# TRA931P

# REFERENCE MANUAL

## RACAL-TACTICOM LIMITED, READING

## AMENDMENT TO

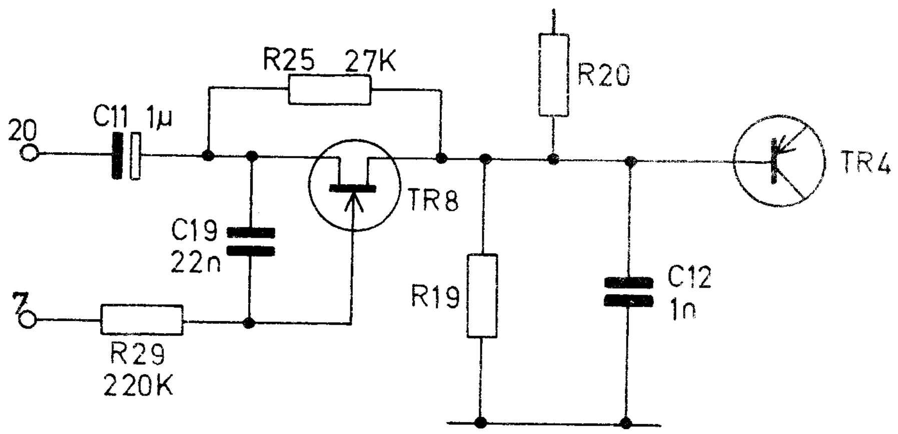
## TRA.931P HF SSB TRANSMITTER-RECEIVER

PART 2 •Fig.10

Some versions of the Transceiver Relay Board incorporate changes as follows.

1. TR4 is deleted and replaced by C19, a 10 µF capacitor.

2. An FET TR8 and associated components are incorporated in the audio input circuit (pin 20); the existing capacitor C12 is changed from 10 nF to 1 nF, and C19 is 22 nF. The FET acts as a switch driven from the 12TX line pin 7. When the transmit condition is selected the FET is conducting, by-passing R25 and increasing the side-tone level to the audio circuit. During reception the FET is cut-off and R25 is in circuit.




PART 2 COMPONENTS LIST - Transceiver Relay Board

Page 6-20 (check page no.)

Alternative Items

| | | | | | |
|---|---|---|---|---|---|
| R21 | 2.7 kΩ | Resistor Carbon Film | ¼W | 5% | Racal Part No. 925129 |
| R22 | 22 kΩ | Variable resistor | | | Racal Part No. 920314 |
| R23 | 2.7 kΩ | Resistor Carbon Film | ¼W | 5% | Racal Part No. 925129 |

Additional Item

| | | | | | |
|---|---|---|---|---|---|
| R29 | 220 kΩ | Resistor | ¼W | 5% | Racal Part No. 925399 |

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Alternative Items

| | | | |
|---|---|---|---|
| C12 | 1 nF | Capacitor, Ceramic | Racal Part No. 924031 |
| C19 | 22 nF | Capacitor, Ceramic | Racal Part No. 926654 |

Additional Item

| | | | |
|---|---|---|---|
| TR8 | | Transistor, FET W300B | Racal Part No. 922990 |

# 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.

*************


# HF SSB Transmitter-Receiver
# Type TRA 931P

WOH 6160

# RACAL TACTICOM LIMITED

## AMENDMENT TO

## TRA.931P SSB MANPACK

## TRANSMITTER/RECEIVER

PART 2 (930P)

COMPONENTS LIST

Page 6

Change capacitors 1C2, 1C3, 1C4, and 1C5 to read:-

| | | | | |
|---|---|---|---|---|
| .01μ | Disc ceramic | 500 | +100-20 | Part No. 927831 |

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Change capacitors 1C14, 1C21, 1C22, 1C27, 1C28, 1C30, 1C31, 1C36, 1C38, and 1C40 to read:-

| | | | | |
|---|---|---|---|---|
| .01μ | Disc ceramic | 500 | +100-20 | Part No. 927831 |

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Change capacitors 1C45, 1C46, 1C47, 1C48, 1C54, 1C55, 1C56, 1C60, 1C64, 1C65, 1C70, 1C71, 1C72, and 1C73 to read:-

| | | | | |
|---|---|---|---|---|
| .01μ | Disc ceramic | 500 | +100-20 | Part No. 927831 |

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Change capacitors 1C76, 1C78, 1C79, 1C80, 1C81, 1C82, 1C83, 1C90, 1C91, 1C92, 1C93, 1C94, 1C95, 1C97, 1C98, 1C100, 1C101, 1C104, 1C107 and 1C110 to read:-

| | | | | |
|---|---|---|---|---|
| .01μ | Disc ceramic | 500 | +100-20 | Part No. 927831 |

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Change capacitors 1C111, 1C112, 1C113, 1C114, 1C115, 1C116, 1C117, 1C119, 1C120, 1C123, 1C124, 1C128, 1C129, 1C130, 1C131, 1C142, 1C144 and 1C145 to read:-

| | | | | |
|---|---|---|---|---|
| .01µ | Disc ceramic | 500 | +100-20 | Part No. 927831 |

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Change capacitors 1C146, 1C147, 1C148, 1C149 , and 1C152 to read:-

| | | | | |
|---|---|---|---|---|
| .01µ | Disc ceramic | 500 | +100-20 | Part No. 927831 |

# ALTERNATIVE TRANSISTOR TYPES

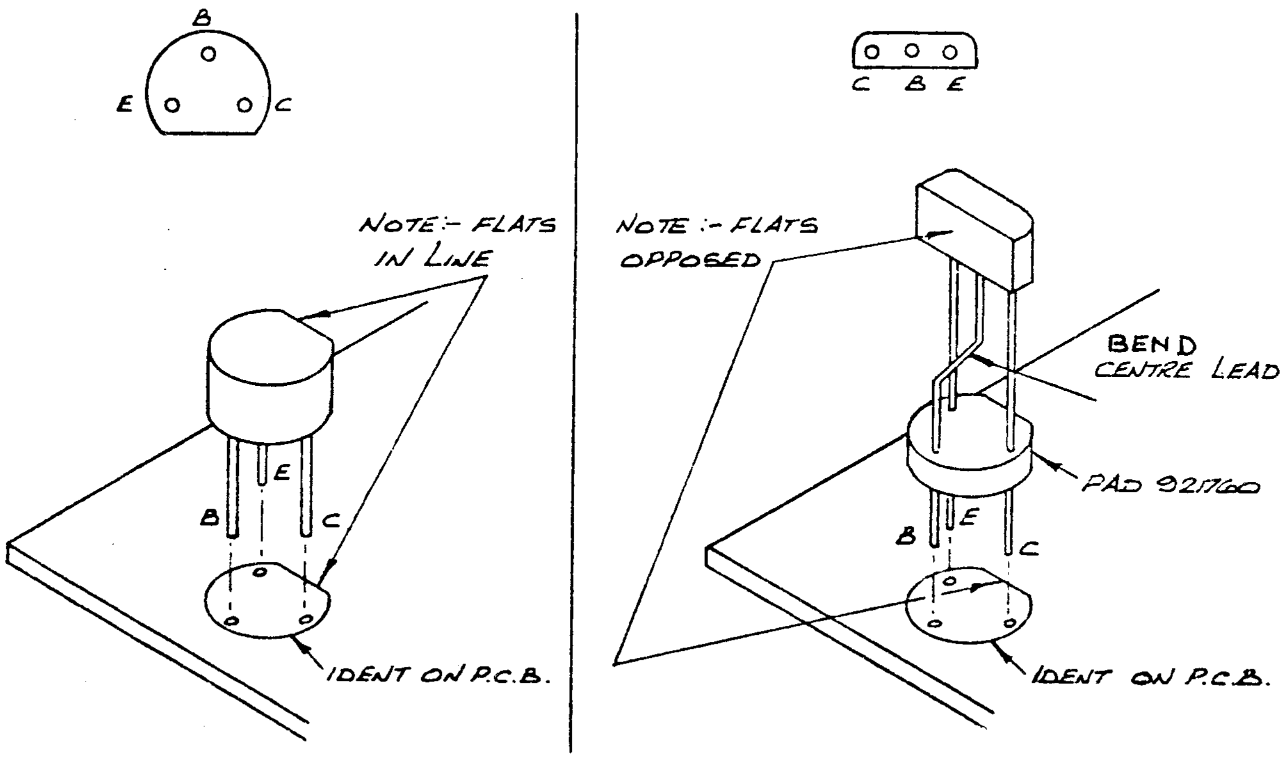
This addendum is applicable to the following equipments:-

| | | | | | | |
|---|---|---|---|---|---|---|
| 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<br>SX 3711 | 917465<br>915119 | alternative | ZTX 237 | 923171 |
| BC 212<br>SX 4060 | 919122<br>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.

# SYNCAL 30

# TRA.931P HF SSB

# TRANSMITTER - RECEIVER

## CONTENTS



A detailed contents list will be found at the front of each Part of the handbook.

# PART I

# HF SSB TRANSMITTER RECEIVER

# TYPE TRA.931 P

# PART 1 HF SSB TRANSMITTER-RECEIVER

# TYPE TRA.931P

## CONTENTS

## CONTENTS (Cont'd.)



## ILLUSTRATIONS

# TECHNICAL SPECIFICATION

## GENERAL

| | |
|---|---|
| Frequency range: | 1.6 MHz to 29.999 MHz. |
| Channels: | (1) 28 400 channels in 1 kHz steps, selected by five in-line switches (manual)<br>(2) Eight preset channels within the range, selected by separate channel switch.<br>Synchronized frequencies derived from TXCO, locking time less than two seconds. |
| Interpolation: | Interpolation between 1 kHz steps may be selected by front panel SEARCH control. |
| Operating Modes: | USB ) VOICE (A3J) or<br>LSB ) Keyed 1 kHz tone (A2J)<br>AM ( Voice (A3) or<br>AM ( Keyed 1 kHz 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<br>Storage: -40°C to +70°C |
| Power supply: Portable Operation: | 24 volt, 3.5 AH 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 60 Hz, Power Unit, Type MA.949 |
| Antennas: | 2.4m (8 ft.) whip (for operation above 2 MHz), long wire or dipole. |
| Antenna tuning: | Single-control tuning of in-built ATU or alternative wideband output for external automatic/ manual ATU. |

Sealing: Transmitter-Receiver case sealed and fitted with desiccator. Screw-on battery container is fully sealed.

Front Panel Controls & Facilities:

(1) Five frequency selection switches (manual)

(2) Channel Switch for 8 preset channels or manual.

(3) SEARCH (interpolation) control.

(4) MODE switch selecting:
AM
USB
LSB
TUNE

(5) POWER switch setting.
I/C ( Intercom)
HIGH power
LOW power
OFF

(6) Antenna tuning control (TUNE)

(7) AF Gain Control (AF GAIN)

(8) Meter indicating RF antenna current in TUNE and transmit conditions, battery voltage in receive condition. Coarse tune indicating lamps are fitted in the meter.

(9) Whip Antenna socket (WHIP).

(10) Two 50 ohm sockets for dipole antenna.
(a) 1.6 - 3 MHz
(b) 3 - 30 MHz

(11) Two 50 ohm sockets for insertion of narrow band selecting unit type MA.4015.

(12) One 50 ohm socket for wideband output for use with external ATU.

(13) One control socket for filter unit type MA.4015.

(14) Ground terminal.

(15) Two accessory sockets for handset, headset or Morse Key or loudspeaker/amplifier/PSU or battery charging unit (AUDIO 1 and 2).

| | |
|---|---|
| Weight: | Basic TRA.931P unit only: 5 kg (11 lb). Operational manpack with handset, whip antenna, nickel cadmium battery and harness assembly: 11 kg (24 lb). |
| Dimensions (excluding battery): | Width: 366 mm (14.4 in).<br>Height: 116 mm (4.6 in).<br>Depth: 275 mm (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 | Low Power |
|---|---|---|
| Voice (SSB) | 20 watts p.e.p. ±1½ dB | 7½ dB ±1½ dB reduction |
| Key | 20 watts ±1½ dB | |
| Voice (AM) | 5 watts carrier with full modulation | |

Note: 'Key' output refers to normal keyed CW operation. The TRA.931P is not suitable for use as a 'beacon' under continuous key-down conditions.

| | |
|---|---|
| Harmonic Emissions: | No harmonic will exceed -40 dB relative to p.e.p. in 50 ohms load at dipole output. |
| Spurious Emissions: | Better than -40 dB relative to p.e.p. in 50 ohms load. |
| Carrier Suppression: | Not worse than 40 dB relative to full p.e.p. output. |
| Unwanted Sideband Suppression: | Not worse than 40 dB relative to p.e.p. output at 1 kHz. |
| Intermodulation Distortion: | Not worse than 25 dB relative to full p.e.p. output. |
| Power Consumption: | 2.0 amp for SSB average speech. |
| Overall AF Response: | Not worse than -6 dB at 500 Hz and 2500 Hz. |

## RECEIVER

| | |
|---|---|
| Sensitivity (SSB): | 10 mW AF output for 1 microvolt pd. RF input. |
| Signal/Noise ratio (SSB): | Under the condition given for sensitivity, the signal/noise ratio is 15 dB minimum. |
| Selectivity: | SSB 6 dB bandwidth 2.0 kHz minimum<br>40 dB bandwidth 6.0 kHz maximum.<br>AM 6 dB bandwidth 8.0 kHz minimum<br>55 dB bandwidth 40.0 kHz maximum. |
| Image Rejection: | Better than 60 dB. |
| IF Rejection: | Better than 60 dB. |
| Spurious Response: | All attenuated by at least 40 dB. |
| AF Output Power: | 30 mW minimum with 100 microvolts p.d. RF input. |
| AF Distortion: | Better than 5% at 10 mW output level with 100 microvolts p.d. RF input. |
| Fixed AF Output: | 50 mW with 50 ohms with 100 microvolts p.d. RF input. |
| AGC: | The AF output changes less than 6 dB for RF input variations of 80 dB above 2 microvolts p.d. |
| Power Consumption: | 300 mA 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.931P transmitter/receiver (transceiver) provides transmission and reception facilities in the frequency range of 1.6 to 29.999 MHz. Any one of eight predetermined channels may be selected by a single front panel control. Under normal control, 28 400 channels are available and a SEARCH control provides continuously variable cover in the 1 kHz channel spacing. 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 is made at a front panel mounted switch.

2. The transceiver 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 transceiver 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 transceiver power supply is 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 vehicle installation a 12/24V DC power unit type MA.937 is available, whilst for static operation the TRA.931P may be powered by a 100-125V/200-250V AC power unit type MA.949.

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

## COMPOSITION OF 'SYNCAL 30' MANPACK TYPE TRA.931P

7. A 'Syncal 30' Transceiver Type TRA.931P consists of three main units in addition to the battery. The three units are the Transceiver Unit Type MA.930P, the Synthesizer Type MA.925 and the Pre-Programmed Frequency Memory. Part 1 of this manual gives information on the complete TRA.931P, Part 2 covers the Transceiver Unit, Part 3 covers the

Synthesizer and Part 4 the Pre-Programmed Frequency Memory Board.

Transceiver Unit MA.930P

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 MHz and 3 to 30 MHz, a W/B socket for connection to either a remote ATU or r.f. amplifier, and a pair of coaxial sockets together with a multi-way connector for use with the externally connected filter unit type MA.4015.

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 printed circuit boards which allow access to all components. Screening of the circuit against unwanted external pick-up is provided by screening covers fitted to the chassis assembly.

Battery

11. The 3.5 ampere-hour nickel-cadmium re-chargeable battery is attached to the base of the manpack by two retaining screws. The contact arrangement between the battery and the main unit is so designed that incorrect connection is impossible (fig. 4).

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 half scale deflection indicates that the battery needs recharging.

Synthesizer MA.925

13. The synthesizer consists of a single printed circuit board housed in a screened compartment. It contains a main oscillator which covers the frequency range 37.0 to 65.4 MHz; the front panel MHz (X10) control selects one of three voltage controlled oscillators which, at a frequency determined by a programmed divider (set either by the frequency switches or by the pre-programmed channelizer) is phase locked to a precision crystal oscillator. The synthesizer also generates 34 MHz and 1.4 MHz signals which are applied to the transceiver unit.

## Pre-Programmed Frequency Memory Board

14. This consists of a single printed circuit board which is mounted in the synthesizer screened compartment. It contains a memory which is programmed using the MA.4008 Encoder Unit. An internal ni-cad cell prevents loss of memory when the TRA.931P is disconnected from the power supply.

## PRINCIPLES OF OPERATION

NOTE: Block diagrams of the overall unit are given in figs. 1 and 2.

15. Microphone inputs are fed to the AF amplifier and then to a limiter stage. The AF input modulates a 1.4 MHz signal and the resultant IF signal is amplified and fed to one of two filters, USB or LSB, or via an AM circuit, dependent upon the mode selected. The filtered signal is then mixed with a 34 MHz frequency, fed through the AM band-pass filter, mixed with a 37 MHz to 65.4 MHz input and amplified in the driver and p.a. stages prior to being fed to relay contacts. Normally the relay contacts will route the output via the internal ATU to the antenna sockets. When either an external RF amplifier or a remote ATU is used, the relays route the output to the WB socket. Where the MA.4015 filter unit is connected, the relays route the 100 mW drive to the PA board via the MA.4015 and the 100 mW input and output sockets.

16. The power output of the transmitter can be HIGH or LOW, dependent upon the setting of the POWER switch, except when an RF 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 low level switching board.

17. Received RF signals are fed via relay contacts to the ATU and then via 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 IF of 35.4 MHz. The signal is fed via the AM filter and the first IF amplifier, to a further mixer stage, where it is mixed with a 34 MHz signal to produce the second IF, centred on 1.4 MHz. Dependent upon mode selected, the second IF is then fed via the appropriate filter to the second IF amplifier, then to the detector to provide an AF output.

18. An AGC circuit, operating upon the IF stages, is provided. This circuit maintains a sensibly constant AF output level for wide variations of RF input level.

## OPERATIONAL SYSTEMS

19. The TRA.931P can be used as a self-contained transmitter/receiver, or with additional units to provide an increased power output or selectivity. The diagrams shown in fig.13 give RF routing paths in various configuration. These diagrams should be read in conjunction with Fig.2 of Part 2.

TRA.931P 5W or 20W Station (Fig. 13(a) and (b))

20. During reception the RF from the antenna and internal ATU is routed directly to the receiver via the relays as shown. During transmission relay RLE connects the transmitter into circuit and relays 2RLA and RLA connect the power amplifier (PA) into circuit.

TRA.931P and BCC.545 5W or 20W Station (Fig. 13(c) and (d))

21. This station uses an external ATU connected to the W/B (wideband socket). The impedance of the ATU is detected and used to energize relay ATU-RLA via a detector circuit. The energized relay disconnects the internal ATU and brings into circuit the W/B socket and external ATU. The remainder of the connections are as described in para. 20.

TRA.931P, MA.4015 and BCC.545 5W or 20W Station (Fig. 13(e) and (f) )

22. In this configuration the W/B output is connected as described in para. 21. In addition, comparators connected to the 100 mW I/P and 100 mW O/P sockets detect the impedance of the MA.4015 filter and route the RF into, and out of, the filter, via relays RLB and RLD. Relay RLC earths an unwanted line.

TRA.931P, TA.4044 and BCC.540 100W Station (Fig. 13(g) and (h) )

23. The 100W Amplifier TA.4044 is connected to the 100 mW O/P socket, causing relays RLC and RLD to be energized. Relay RLD connects RF to the TA.4044, relay RLC earths an unwanted line.

24. During reception the input from the ATU is fed directly through the TA.4044; during transmission the RF is amplified to 100W. A filter unit can be used with this configuration, and is connected to the TA.4044 (not shown).

ATU Tuning (Gig. 13(j) )

25. During tuning of an ATU the 100 mW output from the TRA.931P is returned to the TRA.931P and fed via its PA stage to provide a 5W output. The output is limited at 5W by a 0V signal fed via the AUDIO 1 socket pin G (see fig. 2 part 2).

## PRINTED CIRCUIT BOARD PREFIXES

26. To assist in component identification the printed circuit boards are given prefix numbers. The full identification of resistor R1 on the ATU Relay Board is, therefore, 4R1.

List of Prefixes

| | |
|---|---|
| Transceiver Board and associated Front Panel Components | Prefix 1 |
| PA Board and associated Front Panel Components | Prefix 2 |
| Transceiver Relay Board | Prefix 3 |
| ATU Relay Board | Prefix 4 |
| Decoupling Board | Prefix 5 |
| Pre-Programmed Frequency Memory Board | Prefix 6 |
| Synthesizer Board | No Prefix No. |

# CHAPTER 2

## PREPARATION

1. Unpack the equipment from the transit case and remove the transmitter/receiver from its haversack (if used).

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 waterproof seal between the battery and the main case.

NOTE: Do not overtighten screws.

5. Replace the transceiver in its haversack (if used) 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 CONNECTORS

1. The controls and connectors fitted to the front panel of the transceiver are listed below:

| | |
|---|---|
| (1) CHANNEL Switch | A nine-position switch for selection of pre-programmed channels 1 to 8. The M(manual) position is selected when it is required to set the frequency on the five frequency switches. |
| (2) Frequency Selection Switches | The five switches are used to select the required frequency (manual control). |
| (3) SEARCH control | Allows interpolation within 1 kHz steps. |
| (4) 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. |
| (5) 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. |
| (6) AF GAIN | This potentiometer controls the receiver AF gain and sidetone level. |
| (7) TUNE | This control tunes the antenna, except when remote ATU and/or RF amplifier are used. |
| (8) METER | The meter indicates the battery voltage when the transceiver is in the receive condition, and the antenna current when TUNE or the transmit condition is selected, except when remote ATU and/or RF amplifier are used. The meter incorporates coarse tune indicating lamps. |

| | |
|---|---|
| (9) AUDIO 1 SOCKET | This socket has pins A to F connected in parallel with pins A to F on the AUDIO 2 socket and allows ancillary equipment (such as 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. |
| (10) 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. |
| (11) WHIP SOCKET | This socket allows a whip antenna to be connected to the transceiver. |
| (12) 1.6-3 MHz and 3-30 MHz 50Ω SOCKETS | These sockets allow an antenna (other than a whip) to be connected to the transceiver. |
| (13) W/B SOCKET | This socket provides a connection to either a remote ATU or an RF amplifier. |
| (14) 100 mW I/P and O/P Sockets | For connection to and from the MA.4015 filter unit. |
| (15) MA.4015 control socket | A ten way socket for connection to the MA.4015 filter unit. |
| (16) 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 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 transceiver can be operated with the standard whip antenna. This antenna is generally satisfactory for distances up to 25 km (15 miles). Where greater distances are required the 3-30 MHz 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 3-30 MHz 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 5 MHz may be used at 15 MHz and 25 MHz 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 25 km (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 thinnest 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 if conditions allow.

(4) If a frequency below 25 MHz is to be used the full length (2.4m (8 ft) ) of the whip should be erected. If a frequency above 25 MHz is to be used the antenna should be reduced to 1.8m (6 ft) 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 wires 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 transceiver.

## 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 transceiver 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 transceiver.

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

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 fasted 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 transceiver.

(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 transceiver.

## Horizontal and Inverted V Dipole Antennas

11. These antennas should be used where considerable 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.

## 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 | 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.

## VEHICLE OPERATION

NOTE: The interconnection diagram for a typical HF high power vehicle installation is given in fig. 12.

### Whip Antennas

14. A 2.4m (8 ft) 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 (27 ft) over the frequency range 1.6 to 8 MHz, 4.9m (16 ft) over the range 1.6 to 16 MHz or 2.4m (8 ft) over the range 2.0 to 27 MHz.

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

(2) Using high insulation cable with copper conductor, connect the antenna base to the transceiver. The length of this cable should be as short as possible and must not exceed 0.6m (2 ft). 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 transceiver.

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

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 transceiver.

### Remote ATU

15. When a remote ATU, such as the BCC 540 automatic ATU is used, make the following connections:-

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

(2) Connect the W/B socket on the transceiver to the ATU.

### RF Amplifier

16. The RF amplifier type TA.940B or TA.4040 may be connected as follows:-

(1) Connect the transceiver AUDIO 1 to an AUDIO socket on the RF amplifier.

(2) Connect the transceiver W/B socket to the RF input on the RF amplifier.

### Use with Filter Unit Type MA.4015

17. In dual radio installations, to reduce mutual interference, an MA.4015 should be fitted to each transceiver as follows:-

(1) Connect the MA.4015 input to the 100 mW O/P socket.

(2) Connect the MA.4015 output to the 100 mW I/P socket.

(3) Inter-connect the transceiver 10-way 4015 socket and the MA.4015 TRANSCEIVER socket.

If however, a TA.4044B RF amplifier is in use:

(1) Connect the MA.4015 input to the AUTO FU OUT socket.

(2) Connect the MA.4015 output to the AUTO FU IN socket.

(3) Connect the MA.4015 TRANSCEIVER connector to the transceiver SU connector.

(4) Connect the TRA.931P 100 mW OUT to the 100 mW IN on the TA.4044.

(5) Connect the TRA.931P 100 mW IN to the 100 mW OUT on the TA.4044.

## BATTERY CHECK

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

### Battery Changing

19. (1) Remove the transceiver from the harness (if used).

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

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

(4) Replace the transceiver in the harness (if used).

### 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 transceiver. 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-in 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 transceiver, connect the battery charger output connector to either of the two AUDIO sockets on the front panel of the transceiver.

(5) If the battery is to be charged when detached from the transceiver 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 transceiver (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 CHANNEL switch to the required channel number (1 and 8). Alternatively, set the CHANNEL switch to M(manual)and 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 ATU or RF 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 telephon 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 transceiver 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 transceiver. 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 applies an earth to the key line and also inhibits high power operation.

## Channel Frequency Programming

32. (1) Connect the MA.4008 Encoder Unit to one of the AUDIO sockets.

(2) Set the CHANNEL switch and the required channel number.

(3) Set the five frequency selection switches to display the required frequency.

(4) Depress and release the push button on the MA.4008. The indicator lamp on the MA.4008 illuminates briefly when the programming has been completed.

(5) Repeat steps (2) to (4) for remaining channels.

(6) Disconnect the MA.4008.

MEMORY POWER SUPPLY

33. The pre-programmed frequency memory is maintained by an internal battery whose condition is indicated by the central red lamp on the meter. This lamp illuminates when a pre-programmed frequency is selected at the channel switch.

When the lamp flashes it indicates that the internal battery voltage has dropped below a safe level. The following action should then be taken:-

(1) Connect a serviceable battery to the rear of the transmitter/receiver and allow the internal battery to be charged for at least 5 minutes.

(2) Re-programme all eight channels (or as many as are in use) as given in para.32.

MAIN BATTERY REMOVAL

34. The internal battery (para.33) draws current from the main battery MA.934 to maintain its charged condition. If the transceiver is to be out of service for a long period (say longer than three days) the MA.934 battery should be removed from the transceiver to prevent undue discharging.

# CHAPTER 4

# TEST EQUIPMENT

## INTRODUCTION

1. This chapter lists test equipment which is suitable for all maintenance and alignment procedures carried out on the transceiver.

## TEST EQUIPMENT

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

(2) RF Electronic Multimeter having an RF range up to 100 MHz. The Racal type CT569 is suitable.

(3) Digital Multimeter. Frequency range 20 Hz to 100 kHz, sensitivity 1 mV FSD. The Fluke type 8000A is suitable.

(4) Audio Power Output Meter, having a range of 10 Hz to 100 kHz at an input impedance of 300Ω and range of 1 mW to 10 mW. The Dymar Type 1585 is suitable.

(5) RF 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) AF Two Tone Signal Generator, having outputs of 20 Hz to 100 kHz at 600Ω impedance, with an output level of 0.1 mV to 1V. The Dymar Type 1745 is suitable.

(7) Digital Frequency Counter having a range of 1 MHz up to 30 MHz at 50 mV r.m.s. input. The Racal Type 9822 is suitable.

(8) Oscilloscope having a frequency range of d.c. to 100 MHz and a sensitivity of 10 mV/cm. The Tektronix Type 465 is suitable.

(9) RF Power Meter covering the range of 1 to 30 MHz at 50Ω input impedance and capable of dissipating 25W. The Marconi Type TF2512 is suitable.

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

(11) Decade resistance box up to 99999 ohms.

(12) Channel Encoder Unit Racal Type MA.4008.

(13) 6 pin to 7 pin Adaptors (two) with pin G brought out to a terminal (Local Manufacturer).

(14) 50 ohm Fixed Attenuator (10 or 20 dB) (Example: Marconi TM 5573).

(15) Audio Load:

| | | |
|---|---|---|
| Audio Load: | Resistor | 1k ohm 1/3 watt |
| | Capacitor | 4.7 μF 6 volt |

(16) RF Co-axial 50 ohm terminations (BNC) (2 off).

(17) BNC T junctions 50 ohms (2 off).

(18) 100 nF/100 volts Blocking Capacitor with BNC-50 ohms plugs.

(19) Voltage shunt (zener diode or equivalent) 2.7 - 3.0 volts.

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 movements of output power.

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

(4) Transmit/Receive and Kay switching.

(5) DC current meter.

4. The procedures in this handbook 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 seven 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.

# CHAPTER 5

# OVERALL FUNCTIONAL TESTS

## CONTENTS



## ILLUSTRATIONS

# CHAPTER 5

# OVERALL FUNCTIONAL TESTS

## INTRODUCTION

1. This chapter gives an overall functional test procedure which may be used to check the operation of the transmitter/receiver. Further test procedures for the main sub-units are given in Parts 2, 3 and 4.

## OPERATION OF CONTROLS

2. Check all controls for smooth action. Check that the synthesizer frequency digits are displayed centrally in their viewing windows.

## TRANSMITTER OVERALL TEST

3. (1) Set Power switch to OFF.

(2) Connect the output leads from CA.531 Test Set to the AUDIO sockets on the TRA.931P. Set the Transmit/Receive Switch to TRANS and the Test Set Power switch to ON.

(3) Connect the 600 ohms output of an AF Signal Generator (set to 1 kHz and 2.0 mV) across the MOD and EARTH terminals of the CA.531.

(4) Connect a 50 ohm RF power meter and an oscilloscope to the 1.6 - 3 MHz socket.

(5) Set the Power switch of TRA.931P to High. Using MA.4008 programme the following channel frequencies: Channel 1 - 1.600 MHz; Channel 2 - 3.000 MHz; Channel 3 - 29.999 MHz.

(6) Set the Channel Switch to CH1 (1.600 MHz) and the MODE switch to TUNE. Adjust the Tune control for maximum output on the RF power meter.

(7) The RF power meter reading should be between 17.5W and 18.5W. If necessary, readjust 1R142 to give 18W output.

(8) Connect 100 mW input and output sockets together via a pi network consisting of 100 nF blocking capacitor in series, and shunt resistors of 3k2 ±2% each.

(9) Check that RF power meter indicates between 17W and 21W.

(10) Remove link between 100 mW input and output sockets.

(11) Set MODE switch to LSB. Disconnect the Audio lead of CA.531 and temporarily short circuit pins C and D of the TRA.931P audio socket. Check that the voltage indicated on the oscilloscope is not greater than 250 mV peak-to-peak. If necessary, adjust 1R163 and 1C126.

(12) Set MODE switch to USB. Check that the voltage indicated on the oscilloscope is not greater than 250 mV peak-to-peak.

(13) Re-connect the audio lead of the CA.531 to TRA.931P. Check that the RF Power Meter reading is not less than 17W (see next sub-para.).

(14) Set the MODE switch to LSB and check that the RF power meter reading is not less than 17W. Reset the MODE switch to USB.

NOTE: If the RF power readings during this check and that given in sub-para. (13) are outside limits proceed as follows. Set 1R142 fully clockwise, set MODE switch to USB. Adjust 1R146 to give an RF power meter reading of 21W. Set MODE switch to TUNE and adjust 1R142 for an RF power meter reading of 18W. Set MODE switch to USB and repeat procedure given in sub-paras. (13) and (14).

(15) Increase the output of the AF Signal Generator to 6 mV.

(16) Check that the RF power meter indication increases by not more than 1.5W.

(17) Set MODE switch to AM and increase the AF Signal Generator output to 60 mV e.m.f.

(18) Check that the troughs of the waveform displayed on the oscilloscope do not meet. If necessary, increase the sensitivity and timebase speed of the oscilloscope to enable the point of over-modulation (troughs meeting) to be easily determined. Adjust 1R162 so that this point of over-modulation is not quite obtained.

(19) Connect an RF Electronic Voltmeter to the 3-30 MHz sockets. Set the AF Signal Generator to two-tone output, 1.1 kHz and 1.8 kHz, each at a level of 3 mV e.m.f. Set MODE switch of TRA.931P to LSB.

(20) Check that the two-tone waveform displayed on the oscilloscope is undistorted.

(21) Check the voltmeter reading is at least 27V.

(22) Set MODE switch to TUNE and rotate the TUNE control through the tuning point firstly clockwise and then anti-clockwise and check that both LED's are operating correctly.

(23) Check that maximum deflection of meter on manpack corresponds to the optimum settings of the TUNE control.

(24) Adjust the TUNE control for maximum power output. Set the MODE switch to USB and remove the signal lead from the audio socket.

(25) Set the Channel Switch to CH2.

(26) The following test is best carried out using a 'single-trace-capability' oscilloscope.

Connect the wideband output of the PA board (pin 18) to the Y input (normal signal input) of the oscilloscope. Set the oscilloscope to 50 volts/cm Y-deflection amplitude, 10 ms/cm X-deflection amplitude, single-trace operation internally synchronised.

Switch the MODE switch to TUNE to produce a single-trace display. It will be necessary to continually switch from USB to TUNE to reproduce the single-trace display.

To produce a single-trace display on an oscilloscope without this facility proceed as follows:-

Connect the wideband output of the PA board (pin 18) to the Y input (normal signal input) of the oscilloscope. Set the oscilloscope to 50 volts/cm Y-deflection amplitude, 10 ms/cm X-deflection amplitude, -ve externally triggered trace and connect the external trigger input to the KEY line (pin A41 or SKT 1 Pin E or SKT 2 Pin E). Depress the KEY button to produce a single-trace.

Check that the waveform is similar to Fig. 5.1(a).

(27) Reconnect the RF power meter to the 3-30 MHz socket. Adjust the TUNE control for maximum reading on the RF power meter.

(28) Check that the RF power meter reading is between 17W and 21W.

(29) Set the Power switch to Low.

(30) Check that the RF power meter reading is between 2.5W and 5W.

(31) Set the power switch to High. Remove the power meter coaxial lead from the 3-30 MHz socket and insert the gooseneck into the whip aerial socket. Adjust the TUNE control for maximum deflection on the TRA.931P meter.

(32) Check that no flash-over occurs across the dipole sockets or around the antenna capacitors on the PA board.

(33) Remove Gooseneck and reconnect the RF power meter to the 3-30 MHz socket.

(34) Insert oscilloscope probe (10 : 1) into the Whip Socket. Adjust TUNE control fully clockwise, i.e to HF end.

(35) Check that the waveform is symmetrical. Remove the oscilloscope probe.

(36) Set the Channel Switch to CH3 (29.999 MHz). Adjust the TUNE control for maximum output on the RF power meter.

(37) Check that RF power meter reading is between 17W and 22W. If necessary readjust 1R140 to bring the RF power meter reading 0.5W inside the specification limit, ensuring that power supply current is less than 3.5A. The TUNE control must be peaked each time 1R140 is adjusted. (NOTE: Should it be necessary to readjust 1R140 then recheck that the 3 MHz HIGH and LOW power levels are still within specification).

(38) Check that the power supply current is not greater than 3.5A.

(39) Set channel switch to MANUAL and frequency selection switches to 29.999 MHz.

(40) Connect a Digital Frequency Meter, via a suitable attenuator, to WB socket.

(41) Ensure SEARCH control is OFF.

(42) Check that radiated frequency is within ±15 Hz.

(43) Rotate the frequency selection switches step by step in an anti-clockwise direction noting that the frequency decreases directly as the step in 10 MHz, 1 MHz, 100 kHz, 10 kHz and 1 kHz steps.

(44) Set the frequency selection switches to 2.000 MHz. Check that radiated frequency is within ±2 Hz.

(45) Check that the search control gives at least ±500 Hz variation, then switch it off.

(46) Set the Channel Switch to CH1 (1.600 MHz).

(47) Connect RF power meter to WB socket via 100 nF blocking capacitor and BNC T-junction. To the free socket on T-junction connect 1k resistor in series with the decade box. Set the decade box to 26k. Check that the RF power meter reading is between 17W and 21W.

(48) Reset the channel switch to CH3 (29.999 MHz). Check that the RF power meter reading is between 17W and 30W.

(49) Reduce the value on decade box to 2k2. Check that the RF power meter reading is between 2.5W and 5W.

(50) Reset the channel switch to CH1 (1.600 MHz). Check that the RF power meter reading is between 2.5W and 5W.

(51) Increase value on decade box to 41k (42k total).

(52) Ensure that output falls to zero.

(53) Transfer all the coax connections from WB sockets to 100 mW output socket.

(54) Connect an RF Electronic voltmeter to RF power meter using another BNC T-junction.

(55) Set decade box to 2k2 (3k2 total).

(56) Check that reading on Electronic Voltmeter is between 1.7V and 4.5V.

(57) Remove all connections from the 100 mW output socket.

(58) Connect an MA.4008 to AUDIO 1 or 2 socket.

Connect a Digital Frequency Meter, via a suitable attentuator, to the WB socket.

(59) Select Channel 1 and set frequency selector switches to 20,000 MHz. Press button on MA.4008 and ensure correct output frequency is then given (± 1ppm). Increase kHz control 1 kHz at a time, checking that correct output frequency given when (but not until) button on MA.4008 is pressed. Repeat for 10 kHz, 100 kHz and 1 MHz controls, to 29.999 MHz, then for 19.999 and 09.999 MHz.

(60) Repeat procedure in sub-paras. 5(a) for channels 2 - 8.

(61) Re-programme CH1 - 1.600 MHz, CH2 - 3.000 MHz, CH3 - 29.999 MHz. Set frequency selection switches to 5.555 MHz. Disconnect the MA.4008. Disconnect the audio leads from the TRA.931P under test. Wait 20 secs. Reconnect audio leads.

(62) Check that CH1, CH2 and CH3 display those frequencies programmed (sub-para. 6.1) and not the frequency as selected by the frequency selection switches (5.555 MHz).

(63) Set the channel switch to CH1 (1.600 MHz). Set the MODE switch to TUNE. Connect the RF power meter to the 1.6 - 3 MHz socket.

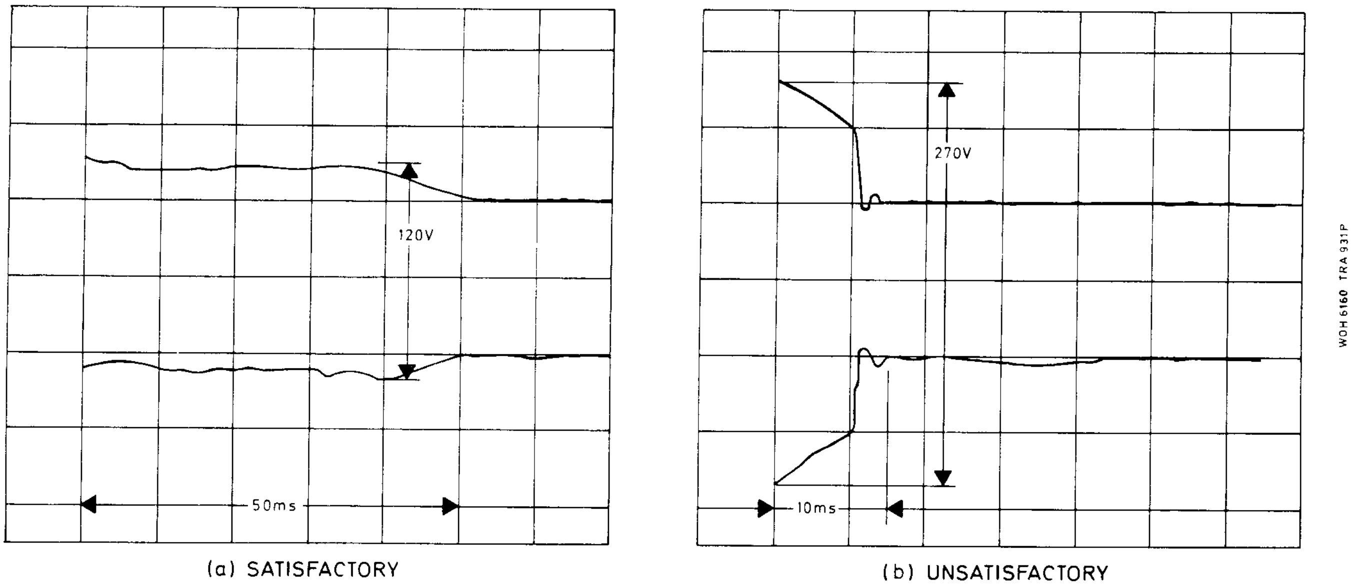
(64) Adjust the TUNE control for maximum RF power output.

(65) Switch the power switch between OFF, low and high successively for at least 20 operations. With the power switch set to High disconnect and reconnect the power supply lead from the CA531 successively at least 20 times.

(66) Check the CH1 is still programmed to 1.600 MHz and has not been spuriously programmed to the dialled frequency of 5.555 MHz.

(67) Set Channel switch to MANUAL. Select frequencies according to Table 1 and ensure correct readout given on pins A, C, F, G and H on 10-way socket.

(68) Short circuit pins E and D of 10-way socket. Select USB and LSB and check low power output obtained with key down.




ALC Check Waveforms Fig. 5.1

## TABLE 1 OUTPUTS AT MA.4015 SOCKET

(See foot of Table for Memory Board Pin Nos.)

| Band | Lower Frequency | Upper Frequency | Binary readout at Pin No. A | C | F | G | H |
|---|---|---|---|---|---|---|---|
| 1 | 1.6 MHz | 1.799 MHz | 0 | 0 | 0 | 0 | 0 |
| 2 | 1.8 | 1.999 | 0 | 0 | 0 | 0 | 1 |
| 3 | 2.0 | 2.199 | 0 | 0 | 0 | 1 | 0 |
| 4 | 2.2 | 2.399 | 0 | 0 | 0 | 1 | 1 |
| 5 | 2.4 | 2.599 | 0 | 0 | 1 | 0 | 0 |
| 6 | 2.6 | 2.799 | 0 | 0 | 1 | 0 | 1 |
| 7 | 2.8 | 3.099 | 0 | 0 | 1 | 1 | 0 |
| 8 | 3.1 | 3.399 | 0 | 0 | 1 | 1 | 1 |
| 9 | 3.4 | 3.699 | 0 | 1 | 0 | 0 | 0 |
| 10 | 3.7 | 3.999 | 0 | 1 | 0 | 0 | 1 |
| 11 | 4.0 | 4.399 | 0 | 1 | 0 | 1 | 0 |
| 12 | 4.4 | 4.799 | 0 | 1 | 0 | 1 | 1 |
| 13 | 4.8 | 5.199 | 0 | 1 | 1 | 0 | 0 |
| 14 | 5.2 | 5.699 | 0 | 1 | 1 | 0 | 1 |
| 15 | 5.7 | 6.199 | 0 | 1 | 1 | 1 | 0 |
| 16 | 6.2 | 6.799 | 0 | 1 | 1 | 1 | 1 |
| 17 | 6.8 | 7.499 | 1 | 0 | 0 | 0 | 0 |
| 18 | 7.5 | 8.199 | 1 | 0 | 0 | 0 | 1 |
| 19 | 8.2 | 8.999 | 1 | 0 | 0 | 1 | 0 |
| 20 | 9.0 | 9.799 | 1 | 0 | 0 | 1 | 1 |
| 21 | 9.8 | 10.699 | 1 | 0 | 1 | 0 | 0 |
| 22 | 10.7 | 12.699 | 1 | 0 | 1 | 0 | 1 |
| 23 | 12.7 | 14.999 | 1 | 0 | 1 | 1 | 0 |
| 24 | 15.0 | 17.699 | 1 | 0 | 1 | 1 | 1 |
| 25 | 17.7 | 19.499 | 1 | 1 | 0 | 0 | 0 |
| 26 | 19.5 | 20.999 | 1 | 1 | 0 | 0 | 1 |
| 27 | 21.0 | 22.499 | 1 | 1 | 0 | 1 | 0 |
| 28 | 22.5 | 23.999 | 1 | 1 | 0 | 1 | 1 |
| 29 | 24.0 | 25.499 | 1 | 1 | 1 | 0 | 0 |
| 30 | 25.5 | 26.999 | 1 | 1 | 1 | 0 | 1 |
| 31 | 27.0 | 28.499 | 1 | 1 | 1 | 1 | 0 |
| 32 | 28.5 | 29.999 | 1 | 1 | 1 | 1 | 1 |
| | | Memory Board Pin Nos. | 42 | 43 | 44 | 45 | 46 |

RECEIVER OVERALL TEST

4. If channels 1, 2 and 3 are programmed to 1.600 MHz, 3.000 MHz and 29.999 MHz respectively, the appropriate channel may be selected by using the channel switch instead of using the frequency selector switches.

(1) Set the transmit/receive switch on the CA.531 to RECEIVE.

(2) Connect the AF power meter, set to 300 ohms and 200 mW to the terminals marked AF and EARTH on the CA.531.

(3) Set the MODE switch to USB and the frequency selection switches to 1.600 MHz, channel switch to Manual.

(4) Connect on RF signal generator, set to 1.601 MHz, and its output to 2 μV e.m.f., to the 1.6 - 3 MHz socket.

(5) Adjust the Tune Control and Generator frequency for maximum output indication on the AF power meter.

(6) Adjust the AF gain control until this reading is reduced by 6 dB. Readjust the TUNE control and RF signal generator for a maximum output on the AF power meter.

(7) Change over connections to audio sockets and ensure that AF power output has not changed.

(8) Check that audio tone in the earpiece is free from "warble".

(9) Increase the RF signal generator output to 20 mV (+80 dB) and check that the audio output changes between 4 dB and 8 dB. If not, readjust 1R33 for a 6 dB change. Reduce output from RF signal generator to 2 μV e.m.f.

(10) Check that the AF power meter reading is between 8 mW and 20 mW. Note reading.

(11) Interrupt the RF signal generator output and check that the change of reading of the AF power meter is at least -15 dB.

(12) Connect signal generator to WB socket.

(13) Check that the AF power meter reading is between 8 mW and 20 mW.

(14) Interrupt the RF signal generator output and check that the change of reading of the AF power meter is at least -15 dB.

(15) Connect signal generator to 100 mW output socket.

(16) Check that the AF power meter reading is between 8 mW and 20 mW.

(17) Interrupt the RF signal generator output and check that the change or reading of the AF power meter is at least -15 dB.

(18) Connect signal generator to the 1.6 - 3 MHz socket.

(19) Increase the output of the RF signal generator to 4 μV e.m.f.

(20) Decrease the frequency of the RF signal generator until the same power level as in sub-para. (10) is achieved. Check that the frequency is between 100 Hz and 500 Hz.

(21) Increase the frequency of the RF signal generator until the same power level as in sub-para. (10) is achieved. Check that the frequency is between 2.5 kHz and 3.5 kHz.

(22) Set MODE switch to LSB and the RF Signal Generator frequency to 1.599 MHz with its output set to 2 μV e.m.f.

(23) Adjust the TUNE control and RF signal generator for maximum output as shown on the AF power meter.

(24) Check that the AF power meter reading is between 8 mW and 20 mW. Note the reading.

(25) Interrupt the RF signal generator output and check that the change of reading of the AF power meter is at least 15 dB.

(26) Increase the output of the RF signal generator to 4 μV e.m.f. Increase the frequency of the RF signal generator until the same power level as in sub-para. (24) is achieved. Check that the frequency is between 100 Hz and 500 Hz.

(27) Decrease the frequency of the RF signal generator until the same power level as in sub-para. (24) is achieved. Check that the frequency is between 2.5 kHz and 3.5 kHz.

(28) Reset the RF signal generator to 2 μV e.m.f. and adjust its frequency for maximum output as shown on the AF power meter.

(29) Disconnect the AF output of the CA.531 from the AF power meter and in its place connect a lead from PIN G of the 7-way audio socket.

(30) Set the impedance of the AF power meter to 50 ohms.

(31) Increase the output of the RF signal generator to 20 mV (+80 dB) and adjust its frequency to give maximum audio output.

(32) Adjust the preset gain control (relay board) to give 50 mW indicated output.

(33) Check that the waveform displayed is undistorted.

(34) Disconnect Pin G of 7-way audio socket from the AF power meter and reconnect the audio output of CA.531 in its place.

(35) Set the impedance of the AF power meter to 300 ohms.

(36) Set the MODE switch to USB, the frequency selection switches to 29.999 MHz and the RF signal generator to 30.000 MHz with its output set to 2 μV e.m.f.

(37) Disconnect the RF signal generator from 2SK4 and connect to 2SK5 (3-30 MHz).

(38) Adjust the TUNE control and RF signal generator for a maximum output on the AF power meter.

(39) Interrupt the RF signal generator output and check that the change of reading of the AF power meter is not less than -15 dB.

(40) Set the frequency selection switches to 19.999 MHz and the RF signal generator frequency to 20.000 MHz.

(41) Adjust the TUNE control and RF signal generator for a maximum output on the RF power meter, adjusting the generator to give approximately 1 kHz audio output.

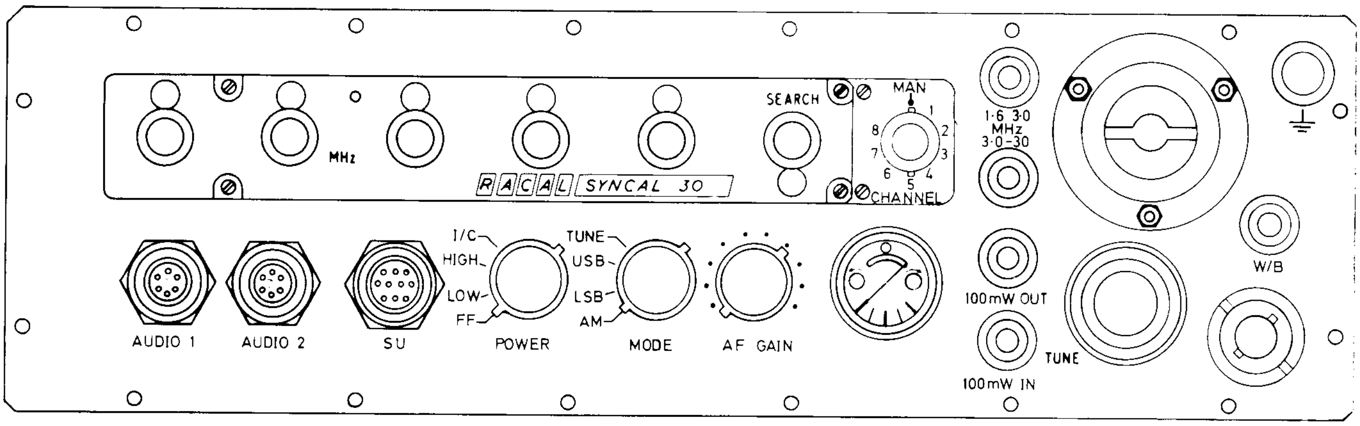
(42) Check that the deflection of the Manpack meter needle is three quarter scale deflection.

(43) Set MODE switch to OFF and disconnect all test equipment.

# CHAPTER 6

## LIST OF COMPONENTS (TRA.931P)

| Cct. Ref. | Value | Description | Rat. | Tol % | Racal Number |
|---|---|---|---|---|---|
| | | Light source (7) | | | 711062 |
| | | Knob (0-9) | | | 711132 |
| | | Knob (Search) | | | 711133 |
| | | Knob (Channel) | | | 711463 |
| | | '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 |

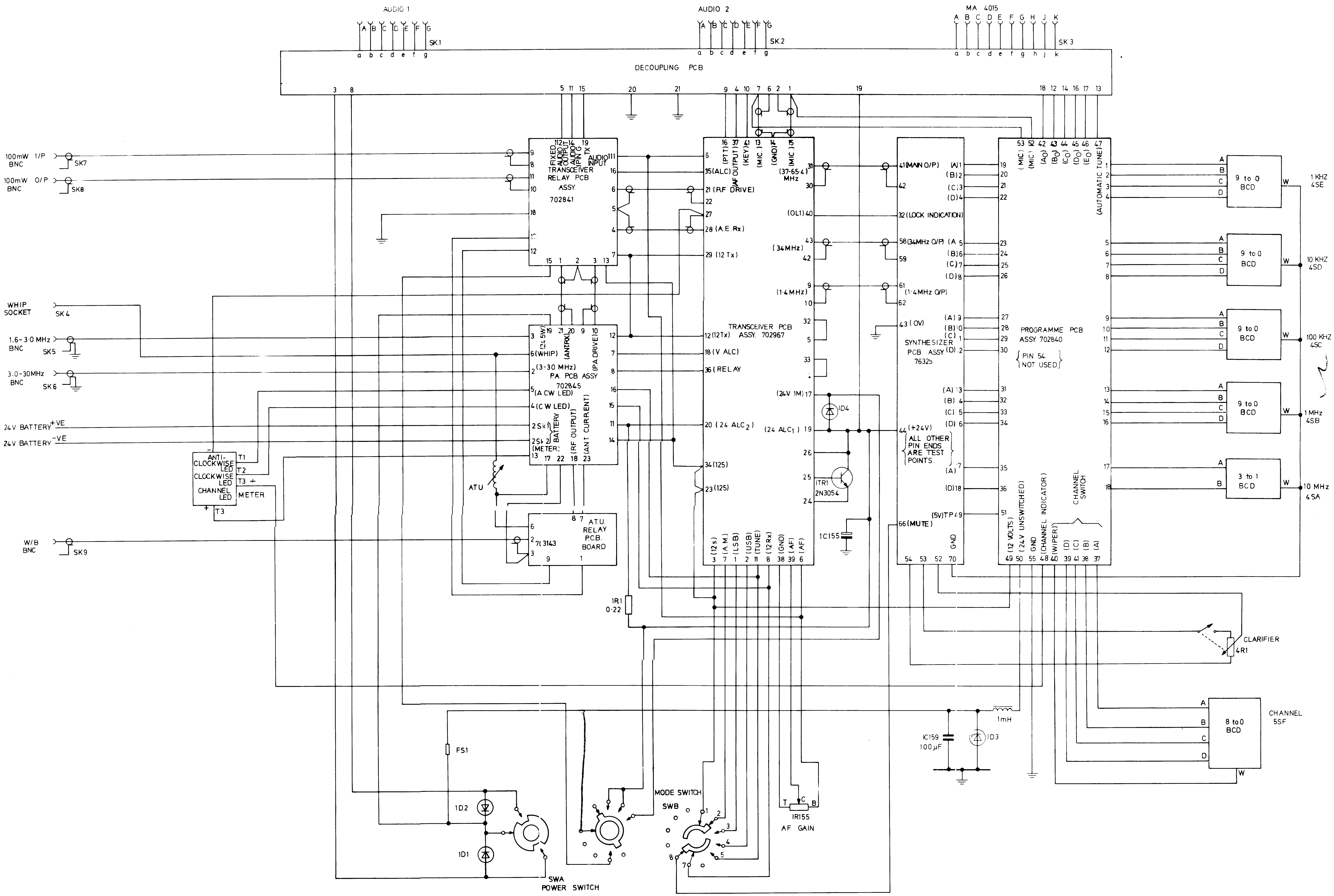



FRONT

WOH 6160
Part 1

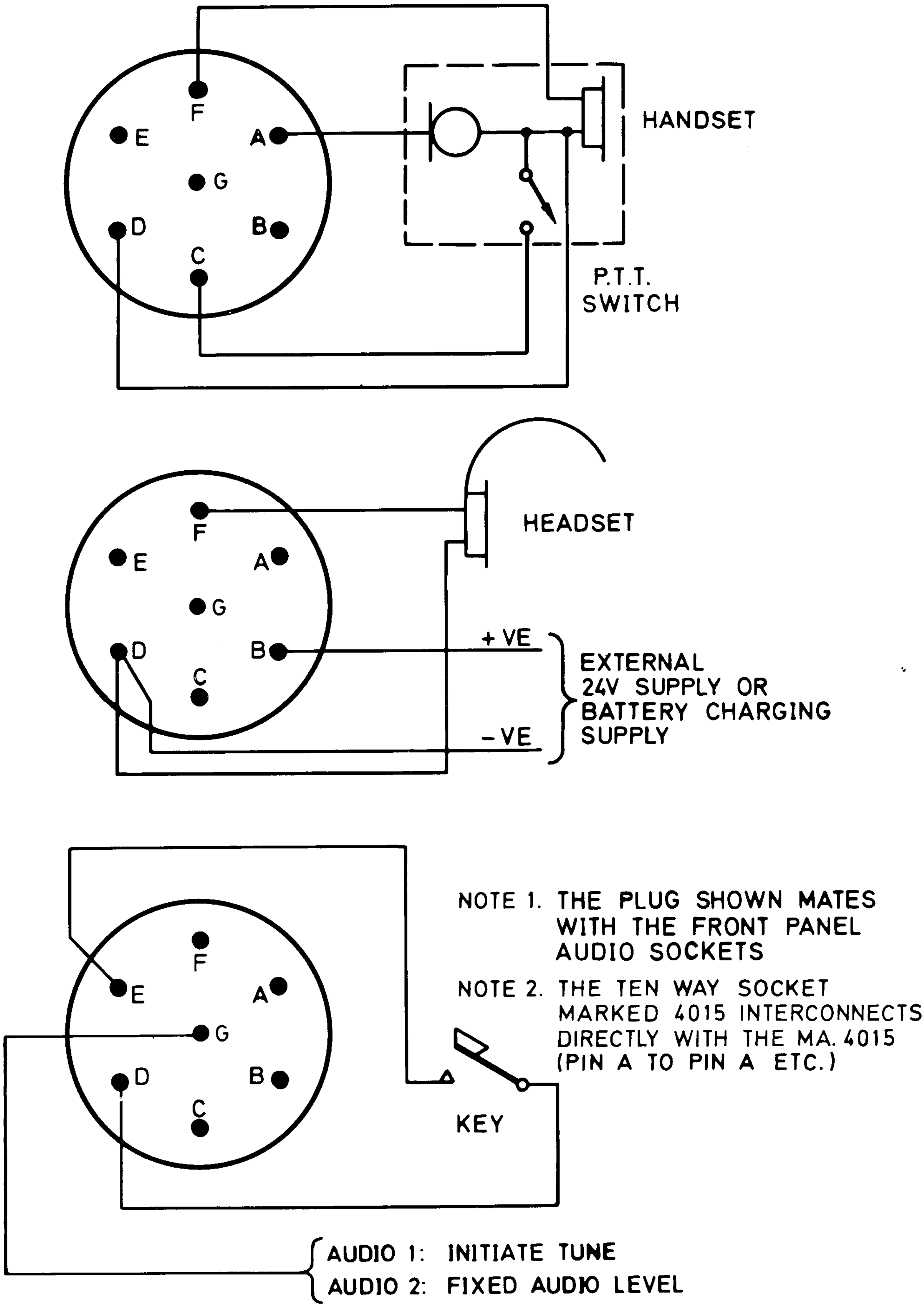
Control Panel: Syncal 30 TRA.931P

Fig. 1




WOH 6160

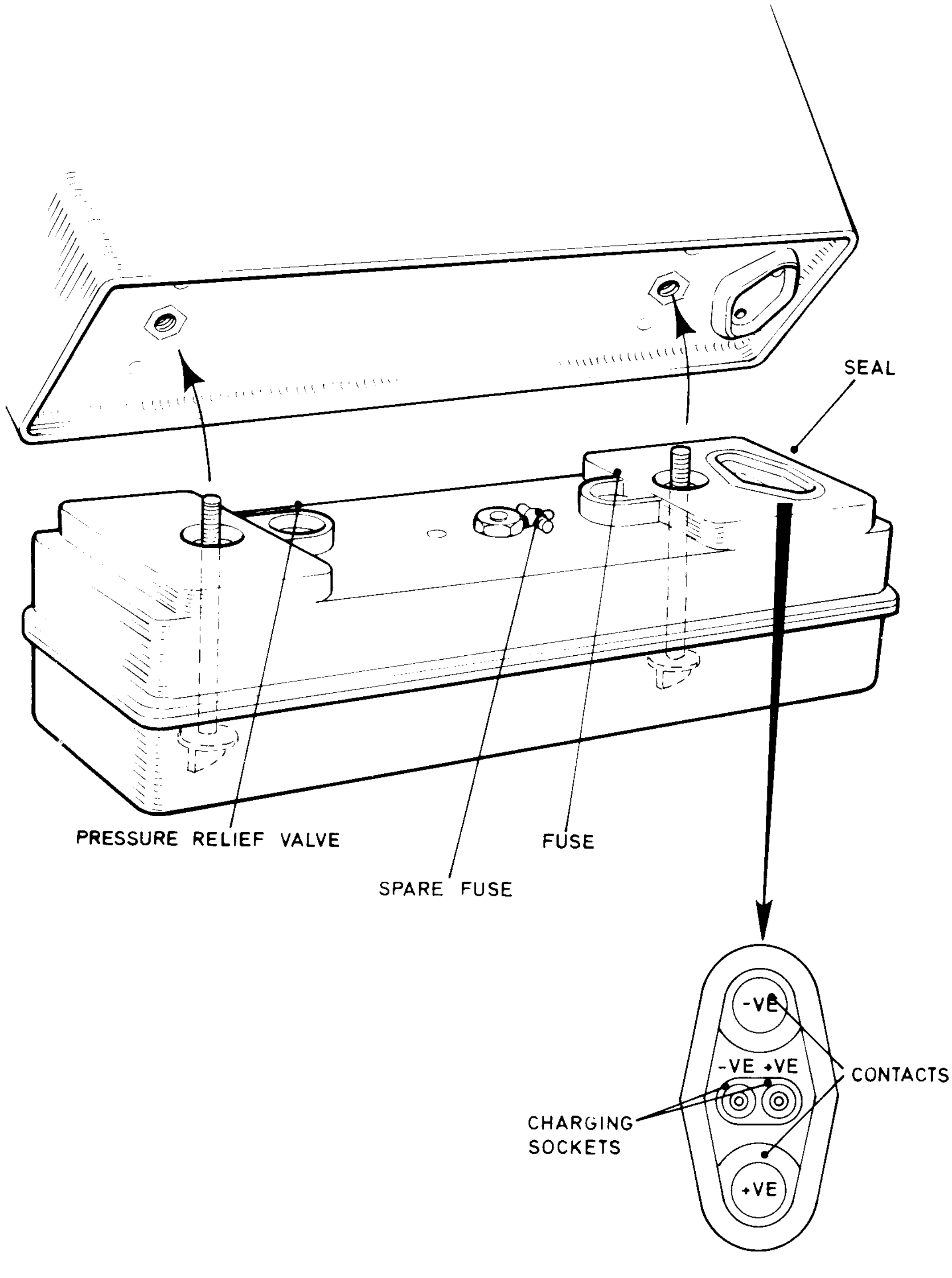
**Interconnection Diagram : TRA.931P Fig 2**




| WOH 6160 |
| --- |
| Part 1 |

External Connections:
Syncal 30 TRA.931 P

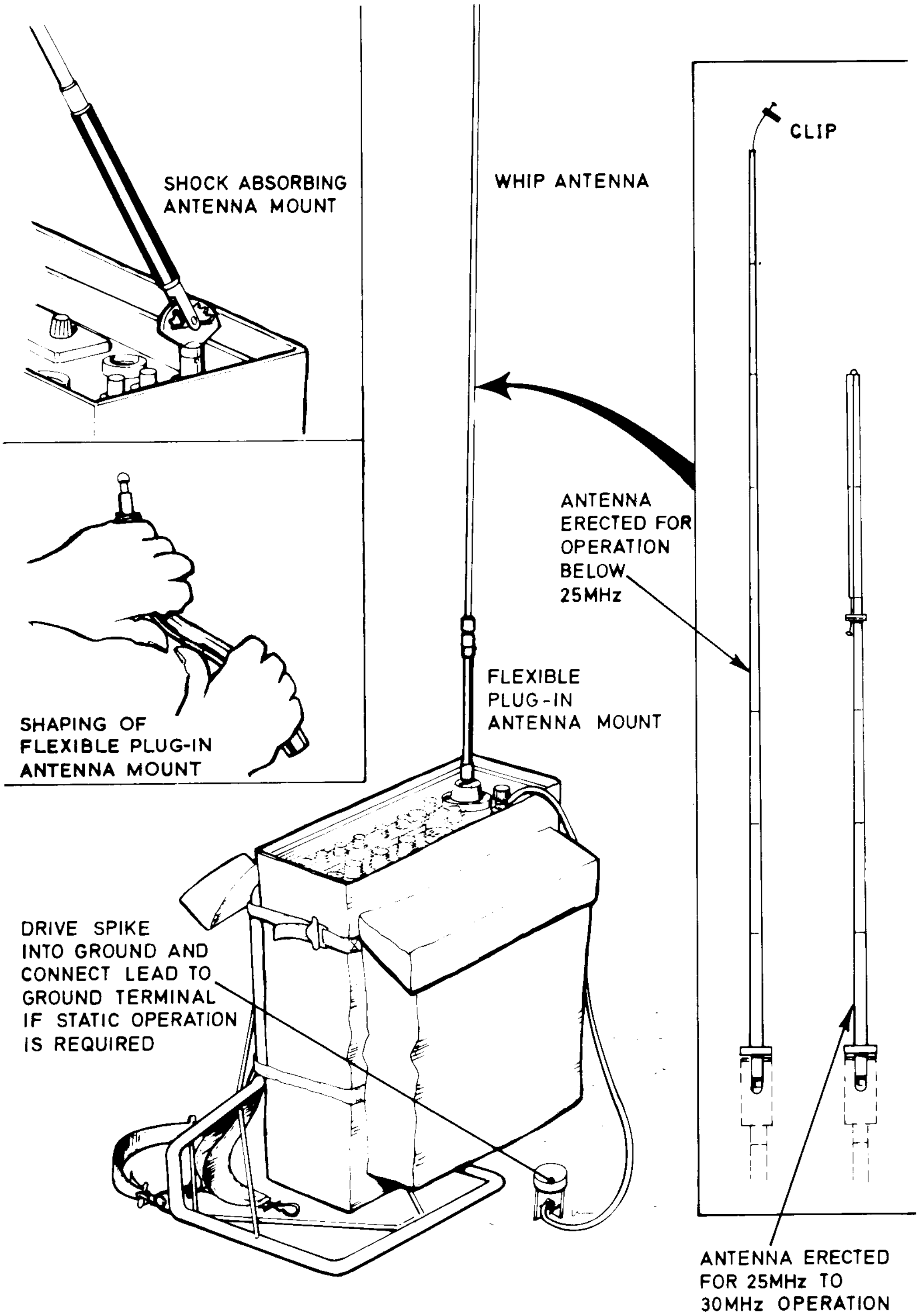
Fig. 3




# Battery and Connections:
# Syncal 30 TRA931P

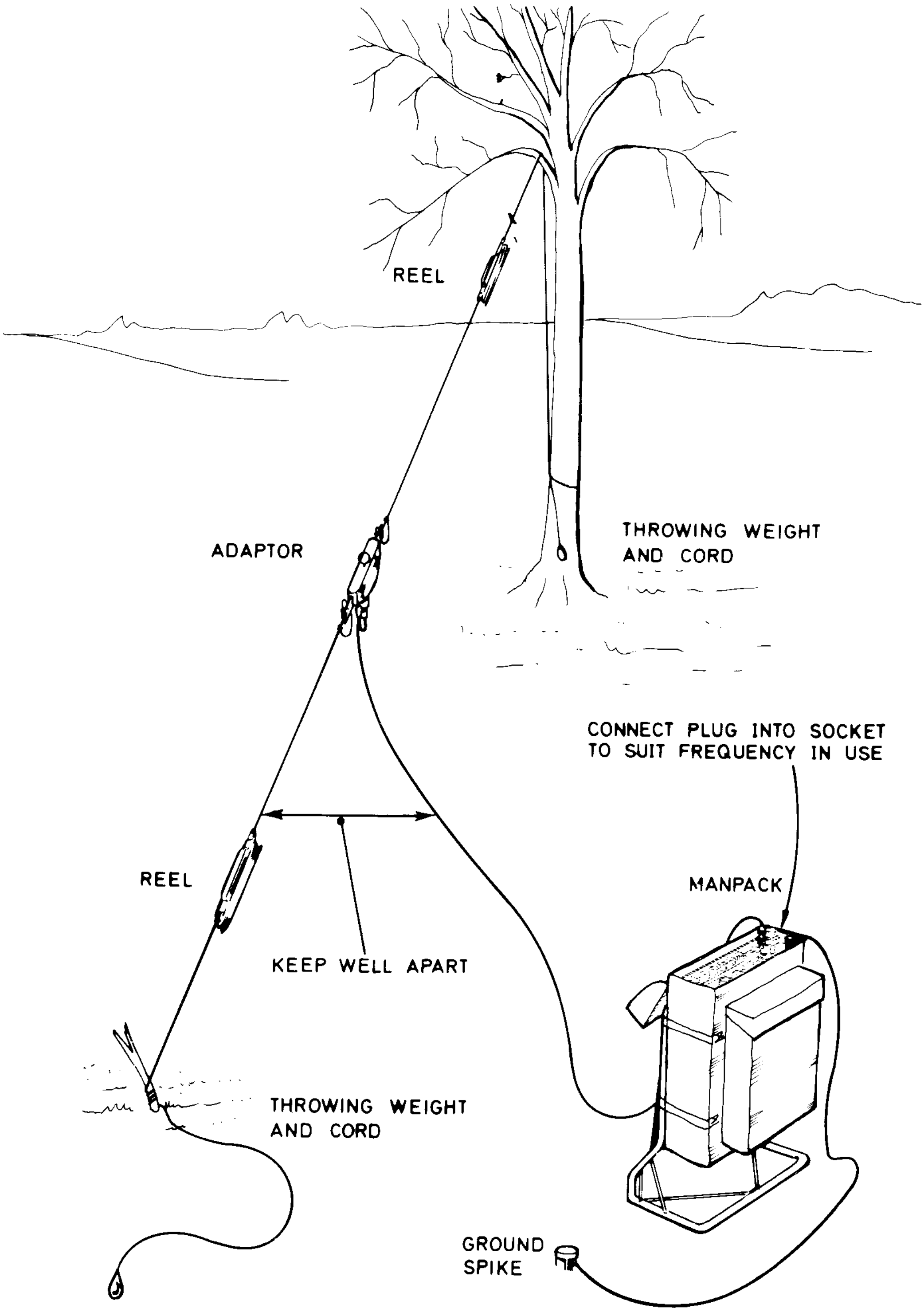
WOH 6160
Part 1

Fig. 4



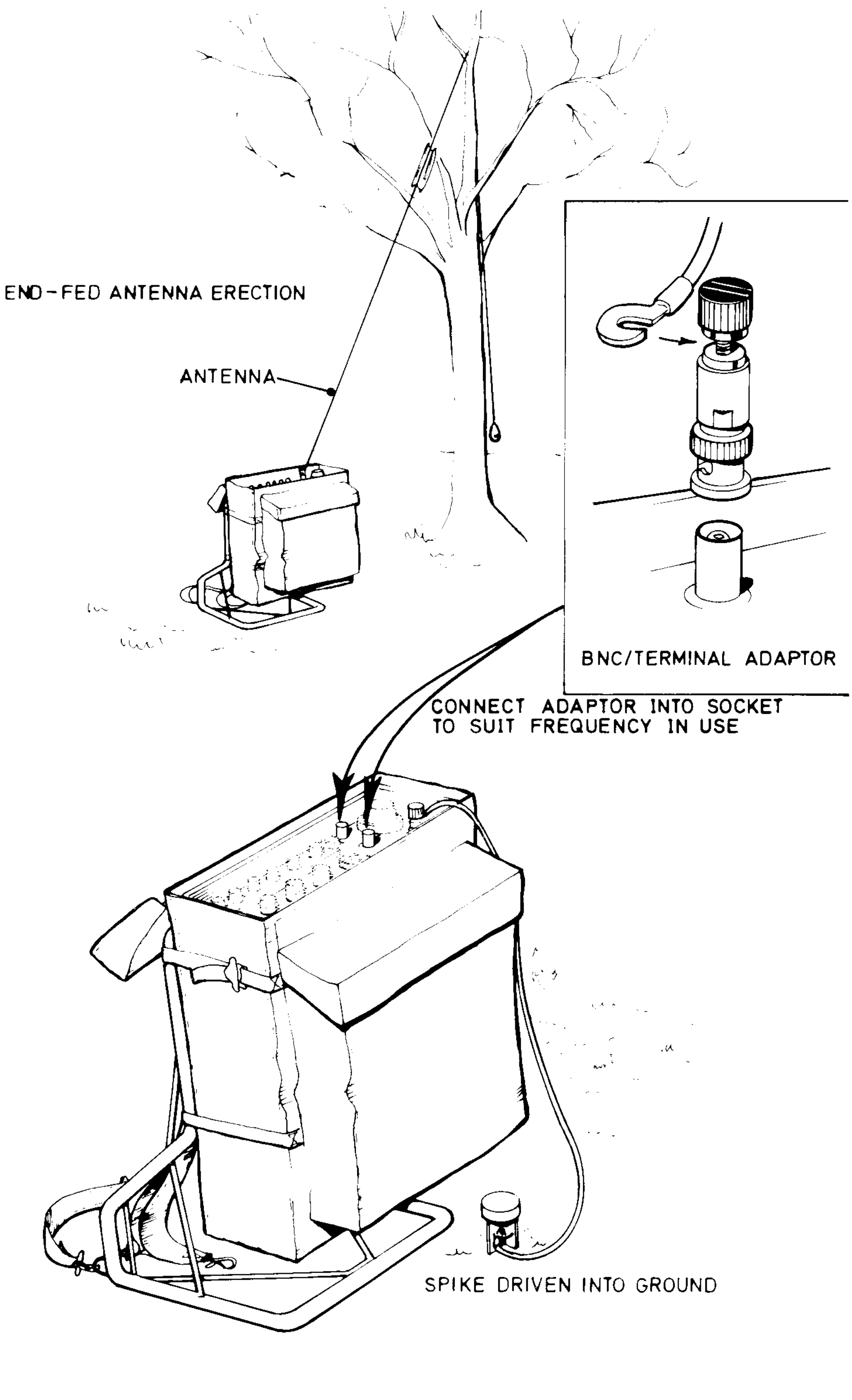

# Whip Antenna

**Fig. 5**



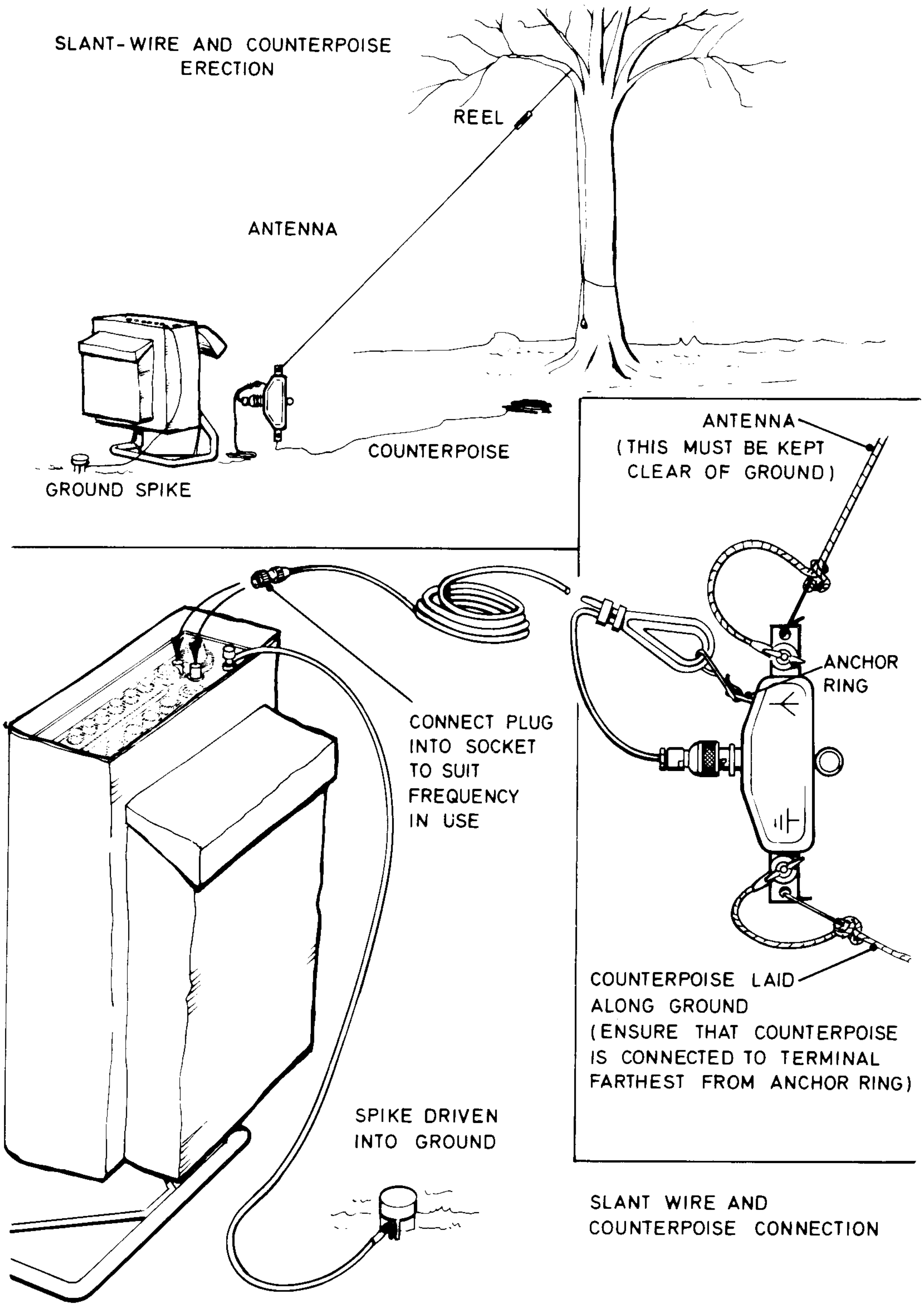

WOH 6160
PART 1

**Vertical Dipole Antenna** **Fig. 6**



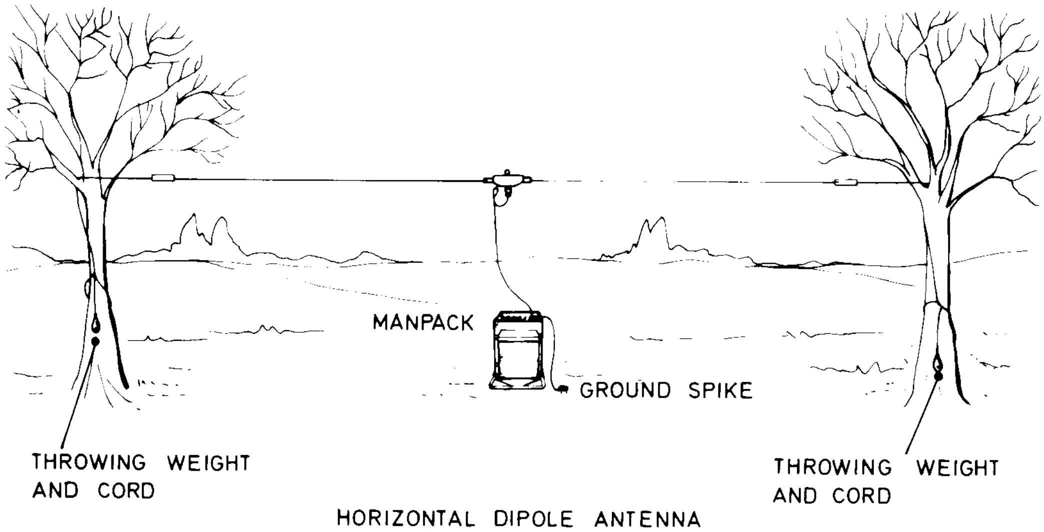

WOH 6160
PART 1

End-fed Antenna Fig. 7

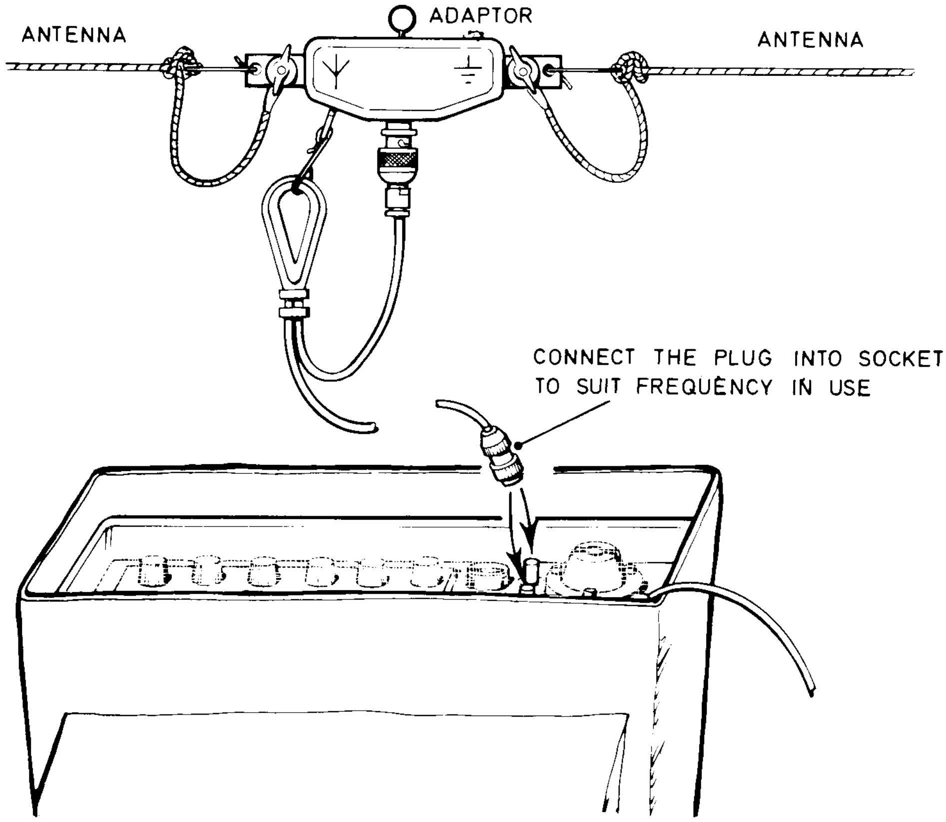



WOH 6160
PART 1

Dipole Used as
Slant-Wire Antenna Fig. 8

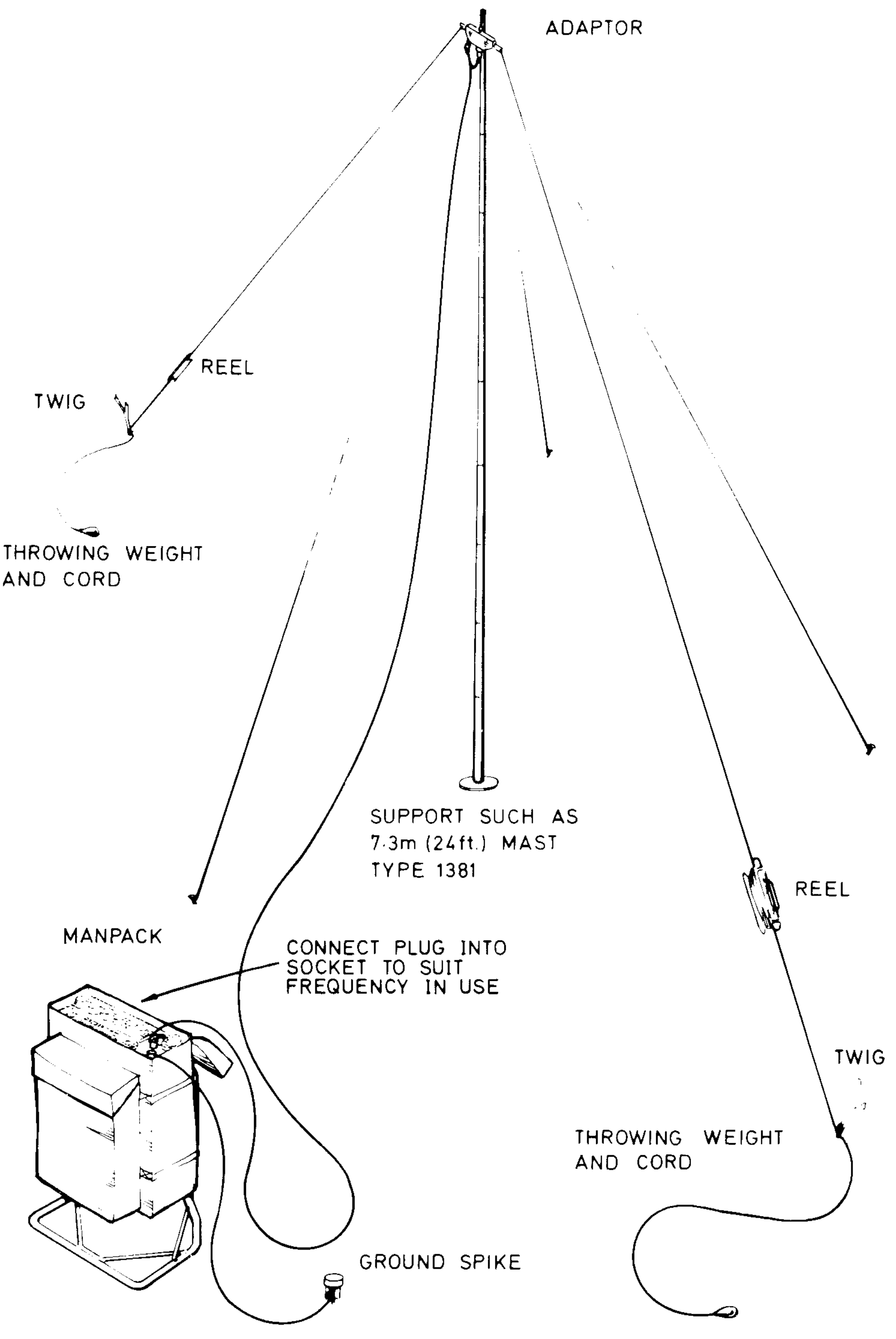



HORIZONTAL DIPOLE ANTENNA
(USED WHEN TWO SUPPORTS
ARE AVAILABLE)



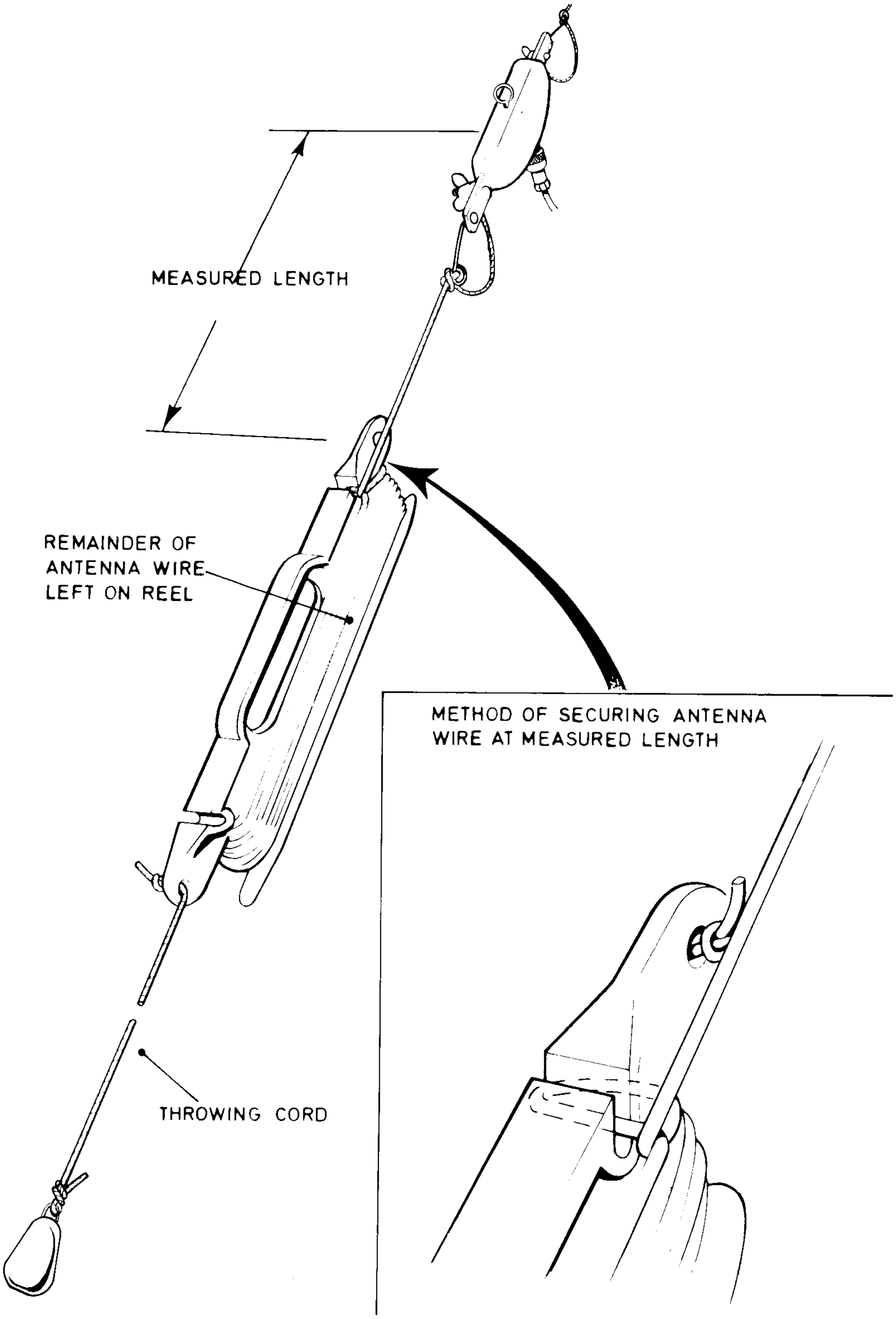

WOH 6160
PART 1

# Horizontal Dipole Antenna Fig. 9



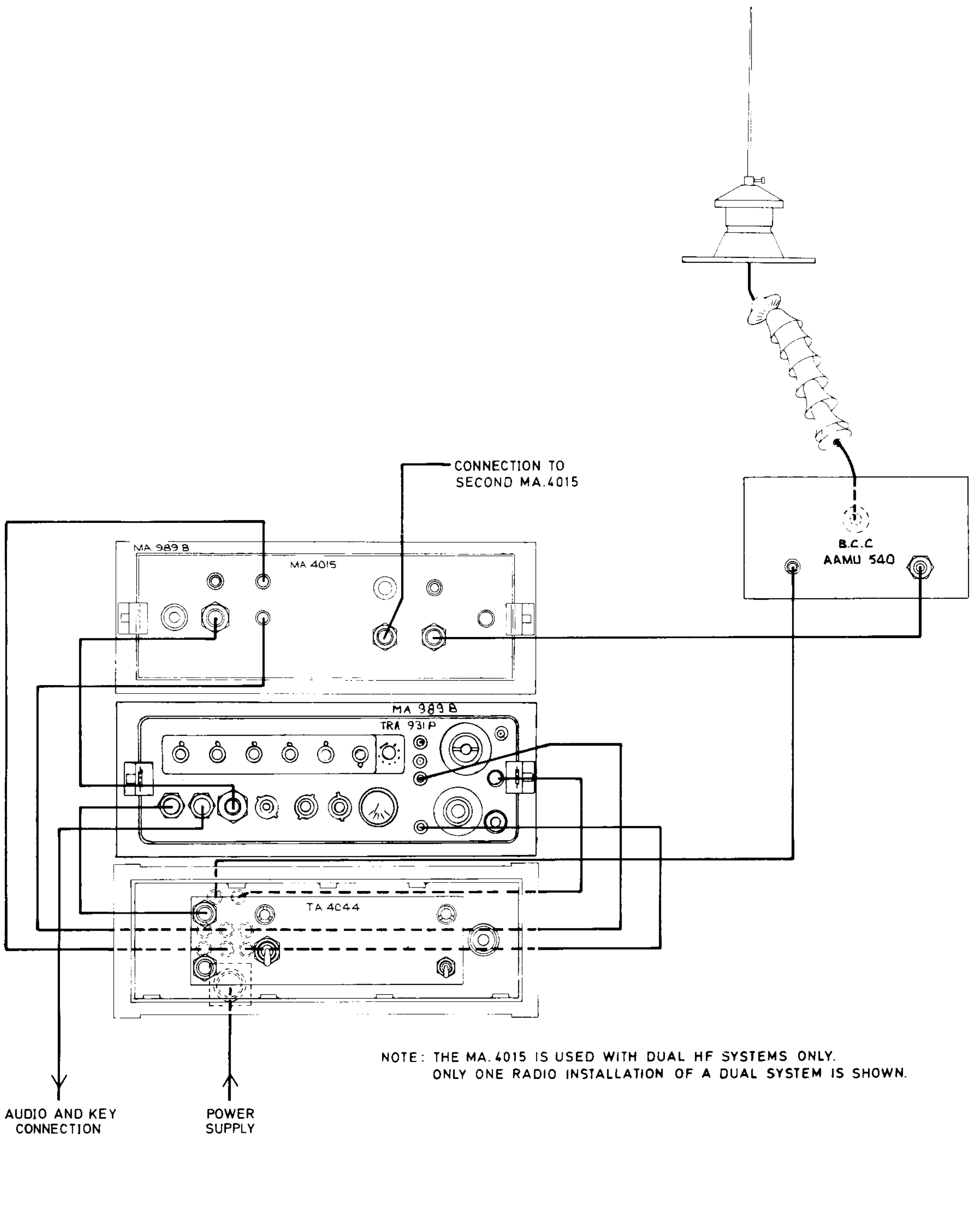

| |
|---|
| WOH 6160 |
| PART 1 |

Inverted V Dipole Antenna Fig. 10




WOH 6160
PART 1

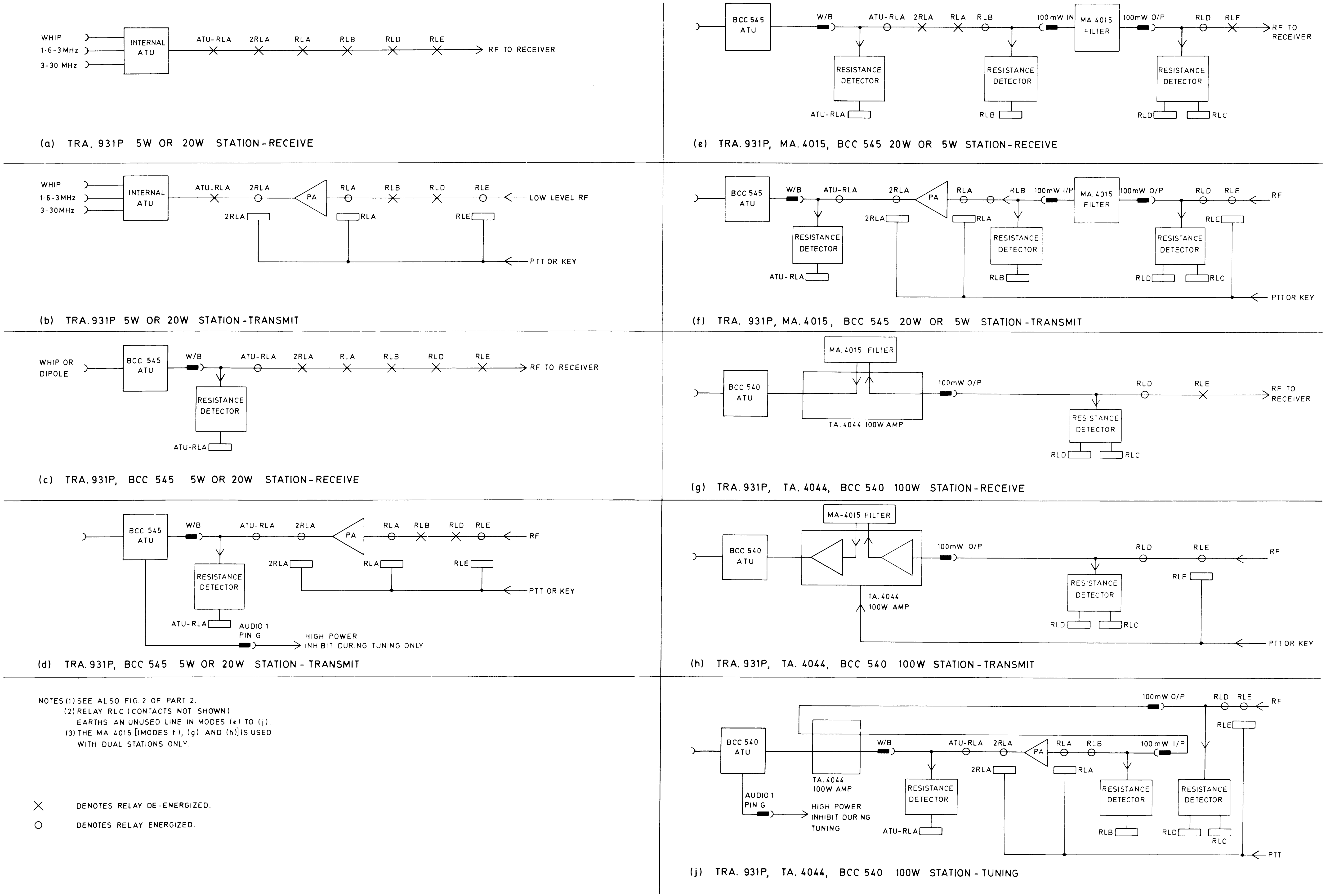
Antenna Securing Fig. 11




WOH6160

## Typical Dual HF High Power System

Fig.12




TRA 931P System Connections Fig. 13

# APPENDIX 1

## LIST OF ANCILLARIES

| ITEM | DESCRIPTION | RACAL REFERENCE | kg | WEIGHT lb | & oz. |
|---|---|---|---|---|---|
| 1 | 2.4m (8 ft) Sectional Whip Antenna | ST711017 | 0.28 | 0 | 10 |
| 2 | Flexible Plug-in Antenna Mount | ST711292 | 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 | 3-30 MHz Dipole Antenna Complete with Feeder, Support Lines, Throwing Weight and Spools. | ST711169 | 1.76 | 3 | 14 |
| 11 | 3-30 MHz 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 |

| ITEM | DESCRIPTION | RACAL REFERENCE | kg | WEIGHT lb | & oz. |
|---|---|---|---|---|---|
| 21 | 100-125V/200-250V, 45-60 Hz A.C. Power Unit/Loudspeaker Amplifier Type MA.949 for Static Operation | ST700883 | 5.8 | 12 | 13 |
| 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 |
| 29 | Filter Unit Type MA.4015 | ST714015 | | | |
| 30 | Channel Encoder Unit Type MA.4008 | ST702777 | | | |

# APPENDIX 2

# THE CARE AND CHARGING

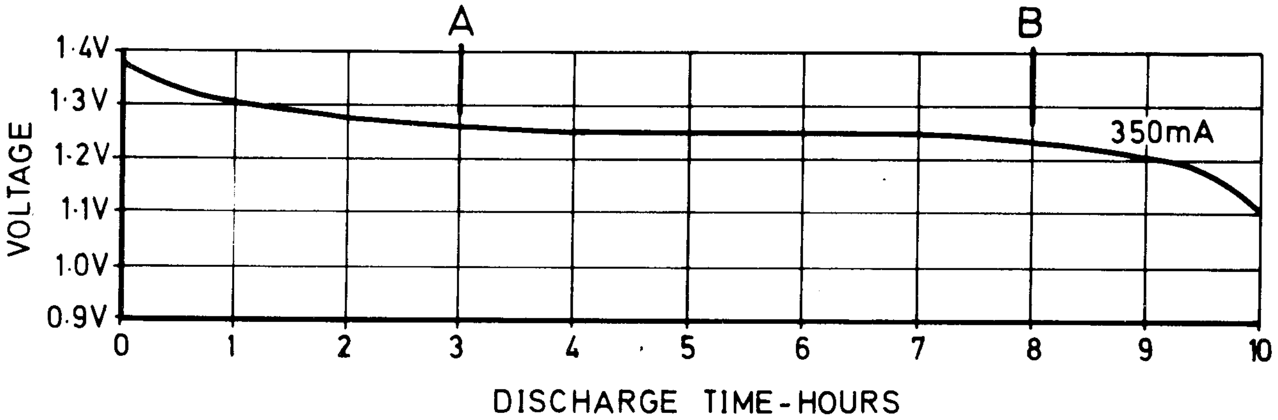
# OF

# 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 350 mA. 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 350 mA. 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.

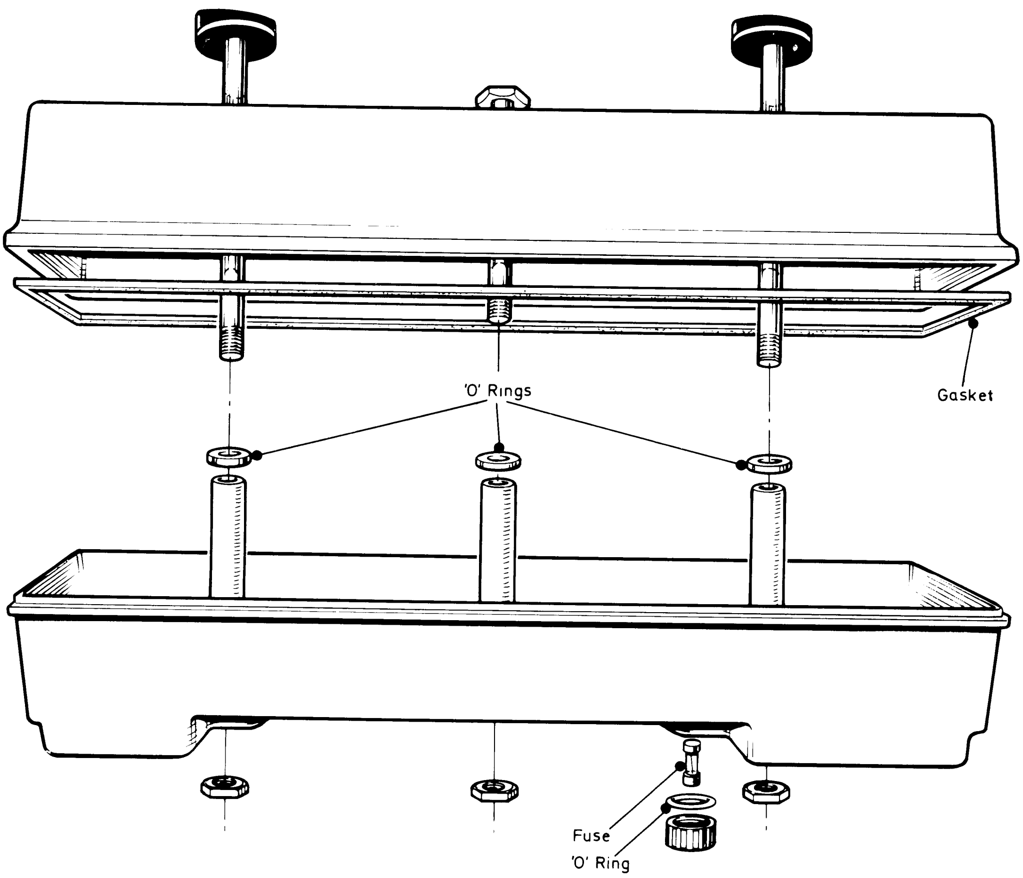
(5) Align the three case-securing screws with the spacer-tubes.

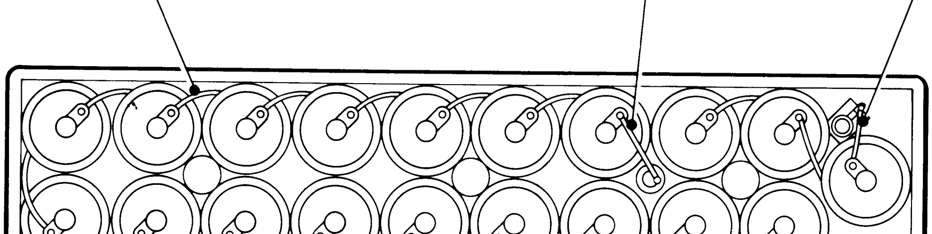
(6) Ensure that the 0-rings are correctly located and re-assemble the MA.934 Unit. Do not over-tighten the nuts.

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 para. 19 to 23.






Battery Assembly - Dismantling Fig. App. 3-1

# APPENDIX 4

## MOUNTING FRAMES TYPE MA.989

### General

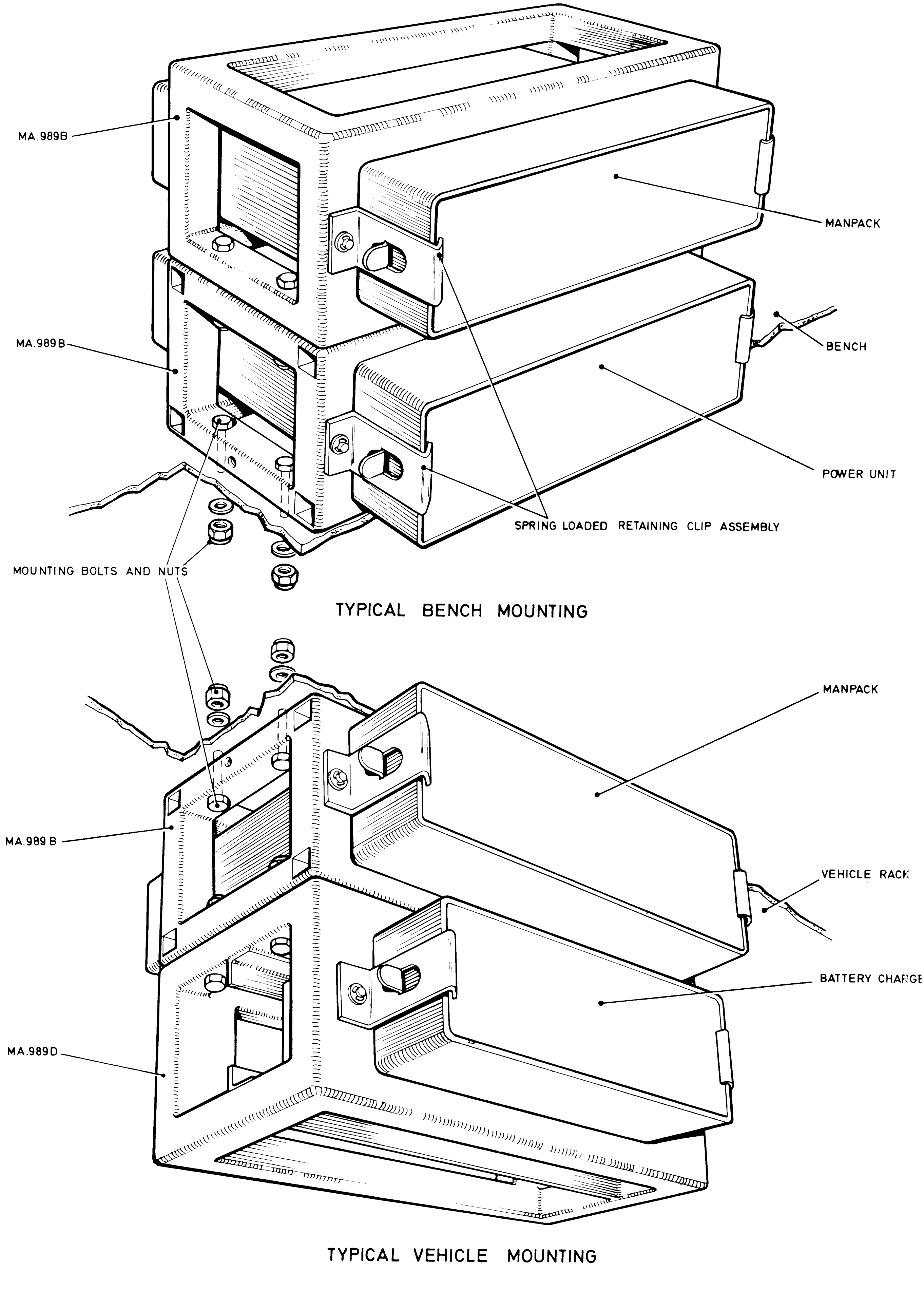
1. The MA.989 Mounting Frames are heavy duty frames designed to accommodate a range of Manpacks, Power Units and Battery Chargers. The frames are suitable for bench mounting or installation into fighting vehicles.

### 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 6 mm 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:-

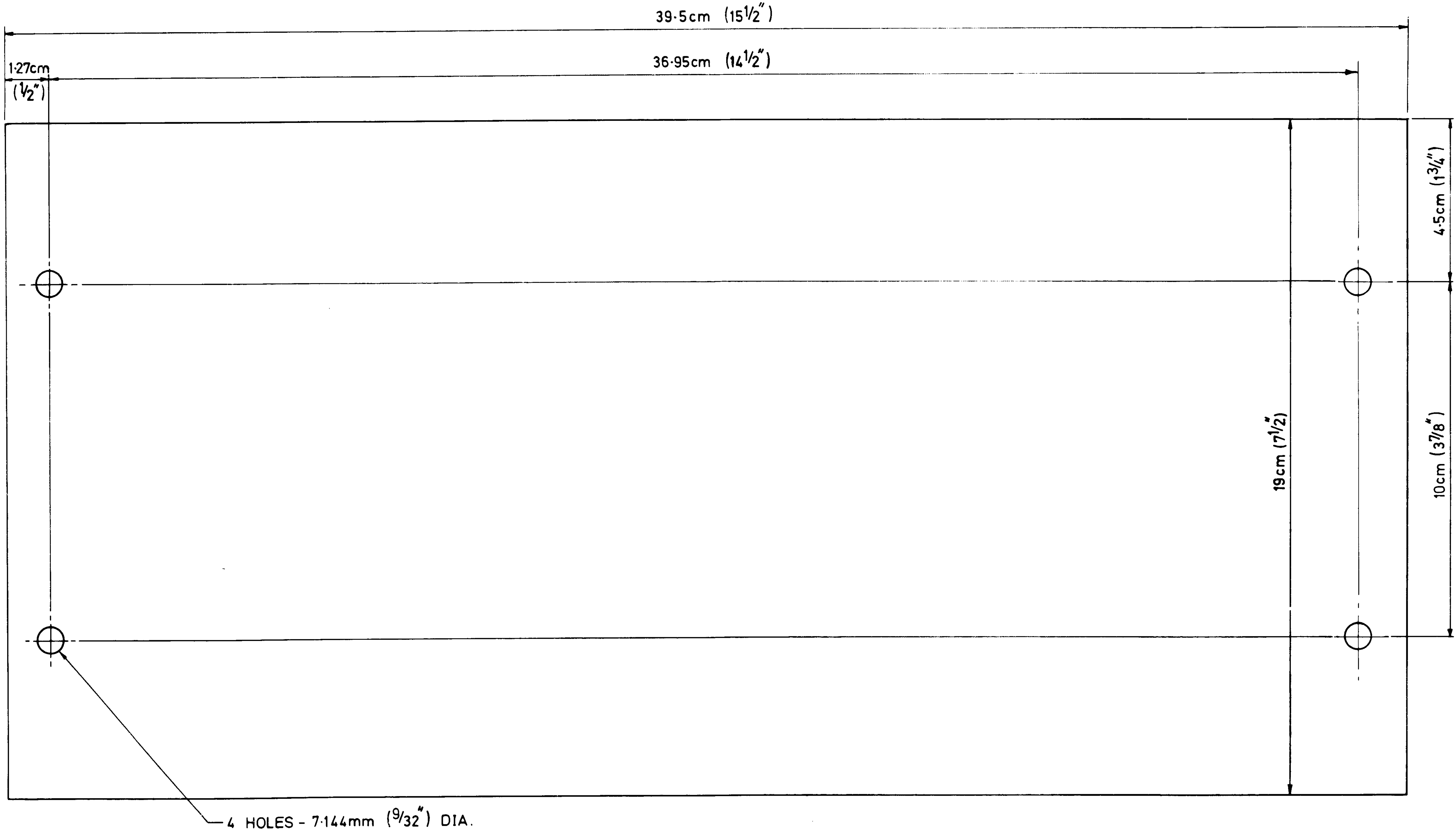
| Unit | Mounting Frame |
|---|---|
| RA.929 Portable HF Receiver | MA.989B |
| TRA.931, TRA.931L, TRA.931P and TRA.931X | MA.989B |
| TRA.932 and TRA.932X | MA.989B |
| MA.937 DC Power Unit and Audio Amp. | MA.989B |
| MA.945 Battery Charger | MA.989D |




WOH 6160
Part 1

**Mounting Frames**
**Type MA.989B & D**

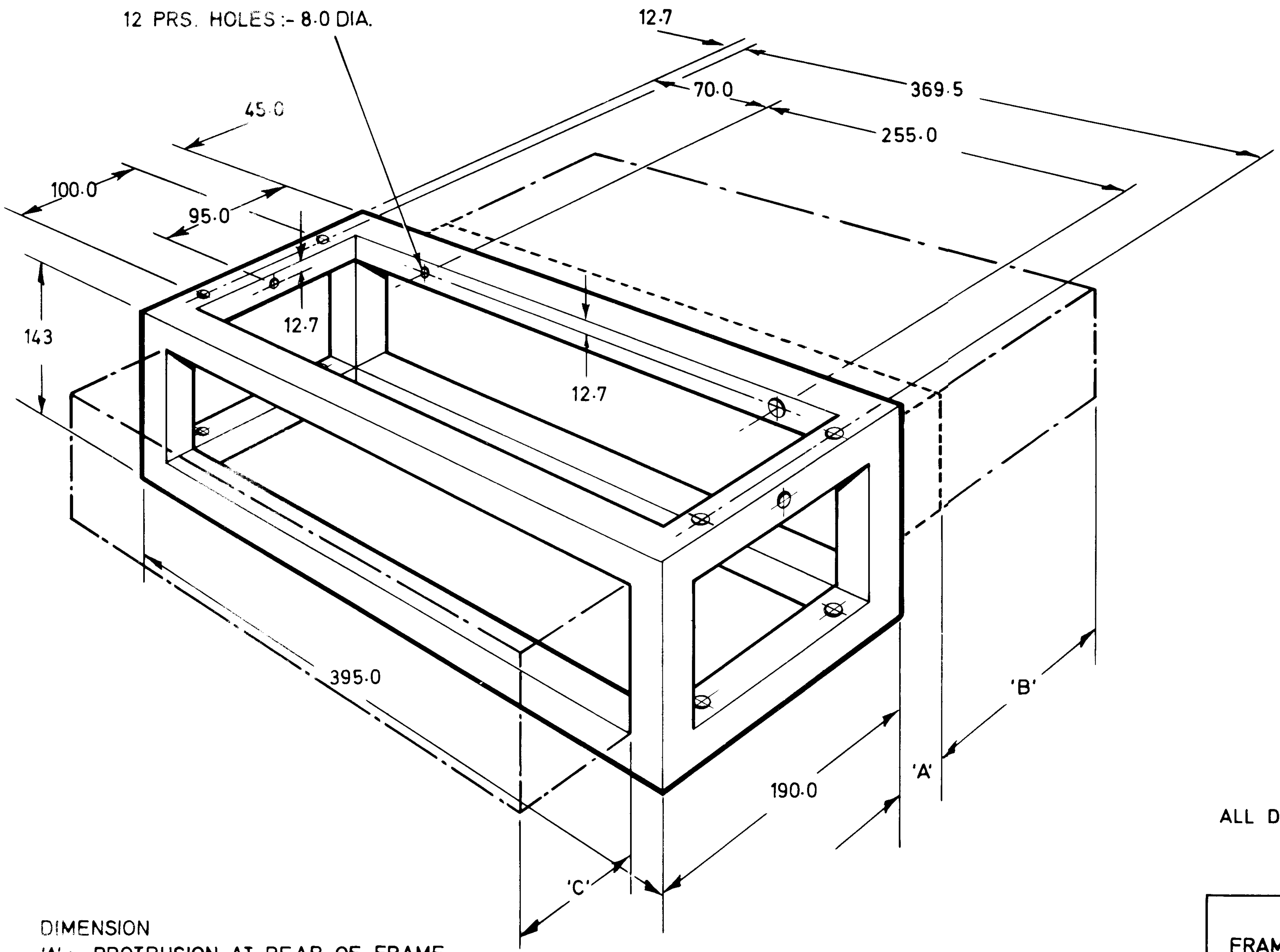
**Fig. APP4-1**




WOH 6160
Part 1

Mounting Template for MA.989A, B & D

Fig. App. 4-2




ALL DIMENSIONS IN MILLIMETRES

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

| FRAME | UNIT | DIMENSION 'A' | DIMENSION 'B' | DIMENSION 'C' |
|---|---|---|---|---|
| MA.989A | TRA.906, TRA.921<br>TRA.922 | 15 | 120 | 60 |
| MA.989B | TRA.931, L, P & X<br>TRA.932, & X<br>RA.929, MA.937 | 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 MA.913B

### 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 0.3m (12 in) 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) | 279 mm | 121 mm | 191 mm |
| | (11 in) | (4.75 in) | (7.5 in) |

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

### 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 SKT1 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:-

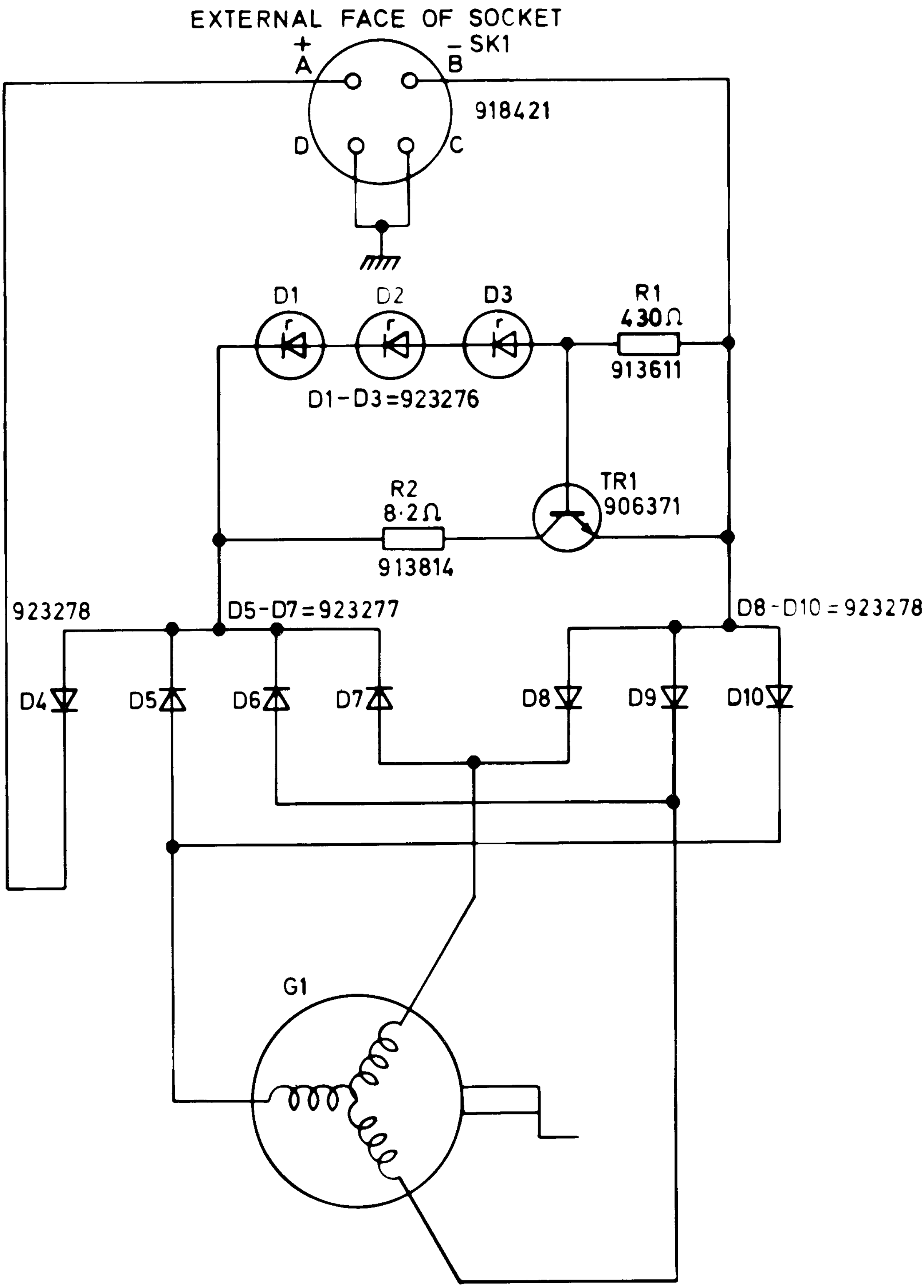
(1) Extend the clamp locking strap to its fullest extent. Fold one handle and affix the generator to a firm support such as a tree or pole.

(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.




WOH 6160
Part 1

Circuit : Hand Operated Generator
Type MA913B

Fig. App. 5-1

# PART 2

# TRANSCEIVER UNIT TYPE MA.930P

# PART 2 - TRANSCEIVER UNIT TYPE MA.930P

## CONTENTS

CONTENTS (Cont'd)

## CONTENTS (Cont'd)



## ILLUSTRATIONS

# CHAPTER 1

# GENERAL DESCRIPTION

## INTRODUCTION

1. The Transceiver Unit Type MA.930P consists of the front panel with controls (except those controls which form part of the synthesizer and the pre-programmed frequency memory) the ATU and all circuitry other than that associated with the synthesizer and the pre-programmed frequency memory. The majority of the circuit components are mounted on 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 AF buffer amplifier. The audio signal from the amplifier is mixed, in the balanced modulator, with a 1.4 MHz signal which is amplified prior to being fed to the modulator. The modulator is unbalanced during AM and TUNE conditions.

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

4. The bandwidth of the signal is limited by the AM filter, then fed to a channel mixer, which is also fed by a variable input in the range 37 MHz to 65.399 MHz. 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 30 MHz) filter, the signal is fed to the driver and PA stages, then to the antenna tuning unit (ATU) and the antenna output connection.

6. During key operation a 1000 Hz 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 (ALC) potentials are generated by PA supply current and RF output voltage level detectors. The outputs from the detectors are gated and used to control the gain of an IF amplifier to ensure that the PA 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 RF voltage applied,to the 1.6 MHz to 30 MHz filter and the channel mixer. After mixing with the variable 37 MHz to 65.399 MHz input the resultant 35.4 MHz IF is limited in bandwidth by the AM filter and fed to a low-noise 35.4 MHz amplifier. It is then fed to a gain controlled amplifier (para. 10) and to a mixer fed with a 34 MHz input.

9. The output from the mixer, a 1.4 MHz IF, is fed via the USB or LSB filters (or the AM circuit) to a second gain controlled amplifier. From the amplifier the signal is detected, either in the SSB detector (by mixing with a 1.4 MHz signal), or by the AM 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.

10. An automatic gain control (AGC) potential is developed from the input signal to the two detectors and is used to control the gain of the IF amplifiers.

RF Signal Routing (Fig. 2)

NOTE: Signal paths are also shown on Fig. 13.

11. When the TRA.931P is used as a self-contained station all relays are de-energized during reception and the antenna input is routed via the ATU to the receiver. During transmission relays RLE, RLA and 2RLA are energized, routing the RF from the transmitter to the ATU via the power amplifier (PA).

12. When an external ATU is connected to the WIDEBAND socket the high impedance detector circuit energizes relay ATU-RLA, connecting the RF path to the WIDEBAND socket.

13. The connection of a filter unit to both the 100 mW IN and 100 mW OUT sockets energizes relays RLB, RLC and RLD (via the comparator circuits), thus routing the low-level RF to and from the filter via the 100 mW sockets and relays RLB and RLD.

14. A 100W station using a TA.4044 Amplifier and MA.4015 Filter Unit is driven from the 100 mW O/P socket. In this case the comparator circuit energizes RLD to rcute RF. Relay RLC earths an unwanted line.

15. During tuning of an ATU a '0' input (via Audio socket 1 pin G) sets the transmitter to low power (5W) output, regardless of the power switch setting on the front panel.

High and Low Power Output

16. The gain of the automatic gain controlled amplifier in the transmit chain is controlled from the front panel POWER switch, to provide two levels of power output.

Manual Tuning

17. 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 (ATU) 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

18. When the synthesizer of a transmitter/receiver is out-of-lock, as occurs momentarily during frequency selection, an out-of-lock 'chopped' tone is heard in the audio circuits.

Power Supplies

19. Power supplies are derived from a 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 RF 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. 39).

### 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. 21). 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. 39).

### Balanced Modulator and 1.4 MHz IF 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 1.4 MHz signal supplied to pin A9. The output of the modulator is the first IF, centred on 1.4 MHz and containing both sidebands. The IF is fed via a stage 1TR43 and 1TR44, which incorporates automatic level control (ALC) (see para. 11) to a 1.4 MHz IF amplifier 1TR39 and 1TR40.

### Sideband and AM Filters

4. The output of 1TR39 is fed via one of three diodes switches 1D35, 1D33 or 1D34 (para. 42) to either the USB or LSB filter, 1FL3, 1FL4 or to the AM 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 35.4 MHz IF Amplifier

5. The filtered signal is fed via 1T15 to the First TX Mixer, 1TR35, 1TR36 and a associated components, where it is mixed with a 34 MHz input from pin A43. The resultant of the mixing process, a 35.4 MHz second IF signal, is fed via 1T14 to an IF amplifier 1TR34. This amplifier includes a rejector circuit tuned to 1.4 MHz (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 IF signal is coupled, via 1T8 and the AM 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 37 MHz to 65.399 MHz, 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 30 MHz), and the 1RLB relay contacts (the relay is energized in the transmit condition, see para. 39) 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 transciever p.c.b., which is connected to pin B10 of the PA board.

## Driver and Power Amplifier

8. The PA board contains a driver and a power amplifier. The driver amplifier consists of two push-pull grounded-base stages, 2TR3 to 2TR6, which operates 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 PA 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 PA is coupled, via 2T3 and 2RLA relay contacts, to the antenna tuning unit, (ATU) 2L3 and associated capacitors.

## ATU

10. Resistor 2R5 in the output circuit is used to limit the maximum resistance in the output circuit when the ATU 2L3 is 'off-tune', thus limiting the required range of the ALC circuit (para. 11). The capacitor 2C3 improves the matching of the ATU to the PA, by increasing the input impedance of the ATU presented to the PA at the higher frequencies.

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

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

12. The current supply to the PA is taken via resistor 1R1 of the transceiver board, which is connected across pins A19 and A20. When the PA 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 ALC circuit.

13. 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.

14. 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 1.4 MHz IF amplifier, thus reducing the PA output level to a safe value. The current level at which the circuit operates is set by 1R140.

15. The voltage-controlled ALC circuit operates from the RF output of the PA. Transformer 2T2 provides a sample of the RF output voltage which is rectified by 2D2 and smoothed by 2C2 and 2R4 to provide an ALC potential at pin B7 of the PA 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 1TR41 is fed to 1TR43 and 1TR44 and is used in the same manner as the potential developed by the current ALC circuit (para. 11). The control potential fed to the 1.4 MHz IF amplifier is therefore determined by both the current voltage ALC systems.

16. 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. An additional resistor, 1R155, is connected in the chain when HIGH is selected to give the increased bias voltage, thus increasing the available output of the 1.4 MHz amplifier and the PA.

Transient ALC stage

17. Components 1D51, 1TR50, 1C156 and 1C157 form a fast ALC loop circuit providing protection for the PA transistors on the PA board agains current surges particularly during the switch 'on' period. The circuit threshold level is arranged to be below the threshold level of the AGC 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

18. 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 side tone during transmission. Sidetone, from the tone oscillator, is also available when the TUNE condition is selected at the MODE switch.

ATU, Tuning Indicator Lights and TUNE Condition

19. The ATU consists of 2L3 and associated capacitors. When the ATU is off-tune one of the two indicator lights (light emitting diodes) in the meter will be illuminated when the 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.

20. When TUNE is selected the AM 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. 42). 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 RF output from the transmitter at the carrier frequency.

21. The voltage from pin A11 is also fed to transistor 1TR29, energizing the tone oscillator 1TR28. The output of the oscillator provides a 1000 Hz 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 ATU and energizing the transmitter circuits.

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

23. The voltage from the 'capacitive end' of the ATU, (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 ATU. This voltage is designated VC.

24. The voltage developed by the chain 2C13 and 2C18 is due to the 'inductive part' and the 'capactive part' of the ATU, 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.

25. 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 transistors 2TR8 or 2TR11 will therefore be switched on when the ATU is off-tune, causing the associated LED (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.

26. Fine tuning of the ATU is achieved by adjusting the TUNE control to obtain a peak meter reading, therefore the LED's are extinguished when a meter indication is given. The meter is driven by an antenna current detector (para. 49) which supplies a d.c. voltage related to RF 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 LED's.

27. The supply for the LED drive circuit is taken from switch 1SB1R pin 5 via B16 of the PA board, and is only available when TUNE is selected.

RECEIVER CIRCUITS (Figs. 6 and 7)

Input Circuit

28. The signal from the antenna is fed via the ATU and the de-energized contacts of relay 2RLA to pin B21 of the PA 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 RF input voltages.

Channel Mixer, Filter and 35.4 MHz IF Amplifier

29. 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 65.399 MHz, supplied from pin A31, via the bandpass filter 1FL5, amplifier 1TR27 and transformer 1T6. After mixing, the resultant IF, centred on 35.4 MHz, is coupled to the AM filter 1FL2 via 1T7. The filter has a bandwidth of approximately 10 kHz.

30. The output of the filter is coupled by 1T8 to a low-noise untuned 35.4 MHz amplifier 1TR4 and 1TR5. The amplified signal is fed to a gain controlled (para.36) cascode amplifier 1TR6 and 1TR7.

Second RX Mixer and 1.4 MHz IF Amplifier

31. The signal from the cascode amplifier is injected into the Second RX Mixer 1TR8 and 1TR9 by the tuned transformer 1T1, as is a 34 MHz signal from pin A43. The resultant of the mixing process, a 1.4 MHz signal, is fed to the USB or LSB filter, 1FL4 or 1FL3, or to the AM 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 1.4 MHz IF amplifier 1TR10 and the d.c. coupled pair 1TR11 and 1TR12.

SSB and AM Detectors, Buffer Amplifier and Muting

32. The SSB detector consists of 1T4 and 1TR13, which mix the 1.4 MHz IF with a 1.4 MHz signal from pin A9, thus recovering the audio signal. The detector is 'switched on' when USB or LSB mode is selected. The AM detector is 'switched off' by 1D14 or 1D15.

33. 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 1.4 MHz input is muted in AM mode to avoid the generation of spurious signals. This is achieved by a 12V d.c. level applied to the synthesizer, via switch 1SB1R and capacitor 1C153.

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

## Audio Amplifier

35. 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).

## AGC Circuits

36. Automatic gain control (AGC) circuits are fitted which maintain a constant output from the receiver with varying input signal levels. An AGC potential is developed from the IF signal of the receiver and applied as a control potential to the 35.4 MHz and the 1.4 MHz IF amplifiers.

37. A part of the IF 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.

38. When the antenna signal exceeds approximately 4µV 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 AGC line, connected to 1TR10 via 1R29 and to 1TR7 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 (Figs. 6 and 7)

39. The transmit condition is achieved by either connecting pin C of an 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 PA board) via pin A36. Contacts 12 and 13 of the relay earth the input to the receiver, contacts 15 and 16 connect the PA to the ATU, contacts 5 and 6 break the battery monitoring circuit (para. 48) 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.

40. In the receive condition all relays are de-energized, connecting the receiver to the ATU, and the battery monitoring circuit to the meter (para. 48).

41. 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.

42. All switching, other than the TX/RX 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 AM 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. 20) and to diodes 1D31 and 1D34. Similar switching diodes are fitted in the USB and LSB is selected, and vice versa, to provide the correct sideband due to an inversion process occuring in the channel mixer.

43. When USB and LSB mode is selected the AM detector transistor 1TR16 (para. 33) is switched off by a voltage applied via 1D14 and 1D15. In AM mode the SSB detector 1TR13 (para. 32) is 'switched off' via 1D11.

44. The transmitter and receiver supply lines are switched off by relay 2RLA, on the 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 IF and local oscillator signals.

## OUT OF LOCK INDICATOR (Fig. 6)

45. Out of lock indication is provided by a 'chopped' tone in the audio circuits. The input at pin A40 is a positive d.c. level when the synthesizer is in lock and is 'earthy' when out of lock.

46. 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.

47. 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 15 Hz, which is used to 'chop' the 600 Hz 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)

48. 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.

49. The RF current output from the PA 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 RF output level. The detector circuit is also used in conjunction with the light emitting diode drive circuit (para. 22).

INTERCOM AND POWER SUPPLIES (Fig. 8)

50. 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.

51. 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.

52. 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.

TRANSCEIVER RELAY BOARD (Fig. 10)

53. The relays RLA to RLE control the routing of RF signals (see Chap. 1 para. 11), dependent upon connections made to front panel sockets.

54. When a connection is made to the 100 mW I/P socket (with an impedance of less than approximately 3.2Ω) the input to IC1 pin 2 (via board pin 9, R3 and R5) causes the output, IC1 pin 1, to change to '0' level, driving TR2 into conduction and energizing relay RLB. When the connection is removed the bias provided by R11, R12 and R13 causes the relay to de-energize.

55. A connection to the 100 mW O/P socket causes relays RLC and RLD to energize in a similar manner to RLB (previous paragraph). The circuit utilises IC1-D and TR1.

56. The circuit comprises IC1-A and IC1-B is an impedance detector. When the impedance at the W/B (wideband) socket (connected to board pin 12) is above approximately 30 kΩ the relay in the ATU relay board (see fig. 2) is de-energized (via TR3 and board pin 17), the W/B socket is disconnected, and the internal ATU is in use. The level at pin 16 is at '1', which allows the transmitter to provide a 20W or 5W output under the control of the front panel POWER switch.

57. When the impedance at the W/B socket is above approximately 3.2 kΩ (but below 30 kΩ) the relay in the ATU relay board is energized (TR3 conducting) connecting the RF output to the W/B socket. Pin 16 continues to provide a '1' level to the ALC circuit of the transmitter, allowing a 20W output to be provided.

58. When the impedance at the W/B socket is 50Ω or below, the level at pin 16 changes to '0', giving a 5W output from the transmitter regardless of power switch setting.

59. The bias at ICI-A is arranged so that its output switches to '1' when an impedance in excess of approximately 30 kΩ is connected to pin 12. This cuts off TR3, giving a '0' output at pin 17. At impedances below 30 kΩ the output at pin 12 changes to '1'.

60. When the impedance at pin 12 is above approximately 3.2 kΩ ICI-B provides a '1' output at pin 15 which allows a high power output to be provided. At impedances below 3.2 kΩ the output at pin 15 changes to '0'. The diodes D3 and D4 prevent inter-action between the external circuits connected to pins 14, 15 and 16.

61. Relays RLA and RLE are directly energized from the PTT circuit (via board pin 7) when transmission is required.

62. The transistors TR4 to TR7 form an audio amplifier with an input at pin 20 and an output at pin 21. This amplifier provides a fixed level output (via Audio 2 socket pin G) to a harness. The gain of the amplifier is pre-set by R22; an r.f. filter is provided by L1, C16, C17.

63. When 'transmit' is selected the FET TR8 is driven into conduction via pin 7 and R29. This by-passes the resistor R25 providing an increased sidetone level to the harness, via the audio amplifier.

ATU RELAY BOARD (Fig. 12)

64. This board routes RF to the ATU or W/B socket (see fig. 2). RF signals at pin 8 are connected to either the ATU (pin 6) or the W/B socket (pin 2) dependent on relay circuit. Components L1 and C2 form a decoupling network for the signal fed to the transceiver relay board.

65. The RF output to the W/B socket is sampled and detected by T1, D1 and R1, providing a d.c. monitoring voltage which is fed, via pin 7, to the meter. The circuit T2, D2, R2 provides a similar circuit which is used when the internal ATU is connected.

DECOUPLING BOARD (Fig. 14)

66. This board carries decoupling components for the connections to the AUDIO and 4015 sockets. The circuit is self-explanatory.

# CHAPTER 3

# MAINTENANCE

## INTRODUCTION

1. This chapter covers maintenance procedures and tests on the Transceiver Unit MA.930P. Overall tests on the transceiver are given in Part 1. Maintenance information for the Synthesizer and for the Pre-Programmed Frequency memory may be found in Part 3 and 4 respectively of this handbook. Ensure that re-alignment is actually necessary before adjusting the position of any preset potentiometer or inductor.

## TEST EQUIPMENT

2. Test equipment required to carry out the following procedures is listed in Part 1, Chap. 4.

3. The following paragraphs are written on the assumption that a test set CA.531 is available (see Part 1, Chap. 4, para. 3). 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.

## INITIAL PROCEDURE

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

(2) Remove the transceiver from its haversack (if used) and remove the battery.

(3) Remove the case from the unit.

(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 channel switch to M(manual) position.

(7) Set the POWER switch to OFF, the MODE switch to A.M., and the SEARCH control to OFF. Set the CHANNEL switch to M(manual).

(8) 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.

(9) 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.

(10) Connect the multimeter, set to the 25 volt d.c. range, between earth and the mute connection (feed through capacitor 1C153) of the transceiver unit. The reading should be between 10.5V and 13V.

(11) 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.

(12) 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.

(13) Disconnect the multimeter.

(14) Turn 1R33 fully anti-clockwise.

## RECEIVER

### AF Power Output and Frequency Response

5. (1) Connect oscilloscope and an Audio Power Output Meter, set to the 300 ohm 100 mW range, to the terminal marked AF and EARTH on the Test Set CA.531. Set POWER switch to LOW.

(2) Connect the 600 ohms output of an AF Signal Generator, set to 1 kHz, to an AF Electronic Multimeter and then, via a series 1k resistor and 4.7 μF 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 30 mW 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 10 mV and 20 mV.

(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 30 mW and 100 mW.

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

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

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

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

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

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

6. IF Alignment

(1) Connect an RF 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.

(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 1TP9 and re-connect to 1TP3.

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

(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 signal generator.

7. Channel, 34 MHz and 1.4 MHz Oscillator Signal Levels

(1) Set the MODE switch to USB and set the synthesizer controls to 1.600 MHz.

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

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

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

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

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

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

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

(9) Disconnect the multimeter.

8. AGC Threshold

(1) Set the synthesizer controls to 1.600 MHz.

(2) Connect an RF Signal Generator to 2SK4 (1.6-3 MHz) with its frequency set to 1.601 MHz 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.

9. 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. 6(3) before carrying out further tests. Set the synthesizer controls to 200 kHz.

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

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

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

(4) Set the MODE switch to LSB and the generator frequency to 1.599 MHz.

(5) Repeat operations 8(3), 9(2) and 9(3).

(6) Set the synthesizer to 3.000 MHz, and MODE switch to USB. Set the generator frequency to 3.001 MHz.

(7) Repeat operation 8(3), 9(2) and 9(3).

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

(9) Repeat operations 8(3), 9(2) and 9(3).

(10) Set the synthesizer to 8.000 MHz and set the generator frequency to 8.001 MHz.

(12) Set the synthesizer to 16.00 MHz and set the generator frequency to 16.001 MHz.

(13) Repeat operations 8(3), 9(2) and 9(3).

(14) Set the synthesizer to 29.999 MHz and set the generator frequency to 30.000 MHz .

(15) Repeat operations 8(3), 9(2) and 9(3).

10. Overall Frequency Response (SSB)

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

(2) Set the synthesizer to 1.600 MHz.

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

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

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

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

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

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

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

(10) Set the MODE switch to LSB and the generator to 1.5999 MHz.

(11) Repeat operations 10(4) to 10(9).

11. AGC Response

(1) Remove 20 dB 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 AF GAIN control to give 1 mW on the Power Meter.

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

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

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

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

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

(9) Increase AF GAIN control setting to maximum.

12. Spurious Responses

(1) Set the synthesizer to 17.702 MHz.

(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 4 mW indication on the Power Meter.

(5) Set the synthesizer to 1.600 MHz.

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

(7) Set the generator frequency to 1.599 MHz and set the output level to 2 microvolts e.m.f. Connect generator to2SK4.

(8) Repeat operations 12(3) and 12(4).

(9) Increase the generator frequency to 72.401 MHz.

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

(13) Repeat operations 12(3) and 12(4).

(14) Increase the generator frequency to 35.401 MHz.

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

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

## TRANSMITTER

13. 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 6 mV.

(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 ± 30 mV 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 10 dB and check that the waveform displayed on the oscilloscope is clipped.

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

(10) Increase the frequency of the generator until the voltage indicated on the AF Electronic Multimeter is half that noted in operation 13(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 13(7).

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

(14) Reset generator frequency to 1 kHz.

14. 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 250 mV and 500 mV.

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

15. Balanced Modulator and IF Adjustments

(1) Set the synthesizer controls to 1.600 MHz.

(2) Connect an RF Wattmeter 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 2 mV.

(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 approximately 0.5 watt.

(11) Adjust 1R140 until the output power reduces by approximately 0.5 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 6 mV and check that increase in output power is less than 3 W.

(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 stnading d.c. current drawn from the supply is between 0.6A and 1A.

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

16. AM, TUNE and ALC Adjustments

(1) Set the MODE switch to AM.

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

(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) Reset the Power switch to HIGH.

(9) Set the synthesizer controls to 3.000 MHz.

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

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

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

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

17. 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 200 mV peak-to-peak with test point 1TP13 connected to earth.

(5) Set the MODE switch to USB.

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

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

18. Power Output Checks

(1) Set the synthesizer controls to 1.6 MHz.

(2) Connect an RF electronic multimeter to 2SK4 and reconnect the AF signal Generator with its output set to two 3 mV 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 RF or above.

(9) Set the synthesizer controls to 3.000 MHz.

(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 RF 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 RF or above.

(15) Set the synthesizer to 8.000 MHz.

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

(17) Repeat operations (6) and (7), reading should be 27V RF or above.

(18) Set the synthesizer to 16.000 MHz.

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

(20) Repeat operations (6) and (7), reading should be 27V RF or above.

(21) Set the synthesizer to 29.999 MHz.

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

(23) Repeat operations (6) and (7), reading should be 27V RF or above.

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

(25) Set the POWER switch to OFF.

(26) 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 RF 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 AM is chose, the 1.4 MHz frequency input (this input is absent during AM reception). The USB, LSB and AM 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 AF circuits during tuning, this provides a simple method of checking the tone oscillator and the receiver AF 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 | |

TABLE OF STATIC VOLTAGES (Continued)

| Transistor | Emitter | Base | Collector | Remarks |
|---|---|---|---|---|
| 1TR12 | 0.7V | 1.3V | 8.4V | Receive selected |
| 1TR13 | - | 0.2V | 10.6V | 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 | |
| | | | PA Board | |
| TR1 | 0V | 0.7V | 23V | Transmit selected |
| TR2 | 0V | 0.7V | 23V | |

TABLE OF STATIC VOLTAGES (Continued)

| Transistor | Emitter | Base | Collector | Remarks |
|---|---|---|---|---|
| TR3 | 0.44V | 0.72V | 23V | Transmit selected |
| TR4 | 0.42V | 0.7V | 23V | |
| TR5 | 0.2V | 0.7V | 23.5V | |
| TR6 | 0.26V | 0.7V | 23.25V | |

## DYNAMIC VOLTAGE CHECKS

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

TABLE OF DYNAMIC VOLTAGES

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

## RECEIVER INJECTION LEVELS

14. The RF levels given below should be used when injecting signals into the receiver. The levels give an AF output of approximately 10 mW 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 | 2 μV | Antenna frequency |
| 1TP2 | 1.4 μV | 35.4 MHz |
| 1TP3 | 0.9 μV | 35.4 MHz |
| 1TP4 | 3.6 μV | 35.4 MHz |

TABLE OF RECEIVER INJECTION LEVELS (Continued)

| Test Point | Injected Level | Frequency |
|---|---|---|
| 1 TP4 | 3.6 µV | 35.4 MHz |
| 1 TP5 | 240 mV | 1.4 MHz |
| 1 TP8 | 2.5 mV | 1.4 MHz |
| 1 TP9 | 1.4 mV | 1.4 MHz |

# 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 (1400 kg/m$^2$) 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 (7000 kg/m$^2$) 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, synthesizer and pre-programmed frequency memory 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 from the PA cover, loosen five screws at the sides of the transceiver cover and slide the cover away from the unit. To remove the cover from the synthesizer and pre-programmed frequency memory boards remove three screws at the front panel end of the cover, remove three screws from the PA cover, loosen five screws at the side 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 removal of the wideband switching board.

## 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.

## ORDERS FOR SPARE PARTS

In order to expedite handling of spare part orders, please quote:-

(1) Type and serial number of equipment.

(2) Circuit reference, description, Racal part number, and manufacturer of part required.

(3) Quantity required.

NOTE: If the equipment is designed on a modular basis, please include the type and description of the module for which the replacement part is required.

## NOTES ON COMPONENT CHANGES AND ADDITIONS

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part No. | Manufacturer |
|---|---|---|---|---|---|---|
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# CHAPTER 6

## LIST OF COMPONENTS

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | | TRANSCEIVER BOARD AND PART OF FRONT PANEL | | | |
| **Resistors** | Ω | | W | | |
| 1R1 | 0.22 | Wirewound | 2.5 | 10 | 920556 |
| 1R2 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R3 | 68 | Carbon | 1/3 | 5 | 922326 |
| 1R4 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R5 | 0.47 | Wirewound | 2.5 | 10 | 921114 |
| 1R6 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R7 | 2.7k | Carbon | 1/3 | 5 | 922341 |
| 1R8 | 330 | Carbon | 1/3 | 5 | 922334 |
| 1R9 | 220 | Carbon | 1/3 | 5 | 922332 |
| 1R10 | 220 | Carbon | 1/3 | 5 | 922332 |
| 1R11 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R12 | 22 | Carbon | 1/3 | 5 | 922320 |
| 1R13 | 680 | Carbon | 1/3 | 5 | 922337 |
| 1R14 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R15 | 6.8k | Carbon | 1/3 | 5 | 922265 |
| 1R16 | 220 | Carbon | 1/3 | 5 | 922332 |
| 1R17 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R18 | 47k | Carbon | 1/3 | 5 | 922349 |
| 1R19 | 22k | Carbon | 1/3 | 5 | 922347 |
| 1R20 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R21 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R22 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R23 | 330 | Carbon | 1/3 | 5 | 922334 |
| 1R24 | 470 | Carbon | 1/3 | 5 | 922272 |
| 1R25 | 470 | Carbon | 1/3 | 5 | 922272 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | Ω | | W | | |
| 1R26 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R27 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R28 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R29 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R30 | 220 | Carbon | 1/3 | 5 | 922332 |
| 1R31 | 10 | Carbon | 1/3 | 5 | 922316 |
| 1R32 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R33 | 470 | Variable | | | 919514 |
| 1R34 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R35 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R36 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R37 | 330 | Carbon | 1/3 | 5 | 922334 |
| 1R38 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R39 | 100 | Carbon | 1/3 | 5 | 922363 |
| 1R40 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R41 | 22k | Carbon | 1/3 | 5 | 922347 |
| 1R42 | 33k | Carbon | 1/3 | 5 | 919340 |
| 1R43 | 470 | Carbon | 1/3 | 5 | 922273 |
| 1R44 | 220 | Carbon | 1/3 | 5 | 922332 |
| 1R45 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R46 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R47 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R48 | 6.8k | Carbon | 1/3 | 5 | 922265 |
| 1R49 | 10 | Carbon | 1/3 | 5 | 922316 |
| 1R50 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R51 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R52 | 47k | Carbon | 1/3 | 5 | 922349 |
| 1R53 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R54 | 6.8k | Carbon | 1/3 | 5 | 922265 |
| 1R55 | 5k | Variable, log | | | 711054 |
| 1R56 | Not Used | | | | |
| 1R57 | 3.9k | Carbon | 1/3 | 5 | 922342 |
| 1R58 | 2.7k | Carbon | 1/3 | 5 | 922341 |
| 1R59 | 33k | Carbon | 1/3 | 5 | 919340 |
| 1R60 | 10k | Carbon | 1/3 | 5 | 922267 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | Ω | | W | | |
| 1R61 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R62 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R63 | 68k | Carbon | 1/3 | 5 | 922351 |
| 1R64 | 12k | Carbon | 1/3 | 5 | 922345 |
| 1R65 | 12k | Carbon | 1/3 | 5 | 922345 |
| 1R66 | 220k | Carbon | 1/3 | 5 | 922354 |
| 1R67 | 220k | Carbon | 1/3 | 5 | 922354 |
| 1R68 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R69 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R70 | 47k | Carbon | 1/3 | 5 | 922349 |
| 1R71 | 47k | Carbon | 1/3 | 5 | 922349 |
| 1R72 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R73 | 47k | Carbon | 1/3 | 5 | 922349 |
| 1R74 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R75 | 33k | Carbon | 1/3 | 5 | 919340 |
| 1R76 | 47 | Carbon | 1/3 | 5 | 922324 |
| 1R77 | 180 | Carbon | 1/3 | 5 | 922331 |
| 1R78 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R79 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R80 | 10 | Carbon | 1/3 | 5 | 922316 |
| 1R81 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R82 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R83 | 1.5k | Carbon | 1/3 | 5 | 919299 |
| 1R84 | 56 | Carbon | 1/3 | 5 | 922325 |
| 1R85 | 680 | Carbon | 1/3 | 5 | 922337 |
| 1R86 | 2.2k | Carbon | 1/3 | 5 | 923273 |
| 1R87 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R88 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R89 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R90 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R91 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R92 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R93 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R94 | 6.8k | Carbon | 1/3 | 5 | 922265 |
| 1R95 | 6.8k | Carbon | 1/3 | 5 | 922265 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | Ω | | W | | |
| 1R96 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R97 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R98 | 330 | Carbon | 1/3 | 5 | 922334 |
| 1R100 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R101 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R102 | 150 | Carbon | 1/4 | 5 | 922361 |
| 1R103 | 680 | Carbon | 1/3 | 5 | 922337 |
| 1R104 | 150 | Carbon | 1/3 | 5 | 922330 |
| 1R105 | 10 | Carbon | 1/3 | 5 | 922316 |
| 1R106 | 27 | Carbon | 1/3 | 5 | 922321 |
| 1R107 | 47 | Carbon | 1/3 | 5 | 922324 |
| 1R108 | 2.7k | Carbon | 1/3 | 5 | 922341 |
| 1R109 | 2.7k | Carbon | 1/3 | 5 | 922341 |
| 1R110 | 15 | Carbon | 1/3 | 5 | 922318 |
| 1R111 | 270 | Carbon | 1/3 | 5 | 922333 |
| 1R112 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R113 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R114 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R115 | 12 | Carbon | 1/3 | 5 | 922317 |
| 1R116 | 820 | Carbon | 1/3 | 5 | 922274 |
| 1R117 | 220 | Carbon | 1/3 | 5 | 922332 |
| 1R118 | 47 | Carbon | 1/3 | 5 | 922324 |
| 1R119 | 2.7k | Carbon | 1/3 | 5 | 922341 |
| 1R120 | 10 | Carbon | 1/3 | 5 | 922316 |
| 1R121 | 1.8k | Carbon | 1/3 | 5 | 922340 |
| 1R122 | 22 | Carbon | 1/3 | 5 | 922320 |
| 1R123 | 150 | Carbon | 1/3 | 5 | 922330 |
| 1R124 | 47 | Carbon | 1/3 | 5 | 922324 |
| 1R125 | 330 | Carbon | 1/3 | 5 | 922324 |
| 1R126 | 330 | Carbon | 1/3 | 5 | 922334 |
| 1R127 | 10 | Carbon | 1/3 | 5 | 922316 |
| 1R128 | 10 | Carbon | 1/3 | 5 | 922316 |
| 1R129 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R130 | 1.8k | Carbon | 1/3 | 5 | 922340 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | Ω | | W | | |
| 1R131 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R132 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R133 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R134 | 1.8k | Carbon | 1/3 | 5 | 922340 |
| *1R135 | 120 | Carbon | 1/3 | 5 | 922329 |
| 1R136 | 6.8k | Carbon | 1/3 | 5 | 922265 |
| *1R137 | 120 | Carbon | 1/3 | 5 | 922329 |
| 1R138 | 6.8k | Carbon | 1/3 | 5 | 922265 |
| 1R139 | 3.3k | Carbon | 1/3 | 5 | 922363 |
| 1R140 | 1k | Variable | | | 919516 |
| 1R141 | 3.6k | Carbon | 1/3 | 5 | 923384 |
| 1R142 | 4.7k | Variable | | | 919511 |
| 1R143 | 1.8k | Carbon | 1/3 | 5 | 922340 |
| 1R144 | 82 | Carbon | 1/3 | 5 | 922327 |
| 1R145 | 390 | Carbon | 1/3 | 5 | 922325 |
| 1R146 | 4.7k | Variable | | | 919511 |
| 1R147 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R148 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R149 | 470k | Carbon | 1/3 | 5 | 922357 |
| 1R150 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R151 | 100 | Carbon | 1/3 | 5 | 922328 |
| 1R152 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R153 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R154 | 22k | Carbon | 1/3 | 5 | 922347 |
| 1R155 | Not used | | | | |
| 1R156 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R157 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R158 | 150 | Carbon | 1/3 | 5 | 922330 |
| 1R159 | 47 | Carbon | 1/3 | 5 | 922324 |
| 1R160 | 47 | Carbon | 1/3 | 5 | 922324 |
| 1R161 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R162 | 1k | Variable | | | 919516 |
| 1R163 | 2.2k | Variable | | | 919974 |
| 1R164 | 1k | Carbon | 1/3 | 5 | 922338 |
| 1R165 | 330 | Carbon | 1/3 | 5 | 922334 |

*1R135 and 1R137. Value fitted may be 100Ω, part number 922328.

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | Ω | | W | | |
| 1R166 | 330 | Carbon | 1/3 | 5 | 922334 |
| 1R167 | 10k | Carbon | 1/3 | 5 | 922267 |
| 1R168 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R169 | 56 | Carbon | 1/3 | 5 | 922325 |
| 1R170 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R171 | 2.7k | Carbon | 1/3 | 5 | 922341 |
| 1R172 | 47k | Carbon | 1/3 | 5 | 922349 |
| 1R173 | 33k | Carbon | 1/3 | 5 | 919340 |
| 1R174 | 560k | Carbon | 1/3 | 5 | 922358 |
| 1R175 | 220k | Carbon | 1/3 | 5 | 922354 |
| 1R176 | 15k | Carbon | 1/3 | 5 | 922268 |
| 1R177 | 1.5k | Carbon | 1/3 | 5 | 919299 |
| 1R178 | 220k | Carbon | 1/3 | 5 | 922354 |
| 1R179 | 2.7k | Carbon | 1/3 | 5 | 922341 |
| *1R180 | 47 | Carbon | 1/3 | 5 | 922324 |
| 1R181 | 150 | Carbon | 1/3 | 5 | 922330 |
| 1R182 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 1R183 | 12k | Carbon | 1/3 | 5 | 922345 |
| 1R184 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R185 | 4.7k | Carbon | 1/3 | 5 | 922343 |
| 1R186 | 18k | Carbon | 1/3 | 5 | 922346 |
| 1R187 | 1.5k | Carbon | 1/3 | 5 | 919299 |
| 1R188 | 1.5k | Carbon | 1/3 | 5 | 919299 |
| 1R189 | 1.5k | Carbon | 1/3 | 5 | 919299 |
| 1R190 | 1.5k | Carbon | 1/3 | 5 | 919299 |
| Capacitors | F | | V | | |
| 1C1 | 4.7μ | Tantalum | 35 | 20 | 914026 |
| 1C2 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C3 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C4 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C5 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |

*1R180. Value fitted may be 56Ω, part number 922325.

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | F | | V | | |
| 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 | +40-20 | 920679 |
| 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 | 500 | +40-20 | 916187 |
| 1C15 | 1000p | Disc ceramic | 500 | +40-20 | 920679 |
| 1C16 | 33p | Polystyrene | 63 | 1p | 920561 |
| 1C17 | 33p | Polystyrene | 63 | 1p | 920561 |
| 1C18 | .01μ | Ceramic | 63 | 20 | 915173 |
| 1C19 | .01μ | Ceramic | 63 | 20 | 915173 |
| 1C20 | 33p | Polystyrene | 63 | 1p | 920561 |
| 1C21 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C22 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C23 | 0.47μ | Tantalum | 35 | 20 | 915168 |
| 1C24 | 5600p | Polystyrene | 30 | 2½ | 918700 |
| 1C25 | 1000p | Polystyrene | 30 | 2½ | 908583 |
| 1C26 | .01μ | Ceramic | 63 | 20 | 915173 |
| 1C27 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C28 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C29 | 4.7μ | Tantalum | 35 | 20 | 914026 |
| 1C30 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C31 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C32 | 33μ | Tantalum | 10 | 20 | 920559 |
| 1C33 | 22μ | Tantalum | 16 | 20 | 919638 |
| 1C34 | 33μ | Tantalum | 10 | 20 | 920559 |
| 1C35 | | Not used | | | |
| 1C36 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C37 | 4.7μ | Tantalum | 35 | 20 | 914026 |
| 1C38 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C39 | 2200p | Polystyrene | 30 | 2½ | 908451 |
| 1C40 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | F | | V | | |
| 1C41 | 0.47µ | Tantalum | 35 | 20 | 915168 |
| 1C42 | 1000p | Polystyrene | 30 | 2½ | 908588 |
| 1C43 | 4.7µ | Tantalum | 35 | 20 | 914026 |
| 1C44 | 0.47µ | Tantalum | 35 | 20 | 915168 |
| 1C45 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C46 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C47 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C48 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C49 | 150µ | Electrolytic | 25 | +50-10 | 921748 |
| 1C50 | 4.7µ | Tantalum | 35 | 20 | 914026 |
| 1C51 | 1000p | Disc ceramic | 500 | +40-20 | 920679 |
| 1C52 | 22µ | Tantalum | 16 | 20 | 919638 |
| 1C53 | 47µ | Electrolytic | 25 | +50-20 | 921525 |
| 1C54 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C55 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C56 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C57 | .01µ | Metal Film | 100 | 20 | 912803 |
| 1C58 | .01µ | Metal Film | 100 | 20 | 912803 |
| 1C59 | .01µ | Metal Film | 100 | 20 | 912803 |
| 1C60 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C61 | 1µ | Tantalum | 35 | 20 | 919635 |
| 1C62 | 1µ | Tantalum | 35 | 20 | 919635 |
| 1C63 | 4.7µ | Tantalum | 35 | 20 | 914026 |
| 1C64 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C65 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 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 | 500 | +40-20 | 916187 |
| 1C71 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C72 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C73 | .01µ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C74 | 680p | Polystyrene | 30 | 2½ | 908455 |
| 1C75 | 680p | Polystyrene | 30 | 2½ | 908455 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | F | | V | | |
| 1C76 | .01μ | Disc ceramic | 500 | +40-20 | 916834 |
| 1C77 | 68p | Polystyrene | 30 | 2½ | 908321 |
| 1C78 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C79 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C80 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C81 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C82 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C83 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C84 | 0.47p | Tantalum | 35 | 20 | 915168 |
| 1C85 | 4.7μ | Tantalum | 35 | 20 | 914026 |
| 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 | +50-10 | 921543 |
| 1C90 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C91 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C92 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C93 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C94 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C95 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C96 | .1μ | Disc ceramic | 18 | +40-25 | 920567 |
| 1C97 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C98 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C99 | 0.1μ | Disc ceramic | 25 | +40-20 | 926259 |
| 1C100 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C101 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C102 | 0.1μ | Disc ceramic | 25 | +40-20 | 926259 |
| 1C103 | 1000p | Disc ceramic | 500 | +40-20 | 920679 |
| 1C104 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C105 | 1000p | Disc ceramic | 500 | +40-20 | 9206679 |
| 1C106 | 1000p | Disc ceramic | 500 | +40-20 | 920679 |
| 1C107 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C108 | .01μ | Ceramic | 63 | 20 | 915173 |
| 1C109 | .01μ | Ceramic | 63 | 20 | 915173 |
| 1C110 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | F | | V | | |
| 1C111 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C112 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C113 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C114 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C115 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C116 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C117 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C118 | 4.7μ | Tantalum | 35 | 20 | 914026 |
| 1C119 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C120 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C121 | 33μ | Tantalum | 10 | 20 | 920559 |
| 1C122 | 33μ | Tantalum | 10 | 20 | 920559 |
| 1C123 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C124 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C125 | 4.7μ | Tantalum | 35 | 20 | 914026 |
| 1C126 | 0.6-5p | Variable | | | 920563 |
| 1C127 | 3.6p | Ceramic | 200 | 0.5P | 922180 |
| 1C128 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C129 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C130 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C131 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 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 | 500 | +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 | 16 | 20 | 919638 |
| 1C141 | 4.7μ | Tantalum | 35 | 20 | 914026 |
| 1C142 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C143 | 0.47μ | Tantalum | 35 | 20 | 915168 |
| 1C144 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C145 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | F | | V | | |
| 1C146 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C147 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C148 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C149 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 1C150 | .01μ | Disc ceramic | 63 | 20 | 915173 |
| 1C151 | .01μ | Disc ceramic | 63 | 20 | 915173 |
| 1C152 | .01μ | Disc ceramic | 500 | +40-20 | 916187 |
| 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 | 925173 |
| 1C158 | 4.7μ | Tantalum | 35 | 20 | 914026 |
| 1C159 | .01μ | Disc ceramic | 63 | 20 | 915173 |
| 1C160 | .01μ | Disc ceramic | 63 | 20 | 915173 |
| 1C161 | .01μ | Disc ceramic | 63 | 20 | 915173 |

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 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| 1T11 | | | | | 710110 |
| 1T12 | | | | | 710110 |
| 1T13 | | | | | 710111 |
| 1T14 | | | | | 710108 |
| 1T15 | | | | | 710107 |
| 1T16 | | | | | 710106 |
| Diodes | | | | | |
| 1D1 | | IN4002 | | | 911460 |
| 1D2 | | IN4002 | | | 911460 |
| 1D3 | | Zener BSY93C33R | | | 921436 |
| 1D4 | | IN4149 | | | 914898 |
| 1D5 | | Zener BZY88C13 | | | 916328 |
| 1D6 | | BAW62 | | | 918982 |
| 1D7 | | BAW62 | | | 918982 |
| 1D8 | | IN4149 | | | 914898 |
| 1D9 | | IN4149 | | | 914898 |
| 1D10 | | IN4149 | | | 914898 |
| 1D11 | | IN4149 | | | 914898 |
| 1D12 | | IN4149 | | | 914898 |
| 1D13 | | BZY886V8 | | | 914064 |
| 1D14 | | IN4149 | | | 914898 |
| 1D15 | | IN4149 | | | 914898 |
| 1D16 | | IN4149 | | | 914898 |
| 1D17 | | BZY88C18 | | | 915920 |
| 1D18 | | IN4149 | | | 914898 |
| 1D19 | | IN4149 | | | 914898 |
| 1D20 | | IN4149 | | | 914898 |
| 1D21 | | IN4149 | | | 914898 |
| 1D22 | | BAW62 | | | 918982 |
| 1D23 | | BAW62 | | | 918982 |
| 1D24 | | BAW62 | | | 918982 |
| 1D25 | | BAW62 | | | 918982 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| 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 | | IN4149 | | | 914898 |
| 1D37 | | IN4149 | | | 914898 |
| 1D38 | | IN4149 | | | 914898 |
| 1D39 | | IN4149 | | | 914898 |
| 1D40 | | BAW62 | | | 918982 |
| 1D41 | | BAW62 | | | 918982 |
| 1D42 | | BZY886V8 | | | 914064 |
| 1D43 | | IN4149 | | | 914898 |
| 1D44 | | IN4149 | | | 914898 |
| 1D45 | | BAW62 | | | 918982 |
| 1D46 | | BAW62 | | | 918982 |
| 1D47 | | IN4149 | | | 914898 |
| 1D48 | | IN4149 | | | 914898 |
| 1D49 | | IN4149 | | | 914898 |
| 1D50 | | IN4149 | | | 914898 |
| 1D51 | | IN4149 | | | 914898 |
| 1D52 | | IN4149 | | | 914898 |

Transistors

| | | | | | |
|---|---|---|---|---|---|
| 1TR1 | | 2N3054 | | | 911951 |
| 1TR2 | | BFY51 | | | 908753 |
| 1TR3 | | ZTX237 | | | 923171 |
| 1TR4 | | 2N4996 | | | 916493 |
| 1TR5 | | 2N4126 | | | 912678 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| 1TR6 | | SX407 | | | 915117 |
| 1TR7 | | SX407 | | | 915117 |
| 1TR8 | | SX407 | | | 915117 |
| 1TR9 | | SX407 | | | 915117 |
| 1TR10 | | ZTX237 | | | 923171 |
| 1TR11 | | ZTX237 | | | 923171 |
| 1TR12 | | ZTX237 | | | 923171 |
| 1TR13 | | ZTX237 | | | 923171 |
| 1TR14 | | ZTX237 | | | 923171 |
| 1TR15 | | ZTX237 | | | 923171 |
| 1TR16 | | ZTX237 | | | 923171 |
| 1TR17 | | ZTX237 | | | 923171 |
| 1TR18 | | ZTX237 | | | 923171 |
| 1TR19 | | ZTX3705 | | | 923170 |
| 1TR20 | | 2N5448 | | | 915118 |
| 1TR21 | | ZTX3705 | | | 923170 |
| 1TR22 | | ZTX237 | | | 923171 |
| 1TR23 | | ZTX237 | | | 923171 |
| 1TR24 | | ZTX237 | | | 923171 |
| 1TR25 | | ZTX237 | | | 923171 |
| 1TR26 | | ZTX237 | | | 923171 |
| 1TR27 | | MPS3563 | | | 920909 |
| 1TR28 | | ZTX237 | | | 923171 |
| 1TR29 | | ZTX237 | | | 923171 |
| 1TR30 | | ZTX212 | | | 923172 |
| 1TR31 | | 2N3866 | | | 917219 |
| 1TR32 | | SX407 | | | 915117 |
| 1TR33 | | SX407 | | | 915117 |
| 1TR34 | | SX407 | | | 915117 |
| 1TR35 | | SX407 | | | 915117 |
| 1TR36 | | SX407 | | | 915117 |
| 1TR37 | | ZTX212 | | | 923172 |
| 1TR38 | | ZTX212 | | | 923172 |
| 1TR39 | | ZTX237 | | | 923171 |
| 1TR40 | | ZTX237 | | | 923171 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| 1TR41 | | ZTX237 | | | 923171 |
| 1TR42 | | ZTX237 | | | 923171 |
| 1TR43 | | ZTX237 | | | 923171 |
| 1TR44 | | ZTX237 | | | 923171 |
| 1TR45 | | ZTX237 | | | 923171 |
| 1TR46 | | ZTX237 | | | 923171 |
| 1TR47 | | ZTX212 | | | 923172 |
| 1TR48 | | BC109 | | | 914900 |
| 1TR49 | | BC109 | | | 914900 |
| 1TR50 | | 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 Link 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, AF gain) | | | 921002 |
| | | Cap (for knob 921002) | | | 921003 |
| | | Knob (ATU) | | | 915125 |

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

## PA BOARD AND PART OF FRONT PANEL

| Resistors | Ω | | W | | |
|---|---|---|---|---|---|
| 2R1 | Not used | | | | |
| 2R2 | 56k | Carbon | 1/3 | 5 | 922350 |
| 2R3 | 150k | Carbon | 1/3 | 5 | 922360 |
| 2R4 | 1k | Carbon | 1/3 | 5 | 922338 |
| 2R5 | 1k | Wirewound | 2½ | 5 | 913626 |
| 2R6 | 220 | Carbon | 1/3 | 5 | 922332 |
| 2R7 | 220 | Carbon | 1/3 | 5 | 922332 |
| 2R8 | 220 | Wirewound | 2½ | 5 | 913604 |
| 2R9 | 220 | Wirewound | 2½ | 5 | 913604 |
| 2R10 | 220 | Carbon | 1/3 | 5 | 922332 |
| 2R11 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R12 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R13 | 220 | Carbon | 1/3 | 5 | 922332 |
| 2R14 | 470 | Carbon | 1/3 | 5 | 922272 |
| 2R15 | 470 | Carbon | 1/3 | 5 | 922272 |
| 2R16 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R17 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R18 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R19 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R20 | 1.5k | Carbon | 1/3 | 5 | 919299 |
| 2R21 | 1.5k | Carbon | 1/3 | 5 | 919299 |
| 2R22 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R23 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R24 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R25 | 10 | Carbon | 1/3 | 5 | 922316 |
| 2R26 | 1k | Carbon | 1/3 | 5 | 922338 |
| 2R27 | 1k | Carbon | 1/3 | 5 | 922338 |
| 2R28 | 8.2k | Carbon | 1/3 | 5 | 922266 |
| 2R29 | 2.2k | Carbon | 1/3 | 5 | 922266 |
| 2R30 | 47k | Carbon | 1/3 | 5 | 922349 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | Ω | | W | | |
| 2R31 | 470 | Carbon | 1/3 | 5 | 922272 |
| 2R32 | 470 | Carbon | 1/3 | 5 | 922272 |
| 2R33 | 10k | Carbon | 1/3 | 5 | 922267 |
| 2R34 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 2R35 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 2R36 | 15k | Carbon | 1/3 | 5 | 922268 |
| 2R37 | 2.2k | Carbon | 1/3 | 5 | 922273 |
| 2R38 | 1.2k | Carbon | 1/3 | 5 | 922339 |
| 2R39 | 470 | Carbon | 1/3 | 5 | 922272 |
| 2R40 | 470 | Carbon | 1/3 | 5 | 922272 |
| 2R41 | 220 | Carbon | 1/4 | 10 | |
| 2R42 | | Not used | | | |
| 2R43 | | Not used | | | |
| 2R44 | 1 | | | 5 | 923887 |
| 2R45 | 1 | | | 5 | 923887 |

Capacitors

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | F | | V | | |
| 2C1 | | Not used | | | |
| 2C2 | .01μ | Ceramic | 63 | 20 | 915173 |
| 2C3 | 100p | Ceramic | 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 | 100p | Ceramic | 4k | 20 | 920887 |
| 2C11 | 66p | Ceramic | 4k | 10 | 923614 |
| 2C12 | | Not used | | | |
| 2C13 | 2.2p | Ceramic | 200 | .5p | 908829 |
| 2C14 | 2p | Ceramic | 4k | .5p | 920558 |
| 2C15 | .01μ | Ceramic | 63 | 20 | 915173 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| | F | | V | | |
| 2C16 | .01μ | Ceramic | 63 | 20 | 915173 |
| 2C17 | 47p | Polystyrene | 30 | 2.5 | 908318 |
| 2C18 | 47p | Polystyrene | 30 | 2.5 | 908318 |
| 2C19 | .01μ | Ceramic | 63 | 20 | 915173 |
| 2C20 | .01μ | Ceramic | 63 | 20 | 915173 |
| 2C21 | .01μ | Ceramic | 63 | 20 | 915173 |
| 2C22 | .01μ | Ceramic | 63 | 20 | 915173 |
| 2C23 | .01μ | Ceramic | 100 | 20 | 922402 |
| 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 | | IN4149 | | | 914898 |
| 2D3 | | IN4997 | | | 917775 |
| 2D4 | | IN4002 | | | 911460 |
| 2D5 | | IN4002 | | | 911460 |
| 2D6 | | IN4002 | | | 911460 |
| 2D7 | | IN4002 | | | 911460 |
| 2D8 | | IN4149 | | | 914898 |
| 2D9 | | IN4149 | | | 914898 |
| 2D10 | | IN4149 | | | 914898 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| 2D11 | | IN4149 | | | 914898 |
| 2D12 | | IN4149 | | | 914898 |
| **Transistors** | | | | | |
| 2TR1* | | 2N5070 | | | 920568 |
| 2TR2* | | 2N5070 | | | 920568 |
| 2TR3 | | 2N3866 | | | 917219 |
| 2TR4 | | 2N3866 | | | 917219 |
| 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 ATU, see 2L3) | | | |
| 2SK4 | | 1.6-3 MHz | | | 905449 |
| 2SK5 | | 3-30 MHz | | | 905449 |
| 2SK6 | | W/B | | | 905449 |
| 2SK7 | | 100 mW OUT | | | 905449 |
| 2SK8 | | 100 mW IN | | | 905449 |

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

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| Miscellaneous | | | | | |
| 2ME1 | | Meter (complete with light emitting diodes) | | | 711413 |
| 2X1 | | Ferrite bead FX1115 | | | 900461 |
| 2X2 | | Ferrite bead FX1115 | | | 900461 |
| 2X3 | | Ferrite bead FX1115 | | | 900461 |
| 2X4 | | Ferrite bead FX1115 | | | 900461 |
| | | '0' ring, ATU drive shaft | | | 909916 |
| | | '0' ring, 5.1 mm I/D whip socket | | | 920581 |
| | | '0' ring, 21.6 mm I/D ATU | | | 920628 |
| | | '0' ring, 13.6 mm I/D ATU | | | 920629 |

| Cct. Ref. | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| | | **ATU RELAY BOARD** (Components Prefixed 4) | | | |
| Resistors | Ω | | W | | |
| R1 | 150 | Carbon Film | 1/3 | 5 | 924671 |
| R2 | 100 | Carbon Film | 1/3 | 5 | 924669 |
| Capacitors | | | | | |
| C1 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C2 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C3 | 100p | Disc Ceramic | | 10 | 917417 |
| C4 | 0.1μ | Polycarbonate | 100 | 10 | 920566 |
| Transformers and Inductors | | | | | |
| L1 | | Choke 100 μH | | | 924345 |
| T1 | | Transformer | | | 710008 |
| T2 | | Transformer | | | 710008 |
| Diodes | | | | | |
| D1 | | 1N4149 | | | 914898 |
| D2 | | 1N4149 | | | 914898 |
| D3 | | 1N4149 | | | 914898 |
| Relays | | | | | |
| RLA | | Relay | | | 920577 |

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

## TRANSCEIVER RELAY BOARD (Components Prefixed 3)

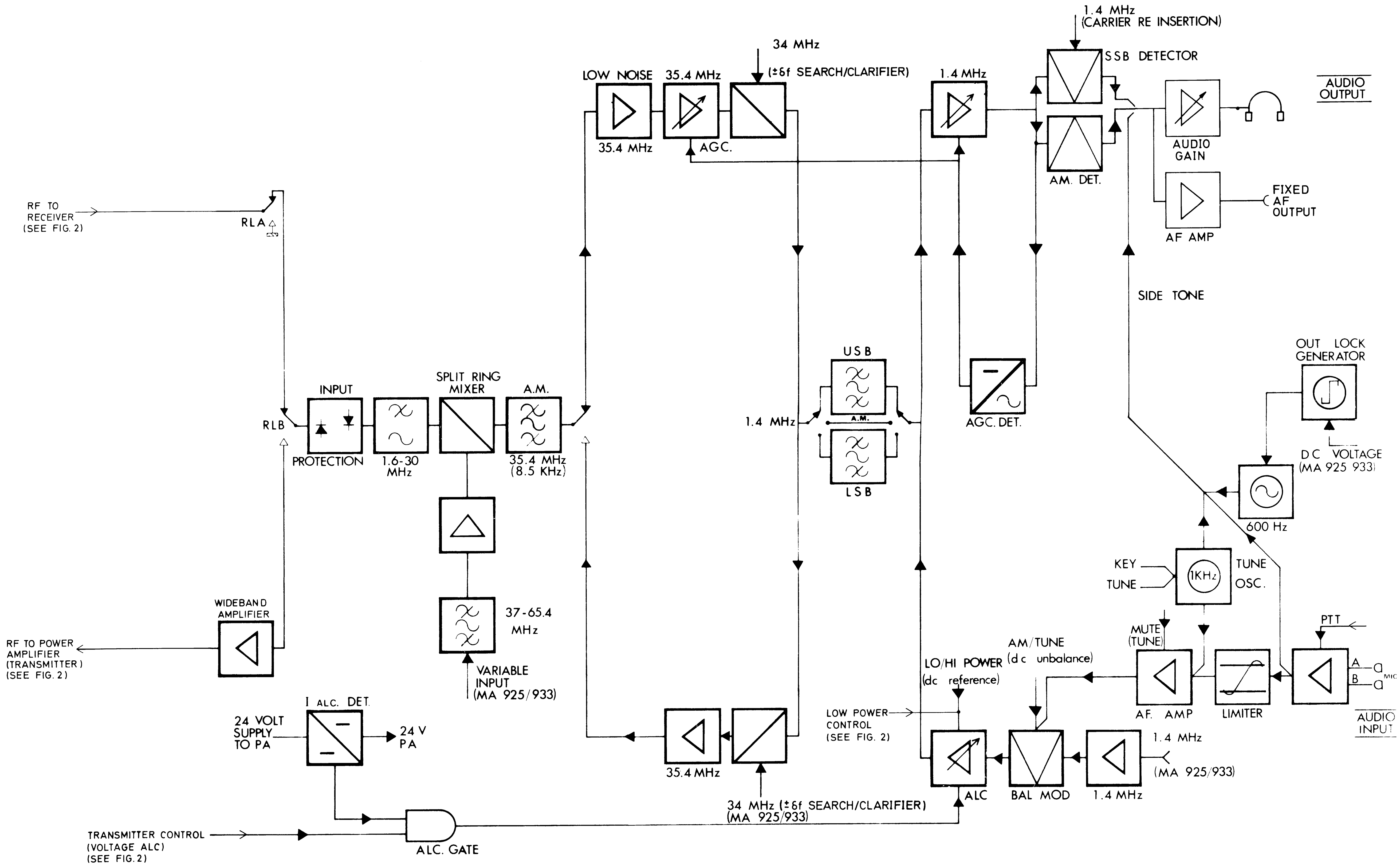
| Resistors | Ω | | W | | |
|---|---|---|---|---|---|
| R1 | 1k | Carbon Film | $\frac{1}{4}$ | 5 | 924227 |
| R2 | 1k | Carbon Film | $\frac{1}{4}$ | 5 | 924227 |
| R3 | 1k | Carbon Film | $\frac{1}{4}$ | 5 | 924227 |
| R4 | 1k | Carbon Film | $\frac{1}{4}$ | 5 | 924227 |
| R5 | 1k | Carbon Film | $\frac{1}{4}$ | 5 | 924227 |
| R6 | 1k | Carbon Film | $\frac{1}{4}$ | 5 | 924227 |
| R7 | 100 | Carbon Film | $\frac{1}{4}$ | 5 | 924235 |
| R8 | 10k | Carbon Film | $\frac{1}{4}$ | 5 | 924224 |
| R9 | 10k | Carbon Film | $\frac{1}{4}$ | 5 | 924224 |
| R10 | 10k | Carbon Film | $\frac{1}{4}$ | 5 | 924224 |
| R11 | 6.8k | Carbon Film | $\frac{1}{4}$ | 5 | 924225 |
| R12 | 12k | Carbon Film | $\frac{1}{4}$ | 5 | 925850 |
| R13 | 12k | Carbon Film | $\frac{1}{4}$ | 5 | 925850 |
| R14 | 2.7k | Carbon Film | $\frac{1}{4}$ | 5 | 925129 |
| R15 | 10k | Carbon Film | $\frac{1}{4}$ | 5 | 924224 |
| R16 | 4.7k | Carbon Film | $\frac{1}{4}$ | 5 | 924226 |
| R17 | 4.7k | Carbon Film | $\frac{1}{4}$ | 5 | 924226 |
| R18 | 4.7k | Carbon Film | $\frac{1}{4}$ | 5 | 924226 |
| R19 | 22k | Variable | $\frac{1}{4}$ | 5 | 924869 |
| R20 | 33k | Carbon Film | $\frac{1}{4}$ | 5 | 924332 |
| R21 | 1k | Carbon Film | $\frac{1}{4}$ | 5 | 924227 |
| R22 | 220 | Variable | | | 924869 |
| R23 | 120 | Carbon Film | $\frac{1}{4}$ | 5 | 926548 |
| R24 | 1.5k | Carbon Film | $\frac{1}{4}$ | 5 | 924229 |
| R25 | 10k | Carbon Film | $\frac{1}{4}$ | 5 | 924224 |

| Capacitors | F | | V | | |
|---|---|---|---|---|---|
| C1 | 100n | Fixed | 100 | 10 | 921368 |
| C2 | 100n | Fixed | 100 | 10 | 921368 |
| C3 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C4 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C5 | 10n | Ceramic | 40 | +100-20 | 924737 |

| Cct Ref. | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| Capacitors (Cont'd.) (Components Prefixed 3) | | | | | |
| C6 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C7 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C8 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C9 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C10 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C11 | 1µ | Tantalum | 35 | +50-20 | 919635 |
| C12 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C13 | | Not Used | | | |
| C14 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C15 | 47µ | Tantalum | 16 | 20 | 923804 |
| C16 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C17 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C18 | 10µ | Tantalum | 25 | 20 | 923646 |
| C19 | 10µ | Tantalum | 25 | 20 | 923646 |
| Inductors | | | | | |
| L1 | | Choke 100 µH | | | 924345 |
| Diodes | | | | | |
| D1 | | 1N4149 | | | 914898 |
| D2 | | 1N4149 | | | 914898 |
| D3 | | 1N4149 | | | 914898 |
| D4 | | 1N4149 | | | 914898 |
| D5 | | 1N4149 | | | 914898 |
| D6 | | 1N4149 | | | 914898 |
| D7 | | 1N4149 | | | 914898 |
| Transistors | | | | | |
| TR1 | | ZTX237 | | | 923171 |
| TR2 | | ZTX237 | | | 923171 |
| TR3 | | ZTX237 | | | 923171 |
| TR4 | | ZTX212 | | | 923172 |
| TR5 | | ZTX237 | | | 923171 |
| TR6 | | BFR41 | | | 926952 |
| TR7 | | BFR41 | | | 926952 |

| Cct Ref | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| Integrated Circuit (Components Prefixed 3) | | | | | |
| 1C1 | | LM 324N Op. Amp | | | 925944 |
| Relays | | | | | |
| RLA | | | | | 922542 |
| RLB | | | | | 922542 |
| RLC | | | | | 922542 |
| RLD | | | | | 922542 |
| RLE | | | | | 922542 |

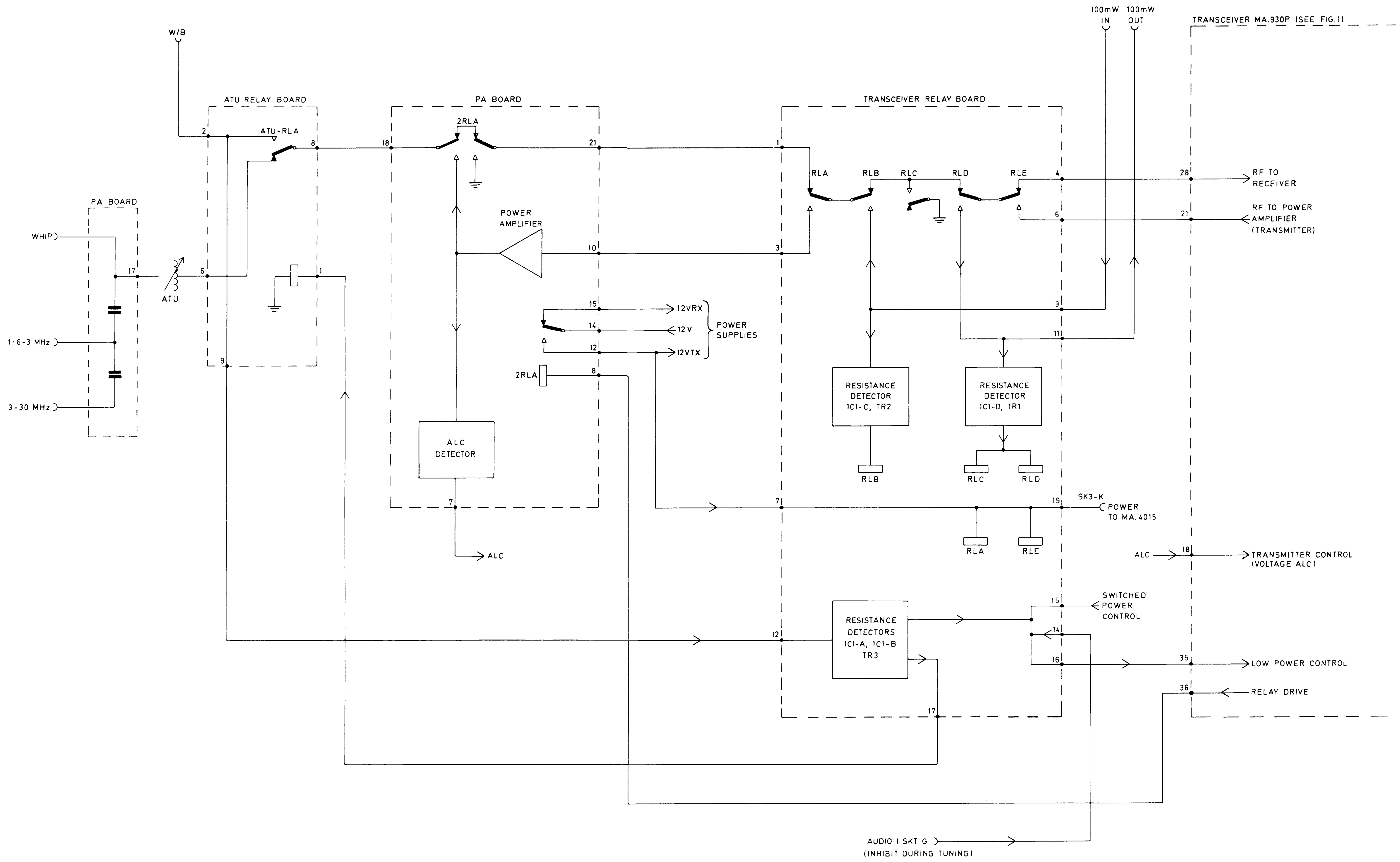
| Cct Ref | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| | | **DECOUPLING BOARD** (Components Prefixed 5) | | | |
| Capacitors | F | | V | | |
| C1 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C2 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C3 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C4 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C5 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C6 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C7 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C8 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C9 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C10 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C11 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C12 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C13 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C14 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C15 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C16 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C17 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C18 | 10n | Ceramic | 40 | +100-20 | 924737 |
| C19 | 10n | Ceramic | 40 | +100-20 | 924737 |
| Diodes | | | | | |
| D1 | | 1N4149 | | | 914898 |
| D2 | | 1N4149 | | | 914898 |
| D3 | | 1N4149 | | | 914898 |

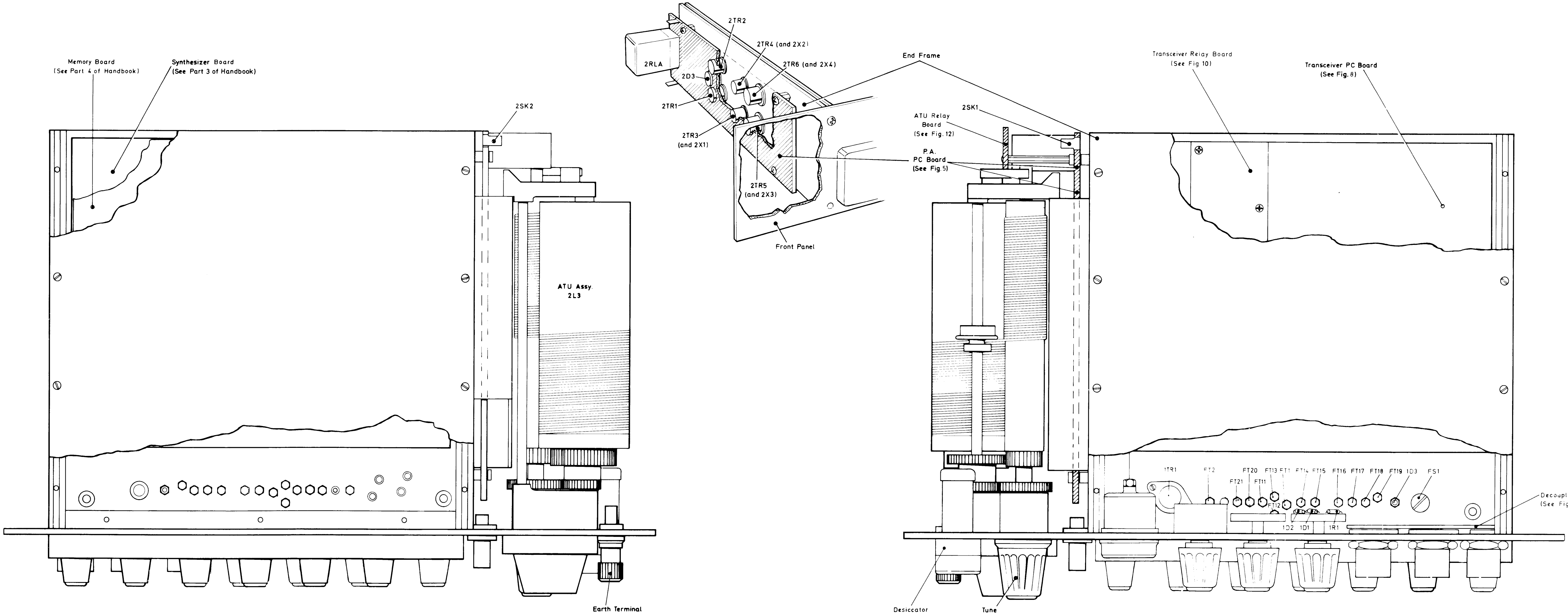



WOH 6160

Block Diagram: Transceiver MA.930P

Fig. 1

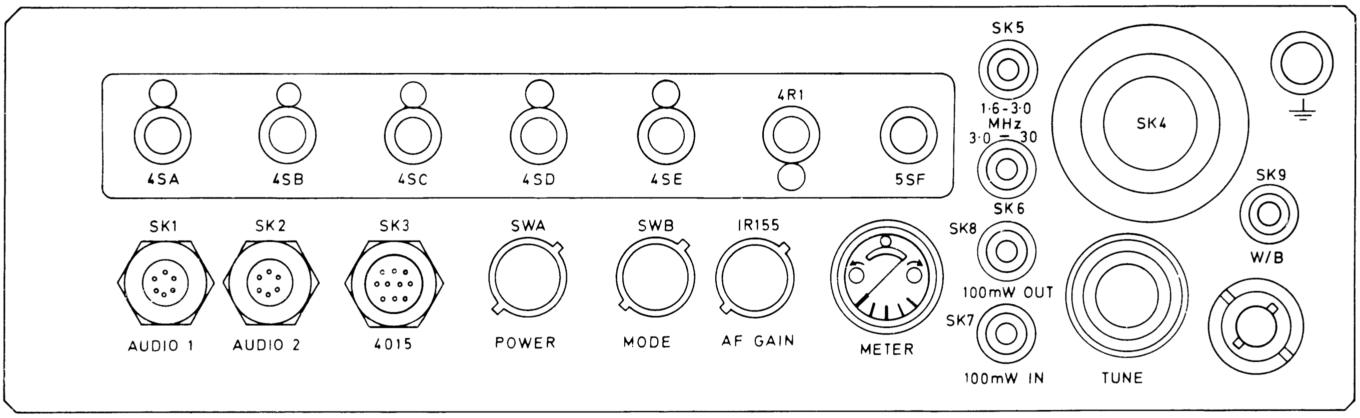

W/B
ATU RELAY BOARD
ATU-RLA
PA BOARD
2RLA
TRANSCEIVER RELAY BOARD
100mW IN
100mW OUT
TRANSCEIVER MA.930P (SEE FIG.1)
PA BOARD
WHIP
1·6-3 MHz
3-30 MHz
ATU
POWER AMPLIFIER
RLA
RLB
RLC
RLD
RLE
RF TO RECEIVER
RF TO POWER AMPLIFIER (TRANSMITTER)
12VRX
12V
12VTX
POWER SUPPLIES
2RLA
RESISTANCE DETECTOR 1C1-C, TR2
RESISTANCE DETECTOR 1C1-D, TR1
ALC DETECTOR
RLB
RLC
RLD
SK3-K
POWER TO MA.4015
RLA
RLE
ALC
ALC
TRANSMITTER CONTROL (VOLTAGE ALC)
SWITCHED POWER CONTROL
RESISTANCE DETECTORS 1C1-A, 1C1-B TR3
LOW POWER CONTROL
RELAY DRIVE
AUDIO 1 SKT G
(INHIBIT DURING TUNING)
WOH 6160




FOR IDENTIFICATION OF FRONT PANEL CONTROLS ETC. SEE FIG. 4

Component Layout : Transceiver MA930P

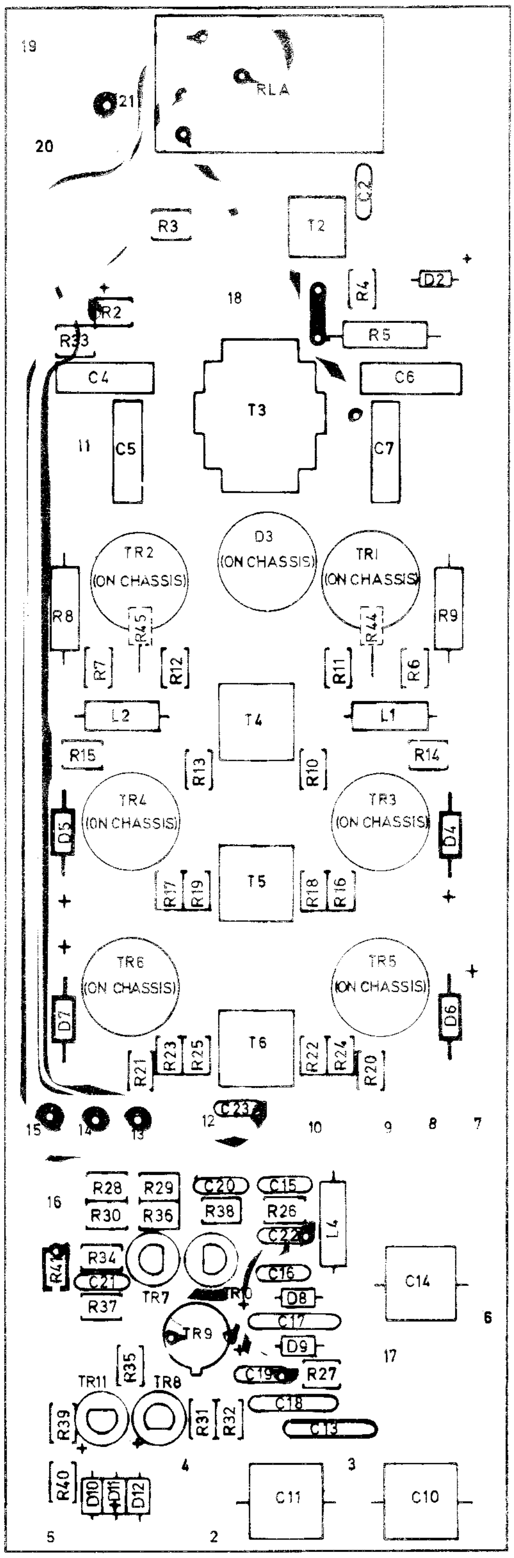
Fig. 3




WOH 6160

Layout : Front Panel

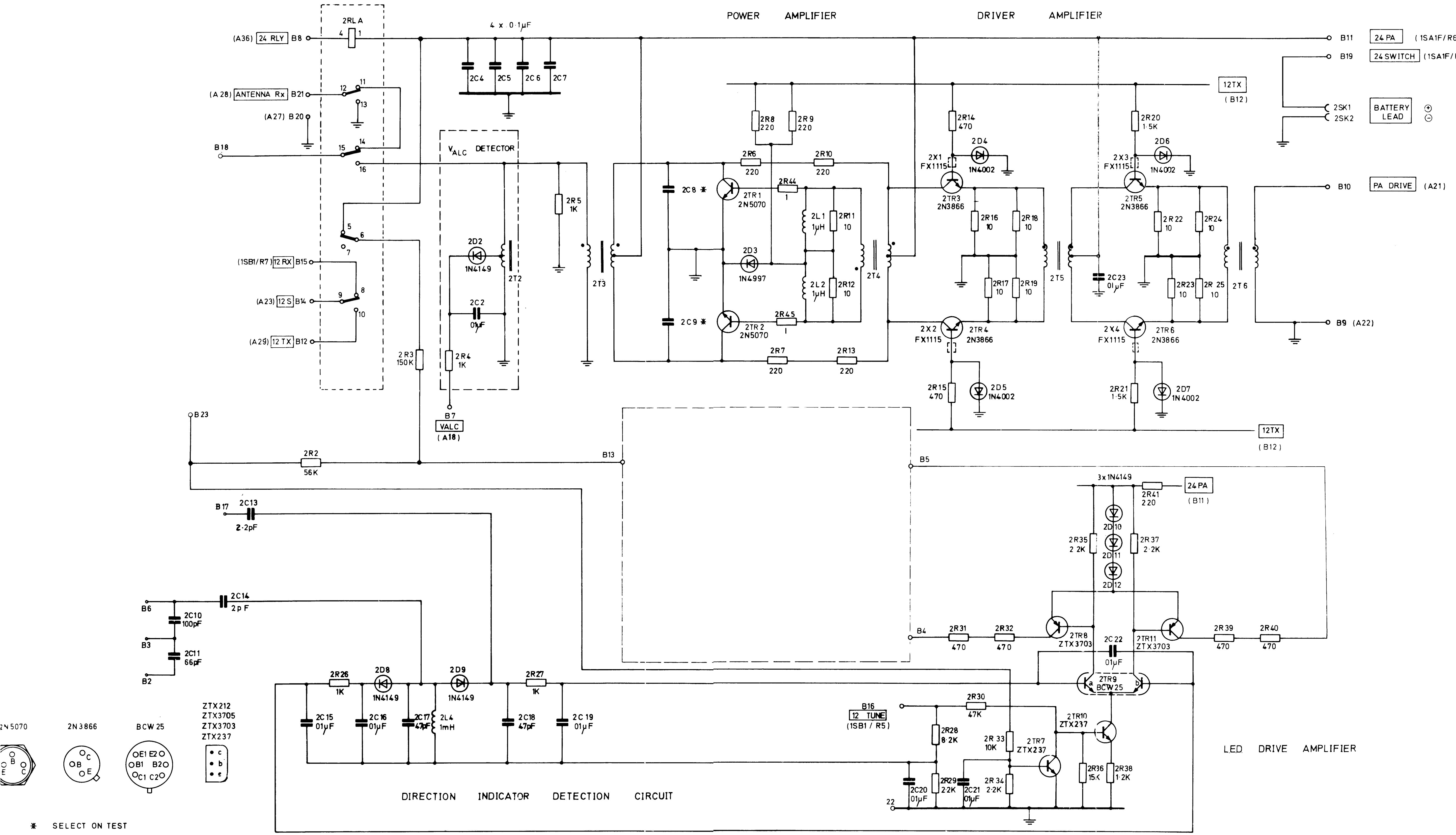
Fig. 4




WOH 6160

Layout : P.A. Board MA. 930P

Fig.5

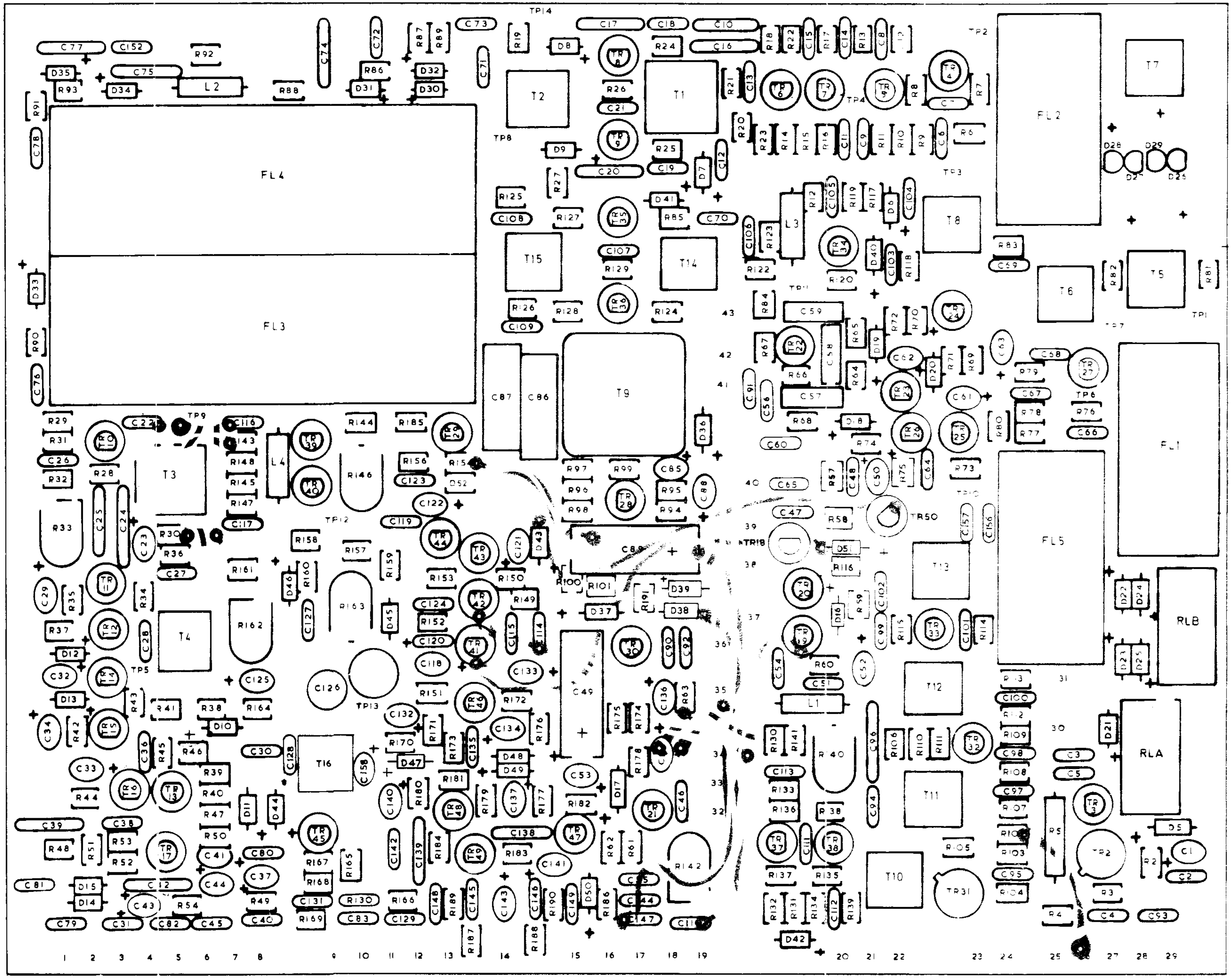



* SELECT ON TEST



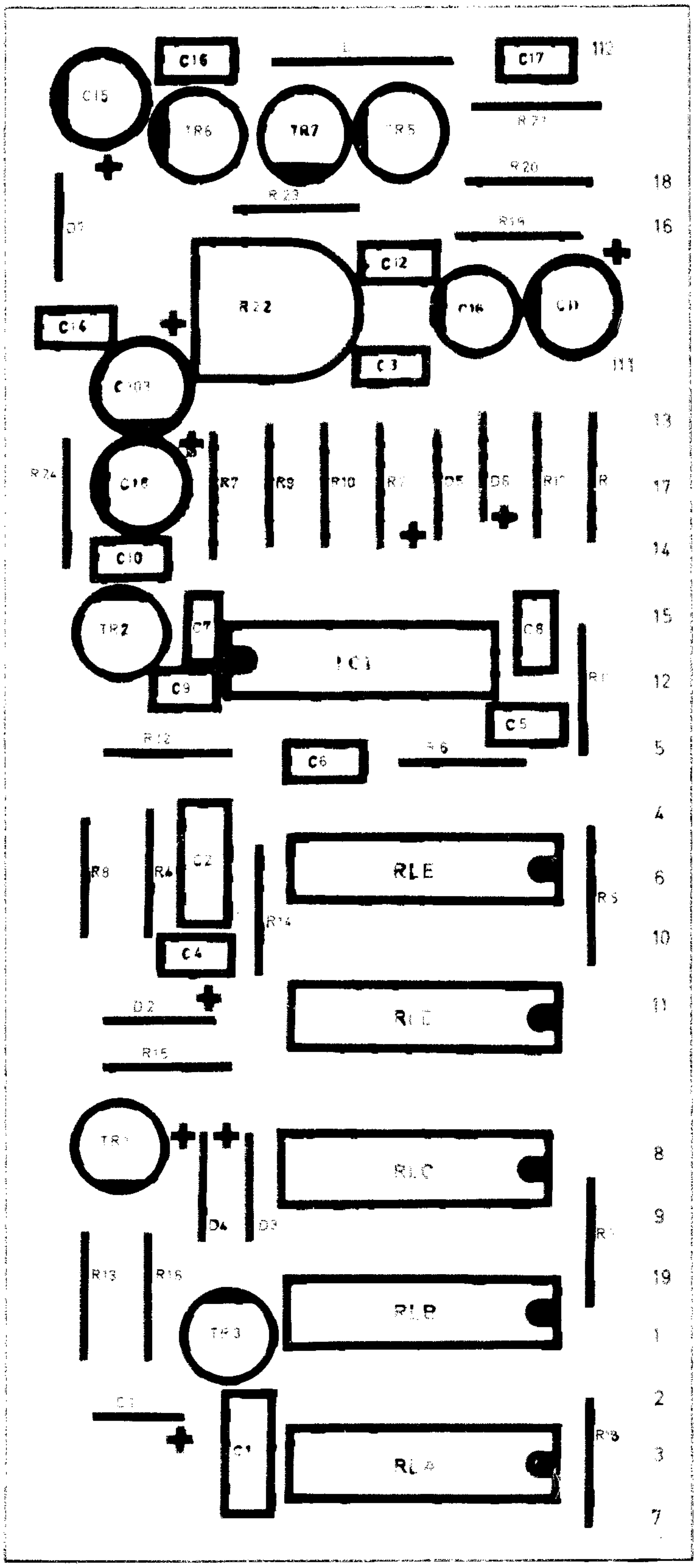
Circuit : P.A. Board Type MA.930P

Fig. 6




NOTE ALL COMPONENTS PREFIXED 1

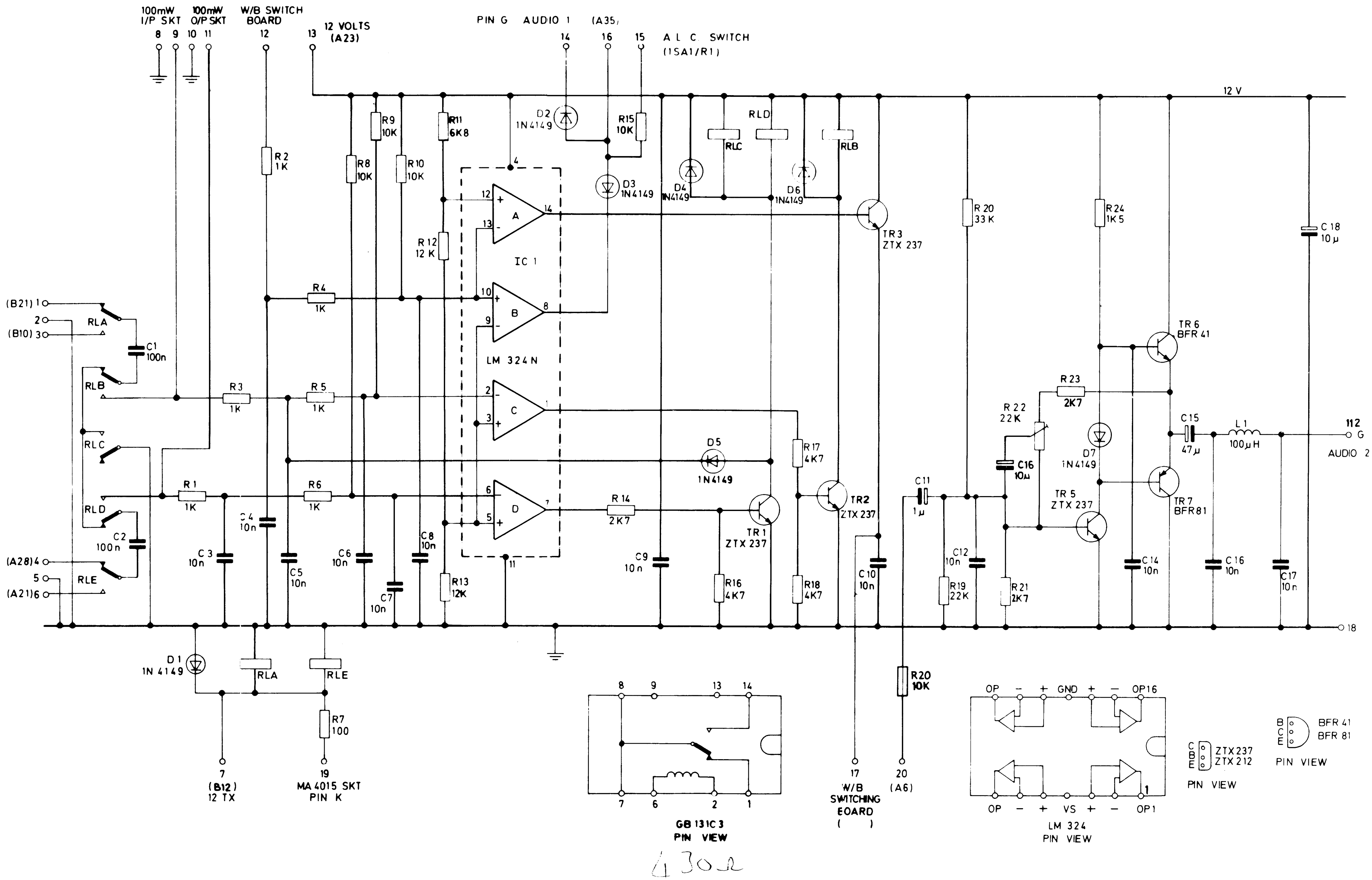
**Layout : Transceiver Board P.C.B. MA.930P** **Fig. 7**



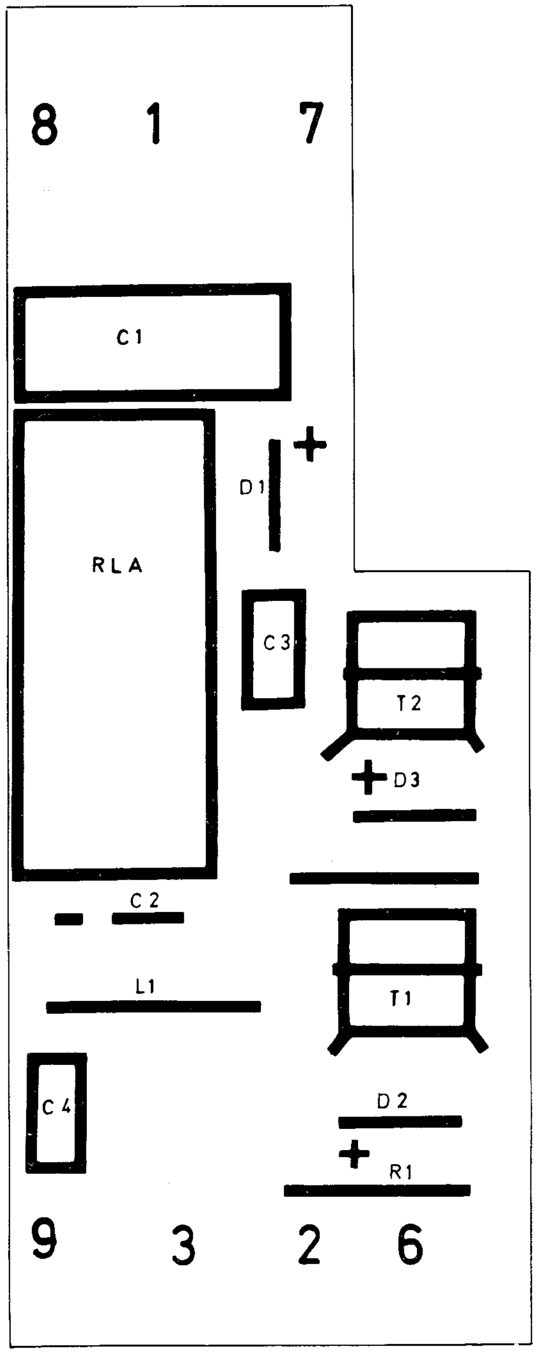

WOH 6160

Transceiver Relay Board

Fig. 9

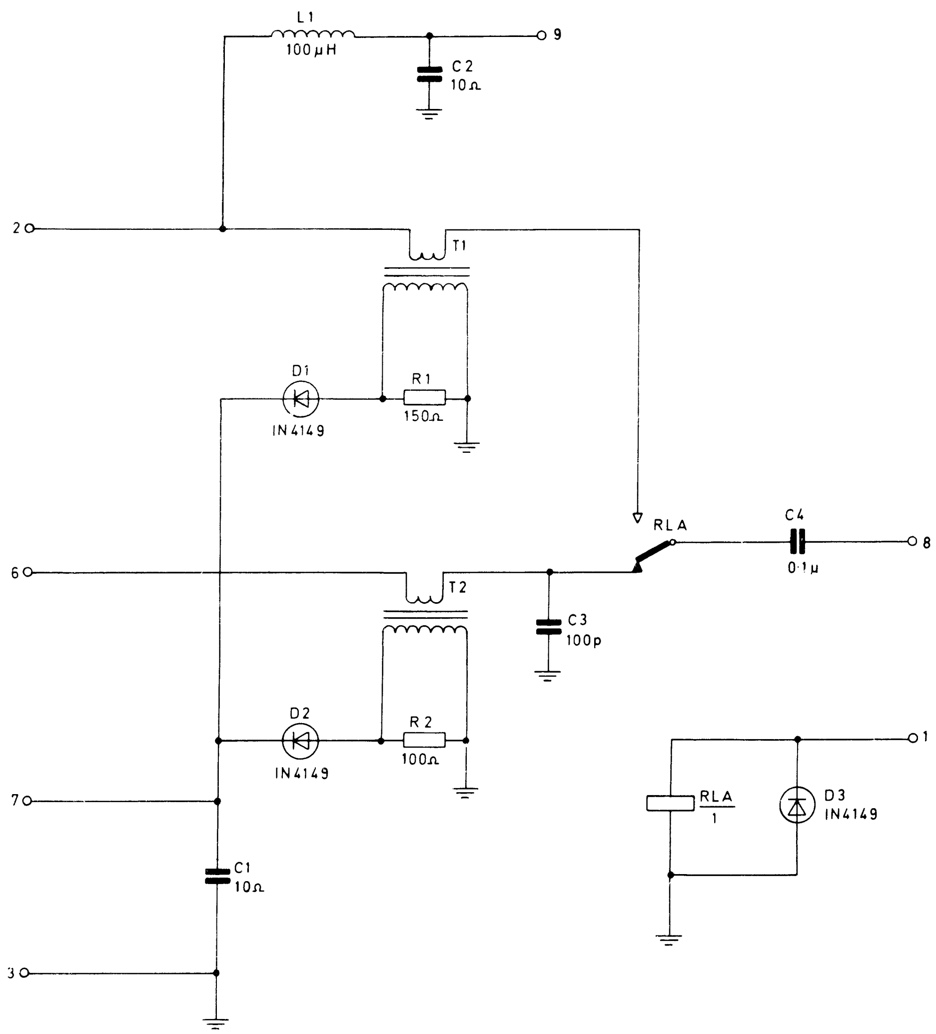



Circuit : Transceiver Relay Board Fig. 10




A.T.U. Relay P.C.B. : Layout

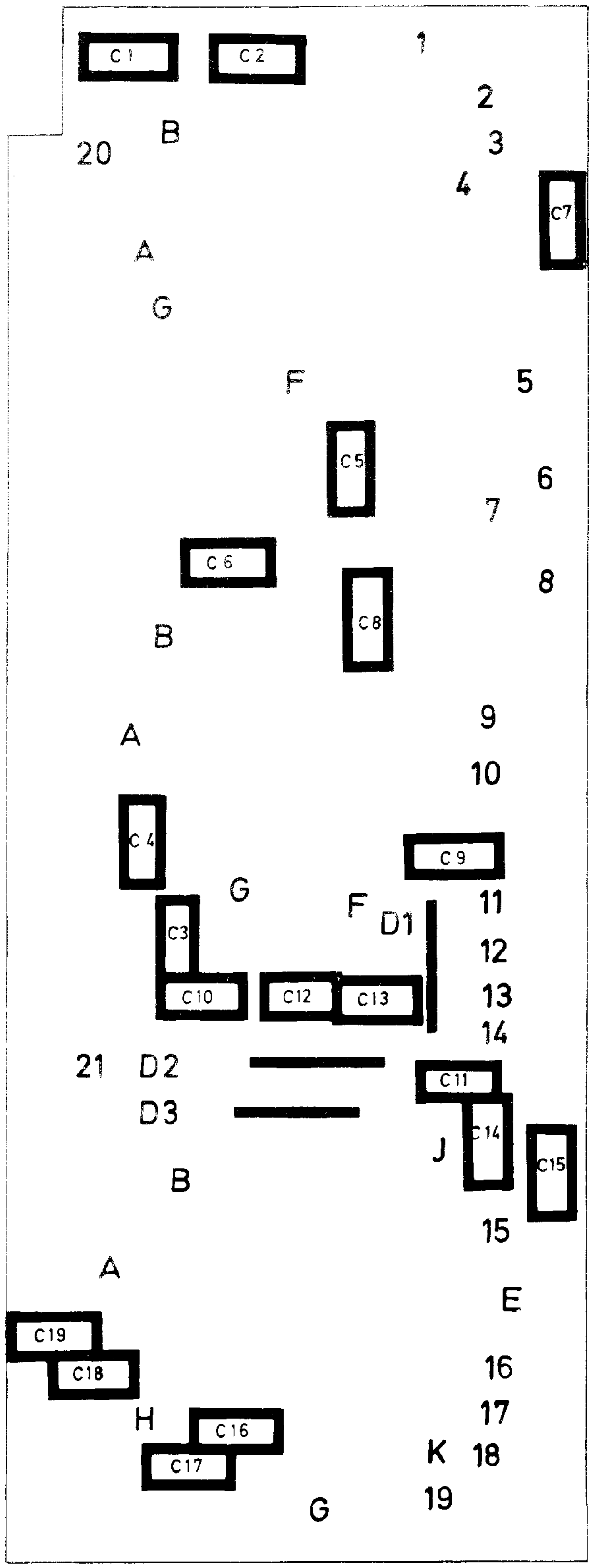
Fig. 11




WOH 6160

# Circuit : ATU Relay Board

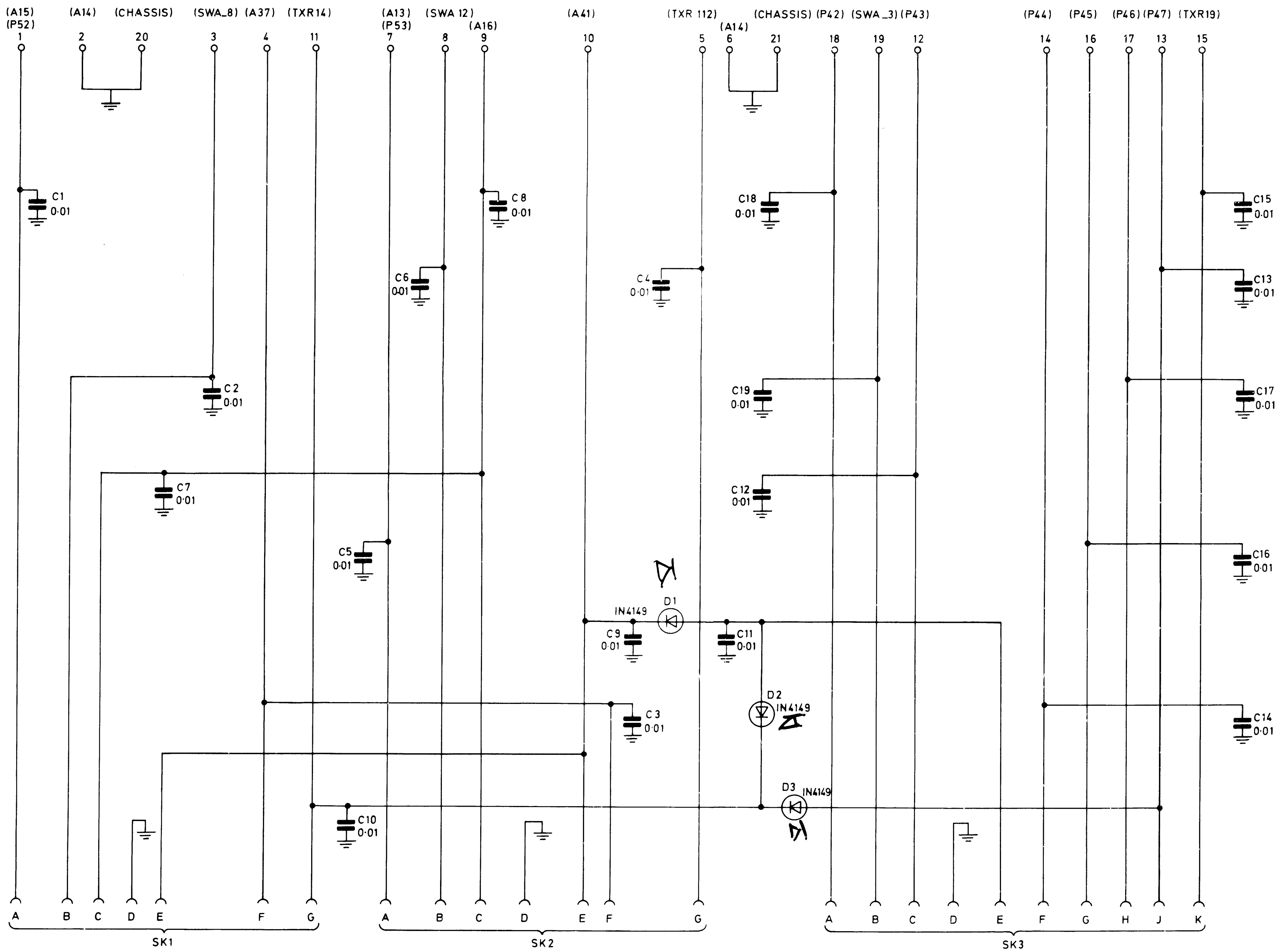
Fig. 12




WOH 6160

MA 930P Decoupling P.C.B. : Layout

Fig.13




Prefix 5

WOH 6160

Circuit : Decoupling Board

Fig. 14

# PART 3

# SYNTHESIZER TYPE MA.925

REF: WOH 2118
Issue: G

# PART 3

# SYNTHESIZER TYPE MA.925

## ADDENDUM No. 1

The following minor changes have been incorporated in the MA.925 used with the TRA.931P.

**Page 7-3**

R93 and R95 are changed as follows.

| | | | | | |
|---|---|---|---|---|---|
| R93 | 2K7 | Fixed | 1/3W | 5% | 924685 |
| R95 | 18 | Fixed | 1/3W | 5% | 926641 |

**Page 7-8**

L18 Racal Part Number is now 710370

**Fig. 3**

Switches 4SA, 4SB, 4SC, 4SD and 4SE are connected to the Pre-Programmed Frequency Memory Board as shown in Fig. 2 of Part 1.

# PART 3 SYNTHESIZER TYPE MA.925

## CONTENTS

## 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 = $\bar{D}$ | 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 | $\bar{Q}$ |
|---|---|---|---|
| 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 $\pm$ 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

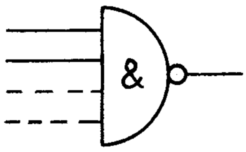
1. This Appendix gives brief details of the integrated circuits used in the MA.925 Synthesizer.

**Gates**

### NANDGATES

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

inputs



output

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

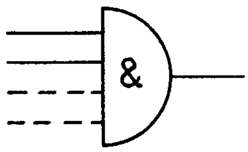
if any input is '0', output is '1'

### ANDGATES

SN 74S11J Triple 3 input

(ii)

inputs



outputs

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

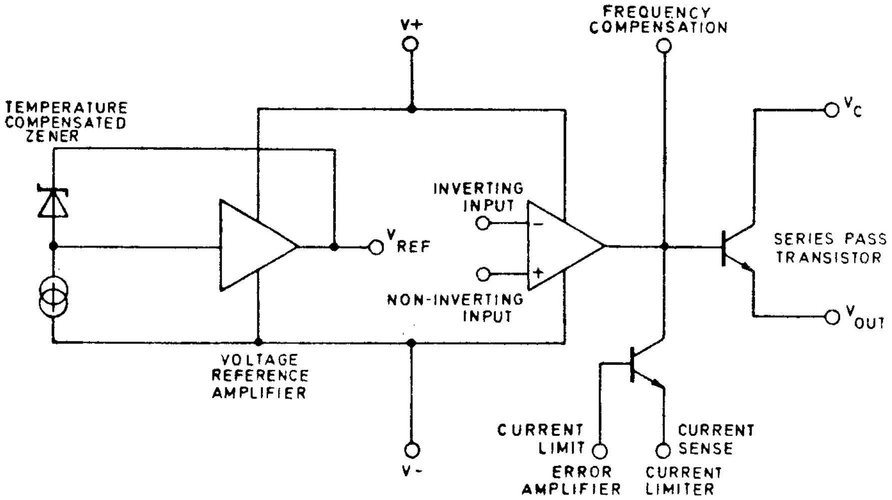
5. The N8290A and N8292A are presettable dividers which count the Ck1 (clock 1) inputs. Each A output is connected to the Ck2 (clock 2) input to provide a divide-by-ten counter. The A, B, C and D outputs are binary-coded decimal (BCD) as given in Table (Chap. 2). When the S (strobe) input is at '0' the ('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 723 HC

# 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 50Ωinput 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).

<u>34MHz Generator Check</u>

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).

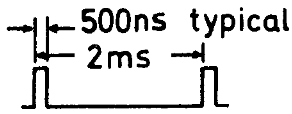
2: All readings are positive (+) unless otherwise indicated.

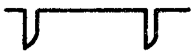
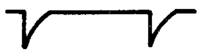
3: These readings are provided as a guide and do not represent a specification. Variations with frequency and component tolerances may be expected. The measurements were made with an AVO Type 8 (20kΩ/volt) multimeter using the 10V or 25V range, as appropriate.

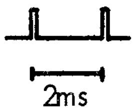
4: The Frequency selection switches of the manpack may be in any in-lock position except where specific instructions are given.

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<br>With MHz x 10 switch in position 1 or 2 | 3.5V d.c.<br>0V d.c. |
| TP36 | With MHz x 10 switch in position 0 or 2<br>With MHz x 10 switch in position 1 | 0V d.c.<br>3.5V d.c. |
| TP37 | With MHz x 10 switch in position 0 or 1<br>With MHz x 10 switch in position 2 | 0V d.c.<br>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 |

| Test Point | Typical Indication | | |
|---|---|---|---|
| TR40 collector CAUTION. Ensure that TR40 collector is not grounded, even momentarily. | 25kHz |  | 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 )<br>TP30 )<br>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 )<br>ML25 Pin 11 ) In Lock 0, Out of Lock 1

ML25 Pin 8 )<br>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 | 922332 |
| R33 | 10k | Fixed | 1/3 | 5 | 922267 |
| 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 | 1/3 | 5 | 922272 |
| R95 | 33 | Metal Oxide | | 5 | 908690 |
| R96 | 3.3k | Metal Oxide | | 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 | 2.2k | Metal Oxide | | 5 | 908270 |
| R121 | 10k | Metal Oxide | | 5 | 922267 |
| 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 | 922320 |
| 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 | 915243 |
| 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 | 220p | Disc ceramic | | 10 | 914916 |
| 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 | | | 919311 |
| 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 | 915243 |
| C39 | 15μ | Electrolytic | 20 | | 910060 |
| C40 | 1000p | Disc ceramic | | 25 | 915243 |
| C41 | 1000p | Disc ceramic | | 25 | 915243 |
| C42 | 1000p | Disc ceramic | | 25 | 915243 |
| C43 | 1000p | Disc ceramic | | 25 | 915243 |
| C44 | 4.7μ | Electrolytic | | 10 | 905388 |
| C45 | 100p | Disc ceramic | | 10 | 917417 |
| C46 | 100p | Disc ceramic | | 10 | 917417 |
| C47 | 1000p | Disc ceramic | | 25 | 915243 |
| C48 | 1000p | Disc ceramic | | 25 | 915243 |
| C49 | 1000p | Disc ceramic | | 25 | 915243 |
| C50 | 1000p | Disc ceramic | | 25 | 915243 |
| C51 | 1000p | Disc ceramic | | 20 | 915243 |
| C52 | 2.2μ | Electrolytic | | 20 | 908316 |
| C53 | 1000p | Disc ceramic | | 25 | 915243 |
| C54 | 1000p | Disc ceramic | | 20 | 915243 |
| 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 | 915243 |
| 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 | 915243 |
| C86 | 1000p | Disc ceramic | | 25 | 915243 |
| C87 | .01μ | Disc ceramic | | +50-25 | 911845 |
| C88 | 1000p | Disc ceramic | | 25 | 915243 |
| C89 | 220p | Silver Mica | | | 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 | | 2N2369 | | | 906842 |
| TR2 | | 2N2369 | | | 906842 |
| TR3 to | | | | | |
| TR8 | Not used | | | | |
| TR9 | | 2N2369 | | | 906842 |
| TR10 | | BC109 | | | 914900 |
| TR11 | | BFX48 | | | 915231 |
| TR12 | | BFW10 | | | 916946 |
| TR13 | | BFW10 | | | 916946 |
| TR14 | | 2N2369 | | | 906842 |
| TR15 | | 2N2369 | | | 906842 |
| TR16 | | 2N4338 | | | 920331 |
| TR17 to | | | | | |
| TR22 | Not used | | | | |
| TR23 | | 2N2369 | | | 906842 |
| TR24 | | BFX48 | | | 915231 |
| TR25 | | BFX48 | | | 915231 |
| TR26 | | 2N2369 | | | 906842 |
| TR27 | | BFX48 | | | 915231 |
| TR28 | | 2N2369 | | | 906842 |
| TR29 | | BFX48 | | | 915231 |
| TR30 | | 2N2369 | | | 906842 |
| TR31 | | BFX89 | | | 916627 |
| TR32 | | 2N2369 | | | 906842 |
| TR33 | | 2N2369 | | | 906842 |

| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| TR34 to | | | | | |
| TR39 | Not used | | | | |
| TR40 | | 2N4037 | | | 922991 |
| TR41 | | 2N3054 | | | 911951 |
| TR42 | | 2N2369 | | | 906842 |
| TR43 | | 2N2369 | | | 906842 |
| TR44 | | 2N2369 | | | 906842 |
| TR45 | | 2N2369 | | | 906842 |
| TR46 to | | | | | |
| TR51 | Not used | | | | |
| TR52 | | BFX48 | | | 915231 |
| TR53 | | BFX48 | | | 915231 |
| TR54 | | 2N2369 | | | 906842 |
| TR55 | | BFX48 | | | 915231 |
| TR56 | | 2N2369 | | | 906842 |
| TR57 | | 2N2369 | | | 906842 |
| TR58 | | 2N2369 | | | 906842 |
| TR59 | | BFW10 | | | 916946 |
| TR60 | | BFX48 | | | 915231 |
| TR61 | | 2N2369 | | | 906842 |
| TR62 | | BFX48 | | | 915231 |
| TR63 | | BFX48 | | | 915231 |
| TR64 | | 2N2369 | | | 906842 |
| TR65 | | 2N2369 | | | 906842 |
| TR66 to | | | | | |
| TR71 | Not used | | | | |
| TR72 | | 2N2369 | | | 906842 |
| TR73 | | 2N2369 | | | 906842 |
| TR74 | | 2N2369 | | | 906842 |
| TR75 | | 2N2369 | | | 906842 |
| TR76 | | 2N2369 | | | 906842 |
| TR77 | | BC109 | | | 914900 |

Integrated Circuits

| | | | | | |
|---|---|---|---|---|---|
| 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 |

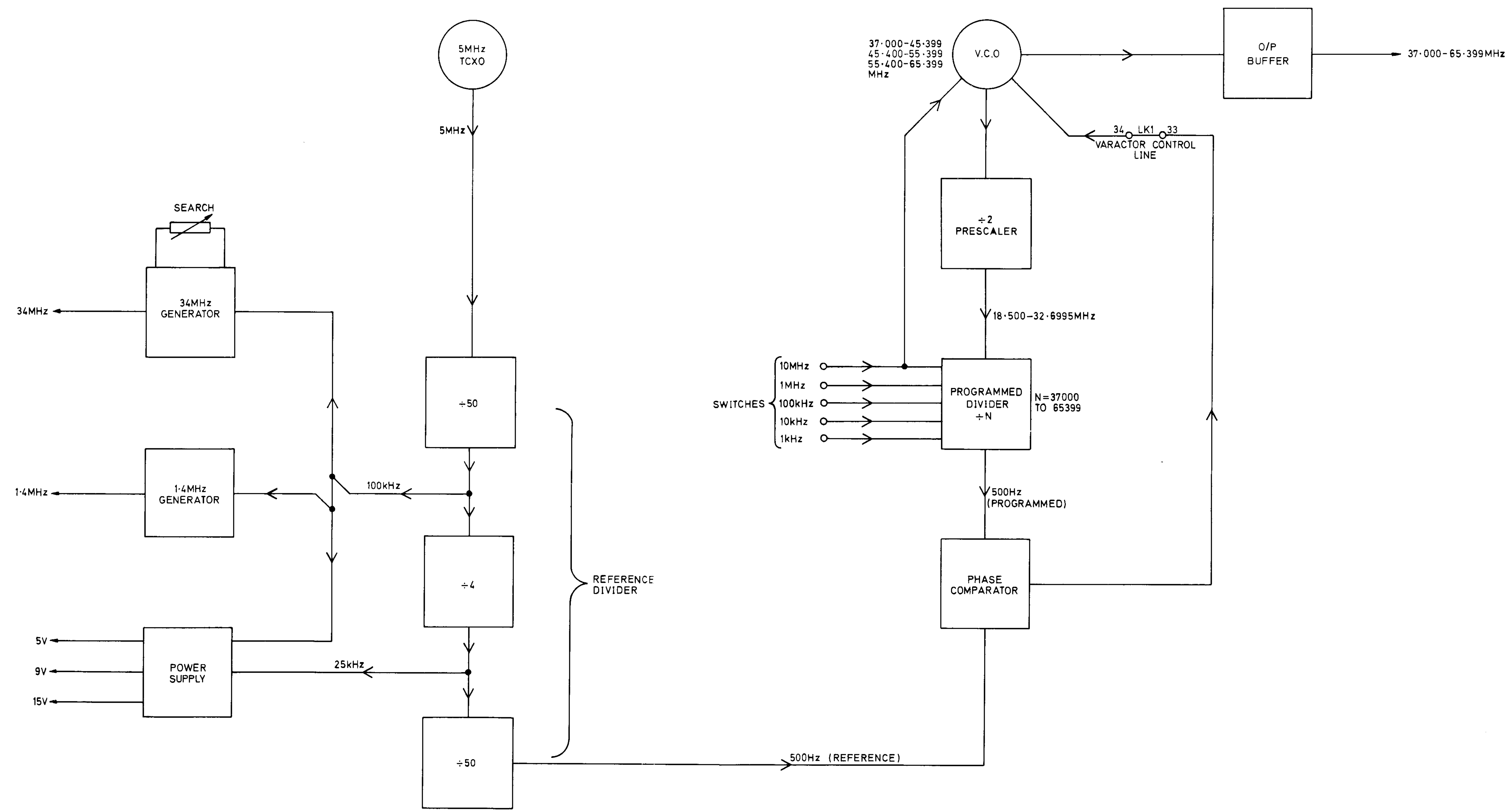
| Cct. Ref. | Value | Description | Rat. | Tol. % | Racal Part Number |
|---|---|---|---|---|---|
| ML6 | | Presettable decade N8290A | | | 920333 |
| ML7 | | Triple 3 I/P Nandgate 7410J | | | 918361 |
| ML8 | | Presettable decade N8292A | | | 918981 |
| ML9 | | Presettable decade N8292A | | | 918981 |
| 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

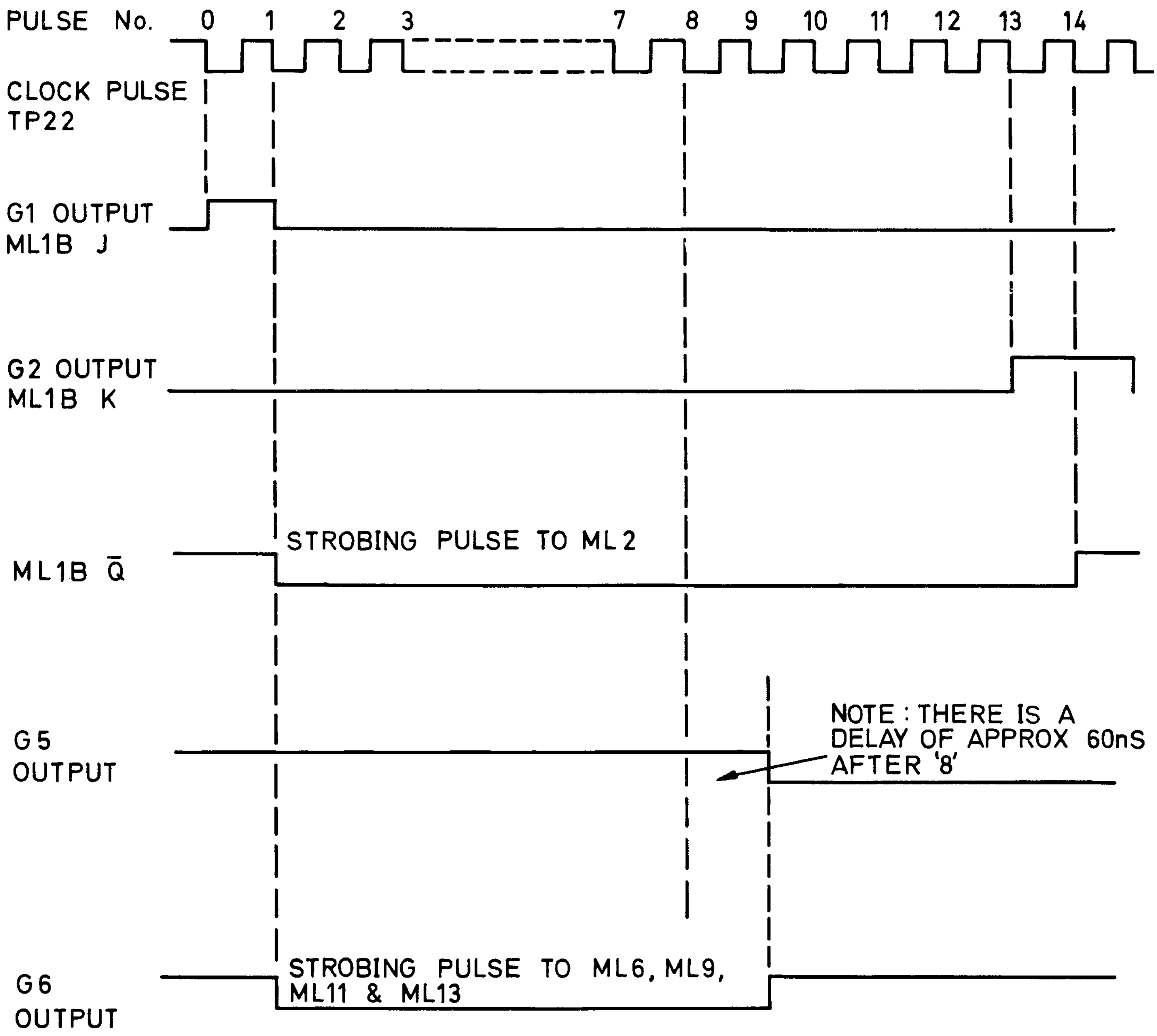
| | | | | | |
|---|---|---|---|---|---|
| TCX0 | | 5MHz frequency standard | | | AD75967 |
| XL1 | | Crystal 17MHz | | | AD75907 |
| XL2 to XL7 | Not used | | | | |
| XL8 | | Crystal 1.4MHz | | | AD75885 |
| XL9 | | Crystal 1.4MHz | | | AD75885 |




WOH2099
Part 3

Block Diagram: MA.925

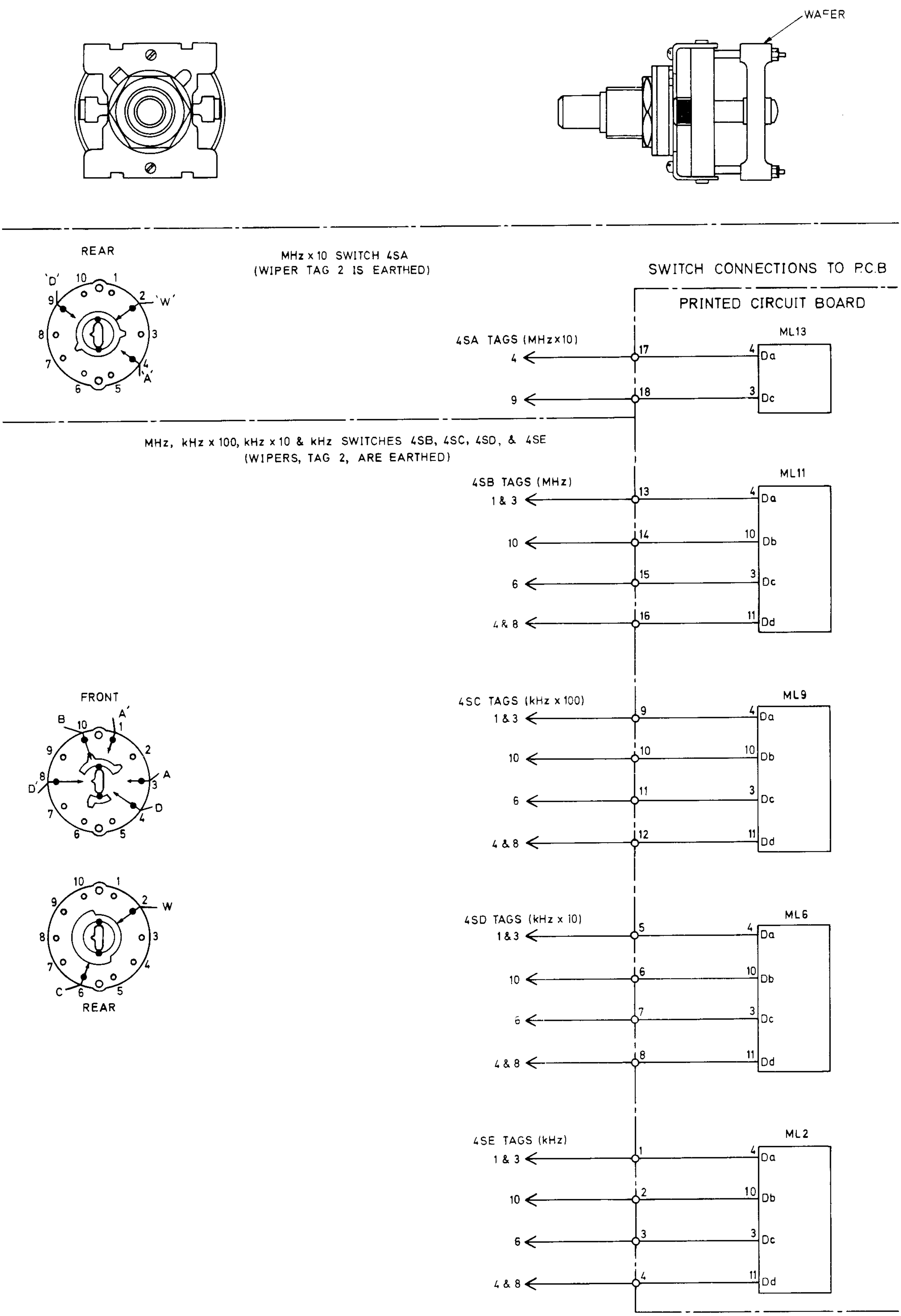
Fig. 1




WOH2099
Part 3

Strobing Waveforms MA.925

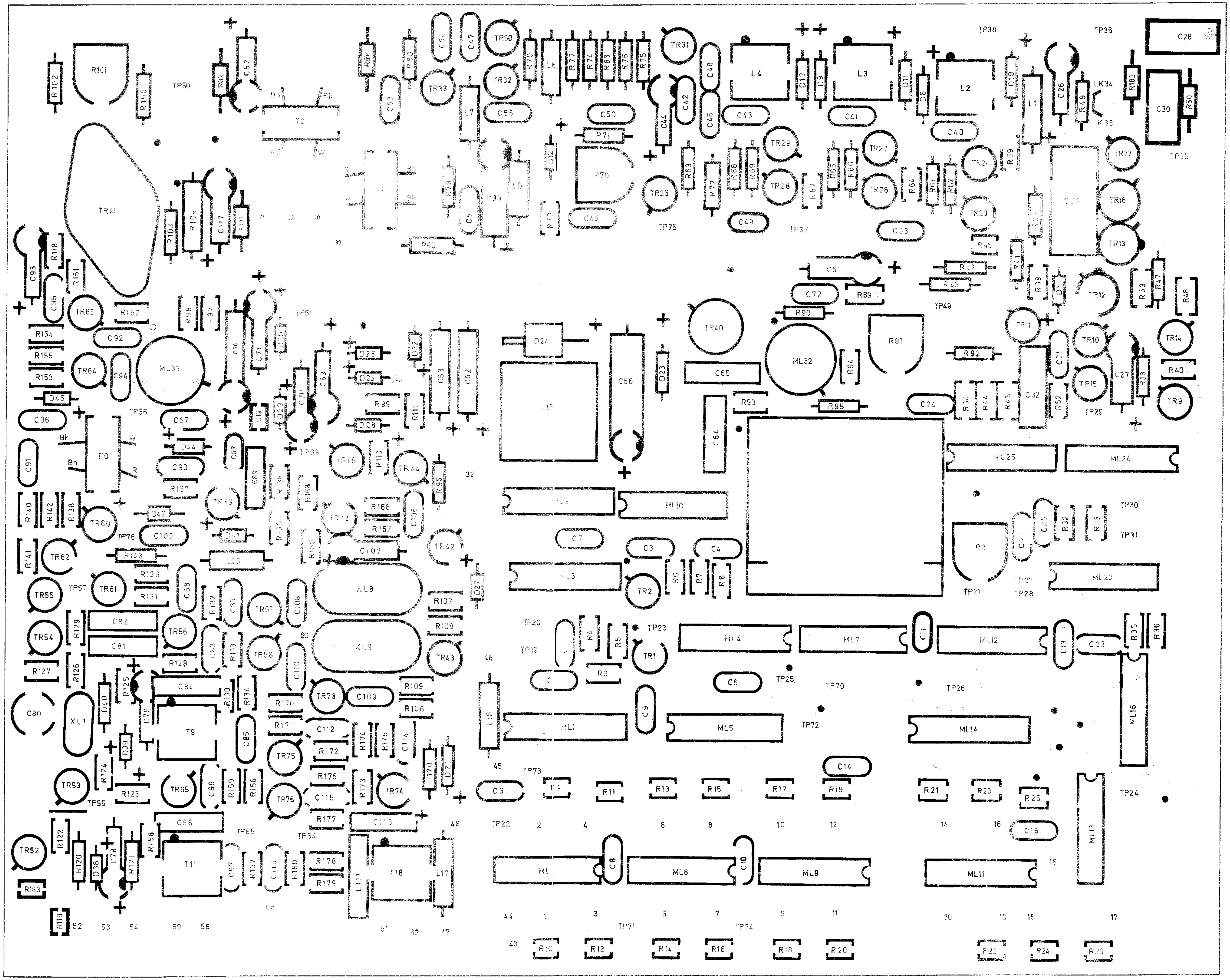
Fig. 2




WOH2099
Part 3

# Frequency Selector Switches MA.925

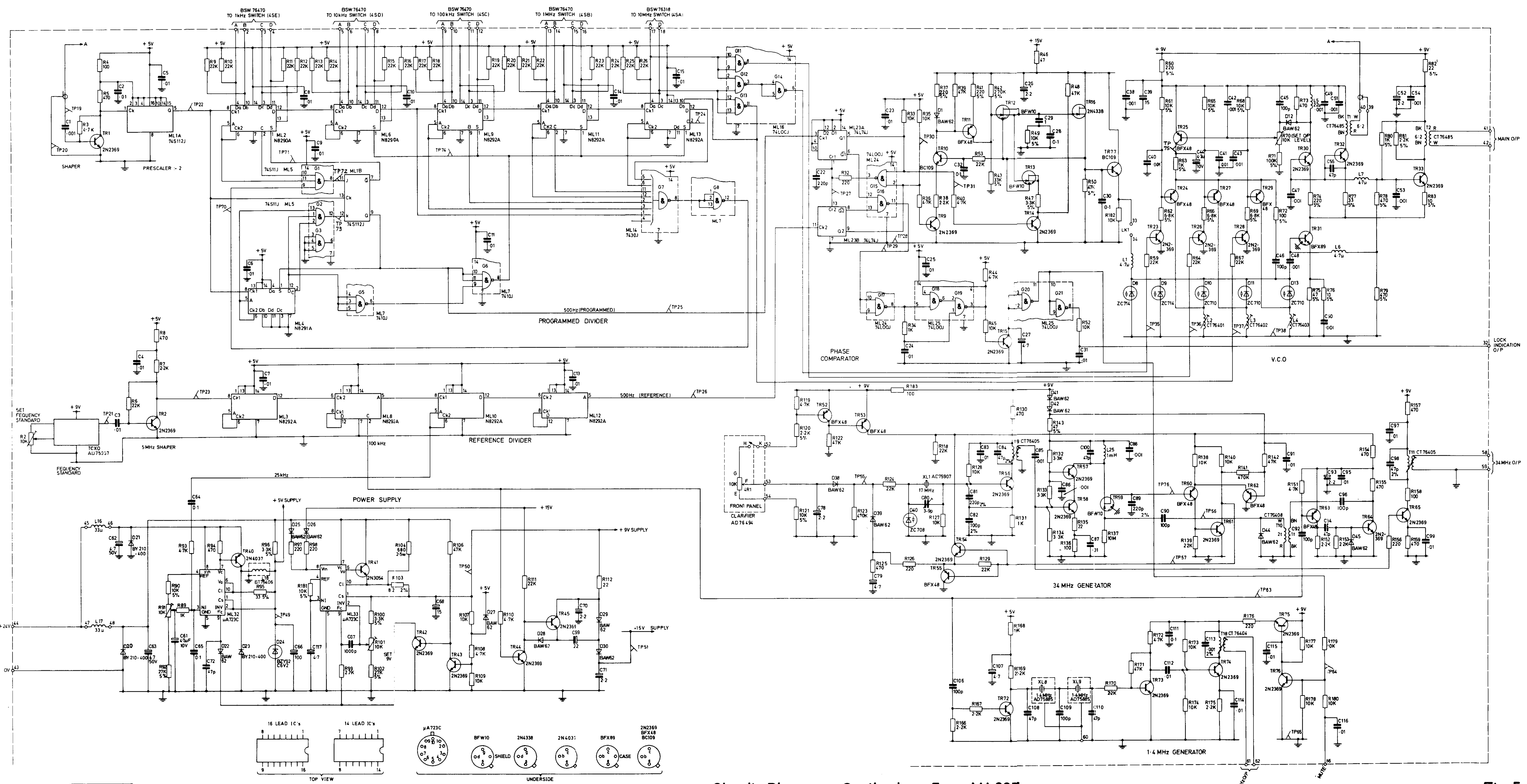
Fig. 3






Component Layout : MA.925

Fig. 4




# Circuit Diagram : Synthesizer Type MA.925

Fig.5

WOH 2099 Part 3

DC 76325

# PART 4

# PRE-PROGRAMMED FREQUENCY MEMORY BOARD

# CHAPTER 2

# PERFORMANCE TESTS

## GENERAL

1. The board should be wired into the transmitter/receiver unit with all connections made, and FS1 open circuit. The 3.6 volt battery should have been kept on float charge to within not more than twenty-four hours of carrying out the Test procedure detailed below.

## TONE ENCODER/DECODER

2. (1) Connect the power supply lead from the CA.531 Test Set to Audio 2 socket and the lead of MA.4008 to the AUDIO 1 socket. Turn the power switch to LOW and the Channels switch to CH1. On the CA.531 switch the AF output "ON", T/R switch to Receive.

(2) Connect link TP14 and TP15.

(3) Connect a frequency counter between microphone input and earth on CA.531.

(4) Momentarily link TP16 to TP14/TP15 to initiate the Tone generator.

(5) Check for 2249 ± 3 Hz on the frequency counter. If incorrect, adjust R88 to suit.

(6) Switch off, and remove the link between TP14 and TP15. Connect TP14 to TP15 with 22 μF (approximate value), positive to TP14.

(7) Switch on and momentarily link TP16 to TP14. Tone generator will now generate three tones in sequence with individual durations of approximately six seconds.

(8) Check that the frequency of first tone is between 2246 - 2252 Hz.

(9) Check that the frequency of second tone is between 975 - 1069 Hz.

(10) Check that the frequency of third tone is between 1464 - 1604 Hz.

(11) Remove 22 μF capacitor.

(12) Press button on MA.4008.

(13) Ensure its lamp lights up.

(14) Turn Channel switch to M(manual).

(15) Press button on MA.4008 and ensure its lamp does not light up.

POWER SUPPLY

3. (1) Check that 5V supply (Pin 51) from MA.925 is within normal limits.

(2) Check that the fully charged 3.6 volt battery, i.e. is charged for fourteen hours at 9 mA, is in temperature equilibrium with rest of set (i.e. not recently soldered etc.).

(3) Turn R58 (10k) fully clockwise (as viewed from component side of PCB).

(4) Put in fuse FS1.

(5) Connect DVM across TP8 and TP10 (positive to TP8) and adjust R58 until DVM reads 11 mV ± 1 mV.

(6) Wait one minute, readjust R58 if necessary.

(7) Disconnect fuse FS1.

(8) Disconnect DVM from TP8 and TP10, and reconnect it between TP11 and earth with a series limiting resistor of 68 ohms $\frac{1}{4}$ watt. Set DVM to 200 mA range, and check that reading is between 40 mA and 60 mA.

(9) Use a fast response meter or oscilloscope connected to TP3 to check IC16/IC17 are oscillating, at approximately 1 Hz, with channel 1 - 8 selected, but not M(manual) (Check that orange LED in meter flashes in unison).

(10) Select channel 1 and press button on MA.4008, and ensure its lamp illuminates.

Note: Instead of using the MA.4008 the channel may be programmed by momentarily linking TP13 to TP15. This method may be used as a "short cut" when required, except when testing the three tone circuit.

(11) Select any convenient channel 1 - 8 and check that orange LED in tuning meter is illuminated steadily, (Correct supply voltage indication).

(12) Remove FS1. Connect the DVM set to 200 µA range across FS1 holder. Switch off set and disconnect power supply and battery pack if fitted. Check that current does not exceed 5 µA with channel switch in each of its nine positions (i.e. including M(manual).

(13) Replace FS1.

(14) With supply off and battery pack disconnected, use DVM to check that voltage to Earth at pins 37, 38, 39, 40 and TP1 are same as VDD (pin 24 of each of the six RAM's), allowing for meter impedance. (This checks that RAM's are inhibited).

## RANDOM ACCESS MEMORY

4. (1) Replace Supply. Connect a frequency counter to VCO output on MA.925 (pins 41/42), and link TP13 to TP14.

(2) Select Channel 1 and set frequency selectors to 20.000 MHz, and ensure VCO frequency is correct (55.400 MHz). Increase kHz control 1 kHz at a time and check output frequencies correct. Repeat for 10 kHz, 100 kHz and 1 MHz controls, to 29.999 MHz, then change to 19.999 and 09.999 MHz.

(3) Select channel 2, disconnect link between TP13 and TP15, and reset frequency controls to 20.000 MHz. Ensure that VCO output frequency remains at 45.399 MHz. Relink TP13 and TP15 and ensure VCO frequency changes to 55.400 MHz.

(4) Repeat procedures (2) and (3) for each position of channel switch.

(5) Remove link between TP13 and TP15, select M(manual) position on channel switch, and repeat frequency check procedure as sub-para. (2).

(6) Select frequencies in accordance with Table 1 of Chapter 5 Part 1, and ensure that correct levels are given on pins 42, 43, 44, 45 and 46 of the Memory Board.

## CHANNEL CHANGE DETECTOR

5. Connect a lamp (240V 40 mA) to pins 47 and 50 of the Memory Board. Connect DVM to TP2. Change Channel Switch position from 1 to 2 and ensure that lamp illuminates momentarily.

## WIRING AND ALC

6. (1) Check that Earth connection to pin G of 7-way audio 1 socket inhibits High Power on Transmit.

(2) On 10-way socket check:-

(a) Pins A, C, F, G, H, J connect to pins 42, 43, 44, 45, 46, 47 respectively on programme board.

(b) 23 volts, pin B.

(c) 0 volts, pin D.

(d) Key from ATU, pin E.

(e) Transmitter 12V line, pin K. Check only present on transmit.

# CHAPTER 3

# FAULT LOCATION AND MAINTENANCE

## INTRODUCTION

1. The following procedure should allow a Memory Board fault to be easily diagnosed to a circuit stage, when conventional fault location methods can be used.

## FAULT LOCATION PROCEDURE

2. (1) Check all power supplies (including internal battery).

(2) Check M(manual) selection of frequency, using a frequency meter at the antenna connection, with a power meter connected, and the mode control in the TUNE position.

(3) Check pre-selected frequencies (eight channels).

(4) Check filter logic levels at 4015 connector (see Table 1 of Chapter 5 Part 1).

(5) Remove fuse FS1 from Memory Board and replace with microammeter. Check current drawn (with set switched off). Current should be less than 5 μA at 25°C, with internal battery fully charged.

(6) If the above procedure does not locate the fault, the detailed procedure given in Chapter 2 should be carried out.

## MAINTENANCE

3. The battery fitted to the memory board has a life of three to five years. The battery should, therefore, be replaced with a new battery at approximately three yearly periods (see also Chapter 1 para. 28).

# PRE-PROGRAMMED FREQUENCY MEMORY BOARD

## CONTENTS



## ILLUSTRATIONS

# PRE-PROGRAMMED FREQUENCY MEMORY BOARD

## CHAPTER 1

## GENERAL AND CIRCUIT DESCRIPTION

### INTRODUCTION

1. The Pre-Programmed Frequency Memory Board (known as the Memory Board) is a single printed-circuit board (p.c.b.) which is located above the Synthesizer Board (as shown in Part 2 Fig. 3). The Memory Board provides the following functions:

(1) Storage of eight pre-programmed frequencies.

(2) Provision for manual frequency selection.

(3) Frequency to band conversion circuits to allow selection of the appropriate band at an associated (MA.4015) 32 band filter unit (for dual HF set working).

(4) An automatic initiate tune circuit for an associated Automatic Antenna Matching and Tuning Unit (AAMTU) when used with an MA.4104A or MA.4015.

(5) Various circuitry associated with power supplies.

### INTERCONNECTIONS AND COMPONENT LOCATION

2. The interconnections between the memory board and the remainder of the unit are shown in Part 1 Fig. 2 . The component location diagram is shown in Fig. 1 of this part.

### CIRCUIT DESCRIPTION

#### Frequency Selection Storage

3. The pre-programmed frequency selection information is stored in the six random access memories (RAM's) IC1 to IC6. Each pair of RAM's (IC1/2, IC3/4, IC5/6) are interconnected to form an eight word eight bit RAM, i.e. each RAM pair can store eight separate 'words' of information, each 'word' consisting of eight logic ('0' or '1') bits.

4. Frequency selection at the synthesizer is achieved by eighteen BCD input lines (see Part 3 Chap. 2), i.e. two lines for the MHz x 10 selection circuit, and four lines for each of the MHz, kHz x 100 and kHz x 10 selection circuits. The synthesizer inputs are taken from pins 19 to 36 of the memory board.

5. Selection of a particular stored frequency (known as a channel) is achieved by setting the channel switch (connections shown in Part 1 Fig. 2) to a number 1 to 8. The channel switch is connected to pins 37 to 41 of the board (wiper of the switch to pin 41). The M(manual) position of the switch allows direct selection of a frequency using the frequency selection switches. A truth table for the switch inputs is given below.

NOTE: The '1' conditions in the truth table represent open circuit switch connections with the appropriate A, B, C or D lines 'pulled-up' to logic '1' (VDD) by resistors R19 to R22.

TRUTH TABLE - CHANNEL SWITCH LINES

| Channel Switch Selection | Inputs | | | |
|---|---|---|---|---|
| | A (pin 37) | B (pin 38) | C (pin 39) | D (pin 40) |
| 8 | 0 | 0 | 0 | 0 |
| 7 | 1 | 0 | 0 | 0 |
| 6 | 0 | 1 | 0 | 0 |
| 5 | 1 | 1 | 0 | 0 |
| 4 | 0 | 0 | 1 | 0 |
| 3 | 1 | 0 | 1 | 0 |
| 2 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 |
| M(manual) | 0 | 0 | 0 | 1 |

NOTE: The W output, pin 41, is at logic '0' (approximately 0V) during normal operation (see para. 30).

6. The A, B and C inputs provide the three address lines to the RAM's. The A and B lines select the appropriate eight bit word at each four word RAM, the C line selects one of each pair of RAM's. The D input (which is only at '1' when M(manual) is selected) activates the memory bypass facility. This allows inputs to the RAM's to be fed directly to the outputs, giving the frequency selection switch lines direct access to the synthesizer. The RAM memories are unaffected in this condition. The RAM outputs are connected to the board pins via non-inverting buffer/driver stages ML7, ML8 and ML9.

7. The stored frequency information can be changed by a '1' input at pin 1 of the RAM's. In this condition the new frequency information selected at the front panel switches is 'written' into the RAM's. Information is 'written' in word by word, i.e. one channel at a time. The frequency changing procedure utilizes an external plug-in unit, type MA.4008.

## Filter Band Selection Circuit

8. The associated MA.4015 Filter Unit selects one from thirty-two frequency bands, the selected band being dependent upon coded outputs from pins 42 to 46 of the memory board. The band frequencies and selection codes are shown in Table No.

### FILTER BAND SELECTION TABLE No. 1

| Band | Lower frequency | Upper frequency | Binary readout at Pin No. 42 | 43 | 44 | 45 | 46 |
|---|---|---|---|---|---|---|---|
| 1 | 1.6 MHz | 1.799 MHz | 0 | 0 | 0 | 0 | 0 |
| 2 | 1.8 | 1.999 | 0 | 0 | 0 | 0 | 1 |
| 3 | 2.0 | 2.199 | 0 | 0 | 0 | 1 | 0 |
| 4 | 2.2 | 2.399 | 0 | 0 | 0 | 1 | 1 |
| 5 | 2.4 | 2.599 | 0 | 0 | 1 | 0 | 0 |
| 6 | 2.6 | 2.799 | 0 | 0 | 1 | 0 | 1 |
| 7 | 2.8 | 3.099 | 0 | 0 | 1 | 1 | 0 |
| 8 | 3.1 | 3.399 | 0 | 0 | 1 | 1 | 1 |
| 9 | 3.4 | 3.699 | 0 | 1 | 0 | 0 | 0 |
| 10 | 3.7 | 3.999 | 0 | 1 | 0 | 0 | 1 |
| 11 | 4.0 | 4.399 | 0 | 1 | 0 | 1 | 0 |
| 12 | 4.4 | 4.799 | 0 | 1 | 0 | 1 | 1 |
| 13 | 4.8 | 5.199 | 0 | 1 | 1 | 0 | 0 |
| 14 | 5.2 | 5.699 | 0 | 1 | 1 | 0 | 1 |
| 15 | 5.7 | 6.199 | 0 | 1 | 1 | 1 | 0 |
| 16 | 6.2 | 6.799 | 0 | 1 | 1 | 1 | 1 |
| 17 | 6.8 | 7.499 | 1 | 0 | 0 | 0 | 0 |
| 18 | 7.5 | 8.199 | 1 | 0 | 0 | 0 | 1 |
| 19 | 8.2 | 8.999 | 1 | 0 | 0 | 1 | 0 |
| 20 | 9.0 | 9.799 | 1 | 0 | 0 | 1 | 1 |
| 21 | 9.8 | 10.699 | 1 | 0 | 1 | 0 | 0 |
| 22 | 10.7 | 12.699 | 1 | 0 | 1 | 0 | 1 |
| 23 | 12.7 | 14.999 | 1 | 0 | 1 | 1 | 0 |
| 24 | 15.0 | 17.699 | 1 | 0 | 1 | 1 | 1 |
| 25 | 17.7 | 19.499 | 1 | 1 | 0 | 0 | 0 |

FILTER BAND SELECTION TABLE No. 1 (cont'd.)

| Band | Lower frequency | Upper frequency | Binary readout at Pin No. | | | | |
|---|---|---|---|---|---|---|---|
| | | | 42 | 43 | 44 | 45 | 46 |
| 26 | 19.5 | 20.999 | 1 | 1 | 0 | 0 | 1 |
| 27 | 21.0 | 22.499 | 1 | 1 | 0 | 1 | 0 |
| 28 | 22.5 | 23.999 | 1 | 1 | 0 | 1 | 1 |
| 29 | 24.0 | 25.499 | 1 | 1 | 1 | 0 | 0 |
| 30 | 25.5 | 26.999 | 1 | 1 | 1 | 0 | 1 |
| 31 | 27.0 | 28.499 | 1 | 1 | 1 | 1 | 0 |
| 32 | 28.5 | 29.999 | 1 | 1 | 1 | 1 | 1 |

NOTE: '1' is open circuit output
'0' is 1 kΩ resistor to 0 volts

9. The coded outputs are derived from the kHz x 100, MHz, and MHz x 10 selection lines to the synthesizer (board pins 9 to 18) via the adder stages IC10, IC11, IC12 and IC14, the read only memory (ROM) IC15, and the buffer/inverters TR3 to TR7.

10. The adders IC10, IC11, IC12 and IC14 convert a particular synthesizer BCD input code to nine line binary which is used to address the ROM. The ROM is capable of storing 4096 bits of pre-coded information in the form of 512 words each of eight bits. Five output bits are used (ROM pins 9, 10, 11, 13 and 14), as addresses to the thirty-two filter bands. The coding of the ROM inputs is given in an appendix to this chapter.

11. The states of the frequency selection lines and ROM outputs for each frequency band is given in Table No. 2 . This table is read as follows:

(1) The Band and frequency columns correspond to Table No. 1

(2) The levels at the output to the synthesizer correspond to the frequency switch inputs (board pins 9 to 18) during M(manual) frequency selection, or to stored information during channel selection.

Pins 36 to 33 are 100 kHz outputs.
Pins 32 to 29 are 1 MHz outputs.
Pins 28 and 27 are 10 MHz outputs.

(3) The output to the Synthesizer is converted to binary and used to address the ROM (see appendix).

(4) The ROM outputs are inverted before being fed to the board outputs (see Table No. 1).

TABLE No. 2

| BAND | FREQ. | OUTPUT TO SYNTHESIZER (Pin No.) 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | ROM INPUTS (DECIMAL) | ROM OUTPUTS (IC15 Pin Nos.) 9 | 10 | 11 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.600 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 383 | 1 | 1 | 1 | 1 | 1 |
| | 1.799 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 382 | | | | | |
| 2 | 1.800 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 381 | 1 | 1 | 1 | 1 | 0 |
| | 1.999 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 380 | | | | | |
| 3 | 2.000 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 379 | 1 | 1 | 1 | 0 | 1 |
| | 2.199 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 378 | | | | | |
| 4 | 2.200 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 377 | 1 | 1 | 1 | 0 | 0 |
| | 2.399 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 376 | | | | | |
| 5 | 2.400 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 375 | 1 | 1 | 0 | 1 | 1 |
| | 2.599 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 374 | | | | | |
| 6 | 2.600 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 373 | 1 | 1 | 0 | 1 | 0 |
| | 2.799 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 372 | | | | | |
| 7 | 2.800 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 371 | 1 | 1 | 0 | 0 | 1 |
| | 3.099 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 369 | | | | | |
| 8 | 3.100 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 368 | 1 | 1 | 0 | 0 | 0 |
| | 3.399 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 366 | | | | | |
| 9 | 3.400 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 365 | 1 | 0 | 1 | 1 | 1 |
| | 3.699 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 363 | | | | | |
| 10 | 3.700 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 362 | 1 | 0 | 1 | 1 | 0 |
| | 3.999 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 360 | | | | | |
| 11 | 4.000 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 359 | 1 | 0 | 1 | 0 | 1 |
| | 4.399 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 356 | | | | | |
| 12 | 4.400 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 355 | 1 | 0 | 1 | 0 | 0 |
| | 4.799 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 352 | | | | | |
| 13 | 4.800 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 351 | 1 | 0 | 0 | 1 | 1 |
| | 5.199 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 348 | | | | | |
| 14 | 5.200 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 347 | 1 | 0 | 0 | 1 | 0 |
| | 5.699 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 343 | | | | | |
| 15 | 5.700 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 342 | 1 | 0 | 0 | 0 | 1 |
| | 6.199 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 338 | | | | | |

TABLE No. 2 (cont'd)

| BAND | FREQ. | OUTPUT TO SYNTHESIZER (Pin No.) | | | | | | | | | | ROM INPUTS (DECIMAL) | ROM OUTPUTS (IC15 Pin Nos.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | | 9 | 10 | 11 | 13 | 14 |
| 16 | 6.200 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 337 | 1 | 0 | 0 | 0 | 0 |
| | 6.799 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 332 | | | | | |
| 17 | 6.800 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 331 | 0 | 1 | 1 | 1 | 1 |
| | 7.499 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 325 | | | | | |
| 18 | 7.500 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 324 | 0 | 1 | 1 | 1 | 0 |
| | 8.199 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 318 | | | | | |
| 19 | 8.200 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 317 | 0 | 1 | 1 | 0 | 1 |
| | 8.999 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 310 | | | | | |
| 20 | 9.000 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 309 | 0 | 1 | 1 | 0 | 0 |
| | 9.799 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 302 | | | | | |
| 21 | 9.800 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 301 | 0 | 1 | 0 | 1 | 1 |
| | 10.699 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 293 | | | | | |
| 22 | 10.700 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 292 | 0 | 1 | 0 | 1 | 0 |
| | 12.699 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 273 | | | | | |
| 23 | 12.700 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 272 | 0 | 1 | 0 | 0 | 1 |
| | 14.999 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 250 | | | | | |
| 24 | 15.000 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 249 | 0 | 0 | 1 | 1 | 1 |
| | 17.699 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 223 | | | | | |
| 25 | 17.700 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 222 | 0 | 0 | 1 | 1 | 0 |
| | 19.499 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 190 | | | | | |
| 26 | 19.500 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 204 | 0 | 0 | 1 | 1 | 0 |
| | 20.999 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 190 | | | | | |
| 27 | 21.000 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 189 | 0 | 0 | 1 | 0 | 1 |
| | 22.499 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 175 | | | | | |
| 28 | 22.500 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 174 | 0 | 0 | 1 | 0 | 0 |
| | 23.999 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 160 | | | | | |
| 29 | 24.000 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 159 | 0 | 0 | 0 | 1 | 1 |
| | 25.499 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 145 | 0 | 0 | 0 | 1 | 1 |

TABLE No. 2 (cont'd)

| BAND | FREQ. | OUTPUT TO SYNTHESIZER(Pin No.) | | | | | | | | | | ROM INPUTS (DECIMAL) | ROM OUTPUTS (IC15 Pin Nos.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | | 9 | 10 | 11 | 13 | 14 |
| 30 | 25.000<br>26.999 | 0<br>0 | 1<br>1 | 0<br>0 | 1<br>0 | 0<br>1 | 0<br>1 | 0<br>0 | 1<br>0 | 0<br>0 | 0<br>0 | 144<br>130 | 0 | 0 | 0 | 1 | 0 |
| 31 | 27.000<br>28.499 | 0<br>0 | 1<br>1 | 0<br>0 | 0<br>0 | 1<br>0 | 0<br>1 | 1<br>0 | 0<br>1 | 0<br>0 | 1<br>1 | 129<br>115 | 0 | 0 | 0 | 0 | 1 |
| 32 | 28.500<br>29.999 | 0<br>0 | 1<br>1 | 0<br>0 | 0<br>0 | 0<br>0 | 1<br>0 | 0<br>0 | 1<br>0 | 0<br>0 | 0<br>0 | 114<br>100 | 0 | 0 | 0 | 0 | 0 |

## Re-Programming Circuit

12. As given in para. 7, the RAM's are re-programmed by an input from the re-programming circuit.

13. A plug-in unit (MA.4008) is connected to either audio socket, and, when energised by a push-button, applies a 'one-shot' series of three tones to pin A of an Audio socket, which is fed to pin 16 of IC18. Integrated circuit IC18 accepts the three tones f1, f2 and f3 and interrogates them for (a) correct frequency (f1 = 2249 Hz, f2 = 1022 Hz, f3 = 1534 Hz and (b) correct duration of tone (each 35 ms). If the inputs are correct IC18 pin 3 (Rx O/P) changes to a '1' level, which is fed to the 'write' inputs of the RAM's (para. 7 ) causing the selected frequency to be entered.

14. After a time delay (of about 100 ms) set by R77 and C4, the Tx ENABLE output (pin 13) changes to '1'. This causes IC18 to emit a series of three tones which are sent (again via an Audio socket pin A) to the MA.4008 unit, to signify completion of programming. After a further short time delay (R78 and C5) the RESET input (pin 4) changes to a '1' level, resetting IC18 ready to accept the next tone sequence (i.e. pin 3 reset to '0'). Although IC18 is permanently connected to the microphone circuit, normal audio input will not cause the memory to be re-programmed.

15. The resistors R82, R83 and R84 determine the tone frequencies (in the order given, i.e. R82 = first tone) for both received and transmitted (reply) tones (identical tones used are for both sequences). Resistor R88 (with R85 to R87) determines the detection bandwidths of the received tones in conjunction with C8 and C9. The time allowed for interrogation of received tones is set by C7 and R81; C6 and R80 define the gate time for sending tones.

## Channel/M(manual) Detector and Channel LED Driver

16. As given in para. 5 the channel switch D output (board pin 40) is at '1' when the M(manual) position is selected. TR10 is turned 'on' in this mode, causing the 'write' input to the RAM to be forced 'low' (via D8) and preventing the tone decoder IC18 from replying to a programme command (via D9).

17. When one of the eight channels is selected TR10 is 'off' thus, when a programme command (three correct tones) is received the RAM write input is allowed to go 'high' (entering the new data into the selected location) and the inhibit on the transmitted tones from IC18 is removed.

18. In the channel mode D6 and R43 hold pin 3 of IC16 'low' (1.5 volts approx.) pin 2 of IC16 will be at approximately half the output voltage from pin 3 of IC17 which, if the circuit is not oscillating (see para.27), will be at approximately 4.4 volts. Thus the output from pin 1 of IC16 will be 'low' and TR11 will cause the channel LED in the meter to be illuminated. If IC17 and IC16 are oscillating then the voltage at pin 3 of IC17 will vary between 0 volt and 4.4 volts which will cause the voltage at IC16 pin 2 to alternately be above and below the voltage on IC16 pin 3. This will cause the channel LED to flash.

19. In the M(manual) frequency mode the D output from the channel switch will be high allowing pin 3 of IC16 to go to the Vcc level (5 volts approx.). The voltage on pin 2 will be less than 2.2 volts so the output at pin 1 will be 'high' (10 volts approx.) and TR11 will be 'off' preventing the LED from being illuminated.

## Change of Channel Detector

20. Each time a new channel is selected a 'low' output signal occurs at pin G Skt 1 and pin J at the MA.4015 Skt. This signal is used by the MA.4104A AAMTU CONTROL unit and the MA.4015 Filter unit to initiate the tuning sequence in the AAMTU. This makes it unnecessary for the operator to manually initiate the tune cycle when working in the pre-programmed frequency mode.

21. Each time the channel switch is operated the A data line must change either from '0' to '1' or from '1' to '0' as given in the table in para. 5 ). The integrated circuit IC13 consists of two monostables, each has an output pulse duration set to approximately ¾ second by R26, C1 and R27, C2 and their inputs are connected so that one will be triggered by a '1' to '0' transition and the other by a '0' to '1' transition of the input signal. Thus for every change of channel one or the other of the monostables will be triggered. Both monostables are re-triggered, i.e. if an input transition arrives before the output resets, the output pulse timing begins again from the last trigger transition. Therefore if the operator is changing from channel 1 to channel 8 only one continuous output pulse will be generated provided that the switch is rotated faster than one channel every ¾ second.

22. The output pulses from both monostables are 'or gated' together by D4 and D5 and TR2. TR8 is used to provide a high current earth signal on board pin 47.

## Power Supplies

23. The memory board uses four power supplies:

(i) A 5 volt line (Vcc) is supplied from the 5 volt switching regulator on the MA.925 synthesizer. Vcc is used for all the logic integrated circuits not supplied by Vdd. (sub-para. iv).

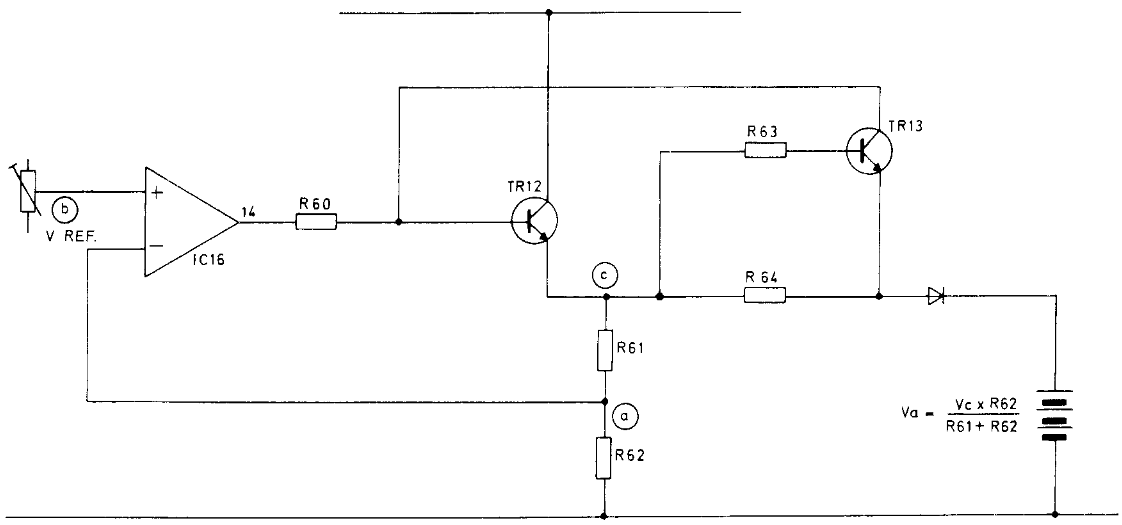
(ii) A 12 volt line, supplied from the MA.930 regulator, is used for the tone decoder IC18, the battery charging integrated circuit IC16 and the channel manual detector TR10.

(iii) A 24 volt line which is supplied from the power input to the transceiver without going through the POWER switch. This is used in the battery charging circuit enabling the battery to be charged even with the POWER switch in the OFF position.

(iv) A Vdd line which is derived either from the Vcc line (5 volts) via D17 or from the battery B1 (3.7 volts) via D18. Thus this line is powered even with the transceiver disconnected from any power source, providing that the battery B1 is not discharged. It is used to maintain the frequency information stored in the RAM's IC1 to IC6, and to hold the information stored in the Under Voltage latch IC17 (as described in para. 27). The battery B1 is a three cell nicad with a terminal voltage of approximately 3.7 volts, thus when the Vcc supply is present, Vdd is at 4.4 volts (i.e. 5V minus the volts drop across a diode). Diode D18 is reversed biassed effectively isolating the battery from the Vdd line.

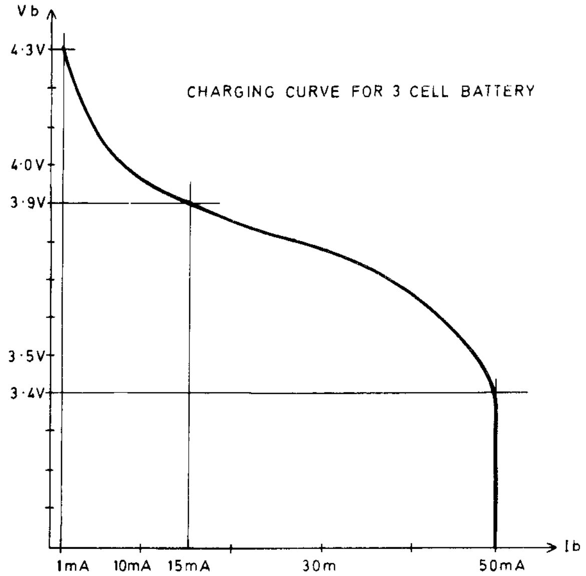
## Battery Charging Circuit

24. The integrated circuit IC16 compares the voltage at point 'c' with the reference voltage at point 'a', the difference is amplified and fed to TR12 in such a way that the differential voltage between 'a' and 'c' is minimised. Therefore, providing V ref. is constant, the voltage at point 'b' is constant. Adjustment to the voltage at 'b' is made by varying the setting of R58.




Battery Charging : Simplified Circuit — Fig 1.1

This is adjusted when the battery is fully charged to give a 0.9 mA charge current. At this setting the circuit is designed to provide a rapid charge when the battery voltage is low and a low trickle charge as the battery voltage approaches its maximum, preventing overcharging.




Battery Charging Graph Fig. 1.2

25. To prevent damage to the battery and TR12 when the battery is completely discharged, current limiting is provided. TR13 senses the voltage across resistor R64. When this becomes sufficient to 'turn on' TR13 drive current is shunted away from TR12 preventing the voltage across R64 increasing. The 12Ω resistor R64 gives a current limit value of approximately 50 mA.

Low Battery Voltage Detector

26. TR14 is used to disable the low battery voltage detector formed by IC16 pins 9, 10 and 11 until the output voltage from IC16 pin 14 is approximately 4.3 volts. This is to prevent the measurement being made before diode D16 is conducting, as, if this happened, the sensing resistors R65 and R66 would sense a voltage anywhere between 0 volts and the actual battery voltage, which could give a false loss of memory warning. However when D16 is conducting the voltage on R65 will be the battery plus the voltage across D16.

27. When TR14 is conducting R65 and R66 divide the battery voltage plus D16 forward voltage to a level such that when the battery voltage falls to below 3 volts (the minimum voltage at which information stored in the RAM's remains unaffected) pin 9 of IC16 is below the voltage on pin 10 (the reference voltage). When this happens IC16 pin 8 goes 'high' setting the latch formed by the cross coupled gates IC17 with pin 10 'low'.
If pin 8 of IC16 subsequently goes 'low' (i.e. the battery becomes charged) the latch will not change state. In this condition with the channel switch in one of the 8 channel positions IC16 pins 1, 2 and 3 and IC17 form a low frequency oscillator with a period determined by R47, R50 and C16. This will cause the channel LED in the meter to flash, indicating that

the battery has become discharged and that there is a possible loss of frequencies stored in the RAM's.

28. The under voltage latch can only be reset by re-programming the memory via the tone decoder IC18. The programme line goes 'high' taking pin 12 of IC17 'high' and resetting pin 10 of IC17 to '1'. This prevents the gates oscillating and enables the channel LED to operate normally.

Power Off Detector

29. Transistor TR9 is 'turned off' when Vcc is absent (i.e. the transceiver switched off) and this is used to disable the output from the RAM's IC1 to IC6 and the output from IC17 pin 3. This prevents the outputs from trying to drive circuits which have no power connected to them, reducing the power drawn from the battery.

30. The RAM's are disabled by taking CI (chip inhibit) and RI (read inhibit) pins on each RAM 'high', accomplished by allowing the wiper of the channel switch to 'float'. Resistor R21 therefore 'pulls' the CI and RI inputs 'high', allowing the emitter of TR1 to 'float' and R24 to 'pull' the R12 and C12 inputs 'high'.

Channel Frequency Storage Time

31. The time that the transceiver may be left disconnected from a power source before the memory information becomes corrupted is determined by two factors - the internal temperature at the transceiver and the charge state of the battery.

32. To fully charge the internal battery the set should be connected to a power source for approximately four days, this will give a memory data retention of approximately twelve days at 55°C and approximately 150 days at 20°C.

33. If however the set is connected to power for fifteen minutes only then the corresponding memory data retention, assuming that initially the battery is fully discharged, would be approximately eight hours at 55°C and three days at 20°C.

Battery Replacement

34. Whenever the TRA.931P is serviced the battery should be inspected for corrosion or other deterioration and should be replaced if necessary. (see also Chapter 3 para. 3).

# CHAPTER 1

# APPENDIX 1

# ROM PROGRAMMING

## INTRODUCTION

1. This Appendix describes how the inputs to the ROM IC15 are derived, and may be of use during fault location.

## DERIVATION OF ROM INPUTS

2. Convert the selected frequency to its decimal count viz:

| MHz x 10 | | MHz and kHz x 100 | |
|---|---|---|---|
| Switch Setting | Decimal Count | Switch Setting | Decimal Count |
| 0 | 3 | 0 | 9 |
| 1 | 2 | 1 | 8 |
| 2 | 1 | 2 | 7 |
| | | 3 | 6 |
| | | 4 | 5 |
| | | 5 | 4 |
| | | 6 | 3 |
| | | 7 | 2 |
| | | 8 | 1 |
| | | 9 | 0 |

3. Write conversion as (10 MHz) (MHz) (kHz x 100).

4. Convert numbers to binary code. These are the ROM address lines.

EXAMPLE 25.729 MHz selected.

(1) 25.7 MHz is converted to 142 (the last two digits are ignored).

(2) 142 is converted to binary (see later) = 010001110.
These are the ROM inputs applied as follows:

| ROM PIN NO. | 23 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| INPUT | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |

Most significant bit (MSB)

## BINARY CONVERSION

One method of binary conversion is to repeatedly divide by two. The 'carry' output then becomes the binary number.

| Example: | No. (- 2) 142 | 71 | 35 | 17 | 8 | 4 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Carry | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |

MSB

# CHAPTER 4

## LIST OF COMPONENTS

| Cct. Ref. | Value Ω | Description | Rat W | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| **Resistors** | | | | | |
| R1 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R2 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R3 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R4 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R5 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R6 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R7 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R8 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R9 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R10 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R11 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R12 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R13 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R14 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R15 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R16 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R17 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R18 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R19 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R20 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R21 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R22 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R23 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R24 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R25 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R26 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R27 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R28 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R29 | 1k | Carbon film | $\frac{1}{4}$ | 5 | 924227 |
| R30 | 2.2k | Carbon film | $\frac{1}{4}$ | 5 | 924230 |

| Cct. Ref. | Value Ω | Description | Rat W | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| R31 | 6.8k | Carbon film | $\frac{1}{4}$ | 5 | 924225 |
| R32 | 1k | Carbon film | $\frac{1}{4}$ | 5 | 924227 |
| R33 | 6.8k | Carbon film | $\frac{1}{4}$ | 5 | 924225 |
| R34 | 1k | Carbon film | $\frac{1}{4}$ | 5 | 924227 |
| R35 | 6.8k | Carbon film | $\frac{1}{4}$ | 5 | 924225 |
| R36 | 1k | Carbon film | $\frac{1}{4}$ | 5 | 924227 |
| R37 | 6.8k | Carbon film | $\frac{1}{4}$ | 5 | 924225 |
| R38 | 1k | Carbon film | $\frac{1}{4}$ | 5 | 924227 |
| R39 | 6.8k | Carbon film | $\frac{1}{4}$ | 5 | 924225 |
| R40 | 1k | Carbon film | $\frac{1}{4}$ | 5 | 924227 |
| R41 | 33 | Carbon film | $\frac{1}{4}$ | 5 | 926465 |
| R42 | 10k | Carbon film | $\frac{1}{4}$ | 5 | 924224 |
| R43 | 2.7k | Carbon film | $\frac{1}{4}$ | 5 | 925129 |
| R44 | 10k | Carbon film | $\frac{1}{4}$ | 5 | 924224 |
| R45 | 470 | Carbon film | $\frac{1}{4}$ | 5 | 924236 |
| R46 | 10k | Carbon film | $\frac{1}{4}$ | 5 | 924224 |
| R47 | 1M | Carbon | $\frac{1}{4}$ | 5 | 925394 |
| R48 | 22k | Carbon film | $\frac{1}{4}$ | 5 | 924228 |
| R49 | 22k | Carbon film | $\frac{1}{4}$ | 5 | 924228 |
| R50 | 470k | Carbon film | $\frac{1}{4}$ | 5 | 924335 |
| R51 | 5.6k | Carbon film | $\frac{1}{4}$ | 5 | 925849 |
| R52 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R53 | 22k | Carbon film | $\frac{1}{4}$ | 5 | 924228 |
| R54 | 1k | Carbon film | $\frac{1}{4}$ | 5 | 924227 |
| R55 | 470k | Carbon film | $\frac{1}{4}$ | 5 | 924335 |
| R56 | 470 | Carbon film | $\frac{1}{4}$ | 5 | 924236 |
| R57 | 8.2k | Carbon film | $\frac{1}{4}$ | 5 | 924330 |
| R58 | 10k | Variable | | | 920312 |
| R59 | 3.3k | Carbon film | $\frac{1}{4}$ | 5 | 924329 |
| R60 | 470 | Carbon film | $\frac{1}{4}$ | 5 | 924236 |
| R61 | 39k | Metal oxide | | 2 | 900993 |
| R62 | 6.8k | Metal oxide | | 2 | 910112 |
| R63 | 220 | Carbon film | $\frac{1}{4}$ | 5 | 924996 |
| R64 | 12 | Carbon film | $\frac{1}{4}$ | 5 | 926894 |
| R65 | 15k | Carbon film | $\frac{1}{4}$ | 5 | 920645 |

| Cct. Ref. | Value Ω | Description | Rat W | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| R66 | 3.3k | Metal oxide | | 2 | 910111 |
| R67 | 4.7k | Carbon film | $\frac{1}{4}$ | 5 | 924226 |
| R68 | 820 | Carbon film | $\frac{1}{4}$ | 5 | 926895 |
| R69 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R70 | 10k | Carbon film | $\frac{1}{4}$ | 5 | 924224 |
| R71 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R72 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R73 | 10k | Carbon film | $\frac{1}{4}$ | 5 | 924224 |
| R74 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R75 | 10k | Carbon film | $\frac{1}{4}$ | 5 | 924224 |
| R76 | 22k | Carbon film | $\frac{1}{4}$ | 5 | 924228 |
| R77 | 22k | Carbon film | $\frac{1}{4}$ | 5 | 924228 |
| R78 | 22k | Carbon film | $\frac{1}{4}$ | 5 | 924228 |
| R79 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R80 | 560k | Metal oxide | | 2 | 920831 |
| R81 | 330k | Metal oxide | | 2 | 920828 |
| R82 | 150k | Metal oxide | | 2 | 917954 |
| R83 | 330k | Metal oxide | | 2 | 920828 |
| R84 | 220k | Metal oxide | | 2 | 921771 |
| R85 | 10k | Metal oxide | | 2 | 914042 |
| R86 | 560 | Metal oxide | | 2 | 917061 |
| R87 | 8.2k | Metal oxide | | 2 | 918202 |
| R88 | 4.7k | Variable | | | 920311 |
| R89 | 10k | Carbon film | $\frac{1}{4}$ | 5 | 924224 |
| R90 | 47k | Carbon film | $\frac{1}{4}$ | 5 | 924333 |
| R91 | 100k | Carbon film | $\frac{1}{4}$ | 5 | 924234 |
| R92 | 560 | Carbon film | $\frac{1}{4}$ | 5 | 925901 |
| R93 | 560 | Carbon film | $\frac{1}{4}$ | 5 | 925901 |
| R94 | 560 | Carbon film | $\frac{1}{4}$ | 5 | 925901 |
| R95 | 560 | Carbon film | $\frac{1}{4}$ | 5 | 925901 |

Capacitors

| | F | | V | | |
|---|---|---|---|---|---|
| C1 | 22µ | Tantalum | 16 | 20 | 919638 |
| C2 | 22µ | Tantalum | 16 | 20 | 919638 |
| C3 | 4.7µ | Tantalum | 16 | 20 | 919636 |

| Cct. Ref. | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| | F | | V | | |
| C4 | 4.7μ | Tantalum | 16 | 20 | 919636 |
| C5 | 470n | Tantalum | 35 | +50 -20 | 921165 |
| C6 | 100n | Polyester | 100 | 10 | 920566 |
| C7 | 470n | Tantalum | 35 | +50 -20 | 921165 |
| C8 | 2.2n | Silver mica | 350 | 2 | 927107 |
| C9 | 2.2n | Silver mica | 350 | 2 | 927107 |
| C10 | 10n | Disc | 250 | +40 -20 | 916187 |
| C11 | 4.7μ | Tantalum | 16 | 20 | 919636 |
| C12 | 10n | Disc | 250 | +40 -20 | 916187 |
| C13 | 10μ | Tantalum | 25 | 20 | 923646 |
| C14 | 10n | Disc | 250 | +40 -20 | 916187 |
| C15 | 10n | Disc | 250 | +40 -20 | 916187 |
| C16 | 470n | Fixed | 60 | 20 | 916167 |
| C17 | 10n | Disc | 250 | +40 -20 | 916187 |
| C18 | 10n | Disc | 250 | +40 -20 | 916187 |
| C19 | 10n | Disc | 250 | +40 -20 | 916187 |
| C20 | 10n | Disc | 250 | +40 -20 | 916187 |
| C21 | 10n | Disc | 250 | +40 -20 | 916187 |
| C22 | 10n | Disc | 250 | +40 -20 | 916187 |
| C23 | 10n | Disc | 250 | +40 -20 | 916187 |
| C24 | 10n | Disc | 250 | +40 -20 | 916187 |
| C25 | 10n | Disc | 250 | +40 -20 | 916187 |
| C26 | 10n | Disc | 250 | +40 -20 | 916187 |
| C27 | 10n | Disc | 250 | +40 -20 | 916187 |
| C28 | 4.7μ | Tantalum | 16 | 20 | 919636 |
| FT1 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT2 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT3 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT4 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT5 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT6 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT7 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT8 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT9 | 1000p | Feedthrough | | +80 -20 | 907011 |

| Cct. Ref. | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| FT10 | 1000p | Feedthrough | | +80 -20 | 907011 |
| FT11 | 1000p | Feedthrough | | +80 -20 | 907011 |

Diodes

| | | | | | |
|---|---|---|---|---|---|
| D1 | | 1N 4149 | | | 914898 |
| D2 | | 1N 4149 | | | 914898 |
| D3 | | 1N 4149 | | | 914898 |
| D4 | | 1N 4149 | | | 914898 |
| D5 | | 1N 4149 | | | 914898 |
| D6 | | 1N 4149 | | | 914898 |
| D7 | | 1N 4149 | | | 914898 |
| D8 | | 1N 4149 | | | 914898 |
| D9 | | 1N 4149 | | | 914898 |
| D10 | | 1N 4149 | | | 914898 |
| D11 | | 1N 4149 | | | 914898 |
| D12 | | ZF3.3P | | | 924299 |
| D13 | | 1N 4149 | | | 914898 |
| D14 | | BZX79C9V1 | | | 921751 |
| D15 | | ZF3.3P | | | 924299 |
| D16 | | 1N 4149 | | | 914898 |
| D17 | | 1N 4149 | | | 914898 |
| D18 | | 1N 4149 | | | 914898 |

Transistors

| | | | | | |
|---|---|---|---|---|---|
| TR1 | | ZTX237 | | | 923171 |
| TR2 | | ZTX237 | | | 923171 |
| TR3 | | ZTX237 | | | 923171 |
| TR4 | | ZTX237 | | | 923171 |
| TR5 | | ZTX237 | | | 923171 |
| TR6 | | ZTX237 | | | 923171 |
| TR7 | | ZTX237 | | | 923171 |
| TR8 | | BFR41 | | | 926952 |
| TR9 | | ZTX237 | | | 923171 |
| TR10 | | ZTX237 | | | 923171 |
| TR11 | | ZTX212 | | | 923172 |

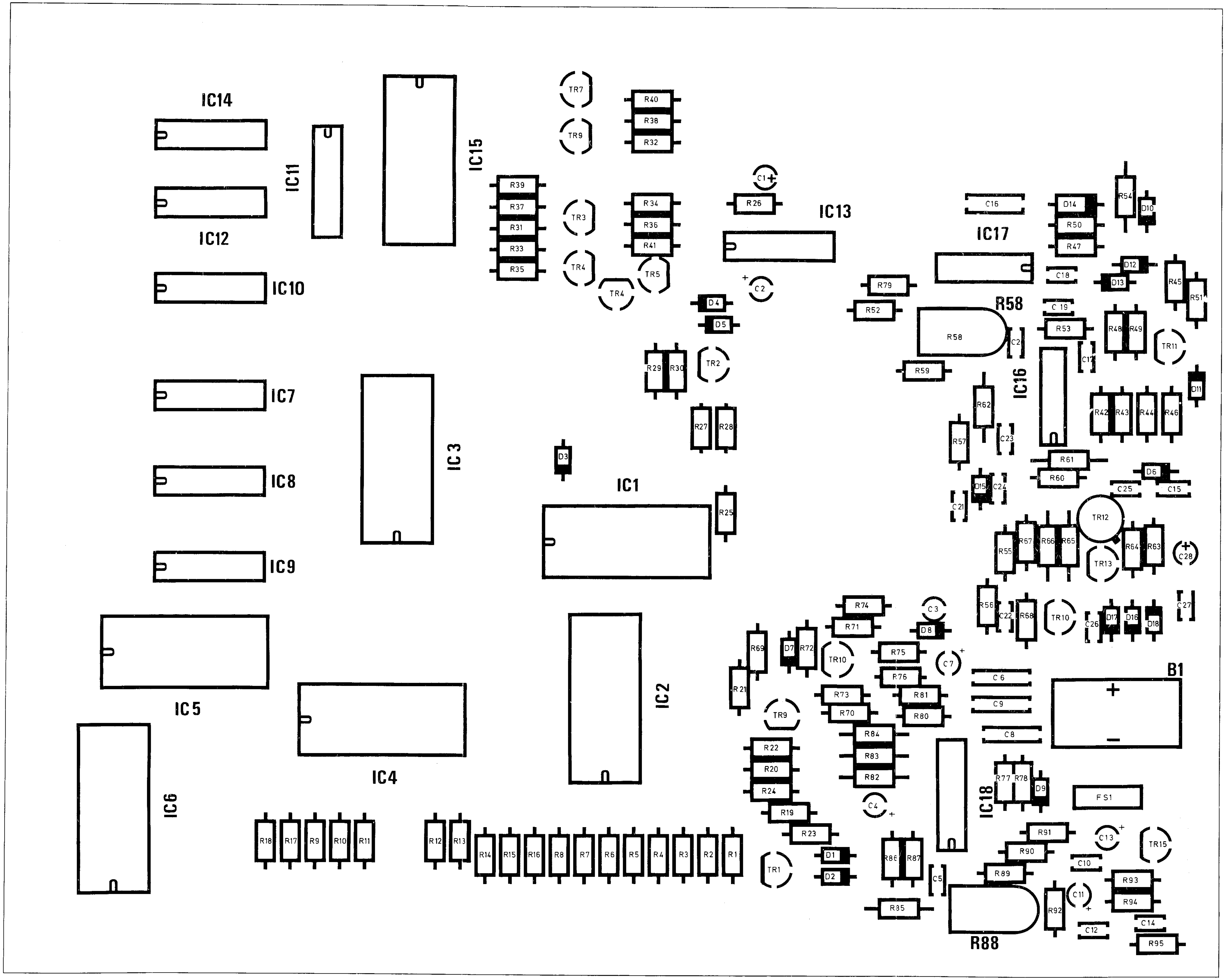
| Cct. Ref. | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| TR12 | | BFY 51 | | | 908753 |
| TR13 | | ZTX237 | | | 923171 |
| TR14 | | ZTX237 | | | 923171 |
| TR15 | | ZTX237 | | | 923171 |

Integrated Circuits

| Cct. Ref. | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| 1C1 | | CD4036AE RAM | | | 926898 |
| 1C2 | | CD4036AE RAM | | | 926898 |
| 1C3 | | CD4036AE RAM | | | 926898 |
| 1C4 | | CD4036AE RAM | | | 926898 |
| 1C5 | | CD4036AE RAM | | | 926898 |
| 1C6 | | CD4036AE RAM | | | 926898 |
| 1C7 | | CD4050AE Hex buffer/converter | | | 923935 |
| 1C8 | | CD4050AE Hex buffer/converter | | | 923935 |
| 1C9 | | CD4050AE Hex buffer/converter | | | 923935 |
| 1C10 | | CD4008AE Four bit adder | | | 926975 |
| 1C11 | | MC14008AL Four bit full adder | | | 926899 |
| 1C12 | | CD4008AE Four bit adder | | | 926975 |
| 1C13 | | MC14528CD Dual monostable | | | 926900 |
| 1C14 | | MC14008AL Four bit full adder | | | 926899 |
| 1C15 | | 93448 ROM | | | 926901 |
| 1C16 | | LM324 Quad OP Amp. | | | 925944 |
| 1C17 | | CD4001AE Two input nor gate | | | 922992 |
| 1C18 | | FX107 Three tone transceiver | | | 925872 |

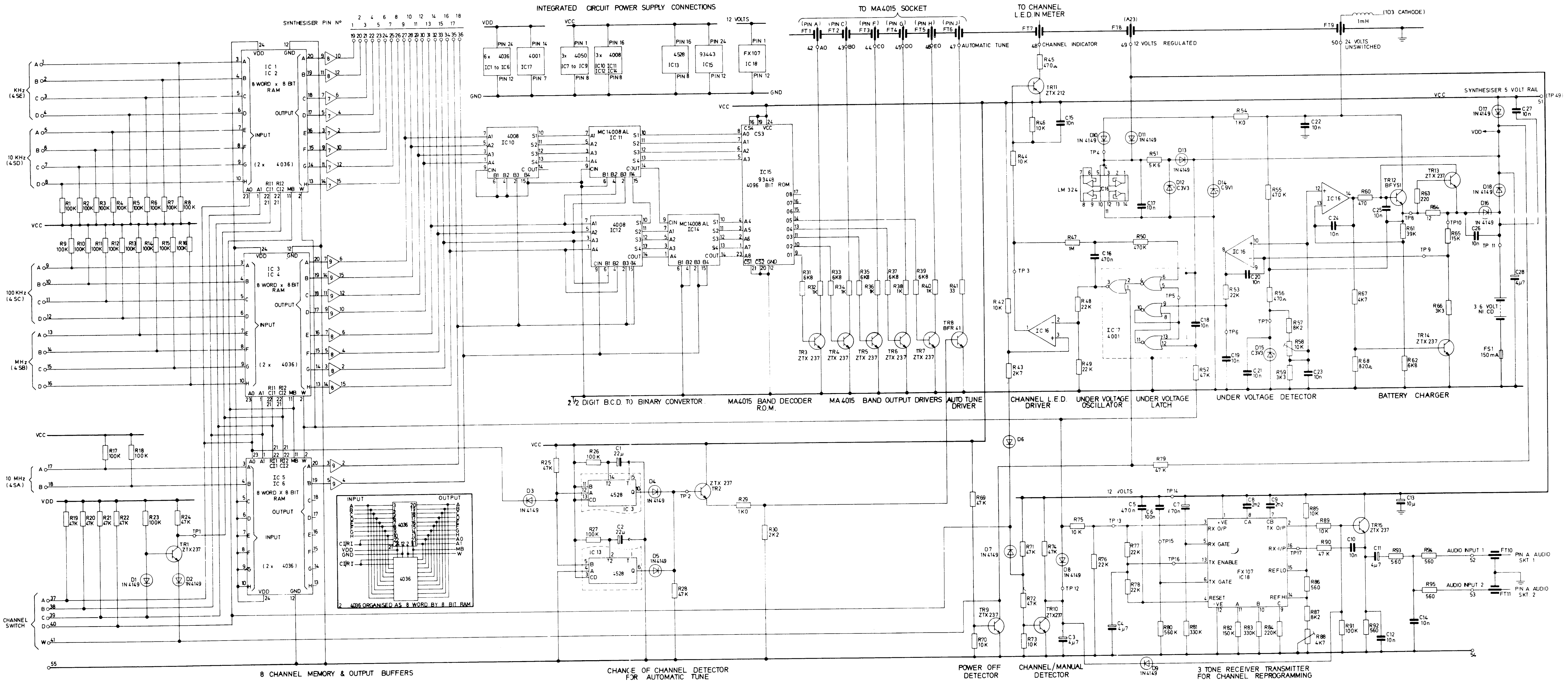
Miscellaneous

| Cct. Ref. | Value | Description | Rat | Tol % | Racal Part Number |
|---|---|---|---|---|---|
| FS1 | | Fuse 150 mA | | | 914055 |
| | | Fuseholder | | | 908352 |
| B1 | | Battery, ni-cad 3.6V | | | 925911 |
| 55F1 | | CHANNEL SWITCH | | | 711416 |




WOH 6160 ED713153 SHT. 4
1 2 3

TRA 931 P Memory Board : Layout Fig. 1




**Pre-Programmed Frequency Memory Board** Fig. 2

WOH 6160