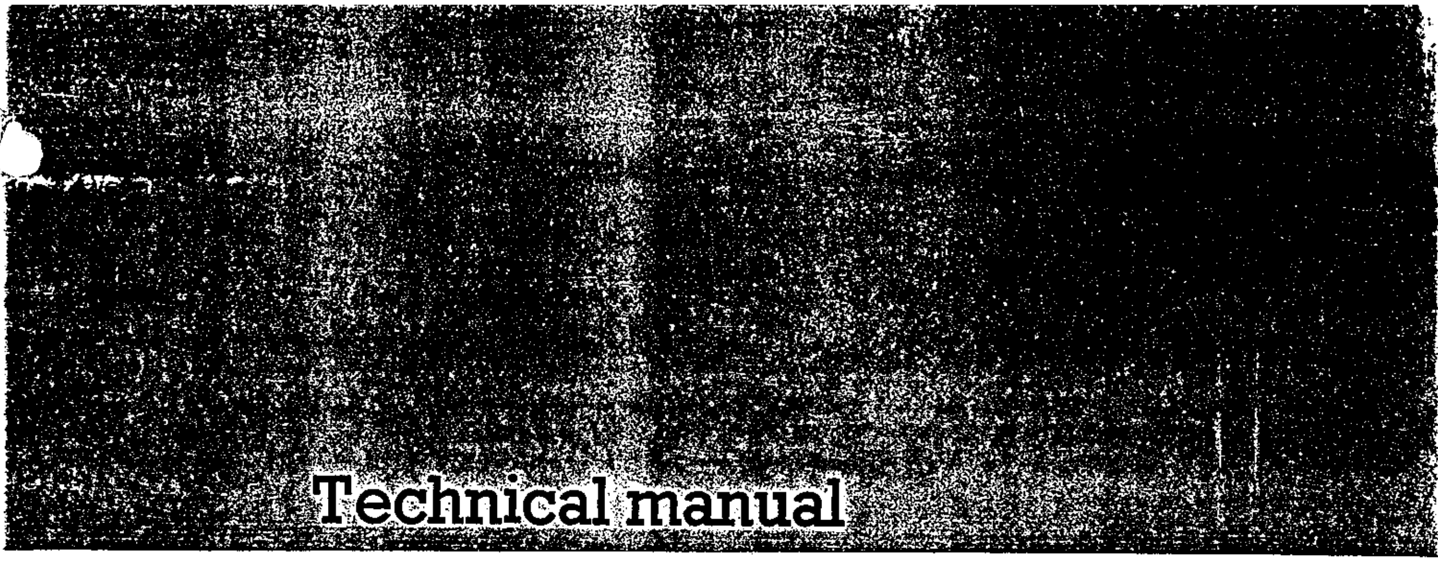

Technical manual

PRM. 4021
HF/SSB Transmitter-Receiver

ELECTRONIC SECTION
1 BASE WORKSHOP
TRENTHAM CAMP

1976
THE QUEEN'S AWARD
FOR EXPORT ACHIEVEMENT
TO RACAL-MOBILCAL LTD.

1977
THE QUEEN'S AWARD
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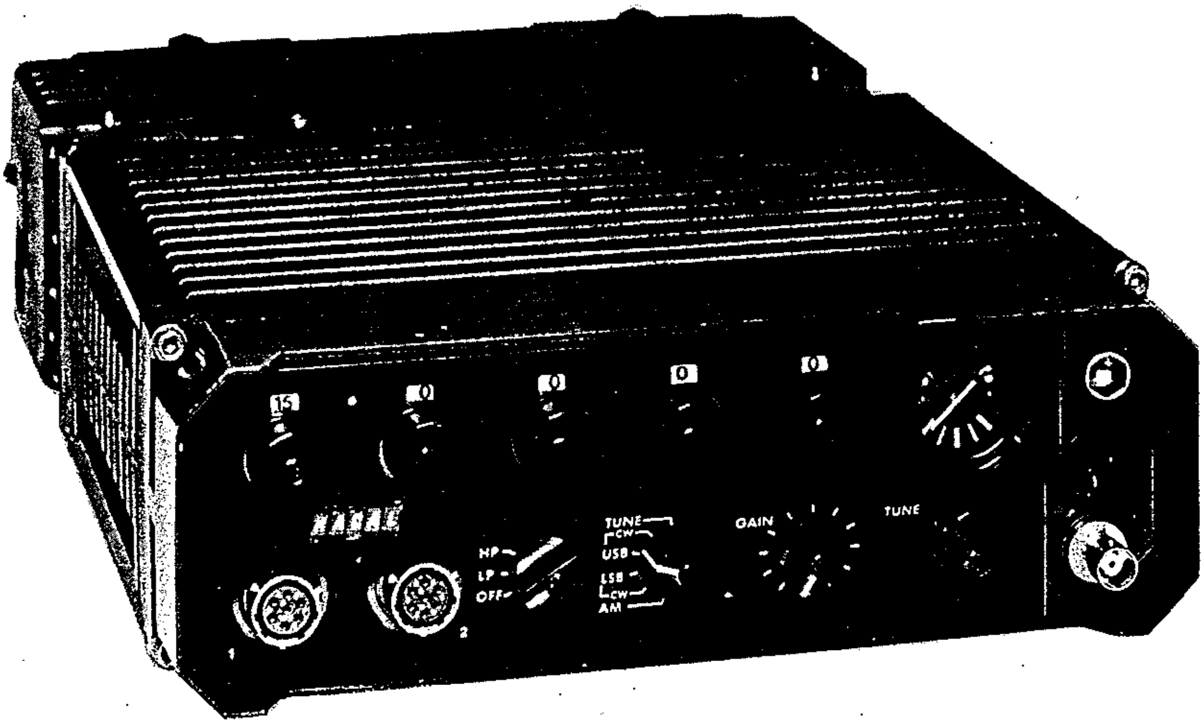

HF SSB Transmitter-Receiver
Type PRM.4021

WOH 7207

PRM.4021

HF SSB TRANSMITTER-RECEIVER

CONTENTS

PART 1

PRM.4021 HF SSB TRANSMITTER-RECEIVER

OVERALL DESCRIPTION

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ILLUSTRATIONS (AT REAR OF PART)

(See individual Chapter Contents pages for in-text illustrations)

PRM.4021

HF SSB TRANSMITTER-RECEIVER

TECHNICAL SPECIFICATION

General

Frequency Range:	2-15.9999MHz
Channels:	140,000 channels in 100Hz steps derived from a single high stability TCXO selected by 5 in-line switches. Maximum synthesizer locking time, less than 2 secs.
Operating Modes:	USB (A3J) USB CW) (A2J) 1kHz keyed tone LSB CW) LSB (A3J) Compatible AM (A3H) ⇐
Frequency Stability:	Better than ±2 ppm over the operating temperature range with respect to that at 20°C.
Power Supply:	12 volt nominal from 4Ah nickel-cadium rechargeable battery type 4025A, or associated power supply unit.
Antennas:	2.4m (8ft) whip Long wire Dipole Optional short helical battle antenna
Antenna Tuning:	Single control tuning. Inbuilt ATU tunes the above antennas for both transmit and receive.
Sealing:	Transmitter-receiver case sealed and fitted with desiccator. Battery case sealed and fitted with desiccator bag.
Weight:	Basic PRM.4021 only: 3.5kg (7.7lb). Operational manpack with handset, nickel-cadmium battery and haversack: 7kg (15lb).
Dimensions:	Basic set (no battery) Width: 230mm (9.05 ins) Height: 75mm (2.95 ins) Depth: 253mm (9.96 ins)

Environmental

a)	Temperature:	Operational:	-10° to $+55^{\circ}C$
		Storage:	-40° to $+70^{\circ}C$
b)	Humidity:	The unit is enclosed in a sealed desiccated box.	

Transmitter

		High Power	Low Power
Output power:	Voice (SSB)	10 watts pep	Approx 6dB reduction
	CW	10 watts	Approx 6dB reduction
		All into a 50 ohm load.	

Harmonic Emissions:	No harmonic will exceed -45dB relative to pep in 50 ohms load.
Carrier Suppression:	Better than -45dB relative to pep in 50 ohms load.
Intermodulation distortion:	Not worse than -25dB relative to full pep output for 3rd order intermodulation products generated out of band.
Compression Threshold:	Not greater than 2mV rms pd for onset of compression.
Dynamic Range of Compressor Input:	Greater than 30dB above compression threshold.
Current Consumption:	CW 3.0 amp (max). Two tones at the compression threshold 1.8A.

Receiver

Sensitivity:	Not less than 5mW into 300 ohms for 1uV pd RF input at stated S/N ratio. (W/B INPUT)..
Signal/Noise Ratio:	SSB: not less than 15dB for a 1uV pd RF input. CW: not less than 22dB for a 1uV pd RF input.
Selectivity:	SSB: 6dB bandwidth 2.2kHz minimum. 40dB bandwidth 5.0kHz max. CW: 3dB bandwidth 100Hz 30Hz centred on 1kHz.
Current Comsumption:	Maximum: 160mA Typical: 130mA

Control and Facilities

a. Front Panel

Frequency Selection Controls:	The five control switches are used to select the required frequency.
Mode Switch.	The six position rotary switch is used to select the mode of operation of the equipment. The positions of the switch are:- AM, LSB-CW, LSB, USB, USB-CW and TUNE.
Power Switch:	The three position rotary switch is used to select a high or low power output condition and is also used to switch the unit off. The positions of the switch are :- OFF, LP and HP.
GAIN:	This potentiometer controls the gain of the handset audio outputs.
TUNE:	This control tunes the antenna except when a remote ATU is used.
Meter:	The meter indicates the battery voltage (when the unit is in the receive condition and the Power Switch is in the HP position), the agc voltage (when the unit is in the receive condition and the Power Switch is in the LP position .) and antenna current (when the unit is in the transmit condition). The meter incorporates coarse tune indicating l.e.d.'s.
Audio 1 socket:	This socket has pins A to F connected in parallel with Pins A to F on the Audio 2 socket and allows ancillary equipment (such as a headset, morse key, external power supply or battery charging equipment) to be connected to the transceiver. Pin G enables initiate tune when a remote ATU is used with the equipment.
Audio 2 Socket:	This socket provides the same facilities as the Audio 1 socket except that pin G has a fixed audio output for use with, example, a vehicle harness.
Whip Socket:	This socket allows a whip antenna to be connected to the set.
50 Ω BNC	This socket allows a dipole antenna to be connected to the set.

b. Rear Panel

W/B Socket:	This socket provides a connection to either an external filter, a remote ATU or an r.f. amplifier. The d.c. impedance presented to the socket automatically switches the output to the socket and determines whether the output is high or low power.
ATU Socket:	This socket provides a return to the set from the external filter so that the internal ATU may be used to match the antenna.
Ground Terminal:	The terminal allows a ground connection to be made to the set.

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

ILLUSTRATIONS (IN TEXT)

CHAPTER 1

GENERAL DESCRIPTION

1. ROLE

1.1 The PRM.4021 is an HF transceiver operating in the SSB, AM and CW modes. Although designed primarily as a manpack the equipment can be used as a ground station or vehicle radio.

2 DESCRIPTION

2.1 The PRM.4021 is a fully waterproof, lightweight portable transceiver which operates in the frequency range 2 to 15.9999MHz. The unit provides 140000 synthesizer-controlled channels separated by 100Hz steps, and has facilities for both voice and telegraphy, operating in SSB (upper or lower) AM or CW modes.

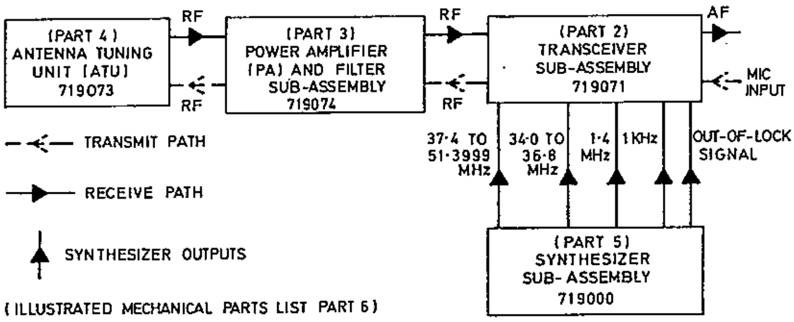
2.2 The design of the manpack allows it to be operated and carried by one operator, although provision is made to allow two operators to use the manpack simultaneously.

2.3 Power supplied to the manpack is obtained from a battery which is contained in a case attached to the base of the main transceiver case. The power supply is a nickel-cadmium (NICAD) rechargeable battery MA.4025A, and is capable of continuous high power operation for 14 hours with a send/receive time ratio of 1:9. A non-rechargeable battery, using primary cells, is available as an altemative.

2.4 As a manpack radio with a whip antenna, the PRM.4021 provides reliable ground wave SSB communication for distances up to 25km, day or night, over rolling terrain. As a ground station using a dipole antenna the sky wave range can be several thousand kilometers. Remote control, including intercommunication and call facilities, is available with MA.985B and MA.986B control boxes.

2.5 Manual rebroadcast facilities can be obtained in conjunction with MA.4009 control unit or vehicle control harness.

2.6 The sub-assemblies which comprise the PRM.4021 transceiver are shown in the block diagram, Fig.1.1.



Block Diagram: PRM.4021 Fig.1·1

3 COMPOSITION OF MANUAL

This manual is sectionalized into Parts as listed below:-

PART 1. PRM.4021. HF SSB TRANSMITTER-RECEIVER OVERALL DESCRIPTION

PART 2. 719171 TRANSCEIVER SUB-ASSEMBLY

PART 3. 719074 POWER AMPLIFIER AND FILTER SUB-ASSEMBLY

PART 4. 719073 ANTENNA TUNING UNIT (ATU)

PART 5. 719000 SYNTHESIZER SUB-ASSEMBLY

PART 6. ILLUSTRATED MECHANICAL PARTS LIST

4 LIST OF ASSOCIATED PUBLICATIONS

User Handbook for Transmitter/Receiver Type PRM.4021	Ref. WOH7206
Technical Manual for Battery Charger MA.945B	Ref. WOH
Technical Manual for Local and Remote Control Units MA.985B/MA.986	Ref. WOH4030

Technical Manual for the Loudspeaker Amplifier MA.988	Ref WOH3074
Technical Manual for the Test Set CA531C	Ref WOH
Technical Manual for the Vehicle Interface Box (H.F and V.H.F) MA.4106	Ref WOH8069
Technical Manual for Hand Generator MA.4175A	

CHAPTER 2

EQUIPMENT AND ACCESSORIES

CONTENTS

ILLUSTRATIONS (IN TEXT)

APPENDICES

CHAPTER 2

EQUIPMENT AND ACCESSORIES

1 INTRODUCTION

1.1 Listed below are brief details of the equipment and accessories commonly used with a PRM.4021 in order to build up a complete transmitter-receiver station (see figs. 2.1, 2.2 and 2.3). A complete list of accessories is given in Appendix 1 to this chapter.

2 RECHARGEABLE BATTERY MA.4025A (ST719004)

2.1 This 12V 4Ah nickel-cadmium battery clips directly to the base of the PRM.4021, an arrangement that facilitates rapid battery changing. The battery may be charged either while attached to the manpack or when removed from it, by using charger type MA.945B.

2.2 The user can charge and discharge the battery many hundred of times before its capacity is seriously affected, and, unlike many secondary batteries, nickel-cadmiums require no maintenance. The MA.4025A is fully sealed thus eliminating any adverse effects due to the ingress of moisture.

3 PRIMARY BATTERY MA.4025B (719063)

3.1 This battery clips directly to the base of the PRM.4021, as does the MA.4025A. It contains 10'D' size cells which are easily replaced by removing two wing nuts, enabling the end cover to be detached.

4 CARRYING FRAME (ST719097)

4.1 This is a plastic coated metal frame, which can accomodate a PRM.4021 complete with an MA.4025A or MA.4025B battery.

5 AUDIO EQUIPMENT

6 Telephone Handset (ST719215)

6.1 This is a lightweight nylon handset complete with plug and coiled lead extendable up to 1.8m.

7 Headset/Boom Microphone Assembly (ST719214)

7.1 This is a twin earpiece and boom microphone assembly, complete with plug and 1.6m lead, which permits 'hands off' operation of the PRM.4021. A pressel switch (PTT) and securing clip is fitted into the lead.

8 Headset Assembly (ST711015)

8.1 This is a single earpiece assembly with a 1.3m lead.

9 Headset Assembly (ST711014)

9.1 This is a twin earpiece headset assembly with a 1.3m lead.

10 Loudspeaker Amplifier Unit MA.988 (ST700860)

10.1 This is a weatherproof monitoring loudspeaker amplifier with an output of 0.5W. The power supply is derived from the PRM.4021.

11 MORSE KEY (ST700059)

11.1 The morse key is complete with knee strap and lead.

12 SECTIONAL WHIP ANTENNA (ST719094)

12.1 This is a 2.4 metre whip antenna comprising eight sections with a stainless steel retaining cord and a flexible plug-in antenna mount which enables the whip antenna to be set to the required operational angle and protects both the whip and manpack from damage due to excessive shock or impact.

13 BATTERY CHARGER MA.945B (ST719238)

13.1 This battery charger enables the nickel-cadmium battery MA.4025A to be recharged from a supply of 12V d.c., 24 V d.c., 110V a.c. or 230 V a.c. (nominal).

14 LOCAL/REMOTE CONTROL BOXES MA.985B/MA.986B (ST701683/4)

14.1 The addition of these two boxes enables a transmitter-receiver to be operated at a distance of up to 3km using D10 twin cable. Intercommunication between the local and remote positions is also provided.

15 3-30MHZ DIPOLE ANTENNA (ST711169)

15.1 This antenna is complete with feeder , support lines throwing weight and spools. If required, it can be supported by the 5.4m mast.

16 5.4m MAST KIT MA.2231

16.1 This kit comprises six glass fibre tubes, colour coded guys, light alloy pegs, mast head adaptor for 'F' rods and PVC coated down lead. Also included are two folding sand anchors which give the extra hold required when using an antenna in soft sand conditions. The golf bag type carrying case has a reinforced cap that can be used as a base plate on soft ground.

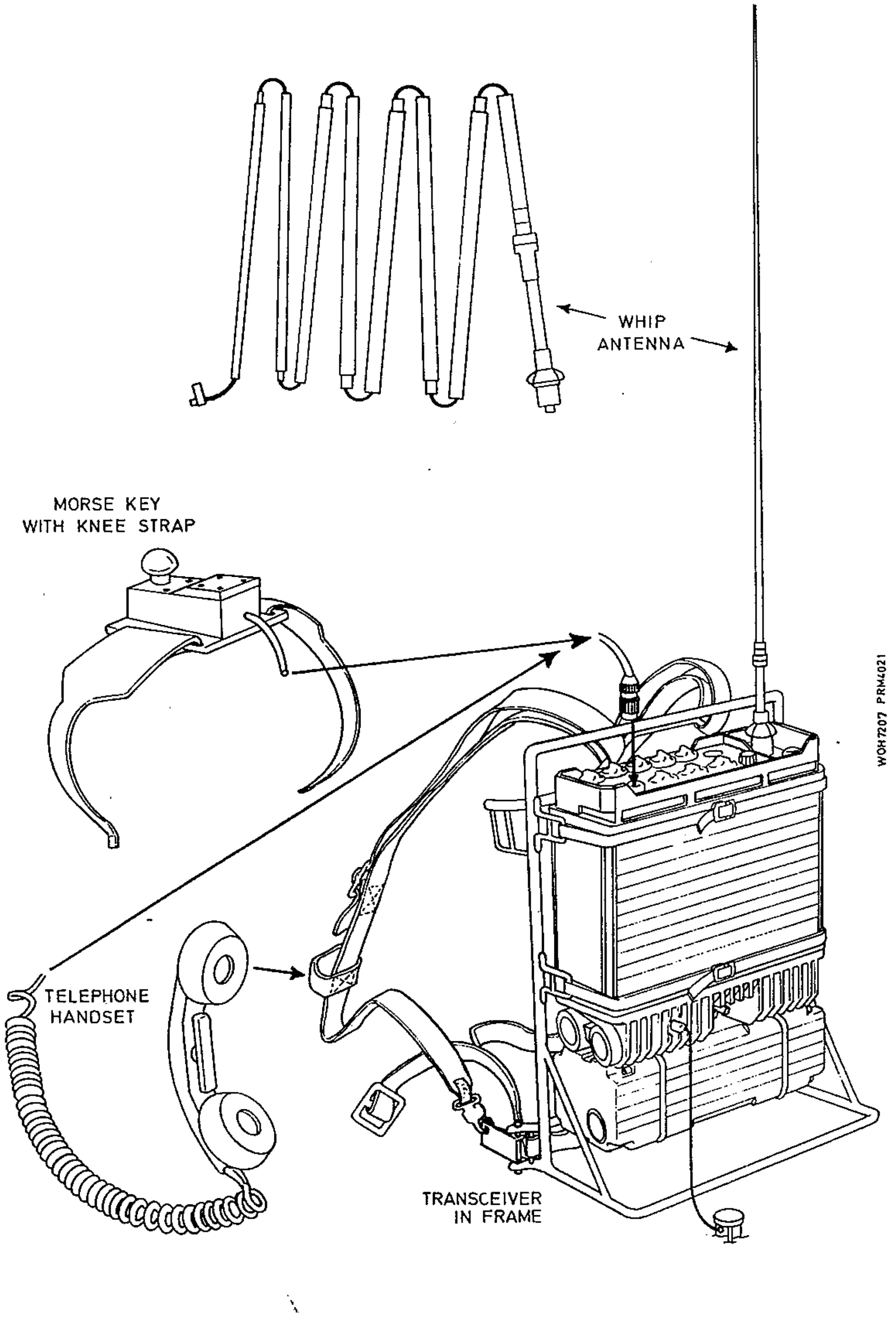
17 Vehicle Interface Box (VIB) MA.4106

17.1 The Vehicle Interface Box (VIB) is used wherever the PRM.4021 is fitted in a vehicle. The VIB provides the following facilities:

(1) Allows the PRM.4021 to be supplied directly from the vehicle electrical system. The VIB can accept an input of 24V to 32V d.c., or with an internal change 12V to 16V d.c., and incorporates a regulator. (Negatively earthed systems only). Supply filtering and transient suppression is provided.

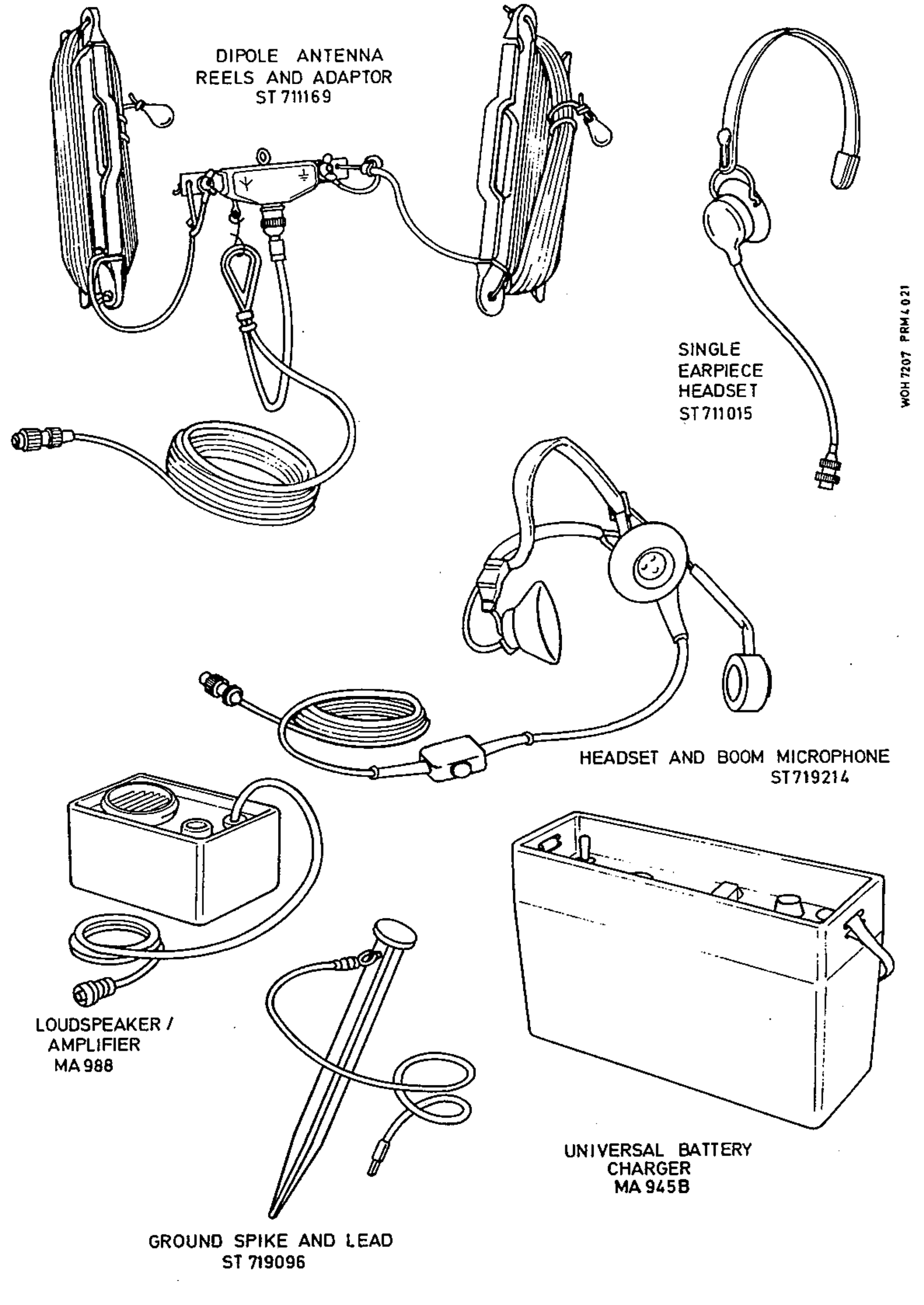
(2) Provides transformer coupling of the audio input to eliminate earth loop problems.

(3) Provides an audio output to drive a loudspeaker (Type HOD).



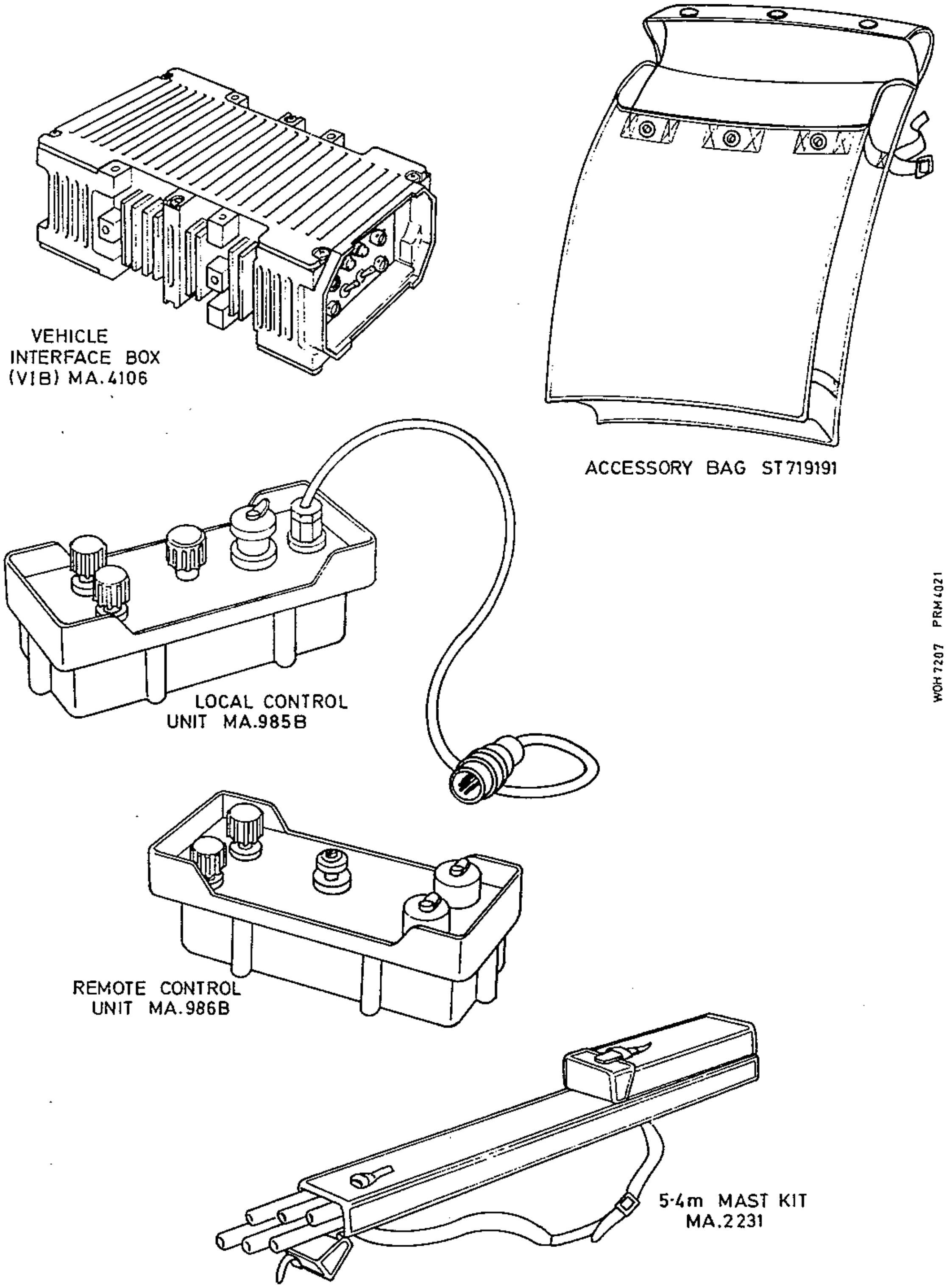
RACAL WOH7207

Basic Equipment **Fig.2.1**



RACAL
WOH 7207

Major Ancillary Items (1) Fig.2.2



Major Ancillary Items(2) Fig 2.3

APPENDIX 1

LIST OF EQUIPMENT AND ANCILLARIES

ITEM	DESCRIPTION	RACAL REFERENCE	WEIGHT kg.	DIMENSION mm.
1	PRM.4021 Transceiver	ST719003	3.5	230x75x253
2	Nickel-Cadmium Rechargeable Battery(4A h 12V) Type MA.4025A	ST719004	2.4	230x80x90
3	Primary Battery Pack MA.4025B (without cells)	ST719063	0.77	230x80x90
4	2.4m (8ft) Sectional Whip Antenna complete with flexible mount Comprising: Flexible Plug-in Antenna Mount MA.712/11 Whip Antenna MA.712/10	ST719094	0.28	360x35 dia. (folded)
5	Battle antenna	ST719103	0.2	475x30 dia.
6	Telephone Handset	ST719215	0.39	196x72x55
7	Headset and Boom Microphone	ST719214	0.63	-
8	Headset, Single earpiece	ST711015	0.14	-
9	Headset, Noise Excluding	ST711014	0.37	-
10	Morse Key with knee strap	ST700059	0.21	-
11	Ground Spike and Lead	ST719096	0.17	305x38 dia.
12	Accessory Bag	ST719191	0.22	230x365x66
13	Carrying Frame	ST719097	1.45	385x323x175
14	3-30MHz Dipole Antenna Complete with Feeder, Support Lines, Throwing Weight and Spools.	ST711169	1.76	-
15	5.4m Mast Kit MA.2231		3.5	110x160x1010
16	F rod No.2	920196	0.13	126x10 dia.
17	F rod No.3	920197	0.07	126x6 dia.
18	Universal Battery Charger Type MA.945B, for Rechargeable Batteries	ST719238	3.74	288x89x160
19	Vehicle Interface Box (VIB) MA.4106	ST719027	2.5	150x75x260
20	Loudspeaker/Amplifier Unit Type MA.988	ST700860	0.77	83x112x54

Continued ....

ITEM	DESCRIPTION	RACAL REFERENCE	WEIGHT kg.	DIMENSION mm.
21	Local Control Unit MA.985B	ST701693	1.1	206x94x68
22	Remote Control Unit MA.986B	ST701694	1.0	206x94x68
23	Test Set Type CA.531C	ST719318	9.8	460x250x180
24	Terminal Adaptor (Whip/Terminal) for separate Whip Antenna	ST719186	0.6	85x30 dia.
25	Terminal Adaptor (BNC/Terminal) for end-fed Antenna	ST700074	0.06	45x15 dia.
26	Mounting Plate for PRM.4021	ST719092	0.75	248x267x8
27	Quick Release Base for PRM.4021 & MA.4106	ST719174	3.1	418x290x27
28	User Handbook	WOH 7206	0.07	

CHAPTER 3

INSTALLATION AND OPERATION

CONTENTS

ILLUSTRATIONS (IN TEXT)

CHAPTER 3

INSTALLATION AND OPERATION

1 MANPACK STATION

1.1 The items of basic equipment which comprise the manpack station are shown in Chapter 2, Fig. 2.1.

2 ASSEMBLY OF MANPACK STATION

(1) Fit transceiver into carrier as shown on Fig. 2.1. The transceiver locates on two protrusions on the frame which engage in recesses in the transceiver front panel. Engage and tighten the two retaining straps.

(2) Fit battery to transceiver and tighten the two wing screws, by hand.

(3) Erect whip antenna by grasping the small whip section and pulling the centre cord. Check that all sections are fully in place.

(4) Insert whip antenna into whip socket and screw down retaining ring.

(5) Plug handset into either audio socket on the transceiver. Fit the handset into the retainer on the harness.

(6) Plug a morse key or handset/headset into the other audio socket if required.

(7) Fit the accessory bag to the carrier if required.

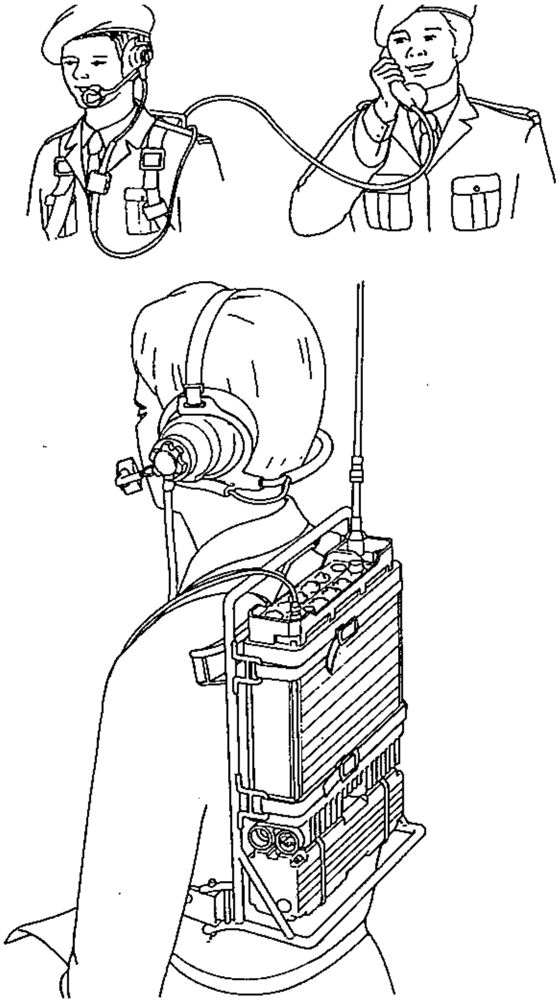
3 CARRYING OF MANPACK STATION

3.1 The correct carrying position is shown in Fig. 3.1. This figure also shows the use of a headset as an alternative to the handset.

4 OPERATING INFORMATION

4.1 Set up and tune the PRM.4021 with reference to Fig. 3.2.

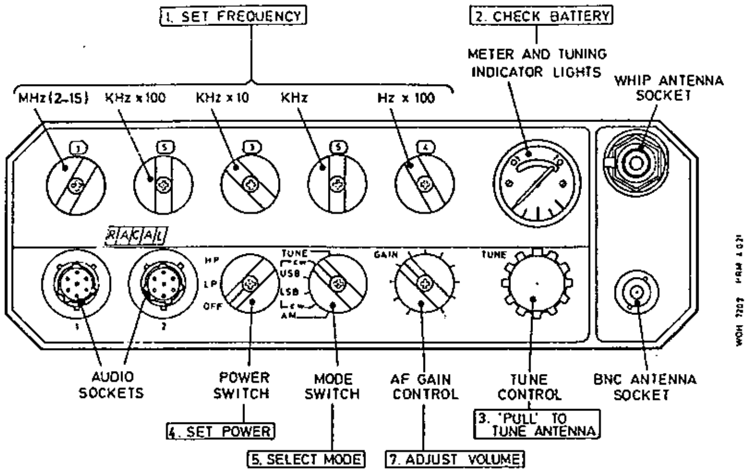
①	Set frequency	Set the five frequency selection controls to the required positions. (Shown set to 3.5354MHz). There is a stop at zero position to enable frequency to be set by touch in the dark.



RACAL WOH7207

Voice Operation **Fig. 3.1**

(2)	Check Battery	Set POWER switch to HP and check that meter reads three quarter scale deflection, or greater. Do not depress key or pressel for this check.
(3)	Tune Antenna	Reset transmitter power as required HP (high power) or LP (low power). Set MODE to TUNE. Pull out and rotate the TUNE control in the direction indicated by the illuminated red lamp in the meter. When the lamp extinguishes continue adjustment to achieve greatest meter deflection. Push in TUNE control.
(4)	Set Power	Reset transmitter power as required to HP (high power) or LP (low power).
(5)	Select Mode	Set MODE switch to USB, LSB, or AM for speech or CW for morse.
(6)	Communicate	To transmit, depress pressel and speak into microphone in speech modes or operate morse key when in CW mode. Sidetone is heard in all modes. To receive, release pressel/ morse key. (A delay of approximately ½ second will occur between releasing the morse key and the changeover to the receive condition).
(7)	Adjust Volume	Adjust AF GAIN control for required volume of received signal.



RACAL WOH7207 **Front Panel** **Fig.3.2**

A	• —	N	— •
B	— • • •	O	— — —
C	— • — •	P	• — — •
D	— • •	Q	— — • —
E	•	R	• — •
F	• • — •	S	• • •
G	— — •	T	—
H	• • • •	U	• • —
I	• •	V	• • • —
J	• — — —	W	• — —
K	— • —	X	— • • —
L	• — • •	Y	— • — —
M	— —	Z	— — • •
1	• — — — —	6	— • • • •
2	• • — — —	7	— — • • •
3	• • • — —	8	— — — • •
4	• • • • —	9	— — — — •
5	• • • • •	0	— — — — —

MESSAGE RECEIVED	R	• — •
OVER	K	— • —
OUT	$\overline{AR}$	• — • — •
QUERY	$\overline{INT}$	• • — • —
SAY AGAIN	$\overline{IMI}$	• • — — • •
ERASE		• • • • • • • •

SIGNALS QSA { 1 UNREADABLE, 2, 3, 4, 5 OK }

WOH7207 PRM4021

RACAL WOH7207 **Morse Code** **Fig.3.3**

NOTE: In the man-carried role, the tuning should be finally adjusted (by a second man) when the set is in its frame and in the normal carrying position on a man's back.
When the set is used in the static role the earth spike should be used wherever possible. If the spike cannot be used (i.e. on concrete paths, etc) care should be taken not to hold metal parts of the set during tuning to avoid mis-tuning due to ground plane effect.

5 SILENT TUNING

5.1 The following procedure may be used for silent tuning, i.e. tuning without a signal being emitted.

(1) Set frequency

(2) Set POWER switch to LP

(3) Select MODE of operation

(4) Pull out and rotate the TUNE control to obtain maximum noise level in the receiver if the channel is clear. If the channel is occupied, tune for maximum deflection on the meter.

(5) When transmitter is to be used carry out the procedure given in para.4.1 (3) to 4.1 (6).

6 METER INDICATION

6.1 The meter performs a number of functions dependant upon the setting of the POWER switch. The Table below explains its indication:

	Power Switch	
	Low Power	High Power
TX	RF output level	RF output level
RX	Receive signal strength	Battery Voltage

7 BATTERY CARE

7.1 The PRM.4021 transceiver may be operated with either an MA.4025A nickel cadmium rechargeable battery or an MA.4025B primary battery. The current available from most readily obtainable primary cells prohibits the use of the high power transmit mode when a primary battery is used.

8 Battery Fuse

8.1 The MA.4025A and MA.4025B battery packs incorporate a fuse mounted in a holder, and also additional spare fuses. The correct fuse is 20mm X 5mm size rated at 6.3A (Racal Part Number 922454).

9 Battery Pack Replacement

9.1 Either battery pack may be disconnected from the transceiver without removing the manpack from its frame. Unscrew the two retaining screws at the bottom, remove battery and replace with fully charged unit.

10 Charging of Rechargeable Battery MA.4025A

10.1 The MA.4025A battery may be recharged using the MA.945B battery charger (see fig. 3-4). Recharging may take place either:-

(1) Via an AUDIO socket while the battery is connected to the manpack, for example when being used in a vehicle.

(2) When the battery is removed from the transceiver using an accessory cable 719115. The charging procedure is as follows:

(1) Set the MA.945B SUPPLY switch to OFF and the SUPPLY VOLTAGE switch to suit the voltage supply i.e. 12V or 24V d.c. or 110V or 230Va.c.

(2) Connect the MA.945B to the supply using appropriate cable.

(3) Set the CHARGE RATE switch to position 2.

(4) Connect the charger output lead either to the transceiver or directly to the battery.

(5) Switch on the MA.945B and check that the charging indicator lamp illuminates.

NOTE: A fully discharged battery will be completely recharged in 16 hours.

11 Cell Replacement for Primary Battery MA.4025B

11.1 The MA.4025B accommodates ten 'D' size primary cells. For best performance it is recommended that alkaline manganese MN 1300 cells are used. If the unit is to be stored for any length of time all cells should be removed to minimise corrosion. The cells can only be replaced when the battery box has been removed from the transceiver.

The procedure is as follows: (see fig. 3.5).

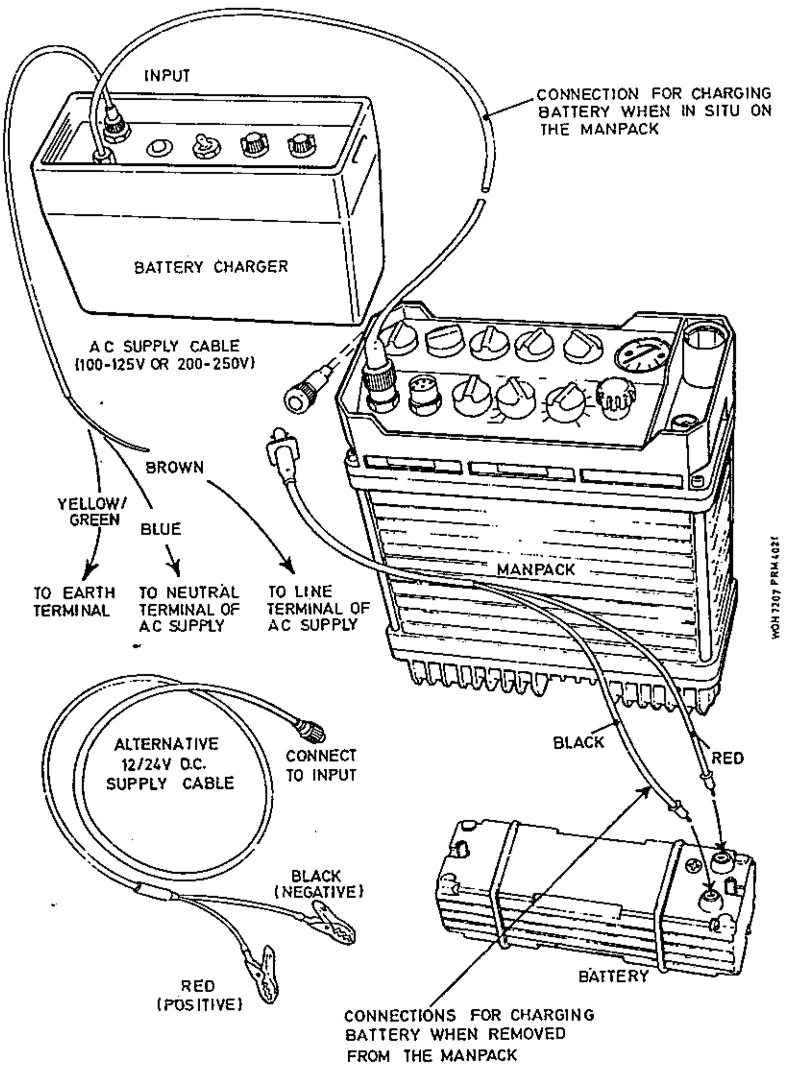
(1) Remove battery from transceiver.

(2) Unscrew the two wing nuts and remove end cover.

(3) Remove the spent cells.

(4) Fit new cells arranged as indicated on the outside of the battery pack. Ten cells are required.

(5) Reassemble end cover ensuring that sealing gasket is properly seated.



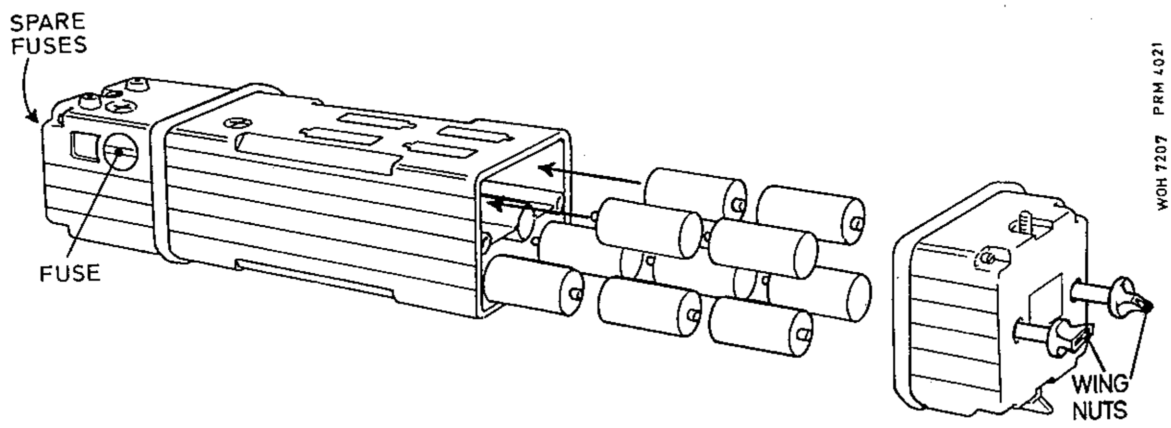
RACAL WOH7207 **Battery Charging** **Fig.3.4**

12 5.4m MAST AND ALTERNATIVE ANTENNAS

12.1 The manpack is normally operated with the standard 2.4m whip antenna. This antenna is generally satisfactory for ground wave propagation over distances of up to 25km. For improved ground wave and for sky wave communication alternative antennas are required. These antennas require to be elevated for good performance using convenient buildings, trees or a 5.4m lightweight mast.

13 5.4m Mast MA.2231

13.1 This kit comprises six glass fibre tubes, colour coded guys, light alloy pegs, mast head adaptor for 'F' rods and PVC coated down lead. Also included are two folding sand anchors which give the extra hold required when using an antenna in soft sand conditions.



RACAL WOH7207 Primary Battery MA 4025B Fig.3.5

13.2 The golf bag type carrying case has a reinforced cap that can be used as a base plate on soft ground.

13.3 While these masts are ideal for desert use they are equally suitable for general field use as:-

(1) Support for sloping wire or in pairs to support a centre fed dipole (halyard provided).

(2) A vertical radiator using the down lead.

(3) A vertical radiator using 'F' rods and the down lead.

14 Erection of 5.4m Mast

14.1 The mast is erected as follows:-

(1) Assemble the mast sections on the ground with the guy plates and halyard cleats fitted as shown on Fig.3.6, with middle guy plate between sections 2 and 3 from top.

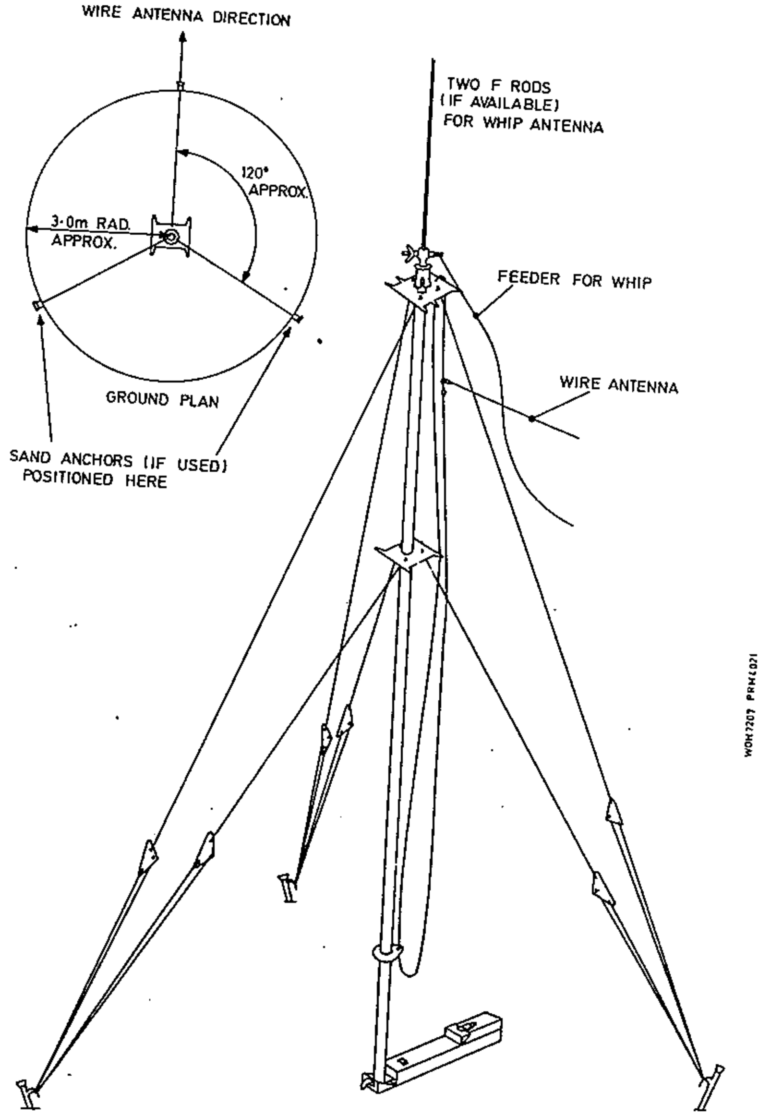
(2) Assemble the masthead adaptor to the top of the mast if a vertical end-fed antenna is to be used.

(3) Fit the two 'F' rods if available (for vertical end-fed antenna).

(4) Place the cap of the case in position (to act as the foot of the mast) and position the pegs (or sand anchors for soft ground) as shown.

(5) Erect the mast and adjust the guys.

(6) If required connect antenna adaptor to halyard and raise adaptor.



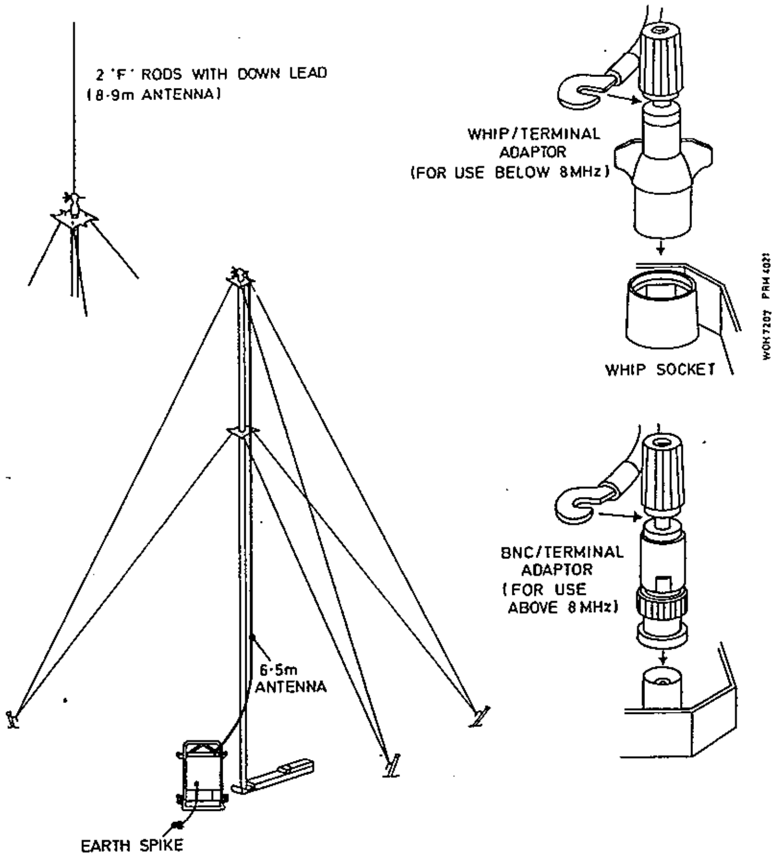
RACAL WOH7202 Erection of 5·4m Mast Fig.3.6

15 Ground Wave Vertical Antennas

15.1 For improved ground wave operation (in comparison with the whip antenna), the PRM.4021 uses vertical antennas supported by the 5.4m mast. If the two 'F' rods are available, they should be used to form the 8.9m antenna.

16 End Fed Antennas

16.1 In both the 6.5m and 8.9m antennas, (Fig.3.7), the down lead is connected either to the whip terminal (below 8MHz) or to the BNC socket (above 8MHz) as necessary. The earth spike or an antenna counterpoise must be used with these antennas.



5·4m Mast With
RACAL Ground Wave Vertical Antenna Fig.3.7
WOH7207

17 Vertical Dipole

17.1 The vertical dipole, illustrated in Fig.3.8, should be erected as close to vertical as conditions allow. The dipole is a kit comprising two reels and a centre junction box. Each reel contains 23.5m of braided wire marked with rings according to resonant frequency, and a throwing cord and weight. Proceed as follows:-

(1) Unwind the throwing cords and enough antenna wire from each reel to the length indicated on the markers for the frequency in use.

(2) Make a small loop in the antenna wire at the measured point. Insert into slot in reel as shown in Fig. 3.9. Repeat for other half.

(3) Connect plug on antenna feeder to centre junction box and fasten the 'D' shackle to anchor ring. Connect other end of feeder to BNC socket on radio.

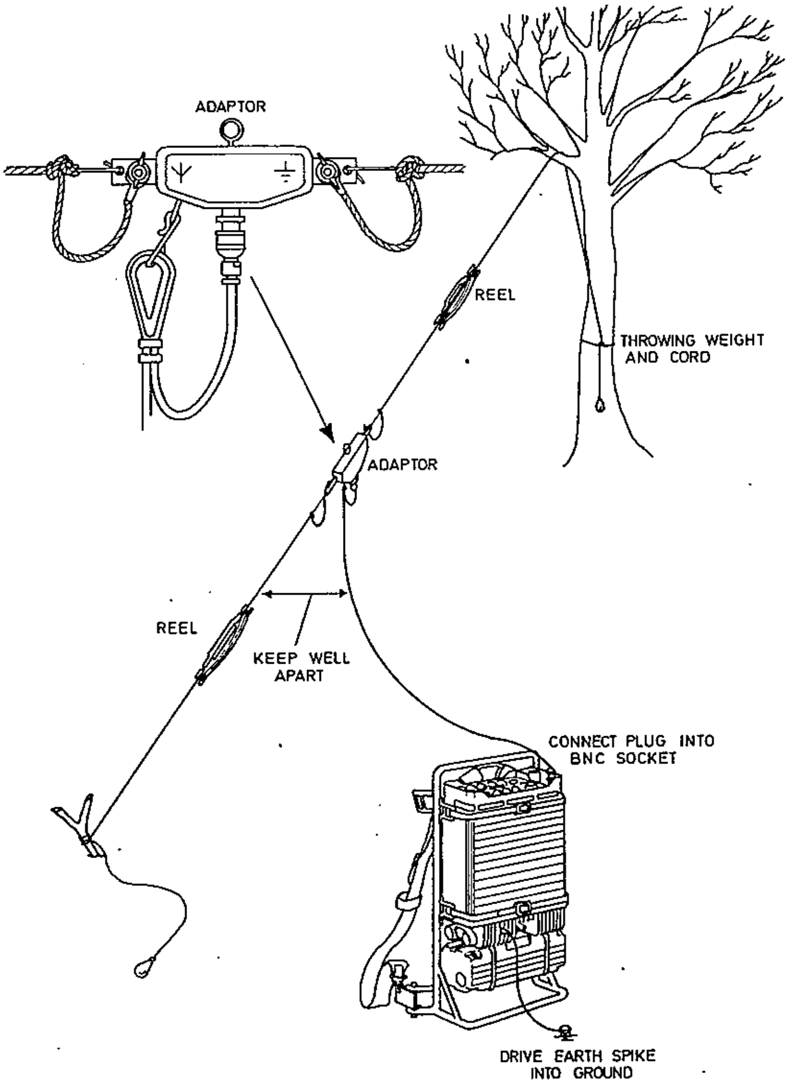
(4) Erect one end of wire on 5.4m mast or throw weight over convenient tree.

(5) Ensure that the antenna feeder is well separated from the antenna braid.

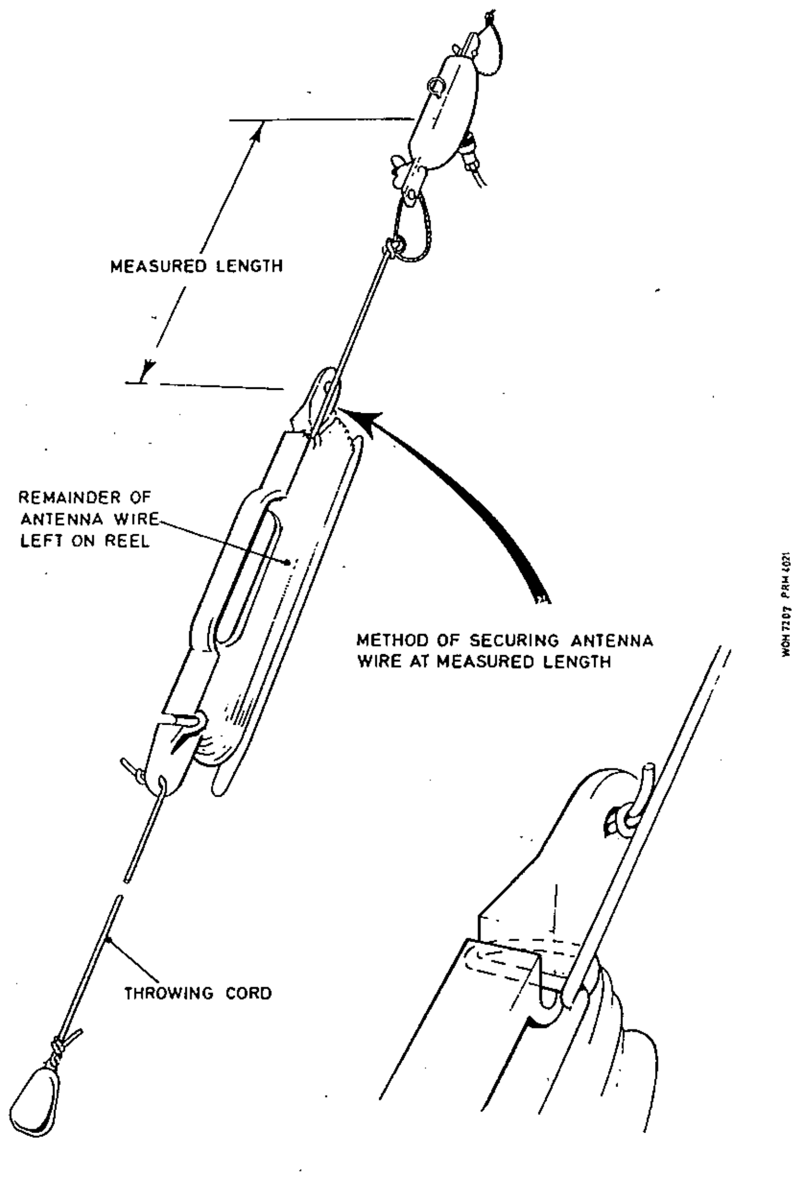
(6) Drive earth spike in ground and connect lead to earth terminal of man-pack,

18 Sky Wave Dipole and Inverted V Antennas

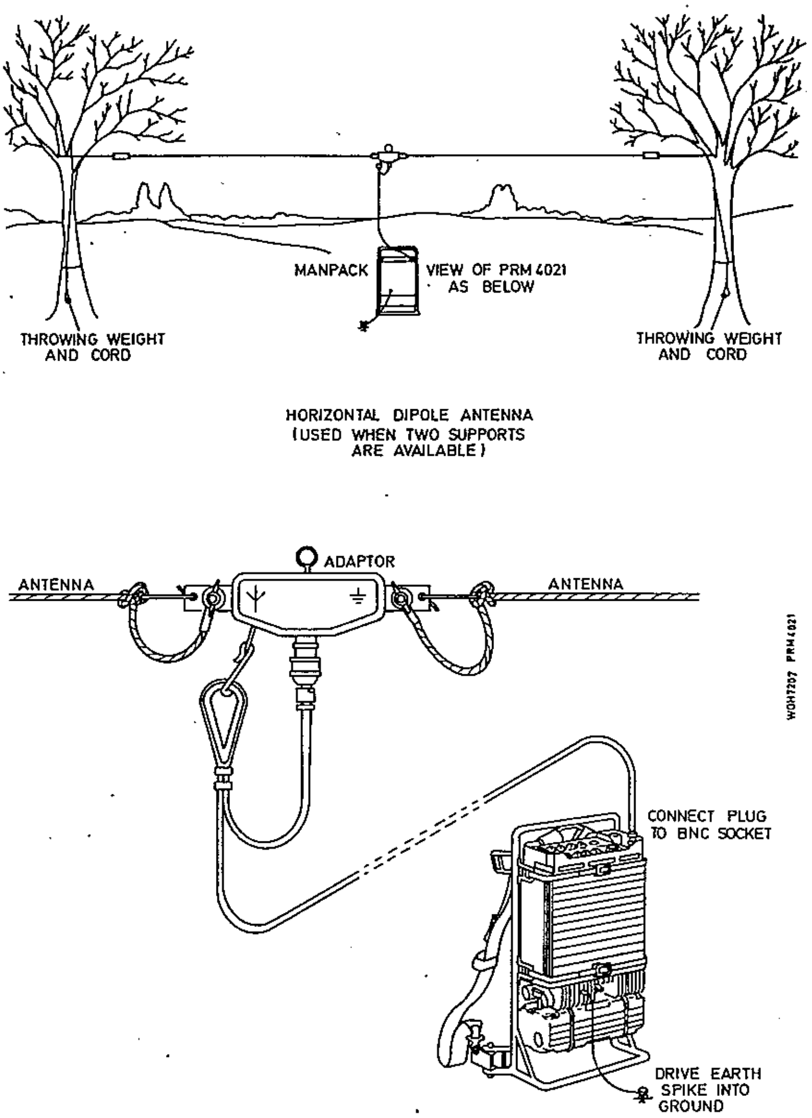
18.1 For sky wave operation the PRM.4021 can use a horizontal dipole or its derative the inverted V antenna. Both are based on the 3-30MHz braid dipole kit.



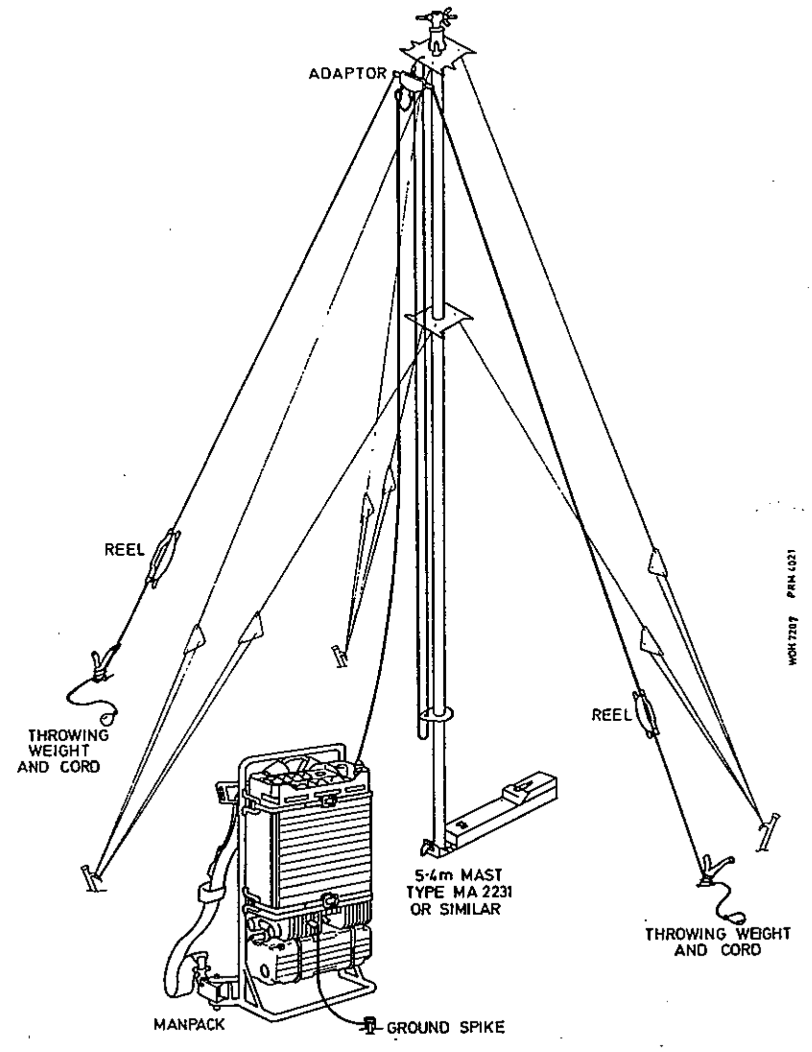
WOH7207 **Vertical Dipole Antenna** **Fig. 3.8**



RACAL WOH7207 Antenna Securing Fig.3.9



RACAL WOH7207 **Horizontal Dipole Antenna Fig.3.10**



RACAL WOH7207 **Inverted V Dipole Antenna** **Fig.3.11**

18.2 For distances greater than 300 km the antenna must be erected broadside to the direction of communication.

18.3 The procedure for erecting these antennas is similar to the vertical dipole (see para. 17 and Figs. 3.10 and 3.11.

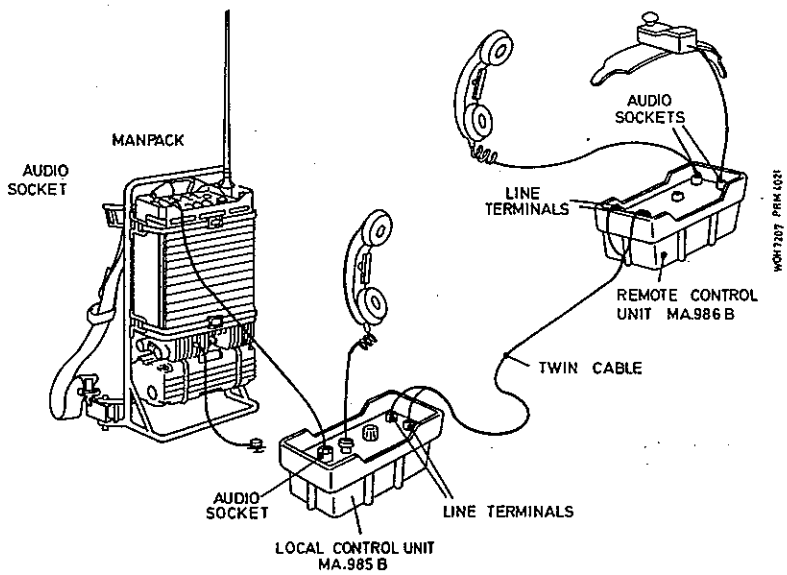
18.4 The horizontal dipole should be used when two supports are available and the inverted V when only one is available. In both cases it is important to raise the centre point as high as possible.

19 LOUDSPEAKER AMPLIFIER

19.1 The loudspeaker/amplifier unit type MA.988 may be used with the PRM.4021. The amplifier should be plugged into either of the AUDIO sockets and the level of output is then adjusted by using the GAIN control on the transceiver. The MA.988 has a maximum output of 0.5watts.

20 REMOTE OPERATION

20.1 The PRM.4021 can be operated remotely in speech or CW modes from a distance of up to 3km using MA.985B and MA.986B control boxes. The two control boxes are connected together using the necessary length of D.10 cable as shown in Fig. 3.12. Call and intercom facilities are also provided.



RACAL WOH7207 Remote Operation Fig. 3.12

21 Setting-Up for Remote Operation

21.1 (1) Set up transceiver for operation as detailed in preceding paragraphs.

(2) Connect flying lead of local control unit MA.985B to an AUDIO socket on the transceiver.

(3) Connect audio ancillaries to local control unit.

(4) Connect D.10 twin cable to the LINE terminals on the local control unit.

(5) Run out cable to remote site and connect to LINE terminals on remote unit MA.986B, disregarding polarity.

(6) Connect audio ancillaries to remote control unit.

(7) Operate system in required mode as outlined below.

22 Modes of Operation

22.1	I/COM (intercom)	Remote operator may speak to local operator and vice-versa without radio transmission.
	KEY	Remote or local operator may communicate with another operator via a radio link using morse.
	VOICE	Remote or local operator may communicate with another operator via a radio link using speech.
	CALL	At both local and remote control units, a warbling tone is produced in the headset when CALL has been selected.

23 WORKING WITH OTHER RADIOS

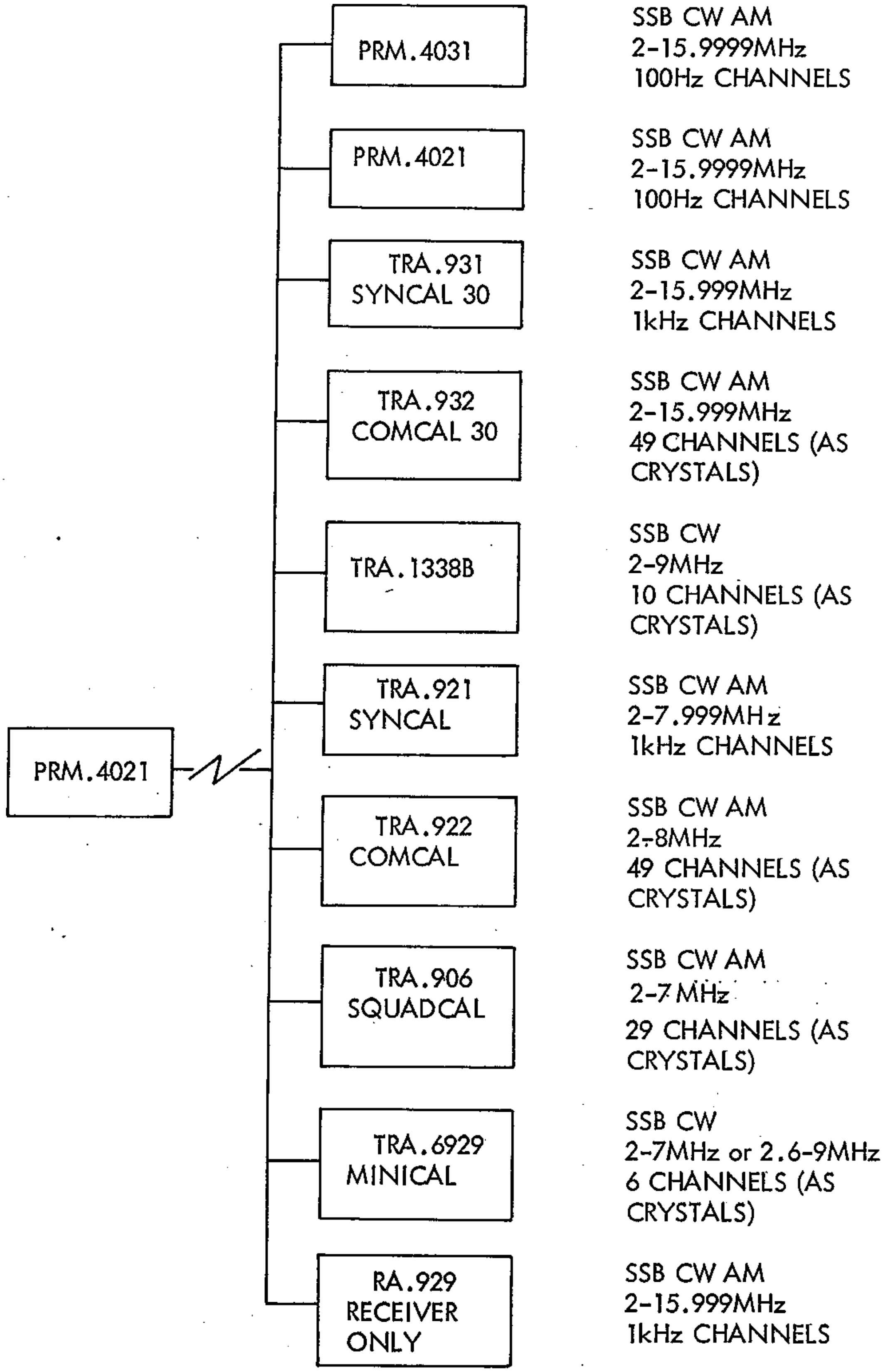
23.1 The PRM.4021 will work with another PRM.4021 without any frequency channel limitation, and in any mode. The PRM.4021 will operate with any other type of HF SSB, AM or CW transceiver in the frequency range 2-16MHz. With other Racal transceivers the channel spacings and modes are as given in the following table.

24 VEHICLE OPERATION

24.1 The following paragraphs give general information on the use of the PRM.4021 in a vehicle installations is covered in the appropriate vehicle installation handbook.

25 Installation

25.1 The PRM.4021 is mounted in a vehicle using a special mounting plate. The equipment can be connected directly to a headset or handset via an audio socket as in the manpack role or into the vehicle harness via a Vehicle Interface Box (VIB) MA.4106.



WORKING TO OTHER RADIOS

The battery may be float-charged by an MA.945B or the radio may obtain its supply from the VIB in 24V installations.
The radio may be connected via its antenna terminal to the vehicle whip antenna if the cable length is less than 0.6 metres.

26 Whip Antennas

26.1 A 2.4m (8ft) whip antenna mounted on a vehicle can give similar range to the standard whip antenna mounted directly in the whip socket. A longer whip antenna gives increased range but is not advisable to use a length greater than 8.2m (27ft) over the frequency range 2 to 8MHz or 4.8m (16ft) over the range 2 to 16MHz.

(1) Mount the whip antenna on the antenna base insulator.

(2) Using high insulation cable with copper conductor, connect the antenna base to the manpack. The length of this cable should be as short as possible and must not exceed 0.6m (2ft). It should be mounted clear of metal surfaces. Connect the free end of the cable to the terminal of the whip adaptor and plug it into the WHIP socket of the manpack.

NOTE: Where a tuning point cannot be obtained, connect the free end of the antenna base cable to the terminal of the BNC adaptor and plug it into the 50Ω socket of the manpack, instead of into the WHIP socket.

(3) Connect a short length of heavy duty cable between a suitable earthing point on the vehicle and the ground terminal on the manpack.

27 Remote ATU

27.1 In situations where the radio cannot be positioned close to the antenna a remote ATU will be required such as the BCC540. In this application the RF connection to the radio is made via the rear W/B socket (5) (see Fig. 3.13).

28 Use of External Filters

28.1 In multi-radio installations external bandpass filters may be incorporated to reduce mutual interference. The filter is connected electrically between the two rear sockets on the PRM.4021 (see Fig. 3.13).

(1) Connect filter input to W/B socket 5.

(2) Connect filter output to the ATU socket 6.

CHAPTER 4

MECHANICAL DESCRIPTION

AND INTERCONNECTION

CONTENTS

ILLUSTRATIONS

CHAPTER 4

MECHANICAL DESCRIPTION

AND INTERCONNECTIONS

1 MECHANICAL DESCRIPTION (Figs.1 and 2 at the end of this Part)

1.1 The transceiver and synthesizer sub-assemblies and the antenna tuning unit are attached to the front panel of the set, which is bolted to one end of the plastic sleeve using metal spacers which clip to the sleeve. The power amplifier and filter sub-assembly is contained in a casting which is bolted to the rear of the plastic sleeve.

1.2 The control, meter, audio and antenna sockets are mounted on the front panel. The battery is attached to the rear of the set by two wing nuts and is removed when access to the rear-mounted spare fuses or W/B (wideband) and ATU sockets is required.

1.3 Figures 1 and 2 illustrate the construction of the set. A detailed mechanical breakdown is provided in the illustrated Mechanical Parts List (part 6 of the handbook) and detailed dismantling instructions are given in Chap.7.

2 INTERCONNECTIONS

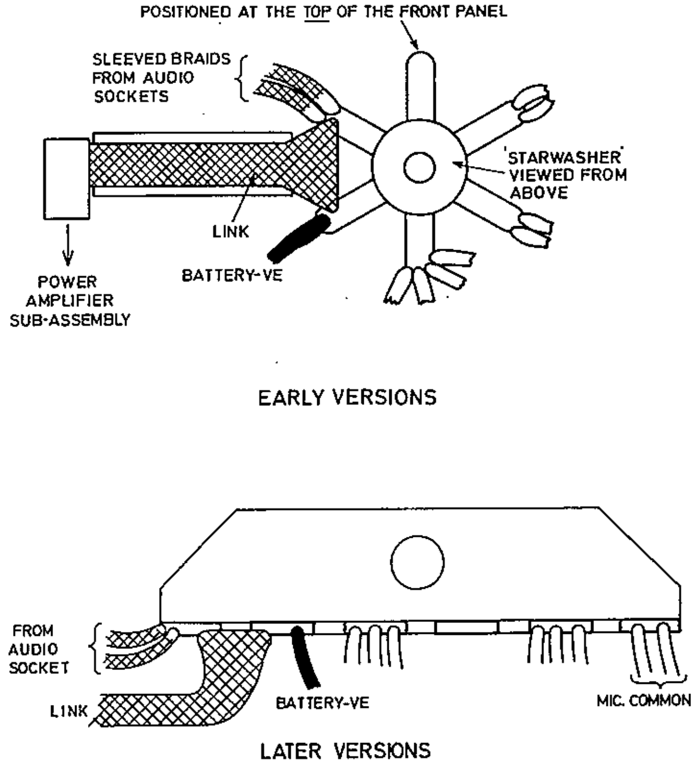
2.1 The interconnections between the various sub-assemblies, controls and sockets are shown in the interconnection diagram, Fig.4.

3 POWER SUPPLIES

3.1 The power circuit allows the battery to be charged via either audio socket when the mode switch is at OFF. Charging is carried out via diodes 1D40 and 1D41 (Fig.4), which prevent current being drawn by equipment connected to the sockets.

4 COMMON EARTH POINT

4.1 All sub-assemblies are earthed to a common point, which is illustrated in Fig. 4.1. Large currents flow from the battery or external supplies to the power amplifier sub-assembly and it is essential to provide the shortest path for this connection, to avoid induced voltages being applied to the microphone preamplifier, causing instability. For this reason, the earth connectors carrying these large currents are made as shown in Fig.4.1. If it is necessary, for repair purposes or otherwise, to remove these connections they must always be reconnected exactly as shown.



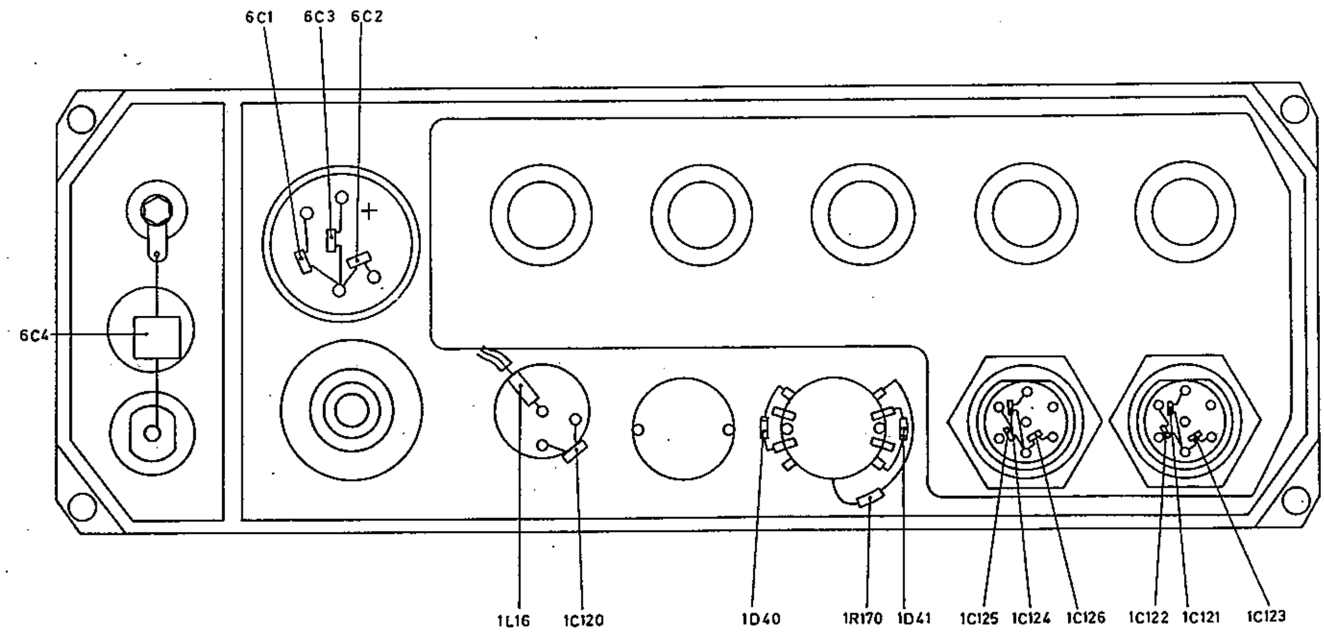
Connections to Common Earth Point Fig.4·1

5 EXTERNAL CONNECTIONS

5.1 External connections are made via plugs connected to audio sockets SK1 and/or SK2 on the front panel. Connections are shown in Fig.3.

6 FRONT PANEL MOUNTED COMPONENTS

6.1 A number of components are mounted on the front panel. These are illustrated and identified in Fig.4.2.



Front Panel Mounted Components Fig. 4.2

CHAPTER 5

TEST EQUIPMENT

CONTENTS

CHAPTER 5

TEST EQUIPMENT

1 INTRODUCTION

1.1 The test equipment listed below is required to carry out fault location and maintenance procedures on the complete transmitter/receiver.

2 TEST EQUIPMENT

(1) Digital Frequency Meter

Frequency: 10Hz to 100MHz with resolution to 1Hz.

Sensitivity: 10mV r.m.s.

Racal 9911 (Option 04A) is recommended.

(2) Oscilloscope

Bandwidth: 0-100MHz

Sensitivity: 5mV/cm to 20V/cm.

Hewlett Packard Type HO7-1715 is recommended.

(3) RF Power Meter (see note)

Bandwidth: Up to 30MHz.

Range: 0-20W r.m.s.

Dymar 2081/30 is recommended.

(4) AF Signal Generator

Range: 30Hz - 10kHz, two-tone.

Output: 1mV - 1V e.m.f.

Impedance: 600 ohms.

Racal 9083 is recommended.

(5) AF Power Meter (see note)

Bandwidth: 30Hz to 10kHz.

Range: 0-10W r.m.s.

Dymar 2085 is recommended.

(6) RF Signal Generator

Range: 10kHz - 30MHz.

Output: 1uV to 1V e.m.f.

Impedance: 50 ohms.

Marconi TF 144H is recommended.

(7) Multimeter

Sensitivity: 500mV to 50V.

Racal 9077A is recommended.

(8) RF Millivoltmeter

Bandwidth: 10kHz to 100MHz.

Range: 1mV to 30V.

Impedance: 100k

Racal 9301 is recommended.

(9) Power Supply (see note)

Voltage range: 12V to 20V d.c.

Output: Up to 3A.

Roband 33-10 is recommended.

(10) RF Adaptor Lead

Racal TJ289.

(11) Adaptor Box (see not e)

Racal TJ290.

(12) Tool Kit

Racal ST 719254

(13) Sniffer Box (see note)

Racal TJ333

(14) Field Test Set

Racal CA531C

NOTE: If the Field Test Set CA531C is used, items 3,5,9,11 and 13 are not required.

CHAPTER 6

PREVENTIVE AND CORRECTIVE MAINTENANCE

CONTENTS

TABLES

CHAPTER 6

PREVENTIVE AND CORRECTIVE MAINTENANCE

1 INTRODUCTION

1.1 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 NCO or man who is in direct charge of the equipment and NOT of the workshop repair staff.

1.2 The tasks in the case of the PRM.4021 are simple and few in number as detailed below. They are performed daily when the set is in use and weekly when in store. The PRM.4021 is a fully sealed radio and is NOT to be opened by the operator.

2 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 sockets are tightly secured to the front panel.
5.	Desiccator	Check that the crystals are blue.
6.	Handset	Inspect for cuts in cable and secure connection to plug.
7.	Battery MA.4025	Inspect for corrosion of terminals, check fuse and establish when the battery was charged/or cells changed.
8.	Whip antenna	Inspect for damage, loose fit and state of inner cord.
9.	Frame	Inspect for damage, particularly to straps.
10.	Transmitter-receiver operating	Perform steps in operational checklists. (Tables 1-5).

3 FAILURE TO OPERATE

3.1 Should the equipment fail to operate correctly, turn the mode switch to OFF and check the following:-

(a) Switches for correct setting

(b) Handset and antenna for loose connection

(c) Insufficient charge in battery to operate radio, check by substitution.

If the above checks do not locate the fault, proceed to the operational checklist.

4 OPERATIONAL CHECKLIST

4.1 Tables 1 to 5 comprise an operational checklist that should enable an operator to locate any trouble quickly. If the corrective measures suggested do not restore normal operation, second-line maintenance is required, Chapter.7.

5 Preliminary Steps

(a) Connect a battery to the manpack.

(b) Connect a 2.4m whip antenna to the antenna socket.

(c) Connect a headset to one audio socket.

(d) Connect a morse key to the other audio socket.

(e) Set the GAIN control to mid range.

TABLE NO. 1

OPERATING MODE CHECKS

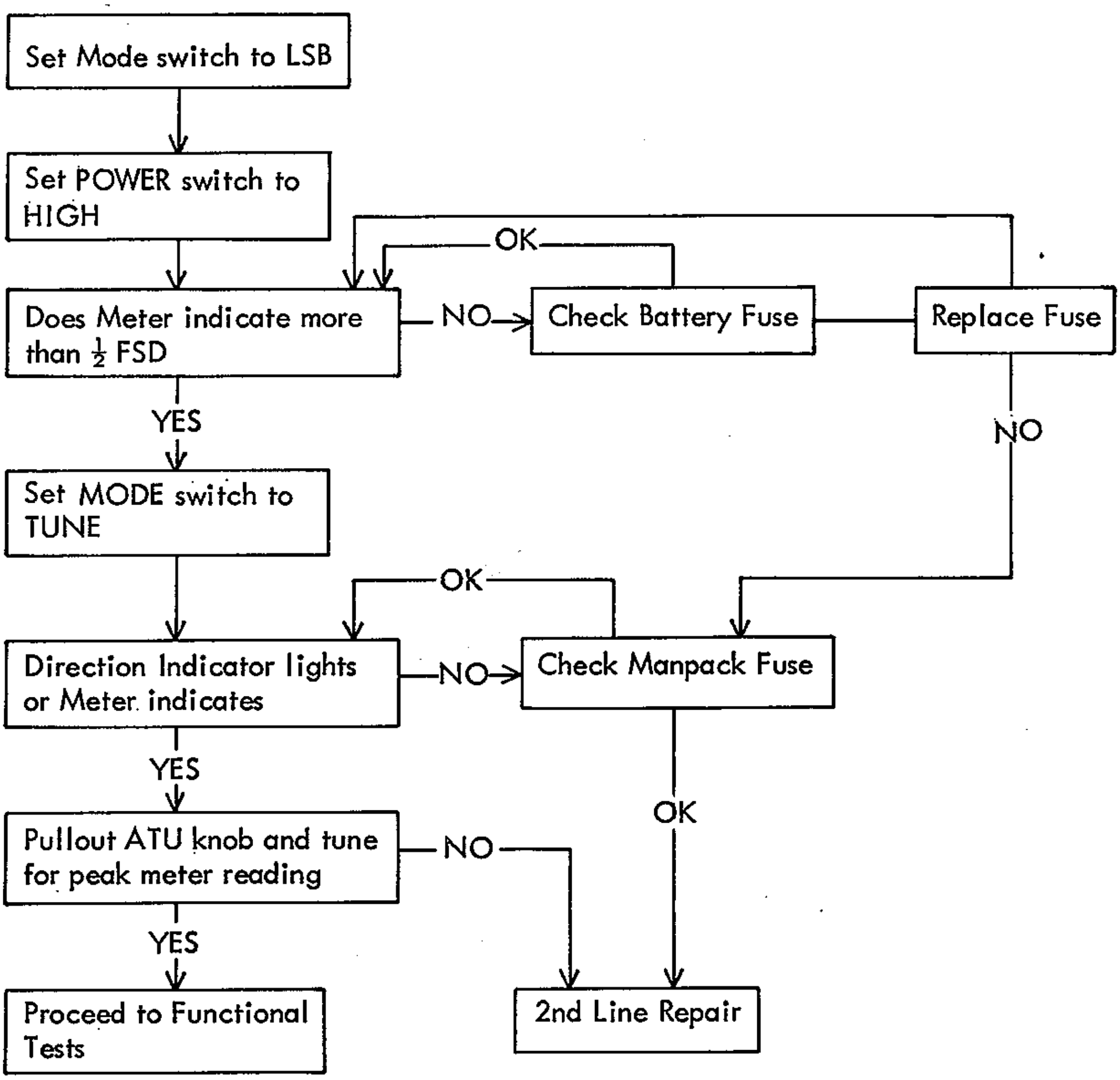
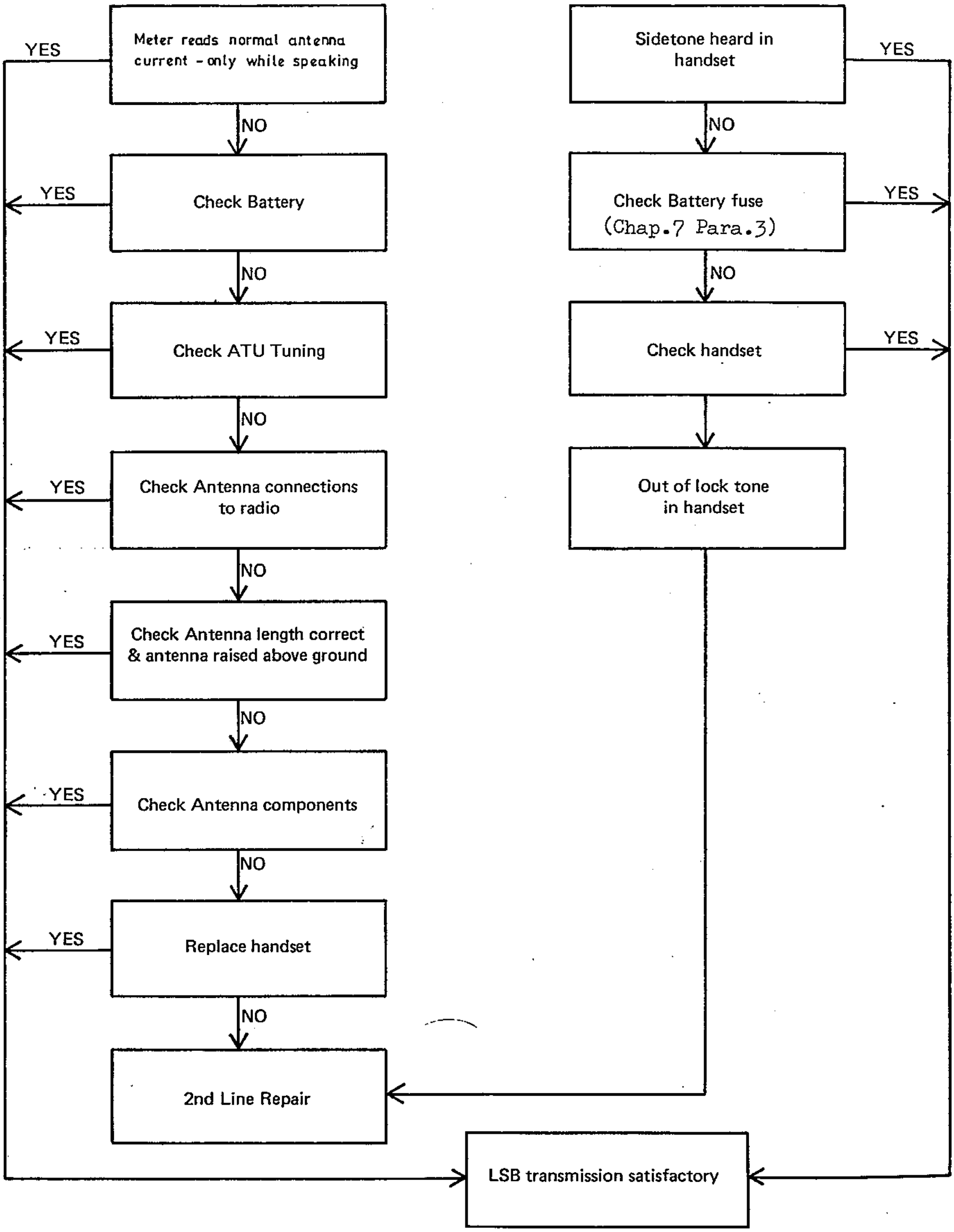


TABLE NO. 2

SSB FUNCTIONAL CHECKS – TRANSMISSION

Set MODE switch to LSB, the GAIN control to a suitable level, depress the pressel switch and speak into microphone.

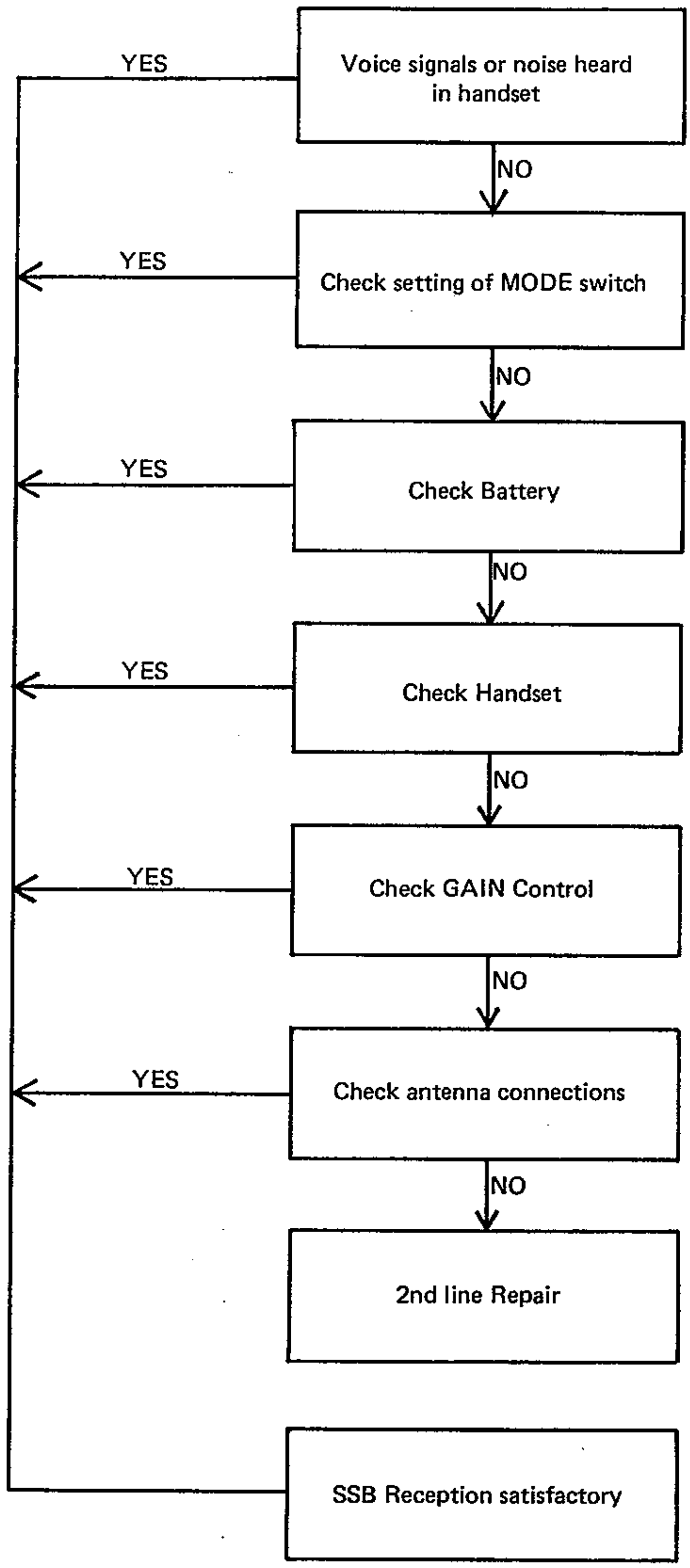


Repeat tests with mode switch set to USB.

TABLE NO. 3

SSB FUNCTIONAL CHECKS – RECEPTION

Set the MODE switch to LSB and the GAIN control to a suitable level.



Repeat tests with MODE switch set to USB

TABLE NO. 4

CW FUNCTIONAL CHECKS - TRANSMISSION

Set the MODE switch to LSB CW, the GAIN control to a suitable level and depress the Morse Key.

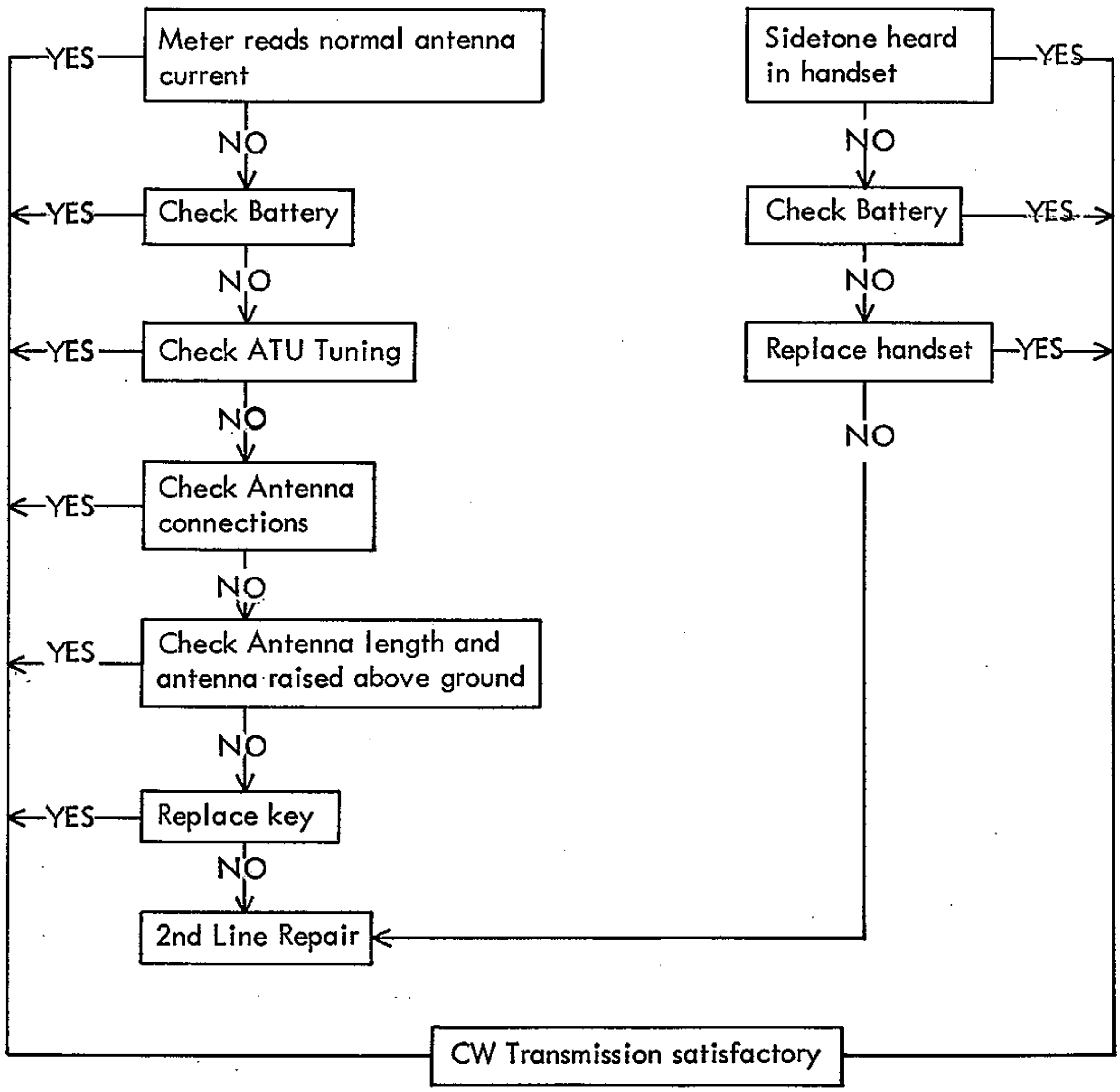
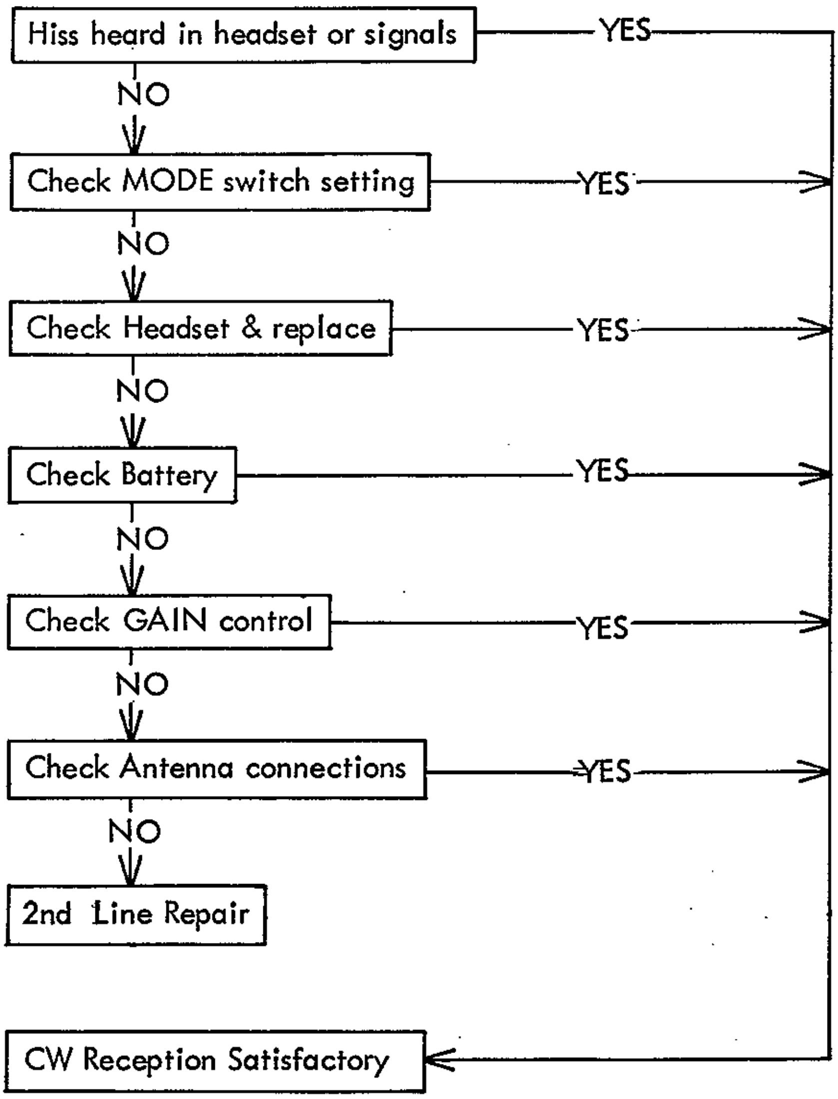


TABLE NO. 5

CW FUNCTIONAL CHECKS -

RECEPTION

Set the MODE switch to LSB CW and the GAIN control to a suitable level.



CHAPTER 7

FAULT FINDING AND PERFORMANCE CHECKS

CONTENTS

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CHAPTER 7

FAULT FINDING AND PERFORMANCE CHECKS

1 INTRODUCTION

1.1 This chapter deals with some aspects of maintenance and repair of the PRM 4021, classified as second-line servicing. Covered in this chapter are:-

(1) Changing and reactivating the desicattor.

(2) Checking the fuse.

(3) Testing the sealing of the case.

(4) Dismantling procedures sufficient to enable performance checks and fault-finding to be carried out.

(5) Re-assembly.

(6) Performance Checks.

(7) Fault location by means of a flow chart, to indicate the area in which a fault is probably to be found.

2 CHANGING AND RE-ACTIVATING THE DESICCATOR

2.1 If routine checks on a unit in service reveal that the desiccator crystals are not blue, the desiccator should be changed after testing the equipment sealing as detailed in para. 4.

(1) The desiccator is located in the casting at the rear of the set (see fig.7.1).

(2) Unscrew the desiccator to remove.

(3) Fit a new (or reactivated) desiccator taking care not to damage the rubber sealing ring.
A desiccator may be reactivated by placing in an oven or a similar source of 'clean' dry heat, at a temperature of 120-150°C for approximatlely two hours.

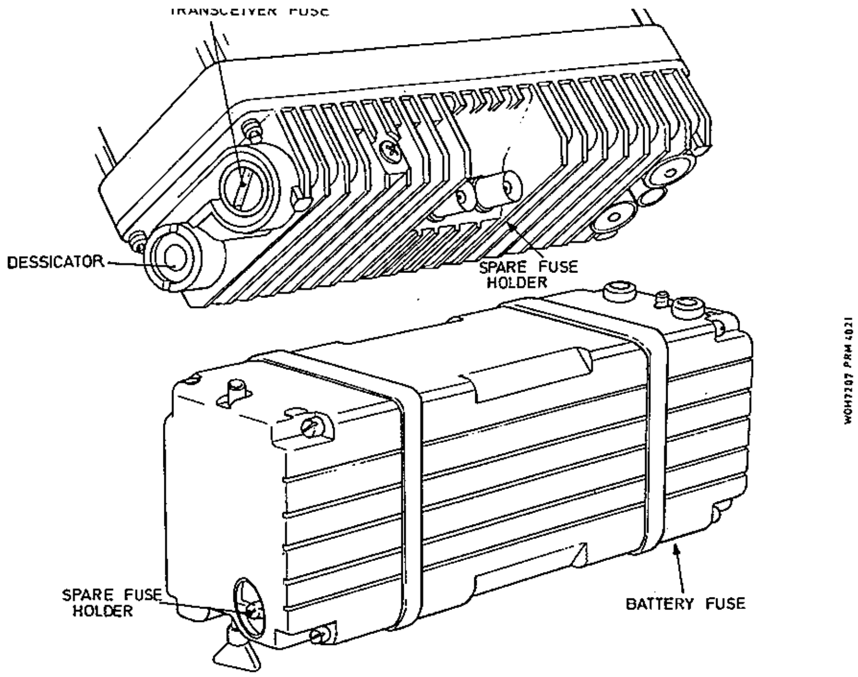
Allow the desiccator to cool before refitting.

3 CHECKING THE FUSE

(1) The fuse is located in the casting at the rear of the set (see fig.7.1)

(2) Check the fuse and replace if necessary.

(3) Spare fuses are located at the rear of the casting and are accessible when the battery is removed (see fig.7.1) The correct fuse is 20mm x 5mm size rated at 6.3A (Racal Part Number 922454).



RACAL
WOH 7207

Location of Fuses and Dessicator Fig.7.1

4 TESTING SEALING OF CASE

4.1 The following equipment is required:

(1) Schrader air valve, Racal Part No.715105.

(2) Pressure gauge and air line.

Proceed as follows:

(1) Remove the desiccator and in its place insert the Schrader air valve. Take care not to lose or damage the rubber sealing ring from its desiccator.

(2) Connect the air-line to the valve and pressurise the case to $17KN/M^2$ ($2\ lb/in^2$), keeping the air-line connected.

(3) Totally immerse the unit in a water tank for at least 20 seconds and inspect for any air leaks. Remove the unit.

(4) Remove any surplus water with the air-line.

(5) Should any leaks occur check that the sealing ring around the offending component or case section is correctly seated and that the component or case is tightly screwed up. The correct torque setting for the case screws is 1.7Nm (15lb in.).

5 DISMANTLING PROCEDURE

5.1 The following procedures detail the amount of dismantling required to gain access to each sub-assembly.
In general the steps should be following in the order given until the required access is obtained. After servicing the unit should be re-assembled in accordance with paragraph 10 Reference to Part 6, illustrated Mechanical Parts List, may prove helpful.

6 Power Amplifier and Filter Sub-Assembly

(1) Remove four socket head screws from the four rear corners of the set.

(2) Place the set on its side and carefully pull the back away. Check that the sealing ring remains seated.

(3) Limited access to the power amplifier board and filter board is now possible. If better access is required, note the position of , then remove, the ten way connector, the individual pull-off connectors and the individual screw-on connectors. The power amplifier and filter sub-assembly may be removed completely from the set.

(4) If it proves necessary to remove either the filter board or power amplifier board this may be achieved by removal of the screws identified in Fig.7.2. Both boards should be removed together as there are several interconnections between them. Note that there is an insulating bush on the centre fixing screw of the power amplifier board.

7 Case Sleeve

(1) To gain access to the rest of the set the plastic sleeve must be removed.

(2) Unscrew the four socket head screws from the four front corners of the set.

(3) Slide off the sleeve towards the rear of the set. Check that the sealing ring remains seated.

NOTE: The following procedures to remove the antenna tuning and synthesizer and transceiver sub-assemblies are independent and one need not be performed in order to facilitate the other.

8 Antenna Tuning Unit (ATU)

(1) Remove the two circlips securing the ATU to the front panel.

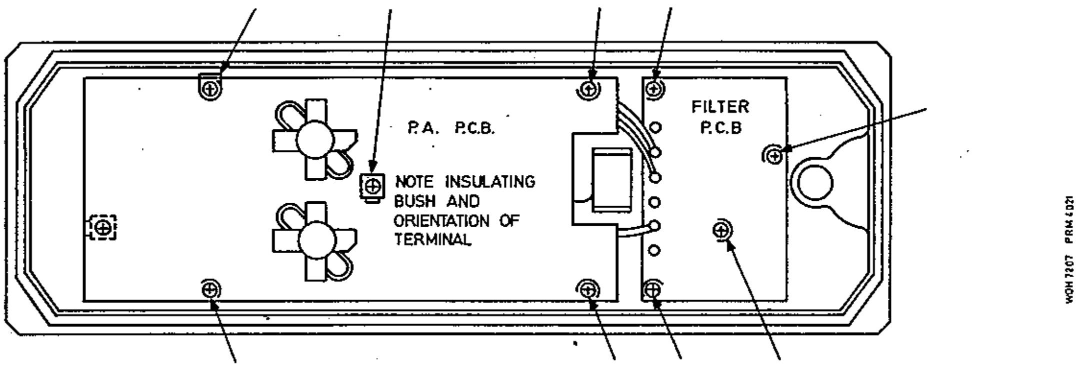
(2) Move the ATU to one side, allow the four-way and five-way sockets, BNC earth and whip socket connection to be removed.

(3) The ATU may now be removed, taking care not to lose the washers and universal coupling, which is loose.

(4) The front panel meter is now accessible.

(5) The meter board may be removed by removing the interconnections and the single centre securing crew, then sliding out of the ATU.

(6) Instructions for dismantling the ATU for mechanical repair are given in Part 4 of the handbook.



Power Amplifier and Filter Board Securing Screws Fig. 7·2

9 Synthesizer and Transceiver Sub-Assemblies

(1) To gain access to the synthesizer or transceiver board, remove the appropriate screened cover which is secured by seven or five cross-head screws, respectively. The cover for the transceiver board is identified by the offset centre screw.

(2) To lift up the synthesizer board remove seven pillars and two screws. The board is connected by film wire to the front panel frequency switches and to the transceiver board by wire connections.

(3) To lift up the transceiver board remove five pillars and three screws. All connections to the board are wire connections.

The synthesizer and transceiver sub-assemblies may be removed as one unit as follows:

(4) Unscrew the front panel knobs, allowing the front panel cover to be removed.

CAUTION BEFORE PROCEEDING WITH NEXT OPERATION REFER TO THE TRITIUM WARNING PAGE AT THE FRONT OF THE MANUAL.

(5) Pull the mylar discs from the frequency selection switch spindles and carefully remove the tritium beta lights to a safe place.

(6) Remove the nuts and washer from the front panel synthesizers and transceiver controls noting the order in which they are fitted. Next remove the cross-head screw securing the earth connection to the front panel (access via transceiver sub-assembly). The synthesizer and transceiver sub-assemblies may now be withdrawn as one unit.

(7) If required to replace a switch, unscrew the plastic ring which secures it to the sub-assembly.

10 RE-ASSEMBLY

10.1 In general, re-assembly is the reverse of the procedures as described in para.5 but the following points should be noted.

(1) If a switch seal is removed it must be renewed. It is a push-on fit.

(2) Ensure that the 'knitmesh' earthing gasket is in position when replacing the transceiver or synthesizer screening covers.

(3) Ensure that all seals are correctly in place.

(4) Take care not to overtighten the socket head screws that secure the front and rear panels to the case sleeve (torque setting 1.7Nm (15 lb in.).

(5) IMPORTANT Ensure that the leads to the common earth ('star washer') connection, if they have been disconnected, are replaced correctly (see Chap.4, para.4 and Fig.4.1).

11 FAULT LOCATION

11.1 The information provided in this section is intended to make it possible to pin-point a fault to a specific sub-assembly. Separate fault-finding procedures for each sub-assembly is provided in the appropriate Part (2,3,4 or 5) of the handbook. Should the equipment fail to operate correctly, the procedure given in Chapter 6, para.4 (Operational Checklist) should be followed. From this it should be possible to isolate the fault to one of the following conditions.

(i) Transmitter and receiver fault.

(ii) Transmitter only fault.

(iii) Receiver only fault.

The following procedure should then be carried out:

(1) Remove the rear panel and main case as detailed in para.5.

(2) Carry out a visual check of the components and wiring for signs of breakage, loose connection or overheating.

(3) Follow the procedure given in Table 2, the Fault-area Identification Flowchart, which should isolate the fault to a particular sub-assembly.

(4) Refer to the appropriate Part of the manual for the fault-finding procedure for the suspected sub-assembly.

(5) Replace the faulty component(s).

(6) Re-align any circuits where components have been replaced.

(7) Follow the procedures given in para.12 to check the performance of the equipment.

Table 1 summarises the fault finding and recification procedure.

12 PERFORMANCE CHECKS

13 General

The instructions in these paragraphs provide a series of checks on the performance of the PRM.4021 for use subsequent to an overhaul or in the event of adverse reports on the performance. The tests should be carried out in the order given and a satisfactory result must be obtained from each test before proceeding to the next.

13.1 Do not attempt to improve the performance of the PRM.4021 by adjusting any preset trimmer or core, etc., other than in an approved alignment procedure (Chap.3 of Part 2, Chap.3 of part 3 and Chap.3 of Part 5).

14 Equipment Required (See Chap.5 for more detailed information).

(1) RF power meter.

(2) Two-tone a.f. signal generator.

(3) AF power meter.

(4) RF signal generator.

(5) Multimeter.

(6) RF adaptor lead TJ289.

(7) Power supply.

(8) Adaptor box TJ290.

(9) Tool Kit.

(10) Digital frequency meter.

(11) Oscilloscope.

15 Preliminary Procedure

(1) Connect the 12 V d.c. power supply to the front panel audio socket 2. Connect the adaptor box TJ290 to audio socket 1. Set the TX/RX switch on to TX.

(2) Select a frequency of 2MHz.

(3) Set the Mode switch to USB CW.

(4) Connect the RF power meter to the wideband socket (rear casting W/B) using the RF adaptor lead TJ289.

(5) Set the Power switch to HP.

(6) Connect the audio generator to the audio input sockets on the adaptor box.

16 CW Performance Check

(1) Connect an oscilloscope across the RF power meter.

(2) Depress the CW button on TJ290 and check that the power output is between 15W and 7.1W.

(3) Release the button and check the transmitter is held on for a short period after releasing and then returns to receive.

(4) Depress the button and examine the waveform on the oscilloscope, check that ripple is not excessive and that there is 1kHz side-tone from the AF output.

(5) Set the Mode switch to LSB CW and repeat steps (1) to (4).

17 AM Performance Check

(1) Set the Mode switch to AM.

(2) Set the AF generator for an audio tone of 1kHz but the output switched OFF.

(3) Set the Power switch to HP.

(4) Switch to transmit.

(5) Check that the carrier output is 10W +3dB -1dB.

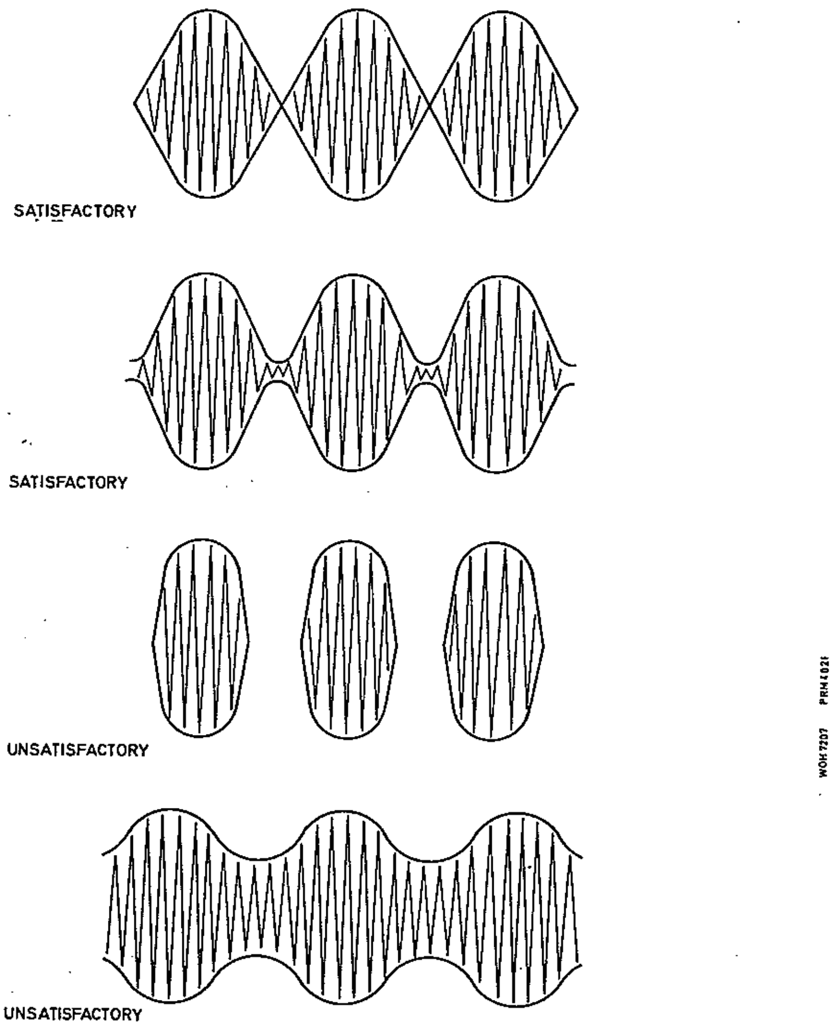
(6) Set the output of the AF generator to 80mV e.m.f. (27mV pd*).

(7) Check that the waveform displayed is a satisfactory compatible AM envelope. and is not overmodulated. (Fig.7.3).

18 Overall Transmitter Check

(1) Replace the adaptor box TJ289 connected to the wideband socket with a normal co-axial lead to the RF power meter.

* Applicable to generator with 600Ω source resistance.



AM Envelope

Fig. 7·3

(2) Set the Mode switch to TUNE.

(3) Set the Power switch to HP.

(4) Check that the output power is between 4W and 1.8W and the supply current does not exceed 1.2A.

(5) Set the Power switch to LP.

(6) Check that the output power does not change.

(7) Set the Power switch to OFF.

(8) Disconnect the co-axial lead from the wideband socket and connect it to the front panel socket. Ensure that the synthesizer and transceiver covers are temporarily fitted.

(9) Set the Power switch to HP.

(10) Check that the light emitting diodes in the meter indicates the direction to turn the tuning knob.

(11) Turn the tuning knob in the direction indicated and check that the panel meter indicates the transmitted power.

(12) Check that when the meter reads approximately ¼ scale, the LED switches off, then tune the transmitter for peak reading on the meter.

(13) Check that the meter peak corresponds with peak power as indicated on the RF power meter.

(14) Check that the output power is greater than 7.1W (-1½dB).

(15) Connect TJ289 to the wideband socket and check that the power reading drops to zero.

(16) Set the Mode switch to USB.

(17) Check that the panel meter reads about 2/3 f.s.d. indicating supply voltage.

(18) Set the frequency controls to 8MHz.

(19) Disconnect the adaptor box.

(20) Set the Mode switch to TUNE.

(21) Check that the anticlockwise LED illuminates and tune the ATU as above.

(22) Repeat step (14).

(23) Set the frequency controls to 4MHz.

(24) Repeat step (21).

(25) Repeat step (14).

(26) Set the frequency controls to 2MHz.

(27) Repeat step (21).

(28) Repeat step (14).

(29) Set the Power switch to LP.

(30) Check that the RF power output is between 4W and 1.8W and the supply current does not exceed 1.2A.

19 Power Supply Protection Check

Note For the following tests a current limited power supply with a limit of 4 Amps must be used to prevent damage to the fuse.

(1) Set the Mode switch to USB.

(2) Increase the supply voltage slowly. Check that the supply trips at approximately 18V.

Note: On no account should the voltage be increased above 22V as permanent damage may result.

(3) Switch the power supply OFF and disconnect.

(4) Reset the power supply to 12 volts.

(5) Connect the power supply to the PRM.4021 with reversed supply connection.

(6) Switch the power supply on and note that the current rises to the current limit.

(7) Switch the power supply off and disconnect the power supply and adaptor box from the audio sockets.

20 AF Bandwidth Check

(1) Connect the power supply lead to audio socket 1 and the adaptor box to audio socket 2. Set the TX/RX switch on the adaptor box to RX.

(2) Connect the a.f. power meter set to 300 ohms impedance, 30mW range to the high level audio output on the adaptor box.

(3) Check that the frequency controls are set to 2MHz. Set the Mode Switch to USB.

(4) Connect the r.f. signal generator set to 2.001MHz to the wideband socket on the rear heatsink via the r.f. adaptor lead.

(5) Connect the digital frequency meter across the a.f. power meter.

(6) Adjust the r.f. signal generator frequency for maximum a.f. output and note the output level.

(7) Increase the r.f. signal generator output level by 6dB.

(8) Reduce the r.f. input frequency until the a.f. output power is the same as at step (6). Check that the counter reading is less than 500Hz.

(9) Increase the r.f. input frequency until the a.f. output power is the same as at step (6). Check that the counter reading is between 2.500Hz and 3000Hz.

21 CW Filter Check

(1) Set Mode switch to USB CW.

(2) Set the r.f. generator to 2.001MHz and an output voltage of 2mV emf.

(3) Adjust the r.f. signal generator frequency for maximum a.f. output and note the output level and frequency which should lie within the limits 950 to 1050Hz.

(4) Reduce the r.f. input frequency until the a.f. output power is reduced by 3dB. Check that the difference in frequency to that recorded in step (3) is -40 to -80Hz.

(5) Increase the r.f. input frequency until the a.f. output is again reduced by 3dB relative to that obtained in step (3). Check that the difference in frequency to that recorded in step (3) is +40 to +80Hz.

(6) Reduce the r.f. input level to 2uV emf and adjust frequency for maximum a.f. output level.

(7) Note the a.f. output level.

(8) Interrupt the r.f. input and check that the change in a.f. output level is greater than 22dB.

22 Overall Receiver Check

(1) Connect the r.f. signal generator to the front panel via the BNC socket.

(2) Set the Mode switch to USB. Set the frequency switches to a frequency of 2MHz.

(3) Set the r.f. signal generator to 2.001MHz at a level of 2uV emf.

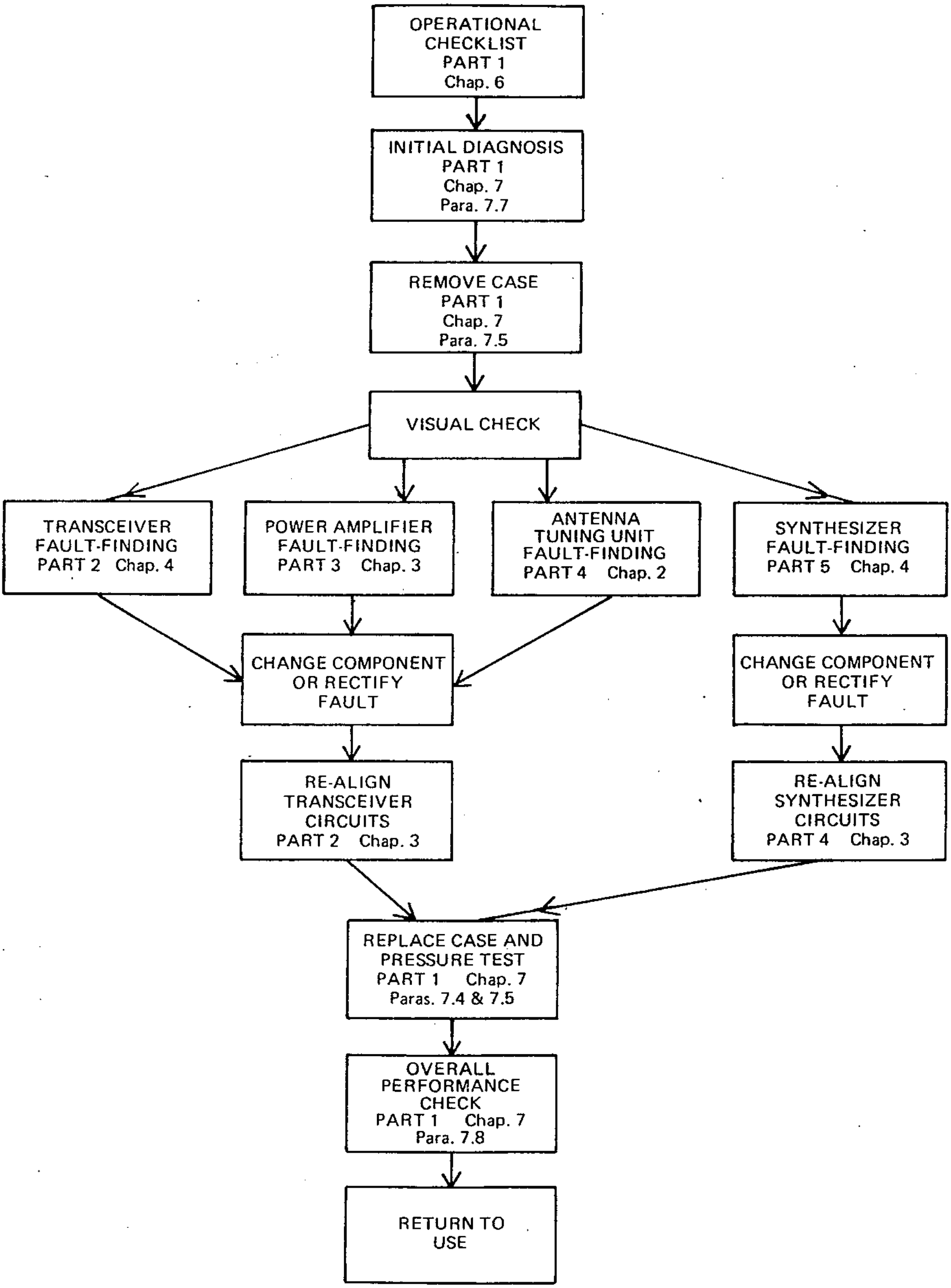
(4) Tune the ATU for maximum audio output and check that the output power is greater than 3mW.

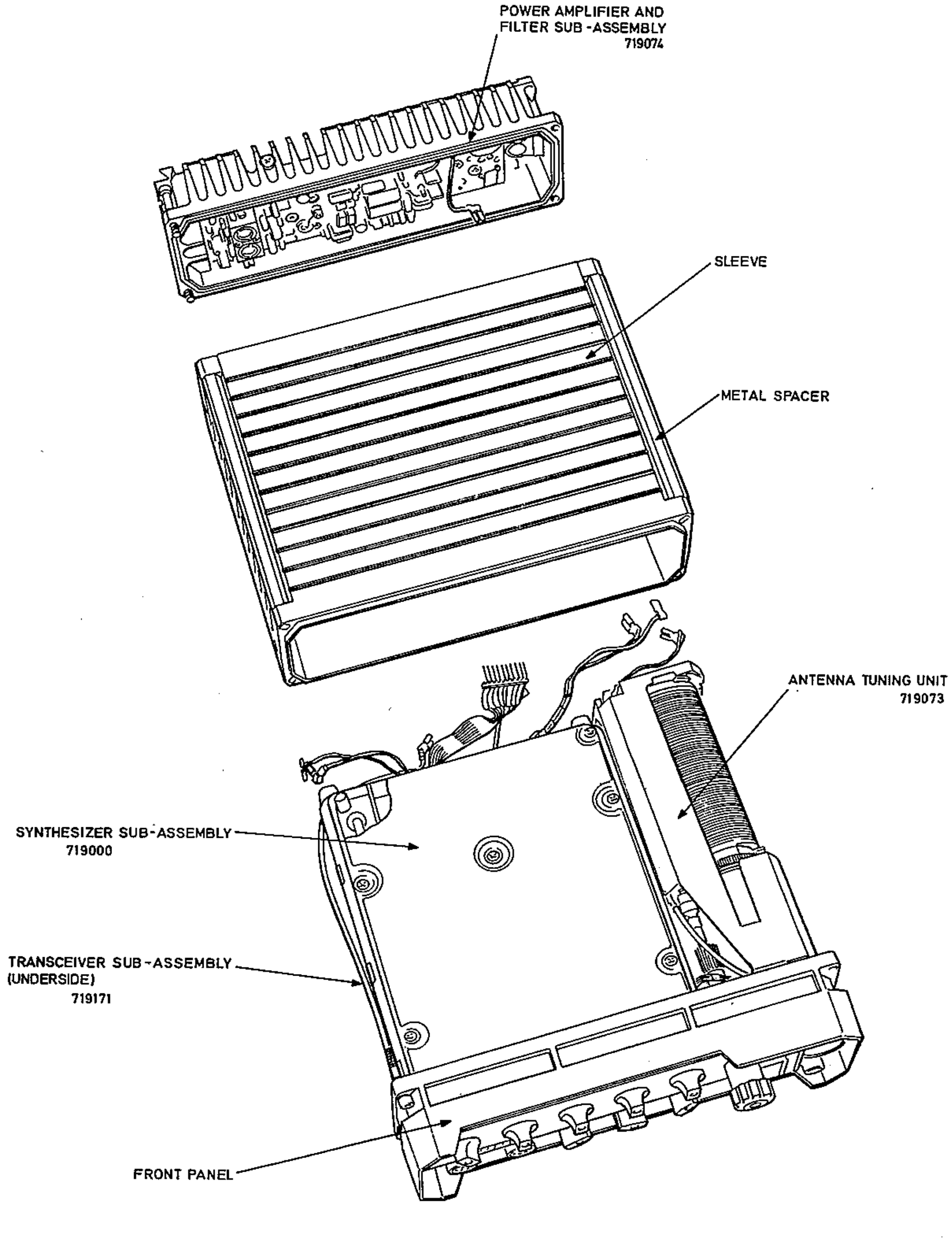
(5) Set the Mode switch to LSB.

(6) Set the RF signal generator to 1.999MHz and repeat step (4).

TABLE NO. 1

FAULT-FINDING AND RECTIFICATION PROCEDURE

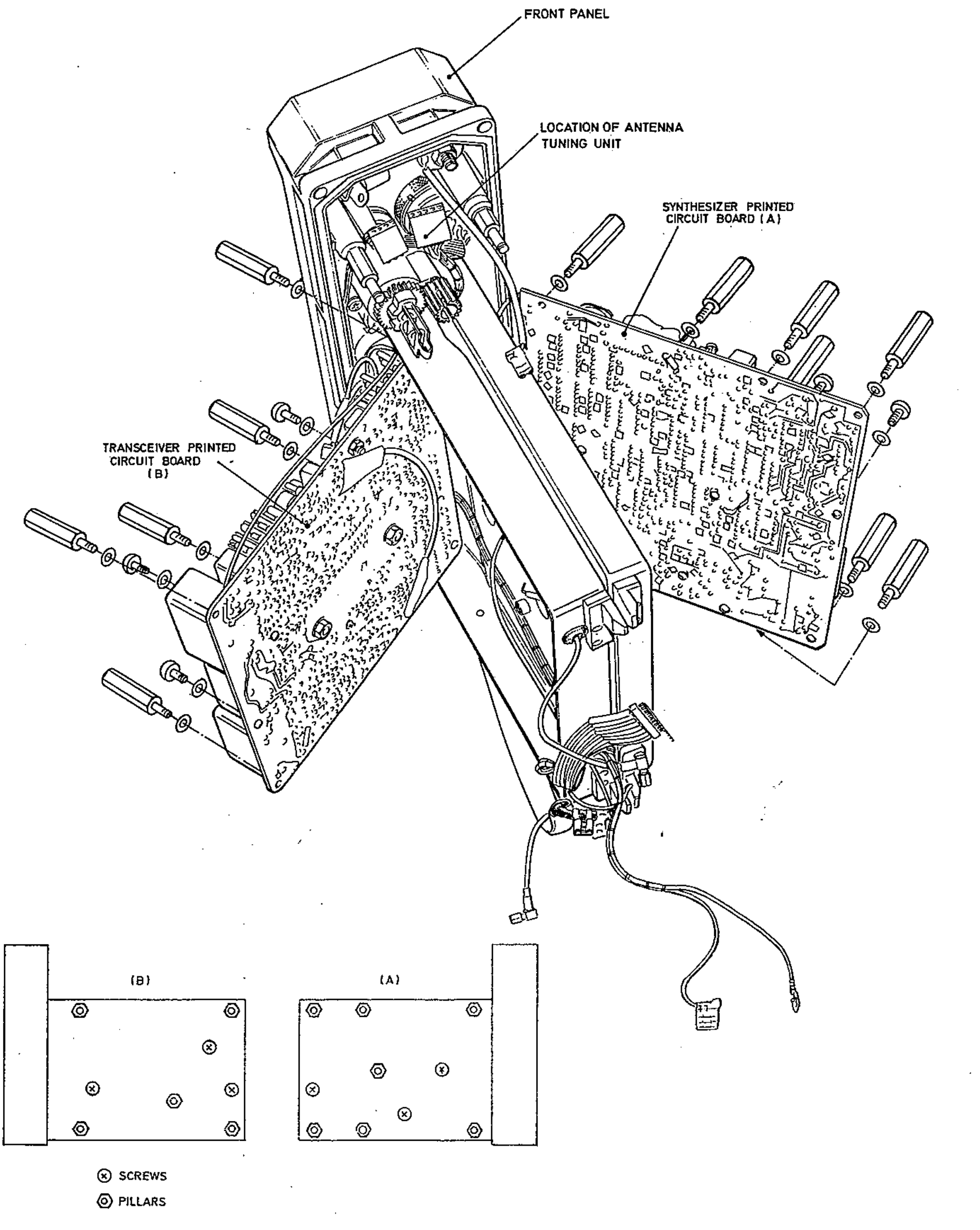




RACAL
WOH7207

Mechanical Construction

Fig. 1



RACAL WOH7207

Mounting of Transceiver and Synthesizer Boards Fig. 2

PART 2

719171 TRANSCEIVER SUB-ASSEMBLY

PART 2

719171 TRANSCEIVER SUB-ASSEMBLY

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

(See individual Chapter Contents pages for in-text illustrations)

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

CHAPTER 1

GENERAL DESCRIPTION

1. INTRODUCTION

1.1 The transceiver sub-assembly provides the circuits for a single sideband transmitter and receiver with the facility of compatible amplitude modulated transmission. The unit is designed to operate with its associated synthesizer, power amplifier and antenna tuning unit in the HF band. Both speech and CW 1kHz tone operation are available.

1.2 The unit provides 100mW r.f. output power to the power amplifier unit. The transmitted r.f. power is determined by a switching circuit incorporated in the power amplifier.

1.3 To minimise the size and weight of the unit, a number of circuits are utilised for both transmission and reception.

2. CONSTRUCTION AND LOCATION

2.1 The transceiver sub-assembly comprises a single printed circuit board of dimensions 144 X 141 mm mounted within a screened casing which houses the front panel POWER/MODE and GAIN controls.

2.2 The sub-assembly is located within the unit as shown in Fig. 1.

3. PRINCIPLES OF OPERATION (Fig. 2)

4. Transmission

4.1 Microphone inputs are fed to the mic.preamplifier and phase splitter. The two outputs in phase quadrature are fed to the balanced modulators which are themselves driven by two 1.4MHz signals from the synthesizer, also in phase quadrature. The modulated outputs are added to produce a single sideband signal. The resultant i.f. signal is fed to the 1.4MHz limiting amplifier to produce a compressed signal and then filtered by the 1.4MHz l.s.b. filter to remove out-of-band intermodulation products and residual upper-sideband components from the signal. If a.m. is selected, the carrier is reinserted after the filter.

4.2 The filtered 1.4MHz IF signal is, after buffering, mixed with a 36.8MHz signal when LSB is selected, or a 34MHz signal when USB or AM is selected. Resultants produced are 35.4MHz and 38.2MHz (LSB) or 32.6MHz and 35.4MHz (USB or AM). The signal is fed via a 35.4MHz bandpass filter, which retains only the 35.4MHz component in either mode. The upper sideband of the 35.4MHz signal is retained for LSB working; the lower sideband is retained for USB or AM working.

4.3 The 35.4MHz IF signal is mixed, in a balanced mixer, with a signal from the synthesizer of 37.4MHz to 51.3999MHz. The resultant is a signal in the range 2MHz to 15.999MHz, i.e. the required signal for transmission. Unwanted signals are removed by the 2-16MHz low-pass filter.

4.4 The 35.4MHz signals are inverted (i.e. upper sideband for LSB working, etc). A further insertion takes place during mixing with the 37.4-51.3999MHz signal, giving correct positioning of the sidebands.

4.5 The filtered output is fed to the wideband linear amplifier which drives the power amplifier unit. An automatic level control (ALC) signal from the power amplifier unit controls the gain of the wideband linear amplifier to maintain a constant level of transmitted output.

4.6 CW operation is essentially the same as for speech operation. A 1kHz audio signal for transmission is provided by the synthesizer and switched by the key circuit.

4.7 A sidetone output is provided during transmission by feeding a proportion of the microphone or CW tone input to the audio amplifier.

4.8 If TUNE is selected on the front panel Mode switch, the output of the microphone phase splitter is muted and the 1.4MHz carrier is reinstated. A 1kHz signal is fed to the audio amplifier to provide an audible indication that TUNE is selected.

5. Reception

5.1 Received r.f. signals are fed via the antenna tuning unit and power amplifier unit, where they are filtered, to the 2-16MHz low-pass filter in the transceiver unit. The filtered signal is applied to the diode ring mixer where it is mixed with the variable synthesizer input of 37.4MHz to 51.3999MHz to produce the first i.f. of 35.4MHz. The signal is fed through the a.m. band-pass filter to a low-noise preamplifier and then to the first i.f. amplifier.

5.2 The amplified 35.4MHz signal is mixed with either a 34MHz or 36.8MHz signal from the synthesizer, depending upon the mode selected. If LSB is selected, the synthesizer frequency is 36.8MHz. If USB or AM is selected, the synthesizer frequency is 34MHz. In both cases, one of the products of mixing is a signal centred on 1.4MHz; the unwanted products are removed by filtering in the 1.4MHz l.s.b. filter.

5.3 The filtered 1.4MHz i.f. signal is buffered then amplified in the second i.f. amplifier and fed to the s.s.b. detector, where it is mixed with a 1.4MHz signal from the synthesizer to produce an a.f. output to the audio amplifier.

5.4 Both stages of i.f. amplification incorporate an a.g.c. circuit. These circuits maintain a (sensibly) constant a.f. output level for wide variations of r.f. input level, whilst ensuring an optimum signal-to-noise ratio.

5.5 When CW is selected a narrow-band filter is introduced in the audio circuit.

6. Out-of-Lock Condition

6.1 If the synthesizer is out-of-lock an interrupted tone is applied to the audio amplifier and a mute control inhibits the operation of the transmitter.

CHAPTER 2

CIRCUIT DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 2

CIRCUIT DESCRIPTION

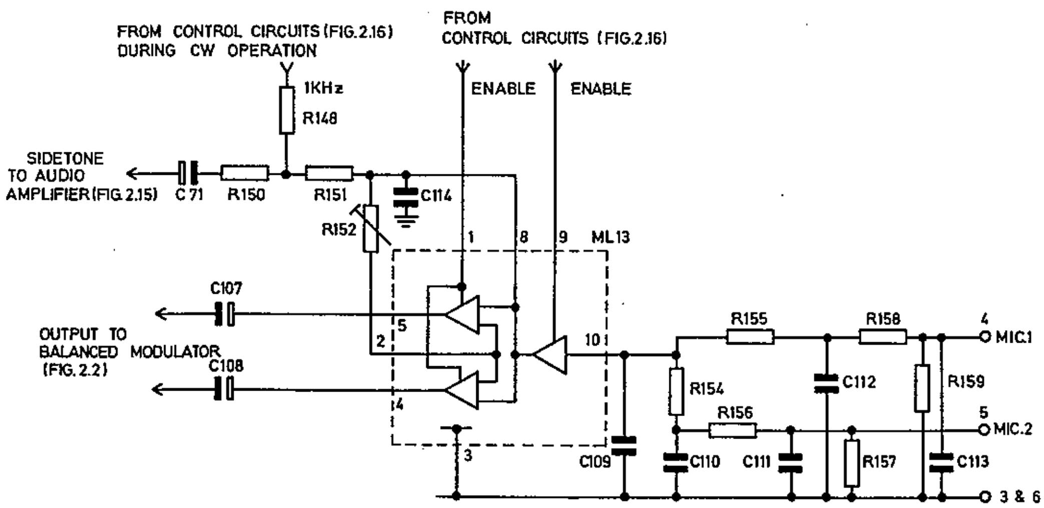
1. INTRODUCTION

1.1 This chapter describes the circuits of the transceiver sub-assembly. The description is divided into Transmitter Circuits, Receiver Circuits, Control Circuits and Power Supplies. Where a circuit is used for both transmission and reception it is described in both roles. All circuits are located on the transceiver board, and a complete circuit diagram is given in Fig. 3 at the rear of this part of the handbook.

2. TRANSMITTER CIRCUITS

3. Microphone Preamplifier and Phase Splitter (Refer to Fig. 2.1)

3.1 During speech operation, microphone inputs from pin A of either Audio socket are fed via MIC 1 and MIC 2 connections (board pins 4 and 5) through buffer and r.f. decoupling circuits (R154 to R159, C109 to C113) to the thick film microphone preamplifier and phase splitter ML13 pin 10. The preamplifier is switched on by the operation of the press-to-talk (PTT) button on the handset which causes power to be applied to ML13 pin 9 by the control circuits.



Microphone Preamplifier and Phase Splitter Circuit Fig.2·1

3.2 The output of the preamplifier is fed to the phase splitter, two active filters within the same thick film circuit. The filters are set up by R152 to have a phase difference of 90° at a centre frequency of 1kHz. During transmission the filters are normally energized, held on by power supplied to ML13 pin 1 via the control circuits from the 9VTX line.

3.3 The outputs of the phase splitter are applied, via C107 and C108, to the inputs of the balanced modulator. A small portion of the signal is fed via R151, R150 and C71 to the input of the audio amplifier to produce a sidetone. C114 provides r.f. decoupling.

3.4 During key operation, the microphone preamplifier is switched off by the control circuits, which also route a 1kHz tone to the audio amplifier (sidetone) and via C71, R150 and R151 to the input of the phase splitter.

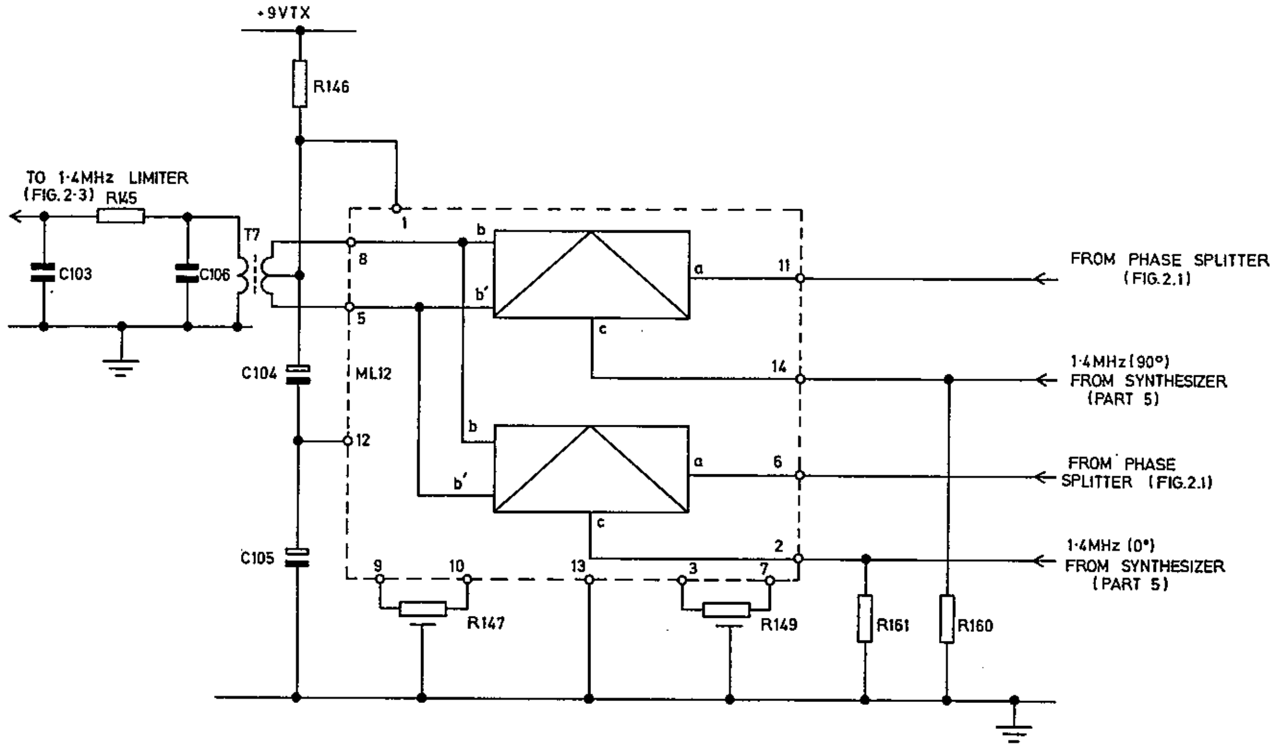
3.5 When TUNE is selected on the front panel Mode switch, the control circuits cease to supply power to the phase splitter so that the 1kHz audible TUNE signal (see para. 2.4) is not transmitted.

4. Balanced Modulator (Refer to Fig. 2.2)

4.1 The two 90° out-of-phase outputs from the phase splitter are fed to the inputs of two identical balanced modulators, ML12 pins 6 and 11, where they are mixed with two 1.4MHz carriers, also 90° out of phase. The relationship between the phase differences is such that the combined output of the two modulators, when summed by the transformer T7, is a single (lower) sideband signal. R147 and R149 are set for maximum carrier rejection and C106, R145 and C103 remove any higher order modulation products.

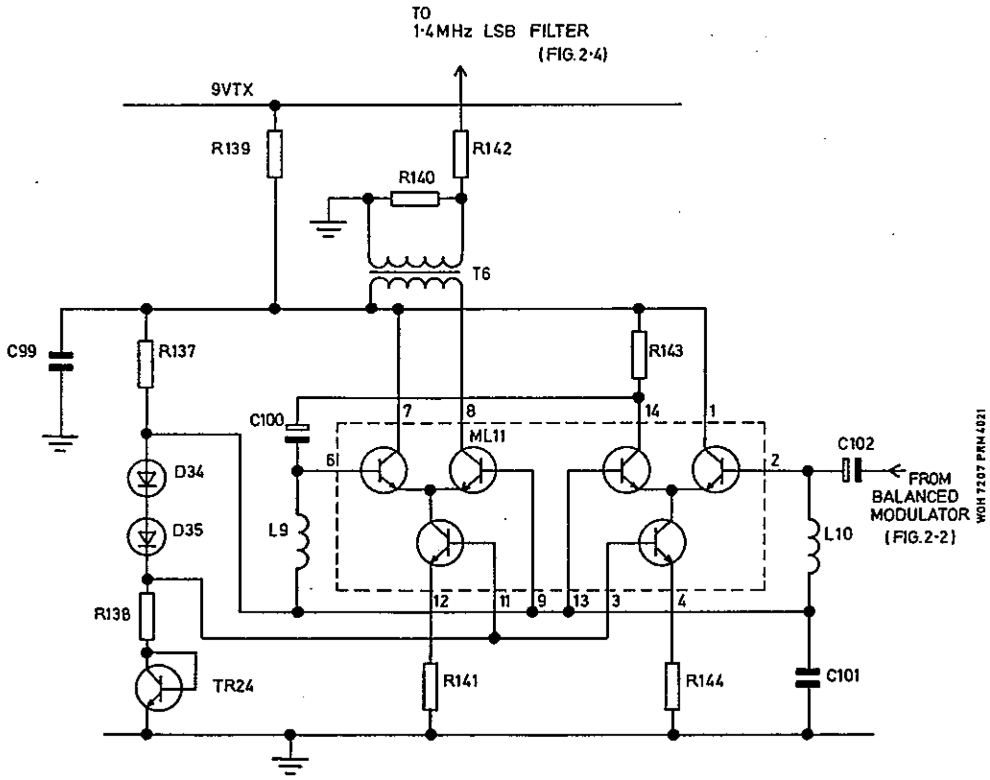
5. 1.4MHz Limiter (Refer to Fig.2.3)

5.1 The output of the balanced modulator is applied to the input of ML11 which comprises two long-tailed pair differential amplifiers in cascade. The amplifier has a restricted dynamic range so that the input from the balanced modulator causes it to 'limit' and therefore provide compression of the s.s.b. i.f. signal. The base drive for the constant current transistors and the dynamic input range are defined by the chain R137, D34, D35, R138 and TR24. The output is provided by transformer T6 and impedance matching by R140 and R142.



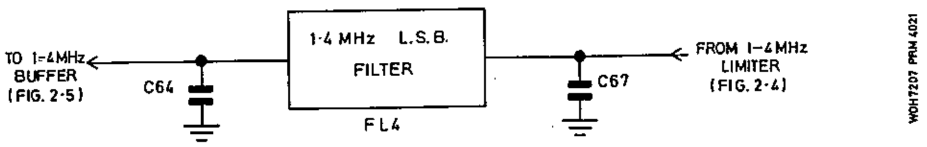
Balanced Modulator Circuit

Fig. 2.2



1·4MHz Limiter Circuit

Fig.2·3

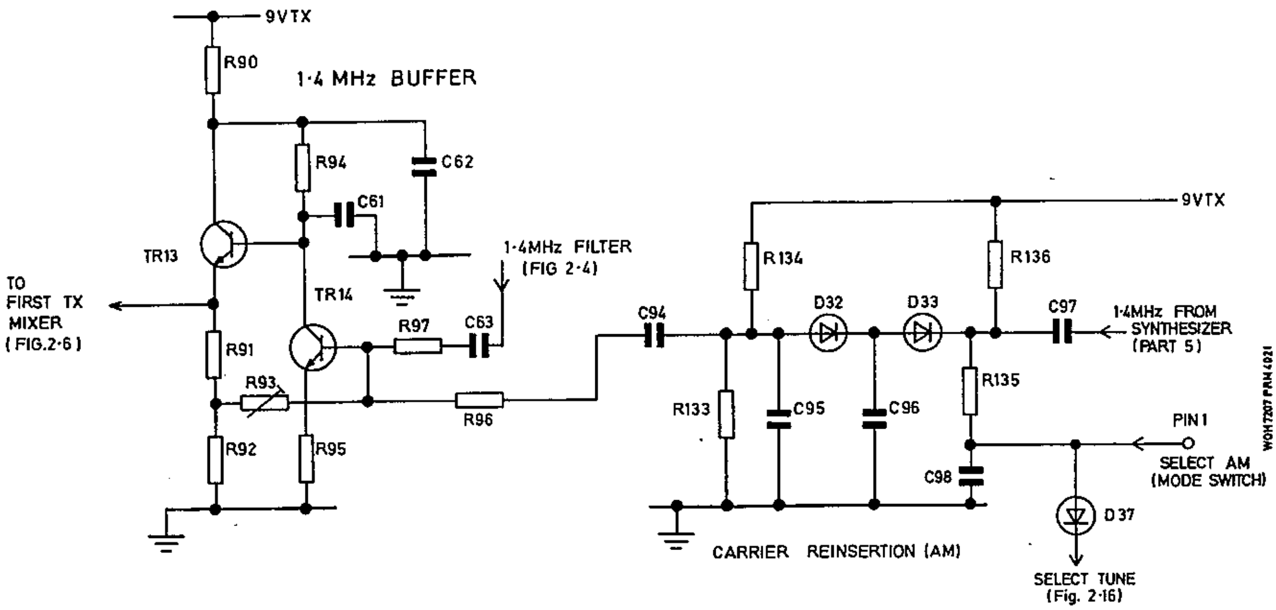


1·4 MHz LSB Filter and Bypass Circuit Fig. 2·4

6. 1.4MHz LSB Filter (Refer to Fig.2.4)

6.1 The output of the limiter is fed via an impedance matching network to the 1.4MHz crystal filter FL4, which removes out-of-band intermodulation products, harmonics and residual upper sideband components.

6.2 Capacitors C64 and C67 are included to provide a correct impedance match for the crystal filter.

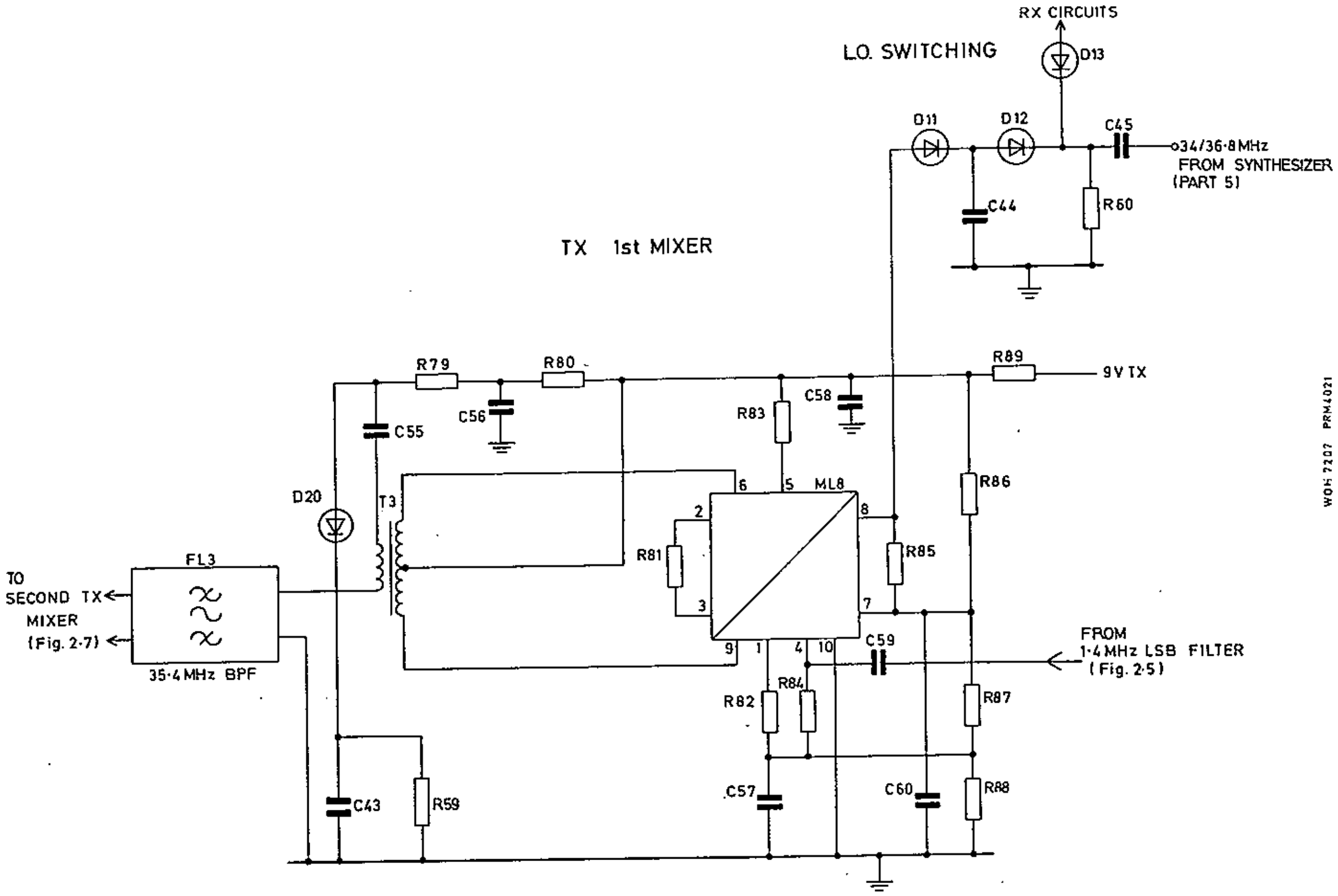


1·4MHz Buffer and Carrier Reinsertion Circuit Fig.2·5

7. <u>1.4MHz Buffer and Carrier Reinsertion (Refer to 2.5)</u>

7.1 The filtered signal is fed to the input of the 1.4MHz buffer which comprises TR13 and TR14 connected as a feedback pair. The correct input level to the wideband linear amplifier is determined by R93, which provides the only gain adjustment in the transmitter circuit. The high frequency cut-off point is established by C61.

7.2 When AM or TUNE is selected on the front panel Mode switch, the 1.4MHz carrier is reinserted by the circuit comprising diodes D32 and D33 and associated components. The diodes are forward biased by an earth on the SELECT AM input to allow the signal to pass to the base of TR14 via C94 and R96.



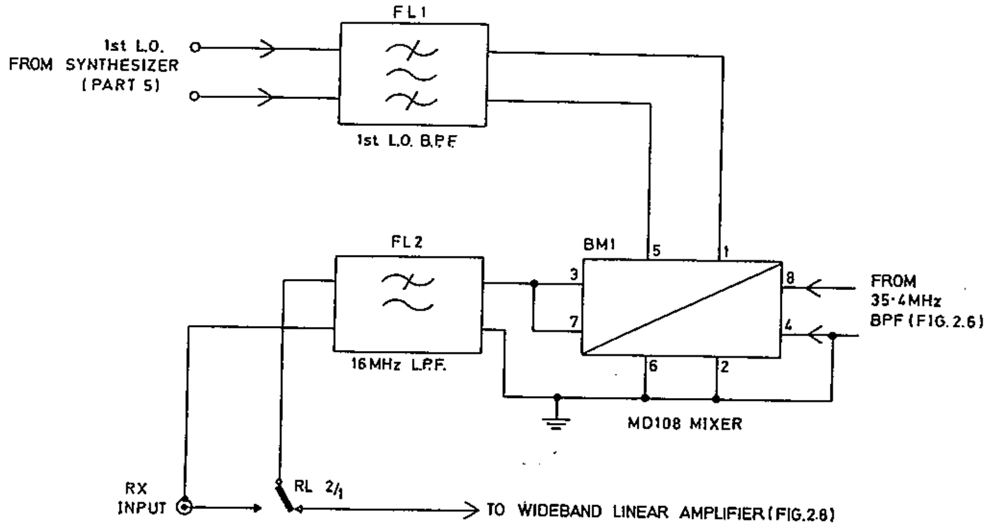
First Transmitter Mixer and 35·4 MHz Band-Pass Filter Circuit Fig.2.6

8. First Transmitter Mixer and 35.4MHz Band-Pass Filter (Refer to Fig. 2.6)

8.1 The 1.4MHz buffered signal is applied to one input of the balanced mixer ML8 where it is mixed with either a 34MHz or 36.8MHz signal from the synthesizer, depending upon whether USB (or AM), or LSB is selected. D11 and D12 are forward biased to accept the synthesizer input only when the transmitter circuits are on.

8.2 The output of ML8 is applied, via transformer T3, to the 35.4MHz bandpass filter FL3, which passes only the 35.4MHz sideband produced by the mixer and rejects the unwanted mixer products. The filter has a bandwidth of 8.5kHz and is known as a roofing filter.

8.3 D20 acts as a switch to earth and during transmission conducts because of the forward bias supplied by the 9VTX line.

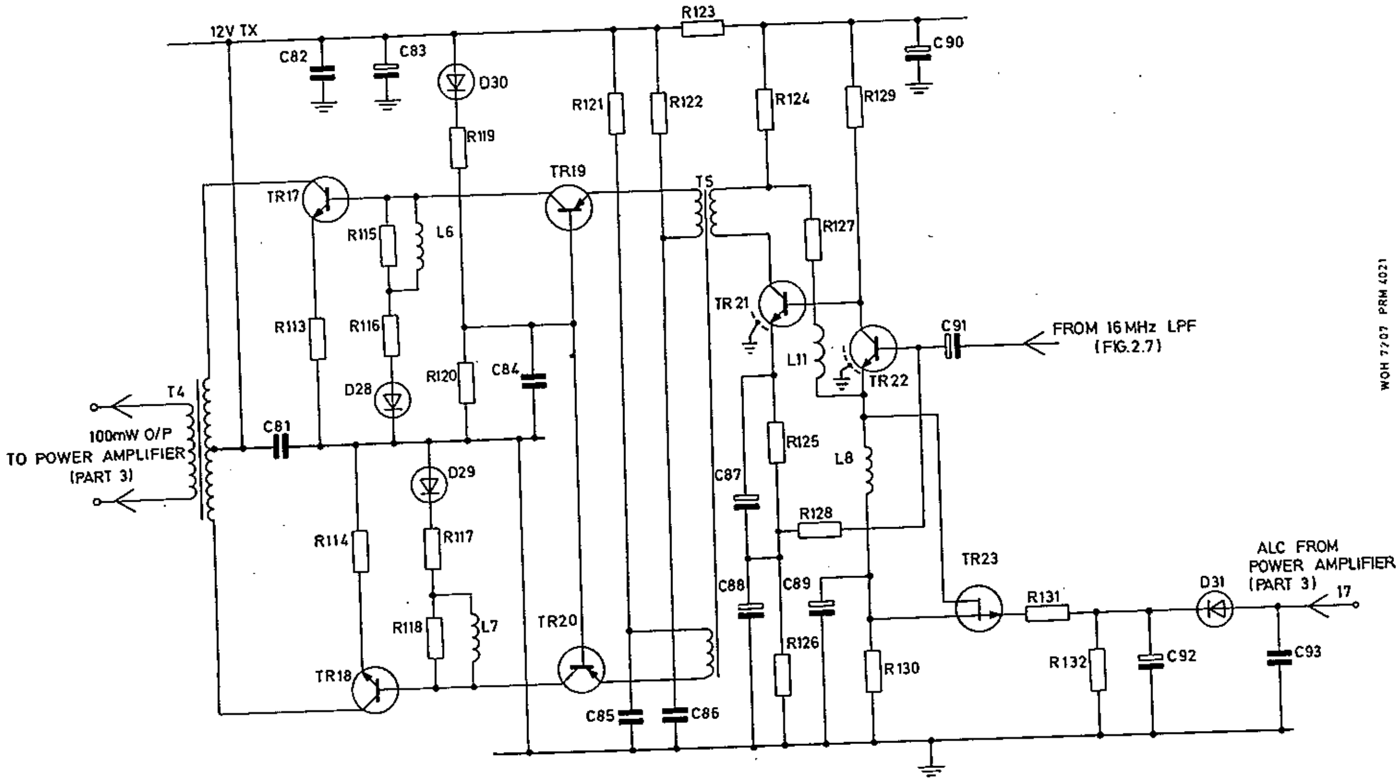


Second Transmitter Mixer, Low Pass Filter and Local Oscillator Band-Pass Filter Circuit Fig.2.7

9. <u>Second Transmitter Mixer, Low-Pass Filter and Local Oscillator Band-Pass Filter (Refer to Fig. 2.7)</u>

9.1 The filtered 35.4MHz signal is applied to one input of BM1, a hot carrier diode ring mixer. The other mixer input is a variable 37.4MHz to 51.3999MHz signal from the synthesizer. The synthesizer signal is applied via FL1, a 37.4MHz to 51.9999MHz band-pass filter which incorporates crystal notches at 34MHz and 36.8MHz to reduce the incidence of spurious signals reaching the mixer.

9.2 The resultant output from the mixer is passed through a 2MHz to 16MHz low-pass LC filter to remove the sum signal and any other out-of-band signals and to present a 2MHz to 15.9999MHz signal to the wideband amplifier via RL2.



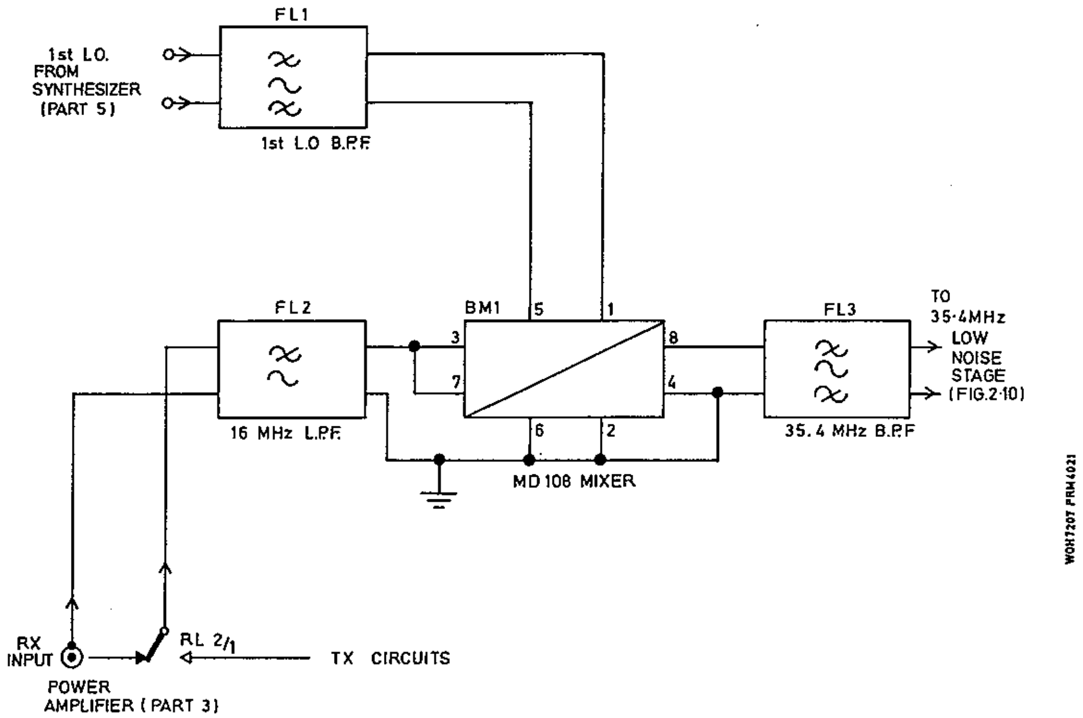
Wideband Linear Amplifier Circuit

Fig. 2.8

10. Wideband Linear Amplifier (Refer to Fig. 2.8)

10.1 The signal from RL2 is applied via C91 to the base of TR22. Transistors TR21 and TR22 form a feedback pair, the gain of which is controlled by TR23, a f.e.t. acting as a variable resistor. The automatic level control (ALC) signal from the power amplifier unit is fed to the gate of TR23, thereby controlling the gain.

10.2 The output of TR21 is applied to T5, a phase-splitter transformer, which feeds TR19 and TR20. TR19 and TR20 act as current sources for the bases of TR17 and TR18 which deliver a push-pull output through T4 to the power amplifier unit.



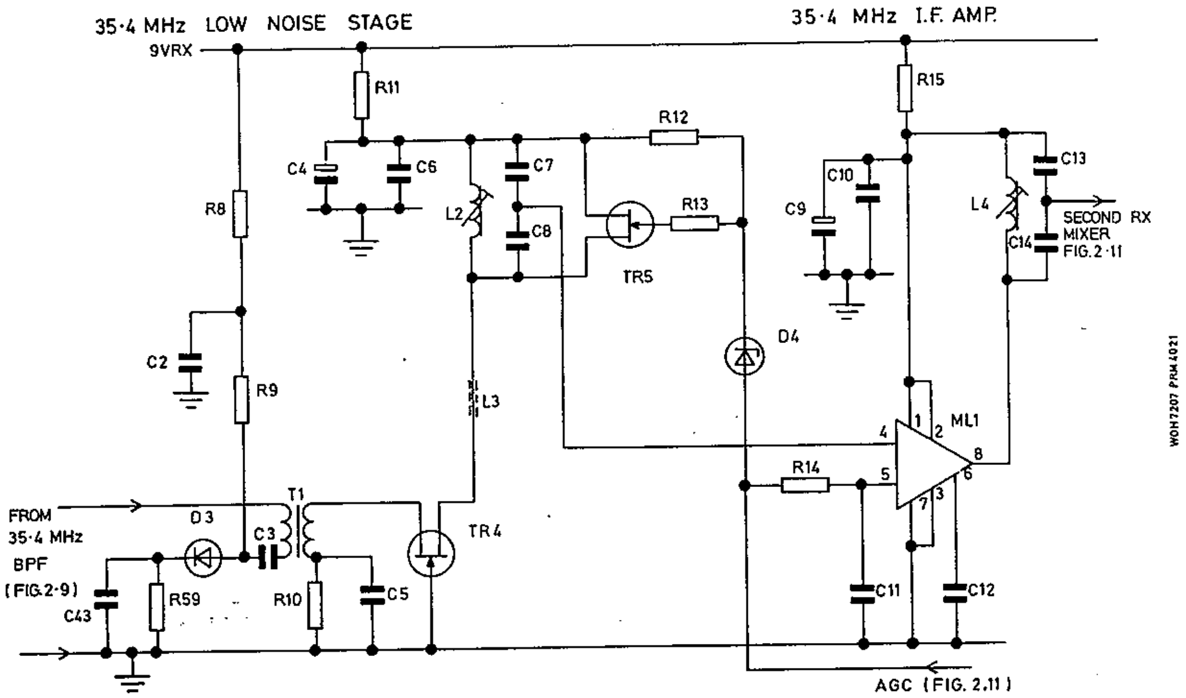
First Receiver Mixer and Filters Circuit Fig.2·9

11. RECEIVER CIRCUITS

12. First Receiver Mixer and Filters (Refer to Fig. 2.9)

12.1 The received signal at the antenna is fed via a protection circuit in the power amplifier sub-assembly (Part 3) to the transceiver sub-assembly. The receiver input is fed via RL2 to FL2, a 2MHz to 16MHz low-pass filter. The filtered r.f. signal is applied to one input of BM1, a hot carrier diode ring mixer, where it is mixed with a filtered signal from the synthesizer in the range 37.4MHz to 51.3999MHz. FL1 incorporates crystal notches at 34MHz and 36.8MHz to reduce the incidence of spurious signals reaching the mixer.

12.2 The synthesizer frequency is adjusted so that the difference frequency at the output of the mixer is 35.4MHz. This first i.f. signal is passed through the 35.4MHz band-pass filter FL3 to remove unwanted mixer products. FL3 has a bandwidth of 8.5kHz.

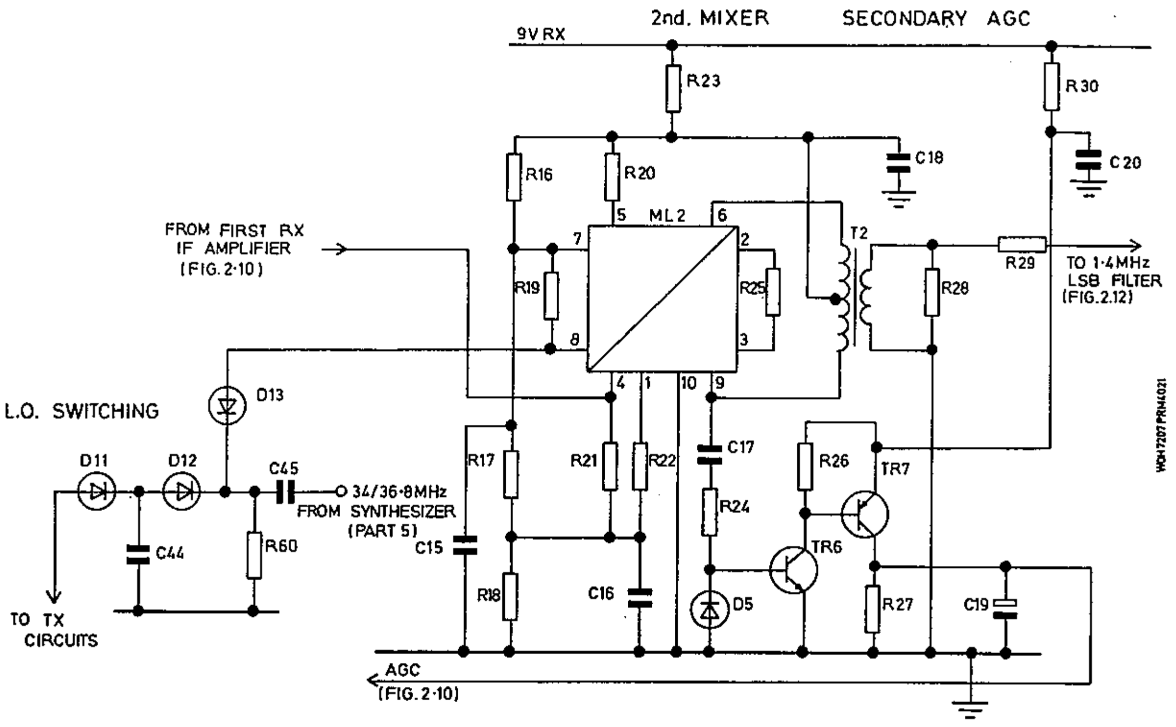


35·4MHz Low Noise Stage and IF Amplifier Circuit   Fig. 2·10

13. 35.4MHz Low Noise Stage and First IF Amplifier (Ref to Fig. 2.10)

13.1. The 35.4MHz i.f. signal is fed to transformer T1 via D3, which acts as a switch, forward biased by the 9VRX line. The output of T1 drives the source of a grounded gate junction f.e.t., TR4, which incorporates an anti-parasitic bead in the drain. A circuit tuned to 35.4MHz is formed by L2, C7 and C8. The gain of this low noise stage is controlled by the a.g.c. element TR5 acting as a variable resistor, the value of which is determined by the a.g.c. voltage applied via D4.

13.2 The output is taken from the junction of C7 and C8 to the input of the integrated circuit i.f. amplifier ML1, which is tuned to 35.4MHz by L4, C13 and C14.



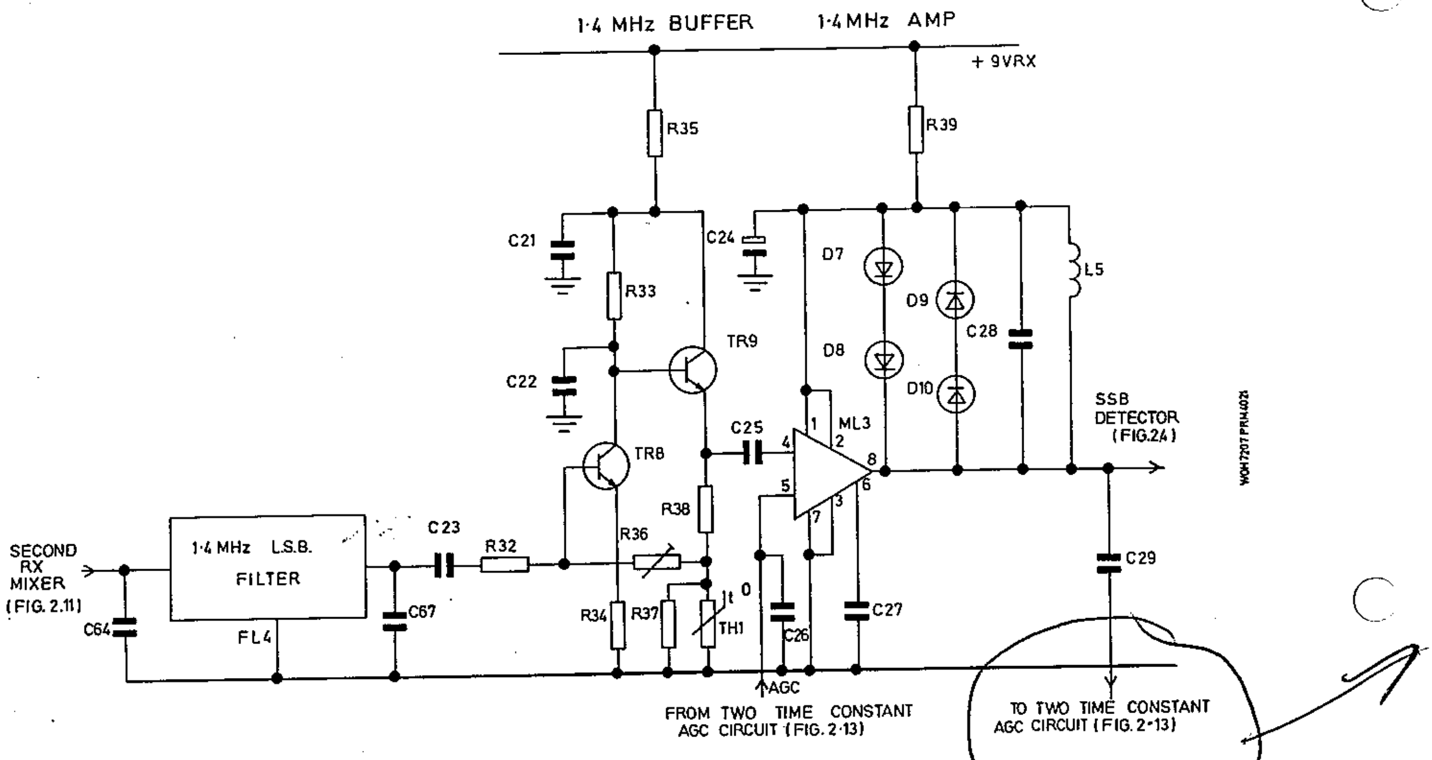
Second Receiver Mixer and Secondary AGC Circuit Fig 2·11

14. Second Receiver Mixer and Secondary AGC (Refer to Fig. 2.11)

14.1 The signal from the first i.f. amplifier is applied to one input of the second mixer ML2, a balanced modulator. The other input of ML2 is a 34MHz or 36.8MHz signal from the synthesizer unit via D13, which is forward biased to pass the signal only when the receiver circuits are on. R25 determines the conversion gain and the mixer provides a balanced output to transformer T2 which drives the next stage.

14.2 The input frequency from the synthesizer is determined by the setting of the front panel Mode switch and is 34MHz for USB or AM and 36.8MHz for LSB. When either frequency is mixed with 35.4MHz a 1.4MHz difference signal is obtained together with an unwanted sum signal of 69MHz or 70.8MHz which is removed by the 1.4MHz sideband filter.

14.3 A fraction of the signal at ML2 pin 9 is fed to the a.g.c. detector TR6. The a.g.c. signal is inverted by TR7 and fed back to control the gain of the 35.4MHz low noise stage and i.f. amplifier. This a.g.c. control operates only at high signal levels, the main control occuring at the 1.4MHz amplifier. The time constants for the a.g.c. are determined by the source impedance of TR7 (which allows a fast attack) and C19 and R27 (which produce a slow decay).

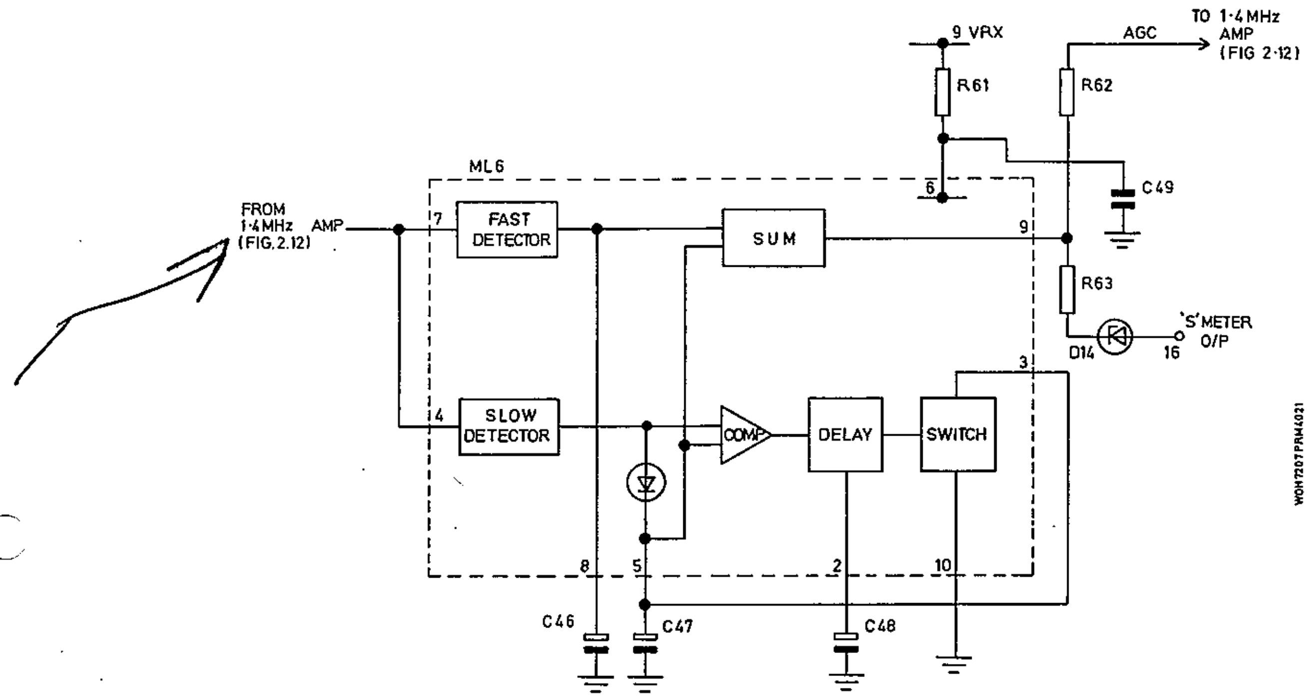


1·4 MHz Filter, Buffer and Amplifier Circuit Fig. 2·12

15. 1.4MHz Filter, Buffer and Amplifier (Refer to Fig. 2.12)

15.1 The output from the second mixer is fed to the 1.4MHz lower sideband filter FL4 which removes the unwanted mixer products. The filtered 1.4MHz signal is applied to the input of the buffer which comprises TR8 and TR9 as a feedback pair, the gain of which is controlled by R36 to set up the overall gain of the receiver. TH1 provides temperature compensation and C22 establishes the high frequency cut-off point.

15.2 The output is applied to ML3, an integrated circuit amplifier, the gain of which is controlled by the input to pin 5 from the two-time constant a.g.c. circuit. Transient suppression diodes, D7 to D10 and a 1.4MHz tuned circuit, L5 and C28, are provided at the output, which is applied to the s.s.b. detector and, via C29, to the two-time constant a.g.c. circuit.

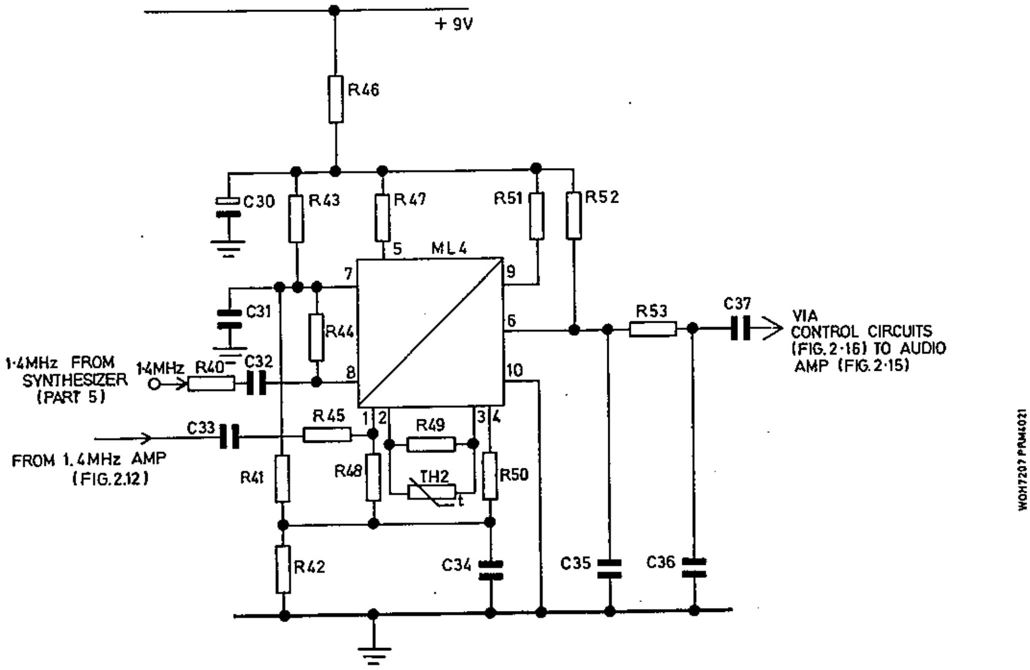


Two-Time Constant AGC Circuit Fig. 2·13

16. Two-Time Constant AGC (Refer to Fig. 2.13)

16.1 Under weak to normal signal conditions the secondary a.g.c. (para 14.1) will not operate and a.g.c. is provided by a thick film circuit which operates on the 1.4MHz amplifier. The two-time constant a.g.c. circuit reacts quickly to sudden increases in the r.f. level but reacts slowly to decreases, sufficiently only to follow fading during short pauses. The a.g.c. circuit has two detectors, a fast detector and a slow detector. The fast detector has an attack time of approximately 3 to 4 msec (and therefore always acts) and a decay time of approximately 10 msec. The slow detector has an attack time of approximately 30 msec and a decay time of approximately 2 seconds. The outputs of the two detectors are summed and either will cause an output to control the gain of the 1.4MHz amplifier. The output of the slow detector is also fed through a comparator, connected as a level detector, to a delay which operates a switch. If a signal disappears for more than approximately ½ second the switch is operated and the a.g.c. is reset to give maximum gain.

16.2 The a.g.c. voltage is also fed via R63 and D14 to the front panel meter to provide an indication of signal strength.



SSB Detector Circuit Fig. 2·14

17. SSB Detector (Refer to Fig. 2.14)

17.1. The 1.4MHz sideband signal is applied to one input of ML4, a balanced modulator, where it is mixed with a 1.4MHz signal from the synthesizer. The resultant output is an audio signal which is fed, via the control circuits, to the audio amplifier. During AM reception, one sideband of the AM signal is detected in the same way. A thermistor, TH2, ensures a constant audio output level over the operating temperature range. If set for CW operation, the audio signal is routed through the 1kHz CW filter (Refer to para. 22).

21.3 The contact of RL1 applies power to the + 9V TX rail (Fig.5.1) and the contact of RL2 connects filter FL2 to the input of the wideband amplifier (Fig. 2.7).

22. CW Transmission

22.1 During CW transmission, the front panel Mode switch is set to either LSB CW or USB CW, connecting board pin 12 (SELECT CW) to ground, and the morse key is operated, connecting board pin 11 (KEY) to ground.

22.2 The KEY signal is applied via D19-D17 to the input of the differential amplifier and performs the same function as the PTT signal (para. 21.1) in that it switches the unit to transmit. The unit is held in the transmit condition when the morse key is momentarily released, by the operation of C54 and R77, which introduce a delay of approximately ½ a second.

22.3 The KEY signal is also fed via R111 to pin 1 of ML10, a quad dual-input NAND gate. The pins of ML10 are interconnected so that the resultant outputs to ML9 switch on the bilateral analogue switches ML9A and ML9C and switch off ML9D. There is no 9VRX present so ML9B is off.

22.4 ML9A connects the 1kHz input from the synthesizer unit to ML7, an active audio filter centred on 1kHz with a 3dB bandwidth of 100Hz. The output of the filter is connected by ML9C to the input of the phase splitter (Fig.2.1).

22.5 The SELECT CW signal is fed to ML10 pin 9 but is redundant in the transmit mode as the gate is controlled by the KEY input via ML10 pin 4.

23. Speech Reception

23.1 During speech reception, the front panel Mode switch is set to USB, LSB or AM. No signal is applied to the KEY, TUNE PTT or SELECT CW inputs on the transceiver unit. Relays RL1 and RL2 are de-energised, applying power to the + 9 VRX rail (Fig. 5.1) and connecting the filter FL2 to the RX INPUT (Fig. 2.9), respectively.

23.2 ML9B is held on by the + 9 VRX rail and ML9D is held on by the output of ML10 pin 11. These two bilateral analogue gates connect the output of the s.s.b. detector (Fig. 2.14) to the input of the audio amplifier, (Fig. 2.15).

24. CW Reception

24.1 During CW reception, the front panel Mode switch is set to LSB CW or USB CW, thereby connecting board pin 12 (SELECT CW) to ground. Relays RL1 and RL2 are de-energised, applying power to the +9 VRX rail (Fig.2.17) and connecting the filter FL2 to the RX INPUT (Fig.2 .9), respectively.

24.2 The SELECT CW input is applied to ML10 pin 9and causes ML9D to be turned off and ML9C to be turned on, connecting the output of the audio filter to the input of the audio amplifier (Fig.2.15). ML9B is held on by + 9 VRX and connects the output of the s.s.b detector to the input of the audio filter (Refer to para.22).

25. Tune Condition

25.1 In the tune condition, the 1.4MHz carrier is enabled by unbalancing the normally balanced modulator; audio modulation is inhibited. The transceiver unit is in the tune condition when the front panel Mode switch is set to TUNE, which connects board pin 9 (TUNE) to ground. Pin 9 is connected to the filter bypass as well as the control circuits.

25.2 The TUNE input is applied to the differential amplifier TR11 and TR12, to TR15 and to the balanced modulator (Fig.2.2). The differential amplifier switches the unit to transmit, TR15 removes the power supply to the phase splitter (Fig.2.1) and the balanced modulator is unbalanced so that the 1.4MHz carrier is no longer suppressed. The TUNE input also causes ML9A and ML9C to be switched on via ML10 pin 2, to produce a continuous 1kHz sidetone from the audio amplifier.

CHAPTER 3

RE-ALIGNMENT

CONTENTS

CHAPTER 3

RE-ALIGNMENT

1. INTRODUCTION

1.1 Adjustments to the transceiver sub-assembly circuitry are not normally required. Random adjustments should not be made in an attempt to improve performance.

1.2 However, should any parameter be outside the specification in Part 1, Chapter 7, or should it have been necessary to replace any component, the following procedure should be followed in the order given.

1.3 Ensure that the synthesizer sub-assembly is correctly adjusted as detailed in Part 5, Chapter 3, before attempting to improve the performance of the transceiver sub-assembly.

2. EQUIPMENT REQUIRED (see Part 1, Chap. 5 for further description)

(1) RF power meter

(2) Two-tone a.f. signal generator

(3) AF power meter

(4) RF signal generator

(5) Multimeter

(6) RF adaptor lead TJ289

(7) Power supply

(8) Adaptor box TJ290

(9) Tool Kit

3. ACCESS TO PRINTED CIRCUIT BOARD

3.1 Reference should be made to Part 1, Chapter 7 for the method of access to the transceiver printed circuit board.

4. POWER SUPPLY CIRCUIT

(1) Connect the 12V d.c. power supply to the front panel audio socket 2. Connect the adaptor box TJ290 to audio socket 1. Set the TX/RX switch on the adaptor box to RX.

(2) Select a frequency of 2MHz.

(3) Set the Mode switch to USB.

(4) Connect the RF power meter to the wideband socket (rear casting W/B) using the RF adaptor lead TJ289.

(5) Set the POWER switch to LOW.

(6) Connect the multimeter set to read 10V FSD to the centre leg (collector) of TR3 and earth.

(7) Adjust R6 for a reading of 9 volts.

(8) Disconnect the multimeter.

5. BALANCED MODULATOR CIRCUIT

(1) Set the TX/RX switch on the adaptor box to TX.

(2) Connect the oscilloscope across the RF power meter.

(3) Adjust R147 and R149 for minimum output as measured on the oscilloscope. These two resistors interact and must be adjusted until no further improvement can be obtained.

6. PHASE SPLITTER CIRCUIT

(1) Connect the audio generator, set to 1kHz and a level of 80mV e.m.f.(27mV pa*). to the audio input sockets on the adaptor box.

(2) Increase the gain of the oscilloscope until the ripple on the waveform can be easily observed.

(3) Adjust R152 for minimum ripple on the envelope noting that the potentiometer is in approximately the mid-position (Phase splitter balance).

(4) Set the AF generator to give 16mV e.m.f. (5.3mV pd*) and readjust R147 and R149 for minimum ripple if required (Carrier balance).

NOTE: True balance is achieved with the above three adjustments when the residual ripple may be seen to be at twice the modulating frequency.

* Assumes 600Ω generator source impedance.

AGC ADJUSTMENT

7. IF GAIN

(1) Set the frequency selection switches to 15.999MHz. Set the Mode switch to TUNE. Note that there is a 1kHz tone at the AF output. Set the Power switch to HP.

(2) Use the r.f. power meter to check that the r.f. output is 10W. If it is not, refer to the Adjustment procedure for the power amplifier sub-assembly, Part 3, Chapter 3, to adjust for an output of 10W.

(3) Set the Mode switch to USB.

(4) Set the audio generator to a frequency of 1kHz and a level of 8mV e.m.f.(2.7

(5) Turn R93 fully anticlockwise and note that the output power falls. Turn R93 slowly clockwise until the output power reaches 10W. Do not continue to turn the control as no further increase in power will be observed and the ALC range will be reduced.

8. RECEIVER ALIGNMENT

(1) Connect the power supply lead to audio socket 1 and the adaptor box to audio socket 2. Set the TX/RX switch on the adaptor box to RX.

(2) Connect the a.f. power meter set to 300 ohms impedance, 30mW range to the high level audio output on the adaptor box.

(3) Check that the frequency controls are set to 2MHz. Set the Mode switch to USB.

(4) Connect the r.f. signal generator set to 2.001MHz to the wideband socket on the rear heatsink via the r.f. adaptor lead.

(5) Inject sufficient r.f. signal to obtain a deflection on the a.f. power meter and adjust L2, L4 and L5 for maximum audio output. Reduce the input signal such that true tuning peaks of the inductors are found, i.e. below the a.g.c. threshold, until the input signal is at 2μV e.m.f. If required R36 may be turned anticlockwise to ensure these conditions.

9. AGC THRESHOLD

(1) Set the output of the r.f. generator to 2μV e.m.f. at 2.001MHz.

(2) Note the level of a.f. output power.

(3) Set the Mode switch to LSB and retune the r.f. generator to 1.999MHz.

(4) Note the level of a.f. output power.

(5) Set the Mode switch to the sideband which gave the lower a.f. output.

(6) Set the frequency controls to 15.990MHz and adjust the frequency of the r.f. generator to give maximum a.f. output.

(7) Set the output of the r.f. generator to 6.4µV e.m.f. Ensure that R36 is set to its mid position and note the a.f. output power.

(8) Reduce the r.f. generator output to 2µV and adjust R36 to give an a.f. output 6dB below that obtained in step (7).

10. RE-ASSEMBLY

Reference should be made to Part 1 Chapter 7 for the method of re-assembly.

CHAPTER 4

FAULT LOCATION

CONTENTS

TABLES

CHAPTER 4

FAULT LOCATION

1. INTRODUCTION

1.1 This chapter provides a guide to the location of a fault in the transceiver sub-assembly. Flowcharts are provided to assist in pin-pointing the fault to a group of components or circuit area. Reference should then be made to the circuit diagram of the transceiver, where typical voltages and waveforms are given, in order to determine which is the faulty component using the test equipment specified.

2. TEST EQUIPMENT REQUIRED (See Chap. 5 for further description)

(1) RF power meter

(2) AF power meter

(3) RF signal generator

(4) Multimeter

(5) Power supply

(6) Digital frequency meter

(7) Tool kit

3. ACCESS TO PRINTED CIRCUIT BOARD

3.1 Reference should be made to Part 1, Chapter 7 for the method of access to the transceiver printed circuit board.

4. RE-ALIGNMENT

4.1 If it is necessary to replace a faulty component, the equipment should be re-aligned as detailed in Chapter 3 of this part.

5. PERFORMANCE CHECKS

5.1 Subsequent to repair and re-alignment the operation of the unit should be checked using the flowcharts provided in Part 1, Chapter 6.

6. VOLTAGES AND WAVEFORMS

6.1 The voltage and waveforms provided on the circuit diagram are a guide and do not represent a specification. Variations with measuring equipment, component tolerances and frequency (unless specified) may be expected.

6.2 Measurements are made relative to chassis (0 volts) and are positive unless otherwise stated.

7. FAULT LOCATION FLOWCHARTS

7.1 The fault location flowcharts, Tables 1 and 2, are included to assist in locating a fault. They provide a guide to the area or group of components where the fault may exist and are not intended to be exhaustive or to indicate the faulty component. If a fault in another sub-assembly is indicated, refer to the appropriate fault location chapter.

COMPONENTS LIST

TRANSCEIVER PRINTED CIRCUIT BOARD

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Resistors (Ohm)					
R1	220K	Carbon Film	$\frac{1}{3}$W	5%	927880
R2	470	Carbon Film	$\frac{1}{4}$W	5%	927879
R3	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R4	4K7	Carbon Film	$\frac{1}{4}$W	5%	926560
R5	2K7	Carbon Film	$\frac{1}{4}$W	5%	925749
R6	2K2	Potentiometer			920310
R7	3K9	Carbon Film	$\frac{1}{4}$W	5%	926559
R8	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R9	4K7	Carbon Film	$\frac{1}{4}$W	5%	926560
R10	150	Carbon Film	$\frac{1}{4}$W	5%	926545
R11	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R12	39K	Carbon Film	$\frac{1}{4}$W	5%	925135
R13	39K	Carbon Film	$\frac{1}{4}$W	5%	925135
R14	15K	Carbon Film	$\frac{1}{4}$W	5%	924331
R15	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R16	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R17	820	Carbon Film	$\frac{1}{4}$W	5%	926553
R18	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R19	56	Carbon Film	$\frac{1}{4}$W	5%	927877
R20	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R21	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R22	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R23	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R24	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R25	150	Carbon Film	$\frac{1}{4}$W	5%	926545
R26	220K	Carbon Film	$\frac{1}{4}$W	5%	927880
R27	4K7	Carbon Film	$\frac{1}{4}$W	5%	926560
R28	68	Carbon Film	$\frac{1}{4}$W	5%	924326
R29	1K2	Carbon Film	$\frac{1}{4}$W	5%	924681
R30	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R31	NOT USED				
R32	2K2	Carbon Film	$\frac{1}{4}$W	5%	927192
R33	6K8	Carbon Film	$\frac{1}{4}$W	5%	926562
R34	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R35	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R36	22K	Potentiometer			920314
R37	150	Carbon Film	$\frac{1}{4}$W	5%	926545
R38	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R39	100	Carbon Film	$\frac{1}{4}$W	5%	927189

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R40	1K	Carbon Film	¼W	5%	926554
R41	820	Carbon Film	¼W	5%	926553
R42	1K	Carbon Film	¼W	5%	926554
R43	1K	Carbon Film	¼W	5%	926554
R44	1K	Carbon Film	¼W	5%	926554
R45	4K7	Carbon Film	¼W	5%	926560
R46	100	Carbon Film	¼W	5%	927189
R47	10K	Carbon Film	¼W	5%	926564
R48	1K	Carbon Film	¼W	5%	926554
R49	150	Carbon Film	¼W	5%	926545
R50	1K	Carbon Film	¼W	5%	926554
R51	2K2	Carbon Film	¼W	5%	927192
R52	2K2	Carbon Film	¼W	5%	927192
R53	1K	Carbon Film	¼W	5%	926554
R54	47K	Carbon Film	¼W	5%	926568
R55	220K	Carbon Film	¼W	5%	927880
R56	15K	Carbon Film	¼W	5%	924331
R57	1	Carbon Film	¼W	5%	923887
R58	1	Carbon Film	¼W	5%	923887
R59	4K7	Carbon Film	¼W	5%	926560
R60	4K7	Carbon Film	¼W	5%	926560
R61	100	Carbon Film	¼W	5%	927189
R62	10K	Carbon Film	¼W	5%	926564
R63	15K	Carbon Film	¼W	5%	924331
R64	6K1	Metal Film			927883
R65	47K	Carbon Film	¼W	5%	926568
R66	47K	Carbon Film	¼W	5%	926568
R67	820	Metal Film			927882
R68	10K	Carbon Film	¼W	5%	926564
R69	10K	Carbon Film	¼W	5%	926564
R70	301K	Metal Film			927884
R71	1K	Carbon Film	¼W	5%	926554
R72	1K	Carbon Film	¼W	5%	926554
R73	10K	Carbon Film	¼W	5%	926564
R74	1K	Carbon Film	¼W	5%	926554
R75	2K2	Carbon Film	¼W	5%	927192
R76	39K	Carbon Film	¼W	5%	925135
R77	1K	Carbon Film	¼W	5%	926554
R78	6K8	Carbon Film	¼W	5%	926562
R79	4K7	Carbon Film	¼W	5%	926560
R80	100	Carbon Film	¼W	5%	927189
R81	120	Carbon Film	¼W	5%	926985
R82	100	Carbon Film	¼W	5%	927189
R83	2K2	Carbon Film	¼W	5%	927192

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R84	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R85	56	Carbon Film	$\frac{1}{4}$W	5%	927877
R86	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R87	820	Carbon Film	$\frac{1}{4}$W	5%	926553
R88	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R89	47	Carbon Film	$\frac{1}{4}$W	5%	924325
R90	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R91	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R92	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R93	22K	Potentiometer			
R94	6K8	Carbon Film	$\frac{1}{4}$W	5%	926562
R95	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R96	4K7	Carbon Film	$\frac{1}{4}$W	5%	926560
R97	2K2	Carbon Film	$\frac{1}{4}$W	5%	927192
R98	NOT USED				
R99	NOT USED				
R100	NOT USED				
R101	47K	Carbon Film	$\frac{1}{4}$W	5%	926568
R102	39K	Carbon Film	$\frac{1}{4}$W	5%	925135
R103	220K	Carbon Film	$\frac{1}{4}$W	5%	927880
R104	47K	Carbon Film	$\frac{1}{4}$W	5%	926568
R105	200K	Carbon Film	$\frac{1}{4}$W	5%	927880
R106	2K2	Carbon Film	$\frac{1}{4}$W	5%	927192
R107	2K2	Carbon Film	$\frac{1}{4}$W	5%	927192
R108	220	Carbon Film	$\frac{1}{4}$W	5%	926546
R109	100K	Carbon Film	$\frac{1}{4}$W	5%	926569
R110	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R111	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R112	1K5	Carbon Film	$\frac{1}{4}$W	5%	926556
R113	10	Carbon Film	$\frac{1}{4}$W	5%	926544
R114	10	Carbon Film	$\frac{1}{4}$W	5%	926544
R115	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R116	47	Carbon Film	$\frac{1}{4}$W	5%	924325
R117	47	Carbon Film	$\frac{1}{4}$W	5%	924325
R118	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R119	390	Carbon Film	$\frac{1}{4}$W	5%	927878
R120	5K6	Carbon Film	$\frac{1}{4}$W	5%	926561
R121	220	Carbon Film	$\frac{1}{4}$W	5%	926546
R122	220	Carbon Film	$\frac{1}{4}$W	5%	926546
R123	10	Carbon Film	$\frac{1}{4}$W	5%	926544
R124	100	Carbon Film	$\frac{1}{4}$W	5%	927189
R125	56	Carbon Film	$\frac{1}{4}$W	5%	927877
R126	390	Carbon Film	$\frac{1}{4}$W	5%	927878
R127	1K5	Carbon Film	$\frac{1}{4}$W	5%	926556

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
R128	56	Carbon Film	¼W	5%	927877
R129	1K	Carbon Film	¼W	5%	926554
R130	220	Carbon Film	¼W	5%	926546
R131	22K	Carbon Film	¼W	5%	926566
R132	22K	Carbon Film	¼W	5%	926566
R133	4K7	Carbon Film	¼W	5%	924689
R134	4K7	Carbon Film	⅓W	5%	924689
R135	1K	Carbon Film	⅓W	5%	924680
R136	100K	Carbon Film	¼W	5%	926569
R137	1K	Carbon Film	¼W	5%	926554
R138	100	Carbon Film	¼W	5%	927189
R139	220	Carbon Film	¼W	5%	926546
R140	68	Carbon Film	¼W	5%	924326
R141	150	Carbon Film	¼W	5%	926545
R142	1K2	Carbon Film	¼W	5%	924681
R143	1K	Carbon Film	¼W	5%	926554
R144	270	Carbon Film	¼W	5%	926508
R145	12k	Carbon Film	¼W	5%	927769
R146	220	Carbon Film	¼W	5%	926546
R147	47K	Potentiometer			920313
R148	8K2	Carbon Film	¼W	5%	924962
R149	47K	Potentiometer			920313
R150	4K7	Carbon Film	¼W	5%	926560
R151	4K7	Carbon Film	¼W	5%	926560
R152	10K	Carbon Film	¼W	5%	920312
R153	100	Carbon Film	¼W	5%	927189
R154	90	Carbon Film	¼W	5%	926556
R155	90	Carbon Film	¼W	5%	926556
R156	1K5	Carbon Film	¼W	5%	926556
R157	270	Carbon Film	¼W	5%	926508
R158	1K5	Carbon Film	¼W	5%	926556
R159	270	Carbon Film	¼W	5%	926508
R160	56	Carbon Film	¼W	5%	927877
R161	56	Carbon Film	¼W	5%	927877
R162	1K5	Carbon Film	¼W	5%	926556
R163	10K	Carbon Film	¼W	5%	920312
R164	10K	Carbon Film	¼W	5%	920312
R165	15K	Carbon Film	¼W	5%	927986

Capacitors

C1	1nF	Ceramic Plate	100V	10%	924031
C2	1nF	Ceramic Plate	100V	10%	924031
C3	1nF	Ceramic Plate	100V	10%	924031
C4	10uF	Tantalum	25V	20%	923646

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C5	1nF	Ceramic Plate	100V	10%	924031
C6	1nF	Ceramic Plate	100V	10%	924031
C7	82pF	Ceramic Plate	63V	2%	923963
C8	82pF	Ceramic Plate	63V	2%	923963
C9	1uF	Tantalum Fixed	35V	+20% -50%	919635
C10	1nF	Ceramic Plate	100V	10%	924031
C11	1nF	Ceramic Plate	100V	10%	924031
C12	1nF	Ceramic Plate	100V	10%	924031
C13	82pF	Ceramic Plate	63V	2%	923963
C14	82pF	Ceramic Plate	63V	2%	923963
C15	0.01uF	Ceramic Plate	100V	20%	927395
C16	0.01uF	Ceramic Plate	100V	20%	927395
C17	0.01uF	Ceramic Plate	100V	20%	927395
C18	0.01uF	Ceramic Plate	100V	20%	927395
C19	47uF	Tantalum Solid	16V	20%	923804
C20	0.01uF	Ceramic Plate	100V	20%	927395
C21	0.01uF	Ceramic Plate	100V	20%	927395
C22	33pF	Fixed	63V	±2%	919841
C23	10nF	Fixed	250V	+40% -20%	916187
C24	10uF	Tantalum	25V	20%	923646
C25	10nF	Fixed	250V	+40% -20%	916187
C26	0.01uF	Ceramic Plate	100V	20%	927395
C27	0.01uF	Ceramic Plate	100V	20%	927395
C28	820pf	Silver Mica	350V	2%	902183
C29	10nF	Fixed	250	+40% -20%	916187
C30	10uF	Tantalum	25V	20%	923646
C31	0.01uF	Ceramic Plate	100V	20%	927395
C32	10nF	Fixed	250V	+40% -20%	916187
C33	10nF	Fixed	250V	+40% -20%	916187
C34	0.01uF	Ceramic Plate	100V	20%	927395
C35	2.2nF	Ceramic Plate	100V	10%	924959
C36	2.2nF	Ceramic Plate	100V	10%	924959
C37	0.1uF	Tantalum Fixed		20%	916033
C38	0.01uF	Ceramic Plate	100V	20%	927395
C39	1uF	Tantalum Fixed	35V	+50% -20%	919635
C40	100pF	Ceramic	63V	±2%	919723

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C41	47nF	Ceramic Disc	25V	+25% -50	919510
C42	47uF	Electrolytic Fixed	25V	+20% -10	929699
C43	1nF	Ceramic Plate	100V	10%	924031
C44	68pF	Ceramic Plate	63V	2%	926613
C45	1nF	Ceramicon Fixed Hi-K	500V	+40% -20	920679
C46	1uF	Tantalum Fixed	35V	+50% -20	919635
C47	47uF	Tantalum Solid	16V	20%	923804
C48	47uF	Tantalum Solid	16V	20%	923804
C49	10uF	Tantalum	25V	20%	923646
C50	10uF	Tantalum	25V	20%	923646
C51	0.01uF	Polyester	100V	1%	928178
C52	0.01uF	Polyester	100V	1%	928178
C53	10uF	Tantalum	25V	20%	923646
C54	47uF	Tantalum Solid	16V	20%	923804
C55	1nF	Ceramic Plate	100V	10%	924031
C56	1nF	Ceramic Plate	100V	10%	924031
C57	0.01uF	Ceramic Plate	100V	20%	927395
C58	0.01uF	Ceramic Plate	100V	20%	927395
C59	0.01uF	Ceramic Plate	100V	20%	927395
C60	1nF	Ceramic Plate	100V	10%	924031
C61	33pF	Ceramic Plate	63V	± 2%	919841
C62	0.01uF	Ceramic Plate	100V	20%	927395
C63	10nF	Fixed	250V	+40% -20%	916187
C64	68pF	Ceramic Plate	63V	2%	926613
C65	NOT USED				
C66	NOT USED				
C67	68pF	Ceramic Plate	63V	2%	926613
C68	NOT USED				
C69	0.1uF	Tantalum Fixed		20%	916033
C70	1uF	Tantalum Fixed	35V	+50% -20	919635
C71	1uF	Tantalum Fixed	35V	+50% -20%	919635
C72	0.01uF	Ceramic Plate	100V	20%	927395
C73	1uF	Tantalum Fixed	35V	+50% -20	919635
C74	47nF	Ceramic Disc	25V	+50% -25%	919510

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C75	0.01uF	Ceramic Plate	100V	20%	927395
C76	0.01uF	Ceramic Plate	100V	20%	927395
C77	10uF	Tantalum	25V	20%	923646
C78	10uF	Tantalum	25V	20%	923646
C79	0.01uF	Ceramic Plate	100V	20%	927395
C80	0.01uF	Ceramic Plate	100V	20%	927395
C81	10nF	Fixed	250V	+40% -20%	916187
C82	0.01uF	Ceramic Plate	100V	20%	927395
C83	10uF	Tantalum	25V	20%	923646
C84	22nF	Ceramic Plate	63V	+80 -20 %	926654
C85	22nF	Ceramic Plate	63V	+80 -20 %	926654
C86	22nF	Ceramic Plate	63V	+80 -20 %	926654
C87	0.1uF	Tantalum Fixed		20%	916033
C88	0.1uF	Tantalum Fixed		20%	916033
C89	0.1uF	Tantalum Fixed		20%	916033
C90	1uF	Tantalum Fixed	35V	+50 -20 %	923646
C91	0.1uF	Tantalum Fixed		20%	916033
C92	22uF	Tantalum Fixed	16V	20%	919638
C93	22nF	Ceramic Plate	63V	+80 -20 %	926654
C94	0.01uF	Ceramic Plate	100V	20%	927395
C95	330pF	Ceramic Fixed	63V	2%	921148
C96	330pF	Ceramic Fixed	63V	2%	921148
C97	0.01 uF	Ceramic Plate	100V	20%	927395
C98	0.01uF	Ceramic Plate	100V	20%	927395
C99	0.01uF	Ceramic Plate	100V	20%	927395
C100	0.1uF	Tantalum Fixed		20%	916033
C101	0.01uF	Ceramic Plate	100V	20%	927395
C102	0.1uF	Tantalum Fixed		20%	916033
C103	150 pF	Ceramic Fixed		2%	919648
C104	10uF	Tantalum	25V	20%	923646
C105	47uF	Tantalum Solid	16V	20%	923804
C106	68pF	Ceramic Plate	63V	2%	926613
C107	10uF	Tantalum	25V	20%	923646
C108	10uF	Tantalum	25V	20%	923646
C109	0.01uF	Ceramic Plate	100V	20%	927395
C110	0.01uF	Ceramic Plate	100V	20%	927395
C111	0.01uF	Ceramic Plate	100V	20%	927395
C112	0.01uF	Ceramic Plate	100V	20%	927395

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C113	0.01uF	Ceramic Plate	100V	20%	927395
C114	10nF	Fixed	250V	+40% -20	916187
C115	10nF	Fixed	250V	+40% -20	916187
C116	330pF	Fixed Ceramic	63V	2%	921148
C117	330pF	Fixed Ceramic	63V	2%	921148
C118	0.01uF	Ceramic Plate	100V	20%	927395
C119	10nF	Fixed	250V	+40% -20	916187
C120	10nF	Fixed	250V	+40% -20	916187
C121	10nF	Fixed	250V	+40% -20	916187

Diodes

D1	Zener BZY88 C5 V6	912747
D2	IN4149	914898
D3	BA182	921781
D4	Zener BZY88 C3 V3	912567
D5	IN4149	914898
D6	NOT USED	
D7	IN4149	914898
D8	IN4149	914898
D9	IN4149	914898
D10	IN4149	914898
D11	BA182	921781
D12	BA182	921781
D13	BA182	921781
D14	Zener BZY88 C3 V3	912567
D15	IN4149	914898
D16	Zener BZY88 C4 V7	914067
D17	IN4149	914898
D18	IN4149	914898
D19	IN4149	914898
D20	BA182	921781
D21	IN4149	914898
D22	IN4149	914898
D23	IN4149	914898
D24	IN4149	914898
D25	IN4149	914898
D26	IN4149	914898
D27	IN4149	914898
D28	IN4149	914898
D29	IN4149	914898
D30	IN4149	914898

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
D31		IN4149			914898
D32		IN4149			914898
D33		IN4149			914898
D34		IN4149			914898
D35		IN4149			914898
D36		IN4149			914898
D37		IN4149			914898

Transistors

TR1		ZTX237			923171
TR2		ZTX237			923171
TR3		TIP32A			922809
TR4		W300B			922990
TR5		W300B			922990
TR6		ZTX237			923171
TR7		ZTX212			923172
TR8		ZTX237			923171
TR9		ZTX237			923171
TR10		BFR81			926951
TR11		ZTX237			923171
TR12		ZTX237			923171
TR13		ZTX237			923171
TR14		ZTX237			923171
TR15		ZTX237			923171
TR16		ZTX212			923172
TR17		2N3866			917219
TR18		2N3866			917219
TR19		BFX48			915231
TR20		BFX48			915231
TR21		2N2369			906842
TR22		2N2369			906842
TR23		E176			927889
TR24		ZTX237			923171

Integrated Circuits

ML1		MC1350			925875
ML2		MC1496G			919747
ML3		MC1350			925875
ML4		MC1496G			919747
ML5		CR711514			711514
ML6		CR711476			711476
ML7		SN72741P			920327

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
ML8		MC1496G			919747
ML9		CD4066AE			927894
ML10		CD4011AE			922994
ML11		CA3054			927893
ML12		CR711515			711515
ML13		CR711465			711465
BM1		MD108			927892

Relays

RL1		RS12V			920577
RL2		RS12V			920577

Filters

FL1		BR711469			711469
FL2		BR711468			711468
FL3		BR711118			711118
FL4		BR711120			711120

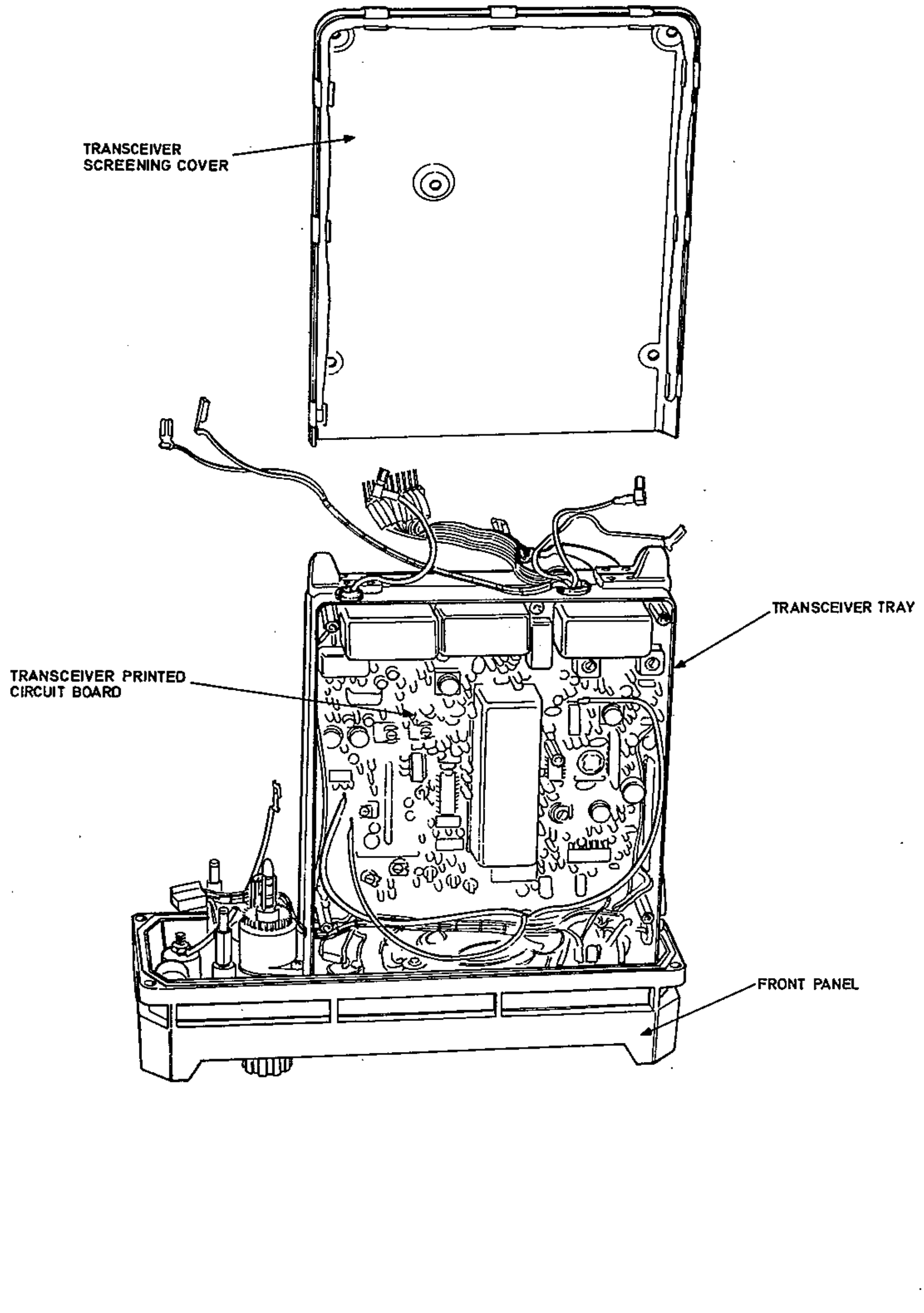
Inductors

L1	68uH		10%		928488
L2		AT710377			710377
L3		Ferrite bead FX115			900461
L4		AT710377			710377
L5		AT710376			710376
L6	10uH		10%		926238
L7	10uH		10%		926238
L8	100uH				926858
L9	1mH				926330
L10	1mH				926330

Transformers

T1					710375
T2					710376
T3					710377
T4					710378
T5					710379
T6					710380
T7					710381

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Thermistors					
TH1	470ohms	Disc	0.6W		928370
TH2	470ohms	Disc	0.6W		928370



Location of Transceiver Sub-Assembly Fig.1

PART 3

719074 POWER AMPLIFIER
AND
FILTER SUB-ASSEMBLY

PART 3

719074 POWER AMPLIFIER AND FILTER SUB-ASSEMBLY

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

(See individual Chapter Contents pages for in-text illustrations)

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 1

GENERAL DESCRIPTION

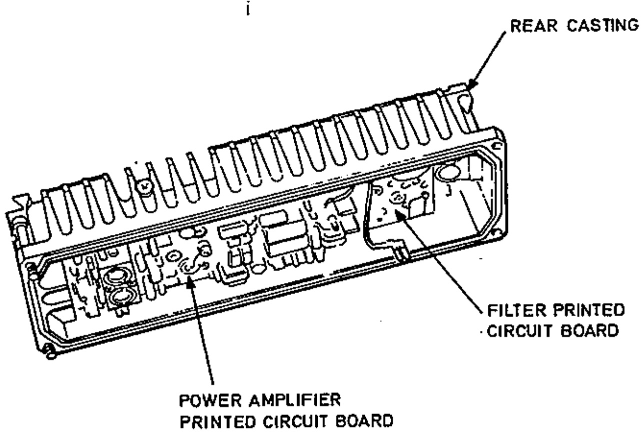
1. INTRODUCTION

1.1 The 719074 power amplifier and filter sub-assembly is designed to operate in conjunction with the transceiver sub-assembly. When operating in the transmit mode, the power amplifier provides 10W (high power) or 2.5W (low power) r.f. output from the transceiver 100mW input In the receive mode, the receiver signal is filtered and fed via a protection circuit to the r.f. input of the transceiver sub-assembly.

1.2 A circuit is also included to protect the complete transceiver from excessively high or reverse polarity supply voltages.

2. CONSTRUCTION AND LOCATION

2.1 The power amplifier and filter sub-assembly is contained in the casting at the rear of the set and comprises two printed circuit boards. The power amplifier p.c.b. has dimensions 135 x 60 mm and the filter p.c b. has dimensions 60 x 41 mm.



Location Power Amplifier and Filter Board Sub-Assembly Fig. 1·1

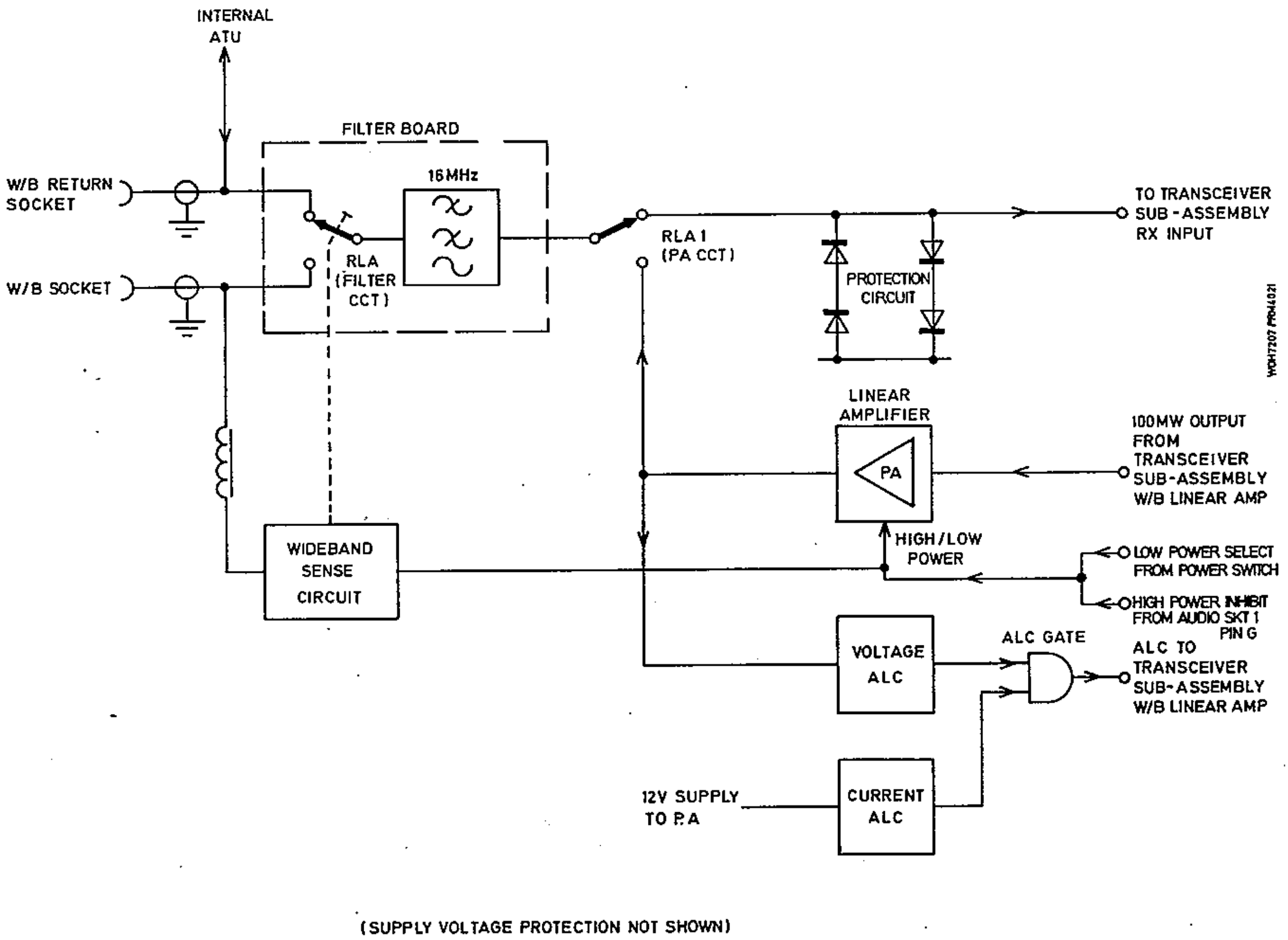
2.2 The sub-assembly is located within the unit as shown in fig.1.1.

3. PRINCIPLES OF OPERATION

3.1 In the transmit condition, the 100mW output from the transceiver sub-assembly is applied to the input of the power amplifier. This is a linear amplifier with a high or low output power, determined by the setting of the front panel Power switch and by the wideband sense circuit.

3.2 The output of the linear amplifier is filtered by the 16MHz low-pass filter to ensure that out-of-band signals are attenuated. The output from the filter is applied either to the internal antenna tuning unit (ATU), (see Part 4 of this handbook) or to the W/B socket, as selected by the wideband sense circuit.

3.3 The wideband sense circuit monitors the impedance presented to the W/B socket. If an external r.f. amplifier or remote ATU is connected a resistance is present between centre pin and ground. This is detected and the output from the 16MHz low-pass filter is switched to the W/B socket. The connection of an RF amplifier automatically sets the transmitter to the low power output condition, regardless of the position of the front panel POWER switch.
The low power condition is also obtained when an ATU, directly connected to the W/B socket, is in the process of tuning.



RACAL WOH7207

Power Amplifier and Filter Board Sub-Assembly Block Diagram Fig.1.2

3.4 Automatic level control (ALC) circuits monitor the power amplifier. If the output voltage swing becomes too great or the current drain excessive an ALC signal is fed back to the transceiver sub-assembly to reduce the output of the wideband linear amplifier.

3.5 In the receive condition, the received r.f. signal is filtered by the 16MHz low-pass filter and fed via a diode protection circuit, which prevents high level r.f. signals reaching the transceiver sub-assembly r.f. input.

3.6 A power supply protection circuit (not shown on fig.1.2) monitors the 12V power input to the complete transceiver unit. If this exceeds a predetermined level the supply is short-circuited causing the fuse to blow. Similarly, if the power supply is connected the wrong way round the supply is short-circuited and the fuse blows.

CHAPTER 2

CIRCUIT DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 2

CIRCUIT DESCRIPTION

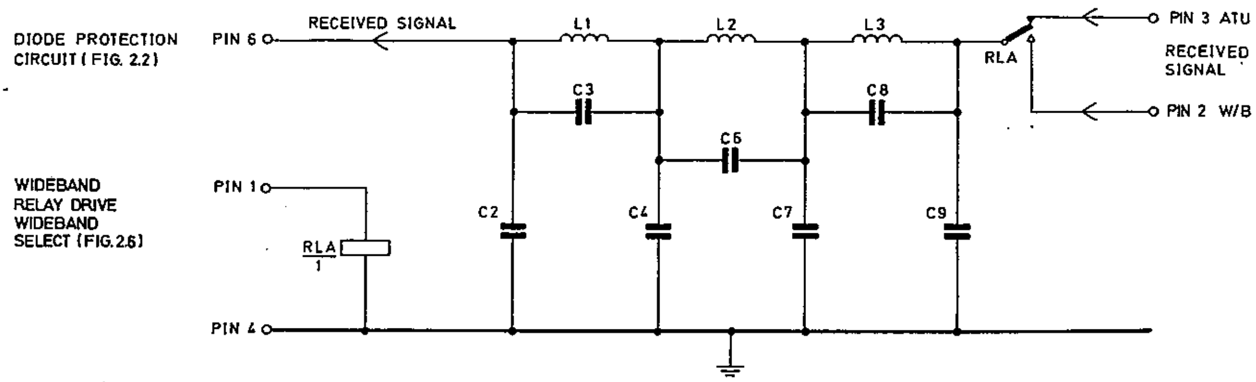
1. INTRODUCTION

1.1 This chapter describes the circuits that comprise the power amplifier and filter sub-assembly. The operation in both the receive and transmit conditions and the function of the power supply protection circuit are described. A complete circuit diagram is given at the rear of this part of the handbook.

2. RECEIVE CONDITION

3. 16MHz Low-Pass Filter (Fig.2.1)

3.1 The received signal from the internal antenna tuning unit or from the W/B return socket is applied via the contact of RLA on the filter board to the 16MHz low-pass filter. This is an L-C network comprising L1 to L3 and C2 to C9, designed to have an impedance of 50Ω over the frequency range of the set. Relay RLA is controlled by the wideband sense circuit.

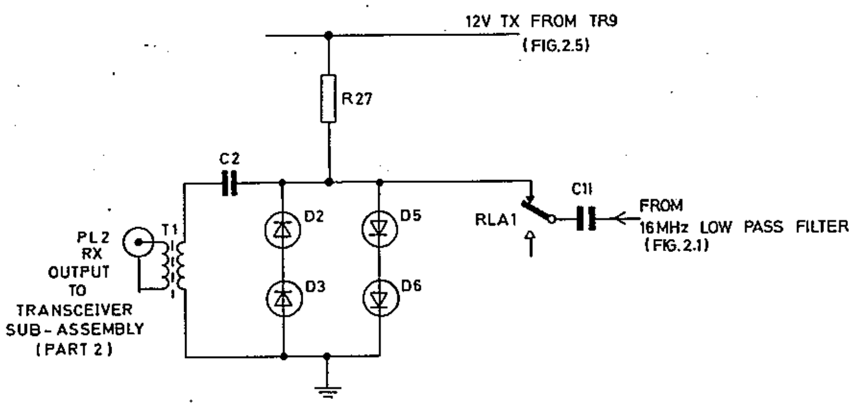


16 MHz Low-Pass Filter Circuit (Receive Condition) Fig. 2.1

4. Diode Protection Circuit (Fig.2.2)

4.1 The output from the 16MHz low-pass filter is applied via C11, the contact of RLA (PA board) and C2 to the primary of transformer T1. Diodes D2, D3 and D5, D6 are connected across the primary of T1. If the signal from the filter exceeds the combined forward voltage drop of D2 and D3, or D5 and D6, the diodes conduct thereby limiting any high level r.f.signals. The output from the secondary of T1 is fed to the RX INPUT of the transceiver sub-assembly.

4.2 R27 controls the forward bias current of D5 and D6. In the transmit condition, when conducting, they effectively short the primary of T1.



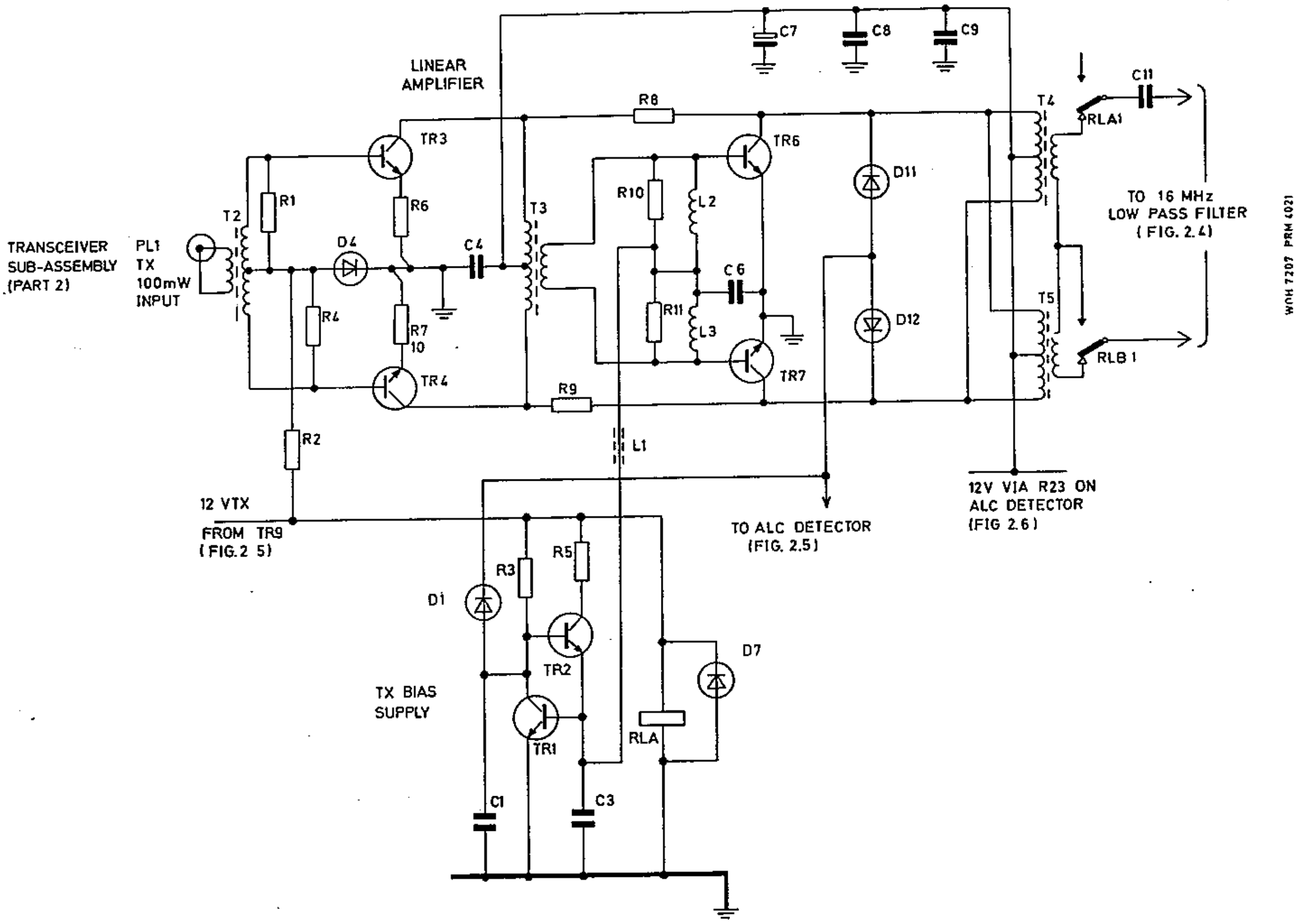
Diode Protection Circuit Fig. 2.2

5. TRANSMIT CONDITION.

6. Linear Amplifier and Bias Circuit (Fig. 2.3)

The 100mW output from the transceiver sub-assembly is applied via transformer T2 to the push-pull drivers TR3 and TR4, which produce approximately 1W power at transformer T3. R2 and D4 provide the bias for TR3 and TR4. The output of T3 is applied to the bases of TR6 and TR7, which drive transformers T4 and T5.

The output of the linear amplifier is taken from the secondaries of T4 and T5 via relay contacts RLA1 and RLB1. Relay RLA is energised by the 12V TX rail. RLB is controlled by the setting of the Power switch and the operation of the wideband select circuit (see para.2.3.4, and fig.2.6) so that, for high power operation, the amplifier output is taken from T4 and T5 secondaries in series and, for low power operation, from T4 secondary only. The amplifier output voltage swing between the collectors of TR6 and TR7 is monitored at the junction of D11 and D12 and fed to the ALC detector circuit (Fig.2.5) and to the bias supply circuit.



Linear Amplifier and TX Bias Supply Circuit Fig. 2·3

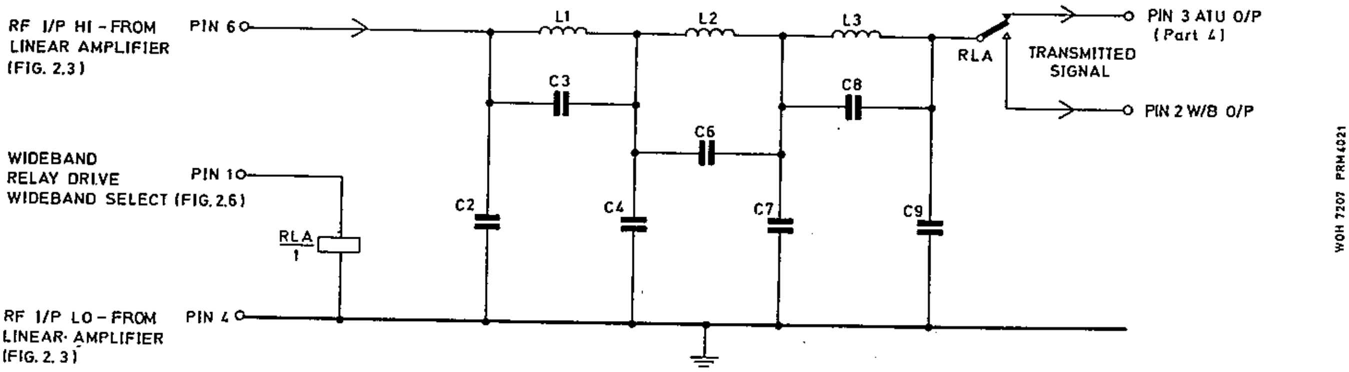
6.2 The bias supply for TR6 and TR7 is controlled by TR1 according to the current drive requirements. If no signal is applied to TR6 and TR7, their base current requirements are small. When a signal is supplied and current is drawn, more base current is required. The base voltage on TR1 tries to fall, causing TR2 to turn on harder, thus supplying more current for the bias. This system gives some saving over conventional fixed biased systems which have to sink the total base current all the time.

6.3 D1 is a fast ALC element, bypassing the conventional ALC circuits. If the output voltage swing is sufficient for the voltage at either TR6 or TR7 collector to fall below the voltage at the base of TR2, D1 and either D11 or D12 conducts and pulls TR2 base voltage down. This in turn removes the bias from TR6 and TR7, which ensure that they never operate in a saturated mode.

6.4 The power to the bias supply (12V TX) is switched by the TX/RX CONTROL from the transceiver sub-assembly via TR9 (Fig.2.5).

7 16MHz Low Pass Filter (Fig.2.4)

7.1 The output of the linear amplifier is applied to the 16MHz low-pass filter. As can be seen from the circuit, this is the same filter that is used in the receive condition, but with the input and output connections reversed. The contact of RLA feeds the output to either the internal ATU or the W/B output socket. The 22MHz cut-off frequency of the filter reduces the likelihood of the transceiver causing interference in the VHF bands.



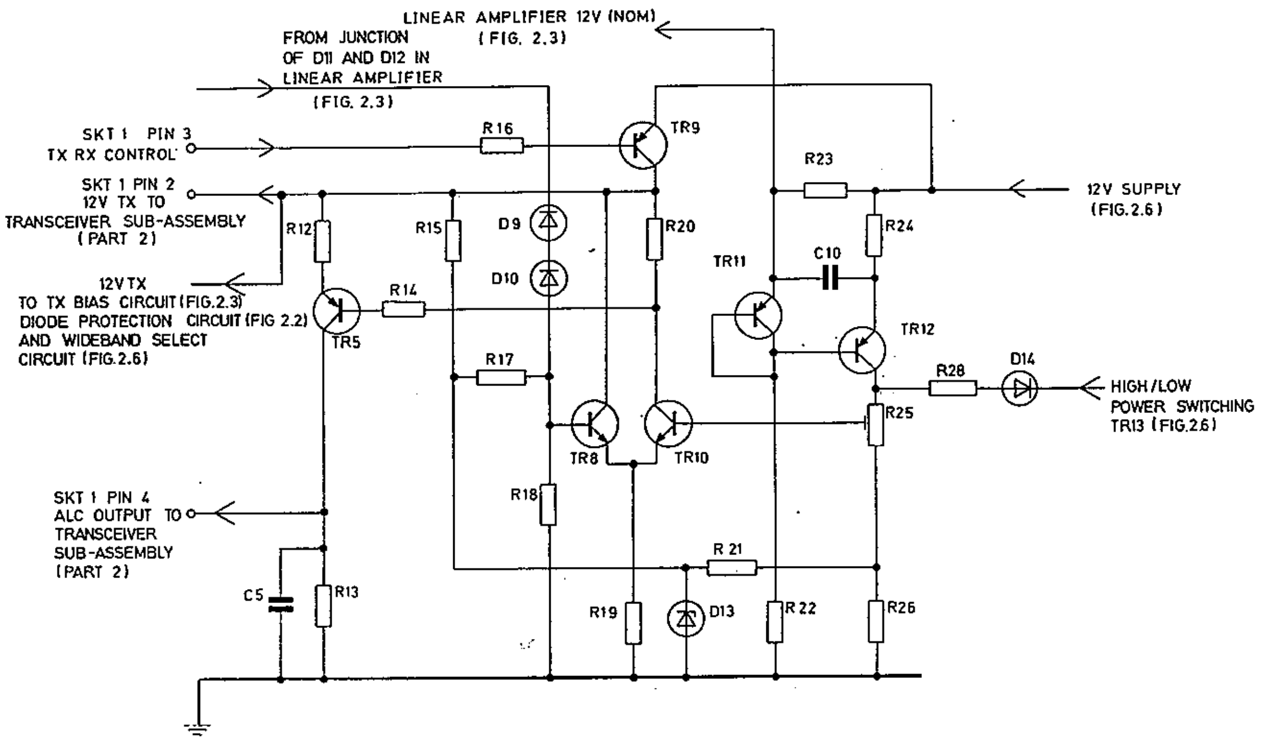
16 MHz Low-Pass Filter Circuit (Transmit Condition) Fig. 2.4

8. ALC Detector (Fig.2.5)

8.1 The automatic level control (ALC) detectors provide a control signal to determine the gain of the wideband linear amplifier in the transceiver sub-assembly (see Part 2 of the handbook). Two detector circuits are fitted, one operated by RF voltage swings, the other by current drawn by the power amplifier. The current detector prevents the power amplifier drawing excessive current when it is feeding into a short circuit. The voltage detector limits the swing when the ATU is off tune, i.e., when the p.a. is driving into a high impedance or gas circuit.

8.2 Excessive voltage swings (tending towards ground potential) are detected via D11 and D12 (Fig.2.3), then D9 and D10, by TR8 and TR10, which form a long-tailed pair differential amplifier. TR10 collector feeds the base of TR5, which provides the ALC output to the transceiver sub-assembly.

8.3 The current detector measures the voltage developed across R23, which is proportional to current drawn. TR11 provides temperature-compensated bias for TR12 which acts as the measuring element. An increase in supply current causes a corresponding increase in current through TR12. R25 sets the point at which TR10 starts to conduct thus establishing the current ALC threshold. When the transmitter is operating on low power, the same voltage swing limits apply, but the current limit is altered by switching off TR13 (Fig.2.6) which removes R28 from the potential divider.

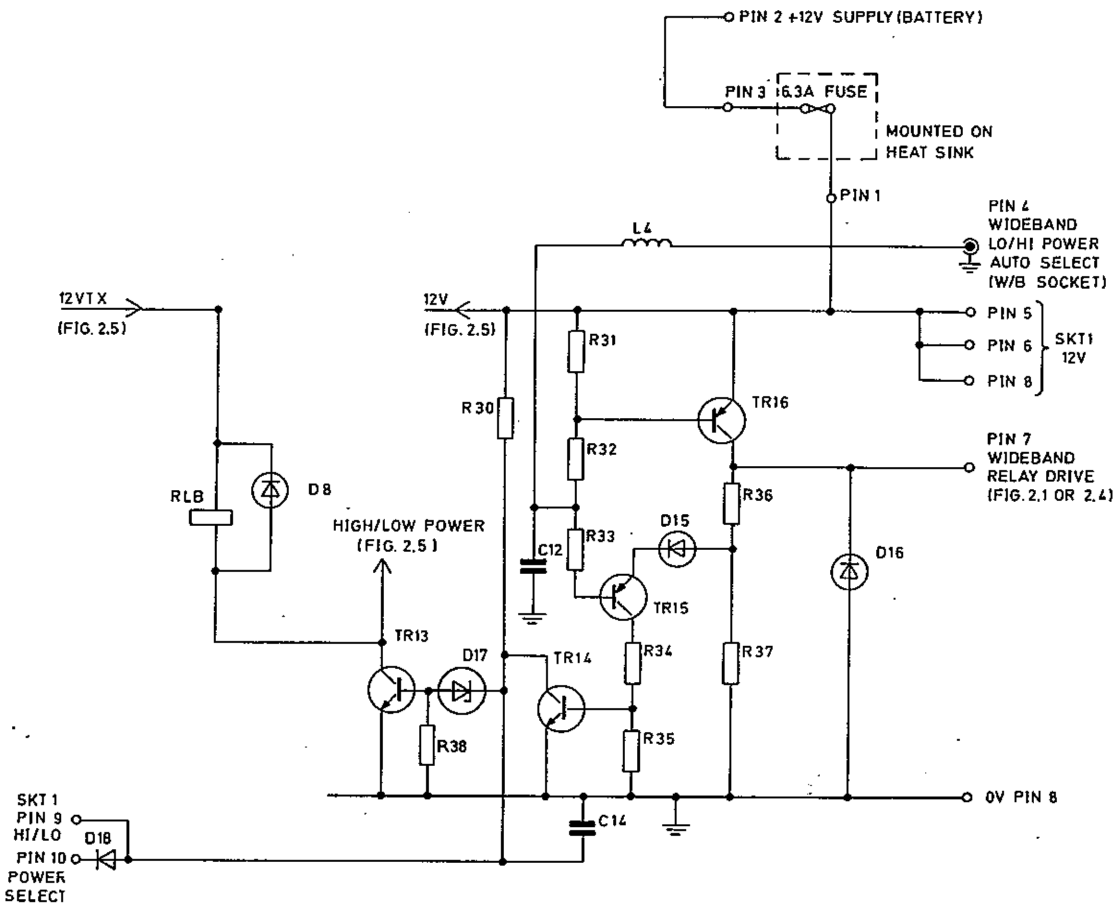


ALC Detector Circuit Fig. 2.5

The power for the ALC circuit (12V TX) is provided from the 12V rail via TR9.

9. Wideband Select (Fig.2.6)

9.1 The wideband select circuit monitors the d.c. impedance presented to the W/B output socket. The impedance is measured through L4, an r.f. blocking choke, and determines the output power of the linear amplifier and whether the output is fed to the W/B output socket or the ATU. In the following description, it is assumed that the front panel Power switch is in the HP position. When in the LP position, TR13 is on and RLB is de-energised so that the power output of the linear amplifier is always low.



Wideband Select Circuit Fig. 2.6

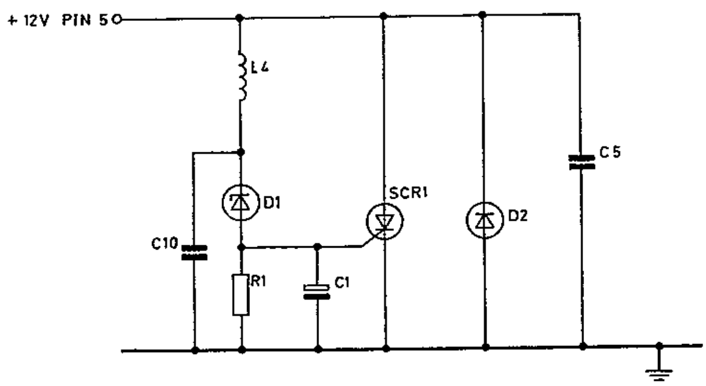
9.2 Resistors R31, R32 and R33 form a potential divider. When the W/B socket is open circuit TR15 and TR16 are reverse biased and are therfore off. D15 protects the base-emitter junction of TR15 in the reverse bias condition. TR15 holds TR14 off, so that TR13 is on and RLB is energised. The wideband relay (RLA on the filter board) connects the output from the 16MHz filter to the internal ATU and RLB switches the linear amplifier output to the high power configuration.

9.3 If a d.c. impedance of 10k ±50% is connected across the W/B socket the junction of R31 and R32 is pulled sufficiently towards ground potential to forward bias TR16, which is therefore switched on. The junction of R36 and R37 rises to approximately 6V but TR15 is still reversed biased so remains off. Power is applied by TR16 to the wideband relay coil, causing the transmitter output to be switched to the W/B output socket. RLB holds the amplifier output high.

9.4 If a d.c. impedance of less than approximately 3.0k is connected across the W/B socket, TR16 is again switched on, so that the junction of R36 and R37 rises to approximately 6V. The base of TR15 is pulled sufficiently towards ground potential for the transistor to be switched on, thereby switching on TR14. TR13 switches RLB off, setting the amplifier output power to low power. The wideband relay is energised by TR16, switching the transmitter output to the W/B socket at the low power level.

10. POWER SUPPLY PROTECTION CIRCUIT (Fig.2.7)

10.1 The power supply for the complete transceiver is fed via the protection circuit and is a nominal 12 volts. If the supply voltage exceeds 18 volts, the limit determined by D1, SCR1 is triggered, thereby shorting the supply and causing the line fuse to blow. If the supply is inadvertently connected the wrong way round D2 conducts and also causes the line fuse to blow.



Power Supply Protection Circuit Fig.2.7

CHAPTER 3

FAULT LOCATION AND ADJUSTMENT

CONTENTS

CHAPTER 3

FAULT LOCATION AND ADJUSTMENT

1. INTRODUCTION

1.1 This chapter provides a brief guide to fault-finding in the power amplifier sub-assembly and details of the adjustment procedure.

2. TEST EQUIPMENT (See Part 1, Chapter 5 for detailed information)

2.1
(1) RF Power meter
(2) AF signal generator
(3) Multimeter
(4) Oscilloscope
(5) Power supply
(6) RF adaptor lead TJ289
(7) Adaptor box TJ290
(8) Tool Kit

3. ACCESS TO PRINTED CIRCUIT BOARDS

3.1 The method of access to the power amplifier and filter boards is given in Part 1, Chapter 7 of this handbook.

4. FAULT LOCATION

4.1 A power amplifier fault may be traced to the power amplifier sub-assembly using the transmitter fault location chart (Part 1, Chapter 4, Table 2). A number of typical waveforms and voltages are given on the circuit diagrams at the end of this part of the handbook. Using items of test equipment from the list in para.3.2 this information should facilitate the location of the faulty component(s).

5. ADJUSTMENT

5.1 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.

(1) Connect the 12V d.c. power supply to the front panel audio socket 2. Connect the adaptor box TJ290 to audio socket 1. Set the TX/RX switch on the adaptor box to TX.

(2) Connect the r.f. power meter to the rear casting wideband (W/B) socket.

(3) Set the frequency selection switches to 15.999MHz. Set the Mode switch to TUNE. Note that there is a 1kHz tone at the AF output. Set the Power switch to HP.

(4) Adjust R25 on the power amplifier board for a power reading of 10W.

(5) Check that the total power supply current does not exceed 3.0A.

CHAPTER 4

COMPONENTS LIST

Cct. Ref.	Value	Description	Rat.	Tol %	Racal Part Number
POWER AMPLIFIER PC BOARD					
R1	220	Carbon Film	¼W	5%	926546
R2	560	Carbon Film	¼W	5%	926547
R3	1K2	Carbon Film	¼W	5%	926555
R4	220	Carbon Film	¼W	5%	926546
R5	47	Metal Oxide		5%	907495
R6	10	Carbon Film	¼W	5%	926544
R7	10	Carbon Film	¼W	5%	926544
R8	220	Metal Oxide		2%	909549
R9	220	Metal Oxide		2%	909549
R10	10	Carbon Film	¼W	5%	926544
R11	11	Carbon Film	¼W	5%	926544
R12	100	Carbon Film	¼W	5%	927189
R13	3K3	Carbon Film	¼W	5%	924580
R14	100	Carbon Film	¼W	5%	927189
R15	220	Carbon Film	¼W	5%	926546
R16	1K	Carbon Film	¼W	5%	926554
R17	8K2	Carbon Film	¼W	5%	926563
R18	5K6	Carbon Film	¼W	5%	926561
R19	3K3	Carbon Film	¼W	5%	924580
R20	2K2	Carbon Film	¼W	5%	927192
R21	2K7	Carbon Film	¼W	5%	926558
R22	6K8	Carbon Film	¼W	5%	926562
R23	0.1	Wire Wound	2.5W	10%	921359
R24	220	Carbon Film	¼W	5%	926546
R25	4K7	Potentiometer			920311
R26	470	Carbon Film	¼W	5%	927879
R27	10K	Carbon Film	¼W	5%	926564
R28	4K7	Carbon Film	¼W	5%	926560
R29	Not Used				
R30	5K6	Carbon Film	¼W	5%	926561
R31	4K7	Carbon Film	¼W	5%	926560
R32	4K7	Carbon Film	¼W	5%	926560
R33	4K7	Carbon Film	¼W	5%	926560
R34	1K	Carbon Film	¼W	5%	926544
R35	10K	Carbon Film	¼W	5%	926564
R36	10K	Carbon Film	¼W	5%	926564

Cct. Ref.	Value	Desctiption	Rat.	Tol %	Racal Part Number
R37	10K	Carbon Film	¼W	5%	926564
R38	1K5	Carbon Film	¼W	5%	970185

Capacitors

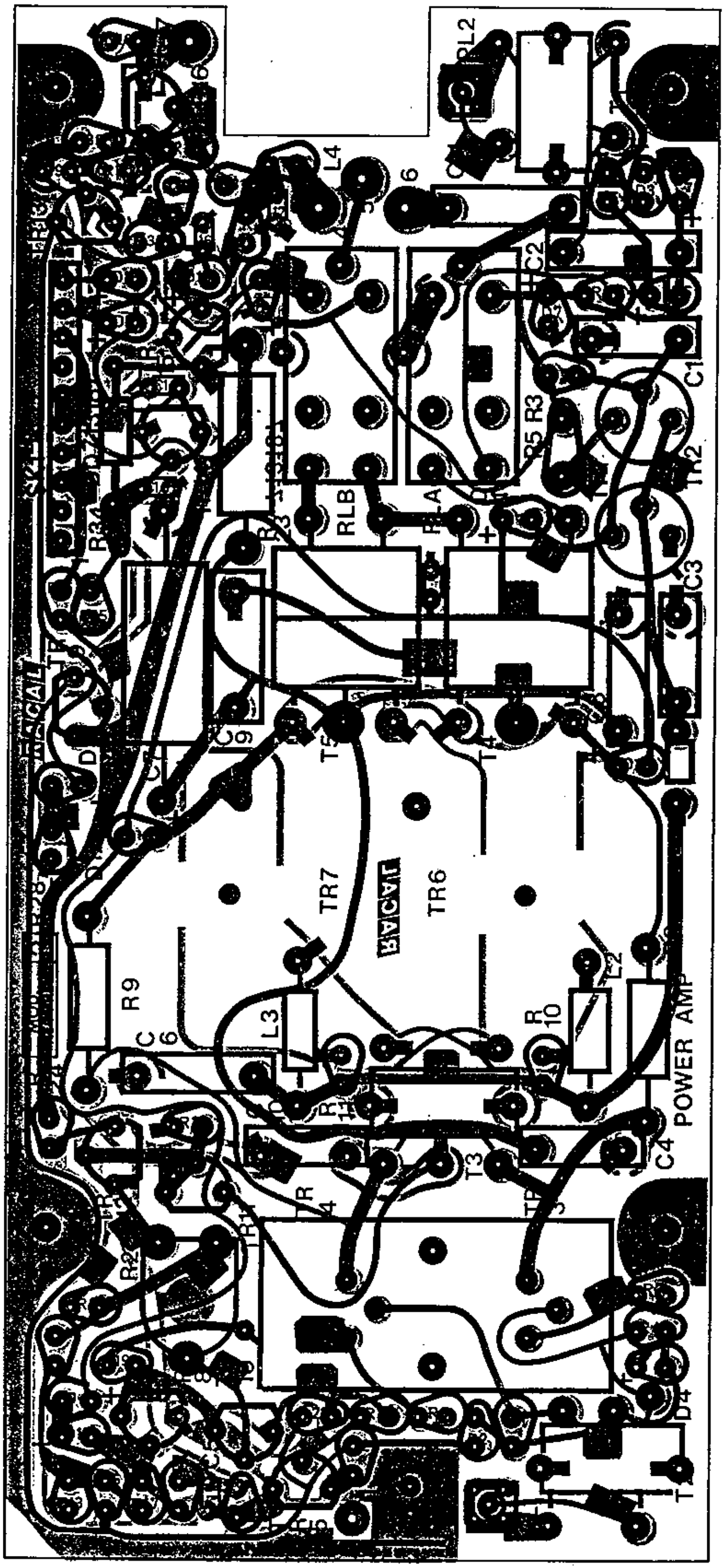
C1	47nF	Polyester	100V	10%	919634
C2	100nF	Polyester	100V	10%	920566
C3	47nF	Polyester	100V	10%	919634
C4	47nF	Polyester	100V	10%	919634
C5	0.01µF	Ceramic		20%	927395
C6	100nF	Polyester	100V	10%	920566
C7	33µF	Tantalum	20V	20%	925962
C8	220nF	Polyester	100V	5%	920142
C9	220nF	Polyester	100V	5%	920142
C10	47nF	Polyester	100V	10%	919634
C11	100nF	Polyester	100V	10%	920566
C12	0.01µF	Ceramic		20%	927395
C13	Not Used				
C14	0.01µF	Ceramic		20%	927395
C15	0.01µF	Ceramic		20%	927395
C16	0.01µF	Ceramic		20%	927395
C17	0.01µF	Ceramic		20%	927395

Diodes

D1		IN 4149			914898
D2		IN 4149			914898
D3		IN 4149			914898
D4		IN 4149			914898
D5		BA 243			923106
D6		BA 243			923106
D7		IN 4149			914898
D8		IN 4149			914898
D9		IN 4149			914898
D10		IN 4149			914898
D11		IN 4149			914898
D12		IN 4149			914898
D13		BZY88C9V1			914899
D14		IN 4149			914898
D15		IN 4149			914898
D16		IN 4149			914898
D17		IN 4149			914898
D18		IN 4149			914898
D19		BZY88C3V3			912567

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
Transistors					
TR1		BFY 51			908753
TR2		BFY 51			908753
TR3		2N 3866			917219
TR4		2N 3866			917219
TR5		ZTX 212			923172
TR6) TR7)	Supplied as matched pair				AR 711548
TR8		ZTX 237			923171
TR9		BFR 81			926951
TR10		ZTX 237			923171
TR11		ZTX 212			923172
TR12		ZTX 212			923172
TR13		ZTX 237			923171
TR14		ZTX 237			923171
TR15		ZTX 212			923172
TR16		ZTX 212			923172
Relays					
RLA		RS 12V			920577
RLB		RS 12V			920577
Inductors					
L1		Ferrite Bead			907488
L2	1μH	Inductor		10%	926326
L3	1μH	Inductor		10%	926326
L4	100μH	Inductor		10%	926858
Transformers					
T1		CT 710385			710385
T2		CT 710386			710386
T3		CT 710387			710387
T4		CT 710388			710388
T5		CT 710388			710388

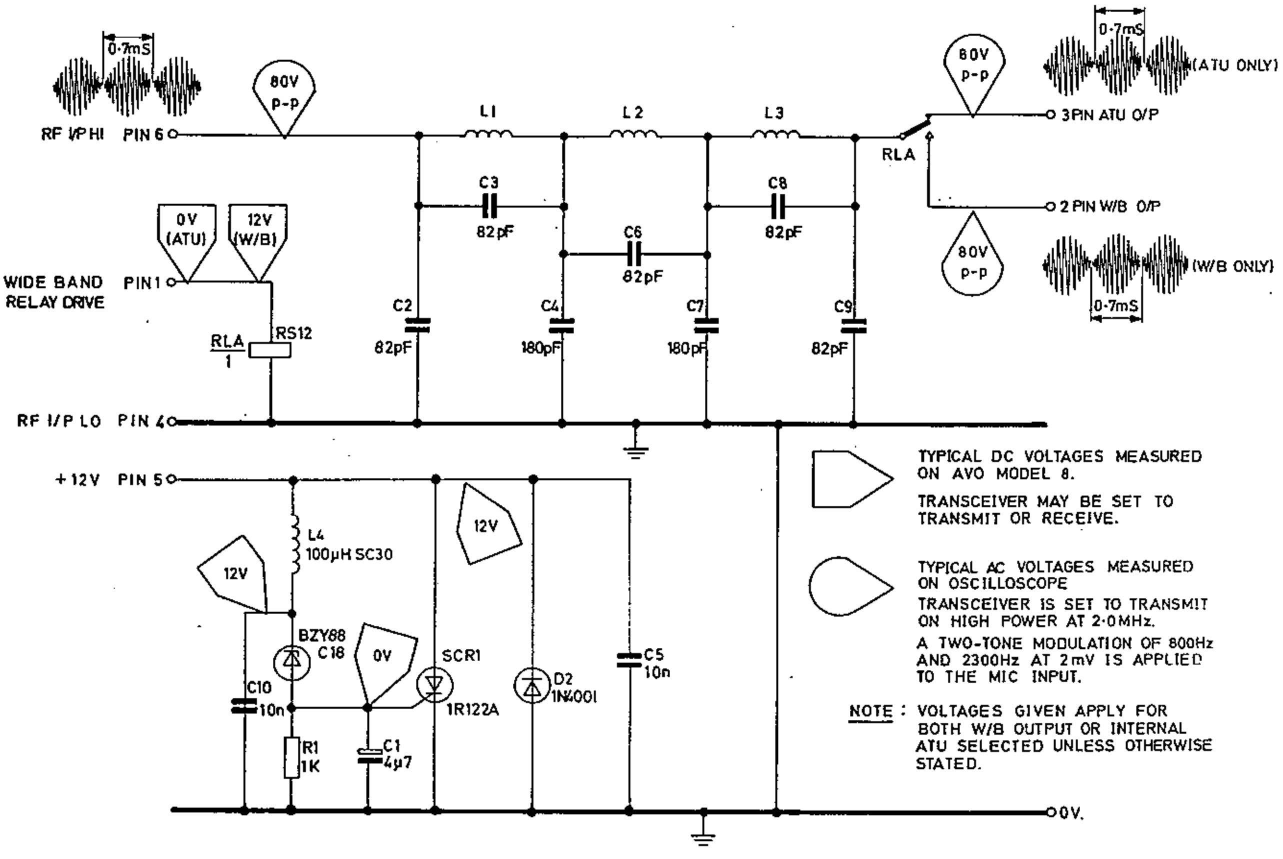
Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
FILTER PC BOARD					
Resistors					
R1	1K	Carbon Film	¼W	5%	926554
Capacitors					
C1	4.7μF	Tantalum	16V	20%	919636
C2	82pf	Silver Mica	350V	2%	902159
C3	82pf	Silver Mica	350V	2%	902159
C4	180pf	Silver Mica	350V	2%	902167
C5	0.01μF	Ceramic	-	20%	927395
C6	82pf	Silver Mica	350V	2%	902159
C7	180pf	Silver Mica	350V	2%	902167
C8	82pf	Silver Mica	350V	2%	902159
C9	82pf	Silver Mica	350V	2%	902159
C10	0.01μF	Ceramic	-	20%	927395
Diodes					
D1		BZY88-C18			915920
D2		IN 4001			915266
Relays					
RLA		RS 12V			920577
Inductors					
L1		Inductor			710384
L2		Inductor			710384
L3		Inductor			710384
L4	100μH	Inductor		10%	926858
Thyristors					
SCR1		IR 122A			927965



WOH7207 DD713187
3

Layout : 719074 Power Amplifier PC Board

Fig. 2



TYPICAL DC VOLTAGES MEASURED ON AVO MODEL 8.
TRANSCEIVER MAY BE SET TO TRANSMIT OR RECEIVE.

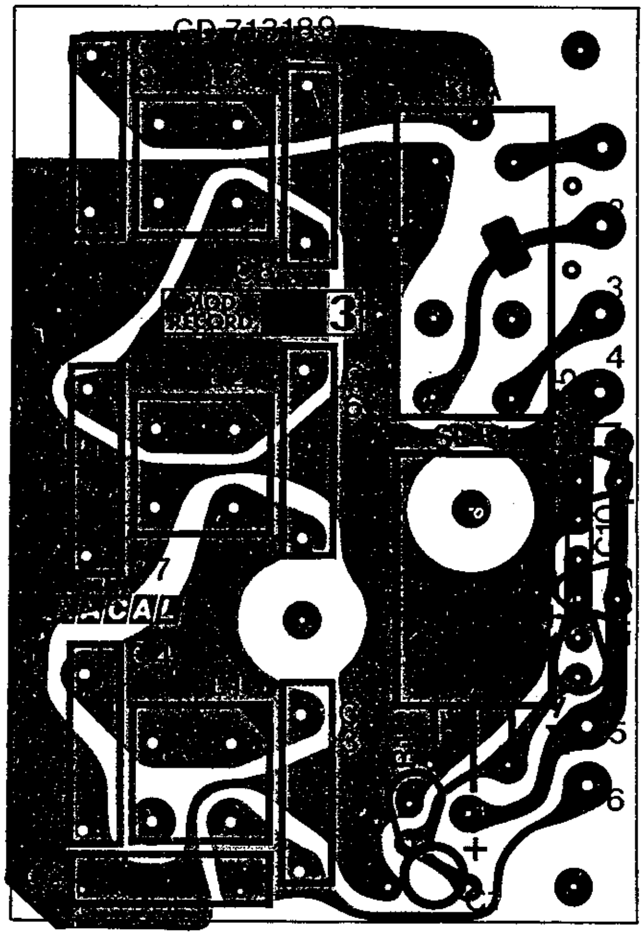
TYPICAL AC VOLTAGES MEASURED ON OSCILLOSCOPE
TRANSCEIVER IS SET TO TRANSMIT ON HIGH POWER AT 2·0MHz.
A TWO-TONE MODULATION OF 800Hz AND 2300Hz AT 2mV IS APPLIED TO THE MIC INPUT.

NOTE : VOLTAGES GIVEN APPLY FOR BOTH W/B OUTPUT OR INTERNAL ATU SELECTED UNLESS OTHERWISE STATED.

RACAL
WOH7207 BC703636
1

Circuit : 719074 Filter PC Board

Fig. 3



RACAL
WOH 7207 | CD 713189
3

Layout : 719074 Filter PC Board

Fig. 4

PART 4

719073 ANTENNA TUNING UNIT (ATU) (INCLUDING METER AND LED CIRCUIT)

PART 4

719073 ANTENNA TUNING UNIT (ATU)

(INCLUDING METER AND LED CIRCUIT)

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

(See individual Chapter Contents pages for in-text illustrations)

CHAPTER 1

DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 1

DESCRIPTION

1. INTRODUCTION

1.1 The antenna tuning unit (ATU) operates in conjunction with its associated meter and LED circuit to tune the antenna to the frequency of operation of the set. The ATU is tuned by rotation of the front panel TUNE knob in the direction indicated by the LED's incorporated in the front panel meter until both LED's are extinguished. Fine tuning is accomplished by further rotation of the TUNE knob for maximum meter deflection. The meter also provides an indication of battery condition when the front panel power switch is set to HP and the set is operating in the receive mode. The meter acts as a signal strength 'S' meter during reception when LP is selected.

2. MECHANICAL DESCRIPTION (Refer to Fig.1)

2.1 The components of the meter and l.e.d. circuit (other than the meter and LED's) are all contained on a single printed circuit board, which is mounted on the ATU. The meter with its integral LED's is mounted on the front panel of the set. The ATU is a mechanically-tuned inductance, with an associated capacitor for dipole operation, contained in a plastic frame secured to the front panel.

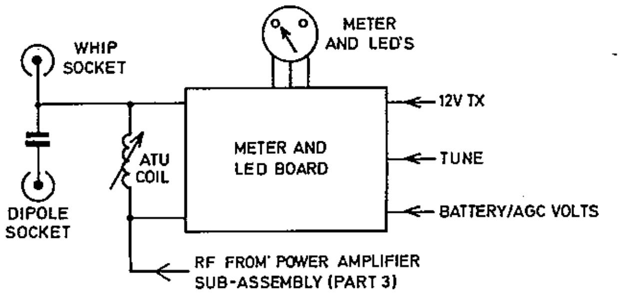
2.2 The ATU is tuned by varying the number of turns of the coil. This is accomplished by winding the wire from the coil onto a conducting metal drum. The coil and drum are geared together and are driven by the front panel knob via a clutch and gearbox assembly. The clutch is engaged by pulling out the front panel TUNE knob and the gearbox reduces the number of turns of the knob required to achieve a particular change in inductance. An idler is driven by the larger (inductance) drum and operates a string stop to prevent overwinding at either extremes of its travel. Wire tension is maintained by spring loading of the smaller drum. The electrical connections to the inductor are by means of pick-up brushes at either end. The complete assembly is secured to the front panel by circlips and the drive train incorporates a loose universal coupling to facilitate removal of the assembly.

3. CIRCUIT DESCRIPTION

3.1 A block diagram of the antenna tuning unit is given in Fig.1.1.

3.2 The ATU is a variable inductance and connects to the HI and LO pins on the meter and l.e.d. circuit board. The HI connection is connected directly to the whip socket and through a high voltage capacitor to the dipole socket; the LO connection connects to the power amplifier sub-assembly.

3.3 The circuit diagram of the meter and l.e.d. circuit is given in fig.1 at the end of this part of the handbook.



Block Diagram: Antenna Tuning Unit Fig. 1·1

3.4 The function of the meter is determined by the 12VTX and BATTERY/AGC volts inputs to the board. If 12VTX is not present TR3 conducts and TR1 is held off by TR2 so the meter will indicate the current flowing from the BATTERY/AGC input; this will be proportional to either the battery voltage or AGC voltage, depending upon the position of the power switch, HP or LP. When the TUNE mode is selected, or if the set is transmitting 12VTX will be present, this switches off TR3 and switches TR1 on so that the meter responds to voltage variations at the H1 end of the ATU coil and thus provides an indication of r.f. current. Selecting TUNE will also cause TR4 to switch on and supply power to the l.e.d. circuit, the inputs of which are connected to either end of the ATU coil. The potential divider comprising R15, R16, R17 and R18 provides biasing for ML1B and ML1C.

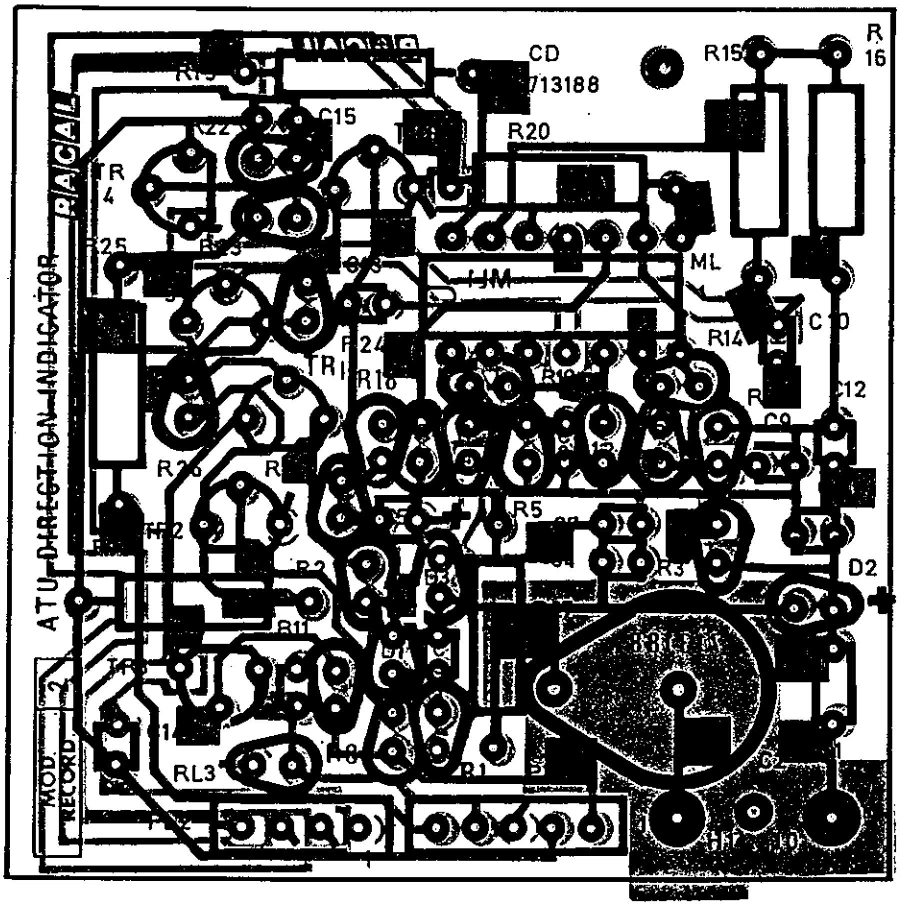
3.5 The voltages present on the HI and LO connections to the ATU are both sinewaves, of the same frequency but of different amplitude and phase. The signal at the LO terminal leads that at the HI terminal by a phase angle that varies as the ATU is tuned.

3.6. The signal at the HI terminal is half-wave rectified by D2 and summed with the sinusoidal signal at the LO terminal; the sum is applied, via a smoothing circuit, to the negative input of ML1A. As the relative phase of these two signals changes, so does the mean level presented to ML1A negative input.

3.7 When the ATU is in tune, the phase difference between the sinewaves at the HI and LO terminals is 90°. Under these circumstances, the subtractive and additive effects of the LO signal on the sum signal are equal; the resultant sum signal therefore has the same amplitude as the rectified HI signal and both inputs to ML1A are the same. The output pin of ML1A, therefore, remains at the potential determined by R15, R16, R17 and R18.

3.8 If the ATU is off tune, the phase difference between the HI and LO signals is either less than or greater than 90°. Under these circumstances, the additive and subtractive effects on the summed signal are not equal. The resultant sum signal therefore has a different amplitude from the rectified HI signal and ML1A produces a corresponding output, either above or below the central level of the potential divider R15, R16, R17 and R18, dependent on whether the ATU is set above or below the required frequency.

3.9 One input of each ML1B and ML1C is held at a level determined by the same potential divider, equally spaced about the central point. The output of ML1A is connected to the other inputs of ML1B and ML1C; if it swings beyond the level of the fixed input of either, the appropriate l.e.d. will illuminate. A portion of the ATU voltage is fed to the base of TR6. When this voltage exceeds the point where the meter reads greater than approximately quarter scale, TR6 switches off TR5 which removes the supply to ML1 via TR4 and inhibits the operation of the l.e.d. circuit.



RACAL

WOH7307	CD713188
2	

Layout : 719073 Meter and LED PC Board

Fig.3

CHAPTER 2

FAULT LOCATION

CONTENTS

ILLUSTRATIONS

CHAPTER 2

FAULT LOCATION

1. INTRODUCTION

1.1 This chapter provides information to enable a possible fault in the antenna tuning unit to be located.

2. TEST EQUIPMENT REQUIRED (See Part 1, Chapter 5 for detailed information)

(1) AF signal generator

(2) Multimeter

(3) Oscilloscope

(4) Power supply

(5) Adaptor box TJ290

(6) Tool kit

3. ACCESS TO ANTENNA TUNING UNIT

3.1 The method of access to the antenna tuning unit and its associated meter and l.e.d. printed circuit board and front panel meter is given in Part 1, Chapter 7 of this handbook.

4. FAULT LOCATION

4.1 A fault in the ATU proper will generally be self-evident, and of mechanical type. A fault in the meter or LED circuit will also be self-evident due to the mal-function of indicators. The faulty component(s) on the printed circuit boards can normally be easily detected by checking voltages as given on the circuit diagram, Fig. 1. The items of test equipment given in para. 2 should be used for location of faulty components.

5. DISMANTLING AND REASSEMBLY

5.1 If it is essential to dismantle the ATU the following procedure should be used. It is important that the correct procedure be followed and the spring within the take-up spool be correctly tensioned as given. Reference should be made to Fig. 5 of Part 6. Figures in brackets ( ) refer to legends on this Fig.

5.2 During dismantling it is important to note the locations of plain washers, PTFE washers etc. to ensure correct replacement. Do not use any lubricants on the ATU.

6. Procedure

(1) Remove the ATU from the main assembly as given in Chap. 7 of Part 1.

(2) Wind the ATU by hand until all gold braid is on the main drum. Place a piece of masking tape over the rear of the drum to retain the braid for later operations.

NOTE: 'Front' and 'rear' refer to the ATU in its normal location in the transceiver.

(3) Remove screw, nut and washers holding connection to front brush (29). Remove brush and connection.

(4) Remove screw, nut and washers (16) to (19) holding PC board. Partly slide board from ATU and unsolder one connection. Remove board.

(5) Remove screw holding connections and brush (28) at rear of ATU. Remove brush.

(6) Remove screw holding braid (39).

(7) Loosen two socket head grub screws in the rear boss of the take-off drum (24) to release internal spring tension (provide finger pressure to allow gentle 'run-down'). After tension is released, lightly tighten grub screws to prevent boss being displaced.

(8) Remove circlip (26) and PTFE washer (25) from spindle of take-off drum.

(9) Remove two socket head screws (32), washers (33) and pillars (34) holding the two housings (30) and (31) together.

NOTE: The hexagonal pillars (34) are retained in hexagonal depressions in the mouldings, and should not be rotated.

(10) Withdraw the rear housing (31) as far as allowed by the cable passing through the housings.

NOTE: Sufficient cable is available to allow normal servicing to be carried out without removing cable end connectors.

(11) Remove follower shaft (20) and follower (21).

(12) Remove screw holding braid (39) to take off drum (24).

(13) If take-off drum is to be dismantled and reassembled carry out operations (a) to (j). If not, proceed with operation (14).

(a) Remove circlip, PTFE washer and small gear wheel from front of take-off drum spindle, and remove drum from housing.

(b) Remove countersunk screw holding rear boss and pull gently apart. Lift end of spring from cross-pin.

(c) Straighten the other end of the spring where it passes through the gear wheel and remove spring.

(d) Using a new spring form the 'blank' (non-looped) end into a straight wire pointing out from the end of the spring. The end should be about 6 mm long.

(e) Feed the straight end of the spring through the hole in the gear wheel. Form the end of the spring over the lug on the gear wheel to retain in position.

(f) Partially replace the boss and place the loop at the other end of the spring over the cross-pin.

(g) Fully replace the rear boss ensuring that it seats properly against the drum. Lightly tighten the two grub screws to retain.

(h) Replace countersunk screw holding drum to boss.

(j) Replace take-off drum in front housing, replace small gear wheel, PTFE washer and circlip.

NOTE: Orientation of lugs on small gear wheel is not important.

(14) Remove circlip and PTFE washer holding spindle of drum (27) to front housing (30). Remove drum from housing.

(15) If drum is to be dismantled carry out operations (a) to (c). If not proceed with operation (16).

NOTE: The drum contains a ferrite core which can slide out and be easily damaged when an end plate is removed.

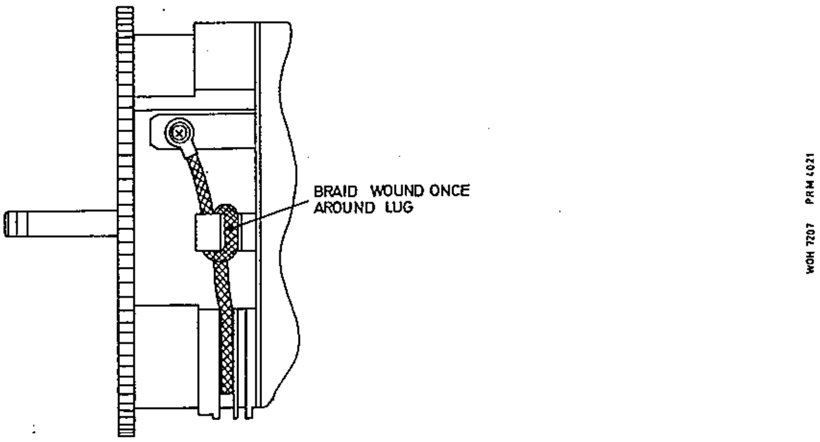
(a) Remove three self-tapping screws holding an end plate to the drum, and remove end plate. Carefully remove ferrite core.

(b) If necessary remove the other end plate.

(c) Replace the ferrite core and reassemble end plate(s).

(16) Remove screw holding braid to front of drum, remove masking tape and remove braid.

(17) Screw one end of new braid (39) to front of drum. Wrap braid once around lug on drum (See Fig. 2.1) and fully wind braid on to drum.

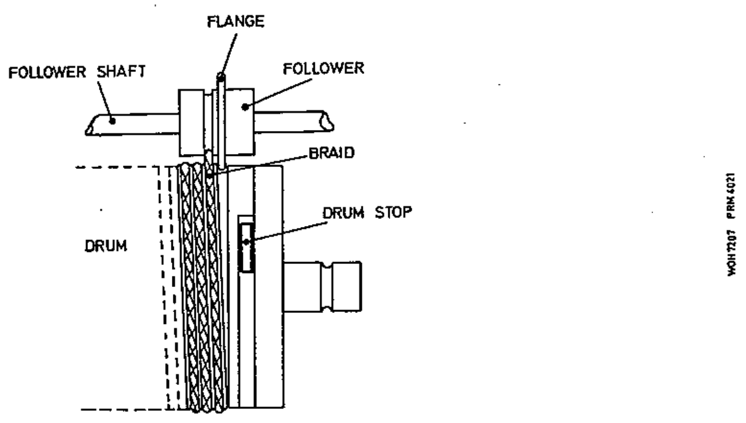


Fixing of Braid to Drum Fig. 2·1

(18) Unwind braid one turn, and retain in position using a piece of masking tape.

(19) Replace drum spindle in front housing (30), ensuring gears mesh correctly. Retain with circlip and PTFE washer.

(20) Replace follower shaft (20) and follower (21). Ensure follower is positioned with flange at rear, that flange engages with the last (empty) thread at rear of drum, that stop on drum is adjacent to follower, and that braid is correctly located on follower. (See Fig. 2.2).



Setting of ATU Rear Stop and Follower Fig.2·2

(21) Replace rear housing (31), ensuring all shafts engage in correct holes.

(22) Fasten the two housings together, using socket head screws (32) washers (33) and pillars (34).

(23) Replace PTFE washer (25) and circlip (25) on take-off drum spindle.

(24) Rotate main drum to wind on braid until drum stop engages with follower. Retain in this position using a piece of masking tape.

(25) Loosen two grub screws in the take-off drum boss.

(26) Gently pull loose braid into a loop and secure end of braid to take-off drum using a screw and crinkle washer.

(27) Carefully wind braid on to take-off drum until all 'loose' braid is taken-up, ensuring braid is close wound on rear of drum. (Drum is rotated anti-clockwise when viewed from rear of ATU).

(28) Place screwdriver in slotted end of take-off drum spindle and rotate spindle eight turns in the clockwise direction whilst holding the drum, to tension the drum spring. Without releasing tension, hold small drum forward on its shaft to create end float and tighten the two grub screws in the boss. Remove screwdriver.

(29) Manually rotate the ATU drums over their full range of travel. Check that drums and follower rotate freely, that braid is wound on and off evenly, and the end stops engage follower to avoid damage at extremes of travel.

(30) Replace rear brush (28) and cable connection, using screw, nut and crinkle washer.

(31) Partly replace PC board in guides and solder one connection. Fully replace board and secure with screw, nut and washers (16) to (19).

(32) Replace front brush (29) and connection, using screw, nut and washers.

(33) Replace the ATU in the chassis as Chap.7 of Part 1.

COMPONENTS LIST

METER AND LED PCB

Cct Ref	Value	Description	Rat	Tol %	Racal Part Number
Resistors					
R1	680	Carbon Film	$\frac{1}{4}$W	5%	924678
R2	12K	Carbon Film	$\frac{1}{4}$W	5%	926986
R3	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R4	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R5	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R6	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R7	47K	Carbon Film	$\frac{1}{4}$W	5%	926568
R8	100K	Carbon Film	$\frac{1}{4}$W	5%	926569
R9	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R10	1K	Carbon Film	$\frac{1}{4}$W	5%	926554
R11	100K	Carbon Film	$\frac{1}{4}$W	5%	926569
R12	120K	Carbon Film	$\frac{1}{4}$W	5%	925879
R13	4K7	Carbon Film	$\frac{1}{4}$W	5%	926560
R14	120K	Carbon Film	$\frac{1}{4}$W	5%	925879
R15	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R16	4K7	Carbon Film	$\frac{1}{4}$W	5%	926560
R17	4K7	Carbon Film	$\frac{1}{4}$W	5%	926560
R18	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R19	680	Metal Oxide Fixed	$\frac{1}{2}$W	5%	906345
R20	680	Metal Oxide Fixed	$\frac{1}{2}$W	5%	906345
R21	15K	Carbon Film	$\frac{1}{4}$W	5%	924695
R22	1K5	Carbon Film	$\frac{1}{4}$W	5%	926556
R23	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R24	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R25	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R26	100K	Carbon Film	$\frac{1}{4}$W	5%	926569
R27	10K	Carbon Film	$\frac{1}{4}$W	5%	926564
R28	2K7	Carbon Film	$\frac{1}{4}$W	5%	925749
Capacitors					
C1	2.2pF	Ceramic Disc	200V	±0.5pF	908829
C2	2pF	Ceramic Disc	4KV	20%	920558
C3	10pF	Ceramic Plate	63V	±2%	921130
C4	33pF	Ceramic Plate	63V	±2%	919841
C5	10nF	Ceramic Plate	100V	20%	927395

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
C6	33pF	Ceramic Plate	63V	±2%	919841
C7	33pF	Ceramic Plate	63V	±2%	919841
C8	10nF	Ceramic Plate	100V	20%	927395
C9	10nF	Ceramic Plate	100V	20%	927395
C10	10nF	Ceramic Plate	100V	20%	927395
C11	10nF	Ceramic Plate	100V	20%	927395
C12	10nF	Ceramic Plate	100V	20%	927395
C13	10nF	Ceramic Plate	100V	20%	927395
C14	10nF	Ceramic Plate	100V	20%	927395
C15	10nF	Ceramic Plate	100V	20%	927395

Diodes

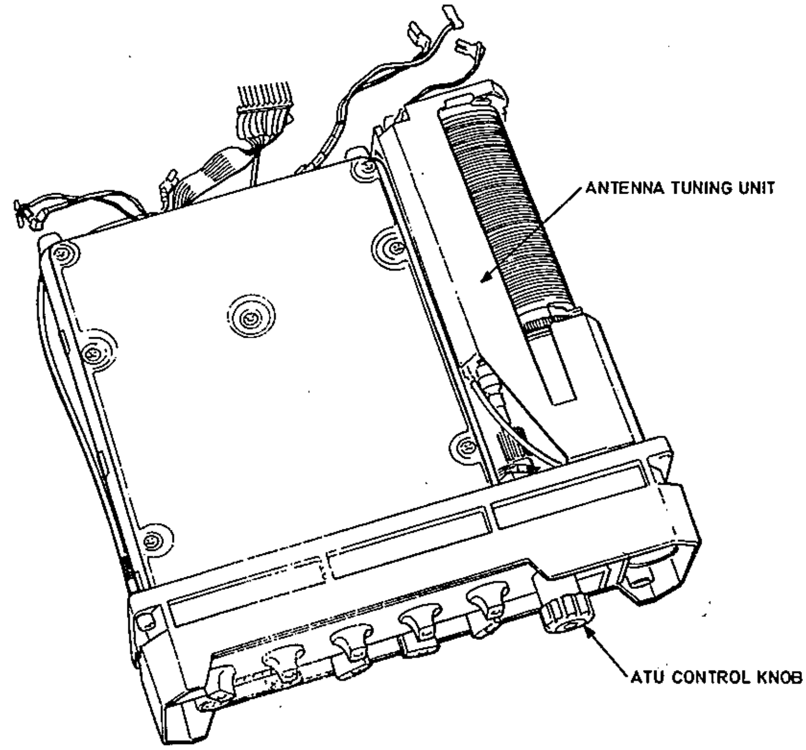
D1		IN4149			914898
D2		IN4149			914898
D3		IN4149			914898
D4		IN4149			914898
D5		IN4149			914898

Transistors

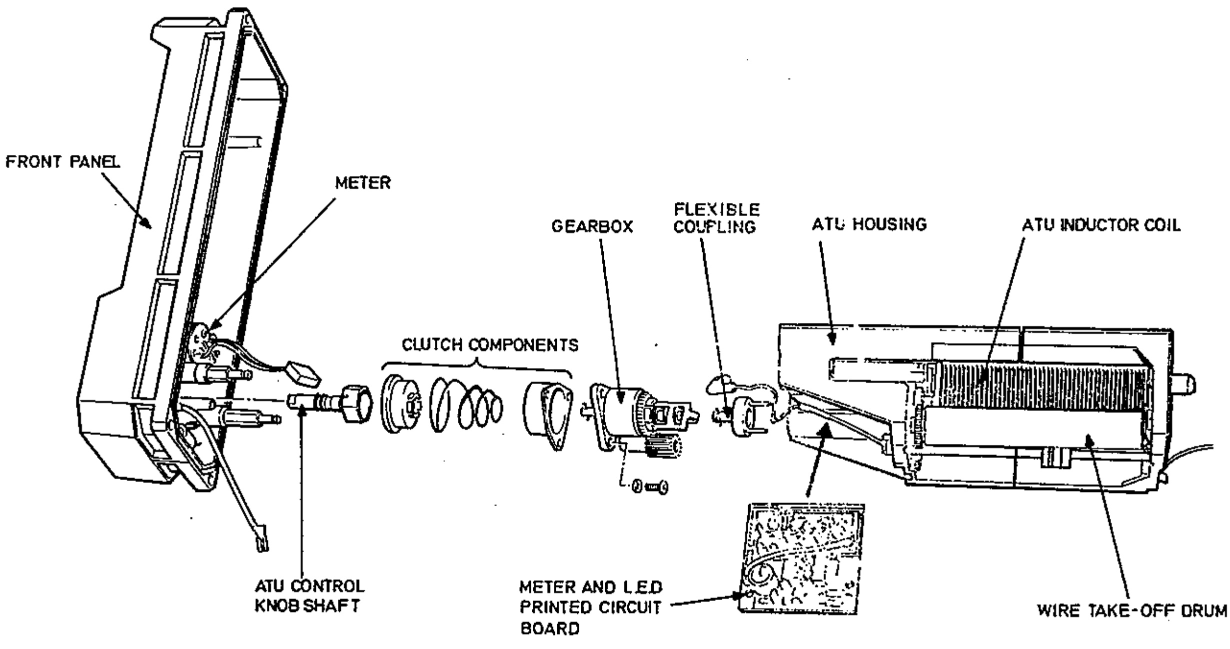
TR1		E176			927889
TR2		ZTX 237			923171
TR3		E176			927889
TR4		ZTX 212			923172
TR5		ZTX 212			923172
TR6		ZTX 237			923171

Integrated Circuits

ML1		LM324N			925944



LOCATION



MECHANICAL CONSTRUCTION

Location and Mechanical Construction of Antenna Tuning Unit

Fig. 1

PART 5

719000 SYNTHESIZER SUB-ASSEMBLY

PART 5

719000 SYNTHESIZER SUB-ASSEMBLY

CONTENTS

ILLUSTRATIONS (AT REAR OF PART)

(See individual Chapter Contents pages for in-text illustrations)

CHAPTER 1

GENERAL DESCRIPTION

CONTENTS

ILLUSTRATIONS

CHAPTER 1

GENERAL DESCRIPTION

1. INTRODUCTION

1.1 The synthesizer sub-assembly is that part of the equipment which supplies all the frequencies required by the transceiver. The main output frequency of the synthesizer is selected by the front panel frequency controls and acts as the first local oscillator during reception (or the equivalent during transmission). Since the first intermediate frequency (IF) is 35.4MHz, the main output frequency is 35.4MHz higher than the setting of the front panel frequency controls and is in the range 37.4MHz to 51.3999MHz in 100Hz steps.

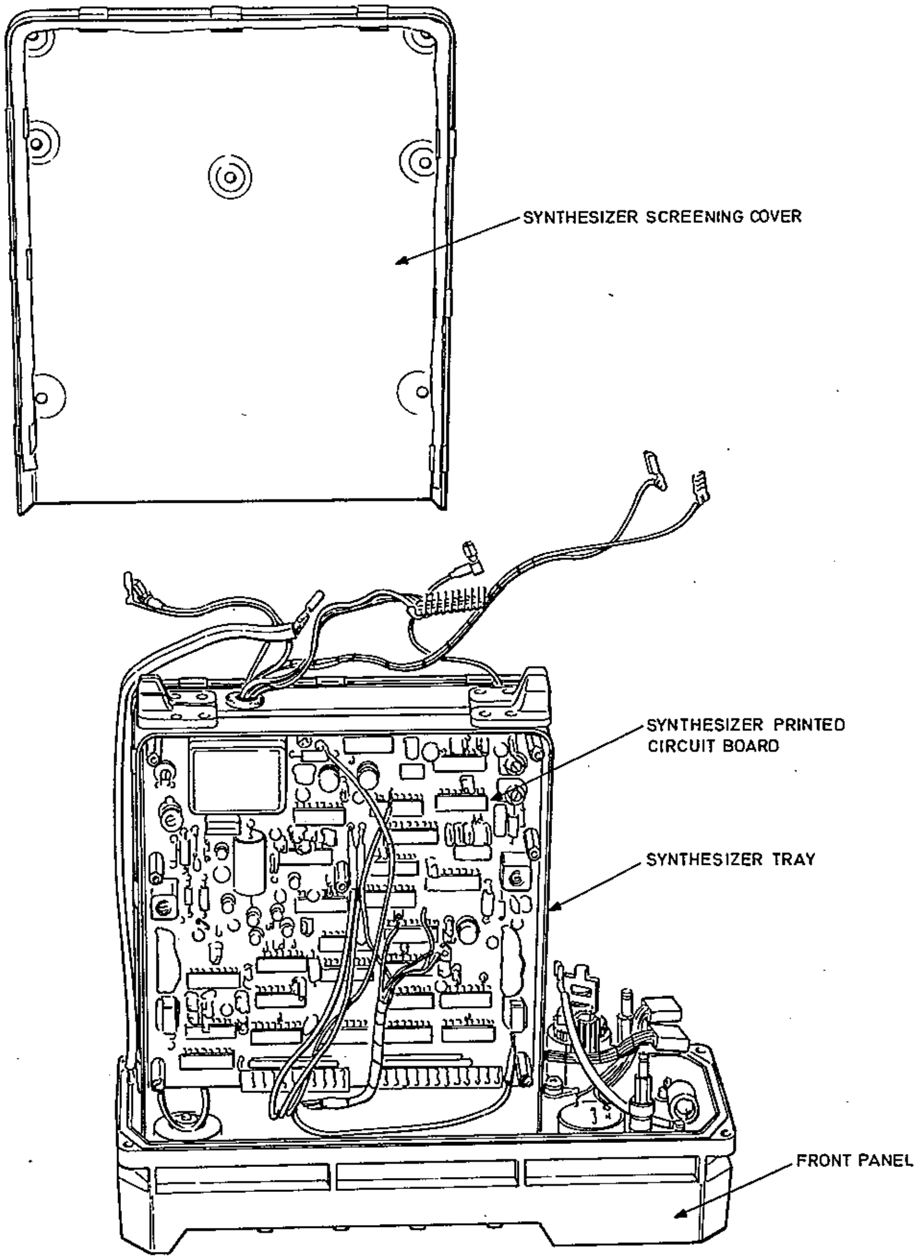
1.2 The second local oscillator frequency is 34MHz or 36.8MHz, depending upon whether the upper sideband (or AM) or the lower sideband is selected, and converts from the first to the second IF (35.4MHz to 1.4MHz).

1.3 In addition, the synthesizer provides other outputs required by the transceiver at 1.4MHz (two signals 90° phase apart), 1kHz, and an out-of-lock warning signal.

1.4 The synthesizer is a single printed circuit board assembly, mounted in a screening tray and forms part of the complete transceiver (see figure 1.1).

2. PRINCIPLES OF OPERATION (Fig. 1.2)

2.1 The frequency generation circuits of the synthesizer comprise a frequency standard (known as the TCXO, para. 4.2) to which all other frequencies are related, a reference divider and two phase-locked loops. The phase-locked loops generate both the main output of 37.4MHz to 51.3999MHz, which is dependent upon the setting of the front panel frequency controls, and also the 34MHz or 36.8MHz output, which is dependant upon the setting of the front panel Mode switch, by multiplying a suitable frequency from the reference divider. The remaining frequency outputs at 1.4MHz and 1kHz are derived directly from the reference divider.



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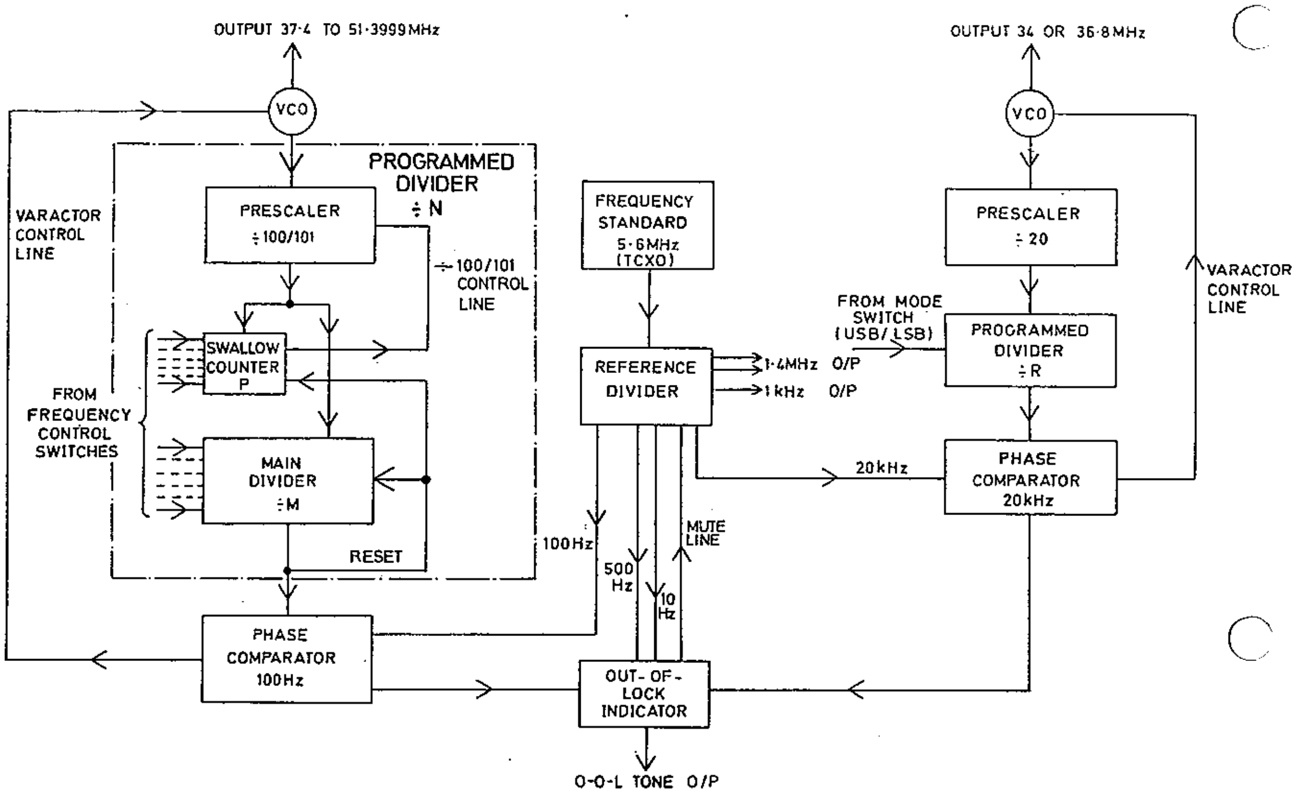
WOH 7207

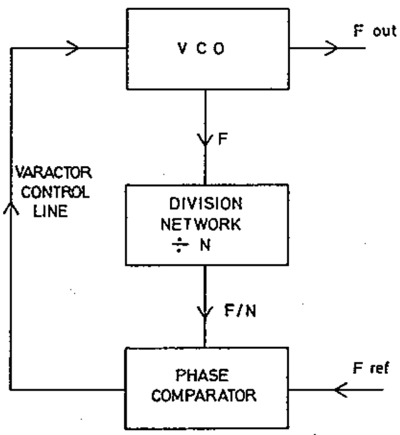
Location of Synthesizer Sub-Assembly Fig.1.1

3. Phase Locked Loops (Fig. 1.3)

3.1 A phase locked loop (PLL) is an electronic servo-control loop where the frequency of a voltage controlled oscillator (VCO) is related to a multiple of a reference frequency. Typically, the VCO frequency F, is divided by a ratio N, which may be controlled by the channel selected switches, to give a frequency F/N, which is fed together with the reference frequency, into a phase comparator. This compares the relative phase and frequency of these two inputs and gives an output voltage which controls the VCO, thereby reducing the frequency error to zero and minimising the phase difference. With this feed back applied the VCO frequency is equal to N times the reference frequency.



Synthesizer Block Diagram Fig. 1.



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Typical Phase Locked Loop Fig.1.3

4. MAIN OUTPUT FREQUENCY GENERATOR

4.1 This phase locked loop generates a frequency in the range 37.4MHz to 51.3999MHz in 100Hz steps, selected by the front panel frequency switches. The frequency required is therefore always on exact multiple of 100Hz, so this is made the phase comparison frequency. The division ratio of the programmed divider N is equal to the desired VCO frequency divided by 100 Hz.

4.2 For example, if a VCO frequency of 37.4MHz is desired, the division ratio is 374 000. If, perhaps, when the equipment is switched on, the VCO frequency is lower than 37.4MHz, the output of the programmed divider will be less than 100Hz. The phase comparator then increases its output voltage, which controls the VCO, until the frequency is correct, referred back to the 5.6MHz standard, which is a Temperature Compensated Crystal Oscillator (TCXO).

5. Voltage-Controlled Oscillator (VCO)

5.1 The voltage-controlled oscillator (VCO) generates the required output frequency, in the range 37.4MHz to 51.3999MHz, controlled by the voltage derived from the phase comparator. The VCO has two buffered outputs, one of which is fed to the prescaler, the other to the transceiver sub-assembly.

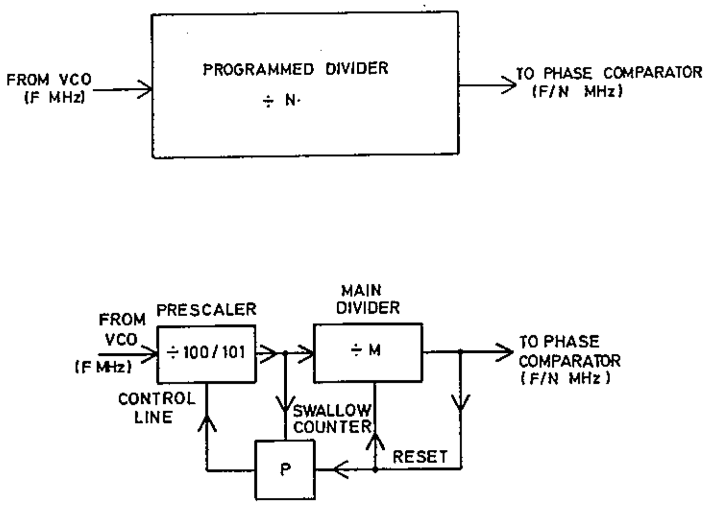
6. Programmed Divider

6.1 This divides the VCO frequency by 'N', as described in paras 3 and 4. To minimise the current drain from the battery, mainly CMOS integrated circuits are used in the programmed divider. These have an extremely low power consumption but suffer from the disadvantage that they will not operate at very high speeds.

6.2 To overcome this,a prescaler is used as part of the programmed divider to reduce the frequency so that it will reliably drive CMOS circuits. Normally, the use of a simple prescaler reduces the reference frequency in the same ratio as the division ratio of the prescaler. It is necessary, therefore, to use a variable modulus prescaler to overcome this problem.

7. Variable modulus prescaler (Fig. 1.4) The prescaler, swallow counter and main divider together form the programmed divider which has an overall division ratio of N, which is achieved as follows. Initially, the prescaler divides by 101. When 101P pulses are received from the VCO, the swallow counter receives P pulses and then instructs the prescaler to divide by 100. The programmed divider has also received P pulses and therefore requires a further M-P pulses to produce an output pulse. As the prescaler is dividing by 100, 100 (M-P) pulses are required at the input. Therefore, the total number of input pulses required to generate an output pulse is:-

$$101\,P + 100\,(M-P)$$
$$= 101\,P + 100\,M - 100\,P$$
$$= P + 100\,M$$
$$= N \text{ which is the overall division ratio}$$



Complete Programmed Divider Block Diagram Fig. 1·4

8. Prescaler The prescaler reduces the frequency of the VCO to the range required by the programmed divider. It has a division ratio of 100 or 101, which is selected by the output of the next stage, the swallow counter. For this reason it is described as a variable modulus prescaler.

9. Swallow counter The swallow counter is preset to a number P by the front panel 100Hz and 1kHz switches. The counter receives pulses from the prescaler and counts downwards from P until zero is reached, when it provides an output to switch the division ratio of the prescaler. The counter remains at zero until a load pulse is received from the next stage, the main divider, which resets the counter to P.

10. Main divider The main divider is set by the front panel 10kHz, 100kHz and 1MHz switches to divide by a number M. The output of the main divider is fed to the next stage, the phase comparator, and to the reset inputs of the swallow counter and main divider.

11. Phase Comparator The phase comparator compares the phase and frequency of the output of the main divider with the 100Hz output of the reference divider. An output voltage is produced which controls the VCO thereby reducing the frequency error to zero and minimising the phase difference. The circuit also provides an out-of-lock indication to warn the user of the equipment should a fault condition occur and the synthesizer fail to lock.

12. 34/36.8MHz FREQUENCY GENERATOR

12.1 The 34/36.8MHz frequency generator provides an output of 34MHz or 36.8MHz for the transceiver unit. The output frequency is determined by the mode selected; for LSB the frequency is 36.8MHz, for USB 34.0MHz and for AM 34.0MHz.

The Mode switch sets a programmed divider to a division ratio which provides a frequency of 20kHz when the output frequency of the VCO is correct. This frequency is phase-compared with a 20kHz reference frequency to provide a voltage which controls the output frequency in a similar manner to the Main Frequency Generator.

13. Voltage-Controlled Oscillator (VCO)

13.1 The voltage-controlled oscillator (VCO) generates the required output frequency, 34 or 36.8MHz, using the voltage derived from the phase comparator. The VCO has two outputs, one of which is fed to the next stage in the loop and the other which is fed to the transceiver sub assembly.

14. Prescaler and Programmed Divider

14.1 Since both desired frequencies, 34MHz and 36.8MHz, are multiples of 400kHz, it is not necessary to employ a variable modulus prescaler as used in the main loop. However, a prescaler is still required and in this case is a fixed divide-by-twenty. The programmed divider is simpler than that required for the main loop and, in lock, its output is 400kHz ÷ 20 = 20kHz, which is therefore the required reference frequency.

15. Prescaler The prescaler reduces the frequency of the VCO to the range required by the programmed divider. It has a division ratio of 20.

16. Programmed divider This circuit divides the output frequency of the prescaler by a number R, which is set by the front panel Mode switch. If USB or AM is selected R is 85, if LSB is selected R is 92. The overall division ratio is such that, if the VCO output corresponds to the frequency required, a 20kHz signal is obtained from the output of the programmed divider.

17. Phase Comparator

17.1 The phase comparator compares the phase and frequency of the output of the programmed divider with the 20kHz output of the reference divider. An output voltage is generated which controls the VCO thereby reducing the frequency error to zero and minimising the phase difference. This circuit also provides an out-of-lock indication to warn the operator if a fault should occur.

18. REFERENCE FREQUENCY GENERATOR

18.1 The reference frequency generator provides outputs at various frequencies, derived from a single reference, as follows:

(a) Two 1.4MHz outputs, used in the transceiver unit.

(b) 100kHz output, used in the synthesizer power supply.

(c) 20kHz output, used in the 34/36.8MHz phase comparator.

(d) 1kHz output, used in the transceiver unit.

(e) 500Hz output, used in the out-of-lock circuit.

(f) 100Hz output, used in the main phase comparator.

(g) 10Hz output, used in the out-of-lock circuit.

19. Temperature Compensated Crystal Oscillator (TCXO)

19.1 The temperature compensated crystal oscillator (TCXO) provides the reference frequency of 5.6MHz from which all the frequencies are derived. It consists of a crystal oscillator with additional internal compensation circuits to ensure that the frequency remains sensibly constant over a wide temperature range.

20. Reference Divider

20.1 The reference divider comprises a chain of frequency dividers from which outputs are taken at the required frequencies to drive the various circuits, in particular to provide the reference frequencies for the two phase locked loops.

21. Out-of-lock Circuit

21.1 Associated with the phase comparator of each phase locked loop is an out-of-lock detector which assesses whether the loop is locked to the correct frequency. The outputs of those detectors are summed and give an audible warning, an interrupted tone, to the operator if either or both loops are out of lock. This normally occurs only in a fault condition, but the warning tone may be heard momentarily when switching the equipment on or when changing channel.

22. Out of Lock Mute

22.1 If either or both loops are out of lock, the 1.4MHz outputs are both muted to prevent accidental transmission on an incorrect frequency.

23. POWER SUPPLY

23.1 The synthesizer power supplies are derived from the battery, which has a nominal output of 12 volts. An 8 volt supply is provided by a conventional integrated circuit regulator and 4.8 volts supply is provided by a high efficiency switching regulator.

CHAPTER 2

CIRCUIT DESCRIPTION

CONTENTS

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APPENDICES

CHAPTER 2

CIRCUIT DESCRIPTION

1. INTRODUCTION

1.1 The synthesizer circuits are contained on one printed circuit board. For ease of description, the circuits are considered as a number of sections, with some sections sub-divided into stages as follows. A functional diagram is given in fig. 1.2.

(1) Frequency Standard and Reference Divider (para. 4).

(2) Main Frequency Generator (para. 5).

(a) Voltage-controlled oscillator (VCO) and RF amplifier

(b) Prescaler

(c) Swallow counter and main divider

(d) Phase comparator

(3) 34/36.8MHz Frequency Generator (para. 17)

(a) Voltage-controlled oscillator (VCO) and RF amplifier

(b) Prescaler

(c) Programmed divider

(d) Phase comparator

(4) Out-of-Lock Circuit (para. 22)

(5) Power Supplies (para. 23)

2. LOGIC LEVELS

2.1 Three types of integrated logic circuits are utilised in the synthesizer, namely, Complementary Metal Oxide Semiconductor (CMOS), Low-power Schottky Transistor-Transistor Logic (LS TTL) and Emitter-Coupled Logic (ECL).

2.2 The logic levels for CMOS, LS TTL and ECL integrated circuits are defined in Appendix 1 at the end of this Chapter. When reference is made to a $\overline{Q}$ output, this is the inverse of the Q output, for example if Q = '0' $\overline{Q}$ = '1'.

3. VOLTAGE RAILS

3.1 The voltage rails are annotated 'A' and 'B'. The 'A' rail is 4.8V, the 'B' rail is 8V.

4. FREQUENCY STANDARD AND REFERENCE DIVIDER (Fig. 2.1)

4.1 All frequencies in the synthesizer are locked to the 5.6MHz Temperature Compensated Crystal Oscillator (TCXO) frequency standard. This is a sealed module and cannot be serviced. It contains a crystal oscillator at 5.6MHz and compensation circuits which ensure that the frequency remains sensibly constant over the full operating range of the equipment. Resistor R39 is a pull-up for the open-collector output and R37 is the fine frequency setting control, enabling the standard to be set up exactly, to compensate for any ageing which may occur. The output, which approximates to a square wave and has a frequency of 5.6MHz, is available at TP47.

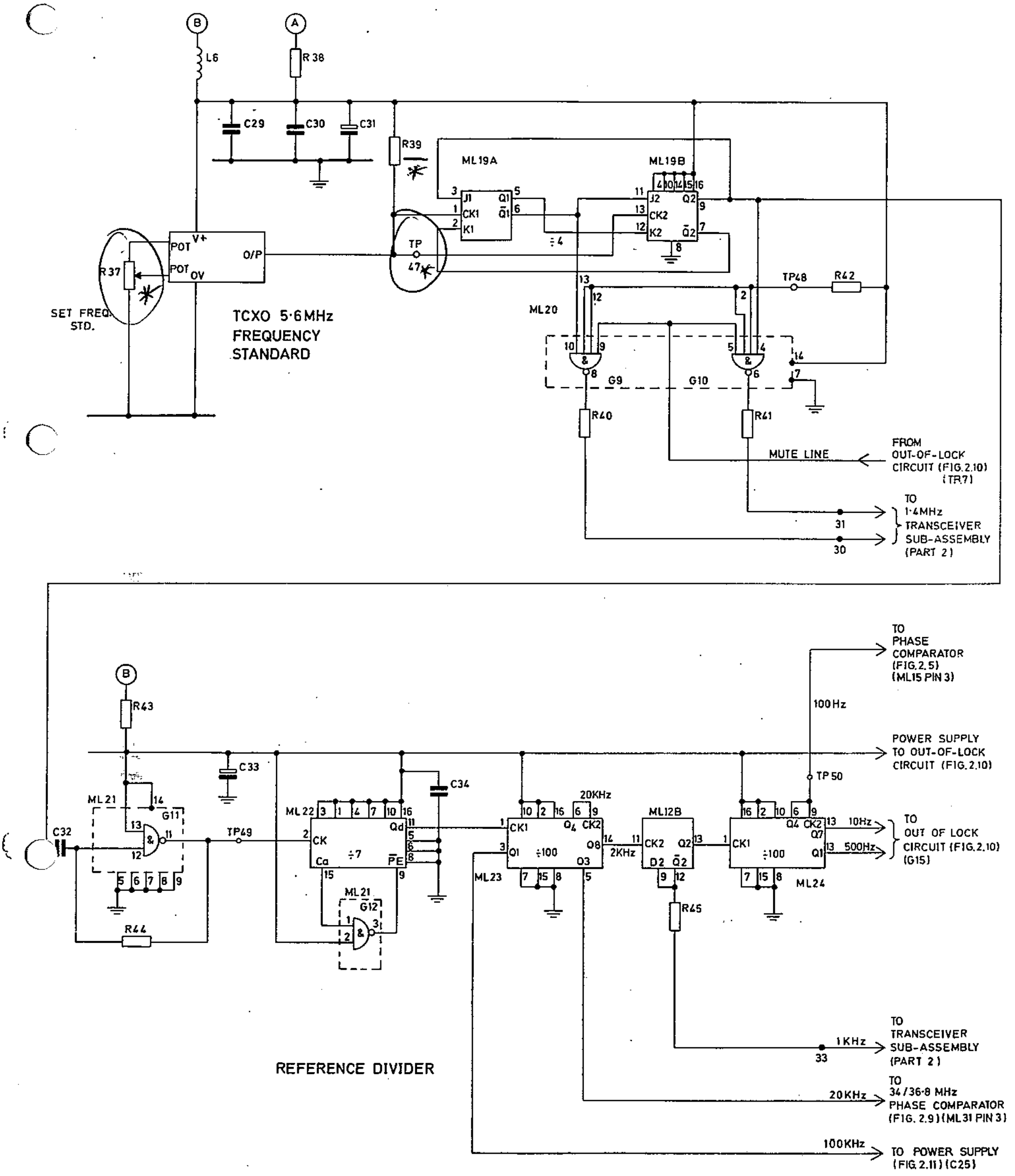
4.2 ML19 is a divide-by-four which provides the two outputs at 1.4MHz, with a phase difference of 90°, required by the transceiver. These outputs are applied to gates G9 and G10. If the out-of-lock circuit is activated, a MUTE signal is applied to G9 and G10 to inhibit the 1.4MHz outputs to the transceiver sub-assembly. This ensures that in the out-of-lock condition, the transceiver may not be accidentally activated on the wrong frequency.

4.3 Since ML19 is LS TTL and ML22 is CMOS, it is necessary to use the logic gate G11 as an amplifier to convert from TTL logic output level to CMOS input level. The input is biased by R44 and coupled to the output of ML19 by C32.

4.4 The division network comprising ML22, ML23, ML12B and ML24 divides the 1.4MHz signal at TP49 to produce the various frequencies listed below. ML22 is designed as a divide-by-ten but G12 is connected to interrupt the counting sequence so that it actually divides by seven.

ML23 pin 3 : 100kHz
ML23 pin 5 : 20kHz
ML12B pin 12 : 1kHz
ML24 pin 3 : 500Hz
ML24 pin 9 : 100Hz
ML24 pin 13 : 10Hz

TCXO



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Frequency Standard and Reference Divider Circuit

Fig.2.1

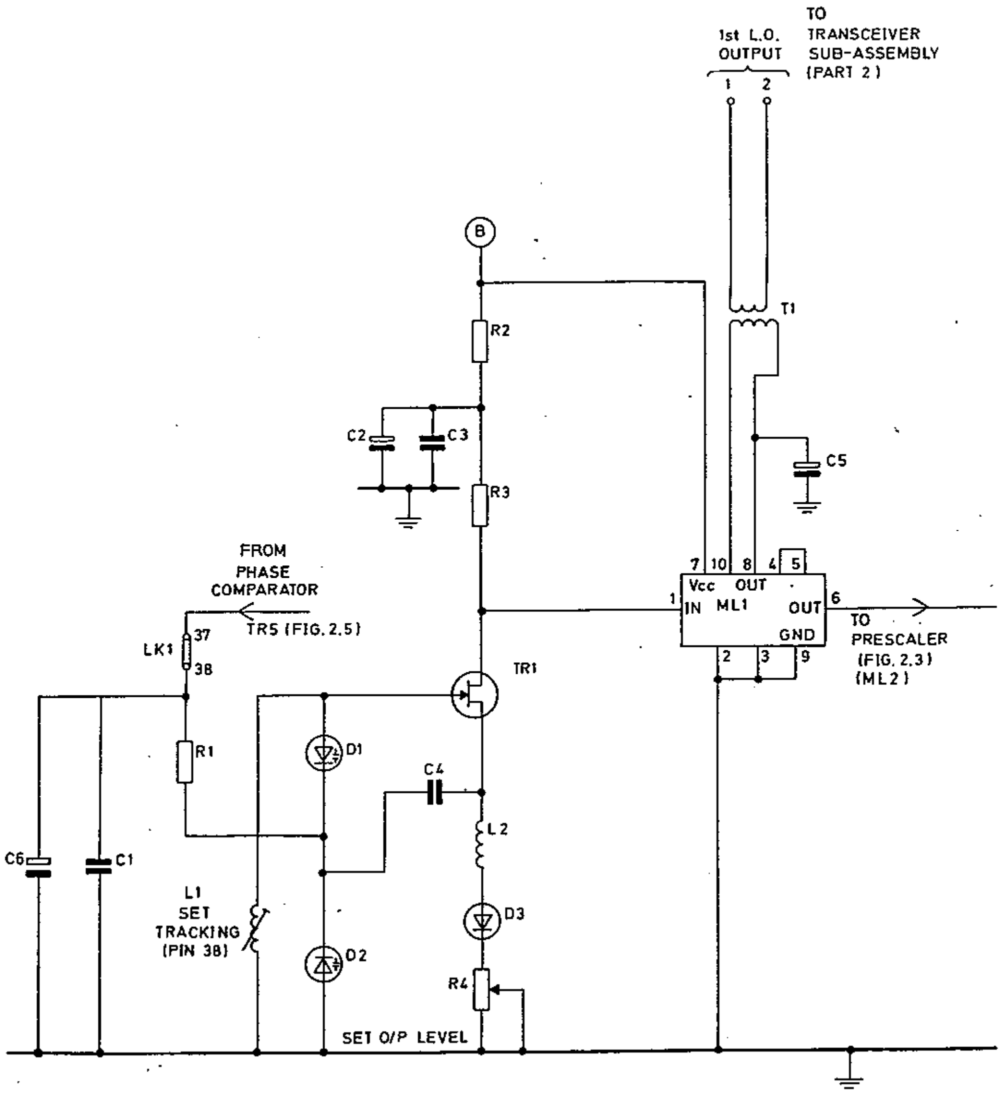
5. MAIN FREQUENCY GENERATOR

6. Voltage-Controlled Oscillator (VCO) and RF Amplifier (Fig. 2.2)

6.1 The voltage-controlled oscillator (VCO) generates an output in the range 37.4MHz to 51.3999MHz for the transceiver. This corresponds to the first IF (35.4MHz) plus the antenna frequency (2 to 15.9999MHz).

6.2 The inductor L1, and variable capacitance diodes D1 and D2 form a tuned circuit which, with TR1, form a Colpitts oscillator. The frequency of the oscillator is controlled by the voltage-controlled variable capacitance (varactor) diodes D1 and D2. The capacitance of the diodes varies with the d.c. voltage on pin 38, fed from the phase comparator, pin 37, thereby varying the frequency of the oscillator.

6.3 The output level of the oscillator is determined by R4 which adjusts the d.c. current through TR1. The tracking range of the oscillator is set by L1. The output of the oscillator is taken from the drain of TR1 to the RF amplifier ML1. This circuit provides a clock for the prescaler and an output to the transceiver via transformer T1.



Voltage - Controlled Oscillator And RF Amplifier Circuit Fig. 2.2
(Main Output Frequency Generator)

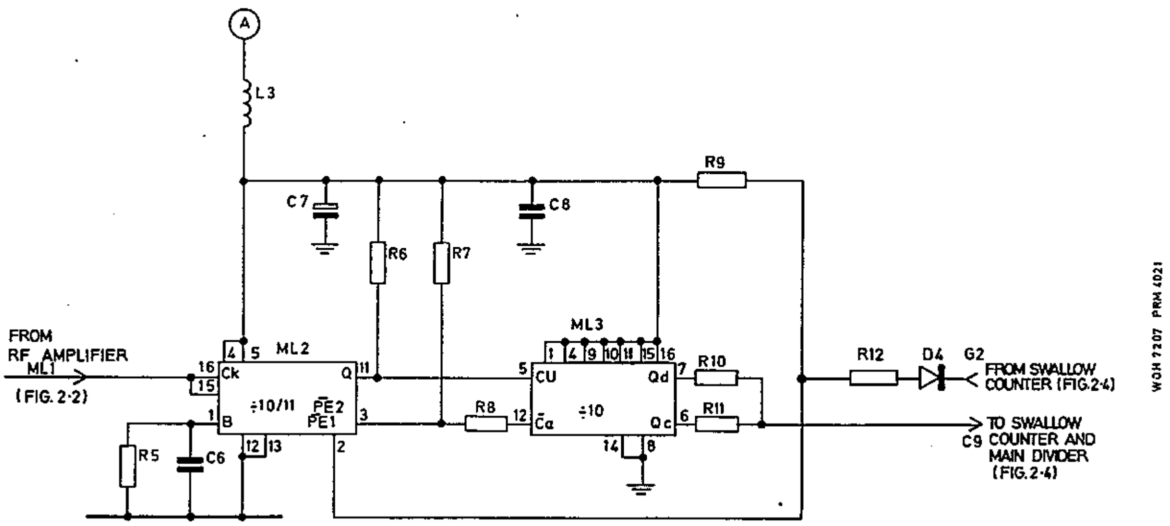
7. <u>Prescaler</u> (Fig. 2.3)

7.1 The prescaler is a variable modulus divider which reduces the frequency of the VCO to the range required by the programmed divider. An output of the RF amplifier ML1 is used to clock ML2 which, in conjunction with ML3, forms the prescaler. The prescaler divides the VCO frequency by 101 if the voltage on ML2 pin 2 is low and by 100 if the voltage on pin 2 is high.

7.2 ML2 is an Emitter-Coupled Logic (ECL) divider with an open-collector output which requires a pull-up resistor R6. This device divides by 11 when both preset inputs (pins 2 and 3) are low and by 10 when either or both preset inputs are high. ML3 is a conventional low power schottky divide-by-ten circuit.

7.3 When pin 2 of ML2 is high, this device divides by 10 irrespective of the state of the other preset input (pin 3). A total division ratio of 100 is therefore obtained from the prescaler.

7.4 When ML2 pin 2 is low, the device devides by 10 when the other preset input (pin 3) is high, that is when no carry output is present on ML3 pin 12. When ML2 pin 3 is low, that is a carry output is present on ML3 pin 12, the device divides by 11. Therefore ML2 divides by 10 for 9 clock periods of ML3 and by 11 for one clock period, so that an overall division ratio of 101 is provided by the prescaler (9 x 10 + 1 x 11 = 101).



Prescaler Circuit Fig. 2.3

(Main Output Frequency Generator)

7.5 It is necessary to convert from low power schottky output level (ML3 pin 12) to ECL input level (ML2 pin 3), so the potential divider R7 and R8 is included. Similarly, R9, R12 and D4 are provided to convert from CMOS output level (G2) to ECL input level (ML2 pin 2).

8. Swallow Counter and Main Divider (Fig. 2.4)

9. Programmable counters and switch code The division network formed by the swallow counter and main divider comprises six down-counters ML4, ML7, ML8, and ML10 are connected to divide-by-ten, ML13 and ML14 to divide-by-sixteen. Switches SA1, 2, 3, 4 and 5 provide either a short-circuit to ground or an open-circuit for the data inputs of ML4, 7, 8, 10 and 13 respectively. A pull-up resistor is therefore required for each input, ML6 and ML11. This input data is transferred to the output when a 'load' pulse is applied (see App. 1 at the end of the chapter).

9.1 The switch code is binary-coded decimal (BCD) for SA1,2, 3 and 4 and binary for SA5 (see table 1). The division ratio of the programmed divider, when the 1kHz and 100kHz switches are set to 0, is the required VCO frequency divided by 100. For example, for a switch setting of 2MHz, the VCO frequency should be 37.4MHz and the division ratio is 374 000.

TABLE 1 Frequency Switch Positions

Switch Indication	SA1-SA4 Outputs				SA5 Outputs			
	A	B	C	D	A	B	C	D
0	0	0	0	0				
1	1	0	0	0				
2	0	1	0	0	0	1	0	0
3	1	1	0	0	1	1	0	0
4	0	0	1	0	0	0	1	0
5	1	0	1	0	1	0	1	0
6	0	1	1	0	0	1	1	0
7	1	1	1	0	1	1	1	0
8	0	0	0	1	0	0	0	1
9	1	0	0	1	1	0	0	1
10					0	1	0	1
11					1	1	0	1
12					0	0	1	1
13					1	0	1	1
14					0	1	1	1
15					1	1	1	1

0 - short-circuit to ground 1 - open-circuit (resistor pulls voltage up)

12.2 Since the number 200 has been loaded into the main divider, this being the code corresponding to 2.000 0MHz (with the 100Hz and 1kHz information fed to the swallow counter), it is clearly impossible to count 3740 pulses by counting down from 200 to zero. It is therefore necessary to insert an offset, of the count loaded in, of 16000. Since ML13 is connected to divide by 16 and ML8 and ML10 each divide by 10, this offset is achieved by loading 10 into ML14.

13. Counter recognition Because of the frequency offset, when 2MHz is selected, the number actually loaded in is 200 + 16000 = 16200. It has been shown that M needs to be 3740 at 2MHz, so the number to be recognised, at which the counting sequence is complete and the main divider is reloaded, must be 16200 - 3740 = 12460. However, two clock pulses are lost during the reloading process (see 2.15), so the number actually detected is 12462.

13.1 This number is detected in gate G4 (ML9). Since the main divider is a down counter, the number can be recognised by detecting only '0's on the outputs of ML8, 10, 13 and 14 equivalent to 12462.

12462	=	7 X 1600	(ML14)
	+	12 X 100	(ML13)
	+	6 X 10	(ML10)
	+	2 X 1	(ML8)

			Code to be detected A	B	C	D	Outputs detected
MHz (	7	Binary	1	1	1	0	ML14 Qd
(	12	Binary	0	0	1	1	ML13 Qa, Qb
100kHz	6	BCD	0	1	1	0	ML10 Qa, Qd
10kHz	2	BCD	0	1	0	0	ML8 Qa, Qc, Qd

14. Counter Recognition (Units up to Serial No. 451)

14.1 On units up to Serial No. 451 the mode of operation of ML14 is slightly different although the overall function is still unchanged. (See Fig. 2.4A). Instead of loading 10 into ML14, counting down to seven and then reloading, the circuit is loaded with 3; counted down to zero and reloaded.

15. Load sequence. The outputs of ML8, ML10, ML13 and ML14 listed above are taken to the 8-input NOR gate G4. At the count 12462, all these outputs are '0', so the output of G4 is '1' and this is clocked into the latch ML12A one period later. This sets the Q1 output of ML12A to a '1' which is fed, via resistors R65, R66 and R67 (which are fault-finding aids), to the 'load' pins of all the counters in the swallow counter and main divider. These now 'load' with information from the switches, thus removing the zeros from the input to G4. The output of G4 therefore returns to '0', as does Q1 of ML12A after the next clock pulse. The result is that the 'load' signal is one clock period wide and this not only loads the programmed divider, to intiate the next counting sequence, but also drives the phase comparator. It should be noted that one clock pulse is required to generate the 'load' signal and another to remove it, so that two pulses are lost in the counting sequence, as explained previously. (para.13). Once the 'load' signal is removed, the swallow counter and main divider continue to count down, as before.

16. Phase Comparator (Fig. 2.5)

16.1 The purpose of the phase comparator is to take the VCO frequency and, after division by the programmed divider, compare its phase and frequency with the 100Hz reference. The phase comparator generates an output voltage, which is the control line for the VCO. This voltage is raised or lowered until the frequency of the VCO is correct and the loop is locked.

16.2 The inputs from the reference and programmed dividers are fed as clocks into the two flip-flops comprising ML15. There are three conditions of operation; when the input of the programmed divider is higher, lower or equal in frequency to the reference.

16.3 The positive edge of each input to the phase comparator triggers, in turn, the relevant flip-flop ML15A or ML15B. If the VCO frequency is too high, the phase and frequency of the input from the programmed divider will be in advance of that of the reference. In this case, $\overline{Q2}$ will go from '0' to '1' before $\overline{Q1}$ goes from '0' to '1'. The time interval between these two transitions is dependant upon the phase difference between the two inputs. When both $\overline{Q1}$ and $\overline{Q2}$ of ML15 are '1', gates G6 and G5 give a '1' to the 'S' inputs, which set $\overline{Q1}$ and $\overline{Q2}$ to 0. The result is a pulse on $\overline{Q2}$ (equal to the time difference between the two inputs) and a very narrow pulse (typically 200ns) on $\overline{Q1}$.

16.4 The pulse on $\overline{Q2}$ turns on the current source TR3, which is switched on for the duration of the pulse. This current, which flows through D6, steadily discharges the hold capacitor and loop filter comprising C19, C20 and R26. This reduces the voltage at this point, which is transferred to the VCO control line via the voltage follower TR4, TR5 and test link LK1.

16.5 This voltage is reduced until the VCO frequency is correct and the phase difference between the two inputs to the phase comparator becomes zero. In this condition, the output pulses on $\overline{Q1}$ and $\overline{Q2}$ of ML15 both become very narrow and have little effect on the current sources. Thus the voltage on the hold capacitor C19 remains constant at that required for correct VCO frequency and the loop is 'locked'.

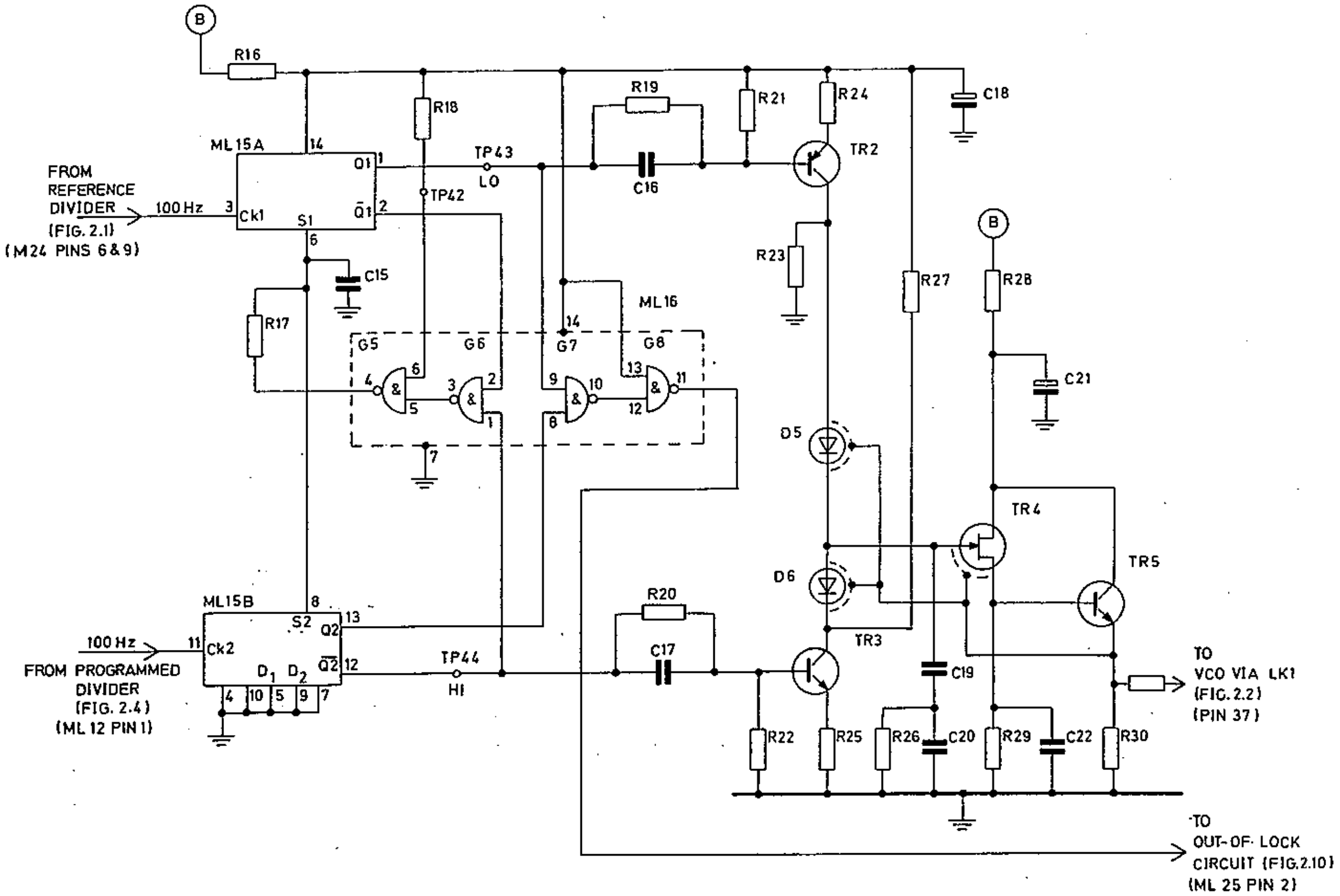
16.6 If instead, the VCO frequency is too low, the pulse on $\overline{Q2}$ becomes very narrow and that on $\overline{Q1}$ becomes wider. Q1 (the inverse of $\overline{Q1}$) turns on the current source TR2, which charges the hold capacitor C19 via D5. This now steadily raises the voltage control line of the VCO until lock is achieved.

16.7 The loop filter comprising C19, C20 and R26 not only acts as a hold capacitor but also stabilises the phase locked loop, giving a fast acquisition of lock. Special techniques are employed to ensure that the leakage of current to or from the hold capacitor is kept to an absolute minimum. Otherwise, deterioration of the voltage at this point would result in severe 100Hz modulation of the VCO. C19 and TR4 are chosen to have a very low leakage. "Picoamp Diodes" D5 and D6 are specified so that, when in lock and TR2 and TR3 are turned off, the leakage currents of TR2 and TR3 flow in R23 and R27 rather than into the hold capacitor.

16.8 When out of lock, the pulse width on either Q1 or Q2 of ML15 becomes wide, but in lock they both become very narrow. This provides a convenient way to determine whether the loop is in or out of lock. The Q1 and Q2 outputs are combined by gates G7 and G8 and fed to the out-of-lock circuit (Fig. 2.10).

17. 34/36.8MHz FREQUENCY GENERATOR

17.1 The principles of operation of this phase locked loop are very similar to those of the main loop described previously. However, in detail, it is significantly simpler, since the phase comparison frequency is higher and there is a choice of only two VCO frequencies.



Phase Comparator Circuit

(Main Output Frequency Generator)

Fig. 2.5

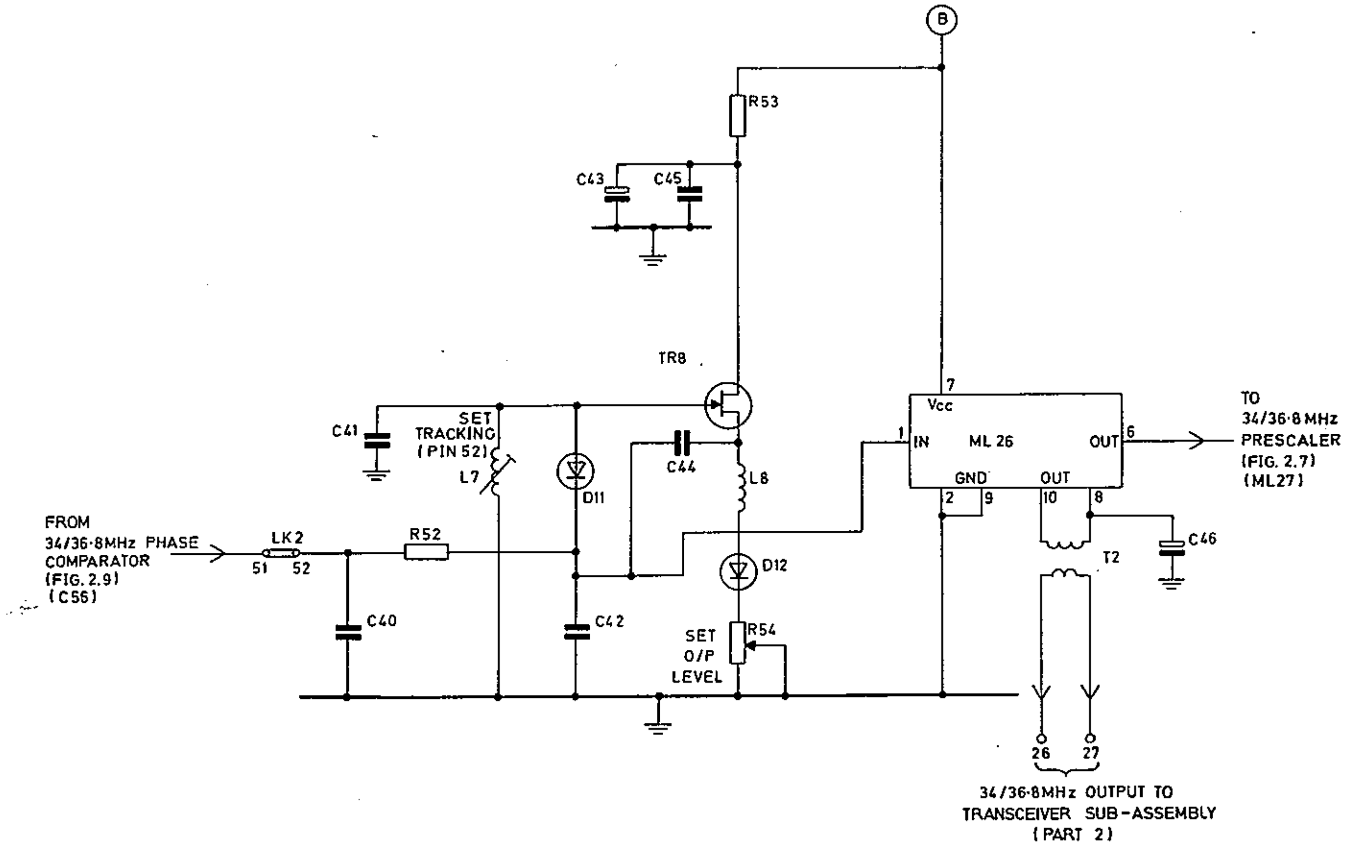
18. 34/36.8MHz Voltage-Controlled Oscillator (VCO) and RF Amplifier (Fig. 2.6)

18.1. The 34/36.8MHz VCO generates an output at one of two frequencies, depending upon the setting of the front panel Mode switch, on the transceiver. For USB or AM operation the output is 34.0MHz and for LSB operation 36.8MHz. These frequencies correspond to the first i.f. plus or minus the second i.f. and are used to convert from the first to the second i.f. in the transceiver. The choice 34MHz or 36.8MHz decides which sideband is used.

18.2 The circuit of this VCO is almost identical to that of the main VCO. However, the frequency range is different and the output voltage required is lower. L7, D11 and C42 form a tuned circuit which, with TR8, forms a Colpitts oscillator. The frequency of the oscillator is controlled by the voltage-controlled variable capacitance (varactor) diode D11. The capacitance of the diode varies with the d.c. voltage from the phase comparator, on pin 51, thereby varying the frequency of the oscillator.

18.3 The output level of the oscillator is determined by R54 which adjusts the d.c. current through TR8. The tracking range of the varactor diode is set by L7.

The output of the oscillator is taken from the tuned circuit to the RF amplifier ML26. This circuit provides clock for the 34/36.8MHz prescaler and an output to the transceiver via transformer T2.

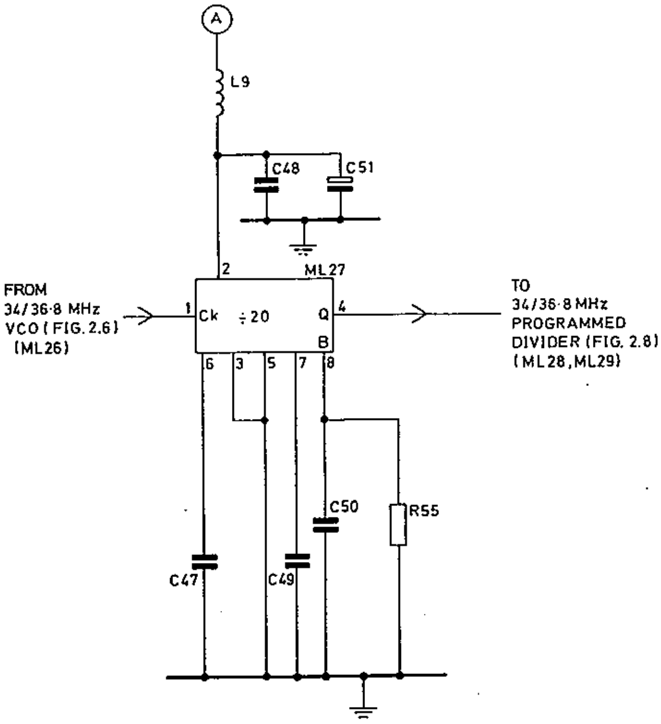


34/36·8 MHz Voltage-Controlled Oscillator and RF Amplifier Circuit Fig. 2.6

19. <u>34/36.8MHz Prescaler (Fig. 2.7)</u>

19.1 The prescaler ML27 is a divider which reduces the frequency of the 34/36.8MHz VCO to the range required by the 34/36.8MHz programmed divider. It has a fixed division ratio of 20 and is driven by an output of the RF amplifier ML26.

19.2 The output of the prescaler clocks ML28 and ML29, the programmed divider.



34/36·8 MHz Prescaler Circuit Fig. 2.7

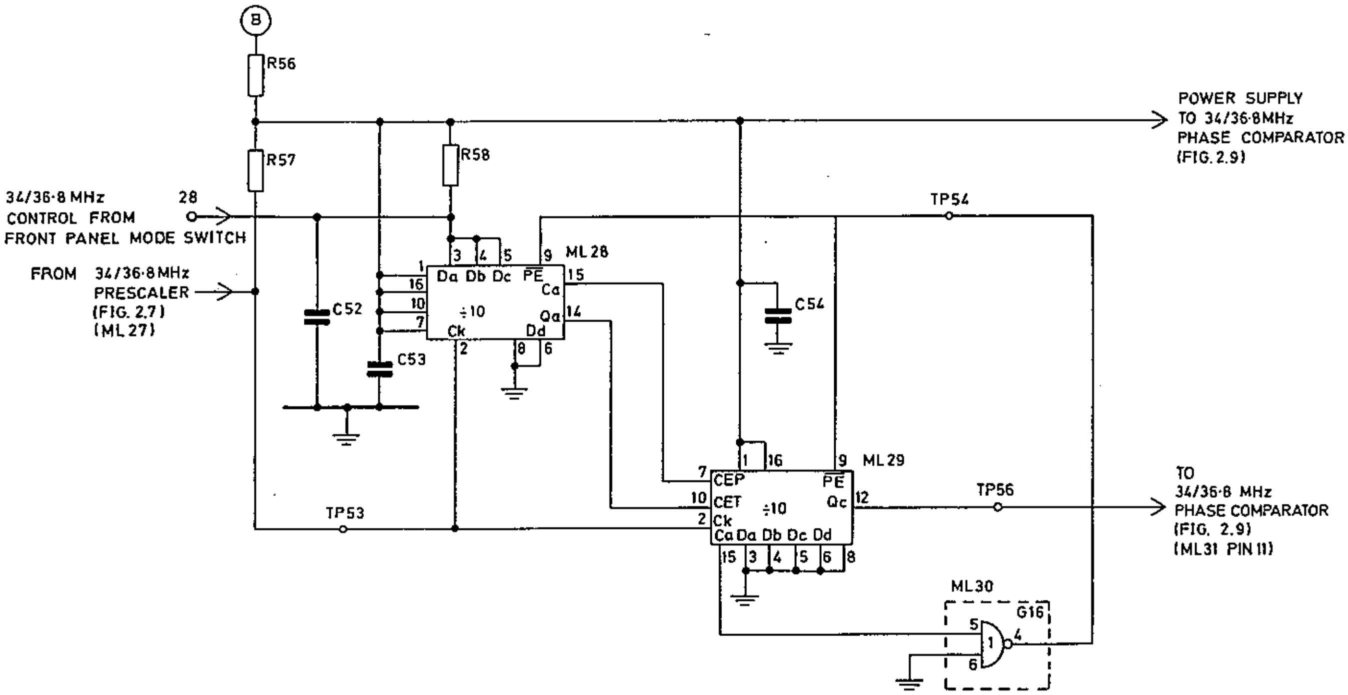
20. 34/36.8MHz Programmed Divider (Fig 2.8)

20.1 The function of the programmed divider is to divide the output frequency of ML27 by either 85 (USB or AM) or 92 (LSB), depending upon the state of the control line from the front panel MODE switch (pin 28).

20.2 The programmed divider in this circuit is considerably simpler than that in the main loop. The prescaler is a fixed divide-by-twenty circuit instead of the variable modulus types so a swallow counter is not required. Nevertheless, the basic principle is the same. It counts (this time up, not down) until it recognises a particular code, in this case 91, when it is 'loaded' with information selected by the front panel Mode switch. This sends an output signal to the phase comparator and initiates the counting sequence of the divider.

20.3 The counters ML28 and ML29 are synchronous types so that the clock, from the prescaler, is connected to both of them (see App. 1:40162). The detection of the terminal count 91 is performed within ML29: the 1 of 91 is determined by the Ca and Qa outputs of ML28 and the Ca output of ML29 recognises when this coincides with its own state 9; that is count 91.

20.4 When this carry output appears on ML29, it is inverted by G16, where it holds down the $\overline{PE}$ inputs of ML28 and ML29. The next clock input then loads the data into the counters, '0' for - 92 (36.8MHz) or '7' for - 85 (34MHz). The divider then resumes its normal counting procedure until it again reaches 91, when it again 'loads'. It may be seen that 92 input pulses are required to count from 0 to 91 and back to 0, whereas 85 are required to count from 7 to 91 and back to 7.

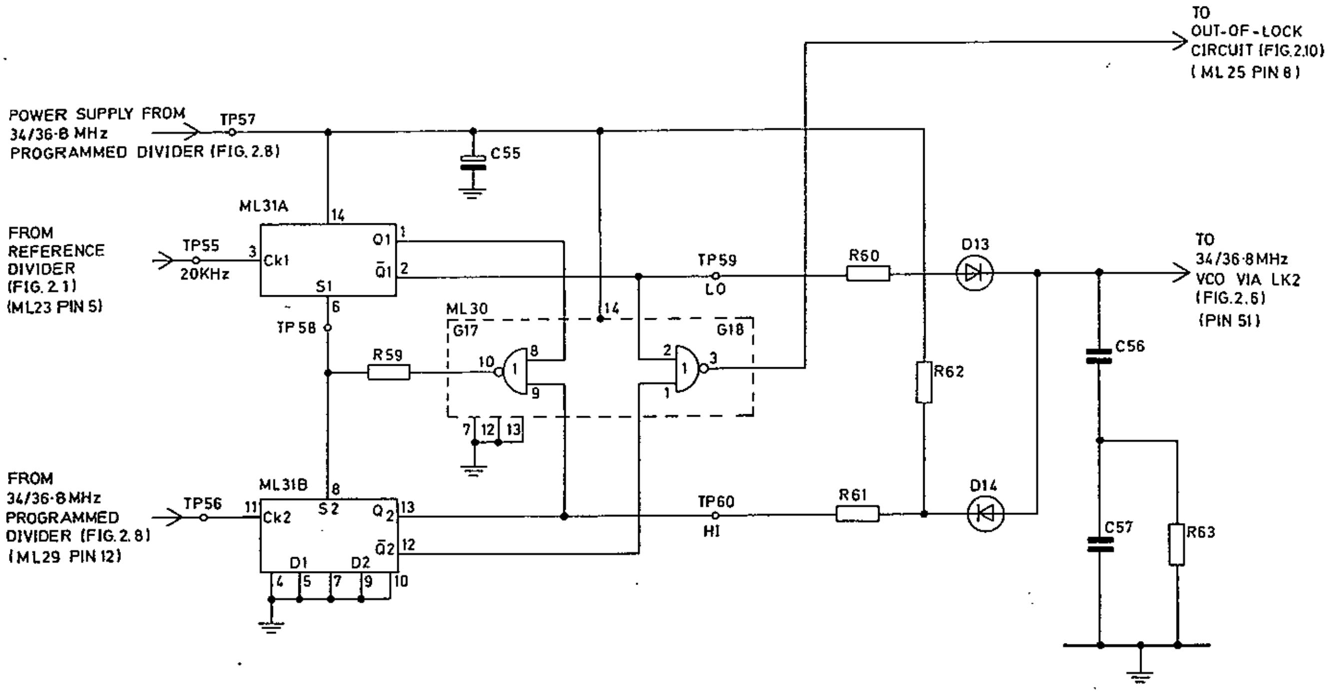


34/36·8 MHz Programmed Divider Circuit Fig. 2.8

21. <u>34/36.8MHz Phase Comparator</u> (Fig. 2.9)

21.1 The principles of operation of this phase comparator are identical to those of the main comparator, described previously. However, since operation is now at 20kHz instead of 100Hz, a simpler design is possible.

21.2 ML31 has the same function as ML15, to generate output pulses which depend upon the relative phases of the 20kHz reference and the output of the programmed divider. ML30 has the same function as ML16, that is, to drive the S inputs of ML31 and combine the outputs of ML31A and ML31B to drive the out-of-lock circuit. R60 and D13, in this simpler circuit, take the place of the current source TR2, D5 and associated components; similarly R61 and D14 take the place of TR3, D6 and associated components. The loop filter and hold capacitor are now formed by C56, C57 and R63. At this higher frequency, there is no need for the voltage follower, equivalent to TR4 and TR5. An output indication of lock condition is available from G18 and drives the out-of-lock indicator. The voltage on the loop filter C56 is taken, via a test link LK2, back to the VCO, thus closing the loop and allowing the phase comparator to control the VCO frequency.



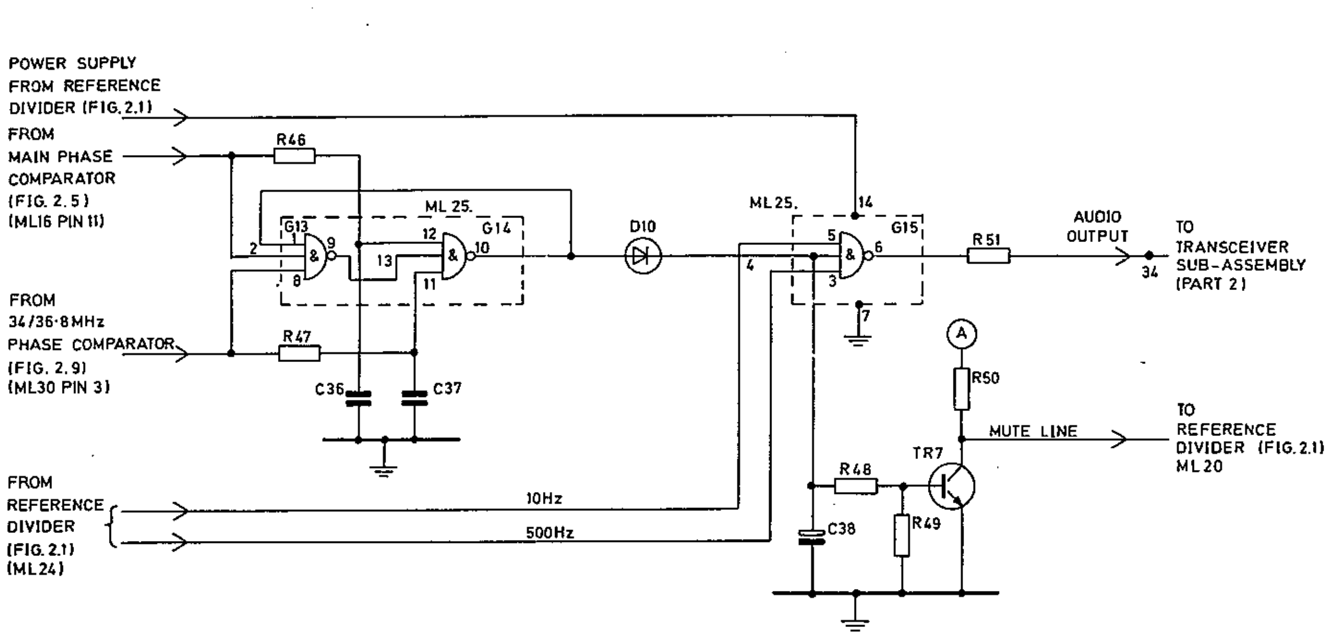
34/36·8 MHz Phase Comparator Circuit Fig. 2.9

22. OUT OF LOCK CIRCUIT (Fig. 2.10)

22.1 The function of the out-of-lock circuit is to determine whether the two phase locked loops are locked onto frequency and to give an audible warning to the operator if they are not. In this case, the two 1.4MHz outputs to the transceiver are muted, to prevent accidental transmission on an incorrect frequency.

22.2 As already explained, the out-of-lock outputs from each phase comparator give narrow pulses when in lock but wide pulses when out of lock. Therefore, this circuit is a pulse width discriminator which decides whether the pulses from the phase comparator are wider or narrower than about 5μs.

22.3 The pulse from the main phase comparator is fed directly to G13 and, via filter R46 and C36, to G14. G13 and G14 are connected together to form a latch. A narrow-pulse cannot pass through the filter so G13 and G14 latch up with a '0' from G14, which turns off G15; this is the 'in lock' condition. A wide pulse passes through the filter, so G13 and G14 latch up with a '1' from G14, turning on the out-of-lock indicator G15. G15 is also fed with 10Hz and 500Hz signals from the reference divider so, when out-of-lock, G15 gives a tone of 500Hz, interrupted at a 10Hz rate. In this condition, the '1' output of G14 also turns on TR7, which mutes the 1.4MHz outputs.



Out-Of-Lock Circuit Fig. 2.10

22.4 The pulse from the 34/36.8MHz phase comparator is also fed directly to G13 and via a filter, in this case R47 and C37, to G14. The out-of-lock condition is detected in the same way as described for the main phase comparator.

23. POWER SUPPLIES (Fig. 2.11)

23.1 The synthesizer power supplies are derived from the 12V d.c. nominal input at pin 36 and pin 35 (earth) from the transceiver. Two stabilised power rails are used within the synthesizer and these are:

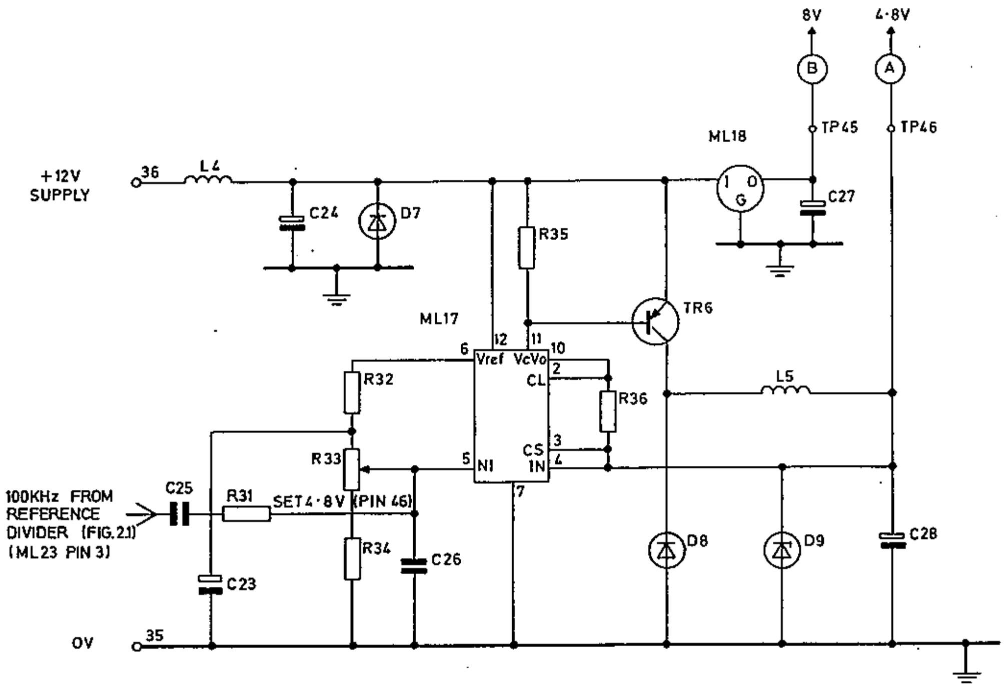
+8V
+4.8V

23.2 The +8V power supply is provided by a three terminal linear regulator ML18. C27 is a reservoir capacitor.

23.3 The +4.8V power supply utilises a high-efficiency switching type regulator ML17. The switching transistor TR6 is alternately driven fully into conduction and fully cut-off by ML17 from the 100kHz input via R31 and C25. The voltage at the collector of TR6 is therefore a square wave of approximately the same amplitude as the supply rail. The mark-space ratio of TR6 is automatically adjusted by feedback controlled by ML17, by comparing the output with a voltage reference set by R33, to give a 4.8V output after smoothing by L5 and C28. When TR6 is cut off, diode D8 conducts, providing a continuous path for the current flow through L5. The switching action reduces the current drain from the supply.

23.4 Diode D9 provides over-voltage protection (above approximately 6V) for the integrated circuits in the rare event of a regulator failure, by causing sufficient current flow to burn out TR6.

23.5 L4 and C24 form an input filter. D7 will cause the unit fuse to blow should an external voltage source be inadvertently connected with reverse polarity.



Synthesizer Power Supplies Circuit Fig. 2.11

APPENDIX 1

INTEGRATED CIRCUITS

CMOS INTEGRATED CIRCUITS

Supply Voltages

In this equipment, the supply voltages are

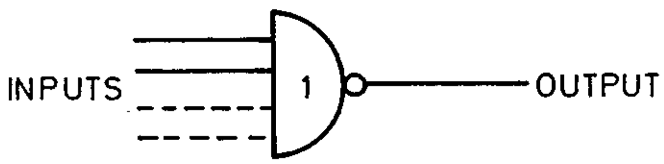
Vdd	+8V
Vss	0V

Logic Levels

Input and output levels are

Logic '0'	0V (earth)
Logic '1'	8V (power supply)

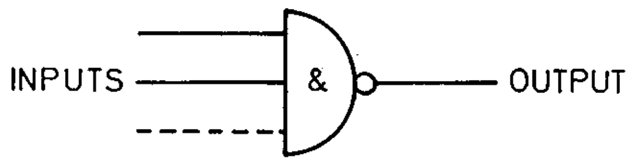
Gates	NOR Gates	4001	Quad 2 input
		4078	Single 8 input



WHEN ALL INPUTS ARE '0', OUTPUT IS '1'
IF ANY INPUT IS '1', OUTPUT IS '0'

NOR Gate Fig.App.1.1

NAND Gates 4011 Quad 2 input
4023 Triple 3 input

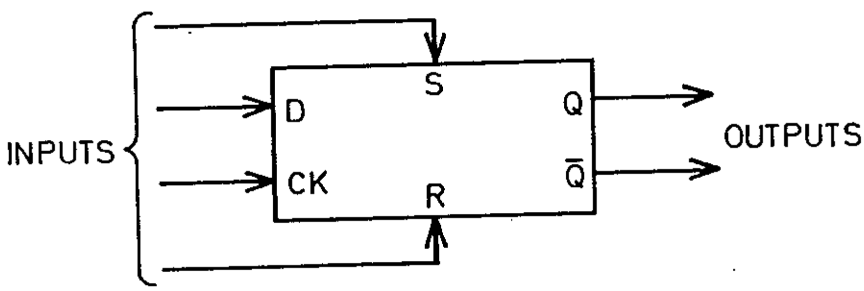


WHEN ALL INPUTS ARE '1', OUTPUT IS '0'

IF ANY INPUT IS '0', OUTPUT IS '1'

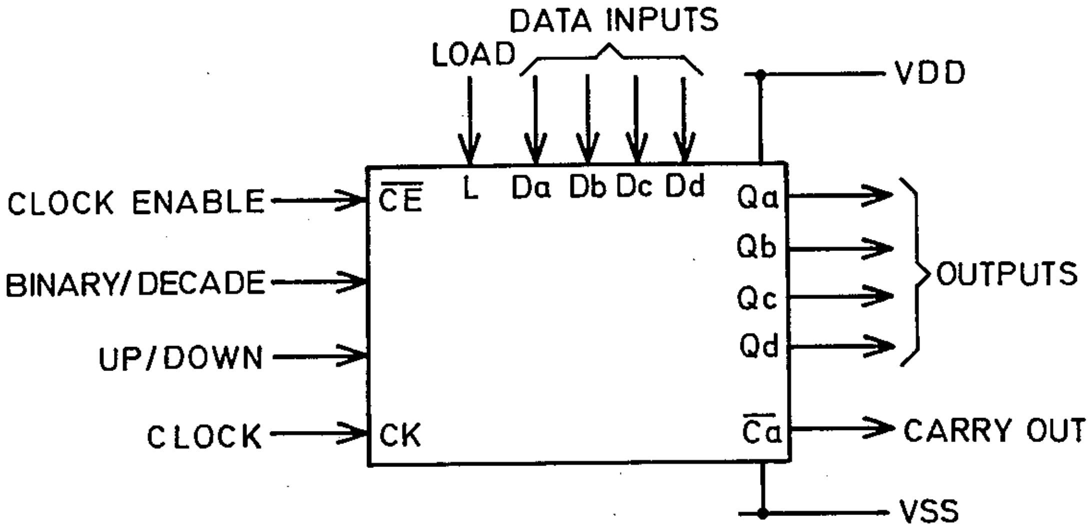
NAND Gate Fig.App. 1.2

Flip-Flop Dual D-Type 4013
(One flip-flop illustrated)



Dual D-Type Flip Flop Fig.App.1.3

$\overline{Q}$ is the inverse of Q
If set (S) is '1', Q goes to '1' immediately
If reset (R) is '1', Q goes to '0' immediately
Provided R and S are '0', on the positive edge of the clock pulse (CK), Q takes up the state of the D input.
If $\overline{Q}$ is connected to D, the flip-flop divides the clock frequency by two.



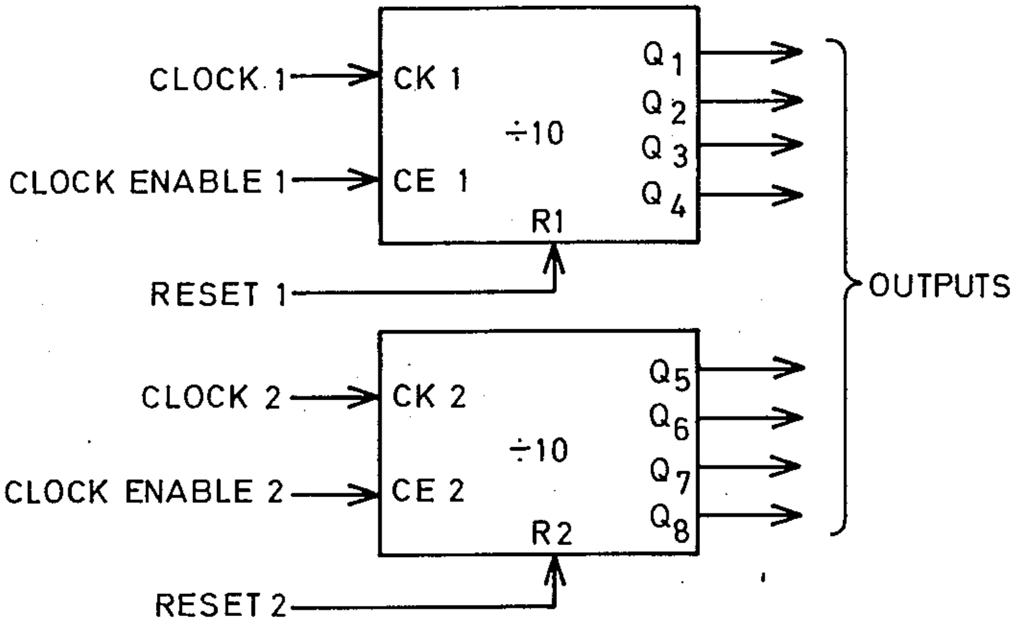
Presettable Up/Down Binary/Decade Counter   Fig.App.1.4

If load (L) is '1', information on the data (Da-Dd) inputs is transferred to the corresponding outputs (Qa-Qd) immediately, for example if Db = 1, Qb = 1. If load (L) is '0' and clock enable ($\overline{CE}$) is '0', the counter is advanced one count at every positive transition of the clock (CK) input. Counting is inhibited if either L or $\overline{CE}$ is '1'.

Binary counting is accomplished when the binary/decade input is '1' and decade counting when it is '0'.

Up counting is achieved when the up/down input is '1' and down counting when it is '0'.

The carry out ($\overline{Ca}$) output is normally '1'. Provided $\overline{CE}$ is '0', $\overline{Ca}$ goes to '0' when the counter reaches its maximum count(counting up) or minimum count (counting down).



Dual Decade Up-Counter Fig.App.1.5

Each counter divides its clock (CK) input by 10 and provides intermediate division ratios, as follows.

Q1 = CK1 ÷ 2	Q5 = CK2 ÷ 2
Q3 = CK1 ÷ 10	Q7 = CK2 ÷ 10
Q4 = CK1 ÷ 10	Q8 = CK2 ÷ 10

Q4 may be linked to CK2 to provide the following overall division ratios

Q5 = CK1 ÷ 20

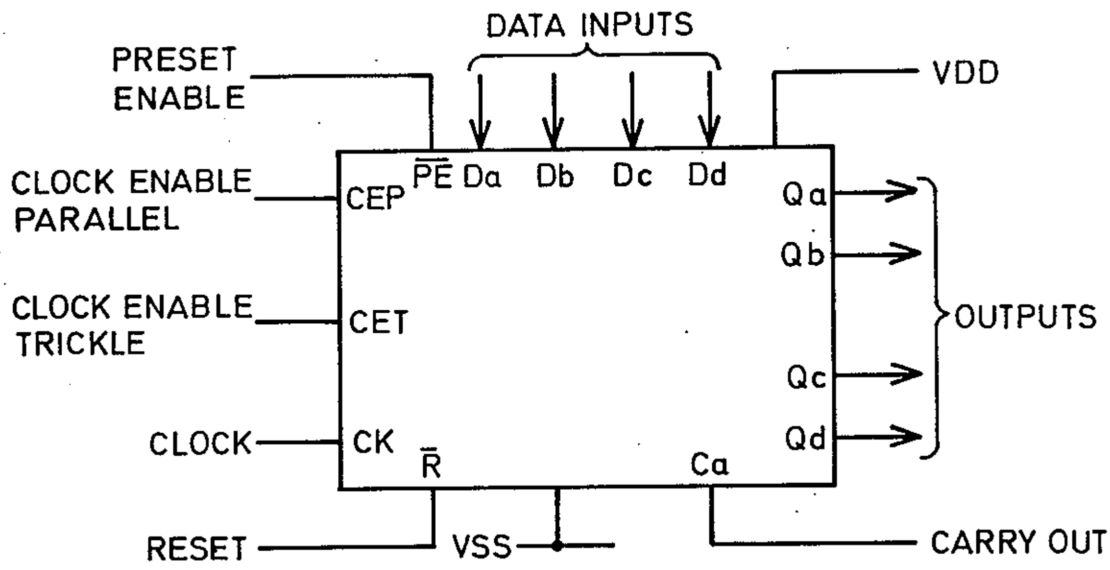
Q7 = CK1 ÷ 100

Q8 = CK1 ÷ 100

Counting is achieved with clock enable (CE) at '1'. If CE is '0' the clock is inhibited.

The reset input must also be at '0' to enable counting. If a reset input is '1', the outputs go to '0' immediately.

Presettable Up Decade Counter 40162



Presettable Up Decade Counter Fig.App.1.6

Operation of this counter is fully synchronous (controlled by the clock) and occurs on the positive transition of the clock (CK) pulse.

If preset enable ($\overline{PE}$) is '0', information on the data inputs (Da-Dd) is transferred to the outputs (Qa-Qd) on the positive transition of the clock. If $\overline{PE}$ is '1' and CEP and CET are both '1' the counter is advanced on each positive transition of the CK input. If either CEP or CET is '0' counting is inhibited. Carry out (Ca) is normally '0' and goes to '1' when the counter reaches the maximum count, provided CET is '1'.

For counting applications the reset ($\overline{R}$) line is normally held at '1'. If $\overline{R}$ is at '0' the outputs are set to '0'.

LOW POWER SCHOTTKY (LS) INTEGRATED CIRCUITS

Supply Voltages

Vcc +5V ± 0.25V, but in this equipment Vcc is 4.8v.

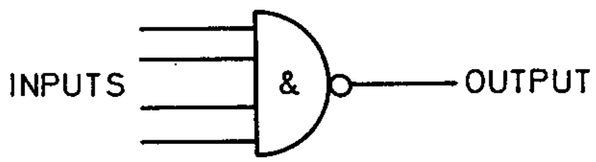
gnd 0V

Logic Levels

Logic levels are defined as follows:

	Input	Output
Logic '0'	0.8V max	0.5V max
Logic '1'	2.0V min	2.5V min

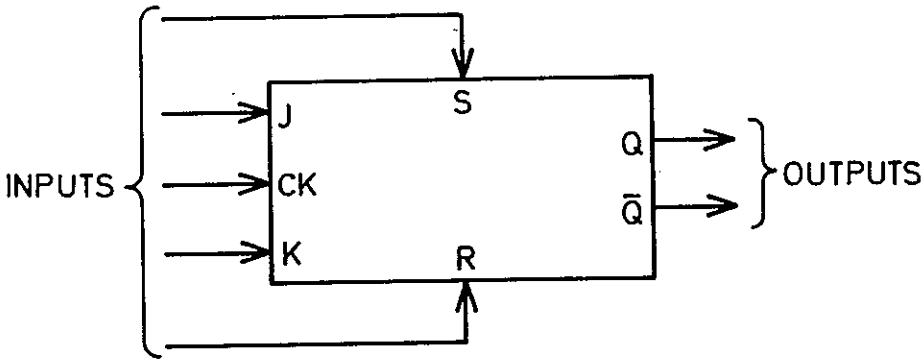
NAND Gate — LS20 Dual 4 input



WHEN ALL INPUTS ARE '1', OUTPUT IS '0'
IF ANY INPUT IS '0', OUTPUT IS '1'

NAND Gate Fig.App.1.7

Flip-flop Dual JK LS112



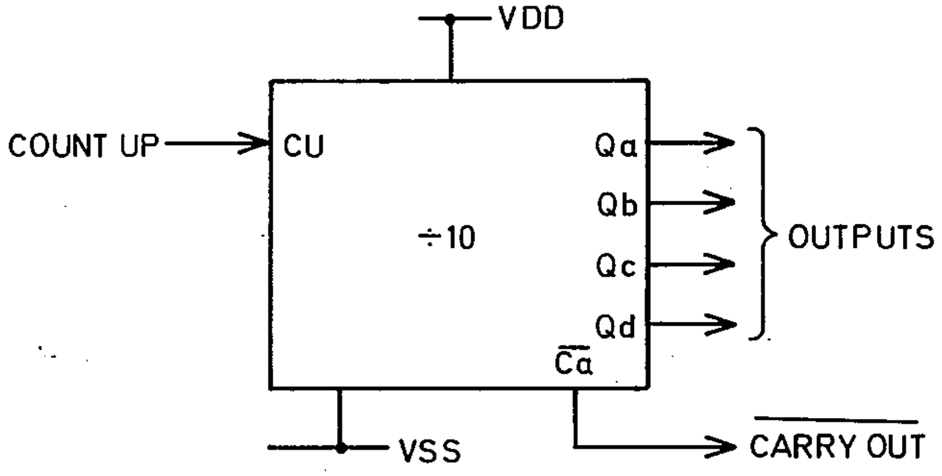
Dual J-K Flip Flop

Fig.App.1.8

$\overline{Q}$ is the inverse of Q
If set (S) is '0', Q goes to '1' immediately
If reset (R) is '0', Q goes to '0' immediately
If both R and S are '1', the flip-flop is triggered by the negative edge of the clock (CK) pulse and the outputs are related to the J and K inputs as follows.

Inputs		Outputs before CK		Outputs after CK	
J	K	Q	$\overline{Q}$	Q	$\overline{Q}$
0	0	0	1	0	1
0	0	1	0	1	0
0	1	0	1	0	1
0	1	1	0	0	1
1	0	0	1	1	0
1	0	1	0	1	0
1	1	0	1	1	0
1	1	1	0	0	1

Counter Decade Up-Counter LS192



Dual Decade Up-Counter Fig.App.1.9

A positive clock transition on the count up input causes the counter to be incremented. The carry out signal is normally a '1' and goes to '0' when the counter reaches its maximum count. Various other inputs are available but are not described here.

EMITTER COUPLED LOGIC (ECL) INTEGRATED CIRCUITS

Supply Voltages

Vcc 5V ± 0.25V, but in this equipment Vcc is 4.8v.

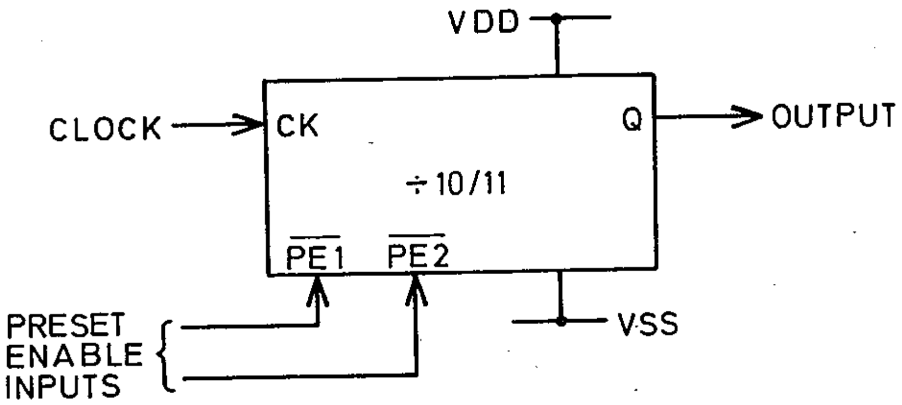
gnd 0V

Logic Levels

Logic levels for the circuits described are defined as follows:

Input Clock Voltage	Preset Enable Inputs				Output Voltage
	logic '0'		logic '1'		
	Min	Max	Min	Max	
500-800mV peak-to-peak sinusoidal AC coupled	0V	3.5V	4.1V	4.5V	Open Collector (see note)

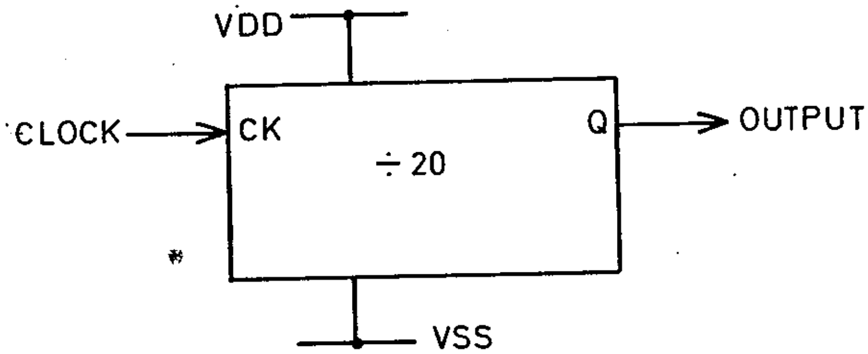
Note The logic '0' state of an open collector is 0.4V max.
The logic '1' state depends upon the supply voltage of the external collector load.



High Speed Programmable Divider (÷10/11) Fig.App.1.10

The device divides the input clock frequency by 10 when either or both preset enable inputs are high and by 11 when both inputs are low.

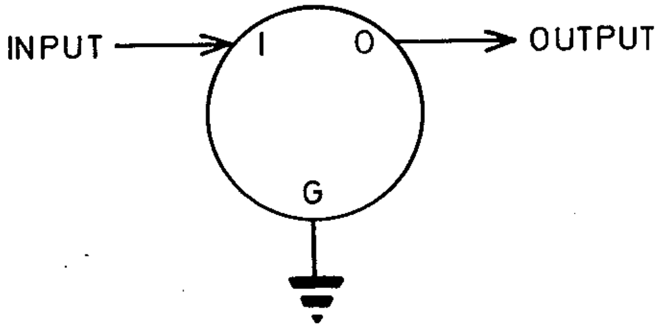
High Speed Divider (÷20) 8657



High Speed Divider (÷20) Fig.App.1.11

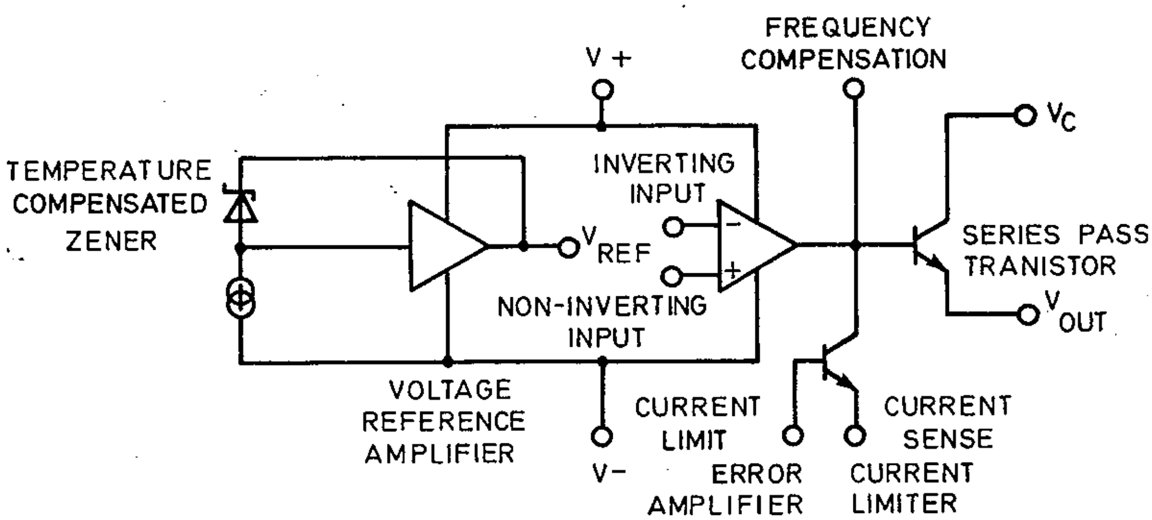
The device devides the input clock frequency by 20.

Voltage Regulators



78M08 Voltage Regulator Fig.App.1.12

The output of this device is a regulated voltage level of 8V ± 0.3V for an input level of 10 to 16V.

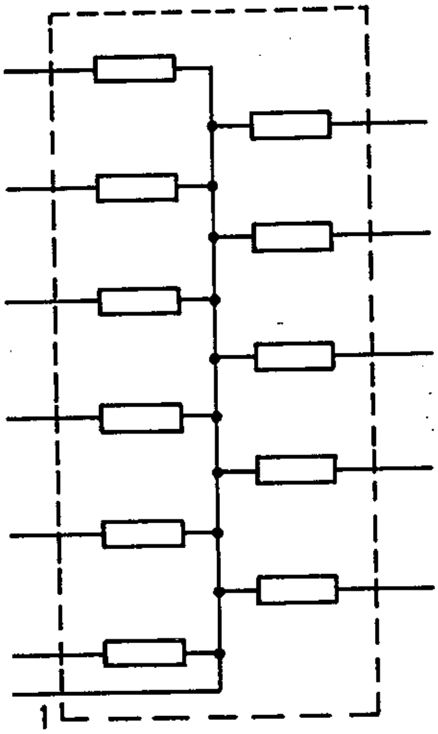


723 Voltage Regulator Fig. App.1.13

This contains a reference voltage (approx. 7.15V), an operational amplifier, a current limit and an output stage. It may be used as a conventional series or shunt regulator, or as a switching regulator for high efficiency.

THICK FILM NETWORKS

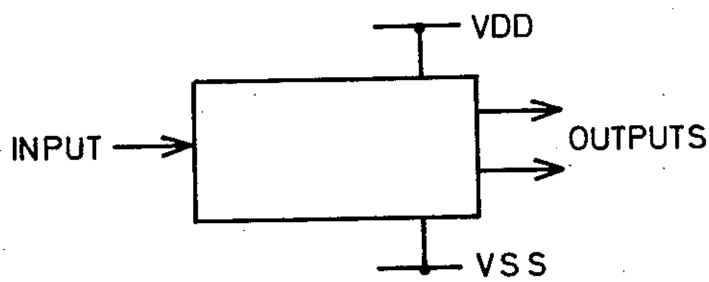
Resistor Network



Thick Film Resistor Network Fig.App. 1.14

This device provides 11 resistors with a common connection.

RF Amplifier 711496



Thick Film RF Amplifier Fig.App.1.15

The frequency at both outputs is equal to the input frequency.

CHAPTER 3

ADJUSTMENTS

CONTENTS

Sift OVER

CHAPTER 3

ADJUSTMENTS

1. INTRODUCTION

1.1 Adjustments to the synthesizer are not normally required. Random adjustments should not be made in an attempt to improve performance. The temperature compensated crystal oscillator is pre-aged, therefore adjustments are required only at infrequent intervals.

2. EQUIPMENT REQUIRED (see Part 1, Chap. 5 for further description)

(1) Multimeter

(2) Digital Frequency Meter

(3) Electronic Millivoltmeter

(4) High Impedance Oscilloscope Probe

If an electronic millivoltmeter is not available an oscilloscope with a minimum bandwidth of 80MHz is an acceptable alternative.

3. ACCESS TO PRINTED CIRCUIT BOARD

3.1 Reference should be made to Part 1 Chapter 7 for the method of access to the synthesizer printed circuit board.

4. POWER SUPPLY CIRCUIT

(1) Leave the synthesizer board connected as normal and provide a power supply via the main unit.

(2) Connect the voltmeter +ve lead to pin 36 on the board and the -ve lead to chassis. Switch on the power supply and the equipment and check that the voltmeter indicates approximately 12 volts. (The synthesizer will function satisfactorily with supply voltages in the range 10V to 16V but a nominal 12V input is desirable for setting-up).

(3) Transfer the +ve lead to board TP 46 and check for an indication of 4.8V ± 0.1V. If necessary, adjust potentiometer R33 to obtain the correct level.

NOTE: A voltage level of 5.5V should never be exceeded.

5. FREQUENCY STANDARD

(1) Ideally this operation should be carried out at a temperature of 25°C ±2°C. If the temperature is significantly different, allowance must be made for the effect of temperature.

(2) Check that the supply voltage is correct (see para.3.4).

(3) Connect the digital frequency meter via the high impedance oscilloscope probe to pin 26 (earth) and pin 27.

(4) Set the front panel Mode switch to USB.

(5) Check that the Digital Frequency Meter indicates 34MHz ±10Hz. If the frequency is incorrect, adjust R37 as required.

5.1 An alternative method to check the frequency standard, without removing the synthesizer cover, is also available.

(1) Connect the front panel BNC socket (6SKT4) to the RF Power Meter via the sniffer box and connect the Frequency Meter to the sniff output.

(2) Set the front panel frequency selection switches to 15.0000MHz and the MODE switch to TUNE.

(3) Tune the ATU and check that the Frequency Meter indicates 15.0000MHz ±5Hz.

If the frequency is incorrect, adjust R37 as required by means of the hole in the lid located directly above R37. An insulated trimming tool must be used to carry out this adjustment. (On some equipments a hole is not provided. In this case remove the lid of the synthesizer).

6. OUTPUT LEVEL AND TRACKING OF MAIN VCO

(1) Disconnect the coaxial termination from pins 1 and 2 on the board.

(2) Connect the 50 ohm input of the electronic millivoltmeter to pins 1 and 2 via a 50 ohm coaxial cable.

NOTE: If an oscilloscope is used as an alternative to the electronic millivoltmeter, connect a 50 ohm terminating resistor between pins 1 and 2.

(3) Connect the voltmeter ±ve lead to board pin 38 and the -ve lead to chassis.

(4) Set the front panel frequency switches to 2.000MHz. Switch on the power.

(5) Adjust L1 to give a reading of 1.8V ± 50mV on the voltmeter at pin 38.

(6) Adjust R4 to give a reading of 580mV ±20mV r.m.s. on the millivoltmeter or 1.6V ±0.1V peak-to-peak on the oscilloscope at pins 1 and 2.

(7) Repeat steps (5) and (6) until no further adjustment is required.

(8) Replace control lead to pins 1 and 2.

7. OUTPUT LEVEL AND TRACKING OF 34/36.8MHz VCO

(1) Disconnect the coaxial termination from pins 26 and 27 on the board.

(2) Connect the 50 ohm input of the electronic millivoltmeter to pins 26 and 27 via a 50 ohm coaxial cable.

NOTE: If an oscilloscope is used as an alternative to the electronic millivoltmeter, connect a 50 ohm terminating resistor between pins 26 and 27.

(3) Connect the voltmeter +ve lead to board pin 52 and the -ve lead to chassis.

(4) Set the front panel Mode switch to USB. Switch on the power.

(5) Adjust L7 to give a reading of 2.4V ±100mV on the voltmeter at pin 52.

(6) Adjust R54 to give a reading of 240mV ±10mV r.m.s. on the millivoltmeter or 680mV ±25mV peak-to-peak on the oscilloscope at pins 26 and 27.

(7) Repeat steps (5) and (6) until no further adjustment is required.

(8) Replace coaxial lead to pins 26 and 27.

8. RE-ASSEMBLY

8.1 Refer to Part 1, Chapter 7 for re-assembly instructions.

CHAPTER 4

FAULT LOCATION

CONTENTS

CHAPTER 4

FAULT LOCATION

1. INTRODUCTION

1.1 The flow charts, tables 1 to 4 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.

2. TEST EQUIPMENT REQUIRED

2.1 The equipment required for fault location is selected from the list given in Chap. 5 of Part 1. The following equipment is usually adequate:

(a) Digital Frequency Meter

(b) Oscilloscope (with high impedance probe)

(c) Digital Voltmeter

(d) Multimeter

3. CMOS HANDLING PRECAUTIONS

3.1 The input impedance of a CMOS device is of the order of 10^{14} ohms. The breakdown 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 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 especially 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.

4. PROCEDURE

5. General

5.1 A short circuit or broken connection to the synthesizer may give the impression of a synthesizer fault, so all connections (including the flexible wire) should be checked prior to investigating the synthesizer board.

5.2 If a particularly obscure fault is encountered, it may be advantageous to remove the appropriate link connecting the phase comparator to the VCO and apply an external d.c. voltage to the control line of the oscillator.

5.3 When measuring the frequency at a point on the board it is preferable to use the oscilloscope (X10) probe, with the frequency meter, although some indication may be seen on the oscilloscope itself.

5.4 The following notes should be read in conjunction with the flow charts:

6. Power Supplies

6.1 The 8V line is supplied by a linear regulator ML18. An apparent fault in ML18 may be caused by excessive load current. If the voltage on TP 45 is zero, a direct short circuit to ground is the most likely cause and may be verified by measuring the resistance between TP 45 and ground. If the voltage is less than 7.5V, C27 or ML18 may be faulty.

6.2 The 4.8V line is supplied by a switching regulator ML17 and associated components. A 100kHz squarewave should be present at the collector of TR6. If ML17 is operating correctly, the d.c. voltage at ML17 pins 4 and 5 should be 4.8V.

6.3 A useful check for faulty components consuming excessive current external to the power supply is to measure the voltage drop across decoupling resistors and inductors. The value should be less than 1V and 0.3V respectively.

Decoupling Resistors		Decoupling Inductors
R2	R43	L3
R14	R53	L6
R15	R56	L9
R16		
R28		
R38		

NOTE: If the 4.8V supply is adjusted to a value greater than about 6V, 2TR9 may be damaged due to excessive current flow through 2D8.

6.4 If a fault is suspected in a circuit other than the power supply, a check should first be made for the correct supply voltage to the circuit under test, as the use of decoupling components may allow a short on the supply, for example, to cause only a localised supply failure.

7. Reference Divider

7.1 Check for a 5.6MHz signal at TP47. If absent, check TCXO, R39 and ML19. Check that the 1.4MHz, 100kHz, 20kHz, 1kHz, 500Hz, 100Hz and 10Hz signals are present. CMOS dividers have buffered outputs, so even if one output is absent the others may be present.

8. Main Phase Comparator

8.1 When the main loop is in lock, both inputs to the phase comparator TP50 and TP40 (narrow pulse) should be 100Hz. If the frequency at TP40 is greater than 100Hz, there should be a composite waveform at TP44 and extremely narrow pulses at TP43. TR2 collector should therefore be at 0V, TR3 should be switched by the composite waveform and the d.c. voltage on pin 37 should be less than 1.3V.

8.2 If the frequency at TP40 is less than 100Hz, the composite waveform should be present on TP43 and extremely narrow pulses on TP44. TR3 collector should be at 8V, TR2 switched by the composite waveform and the d.c. voltage on pin 37 should be greater than 6.4V. If the waveforms on TP43 and TP44 are incorrect, check ML15, G5 and G6.

8.3 If excessive 100Hz sidebands are suspected on the main VCO frequency output, connect TP42 to earth. This opens the loop but the VCO is still controlled by the voltage on C19. If the frequency rises or falls rapidly (by more than several hundred hertz per second) there must be a leakage path associated with C19. If the frequency rises, suspect D6 and TR4; if it falls suspect D5 and C19.

8.4 If this effect is serious it may produce an out-of-lock indication although the VCO output frequency is correct.

9. Main VCO and RF Amplifier

9.1 An apparent fault in the VCO and RF amplifier may in fact be caused by incorrect settings of L1 and R4. If this is suspected, refer to Chap. 3 para. 6 for adjustment procedures.

9.2 Check that a d.c. voltage is present on pin 38. If not, suspect the phase comparator output or a short circuit associated with the control line. If an a.c. signal is present on ML1 pin 1 but absent on ML1 pins 6 and 10, suspect ML1. If no signal is present on ML1 pin 1, check that the d.c. voltage at this point is greater than 5V. If not, check R2, R3 and C2.

9.3 Measure the voltage at the anode of D3. If it is zero, suspect TR1, L2, D3 or R4.

10. Main Prescaler

10.1 The input clock required by ML2 pins 15 and 16 is a sinusoidal signal of amplitude 500 to 800mV p-p. A signal of incorrect level may cause ML2 to operate incorrectly. If this is the case, adjust the VCO output in accodance with Chap.3 para.6.

10.2 Set the frequency selection switches SA1 (100Hz) and SA2 (1kHz) to zero. Measure the frequency at ML2 pin 16 and ensure that the frequency at TP39 is 1/100 of this.

10.3 If SA1 and SA2 have no effect on the output frequency set both switches to 5. Ensure that a narrow pulse is present on ML2 pin 2. If it is present, suspect ML2; if not, suspect R9, R12, D4 or the swallow-counter.

11. Swallow Counter

11.1 If the 100Hz frequency selection switch does not produce the expected 100Hz digit in output frequency, check that the correct BCD data inputs to ML4 are produced by SA1, as follows:-

	Da	Db	Dc	Dd
Switch setting 600Hz	0	1	1	0
Switch setting 900Hz	1	0	0	1

If the above codes are not produced, suspect SA1, the film wire or ML6. Similarly, check that the correct BCD code data inputs to ML7 are produced by SA2, as follows:-

	Da	Db	Dc	Dd
Switch setting 7kHz	1	1	1	0
Switch setting 8kHz	0	0	0	1

11.2 If the above codes are not produced, suspect SA2, the film wire or ML6. If the 100Hz and 1kHz digits in the output frequency are permanently at zero for all positions of both switches, set both to 5. Check for a narrow negative-going pulse on ML7 pin 7. If the pulse is present, suspect a fault in G2, D4, R12 or R9; if not, suspect G3, ML4 or ML7.

11.3 An apparent fault in the output of G1 may in fact be caused by a fault in any of the three inputs clocked by G1. R64 may be used to help in locating the fault.

12. Main Divider

12.1 When the loop is closed, the basis of the fault-finding technique is to measure the input and output frequencies of main divider.

If the loop is out-of-lock, set the frequency selection switches to 4.6000MHz. Check whether the main divider is functioning correctly be measuring the frequency at TP39; it should be 4000 times the frequency at TP41. If the frequency at TP39 is not as predicted, the main divider is at fault.

12.2 If a signal is present at TP39 but not at TP41, check the clock inputs of ML14, ML13, ML10 and ML8 in turn to determine which counter is faulty. If a signal is present at TP41, check whether the narrow pulse signal on TP40 is of the same frequency. If not, suspect a fault in ML9 or ML12A.

NOTE: This test is valid only if BTP4 is not permanently at logic '1'.

12.3 Note that ML12 pin 1 drives the inputs of seven integrated circuits. An apparent fault in the output of ML12A may therefore, be caused by one of these inputs. Resistors R65, R66 and R67 may be used to facilitate location of the fault.

12.4 If the loop is in lock but the VCO output frequency 10kHz, 100kHz, or MHz digits do not correspond to the appropriate switch settings, the following procedure should be followed. Note that the VCO output frequency equals 35.4MHz plus the switch settings if the loop is operating correctly.

12.5 If the VCO output frequency 10kHz digit is incorrect check that the correct data inputs to ML8 are produced for the appropriate switch settings, as given at the end of this paragraph. If not, check the switch, the film wire, ML6 and ML11. If the correct codes are produced, check ML9 pins 3, 2 and 12 for a signal on each.

12.6 If the VCO output frequency 100kHz digit is incorrect, repeat the above test for the 100kHz switch and ML10. Check ML10 pins 2 and 6 for a signal on each if the input code is correct.

12.7 If the VCO output frequency MHz digit is incorrect, repeat the test for the MHz switch and ML13. Check ML13 pins 6 and 11 for a signal on each if the input code is correct.

Switch Setting	Data Inputs			
	Da	Db	Dc	Dd
6	0	1	1	0
9	1	0	0	1

13 34/36.8MHz Phase Comparator

13.1 When the 34/36.8MHz loop is in lock, both inputs to the phase comparator, at TP55 and TP56, should be 20kHz. If the frequency at TP56 is greater than 20kHz, there should be a composite waveform at TP60 and extremely narrow pulses at TP59. C56 should therefore be discharged through R61 and D14 and the voltage at pin 51 should be approximately 1.3V

13.2 If the frequency at TP56 is less than 20kHz the composite waveform should be present on TP59 and the narrow pulses on TP60. Wide pulses on TP59 charge C56 and should produce a voltage at pin 51 of greater than 6.5V. If the waveforms on TP59 and TP60 are not as predicted, check ML31 and G17.

13.3 If excessive 20kHz sidebands are suspected on the 34/36.8MHz frequency output, connect TP57 to TP58. This opens the loop but the VCO is still controlled by the voltage on C56. If the frequency rises or falls rapidly (by more than 100kHz per second) there must be a leakage path associated with C56. If the frequency rises, suspect D14; if it falls, suspect D13 or D11.

13.4 If this effect is serious, it may produce an out-of-lock indication although the VCO output frequency is correct.

14. 34/36.8MHz VCO and RF Amplifier

14.1 An apparent fault in the VCO and RF amplifier may in fact be caused by incorrect settings of L7 and R54. If this is suspected, adjust as necessary in accordance with Chap. 3 Para. 7. Check that a d.c. voltage is present on pin 52. If not, suspect the phase comparator output or a short circuit associated with the control line. If an a.c. signal is present on ML26 pin 1 but absent on ML26 pins 6 and 10, suspect ML26. If there is no signal present on ML26 pin 1, check that the d.c. voltage at this point is equal to that at pin 52. Measure the voltage at the anode of D12. If it is zero, suspect TR8, R53, L8, D12 or R54.

15. 34/36.8MHz Prescaler

15.1 ML27 is a fixed divide-by-20 counter. The frequency at ML27 pin 1 should be 20 times that at TP53. If the device does not operate correctly, check ML27, the pull-up resistor R57 and the input clock which should be a sinusoidal signal with a level of 500mV to 800mV p-p. If the input level is incorrect, reset the output level of the 34/36.8MHz VCO accoding to Chap. 3 Para. 7.

16. 34/36.8MHz Programmed Divider

16.1 If the 34/36.8MHz loop is out-of-lock, set the front panel Mode switch to USB. Check whether the programmed divider is operating correctly by measuring the frequency at TP53 which should be 85 times that at TP56. If the frequency at TP53 is not as predicted, the programmed divider is at fault.

16.2 If a signal is present at TP53 but not at TP56 check ML29 pins 7, 9 and 10 to determine whether ML28, ML29 or G16 is faulty. If a signal is present at TP56, check that the narrow pulse signal at TP54 is at the same frequency.

16.3 If the loop is in lock but the VCO output frequency is incorrect, check that, when USB is selected, ML28 pins 3, 4 and 5 are at logic 1 (8V). Similarly, check that when LSB is selected, the pins are at logic 0 (0V).

17. Out of Lock Circuit

17.1 If the out of lock indicator is enabled check the pulse widths at ML25 pins 2 and 8. If the pulse width on either or both pins is greater than 5μs, the fault lies elsewhere in the synthesizer. For the case of both pulse widths being less than 5μs, ML25 pin 10 should be '0'. If not, check R46, R47, C36, C37, G13 and G14.

17.2 When a '0' is present on ML25 pin 4, the out of lock tone and mute lines should not be fired. If a '1' is present on the pin, the 1.4MHz signals should be muted and the out of lock tone present. If the above conditions are not satisfied, check G15 for a faulty out of lock tone and R48, R49, R50 and TR7 for a faulty mute signal.

18. FAULT LOCATION FLOW CHARTS

18.1 The fault location flow charts, Tables 1-4, are included to assist in locating a fault. They provide a guide to the area or group of components where the fault may exist and are not intended to be exhaustive or to indicate the faulty component. When using the flow charts, always start with Table No.1.

CHAPTER 5

LIST OF COMPONENTS

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
Resistors	Ohms				
R1	5.6K	Carbon Film	¼	5	926561
R2	220	Carbon Film	¼	5	926546
R3	220	Carbon Film	¼	5	926546
R4	2.2K	Potentiometer			920310
R5	47K	Carbon Film	¼	5	926568
R6	2.2K	Carbon Film	¼	5	927192
R7	1.5K	Carbon Film	¼	5	926556
R8	2.2K	Carbon Film	¼	5	927192
R9	2.2K	Carbon Film	¼	5	927192
R10	1.5K	Carbon Film	¼	5	926556
R11	1.5K	Carbon Film	¼	5	926556
R12	3.9K	Carbon Film	¼	5	926559
R13	180K	Carbon Film	¼	5	927992
R14	100	Carbon Film	¼	5	927189
R15	100	Carbon Film	¼	5	927189
R16	220	Carbon Film	¼	5	926546
R17	3.9K	Carbon Film	¼	5	926559
R18	47K	Carbon Film	¼	5	926568
R19	12K	Carbon Film	¼	5	926986
R20	12K	Carbon Film	¼	5	926986
R21	2.2K	Carbon Film	¼	5	927192
R22	2.2K	Carbon Film	¼	5	927192
R23	180K	Carbon Film	¼	5	927992
R24	680	Carbon Film	¼	5	927190
R25	680	Carbon Film	¼	5	927190
R26	12K	Carbon Film	¼	5	926986
R27	180K	Carbon Film	¼	5	927992
R28	680	Carbon Film	¼	5	927190
R29	330K	Carbon Film	¼	5	926673
R30	47K	Carbon Film	¼	5	926568
R31	47K	Carbon Film	¼	5	926568
R32	3.9K	Carbon Film	¼	5	926559
R33	4.7K	Potentiometer			920311
R34	12K	Carbon Film	¼	5	926986

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
R35	2.2K	Carbon Film	$\frac{1}{4}$	5	917292
R36	100	Carbon Film	$\frac{1}{4}$	5	927189
R37	10K	Potentiometer			920312
R38	15	Carbon Film	$\frac{1}{4}$	5	927186
R39	1.5K	Carbon Film	$\frac{1}{4}$	5	926556
R40	330	Carbon Film	$\frac{1}{4}$	5	927991
R41	330	Carbon Film	$\frac{1}{4}$	5	927991
R42	3.9K	Carbon Film	$\frac{1}{4}$	5	926559
R43	100	Carbon Film	$\frac{1}{4}$	5	927189
R44	180K	Carbon Film	$\frac{1}{4}$	5	927992
R45	330K	Carbon Film	$\frac{1}{4}$	5	926673
R46	47K	Carbon Film	$\frac{1}{4}$	5	926568
R47	47K	Carbon Film	$\frac{1}{4}$	5	926568
R48	27K	Carbon Film	$\frac{1}{4}$	5	927193
R49	6.8K	Carbon Film	$\frac{1}{4}$	5	926562
R50	3.9K	Carbon Film	$\frac{1}{4}$	5	926559
R51	180K	Carbon Film	$\frac{1}{4}$	5	927992
R52	5.6K	Carbon Film	$\frac{1}{4}$	5	926561
R53	220	Carbon Film	$\frac{1}{4}$	5	926546
R54	4.7K	Potentiometer			920311
R55	47K	Carbon Film	$\frac{1}{4}$	5	926568
R56	100	Carbon Film	$\frac{1}{4}$	5	927189
R57	3.9K	Carbon Film	$\frac{1}{4}$	5	926559
R58	47K	Carbon Film	$\frac{1}{4}$	5	926568
R59	3.9K	Carbon Film	$\frac{1}{4}$	5	926559
R60	27K	Carbon Film	$\frac{1}{4}$	5	927193
R61	27K	Carbon Film	$\frac{1}{4}$	5	927193
R62	180K	Carbon Film	$\frac{1}{4}$	5	927992
R63	12K	Carbon Film	$\frac{1}{4}$	5	926986
R64	39	Carbon Film	$\frac{1}{4}$	5	927990
R65	39	Carbon Film	$\frac{1}{4}$	5	927990
R66	39	Carbon Film	$\frac{1}{4}$	5	927990
R67	39	Carbon Film	$\frac{1}{4}$	5	927990
R68	1.5K	Carbon Film	$\frac{1}{4}$	5	926556
<u>Capacitors</u>					
C1	.01μF	Ceramic Plate	100	10	924031
C2	10μF	Tantalum	16	20	923569
C3	.001μF	Ceramic Plate	100	10	924031
C4	100pF	Ceramic Plate	63	2	919723
C5	47μF	Tantalum	16	20	923804
C6	.001μF	Ceramic Plate	100	10	924031
C7	10μF	Tantalum	16	20	923569

TABLE NO. 2

FAULT LOCATION FLOW CHART – POWER SUPPLIES

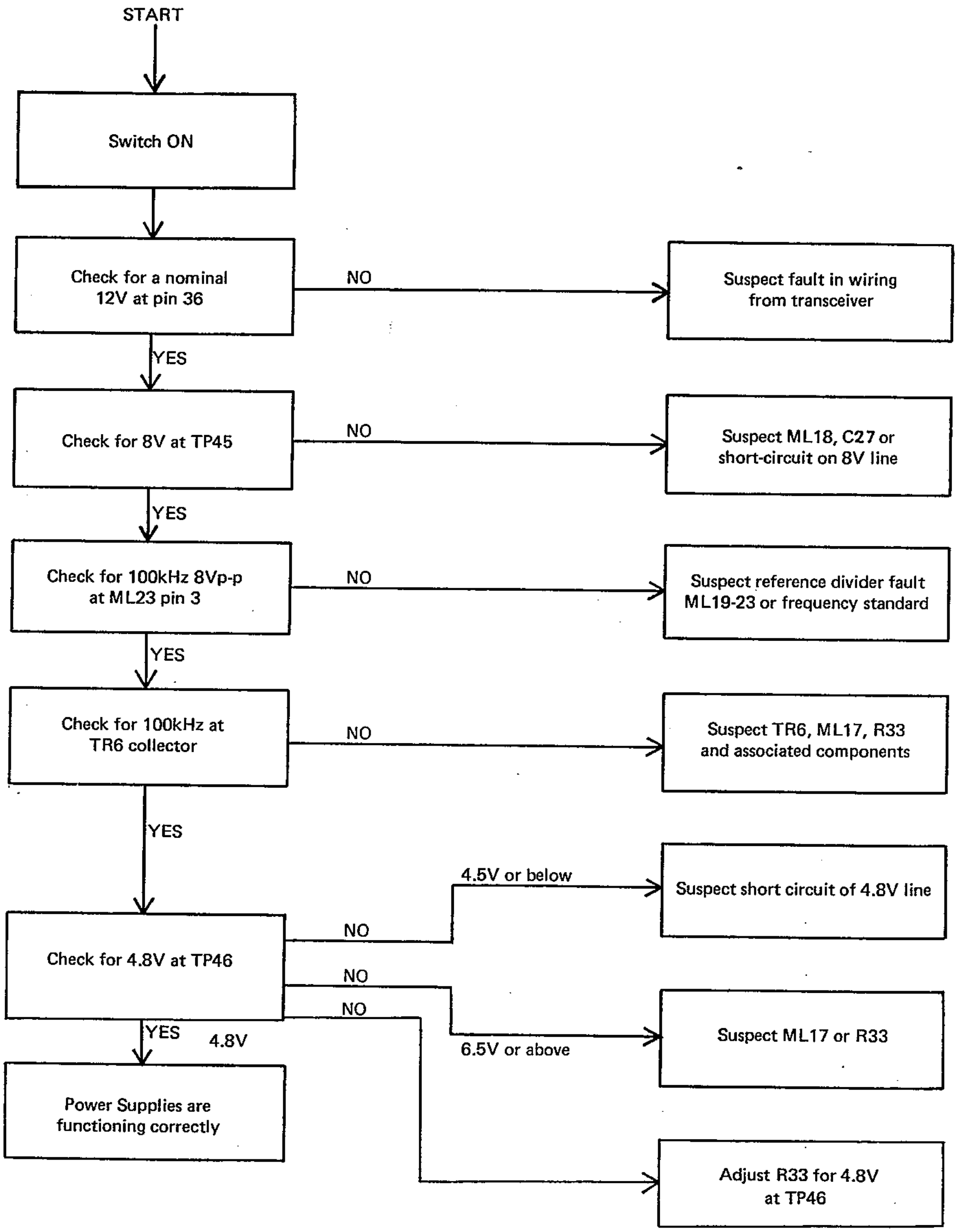
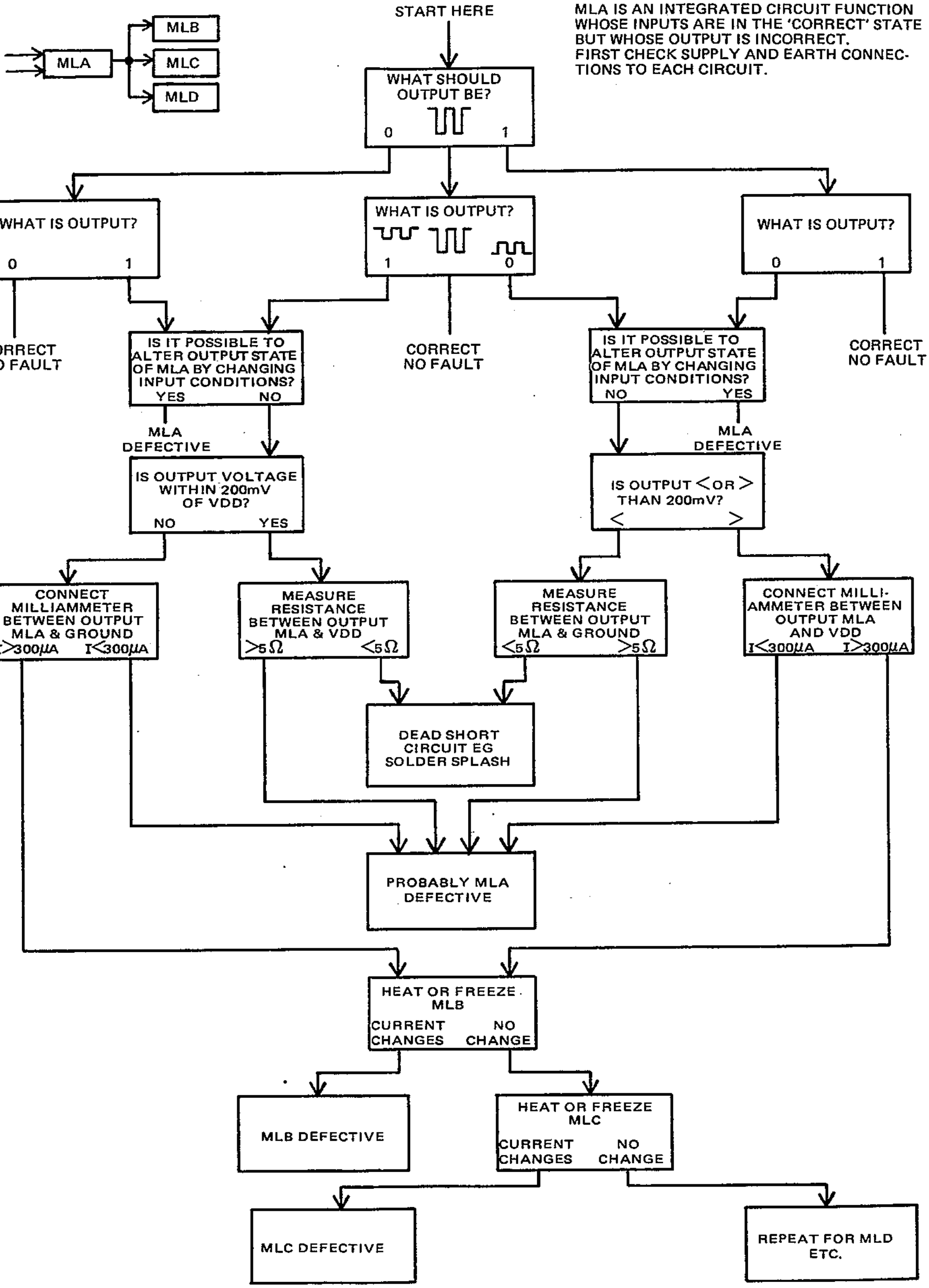


TABLE NO. 5

FAULT LOCATION FLOW CHART
CMOS INTEGRATED CIRCUITS

MLA IS AN INTEGRATED CIRCUIT FUNCTION WHOSE INPUTS ARE IN THE 'CORRECT' STATE BUT WHOSE OUTPUT IS INCORRECT.
FIRST CHECK SUPPLY AND EARTH CONNECTIONS TO EACH CIRCUIT.



Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
C8	.001µF	Ceramic Plate	100	10	924031
C9	.001µF	Ceramic Plate	100	10	924031
C10	.01µF	Ceramic Plate	100	20	927395
C11	.01µF	Ceramic Plate	100	20	927395
C12	10µF	Tantalum	16	20	923569
C13	.01µF	Ceramic Plate	100	20	927395
C14	10µF	Tantalum	16	20	923569
C15	22pF	Ceramic Plate	63	2	919649
C16	22pF	Ceramic Plate	63	2	919649
C17	22pF	Ceramic Plate	63	2	919649
C18	10µF	Tantalum	16	20	923569
C19	2.2µF	Polycarbonate	63	20	928257
C20	.33µF	Polycarbonate	63	20	928257
C21	47µF	Tantalum	16	20	923804
C22	.01µF	Ceramic	100	20	927395
C23	10µF	Tantalum	16	20	923569
C24	47µF	Electrolytic	25	+50-10	921525
C25	.001µF	Ceramic Plate	100	10	924031
C26	.01µF	Ceramic Plate	100	20	927395
C27	10µF	Tantalum	16	20	923569
C28	47µF	Tantalum	16	20	923804
C29	.01µF	Ceramic Plate	100	20	927395
C30	.01µF	Ceramic Plate	100	20	927395
C31	10µF	Tantalum	16	20	923569
C32	.001µF	Ceramic Plate	100	10	924031
C33	10µF	Tantalum	16	20	923569
C34	.01µF	Ceramic Plate	100	20	927395
C35	NOT USED				
C36	100pF	Ceramic Plate	63	2	919723
C37	100pF	Ceramic Plate	63	2	919723
C38	10µF	Tantalum	16	20	923569
C39	NOT USED				
C40	.001µF	Ceramic Plate	100	10	924031
C41	10pF	Ceramic Plate	63	2	927995
C42	100pF	Ceramic Plate	53	2	919723
C43	10µF	Tantalum	16	20	923569
C44	100pF	Ceramic Plate	63	2	919723
C45	.001µF	Ceramic Plate	100	10	924031
C46	47µF	Tantalum	16	20	923804
C47	.01µF	Ceramic Plate	100	2	927395
C48	.001µF	Ceramic Plate	100	10	924031
C49	.01µF	Ceramic Plate	100	20	927395
C50	.01µF	Ceramic Plate	100	20	927395
C51	10µF	Tantalum	16	20	923569

Cat. Ref.	Value	Description	Rat	Tol. %	Racal Part Number
C52	.01μF	Ceramic Plate	100	20	927395
C53	.01μF	Ceramic Plate	100	20	927395
C54	.01μF	Ceramic Plate	100	20	927395
C55	10μF	Tantalum	16	20	923569
C56	.33μF	Polyester	63	20	928257
C57	.047μF	Polyester	100	20	925247
C58	1μF		35		919635

Diodes

D1		DKV 6522B			925082
D2		DKV 6522B			925082
D3		IN 4149			914898
D4		IN 4149			914898
D5		Pad 5			917999
D6		Pad 5			927999
D7		IN 4001			915266
D8		IN 4149			914898
D9		ZPY6.2			924963
D10		IN 4149			914898
D11		MV 1642			917423
D12		IN 4149			914898
D13		IN 4149			914898
D14		IN 4149			914898

Transistors

TR1		W300C			928456
TR2		BFX 48			915231
TR3		2N 2369			906842
TR4		AR 711503			711503
TR5		BC 109			914900
TR6		2N4037			922991
TR7		BC 109			914900
TR8		W300C			928456

Integrated Circuits

ML1		CR 711496 Thick Film			711496
ML2		SP8690B			928008
ML3		74LS192			928006
ML4		4029			927010
ML5		4011			922994

Cct. Ref.	Value	Description	Rat	Tol. ± %	Racal Part Number
ML6	150K	Single-inLine Film Resistor Module		± 5	928465
ML7		4029			927010
ML8		4029			927010
ML9		4078			928000
ML10		4029			927010
ML11	150K	Single-in-Line Film Resistor Module		± 5	928465
ML12		4013			922996
ML13		4029			927010
ML14		4029			927010
ML15		4013			922996
ML16		4011			922994
ML17		723 PC			925040
ML18		78MO8HC			928005
ML19		74LS112			928004
ML20		74LS20			928003
ML21		4011			922994
ML22		40162			928001
ML23		4518			928002
ML24		4518			928002
ML25		4023			922999
ML26		CR 711496 Thick Film			711496
ML27		SP8657B			928007
ML28		40162			928001
ML29		40162			928001
ML30		4001			922992
ML31		4013			922996

Inductors

L1					710372
L2	10µH			10	926225
L3	68µH			5	926338
L4	68µH			5	926338
L5					76533
L6	68µH			5	926338
L7					710372
L8	10µH			10	926225

Cct. Ref.	Value	Description	Rat.	Tol %	Racal Part Number
Transformers					
T1		CT 76485			
T2		CT 76485			
Temperature Compensated Crystal Oscillator					
TCXO	6MHz	BR 711467			711467
Switches(Rotary)					
SA1		BR 711472			711472
SA2		BR 711472			711472
SA3		BR 711472			711472
SA4		BR 711472			711472
SA5		BR 711471			711471

PART 6

ILLUSTRATED MECHANICAL PARTS LIST

PART 6

ILLUSTRATED MECHANICAL PARTS LIST

CONTENTS

PART 6

ILLUSTRATED MECHANICAL PARTS LIST

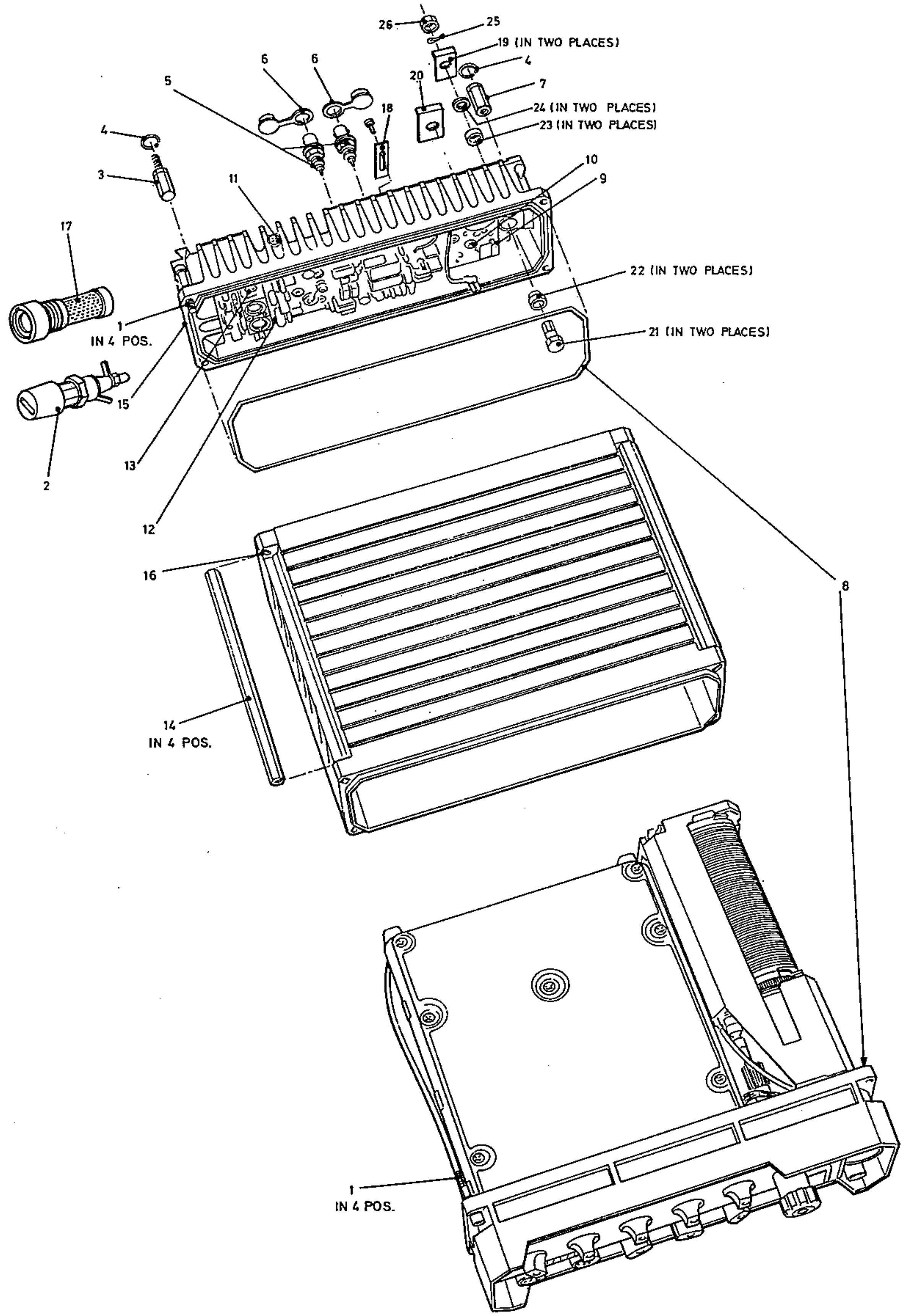
INTRODUCTION

This part gives illustrations of mechanical parts which may be required as replacements. When ordering replacement parts please quote the Item No. Description and Racal Part Number, as given on the tables, as well as the quality required. Electrical components are given in the Components List at the rear of each part of the handbook.

ILLUSTRATED MECHANICAL PARTS LIST

TABLE 1 OVERALL ASSEMBLY

ITEM No. (See Fig. 1)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
1	Screw, module-sleeve securing M4 x25	8	928277
	Crinkle washer M4	8	922408
2	Fuse holder assembly	1	927656
	Fuse link	3	922454
3	Insert (male)	1	703519
4	Circlip, insert retaining	2	928278
5	Socket assembly, BNC	2	905449
6	Dust Cap, BNC	2	703886
7	Insert (female)	1	703518
8	Seal, module-sleeve sealing	2	703782
9	Filter printed circuit board (see Part 3 fig.4 for details of component location)	1	703636
10	Screw, filter PCB securing M3 x 6	4	917844
	Crinkle washer M3	4	917705
11	Screw, earth	1	703873
12	Power amplifier printed circuit board (see Part 3 Fig.2 for details of component location)	1	703634
13	Screw, power amplifier PCB securing M3 x 6	4	917844
	Crinkle washer M3	4	917705
14	Tie bar	4	703686
15	Rear case	1	703405
16	Sleeve	1	703417
17	Dessicator	2 (1 spare)	909909
18	Spare Fuse cover	1	
19	Terminal (small)	1	920579
20	Terminal (large)	1	920578
21	Stud	2	703665
22	Insulating bush	2	701292
23	Insulating washer	2	701291
24	Plain washer	2	918086
25	Crinkle washer	2	917705
26	Nut	2	917825

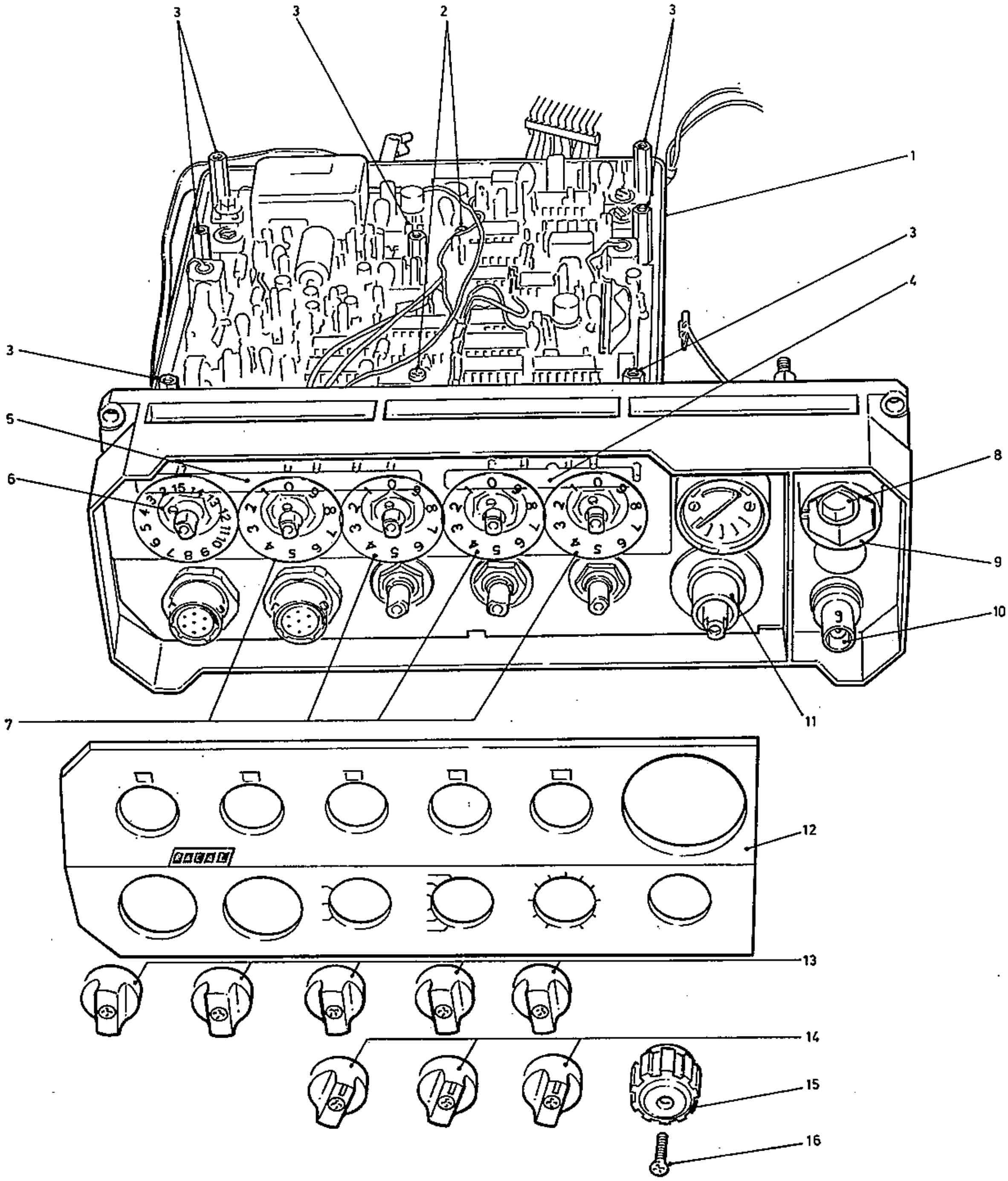


Overall Assembly **Fig.1**

ILLUSTRATED PARTS LIST

TABLE 2 FRONT PANEL/SYNTHESIZER ASSEMBLY

ITEM No. (See Fig.2)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
1	Synthesizer printed circuit board (see Part 5 Fig. 2 for details of component location)	1	703666
2	Screw, synthesizer PCB securing M3 x 5mm	9	917695
	Crinkle washer M3	9	917705
3	Pillar, synthesizer PCB securing	7	700107/35
4	Tritium light source, short	1	703825
5	Tritium light source, long	1	703824
6	Disc, MHz	1	703428
7	Disc, decadic	4	703429
8	Whip stud	1	703433
	'0' ring seal	1	919703
9	Shroud	1	703432
	'0' ring seal	1	919703
	insulating bush	1	703667
	washer	1	703668
	solder tag 0BA	1	905068
	Nut, whip stud, securing, M5 nyloc	1	919941
10	Socket assembly BNC coax	1	905449
11	Bearing, ATU decoupler	1	703649
	Clip, location	1	703685
12	Mask, front panel	1	703427
	Mask feet	3	703798
13	Knob, synthesizer	5	703424
14	Knob, transceiver	3	703425
15	Knob, ATU	1	703650
16	Screw, knob securing, CSK	9	703764



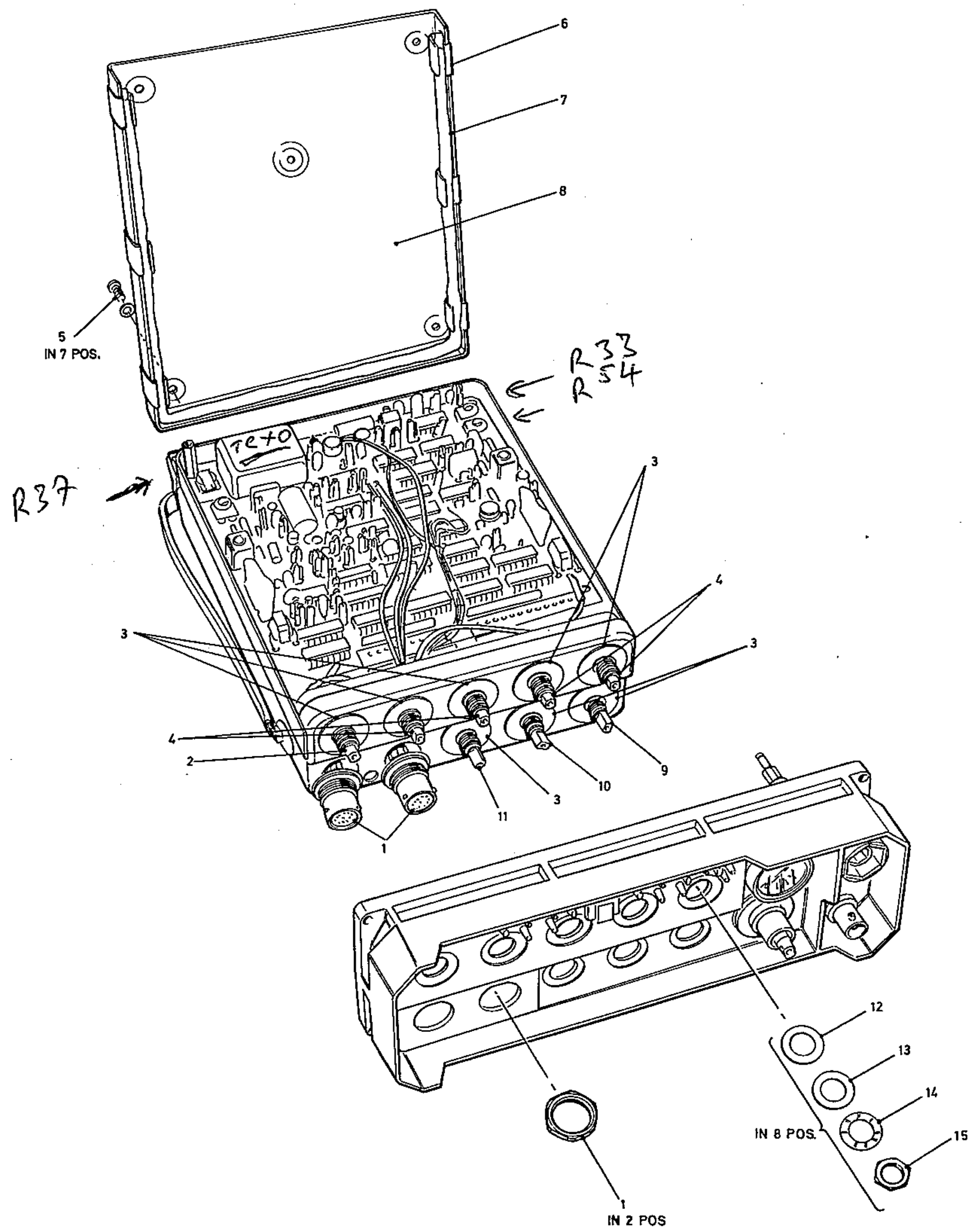
Front Panel/Synthesizer Assembly

Fig.2

ILLUSTRATED PARTS LIST

TABLE 3 TRANSCEIVER/SYNTHESIZER/FRONT PANEL ASSEMBLY

ITEM No (See Fig.3)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
1	Connector assembly, audio comprising body, 0 ring and nut	2	928128
2	Rotary switch, synthesizer	1	711471
3	Switch seal	8	703755
4	Rotary switch, synthesizer	4	711472
5	Screw, synthesizer lid securing M3 x 5	7	917695
	Crinkle washer M3	7	917705
6	Clip, seal securing	9	703789
7	Seal, synthesizer	460mm	926651
8	Lid, synthesizer	1	703419
9	Potentiometer, transceiver	1	711497
10	Rotary switch, transceiver	1	711479
11	Rotary switch, transceiver	1	711480
12	Insulating washer, switch	8	703759
13	Plain washer, switch	8	703822
14	Crinkle washer, switch	8	928585
15	Nut, switch securing	8	Issued with switch



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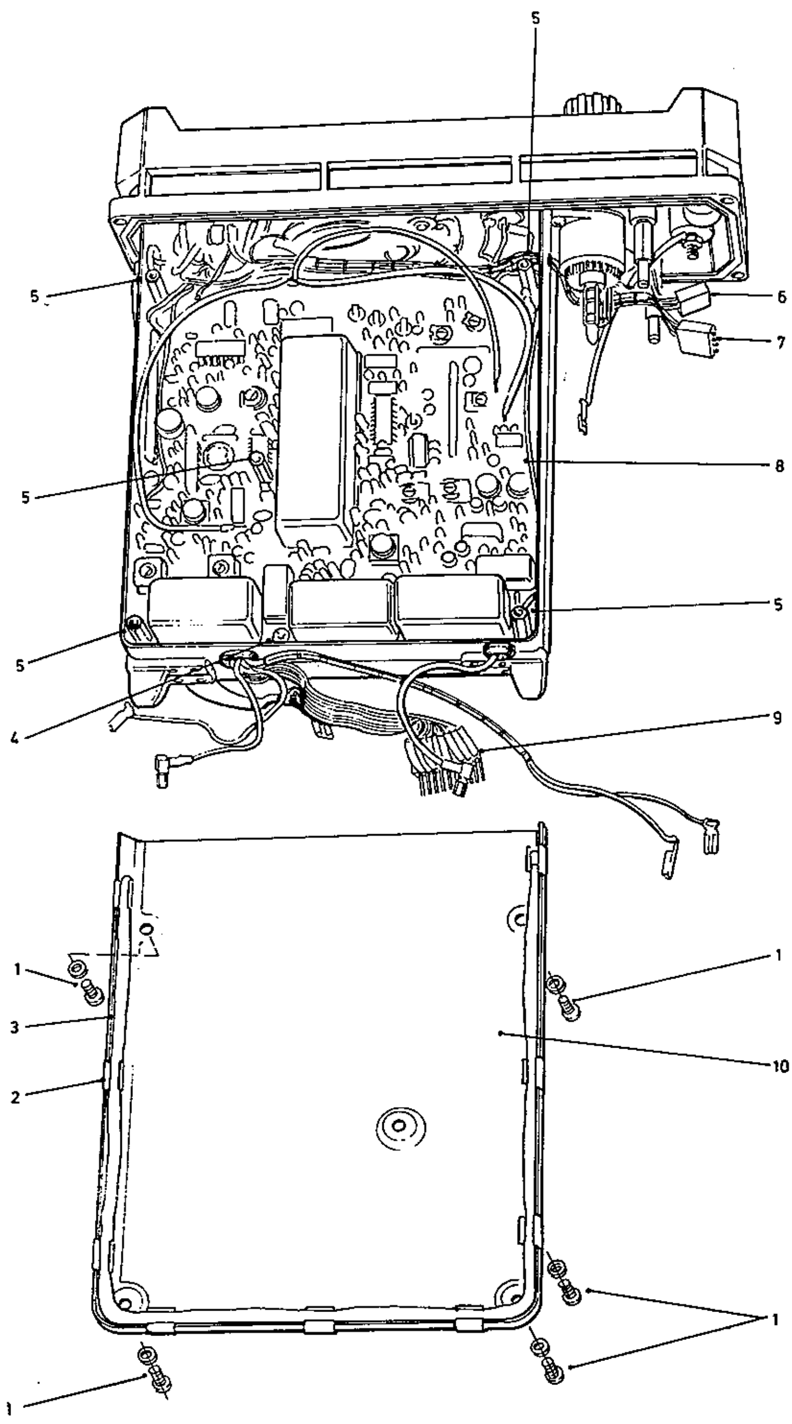
WOH7207

Transceiver /Synthesizer/Front Panel Assembly Fig.3

ILLUSTRATED PARTS LIST

TABLE 4 TRANSCEIVER/FRONT PANEL ASSEMBLY

ITEM No. (See Fig. 4)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
1	Screw, transceiver lid securing M3 x 5	5	917695
	Crinkle washer M3	5	917705
2	Clip, seal securing	9	703789
3	Seal, transceiver	472mm	926651
4	Screw, transceiver PCB securing M3 x 5	1	917695
	Crinkle washer M3	1	917705
5	Pillar, transceiver PCB securing	5	700107/42
	Crinkle washer M3	5	917705
6	Connector 4 way	1	928349
7	Connector 5 way	1	928347
8	Transceiver printed circuit board (see Part 2 Fig. 2 for details of component location)	1	703633
9	Connector 10 way	1	928345
10	Lid, transceiver	1	703953



Transceiver/Front Panel Assembly Fig.4

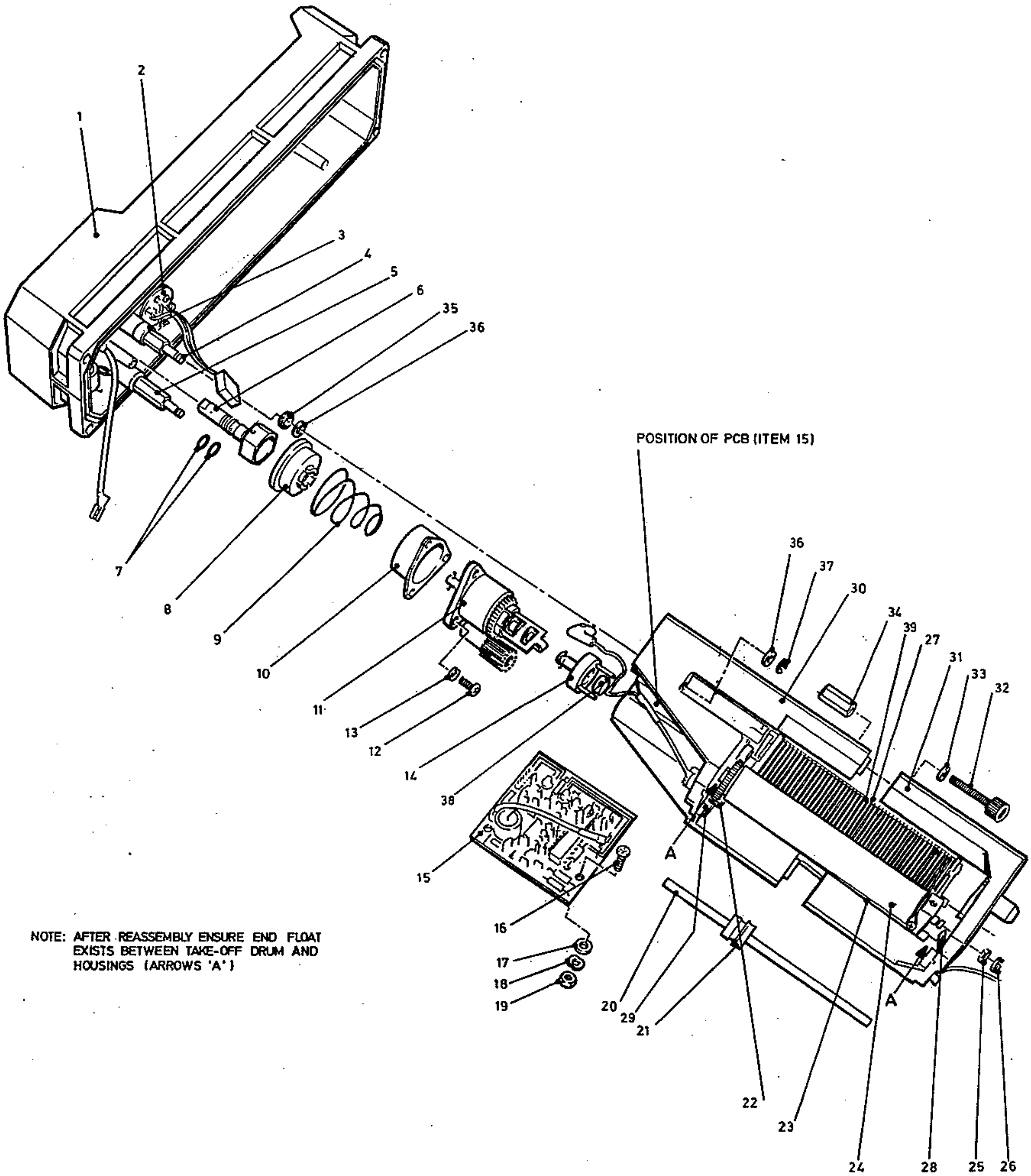
ILLUSTRATED PARTS LIST

TABLE 5 ANTENNA TUNING UNIT (ATU) ASSEMBLY

ITEM No. (See Fig.5)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
1	Front Panel	1	703391
2	Meter	1	711512
3	Spacer	1	703832
4	Mounting spigot	1	703831
5	Mounting spigot	1	703758
6	Shaft assembly	1	703820
7	'0' ring	2	909916
8	Sleeve	1	703437
9	Spring	1	703648
10	Guide	1	703645
11	Gearbox assembly	1	
12	Screw, gearbox securing M3 x 10mm	3	926041
13	Crinkle washer M3	3	917705
14	Coupling shaft	1	703748
15	Meter printed circuit board (see fig for component locations)	1	719073
16	Screw, meter PCB securing, M3 x 10mm	1	926041
17	Plain washer M3	1	918086
18	Crinkle washer M3	1	917705
19	Nut M3	1	917825
20	Follower shaft	1	703640
21	Follower	1	703451
22	Idler gear 15T	1	703447
23	Idler shaft assembly	1	703639
	Washer, PTFE	1	703543
	Circlip, idler shaft securing	1	925099
24	Take off drum assembly	1	703791
25	Washer, PTFE	2	703543
26	Circlip, take off drum assembly securing	2	925099
27	Coil drum assembly	1	703790
	Washer, PTFE	1	703543
	Circlip, coil drum assembly securing	1	925099
28	Brush	1	703590
29	Brush	1	703453
30	Housing Front	1	703441

TABLE 5 (Cont'd)

ITEM No. (See Fig. 5)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
31	Housing rear	1	703442
32	Screw housing securing M4 x 10mm Skt hd	2	920886
33	Washer crinkle M4	2	917706
34	Pillar securing	2	700123/37
35	Foam washer	2	703872
36	Washer plain M4	4	918087
37	Circlip securing ATU housing to front panel	2	925099
38	Rubber Spacer	1	703856
39	Gold braid	8 metre	711417



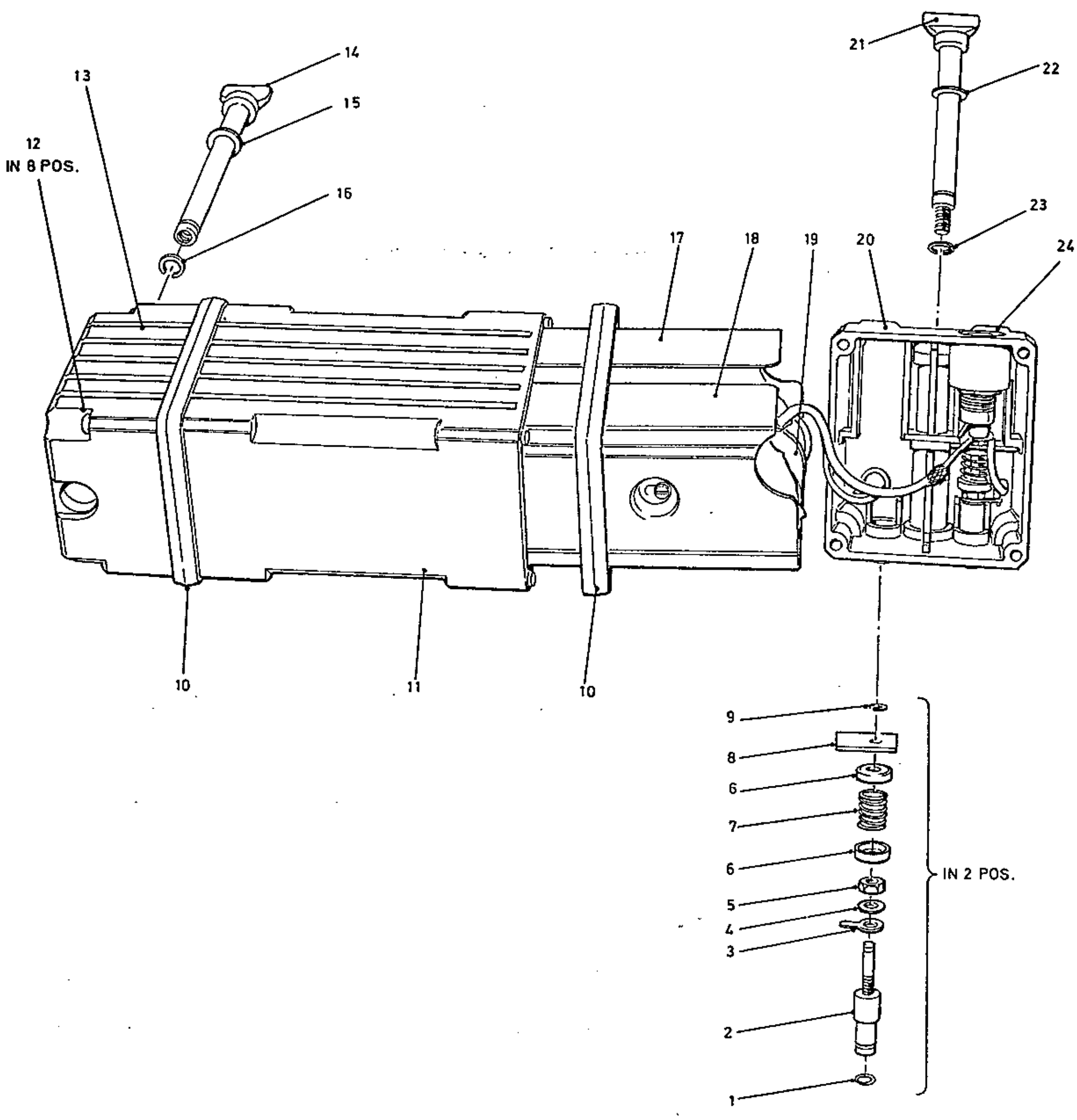
Antenna Tuning Unit Assembly

Fig.5

ILLUSTRATED PARTS LIST

TABLE 6 NI-CAD BATTERY ASSEMBLY MA.4025A

ITEM No. (See Fig.6)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
1	'0' ring	2	703357
2	Contact	2	703349
3	Solder tag	2	922792
4	Plain washer M4	2	919157
5	Nut M4	2	917701
6	Spring guide	4	703335
7	Contact spring	2	703351
8	Contact clamp	2	703350
9	Circlip	2	925099
10	Seal, battery case	2	703346
11	Battery case	1	703340
12	Screw, end cap securing	8	704388
	Crinkle washer M4	8	922408
13	End cap	1	703341
14	Knob assembly, female	1	703339
15	Thrust washer	1	703356
16	Circlip	1	927697
17	Battery holder	1	703343
18	Battery holder	1	703344
19	Battery pack, ni-cad	1	711432
20	End cap, contact housing	1	703342
21	Knob assembly, male	1	703338
22	Thrust washer	1	703355
23	Circlip	1	928649
24	Fuse holder assembly	1	926200
	Fuse link 6.3A	1	922454



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Ni-Cad Battery Assembly MA4025A

Fig.6

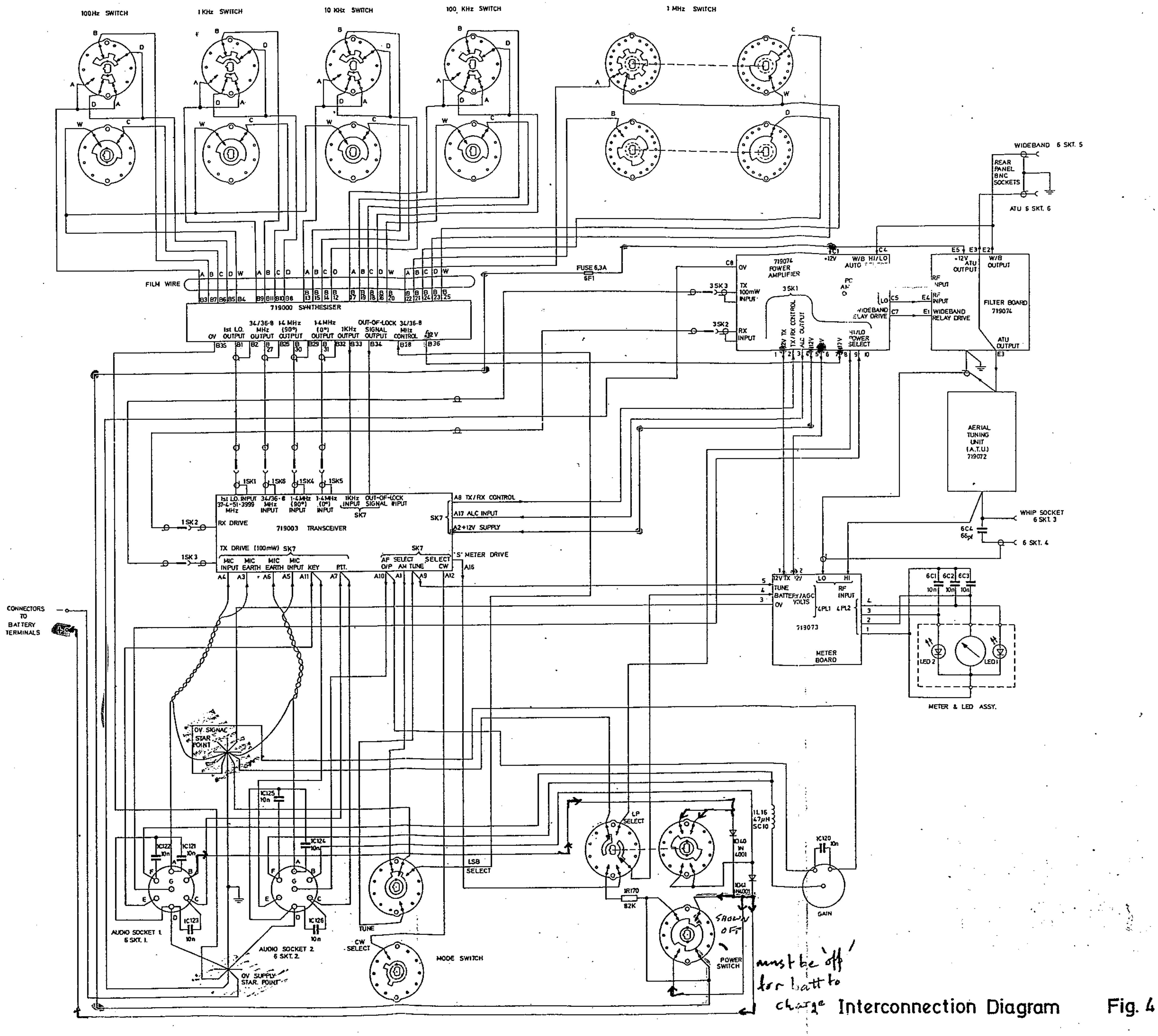
ILLUSTRATED PARTS LIST

TABLE 7 PRIMARY BATTERY ASSEMBLY MA. 4025B

ITEM No. (See Fig.7)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
1	End cap, fixed	1	703976
2	Fuse holder assembly	1	926200
	Fuse link 6.3A	1	922454
3	Screw, end cap securing	4	704388
	Crinkle washer M4	4	922408
4	Contact	2	704043
5	'0' ring	2	703357
6	Control spring	2	704032
7	Circlip	2	920723
	Nut M3	4	921312
	Crinkle washer M3	2	928759
8	Solder tag	2	926652
9	Spacer	1	704038
10	Screw, spacer securing, M3 x 6	2	919842
	Crinkle washer M3	2	928759
11	Spacer, contact	1	704036
12	Screw, contact securing M3 x 16	1	920575
	Crinkle washer M3	3	928759
	Nut M3	2	921312
	Solder tag	1	926652
13	Spring, conical	1	704031
	Screw, spring securing M3 x 12	1	920574
	Crinkle washer	3	928759
	Nut M3	2	921312
	Solder tag	1	926652
14	Seal, battery case	2	703346
15	Battery case	1	704046
16	Pin	4	704030
17	Pillar	2	704040
18	Spacer, contact	2	704036
	Screw, contact securing M3 x 12	2	920574
	Crinkle washer M3	2	928759
19	Spring, conical	2	704031
	Screw, spring securing M3 x 8	2	920898
	Crinkle washer M3	2	928759
20	Contact plate	3	704548

TABLE 7 (Cont'd)

ITEM No. (See Fig.7)	DESCRIPTION	QTY PER UNIT	RACAL PART NUMBER
21	End cap, detachable	1	703977
22	Knob assembly	2	704045
	Circlip	2	927697
	Thrust washer	2	703356
	'0' ring	2	920581
23	Bracket & Tie bar assembly	1	704642
24	Spacer	2	704645/3
25	Spacer	4	704645/2
26	Spacer	1	706454/1
27	Cap	1	704674
28	Disc	6	704646
29	Fixing washer	1	923260
30	Knob Assembly, female	1	703339
	Circlip	1	928697
	Thrust washer	1	703356
31	Spacer, contact	1	704036
	screw, contact securing M3 x 12	1	920574
	Crinkle washer M3	1	928759
	Spring, conical	1	704031
	Screw, spring securing M3 x 8	1	920898
	Crinkle washer M3	1	928759
33	Contact plate	1	704039
34	Knob assembly, male	1	703338
	Circlip	1	928649
	Thrust washer	1	703355



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1

Interconnection Diagram Fig. 4

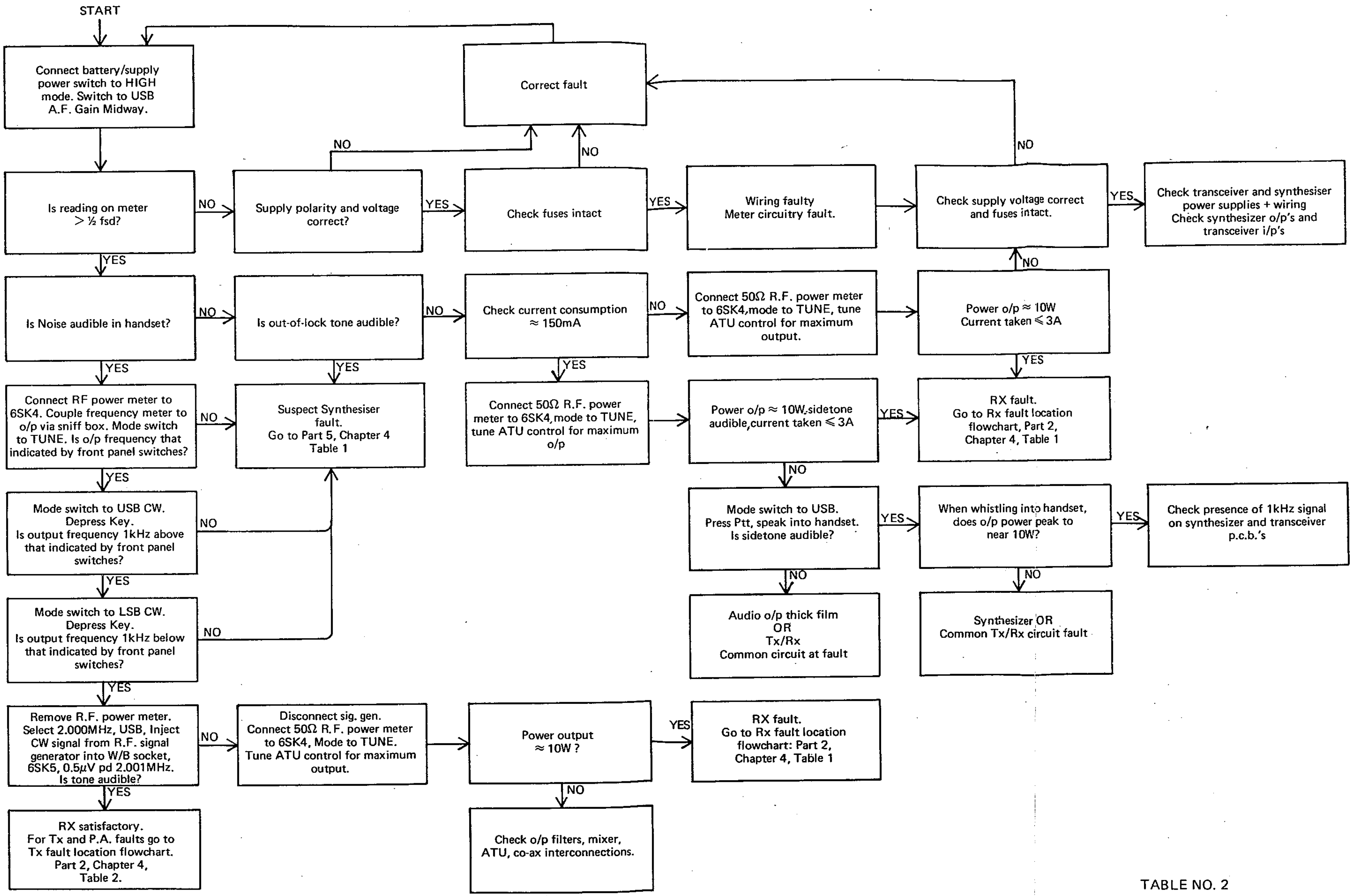


TABLE NO. 2

FAULT AREA IDENTIFICATION FLOWCHART

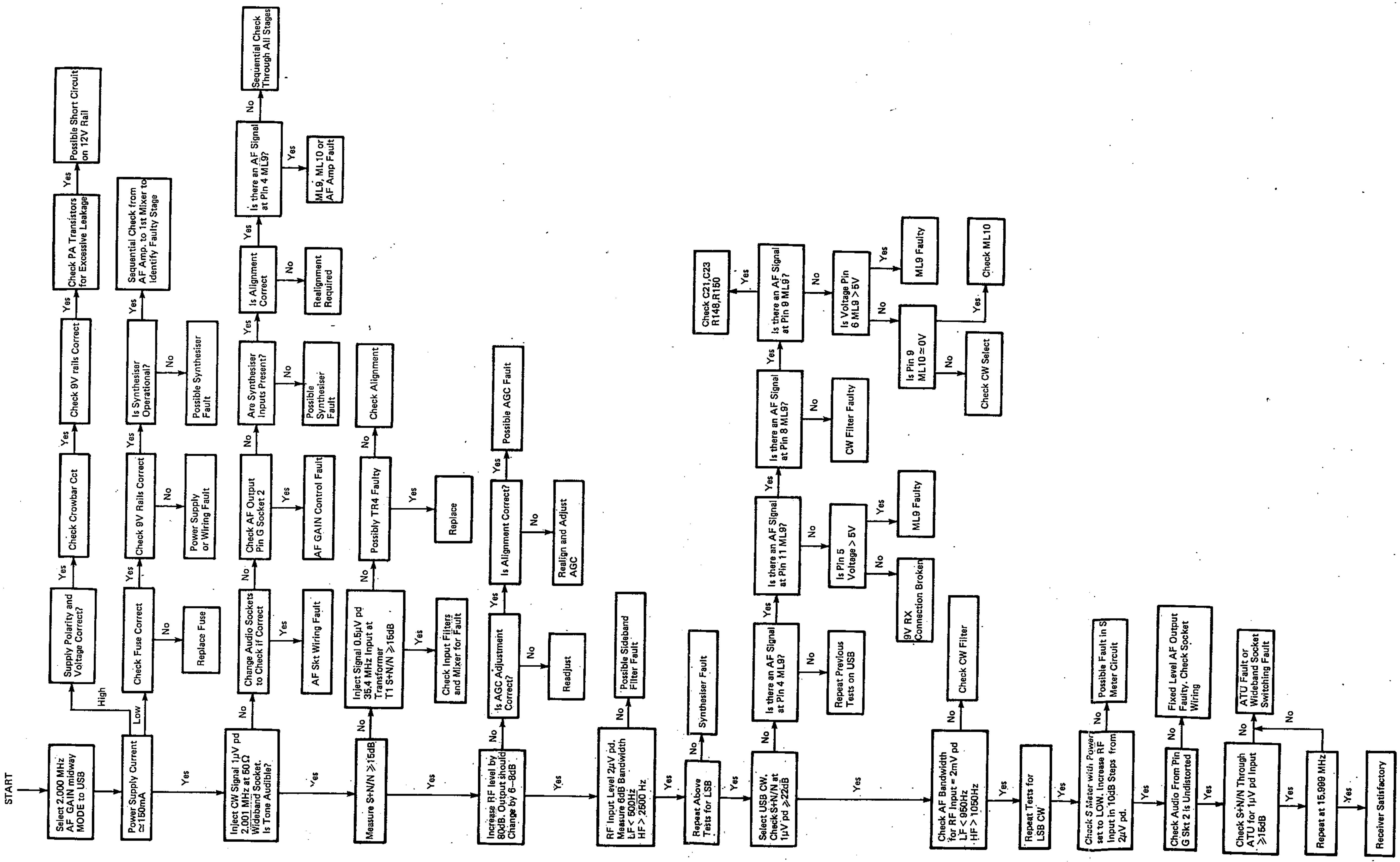


Table 1 Receiver Fault Location Flowchart

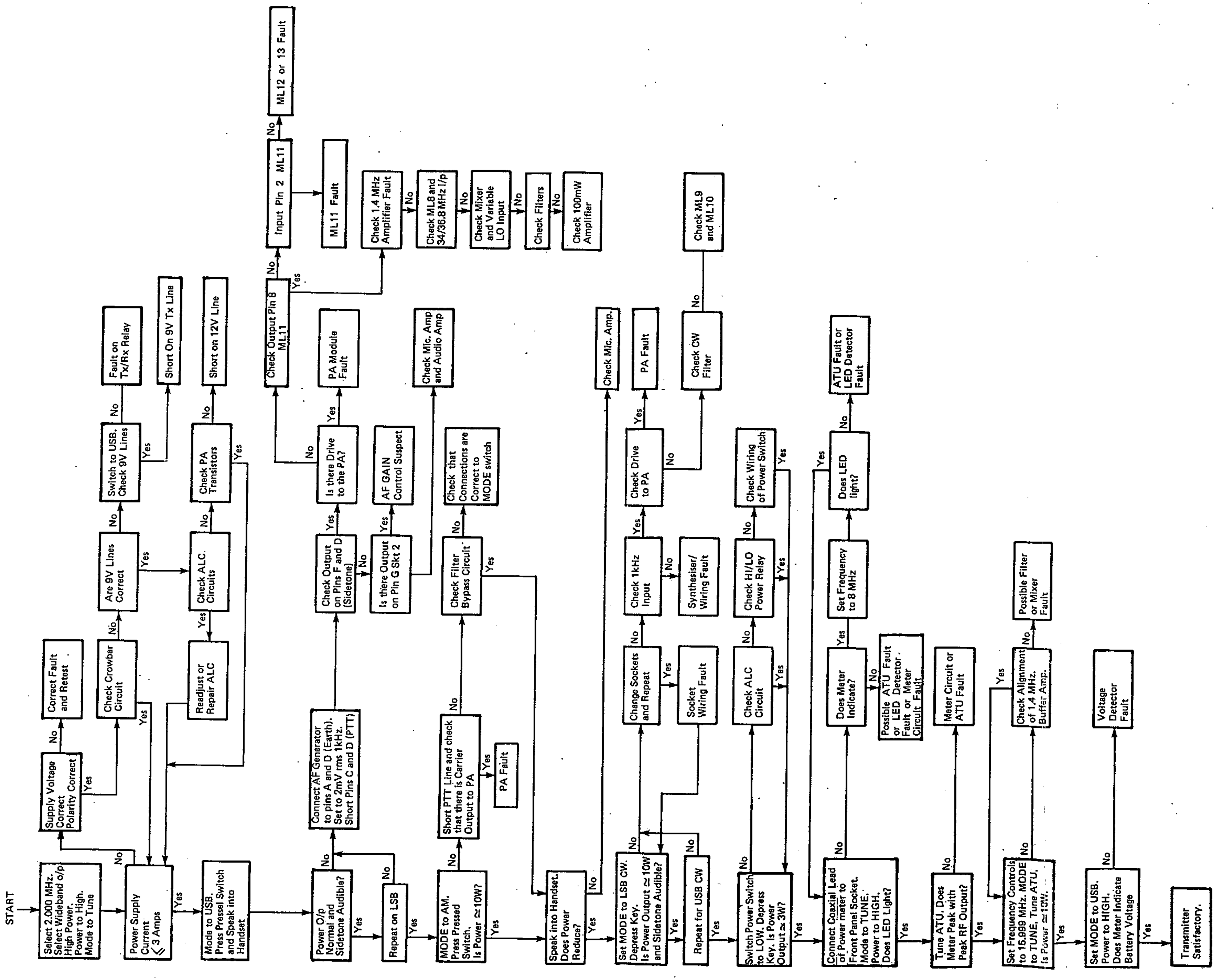
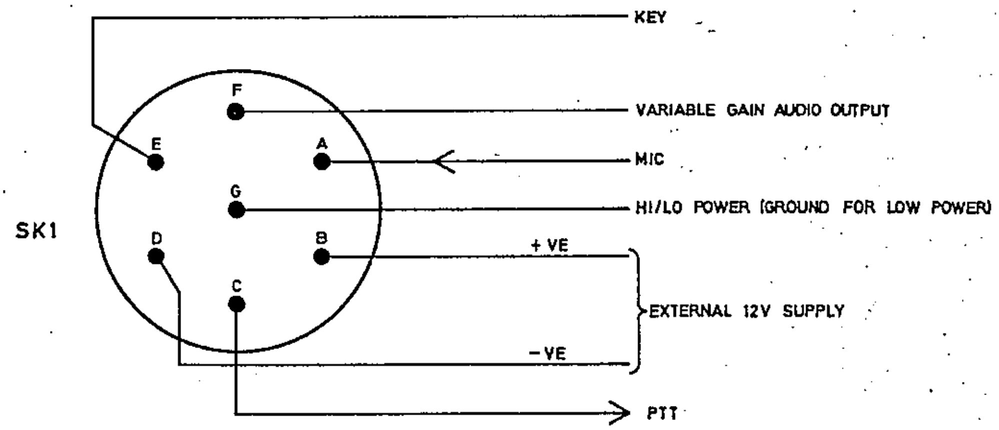
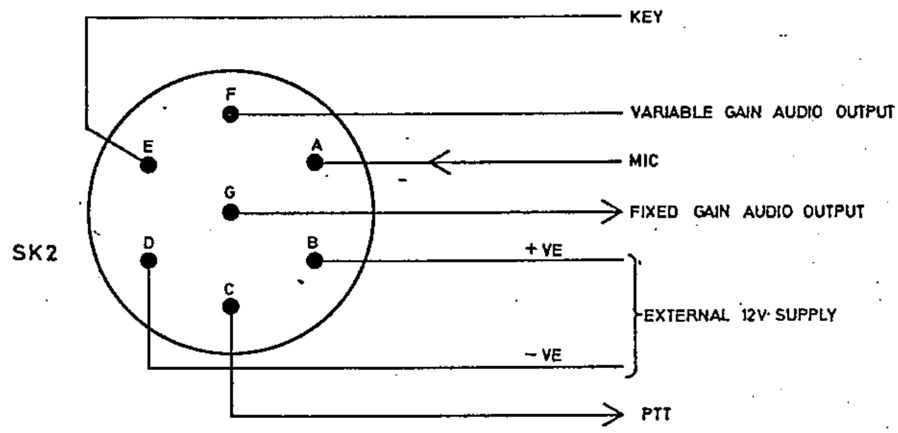


Table 2 Transmitter Fault Location Flowchart





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External Connections to Audio Sockets

Fig.3

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 917796, 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.

Broken components should be individually wrapped and identified as "BROKEN BERYLLIA COMPONENTS". They must not be sent through the post and should be returned by hand.

MEDICAL PRECAUTIONS

If Beryllia is believed to be on, or to have entered the skin through cuts or abrasions, the area should be thoroughly washed and treated by normal first-aid methods followed by subsequent medical inspection.

Suspected inhalation should be treated as soon as possible by a Doctor - preferably at a hospital.

****

GASEOUS TRITIUM - SAFETY PRECAUTIONS

INTRODUCTION

Gaseous tritium emits beta particles, and is used in 'beta lights' for front panel controls. Both button and strip form lights are used. The following safety precautions should be observed.

STORAGE OF SPARES ITEMS

Not more than twenty-four buttons or strips should be handled at any one time. This is to ensure that in the unlikely case when all buttons being handled are broken simulataneously, the amount of escaped gas is kept to a safe level.

BREAKAGE

If buttons or strips are broken the tritium gas will quickly disperse if the area is well ventilated. Should a large quantity, e.g. 24 be broken simultaneously the immediate area should be evacuated for twenty minutes.

HANDBOOK AMENDMENTS

Amendments to this handbook (if any), which are on coloured paper for ease of indentification, 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.

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AMENDMENT TO

PRM 4021 HF/SSB TRANSMITTER RECEIVER

PART 2

COMPONENTS LIST

Page 5-2

Amend R45 to read:

5K6 Carbon Film $\frac{1}{4}$W 5% 926561

Page 5-4

Amend R151 to read:

1K Carbon Film $\frac{1}{4}$W 5% 924680

Amend R163 and K164 to read:

33K Carbon Film $\frac{1}{4}$W 5% 927771

Page 5-9

Amend TR4 and TR5 to read:

J300B 933400

Amend TR23 to read:

J175 933405

Page 5-10

Add the following note referring to BM1:

Replacements of BM1 manufactured by CIMARRON must be fitted with PIN 1 (identified by a blue bead) diagonally opposite to PIN 1 marked on the printed circuit board.

ILLUSTRATIONS

PART 1

Fig. 4

Add capacitors IC127 and IC128, 10n, between pins E and D of 6SKT.1 and 6SKT.2.

Sheet 1 of 2
Change No. 1
Issue No. 2

PART 2

Fig. 3

Amend R45 to read 5K6
Amend R151 to read 1K

Amend R163 and R164 to read 33 K

Amend TR4 and TR5 to read J300B

Amend TR23 to read J175

RACAL TACTICOM LTD

AMENDMENT TO

PRM.4021 HF/SSB TRANSMITTER-RECEIVER

PART 2

Page 5-1

Amend R36 to read:
R36 10K Potentiometer 920312

Page 5-3

Amend R93 to read:
R93 10K Potentiometer 920312

Figure 4

Amend R131, adjacent to R82 to read:
R130

PART 3

Page 4-1

Amend past number of R13 and R19 to read:
927764

PART 4

Page 3-2

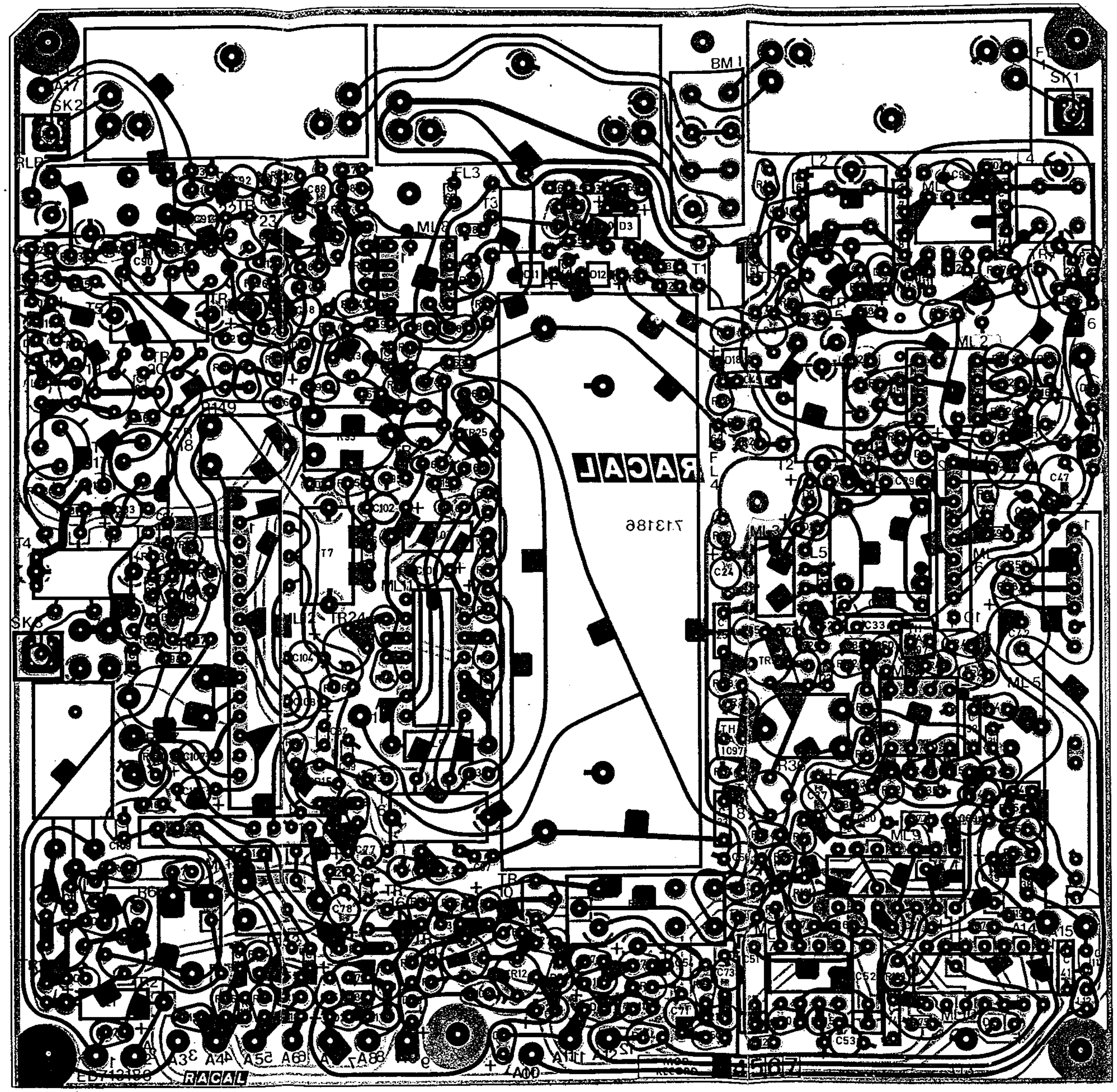
Amend TR1 and TR3 to read:
TR1 J176 933404
TR3 J176 933404

PART 5

Page 5-4

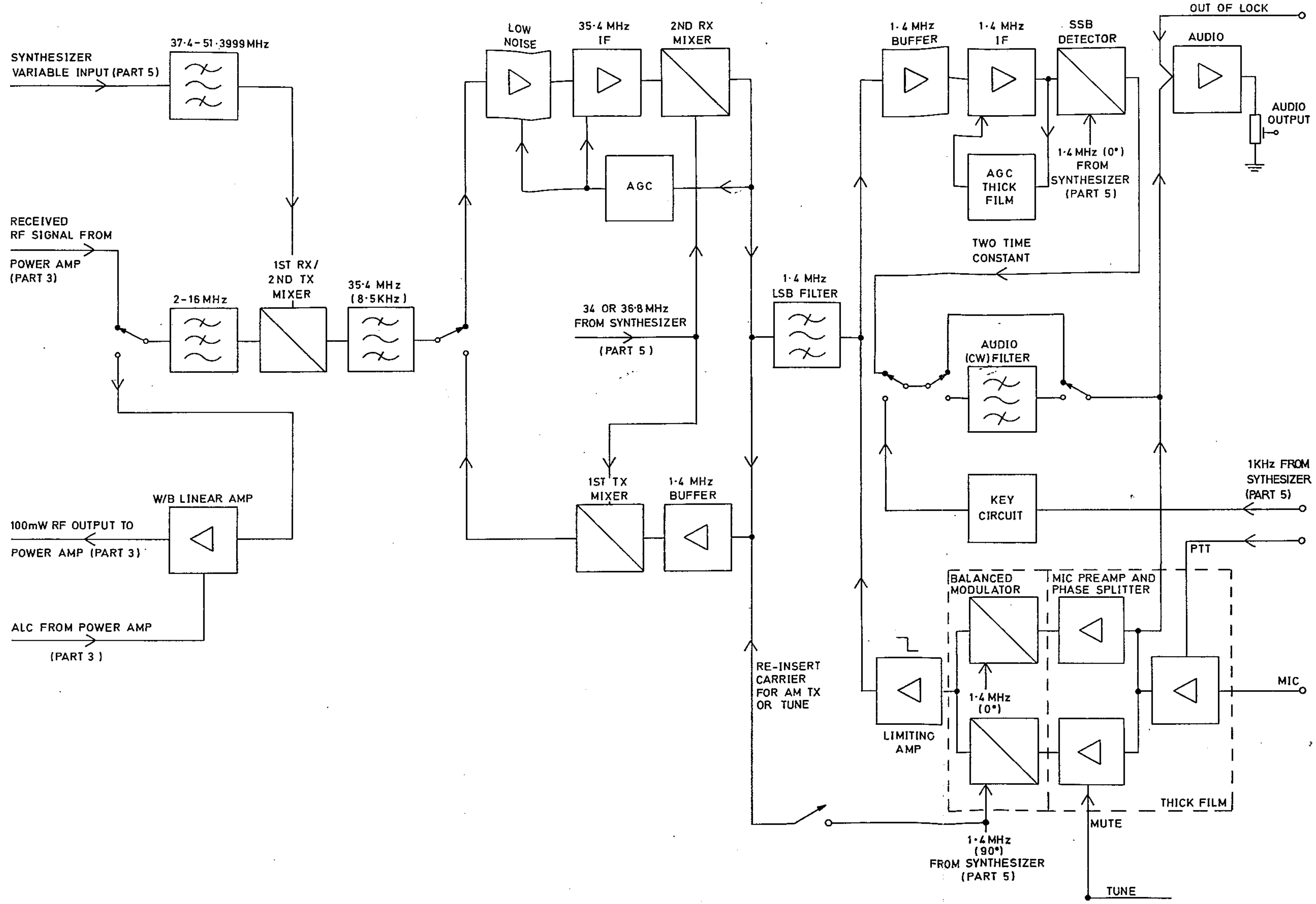
Amend TR1 and TR8 to read:

TR1 J300C 933401
TR8 J300C 933401



Layout : 719171 Transceiver
PC Board

Fig. 4



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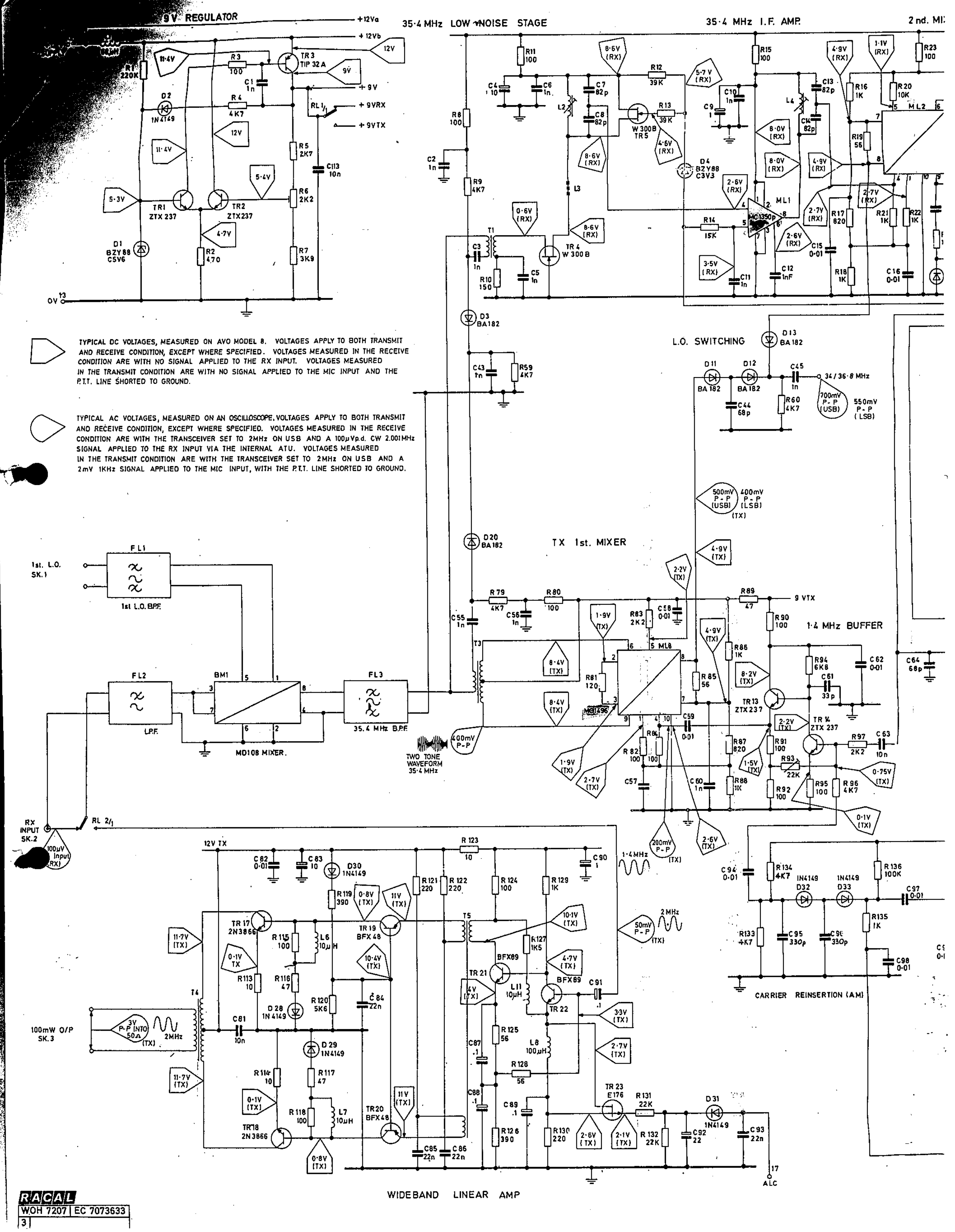
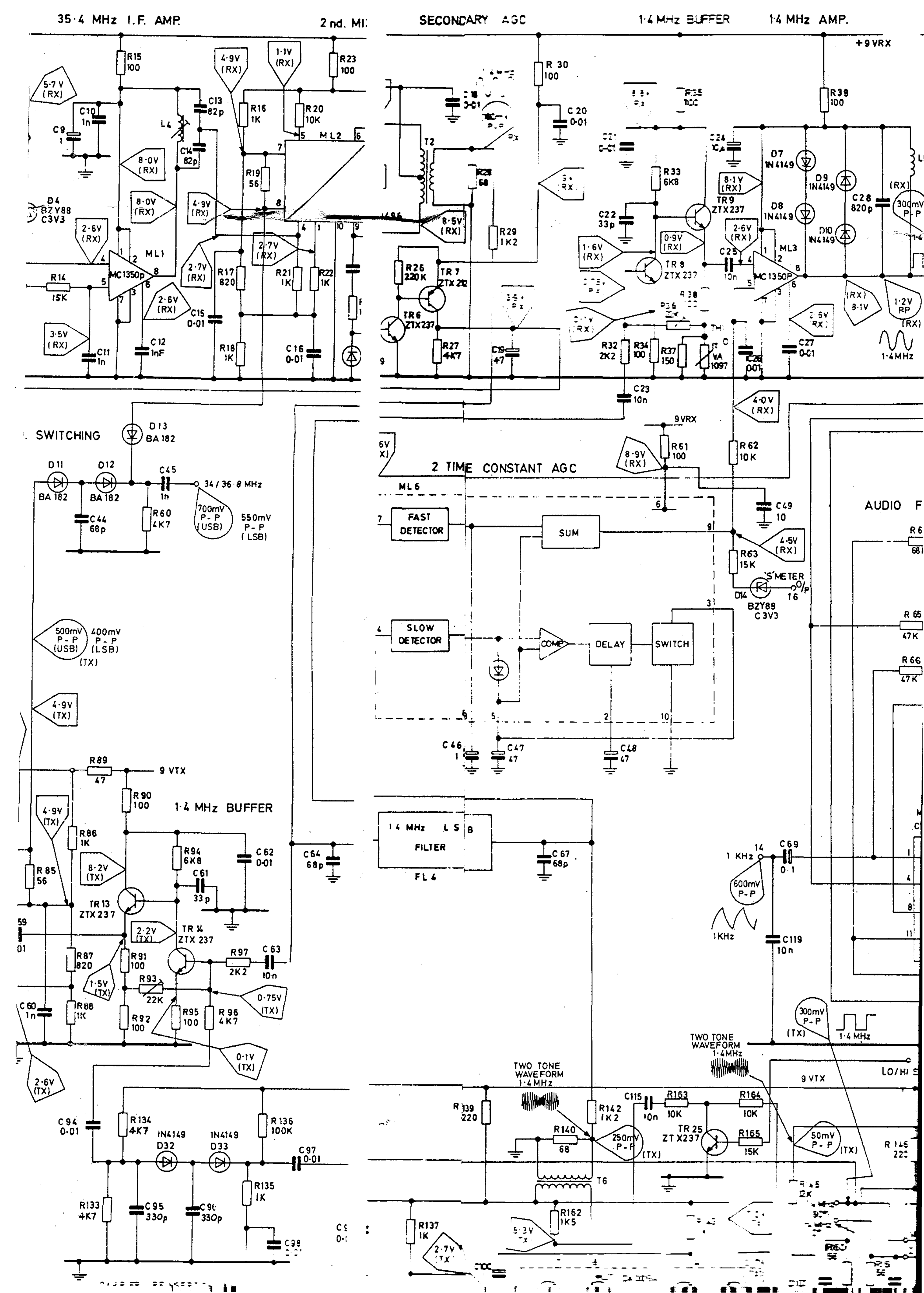
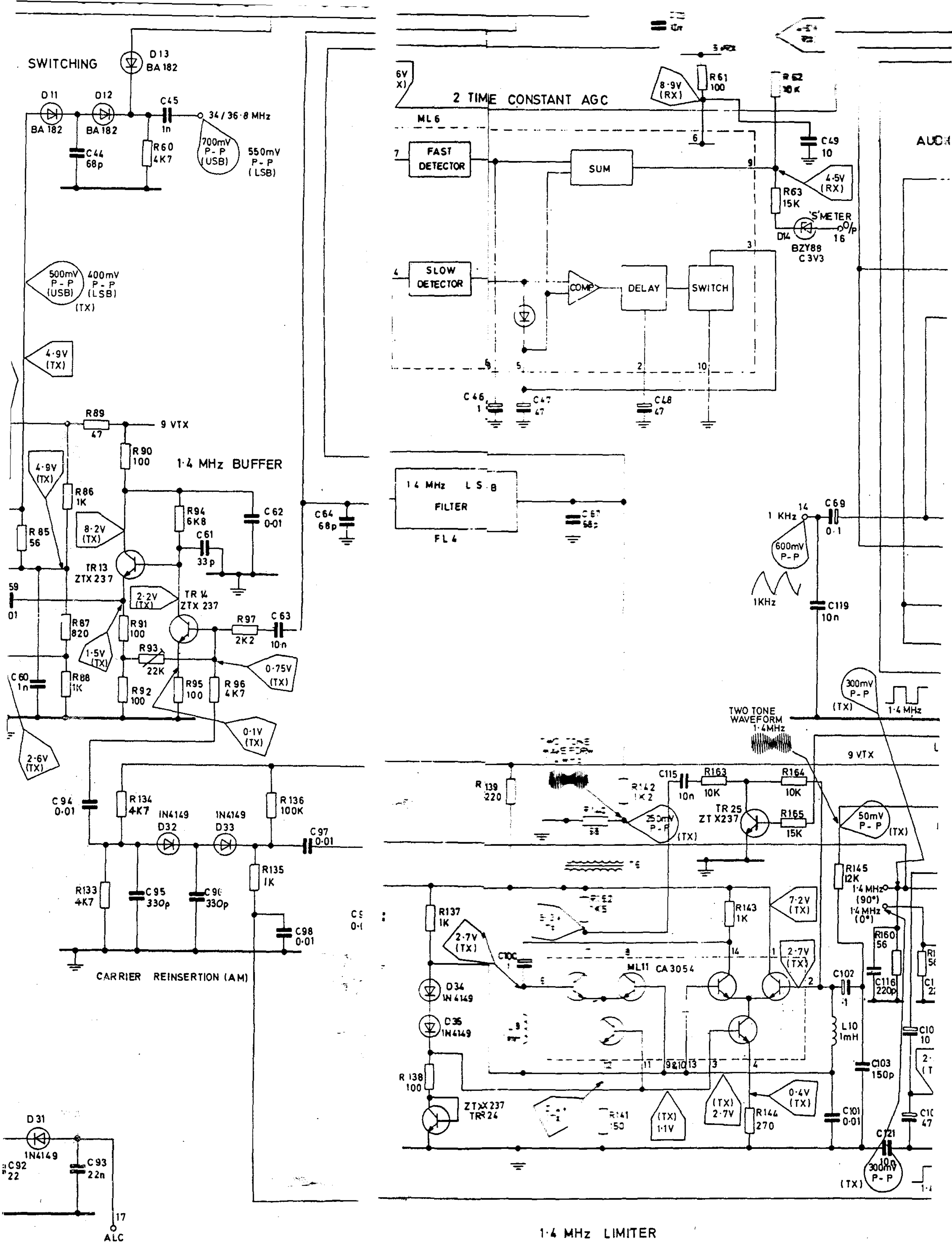
Block Diagram : Transceiver Sub-Assembly

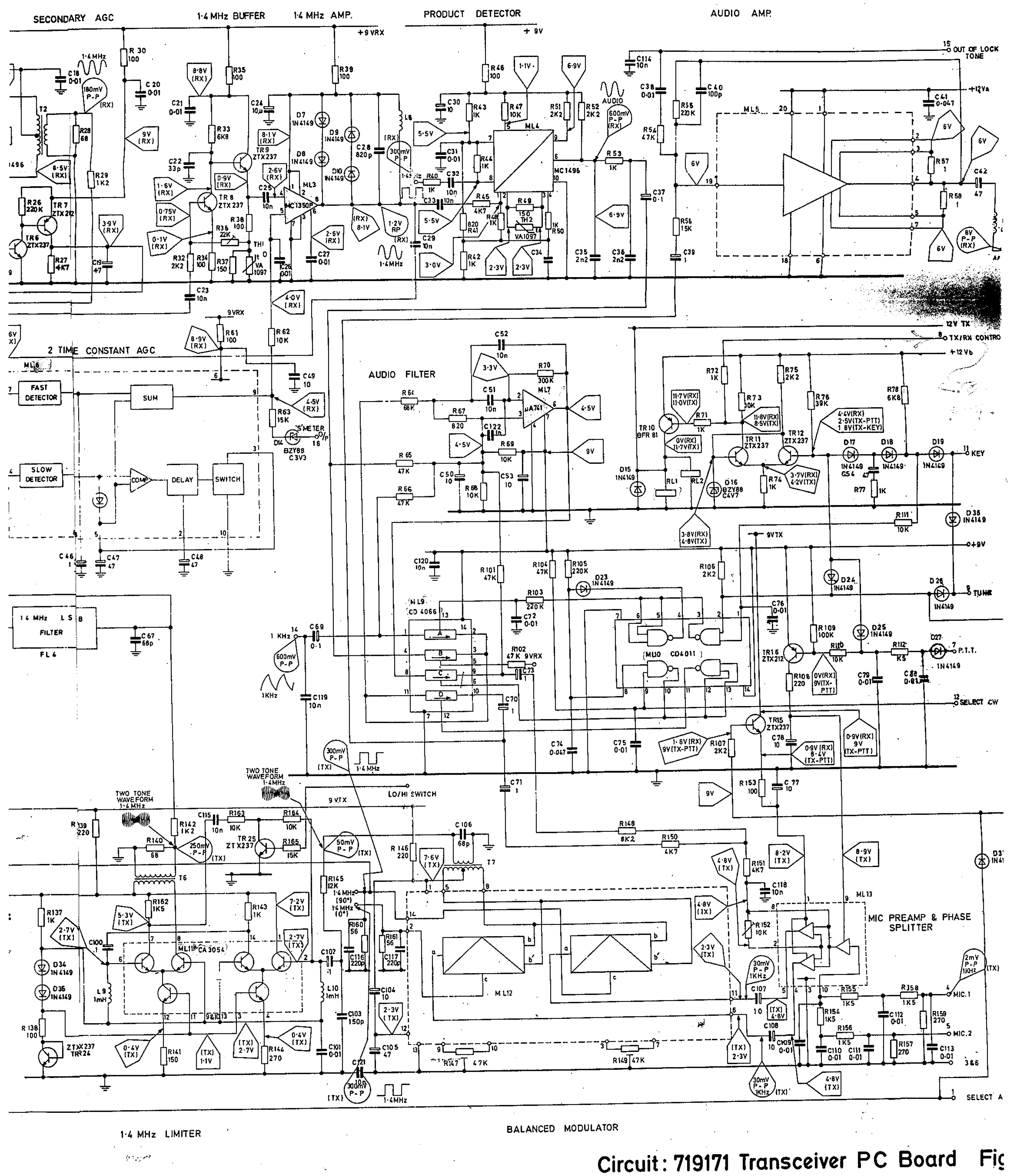
Fig. 2


9V REGULATOR
35·4 MHz LOW NOISE STAGE
35·4 MHz I.F. AMP.
2nd. MI
L.O. SWITCHING
TX 1st. MIXER
1·4 MHz BUFFER
CARRIER REINSERTION (AM)
WIDEBAND LINEAR AMP
TYPICAL DC VOLTAGES, MEASURED ON AVO MODEL 8. VOLTAGES APPLY TO BOTH TRANSMIT AND RECEIVE CONDITION, EXCEPT WHERE SPECIFIED. VOLTAGES MEASURED IN THE RECEIVE CONDITION ARE WITH NO SIGNAL APPLIED TO THE RX INPUT. VOLTAGES MEASURED IN THE TRANSMIT CONDITION ARE WITH NO SIGNAL APPLIED TO THE MIC INPUT AND THE P.T.T. LINE SHORTED TO GROUND.
TYPICAL AC VOLTAGES, MEASURED ON AN OSCILLOSCOPE. VOLTAGES APPLY TO BOTH TRANSMIT AND RECEIVE CONDITION, EXCEPT WHERE SPECIFIED. VOLTAGES MEASURED IN THE RECEIVE CONDITION ARE WITH THE TRANSCEIVER SET TO 2MHz ON USB AND A 100µVp.d. CW 2.001MHz SIGNAL APPLIED TO THE RX INPUT VIA THE INTERNAL ATU. VOLTAGES MEASURED IN THE TRANSMIT CONDITION ARE WITH THE TRANSCEIVER SET TO 2MHz ON USB AND A 2mV 1KHz SIGNAL APPLIED TO THE MIC INPUT, WITH THE P.T.T. LINE SHORTED TO GROUND.
1st. L.O. SK.1
1st L.O. B.P.F.
LPF.
MD108 MIXER.
35.4 MHz B.P.F.
TWO TONE WAVEFORM 35·4 MHz
RX INPUT SK.2
100mW O/P SK.3
ALC
RACAL
WOH 7207 | EC 7073633
3

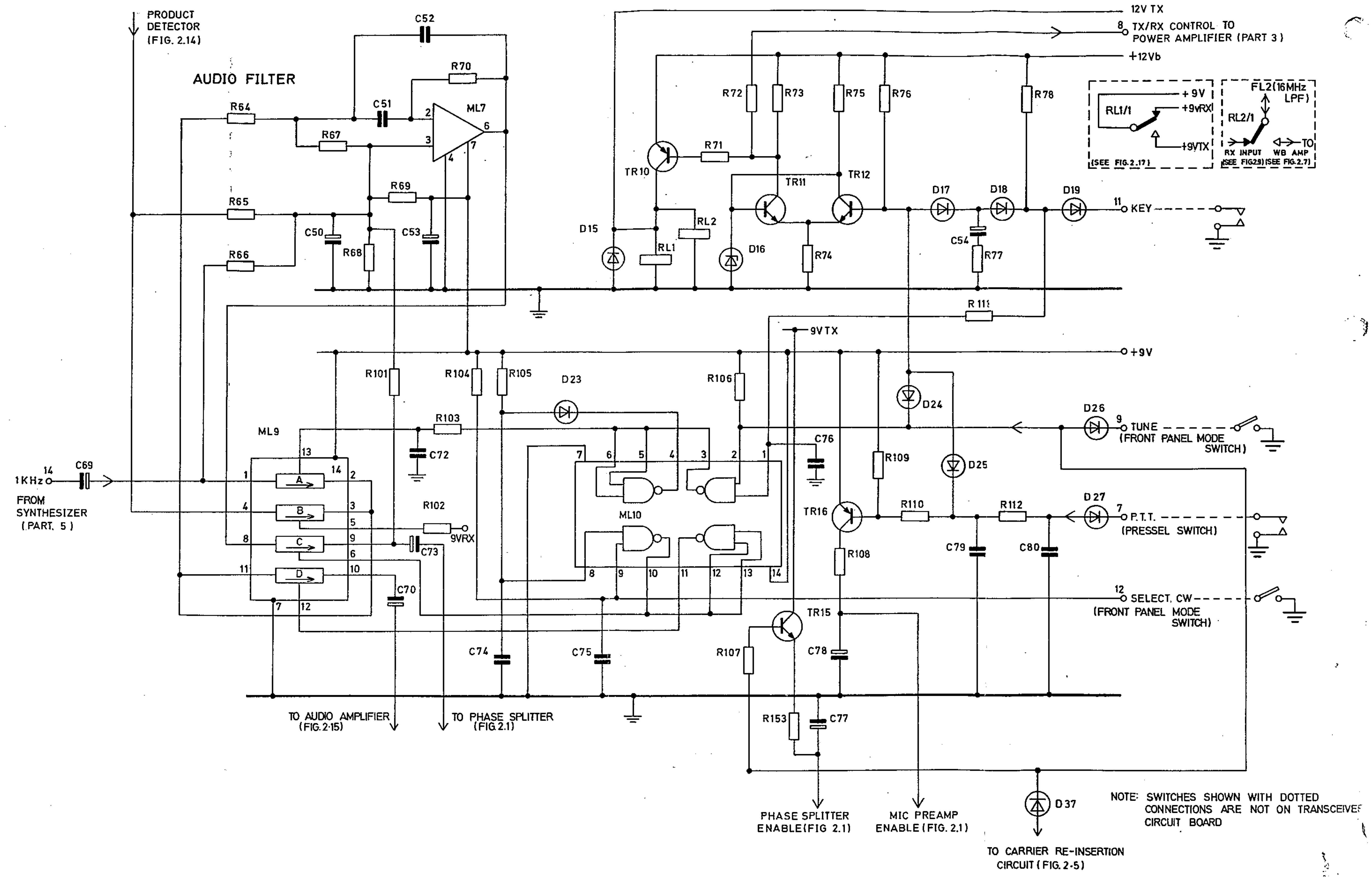


35·4 MHz I.F. AMP.
2 nd. MI
SECONDARY AGC
1·4 MHz BUFFER
1·4 MHz AMP.
+9 VRX
R15 100
R23 100
R 30 100
R39 100
5·7 V (RX)
4·9V (RX)
1·1V (RX)
C13 82p
C10 1n
C9 1
R16 1K
R20 10K
C 20 0·01
L4
C14 82p
ML2
8·0V (RX)
R19 56
T2
R28 68
D4 BZY88 C3V3
4·9V (RX)
8·5V (RX)
R29 1K2
ML1
MC1350p
2·6V (RX)
2·7V (RX)
R17 820
R21 1K
R22 1K
R26 220K
TR 7 ZTX 212
TR6 ZTX237
R27 4K7
R14 15K
3·5V (RX)
C11 1n
C 12 1nF
C15 0·01
R18 1K
C 16 0·01
C19 47
R33 6K8
C22 33p
TR9 ZTX237
TR 8 ZTX 237
8·1V (RX)
0·9V (RX)
1·6V (RX)
2·6V (RX)
C25 10n
ML3
MC1350P
D7 1N4149
D9 1N4149
D8 1N4149
D10 1N4149
C28 820p
300mV P-P
1·2V P-P (RX)
8·1V
1·4MHz
R38
R32 2K2
R34 100
R37 150
VA 1097
C27 0·01
C23 10n
4·0V (RX)
9VRX
R61 100
R62 10K
8·9V (RX)
SWITCHING
D13 BA 182
D11 BA 182
D12 BA 182
C45 1n
34 / 36·8 MHz
C44 68p
R60 4K7
700mV P-P (USB)
550mV P-P (LSB)
2 TIME CONSTANT AGC
ML 6
FAST DETECTOR
SUM
C49 10
4·5V (RX)
R63 15K
S METER O/P
D14 BZY88 C3V3
AUDIO F
SLOW DETECTOR
COMP
DELAY
SWITCH
R 65 47K
R 66 47K
500mV P-P (USB)
400mV P-P (LSB) (TX)
4·9V (TX)
C46 1
C47 47
C48 47
R89 47
9 VTX
R90 100
1·4 MHz BUFFER
4·9V (TX)
R86 1K
R94 6K8
C 62 0·01
C61 33p
C64 68p
1·4 MHz LSB FILTER
FL 4
C 67 68p
R 85 56
8·2V (TX)
TR13 ZTX 237
2·2V (TX)
TR 14 ZTX 237
R87 820
R91 100
R97 2K2
C 63 10n
1 KHz
C69 0·1
600mV P-P
1KHz
C119 10n
1·5V (TX)
R93 22K
0·75V (TX)
C 60 1n
R88 1K
R92 100
R95 100
R 96 4K7
300mV P-P (TX)
1·4 MHz
0·1V (TX)
2·6V (TX)
TWO TONE WAVEFORM 1·4MHz
LO/HI S
9 VTX
C94 0·01
R134 4K7
1N4149 D32
1N4149 D33
R 136 100K
C 97 0·01
R 139 220
R142 1K2
C115 10n
R163 10K
R164 10K
R 146
R140 68
250mV P-P (TX)
TR 25 ZTX237
R165 15K
50mV P-P (TX)
R133 4K7
C 95 330p
C 96 330p
R135 1K
C 98
T6
R162 1K5
R137 1K
5·3V
2·7V (TX)


SWITCHING
D13 BA 182
D11 BA 182
D12 BA 182
C45 1n
34 / 36·8 MHz
C44 68p
R60 4K7
700mV P-P (USB)
550mV P-P (LSB)
500mV P-P (USB)
400mV P-P (LSB)
(TX)
4·9V (TX)
R89 47
9 VTX
R90 100
1·4 MHz BUFFER
R86 1K
R94 6K8
C62 0·01
R85 56
8·2V (TX)
C61 33p
TR13 ZTX 237
2·2V (TX)
TR14 ZTX 237
R87 820
R91 100
R97 2K2
C63 10n
1·5V (TX)
R93 22K
0·75V (TX)
C60 1n
R88 1K
R92 100
R95 100
R96 4K7
0·1V (TX)
2·6V (TX)
C94 0·01
R134 4K7
1N4149 D32
1N4149 D33
R136 100K
C97 0·01
R135 1K
R133 4K7
C95 330p
C96 330p
C98 0·01
CARRIER REINSERTION (AM)
D31 1N4149
C92 22
C93 22n
17 ALC
6V X)
2 TIME CONSTANT AGC
ML 6
8·9V (RX)
R61 100
R62 10K
C49 10
FAST DETECTOR
SUM
4·5V (RX)
R63 15K
'S' METER O/P 16
D14 BZY88 C3V3
SLOW DETECTOR
COMP
DELAY
SWITCH
C46 1
C47 47
C48 47
1·4 MHz LSB FILTER
FL 4
C64 68p
1 KHz
C69 0·1
600mV P-P
1KHz
C119 10n
300mV P-P (TX)
1·4 MHz
TWO TONE WAVEFORM 1·4MHz
9 VTX
R139 220
C115 10n
R163 10K
R164 10K
TR25 ZTX237
R165 15K
250mV P-P (TX)
50mV P-P (TX)
R145 12K
1·4 MHz (90°)
1·4 MHz (0°)
R137 1K
R143 1K
7·2V (TX)
2·7V (TX)
ML11 CA3054
R160 56
C116 220p
C102 ·1
L10 1mH
D34 1N4149
D35 1N4149
C103 150p
R138 100
ZTX 237 TR24
(TX) 1·1V
(TX) 2·7V
R144 270
0·4V (TX)
C101 0·01
C121 10n
300mV P-P (TX)
1·4 MHz LIMITER

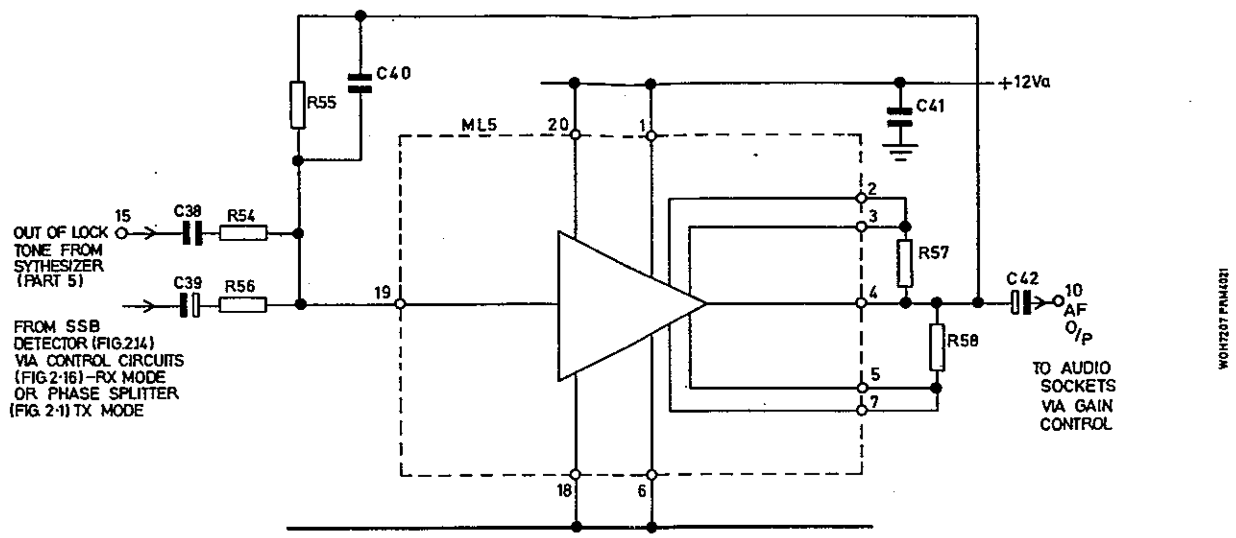


Circuit: 719171 Transceiver PC Board Fig



Control Circuits

Fig. 2.16



Audio Amplifier Circuit Fig.2.15

18. Audio Amplifier (Refer to Fig. 2.15)

18.1 The audio signal is routed by the control circuits via R56 and C39 to pin 19 of ML5, a thick film audio amplifier. The amplifier output is fed via the front panel GAIN control to the Audio sockets; in addition a fixed output, bypassing the GAIN control, is fed to pin G of the Audio 2 socket.

18.2 An output from the out-of-lock circuit in the synthesizer unit is also applied to the input of the amplifier via C38 and R54 to indicate when the synthesizer is out of lock.

19. CONTROL CIRCUITS (Refer to Fig. 2.16)

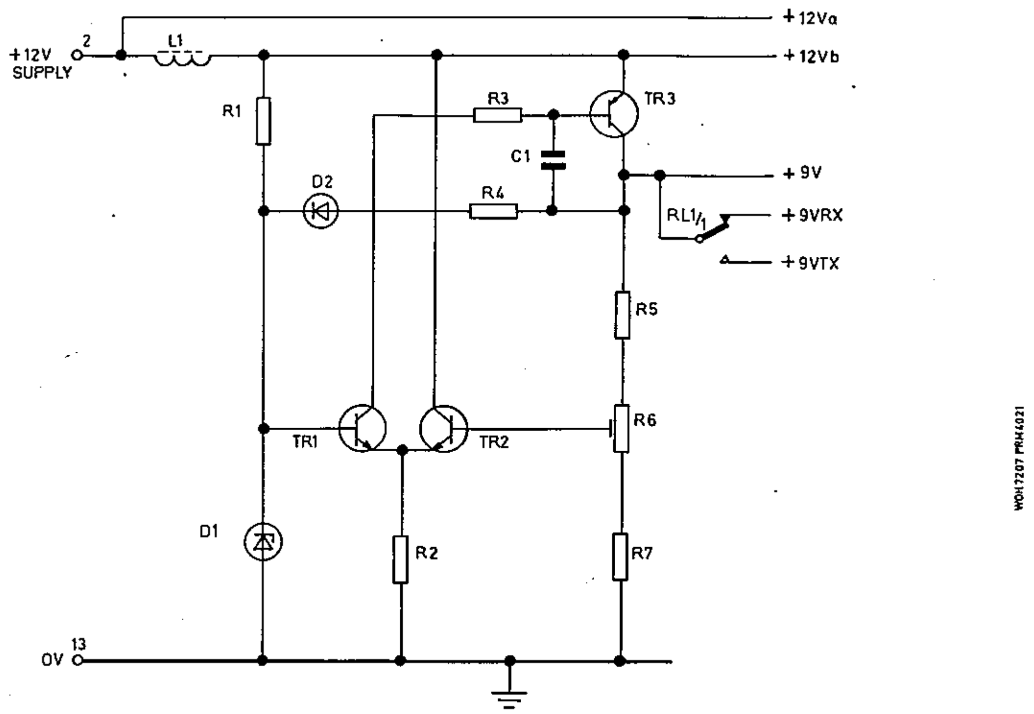
20. Function

20.1 A number of circuits in the transceiver unit are used for both transmission and reception. The function of the control circuits is to enable and disable various circuits and alter the configuration according to the mode of operation required, CW, speech or TUNE, transmission or reception.

21. Speech Transmission

21.1 During speech transmission, the front panel Mode switch is set to USB, LSB or AM and the microphone pressel (PTT) switch is operated, connecting board pin 7 (PTT) to ground.

21.2 The PTT signal switches on TR16 which supplies power to the microphone preamplifier (Fig. 2.1). The PTT signal is also applied via D25 to the input of the differential amplifier comprising TR11 and TR12. The output of the differential amplifier provides a TX/RX CONTROL signal to the power amplifier unit and switches on TR10, which enables the +12V TX rail and energises relays RL1 and RL2.



Power Supplies Circuit Fig. 2·17

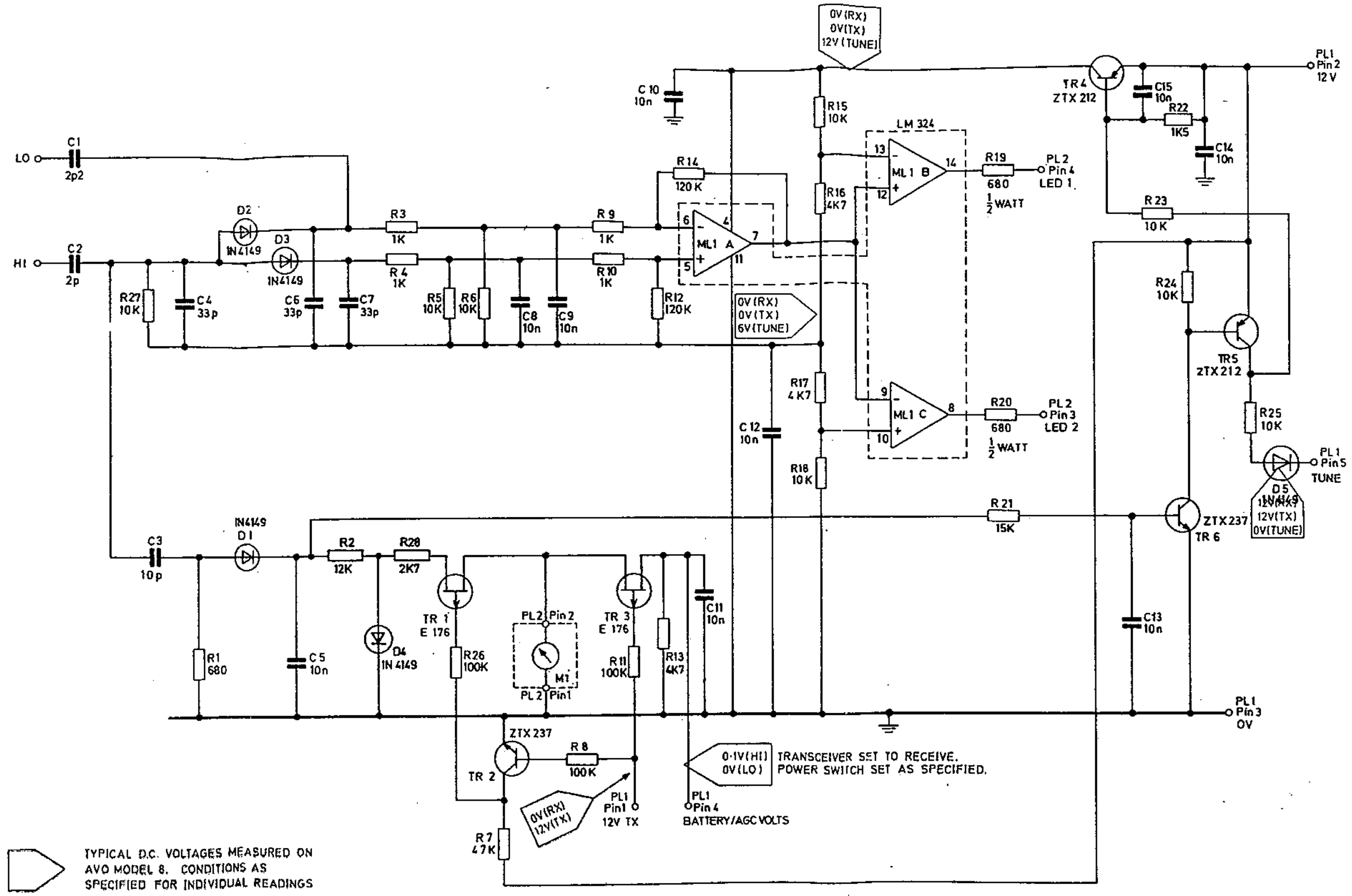
26. POWER SUPPLIES (Refer to Fig. 2.17)

26.1 All power supplies for the transceiver unit are derived from the +12V input, as follows:-

+12Va is connected directly to the +12V input and supplies the audio amplifier. +12Vb is fed from the +12V input via the choke L1 and is used in the control circuits.

26.2 +12VTX is derived from +12Vb to supply the wideband linear amplifier. +9V is derived from +12Vb by the voltage regulator TR1, TR2 and TR3. A proportion of the +9V output is applied to the base of TR2 by the potential divider R5, R6 and R7. The base of TR1 is held at a constant potential by D1. The amplifier adjusts the base current of the series element TR3 to maintain the base of TR2 at the same potential as the base of TR1. +9V is fed to the control circuits and the product detector.

26.3 +9VRX is obtained from +9V via RL1 when the transceiver is in the receive condition and supplies the remainder of the receiver circuits. +9VTX is obtained from +9V via RL1 when the transceiver is in the transmit condition and supplies the remainder of the transmitter circuits.



RACAL

WOH 7207 | CC 703635

2 | 4

Circuit: 719073 Meter and L.E.D. PC Board

Fig. 2

10. Swallow Counter

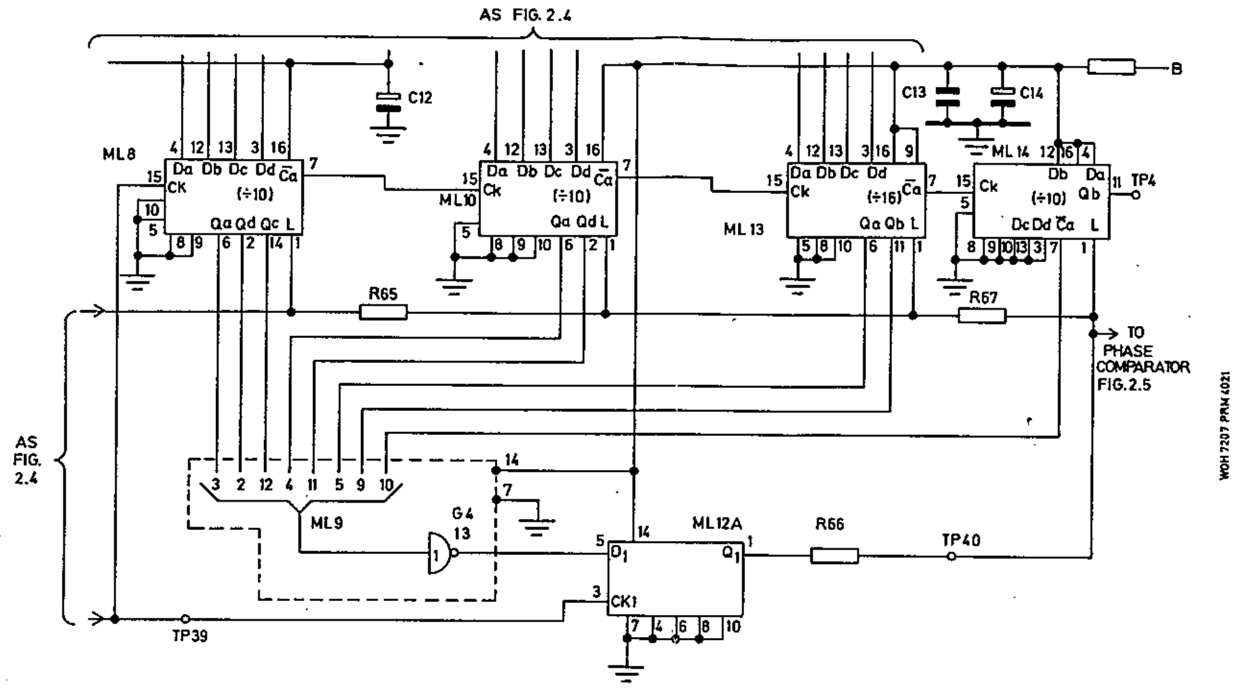
10.1 The swallow counter forms part of the programmable divider and comprises ML4, ML7, G2 and G3. The function of the swallow counter is to count the number P input pulses, as explained in Chap.1 para.7, to instruct the prescaler to divide by 101, while counting the P pulses, and 100 thereafter, according to the state of the 'carry' output of ML7. When the whole programmed divider has completed its sequence, it resets, and repeats the process.

10.2 The output of ML3 is fed via R10 and R11 to G1 which is biased by R13 as a clock amplifier to convert low power schottky output level to CMOS input level. SA1 and SA2 are BCD switches and ML4 and ML7 are divide-by-ten down counters. When a 'load' pulse '1' is applied to ML4 pin 1 and ML7 pin 1 at the start of the counting sequence, the data on the inputs is loaded into the counter and appears on the corresponding outputs (this is the BCD data from the 100Hz and 1kHz switches and corresponds to P in the block diagram, Fig.1.2). ML7 pin 7 ($\overline{\text{CARRY OUT}}$) is set to a '1' (unless P is loaded in = 0: i.e. both 100Hz and 1kHz switches are set to zero in which case the prescaler divides by 100 continuously) and so instructs the prescaler, via G2, D4, R12 and R9, to divide by 101. The counters are then clocked down from P until they reach the zero state when the '0' $\overline{\text{CARRY OUT}}$ output (pin 7) of ML7 inhibits G3, which prevents further clocking of the swallow counter until a 'load' pulse is applied to start a new counting sequence. The $\overline{\text{CARRY OUT}}$ signal also instructs the prescaler to divide by 100. The output from G1 is also used to clock the main divider.

11. Main divider The function of the main divider is to divide the prescaler output frequency by the number M. (Fig.1.2). This is achieved by counting down from a number loaded into ML8, ML10, ML13 (by switches SA3, SA4, SA5) and ML14 to another fixed number such that the difference between these two numbers is M. Each time this number is reached, the circuit is 'loaded', setting the counters to the code set up on the switches. Each time the circuit is 'loaded' an output pulse occurs, giving one pulse out for every M pulse received, that is, a division ratio of M.
The division ratio can therefore be altered by changing the positions of the frequency selection switches. The overall effect of the prescaler, swallow counter and main divider together is to divide the VCO output frequency by N. (Fig.1.2).

12. Frequency offset of the programmed divider. The numerical value of the code on the frequency selection switches is equal to the antenna frequency. However, the VCO output frequency is equal to the antenna frequency plus 35.4MHz. A 35.4MHz offset is therefore required; this is why the fixed number referred to in para.2.11 is not zero.

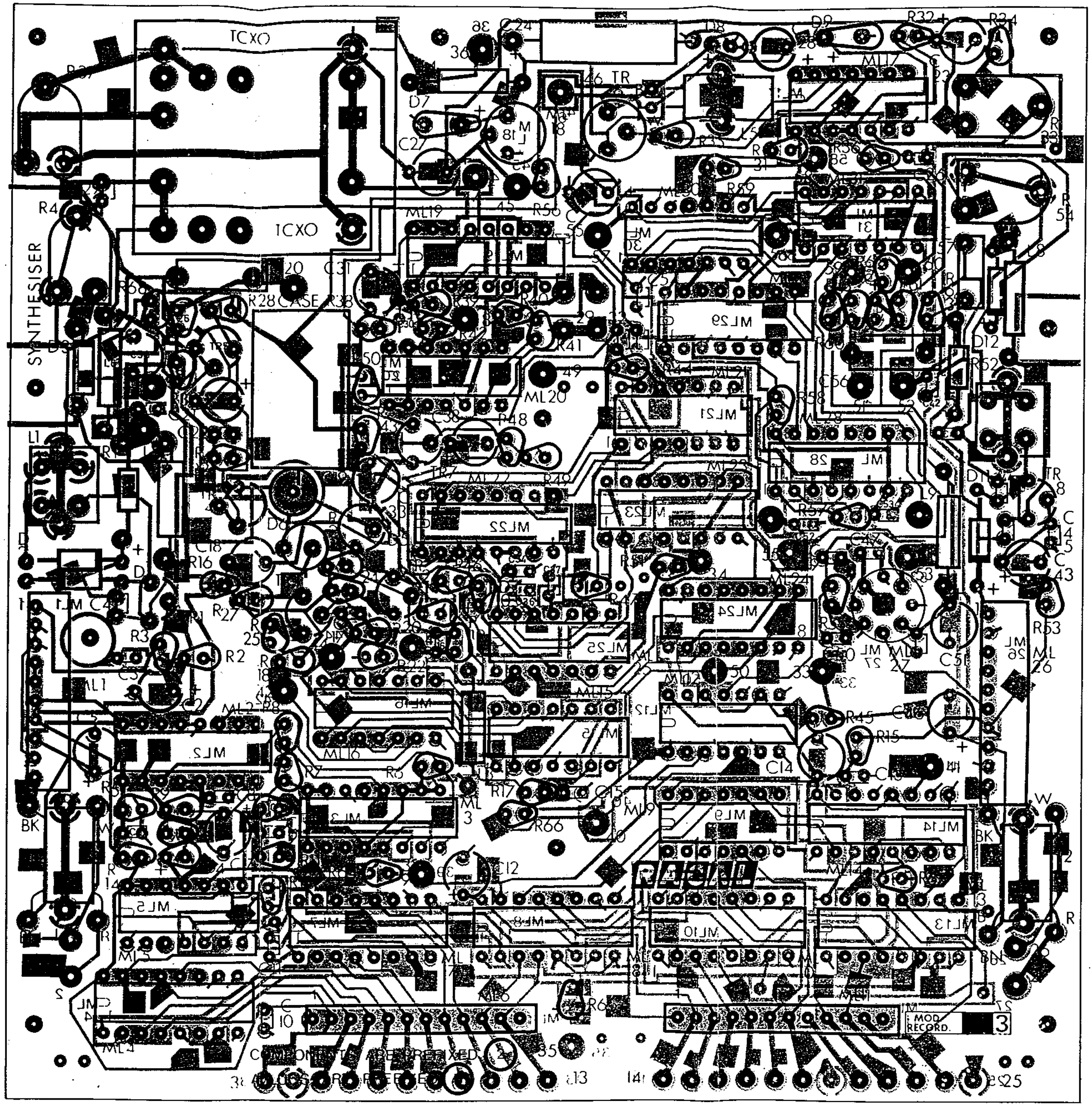
12.1 When the switches are set, for example, to 2MHz, the VCO output frequency is 37.4MHz. The frequency at TP39 is therefore 374kHz as the prescaler is divided by 100, and, as the phase comparison frequency is 100Hz, the main divider must divide the frequency at TP 39 by 3740 for this particular switch setting.



Main Divider Circuit
(Units Up to Serial No.451)

Fig.2.4A

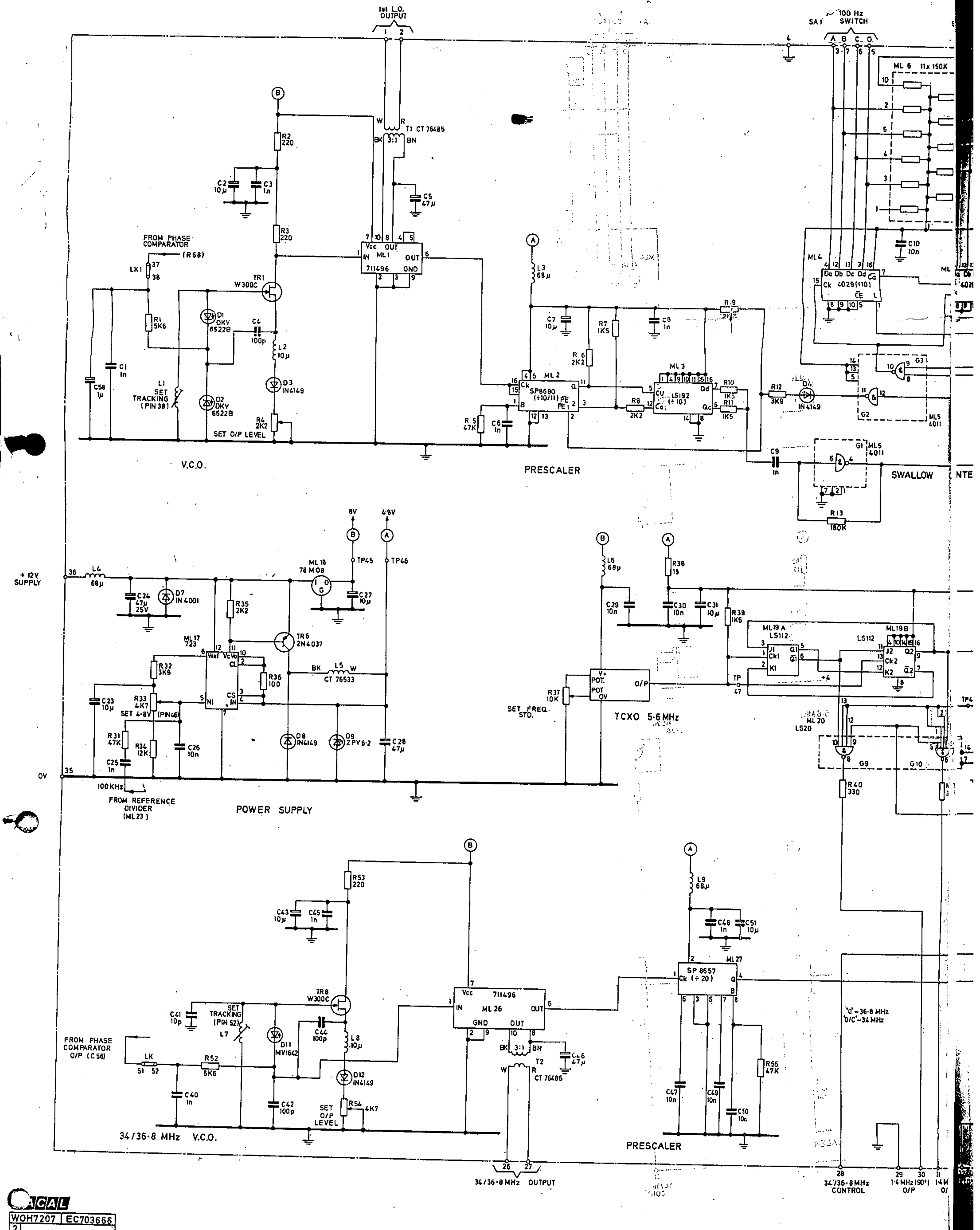
R37



Layout : 719000 Synthesizer
PC Board

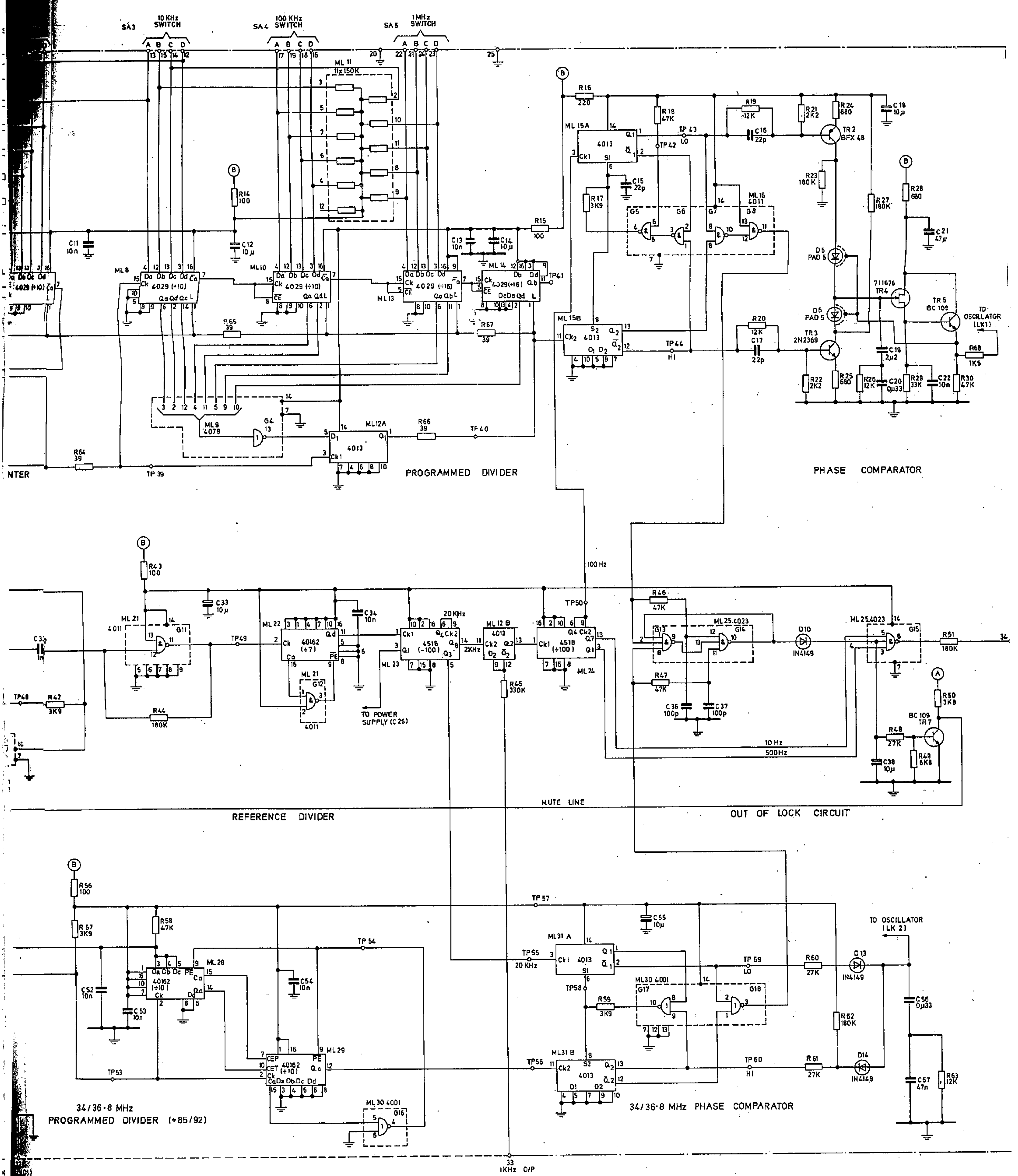
Fig. 2

7 | ED713178



ACAL

WOH7207	EC703666
2	



Circuit : 719000 Synthesizer
PC Board

Fig.

NOTE 1. When fault finding in the synthesizer, start with this table.
2. Whenever a circuit is suspected of malfunction, check that the supply voltage is present at the circuit side of the decoupling resistor or inductor.
3. Unless otherwise stated, all voltages are measured with respect to chassis.

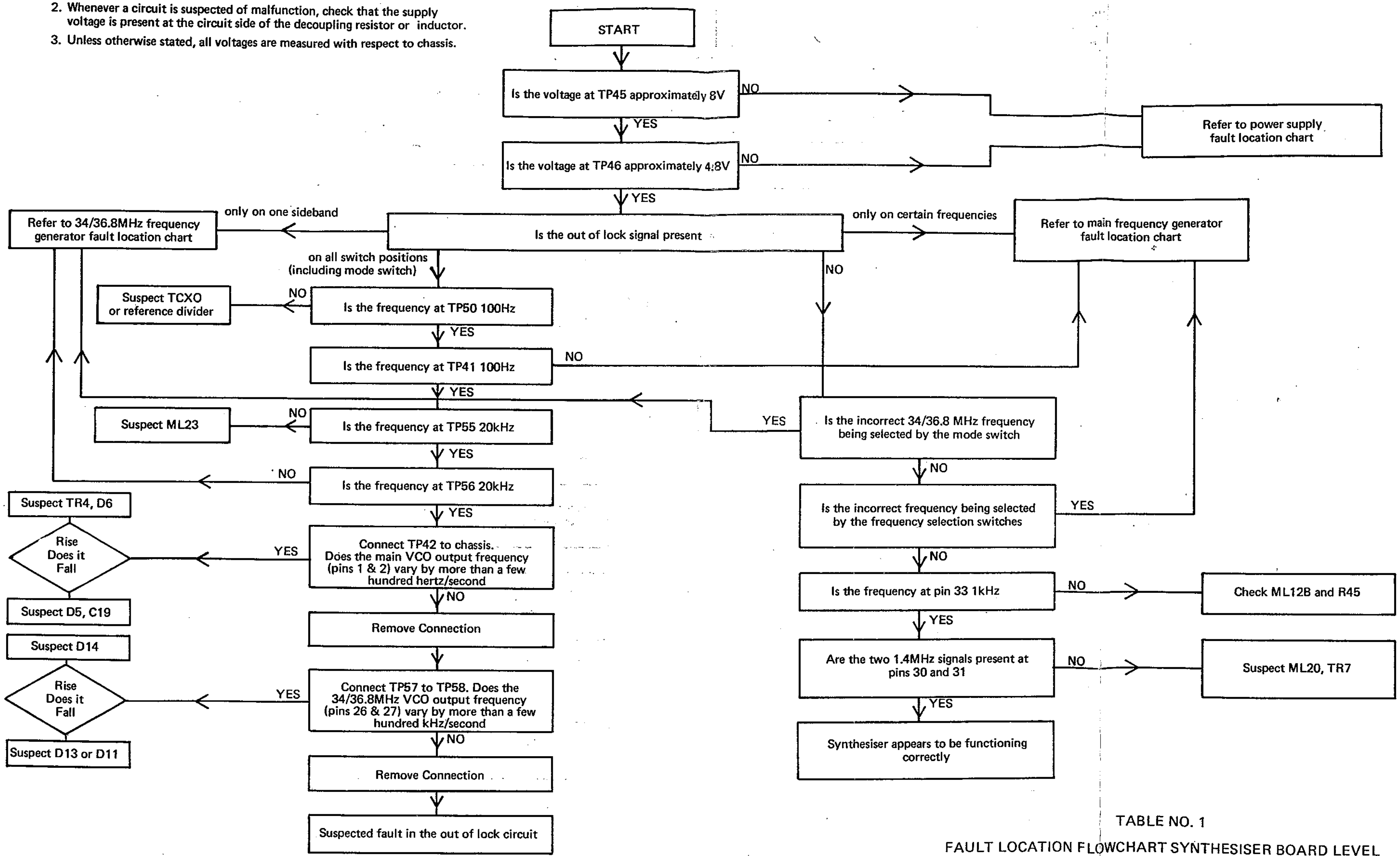
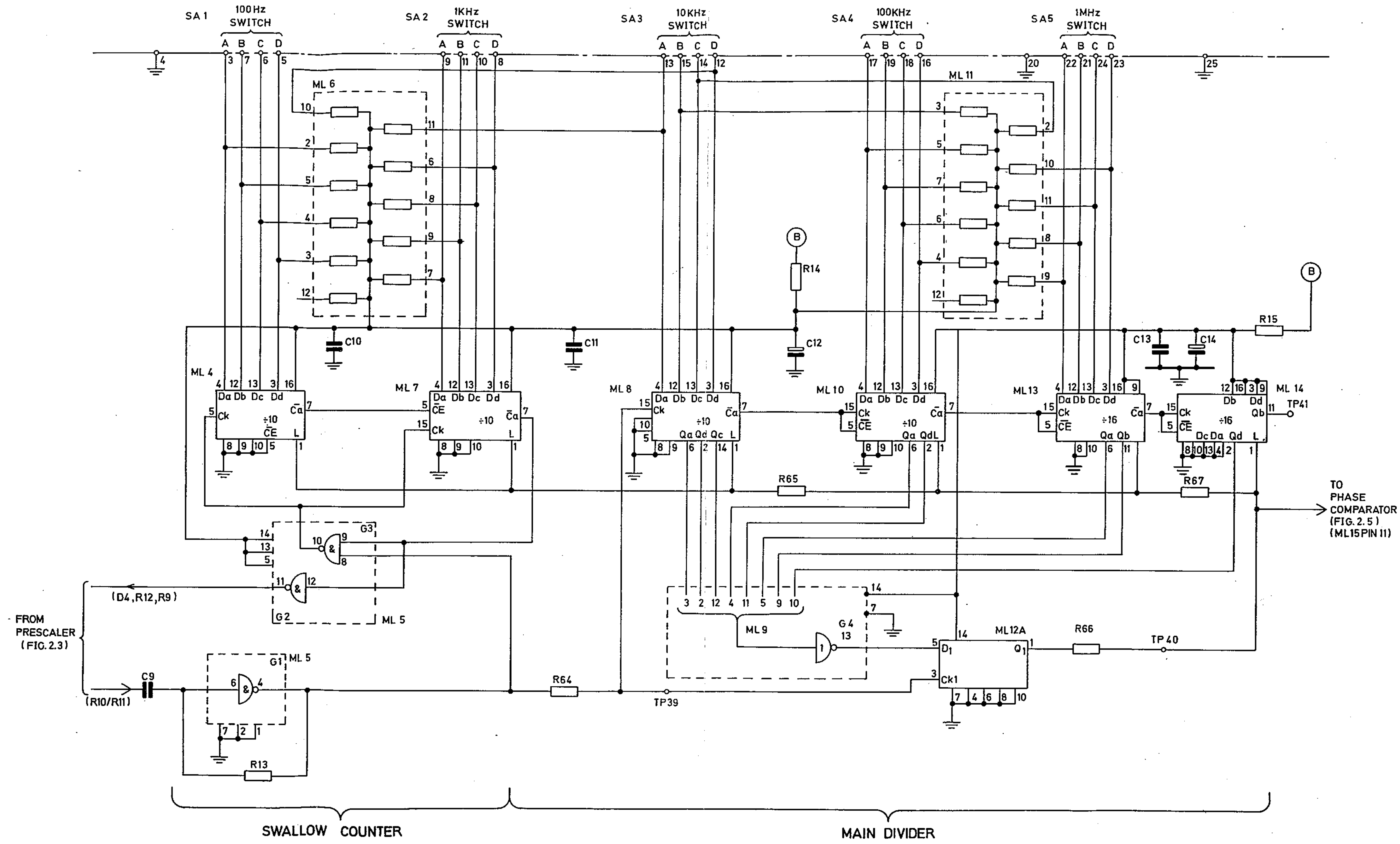


TABLE NO. 1

FAULT LOCATION FLOWCHART SYNTHESISER BOARD LEVEL



RACAL
WOH 7207

Swallow Counter & Main Divider Circuit

(Main Output Frequency Generator)
(Serial No's 452 and Subsequent)

Fig.2-4

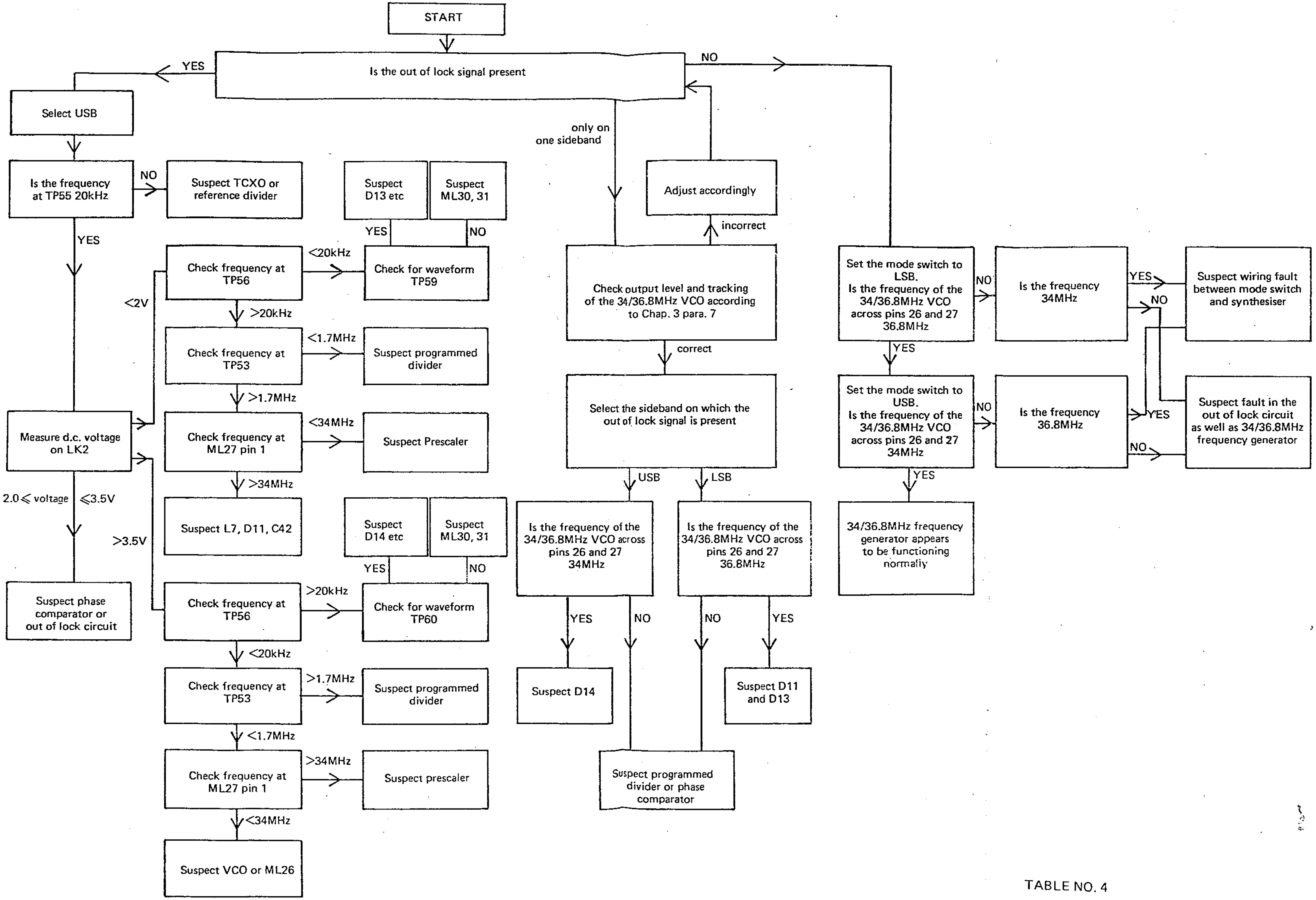


TABLE NO. 4

FAULT LOCATION FLOWCHART – 34/36.8MHz FREQUENCY GENERATOR

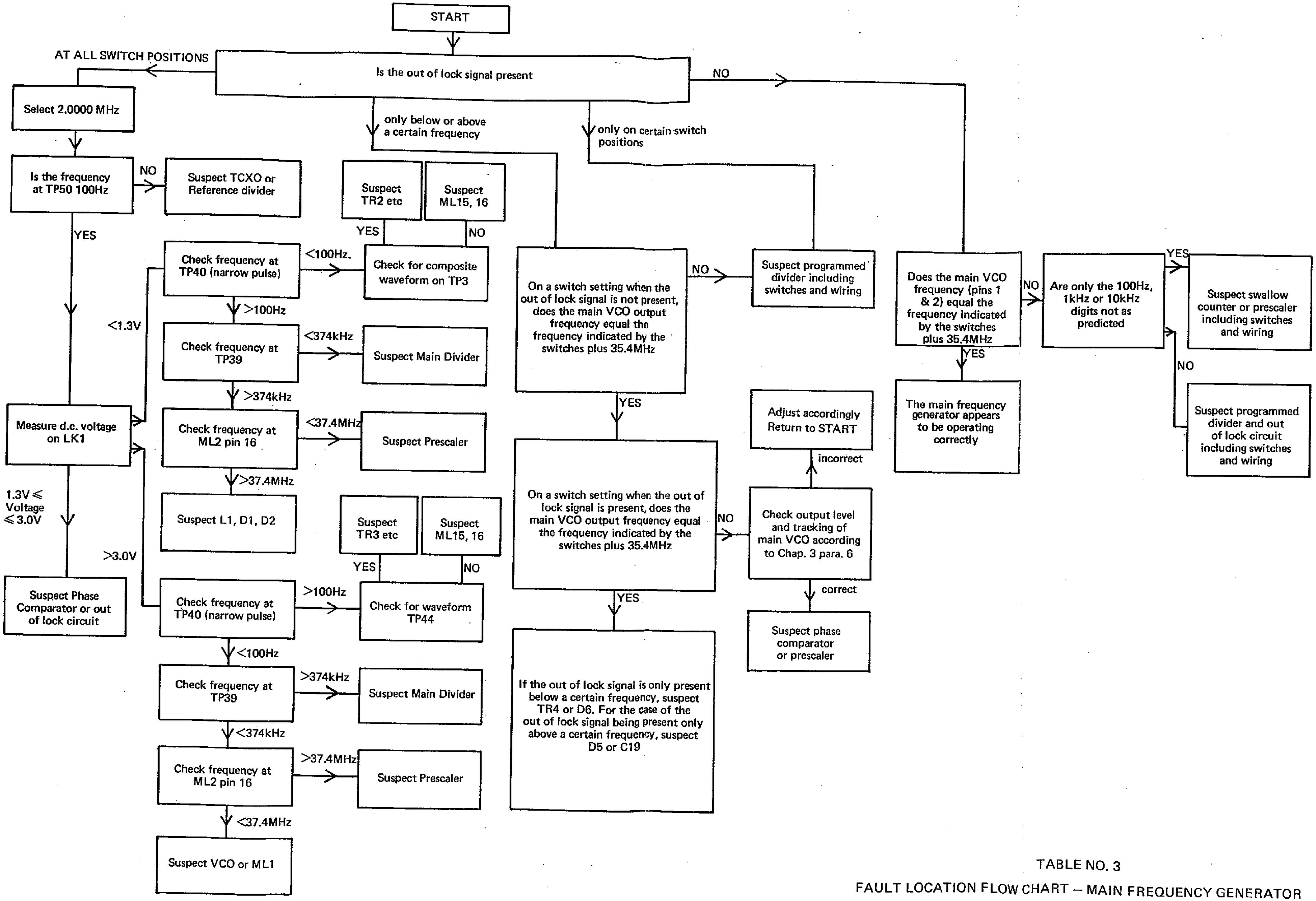
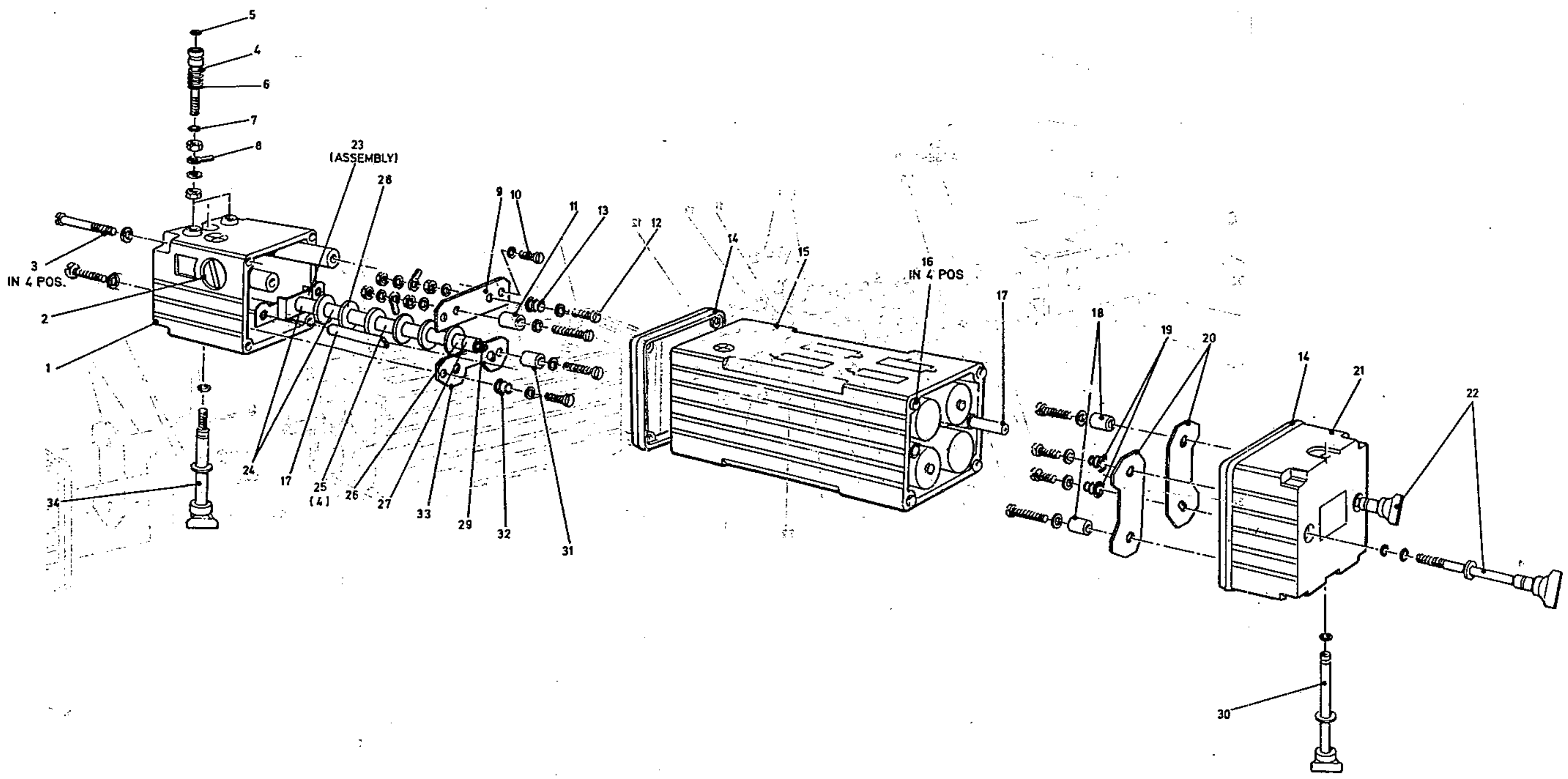


TABLE NO. 3

FAULT LOCATION FLOW CHART – MAIN FREQUENCY GENERATOR



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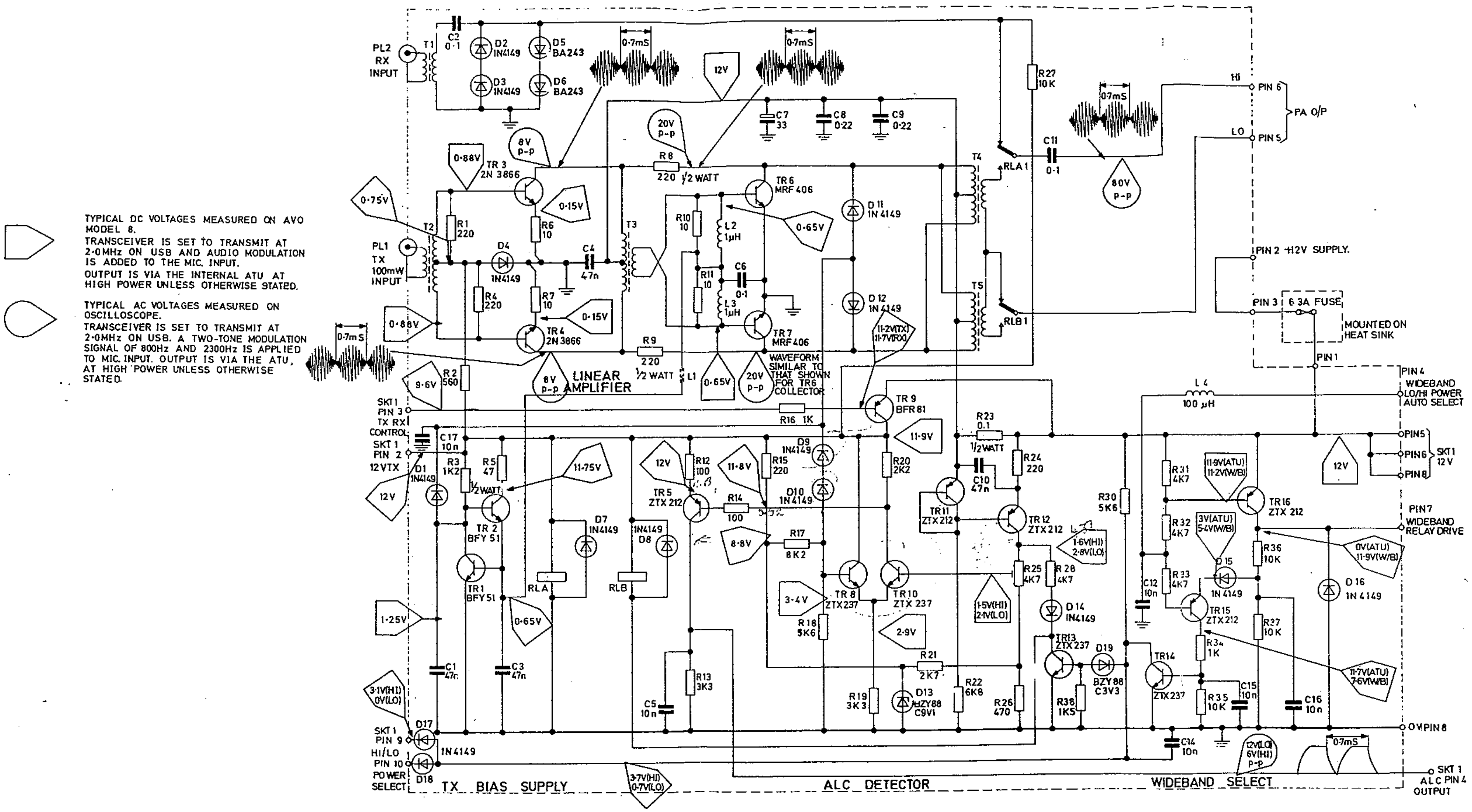
WOH7207

Primary Battery Assembly MA4025B Fig.

TYPICAL DC VOLTAGES MEASURED ON AVO MODEL 8.
TRANSCEIVER IS SET TO TRANSMIT AT 2·0MHz ON USB AND AUDIO MODULATION IS ADDED TO THE MIC. INPUT.
OUTPUT IS VIA THE INTERNAL ATU AT HIGH POWER UNLESS OTHERWISE STATED.

TYPICAL AC VOLTAGES MEASURED ON OSCILLOSCOPE.
TRANSCEIVER IS SET TO TRANSMIT AT 2·0MHz ON USB. A TWO-TONE MODULATION SIGNAL OF 800Hz AND 2300Hz IS APPLIED TO MIC. INPUT. OUTPUT IS VIA THE ATU, AT HIGH POWER UNLESS OTHERWISE STATED.



WOH7207 CD763634
2

Circuit : 719074 Power Amplifier PC Board

Fig. 1