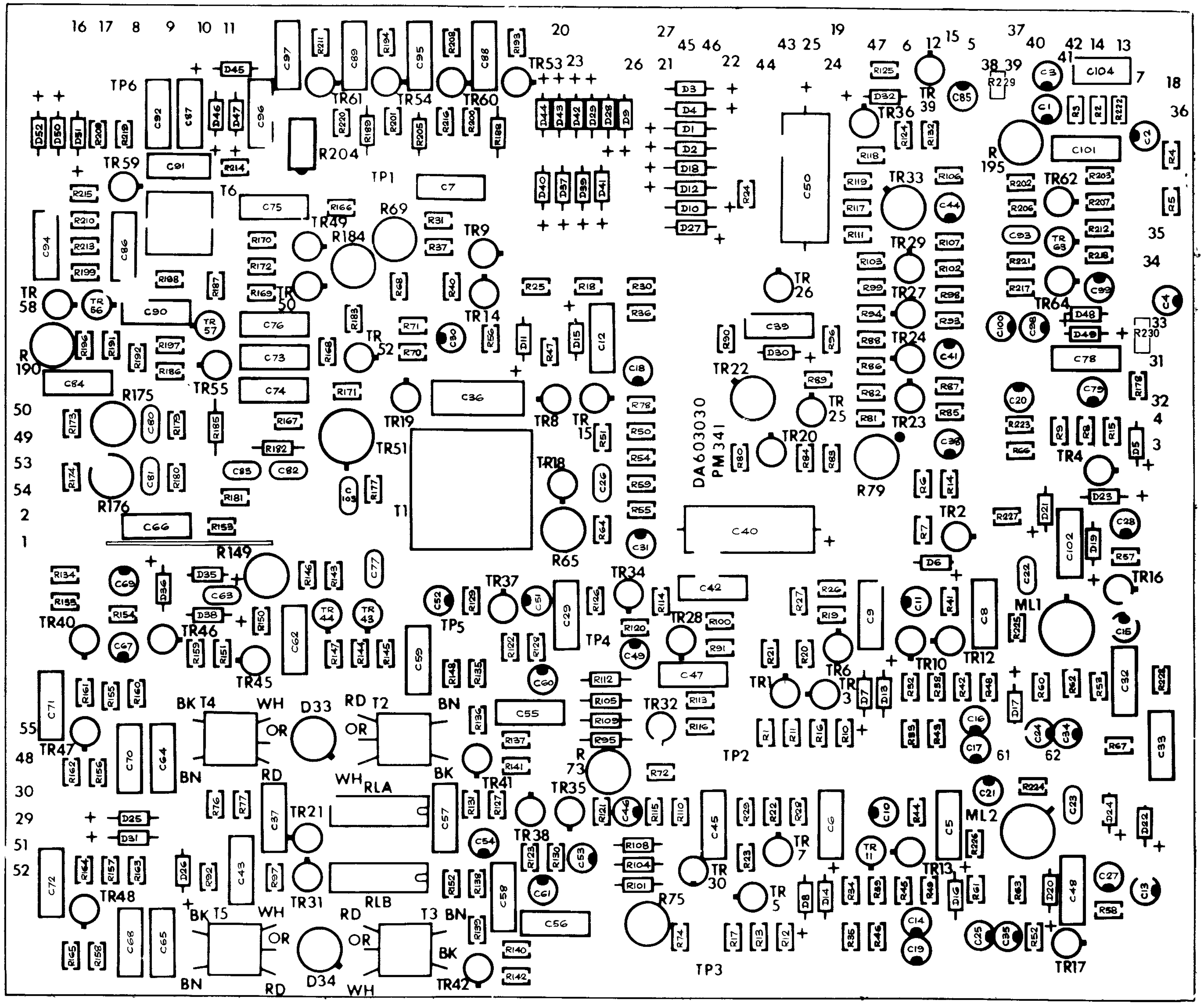


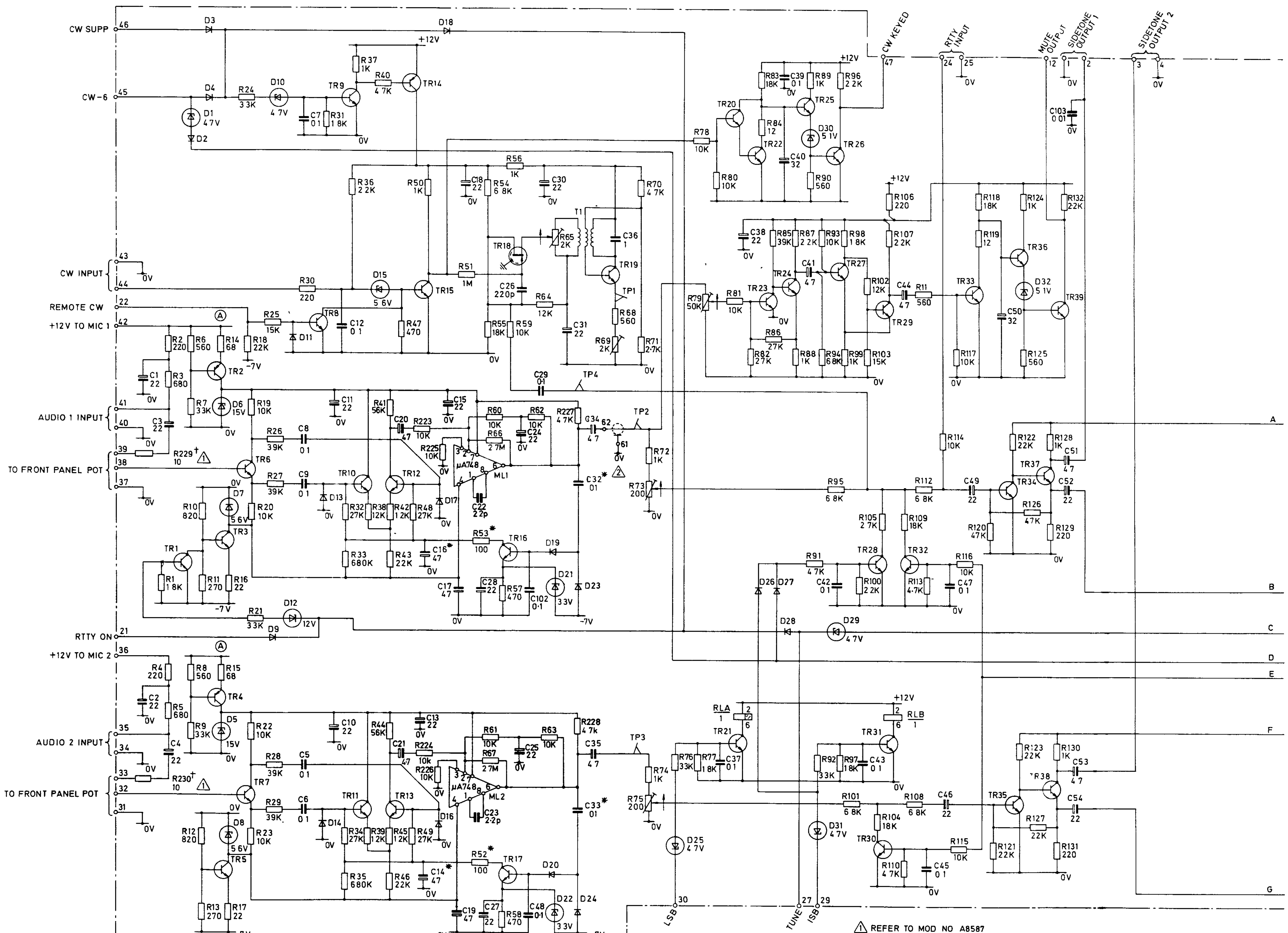
Fig.1 **Low-level board PM341: block diagram** Fig.1



NOTES R229 AND R230 ADDED BY MOD NO A8587
COAXIAL CABLE (C34) ADDED BY MOD NO A8608

Fig.2

Low-level board PM341: component layout



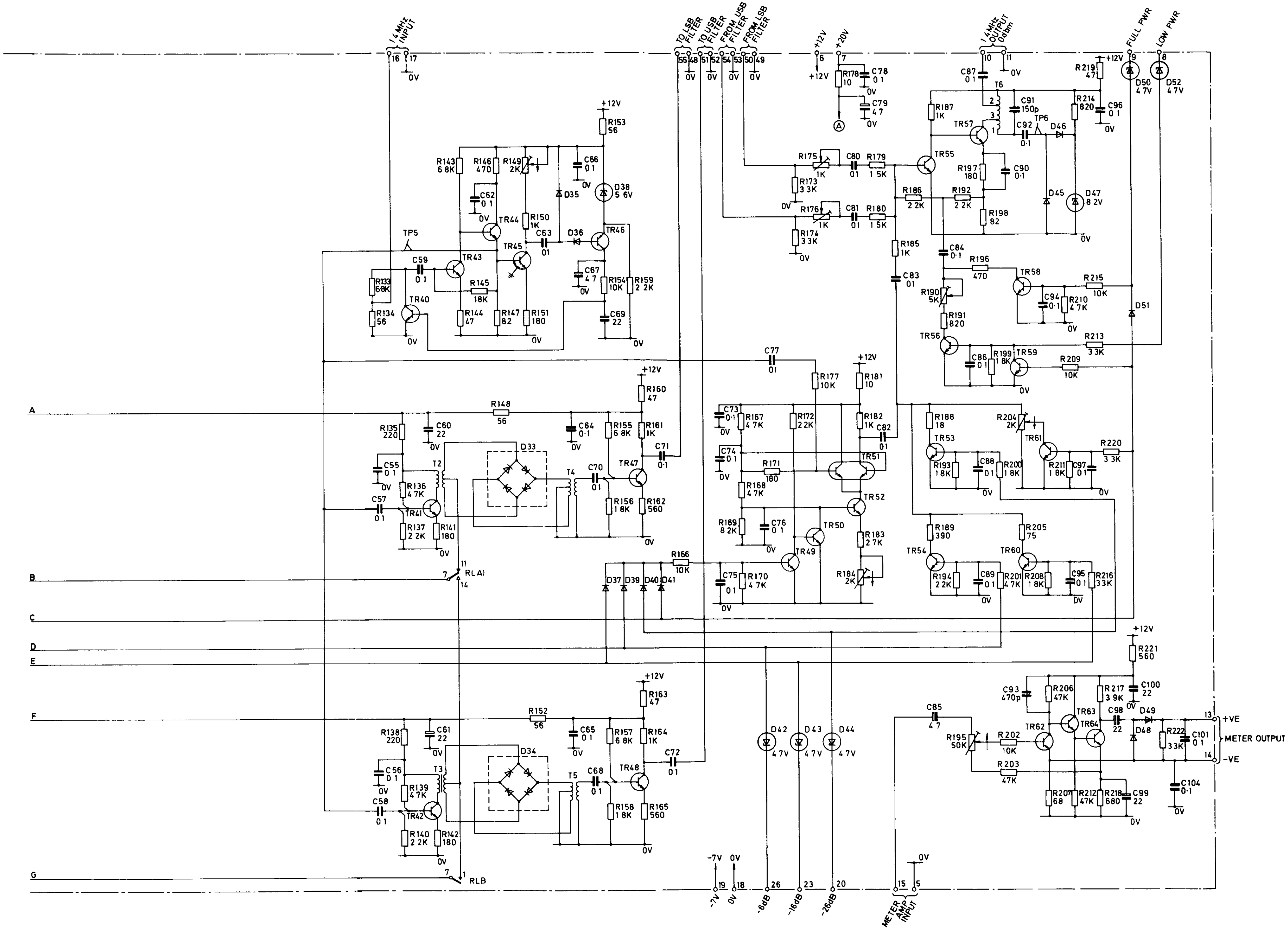
*THESE COMPONENTS ARE FITTED ONLY IN THE MA.1720 VERSIONS THAT INCLUDE AUDIO AGC
† VALUE OF R229 AND R230 IS 100K IN THE MA.1720 VERSIONS THAT DO NOT INCLUDE AUDIO AGC.

⚠1 REFER TO MOD NO A8587

⚠2 REFER TO MOD. NO A8608

Fig.3a

Low-level board PM341: circuit (sheet 1)



Low-level board PM341: circuit (sheet 2)

Fig. 3b

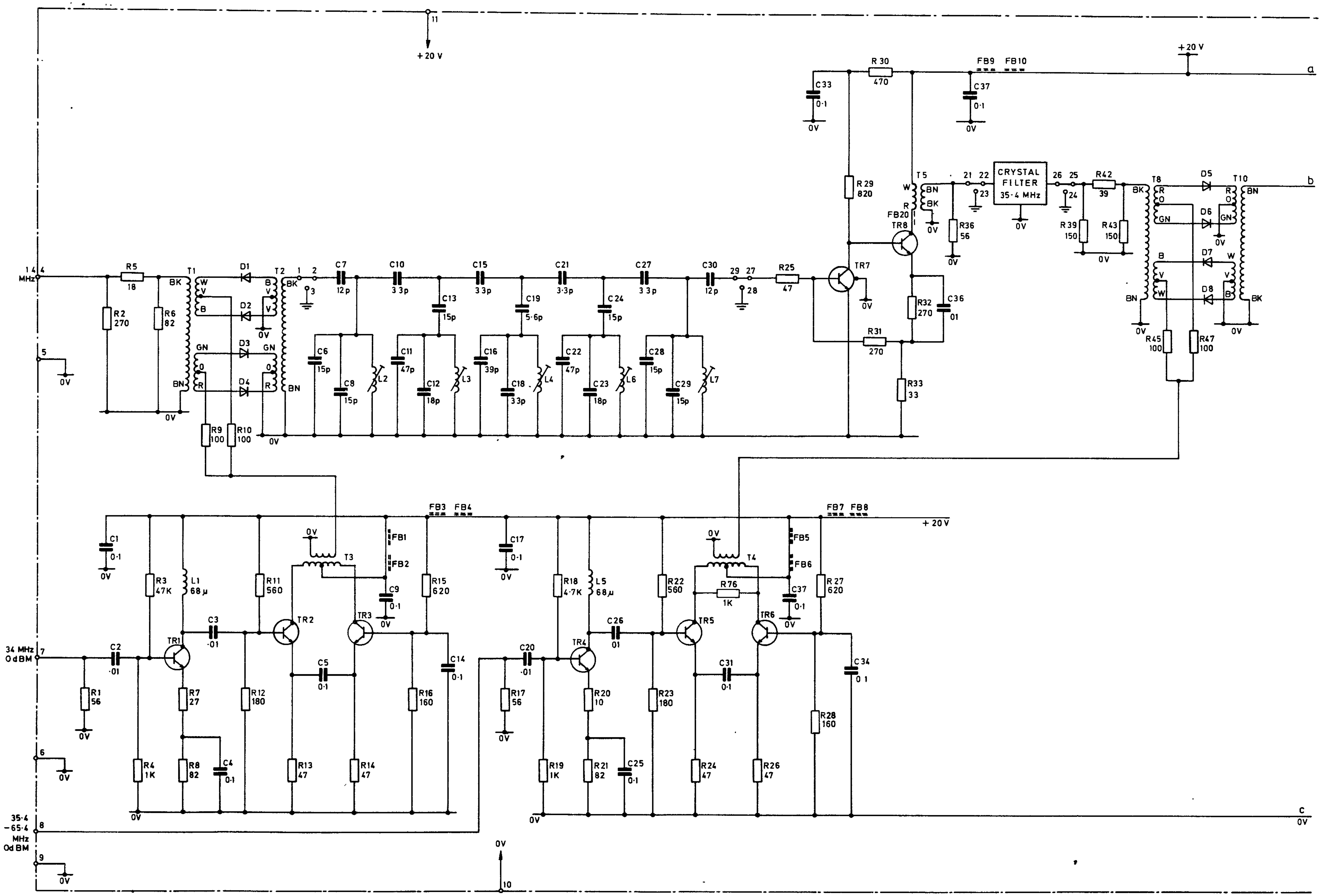
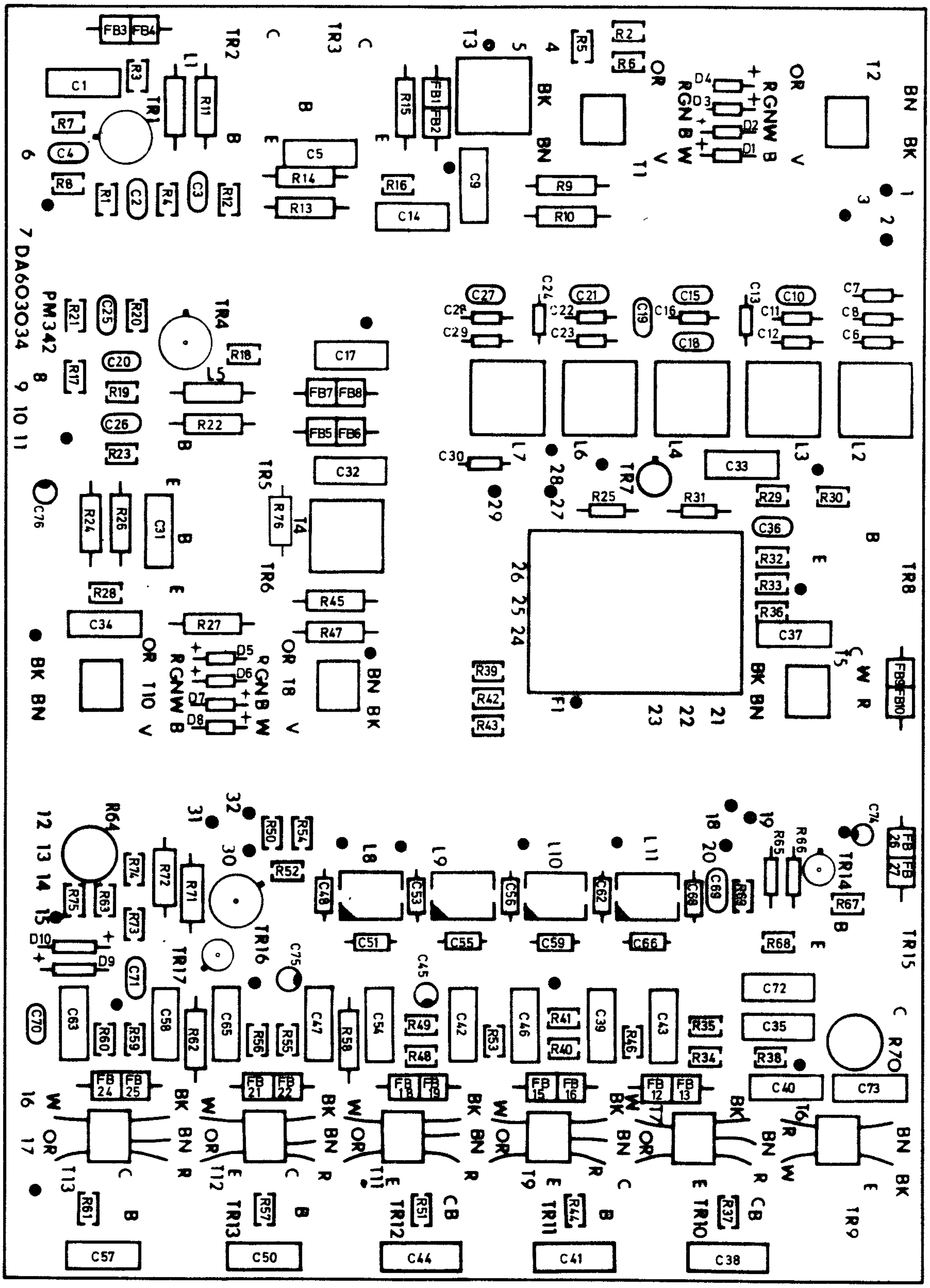


Fig. 5a Mixer and output board PM 342: circuit (sheet 1) Fig. 5a



Mixer and output board PM342: component layout

Fig. 4

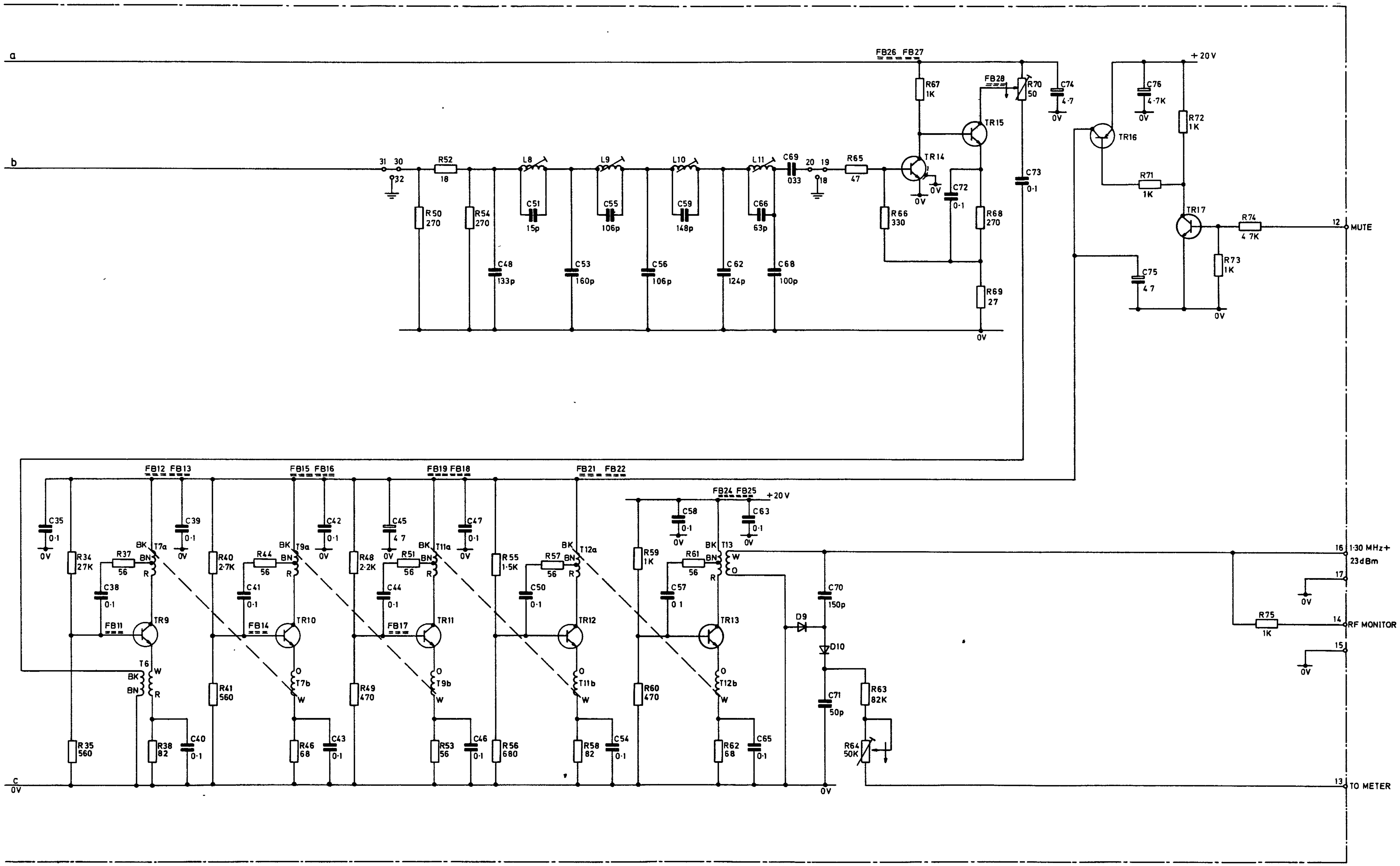


Fig. 5b Mixer and output board PM342: circuit (sheet 2) Fig.5b

Chapter 2-5-3

CIRCUIT DESCRIPTION OF ANCILLARY STAGES

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INTRODUCTION

1. This chapter contains a circuit description of the remaining ancillary boards or sub-assemblies in the drive unit; these embrace control functions and power supplies and are as follows:

(1) Front panel switches and indicators

(2) Control board PM.345

(3) Power supply unit, including power supply board PM.343

These boards and sub-assemblies are identical for both drive units.

2. In general, the control board functions are initiated by the switches on the front panel; hence, it will be necessary to cross-refer to the flow-circuits and interconnecting diagrams contained in Chap. 1. The front-panel switches also affect the operating conditions of the low-level board (Chap.8).

FRONT-PANEL SWITCHES AND INDICATORS (fig. 2)

3. In the main, the front-panel switches initiate logic command levels to solid-state switches on the following boards:

(1) Control board PM.345

(2) Low-level board PM.341 (Chap. 2-5-2)

(3) Mixer and output board PM.342 (Chap. 2-5-2)

4. The effect of the various switch positions becomes apparent when reading the description of the control board PM.345 in this chapter, the description of the low-level board PM.341 in Chap. 2-5-3 and the drive unit functional description in Chap. 1. The circuit of the frequency selection switches is given in fig. 3 of Chap. 2-5-1.

CONTROL BOARD PM.345 (fig. 4)

5. The control board logic and switching circuits accept the inputs and produce the outputs summarised in Table 1.

TABLE 1

Control board : inputs and outputs

Input/pin		Output/pin	
Reset (+12V)	29	'Reset' to Tx (+12V) Removes earth from RESET lamp Removes +12V from remote 'Reset' line	30 4 32
In-lock (+5V)	25,26,27	Earth to in-lock lamp. +12V to remote in-lock line	3 31
Mute (+12V)	24	'Mute' to mixer and output board and Tx (0V)	5
Selector switch inputs (+12V)	18,29,20,21	De-mute to mixer and output board and Tx (+12V)	5

TABLE 1 (cont.)

Input/pin		Output/pin	
Tune switch (+12V)	17	'Tune' to low level board (+12V) 'Inhibit' to mode switch (OV) 'De-mute' to mixer and output board and Tx (+12V)	11 12 5
Fault (OV)	1	Earth to RESET lamp +12V to remote 'reset' line 'Mute' to mixer and output board and Tx (OV)	4 32 5
Reduced power (+12V)	6	Earth to REDUCED POWER lamp +12V to remote 'reduced power' line	7 33
Ready (OV)	8	Earth to READY lamp +12V to remote 'ready' line 'Enable' to mode switch (+12V)	10 34 12
Standby (+12V)	13	Earth to 'standby' line	14
E.H.T.-on (+12V)	15	Earth to e.h.t.-on line	16
Power supplies +12V +5V -7V Earth Logic earth	 9 2 28 22 23		

RESET input (pin 29)

6. Pin 29 is normally open-circuit. When the RESET button on the front panel is pressed, +12V is applied to pin 29; this turns TR2 on, with the following effects:

(1) TR1 turns off, applying +12V to the linear amplifier as a 'Reset' command via pin 30.

(2) The '0' at TR2 collector is inverted by G1 and used to trigger the 2-second monostable ML4, which applies a '0' for 2 seconds to G2 and G3; this resets the latch described in paras. 18 to 20.

In-lock input (pins 25, 26, 27)

7. The inputs to these pins are derived from the lock indicators associated with each of the three phase-comparators in the frequency synthesizer, with output '1' to indicate the 'in lock' condition. When all three inputs are at '1', the output of G6 is '0'; this is inverted to '1' by G8 and applied to:

(1) TR4, which turns on and lights the 'in-lock' lamp via pin 3, and also turns TR5 on to apply +12V to the remote 'in-lock' line via pin 31.

(2) G4 in the latch circuit, leaving the latch in the 'normal' (de-muted) condition.

Mute input (pin 24)

8. Pin 24 is normally open-circuit. When MUTE is selected, +12V is applied via pin 24 to TR8, turning it on and applying '0' to one of the inputs of G9; G9 therefore gives a '1' output which turns TR9 on and applies a 'mute' command of 0V to pin 5.

Selector switch inputs (pins 17 to 21)

9. A +12V signal on any of these inputs, applied through TR12 and G10, results in a '1' being applied to G9. If there is no +12V signal present at any of these inputs, a '0' is applied to G9, which results in a 0V 'mute' command output from pin 5 via TR9.

10. A +12V signal at pin 17 (TUNE selected), applies a +12V 'tune' signal to the low-level board via D17 and pin 11; it also switches TR17 on via Zener diode D18, removing the +12V supply to the LOCAL/EXTENDED/REMOTE switch, via TR16 and pin 12, in order to prevent selection of other modes.

Fault input (pin 1)

11. In normal operation, +12V is applied to pin 1; this back-biases D1, causing Zener diode D2 to conduct via R5 and turn TR3 on, thus applying logic '0' to G2. A fault condition is signalled by 0V at pin 1, resulting in a '1' input to G2 and a '0' output. This causes the output of G5 to go to '1', lighting the RESET lamp via TR6 and pin 4 and applying +12V to the remote RESET line via TR7 and pin 32. The '1' output from G5 is also applied via G7 and G9 to TR9, producing a 0V 'mute' output at pin 5.

12. If the RESET button is now pushed, the output of G5 will change to '0' only for the 2-second period of the monostable ML4; the drive unit will therefore de-mute, and the RESET lamp will extinguish for only two seconds.

Reduced-power input (pin 6)

13. Pin 6 is normally held at 0V. When the linear amplifier is operating at reduced power, +12V is applied, turning TR10 and TR11 on. TR10 lights the 'reduced power' lamp via pin 7, and TR11 applies +12V to the remote 'reduced power' line via pin 33.

Ready input (pin 8)

14. Pin 8 is held at +12V when the system is 'not ready'. When it is 'ready', the input goes to 0V, turning TR13 off, TR14 on and TR15 on. TR14 lights the 'ready' lamp via pin 10, and TR15 applies +12V to the remote 'ready' line via pin 34; TR14 also removes the drive from TR17 via D15 and D18, turning TR16 on and applying +12V via pin 1 to the LOCAL/EXTENDED/REMOTE switch.

15. In the absence of a 'ready' input (i.e. if pin 8 is at +12V), TR14 collector is at +12V which is applied to:

(1) The 'tune' control line on the low level board via D15 and pin 11.

(2) TR12 via Zener diode D13, D14 and R34, turning TR12 on and, via G10, applying logic '1' to pins 1 and 2 of G9.

Standby input (pin 13)

16. A +12V signal is applied to pin 13 when the front panel 'Standby On' button is depressed; this turns TR18 on and applies a 0V signal to the linear amplifier via pin 14. When 'Standby' is not selected, pin 13 is open-circuit and the output at pin 14 is +12V.

E.H.T.-on input (pin 15)

17. This facility is not used in this transmitter.

Latch circuit G3/G4

18. Gates G3 and G4 form a latch which is reset by a '0' on pin 4 of G3 and tripped by a '0' on pin 9 of G4. When the synthesizer is caused to go out-of-lock by a change in the frequency setting, a fast negative pulse is applied to pin 9 of G4 (para. 7). This trips the latch, causing a '1' on pin 11 of G5; this turns TR6 on, lighting the RESET lamp via pin 4 and applying +12V to the remote 'reset' line via TR7 and pin 32.

19. The '1' on pin 11 of G5 is inverted by G7 and applied to pin 5 of G9, causing G9 to produce a '1' output; this turns TR9 on, placing a 0V 'mute' signal on pin 5. D5 in TR9 collector protects TR9 against reverse switching pulses from a muting relay (not used in this transmitter).

20. The latch G3/G4 is reset by a '0' on pin 4 of G3, applied via pin 29, TR2, G1 and the monostable ML4 when the RESET button is pushed.

POWER SUPPLY UNIT (fig. 6)

21. The power supply board, in conjunction with external transistors and resistors, stabilizes the unregulated potentials from the transformer and rectifiers.

22. The d.c. supplies produced are as follows:-

(1) Positive 20V ±2V, variable, maximum current 1.5A.

(2) Positive 5V ± 0.5V, variable, maximum current 1.5A.

(3) Negative 7V ± 0.5V, variable, maximum current 0.5A.

(4) Positive 12V ± 2V, variable, maximum current 1.5A.

23. Reference must be made to fig.8 of Chap.2-0 and fig. 1 (this Chap.) in order to locate the path from the mains input socket (rear of drive unit) via the fuse and mains on/off switching to the input of the voltage selector (fig. 6).

Power supply board PM.343

24. The four d.c. supplies are produced by four almost identical stabilizing circuits, hence, only the +5V supply is described in detail, Figure 6 shows that with the exception of large or heat-dissipating components, the majority of the components are on power supply board PM.343.

25. Each stabilizing circuit uses an integrated circuit regulator (ML1 to ML4) consisting of:-

(1) temperature compensated reference amplifier.

(2) error amplifier.

(3) series-pass transistor.

(4) current-limit transistor.

26. A simplified circuit of the regulator is shown in fig. 1. The error amplifier is used to compare the reference voltage (maximum approximately +7V) with a sample of the final stabilised output voltage (via a potential divider if greater than the reference voltage) and the output of the error amplifier is then used to control the series-pass transistor. This transistor is also controlled by a current limiting stage which itself is controlled by the current drawn from the supply by the external circuit

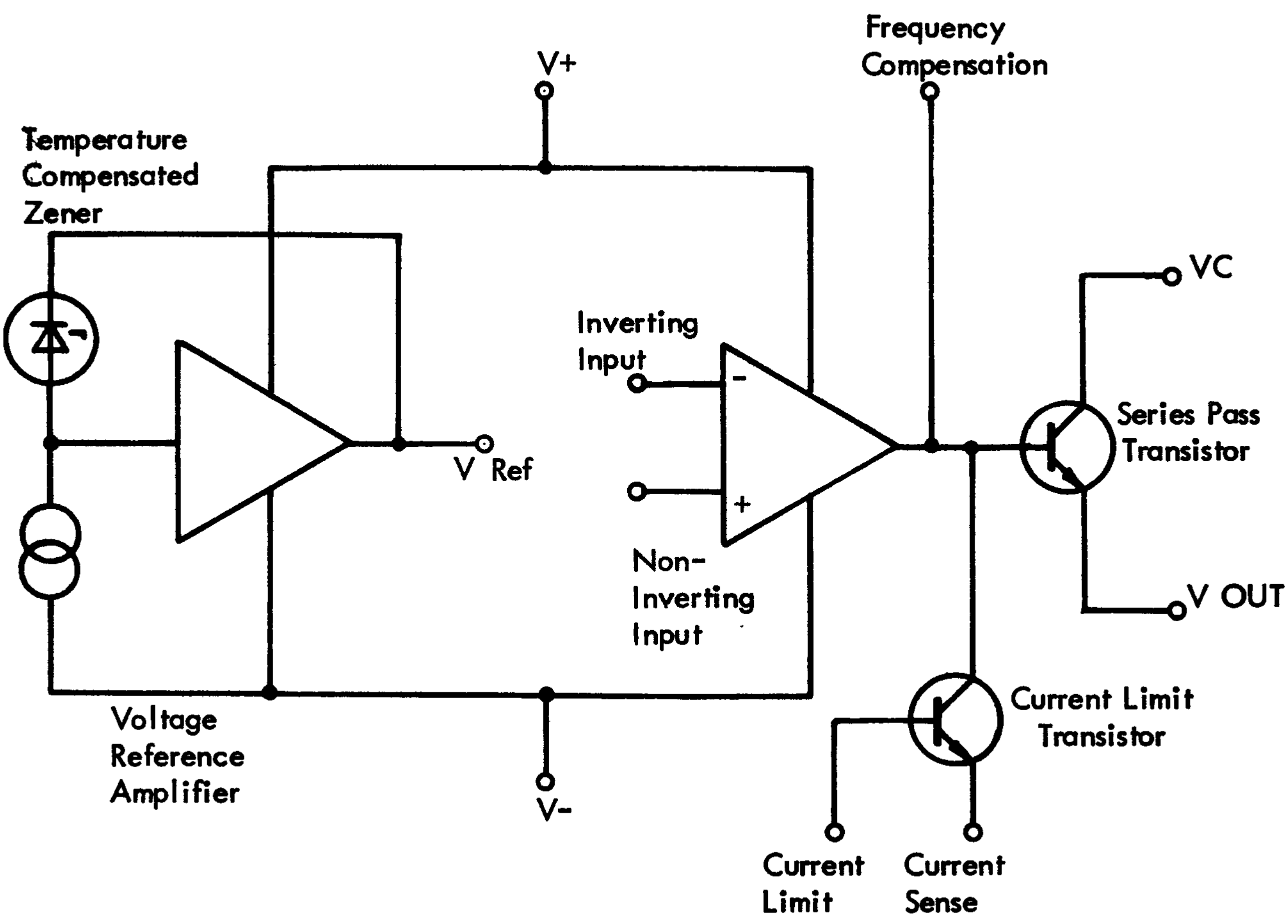


Fig.1 Integrated-circuit regulator : simplified circuit

27. The +5V regulator stage functions as follows. The voltage regulator module ML4 is fed from the unregulated output from 1D2. A reference potential is developed within ML4 and appears at pin 8. A portion of this voltage is fed via potential divider R8, R9, R10 to pin 3, the non-inverting input. Capacitor C4 provides smoothing of the reference potential.

28. Transistor 1TR1 is the series-regulator element. The +5V output appears at pin 3 of the board; C9 is the output smoothing capacitor. A sample of the 5V output is fed to the inverting input (pin 2) of ML4 and the potentials

at pins 2 and 3 are compared. The resultant output from ML4 (pin 6) is fed via TR3 and controls 1TR1 conduction in order to maintain the differential voltage at zero. Potentiometer R9 provides the output-voltage adjustment.

29. A current-limiter circuit gives overload protection. The external load current flows through 1R1 and develops a control potential across this resistor. If this control potential becomes excessive due to an excessive load current, TR3 conduction is reduced which, in turn, reduces 1TR1 conduction; hence, the output voltage is considerably reduced without causing over-dissipation in 1TR1.

Power supply board PM372

30. Some equipments are fitted with an alternative power supply board type PM372, in place of type PM343. The minor physical differencies between the type PM343 and PM372 boards are shown in Fig. 5. The mode of operation of board type PM372 is as described above for type PM343; the circuit diagram (Fig. 6) suffices for both types.

Note. References elsewhere in this publication to board type PM343 may be read as board type PM372, unless stated otherwise.

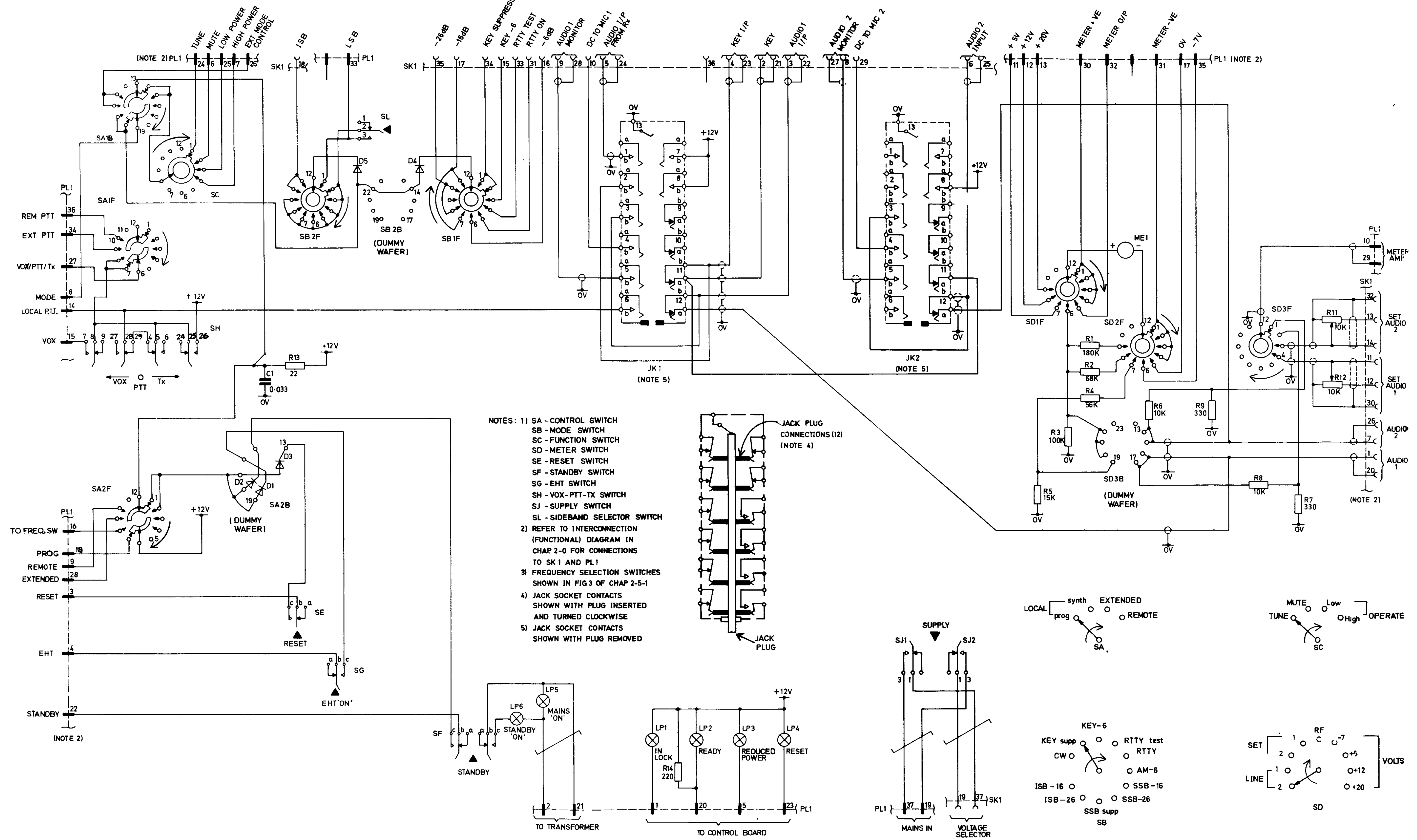


Fig. 2 **Front panel: circuit** Fig. 2

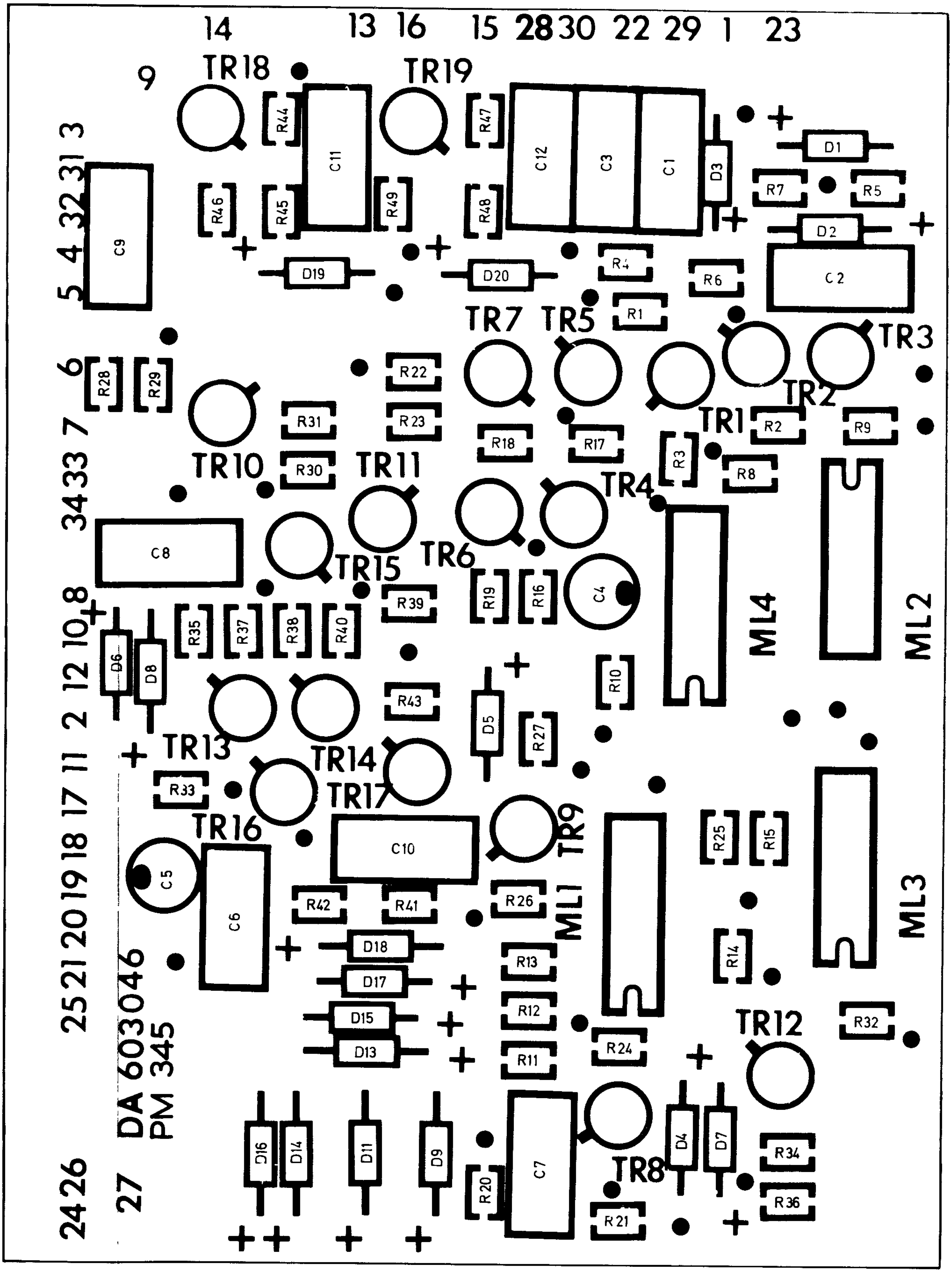


Fig 3 Control board PM345
component layout

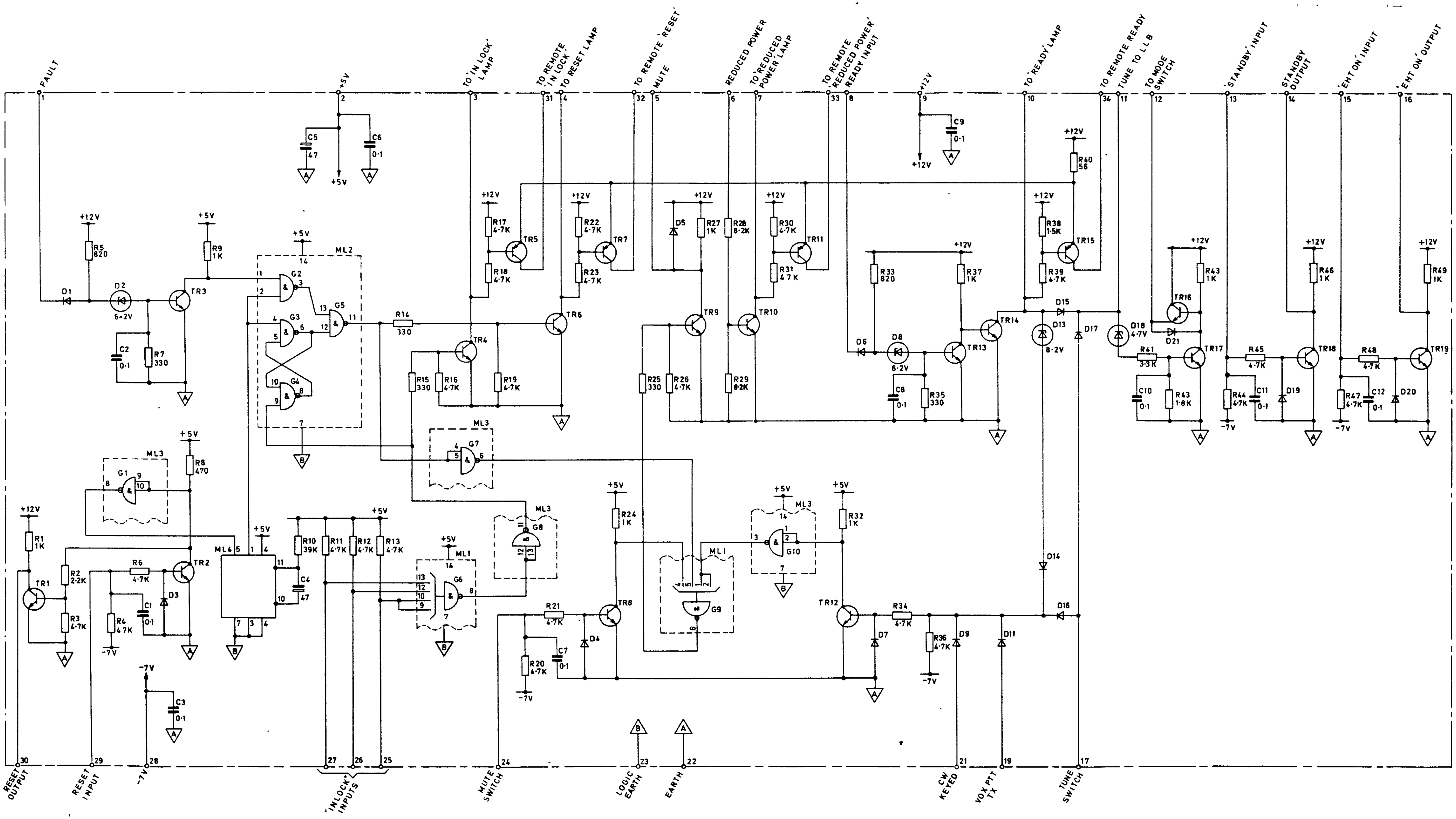
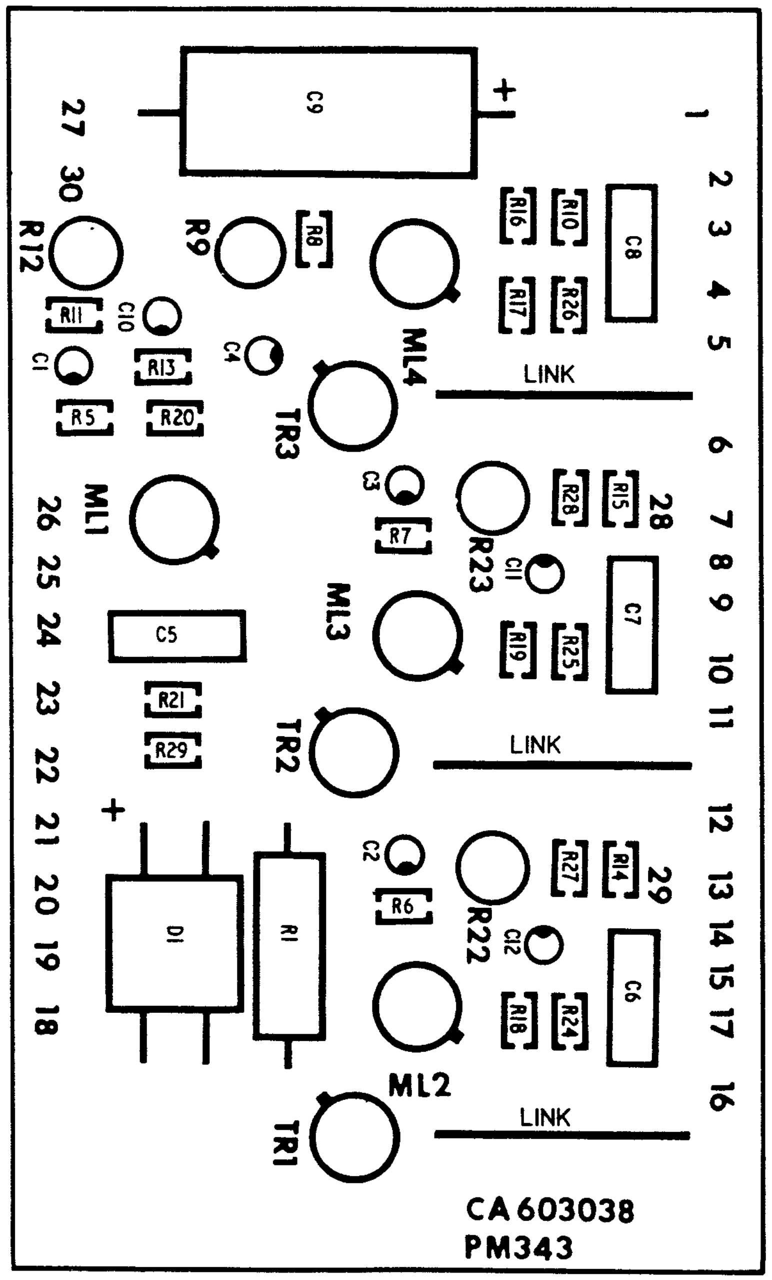


Fig. 4 Control board PM345: circuit Fig. 4



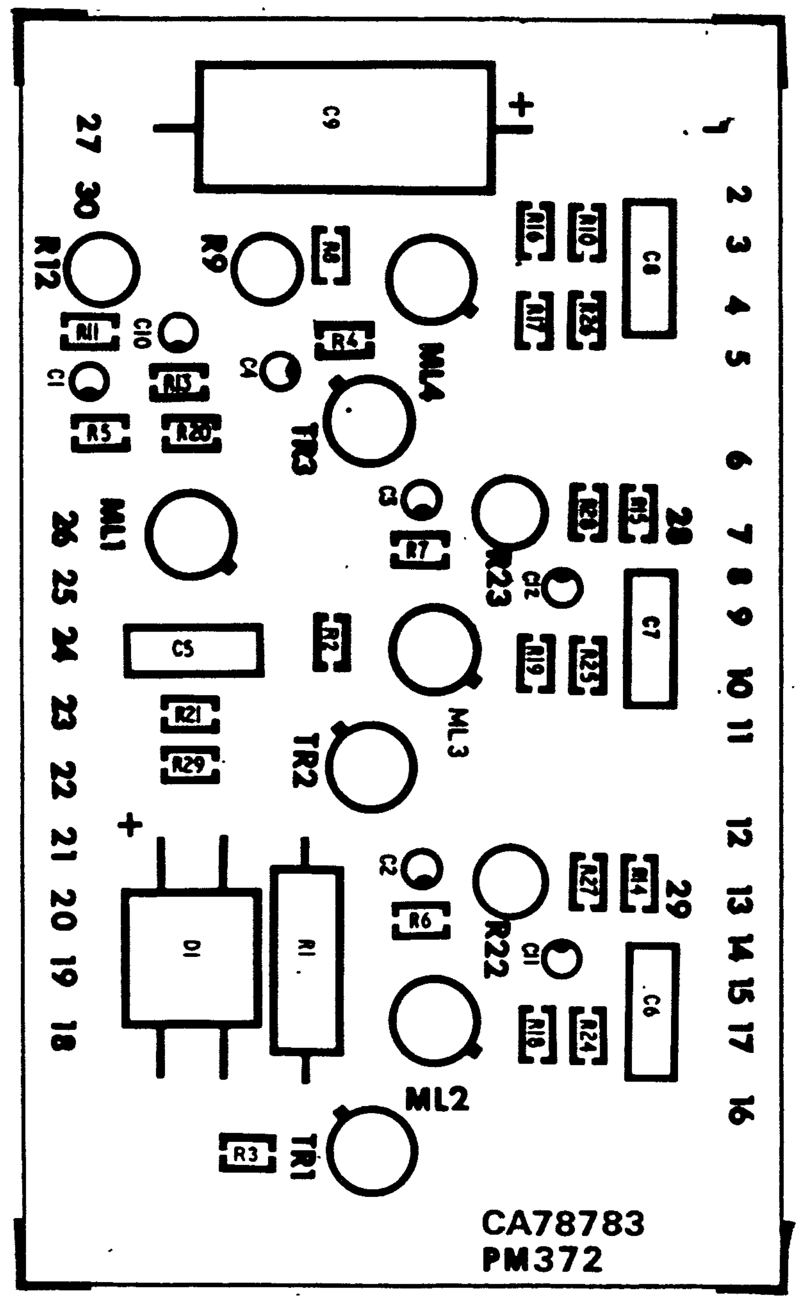


Fig.5 Power supply boards PM 343 and PM 372: component layouts Fig. 5

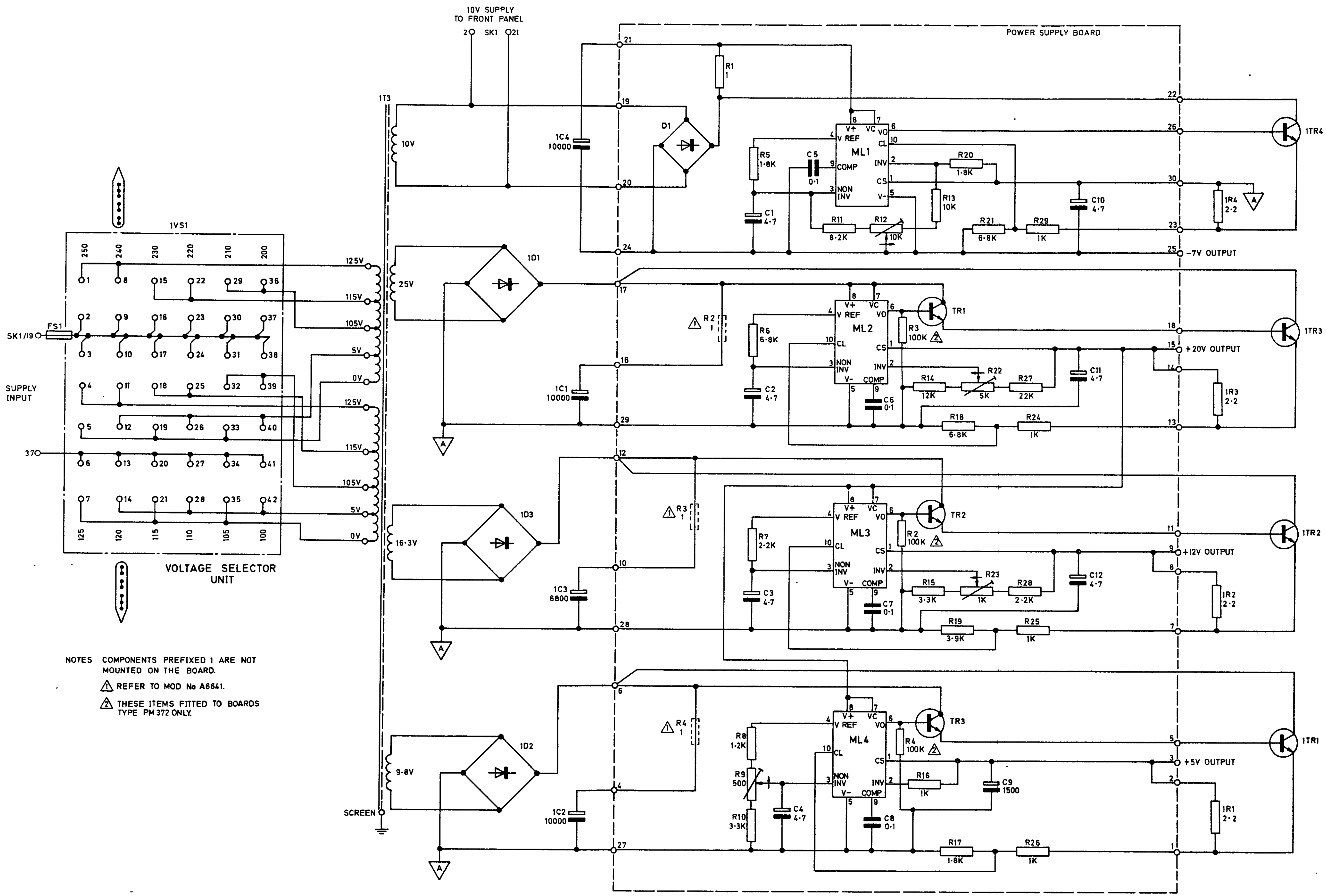


Fig 6

Power supply unit: circuit

Fig.6

Chapter 3-0

GENERAL DESCRIPTION

TRANSMITTER SUB-ASSEMBLIES 10D/5820-99-624-5393 (PART OF TTA.1860A) AND 10D/5820-99-631-8612 (PART OF TTA.1860S)

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INTRODUCTION

1. The transmitter sub-assemblies 10D/5820-99-624-5393 and 10D/5820-99-631-8612 (1 kW cabinet assemblies) each consist of a floor-standing cabinet containing the sub-assemblies listed in Table 1. Detailed information on each sub-assembly is given in Chap.3-1 to 3-8.

TABLE 1

List of sub-assemblies : transmitter sub-assemblies

Sub-assembly	Nato No.	Manufacturers' ref.
Power supply	5820-99-626-4731	MS. 64 (4 off)
Combining unit	5820-99-626-3417	MS.441
Distribution amplifier	5820-99-630-7603	MS.442 (2 off)
Overload unit	5820-99-630-7604	MS.443
Splitter unit	5820-99-630-7605	MS.444
Meter panel assembly (Note 1)	6625-99-626-3416	MS.445
Meter panel assembly (Note 2)		MS.445/2
Voltage standing wave ratio (v.s.w.r.) assembly	5820-99-630-7337	MS.447
Muting unit		MS.564

Notes...

(1) MS.445 fitted to 10D/5820-99-624-5393 only.

(2) MS.445/2 fitted to 10D/5820-99-631-8612 only.

2. The transmitter sub-assemblies are not functional entities until the r.f. modules have been fitted. They then become 1 kW linear amplifier assemblies TA.1810A (part of TTA.1860A) and TA.1810S (part of TTA.1860S).

3. The complete transmitter is formed when the remaining main units (para.5) are installed. Chap.1-0 to 1-4 (TTA.1860A) and 13-0 to 13-4 (TTA.1860S) cover the following aspects of the complete transmitters:-

(1) Functional descriptions.

(2) Operating procedures.

(3) Servicing and repair.

(4) Performance checks.

CONSTRUCTION

4. Each cabinet consists of a main framework to which is attached an outer skin of aluminium alloy. A front panel assembly provides the housing for eight r.f. modules MM.420. The power supply units MS.64 may be withdrawn on telescopic runners after the removal of a front panel.

5. Mountings are provided for the drive unit (MA.1720A or MA.1720S), the feeder matching unit (MA.1004) and the line switching unit (MS.139). The physical locations of these units and of the sub-assemblies are given in Chap.1-0 and 13-0.

6. The cabinet harness contains all the inter-unit wiring for the complete transmitter (TTA.1860A or TTA.1860S); this includes the coaxial cables and relays for the line-switching equipment.

7. All external connections, with the exception of the transmitter r.f. output, are made at the bottom rear of the cabinet; the r.f. output connection is at the top rear of the assembly.

VENTILATION

8. Forced air cooling is provided by two airblower units located immediately below the r.f. modules together with an extractor fan at the top rear of the cabinet. The cool airstream enters via the main filter panel at the lower front of the cabinet.

9. A secondary air inlet is provided via the front-panel filter of the MA.1004.

Chapter 3-1

DESCRIPTION, SERVICING AND REPAIR
SPLITTER UNIT MS.444

CONTENTS

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R.F. power meter	5
Supply distribution	6
Servicing and repair	
Fault location	7
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INTRODUCTION

1. The splitter unit MS.444 accepts the low-level r.f. input from the MS.564 muting unit (Chap.3-7) and provides, via an attenuator network, two identical outputs to the MS.442 distribution amplifiers.

2. A sample of the r.f. signal is rectified and the resultant d.c. level is passed to the meter panel assembly.

TECHNICAL DESCRIPTION

Signal splitter

4. The r.f. input is applied via SK1 to the attenuator network; the degree of attenuation is set by soldered links on the board. The attenuated signal is then fed via matching resistors R9, R10 to the 50-ohm inputs of the distribution amplifiers.

R.F. power meter

5. The signal at junction R9, R10 is rectified by diode D1 and the resultant d.c. signal fed via emitter-follower stage TR1. The potential developed across R13 provides the INPUT power indication for the MS.445 (MS.445/2 in TTA.1860S).

Supply distribution

6. The MS.444 also functions as a supply distribution point. The +30V supplies to the overload unit, the muting unit and the meter panel assembly are fed via PL1 pins 2, 8 and 9. The +30V rail is provided jointly from the distribution amplifiers and hence the MS.444, the MS.443, the MS.564 and the MS.445 (MS.445/2) all remain active whenever at least one MM.420 is active.

SERVICING AND REPAIR

Fault location

7. Fit the suspect unit to a serviceable transmitter (e.g. the bench slave equipment). Carry out the relevant functional checks and hence confirm the fault symptoms found at user level (Chap.1-3 or 13-3).

8. Fault-finding is then carried out with the aid of the technical description and Table 1.

TABLE 1

Supply and signal levels: splitter unit

Test-point		Signal level
SK1		1.58V r.m.s. (Note 1)
D1	anode	1.58V r.m.s.
TR1	emitter	+1.6V
	base	+1.75V
	collector	+30V

Note...

1. Signal levels given are for stated input level to SK1 and zero attenuator setting.

Dismantling and reassembly

9. The manner of dismantling is self-evident after removal of the top cover; reassembly is effected in the reverse order.

Post-repair checks and adjustments

10. Having located and replaced the faulty component, re-fit the complete MS.444 to the transmitter and carry out the functional checks given in Chap.1-4 (13-4).

11. To check the calibration of the r.f. power meter:-

(1) Set the transmitter for c.w. operation at a frequency of 10.000 MHz.

(2) Measure the r.f. signal level at pin 9 (junction R9, R10); this should be 1.58V r.m.s.

(3) Set the R.F. POWER switch on the MS.445 to INPUT 250mW (INPUT 2, 250mW on the MS.445/2).

(4) Check that a level of 50mW ± 10mW is indicated; if not, make a slight adjustment to preset control R12 to give exactly 50mW meter reading.

(5) Re-set the transmitter to 'key-up' conditions.

Note ...

If the level at pin 9 is other than 1.58V r.m.s., disconnect the r.f. cable from SK1 and provide the desired input from the r.f. signal generator. The use of an external signal source will avoid readjustment of the internal controls of the MA.1720A (MA.1720S).

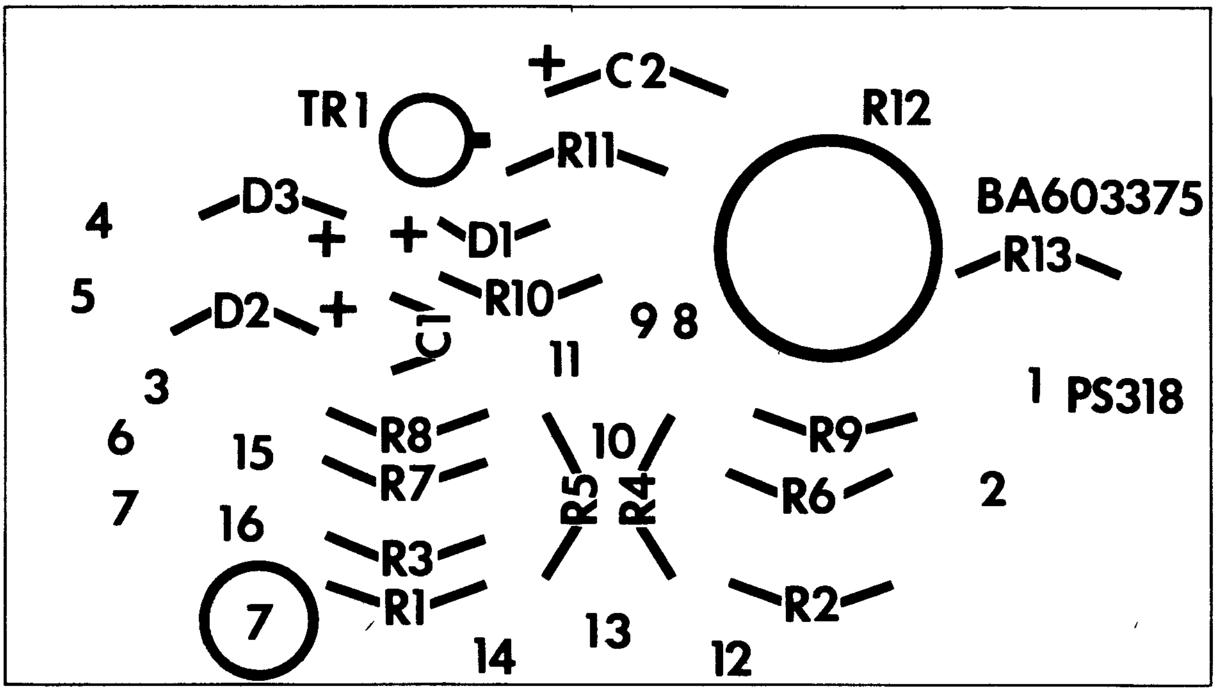

Fig.1 Splitter unit board: component layout

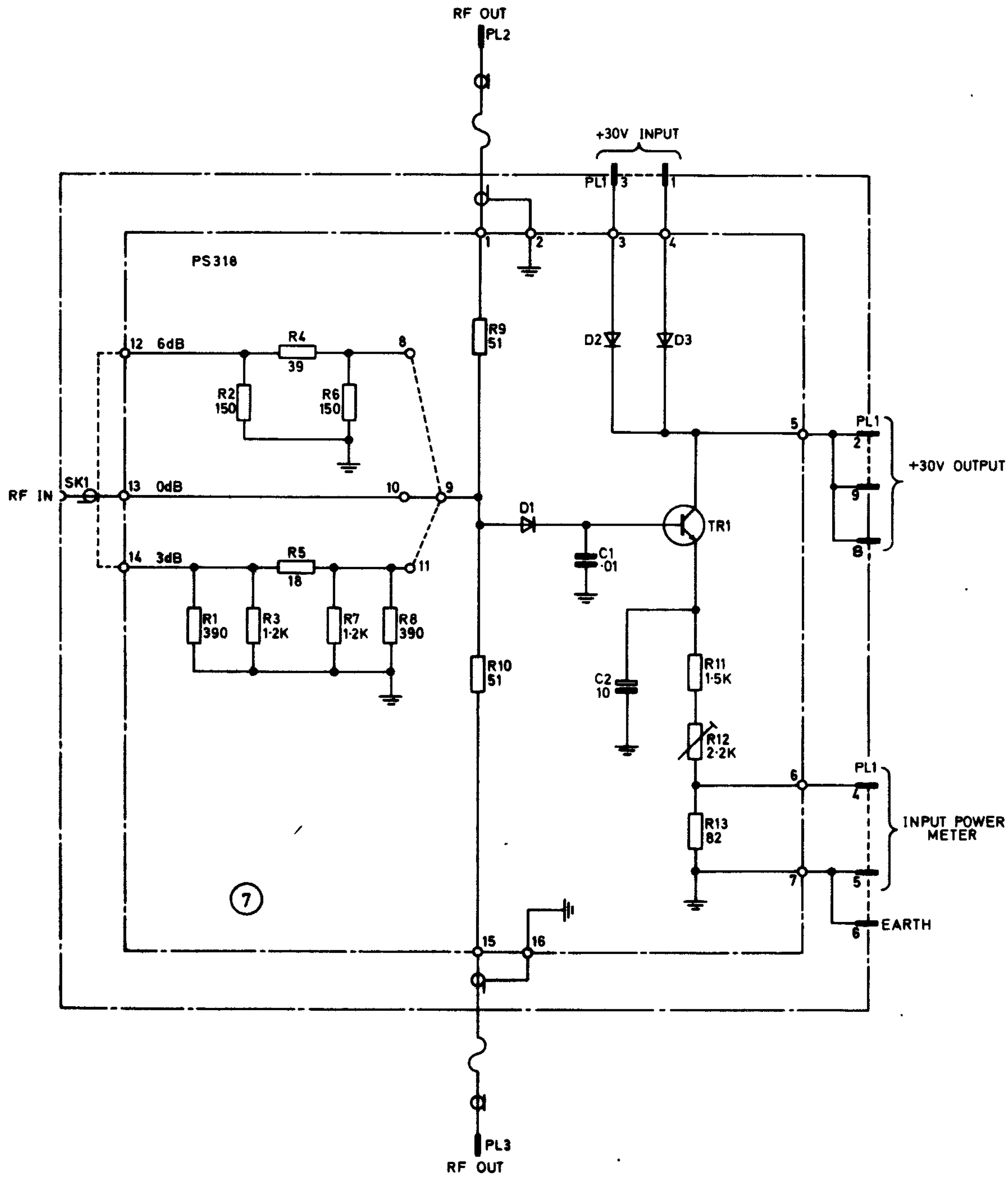

Fig.2 Splitter unit MS.444: circuit

Chapter 3-2

DESCRIPTION, SERVICING AND REPAIR
DISTRIBUTION AMPLIFIER MS.442

CONTENTS

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Technical description	
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Overload protection	7
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INTRODUCTION

1. The distribution amplifier MS.442 provides four separate r.f. outputs from a single input. The outputs are provided by individual amplifier stages, each having about 3dB stage gain. The input and output impedances are 50 ohms, unbalanced.

TECHNICAL DESCRIPTION

R.F. signal paths

3. The four signal paths are similar; only one will be described.

4. The r.f. input from the splitter unit (Chap.3-1) is applied via SK5 to four parallel-connected auto-transformers T2, T4, T6 and T7. Frequency compensation is provided by C10.

5. The signal at T2 centre-tap is applied to the emitter of TR1, a class A grounded-base amplifier stage. The base potential is derived from potential divider R1, R2; this network is common to all four stages.

6. The amplified output from TR1 is fed via T1 and SK1 and thence to the relevant r.f. module (Chap.1-0 and 13-0).

Overload protection

7. Under normal conditions, diode D1 and Zener diode D2 are non-conducting. Should the load be removed from SK4, causing an increase in the output level, the r.f. voltage developed across T1 primary causes D1 and D2 to conduct. The positive excusions of TR1 collector are limited to about +35V and breakdown is prevented.

Supply distribution

8. The MS.442 also functions as a supply distribution point. The +30V rail for the unit is provided jointly by the +30V inputs from four r.f. modules (pins 1 to 4 of PL1); hence the MS.442, together with the splitter unit which is fed via pin 5, will continue to function whenever at least one of the associated MM.420 units is active.

SERVICING AND REPAIR

Fault location

9. Fit the suspect unit to a serviceable transmitter (e.g. the bench slave equipment). Carry out the relevant functional checks and hence confirm the fault symptoms found at user level (Chap.1-3 or 13-3).

10. Fault-finding is carried out with the aid of the technical description and Table 1.

TABLE 1

Supply Voltages, distribution amplifier

Test-point		Normal voltage
TR1	emitter	+0.65V
	base	+1.35V
	collector	+24.4V
TR2	emitter	+0.65V
	base	+1.35V
	collector	+24.4V
TR3	emitter	+0.65V
	base	+1.35V
	collector	+24.4V
TR4	emitter	+0.65V
	base	+1.35V
	collector	+24.4V
D2	Cathode	+26.5V
D4	Cathode	+26.5V
D6	Cathode	+26.5V
D8	Cathode	+26.5V

Dismantling and reassembly

11. The manner of dismantling is self-evident after removal of the top cover reassembly is effected in the reverse order.

Post-repair checks and adjustments

12. Having located and replaced the faulty components, re-fit the complete MS.442 to the transmitter. Carry out the functional checks given in Chap. 1-4 (13-4).

13. No post-repair adjustments are required.

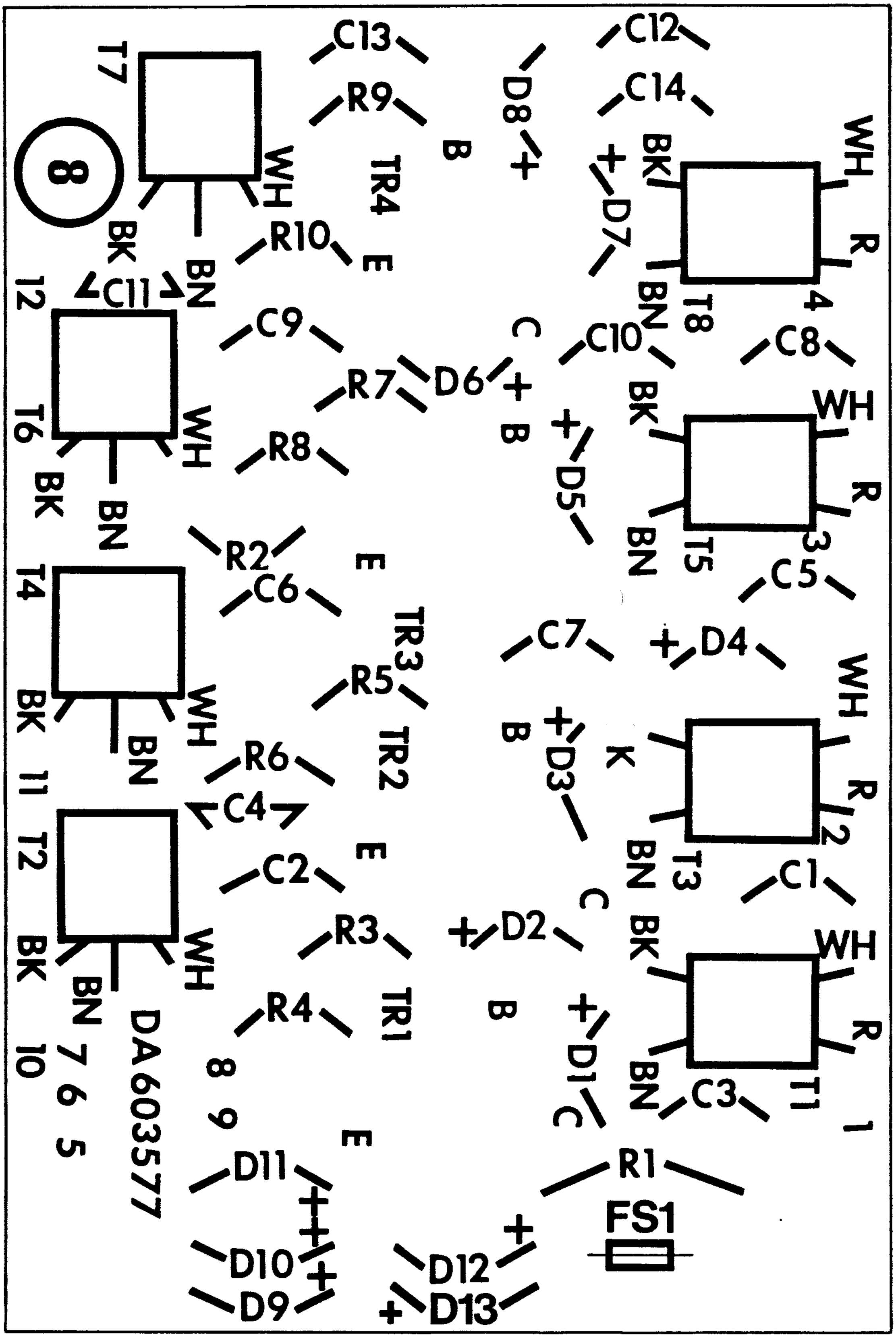

Fig.1 Distribution amplifier board: component layout

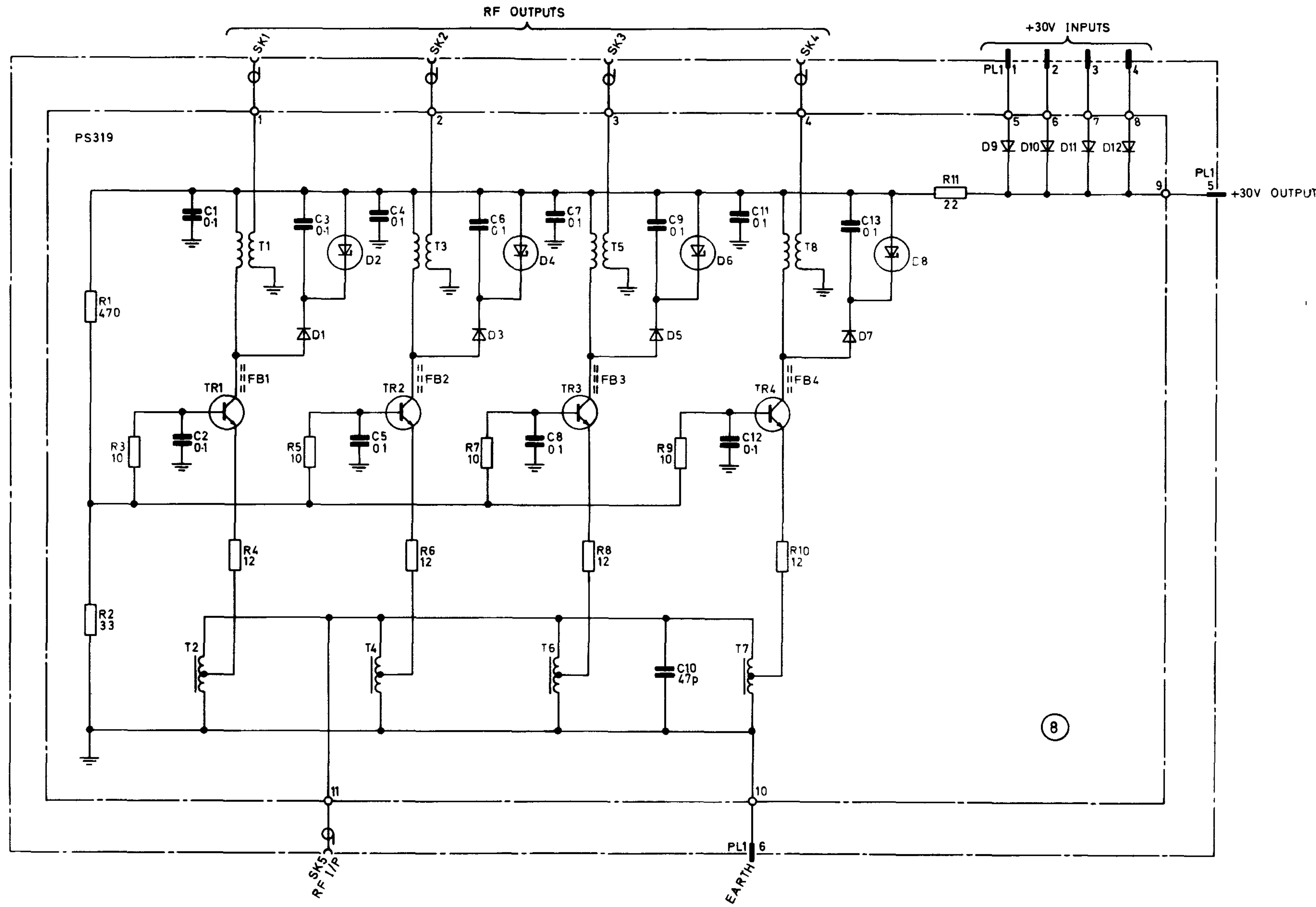

Fig. 2

Distribution amplifier MS. 442: circuit

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Chapter 3-3

DESCRIPTION, SERVICING AND REPAIR

OVERLOAD UNIT MS.443

CONTENTS

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Fault location	18
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INTRODUCTION

1. The overload unit MS.443 generates the 'reduced power' warning signal:-

(1) When one or more of the MS.64 power supplies is switched off, or fails.

(2) When one or more of the MM.420 r.f. modules is switched off, or fails.

2. The MS.443 also provides a 'fault' signal output:-

(1) When a 'fault signal is received from the MA.1004 feeder matching unit.

(2) In the event of a complete power supply failure whilst the main contactor CON A is still closed.

3. The complete circuit diagram is given in Fig.2.

TECHNICAL DESCRIPTION

Reduced power warning

4. The +36V outputs from all four MS.64 power supplies are monitored at pins 8, 9, 11 and 12 of PL1. These inputs are fed via noise-immunity circuits to

the transistor chain TR1 to TR4. If all four inputs are present, conduction occurs. The potential at the junction of R11 and D6 being less than +6.8V, Zener diode D6 is non-conducting and hence TR5 cannot conduct.

5. Under normal conditions, pin 4 is at 0V and TR6 is reverse-biased by the action of TR8. Transistor TR9 conducts and holds TR7 non-conducting.

6. With TR5 and TR7 both 'off', TR10 conducts maintaining C9 in the discharged condition.

7. Transistors TR11 and TR12 form a latching circuit which, after a previous reset action (para.12), holds TR12 conducting and TR11 'off'. Transistor TR13 conducts, drawing base current via R28 and R34; thus the level at pin 10 is about +0.4V.

8. If one or more MS.64 power supplies is switched off or fails, the loss of input to pins 8, 9, 11 or 12 causes the associated transistor (TR1 to TR4) to cease conduction. The potential at TR1 collector rises towards +30V causing TR5 to conduct.

9. Transistor TR10 is switched off and capacitor C9 commences to charge via R26; after a short delay, TR11 conducts. The latching circuit changes state and hence TR13 is switched off. The 'reduced power' warning signal is generated across Zener diode D10 and this signal is passed via pin 10 to the drive unit (MA.1720A or MA.1720S).

10. If one or more of the MM.420 r.f. modules is switched off or fails, an 'r.f. unbalanced' signal is generated in the MS.441 combining unit (Chap.3-6). The potential on pin 4 rises and, when it exceeds that of TR8 base (about +5V), TR6 starts to conduct. Transistor TR9 is switched off and TR7 conducts. TR10 is switched off and as in para.9 results in a 'reduced power' warning signal at pin 10.

Reduced power reset

11. The 'warning' state is maintained until a subsequent reset action; thus the 'reduced power' condition will be indicated at the drive unit even though the inputs to pins 4, 8, 9, 11 and 12 have reverted to 'normal'.

12. The latching circuit is reset by the application of a +12V input to pin 1; noise-immunity is provided by the action of D8. Transistor TR12 conducts causing TR11 to be switched off. On removal of the reset input, these conditions are maintained by the base current drawn via R28 and R29.

Fault signal

13. The +30V supply for the MS.443 (pin 3) is derived from the MS.444 splitter unit and hence is present when at least one MM.420 is active.

14. The main supply contactor (CON A, Chap.1-0 and 13-0) carries an auxiliary contact which holds pin 2 of PL1 at earch potential. Diode D11 conducts via R1 and R2 and D5 cathode is held at about +30V.

15. If a fault condition is signalled by the MA.1004, the 0V signal at pin 6 is passed via pin 5 to the drive unit (MA.1720A or MA.1720S).

16. In the event of a complete power supply faulure, the +30V input disappears and the junction of D5, D11 goes to 0V; this fault condition is signalled to the drive unit.

17. When the transmitter is switched OFF, CON A releases. The open-circuit at pin 2 prevents a false indication of supply failure at pin 5.

SERVICING AND REPAIR

Fault location

18. Fit the suspect unit to a serviceable transmitter (e.g. the bench slave equipment). Carry out the relevant functional checks and hence confirm the fault symptoms found at user level (Chap.1-3 or 13-3).

19. Fault-finding is then carried out with the aid of the technical description and Table 1.

TABLE 1

Electrode potentials, overload unit MS.443

Test-point	Function	Operating condition			Notes
		Normal	Power supply 'off'	R.F. Unbalanced	
Power supply monitor					
Board pin 1	Input	+36V	<+17V		1
Board pin 2	Input	+36V	+36V		
Board pin 3	Input	+36V	+36V		
Board pin 4	Input	+36V	+36V		
TR1 collector		+0.3V	+12V		1
TR2 collector		+0.6V	-		
TR3 collector		+0.9V	-		
TR4 collector		+1.2V	-		
TR5 collector		+15V	+0.4V		2
R.F. Sensor					
Board pin 5	Input	0V		+5V	3
TR6 collector		+9V		+4.5V	
TR7 collector		+15V		+0.4V	2
TR8 collector		+18V		+18V	
TR9 collector		+0.4V		+15V	
Output Stages					
TR10 collector		+0.4V	+24V	+24V	
TR11 collector		+18V	+0.4V	+0.4V	
TR12 collector		+0.4V	+15V	+15V	

TABLE 1 (cont.)

Test-point	Function	Operating condition			Notes
		Normal	Power supply 'off'	R.F. Unbalanced	
TR13 collector		+0.4V	+12V	+12V	
Board pin 11	Output	+0.4V	+12V	+12V	4

Notes...

(1) Transistor chain TR1 to TR4 is switched off when the input to either pin 12, 11, 9 or 8 of PL1 falls below +18V.

(2) A +0.4V level is present at both collectors when either TR5 or TR7 is conducting.

(3) TR6 emitter is held at about +4V by the action of TR8. TR6 conducts when the input to pin 4 of PL1 exceeds about +5V.

(4) +12V no-load; about +9V in-situ.

Dismantling and reassembly

20. The manner of dismantling is self-evident after removal of the top cover; reassembly is effected in the reverse order.

Post-repair checks and adjustments

21. Having located and replaced the faulty component, re-fit the complete MS.443 to the transmitter. Carry out the functional checks given in Chap.1-4 (13-4).

22. No post-repair adjustments are required.

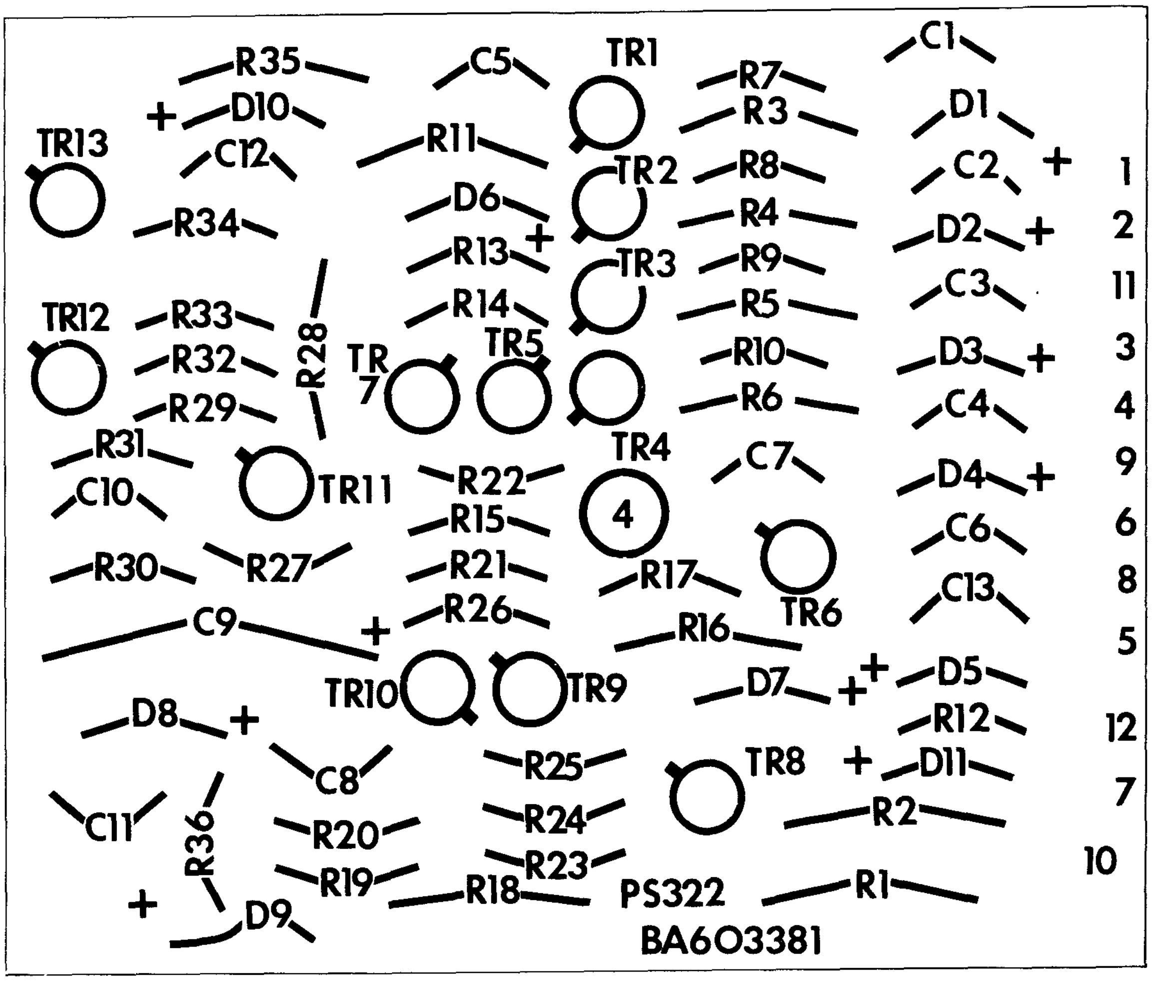

Fig.1 Overload unit board: component layout

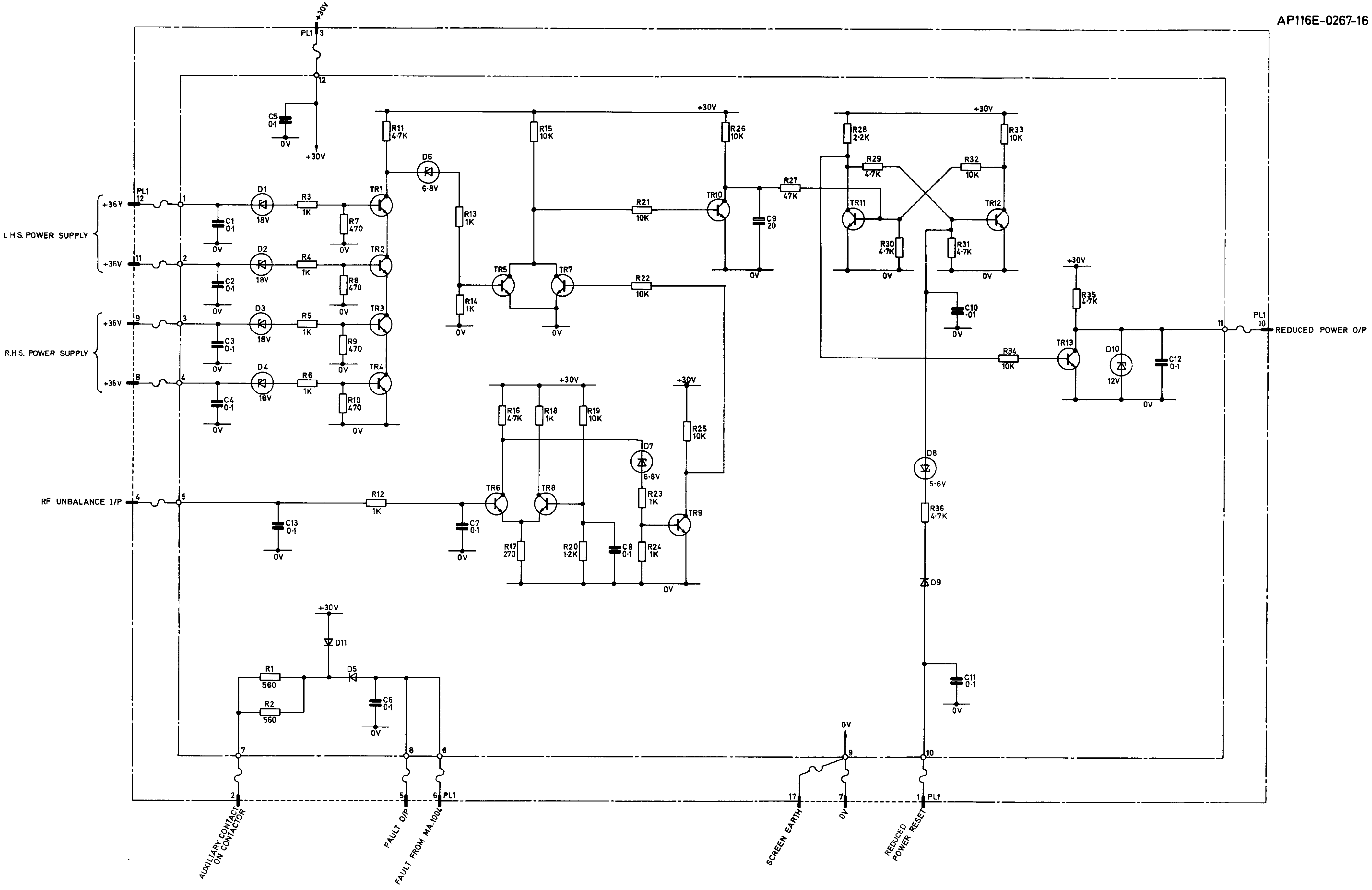

Fig. 2

Overload unit MS.443: circuit

Chapter 3-4

DESCRIPTION, SERVICING AND REPAIR

V.S.W.R. UNIT MS.447

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INTRODUCTION

1. The v.s.w.r. unit MS.447 monitors the transmitter output signal and generates d.c. potentials proportional to the forward and reflected power levels.

2. The complete circuit diagram is given in fig.4.

3. Components L1, C1, C3, C4 and R1 to R4 together form a reflectometer. The signals developed at pins 1 and 2 are separately rectified by diodes D1, D3 and D2, D4 to provide d.c. outputs to the meter panel assembly (Chap.3-5).

PRINCIPLES OF OPERATION

4. For a partially-reactive load, a phase angle Ø will exist between the load current I (fig.1) and the output voltageV; for the desired 50-ohm load, the current and voltage vectors should be in-phase. The reflectometer (fig.2 samples these components of the signal and produces 'maximum forward' and 'minimum reflected' signals when the optimum load conditions are obtained.

Voltage sample

5. A signal V1, which is directly proportional to the output voltage, is provided at point C by the capacitive divider C1, C4.

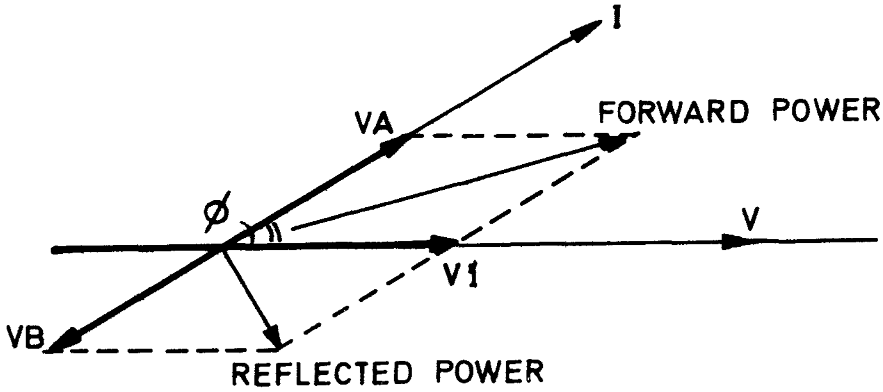

Fig.1 Reflectometer: vector diagram

Current sample

6. At current I2 is induced into the secondary winding of the toroidal transformer such that

$$I2 = \frac{jwM}{2RL + jwL2} \cdot I1.$$

The constants M and L2 are set by the constants of the transformer; the term w is the angular frequency in radians.

7. Provided that the term jwL2 is numerically much greater than 2RL, the current is independent of the operating frequency and is given by:-

$$I2 = \frac{M}{L2} \cdot I1.$$

Thus the current transformer generates equal and opposing voltages across the load resistors. These voltages, which are proportional to the magnitude of the load current, are designated VA and CB in Fig.1.

D.C. outputs

8. The magnitudes of the sampling signals are chosen such that V1 = VA = VB when the load resistance is 50 ohms; the actual voltages are summed vectorially (fig.1).

9. The signal V1 + VA at pin 1 (fig.4) is rectified by diodes D1 and D3 to provide the 'forward power' indication; the 'reflected power' signal is derived from V1 + VB. When the load is non-reactive:-

(1) V1 + VA = 2V1 (maximum forward power)

(2) V1 + VB → Zero (zero reflected power)

For a 1 kW forward power output, the potential developed at pin 5 is typically +9V.

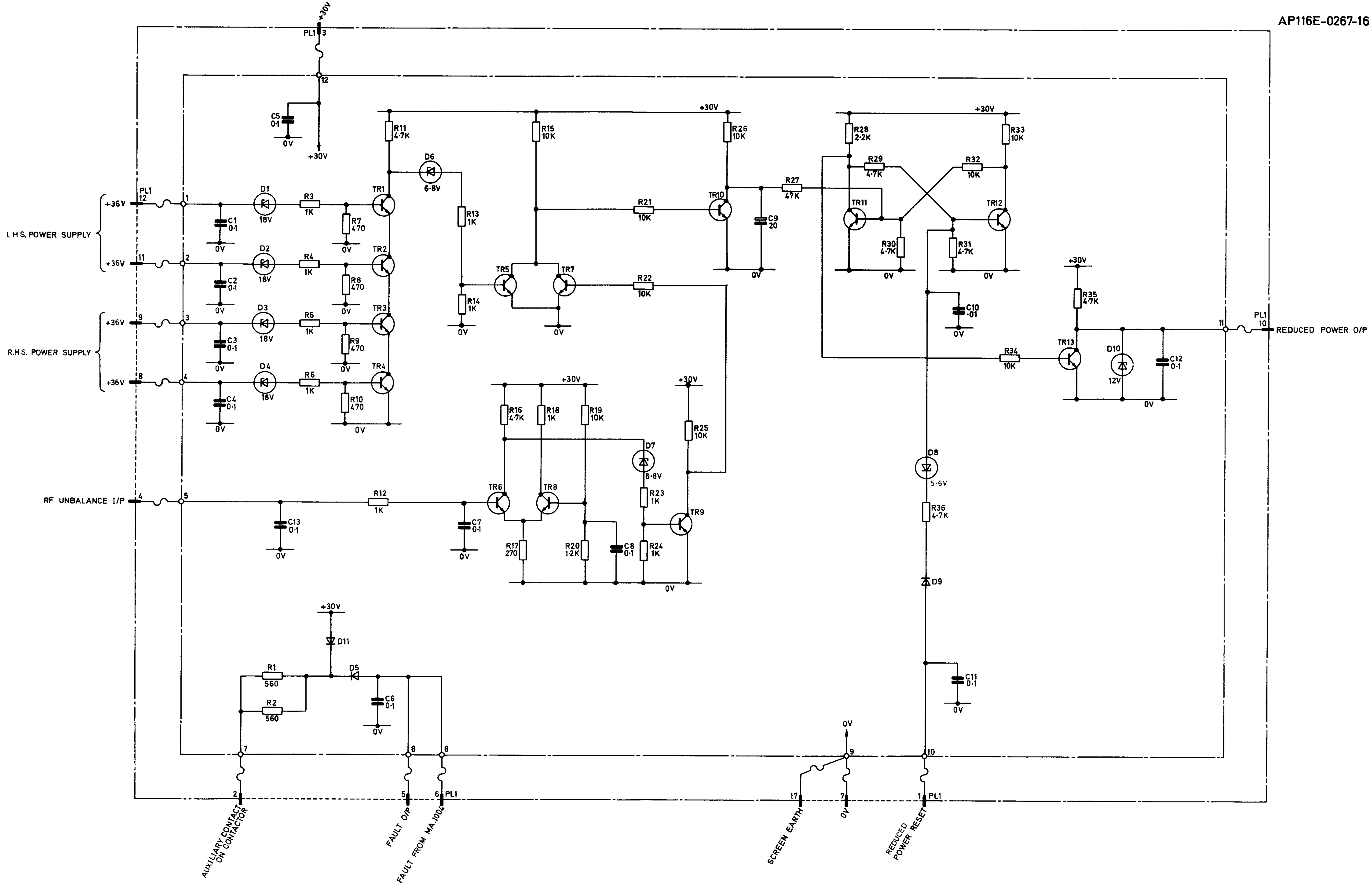

Fig. 2

Overload unit MS.443: circuit

Fig. 2

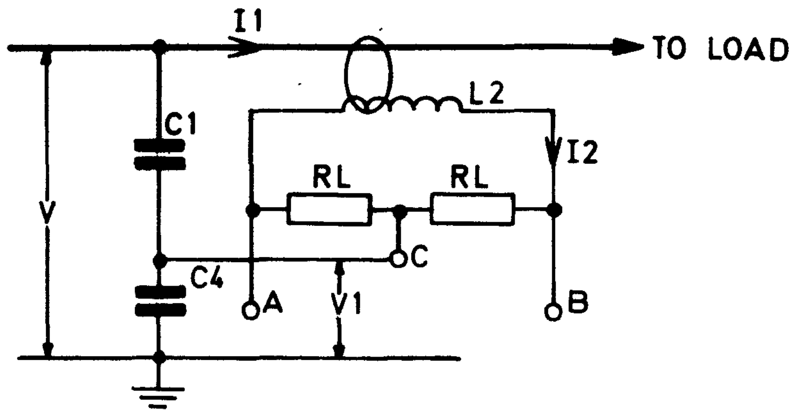

Fig.2 Reflectometer: simplified circuit

SERVICING AND REPAIR

Fault location

10. Fit the suspect unit to a serviceable transmitter (e.g. the bench slave equipment). Carry out the relevant functional checks and hence confirm the fault symptoms found at user level (Chap.1-3 or 13-3).

11. Fault-finding is then carried out with the aid of the technical description.

Dismantling and reassembly

12. The manner of dismantling is self-evident after removal of the top cover; reassembly is effected in the reverse order.

Post-repair checks and adjustments

13. Having located and replaced the faulty component, re-fit the complete MS.447 to the transmitter and carry out the functional checks given in Chap. 1-4 (13-4).

14. To check the reflectometer alignment:-

(1) Connect the 50-ohm non-reactive load to 10 SK1.

(2) Set the transmitter for c.w. operation at a frequency of 10.000 MHz.

(3) Check that at least 800W FORWARD power is obtained.

(4) Check that the NORMAL/CALIBRATE switch (rear of meter panel) is set to NORMAL.

(5) Set the RF POWER switch for REFLECTED power and note the actual value.

(6) Make a slight adjustment to preset control C3 to give a minimum reflected power reading; a sharp null should be obtained.

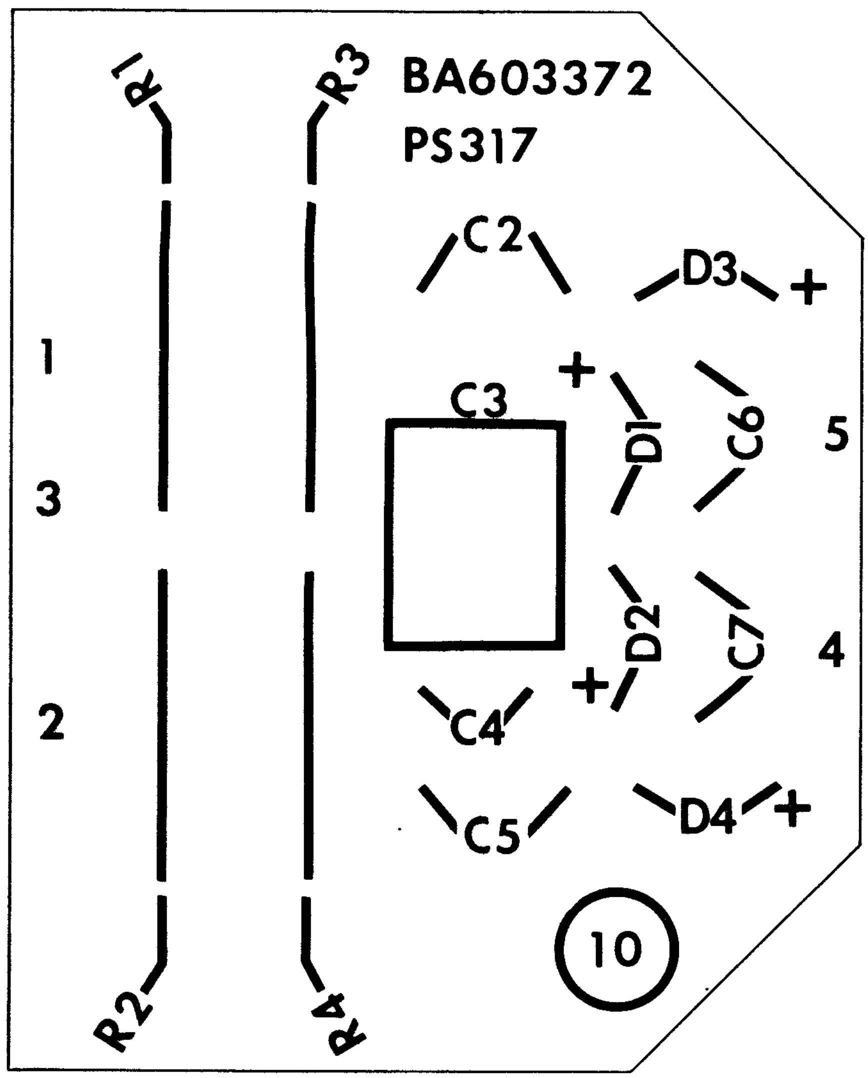

Fig.3 V.S.W.R. unit board: component layout

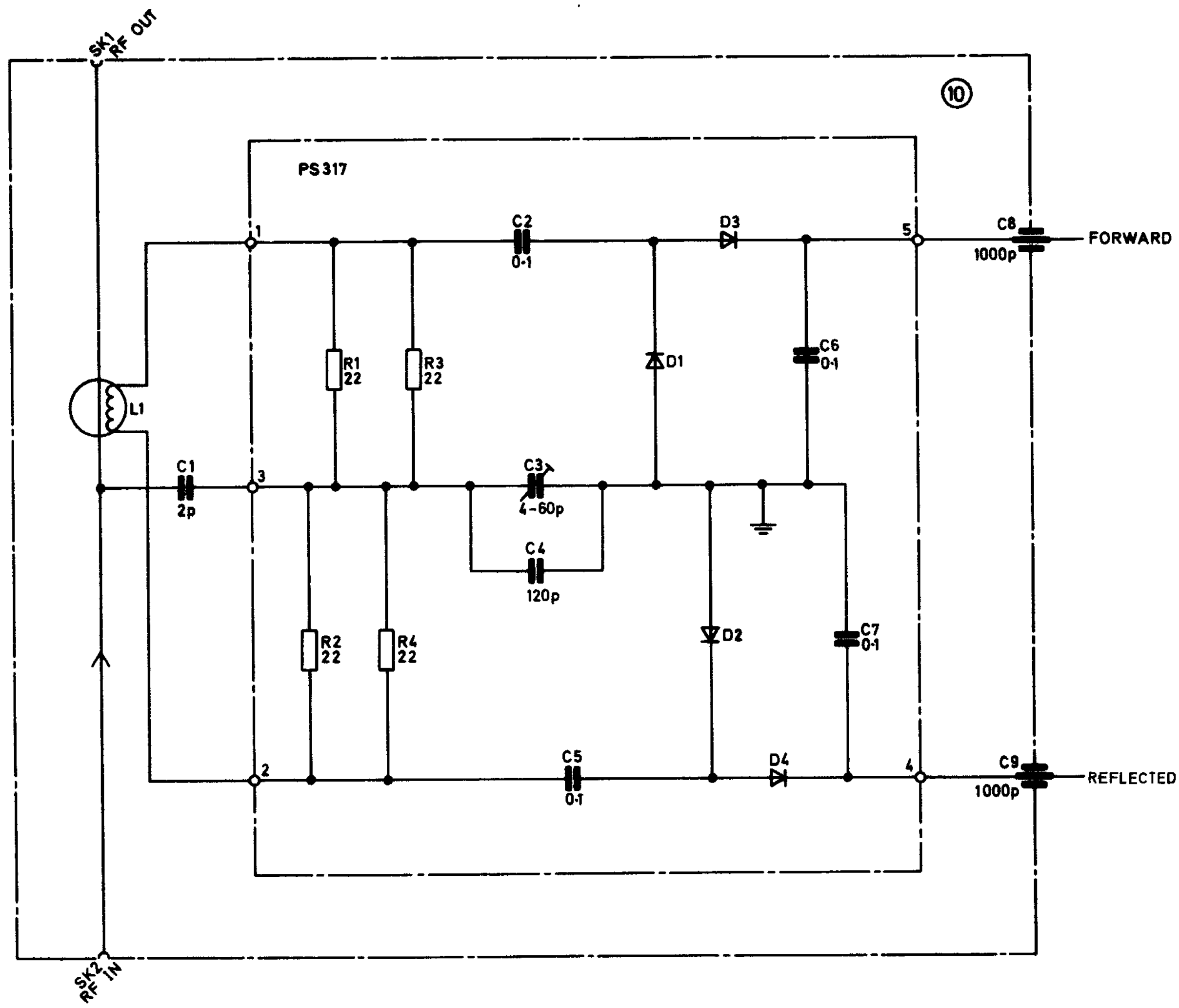

Fig.4 V.S.W.R. unit MS.447: circuit

Chapter 3-5

DESCRIPTION, SERVICING AND REPAIR

METER PANEL ASSEMBLIES MS.445 AND MS.445/2

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4 DC measurements

6 RF measurements

8 VSWR warning

11 VSWR trip

Servicing and repair

13 Fault location

15 Dismantling and reassembly

16 Post-repair checks and adjustments

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3	Meter panel assembly MS445/2: circuit	7
4	Metering board: circuit and component layout	8

INTRODUCTION

1 The purpose of the meter panel assemblies MS445 and MS445/2 is self-explanatory. Each contains two separate metering systems, plus VSWR-trip circuits.

2 The MS445 (part of the TTA1860A) provides the dc and rf measurements in a single rf path. The MS445/2 (part of the TTA1860S) accommodates two rf paths and, in addition, provides switching facilities for the mute signals to the linear amplifiers.

3 The complete circuit diagrams are given in fig.1 to 4. Where two circuits are similar, only one will be described.

TECHNICAL DESCRIPTION

DC measurements

4 Meter ME1 (fig.2) monitors the +20 V and +30 V supply rails and the pa load currents within each MM420 rf module. The operator of switches SA and SB is self-evident.

5 The meter ranges are:-

(1) Voltage : 40 V fsd.

(2) Current : 20 A fsd.

The current readings are derived from the potentials developed across 0.025 ohm resistors in the MS440 stabilizers.

RF measurements

6 Meter ME2, in conjunction with the VSWR unit MM447 (Chap.3-4), indicates the forward and reflected power outputs from the transmitter.

7 The dc potentials generated in the MM447 are fed via pins 1 and 2 of the VSWR Warning board (fig.1) and thence via resistor networks R1, R6, R9 and R2, R7, R10 to ME2; the meter ranges (1250 W and 250 W) are set by means of R1 and R2.

VSWR warning (fig.1)

8 A warning signal is generated and the transmitter is muted if the reflected power exceeds a pre-determined level, e.g. a 3:1 voltage standing wave ratio.

9 Under normal conditions, transistors TR1, TR2 and TR4 are non-conducting; TR2 is reverse-biased by the action of TR3. A OV potential exists at pin 4 of the board.

10 As the reflected power level rises, TR1 starts to conduct and, at a level determined by the setting of R12, TR2 conducts. TR4 is switched on and the potential at pin 4 rises towards +30 V. The warning signal is fed via the Metering board, to appear at 1TB9 (bottom of cabinet).

VSWR trip

11 On the Metering board (fig.4), the +30 V signal produces a +9 V (nominal) level across C1. This potential is fed back via pin 2 of the VSWR Warning board to TR1 on that board. The system becomes latched in the VSWR-warning condition.

12 At the same time, TR1 on the Metering board is switched on. The resultant OV level at pin 9 causes the linear amplifier stages to be muted and hence the forward power output falls to zero.

SERVICING AND REPAIR

Fault location

13 Fit the suspect unit to a serviceable transmitter (e.g. the bench slave equipment). Carry out the relevant functional checks and hence confirm the fault symptoms found at user level (Chap.1-3 or 13-3).

14 Fault-finding is carried out with the aid of the technical description and Tables 1 and 2.

TABLE 1 METER SENSITIVITIES: MS445

Meter	Range	Sensitivity	Pin	
ME1	30 V	+40 V fsd	-	Note 1
	20 V	+40 V fsd	-	
	CURRENT	+0.5 V fsd	-	Notes 1 and 2
ME2	INPUT, 250 mW	+62 mV for 50 mW	PL1-48	Note 3
	FORWARD, 1250 W	+ 9 V for 1000 W	PL1-14	Note 4
	REFLECTED, 250 W	+ 3 V for 250 W	PL1-30	

Notes ...

(1) Pin numbers as selected by MODULE switch SA.

(2) Meter range 20A fsd. Derived from voltages developed across 0.025 ohm resistors in each MM440 stabilizer.

(3) Meter range 100 μA fsd.

(4) Calibration is set by preset controls R1 and R2 on the vswr board(s).

TABLE 2 METER SENSITIVITIES: MS445/2

Meter	Range	Sensitivity	Pin	
ME1	30 V	+40 V fsd	-	Note 1 above
	20 V	+40 V fsd	-	
	CURRENT	+0.5 V	-	Notes 1 and 2 above
ME2	INPUT 1, 250 mW	+62 mV for 50 mW	PL2-3	Note 3 above
	INPUT 2, 250 mW	+62 mV for 50 mW	PL1-48	
	FORWARD 1, 1250 W	+9 V for 1000 W	PL2-5	Note 4 above
	FORWARD 2, 1250 W	+9 V for 1000 W	PL1-14	
	REFLECTED 1, 250 W	+3 V for 250 W	PL2-6	
	REFLECTED 2, 250 W	+3 V for 250 W	PL1-30	

Dismantling and reassembly

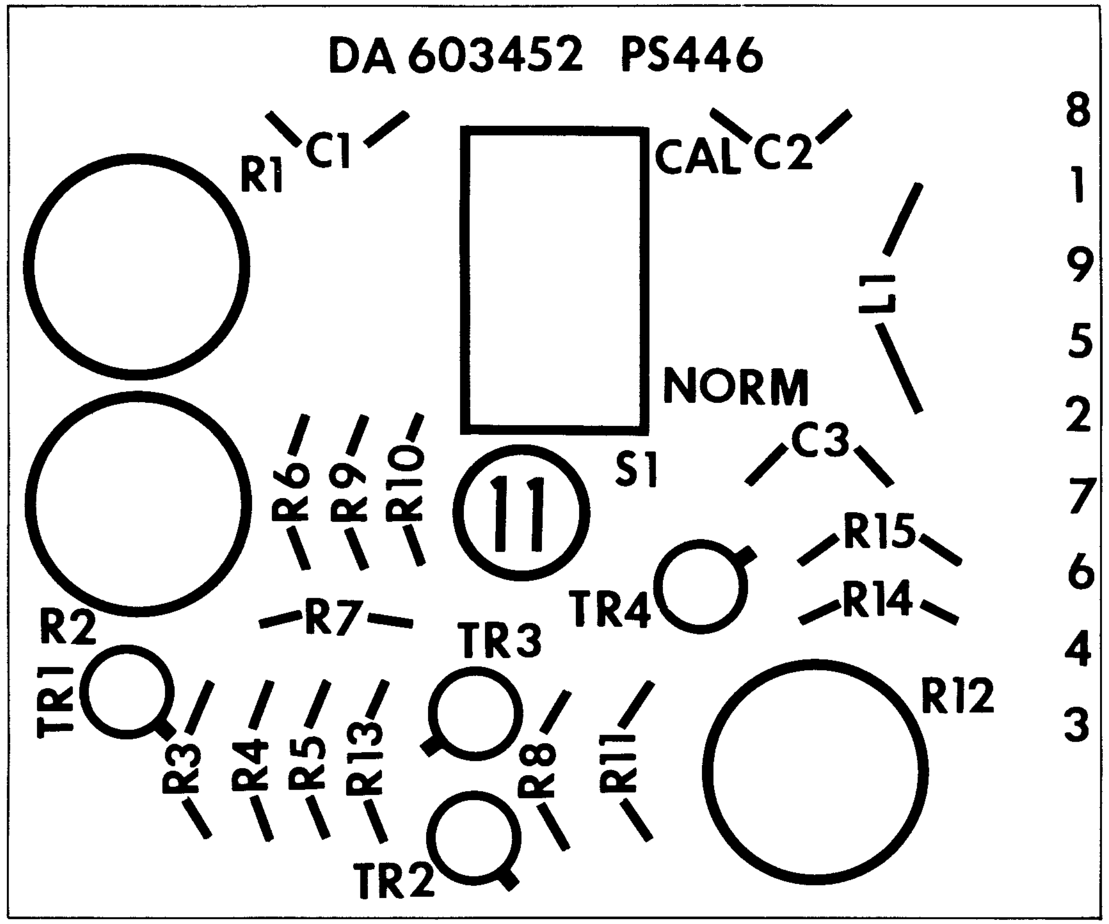
15 The manner of dismantling and reassembly is self-evident.

Post-repair checks and adjustments

16 Meter ME1 ranges are checked by comparison with a 'standard' instrument. No adjustments are required.

17 Instructions for the calibration of the FORWARD and REFLECTED rf power ranges are given in Chap.1-4 and 13-4.

18 Calibration of the INPUT, 250 mW meter range is effected in conjunction with a preset control in the MS444 splitter unit (Chap.3-1). No adjustments are required at the meter panel assembly.



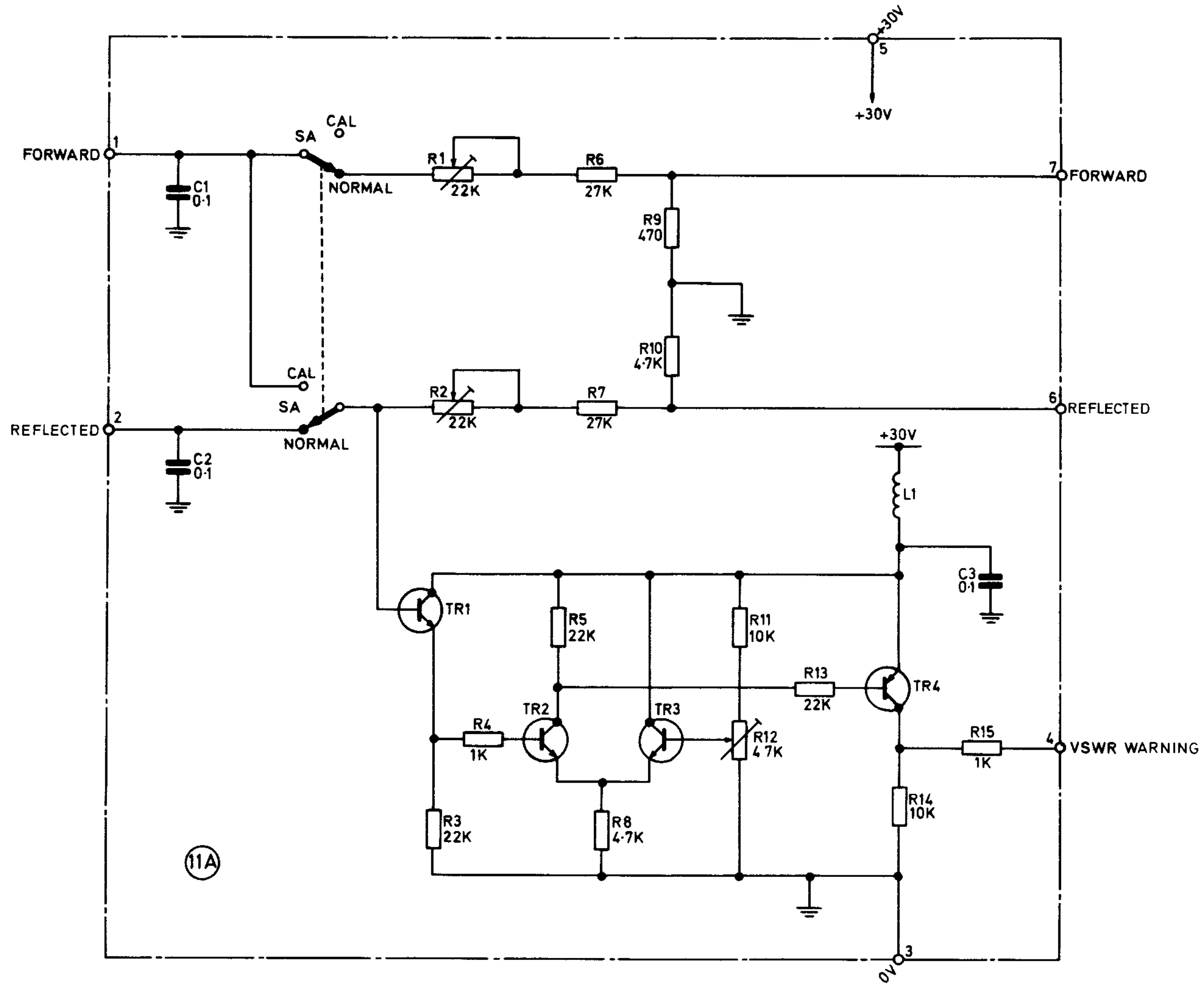
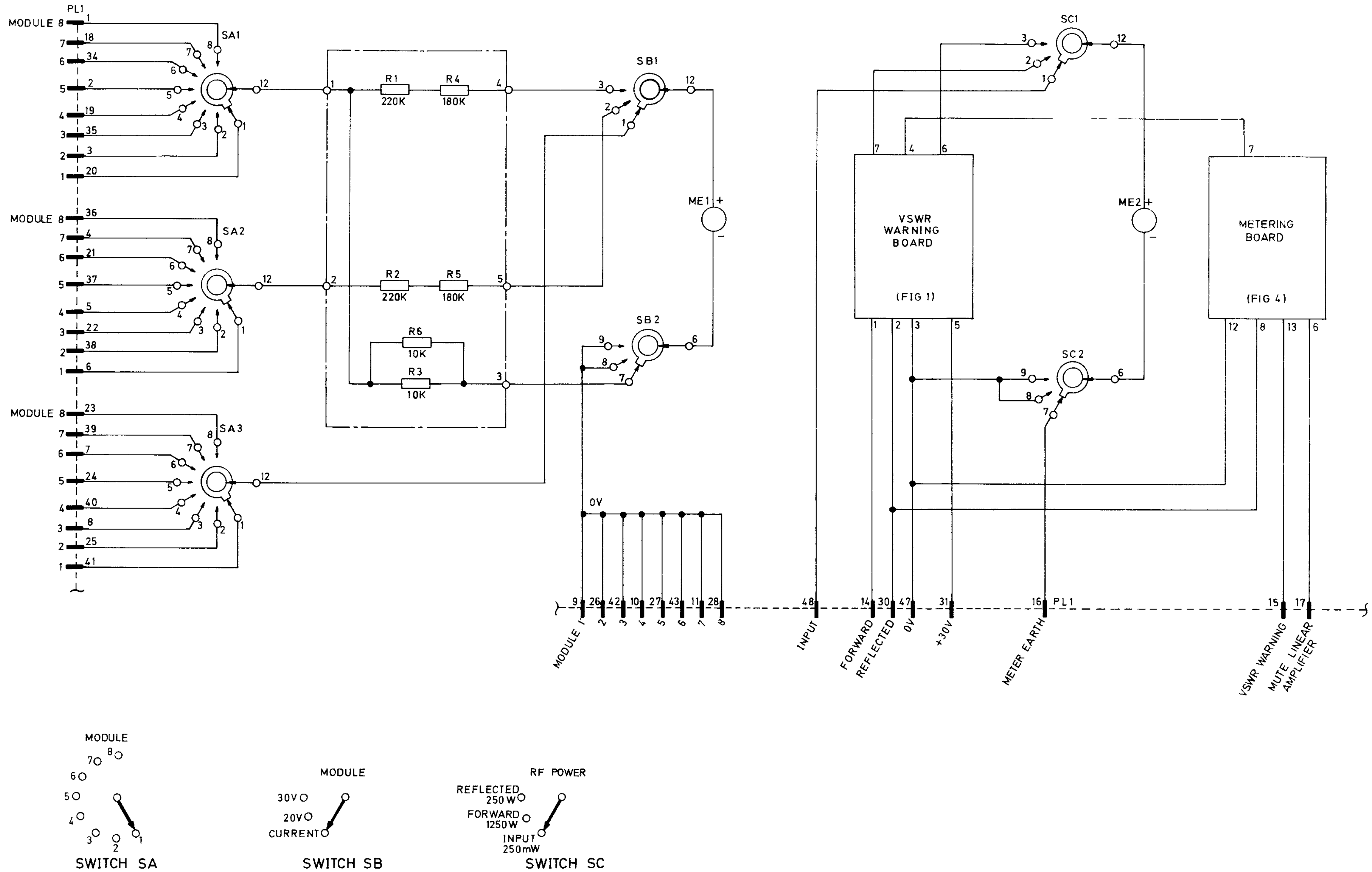


Fig. 1 V.S.W.R. warning board: circuit and component layout



Meter panel assembly MS.445: circuit

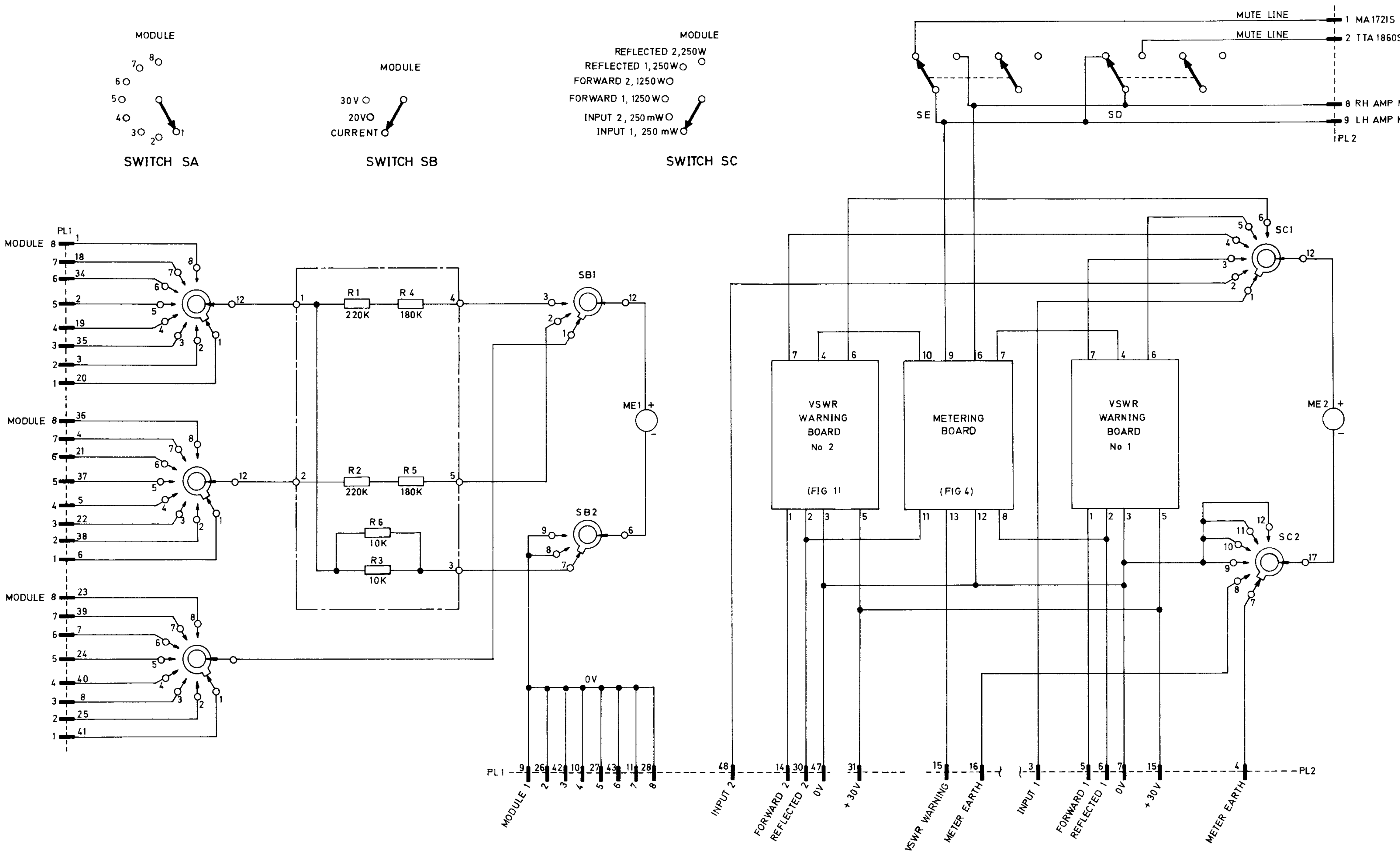
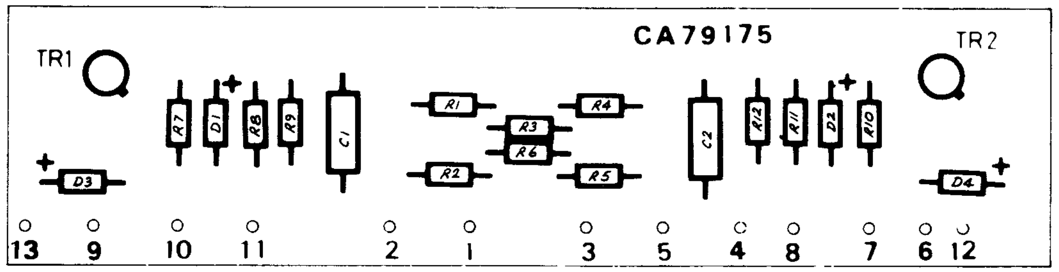


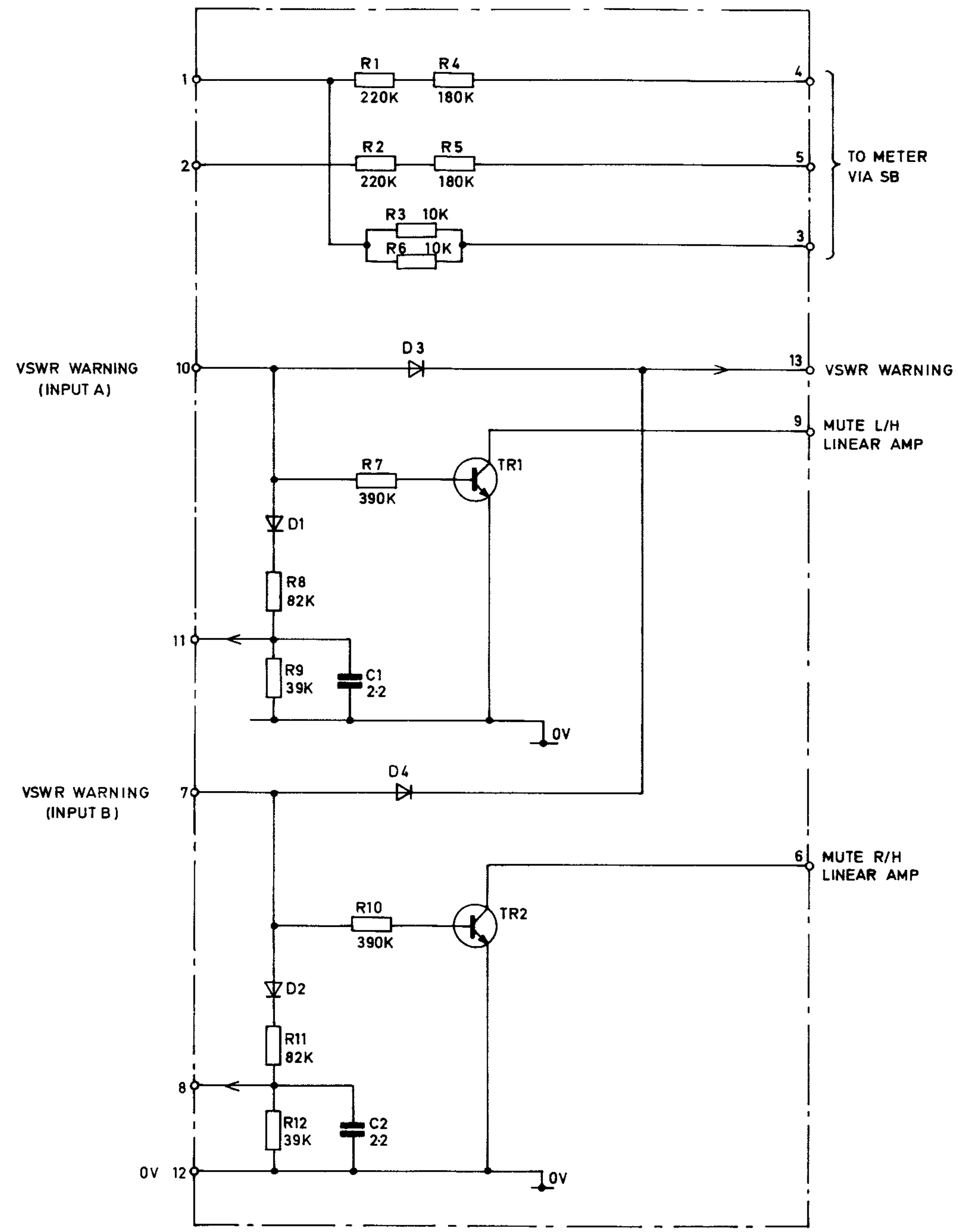
Fig. 3

Meter assembly MS. 445/2: circuit

Dec 80 (Amdt. 12)



NOTE D3 FITTED FOR MS445/2 ONLY



Metering board: circuit and component layout

Chapter 3-6

DESCRIPTION, SERVICING AND REPAIR

COMBINING UNIT MS.441

CONTENTS

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INTRODUCTION

1. The combining unit MS.441 is a passive device containing seven hybrid networks and their associated impedance matching transformers. The MS.441 accepts the individual outputs from the eight r.f. modules and combines them to produce either a single 1 kW output (single-drive) or two 500W outputs (dual-drive).

2. The signals are combined in three stages, viz: pairs of inputs, 'fours' and final combining. Except for the power levels involved, each of the stages is similar; only one will be described in detail (para.16).

3. The complete circuit diagram is given in fig.6.

PRINCIPLES OF OPERATION

Power combining

4. Fig.1 shows the basic hybrid network with all ports correctly terminated.

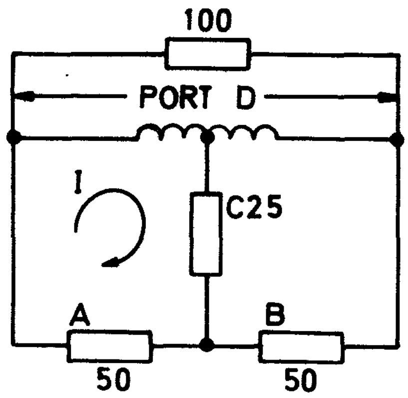

Fig.1 Hybrid network: simplified diagram

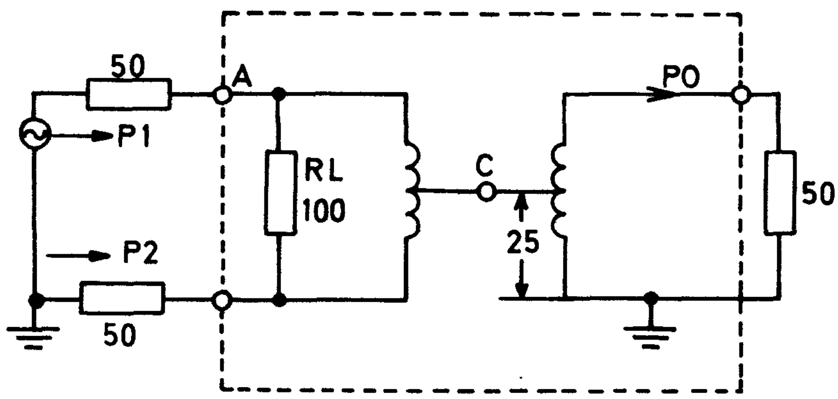

Fig.2 Combining stage: simplified diagram

5. If the r.f. power inputs to ports A and B are equal and in-phase, the resultant mesh currents are additive into port C and the combined power P1 + P2 is developed at this point. No potential difference exists across RL and hence there is no power loss.

6. Matching between port C and the output port of the combiner stage is effected in the second transformer (fig.2).

7. If the r.f. inputs are equal but out-of-phase, the mesh currents into port C cancel; no output is produced. The sum of the input voltages is applied across RL and hence all the power is dissipated in the load resistor.

8. If an r.f. power P1 is applied to port A but none to port B, half of the power input is absorbed in RL and hence the available power output is P1/2. Thus if one of a pair of r.f. modules is switched off, the combined output falls to one quarter of its previous value.

9. Although for maximum power output P1 and P2 should be alike in amplitude and phase, fairly large differences can be tolerated before a significant

reduction in output power occurs. For example, a 10% difference in amplitude results in a power output reduction of approximately 0.2%. A phase difference of 10° results in a power output reduction of 0.75% from the total input power P1 +P2.

Isolation

10. The second basic property of the hybrid network is to provide isolation between the inputs; any impedance change at one input port does not affect the impedance presented to the other.

11. Under normal conditions (fig.3), ports A and B are correctly terminated. No potential difference exists across RL and the power output is P1 + P2 into the 25-ohm impedance at port C. The load presented to port A is 50 ohms.

12. Fig.4 shows the equivalent circuit for a short-circuit at input B. The 50-ohm impedance at the hybrid output is transformed up to 100 ohms at input A, in parallel with RL, giving a resultant input impedance of 50 ohms.

13. Fig.5 shows the equivalent circuit for an open-circuit at input B. The 100-ohm impedance of RL is transformed to 25-ohm in series with the existing 25-ohm load impedance giving a resultant impedance of 50 ohms at input A.

14. It can be shown that input A will always be 50 ohms for all values of impedance appearing at input B.

15. Balancing coils are inserted in series with each load resistor to ensure optimum isolation and input impedance matching over the full frequency range. This offsets the effects of transformer leakage inductance and circuit capacitance which would otherwise degrade the performance.

TECHNICAL DESCRIPTION

16. The eight r.f. inputs from the MM.420 r.f. modules are fed in pairs to their respective hybrid networks.

17. The inputs via SK1 and SK2 (fig.6) are fed to the transformer pair AT3, AT5. The load resistor for this stage (AR3) is connected in series with balancing coil AL1 and current transformer AT1; AL1 in conjunction with C1 provides the frequency compensation. The output from AT1 provides the 'r.f. unbalanced' signal (para.22).

18. The combined output from AT3, AT5 is fed to the second combining stage T1 and T3 together with that from AT4, AT6. Components L3, C5 and C7 provide the frequency compensation for load resistors R5 and R6.

19. The output from T1, at an impedance of 12.5 ohms, is transformed to 50 ohms in T3 and then fed via SK9 to provide one of the 500W outputs. The current transformer T5 provides a sample of the r.f. signal for monitoring purposes.

20. The final stage combining takes place in T7 and T8. The output from T7, at 25 ohms impedance, provides, via T8, the 1 kW output at SK12. A monitoring signal is provided via T9 to SK13.

21. The signal levels for both configurations are given in Table 1.

22. If one or more r.f. inputs is removed, the load resistors for each stage dissipate the out-of-balance r.f. power. The presence of the out-of-balance

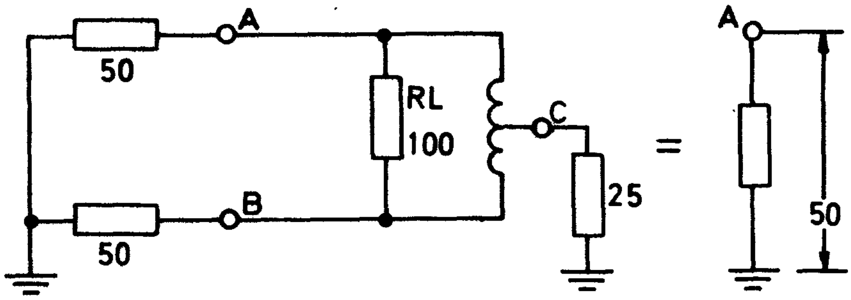

Fig.3 Input impedance, normal conditions

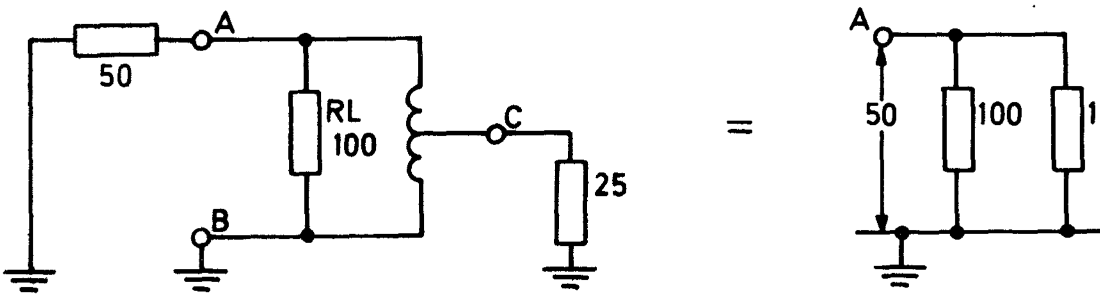

Fig.4 Input impedance, short-circuit at port B

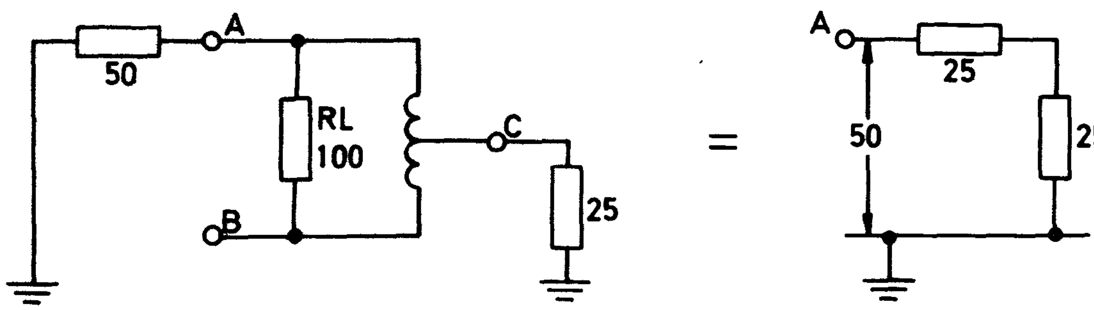

Fig.5 Input impedance, open-circuit at port B

condition is detected by the current flow in either AT1, AT2, BT1 or BT2 and a warning signal is generated.

23. A loss of input to either SK1 or SK2 causes a r.f. voltage to be developed across AR1; this is rectified by diode AD1. A d.c. signal (+5V nominal) is fed via pin 8 of PL1 to the overload unit MS.443 (Chap.3-3) and hence gives a REDUCED POWER indication at the drive unit.

TABLE 1

Signal voltages, combining unit

Connector	Function	Level, V r.m.s.	
		1 kW output	2 X 500W outputs
SK1	Input	80	80
SK2	Input	80	80
SK3	Input	80	80
SK4	Input	80	80
SK5	Input	80	80
SK6	Input	80	80
SK7	Input	80	80
SK8	Input	80	80
SK9	Output	160	160
SK10	Output	160	160
SK11	Monitor	0.7	0.7
SK12	Output	225	-
SK13	Monitor	1.0	-
SK14	Monitor	0.7	0.7

Notes...

(1) All voltages are nominal levels.

(2) All outputs SK9 to SK14 terminated into 50 ohms.

SERVICING AND REPAIR

Fault location

24. Fault-finding is carried out with the aid of the technical description. A fault in a combining stage is localized by passing a low-level r.f. signal 'backwards' through the networks and comparing the responses in the 'good' and suspect paths.

25. To check the final combining stage:-

(1) Disconnect PL2 and PL3. Terminate them into 50 ohms.

(2) Connect the r.f. signal generator to SK12.

(3) Set the generator for c.w. operation at a frequency of 10 MHz. Set the signal input level to 1V r.m.s.

(4) Measure the output levels at PL2 and PL3 which should be 0.71V r.m.s (nominal); if not, check for a 0.71V r.m.s. signal across C9.

26. To check the first and second stages:-

(1) Terminate SK1 to SK4 into 50 ohms.

(2) Connect the signal generator to SK9. Set the signal input level to 1V r.m.s.

(3) Measure the output levels at SK1 and SK2 which should be 0.5V r.m.s. (nominal); if not, check for a 0.5V signal at C5 and a 0.71V signal at C1.

(4) Check that the output levels at SK3 and SK4 are 0.5V r.m.s.

(5) Transfer the 50 ohm terminations to SK5 to SK8.

(6) Connect the signal generator to SK10.

(7) Check that the output levels at SK5 to SK8 are 0.5V r.m.s.

27. A fault in T5, T6 or T9 will be evident from normal high-level operation (Table 1).

Dismantling and reassembly

28. The manner of dismantling is self-evident after removal of the top cover; reassembly is effected in the reverse order.

Post-repair checks

29. Having located and replaced the faulty component, re-fit the complete MS.441 to the transmitter. Carry out the functional checks given in Chap.1-4 and 13-4.

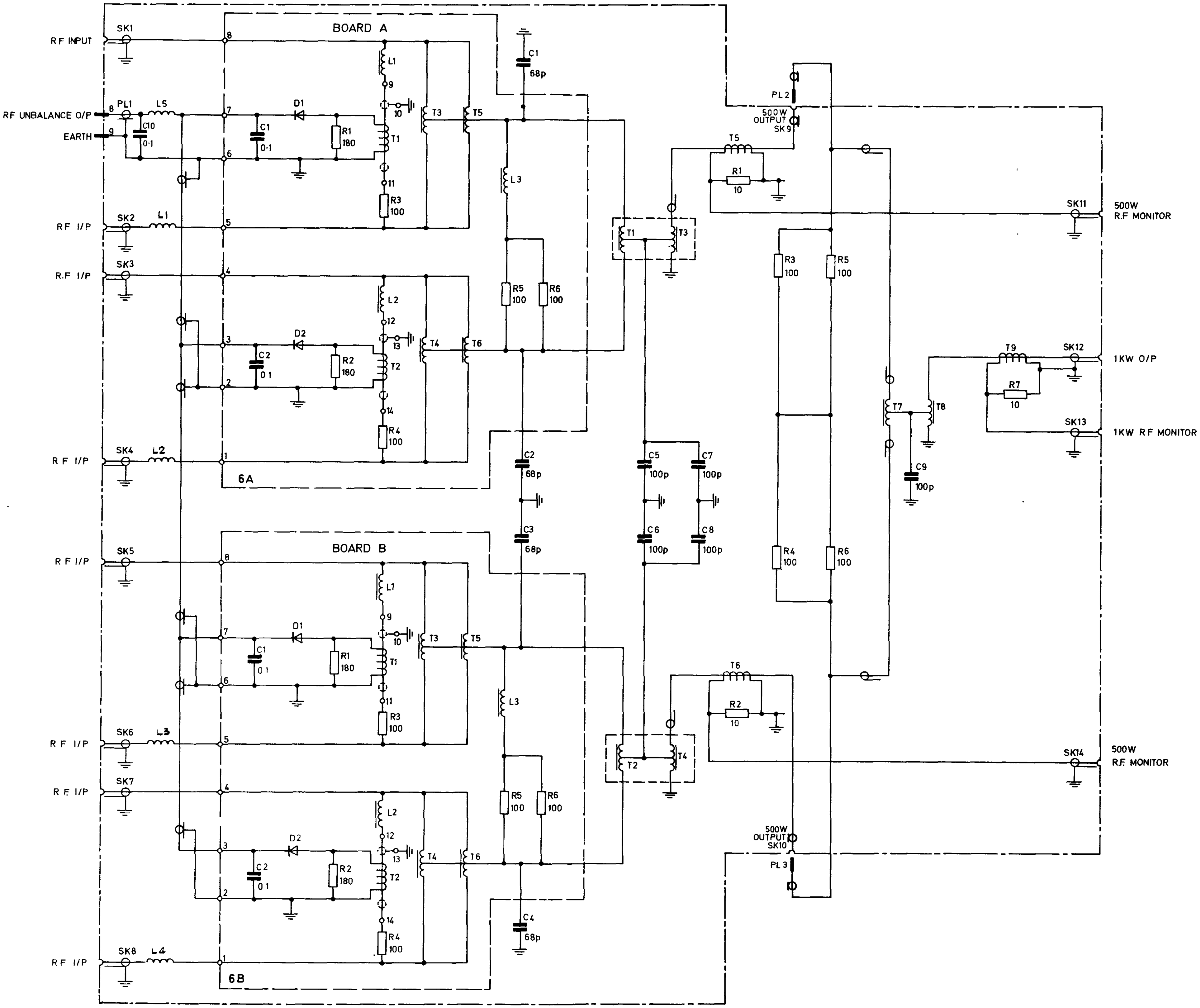

Fig.6

Combining unit MS.441: circuit

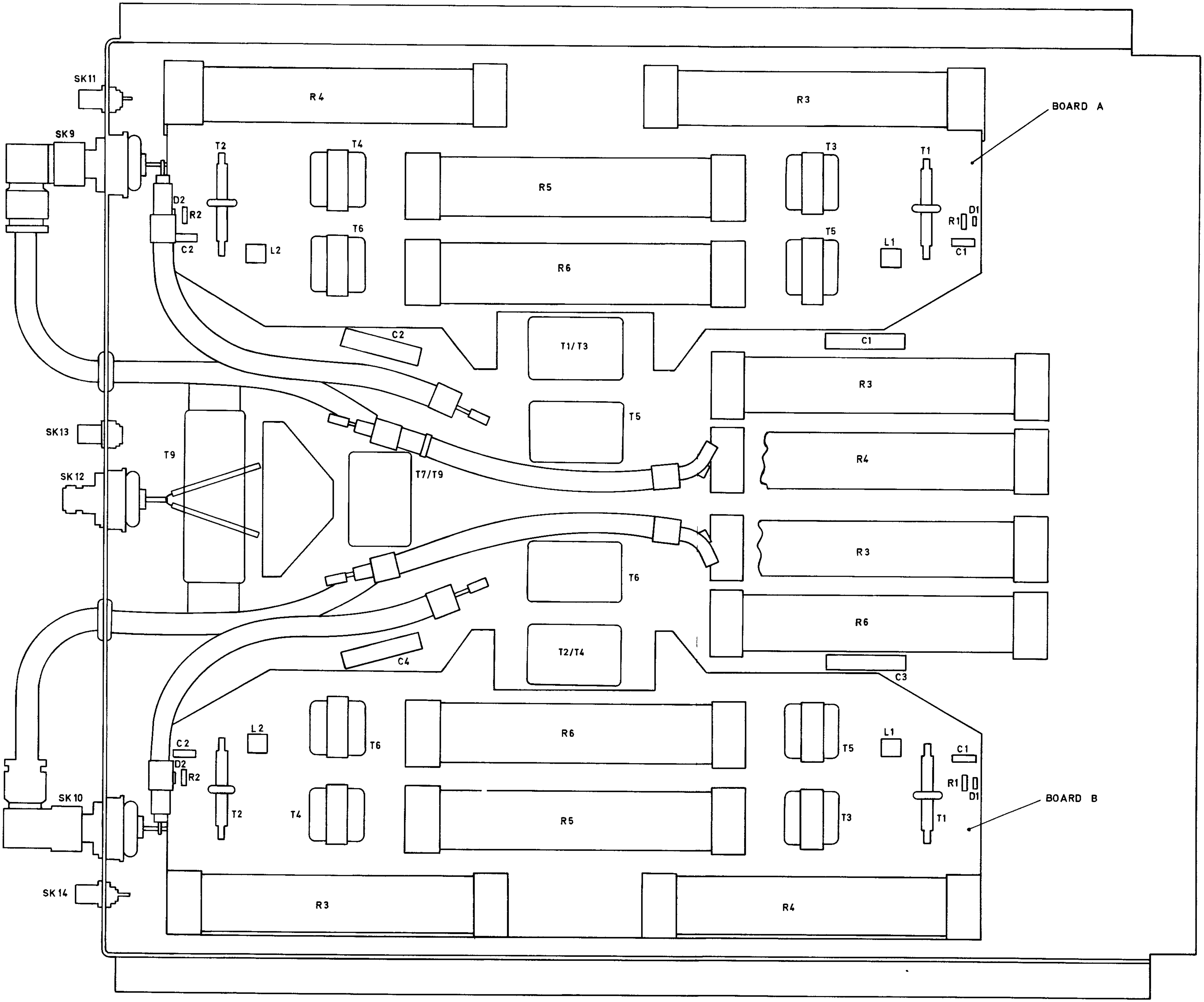

Fig.7

Combining unit MS 441: component layout

Fig. 7

Chapter 3-7

DESCRIPTION, SERVICING AND REPAIR

MUTING UNIT MS.564

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ILLUSTRATIONS

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INTRODUCTION

1. The MS.564 muting unit provides the muting facility for the low-level r.f. input to the linear amplifier. The unit contains a r.f. amplifier stage which is rendered inoperative when a d.c. control signal is applied; when the stage is subsequently de-muted, the r.f. signal is re-applied at a controlled rate.

2. The complete circuit diagram is given in fig. 2.

TECHNICAL DESCRIPTION

R.F. signal path

3. The r.f. input signal is fed via SK2 and an attenuator network to transformer T2; the degree of attenuation is set by soldered links on the board.

4. Transistors TR1 and TR2 form a push-pull class A amplifier stage having approximately unity gain. The r.f. output is fed via T1 and SK1 to the MS.444 splitter unit (Chap.3-1).

Normal operation

5. The base potentials for TR1 and TR2 (+9.3V nominal) are set by Zener diode D3; the emitters assume a potential of about +8.6V.

6. With no 'mute' signal present at pin 3 of PL1, TR6 is conducting; base current is drawn via R22. TR6 emitter potential is set by R20 and R21. A +12V potential exists at D7 cathode and D7 is reverse-biased by about 5V; this potential provides noise-immunity for the 'mute' input.

7. TR6 conduction causes D10 to be 'off' and TR5 base is held at +9.3V via D5 and R17; C8 charges to about +8.5V. A +7.2V potential is developed across R15. Diodes D1 and D2 are reverse-biased and hence have no effect upon the r.f. signal path. The normal signal level appears at SK1.

Muting

8. When the 0V 'mute' signal is applied to pin 3, TR6 is cut off and its collector rises towards +20V. Diode D10 conducts causing D4, D6 and D9 to conduct. TR5 base potential rises to about +12V; its emitter potential rises also, increasing the charge on C8. Transistors TR7 and TR4 follow the voltage rise across C8 and the potential at junction D1, D2 rises to about +10V. Diodes D1 and D2 conduct causing TR1 and TR2 to be cut off.

9. The signal attenuation produced by the muting action is at least 40dB throughout the frequency range.

De-muting

10. When the 'mute' signal is removed, junction D7, D8 reverts to +12V and TR6 again conducts. Diode D10 is reverse-biased and TR5 base potential falls to +9.3V. Capacitor C8 commences to discharge via R16; TR4 and TR7 form a Darlington pair which draws negligible current from C8.

11. During the discharge time of C8 (5 to 7ms), the potential at junction D1, D2 falls progressively to about +7.2V. Transistors TR1 and TR2 start conducting and hence the r.f. output level is restored to 'normal' at a controlled rate.

SERVICING AND REPAIR

Fault location

12. Fit the suspect unit to a serviceable transmitter (e.g. the bench slave equipment). Carry out a functional check and hence confirm the fault symptoms found at user level (Chap.1-3 or 13-3).

13. Fault-finding is carried out with the aid of the technical description and Table 1.

TABLE 1

Electrode potentials, muting unit

Electrode		Normal operation	Muted
TR1	emitter	+8.6V	+10V
	base	+9.3V	+9.3V
	collector	+20V	+20V
TR2	emitter	+8.6V	+10V
	base	+9.3V	+9.3V
	collector	+20V	+20V
TR3	emitter	+9.3V	+9.3V
	base	+10V	+10V
	collector	+20V	+20V
TR4	emitter	+7.2V	+10V
	base	+7.9V	+10.7V
	collector	+20V	+20V
TR5	emitter	+8.5V	+12.1V
	base	+9.3V	+11.4V
	collector	+20V	+20V
TR6	emitter	+6.4V	+6.4V
	base	+7.1V	+1.4V
	collector	-	+12.6
TR7	emitter	+7.9V	+10.7
	base	+8.5V	+11.4
	collector	+20V	+20V
D7	cathode	+12V	+0.7V
D8	cathode	-	0V

Dismantling and reassembly

14. The manner of dismantling is self-evident after removal of the top cover; reassembly is effected in the reverse order.

Post-repair checks and adjustments

15. Having located and replaced the faulty component, re-fit the complete MS.564 to the transmitter and carry out the functional checks given in Chap. 1-4 or 13-4.

16. Post-repair adjustments are required only after the replacement of either TR4, TR7 or C8. The procedure, which sets the value of R16, is as follows:

(1) Switch OFF the main a.c. supply to the TTA 1860 cabinet.

(2) Remove the power supply front panel and obtain access to the MS444 splitter unit.

(3) Remove the top cover from the splitter unit.

(4) Connect the channel 1 input of the storage oscilloscope (ALTE item A11) to pin 13 on the splitter unit board PS.318.

(5) Obtain access to the connectors located at the lower rear part of the cabinet.

(6) Connect the channel 2 input of the oscilloscope to terminal 10 (MUTE) on tagstrip 1TB9.

(7) Switch ON the main a.c. supply to the TTA 1860, and set the ON/OFF/REMOTE switch to ON.

(8) Set the SUPPLY pushbutton on the MA1720 to ON.

(9) Set up the MA1720 for operation at a frequency of 2.0 MHz.

(10) Set the oscilloscope to trigger and store from a positive-going 'edge' input to channel 2.

(11) Press the RESET pushbutton once on the MA1720 whilst observing the oscilloscope. The signals displayed on the oscilloscope should be the Mute signal on channel 2 and the r.f. drive signal on channel 1.

(12) Measure the time-delay between the start of the step-function on channel 2 and the level part of the r.f. waveform; this should be in the range 3 ms to 8 ms.

(13) Set the MA1720 for operation at a frequency of 29.999 MHz.

(14) Repeat operations (11) and (12).

(15) If the desired values of time-delay are not obtained, switch OFF and gain access to the PS.565 muting unit board.

(16) Make an appropriate change to the value of R16 on the PS.565 board, to increase or decrease the time-delay as required. Then repeat operations (9) to (14). The value finally selected for R16 should be either 5.6, 4.7, 3.9 or 2.7 kilohms.

(17) On completion, disconnect the test equipment as appropriate and refit any covers which have been disturbed.

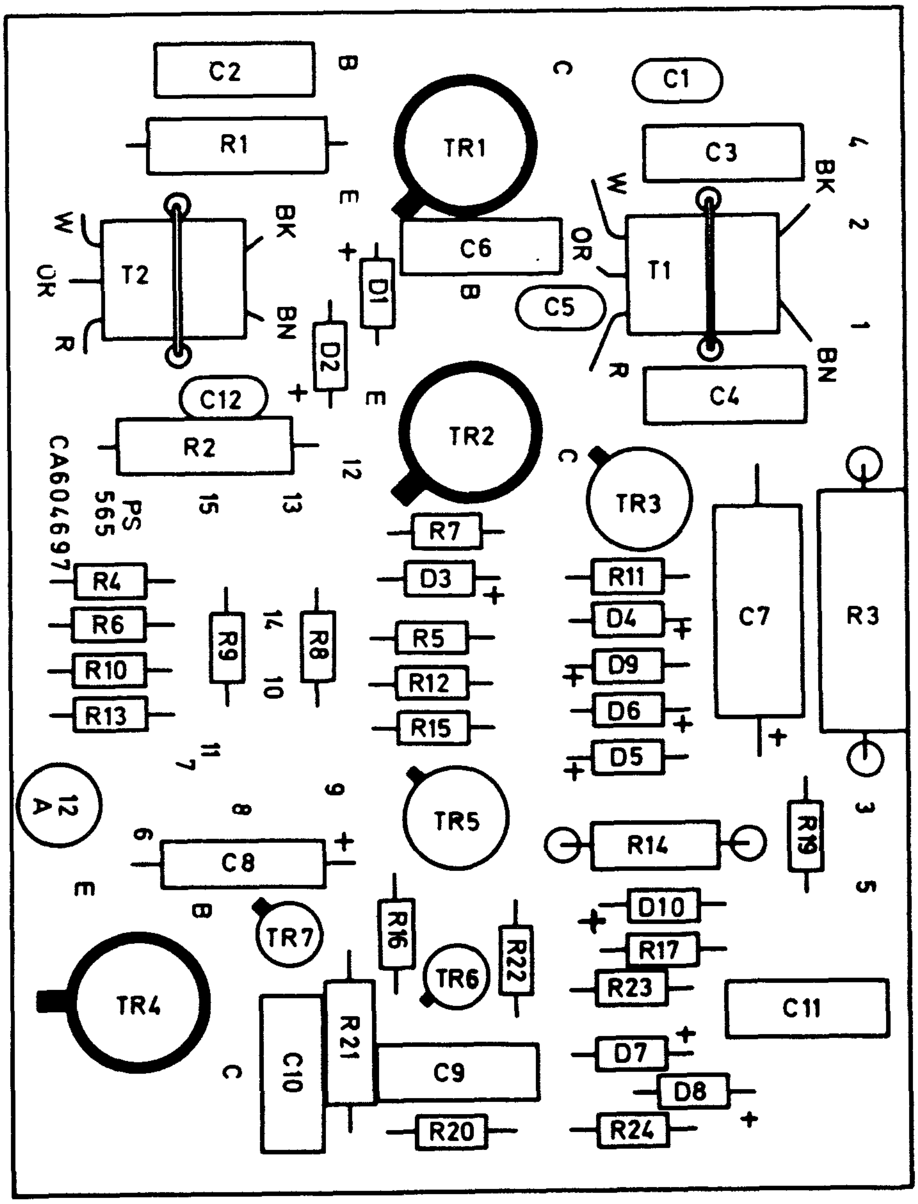

Fig. 1 Muting unit board : component layout

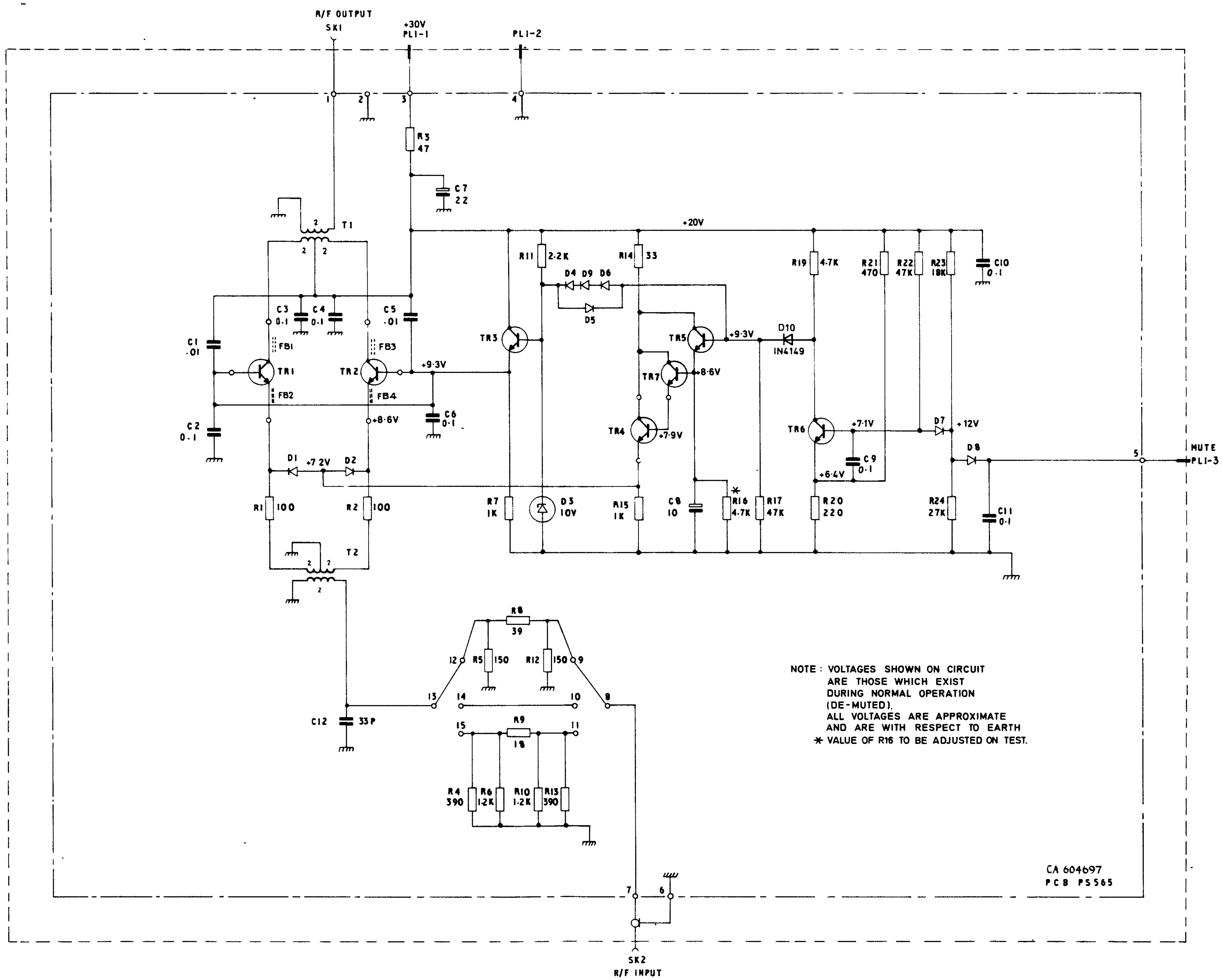

Fig. 2 Muting unit MS.564: circuit Fig. 2

Chapter 3-8

DESCRIPTION, SERVICING AND REPAIR

POWER SUPPLY UNIT MS.64 AND PROTECTION BOARD

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► 5 Surge protection (pre-Mod. A 9003)
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INTRODUCTION

1. The function of the protection board is to control the current surge at switch-on; hence it is described in conjunction with the MS.64 power supply units.

2. The d.c. supplies for the linear amplifier are provided by four MS.64 units (PSU 1 to 4, Chap.1-0 and 13-0) whose outputs feed the stabilizers in the r.f. modules (Chap.4-0).

TECHNICAL DESCRIPTION

Power supply

3. Each MS.64 power supply unit provides two separate d.c. outputs from the 200V to 250V single-phase supply. The d.c. outputs are:-

(1) +36V, rating 30A.

(2) +42V rating 100mA.

4. Two versions of the unit, designated MS.64/1 and MS.64/2, are in Service use. The circuit diagrams are given in fig.4 and 6 respectively. The MS.64/2 operates from 200V to 250V supplies only; the units are otherwise interchangeable. The physical differences will be self-evident from fig.3 and 5. The power transformer carries two secondary windings, each feeding a bridge recitifier. The +36 V output is smoothed by a choke-input filter; the +42V output is developed across a single smoothing capacitor.

Surge protection (pre-Mod. A 9003)

5. A protection board and associated components (fig.1 and 1A) is provided for each pair of power supply units. The circuits being similar, the sequence is given for PSU 4.

6. At the instant of switch-on (the smoothing capacitors being discharged), the MS.64 presents a low impedance to the a.c. supply. To avoid excessive 'in-rush' current, the a.c. input is applied via surge-limiting resistors 1R1 and 1R2. Capacitors C3 to C5 start to charge and the +36V output from PSU 4 appears between pins 1 and 8 of the board.

Note...

The +36V output from PSU 3, rising simultaneously with that of PSU 4, appears at pin 2. Diodes D1 and D4 prevent interaction between the +36V supply rails.

7. The potential at 1TR1 base rises in sympathy with the supply voltage and, when it reaches +15V, Zener diode D3 starts to conduct.

8. Transistor TR1 is switched on and causes 1TR1 to conduct. Relay RLA/1 is energized and contacts RLA1 apply a short-circuit across 1R1 and 1R2.

9. The full a.c. input is now applied to the MS.64, the +36V supply rises to its nominal value and RLA/1 is held energized.

10. Under no-load conditions, the potential at pin 1 rises to about +60V. Zener diode D2 conducts and hence limits the voltage applied to the relay coil to about 38V. The rise in supply potential is absorbed in 1TR1.

▶ Surge protection (Mod. A 9003)

11. A surge protection board and associated components (fig 2 and 2A) is provided for each pair of power supply units. Both circuits are similar therefore only one will be described.

12. The circuit incorporates current limit resistors (1R1 and 1R2) which are shorted out after a pre-determined time, by the solid state relay RLA. which in turn is operated from the surge protection board.

13. Circuit action is as follows:-

(1) At the instant of switch-on all capacitors are discharged, all relays are in their normally open-states, and the a.c. input is applied to MS64 power supplies via current limit resistors 1R1 and 1R2.

(2) A reduced a.c. input voltage is also applied to the diode bridge (via 1R7) on the surge protection board. As the positive rail becomes established zener diode D5 will hold the rail to +12 volts.

(3) When the positive rail is present R3 and zener diode D8 will provide a bias voltage of +8 volt to the gate of TR1 (a programmable unijunction).

(4) The positive rail is also charging C2 via R1. When the potential on the anode of TR1 exceeds that on the gate, TR1 will conduct and a positive pulse from the top of R5 will give SCR1. ◀

(5) When SCR1 fires the solid state relay RLA becomes energised and its normally-open contacts close to short out the current limit resistors 1R1 and 1R2, thus providing a full a.c. input to the MS64 power units.

(6) When SCR1 has fired, C2 is shorted out via D6 and SCR1 to prevent further charging and discharging, and TR1 is held in its off state.

SERVICING AND REPAIR

14. The operating potentials within the MS.64 will be self-evident from the circuit diagrams. Fault-finding is carried out in accordance with established practice - with due observance of safety precautions.

15. The dismantling and reassembly procedures will be self-evident.

16. Fault finding on the protection board is carried out with the aid of either para.5 to 10 and Table 1 on equipments where modification A 9003 has not been carried out, or para 11 to 13 where the modification has been carried out.

TABLE 1

Operating potentials, protection board (pre-Mod. A 9003)

Electrode		Voltage
TR1	emitter	0V
	base	+0.7V
	collector	+0.7V
1TR1	emitter	+35V
	base	+36V
	collector	+36V
D3	anode	+20V
	cathode	+35V

Note...

Voltage levels given are nominal values for a +36V input to either pin 1 or pin 2.

Post-repair checks and adjustments

17. The serviceability of the MS.64 power supply units and the protection boards is proved by the functional checks given in Chap.1-4 or 13-4. With the exception of supply voltage selection, no adjustments are required.

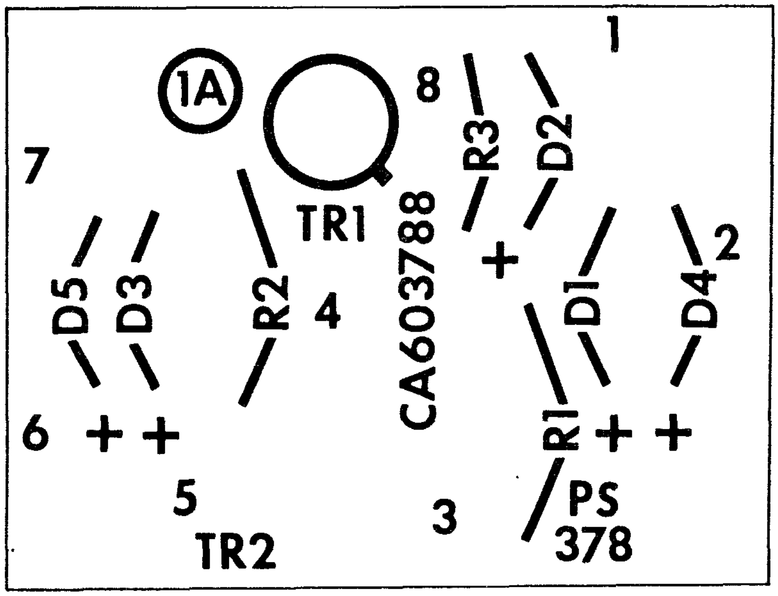


Fig. 1 Protection board : component layout (pre-Mod A9003)

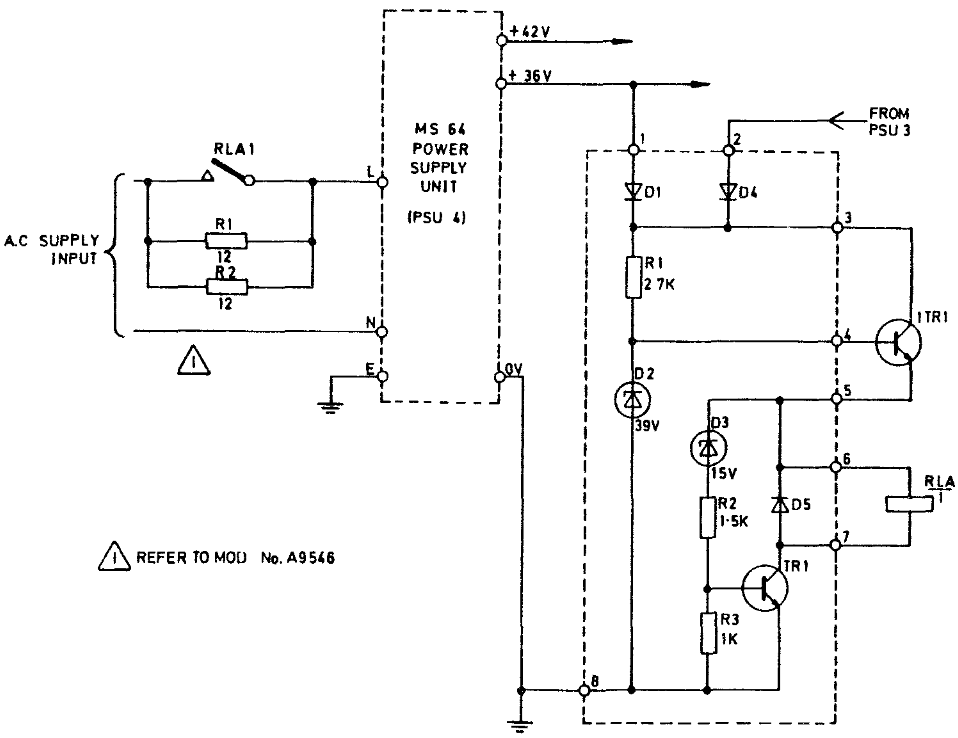


Fig. 1A Protection board :circuit (pre-Mod A9003)

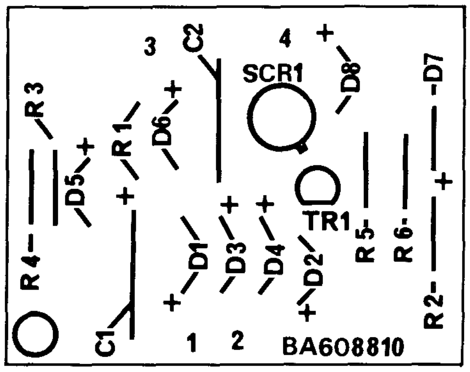


Fig. 2 Protection board : component layout (Mod. A9003)

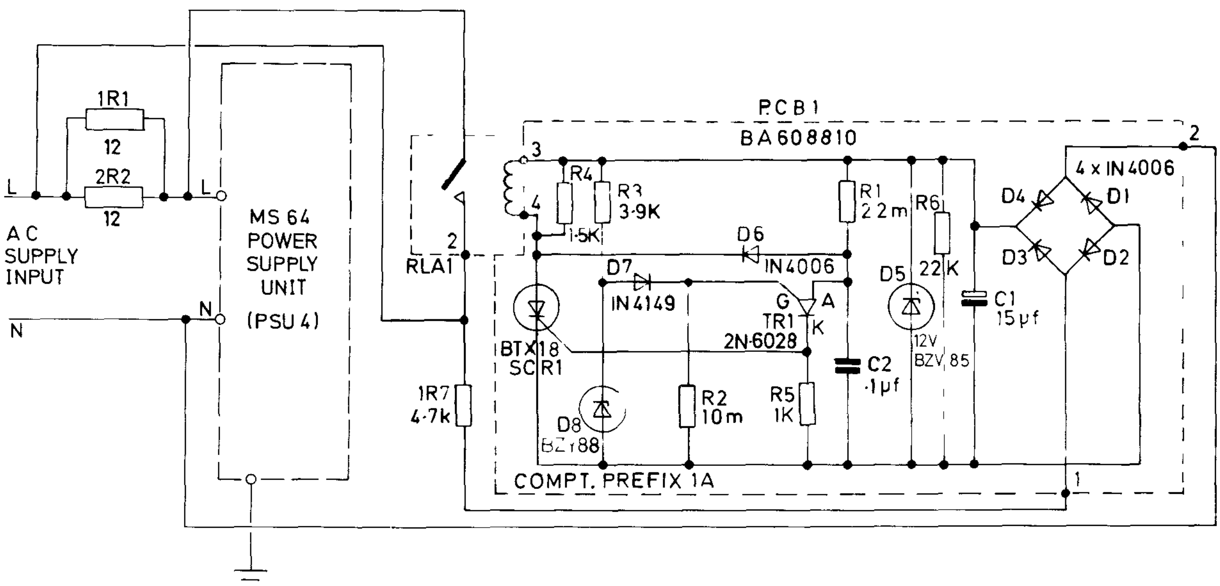
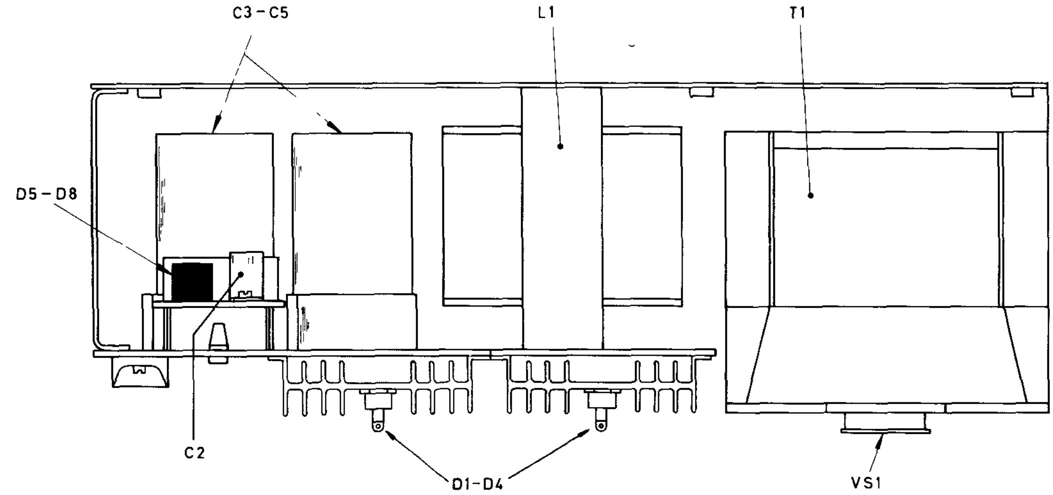
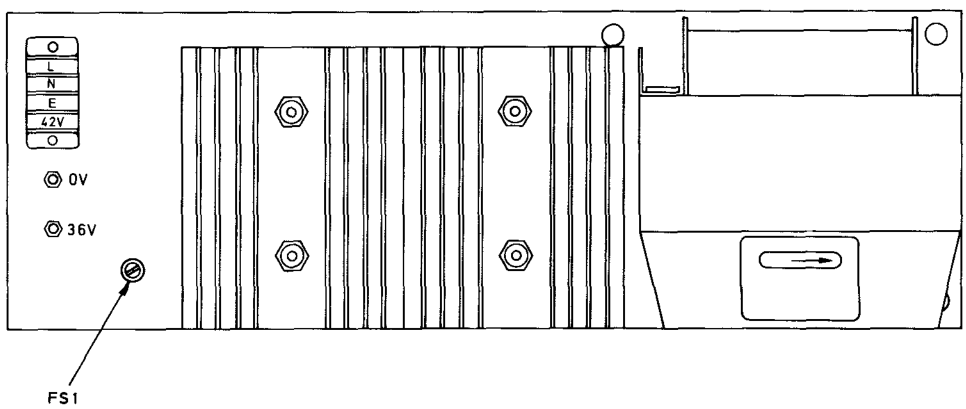


Fig. 2A Protection board : circuit (Mod A9003)

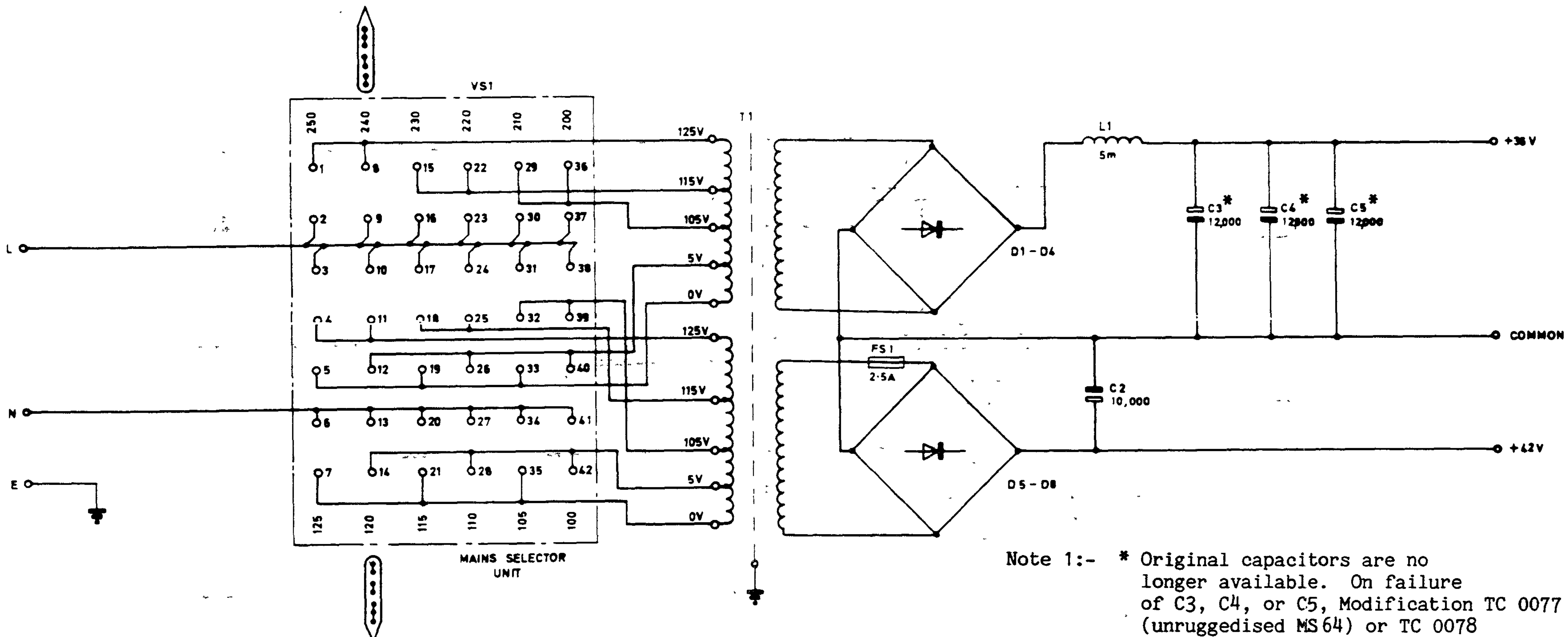


TOP VIEW



FRONT VIEW

Fig. 3 Power supply unit MS. 64/1 : component layout



Note 1:- * Original capacitors are no longer available. On failure of C3, C4, or C5, Modification TC 0077 (unruggedised MS 64) or TC 0078 (ruggedised MS 64) should be embodied. Value of capacitors will then be 10,000 μF.

Fig. 4 Power supply unit MS. 64/1: Circuit

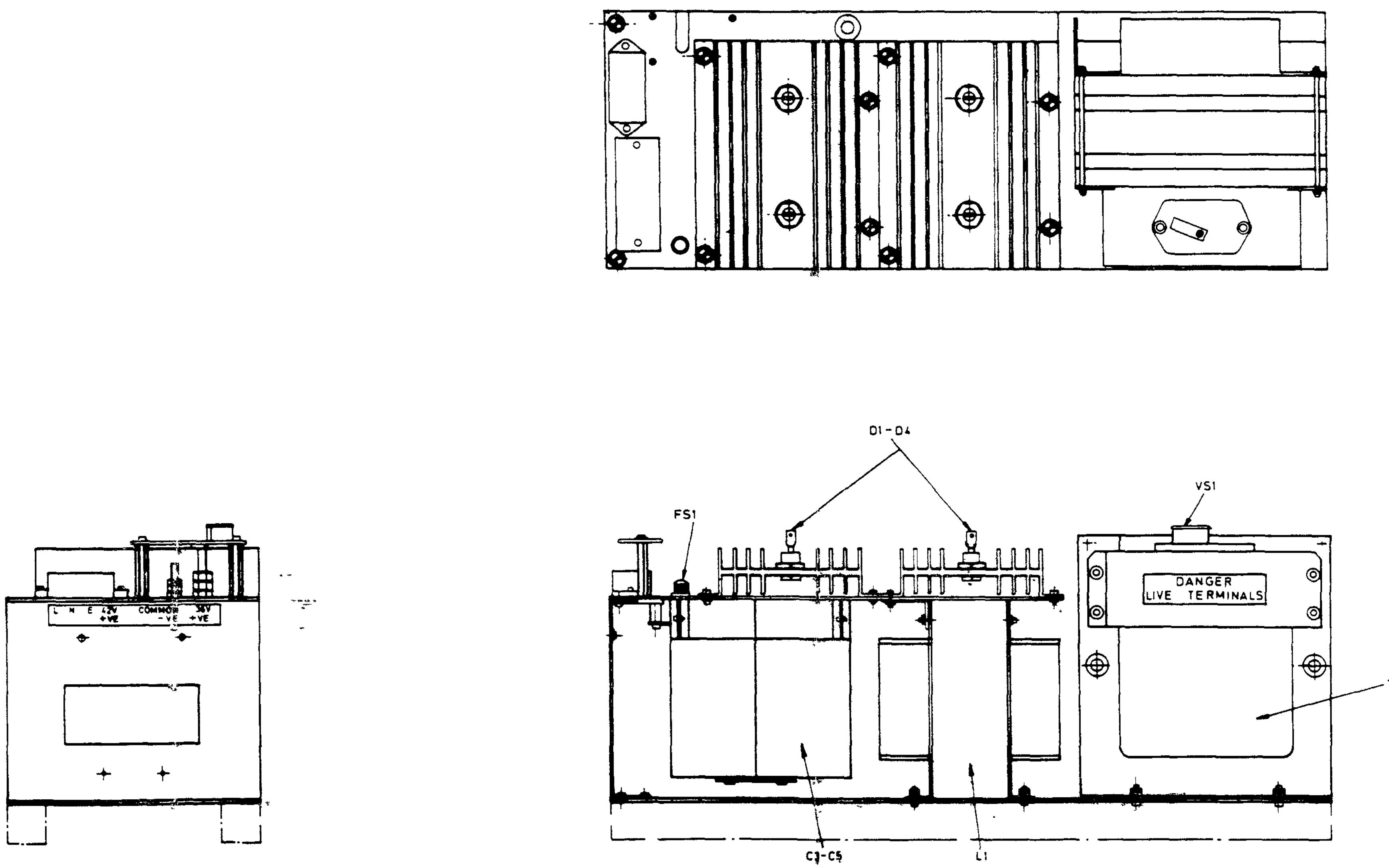


Fig. 5 Power supply unit MS.64/2: component layout Fig.5

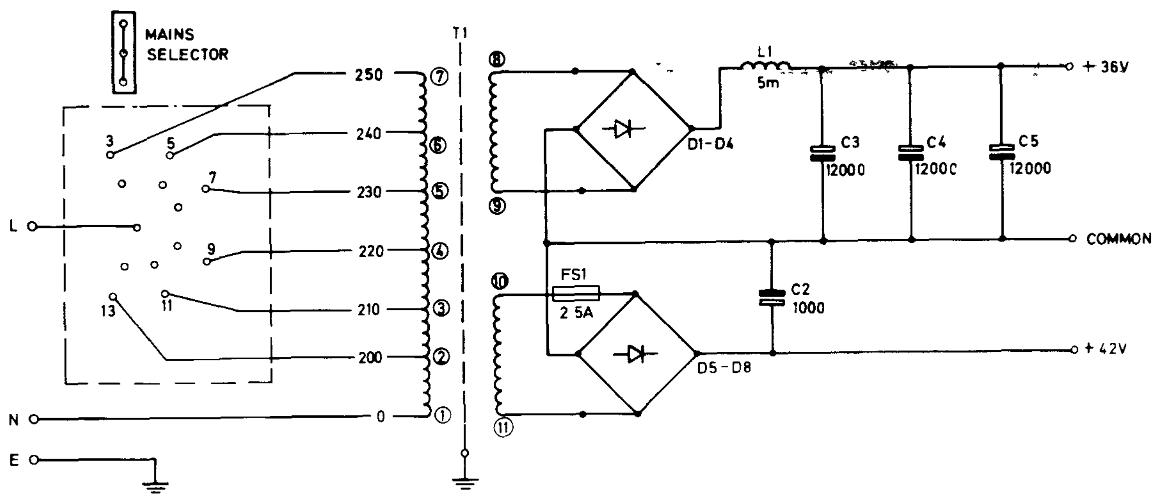


Fig.6 Power supply unit MS.64/2: circuit

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