SYNCAL 30

Technical Manual

TRA. 931X TRA. 931Y HF SSB Manpack Transmitter-Receiver

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

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THE QUEEN'S AWARD
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RACAL
The Electronics Group

Racal-Tacticom Limited, P.O. Box 112, 472 Basingstoke Road, Reading, Berks. RG2 0QF.
Tel. Reading (0734) 85373. Telex: 848011 Grams: Tacticom Reading,
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THIS HANDBOOK REFERS TO EQUIPMENT

SERIAL NUMBER ....AND SUBSEQUENT

HANDBOOK AMENDMENTS

See Yellow Amendment Sheet Numbers ....
which follow this page. The action called for by the amendments should be carried out by hand as soon as possible.

BERYLLIUM OXIDE - SAFETY PRECAUTIONS

INTRODUCTION

The following safety precautions are necessary when handling components which contain Beryllium Oxide. Most RF transistors contain this material although the 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.

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ALTERNATIVE TRANSISTOR TYPES

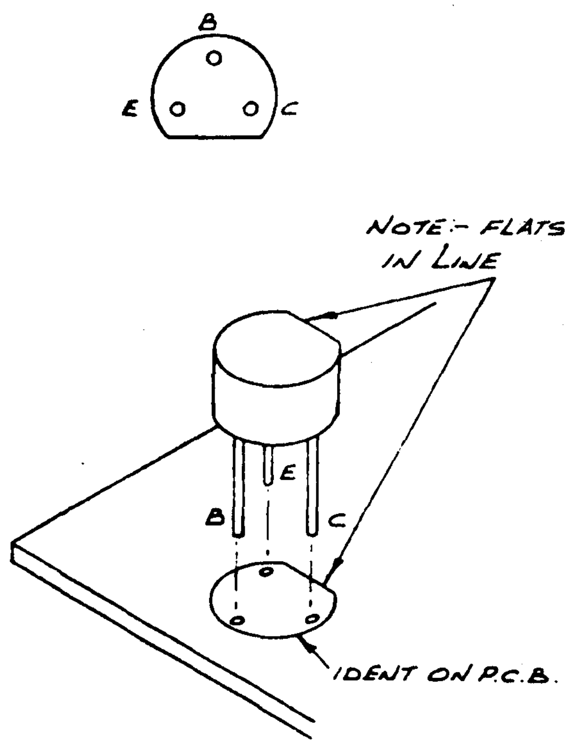
This addendum is applicable to the following equipments:-

CA 531	MA 924L	MA 930P	MA 936	TA 970	MA 985B	MA 990
MA 907	MA 926	MA 930V	MA 937	TA 970H	MA 986B	MA 991
MA 923	MA 927	MA 930X	MA 937B	TRA 971	MA 987	MA 4001
MA 924	MA 930	MA 933	MA 949	MA 978	MA 988	
MA 924B	MA 930L	MA 935	MA 969	MA 984	MA 988B	

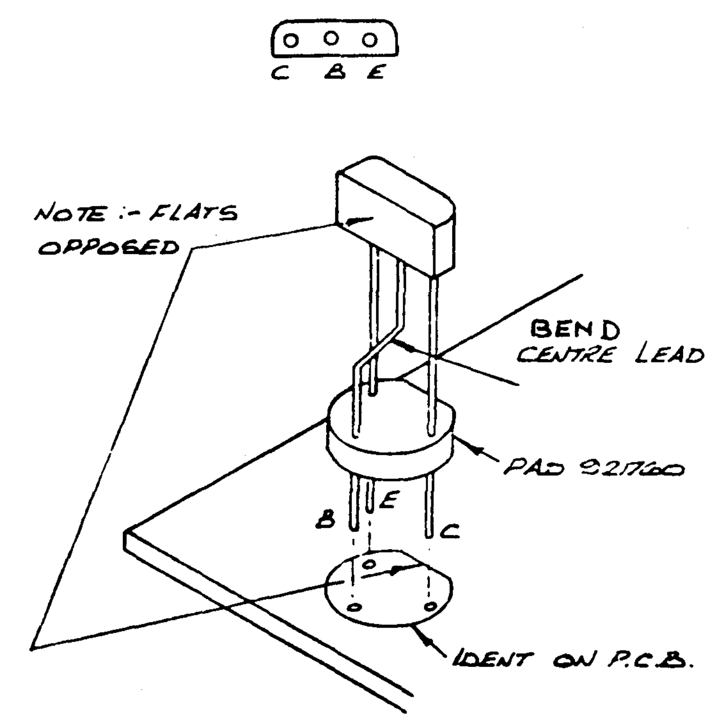
'E-line' (ZTX) Transistors may be used as a replacement for the original transistors listed below. Orientation of transistors on printed circuit boards (PCB's) should be carefully noted as illustrated below.

Original Transistor			Replacement Transistor	
Type	**Racal Part No.**		**Type**	**Racal Part No.**
BC 182 SX 3711	917465 915119	alternative	ZTX 237	923171
BC 212 SX 4060	919122 916092	alternative	ZTX 212	923172
2N 5450	915133	alternative	ZTX 3705	923170
*2N 5448	915118	alternative	ZTX 3703	923169

Configuration (as viewed from lead side of transistor).



Original Transistor Mounting Method



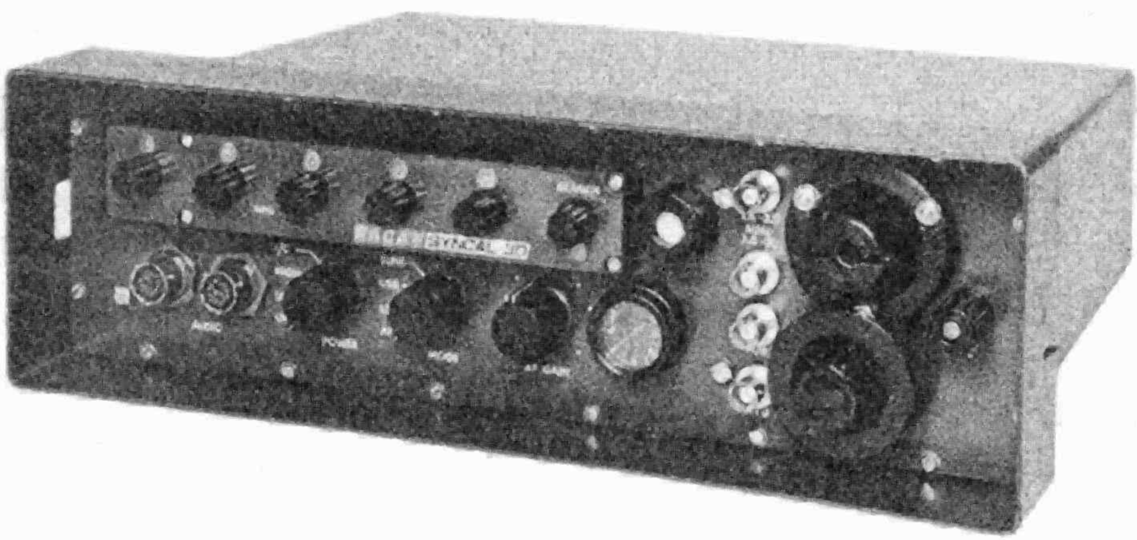
Replacement Transistor Mounting Method

*TR22 on the MA.924 Series and TR20 on the MA.930 Series, are 2N 5448. ZTX 3703 must not be used in these positions.

NOTE TO USERS

The TRA.931X and TRA.931Y Transmitter-Receivers are similar, except that certain components in the TRA.931Y are changed to allow operation over a larger temperature range.

The detailed changes applicable to the TRA.931Y are given in a Supplement at the end of Part 1 of this handbook.



SYNCAL 30

HF SSB Transmitter-Receiver
Type TRA 931X

WOH 6085

PART 1

HF SSB TRANSMITTER RECEIVER

TYPE TRA.931X – TRA.931Y

PART 1 H.F. S.S.B. TRANSMITTER-RECEIVER

TYPE TRA.931X

CONTENTS

CONTENTS (Contd.)

ILLUSTRATIONS

TECHNICAL SPECIFICATION

GENERAL

Frequency range:	1.6MHz to 29.999MHz.
Channels:	28 400 channels in 1kHz steps, derived from a single high stability TCXO, selected by five in-line switches. Maximum synthesizer locking time, less than 2 secs.
Interpolation:	Interpolation between 1kHz steps may be selected by front panel SEARCH control.
Operating Modes:	USB) Voice (A3J) or LSB) Keyed 1kHz tone (A2J) AM) Voice (A3) or) Keyed 1kHz tone (A2)
Frequency Stability:	Better than ± 2 p.p.m. over the operating temperature range with respect to that at 25°C. Accuracy at 25°C better than ± 1 p.p.m.
Temperature range:	Operating: -10°C to +55°C Storage: -40°C to +70°C
Power supply: Portable Operation:	24 volt, 3.5AH nickel-cadmium rechargeable battery, Type MA.934.
Vehicle Operation:	12-30 volt D.C. Power Unit, Type MA.937.
Static Operation:	100-125/200-250 volt, 45 to 60Hz, Power Unit, Type MA.949.
Antennas:	8ft. (2.4m) whip (for operation above 2MHz) Dipole End-fed.
Antenna tuning:	Single-control tuning. Inbuilt ATU tunes above antennas for both transmit and receive.
Sealing:	Transmitter-Receiver case sealed and fitted with desiccator. Battery container is fully sealed and fitted with screw fasteners.

Front Panel Controls & Facilities:	(a) Five frequency selection switches. (b) SEARCH (interpolation) control. (c) MODE switch selecting. TUNE USB LSB AM (d) POWER switch setting. I/C (Intercom) HIGH power LOW power OFF (e) Antenna tuning control (TUNE) (f) AF Gain Control (AF GAIN) (g) Meter indicating r.f. antenna current in TUNE and transmit conditions, battery voltage in receive condition. Coarse tune indicating lamps are fitted in the meter. (h) Whip Antenna socket (WHIP). (j) Two 50 ohm sockets for dipole antenna. (i) 1.6 - 3MHz (ii) 3 - 30MHz (k) Two 50 ohms sockets: (i) W/B for external filter or remote ATU (ii) ATU return from external filter (l) Ground terminal (n) Two accessory sockets for handset, headset or Morse Key or loudspeaker/amplifier/PSU or battery charging unit. (AUDIO).
Weight:	Basic TRA.931X only: 5 kg (11 lb). Operational manpack with handset, whip antenna, nickel cadmium battery and harness assembly: 11kg (24lb).
Dimensions (excluding battery):	Width: 366mm (14.4 in). Height: 116mm (4.6 in). Depth: 275mm (10.8 in).
Ancillaries:	Full details of ancillaries will be found in "RACAL HF SSB MANPACK ANCILLARIES" brochure. A list is given in Appendix 1.

TRANSMITTER

Power Output	High Power
	SSB: 20 watts p.e.p.) ± 1.5 dB CW: 20 watts)
	Low Power
	Power output reduced by 7.5 dB ± 1.5 dB.
Harmonic Emissions:	No harmonic will exceed -40 dB relative to p.e.p. in 50 ohms load with ATU.
Spurious Emissions:	Better than -40 dB relative to p.e.p. in 50 ohms load with ATU.
Carrier Suppression:	40 dB relative to full p.e.p. output.
Unwanted Sideband Suppression:	40 dB relative to p.e.p. output at 1 kHz.
Intermodulation Distortion:	-25 dB relative to full p.e.p. output.
Power Consumption:	4.0A maximum.

RECEIVER

SSB Sensitivity:	1 μV p.d. RF input will give 10 mW a.f. output with a signal to noise ratio of not less than 15 dB.
Selectivity (typical figures):	SSB 6 dB bandwidth 2.0 kHz minimum 40 dB bandwidth 6.0 kHz maximum.
	AM 6 dB bandwidth 8.0 kHz minimum 55 dB bandwidth 40 kHz maximum.
Image Rejection:	Better than 60 dB.
I.F. Rejection:	Better than 60 dB.
Spurious Responses:	All other spurious responses attenuated by at least 40 dB.
AF Output Power:	30 mW nominal with 100 μV p.d. RF input.
AF Distortion:	5% at 10 mW output level with 100 μV p.d. RF input.
Fixed AF Output:	50mW into 50 Ω.

AGC:	The AF output changes less than 6 dB for RF input variations of 80 dB above 2 μV p.d. on SSB.
Power Consumption:	250 mA approximately as a portable.

All the above performance figures are obtained when using a power supply of 24 volts.

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The 'Syncal' Type TRA.931X manpack provides transmission and reception facilities in the frequency range of 1.6 to 29.999MHz. Twenty-eight thousand four hundred channels are available, spaced at 1kHz intervals throughout the frequency range. The transmitter provides a high power output of nominally 20 watts or a low power output of approximately 5 watts; the selection of high or low power output is made at a switch fitted to the front panel.

2. The manpack provides single sideband (upper and lower) and double sideband (a.m.) telephony or telegraphy operation. In addition inter-communication facilities between two sets of audio equipment are provided.

3. The casing is of high impact plastic (allowing the equipment to withstand severe handling) and the front panel is a metal plate. The manpack is fully waterproofed, allowing it to be totally immersed without damage. A desiccator is fitted to the front panel, and can be changed without dismantling the equipment. The element of the desiccator can be re-activated by means of a hot-air blower after removal from the set.

4. Sockets are fitted to the front panel to allow the connection of ancillary equipment and antennas. A wide range of ancillary equipment is available, as listed in Appendix No.1.

5. The power supply is normally provided by a 24V nickel-cadmium battery which is fitted to the main case. The battery can be re-charged in situ, via a front panel socket, or can be changed without disturbing the waterproof sealing of the main case. For certain applications an external power supply can be used in place of the battery.

6. The total weight of the complete manpack, including the haversack, battery, whip antenna and handset, is approximately 11kg (24lb).

COMPOSITION OF 'SYNCAL 30' MANPACK TYPE TRA.931X

7. A 'Syncal 30' Manpack Type TRA.931X consists of two main units in addition to the battery. The two units are the Transceiver Unit Type MA.930X and the Synthesizer Type MA.925. Part 1 of this handbook gives information on the complete manpack, Part 2 covers the Transceiver Unit and Part 3 the Synthesizer.

Transceiver Unit MA.930X

8. This unit includes the control panel on which is mounted all the operating controls and external connector points, (see fig.1). These latter points include one whip

antenna socket, two dipole sockets used to cover the frequency range in two steps of 1.6 to 3 and 3 to 30MHz, a W/B socket for connection to either an external filter, a remote ATU or r.f. amplifier, and an ATU socket for the return from the external filter.

9. The two AUDIO sockets on the front panel have pins A to F connected in parallel permitting the connection of various combinations of handset, headset etc. Examples of these may be a loudspeaker amplifier and a handset, a handset (used by a second operator) and a headset (used by first operator for monitoring), or a headset and a morse key. The sockets are also used to connect the various combined loudspeaker amplifiers and power units or battery charging unit to the manpack. Diode isolating circuits are fitted which allow the battery to be charged when the manpack is switched off, but prevent power being fed to ancillary equipment. On the AUDIO 1 socket, the seventh pin (G) provides an initiate tune when a remote ATU is used. On the AUDIO 2 socket the seventh pin (G) provides an audio output at a fixed level for use with either the MA.987 Audio Amplifier Unit or a vehicle harness system.

10. The majority of transmitter/receiver circuit components are contained on two fibreglass printed circuit boards, the main 930X board and a separate Power Amplifier (P.A.) board. Two smaller boards, the switching and fixed level Audio Amplifier and the A.T.U. Relay board, provide the extra facilities which allow the 931X to be used in the various systems described in this handbook. Screening of the circuits against unwanted external pick-up is provided by the fitting of screening covers to the chassis assembly.

BATTERY

11. The nickel-cadmium re-chargeable battery is attached to the base of the manpack by two retaining screws. The battery has a capacity of 3.5 ampere-hours.

12. Metering of the battery voltage is carried out at the control panel meter. When the manpack is in the receive condition the meter is connected across the battery. A reading of less than three quarters scale deflection indicates that the battery needs recharging.

13. The contact arrangement between the battery and the main unit is so designed that incorrect connection is impossible (see fig. 4).

SYNTHESIZER MA.925

14. The Synthesizer consists of a printed circuit board, and is housed in a separate screened compartment. The five frequency selection controls and a Search (interpolation) control are fitted to the front panel of the manpack.

PRINCIPLES OF OPERATION

Transceiver Unit

15. Microphone inputs are fed to the a.f. amplifier and then to the compressor (limiter) (see simplified block diagram fig. 1 of Part 2). The a.f. input modulates a 1.4MHz signal and the resultant i.f. signal is amplified and fed to one of two filters, u.s.b.

or l.s.b., or via an a.m. circuit, dependent upon the mode selected. The filtered signal is then mixed with a 34MHz frequency, fed through the a.m. band-pass filter, mixed with a 37MHz to 65.399MHz input and amplified in the driver and p.a. stages prior to being fed to the contacts of the relays 4RLA and 4RLB, mounted on the ATU relay board. Normally the relay contacts will route the output via the internal a.t.u. to the antenna sockets. When either an external filter, r.f. amplifier or a remote ATU is used, the relays become energized to route the output to the W/B socket. The output from the external filter is fed back to the internal a.t.u. via the ATU socket.

16. The power output of the transmitter can be HIGH or LOW, dependent upon the setting of the POWER switch, except when an r.f. amplifier is used, or a remote ATU is in the tuning condition which automatically sets the transmitter to low power via the power switching circuit on the switching and fixed level audio amplifier board.

17. Received r.f. signals are fed via the a.t.u., a protection circuit and a low pass filter, to the split ring mixer, where the signals are mixed with the output of the channel oscillator to produce the first i.f. of 35.4MHz. The signal is fed via the a.m. filter and the first i.f. amplifier, to a further mixer stage, where it is mixed with a 34MHz signal to produce the second i.f., centred on 1.4MHz. Dependent upon mode selected, the second i.f. is then fed via the appropriate filter to the second i.f. amplifier, then to the detector to provide an a.f. output.

18. An a.g.c. circuit, operating upon the i.f. stages, is provided. This circuit maintains a (sensibly) constant a.f. output level for wide variations of r.f. input level.

19. An additional fixed level audio output is provided at pin G of AUDIO socket 2. This output is provided by the switching and fixed level audio circuit and has a 50 ohm output impedance.

<u>Synthesizer</u> Fig. 1 of Part 3

20. The synthesizer provides a frequency in the range 37 to 65.399MHz, dependent upon the setting of the decade controls. This frequency is 35.4MHz higher than the nominal setting of the controls. The synthesizer also produces a 34MHz and a 1.4MHz frequency. All outputs are to the same standard of stability as a crystal oscillator incorporated in the unit.

21. The decade controls set a programmed divider to a division ratio which will provide a frequency of 500Hz when the output frequency is correct. This frequency is phase compared with a 500Hz reference frequency to provide a control voltage which adjusts the output frequency until the coincidence condition is obtained. The output frequency is then 'locked' to the frequency standard.

CHAPTER 2

PREPARATION

1. Unpack the equipment from the transit case and remove the manpack from its haversack.

2. Unscrew the two retaining screws and remove the battery.

3. Carefully inspect the equipment for any transit damage.

4. Check that the 7 amp fuse fitted to the battery is serviceable, and that a spare fuse is fitted. Refit the battery and screw the retaining screws firmly home, to ensure a water proof seal between the battery and the main case.

NOTE: Do not overtighten screws.

5. Replace the manpack in its haversack and tighten the haversack frame retaining straps.

6. Set the MODE switch on the control panel to USB, LSB or AM position, set the POWER switch to HIGH or LOW position and read the level indicated. A fully charged battery is indicated by a reading of three-quarters scale deflection. Switch off the manpack.

7. The desiccator fitted to the equipment has been used for initial drying of the unit and should be replaced by the new desiccator in the bag attached to the unit before putting into service.

CHAPTER 3

OPERATION

CONTROLS AND CONNECTIONS

1. The controls and sockets fitted to the front panel of the manpack are listed below:

(a)	Frequency Selection Controls	The five control switches are used to select the required frequency.
(b)	SEARCH Control	Allows interpolation within 1kHz steps.
(c)	MODE Switch	The four position rotary switch is used to select the mode of operation of the equipment. The positions of the switch are AM, LSB, USB and TUNE.
(d)	POWER Switch	The four positions of the switch are OFF, LOW power, HIGH power and I/C. The I/C position provides an intercom facility.
(e)	AF GAIN	This potentiometer controls the receiver a.f. gain and sidetone level.
(f)	TUNE	This control tunes the antenna, except when remote ATU and/or r.f. amplifier are used.
(g)	METER	The meter indicates the battery voltage when the manpack is in the receive condition, and the antenna current when TUNE or the transmit condition is selected, except when remote ATU and/or r.f. amplifier are used. The meter incorporates coarse tune indicating lamps.
(h)	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 ancilliary equipment (such as headset, morse key, external power supply or battery charging equipment etc.) to be connected to the manpack. Pin G provides initiate tune when a remote ATU is used with the equipment.
(j)	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 either the MA.987 or a vehicle harness.
(k)	WHIP SOCKET	This socket allows a whip antenna to be connected to the manpack.

(l)	1.6-3MHz and 3-30MHz 50Ω SOCKETS	These sockets allow an antenna (other than a whip) to be connected to the manpack.
(m)	W/B SOCKET	This socket provides a connection to either an external filter, a remote ATU or an r.f. amplifier.
(n)	ATU SOCKET	This socket provides a return to the manpack from the external filter.
(p)	GROUND TERMINAL	This terminal allows a ground connection to be made to the manpack.

ANCILLARY EQUIPMENT OF OTHER MANUFACTURERS

2. Care should be exercised when using ancillary equipment made by other manufacturers. As an example, certain morse keys which look identical to Racal products have different pin connections. These keys will not normally cause damage to the manpack, but will prevent telegraphy working taking place.

ANTENNAS

3. The manpack is normally operated with the standard whip antenna. This antenna is generally satisfactory for distances up to 25km (15 miles). Where greater distances are required the 3-30MHz dipole antenna should be used, and should be erected as close to the vertical as conditions allow. Where the height of the support is limited the 3-30MHz end fed antenna or the dipole used as a slant wire antenna may be used, giving slightly reduced performance. For considerably greater distances the dipole should be erected horizontally between two supports or as an inverted V when only one support is available.

4. The methods of erection and connection of the various antennas are shown in figs. 5 to 10. The length of the antennas must be adjusted to suit the frequency of operation, so that the best send and receive conditions are obtained. The required lengths for various frequencies are obtained from Table 1 (following para.13) for dipole, slant-wire and end-fed antennas.

5. When a horizontal dipole antenna is being used, it should be erected, if possible, so that the line of the antenna is at 90° to the direction of the distant station. With the slant-wire or end-fed antenna, the direction is not important.

NOTE: Operation at 3rd and 5th harmonics of the antennas may be used with, in some cases better performance. For instance an antenna adjusted for operation at 5MHz may be used at 15MHz and 25MHz without further adjustment.

CONNECTION OF ANTENNAS

6. Reference should be made to para.3 for the appropriate selection of antenna.

Whip Antenna

7. The whip antenna is generally satisfactory for distances up to 25km (15 miles).

(1) Select a location that is as high and clear as possible.

(2) Assemble the sectional whip antenna and fit the thick end into the socket of the flexible plug-in antenna mount (or shock absorbing antenna mount) as shown in fig.5.

NOTE: The antenna is most easily assembled by laying it along the ground in a straight line. Holding the thinest section, draw the centre wire tight until all the sections become interlocked.

(3) Fit the plug of the flexible plug-in antenna mount (or shock absorbing mount) into the whip socket on the manpack. The antenna should be placed in a vertical position id conditions allow.

(4) If a frequency below 25MHz is to be used the full length (2.4m (8ft)) of the whip should be erected. If a frequency above 25MHz is to be used the antenna should be reduced to 1.8m (6ft) by folding the top two sections as shown in fig.5.

(5) If operation is semi-static, drive the spike into the ground and connect its lead to the ground terminal on the manpack.

Vertical Dipole Antenna

8. This antenna should be used where the range of the whip antenna is not sufficient.

(1) Unwind the support lines and enough antenna wire from each reel to equal the length indicated in Table 1 (following para.13) for the frequency in use. Connect the ends to the dipole adaptor terminals as shown in fig.6.

NOTE: Markings on the antenna wire are provided to simplify this operation.

(2) Make a small loop in the antenna wire at the measured point. Insert it into the slot to secure the wire, as shown in fig.11. Repeat for the other half of the antenna.

(3) Connect the plug on the antenna feeder to the socket of the dipole adaptor and fasten the 'D' shackle to the anchor ring.

(4) Erect the antenna with the wire as close as possible to the vertical position as conditions allow.

(5) Ensure that the antenna feeder is well separated from the antenna wire and, ideally, should be positioned at right angles to the wire.

(6) Drive the spike into the ground and connect its lead to the ground terminal of the manpack.

End-Fed Antenna

9. This antenna should be used where the support is not high enough to erect a vertical dipole antenna.

(1) Unwind the support line and enough antenna wire from the reel to equal the length indicated in Table 1 (following para.13) for the frequency in use.

NOTE: Markings on the antenna wire are provided to simplify this operation.

(2) Make a small loop in the antenna wire at the measured point. Insert it into the exposed slot to secure the wire as shown in fig.11.

(3) Connect the free end of the antenna to the terminal of the BNC adaptor and plug it into the appropriate 50Ω socket of the manpack as shown in fig.7.

(4) Erect the antenna with the wire as close to the vertical position as conditions allow.

NOTE: Where the antenna length erected is considerably shorter than recommended, connect the free end of the antenna to the terminal of the whip adaptor and plug it into the WHIP socket of the manpack.

(5) Drive the spike into the ground and connect its lead to the ground terminal on the manpack.

NOTE: If the end-fed antenna is not available, one of the reels from the dipole antenna may be used.

Dipole used as a Slant-Wire Antenna

10. (1) This antenna gives similar performance to the end-fed antenna and is used when a BNC adaptor is not available.

(2) Unwind the support line and antenna wire completely from one reel and connect the free end to the terminal on the dipole antenna adaptor marked with an earth sign (see fig.8).

(3) Unwind the support line and enough antenna wire from the other reel to equal the length indicated in Table 1 (following para.13) for the frequency in use. Connect the free end to the adaptor terminal marked with an antenna sign.

NOTE: Markings on the antenna wire are provided to simplify this operation.

(4) Make a small loop in the antenna wire at the measured point. Insert it into the exposed slot to secure the wire, as shown in fig.11.

(5) Connect the plug on the antenna feeder to the socket on the dipole adaptor and fasten the 'D' shackle to the anchor ring.

(6) Connect the plug at the other end of the feeder to the appropriate 50Ω socket on the manpack.

(7) Erect the antenna with the measured wire as close to the vertical position as conditions allow. Extend the fully unwound wire beneath the antenna taking

care to ensure that the measured wire and terminal of the dipole adaptor do not rest on the ground.

(8) Drive the spike into the ground and connect its lead to the ground terminal on the manpack.

Horizontal and Inverted V Dipole Antennas

11. These antennas should be used where considerably greater ranges than those given by the whip are required.

12. The procedure for erecting an antenna is similar to the Vertical Dipole Antenna (para.8) except that the antenna should be erected with the wire as close as possible to the horizontal position where two supports are available, or as an inverted V where only one support is available (see figs. 9 and 10).

13. If possible this antenna should be orientated so that the direction of reception and transmission are along a line at right angles to the line of the antenna.

For Table 1 see Overleaf

TABLE 1

ANTENNA LENGTH

FOR DIPOLE (EACH HALF), SLANT WIRE AND END FED ANTENNAS

FREQUENCY MHz	LENGTH m	ft
2.0	23.5	77 (fully extended)
2.5	23.5	77 (fully extended)
3.0	22.3	73
3.5	19	62
4.0	16.5	54
4.5	14.5	47.5
5.0	13	42.5
5.5	11.6	38
6.0	10.7	35
6.5	9.8	32
7.0	9	29.5
7.5	8.3	27
8.0	7.6	25
9.0	6.7	22
10.0	6.1	20
12.0	5	16.5
14.0	4.3	14
16.0	3.7	12
18.0	3	10
22.0	2.4	8
26.0	2	6.5
30.0	1.5	5

Lengths are given from centre of adaptor to edge of reel nearest to adaptor. Where the frequency in use is not quoted in the table, adjust the antenna to that frequency which is nearest to the one required.

Use with External Filter

14. In dual radio installations, to reduce mutual interference, external filters should be fitted to each manpack as follows:-

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

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

VEHICLE OPERATION

Whip Antennas

15. 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 it is not advisable to use a length greater than 8.2m (27ft) over the frequency range 1.6 to 8MHz, 4.9m (16ft) over the range 1.6 to 16MHz or 2.4m (8ft) over the range 2.0 to 27MHz.

(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.

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

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

Remote ATU

16. When a remote a.t.u., such as the BCC 540 automatic a.t.u. is used, make the following connections:-

(1) Connect the MA.4104A ATU Control Box RADIO socket to the manpack AUDIO 1 socket.

(2) Connect the W/B socket on the manpack to the a.t.u.

RF Amplifier

17. An r.f. amplifier may be connected as follows:-

(1) Connect the manpack AUDIO 1 to a AUDIO socket on the r.f. amplifier.

(2) Connect the manpack W/B socket to r.f. input on the r.f. amplifier.

BATTERY CHECK

18. Before using the manpack it is advisable to check the state of charge of the batteries. This is carried out simply by setting the POWER switch to the LOW or HIGH position and checking that the meter reads three quarters scale deflection, or greater. Do not depress key or p.t.t. switch for this check.

Battery Changing

19. (1) Remove the manpack from the harness.

(2) Unscrew the two retaining screws holding the battery to the base of the manpack and detach the battery.

(3) To refit the battery to the main case, engage and tighten the two retaining screws.

(4) Replace the manpack in the harness.

Battery Charging

CAUTION: The nickel-cadmium battery MA.934 must only be recharged with a suitable unit e.g. Racal Universal Battery Charger Type MA.945. The type of charging unit normally used with lead-acid type batteries can cause extensive damage to nickel-cadmium batteries.

20. The nickel-cadmium battery may be charged without being detached from the manpack. If the battery is completely discharged, a charging time of 14 hours is needed. For a partially discharged battery, a charge time of 12 hours will ensure complete serviceability.

21. The Universal Battery Charger MA.945 can operate from any of the following power supplies:-

(a) 12 - 15 volts d.c.
(b) 24 - 30 volts d.c.
(c) 100 - 125 volts a.c.
(d) 200 - 250 volts a.c.

22. Two selection switches are mounted on the front panel of the battery charger. It is important that these switches are correctly set for the power supply available, and for 24V output. Failure to do this may result in extensive damage to the charging unit or the battery.

23. The charging output from the unit is available on a flexible connector permanently attached to the front of the unit and terminated in a 6-pin plug. The procedure for using the battery charger is as follows:-

(1) Ensure that the power switch is set to the OFF position.

(2) Set the SUPPLY VOLTAGE switch to the position suitable for the power supply to be used.

(3) Ensure that the BATTERY VOLTAGE switch is set to 24V.

(4) If the battery is to be charged whilst attached to the manpack, connect the battery charger output connector to either of the two AUDIO sockets on the front panel of the manpack.

(5) If the battery is to be charged when detached from the manpack use the adaptor cable. Connect the socket of this cable to the plug of the charging cable, the positive (red) plug to the positive (red) terminal on the battery and the negative (black) plug to the negative (black) terminal.

(6) Select either the 12/24V D.C., or the 100-250V A.C. supply cable assembly as determined by the supply in use.

(7) Plug the selected cable assembly into the SUPPLY VOLTAGE plug on the front panel of the battery charger.

(8) Connect the other end of the selected cable assembly to the supply to be used. Where the A.C. mains supply is being used ensure that the supply is switched off. Details of both A.C. mains and D.C. battery supply connections are as follows:-

INPUT SUPPLY CABLE		A.C. MAINS SUPPLY
Brown wire	to	Line (L)
Blue wire	to	Neutral (N)
Yellow/Green wire	to	Earth (E)

INPUT SUPPLY CABLE		D.C. SUPPLY
Red wire	to	Positive terminal
Black wire	to	Negative terminal

(9) With the input supply connected, set the battery charger power switch to ON. If the A.C. mains supply is being used, switch the supply to ON. Observe that the indicator lamp (CHARGE IND) on the charging unit is illuminated.

OPERATION

Connection of Audio Equipment

24. Connect the required audio equipment to either of the two AUDIO sockets on the manpack (see fig.1). For Telegraphy Operation both the morse key and headset are used, if only one AUDIO socket is available, a 'Y' Audio Adaptor is inserted into this socket and the morse key and headset are connected to the two free ends of the adaptor. The audio equipment available is listed below.

(a) Telephone handset.
(b) Headset and boom microphone.
(c) Single earpiece headset.
(d) Noise excluding headset.
(e) Morse key.
(f) Loudspeaker/amplifier (see para.29).
(g) Universal Battery Charger (see para.20).

Tuning

25. (1) Set the five frequency selection controls to the required positions. Set the SEARCH control to the OFF position.

(2) Set the POWER switch to HIGH position.

(3) Set the MODE selector switch to the TUNE position.

(4) Except when a remote a.t.u. or r.f. amplifier is used, rotate the TUNE control in the direction indicated by the illuminated red lamp in the meter. When the lamp extinguishes continue adjusting the TUNE control to achieve greatest meter deflection.

(5) If immediate transmission or reception is not required set the POWER switch to OFF.

Voice Operation

26. (1) Set the mode selector switch to the required mode of operation i.e. USB, LSB or AM.

(2) Set the POWER switch to HIGH or LOW as required.

(3) To transmit, press the switch in the telephone handset (or the switch on the headset and boom microphone junction box) and speak into the microphone.

(4) During reception adjust the audio level using the AF GAIN control, and adjust the SEARCH control for optimum clarity if necessary.

Telegraphy Operation

27. (1) Set the mode selector switch to the USB, LSB or AM position as required.

(2) Set the POWER switch to HIGH or LOW as required.

(3) To transmit, operate the morse key. A delay of approximately half a second will occur between the releasing of the morse key and the changeover to the receive condition.

(4) During reception adjust the audio level using the AF GAIN control, and adjust the pitch of the tone (if necessary) using the SEARCH control.

Intercom. Operation

28. Intercom. operation is carried out as follows:-

(1) Connect audio gear to the two audio sockets (see para.24).

(2) Set the POWER switch to I/C position.

(3) Press the switch in the telephone handset (or the switch on the headset and boom microphone junction box) and speak into the microphone.

Loudspeaker/Amplifier Operation

29. If the Loudspeaker/Amplifier Unit Type MA.988 is to be used with the manpack it is merely necessary to connect the plug of the loudspeaker/amplifier unit to either of the AUDIO sockets. The level of output of the unit is then adjusted by using the AF GAIN control of the manpack. The loudspeaker/amplifier has a maximum output of 0.5 watts.

Fixed Level Audio Output

30. A fixed level audio output is provided on pin G of AUDIO 2 socket and can be used with either the MA.987 or a vehicle harness system.

Initiate Tune

31. When the MA.4104 ATU Control Unit has set an automatic ATU to the tune condition, it provides an earth as an initiate tune signal to pin G on AUDIO 1 socket.

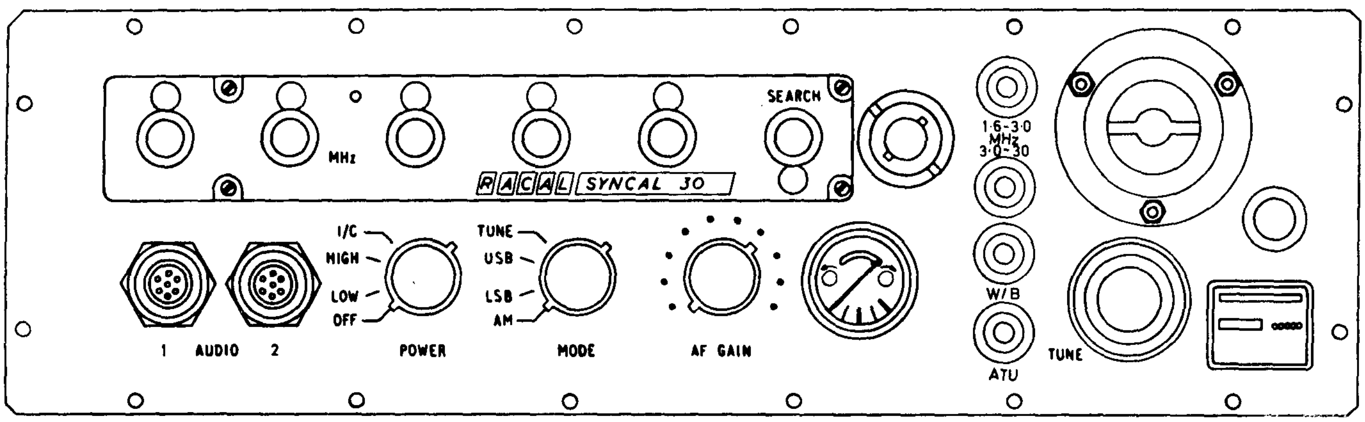
OPERATIONAL SYSTEMS

32. The TRA.931X can be used as a self-contained transmitter/receiver, or with additional units to provide increased power output or selectivity. Some typical systems are shown in fig. 12.

CHAPTER 4

LIST OF COMPONENTS (TRA.931X)

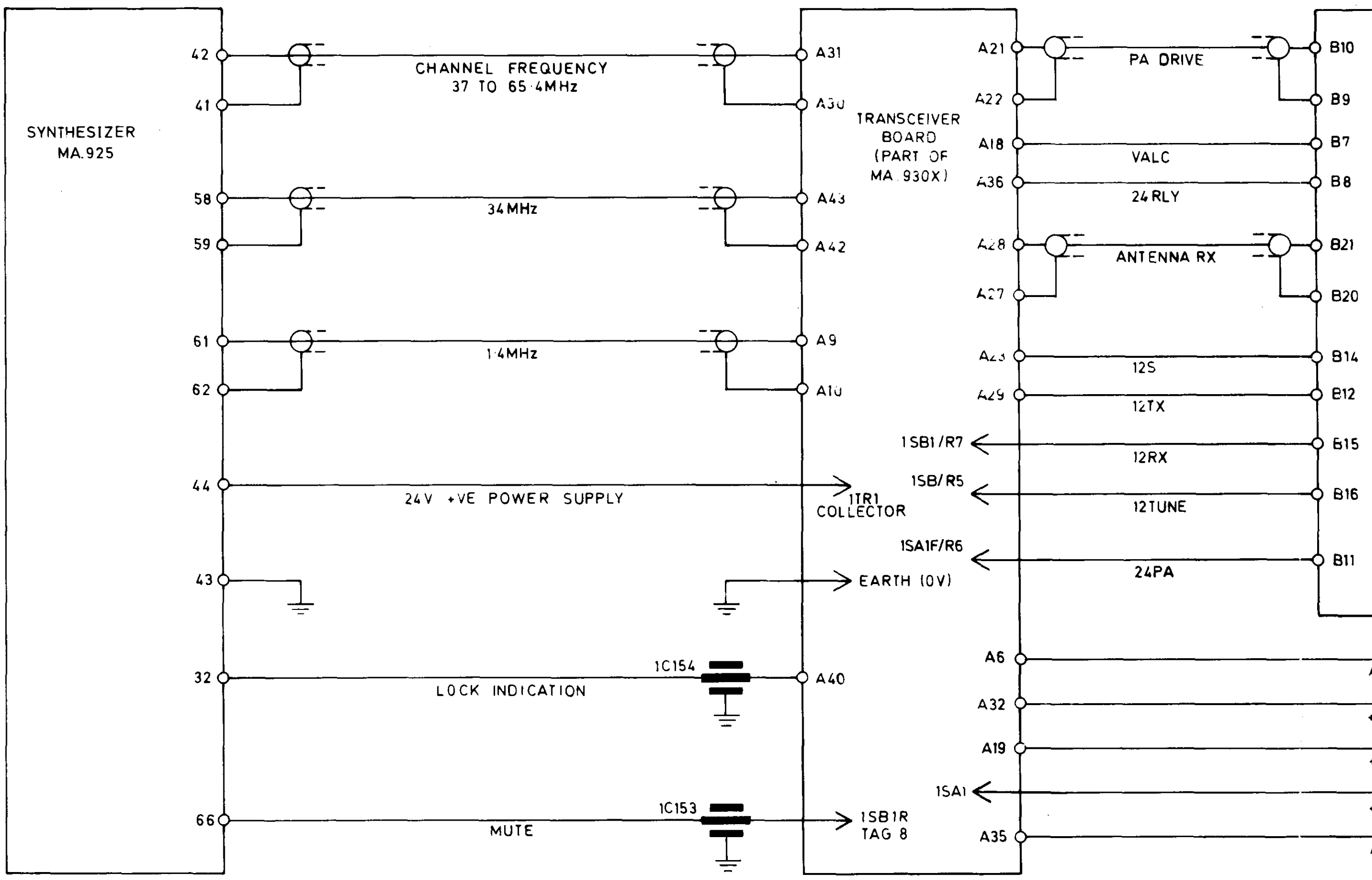
Cct. Ref.	Value	Description	Rat.	Tol %	Racal Part Number
		Light source (7)			711062
		Knob (0-9)			711132
		Knob (Search)			711133
		'O' ring seal, front panel to case			711168
		Desiccator			909909
		Seal, battery to manpack			701226
		Seal, fuse holder cap			920872
		Fuse link 7A (and spare)			910699
		Fuseholder base			917082
		Fuseholder cap			917081
		Socket black (on battery)			916891
		Socket red (on battery)			916892
		Spade terminal .250 (power supply)			920578
		Spade terminal .187 (power supply)			920579



FRONT

Control Panel: Syncal 30 TRA.931X

Fig. 1



NOTES 1. FOR FREQUENCY SELECTION REFER TO FIG. 3 OF PART 3 (MA.925)

2. FOR POWER SWITCH, MODE SWITCH AND EXTERNAL CONNECTIONS, REFER TO FIGS. 6 & 7 OF PART 2 (MA.930X)

WOH 6085
Part 1

Interconnecting Diagram: TRA.931X

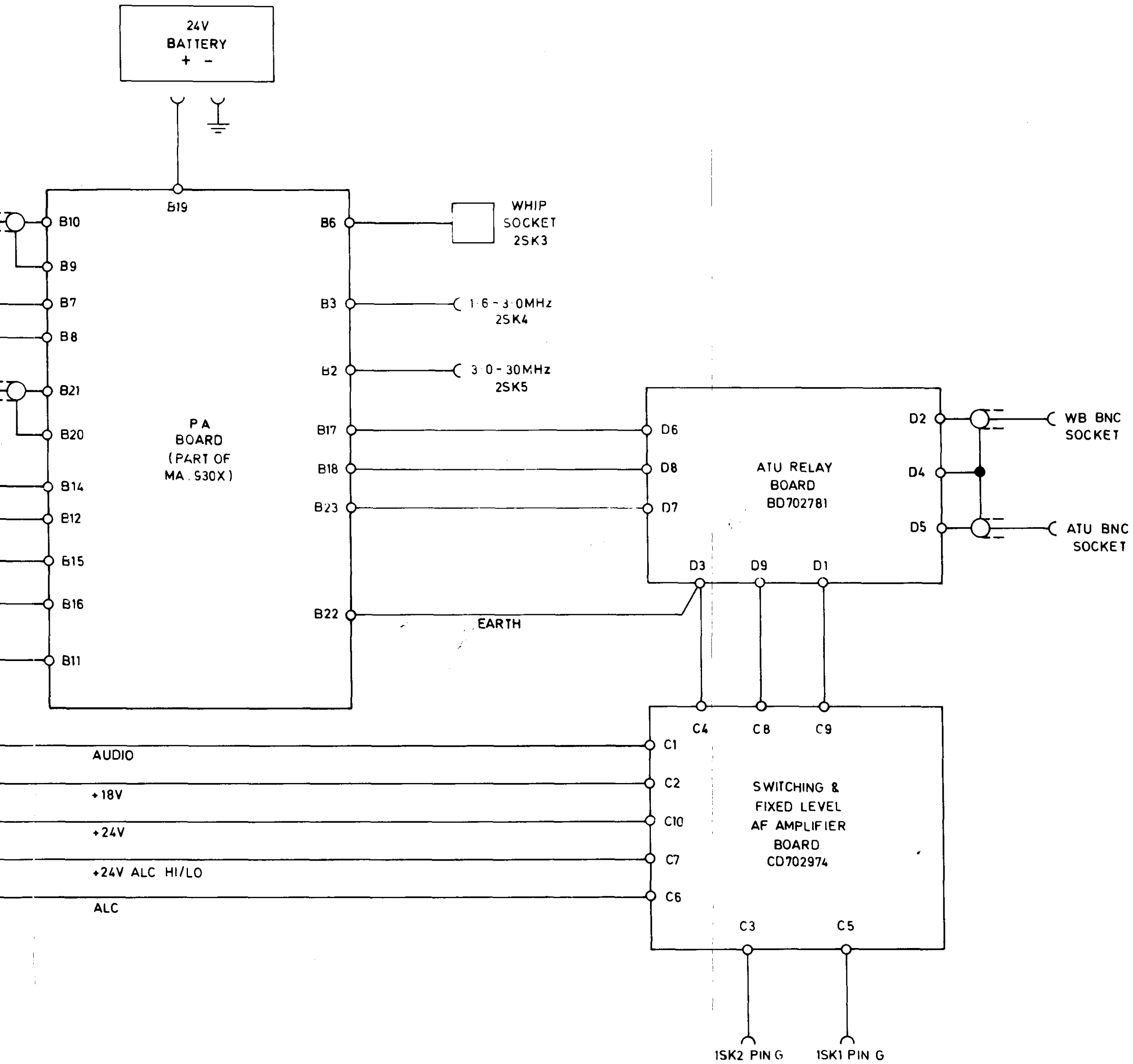
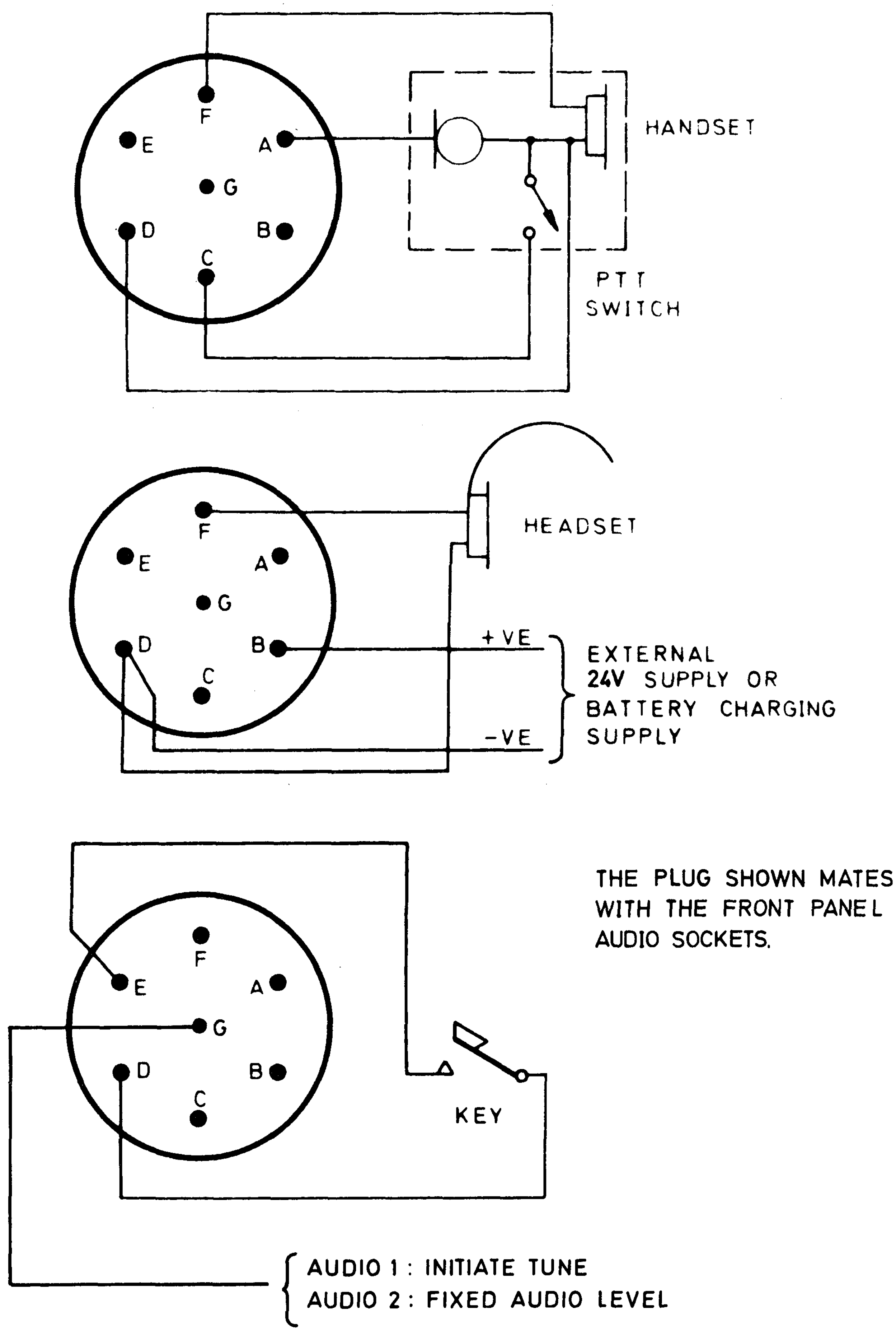

24V
BATTERY
+ -
B19
WHIP
SOCKET
2SK3
B10
B9
B7
B8
B21
B20
B14
B12
B15
B16
B11
B6
B3
B2
1·6 - 3·0MHz
2SK4
3·0 - 30MHz
2SK5
P A
BOARD
(PART OF
MA. 930X)
B17
B18
B23
B22
EARTH
D6
D8
D7
ATU RELAY
BOARD
BD702781
D2
D4
D5
WB BNC
SOCKET
ATU BNC
SOCKET
D3
D9
D1
C4
C8
C9
AUDIO
+18V
+24V
+24V ALC HI/LO
ALC
C1
C2
C10
C7
C6
SWITCHING &
FIXED LEVEL
AF AMPLIFIER
BOARD
CD702974
C3
C5
1SK2 PIN G
1SK1 PIN G

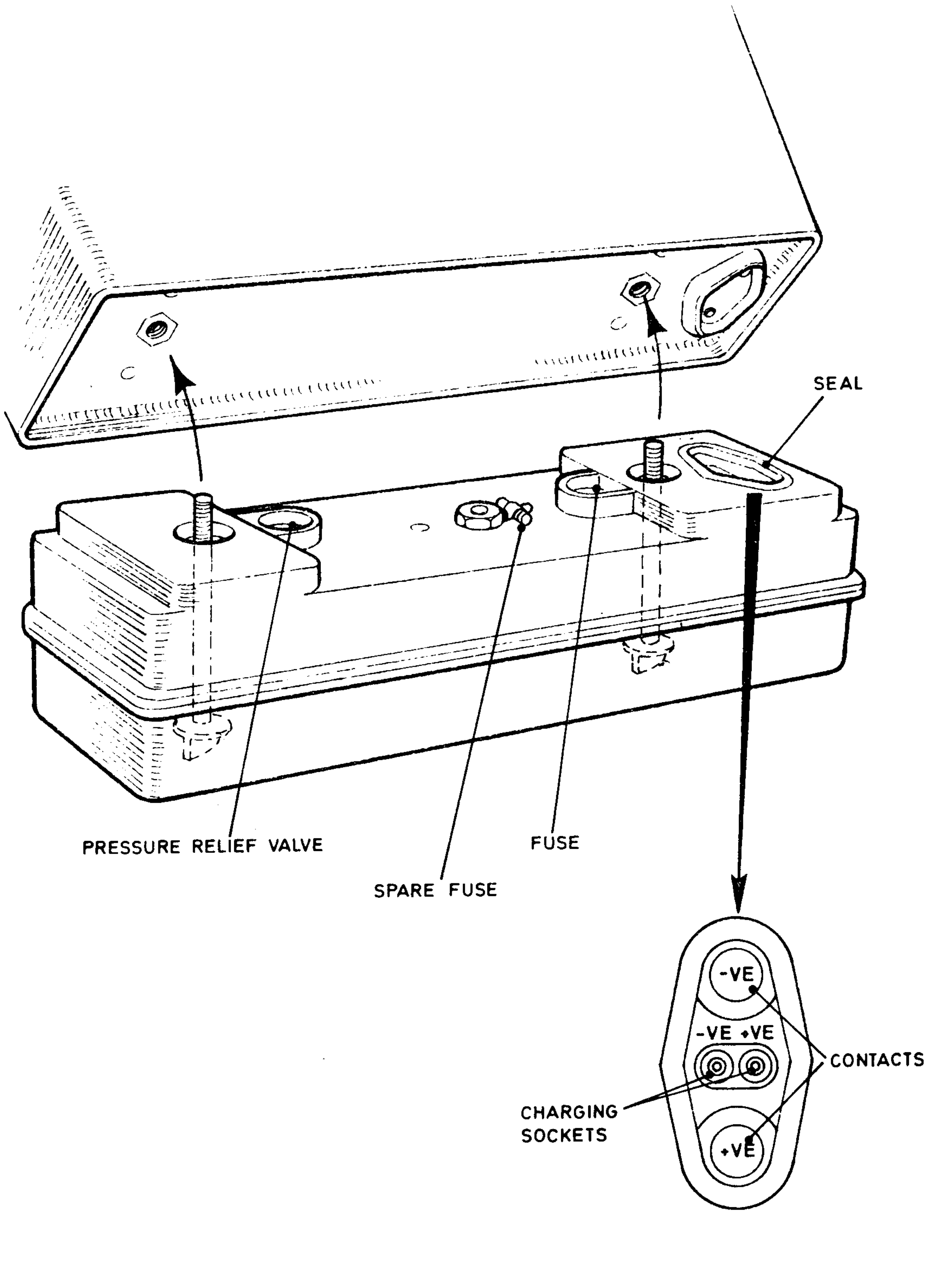
Fig.2



WOH6085
Part 1

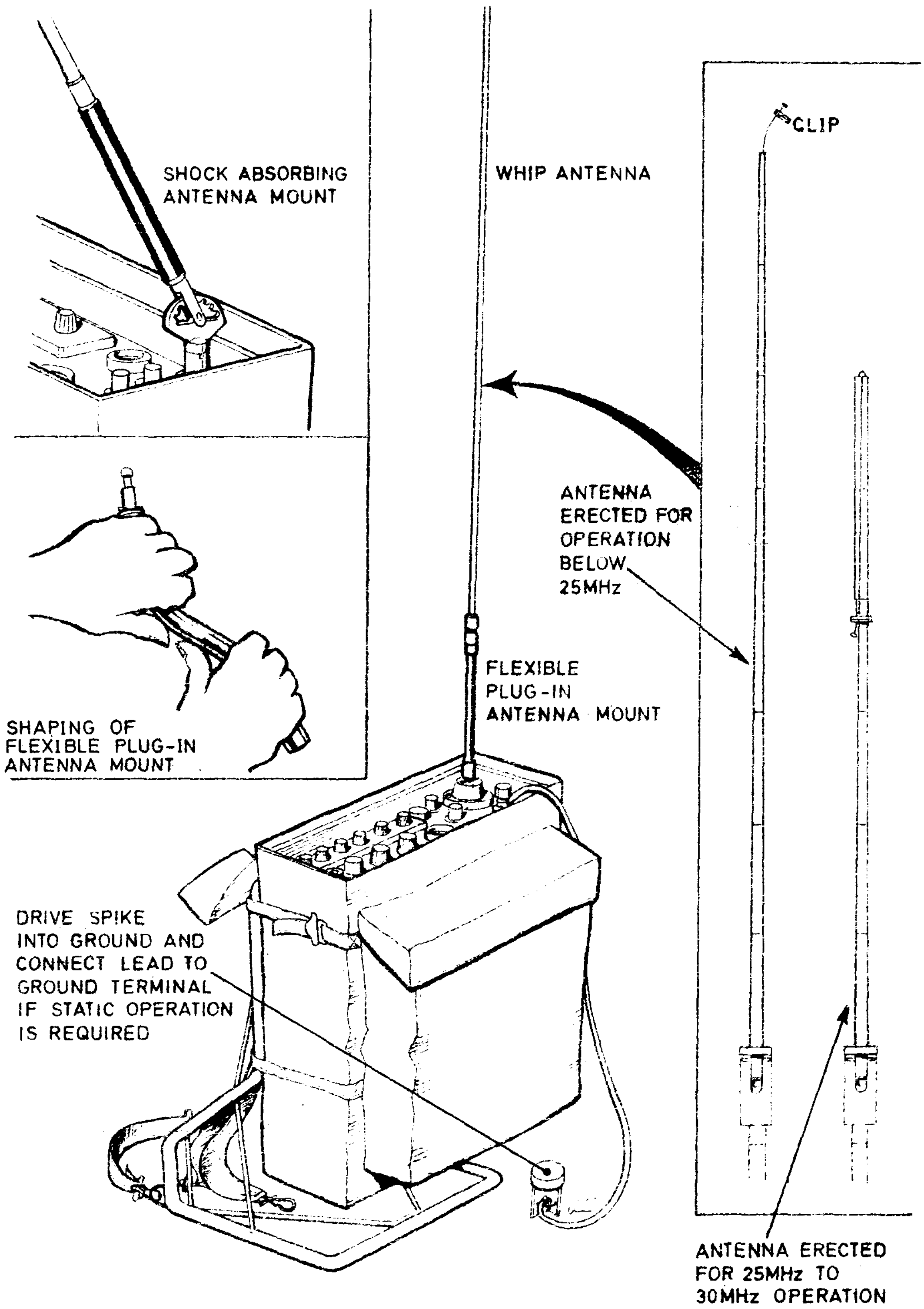
External Connections:
Syncal 30 TRA.931X

Fig. 3

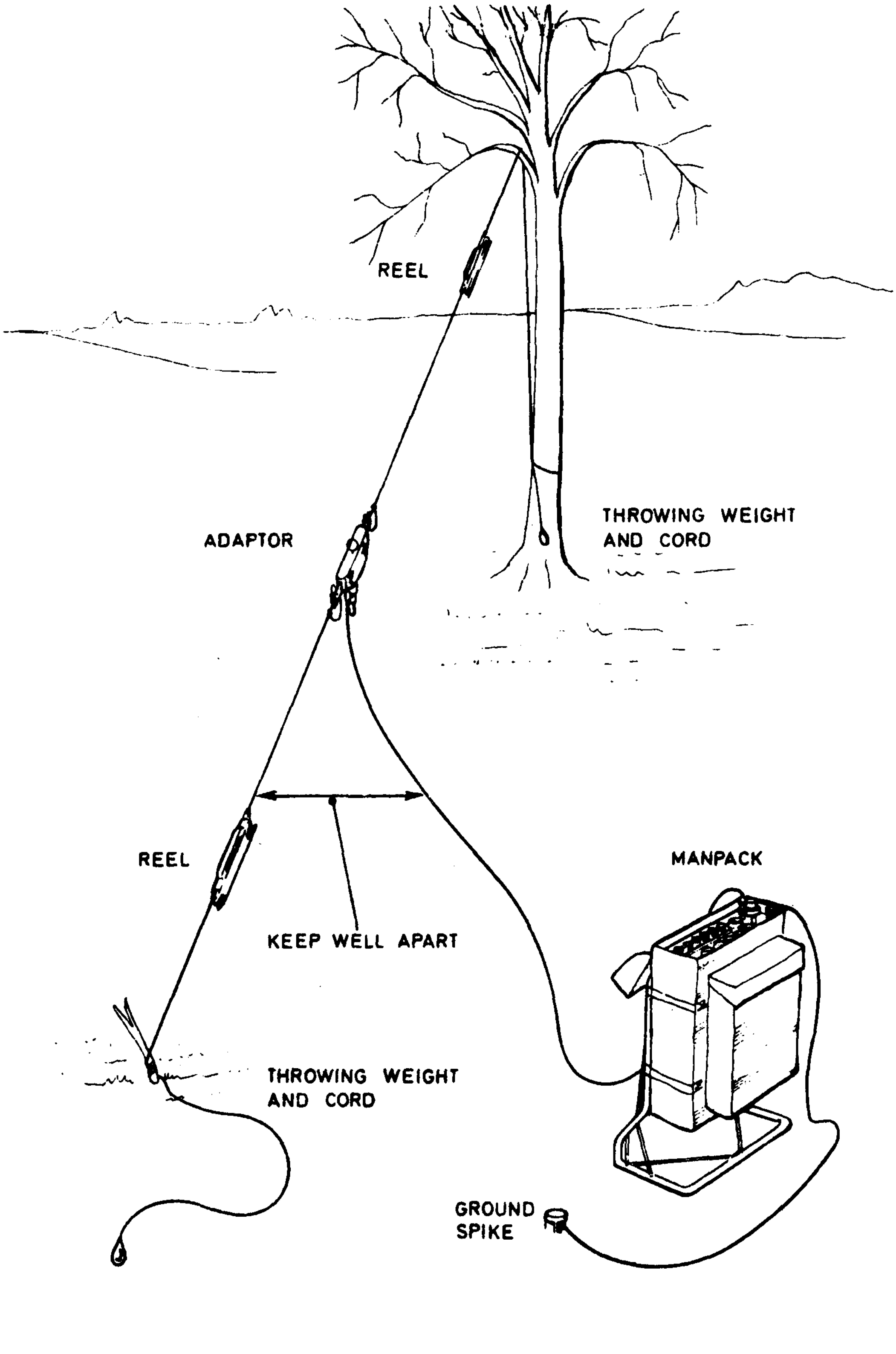


Battery and Connections:
Syncal 30 TRA931X

Fig. 4

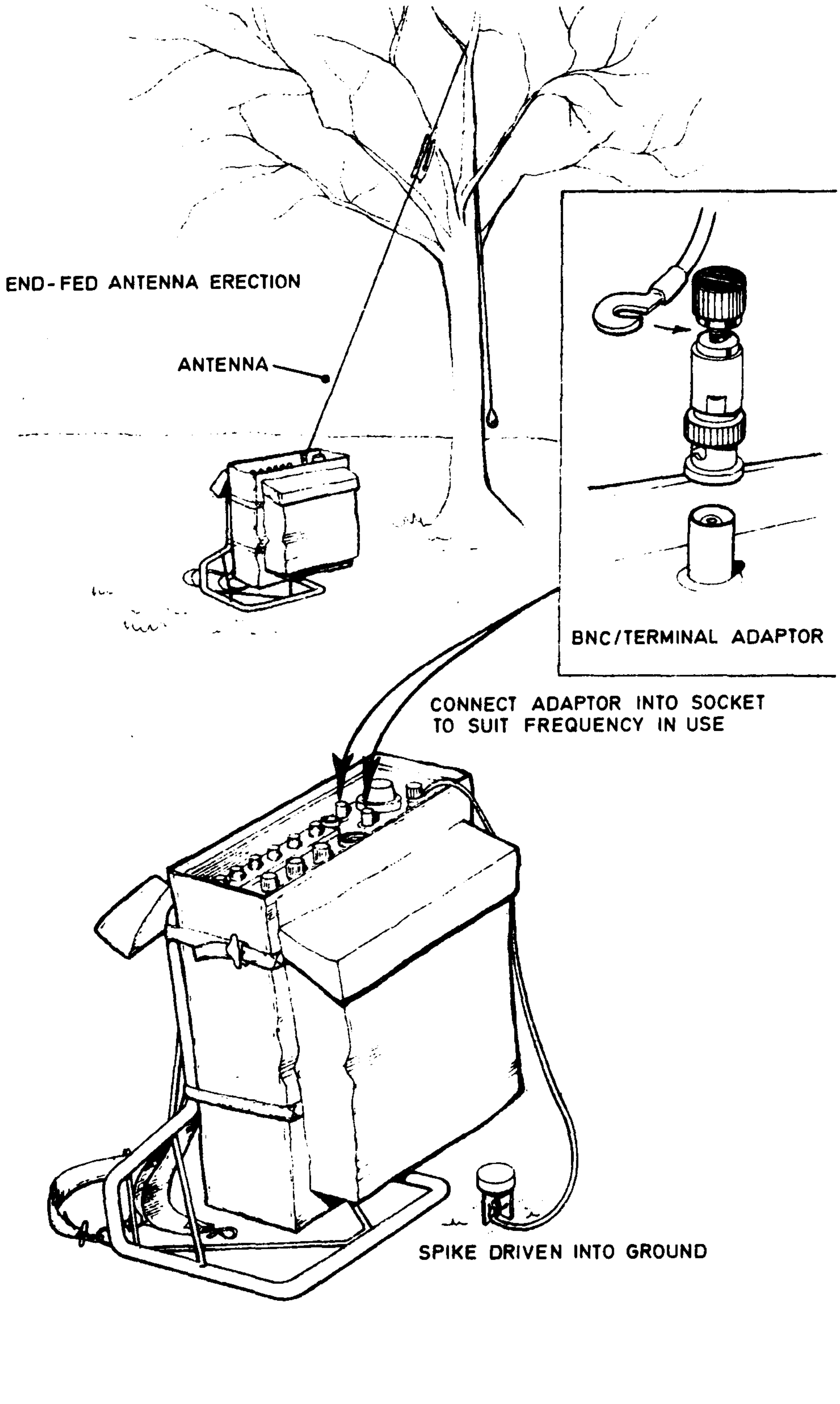


Whip Antenna Fig. 5



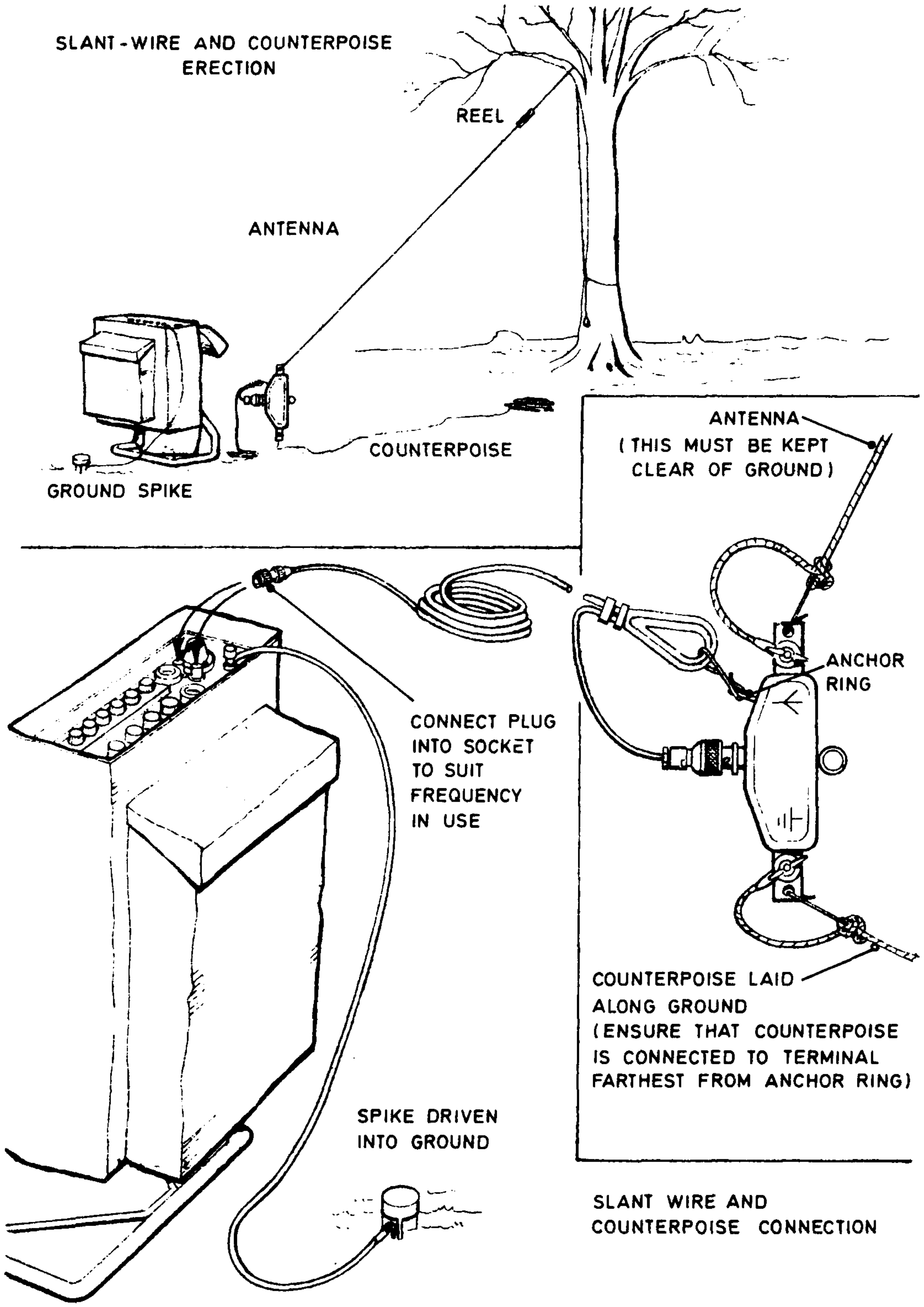
Vertical Dipole Antenna

Fig. 6

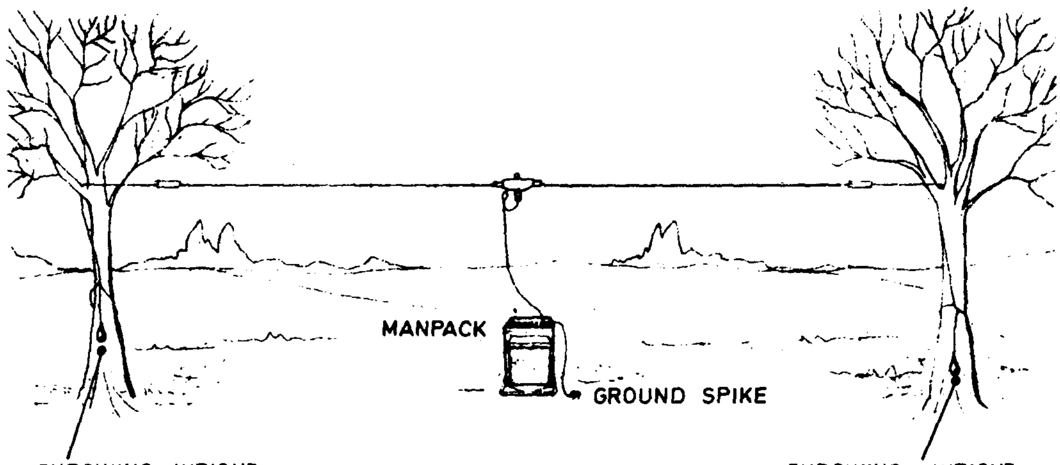


End-fed Antenna

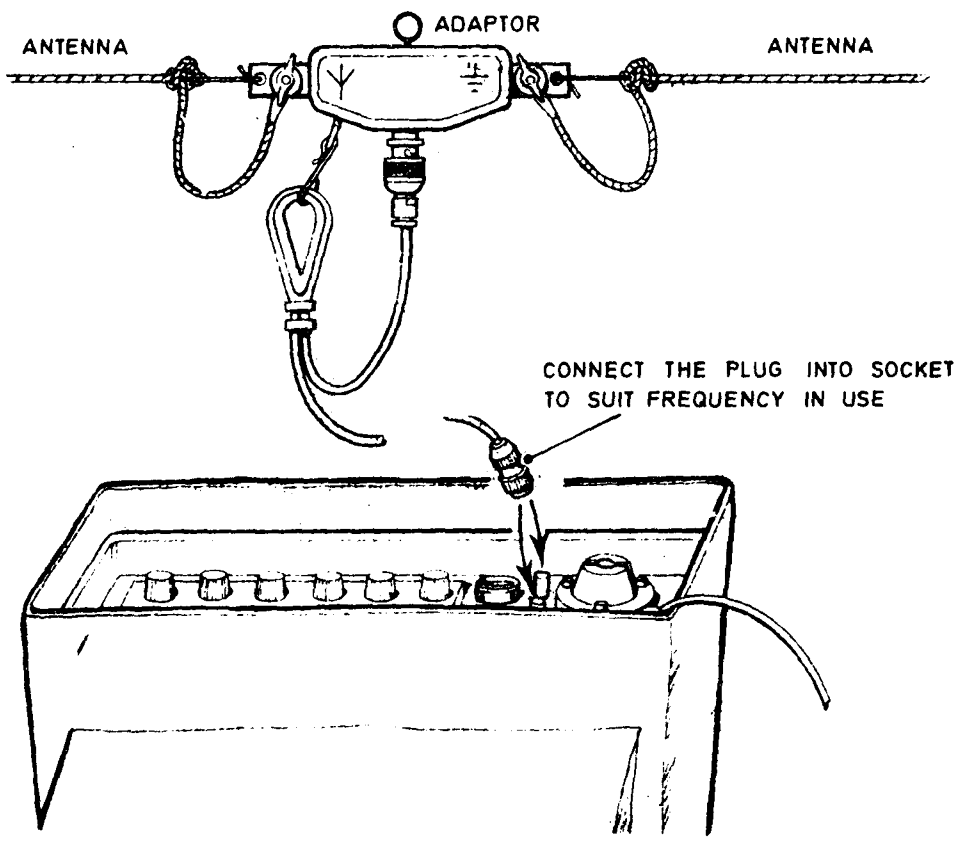
Fig. 7



Dipole Used as Slant-Wire Antenna **Fig. 8**

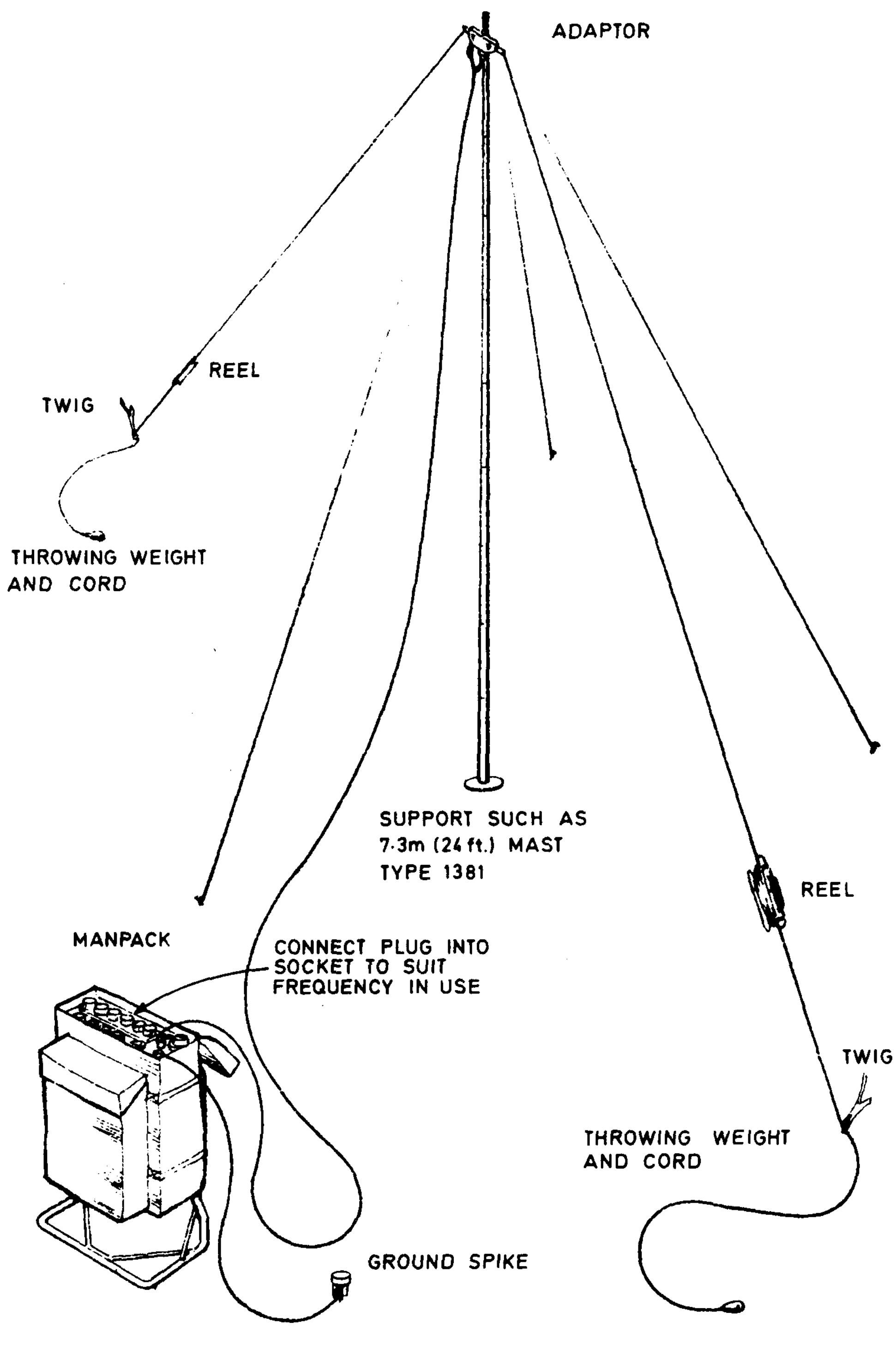


HORIZONTAL DIPOLE ANTENNA
(USED WHEN TWO SUPPORTS
ARE AVAILABLE)



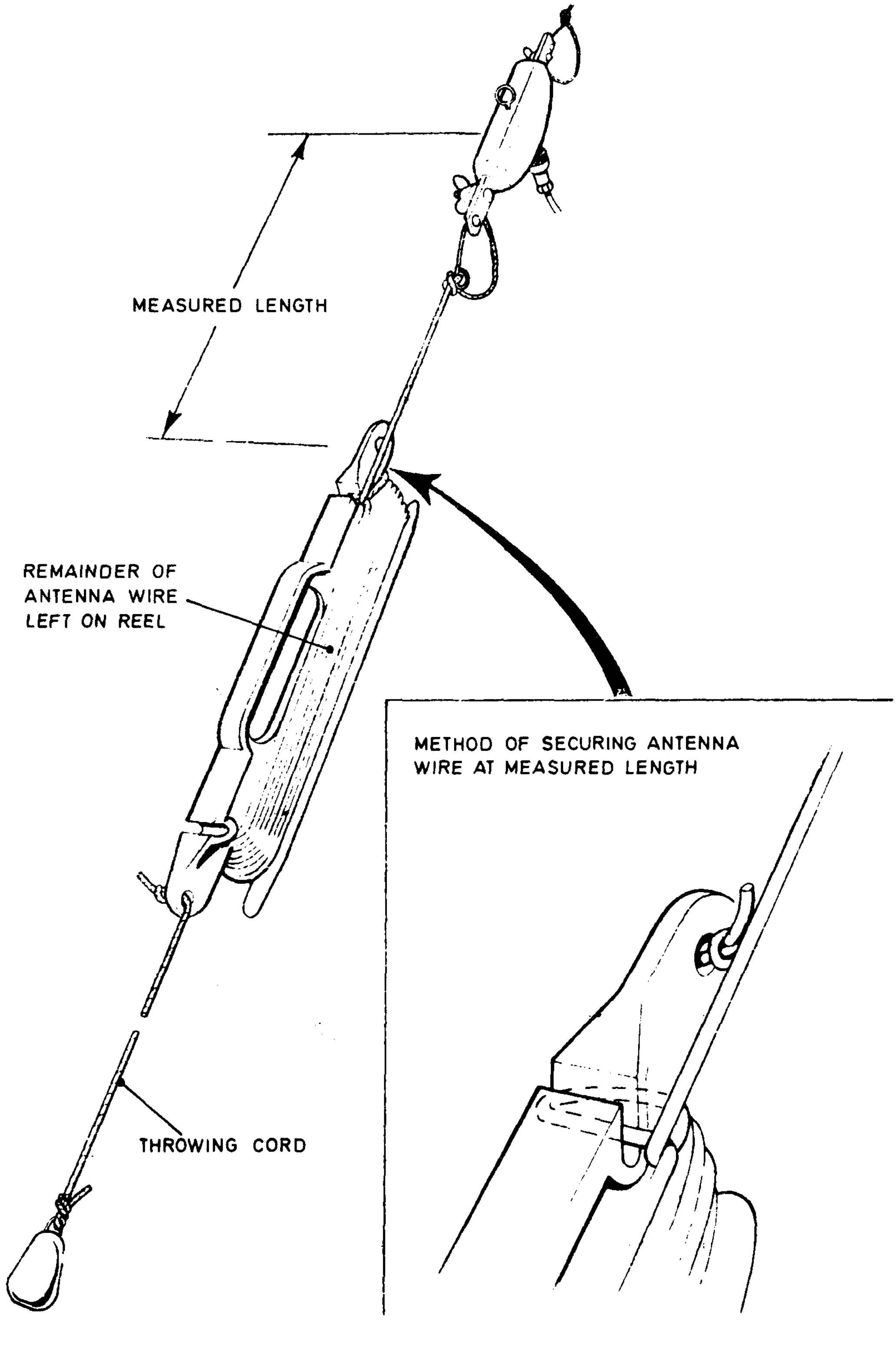
Horizontal Dipole Antenna

Fig. 9



Inverted V Dipole Antenna

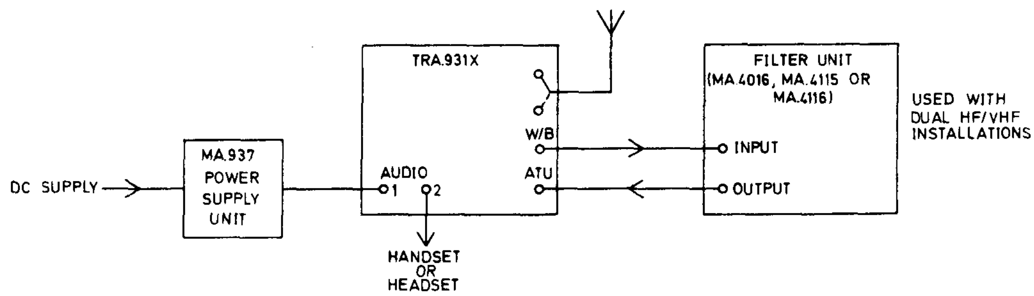
Fig.10



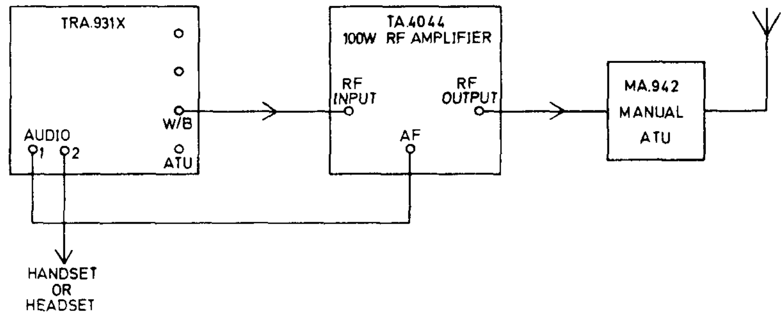
WOH6085
Part 1

Antenna Securing

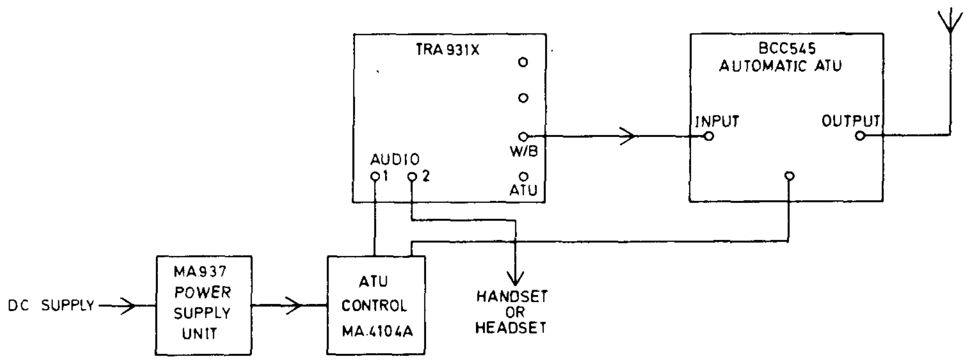
Fig. 11



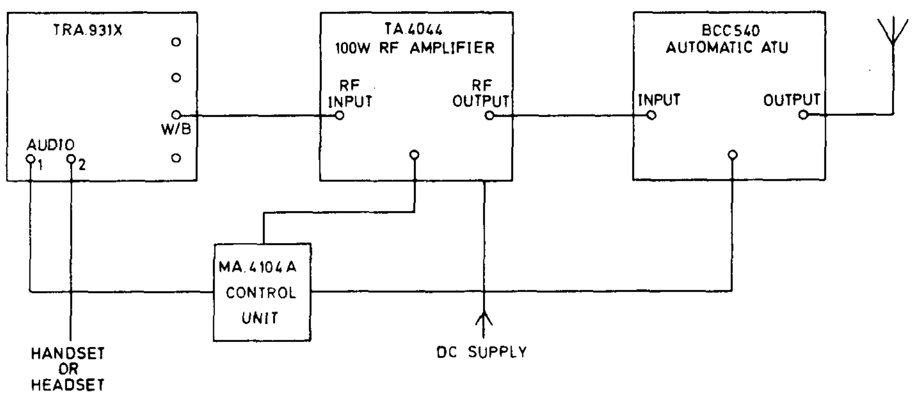
(a) 25W SYSTEM (INTERNAL ATU)



(b) 100W SYSTEM (MANUAL ATU)



(c) 25W SYSTEM (AUTOMATIC ATU)



(d) 100W SYSTEM (AUTOMATIC ATU)

WOH6085

Operational Systems

Fig. 12

APPENDIX 1

LIST OF ANCILLARIES

ITEM	DESCRIPTION	RACAL REFERENCE	WEIGHT kg	lb	oz.
1	2.4m (8 ft) Sectional Whip Antenna (with clip)	ST711017	0.28	0	10
2	Flexible Plug-in Antenna Mount	ST711018	0.20	0	7
3	Shock Absorbing Antenna Mount	ST700072	0.31	0	11
4	Telephone Handset	ST711013	0.39	0	14
5	Headset, Single Earpiece	ST711015	0.14	0	5
6	Headset, Noise Excluding	ST711014	0.37	0	13
7	Headset and Boom Microphone	ST711024	0.63	1	6
8	Morse Key with Knee Strap	ST700059	0.21	0	7.5
9	Ground Spike and Lead	ST700067	0.17	0	6
10	3-30MHz Dipole Antenna Complete with Feeder, Support Lines, Throwing Weight and Spools.	ST711169	1.76	3	14
11	3-30MHz End Fed Antenna	ST711185	0.34	0	12
12	Terminal Adaptor (Whip/Terminal) for separate Whip Antenna	ST714030	0.06	0	2
13	Terminal Adaptor (BNC/Terminal) for end-fed Antenna	ST700074	0.06	0	2
14	Nickel-cadmium Rechargeable Battery (3.5 a.h. 24V) Type MA.934	ST700880	3.74	8	4
15	Harness Assembly	ST701395	1.92	4	4
16	Rear cover plate assembly	ST701258	0.23	0	8
17	Tool Kit	ST701393			
18	User Handbook	-		-	
19	Heavy duty mounting frame Type MA.989B	ST700813	3.61	7	15
20	Universal Battery Charger Type MA.945, for Rechargeable Batteries.	ST700616	3.74	8	4
21	100-125V/200-250V, 45-60Hz A.C. Power Unit/Loudspeaker Amplifier Type MA.949 for Static Operation.	ST700883	5.8	12	13

ITEM	DESCRIPTION	RACAL REFERENCE	WEIGHT kg	lb	oz.
22	12V/24V D.C. Power Unit/Loudspeaker Amplifier Type MA.937 for Vehicle Operation	ST700882	6.01	10	2
23	Loudspeaker/Amplifier Unit Type MA.988	ST700860	0.77	1	11
24	Test Set Type CA.531	ST700881			
25	24V Negative earth d.c. Power Unit for vehicle operation MA.907	ST701394	0.91	2	0
26	Hand-operated battery charger Type MA.913B	ST700884	3.43	7	9
27	Tree clamp for MA.913B	ST700217	0.65	1	7
28	Unipod stand for MA.913B	ST700482	1.24	2	12

APPENDIX 2

THE CARE AND CHARGING

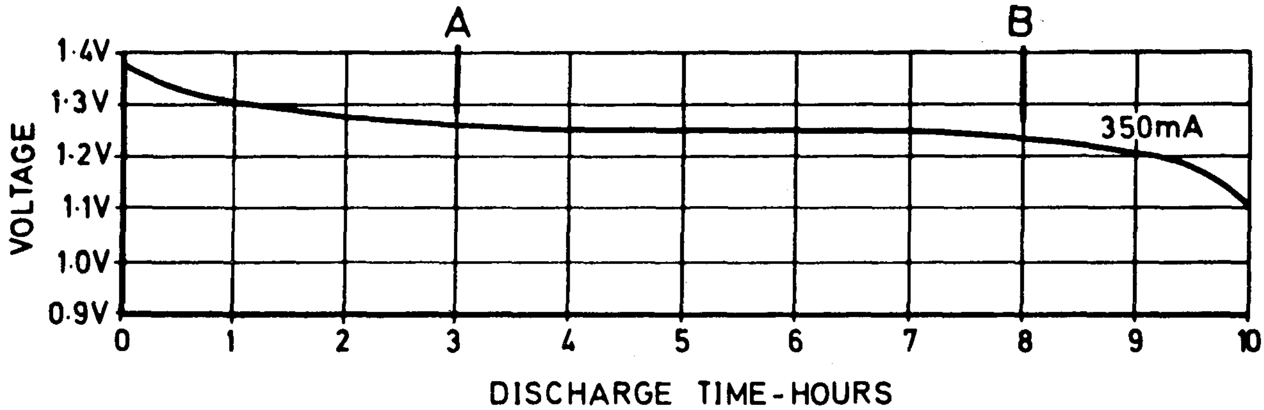
OF

NICKEL-CADMIUM BATTERIES

1. The modern sealed nickel-cadmium rechargeable cell will give many years of useful life if it is properly treated. Certain precautions must be taken during the charging and discharging of these cells and the following notes are intended to serve as a practical guide to the use of 24V Battery Type MA.934 and the Racal battery charger MA.945.

State of Charge

2. During discharge the terminal voltage of Nickel-cadmium cells remains sensibly constant. Fig.1 shows a typical discharge curve of one of the cells in the MA.934 Battery. This curve shows the variation of terminal voltage with time as the cell discharges at a rate of 350mA. It is clear from this curve that it would be very difficult in practice to establish the state of the charge over the middle position of the curve between A and B. To further complicate matters, the terminal voltage during discharge varies slightly with temperature.



TYPICAL DISCHARGE CURVE FIG. 1

3. Because of this difficulty in assessing the state of charge of the cells, the method used to charge the battery must be carefully controlled if serious over-charging, with the consequent possibility of damaging the cells, is to be avoided.

Storage

4. If batteries have been stored for a considerable time it is advisable to charge, discharge and recharge them at least once before use in order to obtain full capacity.

NOTE: A suggested load for battery discharge is a suitably rated vehicle headlamp(s). A multimeter should be placed in series with the headlamp(s) to ensure that discharge current does not exceed 3.5 Amps.

Battery Charger Type MA.945

5. The charging method used in the Battery Charger MA.945 removes, to a great extent, the necessity of accurately determining the state of charge of the battery. The unit is designed to provide a constant current output of approximately 350mA. At this rate, a discharged battery will be fully charged in about 14 hours. However, allowing the battery to remain on charge for periods considerably in excess of this will cause no serious damage.

APPENDIX 3

REPLACEMENT OF BATTERY CELLS

1. The Battery type MA.934 contains 19 seperate cells, which are series-connected to give the 24V supply. Charging is carried out without dismantling. Access to the internal wiring will be required only in the event of failure of individual cells.

2. The dismantling and re-assembly procedures are given below and in Fig. App. 3-1.

(1) The MA.934 Unit is removed from the manpack by loosening two screws in the base of the battery case.

(2) With the battery on its side, remove the three nuts securing the bottom cover. Gently ease the case-sections apart, taking care not to distort the gasket.

(3) Locate and replace the defective cell, observing the correct polarity.

(4) Check that the gasket is serviceable and align it into its groove.

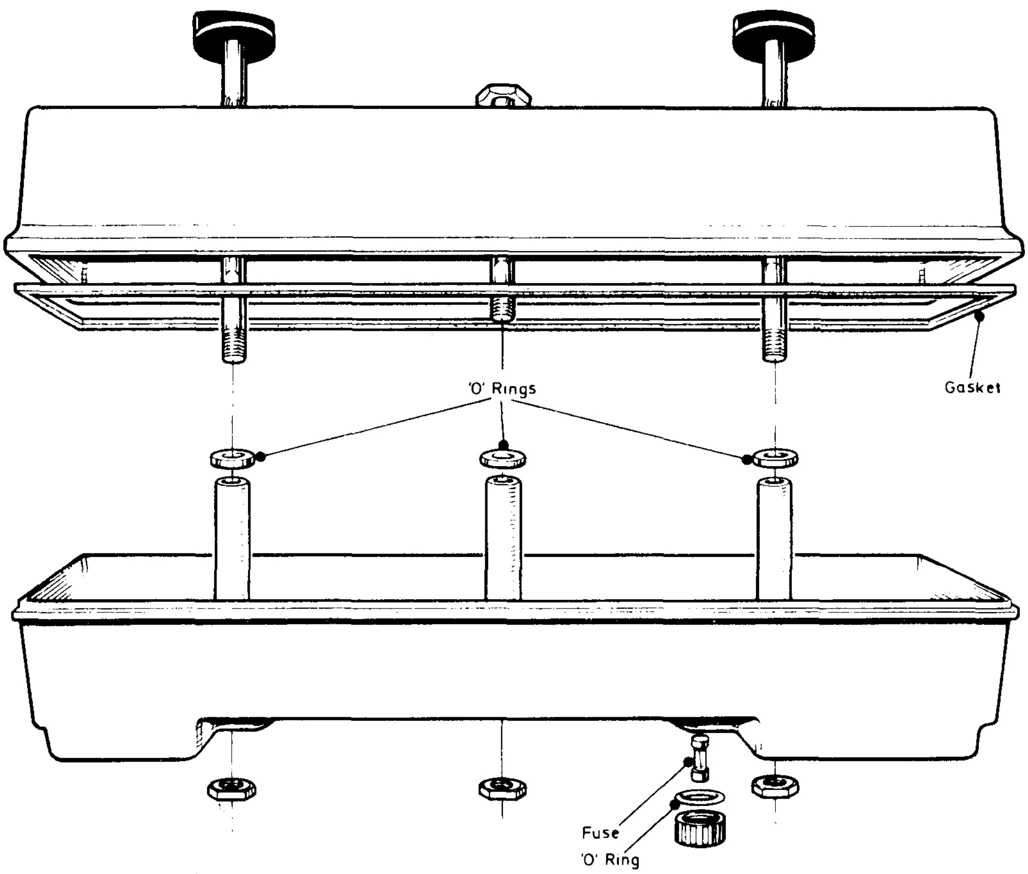
(5) Align the three case-securing screws with the spacer-tubes.

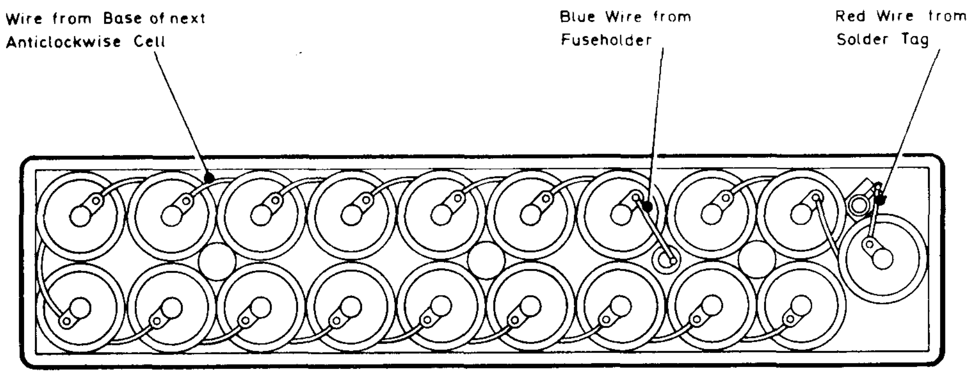
(6) Ensure that the 0-rings are correctly located and re-assemble the MA.934 Unit. Do not over-tighten the nuts.

WARNING: Under no circumstances should grease or any other sealing compound be used on the plastic case or the gasket for sealing purposes, as this may induce stress cracks.

(7) Check that the fuse is serviceable. A spare fuse is located adjacent to the fuse holder.

(8) Recharge the battery as described in Chapter 3.





Battery Assembly - Dismantling   Fig. App. 3-1

APPENDIX 4

MOUNTING FRAMES TYPE MA.989

General

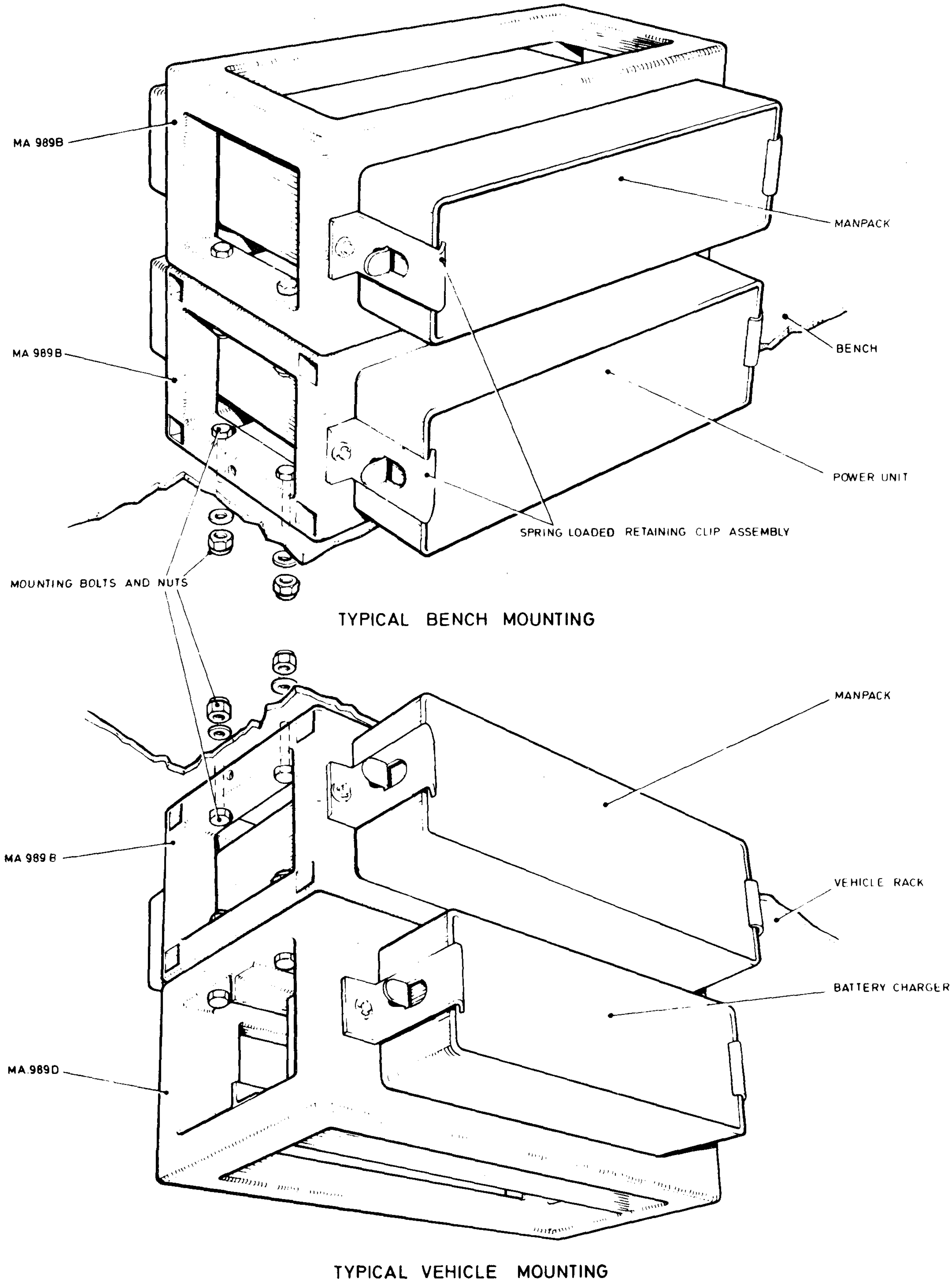
1. The MA.989 Mounting Frames are heavy duty frames designed to accommodate a range of Manpacks, Power Units and Battery Chargers. The frames are suitable for bench mounting or installation into fighting vehicles.

Installation

2. The units are retained in the frames by spring loaded clips. Two or more frames may be bolted together, and typical combinations are shown in Fig. APP.4-1. A vehicle, or bench, mounting template is shown in Fig. APP.4-2. The frames are bolted to each other and to the bench or vehicle rack using 6mm nuts and bolts. Frame dimensions, and clearances required at the front and rear of the frames for different installations, are detailed in Fig. APP.4-3.

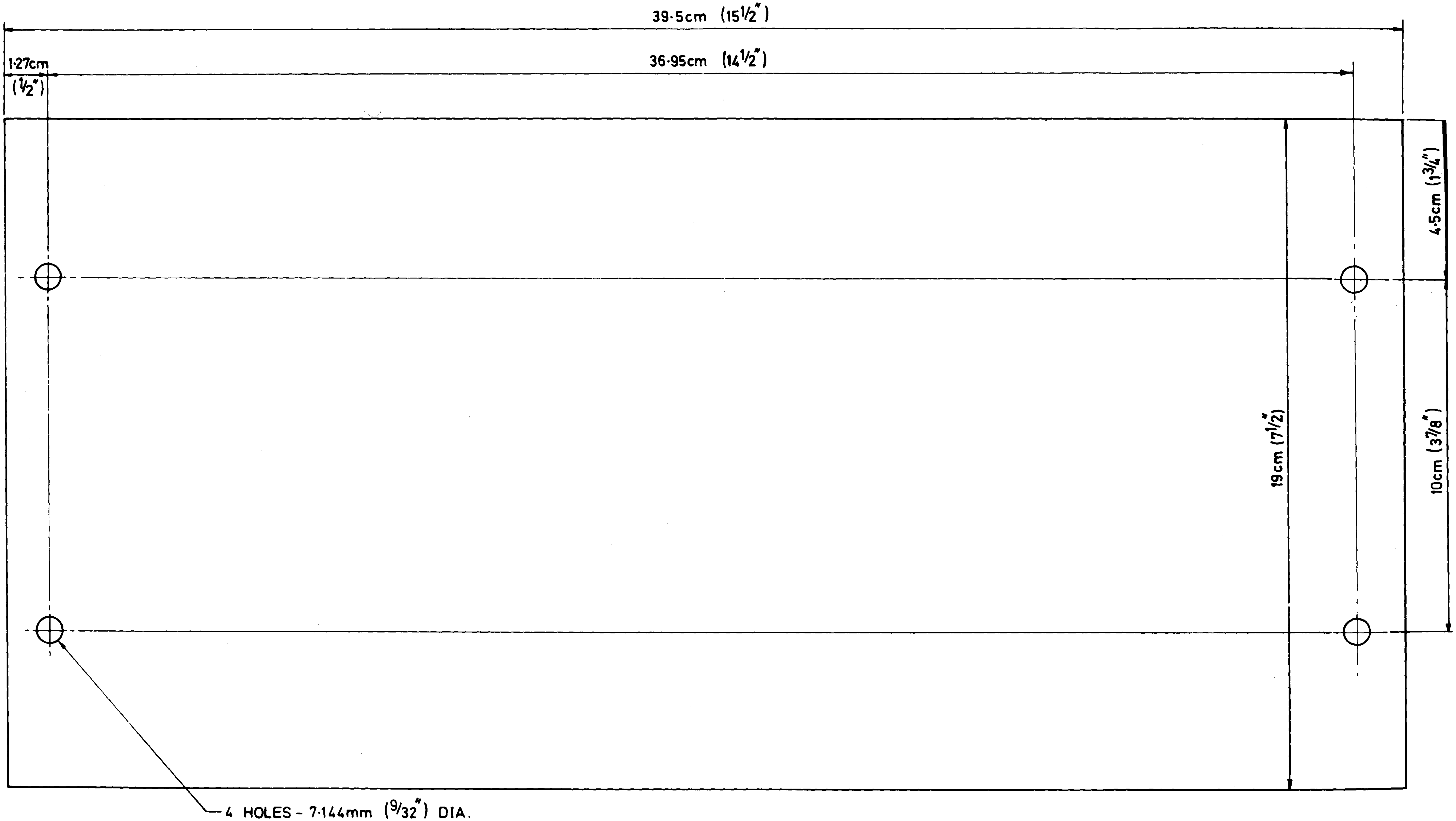
3. The units and their corresponding frame types are shown below:-

Unit	Mounting Frame
RA.929 Portable H.F. Receiver	MA.989B
TRA.931 (Syncal 30)	MA.989B
TRA.931L (Syncal 30L)	MA.989B
TRA.932 (Comcal 30)	MA.989B
MA.937 DC Power Unit and Audio Amp.	MA.989B
MA.945 Battery Charger	MA.989D



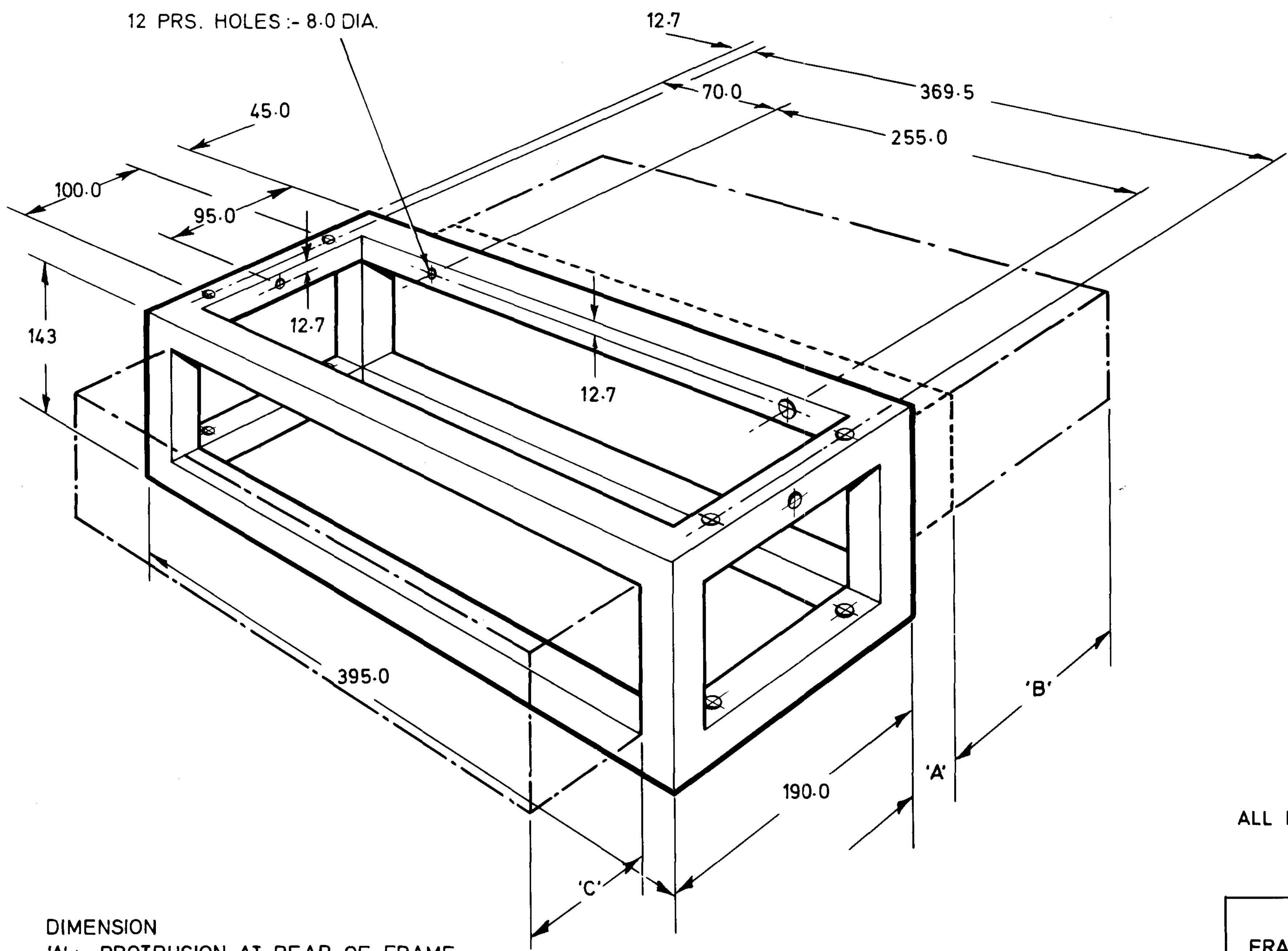
Mounting Frames
Type MA.989B & D

Fig. APP4-1



Mounting Template for MA.989A, B & D

Fig. App. 4-2



DIMENSION
'A' :- PROTRUSION AT REAR OF FRAME
'B' :- ADDITIONAL DEPTH NECESSARY FOR FITTING APPROPRIATE BATTERY BOX, IF REQUIRED
'C' :- PROTRUSION AT FRONT OF FRAME

ALL DIMENSIONS IN MILLIMETRES

FRAME	UNIT	DIMENSION 'A'	'B'	'C'
MA.989A	TRA.906, TRA.921 TRA.922	15	120	60
MA.989B	TRA.931, TRA.931L TRA.932, MA.937 RA.929	45	150	50
MA.989D	MA.926, MA.945	-	-	65

Mounting Frame Dimensions and Clearance Requirements

Fig. App.4-3

APPENDIX 5

HAND - OPERATED GENERATOR TYPE MA913 B

INTRODUCTION

1. The Hand - Operated Generator type MA.913B is a self - contained unit which provides a portable source of primary power for the TRA.931 manpack. The generator gives a d.c. output of up to 28 volts at 1 amp (approx).

2. A tree clamp ST700217 is available allowing the generator to be fixed to a tree or post of up to 12 inches diameter. Alternatively a unipod stand ST700482 may be used in place of the tree clamp.

3. The overall dimensions and weight of the unit are as follows:

Dimensions:	Length	Height	Depth
(Handles folded)	11in. (279mm)	$4\frac{3}{4}$in. (121mm)	$7\frac{1}{2}$in. (191mm)

Weight (Generator complete with tree clamp and strap) 9lb. (4.08 kg.)

USAGE

4. The generator is normally used as a means of charging the nickel - cadmium battery MA.934. It is capable of maintaining the battery in a fully charged condition during reception, by intermittent operation of the generator. It is advisable to limit the periods of transmission to the shortest times possible, or to operate the generator during the complete transmission period.

5. The generator can be used as the sole power source in an emergency, with continuous cranking during transmission and reception. In this condition it is essential to transmit in LOW power, to prevent the generator being overloaded.

CIRCUIT DESCRIPTION

6. The circuit diagram of the MA.913B is given in Fig.App.5-1. The a.c. output from the stator windings is rectified by diodes D5 to D10. The resultant d.c. output is fed via D4 and SKT 1 to the battery. The maximum charging voltage is controlled by a shunt regulator, comprising transistor TR1 and zener diodes D1 to D3. Diode D4 prevents the battery discharging through TR1 and R2 during pauses in hand - cranking.

SETTING-UP FOR USE

7. The generator is set-up for use as follows:-

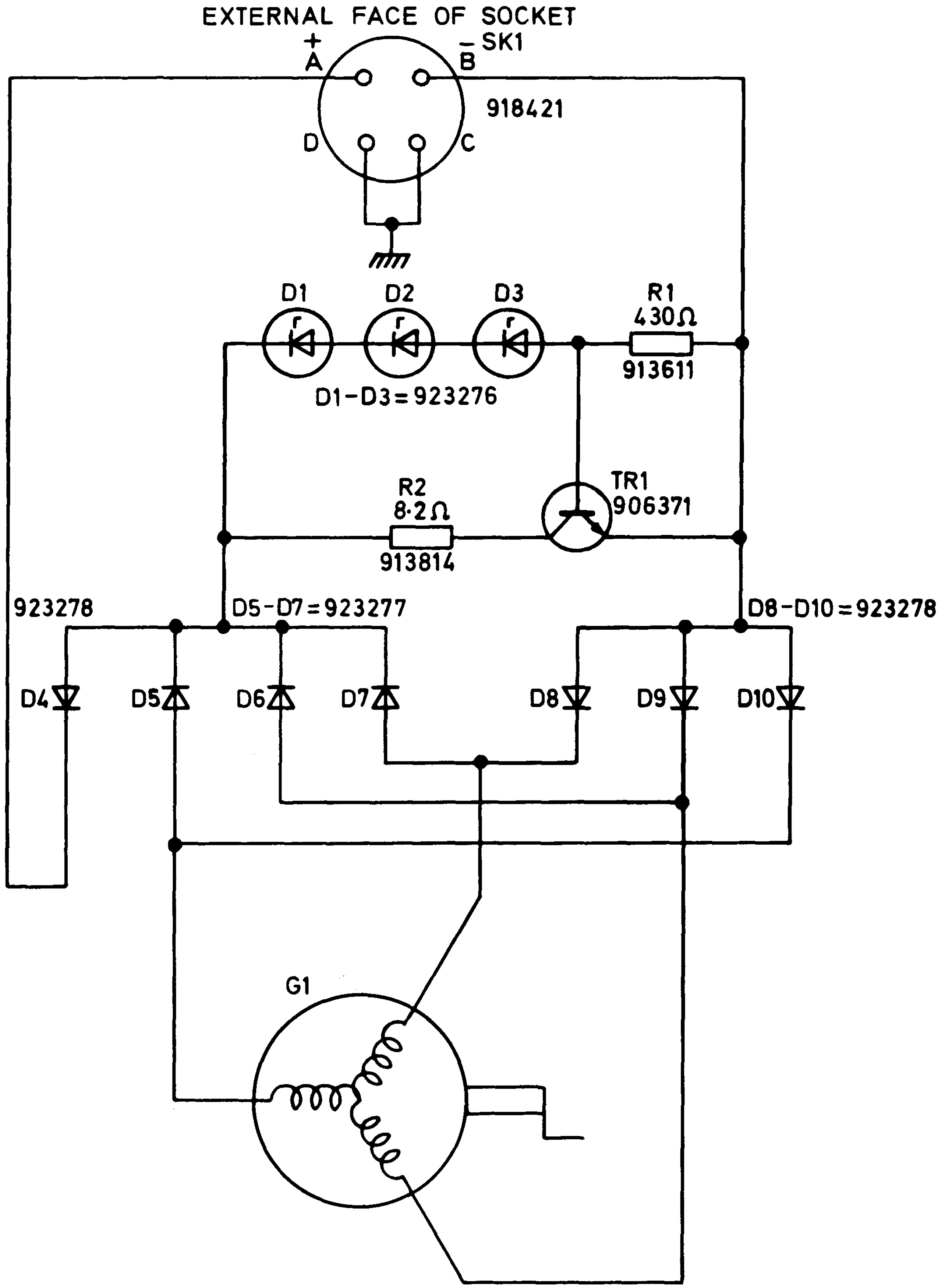
   (1) Extend the clamp locking strap to its fullest extent. Fold one handle and affix the generator to a firm support such as a tree or pole.

   (2) Connect the socket on the generator to an AUDIO socket on the front panel of the manpack, using the cable provided.

   (3) Crank the generator at approximately 70 r.p.m. to obtain power.

MAINTENANCE

8. The generator is a sealed unit and does not require routine maintenance. The desiccator can be removed and re-activated by a hot-air blower.



Circuit: Hand Operated Generator
Type MA.913B

Fig: App. 5-1

SUPPLEMENT

TRA.931Y TRANSMITTER-RECEIVER

INTRODUCTION

1. This Supplement gives details of the differences between the TRA.931X and TRA.931Y versions.

PART 1

TECHNICAL SPECIFICATION Page (1)

Temperature range:	Operating: -25°C to +55°C. Reduced performance below -10°C.

TECHNICAL SPECIFICATION Page (3)

TRANSMITTER

Power Output:	Output reduced by a further 1.5 dB between 1.6 to 2.0 MHz and 27.5 to 29.999 MHz below -10°C.

RECEIVER

AF Output Power:	20mW below -10°C.
AF Distortion:	10% below -10°C.
Fixed AF Output:	35mW below -10°C.

PART 2

PAGE 6-6

Capacitors 1C2 to 1C5 and 1C14 changed as follows:

.01u	Ceramic	100V	20%	926353

PAGE 6-7

Capacitors 1C21, 1C22, 1C27, 1C28, 1C30, 1C31, 1C36, 1C38, 1C40, 1C45 to 1C48 changed as follows:

.01u	Ceramic	100V	20%	926353

PAGE 6-8

Capacitors 1C54 to 1C56, 1C60, 1C64, 1C65, 1C70 to 1C73, 1C78 to 1C83 changed as follows:

.01u	Ceramic	100V	20%	926353

PAGE 6-9

Capacitors 1C90 to 1C95, 1C97, 1C98, 1C100, 1C101, 1C104, 1C107, 1C110 to 1C117, 1C119 and 1C120 changed as follows:

.01u	Ceramic	100V	20%	926353

PAGE 6-10

Capacitors 1C123, 1C124, 1C128 to 1C131, 1C142, 1C144 to 1C149, 1C152 changed as follows:

.01u	Ceramic	100V	20%	926353

Capacitors 1C150, 1C151, 1C159, 1C160, 1C161 changed as follows:

.01u	Ceramic	100V	20%	927828

PAGE 6-14

Filter Part Numbers changed as follows:

1FL1	711491
1FL2	711492
1FL3	711494
1FL4	711493
1FL5	711495

PART 3

PAGE 7-11

Integrated Circuit Type and Part Numbers changed as follows:

ML1	64S112N	927832	or	54S112N	922429
ML2	64LS196N	927834	or	54LS196N	925917
ML3	64LS196N	927834	or	54LS196N	925917
ML4	64177J	927835	or	54177J	
ML5	64S11N	927833	or	54S11N	922430

PART 3 (Continued)

PAGE 7-11 (Continued)

ML6	64196J	927840	or	54196J	
ML7	64S112N	927832	or	54S112N	922429
ML8 to ML13	64LS196N	927834	or	54LS196N	925917
ML14	6430N	920691	or	5430N	925922
ML15	64S112N	927832	or	54S112N	922429
ML16	64L00N	920681	or	54L00N	925916
ML23	64L74N	920684	or	54L74N	925918
ML24	64L00N	920681	or	54L00N	925916
ML25	64L00N	920681	or	54L00N	925916
ML32	MA723HM	920682			
ML33	MA723HM	920682			

Miscellaneous Items Part Numbers changed as follows:

TCX0	AD711488
XL1	AR711489
XL8	AR711490
XL9	AR711490

PART 2

TRANSCEIVER UNIT TYPE MA.930X

Ref. WOH 6085
Issue C

PART 2 - TRANSCEIVER UNIT TYPE MA.930X

CONTENTS

CONTENTS (Cont'd)

CONTENTS (Cont'd)

ILLUSTRATIONS

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The Transceiver Unit Type MA.930X consists of the front panel with controls (except those controls which form part of the synthesizer or 49 channel crystal oscillator), the a.t.u. and all circuitry other than that associated with the synthesizer or 49 channel crystal oscillator. The majority of the circuit components are mounted on two printed circuit boards, one of which is housed in a light alloy box. The printed circuit boards are fitted as shown in fig. 2.

PRINCIPLES OF OPERATION (Fig. 1)

Transmission

2. Audio inputs are fed to a microphone amplifier, then via a compressor (clipper) stage to an a.f. buffer amplifier. The audio signal from the amplifier is mixed, in the balanced modulator, with a 1.4MHz signal which is amplified prior to being fed to the modulator. The modulator is unbalanced during AM and TUNE conditions.

3. The 1.4MHz i.f. signal from the modulator is amplified in an a.l.c. controlled amplifier (para. 7) and fed, via the appropriate sideband filter, or the a.m. circuit, to a mixing stage which is also fed with a 34MHz signal. The output of the mixer is a 35.4MHz i.f. signal.

4. The bandwidth of the signal is limited by the a.m. filter, then fed to a channel mixer, which is also fed by a variable input in the range 37MHz to 65.399MHz. The resultant of the mixing process is a modulated signal at the correct frequency for transmission.

5. After filtering in a low-pass (1.6 to 30MHz) filter, the signal is fed to the driver and P.A. stages, then via the relay contacts 4RLA and 4RLB to either the internal ATU or the W/B socket. These relays are controlled by the d.c. resistance of the equipment connected to the W/B socket via the switching and fixed level audio board. A resistance of 4.7K to 15K will route the output of the transmitter to the W/B socket: a resistance of less than 4.7K will also set the output to the low level, even if the POWER switch is in the HIGH position. Switching to LOW power may also be achieved by short-circuiting pin G of socket AUDIO 1 to earth (Pin D).

6. During key operation a 1000Hz tone is generated in the tone oscillator and fed to the transmitter in the same way as the audio signal. The tone is keyed by a morse key.

7. Automatic level control (a.l.c.) potentials are generated by p.a. supply current and r.f. output voltage level detectors. The outputs from the detectors are gated and used to control the gain of an i.f. amplifier to ensure that the p.a. circuit is protected from being over-driven or short-circuited.

Reception

8. Signals from the antenna are fed, via a protection circuit to limit the maximum r.f. voltage applied, to the 1.6MHz to 30MHz filter and the channel mixer. After mixing with the variable 37MHz to 65.399MHz input the resultant 35.4MHz i.f. is limited in bandwidth by the a.m. filter and fed to a low-noise 35.4MHz amplifier. It is then fed to an a.g.c. controlled amplifier (para. 10) and to a mixer fed with a 34MHz input.

9. The output from the mixer, a 1.4MHz i.f., is fed via the u.s.b. or l.s.b. filters (or the a.m. circuit) to a second a.g.c. controlled amplifier. From the amplifier the signal is detected, either in the s.s.b. detector (by mixing with a 1.4MHz signal), or by the a.m. detector. The resultant is an audio signal which is amplified and fed to the output stages. The receiver audio stages are also used during transmission or tuning to provide sidetone outputs. An additional fixed level audio output is provided at pin G of AUDIO socket 2 for use in vehicle systems.

10. An automatic gain control (a.g.c.) potential is developed from the input signal to the two detectors and is used to control the gain of the i.f. amplifiers.

High and Low Power Output

11. The gain of the a.l.c. controlled amplifier in the transmit chain is also controlled from the front panel POWER switch, to provide two levels of power output.

Tuning

12. Selection of the TUNE condition sets the circuits to the transmit condition and unbalances the balanced modulator to provide a carrier. Indicator lights show the necessary direction of rotation of the TUNE (a.t.u.) control required, and fine tuning is accomplished by adjusting for a peak meter reading. The audio input stages are inhibited during tuning. The tone oscillator is switched into circuit when TUNE is selected to provide sidetone.

Out of Lock Indicator

13. When the synthesiser of a Syncal 30 manpack is out-of-lock, as occurs momentarily during frequency selection, an out-of-lock 'chopped' tone is heard in the audio circuits. The out-of-lock facility is used with Comcal 30 manpacks to indicate that a channel oscillator is not operational, due to either a missing crystal or a faulty circuit.

Power Supplies

14. Power supplies are derived from 24 volt input, either from a battery or power supply unit. A protection circuit is fitted to prevent damage in the case of a reverse polarity input. The front panel meter indicates supply voltage when the manpack is in the receive condition. A 7A fuse is fitted within the unit to protect the circuits.

CHAPTER 2

CIRCUIT DESCRIPTION

TRANSMITTER CIRCUITS (Figs. 6 and 7)

Microphone Inputs, Pre-Amplifier and Buffer

1. During Speech operation microphone inputs from pin A of either 1SKT1 or 1SKT2 are fed, via pins A13 and A15, and r.f. decoupling and d.c. blocking components, to the microphone pre-amplifier, 1TR48 and 1TR49. The output of 1TR48 is fed via the speech compressor (clipper) 1D48 and 1D49, to a buffer stage 1TR46. The power supply to 1TR48 and 1TR49 is controlled by 1TR47 from the p.t.t. line (para. 41).

Keyed Tone Inputs

2. During key operation the key line, pin A41, is used to key the tone oscillator 1TR28, via diode 1D36 (see para. 22). The tone produced by the oscillator is then fed to the audio buffer stage 1TR46 via 1C136. The circuits include delay networks and a relay switching circuit (para. 41).

Balanced Modulator and 1.4MHz I.F. Amplifier

3. The output from the buffer (which can be speech or keyed tone) is fed to a balanced modulator 1D45, 1D46 and associated components, where it is mixed with a 1.4MHz signal supplied to pin A9. The output of the modulator is the first i.f., centred on 1.4MHz and containing both sidebands. The i.f. is fed via a stage 1TR43 and 1TR44, which incorporates automatic level control (a.l.c.) (see para. 12) to a 1.4MHz i.f. amplifier 1TR39 and 1TR40.

Sideband and AM Filters

4. The output of 1TR39 is fed via one of three diode switches 1D35, 1D33 or 1D34 (para. 44) to either the u.s.b. or l.s.b. filter, 1FL3, 1FL4 or to the a.m. circuit 1L2, 1C74 and 1C75, dependent upon the selection made at the front panel MODE control. In the case of USB or LSB operation, the unwanted sideband is removed leaving a single sideband signal. When AM is selected the filter 1L2, 1C74 and 1C75 is used only to ensure that the bandwidth of the signal is within pre-determined limits, and both sidebands are retained.

First TX Mixer and 35.4MHz I.F. Amplifier

5. The filtered signal is fed via 1T15 to the First TX Mixer, 1TR35, 1TR36 and associated components, where it is mixed with a 34MHz input from pin A43. The resultant of the mixing process, a 35.4MHz second i.f. signal, is fed via 1T14 to an i.f. amplifier 1TR34. This amplifier includes a rejector circuit tuned to 1.4MHz (1L3 and 1C106) which ensures that the gain of the amplifier at that frequency is considerably reduced.

Channel Mixer and Wideband Amplifier

6. The second i.f. signal is coupled, via 1T8 and the a.m. band-pass filter 1FL2, to a mixer 1D26 to 1D29, 1T5 and 1T7. The mixer, which is of the hot-carrier diode split-ring type, is also fed with a variable frequency, in the range of 37MHz to 65.399MHz, from pin A31, via a band-pass filter 1FL5 and an amplifier stage 1TR27. The output of the amplifier is coupled to the mixer via transformer 1T6.

7. The output of the mixer, which is a modulated signal of correct frequency for transmission, is fed via the low pass filter 1FL1 (to remove any signals above 30MHz), and the 1RLB relay contacts (the relay is energized in the transmit condition, see para. 41) to a wideband amplifier 1TR31 to 1TR33. The transistors of this amplifier operate in grounded base mode, and are coupled by transformers 1T10 to 1T13. The output transformer 1T10 couples the amplifier to pin A21 of the transceiver p.c.b., which is connected to pin B10 of the p.a. board.

Driver and Power Amplifier

8. The p.a. board contains a driver and a power amplifier. The driver amplifier consists of two push-pull grounded-base stages, 2TR3 to 2TR6, which operate in Class B condition, due to the bias provided by the 'knee voltages' of 2D4 to 2D7. The input signal is coupled to the driver amplifier by 2T6, inter-stage coupling is carried out by 2T5.

9. The output of the driver amplifier is coupled, via 2T4, to the bases of 2TR1 and 2TR2, the power amplifier, which operates in Class B common emitter mode. Resistors R6, R7, R10 and R13 provide feed-back from the output of the p.a. which increases the gain stability of the amplifier and reduces the output impedance of the amplifier to harmonics, thus reducing the generation of harmonics. The output of the p.a. is coupled via 2T3 and 2RLA relay contacts to a second set of relay contacts, 4RLA and 4RLB, the function of which is to route the p.a. output to either the antenna tuning unit, (A.T.U.) 2L3 and associated capacitors, or to the W/B socket.

Output Switching

10. When relays 4RLA and 4RLB are de-energized, the relay contacts route the p.a. output to the internal A.T.U. When either an external filter, R.F. amplifier or a remote A.T.U. is used, the relays become energized to route the output to the W/B socket. This is controlled by the switching and fixed audio board, the circuit of which is included in fig. 7. If the d.c. resistance of equipment connected to the W/B socket is between 4.7K and 15K, transistor 3TR4 will conduct to energize the relays and route the transmitter output to the W/B socket. When the d.c. resistance at the W/B socket is less than 4.7K, the relays will become energized, as already described, and transistors 3TR5 and 3TR6 will also conduct. With 3TR6 conducting, transistor 1TR44 in the a.l.c. circuit on the transceiver board (fig. 6, Part 2) will be cut-off to set the power amplifier to low power if the POWER switch is in the HIGH position. During the tuning sequence of a remote automatic a.t.u. an earth is applied to diode 3D4 via pin G of the AUDIO 1 socket which will cut-off transistor 1TR44 to ensure a low power transmitter output.

A.T.U.

11. Resistor 2R5 in the output circuit is used to limit the maximum resistance in the output circuit when the a.t.u. 2L3 is 'off-tune', thus limiting the required range of the a.l.c. circuit (para. 11). The capacitor 2C3 improves the matching of the a.t.u. to the p.a. by increasing the input impedance of the a.t.u. presented to the p.a. at the higher frequencies.

Automatic Level Control (ALC) and High/Low Power Switching Circuits

12. Both current and voltage automatic level control (a.l.c.) circuits are provided to control and protect the P.A. from being over-driven. The current a.l.c. circuit gives short-circuit protection at the antenna, the voltage a.l.c. circuit prevents the p.a. output transistors 2TR1 and 2TR2 being driven into saturation. The a.l.c. potentials developed are used to control the gain of the 1.4MHz i.f. amplifier 1TR43 and 1TR44. The combined effect of the a.l.c. circuits is to maintain a maximum output of approximately 20W.

13. The current supply to the p.a. is taken via resistor 1R1 of the transceiver board, which is connected across pins A19 and A20. When the p.a. current drawn is of the order of 3.5 amp. the voltage developed across 1R1 provides a collector voltage at 1TR38 of about 4V, which is just insufficient to operate the a.l.c. circuit.

14. When a larger current is drawn the voltage across 1R1 causes the conduction of 1TR38 to increase, thus increasing its collector voltage. Transistor 1TR37 forms the second half of a long-tailed pair, giving an improved switching action to 1TR38.

15. The increased collector voltage of 1TR38 operates a gating transistor 1TR42, which in turn, increases the conduction of 1TR43, reducing the conduction of 1TR44 and decreasing the gain of the 1.4MHz i.f. amplifier, thus reducing the p.a. output level to a safe value. The current level at which the circuit operates is set by 1R140.

16. The voltage-controlled a.l.c. circuit operates from the r.f. output of the p.a. Transformer 2T2 provides a sample of the r.f. output voltage which is rectified by 2D2 and smoothed by 2C2 and 2R4 to provide an a.l.c. potential at pin B7 of the p.a. board. The potential is fed to pin A18 of the transceiver board and, via a pre-set potentiometer 1R142, to a gating transistor 1TR41. The output of 1TR43 and 1TR44 is used in the same manner as the potential developed by the current a.l.c. circuit (para. 12). The control potential fed to the 1.4MHz i.f. amplifier is therefore determined by both the current and voltage a.l.c. systems.

17. The base potential of the controlled transistor 1TR44 is set by the divider chain 1R154 and 1R156, from the 24 volt supply line, when LOW power is selected. If HIGH power is selected the base of 1TR44 is connected via 1D52 and a 10K ohm resistor 3R12 to the 24 volt supply. This increases its bias voltage and so increases the available output of the 1.4MHz amplifier and the p.a. With the front panel switch in the HIGH position, low power may be obtained in two ways. Connecting pin G of AUDIO socket 1 to earth (Pin D) connects point A35 on the transceiver board to earth via diode 2D4, this has the effect of removing the HIGH level bias to 1TR44 and low power is obtained. Similarly 3TR6 being

driven into conduction will connect point A35 to a potential very near to earth having a similar effect. (See para. 10.)

Transient ALC stage

18. Components 1D51, 1TR50, 1C156 and 1C157 form a fast a.l.c. loop circuit providing protection for the p.a. transistors on the p.a. board against current surges particularly during the switch 'on' period. The circuit threshold level is arranged to be below the threshold level of the a.g.c. circuit and therefore only operates on transients. Capacitor 1C158 at the junction of 1D47 and 1R170 provides transient suppression during the switch 'off' period.

Sidetone Circuits

19. During transmission audio signals from microphone pre-amplifier 1TR48 or keyed tones from the tone oscillator 1TR28 are fed to the receiver audio circuits via 1C84. This provides sidetone during transmission. Sidetone, from the tone oscillator, is also available when the TUNE condition is selected at the MODE switch.

A.T.U. Tuning Indicator Light and TUNE Condition

20. The a.t.u. consists of 2L3 and associated capacitors. When the a.t.u. is off-tune one of the two indicator lights (light emitting diodes) in the meter will be illuminated when TUNE condition is selected, thus indicating the direction of rotation of the TUNE control. The TUNE condition is selected at the front panel MODE switch.

21. When TUNE is selected the a.m. circuit 1L2, 1C74 and 1C75 is switched on by a voltage fed from switch 1SB1R via pin A11 and 1D44 to diode switches 1D31 and 1D34 (para. 44). In addition, the voltage is fed to the resistor chain 1R161 and 1R162. The voltage at the wiper of 1R162 unbalances the balanced modulator 1D45, 1D46 (para. 3), providing an r.f. output from the transmitter at the carrier frequency.

22. The voltage from pin A11 is also fed to transistor 1TR29, energizing the tone oscillator 1TR28. The output of the oscillator provides a 1000Hz sidetone. The audio buffer stage 1TR46 is reverse-biased via 1D47 in this condition preventing audio modulation of the carrier. The conduction of 1TR29 also energizes the 'transmit' relays via 1TR30 (para. 39), connecting the transmitter to the a.t.u. and energizing the transmitter circuits.

23. The tuning direction indicator lamps, fitted in the meter, are operated by a detector circuit connected to the a.t.u., and a drive amplifier circuit, both on the p.a. board. The voltages at the ends of the a.t.u. inductor 2L3 are sampled by potential dividers 2C13, 2C18 and 2C14, 2C17 to provide inputs to the detector circuit.

24. The voltage from the 'capactive end' of the a.t.u., (via 2C14 and 2C17) is rectified by 2D8 and smoothed by 2R26, 2C15 and 2C16 to provide a d.c. voltage across 2C15 proportional to the capacitive condition of the a.t.u. This voltage is designated VC.

25. The voltage developed by the chain 2C13 and 2C18 is due to the 'inductive part' and the 'capactive part' of the a.t.u., i.e. VL-VC, but, due to the method of connection of 2D9, the rectified d.c. voltage produced across the smoothing stage 2R27, 2C18 and 2C19 is equal to VL-VC+VC, which equals VL.

26. The two voltages VC and VL are fed to the bases of the dual transistor 2TR9 which is connected in long-tailed configuration. One or other of the driver transistor 2TR8 or 2TR11 will therefore be switched on when the a.t.u. is off-tune, causing the associated l.e.d. (light emitting diode) to illuminate and indicate the direction of rotation of the TUNE control required for coarse tuning. The diodes 2D10, 2D11 and 2D12 provide a threshold voltage for 2TR8 and 2TR11.

27. Fine tuning of the a.t.u. is achieved by adjusting the TUNE control to obtain a peak meter reading, therefore the l.e.d.'s are extinguished when a meter indication is given. The meter is driven by an antenna current detector (para. 51) which supplies a d.c. voltage related to r.f. current. When the voltage gives a meter deflection of approximately quarter scale transistor 2TR7 is driven in conduction, causing 2TR10 to cut-off, removing the current supply to 2TR9 and the drive to 2TR8 and 2TR11, thus extinguishing the l.e.d.'s.

28. The supply for the l.e.d. drive circuit is taken from switch 1SB1R pin 5 via pin B16 of the p.a. board, and is only available when TUNE is selected.

RECEIVER CIRCUITS (Figs. 6 and 7)

Input Circuit

29. The signal from the antenna is fed via the a.t.u. and the de-energized contacts of relay 2RLA to pin B21 of the p.a. board, then to pin A28 of the transceiver board. It is then fed via relay contacts 1RLA and 1RLB to the low-pass filter 1FL1. The 'back-to-back' diodes 1D22 to 1D25 protect the circuit from excessive r.f. input voltages.

Channel Mixer, Filter and 35.4MHz I.F. Amplifier

30. Transformer 1T5 couples the input to the split-ring hot-carrier diode channel mixer 1D26 to 1D29, where it is mixed with the variable signal, in the range 37 to 65.399MHz, supplied from pin A31, via the bandpass filter 1FL5, amplifier 1TR27 and transformer 1T6. After mixing, the resultant i.f., centred on 35.4MHz, is coupled to the a.m. filter 1FL2 via 1T7. The filter has a bandwidth of approximately 10kHz.

31. The output of the filter is coupled by 1T8 to a low-noise untuned 35.4MHz amplifier 1TR4 and 1TR5. The amplified signal is fed to an a.g.c. controlled (para. 38) cascode amplifier 1TR6 and 1TR7.

Second RX Mixer and 1.4MHz I.F. Amplifier

32. The signal from the cascode amplifier is injected into the Second RX Mixer 1TR8 and 1TR9 by the tuned transformer 1T1, as is a 34MHz signal from pin A43. The resultant of the mixing process, a 1.4MHz signal, is fed to the u.s.b., or l.s.b. filter 1FL4 or

1FL3, or to the a.m. circuit 1L2, 1C74, 1C75, dependent upon diode switches 1D30 to 1D35 which are controlled by the MODE switch. The filtered signal is then amplified by the tuned 1.4MHz i.f. amplifier 1TR10 and the d.c. coupled pair 1TR11 and 1TR12.

SSB and AM Detectors, Buffer Amplifier and Muting

33. The s.s.b. detector consists of 1T4 and 1TR13, which mix the 1.4MHz i.f. with a 1.4MHz signal from pin A9, thus recovering the audio signal. The detector is 'switched on' when u.s.b. or l.s.b. mode is selected. The a.m. detector is 'switched off' by 1D14 or 1D15.

34. The AM detector 1TR16 acts as a diode detector when AM mode is selected. The input signal is derived from the collector of 1TR12. The 1.4MHz input is muted in a.m. mode to avoid the generation of spurious signals. This is achieved by a 12V d.c. level applied to the synthesizer, or 49 channel crystal oscillator, via switch 1SB1R and capacitor 1C153.

35. The output from the detector in use is fed to a buffer amplifier 1TR17 then to the audio stages.

Audio Amplifier

36. The output of 1TR17 is fed, via the AF GAIN control 1R55 to the audio amplifier 1TR18 to 1TR20. The output of the amplifier is fed via blocking and filtering components 1C52, 1L1 and 1C54 to the audio output sockets (pin F).

Fixed Level Audio Amplifier

37. The output from the buffer amplifier 1TR17 is also fed via a preset gain control 3R1 to the fixed level audio amplifier which has two stages. Transistor 3TR1 is a driver transistor for the output transistors 3TR2 and 3TR3 connected in the complementary mode. 3TR2 is a n.p.n. transistor, connected as an emitter follower with 3TR3 as the emitter load. 3TR3 is a p.n.p. transistor, connected as an emitter follower with 3TR2 as the emitter load. During the positive portion of the signal 3TR1 conducts and 3TR2 tends to be cut-off. Similarly, during the negative portion of signal 3TR1 conducts less and 3TR2 conducts more. Resistor 3R4 and diode 3D1 provide base bias for the output transistor, preventing crossover distortion. Resistor 3R2 provides d.c. negative feedback which stabilizes the amplifier working voltages. RF filtering is provided in the amplifier output by inductor 3L1 and capacitor 3C6 before it is fed to pin G on AUDIO 2 socket.

A.G.C. Circuits

38. Automatic gain control (a.g.c.) circuits are fitted which maintain a sensibly constant output from the receiver with varying input signal levels. An a.g.c. potential is developed from the i.f. signal of the receiver and applied as a control potential to the 35.4MHz and the 1.4MHz i.f. amplifiers.

39. A part of the i.f. signal from 1TR12 is fed to 1D12 and 1TR14, which act as a pair of 'back-to-back' diodes, limiting the signal applied from the collector of 1TR12 to approximately 1 volt peak-to-peak. The base of transistor 1TR15 is held at approximately 6 volts by the Zener diode 1D13.

40. When the antenna signal exceeds approximately 4uV the signal level at 1TR12 collector exceeds the quiescent 1 volt peak-to-peak level, causing 1TR14 to conduct, thus decreasing the conduction of 1TR15. This reduces the positive voltage level of the a.g.c. line, connected to 1TR10 via 1R29 and to 1TR7 via 1R17, thus reducing the gain of 1TR10 and 1TR7. In this manner the output level of the receiver is automatically controlled.

TRANSMIT, RECEIVE AND MODE SWITCHING (Fig. 6 and 7)

41. The transmit condition is achieved by either connecting pin C of the audio socket to earth via a p.t.t. switch when voice mode is used, or by connecting pin E of an audio socket to earth by a morse key. In either case transistor 1TR30 is driven into conduction, energizing relay 2RLA (on the p.a. board) via pin A36. Contacts 12 and 13 of the relay earth the input to the receiver, contacts 15 and 16 connect the p.a. to the a.t.u., contacts 5 and 6 break the battery monitoring circuit (para. 50) and contacts 9 and 10 energize relays 1RLA and 1RLB on the transceiver board, via pins A23 and A29. Relay 1RLA also earths the receiver input, relay 1RLB connects filter 1FL1 to the wideband amplifier, thus completing the transmitter circuit.

42. In the receive condition all relays are de-energized, connecting the receiver to the a.t.u. and the battery monitoring circuit to the meter (para. 50).

43. During key operation the delay circuit 1C89, 1R100 and 1R101 is brought into use, to provide a 'hold-on' circuit for the transmit condition. The delay period is approximately half a second, preventing receiver 'break-in' during morse transmissions. During voice operation 1D37 is reverse-biased from the p.t.t. line, cutting-off the delay circuit and the tone oscillator.

44. All switching, other than the TX/RX and ATU/WB relays, is achieved by diode switches and gating transistors. Switching diodes 1D31 and 1D34 are forward biased when AM mode or TUNE is selected, providing a conducting path via the a.m. circuit. The diodes are reverse-biased when a mode other than AM or TUNE is selected. Diode 1D44 is also conducting when TUNE is selected, to provide an unbalancing voltage to the balanced modulator (para. 21) and to diodes 1D31 and 1D34. Similar switching diodes are fitted in the USB and LSB circuits. It should be noted that the USB filter is brought into use when the LSB is selected, and vice versa, to provide the correct sideband due to an inversion process occurring in the channel mixer.

45. When USB and LSB mode is selected the a.m. detector transistor 1TR16 (para. 33) is switched off by a voltage applied via 1D14 and 1D15. In AM mode the s.s.b. detector 1TR13 (para. 33) is 'switched off' via 1D11.

46. The transmitter and receiver supply lines are switched by relay 2RLA, on the p.a. board. The diode switches 1D6, 1D7, 1D8 and 1D9 conduct when the receive condition is selected, diodes 1D40 and 1D41 conduct in the transmit condition, to give correct routing of i.f. and local oscillator signals.

OUT OF LOCK INDICATOR (Fig. 6)

47. Out of lock indication is provided by a 'chopped' tone in the audio circuits. When a synthesizer is used the input at pin A40 is a positive d.c. level when the synthesizer is in lock and is 'earthy' when out of lock. Similarly, when a 49 channel oscillator is used the input is 'high' when a channel frequency is available and 'earthy' when a channel frequency is not available (i.e. crystal not fitted or oscillator faulty).

48. When 'in lock' the voltage at pin A40 (via 1C154) drives 1TR26 into conduction, cutting-off 1TR25 and removing the supply to the phase shift oscillator and multivibrator 1TR22, 1TR23 and 1TR24.

49. In the out of lock condition an earthy input cuts-off 1TR26, causing 1TR25 to conduct. The multivibrator has a p.r.f. of about 15Hz, which is used to 'chop' the 600Hz output of the phase-shift oscillator 1TR22. The output of the circuit is fed to the audio stages via 1C56, 1R63 and 1C84.

MONITORING CIRCUIT (Fig. 7)

50. During reception or intercom. (I/C) operation the relay 2RLA is de-energized, routing the 24V supply voltage, via relay contacts 5 and 6, to the meter. During transmission or tune condition the relay contacts are open circuit, disconnecting the supply from the meter.

51. The r.f. current output from the p.a. is sampled by the transformer 2T1, and the sample is detected and smoothed by 2D1 and 2C1. The voltage developed across 2C1 is fed, via 2R2, to the meter, thus providing an indication of the r.f. output level. The detector circuit is also used in conjunction with the light emitting diode drive circuit (para. 23).

INTERCOM. AND POWER SUPPLIES (Fig. 6)

52. When the equipment is switched off, diodes 1D1 and 1D2 allow the battery to be charged from either 1SKT1 or 1SKT2, but prevent power being drawn from either socket, or being fed from one socket to the other. Zener diode 1D3 provides reverse and over-voltage protection via fuse FS1.

53. The audio and microphone amplifiers are powered by a regulator circuit 1TR21, which supplies an 18 volt output. When I/C (intercom.) is selected at the POWER switch only the 18 volt regulator is in circuit. Intercom. is therefore carried out with the remainder of the circuitry switched off. The audio and microphone amplifiers operate in the normal manner in the intercom. mode, under control of the press-to-talk circuit.

54. The 12V regulator circuit, driven from the 24 volt supply, is provided by the series regulator 1TR1 and the driver 1TR2. A reference voltage for the regulator is provided by 1D5. Short-circuit protection is provided by 1TR3 in conjunction with 1R5. Excessive current flow through 1R5 drives 1TR3 into conduction thus reducing the drive to 1TR2 and 1TR1.

CHAPTER 3

MAINTENANCE

INTRODUCTION

1. This chapter covers maintenance procedures and tests on the complete manpack and on the Transceiver Unit MA.930X. Maintenance information on the Synthesizer MA.925 or the 49 Channel Crystal Oscillator MA.933 is given in Part 3 Chapter 3 of this handbook. Ensure that re-alignment is actually necessary before adjusting the position of any pre-set potentiometer or inductor.

TEST EQUIPMENT

2. The following test equipment is required to carry out the procedures given in this chapter.

(1) Test Set (including power supply). The Racal Type CA.531 is suitable.

(2) Multimeter, Electronic, R.F., having d.c. ranges and r.f. ranges which can be used up to 100 MHz. The Racal Type 314A is suitable.

(3) Multimeter, Electronic, A.F., having a range of up to 10mV at 20 Hz to 100 kHz. The Advance Type 77C is suitable.

(4) Audio Power Output Meter, having a range of 10 Hz to 100 kHz at input impedances of 300Ω and 50Ω and range of 1mW to 100mW. The Marconi Type TF893 is suitable.

(5) R.F. Signal Generator having a range of 1 to 72 MHz at 50Ω output impedance which can be modulated up to 30% at 1000 Hz. The Marconi Type TF144H is suitable.

(6) A.F. Two Tone Signal Generator, having outputs of 20 Hz to 100 kHz at 600Ω impedance, with an output level of 0.1mV to 1V. The Dymar Type 745 is suitable.

(7) Digital Frequency Counter having a range of up to 30 MHz at 50mV r.m.s. input. The Racal Type 9022 is suitable.

(8) Oscilloscope having a frequency range of d.c. to 50 MHz and a sensitivity of 50mV/cm. The Roband R040A, Solartron CD1400 or Tektronix 453 is suitable.

(9) R.F. Wattmeter covering the range of 1 to 30 MHz at 50Ω input impedance and capable of dissipating 25W. The Marconi Type TF.1152A/1 is suitable.

(10) Multimeter, General Purpose. The Avometer Model 8 is suitable.

(11) Power Supply capable of continuously providing 4A at 24V d.c.

(12) 50Ω Fixed Attenuator (10 or 20 dB). The Marconi Type TM5573 is suitable.

(13) Resistor, 1k $\frac{1}{4}$W.

(14) Capacitor, 4.7 μF 6V working.

NOTE: Items referred to in sub-paras. 4, 6, 9 and 11 are not required if a CA.531 Test Set is used.

Use of Test Set CA.531

3. The Test Set CA.531 simplifies maintenance operations. It consists of the following circuits.

(1) A power supply with overload protection, allowing a manpack to be driven from 100 to 125V or 200 to 250V 45 to 60 Hz mains, without risk of damage due to internal short circuits etc.

(2) A 50Ω dummy load incorporating a wattmeter, allowing easy measurements of output power.

(3) Connecting points for a.f. inputs and outputs and a frequency counter or oscilloscope.

(4) Transmit/Receive and Key switching.

(5) DC current meter.

4. The following paragraphs are written on the assumption that a test set is available. If a test set is not available it will be necessary to use a six pole plug connected to an audio socket 1SKT1 or 1SKT2, to provide power supplies, audio inputs and outputs, keying signals and p.t.t. signals. A metered dummy load will be required to measure output powers.

CHANNEL FREQUENCY SELECTION

5. As previously stated, the SYNCAL 30 utilises a synthesizer with controls which are marked in frequency, and the COMCAL 30 utilises a 49 channel crystal oscillator, with controls marked in channel numbers. It is important to note that the channel frequency of the oscillator is not the crystal frequency, but is 35.4MHz below crystal frequency. When an MA.925 Synthesizer is used (SYNCAL 30), the controls must not be set to a frequency below 1.6000MHz.

INITIAL PROCEDURE

6. (1) Set the mode switch to the OFF position.

(2) Remove the manpack from its haversack and remove the battery.

(3) Remove the transmitter-receiver from its case.

(4) Remove the cover from the transceiver unit.

(5) Check all controls (including TUNE control) for smooth action. Check plugs and sockets for correct mating.

(6) Set the POWER switch to OFF, the MODE switch to A.M., and the SEARCH or CLARIFIER control to OFF.

(7) Connect the output plugs of the CA.531 Test Set to the two audio sockets. Select REC at the CA.531 and switch on the Test Set.

(8) Select LOW at the POWER switch and check that the meter on the manpack indicates approximately 0.8 scale deflection in the AM, LSB and USB positions. Return the switch to the AM position.

(9) Connect the multimeter, set to the 25 volt d.c. range, between earth and the mute connection (feed through capacitor IC153) of the transceiver unit. The reading should be between 10.5V and 13V.

(10) Connect the multimeter to pin A17 of the transceiver unit and check that 24 volts (approximately) is maintained for all positions except OFF of the POWER switch.

(11) Connect the multimeter to pin A26 of the transceiver unit and check that 24 volts is available when HIGH and LOW positions of the POWER switch are selected.

(12) Disconnect the multimeter.

(13) Turn 1R33 fully anti-clockwise.

RECEIVER

A.F. Power Output and Frequency Response

7. (1) Connect an oscilloscope and an Audio Power Output Meter, set to the 300 ohm 100mW range, to the terminal marked AF and EARTH on the Test Set CA531. Set POWER switch to LOW.

(2) Connect the 600 ohms output of an AF Signal Generator, set to 1KHz, to an AF Electronic Multimeter and then, via a series 1K resistor and 4.7μF capacitor to pin A4 of the transceiver board (negative end of capacitor to pin A4).

(3) Set the AF Gain control 1R55 fully clockwise and adjust the output of the generator to give a reading of 30mW on the Audio Power Output Meter.

(4) Check that the waveform displayed on the oscilloscope is sinusoidal.

(5) Check that the electronic multimeter reading is between 10mV and 20mV.

(6) Increase the output from the generator until the waveform displayed on the oscilloscope just begins to limit.

(7) Check that the power meter output is between 30mW and 100mW.

(8) Set the output from the AF Signal Generator to give a reading of 4mW on the AF Power Meter.

(9) Reduce the frequency of the generator until the reading on the Power Meter falls to 1mW.

(10) Check that the generator frequency is between 50Hz and 100Hz.

(11) Increase the frequency of the generator until the reading on the Power Meter again falls to 1mW.

(12) Check that the generator frequency is between 5 kHz and 15 kHz .

(13) Disconnect audio generator, electronic multimeter, 1KΩresistor and 4.7μF capacitor.

8. IF Alignment

(1) Connect an r.f. signal generator to test point 1 TP9.

(2) Set the frequency of the Generator to 1.400 MHz (calibrated to within ±10 kHz), at an output of 2 millivolts e.m.f. and modulation set to 30% at

1 kHz.

(3) Turn 1R162 fully anti-clockwise. Set the MODE switch to TUNE and adjust the AF GAIN control until the reading on the AF Power Meter is reduced by 6 dB. Reset MODE switch to AM. Set the synthesizer controls to 200 kHz or on units with a 49 channel oscillator, short circuit TP1 (see Fig. 5) to earth.

(4) Set 1R33 to mid-position and tune the IF transformer 1T3, using a suitable trimming tool, for maximum reading on the AF Power Meter. Seal the core with a suitable locking compound.

(5) Check that the waveform displayed on the oscilloscope is sinusoidal.

(6) Disconnect the generator from 1 TP9 and re-connect to 1 TP3.

(7) Set the Signal Generator frequency to 35.400 MHz with its output at 10 microvolts e.m.f. modulated to 30% at 1kHz.

(8) Adjust signal generator frequency for maximum audio output.

(9) Tune the IF transformer 1T1, using a suitable trimming tool, for maximum reading on the AF Power Meter. Seal the core with a suitable locking compound.

(10) Disconnect the generator and on units with 49 channel oscillator remove shorting link from TP1 to earth.

9. <u>Channel, 34 MHz and 1.4 MHz Oscillator Signal Levels</u>

(1) Set the MODE switch to USB and select 1.600 MHz if a synthesizer is used, or the nearest channel to 1.600 MHz if a 49 channel oscillator is used.

(2) Connect an RF Electronic Multimeter to test point 1 TP7.

(3) Check that the multimeter reading is 750mV or above.

(4) Repeat operations (1), (2) and (3) at 3MHz, 8MHz, 16MHz and 29.999MHz, or at nearest channel frequencies.

(5) Disconnect multimeter from 1 TP7 and re-connect to transceiver board pin A43.

(6) Check that multimeter reading is at least 250mV.

(7) Disconnect voltmeter from pin A43 and re-connect to pin A9.

(8) Check that the multimeter reading is at least 200mV.

(9) Disconnect multimeter.

10. AGC Threshold

(1) Set the synthesizer controls to 1.600 MHz or set the channel oscillator to the nearest frequency.

(2) Connect an RF Signal Generator to 2SK4 (1.6-3 MHz) with its frequency set to 1.601 MHz (or to 1 kHz below channel frequency) and output set to 4 microvolts e.m.f. CW.

(3) Adjust the TUNE control and the generator frequency to give maximum reading on the AF Power Meter.

(4) Connect multimeter (set to 10V d.c. range) between test point 1TP14 (+ve) and earth.

(5) Adjust 1R33 until the reading given on the multimeter is reduced by 0.1 volt.

(6) Disconnect the multimeter.

11. Sensitivity and Signal/Noise Ratio

Note: If it is necessary to adjust the AF GAIN control 1R55 whilst measuring the signal/noise ratio, ensure that the control is reset as in para. 9(3) before carrying out further tests. Set the synthesizer controls to 200 kHz or on units with a 49 channel oscillator, short circuit TP1 (see Fig. 5) to earth.

(1) Reduce RF Signal Generator output to 2μV e.m.f.

(2) Check that the power meter reading is between 4mW and 20mW.

(3) Interrupt the Signal Generator output and check that the change of reading of Power Meter is at least 15dB.

(4) Set the MODE switch to LSB and the generator frequency to 1.599 MHz (or to 1 kHz above channel frequency).

(5) Repeat operations 11(3), 12(2) and 12(3).

(6) Set the synthesizer to 3.000 MHz, and MODE switch to USB,or select the nearest channel frequency. Set the generator frequency to 3.1001 MHz, or to 1 kHz above channel frequency.

(7) Repeat operation 11(3), 12(2) and 12(3).

(8) Disconnect RF Signal Generator from 2SK4 and connect to 2SK5 (3-30 MHz).

(9) Repeat operations 11(3), 12(2) and 12(3).

(10) Set the synthesizer to 8.000MHz, or select the nearest channel frequency. Set the generator frequency to 8.001MHz, or to 1kHz above channel frequency.

(11) Repeat operations 11 (3), 12 (2) and 12 (3).

(12) Set the synthesizer to 16.00MHz or select the nearest channel frequency. Set the generator frequency to 16.001MHz, or to 1kHz above channel frequency.

(13) Repeat operations 11 (3), 12 (2) and 12 (3).

(14) Set the synthesizer to 29.999MHz or select the nearest channel frequency. Set the generator frequency to 30.000MHz or to 1kHz above channel frequency.

(15) Repeat operations 11 (3), 12 (2) and 12 (3).

12. FIXED LEVEL AUDIO AMPLIFIER

(1) Connect the 24 volt power supply lead to the AUDIO 1 socket.

(2) Connect an RF signal generator set to 1.599MHz and 20mV output to the 1.6 - 3MHz BNC socket.

(3) Connect an AF power meter, set to 50 ohm input impedance to pins G and D of socket AUDIO 2. Connect an oscilloscope in parallel with it.

(4) Set the MODE switch on the 931X to LSB and the power switch to LOW. Set the frequency selection switches to 1.6MHz. Adjust the TUNE control and the generator frequency for a maximum output on the AF power meter. Check that this value is between 40 and 60mW. Observe the waveform on the oscilloscope to ensure that distortion is not occurring. If necessary the gain may be adjusted to 50mW by the use of potentiometer 3R1.

13. <u>Overall Frequency Response (SSB)</u>

(1) Connect a digital frequency counter across the terminals of the AF Power Output Meter.

(2) Set the synthesizer to 1.600MHz, or select the nearest channel frequency.

(3) Disconnect the RF Signal Generator from 2SK5 and connect via a 20dB attenuator to 2SK4 (1.6-3MHz). Set the frequency of the generator to 1.601MHz, or to 1kHz above channel frequency.

(4) Adjust the TUNE control and generator frequency to give maximum reading on the Power Meter.

(5) Adjust the generator output to give 4mW on the Power Meter.

(6) Increase the generator output by 6dB and increase its frequency until the reading on the Power Meter returns to 4mW.

(7) Check that the frequency counter reading is between 2.5kHz and 3.5kHz.

(8) Decrease the generator frequency until the reading on the Power Meter returns to 4mW.

(9) Check that the frequency counter reading is between 100Hz and 500Hz.

(10) Set the MODE switch to LSB and the generator to 1.599MHz, or to 1kHz below channel frequency.

(11) Repeat operations 13(4) to 13(9).

14. AGC Response

(1) Remove 20dB attenuator and re-connect generator to 2SK4. Set the generator output level to 2 microvolts e.m.f.

(2) Adjust the TUNE control and generator frequency to give maximum reading on the AF Power Meter.

(3) Adjust the A.F. GAIN control to give 1mW on the Power Meter.

(4) Increase the output from the generator by 10dB.

(5) Check that the Power Meter reading is between 1mW and 4mW.

(6) Increase the output from the generator by a further 90dB.

(7) Check that the Power Meter reading is between 1mW and 6mW.

(8) Check that waveform displayed on oscilloscope is sinusoidal.

(9) Increase AF GAIN control setting to maximum.

15. Spurious Responses

(1) Set the synthesizer to 17.702 MHz, or select a channel frequency of 17.702 MHz.

NOTE: A channel frequency of 17.702 MHz must be available for this test.

(2) Disconnect the RF Signal Generator from 2SK4 and connect to 2SK5 (3-30 MHz) and set its frequency to 17.701 MHz and its output to 2 microvolts e.m.f.

(3) Adjust the TUNE control and generator frequency to give maximum reading on the AF Power Meter.

(4) Adjust the GAIN control to give 4mW indication on the Power Meter.

(5) Set the synthesizer to 1.600 MHz, or select the nearest channel frequency.

(6) Check that an increase in output of at least 40dB is necessary from the Signal Generator to obtain a reading of 4mW as before, adjusting the generator frequency for maximum reading on the AF Power Meter.

(7) Set the generator frequency to 1.599 MHz, or to 1 kHz below channel frequency with its output at 2 microvolts e.m.f. Connect generator to 2SK4.

(8) Repeat operations 15(3) and 15(4).

(9) Increase the generator frequency to 72.401 MHz.

(10) Check that an increase in output of at least 60dB is necessary from the generator to obtain a reading of 4mW on the power meter.

(11) Disconnect generator from 2SK4 and connect to 2SK5. Set signal generator to 29.998 MHz.

(12) Set the synthesizer controls to 29.999 MHz, or select nearest channel frequency.

(13) Repeat operations 15(3) and 15(4).

(14) Increase the generator frequency to 35.401 MHz.

(15) Check that an increase in output of at least 60dB is necessary from the generator to obtain a reading of 4mW on the power meter.

(16) Disconnect all test equipment except the Test Set CA.531.

TRANSMITTER

16. AF Amplifier Adjustment and Frequency Response

(1) Turn 1R140, 1R142, 1R146 and 1R162 fully anti-clockwise and 1R163 to mid position.

(2) Connect a shorting link between pins A21 and A22.

(3) Connect the 600 ohms output of an AF Signal Generator between the terminals marked EARTH and MOD on the Test Set Type CA.531. Set the generator frequency to 1000 Hz and its output level to 6mV.

(4) Connect an AF Electronic Multimeter and an oscilloscope to test point 1TP13 and EARTH.

(5) Set the MODE switch to LSB and the Power Switch to LOW.

(6) Set the transmit/receive switch on Test Set CA.531 to TRANSMIT.

(7) Check that the Electronic Multimeter reads 150 ± 30mV and that the waveform displayed on the oscilloscope is not clipped. Note the actual

voltage indicated.

(8) Increase the output of the AF Signal Generator by 10dB and check that the waveform displayed on the oscilloscope is clipped.

(9) Decrease output of AF Signal Generator to 6mV.

(10) Increase the frequency of the generator until the voltage indicated on the AF Electronic Multimeter is half that noted in operation 16(7).

(11) Check that the frequency of the AF generator is between 5 kHz and 20 kHz.

(12) Decrease the frequency of the generator until the voltage indicated on the Electronic Multimeter is half that noted in operation 16(7).

(13) Check that the frequency of the AF generator is between 50 Hz and 200 Hz.

(14) Reset generator frequency to 1 kHz.

17. Tone Oscillator Adjustment and Sidetone Check

(1) Set Transmit/Receive switch on CA.531 to RECEIVE.

(2) Depress key button CA.531 and check that the reading on the AF Electronic Multimeter is greater than 125 mV.

(3) Disconnect a.f. electronic multimeter from 1TP13 and connect a frequency counter to 1TP13 (oscilloscope is to remain connected to 1TP13).

(4) Depress KEY button on CA.531 and adjust 1T9 to give a reading of 1000 Hz on the counter.

(5) Set the MODE switch to TUNE. Set AF GAIN fully clockwise.

(6) Check that all AF signals disappear from 1TP13.

(7) Remove all test equipment from 1TP13.

(8) Connect an AF Electronic Multimeter across the AF and EARTH terminals of Test Set Type CA.531.

(9) Check that the multimeter reading is between 1.3V and 2.5V.

(10) Set the MODE switch to LSB.

(11) Depress KEY button and check that multimeter reading is between 1.3V and 2.5V.

(12) Set Transmit/Receive switch on CA.531 to Transmit.

(13) Check that multimeter reading is between 250mV and 500mV.

(14) Disconnect multimeter from Test Set CA.531. Set POWER switch to OFF.

18. Balanced Modulator and IF Adjustments

(1) Set the synthesizer controls to 1.600 MHz or select nearest channel frequency.

(2) Connect an RF Wattmeter to 2SK4 (1.6-3 MHz).

(3) Connect an oscilloscope across 2SK4.

(4) Set the MODE switch to LSB.

(5) Set the audio generator output to 2mV.

(6) Remove shorting link between pins A21 and A22. Set POWER switch to HIGH.

(7) Adjust 1R142 to mid position. Set 1R140 and 1R146 fully clockwise.

(8) Peak TUNE control and adjust 1R142 to give a maximum output of 22W.

(9) Adjust 1R146 until the Wattmeter reading is approximately 20 watts.

(10) Adjust 1R142 until the output power reduces by approx. ½ watt.

(11) Adjust 1R140 until the output power reduces by approx. ½ watt.

(12) Short circuit 2SK4 momentarily and adjust the D.C. supply current to 3.8 amps with 1R140. Remove short circuit.

CAUTION: Do not exceed 3.8 amps (measured at test set).

(13) Increase AF generator input to 6mV and check that increase in output power is less than 3W.

(14) Reduce the AF Signal Generator output to zero and increase sensitivity of oscilloscope. Connect a shorting link between 1TP13 and earth.

(15) Adjust 1R163 and 1C126 to give minimum voltage on the oscilloscope.

(16) Check (at CA.531 meter) that the standing d.c. current drawn from the supply is between 0.6A and 1A.

(17) Remove shorting link from 1TP13 and earth.

19. **AM, TUNE and ALC Adjustments**

(1) Set the MODE switch to AM.

(2) Set the output of the audio signal generator to 60mV.

(3) Adjust 1R162 until the waveform displayed on the oscilloscope is just under 100% modulated i.e. with no interruption of carrier.

(4) Remove audio signal. Set the MODE switch to TUNE.

(5) Peak the TUNE control and adjust 1R142 to give a maximum output of between 17W and 18W.

(6) Check that maximum deflection of meter on manpack occurs at the optimum setting of the TUNE control.

(7) Set the Power Switch to LOW and check that the RF power output is between 2.5W and 5W.

(8) Re-set the Power switch to HIGH.

(9) Set the synthesizer controls to 3.000 MHz, or select nearest channel frequency.

(10) Disconnect the RF wattmeter from 2SK4 and re-connect to 2SK5 (3-30MHz).

(11) Peak the TUNE control and adjust 1R140 to give a maximum output of between 17W and 18W.

NOTE: Maximum d.c. current must not exceed 3.8A.

(12) Repeat operations (7) and (8).

20. **Carrier Suppression Check**

(1) Disconnect the AF Signal Generator from the Test Set CA.531.

(2) Open circuit terminals MOD and EARTH on the Test Set CA.531.

(3) Set the MODE switch to LSB.

(4) Check that the residual voltage indicated on the oscilloscope is not greater than 200mV peak-to-peak with test point 1TP13 connected to earth.

(5) Set the MODE switch to USB.

(6) Check that the residual voltage indicated on the oscilloscope is not greater than 100mV peak-to-peak with test point 1TP13 connected to earth.

(7) Remove link connecting test point 1TP13 to earth.

21. Power Output Checks

(1) Set the synthesizer controls to 1.6 MHz, or select nearest channel frequency.

(2) Connect an RF electronic multimeter to 2SK4 and reconnect the AF Signal Generator with its output set to two 3mV tones of frequency 1.1 kHz and 1.8 kHz.

(3) Set the MODE switch to TUNE.

(4) Adjust the TUNE Control for maximum power output.

(5) Check that the output power is between 16W and 20W.

(6) Set MODE switch to LSB.

(7) Check that the two-tone output waveform is undistorted.

(8) Check that the multimeter reading is 27V r.f. or above.

(9) Set the synthesizer controls to 3.000 MHz, or select nearest channel frequency.

(10) Repeat operations (2), (3) and (4), output power should be between 20W and 25W.

(11) Repeat operations (6) and (7), reading should be 30V r.f. or above.

(12) Disconnect test equipment from 2SK4 and connect to 2SK5 (3-30 MHz).

(13) Repeat operations (2), (3) and (4), output power should be between 17W and 21W.

(14) Repeat operations (6) and (7), reading should be 27V r.f. or above.

(15) Set the synthesizer to 8.000 MHz, or select nearest channel frequency.

(16) Repeat operations (2), (3) and (4), output power should be between 18W and 24W.

(17) Repeat operations (5) and (7), reading should be 27V r.f. or above.

(18) Set the synthesizer to 16.000MHz, or select nearest channel frequency.

(19) Repeat operations (2), (3) and (4), output power should be between 18W and 24W.

(20) Repeat operations (5) and (7), reading should be 27V r.f. or above.

(21) Set the synthesizer to 29.999MHz, or select nearest channel frequency.

(22) Repeat operations (2), (3) and (4), output power should be between 17W and 24W.

(23) Repeat operations (5) and (7), reading should be 27V or above.

(24) Check that the two-tone output waveform is undistorted.

(25) Set the POWER switch to OFF.

(26) Disconnect all test equipment.

22. OUTPUT SWITCHING CHECKS

(1) Connect the power supply lead from the CA.531 to AUDIO socket 2.

(2) Connect an RF power meter to the 1.6 to 3.0MHz BNC socket. Connect an oscilloscope in parallel.

(3) Set the synthesiser controls to 3.000MHz, the MODE switch to TUNE and the POWER switch to HIGH.

(4) Adjust the TUNE control for maximum output on the RF power meter. Link the W/B and ATU sockets using a short length of coaxial cable. Check that there is a momentary break in transmission as the connection is made, this is seen as a short break in the oscilloscope trace. This checks the operation of relays 4RLA and 4RLB.

(5) Note the output power with these sockets linked, check that it is between 16 and 20 watts.

(6) Link pins G and D on AUDIO socket 1 and check that the output power falls to the LOW level of 2.5 to 5 watts.

(7) Remove the link between pins G and D, and the W/B to ATU socket link. Connect the power meter to the W/B socket, this places a 50 ohm d.c. resistance across the W/B socket which routes the output to it and also switches the 931X to LOW power as described in Chapter 2 paragraph 10. Check that LOW power output is obtained, i.e. 2.5 to 5.0 watts.

(8) Connect the W/B socket to the RF power meter by a pi network consisting of a 10K ohm resistor from the W/B socket to earth. A 10Kohm resistor from the power meter input to earth and a 0.1uF 250V capacitor connecting the W/B output to the power meter. This routes the output to the W/B socket without switching to LOW power. Check that the observed output is greater than 17 watts.

(9) Set power switch to OFF and disconnect all test equipment.

CHAPTER 4

FAULT FINDING

INTRODUCTION

1. The information given in this chapter will, in the majority of cases, allow the fault to be localised to a stage or ancillary component with the minimum use of test equipment. When the faulty stage is determined, the faulty component can be found by checking static voltages at individual components. A table of typical voltages is given at the end of this chapter.

INITIAL PROCEDURE

2. It is advisable to commence fault finding with a battery voltage check, or, if available, to operate the equipment from the test set CA.531. The test set can be used to indicate r.f. power output.

3. The next operation should be to check the ancillary equipment such as headsets, p.t.t. switches, keys and antenna, as this equipment can receive severe handling under operational conditions. The easiest method of checking is by substituting equipment known to be functional in place of the suspect item.

4. A final check prior to internal investigation can be made by checking ancillary equipment connected in turn to both of the two audio sockets on the front panel of the manpack.

FAULT LOCATION PROCEDURE

5. If the foregoing procedure does not locate a fault then the internal circuitry of the unit must be suspected. Prior to removing the equipment from its case a deductive procedure should be adopted on the following lines.

6. Check whether the fault is in the transmit or receive circuits, or in both. If the fault is in only one circuit the common stages can be eliminated. A study of the block diagram fig.2, will show that, amongst others, this will eliminate the channel frequency input, the antenna circuit, the power supply, the 35.4 MHz input and, if a mode other than A.M. is chosen, the 1.4 MHz frequency input (this input is absent during A.M. reception). The u.s.b., l.s.b. and a.m. filters and switches can also be eliminated.

7. If, say, reception only is possible, the transmitter should be checked in all modes. The inability to transmit in any mode will eliminate the input pre-amplifier and the speech compressor circuit of the transmitter, as these are not in use during keying modes. The operation of all relays should be checked.

8. The output of the tone oscillator can be heard in the a.f. circuits during tuning, this provides a simple method of checking the tone oscillator and the receiver a.f. circuits.

9. Further transmitter checks could consist of checking whether an output is given during tuning, using the test set; if for example, an output was available during tuning but not at any other time, the diode switch 1D47 and the gate 1TR29 would need checking, followed by the modulator 1D45 and 1D46 (which is unlikely to be faulty in this particular instance) and the unbalancing circuit 1R161 and 1R162.

10. The above procedure is not intended to be exhaustive, but to illustrate how, with a few simple tests carried out without dismantling the equipment, it may be possible to determine the stage or stages that are faulty.

11. The faulty stages can now be checked by taking voltage measurements at the appropriate points listed in the Table, or by injecting a signal at the input to the suspect stage. If a signal is injected, the signal level should be as in para.14.

STATIC VOLTAGE CHECKS

12. The voltages given in the following table are typical values, and were measured with an Avometer Model 8 multimeter (20k ohm per volt) under the condition stated, with no input signal and a 24V power supply. All readings are positive with respect to ground.

TABLE OF STATIC VOLTAGES

Unless otherwise stated, readings were taken with 8.000 MHz, LSB, and HIGH POWER condition selected.

Transistor	Emitter	Base	Collector	Remarks
		Transceiver Board		
1TR1	12.0V	12.6V	24V	Receive selected
1TR2	12.6V	13.2V	23.5V	
1TR3	12.0V	12.0V	13.2V	
1TR4	3.0V	3.7V	8.3V	
1TR5	8.9V	8.3V	3.0V	
1TR6	6.35V	7.0V	10.1V	
1TR7	5.4V	6.2V	6.35V	
1TR8	2.7V	2.9V	10.0V	
1TR9	2.7V	2.9V	10.0V	
1TR10	5.6V	6.0V	11.2V	
1TR11	0.1V	0.6V	1.3V	
1TR12	0.7V	1.3V	8.4V	
1TR13	-	0.2V	10.6V	

TABLE OF STATIC VOLTAGES (Continued)

Transistor	Emitter	Base	Collector	Remarks
1TR13	0.4V	0.6V	8.0V	Receive and AM selected
1TR14	-	-	6.8V	Receive selected
1TR15	6.2V	6.9V	11.8V	
1TR16	4.5V	2.9V	10.6V	
1TR16	2.6V	3.2V	8.0V	Receive and AM selected
1TR17	-	0.65V	2.2V	Receive selected
1TR18	-	0.6V	8.2V	
1TR19	8.3V	8.8V	18.0V	
1TR20	8.3V	8.2V	-	
1TR21	18.0V	18.7V	23V	
1TR27	3.8V	4.4V	12V	
1TR28	5.5V	6.0V	12V	Transmit selected
1TR29	-	-	23.5V	
1TR30	-	0.5V	1.3V	
1TR30	0V	19V	24V	Receive selected
1TR31	2.1V	2.8V	11.0V	Transmit selected
1TR32	4.5V	5.2V	10.8V	
1TR33	4.6V	5.3V	11.0V	
1TR34	3.0V	3.7V	5.6V	
1TR35	2.6V	3.0V	12V	
1TR36	2.6V	3.0V	12V	
1TR37	21.2V	20.5V	10V	
1TR38	21.2V	20.6V	-	
1TR39	0.7V	1.2V	11.8V	
1TR40	-	0.65V	1.2V	
1TR41	4.9V	-	12V	
1TR42	4.9V	-	12V	
1TR43	4.8V	5.0V	12V	
1TR44	4.8V	5.4V	10V	
1TR45	1.4V	2.0V	10.5V	
1TR46	4.0V	4.6V	12V	
1TR47	18V	17.3V	17.5V	
1TR48	0.65V	1.2V	8.5V	
1TR49	-	0.6V	1.2V	
		P.A. Board		
TR1	0V	0.7V	23V	Transmit selected
TR2	0V	0.7V	23V	
TR3	0.44V	0.72V	23V	
TR4	0.42V	0.7V	23V	
TR5	0.2V	0.7V	23.5V	
TR6	0.26V	0.7V	23.25V	

SWITCHING AND FIXED LEVEL AUDIO BOARD

Transistor	Emitter	Base	Collector	Remarks
3TR1	0V	0.65V	8.3V	
3TR2	8.5V	8.8V	18V	
3TR3	8.5V	8.3V	0V	Tune
3TR4	24V	24V	0V	Selected
3TR5	17.5V	24V	0V	
3TR6	0V	0V	6.0V	

DYNAMIC VOLTAGE CHECKS

13. The voltages given in the following table are typical r.f. values and were measured using an electronic voltmeter. The following conditions apply: 8.000MHz and HIGH POWER selected, Mode switch to TUNE, and pressel depressed. No input signal.

TABLE OF DYNAMIC VOLTAGES

Transistor	Emitter	Base	Collector
TR1	0V	220mV	38V
TR2	0V	220mV	38V
TR3	700mV	420mV	3.9V
TR4	700mV	420mV	3.9V
TR5	360mV	1.7V	4.2V
TR6	360mV	1.7V	4.2V

RECEIVER INJECTION LEVELS

14. The r.f. levels given below should be used when injecting signals into the receiver. The levels give an a.f. output of approximately 10mW when LSB condition is selected. The AF GAIN control should be set to the 90% position, i.e. to the ninth dot from the minimum position.

TABLE OF RECEIVER INJECTION LEVELS

Test Point	Injected Level	Frequency
1TP1	2uV	Antenna frequency
1TP2	1.4uV	35.4MHz
1TP3	0.9uV	35.4MHz
1TP4	3.6uV	35.4MHz
1TP5	240mV	1.4MHz
1TP8	2.5mV	1.4MHz
1TP9	1.4mV	1.4MHz

CHAPTER 5

DISMANTLING AND RE-ASSEMBLY

INTRODUCTION

1. Dismantling and re-assembly procedures are, in general, self evident. The following instructions should be noted to prevent damage to the equipment during these procedures.

WARNING: DO NOT APPLY GREASE OR ANY FORM OF SEALING COMPOUND TO THE SEAL RETAINING GROOVES OR THE RUBBER SEALING RINGS WHEN RE-ASSEMBLING THIS EQUIPMENT.

Front Panel/Main Case Assembly/Battery Box

2. Under no circumstances should grease or any other sealing compound be used on the plastic cases or front panels for sealing purposes as this may induce stress cracks.

Pressure Testing

3. During manufacture a sealing test at an internal pressure of 2 psi (0.9 kg/cm^2) is carried out. It is not normally necessary to repeat this test. If however, a pressure test is required internal pressures greater than 10 psi (4.5 kg/cm^2) must be avoided to prevent distortion of the main case.

REMOVAL FROM, AND REPLACEMENT INTO HARNESS

4. Remove antenna, headsets etc. from the unit. Loosen the straps holding the manpack in the harness, and remove the manpack. Replacement is self evident.

REMOVAL AND REPLACEMENT OF BATTERY

5. The battery is removed by loosening two screws in the base of the battery box.

NOTE: The battery can be charged, via an audio socket, without removing it from the manpack.

REMOVAL AND REPLACEMENT OF MAIN UNIT

6. Remove sixteen screws from the front panel, and slide out the main unit until access can be gained to the power supply connections. Remove the connections and remove the main unit.

7. Prior to replacement of unit check the seal at the underside of the front panel for damage, and renew if necessary. Re-connect power supplies, slide unit into case and replace screws.

NOTE: Do not over tighten screws.

OPERATIONS ON MAIN UNIT

8. The transceiver and the synthesizer or 49 channel crystal oscillator consist of printed circuit boards fitted to each side of a metal web. Access to the boards is achieved by removing two metal covers, as follows. Remove three screws holding the two overlapped covers at the rear of the unit. Remove three screws holding the PA cover. Loosen five screws at the sides of the transceiver cover and slide the cover away from the unit. To remove the synthesizer cover remove three screws at the front panel end of the cover and the three screws holding the PA cover. Loosen five screws at the sides of the cover and slide the cover away from the unit.

PA RELAY

9. The PA relay is a plug-in unit and can easily be changed after removing the ATU relay board which clamps it in place.

KNOBS

10. It is not necessary to remove knobs unless a switch or variable component has to be changed. The knob is removed by first removing the cap at the top of the knob, then loosening the collet screw.

CHAPTER 6

LIST OF COMPONENTS

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number

TRANSCEIVER P.C.B. AND PART OF FRONT PANEL

Resistors	Ohms		Watts		
1R1	0.22	Wirewound	$2\frac{1}{2}$	10	920556
1R2	1k	Carbon film	$\frac{1}{4}$	5	925381
1R3	68	Carbon film	$\frac{1}{4}$	5	925378
1R4	10k	Carbon film	$\frac{1}{4}$	5	925386
1R5	0.47	Wirewound	$2\frac{1}{2}$	10	921114
1R6	3.3k	Carbon film	$\frac{1}{4}$	5	925383
1R7	2.7k	Carbon film	$\frac{1}{4}$	5	925749
1R8	330	Carbon film	$\frac{1}{4}$	5	925405
1R9	220	Carbon film	$\frac{1}{4}$	5	925379
1R10	220	Carbon film	$\frac{1}{4}$	5	925379
1R11	100	Carbon film	$\frac{1}{4}$	5	925404
1R12	22	Carbon film	$\frac{1}{4}$	5	925847
1R13	680	Carbon film	$\frac{1}{4}$	5	925739
1R14	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R15	6.8k	Carbon film	$\frac{1}{4}$	5	925478
1R16	220	Carbon film	$\frac{1}{4}$	5	925379
1R17	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R18	47k	Carbon film	$\frac{1}{4}$	5	925390
1R19	22k	Carbon film	$\frac{1}{4}$	5	925388
1R20	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R21	100	Carbon film	$\frac{1}{4}$	5	925404
1R22	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R23	330	Carbon film	$\frac{1}{4}$	5	925405
1R24	470	Carbon film	$\frac{1}{4}$	5	925380
1R25	470	Carbon film	$\frac{1}{4}$	5	925380
1R26	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R27	100	Carbon film	$\frac{1}{4}$	5	925404
1R28	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R29	10k	Carbon film	$\frac{1}{4}$	5	925386
1R30	220	Carbon film	$\frac{1}{4}$	5	925379

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
1R31	10	Carbon film	$\frac{1}{4}$	5	925376
1R32	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R33	470	Variable			919514
1R34	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R35	10k	Carbon film	$\frac{1}{4}$	5	925386
1R36	1k	Carbon film	$\frac{1}{4}$	5	925381
1R37	330	Carbon film	$\frac{1}{4}$	5	925405
1R38	10k	Carbon film	$\frac{1}{4}$	5	925386
1R39	100	Carbon film	$\frac{1}{4}$	5	925404
1R40	3.3k	Carbon film	$\frac{1}{4}$	5	925383
1R41	22k	Carbon film	$\frac{1}{4}$	5	925388
1R42	33k	Carbon film	$\frac{1}{4}$	5	925389
1R43	470	Carbon film	$\frac{1}{4}$	5	925380
1R44	220	Carbon film	$\frac{1}{4}$	5	925379
1R45	10k	Carbon film	$\frac{1}{4}$	5	925386
1R46	3.3k	Carbon film	$\frac{1}{4}$	5	925383
1R47	10k	Carbon film	$\frac{1}{4}$	5	925386
1R48	6.8k	Carbon film	$\frac{1}{4}$	5	925478
1R49	10	Carbon film	$\frac{1}{4}$	5	925376
1R50	1k	Carbon film	$\frac{1}{4}$	5	925381
1R51	10k	Carbon film	$\frac{1}{4}$	5	925386
1R52	47k	Carbon film	$\frac{1}{4}$	5	925390
1R53	10k	Carbon film	$\frac{1}{4}$	5	925386
1R54	6.8k	Carbon film	$\frac{1}{4}$	5	925478
1R55	5k	Variable, log			
1R56	Not Used				
1R57	3.9k	Carbon film	$\frac{1}{4}$	5	925477
1R58	2.7k	Carbon film	$\frac{1}{4}$	5	925749
1R59	33k	Carbon film	$\frac{1}{4}$	5	925389
1R60	10k	Carbon film	$\frac{1}{4}$	5	925386
1R61	100	Carbon film	$\frac{1}{4}$	5	925404
1R62	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R63	68k	Carbon film	$\frac{1}{4}$	5	925391
1R64	12k	Carbon film	$\frac{1}{4}$	5	925850
1R65	12k	Carbon film	$\frac{1}{4}$	5	925850

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
1R66	220k	Carbon film	$\frac{1}{4}$	5	925399
1R67	220k	Carbon film	$\frac{1}{4}$	5	925399
1R68	10k	Carbon film	$\frac{1}{4}$	5	925386
1R69	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R70	47k	Carbon film	$\frac{1}{4}$	5	925390
1R71	47k	Carbon film	$\frac{1}{4}$	5	925390
1R72	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R73	47k	Carbon film	$\frac{1}{4}$	5	925390
1R74	10k	Carbon film	$\frac{1}{4}$	5	925386
1R75	33k	Carbon film	$\frac{1}{4}$	5	925389
1R76	47	Carbon film	$\frac{1}{4}$	5	925377
1R77	180	Carbon film	$\frac{1}{4}$	5	925738
1R78	3.3k	Carbon film	$\frac{1}{4}$	5	925383
1R79	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R80	10	Carbon film	$\frac{1}{4}$	5	925376
1R81	100	Carbon film	$\frac{1}{4}$	5	925404
1R82	100	Carbon film	$\frac{1}{4}$	5	925404
1R83	1.5k	Carbon film	$\frac{1}{4}$	5	925402
1R84	56	Carbon film	$\frac{1}{4}$	5	927473
1R85	680	Carbon film	$\frac{1}{4}$	5	925739
1R86	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R87	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R88	100	Carbon film	$\frac{1}{4}$	5	925404
1R89	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R90	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R91	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R92	1k	Carbon film	$\frac{1}{4}$	5	925381
1R93	3.3k	Carbon film	$\frac{1}{4}$	5	925383
1R94	6.8k	Carbon film	$\frac{1}{4}$	5	925478
1R95	6.8k	Carbon film	$\frac{1}{4}$	5	925478
1R96	1k	Carbon film	$\frac{1}{4}$	5	925381
1R97	1k	Carbon film	$\frac{1}{4}$	5	925381
1R98	330	Carbon film	$\frac{1}{4}$	5	925405
1R99	1k	Carbon film	$\frac{1}{4}$	5	925381
1R100	1k	Carbon film	$\frac{1}{4}$	5	925381

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
1R101	3.3k	Carbon film	1/4	5	925383
1R102	150	Fixed	1/4	5	922361
1R103	680	Carbon film	1/4	5	925739
1R104	150	Carbon film	1/4	5	928209
1R105	10	Carbon film	1/4	5	925376
1R106	27	Carbon film	1/4	5	928010
1R107	47	Carbon film	1/4	5	925377
1R108	2.7k	Carbon film	1/4	5	925749
1R109	2.7k	Carbon film	1/4	5	925749
1R110	15	Carbon film	1/4	5	928009
1R111	270	Carbon film	1/4	5	927523
1R112	100	Carbon film	1/4	5	925404
1R113	4.7k	Carbon film	1/4	5	925384
1R114	4.7k	Carbon film	1/4	5	925384
1R115	12	Carbon film	1/4	5	928543
1R116	820	Carbon film	1/4	5	926550
1R117	220	Carbon film	1/4	5	925379
1R118	47	Carbon film	1/4	5	925377
1R119	2.7k	Carbon film	1/4	5	925749
1R120	10	Carbon film	1/4	5	925376
1R121	1.8k	Carbon film	1/4	5	925397
1R122	22	Carbon film	1/4	5	925847
1R123	150	Carbon film	1/4	5	925403
1R124	47	Carbon film	1/4	5	925377
1R125	330	Carbon film	1/4	5	925405
1R126	330	Carbon film	1/4	5	925405
1R127	10	Carbon film	1/4	5	925376
1R128	10	Carbon film	1/4	5	925376
1R129	2.2k	Carbon film	1/4	5	925382
1R130	1.8k	Carbon film	1/4	5	925397
1R131	3.3k	Carbon film	1/4	5	925383
1R132	3.3k	Carbon film	1/4	5	925383
1R133	2.2k	Carbon film	1/4	5	925382
1R134	1.8k	Carbon film	1/4	5	925397
*1R135	120	Carbon film	1/4	5	926548

*1R135 and 1R137. Value fitted maybe 100 ohms, part number 925404.

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
1R136	6.8k	Carbon film	$\frac{1}{4}$	5	925478
*1R137	120	Carbon film	$\frac{1}{4}$	5	926548
1R138	6.8k	Carbon film	$\frac{1}{4}$	5	925478
1R139	3.3k	Carbon film	$\frac{1}{4}$	5	925383
1R140	1k	Variable			919516
1R141	3.6k	Carbon film	$\frac{1}{4}$	5	928011
1R142	4.7k	Variable			919511
1R143	1.8k	Carbon film	$\frac{1}{4}$	5	925397
1R144	82	Carbon film	$\frac{1}{4}$	5	925751
1R145	390	Carbon film	$\frac{1}{4}$	5	926185
1R146	4.7k	Variable			919511
1R147	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R148	100	Carbon film	$\frac{1}{4}$	5	925404
1R149	470k	Carbon film	$\frac{1}{4}$	5	925393
1R150	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R151	100	Carbon film	$\frac{1}{4}$	5	925404
1R152	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R153	1k	Carbon film	$\frac{1}{4}$	5	925381
1R154	22k	Carbon film	$\frac{1}{4}$	5	925388
1R155	Not Used				
1R156	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R157	1k	Carbon film	$\frac{1}{4}$	5	925381
1R158	150	Carbon film	$\frac{1}{4}$	5	928209
1R159	47	Carbon film	$\frac{1}{4}$	5	925377
1R160	47	Carbon film	$\frac{1}{4}$	5	925377
1R161	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R162	1k	Variable			919516
1R163	2.2k	Variable			919974
1R164	1k	Carbon film	$\frac{1}{4}$	5	925381
1R165	330	Carbon film	$\frac{1}{4}$	5	925405
1R166	330	Carbon film	$\frac{1}{4}$	5	925405
1R167	10k	Carbon film	$\frac{1}{4}$	5	925386
1R168	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R169	56	Carbon film	$\frac{1}{4}$	5	927473
1R170	2.2k	Carbon film	$\frac{1}{4}$	5	925382

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
1R171	2.7k	Carbon film	$\frac{1}{4}$	5	925749
1R172	47k	Carbon film	$\frac{1}{4}$	5	925390
1R173	33k	Carbon film	$\frac{1}{4}$	5	925389
1R174	560k	Carbon film	$\frac{1}{4}$	5	927578
1R175	220k	Carbon film	$\frac{1}{4}$	5	925399
1R176	15k	Carbon film	$\frac{1}{4}$	5	925387
1R177	1.5k	Carbon film	$\frac{1}{4}$	5	925402
1R178	220k	Carbon film	$\frac{1}{4}$	5	925399
1R179	2.7k	Carbon film	$\frac{1}{4}$	5	925749
1R180	47	Carbon film	$\frac{1}{4}$	5	925377
1R181	150	Carbon film	$\frac{1}{4}$	5	928209
1R182	2.2k	Carbon film	$\frac{1}{4}$	5	925382
1R183	12k	Carbon film	$\frac{1}{4}$	5	925850
1R184	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R185	4.7k	Carbon film	$\frac{1}{4}$	5	925384
1R186	18k	Carbon film	$\frac{1}{4}$	5	925479
1R187	1.5k	Carbon film	$\frac{1}{4}$	5	925402
1R188	1.5k	Carbon film	$\frac{1}{4}$	5	925402
1R189	1.5k	Carbon film	$\frac{1}{4}$	5	925402
1R190	1.5k	Carbon film	$\frac{1}{4}$	5	925402
Capacitors	F				
1C1	4.7μ	Tantalum	35	20	914026
1C2	.01μ	Disc ceramic	250	+100-0	927831
1C3	.01μ	Disc ceramic	250	+100-0	927831
1C4	.01μ	Disc ceramic	250	+100-0	927831
1C5	.01μ	Disc ceramic	250	+100-0	927831
1C6	1000p	Disc ceramic	500	+40-20	920679
1C7	1000p	Disc ceramic	500	+40-20	920679
1C8	1000p	Disc ceramic	500	+40-20	920679
1C9	1000p	Disc ceramic	500	+40-20	920679
1C10	33p	Polystyrene	63	1p	920561
1C11	1000p	Disc ceramic	500	+40-20	920679
1C12	1000p	Disc ceramic	500	+40-20	920679
1C13	1000p	Disc ceramic	500	+40-20	920679
1C14	.01μ	Disc ceramic	250	+100-0	927831
1C15	1000p	Disc ceramic	500	+40-20	920679

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
	F		V		
1C16	33p	Polystyrene	63	1p	920561
1C17	33p	Polystyrene	63	1p	920561
1C18	.01μ	Fixed	63	+20	915173
1C19	.01μ	Fixed	63	±20	915173
1C20	33p	Polystyrene	63	1p	920561
1C21	.01μ	Disc ceramic	250	+100-0	927831
1C22	.01μ	Disc ceramic	250	+100-0	927831
1C23	0.47μ	Tantalum	35	±20	915168
1C24	5600p	Polystyrene	30	2½	918700
1C25	1000p	Polystyrene	30	2½	908583
1C26	.01μ	Fixed	63	±20	915173
1C27	.01μ	Disc ceramic	250	+100-0	927831
1C28	.01μ	Disc ceramic	250	+100-0	927831
1C29	4.7μ	Tantalum	35	±20	914026
1C30	.01μ	Disc ceramic	250	+100-0	927831
1C31	.01μ	Disc ceramic	250	+100-0	927831
1C32	33μ	Tantalum	10	20	920559
1C33	22μ	Tantalum	15	20	915169
1C34	33μ	Tantalum	10	20	920559
1C35		Not Used			
1C36	.01μ	Disc ceramic	250	+100-0	927831
1C37	4.7μ	Tantalum	35	20	914026
1C38	.01μ	Disc ceramic	250	+100-0	927831
1C39	2200p	Polystyrene	30	2½	908451
1C40	.01μ	Disc ceramic	250	+100-0	927831
1C41	0.47μ	Tantalum	35	20	915168
1C42	1000p	Polystyrene	30	2½	908583
1C43	4.7μ	Tantalum	35	20	914026
1C44	0.47μ	Tantalum	35	20	915168
1C45	.01μ	Disc ceramic	250	+100-0	927831
1C46	.01μ	Disc ceramic	250	+100-0	927831
1C47	.01μ	Disc ceramic	250	+100-0	927831
1C48	.01μ	Disc ceramic	250	+100-0	927831
1C49	150μ	Electrolytic	25	+50-10	921748
1C50	4.7μ	Tantalum	35	20	914026

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
	F		V		
1C51	1000p	Disc ceramic	500	+40-20	920679
1C52	22μ	Tantalum	15	20	915169
1C53	47μ	Electrolytic	25	+50-20	921525
1C54	.01μ	Disc ceramic	250	+100-0	927831
1C55	.01μ	Disc ceramic	250	+100-0	927831
1C56	.01μ	Disc ceramic	250	+100-0	927831
1C57	.01μ	Plastic Film	100	±20	912803
1C58	.01μ	Plastic Film	100	±20	912803
1C59	.01μ	Plastic Film	100	±20	912803
1C60	.01μ	Disc ceramic	250	+100-0	927831
1C61	1μ	Tantalum	35	20	919635
1C62	1μ	Tantalum	35	20	919635
1C63	4.7μ	Tantalum	35	20	914026
1C64	.01μ	Disc ceramic	250	+100-0	927831
1C65	.01μ	Disc ceramic	250	+100-0	927831
1C66	1000p	Disc ceramic	500	+40-20	920679
1C67	1000p	Disc ceramic	500	+40-20	920679
1C68	1000p	Disc ceramic	500	+40-20	920679
1C69	1000p	Disc ceramic	500	+40-20	920679
1C70	.01μ	Disc ceramic	250	+100-0	927831
1C71	.01μ	Disc ceramic	250	+100-0	927831
1C72	.01μ	Disc ceramic	250	+100-0	927831
1C73	.01μ	Disc ceramic	250	+100-0	927831
1C74	680p	Polystyrene	30	$2\frac{1}{2}$	908455
1C75	680p	Polystyrene	30	$2\frac{1}{2}$	908455
1C76	.01μ	Disc ceramic	250	+40-20	916834
1C77	68p	Polystyrene	30	$2\frac{1}{2}$	908321
1C78	.01μ	Disc ceramic	250	+100-0	927831
1C79	.01μ	Disc ceramic	250	+100-0	927831
1C80	.01μ	Disc ceramic	250	+100-0	927831
1C81	.01μ	Disc ceramic	250	+100-0	927831
1C82	.01μ	Disc ceramic	250	+100-0	927831
1C83	.01μ	Disc ceramic	250	+100-0	927831
1C84	0.47μ	Tantalum	35	20	915168
1C85	4.7μ	Tantalum	35	20	914026

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
	F		V		
1C86	0.47μ	Polycarbonate	100	10	915172
1C87	0.47μ	Polycarbonate	100	10	915172
1C88	4.7μ	Tantalum	35	20	914026
1C89	47μ	Electrolytic	63	+20-10	921543
1C90	.01μ	Disc ceramic	250	+100-0	927831
1C91	.01μ	Disc ceramic	250	+100-0	927831
1C92	.01μ	Disc ceramic	250	+100-0	927831
1C93	.01μ	Disc ceramic	250	+100-0	927831
1C94	.01μ	Disc ceramic	250	+100-0	927831
1C95	.01μ	Disc ceramic	250	+100-0	927831
1C96	.1μ	Disc ceramic	18	+40-20	920567
1C97	.01μ	Disc ceramic	250	+100-0	927831
1C98	.01μ	Disc ceramic	250	+100-0	927831
1C99	.1μ	Disc ceramic	30	+40-20	906675
1C100	.01μ	Disc ceramic	250	+100-0	927831
1C101	.01μ	Disc ceramic	250	+100-0	927831
1C102	.1μ	Disc ceramic	30	+40-20	906675
1C103	1000p	Disc ceramic	500	+40-20	920679
1C104	.01μ	Disc ceramic	250	+100-0	927831
1C105	1000p	Disc ceramic	500	+40-20	920679
1C106	1000p	Disc ceramic	500	+40-20	920679
1C107	.01μ	Disc ceramic	250	+100-0	927831
1C108	.01μ	Fixed	63	±20	915173
1C109	.01μ	Fixed	63	±20	915173
1C110	.01μ	Disc ceramic	250	+100-0	927831
1C111	.01μ	Disc ceramic	250	+100-0	927831
1C112	.01μ	Disc ceramic	250	+100-0	927831
1C113	.01μ	Disc ceramic	250	+100-0	927831
1C114	.01μ	Disc ceramic	250	+100-0	927831
1C115	.01μ	Disc ceramic	250	+100-0	927831
1C116	.01μ	Disc ceramic	250	+100-0	927831
1C117	.01μ	Disc ceramic	250	+100-0	927831
1C118	4.7μ	Tantalum	35	20	914026
1C119	.01μ	Disc ceramic	250	+100-0	927831
1C120	.01μ	Disc ceramic	250	+100-0	927831

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
	F		V		
1C121	33µ	Tantalum	10	20	920559
1C122	33µ	Tantalum	10	20	920559
1C123	.01µ	Disc ceramic	250	+100-0	927831
1C124	.01µ	Disc ceramic	250	+100-0	927831
1C125	4.7µ	Tantalum	35	20	914026
1C126	0.6-5p	Varible			920563
1C127	4.7p	Ceramic	200	0.5p	920560
1C128	.01µ	Disc ceramic	250	+100-0	927831
1C129	.01µ	Disc ceramic	250	+100-0	927831
1C130	.01µ	Disc ceramic	250	+100-0	927831
1C131	.01µ	Disc ceramic	250	+100-0	927831
1C132	0.47µ	Tantalum	35	20	915168
1C133	4.7µ	Tantalum	35	20	914026
1C134	4.7µ	Tantalum	35	20	914026
1C135	1000p	Disc ceramic	250	+40-20	920679
1C136	0.47µ	Tantalum	35	20	915168
1C137	4.7µ	Tantalum	35	20	914026
1C138	1000p	Polystyrene	30	2½	908583
1C139	2200p	Polystyrene	30	2½	908451
1C140	22µ	Tantalum	15	20	915169
1C141	4.7µ	Tantalum	35	20	914026
1C142	.01µ	Disc ceramic	250	+100-0	927831
1C143	0.47µ	Tantalum	35	20	915168
1C144	.01µ	Disc ceramic	250	+100-0	927831
1C145	.01µ	Disc ceramic	250	+100-0	927831
1C146	.01µ	Disc ceramic	250	+100-0	927831
1C147	.01µ	Disc ceramic	250	+100-0	927831
1C148	.01µ	Disc ceramic	250	+100-0	927831
1C149	.01µ	Disc ceramic	250	+100-0	927831
1C150	.01µ	Disc ceramic	250	+100-0	927831
1C151	.01µ	Disc ceramic	250	+100-0	927831
1C152	.01µ	Disc ceramic	250	+100-0	927831
1C153	1000p	lead through		+80-20	907011
1C154	1000p	lead through		+80-20	907011
1C155	4.7µ	Tantalum	35	20	910274
1C156	.01µ	Ceramic	63	20	915173
1C157	.01µ	Ceramic	63	20	915173
1C158	4.7µ	Tantalum	35	20	914026
1C159	.01µ	Disc ceramic	250	+100-0	927831
1C160	.01µ	Disc ceramic	250	+100-0	927831
1C161	.01µ	Disc ceramic	250	+100-0	927831

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
Inductors					
1L1	1μH	Choke		5	920572
1L2	15μH	Choke		10	915850
1L3	100μH	Choke		5	919471
1L4	1μH	Choke		5	920572
Transformers					
1T1					710103
1T2					710104
1T3					710115
1T4					710105
1T5					710112
1T6					710109
1T7					710112
1T8					710109
1T9					710025
1T10					710109
1T11					710110
1T12					710110
1T13					710111
1T14					710108
1T15					710107
1T16					710106
Diodes					
1D1		IN4002			911460
1D2		IN4002			911460
1D3		Zener BSY93C33R			921436
1D4		BAW62			918982
1D5		Zener BZY88C13			916328
1D6		BAW 62			918982
1D7		BAW 62			918982
1D8		BAW62			918982
1D9		BAW62			918982
1D10		BAW 62			918982
1D11		BAW62			918982
1D12		BAW62			918982
1D13		BZY886V8			914064
1D14		BAW62			918982
1D15		BAW62			918982

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
1D16		BAW62			918982
1D17		BZY88C18			915920
1D18		BAW62			918982
1D19		BAW62			918982
1D20		BAW62			918982
1D21		BAW62			918982
1D22		BAW62			918982
1D23		BAW62			918982
1D24		BAW62			918982
1D25		BAW62			918982
1D26		FH1100			918926
1D27		FH1100			918926
1D28		FH1100			918926
1D29		FH1100			918926
1D30		BAW62			918982
1D31		BAW62			918982
1D32		BAW62			918982
1D33		BAW62			918982
1D34		BAW62			918982
1D35		BAW62			918982
1D36		BAW62			918982
1D37		BAW62			918982
1D38		BAW62			918982
1D39		BAW62			918982
1D40		BAW62			918982
1D41		BAW62			918982
1D42		BZY886V8			914064
1D43		BAW62			918982
1D44		BAW62			918982
1D45		BAW62			918982
1D46		BAW62			918982
1D47		BAW62			918982
1D48		BAW62			918982
1D49		BAW62			918982
1D50		BAW62			918982
1D51		BAW62			918982
1D52		BAW62			918982

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
Transistors					
1T1		2N3054			911951
1T2		BFY51			908753
1T3		ZTX237			923171
1T4		2N4996			916493
1T5		2N3906			914047
1T6		TIS62			924011
1T7		TIS62			924011
1T8		TIS62			924011
1T9		TIS62			924011
1T10		ZTX237			923171
1T11		ZTX237			923171
1T12		ZTX237			923171
1T13		ZTX237			923171
1T14		ZTX237			923171
1T15		ZTX237			923171
1T16		ZTX237			923171
1T17		ZTX237			923171
1T18		ZTX237			923171
1T19		ZTX3705			923170
1T20		2N5448			915118
1T21		ZTX3705			923170
1T22		ZTX237			923171
1T23		ZTX237			923171
1T24		ZTX237			923171
1T25		ZTX237			923171
1T26		ZTX237			923171
1T27		MPS3563			920909
1T28		ZTX237			923171
1T29		ZTX237			923171
1T30		ZTX212			923172
1T31		2N3866			917219
1T32		TIS62			924011
1T33		TIS62			924011
1T34		2N4996			916493
1T35		TIS62			924011

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
1T36		TIS62			924011
1T37		ZTX212			923172
1T38		ZTX212			923172
1T39		ZTX237			923171
1T40		ZTX237			923171
1T41		ZTX237			923171
1T42		ZTX237			923171
1T43		ZTX237			923171
1T44		ZTX237			923171
1T45		ZTX237			923171
1T46		ZTX237			923171
1T47		ZTX212			923172
1T48		2N3707			910839
1T49		2N3707			910839
1T50		ZTX237			923171
Switches					
1SA1		Power switch			711216
1SB1		Mode switch			711215
Relays					
1RLA					920577
1RLB					920577
Sockets					
1SK1		7-way			923849
1SK2		7-way			923849
Miscellaneous					
1FS1 (and spare)		Fuse Line 7A			910699
		Fuseholder			900412
1FL1		Filter Lowpass			711117
1FL2		Filter 35.4 MHz			711118
1FL3		Filter USB			711120
1FL4		Filter LSB			711119
1FL5		Filter 37-65.4 MHz			711121
		Knob (mode, power, a.f. gain)			921002
		Cap (for knob 921002)			921003
		Knob (a.t.u.)			915125

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number

P.A. BOARD AND PART OF FRONT PANEL

Resistors	Ohms		Watts		
2R1		Not used			
2R2	56k	Carbon	1/3	5	924701
2R3	150k	Carbon	1/3	5	924704
2R4	1k	Carbon	1/3	5	924680
2R5	1k	Wirewound	$2\frac{1}{2}$	5	913626
2R6	220	Carbon	1/3	5	924673
2R7	220	Carbon	1/3	5	924673
2R8	220	Wirewound	$2\frac{1}{2}$	5	913604
2R9	220	Wirewound	$2\frac{1}{2}$	5	913604
2R10	220	Carbon	1/3	5	924673
2R11	10	Carbon	1/3	5	924660
2R12	10	Carbon	1/3	5	924660
2R13	220	Carbon	1/3	5	924673
2R14	470	Carbon	1/3	5	924677
2R15	470	Carbon	1/3	5	924677
2R16	10	Carbon	1/3	5	924660
2R17	10	Carbon	1/3	5	924660
2R18	10	Carbon	1/3	5	924660
2R19	10	Carbon	1/3	5	924660
2R20	820	Carbon	1/3	5	924679
2R21	820	Carbon	1/3	5	924679
2R22	10	Carbon	1/3	5	924660
2R23	10	Carbon	1/3	5	924660
2R24	10	Carbon	1/3	5	924660
2R25	10	Carbon	1/3	5	924660
2R26	1k	Carbon	1/3	5	924680
2R27	1k	Carbon	1/3	5	924680
2R28	8.2k	Carbon	1/3	5	924692
2R29	2.2k	Carbon	1/3	5	924684
2R30	47k	Carbon	1/3	5	924700

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
2R31	470	Carbon	1/3	5	924677
2R32	470	Carbon	1/3	5	924677
2R33	10k	Carbon	1/3	5	924693
2R34	2.2k	Carbon	1/3	5	924684
2R35	2.2k	Carbon	1/3	5	924684
2R36	15k	Carbon	1/3	5	924695
2R37	2.2k	Carbon	1/3	5	924684
2R38	1.2k	Carbon	1/3	5	924681
2R39	470	Carbon	1/3	5	924677
2R40	470	Carbon	1/3	5	924677
2R41	220	Carbon	1/4	10	924673
2R42		Not used			
2R43		Not used			
2R44	1			5	923887
2R45	1			5	923887
Capacitors	F		Volts		
2C1					915173
2C2	.01µ	Fixed	63	20	915173
2C3	100p	Fixed	4k	10	921968
2C4	0.1µ	Polycarbonate	100	10	920566
2C5	0.1µ	Polycarbonate	100	10	920566
2C6	0.1µ	Polycarbonate	100	10	920566
2C7	0.1µ	Polycarbonate	100	10	920566
2C8		Not used			
2C9		Not used			
2C10		Not used			
2C11	66p	Fixed	4k	10	923614
2C12		Not used			
2C13	2.2p	Ceramic	200	.5p	908829
2C14	2p	Fixed	4k	.5p	920558
2C15	.01µ	Fixed	63	20	915173
2C16	.01µ	Fixed	63	20	915173
2C17	47p	Polystyrene	30	2.5	908318
2C18	47p	Polystyrene	30	2.5	908318
2C19	.01µ	Fixed	63	20	915173
2C20	.01µ	Fixed	63	20	915173
2C21	.01µ	Fixed	63	20	915173
2C22	.01µ	Fixed	63	20	915173
2C23	.01µ	Fixed	63		922402

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
Inductors					
2L1	1μH	Choke			915849
2L2	1μH	Choke			915849
2L3		A.T.U. Assembly			701050
2L4	1mH	Choke		5	920572
Transformers					
2T1	Not used				
2T2					710098
2T3					710099
2T4					710097
2T5					710096
2T6					710095
Diodes					
2D1		Not used			
2D2		BAW62			918982
2D3		1N4997			917775
2D4		1N4002			911460
2D5		1N4002			911460
2D6		1N4002			911460
2D7		1N4002			911460
2D8		BAW62			918982
2D9		BAW62			918982
2D10		BAW62			918982
2D11		BAW62			918982
2D12		BAW62			918982
Transistors					
2TR1*					711356
2TR2*					711356

* 2TR1 and 2TR2 are supplied as a matched pair.

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
2TR3		2N3553			916730
2TR4		2N3533			916730
2TR5		2N3866			917219
2TR6		2N3866			917219
2TR7		ZTX237			923171
2TR8		ZTX3703			923169
2TR9		BCW25			919124
2TR10		ZTX237			923171
2TR11		ZTX3703			923169
Relays					
2RLA					909880
Sockets					
2SK1		Power supply +ve			920579
2SK2		Power supply -ve			920578
2SK3		Whip antenna (Part of A.T.U., see 2L3)			
2SK4		1.6-3 MHz			905449
2SK5		3-30 MHz			905449
2SK6		W/B			905449
2SK7		ATU			905449
Miscellaneous					
2ME1		Meter (complete with light emitting diodes)			711131
2X1		Ferrite bead FX1115			900461
2X2		Ferrite bead FX1115			900461
2X3		Ferrite bead FX1115			900461
2X4		Ferrite bead FX1115			900461
		'O' ring, ATU drive shaft			909916
		'O' ring, 5.1mm K/D whip socket			920581
		'O' ring, 21.6 mm I/D a.t.u.			920628
		'O' ring, 13.6 mm I/D a.t.u.			920629

Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number

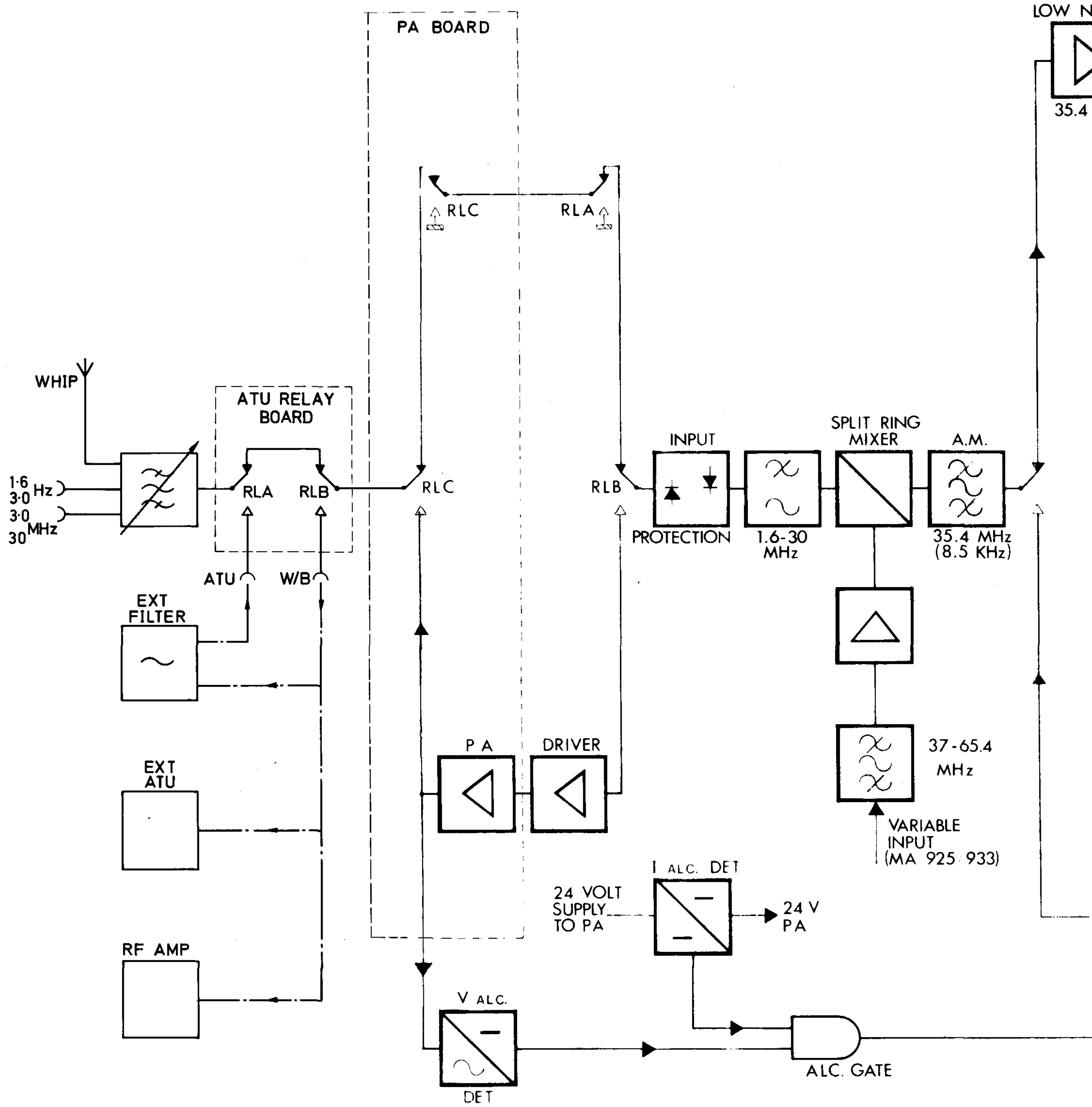
SWITCHING AND FIXED LEVEL AUDIO AMPLIFIER BOARD (Fig. 8)

Resistors			W		
3R1	22k	Variable preset			919517
3R2	33k	Carbon Film	1/3	5	924699
3R3	2.7k	Carbon Film	1/3	5	925200
3R4	4.7k	Carbon Film	1/3	5	924689
3R5	4.7k	Carbon Film	1/3	5	924689
3R6	4.7k	Carbon Film	1/3	5	924689
3R7	4.7k	Carbon Film	1/3	5	924689
3R8	4.7k	Carbon Film	1/3	5	924689
3R9	1k				
3R10	4.7k	Carbon Film	1/3	5	924689
3R11	4.7k	Carbon Film	1/3	5	924689
3R12	10k				
Capacitors					
3C1	47μF	Tantalum	35V	20	914026
3C2	.01μF	Ceramic	250V	-20+40	916187
3C3	.001μF	Ceramic	500V	-20+40	920679
3C4	22μF	Tantalum	15V	20	915169
3C5	22μF	Tantalum	15V	20	915169
3C6	.01 μF	Ceramic	250V	-20+40	916187
3C7	.0μF	Ceramic	250V	-20+40	916187
Inductors					
3L1	1mH	RF Choke			
Diodes					
3D1		BAW62 Silicon			918982
3D2		BAW62 Silicon			918982
3D3		BAW62 Silicon			918982
3D4		BAW62 Silicon			918982

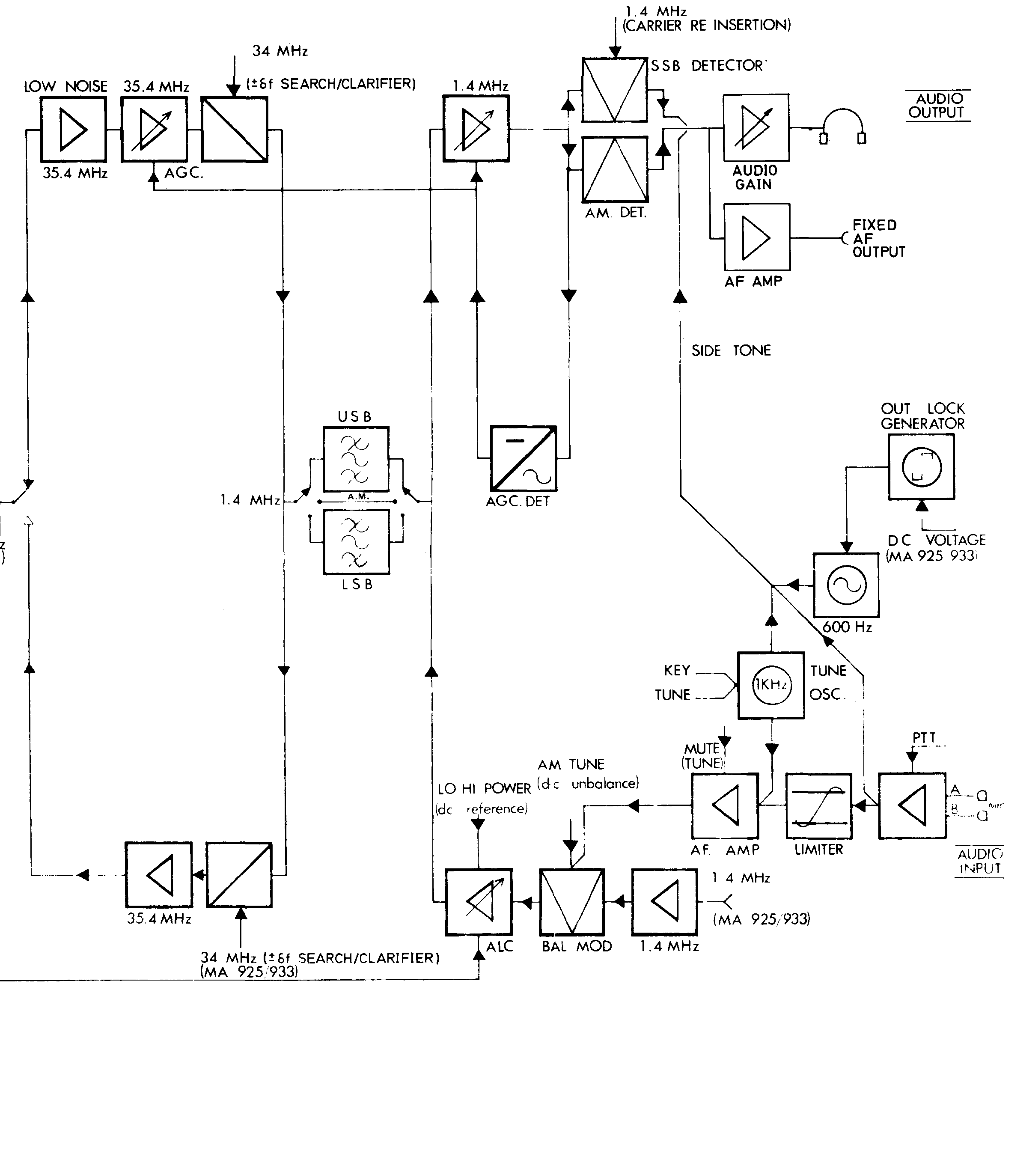
Cct. Ref.	Value	Description	Rat	Tol %	Racal Part Number
Transistors					
3TR1		ZTX237 NPN			923171
3TR2		2N 540 NPN			915133
3TR3		2N 5448 PNP			915118
3TR4		ZTX212 PNP			923172
3TR5		ZTX212 PNP			923172
3TR6		ZTX237 NPN			923171

ATU RELAY BOARD (Fig. 10)

4R1	100	Composition	1/3W	5	922328
4C1	.01	Ceramic	250V	+40-20	916187
4C2	100p	Ceramic	500V	10	917417
4C3	0.1	Polyester	100V	10	920566
4C4	0.1	Polyester	100V	10	920566
4C5	.01	Ceramic	250V	+40-20	916187
4L1	100µH	Choke			900760
4T1		Coil Assembly			CT 710008
4D1		Silicon diode 1N4149			914898
RLA		Relay, 12V			920577
RLB		Relay, 12V			920577

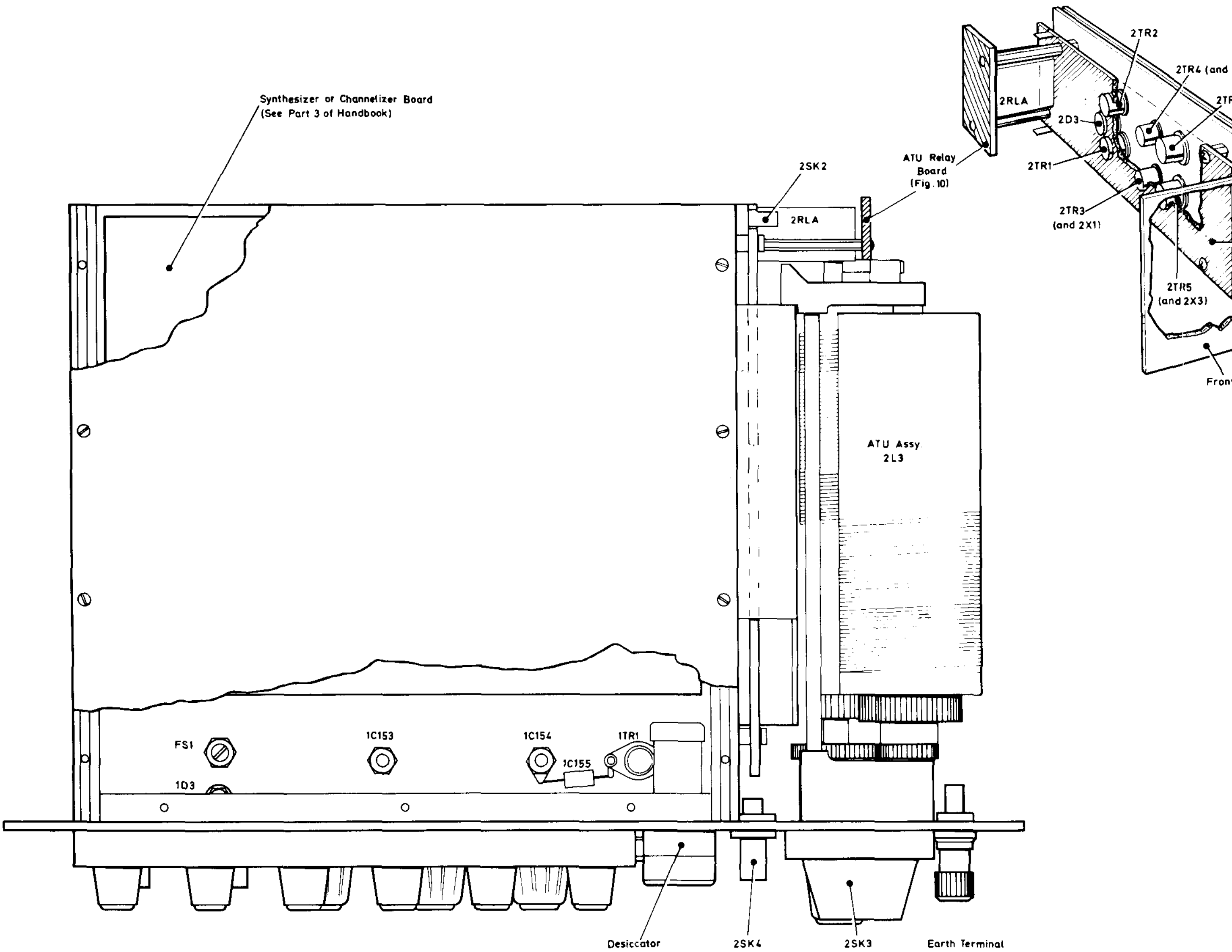

LOW N
35.4
PA BOARD
RLC
RLA
WHIP
ATU RELAY BOARD
1·6
3·0 Hz
3·0
30 MHz
RLA
RLB
RLC
RLB
INPUT
PROTECTION
1.6-30 MHz
SPLIT RING MIXER
A.M.
35.4 MHz (8.5 KHz)
ATU
W/B
EXT FILTER
37-65.4 MHz
VARIABLE INPUT (MA 925 933)
EXT ATU
P A
DRIVER
I ALC. DET
24 VOLT SUPPLY TO PA
24 V PA
RF AMP
V ALC.
DET
ALC. GATE

Block



Block Diagram: Transceiver MA.930X

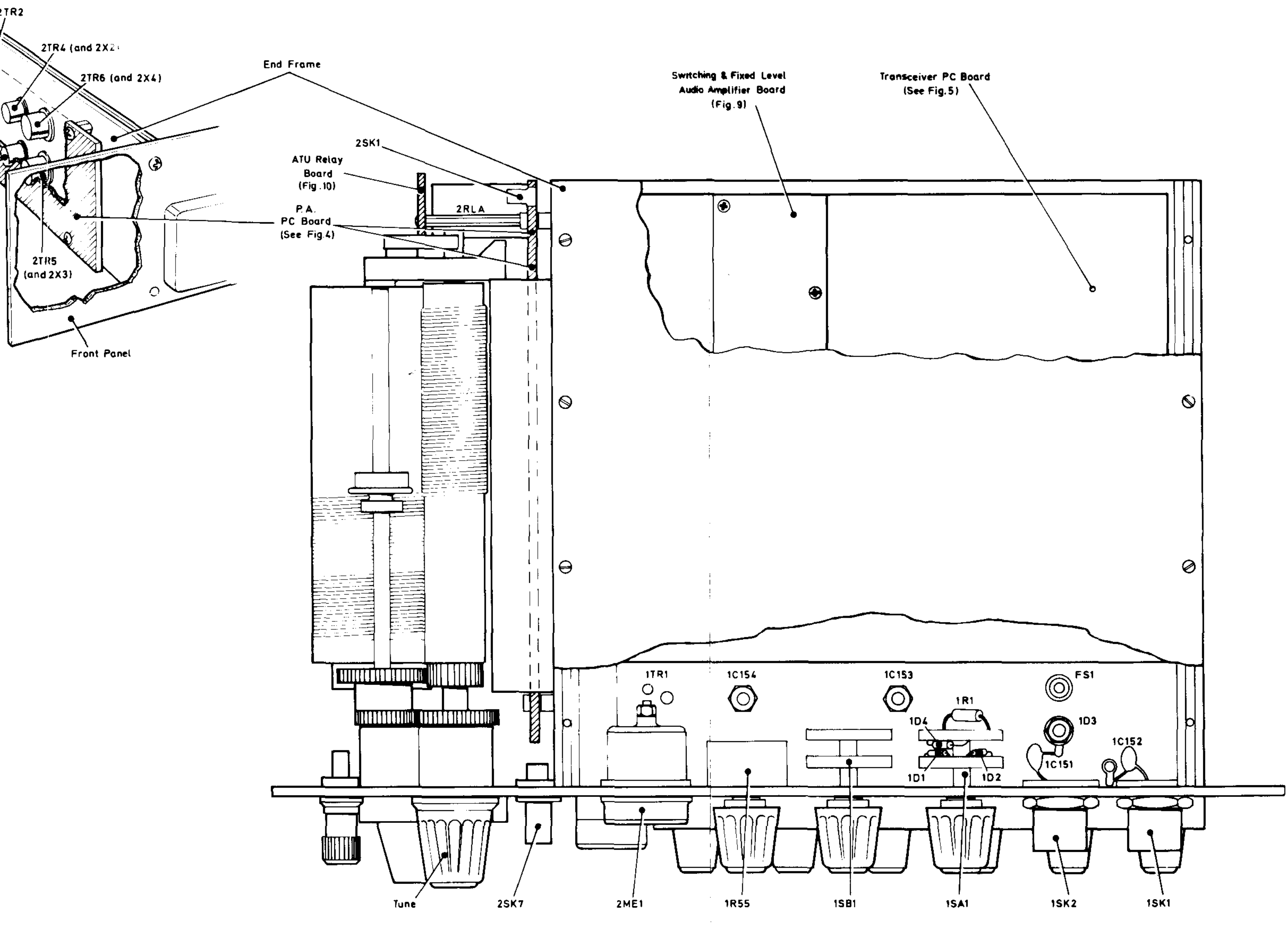
Fig. 1



TOP VIEW

WOH60RS
Part 2

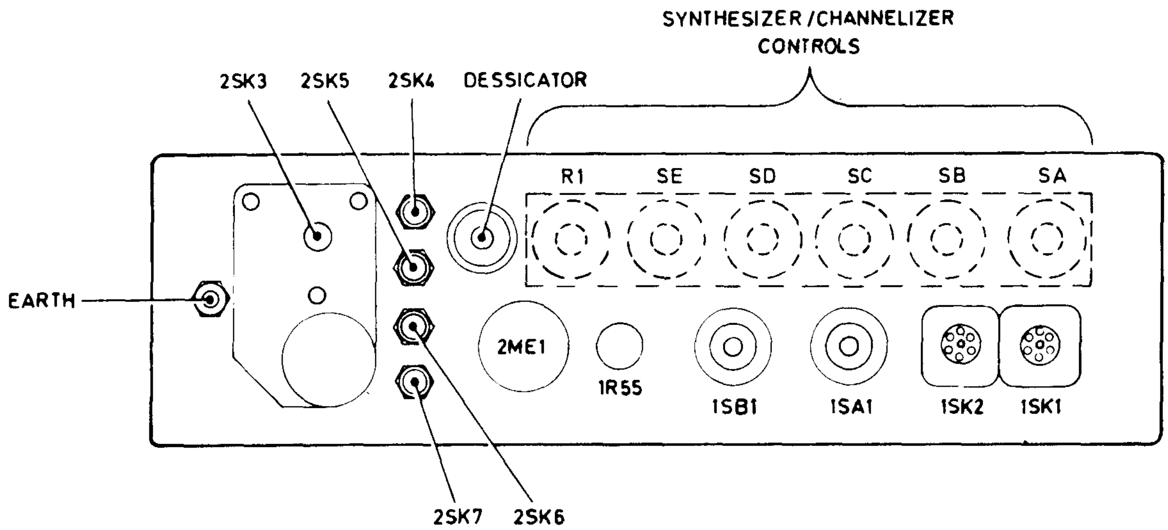
Component Layout : Tran



UNDERSIDE VIEW

t : Transceiver MA930X

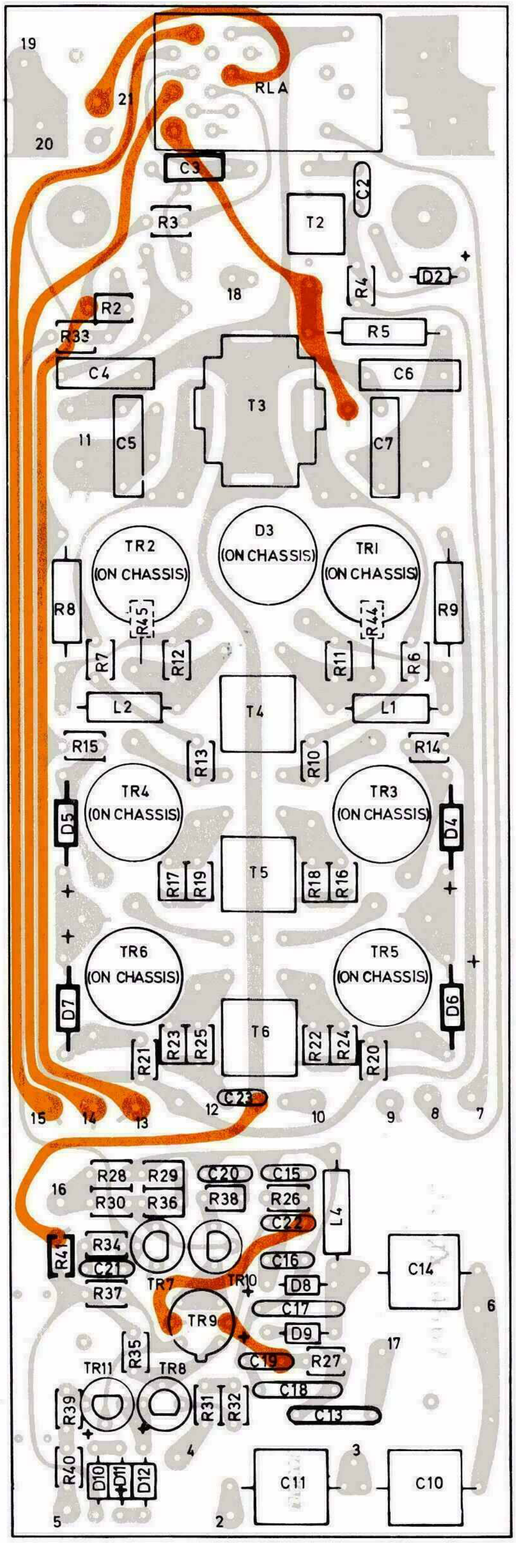
Fig. 2



WOH6085
Part 2

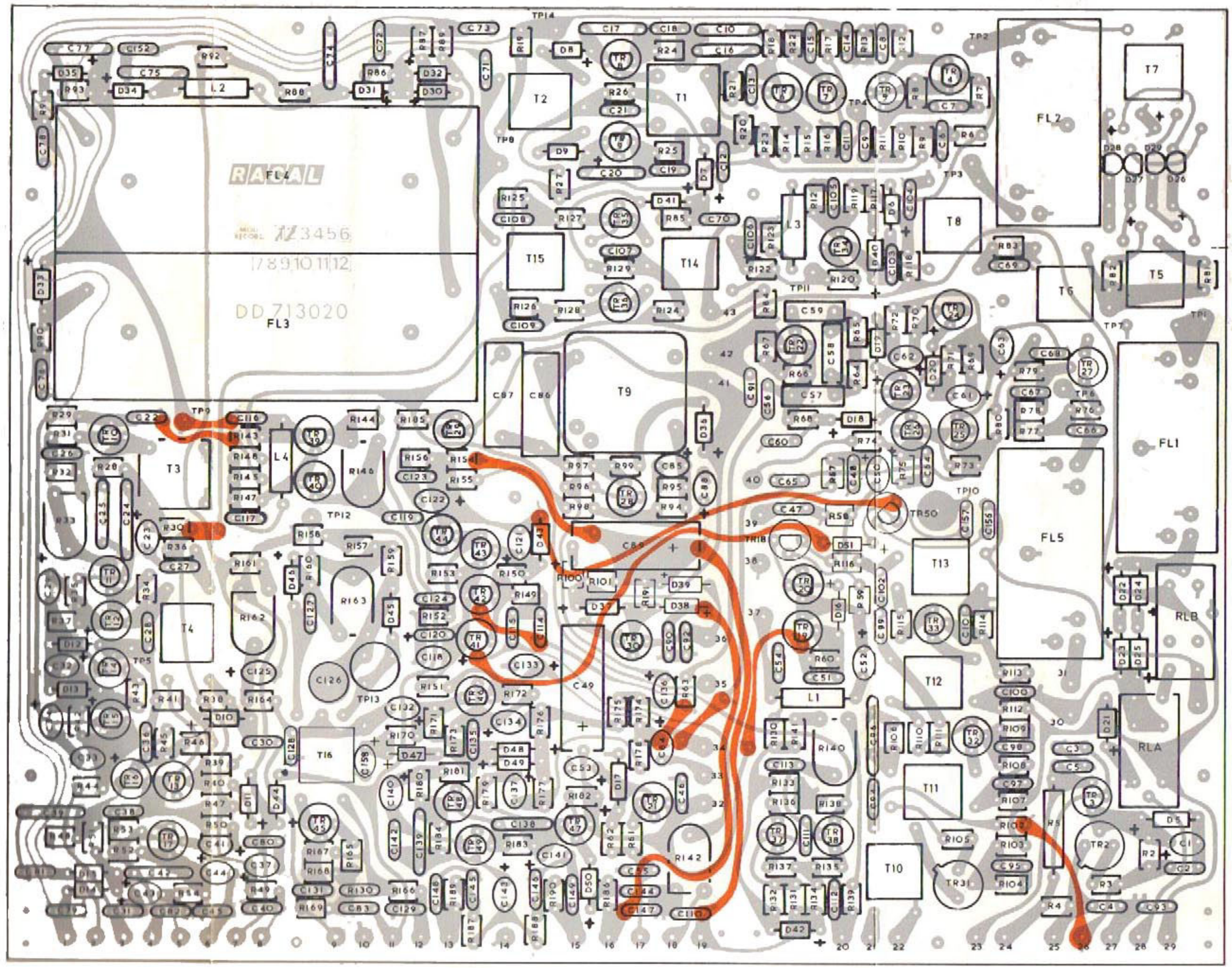
Component Layout: Front Panel
Transceiver MA.930X

Fig. 3



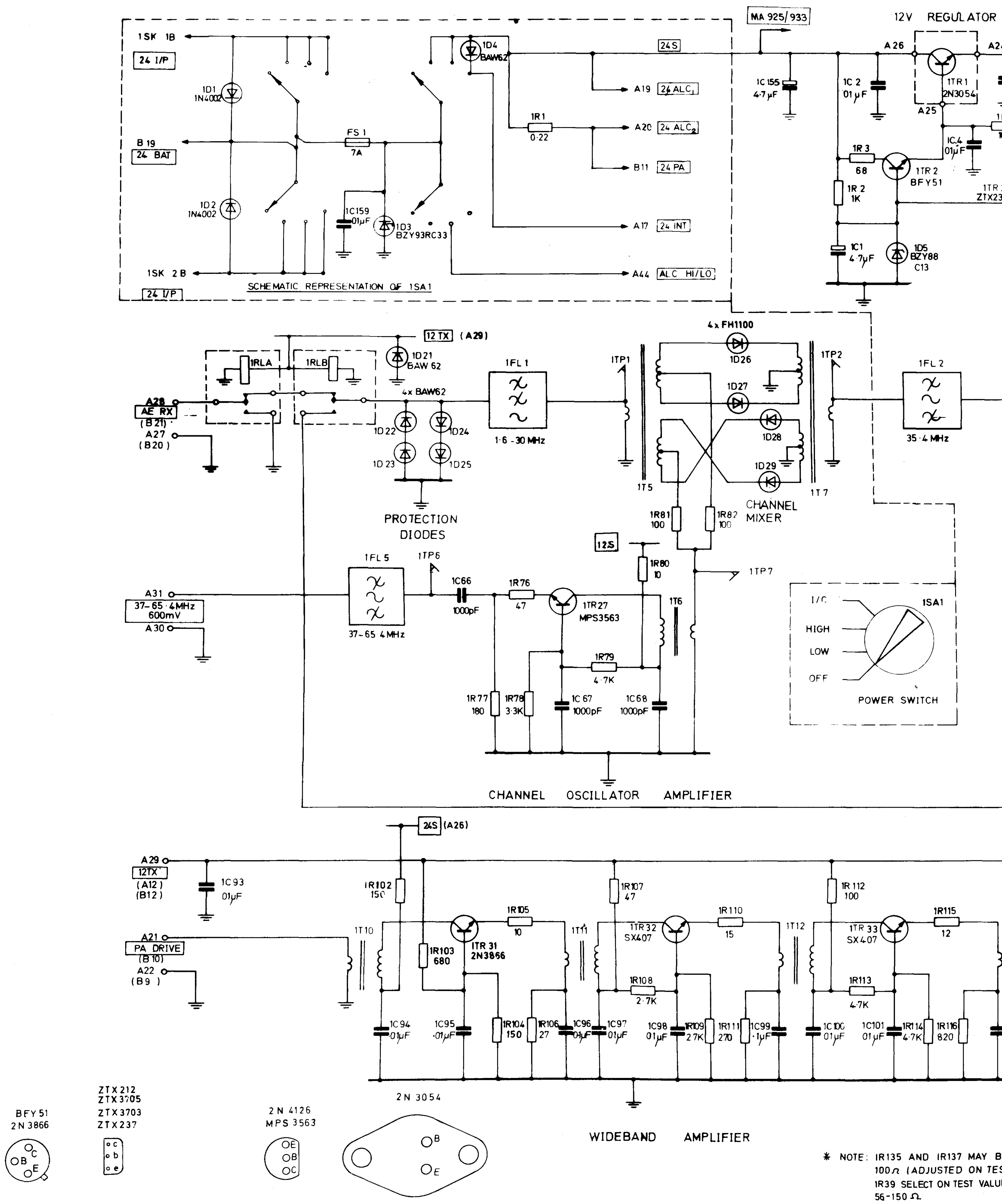
WOH6085 WOH6085 WOH6085

Component Layout : P.C. Board P.A. MA.930X **Fig. 4**



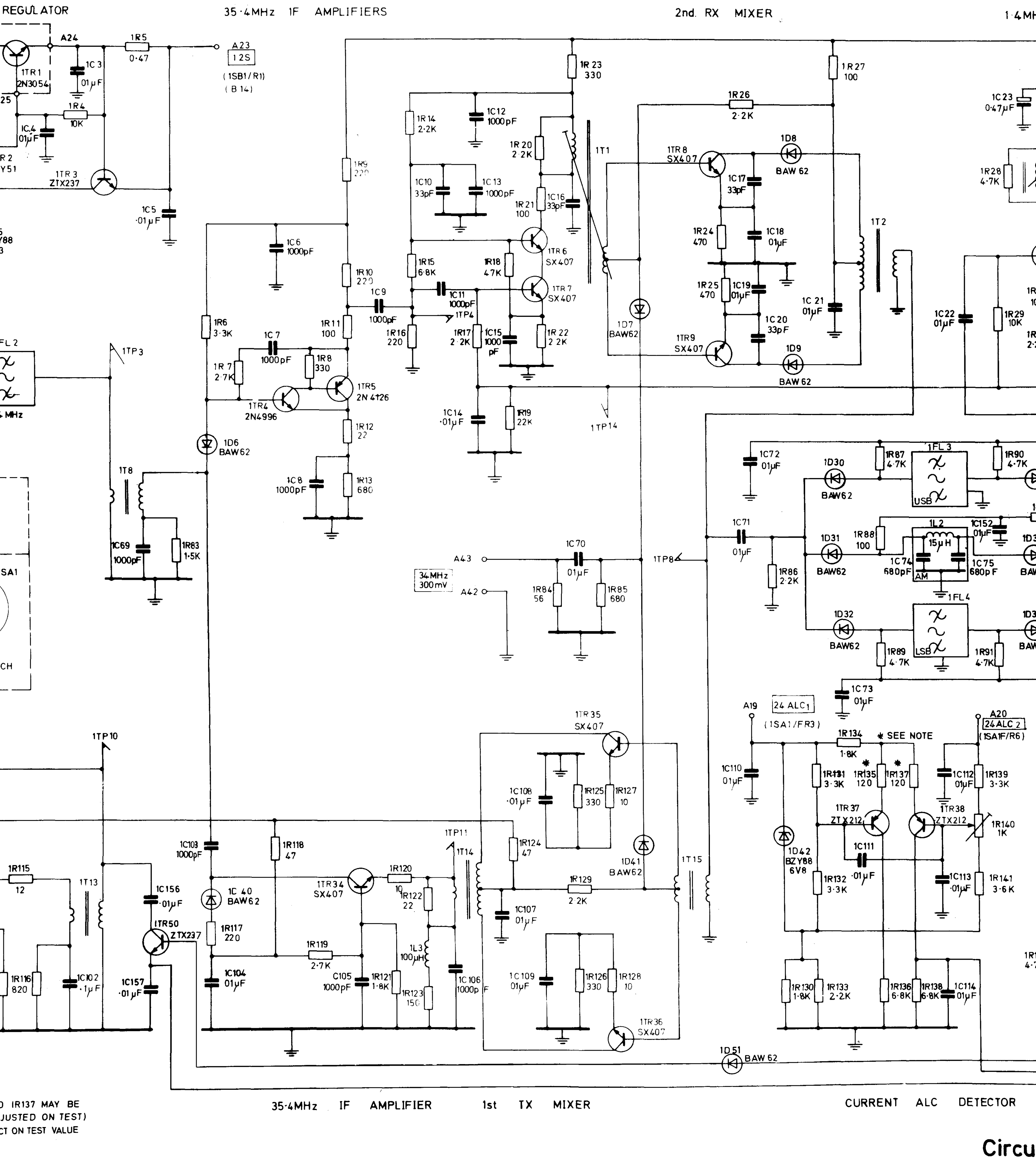
NOTE: ALL COMPONENTS PREFIXED 1

TRANSCEIVER MA930 FIG 5

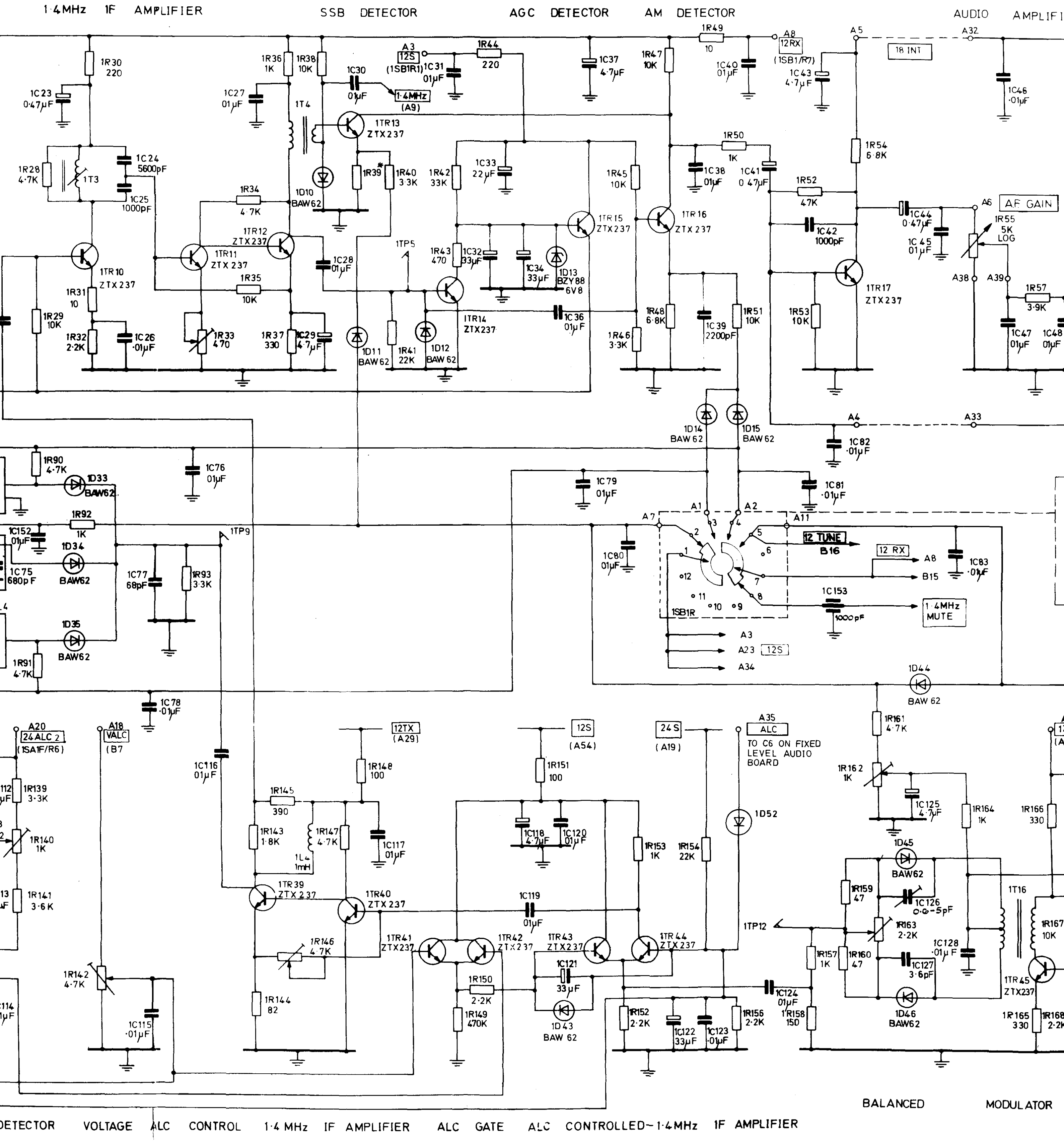


✱ NOTE: IR135 AND IR137 MAY B
100Ω (ADJUSTED ON TES
IR39 SELECT ON TEST VALU
56-150 Ω.

WOH 6085	EC 701000
16	17



REGULATOR
35·4MHz IF AMPLIFIERS
2nd. RX MIXER
1·4MH
A24
A23
12S
(1SB1/R1)
(B14)
1TR1 2N3054
1TR3 ZTX237
1TR4 2N4996
1TR5 2N 4126
1TR6 SX407
1TR7 SX407
1TR8 SX407
1TR9 SX407
1T1
1T2
1T8
1TP3
1TP4
1TP8
1TP10
1TP11
1TP14
1D6 BAW62
1D7 BAW62
1D8 BAW 62
1D9 BAW 62
1FL 3
1FL 4
1L2 15μH
USB
AM
LSB
1D30 BAW62
1D31 BAW62
1D32 BAW62
A43
A42
34MHz 300mV
A19
24 ALC1
(1SA1/FR3)
A20
24 ALC 2
(1SA1F/R6)
* SEE NOTE
1TR34 SX407
1TR35 SX407
1TR36 SX407
1TR37 ZTX212
1TR38 ZTX212
1TR50 ZTX237
1T13
1T14
1T15
1L3 100μH
1D40 BAW62
1D41 BAW62
1D42 BZY88 6V8
1D51 BAW 62
SA1
D 1R137 MAY BE
JUSTED ON TEST)
CT ON TEST VALUE
35·4MHz IF AMPLIFIER
1st TX MIXER
CURRENT ALC DETECTOR
Circu



Circuit : Transceiver Type MA.930X

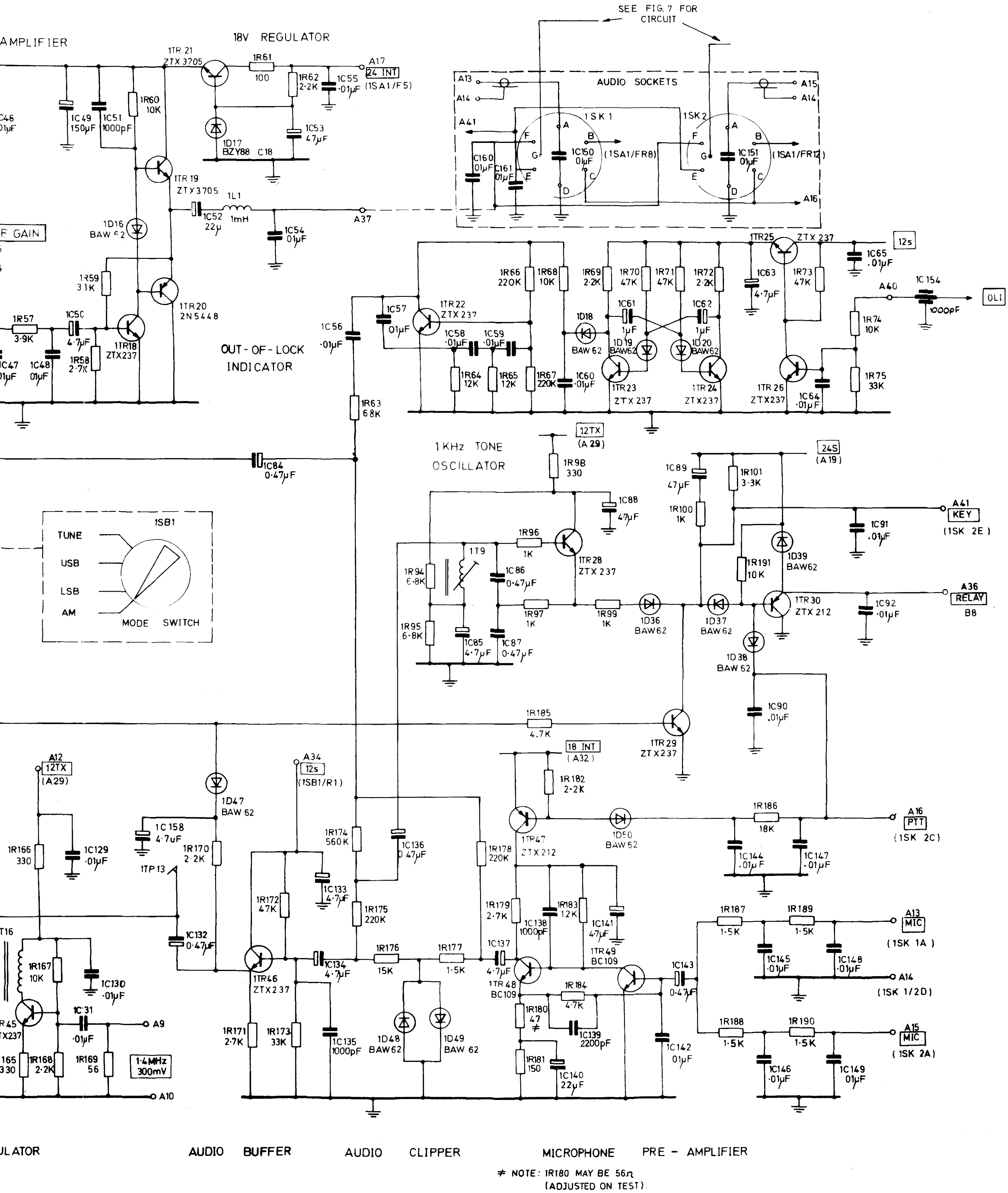
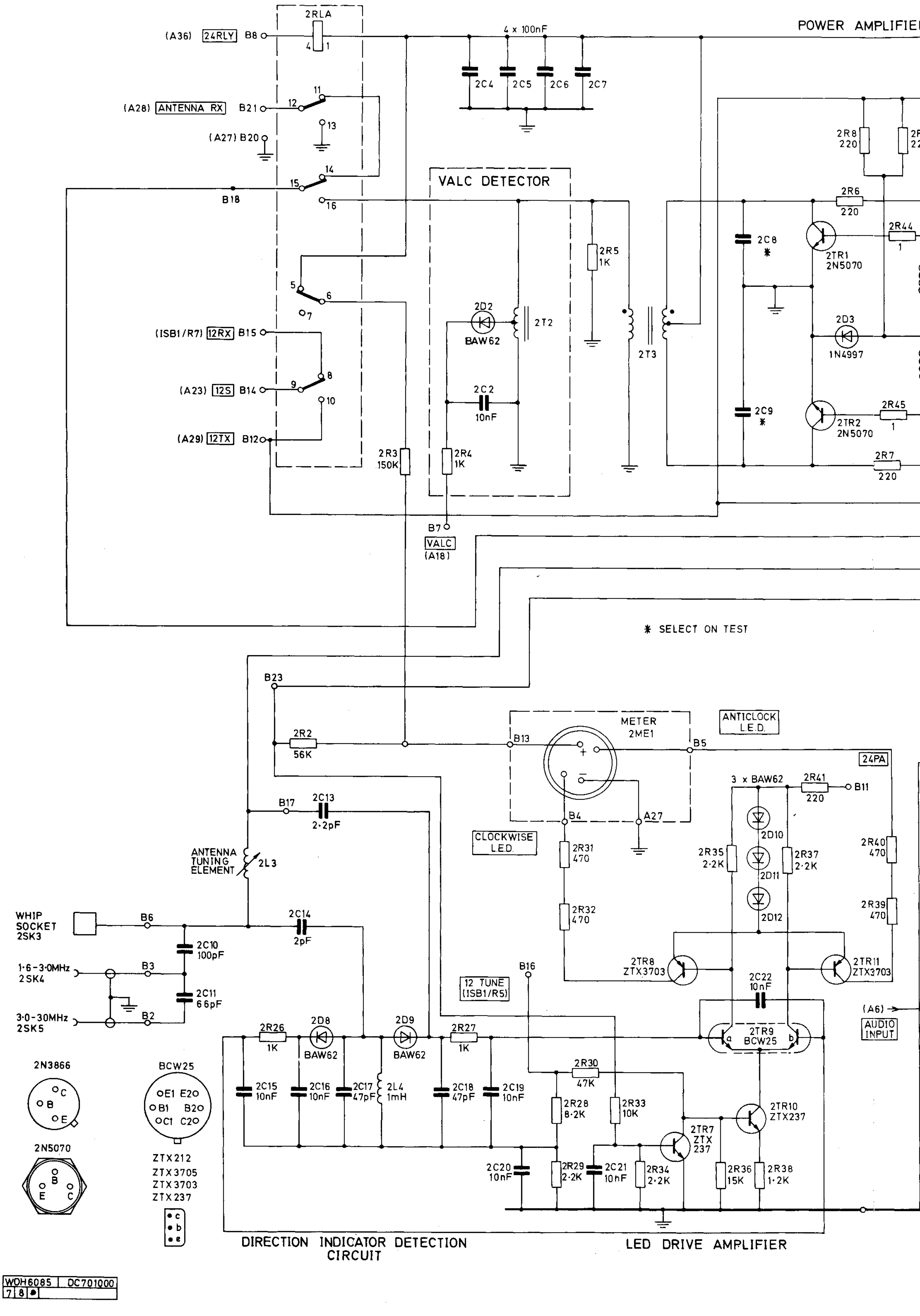
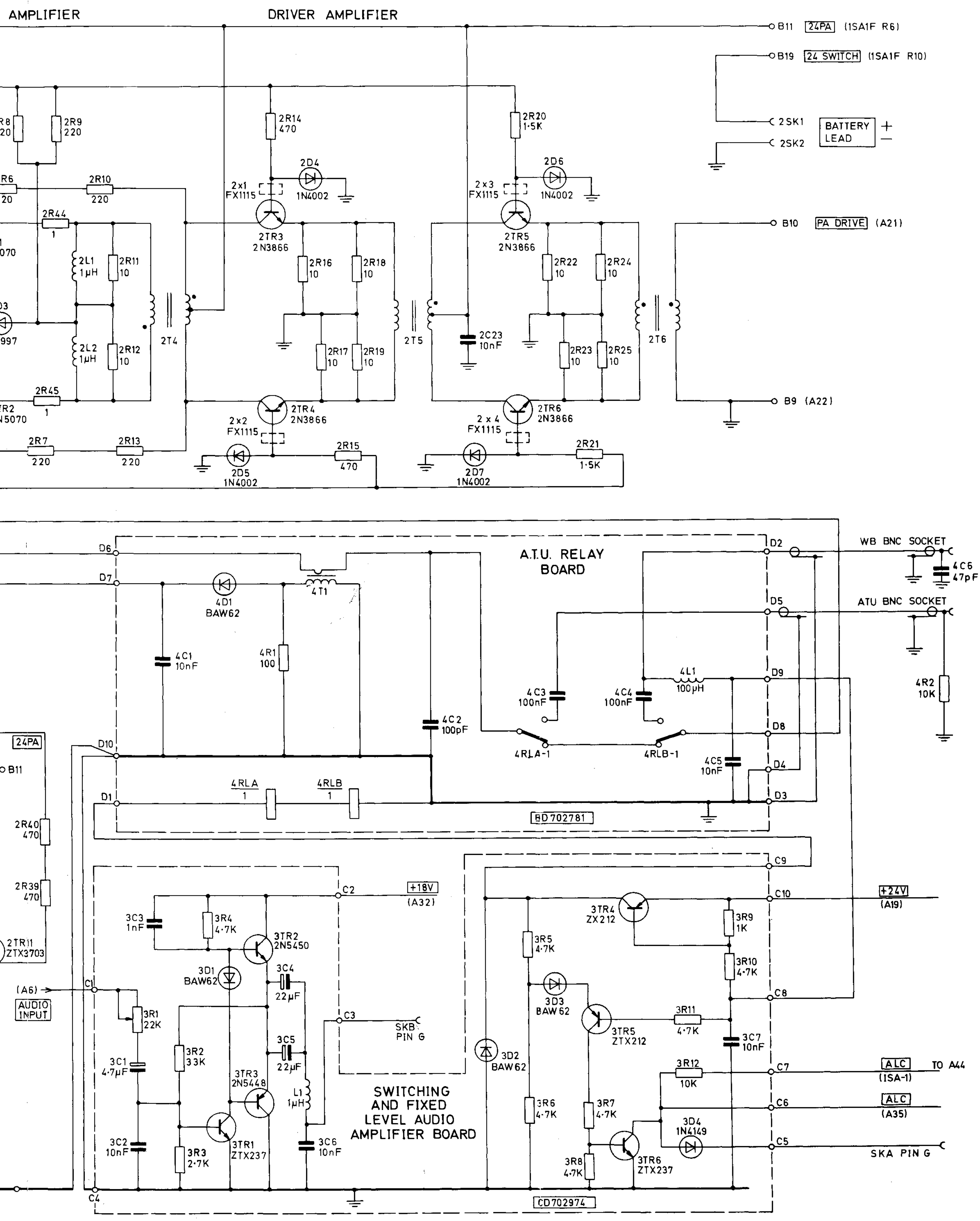

AMPLIFIER
18V REGULATOR
SEE FIG. 7 FOR CIRCUIT
AUDIO SOCKETS
1SK 1
1SK 2
A17 24 INT (1SA1/F5)
(1SA1/FR8)
(1SA1/FR12)
A13
A14
A15
A16
A37
A41
F GAIN
OUT-OF-LOCK INDICATOR
12s
A40
OLI.
1KHz TONE OSCILLATOR
12TX (A29)
24S (A19)
A41 KEY (1SK 2E)
A36 RELAY B8
1SB1
TUNE
USB
LSB
AM
MODE SWITCH
A12 12TX (A29)
A34 12s (1SB1/R1)
18 INT (A32)
A16 PTT (1SK 2C)
A13 MIC (1SK 1A)
A14 (1SK 1/2D)
A15 MIC (1SK 2A)
1·4MHz 300mV
A9
A10
1TP 13
ULATOR
AUDIO BUFFER
AUDIO CLIPPER
MICROPHONE PRE-AMPLIFIER
≠ NOTE: 1R180 MAY BE 56Ω (ADJUSTED ON TEST)

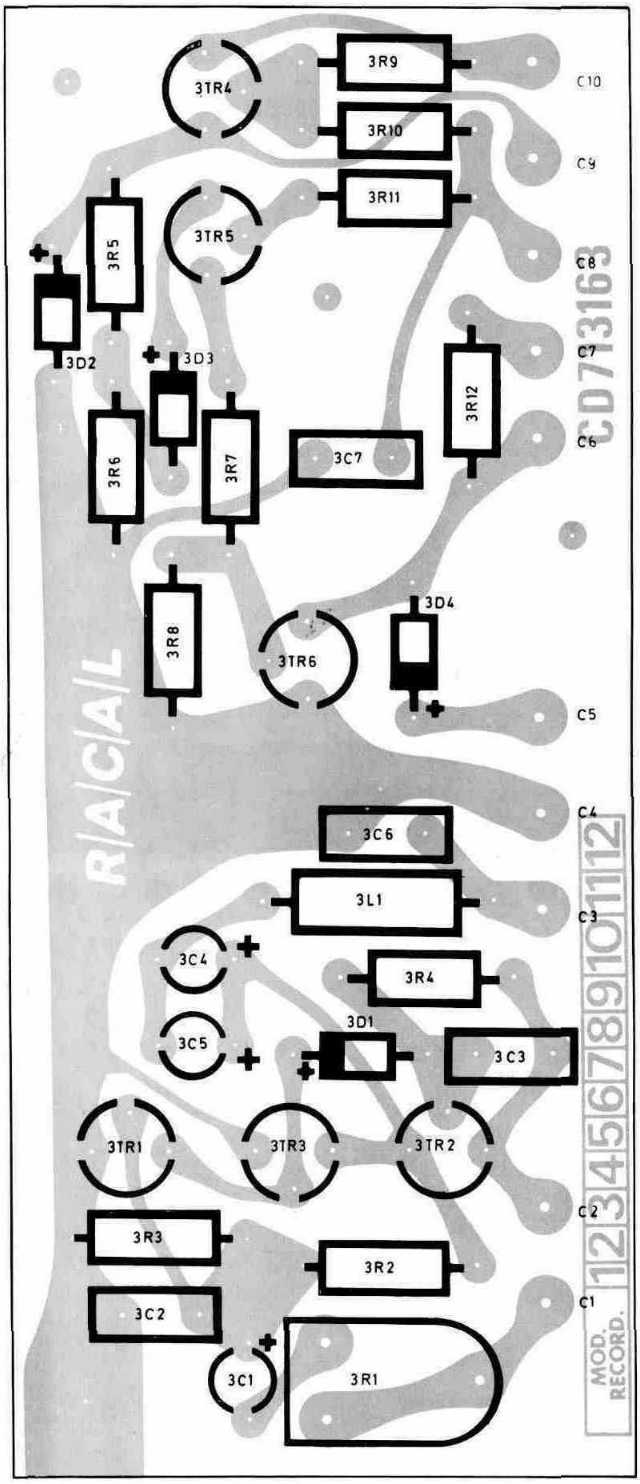
Fig. 6



POWER AMPLIFIER
2RLA
(A36) 24RLY B8
4 x 100nF
2C4 2C5 2C6 2C7
(A28) ANTENNA RX B21
(A27) B20
B18
VALC DETECTOR
2R5 1K
2D2 BAW62
2T2
2T3
2C2 10nF
(ISB1/R7) 12RX B15
(A23) 12S B14
(A29) 12TX B12
2R3 150K
2R4 1K
B7 VALC (A18)
2R8 220
2R6 220
2R44 1
2C8
2TR1 2N5070
2D3 1N4997
2C9
2TR2 2N5070
2R45 1
2R7 220
* SELECT ON TEST
B23
2R2 56K
METER 2ME1
B13
B5
B4
A27
ANTICLOCK L.E.D.
24PA
CLOCKWISE LED
3 x BAW62
2R41 220
B11
2D10 2D11 2D12
2R35 2·2K
2R37 2·2K
2R40 470
2R39 470
2R31 470
2R32 470
B17
2C13 2·2pF
ANTENNA TUNING ELEMENT
2L3
WHIP SOCKET 2SK3
B6
2C14 2pF
2C10 100pF
1·6-3·0MHz 2SK4
B3
2C11 66pF
3·0-30MHz 2SK5
B2
2TR8 ZTX3703
2TR11 ZTX3703
2C22 10nF
B16
12 TUNE (ISB1/R5)
(A6) AUDIO INPUT
2TR9 BCW25
2R26 1K
2D8 BAW62
2D9 BAW62
2R27 1K
2C15 10nF
2C16 10nF
2C17 47pF
2L4 1mH
2C18 47pF
2C19 10nF
2R30 47K
2R28 8·2K
2R33 10K
2TR7 ZTX 237
2TR10 ZTX237
2C20 10nF
2R29 2·2K
2C21 10nF
2R34 2·2K
2R36 15K
2R38 1·2K
2N3866
BCW25
E1 E2 B1 B2 C1 C2
2N5070
ZTX212
ZTX3705
ZTX3703
ZTX237
DIRECTION INDICATOR DETECTION CIRCUIT
LED DRIVE AMPLIFIER
WOH6085 DC701000
7 8



Circuit : PA Board Type MA.930X Fig.7

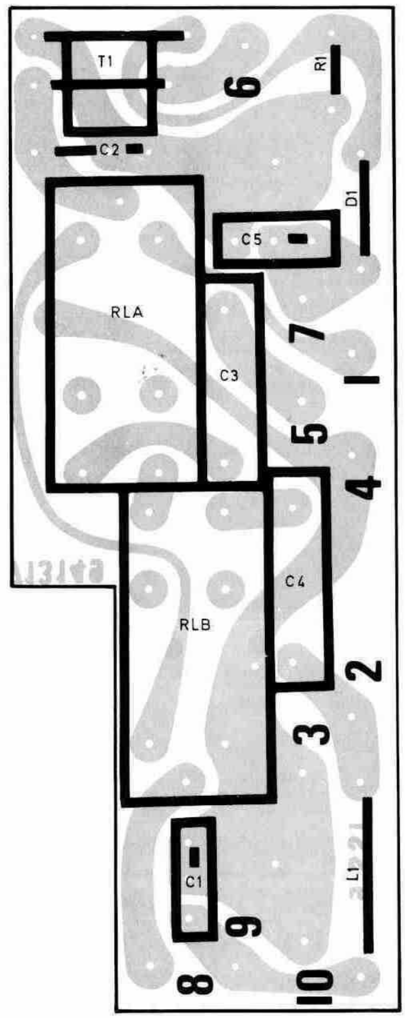


WOH6085	CD713163/2
1	

WOH6085	CD713163/3
1	

Layout : Switching and Fixed Level Audio Amplifier Board

Fig. 8



WOH6085 CD713149
5

Component Layout : ATU Relay Board

Fig. 9
PART 2

PART 3

SYNTHESIZER TYPE MA.925

REF: WOH 2118
Issue: G

PART 3 SYNTHESIZER TYPE MA.925

CONTENTS

CHAPTER 4 (Continued)

ILLUSTRATIONS

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The Synthesizer Type MA.925 provides 28400 frequency channels at 1kHz spacing derived from a single crystal reference, and is suitable for transmitter/receivers operating in the range 1.6 to 30MHz. A 'search' control is fitted to allow interpolation within the 1kHz steps. The synthesizer also provides 34MHz and 1.4MHz outputs.

MECHANICAL DESCRIPTION

2. The synthesizer consists of a single printed circuit board (p.c.b.) and associated frequency selection and 'search' controls. The p.c.b. is housed in a metal case within the Syncal 30 manpack.

3. Connections between the synthesizer and the transmitter/receiver section of the manpack are made by seven soldered cables, three of which are of coaxial type.

PRINCIPLES OF OPERATION (Fig. 1)

4. The frequency generating circuits of the synthesizer comprise a voltage controlled oscillator and a phase-locked loop (PLL). The voltage controlled oscillator (VCO) generates the required output frequency, which is measured by the loop, by comparison with the frequency standard, and a voltage is fed back to the VCO to ensure that the frequency is correct. Additionally a frequency of 34MHz is generated by an oscillator and controlled by another phase-locked loop and 1.4MHz is derived in a crystal filter circuit.

Voltage Controlled Oscillator (VCO)

5. The VCO generates the required output frequency, using the control voltage derived from the phase comparator. The oscillator is split into three frequency ranges and is followed by an output stage which provides signals both to the programmed divider (via the prescaler) and to the transceiver.

Prescaler

6. The prescaler reduces the frequency from the VCO to within the range of the programmed divider. The division ratio is 2.

Programmed Divider

7. This circuit divides its input frequency by a number equal to the number of kHz of the frequency required from the VCO. This is controlled by the frequency selector switches. When in-lock, the output of this stage should be at 500Hz.

Frequency Standard and Reference Divider

8. The reference frequency is derived from a 5MHz temperature compensated crystal oscillator, via a chain of divider stages. The input is divided by 10 000 to produce the 500Hz reference. Other frequencies produced from, or locked to, the chain are:

(a) A 34MHz output

(b) A 1.4MHz output

(c) 100kHz and 25kHz frequencies used within the synthesizer.

Phase Comparator

9. The phase comparator compares the phase and frequency of the outputs of the programmed divider and reference divider. When the VCO is providing the required frequency, both outputs are at 500Hz. A d.c. voltage is generated which controls the VCO via the loop stabilisation filter. The voltage is raised or lowered as required to give the correct frequency. This circuit also drives the lock detector.

Lock Detector

10. A lock indicator output gives a '1' logic level if the main loop is in lock, and a '0' logic level if it goes out of lock. This is a safety check that the equipment is functioning correctly. It controls the out-of-lock indicator (on the receiver) which gives an interrupted tone output when out of lock. This may also be heard briefly when changing frequency.

34MHz and 1.4MHz Outputs

11. The 34MHz frequency is generated by an oscillator which is phase-locked to a 100kHz reference frequency derived from the 5MHz reference source. The 1.4MHz frequency is similarly derived from the reference source but in this case harmonic generation and filtering are used. The 1.4MHz frequency can be muted by a d.c. signal applied to the synthesizer. The frequency is muted during certain operational modes selected at the manpack.

POWER SUPPLY

12. The synthesizer operates from a nominal 24 volt supply, which can be in the range 11V to 32V. The power supply stages within the synthesizer produce 5 volt, 9 volt and 15 volt supplies, all used internally. The 5 volt and 9 volt levels are individually adjustable.

TUNING EXAMPLE

13. Assume that the front panel switches are set to 23.456MHz, with the search control at the OFF position. The actual output frequency required is 23.456MHz + 35.4MHz = 58.856MHz. The '2' position of the MHz x 10 switch causes the 55.400MHz to 65.399MHz VCO to be switched into use, the switch is also used, with the four other switches, to give a division ratio of 58856.

14. The required oscillator frequency is 58.856MHz. This frequency is divided by two in the prescaler, and divided by 58856 in the programmed divider, therefore the output of the divider is f osc/2 x 58856, which equals 500Hz when the oscillator is correctly phase-locked. As previously stated, phase-locking is accomplished by comparing the output of the divider with the 500Hz reference frequency.

CONNECTIONS

15. The synthesizer is connected to the manpack via 13 soldered cables, as under (see fig. 2 of Part 1 for connection points).

MAIN OUTPUT	Coaxial cable to pins 41 and 42 (screen).
34MHz OUTPUT	Coaxial cable to pins 58 and 59 (screen).
1.4MHz OUTPUT	Coaxial cable to pins 61 and 62 (screen).
24V (nominal) SUPPLY	Cable to pin 44 (+ve) pin 43 (0V).
LOCK INDICATION OUTPUT	Cable to pin 32.
CLARIFIER (FRONT PANEL)	Cables to pins 52, 53 and 54.
MUTE	Cable to pin 66.

CHAPTER 2

CIRCUIT DESCRIPTION

INTRODUCTION

1. The circuitry of the synthesizer is contained on one printed circuit board. For ease of description, the circuit will be considered as a series of stages, as follows:-

   (a) Frequency Source and Reference Divider.

   (b) Voltage Controlled Oscillators (VCO's).

   (c) Shaper, Pre-scaler and Programmed Divider.

   (d) Phase comparator.

   (e) Lock Indicator.

   (f) 34MHz Generator and Search Circuit.

   (g) 1.4MHz Generator and Muting.

   (h) Power Supplies.

The circuit diagram for the synthesizer is given in fig. 5.

FREQUENCY SOURCE AND REFERENCE DIVIDER

2. All frequencies supplied from, and used within, the synthesizer are derived from a 5MHz Temperature Compensated Crystal Oscillator (TCXO). This is a sealed unit, therefore a circuit diagram and description are not given. The crystal is pre-aged during manufacture. The variable resistor R2 allows precise frequency setting to be carried out. Transistor TR2 is a shaping stage, which provides a squarewave output at 5MHz.

3. Integrated circuits ML3, ML8, ML10 and ML12 form a divider chain which produces three outputs, viz:

   (a) A 500Hz output used as the reference frequency for the phase comparator (para.35).

   (b) A 100kHz output used for three purposes.

      (i) As a reference frequency for the 34MHz generator (para.47).

      (ii) To drive the harmonic generator which produces the 1.4MHz output (para. 55).

      (iii) To drive the 15 volt supply circuit (para. 61).

(c) A 25kHz output used to control the 5V power supply (para. 57).

4. Integrated circuits ML3, ML8, ML10 and ML12 each consist of a divide-by-two and a divide-by-five stage, interconnected to give a divide-by-ten stage. The 'Ck1' (clock 1) input to ML3 is divided by two and fed to the 'Ck2' input, giving a divide-by-five output 'D' of 500kHz. ML8 is connected with the divide-by-five stage first, giving a 100kHz output at 'C', and a 50kHz output at 'A'. ML10 is connected in divide-by-two followed by a divide-by-five configuration, providing a 'D' output of 5kHz and an 'A' output of 25kHz. The final stage, ML12, provides a 500Hz output.

VOLTAGE CONTROLLED OSCILLATORS (VCO's)

5. There are three Voltage Controlled Oscillators (VCO's), one which operates in the range 37.000 to 45.399MHz (the LF oscillator), one which operates in the range 45.400 to 55.399MHz (the MF oscillator) and one which operates in the range 55.400 to 65.399MHz (the HF Oscillator). The LF VCO comprises TR24, L2 and the voltage controlled variable-capacitance diodes (varactors) D8, D9 and D10. The MF VCO comprises TR27, L3, D8, D9 and D11; the HF VCO comprises TR29, L4, D8, D9 and D13.

NOTE: Varactors D8 and D9 are common to all three VCO's.

6. Inductor L2 and the varactors D8, D9 and D10 form a tuned circuit for the LF VCO. The capacitance of the varactors varies in accordance with the applied d.c. voltage level, thus varying the frequency of the oscillator. The d.c. voltage is developed in the phase comparator (para.35).

7. The tuned circuits for the MF VCO (L3, D8, D9 and D11) and the HF VCO (L4, D8, D9 and D13) operate in a similar manner to the LF VCO.

8. The appropriate VCO is switched on by a gating transistor, TR23, TR26 or TR28. When the MHz x 10 switch is set to the 0 position pins 17 and 18 of the p.c.b. are disconnected from earth at the switch, therefore '1' levels are applied to gates G11, G12 and G13 (due to R25 and R26). The output of G12 is inverted by G14, therefore gates G11 and G13 provide '0' outputs and G14 provides a '1' output. The '1' output drives TR23 into conduction and the two '0' outputs cut-off TR26 and TR28. The LF oscillator is therefore switched on, and the MF and HF oscillators are switched off.

9. The setting of the MHz x 10 switch to the '1' position connects p.c.b. pin 17 to earth, providing a '1' output from G11 which drives TR26 into conduction, energizing the MF VCO. The selection of position 2 at the MHz x 10 switch causes TR8 to conduct, selecting the HF VCO.

10. The output of the VCO in use is taken, via C48, to transistor TR31. This transistor is the 'lower' component of three cascode amplifiers, TR30 and TR31; TR32 and TR31; TR33 and TR31. The main output of the oscillator is provided by the pair TR31 and TR33, coupled to the output by T2. TR31 and TR32 provide the loop output, via T1 (para.12); TR30 and TR31 form an automatic gain control (a.g.c.) amplifier.

11. The output of the a.g.c. amplifier is rectified and smoothed by D12 and associated components, to provide an a.g.c. potential. This potential is added to the standing d.c. level developed across R70, and fed to TR25. The potential increases positively with increase of signal, so that an increase of output level results in a reduction of current supply to TR24, TR27 or TR29, resulting in a sensibly constant output level from the VCO in use. The potentiometer R70 is used, during maintenance, to adjust the output signal level.

SHAPER AND PRESCALER

12. Transistor TR1 'shapes' the input waveform from T1, (para. 10) to an approximate squarewave with edges fast enough to operate ML1, the prescaler. ML1A divides the VCO frequency by 2, to a frequency at which the programmed divider can operate.

PROGRAMMED DIVIDER

General Description

13. The programmed divider divides the input frequency from the prescaler by a number 'N', where 'N' is equal to the output frequency in kilohertz (kHz).

14. The circuit is arranged as a frequency counter which counts from a number determined by the setting of the frequency control switches, up to a fixed number. When this number is reached the counter is 'strobed' or set back to the switch code, and the counter begins to count again.

15. Each time a strobe is generated an output pulse is produced; thus for every 'N' input pulse one output pulse occurs, and the input frequency is divided by 'N'. The ratio 'N' can be varied by altering the switch setting, i.e. the 'set to' number.

Binary Code

16. The decadic binary code is a four bit code. The count is determined by the arrangement of the bits at '1' or '0' levels as shown in Table No.1.

TABLE 1

Count	Bit D (Value 8)	Bit C (Value 4)	Bit B (Value 2)	Bit A (Value 1)
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

This code is known as BCD (Binary Coded Decimal).

Divide by 10 Stages

17. The divider stages ML2, ML6, ML9, ML11 and ML13 are decadic binary counters. When an input frequency is applied to Ck1 (Pin 8) the outputs A, B, C and D count through the sequence shown in Table 1 above.

18. There are four Data inputs on each IC; Da, Db, Dc, and Dd. The data set up on these inputs (by the switches) has no effect on the counting action until the strobe input (Pin 1) is taken to the '0' level. When this happens the code set on the Data inputs is transferred to the outputs, and all counting action is inhibited until the strobe is taken back to the '1' level. After the strobe pulse the counter is therefore set to the switch code and ready to continue counting the clock pulses.

Switch Codes

19. The 1MHz, 100kHz and kHz switches are coded '9's complement BCD' as shown in Table 2.

20. The 10MHz code is '5's complement BCD' as shown in Table 3.

21. TABLE 2

Switches 4SB, 4SC, 4SD and 4SE (Wiper = PIN 2 is grounded)

Switch Setting (READOUT)	D Pin 4,8	C Pin 6	B Pin 10	A Pin 1,3	Decimal count
0	1	0	0	1	9
1	1	0	0	0	8
2	0	1	1	1	7
3	0	1	1	0	6
4	0	1	0	1	5
5	0	1	0	0	4
6	0	0	1	1	3
7	0	0	1	0	2
8	0	0	0	1	1
9	0	0	0	0	0

The code from these switches is presented directly to the Data inputs of ML2, ML6, ML9, and ML11.

22.

TABLE 3

MHz x 10 Switch 4SA (Wiper = PIN 2)

Switch Setting (READOUT)	D Pin 9	A Pin 4	Code on ML13				Decimal Count
			Dd = 0	Dc = D	Db = $\overline{D}$	Da = A	
0	1	1	0	1	0	1	5
1	1	0	0	1	0	0	4
2	0	1	0	0	1	1	3

NOTE: The Data inputs to ML2, ML6, ML9, ML11 and ML13 are connected via resistors to the 5V line. As the switch wipers are earthed, operation of the switch in an open circuit position gives a '1' and in a closed contact position a '0' condition.

Fixed Number Detection

23. The fixed number at which the counting ends and the strobe begins is detected by G7, G8 and G1. To detect this number all the inputs to G7 and G1 must be in the logic '1' condition, when G1 output (Pin 8) will also become logic '1'.

24. By reference to Table 1 the fixed number can be found.

ML13	A = 1,	D = 1	corresponds to decimal 9
ML11	A = 1,	C = 1	corresponds to decimal 5
ML9	A = 1,	B = 1	corresponds to decimal 3
ML6	D = 1		corresponds to decimal 8
ML2	A = 1,	C = 1	corresponds to decimal 5

Thus the output of G1 is at logic '1' when the counter has reached the count 95385.

Strobe Action

25. The JK flip-flop ML1B, gates G1 to G6, and the counter ML4 are used to provide the strobe pulses. The JK flip-flop operates in accordance with the following truth table when clocked.

J	K	Q	$\overline{Q}$
0	0	No change	
1	0	1	0
0	1	0	1
1	1	Outputs 'toggle'	

26. The output of G1 goes high when the fixed number is detected. This is initiated by the negative edge of a clock pulse shown as pulse No. 0 in figure 2 and sets the J input of the JK flip-flop.

27. The next clock input, No. 1 in figure 2, clocks the JK flip-flop causing Q to become logic '1' and $\overline{Q}$ to become logic '0' (see para. 25).

28. The output of G5 is a logic '1' at this time, so that when Q goes to logic '1' G6 output goes to logic '0'. Thus both strobe lines ($\overline{Q}$ and G6 output) have started strobing at count No. 1.

29. The Q output of JK flip-flop ML1B is also connected to the strobe input of ML4, so that on the count No. 1 the strobe on ML4 is released leaving it set to the number A = 1, B = 0, C = 0 and D = 0 which is decimal 1.

30. ML4 now counts input clock pulses until pulse No. 8, at which point the D output of ML4 goes to logic '1', causing the output of G5 to become logic '0'. This in turn causes the output of G6 to become logic '1' and ending the strobe on ML6, ML9, ML11 and ML13.

Note that the first divider ML2 is still strobed. ML4 continues to count until the number 13 is reached at which point all the inputs of G2 are at logic '1' and therefore the K input of ML1B is set to logic '1'.

31. The next input pulse, No. 14 in figure 2, clocks the JK flip-flop and $\overline{Q}$ becomes a '1', thus ending the strobe on ML2 and starting the strobe on ML4. During the strobe action 14 input pulses are 'lost'.

EXAMPLE

32. Assume that the front panel switches are set to 23.456MHz, with the search control at the OFF position. The output frequency when in-lock is 23.456MHz + 35.4MHz = 58.856MHz making the required ratio 'N' equal to 58856.

33. The count from which the counter starts after the end of the strobe can be found from Tables 2 and 3.

MHz x 10 switch set to 2	ML13 count 3
MHz switch set to 3	ML11 count 6
kHz x 100 switch set to 4	ML9 count 5
kHz x 10 switch set to 5	ML6 count 4
kHz switch set to 6	ML2 count 3

From these figures it can be seen that the counting starts at 36543.

34. As the counting ends at the fixed number 95385 (see para. 24), the number of input pulses counted = 95385 - 36543 = 58842. To this must be added the input pulses lost during strobing, thus 58842 + 14 = 58856 which gives the required division ratio.

PHASE COMPARATOR

35. The output of the VCO is divided to provide a frequency of 500Hz when the VCO frequency is correct. This frequency is compared with a 500Hz reference frequency derived from the TCXO (para.2) and the error between the two frequencies is used to develop a d.c. voltage which adjusts the VCO frequency to eliminate the error. The d.c. voltage is generated in the phase comparator. If the VCO frequency is low, the phase comparator increases the voltage applied to the varactors of the VCO, and vice versa.

36. The output of the programmed divider (para.13), consists of short positive-going pulses which are applied to the Ck1 input of the positive edge-triggered flip-flop ML23A. The 500Hz reference output is applied to the Ck2 input of ML23B. Consider the case of the VCO frequency being high. This will mean that the positive-going edge of the 500Hz from the programmed divider (known as the 'P' input) will occur before the edge of the reference frequency output (the 'R' input).

37. When a positive-going edge (from the 'P' input) clocks ML23, the Q1 output changes to '1'. When the 'R' input at ML23 changes to '1', the Q2 output of ML23 changes to '1'. When both the Q1 and Q2 outputs are at '1', the output of G15 changes to '0', clearing both ML23 flip-flops (after a short delay due to C22 and R32) thus resetting the Q1 and Q2 outputs to '0'.

38. The setting and re-setting of the flip-flops causes a positive pulse to appear at test point TP31. The width of the pulse is equal to the time difference of the two inputs, plus the short pulse width generated by R32 and C22. The positive pulse is applied to the base of TR14, driving it into conduction and discharging C28 via TR13 and R47, thus reducing the voltage across C28, C29.

39. The source-follower TR16 acts as a high input-impedance buffer amplifier, transferring the voltage across C28 and C29 to the VCO with minimal leakage, therefore the action described in para. 38 reduces the VCO frequency thus correcting the error. Transistors TR12 and TR13 are used as low-leakage diodes to prevent deterioration of the voltage across C28 and C29. Resistor R43 provides a leakage path for TR11. This ensures that TR12 is back-biased when TR11 is non-conducting, preventing deterioration of the voltage at C28 and C29. Resistor R42 provides a 'self-starting' facility.

40. If the VCO frequency is low, the 'P' input pulse will occur after the reference 'R' input, therefore the flip-flop ML23 (Ck2 input) will trigger before ML23 (Ck1 input), causing TR9 to conduct during the interval between pulses, thus driving TR11 into conduction. This provides a low impedance charging source for C28 and C29 (via R41, TR11 and TR12), causing the voltage across C28 and C29 to increase, and providing an increased voltage level to the VCO, via TR16. The increased voltage causes the output frequency of the VCO to increase, thus correcting the error.

41. When the 'P' and 'R' frequencies are in phase, the two ML23 flip-flops remain open for equal times, i.e. during the time of the very narrow pulse determined by R32 and C22. Transistors TR9 and TR14 conduct for equal periods. Therefore, the voltage developed across C28 and C29 remains at a constant level.

42. The varactor diode voltage/capacitance curve is not linear, as the capacitance change per volt decreases towards the high voltage end of the curve. To linearise the curve, compensation is introduced by TR10. The varactor voltage line is connected to the base of TR10 so that, as the voltage increases, the conductivity of TR10 also increases, giving a greater effect to the TR9 circuit as the varactor voltage increases. The resistor R47 provides a similar effect when TR14 conducts.

43. The diode D1 provides thermal compensation for the circuit. Components R49, C29 and C28 form a loop filter which stabilises the phase locked loop, and also rejects a.c. components from the varactor control line; resistor R50 is the load for this line.

LOCK INDICATOR

44. The inputs to the gate G16 are connected to the $\overline{Q1}$ and $\overline{Q2}$ outputs of the ML23 flip-flops, so that G16 will only give a '1' pulse output during the time interval between the positive edges of the 'P' and 'R' pulse inputs. This interval is wide when the synthesizer is out of lock and narrow when the lock condition is achieved. The output of G16 is inverted by G17, and fed directly to G18, and to G19 via a delay circuit R34 and C24. When the pulse width exceeds the delay time of R34, C24 the gate G19 is triggered, driving TR15 into conduction. Transistor TR15 then causes G20 to give a '1' output, which is converted to a '0' output by G21. The output at pin 32 of the p.c.b. is therefore '0' in the 'out of lock' condition.

45. When the synthesizer is 'in lock' the '1' pulse applied to G17 is very narrow, and is rejected by R34 and C24. The toggle G18, G19 is therefore reset by the input to G18. The output of the toggle cuts-off TR15, causing G20 to give a '0' output which is converted by G21 to give a '1' output, i.e. the locked condition.

46. When the out-of-lock condition is detected, a potential is applied to the muting circuit, via R179, causing the transceiver to be muted in the out-of-lock state. The muting circuit operates as given in para. 55.

34MHz GENERATOR AND SEARCH CIRCUIT

47. The circuit will first be described in the condition when the search control is switched off, i.e. the output is exactly 34MHz and is controlled by a phase-locked loop. This is a sample-hold type, with a sampling frequency of 100kHz.

48. Crystal XL1 and transistor TR56 form an oscillator with an output frequency of 17MHz. The output of the oscillator is taken via a circuit tuned to 34MHz (C84 and T9) which acts as a frequency doubler. The 34MHz frequency is then fed to an output stage TR65 which provides the 34MHz output from the synthesizer, via transformer T11 and p.c.b. pins 58 and 59.

49. A sample of the output frequency from T9 is amplified by a cascode stage, TR57 and TR58, producing an output across inductor L25, which is fed to the sampling f.e.t. TR59.

50. The 100kHz frequency from the reference divider chain is shaped by the TR63, TR64 stage and coupled, via T10, to TR59. The two inputs to TR59 are, therefore, a 34MHz sine wave input (para.49) and a narrow 100kHz input. The level of the instantaneous voltage developed across C89 is a function of the phase difference of the two inputs to TR59, and is used to adjust the frequency of the 34MHz oscillator to achieve phase-locking.

51. The voltage across C89 is amplified by the d.c. coupled stage TR60, TR61 and TR62, and fed via the loop filter C79, R125 and diode D39 (para.54) to the voltage controlled variable-capacitance diode (varactor) D40, which adjust the frequency of the 17MHz crystal oscillator until phase-locking is achieved. In this condition the 34MHz output is locked, via the reference divider chain, to the TCXO frequency.

52. Transistors TR54 and TR55 provide a starting circuit for the phase-locked loop, to ensure that the d.c. level from TR61 is effectively applied to D40 even when large a.c. components are present, as can occur at switch-on.

53. When the SEARCH control is off, diode D38 is reverse-biased, and D39 is conducting, allowing the phase-locked loop to operate as given in the previous paragraphs. In this condition transistor TR52 is cut-off, driving TR53 into conduction, and providing a power supply to the phase comparator and associated circuitry.

54. When the SEARCH control is at a position other than off, TR52 is driven into conduction, cutting-off TR53 and removing the phase comparator power supply. In addition diode D38 is forward biased and D39 reverse biased. This removes the d.c. input to the varactor from the phase comparator, and replaces it with an input from the wiper of 4R1, allowing adjustment of the 34MHz output, by the SEARCH control. An adjustment range of at least ± 500Hz is provided.

1.4MHz GENERATOR AND MUTING

55. The 100kHz output of ML8 is fed via C106 to the base of TR72. The signal here is a narrow pulse at 100kHz, which is rich in harmonics. Crystals XL8 and XL9, in conjunction with C108, C109 and C110, form a circuit tuned to accept the 1.4MHz component of TR72 output. The 1.4MHz frequency is amplified by TR73 and TR74 and coupled, via the tuned circuit T18 and C113, to the output, p.c.b. pins 61 and 62. The power supply for the 1.4MHz generator is fed via a switching transistor TR75, which is normally conducting. The 1.4MHz output is muted when the manpack is in the 'A.M. Receive' condition, to avoid spurious signals in the audio circuits. Muting is carried out by a positive d.c. input applied at p.c.b. pin 66. This input drives TR76 into conduction, cutting-off TR75. The muting circuit is also operated when the 'out of lock' circuit operates (para.46), to prevent an incorrect frequency being transmitted.

POWER SUPPLIES

56. The synthesizer is powered from a 24 volt (nominal) negative earth input, which can vary over the range 11V to 32V. Three supplies are generated from the inputs, viz 5 volts, 9 volt and 15 volt. The input is decoupled by C62 and C73, L16 and L17; diodes D20 and D21 provide reverse voltage protection via the supply fuse in the manpack.

57. The 5 volt power supply utilises a high-efficiency switching type regulator. The switching transistor TR40 is alternately driven fully into conduction, and fully cut-off, by the control circuit ML32, due to the 25kHz input via C64 and R93. The voltage at the collector of TR40 is, therefore, a squarewave of approximately the same amplitude as the supply rail. The mark-space ratio of TR40 is adjusted, by feedback and the setting of R91, to give a 5 volt output after smoothing by L18 and C66. When transistor TR40 is cut-off, diode D23 conducts, providing a continuous path for the current flow through L18. The switching action reduces the current drain from the supply.

58. Diode D24 provides over-voltage protection for the integrated circuits in the rare event of a regulator failure, by causing a sufficient current flow to burn out TR40, which is mounted in such a manner that this can be tolerated without damage to other components.

59. The 9 volt supply is regulated by TR41, under the control of ML33. The circuit operates in a similar manner to the 5 volt supply circuit, except that TR41 is operated in analogue mode instead of switched mode. The input voltage is taken from either the 24 volt rail, via D25 and R97, or from the 15 volt rail via D26 and R98, dependent upon the supply voltage level. This allows the circuits to operate at the lower limit of input voltage. The 9 volt supply is adjusted by R101.

60. Overload protection is provided by TR42 and TR43. Under normal conditions TR43 is conducting and TR42 is cut-off. If a short circuit of the 9 volt or 5 volt rail occurs the voltage drops to zero, cutting-off TR43 and causing TR42 to conduct. This earths the control circuits of the regulators (via D22 and R99), reducing the output voltages of the two supplies, thus completely cutting-off the regulator transistors.

61. The 15 volt supply is derived from the 9 volt supply. Transistor TR44 is switched at 100kHz (from the reference frequency divider chain) causing TR45 to apply a chopped voltage to the voltage doubler D29, D30, C69 and C71, thus producing the 15 volt supply.

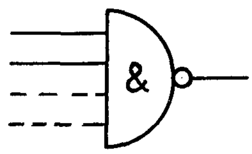
APPENDIX 1

INTEGRATED CIRCUITS

INTRODUCTION

1. This Appendix gives brief details of the integrated circuits used in the MA.925 Synthesizer.

Gates	NANDGATES	SN 74L00J	Quad	2	input	nandgate
2.	(i)	SN 7430J		8	input	nandgate
		SN 7410J	Triple	3	input	nandgate

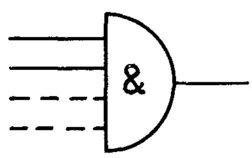


when all inputs are '1', output is '0'

if any input is '0', output is '1'

ANDGATES SN 74S11J Triple 3 input

(ii)



when all inputs are '1', output is '1'

if any input is '0', output is '0'

FLIP FLOPS

Dual D Type Flip Flop 74L74J

3. (i) $\overline{Q}$ output is the inverse of Q output.

(ii) At positive edge of clock input (Ck) Q output changes to same state as D input.

(iii) When clear (Cr) changes to '0', Q changes to '0' immediately.

Dual J-K Type Flip Flop SN74S112J

4. $\overline{Q}$ output is the inverse of Q output. At the negative edge of the trigger the input changes according to the following table.

Before clock		After clock	
J	K	Q	$\overline{Q}$
0	0	No change	
1	0	1	0
0	1	0	1
1	1	Toggles	

PRESETTABLE DECADE DIVIDERS N8290A and N8292A

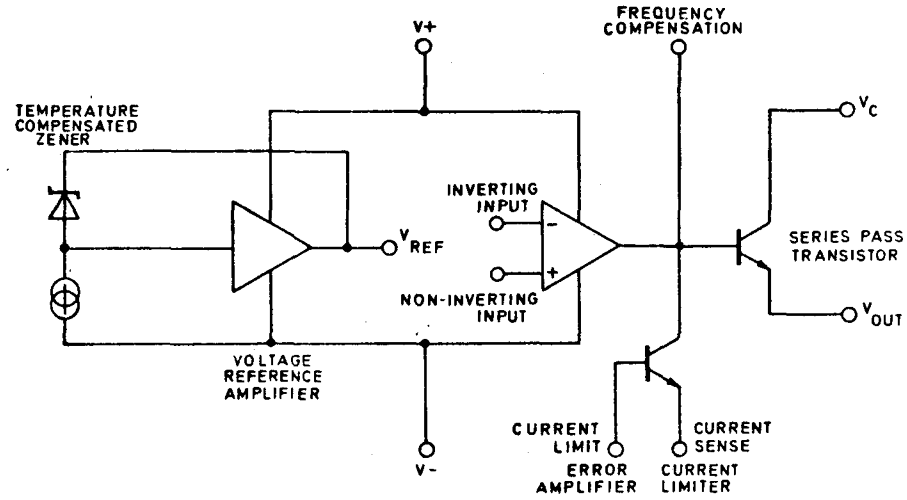
5. The N8290A and N8292A are presettable dividers which count the Ck1 (clock 1) inputs. Each A output is connected to the Ck2 (clock 2) input to provide a divide-by-ten counter. The A, B, C and D outputs are binary-coded decimal (BCD) as given in Table (Chap. 2). When the S (strobe) input is at '0' the ('1' or '0') inputs to Da, Db, Dc and Dd are transferred to the A, B, C and D outputs. Counting recommences when the S input is at '1'. An R (reset) input is not used in this equipment.

Presettable binary dividers N8291A

6. The N8291A is a presettable divider which counts the Ck1 (clock 1) inputs. The A output is connected to Ck2 (clock 2) to provide a 4 bit binary counter. The A, B, C and D outputs are in binary code. When the S (strobe) input is at '0' the ('1' or '0') inputs to Da, Db, Dc and Dd are transferred to the A, B, C and D outputs. Counting recommences when the S input is at '1'. An R (reset) input is not used in this equipment.

Power Supply Regulator 723 HC

7. 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, as described in Chap. 2, para. 57.



Equivalent Circuit 723HC

CHAPTER 3

TEST EQUIPMENT

INTRODUCTION

1. The following test equipment is required for adjustment and fault location purposes.

LIST OF EQUIPMENT

2. (1) Power Supply
The MA.925 can be powered from the Manpack battery or from a suitable 24 volt source such as the Test Set Type CA.531. The load is approximately 130mA.

(2) Multimeter
20 000 ohms per volt
Example: AVO 8.

(3) Digital Frequency Meter

Frequency:	100Hz to 80MHz with resolution to 0.1 Hertz.
Sensitivity:	100mV r.m.s.
Input:	High impedance, or a high impedance active probe must be available.

Example: Racal Type 9837.

(4) Electronic Voltmeter (not essential if suitable oscilloscope available).

AC Input Impedance:	1 megohm or 50 ohm inputs
Frequency Range:	Up to 100MHz.
Measurement Range:	10mV to 250mV.

Example: Farnell TM6/F6000 or Racal Airmec 301A.

(5) Oscilloscope (not essential if electronic voltmeter is available, but is useful for fault location).

Bandwidth:	80MHz or better.
Sensitivity:	100mV/cm when used with high impedance probe.

Example: Tektronix 465 with probe.

(6) Test Set
Racal Type CA.531.

(7) Neosid Trimming Tool
For potentiometers, coils and trimmer capacitor.

(8) Terminating Resistor
50 ohm, ± 10%, $\frac{1}{4}$ watt. Used to terminate outputs. Not required when the 50 ohm input to the electronic voltmeter is used.

CHAPTER 4

ADJUSTMENTS

INTRODUCTION

1. Adjustments to the synthesizer circuitry are not normally required. Random adjustments should not be made an attempt to improve performance. The crystal oscillator is pre-aged, therefore, adjustments are only required at infrequent intervals. It is normally not necessary to remove the printed circuit board from the chassis for adjustment purposes.

ACCESS TO ADJUSTMENTS

2. Access to the adjustment potentiometer for the TCXO is gained via a hole in the cover of the synthesizer, after the main manpack cover has been removed. It is necessary to remove the metal cover from the synthesizer (after first removing the transceiver cover) to gain access to the remainder of the potentiometers.

POWER UNIT ADJUSTMENTS

Equipment Required

3. (1) Test Set Type CA.531.

   (2) Multimeter 20 000 ohms per volt.

Procedure

CAUTION: The voltage levels of the 5V and 9V supply circuits MUST NOT be set above the levels given in the following procedure.

4. (1) Connect up the d.c. power supply to pin 44 (+ve) and earth pin 43 (0 volts), (or via a manpack socket).

   (2) Connect the multimeter +ve lead to pin 44 on the p.c.b., the -ve lead to chassis. Switch on the power supply and the equipment and check that the multimeter indicates approximately 24 volts. (The synthesizer will function satisfactorily with supply voltages within the range 11V to 32V but the nominal 24V input is desirable for setting-up).

   (3) Transfer the +ve lead of the multimeter to TP49 and check for indication of 5 volts plus or minus 100mV. If necessary adjust potentiometer R91 to obtain the correct level.

   (4) Transfer the +ve lead of the multimeter to TP50 and check for an indication of 9 volts plus or minus 100mV. If necessary, adjust potentiometer R101 to obtain the required level.

FREQUENCY STANDARD AND 1.4MHz OUTPUT LEVEL ADJUSTMENTS

5. The easiest way to check the 5MHz reference frequency is to check the frequency of the 1.4MHz output, which is derived from the 5MHz source. The following procedure should be adopted.

Equipment Required

6. (1) Digital Frequency Meter.

   (2) Electronic Voltmeter or Oscilloscope.

   (3) 50Ω Terminating Resistor (for use with oscilloscope).

Procedure

7. (1) Disconnect the 1.4MHz output, from pins 61 and 62.

   (2) Connect a 50Ω terminating resistor across pins 61 and 62 if an oscilloscope is to be used.

   (3) If an electronic voltmeter with 50Ω input impedance is to be used connect it across pins 61 and 62 without using a terminating resistor.

   (4) Connect the digital frequency meter across the 50Ω resistor or the electronic voltmeter.

   (5) Switch on and check that the digital frequency meter indicates 1.400000Hz ± 0.5Hz at a room temperature of 25 ± 1°C (77 ± 2°F). If the frequency is incorrect adjust R2 to suit.

   NOTE: A slight change in frequency will occur at temperatures other than that quoted.

   (6) Check that the indicated output level is approximately 300mV r.m.s. (850V peak-to-peak).

   (7) If the output level is incorrect tune T18 to give a maximum output.

   (8) Switch off, remove test gear and replace disturbed connections.

MAIN OUTPUT FREQUENCY CHECK AND LEVEL ADJUSTMENT

8. The main output frequency is checked as follows. The only adjustment provided controls the level of the output.

Equipment Required

9. (1) Digital Frequency Meter.

(2) Electronic Voltmeter or Oscilloscope.

(3) 50Ω Terminating Resistor (for use with oscilloscope).

Procedure

10. (1) Disconnect the manpack output from pins 41 and 42.

(2) Connect a 50Ω terminating resistor across pins 41 and 42 if an oscilloscope is to be used.

(3) If an electronic voltmeter with 50Ω input impedance is to be used connect it across pin 41 and 42 without using a terminating resistor.

(4) Connect the digital frequency meter across the 50Ω resistor or the electronic voltmeter.

(5) Switch on. Select a frequency of 15.000MHz at the front panel controls.

(6) Check that the frequency meter indicates 50 400 000 ± 40Hz at a room temperature of 25 ± 1°C (77 ± 2°F).

NOTE: A slight change in frequency may be noted at other temperatures.

(7) Check that the output level is typically 600mV r.m.s. (1.7V peak-to-peak). If necessary, adjust output level using R70.

(8) Set the front panel controls to 05.000MHz, and check that the indicated output is 40400 000 ± 30Hz at 25°C, at approximately 600mV r.m.s.

(9) Set the front panel controls to 25.000MHz, and check that the indicated output is 60 400 000 ± 50Hz.

TRACKING OF VCO's

11. The following procedure is only necessary if the varactor or coils of the VCO's have been replaced or disturbed.

Equipment Required

12. Multimeter 20 000 ohms per volt.

Procedure

13. (1) Select 9.999MHz at decade switches.

(2) Connect a multimeter to p.c.b. pin 33, (-ve lead to chassis). The reading should be 11V ± 200mV d.c.

(3) If voltage is incorrect adjust L2 to suit.

(4) Select 19.999MHz at decade switches.

(5) Check that indicated voltage is again 11V ± 200mV d.c.

(6) If voltage is incorrect adjust L3 to suit.

(7) Select 29.999MHz at decade switches.

(8) Check that indicated voltage is 8.7V ± 300mV d.c.

(9) If voltage is incorrect adjust L4 to suit.

(10) If either L2, L3 or L4 setting is disturbed, repeat complete procedure.

(11) Select 1.600MHz. Check that indicated voltage at pin 32 (Lock Indicator) is greater than 2V d.c.

(12) Select 1.600MHz. With multimeter again connected to p.c.b. pin 33 check that indicated voltage is greater than 2V d.c.

(13) Select 10.000MHz and repeat operations (11) and (12).

(14) Select 20.000MHz and repeat operations (11) and (12).

(15) Switch off and remove test gear.

34MHz OUTPUT LEVEL ADJUSTMENT

Equipment Required

14. (1) Digital Frequency Meter.

(2) Electronic Voltmeter or Oscilloscope.

(3) 50Ω Terminating Resistor (for use with oscilloscope).

Procedure

15. (1) Disconnect the 34MHz output from p.c.b. pins 58 and 59.

(2) Connect a 50Ω terminating resistor across pins 58 and 59 of the p.c.b. if an oscilloscope is to be used.

(3) If an electronic voltmeter with 50Ω input impedance is to be used connect it across pins 58 and 59 without using a terminating resistor.

(4) Connect the digital frequency meter across the 50Ω resistor or the electronic voltmeter.

(5) Switch on and check that the digital frequency meter indicates 34 000 000Hz ± 30Hz.

(6) Check that the output level is typically 450mV r.m.s. (1.3V peak-to-peak). If incorrect adjust T9 and T11 for peak output.

34MHz CLARIFIER ADJUSTMENT

Equipment Required

16. (1) Digital Frequency Meter.

(2) Multimeter.

Procedure

17. (1) Connect the digital frequency meter to pins 58 and 59 on the p.c.b.

(2) Connect the multimeter to TP55.

(3) Switch on and set the CLARIFIER to the 'lock' position. Check that the digital frequency meter indicates 34 000 000Hz ± 30Hz. If necessary adjust C80 until the frequency is correct.

(4) Check that the multimeter indicates 5.20V ± .15V. If incorrect further adjust C80 noting that the frequency reading remains correct.

CHAPTER 5

FAULT LOCATION

INTRODUCTION

1. The following procedure is intended to allow a faulty stage to be diagnosed with minimal effort. The equipment required for fault location is given in Chapter 3.

NOTE: Those checks in paras. 2, 3 and 4, can be made with the Synthesizer Cover in position with access from the Receiver side. Other checks are made with Synthesizer Cover removed.

Output Checks

2. The main output level and frequency can be checked as given in Chapter 4, para. 8. Check each position of the five switches. If the main output is incorrect start fault location at Power Supply Checks, para. 8.

1.4MHz Output Check

3. The 1.4MHz output can be checked as given in Chapter 4, para. 5.

NOTE: The 1.4MHz is muted when the synthesizer is out of lock or in AM (receive). If the 1.4MHz output is incorrect AND the lock indicator (Pin 32) is 'high' (i.e. main loop is in lock) then refer to para. 50 for fault location.

34MHz Output Check

4. The 34MHz output can be checked as given in Chapter 4, para. 15. If the 34MHz output is incorrect and the lock indicator (pin 32) is high then refer to para. 38 for fault location.

Switch Checks

5. If the main output is out of lock on only certain frequencies, this can give an indication of the fault.

6. If the output is incorrect over all or most of one setting of the 10MHz switch and is correct for the other two positions the fault is probably due to one oscillator not switching on. In this case proceed with fault location para. 32.

7. If in any of the switch positions a steady output is obtained but at the wrong frequency, then the switch wiring should be checked followed by a check that the correct code (see Chapter 2 Tables 2 & 3) is presented to the p.c.b. pins

Power Supply Checks

8. Check for 5 volt, 9 volt and 15 volt d.c. supplies at test points TP49, TP50 and TP51 respectively. If necessary adjust R91 to correct the 5V line or R101 for the 9V line.

NOTE: If the 9V line is shorted the 5V line will drop to approximately 1 volt. If the 5V line is shorted the 9V line will drop to approximately 5 volts.

If the power supplies are satisfactory proceed with the reference divider checks in para. 16.

9. If the 9V line is at 0V check for input voltage at test point TP48. If this is incorrect check for continuity of L17. If the voltage at TP48 is correct check for a short circuit on the 9V track.

10. If the 9V line is low (see note para. 8) check the potentiometer chain formed by resistors R100, R101 and R102. Check the voltage on the collector of transistor TR42 is greater than the voltage reading at test point TP50. If this condition is found, check for an open circuit condition of transistor TR41 or a faulty ML33.

11. A low 9V line can also be caused by excessive current load. If the voltage across resistor R103 exceeds 0.5V suspect a fault exists is one of the stages using the 9V supply. This can be traced by measuring the voltage drop across the decoupling resistor of each stage.

12. If the 5V line is at 0V check for an input voltage at test point TP46. If this is incorrect check for continuity of L16. If the voltage is correct check for a short circuit on the 5V line.

13. If the 5V line is low (see note para. 8) check the potentiometer chain formed by resistors R90, R91 and R92. Check for an open circuit transistor TR40 or a faulty ML32 or diode D24. Check also for a frequency of 25kHz on the collector of TR40 (see Typical Voltages and Waveforms para. 56). If this is not present check for 25kHz from the reference divider ML10 at pins 5 and 6.

14. If the 15V line is at 0V check for a short circuit on the 15V track. If the 15V line is slightly low check for excessive current in the phase comparator.

15. If the 15V line reads approximately 7.5 volts check for 100kHz from the reference divider. If this is correct check the operation of TR44 and TR45 stages.

Reference Divider Checks

16. Check for a 500Hz squarewave at test point TP26 (TTL levels, see para. 56(5)). The presence of this frequency indicates that the reference divider is working correctly. Proceed with the programmed divider checks in para. 20.

17. If there is no output, check ML12, ML10, ML8 and ML3 for division by 10. Each integrated circuit divides by 2 from Ck1 input to A output, and divides by 5 from Ck2 input to D output.

18. If the waveform on test point TP23 is incorrect (see para. 56) check the waveform on test point TP21. If this is correct check the action of TR2 stage.

19. If the waveform on test point TP21 is incorrect, first check the supply and earth potentials on the TCXO pins. If this is satisfactory suspect the TCXO.

Programmed Divider Check

20. Check the waveform on test point TP24 indicates a frequency of 500Hz with the main loop in lock. (see para. 56.) Note that if the main loop is out of lock the frequency at TP24 should be a little above or below 500Hz.

If this test is satisfactory proceed to para. 23.

21. If the waveform at test point TP24 is not correct check for an input waveform at test point TP22 (see para. 56). If this is not correct check the action of the shaper and prescaler. (see para. 36.)

22. Check the input to Ck1 and output D of flip-flops ML2, ML6, ML9, ML11 and ML13 in turn for correct division by 10.

23. Check for the correct waveform on test point TP25 (see para. 56). If the strobe pulse is absent check for a narrow negative pulse at G7 output (typically 200nS). If this is correct check the output of G1 (30 to 60nS) and if correct check the action of ML1B and ML4 (see Chapter 2 paras. 25-31).

Phase Comparator Check

24. (1) Ensure that the programmed divider (para. 20) and reference divider (para. 16) have been checked and are working correctly.

(2) Remove link LK1, and connect a variable voltage supply, 0-12V d.c. to p.c.b. pin 34.

NOTE: An alternative power supply arrangement for this test is to connect TP34 to the 5V line at TP49.

(3) Connect a digital frequency meter to the output, p.c.b. pins 41 and 42.

(4) Set the front panel switches to 20 000MHz.

(5) Adjust the variable voltage supply, if used, to give an output frequency of approximately 60MHz.

25. Check that the voltage at pin 33 is less than 2V d.c. If this test is satisfactory proceed to para. 27.

26. Check for wide positive pulses at TP31 and very narrow pulses at TP30. If this is satisfactory check the action of transistors TR14, TR13 and TR16. If these tests are satisfactory suspect IC ML23.

27. Set the front panel switches to 29.999 (do not adjust frequency). Check that the voltage on pin 33 is greater than 12V d.c. If satisfactory this indicates that the phase comparator is working correctly.

28. If the test in para. 27 is not satisfactory check for wide positive pulses on TP30 and very narrow pulses on TP31. If this is satisfactory check the action of transistors TR9, TR10, TR11, TR12 and TR16. If these tests are satisfactory suspect IC ML23.

Out of Lock Indicator

29. If the loop locks correctly but the lock indication output on pin 32 is low, look for a short circuit on or connected to this pin.

Check, using the oscilloscope, the pulse shape at TP29. If this is incorrect or too wide, check the phase comparator output stage, checking transistors TR12, TR13, TR16 and capacitor C29, for leakage. If these tests are unsatisfactory check the function of G16 to 21 and transistor TR15.

Oscillator Checks

30. (1) Remove link LK1, and connect a variable voltage supply, 0-12V d.c., to p.c.b. pin 34.

(2) Set supply voltage to 11 volts (Pin 34).

(3) Set the front panel X10 MHz switch to positions 0, 1 and 2 in turn and check that the frequency at p.c.b. pins 41 and 42 is approximately 45.4MHz, 55.3MHz and 67.5MHz respectively.

31. If the tests in para. 30 are satisfactory proceed to para. 35. If two or three of the switch positions give the same frequency the oscillators are not switching correctly.

32. Check the d.c. voltage at test point TP35, TP36 and TP37. With the X10 MHz switch set to '0' position TP35 should be the only TP reading high.

Set X10 MHz switch to position 1 TP36 only TP reading high
Set X10 MHz switch to position 2 TP37 only TP reading high

If these tests are satisfactory proceed to para. 35.

33. Check the front panel switch wiring and ensure that the code presented to the inputs of ML1B is correct (See Chapter 2, Table 3). If unsatisfactory check the action of G11, G12 and G14.

34. Check the action of transistors TR23, TR26 and TR28. One only should be saturated, corresponding to the X10 MHz switch position selected.

35. If the oscillator selection is satisfactory, check the waveform on the collectors of transistors TR30, TR32 and TR33. (See para. 56.) If one output is missing check the corresponding transistor. If all three waveforms are missing check transistor TR31 and the biasing resistors.

36. Check that the oscillator output is present at TP19 and that the output of transistor TR1 is as shown in para. 56.

37. Check that the prescaler output at TP22 is at half the shaper frequency (see para. 56).

34MHz Generator Check

NOTE: When carrying out tests in para. 45 an oscilloscope of the sampling type (if available) is recommended but tests using the 100MHz Type and probe have also been included.

38. Check the power supplies as given in para. 8.

39. If the output frequency is incorrect proceed with para. 41. If the output level is low, check the oscillator stage components TR56, XL1 and diode D40.

40. If there is an output from the oscillator, check the amplifier stage components i.e. transistor TR65, output transformer T11 and the coaxial wiring.

41. If the frequency is wrong only when the clarifier is set to 'lock', proceed with para. 43. If the frequency is wrong only on clarify, check the wiring of the clarifier potentiometer and check diode D38. Check the voltage at TP55; as the clarifier is turned clockwise the voltage should vary from approximately 7V to 3.3V d.c.

42. If the frequency is wrong in the 'clarify' and 'lock' positions, check the oscillator components i.e. capacitor C80, crystal XL1 and diode D40. If necessary adjust C80 (see Chapter 4, Para. 16).

43. If the frequency is wrong only when set to the 'lock' position, check that the voltage on transistor TR53 collector is at least 8.5V d.c. If this voltage is low check the action of transistors TR52 and TR53 and the switch on the 'clarifier' control.

44. Check for 100kHz input at test point TP63. Check for a narrow negative pulse on transistor TR64 collector at 100kHz.

45. Check for a positive pulse on TP56. Using the Sampling Oscilloscope this pulse is approximately 13 volts peak to peak and 12nS wide.

Using the 100MHz oscilloscope and a 10pF probe the pulse can be detected and will appear to be approximately 5 volts peak to peak.

46. Check on the collector of transistor TR57 for an output of approximately 1.5V peak to peak at 34MHz.

47. If the results of the tests carried out in paras. 42 and 43 are satisfactory, the output of the sampling gate transistor TR59 can be measured. Connect the oscilloscope across C89 and check for a sinusoidal waveform of approximately 1 volt peak to peak, biased at 7 volts d.c. (see note). The frequency of this 'error' signal is the difference between the output frequency and 34.000MHz.

NOTE: If the 'clarifier' is in-lock the output of TR59 will be between 6V and 9V d.c., with no AC component.

48. Check the operation of the d.c. amplifier consisting TR60, TR61 and TR62. The output is measured at test point TP57 and gives approximately 8 volts peak to peak in out-of-lock condition or a steady d.c. level if the circuit is in-lock.

49. Check that the waveform at TP57 is present on the emitters of TR55 and TR54. Check that this waveform is transmitted via diode D39 to TP55.

NOTE: The amplitude of the waveform at TP55 will be attenuated by the filter formed by R126, R125 and C79.

1.4MHz Generator Check

50. Check the power supplies as given in para. 8.

51. Check for 100kHz input at TP63.

52. Check that the voltage present on transistor TR75 emitter is greater than 8.5V d.c. If this voltage is low check that the voltage at TP64 is less than 0.5V d.c.

53. Check the waveform at the collector of transistor TR72 (see para. 56). If this is correct check for 1.4MHz output from crystal XL9. This should be about 20-30mV peak to peak at 1.4MHz.

54. If the tests carried out in para. 53 have been satisfactory check the operation of amplifier stages consisting transistors TR73 and TR74.

Muting Check

55. Connect the oscilloscope or an electronic voltmeter to the 1.4MHz output, p.c.b. pins 61 and 62.

Switch on the manpack and check that the 1.4MHz output is less than 10mV when AM is selected with the manpack in the receive condition. Check that the level is approximately 300mV in all other modes.

NOTE: *If the synthesizer is not connected to the manpack the muting can be checked by* connecting mute pin TP66 to the +5V line TP49. The 1.4MHz output is also muted when the synthesizer is out of lock.

VOLTAGE MEASUREMENTS AND WAVEFORMS

56. Typical voltage readings and waveforms are given on the following pages. Voltage readings were taken on a good quality 20 000 ohms per volt instrument, waveforms are recorded on an oscilloscope.

TABLE OF VOLTAGES AND WAVEFORMS

NOTES 1: All measurements are relative to chassis (0 volts).

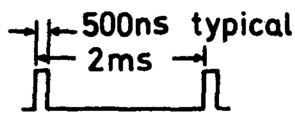
2: All readings are positive (+) unless otherwise indicated.

3: These readings are provided as a guide and do not represent a specification. Variations with frequency and component tolerances may be expected. The measurements were made with an AVO Type 8 (20kΩ/volt) multimeter using the 10V or 25V range, as appropriate.

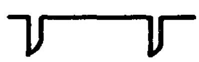
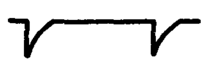
4: The Frequency selection switches of the manpack may be in any in-lock position except where *specific instructions are given.*

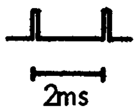
5: T.T.L. levels are defined as:- '0' condition = 0V to 0.4V
'1' condition = 2.4V to 5V.

TYPICAL VOLTAGES AND WAVEFORMS

Test Point	Typical Indication	
TP19	Approx. sinewave 37.0 to 65.4MHz	1 volt peak-to-peak.
TR1 collector	37.0 to 65.4MHz 	2.5V peak-to-peak.
TP22	18.5 to 32.7MHz 	T.T.L. level
TP24	500Hz (in lock). Mark-space ratio varies with frequency.	T.T.L. level
TP25	500Hz (in lock) 	Pulse width varies with frequency.
TP26	500Hz squarewave T.T.L. level	
TP21	5MHz approx. sine wave	1.5V peak-to-peak
TP23	5MHz approx. sine wave	3.5V peak-to-peak
Pin 33	D.C. level is dependent upon frequency	2 to 11V d.c.
TP35	With MHz x 10 switch in position 0 With MHz x 10 switch in position 1 or 2	3.5V d.c. 0V d.c.
TP36	With MHz x 10 switch in position 0 or 2 With MHz x 10 switch in position 1	0V d.c. 3.5V d.c.
TP37	With MHz x 10 switch in position 0 or 1 With MHz x 10 switch in position 2	0V d.c. 3.5V d.c.
TR30 collector	Sinewave 37.0 to 65.4MHz	0.6V peak-to-peak
TR32 collector	Approx. sinewave 37.0 to 65.4MHz	2V peak-to-peak when loaded with 50Ω
TR33 collector	Approx. sinewave 37.0 to 65.4MHz	3V peak-to-peak

TYPICAL VOLTAGES AND WAVEFORMS (Continued)

Test Point	Typical Indication	
TR40 collector 25kHz CAUTION. Ensure that TR40 collector is not grounded, even momentarily.		24V peak-to-peak
TP49	5V ± 100mV d.c.	
TP50	9V ± 100mV d.c.	
TP51	14 to 18V d.c. (nominal 15V).	
TR44 collector 100kHz		9V peak-to-peak
TR56 collector		6V peak-to-peak 34MHz
TR57 collector		2V peak-to-peak 34MHz
TP57	Clarifier control in LOCK	5.2V d.c.
TR64		100KHz, 100nS pulse width, 8V peak-to-peak
TP56	 in LOCK	very narrow 100KHz pulse, needs very good scope to see it.
TR72	100kHz 	4.5V peak-to-peak. pulse width typically 500ns.
TR73	1.4MHz sinewave	1.6V peak-to-peak
TR74	1.4MHz sinewave	8V peak-to-peak
TP63	100kHz 	

Test Point		Typical Indication	
TP29) TP30) TP31)	In LOCK		pulse width typically 200ns.

When out of lock TP29 and either TP30 or 31 will have a waveform of varying mark space ratio

TP30 will have this waveform if the frequency into the phase comparator (on TP25) is low, and the waveform on TP31 will then be as if it were in lock.

TP31 will have this waveform if the frequency into the phase comparator (on TP25) is high, and the waveform on TP30 will then be as if it were in lock.

ML25 Pin 3)
ML25 Pin 11) In Lock 0, Out of Lock 1

ML25 Pin 8)
TP32) In Lock 1, Out of Lock 0

CHAPTER 6

DISMANTLING AND RE-ASSEMBLY

NOTE: The term 'Manpack' is used to denote the complete assembly of transmitter/ receiver together with the Synthesizer Unit.

ACCESS TO THE SYNTHESIZER

1. (1) Remove the complete Manpack unit from its case (refer to Part 2 Chapter 5).

   (2) Place the unit on the bench and remove the transceiver cover (see Part 2, Chap.5, para. 8).

   (3) Remove the cover of the synthesizer by removing three screws from the end of the cover nearest to the front panel, loosening eight screws in the side of the cover and sliding the cover off.

   (4) The components side of the p.c.b. is now accessible. If access to the track side of the board is required loosen nine screws and swing the hinged board away from its normal position.

   (5) To re-assemble follow the above instructions in the opposite sense and sequence.

REMOVAL OF THE SYNTHESIZER UNIT

2. (1) Refer to paragraph 1 and carry out instructions (1) to (3).

   (2) Remove the escutcheon panel from the Synthesizer front panel (4 screws).

   (3) Ease off the plastic cap from each switch knob on the synthesizer (including SEARCH control) to reveal the collet screws. Loosen the screws.

   (4) Pull off the control knobs and unscrew the lock-nuts from each shaft.

   (5) Unsolder three coaxial and four multicore cables from the synthesizer p.c.b.

   (6) Remove nine screws holding the p.c.b. to the manpack.

   (7) Remove the p.c.b. from the hinge pivot studs and remove the p.c.b. complete with controls.

   (8) To re-assemble, follow the above instructions in the opposite sense and sequence.

CHAPTER 7

LIST OF COMPONENTS

NOTE Some of the resistors fitted to the synthesizer are 10% tolerance. The Components List printed here shows 5% resistors in all positions to simplify spares stocking.

Cct. Ref.	Value Ω	Description	Rat. W	Tol %	Racal Part Number
Resistors					
R1	10k	Variable, with switch			AD76494
R2	10k	Variable, lin. preset			920312
R3	4.7k	Fixed	1/3	5	922343
R4	100	Fixed	1/3	5	922328
R5	470	Fixed	1/3	5	922272
R6	22k	Fixed	1/3	5	922347
R7	2.2k	Fixed	1/3	5	922273
R8	470	Fixed	1/3	5	922272
R9	22k	Fixed	1/3	5	922347
R10	22k	Fixed	1/3	5	922347
R11	22k	Fixed	1/3	5	922347
R12	22k	Fixed	1/3	5	922347
R13	22k	Fixed	1/3	5	922347
R14	22k	Fixed	1/3	5	922347
R15	22k	Fixed	1/3	5	922347
R16	22k	Fixed	1/3	5	922347
R17	22k	Fixed	1/3	5	922347
R18	22k	Fixed	1/3	5	922347
R19	22k	Fixed	1/3	5	922347
R20	22k	Fixed	1/3	5	922347
R21	22k	Fixed	1/3	5	922347
R22	22k	Fixed	1/3	5	922347
R23	22k	Fixed	1/3	5	922347
R24	22k	Fixed	1/3	5	922347
R25	22k	Fixed	1/3	5	922347
R26	22k	Fixed	1/3	5	922347
R27 to R31	Not used				
R32	220	Fixed	1/3	5	925379
R33	10k	Fixed	1/3	5	925386
R34	1k	Fixed	1/3	5	922338
R35	10k	Fixed	1/3	5	922267

Cct. Ref.	Value Ω	Description	Rat. W	Tol. %	Racal Part Number
R36	4.7k	Fixed	1/3	5	922343
R37	220	Metal Oxide		5	900988
R38	2.2k	Metal Oxide		5	908270
R39	47k	Fixed	1/3	5	922349
R40	2.7k	Fixed	1/3	5	922343
R41	220	Metal Oxide		5	900988
R42	270k	Metal Oxide		5	915868
R43	33k	Metal Oxide		5	908291
R44	4.7k	Fixed	1/3	5	922343
R45	10k	Fixed	1/3	5	922267
R46	47	Metal Oxide		5	911930
R47	3.3k	Metal Oxide		5	900991
R48	47k	Fixed	1/3	5	922349
R49	10k	Metal Oxide		5	900986
R50	47k	Metal Oxide		5	908391
R51	Not Used				
R52	10k	Fixed	1/3	5	922267
R53	22k	Fixed	1/3	5	922347
R54 to R58	Not Used				
R59	22k	Fixed	1/3	5	922347
R60	220	Fixed	1/3	5	922332
R61	10k	Metal Oxide		5	900986
R62	6.8k	Metal Oxide		5	900987
R63	1k	Metal Oxide		5	908267
R64	22k	Fixed	1/3	5	922347
R65	10k	Metal Oxide		5	900986
R66	6.8k	Metal Oxide		5	900987
R67	22k	Fixed	1/3	5	922347
R68	10k	Metal Oxide		5	900986
R69	6.8k	Metal Oxide		5	900987
R70	10k	Variable, lin. preset			920312
R71	100k	Metal Oxide		5	908293
R72	100	Fixed	1/3	5	922328
R73	470	Fixed	1/3	5	922272

Cct. Ref.	Value Ω	Description	Rat. W	Tol. %	Racal Part Number
R74	220	Metal Oxide		5	900988
R75	47	Metal Oxide		5	911930
R76	10	Metal Oxide		5	912868
R77	33	Metal Oxide		5	908690
R78	470	Metal Oxide		5	900992
R79	470	Metal Oxide		5	900992
R80	1k	Metal Oxide		5	908267
R81	2.2k	Fixed	1/3	5	908270
R82	22	Fixed	1/3	5	911495
R83	10	Metal Oxide		5	912868
R84 to R88	Not Used				
R89	1k	Fixed	1/3	5	922338
R90	10k	Metal Oxide		5	900986
R91	10k	Variable, lin. preset			920312
R92	27k	Metal Oxide		5	908295
R93	4.7k	Fixed	1/3	5	922343
R94	470	Fixed	$\frac{1}{4}$	5	927758
R95	33	Metal Oxide	1/3	5	908690
R96	3.3k	Metal Oxide	1/3	5	900991
R97	220	Fixed	1/3	5	922332
R98	220	Fixed	1/3	5	922332
R99	2.2k	Fixed	1/3	5	922273
R100	3.3k	Metal Oxide		5	900991
R101	10k	Variable, lin. preset			920312
R102	27k	Metal Oxide		5	908295
R103	8.2	Metal Oxide		2	922106
R104	680	Wirewound	$2\frac{1}{2}$	5	913616
R105	Not Used				
R106	47k	Fixed	1/3	5	922349
R107	10k	Fixed	1/3	5	922267
R108	4.7k	Fixed	1/3	5	922343
R109	10k	Fixed	1/3	5	922267
R110	4.7k	Fixed	1/3	5	922343
R111	22k	Fixed	1/3	5	922347

Cct. Ref.	Value Ω	Description	Rat. W	Tol. %	Racal Part Number
R112	22	Fixed	1/3	5	922320
R113 to R117	Not Used				
R118	22k	Fixed	1/3	5	922347
R119	4.7k	Fixed	1/3	5	922343
R120	220	Metal Oxide		5	900988
R121	6.8k	Metal Oxide		5	900987
R122	47k	Fixed	1/3	5	922349
R123	470k	Fixed	1/3	5	922357
R124	22k	Fixed	1/3	5	922347
R125	470	Fixed	1/3	5	922272
R126	220	Fixed	1/3	5	922332
R127	10k	Fixed	1/3	5	922267
R128	10k	Fixed	1/3	5	922267
R129	22k	Fixed	1/3	5	922347
R130	470	Fixed	1/3	5	922272
R131	1k	Fixed	1/3	5	922338
R132	3.3k	Fixed	1/3	5	922363
R133	3.3k	Fixed	1/3	5	922363
R134	3.3k	Fixed	1/3	5	922363
R135	22	Fixed	1/3	5	911495
R136	100	Fixed	1/3	5	922328
R137	10M	Fixed	1/3	10	918963
R138	10K	Fixed	1/3	5	918073
R139	22k	Fixed	1/3	5	922347
R140	10k	Fixed	1/3	5	922267
R141	470k	Fixed	1/3	5	922357
R142	47k	Fixed	1/3	5	922349
R143	47	Metal Oxide		5	911930
R144 to R150	Not Used				
R151	4.7k	Fixed	1/3	5	922343
R152	2.2k	Fixed	1/3	5	922273
R153	2.2k	Fixed	1/3	5	922273
R154	470	Fixed	1/3	5	922272
R155	470	Fixed	1/3	5	922272

Cct. Ref.	Value Ω	Description	Rat. W	Tol. %	Racal Part Number
R156	220	Fixed	1/3	5	922332
R157	470	Fixed	1/3	5	922272
R158	100	Fixed	1/3	5	922328
R159	470	Fixed	1/3	5	922272
R160 to					
R165	Not Used				
R166	2.2k	Fixed	1/3	5	922273
R167	2.2k	Fixed	1/3	5	922273
R168	1k	Fixed	1/3	5	922338
R169	2.2k	Fixed	1/3	5	922273
R170	2.2k	Fixed	1/3	5	922273
R171	47k	Fixed	1/3	5	922349
R172	4.7k	Fixed	1/3	5	922343
R173	10k	Fixed	1/3	5	922267
R174	10k	Fixed	1/3	5	922267
R175	2.2k	Fixed	1/3	5	922273
R176	220	Fixed	1/3	5	922332
R177	10k	Fixed	1/3	5	922267
R178	10k	Fixed	1/3	5	922267
R179	10k	Fixed	1/3	5	922267
R180	10k	Fixed	1/3	5	922267
R181	10k	Fixed	1/3	5	922267
R182	10k	Fixed	1/3	5	900986
R183	100	Fixed	1/3	5	920456
Capacitors					
	F				
C1	1000p	Disc ceramic		20	917419
C2	.01μ	Disc ceramic		+50-25	911845
C3	.01μ	Disc ceramic		+50-25	911845
C4	.01μ	Disc ceramic		+50-25	911845
C5	.01μ	Disc ceramic		+50-25	911845
C6	.01μ	Disc ceramic		+50-25	911845
C7	.01μ	Disc ceramic		+50-25	911845
C8	.01μ	Disc ceramic		+50-25	911845
C9	.01μ	Disc ceramic		+50-25	911845
C10	.01μ	Disc ceramic		+50-25	911845
C11	.01μ	Disc ceramic		+50-25	911845
C12	Not Used				
C13	.01μ	Disc ceramic		+50-25	911845
C14	.01μ	Disc ceramic		+50-25	911845
C15	.01μ	Disc ceramic		+50-25	911845

Cct. Ref.	Value F	Description	Rat.	Tol. %	Racal Part number
C16 to					
C21	Not used				
C22	220	Disc ceramic		10	931148
C23	.01μ	Disc ceramic		+50-25	911845
C24	.01μ	Disc ceramic		+50-25	911845
C25	.01μ	Disc ceramic		+50-25	911845
C26	2.2μ	Electrolytic	20		908316
C27	4.7μ	Electrolytic	10		905388
C28	0.1μ	Polyester			915502
C29	1μ	Polyester	±20		915370
C30	0.1μ	Polyester			915502
C31	.01μ	Disc ceramic		+50-25	911845
C32	0.1μ	Polyester			915502
C33 to					
C37	Not used				
C38	1000p	Disc ceramic		20	917419
C39	15μ	Electrolytic	20		910060
C40	1000p	Disc ceramic		25	917419
C41	1000p	Disc ceramic		25	917419
C42	1000p	Disc ceramic		25	917419
C43	1000p	Disc ceramic		25	917419
C44	4.7μ	Electrolytic		10	905388
C45	100p	Disc ceramic		10	917417
C46	100p	Disc ceramic		10	917417
C47	1000p	Disc ceramic		25	917419
C48	1000p	Disc ceramic		25	917419
C49	1000p	Disc ceramic		25	917419
C50	1000p	Disc ceramic		25	917419
C51	1000p	Disc ceramic		20	917419
C52	2.2μ	Electrolytic		20	908316
C53	1000p	Disc ceramic		25	917419
C54	1000p	Disc ceramic		20	917419
C55	47p	Disc ceramic		10	917418
C56 to					
C60	Not used				

Cct. Ref.	Value F	Description	Rat.	Tol. %	Racal Part Number
C61	4.7µ	Electrolytic		10	905388
C62	4.7µ	Electrolytic		50	918969
C63	4.7µ	Electrolytic		50	918969
C64	0.1µ	Polyester			915502
C65	0.1µ	Polyester			915502
C66	100µ	Electrolytic	10V		918972
C67	1000p	Disc Ceramic		25	917419
C68	15µ	Electrolytic	20V		910060
C69	2.2µ	Electrolytic	20V		908316
C70	2.2µ	Electrolytic	20V		908316
C71	2.2µ	Electrolytic	20V		908316
C72	47p	Disc Ceramic		10	917418
C73 to C77	Not used				
C78	2.2µ	Electrolytic	20V		908316
C79	4.7µ	Electrolytic	10V		905388
C80	3-9p	Variable			918974
C81	220p	Silver mica	125V	2	923898
C82	100p	Silver mica	125V	2	920264
C83	.01µ	Disc ceramic		+50-25	911845
C84	47p	Silver mica	125V	2	920660
C85	1000p	Disc ceramic		20	917419
C86	1000p	Disc ceramic		25	917419
C87	.01µ	Disc ceramic		+50-25	911845
C88	1000p	Disc ceramic		25	917419
C89	220p	Silver mica		10	923898
C90	100p	Disc ceramic		10	917417
C91	.01µ	Disc ceramic		+50-25	911845
C92	100p	Disc ceramic		10	917417
C93	2.2µ	Electrolytic	20V		908316
C94	47p	Disc ceramic		10	917418
C95	.01µ	Disc ceramic		+50-25	911845
C96	100p	Disc ceramic		10	917417
C97	.01µ	Disc ceramic		+50-25	911845
C98	47p	Silver mica	125V		920660

Cct. Ref.	Value F	Description	Rat.	Tol. %	Racal Part Number
C99	.01μ	Disc ceramic		+50-25	911845
C100	47p	Disc ceramic		10	917418
C101 to					
C105	Not used				
C106	100p	Disc ceramic		10	917417
C107	4.7μ	Electrolytic		10	905388
C108	47p	Disc ceramic		10	917418
C109	100p	Disc ceramic		10	917417
C110	47p	Disc ceramic		10	917418
C111	0.1μ	Polyester			915502
C112	.01μ	Disc ceramic		+50-25	911845
C113	1000p	Silver mica	125V	2	920091
C114	.01μ	Disc ceramic		+50-25	911845
C115	.01μ	Disc ceramic		+50-25	911845
C116	.01μ	Disc ceramic		+50-25	911845
C117	4.7μ	Electrolytic		10	905388

Inductors

L1	4.7μH	Choke	919468
L2		Choke	CT76401
L3		Choke	CT76402
L4		Choke	CT76403
L5	2.2μH	Choke	918985
L6	4.7μH	Choke	919468
L7	4.7μH	Choke	919468
L8 to			
L15	Not used		
L16	33μH	Choke	920063
L17	33μH	Choke	920063
L18		Choke	BT76406
L19 to			
L24	Not used		
L25	1mH	Choke	919033

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
Transformers					
T1					CT76485
T2					CT76485
T3 to					
T8	Not used				
T9					CT76405
T10					CT76408
T11					CT76405
T12 to					
T17	Not used				
T18					CT76404
Diodes					
D1		BAW62			918982
D2 to					
D7	Not used				
D8		ZC714			920267
D9		ZC714			920267
D10		ZC710			920725
D11		ZC710			920725
D12		BAW62			918982
D13		ZC710			920725
D14 to					
D19	Not used				
D20		BY210-400			926364
D21		BY210-400			926364
D22		BAW62			918982
D23		BY210-400			926364
D24		BZY92-C6V2			920269
D25		BAW62			918982
D26		BAW62			918982
D27		BAW62			918982
D28		BAW62			918982
D29		BAW62			918982

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
D30		BAW62			918982
D31 to D37	Not used				
D38		BAW62			918982
D39		BAW62			918982
D40		ZC708			920268
D41		BAW62			918982
D42		BAW62			918982
D43	Not used				
D44		BAW62			918982
D45		BAW62			918982

Transistors

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
TR1		ZTX313L			923105
TR2		ZTX313L			923105
TR3 to TR8	Not used				
TR9		ZTX313L			923105
TR10		BC109			914900
TR11		BFX48			915231
TR12		BFW10			916946
TR13		BFW10			916946
TR14		ZTX313L			923105
TR15		ZTX313L			923105
TR16		ZTX313L			923105
TR17 to TR22	Not used				
TR23		ZTX313L			923105
TR24		BFX48			915231
TR25		BFX48			915231
TR26		ZTX313L			923105
TR27		BFX48			915231
TR28		ZTX313L			923105
TR29		BFX48			915231
TR30		ZTX313L			923105
TR31		BFX89			916627
TR32		ZTX313L			923105
TR33		ZTX313L			923105

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
TR34 to					
TR39	Not used				
TR40		2N4037			922991
TR41		2N3054			911951
TR42		ZTX313L			923105
TR43		ZTX313L			923105
TR44		ZTX313L			923105
TR45		ZTX313L			923105
TR46 to					
TR51	Not used				
TR52		BFX48			915231
TR53		BFX48			915231
TR54		ZTX313L			923105
TR55		BFX48			915231
TR56		ZTX313L			923105
TR57		ZTX313L			923105
TR58		ZTX313L			923105
TR59		BFW10			916946
TR60		BFX48			915231
TR61		ZTX313L			923105
TR62		BFX48			915231
TR63		BFX48			915231
TR64		ZTX313L			923105
TR65		ZTX313L			923105
TR66 to					
TR71	Not used				
TR72		ZTX313L			923105
TR73		ZTX313L			923105
TR74		ZTX313L			923105
TR75		ZTX313L			923105
TR76		ZTX313L			923105
TR77		BC109			914900

<u>Integrated Circuits</u>

ML1		Dual J-K flip-flop 74S112J			920332
ML2		Presettable decade N8290A			920333
ML3		Presettable decade N8292A			918981
ML4		Presettable Counter N8291A			920525
ML5		Triple 3 I/P AND Gate 74S11J			920334

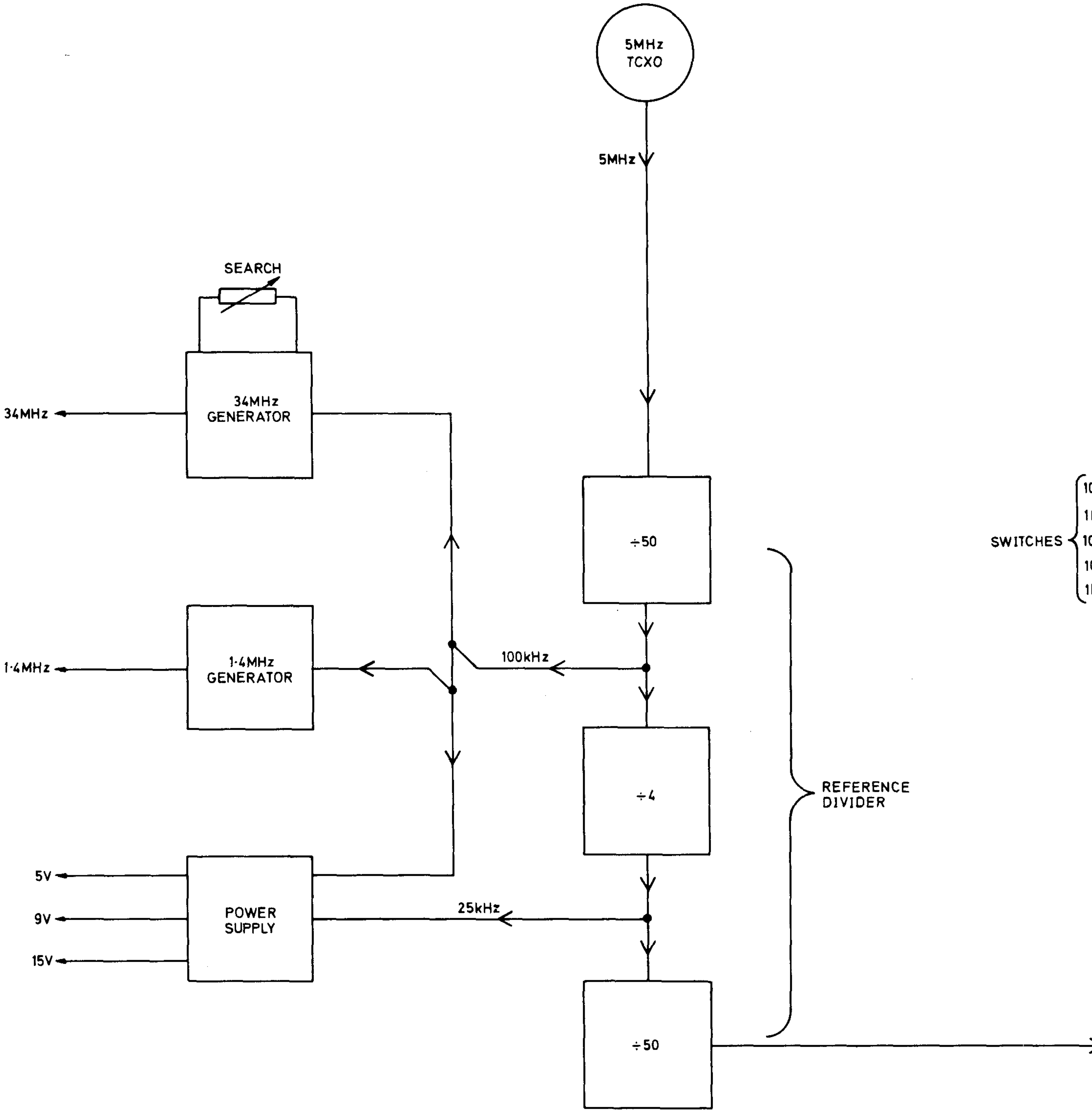
Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part Number
ML6		Presettable decade N8290A			920333
ML7		Triple 3 I/P Nandgate 7410J			918361
ML8		Presettable decade N8292A			918981
ML9		Presettable decade N8292A			918981
ML10		Presettable decade N8292A			918981
ML11		Presettable decade N8292A			918981
ML12		Presettable decade N8292A			918981
ML13		Presettable decade N8292A			918981
ML14		3 I/P Nandgate 7430J			919492
ML15		Not Used			
ML16		Quad 2 I/P Nand gate 74L00J			920335
ML17 to					
ML22	Not used				
ML23		Dual Type D flip-flop 74L74J			920336
ML24		Quad 2 I/P Nand gate 74L00J			920335
ML25		Quad 2 I/P Nand gate 74L00J			920335
ML26 to					
ML31	Not used				
ML32		Voltage regulator MA.723C			916155
ML33		Voltage Regulator MA.723C			916155

Switches

4SA					BSW76318
4SB					BSW76470
4SC					BSW76470
4SD					BSW76470
4SE					BSW76470

Miscellaneous

TCX0		5MHz frequency standard			AD75967
XL1		Crystal 17MHz			AD75907
XL2 to					
XL7	Not used				
XL8		Crystal 1.4MHz			AD75885
XL9		Crystal 1.4MHz			AD75885



WOH2099
Part 3

Block Diag

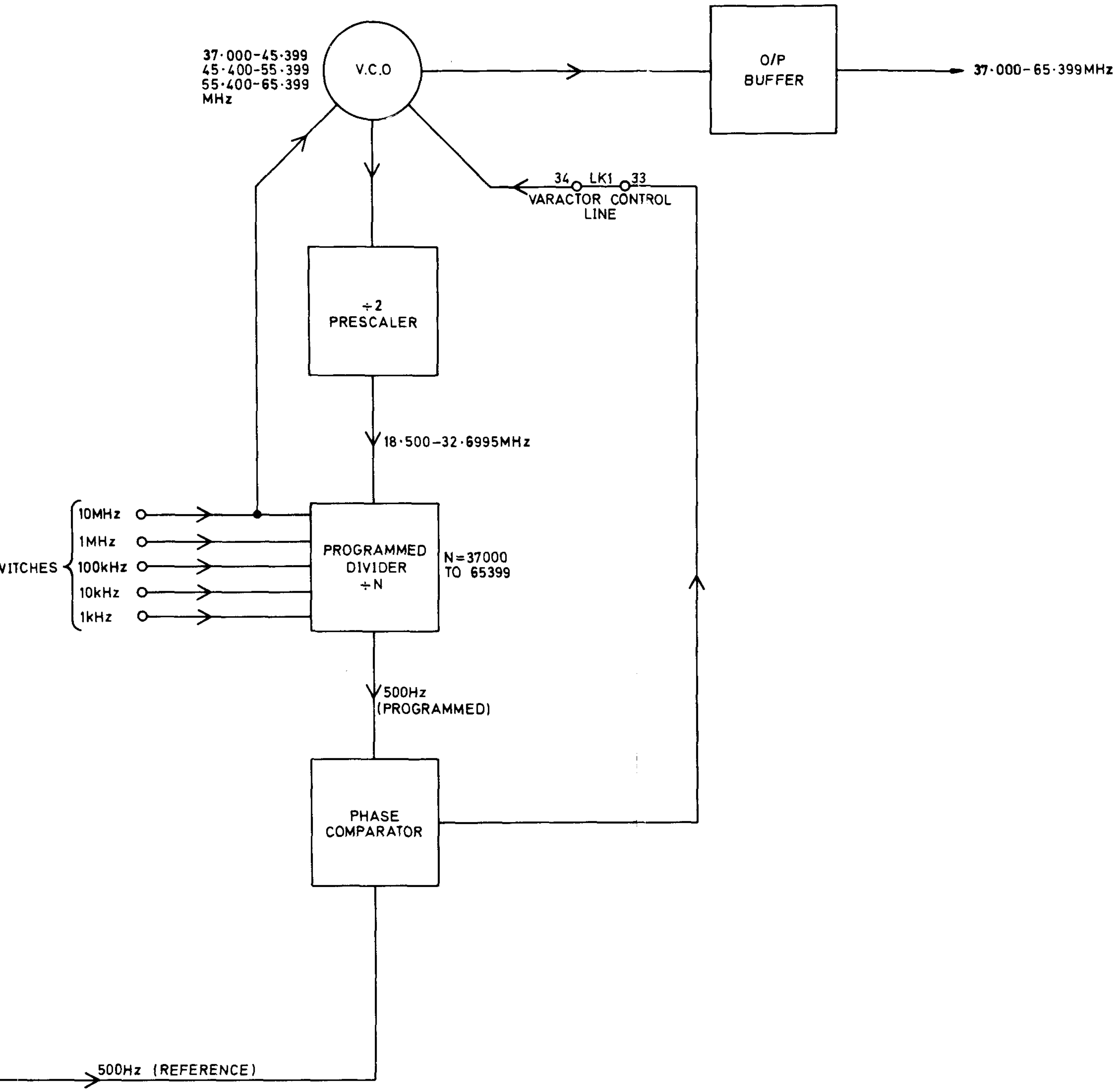
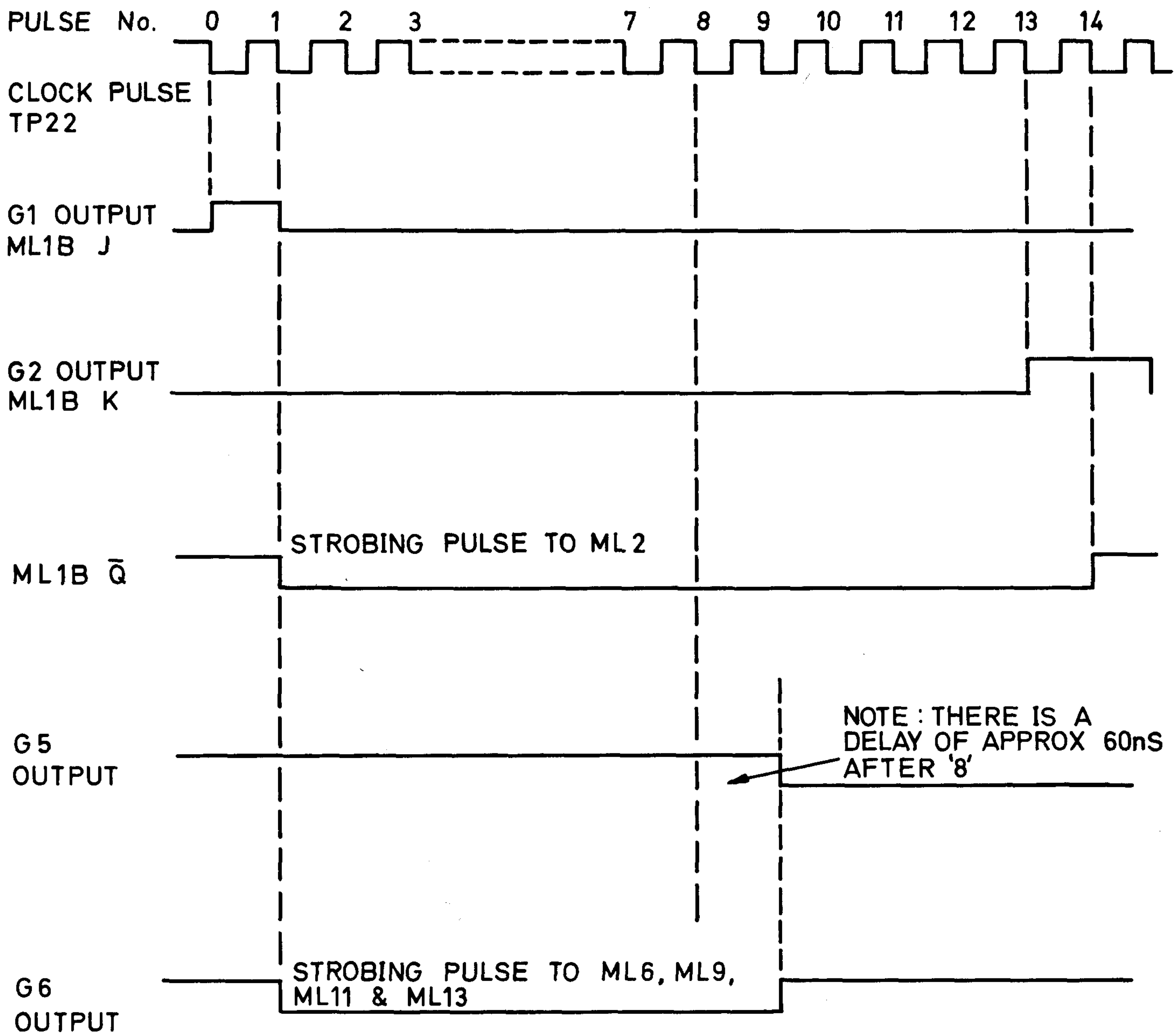


Diagram: MA.925

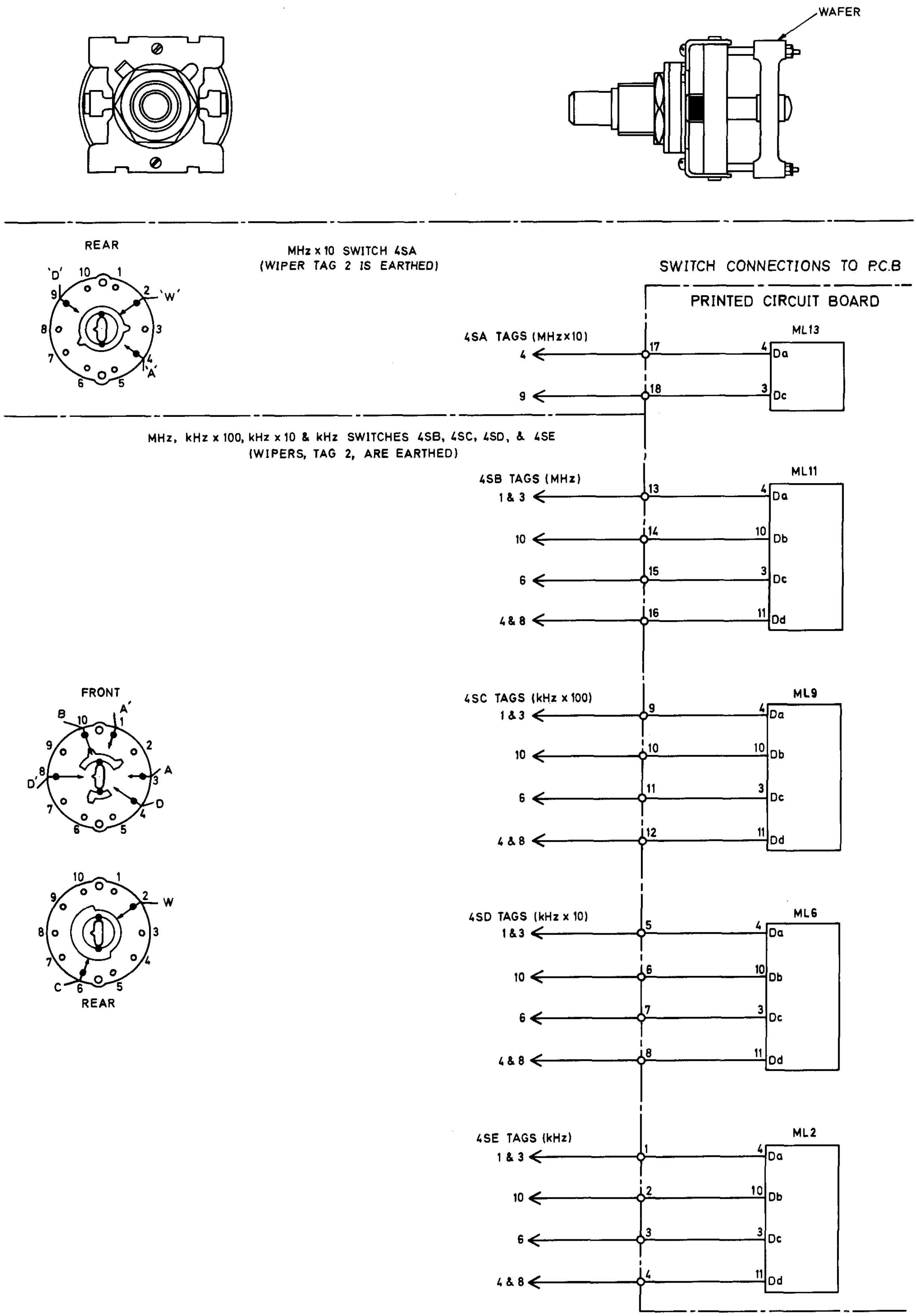
Fig. 1



WOH2099
Part 3

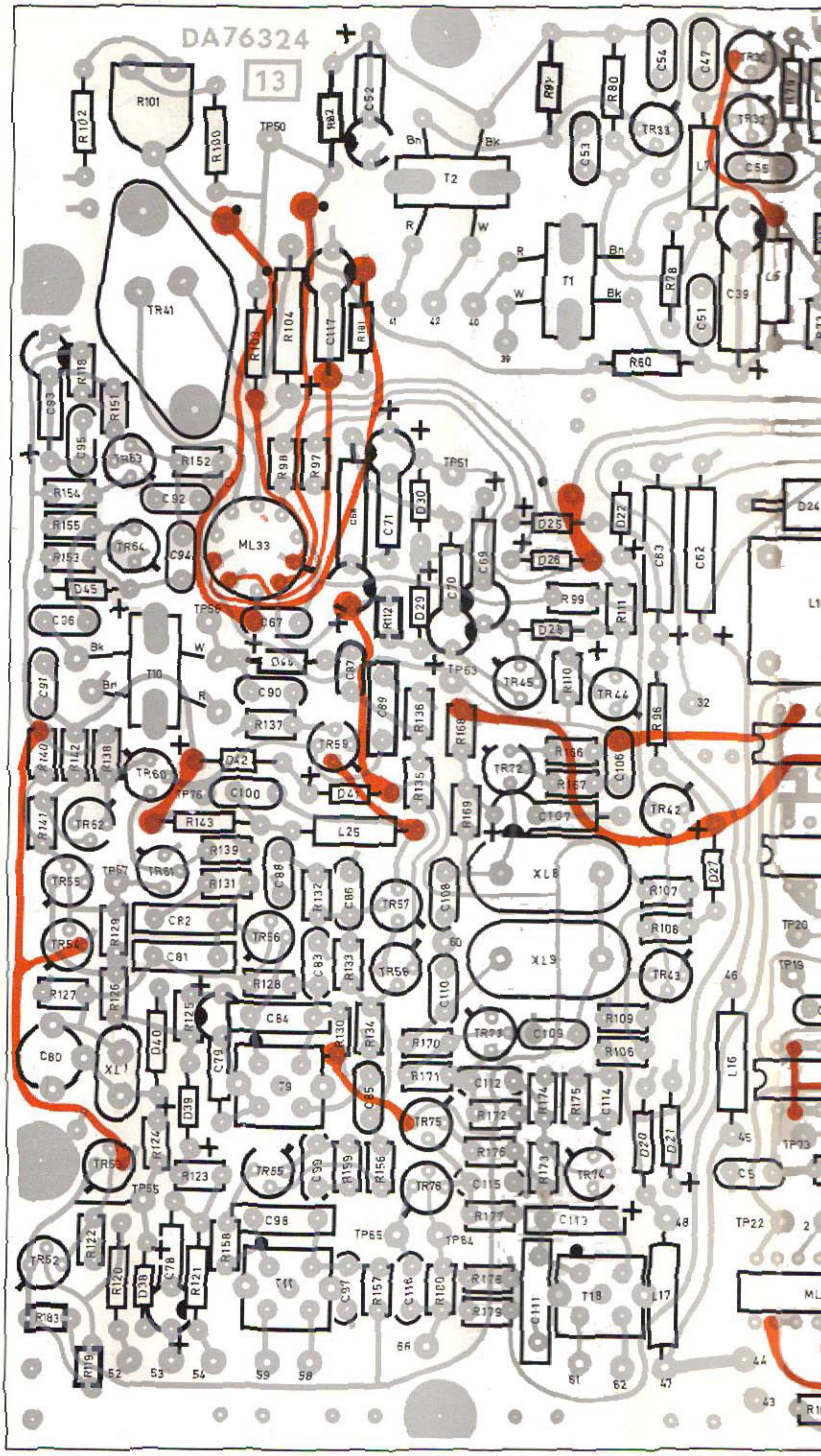
Strobing Waveforms MA.925

Fig. 2



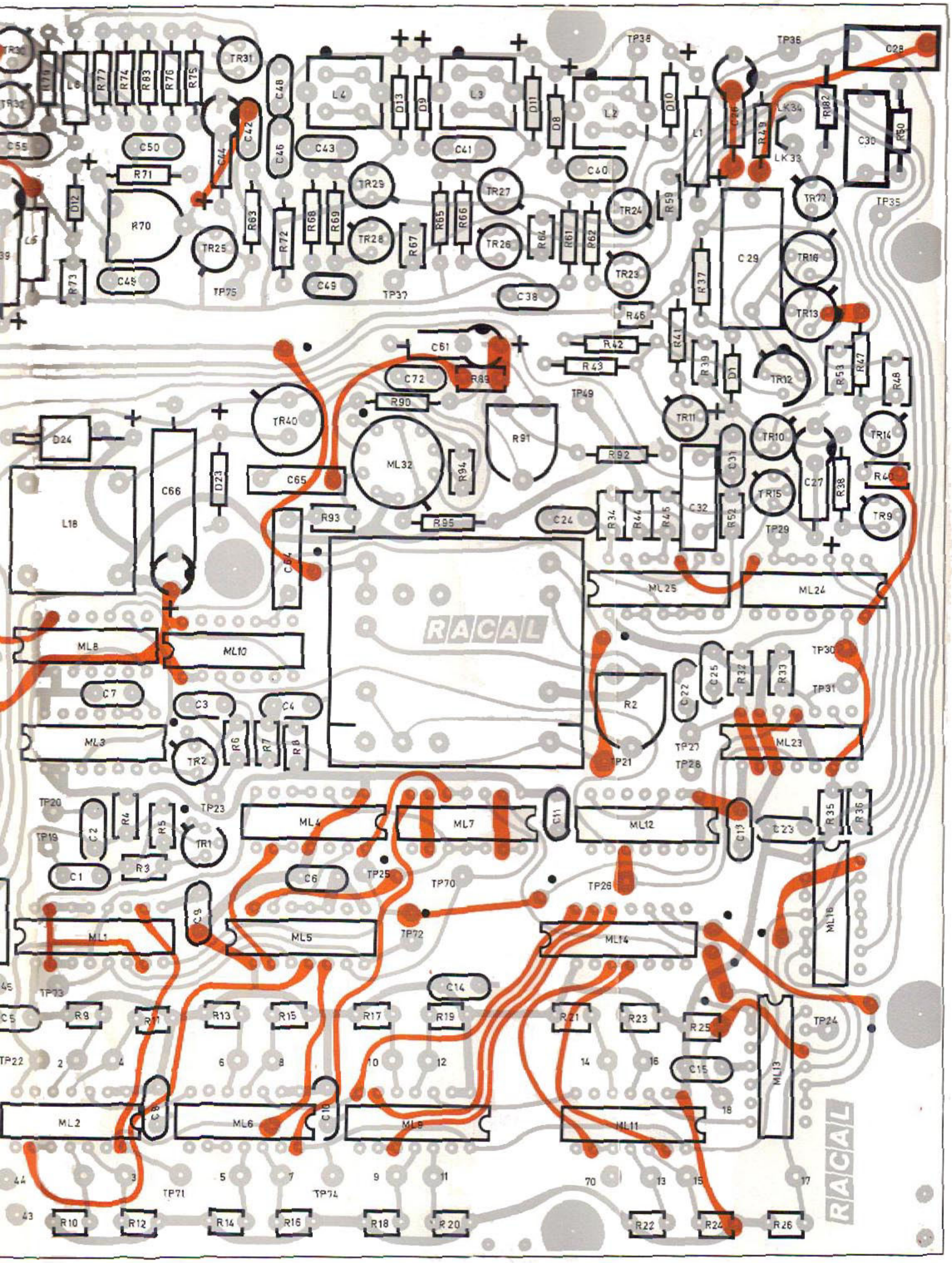
WOH2099
Part 3

Frequency Selector Switches MA.925 Fig. 3



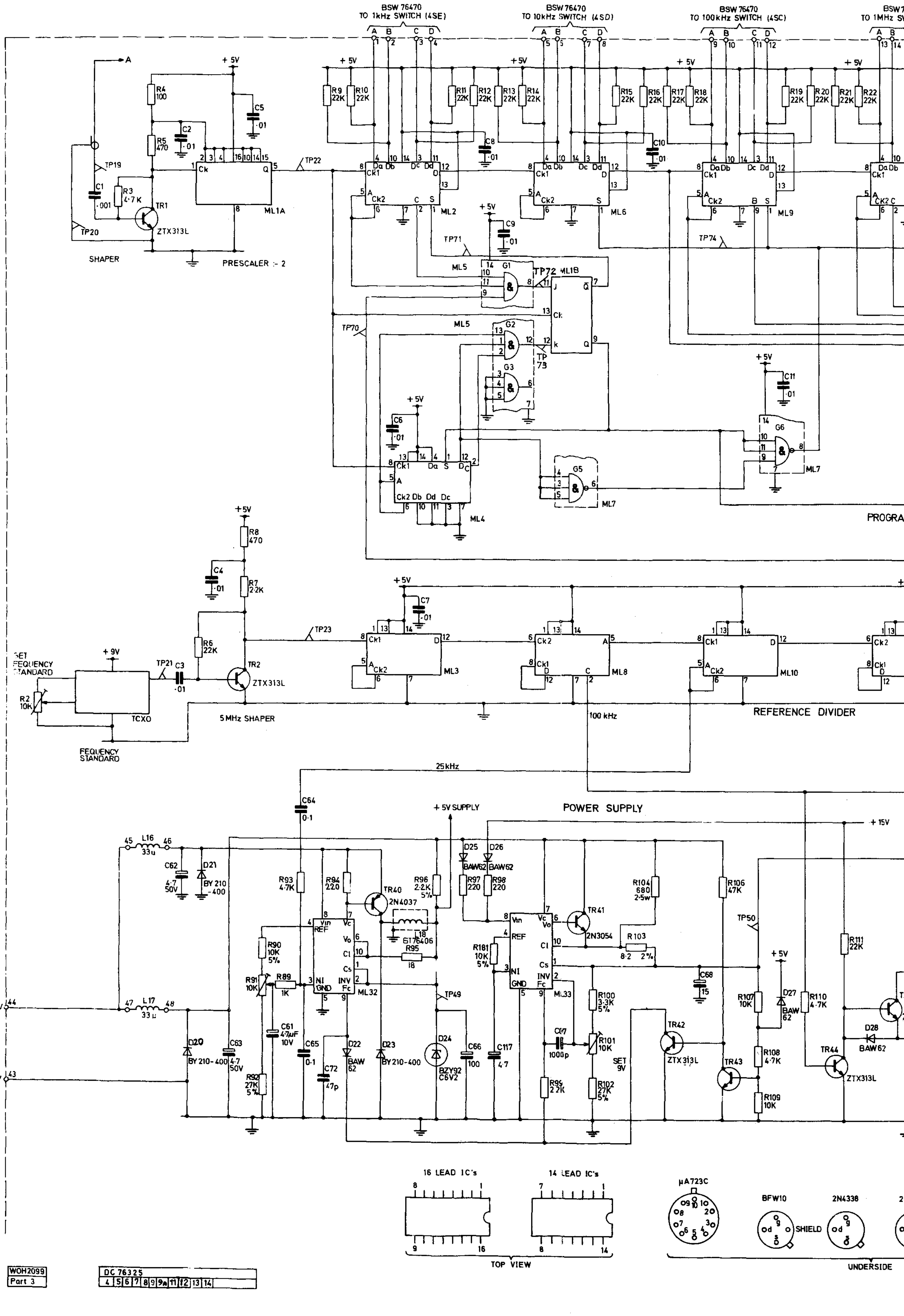
WOH2099 Part 3 | WOH 2099 PART 3 | WOH 2099 Part 3

Compor



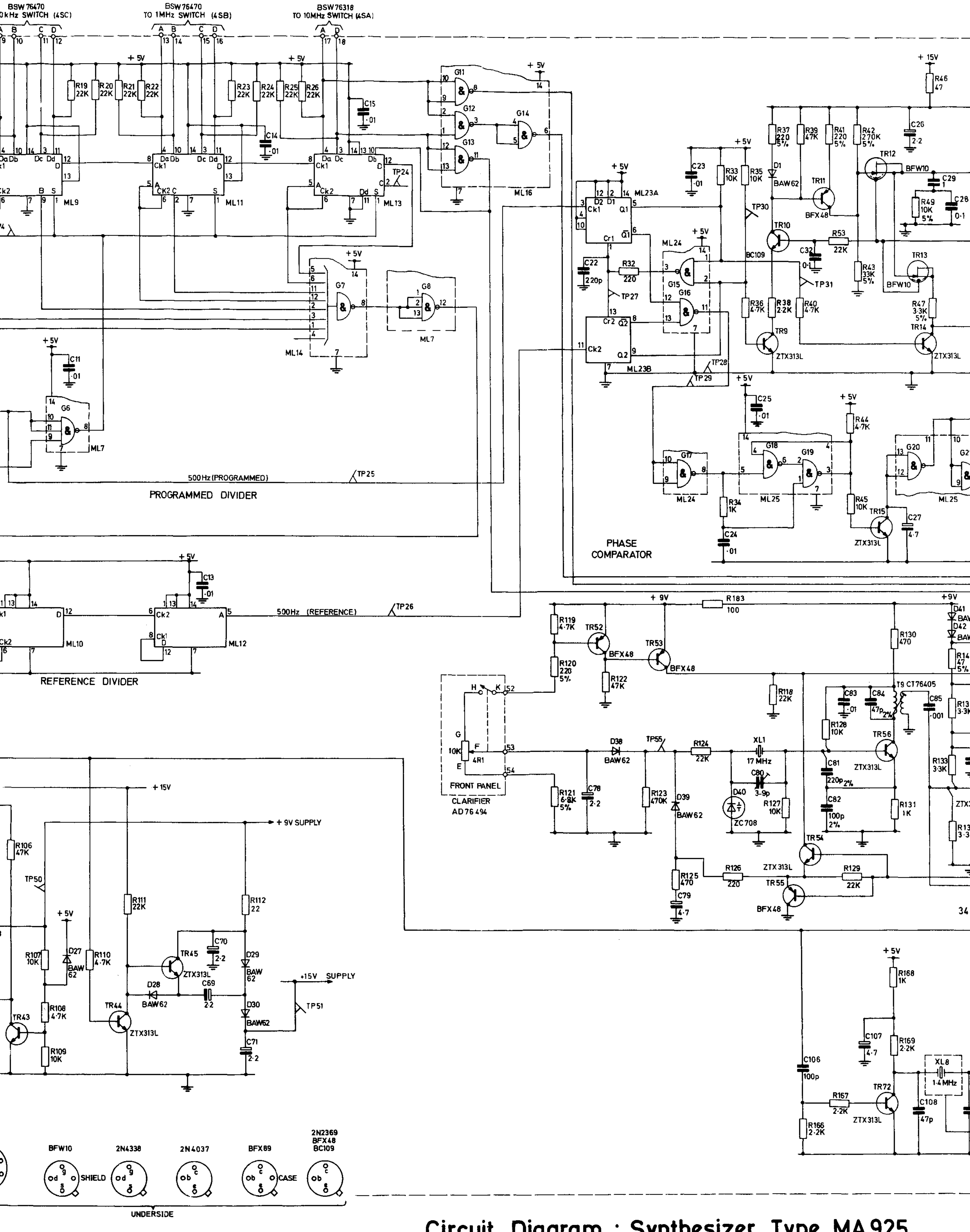
Component Layout : MA.925

Fig. 4

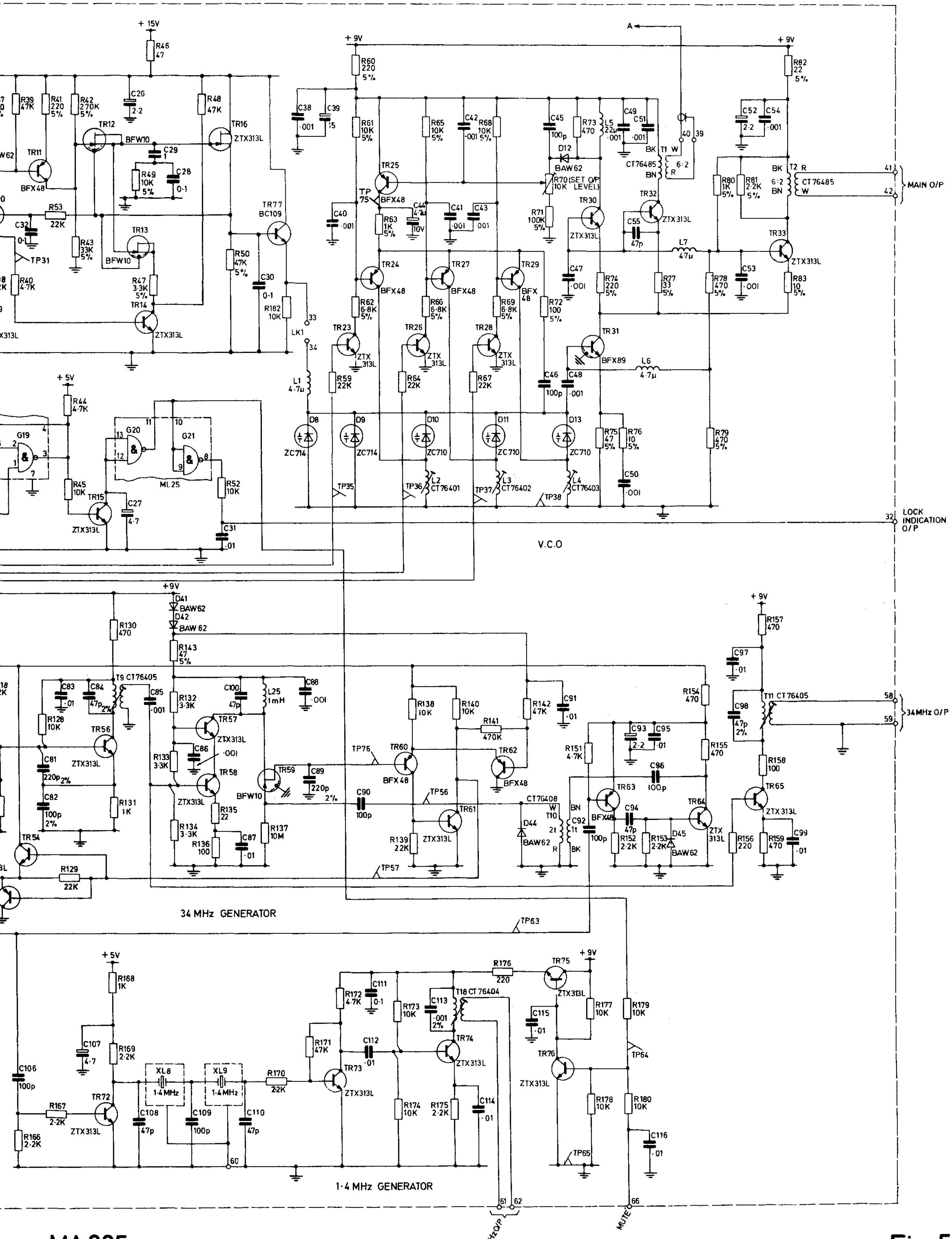


WOH2099
Part 3

DC 76325
4 5 6 7 8 9 9A 11 12 13 14

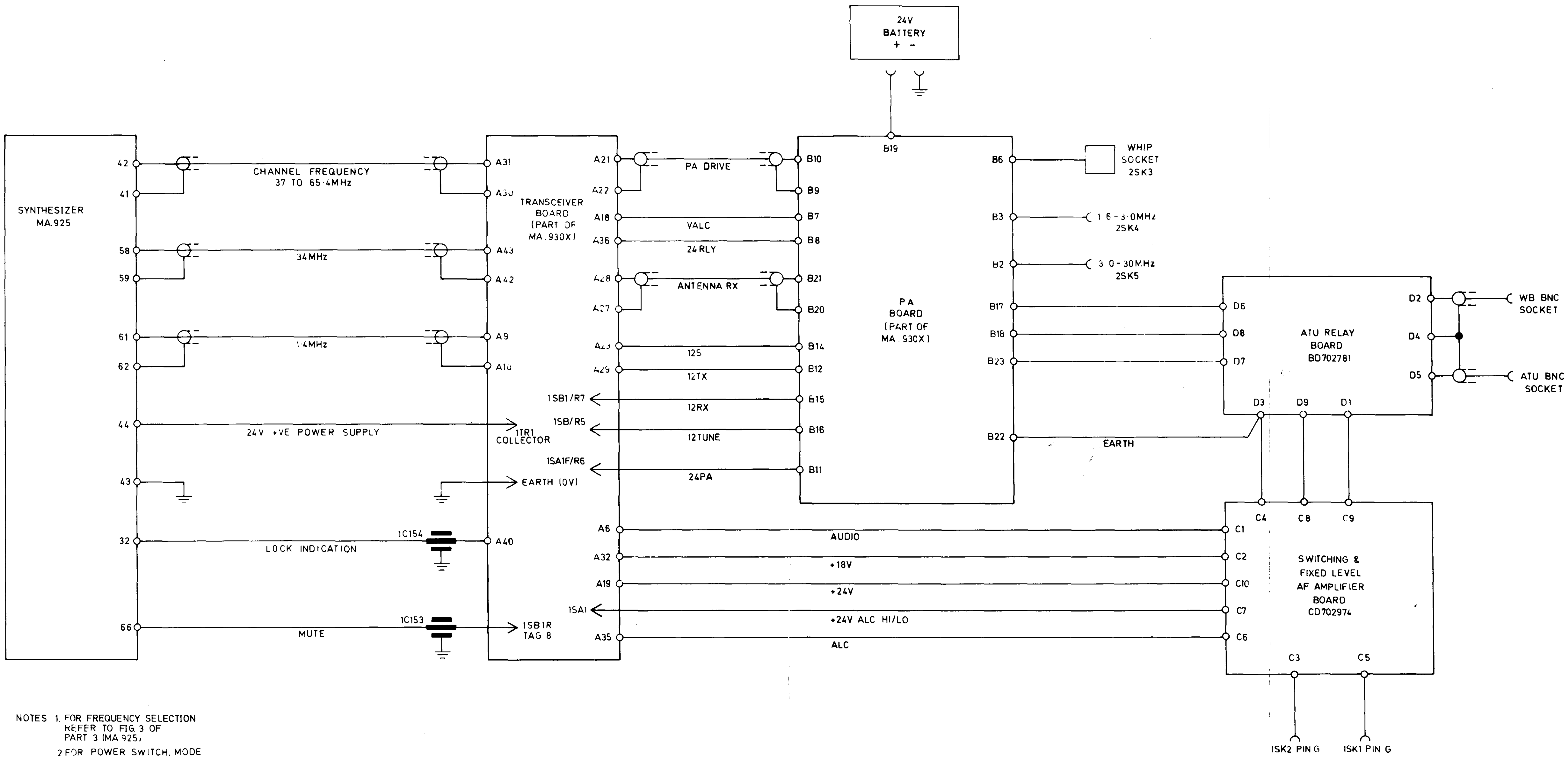


Circuit Diagram : Synthesizer Type MA.925



ype MA.925

Fig.5



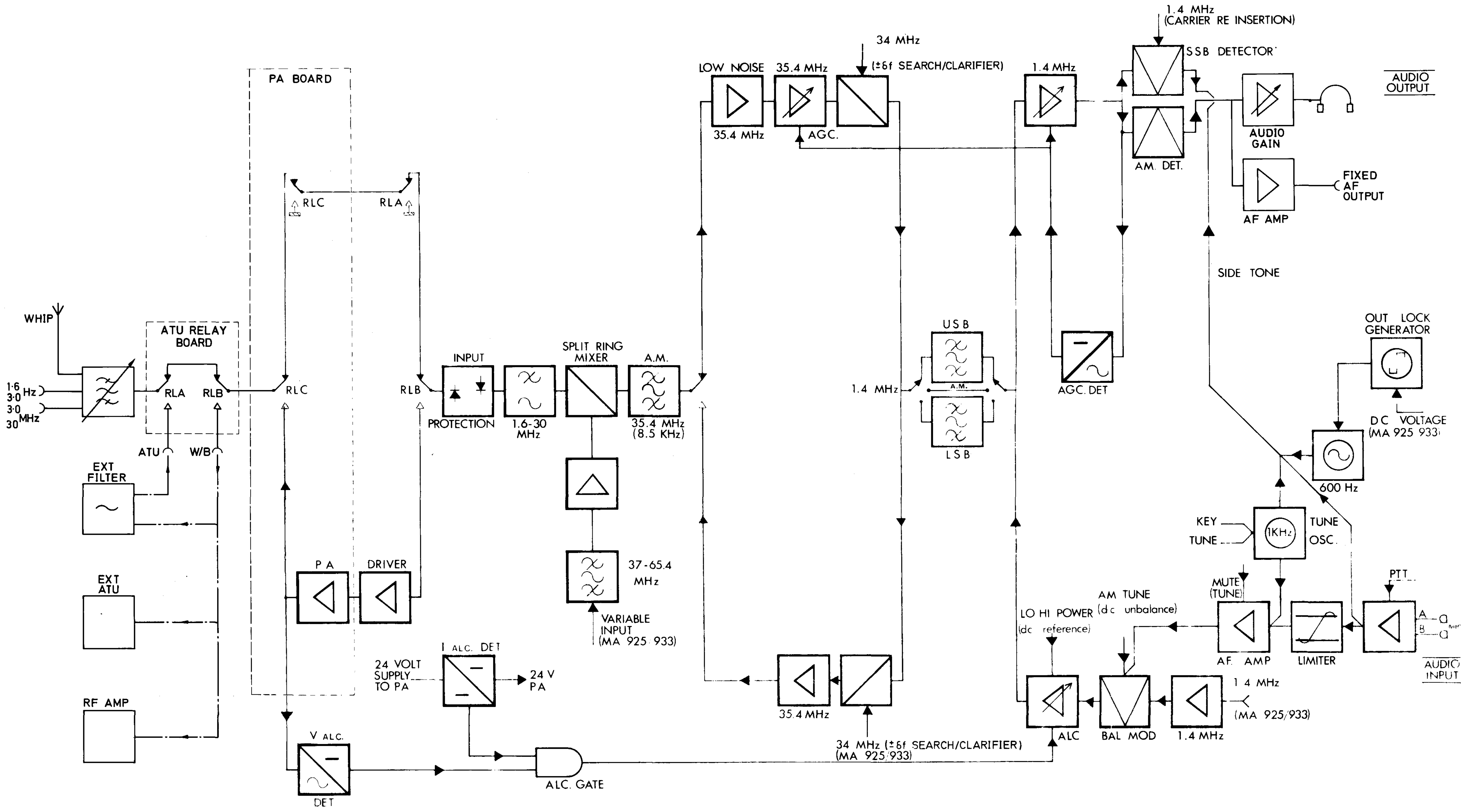
NOTES 1. FOR FREQUENCY SELECTION REFER TO FIG.3 OF PART 3 (MA.925)

2. FOR POWER SWITCH, MODE SWITCH AND EXTERNAL CONNECTIONS, REFER TO FIGS.6 & 7 OF PART 2 (MA.930X)

WOH6085
Part 1

Interconnecting Diagram: TRA.931X

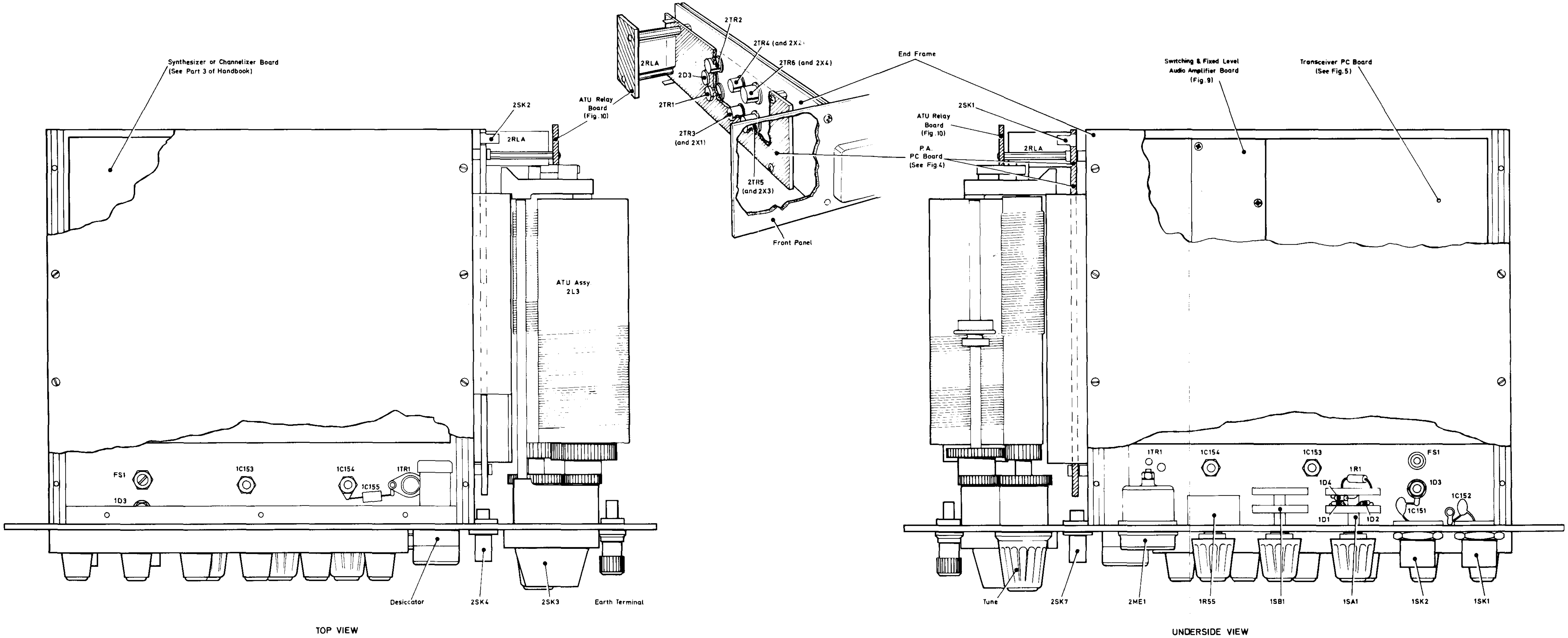
Fig.2



Block Diagram: Transceiver MA.930X

Fig. 1

WOH6085
Part 2



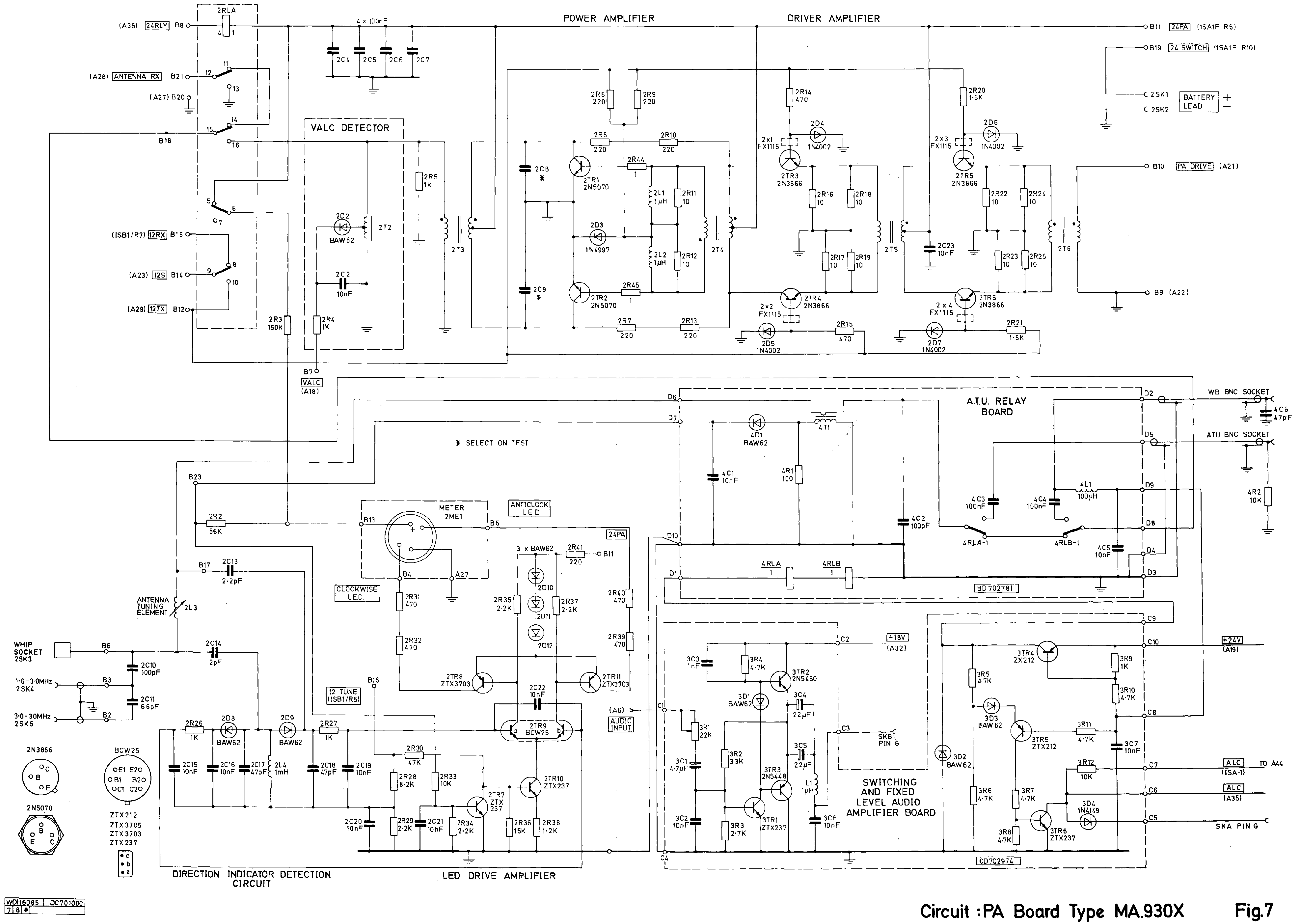
WOH60*5
Part 2

Component Layout: Transceiver MA930X

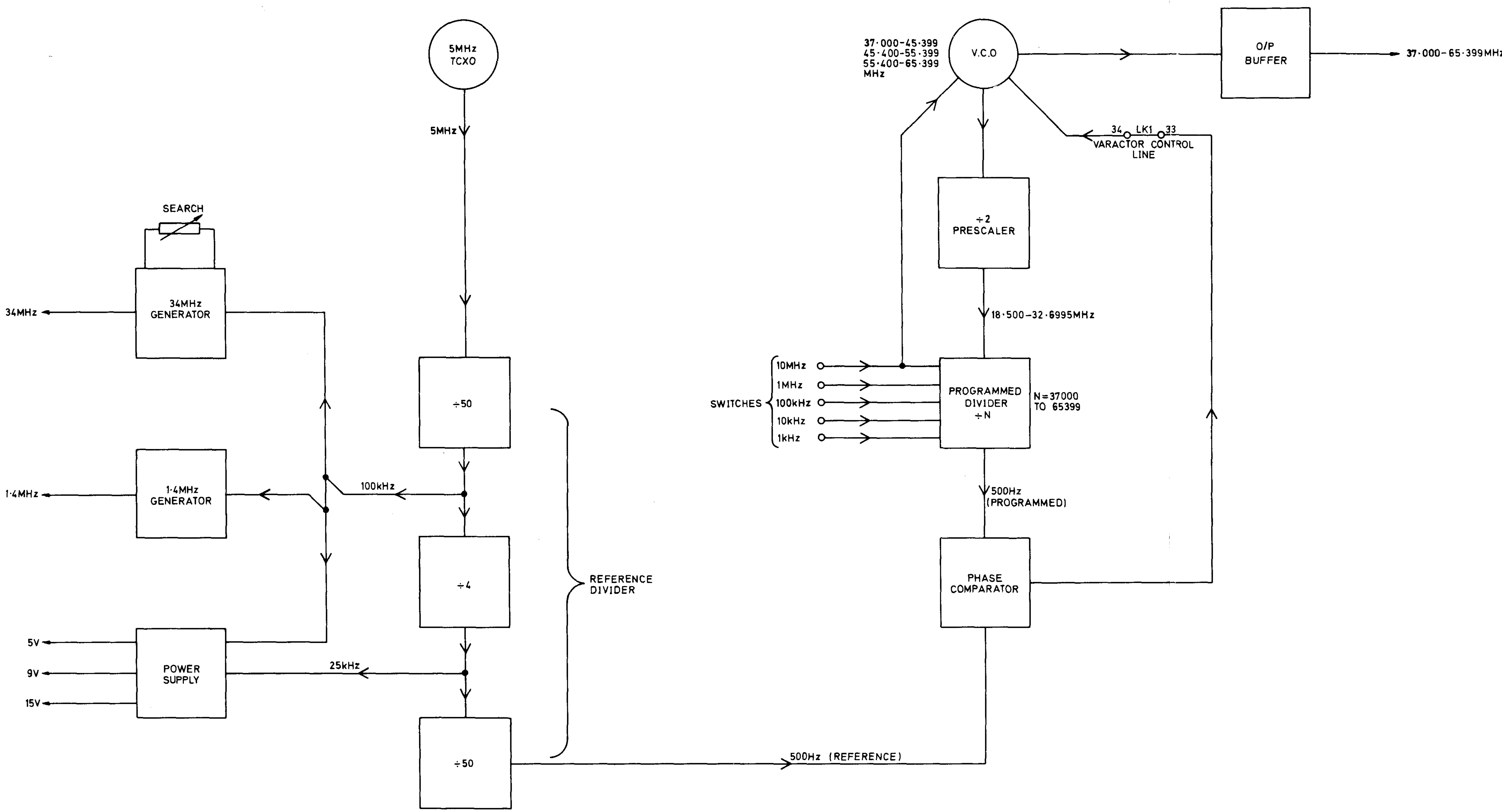
Fig. 2

Circuit : Transceiver Type MA.930X

Fig. 6



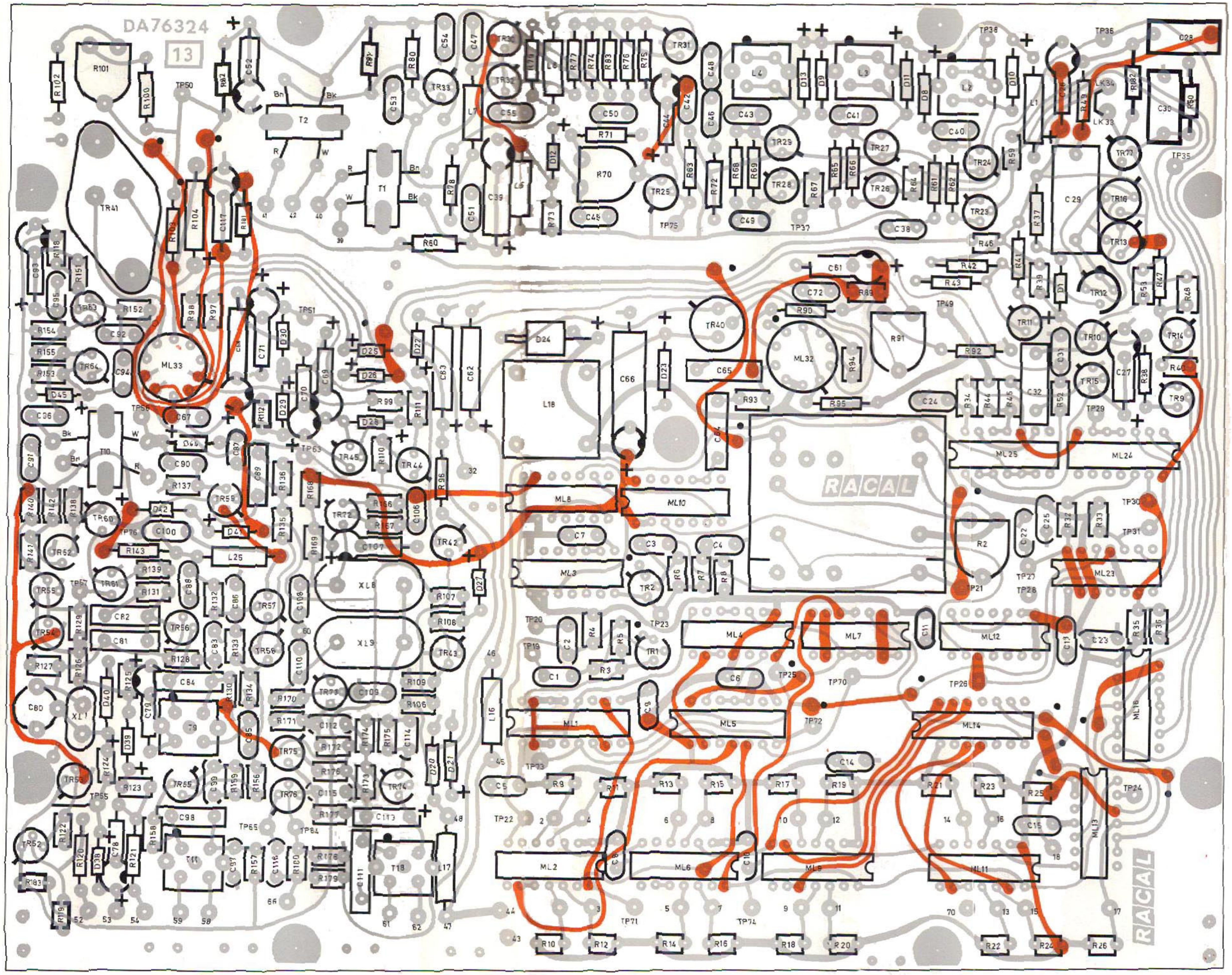
Circuit : PA Board Type MA.930X Fig.7



WOH2099
Part 3

Block Diagram: MA.925

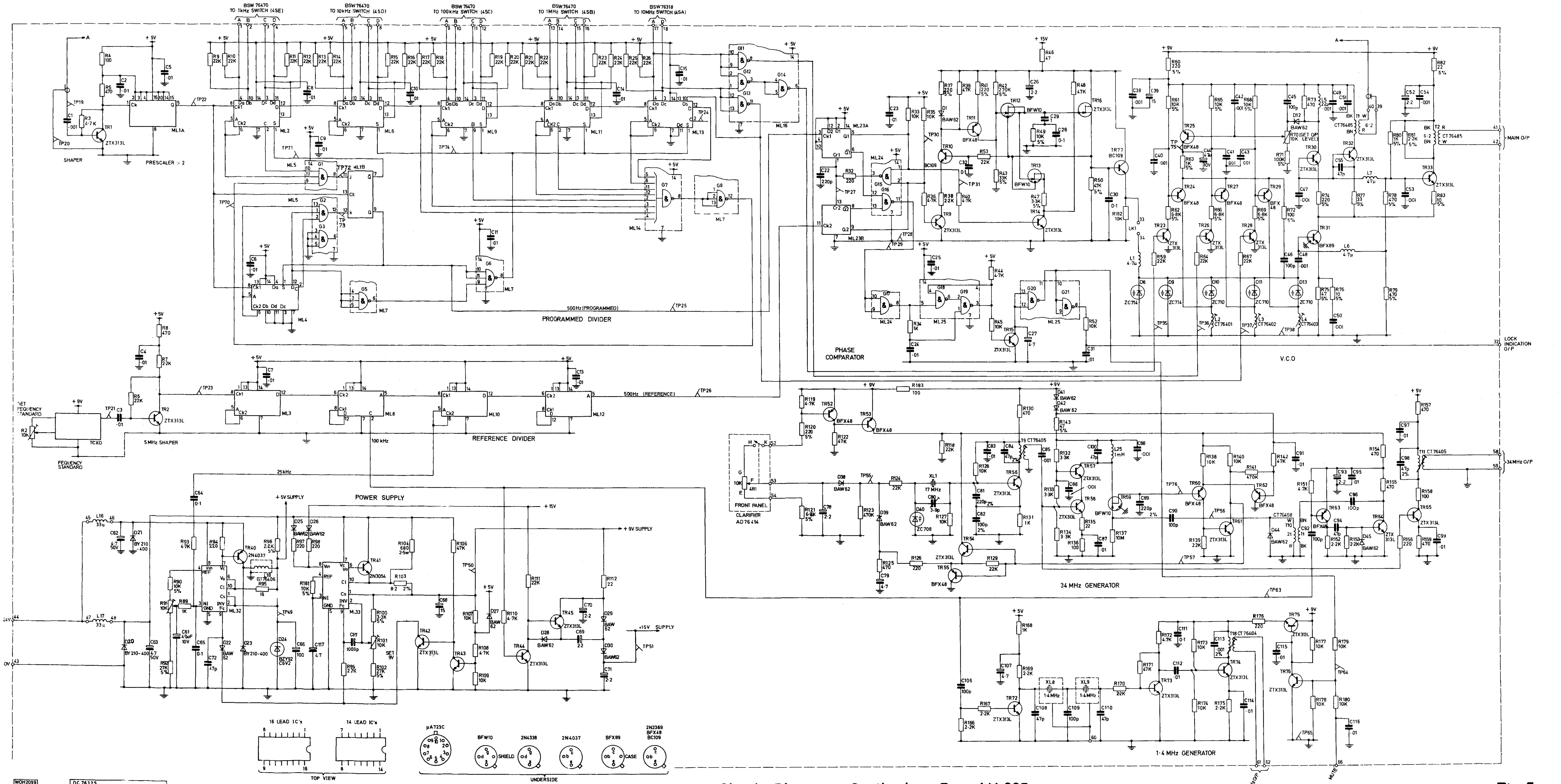
Fig. 1



WOH 2099 Part 3

Component Layout : MA.925

Fig. 4



WOH2099 Part 3

DC 76325 4 5 6 7 8 9 9a 11 12 13 14

Circuit Diagram : Synthesizer Type MA.925

Fig.5