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Colin Hinson
In the village of Blunham, Bedfordshire.

DECCA MESSENGER®

DTR 2002M

100 WATT SSB

HF TRANSCEIVER

INSTALLATION AND MAINTENANCE MANUAL

ISSUE 1

DECCA MESSENGER ®
DTR 2002M

100 WATT SSB

HF TRANSCEIVER

INSTALLATION AND MAINTENANCE MANUAL

ISSUE 1

DECCA COMMUNICATIONS LTD.,
CRAMPTONS ROAD,
SEVENOAKS,
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WARNING — SEMICONDUCTOR HAZARDS
TOXIC EFFECTS OF BERYLLIUM OXIDE (BERYLLIA)

Electronic components containing Beryllium Oxide are a serious hazard to health unless very carefully handled. The components are:—

Power Transistors, particularly types MRF406, MRF454 and equivalents. Power Diodes, Thyristors.
Ceramic material, identified by blue colouration or black lines.
Heat Sink Washers, identified in the finished state by a high polish and dark brass appearance.

Handling Precautions

The components should not be carried loose, which can cause breakages and dust, or broken open for inspection or manipulation. Normal soldering is safe, but excessive heat must be avoided.

Heat sink washers must not be carried loose, abraded by tooling, or heated other than when clamped in a heat sink application. Handle with gloves, cloth or tweezers when removing from equipment.

Cathode Ray Tubes of some makes are coated on the inside with a ceramic Beryllium Oxide mixture. If the glass is broken do not touch with bare fingers or disturb the dust by blowing.

Health Hazards

Beryllium Oxide is highly dangerous in a dust form: if inhaled, poisoning, indicated by respiratory troubles or Cyanosis (grey-blue discolouration of the skin) may develop within a week, or after a latent period, extending to several years. Particles penetrating the skin through wounds or abrasions are liable to cause chronic ulcerations.

Disposal Instructions

In view of the health hazard, scrap components must not be thrown out with industrial or domestic waste. Advice should be sought from the local Authority.

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.

AMENDMENT

Handbook No. & Issue... A4/15000/HB Iss.3
Handbook Title... DTR 2002
Amendment Sheet No.... 1
Date of Issue... 1.11.79

Page/Drg. reference		Details of Amendment(s)
10-3	C77	Add Code No.1462873
10-10	D70	Add Code No.1974211
10-14	1C7	Add Alternatives — Code Nos. CA741G — 1974041 MC1741U — 1974068 LM741J — 1967401 UA741MJ — 1974076
10-14	1C8	Add Code No.1974165
10-14	1C9	All Alternatives — Code Nos. MC3456P — 1974114 LM556CN — 1974122 NE556A — 1974130
10-14	1C10	Add Alternatives — Code Nos. LM340T-8 — 1974157 MC7808CT — 1974149
10-14	1C12	Delete LF225H Add Alternatives — Code No. LM207H — 1974181 LM207J8
10-15	LP1	Add Code No.2119285
10-15	LP1 Holder	Add Code No.2123568
10-15	LS1 (Eliptical) (Square)	Add Code Nos. 2134004 2134020
10-20	R136	Delete 1K $\pm$5% $\frac{1}{4}$W Carbon Film Code No.1104837 Add 1K8 $\pm$5% $\frac{1}{4}$W Carbon Film Code No.1128205
10-24	TR27	Delete ZTX108L Add 2N2222 Code No.1921177 Texas Code No 1974832 SGS/ATES
11	11.6	Change to: 'Location of Crystals, Adjustments and Test Points'
10-10	D72	Add 1N4148. Code No. 1934597. Location: PC164.
10-6	RFC45	Add A2/15000/105. Location: Battery Lead

2002M

DTR 2002M WITH HANDSET

PLATE 1. 1

CONTENTS

1 GENERAL DESCRIPTION AND SPECIFICATION

1. GENERAL DESCRIPTION AND SPECIFICATION

1.1 Introduction

The MESSENGER is a fully solid-state 100 Watt transceiver designed for fixed or mobile speech communications in the 2—16MHz band.

A3j (single — sideband) upper or lower sideband mode is employed.

It is a true transceiver with a high degree of commonality between the send and receive functions.

The MESSENGER operates directly from a 12 volt vehicle battery; no separate power unit is required.

1.2 Receiver

The receiver is a single-conversion superhet, with a 1.4MHz intermediate frequency. The local oscillator operates at Signal frequency +IF. Six channels may be located anywhere within the frequency range, single frequency simplex working, or five channels two frequency simplex.

The carrier insertion oscillator is variable ±50Hz for clarifier purposes.

The input circuits are protected against excessive signal voltage and high voltage static.

1.3 Transmitter

A voice-operated gain adjusting device (VOGAD) ensures adequate modulation over a wide range of voice levels; the basic ssb signal is generated at a nominal carrier frequency of 1.4MHz. After side-band selection the signal is converted to the desired signal frequency.

The power amplifier is radiation cooled, and is protected against overload due to overdrive, and open-circuit or short-circuit antennas.

1.4 Power Supply

A nominal 13.8 volts, negative earth, is required from a vehicle battery.

1.5 Antennas

The transmitter and receiver circuits are designed to match a 50ohm system. Because of the action of the Transmitter Level Control circuits, connection of any other aerial impedance will only cause a reduction in power output at no hazard to the MESSENGER.

1.6 Specification

	Performance Summary
FREQUENCY RANGE:	2—16MHz. Lower and higher frequency range to special order.
TRANSMISSION AND RECEPTION MODE:	Single or double frequency simplex A3j (ssb) upper sideband optionally lower sideband, or both.
	Sideband selection change by a front panel switch (option).
NUMBER OF CHANNELS:	Six, located anywhere in the frequency range.
CONTROLS:	Front Panel: ON/OFF switch, channel selector knob (includes remote antenna selection), volume control knob, clarifier knob, usb/lsb switch (option).
	Other: Two-tone test switch, and P.A. output level by pre-setable potentiometer (internal).

INDICATORS:	"On lamp" and channel number illumination, "Power output" indicating meter.
STABILITY.	±10Hz over the operating range (subject to crystal quality).
CLIMATIC:	95% R.H. at 40°C
VIBRATION.	Compatible with European Maritime Specifications
POWER SUPPLY:	13.8v negative earth only. Reverse polarity protection, suitable for use from a vehicle battery.
POWER CONSUMPTION:	Receive: 700ma (Includes high stability oven). Transmit: 7 amps average (speech), 18 amps peak.
TEMPERATURE RANGE:	a. Operating: −10°C to +55°C b. Specification: 0°C to +50°C c. Storage: −40°C to +75°C
DIMENSIONS AND WEIGHT:	89mm (H), 280mm (W), 305mm (D) 3.5" x 11" x 12¼" 3.5Kg. (7lb).
RECEIVER SECTION	
SENSITIVITY:	Better than 1uV pd for 15dB S+N/N ratio over the frequency range.
CLARIFIER:	±50Hz
AGC PERFORMANCE.	Less than 3dB change in output for 90dB signal change.
SELECTIVITY:	Nominal 250Hz to 3KHz at 3dB. (Shape factor 6 to 60dB better than 1.5:1).
IMAGE REJECTION:	Typically 50dB.
I.F. REJECTION:	Better than 74dB across the range.
AUDIO OUTPUT:	a. Up to 3W into 4ohms with less than 3% distortion b. Up to 2W into 4ohms with less than 1% distortion
EARPIECE OUTPUT:	+7dBm (Adjustable)
RADIATION (OSCILLATOR):	Not greater than 1 Nanowatt into 50ohms.
INPUT PROTECTION:	Up to 30V R.F. at antenna (30 min.)
TRANSMITTER OUTPUT:	100W peak envelope power (±1dB over the frequency range). Power reduction facility (20 to 100W).
DUTY CYCLE:	Better than 1:3 transmit to receive ratio for normal speech and at maximum operating temperature.
INTERMODULATION DISTORTION.	Better than −31dB below p.e.p. at 100W.
HARMONIC OUTPUT:	Better than −43dB when used with recommended filter or aerial tuning unit.
UNWANTED OUTPUTS:	Better than −43dB.
P.A. PROTECTION:	VSWR up to 50:1 (open or short circuit)
CARRIER SUPPRESSION:	Better than −51dB below p.e.p.
SIDEBAND SUPPRESSION:	Opposite sideband suppression better than 55dB
OVERALL A.F. RESPONSE:	As receiver selectivity figures. Supplied with ssb tailored microphone or telephone handset.

AUDIO INPUTS.	a. 1mV into 600 ohms (dynamic microphone fitted). b. 10mV into 5K ohms (auxiliary position).
VOGAD.	Accepts audio variation up to 25dB.

*** Not to be interpreted as a Test Specification.**

2. INSTALLATION

2.1 Unpacking

Remove the transceiver from its packing and check that the following items are also to hand.

(i) Mounting cradle and fixtures (if appropriate)
(ii) Installation kit
(iii) Appropriate handbook

Check the transceiver for damage before fitting in the operating position.

2.2 Supply Voltage

1) Mobile

Check that the vehicle is negative earth. The mounting cradle should be positioned so as to permit the transceiver controls to be easily reached from the driving position (if so required). Adequate ventilation must be allowed for the PA heatsink, a minimum of two inches between the fins and the vehicle bulkhead. Position the microphone/handset fitting appropriately.

Power for the transceiver should be taken via the shortest possible leads (recommended cable 159/.2mm or equivalent) from the vehicle battery. Under no circumstances should the supply cable loop resistance exceed .04 Ohms (equivalent to a loop run of approximately 6m of 159/0.2mm). For longer runs a more heavily rated cable should be used, or cable may be paralleled up for lower resistance.

2) Fixed Station

For desk mounted use the MESSENGER is fitted with plastic feet. Adequate space must be left behind the heatsink and care taken that ventilation is not obstructed by objects placed on top of the transceiver.

The MESSENGER may be powered from an ac psu or from a 12V battery on float charge.

2.3 External Connection

Where specified, ancilliaries should be connected as follows

a) Atu/Linear Control: When specified a flying (multicore) lead terminated in a socket will be factory fitted to the MESSENGER. Consult the relevant interconnection diagram, 11.7.

b) External PTT/Auxilliary microphone

Consult the auxilliary connection list. (Diagram 11.16).

2.4 Antenna Connection

A list of antenna options is given elsewhere.

The MESSENGER is supplied with a style UHF (PL259) antenna plug and adaptor for uniradio 43 coaxial cable, which is recommended for short cable runs (up to 20 metres). For longer runs a lower loss cable (e.g. UR 67) should be used.

Where antenna switching or sub-octave filter switching is specified, consult the relevant systems sketch (11.7).

2.5 Setting Up and Air Testing

Set the MESSENGER to the required channel and sideband, the clarifier to mid position and AF gain to approximately one quarter.

Switch the power to 'ON' and check that signals or off air noise is audible. With a VSWR bridge or directional wattmeter (Bird type 43) adjust the antenna to resonance (if necessary) as described below.

When using the 2 tone test facility, do not leave the MESSENGER in the transmit mode for long periods (e.g. more than a few minutes) in order to avoid unnecessary heating of the PA.

2.5.1 Setting Up – Antenna

The MESSENGER is normally supplied with specified crystals and aligned coil packs. All that remains is to adjust the antenna/atu to resonance.

(i) **Trap dipoles:** These are supplied ready cut to the correct length. Following antenna erection a directional wattmeter (e.g. Bird type 43) should be used to check the VSWR, which should be better than 2:1.

(ii) **Helical Antenna:** Check (against the table given below) that the correct antenna has been fitted.

Frequency Range (MHz)	DAE10 Antenna type No.
30 – 34	M1 555 656 1
33 – 3.8	M1 555 656 2
3.7 – 4.3	M1 555 656 3
4.2 – 4.8	M1 555 656 4
4.7 – 5.3	M1 555 656 5
5.2 – 6.0	M1 555 656 6
5.9 – 6.7	M1 555 656 7
6.5 – 7.7	M1 555 656 8
7.3 – 8.5	M1 555 656 9
8.2 – 94	M1 555 656 10
9.2 – 10.4	M1 555 656 11
10.3 – 11.9	M1 555 656 12
11.6 – 13.2	M1 555 656 13
13.0 – 14.4	M1 555 656 14
14.5 – 16.5	M1 555 656 15

Table 3.1

2.5.2 Mobile Antenna, Helical Whip Adjustment

It is important that the mobile whip is cut accurately to the frequency used. The helically wound whips when installed will initially resonate at a frequency lower than the required operation frequency. To resonate the antenna proceed as follows:

a) Check that the antenna type number is correct for the required frequency by referring to TABLE 3.1.

b) Install the mobile mount and antenna, taking care to keep the base of the antenna as far from the vehicle bodywork as possible. The coaxial cable must be earthed at the base of the antenna via the mobile mount.

c) Insert a SWR meter between the MESSENGER and the co-axial cable using a short (10") length of 50 Ohm coax.

d) Set the MESSENGER to the required channel, switch on internal two-tone oscillator and note the VSWR. The whip antenna must then be cut carefully to reduce this reading to a minimum. An SWR of 2:1 or less is satisfactory.

e) Cut the antenna by no more than ¼" at a time, switching the MESSENGER to RECEIVE whilst each adjustment is made. When the REFLECTED power is at minimum, the antenna is correctly tuned. Any excess feeder cable should be coiled neatly in the trunk compartment. Do **NOT** cut off any portion of this cable after the antenna is tuned.

2.5.3 Mobile Antenna, 3 Metre Whip (with Antenna Tuning Unit Type DTU 05)

The antenna should be installed in a convenient position with the ATU as near to the base as possible. A good earth connection must be made between the vehicle metal work and the earth terminal on the ATU.

The ATU control lead should be connected via a multiway lead to the MESSENGER. The coaxial connector should be connected to SK6.

Remove the DTU 05 side panels and locate the leads to the coil for each channel and its associated variable capacitor, and switch the MESSENGER to the appropriate channel. The DTU 05 has a remote press to send push button switch. Connect the clip lead for the channel to be tuned to a suitable part of the coil, observing the meter in the DTU 05, press switch to send, note indication and release. Move the lead a few turns and repeat, continuing until a maximum is indicated. With switch pressed to send adjust the associated variable capacitor for maximum indication, if the capacitor nears its extremities move the lead a small amount and repeat. Maximum indication should coincide with best match. Repeat for the other channels. Due to a slight interaction between the channels it may be necessary to retrim the capacitors when all the channels have been tuned. Replace DTU 05 side covers.

A preferred technique (instead of using the internal meter in the DTU 05 which monitors relative Antenna current) is to insert an SWR bridge in the input of the ATU. The process is the same except the indication is of reflected power. This gives better resolution since it is easier to see a null (which is sharp) than a peak (which is broad). Remember that a very bad match will give a low output indication due to TLC action.

NOTE: The unused channel leads in the DTU 05 should be clipped back so they cannot interfere with the equipment in operation. The slack in the used leads should also be taken up by using the clips as necessary.

2.6 Vehicle Interference Suppression

2.6.1. Source of Interference

As a current flowing in a conductor varies, the magnetic fields around the conductor also vary, causing energy radiations in the form of radio frequency waves. The strength of the radiated fields will vary as a result of current changes or interruptions due to switch action, transistor operation, commutation etc.

Radio interference can be 'sensed' by receivers either by conduction along the associated wiring system or by direct radiation from the wiring to the receiving antenna.

2.6.2 Legal Requirements

All vehicles manufactured in the United Kingdom must comply with legal standards to control interference from the ignition system. These standards are designed to eliminate or reduce interference to domestic radio and television reception and also radio communication systems.

For this purpose most vehicles now fit resistive type high tension leads. Earlier vehicles were fitted with a resistive brush in the distributor central H.T. connection. Although this arrangement met earlier regulations it is not sufficient for present day requirements.

However, additional suppression for a vehicle's electrical system may still be required if a two-way radio communication system is fitted to the vehicle.

2.6.3 Suppressing Interference

A correctly installed radio system is of prime importance.

INSTALLATION – Correctly installed radio equipment will help to reduce the possibility of unwanted signals being picked up from the vehicle's electrical system.

A radio, antenna etc. should be mounted in the manufacturer's recommended positions. If this is not possible the antenna and feeder, and also the radio should be sited away from the ignition distributor, voltage regulator, etc.

Both the radio and antenna support must be correctly earthed and all connections must make a good metal-to-metal contact.

The radio supply should be taken from a suitable point close to the battery.

GENERAL — The usual method for suppressing electrical interference is to connect a by-pass capacitor between the supply terminal of the component responsible for the source of interference and a good earth. The capacitors are normally valued at 1 or 3 microfarad.

In addition in-line chokes may be used in the supply and earth leads of most electrical components to afford further suppression where by-pass capacitors alone have not eliminated the interference.

For VHF radio equipment chokes are usually connected in series with the supply terminal(s) of the electrical component requiring suppression. Chokes are rated on a current carrying capability and to afford maximum protection, some chokes have a far greater current carrying capability than the units to which they are connected.

It is important that capacitors and chokes are connected close to the supply terminals of the appropriate units. In addition the capacitor lead should be kept as short as possible and the earth connections should be made individually ensuring a good metal-to-metal contact.

Figs. 1-6 on pages 2—11 and2—12illustrate various forms of suppression and connections which may be made.

2.6.4 Method — A Process of Elimination

In the following checks it is assumed the radio system has been correctly installed.

The antenna is disconnected in some tests to prevent interference being picked up from external sources such as industrial machinery, fluorescent lighting, other vehicles etc. It is advisable, however, to use a dummy antenna whenever the vehicle antenna is disconnected, otherwise the receiver sensitivity may be altered and misleading results obtained.

NOTE: A dummy antenna is made from an antenna plug fitted with a 50 Ohm resistor.

The receiver should be checked on all channels when diagnosing interference.

Where more than one suppression item is recommended for an electrical component the interference level for that unit should be checked after fitting the first suppression item. Additional suppression items may then be fitted as necessary.

A list of appropriate suppression components will be found at the end of this section, see page 2—9 and 2—10. Lucas part numbers are quoted where appropriate.

2.6.5 Check 1 — Permanently 'On' Components

a) (i) Disconnect vehicle antenna, and connect dummy antenna if available.
(ii) Ensure ignition is switched off.
(iii) Switch on MESSENGER (Receive).

INTERFERENCE NOISE	PROBABLE SOURCE	RECOMMENDED SUPPRESSION	
		UNIT	FITTING POSITION
Regular ticking	Clock	(i) 1 microfarad capacitor, Part Nos. 78139 or 60600385	Clock feed terminal
		(ii) 3A choke, Part No. 60150094	Clock feed cable (also earth lead if remotely earthed).

b) Repeat this check with the vehicle antenna reconnected.

2.6.6 Check 2 — Ignition Controlled, Non-Switched Units

a) (i) Disconnect antenna and connect dummy antenna if available.
(ii) Switch on ignition.
(iii) Switch on MESSENGER (Receive).

INTERFERENCE NOISE	PROBABLE SOURCE	RECOMMENDED SUPPRESSION	
		UNIT	FITTING POSITION
Slow irregular crackling	Instrument voltage stabiliser	(i) 1 microfarad capacitor Part Nos. 78139 or 60600385	Stabiliser feed or 'B' terminal.
		(ii) 3A choke Part No. 60150094	All leads to the stabiliser unit.
		(iii) 1000 picofarad capacitor*	Across the contacts.
Intermittent clicking	Fuel Pump	(i) 1 microfad capacitor Part Nos. 78139 or 60600385	Fuel pump feed terminal.
Constant Whine	Fuel Pump (P.I. cars)	(i) Earth braid Part No. 60670350	Between fuel pump body and a good earth.
		(ii) 1 microfarad capacitor Part Nos. 78139 or 60600385	Fuel pump feed terminal (Alternatively both terminals in difficult cases).
		(iii) 7A choke Part No. 60150093	Fuel pump supply, and earth leads.
Slow irregular crackling	Oil pressure transmitter	Special RF Part No. 60150216	Transmitter feed terminal.

b) Repeat check with the vehicle antenna connected.

* 1000 picofarad capacitor should be obtained from local sources.

2.6.7 Check 3 — Ignition Controlled, Switched Components

a) (i) Disconnect vehicle antenna and connect dummy antenna if available.
(ii) Switch on ignition.
(iii) Switch on MESSENGER (Receive).
(iv) Switch on accessories in rotation.

ACCESSORY	USUAL INTERFERENCE NOISE	RECOMMENDED SUPPRESSION	
		UNIT	FITTING POSITION
Wiper motor	Whine and crackle	(i) Earth braid Part No. 60670350	Between wiper motor body and a good earth.

ACCESSORY	USUAL INTERFERENCE NOISE	RECOMMENDED SUPPRESSION	
		UNIT	FITTING POSITION
		(ii) 1 microfarad capacitor Part Nos. 78139 or 60600385	Motor feed terminal (A further 1 microfarad capacitor will be required for high speed feed terminal of two speed wipers)
		(iii) Choke Kit Part No. 60670378 or 3A chokes Part No. 60150094 (wound field motors).	The motor leads, Lucas permanent magnet motors only.
		7A chokes Part No. 60150093 (permanent magnet motors)	Motor supply and earth leads.
Heater motor	Whine	(i) 1 microfarad capacitor Part Nos. 78139 or 60600385	Motor feed terminal (A further 1 microfarad capacitor will be required for high speed feed terminal of two speed heater/blowers).
		(ii) 3A chokes Part No. 60150094 (wound field motors)	Motor supply and earth leads.
		7A chokes Part No. 60150093 (permanent magnet motors)	

b) Repeat check with the vehicle antenna connected.

2.6.8 Check 4 — Ignition System

a) (i) Disconnect vehicle antenna and connect dummy antenna, if available.
(ii) Start engine, and leave running at idling speed.
(iii) Switch on MESSENGER (Receive).

INTERFERENCE NOISE	RECOMMENDED SUPPRESSION	
	UNIT	FITTING POSITION
Loud crackling proportional to engine speed	(i) 1 microfarad capacitor Part Nos. 78139 or 60600385	Coil 'SW' terminal, i.e. coil terminal connected to the ignition switch. IT MUST NOT BE CONNECTED TO THE LT COIL TERMINAL WHICH IS CONNECTED TO THE DISTRIBUTOR.
	(ii) Earth braid Part No. 60670350	Bonnet, Exhaust etc. See Check 6.

INTERFERENCE NOISE	RECOMMENDED SUPPRESSION	
	UNIT	FITTING POSITION
	(iii) Plug suppressors (see details on page 2–11)	A. **Wire cored H.T. leads** – Right angled or straight plug suppressor and/or distributor push in adaptors. NOTE: Where possible wire cored H.T. leads should be replaced by resistive cable type. B. **Resistive H.T. leads** – Screened plug caps and distributor push in adaptor. NOTE: Resistive type HT leads should not be replaced by wire cored type as legal requirements may be contravened.

In extreme cases a screening can may be required for the distributor, especially on vehicles with fibre glass bodies.

b) Repeat check with vehicle antenna connected.

2.6.9 Check 5 – Charging System

a) (i) Disconnect vehicle antenna and connect dummy antenna if available.
(ii) Start engine.
(iii) Switch on lighting load and MESSENGER (Receive).
(iv) Increase engine speed.

INTERFERENCE NOISE	PROBABLE SOURCE	RECOMMENDED SUPPRESSION	
		UNIT	FITTING POSITION
DC SYSTEM			
Whine proportional to engine speed	Dynamo	(i) 1 Microfarad capacitor Part Nos. 78139 or 60600386	Dynamo 'D' terminal
		(ii) Feed through capacitor Part No. 60150114	Dynamo 'D' lead
Constant low frequency crackle	Control Box	1 Microfarad capacitor. Part Nos. 78139 or 60600386	Control box 'D' terminal. (In special cases filter unit Pt. No. 78158 may be necessary)
AC SYSTEM			
Whine proportional to engine speed and increasing in intensity with output current	AC, ACR Alternators	(i) 3 Microfarad capacitor. Part Nos. 54200297 15/16/17/18 ACR or 54201329 20 ACT Alternators	Main output terminal
		(ii) 1 Microfarad capacitor. Part Nos. 78139 or 60600385	Alternator 'IND' terminal

INTERFERENCE NOISE	PROBABLE SOURCE	RECOMMENDED SUPPRESSION	
		UNIT	FITTING POSITION
Steady Whine	Control Unit a. Internal	(i) 3 Microfarad capacitor (internal type) Part Nos. 54200297 15/16/17/18 ACR or 54201329 20 ACR Alternators	(AC,ACR Alternator) connected between '+' ve rectifier plate and earth.
		(ii) 1 Microfarad capacitor, Part Nos. 78139 or 60600385	Alternator 'IND' terminal
	b. External	1 Microfarad capacitor Part Nos. 78139 or 60600385	Connect between '+' terminal of control unit and earth for negative earth applications or between '–' terminal and earth for positive earth application.
		(ii) Earthing Point	Ensure control unit earth lead is as short as possible. Remake as necessary ensuring a metal-to-metal contact.

b) Repeat check with vehicle antenna connected.

2.6.10 Check 6 — Earth Straps

It is essential that all the metal parts of a motor vehicle body and its components are bonded together, ensuring a good metal-to-metal connection. Interference may be reduced by connecting braided earth straps between:—

a) Bonnet cover to main bulkhead, (utilise bolts for hinges).
b) Engine block to bulkhead
c) Gearbox to chassis.

Check condition of normal bonding straps.

d) Exhaust pipe to chassis, as close as possible to the engine.
e) Wiper motor or any other motor body (except starter) to earth (see checks 3 and 4).
f) Suspension (rear axle) and a suitable point on the body.
g) Suspension (front end units both sides) and a suitable point on the body.

2.6.11 Check 7 — Miscellaneous

COMPONENT	USUAL INTERFERENCE NOISE	RECOMMENDED SUPPRESSION	
		UNIT	FITTING POSITION
Fluorescent Light	Low frequency noise	(i) 7A choke Part No. 60150093	Fit a choke in each supply lead adjacent to the circuit board.

COMPONENT	USUAL INTERFERENCE NOISE	RECOMMENDED SUPPRESSION	
		UNIT	FITTING POSITION
		(ii)	Wind 1 metre of 7/0.2mm cable around the tube, Cable to be held at one end by the tube clamp and secured at the other end to '—' ve connection.

2.6.12 Suppression Equipment

GENERAL PURPOSE

Capacitors

TYPICAL APPLICATION	DESCRIPTION	MODEL	PART NUMBER
Ignition system, charging system, wiper and heater motors etc.	1 microfarad	LS680	78139
Ignition system, wiper and heater motors, fuel pumps etc.	1 microfarad c/w 'U-Grip' connector for cables up to 28/0.30(28/.012)	LS627	60600385
Dynamo, alternator main output connections, etc.	1 microfarad c/w 'U-Grip' connector for cables up to 94/0.30(95/0.012)	LS628	60600386

Chokes

Voltage stabiliser, wound field motors, clock, radio etc.	3 ampere rating	LS640	60150094
Permanent magnet motors, i.e. wipers, fuel pumps etc.	7 ampere rating	LS639	60150093
Tape players or radios	3 ampere rating Transformer type	LS630	60460085

Earth Braid

Earth/body bonding strap	12"(25mm) long	LS642	60670350

The additional components listed below have specialised applications.

IGNITION SYSTEM

1. Spark Plugs

Right angled 12,500 ohm push-on resistor for use with wire cored HT leads.	LS647	78106
As LS647 Part No. 78106 but with shroud for spark plug insulator.	LS648	78118
Straight screened plug cap. VHF suppression For use with resistive HT cable.	LS632	54421964
Kit, comprising Qty 4 LS632, Part No. 54421964.	LS631	60046089
As LS632, Part No. 54421964 but right angled.	LS634	54422760
Kit, comprising Qty 4 LS634, Part No. 54422760.	LS633	60046090

2. HT Cables

12,500 ohm line resistor, for use with wire cored HT cable.	LS646	78105

3. Distributors

Push-in type distributor end cap adaptor. VHF suppression, for use with resistive HT cable.	LS636	54421441
Kit, comprising Qty 5, LS636, Part No. 54421441	LS635	60046091
As LS636, Part No. 54421441, but right angled	LS638	54423567
Kit, comprising Qty 5, LS638, Part No. 54423567	LS637	60046092
Screening can for 25D4 and 25D6 distributors	LS683	54418559

CHARGING SYSTEMS

DC – Dynamo

Feed through capacitor	LS684	60150114

DC – Control Box

Filter unit	LS681	78158

AC – Alternator

3 microfarad capacitor, internal fitting, for models 15/16/17/18 ACR.	LS629	54200297
3 microfarad capacitor, internal fitting, for model 20 ACR.	LS682	54201329

LUCAS PERMANENT MAGNET WIPER MOTORS

Choke kit, 7 ampere rating, Lucas permanent magnet wipers only.	LS641	60670378

OIL PRESSURE TRANSMITTER (ELECTRICAL)

Special RF choke	LS645	60150216

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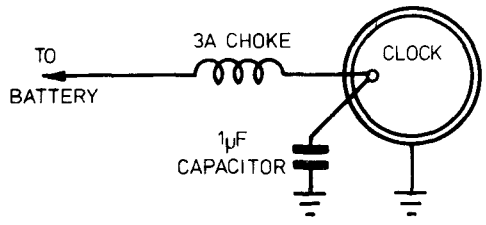

FIG 1 CLOCK SUPPRESSION

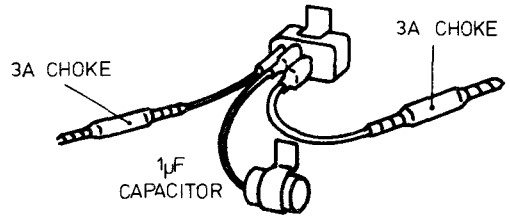

FIG. 2 INSTRUMENT VOLTAGE STABILISER SUPPRESSION

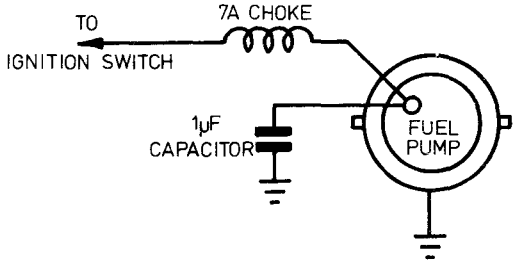

FIG 3. FUEL PUMP SUPPRESSION

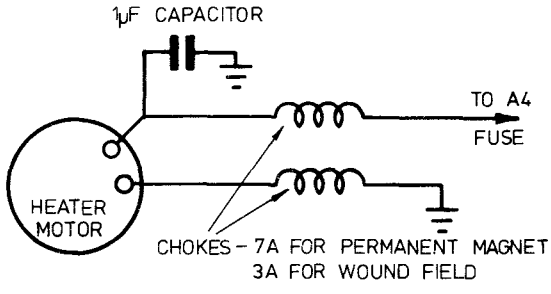

FIG 4. HEATER MOTOR SUPPRESSION

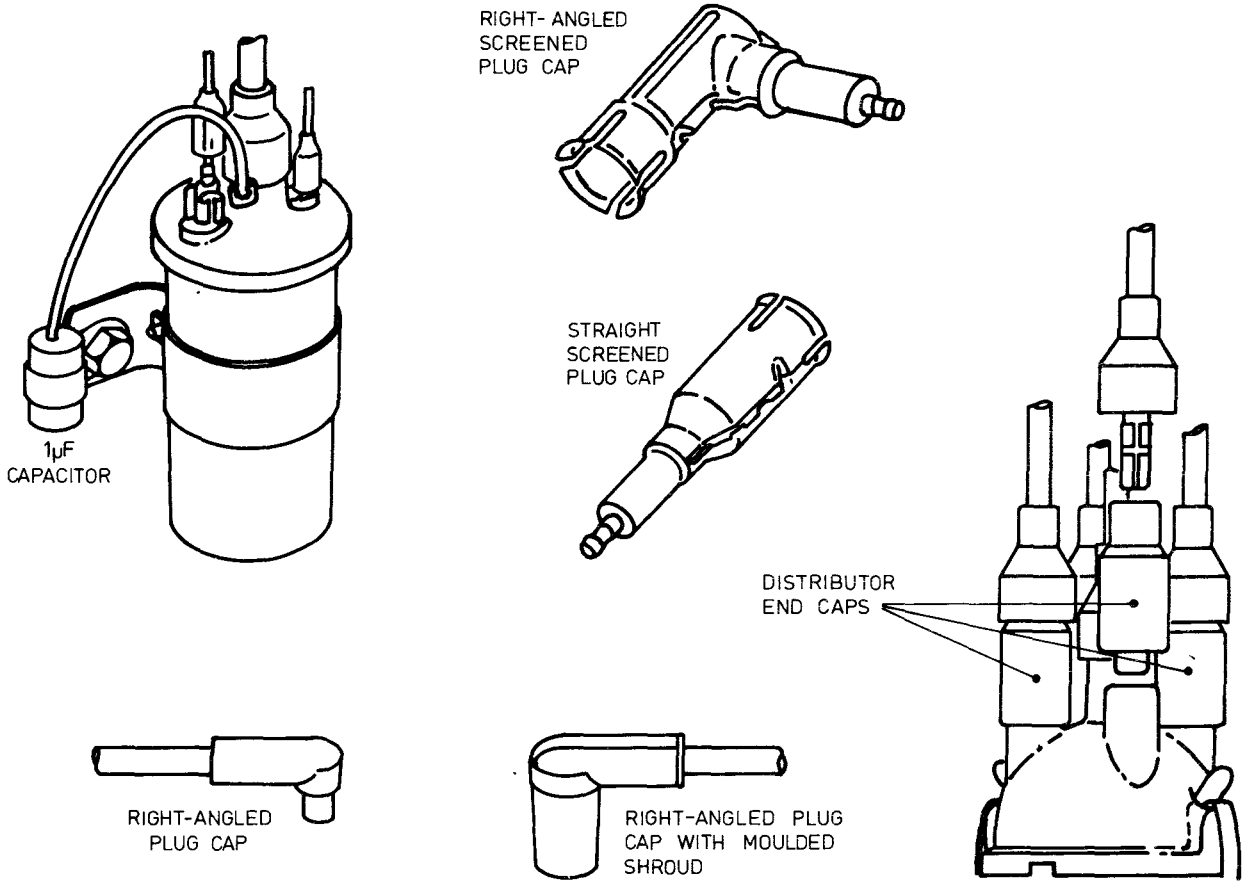

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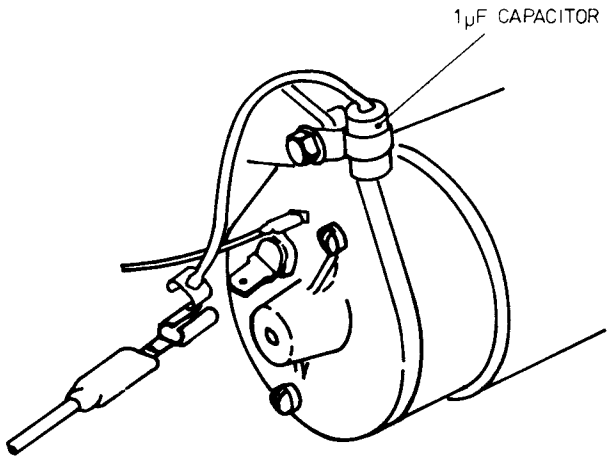
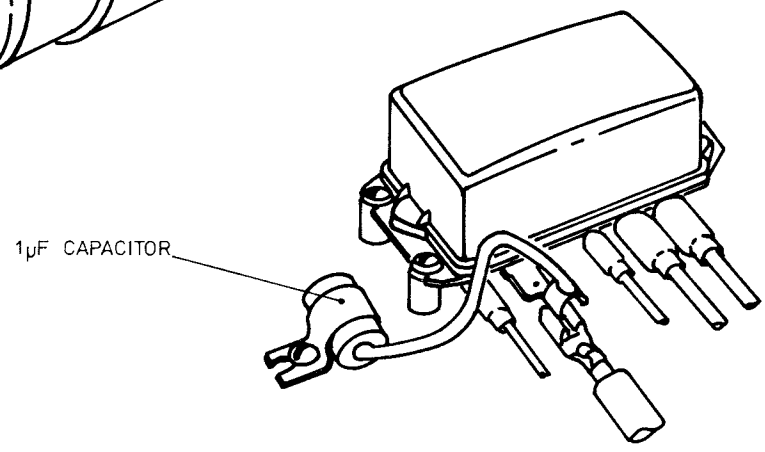
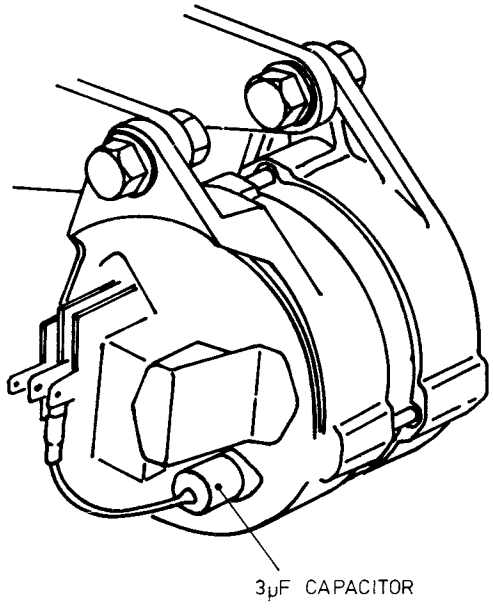
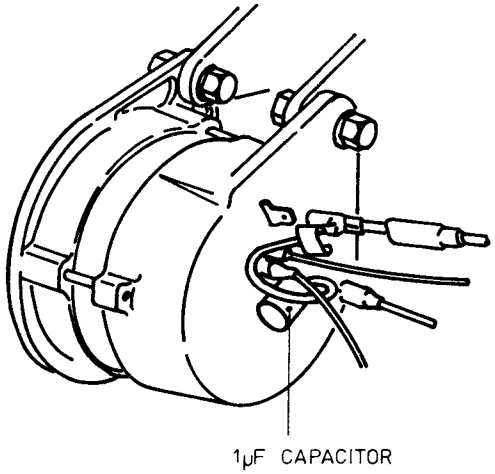
FIG 5. TYPICAL IGNITION SYSTEM SUPPRESSION COMPONENTS





THE 1μF CAPACITOR SHOWN IN THESE DRAWINGS IS PART No 78139 AN ALTERNATIVE 1μF CAPACITOR WITH A 'U-GRIP' CONNECTOR IS PART No 60600386





A1/15000/Z
ISSUE 1

FIG 6. TYPICAL CHARGING SYSTEM SUPPRESSION COMPONENTS

3. OPERATING INSTRUCTIONS

3. OPERATING INSTRUCTIONS

The MESSENGER can be used by an unskilled operator, for the controls are simple and small in number.

The controls, and their function, are listed below:

Power-on Switch — This connects the battery supply to the MESSENGER. When pressed to 'ON' the station is immediately on 'RECEIVE' and the channel switch is illuminated.

Volume Control — The sound level from the loudspeaker may be adjusted to suit the environment. In a noisy vehicle the sound level may be set to a high level without excessive distortion. In the absence of a received signal a rushing noise will be heard.

Channel Switch — This selects the required channel. The channel frequencies will have been specified by the user when the MESSENGER was ordered from Decca Communications Limited. If less than six channels are fitted, on the unused positions the receiver will be quiet. No damage can be caused by attempting to receive or send on an unused channel.

Clarifier Control — On receive, the tuning may be finely adjusted to produce the correct pitch to the human voice. Once set, no further alteration will be necessary unless a different channel is selected.

LSB/USB Switch — Selects upper or lower sideband according to your prearranged operating schedule. If only one sideband has been specified when the MESSENGER was ordered from Decca Communications Limited, the sideband switch will be ineffective. Note that when both sidebands are provided this effectively doubles the number of available channels. Communication will not be possible unless the correct channel **and** correct sideband are selected.

Press-to-talk Switch — (Located on microphone). Squeezing the switch puts the MESSENGER to 'SEND'.

Indicators

RF Output Meter — The meter will kick up with variations of speech on 'SEND' only.

Low-Power Facility — If the MESSENGER is used on 'SEND' continuously for a lengthy time, the transmit section could become overheated. To prevent damage, the 'SEND' power output is automatically reduced to one quarter. No damage will be caused and transmission may continue. Except when operating over very long distances, communication is unlikely to be lost. After a short period on 'RECEIVE' full power will be restored. When the MESSENGER has been specifically ordered for low-power output only, overheating is very unlikely.

Test (Two Tone) Switch — An internal two-tone test oscillator is provided. A slide switch at the chassis rear allows the test oscillators to be turned on, and also switches the transceiver to 'SEND'. This facility can also be switched in by a button fitted to the DTU 05. For normal operation, the slide switch should be in the up position. To switch on the test oscillator, move the switch to the down position.

4. MAINTENANCE AND ROUTINE CHECKS

4.1 Cleaning

4.2 Operational Checks

4.3 Channel–Frequency Re-adjustment

4. MAINTENANCE AND ROUTINE CHECKS

4.1 Cleaning

No maintenance other than cleaning and checking the soundness of external connections is advised.

Remove the covers from the MESSENGER at intervals depending on the environment in which the set is used. For a mobile set this would be more frequently than for a set used in an indoor location.

Remove accummulated dust with a soft brush or vacuum cleaner, taking care not to bend component fixings or disturb the settings of pre-set controls.

The set is fully aligned in the factory and all pre-set controls are adjusted for optimum performance.

No attempt to realign the circuits should be made unless proper test instruments are available. (See section 6).

Check firmness of fixing of all control knobs and clean the front panel with a soft cloth.

Check for dust between the PA cooling fins and remove with a soft brush or vacuum cleaner.

Examine external wires and cables for fraying or cracked insulation.

Wipe the covers with a soft dry cloth internally and externally and refit using the original fixings.

4.2 Operational checks

These may be carried out in the vehicle or fixed location, or the set may be removed for checking in the workshop.

Before switching on the MESSENGER ensure all external connections are correct. Make sure the antenna(s) for the fitted frequencies are connected.

Set the controls as follows:

Switch to the agreed channel number, making sure the appropriate antenna is connected.
Set clarifier control knob to mid-scale.
Select the agreed side-band.
Set the volume control knob to a quarter.
Press the power on/off switch.

The channel switch dial will illuminate.

If a station is transmitting on the channel adjust the volume control knob for a comfortable level.

Adjust the clarifier control knob for the correct pitch of the voice. Check that the clarifier allows the pitch to be adjusted from a high pitch to a low pitch.

In the absence of a received signal a rushing noise will be heard.

To answer the other station or to make a test transmission squeeze the press-to-talk switch on the microphone. Hold it about 2cms from the lips and speak clearly and slowly into it. It is not necessary to shout, the MESSENGER automatically compensates for differences in voice level.

Check that the RF output meter kicks up in sympathy with your voice.

Other channels (when fitted) may be checked in the same way, provided the appropriate antenna is available.

4.3 Channel Frequency Re-adjustment

At least once a year it is desirable to check the channel frequencies.

This is detailed in Chapter 7, paras 7.1 (a) and (f), and 7.2 (b) and (c).

5. SYSTEM AND CIRCUIT DESCRIPTION

5.1 General Note

5.2 Receive Condition

5.3 Channel Oscillator

5.4 Transmit Condition

5.5 Transmit Channel Pre-Set Gain Controls

5.6 Two-Tone Test Oscillator

5.7 Voltage Regulator

5.8 Power Amplifier Module

5. SYSTEM AND CIRCUIT DESCRIPTION

5.1 General Note

(Refer to Block Diagram A2/15000/J and to Circuit Diagram A0/15000/2).

Drawing A2/15000/J shows the basic stages of the MESSENGER in block diagram form. Single conversion is employed, transmitter and receiver sharing mixer, oscillator, IF selectivity and gain blocks. A detailed description follows. The numbers in parenthesis refer to points on the block diagram.

5.2 Receive Condition

The 50 ohm antenna is connected via the PA module antenna relay (26) to the coil pack mother board passing via the Tx protection diode network (1) to the Rx coil pack, (2) (one of up to six of which is diode selected by the channel switch).

Receive and transmit coil packs are identical, and cover the range 2—16MHz in six bands as follows:—

BAND No	FREQUENCY RANGE MHZ	DRAWING REF L 3 AND L 4	VALUE OF C 112
1	2.0– 2.7	A3/15000/40 (BN)	1.5pF
2	2.7– 3.7	A3/15000/41 (RD)	1.5pF
3 A	3.7– 4.4	A3/15000/42 (OE)	1.5pF
3 B	4.4– 5.2	A3/15000/42 (OE)	1.0pF
4 A	5.2– 6.2	A3/15000/43 (YW)	1.5pF
4 B	6.2– 7.4	A3/15000/43 (YW)	1.0pF
5 A	7.4– 9.2	A3/15000/44 (GN)	1.5pF
5 B	9.2–11.5	A3/15000/44 (GN)	1.0pF
6 A	11.5–13.6	A3/15000/45 (BE)	1.0pF
6 B	13.6–16.0	A3/15000/45 (BE)	0.75pF

The receive signal is selected by a pair of top-coupled tuned circuits (2), and routed to the RF amplifier (3) which has an overall voltage gain of approximately 24 dB. The coil slugs, having been preset to a specified inductance should not be moved. In practice the coil packs will give a frequency coverage of from 90% of the nominal low frequency band edge to 110% of the nominal high frequency edge. Any coil pack may be placed in any position and still give the specified performance.

The receiver mixer (4) driven by the channel oscillator (12) via the RF switch (13) converts the received signal to the IF frequency of 1.4MHz. Total front-end voltage gain (up to the crystal filter inputs) is approximately 12 dB. Gain control (derived from the agc system) is applied to the RF amplifier in order to protect the first mixer from overload. A DC voltage 'delay' is incorporated to ensure that the overall noise figure is not worsened at low signal levels. The signal handling performance of the receiver front end is typically +8 dBm at 4MHz. On transmit, a muting voltage (7v) is applied to the agc port, effectively turning off the SL 610. IF selectivity is provided at 1.4 MHz by a crystal filter immediately following the front end mixer.

When only one sideband is specified the USB/LSB switch is hard wired accordingly.

Where USB/LSB switching is required, two crystal filters are supplied and the required filter is selected via diodes D1, D2, D4 and D5. Note that sideband inversion occurs during the IF/signal frequency conversion (local oscillator running above signal frequency) so the USB filter provides LSB operation and vice versa.

Following the crystal filters is a three-stage double-tuned 1.4MHz gain-controlled IF amplifier having the following characteristics:—

(i) Nominal gain 75 dB at 1.4MHz.
(ii) 6 dB bandwidth 80KHz.
(iii) AGC threshold typically 9 microvolts pd.

Additional stopband selectivity is provided by the 1.4MHz tuned circuits at the input (6) and mixer output (9) of the IF amplifier (7 and 8). Both IF amplifiers are agc controlled, with a voltage delay ensuring that gain control is applied to the RF/IF stages in a sequence optimised for best noise figure/in-band intermodulation performance.

In the receive mode agc is applied to IC4, and to IC3 via a DC offset diode (D7) to maintain the optimum S + N/N and linearity gain distribution.

On transmit the IF amplifier gain is set by a DC bias derived from VR2 and applied via isolating diode D6 and offset diodes D8 and D9. Nominal transmit gain is approximately 20dB.

IF output is split as follows:—

(i) To receiver product demodulator (10) which is driven by the 1.4MHz clarifier-controlled oscillator. Audio output is routed to the AF output stage (11). An auxiliary audio output (25mV via 10K ohms) is also provided.

(ii) To a 1.4MHz buffer amplifier (18) which drives the agc envelope detector (17). Output from the agc detector is used to pump charge into the agc time-constant capacitors (16), from which agc/VOGAD control voltage is derived. A rapid discharge (dump) facility is provided by the agc strobe (23). In the receive condition the microphone amplifier (15), Tx amplifier (19), and PA (24) are held biased off.

The second mixer (IC5, SL641) functions as.—

(i) Product demodulator (receive mode).
(ii) IF to signal frequency converter (send mode).
VR3 is an oscillator null preset, enabling the oscillator (pin 3) leak to be minimised when on transmit.

Two audio outputs are provided.—

(i) To drive the 3 watt audio output stage.
(ii) Auxilliary output (eg. for line output amplifier).

The Audio amplifier uses a Mullard integrated circuit type TDA 1011 to provide up to 4 watts into a 4 ohm load. Audio from R 18 is taken to the af gain control pot, VR9, and from its wiper, via C84, to the input (pin 8) of the IC. Approximately 10 mV rms at pin 8 gives 4 watts output. A preset output (VR8) for 300 ohm headphones/handset-earphone is available, giving an output of up to 8 mW. Frequency response is rolled off above 4KHz by C82, 2700pF.

5.3 Channel Oscillator (12)

TR13 is a conventional colpitts oscillator, with the feedback capacitors (C91 and C92) optimised for the crystal frequency range of 3.4 to 17.4MHz. Crystals are specified for operation at 30pF parallel capacity.

Channel crystals (up to eleven) are housed in a proportionally controlled oven which maintains them at a temperature of $75^{o}C \pm 1^{o}C$. The twelfth position is dedicated to the 1.4MHz carrier crystal. Selection of the required crystal and trimmer combination is by RF switching diodes, DC controlled via the channel selector switch S3A and RX/TX switching transistors TR10 and TR11 respectively.

There are two crystal bus lines, viz.

(i) Via C87, XL2/1-6. These crystals correspond to channels 1-6 respectively, and are used for transmit and receive (on single frequency simplex), or for receive only (on two frequency simplex).

(ii) Via C88, XL3/1-5. These crystals correspond to channels 1-5 respectively, and are used only when the two-frequency simplex mode is required.

It follows that any channel (1-6) may be specified for single-frequency simplex, and channels (1-5) may be specified for two-frequency simplex. Channel 6 may be specified for single-frequency simplex only. Trimmers VC2/1-6 and VC3/1-5 allow the crystals to be trimmed to their correct frequencies. The channel oscillator (12) and 1.4MHz oscillator (14) are applied to mixers 1 (4) and 2 (10) via an RF changeover switch which uses four BA182 diodes.

5.4 TRANSMIT CONDITION

Microphone Amplifier (15)

This is based on an integrated circuit type SL 1630, has maximum gain of approximately 40 dB (x 100), a nominal input impedance of 500 ohms and is DC gain-controllable.

Gain control, applied to pin 7 of the SL 1630, may be derived from one of three sources viz.

(i) Via D28, and set by preset VR7. This may be used to set back the nominal AF gain of the SL 1630 (giving an increased VOGAD threshold) or to preset a fixed gain (when D27 must be removed to disable the VOGAD).

(ii) Via D27, a VOGAD control voltage, derived from the generated IF SSB signal.

(iii) Via D26, a muting voltage applied in the receive mode to disable the microphone amplifier.

The amplified audio signal is applied to the SSB modulator (4), along with the 1.4MHz carrier (derived from the VCXO, 14, via RF switch, 13). The resulting DSB signal is applied to the selected (USB or LSB) crystal filter (5) and the selected sideband is amplified by the IF amplifier 1, 6, 7, 8, 9 to 50 mV pev pd at the input to the second mixer (10). This level is set (during alignment) by presetting the gain control voltage applied to the IF amplifiers, which are **not** controlled by the agc/VOGAD in the send condition. VOGAD is applied to the microphone amplifier, audio threshold is approximately 1 mV pd (for VOGAD), with a corresponding audio drive level (to the DSB modulator, 4) of approximately 100 mV pd. The VOGAD control voltage is generated (by 16, 17, 18) exactly as for agc when in the receive mode.

Signal frequency output from the second mixer (10) is routed via the Tx coil pack (20) where image, oscillator and other unwanted output component frequencies are attenuated to an acceptable level. A signal frequency loss of 6 to 7 dB is typical at this point. The Tx amplifier (19) provides approximately 46 dB of gain, giving a maximum drive output of nominally +16 dBm, which is routed to the PA module (24, 25).

5.5 Transmit Channel Preset Gain Controls

RV14/1-6 are used to preset Tx gain to a level approximately 11 dB into TLC on each channel. TLC level is set to that necessary to produce 100 watts ± 1 dB into a 50 ohm resistive load.

Transmitter overdrive, and any variations between USB/LSB signal levels etc. is taken care of by the closed loop gain control system comprising the Tx driver amplifier (19) and PA/TLC detector (24). In addition to the normal PTT function, transmit condition may also be selected by:—

(i) VOX operation input.
(ii) MIC ptt input.
(iii) Operation of the 'Test' switch.

5.6 Two-Tone Test Oscillator (21)

This is provided as a standard facility, controlled by a slide switch (at the rear of the chassis) which has two functions:

(i) To put the transceiver into the transmit mode (via D39).
(ii) To turn on the two-tone oscillator (IC9) via transistor switch Tr15.

Pin 12 (TEST) of the signal processing pcb may be wired to an external switch (in addition to that mounted at the rear of the chassis) in order to provide extended control of the two-tone test facility. The two-tone oscillator (21) provides an audio drive level which results in a VOGAD operation of approximately 20 dB. Tone frequencies are approximately 1.6KHz and 2.5KHz giving a nominal tone spacing of 900 Hz, and ensuring that the audio harmonic frequencies are outside of the transmitted SSB bandwidth.

The following additional points should be noted:—

(c) The RF — derived agc system doubles (on transmit) as a microphone VOGAD.

(d) Agc strobe (23), TR17/R110 are used to discharge the agc time constants on transitions between transmit-receive and receive-transmit. The agc 'dump' strobe, applied to the base of TR17 is derived from the make to break and break to make transitions of the PTT switch (or other TX/RX command switch, via D39, D40, D41 or D42). The absence of this facility would permit agc voltage (generated by a received station) to affect the level of gain when switched to the VOGAD (Tx) condition. Similarly, a VOGAD voltage (generated on Tx) might desense the receiver when reverting to the receive mode.

(e) On receive, both IF stages (7,8) and the Rx RF amplifier are agc controlled, giving less than 3 dB change in audio output for up to 100 dB increase in received signal level (above the agc threshold). Agc distribution to the three stages is weighted in order to maintain a satisfactory noise figure over the gain controlled range.

(f) On send, a VOGAD control voltage is applied to the microphone pre-amplifier (15). Audio drive to the Tx modulator mixer (4) is held within 2 dB for a range of up to 20 dB above VOGAD threshold (1 mV pd). A preset microphone gain facility is provided as an option.

(g) Image rejection and signal frequency selectivity is provided in the send and receive states by identical (but separate) coil packs consisting of top-capacity coupled pairs of tuned circuits, giving approximately 50 dB of image rejection, having a nominal 8 dB of insertion loss and which are selected by DC controlled diode switching. The use of separate transmit and receive coil packs permits split frequency simplex operation to be offered.

(h) The 1.4MHz voltage controlled crystal oscillator (14) has two functions:—

(i) On send, it is set to 1.4MHz exactly (by means of a preset potentiometer) and is routed via the oscillator changeover switch (13) to the DSB modulator (4).

(ii) On receive it provides demodulation of the (1.4MHz IF) received signal, in which condition the frequency may be pulled by up to 50Hz either side of nominal (1.4MHz) by means of a DC voltage derived from the clarifier potentiometer.

5.7 Voltage Regulator (IC 10)

This supplies the majority of the transceiver low level stages with a nominal 8v line, and is a commercial package type LM 340J.

5.8 P.A. MODULE DESCRIPTION

5.8.1 SYSTEMS DESCRIPTION

The system diagram Drg. A2/15000/AA shows the various stages of the P.A. module.

Driver input to the P.A. is taken from the coil pack mother board. This level (several mW) is amplified to 100W and then fed to the Aerial change over unit (Relay). Output level control for the P.A. is provided by the T.L.C. circuitry (Transmit Level Control) which feeds back a gain controlling dc voltage to the coil pack mother board to close the control loop. A special feature of the T.L.C. is that is has two selectable levels of threshold, one of which can be selected by an external switch to produce a low power level. This feature may be worked in conjunction with an A.T.U. (Aerial Tuning Unit) for setting up purposes. A detector on the P.A. output is fed to the T.L.C. block for processing and to the RF output meter on the front panel.

Should the duty cycle or ambient temperature exceed the specified limits the P.A. is protected by a thermostat which will operate the low power facility on the T.L.C. block.

The Aerial change over control is initiated via the press to talk facility in the main frame.

5.8.2 CIRCUIT DESCRIPTION

Power Amplifier

The P.A. amplifier consists of three stages; a pre-amp, driver and output push-pull stage. Refer to the circuit diagram DP1000/1.

The pre-driver and driver stages are operated in Class A, and the final P.A. in Class AB (push-pull). Biasing of the pre-driver and driver is derived from potential divider chains R120/R121 and R126/R127.

Bias for the P.A. is derived from diode D60, R129/R155 and pot VR11. The current in D60 is provided by a mirror current source (necessary due to the high current demands of TR21 and TR22, compared with TR19 and TR20). Voltage variation across D60 would degrade the linearity of the P.A. and the mirror source avoids this.

The RF path starts at T9, a transmission line type transformer, giving a 4:1 impedance transformation. The signal is amplified by TR19 and fed into T10, which is also of the transmission line type. T10 also has a 4:1 impedance ratio but uses 3 times as many strands of wire as T9, in order to reduce the transmission line characteristic impedance. TR20, the driver, is a 20 watt device producing about 10W — depending on the gain of the final P.A. transistors. The output of TR20 is fed into transformer T11 which is specially constructed for low leakage inductance (see drawings AP 100/42) because of the low impedance into which the transistors must operate. A similar type of transformer is also used for the final output (see drawings AP 100/41). Transformers T11 and T12 are made up of ferrite beads slid over a length of copper tubing and held in position by two end cheeks which complete the secondary circuit for T11, and the primary circuit for T12.

All the RF transistors have feedback to varying degrees, but the only feedback circuit that is frequency tailored is across TR19 which was characterised for 2MHz at the LF end and 16MHz at the HF end, (C128, R122, RFC 30).

Frequency characterising is also provided by C145 and C148. C145 has two functions. It improves the wide band match of the transformer (thus improving linearity), and contributes to the frequency characterising at the HF end. C148 improves high frequency cut off, reducing harmonic levels (as do the other frequency compensating components).

T.L.C. Circuitry

The T.L.C. drive voltage is derived by the detector circuit D63, R134 and C149. This voltage is fed to TR25, which is in an emitter follower configuration, and the output of which is directly coupled to IC12. This voltage is also divided down and fed to TR26, which drives the RF output meter.

When the voltage at the input of IC12 rises sufficiently it will reach the reference voltage set at the junction of VR12, R141. This level is the T.L.C. threshold, and when the input reaches it the comparator will operate, with a gain set by the ratio of R142 and R140.

The threshold level set by VR12 relates directly to power output. Low power level facility is achieved by switching resistor R143 electrically across R141 thus changing the threshold level. Resistor R143 is switched in by transistor TR27, which can be brought into operation by one of two methods. One, by the removal of a link, (see circuit diagram), and the other by a thermostat mounted on the P.A. heat sink.

The dc output of IC12 is taken via D66 and R147, and used to charge C155. The attack time constant (set by R147 and C155) is for 1 to 2 ms, and the delay of 1.5 to 2 sec. is achieved by the time constant C155 and R146. D66 prevents C155 discharging back into IC12 in the no signal condition. The voltage across C155 is fed to the driver (coil pack mother board) via the buffer amplifier TR29, which operates as an emitter follower.

RL2 contacts provide a 13.8v output via C178 feedthrough capacitor on receive and 13.8v via C179 on transmit, for transmit-receive control of the transceiver circuits.
RL2 also has a spare set of decoupled contacts, which are available for the control of external equipment.

6. TEST REALIGNMENT AND PERFORMANCE MEASUREMENT

6.1 General Note

The following information is provided for use where a repair and replacement of parts renders realignment of a section necessary.

Complete realignment and test figures are given, covering all adjustable components. However, it is unlikely that any failure will necessitate readjustment of the whole MESSENGER

After completion of repairs and readjustment of the stages involved, the overall performance may be checked to ensure the MESSENGER meets it's published specification.

The various signal input and output figures quoted will be an aid to the service engineer when fault finding. (See also voltage analysis, Section 8). Test methods are described and the necessary test equipment includes nothing that is unlikely to be posessed by a well-equipped base workshop.

6.2 Test Equipment Required

RF Signal Generator, 1-20MHz, 50 ohms output impedance.
e.g. Marconi TF 144H

AF Output Power Meter, 4 ohms, 4W and 300 ohms, 10mW
e.g. Marconi TF 893A

AF Two-Tone Signal Generator, 1KHz, 600 ohms output impedance, two-tone
e.g. Dymar 2045

RF Wattmeter, 250 W, 50 ohms impedance
e.g. Bird model 43

RF Load/Attenuator, 100W, 50 ohms impedance, 50 dB attenuation.
e.g. Bird Tenuline 30 dB attenuator
plus 20 dB 50 ohms coaxial attenuator

RF Millivoltmeter	e.g. Racal model 9301
AF Millivoltmeter	e.g. Marconi TF 2600
Frequency Counter, 1-18MHz	accuracy 1 part in 10^7 e.g. Marconi TF 2430
Spectrum Analyser	e.g. Marconi TF 2370, with high impedance probe.
Power Supply, 13.8 v, 18A	e.g. Philips PE1516
Multimeter	e.g. Avo model 8/9
Stopwatch	
Fan, 100 CFM	
10 dB attenuator pad	(See fig. 11.9)
AF Distortion meter	e.g. Dymar 2065

RF fuse unit for Signal Generator
e.g. Marconi TM 9884

6.3 1.4MHz Carrier Oscillator

Allow the crystal oven to stabilise at normal working temperature. (5 mins.)

Connect the RF Millivoltmeter and Frequency Counter to pins 22 and 23 on mixer 2, check level and frequency. The clarifier control should be fully clockwise for these measurements, and VC1 adjusted for the frequency stated.

Oscillator level not less than 100 mV pd

Oscillator frequency 1.4MHz + 55Hz $^{+5\ Hz}_{-0\ Hz}$

Turn the clarifier control fully anti-clockwise and adjust RV5 for 1.4MHz $\begin{matrix}-5\text{Hz} \\ -55\text{Hz} \\ -0\text{Hz}\end{matrix}$.

To check the operation of the oscillator switch, connect the Frequency Counter to pins 19 and 20 on mixer 1.

The frequency should be 1.4MHz ± 1Hz when in the transmit mode. Adjust VR6 to achieve this.

6.4 Channel Oscillator

Connect the RF Millivoltmeter and Frequency Counter between pins 19 and 20 on mixer 1 Check level and frequency:

Oscillator level not less than 100 mV pd.

Oscillator frequency as marked on the appropriate crystal.

Adjust the appropriate VC2 for the marked frequency ±5Hz. Connect Frequency Counter to pins 22 and 23 on mixer 1. Check that the counter reads the same frequency when in the transmit mode.

6.5 RF/IF Alignment (Receive)

With the USB/LSB switch to USB, connect the RF signal Generator to the antenna socket via the RF fuse. Inject a signal at the appropriate channel frequency **plus** 1KHz, at 20 mV. (Channel frequency equals channel oscillator crystal frequency **minus** 1.4MHz). If all is well, a 1KHz tone should be heard from the loudspeaker, but if the set is badly out of alignment a larger input may be necessary.

At no time must the MESSENGER be operated on 'SEND' when the RF Signal Generator is connected.

Connect the AF Distortion Meter and the AF Output Meter, set to 4 ohms and switched to the 1 watt range, to the loudspeaker leads. Reduce the signal input until the tone is approximately 6 dB above the noise level (i.e. below agc threshold) and adjust the trimmer capacitor on the appropriate **receive** coil unit. **Do not adjust the coil cores.** Adjust VC4, VC5, (RX) and L1, L2 for maximum AF output.

The RF input level should be progressively reduced during alignment, and the generator frequency fine tuned for maximum output. Keep the audio output at approximately 0.5 watt by adjusting the volume control, VR9. Keep the RF input well below agc threshold during alignment.

6.6 Receiver Performance Checks

6.6.1 SINAD

With 1 uV emf input from the Signal Generator peaked in the IF passband measure the SINAD by tuning the AF Distortion Meter for a null in its meter reading. The fall in reading on its dB scale is the SINAD. This should be approximately 9 dB.

6.6.2 Image Rejection

Proceed as 6.6.1 above. Note the SINAD. Tune the Signal Generator to the image frequency (channel frequency plus 2.8MHz), increase its output and fine tune to produce the same SINAD.

The increase in Signal Generator output is the image rejection. This should be approximately 45 to 50 dB depending on frequency.

6.6.3 IF Rejection

Proceed as 6.6.1 above. Note the SINAD. Tune the Signal Generator to the IF (1.4MHz minus 1KHz) and increase its output by 80 dB. Fine tune for maximum response and readjust output level to produce the same SINAD.

The increase in Signal Generator ouput is the IF rejection. This should be approximately 70 to 80 dB, depending on frequency.

6.6.4 AGC Operation, To find the Threshold

With the AF Output Meter connected increase the Signal Generator output until the approximate AGC threshold is reached. At this point the rise in output measured on The AF Output Meter will be much less than the change in output (in dB's) from the Signal Generator. To establish the specified threshold adjust the Signal Generator output in 1dB steps to find the point where a 1dB increase causes only ½dB change in AF output.

This should be approximately 4 uV.

6.6.5 To Check the AGC Range

After 6.6.4 above, set the AF output by the volume control to 500mW. Increase the Signal Generator output by 90 dB.

The corresponding increase in AF output should be less than 3 dB.

6.6.6 To Check the AGC Time Constant

After 6.6.4 and 6.6.5 above, set the Signal Generator output to a level 10 dB above the threshold. By the volume control set the AF output to 50mW. Increase the Signal Generator output by a further 20dB. Using a stopwatch note the time taken for the AF output to return to within 2dB of 50mW when the Signal Generator output is reduced in one step by 20dB.

This should be between two and four seconds.

6.6.7 AF Output, Distortion

Tune the Signal Generator to the appropriate channel frequency + 1KHz, with a 1mV output, and set the volume control for 3W into the 4 ohms AF Output Meter **with one side of the loudspeaker disconnected.**

Using the AF Distortion Meter measure the total harmonic distortion.

This should not be more than 3%.

6.6.8 Earpiece Output Power

Connect a 4 ohm 5W resistor between the loudspeaker leads and transfer the AF Output Meter set to 300 ohms on the 10mW range to the leads to the earpiece with the earpiece disconnected.

With all other conditions as in 6.6.7 above, the corresponding earpiece power should be at least 8mW.

6.6.9 Auxiliary Output Voltage

Re-connect earpiece and with all other conditions as in 6.6.7 above, connect the AF Millivoltmeter to the auxiliary output leads P26 and P27 (earth).

The meter reading should be greater than 25 mV rms.

6.6.10 Selectivity

With the AF Output Meter re-connected to the loudspeaker leads and the 4 ohm resistor and AF Millivoltmeter removed set the Signal Generator output to a level 6dB less than that established in 6.6.4. Tune for a peak in AF output. Connect the Frequency Counter to the counter output socket on the Signal Generator. By the volume control set the AF output power to 50mW.

Slowly tune the Signal Generator to a slightly lower frequency until the AF output falls by 3 dB. Note the Frequency Counter reading.

This should be not more than the precise channel frequency **plus** 0.300KHz.

Repeat the process but tuning the Signal Generator to a slightly higher frequency for a corresponding 3dB fall in AF output power. Note the Frequency Counter reading.

This should be not less than the precise channel frequency **plus** 3.450KHz.

By tuning the Signal Generator between the two frequencies measured, explore for ripple in the passband.

This should be less than 3dB peak to peak.

6.7 Transmitter Alignment and Performance Checks

For the initial setting-up procedure the P.A. should be disabled.

(i) Disconnect the lead from the RF coil pack board (P64 and P65) to the P.A. unit and connect the RF Millivoltmeter with a 50 ohms termination to the same points on the RF coil pack board.

(ii) Open circuit the push-to-talk line (P10).

6.7.1. Tx IF Gain/VOGAD Adjustment.

Connect the 600 ohms AF Signal Generator to the microphone input terminals (i.e. across R46). Set its output to 1KHz at 2mV emf, VR7 fully clockwise and VR2 anticlockwise.

Connect the AF Millivoltmeter (high input impedance) between TP2 and ground. Set its range to 300mV fsd.

The AF Millivoltmeter should read approximately 100 to 120mV pd rms. For reduced mic sensitivity adjust VR7 anticlockwise. Normally set for 10mV emf.

Slowly increase the Tx IF gain by clockwise rotation of VR2 until the Millivoltmeter reading is reduced by 1dB. This establishes the VOGAD threshold and the Tx IF input to mixer 2.

Increase the output from the AF Signal Generator by 20dB.

The increase in AF Millivoltmeter reading should be not more than 2dB.

6.7.2 Internal Two-Tone Test

Disconnect the AF Signal Generator from the microphone input terminals.

Switch on the internal two-tone oscillator. Connect the HF Spectrum Analyser via a high-impedance probe to TP8, the sidebands produced by the two-tone oscillator will be displayed, (1.4MHz).

Adjust the tone balance control VR10 so that the two sidebands are equal in amplitude, ± 0.5dB.

Temporarily short pins 8 and 12 of IC9 to ground. Connect the AF millivoltmeter and Frequency Counter to TP15.

The readings should be 1600Hz ± 100Hz and 10 to 20mV rms. Remove short on pins 8 and 12.

Repeat, but with pins 2 and 6 of IC9 temporarily shorted to ground.

The readings should be 2500Hz ± 150Hz and 10 to 20mV rms.

Remove the shorts on pins 2 and 6 of IC9.

6.7.3 Carrier Suppression

Connect instruments as in 6.7.2. Adjust VR1 for minimum 1.4MHz carrier amplitude. Measure the residual carrier amplitude.

This should be at least 45dB below the amplitude of either test-tone.

Switch the MESSENGER to LSB and re-check the carrier suppression. If the carrier suppression is not at least 45dB below either test-tone re-adjust VR1 for a compromise between USB and LSB so that at least 45dB suppression is obtained on both sidebands.

6.7.4 Unwanted Sideband Suppression

Switch off the internal two-tone test oscillator. Re-connect the AF Signal Generator as in 6.7.1. Set its output to 1KHz, 10mV emf. Using the Spectrum Analyser measure the unwanted sideband suppression on LSB and USB.

This should be at least 60dB in both cases.

6.7.5 Hum and Noise

Note the wanted sideband level on USB measured in 6.7.4 above.

Disconnect the AF Signal Generator and connect a 600 ohms non-inductive resistor in its place.

Note the highest level of hum and noise in the plateau displayed on the Spectrum Analyser.

This should be at least 50dB below the wanted sideband level.

6.7.6 Transmitter Drive Adjustment

Connect the AF Signal Generator as in 6.7.1. above. With Tx drive disconnected and RF Millivoltmeter connected as in 6.7. above. Adjust the Tx drive potentiometer (VR14/1 to 6) for the appropriate channel for 0dBm reading on the RF Millivoltmeter. Adjust VC4 and VC5 for maximum reading and then set VR14 fully clockwise.

The RF Millivoltmeter should read at least +16dBm for a single tone into 50 ohms.

Apply an external variable DC positive voltage between the TLC control pin 14 on the coil pack board and ground. The applied voltage under no circumstances should exceed 8 volts.

Varying the voltage should vary the output reading on the RF Millivoltmeter.

Set the voltage to 5V.

The RF Millivoltmeter reading should fall by at least 30 dB.

6.7.7. Power Amplifier and TLC Adjustment

All connections or disconnections must be made with the MESSENGER switched off. Reconnect the push-to-talk line. Reconnect the drive output from the coil pack board to the PA via the 10dB Attenuator Pad.
Set VR14 fully anticlockwise (minimum drive), and the TLC potentiometer VR12 fully anticlockwise.
(TLC inoperative).
Connect the RF Power Meter on the 250W range in series with the 100W 50 ohms Power Attenuator to the PA coaxial output socket.
Connect the Spectrum Analyser to the Power Attenuator output via an additonal low level Coaxial Attenuator so that the total attenuation is 50dB.
(The recommended Bird Power Attenuator has an attenuation of 30dB, therefore a low-level 20dB attenuator is required). Connect the AF Signal Generator as in 6.7.1 above.

Switch to transmit with 1KHz 10mV input and slowly turn VR14 clockwise until the RF Power Meter reads 120W. Do not exceed this power.

Turn VR12 clockwise until the reading is reduced to 100W by TLC action. This corresponds to a TLC level of 1dB.

Switch off and remove the 10dB Attenuator Pad.

Switch on and check the increase in RF Power Meter reading.

This should not be more than 0.5dB (110W approximately).

Switch the AF Signal Generator to two-tones of 1600 and 2500 Hz each of 5mV amplitude.
Alternatively, if a two-tone AF Signal Generator is not available, switch on the internal two-tone generator (switch off the external oscillator).

The RF Power Meter should read 50W ± 1dB.

Using the Spectrum Analyser, measure the second harmonics at twice the signal frequency.

These should be at least 25dB down on the fundamentals.

Measure the third harmonics at three times the signal frequency.

These should be at least 12dB down on the fundamentals.

Measure the in-band third-order intermodulation products.

These should be at least 31dB down on the rated pep output (25dB down on the amplitude of either tone).

6.7.8 Power Consumption

Switch off the MESSENGER and connect a DC Ammeter in series with the positive battery supply lead. Switch on and to transmit and measure the supply current for the rated two-tone pep output.

This should be not more than 16 Amps.

Switch off the two-tone AF source and apply a 1KHz tone to produce the rated RF output power.

The supply current should be not more than 19 Amps.

These measurements are referred to a 13.8V DC supply.

6.7.9 Replacement of Power Transistors in P.A.

Tools and facilities

Screwdriver, snipe-nosed pliers, temperature controlled 70 watt soldering iron, or 25 watt uncontrolled iron. Solder-wick. Torque screwdriver set to 4lb. ft., heat sink thermal compound. Diagram 11–5.

Method of removal

Locate PA assembly.
Disconnect all leads to feed-through capacitors on PA cover, noting connections.
Take extreme care, avoiding all strain on the insulated body.
Disconnect screened lead from the right-hand end of PA at the small tag strip on the mainframe metalwork.
Disconnect two screened leads to PC164 at the pins on that printed circuit board.
Free these leads from other wires to allow them to be removed with the PA.
Disconnect heavy red and black battery leads.
Remove four screws fixing the PA to the main chassis.
Remove PA from the main chassis.
(In early sets (Serial Nos. PA1, PA2 and PA14), the fixing screws also retain the PA cover. In later sets ten further screws connect the cover to the edge of the heatsink).

Remove the PA complete with cover. Lay it with heatsink down and remove cover as above, carefully setting it at right angles to the heatsink, avoiding all strain on the cableform and other connections between the two parts.

Refer to diagram page 11–13 of the handbook.
Several components must be removed to allow access to the transistors.
These parts have preformed wires and are soldered to the pcb etc.
There are no locating holes and they must be reassembled precisely in the same positions later.

If replacing TR21 and TR22: R128, R130, R129 and R155 must be unsoldered at one end and carefully bent up clear of the transistors.
To replace TR20: R125 must be unsoldered at one end and the resistor moved aside.
To replace TR19: Transformer T9 must be similarly unsoldered and moved aside.
Do not unscrew the transistor fixing screws at this stage.

The tab connections of the transistors must be thoroughly unsoldered from the pcb. Use solder-wick; a desoldering pump is not suitable. Make sure each tab is free to bend slightly away from the pcb. It may be necessary to introduce the solder-wick under the tab to remove the solder.
When completely sure the transistor tabs are all free it is permissible to loosen the fixing screws by equal amounts each side initially.
Remove the screws completely and lift out the transistors.
Note: There are no washers under the fixing screwheads.

Replacing transistors

Clean off all traces of thermal compound on the heat sink to allow the replacement transistor to mate squarely with the heat sink.
Before fitting the new transistor coat the underside of the flange with a thin film of thermal compound.
Observe the orientation of the tab with the cropped corner (collector) on diagram 11–13.
Fit the transistor to the heat sink with screws finger-tight at this stage. Make sure the tabs are very slightly above the plane of the pcb.
Now torque down the transistor to 4lb. ft. (5.5Nm).
A small amount of compound should squash out all round the flange.
Solder the tabs, one tab per transistor, then return to the first transistor and solder on second tab, and so on.
If replacing only one transistor allow the joint to cool down thoroughly before soldering another tab.

In all cases the solder should thoroughly flood the tab and joint, but beware of excess.

Resolder the disconnected component ends, observing the precise location and positioning in relation to transistors, transformers, etc.

Testing

When a power transistor is replaced the standing current should be checked in case other components in that stage have been damaged by the faulty transistor.
Connect the heavy red and black wires to the power supply, observing polarity.
Disconnect the supply end of the choke listed below, connect a dc milliameter in series, negative lead to the choke.
Switch on power supply and measure, adjusting RV11 as appropriate.

Transistor	Measuring Point	Typical Current
TR 19	In series with RFC 28	375mA
TR 20	In series with RFC 33	1.1A
TR 21 & TR 22	In series with RFC 35	Set to 75mA by adjusting RV11

Reassemble the cover to the PA, the PA to the main-frame and remake joints to leads etc. in the reverse order to removal.

Note: It is not recommended that TR21 or TR22 are replaced singly. Failure of one will almost certainly have damaged the other even if simple tests suggest it is serviceable. Early failure is therefore likely.

7. CHANNELISATION

7.1 Receive Mode

7.2 Transmit Mode (PA Disabled)

7.3 Transmit Mode (PA Operating)

7 CHANNELISATION

This section explains the procedure necessary when the user requires the channel frequencies to be changed.

Test equipment needs are as listed in Section 6, para 6.2

In addition, quartz crystals for the new channel frequencies and the appropriate coil packs must be installed. Consult the coil pack frequency coverage listed in Section 5, para 5.2.

Depending on the number of channels previously fitted, some switching diodes may need fitting or removing.

If the service is to be changed from a single frequency simplex to two frequency simplex or vice-versa some switching diodes may need fitting or removing.

It is recommended that previously fitted frequencies and channel numbers and the new frequencies and channel numbers are listed side by side so that it may readily be seen which coil packs and switching diodes must be changed.

(a) Fit the appropriate transmit and receive coil packs.

(b) Fit the crystals in the appropriate oven position, referring to the chart below.

CHANNEL NO.	TRANSMIT/RECEIVE (SINGLE FREQUENCY) or RECEIVE (TWO-FREQUENCY)	TRANSMIT POSITION (TWO-FREQUENCY)
1	1	A
2	2	B
3	3	C
4	4	D
5	5	E
6	6*	not available
	* single frequency	

See Drg. A1/15000/Q, Page 11–6.
Positions 1 to 6 are used for single-frequency simplex transmit and receive: or for the receive channel on two-frequency simplex.
Positions A to E are used for two-frequency simplex, transmit only.

(c) Diodes D71/1 to 6 must be fitted for all used channel frequencies.

(d) Diodes D36/1 to 6 must be removed for all channels designated two-frequency simplex.

7.1 Receive Mode

(a) Connect the Frequency Counter to pins 19 and 20 on Mixer 1 and adjust the frequency by the appropriate VC2 for the crystal frequency ± 5Hz. Allow at least 5 minutes for oven to reach operation temperature before final adjustment.

(b) Connect the RF Signal Generator, AF Output Meter and AF Distortion Meter as in Chapter 6, paragraph 6.5. Adjust the appropriate coil pack by VC4 and VC5, keeping the Signal Generator input below the AGC threshold.

Measure the SINAD for a 1uV emf signal as in Section 6, paragraph 6.6.1. This should be approximately 9dB.

(c) Measure the image rejection as in Section 6, paragraph 6.6.2. This should be approximately 50dB.

(d) Measure the IF rejection as in Section 6, paragraph 6.6.3. This should be approximately 75dB.

(e) Increase the Signal Generator input to 2mV emf and measure the maximum AF output. This should be approximately 4 Watts with the loudspeaker disconnected.

(f) Measure the clarifier range with respect to the nominal received frequency. This should be at least ± 50Hz.

Repeat 7.1 (a) to (e) for all fitted channels.

7.2 Transmit Mode (P.A. Disabled)

(a) Connect the AF Signal Generator to the microphone input terminals (i.e. across R46). Set its output to 1KHz 5mV pd, and connect the RF Millivoltmeter to the TX driver output with a 50 ohms termination, disconnecting the lead from this point to the PA.

(b) Set the appropriate pre-set control VR14/1-6 to maximum gain (clockwise) and all others to minimum gain (anti clockwise). Tune the appropriate coil pack by VC4 and VC5 for maximum RF Millivoltmeter reading, reducing the RF drive to keep the reading below +10dBm. With the push-to-talk line inhibited, switch to transmit and check the Transmit oscillator frequency. These should be as recorded in paragraph 7.1 (a).

(c) When two-frequency simplex is required adjust the appropriate VC3 to the Transmit oscillator Frequency +5Hz.

Repeat 7.2 (a) to (c) for all fitted channels.

7.3 Transmit Mode (PA Operating)

All connections and disconnections should be made with the MESSENGER switched off.

(a) Set all pre-set controls VR14 anticlockwise and reconnect the TX driver to the PA via the 10dB Attenuator Pad.

(b) Reconnect the push-to-talk line and connect the RF Power Meter on the 250W range in series with the 100W 50 ohms Power Attenuator to the PA coaxial output socket.

(c) Connect the Spectrum Analyser to the output socket of the RF Power Attenuator via an additional low-level 50 ohms Coaxial Attenuator to provide a total of 50 dB attenuation.

The AF Signal Generator should remain connected as 7.2 (a), above.

(d) On transmit adjust the drive with the appropriate VR14 until the RF Power Meter reads 100W ± 1dB. This assumes that VR12 (TLC setting) has not been disturbed.
Repeat 7.3 (a) to (d) for all fitted channels.

(e) Remove the 10dB Attenuator pad and measure the following performances using the Spectrum Analyser.

(f) Using the internal two-tone test oscillator, measure the power output.
This should be 50W ± 1dB. It may be necessary to make a small adjustment to VR12 in order to achieve this on all channels.

(g) Measure the second harmonic level at twice the signal frequency.
These should be at least 25dB down relative to the signal frequency.

(h) Measure the third harmonic level at three times the signal frequency.
These should be at least 12dB down relative to the signal frequency.

(i) Measure the in-band third order intermodulation products.

These should be at least 31dB below the rated pep (or 25dB below the level of either tone).

(j) Measure the 1.4MHz leakage.

This should be approximately 60dB below rated p.e.p.

(k) Measure the TX oscillator leakage.

This should be approximately 60dB below rated p.e.p.

(l) Measure the TX image frequency attenuation. This should be approximately 50dB

Repeat 7.3 (e) to (i) for all fitted channels.

8. TYPICAL VOLTAGE MEASUREMENTS

The figures given are typical values. DC voltages were measured using a DVM, and the signal levels with RF/AF high impedance millivoltmeters (unless stated otherwise). All dc voltages are with respect to chassis (earth).

8.1 ACTIVE DEVICES

	Rx	Tx
IC1/ 1	0	0
2	7.7	7.4
3	2.1	4.1
4	0	0
5	1.0	2.0
6	1.0	2.0
7	0	6
8	0	0
IC2/ 1	0	0
2	3.6	3.6
3	3.6	3.6
4	7.9	7.8
5	7.9	7.8
6	0	0
7	3.6	3.6
8	0	0
IC3/ 1	0	0
2	7.3	7.1
3	2.3	4.7
4	0	0
5	1.0	1.2
6	1.0	1.2
7	0.75	4.5
8	0	0
IC4/ 1	0	0
2	7.3	7.1
3	2.3	3.9
4	0	0
5	0.8	1.0
6	0.8	1.0
7	0.5	3.6
8	0	0

	Rx	Tx
IC5/ 1	0	0
2	3.4	3.3
3	3.4	3.3
4	7.4	7.2
5	6.1	6.0
6	0	0
7	3.4	3.3
8	0	0
IC6/ 1	3.9	3.9
2	7.8	7.8
3	5.3	5.3
4	1.4	1.4
5	1.5	2.1
6	1.5	2.1
7	6.2	0.8
8	0	0
IC7/ 1	0	0
2	2.9	3.0
3	2.5	2.5
4	0	0
5	0	0
6	1.3	1.3
7	10.2	10.2
8	0	0
IC8/ 1	0	0
2	6.6	6.6
3	13.8	13.8
4	13.0	13.0
5	13.0	13.0
6	1.5	1.5
7	3.0	3.0
8	0.7	0.7
9	0	0

	Test Osc. On
IC9/ 1	3.9
2	3.9
3	5.2
4	7.8
5	4.0
6	3.9
7	0
8	3.9
9	3.5
10	7.8
11	5.2
12	3.9
13	3.9
14	7.8

		Rx	Tx
NB_1	TR5/ E	0	0
	B	0.3	0.3
	C	7.4	7.2
	TR6/ E	0	0
	B	0	0.6
	C	0.3	0
NB_1	TR7/ E	0.3	0.3
	B	0.9	0.9
	C	7.4	7.2
NB_2	TR8/ E	1.0	4.9
	B	0.3	8.6
	C	0	0

		Rx	Tx
IC10/	1	13.8	13.8
	2	0	0
	3	8.0	8.0
TC11/	1	0	0
	2	7.8	7.8
	3	1.8	2.3
	4	0	0
	5	0.9	0.9
	6	0.9	0.9
	7	0	0
	8	0	0
TR1/	E	2.5	2.5
	B	3.3	3.2
	C	8	8
TR2/	E	1.7	1.7
	B	2.4	2.4
	C	8	8
TR3/	E	1	1
	B	1.7	1.7
	C	8	8
TR4/	E	0	0
	B	0	0.7
	C	6.5	0.1
Test Osc:		OFF	ON
TR15/	E	0	8
	B	8	8
	C	8	8
TR16/	E	8	8
	B	8	8
	C	0	0
TR17/	E	0	0
	B	0	0
	C	0.9	0.9
TR18/	E	0	0
	B	0	0
	C	0.9	0.9
TR 9/	E	3.4	3.4
	B	4.2	4.2
	C	7.5	7.5
NB_3 TR10/	E	0	0
	B	0.7	0.7
	C	0	0
NB_4 TR11/	E	0	0
	B	0	0.7
	C	8.0	0
NB_5 TR12/	E	0	0
	B	0	0
	C	6.4	6.1
TR13/	E	4.4	4.4
	B	5.1	5.1
	C	8	8
TR14/	E	4	3.6
	B	4.8	4.2
	C	8	7.8

NB_1 Depends on AGC/VOGAD status. Figures given are for no signal.

NB_2 Depends on setting of VR2.

NB_3 For enabling of XL2/1-6.

NB_4 For inhibition of XL3/1-6.

NB_5 Depends on osc. gain control. Figures given are for a low activity crystal (no gain control).

8.2 SIGNAL AND OSCILLATOR VOLTAGE LEVELS

8.2.1 Receiver RF gain distribution

	Circuit Point	Typical voltage at AGC Threshold
(i)	Antenna Input	2 uV pd.
(ii)	Pin 6 of IC1 (RF amp Input)	1.6 uV pd.
(iii)	Pin 7 of IC2 (Mixer 1 signal Input, TP2)	25 uV pd.
(iv)	Output tap of T2 (Crystal filter Input TP22)	12 uV pd.
(v)	Pin 6 of IC3 (IF Amplifier Input, TP3)	20 uV pd.
(vi)	Pin 6 of IC4 (IF Amp 2nd stage Input, TP5)	0.5 mV pd.
(vii)	Pin 3 of IC4 (2nd IF stage Output, TP7)	50 mV pd.
(viii)	Pin 7 of IC5 (Mixer 2 signal Input, TP8)	25 mV pd.

Measurements of 1 mV rms pd or less were made using the spectrum analyser with high impedance RF probe.

8.2.2 Receiver Audio

(i)	Input to IC8 for 4W output (1KHz)	10 mV rms pd.
(ii)	Auxiliary output (open circuit)	25 mV rms pd.
(iii)	Phones output (in 300 ohms load)	8 mW

8.2.3 Transmitter AF/RF Gain Distribution

		Typical values at VOGAD Threshold
(i)	Mic. Input (IC6 Pin 5)	1 mV rms pd.
(ii)	Auxiliary AF Input	10 mV rms pd.
(iii)	Audio Input to Mixer I (IC2 Pin 7, TP2)	100 mV rms pd.
(iv)	SSB IF drive to IC3 (TP3)	5 mV rms pd.
(v)	SSB IF Drive to TR1 (TP7)	25 mV rms pd.
(vi)	SSB IF drive to Mixer 2 (TP8)	50 mV rms pd.
(vii)	SSB signal frequency drive at T4 top	7 mV rms pd.
(viii)	SSB signal frequency drive at IC11 Pin 6 (TP18)	4 mV rms pd.
(ix)	Output from TR18 (in 50ohm RF millivoltmeter)	+16 dBm p.e.p.

8.2.4 Oscillator Levels

(i)	1.4MHz Oscillator (TP11)	100 mV rms pd.
(ii)	Channel Oscillator (T6 output)	80-300 mV rms pd.

8.2.5 Two-Tone Test Oscillator

(i)	IC9, pins 5 and 9	TTL output (square wave)
(ii)	TP15	10-20 mV pd. each tone.

8.2.6 Clarifier DC Levels

VR6	(Tx)	6.7v
VR4	(Rx)	5-10v
VR5	(Rx)	5v

8.2.7 Power Amplifier Measurements

The figures given are typical values. DC currents were measured using an AVO meter, DC voltages were measured using a D.V.M. and the signal levels with RF high impedance millivoltmeter. All DC voltages are with respect to chassis.

DC Quiescent Currents

Pre-driver		375mA
Driver		1.1A
Output stage	set to	75mA
Supply current, no drive		2.8A

DC Voltage Levels (No Drive)

TR23/C	3.8v
TR23/B	1.5v
TR24/E	0.18v
R126/R127	0.85v
R120/R121	1.2v
D63/R135	0v
R138/R139	0v
R140/R141	3v
TP21	1v
P83	0.43v

DC voltage levels with 50 watts (Mean, 1 tone) output, in T.L.C.

TR23/C	4.7v
TR23/B	1.5v
TR24/E	0.2v
R126/R127	0.85v
R120/R121	1.2v

dependant on frequency D63/R135	13.7v max. 7.5v min.
R138/R139	2.5v
R140/R141	5v
TP21	5v
P83	4.3v

RF Levels for 100 watts (Mean, 1 tone) output

	2 MHz	**4 MHz**	**8 MHz**	**16 MHz**
C124/T9	40mV	50mV	66mV	150mV
TR19/C	215mV	150mV	130mV	250mV
TR20/B	75mV	130mV	290mV	750mV
TR20/C	2.3v	2.55v	2.55v	3.6v
TR21/B	1.2v	1.37v	1.65v	2.7v
TR22/B	1.2v	1.4v	1.5v	2.3v
TR21/C	10v	10.2v	10.5v	11.5v
TR22/C	10v	10.2v	10.5v	11.5v

Power Amplifier Drive Level

PA input Sensitivity for 100 watts p.e.p. output.

	FREQUENCY				
Level of one tone	2 MHz	4 MHz	8 MHz	12 MHz	16 MHz
	0 dBm	+2 dBm	−7 dBm	−5 dBm	−3 dBm

9. SEMICONDUCTOR AND VARIABLE COMPONENT FUNCTIONS

9.1 Semiconductors

9.2 Potentiometers

9.3 Variable Capacitors

9. SEMICONDUCTOR AND VARIABLE COMPONENT FUNCTIONS

9.1 Semiconductors

Circuit Reference	Type	Function
IC 1	SL 1610	RF Amp.
IC 2	SL 641C	Mixer I (Rx: 1st mixer) (Tx: bal. mod)
IC 3	SL 1612	1st IF Amp.
IC 4	SL 1612	2nd IF Amp.
IC 5	SL 641C	Mixer 2 (Tx: 2nd mixer) (Rx: Prod. demod)
IC 6	SL 1630	Tx mic amp.
IC 7	LM 741 CN	AGC Comparator
IC 8	TDA 1010/1011	Audio output amp
IC 9	NE 556	Two tone oscillator
IC 10	LM 340 J 8.0	8v regulator
IC 11	SL 1612	Tx (signal frequency) Amp
IC 12	MC 1741 U	TLC Comparator
TR 1	BF 195	Tuned (1.4MHz) Amp
TR 2	BF 195	1.4MHz osc.
TR 3	BF 195	Buffer
TR 4	ZTX 108L	Osc. changeover switch
TR 5	ZTX 108L	AGC buffer
TR 6	ZTX 108L	AGC switch
TR 7	ZTX 108L	AGC time-constant buffer
TR 8	ZTX 213L	IF Gain switch
TR 9	BF 195	AGC amp
TR 10	ZTX 108L	Channel Crystal (1-6) bus switch
TR 11	ZTX 108L	Channel Crystal (A-E) bus switch
TR 12	BF 195	Channel Crystal AGC control
TR 13	BF 195	Channel Crystal oscillator
TR 14	BF 195	Channel Crystal amplifier
TR 15	ZTX 213L	Test oscillator switch
TR 16	ZTX 213L	AGC strobe generator
TR 17	ZTX 108L	AGC strobe generator
TR 18	2N3866	Tx Amp
TR 19	2N6367 or ZTB 312 FL	Tx Pre-driver Amp

Circuit Reference	Type	Function
TR 20	MRF 406	Tx Driver Amp
TR 21	MRF 454	Tx Output Amp.
TR 22	MRF 454	Tx Output Amp.
TR 23	TIP 41	Tx bias source
TR 24	2N5190	Tx bias source
TR 25	ZTX 108L	TLC input buffer
TR 26	ZTX 108L	Meter Driver
TR 27	ZTX 108L	Low Power Switch
TR 28	NOT USED	
TR 29	ZTX 108L	TLC Output buffer
D 1	BA 182	USB/LSB switch
D 2	BA 182	USB/LSB switch
D 3	BZY88C3V9	USB/LSB reference
D 4	BA 182	USB/LSB switch
D 5	BA 182	USB/LSB switch
D 6	IN 4148	TX IF gain isolator
D 7	IN 4148	Rx AGC Offset
D 8	IN 4148	Tx IF gain Offset
D 9	IN 4148	Tx IF gain Offset
D 10	IN 4148	Set 1.4MHz isolator
D 11	IN 4148	Clarifier isolator
D 12	MV 1404	1.4MHz varicap
D 13	BZY88C3V9	Osc. switch reference
D 14	BA 182	Osc. switching diodes
D 15	BA 182	Osc. switching diodes
D 16	BA 182	Osc. switching diodes
D 17	BA 182	Osc. switching diodes
D 18	BZY88C10	Tx control zener
D 19	IN 4148	Tx isolator
D 20	IN 4148	Rx isolator
D 21	BZY88C10	Rx control zener
D 22	IN 4148	Two tone control isolator
D 23	IN 4148	RF amp (Tx mute) isolating
D 24	IN 4148	RF amp agc isolating
D 25	IN 4148	Tx (IF gain switch) isolating
D 26	IN 4148	Vogad mute isolating
D 27	IN 4148	Vogad isolating
D 28	IN 4148	Preset mic. gain isolating
D 29	IN 4148	AGC isolating

Circuit Reference	Type	Function
D 30	IN 4148	Vogad isolating
D 31	IN 4148	AGC comparator isolating
D 32	BZY88C10	AGC comparator offset
D 33	IN 4148	AGC comparator offset
D 34	OA 91	AGC envelope detector
D 35/1-6	BA 182	Channel osc (1-6) switching
D 36/1-6	IN 4148	Channel osc. two frequency simplex
D 37/1-5	BA 182	Channel osc (A-E) switching
D 38	IN 4148	Channel osc. supply switching
D 39	IN 4148	Test isolating diode
D 40	IN 4148	VOX isolating
D 41	IN 4148	Local Tx control isolating
D 42	IN 4148	Ext. Tx control isolating
D 43	IN 4148	PA Control isolating
D 44	IN 4148	Strobe generator isolating
D 45	IN 4148	Aerial protection
D 46	IN 4148	Aerial protection
D 47	IN 4148	Aerial protection
D 48	IN 4148	Aerial protection
D 49	IN 4148	Aerial protection
D 50	IN 4148	Aerial protection
D 51	IN 4148	Aerial protection
D 52	IN 4148	Aerial protection
D 53 Tx & Rx	BA 182	Coil pack switching
D 54 Tx & Rx	BA 182	Coil pack switching
D 55	BZY88C5V1	Tx amp mute control offset
D 56	IN 4148	Tx amp mute isolating
D 57	IN 4148	TLC isolating
D 58	deleted	
D 59	deleted	
D 60	MR 501	PA bias source
D 61	IN 4148	RLI isolating
D 62	IN 4148	RLI Spike voltage protect
D 63	IN 4148	TLC Detector
D 64	IN 4148	RL2 spike voltage protection
D 65	NOT USED	
D 66	IN 4148	TLC comparator isolating
D 67	NOT USED	
D 68/1-6	IN 4148	Channel osc supply diodes

Circuit Reference	Type	Function
D 69	B436-150	Reverse polarity protection
D 70	IN 5347B	TLC supply
D 71/1-6	IN 914	Tx gain isolating

9.2 Potentiometers

VR 1	10K preset	Tx carrier balance
VR 2	10K preset	Tx IF gain set
VR 3	10K preset	Channel osc. balance
VR 4	5K log variable	Clarifier
VR 5	4K7 preset	Set clarifier –55Hz
VR 6	4K7 preset	Set 1.4MHz Tx
VR 7	10K preset	Preset mic gain
VR 8	4K7 preset	Phones output
VR 9	5K log variable	AF gain
VR 10	10K preset	Two tone test equaliser
VR 11	5K 3W preset	PA bias
VR 12	10K preset	TLC threshold
VR 13	10K preset	RF O/P adjust
VR 14/1-6	10K preset	Tx gain presets

9.3 Variable Capacitors

VC 1	2-18pF preset	Clarifier set +55Hz
VC 2/1-6	5-60pF preset	Set channel (1-6) freq.
VC 3/1-5	5-60pF preset	Set channel (A-E) freq.
VC 4/1-6 Tx & Rx	5-60pF preset	Coil pack frequency set
VC 5/1-6 Tx & Rx	5-60pF preset	Coil pack frequency set
L 1	1.4MHz tuned circuit IF selectivity	
L 2	1.4MHz tuned circuit IF selectivity	

10. COMPONENTS LIST

10. COMPONENTS LIST

10.1 Capacitors

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
C1	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C2	0 001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C3	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C4	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C5	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C6	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C7	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C8	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C9	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C10	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C11	0.1 uF Ceramic Disc 12v −20 +80%	1456873	PC 165
C12	0.1 uF Ceramic Disc 12v −20 + 80%	1456873	PC 165
C13	0.1 uF Ceramic Disc 12v −20 + 80%	1456873	PC 165
C14	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C15	0.1 uF Ceramic Disc 12v −20 + 80%	1456873	PC 165
C16	3900 pF Polystyrene 63v ±2.5%	1456644	PC 165
C17	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C18	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C19	0.001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C20	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C21	0.001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C22	0 001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C23	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C24	0 01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C25	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C26	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C27	3900 pF Polystyrene 63v ±2.5%	1456644	PC 165
C28	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C29	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C30	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C31	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C32	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C33	NOT USED		
C34	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C35	0.001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C36	0.001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C37	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C38	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C39	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C40	150 pF Polystyrene 63v ±2.5%	1456547	PC 165
C41	330 pF Polystyrene 63v ±2.5%	1456563	PC 165
C42	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C43	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C44	2200 pF Polystyrene 63v ±2.5%	1456628	PC 165
C45	2200 pF Polystyrene 63v ±2.5%	1456628	PC 165
C46	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C47	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C48	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C49	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C50	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
C51	0 1 uF Polyester 250v ± 20%	1456679	PC 165
C52	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C53	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C54	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C55	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C56	0 1 uF Polyester 250v ± 20%	1456679	PC 165
C57	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C58	10 uF Electrolytic 40v −10 + 50%	1455699	PC 165
C59	10 uF Electrolytic 40v −10 + 50%	1455699	PC 165
C60	0.001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C61	0.1 uF Ceramic Disc 12v −20 + 80%	1456873	PC 165
C62	0 1 uF Polyester 250v ± 20%	1456679	PC 165
C63	3900 pF Polystyrene 63v ±2.5%	1456644	PC 165
C64	100 pF Polystyrene 63v ±2 5%	1456539	PC 165
C65	1 uF Electrolytic 100v −10 + 75%	1455672	PC 165
C66	22 uF Electrolytic 16v −10 + 50%	1455702	PC 165
C67	1 uF Electrolytic 100v −10 + 75%	1455672	PC 165
C68	0.001 uF Ceramic Disc 500v ±20	1405624	PC 165
C69	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C70	10 uF Tantalum 16v ± 20%	1456776	PC 165
C71	100 uF Tantalum 16v ± 20%	1451618	PC 165
C72	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C73	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C74	0 01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C75	3900 pF Polystyrene 63v ±2 5%	1456644	PC 165
C76	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C77	0 47 uF Tantalum 35v ± 20%		PC 165
C78	0 1 uF Polyester 250v ± 20%	1456679	PC 165
C79	470 uF Electrolytic 16v −10 + 50%		PC 165
C80	10 uF Electrolytic 40v −10 + 50%	1455699	PC 165
C81	100 uF Electrolytic 25v −10 + 50%	1461621	PC 165
C82	2700 pF Polystyrene 63v ±2 5%	1456636	PC 165
C83	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C84	1 uF Electrolytic 100v −10 + 75%	1455672	PC 165
C85	3900 pF Polystyrene 63v ±2 5%	1456644	PC 165
C86	10 uF Electrolytic 40v −10 + 50%	1455699	PC 165
C87	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C88 2fs	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C89	470 pF Polystyrene 63v ±2 5%	1456571	PC 165
C90	3900 pF Polystyrene 63v ±2.5%	1456644	PC 165
C91	220 pF Polystyrene 63v ±2 5%	1456555	PC 165
C92	270 pF Polystyrene 63v ±2 5%	1461613	PC 165
C93	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C94	47 pF Polystyrene 63v ±2.5%	1456512	PC 165
C95	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C96	3900 pF Polystyrene 63v ±2.5%	1456644	PC 165
C97	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C98	1 uF Tantalum 35v ± 20%	1449362	PC 165
C99	1 uF Tantalum 35v ± 20%	1449362	PC 165
C100	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C101	3900 pF Polystyrene 63v ±2.5%	1456644	PC 165
C102	2.2 uF Tantalum 35v ± 20%	1461176	PC 165
C103	2.2 uF Tantalum 35v ± 20%	1461176	PC 165
C104	0.22 uF Polyester 250v ± 20%	1456687	PC 165
C105	0.22 uF Polyester 250v ± 20%	1456687	PC 165

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
C107 TS3	0.47 uF Polyester 100v ± 10%	1407880	PC 165
C108	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C109	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C110	0.1 uF Polyester 250v ± 20%	1456679	PC 163
C111	22 pF Polystyrene 63v ±2.5%	1456504	PC 163
C112 FD	0.75 pF Ceramic Tube 400v ± 0.1pF	1456806	PC 163
C112 FD	1.0 pF Ceramic Tube 400v ± 0.1pF	1456814	PC 163
C112 FD	1.5 pF Ceramic Tube 400v ± 0.1pF	1461591	PC 163
C113	22 pF Polystyrene 63v ±2.5%	1456504	PC 163
C114	0.1 uF Polyester 250v ± 20%	1456679	PC 163
C115	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C116	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C117	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C118	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C119	0 01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 164
C120	0 01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 164
C121	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C122	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C123	0.1 uF Polyester 250v ± 20%	1456679	PC 164
C124	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C125	0 1 uF Polyester 250v ± 10%	1440381	PC 170
C126	0 47 uF Polyester 100v ± 10%	1407880	PC 170
C127	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C128	470 pF Silver Mica 350v ± 5%	1456474	PC 170
C129	0.047 uF Polyester 400v ± 10%	1407813	PC 170
C130	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C131	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C132	0.47 uF Polyester 100v ± 10%	1407880	PC 170
C133	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C134	0 1 uF Polyester 250v ± 10%	1440381	PC 170
C135	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C136	0.47 uF Polyester 100v ± 10%	1407880	PC 170
C137	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C138	0 47 uF Polyester 100v ± 10%	1407880	PC 170
C139	330 uF Tantalum 25/30v −15 + 50%	1462431*	PC 170
C140	0.01 uF Polyester 400v ± 10%	1436325	PC 170
C141	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C142	NOT USED		
C143	NOT USED		
C144	0.01 uF Polyester 400v ± 10%	1436325	PC 170
C145	1500 pF Silver Mica 350v ± 5%	1456482	PC 170
C146	0.01 uF Polyester 400v ± 10%	1436325	PC 170
C147	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C148	120 pF Silver Mica 350v ± 5%	1456466	PC 170
C149	0.01 uF Polyester 400v ± 10%	1436325	PC 170
C150	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 170
C151	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 170
C152	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 170
C153	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 170
C154	1000 pF Silver Mica 350v ± 5%	1462393	PC 170
C155	22 uF Electrolytic 16v −10 + 50%	1455702	PC 170
C156	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 170
C157/1-6	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C158/1-5	0.01 uF Ceramic Disc 250v −20 + 80%	1456830	PC 165
C159	10 uF Electrolytic 40v −10 + 50%	1455699	PC 165
C160	0.1 uF Polyester 250v ± 20%	1455679	PC 165

*OR 1462423

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
C161	0 001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C162	0.01 uF Ceramic Disc 250v –20 + 80%	1456830	PC 165
C163	0.47 uF Polyester 100v ± 10%	1407880	PC 170
C164	0.1 uF Polyester 250v ± 20%	1456679	PC 165
C165	0.001 uF Ceramic Disc 500v ± 20%	1405624	PC 165
C166	0.1 uF Polyester 250v ± 10%	1440381	PC 170
C167	0.01 uF Ceramic Disc 250v –20 + 80%	1456830	PC 164
C168	0 01 uF Ceramic Disc 250v –20 + 80%	1456830	PC 170
C169	0.47 uF Polyester 100v ± 10%	1407880	PC 170
C170	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C171	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C172	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C173	NOT USED		
C174	NOT USED		
C175	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C176	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C177	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C178	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C179	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C180	0.01 uF Ceramic Disc 250v –20 + 80%	1456830	PC 165
C181	0.22 uF Polyester 250v ± 20%	1456687	PA Screen
C182	0.22 uF Polyester 250v ± 20%	1456687	PA Screen
C183	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C184	1000 pF C'mic Feed Thru 500v –20 + 80%	1455656	PA Screen
C185	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C186	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C187	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C188	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C189	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C190	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C191	82 pF Silver Mica 350v ± 5%	1461605	PC 170
C192	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C193	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C194	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C195	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C196	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C197	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C198	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 164
C199	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 170
C200	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 170
C201	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 170
C202	0.01 uF Ceramic Disc 25v –20 + 80%	1456830	PC 170
C203	0.47 uF Polyester 100V ± 10%	1407880	S4

10.2 Capacitors Variable

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
VC1	2 to 18 pF	1432036	PC 165
VC2/1 to 6	5 to 60 pF	1456164	PC 165
VC3/1 to 5	5 to 60 pF 2f simplex	1456164	PC 165
VC4/CD	5 to 60 pF	1456164	Coil Packs
VC5/CD	5 to 60 pF	1456164	Coil Packs

10.3 RF Chokes

CIRCUIT REF	TABLE 10.3	CODE No.	LOCATION
RFC1	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC2	NOT USED		
RFC3	470 uH 0.33w ± 10% SC10	1574388	PC 165
RFC4	100 uH 0.33w ± 10% SC60	1574353	PC 165
RFC5	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC6	100 uH 0 33w ± 10% SC10	1574418	PC 165
RFC7	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC8	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC9	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC10	10 uH 0.33w ± 10% SC10	1574345	PC 165
RFC11	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC12	100 uH 0 33w ± 10% SC10	1574418	PC 165
RFC13	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC14	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC15	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC16	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC17	470 uH 0.33w ± 10% SC10	1574388	PC 165
RFC18	470 uH 0.33w ± 10% SC10	1574388	PC 165
RFC19/1-6	1000 uH 0.33w ± 10% SC10	1574442	PC 165
RFC20	1000 uH 0.33w ± 10% SC10	1574442	PC 165
RFC21/1-5	1000 uH 0.33w ± 10% SC10	1574442	PC 165
RFC22	1000 uH 0.33w ± 10% SC10	1574442	PC 165
RFC23	100 uH 0.33w ± 10% SC10	1574418	PC 165
RFC24	1000 uH 0.33w ± 10% SC10	1574442	PC 165
RFC25	10 uH 0.33w ± 10% SC10	1574345	PC 165
RFC26	470 uH 2.0A ± 20%	1574493	TS3
RFC27	100 uH 0.33w ± 10% SC10	1574418	PC 164
RFC28	330 uH 0.5A ± 20%	1574485	PC 170
RFC29	68 uH 0.5A ± 20%	1574477	PC 170
RFC30	1 uH 0.33w ± 10% SC10	1574426	PC 170
RFC31	10 uH 3.0A ± 20%	1574507	PC 170
RFC32	33 uH 0.5A ± 20%	1574469	PC 170
RFC33	10 uH 0.33w ± 10% SC10	1574345	PC 170
RFC34	DRG A4/15000/81	A4/15000/81	PC 170
RFC35	DRG A4/15000/82	A4/15000/82	PC 170
RFC36	0.47 uH 0.33w ± 10% SC10	1574361	PC 170
RFC37	100 uH 0.33w ± 10% SC60	1574353	PC 164
RFC38	100 uH 0.33w ± 10% SC10	1574418	PC 164
RFC39	100 uH 0.33w ± 10% SC10	1574418	PC 164
RFC40	470 uH 0.33w ± 10% SC10	1574388	Front Panel
RFC41	Ferrite Double Aperture FX2049	1574515	PC 165
RFC42	DRG A3/15000/93	A3/15000/93	PA Screen
RFC43	DRG A3/15000/93	A3/15000/93	PA Screen
RFC44	100 uH 0.33w ± 10% SC10	1574418	PC 164

10.4 Coil Assemblies

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
L1	DRG A3/15000/39	A3/15000/39	PC 165
L2	DRG A3/15000/39	A3/15000/39	PC 165
L3/1-6 } BANDS 1-6	DRG A3/15000/40-45		Coil Pack
L4/1-6 } BANDS 1-6	DRG A3/15000/40-45		Coil Pack

10.5 Crystals and Oven

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
XL1	1.4MHz to DRG A4/15000/55	A4/15000/55	Crystal
XL2/1-6	to DRG A4/15000/56	A4/15000/56	Oven
XL3/1-5	to DRG A4/15000/56	A4/15000/56	
X01	12V 75°C 12 WAY	1618504	PC 165

10.6 Diodes

CIRCUIT REF	DESCRIPTION		CODE No.	LOCATION
D1	BA182		1947818	PC 165
D2	BA182		1947818	PC 165
D3	BZY88C3V9		1957627	PC 165
	OR ZF 3V9P			
D4	BA182		1947818	PC 165
D5	BA182		1947818	PC 165
D6	IN4148		1934597	PC 165
D7	IN4148		1934597	PC 165
D8	IN4148		1934597	PC 165
D9	IN4148		1934597	PC 165
D10	IN4148		1934597	PC 165
D11	IN4148		1934597	PC 165
D12	MV1404		1971840	PC 165
D13	BZY88C3V9		1957627	PC 165
	OR ZF 3V9P			
D14	BA182		1947818	PC 165
D15	BA182		1947818	PC 165
D16	BA182		1947818	PC 165
D17	BA182		1947818	PC 165
D18	BZY88C10		1968149	PC 165
	OR ZF 10P			
D19	IN4148		1934597	PC 165
D20	IN4148		1934597	PC 165
D21	BZY88C10		1968149	PC 165
	OR ZF 10P			
D22	IN4148		1934597	PC 165
D23	IN4148		1934597	PC 165
D24	IN4148		1934597	PC 165
D25	IN4148		1934597	PC 165
D27	IN4148		1934597	PC 165
D28	IN4148		1934597	PC 165
D29	IN4148		1934597	PC 165
D30	IN4148		1934597	PC 165
D31	IN4148		1934597	PC 165
D32	BZY88C10		1968149	PC 165
	OR ZF 10P			
D33	IN4148		1934597	PC 165
D34	OA91-05		1919717	PC 165
D35/ 1-6	BA182	CHANNEL DEP.	1947818	PC 165
D36/ 1-6	IN4148	CHANNEL DEP.	1934597	PC 165
D37/ 1-5	BA182	OPTION 2f SIMPLEX	1947818	PC 165
D38	IN4148		1934597	PC 165
D39	IN4148		1934597	PC 165
D40	IN4148		1934597	PC 165
D41	IN4148		1934597	PC 165
D42	IN4148		1934597	PC 165
D43	IN4148		1934597	PC 165
D44	IN4148		1934597	PC 165
D45	IN4148		1934597	PC 164
D46	IN4148		1934597	PC 164
D47	IN4148		1934597	PC 164
D48	IN4148		1934597	PC 164
D50	IN4148		1934597	PC 164
D51	IN4148		1934597	PC 164
D52	IN4148		1934597	PC 164

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
D53 CD	BA182	1947818	PC 163
D54	BA182	1947818	PC 163
D55	BZY88C5V1	1919792	PC 164
	OR ZF 5VIP		
D56	IN4148	1934597	PC 164
D57	IN4148	1934597	PC 164
D58	NOT USED		
D59	NOT USED		
D60	MR501	1971859	PC 170
D61	IN4148	1934597	PC 170
D62	IN4148	1934597	PC 170
D63	IN4148	1934597	PC 170
D64	IN4148	1934597	PC 170
D65	NOT USED		
D66	IN4148	1934597	PC 170
D67	NOT USED		
D68/ 1-6	IN4148	1934597	PC 165
D69	BYX36 150	1929070	S4
D70	IN5347B		PC 170
D71/ 1-6	IN4148	1934597	PC 164

10.7 Filters

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
FL1	LSB DRG A3/15000/34	A3/15000/34	PC 165
FL2	USB DRG A3/15000/35	A3/15000/35	PC 165

10.8 Fuses

REF	DESCRIPTION	CODE No.	LOCATION
FS 1	20A 1¼ x ¼		Supply Lead
	FUSE HOLDER IN LINE		Supply Lead

10.9 Heatsinks

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
	FAN TOP TO5	2509245	TR18
	DRG A0/15000/16	A0/15000/16	P A.
	DRG A4/15000/84	A4/15000/84	PC 165

10.10 Integrated Circuits

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
IC1	SL 1610C	1971778	PC 165
IC2	SL 641C	1971808	PC 165
IC3	SL 1612C	1971786	PC 165
IC4	SL 1612C	1971786	PC 165
IC5	SL 641C	1971808	PC 165
IC6	SL 1630C	1971794	PC 165
IC7	MC 1741U		PC 165
	OR CA 741G		
	LM 741J		
	UA 741MJ		
IC8	TDA 1011		PC 165
IC9	NE 556A		PC 165
	OR LM 556CN		
	MC 3456P		
IC10	MC 7808CT		PC 165
	OR LM 340T-8.0		
IC11	SL 1612C	1971786	PC 165
IC12	LF 225H		PC 165

10.11 Lamp/Loudspeaker

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
LP1	0.04A 0.56W LES TYPE		Front Panel
	LAMP HOLDER CLIP ON		Front Panel
LS1	LOUDSPEAKER, 8R, ELIPTICAL, 76 x 131mm OR SQUARE, 81 x 81mm		

10.12 Potentiometers

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
VR1	10K LIN PC MTG Cermet ± 20%		PC 165
VR2	10K LIN PC MTG Cermet ± 20%		PC 165
VR3	10K LIN PC MTG Cermet ± 20%		PC 165
VR4	5k LOG PANEL MTG Carbon ± 20%		Front Panel
VR5	4K7 LIN PC MTG Cermet ± 20%		PC 165
VR6	4K7 LIN PC MTG Cermet ± 20%		PC 165
VR7	10K LIN PC MTG Cermet ± 20%		PC 165
VR8	4K7 LIN PC MTG Cermet ± 20%		PC 165
VR9	5K LOG PANEL MTG Carbon ± 20%		Front Panel
VR10	10K LIN PC MTG Cermet ± 20%		PC 165
VR11	5R LIN PC MTG Wire Wound ± 20%		PC 170
VR12	10K LIN PC MTG Cermet ± 20%		PC 170
VR13	10K LIN PC MTG Cermet ± 20%		PC 170
VR14/1-6	10K LIN PC MTG Cermet ± 20%		PC 164

10.13 Relays

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
RL1	2 Pole Change Over 12v PC Mtg		PC 170
RL2	2 Pole Change Over 12v PC Mtg		PC 170

10.14 Resistors

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
R1	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R2	390R ± 5% 1/4w Carbon Film	1104845	PC 165
R3	270K ± 5% 1/4w Carbon Film	1104594	PC 165
R4	56R ± 5% 1/4w Carbon Film	1106570	PC 165
R5	330R ± 5% 1/4w Carbon Film	1106406	PC 165
R6	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R7	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R8	100R ± 5% 1/4w Carbon Film	1104888	PC 165
R9	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R10	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R11	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R12	8K2 ± 5% 1/4w Carbon Film	1107143	PC 165
R13	560R ± 5% 1/4w Carbon Film	1108689	PC 165
R14	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R15	270K ± 5% 1/4w Carbon Film	1104594	PC 165
R16	56R ± 5% 1/4w Carbon Film	1106570	PC 165
R17	560R ± 5% 1/4w Carbon Film	1108689	PC 165
R18	10K ± 5% 1/4w Carbon Film	1104721	PC 165
R19	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R20	10K ± 5% 1/4w Carbon Film	1104721	PC 165
R21	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R22	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R23	100K ± 5% 1/4w Carbon Film	1104632	PC 165
R24	100K ± 5% 1/4w Carbon Film	1104632	PC 165
R25	15K ± 5% 1/4w Carbon Film	1104705	PC 165
R26	33K ± 5% 1/4w Carbon Film	1104683	PC 165
R27	82R ± 5% 1/4w Carbon Film	1105817	PC 165
R28	1K8 ± 5% 1/4w Carbon Film	1128205	PC 165
R29	100R ± 5% 1/4w Carbon Film	1104888	PC 165
R30	47R ± 5% 1/4w Carbon Film	1104918	PC 165
R31	820R ± 5% 1/4w Carbon Film	1116738	PC 165
R32	2K2 ± 5% 1/4w Carbon Film	1104802	PC 165
R33	3K3 ± 5% 1/4w Carbon Film	1104780	PC 165
R34	3K3 ± 5% 1/4w Carbon Film	1104780	PC 165
R35	2K2 ± 5% 1/4w Carbon Film	1104802	PC 165
R36	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R37	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R38	33K ± 5% 1/4w Carbon Film	1104683	PC 165
R39	220R ± 5% 1/4w Carbon Film	1104853	PC 165
R40	220R ± 5% 1/4w Carbon Film	1104853	PC 165
R41	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R42	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R43	2K2 ± 5% 1/4w Carbon Film	1104802	PC 165
R44	2K2 ± 5% 1/4w Carbon Film	1104802	PC 165
R45	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R46	560R ± 5% 1/4w Carbon Film	1108689	PC 165
R47	33K ± 5% 1/4w Carbon Film	1104683	PC 165
R48	330R ± 5% 1/4w Carbon Film	1106406	PC 165
R49	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R50	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R51	10R ± 5% 1/4w Carbon Film	1113453	PC 165
R52	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R53	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R54	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R55	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
R56	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R57	100R ± 5% 1/4w Carbon Film	1104888	PC 165
R58	33K ± 5% 1/4w Carbon Film	1104683	PC 165
R59	270K ± 5% 1/4w Carbon Film	1104594	PC 165
R60	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R61	220K ± 5% 1/4w Carbon Film	1104608	PC 165
R62	390R ± 5% 1/4w Carbon Film	1104845	PC 165
R63	10K ± 5% 1/4w Carbon Film	1104721	PC 165
R64	10K ± 5% 1/4w Carbon Film	1104721	PC 165
R65	2K7 ± 5% 1/4w Carbon Film	1104799	PC 165
R66	10K ± 5% 1/4w Carbon Film	1104721	PC 165
R67	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R68	2K2 ± 5% 1/4w Carbon Film	1104802	PC 165
R69	15R ± 5% 1/4w Carbon Film	1145940	PC 165
R70	150R ± 5% 1/4w Carbon Film	1104861	PC 165
R71	3K3 ± 5% 1/4w Carbon Film	1104780	PC 165
R72	5K6 ± 5% 1/4w Carbon Film	1106163	PC 165
R73	330R ± 5% 1/4w Carbon Film	1106406	PC 165
R74	150R ± 5% 1/4w Carbon Film	1104861	PC 165
R75	4R7 ± 5% 1/4w Carbon Film	1122002	PC 165
R76	330K ± 5% 1/4w Carbon Film	1104586	PC 165
R77/1-6	1K CD ± 5% 1/4w Carbon Film	1104837	PC 165
R78/1-5	1K 2fS ± 5% 1/4w Carbon Film	1104837	PC 165
R79	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R80	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R81	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R82	33K ± 5% 1/4w Carbon Film	1104683	PC 165
R83 2fS	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R84 2fS	33K ± 5% 1/4w Carbon Film	1104683	PC 165
R85	18K ± 5% 1/4w Carbon Film	1105752	PC 165
R86	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R87	2K2 ± 5% 1/4w Carbon Film	1104802	PC 165
R88	27K ± 5% 1/4w Carbon Film	1104942	PC 165
R89	1K8 ± 5% 1/4w Carbon Film	1128205	PC 165
R90	22K ± 5% 1/4w Carbon Film	1104691	PC 165
R91	18K ± 5% 1/4w Carbon Film	1105752	PC 165
R92	22R ± 5% 1/4w Carbon Film	1115324	PC 165
R93	390R ± 5% 1/4w Carbon Film	1104845	PC 165
R94	820R ± 5% 1/4w Carbon Film	1116738	PC 165
R95	68K ± 2% 1/4w Metal Film	1020528	PC 165
R96	12K ± 2% 1/4w Metal Film	1015702	PC 165
R97	680R ± 5% 1/4w Carbon Film	1106155	PC 165
R98	6K8 ± 5% 1/4w Carbon Film	1104748	PC 165
R99	2K2 ± 5% 1/4w Carbon Film	1104802	PC 165
R100	12K ± 5% 1/4w Carbon Film	1104713	PC 165
R101	100K ± 2% 1/4w Metal Film	1021575	PC 165
R102	27K ± 2% 1/4w Metal Film	1017934	PC 165
R103	2K2 ± 5% 1/4w Carbon Film	1104802	PC 165
R104	1K8 ± 5% 1/4w Carbon Film	1128205	PC 165
R105	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R106	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R107	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R108	1K8 ± 5% 1/4w Carbon Film	1128205	PC 165
R109	4K7 ± 5% 1/4w Carbon Film	1104756	PC 165
R110	100R ± 5% 1/4w Carbon Film	1104888	PC 165

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
R111	2K2 ± 5% 1/4w Carbon Film	1104802	PC 164
R112	2K2 ± 5% 1/4w Carbon Film	1104802	PC 164
R113CD	560R Coil Pack ± 5% 1/4w Carbon Film	1108689	PC 163
R114CD	1K Coil Pack ± 5% 1/4w Carbon Film	1104837	PC 163
R115	2K2 ± 5% 1/4w Carbon Film	1104802	PC 164
R116	2K2 ± 5% 1/4w Carbon Film	1104802	PC 164
R117	100R ± 5% 1/4w Carbon Film	1104888	PC 164
R118	27R ± 5% 1/4w Carbon Film	1137808	PC 164
R119	22R ± 5% 1/4w Carbon Film	1115324	PC 164
R120	22R ± 5% 1/4w Carbon Film	1115324	PC 170
R121	220R ± 5% 2.5W Wirewound	1105973	PC 170
R122	120R ± 5% 1/4w Carbon Film	1106589	PC 170
R123	2R2 ±20% 1/2w Carbon Film		PC 170
R124	2R2 ±20% 1/2w Carbon Film		PC 170
R125	100R ± 5% 1w Carbon Film		PC 170
R126	22R ± 5% 1/4w Carbon Film	1115940	PC 170
R127	180R ± 5% 2.5W Wire Wound	1068660	PC 170
R128	68R ± 5% 2W Carbon Film		PC 170
R129	10R ± 5% 1/2w Carbon Film		PC 170
R130	68R ± 5% 2W Carbon Film		PC 170
R131	3R3 ± 5% 1/2w Carbon Film		PC 170
R132	220R ± 5% 2.5w Wirewound	1105973	PC 170
R133	15R ± 5% 2.5w Wirewound	1109227	PC 170
R134	820R ± 5% 1/4w Carbon Film	1116738	PC 170
R135	3K3 ± 5% 1/4w Carbon Film	1104780	PC 170
R136	1K ± 5% 1/4w Carbon Film	1104837	PC 170
R137	1K2 ± 5% 1/4w Carbon Film	1104829	PC 170
R138	270R ± 5% 1/4w Carbon Film	1121960	PC 170
R139	47K ± 5% 1/4w Carbon Film	1104667	PC 170
R140	4K7 ± 5% 1/4w Carbon Film	1104756	PC 170
R141	1K ± 5% 1/4w Carbon Film	1104837	PC 170
R142	18K ± 5% 1/4w Carbon Film	1105752	PC 170
R143	180R ± 5% 1/4w Carbon Film	1108921	PC 170
R144	27K ± 5% 1/4w Carbon Film	1104942	PC 170
R145	NOT USED ± 5% 1/4w Carbon Film		PC 170
R146	560K ± 5% 1/4w Carbon Film	1106392	PC 170
R147	22R ± 5% 1/4w Carbon Film	1115324	PC 170
R148	1K ± 5% 1/4w Carbon Film	1104837	PC 170
R149	1K ± 5% 1/4w Carbon Film	1104837	PC 165
R150	56R ± 5% 1.6W Carbon Film		PC 165
R151	1K2 ± 5% 1/4w Carbon Film	1104829	PC 164
R152	470R ± 5% 1/4w Carbon Film	1104950	PC 164
R153	47R ± 5% 1/4w Carbon Film	1104918	PC 170
R154	10R ± 5% 1/2w Carbon Film		PC 170
R155	10R ± 5% 1/2w Carbon Film		PC 170
R156	4K7 ± 5% 1/4w Carbon Film	1104756	PC 164
R157	1K ± 5% 1/4w Carbon Film	1104837	PC 165

10.15 Switches

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
S1	S.P.S.T. Rocker		Front Panel
S2	2PCO Slider		Rear Panel
S3A S3B S3C S3D	) Rotary To) DRG A3/15000/73	A3/15000/73	Front Panel
S4	S.P.S.T. Rocker		Front Panel
ST2	Switch Thermal DRG A4/15000/37	A4/15000/37	PC 170

10.16 Terminal Assemblies

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
TP1 to 21	Terminal Assemblies		) PC 170) PC 165) PC 164

10.17 Transformers

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
T1	DRG A3/15000/57	A3/15000/57	PC 165
T2	DRG A3/15000/58	A3/15000/58	PC 165
T3	DRG A3/15000/59	A3/15000/59	PC 165
T4	DRG A3/15000/58	A3/15000/58	PC 165
T5	DRG A3/15000/60	A3/15000/60	PC 165
T6	DRG A3/15000/61	A3/15000/61	PC 165
T7	DRG A3/15000/58	A3/15000/58	PC 164
T8	DRG A3/15000/62	A3/15000/62	PC 164
T9	DRG A3/15000/63	A3/15000/63	PC 170
T10	DRG A3/15000/64	A3/15000/64	PC 170
T11	DRG A3/15000/47	A3/15000/47	PC 170
T12	DRG A3/15000/51	A3/15000/51	PC 170

10.18 Transistors

CIRCUIT REF	DESCRIPTION	CODE No.	LOCATION
TR1	BF195		PC 165
TR2	BF195		PC 165
TR3	BF195		PC 165
TR4	ZTX108L		PC 165
TR5	ZTX108L		PC 165
TR6	ZTX108L		PC 165
TR7	ZTX108L		PC 165
TR8	ZTX213L		PC 165
TR9	BF195		PC 165
TR10	ZTX108L		PC 165
TR11	ZTX108L		PC 165
TR12	BF195		PC 165
TR13	BF195		PC 165
TR14	BF195		PC 165
TR15	ZTX213L		PC 165
TR16	ZTX213L		PC 165
TR17	ZTX108L		PC 165
TR18	2N3866		PC 164
TR19	2N6367 or		PC 170
	ZTB 312 FL (Flange Mtg.)		PC 170
TR20	MRF406 (Flange Mtg.)		PC 170
TR21	MRF454 (Flange Mtg.)		PC 170
TR22	MRF454 (Flange Mtg.)		PC 170
TR23	TIP41		PC 170
TR24	2N5190		PC 170
TR25	ZTX108L		PC 170
TR26	ZTX108L		PC 170
TR27	ZTX108L		PC 170
TR28	NOT USED		
TR29	ZTX108L		PC 170

11. DIAGRAMS

11.1 Receive Functions, Block Diagram

11.2 Transmit Functions, Block Diagram

11.3 Receive/Transmit Complete, Block Diagram

11.4 Front and Rear Views

11.5 PA Block Diagram

11.6 Location of Crystals and Adjustable Components

11.7 Accessories and Interconnections

11.8 Fixed Station Interconnections

11.9 Attenuator for TLC Adjustment

11.10 Tuning Unit Printed Circuit Board PC163

11.11 Tuning Unit Mother Board PC164

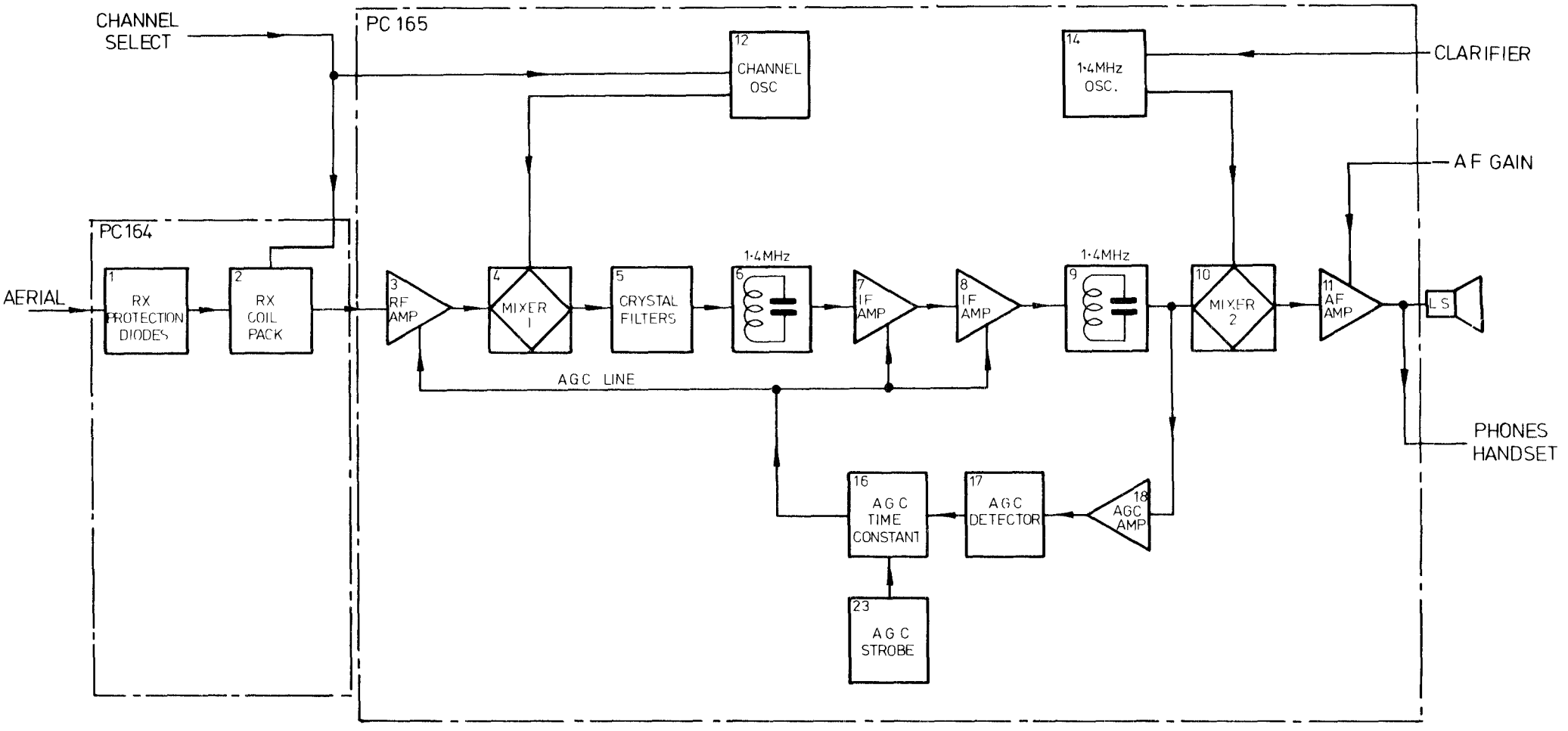
11.12 Signal Processing Board PC165

11.13 PA Board PC170

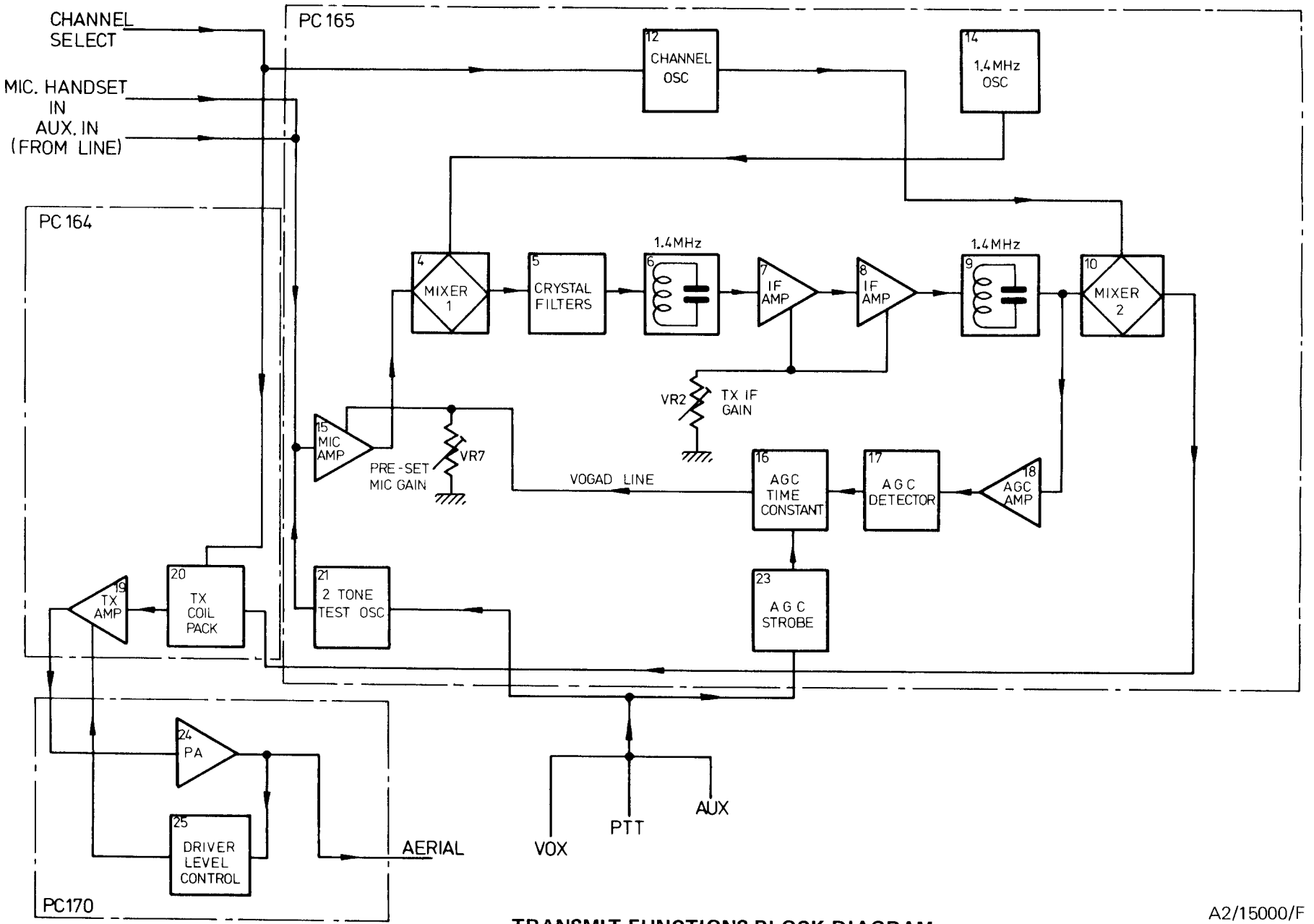
11.14 Circuit Diagram

11.15 Mobile Mount Arrangement

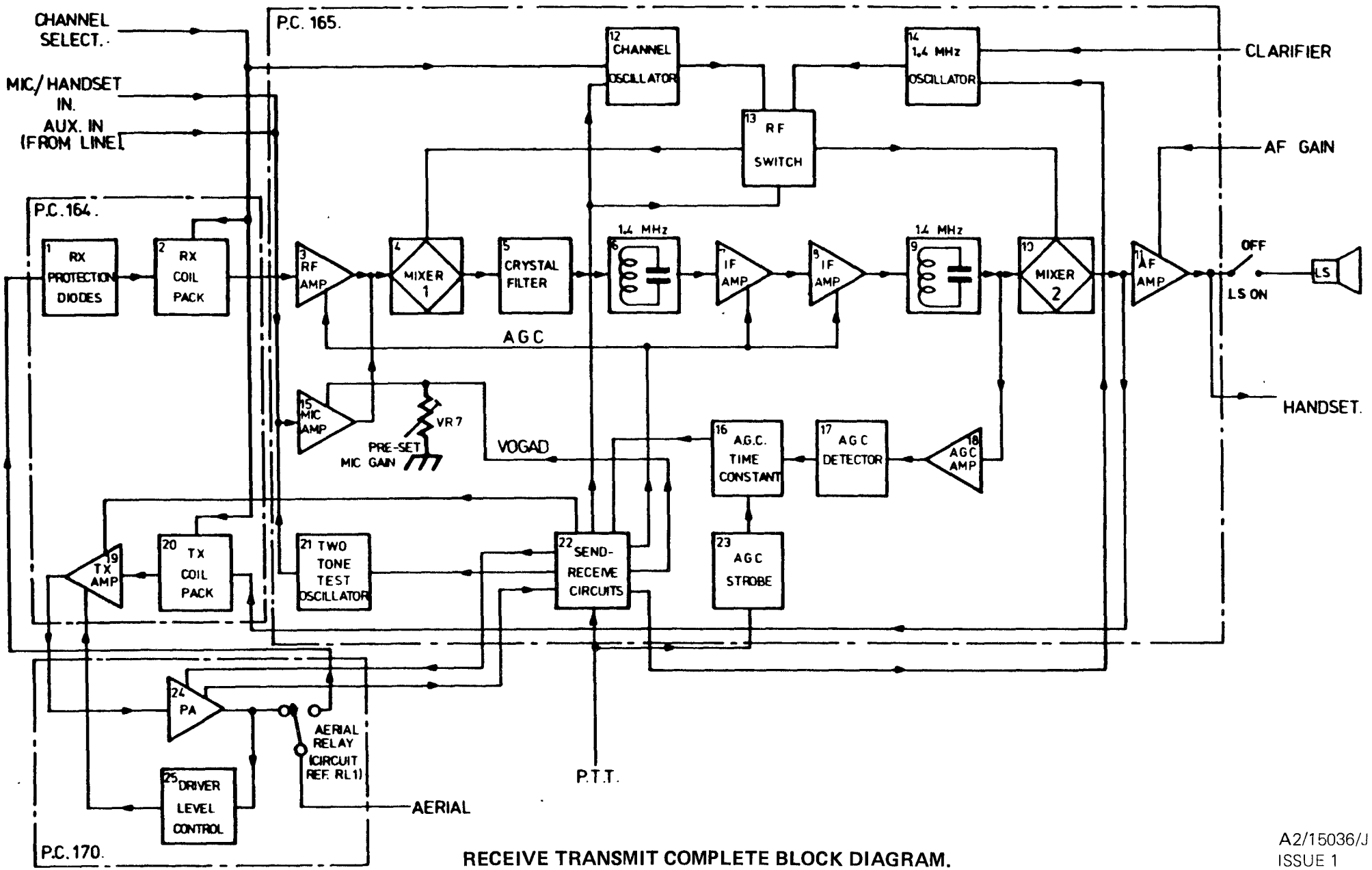
11.16 Auxilliary Connection List



RECEIVE FUNCTIONS BLOCK DIAGRAM



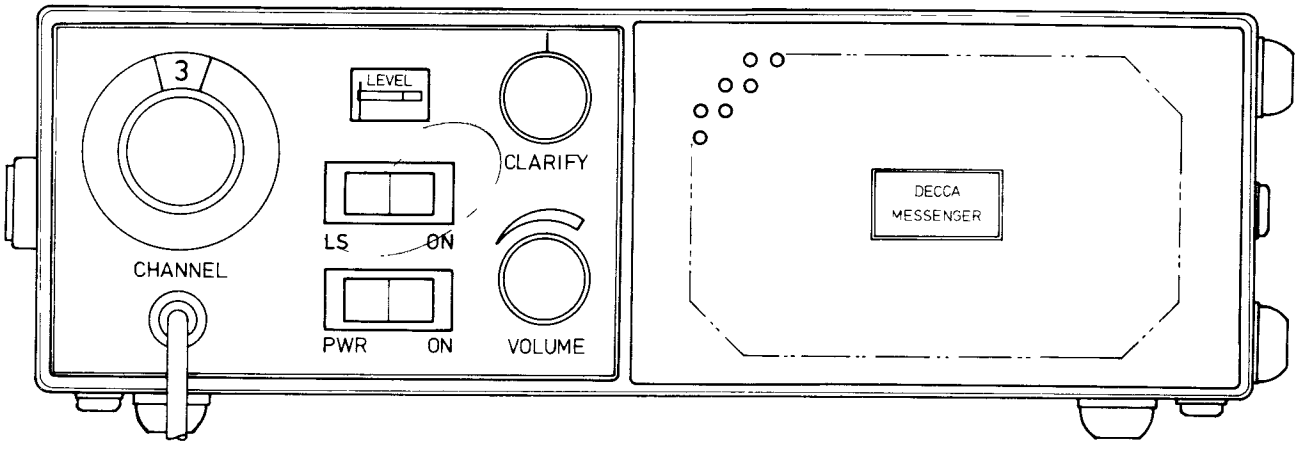
TRANSMIT FUNCTIONS BLOCK DIAGRAM



RECEIVE TRANSMIT COMPLETE BLOCK DIAGRAM.

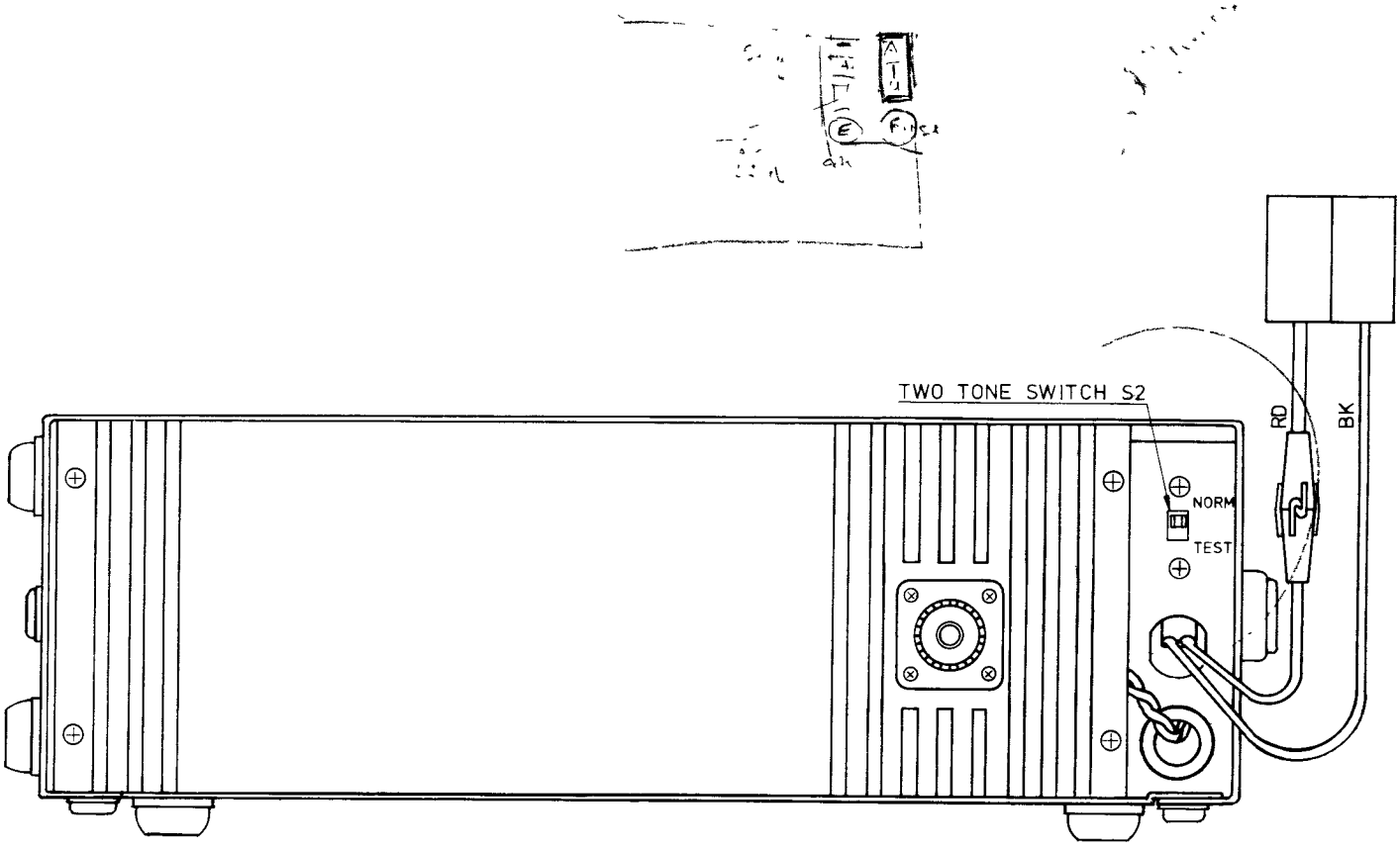
(INCORPORATING L.S. ON/OFF SWITCH)

A2/15036/J
ISSUE 1



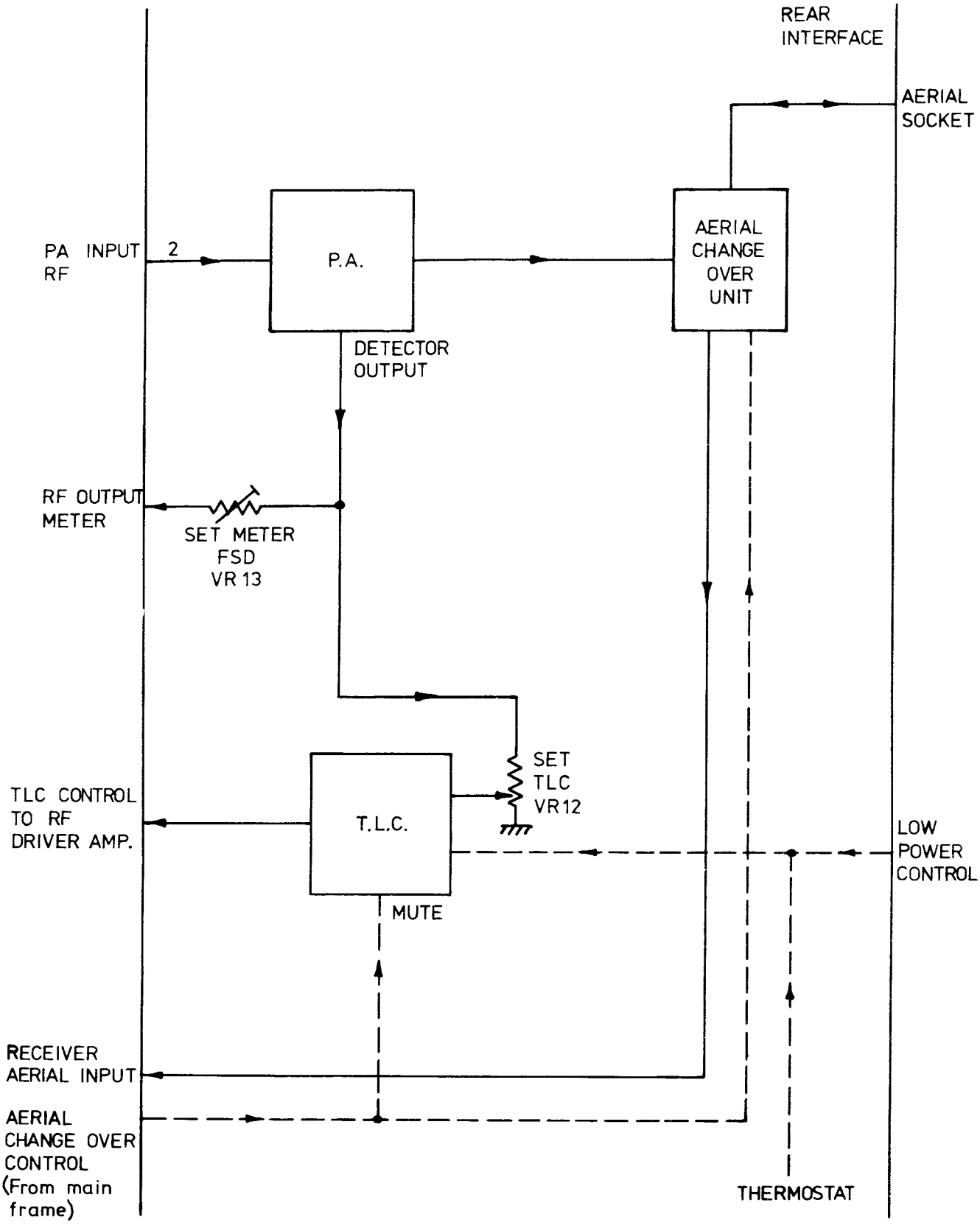
A3/15036/S
ISSUE 2

H.F. RADIO SET – FRONT PANEL.



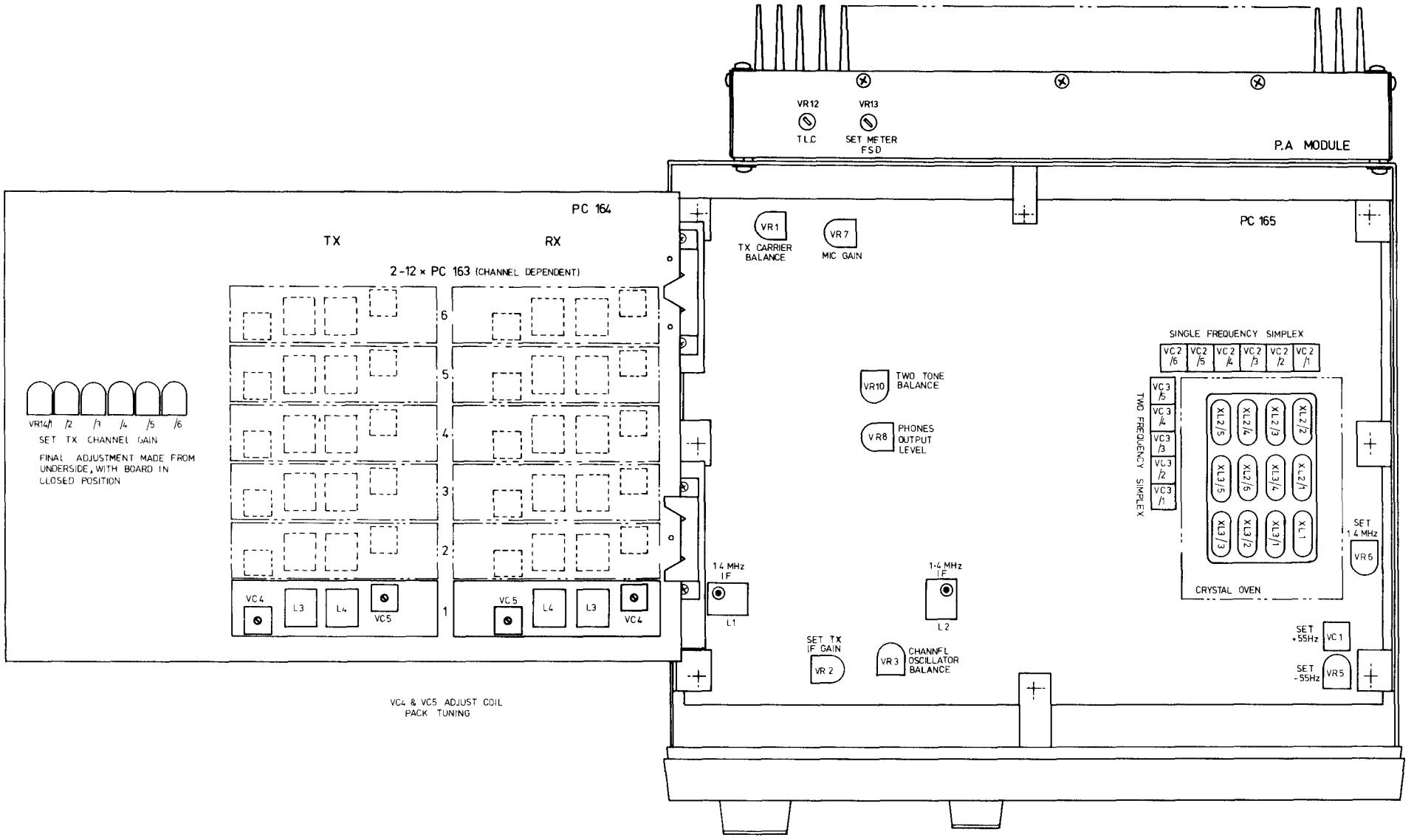
A3/15036/T
ISSUE 2

REAR VIEW

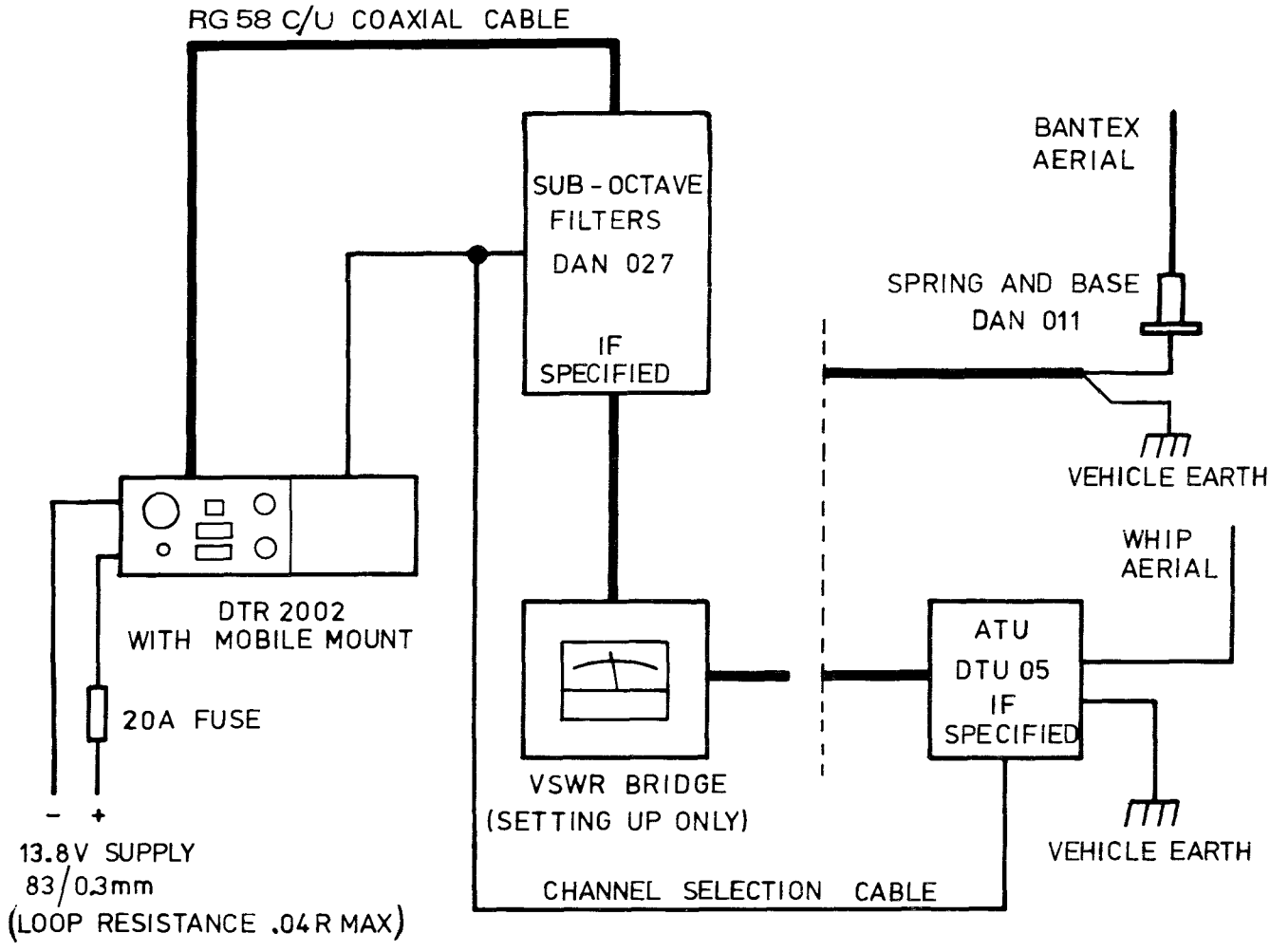


A2/15000/AA
ISSUE 1

DTR 2002 PA MODULE BLOCK DIAGRAM

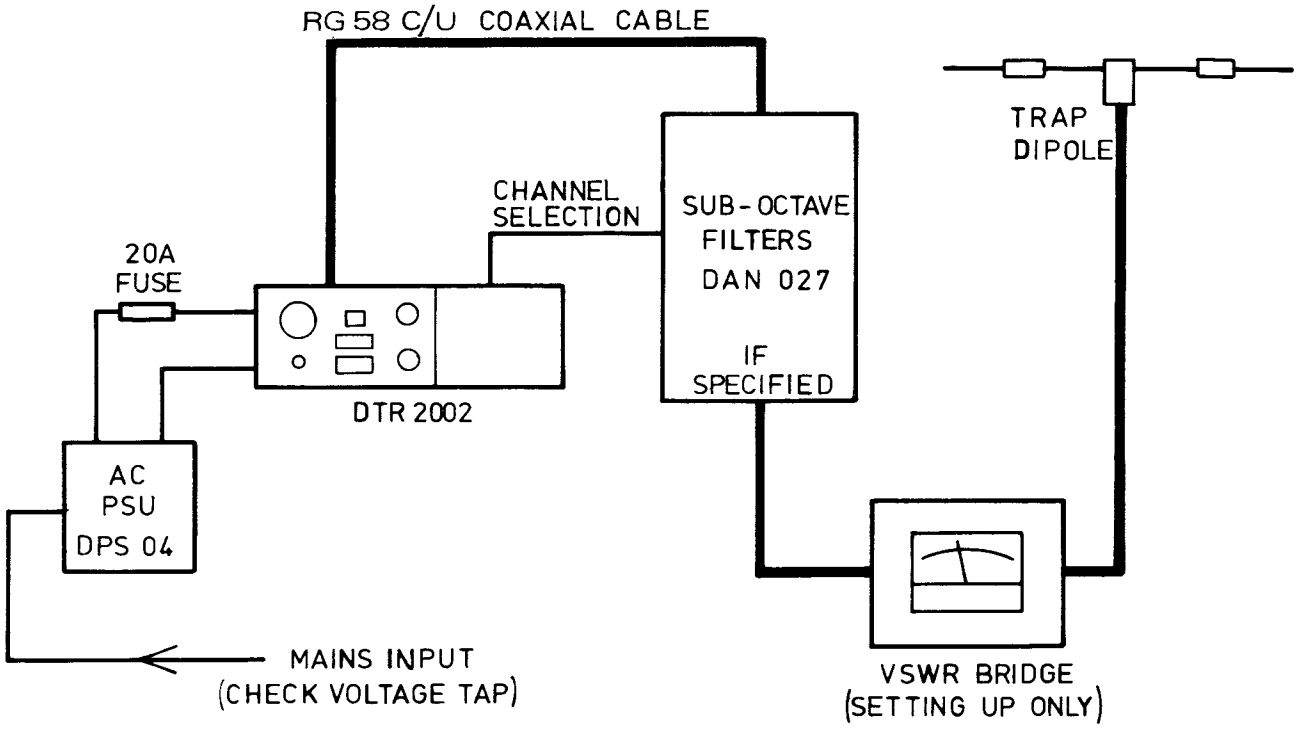


LOCATION OF CRYSTALS AND ADJUSTABLE COMPONENTS



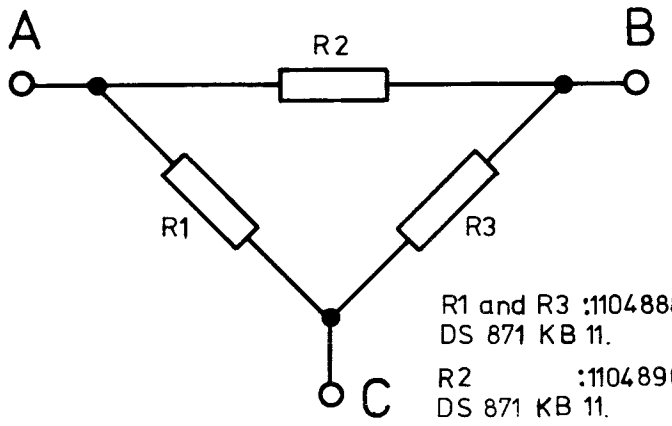
A4/15000/V
ISSUE 3

INTERCONNECTION OF DTR 2002 AND ACCESSORIES



A4/15000/W
ISSUE 2

TABLE MOUNTED DTR 2002.
FIXED STATION INTERCONNECTIONS



R1 and R3 :1104888 RESISTOR 100Ω ¼W 5%
DS 871 KB 11.

R2 :1104896 RESISTOR 68Ω ¼W 5%
DS 871 KB 11.

ATTENUATOR FOR SETTING UP TLC (NOMINAL 10dB)

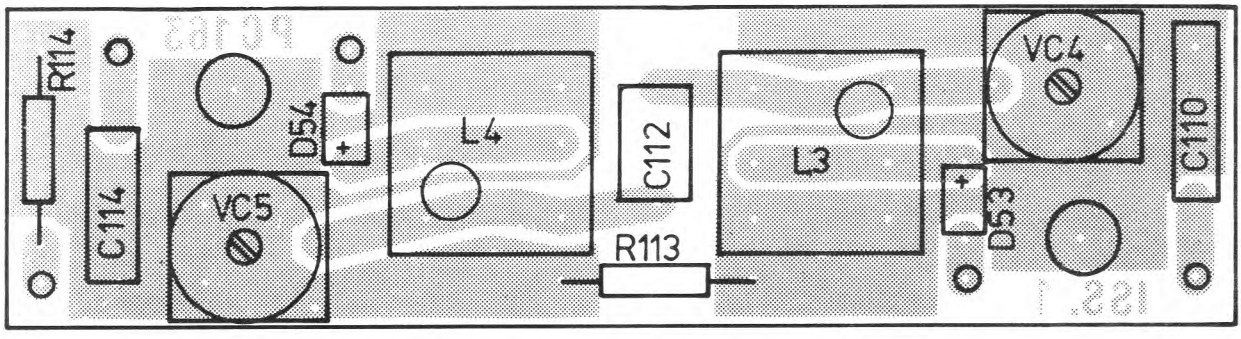
RESISTOR LEADS TO BE KEPT AS SHORT AS POSSIBLE.

NOTE FOR FIELD SERVICE USE:

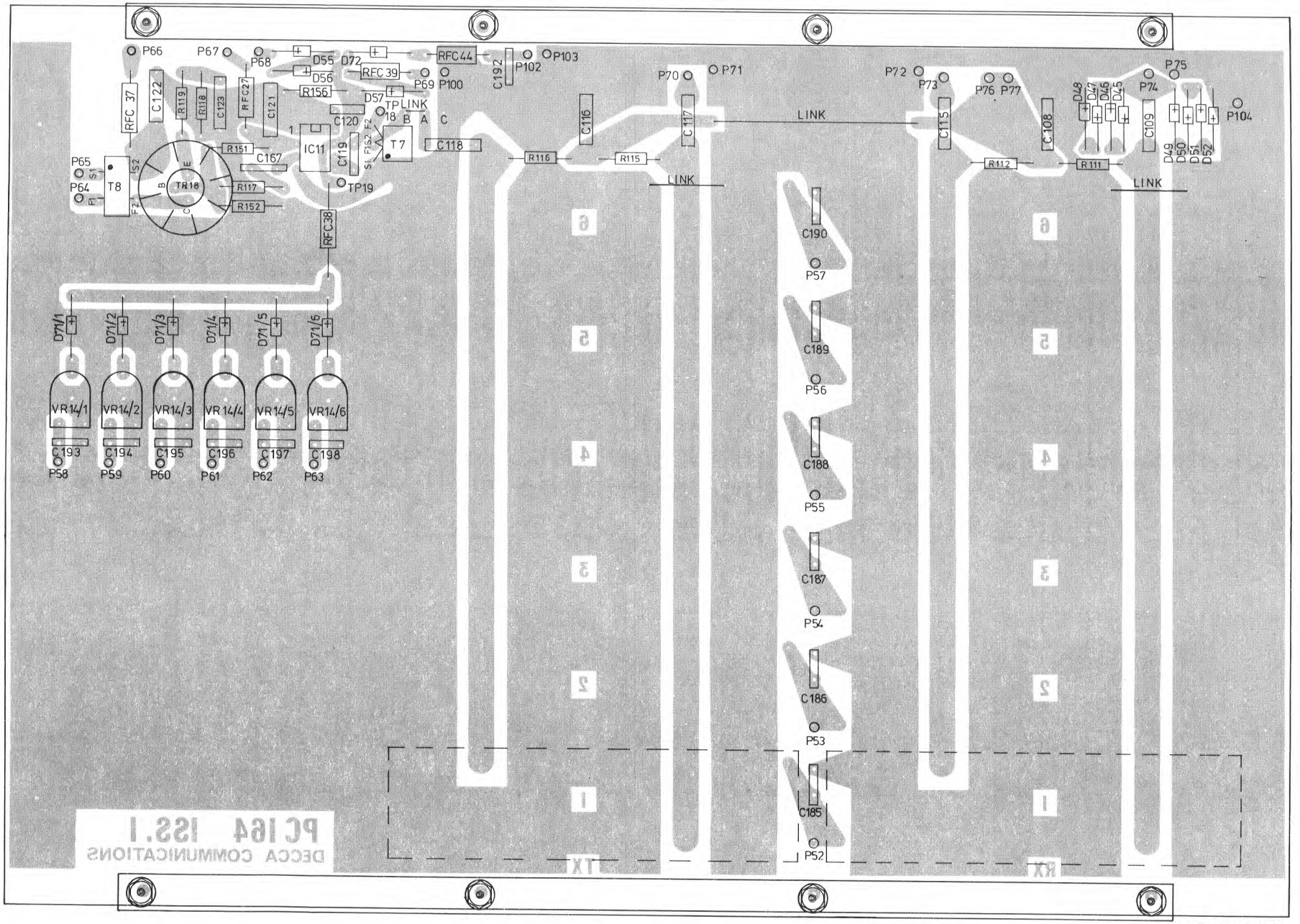
THESE RESISTORS ARE CARBON FILM, FOR EXAMPLE, MULLARD CR 25.

A4/15000/U
ISSUE 2

ATTENUATOR FOR SETTING UP TLC (NOMINAL 10 dB)
RESISTOR LEADS TO BE KEPT AS SHORT AS POSSIBLE

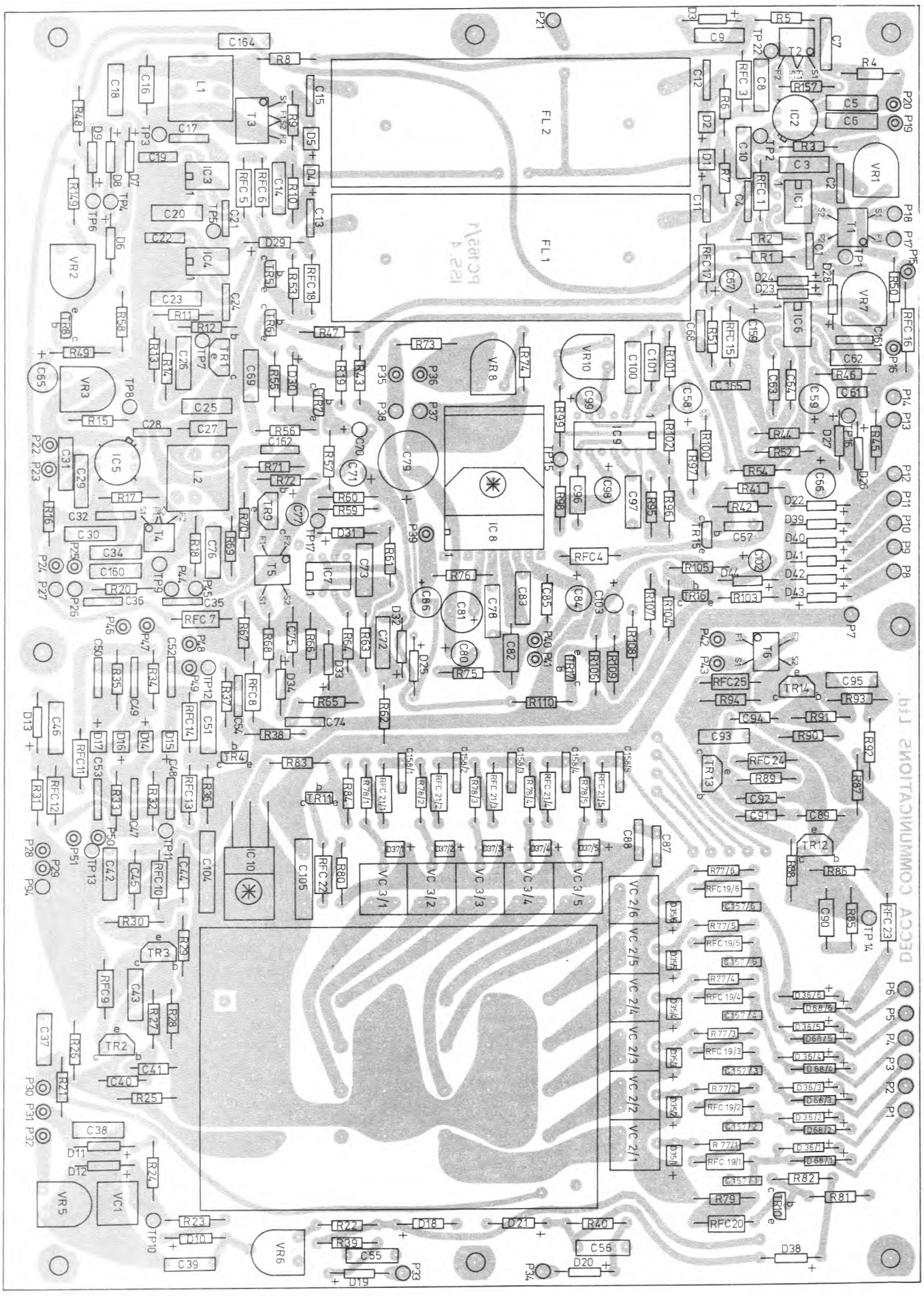


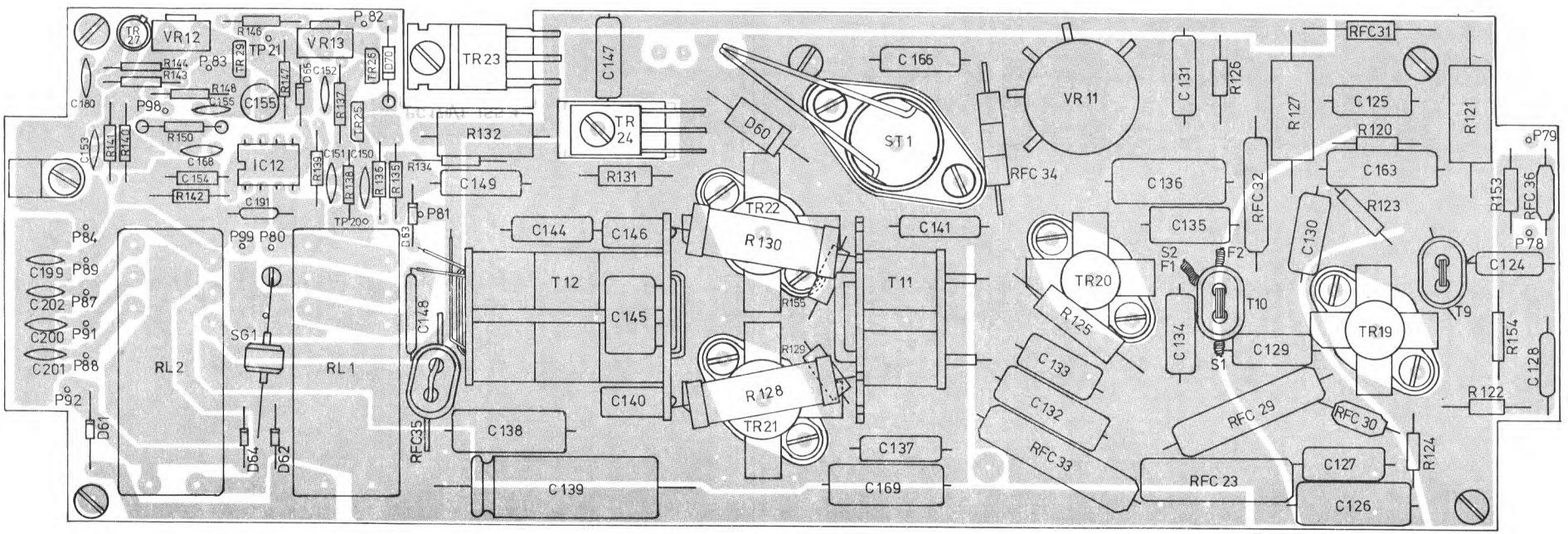
A3/15000/N
ISSUE 1



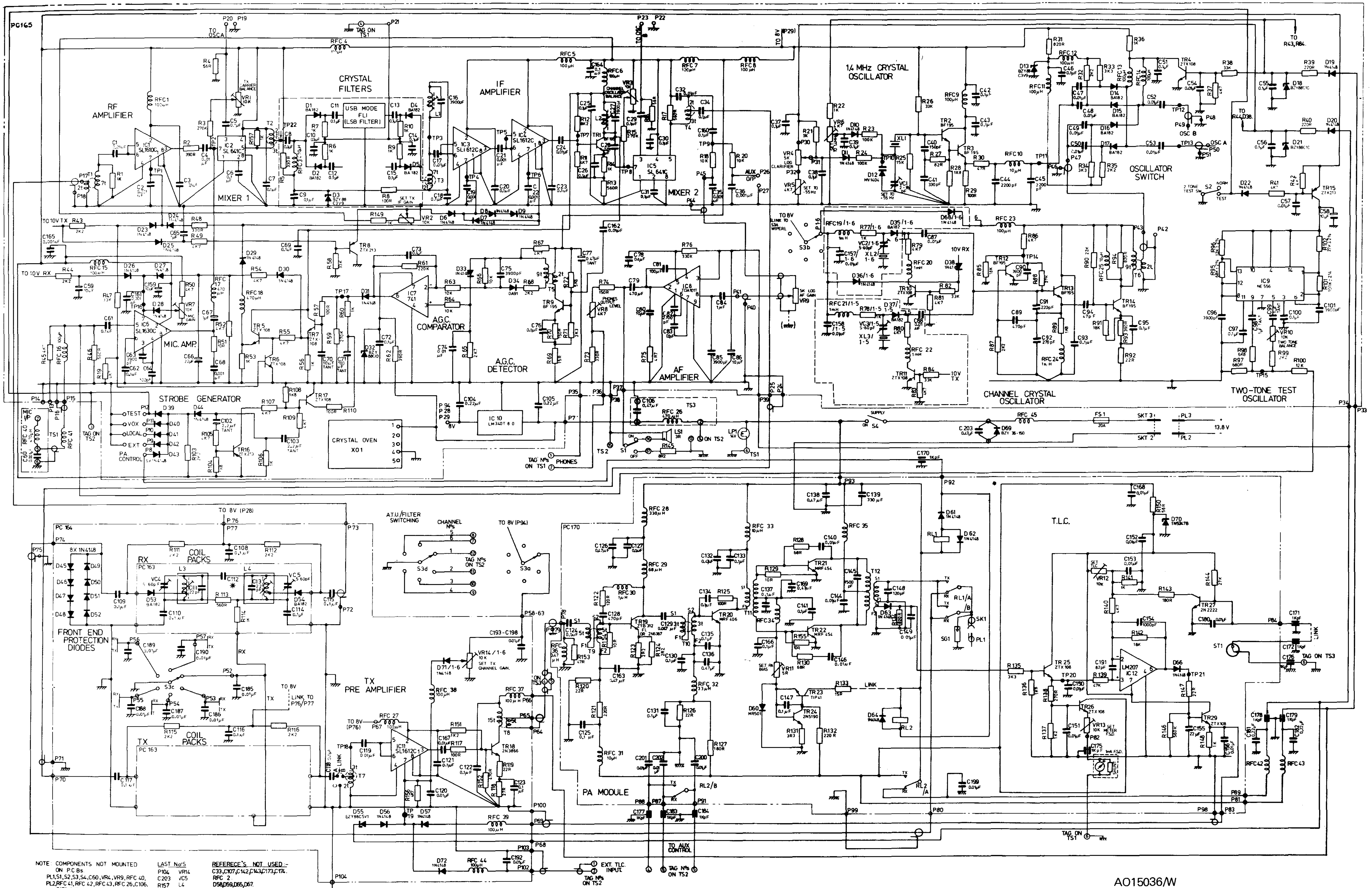
TUNING UNIT MOTHER BOARD PC 164

A1/15000/L
ISSUE 1


R157 MOUNTED ON U'SIDE OF BOARD.
DECCA COMMUNICATIONS Ltd.



LOCATION OF COMPONENTS, PC 170



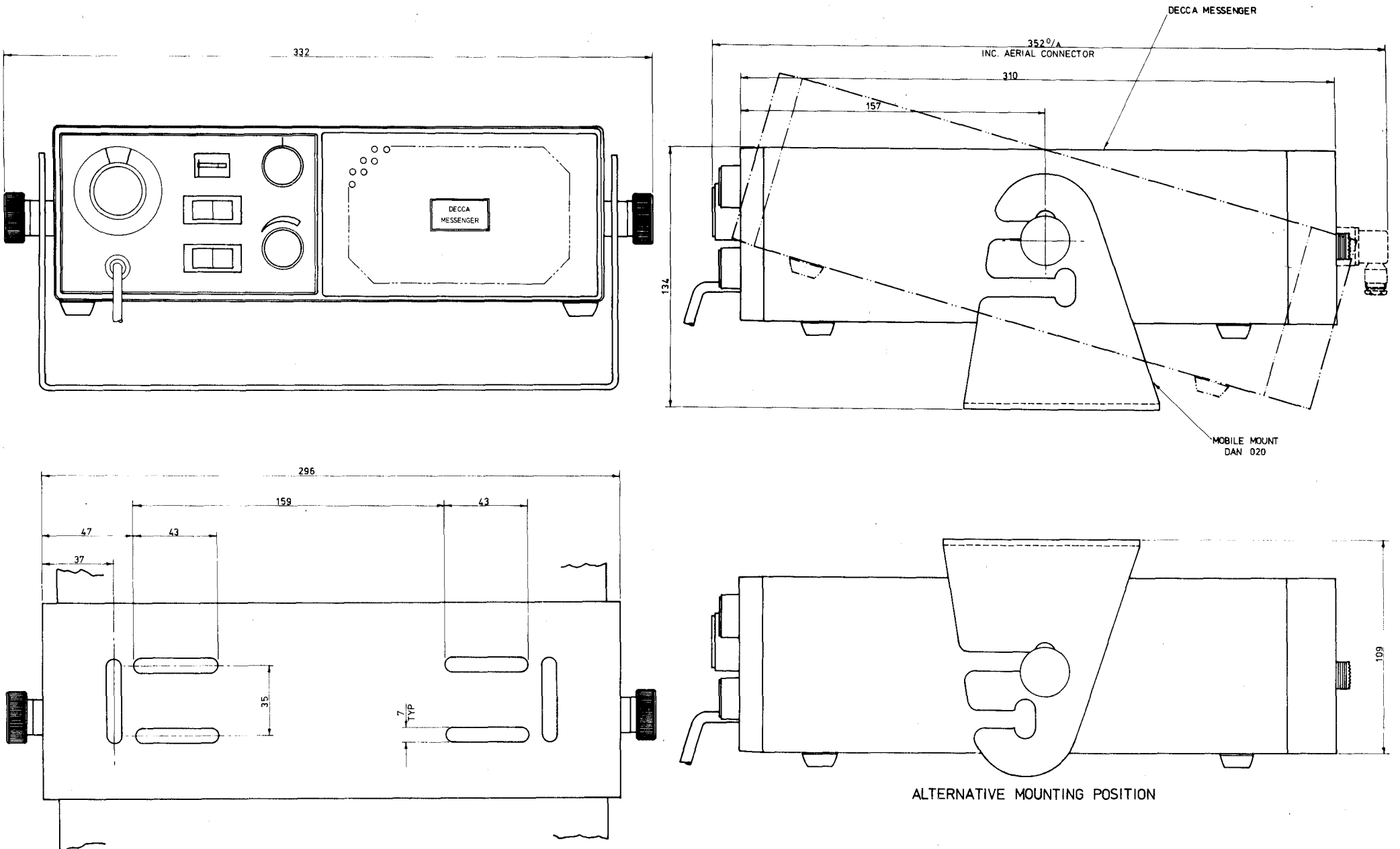
NOTE: COMPONENTS NOT MOUNTED ON P.C.Bs.
PL1, S1, S2, S3, S4, C60, VR4, VR9, RFC 40, PL2, RFC 41, RFC 42, RFC 43, RFC 26, C106, C170, C171, C172, C173, C174, C175, C176, C177, C178, C179, C181, C182, C183, C184, D67, D69, FS1, C203. RFC 45, LS1, TS1, TS2, TS3, SK1, SK2,

LAST No'S	
P104	VR14
C203	VC5
R157	L4
TR29	RFC45
D72	TP22
T12	
IC12	

REFERECE'S NOT USED:-
C33, C107, C142, C143, C173, C174.
RFC 2.
D58, D59, D65, D67.
R149.
TR 28.

✱ DENOTES COMPONENTS THAT ARE FREQUENCY DEPENDANT.

AO15036/W
ISSUE 1

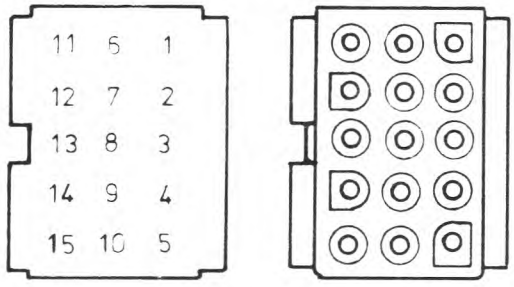


A1/15000/AC
ISSUE 1

MOBILE MOUNT ARRANGEMENT

AUX CONNECTION LIST

VIEW OF PLUG FROM
RECEPTICAL ENTRY SIDE.



CONNECTIONS TO TAG STRIP Nº2	WIRE COLOUR	FUNCTION	PLUG PIN Nº
———	WT	PTT	10
17	PK	L.S. AMP	12
16	TQ	L.S.	13
15	GN/RD	L.S EARTH	14
14	VT	13.8 V	7
12	BN	CH.1	1
11	RD	CH.2	2
10	OE	CH.3	3
9	YW	CH.4	4
8	GN	CH.5	5
7	BE	CH.6	6
3	RD/BE	TEST	8
1	BK	EARTH	9
1	GY	EARTH	11
1	BRAID	SCREEN	15

A3/15000/124
ISSUE 1

DO NOT SCALE.

USED ON	ASSY No

HF AERIAL TYPE MI

TYPE MI IS AN AERIAL DESIGNED FOR THE FREQUENCIES BETWEEN 3 & 16·5 MHz. THERE ARE 15 VARIATIONS OF AN INDUCTIVE LOADING, EACH COVERING PART OF THE BAND, AND THE AERIAL IS TRIMMED FOR EXACT TUNING BY MEANS OF A TRIMMING CHART ISSUED WITH EACH AERIAL WHEN TRIMMED, THE BAND WIDTH IS APPROXIMATELY ± 50 KHz.

THIS AERIAL IS EXTREMELY USEFUL IN SITUATIONS WHERE ONLY A FEW FREQUENCIES ARE USED, THUS ELIMINATING THE NEED FOR AN EXPENSIVE AERIAL TUNING UNIT.

THE STANDARD MODELS GO DOWN TO 3 MHz, BUT WHEN REQUIRED, AERIALS FOR LOWER FREQUENCIES ARE PRODUCED AS SPECIALS (738065)

LENGTH	2600 mm (8' 6")
DIAMETER	23 mm TAPERING TO 6 5 mm (7/8"- 1/4")
CONDUCTOR	19 SWG COPPER
TERMINATION	STUDDED FERRULE 9 5 mm (3/8") 24 UNF
MAXIMUM POWER INPUT	750 W MAX

BANDS

No	MHz	No.	MHz
1	3 0 - 3 4	8	6.5 - 7 7
2	3 3 - 3 8	9	7·3 - 8 5
3	3 7 - 4 3	10	8 2 - 9·4
4	4 2 - 4 8	11	9 2 - 10 4
5	4 7 - 5 3	12	10 3 - 11 9
6	5 2 - 6 0	13.	11 6 - 13 2
7	5 9 - 6 7	14	13 0 - 14 6
		15	14·5 - 16·5

THIS DRAWING MUST NOT BE RAISED TO ISSUE UNTIL IT HAS BEEN FULLY SIGNED

ISSUE

RACAL – MESSENGER LTD., READING, ENGLAND.

DRAWN LM	DATE 28-5-81	TOLERANCES (UNLESS OTHERWISE STATED)	MAT'L
SECT LDR	DATE		SPEC
ENG	DATE	NO PLATING ALLOWANCE REQUIRED / ALLOWANCE REQUIRED FOR PLATING	FINISH
QUALITY	DATE	THIRD ANGLE PROJECTION	REMOVE BURRS & SHARP EDGES ALL DIMENSIONS IN mm
SCALE			SYSTEMS ENQUIRY No

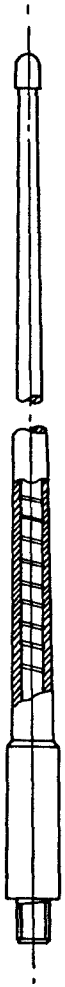
TITLE: BANTEX MI & MI (SPECIAL) 2·6 m WHIP

DRAWING No: AD 738056/65

DO NOT SCALE.

USED ON	ASSY No

ANTENNA TYPE MJ



THIS ANTENNA HAS BEEN DEVELOPED TO COMPLEMENT TYPE MI FOR MOBILE HF COMMUNICATIONS. TYPE MJ IS INTENDED FOR LIGHTER UTILITY VEHICLES OR SALOON CARS WHERE THE STANDARD ANTENNA MI MAY BE TOO HEAVY. TYPE MJ HAS BEEN REDUCED BOTH IN LENGTH AND DIAMETER, THE OVERALL LENGTH BEING JUST OVER 2 m (7 ft.)

THE INDUCTIVE LOADING STRETCHES OVER THE COMPLETE LENGTH OF THE ANTENNA, EXCEPT A STRAIGHT LENGTH OF WIRE AT THE TOP OF THE ANTENNA, ABOUT 30 cm (1 ft.) LONG, ALLOWING THE ANTENNA TO BE TRIMMED TO OPTIMUM PERFORMANCE.

WHILE TYPE MI IS MADE IN 15 BANDS, SPANNING AN OVERALL RANGE OF 3 - 15 MHz, THE LOWEST FREQUENCY ON THE ANTENNA TYPE MJ IS 5·7 MHz. THE TRIMMING RANGE IS ± 5% AND 11 BANDS WILL SPAN THE RANGE BETWEEN 5.8 & 15·6 MHz.

WHEN LOWER FREQUENCIES THAN 5·8 MHz ARE CALLED FOR, A CONVENTIONAL ATU WILL HAVE TO BE USED, PARTICULARLY WHEN SEVERAL FREQUENCIES ARE REQUIRED

FOR SINGLE OR TWIN FREQUENCY USE, THE RANGE OF THE ANTENNA MJ CAN BE EXTENDED DOWNWARDS BY MEANS OF 2 METHODS :

1. A NUMBER OF INTERCHANGEABLE COILS WHICH ARE FITTED BETWEEN ANTENNA MOUNT & WHIP.
2. WE HAVE DEVELOPED A TUNABLE COIL, AGAIN BEING FITTED BETWEEN MOUNT & ANTENNA. IT CONSISTS OF A COIL EMBEDDED IN GLASS FIBRE THROUGH WHICH FERRITES MOVE UP OR DOWN BY MEANS OF A DOUBLE FERRULE AT THE BOTTOM END.

DIMENSIONS :	LENGTH	2·1 m (7 ft.)
	DIAMETER	11·0 mm (0·45") TO 8·0 mm ($^5/_{16}$")
	WEIGHT	700 g (1 $^1/_2$ lbs.)
	TERMINATION	STUDDED FERRULE 3/8 UNF
	MAX. POWER INPUT	100 W PEP

BAND 1	5·7 - 6·15 MHz	BAND 5	8·3 - 9·1 MHz	BAND 9	12·0 - 13·2 MHz
2	6·0 - 6·8 MHz	6	9·0 - 10·0 MHz	10	13·1 - 14·4 MHz
3	6·8 - 7·7 MHz	7	10·0 - 11·1 MHz	11	14 2 - 15 6 MHz
4	7·6 - 8·4 MHz	8	11·0 - 12·1 MHz		

THIS DRAWING MUST NOT BE ISSUED TO ISSUE 1 UNTIL IT HAS BEEN FULLY SIGNED

ISSUE

RACAL - MESSENGER LTD., READING, ENGLAND.

DRAWN LM	DATE 1-6-81	TOLERANCES (UNLESS OTHERWISE STATED)	MAT L
SECT LDR.	DATE		SPEC
ENG.	DATE	NO PLATING ALLOWANCE REQUIRED	FINISH
QUALITY	DATE	ALLOWANCE REQUIRED FOR PLATING	
SCALE		THIRD ANGLE PROJECTION	REMOVE BURRS & SHARP EDGES ALL DIMENSIONS IN mm / SYSTEMS ENQUIRY No.

TITLE. BANTEX MJ 2·1 m WHIP

DRAWING No. AD 738057