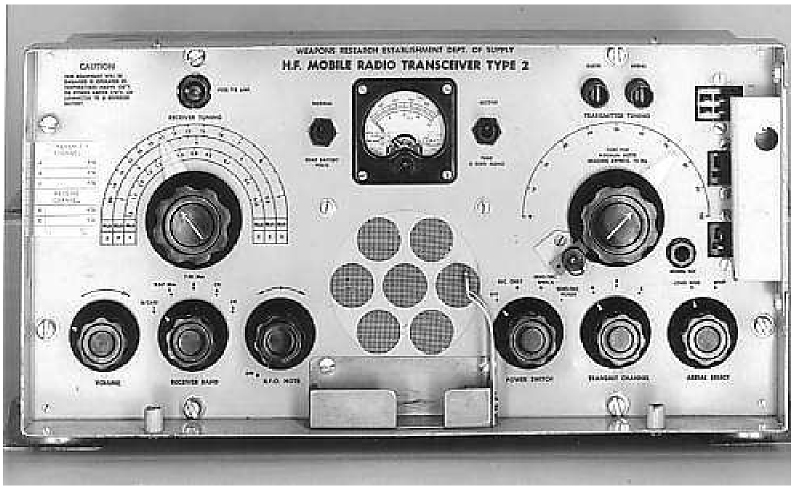

HIGH FREQUENCY MOBILE TRANSCEIVER

WEAPONS RESEARCH ESTABLISHMENT TYPE 2

INSTRUCTION HANDBOOK

[Originally Prepared by A. L(Lloyd). Butler - December 1, 1961]

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SUMMARY

The following notes have been prepared to provide guidance to Woomera Maintenance staff in the field testing of pilot models of the Type 2 Transceiver manufactured in WRE workshops. They should also provide guidance to the type of handbook required for the production models manufactured by A.W.A.

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LIST OF DIAGRAMS

1. GENERAL SPECIFICATION

1.1 General

(a) Physical Size - 16" wide a 10.25" deep x 8" high (8.25" high with anti-vibration mounts).
(b) Weight - 40 lbs.
(c) Dustproof providing front cover is in place and cable entry holes are filled.
(d) Not suitable for mounting without outside protection from weather.
(e) Remote control facilities - Remote microphone with press to talk facility. Also remote speaker extension.
(f) Temperature Range - MINUS 10°C to PLUS 70°C with some reduction of efficiency at higher temperatures.
(g) Maximum Storage Temperature 75°C.
(h) Power Source - 12 volt battery supply (NOTE POSITIVE EARTH ONLY).
(i) Battery load - Receive only - 18 mA (quiescent operation)
Receive & Transmit (Standby) - 0.82A
Transmit Speech - 5A (Modulator quiescent)
Transmit Speech - 6A (100% modulation)
Transmit C.W.- 4.5A

1.2 Transmitter

(a) Frequency Range - 2.5 to 12 Mc/s
(b) Operating channels - switched, all pretunable between 2.5 to 12 Mc/s.
(c) Mode of Transmission - Radio Telephony or Radio Telegraphy (C.W.)
(d) R.F. Output Power - 12 watts.
(e) Aerial system - Preset operation for each channel for both whip and 0.25 wave long wire.
(f) Overall frequency Response - 400 c/s to 2500 c/s +/- 2db. Response falls sharply below 400 c/s and above 2500 c/s.
(g) Noise level below 50% modulation at 1000 c/s, 35 - 40 db.
(h) Harmonic Distortion 50% modulation 1000 c/s - 5%.
(i) Crystals - D type - 20 pf circuit capacity

1.3 The Receiver

(a) Frequency Range - 550 to 1600 Kc/s, 2.5 to 20 Mc/s tunable, plus two crystal locked channels each within the range of 2.5 to 12 Mc/s.
(b) Intermediate Frequency - 455 Kc/s.
(c) Mode of Reception - Radio Telephony or Radio Telegraphy (C .W.) - Beat Frequency Oscillator fitted.
(d) Overall Sensitivity
(1) H.F. Bands - In the region of 1 micro- volt to the aerial via a 50 ohm source to give 50 mW audio output with a signal to noise ratio of 6 db at 25°C.
(2) Broadcast Band - 2 to 5 microvolts to the aerial via a 50 ohm source to give 50 mW audio output with a signal to noise ratio of 6db at 25°C.
(e) Bandwidth - Approx. 5 Kc/s at 3 db points.
(f) Image Ratio - 550 KHz - 30 dB
- 2.5 MHz - 40 dB
- 12 Mc/s - 20 dB
- 18 MHz - 16 dB
- 20 Mc/s - 4 dB
(g) AVC Characteristic 1 microvolt to 1000 microvolts - 3 dB change in audio output level.
- 1 microvolt to 100 millivolts - 10dB change in audio output level.
(h) Aerial Circuit input impedance — suitable for 10-50 ohms aerial.
(i) Beat Frequency Oscillator — Variable 7500 c/s - 0 - 4000 c/s.
(j) H.F. Oscillator Temperature stability — (Temp. Range 20°C to 70*C).
H.F. Bands Tunable - Less than 1% shift
Broadcast Band - 3 to 5% shift
Crystal locked - Less than 0.01% shift
(k) Max. audio output — 290 mW into 3.5 ohm load at 1000 c/s.
(l) Distortion audio amplifier - 5% at 150 mW 1000 c/s.
(m) Crystal – D type – Circuit capacity - 20pf

1.4 Valve & Semi-conductor complement

Transmitter

1\. 6AU6WA, or CV4023
1\. 6AQ5W, or CV4019, or 6005
1\. 2E26

Modulator

2. OC45
1. OC72
2. 2N301

H.T. Power Supply

2. 2N301
4. OA210

Receiver

3. OC170
2. OC45
1. OC44
2 OA261
1. OC71
2. OC72
1. HC7002

L.T. Circuit

1. OA31

OPERATING INSTRUCTIONS

2.1 Operating.Channels

A plate on the front panel of the unit is provided to indicate the frequency of the transmitter operating channels and the locked frequency receiver channels that are available for use. For stationary operation either the tunable section of the receiver or the locked channels may be used, but during mobile operation it is essential to receive on the locked channels. The correct channel to use is determined by previous arrangement with the base stations and depends on the radio network involved, and the variable operating conditions which are effected by the time of the day, the season, and the distance.

2.2 Use of Aerials

Whip aerial. The whip is used for mobile operation and for stationary operation where communication is not difficult. The "Aerial Select" switch is turned to the "Whip" position for this aerial.

Long wire Aerial. This is used for stationary operation only when communication on the whip is unsatisfactory and improved performance is required. Connect the aerial links for the required frequency as indicated on the aerial reel and tie the end designated "mast" to a high object. The end marked "Transceiver" is connected to the aerial terminal of the transceiver. If a counterpoise wire is also provided, run this out along the ground under the aerial, and connect the end to the earth terminal of the transceiver. When the transceiver is mounted in the vehicle, the counterpoise is not required. The whip aerial feed wire must not be connected when operating on a long wire. For best results the aerial wire should be at right angles to the direction of communication. The "Aerial Select" switch is turned to the "Long Wire" position for this aerial.

To Receive Signals

Turn the "Power Switch" to either of the following positions :"Rec. only", "Send/Rec. speech", or "Send/Rec. Morse". It is advisable to operate as much as possible in the "Rec only" position as negligible current is drawn from the battery under this condition. The other two positions are only used where the delay in waiting for the transmitter warm up is not permissible i.e. between transmissions during and operating schedule.

For frequency locked operation turn the "Receiver Band" switch to either "CHA" or "CHB" as indicated for the required frequency on the plate on the front panel. Set the "Volume" control as is required.

For tunable operation turn the "Receiver Band" switch to the required freouency range (position 2 or 3 for communication purposes), and tune the "Receiver Tuning" dial to the correct frequency as indicated on the scale. Adjust the "Volume" control to give a suitable sound level from the loudspeaker and adjust the tuning around the calibrated spot until the signal (if available) is heard.

On reception of speech signals the "B.F.O. note" control must be in the "OFF" position. The control can be felt to click into this position when turning extreme anti-clockwise. Unless this is in position, an interfering note will be heard.
On reception of morse (C.W.) signals, the "B.F.O. note" control is adjusted to give a suitable pitch.

Note. When using the receiver in tunable operation, it may be necessary to transmit first, so that a reply can be received to find the exact spot on the receiver dial. However, to prevent. interference to other stations, it is important that a check is made to see if the channel is clear before transmitting.

2.4 To Send Signals

Turn the "Power Switch" to the "Send/Rec. Speech" position for speech operation or the "Send/Rec. Morse" position for morse (C.W.) operation. Allow 30 sections for the transmitter heaters to warm up. The switch is normally left in this position for the duration of the communication schedule. Set the "Transmit Channel" switch to position A,B, or C indicated for the required frequency on the plate on the front panel.

Before initial transmission the transmitter tuning must be checked. Unscrew the transmitter tuning lock, press the switch at the right hand of the meter down to the "Tune & Send Morse" position, and adjust the "Transmitter Tuning" control for a minimum meter reading. This should read approximately 70 ma if operating correctly but could vary from 60 to 80 mA depending on the way the aerial is erected and on battery voltage. Screw up the transmitter tuning lock on completion of tuning and restore the switch to the "Receive" position.

To send speech, press the button on the microphone which is then ready to accept voice. To restore to receive condition, release the button.

Caution

The microphone button can be locked on by turning and care should be exercised that this is not accidently turned when pressing. Care should also be taken to ensure that the switch at the right of the meter is left in the "Receive" position otherwise the transmitter will continuously emit a signal.

For morse (C.W.) transmission, a morse key with a plug attached is provided. The plug is inserted in the jack designated "Morse Key" at the commencement of the communication schedule. The switch at the right of the meter is used as a send/receive switch for morse operation. The morse key plug must be withdrawn when it is required to send speech or tune the transmitter.

2.5 To Receive Broadcast Programmes and Time Signals

When used at long periods for amenities, it is important that the "Power Switch" is left in the "Rec. Only" position to prevent high battery discharge. In this position the current drain feeding the transistor receiver is that small, that it can be ignored.

Band switch position 1 (B/Cast) is the normal broadcast band but positions 2 or 3 may be used for short wave broadcast when out of range of the lower frequency stations. Positions 2 and 3 are also used for time signals in the tunable condition of the receiver.

The nature of the aerial used is not very important when used for receiving purposes only.

.6 Switching Off

On completion of use of the transceiver, the power switch must be returned to the "OFF" position.

3. CIRCUIT DESCRIPTION

3.1 The Transmitter

The transmitter is a three stage three channel crystal controlled unit. Channel change is controlled by a three position switch. All channels can be preset within the range of 2.5 to 12 Mc/s.

3.1.1 The Crystal Oscillator

The oscillator uses a 6AU6WA ruggedised valve as a pierce oscillator. Three crystals are provided under the control of the channel switch. The crystals are "D" type and the crystal circuit capacity is 20 pf.

3.1,2 The Buffer Amplifier

This stage gives sufficient power gain from the oscillator to drive the power amplifier. It provides isolation between these two stages and is also used as a keying point for C.W. operation. The valve used is a ruggedised type 6AQ5W. Tuning of the plate circuit is achieved by the adjustment of L201, L202 and L203 respectively for channels A, B and C. Capacitors C214, C215, C216 and C217 can be connected to cover a wave range as required. With the largest condenser C217 connected, the coils can be adjusted to a minimum frequency of 2.5 Mc/s. With no condensers connected, the coils can be adjusted to a maximum frequency of 12 Mc/s.

The cathode of the valve is jacked for the manipulating key connection.

3.1.3 The Power Amplifier

This is a 2E26 beam power tetrode. Approximately 350 volts of H.T. is applied to this stage and when loaded correctly operates at a cathode current of 70 mA. Under these conditions, 10 to 12 watts is delivered to the aerial.

Grid bias is mainly achieved by grid leak resistance R208 but sufficient protective bias is applied to prevent excessive dissipation during key up condition. Protective bias is partly applied from cathode resistance and partly by returning the grid circuit to the 12 volt negative supply line.

The P.A. plate is shunt fed to the P.A. tank inductance L205.
This reduces the chance of electric shock during adjustment operations. To cover the range of frequencies of 2.5 to 12 Mc/s, the inductance L205 has four plate taps, and two fixed capacitors C220 and C221 are provided. If connected as specified, the tank Q will remain quite near to optimum value over the frequency range. The P.A. is resonated by tuning C219. This variable capacitor is sufficiently small to prevent the operator from finding an unwanted harmonic once the taps are preset correct.

3.1.4 The Aerial Loading Circuit

Each of the three channels on the transmitter can be preset for correct loading to supply two different aerial systems. The two systems are selected by a switch designated Long Wire/Whip.

Tapped loading inductance L206 allows a capacitive aerial to be resonated. If the aerial is inductive capacitors C222, C223, or C224 can be inserted. To resonate the aerial in this case, a capacitor over large is connected and adjustment is again made by adding inductance on L206.

As there are six preset aerial loading conditions that can be set up. Six tap leads are provided for L205 and L206 and six connecting posts for the series capacitors to be connected.

It is recommended that if a long wire is used it should be a 0.25 wave. In most cases such an aerial will not require series L or C, - L206 will be shorted out and the condensers bypassed. Where more than one frequency is used, one length of aerial with taps at each 0.25 wave point can be provided. The aerial select switch is designated "long wire" for this operation.

The "whip" position of the switch is provided for mobile operation on a whip aerial. Under most normal conditions, L206 will always be required to load the whip.

3.1.5 Metering

During normal operation the meter reads P.A. cathode current and is used to indicate resonance dip of the P.A. when adjusting the tuning condenser.

A switch is provided inside the unit to connect the meter to read P.A. grid current. This allows tuning of the buffer amp plate circuit inductances for an indication of maximum P.A. grid current. The switch has purposely been made inaccessible to the user to avoid confusion as it is not required once the transmitter has been preset by a technician.

A switch on the front panel can be pressed to select battery volts. This has been made non-locking to prevent the user from attempting to tune the P.A. with the meter incorrectly switched.

3.2. The H.T. Power Supply

Two 2N301 power transistors are used in a D.C. converter of the saturating core variety connected in a push pull symmetrical arrangement. A simplified explanation of the operation is as follows:

The converter is readily made self starting by applying forward bias via divider R401 and R402. Switching on causes random impulses to appear across the various windings of TR401 of such polarities as to increase conduction in one transistor and decrease conduction in the other. The rise of collector current in the first transistor induces a voltage in its associated feedback winding of such polarity as to increase the base potential and further increase the collector current, whilst the fall of collector current in the second transistor induces a voltage in its associated feedback winding of such polarity as to decrease the base potential and further decrease the collector current.

The accumulated action causes the first transistor to turn fully on and the second transistor to turn off. The current in the first transistor continues to rise, at a rate determined by the inductance of the primary, until the transformer core saturates and the field collapses. The induced voltages now collapse and a reversed field is set up in the transformer causing regenerative "switch off" of the first transistor and regenerative "switch on" of the second transistor. The second condition will remain until the increase of collector current in the second transistor again causes the core to saturate and cause the field to collapse. The transistors continue to alternate between the two conditions at a frequency determined by the circuit constants and in the order of 400 Kc/s to 500 c/s.

The voltage is stepped up in the secondary of TR401 and rectified by four OA201 silicon diodes in a bridge circuit. After filtering, the nominal output voltage is 350 when the transmitter is loaded to a PA - Ik of 70 mA.

3.3 The Modulator and Speech Amplifier

The output of the 25 ohm vitavox moving coil microphone is fed direct to the emitter of transistor V301 that is connected in grounded base operation. V302 and V303 amplify the power level suffcient to operate class B modulators V304 and V305.

Transistors V301, V302 and V303 are temperature stabilised via D.C. feedback in the emitter circuits. Transistors type OC45 are used in the first two R/C coupled stages in view of their low collector leaking current. This reduces the tendency for collector voltage bottoming so common to R/C coupled stages.

The 2N301 Modulator transistors are temperature stabilised by thermistor X301 connected in the base bias circuit. Base bias resistor R322 is adjustable and is set to a point of minimum cross over distortion in the transistors. That corresponds to a total collector current in V304 and V305 of about 60 mA.

The output of the modulator is applied to the plate and screen grid of the Power Amplifier V203 and can deliver up to 17 watts of audio at full battery volts.

The modulation level is set by potentiometer RV301.

3.4 Receiver

The receiver is a fully transistorised unit consisting of an RF stage, mixer, separate H.F. oscillator, two I.F. stages and two audio stages. A five position switch SWG provides selection of bands and channels as follows :-

Pos. 1 - 550 to 1600 Kc/s (B/C Band)
Pos. 2 - 2.5 to 7 Mc/s Tunable
Pos. 3 - 7 to 20 Mc/s Tunable
Pos. 4 - CH.A (crystal locked any frequency 2.5-12 Mc/s)
Pos. 5 - CH.B (crystal locked any frequency 2.5-12 Mc/s)

3.4.1;R.F. Amp and Converter Stages

The R.F. amp V501, Mixer V502 and oscillator V503 are all drift transistors type OC170.

As the impedance of the aerials expected to be used is comparable with the base input impedance of the first transistor, a tap for this purpose is not necessary on the aerial circuit coils and the aerial is connected direct to the base of V501. Base taps only are provided on the aerial coils. Tuning on all tunable bands is achieved with variable 3 gang condenser C501 A–B–C. Capacitors C530, C531 and C532 provide padding of the oscillator circuit to obtain tracking.

In tunable operation the oscillator is the transistor equivalent of the Hartley circuit and its output is injected into the emitter of the mixer transistor from a secondary winding on the oscillator coils. In crystal locked operation the circuit is the transistor equivalent of the Pierce oscillator. The crystals used are "D" type and the crystal circuit capacity is 20 pf. Injection in this case is from collector of the oscillator via capacitor C539 to the input circuit of the mixer.

The Locked Channel Aerial and R.F. tuned circuits are preset in their tuning before supply to the user. Coils TR504 and TR509 are set for channel A and coils TR505 and TR510 are set for channel B. To provide a range from 2.5 to 12 Mc/s capacitors C511 to C514 and C523 and C526 are connected in parallel with the coils as is necessary.

A large degree of temperature stabilisation is necessary to prevent excessive frequency shift of the oscillator and this is provided by a combination of emitter D.C. feedback from R512 and thermistor (X502) correction in the base bias circuit.

Normal emitter D.C. feedback is used on the mixer for stabilisation but the R.F. Amplifier has a special circuit to assist A.V.C. action (refer Paragraph 3.4.3).

3.4.2 I.F. Amplifier Stages

Two stages of transistors type 0C45 provide most of the gain and selectivity in the receiver. To reduce instability and to give a more symmetrical selectivity curve, the collector to base capacity of both stages are neutralised by capacitors C604 and C610.

Normal emitter D.C. feedback is used for temperature stabilisation on V602 but V601 has a special circuit to assist the A.V.C. action (Refer Paragraph 3.4.3).

2nd Detector and Automatic Volume Control

Germanium diode MR602 is used for detection of the I.F. signal and the D.C. voltage developed across the load resistor R612 is used to provide automatic volume control to vary the gain of V501 and V601.

The base bias divider circuits of V501 and V601 are returned to earth via R612 and the voltage developed across this resistor by rectified signal current is of opposite polarity to the fixed forward bias. As this voltage increases, the forward bias on the base of the transistors is reduced and the base input impedance is increased. This in turn reduces the A.C. signal drive current and thus the overall gain of the stages. To increase the effectiveness of control, the amount of emitter resistance in the controlled stages has been reduced to a very small value. This eliminates most of the D.C. feedback that in a normal temperature stabilised stage would oppose A.V.C. action. To restore temperature stability, thermistors X501 and X601 are connected in the base divider circuit. To further improve the A.V.C action at high signals levels a shunt diode circuit is added. Voltages have been so proportioned that at low signal levels, diode MR601 does not conduct and the junction of R606 and MR601 is slightly positive in respect to the other side of the diode. As transistor V601 is controlled by A.V.C. action, the emitter current will reduce and cause the junction of R606 and MR601 to become more negative until a point is reached where the diode receives reverse polarity and conducts. As the diode is connected to the emitter tap of I.F.transformer TR601 and via C607 to earth, TR601 will be heavily damped to further reduce the signal level.

3.4.4 Beat Frequency Oscillator

V603 is an 0C44 transistor connected in the transistor equivalent of the Colpitts circuit. Injection of this oscillator is via C609 to the base of I.F. amplifier V602. A large amount of D.C. emitter feedback is applied to reduce the amount of frequency change as temperature is increased. B.F.O. on/off and B.F.O. note control is facilitated by combination switch potentiometer SWH/RV601. The switch connects battery to this stage for switch on. The potentiometer RV601 varies the amount of D.C. voltage applied to Silicon Variable Voltage capacitor MR603. This device will vary its capacity from 30 pf when 12 volts of reverse potential is applied, to 130 pf, when the voltage is reduced to 0.1. MR603 is connected across the tuned circuit of the B.F.O. and the change of capacity, under control of the potentiometer, thus varies the frequency of the B.F.O.

3.4.5 Audio Amplifier Stages

The output from the detector is fed via audio volume control RV602 to audio driver stage OC71 - V604. This is transformer coupled to a push pull class B OC72 transistor stage that can supply 290 milliwatts to the 4 inch loudspeaker.

Temperature stabilisation in V604 is via emitter feedback. Thermistor X631 stabilises the class B output stage over the temperature range. Emitter resistor R635 protects against thermal runaway at the extreme upper end of the temperature range.

3.5 Switching and Transmit Receive Facilities

The main power switch is a 3 pole 4 position unit. The switching is as follows :-

Position 1 - OFF

Position 2 - REC. ONLY - 12 volts fed to receiver

Position 3 - SEND/REC SPEECH - Receive Condition - 12 volts to receiver
- Transmit Condition - 12 volts to H.T. power supply
- 12 volts to modulator

Position 4 - SEND/REC MORSE - Receive Condition - 12 volts to receiver
- Transmit Condition - 12 volts to H.T. power supply
(Modulator no power)

Relay PT is the transmit/receive change over relay and is operated either from the press to talk button on the microphone or from send/rec switch SWE that is used for tuning purposes and for C.W. operation. Contacts PT1, PT2 and PT3 distribute 12 volts to the various sections of the transceiver and contact PT4 is for aerial change over. A D.C. wetting voltage is supplied to the receive aerial contacts via R501 and R102 to break down any oxidisation that may occur.

3.6 Reverse Battery Protection

Reverse battery must not be applied to the transceiver. However to protect the transistors against this accident occurring, germanium power diode OA31-MR101 is connected in the non-conducting direction across the load side of battery fuse FS1. Reverse battery causes the diode to conduct heavy current and open the fuse. CAUTION The fuse must not be replaced with any cartridge greater than 7.5 amp rating, as the protection diode could be caused to draw excessive current and be destroyed.

3.7 Remote Operation

In mobile installations where it is desired to mount the transceiver in a position not accessible to the operator, the microphone and speaker can be extended. For the microphone, a connector is extended from PLA to an additional connector to fit the microphone socket SKC. For the extension speaker, PLC is removed and replaced with an extension connector via pins 1 and 2.

When remote operation is not required, the microphone is fitted on the microphone mount on the front panel of the transceiver and PLA is left in circuit. To fill the cable cut out holes in this case,blank solid rubber grommets replace the ones used for the remote cables.

4. INSTALLATION

To mount the transceiver in a mobile vehicle it essential to provide vibration isolation and the four ant-vibration mounts supplied must be used. These are Silent Block Type BPR15 (Folio 5/4694). The only possible exception to this rule is a sedan car that already has good high frequency vibration isolation.

The battery cable used should be sufficiently heavy to prevent voltage drop. Miniature Multicore cable type Dumetvin small 16A (3E/1541) should be satisfactory. If the dust seal where the cable enters the transceiver via the rubber grommets is not good, pack with plasticine. It should be pointed out to the user that if the dust seal is to be effective, the front cover must be kept in place as much as possible.

In choosing a location on a vehicle for installation, avoid places where high temperatures from the engine, or from the sun, may be encountered. A lead should be run from the earth terminal of the transceiver direct to the vehicle chassis or metal body. Make this as short as possible.

When a whip aerial is used, it should be remembered that the lead to the whip is part of the radiator, and must be kept as short as possible. Shielded cable such as coaxial line should not be used.

5. SETTING UP THE TRANSMITTER

Select the transmitter crystal the same frequency as the operating frequency.

Connect the buffer circuit capacity links for channels A, B or C as required:

Frequency	Tap	Capacity	Circuit Ref.
2.5 - 3.5 Mcs	A	560 pf	C217
3.5 - 4.75 Mcs	B	270 pf	C216
4.75 - 6.5 Mcs	C	120 pf	C215
6.5 - 9 Mcs	B	47 pf	C214
9 - 12 Mcs	No Tap	Circuit Cap only	- - - -

Connect the PA tank coil L205 fixed taps for channels A, B or C as required :—

Frequency	Tap	Turns
2.5 - 4 Mc/s	No tap	All Turns
4 - 5 Mc/s	A	25
5 - 7.5 Mc/s	B	22
7.5 - 12 Mc/s	C	13

Connect the PA tank circuit capacity for channels A, B or C as required:-

Frequency	Tap	Capacity	Circuit Ref.
2.5 - 3 Mc/s	A	100 pf	C220
3 - 5 Mc/s	B	47 pf	C221
5 - 12 Mc/s	No Tap	Circuit Cap. Only	-----

Set the power switch to send/Rec. Speech, set the meter switch at the rear. of the front panel to the "grid current" position, and allow heaters of transmitter to warm up.

Operate the "Tune & Send Morse" switch and tune the buffer coil slug (L201, L202 or L203) to give maximum reading of grid current on the meter. This should read from 2 to 5 mA (Read the top scale divided by 10).

Restore the meter switch at the rear of the front panel to the "cathode current" position. This is the operational position.

Check that the P.A. tank circuit resonates by tuning the P.A. tank Condenser for minimum reading on the meter, now showing cathode current.

5.1 Loading the transmitter to the aerial

5.1.1 Whip Aerial (Aerial switch. in whip position)

Connect link W1, W2, or W3 (for channels A, B or C respectively) to A. This directly joins the aerial loading coil L206 to the coupling taps of L205.

Connect the appropriate loading coil tap for the channel concerned at the top of L206.

The colour code is :—

Channel A Orange
Channel B Yellows
Channel C Green

Connect the appropriate coupling tap for the channel concerned a few turns up on L205. Minimum coupling is at the right when viewed from the front of the transceiver.
The colour code is the same as for L206.

Connect on 0-1 amp R.F. ammeter between the aerial terminal and the whip lead. Resonate the PA tank circuit and adjust the tap on L205 for maximum aerial current. Keep repeating and increase the coupling tap on L206 until all of the following are satisfied:-

The P. A. tuning is resonated i.e tuned for a minimum.

The loaded P.A. cathode current is in the vicinity of 70 ma.

The loading coil is adjusted for maximum aerial current.

The ideal is that the P.A. tuning point should be the same both loaded and unloaded. However in practice, the tap points on the coils are not fine enough to often achieve this. If the unloaded tuning point is near one end of the tuning scale, it is also advisable to arrange the tap in L206 so that the tuning point shifts nearer to the centre of the scale when loaded.

When more than one channel is to be adjusted, the lower frequency channel should be adjusted first and followed in ascending order to the highest frequency channel. The chassis should also be pushed back into its case for all final settings as the case can cause some detuning. Interaction may also be noticed between channels and the procedure may require repeating several times.

If a very high frequency is used and the whip lead is long, the aerial circuit may become inductive. In this case, instead of connecting to tap A, it will be necessary to add capacity by connecting C222, C223 or C224, (taps B, C or D) to Wi, W2 or W3. Note that if this is used, more capacitive reactance than necessary is added, and the aerial circuit is still adjusted by L206.

3.1.2 Long Wire Aerial (Aerial switch in Long Wire position)

It is proposed that where possible, the aerial will consist of tapped sections to provide 0.25 wave lengths for each frequency used. In most cases the aerial will be nominally resistive and the loading coil L206, or the series loading capacitors will not be required. Assuming this to be correct, set up as follows :-

Connect link L1, L2, or L3 (for channels A, B or C respectively) to A, i.e. no series capacity.

Connect the appropriate loading coil tap for the channel concerned at the top of L206, i.e. no series inductance.

The colour code is :-
Channel A Black or Blue
Channel B Brown
Channel C Red

Resonate the PA tank circuit and adjust the appropriate tap on L205 until the loaded resonant cathode current is in the vicinity of 70 mA. The colour code is the same as for L206.

If the loaded resonant tuning point is not near the unloaded point, or if it tends to tune off the scale, the following may be necessary:-

(1)Add turns to L206 if the aerial circuit is capacitive, or, (2)Connect capacity if the aerial circuit is inductive, (and adjust as in the case of the whip aerial).

The procedure of adjusting in order of frequency, final adjusting within the case, and interaction between channels (as referred to in the whip adjustment), still applies for long wire.

Interaction may also occur between long wire and whip adjustments and all settings of both should be rechecked several times.

6. SETTING UP THE RECEIVER CRYSTAL LOCKED

A crystal is selected either 455 Kc/s above or 455 Kc/s below the operating frequency. Connect the fixed capacity links on the aerial and R.F. tuned circuits to channel A or channel B taps as required :–

Frequency	Tap	Capacity	Capacitor aerial tuned circuit	Capacitor R.F. tuned circuit
2.5 - 3.5 M/cs	A	470 pf	C514	C526
3.5 - 4.75 Mc/s	B	240 pf	C513	C525
4.75 - 6.5 Mc/s	C	120 pf	C512	C524
6.5 - 9 Mc/s	D	33 pf	C511	C523
9 - 12 Mc/s	No Tap	Circuit Cap. only	-------	--------

Connect a signal generator across the aerial terminals and an output meter across the speaker connector. Set the signal generator on modulation and near the operating frequency.

Adjust the signal generator frequency for maximum audio output.

Adjust the RF coils (TR509 or TR510) and the aerial circuit coils (TR504 or T2505) for maximum audio output.

Check that approximately 1 microvolt modulated with 400 c/s at 30% will give an audio output of 50 millivolts with a signal to noise ratio of 6 db.

7. PRECAUTIONS IN SERVICING AND OPERATION

(1) Do not connect to reverse battery.

(2) Do not operate in the field of other transmitters, particularly if the transceiver receiver is tuned to the same frequency. This operation can cause destruction of the RF amplifier transistor. The fault symptoms are operation normal except for serious loss of sensitivity.

(3) Always use a high resistance voltmeter when taking measurements on the transistor circuits. At least 100,000 ohms per volt is recommended. A vacuum tube voltmeter is ideal. Too low a resitance voltmeter apart from giving incorrect readings can sufficiently unbalance biasing circuits to cause collector current overload.

(4) Be careful in taking measurements with voltmeter probes. If the base circuit is accidentally short circuited to the collector circuit, the transistor will be destroyed.

(5) Where it is necessary to feed an oscillator to various transistor stages for fault tracing, always couple through a small capacitor to provide D.C. isolation. Do not use too large a value as the charge current could be sufficient to ruin a transistor.

(6) Do not operate in temperatures above 65°C and do not store in locations above 75°C

Sectional circuit sensitivity figures and voltage analysis figures are listed to assist in locating faults. As far as the receiver is concerned, it should be possible to locate the source of the fault by checking stage sensitivity point to point to locate the offending stage. The voltage analysis should then help to locate the faulty component in this stage.

8.1.1 RF and IF sensitivities (approx. values)

All measurements are the A.C. input voltages applied to the stages concerned necessary to give 50 milliwatts of audio output. In each case the voltage is supplied from a 50 ohm generator source through a 0.01 mfd capacitor and the voltage quoted is the source voltage. If a 10 ohm signal generator is used, a 39 ohm resistor is connected in series. The generator is modulated 30% at 400 Kc/s. The receiver volume control is set at maximum.

Aerial:

HF Bands - 1 microvolt
B/C Band — 5 microvolts

Mixer (V502) Base
HF Bands - 3 microvolts
B/C Band - 5 microvolts
At IF Frequency (455 Kc/s) - 1 microvolt

1st IF amp (V601) Base - 60 microvolts

2nd IF amp (V602) Base - 2.5 millivolts

Detector Diode (MR602) Connection to TR603 - 150 millivolts

8.1.2 Audio Sensitivities

Voltages quoted are the audio input levels at 1000 c/s applied to the stages concerned necessary to give 50 milliwatts of audio output. A 0.5 mfd isolating capacitor is used in each case.

Audio driver (V604) Base - 15 millivolts

Audio driver (V604) Collector - 1.3 volts

If a suitable sensitive instrument is not available to measure the base input audio voltage to V604, the audio signal generator can be applied via a 1000 ohm resistor and a 10 ohm resistor in series and the resistor junction coupled to the transistor base. The voltage can then be measured across the total network and divided by 100.

8.1.3. Speech Amplifier sensitivity

The overall gain of the speech amplifier and modulator may be checked using the test arrangement specified in paragraph 10.2. The input level to the speech amplifier, with the control RV301 set for maximum gain, is minus 80 dBm for full modulation with the PA - Ik set at 70 mA. After this test is concluded, RV301 must be reset as outlined in paragraph 10.2.

8.2 Voltage Analysis

8.2.1 Voltage Analysis Receiver

Transistor	Emitter	Base	Collector	Remarks
V501 R.F. Amps	-0.2V	-0.4V	-11.5V	(No signal input)
V501 " "	-0.1V	-0.3V	-12V	(100 microvolts input to aer.)
V502 Mixer	-1.4V	-1.5V	-11.5V	
V503 Osc.	-1.5V	-1.6V	-11.5V	(Varies with frequency)
V601 I.F. Amp 1	-0.3V	-0.15V	-10V	(no signal input)
" " "	-0.05V	-0.2V	-12V	(100 microvolts input to aer.)
V602 I.F. Amp 2	-3V	-3.2V	-9.5V	
V603 B.F.O.	-2.4V	-2.5V	-6.5V	(B.F.O. Switched on)
V604 and Driver	-1.9V	-2V	-11.5V	
V605 output	-0.1V	-0.25V	-12V	(no signal input)
V606 output	-0.1V	-0.25V	-12V	(no signal input)

MR602 - Detector diode load. R612
- No signal: -0.1V
- 100uV input: +0.06V

8.2.2 Voltage Analysis Transmitter (PA - IK Loaded to 70 ma)

Valve	Cath.	Cont Grid	Screen Grid	Plate	Remarks
V201-Xtal Osc.	0	-5V	+170V	+50V	*(Normal operation)
" " "	0	-1V	+ 75V	+15V	(Xtal Removed)
V202-Buffer Amp	+22V	-25V	+215V	+215V	*(Normal operation)
" " "	+20V	- 3V	+260V	+260V	(Xtal Removed)
V203-Power Amp	+16V	-12V	+150V	+360V	*(Normal operation)
" " "	+ 9V	-12V	+220V	+375V	(Xtal Removed)

P.A. IK (Key up condition) = 39ma.
* Note. As detuning occurs with measurement, readings are only a guide.

8.2.3 Voltage Analysis Modulator (No audio input)

Transistor	Emitter	Base	Collector
V301 Micro Pre-amp	-2.8V	-3V	-5V
V302 Audio amp	-3.3V	-3.5V	-6.8V
V303 Audio driver	-2V	-2.25V	-11.5V
V304 Modulator	0	-0.15V	-12V
V305 Modulator	0	-0.15V	-12V

8.2.4 Voltage Anlaysis H.T. Power Supply

Transistor	Emitter	Base	Collector
V401	-0.1V	+2,5V	-12V
V402	-0.1V	+2.5V	-12V

H.T. output Voltage 360 (Transmitter loaded to 70 ma PA - IK)

H.T. output Voltage 380 (Xtal removed)

H.T. Total current — 95 ma (Transmitter loaded to 70 ma PA - IK)

9. RECEIVER ALIGNMENT

9.1 I.F. Stages

Connect a signal generator tuned to 455 Kc/s to the base of the mixer V502 through a 1000 ohm resistor and a 1000 pf capacitor. Accurately calibrate the signal generator on this frequency against a known accurate signal source such as a heterodyne wavemeter. This is important because if the IF Frequency is not accurate, the receiver will not align correctly in crystal locked condition.

Connect an output meter to the speaker output connector and with the RF signal tone modulated, adjust the slugs of TR601, TR602 and TR603 for maximum audio output. Repeat the process until no further improvement is shown.

Under normal conditions in the field, neutralisation of the IF stages will not require checking, however, if the receiver is being aligned for the first time following manufacture, or if TR602 or TR603 is changed in the field, this must be checked to ensure that the secondaries of TR602 and TR603 are phased correctly.
The effects of incorrect neutralisation are :-

Tendency to instability in the IF stages.

Asymmetrical selectivity curve.

Interaction between tuning of IF transformers.

A neutralisation check method is described in Appendix 1 (Paragraph 10).

0n completion of alignment, lock the IF coil slugs with shellac.

9.2 RF Stages

Before alignment, check that the dial pointer corresponds to the left hand horizontal line above the Mc/s markings on the dial scale when the tuning gang is set at minimum capacity. At this setting the pointer should be parallel with the top and bottom of the transceiver case. Note that the type of tuning gang used will not quite cover 180 degrees and the dial will not quite rotate to a parallel point at the high capacity end.

To eliminate the chance of detuning when the cover is replaced, it is preferable to align the RF stages with a dummy cover in place drilled for access to coils and trimmers.

9.2.1 Location of Coils and Trimmers

In the RF assembly, the location of the various sections are as follows :-

Front compartment - Aerial circuit coils and trimmers.

Centre compartment - RF circuit coils and trimmers.

Rear compartment - Oscillator circuit coils and trimmers.

All the coils are designated with their circuit reference and the trimmers are marked 1, 2 or 3 to indicate the Band number.

In each compartment, Band 1 coils and trimmers are nearest the front, Band 2 in the centre and Band 3 at the rear.

Proceed with alignment in ascending order Band 1, 2 and 3.

9.2.2 Band 1 - Broadcast, 550 - 1600 Kc/s

(1) Set the signal generator on 600 Kc/s and adjust TR511 to make the pointer on the tuning dial read 600 Kc/s on the scale.

(2) Set the signal generator on 1450 Kc/s and adjust C535 to make the pointer on the tuning dial read 1450 Kc/s on the scale. C535 is the front trimmer in the rear compartment.

(3) Repeat 1 and 2 a number of times until both conditions are satisfied.

(4) Set the signal generator on 600 Kc/s and adjust TR501 and TR506 for maximum audio output when the receiver is tuned to that frequency.

(5) Set the signal generator on 1450 Kc/s and adjust C503 and C516 for maximum audio output when the receiver is tuned to that frequency. C503 and C5I6 are the front trimmers in the front and centre compartments.

(6) Repeat 4. and 5 a number of times until no further improvement is noticeable.

9.2.3 Band 2 - 2.5 to 7 Kc/s

(1) Set the signal generator on 2.7 Mc/s and adjust TR512 to make the pointer on the tuning dial read 2.7 Mc/s on the scale.

(2) Set the signal generator on 6.3 Mc/s and adjust C537 to make the pointer on the tuning dial read 6.3 Mc/s on the scale. C537 is the centre trimmer in the rear compartment.

(3) Repeat 1 and 2 a number of times until both conditions are satisfied.

(4) Set the signal generator on 2.7 Mc/s and adjust TR502 and TR507 for maximum audio output when the receiver is tuned to that frequency.

(5) Set the signal generator on 6.3 Mc/s and adjust C504 and C517 for maximum audio output when the receiver is tuned to that frequency. C504 and C517 are the centre trimmers in the front and centre compartments.

(6) Repeat 4. and 5 a number of times until no further improvement is noticeable.

9.2.4 Band 3 - 7 to 20 Mc/s

(1) Set the signal generator on 7.7 Mc/s and adjust TR513 to make the pointer on the tuning dial read 7.7 Mc/s on the scale.

(2) Set the signal generator on 18 Mc/s and adjust C540 to make the pointer on the tuning dial read 18 Mc/s on the scale. C540 is the rear trimmer in the rear compartment.

(3) Repeat 1 and 2 a number of times until both conditions are satisfied.

(4) Set the signal generator on 7.7 Mc/s and adjust TR503 and TR508 for maximum audio output when the receiver is tuned to that frequency

(5) Set the signal generator on 13 Mc/s and adjust C505 and 0513 for maximum audio output when the receiver is tuned to that frequency. C505 and C518 are the rear trimmers in the front and centre compartments.

(6) Repeat 4 and 5 a number of times until no further improvement is noticeable.

9.2.5 Locking of adjustments

All RF coils are fitted with a piece of 1 mm Symel sleeving to prevent the slug working loose.

The trimmers should be sealed with a small amount of shellac.

9.2.6 Centre Tracking Points

The centre tracking points should occur near 1025 Kc/s for Band 1, 4.5 Mc/s for Band 2, and 12.85 Mc/s for Band 3. If there is a serious loss of sensitivity in the centre of the band, the padder condensers C530, C531 and C532 should be suspect. The effect could also be caused by peaking up one end of a band on the image frequency instead of the signal frequency. Note that on the tuning dial, the image frequency should always be higher than the signal frequency.

10. Adjustment of Modulator and Speech Amplifier.

10.1. Adjustment Modulator Collector current

Disconnect the centre tap of the primary of modulation transformer TR302 and insert a milliameter in series with the tap and the connecting wire. Set the tap on base bias resistor R322 to give 60 mA collector current.

Precaution - To prevent damage to the transistors due to overbias condition, resistor R322 should be initially set at maximum resistance and the tap then gradually shifted until the correct collector current is obtained.

10.2- Adjustment of Modulation Level and performance checks.

The gain of the speech amplifier is adjusted by potentiometer RV301. The nominal setting is such that when a 1000 c/s tone is fed to the 50 ohm input at a level of minus 60 dBm, the transmitter , when loaded to a P. A. - Ik of 70 mA, will be modulated 50%. To check specifications for frequency response, noise level,and harmonic distortion, as quoted in paragraphs 1.2 (f), (g) and (h), the speech amplifier is set in this nominal condition. The input is fed from a 600 ohm balanced audio oscillator via a 600 ohm balanced adjustable attenuator and a 600 to 50 ohm transformer. Due to the chance of noise pick up and R. F. feedback, all leads must be shielded and a transformer used with an electrostatic shield to prevent longitudinal effects. The modulation is checked with a suitable modulation monitor. If noise and distortion measurements are to be carried out, the output is coupled to a noise and distortion meter.

The final setting of RV301 is dependent on the output level of the microphone and should be set on speech with the particular microphone allocated to the transceiver. This is important as some discrepancy will be found in the output level of various microphones. The speech level is set such that the peaks of speech fully modulate the carrier. This is preferably checked by observing the modulation pattern on a cathode ray oscilloscope rather than using the modulation monitor which may not follow the speech peaks.

11 APPENDIX I

Neutralisation Check of IF Amplifiers V601 and V602

A signal generator is required to feed on output of at least 100 millivolts to the secondary of the stage output transformer. This is fed via a 1000 ohm resistor and a 1000 pf capacitor at the IF frequency 455 Kc/s. A detector is also required with at least 40 microvolts, or better sensitivity. This could be an amplifier followed by a C.R.O., a V.T.V.M., or a multimeter. A signal tracer operational on 455 Kc/s with V.T.V.M. fitted is quite a useful instrument for the purpose. The detector is coupled via a 1000 pf capacitor from the base of the stage concerned. The connections for both stages are as follows :-

V601
Signal Generator - connect to V602 base

Detector - connect to V601 base

V602
Signal Generator - connect to the hot side of TR603 secondary

Detector - connect to V602 base

For the neutralisation check, the converter oscillator must be disabled. This can be achieved by switching to a crystal locked position and removing the crystal. The A.V.C. must also be disabled. This can be achieved by opening one leg of detector diode MR602.

To check for correct phasing of the neutralising circuit, neutralising capacitor C604 (for V601), or C610 (for V602), is disconnected. If the detected level rises, then the phasing can be assumed to be correct. If the level falls, the secondary of the output transformer TR602 (or TR603) must be reversed.

On completion of the neutralisation check, carry out normal IF alignment procedure.

12. SOME COMPONENT LAYOUT PICTURES

Layout 1
Layout 2
Layout 3
Layout 4

13. OTHER REFERENCES

Mobile Radio at the Woomera Radio Range - by Lloyd Butler - Published in "Amateur Radio", Jan. 1988