VHF Transmitter-Receiver

PRM 4700A

Technical Manual

1983

Racal-Tacticom Limited

P.O. Box 112, 472 Basingstoke Road, Reading, Berks. RG2 0QF
Tel: Reading (0734) 875181 Telex: 848011

Prepared by Group Technical Handbooks Department, Racal Group Services Limited

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HANDBOOK AMENDMENTS

Amendments to this handbook (if any), which are on coloured paper for ease of identification, will be found at the rear of the book. The action called for by the amendments should be carried out by hand as soon as possible.

BERYLLIUM OXIDE - SAFETY PRECAUTIONS

INTRODUCTION

The following safety precautions are necessary when handling components which contain Beryllium Oxide. Most RF transistors contain this material although Beryllium Oxide is not visible externally. Certain heatsink washers are also manufactured from this material.

PRACTICAL PRECAUTIONS

Beryllium Oxide is dangerous only in dust form when it might be inhaled or enter a cut or irritation area. Reasonable care should be taken not to generate dust by abrasion of the bare material.

Power Transistors

There is normally no hazard with power transistors as the Beryllium Oxide is encapsulated within the devices. They are safe to handle for replacement purposes but care should be exercised in removing defective items to ensure that they do not become physically damaged.

They MUST NOT:

(a) be carried loosely in a pocket, bag or container with other components where they may rub together or break and disintegrate into dust,

(b) be heated excessively (normal soldering is quite safe),

(c) be broken open for inspection or in any way abraded by tools.

Heatsink Washers

Heatsink washers manufactured from Beryllium Oxide should be handled with gloves, cloth or tweezers when being removed from equipment. They are usually white or blue in colour although sometimes difficult to distinguish from other types. Examples of washers used are 917797, 917216 and 700716.

They MUST NOT:

(a) be stored loosely,

(b) be filed, drilled or in any way tooled,

(c) be heated other than when clamped in heatsink application.

DISPOSAL

Defective and broken components must not be disposed of in containers used for general refuse. Defective components should be individually wrapped, clearly identified as "DEFECTIVE BERYLLIA COMPONENTS" and returned to the Equipment Manufacturer for subsequent disposal.

CMOS HANDLING PRECAUTIONS

The input impedance of a CMOS device is of the order of 10^{14} ohms. The breakdown of voltage of the oxide within the device is about 100 volts. As static voltages of up to 4KV can be generated by stroking silk, nylon or creative plastic containers, it is essential that precautions are taken to prevent high voltages occurring at the leads of CMOS devices, as follows:

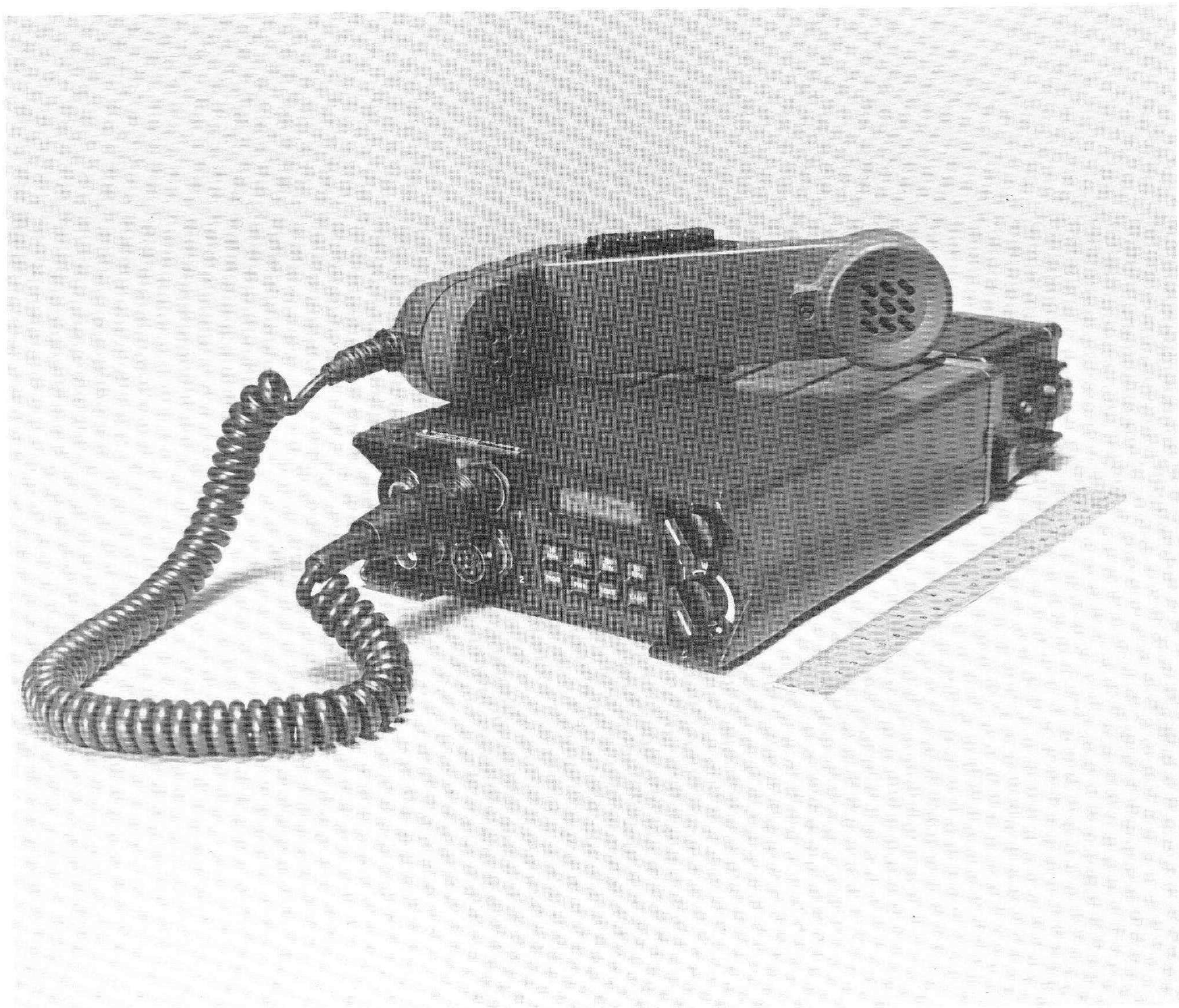
(1) The tips of soldering irons should be earthed to the earth plane of the board being soldered.

(2) The devices should not be stored in plastic bags or containers (unless the plastic has been specially treated with anti-static chemicals).

(3) Operators should not wear nylon or plastic gloves, or rubber-soled shoes.

(4) As many leads as possible should be 'shorted' with the fingers during handling.

(5) Do not remove the input connection with the device connected to the supply rail.



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TH 5160/1

PRM 4700 VHF Transmitter Receiver

PRM 4700

VHF TRANSMITTER RECEIVER

CONTENTS

PART 1

PRM 4700 VHF TRANSMITTER RECEIVER

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

GENERAL

Frequency Range:	30MHz to 88MHz
Channels:	9 programmable and 1 manually selectable from a possible 2321
Channel Spacing:	25KHz
Frequency Stability:	Better than ± 10 ppm
Operating Mode:	Simplex; or two frequency simplex (half duplex) on the programmable channels only. Voice (F3E); data (FID), or encrypted Voice (FIE) up to 16K bit/sec.
Duty Cycle:	Continuous without external or internal forced cooling up to +55^{o}C (for supplies up to 12 V, and O/C Load).
Antennas:	0.5m helical or, 1m tape antenna, 1.4m or 2.5m whip
Power Supply:	10V 2Ah Nickel Cadmium battery, type MA 4705A 10V Alkaline Manganese Primary battery, type MA 4705B ('D' cells) or MA 4705C ('C' cells) Regulated supply from TA 4703A Amplifier or MA 4704A Vehicle Interface Unit.
Battery Life:	MA 4705A 10 hours MA 4705B 35 hours) Dependent upon cell type, quality and age MA 4705C 8 hours) at 20^{o}C for 1:1:8, Transmit: Receive: Standby Ratio (10 sec. Tx).
Weight:	PRM 4700 2.0 kg; with MA 4705A 3.0 kg.
Current Consumption:	Standby 30mA Typical Receive 100mA Typical — at 10.5V supply Transmit 1.5A typical 1.8A max.
Dimensions:	Width 158mm Height 58mm Depth 210mm (282mm including MA 4705A) (347mm including MA 4705B)

TRANSMITTER

Output Power (nominal)	Manpack: Low 10mW High 4W Vehicle: High 25W with TA 4703A Amplifier
Peak Deviation: (Nominal)	± 5KHz
AF Response:	Voice 400Hz to 3.0kHz — Less than 6 dB relative to 1 kHz Data: 30Hz to 8.0kHz 'NORMAL VOICE' and 'WHISPER' modes

Pilot Tone:	150Hz with 3kHz deviation (Nominal)
Harmonic Emission:	Better than - 40dB Below Carrier

RECEIVER

Sensitivity: (Nominal)	0.2 µV p.d for 12 dB SINAD with 5KHz deviation.
AF Output Power: (nominal)	1.25mW into 300Ω for 5 kHz deviation.
Squelch: Internal	Carrier operated
External	150Hz Tone operated
Deviation:	Accepts up to 10kHz Deviation (from 50kHz channel spaced Radios)
AF Response:	Voice 400Hz and 3.0kHz. Less than 6 dB down relative to the level of 1 kHz. (Into 300 ohm load).
	Data 30Hz and 8kHz. Less than 3 dB down relative to the level of 1 kHz. (Into 10 k load).

ENVIRONMENTAL

Immersion/Humidity:	All units are enclosed in fully sealed cases.	
Temperature:	Operational	-40^oC to $+70^oC$
	Within full spec.	-30^oC to $+55^oC$
	Storage	-40^oC to $+85^oC$

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

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GENERAL DESCRIPTION

ROLE

1. The PRM 4700 is a VHF FM Transceiver. The equipment can be used in manpack, vehicle or ground station roles.

DESCRIPTION

2. The PRM 4700 is a fully waterproof, extremely compact and lightweight transceiver which operates in the frequency range 30-88MHz. Manual frequency access and nine programmable channels are available, channel selection being carried out by a single switch.

3. Channels may be programmed manually using the front panel keyboard or by using the MA 4073B Programmer or MA 4083B Fill Gun.

4. The radio may be programmed to operate in either simplex or two frequency simplex (half duplex) mode. All nine channels can be programmed for single frequency operation, two frequency operation or a mixture.

5. If required, frequency selection can be carried out manually using the front panel keyboard frequency controls. In this mode, Single Frequency operation only is available.

6. The radio can accept 16k bit/sec digital signals and this allows the use of an optional external encryption device. (MA 4423).

7. A Built in Test Equipment (BITE) facility is provided to check the transceiver each time it is used. This facility checks the accuracy of programmed channels, the control system and the receiver functions. In transmit, power output is confirmed by the presence of sidetone in the handset.

8. The keyboard provides a simple means of operational control incorporating snap action keys. When the handset is connected an audible tone is given confirming that a key entry has been made.

9. As a manpack, the PRM 4700 is normally powered by a 10V nickel cadmium rechargeable battery MA 4705A attached to the base of the unit. The battery can be recharged in situ via a front panel socket. The MA4705B non-rechargeable battery, using primary cells, is available as an alternative. (Battery life is extended by the use of 'economy' circuits in the receive mode). The PRM 4700 can be powered by a regulated supply from the TA 4703A VHF Amplifier or the MA 4704A Interface Unit.

10. The transceiver is designed to provide automatic rebroadcast facilities using the MA 4009B Rebroadcast Unit (Voice signals) or the MA 4709A Rebroadcast Unit (Voice or 16k-bit signals).

11. In the vehicle role, the PRM 4700 is used with the Vehicle Interface Unit (VIU) MA 4704A, or VIU and 25 Watt amplifier TA4703A. Associated AMU's are the BCC 587B (Band Switched) or the BCC 588 (Wide Band).

12. In the ground station role, the PRM 4700 is used with the TA 4703A and MA 949M mains power supply and audio amplifier. Various wide band antennas such as discones or log periodics can be used.

LIST OF ASSOCIATED PUBLICATIONS

13.

Operating Instructions for PRM 4700	Ref TH 5160
Technical Handbook for 25 W Amp. TA4703A and V.I.U. MA4704A	Ref TH 6109
Technical Handbook for Programmer MA4073B	Ref TH 5413
Technical Handbook for Fill Gun MA 4083B	Ref TH 5414
Technical Handbook for Battery Charger MA 945S	Ref WOH 9149
Technical Handbook for Battery Charger MA 978F	Ref WOH 3105
Technical Handbook for Audio Amplifier MA 987C	Ref WOH 6189
Technical Handbook for Loudspeaker Amplifier MA 4988A	Ref TH 5466
Technical Handbook for Rebroadcast Control Unit MA 4009B	Ref WOH 6096
Technical Handbook for Power Unit and Loudspeaker Amplifier MA 949M	Ref WOH 7332
Technical Handbook for A.M.U. BCC 588	Ref TH 5186
Technical Handbook for A.M.U. BCC 587B	
Technical Handbook for Encryption Unit MA 4423	

OPERATING INSTRUCTIONS

CONTENTS

TABLES

ILLUSTRATIONS

OPERATING INSTRUCTIONS

CONTROLS AND CONNECTORS (Reference Figure 2.1)

1. The function of the controls and connectors are as follows:-

(1)	Audio Connector SK1	Used for connection of handset or headset. Also for battery charging and connection of ancillaries. (SK1 is used for data and external programming; SK2 for rebro and vehicle interface connections).
(2)	Audio Connector SK2	
(3)	Whip Socket SK3	For connection of whip antenna.
(4)	Channel Selection Switch (CH)	Set to CH 0 (fully anti-clockwise) or CH 1-9
(5)	Gain Control Switch	Selects power off, audio volume, microphone normal or whisper (W) and squelch disable (*). Microphone sensitivity is increased by 4 times when whisper (W) is selected. The selected levels are:-

Position	
0	Power off
1	Whisper with minimum audio volume
2	Whisper with increased audio volume
3,4,5	Normal microphone operation, increasing audio volume
6	Normal microphone operation, maximum audio volume
7	Squelch disabled with low audio volume, normal microphone
8	Squelch disabled with increased audio volume, normal microphone

KEYBOARD

(6)	10MHz selection switch)	Increments digit(s) each time a key is
(7)	1MHz selection switch)	pressed. Will cycle through digits if

(8)	100kHz selection switch)	key is held pressed for more than one
(9)	25kHz selection switch)	second.
		NOTE: 25kHz selection increments in 25kHz steps.
(10)	PROG	Press once to initiate channel programming sequence for transmit and receive frequencies. Press again to initiate channel programming for receive only.
(11)	PWR	Press to select HI PWR (high power) or LO PWR (low power).
(12)	LOAD	Press to enter programmed frequency into store.
(13)	LAMP	The display is illuminated when this key is pressed.
(14)	50 Ω SOCKET SK4	For connection of dipole antenna or VIU.

NOTE: An audible indication is given in the handset or headset when any key (6) to (12) is pressed, in a valid mode.

DISPLAY

2. The display indicates the status of the transceiver as follows:

XX.XXX MHz	Normally displays the Receiving or Transmitting frequency (different in the case of two frequency simplex). During programming displays the frequency selected ready for entry into store.
CH 0 to 9	Channel 0 is used for manual selection of frequency. Channels 1 to 9 are pre-programmed channels, which can be used for single or two frequency simplex (transmit and receive on differing frequencies).
PROG	Denotes that programming of Tx and Rx channels is selected.
PROG RX	Denotes that programming of Rx channel is selected.
HI PWR	Denotes that High TX output Power is selected.
LO PWR	Denotes that Low TX output Power is selected.
SIGNAL	Denotes that an incoming signal has been detected.

(Approximately 8.0 volts)

PREPARATION FOR USE (See Fig. 2.1 & 2.2)

3. (1) Place the transceiver in the pouch.

(2) Clip the battery to the base of the unit. (See Fig. 2.3)

(3) Clip the flap to the pouch with the padded part under the battery.

(4) Fit the antenna into the whip socket (3).

(5) Connect the handset or the headset to an audio socket (1) or (2).

(6) Close the lid of the pouch, securing the lid around the whip and handset cable.

(7) Fit the pouch on the back, or sling the pouch from the shoulder.

NOTE: Two types of pouch are available, one for backpack use, (the strap clips around the operators belt) or one for hip use (the belt is removable if required, and the operator can strap the pouch to his belt).

OPERATION

4. The transceiver can be operated in channel or manual mode.

OPERATION PROCEDURE - CHANNEL MODE (See Fig. 2.1)

5. (1) Move switch (5) from the OFF position. Check that the complete display (as illustration) is displayed for approximately five seconds (part of BITE, see Chap. 5 Para. 4). The display then presents the channel selected, reception frequency and Tx power level selected.

(2) Select the required channel using switch (4).

(3) The transceiver is now in the receive condition. Adjust gain control (5) to give required listening level, with signal present. (* is squelch disable position and has two volume levels).

(4) If a signal is detected on the selected channel, SIGNAL is indicated in the display.

(5) Press PWR (11) to change power level ready for transmission. HI PWR or LO PWR is indicated. Low power should be used if practicable to extend battery life and reduce the risk of interception.

(6) Press the PTT switch on the handset or headset and speak into the microphone to transmit. NOTE: W = Whisper can be selected on switch (5) for ambush type operation.

NOTE: 1) If required, the PTT switch can be pressed at switch-on, overriding the BITE function and allowing immediate transmission. Quickly releasing the PTT will give immediate reception.

2) The Internal Channel RAM Battery retains the Channel Frequencies when the radio is turned off.

OPERATING PROCEDURE - MANUAL MODE

6. (1) Carry out the procedure given in para. 5(1).

(2) Set switch (4) fully anti-clockwise to display CH 0. The transceiver is now in the receive condition at the frequency last used in manual mode. To change frequency press keys (6) to (9) as required.

(3) Carry out the procedures given in paras. 5(3) to 5(6).

SITING FOR OPERATION

7. The PRM 4700 operates at low power and high frequencies; consequently the location of equipment greatly affects its operating range. Line-of-sight communication normally can be expected, therefore location on a hill top or a tall building will increase the operating range.

Valleys, densely wooded areas and sites near sources of electrical interference should be avoided.

EFFECTIVE RANGE

8. The effective range between manpacks in high power mode using 1.4m whip antennas is approximately as follows:-

Over open rolling terrain	8km
In wooded country	5km
In built-up areas	3km
Over open water	30km

2.5m Whip:	Approximatey 40% increase in range, for lower frequencies
Tape:	Slightly less range than 1.4m Whip
Battle Whip:	Considerably less range than 1.4m Whip, with best range around 50MHz.

AFTER USE

9. After use proceed as follows:

(1) Turn switch (5) to OFF.

(2) Unplug antenna and if using a rod antenna dismantle from the top by withdrawing and folding over each section in turn.

(3) Remove handset or headset.

BATTERY

10. The MA 4705A is a rechargeable battery using ni-cad cells.

11. Cells are protected against an external short circuit by an internal thermistor which automatically resets itself when the short circuit is removed.

MA 4705A BATTERY CHARGING-USING MA 945S (See Fig. 2.4)

12. The MA 945S is a two way charger capable of charging one or two nickel-cadmium batteries detached from the manpack or via audio sockets, with the batteries attached to the radios. Proceed as follows:-

NOTE: The charging rate switch on the MA 945S must be set to Rate 1.

(1) Set the MA 945S SUPPLY switch to OFF, and the SUPPLY VOLTAGE switch to suit the voltage supply, using a screwdriver.

(2) Connect the MA 945S SUPPLY plug to the supply.

(3) If charging is carried out with the battery attached to the radio, set the PRM 4700 switch (5) to OFF.

(4) Plug one of the MA 945S flying leads into

(a) The contacts of the battery, using adaptor lead ST719115, when the battery is removed from the radio,

OR

(b) Plug one of the MA 945S flying leads into an audio socket (1) or (2).

(5) Switch on the MA 945S and check that the associated charging indicator lamp lights.

NOTE: A fully discharged battery will be completely recharged in approximately fourteen hours.

A five way battery charger, MA 978F, is available for charging up to five MA 4705A batteries when detached from the manpack.

CHANNEL FREQUENCY PROGRAMMING

13. Channel frequency programming can be carried out from the front panel (as follows) or by using an MA 4073B Programmer or MA 4083B Fill Gun (refer to appropriate handbooks).

CHANNEL FREQUENCY PROGRAMMING FROM FRONT PANEL (See Fig. 2.1)

14. Channel frequency programming, using the front panel controls, is carried out as follows:-

(1) Select channel to be programmed at switch (4), observing channel number indicated on display.

(2) Press PROG (10) and check that PROG is indicated on the display.

(3) Enter required frequency using keys (6) to (9).

(4) Press LOAD (12) and check that PROG is extinguished. This indicates that the frequency is loaded into the channel for both transmit and receive functions.

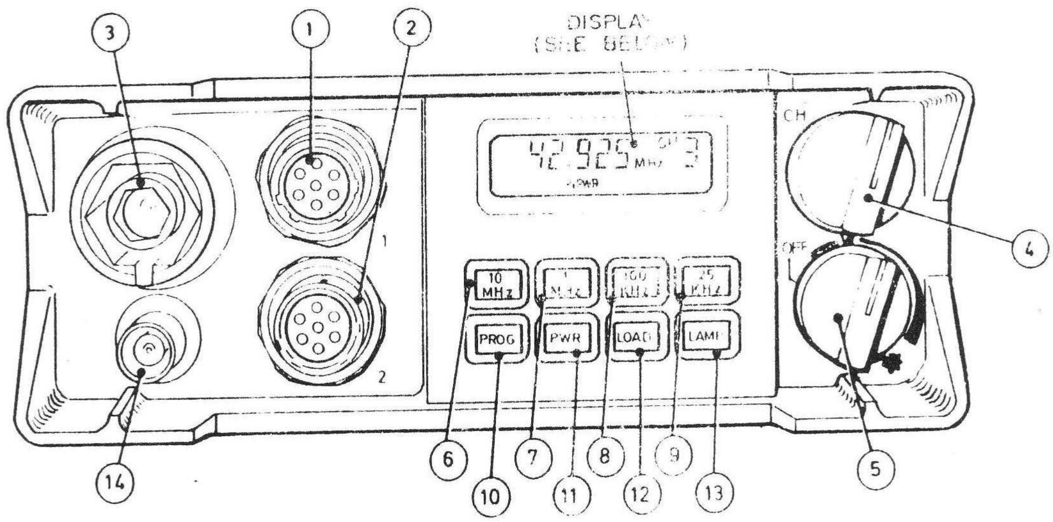
(5) If a different frequency is to be programmed for reception, carry out the procedure given in (1) to (4), but in (2) press PROG (10) twice and check that PROG RX is indicated on the display. This denotes that the frequency, when loaded, will be used for reception only. On Pressing LOAD (12), PROG RX is extinguished.

WORKING WITH OTHER RADIOS

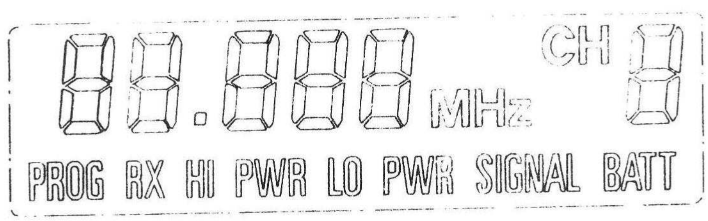
15. The PRM 4700 will operate with other types of VHF/FM transceiver in the frequency range 30MHz to 88MHz, including those designed for 50kHz channel spacing with 10kHz deviation.

TABLE 2-1 ANCILLARY EQUIPMENT (See Fig. 2.2)

Item	Description	Racal Reference
1	Whip Antenna, Flexible Mounting 2.5M	ST 719094
2	Whip Antenna, Flexible Mounting 1.4M	ST 719519
3	Tape Antenna 1.0M	ST 712272
4	Battle Antenna Helical 0.5M	ST 719518
5	Ni-cad Battery 10V	MA 4705A
6	Primary Battery (D size cells)	MA 4705B
7	Primary Battery (C size cells)	MA 4705C
8	Battery Chargers	MA973F, MA 945S
9	Adaptor lead (for MA 945S Charger)	ST 719115
10	Telephone Handset	ST 712275
11	Carrying Bag (Waist)	ST 712274
12	Carrying Bag (Back)	ST 712273
13	Carrying Frame	ST 719796
14	Headset & Boom Microphone	ST 719214
15	AUDIO Amplifier	MA 987C
16	Loudspeaker Amplifier	MA 4988A
17	Encryption Unit Speech (Portable)	MA 4463
18	Programmer	MA 4073B
19	Fill Gun	MA 4083B
20	Rebroadcast Control Unit (Voice)	MA 4009B
21	Rebroadcast Control Unit (Voice/Data)	MA 4709A
22	Local/Remote Control Unit	MA 4985B/4986A
23	AMU (Vehicle) Band Switched	BCC 587B
24	AMU (Vehicle) Wideband	BCC 588
25	Mains power supply	MA 949M
26	Vehicle Interface Unit - Low Power	MA 4704A
27	Vehicle Interface Unit - High Power	MA 4703A
28	Field Test Set	CA 4610A
29	Hand Generator	MA 4190A



PRM 4700 Front Panel

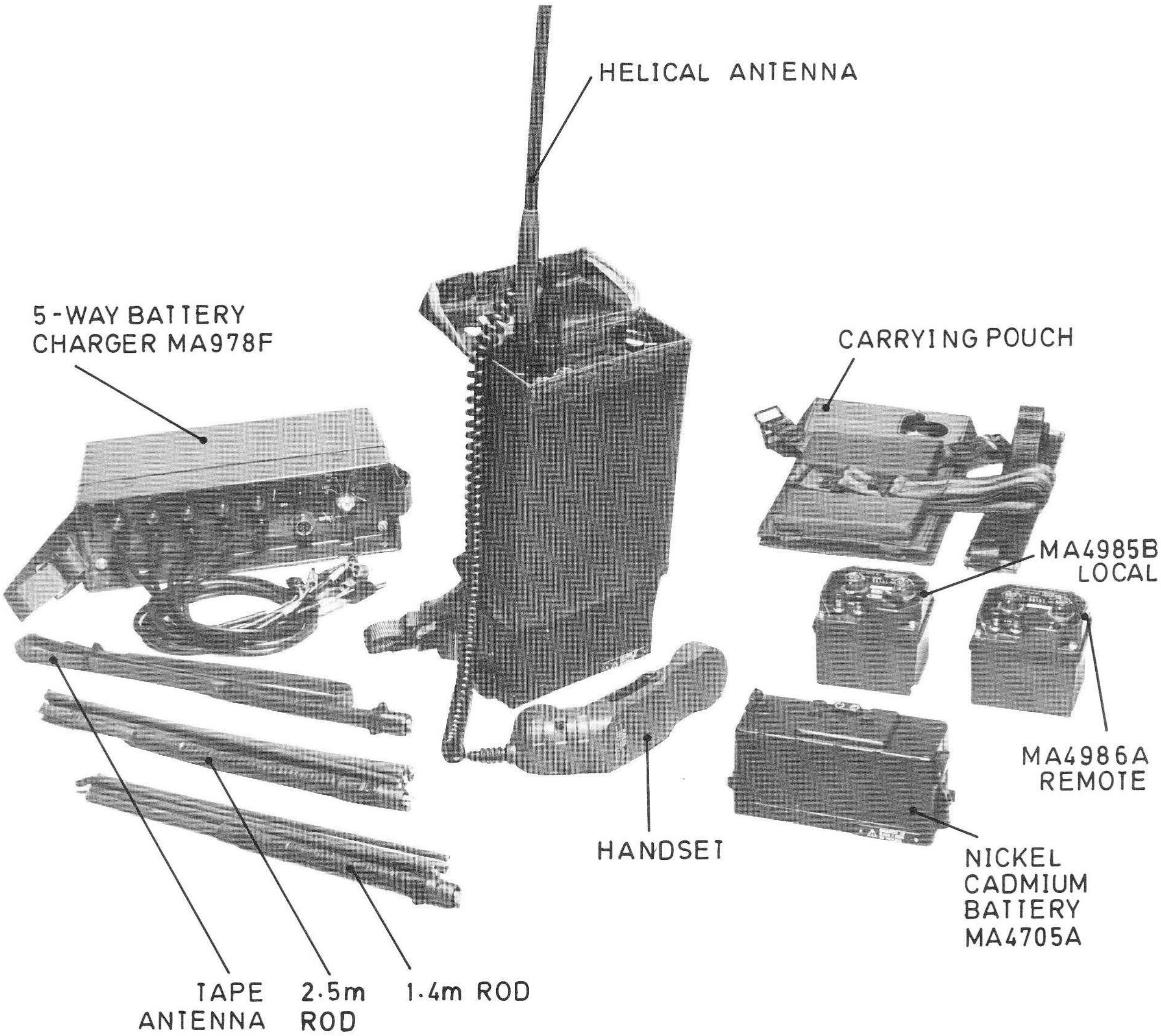


Display (Shown in Power-up Condition)

Front Panel and Display

Fig 2-1

TH 5160/1



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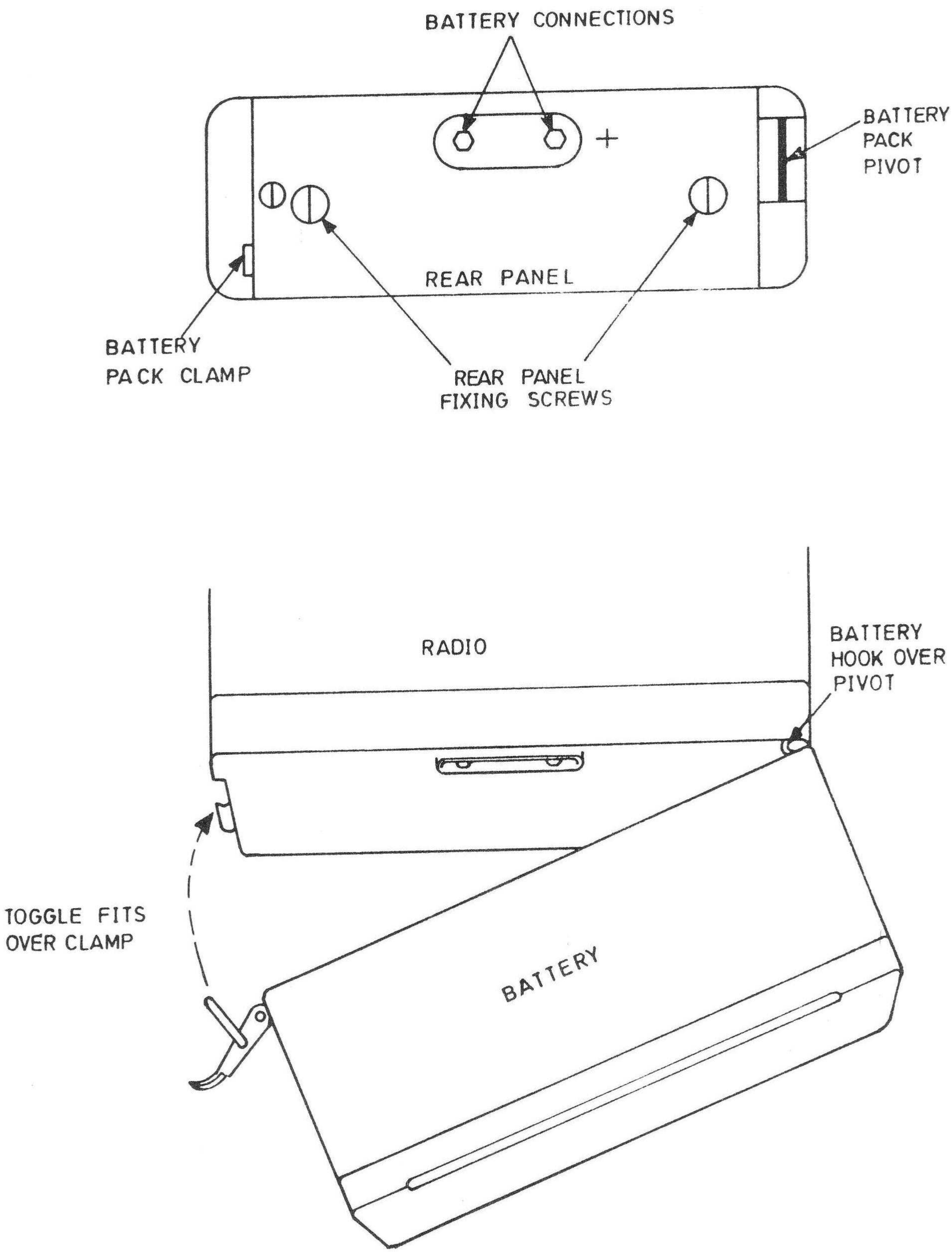
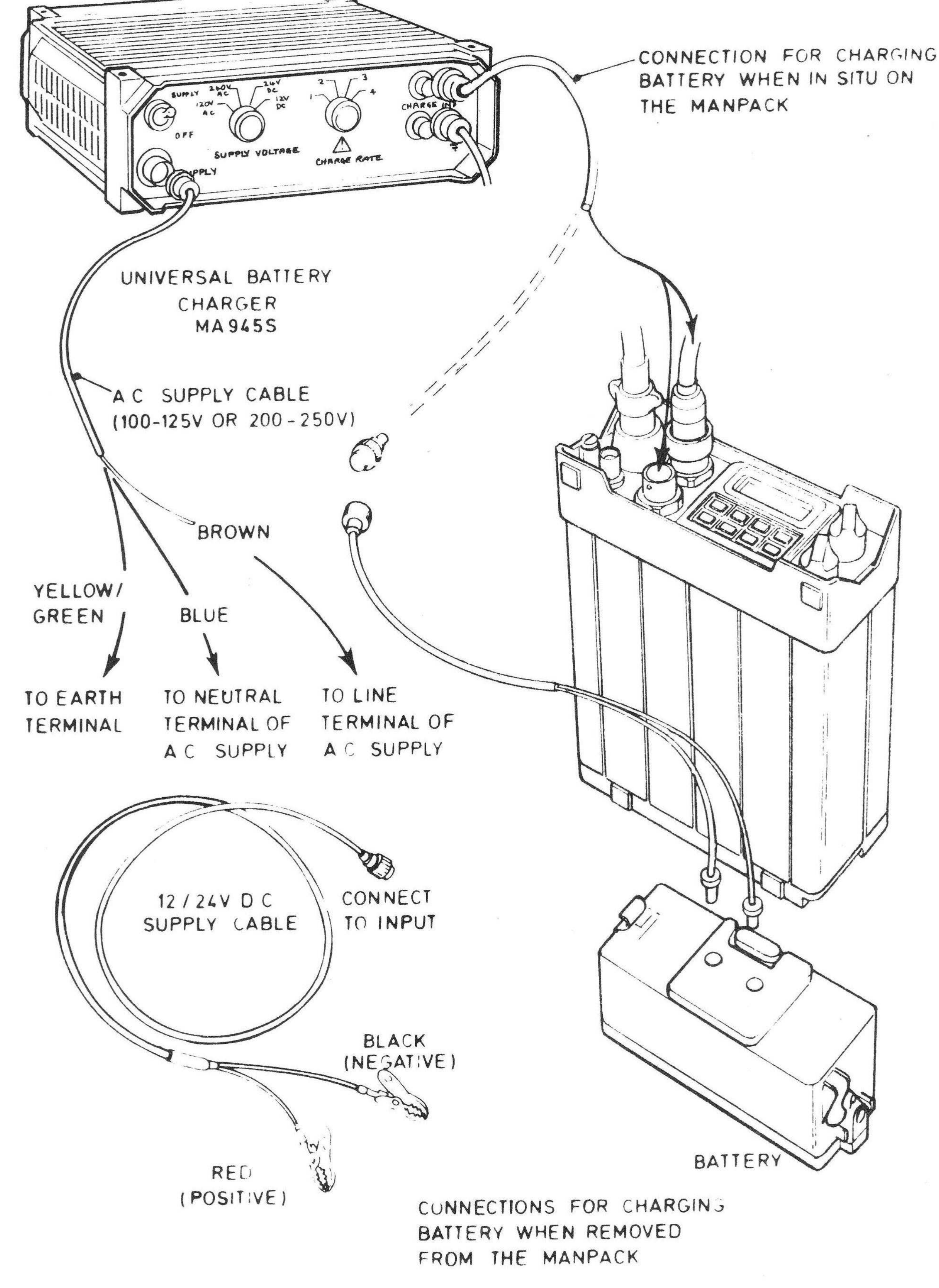
Manpack Station Items

Fig 2·2



Rear Panel and Battery Attachment

Fig 2.3



Battery Charging Fig 2.4

CHAPTER 3

TRANSCEIVER SYSTEMS

CONTENTS

ILLUSTRATIONS

CHAPTER 3

TRANSCEIVER SYSTEMS

INTRODUCTION

1. This chapter gives information on the use of the PRM 4700 Transceiver in vehicle systems and fixed station applications. Typical vehicle items are shown in Fig. 3.1.

TYPICAL SYSTEMS

Typical Low/Medium Power System (Figure 3.2) with MA 4704A

2. This system uses a Vehicle Interface Unit (VIU) MA 4704A which allows the unit to be supplied from either a 12V or a 24V vehicle system. The VIU also allows the transceiver to operate with either a Type 400 or a Type 600 Vehicle Harness System. The TX power outputs available are the same as for the Manpack.

Typical High Power System (Figure 3.3) with TA 4703A

3. This system is the same as the above with the addition of a high Power TX output of 25 Watts nominal.

TYPICAL BASE STATION (Figure 3.4)

4. The system can be operated from an AC input using the MA 949M Power Unit which incorporates a loudspeaker and amplifier. Either a high power system, using a TA 4703A, or a medium power system using a MA 4704A can be used. Several antenna options are possible including: BCC 588, or BCC 587B and 2m. Whip; RA 959 discone or MA 751 log periodic.

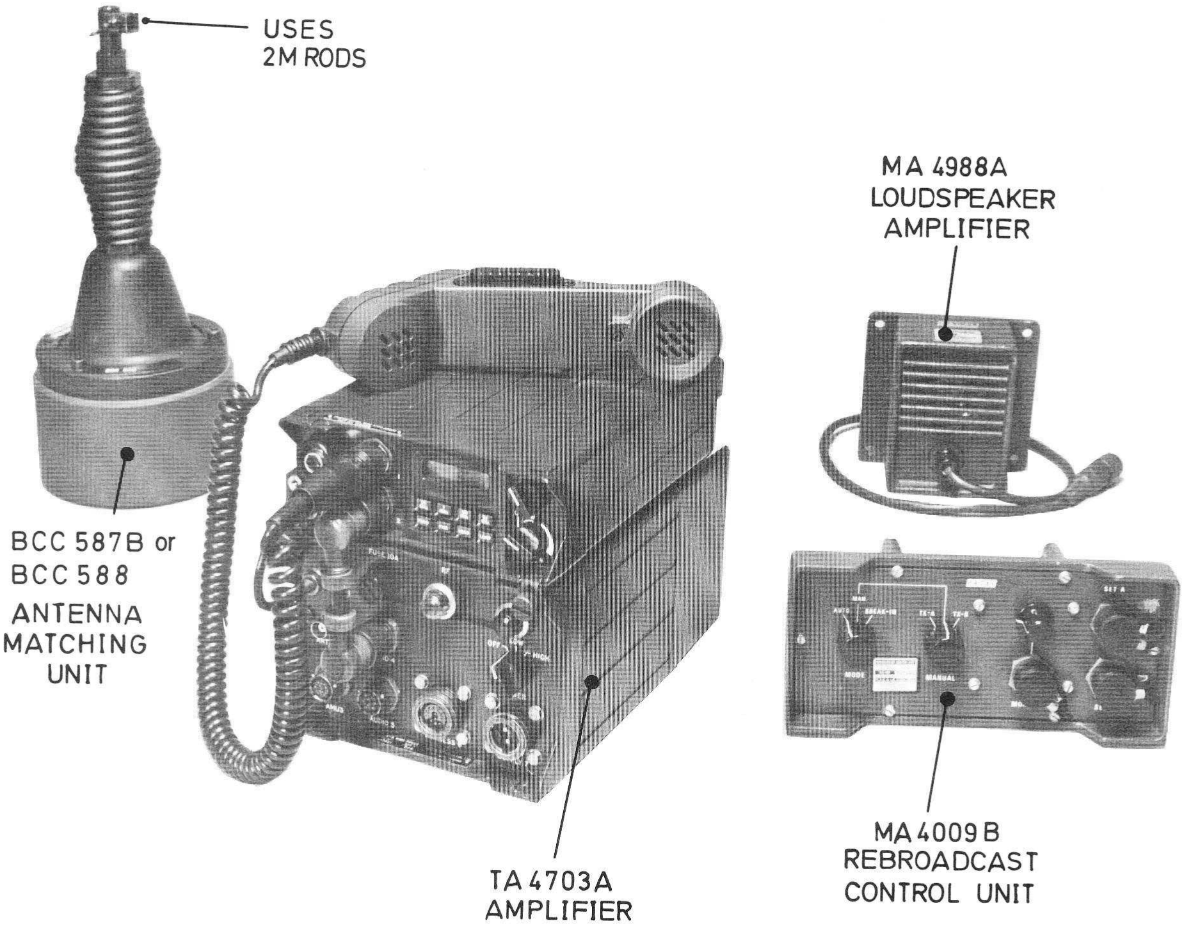
ANTENNA SYSTEMS

5. The BCC 588 is a simple wideband AMU, which only requires an R.F. coaxial cable feed. (Figs. 3.2 - 3.4). A more efficient antenna system consisting of an 11 band AMU, the BCC 587B, is also available. A control lead is then also required between the TA 4703A/MA 4704A and the AMU. For base station use the RA 959 is an omni-directional antenna, and the MA 751 directional with high gain. Both are wideband.

REBROADCAST FACILITY

Introduction

6. Radio rebroadcast enables the signals received by one radio set to be simultaneously retransmitted by a second radio, on a different frequency. The station, therefore, comprises two transmitter-receivers and is capable of simplex operation only. The two units are connected by a special harness incorporating the MA.4009B Rebroadcast Unit. The radios may be both HF, both VHF or one of each.



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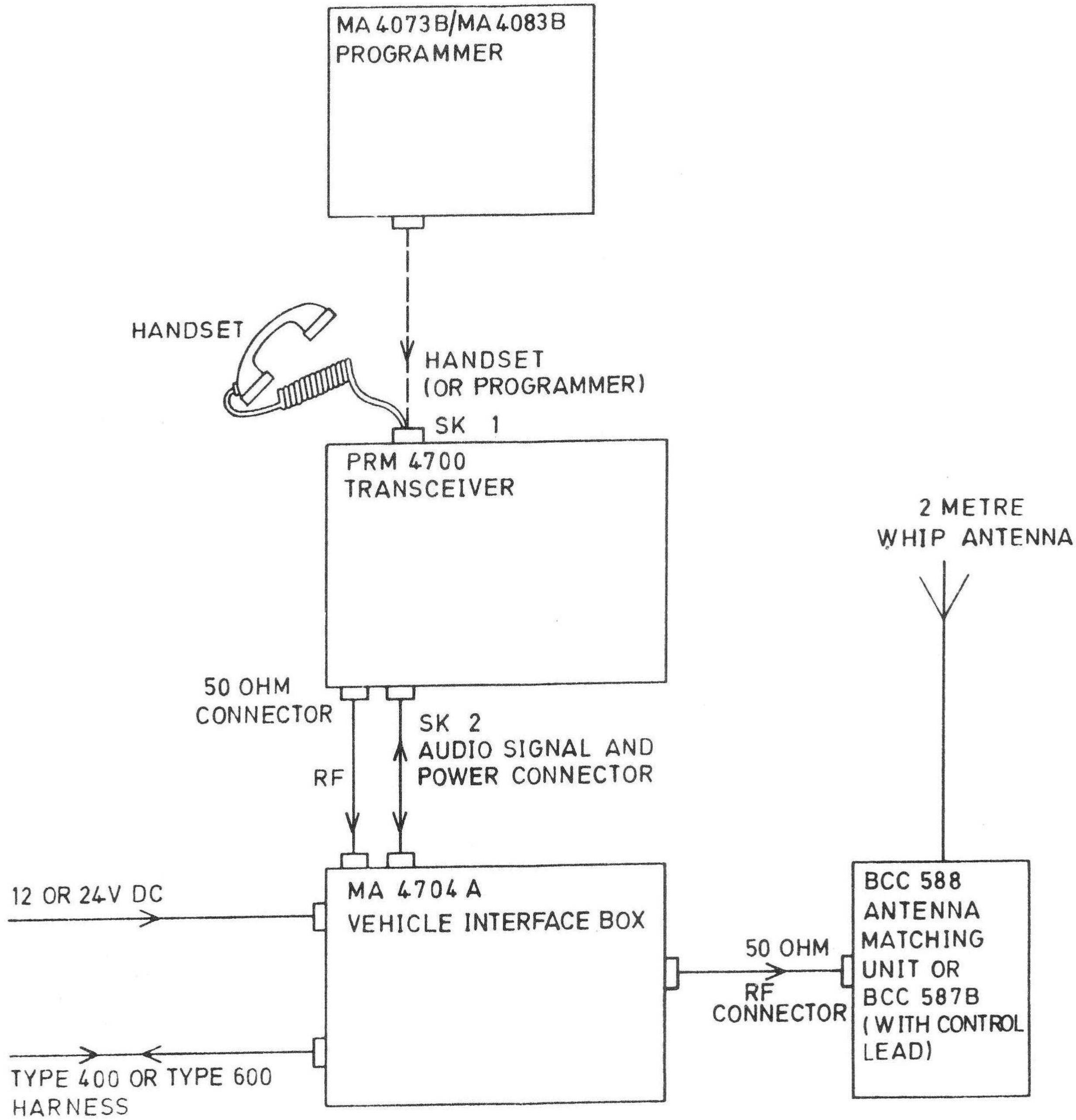
TH 5160/1

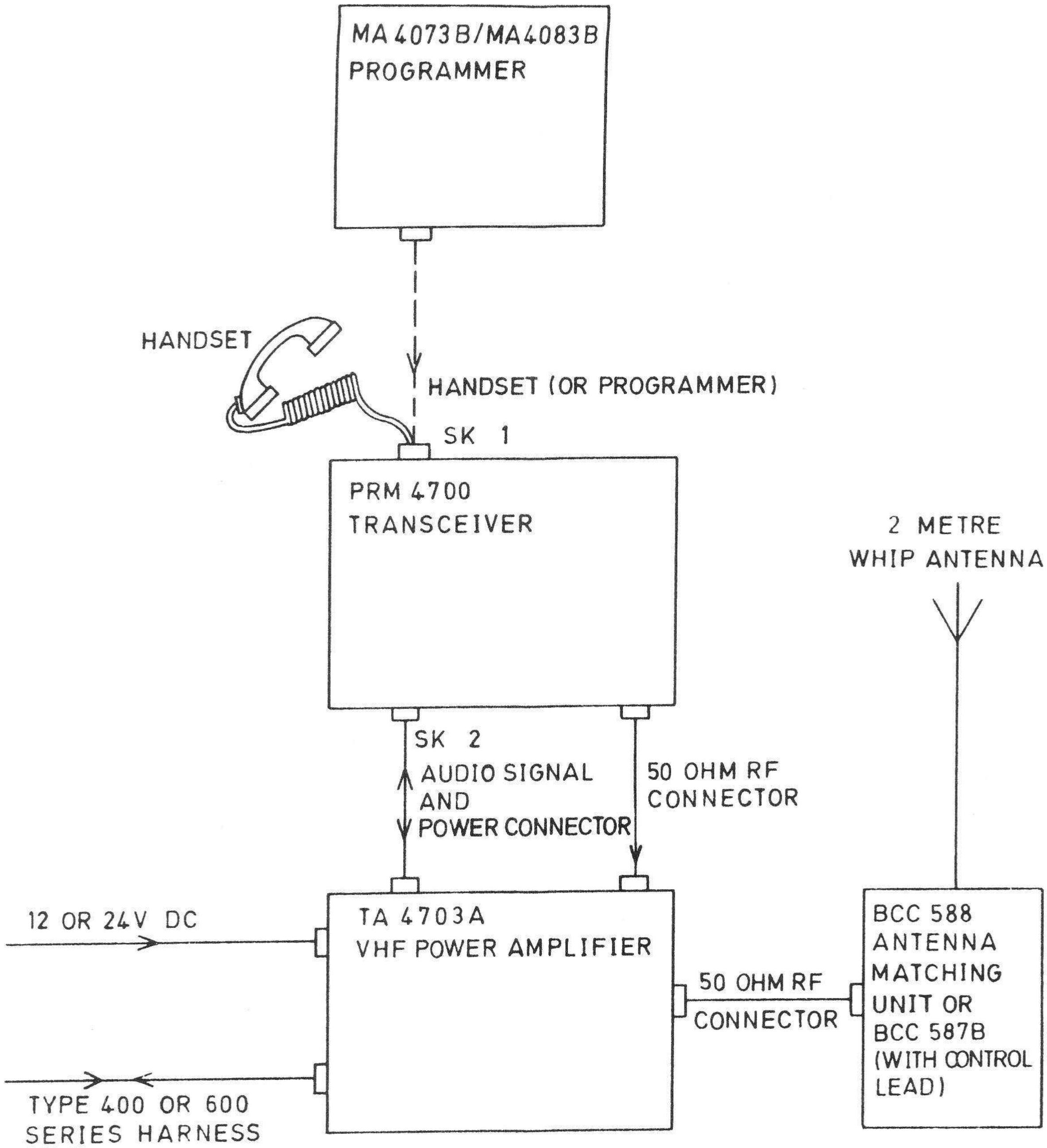
Vehicle/Station Items

Fig 3.1

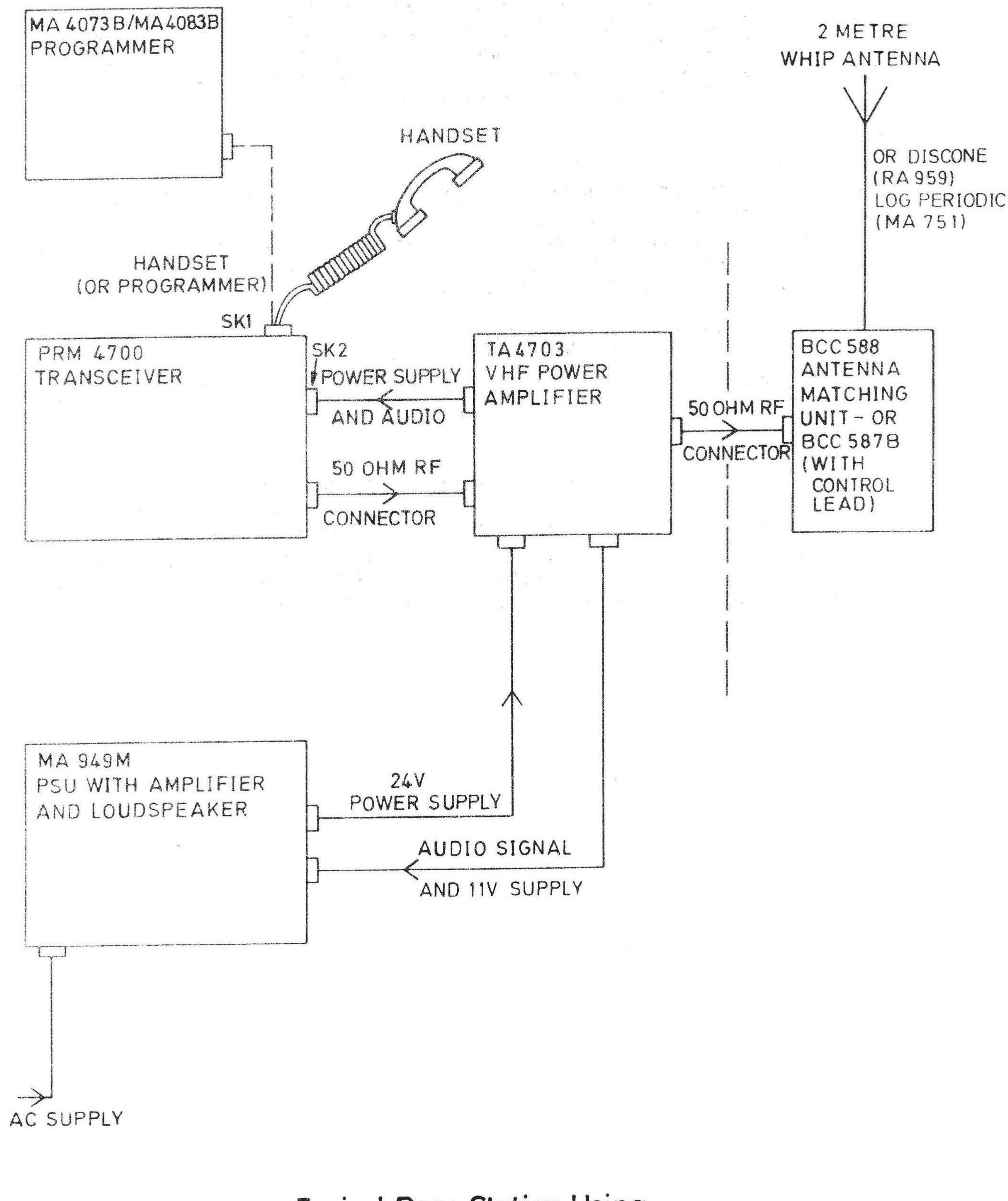


Low/Medium Power System

Fig 3.2



RACAL TH 5160 High Power System Fig 3.3



Typical Base Station Using
Power Unit and Loudspeaker Amplifier — Fig 3.4

TH 5160

Uses

7. The rebroadcast facility may be used for tactical reasons or to overcome the inability of the stations to work over the distance or terrain required. A whole variety of configurations is available for extending range or establishing a link around high obstacles, in both manpack and mobile roles. (See MA 4009B Handbook). In a vehicle, the harness system (BCC 400 or 600) can be used for rebroadcast.

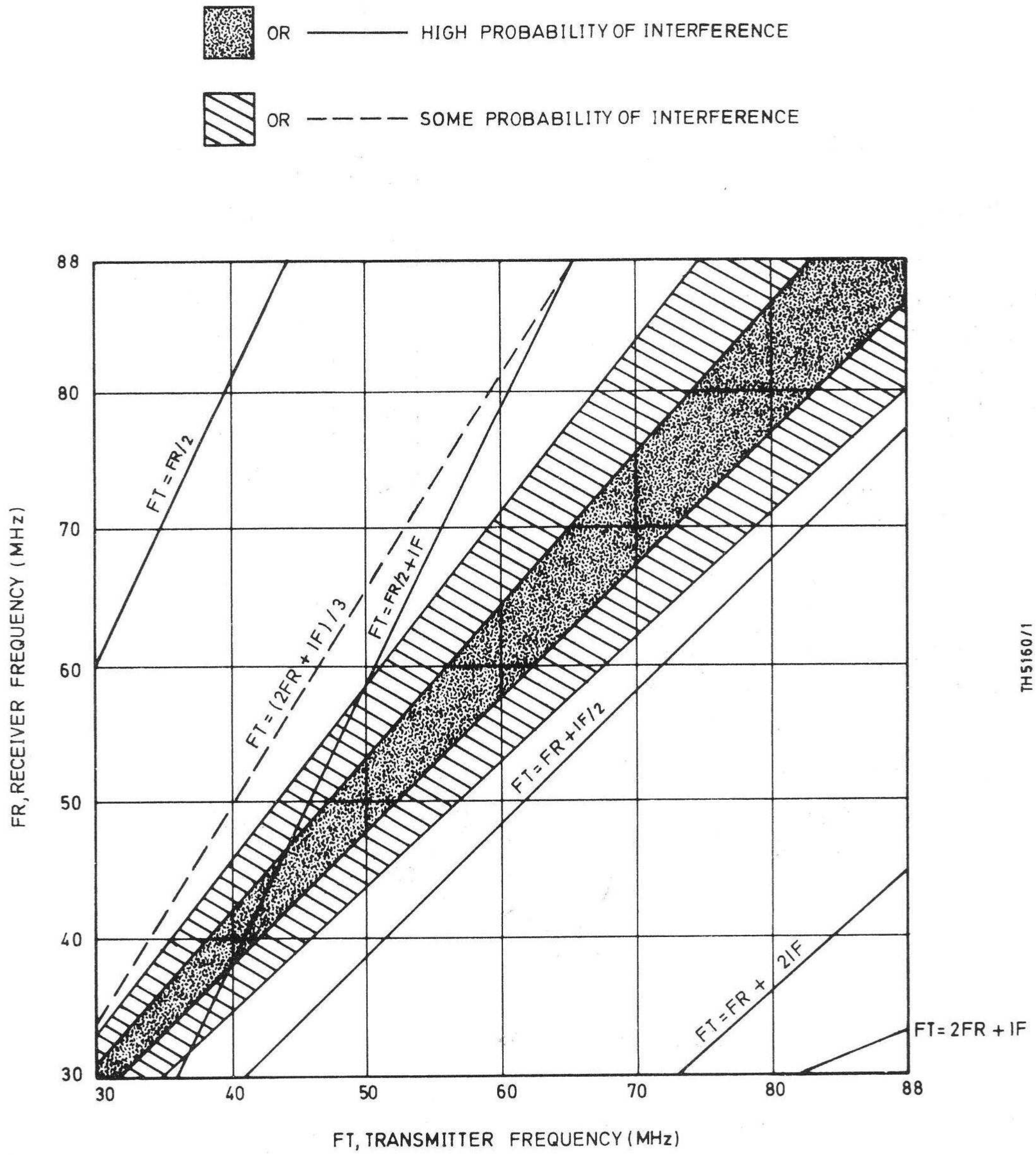
Description

8. For portable use the MA.4009B control unit is included in a kit which also contains a carrying bag and two 5 metre cable assemblies. The MA.4009B will permit both automatic or manual rebroadcast and includes a 'break-in' facility which enables the operator to switch both sets to transmit when he wishes to speak on the two frequencies simultaneously.

Selection of Operating Frequencies

9. The two channels F1 and F2 to be used for rebroadcast must be selected so that the transmitter of either set will not interfere with the receiver of the other.

10. Figure 3.5 shows the rebroadcast interference graph where the transmit frequency is plotted from left to right; the receive frequency is plotted from bottom to top. The straight full lines and the heavily shaded area in the middle represent combinations of frequencies where interference is most likely to occur. The broken line and lightly shaded area represent frequencies where there is less probability of interference.

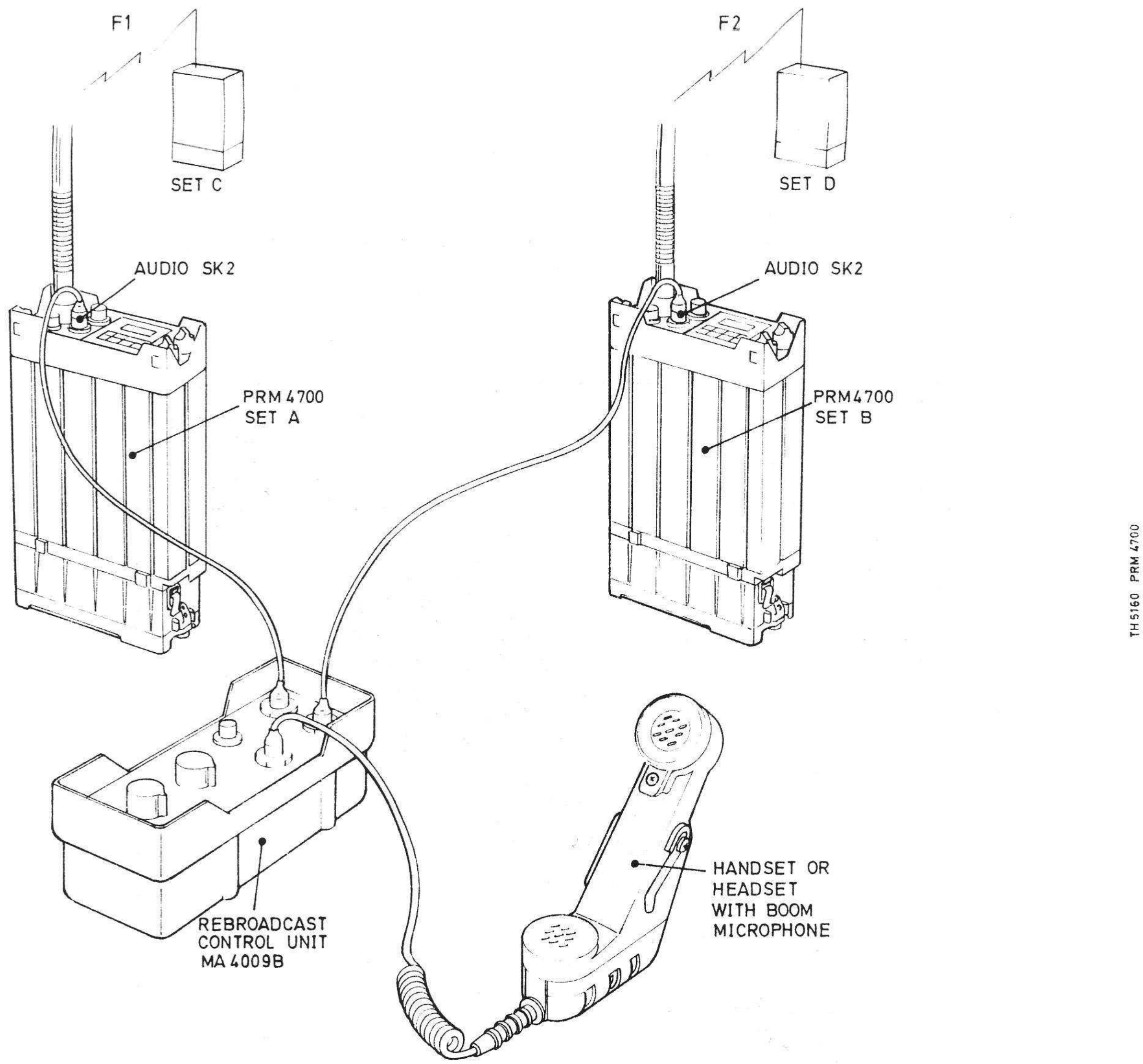


Rebroadcast Chart for 2 x PRM 4700 at 10 metre separation Fig 3.5

Check for operation in both directions, i.e. when F1 = reception frequency, F2 = transmission frequency, and when F2 = reception frequency and F1 = transmission frequency. IF = 21.4 MHz.

Operation

11. A rebroadcast link is represented in Figure 3.6.



Rebroadcast Link Fig 3.6

Sets A and C use the same operating frequency, F1

Sets B and D use the same operating frequency, F2

A rebroadcast link is set up as follows:

(1) Place SET A and SET B PRM 4700 transceivers on a level surface and interconnect them using the two cables and the MA.4009B Rebroadcast Control Unit as shown in Fig. 3.6. Space the sets as far apart as the cable allows i.e. 10 m, and ensure that the cable is connected to AUDIO 2 socket on each transceiver.

(2) Install the whip antenna into each set.

(3) Set SET A to frequency F1 and SET B to frequency F2 and the volume switch on each transceiver to a middle position i.e. not whisper and not squelch override.

(4) With both sets in the RECEIVE condition, ensure that the SIGNAL indicator is not displayed on either Set A or Set B.

(5) Set the MA 4009B to MANUAL mode. Switch to 'Tx-A' and check that the SIGNAL indicator of Set B is not displayed; switch to 'Tx-B' and check that the SIGNAL indicator of Set A is not displayed.

(6) If the SIGNAL indicator is displayed in (4) or (5) above, the frequency of one or both of the sets must be changed and the above procedure repeated. (See Rebroadcast Chart, Fig. 3.5).

(7) Connect a telephone handset to the MONITOR socket on the MA.4009B Control Unit.

(8) Switch the spring loaded MODE switch to BREAK-IN which will cause both SET A and SET B to transmit and instruct the operators of the remote transceivers, C and D, that the rebroadcast link is operational.

(9) Set the MODE switch to AUTO; the link will now operate automatically whilst the rebro operator may monitor traffic through the link.

MANUAL OPERATION

12. The link is normally operated in the AUTO mode where switching is automatic on receipt of a signal. There are, however, occasions when automatic operation cannot be used and it becomes necessary to revert to manual, i.e.:

(a) When one of the sets is H.F.

(b) When the interference, noise or jamming is so great that false switching occurs and an operator is needed to distinguish between wanted and unwanted signals.

13. In this MANUAL mode, the rebro operator decides the direction of traffic and switches his station to rebroadcast in the correct direction, TX-A or TX-B.

CHAPTER 4

PREVENTIVE MAINTENANCE

CONTENTS

TABLE

PREVENTIVE MAINTENANCE

GENERAL

1. No equipment can be expected to work properly unless it is kept in first class condition by regular maintenance conscientiously carried out. This is the responsibility of the operator who is in direct charge of the equipment and NOT of the workshop repair staff.

2. The tasks in the case of the PRM 4700 are simple and few in number as detailed below. They are performed daily when the equipment is in use, and periodically when in store. The PRM 4700 is a fully sealed radio and is NOT to be opened by the operator.

TABLE 4.1 ROUTINE CHECK LIST

	Item to be checked	Procedure
1.	Completeness	Check that the equipment is complete with accessories.
2.	Exterior Surfaces	Remove dust, dirt and moisture from equipment surfaces.
3.	Controls	Check that controls work smoothly, are tight on their shafts and do not bind.
4.	Sockets	Check that the sockets are tightly secured to the front panel.
5.	Handset	Inspect for cuts in the cable and secure connection to plug.
6.	Battery MA 4705 A/B/C	Inspect for corrosion of terminals and establish when the battery was charged or cells changed. Remove cells from MA 4705B/C before storage, and wipe clean any corrosion inside especially around cassette connections.
7.	Whip Antenna	Inspect for damage, loose fit and state of inner cord.
8.	Carrying Pouch	Inspect for damage.
9.	Transmitter-receiver	Perform steps in operation checklist in Chapter 5.

CHAPTER 5

CORRECTIVE MAINTENANCE AND FUNCTIONAL CHECKS

CONTENTS

TABLES

CHAPTER 5

CORRECTIVE MAINTENANCE AND FUNCTIONAL CHECKS

GENERAL

1. The procedure outlined is to be followed when checking the set and accessories. This check is to be done as part of preventive maintenance (Chapter 4) or in the event of set failure. It is designed to enable an operator to quickly prove that the set is functioning correctly or to localise the fault if it is not. The following points are to be observed at all times:

   (1) The operator is not to open sealed equipment under any circumstances.

   (2) The set will not normally be removed from its parent installation in order to perform maintenance.

   (3) The user is to take remedial action where this is stated to be specifically within his capability.

   (4) The user is not to make adjustments or replace items unless he can make a confirmatory test.

OPERATIONAL CHECKS

2. (1) Operational checks, as given in Table 5.1 should be carried out using a second, tested, PRM 4700 unit to allow transmission and reception in various modes to be checked.

   (2) Both units should be programmed using the same frequencies, and a mixture of single frequency and two-frequency channels should be used.

   (3) If it is required to check the unit for data transmission and reception, data units should be connected to both transceivers, and programmed with identical codes.

   (4) Prior to carrying out checks, ensure that a fully charged battery, or a suitable power supply, is connected (see Fig. 3 for battery attachment).

FUNCTIONAL CHECKS

3. Functional checks can be carried out as follows:

   (1) Select either * position at switch (5). Noise is heard when the receiver is operational, with no signal present.

   (2) Sidetone is heard in the handset or headset during transmission. This denotes that the transmitter is operational.

(3) If BATT is indicated on the display at any time (other than for five seconds after switch-on), it denotes that the battery voltage is low. (Approximately 8 Volts). The battery should be charged or changed as soon as possible.

(4) An interrupted (warbling) tone is heard in the handset or headset if a frequency outside the range of the equipment (88MHz to 89.975MHz) is selected, an internal synthesizer fault occurs, or the battery voltage is too low. (Less than 7 Volts).

BUILT-IN TEST EQUIPMENT (BITE)

4. When the radio is first switched on, BITE is activated. This gives a complete display presentation for five seconds as shown in Fig. 2.1.

5. If the BITE detects a fault, an indication E1 to E4 is flashed in the display for about five seconds and an interrupted tone is heard in the handset or headset. The transceiver then returns to normal operation (if possible).

6. The indicated faults are:

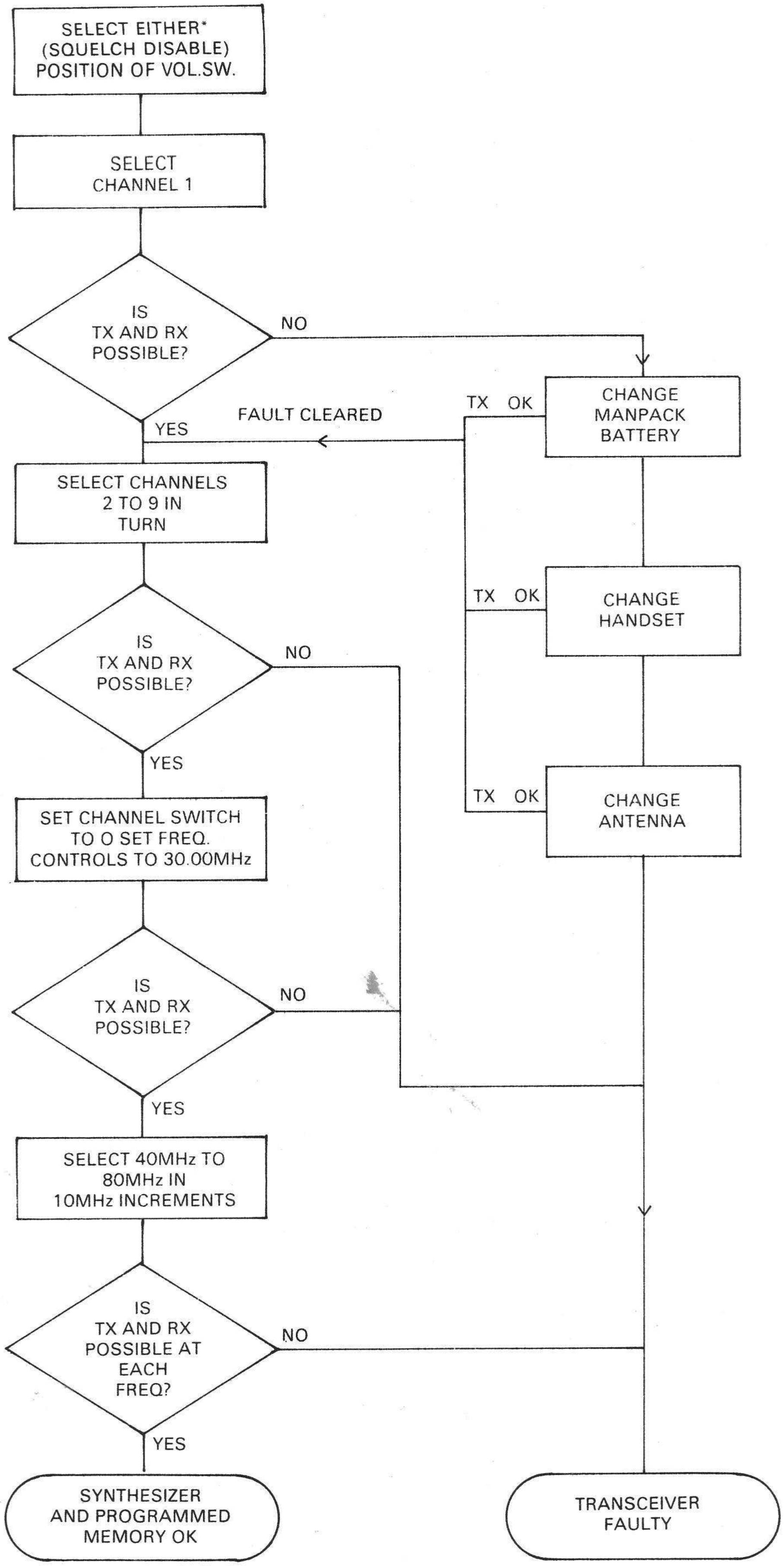
E1	ROM (Read Only Memory) Fault	) No operator) rectification
E2	RAM (Random Access Memory) Fault	) action is) possible

E3 Denotes that stored frequency information is degraded. The channel frequencies can be re-loaded, or the transceiver can be operated in manual mode (channel 0).

E4 Receiver Fault. No operator rectification action is possible.

7. If a non-rectifiable fault is denoted, further testing can be carried out using the Field Repair Test Set CA 4610A and associated handbook, or flow chart Table 5.1.

TABLE No. 5.1 FREQUENCY AND CHANNEL CHECKS



CHAPTER 6

MECHANICAL DESCRIPTION & DISMANTLING

CONTENTS

ILLUSTRATIONS

CHAPTER 6

MECHANICAL DESCRIPTION & DISMANTLING

INTRODUCTION

1. The PRM 4700 comprises a metal chassis with four separate module compartments protected by metal covers. (See Fig. 6.1).
Front and rear Panels are affixed to the chassis, the chassis being protected by a metal slide-on cover.

Dimensions: W 158mm, H 58mm, D 210mm
Weight: 2.0kg (excluding battery)

FRONT PANEL

2. The front panel casting contains:- (See Fig. 6.3 and 6.4)

(1) Antenna Socket
(2) 50 Ω Socket for V.I.U. connection
(3) 7-way input/output sockets (two)
(4) Frequency Select & Channel Programming keyboard
(5) L.C.D. and Display Driver Sub-Module
(6) Channel Switch
(7) On/Off Volume Switch
(8) A.M.U. Board
(9) Control Board Sub-Module

CHASSIS

3. The chassis contains the following Modules:- (See Fig. 6.2)

(1) Audio Motherboard + 10 micro boards
(2) Synthesizer Board + 3 micro boards
(3) Receiver Board
(4) P.A. Board

The Motherboard is screwed to the chassis (See Fig. 6.7).

DISMANTLING

4. Care should be exercised when removing the Audio Motherboard and Synthesizer Board to avoid damage to the micro PCBs.

(1) Unscrew the two 12mm self retaining screws to remove rear panel.
(2) To remove main cover slide rearwards.
(3) The four Modules are now accessible by removing the screws from the appropriate cover.

PCB Removal

5. PCBs are removed by gently prising off the coaxial connectors (where necessary), unscrewing with a 5mm A/F box spanner the captive spring-loaded 5mm Hexagonal-headed pillars, and on the P.A. Board the M3

crosshead screws. The board is then pulled carefully rearwards by the extractor handle at the rear to disconnect from the multiway socket in the motherboard.

Front Panel Dismantling

5. (1) To remove the front panel:

(a) Pull out the coaxial socket from the corner of the P.A. module.

(b) Remove the four M3 countersunk screws from the side panels.

(c) Carefully 'hinge' back the chassis and disconnect the three flexible cable connectors from the Motherboard. The front panel is now free. (See Fig. 6.3).

(2) The control board may now be removed as follows:

(a) Disconnect the flexible cable from the control board.

(b) Remove the four M3 cross-head screws from the board.

(c) Carefully unplug the whole board from the front panel.

(3) The AMU board may be removed as follows:

(a) Unsolder the three wires from the AMU board.

(b) Remove the three M3 cross-head screws and the board may be removed.

(c) The whip socket or 50-ohm socket may now be removed if required.

(4) The display/driver board may be removed as follows:

(a) Remove the Control Board as described above.

(b) Unscrew with a 5 mm A/F box spanner the four hexagonal-headed pillars.

(c) Unscrew the two M3 cross-head screws from the board. The board may now be removed from the panel complete with display unit. (See Fig. 6.4).

(5) To remove the Channel and Volume switches:

(a) Remove the Control Board as described above.

(b) Remove the Channel and Volume knobs by loosening the grub screws with a 1.2 mm A/F Allen Key and withdrawing the knobs.

(c) Unscrew the nuts securing the switches with an 8 mm A/F box spanner.

(d) The two switches may now be withdrawn complete with flexible cable and connector.

(6) To remove the Audio Sockets:

(a) Remove both the Control Board and the Display/Driver board as described above.

(b) Remove the M3 cross-head screw securing the Audio flexible cable to the front panel.

(c) Unscrew the nuts securing the Audio sockets to the front panel using a 21 mm A/F box spanner.

(d) The two sockets may now be withdrawn complete with flexible cable and connector.

(7) To remove the keypad:

(a) Remove both the Control Board and the Display/Driver Board as described above.

(b) Unscrew the two hexagonal pillars and the two cross-head screws securing the metal plate over the keypad.

(c) Remove the metal plate and the keypad from the front panel.

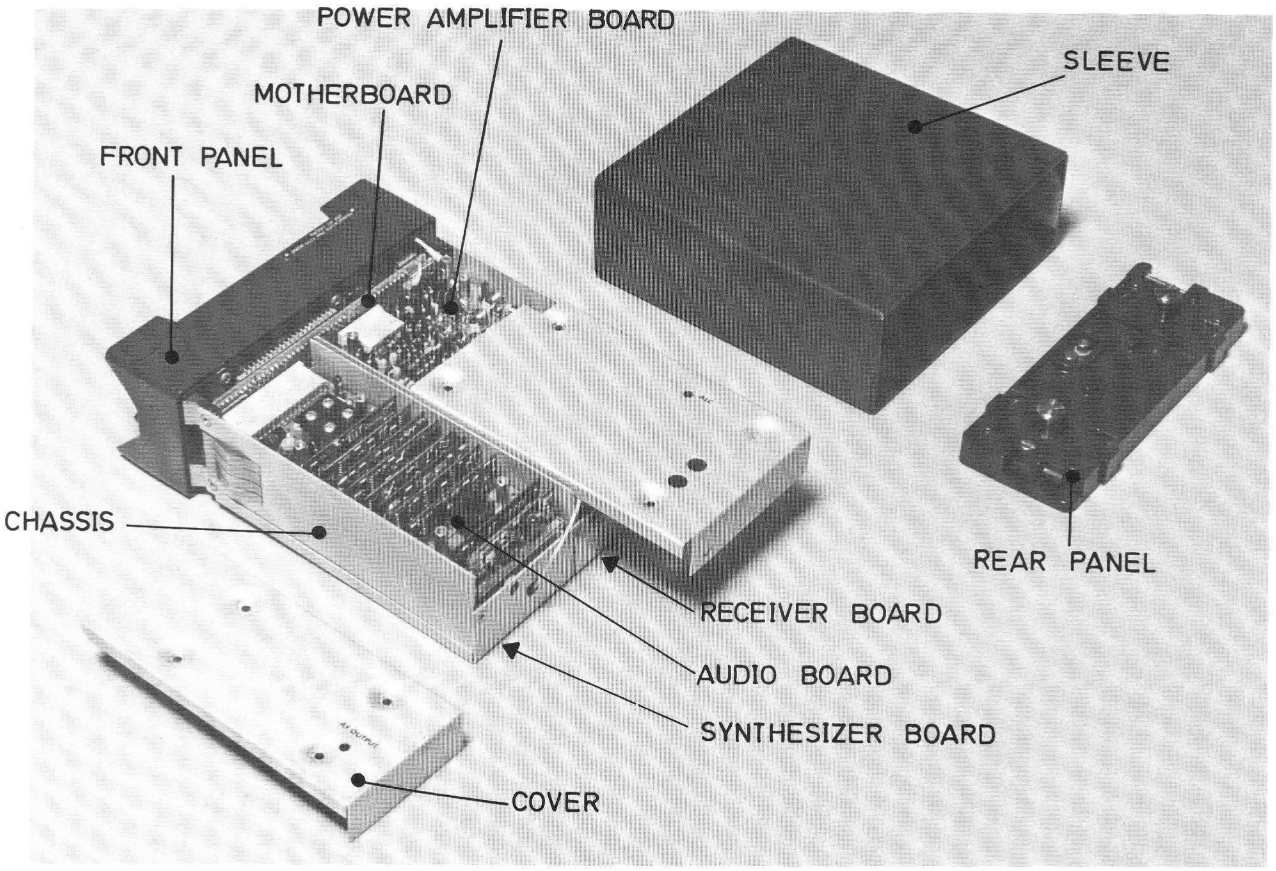
NOTES

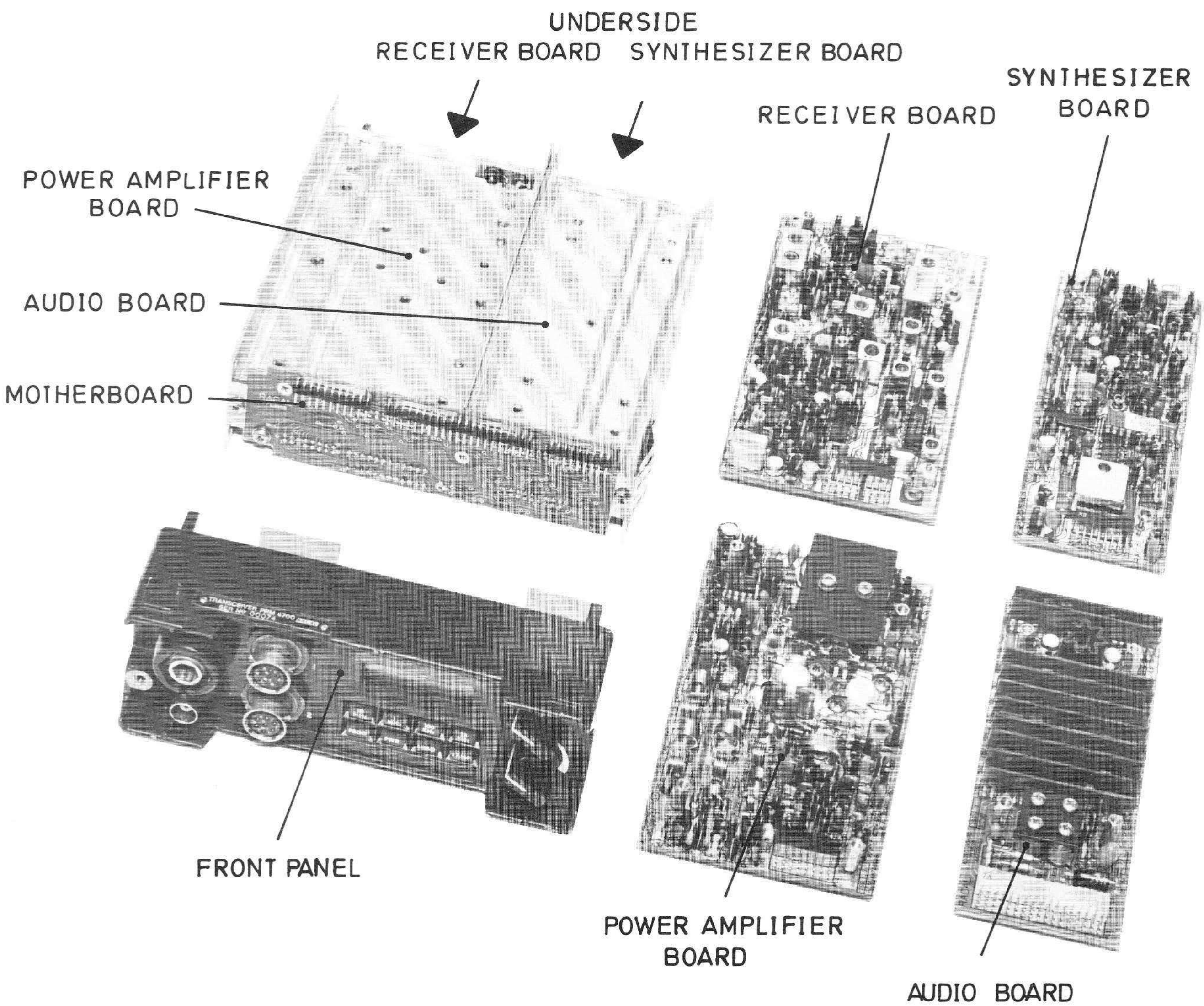
7. (1) The replacement procedure of boards or components is the direct reversal of the dismantling procedure. Ensure that the extractor handle is not trapped under the cover when this is replaced.

(2) Take care when removing screws, nuts or pillars not to lose the washers fitted underneath.

(3) Note that the desiccator sachet located in the rear panel should be changed whenever the set is dismantled.

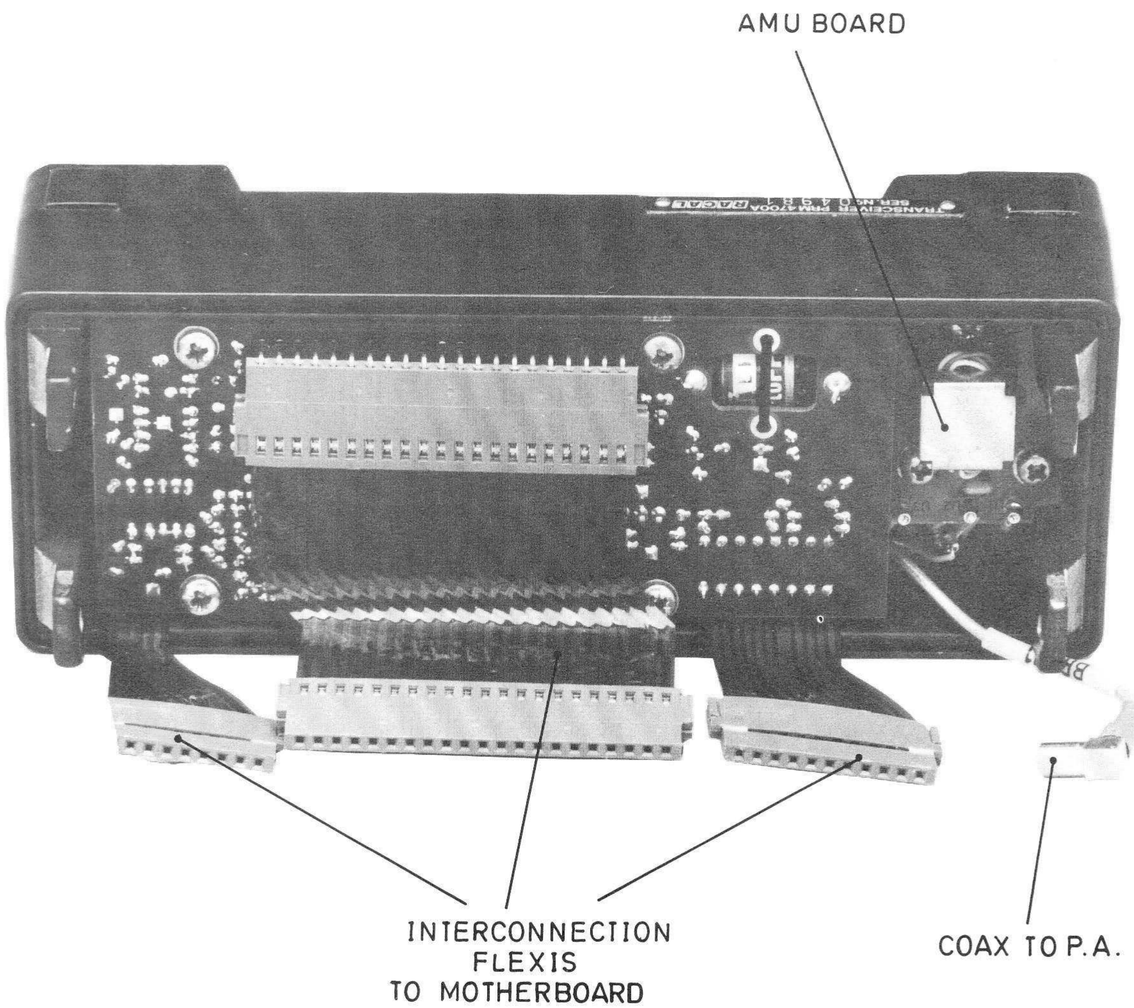
(4) The coaxial plugs and sockets are colour-coded for identification.


POWER AMPLIFIER BOARD
SLEEVE
MOTHERBOARD
FRONT PANEL
CHASSIS
REAR PANEL
RECEIVER BOARD
AUDIO BOARD
SYNTHESIZER BOARD
COVER



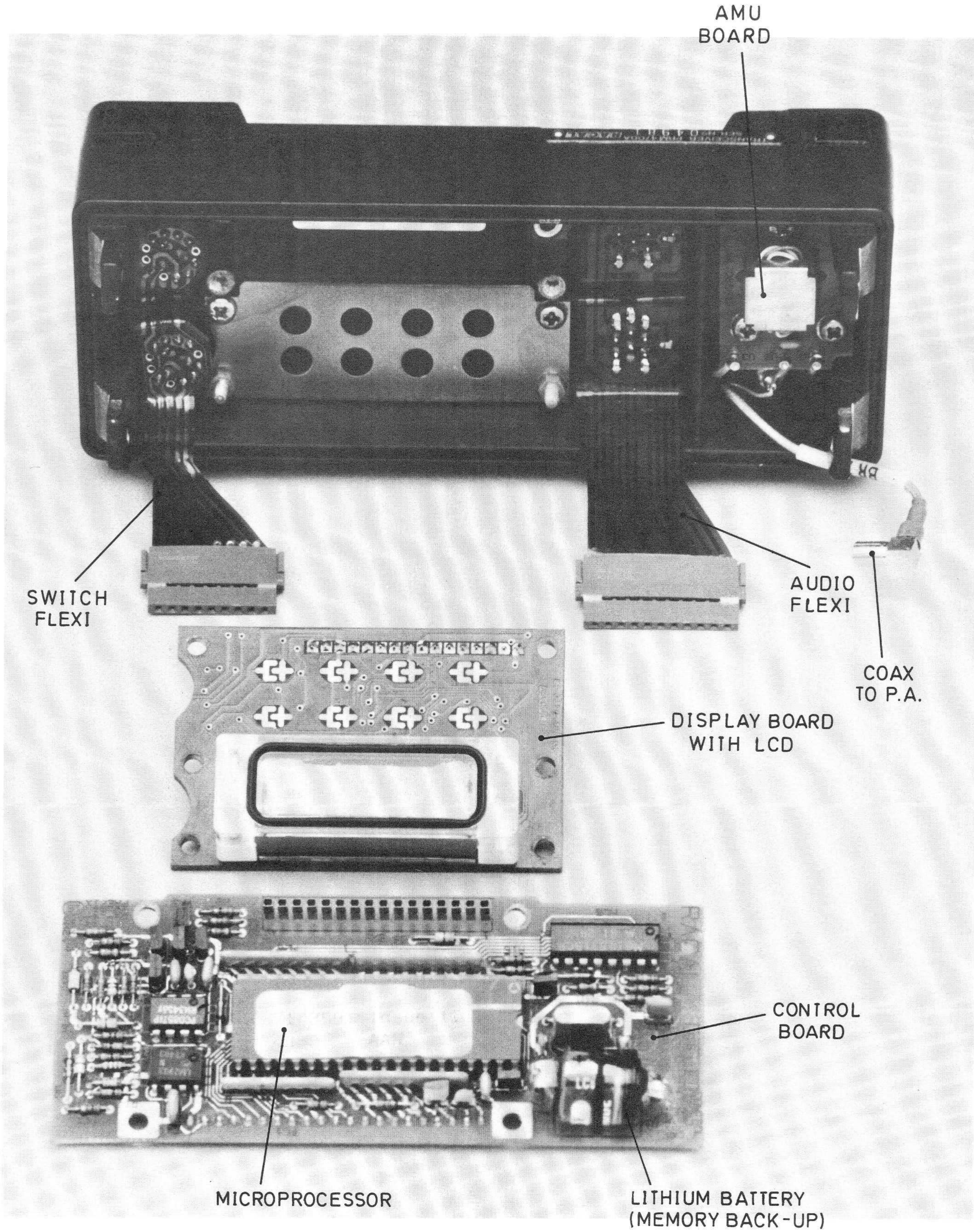
Transceiver Internal View 2

Fig 6.2



Front Panel Rear View

Fig 6.3



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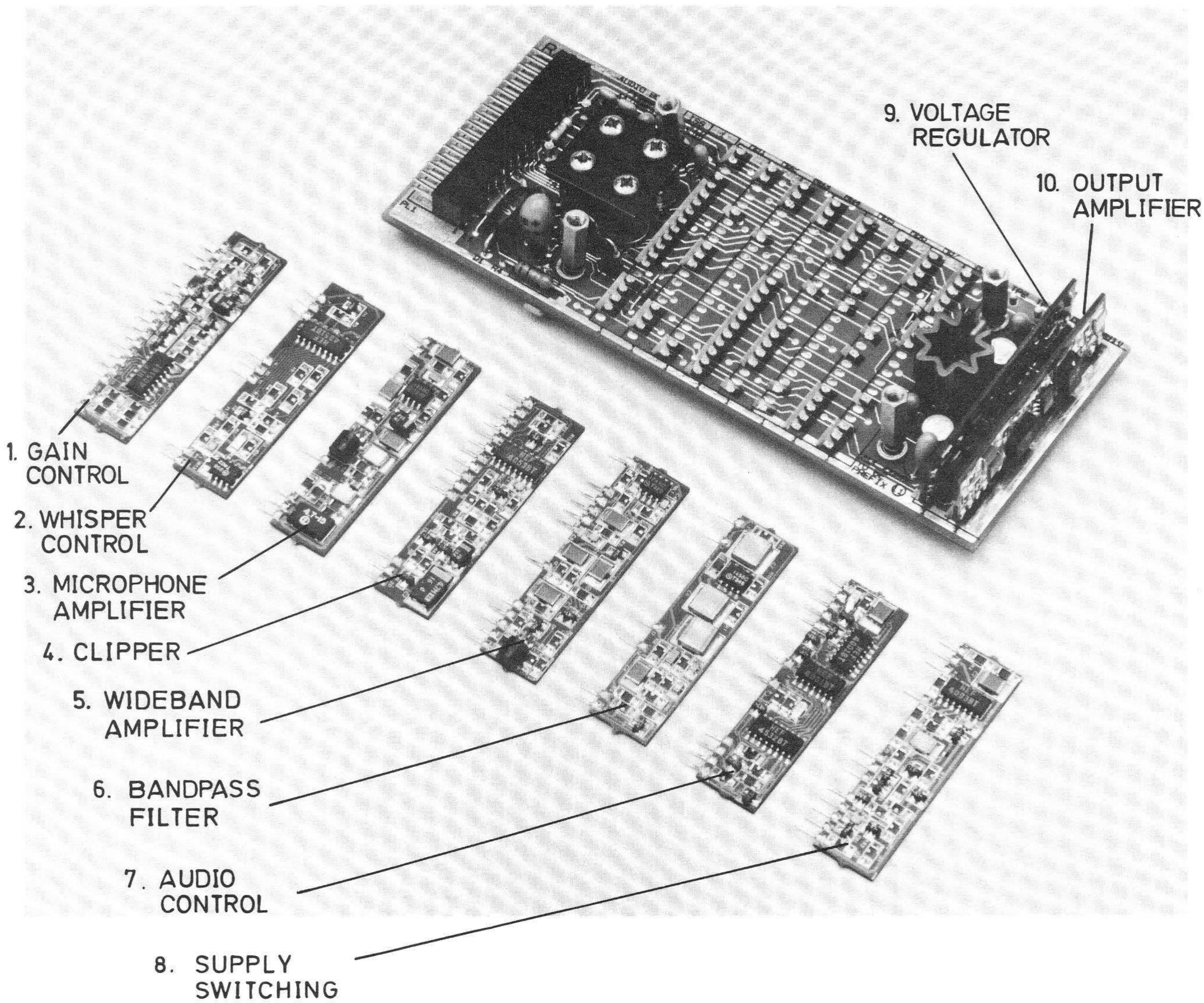
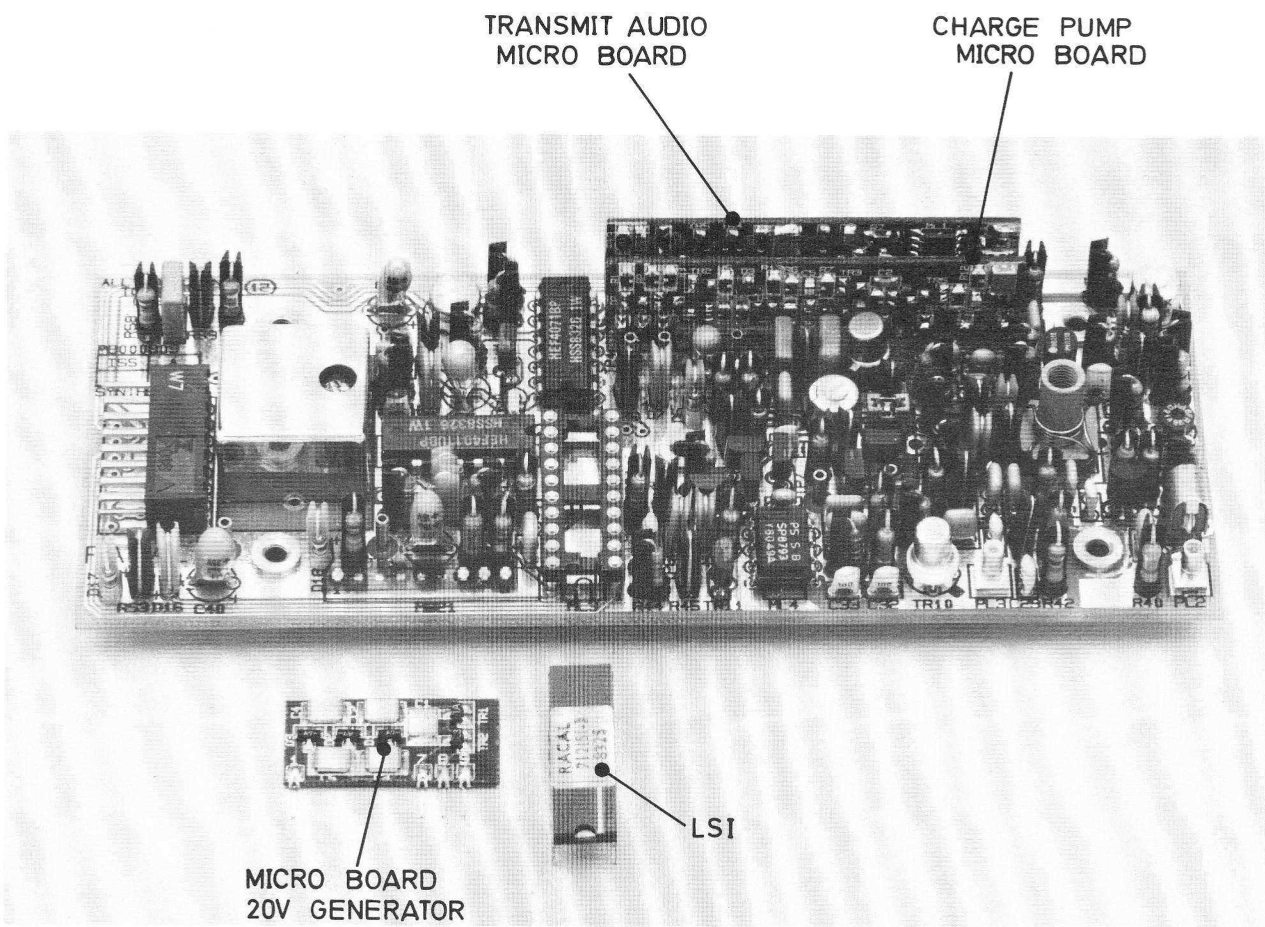
TH 5160/1

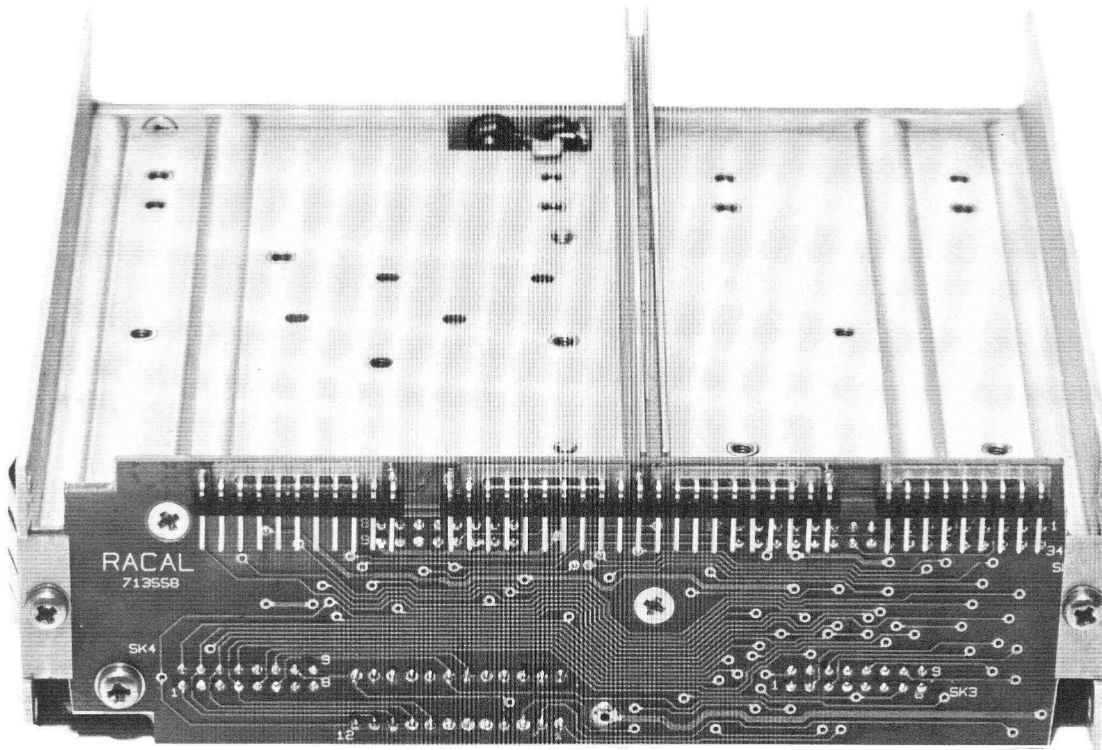
Front Panel with Control and Display Boards removed

Fig 6.4


1. GAIN CONTROL
2. WHISPER CONTROL
3. MICROPHONE AMPLIFIER
4. CLIPPER
5. WIDEBAND AMPLIFIER
6. BANDPASS FILTER
7. AUDIO CONTROL
8. SUPPLY SWITCHING
9. VOLTAGE REGULATOR
10. OUTPUT AMPLIFIER



TRANSMIT AUDIO
MICRO BOARD
CHARGE PUMP
MICRO BOARD
LSI
MICRO BOARD
20V GENERATOR



Chassis and Motherboard

Fig 6.7

CHAPTER 7

PRINCIPLES OF OPERATION

CONTENTS

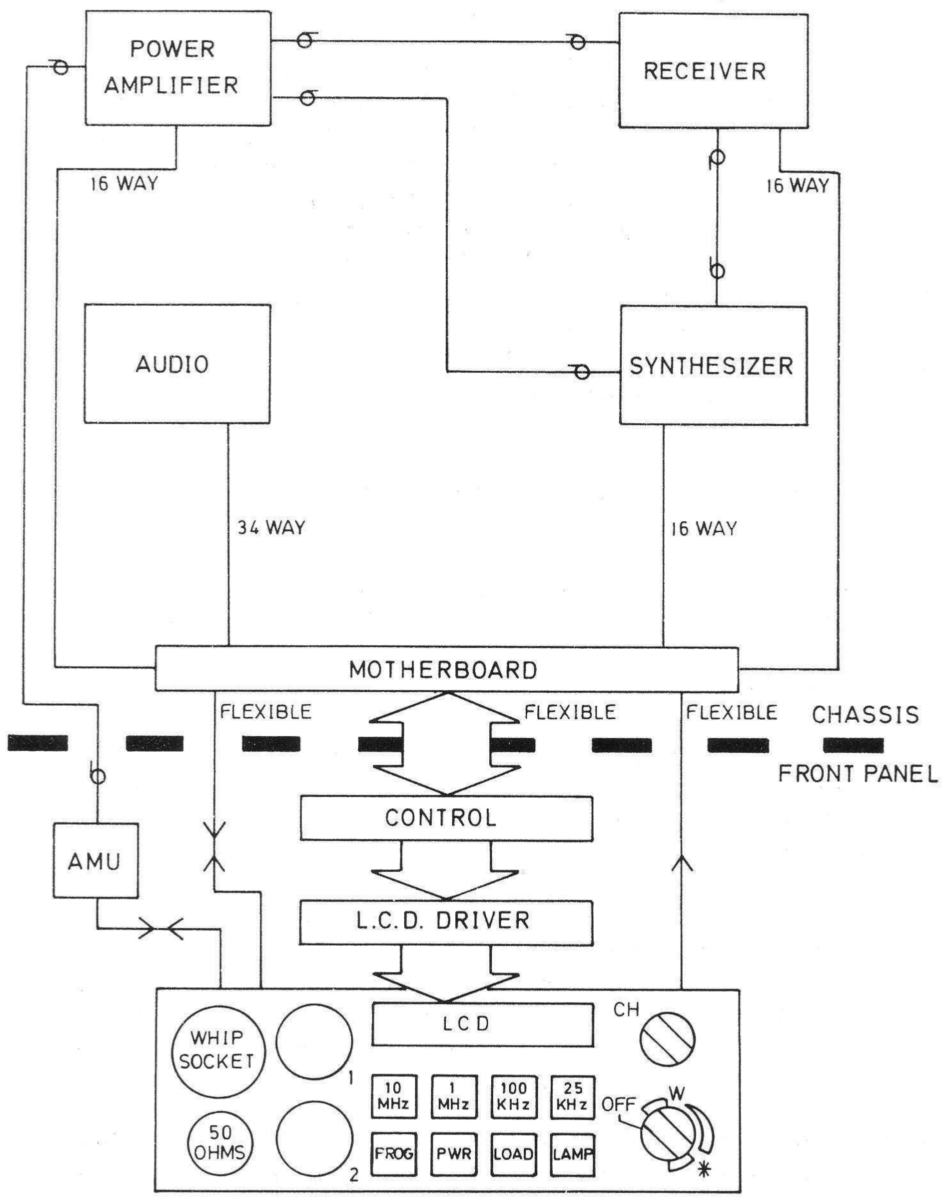
ILLUSTRATIONS

CHAPTER 7

PRINCIPLES OF OPERATION

INTRODUCTION

1. The PRM 4700 VHF transceiver is a modular equipment shown in block diagram form in Figure 7.1.



RACAL TH 5160/1

Block Diagram PRM 4700 Fig 7·1

2. When the transceiver is first switched on a built-in test equipment (BITE) sequence is initiated. During BITE operation the microprocessor controls a self test procedure, a channel memory check and two receiver tests. When the PTT switch is operated the BITE checks the transmitter (presence of sidetone).

RECEPTION (See Fig. 7.2)

3. Frequency or channel data is fed from the front panel frequency keys or the channel switch in parallel form to the microprocessor. The parallel data input to the microprocessor is used to produce serial data which is sent to the Synthesizer board to determine the frequency of the Receiver board VCO (Voltage controlled oscillator).

4. The incoming frequency modulated rf signal from the antenna is fed through the AMU board and switched via a PIN diode on the PA board and applied to the rf amplifier on the receiver board. The amplified rf signal is mixed with the output of the receiver VCO and the difference frequency fed to a series of IF (intermediate frequency) filters and IF amplification stages. The output of the final IF amplifier is applied to a crystal quadrature detector circuit. A carrier detect output from the detector is used to open the squelch to enable the audio output of the detector to be applied to the audio amplifier on the audio board. A 150Hz pilot tone detect circuit fed from the audio circuit is used to detect the presence of an incoming signal when the transceiver is used as part of a rebroadcast station.

5. The level of audio output is set by the front panel ON/OFF, volume switch SW2.

6. When no incoming signal is present current saving circuits on the audio board are implemented to conserve the radio battery.

TRANSMISSION (See Fig. 7.3)

7. As on reception, frequency or channel data is fed from the front panel frequency keys or the channel switch and used by the microprocessor to produce serial data to determine the frequency of the transmitter VCO on the synthesizer board.

8. During transmission voice signals from the microphone, are fed to the microphone amplifier and speech clipper circuits on the audio board, and used to frequency modulate the Synthesizer board transmitter VCO. 16k - bit/s data is fed directly to the clipper circuit. A PTT signal from the handset is fed to the control board microprocessor to put the radio to the transmit mode.

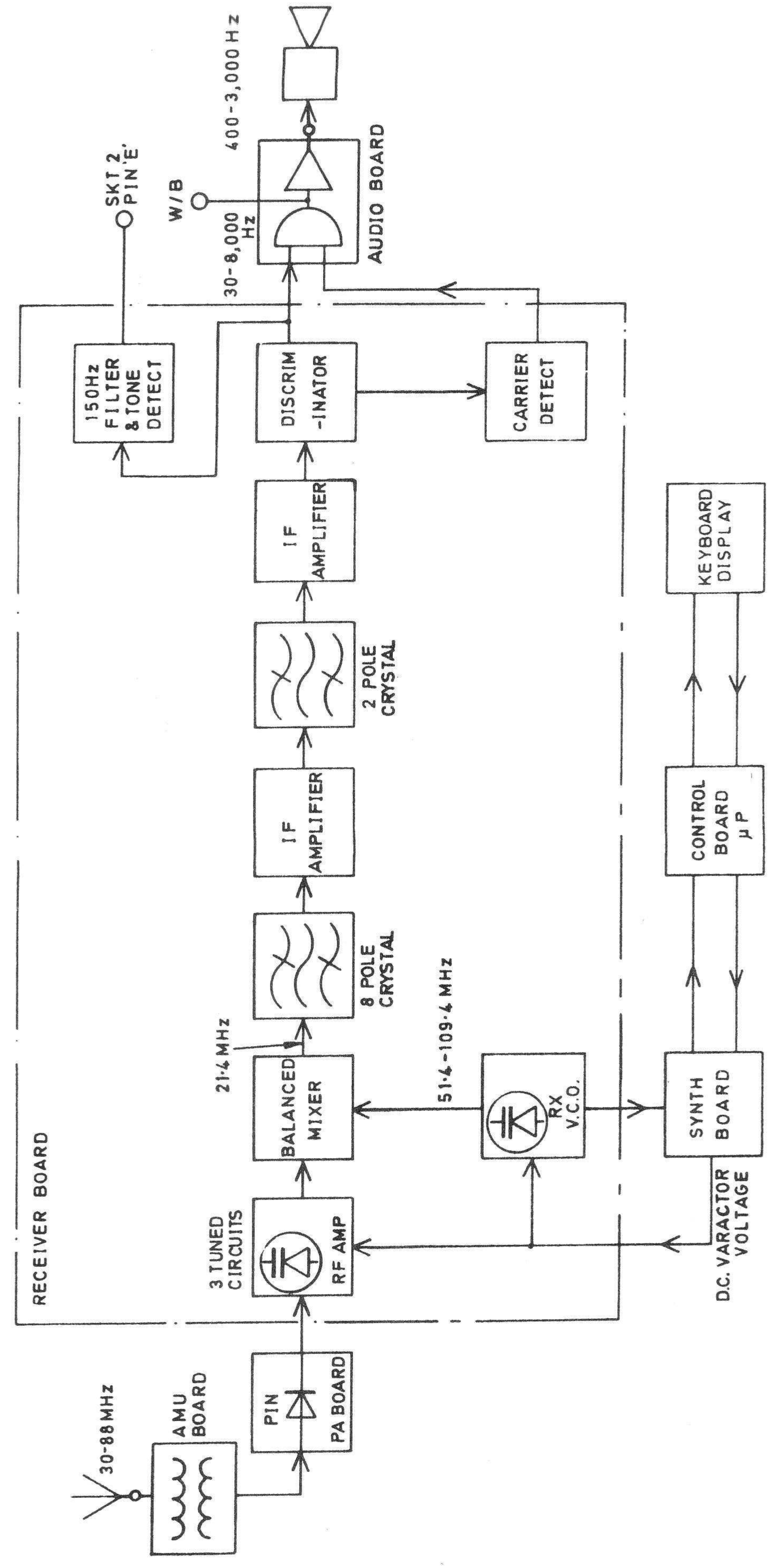
9. A 150 Hz pilot tone generated in the synthesiser is passed through a band pass filter on the receiver board before being added to the audio modulation on the synthesiser board.

10. The frequency modulated transmitter VCO output signal on the Synthesizer board is fed to the power amplifier board where the signal is applied to a buffer amplifier. In the high power mode the signal is fed to a driver stage and an output high power amplifier, in the low power mode the signal

is fed to a low power amplifier stage. The amplified signal is routed through one of three output low pass filters (LPF) and fed to the AMU board. The output of the AMU board feeds the whip antenna and the 50Ω BNC sockets.

Sidetone

11. When the correct level of transmitter RF signal is present a dc voltage is fed from the P.A. board to the RF DET input of the audio board. This dc level is used to enable the audio path so that the output of the microphone amplifier can be heard in the handset earpiece as sidetone, only when there is sufficient signal at the P.A. output.



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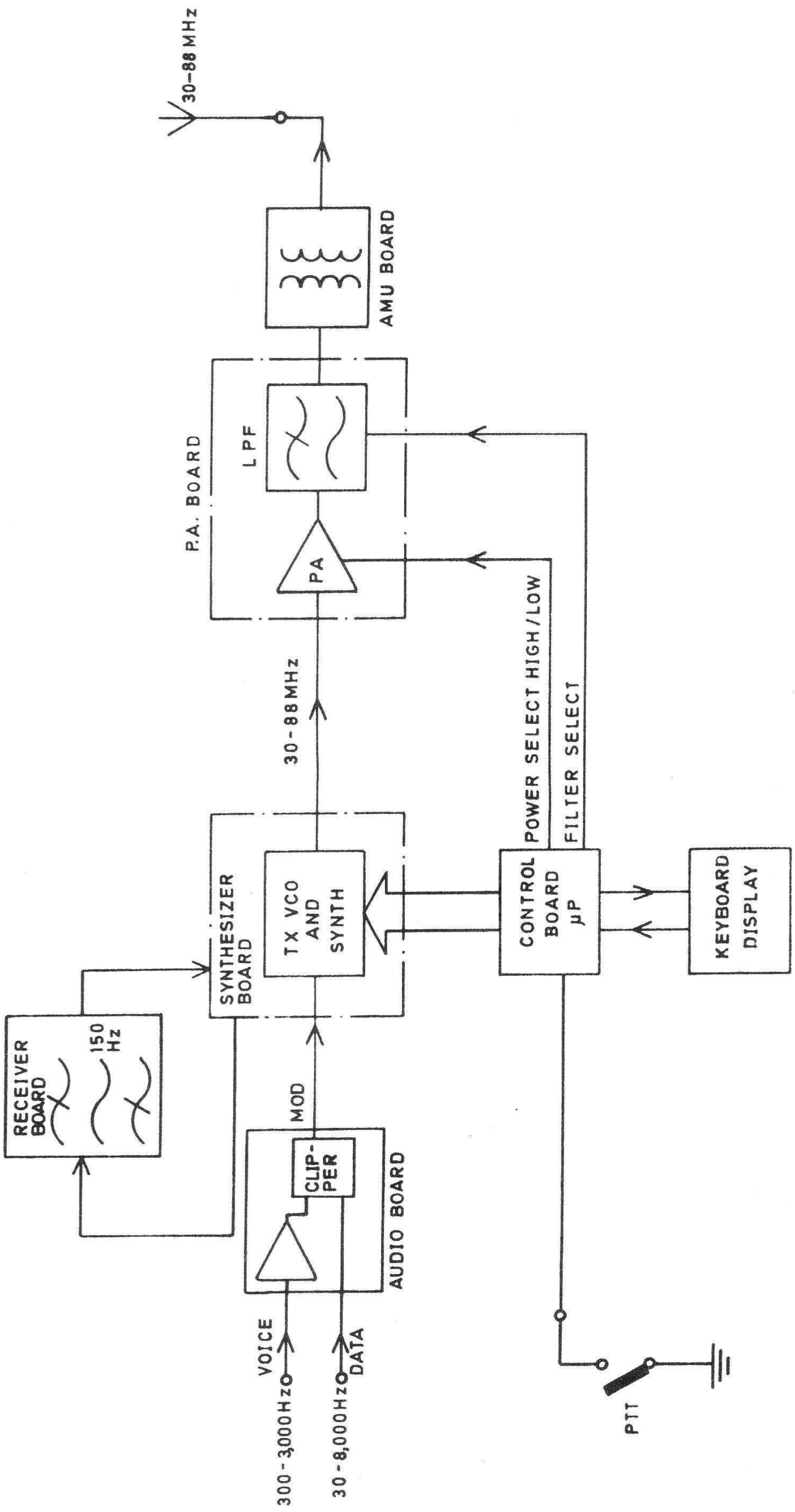
Block Diagram: Receiver

Fig 7.2



RACAL

Block Diagram: Transmitter

Fig 7.3

CHAPTER 8

INTERCONNECTIONS

CONTENTS

TABLE

ILLUSTRATIONS

CHAPTER 8

INTERCONNECTIONS

INTRODUCTION

1. The interconnections between the various sub-assemblies, controls, sockets and terminals are shown in the interconnection diagram Fig 2. The Motherboard PCB layout is shown in Fig. 1. (Located at the end of Part 1).

FRONT PANEL

2. Connections from the front panel to the Motherboard, where they can be unplugged are made via three flexible cables; from the switches, from the sockets, and from the Control Board. A coaxial cable from the AMU Board can be unplugged on the PA Board.

AUDIO SOCKETS (See Fig. 8.1)

3. Audio equipment may be connected to either Audio socket. The pins of these sockets are used as follows:

SK1

- A Microphone/Data input.
- B +10.5V Supply input/output.
- C PTT/4k bit data programming input.
- D 0V.
- E Voice/Data Control of pin A. (1 V = Data and Mute Tone)
- F Variable Audio output.
- G W/B Data output.

SK2

- A Microphone input. (+10 V = Mute Tone)
- B +10.5V Supply input/output.
- C PTT/4k bit data programming input.
- D 0V
- E Channel in use (tone operated for Rebro) (0 V = 150 Hz Detected)
- F Variable Audio output
- G Fixed Audio output.

NOTE: A D.C. O/P Proportional to the vol. control setting for use by ancillaries is superimposed on the var. audio O/P from pin F (SK1 & SK2).

4k BIT DATA

4. Programming of channel frequencies (with MA 4073B programmer or MA 4083B fill gun) and extended control of the following functions is possible using the 4k bit PWM input on pin C.

Channel Request (0-9)
Program Fixed Frequency
Program 2nd Fixed Frequency
Tx Power Mode
Squelch override

For further information of the 4k bit PWM data format see Para. 5 and MA 4073B handbook.

50 OHM CONNECTOR

5. Frequency data is sent from the 50 ohm front panel socket for control of filter switching in the TA 4703A, MA 4704A, and band selection in the BCC 587B AMU. (After modification to format)

It is a 4k bit PWM signal in the form of modulated d.c. keying to 0 V. It is sent only at channel change and at Rx-Tx-Rx changeover, and is of 4mS duration. The format of the 16 bit serial word is shown in Table 8.1.

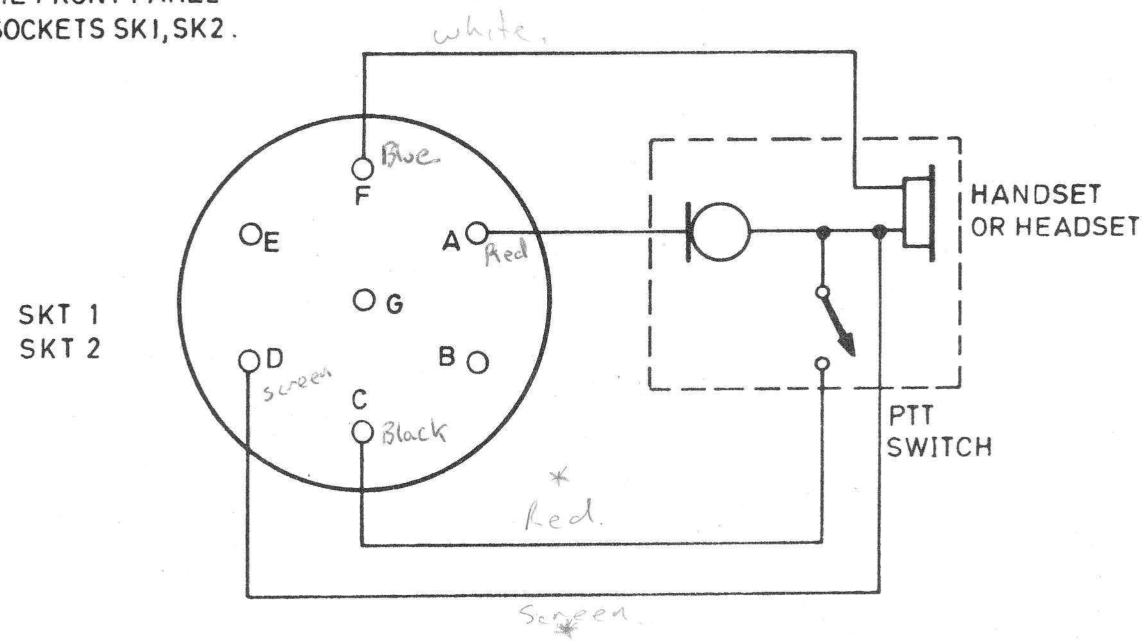
Table 8.1

50 OHM SOCKET FREQUENCY DATA FORMAT

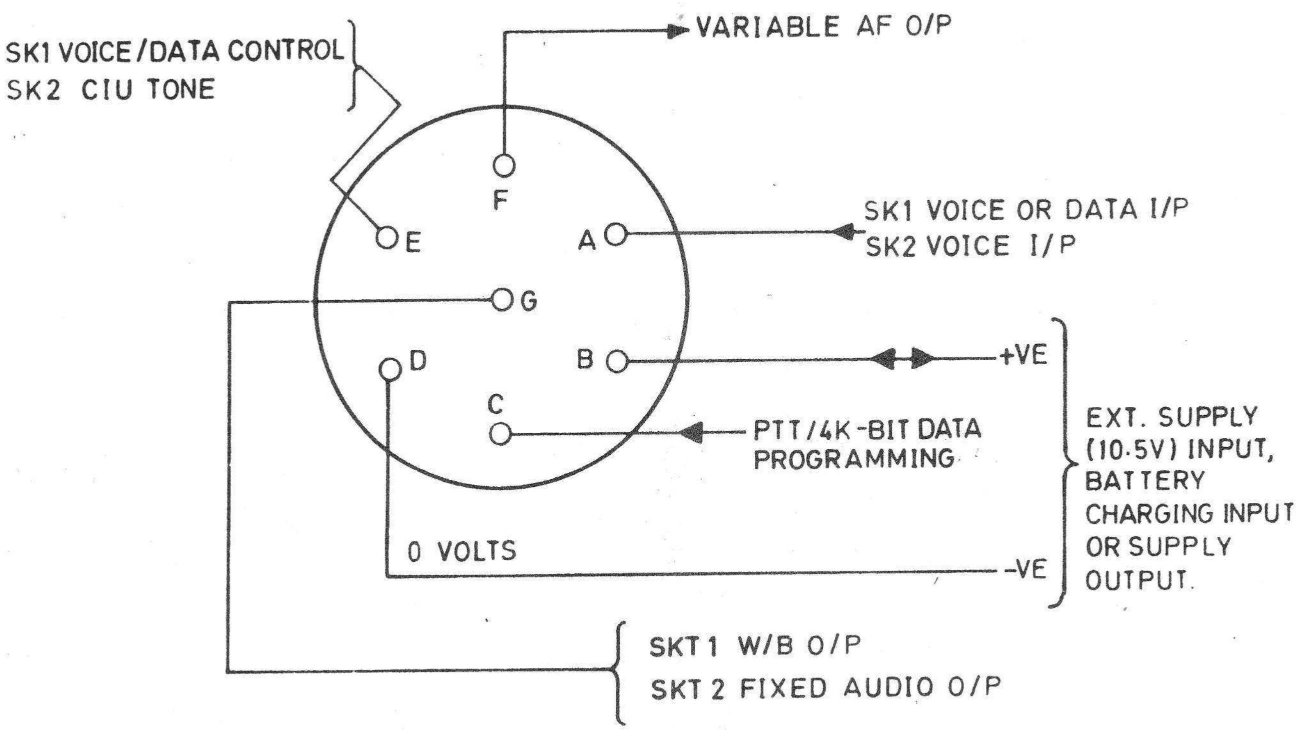
16 BIT WORD	
1	0
2	0
3	25kHz
4	50kHz
5	
6	100kHz
7	
8	
9	
10	1MHz
11	
12	
13	
14	10MHz
15	
16	

N.B. Sent only once at channel change, and Rx-Tx-Rx changeover for 4mS.

THE PLUG SHOWN MATES
WITH THE FRONT PANEL
AUDIO SOCKETS SK1, SK2.



Handset / Headset Plug Connections



Audio Socket SK1 & SK2 Connections

Fig 8.1

CHAPTER 9

FAULT LOCATION

CONTENTS

FLOW CHARTS

TABLES

CHAPTER 9

FAULT LOCATION

INTRODUCTION

1. Functional checks, intended for operator use, are given in Chapter 5. If the checks reveal a fault condition the flow charts in this chapter should be used to allow faults to be isolated to a board or stage. Fault finding information for the various modules is given in the appropriate Parts of this handbook.

LITHIUM BATTERY RENEWAL

2. The lithium battery on the Central Control PCB is necessary for the retention of channel frequencies. It is recommended that this battery is renewed after 5 years.

NOTES ON USE OF FLOW CHARTS

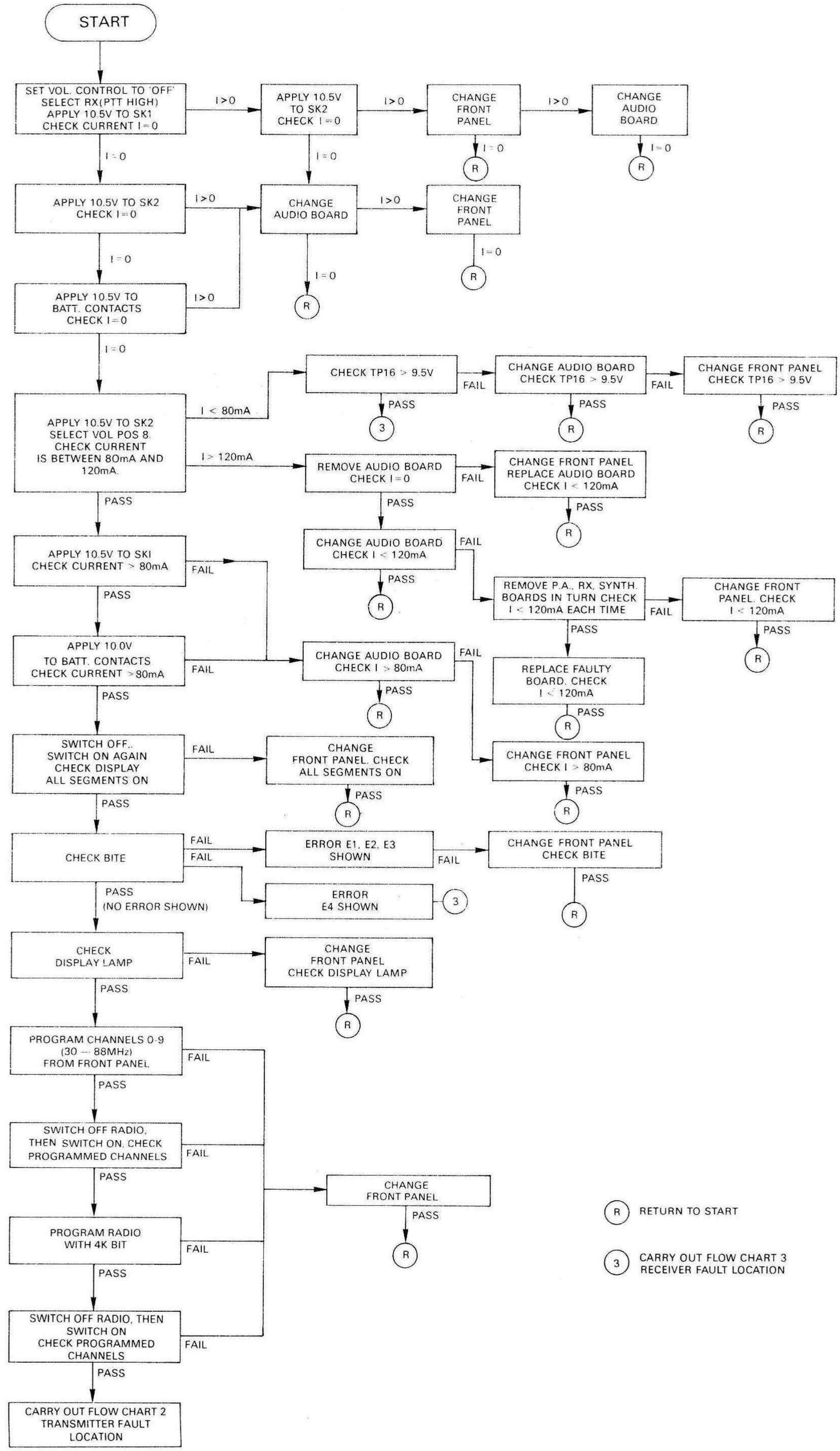
3. The test points referred to in the Flow Charts (except TP1, PA) are part of 15SK5 which is positioned on the Mother Board near to the Receiver Board. TP1 (PA) is positioned at the rear of the P.A. Board and consists of a pair of sockets for the connection of a co-axial lead. 15SK5 and TP1 (PA) can be accessed by removing the outer sleeve of the radio but without the need to remove the individual board covers.

   Note: TP24 15SK5 = 0 V.

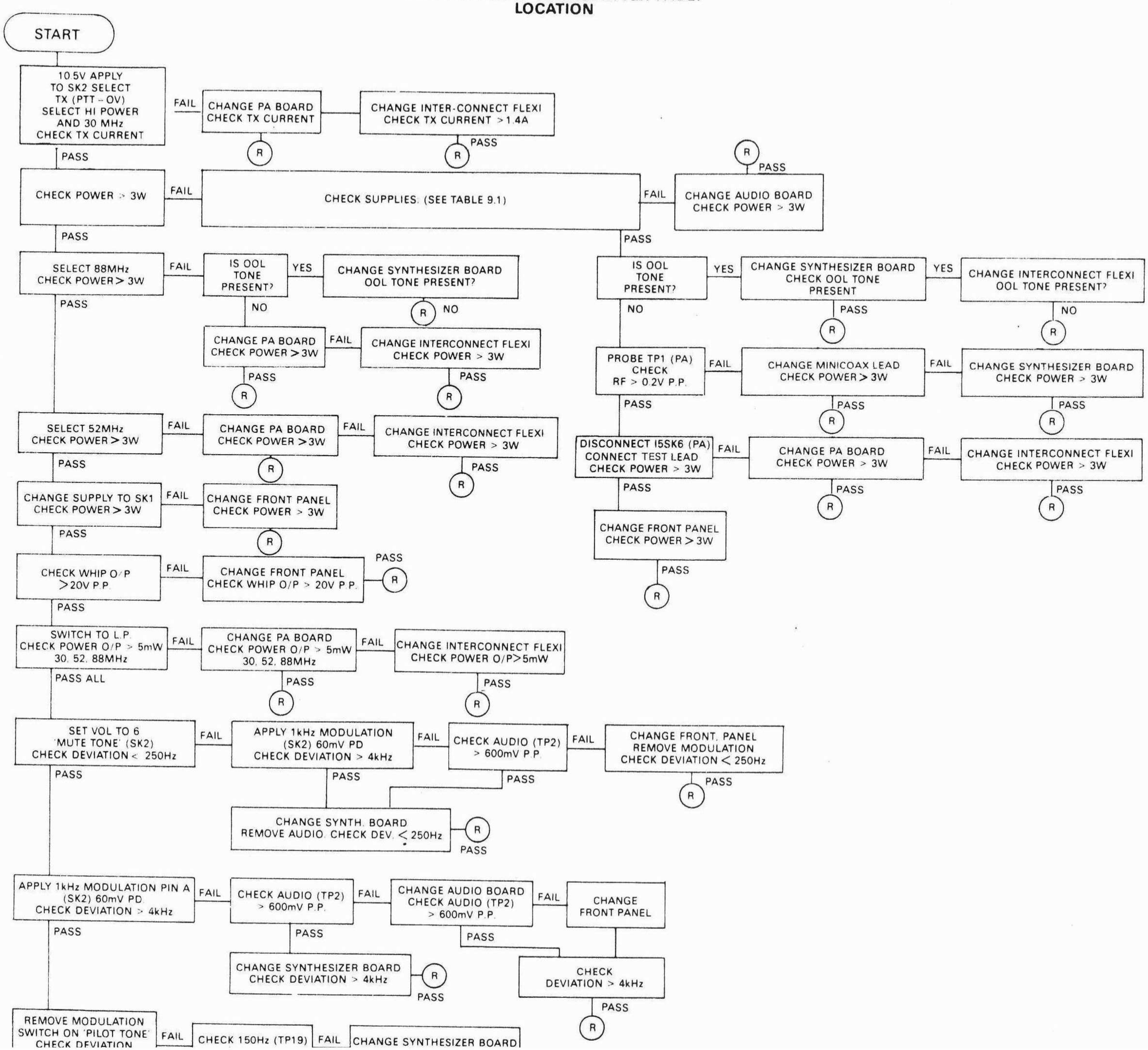
4. The volume control is assumed to be numbered from 0 to 8, i.e. 0 = OFF or fully anti-clockwise.

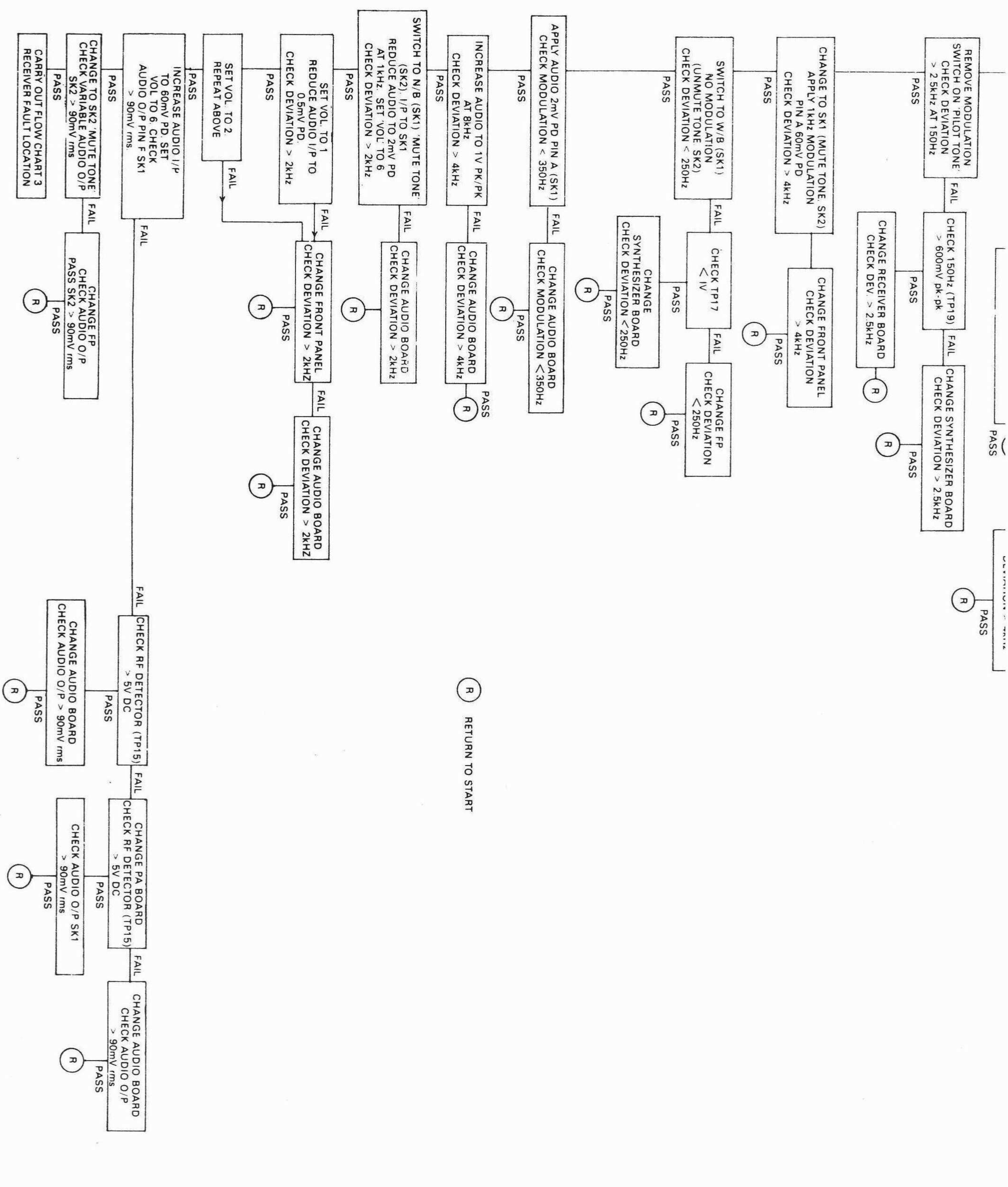
5. The radio should be powered from a 10.5 V/2 A power supply connected to pins B(+ve) and D(-ve) of SK1 or SK2 on the Front Panel, or across the battery contacts at the rear of the chassis (+ve terminal marked red) as indicated in the flow charts.

6. Test equipment. See Chapter 10.

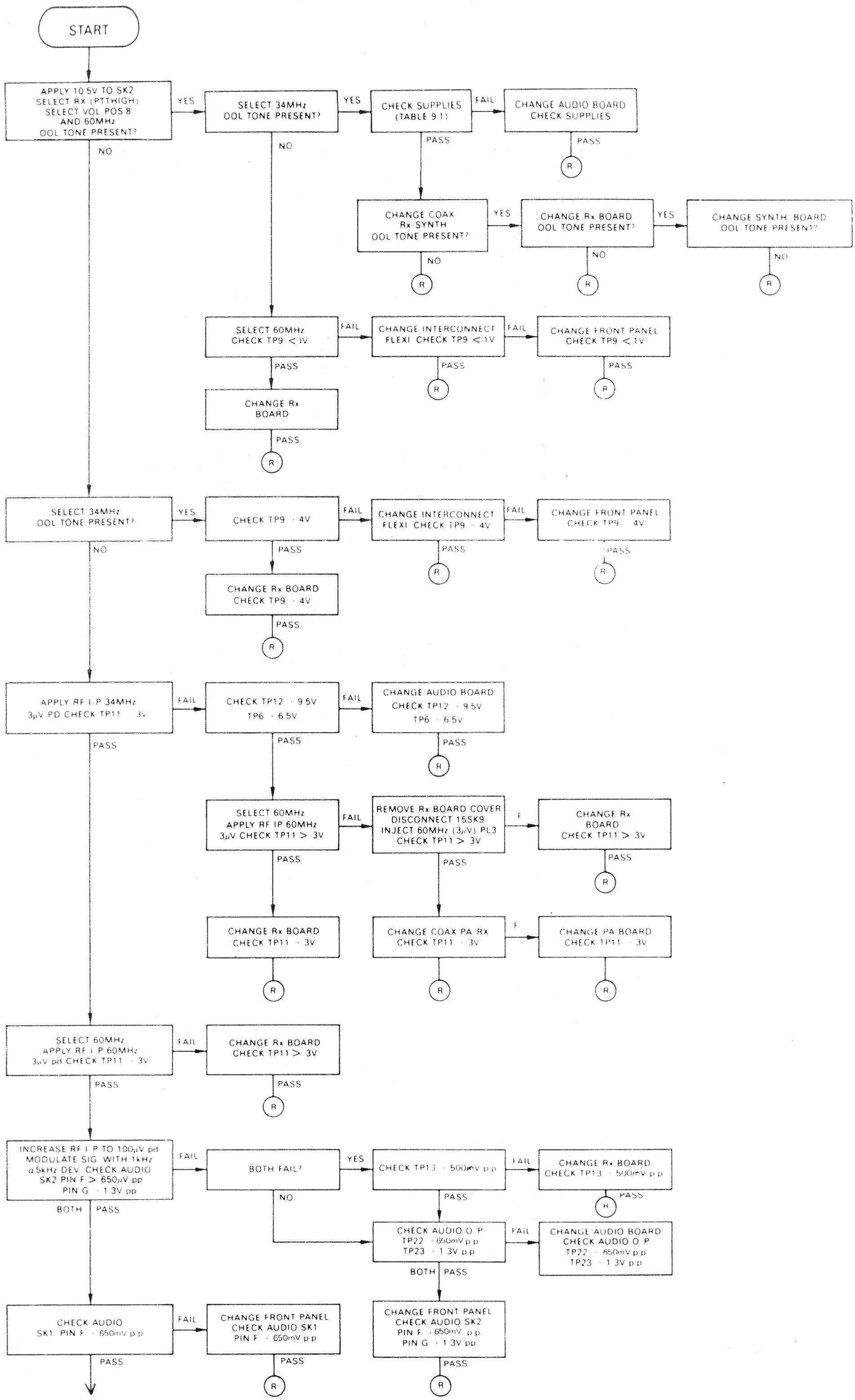

START
SET VOL. CONTROL TO 'OFF' SELECT RX(PTT HIGH) APPLY 10.5V TO SK1 CHECK CURRENT I = 0
I > 0
APPLY 10.5V TO SK2 CHECK I = 0
I > 0
CHANGE FRONT PANEL
I > 0
CHANGE AUDIO BOARD
I = 0
R
APPLY 10.5V TO SK2 CHECK I = 0
CHANGE AUDIO BOARD
CHANGE FRONT PANEL
APPLY 10.5V TO BATT. CONTACTS CHECK I = 0
APPLY 10.5V TO SK2 SELECT VOL POS 8. CHECK CURRENT IS BETWEEN 80mA AND 120mA.
I < 80mA
I > 120mA
CHECK TP16 > 9.5V
FAIL
PASS
3
CHANGE AUDIO BOARD CHECK TP16 > 9.5V
CHANGE FRONT PANEL CHECK TP16 > 9.5V
REMOVE AUDIO BOARD CHECK I = 0
CHANGE FRONT PANEL REPLACE AUDIO BOARD CHECK I < 120mA
CHANGE AUDIO BOARD CHECK I < 120mA
REMOVE P.A., RX, SYNTH. BOARDS IN TURN CHECK I < 120mA EACH TIME
CHANGE FRONT PANEL. CHECK I < 120mA
REPLACE FAULTY BOARD. CHECK I < 120mA
APPLY 10.5V TO SKI CHECK CURRENT > 80mA
APPLY 10.0V TO BATT. CONTACTS CHECK CURRENT >80mA
CHANGE AUDIO BOARD CHECK I > 80mA
CHANGE FRONT PANEL CHECK I > 80mA
SWITCH OFF., SWITCH ON AGAIN CHECK DISPLAY ALL SEGMENTS ON
CHANGE FRONT PANEL. CHECK ALL SEGMENTS ON
CHECK BITE
ERROR E1, E2, E3 SHOWN
CHANGE FRONT PANEL CHECK BITE
ERROR E4 SHOWN
PASS (NO ERROR SHOWN)
CHECK DISPLAY LAMP
CHANGE FRONT PANEL CHECK DISPLAY LAMP
PROGRAM CHANNELS 0-9 (30 — 88MHz) FROM FRONT PANEL
SWITCH OFF RADIO, THEN SWITCH ON, CHECK PROGRAMMED CHANNELS
CHANGE FRONT PANEL
PROGRAM RADIO WITH 4K BIT
SWITCH OFF RADIO, THEN SWITCH ON CHECK PROGRAMMED CHANNELS
CARRY OUT FLOW CHART 2 TRANSMITTER FAULT LOCATION
R RETURN TO START
3 CARRY OUT FLOW CHART 3 RECEIVER FAULT LOCATION

FLOW CHART 2 TRANSMITTER FAULT LOCATION




REMOVE MODULATION SWITCH ON 'PILOT TONE' CHECK DEVIATION > 2.5kHz AT 150Hz
PASS
FAIL
CHECK 150Hz (TP19) > 600mV pk-pk
PASS
FAIL
CHANGE RECEIVER BOARD CHECK DEV. > 2.5kHz
CHANGE SYNTHESIZER BOARD CHECK DEVIATION > 2.5kHz
PASS
CHANGE TO SK1 (MUTE TONE, SK2) APPLY 1kHz MODULATION PIN A 60mV PD CHECK DEVIATION > 4kHz
PASS
CHANGE FRONT PANEL CHECK DEVIATION > 4kHz
PASS
SWITCH TO W/B (SK1) NO MODULATION (UNMUTE TONE SK2) CHECK DEVIATION < 250Hz
PASS
FAIL
CHECK TP17 < 1V
PASS
FAIL
CHANGE SYNTHESIZER BOARD CHECK DEVIATION <250Hz
PASS
CHANGE FP CHECK DEVIATION < 250Hz
PASS
APPLY AUDIO 2mV PD PIN A (SK1) CHECK MODULATION < 350Hz
PASS
FAIL
CHANGE AUDIO BOARD CHECK MODULATION <350Hz
PASS
INCREASE AUDIO TO 1V PK/PK AT 8kHz CHECK DEVIATION > 4kHz
PASS
FAIL
CHANGE AUDIO BOARD CHECK DEVIATION > 4kHz
PASS
SWITCH TO N/B (SK1) 'MUTE TONE' (SK2). I/P TO SK1 REDUCE AUDIO TO 2mV PD AT 1kHz. SET 'VOL' TO 6 CHECK DEVIATION > 2kHz
PASS
FAIL
CHANGE AUDIO BOARD CHECK DEVIATION > 2kHz
SET VOL. TO 1 REDUCE AUDIO I/P TO 0.5mV PD. CHECK DEVIATION > 2kHz
PASS
FAIL
CHANGE FRONT PANEL CHECK DEVIATION > 2kHZ
PASS
FAIL
CHANGE AUDIO BOARD CHECK DEVIATION > 2kHZ
PASS
SET VOL. TO 2 REPEAT ABOVE
PASS
FAIL
INCREASE AUDIO I/P TO 60mV PD. SET VOL TO 6. CHECK AUDIO O/P PIN F SK1 > 90mV rms.
PASS
FAIL
CHECK RF DETECTOR (TP15) > 5V DC
PASS
FAIL
CHANGE AUDIO BOARD CHECK AUDIO O/P > 90mV rms
PASS
CHANGE PA BOARD CHECK RF DETECTOR (TP15) > 5V DC
PASS
FAIL
CHECK AUDIO O/P SK1 > 90mV rms
PASS
CHANGE AUDIO BOARD CHECK AUDIO O/P > 90mV rms
PASS
CHANGE TO SK2 'MUTE TONE' CHECK VARIABLE AUDIO O/P SK2 > 90mV rms
PASS
FAIL
CHANGE FP CHECK AUDIO O/P PASS SK2 > 90mV rms
PASS
CARRY OUT FLOW CHART 3 RECEIVER FAULT LOCATION
R
RETURN TO START

FLOW CHART 3. RECEIVER FAULT LOCATION



FLOW CHART 3 RECEIVER FAULT LOCATION (contd)

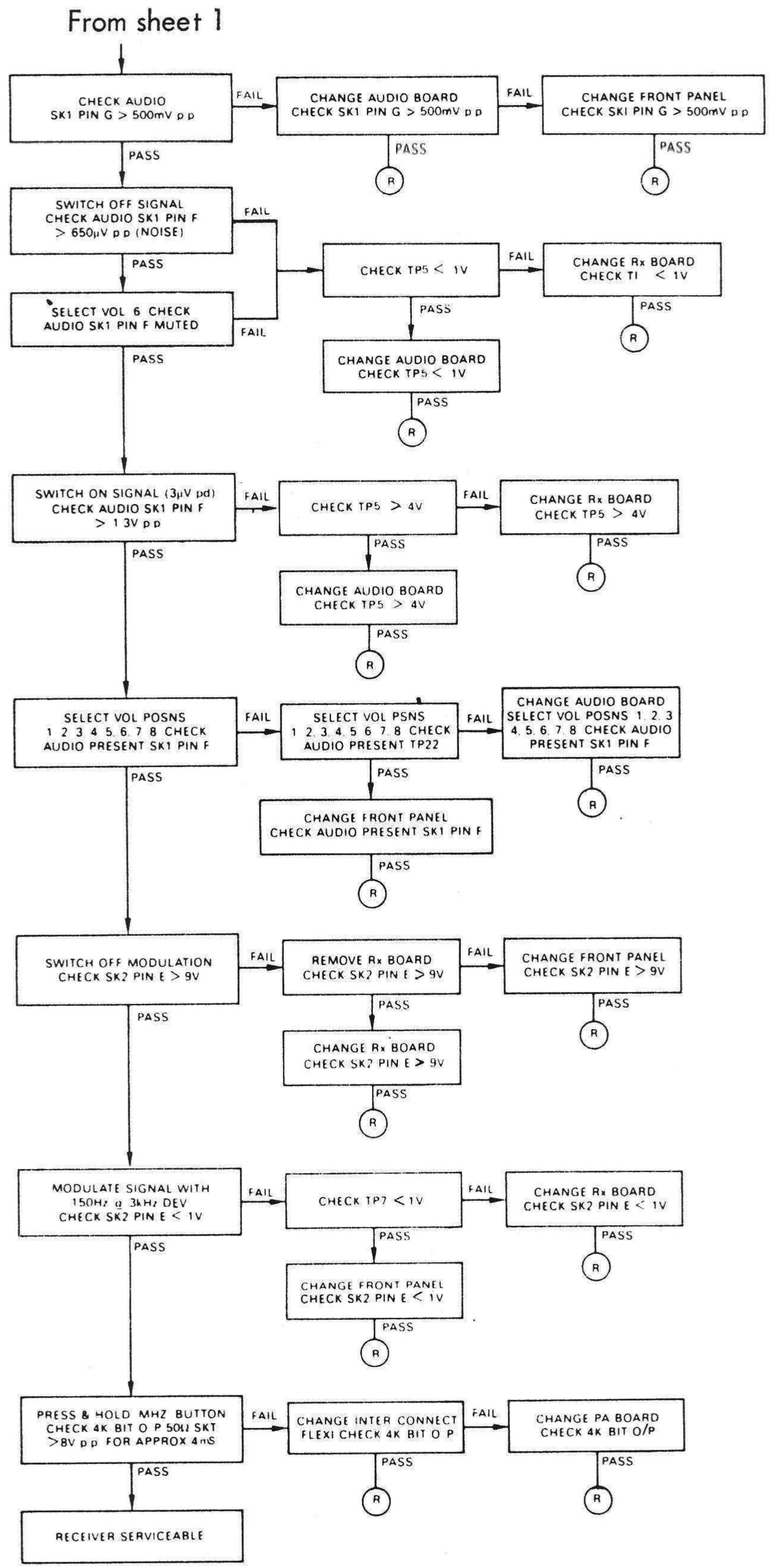


TABLE 9.1

Supply Voltages

(Referred to in Flow Charts 2 and 3)
(Not current-Saving, Vol. position 8)

Test Point	Function	Receive	Transmit
16	10 V	>9.5 V	>9.5 V
12	10 V RX	>9.5 V	< 1 V
10	10 V RX SYNTH	>9.5 V	< 1 V
18	7 V	>6.5 V	>6.5 V
6	7 V RX	>6.5 V	< 1 V
3	7 V RX SYNTH	>6.5 V	< 1 V
14	7 V TX	< 1 V	>6.5 V

CHAPTER 10

TEST EQUIPMENT

CONTENTS

CHAPTER 10

TEST EQUIPMENT

INTRODUCTION

1. The following is a list of test equipment required for test and fault finding procedures on the complete transceiver.

TEST EQUIPMENT

2. (1) PRM 4700 Switching Interface Unit TJ947.

(2) Power Supply

Voltage	:	10.5V
Current	:	2A Maximum
Example	:	Farnell L30-2

(3) R.F. Power Meter

Frequency	:	30MHz - 88MHz
Ranges	:	30mW, 10W
Impedance	:	50 Ω
Preferred Type	:	Farnell 2081

(4) Digital Frequency Meter

Frequency	:	150Hz - 88MHz
Accuracy	:	Better than ± 1 part in 10^7
Example	:	Racal, 9912/04A/09

(5) Modulation Meter

Frequency	:	30MHz - 88MHz
Deviation Measurement	:	up to 10kHz
Impedance	:	50 Ω
Example	:	Racal Type 9009

(6) AF Generator

Frequency	:	30Hz - 8kHz
Impedance	:	600 ohms
Output	:	180mV emf
Example	:	Racal 9083

(7) Oscilloscope

Frequency	:	0 - 100MHz
Sensitivity	:	50mV/cm
Example	:	Tektronix Type 465 or similar (HP 1740A/H07) with probe and 50 ohm adaptor.

(8) RF Signal Generator

Frequency	:	1MHz - 150MHz
Impedance	:	50 Ω
Output	:	0.2uV - 1Vemf
Preferred Type	:	Hewlett Packard 8640B

(9) AF Power Meter

Frequency	:	30Hz - 8kHz
Power	:	Up to 10mW
Impedance	:	300 Ω/10 kΩ
Example	:	Dymar type 2085

(10) Distortion Analyser (SINAD Meter)

Frequency	:	0 - 20kHz
Example	:	Hewlett Packard 333A Distortion Analyser.

(11) Multimeter

Example	:	Avometer Model 8

(12) Digital Voltmeter

Range	:	0 - 100V
Resolution	:	100uV
Example	:	Racal 4001

(13) Leads and Adaptors

Coax 700664 1.0m 3 off
'N' to 'BNC' Coax adaptor

(14) Ancillaries

Battery	:	MA 4705A, ST 719759 2 off
Whip	:	0.5m, ST 719518 2 off
Handset	:	ST 712275 2 off

(15) 16K-BIT Generator

Racal TJ841	:	Use Low Output Terminals

CHAPTER 11

PERFORMANCE CHECKS

CONTENTS

APPENDICES

CHAPTER 11

PERFORMANCE CHECKS

INTRODUCTION

1. This chapter gives overall test procedures for the complete Transceiver. Random adjustments should not be made.

OPERATION OF CONTROLS AND BITE

2. (1) Connect PL1 and PL2 of the TJ 947 to Audio SKTs 1&2 respectively on the PRM 4700. Connect a power supply set to 10.5V to + V2 and OV on the TJ 947 with a multimeter set to AMPS in series. Switch the TJ 947 to 'Rx'.

(2) Switch on Unit and check that all segments of the display can be seen. Wait 5 seconds and check that no error is displayed (BITE).

(3) Check all controls for smooth action.
Check that the volume control indicates the correct positions.

TRANSMITTER TESTS

3. (1) Connect a coax lead from the 50 Ω SKT of the PRM 4700 to the RF Power Meter. Select the 10 W range on the Power Meter. (Ensure that the output at the rear of the Power Meter is correctly terminated).

(2) Switch on the radio and select channel 0, select 30.000 MHz and HI PWR on the keyboard.

(3) Switch the TJ 947 to 'Tx' and adjust the Power Supply to give 10.5V between pin B (2) and pin D (2) of the TJ 947. Check that the supply current is less than 1.8A.

(4) Check that the power output is greater than 3.0W. Repeat for the following frequencies.

40.000 MHz
50.000 MHz
60.000 MHz
70.000 MHz
80.000 MHz
88.000 MHz

(5) Select 30.000MHz and LO PWR on the keyboard. Select the 30mW range on the Power Meter.

(6) Check that the power output is between 5.0mW and 30.0mW. Repeat for the following frequencies.

40.000MHz
50.000MHz
60.000MHz
70.000MHz
80.000MHz
88.000MHz

(7) Connect the Frequency Meter to the attenuated output at the rear of the Power Meter. Check that the frequency is 88.000MHz ± 880Hz.

(8) Disconnect the Frequency Meter and connect the Modulation Meter to the output of the Power Meter. Select the 10W range on the Power Meter. Select 30.000MHz and HI PWR on the radio keyboard.

(9) Switch out AF Filter on Modulation Meter. Set Pilot tone switch on TJ 947 to 'ON'. Check that deviation is between 2.5kHz and 3.5kHz.

Repeat for the following frequencies:

40.000MHz
50.000MHz
60.000MHz
70.000MHz
80.000MHz
88.000MHz

(10) Connect the Frequency Meter to the AF Output on the Modulation Meter. Check that the frequency is 150Hz ± 2Hz.

(11) Switch Pilot tone switch on TJ 947 to 'OFF'. Connect AF Signal Generator to AF Input terminals (2) on TJ 947 and set Generator to give 180mV emf (from 600 Ω) at 1kHz. Set volume control on radio to position 3.

(12) Set frequency on radio to 30.000MHz. Check deviation is between 4.0kHz and 6.0kHz. Repeat for the following frequencies.

40.000MHz
50.000MHz
60.000MHz
70.000MHz
80.000MHz
88.000MHz

(13) Reduce level of AF Signal Generator to give 3.0kHz deviation. Reduce frequency of Generator to 400Hz and check that the deviation is greater than 1.5kHz.

(14) Increase frequency of Generator to 3.0kHz and check that the deviation is greater than 1.5kHz. Disconnect AF Generator from TJ 947.

(15) Connect AF Signal Generator to AF input terminals (1) on TJ 947 and set switch to 'W/B'. Set generator to give 3kHz deviation at 1kHz modulating frequency. Reduce frequency of generator to 30Hz and check that deviation is greater than 1.5kHz.

(16) Increase frequency of generator to 8kHz and check that deviation is greater than 1.5kHz. Disconnect AF generator from TJ 947.

(17) Connect low output terminals of 16K-BIT Generator, TJ841, to AF Input terminals (1) on TJ947. Check deviation is 5kHz ± 1.0kHz.

RECEIVER TESTS

4. (1) Set the TJ 947 to 'RX'. Adjust the power supply to give 10.5V between pin B2 and OV of the TJ 947. Set the Volume Control on the PRM 4700 to position 8. Check that the supply current is less than 120mA.

(2) Connect a handset to an audio socket on TJ 947. Check that noise is heard in the handset (squelch defeat).

(3) Connect a coax lead from the 50 Ω socket of the radio to the RF Signal Generator. Set the radio to Channel 0 and select 30.025MHz on the keyboard. Set the Signal Generator to 30.025MHz with a frequency modulating signal of 1kHz at 5.0kHz peak deviation. Set output level to 0.6μV emf.

(4) Connect the SINAD meter to the AF O/P FIXED N/B terminals of the TJ 947. Set the Volume Control on the radio to position 6. Check that the SINAD is greater than 12dB. Switch off the carrier of the Generator and ensure that AF O/P is muted. Repeat for the following frequencies.

40.025 MHz
50.025 MHz
60.025 MHz
70.025 MHz
80.025 MHz
87.975 MHz

(5) Switch off the carrier of the Signal Generator and wait for 10 seconds. Check that the supply current is less than 35mA.

(6) Increase the output level of the Generator to 100μV emf. Connect a 10k Ω AF power Meter to the AF O/P FIXED W/B terminals of the TJ 947 and note the power level. Reduce the modulating frequency of the Generator to 30Hz and check that the AF level does not fall by more than 3dB relative to 1kHz.

(7) Increase the modulating frequency of the Generator to 8kHz and check that the AF level does not fall by more than 3dB relative to 1kHz.

(8) Disconnect AF Power Meter from AF O/P FIXED W/B terminals of the TJ 947 and connect to AF O/P FIXED N/B terminals. Change power meter to 300Ω. Reset the modulating frequency to 1kHz and note the power level. Reduce the modulating frequency of the Generator to 400Hz and check that the AF level does not fall by more than 6dB relative to 1kHz.

(9) Increase the modulating frequency of the Generator to 3.0kHz and check that the AF level does not fall by more than 6dB relative to 1kHz.

(10) Disconnect handset from TJ 947. Reset the modulating frequency to 1kHz. Check that the AF power output is between 0.8 and 1.6mW (300 Ω load).

(11) Connect the AF Power Meter to the AF O/P VAR terminals of the TJ 947. Set the Volume Control on the radio to position 6. Disconnect the handset from the TJ 947. Check that the AF power output is between 0.8mW and 2.0mW (300 Ω load).

(12) Connect an AVO meter to pin E(2) and OV on the TJ 947. Check that the voltage is greater than 9.5V.

(13) Reduce the modulating frequency of the Signal Generator to 150Hz and the peak deviation to 3.0kHz and set the output level to 0.6uV emf. Check that the voltage on pin E(2) is less than 1.0V.

AIR TESTS

5. (1) Select two manpacks and fit with batteries, whips and handsets.

(2) Program channels 0 - 9 on each manpack with the following frequencies:-

CH. 0	:	30.050 MHz
CH. 1	:	35.050
CH. 2	:	45.050
CH. 3	:	50.050
CH. 4	:	55.050
CH. 5	:	60.050
CH. 6	:	65.050
CH. 7	:	75.050
CH. 8	:	80.050
CH. 9	:	87.950

(3) Switch both sets to Volume Control position 6 and channel 0. Check that audio is muted when neither set is transmitting. Establish communication on Channel 0. Repeat procedure for channels 1 - 9.

(4) Select one channel and switch the Volume Control to position 2. Check for communication by whispering into the handset.

(5) With neither set transmitting, switch the Volume Control to position 8. Check that the audio is unmuted and noise is heard.

(6) Check that the communication can be established in Volume Control position 8 and that the noise level decreases when the other set is transmitting.

(7) Press LAMP button and check that display is illuminated.

(8) Switch Volume Control to OFF position. Disconnect battery, whip and handset.

APPENDIX 1

PERFORMANCE CHECK LIST

Sub-Clause Number	Test		Upper Limit	Lower Limit	Result
2. (2)	Bite		*	*	
(3)	Operation of Controls		*	*	
	TRANSMIT				
3. (3)	Supply Current		1.8A		
(4)	Power Output (High)	30.000MHz	-	3.0W	
		40.000MHz	-	3.0W	
		50.000MHz	-	3.0W	
		60.000MHz	-	3.0W	
		70.000MHz	-	3.0W	
		80.000MHz	-	3.0W	
		88.000MHz	-	3.0W	
(6)	Power Output (low)	30.000MHz	30mW	5.0mW	
		40.000MHz	30mW	5.0mW	
		50.000MHz	30mW	5.0mW	
		60.000MHz	30mW	5.0mW	
		70.000MHz	30mW	5.0mW	
		80.000MHz	30mW	5.0mW	
		88.000MHz	30mW	5.0mW	
(7)	Frequency	88.000MHz	+880Hz	-880Hz	
(9)	Pilot Deviation	30.000MHz	3.5kHz	2.5kHz	
		40.000MHz	3.5kHz	2.5kHz	
		50.000MHz	3.5kHz	2.5kHz	
		60.000MHz	3.5kHz	2.5kHz	
		70.000MHz	3.5kHz	2.5kHz	
		80.000MHz	3.5kHz	2.5kHz	
		88.000MHz	3.5kHz	2.5kHz	
(10)	Pilot frequency	88.000MHz	152Hz	148Hz	
(12)	1kHz Deviation	30.000MHz	6.0kHz	4.0kHz	
		40.000MHz	6.0kHz	4.0kHz	
		50.000MHz	6.0kHz	4.0kHz	
		60.000MHz	6.0kHz	4.0kHz	
		70.000MHz	6.0kHz	4.0kHz	
		80.000MHz	6.0kHz	4.0kHz	
		88.000MHz	6.0kHz	4.0kHz	
(13)	AF B/W N/B	400Hz		1.5kHz	

APPENDIX 1

PERFORMANCE CHECK LIST Cont.d

Sub-Clause Number	Test		Upper Limit	Lower Limit	Result
(14)	AF B/W N/B	3.0kHz		1.5kHz	
(15)	AF B/W W/B	30Hz		1.5kHz	
(16)	AF B/W W/B	8kHz		1.5kHz	
(17)	Data Deviation		6.0kHz	4.0kHz	
	RECEIVE				
4. (1)	Supply Circuit	120mA			
(2)	Squelch Defeat		*	*	
(4)	Sensitivity at 0.6uV emf			12dB	
	SINAD at	30.025MHz		12dB	
		40.025MHz		12dB	
		50.025MHz		12dB	
		60.025MHz		12dB	
		70.025MHz		12dB	
		80.025MHz		12dB	
		87.975MHz		12dB	
	Carrier Squelch	30.025MHz	*	*	
		40.025MHz	*	*	
		50.025MHz	*	*	
		60.025MHz	*	*	
		70.025MHz	*	*	
		80.025MHz	*	*	
		87.975MHz	*	*	
(5)	Standby Current		35mA	-	
(6)	Audio Bandwidth	30Hz	3dB	-	
(7)	Audio Bandwidth	8kHz	3dB	-	
(8)	Audio Bandwidth	400Hz	6dB	-	

* Record Result as Satisfactory or Unsatisfactory

APPENDIX 1

PERFORMANCE CHECK LIST Cont.d

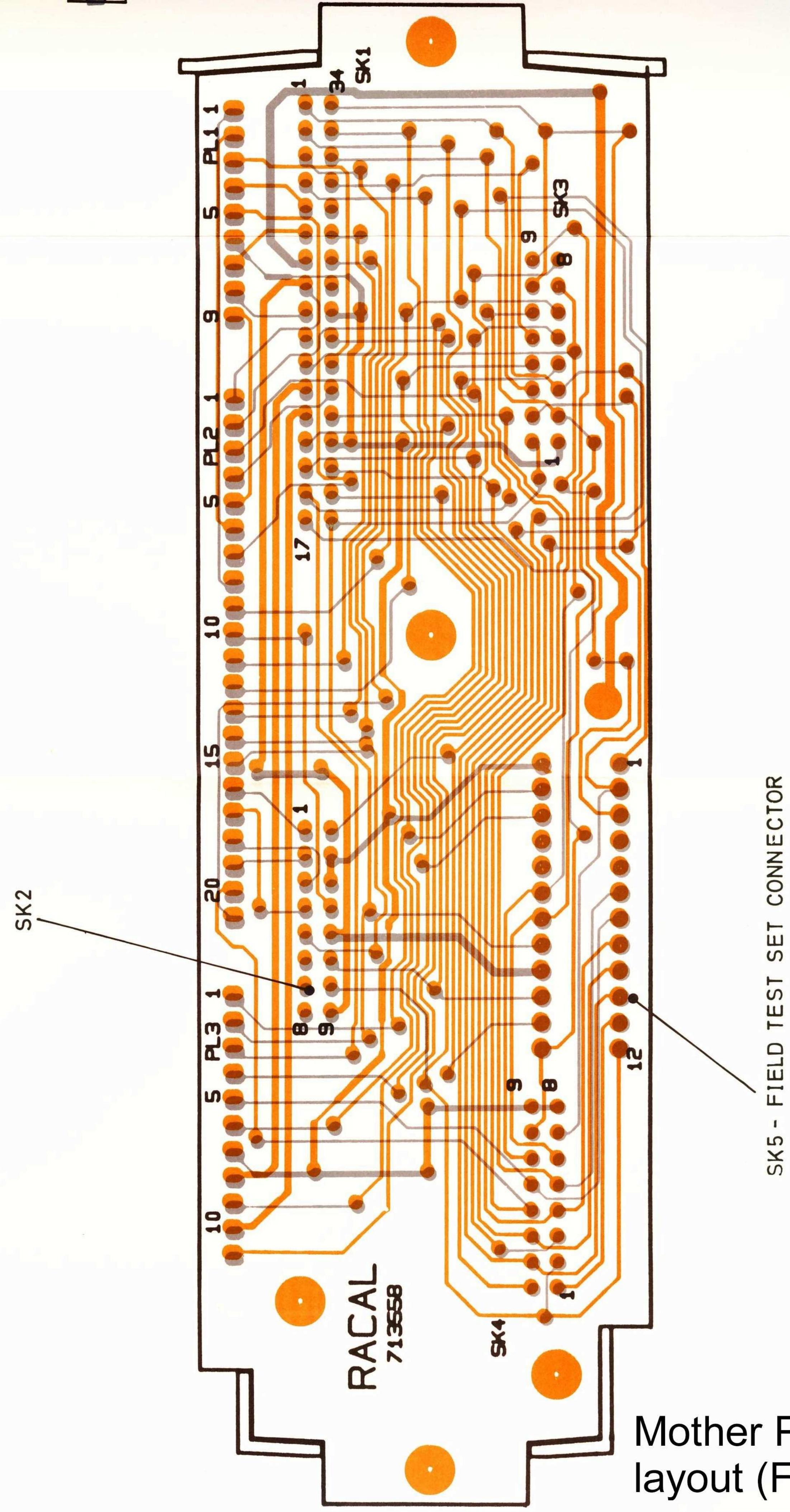
Sub-Clause Number	Test	Upper Limit	Lower Limit	Result
(9)	Audio Bandwidth 3.0kHz	6dB		
(10)	Power Output (Fixed into 300 Ω 5kHz deviation	1.6mW	0.8mW	
(11)	Power Output (Variable) into 300 Ω 5kHz deviation	2.0mW	0.8mW	
(12)	C.I.U. No Pilot Tone		9.5V	
(13)	C.I.U. 150Hz, 3.0kHz deviation	1.0V		
	AIR TEST			
5. (3)	Communication on Channels 0-9	*	*	
(4)	Whisper Mode	*	*	
(5)	Squelch Defeat	*	*	
(6)	Communication in noise Mode Noise quieting	*	*	
(7)	Display Illumination	*	*	

* Record Result as Satisfactory or Unsatisfactory.

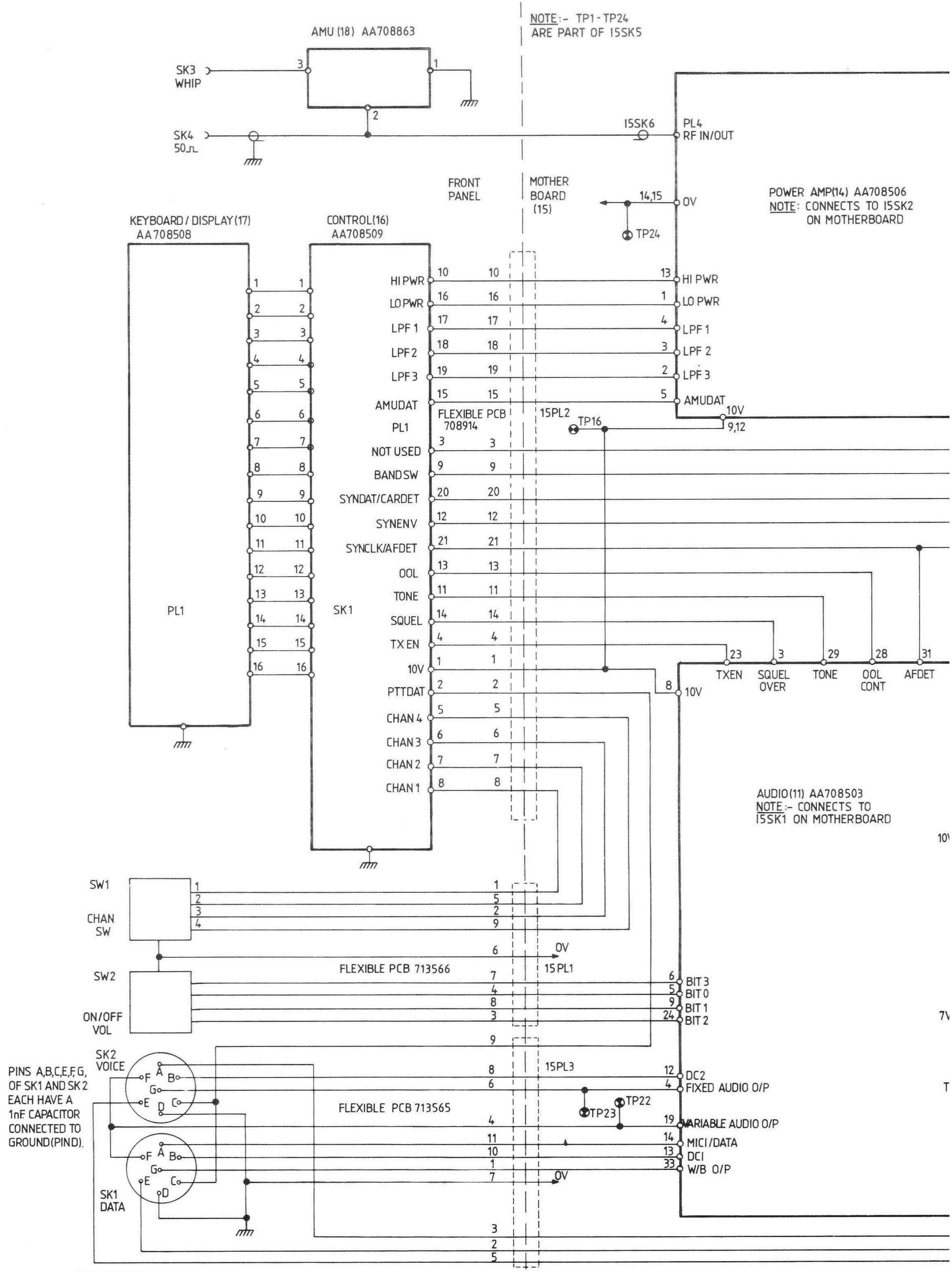
CHAPTER 12

COMPONENTS LIST

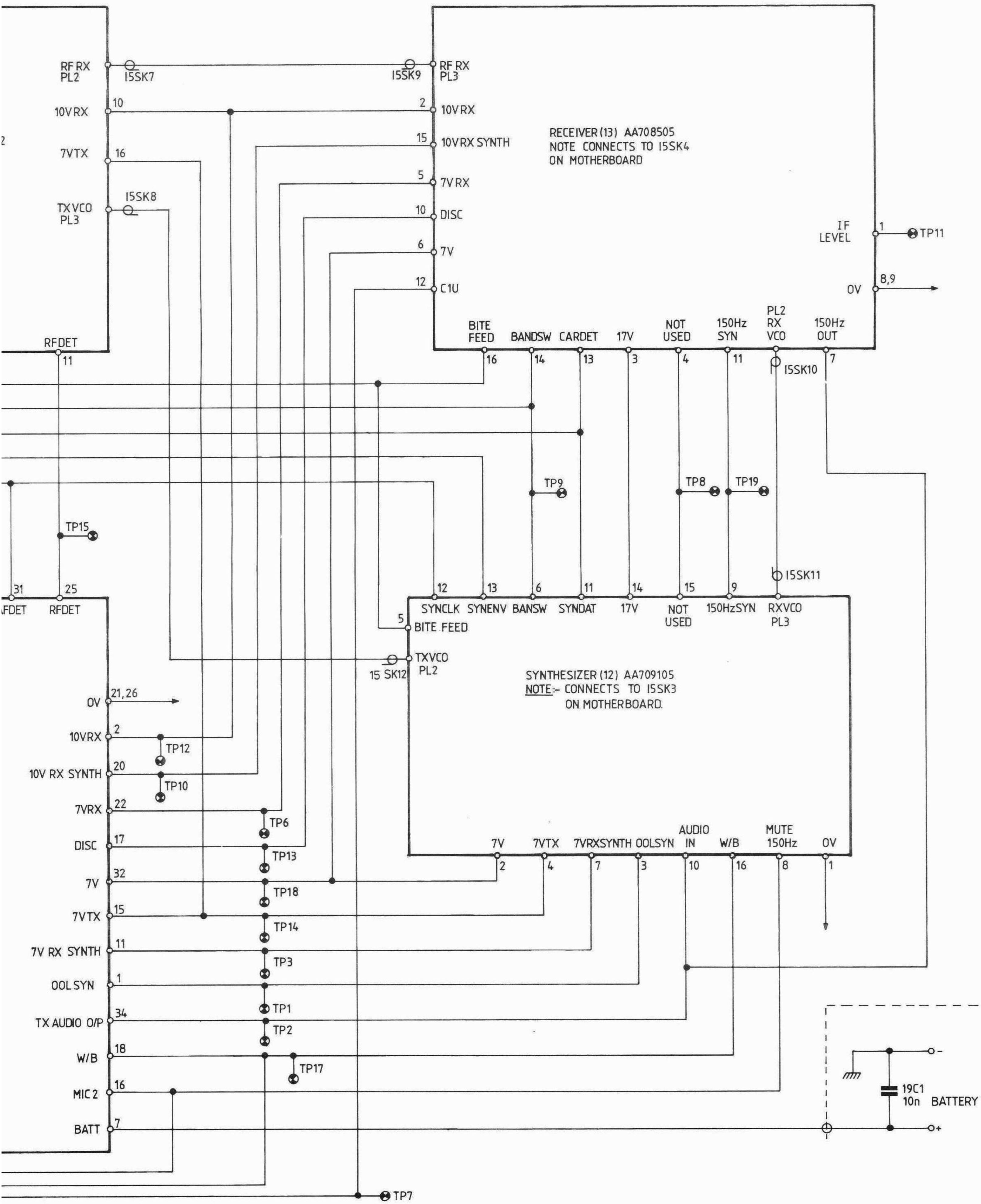
Cct. Ref.	Description	Racal Part Number
	MOTHERBOARD PCB (AA708502)	
CONNECTORS		
PL1	9 Way Plug	708921/9
PL2	21 Way Plug	708921/21
PL3	11 Way Plug	708921/11
SK1	34 Way Socket	992104/EQ
SK2	16 Way Socket	992105/EQ
SK3	16 Way Socket	992105/EQ
SK4	16 Way Socket	992105/EQ
SK5	24 Way Socket	992437/EQ
MISCELLANEOUS		
	Polarizing Key	936911/EQ
	Lug	914054
	Spacer (4 Used)	708913



Mother PCB layout (Fig 1)


NOTE:- TP1-TP24 ARE PART OF 15SK5
AMU (18) AA708863
SK3 WHIP
SK4 50Ω
15SK6
PL4 RF IN/OUT
FRONT PANEL
MOTHER BOARD (15)
14,15
0V
TP24
POWER AMP(14) AA708506
NOTE: CONNECTS TO 15SK2 ON MOTHERBOARD
KEYBOARD / DISPLAY (17) AA708508
CONTROL(16) AA708509
HI PWR
LO PWR
LPF 1
LPF 2
LPF 3
AMUDAT
PL1
NOT USED
BAND SW
SYNDAT/CARDET
SYNENV
SYNCLK/AFDET
OOL
TONE
SQUEL
TX EN
10V
PTTDAT
CHAN 4
CHAN 3
CHAN 2
CHAN 1
FLEXIBLE PCB 708914
15PL2
TP16
9,12
PL1
SK1
TXEN
SQUEL OVER
TONE
OOL CONT
AFDET
AUDIO(11) AA708503
NOTE:- CONNECTS TO 15SK1 ON MOTHERBOARD
SW1
CHAN SW
SW2
ON/OFF VOL
FLEXIBLE PCB 713566
15PL1
BIT 3
BIT 0
BIT 1
BIT 2
SK2 VOICE
PINS A,B,C,E,F,G, OF SK1 AND SK2 EACH HAVE A 1nF CAPACITOR CONNECTED TO GROUND(PIN D).
15PL3
FLEXIBLE PCB 713565
TP22
TP23
DC2
FIXED AUDIO O/P
VARIABLE AUDIO O/P
MICI/DATA
DCI
W/B O/P
SK1 DATA

TH 5160



Interconnection Diagram **Fig.2**

PART 2

RECEIVER BOARD

ST 708505

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The Receiver Board provides the following circuits:

   (1) Receiver voltage controlled oscillator (VCO)

   (2) Receiver RF Amplifier

   (3) Receiver Mixer

   (4) IF Filters and IF Amplification

   (5) Discriminator

   (6) Carrier and 150 Hz Squelch detection circuits.

2. For ease of description the Receiver Board is considered in three sections, the receiver VCO, receiver and squelch circuits.

CONSTRUCTION AND LOCATION

3. The Receiver Board is mounted on the lower half of the chassis assembly. The printed circuit board is rectangular of dimensions 140 mm x 80 mm. Connections to the board are made by a 16 way edge connector and three coaxial connectors.

PRINCIPLES OF OPERATION

Receiver VCO (Figure 1.1)

4. The receiver VCO forms part of an electronic servo-control system or phase locked loop (PLL). In a phase locked loop the frequency of the VCO is related to a crystal reference frequency. Typically the VCO frequency, F, is divided by a ratio N, which is controlled by the frequency selection switches to give a frequency F/N which is fed together with a sub-multiple of the reference frequency to a phase comparator. The comparator compares the relative phase of the two inputs and gives an output voltage which controls the frequency of the VCO in such a manner as to reduce the frequency error to zero (see Chap. 7, Synthesiser Board).

5. Only the receiver VCO itself and its associated components are on the Receiver Board, the remainder of the phase locked loop forms part of the Synthesizer Board. The d.c. varactor control voltage from the Synthesizer Board is fed down the same coax as the VCO output to the Synthesizer Board.

6. The receiver VCO covers a frequency range of 51.4MHz to 109.4MHz (in 25kHz steps), i.e. 21.4 MHz above the received frequency.

7. Because of the wide frequency coverage of the receiver, the VCO frequency range is split into the following two bands, 51.4MHz to 59.4MHz and 59.4MHz to 109.4 MHz.

Receiver (Figure 1.2)

8. The received signal, after passing through the AMU and the PIN diode switch on the PA PCB, is applied to the tuned RF amplifier. Tuning components for the RF amplifier are switched to cover the wide input frequency range in two bands, 30MHz to 37.975MHz and 38MHz to 88MHz. The RF amplifier is varactor tuned, the tuning voltage being derived from the Synthesizer Board. A single tuned circuit is used before the RF amplifier and a double tuned circuit following.

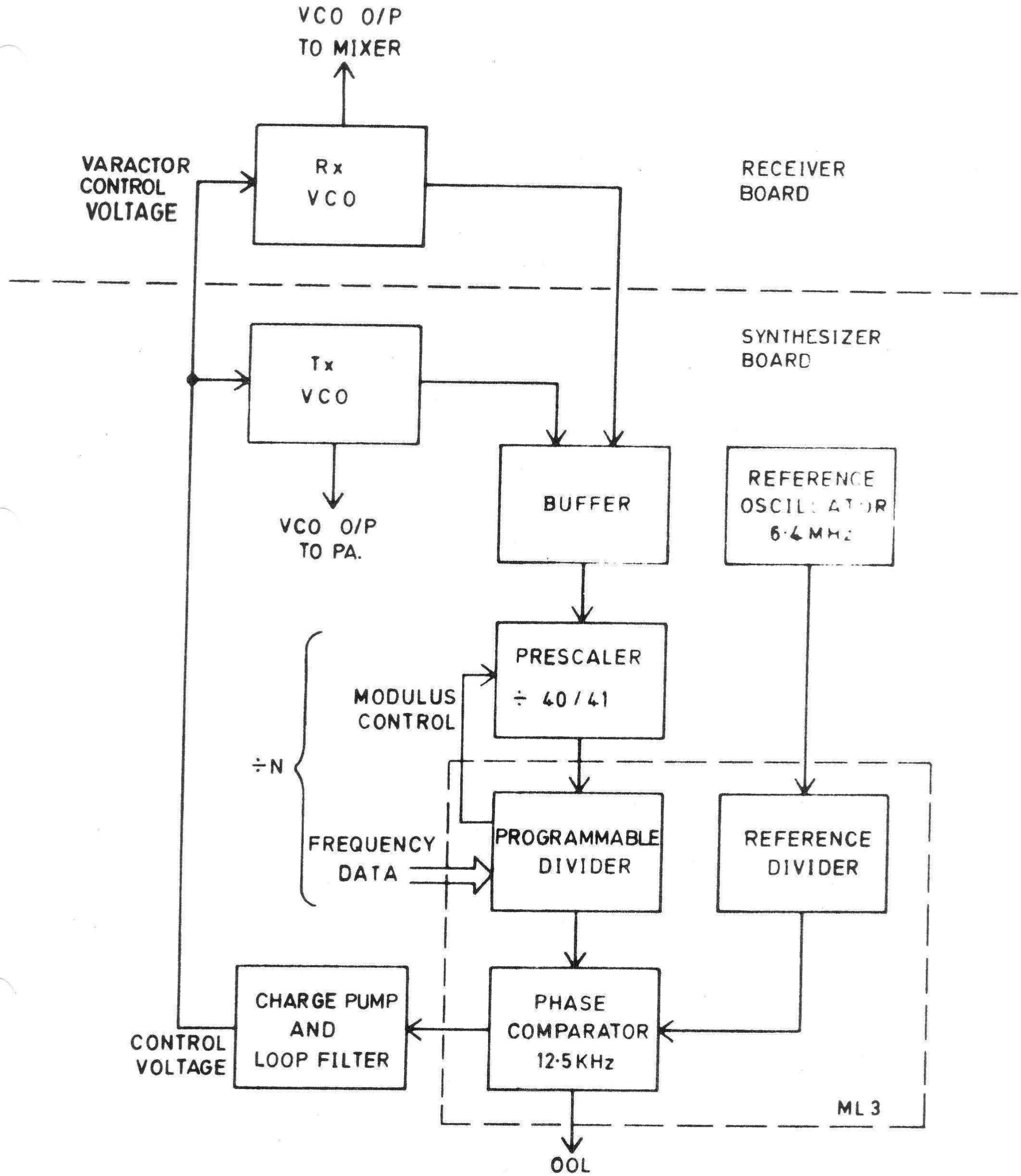
9. The output of the double tuned circuit is applied to a double-balanced quad FET mixer together with the receiver VCO output. The resulting difference frequency of 21.4MHz (intermediate frequency) is filtered (in order to remove unwanted mixing products) by an 8 pole crystal filter, amplified and filtered again, this time in a 2 pole crystal filter to reduce IF noise. After high gain IF amplification the signal is demodulated in a crystal quadrature circuit, and applied to the Audio Board.

Squelch Operation

10. Under no signal conditions a d.c. signal proportional to the noise output from the IF/demodulator stage is applied to the carrier squelch integrator and detector circuits to mute the audio stage. When a signal is present the noise output is reduced and the squelch is opened to enable the audio stages.

11. The demodulated audio is applied to a 150Hz filter and detector circuit, the d.c. output of which is taken to pin E of SKT 2 on the front panel, channel in use (CIU), and used when the radio forms part of a rebroadcast station.

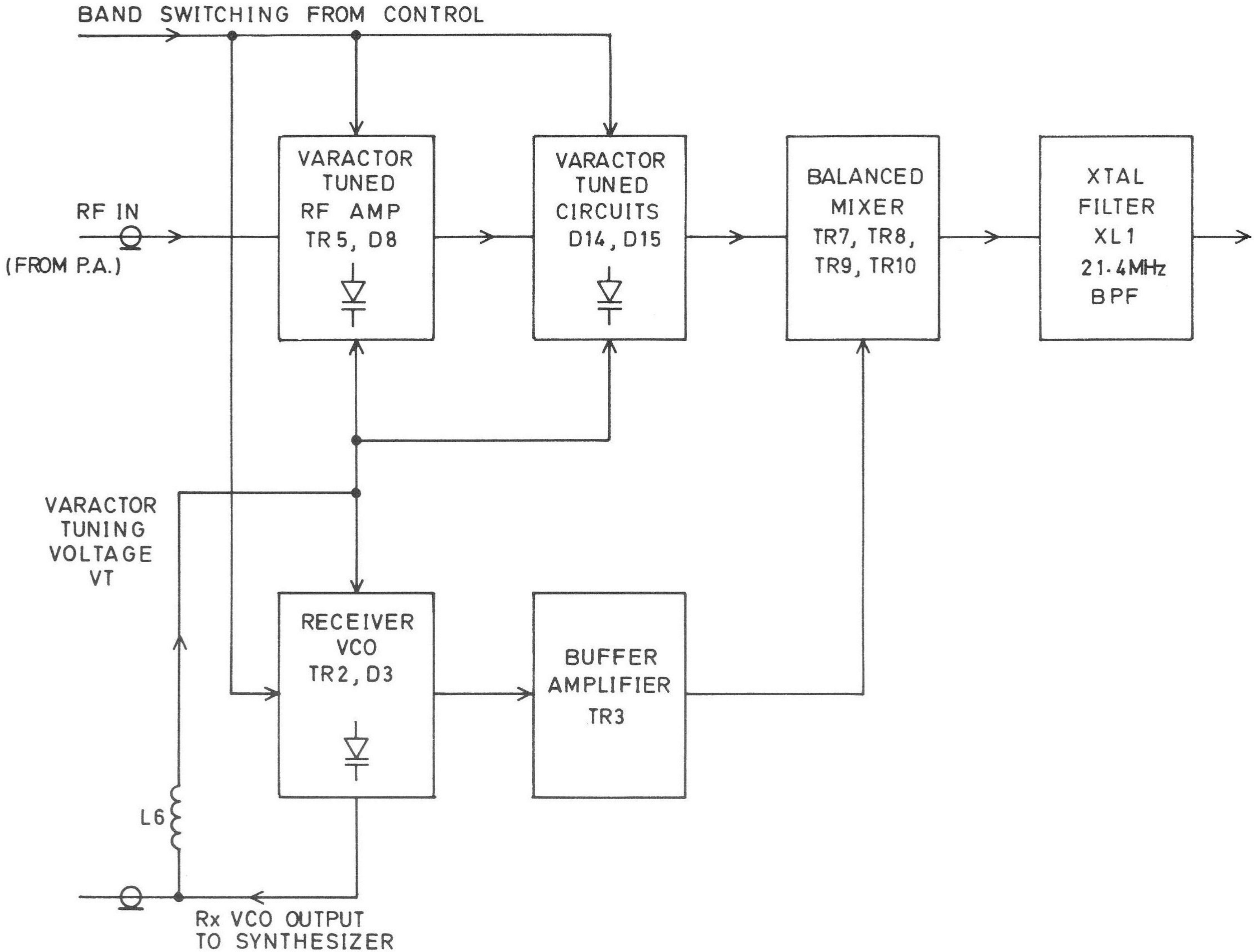
12. In the transmitter mode the 150 Hz tone from the synthesizer is passed through the same 150 Hz filter (to remove harmonics) and forms the 150 Hz pilot tone, which is added to the transmitter audio signal in the synthesizer.

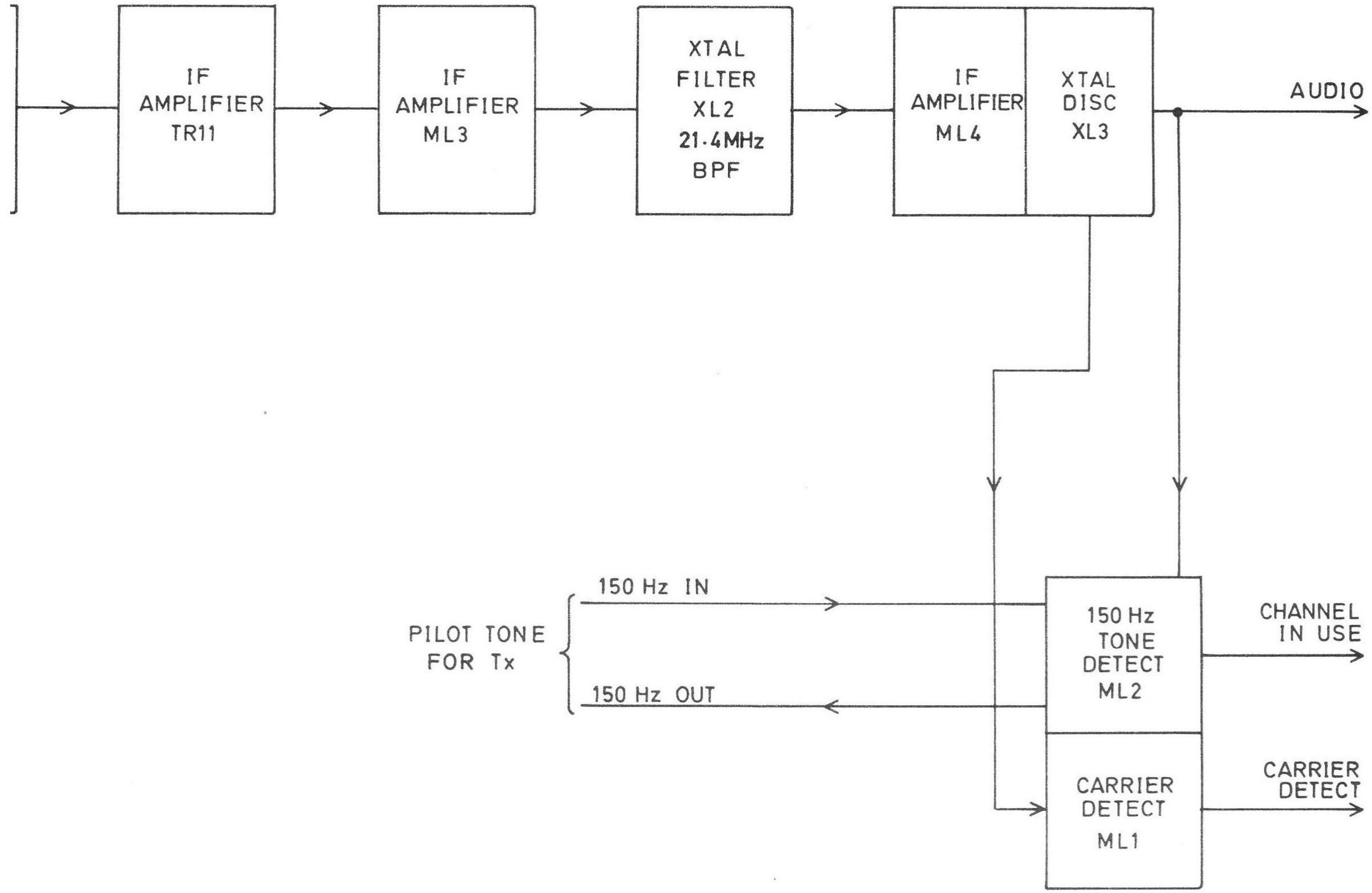


RACAL
TH 5160

Block Diagram of Phase Locked Loop

Fig 1.1


BAND SWITCHING FROM CONTROL
RF IN
(FROM P.A.)
VARACTOR TUNED RF AMP TR5, D8
VARACTOR TUNED CIRCUITS D14, D15
BALANCED MIXER TR7, TR8, TR9, TR10
XTAL FILTER XL1 21.4MHz BPF
VARACTOR TUNING VOLTAGE VT
RECEIVER VCO TR2, D3
BUFFER AMPLIFIER TR3
L6
Rx VCO OUTPUT TO SYNTHESIZER



Receiver Board Block Diagram. Fig 1.2

CHAPTER 2

CIRCUIT DESCRIPTION

CONTENTS

TABLES

ILLUSTRATIONS

CHAPTER 2

CIRCUIT DESCRIPTION

INTRODUCTION

1. This chapter describes the circuits of the receiver board. The description is divided into three sections, receiver VCO, receiver and squelch circuits. A complete circuit diagram of the receiver is given in Figure 2 at the rear of this part of the handbook.

RECEIVER VCO (Fig. 2.1)

2. The frequency range of the receiver VCO is 51.4MHz to 109.4MHz covered in two bands. The additional tuning components required for the lower band 51.4MHz - 59.4 MHz are selected by the control board.

3. The oscillator transistor is TR2. The tuned circuit for the higher band 59.4MHz to 109.4MHz comprises L4, C8, C10 and D3. D3 is a varactor diode whose capacitance varies according to the d.c. voltage applied when the device is reverse biased. As the voltage at the cathode of D3 varies from the Synthesizer Board via R5, L6 and PL2, the diode capacitance is varied and hence the frequency of oscillation of the VCO varies. D4 clamps the level of oscillation at the gate of TR2.

4. The additional tuning components required for the low frequency band are L1, C2, C3, C4 and C5. These are brought into circuit when D1 and D2 are forward biased by the band switching circuit TR1, controlled by the voltage on pin 14, determined by the Control Board.

5. The output of the receiver VCO is applied to an output buffer amplifier consisting of TR3 and its associated components. The balanced output of TR3 from the secondary winding of T1 is fed to the double balanced mixer stage.

Varactor Control Voltage

6. The d.c. varactor control voltage is applied to the cathodes of the varactor diodes via the inner core of the co-axial lead at PL2 from the Synthesizer Board. L6 and C16 stop any RF components from affecting the varactor control voltage line.

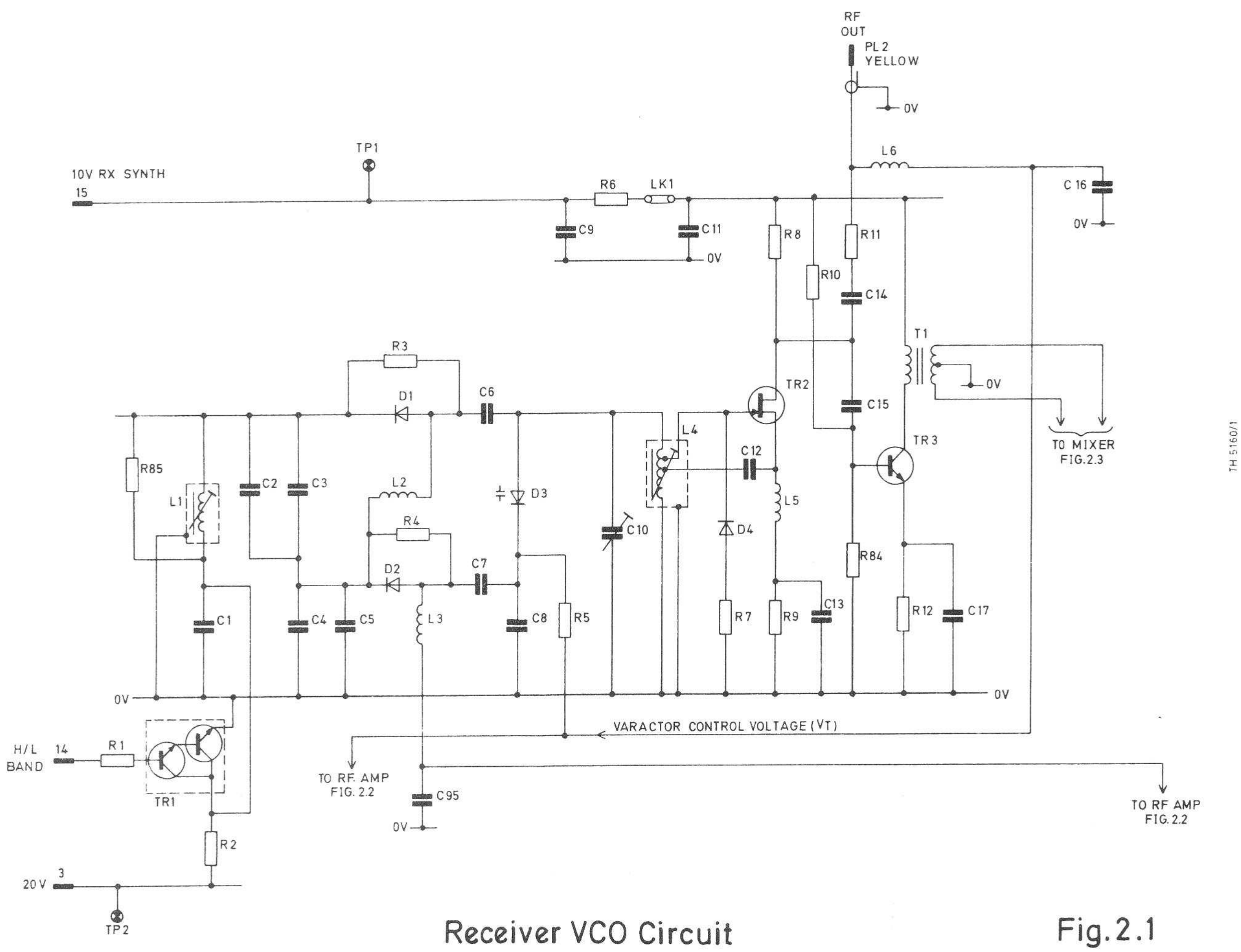
Band Switching (Fig. 2.1)

7. On the high band, 59.4MHz to 109.4MHz, the five PIN diodes D1, D2, D9, D13 and D16 (Fig. 2.2) form a series chain and are reverse biased and no additional tuning components are in circuit. When a receiver frequency in the low band is selected the PIN diodes are forward biased and the additional tuning components are brought into circuit.

8. The biasing at the anode end of the PIN diode chain is fixed at +7 V via R32, and the cathode end is controlled by TR1 which is switched by the Control Board. When a receiver frequency in the low band is required the base of TR1 is high, turning TR1 on and forward biasing the PIN diodes.

On the high band TR1 is turned off and the PIN diodes are reverse biased, due to 20 V supply, via R2.

9. D1, D2, D9, D13 and D16 act like switches, bringing the additional tuning components into circuit when required. (PIN diodes have a low impedance to RF when forward biased).



Receiver VCO Circuit

Fig.2.1

RECEIVER CIRCUITS

Tuned RF Amplifier (Fig. 2.2)

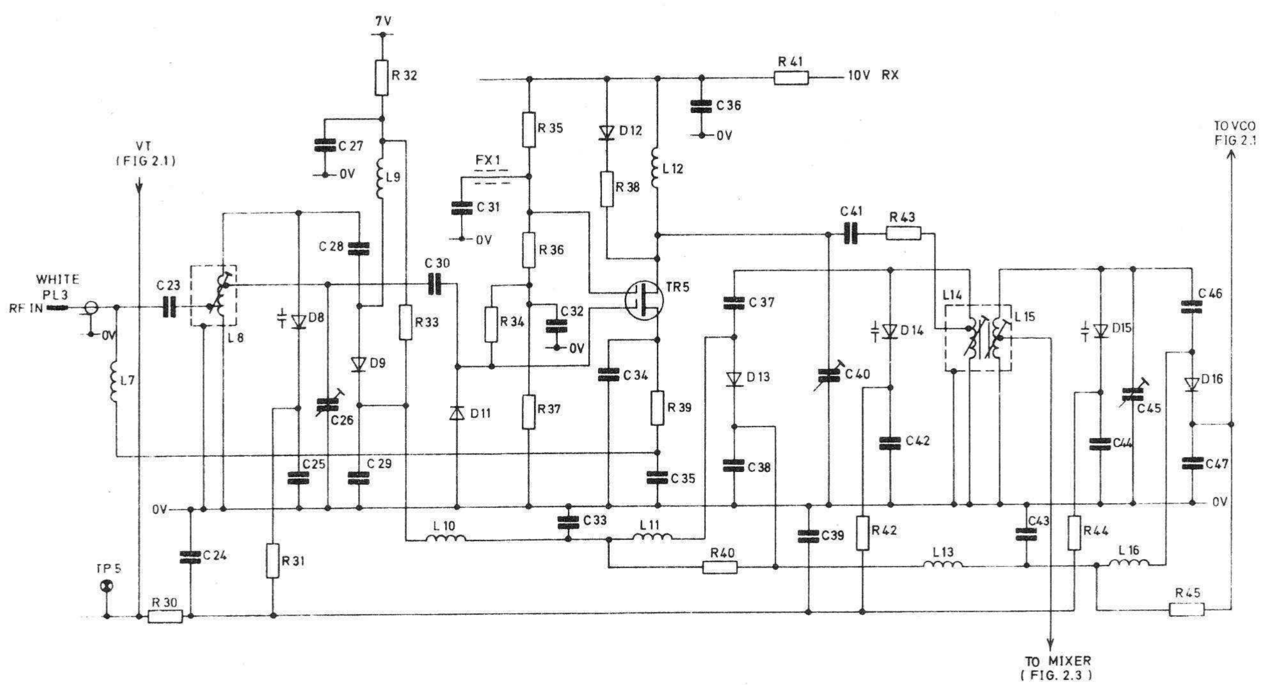
10. The RF input to the Receiver Board (from the P.A. board) enters the receiver board on coaxial socket PL3. The signal is then applied to a tuned RF amplifier TR5 and its associated components.

11. The input tuned circuit of TR5 on the high band comprises L8, C25, C26 and D8. When a frequency in the low band is selected D9 will be forward biased and additional tuning components C28 and C29 are brought into circuit. The resonant frequency of the parallel tuned circuit is dependant on the voltage applied by the Synthesizer Board to the cathode of varactor diode D8.

12. The output of the tuned circuit is applied to gate 1 of TR5 via a tap on L8 and C30. R34, R35, R36, R37 and R39 provide bias for the FET. D11 protects TR5 against very high level input signals. The output from the drain of TR5 is applied via C41 and R43 to a double tuned circuit. D12 and R38 reduce overload effect caused by high level input signals. On the high band, L14 is tuned by C40, D14 and C42 in the primary circuit, and L15 is tuned by D15 and C44, C45 in the secondary circuit. When a frequency in the low band is selected D13 and D16 will be forward biased and additional tuning components C37, C38 on the primary side and C46, C47 on the secondary side are brought into circuitry. Table 2.1 shows the tuning components for each band for all of the tuned circuits in the receiver VCO and the rf amplifier. The output of the double tuned circuit is applied to the input transformer of the mixer, via a tap on L15.

Note: The d.c. return for the source of TR5 is via R39, L7, the inner of the coax connected to PL3, and the PIN diode components on the P.A. Board. (See Part 4 page 2-10).

13. The same varactor tuning voltage (derived from the Synthesizer Board) which tunes the VCO is used to tune the RF Amplifier. In order that the RF Amplifier 'tracks' the VCO accurately over the whole of the frequency range it is necessary that the 4 varactor diodes D3, D8, D14 and D15 are closely matched to each other, indicated by a common colour marking.



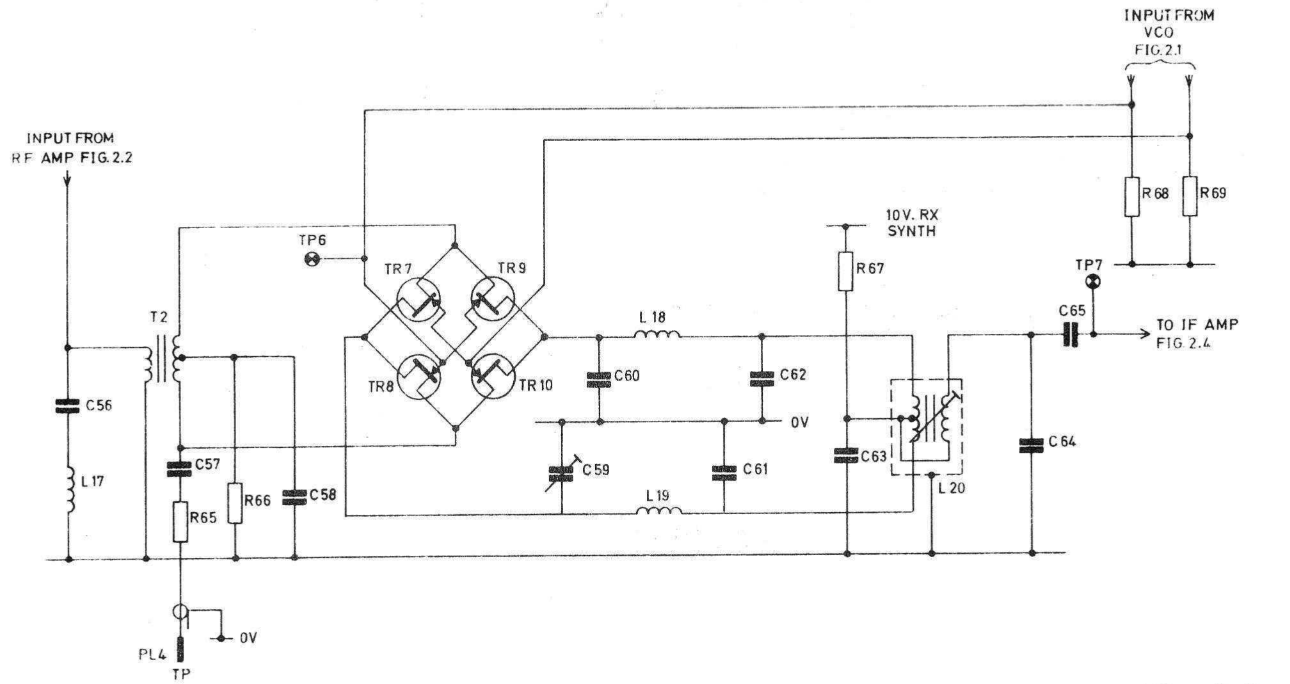
Tuned RF Amplifier Circuit Fig. 2.2

Table 2.1 Effective Components in Tuned Circuits

Circuit	High Band	Additional Components on Low Band
Receiver VCO	L4 C8 C10 D3	L1 C2 C3 C4 C5
R.F. Amp i/p tuned circuit	L8 C25 C26 D8	C28 C29
R.F. Amp o/p tuned circuit primary	L14 C40 C42 D14 C41 R43	C37 C38
R.F. Amp o/p tuned circuit secondary	L15 C44 C45 D15	C46 C47

Mixer Stage (Fig. 2.3)

14. The output of the RF amplifier is applied to a mixer, which comprises TR7, TR8, TR9 and TR10 and associated components in an FET double balanced configuration. The output of the RF amplifier is applied to the primary of transformer T2, the components L17 and C56 forming a series trap to IF signals. The balanced input, from the receiver VCO, is applied to the gates of the FETs TR8, TR9, and TR7, TR10. Two pi-networks match the output of the mixer stage to the crystal filter XL1, one network comprising L18, C60 and C62, the other comprising L19, C59 and C61. The output from these networks, at a frequency of 21.4MHz, is fed via further matching components L20 and C64 to crystal filter XL1. Connector PL4 is used as a test point for alignment and fault finding.



Mixer Circuit

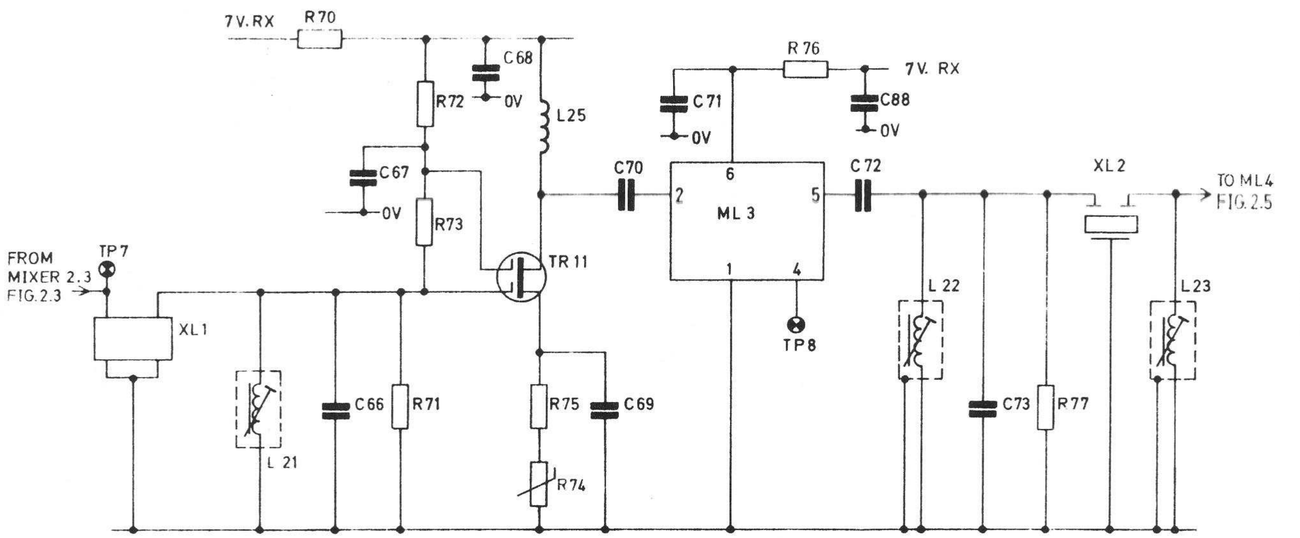
Fig. 2.3

Intermediate Frequency Amplifier (Fig. 2.4)

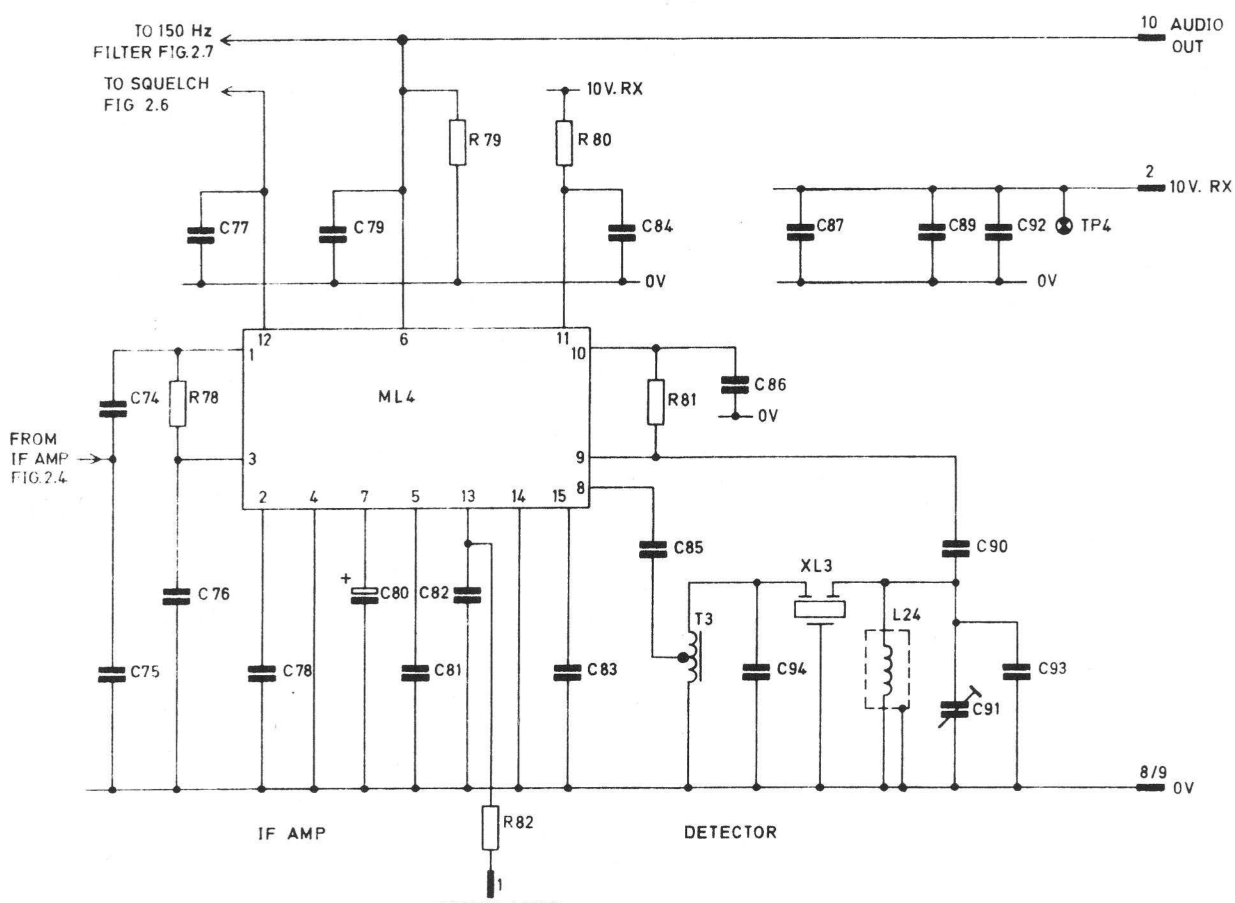
15. The 21.4MHz output from the mixer is applied to an 8 pole bandpass filter XL1. L20 and L21 can be adjusted to provide minimum distortion of the demodulated audio signal, by optimising the filter terminating impedances.

16. The output of XL1 is applied to the first stage of I.F. amplification TR11 and its associated components, via the matching components L21 and C66. Thermistor R74 is used to temperature compensate the total receiver gain and ensure correct squelch operation over the whole temperature range.

17. The output of TR11 is then applied, via C70, to ML3, a thick film IF amplifier. Because of the gain of the IF amplifier the signal at the output of ML3 is applied, via C72, to a 2-pole 21.4MHz bandpass filter, XL2, to reduce the wideband noise applied to ML4. XL2 input and output terminating impedances are determined by L22, C73, R77 and L23, C75, R78 respectively.



IF Amplifier Fig.2.4



IF Amplifier and Detector Fig. 2.5

IF Amplifier Detector Circuit ML4 (Fig. 2.5)

18. Integrated circuit ML4 incorporates a high gain IF amplifier, quadrature detector circuit and squelch circuit.

19. The output of XL2 is applied to ML4 pin 1 via C74. The demodulated audio output is derived from pin 6 of ML4. The output at pin 12 is used to drive the carrier squelch detection circuit. The d.c. output, proportional to signal level, at pin 13 is taken via pin 1 to a test point on the Motherboard (TP11).

20. XL3 (a 2 pole crystal), T3, C94, L24, C91 and C93 form a phase shift network for the quadrature detector circuit of ML4. This is coupled into the I.C. via C85 and C90. C91 is adjusted for minimum audio distortion.

SQUELCH CIRCUITS

Carrier Squelch Detection (Fig. 2.6)

21. The output of ML4 squelch drive circuit (pin 12), which is a series of pulses inversely proportional to receiver input signal level, is applied to integrator circuit R14, R15 and C19 to produce an average dc level from the pulses. The integrator output is inverted by ML1a operational amplifier. The gain of ML1a is set by R16 and R19. The inverted output of ML1a is applied to the non-inverting input of ML1b. R20 and C21 form a second integrating circuit to further smooth the squelch signal. The threshold at which ML1b will give an output is determined by divider chain R21, R22 and R23. R22 sets the level at which a received rf signal will open the squelch. Hysteresis action is provided by R26, R27 connecting the non-inverting input of ML1b to its output. The amount of hysteresis is set by R26.

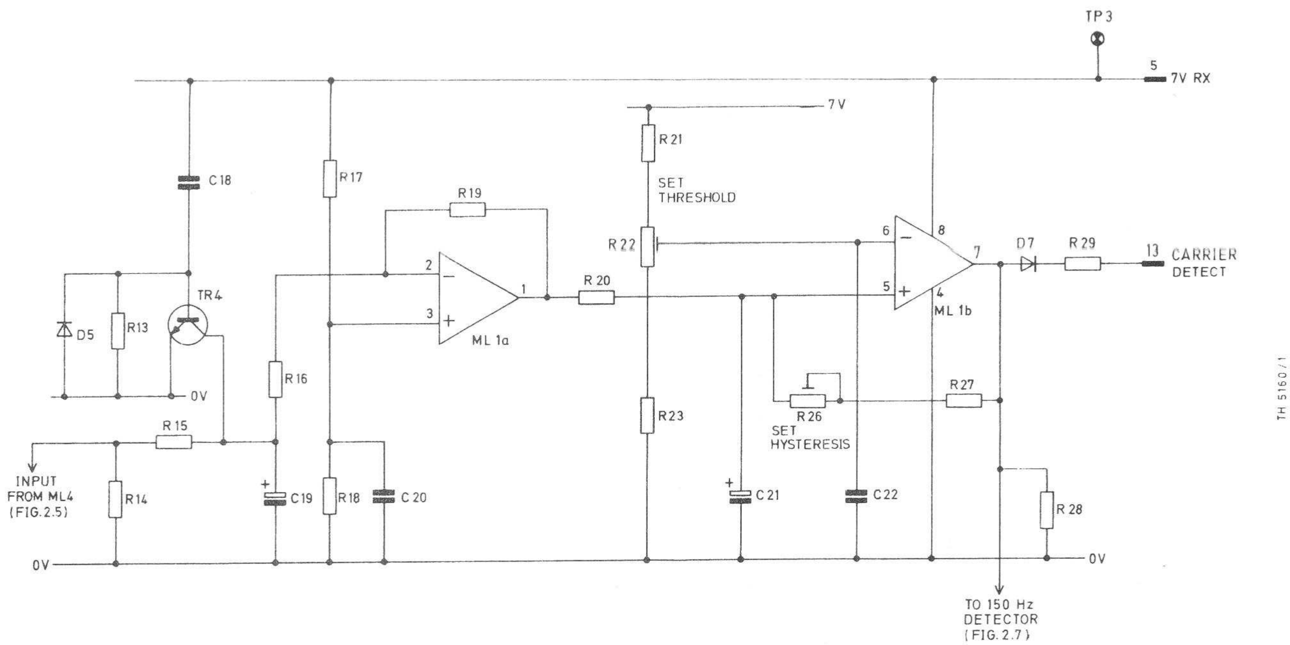
22. Under no signal conditions the output from the squelch drive circuit of ML4 will have a high pulse content above a d.c. level of approximately 1V. After integration the inverting input of ML1a will be high and so the output of ML1a will be low. This voltage will be below the threshold set by R22 so the output of ML1b will be low; thus there will be no carrier detect output to the control board.

23. When an RF signal is present the output from the squelch drive circuit of ML4, pin 12, will be reduced. This will cause the output of ML1a to rise. If the RF signal is large enough, then the voltage level at the non-inverting input of ML1b will be sufficient to overcome the threshold set by R22 and a carrier detect output will be present.

24. TR4 is concerned with the current-saving operation of the circuit (see para. 35).

25. R22 sets the receiver input level at which the carrier detect output goes high and so allows the received input signal to be heard at the audio output. R26 sets the hysteresis i.e. the difference in level between the receiver input level which opens the squelch, and the receiver input level that closes the squelch.

N.B. Squelch opens = audio output enabled.
Squelch closes = audio output disabled.



Carrier Squelch Circuit Fig.2.6

150Hz Tone Detection (Fig. 2.7)

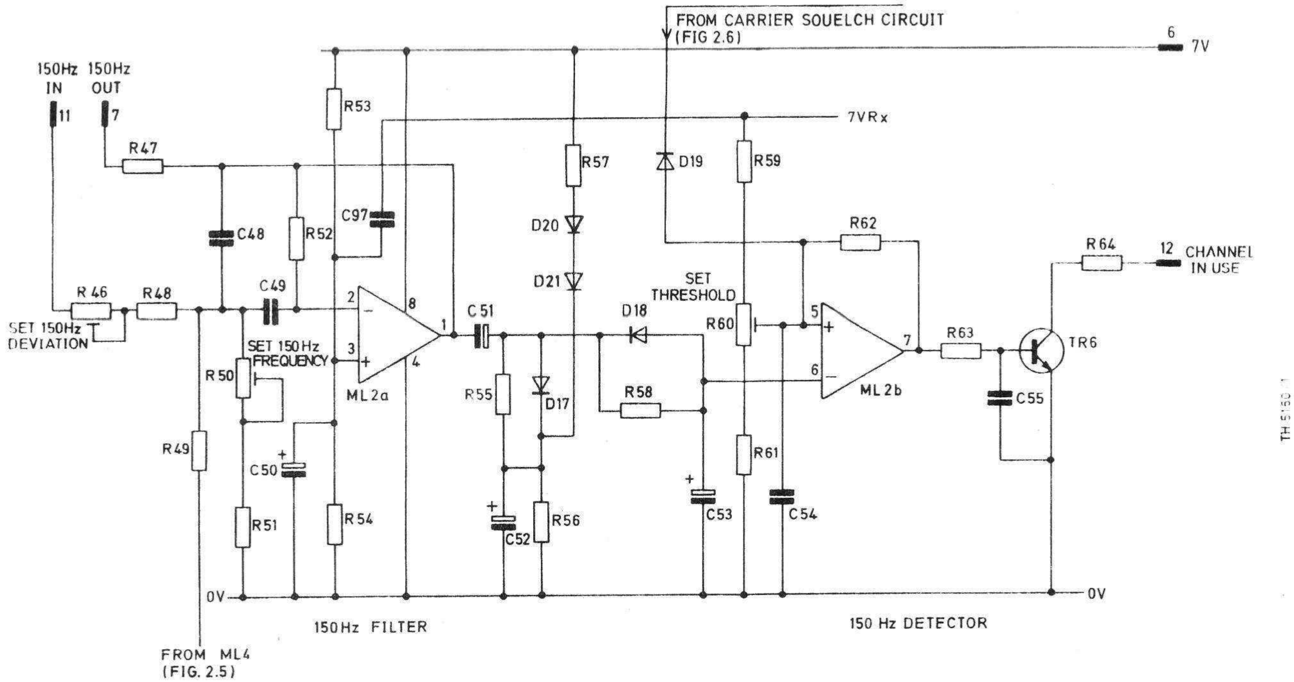
26. The audio output of ML4, pin 6, is applied to a 150Hz bandpass filter ML2a. The 150Hz output of ML2a is rectified by D17 and D18 and smoothed by R58 and C53 and applied to a level detector voltage doubler ML2b. R59, R60 and R61 form a potential divider chain. R60 is adjusted to set the level at which the 150Hz tone is detected. With no 150Hz tone present the output of the diode detector rests at about 5 V due to the potential divider R57 and R56. Thus pin 6 of ML2b is above the level set by R60 and the output of ML2b is low and TR6 is turned off. As the level of 150Hz tone increases, the output of the detector reduces until it goes below the level set by R60. Then the output of ML2b will go high causing TR6 to turn on, placing 0v on the Channel in Use line which is fed to pin E, audio socket SK2 for use in a rebroadcast station. (Pin E SK2 is connected to pin C SK2 of the other radio in a rebroadcast station, thus operating the other radio's PTT line and changing it to transmit). R62 connected to the non-inverting input of ML2b, is set for the required amount of hysteresis on the channel in use output.

27. Diodes D20 and D21 compensate for the temperature variation of the diode detector D17, D18 to ensure that the CIU threshold remains constant.

28. Diode D19 ensures channel in use line goes low only when 150 Hz and carrier is detected. When carrier is detected cathode of D19 will go high and so be reverse biased removing its clamping action on the positive input of ML2b.

150Hz Transmitter Pilot Tone

29. The 150Hz o/p of the synthesizer board is filtered by ML2a for use in the transmitter. The level of the 150Hz fed to the Motherboard (where it is summed with the Tx audio input to the Synthesizer) can be adjusted by R46.



150Hz Filter and Detector

Fig 2.7

CURRENT-SAVING MODE

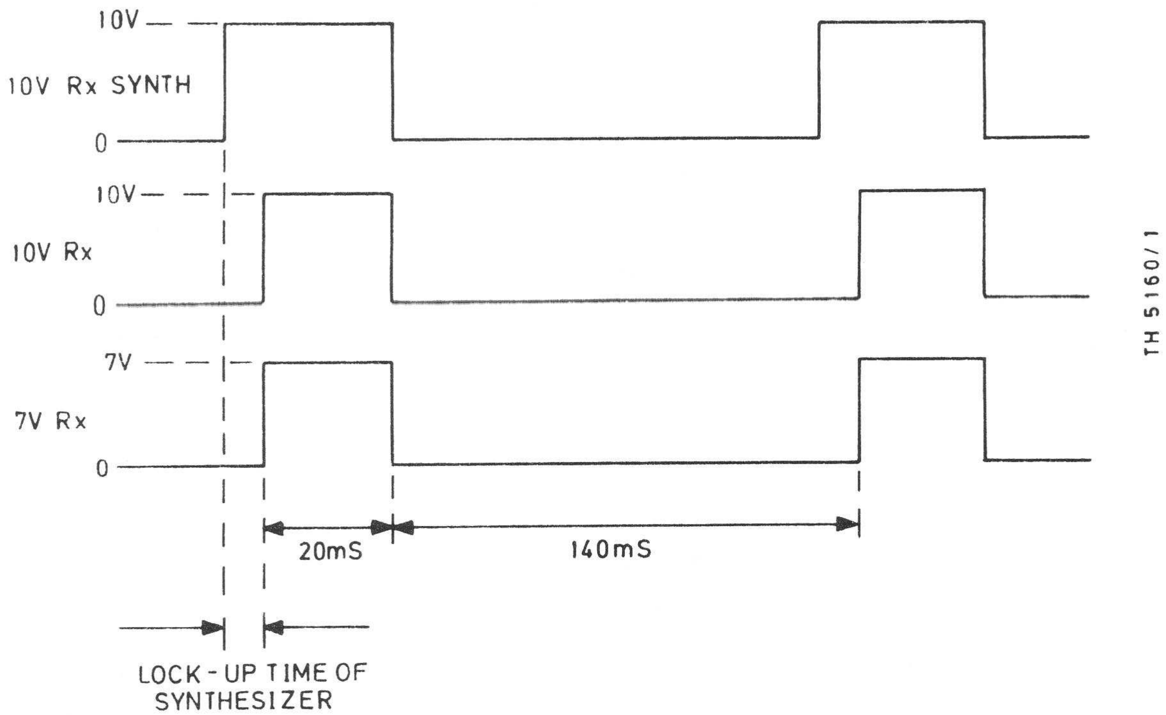
Introduction

30. The current-saving mode enables the current drawn by the whole radio to be reduced to less than one-third its normal value when no signal is being received so as to extend battery life. On the Receiver Board this is achieved by switching some parts of the circuit on and off at a rate of 6Hz: 20mS on and 140mS off. During the 20mS sampling period, the squelch circuits 'look' for the presence of a signal and, if detected, the carrier detect line goes high. This is fed via the Control Board to the Audio Board which then stops the switching and the normal current mode is resumed. The switching waveform is generated by the Audio Board (see Part 3 Page 2.8).

VCO and Mixer

31. During current-saving the VCO is switched on before the rest of the circuit to enable the synthesizer to lock up. This ensures that the full 20mS sampling period is available for signal detection, regardless of the lock-up time of the synthesizer (see Fig. 2.8). Hence the VCO supply is '10V RX SYNTH'.

32. The mixer is powered by the same supply as the VCO so that when it turns on it does not throw the synthesizer out of lock due to the change in loading of the VCO.



Current-Saving Waveforms. Fig.2.8

RF Amplifier and ML4

33. These circuits are powered by the '10V RX' supply which switches at the standard rate of 20mS on and 140mS off.

IF Stages (TR11 and ML3)

34. These circuits are powered by '7 V RX' which is the same function as '10 V RX' but simply regulated to 7 V.

Carrier Squelch (Fig. 2.6)

35. This circuit (ML1 and associated components) is powered by '7V RX'. This ensures that the carrier detect output is always low during the 'off' period of 140mS. Note that the potential divider for ML1b runs off 7V (continuous) to ensure that when ML1b is powered up at the beginning of the 20mS period its output remains low. The function of TR4 is to suppress the pulse which appears at pin 12 of ML4 as ML4 switches on at the beginning of the 20mS period, and which would otherwise charge up C19 and inhibit carrier detect. This is achieved by C18 charging up at the beginning of the 20mS period, causing TR4 to momentarily turn on and clamp C19 to 0 V. When C18 is fully charged TR4 turns off and normal squelch operation is resumed. D5 prevents excessive negative voltage swing at the base of TR4 from the charge on C18 when the supply turns off.

150Hz Squelch (Fig. 2.7)

36. This circuit (ML2 and associated components) is not current-saved and is powered by the 7V (continuous) supply (except ML2b reference divider, which uses 7 V RX).

37. During current-saving, the audio output of ML4 (pin 6) produces a pulse at the beginning of the 20 mS sampling period. This would cause the 150 Hz filter to ring and activate the 150 Hz detector. If carrier detect were also activated at this time, a false CIU output would be produced. C97 prevents this happening by momentarily pulling up pin 3 of ML2a (from 7 V RX) at the same time as pin 2 goes high so that the output (pin 1) does not change.

RX BITE

38. In the Built in Test Equipment (BITE) sequence at switch on of the radio, the receiver is tested by checking for squelch operation on a channel coincident with a harmonic of the reference oscillator, then stepping up to 40 channels away until noise is detected.

39. Carrier squelch operation is checked at 32 MHz (5th harmonic of 6.4 MHz). The harmonic of the reference oscillator is gated on the Synthesizer Board (for 5 seconds only after switch on, See Part 7 page 2-13) to the Receiver Board pin 16 (Bite feed). A length of printed circuit track couples the signal to the receiver tuned RF amplifier stage. If the receiver circuits up to the carrier detect circuit are working correctly, then an output will be passed to the Control Board.

40. For the second part of the test the Control Board steps the Synthesizer frequency up to 40 channels higher than 32 MHz. During this time the Control Board is looking for an audio output from the audio detector line of the Audio Board, which it should receive if the Rx detector and audio circuits are functioning correctly and one of these 40 channels is clear, without a signal.

CHAPTER 3

ALIGNMENT AND TESTING

CONTENTS

TABLES

CHAPTER 3

ALIGNMENT AND TESTING

INTRODUCTION

1. Table 3.1 gives details for full alignment of the Receiver Board and for measurement of the main parameters of this board while it is fitted to a PRM 4700 unit. This may be necessary for routine purposes, but should always be carried out after any components have been replaced.

2. It is assumed in the procedure given that all other boards in the unit are working correctly and within their specifications.

3. All adjustments must closely follow the procedure given, and random adjustments must not be made.

INITIAL CONDITIONS

4. A 10.5 V power supply should be connected to pins B (+ve) and D (-ve) of SK2 on the front panel of the unit. This may conveniently be done using a Racal Test Jig TJ 947.

5. Testing starts in the RECEIVE mode (RX), i.e. pin C of SK1 and SK2 should be open-circuit.

6. Note that in Tests Nos. 4-7 it is necessary to connect an external power supply to TP5 to manually tune the RF Amplifier. Also, these tests may be done using TJ 756 Front End Tuning Box. Positions 1 and 2 should be used for tuning at 30 MHz and positions 5 and 6 for tuning at 88 MHz. Signal Generator input to the TJ 756 should be 21 mV pd. (10 V supply). When not using TJ 756, two RF signal generators and an RF combiner are required.

TEST EQUIPMENT REQUIRED

7. (1) Oscillsocope

Frequency Range : 0 - 110 MHz with 50Ω input
Suitable Instrument: HP 1740A/H07 or Tektronics 465 with probe

(2) DVM

Voltage Range : 0 - 20 V
Suitable Instrument: HP 3476A

(3) RF Signal Generator

Frequency Range : 20 - 90 MHz
Suitable Instrument: HP 8640B

(4) AF Signal Generator

Frequency : 150 Hz
Suitable Instrument: Racal 9083

(5) Distortion Factor Meter

Suitable Instrument: HP 333A or 332

(6) DC Power Supplies

Unit 1 : 10.5 V, 1 A
Unit 2 : 1 - 15 V (V_t)
Suitable Instrument: Farnell L30BT or 2 off Farnell L30-2.

(7) Test Jig

Racal TJ 947

(8) Front End Tuning Box

Racal TJ 756

or

(9) RF Signal Generator

Frequency Range 30-90 MHz
Suitable Instrument: Racal 9081

and

Signal Generator Combiner

Frequency Range 30-90 MHz
Suitable Instrument: Hatfield Type 3250

LINK, LK1

8. A removable link, LK1, is provided for test purposes and is used in the alignment procedure (Table 3.1). Ensure that this link is pushed firmly in after test.

TABLE 3.1

Receiver Board Alignment

Test No	Parameter	Mode	RF Input	Freq MHz	Monitor	Adjust	Limits	Notes
1	High Band	Rx (PTT high) Vol. 8		38.000	TP5	L4	1V 0.05V	Repeat Tests 1 & 2 until both are correct
2	Tracking			88.000		C10	15V 0.1V	
3	Low Band Tracking	Vol. 8		30.000	TP5	L1	1V 0.05V	
	Set C26, C40, C45, C59, C91 to mid position. Remove Link LK1. Disconnect 15SK10 (Rx - synth coax). Connect V_T supply to TP5.							
4	Front End Tuning, Low band	EXT V_T applied to TP5	30.0MHz 8.0mV pd V_T = 1 V See Para. 6		PL4 into 50Ω Oscilloscope	L8		Adjust for maximum amplitude
5		Vol. 8	29.6 + 30.4MHz 3.5mV pd each Equal amplitudes V_T = 1V		PL4 into 50Ω oscilloscope	L14 & L15		Adjust for good crossover of two-tone wave-form
6	Front End Tuning, High Band	Vol. 8 EXT V_T applied to TP5	88.0MHz 3.5 mV pd V_T = 15V		PL4 into 50Ω oscilloscope	C26		Adjust for max-Amplitude
7	Front End Tuning, High Band	Vol. 8 EXT V_T applied to TP5	86.0 + 90.0MHz 1.6mV pd each Equal amplitudes V_T = 15V		PL4 into 50Ω oscilloscope	C40 & C45		Adjust for good crossover of two-tone wave-form
8	REPEAT TEST 4/5 and 6/7 ALTERNATELY UNTIL NO FURTHER IMPROVEMENT CAN BE OBTAINED							Remove EXT Vt Reconnect 15SK10 Disconnect scope from PL4
9	Discrim-inator	Vol. 3	10mV pd, 1kHz mod 10kHz deviation, Pin 1 ML4	21.400	Audio O/P Pin G, SK2	C91		Inject IF from 50Ω (A-C coupled). Adjust for minimum distortion
10	Filter 1	Vol. 3	100 V pd, 1kHz mod 10kHz deviation, 50Ω SKT Front Panel	30.025	TP8	L20, L21		Set C59 to mid-position. Replace LK1 Adjust for minimum AM on IF waveform
11	Filter 2	Vol. 8	100 V pd, 1kHz mod 10kHz devi-ation, 50Ω SKT Front Panel	30.025	Pin 1, ML4	L22, L23		Adjust for mini-mum AM on IF waveform
					Audio O/P Pin G SK2			Note AF distortion Less than 10%
12	Filter 2	Vol. 8	100 V pd, 1kHz mod 10kHz devation	30.025	Audio O/P Pin G SK2	L23		Remove probe from ML4 Re-adjust L23 for same distortion as in (11) above
12a	Distortion	Vol. 8	100 V pd, 1kHz mod 5kHz deviation	30.025	Audio O/P Pin G SK2		Less than 5%	Reduce deviation and check distortion
13	Sensitivity	Vol. 8	0.3 V pd, 1kHz mod 5kHz deviation	30.025 34.025 37.975 38.025 60.025 87.975	Audio O/P Pin G SK2	C59	12dB min SINAD	Adjust C59 for best SINAD at 30.025 MHz
14	Carrier Squelch Threshold	Vol. 6	1kHz mod, 5kHz deviation	87.975	Audio O/P Pin G SK2	R22	6dB SINAD	Adjust RF level and R22, for squelch to open at 6dB SINAD
15	Carrier squelch Hysteresis	Vol. 6	1kHz mod, 5kHz deviation Return to test 14 if R26 is adjusted	87.975	Audio O/P Pin G SK2	R26	2 - 3dB	Measure RF level below that in Test 14 where squelch just closes
16	Carrier Squelch Threshold	Vol. 6	1kHz mod, 5kHz deviation	30.025	Audio O/P Pin G SK2			Check squelch opens and closes

TABLE 3.1 (Continued)

Test No	Parameter	Mode	RF Input	Freq MHz	Monitor	Adjust	Limits	Notes
17	150Hz Tone	TX (PTT low) LO PWR Vol. 8	Disconnect Sig Gen Connect Modulation Meter to SK4	30.025	50Ω SKT Front Panel modulation meter (Filter 'Out')	R50 R46	- 3.0kHz deviation	Adjust R50 to give maximum output, then adjust R46 for correct level
18	CIU High	RX (PTT high) Vol. 8	Reconnect Sig Gen 0.5 V pd, no mod,	30.025	Pin E SK2 (CIU)	R60 fully clockwise	>9.5V	1kΩ Pull up to 10.5V reqd., pin E SK2.
19	CIU Low	Vol. 8	0.5 V pd, 150Hz Mod, 1.2kHz devi-ation	30.025	Pin E SK2 (CIU)	R60	<0.8V	Adjust R60 so that CIU just falls for 1.2kHz deviation.
20	CIU Hysteresis	Vol. 8	0.5 V pd, 150Hz Mod, 0.5kHz devi ation	30.025	Pin E SK2 (CIU)		>9.5V	When deviation is reduced to 0.5kHz CIU should go high.

CHAPTER 4

FAULT LOCATION

CONTENTS

TABLES

CHAPTER 4

FAULT LOCATION

INTRODUCTION

1. Fault location on the Receiver Board is carried out by checking voltages and waveforms at various points on the board and by using the Flowcharts provided.

TEST EQUIPMENT REQUIRED

2. The equipment required for fault location is listed in Chapter 3.

VOLTAGES AND WAVEFORMS

3. The information given in Tables 4.1, 4.2 and 4.3 should be used in conjunction with the circuit diagram, Fig. 2 to which the nodes refer. All voltages and waveforms are nominal and are measured using an oscilloscope with a 1MΩ/10pF probe unless otherwise stated. All RF and IF voltages must be measured using a probe with a very short earth lead (0.5 inch).

USE OF FLOWCHARTS

4. The first flowchart, Table 4.4, tests the RF and IF stages. The second flowchart, Table 4.5, tests the squelch and CIU functions, and assumes that the RF and IF stages are working correctly. The charts provide a guide to the area or group of components where the fault may exist but are not intended to be exhaustive. The tests are performed with the faulty board in a PRM 4700 unit in which all the other boards are known to be working and within their specifications.

GENERAL

5. If any components are changed or any adjustments made during fault finding the alignment and testing procedure given in Chapter 3 should be followed before returning the board to service.

TABLE 4.1

Receiver Board Voltages

DC VOLTAGES (Receive Mode) Vol. POS '8'. Apply 10.5 V to pins B and D of SK2
* Use DVM

NODE	RF INPUT	30 MHz	88 MHz	NOTES
1*	NONE	4.96	0.02	
2*	NONE	0.63	15.93	
3*	NONE	1.42	13.39	
5	NONE	1.00	1.22	
7	NONE	2.78	2.96	
8	NONE	0.81	0.81	
9	NONE	1.00	15.00	
10*	NONE	4.58	7.01	
11*	NONE	3.78	8.31	
12	NONE	3.16	3.16	
13	NONE	6.31	6.31	
14	NONE	3.64	3.64	
16*	NONE	2.98	9.80	
17*	NONE	2.19	11.47	
20	NONE	2.08		
22	NONE	5.09		
24	NONE	0.63		
28	3 µV pd	2.88		
30	NONE	5.49		
33	NONE	0.47		
"	0.3 µV pd	0.27		
34	NONE	1.40		
35	NONE	2.80		
"	0.3 µV pd	3.65		
36	NONE	3.01		
37	NONE	0.63		
"	0.3 µV pd	5.50		
38	NONE	3.18	3.18	
40	0.3 µV pd	5.16	5.16	
41	3 kHz dev	5.50	5.50	
42	@ 150 Hz	1.45	1.45	
43		5.63	5.63	
40		1.16	1.16	
41	NONE	5.50	5.50	
42		5.25	5.25	
43		0.02	0.02	

TABLE 4.2

A.C. Voltages (Receive Mode) - All Sine Waves

NODE	RF INPUT	MODN	30 MHz	88 MHz	NOTES
			pk-pk	pk-pk	
4	NONE	NONE	640 mV	900 mV	
6	NONE	NONE	4.0 V	2.0 V	
15	20 mV pd	NONE	600 mV	720 mV	
18	20 mV pd	NONE	250 mV	120 mV	Use 10 pF scope probe with short earth
19	NONE	NONE	2.6 V	1.5 V	
21	1 mV pd	NONE	90 mV	130 mV	
23	1 mV pd	NONE	640 mV	880 mV	
25	100 µV pd	NONE	240 mV	300 mV	
26	10 µV pd	NONE	120 mV	150 mV	
27	10 µV pd	NONE	150 mV	200 mV	
29	100 µV pd	1kHz (5kHz dev)	750 mV	750 mV	
39	100 µV pd	150Hz (3kHz dev)	4.8 V	4.8 V	

TABLE 4.3

A.C. Voltages (Transmit Mode) - LO PWR (150 Hz)

NODE		pk-pk	
31	Use TP19, Motherboard	700 mV	Triangular wave
32		540 mV	Sinewave
39		2.0 V	Sinewave

TABLE 4.4 RECEIVER BOARD FLOW CHART RF AND IF STAGES

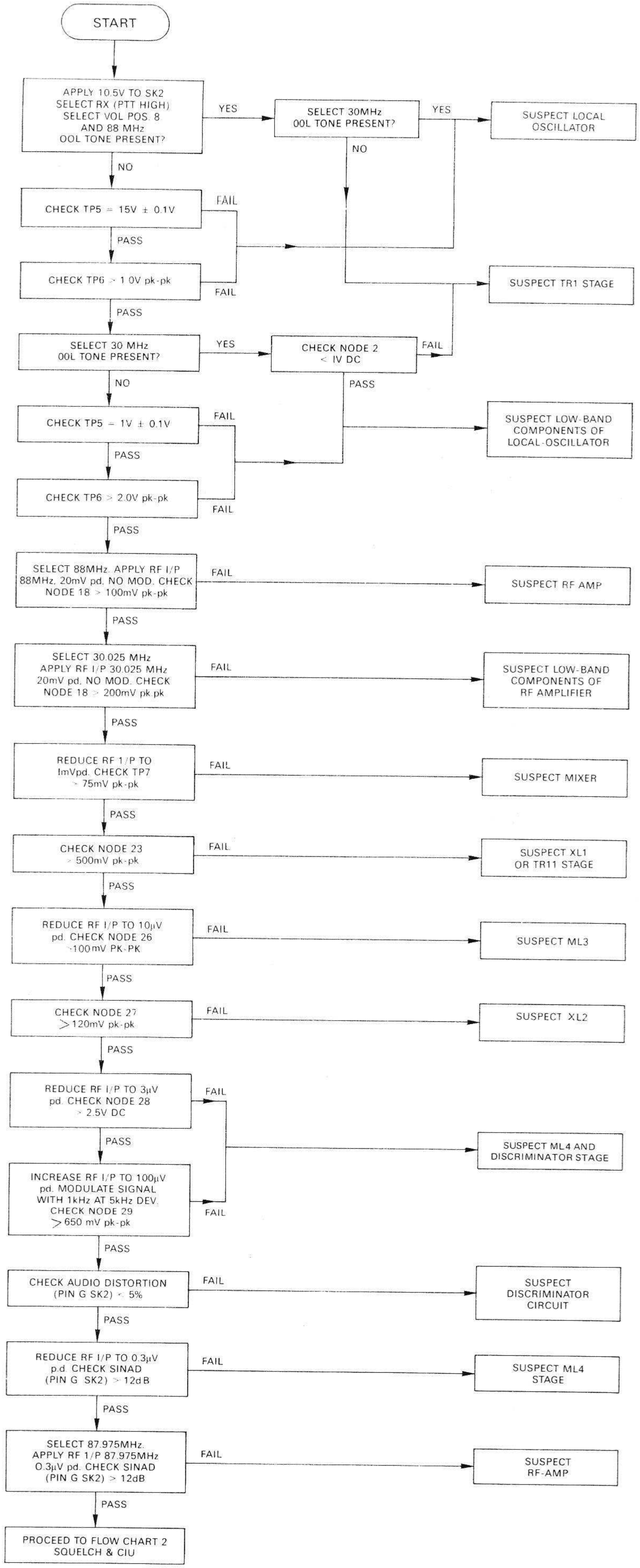
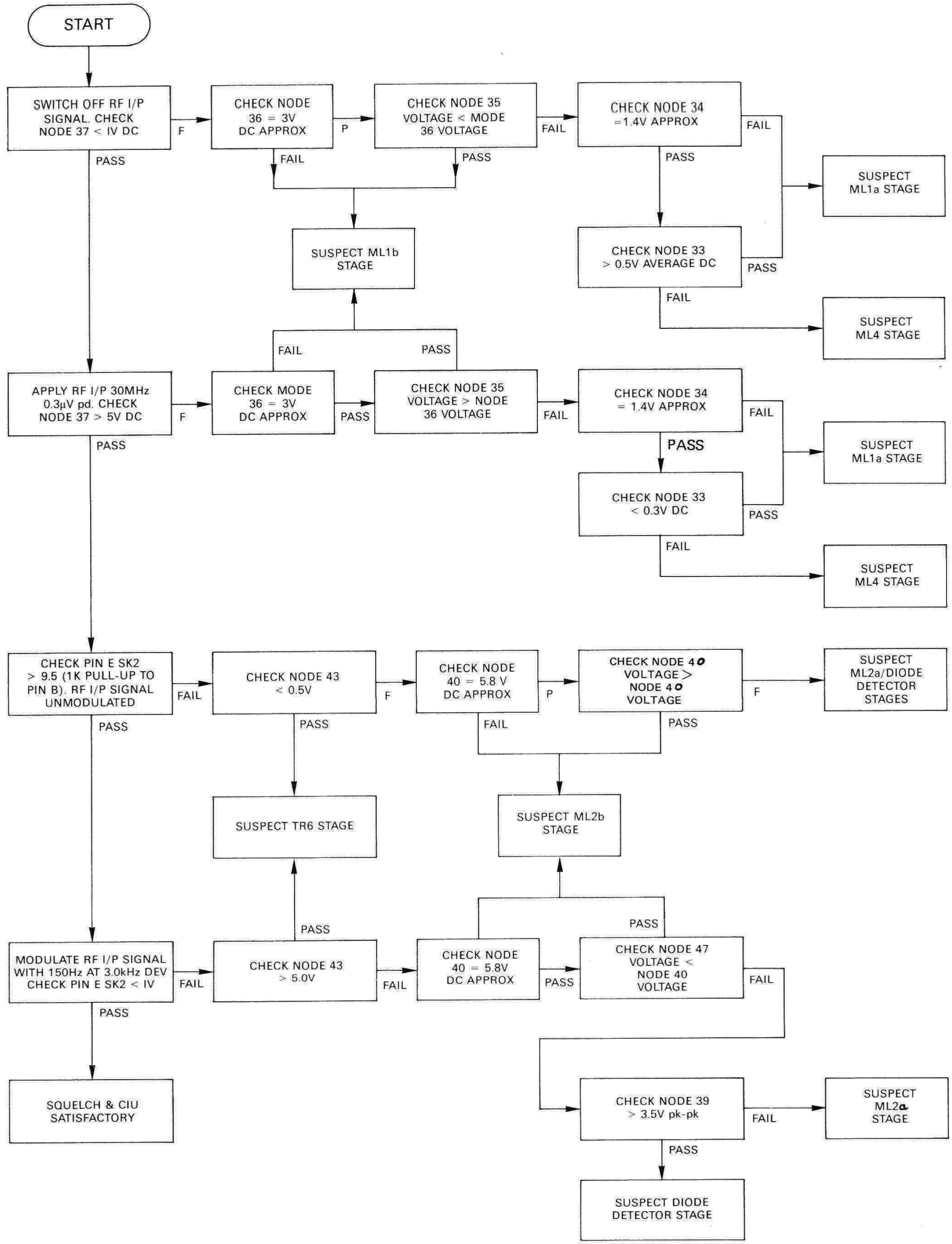


TABLE 4.5 RECEIVER BOARD FLOW CHART SQUELCH & CIU



CHAPTER 5

COMPONENTS LIST

CHAPTER 5

COMPONENTS LIST

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number

RECEIVER PCB (AA708505) - Component Prefix 13

Resistors

Cct Ref.	Value Ω	Description	Rat W	Tol %	Racal Part Number
R1	220k	Carbon Film	1/4	5	927773EQ
R2	1M5	Carbon Film	1/4	5	933361EQ
R3	1M5	Carbon Film	1/4	5	933361EQ
R4	1M	Carbon Film	1/4	5	927803EQ
R5	10k	Carbon Film	1/4	5	927768EQ
R6	47	Carbon Film	1/4	5	927752EQ
R7	470	Carbon Film	1/4	5	927758EQ
R8	180	Carbon Film	1/4	5	927981EQ
R9	220	Carbon Film	1/4	5	927756EQ
R10	4k7	Carbon Film	1/4	5	927765EQ
R11	180	Carbon Film	1/4	5	927981EQ
R12	560	Carbon Film	1/4	5	928067EQ
R13	100k	Carbon Film	1/4	5	928070EQ
R14	22k	Carbon Film	1/4	5	927770EQ
R15	1.5k	Carbon Film	1/4	5	927984EQ
R16	100k	Carbon Film	1/4	5	928070EQ
R17	220k	Carbon Film	1/4	5	927773EQ
R18	56k	Carbon Film	1/4	5	928127EQ
R19	180k	Carbon Film	1/4	5	929481EQ
R20	3k9	Carbon Film	1/4	5	927823EQ
R21	22k	Carbon Film	1/4	5	927770EQ
R22	5k	Variable		20	912659EQ
R23	15k	Carbon Film	1/4	5	927986EQ
R24		Not Used			
R25		Not Used			
R26	20k	Variable		20	914169EQ
R27	18k	Carbon Film	1/4	5	927987EQ
R28	10k	Carbon Film	1/4	5	927768EQ
R29	22k	Carbon Film	1/4	5	927770EQ
R30	47k	Carbon Film	1/4	5	927772EQ

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
R31	10k	Carbon Film	1/4	5	927768EQ
R32	820	Carbon Film	1/4	5	927983EQ
R33	1M	Carbon Film	1/4	5	927803EQ
R34	10k	Carbon Film	1/4	5	927768EQ
R35	100k	Carbon Film	1/4	5	928070EQ
R36	100k	Carbon Film	1/4	5	928070EQ
R37	100k	Carbon Film	1/4	5	928070EQ
R38	47	Carbon Film	1/4	5	927752EQ
R39	470	Carbon Film	1/4	5	927758EQ
R40	1M	Carbon Film	1/4	5	927803EQ
R41	47	Carbon Film	1/4	5	927752EQ
R42	10k	Carbon Film	1/4	5	927768EQ
R43	10	Carbon Film	1/4	5	927750EQ
R44	10k	Carbon Film	1/4	5	927768EQ
R45	1M	Carbon Film	1/4	5	927803EQ
R46	100k	Variable		20	929741EQ
R47	10k	Carbon Film	1/4	5	927768EQ
R48	33k	Carbon Film	1/4	5	927771EQ
R49	15k	Carbon Film	1/4	5	927986EQ
R50	100	Variable		20	917066EQ
R51	300	Metal Oxide	1/4	2	920755EQ
R52	330k	Metal Oxide	1/4	2	992090EQ
R53	100k	Carbon Film	1/4	5	928070EQ
R54	82k	Carbon Film	1/4	5	928544EQ
R55	100k	Carbon Film	1/4	5	928070EQ
R56	100k	Carbon Film	1/4	5	928070EQ
R57	10k	Carbon Film	1/4	5	927768EQ
R58	100k	Carbon Film	1/4	5	928070EQ
R59	12k	Carbon Film	1/4	5	927769EQ
R60	20	Variable		20	914169EQ
R61	68k	Carbon Film	1/4	5	927802EQ
R62	220k	Carbon Film	1/4	5	927773EQ
R63	22k	Carbon Film	1/4	5	927770EQ
R64	47	Carbon Film	1/4	5	927752EQ
R65	220	Carbon Film	1/4	5	927756EQ
R66	150	Carbon Film	1/4	5	927755EQ
R67	47	Carbon Film	1/4	5	927752EQ
R68	220	Carbon Film	1/4	5	927756EQ
R69	220	Carbon Film	1/4	5	927756EQ
R70	100	Carbon Film	1/4	5	927754EQ

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
R71	6.8k	Carbon Film	1/4	5	927767EQ
R72	6k8	Carbon Film	1/4	5	927767EQ
R73	22k	Carbon Film	1/4	5	927770EQ
R74	150	Thermistor			992803EQ
R75	150	Carbon Film	1/4	5	927755EQ
R76	47	Carbon Film	1/4	5	927752EQ
R77	1.5k	Carbon Film	1/4	5	927984EQ
R78	1.5k	Carbon Film	1/4	5	927984EQ
R79	10k	Carbon Film	1/4	5	927768EQ
R80	10	Carbon Film	1/4	5	927750EQ
R81	15k	Carbon Film	1/4	5	927986EQ
R82	10k	Carbon Film	1/4	5	927768EQ
R83		Not normally fitted			
R84	2k7	Carbon Film	1/4	5	927763EQ
R85	4k7	Carbon Film	1/4	5	927765EQ

Capacitors

	F		V		
C1	10n	Ceramic	100	20	927395EQ
C2	10p	Ceramic	100	2	921130EQ
C3	56p	Ceramic	100	2	991135EQ
C4	100p	Ceramic	100	2	919723EQ
C5	15p	Ceramic	100	2	921134EQ
C6	10n	Ceramic	100	20	927395EQ
C7	10n	Ceramic	100	20	927395EQ
C8	150p	Ceramic	100	2	919648
C9	10n	Ceramic	100	20	927395EQ
C10	1.0-3.5p	Variable			992093EQ
C11	10n	Ceramic	100	20	927395EQ
C12	1n	Ceramic	100	20	937085EQ
C13	1n	Ceramic	100	20	937085EQ
C14	1n	Ceramic	100	20	937085EQ
C15	1n	Ceramic	100	20	937085EQ
C16	1n	Ceramic	100	20	937085EQ
C17	1n	Ceramic	100	20	937085EQ
C18	10n	Ceramic	50	10	927395EQ
C19	470n	Tantalum	35V	20	915168EQ
C20	100n	Ceramic	50	10	936877EQ
C21	220n	Tantalum	35V	20	916030
C22	10n	Ceramic	100	20	927395EQ
C23	10n	Ceramic	100	20	927395EQ
C24	10n	Ceramic	100	20	927395EQ
C25	10n	Ceramic	100	5	990151EQ

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
C26	1.8-10p	Variable			926303
C27	10n	Ceramic	100	20	927395EQ
C28	68p	Ceramic	100	2	926613
C29	10n	Ceramic	100	20	927395EQ
C30	1n	Ceramic	100	20	937085EQ
C31	10n	Ceramic	100	20	927395EQ
C32	10n	Ceramic	100	20	927395EQ
C33	10n	Ceramic	100	20	927395EQ
C34	10n	Ceramic	100	20	927395EQ
C35	10n	Ceramic	100	20	927395EQ
C36	10n	Ceramic	100	20	927395EQ
C37	68p	Ceramic	100	2	926613
C38	10n	Ceramic	100	20	927395EQ
C39	10n	Ceramic	100	20	927395EQ
C40	1.0-3.5p	Variable			992093EQ
C41	10n	Ceramic	100	20	927395EQ
C42	10n	Ceramic	100	5	990151EQ
C43	10n	Ceramic	100	20	927395EQ
C44	10n	Ceramic	100	5	990151EQ
C45	1.8-10p	Variable			926303
C46	68p	Ceramic	100	2	926613
C47	10n	Ceramic	100	20	927395EQ
C48	100n	Polycarbonate	100	5	923956
C49	100n	Polycarbonate	100	5	923956
C50	1.0µ	Tantalum	35	20	919635EQ
C51	1.0µ	Tantalum	35	20	919635EQ
C52	1.0µ	Tantalum	35	20	919635EQ
C53	470n	Tantalum	35	20	915168EQ
C54	10n	Ceramic	100	20	927395EQ
C55	10n	Ceramic	100	20	927395EQ
C56	330p	Ceramic	100	2	921148EQ
C57	10n	Ceramic	100	20	927395EQ
C58	10n	Ceramic	100	20	927395EQ
C59	1.0-3.5p	Variable			992093EQ
C60	3.9p	Ceramic	100	±1/4p	925603
C61	33p	Ceramic	100	2	919841EQ
C62	33p	Ceramic	100	2	919841EQ
C63	10n	Ceramic	100	20	927395EQ
C64	68p	Ceramic	100	2	926613
C65	10n	Ceramic	100	20	927395EQ

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
C66	39p	Ceramic	100	2	921314
C67	10n	Ceramic	100	20	927395EQ
C68	10n	Ceramic	100	20	927395EQ
C69	10n	Ceramic	100	20	927395EQ
C70	10n	Ceramic	100	20	927395EQ
C71	10n	Ceramic	100	20	927395EQ
C72	10n	Ceramic	100	20	927395EQ
C73	39p	Ceramic	100	2	921314
C74	1n	Ceramic	100	20	937085EQ
C75	33p	Ceramic	100	2	919841EQ
C76	10n	Ceramic	100	20	927395EQ
C77	1n	Ceramic	100	20	937085EQ
C78	10n	Ceramic	100	20	927395EQ
C79	100p	Ceramic	100	2	919723EQ
C80	4.7µ	Tantalum	16	20	919636EQ
C81		Not Used			
C82	10n	Ceramic	100	20	927395EQ
C83	10n	Ceramic	100	20	927395EQ
C84	10n	Ceramic	100	20	927395EQ
C85	10n	Ceramic	100	20	927395EQ
C86	10n	Ceramic	100	20	927395EQ
C87	10n	Ceramic	100	20	927395EQ
C88	10n	Ceramic	100	20	927395EQ
C89	10n	Ceramic	100	20	927395EQ
C90	10n	Ceramic	100	20	927395EQ
C91	1.8-10p	Variable			926303
C92	10n	Ceramic	100	20	927395EQ
C93	47p	Ceramic	100	2	919646EQ
C94	3.3p	Ceramic	100	±¼p	919724
C95	1n	Ceramic	100	20	937085EQ
C96		Not normally fitted			
C97	10n	Ceramic	100	20	927395EQ

Diodes

D1	BA482	991318EQ
D2	BA482	991318EQ
D3*	Varactor	
D4	BAW62	918982
D5	BAW62	918982
D6	Not Used	
D7	BAW62	918982
D8*	Varactor	
D9	BA482	991318EQ
D10	Not Used	

* D3, D8, D14, D15 - Matched set of Four: BR712283

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
D11		BAW62			918982
D12		BAW62			918982
D13		BA482			991318EQ
D14 *		Varactor			
D15 *		Varactor			
D16		BA482			991318EQ
D17		IN6263			936862EQ
D18		IN6263			936862EQ
D19		BAW62			918982
D20		BAW62			918982
D21		BAW62			918982

* D3, D8, D14, D15 - Matched set of Four: BR712283

NB Single diodes may be changed provided they are of the same colour code as the rest of the set.

Transistors

TR1		BCX38A			992085EQ
TR2		Field Effect			712408
TR3		BFR91A			992087EQ
TR4		ZTX237			923171
TR5		BF982			992094EQ
TR6		ZTX337			936866EQ
TR7					
TR8		Field Effect Matched 4			AR712281
TR9					
TR10					
TR11		BF982			992094EQ

Integrated Circuits

ML1		CA2904E			992098EQ
ML2		CA2904E			992098EQ
ML3		Thick Film I.F. Amp			DR711831
ML4		CA3089E			923961

Transformers

T1		Transformer Assy			AT710801
T2		Transformer Assy			AT710799
T3		Transformer Assy			AT710800

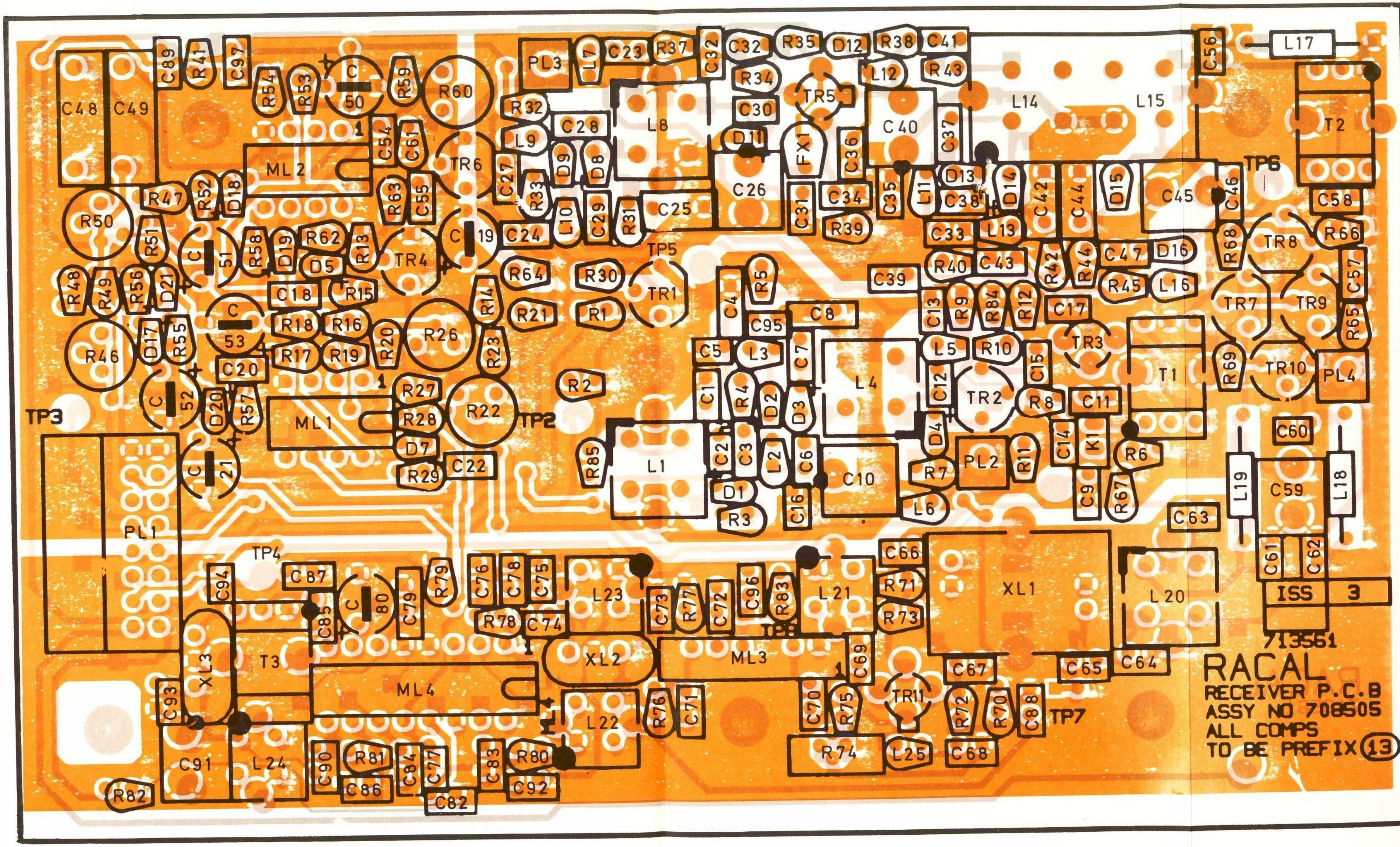
Inductors

	µH				
L1		Coil Assy 2nd L.O.			AT710807
L2	10	Choke			926238EQ
L3	10	Choke			926238EQ
L4		Coil Assy 1st L.O.			AT701806
L5	1.0	Choke		10	926500EQ

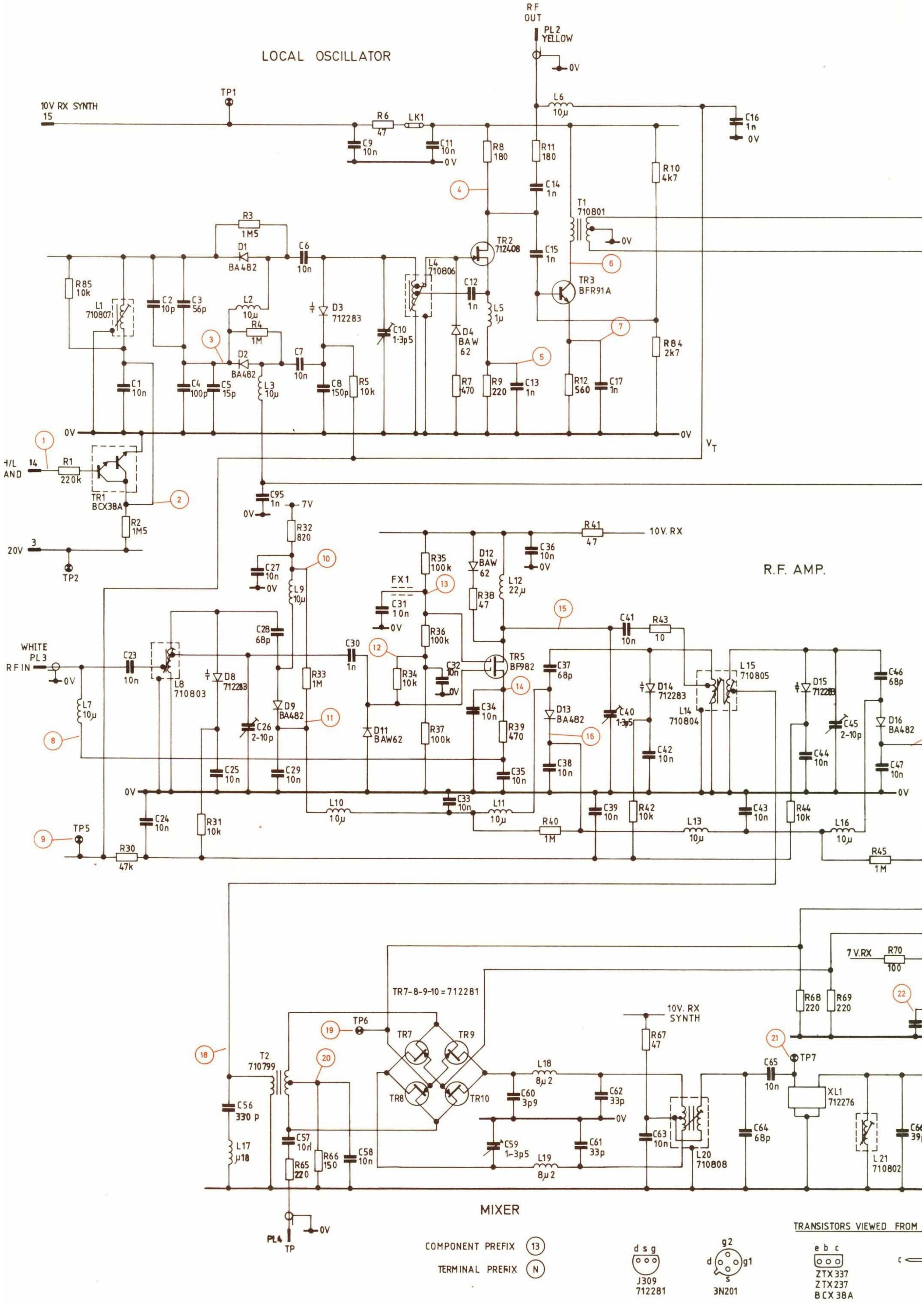
Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
L6	10	Choke		10	926238EQ
L7	10	Choke		10	926238EQ
L8		Coil Assy R.F. Input			AT710803
L9	10	Choke		10	926238EQ
L10	10	Choke		10	926238EQ
L11	10	Choke		10	926238EQ
L12	22	Choke		10	937213
L13	10	Choke		10	926238EQ
L14		Coil Assy 1st R.F. Output			AT710804
L15		Coil Assy 2nd R.F. Output			AT710805
L16	10	Choke		10	926238EQ
L17	0.18	Choke		5	992421EQ
L18	8.2	Choke		10	936857EQ
L19	8.2	Choke		10	936857EQ
L20		Coil Assy Mixer Output			AT710808
L21		Coil Assy I.F.			AT710802
L22		Coil Assy I.F.			AT710802
L23		Coil Assy I.F.			AT710802
L24		Coil Assy I.F.			AT710802

<u>Miscellaneous</u>

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
XL1		Crystal Filter 8-pole			BR712276
XL2		Crystal Filter 2-pole			BR712277
XL3		Crystal Discriminator			BR712278
FX1		Ferrite Bead			907488
		Connector 16-way			992107EQ
		Socket Co-ax 50 Ω			930649EQ
		Ferrite Core for L1, L4, L8, L14, L15 and L20			935753
		Ferrite Core for L21, L22 and L23			992103EQ
LK1		Link Shorting			990776EQ
		Extractor Handle			BD709031
		Bush - Resistor ¼W (Black)			707207
		Bush (Orange)			703009
		Bush (Green)			702971
		Transformer Clamp			708867
		Connector Header 2-way			708919
		Pad Mounting 7092			921760
		Double Coil Can (L14 and L15)			706195



Receiver PCB Layout



RACAL

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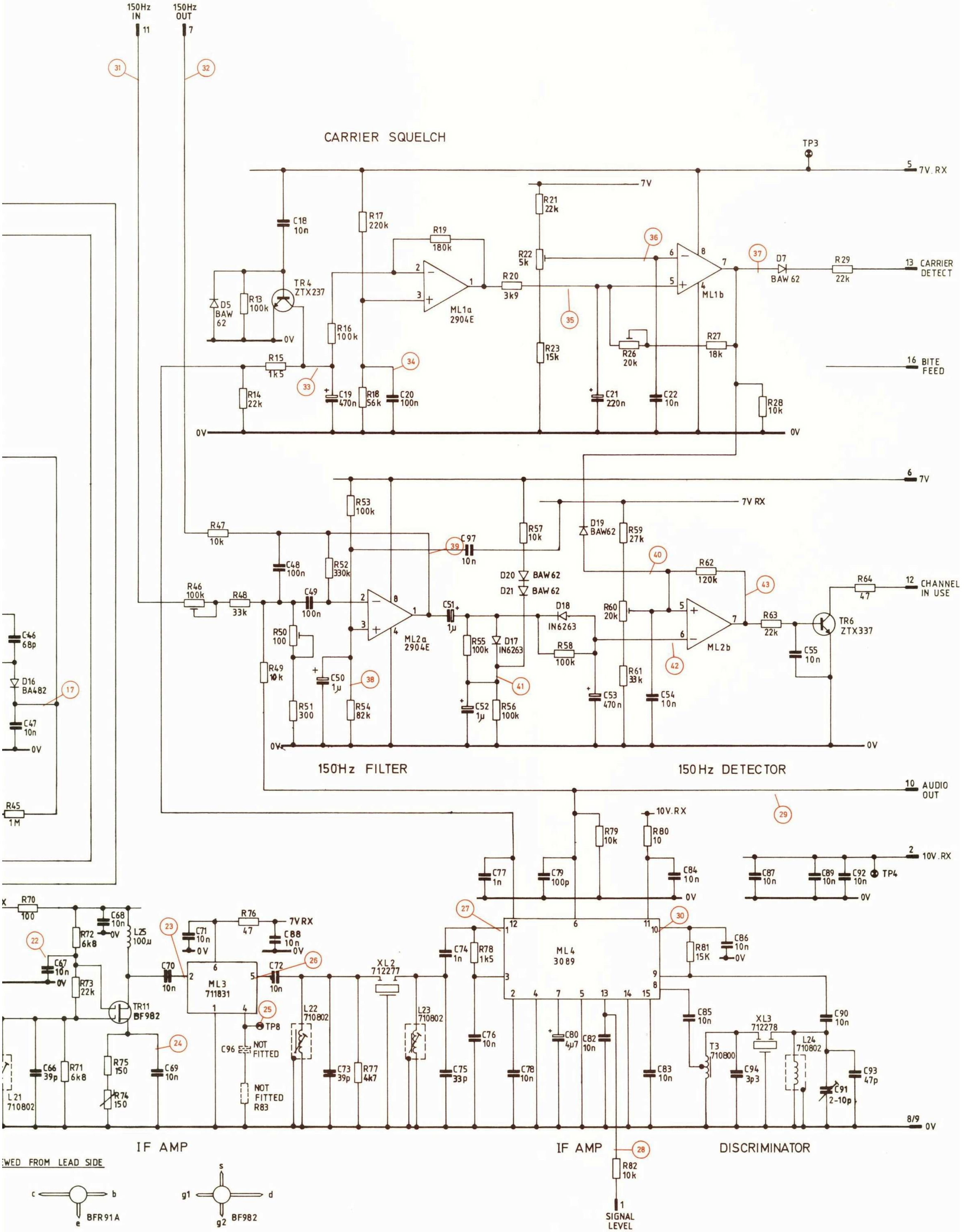


Receiver PCB: Circuit Diagram **Fig. 2**

CHAPTER 12

COMPONENTS LIST

PART 3

AUDIO BOARD

(ST 709112)

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The Audio Board Module performs the following functions:

   (1) Amplification of microphone audio signals

   (2) Peak clipping of transmit audio and data signals

   (3) Variable audio output gain control and whisper control

   (4) Receive audio filtering, switching control and amplification

   (5) Voltage regulation and supply switching

   (6) Squelch, out of lock control, and detection for BITE.

CONSTRUCTION AND LOCATION

2. The Audio Board Module consists of the Audio Motherboard of dimensions 140mm x 56mm onto which are mounted ten plug in Micro Boards. The motherboard is connected to the main chassis by means of a 34 way connector.

NOTE: Repair of individual Micro Boards is not recommended.
The complete Micro Board should be unplugged and replaced.

PRINCIPLES OF OPERATION

Receive Audio Path (Fig. 1.1)

3. The discriminated audio output from the Receiver Board is applied to the Wideband Amplifier MB5 on the Audio Motherboard (which includes the Rx gate controlled by the squelch). The Wideband Output is fed to pin G SK 1 on the front panel for use with 16 K-bit ancillaries.

4. The output of MB5 is also fed to the input of Bandpass Filter MB6. The Bandpass Filter has a bandwidth of 400Hz to 3KHz to remove the 150Hz pilot tone and any noise above 3 kHz.

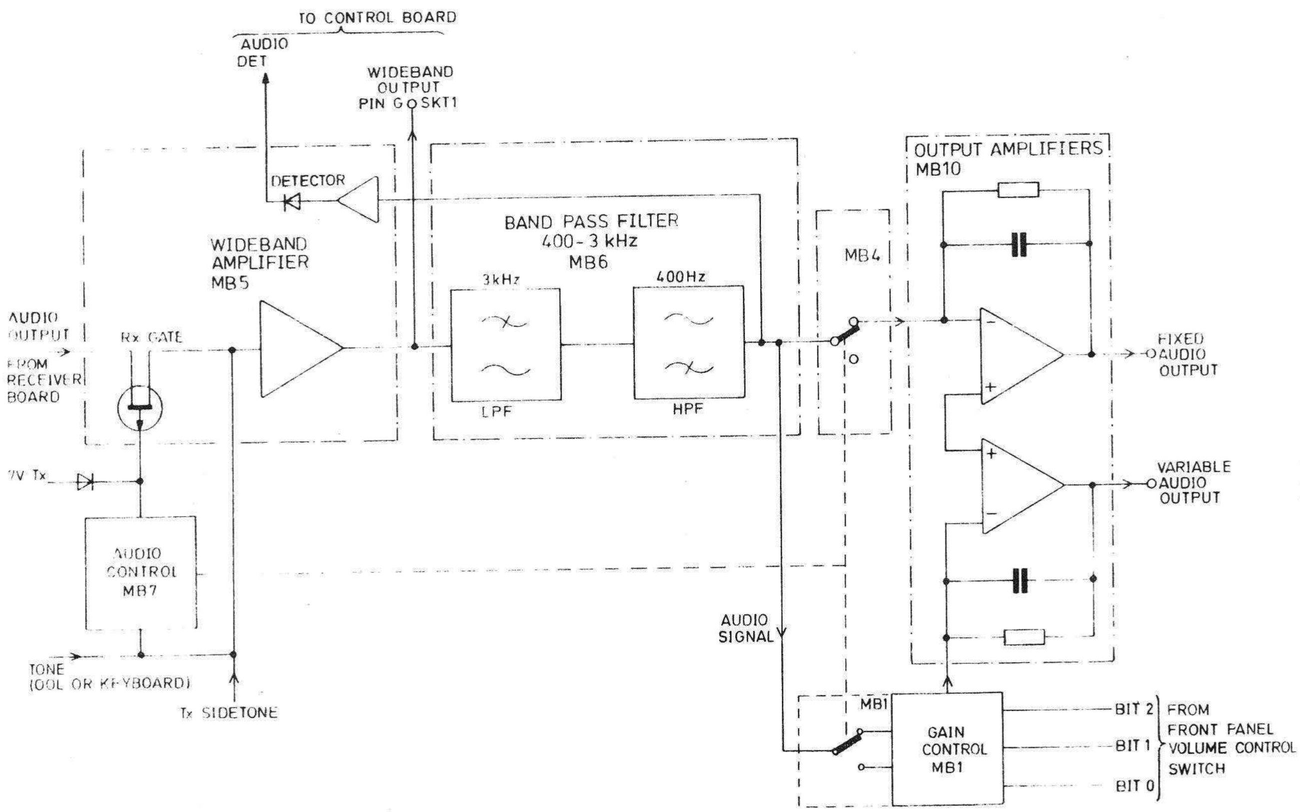
5. The audio output of the Bandpass Filter is routed 3 ways:

   (1) Via the Gain Control MB1 and the Output Amplifiers MB10 to the Variable Audio Output. The Variable Audio Output is used to drive the handset earpiece.

   (2) Via a switch on MB4 and the Output Amplifiers MB10 to the Fixed Audio Output. The Fixed Audio Output is used to drive a vehicle harness or loudspeaker system.

(3) Back to MB5 where it is detected and fed to Audio Det. The Audio Det. line is fed to the Control Board where it is used in the Receiver BITE test.

6. When the OOL or keyboard tone are required they are fed to the input of Wideband Amplifier MB5.



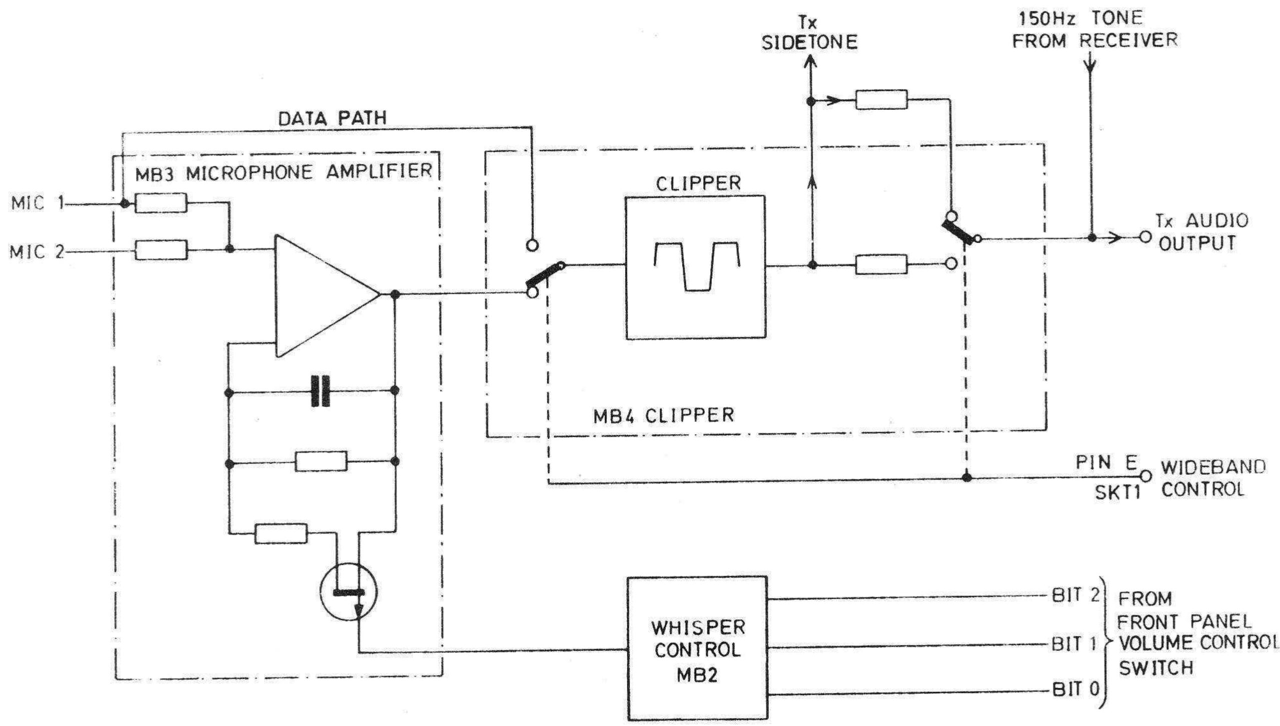
Functional Diagram : Receive Audio Path. Fig. 1.1

Transmit Audio Path (Fig. 1.2)

7. The microphone audio signal is fed to the Microphone Amplifier MB3. Whisper Control MB2 increases the gain of the Microphone Amplifier by four times when the PRM 4700 is in Whisper mode. Whisper mode is selected by the 'W' positions on the front panel Volume Control switch.

8. The output of MB3 is fed through the Clipper MB4 (via a resistor on the Audio Motherboard) to the Tx Audio Output, which is then fed to the Synthesizer Board where it is used to modulate the VCO. The 150Hz pilot tone is added to the Transmit Audio as it enters the Synthesizer Board.

9. Transmit sidetone for the handset earpiece is provided by the output of the Clipper MB4 which is summed into the receive audio path at the input to the Wideband Amplifier MB5. (See Fig. 1.1)



Functional Diagram : Transmit Audio Path. Fig 1.2

Transmit Data Path

10. 16 K-bit data from a 16 K-bit ancillary (e.g. Encryption Unit) is applied via MB3 to the Clipper MB4. When the 16K BIT ancillary is plugged in SK1 the Wideband Control (Pin E) is grounded and Data mode is selected in MB4. The output of MB4 is fed to the Transmit Audio Output pin and then to the Synthesizer Board where it is used to modulate the VCO.

CHAPTER 2

CIRCUIT DESCRIPTION

CONTENTS

TABLES

ILLUSTRATIONS

CHAPTER 2

CIRCUIT DESCRIPTION

INTRODUCTION

1. The circuit and functional descriptions are given below for each Micro Board. For ease of description the ON/OFF circuitry is included in the description of Micro Board 1. The overall circuit diagram, Fig. 2, showing interconnections of the Microboards is at the end of Part 3.

MB1 GAIN CONTROL AND ON/OFF SWITCHING

2. MB1 and associated components carry out on the following functions:

(1) Radio supply ON/OFF switching

(2) Audio volume selection

(3) Audio output gating

Radio Supply ON/OFF Switching

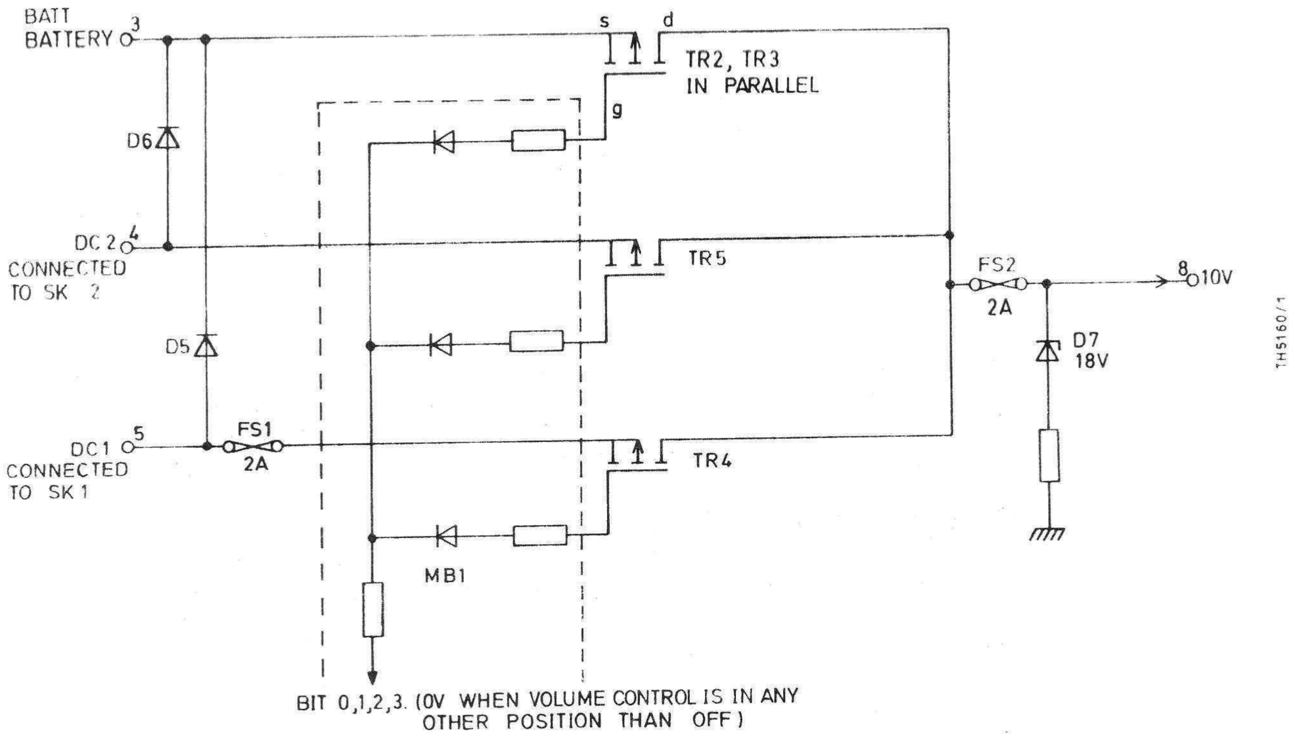
3. Supply ON/OFF switching is performed by VMOS FETs. The FETs have a very low source to drain resistance of approximately 0.3 Ohms when turned ON. When the front panel Volume Control switch is in any position other than OFF, at least one of the BIT 1 to BIT 3 lines will be grounded. This ground potential is applied via a series resistor and diode to the gate of a FET power switch. Table 2.1 shows the function of each FET.

Table 2.1 FET Functions

FET	Function
TR2, TR3	Switch for radio battery
TR4	Switch for DC input from Audio SK 1
TR5	Switch for DC input from Audio SK 2

(TR2 and TR3 in parallel to reduce voltage drop from battery supply).

4. When the gates of the FETs are grounded they will turn ON and conduct. This switches the power from the supply source, either DC1, DC2 or BATT, via the radio supply fuse FS2 to the 10V line, pin 8. Figure 2.1 shows a simplified diagram of the supply switching circuit. The FETs fuses, and Zenner Protection circuit are on the Audio Motherboard.



Simplified Supply Switching Circuit Fig 2.1

SUPPLY PROTECTION CIRCUITS

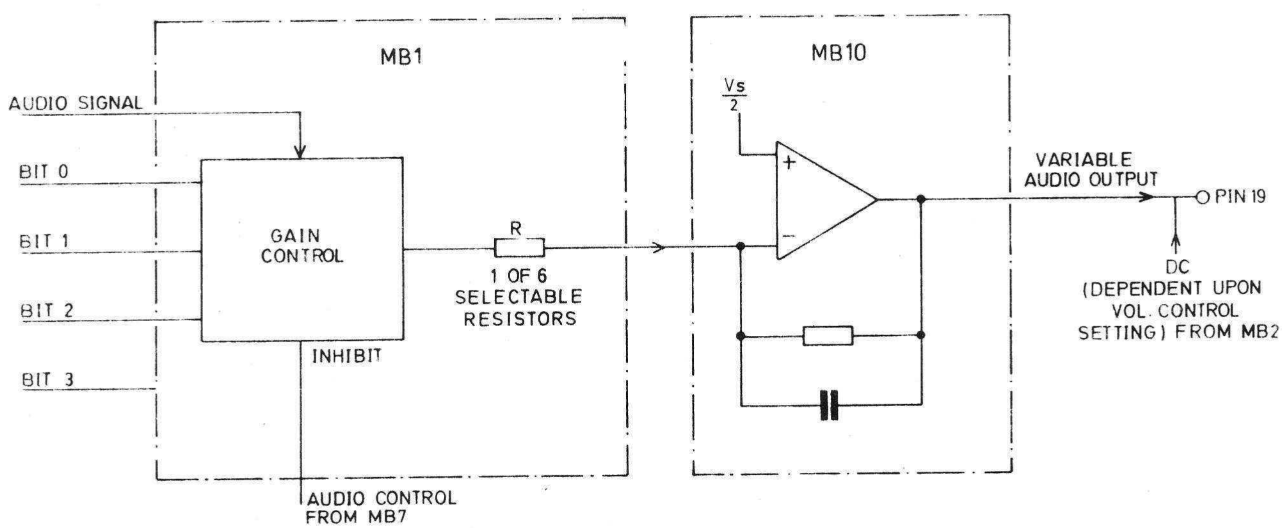
5. Fuse FS1 protects FETs TR4 and TR5 from damage should either the DC1 or DC2 input be shorted to ground whilst volts are being applied to the other input. The 18V zener diode D7 protects the radio supply from high voltage spikes and provides reverse voltage protection. If reverse volts are applied to either DC1, DC2 or BATT inputs, D7 will be forward biassed and conduct causing FS2 to blow. Diodes D5 and D6 allow the battery to be charged from the DC1 or DC2 inputs on the front panel, but do not allow current from the battery to flow out of DC1 or DC2, with the volume control in the OFF position. Overvoltage protection (greater than 18 V) at either DC1, DC2 or BATT inputs, is provided by MB1, taking the gate of the FET up to the supply input volts and so turning if off.

Audio Gain Control

6. The BIT 0 to BIT 3 BCD output from the front panel Volume Control switch is applied to Gain Control MB1. The audio output from MB6 is fed to MB1 where it is switched through one of six fixed resistors which form the input resistances to the variable audio amplifier on MB10. The BIT 0 to BIT 2 BCD inputs are used to select the fixed resistor required and therefore the gain of the audio amplifier. The BIT 3 line ensures that a logic 1 is fed to the ON/OFF switching circuit maintaining the radio in an ON condition even when BIT 0, BIT 1 and BIT 2 are all at logic 0. Table 2.2 shows the BCD control bits for each Volume Control switch setting and Figure 2.2 the functional diagram. An audio control signal from MB7 will inhibit the audio output of MB1 (See Para. 19).

Table 2.2 Volume Control Switch

SW2 VOLUME CONTROL SWITCH	BIT 2	BIT 1	BIT 0	SW2 FUNCTION
0	RADIO OFF			
1 2	1 1	1 0	0 1	WHISPER W
3 4 5 6	1 0 0 0	0 1 1 0	0 1 0 1	NORMAL
7 8	0 1	0 1	0 1	SQUELCH DISABLE *



Volume Control Functional Diagram. Fig. 2.2

MB2 WHISPER CONTROL

7. The BCD input from the Volume Control switch (Bits 0, 1 and 2 only) is fed through MB1 and applied to Whisper Control MB2. MB2 gives two binary outputs, Squelch Off and Whisper, plus one dc output. The dc output voltage, which depends on the Volume Control setting, is superimposed on the Variable Audio Output and can be used for remote volume control of ancillaries, e.g. on encryption unit. Table 2.3 shows the truth table for MB2.

Table 2.3 Whisper Control MB2 Truth Table

VOLUME CONTROL SWITCH	INPUTS BIT 2	BIT 1	BIT 0	WHISPER O/P	SQUELCH O/P	D.C. OUTPUT
0		RADIO			OFF	
1	1	1	0	1	0	0v - 0.1v
2	1	0	1	1	0	0.5v - 0.7v
3	1	0	0	0	0	1.0v - 1.4v
4	0	1	1	0	0	1.6v - 2.0v
5	0	1	0	0	0	2.1v - 2.6v
6	0	0	1	0	0	2.7v - 3.3v
7	0	0	0	0	1	1.0v - 1.4v
8	1	1	1	0	1	2.1v - 2.6v

MB3 MICROPHONE AMPLIFIER

8. The two microphone inputs, pin A SK1 and pin A SK2 on the front panel, are summed together at the input of the Microphone Amplifier MB3. The output of MB3 is fed to the Clipper MB4. In Whisper mode the gain of the Microphone Amplifier is increased by a factor of 4 times, if the input control from MB2 goes high. A data signal from Pin A SK1 passes straight through MB3.

MB4 CLIPPER

9. MB4 amplifies and clips the Microphone Amplifier output signal or the data signal. It also switches the 7V TX supply. Two audio switches control the narrow band/wideband (DATA) switching. A third switch controls the received filtered audio from MB6 to the fixed audio amplifier in MB10.

7V TX, 7V MIC

10. When the TX ON input to MB4 is grounded the 7V TX and 7V MIC supplies are switched ON, being fed from the 7V supply on MB4. The 7V MIC line also switches ON the clipper circuit which is internal to MB4, and also MB3.

Peak Clipping and Switching

11. When the Wideband Control, pin 18, is at 7V, i.e. pin E SK1 is open circuit, the PRM 4700 is in narrowband mode of operation. In this mode

MB4 amplifies and clips the audio output of Microphone Amplifier MB3 to a level of approximately 1V peak to peak.

12. When the Wideband Control, pin 18, is grounded, i.e. pin E SK1 is grounded, the PRM 4700 is in wideband mode of operation. In this mode the data input from pin A SK1 on the front panel does not pass through the amplifier circuit on MB3, but instead passes straight from MB3 to MB4 via C8. The data signal is then amplified and clipped in the same way as audio signals are in narrowband mode.

Fixed Audio Control

13. When a carrier is detected by the Receiver Board the Control Board grounds Squelch Override, pin 3, which in turn grounds the Audio Control line. In this condition the output of Bandpass Filter MB6 is switched through to the input of the fixed audio amplifier on MB10. When the Audio Control line is at 7V there is an open circuit between the output of Bandpass Filter MB6 and the input to the fixed audio amplifier on MB10. In this condition there is no fixed audio output.

MB5 WIDEBAND AMPLIFIER

14. MB5 provides receive audio gating, a wideband summing amplifier and an audio detector. MB5 is normally supplied by 7V CARR, but in transmit mode is supplied by 7V TX via a diode on MB5 which couples the two supplies. The potentiometer R1 on the Audio Motherboard sets the Fixed Audio Output level, by setting the gain of the wideband amplifier.

15. The Rx gate is turned ON when the RX GATE input to MB5 is grounded. In transmit mode 7V TX turns the Rx gate OFF, which breaks the signal path between the Discriminator Input and the output of Wideband Amplifier MB5.

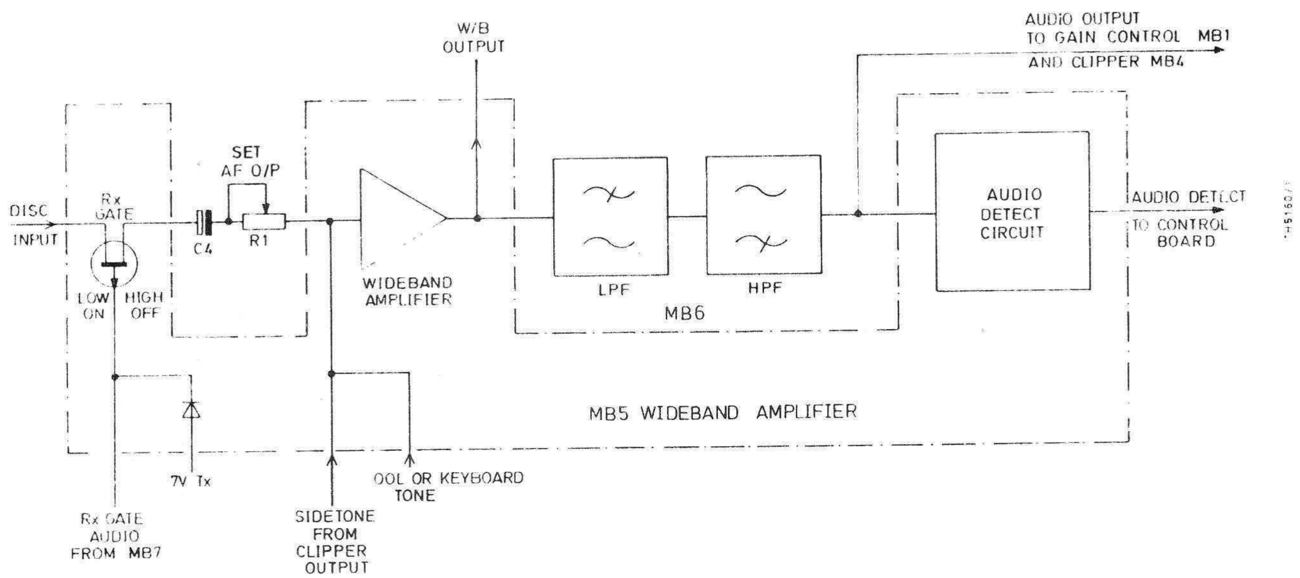
16. Three inputs are summed in the Wideband Amplifier MB5:

(1) Discriminator Input signal from the Receiver Board

(2) OOL tone or keyboard tone from the Control Board

(3) Sidetone from the Clipper MB4.

17. The Audio Det. line, pin 31, is used only during the receiver BITE test. It acts as a flag for the Control Board to indicate that a signal has been received. Figure 2.3 shows the circuit functions of MB5, and Table 2.4 the input and output conditions.



MB5 Wideband Amplifier Functional Diagram. Fig 2.3

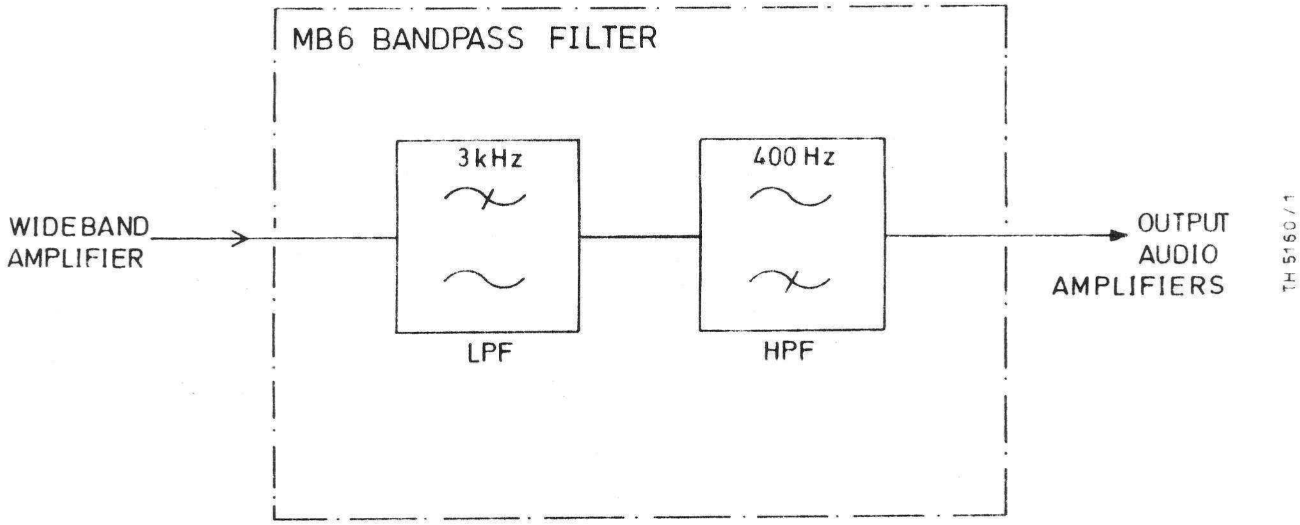
Table 2.4 MB5 Input and Output Conditions

Conditions	Input	Output
7 V Tx = 7 V or RX GATE = 7 V	Disc I/P	NIL
7v Tx or RX GATE = 0 V	DISC I/P	W/B O/P
X	TONE	W/B O/P
X	CLIPPER O/P	W/B O/P

X Doesn't Matter

MB6 BANDPASS FILTER

18. MB6 provides a bandpass filter with a bandwidth of 400Hz to 3KHz. The board has two cascaded active filters, the first a 3KHz low pass filter to remove unwanted high frequency noise and the second a 400Hz high pass filter to remove the 150Hz pilot tone. The output of Bandpass Filter MB6 is applied to the audio detect circuit on MB5 and, via MB4 and MB1, to the Output Amplifiers MB10. Figure 2.4 shows the Bandpass Filter block diagram.



Bandpass Filter Block Diagram. Fig 2.4

MB7 AUDIO CONTROL

19. MB7 provides 7V CARR switching, control of the current saving circuit on MB8, control of the receiver gate on MB5 and control of the switch in the audio path on MB4 and inhibit input to MB1. The outputs present are determined by the five inputs: RF Detect, Squelch Override, OOL Control, Tone and Squelch Off. The Stop Current Save output is at 0v when the 7V CARR voltage is present. Tone input can be OOL, Invalid Frequency or Keyboard Tone. Squelch OFF is derived from the Squelch Disable Switch on the front panel. Table 2.5 shows the truth table which describes the operation of MB7.

Table 2.5 MB7 Audio Control Truth Table

STATE	INPUTS					OUTPUTS			
	RF DET	SQ OVER	OOL CONT	TONE	SQ OFF	RX GATE	7V CARR	AUDIO CONTROL	STOP C/S
CURRENT SAVING	0	1	1	1	0	1	0	1	1
SQUELCH DISABLED	0	1	1	1	1	0	1	0	0
TONE	0	1	1	0	0	1	1	0	0
SQUELCH DISABLED TONE	0	1	1	0	1	1	1	0	0
SYNTH OOL NO TONE	0	1	0	1	0	1	1	0	0
SYNTH OOL NO TONE SQUELCH DISABLED	0	1	0	1	1	1	1	0	0
SYNTH OOL, TONE	0	1	0	0	0	1	1	0	0
SYNTH OOL, TONE SQUELCH DISABLED	0	1	0	0	1	1	1	0	0
SIGNAL RECEIVED	0	0	1	1	0	0	1	0	0
SIGNAL RECEIVED SQUELCH DISABLED	0	0	1	1	1	0	1	0	0
BITE	0	0	1	0	0	0	1	1	0
	0	0	1	0	1	0	1	1	0
	0	0	0	1	0	0	1	1	0
	0	0	0	1	1	0	1	1	0
	0	0	0	0	0	0	1	1	0
	0	0	0	0	1	0	1	1	0
TX	1	X	X	X	X	0	1	0	0

N.B. SQ OVER is at '1' when TONE is '0' except in BITE STATE.

MB8 SUPPLY SWITCHING

20. MB8 provides various switching and timing functions. The inputs to the board are as follows:

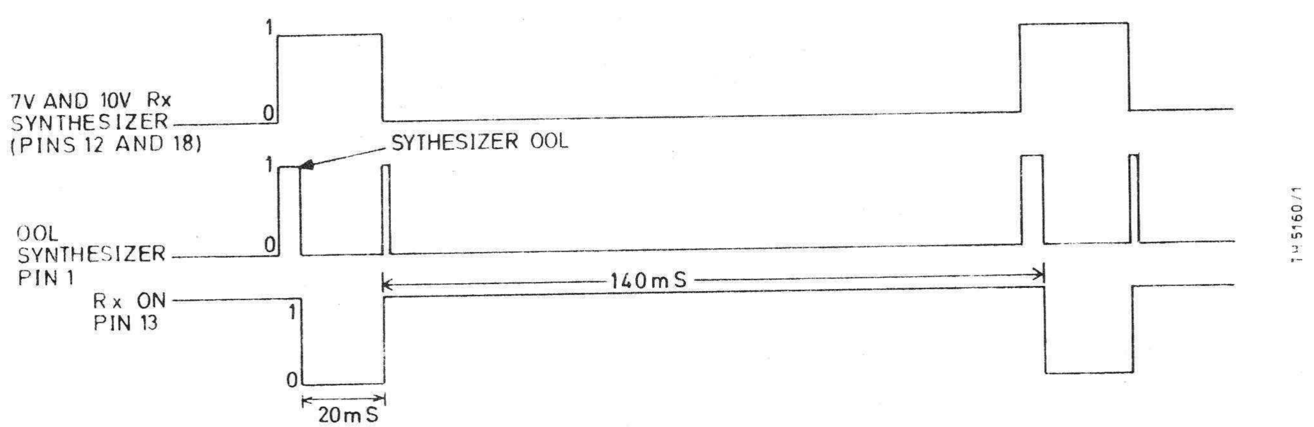
(1) 7V and 10V supplies from the Voltage Regulator MB9.

(2) Stop Current Save (SCS) from the Audio Control MB7. This is open circuit in the current saving mode.

(3) OOL SYNTH from the Control Board. This is grounded when the synthesizer is in lock, 7V when out of lock.

(4) TX EN from the Control Board. This is grounded in receive mode, 7V in transmit. In transmit mode, TX EN switches OFF the 7V RX, 7V RX SYNTH, 10V RX, 10V RX SYNTH and RX ON lines, and switches the TX ON line (pin 17) to 0V.

21. When the PRM 4700 is in a receive mode other than Squelch Off and no carrier has been detected for at least 7 seconds, the radio will enter the current saving mode. When in current saving the radio is repeatedly switched ON for 20mS and OFF for 140mS by MB8. Since there is a delay while the synthesizer comes into lock, the 7V RX SYNTH and 10V RX SYNTH supplies are switched ON first, but the remaining receiver supplies, 7V RX and 10V RX from MB9, are not switched ON, output RX ON high, until the receiver VCO has locked onto frequency. Figure 2.5 shows the relative timing of the waveforms.



Current Saving Waveforms Fig 2.5

OOL CONT Delay

22. When the synthesizer is out of lock the OOL SYNTH line, pin 1, goes high to 7V. Then, after a delay of approximately 30mS the OOL CONT line, pin 28, is grounded. The delay allows the phase locked loop time to lock, so that premature action is not taken by the Control Board to signal out of lock during the period when the synthesizer is coming into lock.

MB9 VOLTAGE REGULATOR

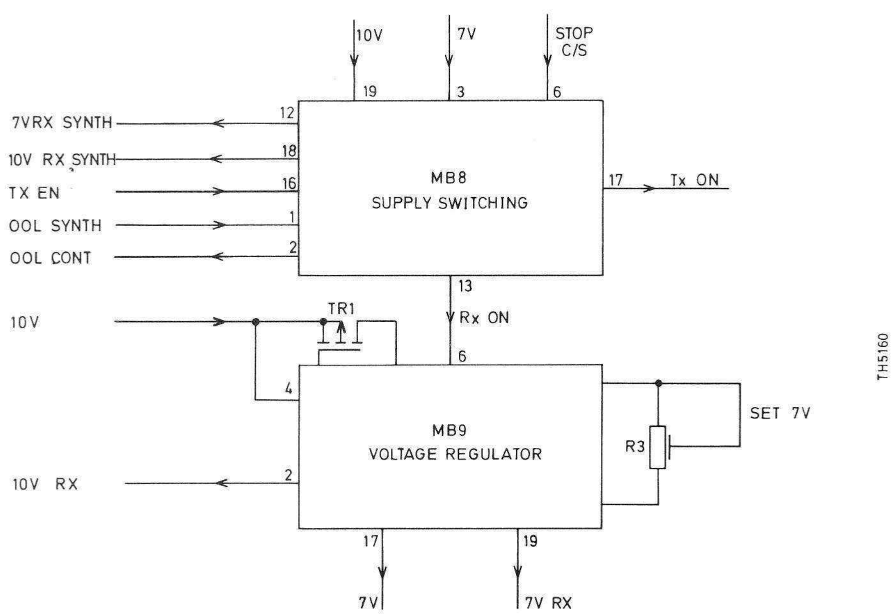
23. MB9 provides the 7V regulated supply plus the 7V RX and 10V RX switched supplies. The 10V battery supply is applied directly to MB9 and the source of the FET TR1. The 7V regulated output is present whenever the PRM 4700 is switched ON and is set by the potentiometer R3 on the Audio Motherboard. Both the 7V RX and the 10V RX supplies are current saved and are enabled when the RX ON line from MB8 is grounded.

MB10 OUTPUT AMPLIFIERS

24. MB10 provides two audio amplifiers, one with fixed gain and one with switchable gain. The input to the fixed audio amplifier is fed from the output of Bandpass Filter MB6 via a switch on MB4, while the input to the switched gain amplifier is fed from the output of Gain Control MB1.

25. The Fixed Audio Output, pin 4, is used to drive a vehicle harness audio amplifier or a loudspeaker system. The Variable Audio Output, pin 19, is used to drive the earpiece of the operator's handset. A DC voltage, dependent on the volume control setting, is added to the variable audio output at pin 19 (See Fig. 2.2).

26. Potentiometer R1 on the Audio Motherboard is used to set the Fixed Audio Output to 1.25mW for a received signal with 1KHz modulation and 5KHz deviation.



ML8 and ML9 Supply Switching and Regulation. Fig 2.6

CHAPTER 3

ALIGNMENT AND TESTING

CONTENTS

TABLES

CHAPTER 3

ALIGNMENT AND TESTING

INTRODUCTION

1. Table 3.1 gives details of the alignment and measurement procedure for the main parameters of the Audio Board Module whilst fitted to a PRM 4700 Unit. This may be necessary for routine purposes, but should always be carried out after any components or Micro Boards have been replaced.

2. It is assumed in the procedure given that all other boards in the unit are working correctly and within their specifications.

3. All adjustments must closely follow the procedure given, and random adjustments must not be made.

INITIAL CONDITIONS

4. A 10.5 V power supply should be connected to pins B (+ve) and D (-ve) of SK1 on the Front Panel of the unit. This may conveniently be done using a Racal Test Jig TJ 947.

5. Testing starts in the Receive mode (RX), i.e. pin C of SK1 and SK2 should be open-circuited, Pilot Tone OFF and Narrow Band (N/B) mode selected.

TEST EQUIPMENT REQUIRED

6. (1) Oscillsocope

Suitable Instrument: HP 1740A/H07 or Tektronix 465 with probe

(2) Audio Signal Generator

Output Impedance : 600Ω
Output Level : 1.5 mV - 1.5 V emf
Frequency Range : 400 Hz - 3 kHz
Suitable Instrument: Racal 9083

(3) DVM

Suitable Instrument: HP 3476A

(4) Audio Power Meter

Impedance : 300Ω
Range : 10 mW
Suitable Instrument: Dymar 2085

(5) Power Supply

Output : 10.5 V at 200 mA
Suitable Instrument: Farnell L30-2

(6) Test Jig

Suitable Instrument: Racal TJ 947

TABLE 3.1

Alignment Parameters

Test No	Parameter	Mode	Inputs	Monitor	Limits	Notes
1	ON/OFF	VOL 0	Pin B SK1 = 10.5V	PL1 pin 8	< 1.0V	
2	ON/OFF	VOLS 1-8	Pin B SK1 = 10.5V	PL1 pin 8	> 9.8V	
3	ON/OFF	VOL 0	Pin B SK2 = 10.5V	PL1 pin 8	< 1.0V	
4	ON/OFF	VOL 1	Pin B SK2 = 10.5V	PL1 pin 8	> 9.8V	
5	ON/OFF	VOL 0	BATT CONTACT = 10V	PL1 pin 8	< 1.0V	
6	ON/OFF	VOL 1	BATT CONTACT = 10V	PL1 pin 8	> 9.8V	
7	Over Voltage	VOL 1	Switch input to 24V Pin B SK1	PL1 pin 8	< 1.0V	Reduce input voltage to 10.5V before next test
8	7V Regulator	VOL 1		7V MB9 pin 17	7.1V ± 0.1V	Adjust R3, Measure using DVM or AVO
9	RX Supplies	VOL 8		7V RX MB9 pin 19	> 6.8V	DVM
				10V RX PL1 pin 2	> 9.7V	DVM. Ensure 10V input is accurate
				10V RX SYN MB8 pin 18	> 9.8V	DVM. Ensure 10V input is accurate
				7V RX SYN PL1 pin 11	6.4V ± 0.3V	DVM
				OOL CONT MB8 pin 2	> 6.5V	DVM
				7V TX PL1 pin 15	< 1.0V	DVM
10	TX Supplies	TX, LO PWR 30.025MHz		7V TX PL1 pin 15	> 6.8V	DVM
				7V RX MB9 pin 19	< 1.0V	DVM
				7V RX SYN PL1 pin 11	< 0.2V	DVM
11	Current Saving	RX, VOL 1		7V RX MB9 pin 19	On time: 17-26mS Off time: 120-170mS	Scope
12	Audio Control	RX, VOL 3		TP1	0	For Tests 13-19, 1 is 6.5V, 0 is 0.5V
				TP2	1	
13	SQ Override	RX, VOL 7 and 8		TP1	1	
				TP2	0	
14	RF Detect	TX, LO PWR 30.025MHz		TP1	1	
15	OOL	RX, CHAN 0 89.000MHz		TP1	1	
16	Tone	RX, CHAN 0 89,000MHz		TP1	1	
17	Bite	RX, CHAN 0 89,000MHz VOL 7		TP2	1	
18	RX Audio	RX, CHAN 0 30,025MHz VOL 1	50Ω BNC SKT 30.025MHz, 1kHz mod 10kHz deviation 100µV pd	Fixed Audio O/P Pin G SK2	5mW	Use 300Ω AF Power Meter. Adjust R1.
19	Wideband Output	RX, VOL 1	50Ω BNC SKT 30.025MHz, 1kHz mod 10kHz deviation 100µV pd	W/B O/P Pin G SK1	1 - 2V	Peak to peak sinewave.

TABLE 3.1 (Continued)

Test No	Parameter	Mode	Inputs	Monitor	Limits	Notes
20	Mute	RX, VOL 1	Remove Input	Fixed Audio O/P Pin G SK2	>25dB Below 5mW	Use 300Ω Power Meter. Note Level Compares to that in Test 18
21	Audio Detect	RX, VOL 1	50Ω BNC SKT 30.025MHz, 1kHz mod 10kHz deviation 100μV pd	Audio DET D2 Cathode	>3V	
22	Audio Detect	RX, VOL 7	Remove RF	Audio DET D2 Cathode	<1.0V	
23	RX Mute	TX, LO PWR VOL 7	50Ω BNC SKT 30.025MHz, 1kHz mod 10kHz deviation 100μV pd	Fixed Audio Output Pin G SK2	>25dB below 5mW	Use 300Ω AF Power Meter. Note level compared with that in Test 16
24	Variable Audio	RX VOL 6	50Ω BNC SKT 30.025MHz, 1kHz mod 10 kHz deviation 100μV pd	Variable Audio O/P pin F SK2	5mW ± 2dB	Use 300Ω AF Power Meter.
25	Bandwidth	RX VOL 6	50Ω BNC SKT 30.025MHz, 400Hz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2	-6dB	Less than 6dB down relative to 1kHz
26	Bandwidth	RX VOL 6	50Ω BNC SKT 30.025MHz, 3kHz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2	-6dB	Less than 6dB down relative to 1kHz
27	Volume 5	RX VOL 5	50Ω BNC SKT 30.025MHz, 1kHz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2		4 - 6dB below Vol 6 (Test 21)
28	Volume 4	RX VOL 4	50Ω BNC SKT 30.025MHz, 1kHz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2		11 - 13dB below Vol 6
29	Volume 3	RX VOL 3	50Ω BNC SKT 30.025MHz, 1kHz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2		17 - 19dB below Vol 6
30	Volume 2	RX VOL 2	50Ω BNC SKT 30.025MHz, 1kHz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2		17 - 19dB below Vol 6
31	Volume 1	RX VOL 1	50Ω BNC SKT 30.025MHz, 1kHz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2		22 - 24dB below Vol 6
32	Volume 8	RX VOL 8	50Ω BNC SKT 30.025MHz, 1kHz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2		4 - 6dB below Vol 6
33	Volume 7	RX VOL 7	50Ω BNC SKT 30.025MHz, 1kHz mod, 10kHz deviation 100μV pd	Variable Audio O/P Pin F SK2		17 - 19dB below Vol 6
34	TX Output	TX VOL 3	MIC 1 I/P 30mV emf 1kHz (600Ω) Pin A SK1	TX Audio O/P MB4 Pin 7	0.65 - 0.95V	Peak to peak, use scope
35	MIC Sensitivity	TX VOL 3	MIC 1 I/P 1kHz (600Ω) Pin A SK1	TX Audio O/P MB4 Pin 7	6mV emf ± 3dB	Set TX Audio O/P to be 600mV peak to peak
36	MIC Sensitivity	TX VOL 3	MIC 2 I/P Pin A SK2	TX Audio O/P MB4 Pin 7	6mV emf ± 3dB	Set TX Audio O/P to be 600mV peak to peak
37	Whisper	TX VOL 1	MIC 2 I/P Pin A SK2	TX Audio O/P MB4 Pin 7	1.5mV emf ± 3dB	Set TX Audio O/P to be 600mV peak to peak
38	Wideband Transmit	TX W/B	MIC 1 I/P 1.3V peak to peak 1kHz pd Pin A SK1	TX Audio O/P MB4 Pin 7	0.65 - 0.95V	Peak to peak squarewave, use scope

TABLE 3.1 (Continued)

Test No	Parameter	Mode	Inputs	Monitor	Limits	Notes
39	DC Control	TX VOL 1		Variable Audio O/P Pin F SK2	<0.1V	Measure DC voltage with DVM. No load on Variable Audio O/P Pin F SK2 or Pin F SK1
		VOL 2			0.5 - 0.7V	
		VOL 3			1.0 - 1.4V	
		VOL 4			1.6 - 2.0V	
		VOL 5			2.1 - 2.6V	
		VOL 6			2.7 - 3.3 V	
		VOL 7			1.0 - 1.4V	
		VOL 8			2.1 - 2.6V	

CHAPTER 4

FAULT LOCATION

CONTENTS

TABLES

CHAPTER 4

FAULT LOCATION

INTRODUCTION

1. Fault location on the Audio Board Module is carried out by checking voltages and waveforms at various points on the Audio Motherboard and by using the Flowcharts provided.

TEST EQUIPMENT REQUIRED

2. The equipment required for fault location is listed in Chapter 3.

VOLTAGES AND WAVEFORMS

3. The information given in Tables 4.1, 4.2 and 4.3 should be used in conjunction with the circuit diagram, Fig. 2 to which the nodes refer. All voltages and waveforms are nominal and are measured using an oscilloscope with a 1MΩ probe unless otherwise stated.

USE OF FLOWCHARTS

4. If a fault is known to exist in the Power Supplies, the Supplies Fault Finding Guide, Table 4.4 should be followed to trace the fault to either the Micro Boards or one of the major components on the Audio Motherboard.

5. Similarly, if a fault is known to exist in the Transmit or Receive Audio paths, the Transmit Audio Fault Finding Guide, Table 4.5 or the Receive Audio Fault Finding Guide, Table 4.6 should be followed to trace the fault to one or more of the Micro Boards.

GENERAL

6. Care should be taken not to bend the Micro Boards on their pins. If this action is repeated the pins may break off causing irreparable damage to the Micro Board and the Audio Motherboard.

7. Repair of individual Micro Boards is not recommended. The complete Micro Board should be unplugged and replaced.

8. If any components are changed or Micro Boards replaced during fault finding the alignment and testing procedure given in Chapter 3 should be followed before returning the board to service.

TABLE 4.1

Audio Board Voltage and Waveforms - Transmit, Receive and Receive Current Saving Modes

Apply 10.5 Volts to SK2

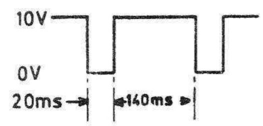
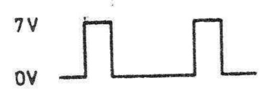
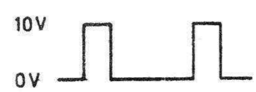
NODE	TITLE	TX	RX	RX C/S
01	10 V	> 9.8 V	>9.8 V	> 9.8 V
02	7 V	7 V	7 V	7 V
03		6 V	6 V	6 V
04		2 V	2 V	2 V
05	RX ON	10 V	0 V	
06	7 V RX	0 V	7 V	
07	10 V RX	0 V	10 V	
08	7 V RX SYNTH	0 V	6 V	
09	10 V RX SYNTH	0 V	10 V	
10	STOP C/S (Use 10 MΩ Probe)	0 V	0 V	6 V
11	SQ OFF		7 V	0 V
12	7 V TX	7 V	0 V	0 V
13	TX ON	0 V	7 V	7 V
14	7 V MIC	7 V	0 V	0 V

TABLE 4.2

Audio Board Voltages and Waveforms - Receive Mode

Input Conditions:

Set radio Rx frequency to 30.025 MHz on Front Panel. Input 30.025 MHz, 1 kHz modulation, 5 kHz deviation, 100 μV pd to 50 Ω BNC (SK4)

NODE	CONDITIONS	DC COMPONENT	AC COMPONENT
15			0.8 V peak to peak
16		0 V	
17			0.7 V peak to peak
18			15 mV peak to peak
19	VOL 1	< 0.1 V	130 mV peak to peak
	VOL 2	0.5 - 0.7 V	230 mV peak to peak
	VOL 3	1.0 - 1.4 V	230 mV peak to peak
	VOL 4	1.6 - 2.0 V	480 mV peak to peak
	VOL 5	2.1 - 2.6 V	1.04 V peak to peak
	VOL 6	2.7 - 3.3 V	1.8 V peak to peak
	VOL 7	1.0 - 1.4 V	230 mV peak to peak
	VOL 8	2.1 - 2.6 V	1.04 V peak to peak
20			0.7 V peak to peak
21			1.8 V peak to peak
22		> 3.5 V	Ripple

TABLE 4.3

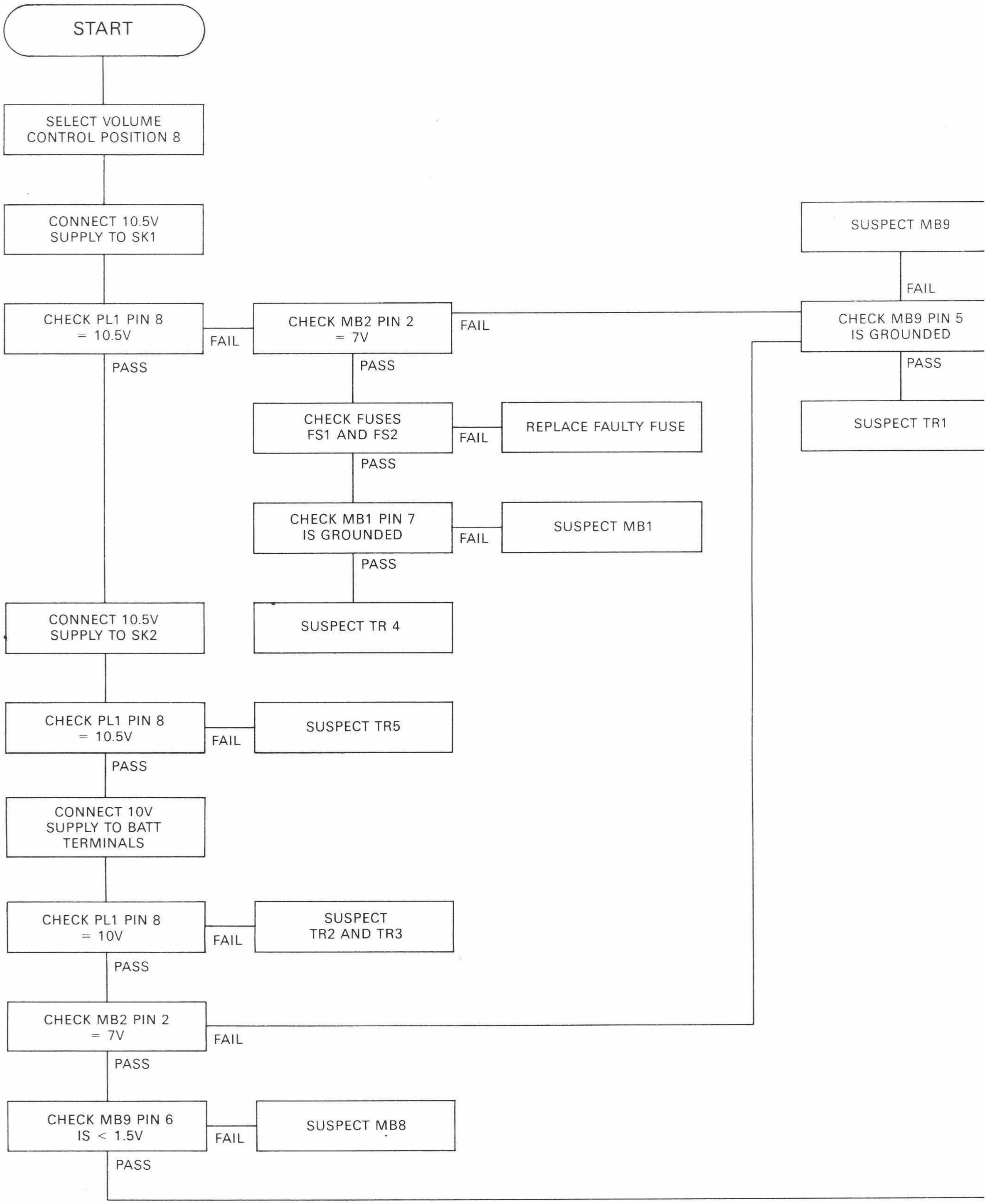
Audio Board Voltages and Waveforms - Transmit Mode

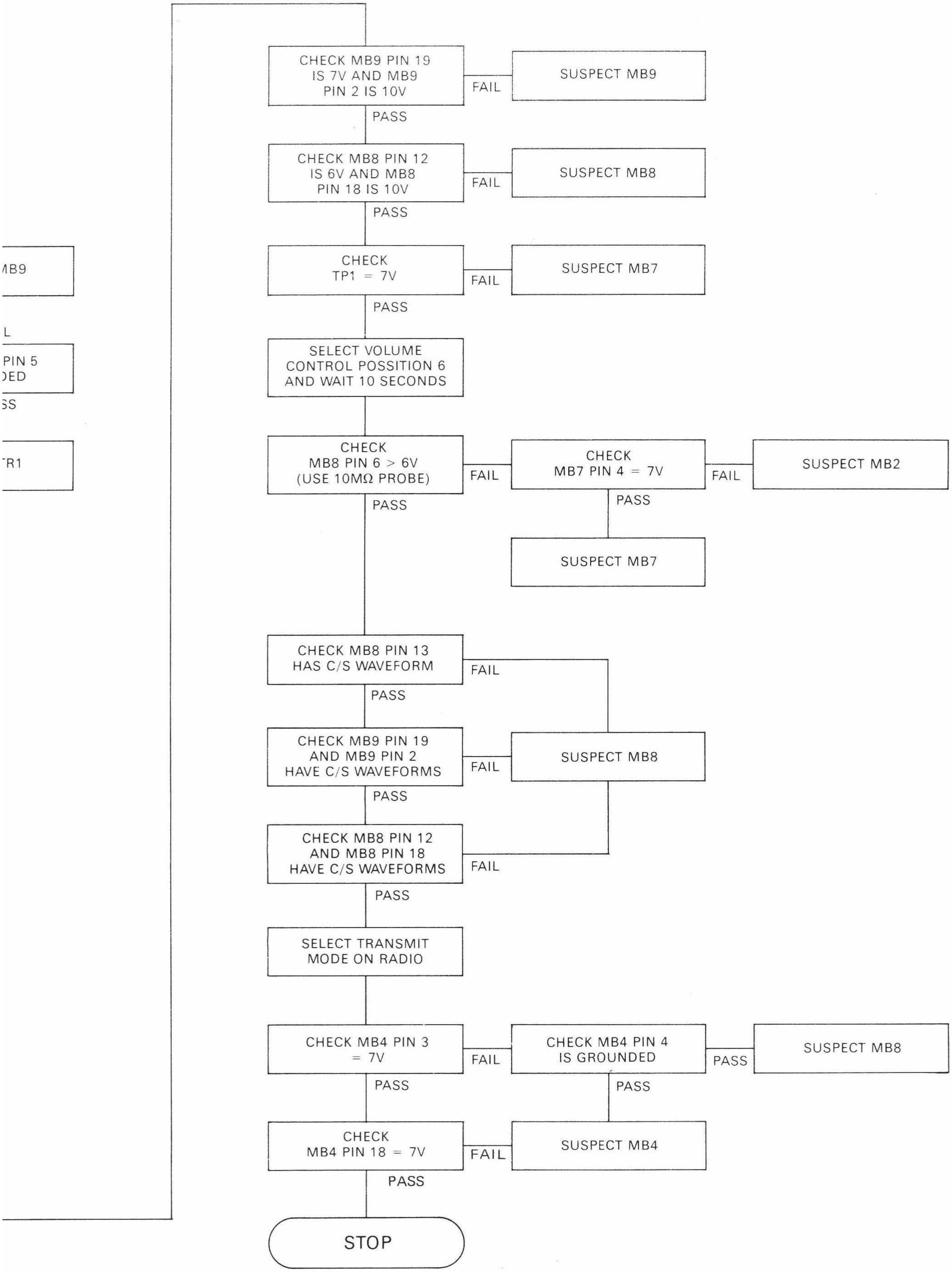
Input Conditions:

Input 30 mV emf 1 kHz from 600 Ω to pin A SK1.

NODE	CONDITIONS	DC COMPONENT	AC COMPONENT
23	VOL 3		1.04 V peak to peak
	VOL 2		3.8 V peak to peak
24	VOL 3		1.2 V peak to peak squarewave
25	VOL 3		0.8 V peak to peak squarewave
26	VOL 3		30 mV peak to peak
27	VOL 2	7 V	

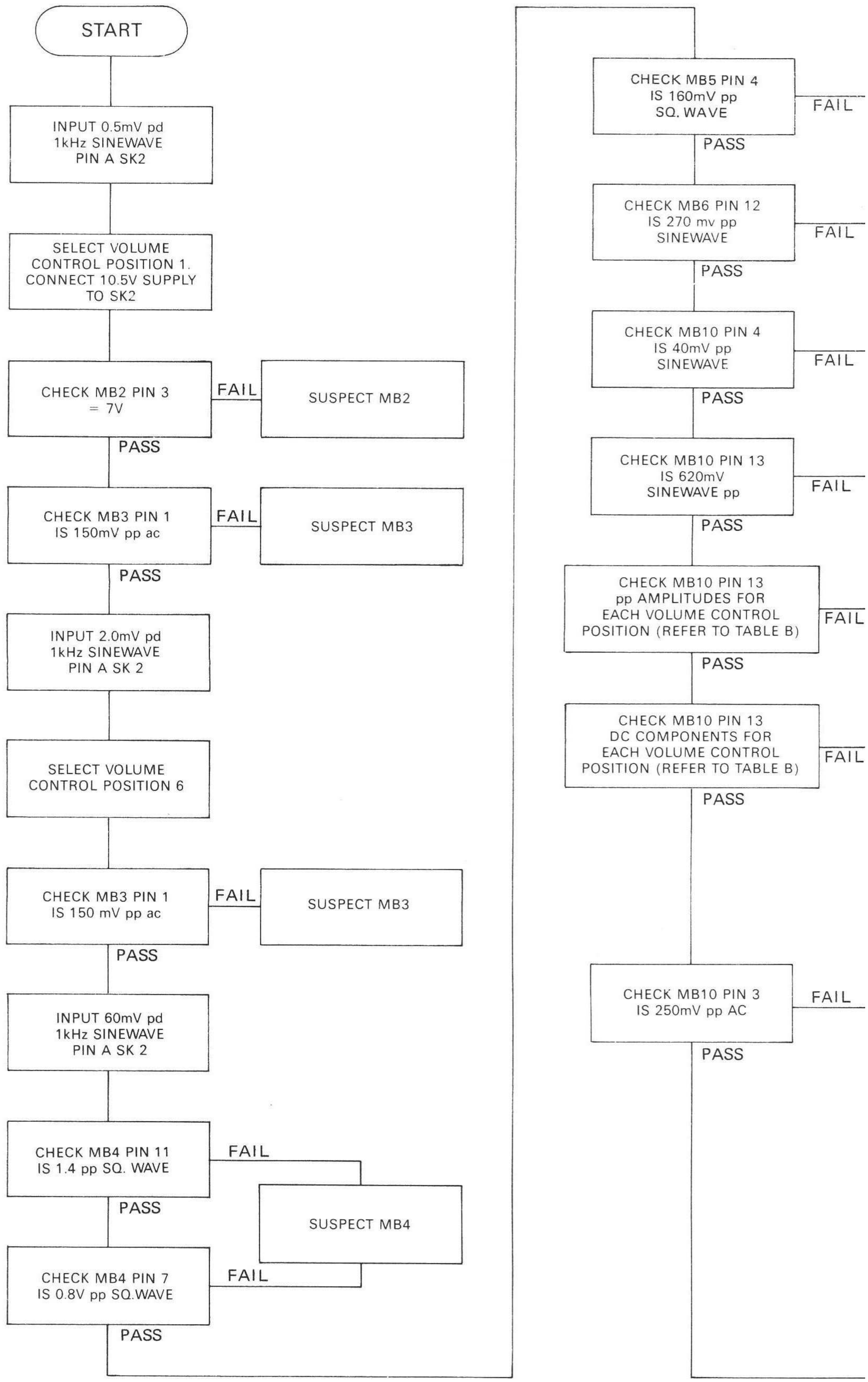
TABLE 4.4 SUPPLIES FAULT FINDING GUIDE





racal$$$13
27-09-85 08:43:44

TABLE 4.5 TRANSMIT AUDIO FAULT FINDING GUIDE



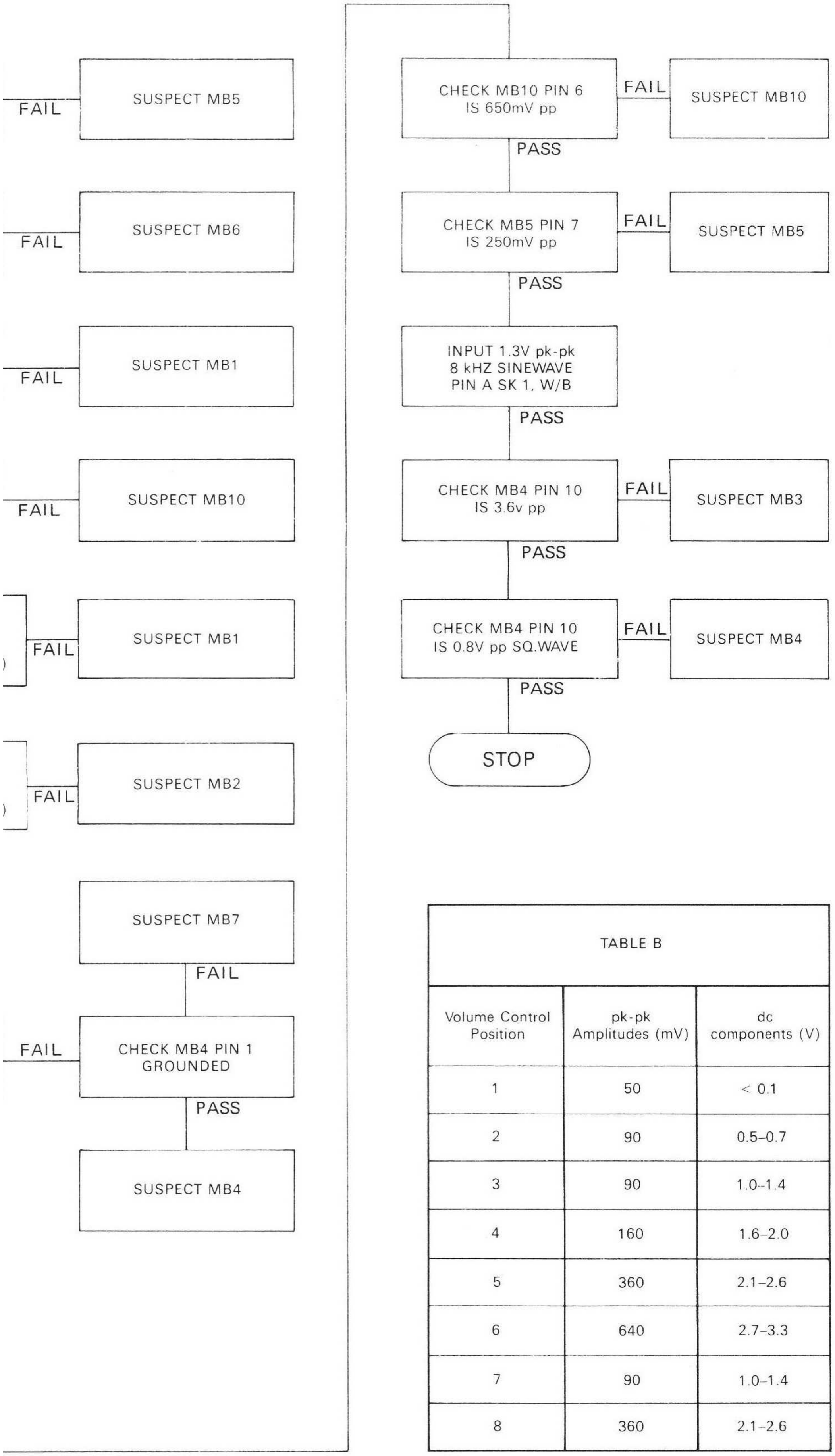


TABLE B		
Volume Control Position	pk-pk Amplitudes (mV)	dc components (V)
1	50	< 0.1
2	90	0.5–0.7
3	90	1.0–1.4
4	160	1.6–2.0
5	360	2.1–2.6
6	640	2.7–3.3
7	90	1.0–1.4
8	360	2.1–2.6

TABLE 4.6 RECEIVE AUDIO FAULT FINDING GUIDE

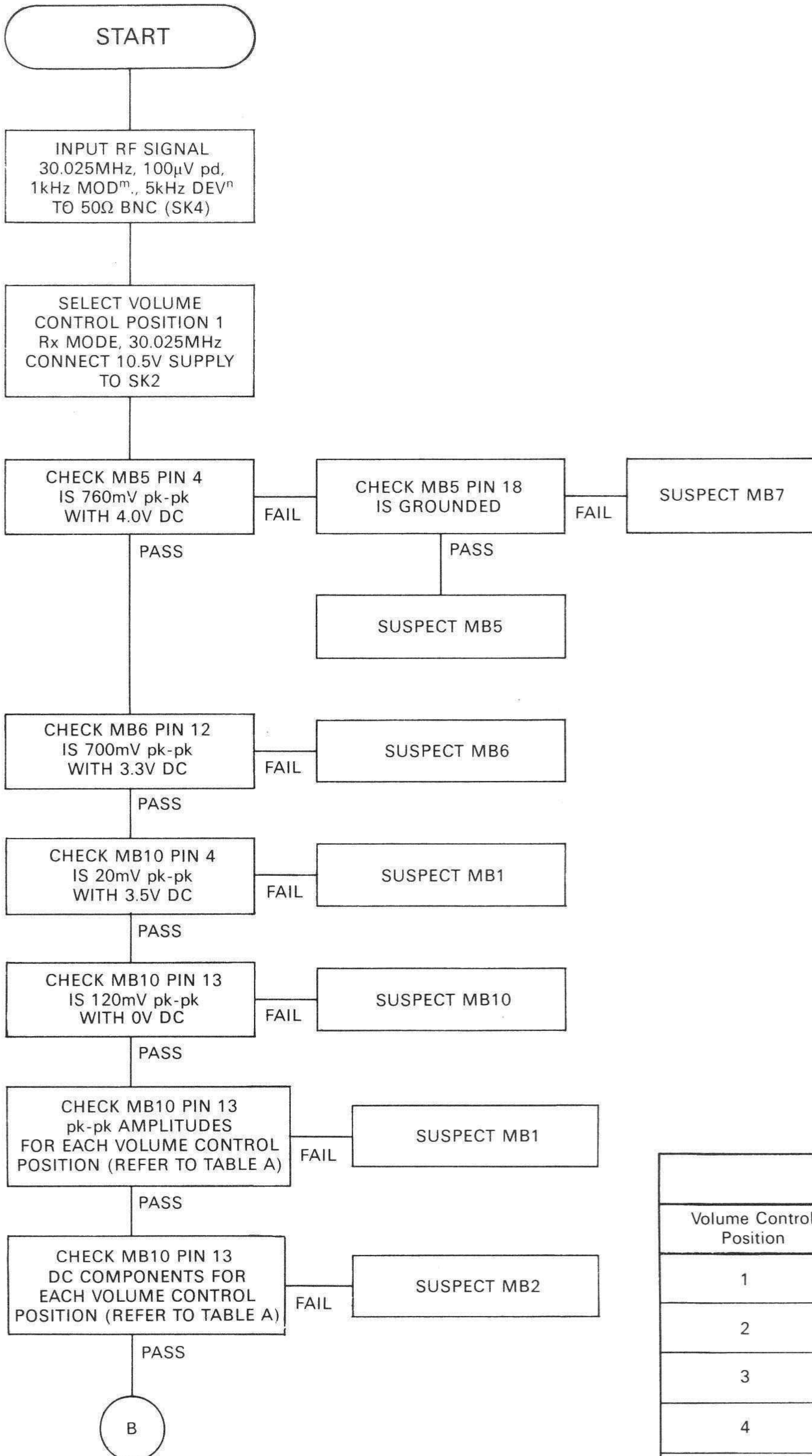
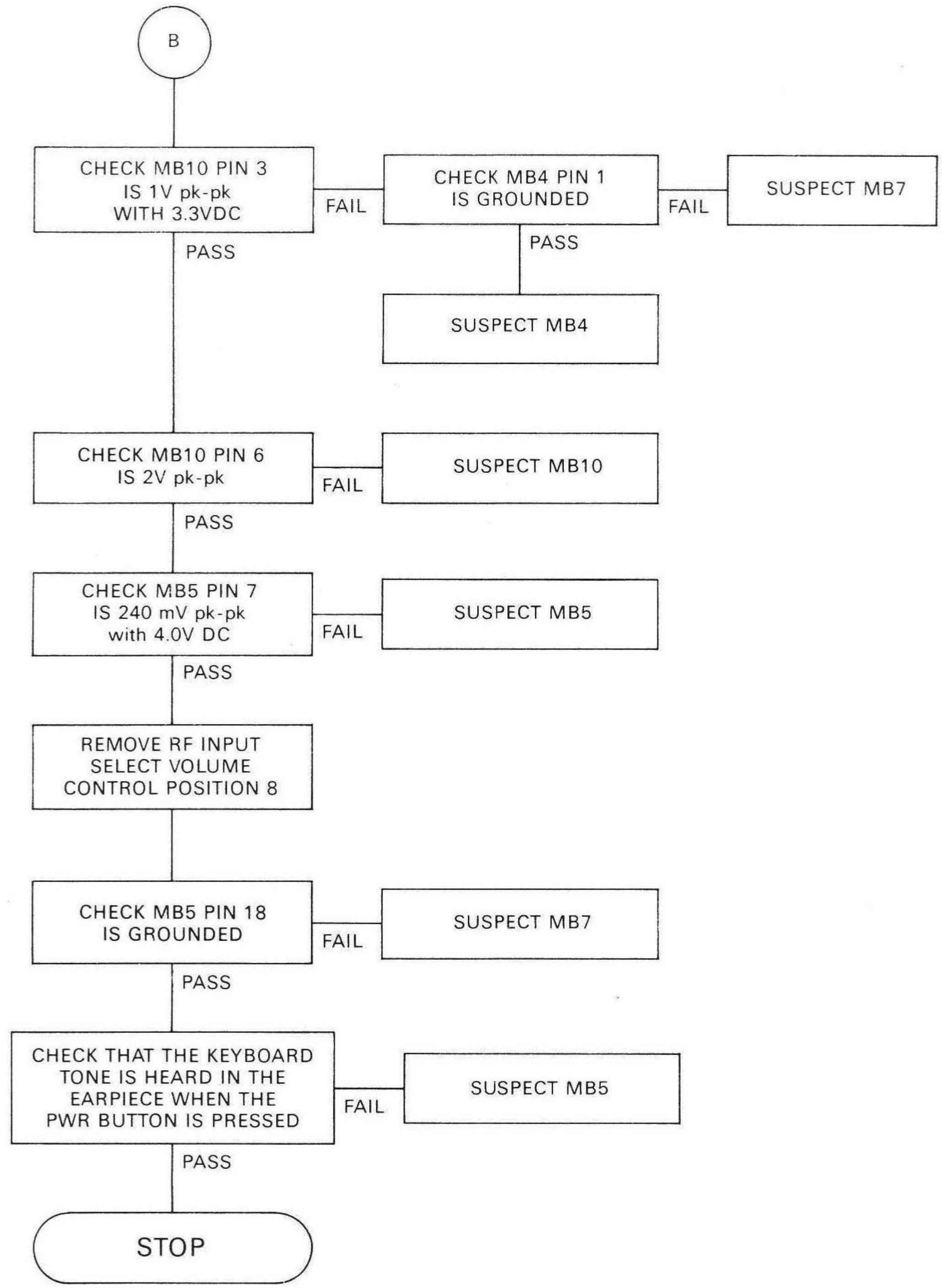


TABLE A

Volume Control Position	pk-pk Amplitudes (mV)
1	120
2	220
3	220
4	440
5	960
6	1700
7	220
8	960



BLE A	
-pk des (mV)	dc Components (V)
20	< 0.1
20	0.5–0.7
20	1.0–1.4
40	1.6–2.0
60	2.1–2.6
00	2.7–3.3
20	1.0–1.4
60	2.1–2.6

CHAPTER 5

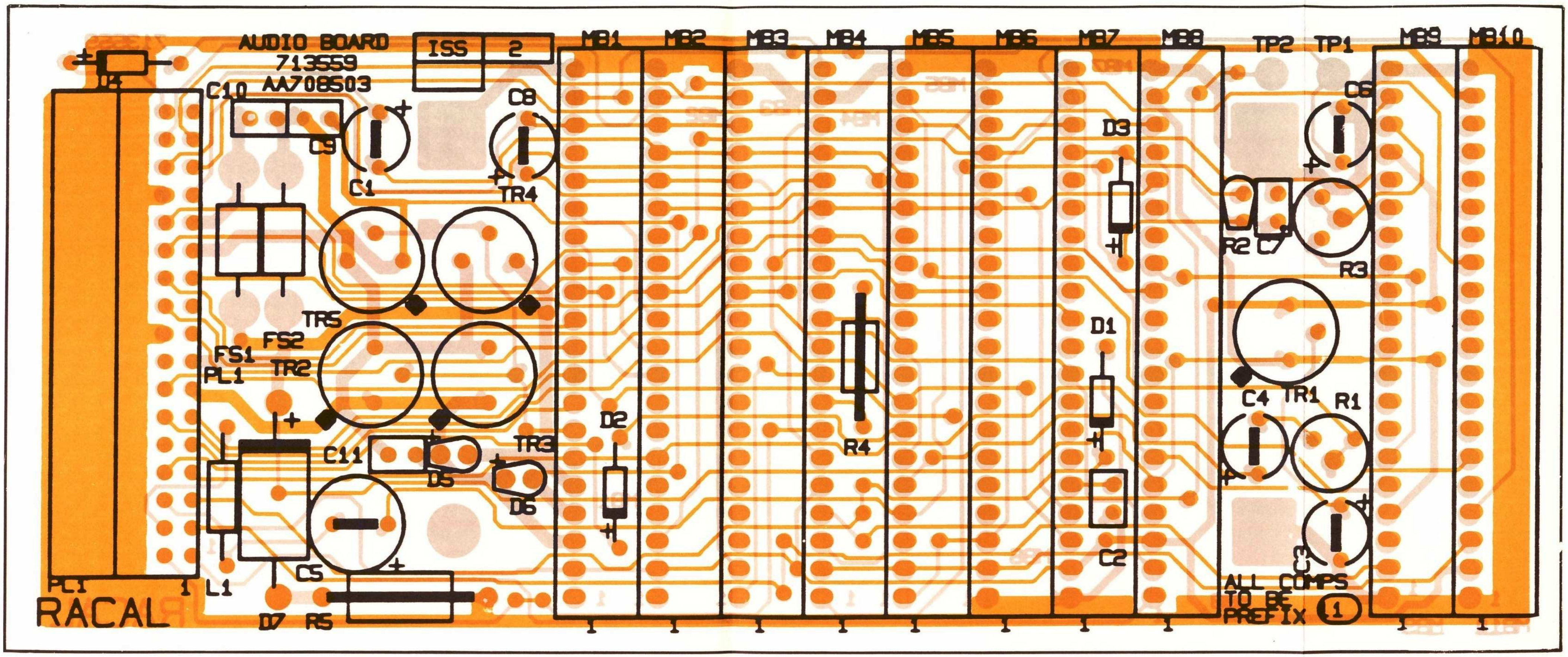
COMPONENTS LIST

CHAPTER 5

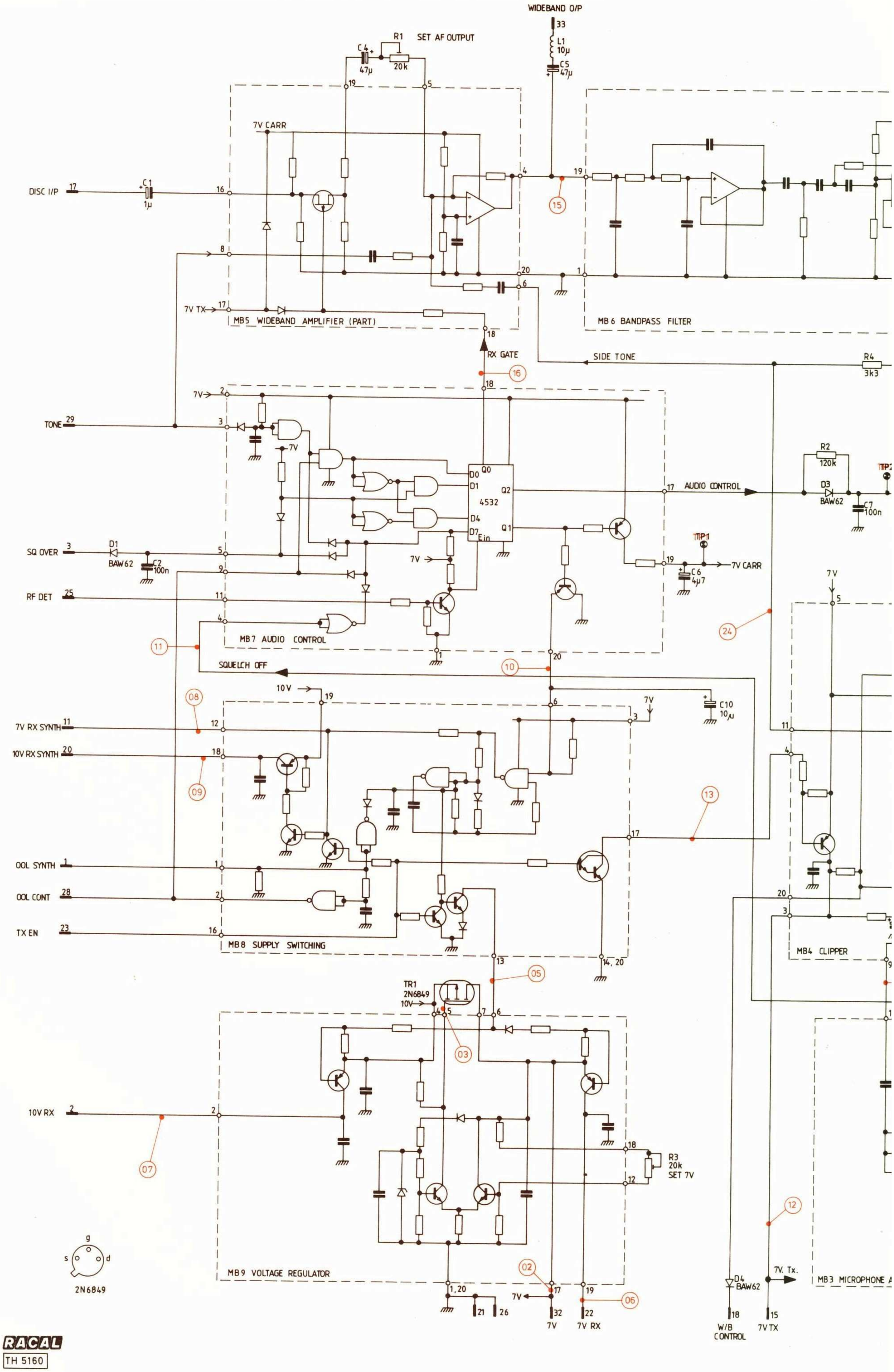
COMPONENTS LIST

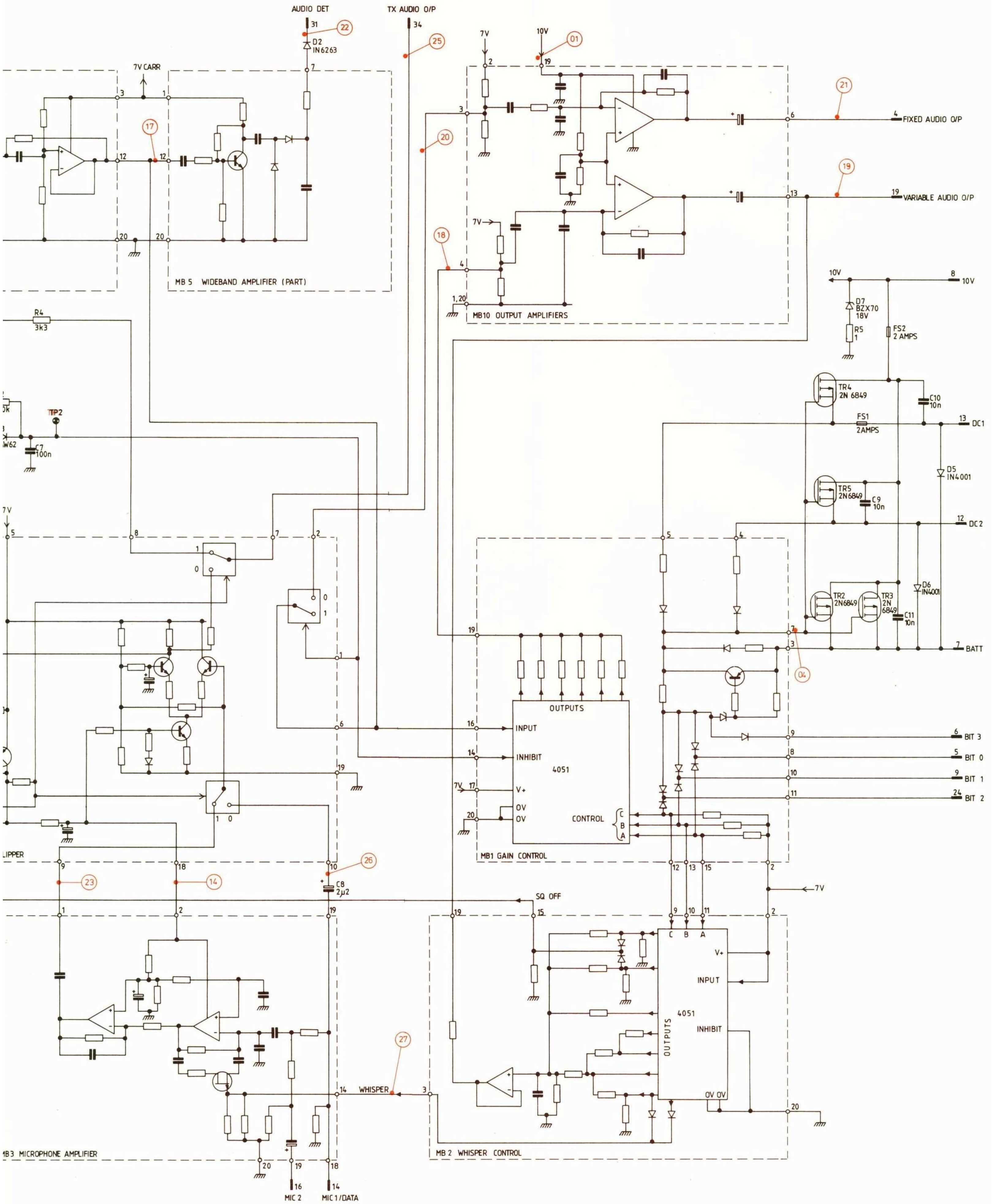
Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
		AUDIO PCB (AA 709112) Component Prefix 11			
Resistors					
	Ω		W		
R1	20k	Variable			914169 EQ
R2	120k	Carbon Film	¼	5	929046 EQ
R3	50k	Variable			932128 EQ
R4	3.3k	Carbon Film	¼	2	910111 EQ
R5	1.0	Carbon Film	1/3	5	924659
Capacitors					
	μF		V		
C1	1.0	Tantalum	35	20	919635 EQ
C2	100n	Ceramic	50	10	936877 EQ
C3	10	Tantalum	16	20	923569 EQ
C4	470n	Tantalum	35	20	915168 EQ
C5	47	Tantalum	16	20	923804 EQ
C6	4.7	Tantalum	16	20	919636 EQ
C7	100n	Ceramic	50	10	936877 EQ
C8	2.2	Tantalum	16	20	921089 EQ
C9	10n	Ceramic	100	20	927395 EQ
C10	10n	Ceramic	100	20	927395 EQ
C11	10n	Ceramic	100	20	927395 EQ
Diodes					
D1		BAW 62			918982
D2		IN6263			936862 EQ
D3		BAW 62			918982
D4		BAW 62			918982
D5		IN4001			915266 EQ
D6		IN4001			915266 EQ
D7		BZX70C18V			929462
Transistors					
TR1		2N6849			992083 EQ
TR2		2N6849			992083 EQ
TR3		2N6849			992083 EQ
TR4		2N6849			992083 EQ
TR5		2N6849			992083 EQ

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Inductors					
L1	10μH	Choke		10	926238 EQ
Microboards					
MB1		Gain Control Micro PCB			779000
MB2		Whisper Control Micro PCB			779001
MB3		Microphone Amp Micro PCB			779002
MB4		Clipper Micro PCB			779003
MB5		Wideband Amp Micro PCB			779004
MB6		Bandpass Filter Micro PCB			779005
MB7		Audio Control Micro PCB			779006
MB8		Supply Switching PCB			779007
MB9		Voltage Regulator Micro PCB			779008
MB10		Output Amps Micro PCB			779009
Miscellaneous					
FS1		Fuselink 2A			992213 EQ
FS2		Fuselink 2A			992213 EQ
		Connector 34-way			992106 EQ
		Extractor Handle			BD709032
		Bush Resistor ¼W			707207
		Heatsink Plate			708865
		Heatsink Ring			936668
		Heatsink Finned			992171 EQ
		Mounting Pad 705			919348 EQ
		Terminal Post Lug			914054
		Connector Sockets for Micro Boards			937117



Audio Motherbrd PCB


WIDEBAND O/P
R1 SET AF OUTPUT
20k
C4 47μ
L1 10μ
C5 47μ
7V CARR
DISC I/P
C1 1μ
7V TX
MB5 WIDEBAND AMPLIFIER (PART)
MB6 BANDPASS FILTER
RX GATE
SIDE TONE
R4 3k3
7V
TONE
4532
R2 120k
AUDIO CONTROL
D3 BAW62
C7 100n
TIP1
7V CARR
C6 4μ7
SQ OVER
D1 BAW62
C2 100n
RF DET
MB7 AUDIO CONTROL
SQUELCH OFF
10V
C10 10μ
7V RX SYNTH
10V RX SYNTH
OOL SYNTH
OOL CONT
TX EN
MB8 SUPPLY SWITCHING
MB4 CLIPPER
TR1 2N6849
10V
10V RX
R3 20k SET 7V
MB9 VOLTAGE REGULATOR
2N6849
7V
7V RX
D4 BAW62
W/B CONTROL
7V. Tx.
7V TX
MB3 MICROPHONE A
RACAL
TH 5160



Audio Motherboard PCB:
Circuit Diagram

Fig 2

PART 4

POWER AMPLIFIER BOARD

(ST 708506)

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The Power Amplifier Board comprises the following circuits:

(1) Buffer amplifier

(2) Driver amplifier

(3) Output amplifier

(4) Low power amplifier (10 mW stage) and switching circuit

(5) Output bias control (ALC)

(6) Low pass filter circuits (3 bands) and switching circuits

(7) High voltage generator

(8) AMU data driver

(9) RF Detectors

(10) Receiver Switching

CONSTRUCTION AND LOCATION

2. The Power Amplifier (PA) board is a printed circuit board mounted on the top side of the chassis assembly. The board is rectangular of dimensions 140mm x 80mm. Connections to the board are made by a 16 way edge connector and three coaxial connectors.

PRINCIPLES OF OPERATION

3. The frequency modulated output of the transmitter VCO on the synthesizer assembly is applied to a buffer amplifier stage. In the high power mode the output of the buffer amplifier is fed to a push-pull driver stage and on to a push-pull power amplifier. The gain of the power amplifier is determined by an output bias control circuit. The output of the power amplifier is applied to one of three low pass filters depending on the transmitter frequency. The filters cover the following bands:

(1) LPF 1 30MHz - 42.975MHz

(2) LPF 2 43MHz - 61.975MHz

(3) LPF 3 62MHz - 88MHz

4. The output of the selected filter is applied to the 50 ohm antenna socket and via the AMU transformer to the whip socket.

5. In the low power mode the output of the buffer amplifier is applied to a separate low power amplifier and on to the selected low pass filter circuit as described in para. 3 and to the front panel sockets as in para. 4.

6. In the receive mode, the input from the 50 ohm socket, or AMU transformer and whip socket, is passed to the Receiver Board via a PIN diode switch on the P.A. Board.

CHAPTER 2

CIRCUIT DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 2

CIRCUIT DESCRIPTION

INTRODUCTION

1. This chapter describes the circuits of the power amplifier board. For ease of description the circuits are considered under the following headings:

(1) Buffer Amplifier

(2) Driver Stage

(3) Output Amplifier

(4) Output Bias Control (ALC)

(5) Low Power Amplifier

(6) Low-Pass Filter Circuits

(7) High Voltage Generator

(8) RF Detector

(9) AMU Data Driver

(10) Power Supplies

(11) Receiver RF Path

The circuit diagram of the Power Amplifier is given in Fig. 2.

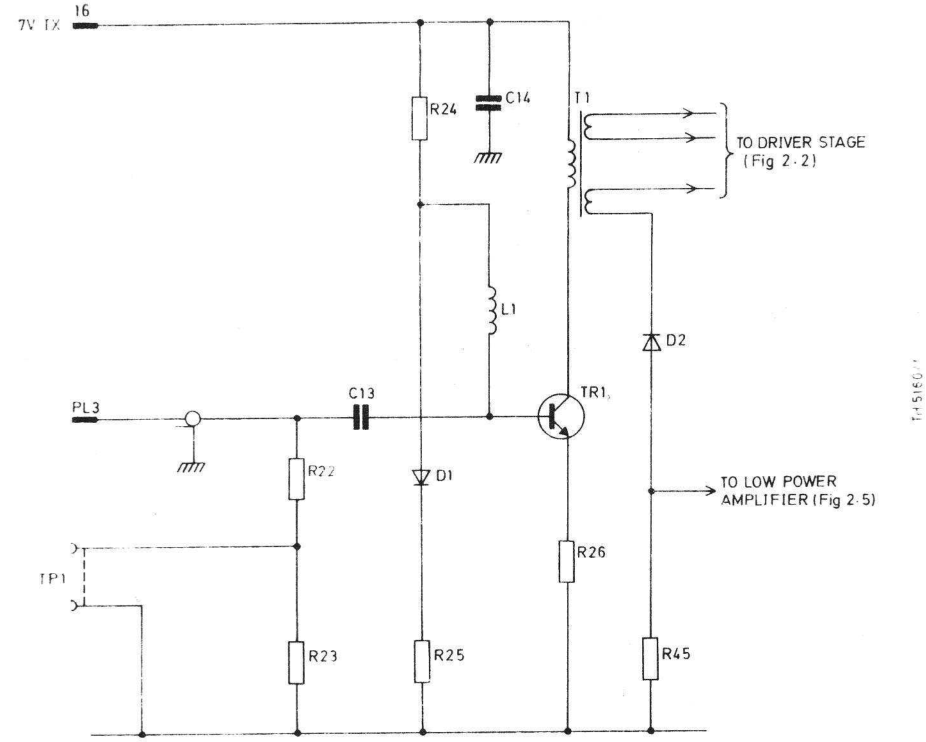
Buffer Amplifier (Fig. 2.1)

2. TR1 and its associated components form a buffer amplifier. This stage amplifies the signal from the transmitter VCO on the Synthesiser Board and provides a defined input impedance.

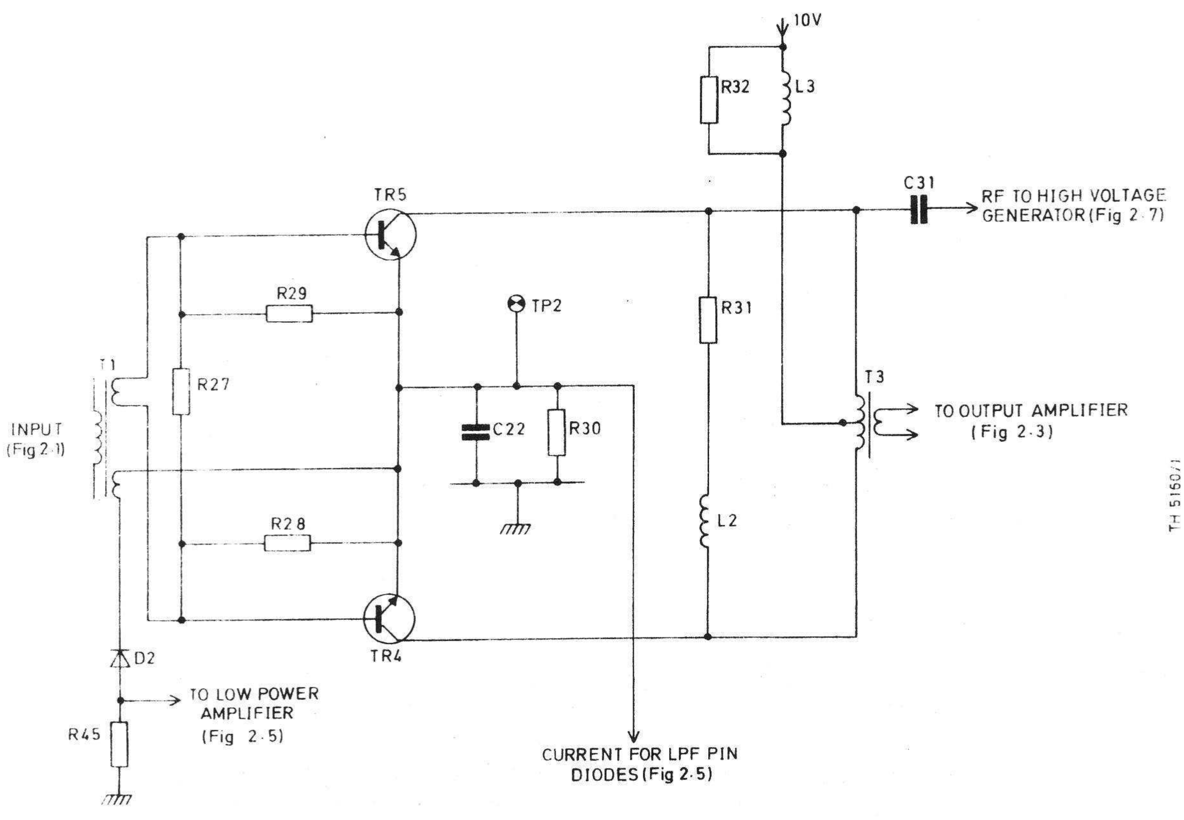
3. The output of the buffer amplifier is applied via transformer T1 to the driver stage in the high power mode, or the low power amplifier in the low power mode.

Driver Stage (Fig. 2.2)

4. The output from T1 is applied to the bases of TR4 and TR5, a push-pull Class B amplifier stage. In the high power mode 10V is supplied to the stage via L3 (see para. 7). The RF output of the driver stage is applied to the output amplifier stage via transformer T3. In this condition the emitter voltage of TR4, TR5 (TP2) rises to about 2V, thus reverse-biasing PIN diode D2, which switches off the diode and prevents the RF signal flowing into the Low Power Stage. The RF output is also applied to the high voltage generator circuit via C31 (See para. 14).



Buffer Amplifier Fig 2·1

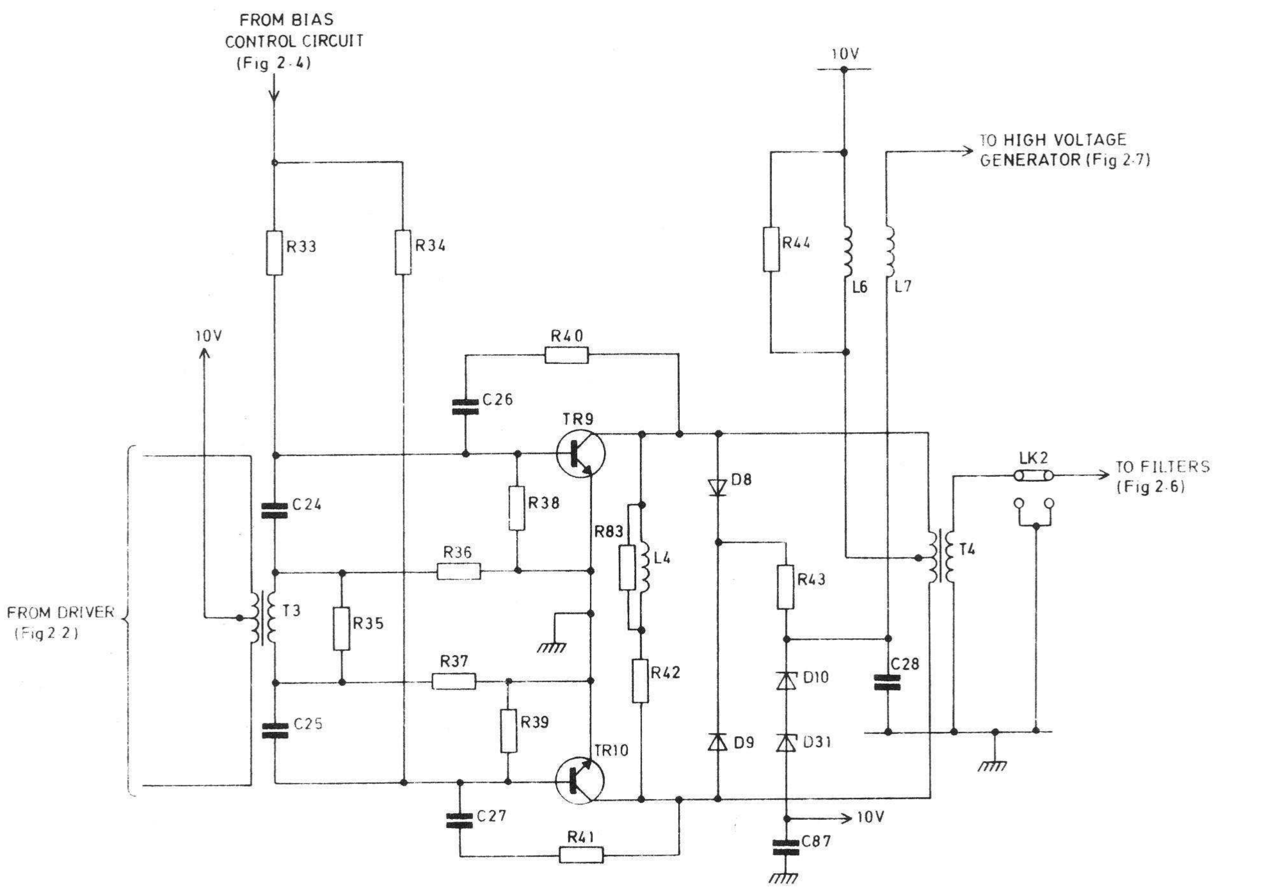


Driver Circuit Fig 2·2

Output Amplifier (Fig. 2.3)

5. The output amplifier stage is formed by push-pull Class A amplifier TR9 and TR10 with their associated components. R33 and R34 provide bias current for TR9 and TR10. R40, C26 and R41, C27 provide negative feedback for TR9 and TR10 respectively. The output of TR9 and TR10 is applied via T4 to the selected output filter circuit. Pluggable link LK2 is provided for test purposes, so that the output of this stage can be checked into a 50 ohm load, or so that the filters can be checked independently.

6. A voltage-limiter circuit is formed by D8, D9, R43, D10, D31 and C28. When the load on the output of the P.A. Board is 50 ohms, D8 and D9 charge up C28 to about 20V, and the diodes virtually cease to conduct, having no effect on the collector voltage of TR9 and TR10. When the output load changes such as to make the collector voltage swings increase, D8 and D9 will further charge C28 until it reaches the zener voltage of D10 and D31 plus the supply voltage i.e. 22.5 V. Any further increase in collector swing will cause D8 and D9 to conduct heavily, the current limited only by R43, causing the collector voltage to be limited and protecting TR9 and TR10 against an excessive positive voltage swing. In addition, this circuit contributes about 20V to the High Voltage Generator via L7 (see para. 15).



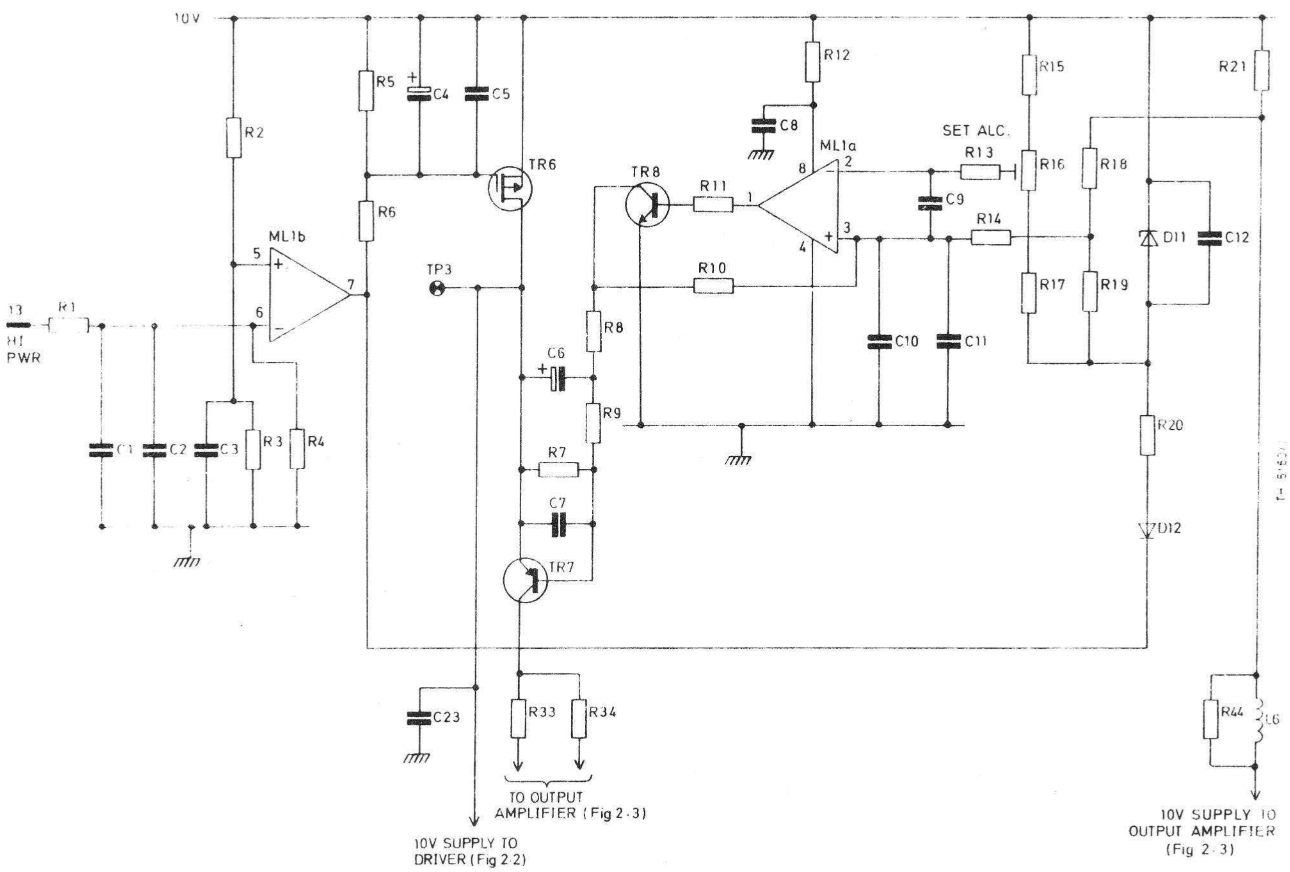
Output Amplifier

Fig 2.3

Output Bias Control (ALC) (Fig. 2.4)

7. When High Power is selected, the Control Board feeds a logic 1 (5v) to pin 13 of the P.A. Board (provided also TX is selected, the Synthesiser is in lock and the 4 K-bit data stream is completed). Then pin 6 of ML1b goes high, causing pin 7 of ML1b to go low, turning on the bias network for ML1a via D12 and R20. Also TR6 conducts, feeding 10V to the driver stage via L3.

8. The 10V supply for the output amplifier TR9 and TR10 is applied to the centre tap of T4 via R21, R44 and L6. The voltage across R21, which is proportional to the current drawn by the output transistors, is monitored and compared with a reference level set by R16 and regulated by zener diode D11. The output of ML1a drives TR8 and TR7 which controls the base bias of TR9 and TR10 and hence maintains a constant current in the output amplifier. Thus the ALC potentiometer, R16, sets the current taken by the output amplifier.

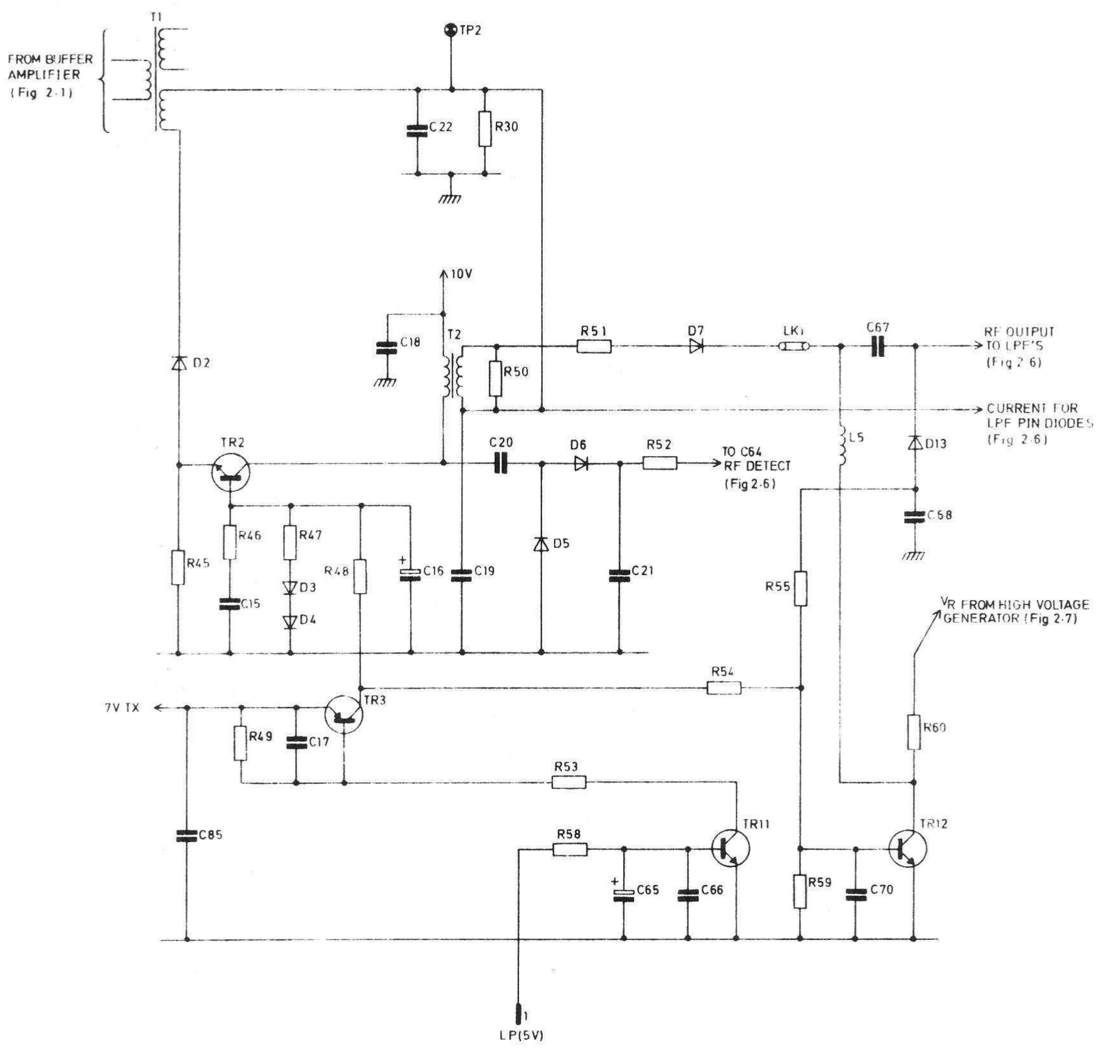


Output Bias Control Fig 2.4

Low Power Amplifier (Fig. 2.5)

9. TR2 and its associated components form a common base amplifier. The buffer amplifier output signal is applied from T1 via D2 to the emitter of TR2. When Low Power is selected 5V is applied from the Control Board to pin 1 and via R58 to the base of TR11. TR11 will turn on, causing TR3 to conduct. The 7V TX voltage is then applied via TR3 and R48 to the base of TR2, causing TR2 to conduct. At the same time the High Power input (pin 13, Fig 2.4) from the Control Board will be low, causing TR6 to turn off, thus disabling the driver stage by removing its supply voltage.

10. When TR11 is turned on it causes TR3 and TR12 to conduct, grounding the cathode of PIN diode D7 via L5. This allows the emitter current of TR2 to flow through D2, T1, T2, R51, D7 and L5 to ground. Thus PIN diodes D2 (input switch) and D7 (output switch) are turned on, allowing the RF signal to pass into the Lower Power Amplifier stage and out via T2, R51, D7 and C67 to the selected filter circuit. A pluggable link, LK1, is provided for test purposes, to enable the output of the low power amplifier to be checked independently of the filter circuit. (Provided the load has a DC path to ground).



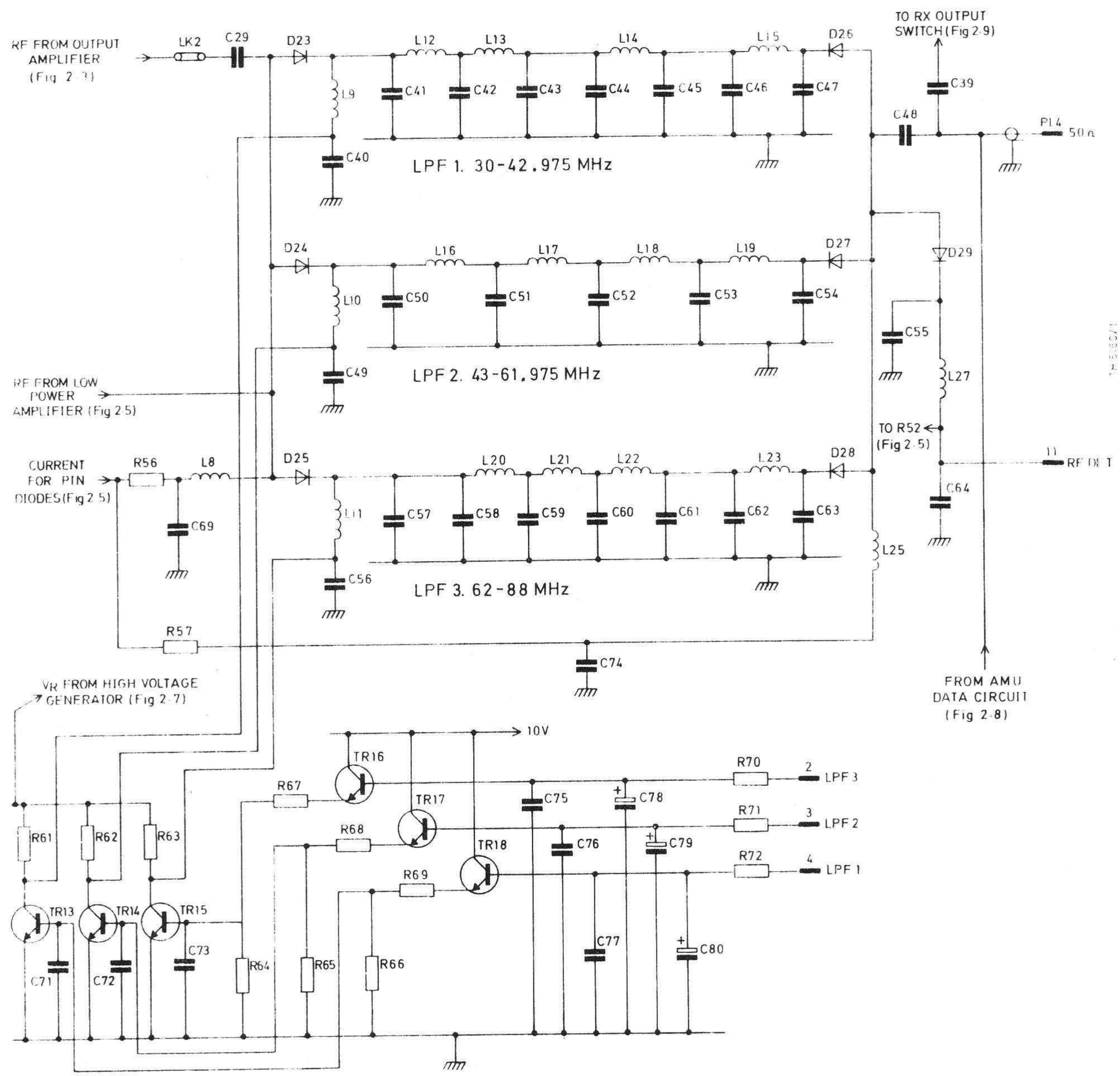
Low Power Amplifier and RF Detector Fig 2·5

11. D13 and C68 form a reverse power detector protecting the Low Power Amplifier against high level signals at the antenna. When the reverse power exceeds approximately 1 Watt, it produces a negative voltage on the anode of D13 sufficient to turn off TR12 causing its collector to be pulled up to the high voltage line via R60. This turns off D7 and hence protects R50, R51 and the Low Power stage from damage.

<u>Low-Pass Filter Circuits</u> (Fig. 2.6)

12. When a frequency in the range 30 to 42.975 MHz is selected the Control Board feeds a logic 1 (5v) on the LPF1 line at pin 4. TR18 will conduct, which in turn causes TR13 to turn on, connecting D23 and D26 PIN diode cathodes to ground via L9. Part of the current from the driver stage (TR4, TR5) then flows via R56, L8 and R57, L25 through the PIN diodes thus switching them on (approx. 30mA per diode in high power). Note that in low power the same switching circuit is used, but the current is derived from the low power stage and is reduced to approx. 10mA per diode.

13. When a frequency outside the range 30 to 42.975 MHz is selected, the Control Board feeds a logic 0 (0V) on the LPF1 line at pin 4. TR18 and TR13 then turn off, causing the collector of TR13 to be pulled up to the high voltage line via R61. Thus PIN diodes D23 and D26 are reverse-biased and hence turned off, disconnecting LPF1 from the circuit. In this case either LPF2 or LPF3 would be connected into circuit, depending on the frequency selected, in the same way as LPF1 described above.



Low Pass Filter and High Power RF Detector

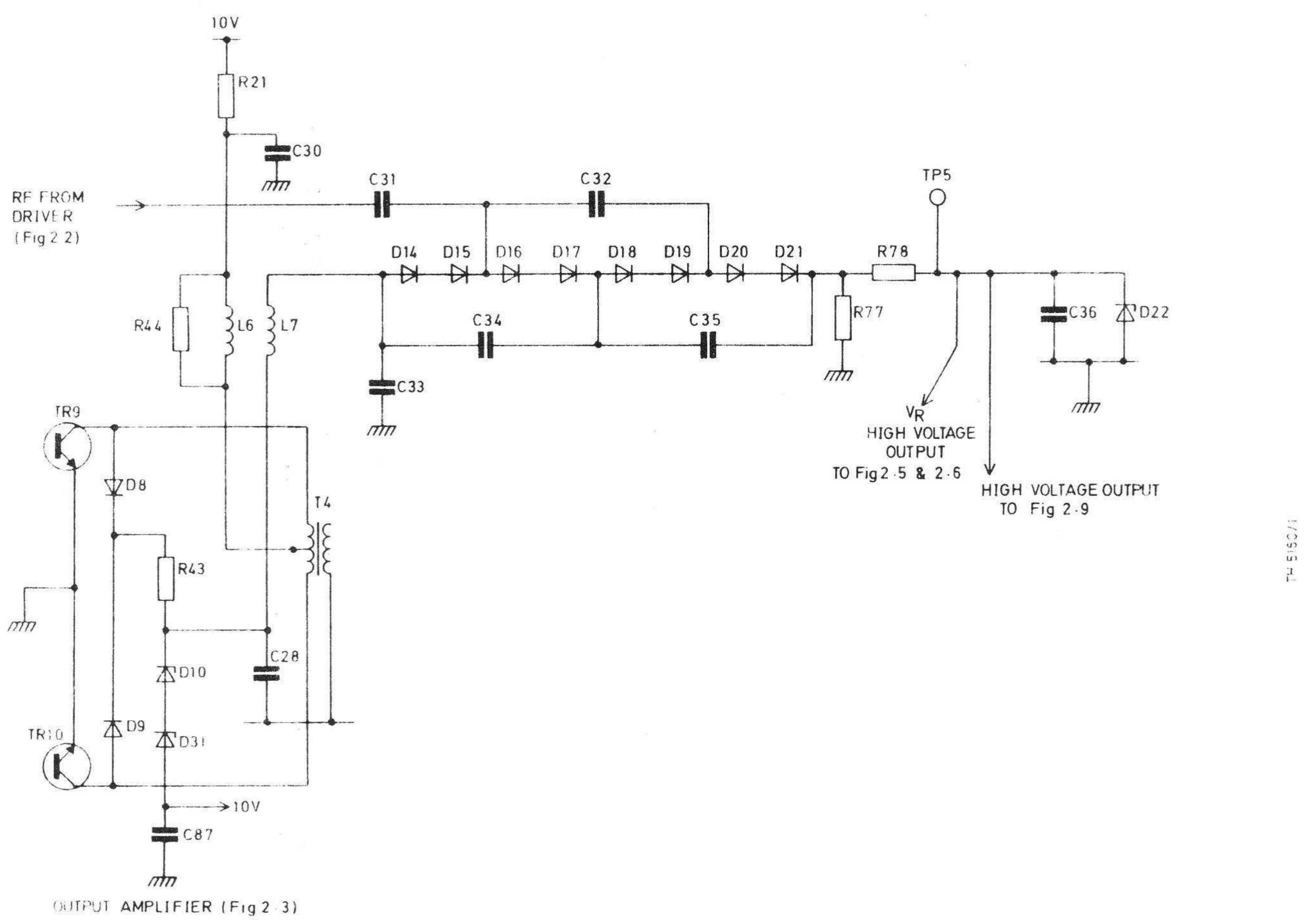
Fig 2.6

High Voltage Generator (Fig. 2.7)

14. The high voltage generator is used to reverse-bias the PIN diodes in the Low Pass Filters and in the receive path when these circuits are not required. The output of the driver stage (T3 primary) drives a two-stage diode-capacitor voltage multiplier, comprising D14-D21 and C31-C35. This gives a DC output equal to twice the peak-to-peak voltage at the collector of TR5 (approx. 30V dc).

15. The voltage multiplier is connected in DC-series via L7 with the voltage-limiter circuit on the output stage formed by D8, D9, R43, D10, D31 and C28 (see para. 6). This produces a level of typically 20V DC on C28, making a total of about 50V at the output of the generator (high power mode, 50 ohm load). If the P.A. output load is not equal to 50 ohms, the output of the high voltage generator may rise far above 50V, so a 68V zener diode (D22) limits the output voltage to prevent the voltage ratings of the PIN diodes and switching transistors being exceeded.

16. In the low power mode there is no RF output from the driver stage or the voltage-limiter circuit. However, DC flows from the 10V supply into the voltage multiplier via T4, D8/D9, R43 and L7. This provides about 5V at the output of the generator, TP5 (10V minus the diode voltage drops) which is sufficient to reverse-bias the PIN diodes in low power.



High Voltage Generator Fig 2.7

RF Detectors

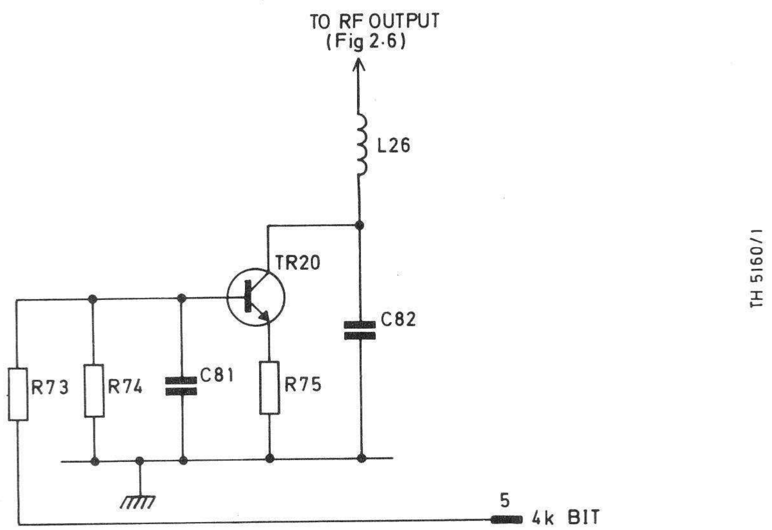
17. To enable sidetone circuitry on the audio board during transmit an RF detect signal is generated on the P.A. Board and fed to the Audio Board.

18. In High Power (Fig. 2.6) this voltage is generated by D29, C55 at the 50 ohm output and fed to pin 11 via L27. The RF detect signal will only enable the audio sidetone if the RF output is present, thus giving a confidence check of transmitter output.

19. In Low Power (Fig. 2.5) the RF detect signal is generated by the peak-to-peak voltage detector D5, D6, C21 at the output of the low power stage. This voltage is fed to pin 11 via R52.

AMU Data Driver (Fig. 2.8)

20. Frequency information in the form of a 4 k-bit serial data stream is fed from the Control Board to pin 5 of the P.A. Board. This drives TR20, a constant-current sink with open-collector output which is connected to the 50 ohm RF output via L26. The data stream is present for only 4mS after a frequency change or after a RX-TX or TX-RX change. The information is used to change filter bands on the Vehicle Interface Unit, and/or to change bands on an external AMU. Note that in transmit the RF power output is inhibited by the Control Board until the data transmission is completed.



AMU Data Driver Circuit Fig 2·8

Power Supplies

21. The board is supplied by the following voltages:

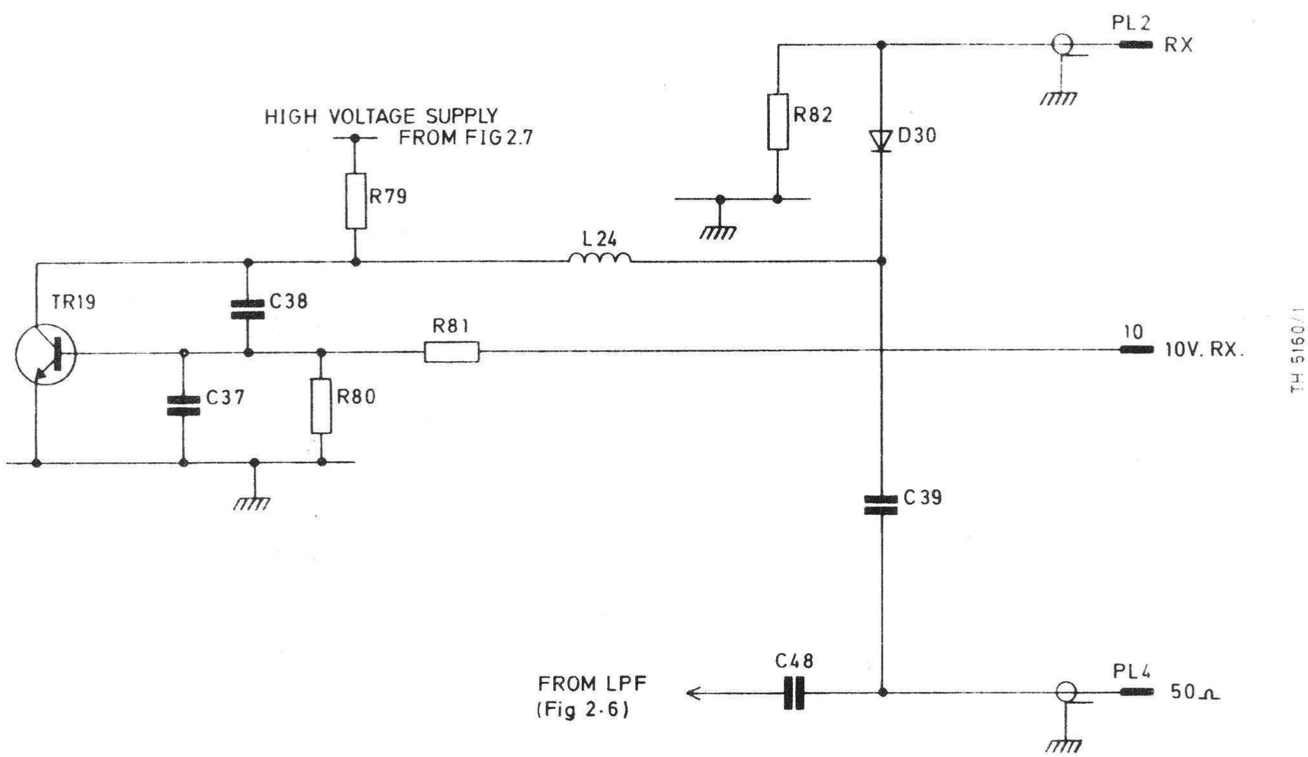
10V (TX and RX)
7V TX
10V RX.

In transmit the Power Amplifier Board is supplied from the 10V supply voltage with the exception of the buffer amplifier TR1 and the bias currents for TR2 and TR12, which are supplied by the 7V TX supply. In receive, the 10V RX supply only is used to switch on TR19.

Receiver RF Path (Fig. 2.9)

22. The received signal enters the Power Amplifier Board at the 50 ohm coaxial input PL4, and is fed via C39 and PIN diode D30 to the RX coaxial socket PL2. In the receive mode the 10V RX supply at pin 10 turns on TR19 which grounds the cathode of D30 via L24. Current then flows from the RF amplifier on the Receiver Board via the inner wire of the coaxial cable connecting to PL4 and through D30, L24 and TR19 to ground. Hence D30 is switched on, allowing the received signal to pass through to the Receiver Board. In the radio's current saving mode the current through D30 is economised at the 6Hz rate until a signal is detected. In the receive mode all three low-pass filters are switched off so that the transmit circuits are disconnected from PL4.

23. In the transmit mode the 10V RX supply is at 0V and hence TR19 is turned off causing its collector to be pulled up to the high voltage supply via R79. Then D30 is reverse-biased and hence switched off.



RF Path Control Circuit

Fig 2.9

CHAPTER 3

ALIGNMENT AND TESTING

CONTENTS

TABLES

CHAPTER 3

ALIGNMENT AND TESTING

INTRODUCTION

1. There is only one adjustment available in the Power Amplifier sub-assembly. This adjustment should be made exactly as described and random adjustments should not be made in an attempt to improve performance.

2. Table 3.1 gives details of the alignment and measurements procedure for the main parameters of this board while fitted to a PRM 4700 Unit. The procedure should always be carried out after any components have been replaced or adjutment made.

3. It is assumed in the procedure given that all other boards in the unit are working correctly and within their specifications.

INITIAL CONDITIONS

4. A 10.5 V power supply should be connected to pins B (+ve) and D (-ve) of SK2 on the Front Panel of the PRM 4700. This may conveniently be done using a Racal Test Jig TJ 947.

5. Testing commences in the TRANSMIT mode (TX), i.e. pin C of SK1 or SK2 should be grounded, Pilot Tone OFF and Narrow Band (N/B) mode selected.

TEST EQUIPMENT REQUIRED

6.

(1)	Power Supply (10.5 V, 1.5A)	:	e.g. Farnell L30-2
(2)	RF Signal Generator 30 - 88 MHz 2 V rms emf O/P, 50 Ω	:	e.g. HP 8640B
(3)	RF Power Meter (30 mW, 10 W) 50 Ω, 30 - 88 MHz	:	e.g. Farnell 2081/100
(4)	DVM with high impedance probe 10M ohms	:	e.g. Racal 9077A
(5)	Ammeter, 2A	:	e.g. AVO 8
(6)	Oscilloscope 0 - 100 MHz	:	e.g. HP 1740A/H07 or Tektronix 465 with probe and 50 ohm adaptor
(7)	Distortion Factor Meter	:	e.g. HP 333A or 332
(8)	Test Jig	:	Racal TJ 947

TABLE 3.1

Alignment Procedures

Test No	Parameter	Mode	RF Input	Freq MHz	Monitor	Adjust	Limits	Notes
1	TX Current HI PWR	TX, HI PWR		30.000	Supply Current	R16	1.5A	50Ω load
2	High Voltage Generator	TX, HI PWR		30.000	TP5 (DVM)	-	>36V	Probe must be > ½10MΩ
3	HI PWR Output LPF 1	TX, HI PWR		30.000 35.000 40.000 42.975	Power Output, 50Ω SKT, Front Panel	-	>3.0W	10.5V supply Pins B & D SK2
4	HI PWR Output LPF 2	TX, HI PWR		43.000 50.000 55.000 60.000 61.975	Power Output, 50Ω SKT, Front Panel	-	>3.0W	10.5V supply Pins B & D SK2
5	HI PWR Output LPF 3	TX, HI PWR		62.000 70.000 75.000 80.000 85.000 88.000	Power Output, 50Ω SKT, Front Panel	-	>3.0W	10.5V supply Pins B & D SK2
6	RF DET HI-PWR	TX, HI PWR		88.000	RF DET TP15 Motherboard	-	>5V	DVM
7	LPF Reverse Voltage Supply	TX, LO PWR		30.000	TP5 (DVM)	-	>5V	DVM Probe must be ½10MΩ
8	LO PWR Output LPF 1	TX, LO PWR		30.000 35.000 40.000 42.975	Power Output, 50Ω SKT, Front Panel	-	5 - 30mW	
9	LO PWR Output LPF 2	TX, LO PWR		43.000 50.000 55.000 60.000 61.975	Power Output, 50Ω SKT, Front Panel	-	5 - 30mW	
10	LO PWR Output LPF 3	TX, LO PWR		62.000 70.000 75.000 80.000 85.000 88.000	Power Output, 50Ω SKT, Front Panel	-	5 - 30mW	
11	RF-DET, LO PWR	TX, LO PWR		88.000	RF DET TP15 Motherboard	-	>5V	
12	Receive Switching	RX	0.3 V pd, 1kHz mod, 5kHz dev	30.000	SINAD, Pin G SK2	-	>12dB SINAD minimum	
13	4k-bit Output	CHAN 0 Depress and hold 10MHz button		-	Voltage (Scope) 50Ω SKT, Front Panel (with 560Ω pull-up to 10V)	-	>8V p-p	Disconnect Power Meter

CHAPTER 4

FAULT LOCATION

CONTENTS

TABLES

CHAPTER 4

FAULT LOCATION

INTRODUCTION

1. Fault location on the Power Amplifier Board is carried out by checking voltages and waveforms at various points on the board and by using the Flowcharts provided.

TEST EQUIPMENT REQUIRED

2. The equipment required for fault location is listed in Chapter 3.

VOLTAGES AND WAVEFORMS

3. The information given in Tables 4.1, 4.2 and 4.3 should be used in conjunction with the circuit diagram, Fig. 2 to which the nodes refer. All voltages and waveforms are nominal and are measured using an oscilloscope with a 1MΩ/10 pF probe unless otherwise stated. All RF voltages must be measured using a probe with a very short earth lead (0.5 inch). To remove driver heatsink, gently prize off. Push back on after test.

USE OF THE FLOWCHART

4. The flow chart Table 4.3, covers the main fault conditions that are likely to occur. It provides a guide to the area or group of components where the fault may exist but it is not intended to be exhaustive. The tests are performed with the faulty board in a PRM 4700 unit in which all the other boards are known to be working and within their specification.

GENERAL

5. If any components are changed or any adjustments made during fault finding the alignment and testing procedure given in Chapter 3 should be followed before returning the board to service.

REMOVEABLE LINKS, LK1 AND LK2

6. Pluggable links LK1 and LK2 at the output of the Low Power and High Power Amplifiers are provided for fault finding. If they are removed, ensure after the test that they are plugged in securely.

TABLE 4.1

Voltage and Waveforms - Transmit Mode

Apply 10.5 V to SK2

Node or Test Point	Conditions	Voltage or Waveforms	
		LO PWR	HI PWR
TP1	30.000 MHz 88.000 MHz	0.3 V p-p RF 0.3 V p-p RF	0.3 V p-p RF 0.3 V p-p RF
TP2	30.000 MHz 88.000 MHz	0.8 V DC 0.9 V DC	2.0 V DC 1.4 V DC
TP3	30.000 MHz 88.000 MHz		9 V DC 9 V DC
TP5	33.000 MHz 88.000 MHz	7.6 V DC 8.6 V DC	40 V DC 45 V DC
01	Transmit	7 V DC	7 V DC
02	30.000 MHz 88.000 MHz	7.5 V p-p RF 9 V p-p RF	14 V p-p RF 9 V p-p RF
03	30.000 MHz 88.000 MHz	2.5 V p-p RF 3.0 V p-p RF	2.5 V p-p RF 3.0 V p-p RF
04	30.000 MHz Driver 88.000 MHz Heatsink Removed	2.7 V p-p RF 2.9 V p-p RF	7.6 V p-p RF 4.8 V p-p RF
05	30.000 MHz 88.000 MHz	10 V p-p RF 13 V p-p RF	
06	Transmit	1.8 V DC	
07 (LK1)	30.000 MHz 88.000 MHz	1.7 V p-p RF 1.7 V p-p RF	
08	30.000 MHz Driver 88.000 MHz Heatsink Removed		4.5 V p-p RF 3.5 V p-p RF
09	30.000 MHz Driver 88.000 MHz Heatsink Removed		15 V p-p RF 15 V p-p RF
10	30.000 MHz 88.000 MHz		4.5 V p-p RF 2.0 V p-p RF
11	30.000 MHz 88.000 MHz		28 V p-p RF 22 V p-p RF

TABLE 4.1 (Continued)

Node or Test Point	Conditions	Voltage or Waveforms	
		LO PWR	HI PWR
12 (LK2)	30.000 MHz 88.000 MHz		42 V p-p RF 36 V p-p RF
13	Transmit	<1 V DC	5 V DC
14	Transmit	10.5 V DC	10.5 V DC
15	Transmit	9.5 V DC	<1 V DC
16	88.000 MHz	<1 V DC	4.8 V DC
17	88.000 MHz	<1 V DC	8 V DC
18	88.000 MHz	9 V DC	<1 V DC
19	88.000 MHz	10 V DC	3.8 V DC
20	30.000 MHz 88.000 MHz	9.5 V DC 10 V DC	33.5 V DC 34 V DC
21	30.000 MHz 88.000 MHz	1.6 V p-p RF 1.6 V p-p RF	42 V p-p RF 30 V p-p RF
22	30.000 MHz 88.000 MHz	8 V DC 11 V DC	22 V DC 14 V DC
23	30.000 MHz 50.000 MHz 88.000 MHz	5.4 V DC <1 V DC <1 V DC	5.4 V DC <1 V DC <1 V DC
24	30.000 MHz 50.000 MHz 88.000 MHz	0.8 V DC 0 V DC 0 V DC	0.8 V DC 0 V DC 0 V DC
25	30.000 MHz 50.000 MHz 88.000 MHz	<1 V DC 7 V DC 7 V DC	<1 V DC 40 V DC 40 V DC
26	Transmit	4.5 V DC	<0.5 V DC
27	Transmit	6.0 V DC	6.8 V DC

TABLE 4.2

Voltages and Waveforms - Receive Mode

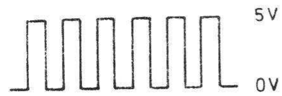
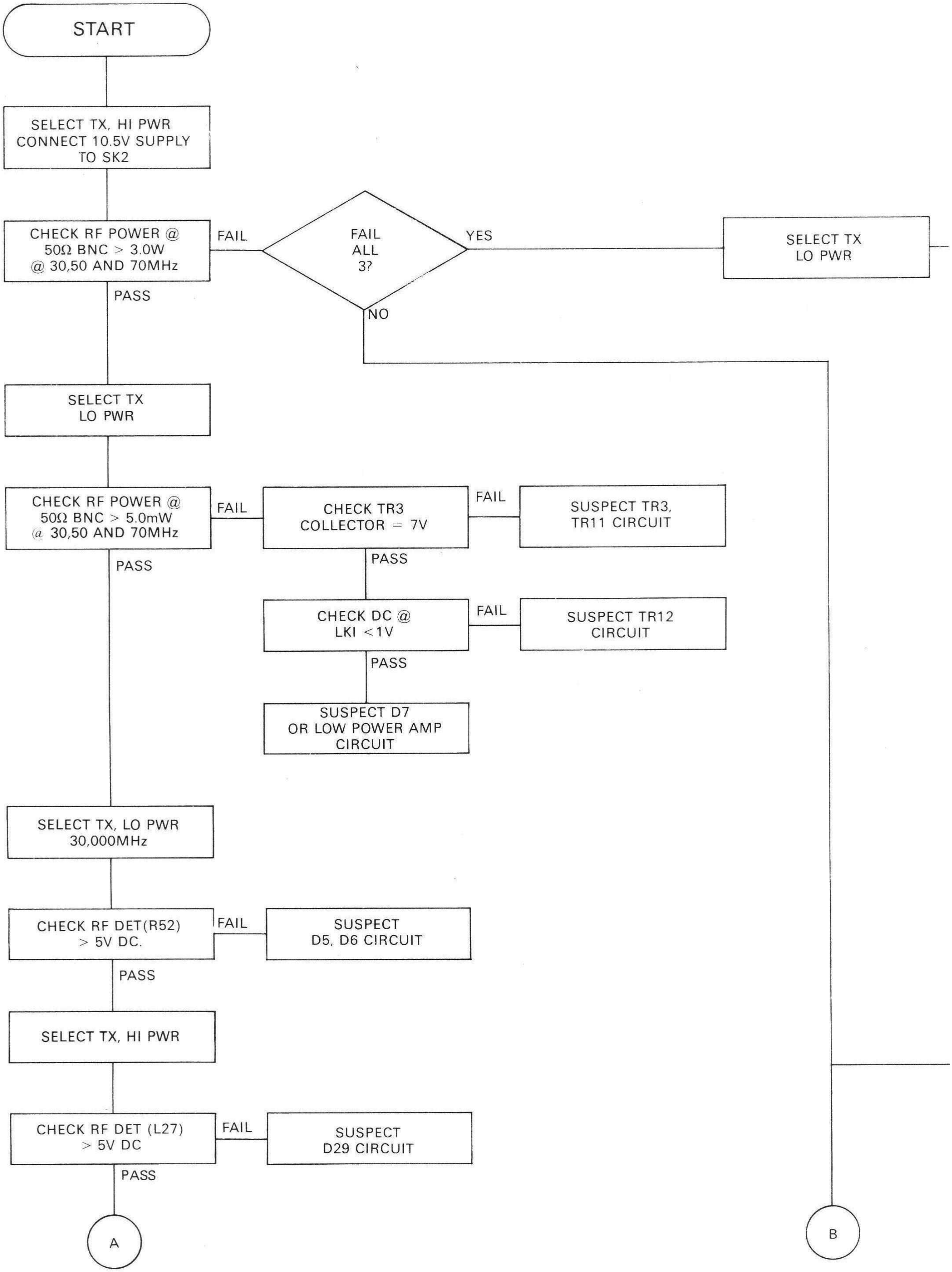
Node or Test Point	Conditions	Voltage or Waveforms
28	Receive, Volume Control Position 8	< 1 V DC
29	Receive, Volume Control Position 8	10.5 V DC
30	Receive, Volume Control Position 8 CHAN 0, press 10 MHz button	

TABLE 4.3 FAULT FINDING GUIDE



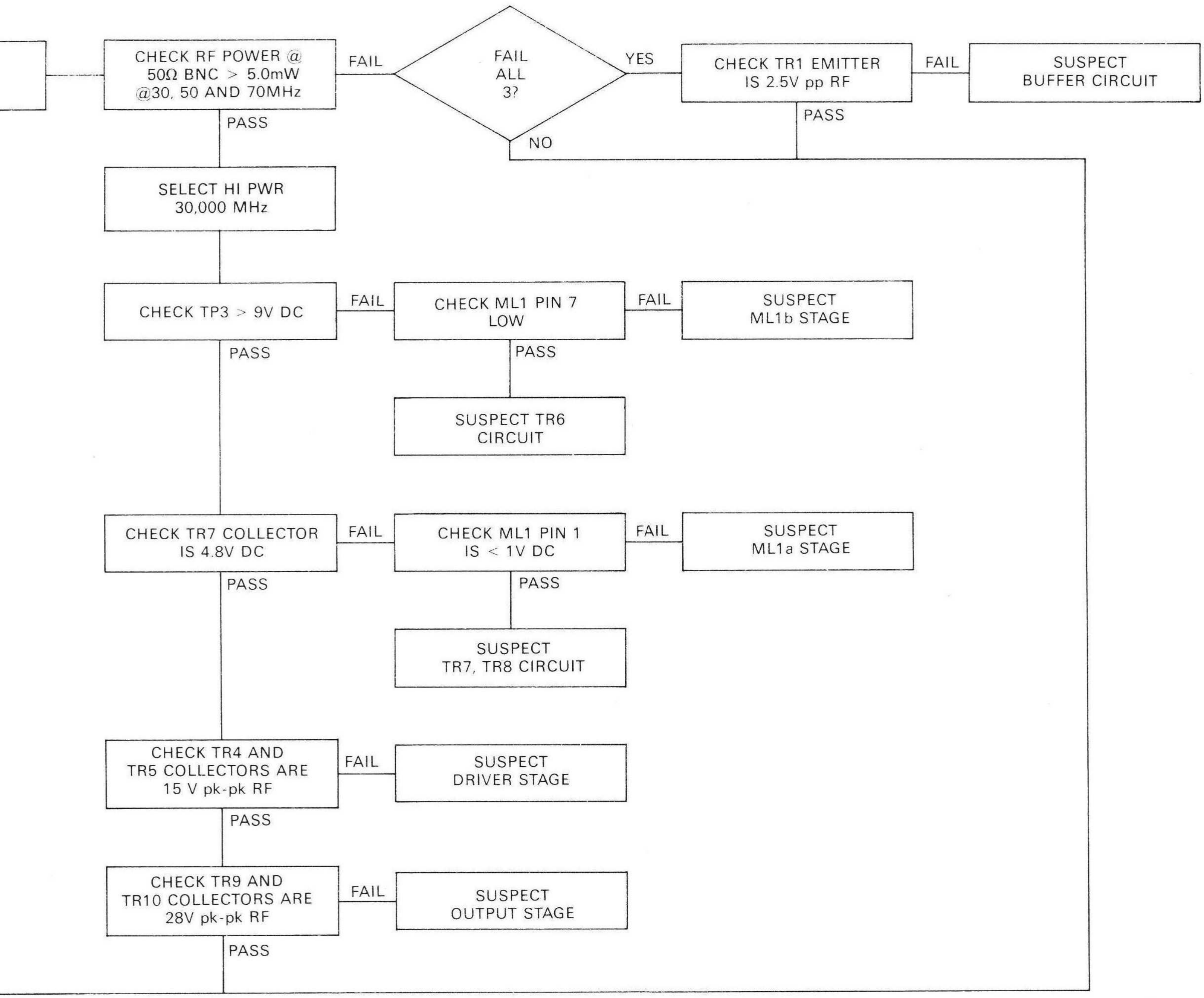
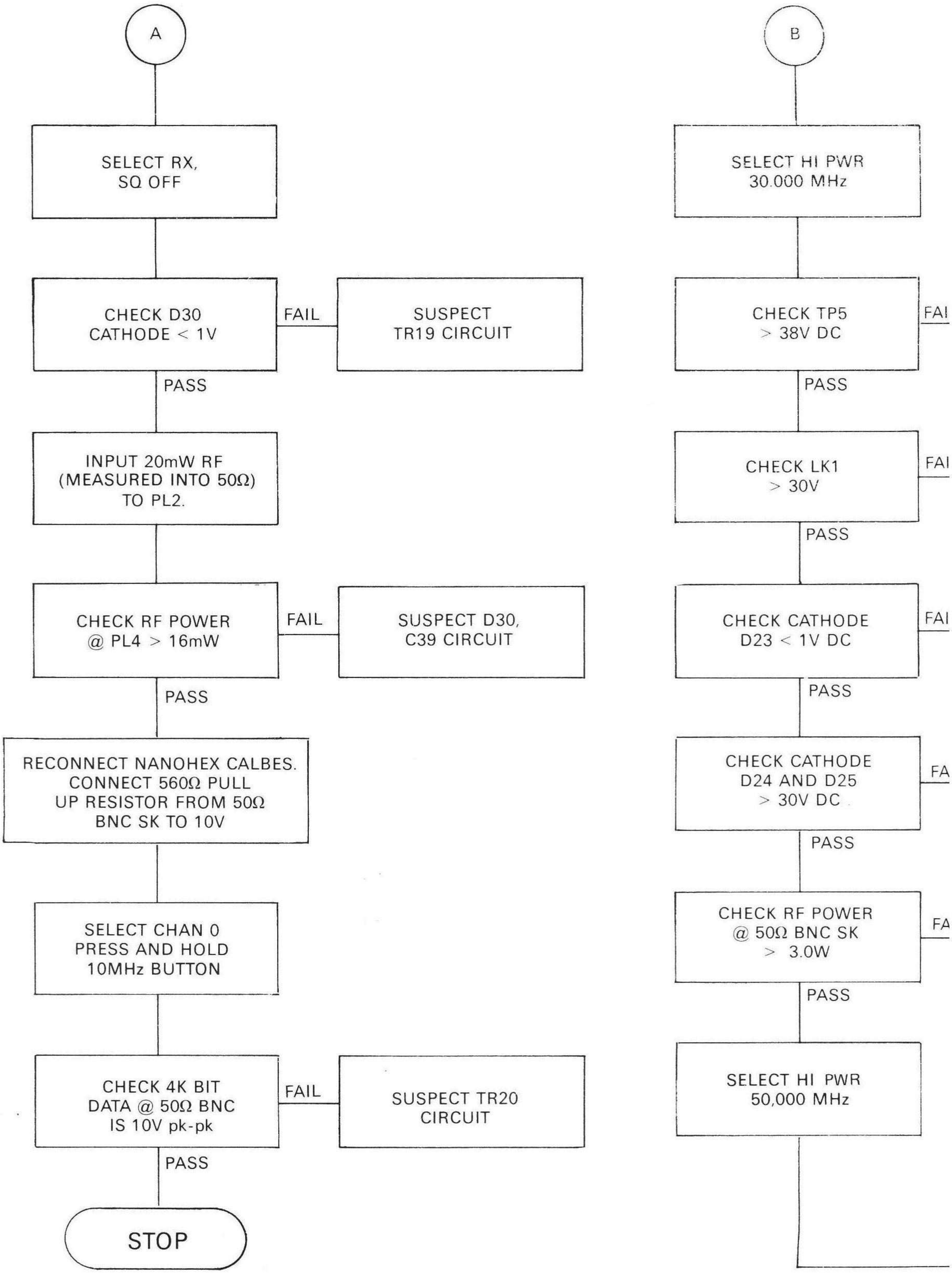
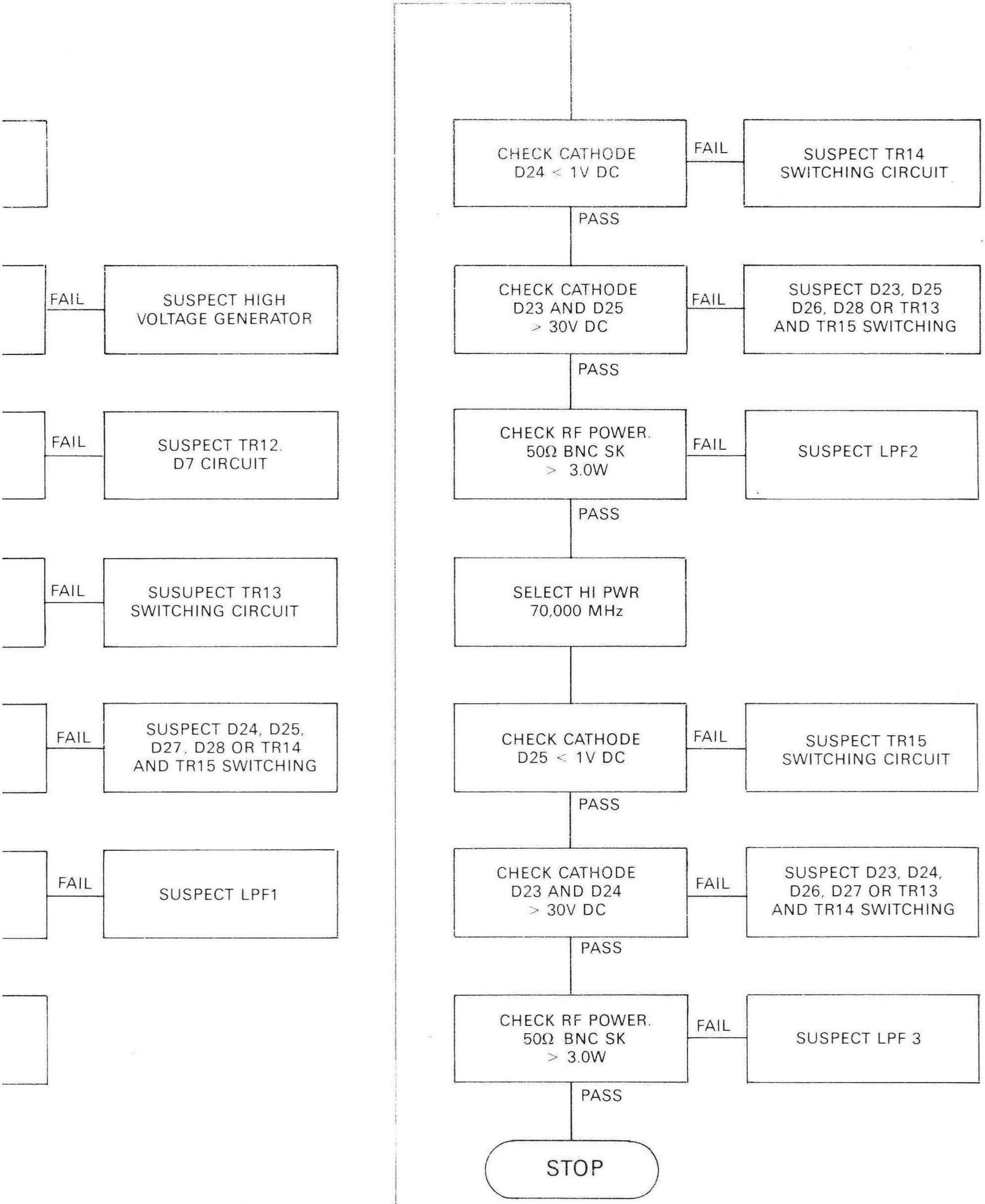

CHECK RF POWER @ 50Ω BNC > 5.0mW @30, 50 AND 70MHz
FAIL
FAIL ALL 3?
YES
CHECK TR1 EMITTER IS 2.5V pp RF
FAIL
SUSPECT BUFFER CIRCUIT
PASS
NO
PASS
SELECT HI PWR 30,000 MHz
CHECK TP3 > 9V DC
FAIL
CHECK ML1 PIN 7 LOW
FAIL
SUSPECT ML1b STAGE
PASS
PASS
SUSPECT TR6 CIRCUIT
CHECK TR7 COLLECTOR IS 4.8V DC
FAIL
CHECK ML1 PIN 1 IS < 1V DC
FAIL
SUSPECT ML1a STAGE
PASS
PASS
SUSPECT TR7, TR8 CIRCUIT
CHECK TR4 AND TR5 COLLECTORS ARE 15 V pk-pk RF
FAIL
SUSPECT DRIVER STAGE
PASS
CHECK TR9 AND TR10 COLLECTORS ARE 28V pk-pk RF
FAIL
SUSPECT OUTPUT STAGE
PASS

table 4.3 (Continued)




CHECK CATHODE D24 < 1V DC
FAIL
SUSPECT TR14 SWITCHING CIRCUIT
PASS
CHECK CATHODE D23 AND D25 > 30V DC
FAIL
SUSPECT D23, D25 D26, D28 OR TR13 AND TR15 SWITCHING
PASS
CHECK RF POWER. 50Ω BNC SK > 3.0W
FAIL
SUSPECT LPF2
PASS
SELECT HI PWR 70,000 MHz
CHECK CATHODE D25 < 1V DC
FAIL
SUSPECT TR15 SWITCHING CIRCUIT
PASS
CHECK CATHODE D23 AND D24 > 30V DC
FAIL
SUSPECT D23, D24, D26, D27 OR TR13 AND TR14 SWITCHING
PASS
CHECK RF POWER. 50Ω BNC SK > 3.0W
FAIL
SUSPECT LPF 3
PASS
STOP
FAIL
SUSPECT HIGH VOLTAGE GENERATOR
FAIL
SUSPECT TR12. D7 CIRCUIT
FAIL
SUSUPECT TR13 SWITCHING CIRCUIT
FAIL
SUSPECT D24, D25, D27, D28 OR TR14 AND TR15 SWITCHING
FAIL
SUSPECT LPF1

CHAPTER 5

COMPONENTS LIST

CHAPTER 5

COMPONENTS LIST

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
		POWER AMPLIFIER PCB (AA 708506) Component Prefix 14			
Resistors					
	Ω		W		
R1	10k	Carbon Film	1/4	5	927768EQ
R2	100k	Carbon Film	1/4	5	928070EQ
R3	22k	Carbon Film	1/4	5	927770EQ
R4	47k	Carbon Film	1/4	5	927772EQ
R5	100k	Carbon Film	1/4	5	928070EQ
R6	10k	Carbon Film	1/4	5	927768EQ
R7	10k	Carbon Film	1/4	5	927768EQ
R8	470	Carbon Film	1/4	5	927758EQ
R9	470	Carbon Film	1/4	5	927758EQ
R10	470k	Carbon Film	1/4	5	927774EQ
R11	100k	Carbon Film	1/4	5	928070EQ
R12	100	Carbon Film	1/4	5	927754EQ
R13	100	Carbon Film	1/4	5	927754EQ
R14	100	Carbon Film	1/4	5	927754EQ
R15	2k2	Carbon Film	1/4	5	927762EQ
R16	200	Variable			936909EQ
R17	2k	Carbon Film	1/4	5	992161EQ
R18	2k2	Carbon Film	1/4	5	927762EQ
R19	2k2	Carbon Film	1/4	5	927762EQ
R20	1k	Carbon Film	1/4	5	927760EQ
R21	0.22	Metal Film	0.7	2	927016
R22	1k	Carbon Film	1/4	5	927760EQ
R23	100	Carbon Film	1/4	5	927754EQ
R24	1k5	Carbon Film	1/4	5	927984EQ
R25	330	Carbon Film	1/4	5	927757EQ
R26	22	Carbon Film	1/4	5	927751EQ
R27	100	Carbon Film	1/4	5	927754EQ
R28	100	Carbon Film	1/4	5	927754EQ
R29	33	Carbon Film	1/4	5	926465EQ
R30	22	Carbon Film	1/4	5	927751EQ

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
R31	330	Carbon Film	1/4	5	927757EQ
R32	10	Carbon Film	1/4	5	927750EQ
R33	150	Metal Oxide	½	2	918353EQ
R34	150	Metal Oxide	½	2	918353EQ
R35	100	Resistor Chip	1/8	5	999001/101R
R36	10	Resistor Chip	1/8	5	999001/100R
R37	10	Resistor Chip	1/8	5	999001/100R
R38	100	Carbon Film	1/8	5	928013EQ
R39	100	Carbon Film	1/8	5	928013EQ
R40	330	Metal Oxide	½	2	910200EQ
R41	330	Metal Oxide	½	2	910200EQ
R42	330	Metal Oxide	½	2	910200EQ
R43	47	Metal Oxide	1	2	919603
R44	33	Metal Oxide	½	2	920592EQ
R45	470	Carbon Film	1/4	5	927758EQ
R46	1Ω	Carbon Film	1/4	5	923887EQ
R47	100	Carbon Film	1/4	5	927754EQ
R48	1k	Carbon Film	1/4	5	927760EQ
R49	10k	Carbon Film	1/4	5	927768EQ
R50	22	Carbon Film	1/4	5	927751EQ
R51	22	Carbon Film	1/4	2	927751EQ
R52	22k	Carbon Film	1/4	5	927770EO
R53	18k	Carbon Film	1/4	5	927987EQ
R54	18k	Carbon Film	1/4	5	927987EQ
R55	12k	Carbon Film	1/4	5	927769EQ
R56	22	Carbon Film	1/4	5	927751EQ
R57	22	Carbon Film	1/4	5	927751EQ
R58	1k	Carbon Film	1/4	5	927760EQ
R59	100k	Carbon Film	1/4	5	928070EQ
R60	1M	Carbon Film	1/4	5	927803EQ
R61	1M	Carbon Film	1/4	5	927803EQ
R62	1M	Carbon Film	1/4	5	927803EQ
R63	1M	Carbon Film	1/4	5	927803EQ
R64	10k	Carbon Film	1/4	5	927768EQ
R65	10k	Carbon Film	1/4	5	927768EQ
R66	10k	Carbon Film	1/4	5	927768EQ
R67	390	Carbon Film	1/4	5	927982EQ
R68	390	Carbon Film	1/4	5	927982EQ
R69	390	Carbon Film	1/4	5	927982EQ
R70	1k	Carbon Film	1/4	5	927760EQ

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
R71	1k	Carbon Film	1/4	5	927760EQ
R72	1k	Carbon Film	1/4	5	927760EQ
R73	2k7	Carbon Film	1/4	5	927763EQ
R74	2k2	Carbon Film	1/4	5	927762EQ
R75	22	Carbon Film	1/4	5	927751EQ
R76	Not normally fitted				
R77	470k	Carbon Film	1/4	5	927774EQ
R78	47k	Carbon Film	1/4	5	927772EQ
R79	1M	Carbon Film	1/4	5	927803EQ
R80	10k	Carbon Film	1/4	5	927768EQ
R81	10k	Carbon Film	1/4	5	927768EQ
R82	100k	Carbon Film	1/4	5	928070EQ
R83	330	Carbon Film	½	2	910200EQ

Capacitors

	F		V		
C1	10n	Ceramic	100	20	927395EQ
C2	10n	Ceramic	100	20	927395EQ
C3	10n	Ceramic	100	20	927395EQ
C4	0.47µ	Tantalum	35	20	915168EQ
C5	10n	Ceramic	100	20	927395EQ
C6	10µ	Tantalum	16	20	923569EQ
C7	10n	Ceramic	100	20	927395EQ
C8	10n	Ceramic	100	20	927395EQ
C9	1n	Ceramic	100	10	937121EQ
C10	1n	Ceramic	100	10	937121EQ
C11	1n	Ceramic	100	10	937121EQ
C12	10n	Ceramic	100	20	927395EQ
C13	10n	Ceramic	100	20	927395EQ
C14	100n	Ceramic	50	10	936877EQ
C15	10n	Ceramic	100	20	927395EQ
C16	10µ	Tantalum	16	20	923569EQ
C17	10n	Ceramic	100	20	927395EQ
C18	10n	Ceramic	100	20	927395EQ
C19	10n	Ceramic	100	20	927395EQ
C20	10n	Ceramic	100	20	927395EQ
C21	100p	Ceramic	100	2	919723EQ
C22	10n	Ceramic	100	20	927395EQ
C23	10n	Ceramic	100	20	927395EQ
C24	4n7	Chip	50	5	999034/472P
C25	4n7	Chip	50	5	999034/472P

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
C26	10n	Ceramic	100	20	927395EQ
C27	10n	Ceramic	100	20	927395EQ
C28	10n	Ceramic	100	20	927395EQ
C29	10n	Ceramic	100	20	927395EQ
C30	10n	Ceramic	100	20	927395EQ
C31	100p	Ceramic	200	10	990708EQ
C32	100p	Ceramic	200	10	990708EQ
C33	10n	Ceramic	100	20	927395EQ
C34	100p	Ceramic	200	10	990708EQ
C35	100p	Ceramic	200	10	990708EQ
C36	10n	Ceramic	100	20	927395EQ
C37	10n	Ceramic	100	20	927395EQ
C38	10n	Ceramic	100	20	927395EQ
C39	10n	Ceramic	100	20	927395EQ
C40	10n	Ceramic	100	20	927395EQ
C41	68p	Ceramic	63	2	926613
C42	120p	Ceramic	63	2	923721
C43	120p	Ceramic	63	2	923721
C44	12p	Ceramic	63	2	921131EQ
C45	100p	Ceramic	100	2	919723EQ
C46	33p	Ceramic	100	2	919841EQ
C47	68p	Ceramic	63	2	926613
C48	10n	Ceramic	100	20	927395EQ
C49	10n	Ceramic	100	20	927395EQ
C50	47p	Ceramic	63	2	919646EQ
C51	82p	Ceramic	100	2	923963EQ
C52	82p	Ceramic	100	2	923963EQ
C53	82p	Ceramic	100	2	923963EQ
C54	33p	Ceramic	100	2	919841EQ
C55	100p	Ceramic	100	2	919723EQ
C56	10n	Ceramic	100	20	927395EQ
C57	22p	Ceramic	100	2	919649
C58	22p	Ceramic	100	2	919649
C59	68p	Ceramic	63	2	926613
C60	68p	Ceramic	63	2	926613
C61	22p	Ceramic	100	2	919649
C62	56p	Ceramic	100	2	921135EQ
C63	27p	Ceramic	100	2	919647
C64	10n	Ceramic	100	20	927395EQ
C65	1.0µ	Tantalum	35	20	919635EQ
C66	10n	Ceramic	100	20	927395EQ
C67	10n	Ceramic	100	20	927395EQ
C68	10n	Ceramic	100	20	927395EQ
C69	10n	Ceramic	100	20	927395EQ
C70	10n	Ceramic	100	20	927395EQ

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
C71	10n	Ceramic	100	20	927395EQ
C72	10n	Ceramic	100	20	927395EQ
C73	10n	Ceramic	100	20	927395EQ
C74	10n	Ceramic	100	20	927395EQ
C75	10n	Ceramic	100	20	927395EQ
C76	10n	Ceramic	100	20	927395EQ
C77	10n	Ceramic	100	20	927395EQ
C78	1.0μ	Tantalum	35	20	919635EQ
C79	1.0μ	Tantalum	35	20	919635EQ
C80	1.0μ	Tantalum	35	20	919635EQ
C81	1n	Ceramic	100	10	937121EQ
C82	1n	Ceramic	100	10	937121EQ
C83	10n	Ceramic	100	20	927395EQ
C84	100μ	Alum. Tubular	25	+50-10	990450EQ
C85	10n	Ceramic	100	20	927395EQ
C86	4p7	Ceramic	100	2	923955
C87	10n	Ceramic	100	20	927395EQ
Diodes					
D1		BAW 62			918982
D2		PIN Diode	200 V		AR711921
D3		BAW 62			918982
D4		BAW 62			918982
D5		BAW 62			918982
D6		BAW 62			918982
D7		PIN Diode	200 V		AR711921
D8		BAV 10			918130
D9		BAV 10			918130
D10		BZV85C6V2			991514EQ
D11		BZX79C5V6			921749
D12		BAW 62			918982
D13		BAW 62			918982
D14		BAW 62			918982
D15		BAW 62			918982
D16		BAW 62			918982
D17		BAW 62			918982
D18		BAW 62			918982
D19		BAW 62			918982
D20		BAW 62			918982

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
D21		BAW 62			918982
D22		BZX79C68V			992089EQ
D23		PIN Diode	200 V		AR711921
D24		PIN Diode	200 V		AR711921
D25		PIN Diode	200 V		AR711921
D26		PIN Diode	200 V		AR711921
D27		PIN Diode	200 V		AR711921
D28		PIN Diode	200 V		AR711921
D29		BAW 62			918982
D30		PIN Diode	200 V		AR711921
D31		BZV85C6V2			991514EQ

Transistors

TR1		BFR96			992086EQ
TR2		2N3866			917219EQ
TR3		ZTX212			923172
TR4		2N3866			917219EQ
TR5		2N3866			917219EQ
TR6		IRFD9120			992084EQ
TR7		ZTX550			931489
TR8		ZTX237			923171
TR9		BLV10	Matched Pair		} AR712289
TR10		BLV10			
TR11		ZTX237			923171
TR12		ZTX341			936209
TR13		ZTX341			936209
TR14		ZTX341			936209
TR15		ZTX341			936209
TR16		ZTX237			923171
TR17		ZTX237			923171
TR18		ZTX237			923171
TR19		ZTX341			936209
TR20		BCX38A			992085EQ

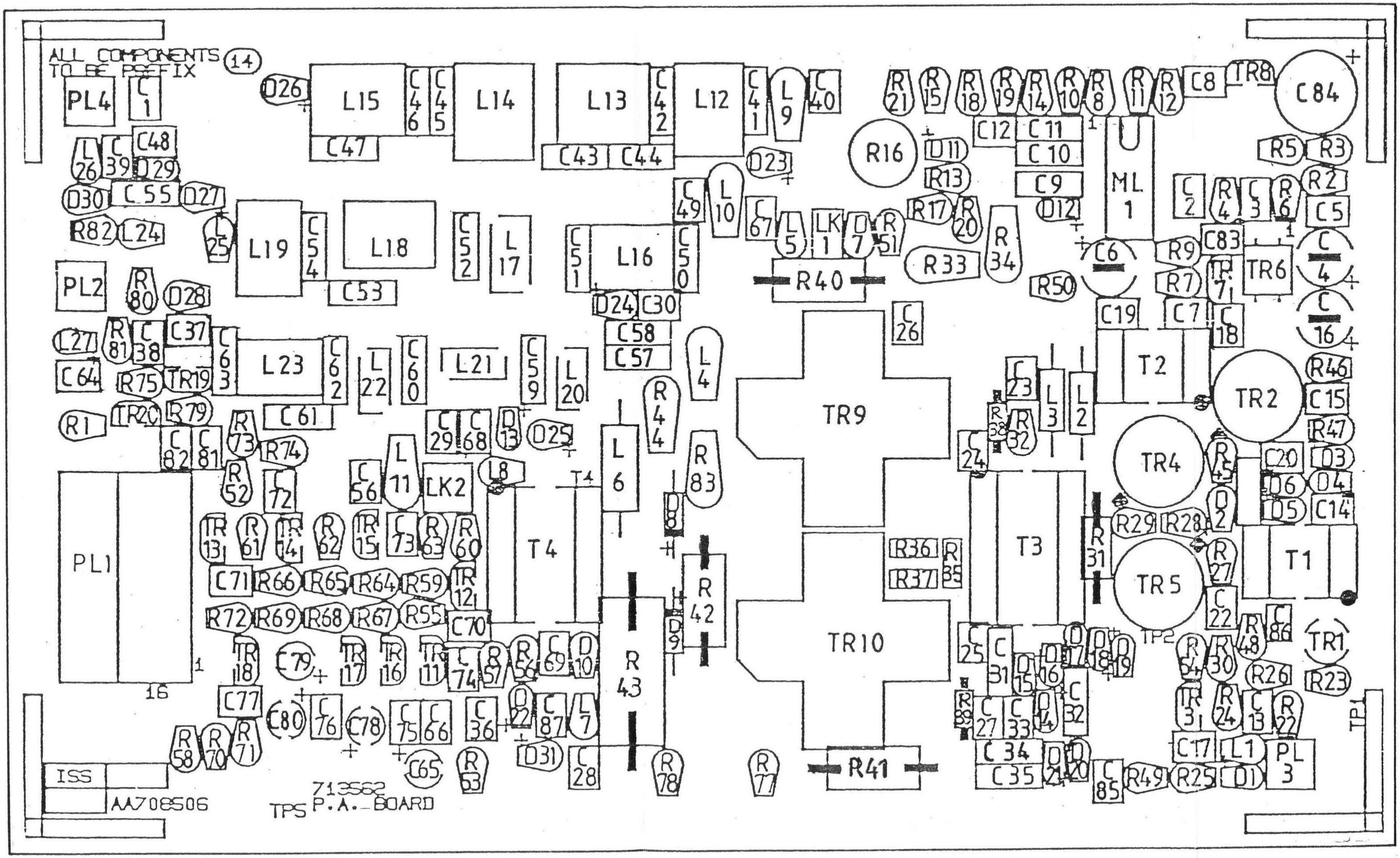
Integrated Circuits

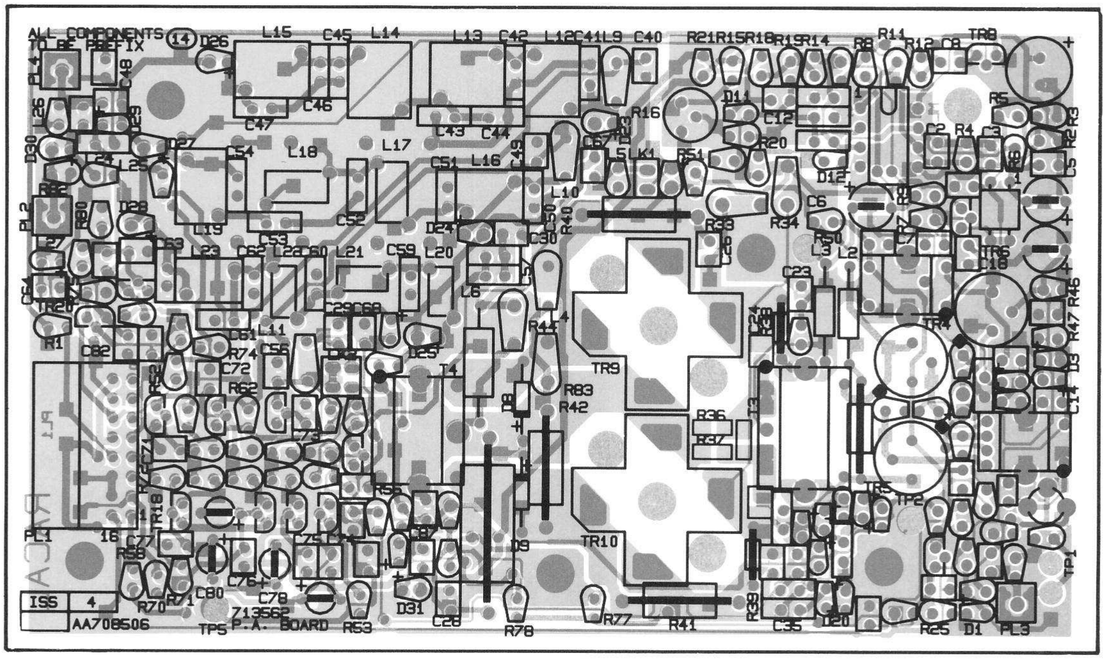
ML1		LM2904N			992098EQ

Transformers

T1		Transformer Assy			AT710809
T2		Transformer Assy			AT710812
T3		Transformer Assy			AT710810
T4		Transformer Assy			AT710811

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
Inductors					
	μH				
L1	10	Choke		10	926238EQ
L2	2.2	Choke		10	933957EQ
L3	1.0	Choke		10	926500EQ
L4	1.5	Choke		10	926328EQ
L5	10	Choke		10	926238EQ
L6	0.22	Choke		10	926334EQ
L7	10	Choke		10	926238EQ
L8	10	Choke		10	926238EQ
L9	10	Choke		10	926225EQ
L10	10	Choke		10	926225EQ
L11	10	Choke		10	926225EQ
L12		Coil Assembly			AT710813
L13		Coil Assembly			AT710821
L14		Coil Assembly			AT710814
L15		Coil Assembly			AT710815
L16		Coil Assembly			AT710816
L17		Coil Assembly			AT710852
L18		Coil Assembly			AT710852
L19		Coil Assembly			AT710816
L20		Coil Assembly			AT710818
L21		Coil Assembly			AT710857
L22		Coil Assembly			AT710819
L23		Coil Assembly			AT710820
L24	10	Choke		10	926238EQ
L25	10	Choke		10	926238EQ
L26	10	Choke		10	926238EQ
L27	10	Choke		10	926238EQ
Miscellaneous					
		Socket Co-ax 50			930649EQ
		Plug 16-way			992107EQ
LK1		Link Shorting			990776EQ
LK2		Link Shorting			990776EQ
		Extractor Handle			BD709031
		Heatsink	For TR4, TR5		708704
		Heatsink Ring (2 off)	For TR4, TR5		992248 EQ
		RF Shield (between filters)			709077
		Connector Header 2-way			708919
		Transformer Clamp (for T4)			702178
		Transformer Clamp (for T1, T2)			708867
		Transformer Clamp (for T3)			708992
		Bush Resistor ¼W (Black)			707207
		Bush Insulating (Red)			703073
		Bush (Green)			702971


ALL COMPONENTS
TO BE PSEFIX
14
ISS
AA708506
713562
TPS P.A. BOARD
TP1
TP2

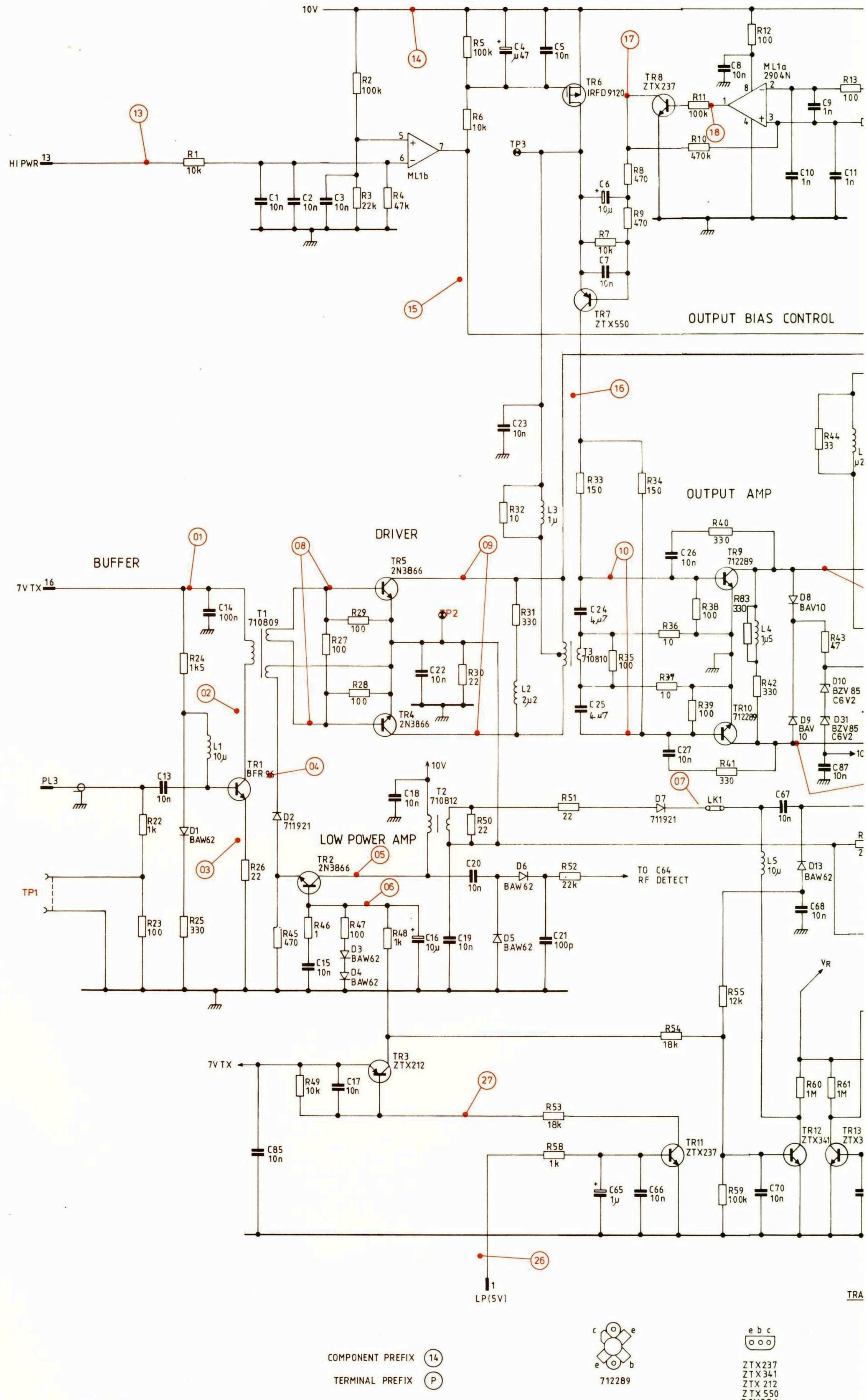


RACAL

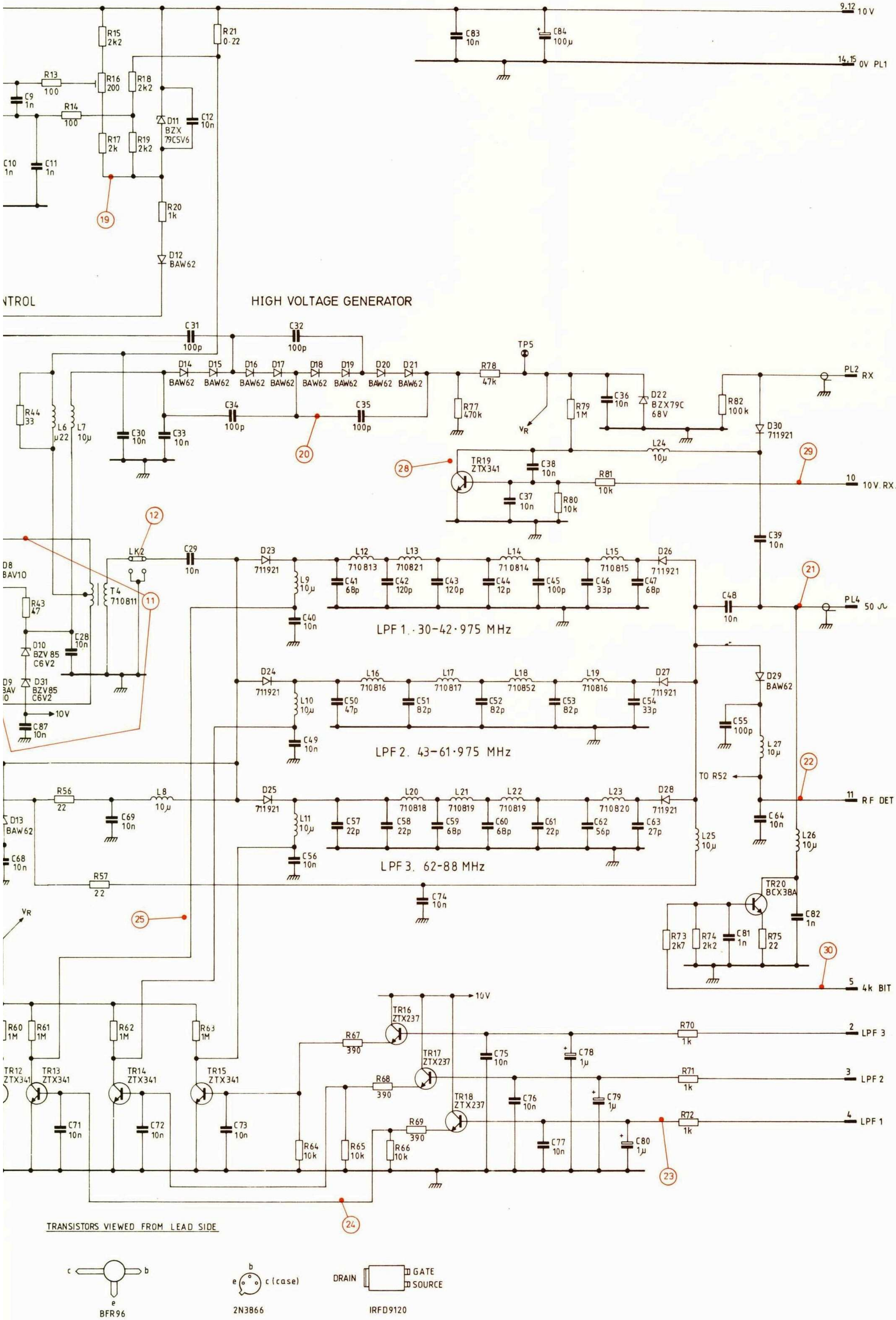
TH5160/1	713562
4	

Layout-Power Amplifier PCB

Fig.1



RACAL
TH 5160



Power Amplifier PCB: Circuit Diagram

Fig 2

PART 5

FRONT PANEL

(INCLUDING CONTROL BOARD AND AMU)

(ST 708507)

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The Front Panel Assembly contains the Display Board, the Antenna Matching Unit (AMU), the Control Board, and the flexible connectors.

DISPLAY BOARD

2. The Display Board carries the liquid crystal display which is read via an aperture in the front panel. The Display Board is a module which must be replaced (if necessary) as a complete item, (refer to Part 6).

AMU

3. The AMU (fig. 4) consists of a wideband transformer which matches the output of the power amplifier to the whip antenna, on transmit. In receive it matches the receiver RF amplifier to the whip antenna.

CONTROL BOARD

4. The Control Board performs the following functions:

   (1) Establishes a bi-directional serial and parallel data interface with the PRM 4700.

   (2) Controls circuitry within all parts of the PRM 4700 in accordance with the microprocessor software program.

   (3) Provides the facility for channelized operation and the storage of channel data when the radio is switched OFF.

   (4) Monitors the radio status continuously, reads the front panel switches, and provides the data for the LCD display on the Display Driver Board.

   (5) Provides a warning tone for the Audio Board when the synthesizer is out of lock (OOL), or an invalid frequency has been selected. It also provides the blip tone when a key is pressed on the keyboard.

   (6) Provides a lamp driver circuit for the LCD backlights.

   (7) Receives and responds to external frequency and mode data.

   (8) Provides a 5 Volt regulator for the Control circuit and also for the Display/Driver Module.

5. The behaviour of the Control Board is totally defined by a set of instructions held within the microprocessor, ML5. This set of instructions, encoded as 8-bit words (bytes), is known as the software.

CONSTRUCTION AND LOCATION - CONTROL BOARD

6. The Control Board is a P.C.B. of dimensions 112 mm x 45 mm located in the Front Panel and plugs component side into the LCD driver board. A 21 way flexible connector plugs into the track side and connects to the motherboard.

Microprocessor Integrated Circuit MPU ML5

7. The microprocessor CMOS integrated circuit consists of an eight bit MPU, a 2k byte read-only-memory (ROM) and a 112 byte random access memory (RAM) plus other functions required for the operation of a microprocessor. The ROM holds a preset programme the software which instructs the MPU in its processing action. The RAM performs the following functions:

(1) MPU Stack - necessary for executing sub-routines.

(2) Temporary storage of data during programme operation.

(3) Channel memory during radio operation.

Channel Memory ML4

8. When the radio is switched off it is necessary to store the channel information. A separate random-access-memory RAM ML4 with a battery back-up is used. During operation channel information is stored in the microprocessor RAM with ML4 being constantly updated with the channel data. This means that for any reason the microprocessor operation is interrupted channel data is stored in ML4. As the RAM is volatile the RAM supply is protected when the radio is off by a standby 2 volt primary cell circuit.

Interrupt Integrated Circuit ML6

9. The following inputs are applied to ML6:

(1) CHAN1

(2) CHAN2

(3) CHAN3

(4) CHAN4

BCD input from SW1 channel switch

(5) Low battery warning

(6) Press to talk or Data (PTTDAT) from pin C of the front panel sockets SK1 and SK2.

(7) Key select - high when a front panel key is operated.

(8) Carrier Detect (CARDET) when a received signal is detected.

(9) Synthesizer out of lock (OOL).

(10) MPU acknowledge of an interrupt.

10. When any of these inputs are altered an interrupt is generated to tell the microprocessor that action is required. Instructions for interrupts are contained in the software. The microprocessor acknowledges receipt of an interrupt by applying a reset.

CHAPTER 2

CIRCUIT DESCRIPTION - CONTROL BOARD

CONTENTS

FLOW CHART

ILUSTRATIONS

CHAPTER 2

CIRCUIT DESCRIPTION

INTRODUCTION

1. For ease of description the Control Board (Fig. 2) will be considered under four areas:

   (1) Microprocessor ML5

   (2) Channel Memory ML4

   (3) Interrupt I.C. ML6

   (4) Additional Circuitry

MICROPROCESSOR ML5

Interconnections

2.

Power Supply	VDD pin 40	+5 V Supply
0 Volt	VSS pin 20	
Reset	$\overline{RES}$	Used to reset MPU to provide an orderly software start-up procedure. R22 and C9 give a delay on switch-on. D7 provides a discharge path for C9 when radio is switched off.
Timer	TIMER	Connected to ground via 150k resistor, allows operation of internal timer.
4MHz Oscillator	OSC1, OSC2	XTL1, R18, C4 and C6 are components required for use with internal oscillator circuit.
NUM	NON-USER MODE	Connected to ground by 10k resistor, to disable self-check facility.
Interrupt Request	IRQ	Input signal from ML6. Normally logic '1' except when state of any of ML6 inputs changes when it is logic '0'.

PORT A (PA0 - PA7)

3. When the pins of Port A are used as an output then they perform the following functions:

A0	DSC1	LCD digit select code input 1	To display drivers (See Part 6)
A1	DSC2	LCD digit select code input 2	
A2	CSM	LCD driver chip select master	
A3	CSS	LCD driver chip select slave	

A4, A5, A6, A7 — LCD data on four lines (LCDAT0 - LCDAT3)
Only an output when the display needs updating for example a new frequency or channel.

A5 SYNDAT, A6 SYNCLK — Dual function with LCD data when set to an output, to carry the clock SYNCLK and data SYNDAT for the synthesizer board LSI.

A5 CARDET, A6 AFDET — These pins are normally an input for the carrier detect CARDET and noise (BITE) detect, AF DET. Also A6 is a dual function input with the LOW BATT warning circuit.

PORT B (PB0 - PB7)

4.

B0	KEY1
B1	KEY2
B2	CHAN1
B3	CHAN2
B4	CHAN3
B5	CHAN4
B6	KEY3

All the above are inputs. The 3 KEY lines carry parallel data from the front panel keyboard encoder IC on the display driver board. The 4 CHAN lines carry parallel data from the Binary Coded Decimal channel switch SW1 on the front panel.

B7 PTTOUT. An output at logic '1' in transmit mode (i.e. inverse to normal PTT). Referred to as TXEN elsewhere.

PORT C PC0 - PC7

5. C0 Serial Data input/output for the Channel Memory ML4.

C1 Clock pulse output for ML4.

C2 Interrupt acknowledge (reset) output for ML6.

C3 SYNENV. SYNTHESIZER ENVERLOPE Framing pulse output to latch synthesizer Data (SYN DAT)

C4 TONE. Audio output (warbling tone) when synthesizer is out of lock, or invalid frequency selected and blip-tone when keyboard is operated.

C5 HIPWR. Logic '1' when high power is selected. (Tx must be selected and synthesizer in lock).

C6 BANDSW. Output used for band switching on receiver board and in the Tx synthesizer circuits. Logic '1' in low band Rx (30-37.975 MHz) and high band Tx (50-88.000 MHz).

C7 Input derived from the PTT/4k-BIT data at PIN C of front panel audio sockets. (See para. 23).

PORT D (PD0 - PD7)

6.	D0	OOL	An input at logic '0' when the synthesizer is out of lock.
	D1	SQUEL	Squelch override output applied to audio board. Logic '0' when CARDET = '1', or during BITE, or under valid remote control. Logic '1' when sending any tones.
	D2	AMUDAT	Serial Data Output for external Vehicle Interface Unit (VIU), applied to 50 ohm BNC socket via Power Amplifier Board.
	D3	LOPWR	Logic '1' output when low power is selected. (Tx must be selected and synthesizer in lock).
	D4	LPF1	Logic '1' output for the required LPF on the P.A. board.
	D5	LPF2	
	D6	LPF3	
	D7	An output to drive TR4 a constant current source, for data acknowledgement (see para. 24).	

Built in Test Equipment (BITE) (Flowchart Page 2-8)

7. When the radio is switched on the microprocessor performs a self test routine and carries out testing of the receiver. The Carrier Detect test for the receiver is carried out at 32 MHz in order to receive the 5th harmonic of the Synthesizer reference 6.4 MHz. Transmitter testing is carried out only when the press to talk is applied.

8. The BITE routine is completely controlled by the software but can be overridden by pressing the PTT switch. If a faulty condition exists, a flashing 'E' & Error numbers appear on the front panel display to indicate the area of the fault.

9. The indicated faults are:

E1 ROM fault

E2 RAM fault

E3 Channel memory degraded

E4 Receiver fault

WAIT Mode

10. The WAIT mode (which is written into the software) places the microprocessor in a low power consumption mode, when it has completd its last task. In the WAIT mode all Port A to D I/O lines remain at their last state. If an interrupt is generated from ML6 then the microprocessor will begin to operate, carrying out the required instructions contained in the software.

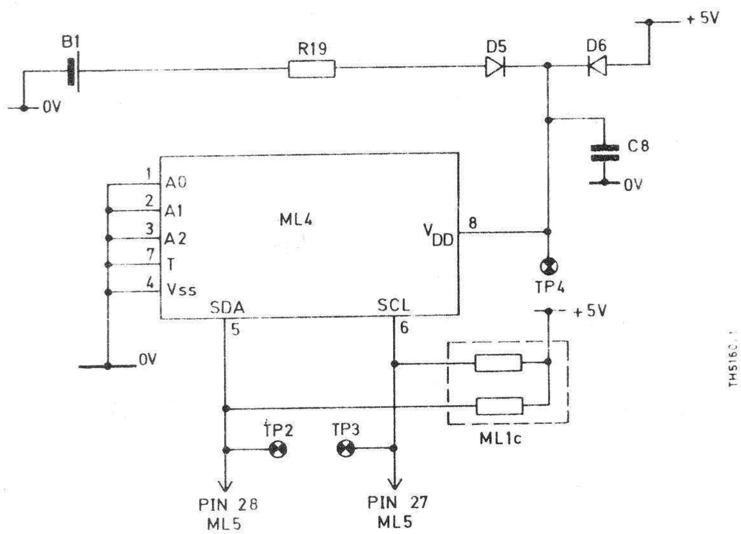
CHANNEL MEMORY ML4

11. When the radio is switched off channel information is stored in ML4, a random access memory (RAM) (Fig. 2.1). As this is a volatile memory a 2 volt battery B1 is provided as a supply when no external power is supplied. The lithium copper-oxide battery will retain the channel information in the RAM until the voltage at TP4 falls to approximately 1.0 volts, giving a life of at least 5 years at 25^{0}C.

12. In both the read and write modes of ML4, address and data are transferred via a two wire bi-directional bus SDA and SCL.

13. During radio operation ML4 is constantly updated with any change of channel information. When the radio is switched on data is applied from ML4 to the RAM of the microprocessor.

14. When the radio is switched off D5 will be forward biased and the 2 volt battery B1 is applied to pin 8 to provide approximately one microamp of current required to store the channel information in ML4. When the radio is switched on D6 will be forward biased to apply power to PIN 8. D5 will now be reverse biased and no current will flow, conserving the life of the battery.



Channel Memory ML4 Fig. 2.1

INTERRUPT I.C. ML6

15. The inputs to ML6 (see Page 1-2) are all important functions so that if any of them change then action is required by the microprocessor. The output of ML6 is normally a logic '1'. When any input changes then ML6 goes to logic '0' to tell the microprocessor action is required, and the input data must be read.

16. After the microprocessor has carried out the required action determined by the software, an interrupt acknowledge is applied from the MPU to pin 0 to reset the output of ML6 to logic '1'.

ADDITIONAL CIRCUITRY

Low Battery Warning

17. The LCD will display BATT if the radio battery voltage falls to 8 V ± 1 volt.

18. The battery input voltage (+10 V supply) is applied to D3 and R6 (Fig. 2.2). If the battery input is high enough then the voltage at TP7 will be greater than the 5 V reference, and the output will be "pulled" high by the pull-up resistor. If the battery voltage falls and the level at TP7 falls below 5 V then the output of ML2a will be a logic '0'.

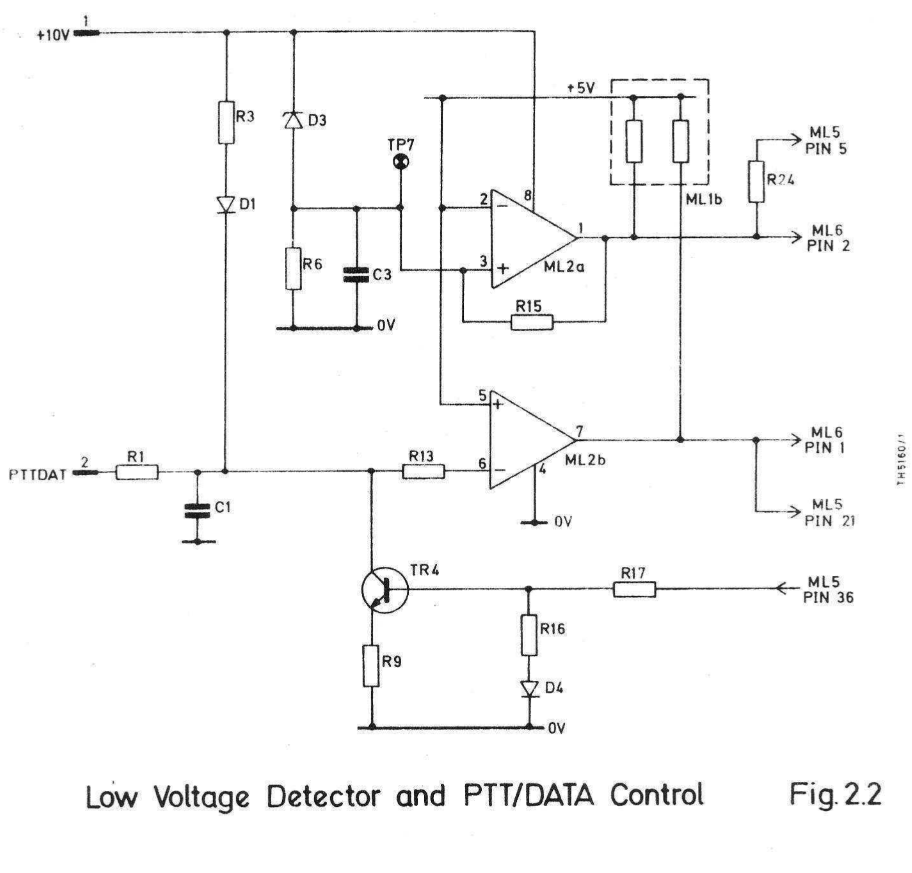
19. If the battery voltage falls, the logic '0' is applied to microprocessor ML5 pin 5, and also to ML6 Pin 2 to generate an interrupt for microprocessor action.

Press to Talk

20. When the radio is in the receive condition there is no input to the PTT DAT line, therefore the inverting (-) input of ML2b is "pulled up" to 10 V by R3. Under these conditions the output of ML2b will be at logic '0' (Fig. 2.2).

21. When the press to talk switch is operated the PTT DAT line will be at 0 V. The output of ML2b will be pulled up to 5v by the pull up resistor at the output.

22. The output of ML2b is applied to pin 21 ML5, and to ML6 pin 1 to generate an interrupt to request action by the microprocessor.



Low Voltage Detector and PTT/DATA Control Fig. 2.2

Channel Data Input

23. When the MA4073B Programmer or the MA4083B Fill Gun are used to program channel data, the 4 k-bit input from the MA4073B or MA4083B is applied to the PTT DAT line from either of the front panel audio sockets.

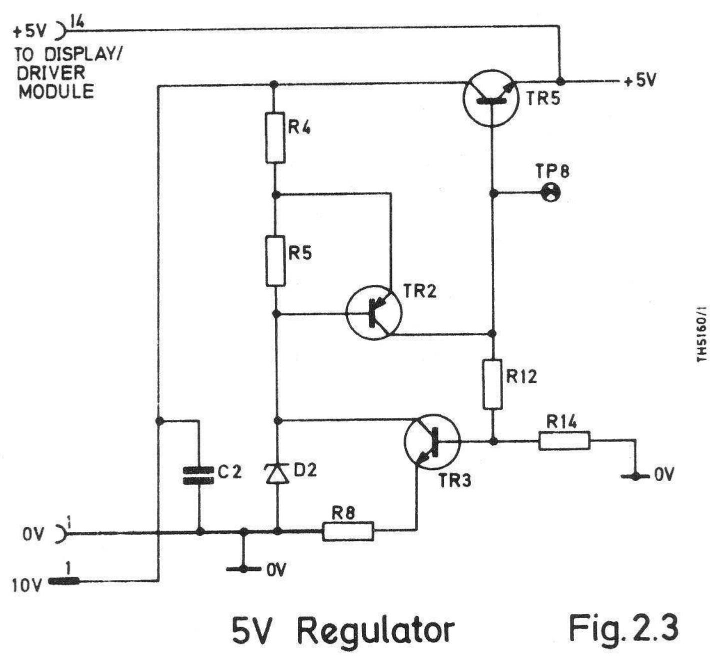
24. How the microprocessor distinguishes between the 4 k-bit data input and the constant logic '0' level of the PTT input is decided by the software. If the input is channel data then the programming source requires a reply from the microprocessor. On completion of data transfer the microprocessor generates an acknowledgement in the form of a data stream identical to the input data. This is applied to the PTT DAT line via pin 36 ML5 and constant current source TR4 (Fig. 2.2).

Key Select

25. When any of the front panel keyboard switches are operated a logic '1' from the display driver board encoder is applied to the key select line. C11 and R25 form a switch debouncing circuit.

5V Regulator

26. TR5, TR2, TR3 and their associated components form a 5V series regulator. To ensure that the microprocessor resets properly under various power supply switch on conditions, the regulator gives no output until the input voltage reaches a threshold of 6V because TR5 is turned off by TR2. When the radio is switched on, current flows in R4, R5 and 5.6 V Zener D2. When the voltage drop across R5 reaches 0.6V, TR2 will turn on allowing current to flow through R12 and R14, turning on TR3. This increases the base current of TR2 and creates a regenerative effect. When the input voltage has stabilised at a nominal 10V, TR5 functions as an emitter follower regulator, with zener diode D2 providing the voltage reference. Base current for TR5 is supplied by TR2 which is turned hard on. A 5 volt output is provided for the Display/Driver Module.

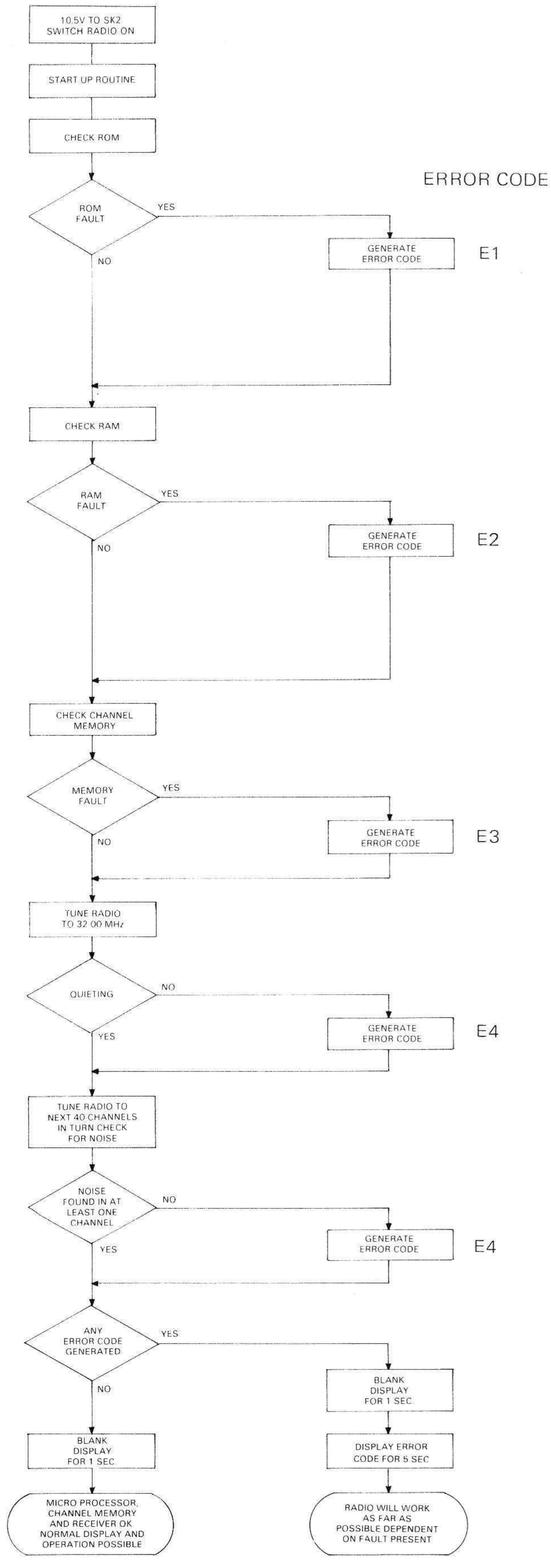


5V Regulator Fig. 2.3

LAMP DRIVER

27. TR1 controlled by the LAMP SWITCH line from the LAMP key on the Display Driver Module, drives the two LED's in the LCD (See Part 6 Page 2-1).

RECEIVER BITE SEQUENCE FLOW CHART



CHAPTER 3

FAULT LOCATION

CONTENTS

TABLES

CHAPTER 3

FAULT LOCATION

INTRODUCTION

1. Fault location on the Control Board is carried out by checking voltages and waveforms at various points on the board and by using the Flow chart provided.

TEST EQUIPMENT REQUIRED

2. (1) DC Power Supply: 10 V, 1A

Suitable Instrument: Farnell L30-2

(2) Oscilloscope

Frequency Range : 0-100 MHz
Suitable Instrument: HP 1740A/H07 or Tektronix 465 with probe.

VOLTAGES AND WAVEFORMS

3. The information given in Table 3.1 should be used in conjunction with the circuit diagram, Fig. 2 to which the nodes and test points refer. All voltages and waveforms are nominal and are measured using an oscilloscope with a 1 MΩ/10 pF probe unless otherwise stated.

USE OF FLOWCHART

4. The Control Board Flow Chart, Table 3.2, can be used to locate a fault on a Control Board whilst it is fitted to a PRM 4700 Front Panel. For ease of access to the various test points, the complete chassis assembly should first be removed from the Front Panel, including the Interconnect Flexi (see Part 1, Chap. 6 for removal procedure). The Control Board can then be powered up by connecting +10 V to pin 1 of PL1 and 0 V to any convenient point on the Front Panel metalwork (e.g earth screw near 50 Ω BNC socket). Note that the on-off switch and channel switch will now be ineffective.

5. The Display/Driver Board and Keyboard are assumed to be working correctly. The chart provides a guide to the area or group of components where the fault may exist but is not intended to be exhaustive.

TABLE 3.1

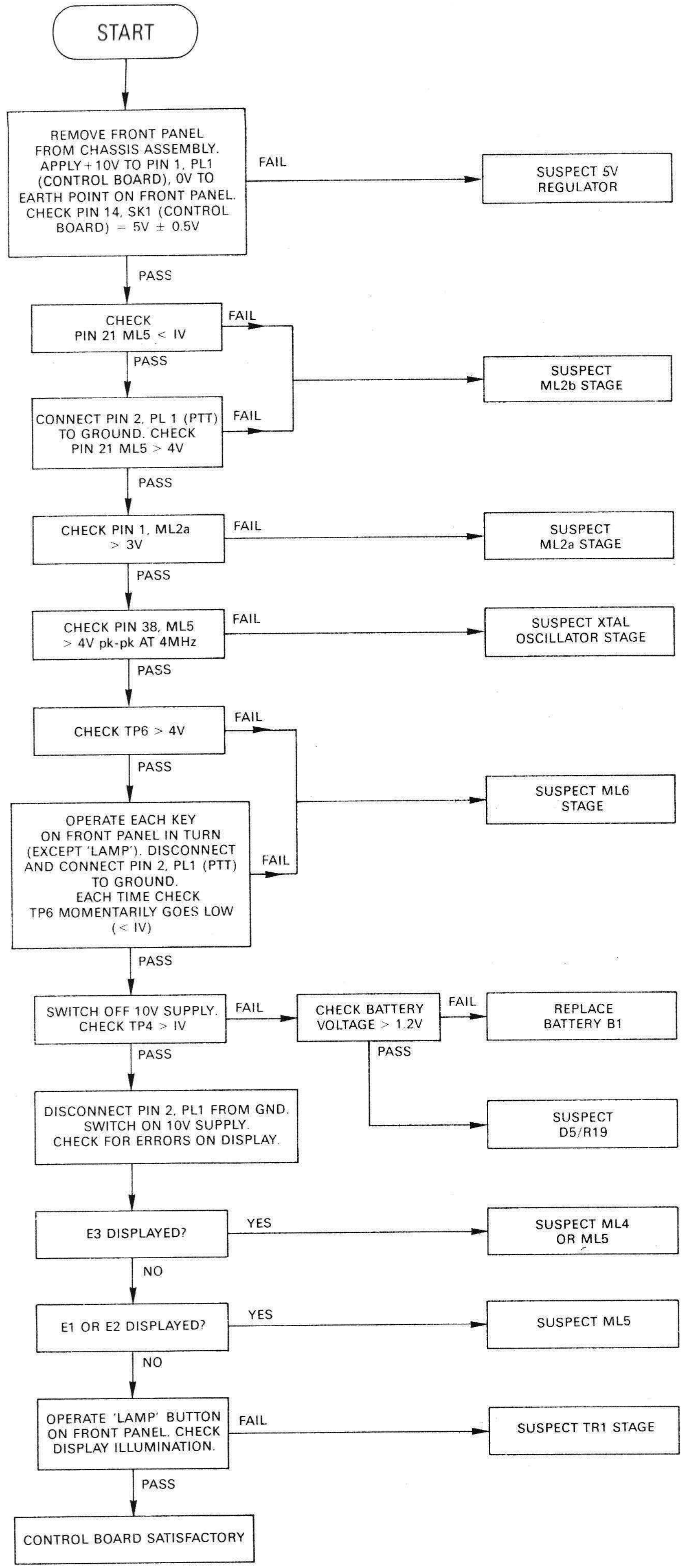
Voltages

PL1, Pin 1 = 10.0 V, Pin 2 O/C

NODE	VOLTAGE	
1	5.0 V	
2	5.0 V	
3	10.0 V	
4	9.8 V	
5	5.5 V pk-pk	Sinewave, 4.0 MHz
TP1*	4.0 V pk-pk	Sinewave, 4.0 MHz
TP2	5.0 V	
TP3	5.0 V	
TP4	4.8 V	
TP5	5.0 V	
TP6	5.0 V	
TP7	7.0 V	
TP8	5.6 V	

* Note: Scope must be A-C coupled.

TABLE 3.2 CONTROL BOARD FLOW CHART



CHAPTER 4

COMPONENTS LIST

CHAPTER 4

COMPONENTS LIST

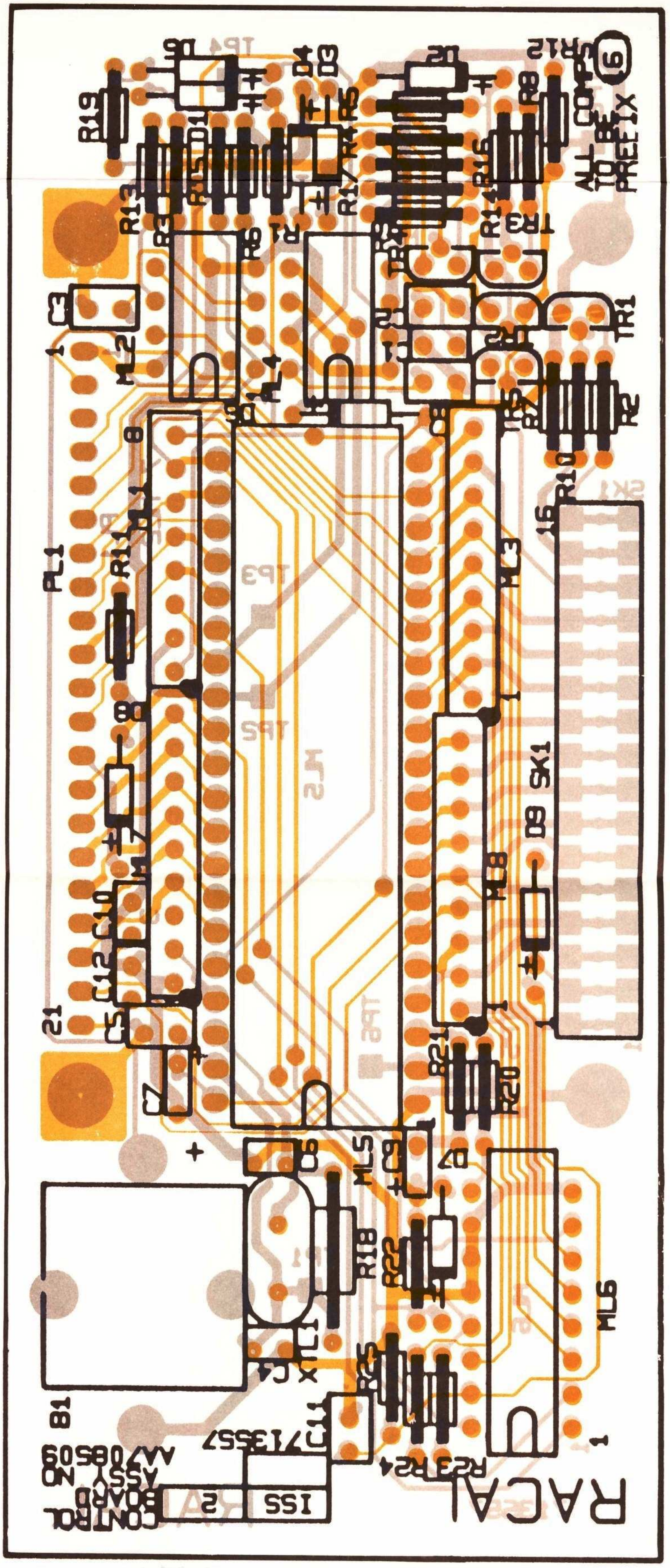
Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
		A.M.U. PCB (AA708863)	Component Prefix 18		
Capacitors					
C1	10n	Ceramic	100	20	927395EQ
Transformers					
T1		Transformer Assy			710822
Miscellaneous					
		Transformer Clamp			708866
		Terminal Post			914054
		CONTROL PCB (AA708509)	Component Prefix 16		
Resistors	Ω		W		
R1	10	Carbon Film	1/8	5	932806EQ
R2	33	Carbon Film	1/8	5	990751EQ
R3	1.5K	Carbon Film	1/8	5	931458EQ
R4	5.6k	Carbon Film	1/8	5	932330EQ
R5	5.6k	Carbon Film	1/8	5	932330EQ
R6	10k	Carbon Film	1/8	5	928015EQ
R7	47k	Carbon Film	1/8	5	928018EQ
R8	10k	Carbon Film	1/8	5	928015EQ
R9	22	Carbon Film	1/8	5	930125EQ
R10	2.2k	Carbon Film	1/8	5	928020EQ
R11	1M	Carbon Film	1/8	5	932336EQ
R12	22k	Carbon Film	1/8	5	928017EQ
R13	100k	Carbon Film	1/8	5	936823EQ
R14	47k	Carbon Film	1/8	5	928018EQ
R15	1M	Carbon Film	1/8	5	932336EQ
R16	470	Carbon Film	1/8	5	936814EQ
R17	3.3k	Carbon Film	1/8	5	936818EQ
R18	10M	Carbon Film	1/3	5	926676EQ
R19	100	Carbon Film	1/8	5	928013EQ
R20	10k	Carbon Film	1/8	5	928015EQ
R21	10k	Carbon Film	1/8	5	928015EQ
R22	47k	Carbon Film	1/8	5	928018EQ
R23	150k	Carbon Film	1/8	5	930127EQ
R24	10k	Carbon Film	1/8	5	928015EQ
R25	1M	Carbon Film	1/8	5	932336EQ

Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number
Capacitors					
	NF		V		
C1	1n	Ceramic	100	10	924031EQ
C2	10n	Ceramic	100	20	927395EQ
C3	100n	Ceramic	50	10	936877EQ
C4	22p	Ceramic	100	2	919649
C5	10n	Ceramic	100	20	927395EQ
C6	22p	Ceramic	100	2	919649
C7	6.8	Ceramic	10	5	992122EQ
C8	100n	Ceramic	50	10	936877EQ
C9	6.8	Ceramic	10	5	992122EQ
C10	100p	Ceramic	63	2	919723EQ
C11	100n	Ceramic	50	10	936877EQ
C12	1n	Ceramic	100	10	924031EQ
Diodes					
D1		BAW 62			918982
D2		BZX79B5V6			990672EQ
D3		BZX79C3V9			925667
D4		BAW 62			918982
D5		IN6263			936862EQ
D6		IN6263			936862EQ
D7		IN6263			936862EQ
D8		IN6263			936862EQ
D9		BAW 62			918982
Transistors					
TR1		ZTX237			923171
TR2		ZTX212			923172
TR3		ZTX237			923171
TR4		ZTX237			923171
TR5		ZTX237			923171
Integrated Circuits					
ML1	47k	Resistor Network 7-way		5	992091EQ
ML2		LM2903N			991573EQ
ML3	150k	Resistor Network 8-way		5	936897EQ
ML4		PCD8571			992095EQ
ML5		MC146805G2CP			BR714359
ML6		MC14531BCP			931479
ML7	150k	Resistor Network 8-way		5	936897EQ
ML8	150k	Resistor Network 8-way		5	936897EQ

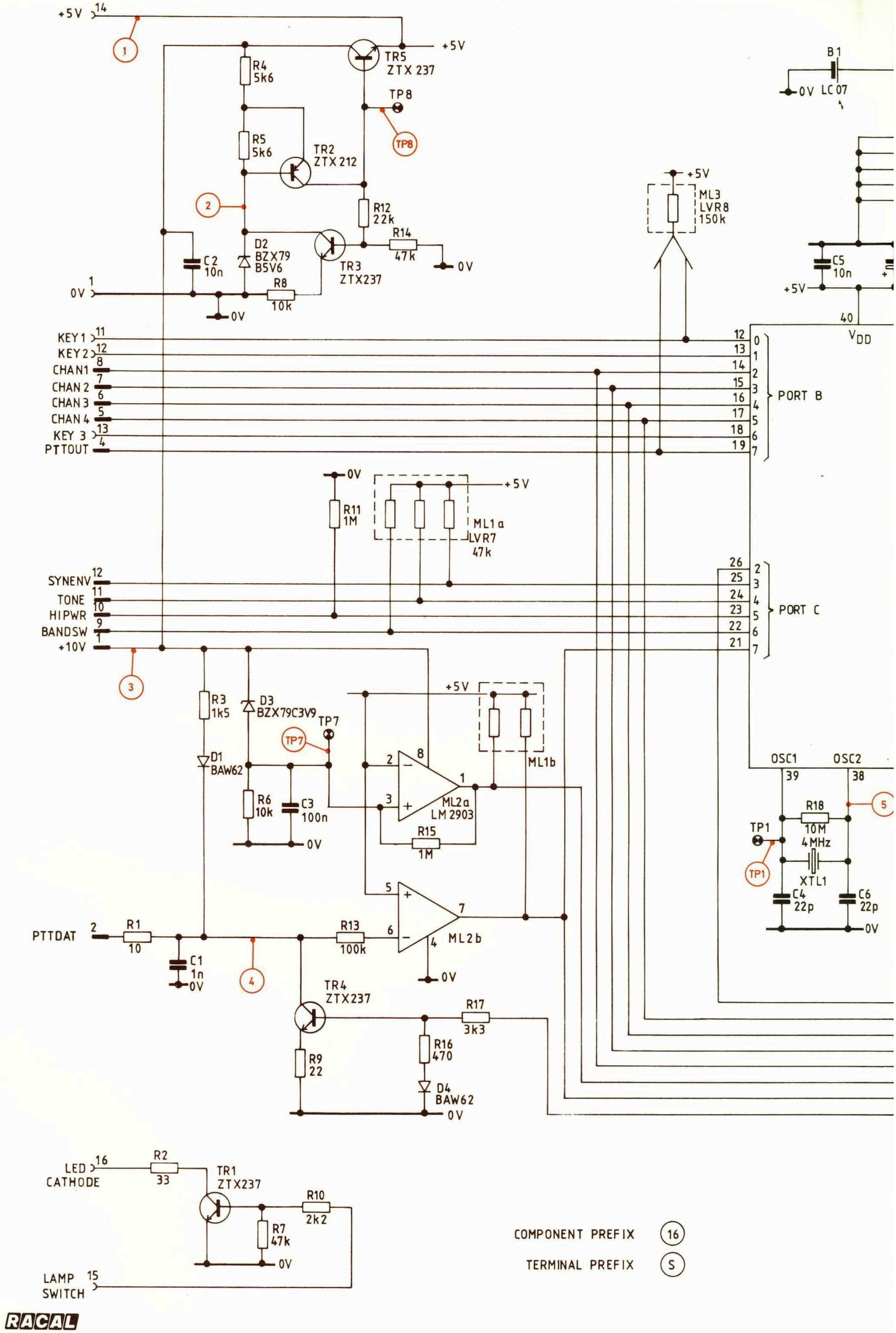
Cct Ref.	Value	Description	Rat	Tol %	Racal Part Number

Miscellaneous

XTL1	4MHz	Crystal Quartz			991165EQ
B1		Battery			992099EQ
		Connector 21-way			BD708920/21
		Socket (16 off for SK1)			990185EQ
		Socket (40 off for ML5)			937117
		Terminal Post			914054
		Pin Mini wrap (fits into 914054)			934875


RACAL
CONTROL BOARD ASSY NO AA708509
ISS 2
713557
ALL COMPS TO BE PREFIX

Control PCB

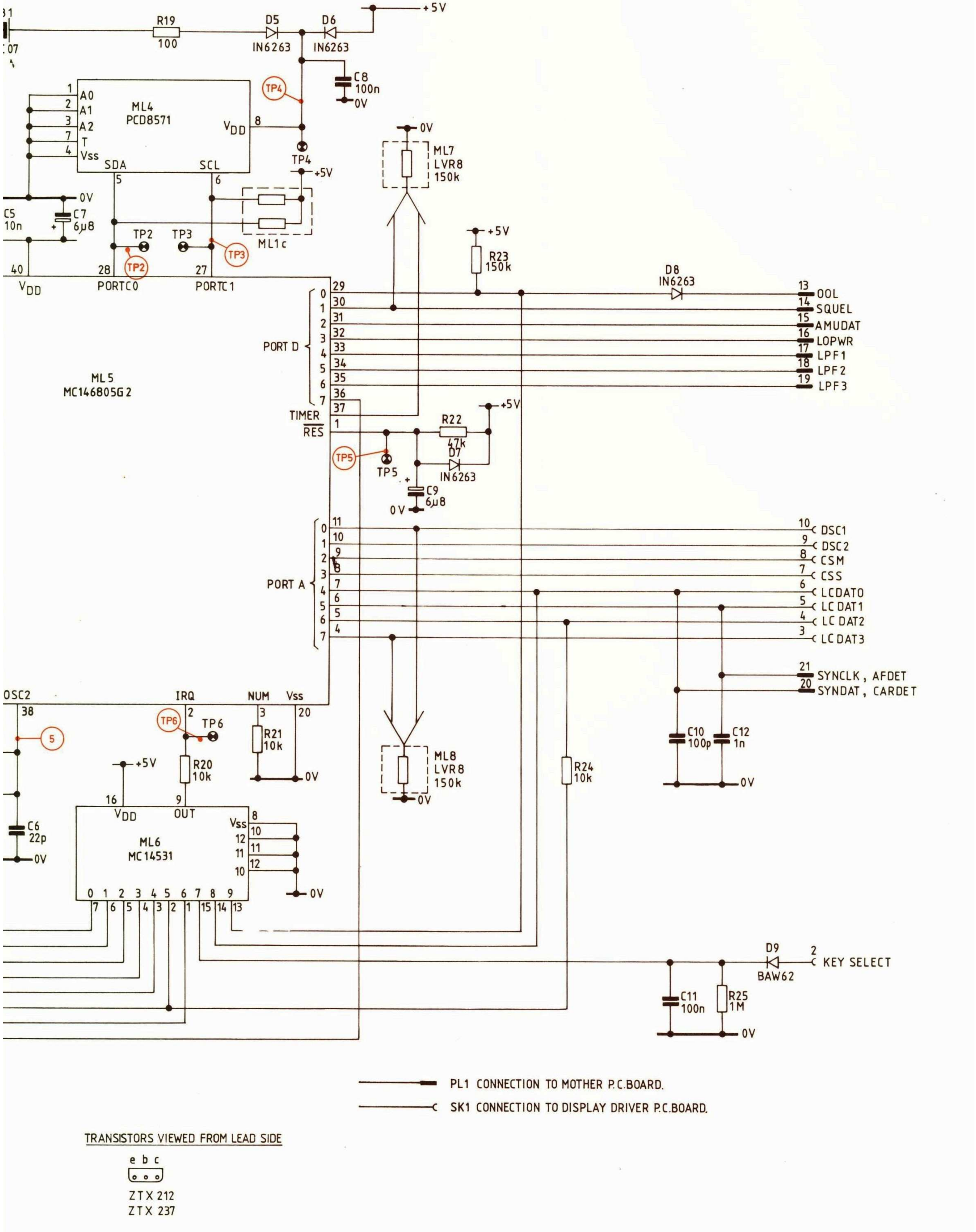


COMPONENT PREFIX (16)

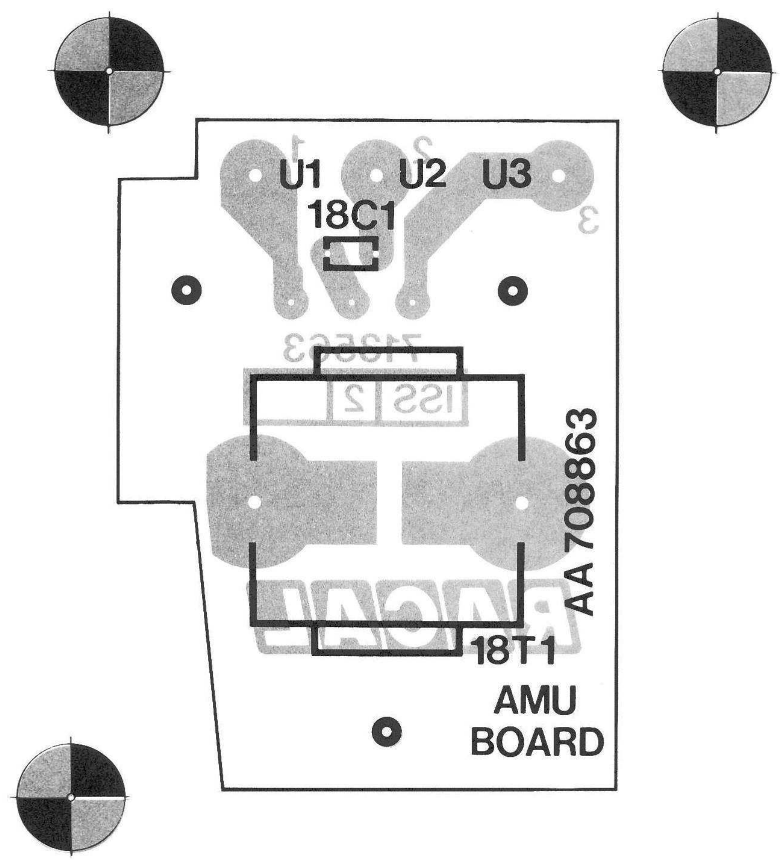
TERMINAL PREFIX (S)

RACAL

TH 5160

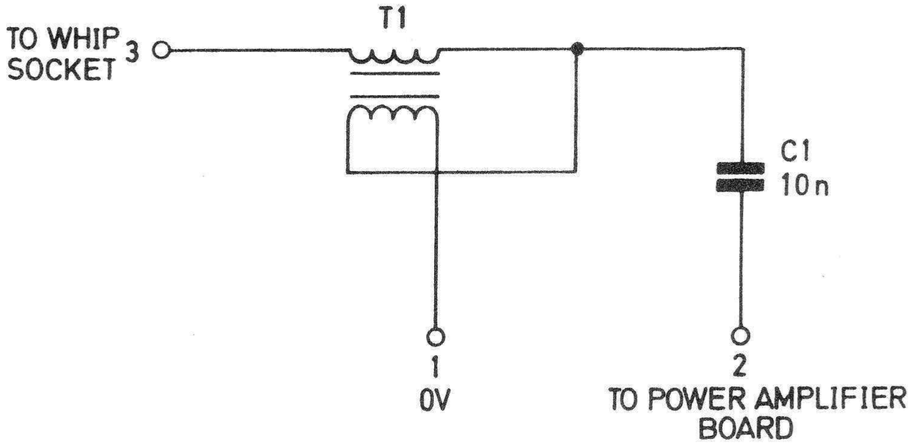


Control PCB: Circuit Diagram **Fig. 2**



A.M.U. PCB: Layout

Fig.3



A.M.U. PCB Circuit Diagram

Fig 4

PART 6

DISPLAY/DRIVER MODULE

(ST 708508)

CONTENTS

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The DISPLAY/DRIVER MODULE consists of a PCB on which is mounted several surface-mounted 'chip' components and the Liquid-Crystal Display itself.

ASSEMBLY

2. The module is screwed into the Front Panel such that the Display is visible through an aperture in the panel. A sealing ring in the Display Clamp ensures a water-tight seal between the Display and the Front Panel.

3. The keyboard is in two parts. The keys themselves consist of a one-piece rubber moulding mounted in the Front Panel casting and retained by a metal plate. The rear tips of the keys are electrically conductive, and each one when pressed shorts together two gold-plated contacts on the DISPLAY/DRIVER Board. The keyboard moulding also acts as a water-tight seal with the Front Panel.

4. The DISPLAY/DRIVER module connects directly to the CONTROL board by means of a 16-way two-part connector.

Liquid-Crystal Display

5. The display itself is clamped between two plastic mouldings which are then attached to the PCB by two screws. Electrical contact is made to the display by means of two flexible conductive strips compressed between the Display and the PCB. These strips consist of alternate layers of conductive and non-conductive rubber so that they conduct across their width but no across their length.

6. Backlighting of the display is achieved by means of two Light-Emitting Diodes mounted on the PCB which protrude into the display housing so that light is reflected from the back of the housing through the display.

CHAPTER 2

CIRCUIT DESCRIPTION

CONTENTS

TABLES

CHAPTER 2

CIRCUIT DESCRIPTION

INTRODUCTION

1. The following are mounted on the display driver board:

(1) Front panel keyboard contacts.

(2) Two front panel display driver IC's and pull-down resistors.

(3) Keyboard encoder I.C. and pull-down resistors.

(4) Front panel lamps.

(5) Front panel liquid crystal display.

The 5 volt regulated supply is provided at Pin 14 by the Control Board.

Keyboard

2. When a front panel keyboard switch (other than lamp key) is operated 5v is applied via the switch to one of the inputs of the keyboard encoder I.C. The output of the encoder is fed to the KEY 1, KEY 2 and KEY 3 line and routed to the microprocessor on the Control Board (see Fig. 2 Part 5). When a key (other than lamp key) is operated a logic '1' is applied to the Key Select line to tell the microprocessor that action is required. Table 2-1 shows the truth table for the keyboard encoder.

Table 2-1 Truth Table for Keyboard Encoder

Output Line:	Key 1	Key 2	Key 3
Selected Key	Pin 11	Pin 12	Pin 13
NONE	0	0	0
LOAD	1	0	0
10MHz	0	1	0
1MHz	1	1	0
100kHz	0	0	1
25kHz	1	0	1
PROG	0	1	1
PWR	1	1	1

Logic '0' = 0 V Logic '1' = 5 V

Display Illumination

3. When the lamp key is operated 5v is applied to the LAMP SWITCH line and fed via pin 15 to a lamp driver circuit on the control board (See Part 5 Page 2-6). The output of the lamp driver is 0v when the lamp key is operated and is fed via pin 16 to the cathodes of the two LEDs which illuminate the display.

Display Drivers

4. There are two IC's, master and slave, which are used to decode the inputs from the Control Board and drive the appropriate segments of the display. These inputs are applied to pins 3-10 (see Fig. 2 Part 1 Control Board), from pins 3-10 on the Control Board (See Part 5 Page 2-2).

PIN	TITLE	FUNCTION
3	LCDAT3	Four lines of data to LCD
4	LCDAT2	
5	LCDAT1	
6	LCDAT0	
7	CSS	Slave Display Driver Select
8	CSM	Master Display Driver Select
9	DSC2	LCD Digit Select Code 2
10	DSC1	LCD Digit Select Code 1

CHAPTER 3

FAULT-FINDING AND REPAIR

CONTENTS

ILLUSTRATIONS

CHAPTER 3

FAULT-FINDING AND REPAIR

FAULT-FINDING

1. Before investigating a possible fault in the DISPLAY/DRIVER Module, the CONTROL Board should first be checked for correct operation (see Flow Chart, Table 3.2, Part 5).

2. Fault-finding on the DISPLAY/DRIVER Module is limited to checking operation of the Keyboard Encoder, Lamp Switch and LED's.

Keyboard Encoder

3. Without removing the Front Panel from the Chassis check the Encoder by pressing each key in turn and measuring the voltages at pins 11, 12 and 13 of SK1 on the Control Board (see Table 2.1). Note when any key is pressed KEY SELECT (Pin 2) should be at Logic '1'.

LAMP SWITCH AND LED'S

4. As in Para. 3 above, press the LAMP key and check that the voltage on pin 15 of SK1 on the Control Board is +5 volts. Check also that pin 16 is less than 1.5 volts, and the two LED's in the LCD are lit.

Module Repair

5. No attempt should be made to replace soldered components on the Display/Driver Board. If a fault is suspected on the PCB, the whole board should be replaced with a new tested unit.

6. The L.C. Display, Display Housing or Elastomeric Connector Strip may be replaced if required.

Display Removal (See Fig. 3.1)

7. First remove the Display/Driver Module from the Front Panel as described in Chapter 6, Part 1.

8. Remove the two screws securing the Display Assembly to the PCB thus releasing the complete assembly.

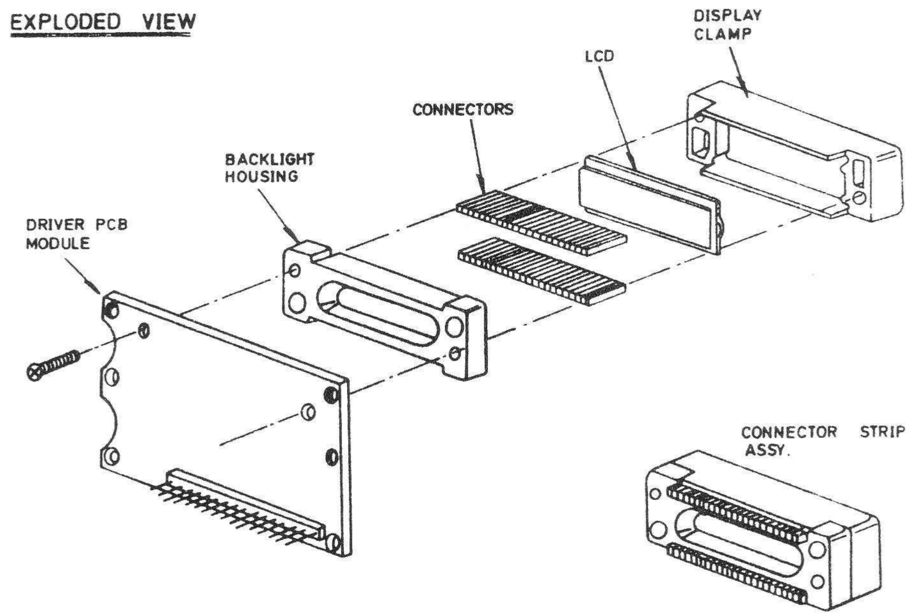
Display Re-Assembly (See Fig. 3.1)

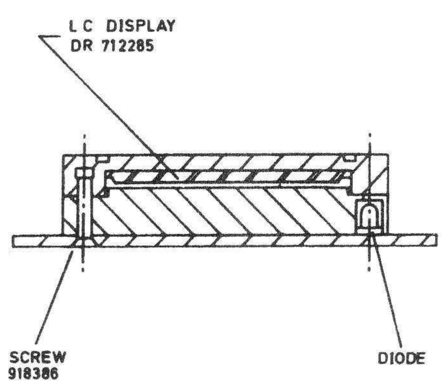
9. Note that during assembly great care must be taken not to handle the L.C. Display or the tracks of the PCB. The whole module must be kept free from dirt, especially the keyboard pads.

10. Fit L.C. Display into Display Clamp, carefully noting the orientation of the tab on the L.C. Display to guideway in clamp.

11. Fit backlight with elastomeric connector strips as shown, and press firmly into position.

12. Fasten PCB to display clamp with the 2 counter-sunk screws. Note this operation is to be done taking great care at all times not to distort the connector strips as the screws are tightened. Tighten screws until clamp touches PCB.


EXPLODED VIEW
DISPLAY CLAMP
LCD
CONNECTORS
BACKLIGHT HOUSING
DRIVER PCB MODULE
CONNECTOR STRIP ASSY.


L C DISPLAY
DR 712285
SCREW
918386
DIODE

CHAPTER 4

COMPONENTS LIST

Description	Quantity	Racal Part No.
Display/Driver Module	1	ST708508
PCB (with soldered components)	1	ER712252
L.C. Display	1	DR712285
Elastomeric Connector Strip	2	AR712296
Display Clamp	1	BD708731
Backlight Housing	1	BD708733
Screw M3 x 12 CSK. REC. HD. CP	2	918386

PART 7

SYNTHESIZER BOARD

ST 709105

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The synthesizer board provides 2321 channels at 25 kHz spacing derived from a single crystal reference. During transmission a Phase Locked Loop (PLL) locks the frequency of a Voltage Controlled Oscillator (VCO) to the crystal reference which is then Frequency Modulated to provide the transmitted signal used to drive the P.A. The output frequency of the transmitter VCO is determined by the front panel keyboard frequency selection or the channel switch setting via the channel memory, or external frequency data applied to a front panel socket.

   Tx VCO Frequency = Transmit frequency indicated on LCD.

2. During reception the synthesizer PLL is used to control the frequency of a separate VCO which is located on the receiver board. This receiver VCO is at the frequency set by the front panel controls + the intermediate frequency (I.F.) of 21.4 MHz.

   Rx VCO frequency = Rx frequency indicated on LCD + I.F. (21.4 MHz).

3. The following functions are also provided by the synthesizer board.

   (1) The modulating signal is low pass filtered at 3KHz for audio. For a 16K bit data signal the low pass filter is switched to cut-off at 8KHz.

   (2) The 150Hz Pilot Tone which is used during voice transmission, is generated and switched in or out as required.

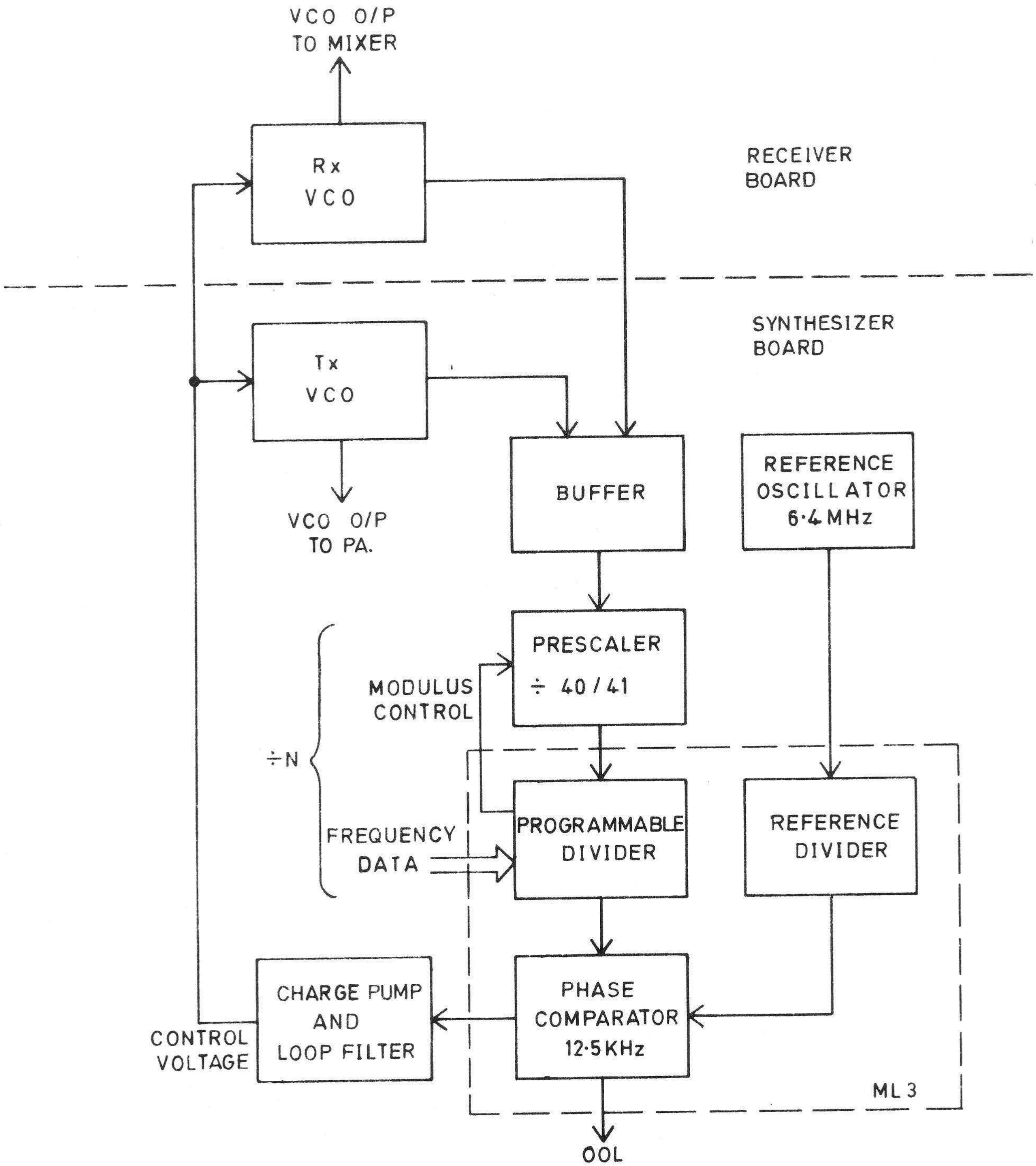
   (3) A 32 MHz signal is produced to test the receiver during the BITE sequence.

   (4) A nominal 20 V supply, generated by the synthesizer, is made available for use on this board and on the receiver board.

   (5) The correct operation of the PLL is continuously monitored. An Out Of Lock (OOL) condition will result in a warbling tone being heard in the operator's headset. (The same tone can be heard when an out of range frequency is selected on the front panel.)

CONSTRUCTION AND LOCATION

4. The Synthesizer Board consists of a Motherboard of dimensions 140 x 56 mm onto which are plugged three Micro Circuit Boards and an LSI. The Motherboard is connected to the main chassis by means of a 16 way connector. One coaxial cable connects to the Receiver Board and one to the P.A. Board.



RACAL TH 5160

Block Diagram of Phase Locked Loop

Fig 1.1

PRINCIPLES OF OPERATION

Phase Locked Loop

5. A block diagram of the Synthesizer PLL is shown in Figure 1.1. The PLL uses a 6.4 MHz crystal oscillator to provide a stable reference frequency. A reference divider, internal to ML3, divides this to a sampling frequency of 12.5 KHz. The PLL is then used to lock the frequency of the VCO to a multiple of the sampling frequency. When this occurs, both the reference divider and the programmable divider will be giving a 12.5KHz output to the phase comparator, with the feedback loop ensuring that the two signals are locked together in phase. The VCO frequency is then defined as N x Sampling Frequency, where N = the product of prescaler and programmable divider division ratio.

Voltage Controlled Oscillators

6. There are two voltage controlled oscillators, one on the synthesizer board covering the range 30 MHz to 88 MHz for the transmitter, and one on the receiver board covering the range 51.4 MHz to 109.4 MHz for the receiver local oscillator. The power supply to the oscillator which is not being used is switched off so that it has no effect.

LSI CIRCUIT

7. The large scale integration (LSI), ML3, contains the reference divider, the programmable divider and phase comparator. Because the VCO frequency is too high to feed directly into the LSI, a Prescaler is used, its division ratio of 40 or 41 being set by the LSI. This device then forms part of the programmable divider. The data to set the ratio by which the VCO signal is divided is sent by the Control Board to the LSI where it is held in memory. The phase comparator provides two pulsed outputs, either "pump-up" or "pump-down" converted to a voltage level in the Pump/Filter and used to correct any VCO frequency error. The LSI also provides an output (OOL) which is used to provide an audible warning if the PLL is out of lock (OOL). A 200 KHz output is used to drive the 20V generator and provide a 150 Hz pilot tone output, both of which are derived from the reference frequency.

MODULATION CONTROL

8. A characteristic of the modulation system is that as the transmitted carrier frequency increases the audio input level it requires is reduced. This is achieved by a modulation control circuit, the gain of which is inversely proportional to the carrier frequency thus maintaining the frequency deviation at a constant level, across the whole frequency range.

MODULATION

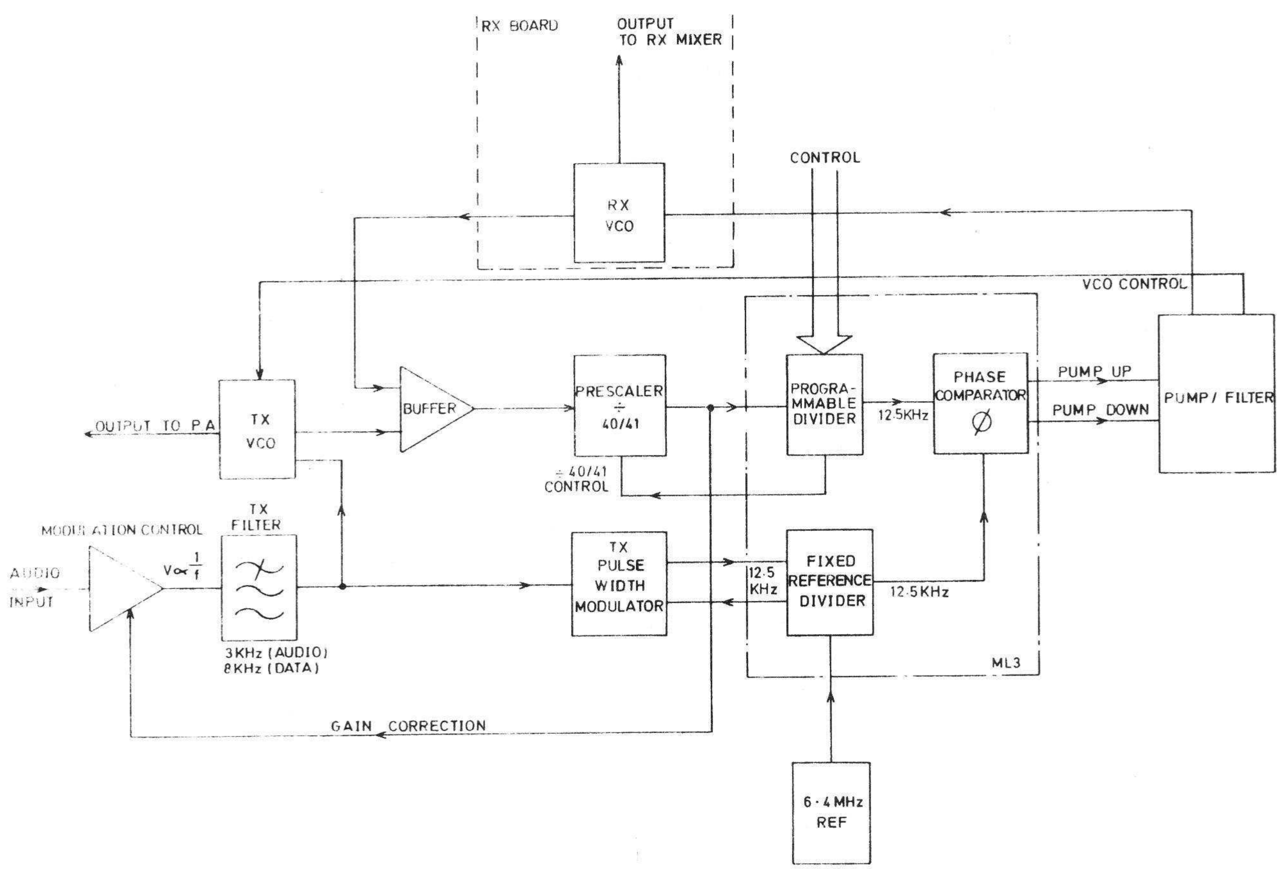
9. The block diagram of Figure 1.2 shows how the modulation is applied to the PLL. The output of the modulation control circuit is applied first to the transmit filter. This is a low pass filter which can be switched to one of two bandwidths. For a microphone input the bandwidth is 3KHz. When a DATA input from a 16K-bit ancillary is fed into the front panel audio socket SKT1, the filter switches to a bandwidth of 8KHz. The filtered output is used to frequency modulate the transmitter VCO, and also a pulse width modulator.

10. Without pulse width modulation, the VCO modulation would be seen as frequency errors by the PLL which would try to cancel the modulation out by pulling the VCO back towards the carrier frequency. Because the bandwidth of the PLL is nominally 1KHz the audio frequencies within the loop bandwidth would be attenuated. To compensate for this the 12.5 KHz output of the fixed divider is also modulated by the pulse width modulator. The two inputs to the phase comparator are then modulated together so that the PLL sees no errors.

POWER SUPPLIES

11. The synthesizer board power supply is derived from the radio supply which has a nominal output of 10V. A 7V and 7V Tx supply are provided by a regulator on the audio board. A voltage multiplier on the synthesizer board provides a nominal 20V supply for the charge pump and the same 20V is used on the receiver.

12. Under receive no signal conditions current saving circuits are in operation to preserve the radio battery controlled by the 7 V Rx SYN line. The supplies to the O/P Buffer Amp, Prescaler, and Charge Pump are switched at the 6 Hz rate, and the two LSI inputs are toggled at 10 kHz rather then at operating frequency.



TH5160

Synthesizer Overall Block Diagram.

Fig 1.2

CHAPTER 2

CIRCUIT DESCRIPTION

CONTENTS

TABLES

ILLUSTRATIONS

CHAPTER 2

CIRCUIT DESCRIPTION

INTRODUCTION

1. All of the synthesizer circuits except the receiver VCO are contained on one printed circuit board. Three micro printed circuit boards are mounted on the synthesizer containing the charge pump, 20V generator and the Tx audio filter and PWM circuits.

Reference Frequency Oscillator and Reference Divider

2. The output frequency of the synthesizer is locked to the 6.4 MHz temperature compensated oscillator (TCXO) module. The TXCO output is applied via gating circuit ML2C, to the reference divider input of ML3 pin 15 which can be monitored at TP1. The main purpose of the divider is to provide the 12.5 KHz sampling frequency to which the VCO is locked. Two other frequencies are taken from the divider chain:-

(1) 200 KHz (ML3 pin 16). Used in the 20V generator.

(2) 150 Hz (ML3 pin 17). Used to provide the 150 Hz Pilot Tone. (Actual frequency is approximately 148.8 Hz.)

Transmitter Voltage Controlled Oscillator (Fig. 2.1)

3. The frequency range of the transmitter VCO is 30 MHz to 88 MHz covered in two bands. The lower band is 30 MHz to 49.975 MHz and the higher band is 50 MHz to 88 MHz. Band switching is controlled by the microprocessor on the control board.

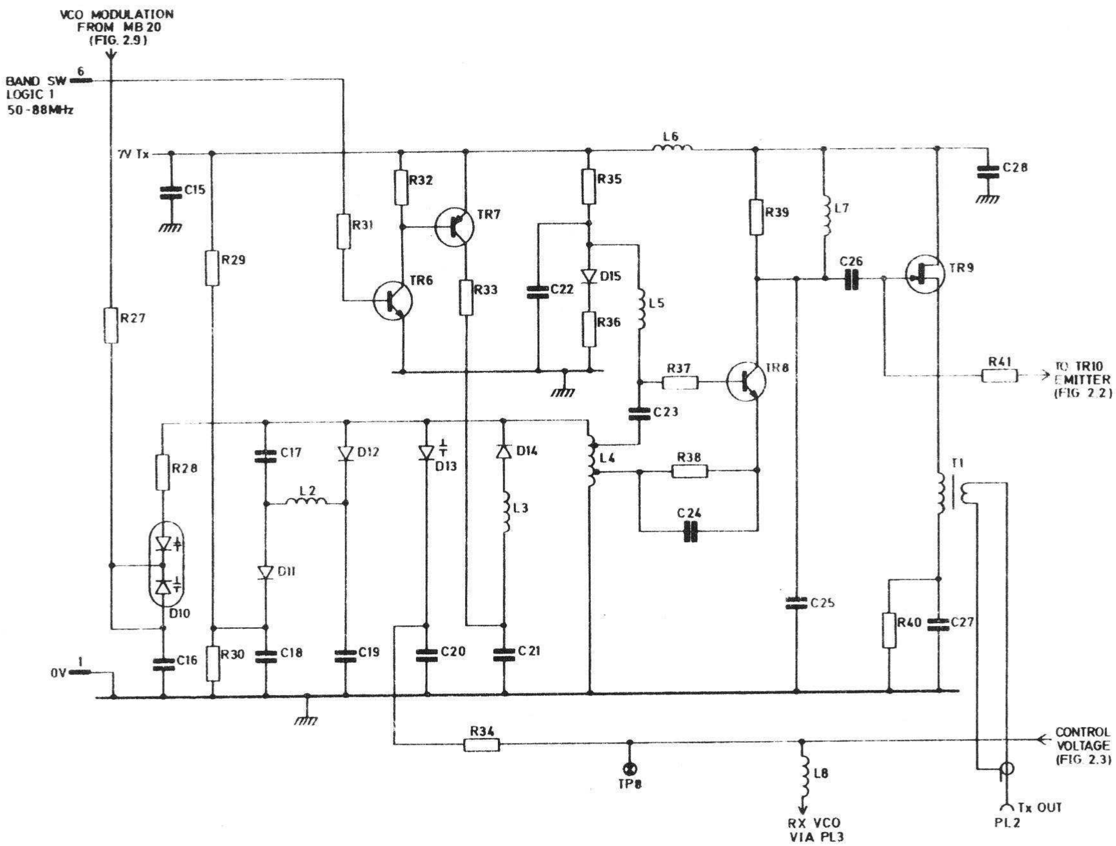
4. The oscillator transistor is TR8 with base bias provided by R35, D15, and R36. The main tuning components are L4, C20 and D13. D13 is a varactor diode whose capacitance varies according to the dc voltage applied when the device is reverse biased. As the voltage at the cathode of D13 is increased, the diode capacitance reduces and hence the frequency of oscillation of the VCO increases. The control voltage from the Charge Pump, MB22, is applied to D13 via R34. (Also to the Rx VCO via L8).

5. When a frequency in the high band 50-88 MHz is selected, the band switching line from the control board is high at pin 6 of the synthesizer board. This voltage at the base of TR6 causes TR6 to conduct which in turn causes TR7 to conduct. When TR7 conducts current flows from 7V TX through R33, L3, D14 and L4. PIN Diode D14 is now forward biased and additional tuning component L3 is placed in parallel with L4 so reducing its inductance.

6. The audio output of the Tx Audio filter is applied via C13 and R27 to the cathode of varactor diode D10, (a double varactor in which only one half is used). As the voltage at the cathode varies the frequency of oscillation of the VCO will vary as a function of the AF applied.

7. An automatic level control circuit is formed by D11, D12, C17, C18, C19, L2, R29 and R30. C19 and D12 form a peak detector circuit. When the r.f. voltage at the anode of D12 is high enough PIN diode D11 will conduct. R29 and R30 set the threshold at which D11 conducts. When D11 conducts it appears as a resistance to the r.f. across the tuned circuit to dampen the amplitude of oscillation.

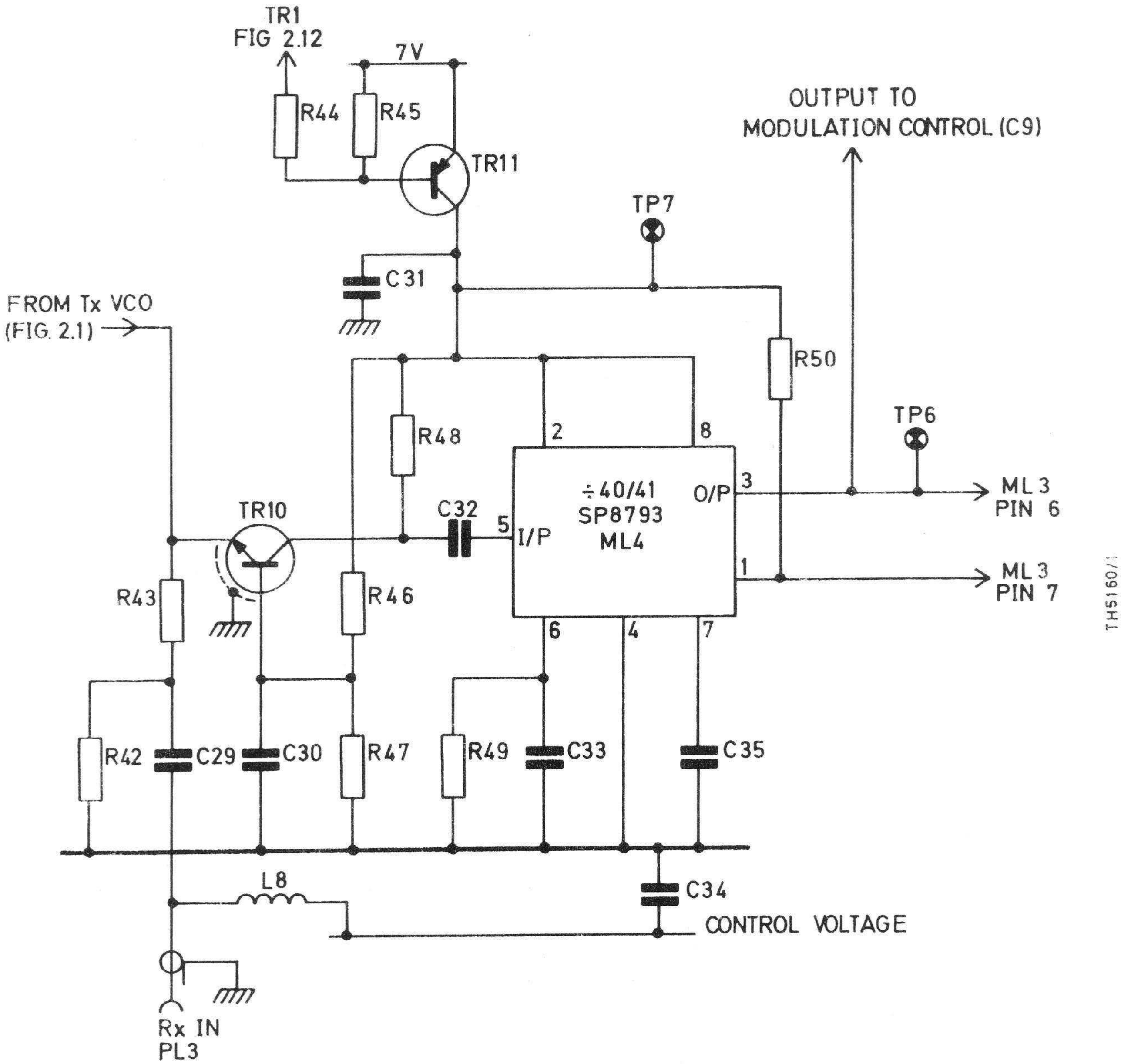
8. The output of the VCO is fed out via a buffer stage TR9, output transformer T1 and coaxial socket PL2 to the power amplifier board. A second output via R41 provides a signal to the buffer stage TR10 for the synthesizer loop. In receive the RF signal for the loop comes from PL3.



Transmit VCO Fig. 2.1

Prescaler (Fig. 2.2)

9. The output of the synthesizer buffer stage is fed to the prescaler ML4 at a level of approximately 400mV pk-pk. This device uses emitter coupled logic (ECL) to divide down the VCO frequency to a low enough frequency for the programmable CMOS divider of ML3. The prescaler is controlled by the control output of ML3 pin 7. R50 is a pull up resistor for this output. With this pin low it will divide every 40 pulses at its input to give one pulse at its output. When this pin is high it will divide by 41. TR11 is held ON in transmit and received signal modes via gate ML1C and TR1, so providing a 7 V supply to ML4. In current saving mode it switches the 7 V supply at 6 Hz (See Para. 32).

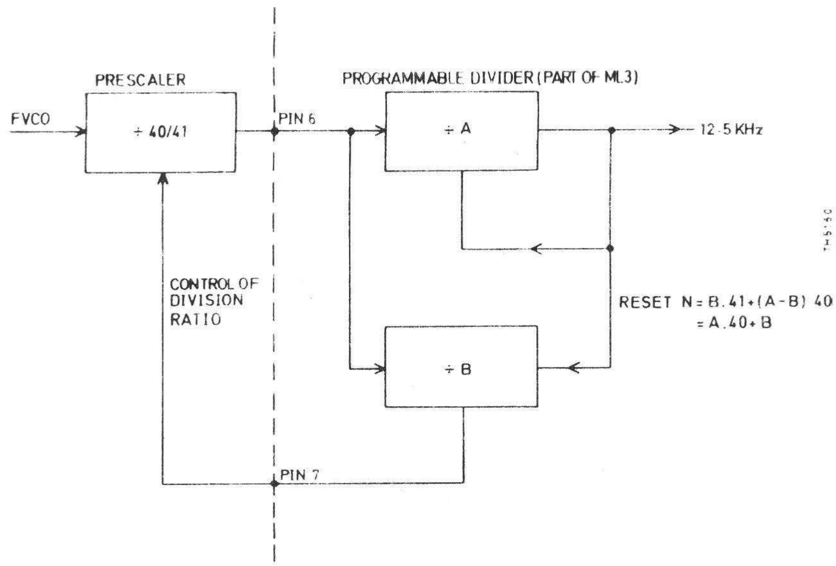


Input Buffer and Prescaler Circuit Fig. 2.2

Programmable Divider

10. The overall function of the programmable divider and prescaler is to divide the input frequency by "N". When the output of the dividers is equal to the sampling frequency of 12.5KHz, the synthesizer is in lock and the VCO frequency is then defined by:-

$$F_{vco} = N \times 12.5 \text{ KHz.}$$



Prescaler/Programmable Divider Block Diagram Fig 2.3

11. The programmable divider is formed by a counter inside ML3 which is set to count to "A" at the beginning of each sample period. With the prescaler set to divide by 40 the VCO frequency is:-

$$F_{vco} = A(40 \times 12.5)\ \text{kHz}$$

so the counter controls the frequency in 500 KHz steps.

12. Further 12.5 KHz steps in frequency can be added from 0 to 487.5 KHz by counting extra pulses with the prescaler. In operation the Prescaler divides by 41 until the count in another programmable counter in ML3 reaches 'B' and then divides by 40 until the first counter reaches 'A'. Then both counters are reset when a pulse passes to the output (see Fig. 2.3). The prescaler division number is set by ML3 Pin 7. The first counter has received 'B' pulses during the Prescaler division by 41 period, and therefore requires a further (A-B) pulses to produce an output pulse. Therefore the total number of input pulses required to produce an output is:-

$$N = B.41 + (A-B).40$$
$$= A.40 + B$$

The frequency is now defined by:-

$$F_{vco} = ((A \times 40) + B)12.5\ \text{kHz}.$$

B is set as a number from 0 to 39. For 25 KHz channel spacing, only even numbers are used so:-

for Fvco = 30.000 MHz A = 60 ; B = 0 ; N = 2400

for Fvco = 30.025 MHz A = 60 ; B = 2 ; N = 2402

for Fvco = 30.475 MHz A = 60 ; B = 38 ; N = 2438

for Fvco = 30.500 MHz A = 61 ; B = 0 ; N = 2440

13. The frequency data which sets the correct value of "N" is sent from the control board and stored in ML3. When the synthesizer frequency is changed new data is sent in serial form using the DATA, CLOCK and ENVELOPE inputs. At the beginning of every sample period the data is then used to set the values of A and B. For the example of Fvco = 30.475 MHz, the prescaler will give 60 output pulses, dividing by 41 for the first 38 pulses and then by 40 for the other 22 pulses.

Phase Comparator and Lock Detector

14. For the VCO frequency to be correct the output of the programmable divider must be locked to the output of the reference divider. The phase comparator in ML3 does this by comparing these two outputs and producing two pulsed outputs on the "pump-up" and "pump down" output lines. Depending on whether the divided VCO output is at a lower or higher frequency than the divided reference frequency, one of these pulses is lengthened. Pump-up pulses will cause the VCO frequency to increase and pump-down pulses cause the frequency to decrease.

15. A third output from the comparator is the out of lock (OOL) line (Pin 19). This line is high while the VCO is being locked onto frequency. When the correct frequency is reached the OOL line then goes low. A continuous high indicates that the synthesizer loop is unable to lock the VCO onto the required frequency. When the synthesizer is switched off during a 140 ms current saving period, the 7 V Rx SYN line is low, making the output of gate ML1C a logic '0', and components D16 and R53 ensure that the OOL SYN line from the board is held low. Thus the Control Board will not generate the OOL signal.

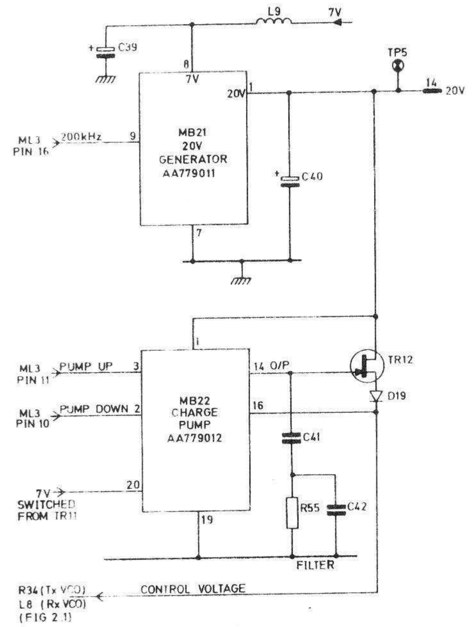
Charge Pump and Loop Filter (Fig. 2.4)

16. The charge pump circuitry is mounted on a Micro PCB MB22 and the loop filter is formed by C41, C42 and R55. The purpose of the charge pump and the loop filter is to convert the digital pump outputs of the LSI to a voltage level appropriate to the required frequency. This tuning voltage is applied to the varactor diode of the transmitter VCO via R34, and to the varactor diodes of the receiver VCO and RF tuned circuits on the Receiver Board via L8 and PL3.

17. If the VCO frequency is too low, negative pulses on the "pump-up" line are applied to the charge pumps and charge is pumped into the loop filter from pin 14 MB22. This charge is stored in C41 to give a higher voltage level for the varactor diodes. If the VCO frequency is too high, "pump-down" pulses are fed to the charge pump and the voltage to the varactor diodes will fall. To ensure stability of the phase locked loop and to give a short lock-up time, C42 and R55 are combined with C41 to give the required filter response. Because we require a steady tuning voltage, TR12 is used as a buffer stage to ensure that charge does not leak from the loop filter, and the control voltage is taken from its source. Pin 16 of MB22 provides a constant current source for the varactor control line, and also in the current saving mode turns OFF TR12 when the 7 V SW line on pin 20 goes low. A higher voltage than the 7 volts available is required for the varactor to cover the required frequency range (see Table 2.1). In addition as the loop comes into lock, overshoot has to be allowed for, and the maximum control voltage is therefore set to about 20 V.

20 V Generator

18. The 20 V generator derives its input, a square-wave at 200 kHz from ML3 pin 16. The output of nominally 20 V is fed to the charge pump micro PCB and to the Synthesizer Board pin 14 for use on the Receiver Board.



Charge Pump, Loop Filter Circuit
and 20V Generator Circuit Fig 2.4

Table 2.1 Control Voltage Range

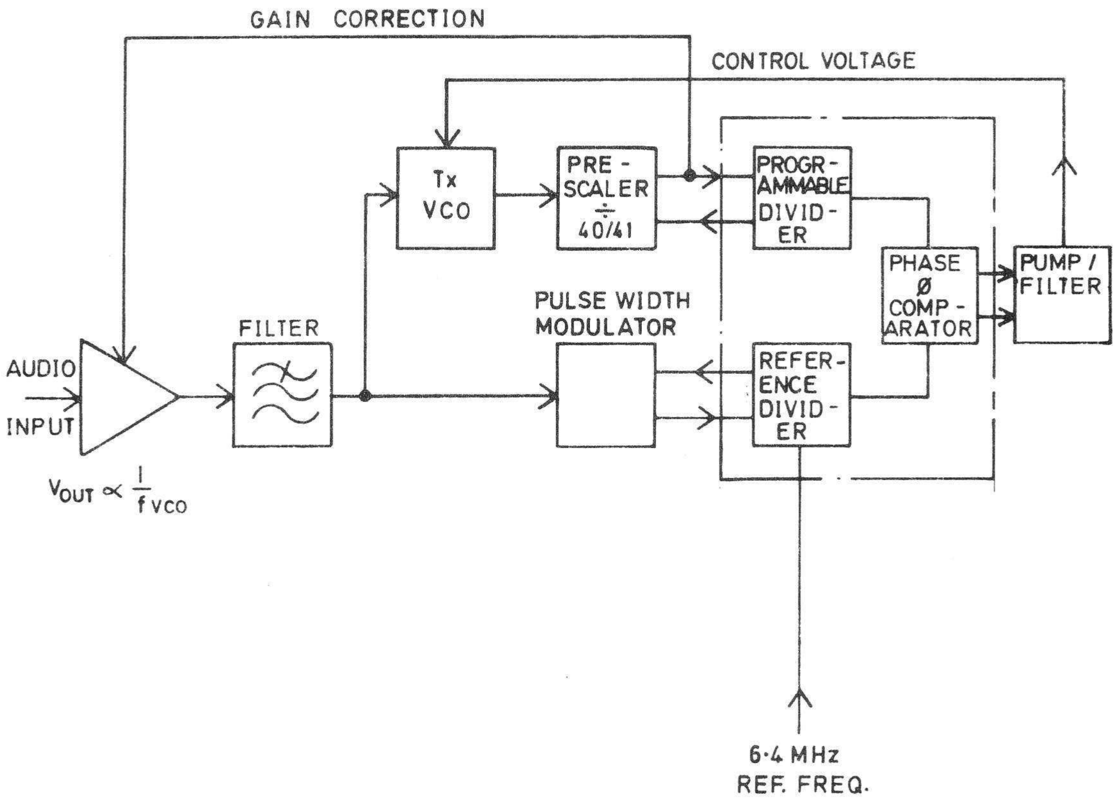
MODE	BAND	APPROX. CONTROL VOLTAGE RANGE
LOW BAND RX	30-37.975 MHz	1.0 - 7.5 volts
HIGH BAND RX	38-88 MHz	1.0 - 15.0 volts
LOW BAND TX	30-49.975 MHz	2.5 - 8.5 volts
HIGH BAND TX	50-88 MHz	3.5 - 12.0 volts

Principles of Modulation

19. Figure 2.5 is a general diagram of the synthesizer modulation system. The transmit VCO frequency, dependent on the loop filter control voltage, is modulated by the audio from the output of the low pass filter. The amplitude of the audio is frequency corrected by an output from the Prescaler (See Para. 22-24).

20. As the VCO frequency is modulated the 12.5 KHz entering the phase comparator from the programmable divider is also modulated. If this was compared directly with the 12.5 KHz output of the reference divider, this modulation would be seen by the phase comparator as errors in the VCO frequency. The phase comparator outputs would then vary the VCO control voltage to try and cancel out the frequency modulation. With a nominal loop bandwidth of 1 KHz the modulation would then be lost at low frequencies. It is thus necessary to stop the phase comparator from seeing these errors.

21. This is achieved by the Pulse Width Modulator. This circuit takes the output of the reference divider at 12.5 KHz, modulates and then feeds it to the phase comparator so that now both the reference divider output and the programmable divider output are equally modulated. The phase comparator now sees no error and the control voltage no longer tries to cancel out the modulation.



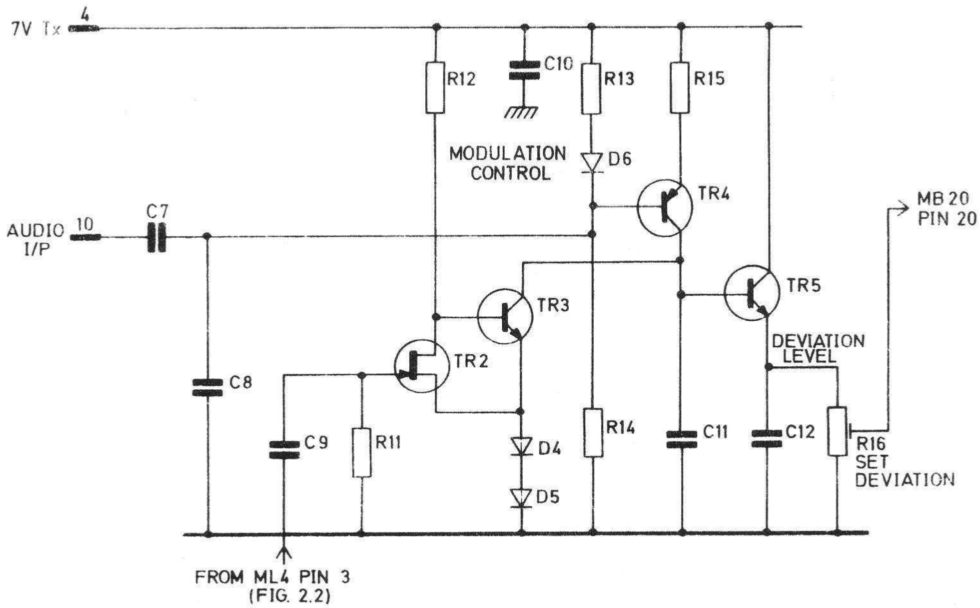
TH 5160

Block Diagram:
Synthesizer Modulation

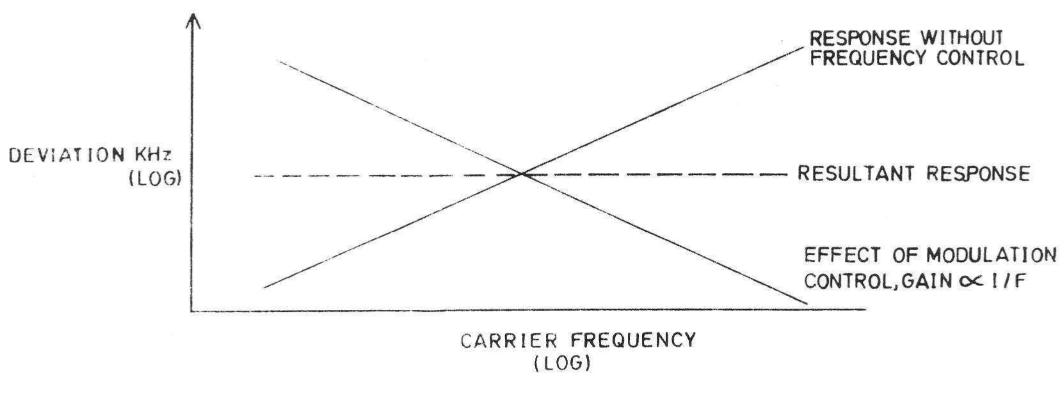
Fig 2.5

Modulation Control (Fig. 2.6 and 2.7)

22. The modulation system used has the characteristic that as the VCO frequency increases, the deviation level also increases for a set audio input. Because the same level of deviation is required for all carrier frequencies the Modulation Control circuit is used. As the carrier frequency increases, the audio gain of this circuit decreases. This is shown in Figure 2.7. The circuit is formed by TR2, TR3 and TR4 with their associated components.



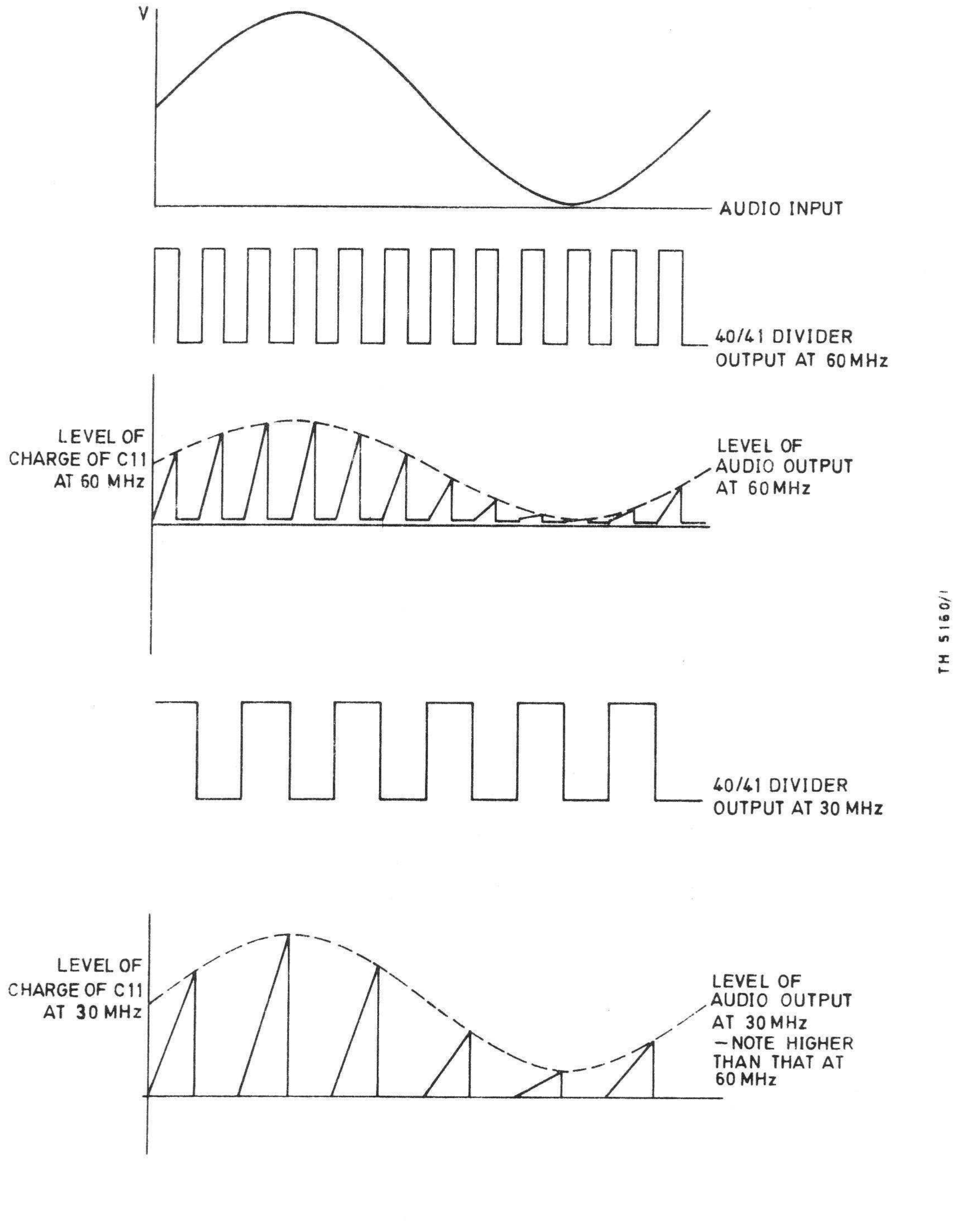
Modulation Control Circuit Fig. 2.6



Effect of Modulation Control Circuit. Fig. 2.7

23. A square wave output from the 40/41 divider is fed to the gate of buffer TR2 causing it to switch on and off. This in turn causes TR3 to switch off and on. When TR3 is off C11 will charge up via TR4 and the voltage at the collector of TR4 rises. The rate at which C11 charges depends on the audio signal voltage. Figure 2.8 shows that C11 will charge to a lower level at 60 MHz than at 30 MHz because it only has half the time to charge up.

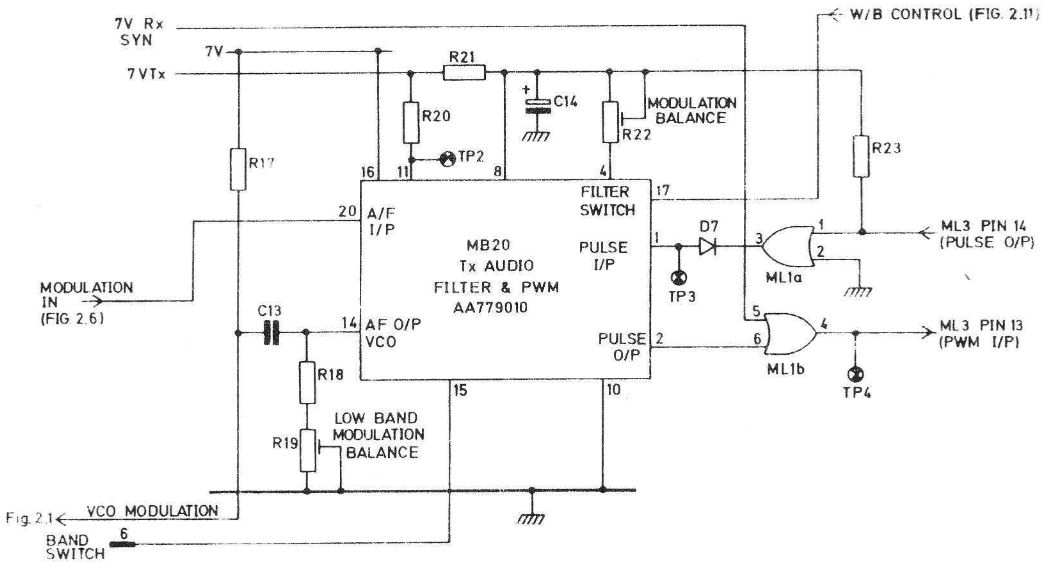
24. The final part of the modulation control circuit is a peak detector formed by TR5, C12 and R16 to remove the high frequencies. The overall gain of the synthesizer board is set by R16 to give the required deviation level.



Modulation Control Waveforms. Fig. 2.8.

Audio Filter (Fig. 2.9)

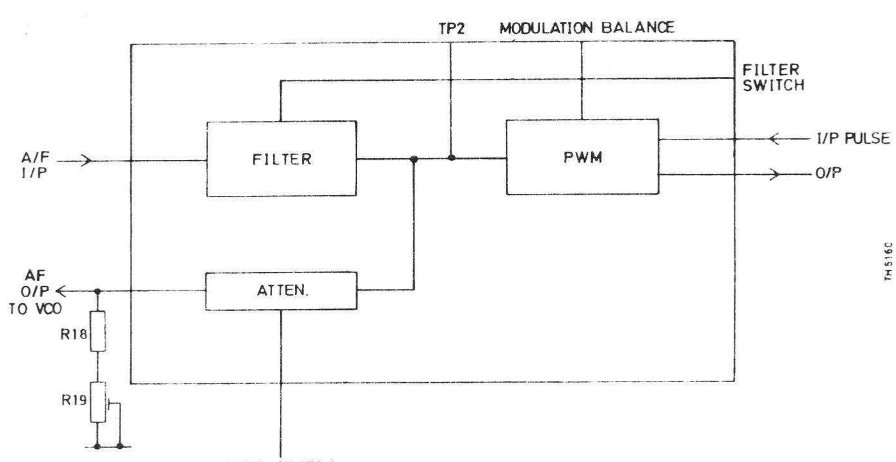
25. The modulating signal is low pass filtered by MB20 before being used to modulate the PLL. Pin 17 of MB20 is used to set the filter to one of two bandwidths. When this input is high the bandwidth is 3KHz. When pin 17 is low this is increased to 8KHz so that a 16K-bit data signal can be transmitted. The filter output can be monitored at TP2.



Audio Filtering and PWM Circuit Fig. 2.9

VCO Modulation

26. The output of the transmit filter modulates the transmit VCO frequency via varactor diode D10 (Fig 2.1). As the voltage at the cathode varies the frequency of oscillation of the VCO will vary as a function of the AF applied. In the high band, 50-88 MHz, the VCO audio comes directly from the output of the transmit filter. When the VCO is switched into the low band, pin 6 low, the audio level required by D10 becomes approximately a third of that provided by the transmit filter. The band switch input to MB20 (Fig 2.10) then switches in an attenuator circuit part of which is formed by R18 and R19. R19 allows the required attenuation to be set.

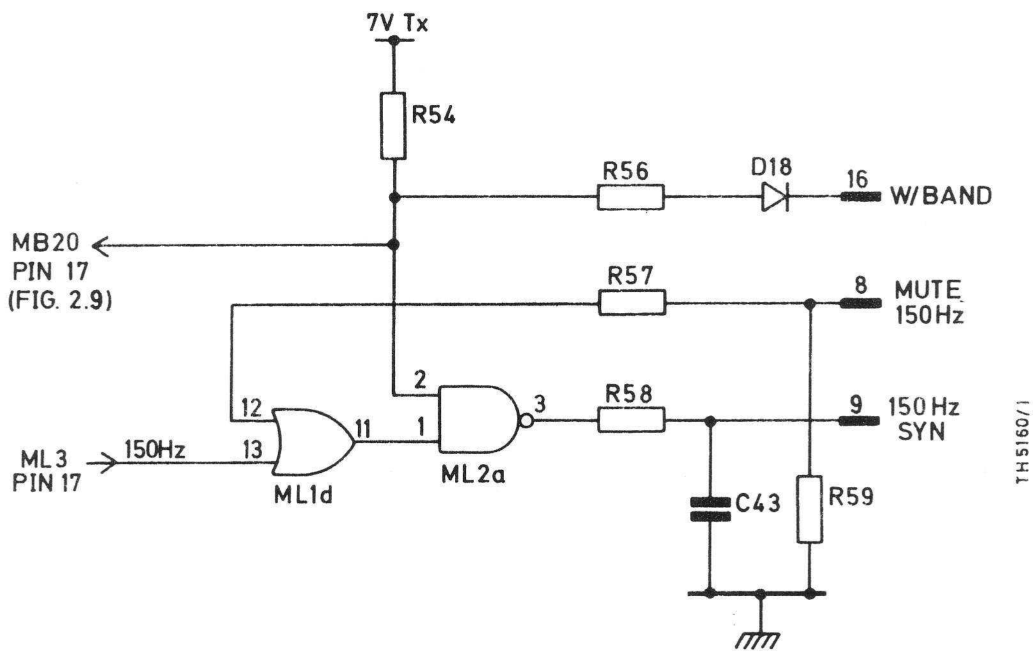


MB20 Block Diagram Fig 2.10

Pulse Width Modulation (Fig 2.9)

27. The Pulse Width Modulator is part of MB20. During transmit the sampling output from the reference divider is gated out through ML3 pin 14 as a positive going pulse edge. R23 is a pull up resistor for this output. This pulse edge is delayed and modulated by the pulse width modulator before returning to the phase comparator of ML3. The level of modulation is set up using R22. In receive, when the modulation circuits are switched off, the input to ML3 pin 13 is held high by 7V RX SYN on Pin 5 of ML1b, and the reference divider output is internally gated to the phase comparator inside ML3.

150 Hz Switching (Fig. 2.11)



150Hz Switching Fig. 2.11

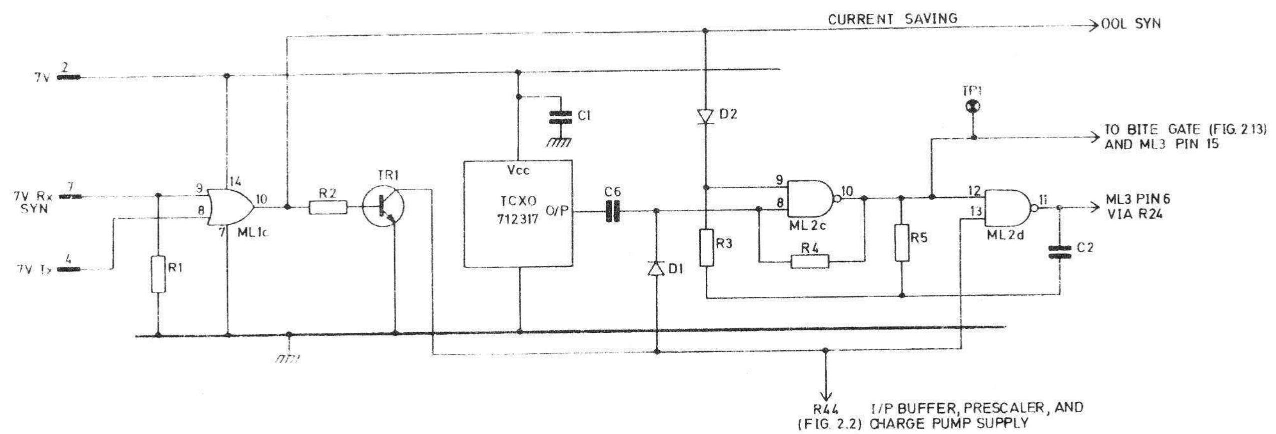
28. The 150 Hz pilot tone which is used during transmission is generated from the output of the reference divider. The tone is gated and then filtered by R58 and C43 before leaving the board. In transmit the tone then passes through the 150 Hz filter on the receiver board before being mixed with the synthesizer audio input, on the Motherboard.

29. The Mute input is used to switch off the 150 Hz tone for test purposes by applying +10V to the front panel audio SK2 pin A and therefore Pin 8, which inhibits the 150 Hz at the output of ML1d. This allows the transmit deviation to be measured without the pilot tone.

30. The Wide Band control input Pin E SK1, is pulled low when a 16 K-bit DATA ancillary is connected to the front panel audio SK1. This pulls Pin 16 low, which inhibits the 150 Hz at the output of ML2a since, under these conditions the pilot tone is not required.

31. When the radio is in the receive condition the 7 V Tx line is at 0 V, and hence R54 causes ML2 pin 2 to be low thus switching off the pilot tone.

Current Saving (Fig. 2.12)



6·4MHz Oscillator and Current Saving Circuit   Fig. 2.12

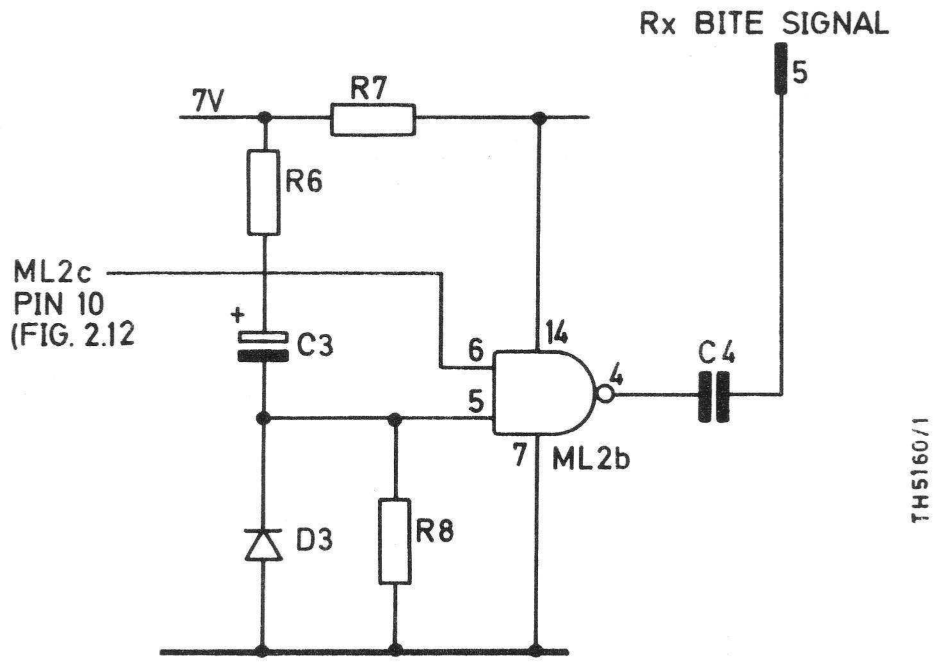
32. Under no signal conditions during receive, the current saving circuitry on the Audio board causes the 7V Rx SYN line to be low for approximately 140 mS in every 160 mS. When both 7V Rx SYN and 7V Tx are low ML1 Pin 10 is low, TR1 if OFF and, the supply to the prescaler, and input buffer TR10 and Charge Pump is switched off, by TR11 (via R44) to reduce power consumption. (See Fig. 2.2)

33. During the 140mS off period ML2c and ML2d form a 10 kHz free-running RC oscillator. The 10 kHz output of the oscillator is applied to I/P pin 6 (via R24) and I/P pin 15 of ML3 to ensure that the dynamic dividers in ML3 do not draw current when no Rx signal is present.

34. The 10 kHz free-running oscillator formed by ML2c and ML2d is stopped, when a signal is received (or in Tx), by either input to ML1c going high, and TR1 collector going low. Thus input 13 on ML2 is clamped at '0' and input 9 of ML2c clamped at '1'. Similarly via R44, TR11 is turned ON and supply is switched ON to the prescaler, input buffer TR10 and charge pump.

BITE Gate (Fig. 2.13)

35. When the radio is switched on the voltage at pin 5 of ML2b will be 7V therefore opening the gate for the 6.4 MHz and its harmonics to be used during the receiver BITE sequence. The 5th harmonic (32 MHz) enters the Receiver Board at Pin 16 where it is picked up by the Rx input. As C3 charges the voltage at pin 5 of ML2b will fall so that after approximately five seconds the gate is closed at the end of the BITE sequence.



BITE Gate Circuit Fig. 2.13

CHAPTER 3

ALIGNMENT AND TESTING

CONTENTS

TABLES

CHAPTER 3

ALIGNMENT AND TESTING

INTRODUCTION

1. Table 3.1 gives details for full alignment of the Synthesizer Board and for measurement of the main parameters of this board while it is fitted to a PRM 4700 unit. This may be necessary for routine purposes, but should always be carried out after any components have been replaced.

2. It is assumed in the procedure given that all other boards in the unit are working correctly and within their specifications.

3. All adjustments must closely follow the procedure given, and random adjustments must not be made.

4. The TCXO is pre-aged, therefore frequency adjustments are required at infrequent intervals (i.e. check about once per year).

INITIAL CONDITIONS

5. A 10.5 V power supply should be connected to pins B (+ve) and D (-ve) of SK2 on the front panel of the unit. This may conveniently be done using a Racal Test Jig TJ 947.

6. The tests should be followed in numerical order. In the chart the following abbreviations have been made which refer to the switching on the interconnection box TJ 947:-

(1) TX/RX/RX Economising: Refer to whether the radio is in the Transmit, Receive (Squelch Overriden) or Current Saving state (Squelch - no signal).

(2) Tone/Mute: Refer to the 150 Hz pilot tone switch.

Tone = Pilot Tone ON.
Mute = Pilot Tone OFF.

(3) Nrow/Wide: Refer to the selection for N/B or W/B.

Nrow = Narrow Band MIC I/P selected.
Wide = Wide Band DATA I/P selected.

TEST EQUIPMENT REQUIRED

7. (1) Power Supply

Voltage	:	10.5 V
Current	:	2 A
Suitable Instrument	:	Farnell L30-2

(2) AF Generator

Frequency	:	1 - 10 kHz sinewave
Output Level	:	1 V pk-pk
Suitable Instrument	:	Racal 9083

(3) Oscilloscope

Frequency	:	0 - 100 MHz
Suitable Instrument	:	Tektronix 465 or HP1740A/H07 with probe

(4) Digital Frequency Meter

Frequency	:	100 MHz
Accuracy	:	Better than ±1 part in 10^7
Suitable Instrument	:	Racal 9912 04A/09 option

(5) Modulation Meter

Frequency	:	30 - 90 MHz
Deviation Measurement	:	100 Hz to 10 kHz
Suitable Instrument	:	Racal 9009

(6) RF Power Meter

Frequency	:	30 - 90 MHz
Range	:	30 mW
Impedance	:	50Ω
Suitable Instrument	:	Farnell 2081

(7) Distortion Analyser

Frequency	:	0 - 20 kHz
Suitable Instrument	:	HP333A or 332

(8) Interconnection Box Racal TJ 947

NOTE: Items 4, 5, 6 and 7 may all be replaced with a Marconi Modulation Meter 2305 with option 46883-527G.

TABLE 3.1

Alignment Procedures

Test No	Parameter	Audio Input	Input Conditions	Freq MHz	Monitor	Adjust	Limits	Notes
1	Synthesizer Lock	Off	TX Tone Nrow	50.000	Motherboard TP1		< 1.2V	
2	150Hz Tone O/P		TX Tone Nrow RX Tone Nrow TX Mute Nrow TX Mute Wide TX Tone Wide		Motherboard TP19		> 0.5V p-p < 1.0V p-p No Signal No Signal No Signal No Signal	Using Oscilloscope
3	20V Generator		TX		TP5		> 17V	Using Oscilloscope
4	RX BITE		RX		ML2 Pin 4		Signal only present for 3 to 5 secs. after switch on	Switch off power supply for at least sec then switch on
5	Frequency		TX	50.000	RF Freq PL2	TCXO	50Hz	At 25^{o}C
6	Economising Clocking Oscillator		RX Economising		TP1 TP6		Period > 75 S < 170 S < 5.8V p-p > 3.8V p-p	The oscillation is broken by pulses of 6.4MHz. Measure required signal using Oscilloscope on 20 S/div
7	Prescaler		RX		TP6		No Signal	Disconnect PL3 (Reconnect after Test)
8	VCO Power Low Band		TX	30.000 40.000 49.000	RF Power Output & RF Freq at PL2		> 7mW < 16mW ±1kHz	50Ω load
9	VCO Power High Band		TX	50.000 60.000 70.000 80.000 88.000	RF Power Output & RF Freq at PL2		> 7mW < 16mW ±1kHz	50Ω load
10	Modulation Balance High Band	1.0kHz Sinewave 1.0V p-p pd W/B I/P	TX Wide	70.000	Demodulated RF O/P PL2	R22 & R16	Cleanest Sqr.Wave 5kHz dev	Modulation Meter with Filter Out AF O/P to Oscilloscope Display max amplitude & 1 cycle of waveform
11	Modulation Balance Low Band	1.0kHz Sinewave 1.0V p-p pd W/B I/P	TX Wide	40.000	Demodulated RF O/P PL2	R19	Cleanest Sqr.Wave	Modulation Meter with Filter Out AF O/P to Oscilloscope Display max amplitude & 1 cycle of waveform
12	Frequency Synthesis	Off	TX	30.000 1MHz steps to 39.000 .1MHz steps to 39.900 25kHz steps to 39.975	RF Freq PL2		±1kHz	
13	RX Lock Up Time & Frequency Range Low Band	Off	RX Economising	30.000 34.000 37.000	Motherboard TP1		< 8mS	Using Oscilloscope See Chap. 4 Table 4.3
14	RX Lock Up Time & Frequency Range High Band		RX Economising	38.000 50.000 60.000 70.000 80.000 88.000	Motherboard TP1		< 8mS	Using Oscilloscope
15	Deviation	1.0kHz Sine Wave 60mV rms pd N/B I/P	TX Mute Nrow	50.000	Demodulated RF O/P	R16	5.0kHz	Modulation Meter with Filter Out

TABLE 3.1 (Continued)

Test No	Parameter	Audio Input	Input Conditions	Freq MHz	Monitor	Adjust	Limits	Notes
16	Filter Switching	5kHz Sine Wave 1.0V p-p pd W/B I/P 5kHz Sine Wave 60mV rms pd N/B I/P	TX Wide TX Mute Nrow	50.000	Demodulated RF O/P		> 4.0kHz < 2.3kHz	Modulation Meter with Filter Out
17	Modulation Balanced Distortion Low Band	1.0kHz Sine Wave N/B I/P Set to give 3kHz dev	TX Mute Nrow	30.000 40.000 49.000	Demodulated RF O/P		< 10%	Modulation Meter with Filter Out
18	Modulation Balanced Distortion High Band	1.0kHz Sine Wave N/B I/P Set to give 3kHz dev	TX Mute Nrow	50.000 60.000 70.000 80.000 88.000	Demodulated RF O/P		< 10%	Modulation Meter with Filter Out
19	Residual Deviation Low Band	Off	TX	30.000 40.000 49.000	Demodulated RF O/P		< 250Hz	Modulation Meter with Filter In
20	Residual Deviation High Band	Off	TX	50.000 60.000 70.000 80.000 88.000	Demodulated RF O/P		< 250Hz	Modulation Meter with Filter In

CHAPTER 4

FAULT LOCATION

CONTENTS

TABLES

ILLUSTRATIONS

CHAPTER 4

FAULT LOCATION

INTRODUCTION

1. The flow charts, Tables 4.4 to 4.7 of this chapter, should be used to locate a faulty stage in the synthesizer. The procedure should, preferably, be carried out at room temperature, unless the fault occurs only at extremes of temperature.

CMOS HANDLING PRECAUTIONS

2. The input impedance of a CMOS device is of the order to 10^{14} ohms. The break-down voltage of the oxide within the device is about 100 volts. As static voltages of up to 4 kV can be generated by stroking silk, nylon or certain plastic containers, it is essential that precautions are taken to prevent high voltages occurring at the leads of CMOS devices, as follows:-

(1) The tips of soldering irons should be earthed to the earth plane of the board being soldered.

(2) The devices should not be stored in plastic bags or containers (unless the plastic has been specially treated with anti-static chemicals).

(3) Operators should not wear nylon or plastic gloves, or rubber-soled shoes.

(4) As many leads as possible should be 'shorted' with the fingers during handling.

(5) Do not remove the input connection with the device connected to the supply rail.

TEST EQUIPMENT REQUIRED

3. The equipment required for fault location is listed in Chapter 3.

VOLTAGES AND WAVEFORMS (Nodes and test points refer to circuit diagram Fig. 2).

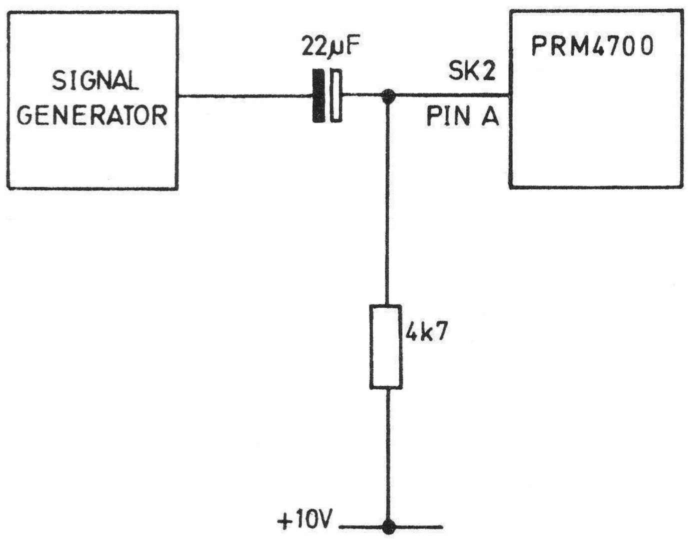
4. To assist in fault finding Table 4.1 gives typical voltages and waveforms at two transmit frequencies (in a radio set up to give 5 kHz deviation). The audio input can be either:-

(1) Narrow Band, 150 Hz tone off.
1 kHz sinewave at 60 mV rms pd into N/B input.

or

(2) Wide Band.
1 kHz sinewave at 1.0 V pk-pk pd into W/B input.

5. It is necessary to mute the 150 Hz pilot tone to carry out voltage and waveform testing. If a TJ 947 interconnection jig is not available then the circuit shown in Fig. 4.1 must be used to mute the 150 Hz tone.



TH5160/1

150Hz Mute Circuit Fig 4.1

6. Table 4.2 gives typical voltages and waveforms at one receive frequency. There are two columns; one for the normal receive state, 7 V Rx high, and one for the 140 mS "OFF" condition which ocurs during current saving, when both 7 V Tx and and 7 V Rx SYN are low. This can be seen in Table 4.3.

7. All voltages and waveforms are nominal and are measured using an oscilloscope with a 1 M ohm/10 pF probe unless otherwise stated. All RF voltages must be measured using a probe with a very short earth lead (less than 0.5 in).

<u>USE OF FLOW CHARTS</u>

8. The flow charts cover the main fault conditions that are liable to be seen. They provide a guide to the area or group of components where the fault may exist but are not intended to be exhaustive. If the fault can be described under one of the following headings then that chart may be used.

Table 4.4 OOL in both Transmit and Receive
Table 4.5 OOL in Transmit only
Table 4.6 OOL in Receive only
Table 4.7 Modulation distorted or missing

A removable link, LK1, is provided to enable the phase locked loop to be opened to aid 'fault' finding. The tests are performed with the faulty board in a PRM 4700 set to low power, in which all the other boards are known to be working and within their specifications.

GENERAL

9. If the fault is not clear, first follow the test and alignment procedure in Chapter 3 until the fault becomes evident. If any components are changed or any adjustments made during fault finding, this procedure should again be followed before returning the board to service.

TABLE 4.1

Voltage or Waveforms - Transmit Mode

Apply 10.5 volts to Pin B and D of SK2. Mute 150 Hz tone, LO PWR, Audio I/P as Para. 4.

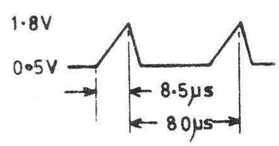
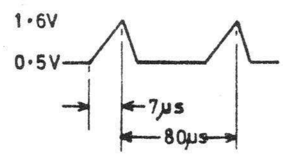
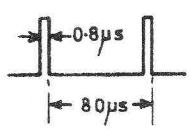
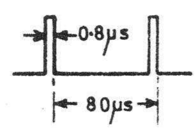
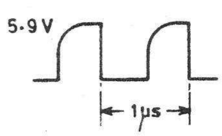
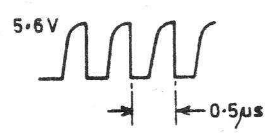
Node or Test Point	Tx 40.100 MHz	Tx 80.000 MHz
TP1	6.4 MHz - 6.5 V p-p	6.4 MHz - 6.5 V p-p
TP2	AF 280 mV p-p @ 1.8 V DC	AF 140 mV p-p @ 1.6 V DC
TP3		
TP4		
TP5	19 V	19 V
TP6		
TP7	6.9 V	6.9 V
TP8	6.0 V	9.0 V
1	6.9 V	6.9 V
2	6.9 V	6.9 V
3	AF 540 mV p-p @ 5.5 V DC	AF 540 mV p-p @ 5.5 V DC

Table 4.1 Continued

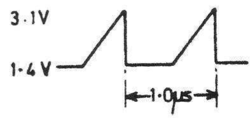
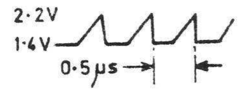
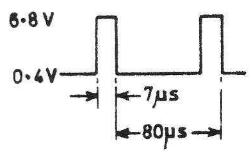
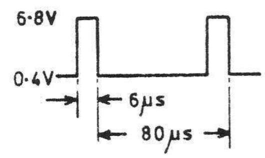
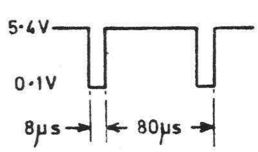
Node or Test Point	Tx 40.100 MHz	Tx 80.000 MHz
4		
	Without Modulation	Without Modulation
5	AF 280 mV p-p @ 0.52 V DC	AF 140 mV p-p @ 0.32 V DC
6	6.8 V	6.8 V
7	85 mV p-p @ 0.6 V DC	130 mV p-p @ 1.5 V DC
8		
9	0 V	5.3 V
10	-1.2 V	6.7 V
11	AF 80 mV p-p @ 3.5 V DC	AF 125 mV p-p @ 3.5 V DC
12	0.65 V	0.6 V
13	0.95 V	1.0 V
14	RF 3.8 V p-p @ 0 V DC	RF 3.7 V p-p @ 0 V DC
15	0.75 V	0.75 V
16	RF 2.4 V p-p @ 0.7 V DC	RF 2.1 V p-p @ 0.7 V DC
17	RF 2.7 V p-p @ 1.4 V DC	RF 3.2 V p-p @ 1.4 V DC
18	RF 5.3 V p-p @ 6 V DC	RF 5.2 V p-p @ 6 V DC
19	RF 2.0 V p-p @ 0.8 V DC	RF 1.5 V p-p @ 0.8 V DC
20	RF 0.6 V p-p @ 4.8 V DC	RF 0.45 V p-p @ 4.8 V DC
21	0 V	0 V
22		5.4 V

Table 4.1 Continued

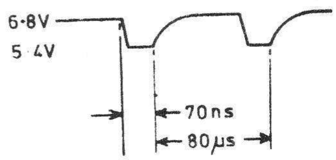
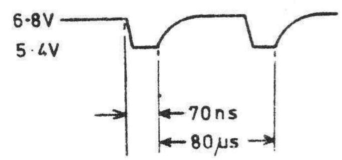
Node or Test Point	Tx 40.100 MHz	Tx 80.000 MHz
23	0.1 V	0.1 V
24	0.6 V	0.6 V
25 & 26		

TABLE 4.2

Voltage or Waveforms - Receive Mode

Apply 10.5 volts to Pins B and D of SK2. Mute 150 Hz tone, LO PWR.

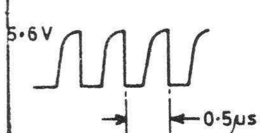
Node or Test Point	Rx 58.600 MHz 7 V Rx High	Rx (Current-Saved) 58.600 MHz 7 V Rx Low
TP1	6.4 MHz - 6.5 V p-p	8.5 kHz 7 V p-p
TP2	0.1 V	0 V
TP3	0 V	0 V
TP4	7 V	0 V
TP5	19 V	19 V
TP6		8.5 kHz 5.5 V p-p
TP7	6.9 V	0 V
TP8	6.0 V	Approx. 6.0 V
1	6.9 V	0 V
2	6.9 V	8.5 kHz

Table 4.2 Continued

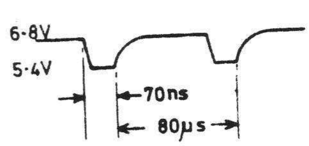
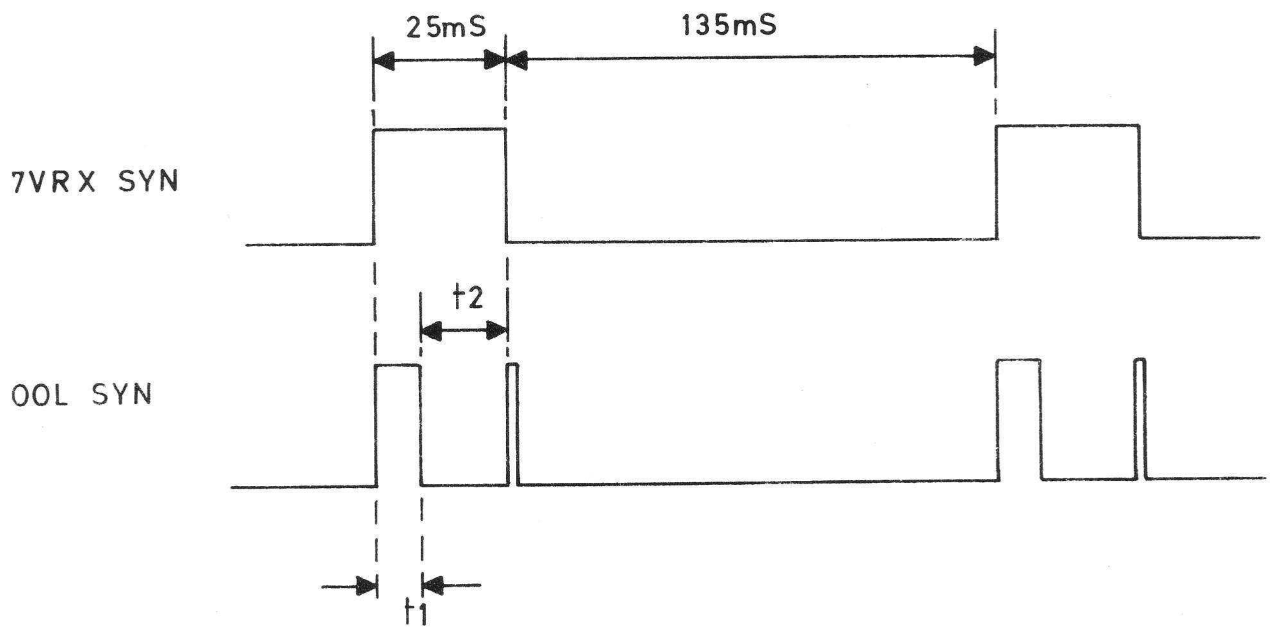
Node or Test Point	Rx 58.600 MHz 7 V Rx High	Rx 58.600 MHz 7 V Rx Low
3	0 V	0 V
4	0.4 V	-0.1 V
5	0 V	0 V
6	0.1 V	0 V
7	0 V	0 V
8	0 V	0 V
9	0 V	0 V
10	0 V	0 V
11	3.5 V	3.5 V
12	0 V	0 V
13	0 V	0 V
14	0 V	0 V
15	0 V	0 V
16	0 V	0 V
17	0.1 V	0 V
18	0.1 V	0 V
19	RF 2.0 V p-p @ 0.8 V DC	0 V
20	RF 0.65 V p-p @ 4.8 V DC	0 V
21	0 V	6.2 V
22	5.4 V	0 V
23	0.1 V	6.8 V
24	0.6 V	0 V
25		0 V
26		6.9 V

TABLE 4.3

Typical Supply Switching and Lock Up Waveforms during Current Saving

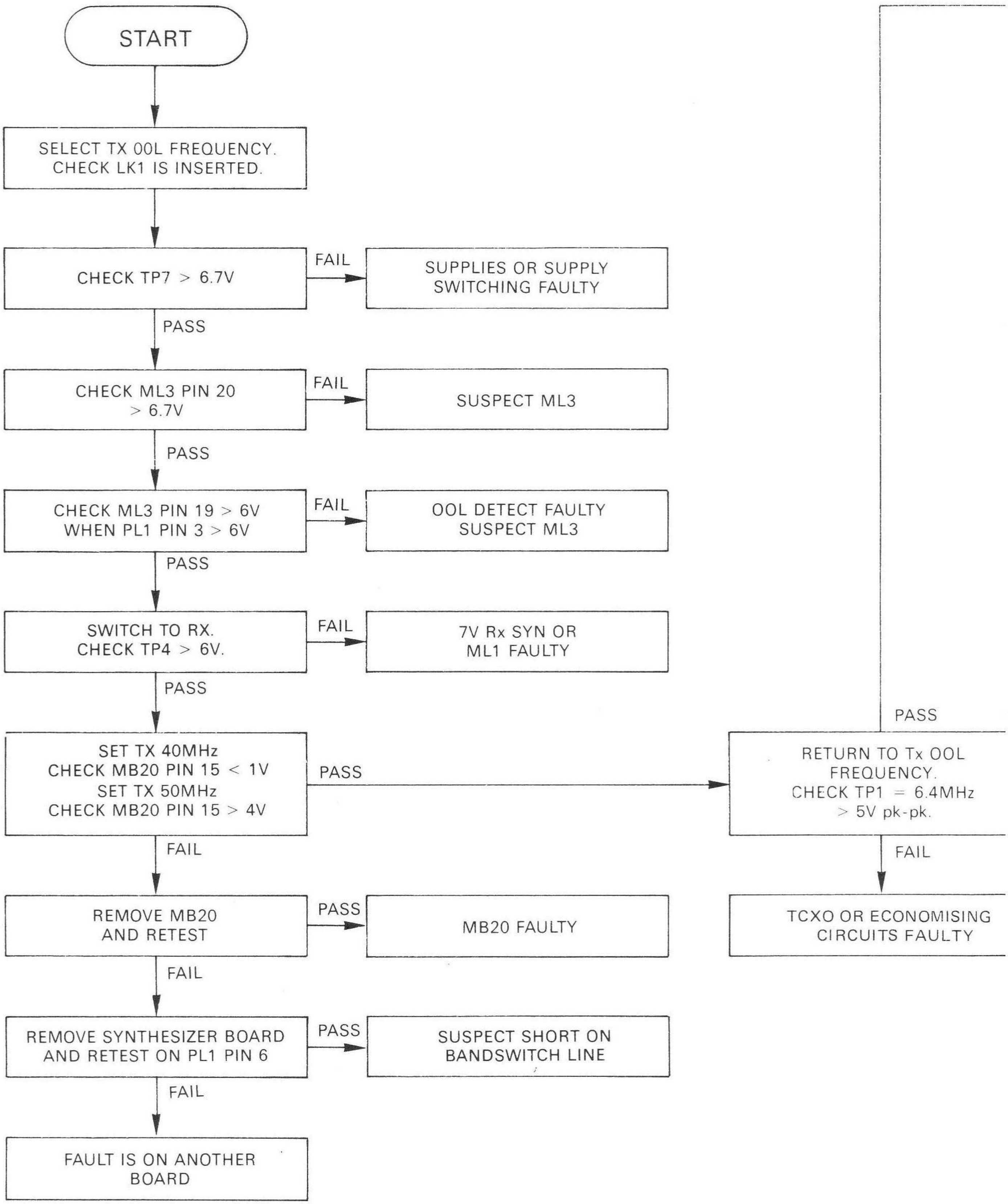


LOCK UP TIME = t1

N.B. When measuring lock up time in current saving the OOL line must remain low during period t2, i.e. until the 7 V Rx line goes low. The OOL line is not necessarily continuously high during period t1.

TABLE 4.4 FAULT FINDING GUIDE FOR OOL IN BOTH TRANSMIT AND RECEIVE.

10.5V at SK2



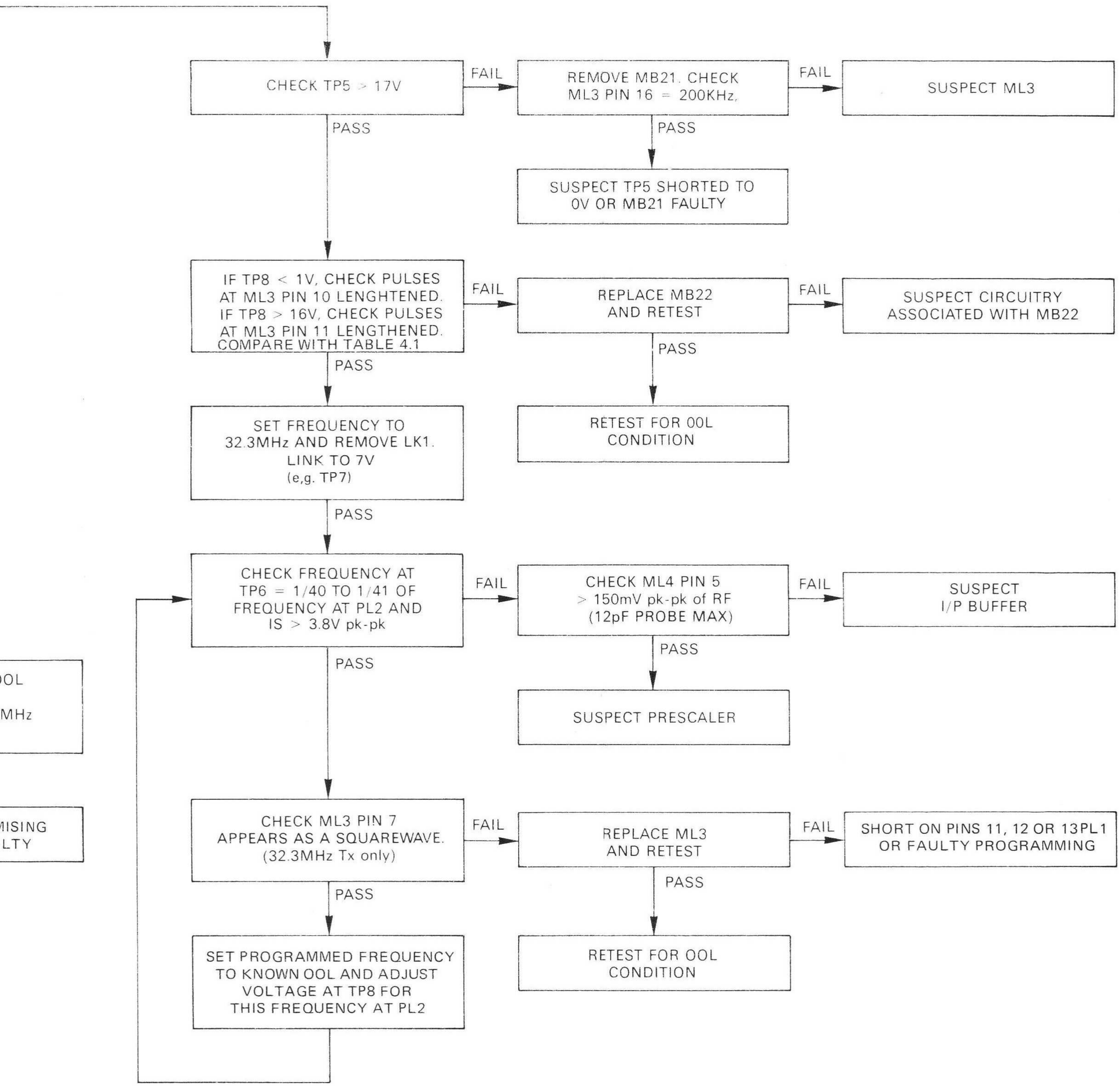
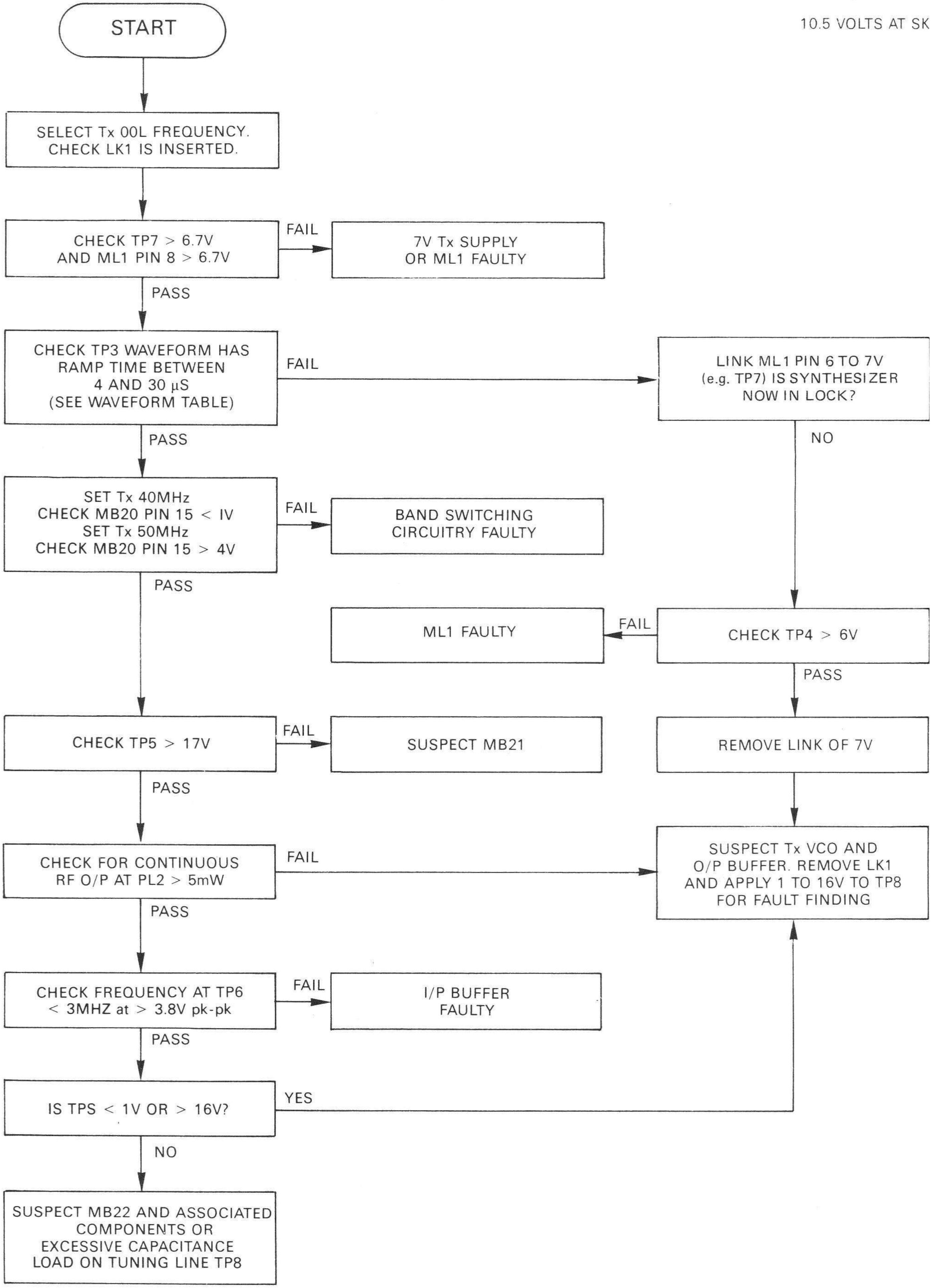

CHECK TP5 > 17V
FAIL
REMOVE MB21. CHECK ML3 PIN 16 = 200KHz.
FAIL
SUSPECT ML3
PASS
SUSPECT TP5 SHORTED TO 0V OR MB21 FAULTY
PASS
IF TP8 < 1V, CHECK PULSES AT ML3 PIN 10 LENGHTENED. IF TP8 > 16V, CHECK PULSES AT ML3 PIN 11 LENGTHENED. COMPARE WITH TABLE 4.1
FAIL
REPLACE MB22 AND RETEST
FAIL
SUSPECT CIRCUITRY ASSOCIATED WITH MB22
PASS
RETEST FOR 00L CONDITION
PASS
SET FREQUENCY TO 32.3MHz AND REMOVE LK1. LINK TO 7V (e,g. TP7)
PASS
CHECK FREQUENCY AT TP6 = 1/40 TO 1/41 OF FREQUENCY AT PL2 AND IS > 3.8V pk-pk
FAIL
CHECK ML4 PIN 5 > 150mV pk-pk of RF (12pF PROBE MAX)
FAIL
SUSPECT I/P BUFFER
PASS
SUSPECT PRESCALER
PASS
OOL
MHz
MISING
LTY
CHECK ML3 PIN 7 APPEARS AS A SQUAREWAVE. (32.3MHz Tx only)
FAIL
REPLACE ML3 AND RETEST
FAIL
SHORT ON PINS 11, 12 OR 13PL1 OR FAULTY PROGRAMMING
PASS
RETEST FOR OOL CONDITION
PASS
SET PROGRAMMED FREQUENCY TO KNOWN OOL AND ADJUST VOLTAGE AT TP8 FOR THIS FREQUENCY AT PL2

TABLE 4.5 FAULT FINDING GUIDE ONLY

10.5 VOLTS AT SK



GUIDE FOR 00L IN TRANSMIT
NLY

.TS AT SK2

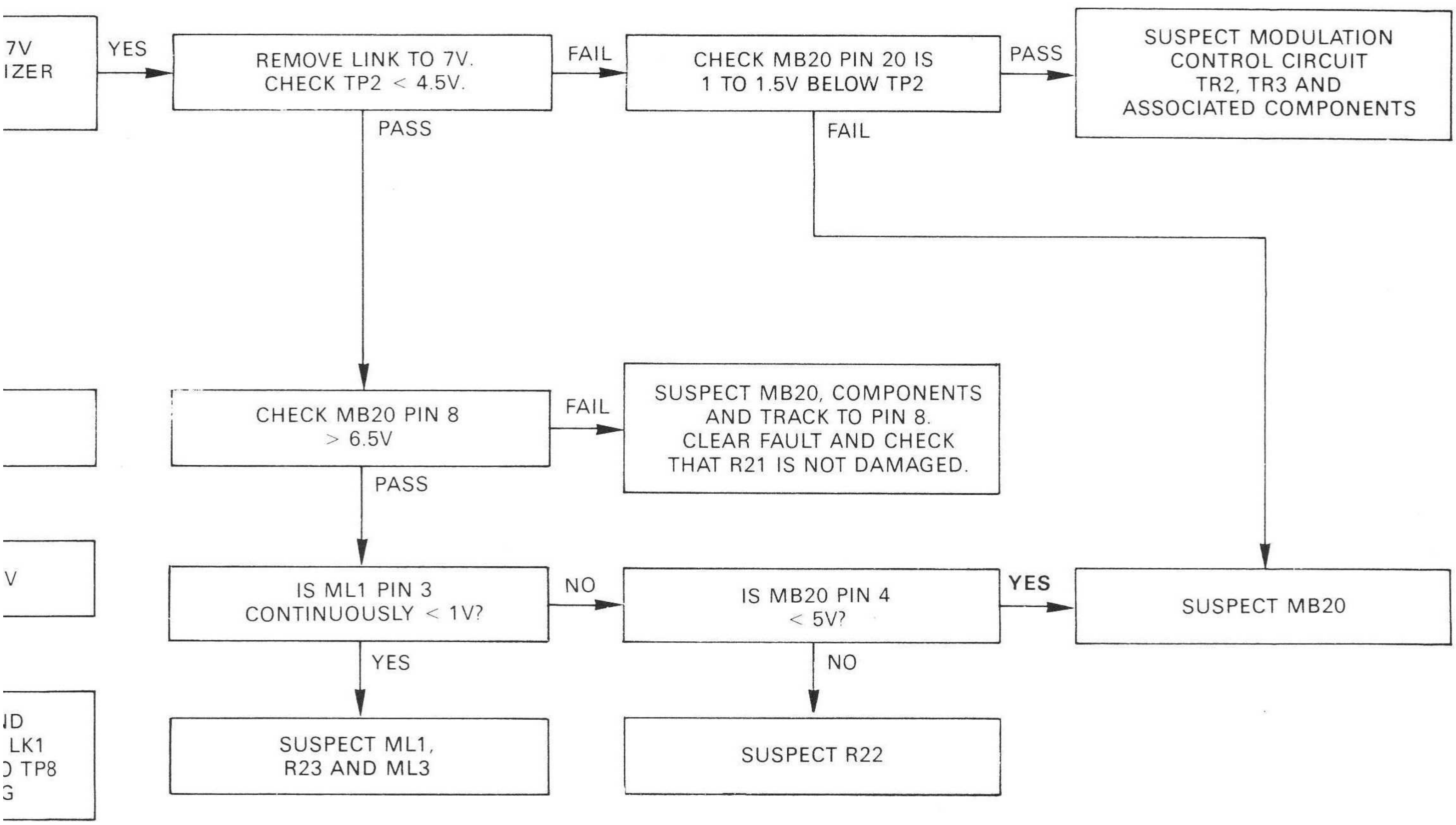


TABLE 4.6 FAULT FINDING GUIDE FOR OOL IN RECEIVE ONLY.

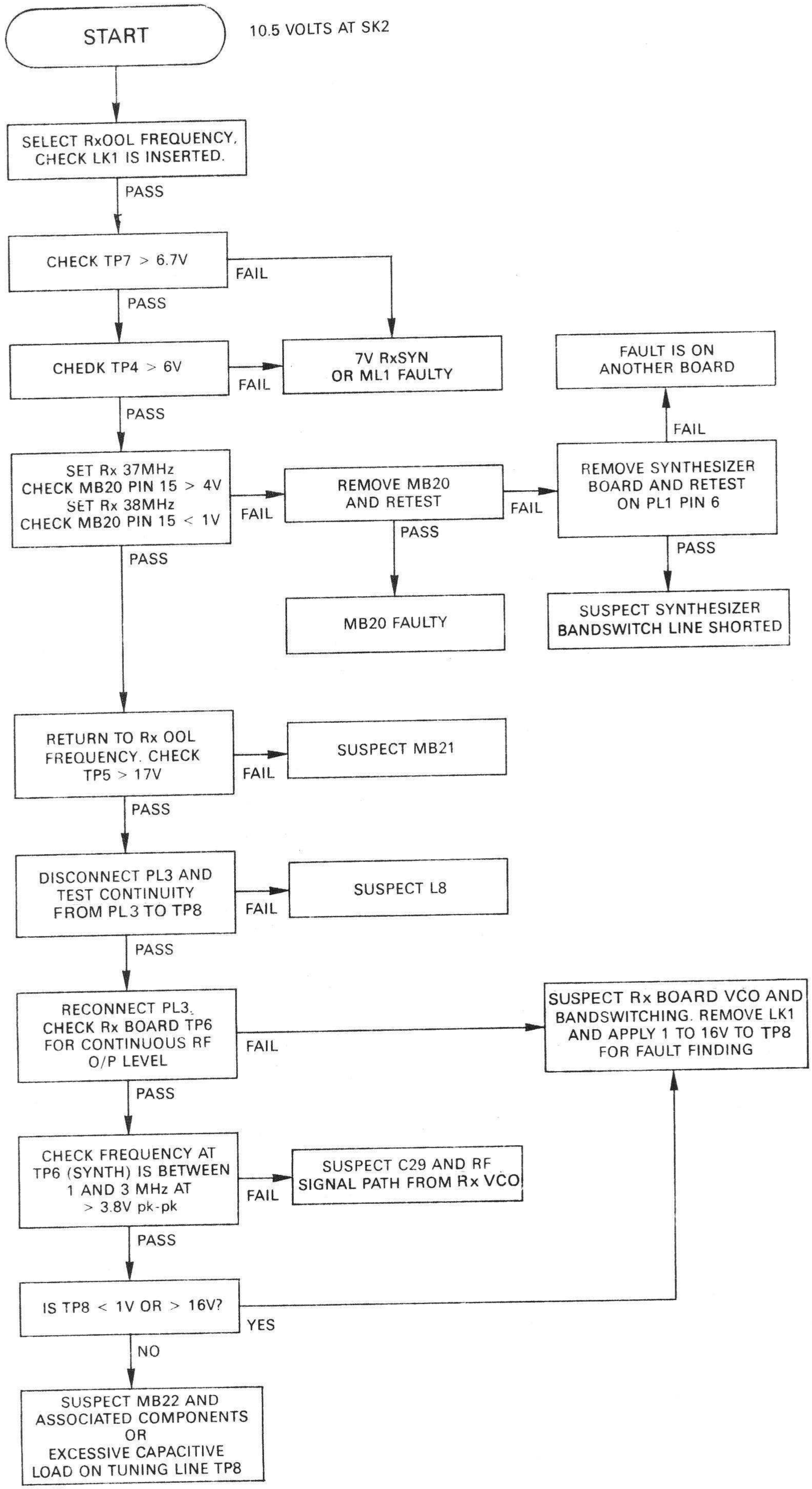
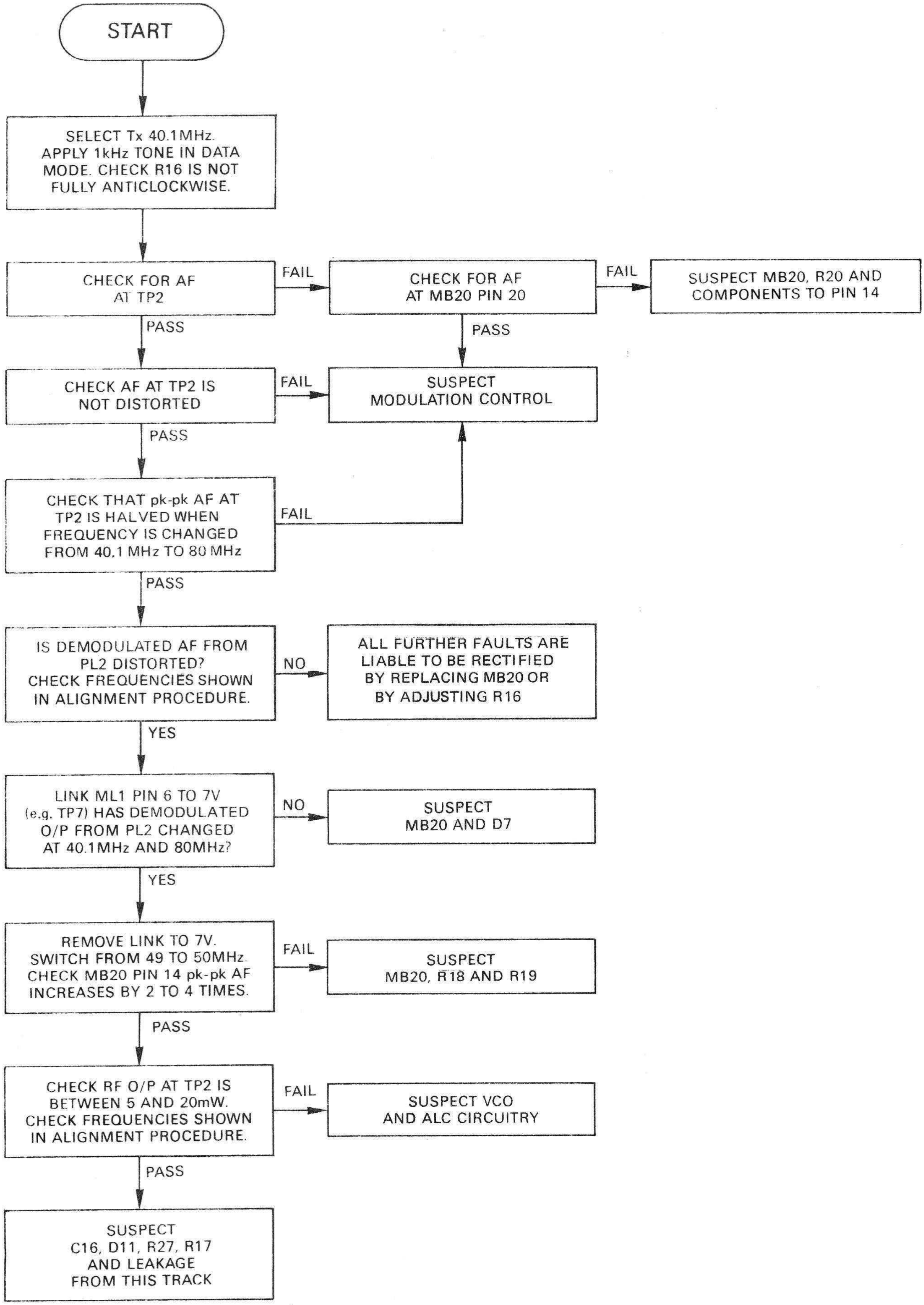


TABLE 4.7 FAULT FINDING GUIDE FOR INCORRECT MODULATION

10.5 VOLTS ON SK2



CHAPTER 5
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COMPONENTS LIST
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CHAPTER 5

COMPONENTS LIST

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
		SYNTHESIZER PCB (AA 709105) Components Prefix 12			
Resistors	Ω		W		
R1	220k	Carbon Film	¼	5	927773 EQ
R2	47k	Carbon Film	¼	5	927772 EQ
R3	220k	Carbon Film	¼	5	927773 EQ
R4	220k	Carbon Film	¼	5	927773 EQ
R5	47k	Carbon Film	¼	5	927772 EQ
R6	5.6k	Carbon Film	¼	5	930007 EQ
R7	68	Carbon Film	¼	5	924326 EQ
R8	1M	Carbon Film	¼	5	927803 EQ
R9		Not Used			
R10		Not Used			
R11	1M	Carbon Film	¼	5	927803 EQ
R12	5.6k	Carbon Film	¼	5	930007 EQ
R13	18k	Metal Oxide	¼	2	900994 EQ
R14	100k	Metal Oxide	¼	2	915190 EQ
R15	1.2k	Metal Oxide	¼	2	911179 EQ
R16	5k	Variable			912659 EQ
R17	1M	Carbon Film	¼	5	927803 EQ
R18	3.3k	Carbon Film	¼	5	927764 EQ
R19	5k	Variable			912659 EQ
R20	1k	Carbon Film	¼	5	927760 EQ
R21	33	Carbon Film	¼	5	926465 EQ
R22	10k	Variable			915565 EQ
R23	5.6k	Carbon Film	¼	5	930007 EQ
R24	10k	Carbon Film	¼	5	927768 EQ
R25		Not normally fitted			
R26		Not normally fitted			
R27	220	Carbon Film	¼	5	927756 EQ
R28	820	Metal Oxide	¼	2	917065 EQ
R29	10k	Carbon Film	¼	5	927768 EQ
R30	1k	Carbon Film	¼	5	927760 EQ
R31	1M	Carbon Film	¼	5	927803 EQ
R32	47k	Carbon Film	¼	5	927772 EQ
R33	1k	Carbon Film	¼	5	927760 EQ
R34	1k	Carbon Film	¼	5	927760 EQ
R35	1k	Carbon Film	¼	5	927760 EQ

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R36	150	Carbon Film	¼	5	927755 EQ
R37	33	Carbon Film	¼	5	926465 EQ
R38	22	Carbon Film	¼	5	927751 EQ
R39	220	Carbon Film	¼	5	927756 EQ
R40	470	Carbon Film	¼	5	927758 EQ
R41	2.2k	Carbon Film	¼	5	927762 EQ
R42	1k	Carbon Film	¼	5	927760 EQ
R43	33	Carbon Film	¼	5	926465 EQ
R44	5.6k	Carbon Film	¼	5	930007 EQ
R45	2k2	Carbon Film	¼	5	927762 EQ
R46	10k	Carbon Film	¼	5	927768 EQ
R47	5.6k	Carbon Film	¼	5	930007 EQ
R48	220	Carbon Film	¼	5	927756 EQ
R49	150k	Carbon Film	¼	5	928071 EQ
R50	10k	Carbon Film	¼	5	927768 EQ
R51		Not normally fitted			
R52		Not normally fitted			
R53	47k	Carbon Film	¼	5	927772 EQ
R54	220k	Carbon Film	¼	5	927773 EQ
R55	5.6k	Carbon Film	¼	5	930007 EQ
R56	10k	Carbon Film	¼	5	927768 EQ
R57	220k	Carbon Film	¼	5	927773 EQ
R58	150k	Carbon Film	¼	5	928071 EQ
R59	220k	Carbon Film	¼	5	927773 EQ

Capacitors	μF		V		
C1	100n	Ceramic	50	10	936877 EQ
C2	1n	Ceramic	100	10	924031 EQ
C3	4.7	Tantalum	35	20	921167 EQ
C4	4.7p	Ceramic	100	±¼p	923955
C5	100n	Ceramic	50	10	936877 EQ
C6	150p	Ceramic	100	10	990164 EQ
C7	0.68	Polyester	50	10	992471 EQ
C8	1n	Ceramic	100	10	924031 EQ
C9	1n	Ceramic	100	10	924031 EQ
C10	100n	Ceramic	50	10	936877 EQ
C11	150p	Ceramic	100	10	990164 EQ
C12	1n	Ceramic	100	10	924031 EQ
C13	10n	Ceramic	100	20	927395 EQ
C14	10	Tantalum	16	20	923569 EQ
C15	10	Ceramic	100	20	927395 EQ

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C16	1n	Ceramic	100	10	924031 EQ
C17	150p	Ceramic	100	10	990164 EQ
C18	100n	Ceramic	50	10	936877 EQ
C19	150p	Ceramic	100	10	990164 EQ
C20	10n	Ceramic	100	20	927395 EQ
C21	100n	Ceramic	50	10	936877 EQ
C22	10n	Ceramic	100	20	927395 EQ
C23	1n	Ceramic	100	10	924031 EQ
C24	150p	Ceramic	100	10	990164 EQ
C25	4.7p	Ceramic	100	$\pm\frac{1}{4}$p	923955
C26	1n	Ceramic	100	10	924031 EQ
C27	10n	Ceramic	100	20	927395 EQ
C28	100n	Ceramic	50	10	936877 EQ
C29	1n	Ceramic	100	10	924031 EQ
C30	10n	Ceramic	100	20	927395 EQ
C31	100n	Ceramic	50	10	936877 EQ
C32	1n	Ceramic	100	10	924031 EQ
C33	1n	Ceramic	100	10	924031 EQ
C34	1n	Ceramic	100	10	924031 EQ
C35	100n	Ceramic	50	10	936877 EQ
C36	47	Tantalum	16	20	923804 EQ
C37		Not normally fitted			
C38		Not normally fitted			
C39	10	Tantalum	16	20	923569 EQ
C40	4.7	Tantalum	35	20	921167 EQ
C41	100n	Polyester	63	5	990597 EQ
C42	10n	Polyester	63	5	990587 EQ
C43	100n	Polyester	63	5	990597 EQ

Diodes

D1		1N4149			914898 EQ
D2		1N4149			914898 EQ
D3		1N4149			914898 EQ
D4		1N4149			914898 EQ
D5		1N4149			914898 EQ
D6		1N4149			914898 EQ
D7		1N4149			914898 EQ
D8		Not normally fitted			
D9		Not normally fitted			
D10		BB212			992088 EQ

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
D11		PIN Diode	200 V		AR 711921
D12		5082-2811	35 V		919460 EQ
D13		DKV6523B			936850
D14		BA482			991318 EQ
D15		1N4149			914898 EQ
D16		1N4149			914898 EQ
D17		1N4149			914898 EQ
D18		1N4149			914898 EQ
D19		1N4149			914898 EQ
Transistors					
TR1		ZTX 237			923171
TR2		J309			936854 EQ
TR3		ZTX 313			916063
TR4		ZTX 212			923172
TR5		ZTX 313			916063
TR6		ZTX 237			923171
TR7		ZTX 212			923172
TR8		BFR 96			992086 EQ
TR9		F.E.T.			AR 712013
TR10		BFX 89			916627
TR11		ZTX 212			923172
TR12		F.E.T.			AR 711676
Integrated Circuits					
ML1		HEF 4071B			992096 EQ
ML2		HEF 4011UB			992097 EQ
ML3		Synthesizer L.S.I.			BR 712151
ML4		SP 8793DP			990804 EQ
Transformers					
T1		Transformer Assy			AT 710798
Inductors	μH				
L1		Not normally fitted			
L2	10	Choke		10	926238 EQ
L3	0.1	Choke		5	992478 EQ
L4		Coil Assy			AT 710797
L5	10	Choke		10	926238 EQ

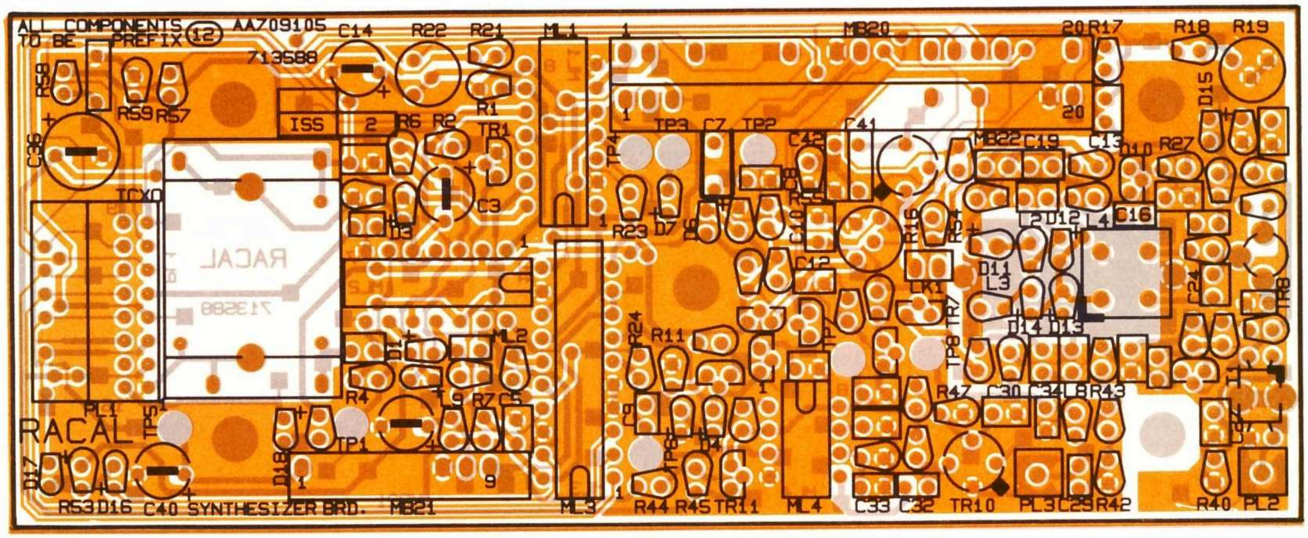
Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
L6	10	Choke		10	926238 EQ
L7	10	Choke		10	926238 EQ
L8	10	Choke		10	926238 EQ
L9	10	Choke		10	926238 EQ

Microboards

MB20	Tx Audio	AA779010
MB21	20 V Generator	AA779011
MB22	Charge Pump	AA779012
	Connector Socket (22 off for Microboard)	937117
	Terminal Post	914054
	Mounting Pad T018	919312

Miscellaneous

LK1	Link Shorting	990776 EQ
	Socket 20-pin I.C.	992100 EQ
	Connector 2-way	BD 708919/2
	Socket Co-ax 50 ohm	930649 EQ (2 off)
	Plug 16-way	992107 EQ
	TCXO 6.4 MHz	BR 712317
	Extractor Handle	BD 709032
	Transformer Clamp	706193
	Bush Resistor ¼W (Black)	702707
	Bush (Green)	702971



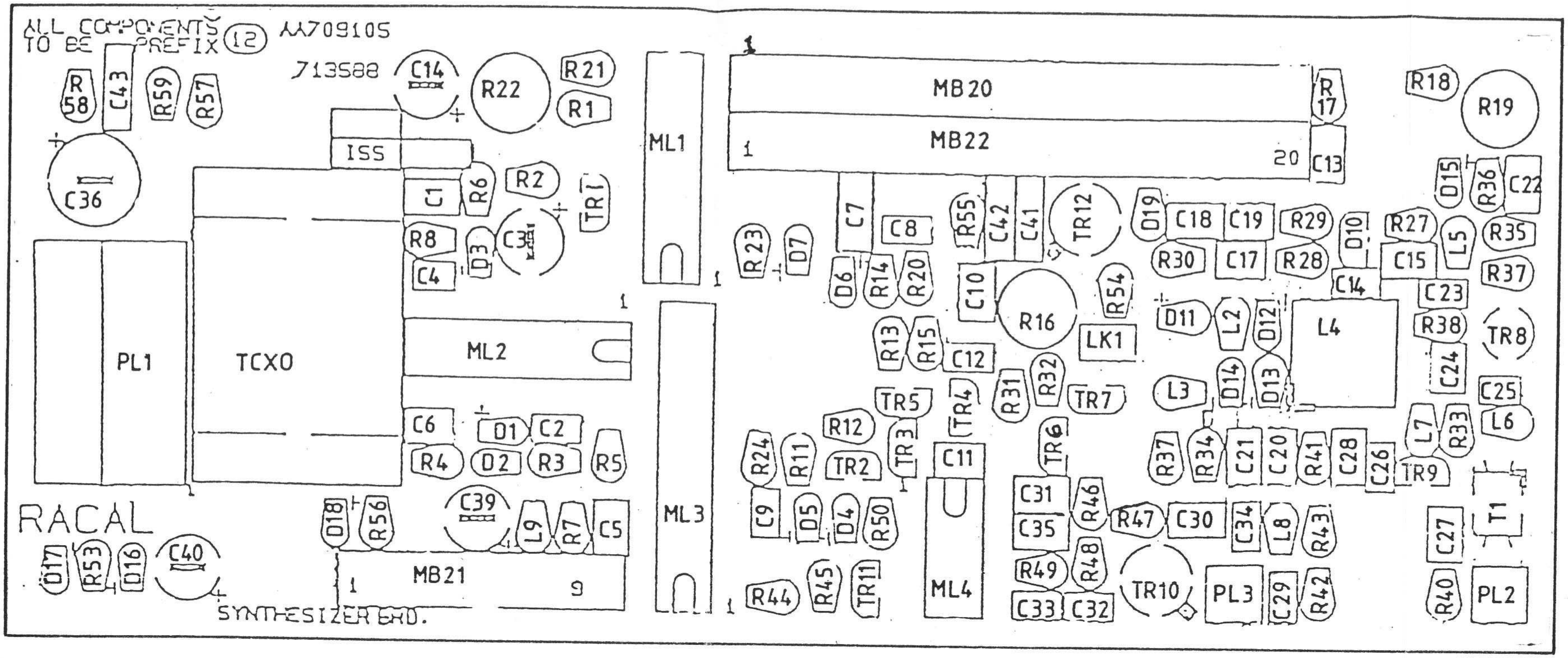
RACAL

TH 5160/1	713588
2	

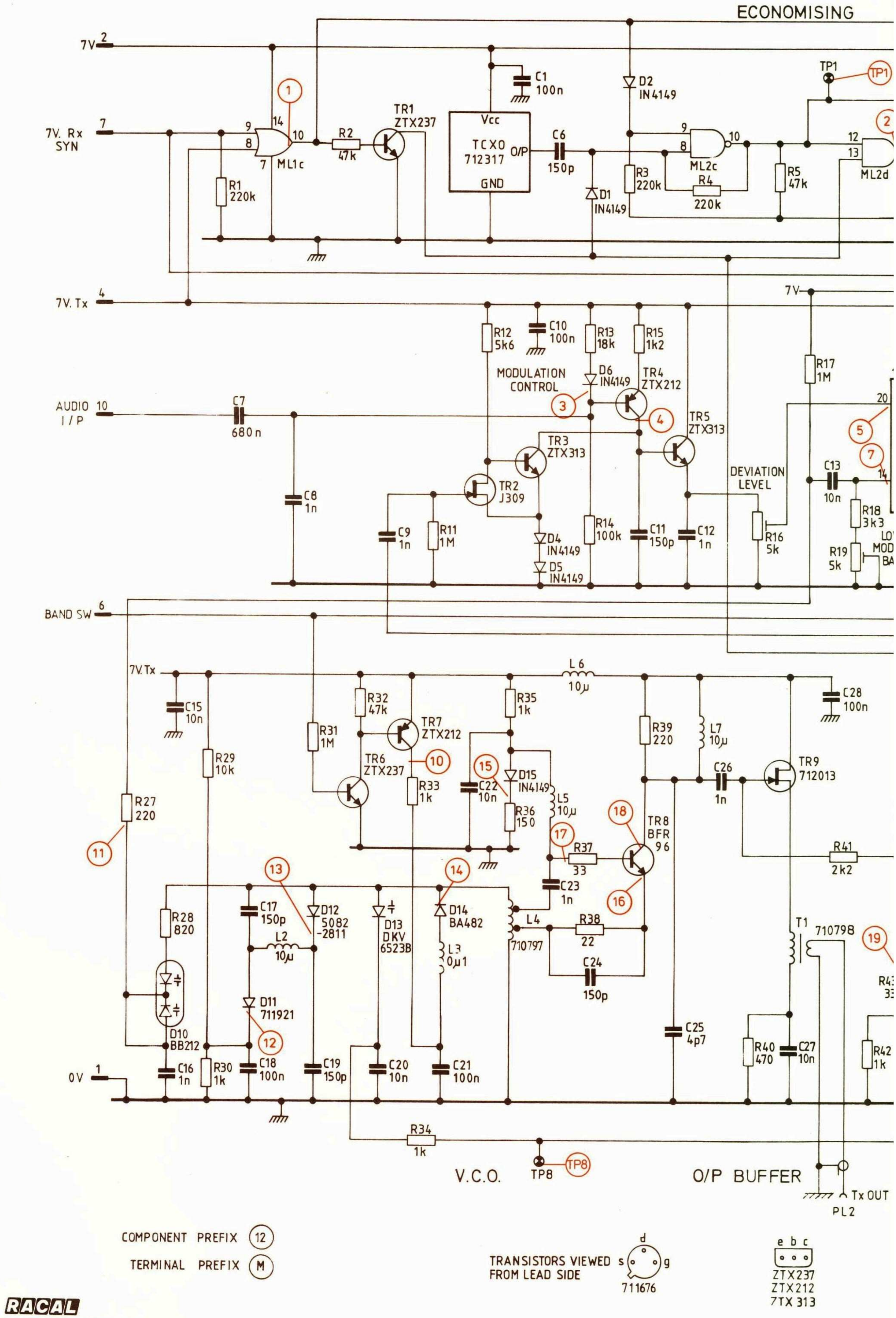
PART 7

Layout Synthesizer P.C.B

Fig.1



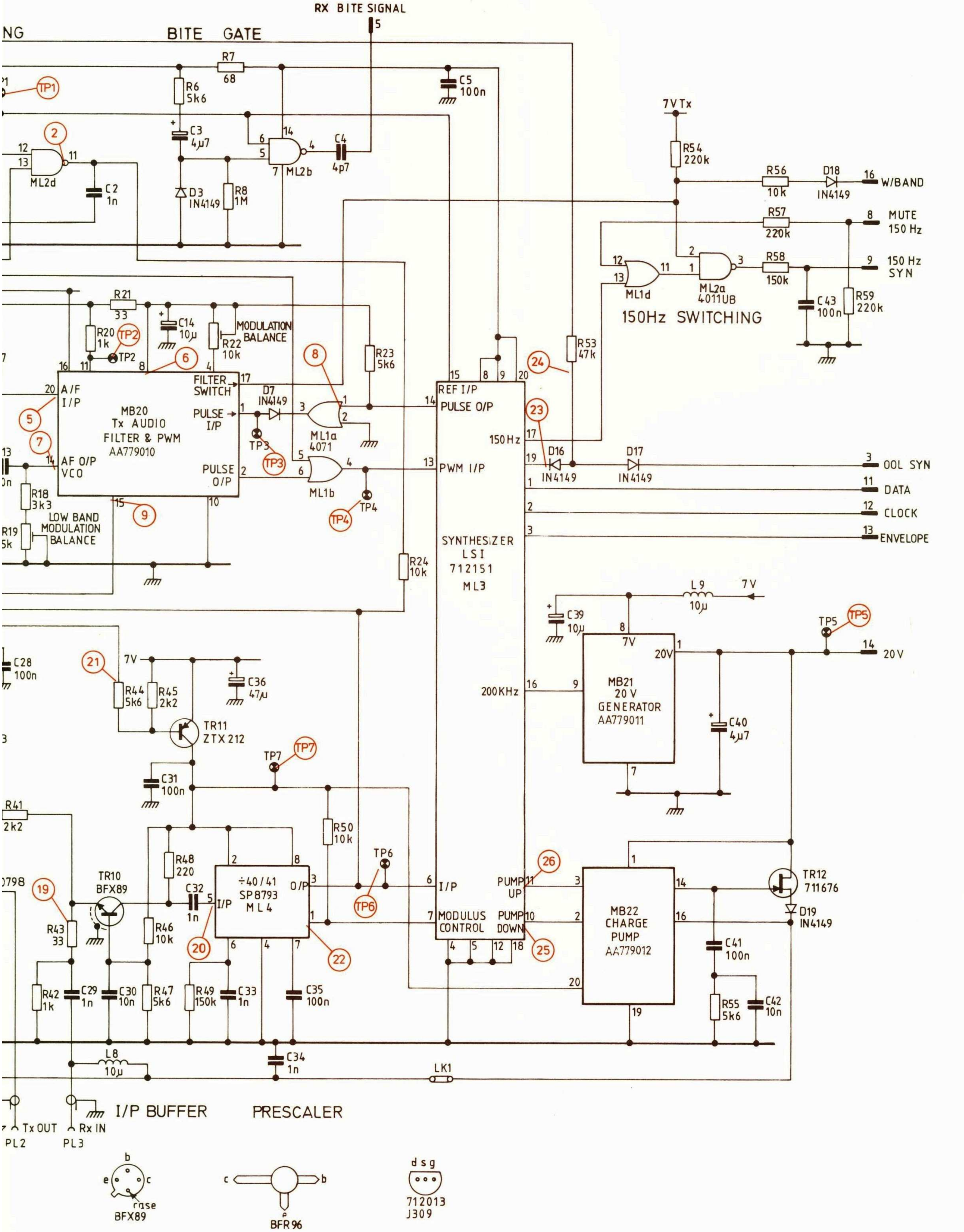
Synthesizer P.C.B. Assy



RACAL

TH 5160/1	DC 709105
4	

PART 7



Circuit: Synthesizer P.C.B

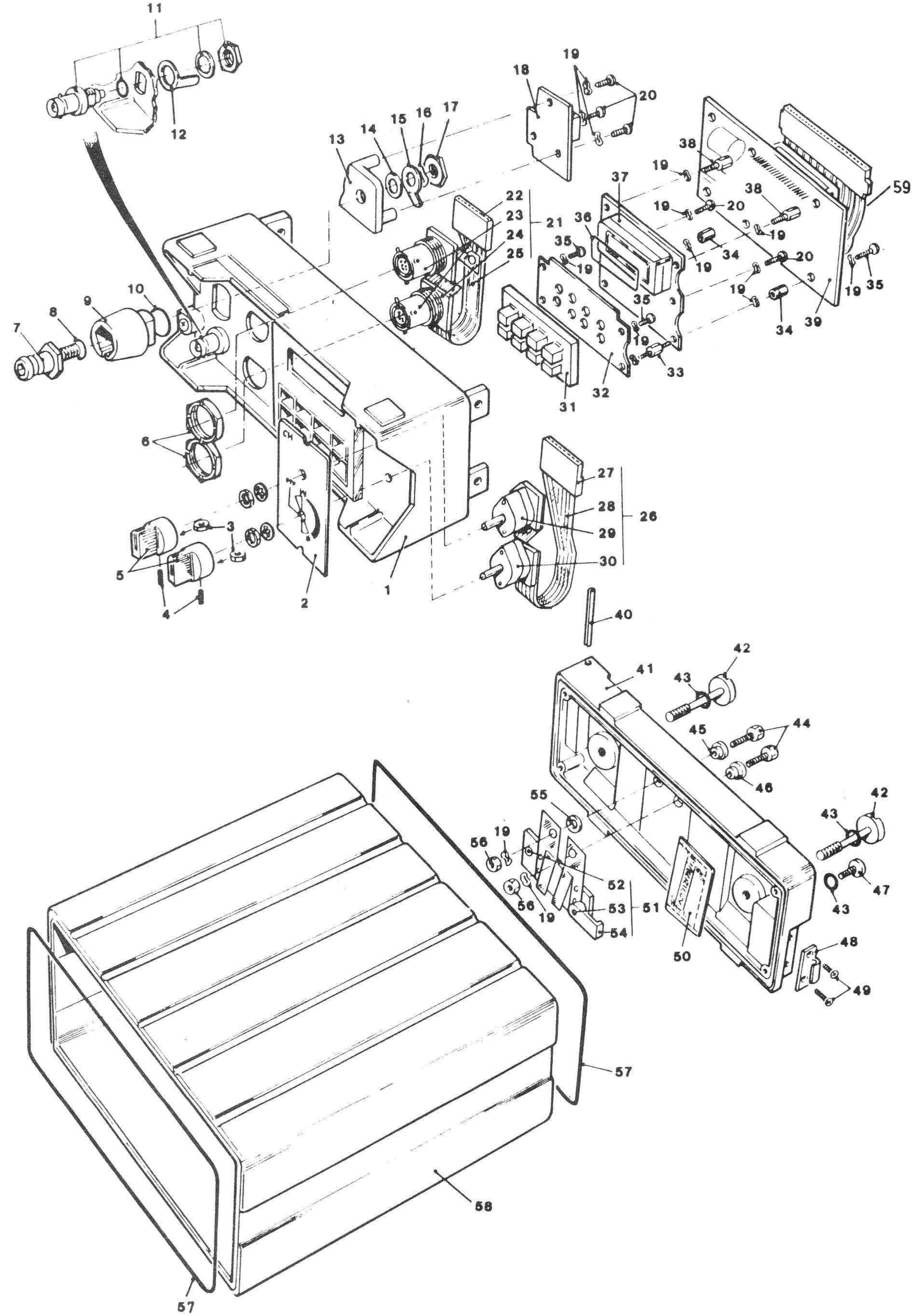
Fig.2

PART 8

MECHANICAL PARTS LIST

CONTENTS

ILLUSTRATIONS

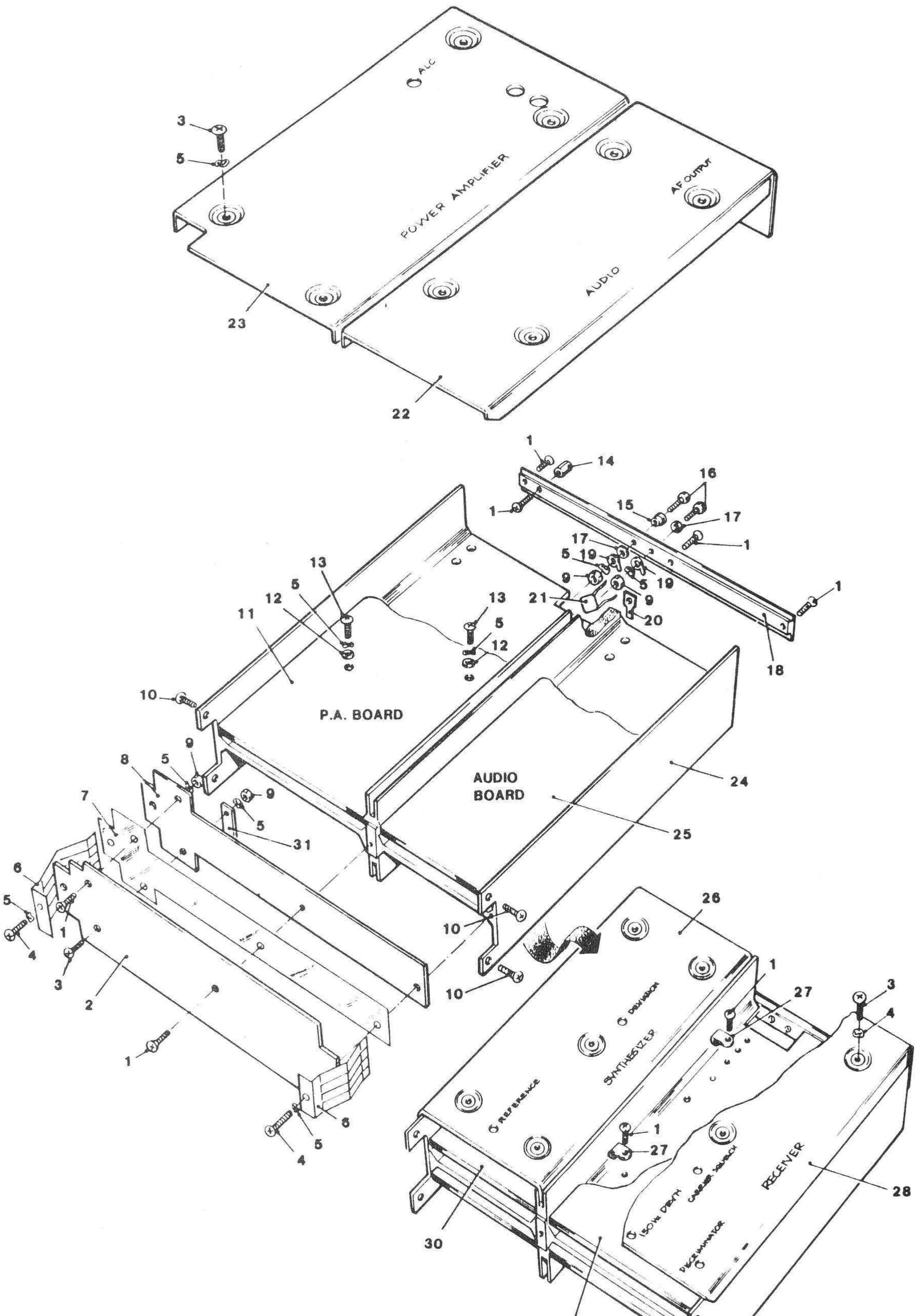


Transceiver PRM 4700 Fig. 1

TRANSCEIVER V.H.F. PRM 4700

FIGURE 1

Figure/ Item No.	Description	RACAL Part No.	Qty/ Unit
1-1	Front Panel, Printed	708387	1
2	Plate Marking	709068	1
3	Nut M2,5	922392	2
4	Screw, Grub M2,5x6	992372EQ	2
5	Knob, Silk Screen	708716	2
6	Connector Nut	991464EQ	2
7	Whip Stud	706196	1
8	'O' Ring, Whip	990880EQ	1
9	Shroud, Whip	706198	1
10	'O' Ring, Whip	990080EQ	1
11	Connector, Coax Skt. Fix	990837EQ	1
12	Solder Tag in	909527	1
13	Insulator Mount	708706	1
14	Washer M6, Thin	928331	1
15	Solder Tag 3/8in	900477	1
16	Washer M6, Crinkle	917707	1
17	Nut M6, thin	927436	1
18	A.M.U. PCB Assembly	708863	1
19	Washer M3, Crinkle	917705	27
20	Screw M3x8	917845	5
21	Socket Assembly, Flexible, Comprising:	709118	1
22	Connector, 11-Way	992111EQ	1
23	Connector Socket, 7-Way	990305EQ	2
24	Capacitor, Chip 1nF	999021/102P	12
25	Flexible PC	713565	1
26	Switch Assembly, Flexible Comprising:	709119	1
27	Connector, 9-Way	992112EQ	1
28	Flexible PC	713566	1
29	Switch, 10-Way	712268	1
30	Switch, 9-Way	712269	1
31	Keyboard Seal	709075	1
32	Back Plate	708729	1
33	Pillar	703128/40	2
34	Pillar	700123/82	2
35	Screw M3x6	917844	6
36	Display Seal	708711	1
37	Display and Driver Module	708508	1
38	Pillar	700107/135	2
39	Control PCB Asembly	708509	1
40	Tension Pin	992200EQ	1
41	Rear Panel, Blank	708390	1
42	Screw, Rear Panel	708712	2
43	'O' Ring Seal	918846EQ	3
44	Contact Stud	708703	2
45	Seal, POS	706671	1
46	Seal	701291	1
47	Screw M4x6 ST.ST.	926580	1
48	Hook	708710	1
49	Screw M3x6, Black	705749	2
50	Desiccant Sachet	712178/1	1
51	Spring Assembly, Battery, Comprising:	AA708702	1
52	Rivet, Pan Hd.	992177EQ	1
53	Rivet, Csk Hd.	992178EQ	1
54	Clip	707818/1	1
55	Seal	701292	1
56	Nut M3	917825	2
57	'O' Ring (Front & Rear Cover)	708721	2
58	Sleeve	708739	1
59	Motherboard/Control Flexible Assembly	708914	1



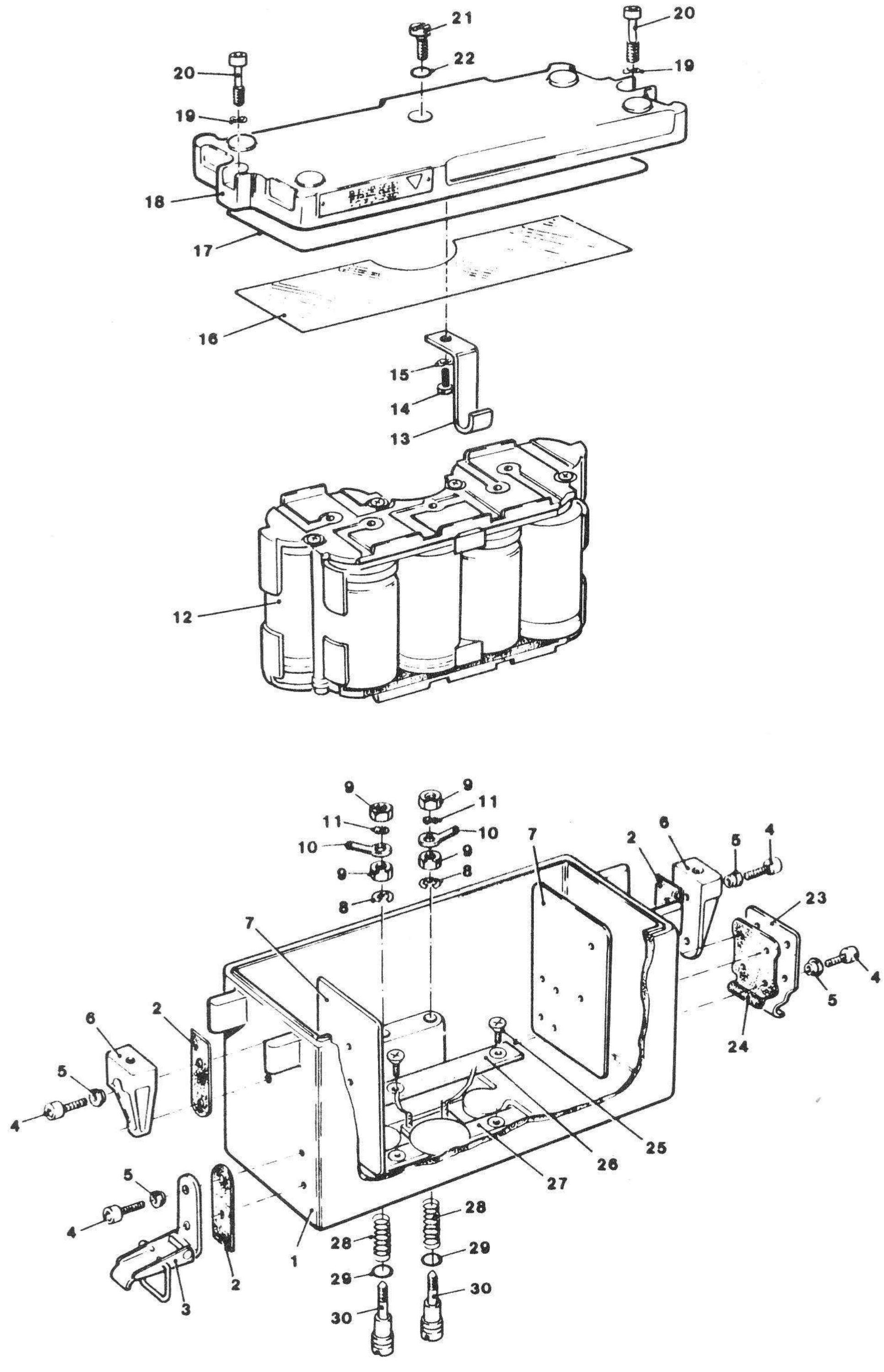
PCB Chassis

Fig. 2

PCB CHASSIS

FIGURE 2

Figure/ Item No.	Description	RACAL Part No.	Qty/ Unit
2-1	Screw, M3x6 Csk.	918382	8
2	Mother PCB Assembly	708502	1
3	Screw, M3x6 Pan Hd.	917844	18
4	Screw, M3x8 Pan Hd.	917845	2
5	Washer, M3 Crinkle	917705	25
6	Spring, Earth	708819	2
7	Insulator Front, Blank	708723	1
8	Panel Front, Blanking	708722	1
9	Nut, M3	917825	2
10	Screw, M3x5mm.	918573	4
11	Power Amp. PCB Assembly	708506	1
12	Washer, Plain, M3	918086	2
13	Screw, M3x10	917818	2
14	Pillar, 7mm.	700123/83	1
15	Seal, Positive	706671	1
16	Contacts	708713	2
17	Seal	701291	2
18	Plate Rear, Blanking	708728	1
19	Tag, Solder	919872EQ	2
20	Retainer	709114	1
21	Capacitor 100V 10nF.	927395EQ	1
22	Cover, Audio	708846	1
23	Cover, Power Amp.	708849	1
24	Chassis, Main M/C	708718	1
25	Audio PCB Assembly	709112	1
26	Cover, Synthesizer	708848	1
27	Wire Clamp	708726	2
28	Cover, Receiver	708847	1
29	Receiver PCB Assembly	708505	1
30	Synthesizer PCB Assembly	709105	1
31	Wire Clip	709115	1



Battery Box MA4705A

Fig. 3

BATTERY BOX MA4705A

FIGURE 3

Figure/ Item No.	Description	RACAL Part No.	Qty/ Unit
3-1	Battery Pack, Case	708796	1
2	Seal	708804	3
3	Fastener	708881	1
4	Screw M3x10	708878	10
5	Seal M3	992173EQ	10
6	Securing Block	708813	2
7	Mounting Plate	708882	2
8	Circlip	920723	2
9	Nut M4	920590	4
10	Solder Tag 3BA	929169	2
11	Washer, Crinkle M4	922408	2
12	Battery Assembly	709113	1
13	Clamp	708879	1
14	Screw M3x8	928212	1
15	Washer M3	928759	1
16	Insulating Lamina	708877	1
17	'O' Ring, Large	708800	3
18	Cover	708794	1
19	Washer, Special	708994	2
20	Screw, Captive	708811	2
21	Screw, M4x10	708911	1
22	'O' Ring	918846EQ	1
23	Hook	708806	1
24	Rubber Moulding	708883	1
25	Screw M3x6	928195	2
26	Contact Board	708810	1
27	Fuse PCB	708912	1
28	Spring	707742	2
29	'O' Ring	703357	2
30	Contact	707426	2

BATTERY CHARGER TYPE MA.945B

CONTENTS

ILLUSTRATIONS

BATTERY CHARGER TYPE MA.945B

INTRODUCTION

1. The Battery Charger MA.945B can be used to charge various Racal nickel-cadmium batteries of 12 V, 18 V, or 24 V. These batteries may be charged in situ or when removed from their associated manpacks. See page 2 para. 7.

CONSTRUCTION

2. The unit is assembled in a splashproof plastic case of dimensions 290 mm (11.4 in) x 90 mm (3.5 in) x 162 mm (6.4 in). The weight of the unit is 3.05 kg (6.7 lb) approx.

3. The front panel of the unit is illustrated in fig. 1, and carries all controls and connectors, as under:-

(a) Supply input plug
(b) Supply ON/OFF switch
(c) Supply voltage selector switch
(d) Charge rate selector switch
(e) Charging indicator lamp
(f) Battery lead

4. Two separate fuses, one for a.c. the other for d.c. input supplies, are mounted internally.

ELECTRICAL CHARACTERISTICS

5. Inputs: 12-15 volts or 24-30 volts d.c.
100-125 or 200-250 volts a.c. 45-60Hz.
Approx. consumption is 40VA a.c., 40W d.c.

Outputs: The optimum charging current for each battery is obtained automatically when the charge rate is selected in accordance with the table given below.

Charge Rate	Nominal Current	Battery Voltage
1	200mA	12V
2	350mA	12V
3	350mA	18V
4	350mA	24V

WARNING: INCORRECT CHARGE RATE MAY DAMAGE THE BATTERY.

OPERATING INSTRUCTIONS

6. Two input supply leads are provided with the unit, one for connection to an a.c. supply and one fitted with crocodile clips for connection to a d.c. supply. Either of these leads will connect into the supply plug on the front panel of the battery charger. The unit is protected against damage if the wrong connector is used. For example, if the supply selector switch is set to the a.c. position and a d.c. supply lead is connected, the charger input circuit cannot be completed.

7. The charging output lead is permanently attached to the battery charger and is terminated in a plug which is connected to an AUDIO socket on the front panel of a manpack when charging 12 V, 18 V or 24 V batteries. Adaptor cables can be provided for charging these batteries when they are removed from their manpacks, or for charging equipment not using Pattern 105 sockets. The adaptor cables are listed in fig. 1 page 7 and illustrated in fig. 5.

8. The procedure for using the battery charger is as follows:-

IMPORTANT NOTE: To prevent damage it is essential that the SUPPLY VOLTAGE and CHARGE RATE selectors are correctly set before applying the supply.

(1) Set the SUPPLY VOLTAGE selector to the required position.

(2) Set the CHARGE RATE selector to the appropriate position in accordance with the table on Fig.4.

(3) Ensure that the battery charger power switch is not set to ON.

(4) Connect the charging output lead to an AUDIO socket on the front panel of the manpack or to the battery (see sub para. 9).

WARNING: WHERE AN A.C. MAINS INPUT SUPPLY IS BEING USED, ENSURE THAT THE SUPPLY IS SWITCHED OFF BEFORE ANY CONNECTIONS ARE MADE.

(5) Select the correct input supply lead (a.c. or d.c.) and connect it to the supply plug on the front panel of the battery charger.

(6) Check that the fuse FS1 is of the correct rating (500mA for 240V or 1A for 120V operation).

(7) Connect the other end of the supply lead to the supply as follows:-

OPERATING INSTRUCTIONS (Cont'd)

AC Input Supply Cable		AC Mains Supply
Brown Wire	to	Line (L)
Blue Wire	to	Neutral (N)
Yellow/Green Wire	to	Earth (E)
DC Input Supply Cable		**DC Supply**
Red Wire	to	Positive Terminal
Black Wire	to	Negative Terminal

NOTE: Either polarity of the d.c. supply can be earthed.

(7) Complete the input supply and set the battery charger power switch to ON.

(8) Check the CHARGE IND lamp. This will be illuminated while a battery is being charged. If this lamp is not illuminated, check that the battery circuit is completed before suspecting any fault in the battery charger.

(9) An adaptor cable is provided to enable a battery to be charged when it is not installed in a manpack. To make use of this facility, connect the socket (SKT3) of the adaptor cable to the plug (PL2) on the charging output lead. Connect the ferrules on the other end of the adaptor cable into the sockets on the battery; red lead (+ve) to red socket and black lead (-ve) to black socket. Operate the battery charger as detailed in this paragraph, omitting operation (4).

(10) A discharged battery will take approximately fourteen hours to charge. A discharged 4025A or 24V .4AH battery requires sixteen hours.

CIRCUIT DESCRIPTION

AC Input Circuit

9. The a.c. supply is connected to pins C and F of free socket SKT1, which mates with plug PL1 on the battery charger. Pins D and E are linked within the free socket SKT1. The line side of the supply, on pin F of plug PL1, is routed via the Supply switch SA2, the link between pins D and E and fuse FS1 to the 120V primary windings of transformer T2. The neutral side of the supply, on pin C of PL1, is fed via the supply switch SA1 and the selected contacts on wafer SB1F of the SUPPLY VOLTAGE switch to the appropriate primary windings of transformer T2. When a 200-250V input is selected, the two primary windings are connected in series by switch SB1B; the switch connects the windings in parallel when a 100-125V input is selected.

DC Input Circuit

10. The d.c. supply is connected to pins C and F of free socket SKT2, which mates with plug PL1 on the battery charger. The positive supply circuit, on pin C of plug PL1, is fed via the Supply switch SA1 and the selected contacts on wafer SB1F of the SUPPLY VOLTAGE switch to the centre tap of the 24 and 12 volt primary windings of transformer T2. Pins A and B are linked within the free socket SK2. The negative side of the d.c. supply is via the Supply switch SA2, the link between pins A and B in socket SKT2, fuse FS2 and diode D1 to the emitters of transistors TR1 and TR2.

11. Transistors TR1 and TR2 are connected in a d.c. to a.c. converter circuit operating as follows. When the supply is made to the circuit, differences in gain and leakage currents cause an unbalance between TR1 and TR2. Assume TR1 passes more current than TR2, this will produce an unbalance current in the primary winding of the transformer T2 which will cause a voltage to be developed across it. This voltage is applied to the primary of T1. The secondary of T1 feeds the bases of the two transistors such that TR1 will receive more base current and hence draw more collector current and TR2 will receive less and tend to switch off. This effect causes TR1 to become fully switched on with nearly the full d.c. supply voltage being applied across half the transformer T2 primary winding.

12. The magnetic flux in the core of T1 increases until it becomes saturated. Immediately this occurs, the secondary voltage collapses which removes the base current from TR1 which switches it off and a reverse e.m.f. is produced which applies drive to TR2 base. TR2 then conducts until core saturation occurs in the reverse direction. The process then repeats with TR2 being turned off and TR1 turned on again.

13. This sequence carries on being repeated at approximately 400Hz, the waveform generated in T2 being a square wave. The output from the secondary being applied to the rectifier circuit (paragraph 15).

14. Transformer T2 is tapped to allow for a 12V or 24V d.c. input; the tappings are selected by switch wafers SB2F and SB2B.

Rectifier and Regulator Circuit

15. A full wave rectifier, diodes 1D4 to 1D7, is connected across transformer T2 secondary. Capacitor C4 is the reservoir capacitor. The rectified voltage developed across the reservoir capacitor is applied to a constant current regulator circuit.

16. Transistor TR3 forms a simple type of series regulator. Zener diode 1D3 provides a stabilized reference voltage of 4.7 volts to the base of TR3. Transistor TR3, in series with either 1R4 or 1R5, is connected in the negative line from the bridge rectifier. The appropriate resistor and hence the correct charging current is selected by switch SC.

Rectifier and Regulator Circuit (cont'd)

17. An increase in charging current will increase the volts drop across the selected resistor and cause the emitter of TR3 to become more positive. As a result the base/emitter potential of the transistor is reduced, the transistor impedance increases and the charging current is reduced to its previous level.

18. The indicator lamp LP1 illuminates when the charging current flows. Diode 1D8 is included in the circuit to prevent the battery from being discharged through the charging unit, should the supply fail or be switched off, with the battery connected.

COVER REMOVAL

19. The charging unit cover is held in position by two large slotted screws on the back panel. The complete unit is assembled on the rear of the front panel, and all components are readily accessible when the cover is removed. The location of all components is illustrated in Fig.2.

TESTING AND FAULT FINDING

Protection Circuits

20. The battery charger will not operate if the a.c. supply connector is used with the voltage selector switch set to one of the d.c. positions, or the d.c. supply connector used and the voltage selector set to one of the a.c. positions. No damage is done to the equipment in either of these conditions as the supply circuit is not completed. Damage can occur if the SUPPLY VOLTAGE or CHARGE RATE selectors are set to an incorrect voltage range, therefore it is essential that the correct selections are made before applying a supply.

21. The battery charger will not operate if the d.c. input supply leads are connected in reverse polarity as diode D1 cuts off the supply to the inverter circuit in this condition.

22. Protective fuse FS1 (400 mA/1A) is provided in the a.c. supply circuit, and FS2 (4 amp.) in the d.c. supply circuit.

23. No damage will occur if the charging output lead is temporarily short-circuited.

24. The charging indicator lamp LP1 will not be illuminated if the battery circuit is not completed.

25. Diode 1D8 prevents the battery from being discharged if the charging supply fails or is switched off, and the battery is left connected.

TEST EQUIPMENT REQUIRED

26. (a) A 50Ω ± 5% 20W resistor.

(b) Two Avo Model 8 multimeters, or similar 20,000 ohm per volt instruments.

(c) A variac covering the range 0-250 volts at 2A, example Duratrak type V5HM.

(d) A variable d.c. power supply 0-30 volts at 5A, example APT TCU55.

TEST PROCEDURES

AC Input Supply

27. (1) Connect the output adaptor cable to the output plug of the MA.945B and connect to a 50 ohm ±5% 20 watt resistor via a multimeter set to the 1A d.c. range. Connect a second multimeter set to the 100V d.c. range across C4.

(2) Set the CHARGE RATE selector switch to 4 and the SUPPLY VOLTAGE selector switch to 240V a.c.

(3) Connect the a.c. mains supply lead to the supply input plug and connect its wire-ended terminations to a 2 amp. Variac set to 250 volts.

(4) Switch SA (SUPPLY) to ON and check that the CHARGE IND lamp is illuminated.

(5) Check that the reading on the 1A d.c. multimeter is between 280 and 420mA.

(6) Check that the reading on the 100V d.c. multimeter is approximately 50 volts.

(7) Set the CHARGE RATE selector switch to 3 and check that the reading on the 1A d.c. multimeter is between 280 and 420mA.

(8) Check that the reading on the 100V d.c. multimeter is approximately 34 volts.

(9) Set the CHARGE RATE selector switch to 2 and check that the reading on the 1A d.c. multimeter is between 280 and 420mA.

(10) Check that the reading on the 100V d.c. multimeter is approximately 34 volts.

(11) Set the CHARGE RATE selector switch to 1 and check that the reading on the 1A d.c. multimeter is between 170 and 230mA.

(12) Check that the reading on the 100V d.c. multimeter is approximately 36 volts.

(13) Set the Variac to 125 volts, the CHARGE RATE selector switch to 4, the SUPPLY VOLTAGE selector switch to 120V a.c. and check that the reading on the 100V d.c. multimeter is approximately 50 volts.

(14) Switch SA to OFF and disconnect the a.c. mains lead and Variac.

DC Input Supply

28. (1) Connect the d.c. supply lead to the supply input plug and connect its crocodile clip terminations to a 5A power supply.

(2) Set the SUPPLY VOLTAGE selector switch to 12V d.c. and the 5A power supply to 15 volts.

(3) Switch SA to ON and check that the reading on the 100V d.c. multimeter is approximately 53 volts.

(4) Set the SUPPLY VOLTAGE selector switch to 24V d.c. and the 5A power supply to 30 volts.

(5) Check that the reading on the 100V d.c. multimeter is approximately 55 volts.

(6) Disconnect the 100V d.c. multimeter and re-connect it between TR3 collector and the chassis, and check that the reading is zero.

(7) Switch SA to OFF and disconnect all test equipment.

EQUIPMENT	ADAPTOR CABLE NO.
TRA 906	700654/D
TRA 921	700654/D
TRA 922	700654/D
TRA 929	700654/D
TRA 931	700654/D
TRA 932	700654/D
TRA 965	719235
TRA 967	719235
TRA 971	719235
PRM 4160	719235
PRM 4021	719115
PRM 4031	719115
PRM 4031	719115
Clansman series	790032
PRM 4090	790414*
TRA 6929 (Racal USA)	AA6808

TABLE 1

Cables marked * connect directly to the radio, not the battery

LIST OF ELECTRICAL COMPONENTS

Cct. Ref.	Value	Description	Rat.	Tol %	Racal Part Number
		MA945B Chassis			
Capacitors			V		
C1	0.1	Polystyrene	160	20	900066
C3	0.1	Polystyrene	160	20	900066
C4	500	Electrolytic	75	+50-10	917848/EQ
C6	0.1	Polystyrene	160	20	900066
Diodes					
D1		Rectifier S6103K			924628/EQ
		Insulator kit for D1			916099
Transistors					
TR1		2N3055			915654
TR2		2N3055			915654
TR3		2N3055			915654
Transformers					
T1					CT 710016
T2					CT 710049
Plugs					
PL1		7 way			928332/EQ
PL2		6 way			910130
Switches					
SA		DPDT Lever 3A			930821/EQ
SB		4 pole, 4 position rotary			711088
SC		2 pole, 4 position rotary			711087
Fuses					
FS1		1A (120 V operation)			991170/EQ
		500 mA (240 V operation)			990989/EQ
FS2		4A			906931/EQ

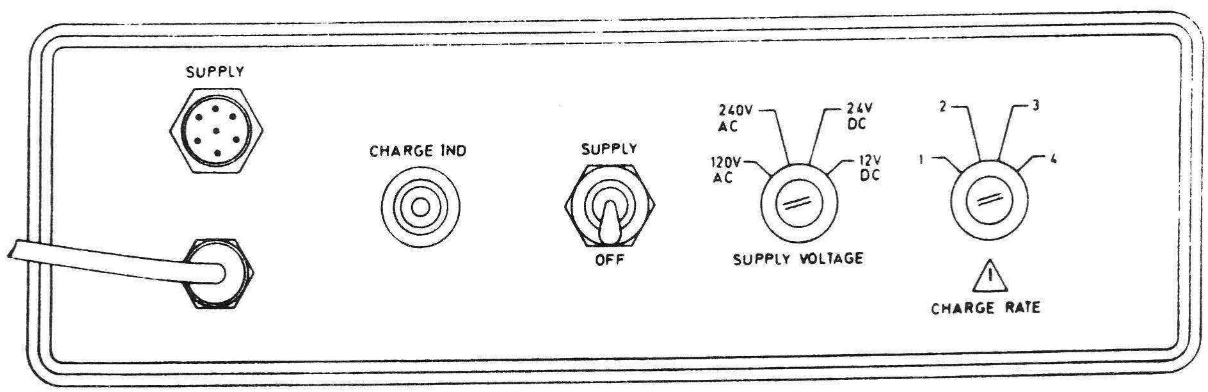
Cct. Ref.	Value	Description	Rat.	Tol %	Racal Part Number
Lamps					
LP1		4.5 V, 0.27 W			916078
		Lamp holder, yellow			916077
		Fuseholder			912190
Miscellaneous					
Adaptor lead (MA945B/CLANSMAN BATTERY)					ST790032

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
		PCB Assembly (705177)			
Resistors			W		
1R1	1K	Wirewound	6	5	913662/EQ
1R2	100	Wirewound	6	5	913686/EQ
1R3	Not used				
1R4	15	Wirewound	6	5	913706/EQ
1R5	33	Wirewound	6	5	913698/EQ
1R6	2k	Wirewound	6	5	913655/EQ
Capacitors			V		
1C2	47	Electrolytic	35	20	917478/EQ
1C5	0.1	Polystyrene	160	20	900066
1C7	10n	Ceramic	200	20	991396/EQ
1C8	10n	Ceramic	200	20	991396/EQ
1C9	10n	Ceramic	200	20	991396/EQ
1C10	10n	Ceramic	200	20	991396/EQ
1C11	0.1	Polystyrene	160	20	900066
Diodes					
1D2		1N4002			911460/EQ
1D3		1N4734A			991749/EQ
1D4		30S2			928691/EQ
1D5		30S2			928691/EQ
1D6		30S2			928691/EQ
1D7		30S2			928691/EQ
1D8		1N4002			911460/EQ

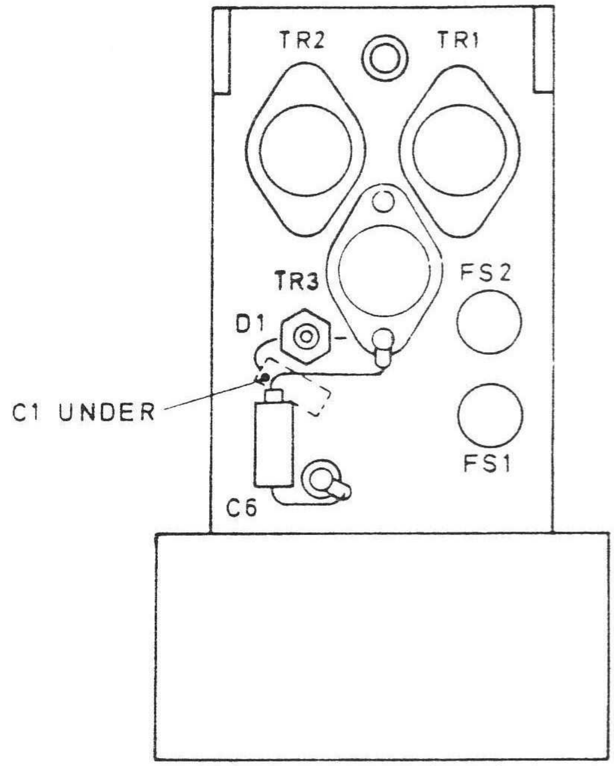
LIST OF MECHANICAL COMPONENTS

DESCRIPTION	PART No.
Case Assy.	702514/2
Cover	705178/1
Front Panel	704681/3
Frame	703657/7
Carrying Strap	711032/3
Pillar	701215/1
Washer	702001/1
Spacer M3 x 4 Clear	927749
Clamp, Capacitor	909295
Cable Gland Black	929384
Nut $\frac{1}{2}$" Black Nylon Lock	930435
Nut, Potentiometer Lock	906368
Clip Plasklip NX1 Black	900205
Clip Plasklip NX2 Black	900123
Screw M3 x 6 Rec.Pan Hd.Stl.	917844
Screw M3 x 8 Hex. Hd. Stl.	921413
Screw M3 x 12 Rec.Pan Hd.Stl.	917846
Screw 6-32 UNC x 5/16" Rec. Pan Hd.Stl.	909904
Screw 4-40 UNC x 5/16" Rec. Pan Hd.Stl.	912569
Screw M4 x 20 Slot.Pan Hd. St.Stl.	922362
Washer 3/8" I/D Lock and Seal	916074
Washer 3/8" I/D Cri.Ber.Cu.Stl.	904252
Washer M3 Cri.Ber.Cu.Stl.	917705
Washer 4BA Cri.Ber.Cu.Stl.	904248
Washer 6BA Cri.Ber.Cu.Stl.	904247
Washer 3/8" I/D L/Gauge Bright Small Stl.	906268
Washer 4BA Bright Small Stl.	904243

DESCRIPTION	PART No.
Washer 6BA Bright Small Stl.	904244
Washer 6BA Bright Large Stl.	904240
Nut M3 Full Hex. Stl.	917825
Nut M3 'Nyloc' Zinc Plated Stl.	920597
Nut M4 'Nyloc' Zinc Plated Stl.	923858
Retaining Ring 5/32"	921786
Washer M4 Bright Stl.	918087
Screw M3 x 8 Hex Hd. Stl.	921413
'0' Ring Main Case	711130
Fuseholder '00'	912190
Lampholder Yellow	916077
Seal '0' Ring	909929
Insulator Kit	915890
Connector Plug 7 Way Fixed	928332
Connector Plug 6 Way Free	910130
Electrical Cap	711069/2
Fuse Link 500 mA	906850
PCB Assy	705177

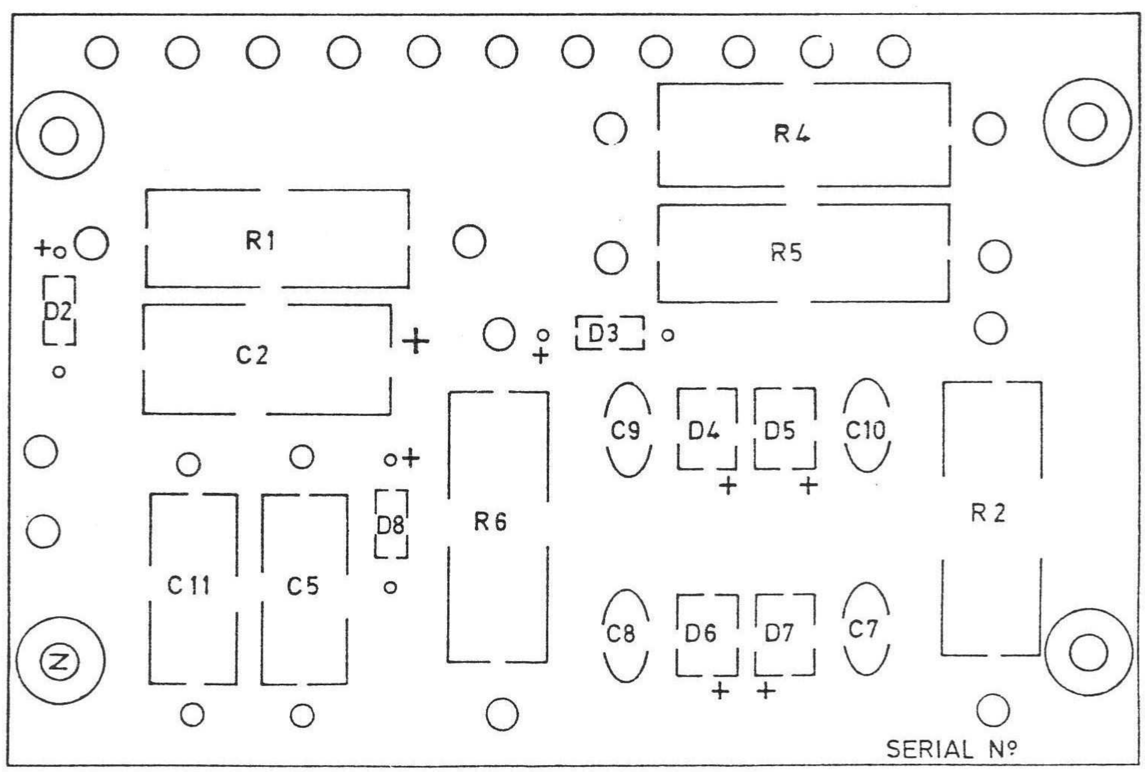


RACAL Battery Charger Type MA 945B Fig 1



END VIEW

PC

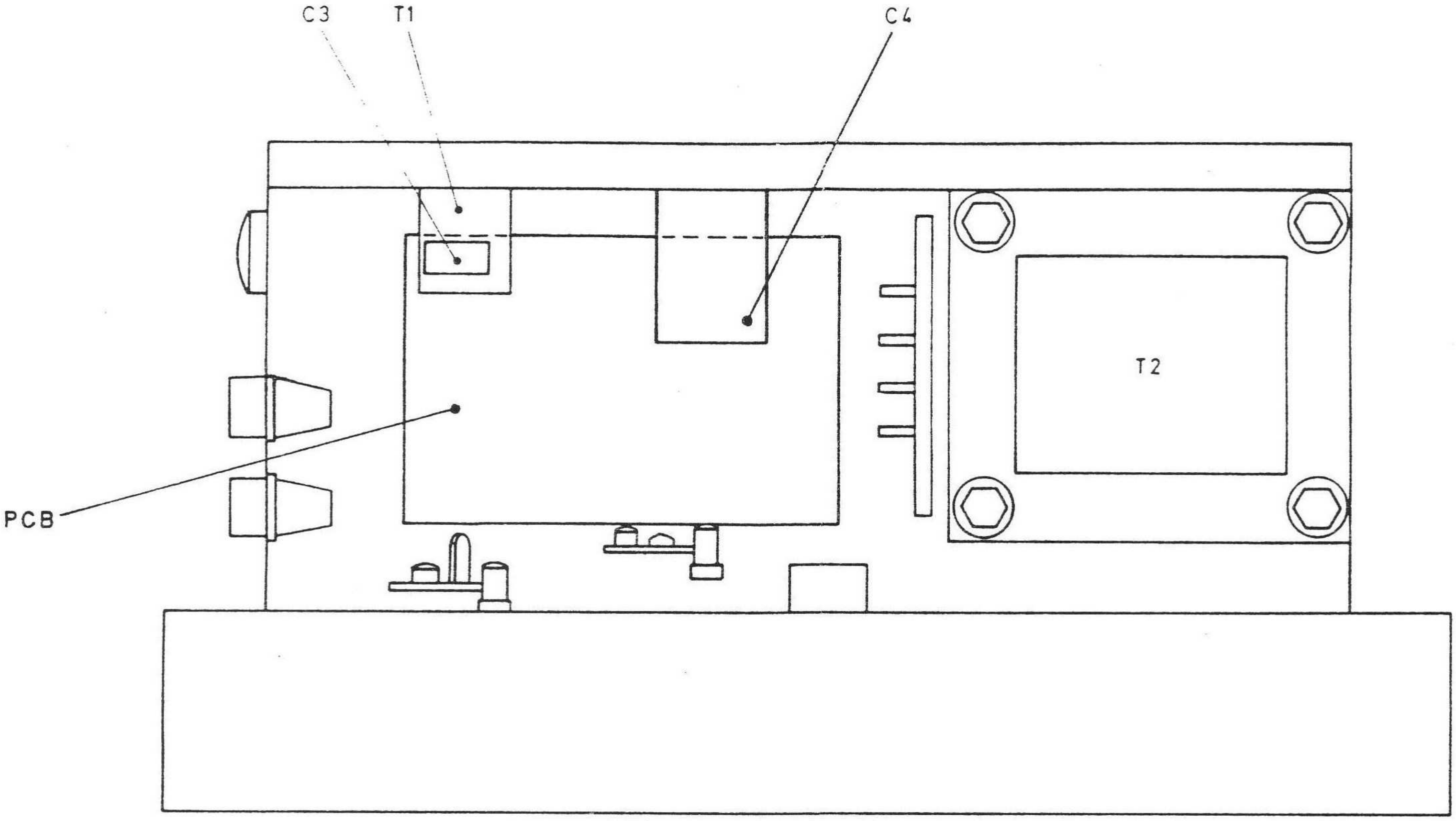


PL2 ON END

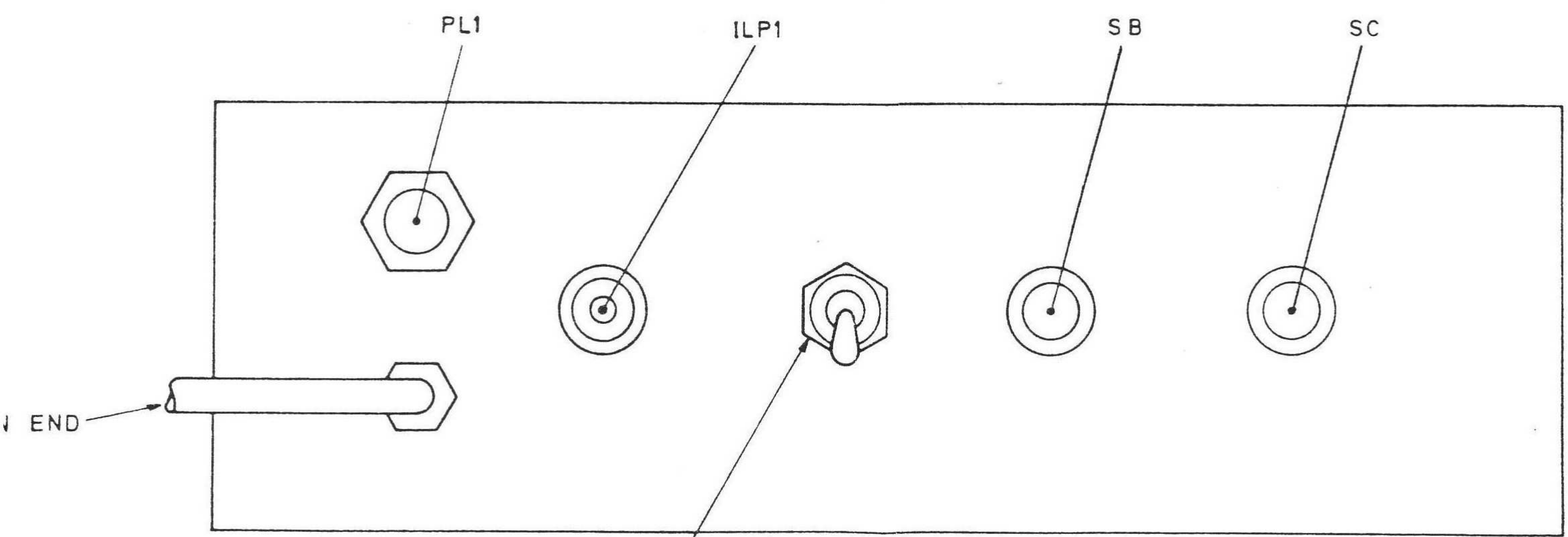
PCB LAYOUT

RACAL

WOH 8058

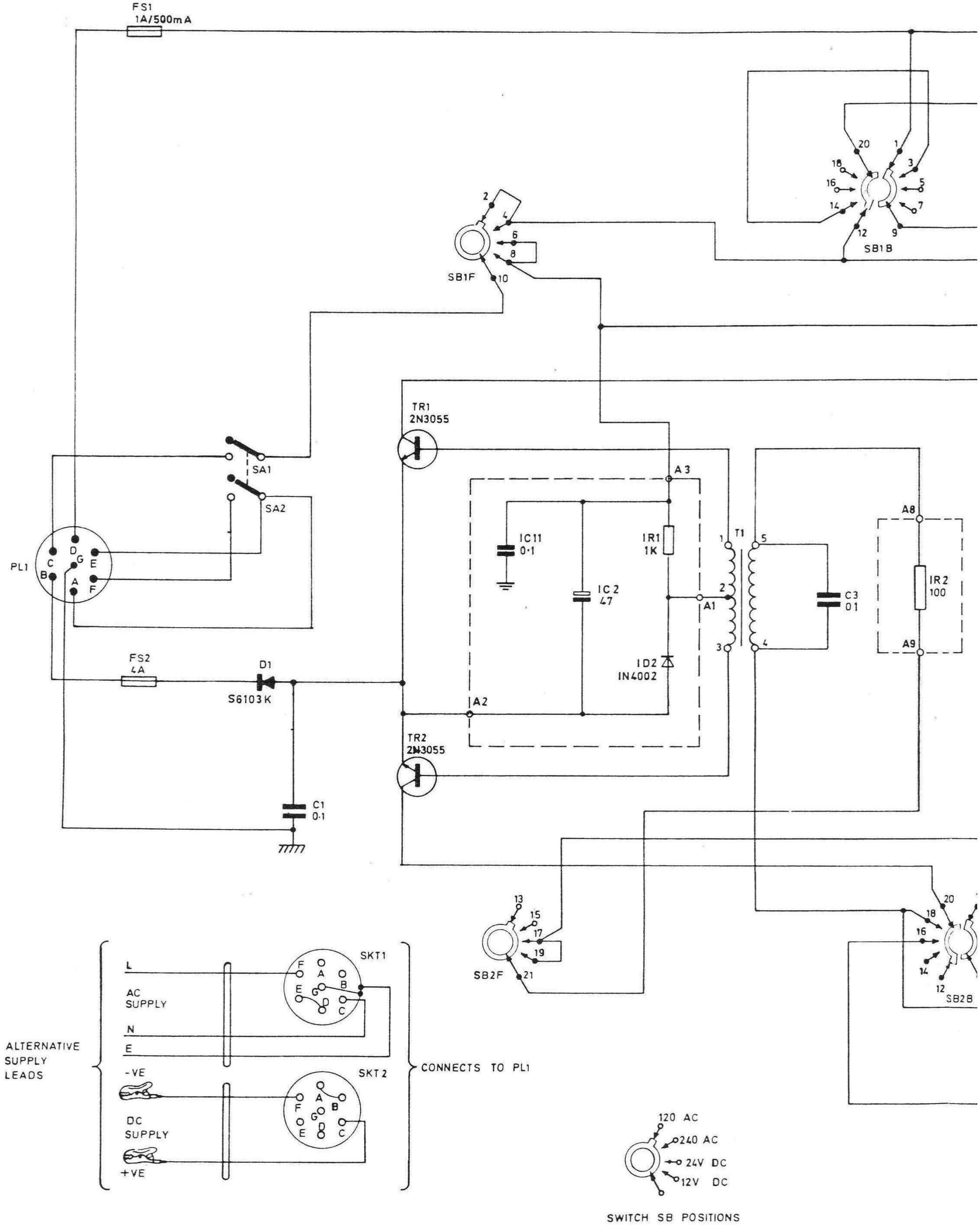


MAIN VIEW

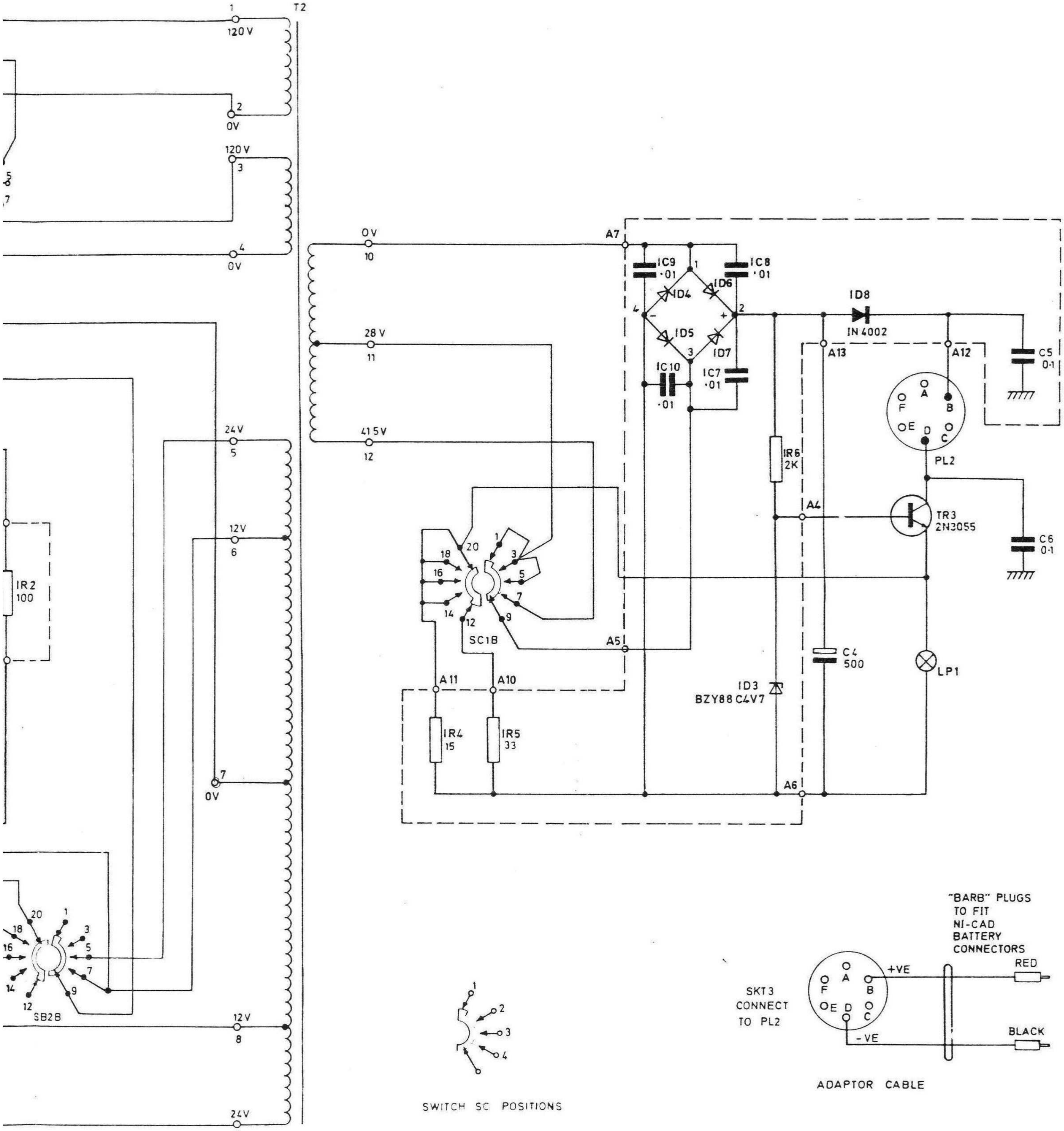


FRONT PANEL

Component Layout : MA.945B Fig. 2



FS1
1A/500mA
SB1B
SB1F
TR1
2N3055
SA1
SA2
PL1
A3
IC11
0·1
IC2
47
IR1
1K
T1
C3
01
A8
IR2
100
A9
A1
ID2
IN4002
FS2
4A
D1
S6103K
A2
TR2
2N3055
C1
0·1
SB2F
SB2B
ALTERNATIVE
SUPPLY
LEADS
L
AC
SUPPLY
N
E
-VE
DC
SUPPLY
+VE
SKT1
SKT2
CONNECTS TO PL1
120 AC
240 AC
24V DC
12V DC
SWITCH SB POSITIONS



Circuit : Battery Charger
Type MA.945B

Fig. 3

OPERATING INSTRUCTIONS - MA 945B

1 SET SUPPLY VOLTAGE SELECTOR SWITCH TO REQUIRED INPUT VOLTAGE

2 SET CHARGE RATE SELECTOR SWITCH FROM TABLE OPPOSITE

3 CONNECT CHARGING LEAD TO BATTERY/EQUIPMENT

4 CONNECT APPROPRIATE SUPPLY LEAD, OBSERVE POLARITY IF D.C.

5 SWITCH ON AND CHECK THAT THE CHARGE INDICATOR LAMP IS ALIGHT

NOTE - A FULLY DISCHARGED BATTERY WILL TAKE APPROXIMATELY 14 HOURS TO CHARGE

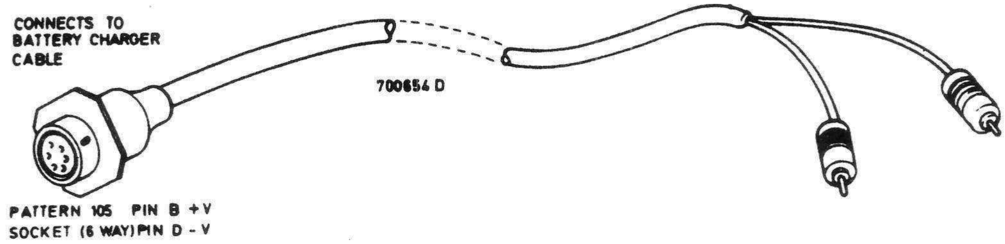
WARNING

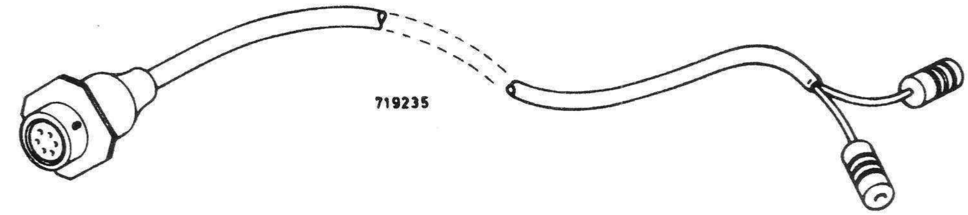
THE BATTERY WILL BE DAMAGED UNLESS CORRECT SWITCH POSITION IS SELECTED

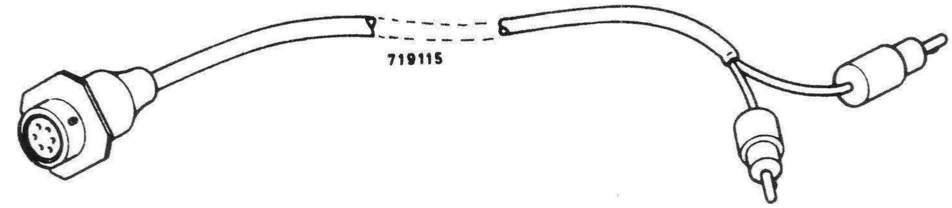
EQUIPMENT TYPE	VARIANT	BATTERY TYPE MA	CHARGE RATE
[illegible]	— C	925 [illegible] 9[illegible]	[illegible]
TRA 92[illegible]	— B C	928 9-8 9-8C	3 2
TRA 922	—	928 948	3
[illegible] 929	ALL	934	4
TRA 93[illegible]	ALL	93[illegible]	4
TRA 932	ALL	9[illegible]	[illegible]
TRA 965	A[illegible]	959A	1
TRA 957	ALL	956A	1
TRA 971	ALL	960A	1
PRM 402[illegible]	—	[illegible]25A	2
PRM 4150	—	[illegible]	1
TRA 6929	—	6938	1

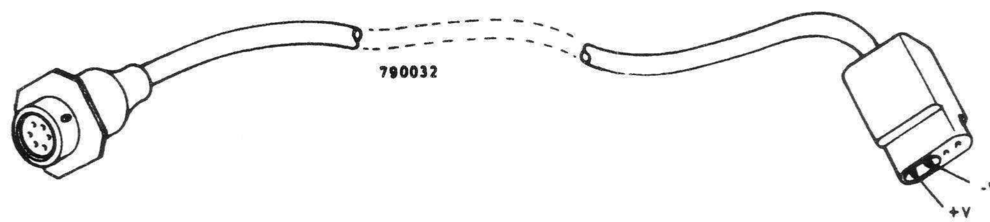
RACAL WOH8058

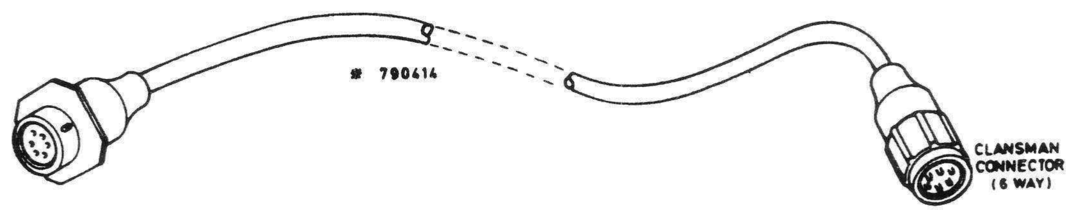
Instruction Label : Battery Charger MA.945B Fig. 4

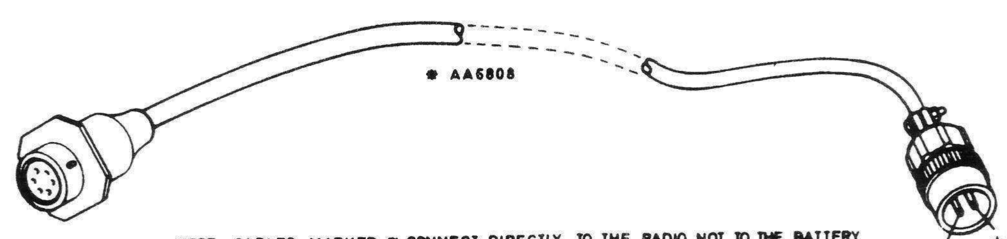












NOTE: CABLES MARKED * CONNECT DIRECTLY TO THE RADIO, NOT TO THE BATTERY.

FIVE OUTPUT BATTERY CHARGER TYPE MA978F

The MA978F is similar to the MA978A (as described in this Manual) except for the five battery charging lead terminations. The MA978F is fitted with five special connectors to suit the MA4705A battery, as used with the PRM4700 Transceivers.

The following additional items should be added to the Mechanical Parts List for the MA978F.

Description	Racal Part Number
Plug Body	CD709101
Plug Cover	BD709102
Connector	AD709103
Connector Spring	AD709104
Screw M3 x 10 Stainless Steel	921313
Screw M3 x 4 Socket Head	919844

Battery Charger Type MA.978

ALTERNATIVE TRANSISTOR TYPES

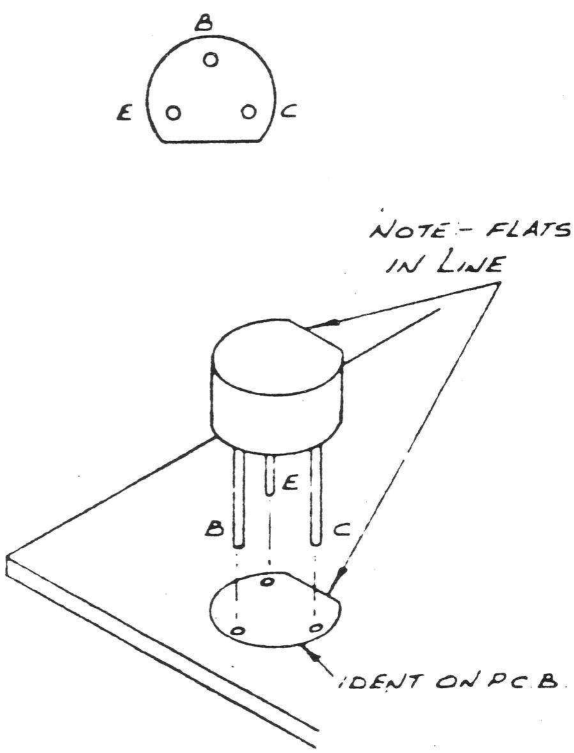
This addendum is applicable to the following equipments:-

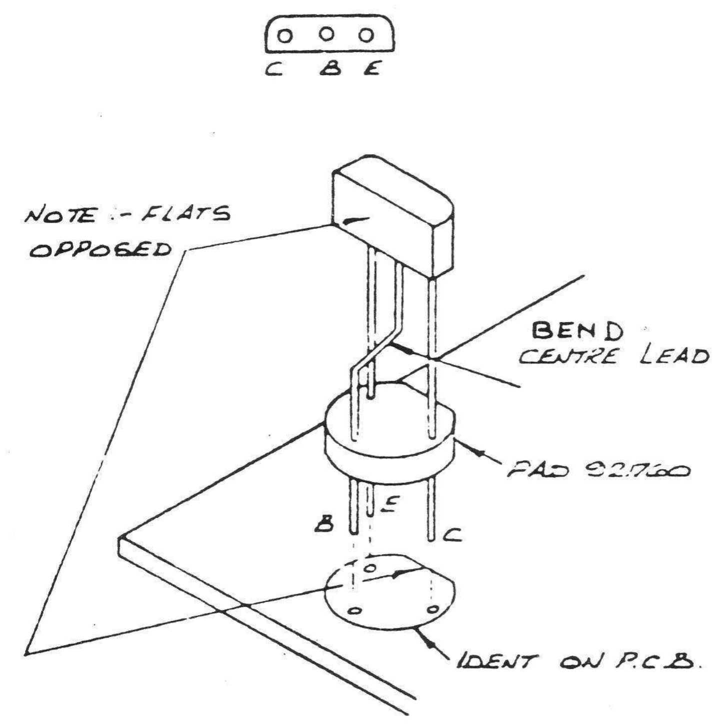
CA 531	MA 924L	MA 930P	MA 936	TA 970	MA 985B	MA 990
MA 907	MA 926	MA 930V	MA 937	TA 970H	MA 986B	MA 991
MA 923	MA 927	MA 930X	MA 937B	TRA 971	MA 987	MA 4001
MA 924	MA 930	MA 933	MA 949	MA 978	MA 988	
MA 924B	MA 930L	MA 935	MA 969	MA 984	MA 988B	

'E-line' (ZTX) Transistors may be used as a replacement for the original transistors listed below. Orientation of transistors on printed circuit boards (PCB's) should be carefully noted as illustrated below.

Original Transistor			Replacement Transistor	
Type	Racal Part No.		Type	Racal Part No.
BC 182 SX 3711	917465 915119	alternative	ZTX 237	923171
BC 212 SX 4060	919122 916092	alternative	ZTX 212	923172
2N 5450	915133	alternative	ZTX 3705	923170
*2N 5448	915118	alternative	ZTX 3703	923169

Configuration (as viewed from lead side of transistor).





Original Transistor Mounting Method

Replacement Transistor Mounting Method

* TR22 on the MA 924 Series and TR20 on the MA 930 Series, are 2N 5448. ZTX 3703 must

FIVE OUTPUT BATTERY CHARGER

TYPE MA.978

CONTENTS LIST

ILLUSTRATIONS

FIVE OUTPUT BATTERY CHARGER

TYPE MA.978

INTRODUCTION

1. The Battery Charger MA.978 can be used to charge up to five MA.968A batteries as used with the TRA.965 and TRA.967 transceivers, or up to four MA.980 batteries as used with the TRA.971 Telecal. Each battery may be charged when attached to its associated transceiver by the use of an adaptor lead.

2. Two input supply leads are supplied with the unit; one for connection to an a.c. supply, and one fitted with crocodile clips for connection to a d.c. supply. Either of these leads will connect to the supply plug on the front panel.

CONSTRUCTION

3. The unit is housed in a plastic case of dimensions 290mm (11.4in) x 90mm (3.5in) x 162mm (6.4in). The weight of the unit is approximately 3.05kg (6.7lb).

4. The front panel carries all controls and connectors. These are listed below.

   (a) Supply input plug.

   (b) Supply ON/OFF switch.

   (c) Supply selector switch (120V or 240V a.c., 12V or 24V d.c.).

   (d) Charging indicator lamps (one for each output).

   (e) Battery charging leads (one for each output).

5. Two fuses, one for a.c. and one for d.c. input supplies, are mounted internally.

6. The battery charging leads, which are permanently attached to the battery charger, are terminated in miniature sockets for connection directly into the recessed pins of the batteries. If the batteries are to be charged while they are attached to their associated transceivers, the miniature sockets are inserted into an adaptor cable, which in turn is plugged into an AUDIO socket on the transceiver.

ELECTRICAL CHARACTERISTICS

7.	Input Voltages:	12-15 or 24-30 volts d.c. 100-125 or 200-250 volts a.c., 45-60Hz.
8.	Input Power:	Approximate maximum consumption is 40W.
9.	Output current:	Each output delivers 200mA nominal charging current into a 12V battery.

OPERATING INSTRUCTIONS

10. The battery charger operating procedure is as follows:

NOTE: To prevent damage it is essential that the supply selector switch is correctly set before connecting the supply lead.

(1) Set the supply selector switch to the required position.

(2) Connect the charger to the batteries. The charger leads are terminated in miniature sockets which have to be pressed on to the recessed pins on the batteries (red to red, black to black). If the batteries are to be charged while attached to their associated transceivers, the adaptor lead type CA 701643 should be used. In this case, press the miniature sockets on to the recessed pins on the adaptor, and connect the adaptor lead to an AUDIO socket on the transceiver.

WARNING: DO NOT ATTEMPT TO OPERATE THE TRANSCEIVER DIRECTLY FROM THE BATTERY CHARGER WITHOUT THE BATTERY BEING CONNECTED.

(3) Select the correct input supply lead and connect it to the supply plug on the battery charger front panel. Connect the other end of the input supply lead to the supply as follows:

WARNING: WHEN AN A.C. MAINS INPUT SUPPLY IS BEING USED, ENSURE THAT THE SUPPLY IS SWITCHED OFF BEFORE ANY CONNECTIONS ARE MADE.

A.C. Input Supply Cable		A.C. Mains Supply
Brown Wire	to	Line (L)
Blue Wire	to	Neutral (N)
Green/Yellow Wire	to	Earth (E)

D.C. Input Supply Cable		D.C. Supply
Brown Wire (Red Marker)	to	Positive Terminal
Blue Wire (Black Marker)	to	Negative Terminal

NOTE: Either polarity of the d.c. supply can be earthed.

(4) Apply input power, and set the battery charger switch to ON.

(5) Check the charging indicator lamp for each charging circuit being used. When a battery is being charged, the associated lamp will light. If a lamp is not lit, check that the charging circuit is completed before suspecting a fault in the charger.

NOTE: A fully discharged battery will take approximately 14 hours to charge.

CIRCUIT DESCRIPTION (Figure 3)

A.C. Input Circuit

11. The a.c. supply is connected to pins C and F of free socket SKT1, which mates with plug PL1 on the battery charger. Pins D and E are linked within SKT1. The line side of the supply (pin F) is routed via the supply ON/OFF switch SA2, the link between pins D and E, and FS1, to the 120V primary winding of T2. The neutral side of the supply (pin C), is routed via the supply ON/OFF switch SA1 and the selected contacts on wafer SB1F of the supply selector switch, to the appropriate winding of T2. When 240V input is selected, the two primary windings are connected in series by switch SB1B; the switch connects the windings in parallel when 120V input is selected.

D.C. Input Circuit

12. The d.c. supply is connected to pins C and F of free socket SKT2, which mates with plug PL1 on the battery charger. Pins A and B are linked within SKT2. The positive side of the supply (pin C) is routed via the supply ON/OFF switch SA1 and the selected contacts on wafer SB1F of the supply selector switch, to the centre tap of the 12 and 24 volt primary windings of T2. The negative side of the supply (pin F) is routed via the supply ON/OFF switch SA2, the link between pins A and B, FS2 and D1, to the emitters of TR1 and TR2. D1 protects the inverter against polarity reversal of the d.c. input supply.

13. TR1 and TR2 are connected in a d.c. to a.c. inverter circuit operating as follows. When the supply is made to the circuit, differences in gain and leakage currents cause an unbalance between TR1 and TR2. Assume TR1 passes more current than TR2, an unbalance current will flow in the primary of T2 causing a voltage to be developed. This voltage is applied to the primary of T1. The secondary of T1 feeds the bases of the transistors such that TR1 will receive more base current and hence draw more collector current. TR2 will receive less base current and will tend to turn off. TR1 then becomes fully turned on with nearly the full d.c. supply voltage being applied across half of T2 primary winding.

14. The magnetic flux in the core of T1 increases until it becomes saturated. Immediately this occurs, the secondary voltage collapses, removing the base current from TR1, switching it off. A reverse e.m.f. is produced, applying drive to the base of TR2 which conducts until core saturation occurs in the reverse direction. The process then repeats with TR2 being turned off and TR1 turning on again.

15. This sequence is repeated at approximately 400Hz, the waveform in T2 being a square wave. The output from the secondary is applied to the rectifier circuit.

16. The low voltage primary of T2 is tapped to allow for either 12V or 24V d.c. input; the tappings are selected by the supply selector switch SB2F and SB2B.

Rectifier and Regulator Circuits

17. The output from the bi-phase secondary of T2 is rectified by D1 and D2. C4 is the reservoir capacitor.

18. There are five identical regulator circuits, one for each output. The action of the regulator circuit for output 1 is described.

19. Transistors 1TR1 and 1TR2 form a current regulator. Zener diode 1D3 sets the reference for the base of 1TR1. This sets the potential difference across 1R2 to be the zener voltage less the base to emitter voltage of 1TR1. The current through 1R2 and 1LP1 is thus set, and it is this current which is used to charge the battery.

20. The indicator lamp 1LP1 lights when a charging current is being drawn. 1D4 prevents the battery from being discharged through the battery charger should this fail or be switched off with the battery still connected. 1D5 acts as a reversed polarity protection diode. If a battery is connected incorrectly, the diode is forward biased and a high current is drawn which causes the fuse in the battery to blow.

MAINTENANCE

Equipment Required

21. For the fault-finding and performance checks, the following items of equipment are required:

(a) Multimeter e.g. Avo Model 8.

(b) Resistor 68 ohms 5% 3 watts minimum.

(c) Power supply 0-30V DC at 5A e.g. APT type TCU55.

(d) Variable Transformer, output 0-250V at 2A e.g. Duratrak type V5HM.

Dismantling Procedure

22. The battery charger cover is held in position by two large slotted screws on the back panel. The complete unit is assembled on the rear of the front panel, therefore the cover can be slid off completely once the screws are released. Care must be taken not to lose the rubber sealing ring fitted into the groove around the rear of the front panel.

23. The chassis is held onto the front panel with four screws. Figure 1 shows the underneath view of the battery charger with the front panel tilted away from the chassis. The circuit board, which is held in position on two pillars, is shown pulled back to reveal the chassis mounted components.

Re-assembly

24. This is a reversal of the dismantling procedure. Care must be taken to ensure that the rubber sealing ring is fitted into the groove around the rear of the front panel. The cover is pressed into this groove and the screws at the rear are fastened.

Fault-Finding

25. When charging is taking place, the indicator lamp for each output being used should be lit. Should a lamp not light and the charging circuit is complete, connect the 68 ohms (3 watt) resistor in series with the multimeter (1A range) across the relevant output and measure the current. If the current is between 120mA and 170mA, suspect that the bulb in the relevant lamp has failed. If the output current is less than 120mA, determine whether only one or all outputs have failed.

26. If only one output has failed remove the input power and disconnect all batteries. Open the battery charger and inspect for possible open circuits between the output on the circuit board and the end of the charging lead. If continuity is correct suspect a fault in the regulator components for that particulary output. Table 1 provides a list of transistor voltages that may be used as an aid to fault diagnosis.

27. If all outputs have failed check that the right input selection has been made on the front panel switch, that the unit has been switched on, and that the input supply is correct. Should these checks prove to be correct remove the input power and disconnect all batteries. Open the battery charger.

WARNING: IF MAINS IS BEING USED TO POWER THE BATTERY CHARGER, CARE MUST BE TAKEN TO ENSURE THAT THE TRANSFORMER (T2) TERMINALS AND THE ROTARY SWITCH WAFERS ARE NOT TOUCHED.

28. Check the fuse for the supply being used (FS1 for a.c. supply, FS2 for d.c. supply). If a fuse has failed, investigate and rectify the cause of failure e.g. short circuit, and renew fuse. If the fuses are serviceable, re-connect the input supply and switch on. If a.c. is being used, check that the voltage across C4 (can be measured across pins 2 and 4 of the circuit board) is between 29 and 31V under no load conditions. If this voltage is zero suspect that either T2 is faulty or the wiring between T2 and the circuit board is open circuit. If the voltage across C4 is low, suspect that either 1D1 or 1D2 is faulty, or the wrong voltage tap on T2 has been selected.

29. If. d.c. is being used a 400Hz tone from the inverter should be heard. If this tone is present check that the voltage across C4 (can be measured across pins 2 and 4 of the circuit board) is between 22 and 24V under no load conditions. If this voltage is zero suspect that either T2 is faulty or the wiring between T1 and the circuit board is open circuit. If the voltage across C4 is low, suspect that either 1D1 or 1D2 is faulty, or the wrong voltage tap on T2 has been selected.

30. If the tone from the inverter cannot be heard, confirm that the inverter is not working by measuring the a.c. voltage across the low voltage primary windings of T2. If no voltage is present measure the d.c. voltage on the anode (case) of D1. If no voltage is present, suspect that either D1 is at fault, or the wiring between PL1 and D1 is open circuit. If the voltage on the anode of D1 is present, suspect a fault in the inverter. Table 1 provides a list of transistor voltages that may be used as an aid to fault diagnosis.

Performance Check

31. The following procedure enables a check to be made of the charging current for a.c. input.

    (a) Set the SUPPLY VOLTAGE switch to 240VAC.

    (b) Mate the a.c. supply lead (CA700654/B) to the SUPPLY plug, and connect the wire ended terminations to the variable transformer which should be set to 200V.

    (c) Switch the battery charger on.

    (d) Connect the 68 ohm 3 watt resistor in series with the multimeter (1A range) across each of the 5 charging outputs in turn. The current output should be between 170mA and 230mA. Note that the lamp should light.

    (e) Adjust the variable transformer to 100V, and set the SUPPLY VOLTAGE switch to 120VAC. Repeat check (d).

    (f) Switch the battery charger off, and remove connections.

32. The following procedure enables a check to be made of the charging current for d.c. input.

    (a) Set the SUPPLY VOLTAGE switch to 12VDC.

    (b) Mate the d.c. supply lead (CA 700654/C) to the SUPPLY plug, and connect the crocodile clips to the 5A power supply which should be set to 15V.

    (c) Switch the battery charger on.

    (d) Connect the 68 ohm 3 watt resistor in series with the multimeter (1A range) across each of the 5 charging outputs in turn. The current output should be between 170mA and 230mA. Note that the lamp should light.

    (e) Switch off and set the SUPPLY VOLTAGE switch to 24VDC.

    (f) Increase the output of the power supply to 30V.

    (g) Switch on and repeat check (d).

    (h) Switch off the battery charger and remove connections.

TABLE 1

Typical Transistor Voltages

These voltages were measured on an operational Battery Charger (MA.978).

Transistor	E	B	C	Remarks	
1TR1	21.5	21	1.35	Output 1 Short Circuited	120 or 240V a.c. Input
1TR2	0.8	1.35	26		
1TR3	21.5	21	1.35	Output 2 Short Circuited	
1TR4	0.8	1.35	26		
1TR5	21.5	21	1.35	Output 3 Short Circuited	
1TR6	0.8	1.35	26		
1TR7	21.5	21	1.35	Output 4 Short Circuited	
1TR8	0.8	1.35	26		
1TR9	21.5	21	1.35	Output 5 Short Circuited	
1TR10	0.8	1.35	26		
TR1	0.8	0.08	11.8	+12V d.c. Input	One Output Short Circuited
TR2	0.8	0.08	11.8		
TR1	0.8	0	23.7	+24V d.c. Input	
TR2	0.8	0	23.7		

COMPONENTS LIST

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Chassis Components					
		Resistors	W		
R1	1K	Wirewound	6	5	913662
R2	100	Wirewound	6	5	913686
		Capacitors	V		
C1	0.1	Polyester	160	10	906737
C2	47	Tantalum	35		917478
C3	0.1	Polyester	160	10	906737
C4	1000	Electrolytic	40	+50 -10	919117
C5	0.1	Polyester	100	20	915502
		Transformers			
T1					CT710016
T2		Mains			CT710161
		Switches			
SA		DPDT Sealed Lever	3A		930821/EQ
SB		Rotary			BR711088
		Transistors			
TR1		2N3055			906371/EQ
TR2		2N3055			906371/EQ
		Diodes			
D1		6FR5			920025/EQ
D2		10D1			909879
		Connectors			
PL1		Plug 6-way			929140
		Fuses			
FS1		500mA			990989/EQ
FS2		4A			906931/EQ

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Chassis Components contd					
		Lamps			
1LP1 to 1LP5		Bulb 4.5V	0.27W		916078
		Lampholder (Yellow)			916077
		Supply Leads			
		A.C. lead			CA700654/B
		D.C. lead			CA700654/C
Circuit Board Components					
		Resistors	W		
1R1	3.3K	Composition	0.1	10	902514
1R2	27	Wirewound	2.5	5	913582
1R3	1K	Composition	0.3	5	924680
1R4	3.3K	Composition	0.1	10	902514
1R5	27	Wirewound	2.5	5	913582
1R6	1K	Composition	0.3	5	924680
1R7	3.3K	Composition	0.1	10	902514
1R8	27	Wirewound	2.5	5	913582
1R9	1K	Composition	0.3	5	924680
1R10	3.3K	Composition	0.1	10	902514
1R11	27	Wirewound	2.5	5	913582
1R12	1K	Composition	0.3	5	924680
1R13	3.3K	Composition	0.1	10	902514
1R14	27	Wirewound	2.5	5	913582
1R15	1K	Composition	0.3	5	924680
		Capacitors	V		
1C1	0.1	Disc Ceramic	250	+40 -20	916187/EQ
1C2	0.1	Disc Ceramic	250	+40 -20	916187/EQ
		Transistors			
1TR1		ZTX 212			923172
1TR2		TIP31			922492
1TR3		ZTX 212			923172
1TR4		TIP31			922492
1TR5		ZTX 212			923172

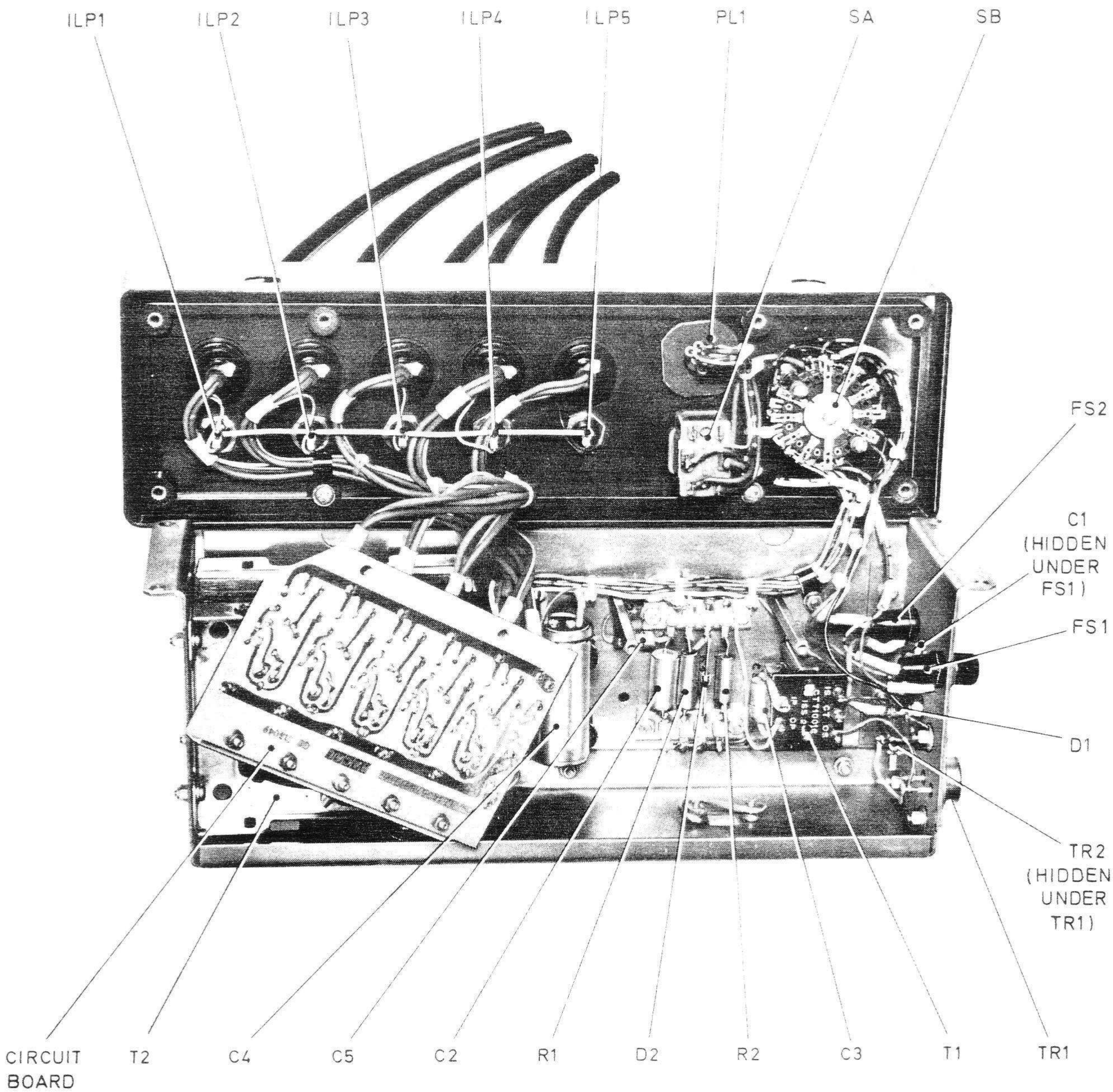
Cct. Ref	Value	Description	Rat	Tol %	Racal Part Number
Circuit Board Components contd					
		Transistors			
1TR6		TIP31			922492
1TR7		ZTX 212			923172
1TR8		TIP31			922492
1TR9		ZTX 212			923172
1TR10		TIP31			922492
		Diodes			
1D1		1R3052			921357
1D2		1R3052			921357
1D3	4.7V	BZY88 C4V7			914067/EQ
1D4		1N4002			911460/EQ
1D5		1N4002			911460/EQ
1D6	4.7V	BZY88C4V7			914067/EQ
1D7		1N4002			911460/EQ
1D8		1N4002			911460/EQ
1D9	4.7V	BZY88C4V7			914067/EQ
1D10		1N4002			
1D11		1N4002			911460/EQ
1D12	4.7V	BZY88 C4V7			914067/EQ
1D13		1N4002			911460/EQ
1D14		1N4002			911460/EQ
1D15	4.7V	BZY88 C4V7			914067/EQ
1D16		1N4002			911460/EQ
1D17		1N4002			911460/EQ

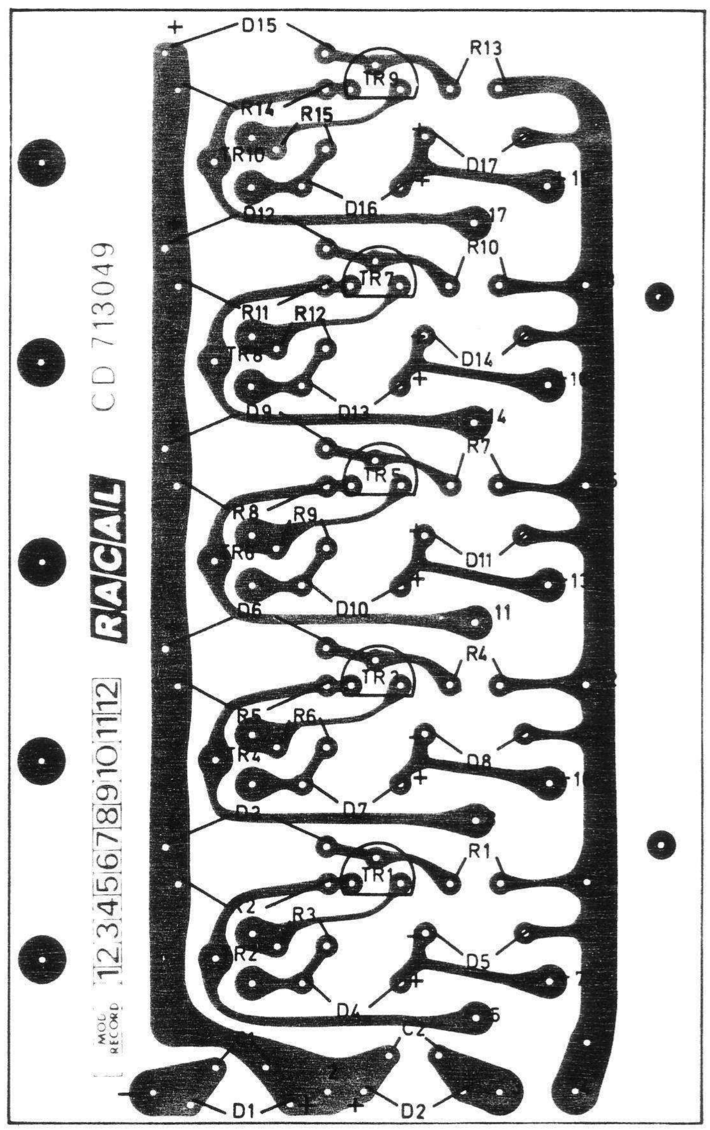
MA 978 FIVE OUTPUT BATTERY CHARGER

MECHANICAL PARTS LIST

Description	Racal Part Number
Boot Resistor	703073
Boss	706126
Bracket	706125
Bush Transistor	921793
Cable Tie	915371/EQ
Cap Electrical	711069
Case Battery Assy	706245
Cover	701586
Fastener Special	701074
Frame	701587
Gland Cable	991097/EQ
Grommet Half	919956
Heatsink	706128
Insulator Mica	935337
Lampholder Yellow	916077
Nut	906368
Nut	912542
Nut Case	702963
Nut M2.5	917826
Nut M3	920597
Nut M3	917825
Nut M4	923858
O Ring	711130
Pad Transistor	921760/EQ
Panel Front	701588
Pillar	701215
Pillar	700123-20
Pin	926428
Plasklip	900096
Plasklip	900205
Plasklip	900123
Plasklip	905625
Ring Retaining	921786
Ring Retaining	934911
Screw	909904
Screw M2.5X10	917823
Screw M3X10	917818
Screw M3X12	935085
Screw M3X30	933201
Screw M3X6	917844
Screw M3X8	917845
Screen M4X20	922362
Seal O Ring	909887
Seal Rubber	706124
Strap Carrying	711038
Washer	702001
Washer	904240
Washer	904252
Washer	906268
Washer M2.5	916074
Washer M2.5	918653
Washer M3	918086
Washer M3	925588
Washer M3	917705

Description	Racal Part Number
Washer M3	928759
Washer M4	918087
Washer M4	917706
Washer M5	918661
Washer	916074
Washer M2.5	917704

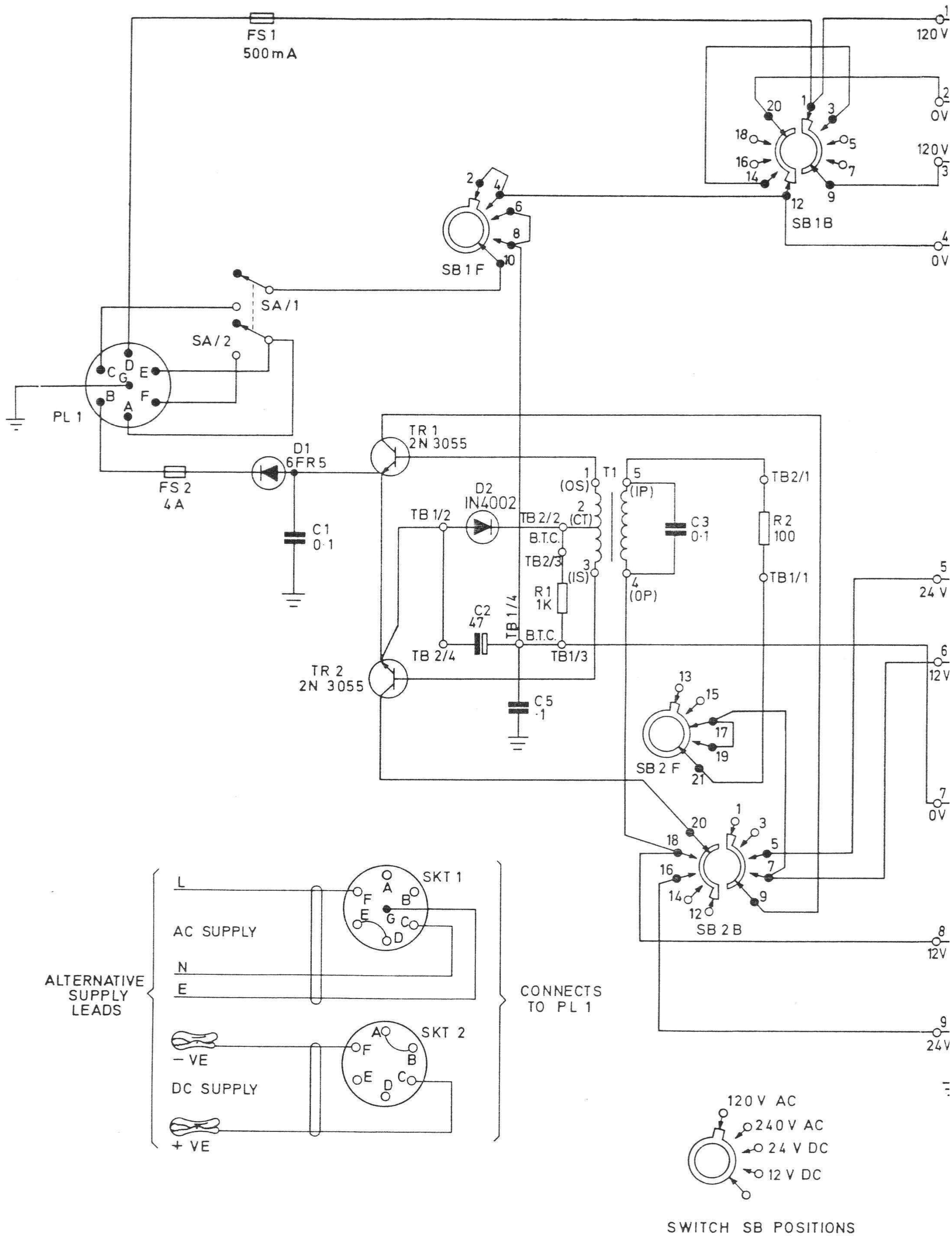

ILP1
ILP2
ILP3
ILP4
ILP5
PL1
SA
SB
FS2
C1 (HIDDEN UNDER FS1)
FS1
D1
TR2 (HIDDEN UNDER TR1)
CIRCUIT BOARD
T2
C4
C5
C2
R1
D2
R2
C3
T1
TR1



ALL COMPONENTS PREFIXED 1

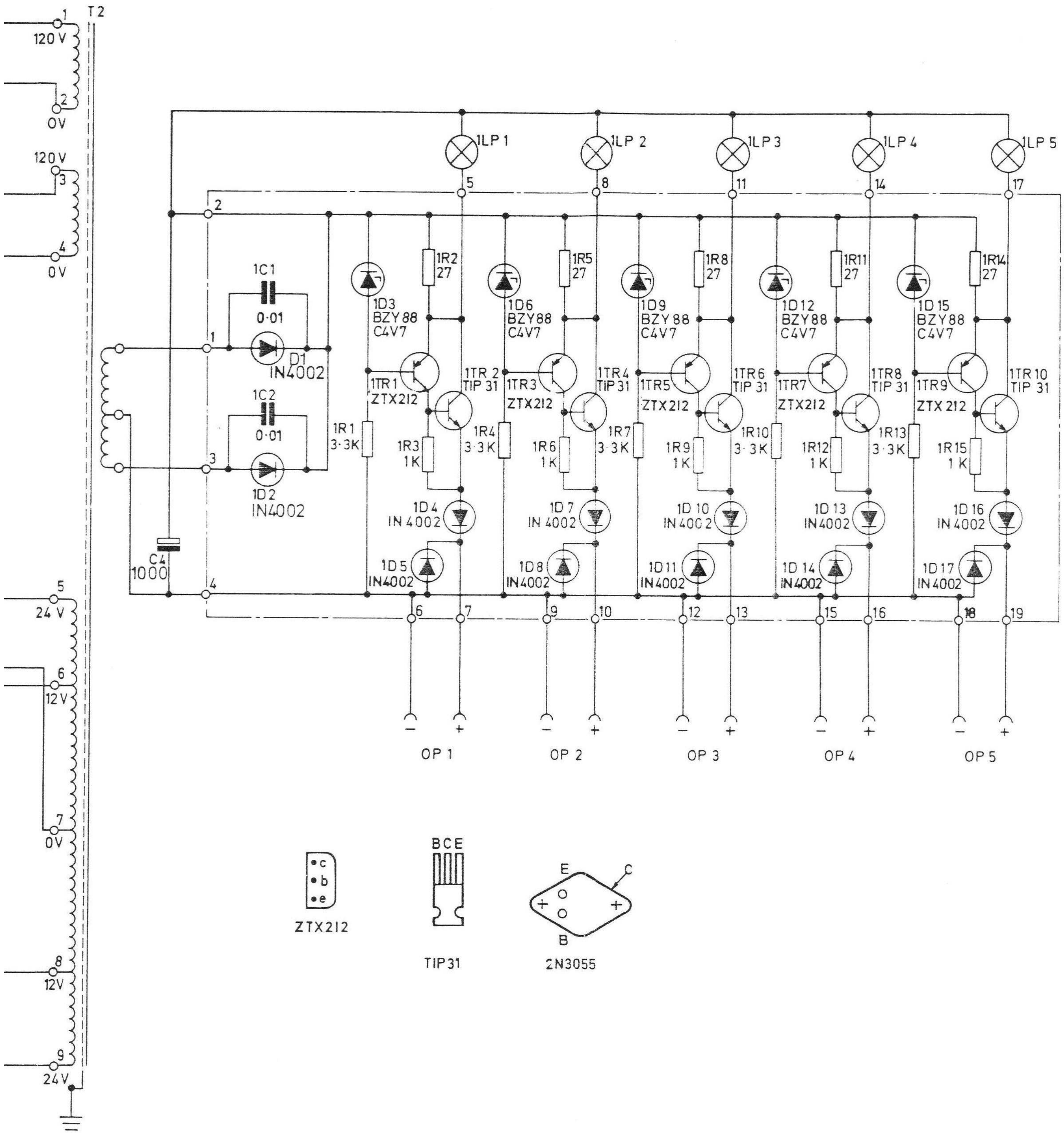
WOH 3105	CD 713049
1	
WOH 3105	CD 713049

Layout: P.C. Board Battery Charger MA.978 Fig. 2



WOH3105	CC701204
1 2 3 4	

Circuit:



rcuit: Battery Charger MA.978

Fig. 3

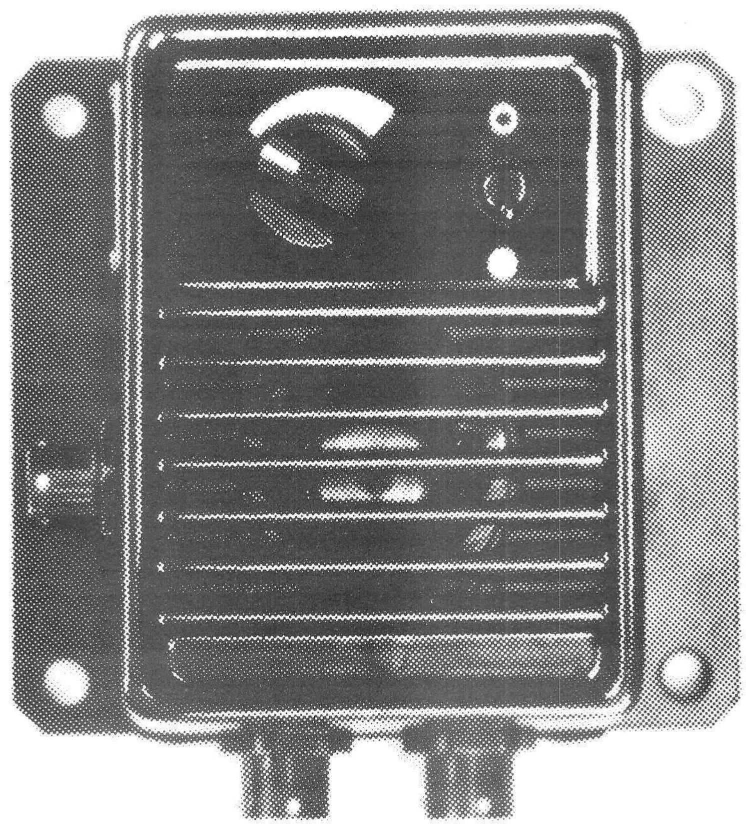
MA 4988A LOUDSPEAKER AMPLIFIER UNIT

CONTENTS

ILLUSTRATIONS

'POZIDRIV' SCREWDRIVERS

Metric thread cross-head screws fitted to Racal equipment are of the 'Pozidriv' type. Phillips type and 'Pozidriv' type screwdrivers are not interchangeable, and the use of the wrong screwdriver will cause damage. POZIDRIV is a registered trademark of G.K.N. Screws and Fasteners Limited. The 'Pozidriv' screwdrivers are manufactured by Stanley Tools Limited.



RACAL

TH5466/1 MA4988A Loudspeaker Amplifier Unit.

CHAPTER 1

DESCRIPTION

CONTENTS

CHAPTER 1

DESCRIPTION

INTRODUCTION

1. The MA 4988A (see Frontispiece) is a compact loudspeaker amplifier unit, with an integral 50 ohm loudspeaker, capable of operating from both nominal 12 and 24 volt inputs. A socket is provided to connect an external loudspeaker of not less than 4 ohms impedance.

2. The unit is fitted with 'Larkspur' compatible input/output connectors.

TECHNICAL SPECIFICATION

3. Nominal Parameters: Operational temperature range, -30°C to +70°C.

Note: When operating from a supply voltage of 24 V or above, into an external speaker of less than 8 ohms with a continuous signal (not speech) at levels above 10 watts for periods of time greater than 20 minutes, the maximum operating temperature is 50°C.

Storage temperature range: -30°C to +70°C.
Supply voltage range: 10 to 32 V dc.
Frequency response (w.r.t. 1 kHz into 8 ohms): -3 dB points, lower - not greater than 200 Hz; upper - not less than 3.5 kHz.
Signal/Noise ratio: better than 50 dB.
Distortion: better than 1% before clipping.
PTT muting: amplifier will mute when the PTT line is less than or equal to 3 V.
Input level required: 1.7 V rms.
Input impedance: greater than 3k ohm.

4. Typical Performance at 1 kHz (25°C).

Supply Voltage	14 V		28 V	
Speaker	Output (5% T.H.D)	Current Loading	Output (5% T.H.D)	Current Loading
External 4 ohm	2.4 W	410 mA	13.3 W	1010 mA
External 8 ohm	1.55 W	255 mA	8.65 W	595 mA
External 50 ohm	300 mW	60 mA	1.7 W	115 mA

CONSTRUCTION

5. The components are secured to an alloy front casting enclosed by a mounting back plate. The mounting centres are 102 x 93 mm.

Connectors: Connectors 1 and 2 (A model) 7-way 62GB-5016-10-7S
Connector 3 2-way 62GB-57A-8-2S

The overall unit dimensions including connectors are:-

Height: 127 mm
Width: 120 mm
Depth: 70 mm
Weight: 1 kg

CIRCUIT DESCRIPTION Figs. 2 and 4

6. An integrated circuit power amplifier ML1, and all the other unit active components, are mounted on the printed circuit board. For muting purposes, ML1 has an FET gate (TR3) in its audio input line and also a switched positive power supply (TR1).

7. Unit power switch S1 'on'. With the PTT line low (less than or equal to 3 V), switching transistor TR2 is off holding both the power switch TR1 and the audio gate TR3 off; ML1 is therefore both switched off and isolated from the audio input line.

8. With the PTT line high (5 V or greater), TR2 is conducting, TR1 and TR3 are held in the on state connecting power and input audio to ML1.

9. Integrated circuit ML1 has integral short circuit and thermal protection; D3 and D4 are protective diodes for ML1. See para. 4 for unit performance with or without an external loudspeaker connected.

Audio Input

10. It should be noted that the audio input is the radio Fixed Audio signal, pin G Connectors 1 and 2 (Fig. 2), therefore the unit loudspeaker output level is only controlled by the volume potentiometer R1. The radio Variable Audio signal, pin F, routed through the unit for connection to a headset or handset is not controlled by R1.

CHAPTER 2

OPERATING INSTRUCTIONS

CONTENTS

CHAPTER 2

OPERATING INSTRUCTIONS

1. With a received signal, adjust the volume control for the reuqired loudspeaker output level.

Note: The unit Volume control has no effect on the volume at a headset or handset connected to the unit. The volume of a connected headset or handset is set by the appropriate control on the radio or operater harness unit.

CHAPTER 3

MAINTENANCE

CONTENTS

CHAPTER 3

MAINTENANCE

INTRODUCTION

1. This Chapter details the test procedure, the equipment required to carry out the test procedure and notes on dismantling and reassembling.

TEST PROCEDURE

Equipment Required

2. (1) Power Supply: Output voltage 28 V dc, output current 2 Amps. Example: Weir 761.1

(2) AF Signal Generator: Frequency range 50 Hz to 20 kHz, impedance 600 ohm balanced, output level 10 mV to 3 V rms adjustable. Example: Gould J3B

(3) AF Power Output Meter: Impedance 8 ohm, sensitivity 50 mW to 15 W FSD Example: Farnell 2085

(4) Distortion Factor Meter: Operating frequency 1 kHz, sensitivity 0.1% to 100% FSD. Example: Farnell 2065

(5) Multimeter: Sensitivity 20,000 ohm/volt dc, ohms, and ohms x 10 k ranges. Example: Avo 8

Continuity Tests

3. With multimeter set to low ohms range, check resistance between following connector pins. Readings must be less than 1 ohm.

Connector 1	to	Connector 2
A		A
B		B
C		C
D		D
E		E
F		F
G		G

Connector 1	to	Connector 3
D		A

4. With multimeter set to high ohms range, check that all pins are insulated from unit case. Insulation reading must not be less than 1 megohm.

Amplifier Output Tests

5. (1) Connect power supply positive terminal to Con.2 pin B and negative terminal to Con.2 pin D. Adjust supply to 28 V and switch it on.

(2) Connect AF Signal Generator to Con.2 pin G (high), pin D (low). Connect AF Power Meter to Con.3 pin B (high), pin A (low).

(3) Adjust AF Signal Generator output to 100 mV rms (emF) at 1 kHz sinusoidal. Set AF Power Meter to 8 ohm impedance position and 50 mW full scale deflection.

(4) Set volume control to mid position. Check that ON/OFF switch does switch the amplifier on/off. Set switch to on position.

(5) Check that clockwise rotation of volume control increases and counter-clockwise rotation decreases amplifier volume repsectively.

(6) Set volume control to its fully clockwise position. Amplifier output power should be between 18 and 35 mW.

(7) Set AF Signal Generator to give a reading of +15 dBm (31.6mW) on AF Power Meter.

(8) Increase generator frequency until AF Power Meter reading falls to +12 dBm (15.8 mW). Frequency at which this occurs should be between 3.5 kHz and 6.5 kHz.

(9) Decrease generator frequency until AF Power Meter reading once again falls to +12 dBm (15.8 mW). Frequency at which this occurs should be between 100 Hz and 200 Hz.

(10) Set AF Signal Generator output to 100 mW rms (emf) at 1 kHz sinusoidal.

(11) Connect Distortion Factor Meter across leads to AF Power Meter (Con.3 pins A and B). Distortion should be less than 0.5%.

(12) At Con.1 link together pins C and D; there should be no amplifier output.

(13) Disconnect link between Con.1 pins C and D; amplifier output should be as in step (10).

(14) Set AF Power Meter to 4 ohm impedance position and 15 W full scale deflection.

(15) Increase AF Signal Generator output until amplifier output metered in 10 W. Distortion recorded should not be greater than 5%.

(16) Switch off the power supply and disconnect all test equipment.

DISMANTLING

6. (1) Remove four M4 screws securing backplate. Remove backplate.

(2) Remove six M3 cross-head screws securing PCB. Do not remove single slotted screw visible (secures PCB heatsink). Pivot PCB outwards clear of loudspeaker.

(3) Loudspeaker is secured to front casting by four PCB pillars.

ASSEMBLING

7. (1) Before assembling; check all soldering for serviceability, check sheet gasket for serviceability.

(2) Assemble in reverse order to dismantling.

CHAPTER 4

COMPONENTS LIST

CONTENTS

CHAPTER 4

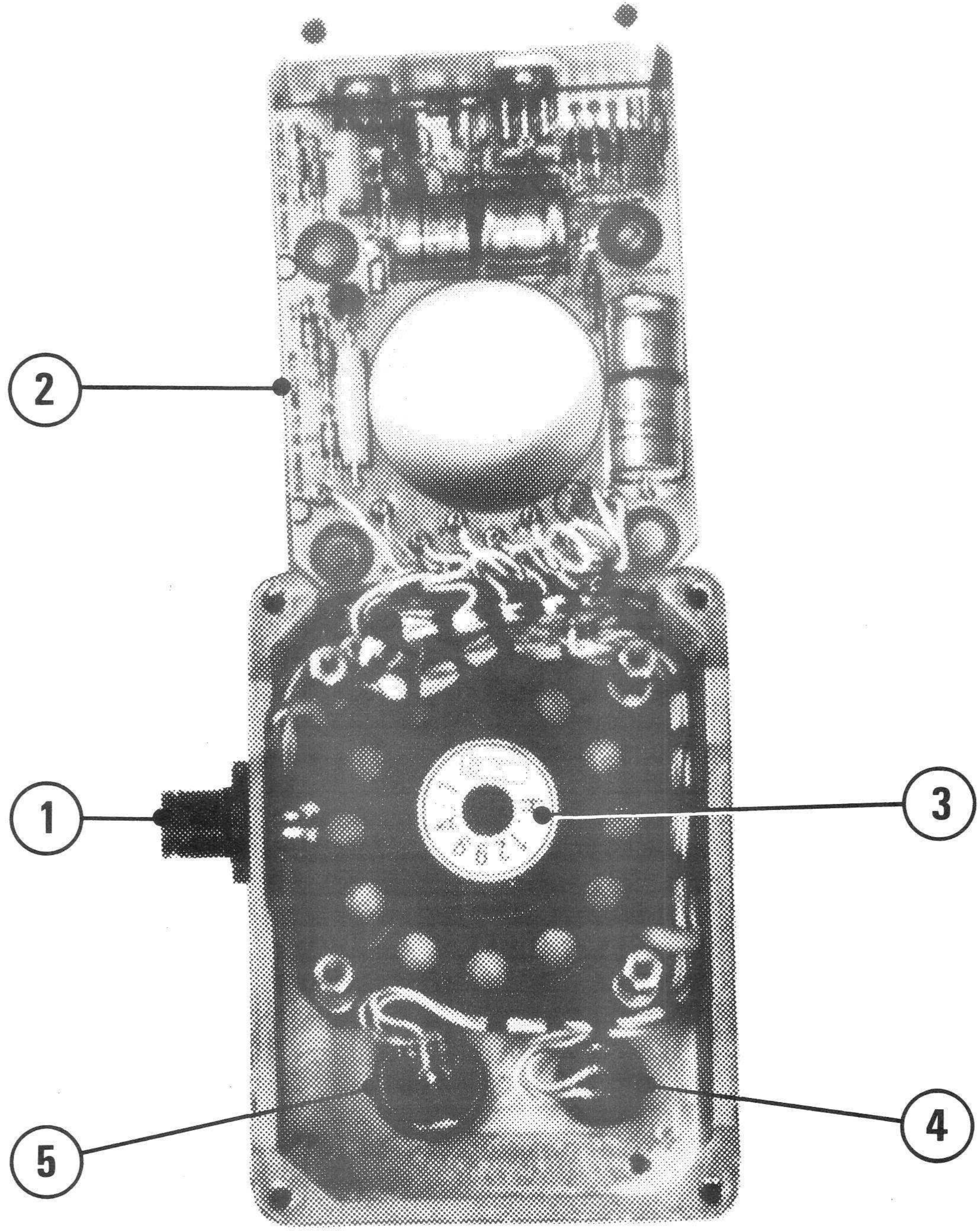
COMPONENTS LIST

UNIT COMPONENT LIST

Circuit Ref	Description		Racal Part No.
	PCB Assemly		791173
R1	Potentiometer 4.7k ohm log.		782584
	Knob, potentiometer		705588
LS1	Loudspeaker 50 ohm		923410
S1	Switch, single pole 6104		992236 EQ
	Board, de-coupling	(2 off)	703211
C1 to C12	Capacitors, 10 nF 20% 100 V ceramic		927395 EQ
Connectors 1 & 2	Connector, 7 way 62GB-5016-10-7S		928128 EQ
Connector 3	Connector, 2 way 62GB-57A-8-2S		915571 EQ
	Gasket		782821

AMPLIFIER PCB 791173 COMPONENTS LIST

Circuit Ref	Value	Description	Racal Part No.
Capacitors			
IC1	100 nF	10% 100 V electrolytic	920566 EQ
IC2, IC5	470 µF	-10 + 50% 40 V electrolytic	921537
IC3	100 nF	10 % 50 V ceramic	936877 EQ
IC4	1 nF	10% 100 V ceramic	924031 EQ
IC6	220 nF	10% 63 V MKS2	990033 EQ
IC7, IC9	1.8 nF	10% 100 V ceramic	991685 EQ
IC8	22 µF	20 % 25 V tantalum	924032 EQ
IC10	4.7 nF	10% 100 V ceramic	920598
IC11	1 µF	20 % 35 V tantalum	919635 EQ
IC12	10 nF	20% 100 V ceramic	927395 EQ
Diodes			
D1, D2		IN 4149	914898 EQ
D3, D4		IN 4001	915266 EQ
D5		Zener BZX 79C 3.9 V	925667
Integrated Circuits			
ML1		TDA 2030 V	991689 EQ
Inductors			
L1	5 µH	RFS - 2	991697 EQ
Resistors			
R1,R4,R7,R9	22k ohm	5% 0.25 W carbon film	927770 EQ
R2,R3,R11	2.7k ohm	5% 0.25 W carbon film	921116 EQ
R5	1.0M ohm	5% 0.25 W carbon film	927803 EQ
R6	220k ohm	5% 0.25 W carbon film	927773 EQ
R8	1 ohm	5% 0.25 W carbon film	923887 EQ
R10	4.7k ohm	5% 0.25 W carbon film	927765 EQ
R12	10 ohm	5% 0.25 W carbon film	927750 EQ
Transistors			
TR1		TIP 127	936208 EQ
TR2		ZT X 237	923171
TR3		J176	933404



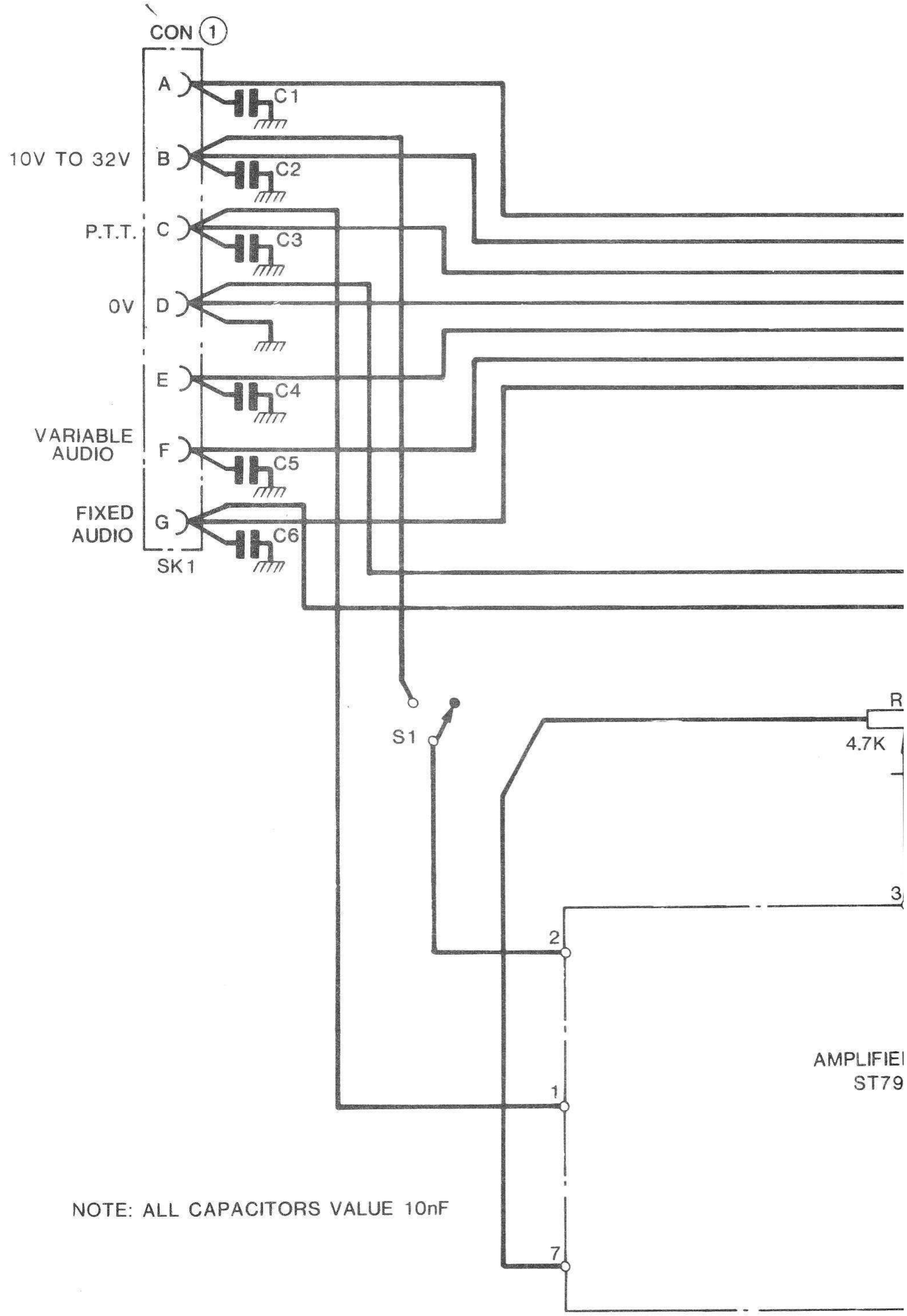
1. Connector 3
2. PCB
3. Loudspeaker
4. Switch S1
5. Potentiometer R1

RACAL

TH5466/1

MA4988A : Layout.

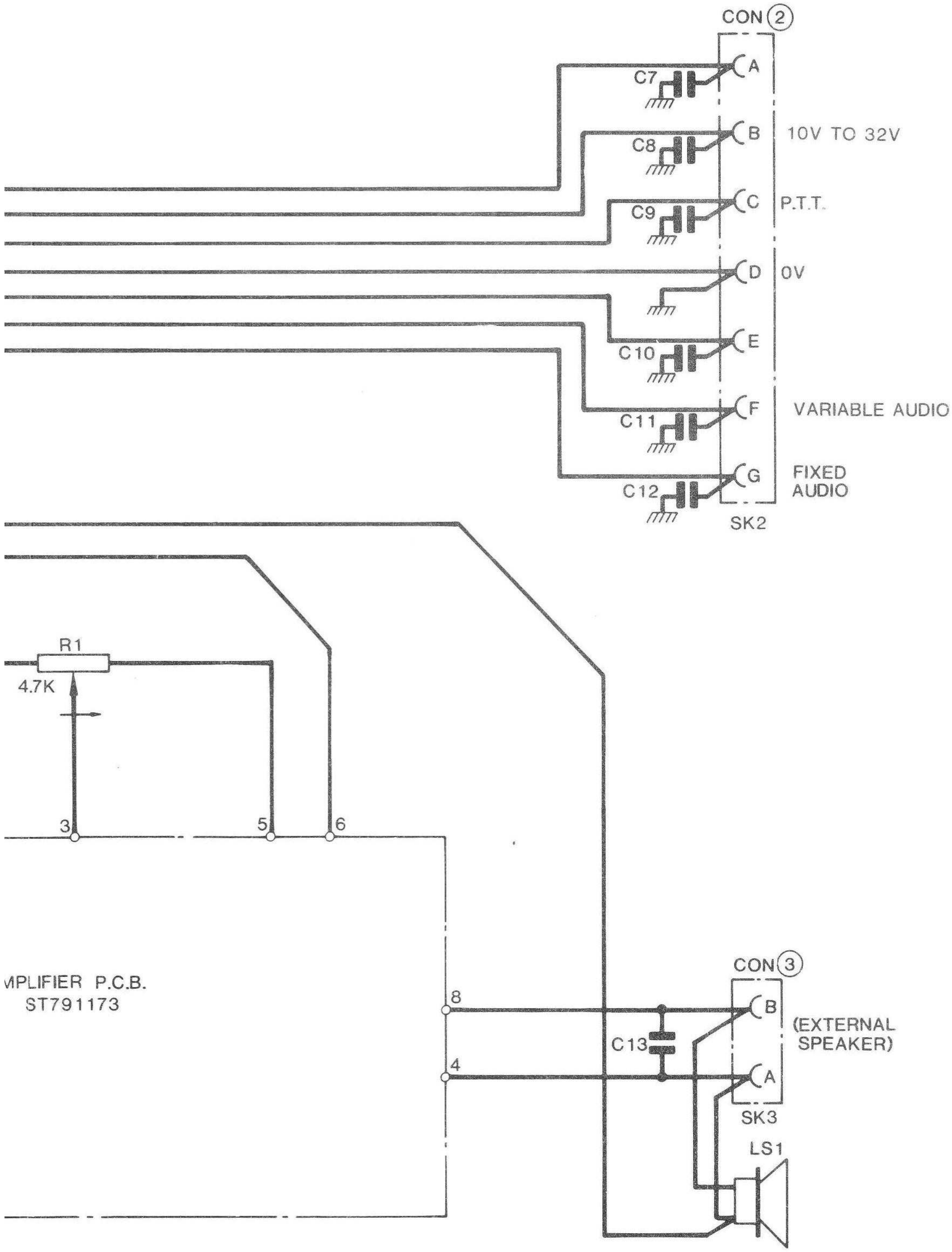
Fig. 1



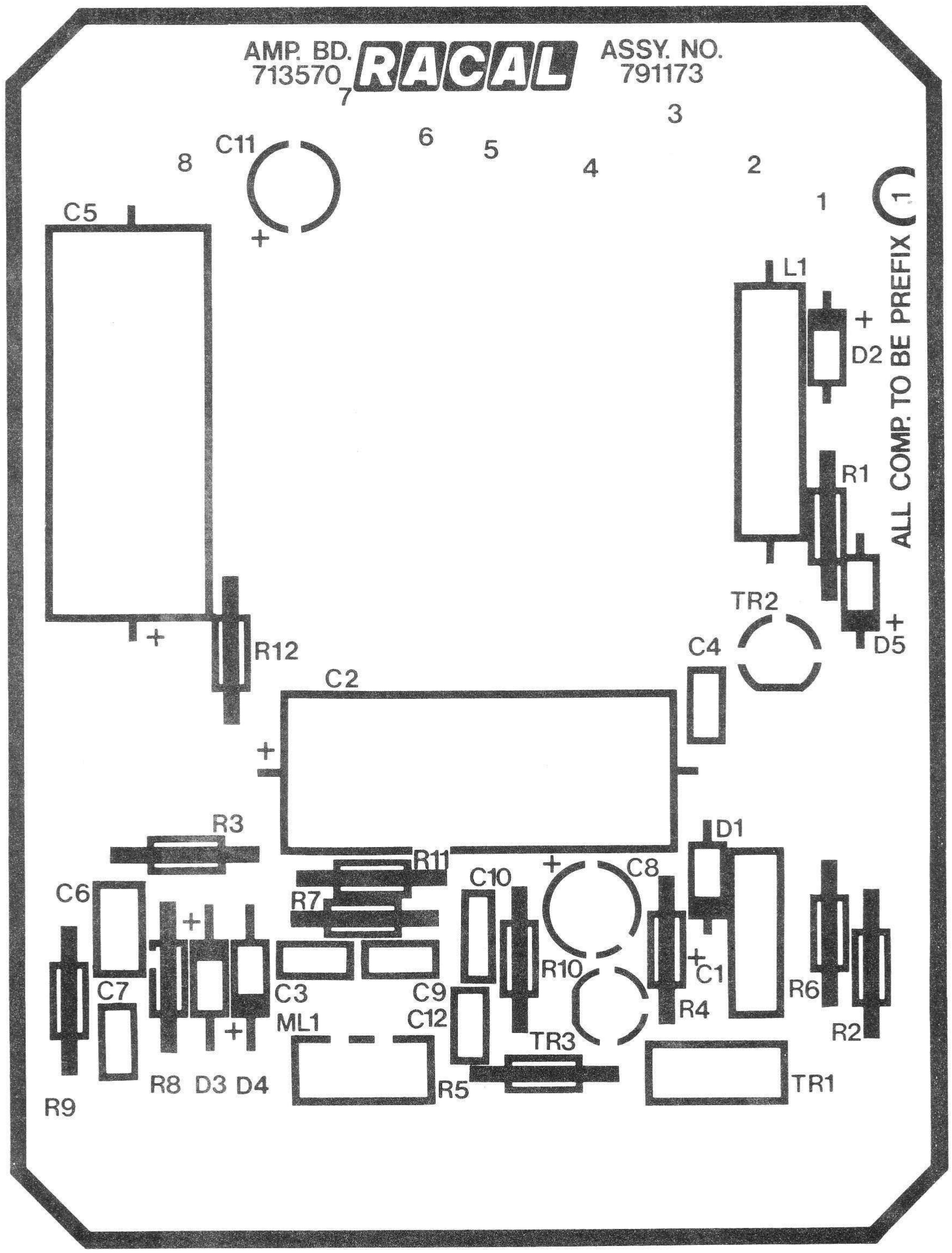
NOTE: ALL CAPACITORS VALUE 10nF

RACAL

TH5466/1



MA4988A : Circuit Diagram. Fig. 2



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TH5466/1 | DD 713570
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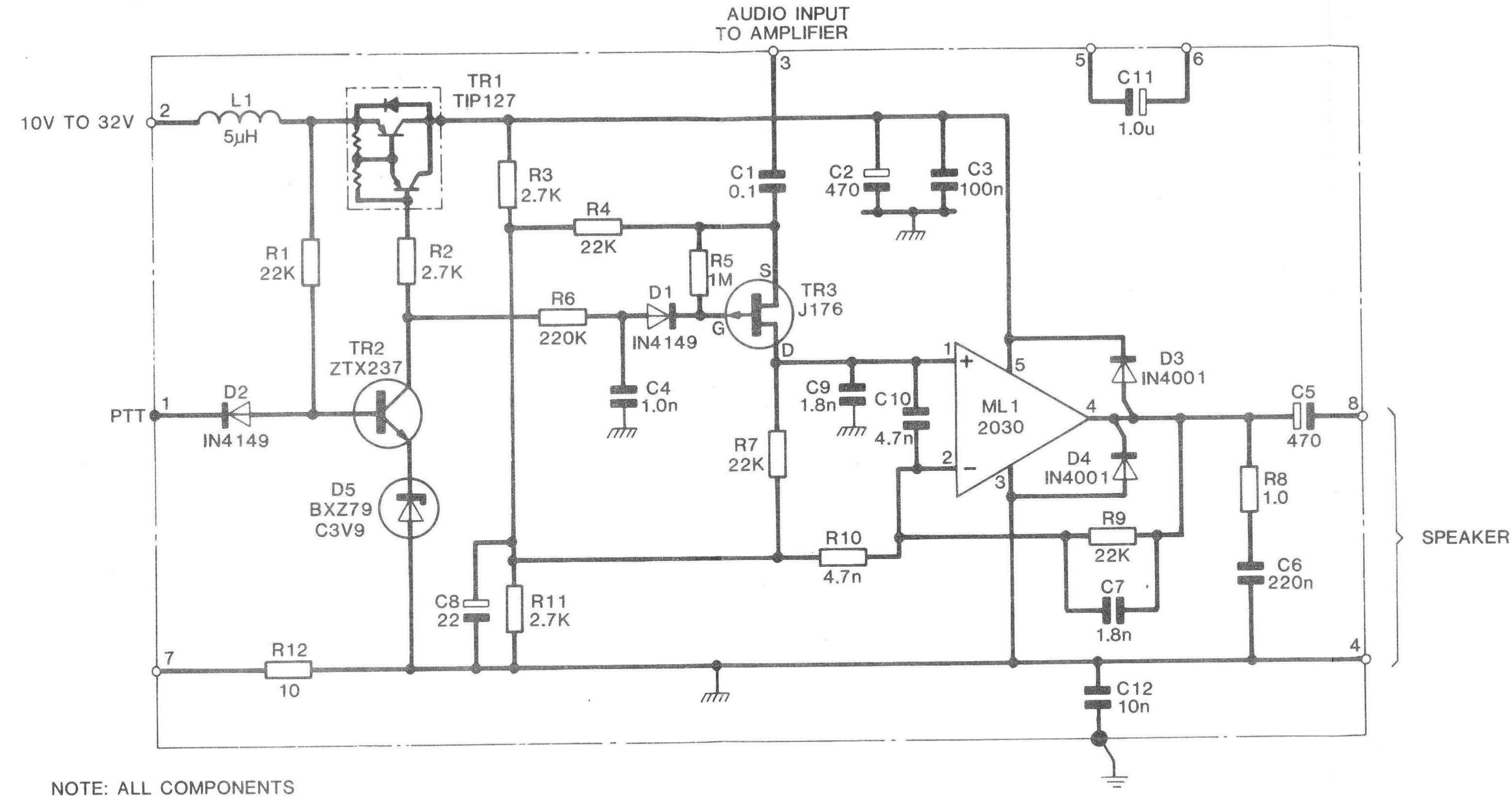
PCB Assembly Layout

Fig. 3



NOTE: ALL COMPONENTS
PREFIX1