COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF CIVIL AVIATION

HANDBOOK

(ISSUE 1)

(MANUFACTURER'S REF. 60624R)

FOR

SINGLE SIDEBAND RECEIVER

DCA TYPE No. R 22

(MANUFACTURER'S REF. IC60624)

AMALGAMATED WIRELESS (AUSTRALASIA) LTD.

47 YORK STREET,
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HANDBOOK IDENT NO. Y5/HB857

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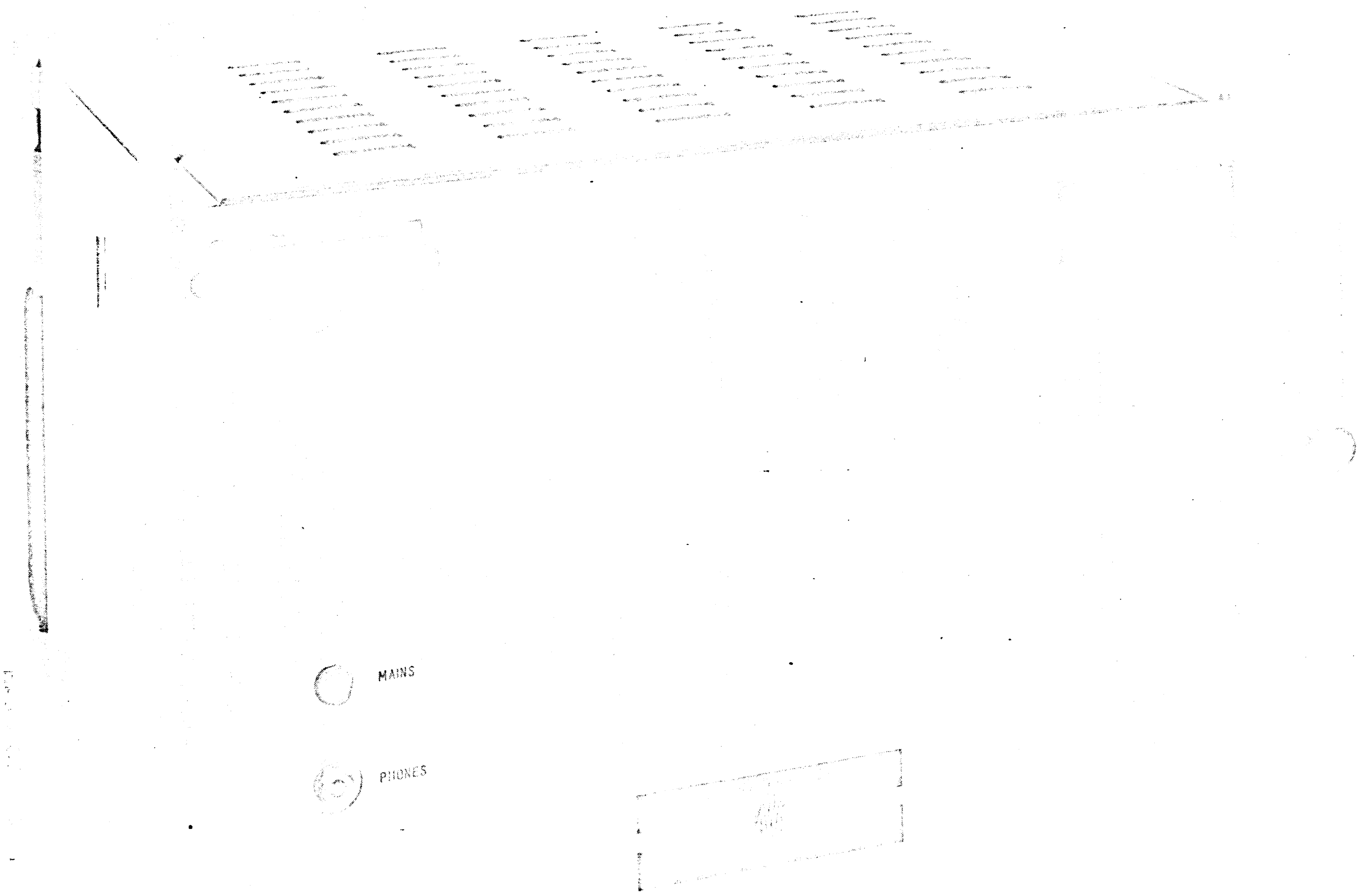

Plate 1
FRONT VIEW OF RECEIVER IN FULLY CLOSED CONDITION

R501

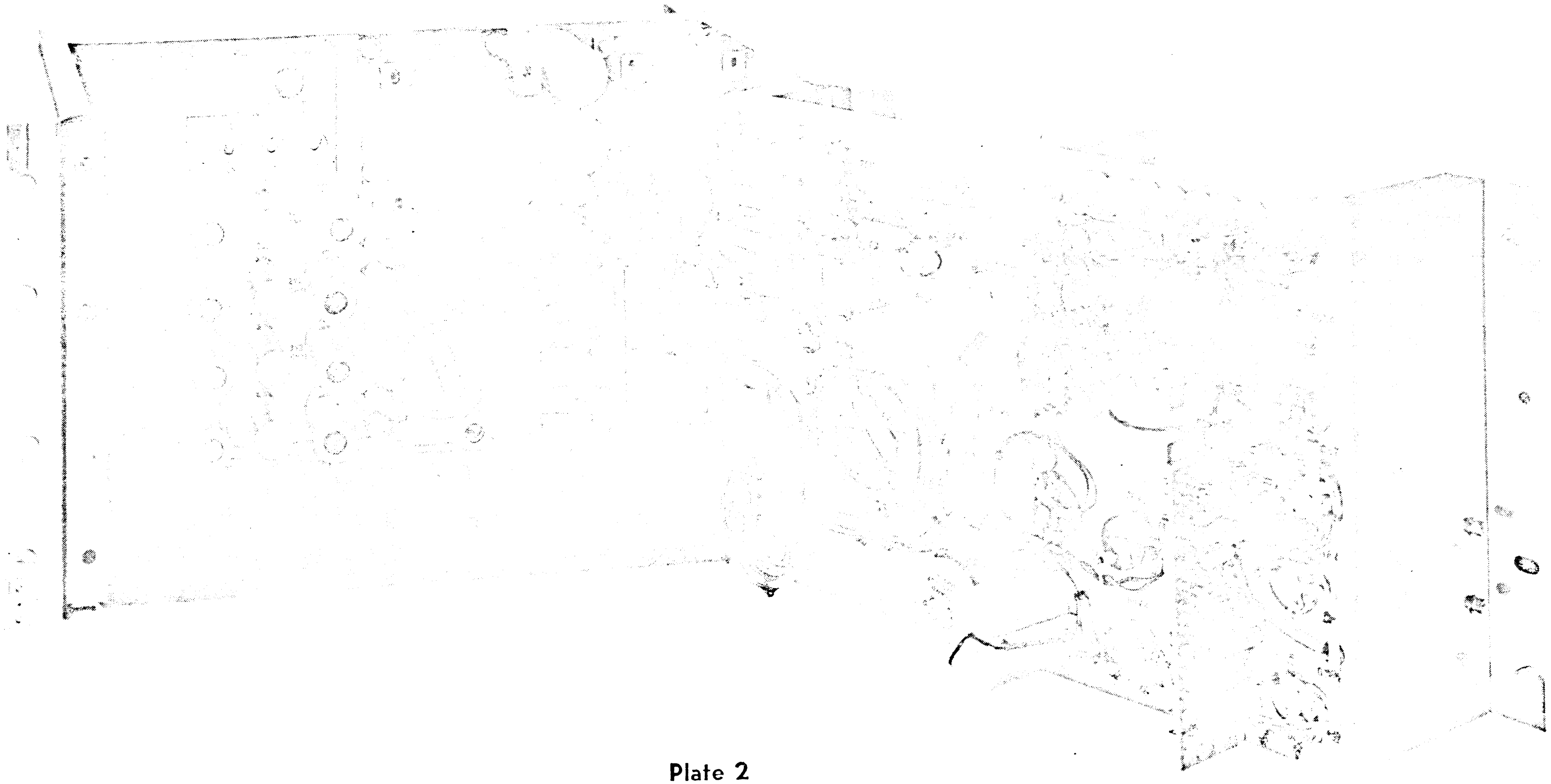

Plate 2
FRONT VIEW OF RECEIVER OPENED

1. BRIEF SPECIFICATION

1.1 Classification

The A.W.A. Receiver SSR-10, type 1C60624, is designed for the reception of single sideband suppressed carrier (s.s.b.) signals on selected frequencies between 2 and 12 Mc/s.

The receiver is suitable for both simplex and duplex operation in services employing single sideband suppressed carrier, single sideband keyed tone or on/off telegraphy emissions. It is ideally suited for combination with the A.W.A. Transmitter SST-10 to provide a reliable point-to-point communication system.

1.2 Type Numbers

The receiver type and identification numbers are as follows:-

A.W.A. Type:	SSR-10, type 1C60624
D.C.A. Type:	R22
D.C.A. Identification No.:	Y5/698

1.3 Basic Principles of S.S.B. Communication

1.3.1 Theoretical Discussion

An s.s.b. signal is formed by transferring a band of frequencies in the audio range to a frequency band of equal width in the radio frequency portion of the spectrum. As an example, if an intelligible voice signal containing frequencies over the range of 300 to 3000 c/s is converted to a radio frequency signal by mixing with a 15 Mc/s carrier signal then the resultant frequencies will be 15 Mc/s and those lying in the frequency bands, 14.9997 to 14.997 Mc/s and 15.0003 to 15.003 Mc/s.

Either one of these two bands of frequencies by itself constitutes an s.s.b. signal. Reference is made to them as the lower and upper sidebands, respectively. So by eliminating both the carrier and one of the sidebands from the composite signal, one s.s.b. signal is obtained. Note particularly that the 15 Mc/s carrier is not included in the s.s.b. signal.

From the above description of an s.s.b. signal it is apparent that only one sideband need be transmitted to convey the intelligence. Although two sideband signals

* Throughout this Instruction Book, the abbreviation "s.s.b." implies single sideband suppressed carrier.

are obtained when an audio and an r.f. signal are mixed in the transmitter, the unwanted sideband is rejected and only the wanted sideband is transmitted. The carrier is suppressed to a negligible level and the emission is designated "single sideband suppressed carrier".

1.3.2 System Advantages

Certain advantages accrue from the single sideband suppressed carrier method of communication. These are:-

(a) the radio frequency spectrum is more efficiently utilised because the single sideband is transmitted in slightly less than one-half the bandwidth required by the carrier and both sidebands of conventional a.m. system,

(b) The reduced bandwidth provides an improvement in the signal-to-noise ratio of approximatley 3 db, and minimises the possibility of interference; the effects of fading and phase distortion are also greatly reduced,

(c) reception is improved by the reduction of steady heterodyne beats from adjacent channels; these heterodyne whistles are most prevalent on a.m. transmission as a result of carrier interference, and

(d) a single sideband suppressed carrier transmitter has a power gain of 6 db over a conventional a.m. transmitter since all the available power is transmitted in one sideband.

1.3.3 Reception of S.S.B. Signals

Proper reception of an s.s.b. signal requires a heterodyning system capable of converting the r.f. signal back down to its original position in the frequency spectrum, i.e., the audio range. An s.s.b. receiver is similar to a conventional heterodyne receiver but is more selective and has a different detection circuit.

In a typical s.s.b. receiver, the r.f. signal is amplified and heterodyned down to a fixed intermediate frequency, generally of the order of 100 kc/s. An extremely sharp bandpass filter of the order of 3-5 kc/s wide is employed at this frequency to select the desired sideband signal. Finally, the selected sideband signal is transferred to its original position in the audio range of the frequency spectrum. The circuit most commonly used to accomplish this requirement is called a product detector. It is essentially a mixer in which the s.s.b. signal in the vicinity of the intermediate frequency is heterodyned with a locally generated signal of intermediate frequency. The resultant "difference" frequencies are then applied to the audio stages of the receiver.

1.4 Brief Description

1.4.1 Radio Frequency Circuits

The receiver has four separate input channels with a common i.f. output. Each channel contains a low noise r.f. amplifier followed by a frequency converter in which the crystal-controlled oscillator section operates on a frequency 1400 kc/s higher than that of the transmitted signal.

The output of the frequency converter is applied to a mixer stage via a double-tuned transformer which passes only the "difference" signal lying in the vicinity of 1400 kc/s.

For example, assume that an UPPER sideband signal of frequency F + M kc/s is being received, where F is the channel frequency and M is the frequency of the audio signal. The signal passed by the transformer will be:

$$(F + 1400) - (F + M) = 1400 - M \text{ kc/s.}$$

The crystal-controlled second oscillator operates on a frequency of 1500 kc/s (for UPPER sideband operation) or 1300 kc/s (for LOWER sideband operation). The output of the mixer is applied to a crystal filter which passes only the "difference" frequency. The difference frequency is always 100 + M kc/s as indicated in the following table.

	UPPER SIDEBAND	LOWER SIDEBAND
Signal Frequency	F + M kc/s	F - M kc/s
1st Osc. Frequency	F + 1400 kc/s	F + 1400 kc/s
1st I.F. (difference)	1400 - M kc/s	1400 + M kc/s
2nd Osc. Frequency	1500 kc/s	1300 kc/s
2nd I.F. (difference)	100 + M kc/s	100 + M kc/s

The appropriate mixer oscillator frequency for UPPER or LOWER sideband operation is selected by a relay, the action of which is controlled by the sideband selector switch.

NOTE: If the 1st oscillator operates on a frequency 1400 kc/s lower than that of the transmitted signal, the function of the sideband selector switch will be reversed.

The output of the 100 kc/s filter is applied to the grid of an i.f. amplifier which is R-C coupled to another identical stage. The output of the second i.f. amplifier is fed to a product detector which employs a triode heptode in a pentagrid mixer configuration.

1.4.2 Audio Circuits

The output of the product detector is fed to an audio amplifier and its associated squelch circuit. This audio amplifier feeds two separate output stages with the following facilities.

Stage 1: 250mW into 600Ω, and
1mW into high impedance headphones.

Stage 2: 250mW into 600Ω.

Squelch operation is obtained by applying a cut-off bias to the first audio amplifier in the absence of signal. Incoming signals produce a voltage which removes the bias.

1.4.3 Automatic Gain Control

A sample signal from the second 100 kc/s i.f. amplifier is amplified by a pentode and rectified to provide the a.g.c. control voltage. Automatic gain control is applied to the r.f. and i.f. amplifiers. Both fast and slow a.g.c. time constants are provided.

1.4.4 Rectifiers

The 225V and regulated 150V h.t. requirements of the receiver are provided by a bridge-connected rectifier in which silicon diodes are used. A further silicon diode in a half-wave circuit provides the d.c. voltage necessary for the operation of relays.

·.5 Power Requirements

The power requirements of the receiver are as follows:

Number of Phases:	1
Voltage:	220V/230V/240V/250V
Frequency:	50 c/s ±5%
Consumption:	130 watts

·.6 Remote Control Facilities

Facilities are provided for operating the receiver from a remote location. Change-over from local to remote control is effected by replacing a "link" plug on the rear unit with one terminating the control lines. Output and control lines require a total of 15 wires.

Function	No. of Wires
Channel Selection	5 (including common 50V line)
Squelch Gain	1
Speech Clarifier	2
Sideband Selection	1
Muting	1
Output Line 1	2
Output Line 2	2
Earth	1

1.7 Performance Summary

Frequency Range:	2 to 12 Mc/s.
Number of Channels:	Four channels in the range 2 to 12 Mc/s.
Frequency Control:	Type D crystals housed in temperature controlled ovens; trimmer capacitors allow accurate channel tuning of the receiver.
Frequency Stability:	Better than 5 c/s per Mc/s over the ambient temperature range 0°C to +50°C.
Nominal Input Impedance:	100Ω balanced.
Sensitivity:	1μV for 10 db minimum signal-to-noise ratio.
Bandwidth:	3 kc/s nominal.
Frequency Response:	Not more than 7 db variation over 3 kc/s bandwidth.
Image Rejection:	At least 42 db.
Selectivity:	60 db down 1.5 kc/s outside the 3 kc/s passband.
Intermodulation Products:	-30 db at 0.25W output.
Audio Output:	(a) Not less than 50mW for 1μV input. (b) 250mW into 600Ω both LINE 1 and LINE 2.

(c) 1mW into high impedance PHONES jack.

Distortion: Less than 5% at rated output.

1.8 Electron Tube and Crystal Complement

1.8.1 Detailed Tube Complement

Circuit Ref. No.	Type	Function
1V1	6BY7/EF85	Channel 1 R.F. Amplifier
1V2	6AJ8/ECH81	Channel 1 Frequency Converter
2V1	6BY7/EF85	Channel 2 R.F. Amplifier
2V2	6AJ8/ECH81	Channel 2 Frequency Converter
3V1	6BY7/EF85	Channel 3 R.F. Amplifier
3V2	6AJ8/ECH81	Channel 3 Frequency Converter
4V1	6BY7/EF85	Channel 4 R.F. Amplifier
4V2	6AJ8/ECH81	Channel 4 Frequency Converter
5V1	OA2	Voltage Regulator
6V1	6AJ8/ECH81	Mixer
6V2	6AU6	1500/1300 kc/s Oscillator
6V3	6BA6	1st I.F. Amplifier
6V4	6BA6	2nd I.F. Amplifier
6V5	6AU6	A.G.C. Amplifier
6V6	6AJ8/ECH81	Product Detector
6V7	12AT7	Squelch/Audio Amplifier
6V8	6AQ5	Audio Output Line 1 and Phones
6V9	6AQ5	Audio Output Line 2

1.8.2 Total Tube Complement

Type	Quantity
6AJ8/ECH81	6
6AQ5	2
6AU6	2
6BA6	2
6BY7/EF85	4
12AT7	1
OA2	1

1.8.3 Crystal Complement

Circuit Ref. No.	A.W.A. Type	Frequency	Function
1XL1	D/ENF	Channel 1 + 1400 kc/s	H.F. Oscillator
2XL1	D/ENF	Channel 2 + 1400 kc/s	H.F. Oscillator
3XL1	D/ENF	Channel 3 + 1400 kc/s	H.F. Oscillator
4XL1	D/ENF	Channel 4 + 1400 kc/s	H.F. Oscillator
6XL1	D/ENF	1500 kc/s	Upper Sideband Oscillator
6XL2	D/ENF	1300 kc/s	Lower Sideband Oscillator
6XL3	3R7106/FEF	100 kc/s	Detector Oscillator

NOTES: (1) Type D crystals are adjusted for a shunt capacitance of 30pF with a frequency tolerance of ±0.0015% at a temperature of 65°C.

(2) Type 3R7106 crystals are adjusted for a shunt capacitance of 30pF with a frequency tolerance of 0.003% at a temperature of 25°C.

1.9 Mechanical Construction

The receiver is built in two sections. The rear section, which contains the r.f. amplifiers, frequency converters, h.f. crystal oven, channel-selector relays and power converter components, is formed as a deep "U" chassis. Components mount on the base portion while the side flanges form the mounting brackets which attach the unit to a standard rack.

The front section, which carries the remainder of the circuits and the operating controls, is attached by hinges at one side and can be swung aside to give access to the r.f. tuning adjustments. A hinged cover panel encloses the complete unit.

Interconnection between sections is by a multiwire cable attached to the front section. The cable is terminated in a socket which plugs into the rear unit.

Terminations for aerial leads, power connection, remote control and output lines are mounted on the rear of the unit.

.10 Dimensions and Weight

The dimension and weight of the complete receiver are:-

Width:	19 inches
Height:	10.1/2 inches
Depth:	13.1/2 inches
Weight:	42 lbs.

2. TECHNICAL DESCRIPTION

2.1 Radio Frequency Amplifiers and Frequency Converters (Drg. 60624G1)

The receiver has four separate input channels each of which contains an r.f. amplifier followed by a frequency converter. The following description applies to all four input channels, however, the circuit reference numbers will change for each channel 1 through 4.

A slug-tuned transformer 1TR1 couples the aerial to the grid of the r.f. amplifier 1V1 which uses a low noise pentode type 6BZ7. The tuned output circuit which comprises a slug-tuned inductor 1L1 and fixed capacitors 1C7, 1C8, is capacitance-coupled to the frequency converter. Automatic gain control voltage is applied to 1V1 via 1R1.

The sensitivity of the r.f. amplifier is controlled by the SQUELCH GAIN control 6RV3 (Drg. 60624G2). The cathode resistor 1R3 is returned to earth via 6RV3, the setting of which determines the minimum signal strength necessary to unmute the receiver (see paragraph 2.7.2).

NOTE: The effect of the SQUELCH GAIN control on the sensitivity of the r.f. stage is independent of the setting of the SQUELCH ON/OFF switch.

A triode heptode type 6AJ8 is used in the frequency converter stage 1V2. A conventional circuit is used in which the oscillator is crystal controlled. Fine adjustment of oscillator frequency is accomplished by 1C17.

The four crystals, one for each channel, are mounted in a thermostatically-controlled oven which keeps them at a constant temperature of 65°C ±3°C. The oven heater is supplied with 50V a.c. from transformer 5TR2.

The anodes of the frequency converters are connected in parallel to the primary winding of double-tuned transformer 5TR1 and a low impedance coaxial line couples the secondary of 5TR1 to the primary of 6TR1.

Channel selection is accomplished by energising the appropriate relay 1RLA whose contact 1RLA2, when closed, supplies regulated 150V to the oscillator anode and 1V1, 1V2 screens of the required channels.

2.2 Mixer and 2nd Oscillator (Drg. 60624G2)

The heptode section of a type 6AJ8 is used in a pentagrid mixer circuit in the mixer stage 6V1. The control grid is connected to the secondary of 6TR1 and the oscillator voltage is injected at the third grid. The output from the mixer is applied to the crystal filter 6Z1.

The crystal oscillator 6V2 uses a type 6AU6 pentode in a modified Pierce circuit. The oscillator operates on either 1500 kc/s (6XL1) or 1300 kc/s (6XL2) depending upon the position of relay contacts A1 and A2. The operation of relay 6RLA is governed by the sideband selector switch. Crystals 6XL1 and 6XL2 are housed in a thermostatically-controlled oven which keeps them at a constant temperature of 65°C ±3°C.

The output from the anode of 6V2 is fed to the injection grid of 6V1 by a double-tuned over-coupled transformer 6TR4. The transformer is nominally tuned to 1400 kc/s with peaks occuring at 1500 kc/s and 1300 kc/s.

2.3 Crystal Filter (Drg. 60624C2)

A high order of adjacent channel selectivity is required in the receiver in order to realize the inherent advantages which stem from the reduced bandwidth of an s.s.b. signal. The requisite selectivity is provided by the crystal filter 6Z1, in which four crystals are arranged to give a passband of 100.3 - 103 kc/s with greater than 60 db rejection 1500 c/s outside the passband.

Further details are given in Sub-Section 5.3.

2.4 Speech Clarifier (Drg. 60624G2)

The speech clarifier is included to compensate for slight frequency drift and also for minor differences in operating frequencies. Adjustment of the CLARIFIER control 6RV1 varies the voltage across 6MR1. The subsequent change in capacity of 6MR1 changes the frequency of the second oscillator (by approximately 160 c/s).

2.5 Intermediate Frequency Amplifiers (Drg. 60624G2)

The intermediate frequency amplifiers 6V3 and 6V4 use type 6BA6 pentodes in identical R-C coupled circuits. The output of the crystal filter 6Z1 is applied via 6C15 to the grid of 6V3 and the output of 6V4 is R-C coupled to the product detector.

Automatic gain control voltage is applied to 6V3 and 6V4 via 6R13 and 6R17, respectively.

section is crystal-controlled and operates on a frequency of 100 kc/s.

The output of the product detector is fed to a double-pi low pass filter which rejects the intermediate frequency components and allows only the audio components to pass to the grid of the audio amplifier.

2.7 Automatic Gain Control and Squelch (Drg. 60624G2)

A portion of the output of the last i.f. amplifier 6V4 is applied to the a.g.c. amplifier 6V5 which uses a type 6AU6 pentode. The anode circuit is tuned by 6L1, 6C62 and the output is capacitance coupled to each of two diodes. These diodes provide control voltages for the following functions, namely,

(i) automatic gain control
(ii) squelch

2.7.1 Automatic Gain Control (Drg. 60624G2)

The a.g.c. rectifier 6MR2 is biased by the voltage divider 6R64, 6R66 and the voltage developed across 6R68 is filtered by 6R67 and 6C19. The a.g.c. voltage is applied to the i.f. amplifiers via 6R13 and 6R17, and to the r.f. amplifiers via 1R1, 2R1, 3R1 and 4R1.

Switch 6SWB provides selection of fast or slow a.g.c. and is also used to ground the a.g.c. line when required.

2.7.2 Squelch (Drg. 60624G2)

In the absence of signal the squelch valve 6V7A will conduct heavily and the voltage developed across 6R49 will be sufficient to bias the audio amplifier 6V7B to cut-off.

An incoming signal of sufficient strength will cause the biased diode 6MR3 to conduct. The negative voltage developed across 6R46 and 6R49 in series is applied via 6R43 to the grid of 6V7A and cuts off the anode current.

The subsequent reduction in bias voltage across 6R49 will release 6V7B from the cut-off condition.

The SQUELCH GAIN control 6RV3 adjusts the level of the incoming signal relative to the bias on the diode by changing the bias on the r.f. amplifier and 2nd mixer. Note this control still operates even though the squelch circuit is rendered inoperative by opening the SQUELCH ON/OFF switch 6SWC.

The receiver can be muted by connecting the free end of 6R42 (6PLB21) to earth through an external relay contact or switch. With 6R42 connected to earth the squelch valve 6V7A will conduct heavily causing the bias voltage on 6V7B to reach cut-off valve.

NOTE: The muting facility is not available when the SQUELCH switch is set to OFF.

2.8 Audio Circuits (Drg. 60624G2)

The audio output of the product detector is applied via the low-pass filter to the grid of the audio amplifier 6V7B which is one-half of a twin triode type 12AT7. The audio amplifier is open only when the level of the incoming signal is sufficient to overcome the fixed bias on the squelch diode as described in paragraph 2.7.2 above.

The output of 6V7B is applied to two separate output stages 6V8 and 6V9 both of which use beam power tetrodes type 6AQ5. Negative feedback is used in each stage and the output levels are adjusted by LINE 1 LEVEL control 6RV2 and LINE 2 LEVEL control 6RV4. A PHONES jack 6JKA is connected to 6V8 anode via 6R57 and 6C56.

2.9 Power Supplies (Drg. 60624G1)

The h.t. requirements of the receiver are met by a bridge-connected rectifier employing silicon diodes 5MR2 through 5MR5 in conjunction with transformer 5TR3. The output of the rectifier is filtered by a capacitance input filter comprising 5C6, 5L1 and 5C7 to give an output of 225 volts. A regulated output of 150V for the h.f. oscillators, 1V1 and 1V2 screens and the speech clarifier is provided by a gaseous regulator 5V1 and associated limiting resistor 5R2.

The filaments are supplied from a 6.3V, 6A winding on 5TR3 while 50V a.c. for the crystal ovens is supplied from 5TR2. A silicon rectifier 5MR1 performs half-wave service to provide 55V (nominal) for the control relays.

NOTE: The voltage will vary between 50V and 60V (approximately) depending upon the "on/off" condition of the oven heater elements and the number of energised relays.

Delayed action fuses are used in the power supply circuits.

3. INSTALLATION AND OPERATING INSTRUCTIONS

3.1 General

The equipment is designed for mounting in a rack with local or remote control of the operational facilities (refer Sub-Section 1.6). Cabinet mounting may be used to suit a particular installation.

3.2 Installation

After unpacking the receiver, check the items against the packing list. If the valves and crystals are packed separately carefully insert the valves in the sockets according to the stencilled designations on the chassis. Plug in the crystal ovens.

Check that r.f. transformers 1-, 2-, 3-, 4TR1, inductors 1-, 2-, 3-, 4L1, and capacitors 1-, 2-, 3-, 4C4 and 1-, 2-, 3-, 4L8 are of the correct type and value for the proposed operating frequencies (refer to Drg. 60624G1).

Before connecting the a.c. supply to the receiver ensure that the connections to 5TR3 in the rear section are correct for the nominal mains voltage at the installation site. The connections for various voltages are:-

220V	-	14, 15
230V	-	13, 15
240V	-	14, 16
250V	-	13, 16

The remote control connections should be made in accordance with Drg. 60624C1.

For local control or test purposes use a dummy plug wired as shown in Drg. 60624D1.

3.3 Aerial and Ground Connections

The aerial connections are made to sockets 1SKA through 4SKA located at the rear of the receiver. A connection should be made between the receiver and the station earth system using the shortest possible route.

3.4 Post-Installation Adjustments

The stringent frequency tolerance imposed by the s.s.b. system requires that all transmitters and receivers in the network are EXACTLY netted to assigned channel frequencies. The final netting adjustments may only be made after all stations in the network are available for use.

3.4.1 Preliminary Checks

After the equipment has been installed, switch on power and check that:-

(a) the filaments are alight,
(b) the crystal ovens are heating, and
(c) all relays operate.

Set the controls as follows:

LINE LEVEL 1	-	Maximum
LINE LEVEL 2	-	Maximum
SQUELCH GAIN	-	Maximum
SQUELCH	-	Off
A.G.C. Switch	-	FAST
UPPER/LOWER SIDEBAND	-	Appropriate to system
CLARIFIER	-	Mid-position of range
CHANNEL SELECTOR	-	Appropriate channel

3.4.2 Netting

The netting procedure involves precise adjustments of trimmer capacitors 1-, 2-, 3- and 4C17 to offset the combined effects of stray capacitance, crystal tolerance and component tolerance on the frequency of the first oscillator. The trimmers are located adjacent to the crystal oven on the rear section and are readily accessible after the front section has been swung forward. The frequency range of each trimmer is not less than 0.005%.

WARNING: Capacitors 6C10,6C13 and 6C38 control the frequency of the second and third oscillators and are correctly adjusted at the factory. The settings of these controls must not be disturbed.

The receiver should be switched on not less than half an hour before making the following adjustments:

1. Set the controls as in paragraph 3.4.1 above.

2. Whilst receiving a signal on channel 1, adjust the LINE LEVEL controls to give a comfortable listening output and slowly adjust 1C17 until the speech assumes a natural tone.

3. Repeat the procedure for the other channels.

NOTE: Netting should not be confused with the operational use of the CLARIFIER. Netting is a semi-permanent adjustment in contradistinction to the transitory adjustment of the CLARIFIER (see Sub-Section 3.5).

3.5 Operation

The setting of the operating controls will depend upon the frequency channel sideband selection and the conditions prevailing at the time.

Notes on the adjustment of each control are listed below:

Control	Notes on Adjustment
LEVEL LINE 1	Adjust level to line to meet installation requirements.
LEVEL LINE 2	As for LEVEL LINE 1.
SQUELCH GAIN	With aerial connected, set control maximum clockwise and slowly rotate anti-clockwise until the receiver is muted. If the squelch facility is not required, turn the SQUELCH switch OFF. With the SQUELCH switch set to OFF, the SQUELCH GAIN control may be used as an r.f. sensitivity control.
CLARIFIER	The CLARIFIER provides vernier adjustment of the second oscillator frequency to offset any random minute variations in the frequencies of the received signal and/or the receiver oscillators which may occur during actual operation. These variations cause deterioration of the speech quality which can be corrected by careful adjustment of the control.

4. MAINTENANCE

4.1 Crystal Ovens

The crystal ovens are built on a moulded bakelite base with twelve pins which fit a duo-decal socket.

The type D crystals are contained within a metal isothermal chamber mounted on projections on the bakelite base. The isothermal chanber consists of a base and a casing around which is wound a 210Ω heater with as little insulation from the chamber wall as the electrical circuits permit. A small bi-metallic temperature-sensitive switch is mounted on top of the casing. The assembly is enclosed by a light metal cover.

The operating temperature of the oven is 65°C ±3°C with a short term stability of 1°C.

In the event of heater failure, the crystals will cool to ambient temperature, under which conditions the frequency stability of the crystals may be such that the speech CLARIFIER control has insufficient range to permit the receiver to be correctly tuned.

4.2 Valve Replacement

Replacement of valves without subsequent realignment will not cause the performance of the receiver to become inferior to that specified in Section 1.

However, in the case of the h.f. crystal oscillators, a check should be made against the appropriate transmitting station to ensure that the CLARIFIER retains sufficient control. If not, re-adjust crystal trimmers as laid down in paragraph 3.4.2.

4.3 D.C. Voltage Analysis

The following voltages were measured with a vacuum tube voltmeter under "no signal" conditions with the controls set as follows:-

LINE 1 LEVEL	-	Maximum
LINE 2 LEVEL	-	Maximum
SQUELCH GAIN	-	Maximum
A.G.C.	-	Off
SQUELCH	-	Off

unless stated otherwise.

These voltages are typical values only and are provided for fault-finding purposes.

Valve	Type	1	2	3	4	5	6	7	8	9
1-4V1	6BY7			2.2				210	95	
1-4V2	6AJ8	100		2.7			225		80	-13
5V1	OA2	150				150				
6V1	6AJ8	103		2.5			190	20 *		
6V2	6AU6	1.0 *				60	40	0		
6V3	6BA6					80	99	1.8		
6V4	6BA6					80	100	2.0		
6V5	6AU6					200	120	1.5		
6V6	6AJ8	80		1.8			138		54	-28 ∅
6V7	12AT7	150 ◊		1.6			86		1.6	
6V8	6AQ5		14.0			220	220			
6V9	6AQ5		14.2			220	220			

* Measured with crystal probe.

◊ 15V with crystal probe.

∅ Squelch on.

Junction of 6R64, 6R66:	60V (A.G.C. Delay)
Junction of 6R74, 6R76:	40V (Squelch Delay)
H.T. Rail:	225V

4.4 Typical Signal Levels

The following table shows typical signal levels for a nominal audio output of 300mW at 1000 c/s. The control positions are:

LINE 1 LEVEL	-	Maximum
LINE 2 LEVEL	-	Maximum
SQUELCH GAIN	-	Maximum
A.G.C.	-	Off

SQUELCH - Off

unless stated otherwise.

Input Point	Input Frequency	Input Level	Remarks
6V9 Pin 1	1500 c/s	6V	
6V8 Pin 1	1500 c/s	6V	
6V7 Pin 7	1500 c/s	0.7V	
6V6 Pin 2)	101 kc/s	200mV	
6V5 Pin 1)	101 kc/s	(370mV (400mV	-2V a.g.c. ∅ -13.5V a.g.c. ∅
6V4 Pin 1	101 kc/s	6.5mV	
6V3 Pin 1	101 kc/s	200μV	
6V1 Pin 2	1401 kc/s	~~[illegible]V~~ 200μV	
6PLB1	1401 kc/s	60μV	
1V2 Pin 2	1401 kc/s	~~350μV~~ 35	
1V1 Pin 2	F + 1000 kc/s *	5μV	
1SKA	F + 1000 kc/s *	0.5μV	

∅ A.G.C. in FAST position.

* F - channel frequency.

4.5 Receiver Alignment and Stage Gain Measurements

4.5.1 Test Equipment

Details of the significant minimal specifications of test equipment used in aligning and testing the receiver are given below:

Harmonic Generator: Fundamental frequency 100 kc/s, crystal controlled, accuracy 1 part in a million.

Signal Generator: Range 100 kc/s to 13 Mc/s, vernier frequency adjustment, good short term stability, low

	output impedance, low distortion.
Audio Oscillator:	Range 50 c/s to 5 kc/s, accuracy ±5%.
Audio Output Meter:	Range 0-5W, accuracy ±10%, 600Ω impedance.
Audio Frequency Meter:	Range 50 c/s to 5 kc/s, accuracy ±5%.
Distortion and Noise Meter:	Capable of reading up to 10%, high input impedance.
Vacuum Tube Voltmeter:	Range 0-500V a.c. and d.c.
Cathode Ray Oscilloscope:	Single beam, general purpose.

The following components are also required:

Capacitor	-	0.01µF, 400V.
Resistor	-	600Ω, 1W.

4.5.2 General Notes on Receiver Alignment

Care must be taken to adjust all crystal frequencies accurately as the CLARIFIER provides adjustments over a limited range only, of the order of 160 c/s. The frequency of all "hot" crystals must be within ±1 part in 10^{o} c/s. Hence the final adjustment to crystal trimmers should only be made after oven temperatures have stabilised. Some 30 minutes running time is essential to ensure thermal stability has been reached.

The crystal filter is a sealed unit and except for a resistance check across the input and output terminals (both 37Ω), no attempt should be made to service the unit. If the performance of the filter is suspect it should be returned, together with relevant details, to A.W.A. (Engineering Sales Department), 72 Clarence Street, Sydney.

4.5.3 Audio Gain

1. Set LINE LEVEL controls to maximum.

2. Terminate LINE 1 in 600Ω. Connect output meter to LINE 2 and audio oscillator between pin 1 of 6V9 and ground.

3. Set audio oscillator to 1000 c/s and check gain of 6V9 (see Sub-Section 4.4).

4. Terminate LINE 2 in 600Ω. Transfer output meter to LINE 1 and audio oscillator to pin 1 of 6V8. Check gain of 6V8. (See Sub-Section 4.4).

5. Transfer audio oscillator to pin 7 of 6V7 and check gain. (See Sub-Section 4.4).

4.5.4 Adjustment of 100 kc/s Oscillator

1. Connect the X-amplifier of a c.r.o. between junction of 6C40, 6C41 and chassis and the Y-amplifier to the appropriate harmonic generator output.

2. Adjust 6C38 for a stationary pattern. Note that the pattern will be irregularly shaped. (Range of adjustment for 6C38 is approximately 35 c/s).

4.5.5 Adjustment of A.G.C. Amplifier

1. Connect output meter to LINE 1.

2. Connect audio frequency meter to LINE 2.

3. Connect signal generator tuned to a nominal 100 kc/s between pin 2 of 6V6 (pin 1 of 6V5) and ground.

4. Adjust signal generator to give 1000 c/s output from receiver. Check gain of 6V6.

5. Connect v.t.v.m. to a.g.c. line (wiper of SWB) and set A.G.C. switch to FAST.

6. Increase input until a.g.c. is developed and adjust slug of 6L1 for maximum a.g.c. voltage.

7. Check a.g.c. response (See Sub-Section 4.4).

4.5.6 I.F. Amplifier Gain

1. Connect output meter to LINE 1.

2. Connect audio frequency meter to LINE 2.

3. Connect signal generator tuned to a nominal 100 kc/s between pin 1 of 6V4 and ground and set the a.g.c. switch to OFF.

4. Adjust signal generator to give 1000 c/s output from receiver.

5. Check gain of 6V4.

6. Transfer signal generator to pin 1 of 6V3 and check gain.

4.5.7 Adjustment of 2nd Oscillator

1. Connect output meter to LINE 1.

2. Connect audio frequency meter to LINE 2.

3. Remove crystal oven from socket 6SKA and set A.G.C. switch to OFF.

4. Connect v.t.v.m. crystal probe between pin 7 of 6V1 and ground.

5. Connect signal generator to pin 1 of 6V2.

6. Shunt 6C57 with the 0.01µF capacitor. Set the signal generator to give an output of 400mV at 1300 kc/s.

7. Adjust both slugs of 6TR4 for maximum reading on the v.t.v.m.

8. Remove the shunt capacitor and check the response of 6TR4 by tuning the signal generator and noting the v.t.v.m. reading. Two peaks approximately 200 kc/s apart (1300 kc/s and 1500 kc/s) should be found. If the separation is correct, but the peaks lie above or below the correct frequencies, this will be corrected by step 10. If the peaks are not 200 kc/s apart, check the values of 6C54, 6C55 and 6C57.

   NOTE: Capacitor 6C57 must be shunted by the 0.01µF capacitor when adjusting the slugs in 6TR4.

9. Remove signal generator and replace oven.

10. Switch the UPPER and LOWER sideband in turn. The injection into 6V1 should be equal and not less than 12 volts. If the injection voltage is not equal proceed as follows:-

    (a) Set the SIDEBAND SELECTOR switch to the position giving the lower output. Adjust either core of 6TR4 to increase the output until it is slightly less than the higher output obtained from the other sideband.

(b) Set the SIDEBAND SELECTOR switch to the position giving the higher output and adjust the other core of 6TR4 for a slightly lower output.

(c) Repeat (a) and (b) until outputs equal.

NOTE: Having selected a core of 6TR4 for lower sideband adjustment this core only must be adjusted when the SIDEBAND SELECTOR switch is set to the lower sideband position. Similarly, the opposite core of 6TR4 is adjusted only when the upper sideband is selected.

11. Connect the X-amplifier of a c.r.o. to pin 6 of 6V1, if necessary, through an h.t. isolating capacitor. Connect the Y-amplifier to the appropriate harmonic generator output.

12. Set CLARIFIER to the mid- position of its range.

13. Set SIDEBAND SELECTOR to UPPER sideband, i.e., the 1500 kc/s oscillator, and adjust 6C10 for a stationary pattern. (Range of adjustment of 6C10 is approximately 100 c/s).

14. Set SIDEBAND SELECTOR to LOWER sideband, i.e., the 1300 kc/s oscillator, and adjust 6C13 for a stationary pattern. (Range of adjustment of 6C13 is approximately 100 c/s).

15. Note the range of the CLARIFIER control; 160 c/s is typical.

4.5.8 Adjustment of 1400 kc/s I.F. Transformer

1. Connect output meter to LINE 1.

2. Connect audio frequency meter to LINE 2.

3. Connect signal generator set to a nominal 1400 kc/s across 6C2. Set A.G.C. switch to OFF.

4. Adjust signal generator to give 1000 c/s output from receiver.

5. Adjust both slugs of 6TR1 for maximum output.

6. Transfer signal generator to pin 2 of 1V2 and select channel 1.

7. Adjust both slugs of 5TR1 for maximum output. Recheck alignment of 6TR1.

8. Check gain of 1V2. (See Sub-Section 4.4).

9. Transfer signal generator to pin 2 of 2V2 select channel 2 and note gain.

10. Repeat (9) for 3V2 and 4V2 on channels 3 and 4.

4.5.9 R.F. Alignment

1. Connect output meter to LINE 1.

2. Connect audio frequency meter to LINE 2.

3. Select channel 1 and connect signal generator via a resistor to present a source impedance of 100Ω at the aerial input 1SKA. Set the A.G.C. switch to OFF.

4. Check that capacitors 1C4 and 1C8 are wired according to Note on Drg. 60624G1.

5. Set the signal generator to the nominal signal frequency and adjust to give 1000 c/s output from the receiver.

6. Adjust slugs of TR1 and 1L1 for maximum output, reducing input level as necessary. Finally peak these circuits with r.f. gain reduced by advancing the SQUELCH GAIN control thus reducing effects of circuit noise.

7. Set SQUELCH GAIN to maximum and check overall gain.

8. Align the remaining channels in a similar manner.

.6 Performance Tests

After completing the alignment procedures detailed in Sub-Section 4.5, the following tests may be made.

4.6.1 Sensitivity

1. Set up the test equipment as in paragraph 4.5.9.

2. Set signal generator to 1μV output.

3. Adjust LINE 1 LEVEL control for 50mW output.

4. Reduce signal input to zero and read signal-to-noise ratio by noting the reduction in output. The signal-to-noise ratio should be not less than 10 db.

4.6.2 Audio Tests

1. Set up test equipment as in paragraph 4.5.9.

2. Connect distortion and noise meter across LINE 1.

3. Switch A.G.C. to FAST.

4. Set input level to 100µV.

5. Adjust LINE 1 LEVEL control for 250mW and measure distortion which should not exceed 5%.

6. Transfer distortion and noise meter to LINE 2 and measure distortion at same level.

7. Check that PHONES output is not less than 1mW.

4.6.3 Overall Frequency Response

1. Set up test equipment as in paragraph 4.5.9.

2. Connect noise and distortion meter across LINE 1.

3. Switch A.G.C. and SQUELCH off.

4. Select highest frequency channel and adjust signal generator for 1000 c/s receiver output with 1µV input.

5. Adjust SQUELCH GAIN for 50mW output.

6. Vary input frequency for receiver output frequencies from 400 c/s to 3000 c/s. The output should not vary more than 6 db over the bandwidth.

4.6.4 A.G.C. Response and Squelch

1. Set up test equipment as in paragraph 4.5.9.

2. Switch A.G.C. to FAST.

3. Adjust signal generator for 1000 c/s receiver output with 5µV input.

4. Adjust LINE 1 LEVEL control for 50mW output.

5. Increase input to 100mV. The output should not increase more than 6 db.

6. Switch SQUELCH on and adjust SQUELCH GAIN to maximum clockwise position.

7. Reduce input to zero. Receiver should remain open.

8. Reduce SQUELCH GAIN (anti-clockwise) until receiver is just muted.

9. Slowly increase input; a signal of less than 0.5µV should unmute the receiver.

10. Check that the SQUELCH GAIN can be set to unmute the receiver at 1µV and 10µV levels.