# Jaguar Radio

# BCC 66 Vol. 1H

## Technical Manual


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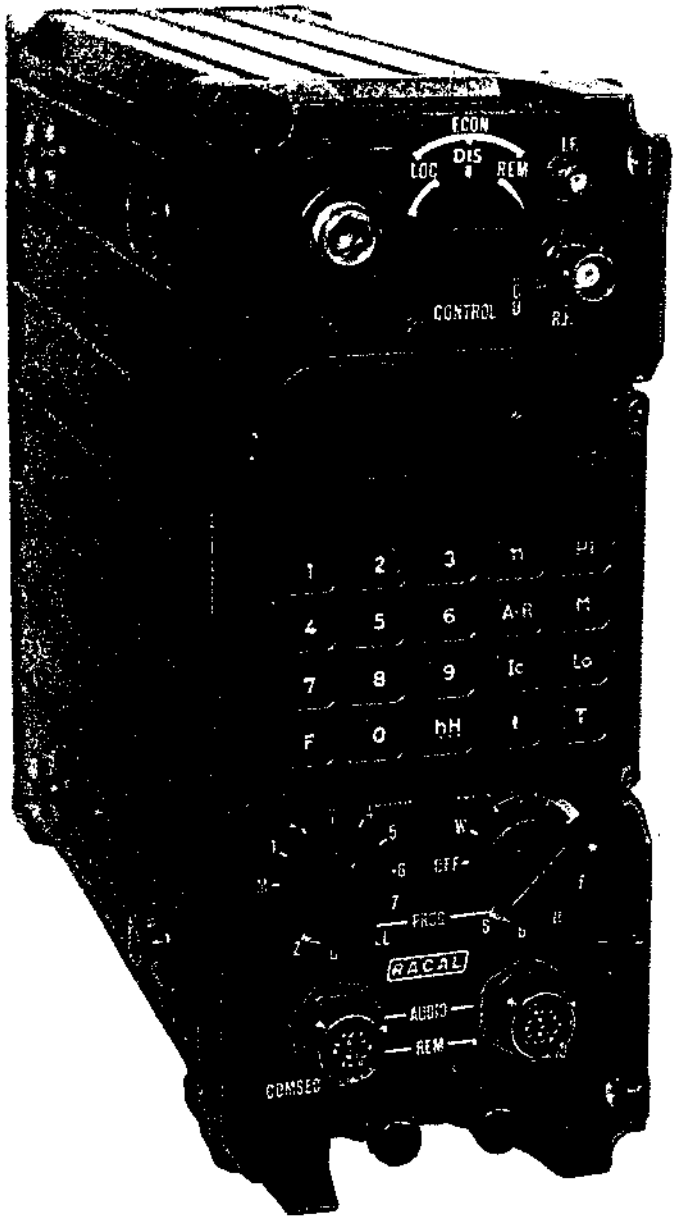


RACAL
TH2250
BCC66 VOL1H

# Jaguar V Radio BCC 66H

# TECHNICAL SPECIFICATION

| | |
|---|---|
| Frequency Range | 30 MHz to 88 MHz |
| Number of Channels | 2319 |
| Number of Preset Channels | 8 |
| Channel Spacing | 25 kHz |
| Modulation | Frequency modulation, ± 6 kHz peak deviation |
| Power Output | 10 mW or 3 W |
| Receiver Sensitivity | >10 dB (S+N):N Ratio for 1 μ V e.m.f. (-113 dBm) RF input |
| Hop Rate | 100 hops/second |
| Number of Hop Codes | $> 10^{22}$ |
| Number of Hop Bands | 9 |
| Hop Band Range | 6.4 MHz |
| Hop Bands | |
| 1 | 30.000 MHz to 36.375 MHz |
| 2 | 36.400 MHz to 42.775 MHz |
| 3 | 43.200 MHz to 49.575 MHz |
| 4 | 49.600 MHz to 55.975 MHz |
| 5 | 56.000 MHz to 62.375 MHz |
| 6 | 62.400 MHz to 68.775 MHz |
| 7 | 68.800 MHz to 75.175 MHz |
| 8 | 75.200 MHz to 81.575 MHz |
| 9 | 81.600 MHz to 87.975 MHz |
| Supply Voltage | 10 V to 16 V DC (battery) |
| Battery Life | >12 hours at 1:1:8 Tx/Rx/Standby Ratio |
| Antenna | 1.2 m or 2.4 m whip |
| Working Range (Nominal) | 5 km (1.2 m whip), 10 km (2.4 m whip) |
| Working Temperature Range | -40°C to +70°C |
| Height | 230 mm (9.1 in.) |
| Width | 90 mm (3.5 in.) |
| Depth | 275 mm (10.8 in.) |
| Depth with Battery | 365 mm (14.4 in.) |
| Weight | 5.0 kg (11.0 lb) |
| Weight with Battery | 7.4 kg (16.4 lb) |

VOLUME 1H

BCC 66H

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## CONTENTS

# CHAPTER 1

# GENERAL DESCRIPTION

## INTRODUCTION

1. The Jaguar V Radio BCC 66H is a sophisticated, FM, VHF Transmitter-Receiver with ECCM (anti-jamming) capability and an optional COMSEC (secure speech) facility. The radio is designed for use as a Manpack station in a forward area infantry role. It can also form the basic radio unit for the Jaguar V Vehicle Radio VRQ 316.

## FACILITIES

2. The facilities provided by the BCC 66H and the COMSEC facility are outlined below.

### General

3. The BCC 66H is a Jaguar V Radio BCC 66 variant, the suffix H indicating that it is capable of both fixed frequency and frequency hopping (ECCM) operation. When in this form, the following items of ancillary equipment are necessary in order to bring the radio into service:

Battery Rechargeable MA 4025A.

Whip Antenna 1.2 m or 2.4 m.

Handset.

4. The battery is a self-contained, sealed unit which attaches to the rear panel of the radio; electrical connection between the radio and the battery is by means of pairs of mating stud contacts. The whip antenna is fitted to the hexagonal socket on the top left of the front panel. The handset is fitted to either of the AUDIO sockets (VIU or COMSEC) at the bottom of the front panel; a headset of a suitable type may be used in preference to the handset.

5. The operator controls combine rotary switches with a display and a keyboard to provide:

(1) Selection between local and remote working.

(2) Selection between fixed frequency and frequency hopping operation.

(3) Selection of channel frequency.

(4) Selection of transmitter output power level.

(5) Selection of audio output level.

### Local Working

6. Local working enables the broadcast and reception of clear-speech messages, in either fixed frequency or frequency hopping operation and at either of two transmitter power output levels, under the control of a local operator.

7. All messages are input and output via the handset. The associated volume control arrangements provide a choice between 'normal' microphone sensitivity accompanied by one of four preset audio output levels, and a 'whisper' condition in which the microphone sensitivity is increased - enabling a whispered message to be heard satisfactorily by a receiving station - and the audio output is reduced to a level that is just sufficient for received signals and sidetone to be heard. Switching between the transmit and the receive conditions is controlled by the PTT (Press-To-Talk) switch fitted on the handset.

8. Selection between fixed frequency and frequency hopping operation is performed via the keyboard. The operating frequency (the significance of which depends upon whether fixed frequency or frequency hopping operation is selected, as described below) is selected from amongst eight preset channel frequencies, using a channel selector rotary switch. One of these channels - the manual channel (M) - can be reprogrammed rapidly by entering the desired frequency on the keyboard. Further positions of the channel selector switch, in conjunction with positions on the volume control switch, enable the remaining preset channels to be programmed.

9. The transmitter output power level is also selected via the keyboard. As indicated in the Technical Specification, two such levels are available; the lower of these enables communication over short distances only, thus minimising the risk of interference with adjacent nets.

10. As each keyboard entry is made, or preset channel selected, the display is activated for 10 seconds to enable the operator to confirm his selection (see also para. 45(2)). Should an erroneous entry be made, the operator is advised of the error by means of a distinctive warning tone; the keyboard facilities enable both the incorrect entry and the warning tone to be cancelled, and a new entry to be made.

Fixed Frequency Operation

11. With fixed frequency operation selected, the operating frequency is the channel frequency on which all messages are transmitted and received. Voice communication between a fixed frequency radio and a frequency hopping radio is not directly possible, but the latter can be 'hailed' by a fixed frequency station (see para. 15).

Hopping Frequency Operation

12. The BCC 66H provides 9 hop bands, as detailed in the Technical Specification. Each band contains 256 channel frequencies at the standard 25 kHz channel separation and, unless it is a barred frequency, each channel is hopped onto in accordance with the hop code stored against the channel switch position in use. The operating frequency for that position defines the hop band to be used and influences the hopping sequence. Hop codes and barred frequencies can be programmed from the keyboard, in conjunction with the channel selector and volume control switch positions allocated for those purposes.

13. Synchronisation with other radios on the net is performed automatically, in accordance with the hopping authority - control or outstation - selected at the keyboards of the various radios. A single key is arranged to serve the dual purpose of selecting both hopping operation and hopping authority.

14. Normally, one radio on the net is nominated as the control and all others operate as outstations and are synchronised to it. It is possible to operate a hopping net without a control, but this leads to increased synchronisation times. Should a net containing two controls be established, then when one control receives a transmission from the other control, the 'Error Tone' is generated at the receiving control to indicate that an undesirable situation is in being. Also, should the operator of a hopping radio attempt to transmit while not synchronised (with either the control or the partner outstation) he will receive an 'Unready Tone'.

15. A hailing facility is included which enables a radio operating on a fixed frequency to make contact with a hopping receiver, providing that the fixed frequency radio is on the same channel frequency as that displayed at the hopping radio. When such contact is made, the hopping radio operator receives a distinctive 'Hailing Tone' for 5 seconds; when he wishes to reply, he must change to fixed frequency operation.

Remote Working

16. Four methods of working over remote lines are possible:

(1) Remote operation, using a normal handset/headset and the Remote Audio Unit (BCC 568).

(2) Remote control of any or all of the facilities available when the radio is under local control, using another BCC 66 radio or a suitable remote control unit.

(3) Auto-Rebroadcast.

(4) Intercom.

In each case, the lines can consist of up to 3 km (1.9 miles) of field telephone cable.

Remote Operation

17. The Remote Audio Unit enables the facilities associated with the handset during local working (viz: the input and output of messages, and transmit-receive control) to be extended to an operator at a point distant from the radio. The unit is fitted with a 'call' button, operation of which causes the local operator to receive a distinctive warning tone, to advise him that intercommunication is requested.

Remote Control

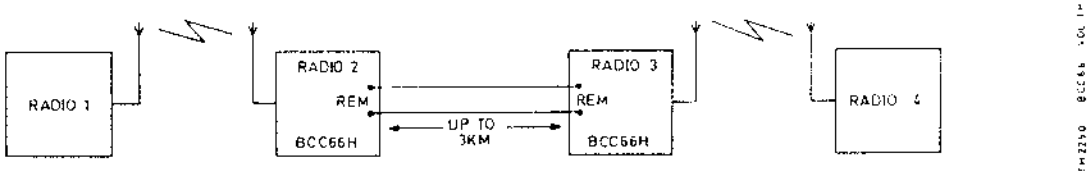
18. Provision is made for two states for remote control, one (REM) as a radio under control and one (RCU) as a controller.

19. A BCC 66H set to the REM state can be remotely controlled and programmed by another BCC 66 radio or a suitable remote control unit. The transmitter and the receiver remain 'on' but the local keyboard is rendered inactive. Control of the radio is now exercised by the remote keyboard and channel selector switch and the remote PTT switch, the necessary signals being input from the remote controller via the line terminals. All messages passed by the radio are similarly routed to and from the remote equipment. Local break-in is available.

20. When a BCC 66H is set to the RCU state, the role of the radio is changed from that of a transmitter-receiver to that of a remote control unit. The transmitter and receiver are switched 'off' and the audio input and output paths, together with the control signals generated at the keyboard, the channel selector switch and the PTT switch, are routed to the two-wire line terminals on the front panel. Both clear and secure speech may be sent from the RCU.

Auto-Rebroadcast

21. The Auto-Rebroadcast mode enables messages received by one radio to be automatically relayed to other radios. The manner in which this relay is achieved is best appreciated by considering the operation of the simple relay network shown in Figure 1.1.




Simple Relay Network Fig. 1.1

22. The essential features of the network are as follows:

(1) Radios 1 and 2 are operating at the same fixed channel frequency.

(2) Radios 3 and 4 are operating at the same fixed channel frequency (not that of Radios 1 and 2).

(3) The two-wire line terminals of Radio 2 are suitably linked to those of Radio 3.

(4) Radios 2 and 3 are both set to the Auto-Rebroadcast mode of operation.

23. With the arrangement as described, any message broadcast by Radio 1 is received by Radio 2 and passed via the wire link to Radio 3, accompanied by a 'transmit' command; the command causes Radio 3 to retransmit the message, thus enabling its reception by Radio 4. Similarly, messages sent by Radio 4 are relayed to Radio 1 via Radios 3 and 2. Both clear and secure speech may be rebroadcast in this manner.

24. While the preceding description assumes that all four radios are selected to fixed frequency operation, it should be noted that Auto-rebroadcast is also possible with all radios selected to frequency hopping, or even with one radio link (e.g. Radios 1 and 2) selected to frequency hopping and the other to fixed frequency. Of course, the radios in each frequency hopping radio link must be identically programmed and must be selected to the same operating frequency.

Intercom

25. The Intercom mode allows operators of a pair of BCC 66H radios which are joined by a field telephone cable to converse. Provision is made for the sending of a 'Call Tone' to advise the remote party that intercommunication is requested. While in this mode, the transmitter function of both radios is inhibited although receiver monitoring is permitted.

Miscellaneous Facilities

26. In addition to those associated with the modes of operation described above, the following facilities are provided.

Data Retention

27. Any function or information entered via the keyboard is 'memorised' by the radio's control circuits and retained until that particular function or category of information is reselected, at which time the memorised data is updated to include the new selection. Thus when next the radio is switched 'on', it automatically adopts the condition specified by the 'last-remembered' data, all preset channel frequencies and codes being as specified at the end of the last period of use. Provision is made for quickly erasing all stored data in an emergency.

Test

28. The keyboard includes a key which provides for a confidence check on the radio's operation and also enables the current mode and frequency information to be reviewed.

Noise-On Operation

29. During the Receive condition, the receiver output is normally silenced automatically until an incoming signal is detected. A 'noise-on' position on the volume control switch enables the operator to remove this silencing, so that the receiver noise can be heard in the headset.

Low Battery Warning

30. If the voltage at the battery terminals falls to approximately 10 V, short bursts of receiver noise are automatically output to the operator's earpiece to advise him of the fact (except when actively receiving or transmitting or when switched to Noise On).

Battery Saving

31. During either local (LOC) or remote (REM) working, the user can further select the mode to an 'economy' mode. This results in certain units within the radio receiving their supplies on a 10 per cent duty cycle (i.e. on average, the supply is applied for only 10 per cent of the total time). This significantly reduces the current drain on the battery, and hence prolongs battery life. (See also para. 45.) Only functional during non active receive (i.e. Standby).

32. It should be noted that when frequency hopping operation is selected, battery saving can only take place between 15 seconds and 4 hours from last receiving or transmitting a message.

Equipment Expansion

33. All the facilities required to allow the radio to be provided with the secure speech capability, and for it to be included in either of the basic station configurations, are present (e.g. the electrical connectors and fixing points required to enable a secure speech unit to be used are fitted, etc.).

Encryption Unit MA 4261

34. The COMSEC (Communication Security) facility enables speech messages to be passed with a high degree of security. This is achieved by converting plain speech messages for transmission into an equivalent digital data signal, and then combining this with a pseudo-random digital data stream. On reception, the pseudo-random element of the signal is removed and the remainder then converted back to analogue form.

35. In the case of the BCC 66H, the facility is provided by the Encryption Unit MA 4261. This is a small, compact unit which mounts on the left side panel (viewing from the front) of the radio. The unit and the radio are interconnected by a short cable, which is inserted into the AUDIO-COMSEC socket on the radio front panel. This allows secure communication over remote lines as well as by means of broadcast transmissions in either frequency hopping or fixed frequency operation.

36. When the facility is in use, the operator's handset is connected to the encryption unit and not the radio. The microphone sensitivity control and volume control functions are transferred to the unit, and the radio receives fixed-level audio signals from - and outputs fixed-level audio signals to - the unit. The primary power supply (+12 V) for the unit is obtained from the radio via the interconnecting cable, with 'on/off' switching controlled by the radio.

37. The secure code stored on the channel selected defines the pseudo-random digital data stream used. These codes can be programmed using the radio keyboard.

38. The encryption unit operator controls enable:

(1) On/off switching of the unit.

(2) Three levels of audio output -

Whisper (increased microphone sensitivity, decreased audio output),

Normal ('normal' microphone sensitivity and audio output),

High ('normal' microphone sensitivity, increased audio output).

(3) Selection between clear speech and secure speech transmission (reception of both is automatic).

(4) Erasure of all secure codes held in the unit. (This operation may also be performed from the radio.)

STATION CONFIGURATIONS AND FACILITIES

39. The form of each of the Jaguar V stations in which the BCC 66H is used, and the facilities which each provides, are reviewed below.

Jaguar V Manpack Radio BCC 66H

40. The Jaguar V Manpack Radio BCC 66H is made up of the following items:

Jaguar V Radio BCC 66H.

Battery Rechargeable MA 4025A.

Whip Antennas 1.2 m and 2.4 m.

Handset.

Carrying frame.

The radio, battery, antenna and handset are assembled as described in para. 4 and the complete assembly then attached to the carrying frame, using the four fixing points provided on the right side panel (viewing from the front) of the radio. All the facilities provided by the BCC 66H are available; if the secure speech facility is required, the station also includes an Encryption Unit MA 4261, located as described in para. 34.

Jaguar V Vehicle Radios VRQ 316H/LP, VRQ 316H/HP

41. The Jaguar V Vehicle Radio VRQ 316H is designed for use in forward areas and can be fitted in armoured and soft-skinned vehicles. Two versions of the radio are available - the VRQ 316H/LP (Low Power), which provides output power levels of 10 mW and 3 W, and the VRQ 316H/HP (High Power), which provides output power levels of 10 mW, 3 W and 50 W.

42. The installation comprises:

Jaguar V Radio BCC 66H.

Vehicle Interface Unit BCC 566 (VRQ 316H/LP) or BCC 567 (VRQ 316H/HP).

Mounting Tray.

Interconnecting Cables (BCC 66 to VIU) - 2.

Interconnecting Cables (AMU to VIU) - 2, length to suit vehicle.

Antenna Matching Unit BCC 586 (+ Antenna Base and additional cable) or BCC 587.

Whip Antenna 2.0 m.

Handset.

43. The VIU (Vehicle Interface Unit) is mounted on the right side panel (viewing from the front) of the radio. The assembly so formed is then fitted to the mounting tray, to which it is secured by screws locating in the bottom surfaces of the units. The AMU (Antenna Matching Unit) is mounted at some convenient point on the vehicle.

Vehicle Interface Units BCC 566/BCC 567

44. The VIUs provide the electrical interfaces between the BCC 66H and the electrical services associated with a military vehicle. In the case of the VIU BCC 567, the unit also provides the additional circuits necessary in order to obtain the 50 W output power level.

Vehicle Radio VRQ 316H/LP, VRQ 316H/HP

45. When used in either of the vehicle radios, the facilities and control functions offered by the BCC 66H are modified as follows:

(1) The 12 V primary supply is obtained from the vehicle battery supply via the VIU. 'On/off' switching of the radio is still controlled from the radio panel, but the availability of the supply is now dependent on the 'on/off' switching provided on the VIU.

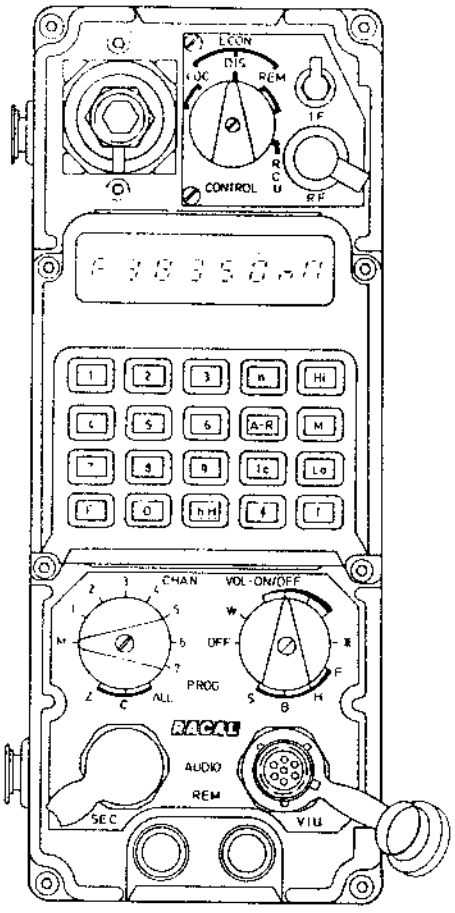
(2) The display time-out (para. 10) is inhibited.

(3) If the VIU BCC 567 is included in the installation, it is now possible to select and obtain the high power output level.

(4) Battery saving (para. 31) is inhibited.

In all other respects, the radio facilities are unchanged, and are still under the control of the rotary switches and keyboard fitted on the radio.

46. If required, an encryption unit may be included in the station.



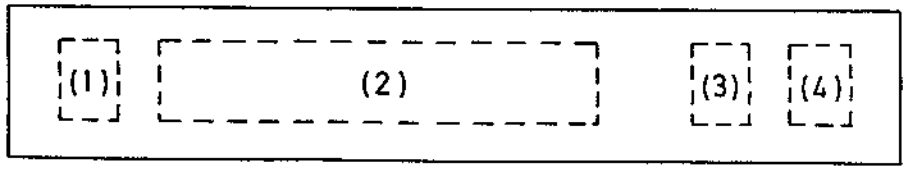

Jaguar V Radio BCC 66H Front Panel

Fig.1-2

DISPLAY AND CONTROLS (Figure 1.2)

Display

47. The display uses red, 7-segment, LED elements to depict figures, mode letters and status indicator. It takes the form:




where (1) = (a) A single, flashing, horizontal bar indicating the keyboard status (para. 49(1)), or

(b) a character indicating the type of operation selected (para. 49(4)(d)), or

(c) a horizontal bar display indicating the hop synchronisation status (Figure 1.3).

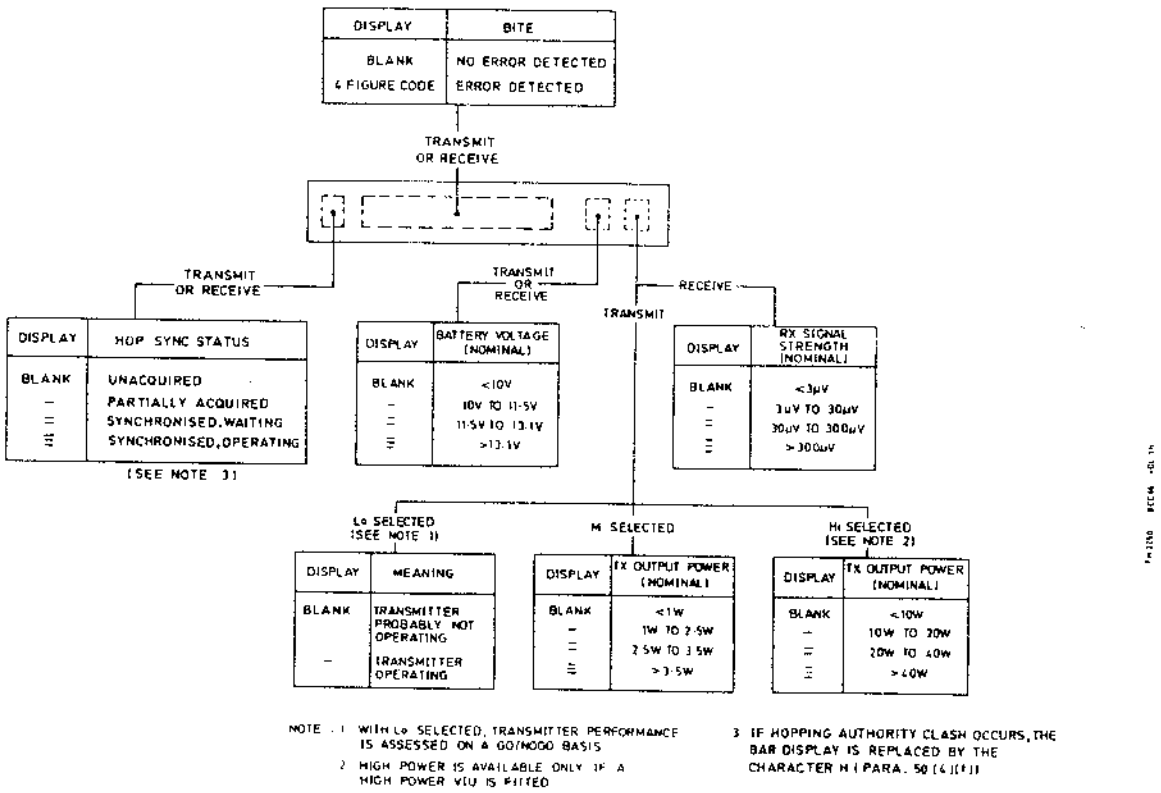
(2) = (a) Numerals showing the selected channel frequency in kHz (30 000 to 87 975), or

(b) a 5-figure section of the code number (para. 49(4)(e)), or

(c) a 4-figure BITE message (para. 49(4)(f)).

(3) = (a) A character indicating the selected mode of operation (para. 49(4)(c)), or

(b) a horizontal bar display indicating the battery voltage level (Figure 1.3).




NOTE 1 With Lo SELECTED, TRANSMITTER PERFORMANCE IS ASSESSED ON A GO/NOGO BASIS

2 HIGH POWER IS AVAILABLE ONLY IF A HIGH POWER VIU IS FITTED

3 IF HOPPING AUTHORITY CLASH OCCURS, THE BAR DISPLAY IS REPLACED BY THE CHARACTER H (PARA. 50 (4)(f))

Monitor Information Display

Fig.1-3

(4) = (a) A single, flashing, horizontal bar indicating the keyboard status (para. 49(1)), or

(b) a character indicating the transmitter output power level selected (para. 49(4)(b)), or

(c) a horizontal bar display indicating either:

(i) the received signal strength, or

(ii) the transmitter output power level (Figure 1.3).

(d) a numeral showing code block number.

48. The display brightness is controlled automatically, by a light sensor fitted into a gap in the display, to give maximum brightness in sunlight and minimum in the dark.

Controls

49. The function of each of the front panel controls is summarised below:

(1) CONTROL switch — Selects the keyboard mode of operation and the battery saving (ECON) facility, as follows:

| | |
|---|---|
| LOC | - Local (front panel) keyboard and display enabled, battery saving 'off'. |
| LOC ECON | - Local keyboard and display enabled, battery saving 'on'. |
| DIS ECON | - Keyboard disabled except for Test key (T), display 'off', battery saving 'on'. |
| REM ECON | - Local keyboard disabled except for Test key (T), local channel switch (CHAN) disabled, display disabled except for recall (for 10 secs) of information, battery saving 'on'. Radio expects to be controlled from remote lines. |
| REM | - Local keyboard disabled except for Test key (T), local channel switch (CHAN) disabled, display disabled except for recall (for 10 secs) of information, battery saving 'off'. Radio expects to be controlled from remote lines. |

| | | |
|---|---|---|
| | RCU | - Keyboard and channel switch function as a remote controller for a distant radio connected to remote lines, local control disabled. |

Manpack station only: In either of the two LOC settings, the left and right-hand display characters are replaced by alternately-flashing, single horizontal bars until a key or the channel switch is operated.

(2) VOL-ON/OFF switch

Provides battery supply on/off control, audio output level/microphone sensitivity adjustment, and selection of frequency channel programming configuration, as follows:

| | |
|---|---|
| OFF | - Battery supply 'off'. |
| W (Whisper) | - Battery supply 'on', minimum audio output level and increased microphone sensitivity. |
| Volume (4 positions) | - Audio output level increases in discrete steps as control is rotated clockwise. |
| * | - Noise-On (receiver mute open), audio output level as in second volume setting. |
| F | - Programme frequency to Channels 1 to 7 and M. |
| H | - Programme hop codes to Channels C, M and 1 to 7. |
| B | - Programme up to eight barred frequencies, using positions M and 1 to 7 on CHAN switch. |
| S | - Programme secure codes to Channels C, M and 1 to 7. |

To avoid unintentional programme operations being performed, a mechanical lock is provided between positions * and F. The lock is released by means of a recessed button on the right-hand side of the panel.

(3) CHAN switch

Enables selection of preset operating data and provides data reprogramming facilities, as follows:

M - Manual channel. The transmit/receive frequency can be set directly from the keyboard, without setting the VOL-ON/OFF switch to F, but codes must be entered as for 1-7.

1-7 - Preset channel frequencies and codes. To programme these channels, the VOL-ON/OFF switch must be set to F, B, H or S (see (2) above).

ALL - All channels. Codes entered with this position selected are stored in all channel memories.

C - Common codes. Those segments of the hop and secure codes which change only at infrequent intervals, and which are common to all channels, are programmed with this position selected.

Z - Zeroise. This facility is provided for emergency use; provided the radio is switched 'on' and connected to a power source, its selection causes all frequencies and codes to be erased from memory.

To avoid unintentional programme or zeroise operations being performed, a mechanical lock is provided before positions ALL and Z. The lock is released by a recessed button on the left-hand side of the panel.

(4) Keyboard

Twenty press-button switches, allocated as described below:

(a) Channel frequency/code selection:

Keys 0 to 9 are used to key in channel frequencies and 5-digit codes when programming channels from the keyboard.

(b) Transmitter power:

Three keys enable the nominal transmitter output power level to be selected, as follows:

Hi - 50 W (vehicle high-power station only).

M (medium) - 3 W.

Lo - 10 mW.

H, M or L is displayed at the character position above the column of keys.

(c) Normal/Auto-Rebroadcast/Intercom:

Three keys provide selection between these modes of operation, as follows:

⊓ - Normal operation of the transmitter-receiver.

A/R - Auto-Rebroadcast.

Ic - Intercom (transmitter inhibited). A 'Call Tone' is sent while the key is depressed.

⊓, A or I is displayed at the character position above the column of keys; I is replaced by C while the Ic key is depressed.

(d) Fixed frequency/frequency hopping:

A pair of keys enable selection of the type of operation and the hopping authority, as follows:

F - Fixed frequency.

h H - Hopping. Key pressed once = h (hop outstation); key pressed twice within one second = H (hop control station).

F, h or H is displayed at the left-hand character position.

(e) Stepping:

Stepping key ↑ is used to enter up to four blocks of code into a channel memory during programming.
As the blocks are entered, 1,2,3,4 is displayed in sequence at the right-hand character position. When the key is operated, the current 5-digit code is cleared from the display in readiness for the next.

(f) Test:

Test key T is used to check the state of the radio and to correct an erroneous frequency or code entry.

The key is operative even when the CONTROL switch is set to DIS; the display functions normally for 10 seconds following the key being pressed.

When used for checking purposes, while the key is operated:

- Noise-On is enabled.
- If in Receive, the two right-hand display positions contain horizontal bar codes giving an indication of the received signal strength and the battery voltage, as shown in Figure 1.3.
- If in Transmit, the two right-hand display positions contain horizontal bar codes giving an indication of the transmitter output power and the battery voltage, as shown in Figure 1.3.
- If hopping operation is selected, the left-hand display position contains a horizontal bar code indicating the current hop synchronisation status, as shown in Figure 1.3.

  If 'control' hopping authority (H) is selected, a transmission from another radio on the net which is also operating as a hop control station causes 'Error Tone' to be generated and the bar code to be replaced by the character H.

- If BITE has detected an error, the centre portion of the display contains a 4-figure code indicating the nature of the error.

To correct an erroneous frequency or code entry, the Test key is operated momentarily and the correct frequency or code then entered.

WARNING TONES AND SIGNALS

50. The operator is warned automatically of the existence of certain operational conditions by means of distinctive tones and signals. A description of each of the warning tones and signals is given below; phonetic approximations of how they are heard by the operator are given in Figure 1.4.

(1) Error Tone

A continuous tone alternating between 2.0 kHz and 1.6 kHz (512 ms high frequency, 512 ms low frequency). It is activated by:

- An incorrect key entry.
- The faulty transmission of data from the Keyboard to the Central Control Unit, incorrect stored data in the Central Control Unit, or faulty reply to the Keyboard from the Central Control.
- Operation of a hopping net with two radios switched to 'control'.

(2) Call Tone

A continuous 2 kHz tone. It is generated:

- While the Intercom (Ic) key is pressed.
- In the remote mode, while the dc sensor in the remote lines is activated by a call signal, or if the remote lines are short-circuit or reverse-connected.

(3) Hailing Tone

An intermittent, 500 Hz tone (256 ms on, 256 ms off). It is initiated during frequency hopping operation when hailed on the channel reference frequency for at least 3 seconds, and continues for 5 seconds.

(4) Unready Tone

An intermittent, 2 kHz tone (64 ms on, 192 ms off). It is generated when the transmit path is not clear to send (normally, while the radio is synchronising; lasts 5 seconds for initial synchronisation).

(5) Low Battery Warning

Intermittent bursts of received noise (70 ms on, 570 ms off). It is initiated when the supply voltage at the battery terminals falls to approximately 10 V and the radio is not actively receiving or transmitting.

## CONNECTORS

51. The paragraphs which follow briefly describe the purpose of each of the connectors provided on the BCC 66H.

### Whip Antenna Socket

52. The whip antenna socket (SK5) provides a bidirectional interface for RF signal input/output over the frequency range 30 MHz to 88 MHz. Matching is suitable for a 1.2 m or 2.4 m whip antenna. The RF socket should not also be in use.

### RF Socket

53. The RF socket (SK6) provides a bidirectional interface for RF signal input/output over the frequency range 30 MHz to 88 MHz at 50 ohms impedance. The whip antenna socket should not also be in use.

### IF Socket

54. The IF socket (SK7) provides an IF output (10.7 MHz) at 50 ohms impedance the level of which is approximately equal to the RF signal input level. This output is provided for test purposes and also for use with external antenna nulling systems.

### AUDIO-VIU Socket

55. The 7-pin AUDIO-VIU socket (SK1) provides connections which enable audio signals to be exchanged between the radio and a local headset or handset, or between the radio and a VIU. It also provides the data input/output and control signal paths necessary to allow channels to be programmed from an external device.

### AUDIO-COMSEC Socket

56. The 7-pin AUDIO-COMSEC socket (SK2) provides connections which enable audio signals to be exchanged between the radio and a local headset or handset, and between the radio and a COMSEC unit; in the latter case, the signals may be in either an analogue form (clear speech) or a digital form (secure speech). It also provides the data input/output and control signal paths necessary to allow channels to be programmed from an external device.

### REM Terminals

57. The REM (remote line) terminals (SK3, SK4) may be used for three purposes:

(1) To connect a suitable remote control unit (or another BCC 66 radio, in RCU mode) to the radio via up to 3 km of field telephone cable. This will provide remote control of all radio functions except on/off switching and battery saving.

(2) To connect the Remote Audio Unit and handset. This will provide pressel and call control only.

(3) For rebroadcast to another BCC 66 radio.

VIU Plug

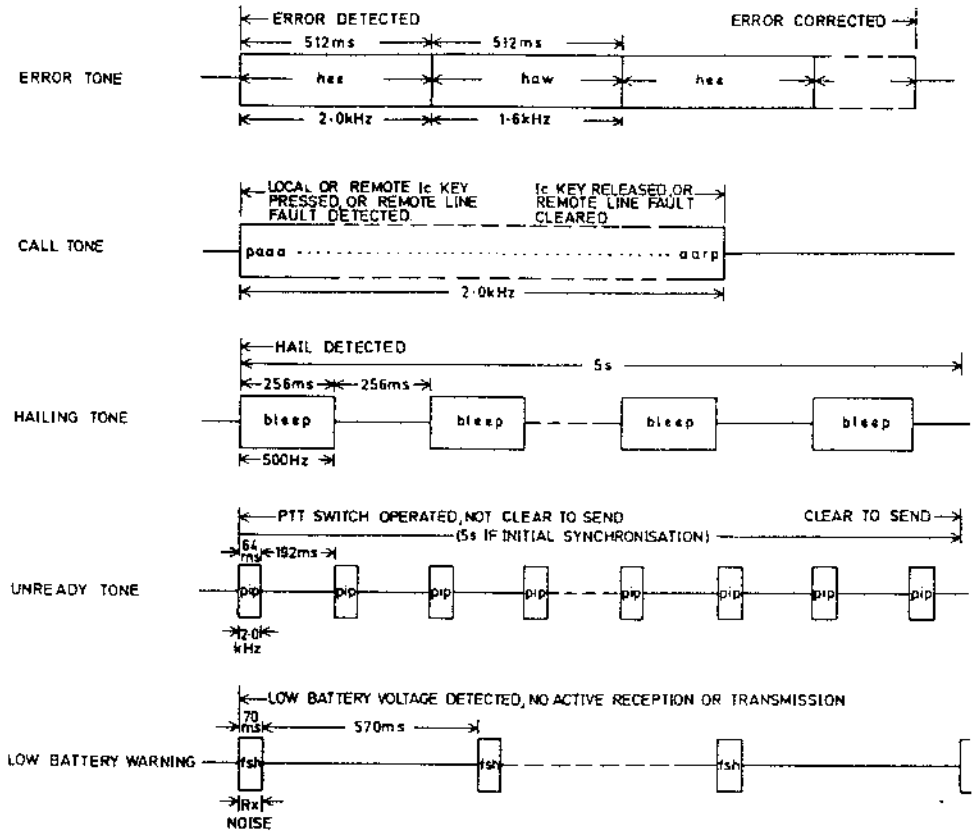
58. The 10-pin plug (PL1) fitted at the rear panel of the BCC 66H provides the connections for those control signals and supplies which are necessary to enable the radio to interwork with a VIU but which are not directly associated with the audio output and input.

ASSOCIATED PUBLICATIONS

59. The following publications relating to the BCC 66H are available:

User Handbook Jaguar Manpack Radio BCC 66F/BCC 66H Ref TH 2275.

User Handbook Jaguar Vehicle Radio VRQ 316 Ref TH 2276.






Summary of Warning Tones and Signals

Fig. 1·4

# CHAPTER 2

# OPERATING INFORMATION

## CONTENTS



## Tables

# CHAPTER 2

# OPERATING INFORMATION

## INTRODUCTION

1. This chapter provides the operating information for the Jaguar V Radio BCC 66H only. The procedures given take no account of any change in the method of operation caused by the radio's use in a vehicle station or by the provision of secure speech facilities. For details of the operating procedures to be used in such circumstances, refer to the appropriate User Handbook and/or Technical Handbook.

## BASIC OPERATING INSTRUCTIONS

### Preliminary

2. Connect a battery in charged condition to the rear panel.

3. Connect the 1.2 m or 2.4 m whip antenna (depending on the range required), taking care to locate the hexagonal rod in the socket before tightening.

4. Connect the handset or headset to either of the AUDIO sockets (COMSEC or VIU).

5. Set the CHAN switch to the required channel of operation.

### How to Communicate in Fixed Frequency Mode

Note: These instructions assume that all channels have been programmed with the required frequencies.

Using the Programmed Frequency

6. Set the CONTROL switch to LOC (local) - the fully counter-clockwise position of the switch.

7. Switch the radio on by turning the VOL-ON/OFF switch in a clockwise direction.

8. The display will, for a period of 10 seconds, show the eight characters of information stored in the channel's memory. (After 10 seconds the display reverts to a single horizontal bar at either the left end or the right end of the display).

9. Say, for example, we have selected Channel 1 and the display reads:


F indicates the fixed frequency mode of operation.

36850 indicates the channel frequency in kHz.

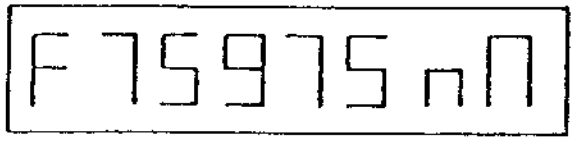
n indicates normal operation. ( n signifies n for normal.)

M indicates a medium power output of 3 W. ( M signifies M for medium).

10. Assuming that this is the desired information the radio is now ready for normal use on this channel.

Changing the Programmed Frequency

11. If we now select Channel 2, let's say the display reads:




F - fixed frequency operation.

75975 - channel frequency 75975 kHz.

n - normal operation.

M - medium power output, 3 W.

12. The information on the display is the same as for channel 1 except for the different frequency. Let's suppose, however, that a new frequency is wanted - say 55975.

13. This frequency can be quickly introduced by turning the CHAN switch to M (the Manual Channel) and pressing in sequence the 55975 buttons on the keyboard. The display will now read 55975. (The fifth figure is entered automatically since there is a channel spacing of 25 kHz.)

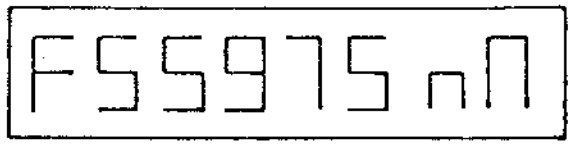
14. Since we want fixed frequency, normal mode and medium power operation we must check the display and press the following buttons on the keyboard if necessary:

F - for fixed frequency.

n - for normal operation.

M - for medium power.

The display now reads:




The radio is now ready for normal use on this the manual channel.

## How to Communicate in Hopping Mode

Note: These instructions assume that all channels have been programmed with the required frequencies and codes.

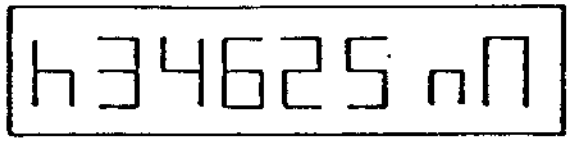
15. Check that the preliminary connections and settings given in paragraphs 2 to 5 are carried out, i.e. battery, whip antenna, handset or headset are connected and channel selected.

16. Set the CONTROL switch to LOC (local), the fully counter-clockwise position of the switch.

17. Switch the radio on by turning the VOL-ON/OFF switch in a clockwise direction.

18. The display will, for a period of 10 seconds, show the eight characters of information stored in the selected channel's memory.

19. Say, for example, we have selected Channel 5 and the display reads:




h indicates the hopping mode.

34625 indicates the channel reference frequency in kHz.

n indicates normal operation.

Π indicates a medium power output of 3 W.

20. Check that the displayed information is correct. When last used the mode of operation (position 1 of the display) could have been altered to fixed frequency (F). The channel memory will recall the last selection made. If necessary, select hopping mode by pressing the hH button and check that the display shows h in position 1.

21. The radio is now ready to communicate on this channel as a hopping mode outstation. In a typical operation there are normally a number of outstations, but only one radio is a hopping mode control station. The display on this radio would indicate H on position 1 of the display, this is selected by pressing the hH button twice rapidly.

22. In order to set up a hopping net, first ensure that the control and all outstations are switched to the same channel and to the hop mode before making the initial synchronising transmission (otherwise synchronisation may take longer, see para. 31). The initial synchronising transmission should normally be made by the control station, who will hear a rapid series of high-pitched pips on operating the pressel for the first time. These continue for about 5 seconds while the other radios are becoming synchronised. When the pips have stopped the synchronising (control station) radio operator should start speaking and operate the net in the normal way. Synchronisation will now be maintained unless (a) a radio is switched off, or (b) there is a channel change, when initial synchronisation will occur as above.

CONTROL Switch

23. With the CONTROL switch set to LOC (local), the radio is controlled by its own keyboard. This position is used for normal local operation. With the switch set to LOC ECON (local economy) the operation is the same as for the LOC position except that a battery saving facility is provided.

24. With the switch set to DIS (disabled) the keyboard is inactive to prevent the buttons being accidentally knocked and selected by, for example, branches and undergrowth. The display is also turned off in this position to avoid showing a light.

25. The REM ECON, REM and RCU positions are for use with the remote lines and are explained in para. 72.

CHAN Switch

26. The CHAN switch selects the radio operating channel. All eight channels can be programmed with frequencies and where relevant with codes. The programmed frequency on the manual (M) channel can be overwritten directly from the keyboard. For radios with the hopping facility, hop codes can be included on the channel programme. For radios with the secure speech facility using a COMSEC unit, these secure codes can also be included on the channel programme.

Note: Do not attempt to turn the CHAN switch past its restriction during normal operation. The restriction, situated after the Channel 7 position, is fitted to prevent inadvertent selection of a programme function.

VOL-ON/OFF Switch

27. The VOL-ON/OFF switch has seven positions and when it is set to any position from OFF, the radio is switched on. The W (whisper) position enables a whispered transmission to be heard satisfactorily by a receiving station, also received signals and sidetone are at a reduced level. Positions 3 to 6 give increasing levels of audio. The last position (*) is the Noise-On facility, which gives a hiss in the phones to enable the receiver operation to be checked.

Note: Do not attempt to turn the VOL-ON/OFF switch past the restriction during normal operation. The restriction, situated after the * (Noise-On) position, is fitted to prevent inadvertent selection of a programme function.

Changing the Power Output Setting

28. To change from medium power output to low power, press the Lo button on the keyboard - the eighth display character will show L. To select medium power press the M button - the eighth display character will show ⊓ . To select high power, press the Hi button - the eighth display character will show H.

Note: If high power is selected, a two-tone note - Error Tone - will be heard in the phones and the display will flash in the 1st, 7th and 8th character. The 8th character will be ⊓ . Error Tone is explained in para. 42. High power can only be selected in the high power vehicle radio installation.

Changing the Mode of Operation

29. The operation modes 'fixed frequency', 'hopping control' and 'hopping outstation' are displayed at the left end (position 1) of the display. To change from either hopping mode to fixed frequency press the F button - check for a display of F. To change from fixed frequency to hopping, press the hH key once (h) for hopping outstation (display of h) and rapidly twice (H) for hopping control (display of H).

30. To change from normal operation ( ⊓ on display position 7) to Auto-Rebroadcast, Intercom or Call:

Press the A-R button for Auto-Rebroadcast - seventh display character shows A.

Press the Ic button for Intercom - seventh display character shows I.

Press and hold the Ic button for Call - seventh display character shows C and a loud, high-pitched tone will be heard.

The Auto-Rebroadcast, Intercom and Call facilities are explained later.

FURTHER HOPPING INFORMATION

Initial Synchronisation

31. To ensure a satisfactory synchronisation of the net radios it is important that they are all switched on, set to hopping mode and to the correct channel. One radio, normally the control station, makes the synchronising transmission. This radio will hear the synchronising pip tones for 5 seconds - the other net radios will not expect to hear anything in this period. The synchronising radio, after the pip tones have stopped, will make the initial speech transmission to the other net radios. They will hear this transmission if they are synchronised and can then reply in the normal manner. If any member of the net is late switching on, or for any other reason does not hear the initial speech transmission, this radio is not synchronised. This unsynchronised (unacquired) radio will adopt the Late Entry mode. Two control radios in a net is an unacceptable state and will set off the 'Error' warning tone in a control station receiving from another control station.

Late Entry

32. The unsynchronised radio can become synchronised in one of two ways:

(1) If the net is busy, the radio should expect to become synchronised and hear transmissions with 16 seconds of total transmission time.

(2) If the net is quiet, the unsynchronised radio can transmit to the net. At the end of the 5 seconds of synchronising pip tones, the rest of the net will be temporarily synchronised to him and he may pass traffic. At the end of this transmission, the net will resume synchronisation to the control radio, who should then reply with a transmission at least 16 seconds long to correctly synchronise the late entry radio. Urgent traffic can be passed to other outstation radios within the net during this time, as synchronisation has not been permanently disrupted by the late entry radio.

33. The control radio believing that an outstation is not synchronised should transmit to the net for at least 16 seconds to ensure the synchronisation of the late entry radio.

Changing Channel

34. If a net is in the hopping mode and communicating normally, a change to another channel can be made in the same manner as for a fixed frequency net. However, the synchronisation procedure and initial transmission as described in para. 31 will normally be repeated.

35. Exceptions to this are:

(I) If a radio switches to a fixed frequency channel to speak to another non-hopping radio and then returns to the hopping net.

(2) If a radio switches to another hopping channel but does not transmit or receive a message and then returns to the hopping net.

Hailing Tone

36. The 'Hailing Tone' facility is provided to enable a radio operating on fixed frequency to make contact with a hopping net. The 'outside' radio must be on the same channel (the same displayed frequency) as the hopping net.

37. The 'Hailing Tone' is a low frequency audio tone which is on for 1/4 second and off for 1/4 second for a duration of 5 seconds. It is produced when the 'outside' radio transmits. Each radio in the hopping net will hear the 'Hailing Tone'. One of the hopping net radios, normally the control, may then select fixed frequency mode and talk to the outside radio.

38. A hopping radio cannot be hailed if it is in active Receive, Transmit or rebroadcast mode. Once a radio has been hailed, the radio cannot be hailed again for 40 seconds.

Changing the Power Output Setting

28. To change from medium power output to low power, press the Lo button on the keyboard - the eighth display character will show L. To select medium power press the M button - the eighth display character will show ⊓ . To select high power, press the Hi button - the eighth display character will show H.

Note: If high power is selected, a two-tone note - Error Tone - will be heard in the phones and the display will flash in the 1st, 7th and 8th character. The 8th character will be ⊓ . Error Tone is explained in para. 42. High power can only be selected in the high power vehicle radio installation.

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29. The operation modes 'fixed frequency', 'hopping control' and 'hopping outstation' are displayed at the left end (position 1) of the display. To change from either hopping mode to fixed frequency press the F button - check for a display of F. To change from fixed frequency to hopping, press the hH key once (h) for hopping outstation (display of h) and rapidly twice (H) for hopping control (display of H).

30. To change from normal operation ( ⊓ on display position 7) to Auto-Rebroadcast, Intercom or Call:

Press the A-R button for Auto-Rebroadcast - seventh display character shows A.

Press the Ic button for Intercom - seventh display character shows I.

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Initial Synchronisation

31. To ensure a satisfactory synchronisation of the net radios it is important that they are all switched on, set to hopping mode and to the correct channel. One radio, normally the control station, makes the synchronising transmission. This radio will hear the synchronising pip tones for 5 seconds - the other net radios will not expect to hear anything in this period. The synchronising radio, after the pip tones have stopped, will make the initial speech transmission to the other net radios. They will hear this transmission if they are synchronised and can then reply in the normal manner. If any member of the net is late switching on, or for any other reason does not hear the initial speech transmission, this radio is not synchronised. This unsynchronised (unacquired) radio will adopt the Late Entry mode. Two control radios in a net is an unacceptable state and will set off the 'Error' warning tone in a control station receiving from another control station.

39. The Hailing Tone also operates when other radios, not on the hopping net, but on the reference frequency and in fixed frequency mode, are transmitting.

Note: In order for a fixed frequency radio to 'hail' a hopping net, it is necessary to transmit on the reference frequency of the hopping net for a period of at least 3 seconds. Should the hopping net be inactive then the 'Hailing Tone' will be triggered in all radios hearing the call. A member of the hopping net can then transfer to the fixed frequency mode and respond to the 'hail'. This will normally take a little time for the operator to change mode. If the hopping net is active then the Hailing Tone will not be heard. It is therefore prudent to wait a certain length of time after a 'hail', to see if a response has been elicited, before trying again.

Hop Bands

40. For radios operating in the hopping mode there are 9 hop bands, each of 6 400 kHz, within the overall frequency range of 30 000 to 88 000 kHz. The frequency ranges of the 9 hop bands are shown below:

| Hop Band | |
|---|---|
| 1 | 30 000 to 36 375 kHz |
| 2 | 36 400 to 42 775 kHz |
| 3 | 43 200 to 49 575 kHz |
| 4 | 49 600 to 55 975 kHz |
| 5 | 56 000 to 62 375 kHz |
| 6 | 62 400 to 68 775 kHz |
| 7 | 68 800 to 75 175 kHz |
| 8 | 75 200 to 81 575 kHz |
| 9 | 81 600 to 87 975 kHz |

41. Between Hop Band 2 and Hop Band 3 - i.e. frequencies 42 800 to 43 175 kHz - there is a no-go band which cannot be used for hopping. If frequencies within this range are selected an Error Tone is produced and the radio reverts to fixed frequency mode. The no-go band does not apply to fixed frequency operation.

ERROR INFORMATION

42. Error information is provided by an audio 'Error Tone' which may be accompanied by a flashing or blank display. The audio 'Error Tone' is a two-tone note which is a high frequency of 2 kHz for ½ second then a lower frequency of 1.6 kHz for ½ second. Once activated, the Error Tone will continue until a cancelling or correct key selection is made.

43. The Error Tone can be activated by an incorrect key entry in the following ways:

(1) Frequency between 88 000 - 90 000 kHz selected.

Note: The keyboard does not permit frequencies below 30 000 kHz and above 90 000 kHz to be selected.

(2) High power output selected (when not in a high power vehicle installation).

(3) Hopping selected when in the no-go hop band of 42 800 to 43 175 kHz.

(4) Hopping selected when the hop code has not been programmed.

(5) Secure speech programme selected when COMSEC unit not fitted.

(6) Two hopping control stations. Tone heard by receiving station.

(7) Channel programmed with out-of-range frequency. Tone heard when channel selected.

44. The Error Tone could also be activated in the remote mode of operation (with the CONTROL switch set to RCU) as follows:

(1) Other radio not switched on or not set to REM.

(2) Remote lines not connected or faulty (open circuit or faulty connection).

(3) Interference and excessive noise picked up by the remote lines can cause a flashing or blank display and the Error Tone. Cables in excess of 3 km length could also produce these symptoms.

Note: If the remote lines are crossed or short circuited, the Call Tone will be activated.

45. The Error Tone is normally stopped by reselecting the correct key or operating the Test key. (The Test key reproduces information stored in the radio memory - if this is incorrect the Error Tone will continue.) The Error Tone volume can be adjusted by the radio volume control.

Note: If when the radio is switched on the Built-In Test Equipment (BITE) detects a fault within the radio, the Error Tone will be triggered. After pressing the Test key, a 4-digit fault code will appear in the central area of the display (where the frequency and codes are normally displayed). The BITE testing is done in two stages - the first stage on switch on and the second on selecting hopping mode. If the radio is switched on in the hopping mode the two stages are combined.

## PROGRAMMING

46. Programming of radio channel frequencies, hop codes and secure speech (COMSEC) codes - especially for numbers of radios - will normally be carried out by using the Portable Programmer, Racal MA 4073 or the Fill Gun, Racal MA 4083. Each radio can also be programmed manually. It is recommended that the programmes are set and altered by experienced personnel.

47. Manual programming can only be carried out when the VOL-ON/OFF and CHAN switches are set beyond their restrictions after the * (Noise-On) and 7 positions respectively. These are overcome by pressing the button on the side panel adjacent to each switch.

48. The VOL-ON/OFF switch programme positions are:

F - Frequencies.

H - Hop codes.

B - Barred frequencies.

S - Secure speech codes.

49. The CHAN switch programme positions are:

ALL - All channels with the same code.

C - Common parts of the codes.

Z - Zeroise (erases programme memories).

Note: A further restriction exists before the Z (Zeroise) position to prevent accidental selection. This is overcome by pressing the button on the side panel adjacent to the CHAN switch.

### Programming Frequencies

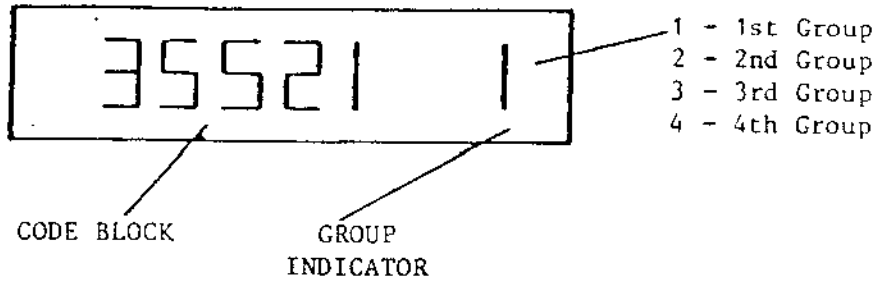
50. For Channel M the frequency only can be set without going to the programme mode, by setting the CHAN switch to position M and pressing the appropriate keys.

51. Channels 1 to 7 can only be programmed when the VOL-ON/OFF switch is set past the restriction to programme position F. Set the CHAN switch to the channel required then press the relevant keys for the frequency required. The frequency selected, which will be indicated on the display, must be in the range 30 000 to 88 000 kHz and since the channel spacing is 25 kHz the last two figures must be multiples of 25 - i.e. the fourth figure can only be either 2, 5, 7 or 0. The fifth figure is entered automatically, 5 for fourth figures 2 and 7 - so that they become 25 and 75 - and 0 for fourth figures 5 and 0 - so that they become 50 and 00. The Keyboard will ignore any fourth figure selection which is not 2, 5, 7 or 0. If a fifth figure is entered the keyboard will ignore it. If any error is made the channel should be re-programmed by pressing the T (Test) key and reselecting.

## Programming Hop Codes

52. To programme the hop codes, the VOL-ON/OFF switch must be set past the restriction to the H position. Then set the CHAN switch to the required channel. The display will not indicate the code already programmed to the channel.

53. The hop code consists of 25 characters, the last five of which are the common code - common to all channels. The code numbers are in octal, i.e. 0 to 7 only. The code is displayed in four groups of five characters in positions 2 to 6 of the display. Each group is identified by a number, 1, 2, 3 or 4, at the right end of the display. When the first five characters of code have been keyed in, press the Stepping key (↑) and




the next group number will then appear at the right end of the display and this group of code can then be entered. This process is repeated until the fourth group is fed to the memory. Mistakes can be rectified by pressing the T button and re-entering the correct code. Mistakes on any group can be rectified by first selecting the relevant group and then re-entering the correct code.

54. The last five characters of the hopping code are the common code, which is the same for all eight channels. This is programmed by setting the CHAN switch to the C position and keying in the five figures of code. Only the group number (1) is valid for this operation.

55. In addition, all eight channels can be programmed with the same hop code - the first 20 characters - when the CHAN switch is set to ALL.

Note: Care should be taken when programming. To communicate on any one channel, figures of frequency and 25 characters of hop code must be programmed. If any radio in the net is programmed incorrectly no signals would be heard by that radio on the affected channel/ channels. Also, transmissions by this radio on the affected channel/channels would not be heard by other radios in the net.

## Programming Barred Frequencies

56. The radio can be programmed not to hop on to any selected frequency of the 2304 channels in the 9 hop bands - these are termed barred frequencies. Up to eight barred frequencies can be programmed manually, while up to 64 can be programmed using the Portable Programmer MA 4073. For the latter, not more than 16 can be entered in any one hop band; the Error Tone is initiated if more than 16 frequencies are entered.

57. To programme a barred frequency manually the VOL-ON/OFF switch must be set to programme position B and the CHAN switch to any channel position. The frequency is selected by pressing the appropriate keys. The maximum of eight barred frequencies can be programmed by entering one on each channel position - M and 1 to 7 - of the CHAN switch.

Note: Although the barred frequencies are programmed via the CHAN switch, the frequencies are not stored as channel information.

58. All barred frequencies can be erased by first setting the VOL-ON/OFF switch to programme position B and then the CHAN switch to programme position Z - the Zeroise position.

Notes: (1) Barred frequencies are applicable to hop frequencies only.

(2) Barred frequencies cannot be selected in the no-go hop band, i.e. 42 800 to 43 175 kHz.

(3) If the reference frequency is barred the radio can still be hailed.

(4) The barred frequency is displayed during programming and can be reviewed. This can be overwritten if a new barred frequency is required.

SELF-TEST FACILITY

59. The Self-Test facility enables the operator to check various aspects of the radio performance by pressing and holding the T (Test) key. The Test key also introduces the Noise-On condition in the phones - this checks the receiver performance. The information displayed gives the state of the radio at the instant the Test key is pressed. Providing that the radio is operating in the relevant mode, information will be displayed as follows:

Display position 1 - Hopping Synchronisation.

7 - Battery Level.

8 - Receive Signal Level or Transmit Power Output Level.

60. The information is given by up to three horizontal bars. Generalising, the more bars the better the condition. The individual interpretations are explained in more detail in the following paragraphs.

Battery Level

61. This information is available whenever a battery is fitted and the radio is switched on. The information on position 7 of the display is:

| | |
|---|---|
| Blank | Charge Battery (Low Battery Warning). |
| - | Battery Volts Low. |
| = | Battery Volts Normal. |
| ≡ | Battery Volts High. |

62. If the battery level is indicated as one, two or three bars the radio will work normally. In normal operation and in Receive mode the Low Battery Warning (70 ms receiver noise, 570 ms off) will be heard in the phones when the battery reaches the 0-bars condition. When the Low Battery Warning is heard the battery must be recharged. The battery level can be checked on Transmit by first operating the pressel and then pressing the Test key - one bar is satisfactory, no bars indicates that the battery should be recharged. In this condition no bars would not cause the Low Battery Warning - this only occurs in the Receive mode.

Receive Signal Strength

63. This information is available only when a signal is being received at the instant the Test key is selected. The information on the right hand end (position 8) of the display is:

| | |
|---|---|
| Blank | Weak Signal. |
| - | Normal Signal. |
| = | Strong Signal. |
| ≡ | Very Strong Signal. |

64. Quite frequently a 0-bar indicated signal will be sufficient to operate the radio. The signal information would be confirmed by the audio level in the headset. A blank display with a noisy audio level would indicate a weak signal while a blank display and no audio would mean there was no signal. If a very strong signal was indicated and there was no audio in the headset then the radio is probably being jammed. Jamming is more likely to occur from other local radios than an enemy jammer.

Transmitter Power Level

65. This information is available only when a signal is being transmitted at the instant the Test key is selected. The information on the right end (position 8) of the display is:

| | |
|---|---|
| Blank | Transmitter probably not working, no sidetone. |
| - | Transmitter working, power low. |
| = | Transmitter working, power normal. |
| ≡ | Transmitter working, power high. |

66. This facility gives information on the output level of the power range selected. In general a 1, 2 or 3-bar display will mean that the radio will operate normally. When low power is selected the indication will not be above one bar. Where a medium power or high power level is set, a 1-bar display could mean that there is an antenna mismatch and may be rectified by re-positioning the antenna. It could also mean that the battery level is low.

Hopping Synchronisation

67. This information is available only when a hopping net is set up and it gives the state of synchronisation at the instant the Test key is selected. The information on the left end (position 1) of the display is:

| | |
|---|---|
| Blank | Unacquired. |
| - | Waiting, synchronised (but not recently). |
| = | Waiting, synchronised recently. |
| ≡ | Synchronised and operating (on Receive or Transmit). |
| H | Two Controls error warning. |

68. This information will be provided when a radio is either in the process of becoming synchronised or is already synchronised to the hopping net at the instant the Test key is selected. Where a radio is making a synchronising transmission (hears pip tones) the other radios would have a blank display if their Test keys were selected. Once the radios are synchronised three bars would be indicated on the display (while transmitting or receiving). After this, whenever the net goes quiet (no radio transmitting) and within 45 minutes since the last transmission the display would indicate two bars if the Test key was selected. As soon as a radio transmits, three bars would again be indicated. After 45 minutes and up to 4 hours, one bar would be displayed. After 4 hours the radios would be unacquired (no bars).

69. If the two hop control condition (H) exists (the radio could only be in the receive mode) the Error Tone would be activated.

70. The Test key is operative at all times when the radio is working even when the display is otherwise inactive, i.e. with the CONTROL switch set to DIS (Disabled), REM or REM ECON.

71. The Test key, which recalls selections made to a channel memory, enables a wrong input to be corrected. When programming frequencies and codes, entries can be cancelled by pressing the Test key and selecting the new frequency or code which overwrites the previous entry. When the Error Tone is on, in most instances, it will be cleared when the Test key is selected.

Note: If when the radio is switched on the Built-In Test Equipment (BITE) detects a fault within the radio, the Error Tone will be triggered. After pressing the Test key a 4-digit fault code will appear in the central area of the display (where the frequency and codes are normally displayed). The BITE testing is done in two stages - the first stage on switch on and the second on selecting hopping mode. If the radio is switched on in the hopping mode the two stages are combined.

## REMOTE OPERATION AND REBROADCAST

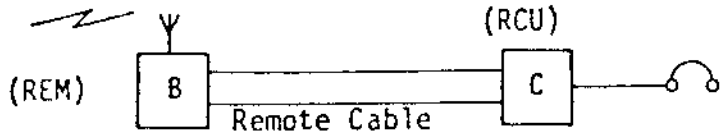
72. The radio can be operated with remote lines in three ways:

(1) With another Jaguar V radio where either radio could control the other (remote control).

(2) With another Jaguar V radio for rebroadcast purposes.

(3) With a remote handset or Remote Audio Unit.

### Remote Control




73. Two Jaguar V radios can work together to provide remote control of one by the other, providing one radio's CONTROL switch is set to REM and the other is set to RCU. The radio set to REM (Radio B) will be controlled remotely by the radio set to RCU (Radio C) for all facilities and switch positions except on/off and battery saving (ECON).

74. Connect the remote lines, 2-wire field cable (D10 or equivalent), to the remote terminals of one of the Jaguar V radios. Lay out up to 3 km of remote line avoiding any possible sources of noise or interference, e.g. power lines. Connect the remote line to the other Jaguar V radio remote terminals.

75. Switch both radios on and set both CONTROL switches to LOC (local). If the Call Tone (continuous high-pitched note) is heard in the phones the remote lines are crossed or faulty. If they are crossed it is important that only one radio's remote line connections are reversed.

76. Whilst setting up the link the two operators can communicate. One can call the other by pressing and holding down the Ic key (Call mode). The other should now go to Intercom by selecting the Ic key. When using Intercom, the operation is simplex - only one operator can operate his pressel and speak at a time.

77. When the stations are ready to operate, set Radio B to REM and Radio C to RCU. Key Radio C for the channel and mode of operation required.

78. In effect the two stations now form one radio, i.e. the front panel of Radio C and the RF circuits of Radio B. (The RF circuits of Radio C and the front panel of Radio B are now ineffective.)

79. After adjusting the position of Radio B for optimum signal and security conditions it can be left unmanned. Alternatively, a radio operator can monitor signals and transmissions at Radio B.

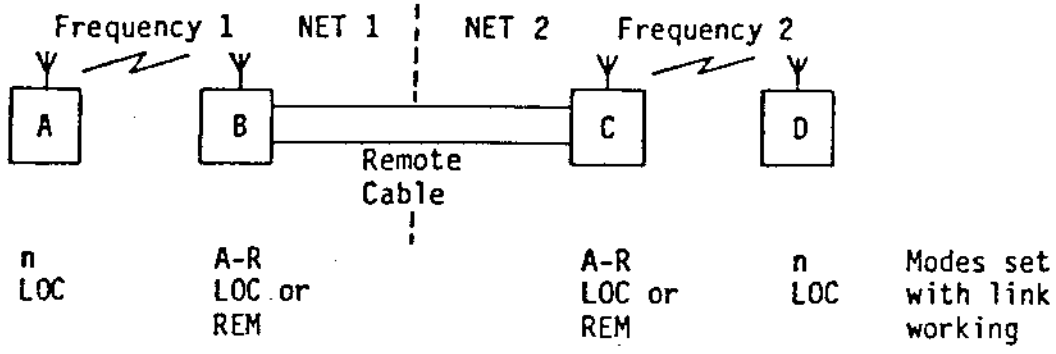
80. The facilities available to each radio are summarised in the following table.

Table 2.1 - Remote Control Facilities

| FUNCTION | OPERATOR AT RADIO C (RCU) | OPERATOR AT RADIO B (REM) |
|---|---|---|
| Transmit/ Sidetone | Can Transmit and hear own sidetone | Can Transmit. Can hear own sidetone. Can monitor RCU transmission. |
| Receive | Can Receive | Can monitor Receive |
| Call | Can Call and hear own Call Tone | Cannot Call. Can hear Call Tone. Call is available if LOC selected first. |
| Intercom | Intercom available | Cannot select Intercom (unless LOC selected beforehand) |
| Mode Control | Can change operating mode | Cannot change operating mode (unless LOC selected beforehand). |

Rebroadcast

81. Remote lines are also used when two Jaguar V radios form part of a rebroadcast link and are set to operate in the Auto-Rebroadcast mode. Four radio stations are needed to set up a rebroadcast link, two operating on one frequency and the others on another frequency.




Auto-Rebroadcast

Setting Up a Rebroadcast Link

82. Referring to the diagram, set Stations A and D as follows:

(1) CONTROL switch to LOC (local).

(2) Switch radios on and set to n - normal operation.

(3) Set frequency. Check frequencies on Nets 1 and 2 are not too close (see Table 2.2).

(4) Assemble and connect whip antenna to the hexagonal socket on the front panel.

83. Set Stations B and C as follows:

(1) Switch radios on and set to n - normal operation.

(2) Set frequency as in para. 82.

(3) Set CONTROL switch to LOC (local).

(4) Assemble and connect whip antenna to the hexagonal socket on the front panel.

84. Stations A to B and C to D establish radio communication. Station A then tells B to set up rebroadcast link to D via c.

85. Station B then:

(1) Acknowledges A and requests A to standby.

(2) Connects the remote cable to the remote terminals.

(3) Reels out cable (maximum 3 km) to C position.

86. Station C then:

(1) Connects remote cable to remote terminals. (If Call Tone is heard in phones, reverse cable connections on one radio only.)

(2) Selects Ic (Intercom mode) - as does Radio B - and checks that the line is operating.

(3) Keys in n (normal operation) and calls D to say that rebroadcast link is now ready and to standby for call from A.

(4) Selects Ic (Intercom mode) and informs B that cable is connected and that D is ready to receive a call from A.

(5) Selects A-R (Auto-Rebroadcast) mode.

87. Station B:

(1) Selects n (normal operation).

(2) Calls A and advises that rebroadcast link is now ready and that D is standing by to be called.

(3) Selects A-R mode.

88. Station A then communicates with Station D and the rebroadcast link is established.

89. Stations B and C can monitor transmissions in both directions. Stations A, B, C and D can communicate with each other while B and C are in A-R mode.

90. When the link is operating satisfactorily, B and C can be left unattended provided their CONTROL switches are set to REM. It is possible for only one of Stations B and C to be attended. If so, the other should be set to REM. The attended station can control both Stations B and C by controlling his own in the normal way and the unattended one by switching to RCU. It is possible to set up a rebroadcast net using RCU and REM in this way once the remote lines have been laid and connected.

Rebroadcast Links with Hopping and Fixed Frequency Modes

91. Nets can establish a rebroadcast link when either hopping or fixed frequency modes are selected provided each net uses a base frequency in the hop bands shown in the Frequency Separation Table.

92. To rebroadcast with both nets working in the hopping mode, set Stations A, B, C and D to h or H as appropriate. Then set each net to the required frequency and hop code. The two nets could have the same hop code but the frequencies must be separated as per table. In this mode, the third radio could experience slightly distorted messages, i.e. if A is transmitting C can hear and understand him but the speech will sound distorted.

Table 2.2 - Frequency Separation/Distance Between Antennas

| DISTANCE BETWEEN ANTENNAS | FREQUENCY SEPARATION | |
|---|---|---|
| | Fixed Frequency Nets | Hopping Nets |
| 2 m or greater | Greater than 10% | Hop bands separated by one or more bands |
| 10 m or greater | Greater than 5% | Hop bands adjacent or with greater separation |
| 100 m or greater | Greater than 2% | Can use the same hop band but must use different reference frequency or different hop codes |

93. The Table 2.3 at the end of this chapter gives details of the expected performance of rebroadcast systems using all possible combinations of modes and using clear speech and secure speech. →

## Call and Intercom

### Call

94. The Call facility is available to radios connected by remote lines when they require to use the Intercom mode. Call is initiated by either radio to alert the other radio or a remote handset.

95. Call is selected by pressing and holding down the Ic key, whereupon C will be indicated on position 7 of the display. The resultant Call Tone, a high-pitched note, will be heard in the phones of the local and remote radios.

### Intercom

96. The Intercom facility is available to radios connected by remote lines. Intercom is selected by either radio in order to communicate with the other radio or a remote handset. A radio set to Intercom will not transmit when the pressel is operated, but it will allow reception of signals in the normal manner (provided transmission has valid squelch-opening information).

97. Intercom is selected by pressing the Ic key and I will be indicated on position 7 of the display. Intercom operation can only take place in one direction at a time (simplex operation).

Table 2.3 - Rebroadcast Performance

| MESSAGE SOURCE | NET 1 MODE | NET 2 MODE | NOTES |
|---|---|---|---|
| 1 Clear Speech | Fixed Freq | Fixed Freq | Satisfactory |
| 2 Clear Speech | Hopping | Hopping | Satisfactory |
| 3 Clear Speech | Hopping | Fixed Freq | Possible with some distortion. Satisfactory using Rebro Unit |
| 4 Clear Speech | Fixed Freq | Hopping | Satisfactory |
| 5 Secure Speech | Fixed Freq | Fixed Freq | Satisfactory |
| 6 Secure Speech | Hopping | Hopping | Possible delay in receipt of message - losing 1 or 2 seconds. |
| 7 Secure Speech | Hopping | Fixed Freq | As above (in 6) |
| 8 Secure Speech | Fixed Freq | Hopping | As above (in 6) |

Note: When more than two radio links are used in an extended rebroadcast system, there will be a progressive degradation of signals depending on the quality of the radio links.

# CHAPTER 3

# USER MAINTENANCE

## CONTENTS

# CHAPTER 3

# USER MAINTENANCE

## INTRODUCTION

1. User maintenance of the BCC 66H is restricted to the periodic performance of the cleaning, lubrication and inspection procedures set out below. For details of the user maintenance procedures for any item of ancillary or optional equipment (e.g. harness, VIU, etc.), refer to the User Manual and/or Technical Manual for that item.

2. The frequency with which each of the user maintenance procedures is applied, and whether or not every operation of a particular procedure is required at every maintenance period, depends upon local circumstances. However, it is recommended that all the procedures are conducted in full before returning the radio to stores following its use in the field.

## PROCEDURES

### Tools and Materials Required

3. (1) Small, clean, dusting brush.

(2) Clean, soft, lint-free cloth.

(3) Clean water.

(4) Petroleum jelly.

### Cleaning

WARNING

UNDER NO CIRCUMSTANCES ATTEMPT TO CLEAN THE RADIO USING SOLVENTS, DETERGENTS OR ABRASIVE SUBSTANCES. TO DO SO CAN RESULT IN DAMAGE TO THE DISPLAY WINDOW AND/OR THE UNIT SEALS, THUS IMPAIRING THE OPERATIONAL EFFICIENCY OF THE UNIT.

4. Taking care not to scratch or otherwise damage the window protecting the display, remove all loose dirt, grit, etc. from the exterior of the radio. A dusting brush should be used to clean out corners and recesses, around the keypad pushbuttons, etc.

5. Moisten a piece of clean, lint-free cloth in clean water (warm water may be used, if available).

6. Using the moist cloth, thoroughly wipe over the exterior surfaces to remove and remaining dirt and stains. Caked dirt should be 'soaked' off.

7. Using a dry, clean, lint-free cloth, dry the exterior of the radio. Ensure that all moisture is removed from within recesses, connector sockets, etc.

## Lubrication

8. Immediately following cleaning, the battery input terminals (i.e. the pair of stud contacts contained in the recess in the rear panel) must be coated with petroleum jelly to protect them against corrosion.

9. It is important that this protection is maintained while the radio is in use, especially if there is a possibility that it will be subjected to immersion in salt water or exposed to salt spray.

## Inspection

10. Should a defect be found during any stage of the procedure which follows, the local repair authority must be notified. Under no circumstances should user personnel attempt any repair.

11. Examine the exterior of the radio for indications of mechanical damage, paying particular attention to the seals fitted between the front and rear panel assemblies and the centre sleeve section of the case.

12. Confirm that all the screws fixing the two panel assemblies to the centre section are present and securely tightened.

13. Inspect the display window for scratches and other marking. In particular, check that there is no blemish which could obscure or distort any part of the display or which could prevent light reaching the sensor that controls the display brightness.

14. At the CONTROL switch:

    (1) Check that the control knob is correctly orientated and securely fastened.

    (2) Check for the correct mechanical operation of the switch over its complete range of movement.

15. At each of the CHAN and VOL-ON/OFF switches in turn:

WARNING

DO NOT SET THE CHAN SWITCH TO 'Z' UNLESS THE STORED DATA IS NO LONGER REQUIRED.

    (1) Check that the control knob is correctly orientated and securely fastened.

    (2) Check that the mechanical lock operates and releases correctly.

    (3) Check for the correct mechanical operation of the switch over its complete range of movement.

16. Depress and release each of the keypad pushbuttons in turn, checking that the pushbutton operates and releases correctly and without grating or binding.

17. Check that each of the multi-way and coaxial connectors on the front and rear panels is undamaged and securely fitted. Also check that the connector interior and pins are clean and dry.

18. Check that each of the AUDIO-COMSEC, AUDIO-VIU and IF sockets on the front panel, and the VIU plug on the rear panel, is provided with a protective cap. Confirm that each of these caps is clean and undamaged and that the cap retaining strap is intact.

19. At the rear panel, check that the battery terminals are clean and are protected against corrosion by a film of petroleum jelly.

# CHAPTER 4

# FUNCTIONAL CHECKS

## CONTENTS



## Tables

# CHAPTER 4

# FUNCTIONAL CHECKS

## INTRODUCTION

1. The procedures contained in this chapter enable a comprehensive functional check-out of a BCC 66H to be performed without the use of common or special-to-type test equipment, and without removing the radio from its case.

2. The procedures take no account of the radio's use in a vehicle radio station or of the provision of secure speech facilities. For details of the functional check procedures to be used in such circumstances, refer to the appropriate User Handbook and/or Technical Handbook.

3. The frequency with which the functional check procedures are performed and whether or not every test is required at each performance, depends upon local circumstances. However, it is recommended that the procedures are conducted as follows:

   (1) Before the radio's use in the field, at least those functions appropriate to the proposed method of use should be checked (see table 4.1).

   (2) Before returning the radio to stores following its use, the procedures should be performed in full.

   (3) At any time that it is suspected that the radio is faulty, those checks appropriate to the type of fault suspected should be performed.

   NOTE: If only the radio is available, testing is normally restricted to the performance of the Preliminary Check-Out procedure.

## EQUIPMENT REQUIRED

4. (1) Jaguar V Radio BCC 66H - 2.

   (2) Battery Rechargeable MA 4025A - 2.

   (3) Whip Antenna 1.2m or 2.4m - 2.

   (4) Handset/Headset - 2.

   (5) Field telephone cable (D10 or similar) - as required.

5. Ensure that the batteries (item 4(2)) are fully charged.

## PREPARATION

6. At each radio:

   (1) Fit a fully charged battery.

(2) Fit an antenna to the whip antenna socket.

(3) Connect a handset/headset to the AUDIO-VIU or AUDIO-COMSEC socket.

7. Assign an operator to each radio.

8. Position the radios so that the operators are within easy calling distance of one another (say, 5m apart). Preferably, the siting should be such as to also enable visual contact between the operators.

PRELIMINARY CHECK-OUT

NOTE: The tests which follow should be applied to both radios.

9. Set the CONTROL switch to LOC and the VOL-ON/OFF switch to mid-volume.

10. If Error Tone is not heard, proceed to para. 12.

11. If Error Tone is heard, press and release the Test key (T). Then:

(1) If the Tone ceases, proceed to para. 12.

(2) If the Tone persists and a 4-digit number appears on the display (whilst key pressed), the radio is faulty and should be rejected.

(3) If the Tone persists, but no number is displayed, key in

F, 5000, n, M (with CHAN switch set to M).

(4) If the Tone ceases, proceed to para. 12. If the Tone still persists, the radio is faulty and should be rejected.

12. Set the CHAN switch to M.

13. Key in

F, 3450, n, M.

Confirm that the correct display is obtained.

14. Hold down the Test key (T). Confirm that receiver noise is heard.

15. Hold down the PTT switch. Hold down the Test key. Confirm that at least two horizontal bars are displayed at the right hand character position and that sidetone is present. Release the key and the switch.

16. Key in

6100, Lo.

Confirm that the correct display is obtained.

17. Hold down the PTT switch. Hold down the Test key. Confirm that a single horizontal bar is displayed at the right hand character position. Release the key and the switch.

18. Key in

    7892.

    Confirm that the correct display is obtained.

19. Repeat the check details in para. 17.

20. Set the VOL-ON/OFF switch to '*' and confirm that receiver noise is heard.

21. Set the CONTROL switch to LOC ECON. Confirm that after 15 seconds, short bursts of receiver noise are heard. (Note: this will only occur if no signals are received)

22. Return the CONTROL switch to LOC and the VOL-ON/OFF switch to mid-volume.

23. Hold down the Ic key. Confirm that Call Tone is heard and that the seventh character on the display is now C.

24. Release the Ic key. The Call Tone should cease and the seventh character of the display should become I.

25. Key in

    n.

26. If no further checks are to be performed, set the VOL-ON/OFF switch to OFF.

LOCAL WORKING (FIXED FREQUENCY) FUNCTIONAL AND TALK-THROUGH CHECKS

27. Perform the sequence of checks detailed in paras. 9 to 26 inclusive.

28. At each radio, set the CHAN switch to each of positions M and 1 to 7 in turn. After each selection is made, check that:

    (1) The channel is programmed for fixed frequency operation, adjusting as necessary.

    (2) The channel frequency has not been zeroed.

    (3) The radios display the same channel frequency.

29. If all the conditions of para. 28 are satisfied, proceed to para. 31. If channels on either radio are zeroed or there is a difference in the programming of the radios:

    (1) Ascertain whether the appropriate channel frequencies have been allocated.

    (2) If the frequencies have been allocated, programme both radios accordingly.

    (3) If the frequencies have not been allocated, programme both radios as follows:

| Channel | Key in |
|---|---|
| M | 3317 |
| 1 | 3957 |
| 2 | 4637 |
| 3 | 5277 |
| 4 | 5977 |
| 5 | 6557 |
| 6 | 7197 |
| 7 | 7837 |

30. Repeat the operations of para. 28.

31. Key in

n, Lo.

32. Select each channel in turn. Following each selection, perform a bothway talk-through check. During the first talk-through check, both the mid-volume and the W (whisper) setting of the VOL-ON/OFF switch should be used. Return the switch to mid-volume before proceeding to the next channel.

33. Should any check produce unsatisfactory results at either radio:

(1) Reselect the suspect channel.

(2) Confirm that the correct channel frequency is displayed on both radios.

(3) Repeat the talk-through check.

If the result of the recheck is unsatisfactory, the suspect radio should be rejected as faulty.

34. Return the CHAN switch to M and enter

8797.

35. Perform a bothway talk-through check. If an unsatisfactory result is obtained, proceed as in para. 33.

36. Key in

M.

37. Select an agreed channel and perform a bothway talk-through check. If an unsatisfactory result is obtained, proceed as in para. 33.

38. If no further checks are to be performed, set the VOL-ON/OFF switch to OFF.

## LOCAL WORKING (HOPPING FREQUENCY) FUNCTIONAL AND TALK-THROUGH CHECKS

39. Perform the sequences of checks detailed in paras. 9 to 26, and 28 to 38 inclusive.

40. At one radio, key in

h.

At the other radio, key in

H.

41. If Error Tone is not heard at either radio, proceed to para. 46.

42. If Error Tone is heard at one, or both, of the radios, ascertain whether a prepared Programmer or Fill Gun is available.

43. If it is, use it to programme the radios with the same hop codes and then proceed to para. 45.

44. If it is not:

(1) Manually programme the following hop codes to ALL channels -

| | | |
|---|---|---|
| Group | 1 | 01234 |
| | 2 | 56701 |
| | 3 | 12121 |
| | 4 | 34567. |

(2) Manually programme the following Common code -

77777.

45. Repeat the operations of para. 40. If Error Tone is heard, the radio concerned is faulty and should be rejected. If Error Tone is not heard, proceed as below.

46. Select each channel in turn. Following each selection, key in h or H as required and then perform a bothway talk-through check. (Remember that the first transmission on a new channel frequency by either radio should cause Unready Tone to be heard for 5 seconds at the transmitting set).

47. Should any check produce unsatisfactory results at either radio:

(1) Reselect the suspect channel.

(2) Confirm that both radios display the same channel frequency.

(3) Repeat the talk-through check.

If the result of the recheck is unsatisfactory, the suspect radio should be rejected as faulty.

48. At one radio, key in

F

and hold down the PTT switch. Confirm that Hailing Tone is heard at the second (hopping) radio. Release the PTT switch and key in

h.

49. Repeat the check of para. 48 with the second radio.

50. At each radio, set the VOL-ON/OFF switch to B. Select each channel in turn and see whether any barred frequencies are held in the radio.

51. If any barred frequencies are found, proceed to para. 58.

52. If no barred frequencies are found, programme any frequency to channel M and confirm that the display shows this frequency.

53. If the display is correct, proceed to para. 55.

54. If the display is incorrect, repeat the programming operation. If the display is still incorrect, the radio should be rejected as faulty.

WARNING: DURING THE NEXT OPERATION, EXTREME CARE MUST BE TAKEN NOT TO ERASE ANY STORED DATA (E.G. HOP CODES) WHICH MAY BE REQUIRED FOR FUTURE USE.

55. Zeroise the barred frequency just entered by setting the CHAN switch to Z and confirm that the zeroising operation is correctly performed.

56. If the frequency is correctly erased, proceed to para. 58.

57. If the erasure fails, repeat the zeroising operation. If this second erasure also fails, the radio should be rejected as faulty.

58. Set the CHAN switch to M. If no further checks are to be performed, set the VOL-ON/OFF switch to OFF.

REMOTE WORKING FUNCTIONAL AND TALK-THROUGH CHECKS

59. At both radios, perform the Preliminary Check-Out procedure, and the Local Working (Fixed Frequency and Frequency Hopping ) Functional and Talk-Through Checks.

60. Using a suitable length of field telephone cable (not more than 3 km), join the REM terminals on one radio to the REM terminals on the other. Take care to observe the correct polarity of connection. (Incorrect connection will result in Call Tone being heard, as a warning.)

61. On both radios, set the CONTROL switch to LOC and the VOL-ON/OFF switch to ON.

62. Confirm that an intercom link can be established by use of the Ic key on both radios to select Intercom mode.

63. Key in

n.

64. Set the CONTROL switch on one radio to RCU, and on the other to REM.

65. On the RCU set, press Test key (T) and note the resultant display.

66. On the REM set, press the Test key and confirm that the display is the same as that obtained in the previous operation.

67. At the RCU set, change the power output level from medium (M) to low (Lo) - or vice versa. At the REM set, operate the Test key and confirm that the display has changed to show the new output level.

68. At the RCU set, select the CHAN switch to a new channel. At the REM set, operate the Test key and confirm that the two displays agree.

69. If a third radio is available, this may be used for a bothway talk-through test.

70. Check that local break-in is available at the REM set.

71. If deemed necessary, paras. 66 to 70 inclusive can be repeated with the roles of the two radios reversed.

72. If a check on Auto-Rebroadcast operation is required, four radios are necessary. The check is performed by setting up and operating an A-R link as described in chapter 2.

73. If no further checks are to be performed, set the VOL-ON/OFF switch to OFF.

Table 4.1 Method of Use and Corresponding Functional Checks Required

| METHOD OF USE | FUNCTIONAL CHECKS REQUIRED | | | |
|---|---|---|---|---|
| | Preliminary Check-Out | Local Working (Fixed Frequency) | Local Working (Frequency Hopping) | Remote Working |
| Locally controlled, fixed frequency radio | * | * | | |
| Locally controlled, frequency hopping radio | * | * | * | |
| Remotely controlled, fixed frequency radio | * | * | | * |
| Remotely controlled, frequency hopping radio | * | * | * | * |
| Remote Control Unit | * | | | * |
| Auto-Rebroadcast, fixed frequency station | * | * | | * |
| Auto-Rebroadcast, frequency hopping station | * | * | * | * |
| Intercom station | | | | * paras. 60 to 62 |
| REFERENCE | paras. 9 to 26 | paras. 27 to 38 | paras. 39 to 57 | paras. 59 to 73 |

# CHAPTER 5

# MECHANICAL DESCRIPTION AND SERVICING

## CONTENTS



## Tables



## Illustrations

# CHAPTER 5

# MECHANICAL DESCRIPTION AND SERVICING

## INTRODUCTION

1. This chapter describes the main mechanical characteristics of the Jaguar V Radio BCC 66H, and sets out the mechanical servicing procedures required during first line servicing of the radio. For the corresponding information for the VIU, the COMSEC unit, or any other item of optional or ancillary equipment, refer to the appropriate Technical Handbook (see Chapter 1). For a detailed mechanical description of any assembly or unit contained in the radio, refer to the appropriate part of Volume 2 of this handbook.

## MECHANICAL DESCRIPTION

2. The BCC 66H is of modular construction and uses printed circuit and large scale integration (l.s.i.) techniques throughout. The radio is mounted in an aluminium alloy, sealed box-frame comprising:-

(1) The Front Panel Assembly.
(2) The Chassis and Motherboard Assembly, containing six discrete units (modules) and secured to the Front Panel Assembly.
(3) The Rear Panel Assembly.
(4) The Sleeve Assembly, to which the Front Panel Assembly (complete with the filled Chassis and Motherboard Assembly) and the Rear Panel Assembly secure and which protects the interior of the radio.

A complete list of the main assemblies and units is given in table 5.1 below, and they are illustrated in figure 5.1.

Table 5.1 Main Assemblies and Units

| UNIT NO. | DESCRIPTION | RACAL PART NO. |
|---|---|---|
| | VHF Transmitter-Receiver BCC 66H comprising: | 49226-100-10 |
| 1 | Front Panel Assembly | 49226-110-10 |
| 2 | Chassis and Motherboard Assembly | 49226-130-10 |
| 3 | Interface | 49226-140-10 |
| 4H | Central Control Hop | 49226-210-09 |
| 5 | IF Unit | 49226-160-10 |
| 6 | RF Head | 49226-170-10 |
| 7 | Synthesizer | 49226-180-10 |
| 8 | Modulator | 49226-190-10 |
| 9 | Rear Panel Assembly | 49226-200-10 |
| | Sleeve Assembly | 49226-560-10 |

3. The radio is sealed by toroidal seals fitted in the mating surfaces between the Front and Rear Panel Assemblies and the Sleeve Assembly. The keyboard switches and the l.e.d. display are contained in a separately sealed compartment, enabling them to be removed from the Front Panel Assembly without disturbing the main seal. A sealing test point is provided at the Rear Panel Assembly.

4. With the exception of the PTT switch, all the operator controls are mounted on the Front Panel Assembly. The design and arrangement of these controls is such as to provide ease of operation under all conditions of service.

5. All external surfaces of the Panels and the Sleeve are finished in matt deep bronze-green. Other surfaces - including knobs, keyboard and labels - are finished in matt black.

6. The overall dimensions and weight of the radio are as detailed in the Technical Specification.

## INTERCHANGEABILITY

7. Provided that the items concerned are at the same modification state, any assembly or unit of one BCC 66H is electrically and mechanically interchangeable with the corresponding assembly or unit of another BCC 66H. With the exception of the Central Control Hop (Unit 4H), and conditional on the modification state requirement being met, assemblies and units may also be interchanged between a BCC 66H and a BCC 66F.

8. Any BCC 66H may be converted to a BCC 66F simply by replacing the Central Control Hop (Unit 4H) with a Central Control Fixed 49226-150-10 (Unit 4F).

## MECHANICAL SERVICING

### Environmental Requirements

9. Every effort must be made to ensure that:

   (1) The working area is adequately protected against the ingress of rain, blown dust, etc.

   (2) All working surfaces are dry, and clean from dirt and other foreign particles.

### Tools and Materials Required

10. A complete list of the tools and materials required for the performance of the procedures which follow is given below. The requirements for specific procedures are detailed in table 5.2 at the end of the chapter.

   (1) Torque wrench, 0.35 to 0.39 Nm (50 to 55 oz. in.) loading, with the following attachments:

   Socket wrench 2.5 mm (0.098 in.) AF
   Socket wrench 3.0 mm (0.118 in.) AF
   Screwdriver blade.

(2) Extractor Tool, Racal Part No. 49226-051-10.

(3) Test Spacers, Racal Part No. 39226-792-10 (4 off).

(4) Continuity Tester (e.g. Avometer).

(5) Small, clean, dusting brush.

(6) Clean, soft, lint-free cloth.

(7) Grease XG271.

(8) Clean warm water.

Replacement Parts

11. When fitting a new unit or item, ensure that the correct replacement part is used. A complete list of the parts available at the present level of servicing is given in chapter 12.

12. Before fitting a new unit, ensure that the interchangeability conditions of paragraphs 7 and 8 are satisfied.

CAUTION

DURING THE PROCEDURES WHICH FOLLOW, CARE MUST BE TAKEN NOT TO DAMAGE UNITS OR ITEMS BY CARELESS HANDLING, CLEANING WITH ABRASIVE SUBSTANCES OR SOLVENTS, ETC.

Control Knobs

Removal

13. Remove and retain the securing screw fitted through the top of the knob and withdraw the knob from the control spindle.

Fitting

14. Carefully clean the exposed portion of the control spindle and the area of the Front Panel normally concealed by the knob, taking care that the threaded hole in the spindle is free from dirt and other foreign particles.

15. In the case of the VOL-ON/OFF and CHAN switches, carefully clean and inspect the Locking Slide Assemblies fitted at these switches (figure 5.2).

16. Carefully clean and inspect the control knob and secure screw, replacing as necessary.

17. Fit the knob to the control spindle and slide the knob fully home. In the case of the VOL-ON/OFF and CHAN switches, ensure that the Locking Slide is correctly located within the underside of the knob.

18. Enter the securing screw and tighten the screw to a torque of 0.35 to 0.39 Nm (50 to 55 oz. in).

19. Check for correct mechanical operation of the switch and, where applicable, the Locking Slide Assembly.

Keyboard and Display Assembly (Figure 5.3)

20. Removal and inspection of any item contained in the Keyboard and Display Assembly entails the procedure set out below.

Dismantling

21. Fully loosen the four socket-headed, captive screws securing the Keyboard Cover to the Front Panel Assembly.

22. Carefully lift the Cover away from the Assembly, taking care that the Display Window does not drop out onto the workbench or floor.

23. Withdraw the Display Window, complete with Window Seals and Seal Retainer, through the back of the Cover.

24. Unplug the Display Board from the Front Panel Assembly, using the minimum force necessary.

25. Carefuly remove the Keyboard Boot and the Support Plate.

26. Unplug the Keyswitch Assembly from the Front Panel Assembly, using the minimum force necessary.

Cleaning and Inspection

27. Carefully clean the area of the Front Panel normally concealed by the Keyboard and Display Assembly. Ensure that the threaded holes receiving the Keyswitch Cover securing screws, and the sockets associated with the Display Board and the Keyswitch Assembly, are dry and free from dirt and other foreign particles.

28. Carefully clean and inspect all items removed during dismantling, replacing as necessary.

29. Check for correct mechanical and electrical operation of each switch of the Keyswitch Assembly (figure 5.4).

Re-Assembly

30. Plug the Keyswitch Assembly into the Front Panel Assembly, ensuring that the jack pins are fully home in the sockets. Use the minimum force necessary.

31. Lightly smear the sealing edges of the Keyboard Boot (figure 5.3) with grease XG271, and fit the Boot and the Support Plate to the Keyswitch Assembly.

32. Check for correct mechanical operation of the Keyswitches.

33. Correctly orientate the Display Board w.r.t. the associated sockets on the Front Panel Assembly (i.e. with the Light Sensor at the right hand side when viewing from the front).

34. Plug the Display Board into the Front Panel Assembly, ensuring that the jack pins are fully home in the sockets. Use the minimum force necessary.

35. Lightly smear the Window Seals with grease XG271. Fit the Seals onto the Seal Retainer, ensuring that they are correctly orientated (figure 5.3).

36. Fit the Seal Retainer - complete with Seals - around the Display Window, and insert the assembly so formed into the window recess in the Keyboard Cover.

37. Taking care to retain the Display Window in the Cover, fit the Keyboard Cover to the Front Panel Assembly. Ensure that the Cover is correctly positioned over the Keyboard Boot.

38. Enter the four socket-headed, captive screws securing the Keyboard Cover to the Front Panel Assembly. Tighten the screws to a torque of 0.35 to 0.39 Nm (50 to 55 oz. in.).

Front Panel Assembly (Figure 5.5)

Removal

39. Fully loosen the four socket-headed, captive screws securing the Front Panel Assembly to the Sleeve Assembly.

40. Fully withdraw the Front Panel Assembly, together with the filled Chassis and Motherboard Assembly, from the Sleeve Assembly. (A little force may be required in order to overcome the resistance of the plug and socket interface with the Rear Panel Assembly; use the minimum necessary.)

41. Disconnect coaxial connectors 5SK1, 6SK1 and 2SK1 from the Front Panel Assembly.

42. Remove Units 3 and 4 as described in paras. 52 to 56.

43. Prise away the socket retaining clips and disconnect film wire connectors 1SK10, 1SK11, and 1SK12 from the Chassis and Motherboard Assembly. Care must be taken when handling the film wire connectors.

44. Remove and retain the six pan-headed screws and crinkle washers securing the Chassis and Motherboard Assembly to the Front Panel Assembly.

45. The Front Panel Assembly may now be separated from the Chassis and Motherboard Assembly.

Fitting

46. Carefully clean and inspect the Toroidal Seal fitted in the rear face of the Front Panel Assembly, replacing as necessary.

47. Ensure that the mating surfaces of the Front Panel Assembly and the Sleeve Assembly, the exposed surfaces of the Chassis and Motherboard Assembly and Units, and the interior of the Sleeve Assembly, are dry and free from dirt and other foreign particles.

48. Inspect the Desiccant Container fitted in the rear, left hand, interior corner of the Chassis and Motherboard Assembly. Replace as necessary.

49. Lightly smear the Toroidal Seal with grease XG271 and fit the Seal to the Front Panel Assembly.

50. Fit the Front Panel Assembly to the radio by reversing the procedure of paras 39 to 44 inclusive. The following should be noted:-

(1) Tighten all screws to a torque of 0.35 to 0.39 Nm (50 to 55 oz. in).

(2) When fitting the Front Panel Assembly/Chassis and Motherboard Assembly into the Sleeve Assembly, ensure that the embossed arrow at the top, right hand side of the Front Panel Assembly is aligned with the corresponding mark on the Sleeve Assembly.

Chassis and Motherboard Assembly (Figure 5.5)

51. Proceed as detailed in paras. 39 to 50 inclusive.

Units 3 to 8 (Figure 5.6)

Removal

52. Withdraw the Front Panel Assembly/Chassis and Motherboard Assembly from the Sleeve Assembly as described in paras. 39 to 40.

53. If Unit 5, 6 or 8 is to be removed, disconnect coaxial connectors as follows:-

Unit 5 - 5SK1 (slide out cable and connector from under retaining clip).

Unit 6 - 6SK2 (slide out cable from under retaining clip).

Unit 8 - 2SK10 (accessible through cut-out in rear face of Chassis).

54. Fully unlock the slidelocks at either side of the Chassis, adjacent to the Unit.

55. Fit the extractor tool to the Unit, ensuring that the tool's arms are correctly located in the slots in the unit backplate.

56. Press down on the extractor tool handle. The tool will rotate about the bosses on each arm, raising the Unit from the Chassis; it may then be removed by hand. Use the minimum force necessary.

Fitting

57. Ensure that the slidelocks at the Unit's position are fully unlocked.

58. Locate the flanges at either side of the unit backplate in the slidelocks and press the Unit fully home. Use the minimum force necessary.

59. Fully lock both sidelocks. Connect any coaxial connectors disconnected during the operations of para. 53.

60. Carefully clean and inspect the Toroidal Seal fitted in the rear face of the Front Panel Assembly, replacing as necessary.

61. Ensure that the mating surfaces of the Front Panel Assembly and the Sleeve Assembly, the exposed surfaces of the Chassis and Motherboard Assembly and Units, and the interior of the Sleeve Assembly, are dry and free from dirt and other foreign particles.

62. Inspect the Desiccant Container fitted in the rear, left hand, interior corner of the Chassis and Motherboard Assembly. Replace as necessary.

63. Lightly smear the Toroidal Seal with grease XG271 and fit the seal to the Front Panel Assembly.

64. Fit the Front Panel Assembly/Chassis and Motherboard Assembly into the radio by reversing the procedure of paras. 39 and 40. The following should be noted:-

(1) When fitting the Front Panel Assembly/Chassis and Motherboard Assembly into the Sleeve Assembly, ensure that the embossed arrow at the top, right hand side of the Front Panel Assembly is aligned with the corresponding mark on the Sleeve Assembly.

(2) Tighten all screws to a torque of 0.35 to 0.39 Nm (50 to 55 oz. in).

Rear Panel Assembly (Figure 5.7)

65. Fully loosen the four socket-headed, captive screws securing the Rear Panel Assembly to the Sleeve Assembly.

66. Remove the Assembly from the radio. (A little force may be required in order to overcome the resistance of the plug and socket interface with the Chassis and Motherboard Assembly; use the minimum force necessary).

Fitting

67. Carefully clean and inspect the Toroidal Seal fitted in the front face of the Rear Panel Assembly, replacing as necessary.

68. Ensure that the mating surfaces of the Rear Panel Assembly and the Sleeve Assembly, and the rear face of the Chassis and Motherboard Assembly, are dry and free from dirt and other foreign particles.

69. Lightly smear the Toroidal Seal with grease XG127 and fit the Seal to the Rear Panel Assembly.

70. Fit the Rear Panel Assembly to the radio by reversing the procedure of paras. 65 and 66. taking care that the locating dowels and the socket on the Assembly are correctly positioned in their receptacles on the Chassis and Motherboard Assembly before pushing the Panel Assembly fully home. Tighten all screws to a torque of 0.35 to 0.39 Nm (50 to 55 oz. in.).

Desiccant

71. The contents of the Desiccant Container fitted in the rear, left hand, interior corner of the Chassis and Motherboard Assembly are intended to

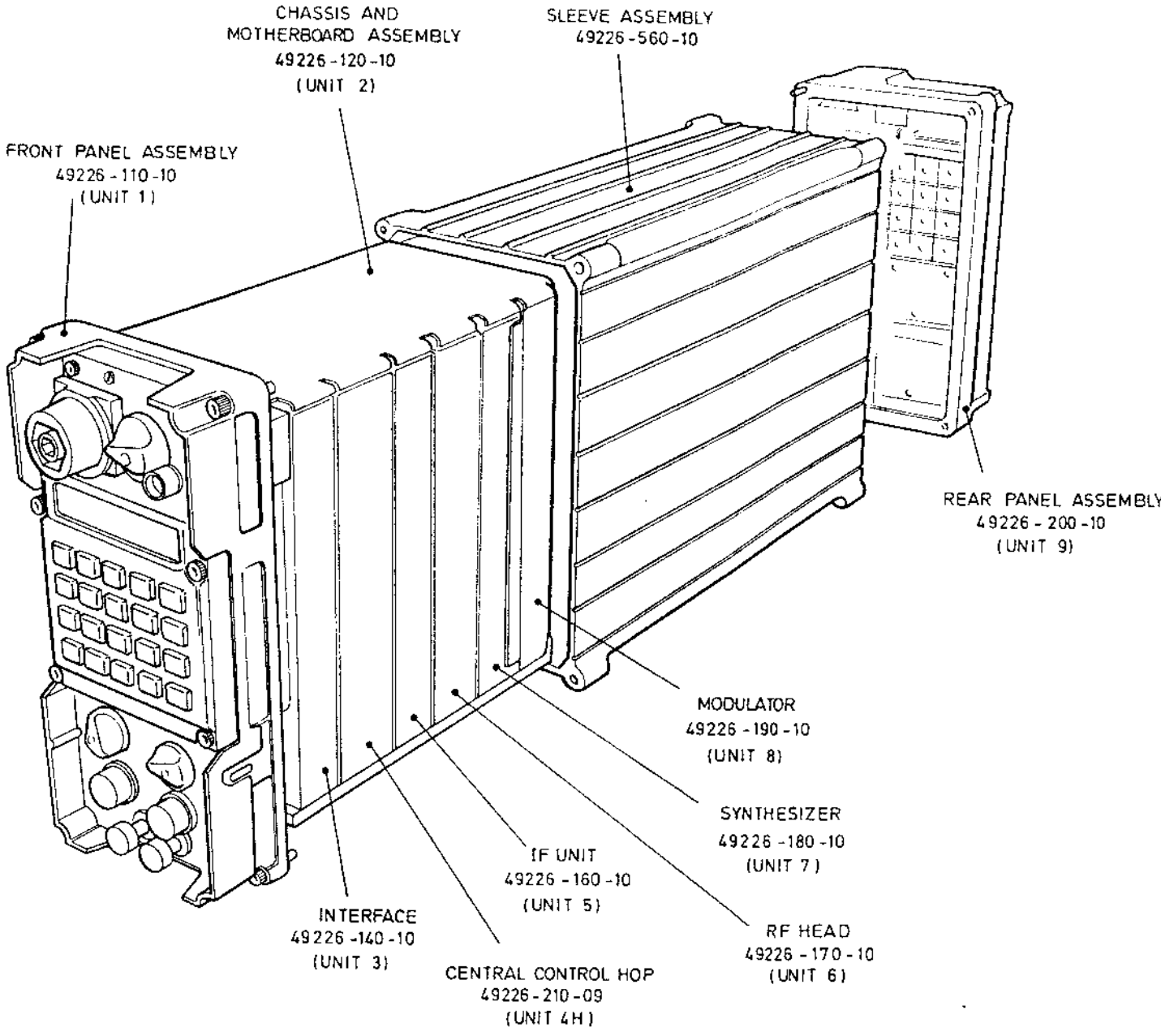
to one year. At any time that it is suspected that the desiccant is saturated, and at intervals of not more than ten months, the Front Panel Assembly/Chassis and Motherboard Assembly should be removed from the radio and the Container replaced.

Use of Test Spacers

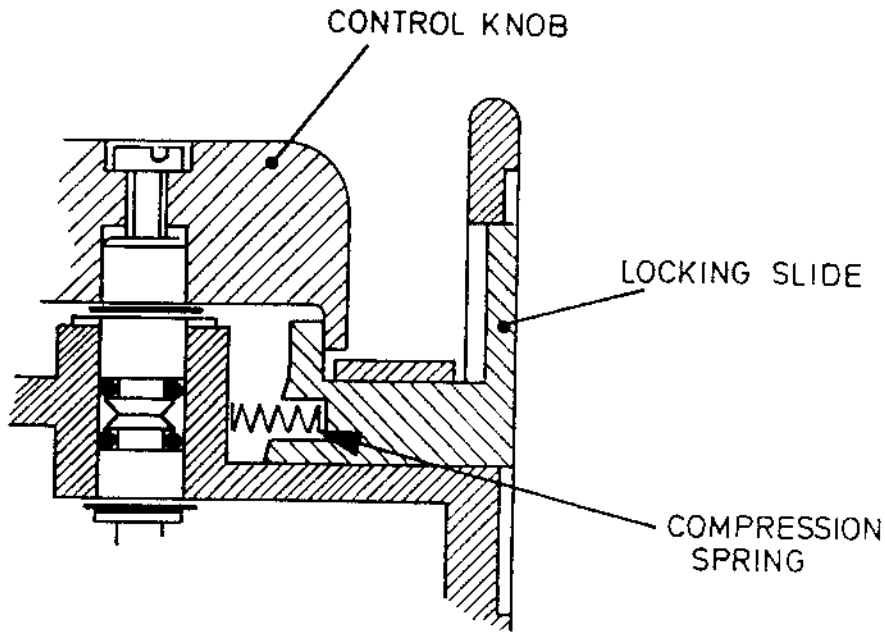
72. The Test Spacers enable the radio to be arranged in a working configuration without the Sleeve Assembly fitted. The method of use is illustrated in figure 5.8.

Table 5.2 Mechanical Servicing Procedure and Corresponding Tools and Materials Required

| MECHANICAL SERVICING PROCEDURE | TOOLS AND MATERIALS REQUIRED | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Torque Wrench | Socket Wrench Attachment | | Screwdriver Blade | Extractor Tool | Continuity Tester | Dusting Brush | Cloth | Grease | Water |
| | | 2.5 mm AF | 3.0 mm AF | | | | | | | |
| ontrol Knobs | * | | | | | | * | * | * | * |
| eyboard and isplay Assembly | * | * | | | | * | * | * | * | * |
| ront Panel ssembly | * | | * | * | | | * | * | * | * |
| hassis and otherboard ssembly | * | | * | * | * | | * | * | * | |
| nits 3 to 8 | * | | * | | * | | * | * | * | |
| ar Panel sembly | * | | * | | | | * | * | * | * |




Jaguar V Radio BCC 66H:
Main Assemblies and Units Fig

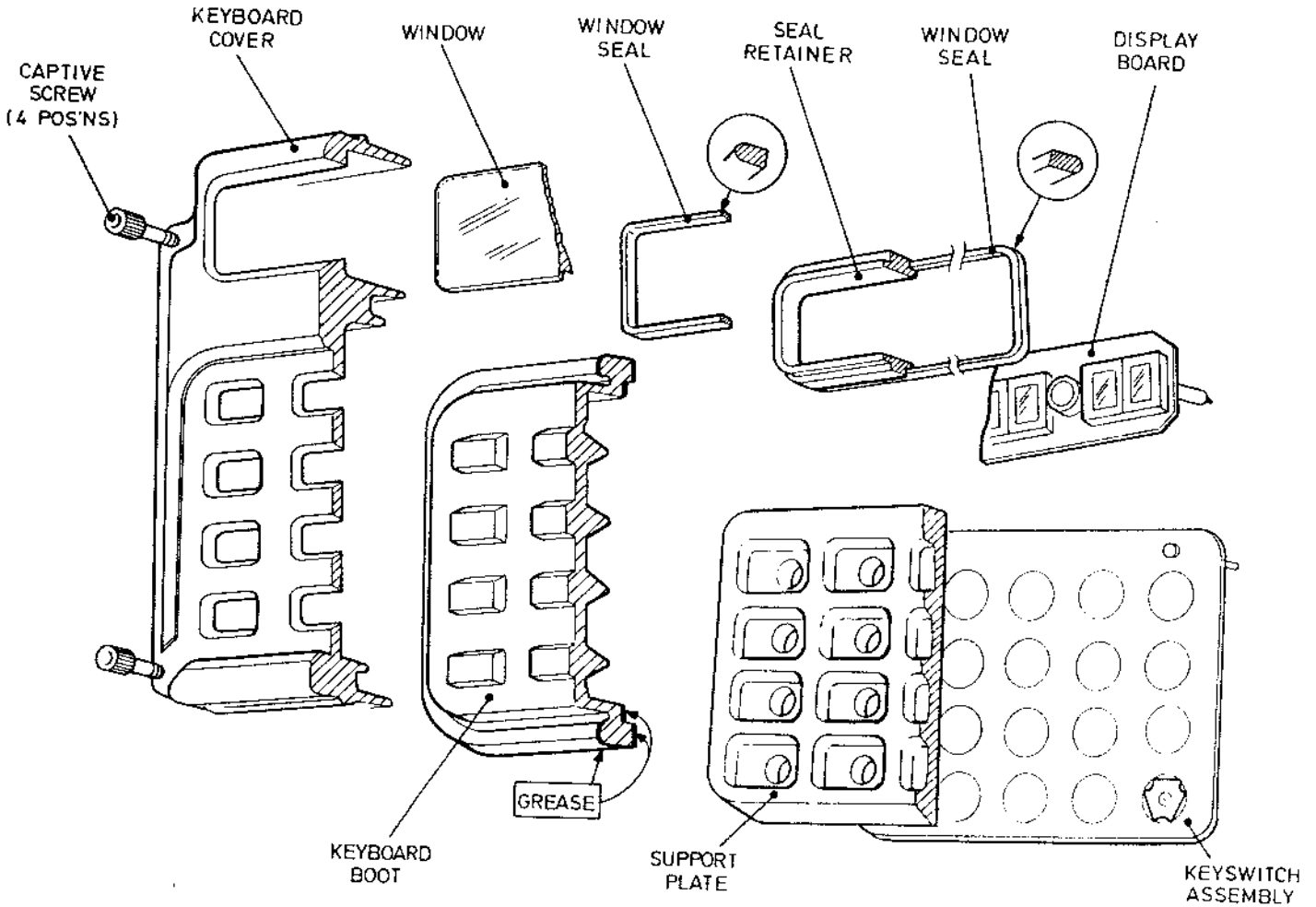



NOTE: FIGURE SHOWS ASSEMBLY FITTED AT VOL.-ON/OFF SWITCH.



Locking Slide Assembly

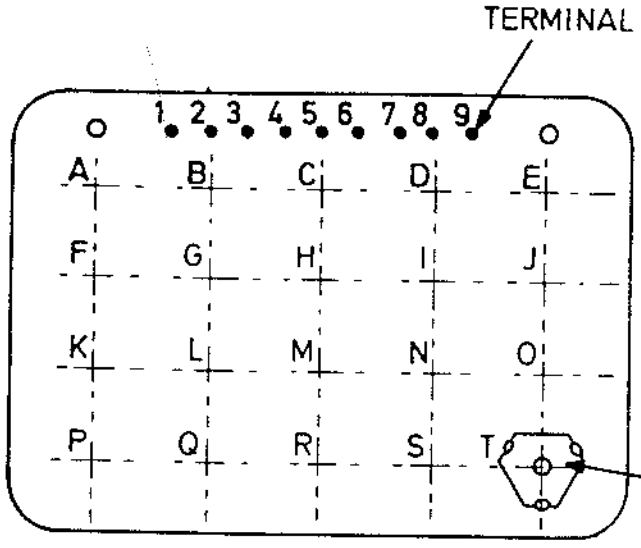
Fig. 5.2




RACAL
TH2250

Keyboard and Display Assembly: Exploded View

Fig 5.3




(a) KEYSWITCH/TERMINAL PIN LAYOUT

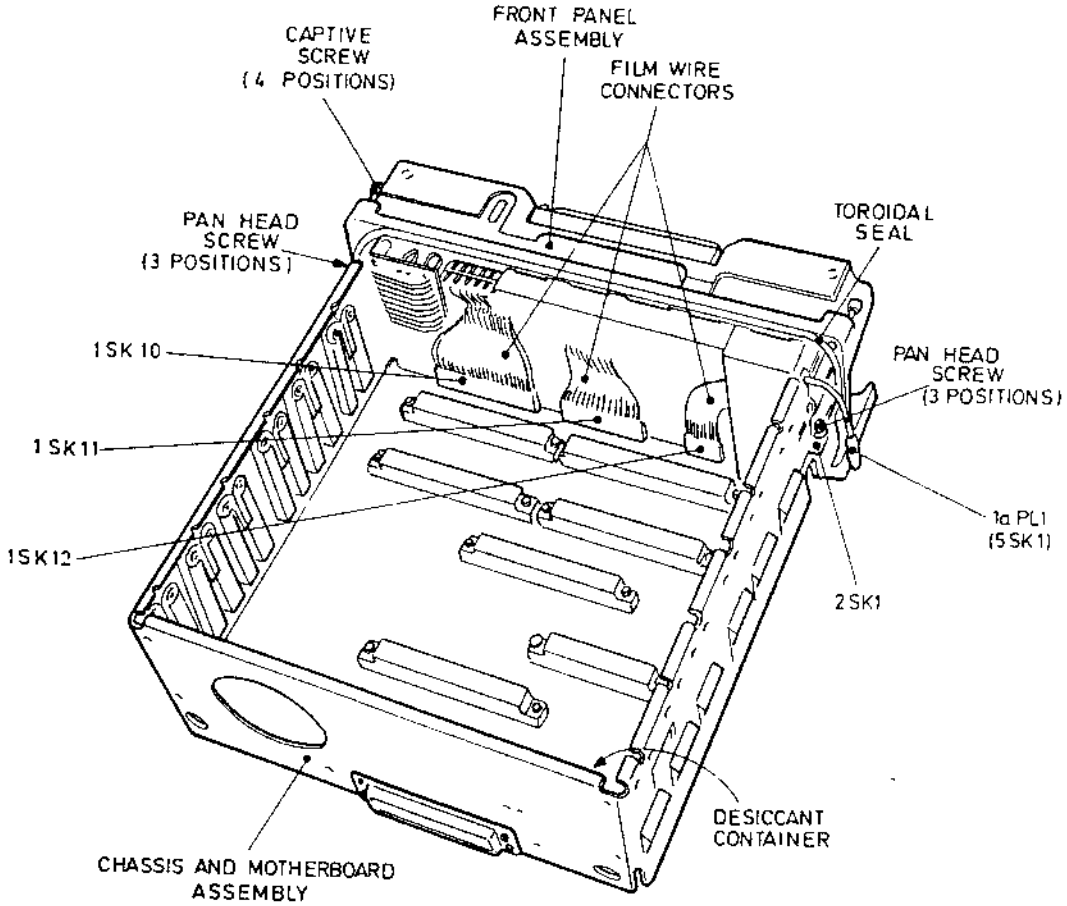
| TERMINAL PIN | 2 | 3 | 4 | 7 | 8 |
|---|---|---|---|---|---|
| 5 | A | B | C | D | E |
| 6 | F | G | H | I | J |
| 9 | K | L | M | N | O |
| 1 | P | Q | R | S | T |

(b) ELECTRICAL MATRIX



Keyswitch Assembly - Matrix Details

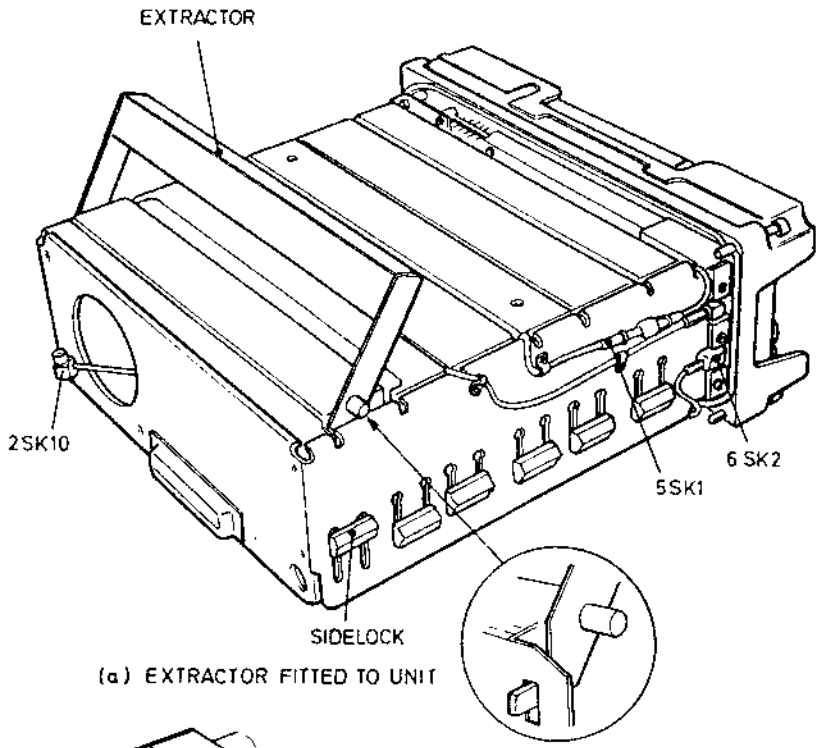
Fig.5.4



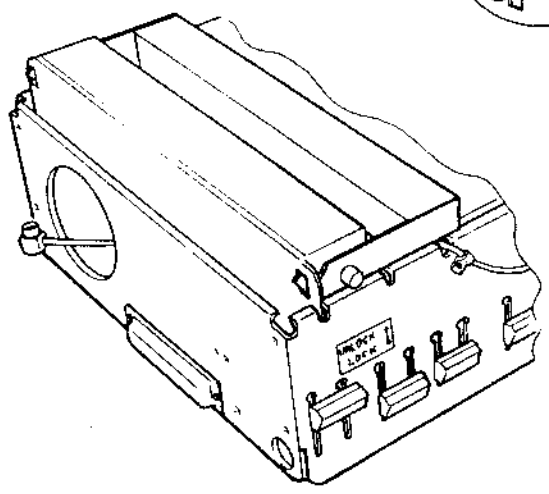



Front Panel Assembly / Chassis and Motherboard Assembly

Fig.5.5




(a) EXTRACTOR FITTED TO UNIT

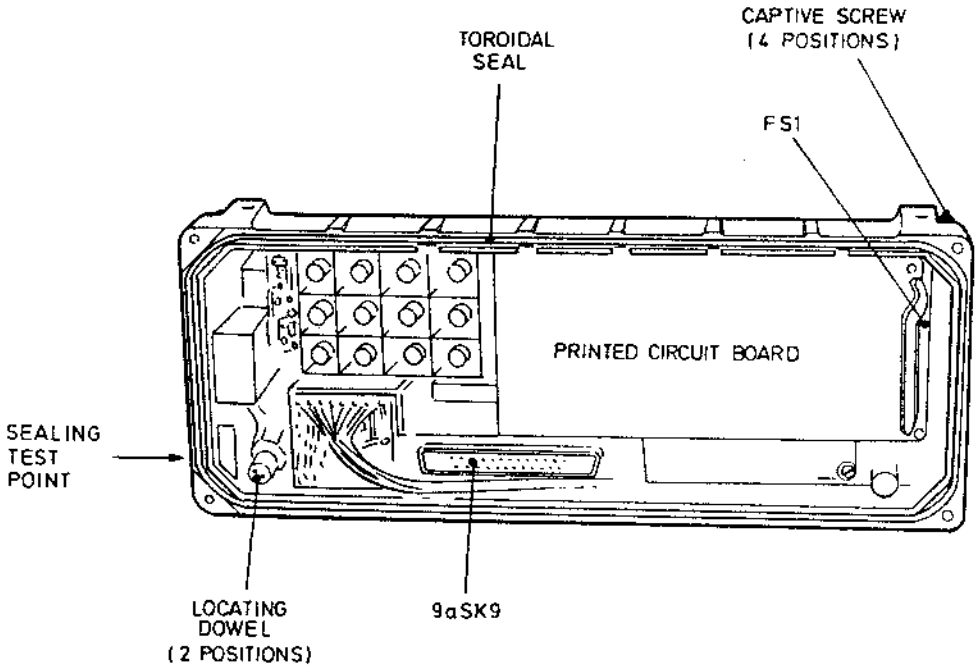


(b) EXTRACTOR OPERATED



Removal of Units 3 to 8

Fig. 5.6






Rear Panel Assembly

Fig.5.7

# CHAPTER 6

# CONTROL SYSTEM

## CONTENTS

## Illustrations

Fig. No.

# CHAPTER 6

# CONTROL SYSTEM

## INTRODUCTION

1. The BCC 66H control system consists of two main functional areas:

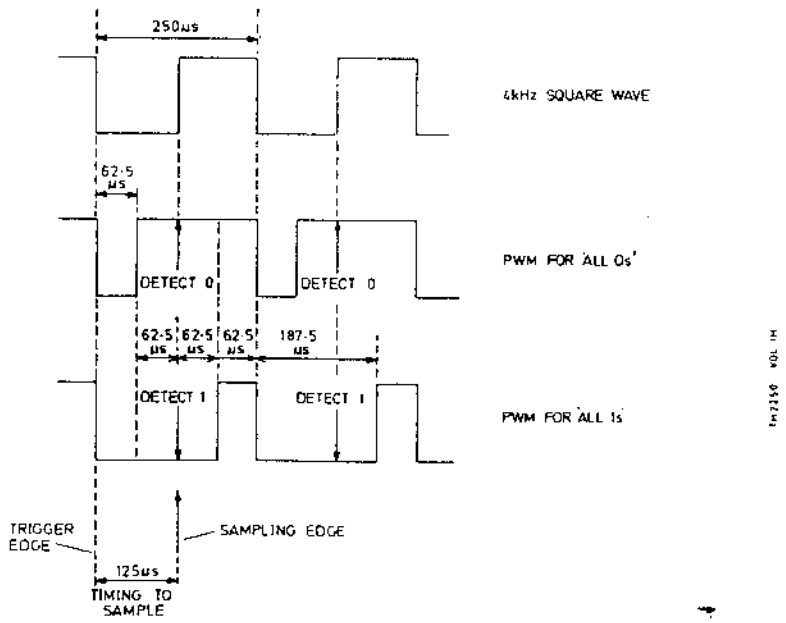
   (1) The Keyboard and Display. Together with the associated electronic circuits and the rotary control switches, these provide a man-radio interface which enables the user to input control information and to receive an indication of the radio's response to this information, to call up and display the 'last entered' control information, and to visually monitor certain aspects of the radio's operation.

   (2) The Central Control, Hop. This provides all the signal and control routing for the transmitter-receiver.

2. The sections which follow briefly describe how each of these areas performs its allotted roles and outline the manner in which they interact (both with each other and with other units of the radio) to provide the required level of control. Unless otherwise stated, it is assumed that normal working is selected and that the secure speech option is not fitted.

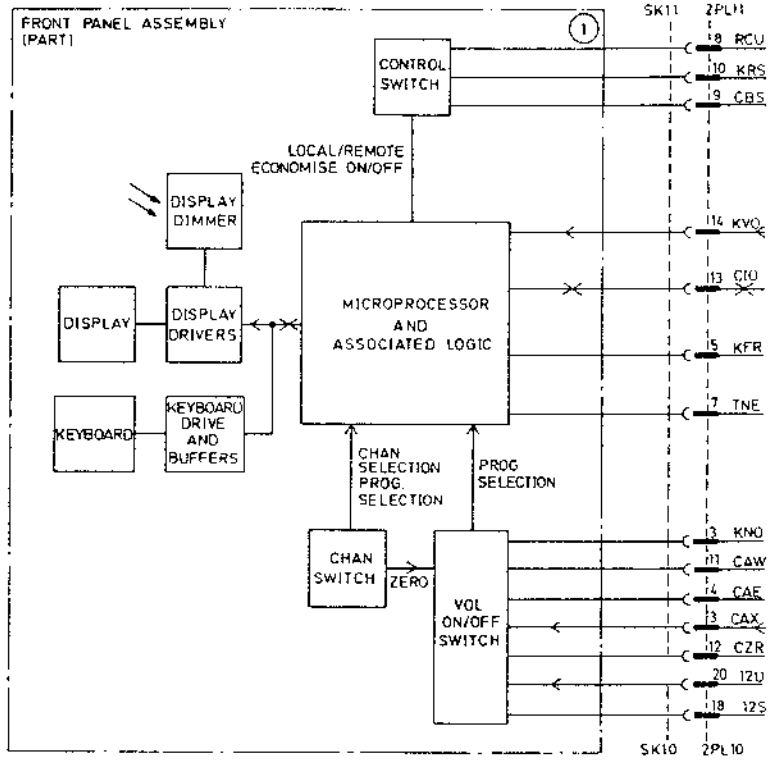
## SERIAL WORDS

3. The principal medium for the exchange of information between the Keyboard/Display and the Central Control is a 4 kbit/sec, pulse-width-modulated, serial word (Figure 6.1) transmitted over a common, bidirectional input/output line (CIO).




Pulse Width Modulation Fig. 6-1

4. Words exchanged in this manner can be formed of two parts. The first of these is a header word which contains synchronising information, the identity of the unit for which the word is intended, the control action required, and an indication of whether or not data is to follow. The second is a data word containing the information associated with the requested control action. Each transaction commences with the appropriate header word being sent twice, i.e. a double header; any data involved is then sent once.




Keyboard/Display – Functional Block Diagram Fig. 6·2

## OUTLINE OF OPERATION

5. In the Keyboard/Display circuits (Figure 6.2), a microprocessor continually scans the rotary control switches, the keyboard switches and the display drivers. When the microprocessor detects that a function requiring a serial word transfer has been selected, it sends to the Central Control:

(1) a double header containing a request for information already stored in the Central Control to be issued within the radio and to the Display, or

(2) a double header containing a request for new information from the keyboard to be stored, issued to the radio and echoed to the display, followed by a data word containing the new information, or

(3) a double header containing a request for a specific control action.

as appropriate to the selection.

6. The Central Control (Figure 6.3) only reacts to valid double headers (i.e. those headers specifically identified as being for use by the Central Control). On receipt of such a header, the microprocessor contained in the unit initiates the sequence of actions appropriate to the request conveyed by the header. Included in this sequence is the transmission of a reply to the Keyboard/Display, as an acknowledgement of the request and to provide a confirmation check of the operating data. If the reply is not received within 100 ms of the request being sent, Error Tone is initiated (TNE) to signal 'lost word'. Where more than one reply is expected (para. 27) these should follow within 100 ms of one another; if this period is exceeded, 'lost word' is signalled as previously described.

7. The display shows details of the radio's operation as supplied by the Central Control, except during information entry, when it temporarily shows the new information as it is entered. Unsolicited data words received from the Central Control are displayed, unless this would cause confusion, as (for example):

(1) When information is being entered, or

(2) when the echoed information is incompatible with the keyboard operation.

SERIAL WORD HANDLING AND CONTROL STORAGE

Request for Entry of a Fixed Frequency Setting, Hop Code, Barred Frequency or Common Code

8. If entry of a fixed frequency setting, hop code, barred frequency or common code is requested, the Keyboard/Display issues a double header followed by a data word. The header contains the number of the channel in which the frequency or code information is to be entered, while the data word contains the information itself.

9. When the Central Control has correctly identified the header, it checks the incoming data word for correct parity and, in the case of frequency information, out-of-range frequency (out-of-range frequencies are those not within the band 30 000 kHz to 87 975 kHz). Assuming successful completion of these tests, the information is then extracted from the data word and stored against the location indexed by the channel number in the header.

10. When the radio is in a programming mode, i.e. the Keyboard/Display has previously transmitted the request 'Set Fill TX-Inhibit' (para. 34), the Central Control takes no further action. This will be the case when programming Channels 1 to 7 from the keyboard, having selected PROG F, H, B or C at the VOL-ON/OFF switch. When the radio is on the Manual channel (M), there is no necessity to select PROG F in order to programme a fixed frequency setting to the channel; thus no 'Set Fill TX-Inhibit' is sent and so the Central Control performs an information re-issue sequence. However, to enable a hop code, barred frequency or common code to be programmed to Channel M, PROG H, B or C must be selected; this causes the 'Set Fill TX-Inhibit' request to be sent, with the result already described.

11. For the re-issue, the information is transferred to the Synthesiser as a serial data stream (SYD), accompanied by a clock signal (SYC) and a framing pulse (SYF).

12. After a delay determined by the current microprocessor activity, the Central Control sends a reply consisting of a double header and a data word which, apart from the 'destination' indicator being changed to show 'Keyboard/Display', echo those received.

13. On detecting the reply header, the microprocessor at the Keyboard/Display extracts the echoed information from the following data word and passes it to the display. It also performs a parity check on the data word to determine whether the data has been corrupted during transmission from the Central Control. If incorrect parity is found, the display is caused to flash.

14. If the Central Control detects incorrect parity in the incoming data word, it ignores the data word and sets TNE to initiate the Error Tone; also no reply is sent. If an out-of-range frequency is found, the unit completes the sequence described in the preceding paragraphs, including the re-issue of the out-of-range information to the Synthesiser. However, it also activates the Error Tone to advise the user that the condition exists.

15. Hop codes are entered in blocks of five digits within the range 0 to 7. Provision is made to enter up to four groups per channel and one further group common to all channels. When the CHAN switch is set to the required channel or C, the mode and frequency information is cleared from the display and the right-hand character position shows a 1, to indicate '1st block'.

16. The first code block can now be keyed in, commencing with the most significant digit. As the digits are keyed in, so they appear in the frequency field of the display. When the fifth digit is entered and the key released, the request for entry of the block is forwarded to the Central Control and all numerical keys are inhibited.

17. The operator now presses the Stepping key (↑). This increments the group indicator display and re-enables the numerical keys. This is purely a Keyboard/Display function and involves no communication with the Central Control.

18. If required, the next block or blocks may be omitted. Successive operations of the Stepping key change the block indicator but leave the existing code unchanged.

Request for a Fixed Frequency Setting

19. In this case, the double header is not followed by a data word, but does contain the channel number for information retrieval.

20. If Fill TX-Inhibit is clear, the channel memories are accessed at the location indexed by the stored header and the information thus obtained issued to the Synthesiser; also, there is an update of the mode control setting. Parity and out-of-range frequency checking of the readout data is performed. If Fill TX-Inhibit is set, the only action resulting from the request is to reply to the sender. The latter arrangement allows the user to 'scroll' through all stored frequency settings, for monitoring purposes, while maintaining the Synthesiser set to the frequency last selected.

21. If hopping operation is in demand at the time the request is received (or such a demand is made subsequent to the request) the hop code and barred frequency store locations for the selected channel are accessed; also, the information re-issue sequence is modified so that the Central Control updates the frequency information to the Synthesiser in accordance with the stored hop code and barred frequencies and at the required rate.

22. As before, a delay elapses before a reply is sent, this reply consisting of a double header (with a suitably-changed 'destination' and 'data following' indication) followed by a data word containing the requested information. The reaction of the Keyboard/Display to the reply is as described in para. 13.

Request for a Change of Mode Setting

23. When a change of the mode setting is requested, the double header is followed by a data word specifying the new setting.

24. Before a reply is sent, the stored information is issued to other units of the radio. These signals remain as set until changed by an update or power is removed from the unit. The reply is subjected to the delay as in previous cases, and consists of a double header and a data word which, apart from the changed 'destination', echo those received. Parity checking is performed on all data used from store.

25. If an unobtainable function is requested - e.g. high power when a high power VIU is not connected or hopping operation when the selected channel frequency is in the 'no go' band - the mode is updated to as near the requested mode it is possible to achieve (in the case of the examples given, this is medium power and fixed frequency respectively), TNE is set to activate the Error Tone, the data word for the reply is changed to show the achieved mode, and incorrect parity is set in the word. To the Keyboard/Display Assembly, it now appears that the reply data word has been corrupted during transmission and thus it causes the mode characters of the display to flash.

26. If hopping operation is requested when no hop code is stored against the selected channel number, the radio is allowed to adopt the hop condition, but TNE and incorrect parity in the reply word are set. Thus Error Tone is generated and the mode characters of the display flash.

Request for a Data Re-Issue

27. For this request, there is no data word following the double header. After the delay, three consecutive replies are sent to the Keyboard/ Display:

(1) An echo of the received double header, with the 'destination' indicator suitably changed.

(2) The double header for the channel change last executed, again with the destination changed to 'Keyboard/Display', followed by a data word containing the frequency information recalled from the store location indexed by the header.

(3) The double header for the mode control change last executed, addressed to the Keyboard/Display Assembly, followed by a data word containing the mode control data recalled by the store location indexed by the header.

28. The execution of the request also causes the release of Fill TX-Inhibit and the resetting of CNO (para. 32), to permit normal operation of the radio.

Request to Erase Stored Data (Software Zeroise)

29. This request is sent as a double header only. After the delay, a reply is transmitted consisting of an echo of the received header addressed to the Keyboard/Display.

30. The request is initiated in two ways. The first of these is by setting the CHAN switch to Z while the VOL-ON/OFF switch is at any position other than OFF, H, B or S. The Central Control reacts to the header by writing zeroes into all store locations used for fixed frequency settings, hop codes and barred frequencies. The zeroed condition of the locations is maintained until the information is re-entered. The mode control data reverts to the default condition (fixed frequency, normal working, medium power).

31. The second way of initiating the request enables selective zeroising to be carried out. This is achieved by setting the CHAN switch to Z while the VOL-ON/OFF switch is at S, H or B. In this case, the Central Control reacts to the header by writing zeroes into all store locations used by the function selected at the VOL-ON/OFF switch. The condition of the zeroed locations is maintained until the information is re-entered, as before, but the mode control data is retained intact.

Request for Monitor Information

32. For this request, there is no data word following the double header. The Central Control reacts to the request by setting the 'test output' (CNO) for a Noise-On test and a check of Synthesiser lock, but there is no further data update.

33. After a delay, the reply header is sent with 'destination' changed and 'data following' indicated. Parity checking is performed, in order to generate the correct parity for the transmitted word. If there is a BITE failure, a BITE Error Message is also sent.

Request to Set Fill TX-Inhibit

34. As for other requests involving control actions only, there is no data word following the double header containing this request. Following the delay, the received header (with 'destination' changed) is echoed to the Keyboard/Display.

35. The Central Control's reaction to the request is to set Fill TX-Inhibit. This prevents the radio being switched to Transmit, usually as a preliminary step to programming. The condition is maintained until a release command is received (para. 28).

Data Retention

36. The random access memory (RAM) used in the Central Control to store the frequency, code and mode data is provided with a standby battery, enabling data to be retained when the radio is switched 'off' or in the event of a prolonged interruption of the radio supplies (the change over to the standby supply is performed automatically). Thus at start-up, the 'last entered' frequency, code and mode control data can be re-issued to set the radio in a defined state.

BITE

37. BITE (Built-In Test Equipment) is a software routine which is performed automatically. It contains two main subroutines, one dedicated to checking for correct functioning of the Central Control during fixed frequency operation and one dedicated to checking for correct functioning of the Central Control during frequency hopping operation. The first of the subroutines is always executed immediately following switch on. If the remembered type of operation is 'hopping', the second subroutine is also executed at that time. If the remembered type is 'fixed', execution of the second subroutine is delayed until the hopping key (hH) is next operated.

38. The routine detects any one of a range of faults and indicates the presence of the fault by initiating Error Tone. If the Test key is then pressed, the Central Control responds to the request for monitor information it thus receives by addressing a BITE Error Message to the Keyboard/Display.

39. The BITE Error Message consists of a double header and a data word. The data word contains a 4-digit number which uniquely identifies the fault, and this number now appears in the frequency field of the display. As the Keyboard/Display is expecting the normal monitor information, it regards the incoming data word as corrupt and so causes the display to flash.

SIGNAL PATH ROUTING AND CONTROL (Figure 6.3)

Fixed Frequency Reception

40. With the radio in Receive, the input signal to the Central Control from the IF Unit (CIF) is returned directly to the IF Unit as signal CAR, and also connected to a linear inverting wideband amplifier in the signal routing/level shift/slicer circuit. The inversion provides the correct polarity for digital (secure speech) signals by compensating for the inversion which occurs in the IF and discriminator stages; in addition to ac amplification, the amplifier performs a dc level translation. The wideband amplifier output is used as the 'wideband received signal' (CWR) to the Interface Unit, and is also fed to the clock recovery circuit.

41. Should the clock recovery circuit find that the incoming signal contains 16 kbit/sec data (secure speech), it causes the microprocessor to generate control signals CSB/CFB. This signal is used by the microprocessor to augment the radio squelch CSS in the production of the 'any squelch open or 16 kbit/sec detected' flag CSQ (removing the receiver muting) and for the control of the 150 kHz tone (para. 76). Externally, CSB and CFB are connected to the Interface Unit for use in steering the CWR signal to the remote lines.

Fixed Frequency Transmission

42. Control over the transmit status of the Power Amplifier is exercised by the 'controlled pressel' output CPS. This signal is inhibited if:

(1) a Set Fill TX-Inhibit request has been received,

(2) the Intercom mode has been selected or Call Tone is active, or

(3) the Remote Control Unit mode has been selected.

If no such inhibition is present, CPS follows the 'input pressel' CPI to switch to 'transmit' supply to the Power Amplifier, although transmission is allowed only if both the Synthesiser and the Modulator loops are locked. CPI active also makes TNI active; hence the Unready Tone is generated, to warn the user that the transmit path is not yet 'clear to send'.

43. When signal CPS is active and the 'transmit power level' inputs MPL and MPM from the Power Amplifier indicate that transmitter output has been detected, the microprocessor returns TNI to the inactive state and activates the CTX ('clear to send') output to the Interface Unit. This terminates the Unready Tone and enables the user to receive sidetone. It should be noted that, during fixed frequency operation, the delay between operation of the pressel and the onset of the 'clear to send' condition is normally so short that the user is unlikely to hear the Unready Tone.

44. All message signals for transmission enter the Central Control as signal CWT from the Interface Unit, and are directed to the TMD output - for processing by the Modulator Unit - and also routed to the clock recovery circuit. If the 'input pressel' CPI and the recovery circuit squelch CSB are both active, the microprocessor produces control signal CAD, which prevents the generation by the Synthesiser of the 150 Hz modulation tone (used for receiver squelch purposes).

45. The 'clear to send' is also required in Intercom and Auto-Rebroadcast modes, and when the radio is used as a Remote Control Unit. Provision is made to enable the signal to be generated under these conditions. During reception, CTX follows the squelch control CSQ to enable the audio/digital (clear/secure speech) signal to pass to the user.

Monitoring During Fixed Frequency Operation

46. For the monitor facility (para. 32), the two inputs indicating 'received signal strength' (MRL and MRM) are input to the microprocessor during Receive. In Transmit, the microprocessor receives the 'transmitter power level' inputs MPL and MPM. The 'battery measure' inputs MBL and MBM are passed to the microprocessor all the time the radio is 'on', regardless of the mode of working.

Frequency Hopping Reception

47. With the radio in Receive, signal CIF takes the form of bursts of 19.2 kbit/sec message data interspersed with bursts of synchronising data at the same rate.

48. Included in the synchronising data is information indicating the source type (analogue or digital) of the associated message data. This source type, together with whichever of normal and Auto-Rebroadcast working is selected, determines the processing the Central Control performs on the message data, as follows:

(1) Analogue/Normal. The message data is delta-demodulated and output to the IF Unit as signal CAR and to the Interface Unit as CWR.

(2) Digital/Normal. The message data is (a) delta-demodulated and output to the IF Unit as CAR, and (b) squared, retimed to 16 kbit/sec and output to the Interface Unit as CWR. Both of control outputs CSB and CFB are generated.

(3) Analogue/Auto-Rebro. As in (2) except that of CSB and CFB, only the former is produced.

(4) Digital/Auto-Rebro. As in (2).

All this processing is performed by the signal routing/level shift/slicer and associated circuits, in conjunction with the microprocessor.

49. In each case, the synchronising data is extracted by the correlator and passed to the timebase and the microprocessor in the form of timing information. The receiving circuits respond to the information by adjusting the timing within the Central Control, and the frequency data output to the Synthesiser, as required to bring the radio into synchronisation with the transmitting station. When synchronisation is achieved, the microprocessor activates the CSQ and CHS control outputs.

Frequency Hopping Transmission

50. Control of the transmit status of the Power Amplifier and enabling of the 'clear to send' output CTX are performed in a similar manner to that described in paras. 42, 43 and 45, except that:

(1) During the change from one channel frequency to the next, transmission is inhibited by the 'hop mute' output CHM from the phase-locked clock generator, under the control of the 16 kHz system clock CCK and the microprocessor.

(2) When the pressel is released, CPS remains active for the time required to transmit 'end of message'.

(3) The microprocessor subjects CTX to a set-up delay, which allows the receiving station to synchronise before a valid message is sent. During this delay, TNI is active, causing Unready Tone to be passed to the operator. When transmitting for the first time in a net which has not previously been synchronised to a control station, the delay is of some 5 seconds duration.

51. The processing carried out on the message signal which is to be transmitted depends upon the message source type, as follows:

(1) Analogue. The message is input from the Interface Unit as signal CAT. This is first delta-modulated and the resultant digital data retimed to 19.2 kbit/sec. Synchronising data with the source flag set to 'analogue' is then inserted into the message and the whole level-shifted before being output to the Modulator Unit as signal TMD.

(2) Digital. The message is input from the Interface Unit as signal CWT. As it is already in the form of digital data (at 16 kbit/sec), delta-modulation of the incoming signal is not necessary. In all other respects, the processing is as described in (1), except that the synchronising data source flag is set to 'digital'.

Monitoring During Frequency Hopping Operation

52. During frequency hopping operation, the monitoring arrangements of para. 46 are expanded to include an indication of the synchronisation status, as determined by the microprocessor.

Hopping Authority Clash

53. The synchronising data includes the hopping authority of the transmitting station. On reception, this is compared with the hopping authority of the receiving station (held in the microprocessor as part of the mode information). If both authorities are found to be 'control', Error Tone is initiated at the receiving station. If the Test key (T) at the latter is then operated, the synchronisation status indication is replaced by the character H.

54. The error is cleared by either station going to 'outstation' status.

Hailing

55. If a fixed frequency, clear speech, transmission at the displayed channel frequency is received by a hopping radio during normal working, ISQ is activated. The microprocessor reacts to this by initiating Hailing Tone (TNH) to advise the operator of the fact. Further hailing is then ineffective for a period of 45 seconds.

SUPPLY DIP DETECTOR AND REGULATOR (Figure 6.3)

56. The purpose of the supply dip detector is to cause data to be re-issued at switch on and in the event of a supply voltage interruption which is sufficient to cause data corruption within the Central Control. The circuit incorporates a voltage regulator which derives +5 V and +6 V supplies from the incoming 9.5 V line, to power internal circuits of the Central Control.

ECONOMISE CONTROL (Figure 6.3)

57. Economise (Battery Saving) is a mode of operating the radio in which certain internally-derived power supplies are made available on a 10 per cent (approx.) duty cycle (i.e. the supplies are only applied for approximately 10 per cent of the total time) under the control of the microprocessor. While not all supplies can be 'economised', the mode does significantly reduce the current drain on the battery.

58. The mode is selected by setting the CONTROL switch to any one of the ECON positions, this action applying signal CBS to the Central Control. Then providing that:

(1) The states of the squelch signals indicate that there is no 'active receiving',

(2) CPS indicates that transmission is not demanded,

and

(3) a hold time of 15 seconds has elapsed.

the 'battery saving control' waveform CSC appears at the output of the Central Control. The waveform is passed to the power supply regulators contained on the Rear Panel Assembly, where it causes the 'economised' supplies to be switched 'on' for 70 ms and 'off' for 570 ms.

59. It should be noted that when frequency hopping operation is selected, battery saving can only take place between 15 seconds and 4 hours from last receiving or transmitting control synchronisation.

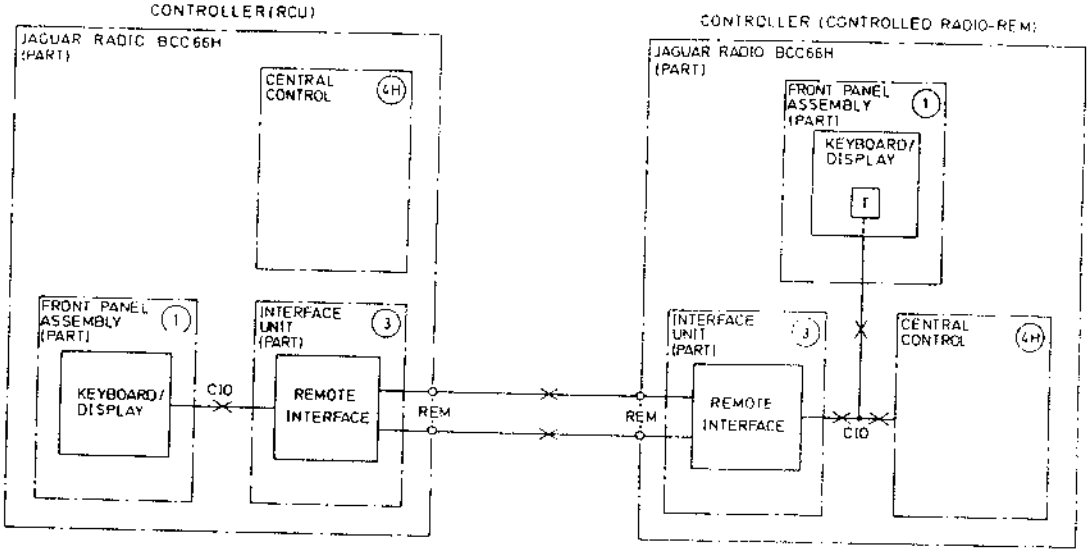
LOW BATTERY WARNING

60. The microprocessor constantly monitors the 'battery measure' inputs MBL and MBM. When the inputs indicate that the voltage at the battery terminals has fallen to approximately 10 V, the microprocessor generates the flag output CSQ as a 70 ms 'on', 570 ms 'off' waveform. Thus the receiver muting is switched 'off' for 70 ms and 'on' for 570 ms, and hence the operator hears short bursts of receiver noise at regular intervals to warn him of the 'low battery' condition.

## REMOTE WORKING

### Remote Control

61. When remote control operation is selected, the control system configuration is modified according to whether the radio under consideration is the 'controlled' or the 'controller' (i.e. whether the CONTROL switch on the radio is set to REM or to RCU), as indicated in Figure 6.4.




Remote Control – Simplified Block Diagram Fig. 6-4

62. The vocabulary of serial words remains as used in normal working, and the two main functional areas are still a Keyboard/Display combination and a Central Control unit. Now, however, the Central Control at the 'controller' is prevented from responding to serial word inputs and these pass to the Central Control in the 'controlled' radio, via the Interface Units and the remote lines. At the 'controlled' radio, the Keyboard/Display is prevented from acting upon any operator input other than a request for update information and from displaying anything other than recalled information, and all replies generated by the Central Control are routed to the Keyboard/Display at the 'controller'.

63. For a more detailed description of remote control operation, refer to Chapter 7.

### Intercom and Auto-Rebroadcast

64. If Intercom or Auto-Rebroadcast is selected (except when in remote), the linked radios each remain under control of the local operator, and hence the control system configuration remains as described for the normal mode. For a more detailed description of Intercom and Auto-Rebroadcast operation, refer to Chapter 7.

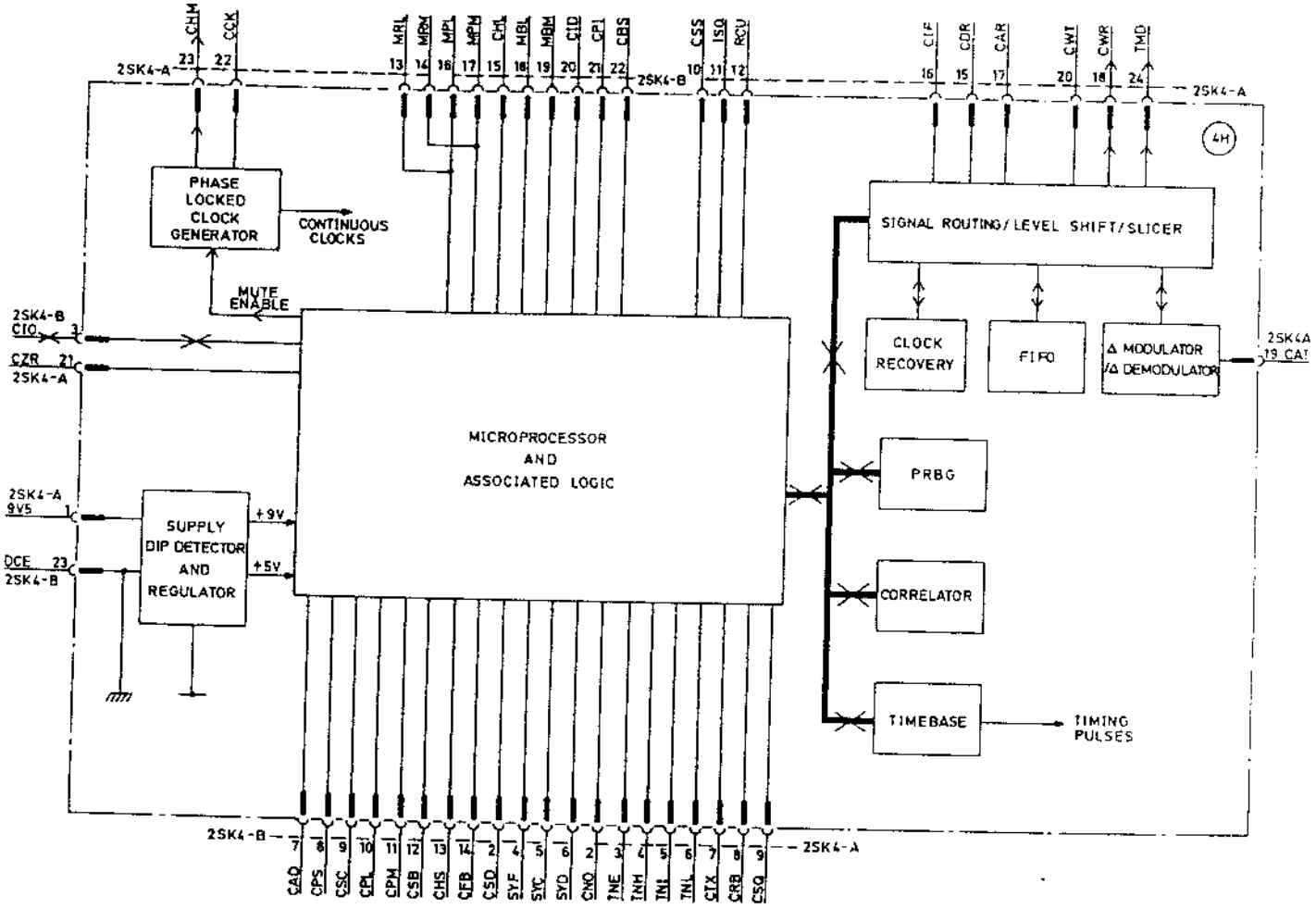
## PROGRAMMING FROM AN EXTERNAL DEVICE

65. When programming frequencies or codes using an external device, the device is normally connected to the AUDIO-VIU socket on the radio's front panel. The Interface Unit senses this termination and adjusts its circuits so as to provide a suitable interface between the programmer and the CIO line, thus enabling the exchange of information and replies between the Central Control and the device (see Chapter 7). All such communication is performed using the serial word arrangement described in earlier sections.

66. Alternatively, the AUDIO-COMSEC socket may be used if no COMSEC unit is fitted and programming via the remote lines is not required.

## OPERATION WITH COMSEC

67. With a COMSEC unit connected to the radio, the Interface Unit extends the CIO line to the COMSEC unit, via the AUDIO-COMSEC socket. This enables secure codes to be programmed from the radio, using either the keyboard or a programming device. It also enables such codes to be erased via the radio, either as part of a 'zeroise all' routine (VOL-ON/OFF switch to a position other than OFF, B, H or S; CHAN switch to Z) or as a 'zeroise secure codes' routine (VOL-ON/OFF switch to S; CHAN switch to Z). The Central Control unit plays no part in these operations.




Central Control, Hop – Functional Block Diagram

Fig. 6·3

# CHAPTER 7

# FUNCTIONAL DESCRIPTION

## CONTENTS

## ILLUSTRATIONS

Figure

# CHAPTER 7

# FUNCTIONAL DESCRIPTION

## INTRODUCTION

1. The sections which follow outline the various functions performed by the power supply, receiver, transmitter, and input and output interfacing circuits of the radio. An overall block diagram, illustrating how these functions interconnect and interact, is given in figure 7.1; functional block diagrams of individual areas of the circuits are given as indicated in the text.

## POWER SUPPLY GENERATION AND CONTROL (Figure 7.2)

2. When the VOL-ON/OFF switch is moved away from the OFF position, the fused +12 V input supply (12 U) is connected as 'switched' supply 12 S to the input of the power supply and logic circuit at the Rear Panel Assembly, and also distributed as required within the Front Panel Assembly. On receipt of the supply, the power supply and logic commences to generate the general DC supplies necessary for operation of the radio in accordance with the requirements specified by the control inputs from the Central Control, as follows:

   (1) 9V5C. The +9.5 V 'constant' supply, present all the time that the radio is 'on'.

   (2) 9V5BS. The +9.5 V 'battery saved' supply. Providing the radio is 'on' and the CONTROL switch is set to LOC or REM, this supply is constant. However, if the CONTROL switch is set to LOC ECON, DIS ECON, or REM ECON, the 'battery save control' signal CBS is activated. After 15 seconds hold time - and providing the radio is not actively receiving or transmitting - this causes 'battery save' waveform CSC to be generated, with the result that the supply is available for only 10 per cent (approx.) of the total 'on' time. Setting the CONTROL switch to RCU activates signal RCU; this in turn causes CSC to be held in the 'off' state, with the result that the supply is switched off.

   (3) 9V5BSRX. The +9.5 V 'battery saved, receive only' supply. As well as being controlled by waveform CSC in the manner described in (2), the availability of this supply is also dependent upon the state of control signal CPS. When Transmit is demanded, CPS becomes active and inhibits the generation of the supply.

   (4) 9V5TX. The +9.5 V 'transmit only' supply. This supply is present only while control signal CPS is active (i.e. while Transmit is demanded, provided that the CONTROL switch is not set to RCU).

3. These supplies are distributed to the main units of the radio as indicated in the figure. The application of the 9V5C supply to the Synthesizer energizes the 85 V inverter contained in that unit, which therefore commences to output the +85 V supply used by other circuits of the

Synthesizer and by circuits elsewhere in the radio. Any other supply rails required by a particular unit are derived from the incoming supplies by circuits within the unit.

TUNING AND FREQUENCY CONTROL (Figure 7.3)

4. Tuning of the receiver and transmitter circuits to the selected channel frequency, and the subsequent maintenance of the circuits on that frequency, is controlled by the Synthesizer. The unit also provides a 16 kHz 'system clock' (CCK), a 150 Hz modulation tone, and the +85 V supply described in the preceding section.

5. The majority of the unit's functions are performed by a large scale integrated (LSI) circuit, in response to three frequency information inputs:

(1) A BCD-encoded, serial data word (SYD) specifying the channel frequency. This information is issued by the Central Control each time a change of channel frequency is required and each time a data re-issue is requested (see Chapter 6). It is accompanied by a clock (SYC) and a framing pulse (SYF).

(2) A reference signal from either the local oscillator (SYR) or the master oscillator (SYT), depending upon whether the radio is in Receive or Transmit, which indicates the frequency at which the circuit concerned is currently operating.

(3) A stable, 6.4 MHz frequency reference from the temperature-controlled crystal oscillator contained in the unit. This signal is used in the development of the tuning and frequency control signals, and in the production of the CCK and 150 Hz outputs.

Receiver Tuning and Frequency Control

6. Assume that the radio is in Receive and that the Central Control has just issued a fresh SYD word to the Synthesizer. When SYF becomes active, indicating that the data on SYD is valid, the word is loaded into the LSI under the control of SYC. The immediate effect of this fresh data is to cause the LSI to update the 'band select' outputs BSA and BSB, so as to indicate to the receiver circuits which of the three discrete frequency bands listed below contains the new channel frequency.

| BAND | FREQUENCY (kHz) |
|---|---|
| 1 | 30 000 to 43 175 |
| 2 | 43 200 to 62 375 |
| 3 | 62 400 to 87 975 |

7. If it is further assumed that the new channel frequency is such as to require a change of band, then BSA and BSB cause the receiver circuits to be adjusted so as to enable operation within the appropriate band, as described later.

8. Receiver tuning within the frequency band is performed by voltage-controlled elements in the local oscillator circuit, under the control of the 'tuning voltage' (VT) output of the Synthesizer. The LSI uses the SYD information and the 6.4 MHz refrence frequency to process a sub-multiple of the SYR input from the local oscillator (obtained by dividing that input by a modulus determined by the LSI) so as to provide current drive to the non-linear amplifier which generates VT. The value of this drive is such as to set VT to a level which will cause the local oscillator frequency to move towards the required channel frequency +10.7 MHz.

9. The LSI also generates an 'out of lock' control output (SYL). While the state of this signal indicates an out of lock condition (i.e. that the local oscillator is off tune), the loop filter characteristics are modified to make more current available to the amplifier, thus enabling the tuning operation to be performed rapidly. Once lock is achieved, the filter is returned to the normal configuration, as the variations in VT then required are only the small adjustments needed to maintain the local oscillator frequency as set.

Transmitter Tuning and Frequency Control

10. Transmitter tuning and frequency control is performed in a similar fashion to that described above, with two important differences. The first of these is that the reference input to the Synthesizer is now provided by signal SYT. The second is that whereas the local oscillator is tuned to 10.7 MHz above the channel frequency, the master oscillator must be precisely tuned to half the actual channel frequency. The latter is enabled by means of control signal CPS; this signal is active throughout Transmit, causing the 10.7 MHz offset inserted into VT by the LSI during Receive to be removed.

150 Hz Tone Control

11. The 150 Hz modulation tone is used only when transmitting analogue modulating signals (e.g. clear speech) during fixed frequency operation. When sending digital messages (e.g. secure speech) at fixed frequency and during frequency hopping operation, the Central Control makes 'audio or digits' control signal CAD active, and hence the 150 Hz output from the Synthesizer is discontinued.

ANTENNA MATCHING UNIT (Figure 7.4)

12. The receiver input and transmitter output ports interface with the whip antenna and 50 ohm (RF) antenna sockets via the Antenna Matching Unit. This unit provides:

(1) Matching between the 50 ohm RF input and output impedances of the radio circuits and the impedance of the whip antenna.
(2) High-pass filtering of all RF input and output signals.
(3) Transmit-Receive (TR) switching.
(4) Protection of the receiver input against large RF signal inputs.

TR Switching

13. TR switching is performed by the PIN diodes referenced $D_R$ and $D_T$ in the diagram. These are forward-biased from the 9V5BSRX supply to the RF unit and the 9V5TX supply to the Power Amplifier respectively. Thus when in Receive, $D_R$ is enabled to conduct, while $D_T$ is held 'off' and so presents a high impedance to any signal appearing at the junction of the diodes; hence any received signals are steered to the input of the RF Unit. Similarly, when in Transmit, $D_T$ is enabled to conduct, while $D_R$ is held 'off', and thus the Power Amplifier output is routed to the antenna sockets (figure 7.7).

Receiver Protection

14. The Protection Circuit constantly monitors the RF power level applied to diode $D_R$. Should this level increase beyond 3 to 5 W, the Circuit causes the signal path between $D_R$ and the RF Head to be opened; hence if the radio is in Receive, the large signal is prevented from having any harmful effects on the receiver circuits. However, opening this signal path also breaks the DC path for the PIN diodes at the input of the RF Unit. As it is essential to maintain current to these diodes, the switching is arranged to provide an alternative path by connecting them to the 9V5BSRX supply rail.

RECEPTION

RF Amplification and Conversion (Figure 7.4)

15. At the RF Unit, the incoming signal from the Antenna Matching Unit (RRF) is first amplified and then converted to an equivalent signal at the required IF of 10.7 MHz.

16. The RF amplifier section of the unit contains three similar filter/amplifiers, one for each of the principal frequency bands listed in table 7.1 and each having an overall gain of some 7 dB. Conversion to IF is performed by a single, balanced mixer with a conversion gain of 3 dB, the required local oscillator signal being supplied by a local oscillator consisting of a single maintaining amplifier and three, switched tank circuits.

17. Bandswitching is carried out under the control of the 'band select' signals BSA and BSB from the Synthesizer (para. 6). On entering the Receive condition, the bandswitch reacts to BSA and BSB by:

(1) Causing the appropriate filter/amplifier to switch 'on'. This results in the PIN diodes at the input and output of that filter/amplifier becoming forward-biased; thus signal RRF is allowed to enter the selected circuit, and the resultant output is steered to the input of the mixer.

(2) Causing the appropriate tank circuit to be switched into the local oscillator circuit by the associated PIN diodes. →

If BSA and BSB subsequently indicate that a band change is required, the new filter/amplifier and tank circuit are selected as described, and simultaneously those formerly in use are deselected.

18. In both the filter/amplifier and the tank circuits, tuning within the band is performed by voltage-controlled elements, using the 'tuning voltage' input VT supplied by the Synthesizer. A sample of the LO frequency (SYR) provides the Synthesizer with a reference signal used in determining the value of VT required at any instant.

19. The 10.7 MHz derived by the mixer is transformer-coupled to the unit output, from where it is passed to the IF Unit as signal RIF.

IF Amplification and Demodulation (Figure 7.5)

20. The RIF input to the IF Unit is applied to a band-pass filter. This provides a balanced output to the 60 dB amplifier which follows, which in turn provides a balanced output to a further band-pass filter. A balanced IF amplifier configuraton is used because this produces more gain for less current and also provides immunity from common mode signals.

21. After limiting, the unbalanced output of the IF amplifier is applied to a quadrature discriminator, resulting in the production of AF output signal CIF, which contains the information conveyed by the modulation. The discriminator also provides a DC reference output (CDR) which is nominally at the centre of the discriminator output voltage range.

22. Both the discriminator output signals pass to the Central Control, resulting in the appearance at the output of that unit of the 'audio received' signal CAR (see chapter 6). This signal is returned to the IF Unit, where it is first subjected to filtering - to remove any signal components that are outside the desired audio band, and also the 150 Hz modulation tone used for receiver squelch purposes when passing analogue message signals - and then applied to the input of the muting switch circuit.

Receiver Muting (Figure 7.5)

Fixed Frequency Mode

23. With no incoming signal at the selected channel frequency, the noise squelch and 150 Hz squelch are both closed. Thus providing Noise-On Test is not requested (i.e. CNO is inactive), the 'radio squelch selected' (CSS) output from the IF Unit to the Central Control is inactive. At the latter unit, CSS is augmented by a '16 kbit/sec detected' function to produce signal CSQ ('any squelch'); as there is no digital signal present, CSQ is also inactive. Assuming that Noise On is not demanded from the VOL-ON/OFF switch (i.e. KNO is inactive), this means that no drive is applied to the muting switch. Hence the switch is open, preventing the receiver noise from passing to the audio interface circuits.

24. If the radio is operating in the normal mode (n has been selected at the keyboard), then when a frequency-modulated signal at the selected channel frequency and of sufficient amplitude to provide a preset degree of noise quieting is received, the noise squelch opens. Providing SYL ('synthesized locked') is active, indicating that the receiver is on tune, this causes CSS - and consequently CSQ - to become active. As RCU is inactive during local working, drive is therefore applied to the muting switch, enabling the receiver output to the summing amplifier which follows the switch.

25. If the radio is in the Auto-Rebroadcast mode (A-R has been selected at the keyboard), the CRB input to the squelch logic from the Central Control is active. This causes the noise squelch to be disabled after 0.25 seconds unless the 150 Hz tone squelch is opened, i.e. unless the incoming signal contains 150 Hz tone modulation of sufficient amplitude to open the tone squelch, preventing further receiver output reaching the summing amplifier.

26. At the summing amplifier, the receiver output is summed with any warning tone currently being generated (TNX) and the resultant passed to the audio interface circuits as the 'fixed level audio' signal CAF.

27. If the information conveyed by the incoming signal is in digital form and the information data rate is 16 kbit/sec (e.g. the signal is a secure speech transmission from another Jaguar V radio), then the Central Control acts to route the incoming message to the CWR ('wideband received signal') line as well as making CSQ active and thus enabling the information to pass to the Interface via the CAF line (see paras 55 to 58).

Frequency Hopping Mode

28. During frequency hopping operation, when all message signals are transmitted in a 19.2 kbit/sec form (see chapter 6), it is necessary to maintain the muting until the radio is accurately synchronised to the transmitting station. The Central Control therefore makes CSQ synchronisation-dependent, activating the signal only when the required degree of synchronisation has been achieved regardless of whether the original message source is in analogue or digital in nature. (It should be noted that although the noise squelch may react to the incoming signal, CSS plays no part in the signal routing control).

Noise-On Test

9. With Test key T operated, CNO is active. Via the squelch logic, this makes CSS active and so removes the receiver muting. Hence provided SYL is active, the operator hears the receiver noise.

0. Setting the VOL-ON/OFF switch to '*' makes KNO active. Thus irrespective of the state of CSQ and SYL, the muting switch closes to complete the path between the receiver output and the audio interface circuits.

TRANSMISSION

Generation and Modulation of Carrier (Figure 7.6)

. The basic operating frequency is generated by the Modulator Unit, under the control of the Synthesizer. This frequency is modulated by an AF input (speech or data), using a slave oscillator in a phase-locked loop (PLL) with the master oscillator output as the reference. These operations result in a frequency-modulated RF signal (RTD) at the selected channel frequency being fed from the modulator to the power amplifier circuit contained in the Rear Panel Assembly.

. The master oscillator section of the Modulator is a low-power, voltage-controlled oscillator with a frequency range of from 15 to 44 MHz. It is in a closed feedback loop with the Synthesizer, which applies frequency control (VT) via varactor diode and bandswitching (BSA, BSB) via PIN diodes.

33. All message signals for transmission enter the Modulator as signal TMD from the Central Control (chapter 6). Following low-pass filtering, the TMD input is integrated and the resultant applied to the reference path of the PLL. If the message is in analogue (clear speech) form, the 150 Hz tone from the Synthesizer is also present at the integrator input (para. 11), resulting in the required 150 Hz tone modulation component being included in the transmitted signal.

34. The ÷ 32 reference prescaler at the output of the master oscillator ensures sufficient phase excursions at the antenna frequency. A constant-amplitude sawtooth waveform is generated from the prescaler output. This is voltage-compared with the output of the integrator and the resultant pulse-width-modulated signal fed to the phase comparator in the PLL containing the slave oscillator.

35. The slave oscillator is a single push-pull oscillator, covering the range 30 to 88 MHz and operating at a high power level to obtain a low noise plateau. As in the master oscillator, frequency control is by means of varactor diodes and bandswitching is performed by PIN diodes. In this case, however, the tuning voltage for the varactor diodes is derived by the PLL and not supplied by the Synthesizer. Two outputs are provided: a 1 W output (RTD) which passes via the unit output to the Rear Panel Assembly, and a low-level output which is used to drive the ÷ 64 prescaler in the PLL.

36. The output of the ÷ 64 prescaler is applied to the phase comparator, which also receives the pulse-width-modulated signal from the voltage comparator in the reference path. The phase comparator generates differential pulses, the width of which is proportional to the phase difference between the two input signals. This pulse output is then passed through a current pump and a non-linear amplifier before being used to control the varactor diodes in the slave oscillator. The result of these operations is that the slave oscillator output has a mean frequency which is twice that at which the master oscillator is operating and tracks the modulation applied in the reference path.

37. Provision is made for signalling the 'out of lock' condition to the power amplifier circuits, to inhibit transmission while the modulator is 'off tune'.

Power Amplification and Output (Figure 7.7)

38. At the Rear Panel Assembly, the RTD input from the modulator is first applied to two stages of attenuation, the first of which is a constant-impedance PIN diode giving 20 dB of attenuation and the second a normal half-section PIN diode giving up to approximately 50 dB of attenuation. These are followed by a shunt-type AGC PIN diode, a Class AB RF power amplifier and a 3-band, low-pass filter.

39. The constant impedance and variable attenuators are controlled by DC ramping circuits (i.e. the clamps, Bessel filter, etc.), the purpose of which is to provide smoothly-controlled 'off-on' and 'on-off' transitions of the transmitter power during hopping frequency operation. These ramping circuits are, in turn, controlled by the CHM and SYL signal

inputs. In fixed frequency operation, the 'hop mute' signal CHM is held permanently active by the Central Control; thus 'off-on/on-off' control of the attenuators is exercised solely by the SYL signal from the Synthesizer and the Modulator, such that until both those units indicate that their circuits are in lock (i.e. that the frequency is accurate), the attenuators are held 'off' and hence transmission is inhibited. During frequency hopping operation, CHM is active only when the frequency is static (i.e. valid); only at such times is transmission enabled, subject to the SYL control. This effects the clamping 'off' of the transmitter power during frequency changeover periods.

10. The value of attenuation inserted into the signal path of the AGC attenuator, together with the DC operating bias applied to the Power Amplifier, is determined from two sources. The power selector sets the mean values of attenuation and bias as required to obtain the output power level indicated by the CPL, CPM code input from the Central Control. The current sensing AGC and bias control circuit then adjusts the two quantities about these mean values as required to maintain the output level constant.

11. Bandswitching of the low-pass filters is carried out by means of PIN diodes, under the control of BSA and BSB, as described earlier.

12. The output of the selected filter (RTO) is routed to the transmit element of the TR switching at the Antenna Matching Unit (para. 12), from whence it passes via the high-pass filter direct to the 50 ohm antenna socket (SK6) and via the high-pass filter and the matching transformer to the whip antenna socket (SK5).

AUDIO, REMOTE AND SERIAL CONTROL DATA INTERFACING

13. All inputs to, and outputs from, the radio connected via sockets SK1 (AUDIO-VIU) and SK2 (AUDIO-COMSEC), or the remote line terminals SK3 and SK4 (REM), are handled by the Interface Unit. The circuits of this unit divide into three main functional areas - the Audio Interface, the Remote Interface and the Fill Interface. The duties of each of these areas can be summarised as follows:

(1) The Audio Interface: To handle all speech signals (both clear and secure) to and from SK1 and SK2, and to generate warning tones as demanded by the Central Control and the Remote Interface.

(2) The Remote Interface: To handle all speech signals (both clear and secure) and serial control data transmitted or received over the remote lines, and to generate and detect the accompanying control tones.

(3) The Fill Interface: To handle the input and output of serial control (programming) data from and to SK1 and SK2, and to detect and debounce local pressel inputs.

. The versatility required of the Interfaces is achieved by the extensive use of multiplexing techniques. These are beyond the scope of the present chapter to illustrate or describe; thus the sections which follow - and the accompanying diagrams - only deal with the principal features of the circuits in each of their possible operating configurations.

## AUDIO INTERFACE

45. The configuraton adopted by the Audio Interface varies in accordance with whether clear or secure speech is being handled; the circuit behaviour is further modified according to whether the source and destination of the signals being handled is a handset/headset (clear speech only), a VIU (clear speech only), or a COMSEC unit (clear and secure speech).

### Local Working with Handset/Headset (Figure 7.8)

Fixed Frequency Mode

46. In Receive, the message signal output of the receiver circuits is summed in the IF Unit with any warning tone presently being generated (signal TNX), and the resultant input to the Interface as the 'fixed level audio' signal CAF. The Interface routes CAF directly to the volume control section of the VOL-ON/OFF switch at the Front Panel Assembly, to obtain the CAX audio signal at the level appropriate to the volume control setting. With a handset/headset connnected to the radio, FLA Select (VIU) and FLA Select (COMSEC) are inactive, and so CAX is applied to the VIU output amplifier and to the COMSEC output amplifier. Since CSQ is active (para. 24), CTS is also active; since RCU is inactive also, both output amplifiers are enabled and so the message signal is made available to the handset/headset at Pins D and G of both SK1 and SK2.

47. When the PTT switch on the handset/headset is operated to demand Transmit, the resultant pressel input from SK1 or SK2 is detected and debounced by the Fill Interface, which then activates local pressel. This latter signal effectively switches 'on' the microphone amplifier, which proceeds to operate at either 'normal' gain (volume settings 1-4) or increased gain (whisper volume setting W), as demanded by the 'audio whisper' signal CAW. Thus all message signals now applied to the amplifier via the microphone input line associated with the pressel input are processed accordingly.

48. Simultaneous with activating local pressel, the Fill Interface outputs the 'any pressel' signal CPI to the Central Control, causing the Power Amplifier to be powered up and CTS to be generated as described in chapter 6.

49. Irrespective of the microphone amplifier gain, all output signals from it are brought to a standard fixed level by the AGC circuit. The 'Tone A/B detected' signal from the Remote Interface is inactive at this time, also the CSB ('16 kbit/sec detected') input from the Central Control. Thus the fixed level message signals are passed via the bandpass filter (400 Hz to 3 kHz) to the CWT ('audio/digits transmit') signal output to the Central Control - where, as described in chapter 6, it results in the production of the 'transmitter modulation' signal TMD - and to the mixer stage. The buffered CAT output from the filter to the Central Control is not used in the present application.

50. In the mixer, CWT is mixed with any warning tone currently being generated, the resultant (TNX) passing to the IF Unit as in Receive. Now, however, the receiver output is muted (para. 23) and so the CAF signal returned to the Interface is identical with TNX. Thus as CTX is again active and the FLA Select signals still inactive, the phone outputs are again available, this time consisting of sidetone plus any warning tone currently in existence.

51. If the radio is not actively receiving or transmitting, CTX is inactive. Then providing Noise-On is not demanded from the VOL-ON/OFF switch and no warning tone is demanded, the VIU and COMSEC output amplifiers are disabled. When the VOL-ON/OFF switch is set to '*' (Noise-On), signal KNO becomes active, enabling the amplifiers. KNO also lifts the mute on the receiver output (para. 30), and so the receiver noise is allowed to pass to the phone outputs via CAF and CAX.

Frequency Hopping Mode

52. During frequency hopping operation, the action of the Audio Interface remains as described. However, the Central Control now processes the CAT ('audio to delta modulator') output from the Interface in order to obtain TMD, instead of the message signal on the CWT line.

Local Working with VIU (Figure 7.8)

53. With a VIU attached at SK1, a constant 1 mA (nominal) DC programming input is applied to the radio via the microphone input line (SK1/A) from the VIU. Detection of this current at the Interface activates FLA Select (VIU), with the following results:

(1) The input of the VIU output amplifier is switched from the volume-control-dependent CAX signal to the fixed-level CAF signal. Thus any audio output from the radio to the VIU is at a predetermined, fixed level.

(2) When the pressel input from the VIU becomes active to demand Transmit, local pressel switches 'on' the microphone amplifier, and the CPI output to the Central Control is generated, as when working with a handset/headset attached at SK1. Within the microphone amplifier, the pressel input from SK1 is gated with FLA select (VIU). When both these signals are active - as is now the case - the output of the gating is also active, causing the gain of the amplifier to be adjusted to the value required to handle the fixed level audio inputs received from the VIU, irrespective of the volume control setting.

In all other respects the Audio Interface's operation is as described in the preceding subsections (e.g. the phone outputs from the COMSEC output amplifier are still volume-control-dependent, the processing of the microphone amplifier outputs is unchanged, etc.).

Local Working with COMSEC - Clear Speech (Figure 7.8)

54. When a COMSEC unit set to 'clear speech' is attached at SK2, the Audio Interface operates in a similar manner to that described in para. 53. In this case, however:

(1) The programming current is applied to the radio via SK2/A. Thus FLA select (COMSEC) is active, switching the input of the COMSEC output amplifier to the fixed level CAF line and causing the microphone amplifier to be set to the fixed level condition on receipt of a pressel input via SK2/F.

(2) The VIU input and output circuits remain volume-control-dependent (in the absence of current programming via SK1/A).

Local Working with COMSEC - Secure Speech (Figure 7.9)

55. If the COMSEC unit at SK2 is switched to 'secure speech', a constant 1 mA (nominal) DC programming current is applied to the radio via the microphone earth line (SK2/B) from the unit. Detection of this current (in conjunction with pressel) at the Interface activates digital select, with the result that:

(1) The microphone amplifier is disabled.

(2) The circuits associated with the microphone amplifier and the COMSEC output amplifier are reconfigured as shown in the diagram.

(3) The 'narrowband/wideband detect' signal to the Central Control (CID) becomes active, causing the production of the 150 Hz tone modulation to be inhibited.

The VIU output amplifier is unaffected, and remains connected as shown in figure 7.8.

56. In Receive, the COMSEC output amplifier is now fed with 16 kbit/sec message signals via the CWR ('wideband received signal') track from the Central Control. Now, however, the message signal is output to the COMSEC via SK2/D only, while SK2/G carries the 16 kHz clock (CCK) required by the COMSEC for the decoding and encoding of messages.

57. When the pressel input from the COMSEC becomes active to demand Transmit, the 'any pressel' signal CPI is passed to the Central Control as in the other methods of local working, and local pressel causes the output amplifier input to be switched from the CWR line to the CWT line. Thus, the data stream received from the COMSEC is echoed back to that unit.

58. The clock output at SK2/G is augmented by the 'clear to send or any squelch' signal CTX. As this is only active while the radio is actively receiving or transmitting, it serves to indicate to the COMSEC the validity (or otherwise) of any data passed to it by the radio during Receive, and the 'readiness' of the radio to accept data from the COMSEC during Transmit.

59. No provision for the insertion of warning tones into the CWR signal path is made. As it is necessary for the operator to receive the tones, the warning tones generator output is now placed on the output signal path by the COMSEC output amplifier. Obviously, it is undesirable to output the analogue tone at the same time as a digital data signal. To prevent this, the connection between the generator and the output amplifier is made via gating which ensures that a tone can be transmitted to the COMSEC only if the radio is not actively receiving or transmitting, or Transmit is not demanded.

Warning Tones (Figure 7.8)

60. The warning tones are derived from the 16 kHz clock signal CCK. They are selected in an exclusive manner and in order of priority are as follows:

(1) Error Tone. Generated in response to an active TNE input from the Central Control or the Front Panel Assembly.

(2) Call Tone. Generated in response to an active TNL input from the Central Control, or an active 'line polarity incorrect' signal from the Remote Interface.

(3) Unready Tone. Generated in response to an active TNI input from the Central Control, or an active TNI (Remote) signal.

(4) Hailing Tone. Generated in response to an active TNH input from the Central Control.

The tones are described in chapter 1.

REMOTE INTERFACE

As with the Audio Interface, the configuration of the Remote Interface varies according to the operational conditions in being, i.e. whether a signal is being received from, or sent to, the remote lines and the type of signal being handled. At the same time, control signals generated at the Remote Interface and the Central Control modify the Audio Interface configuration as required to provide the necessary paths between the transmitter and receiver circuits, or the operator, and the remote lines.

Signal Format

The signal sent over the remote lines take the form of a message signal accompanied by an identifying control tone. In certain cases, the message signal is terminated by a second control tone.

The control tones are derived from the 16 kHz clock signal CCK and are as follows:

(1) Tone A - an intermittent 23.3 kHz tone (10 ms on, 500 ms off).

(2) Tone B - an intermittent 32 kHz tone (10 ms on, 500 ms off).

(3) Tone C - a continuous 18.3 kHz tone when used as an identifier, a 10 ms burst of 18.3 kHz when used as a terminator.

Four types of message signal may be sent over the remote lines joining a pair of BCC 66H radios:

(1) Serial control data - 4 kbit/sec, pulse-width-modulated data. It is identified by Tone C.

(2) Narrowband speech - narrowband analogue (clear speech) signals. These are identified by Tone A; during Auto-Rebroadcast only, they are terminated by Tone C.

(3) Wideband - 16 kbit/sec digital (secure speech) or wideband analogue signals. These are identified by Tone B; during Auto-Rebroadcast only, they are terminated by Tone C.

(4) Analogue warning tones - which of the warning tones of para. 60 may be placed on the lines, and the identifying control tones used, depends upon the precise remote working conditions selected (see para 107 and 114).

Enabling the Interface (Figure 7.10)

65. The Remote Interface is enabled by setting the CONTROL switch to RCU (RCU active) or REM (KRS active), or by operating the Ic or A-R key (CRB active). Subsequent operations within the Interface are governed by the states of the other control inputs to the selection logic (which, in turn, depend upon the particular method of remote working set in), and by the incoming control tones.

66. Selection of RCU also results in the 'battery save' power supply condition being deselected (para. 2) and power-up of the transmitter circuits being inhibited; furthermore, the receiver output is muted (para. 23), so that the CAF output from the IF Unit now carries sidetone and warning tones only. (Transmitter power-up is also inhibited when Ic is selected at the keyboard).

Remote Working as Remote Control Unit

67. To function as a Remote Control Unit (CONTROL switch set to RCU), the BCC 66H must be capable of:

(1) Sending to line -
   (a) Serial control data (e.g. a request for a change of channel frequency, a request for monitor information, etc.).
   (b) Clear speech.
   (c) Secure speech.

(2) Receiving from line -
   (a) Serial control data (e.g. the reply to a request for a change of channel frequency, monitor information etc.).
   (b) Clear speech.
   (c) Secure speech.
   (d) Warning tones.

Serial Control Data Handling - RCU (Figures 7.9, 7.10, 7.11)

Sending to Line

68. The serial control data from the Keyboard/Display Assembly (Chapter 6) enters the selection logic on the bidirectional, input/output highway CIO. The appearance of valid data on the highway is signalled by the 'keyboard framing pulse' KFR, and during that pulse:

(1) CIO is routed to the selected signal output of the selection logic.

(2) The 'send' output from the selection logic is activated. This switches 'on' the line driver, completes the path between the selected signal output and the line driver, and completes the circuit of transformer T1.

(3) The 'tone selection' output of the selection logic is such as to cause the tones generator to provide a continuous Tone C input to transformer T2.

Thus the data, together with required identifying tone, is applied to the remote lines via SK3 and SK4 (REM).

The facility to programme the channel frequencies of a remote radio using a Programmer or Fill Gun connected to the RCU set is also available. In this case, although the serial data issued by the external device is identical to that used when programming from the keyboard, and the data is again input to the Interface via CIO, signal KFR is no longer generated; thus some means of steering the data to the 'selected signal' line is required. This requirement is fulfilled by inputting a framing pulse in the form of a 1 mA (nominal) DC programming current from the external device via SK1/G. At the Interface, detection of this current causes 'fill remote select' to be made active and perform the desired routing function.

Receiving from Line

The signal developed across transformer T2 in response to an incoming signal on the remote lines is subjected to two stages of filtering and the resultant applied to the tones detector. Both filter stages have a high-pass characteristic with a cut-off frequency of 17 kHz; thus any 4 kbit/sec data is removed from the signal and just the Tone C component of it (see paras. 63, 64) is connected to the detector.

The detection of the Tone C causes the 'tone received' and the 'Tone C (data) detected' signals to be activated. 'Tone received' active results in the T1 circuit being completed, and so the incoming signal is applied to the receive termination. As 'send' and 'Tone A/B (signal) detected' are both inactive at this time, the signal developed across the receive termination passes via the low-pass filter (which removes the Tone C) and the slicer to the CIO highway, and hence to the Keyboard/Display. (A 'received digits' (remote) signal is also available, but this is not used during the reception of serial control data).

Clear Speech Handling - RCU (Figures 7.8, 7.10, 7.11)

Sending to Line

A demand to send clear speech to line for transmission by the remote radio is signalled by either local pressel input (SK1/F, SK2/F) becoming active. This causes the tones generator to send bursts of Tone A to line; also, the Fill Interface generates the 'pressel' signal (CPI) to the Central Control, which responds by activating CTX. The Remote Interface is now in the 'send' condition described in para. 68(2), with the CAF line routed to the 'selected signal' output of the selection logic and Tone A selected. However, because of the states of the RCU and 'Tone A/B (remote pressel) detected' signals, the TNI (remote) signal at the Audio Interface (figure 7.8) is presently active, and so the RCU set operator receives Unready Tone, advising him that transmission cannot proceed.

When the remote radio is 'clear to send', it replies to the RCU set with bursts of Tone A. This causes the tones detector to activate the 'Tone A/B (signal) detected' and 'Tone A/B (remote pressel) detected' signals. The effect of the former can be ignored in the present description. The latter terminates the Unready Tone while maintaining the VIU and COMSEC output amplifilers enabled, thus indicating to the operator that the sending of messages can commence.

Releasing the local pressel returns the Remote and Audio Interfaces to the quiescent condition.

Receiving from Line

75. The Tone A identifier accompanying clear speech signals placed on the remote lines by the remote radio is applied to the tones detector, as described in para. 70, resulting in the incoming signals being connected to the receive termination as before, and the 'Tone A/B (signal) detected', 'Tone A/B (remote pressel) detected' and 'Tone A/B/C detected' signals being activated. Thus:

(1) The received audio output of the low-pass filter contained in the receive path is switched through to the input of the AGC circuit in the Audio Interface as 'received narrow/wideband' signal (remote).

(2) The output of the AGC circuit is connected directly to CWT.

(3) The VIU and COMSEC output amplifiers are enabled.

76. Hence the audio signal now follows a similar path to audio inputs received from the microphone during normal working (except, of course, that no bandpass filtering is applied), and so re-enters the Audio Interface as signal CAF and is output to the local operator. (As the transmitter is not powered up, the signal on the CWT output from the Interface has no effect).

77. The Tone A and B 'detected' signals and the 'tone received' signals are subject to a time-out which is renewed by the successive bursts of received tone. The Tone C terminator sent by the remote radio at the end of the message overrides this timeout to cause the instant de-activation of the signals concerned. Thus on receipt of the terminator, the Remote and Audio Interfaces are returned to the quiescent condition.

Secure Speech Handling - RCU (Figures 7.8, 7.9, 7.10, 7.11)

Sending to Line

78. A demand to send secure speech to line for transmission by the remote radio is signalled by the local pressel input at SK2/F (with current programming) becoming active. This causes the tones generator to send bursts of Tone B to line; also, the Fill Interface generates the 'pressel' signal CPI, which causes the Central Control to activate CTX, and also results in the input of the COMSEC output amplifier - and hence the 'send digits (remote)' signal to the selection logic - being connected to the CWT line. The Remote Interface is now in the 'send' condition, described in para. 68(2), with the 'send digits (remote)' line routed to the 'selected signal' output of the selection logic and Tone B selected. However, because of the inactive state of Tone A/B (remote pressel) detected, TNI (remote) at the Audio Interface (figure 7.9) is active and so the RCU set operator receives Unready Tone, advising him that transmission cannot proceed.

79. When the remote radio is 'clear to send', it replies to the RCU set with bursts of Tone B. This causes the tones detector to activate the 'Tone A/B (signal) detected' and 'Tone A/B (remote pressel) detected' signals. The effect of the former can be ignored in the present description. The latter terminates the Unready Tone, thus indicating to the operator that the sending of messages can commence.

Releasing the local pressel returns the Remote and Audio Interfaces to the quiescent condition.

Receiving from Line

The reception of 16 kbit/sec data sent over the lines by the remote radio commences as described in paras 75 and 76. However, the presence of the 16 kbit/sec signal on the CWT line is detected in the Central Control, which then causes signal CSB ('16 kbit/sec detected') to become active. Thus the 'received narrow/wideband' signal (remote) input to the CWT line is replaced by the 'received digits' (remote) output of the Remote Interface. As the detection of the accompanying Tone B has made CTX (COMSEC) active, this means that the 16 kbit/sec secure speech now passes to the COMSEC output amplifier and is therefore output to the COMSEC, together with the necessary CTX and clock signals. As in clear speech handling, the Tone C terminator returns the Interfaces to the quiescent condition.

The received Tone B also causes the tone detector to generate 'Tone B (digital source) detected'. This is ineffective in the present application.

Remote Working as Remotely Controlled Radio

To function as a remotely controlled radio (CONTROL switch set to REM), the BCC 66H must be capable of:

(1) Sending to Line -
  (a) Serial control data (e.g. the reply to a request for a change of channel frequency, monitor information etc.).
  (b) Clear speech.
  (c) Secure speech.
  (d) Warning tones.

(2) Receiving from line -
  (a) Serial control data (e.g. a request for a change of channel frequency, a request for monitor information, etc.).
  (b) Clear speech.
  (c) Secure speech.

The circuits used to provide this capability are those which provide the facilities described in the preceding sub-sections. However, the changed operational circumstances mean that there are certain differences in the manner in which the circuits are controlled and in the source or destination of individual signals passed across the Interface. These differences are outlined below.

Serial Control Data Handling - REM

Sending to Line

While it is still conveyed to the Remote Interface by the CIO highway, the serial data which is to be sent to line now originates at the Central Control and is placed on the remote lines - together with the identifying Tone C - in response to the CSD ('reply enable') signal, also from the Central Control.

Receiving from Line

6. The manner in which the received serial data is steered to the CIO highway is identical to that used during RCU working. Now, however, all such data is addressed to the Central Control, and so is actioned by that unit.

Clear Speech Handling - REM

Sending to Line

7. The clear speech to be sent to line and applied to the selection logic as signal CAF is now the message signal received by the radio. As such, there is no accompanying pressel input, and thus some alternative means of indicating that the signal is to be placed on the remote lines must be provided. The manner in which this is accomplished depends upon whether the radio is operating in the fixed frequency mode or the frequency hopping mode.

8. Fixed frequency mode. If the message signal contains 150 Hz tone modulation, the ISQ ('tone squelch') output of the IF Unit is active and it is this signal - together with CTX - which is used to activate the 'send' output of the selection logic, route CAF to the 'selected signal' line and initiate the generation of Tone A. When ISQ and CTX return to the inactive state, a burst of Tone C is sent to line to indicate 'end of message' and the Remote Interface reverts to the quiescent condition.

9. If the message signal does not contain 150 Hz tone modulation, ISQ remains inactive and control of the Remote Interface is taken over by CTX; also, the signal sent to line is identified by Tone B instead of Tone A. When CTX returns to the inactive state, 'end of message' is indicated to the RCU set by a burst of Tone C and the Remote Interface reverts to the quiescent condition.

0. Frequency hopping mode. During the frequency hopping mode, all message signals are transmitted in digital form (see chapter 6) and hence those originating from an analogue source are never accompanied by the 150 Hz tone; thus ISQ remains inactive. However, when synchronisation is achieved, the Central Control makes CHS ('hop sync') active. As CFB ('flag B') from the Central Control is inactive - indicating that the received signal is from an analogue source - and CTX active, this causes the Interface to be set to 'send' and the signal on CWR and Tone A to be placed on the line. When CHS and CTX return to the inactive state, 'end of message' is indicated by a burst of Tone C as before.

Receiving from Line

1. On detecting the burst of Tone A which indicates that a pressel has been operated at the RCU set, the tones detector activates the 'tone received, Tone A/B (signal) detected' and 'Tone A/B (remote pressel) detected' signals. Thus the receive path is set up to route any incoming message signals to the Audio Interface as the 'received narrow/wideband' signal (remote), and the Fill Interface receives an indication that the remote pressel is operated.

The Fill Interface responds to the pressel indication by generating CPI to the Central Control. The Central Control therefore proceeds to activate CPS, initiating power up of the transmitter circuits to enable Transmit; thus after a short interval, CTX again becomes active. The combination of CPS and CTX both active causes the Remote Interface to send to line bursts of Tone A, indicating to the RCU set that sending of message signals can commence. Such signals subsequently entering the radio are routed to the CWT and CAT lines as in RCU operation; now, however, the signal on the CWT output (fixed frequency) or CAT output (frequency hopping) of the Audio Interface is transmitted as in local working.

The Tone A and B 'detected' signals and the 'tone received' signals are subject to a time-out which is renewed by the successive bursts of received tone. When time-out occurs (e.g. at the end of the message from the RCU set), the transmitter is switched off and the Remote and Audio Interfaces returned to the quiescent condition.

Secure Speech Handling - REM (Figures 7.8, 7.9, 7.10, 7.11)

Sending to Line

As in clear speech handling, the secure speech signal sent to line is the message signal received by the radio. Now, however, it originates from a digital source, and thus ISQ remains inactive irrespective of whether fixed frequency or frequency hopping operation is in use. In both instances, the Central Control detects the presence of the 16 kbit/sec data and activates CFB. During fixed frequency operation, CFB active with CTX active sets up the Remote Interface to route the contents of the CWR line to the remote lines and to cause Tone B to be selected as the message identifier. When in the frequency hopping mode, CHS active is also necessary to enable the required Interface action to take place, and as in clear speech handling, CTX is also subjected to the 'synchronising' delay.

Receiving from Line

On receipt of Tone B, the Remote and Audio Interface circuits are set up as in the equivalent case in RCU working. Now, however, two additional effects of the tone signal must be taken into account:

(1) 'Tone A/B (remote pressel) detected' causes the transmitter to be powered up and a 'clear to send' indication returned to the RCU set, as when handling clear speech.

(2) 'Tone B (digital source) detected' causes CID to be sent from the Audio Interface to the Central Control, resulting in the inhibition of the 150 Hz modulation.

As in RCU working, the Central Control detects the 16 kbit/sec data on CWT and generates CSB, so that the signal routed through the Interface to CWT - and hence transmitted by the radio - is taken from the 'received digits (remote)' output of the Remote Interface.

Once again, time-out in the tones detector results in the shutdown of the transmitter and the return of the Remote and Audio Interfaces to the quiescent condition.

Intercom (Figures 7.8, 7.10, 7.11)

Sending to Line

98. If the CONTROL switch is at LOC, then while the Ic key is operated, the Central Control outputs the TNL ('Call Tone control') signal to the warning tones generator in the Audio Interface and to the selection logic in the Remote Interface. At the Audio Interface, this causes Call Tone to appear on the TNX output to the IF Unit and hence on the CAF input from that unit. At the Remote Interface (enabled by CRB), it results in the Interface being set to 'send', the CAF line being routed to the selected signal output of the selection logic, and continuous Tone C being selected at the tones generator; thus the Call Tone and the required identifier appear on the remote lines.

99. On release of the key, Call Tone is terminated. The sending of further signals over the lines is then controlled by the local pressels and the radio squelch as described in paras 87 to 90 and 94.

Receiving from Line

100. Receipt of the Tone C identifying the Call Tone causes the Remote Interface to be set to 'receive', as in previous instances of Remote working, and the incoming warning tone to be routed to the Audio Interface as Call Tone (remote). At the Audio Interface, the warning tone is placed on the TNX input to the IF Unit. It is therefore returned to that Interface via signal CAF and so is output to the operator's earpiece.

101. Following the cessation of Call Tone, the reception of further message signals sent over the remote lines is controlled as described in paras. 91 to 93 and 95 to 97, except that the signals are not transmitted.

Auto-Rebroadcast

102. When the radios linked by the remote lines are both set to local Auto-Rebroadcast (CONTROL switch to LOC; A-R selected at the keyboard), each function is as described in the sub-sections dealing with remote working as a remotely controlled radio.

Warning Tones (Figures 7.8, 7.9, 7.11)

103. During remote working, warning tones are generated and processed in accordance with the precise method of working and mode of operation selected at the radio, as described below.

RCU

104. If the keyboard detects an error in the serial control data reply from the remote set, Error Tone is generated but not sent to line.

105. When sending speech (clear or secure) over the lines, Unready Tone is generated while awaiting the 'clear to send' indication from the remote set but is not sent to line.

106. When the Ic key is operated, a serial control word requesting Call Tone is sent to the remote set; Call Tone is not generated at the RCU set, but received from the remote set.

REM n

107. If the Central Control finds that an incoming serial data word contains a request for an erroneous condition, Error Tone is generated and thus appears on the CAF input to the Remote Interface. TNE active causes the Remote Interface to be set to 'send', the tones generator to commence to output bursts of Tone A, and CAF to be selected as the source of the signal placed on the remote lines. Hence the Error Tone is sent to the RCU set, where it is processed in the same way as a clear speech signal and is therefore heard by the RCU set operator, and is also heard by the REM set operator.

108. On receipt of a request for Call Tone from the RCU set, the Central Control activates TNL. This has a similar effect to TNE active, i.e. Call Tone is generated and sent to the RCU set (via CAF) accompanied by Tone A, and is also heard by the REM set operator. (It should be remembered that with the radio set to REM, only the Test (T) key at the keyboard is enabled; hence its operator cannot call the RCU set operator).

109. If the radio is operating in the frequency hopping mode and is hailed by a fixed frequency radio, the Central Control activates TNH. By a similar action to that described in para. 107, this causes Hailing Tone to be sent to the RCU set via the remote lines, and also to be heard by the REM set operator.

REM A-R

110. As in paras. 107 to 109.

REM Ic

11. As in paras. 107 to 109.

Local A-R

12. Error Tone, Unready Tone and Call Tone are generated as in local normal working. In each case, however, the tone control signal (e.g. TNI) also causes the warning tone to be sent to line. Call Tone is identified by Tone C; no identifying tone is issued with Error Tone, Unready Tone or Hailing Tone.

Local Ic

13. As in para. 112.

Remote Line Monitoring

14. Irrespective of the method of remote working in use, the polarity of the remote lines is constantly sampled during all times that the Remote Interface is not actively sending or receiving. Should it be found that the lines are reverse connected or are short circuit, the line polarity detector circuit at the Remote Interface outputs a 'line polarity incorrect' signal to the warning tones generator. The latter responds by generating Call Tone, thus warning the operator of the faulty condition.

FILL INTERFACE

115. In addition to the duties described in the preceding sections, the Fill Interface handles the input and output of data to SK1/F and SK2/F (e.g. during programming using an external device) in accordance with the following:

(1) Data input on SK1/F or SK2/F is routed to CIO.

(2) Data from CIO is routed to SK1/F by -
(a) CSD active, or
(b) KFR active, or
(c) 'Tone C (data) detected' active, or
(d) a data input on SK2/F.

(3) Data from CIO is routed to SK2/F by -
(a) CSD active, or
(b) KFR active, or
(c) 'Tone C (data) detected' active, or
(d) a data input on SK1/F.

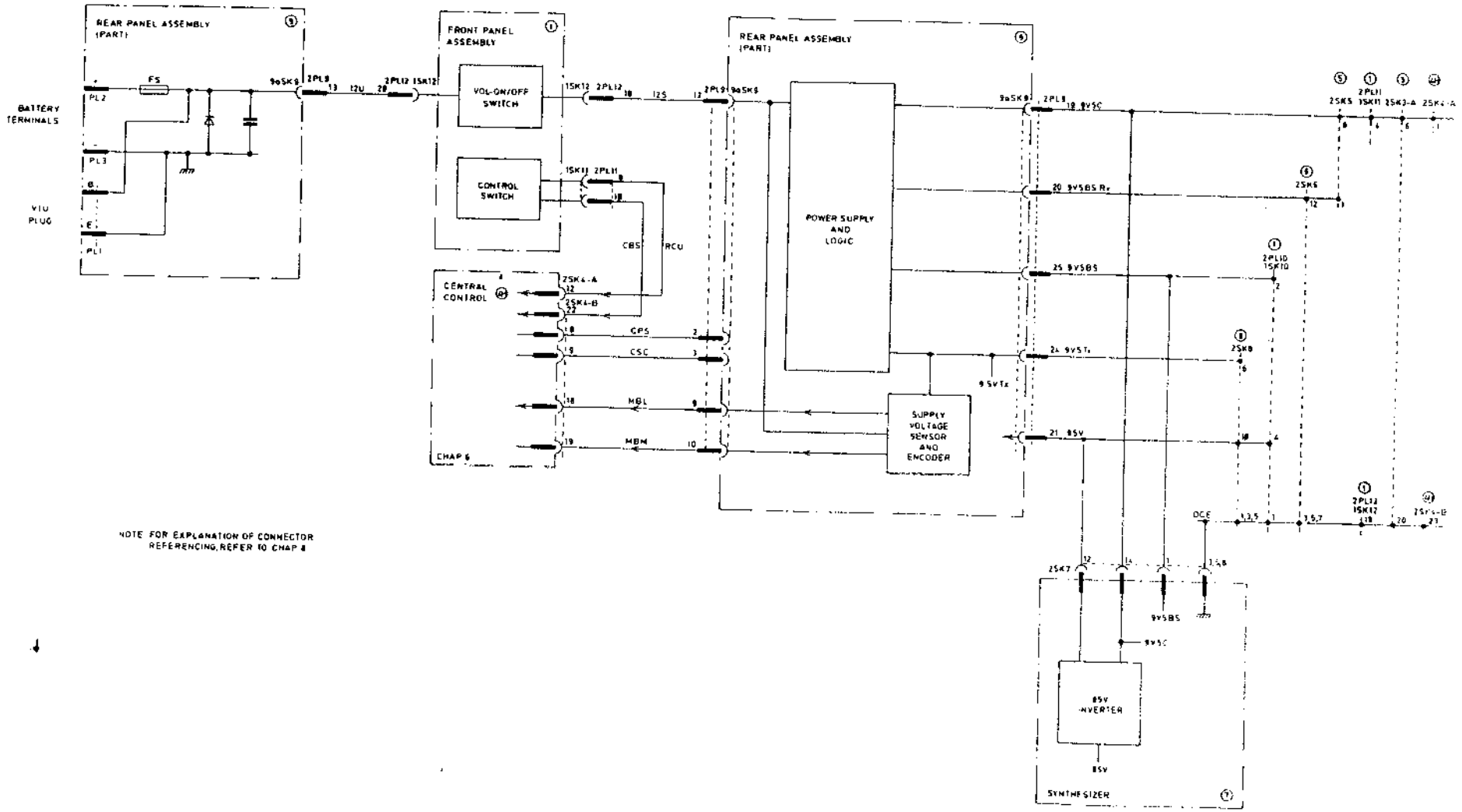
116. Data input on SK1/F is only routed to the remote lines when the radio is switched to RCU, and requires the simultaneous application of current programming to SK1/G to serve as a 'frame' for the data.

VIU CONTROL AND SUPPLY INTERFACING

117. A 10-pin plug (PL1) at the rear panel of the BCC 66H provides the connections for those control signals and power supplies which are necessary to enable the radio to interwork with a VIU but which are not directly associated with the audio output or input (see chapter 8).

EMP PROTECTION

118. Protection against the possibly harmful effects of electro-magnetic pulses (EMP) induced in the interconnecting cables by external agencies is provided at all audio, control and supply inputs and outputs of the radio.

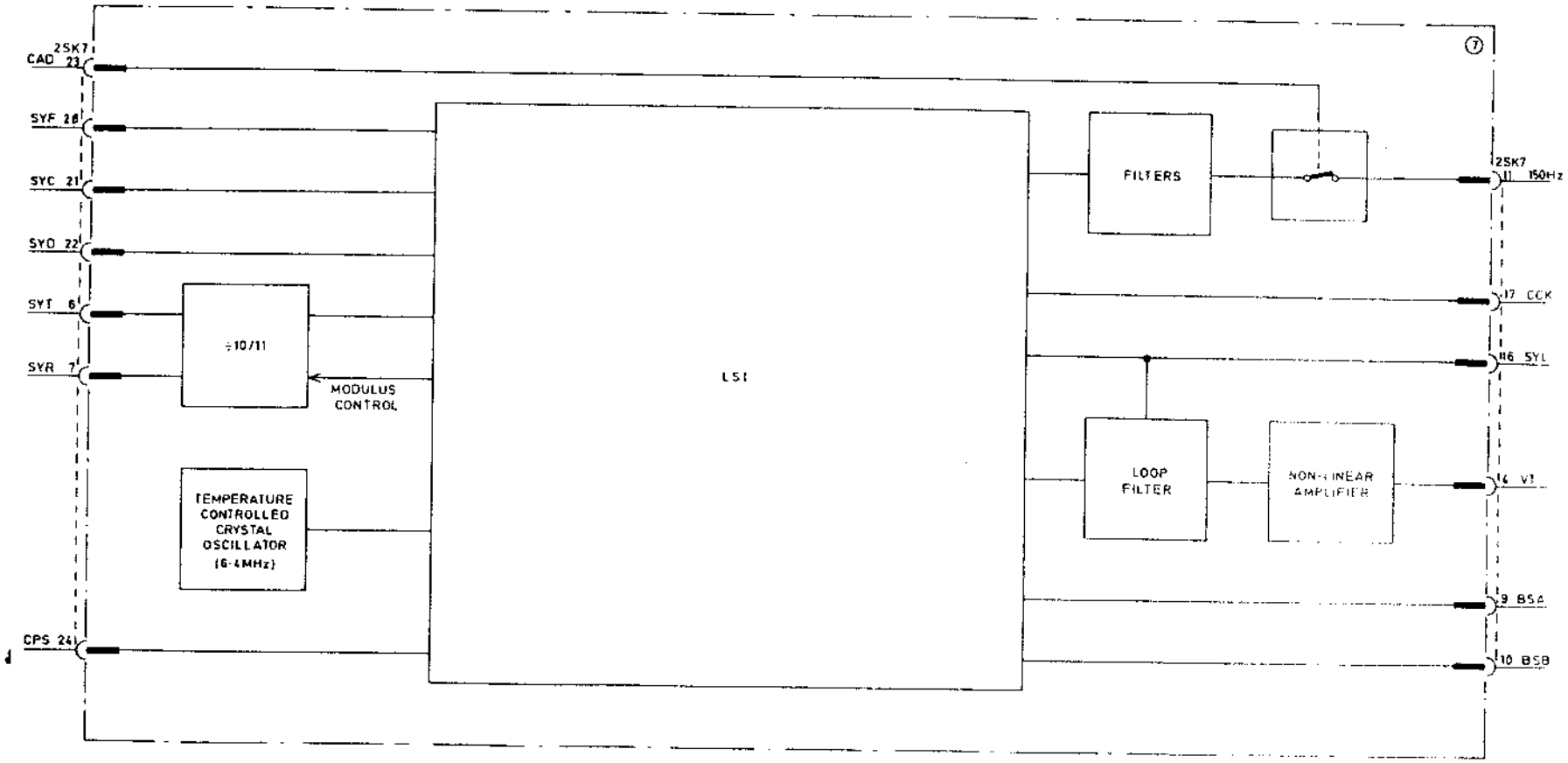



NOTE FOR EXPLANATION OF CONNECTOR REFERENCING, REFER TO CHAP 8

RACAL TH2250 RCC88 VOL IH

Power Supply Generation and Distribution: Functional Block Diagram

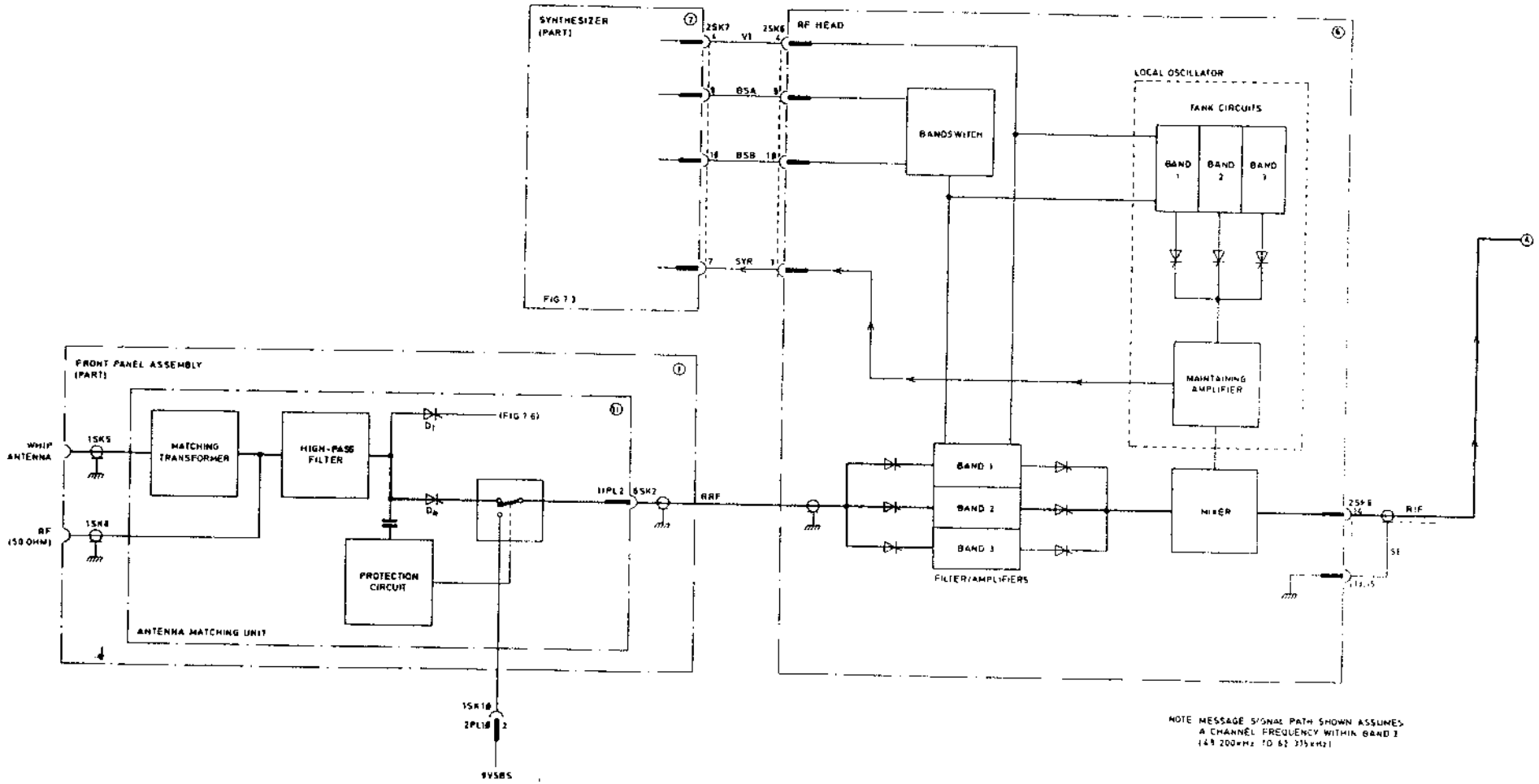
Fig.7.2




RACAL
TH 2250
BCC66 VOL 1H

Synthesizer - Functional Block Diagram

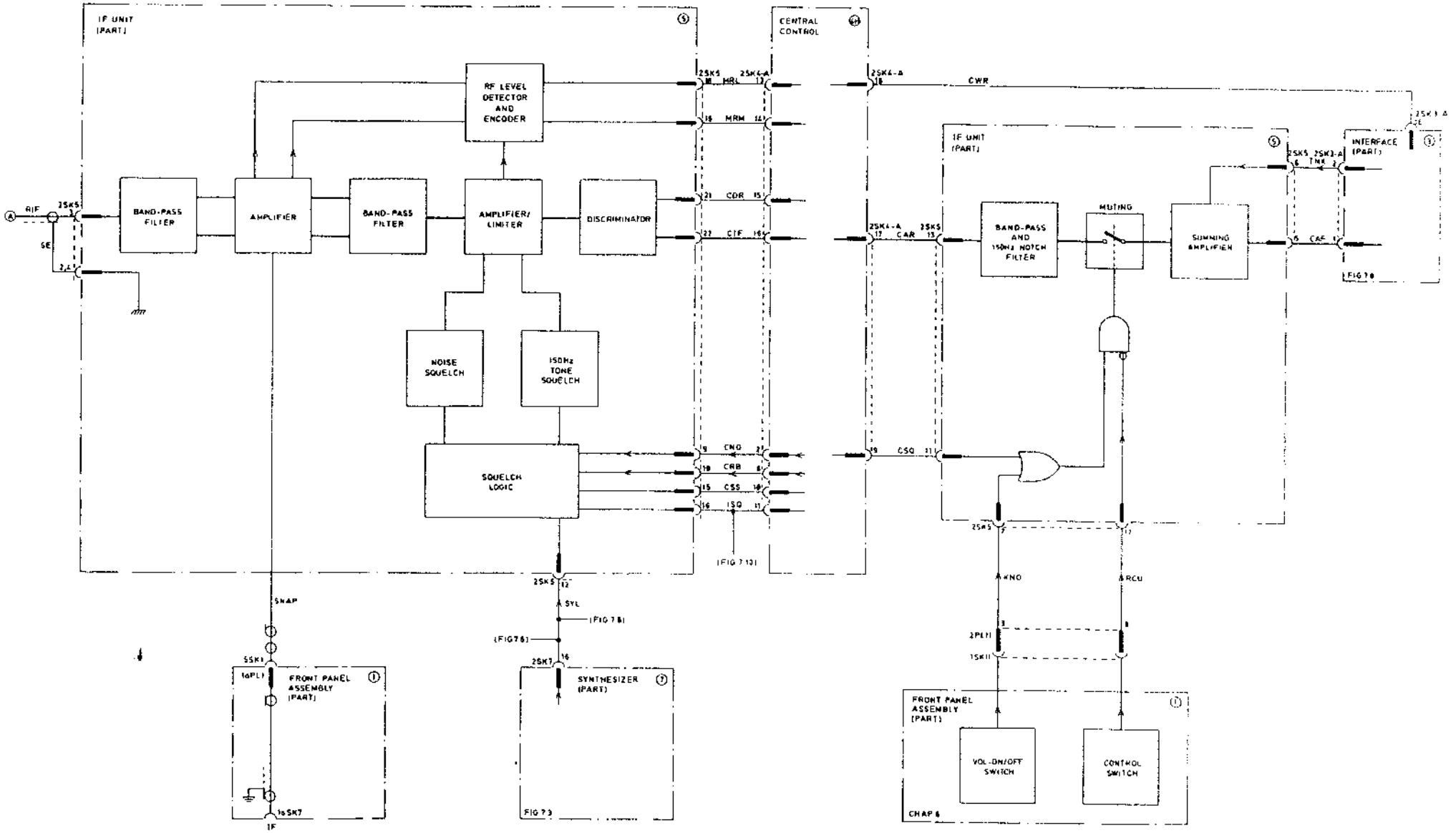
Fig.7.3




RACAL
TH 3250
BCC66 VOL VII

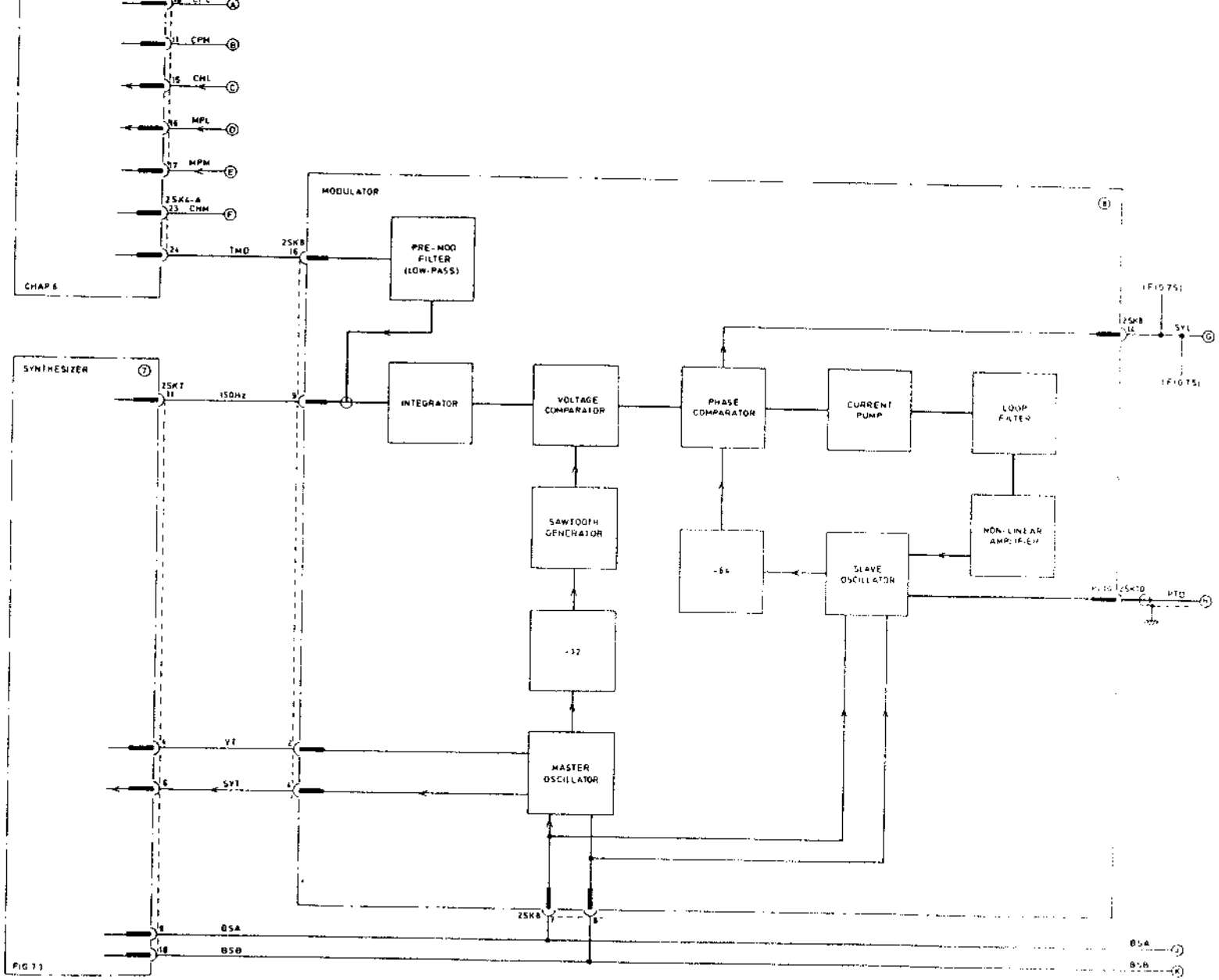
Receiver - Functional Block Diagram (Part A)

Fig.7.4




RACAL TM 2250 BOOK VOL IM

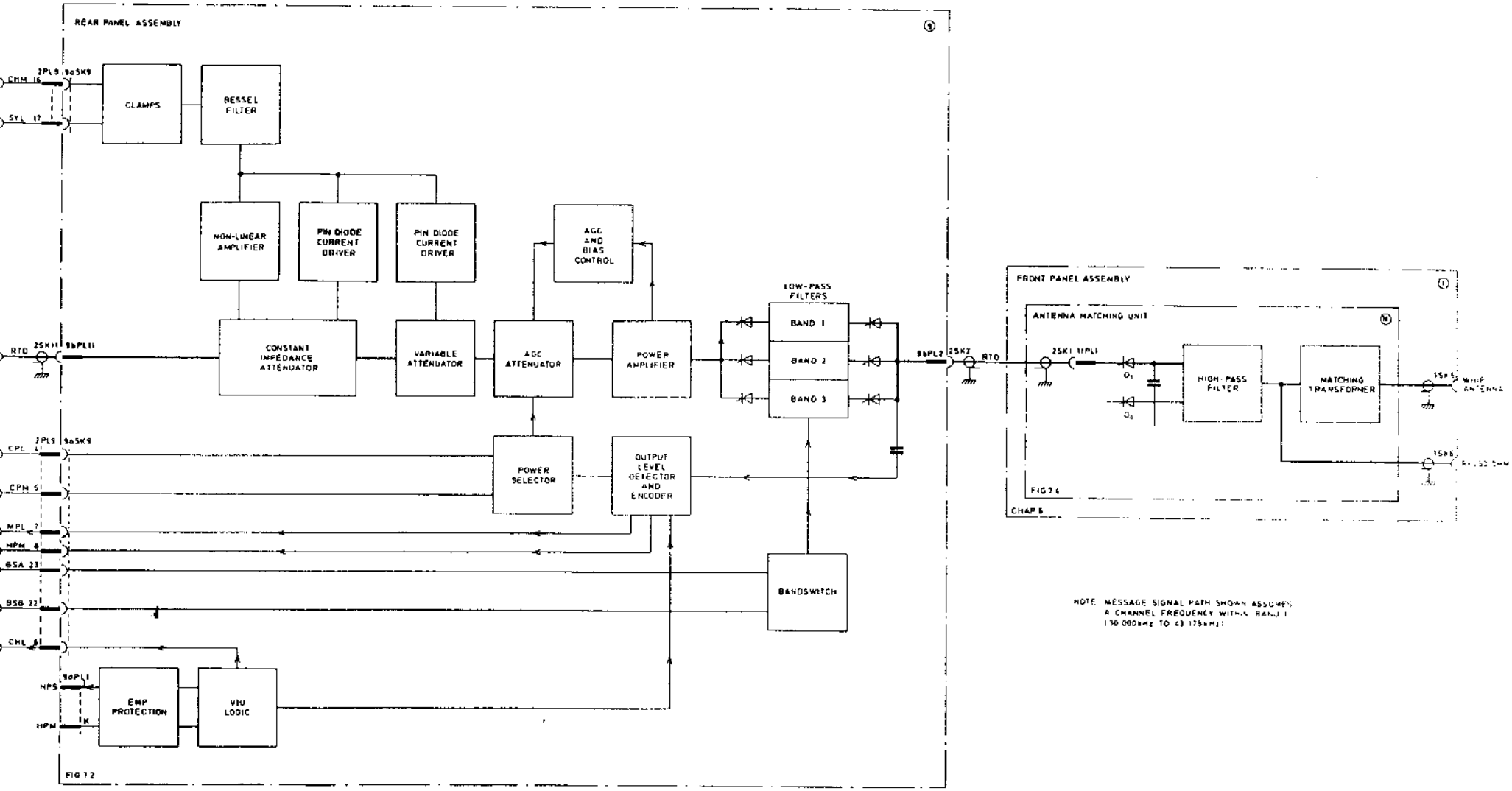
**Receiver – Functional Block Diagram (Part B)** Fig.7.5




RACAL
TH 2250
BOOK VOL IH

Transmitter - Functional Block Diagram (Part A)

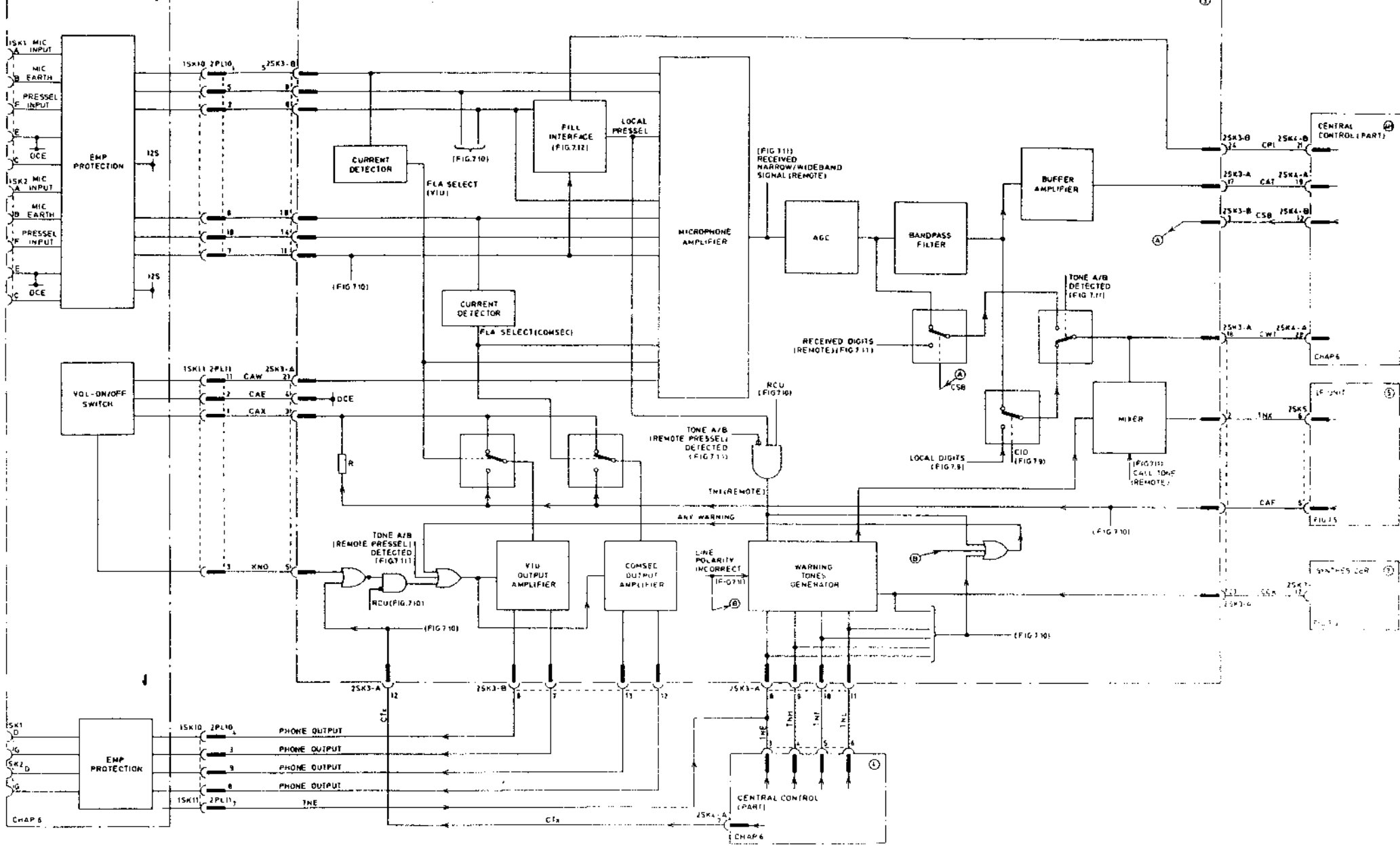
Fig. 7.6




RACAL
TH 2250
BCC66 VOL1H

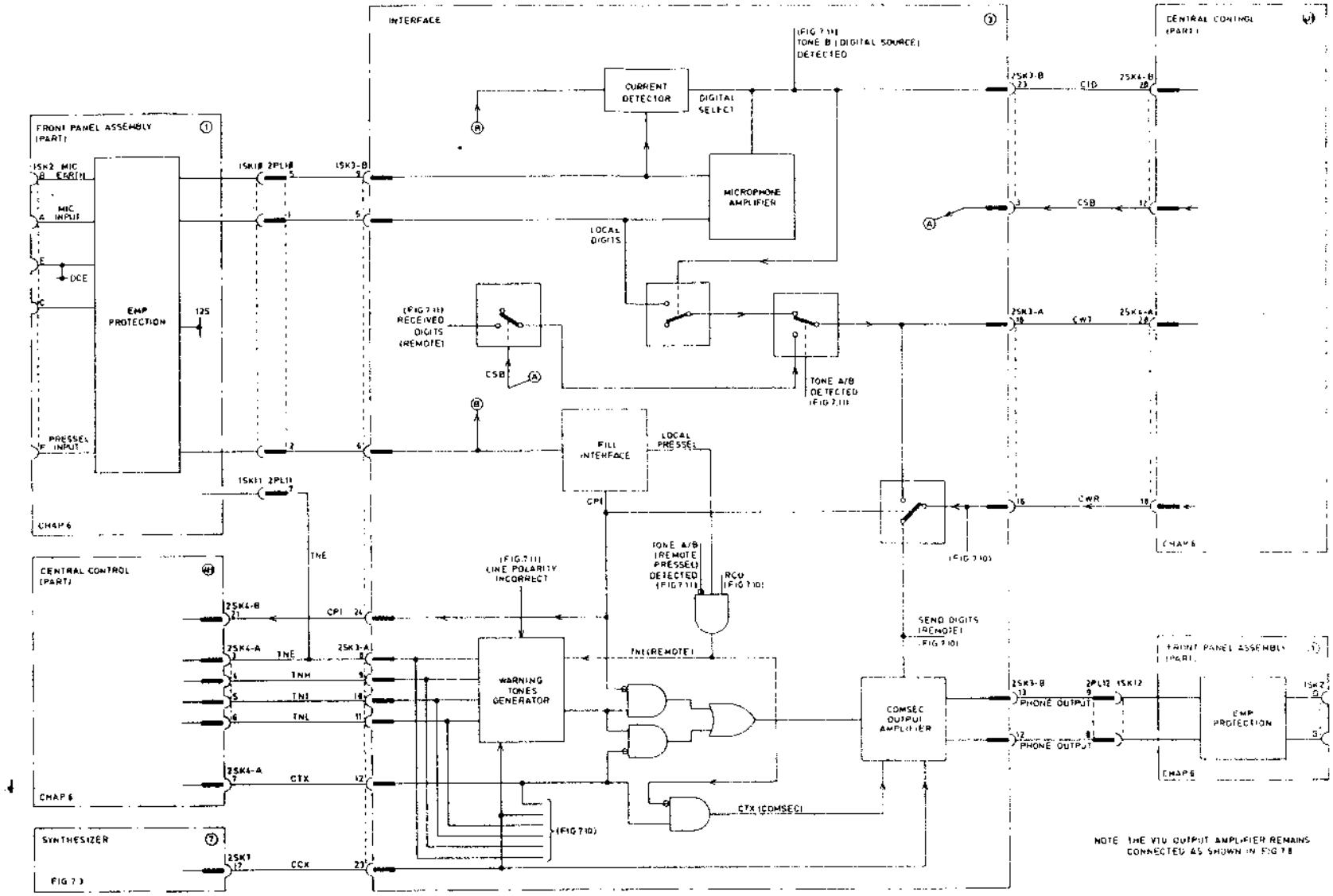
**Transmitter - Functional Block Diagram (Part B)**

Fig.7.7



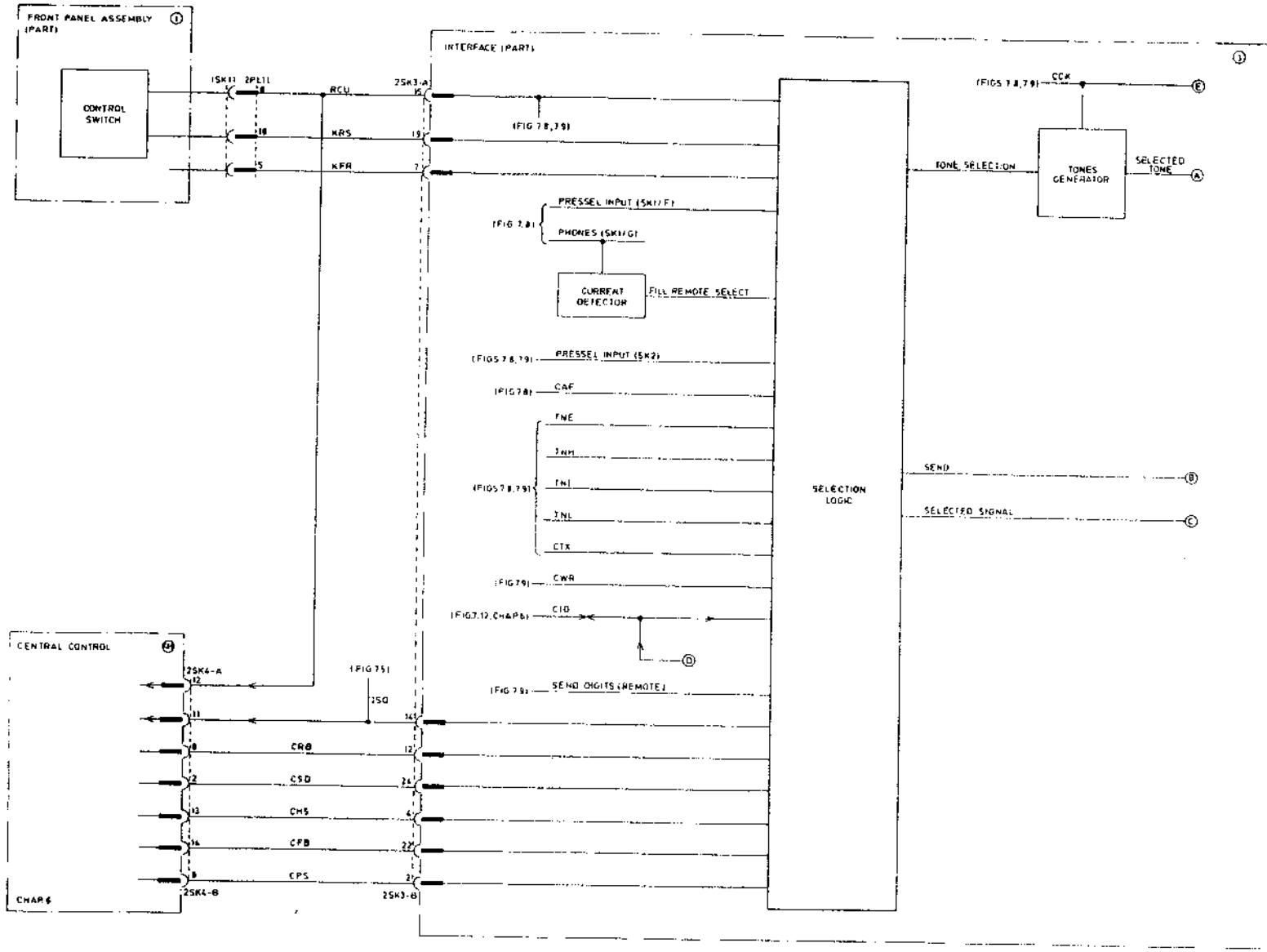

RACAL
TM 2250
BCC66 VOL IN

Audio Interface (Clear Speech)- Fig. 7.8
Functional Block Diagram



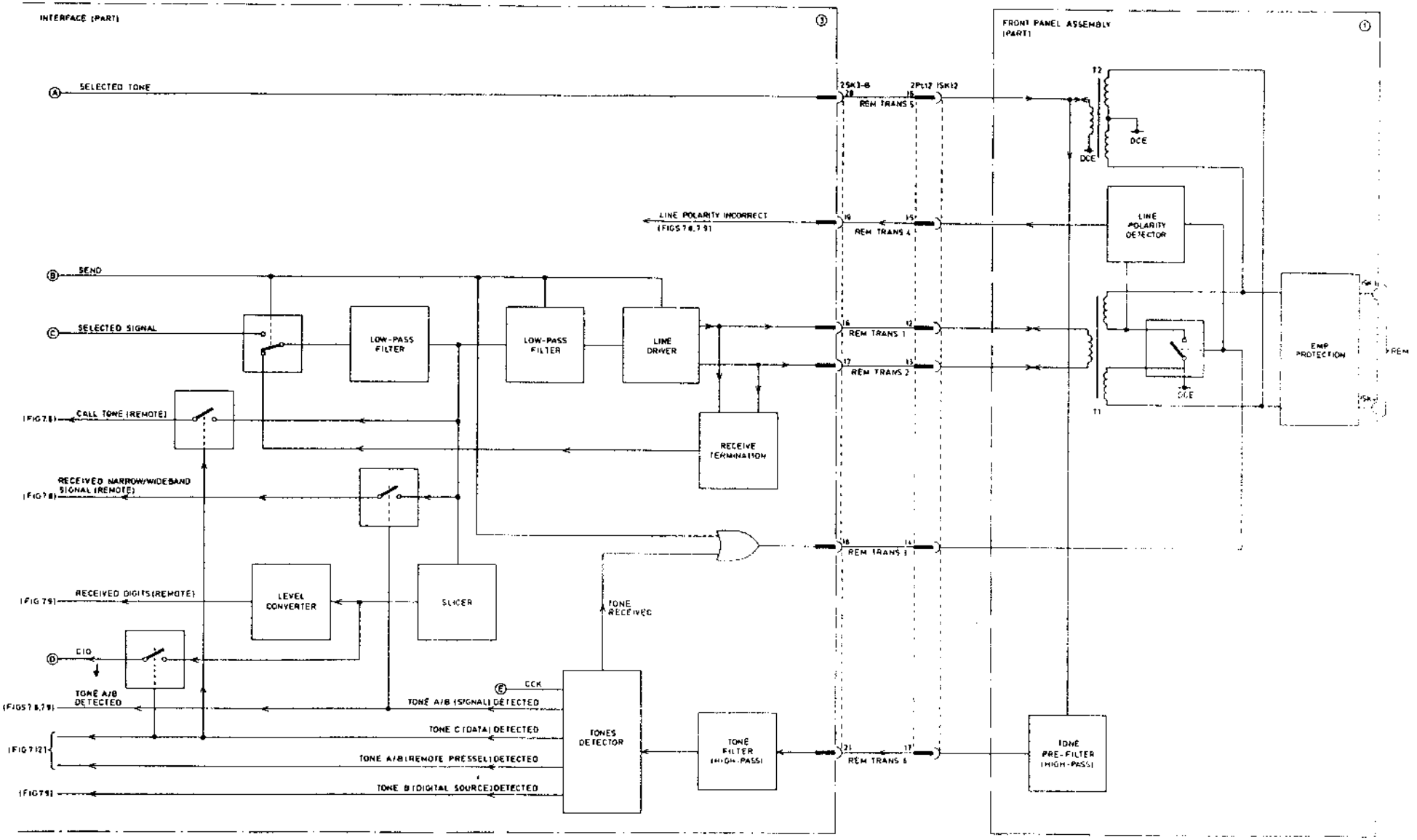

RACAL TH 2250 BCC66 VOL 1/1

**Audio Interface (Secure Speech)- Fig.7.9**
**Functional Block Diagram**




RACAL TH2250 BC094 VOL IIA

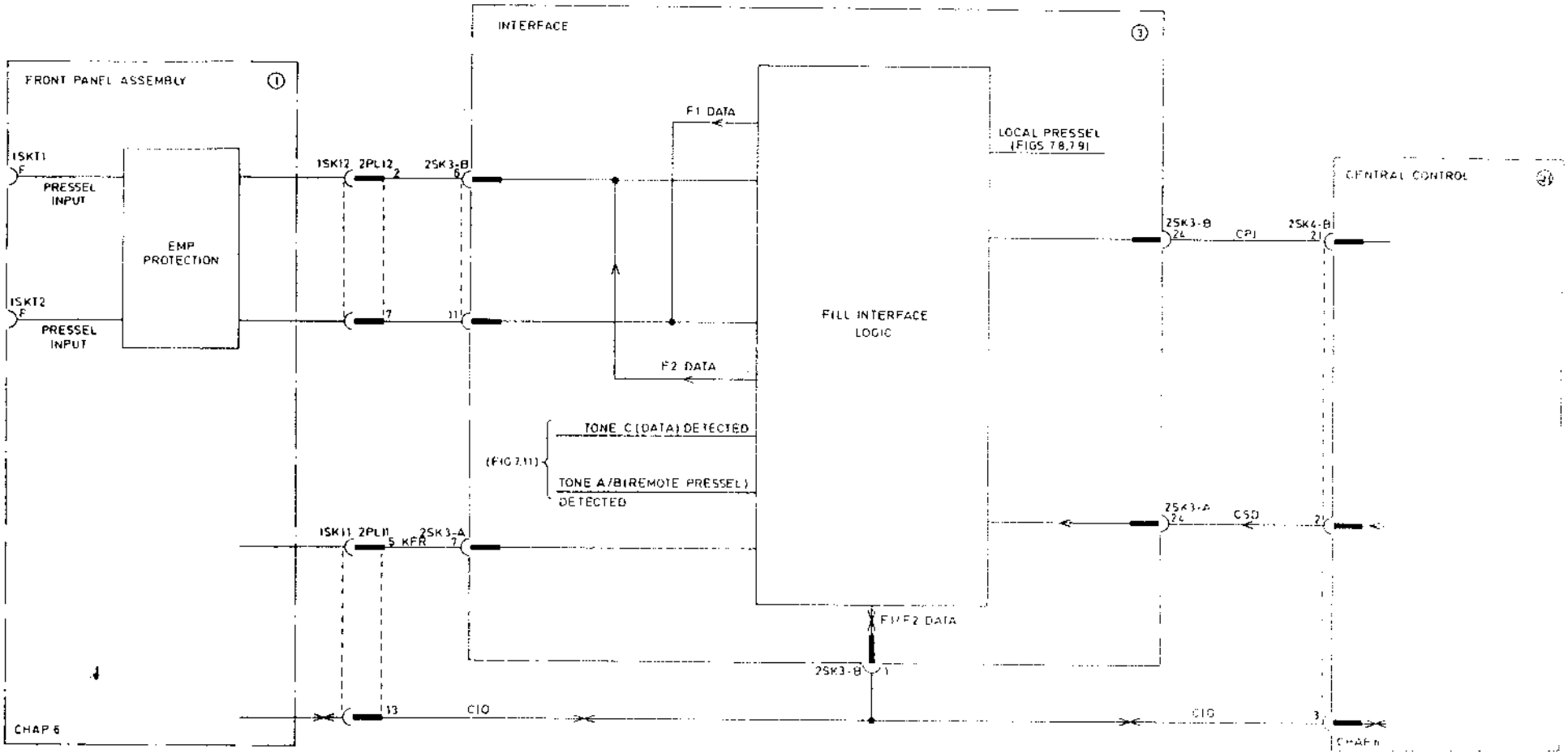
**Remote Interface - Functional Block Diagram (Part A)** Fig.7.10




RACAL
IH2250
BCOSS VOL IIH

Remote Interface - Functional Block Diagram (Part B)

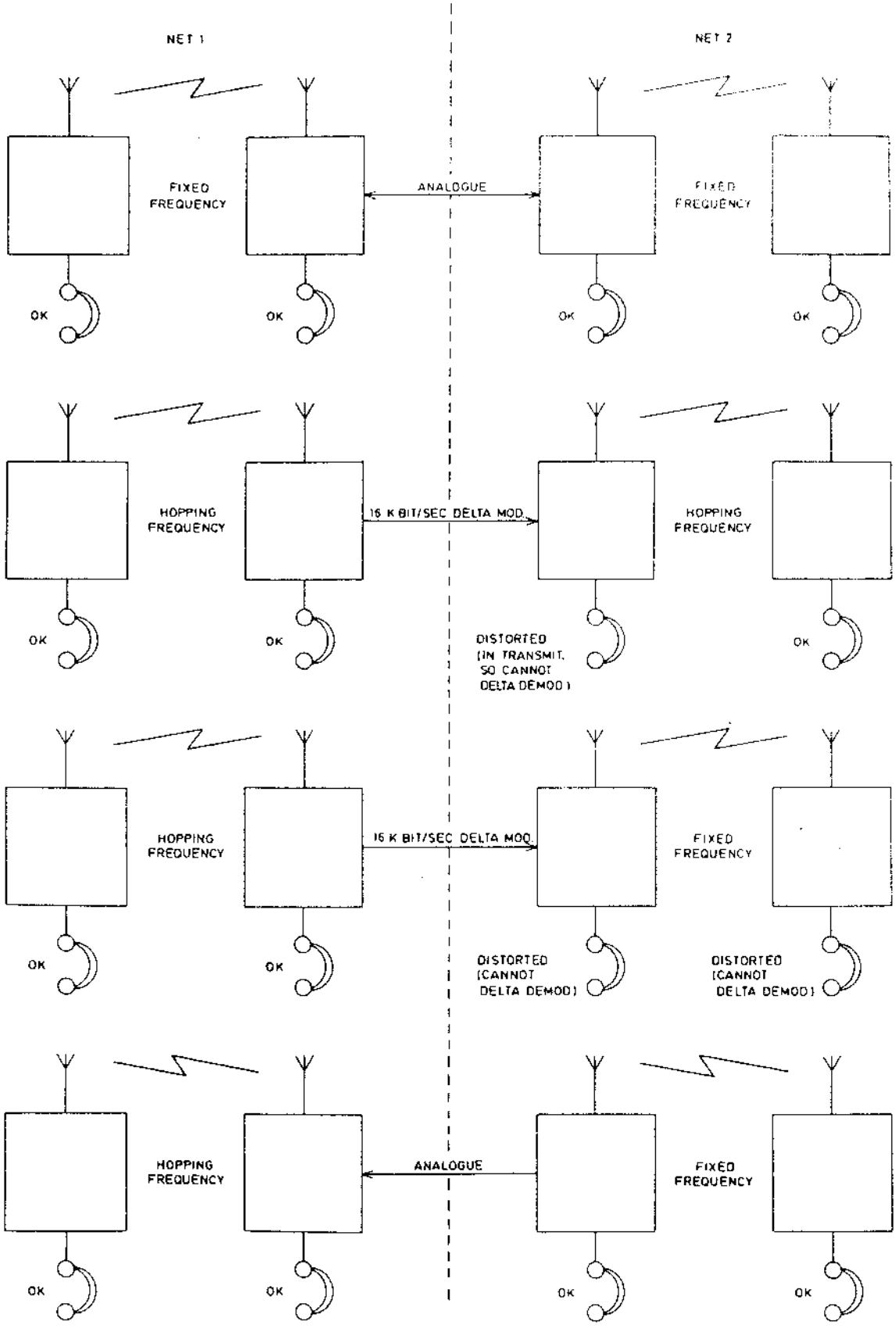
Fig.7.11




RACAL
TH2250
BCC66 VOL 1H

Fill Interface-Functional Block Diagram.

Fig.7.12




RACAL
YH2250
BCC66 VOL 1H

Summary of Auto-Rebroadcast Performance without Rebroadcast Unit (Clear Speech)

Fig.7.13

# CHAPTER 8

# INTERCONNECTIONS

## CONTENTS



## Tables



## Illustrations

# CHAPTER 8

# INTERCONNECTIONS

## INTRODUCTION

1. The purpose of this chapter is to detail the interconnections between the main units of the radio. It also contains a Glossary of Signals - which briefly describes each of the signals carried by these interconnections in terms of its function, routeing and voltage levels - and defines the characteristics of the various signals exchanged across the audio and control interfaces with external equipment.

2. Before attempting to utilise the information contained in this chapter, the user should familiarise himself with the notes given below.

### Interconnection Diagrams

3. For clarity, the interconnection diagram is divided into two sheets. Sheet 1 (figure 8.1) shows the interconnections made via flexible connectors and/or printing wiring. Sheet 2 (figure 8.2) shows the interconnections made by means of coaxial cables.

### Connector Referencing

4. Within each main unit, connectors are generally referenced in numerical order (e.g. SK1, PL2, SK3, etc.). However, where a connector mates with a connector on another main unit, the referencing is arranged so that both connectors carry the same number and thus certain numbers may be omitted from the sequence for one of the units.

5. In the case of the Chassis and Motherboard Assembly, each edge-connector socket is referenced to indicate the number of the unit carried in that socket; thus Unit 8 plugs into SK8. Where a unit requires more than one socket, these are further distinguished by means of a letter suffix (e.g. SK4-A, SK4-B).

6. When the connector reference is quoted in isolation from the unit in which the connector is fitted (as, for instance, in table 8.1), it is further qualified by prefixing it with the appropriate unit number. Thus the reference 1SK1 indicates SK1 in Unit 1.

### Motherboard Connector and Track Identification

7. Normally, the printed wiring tracks on the Motherboard are concealed by the Chassis, so that with the Assembly loaded with units, the only connection points available for test purposes are the pins at the underside of the connectors, accessible through suitably-positioned slots in the Chassis. To assist in identifying specific connections the reference of each connector is printed on the underside of the Chassis adjacent to the socket, and each signal and service carried by a connector is identified by a unique Track Code, printed on the underside of the Chassis adjacent to the appropriate pin.

Table 8.1 Glossary of Signals

| | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| | Band Select A | 2SK7/9 | BSA BSB Band Frequency (kHz)<br>0 1 1 30 000 to 43 175<br>1 1 2 43 200 to 62 375<br>1 0 3 62 400 to 87 975 |
| | Band Select B | 2SK7/10 | 0 = 0 to +0.9 V<br>1 = +9.1 to +9.5 V |
| | Narrow Band/Wide Band Tx Modulation Select | 2SK4-B/7 | 0 = 0 to +0.1 V = Narrow band transmission in use (clear speech)<br>1 = +3.0 to +5.0 V = Wide band transmission in use (hopping or secure speech). |
| | AF Volume - Earth Return | 2SK3-A/4 | See CAX |
| | Receiver Audio Fixed Level | 2SK5/5 | Signal consists of:<br>(1) Rx Audio (on Receive) = 1.14 to 1.32 V peak-to-peak centred on +5 V.<br>(2) Sidetone and Tones on TNX. |
| | Audio Received Signal | 2SK4-A/17 | Level = 600 mV RMS (nominal) for sinewave modulation and ±6 kHz deviation. |
| | Audio to Delta Modulator | 2SK3-A/17 | Used only in hopping clear speech operation.<br>Level = 0.79 to 1.19 V RMS. |
| | AF Volume/Whisper | Front Panel Assy (1) | 0 = 0 to +0.9 V = Whisper (selected by W position of VOL-ON/OFF switch.<br>1 = +9.1 to +9.5 V = Normal operation (at all other positions of VOL-ON/OFF). |

Table 8.1 Glossary of Signals (cont'd)

| TRACK CODE | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| CAX | AF Volume - Signal | Front Panel Assy (1) | Generated as a resistance to CAE with values as follows:<br><br>VOL - ON/OFF Switch Position — Resistance Value (Kilohms)<br><br>Off — 1.76 (value irrelevant)<br>W — 0 (CAE direct)<br>Vol. (1) — 0.56 ±5%<br>Vol. (2) — 1.76 ±5%<br>Vol. (3) — 7.36 ±5%<br>Vol. (4) — Open circuit<br>*, F, H, B, S — 1.76 ±5%<br><br>Max. AC level (open-circuit condition) = 1.2 V RMS (approx.) audio signal.<br><br>No DC present. |
| CBS | Economise Select | Front Panel Assy (1) | 0 = 0 to +0.9 V = Battery saving requested (CONTROL switch set to an ECON position or Vehicle Battery attached, i.e. KVO = High).<br><br>1 = +4.1 to +5.0 V = Continuous operation |
| CCK | 16 kHz Clock | 2SK7/17 | 0 = 0 to +1.5 V<br>1 = +8.0 to +9.5 V |
| CDR | DC Reference to Slicer | 2SK5/21 | DC reference level of +4.0 to +5.7 V, nominally at the centre of the receiver discriminator output voltage. |
| CFB | Flag B | 2SK4-B/14 | 0 = 0 to +0.9 V = Analogue information reception in use.<br>1 = +4.1 to +5.0 V = Reception of an original digital source detected. |
| CHL | High Power Available | Rear Panel Assy (9) | 0 = 0 to +0.9 V = 50 W amplifier not connected.<br>1 = +4.1 to +5.0 V = 50 W amplifier connected. |
| CHM | Hop Mute | 2SK4-A/23 | Used during hopping operation only.<br>0 = 0 to +0.1 V = Frequency static (data valid).<br>1 = +5 V (nominal) = Frequency slewing (no data present).<br>Grounded when Central Control, Fixed (4F) fitted. |

Table 8.1 Glossary of Signals (Cont'd)

| TRACK CODE | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| CHS | Hop Sync. | 2SK4-B/13 | Used during hopping operation only.<br>1 = +4.1 to +5.0 V = Central Control, Hop (4H) tracking hopping received signal.<br>0 = 0 to +0.9 V = All other conditions.<br>Grounded when Central Control, Fixed (4F) fitted. |
| CID | Narrow Band/Wide Band Detect | 2SK3-B/23 | 0 = 0 to +0.9 V = Narrow band modulation selected by termination to ISK2.<br>1 = +4.1 to +5.0 V = Wide band modulation selected by termination to ISK2. |
| CIF | IF Output | 2SK5/22 | Bufferred output from discriminator, centred at a level nominally equal to that of CDR. This output corresponds to: 1.764 to 1.836 V peak-to-peak for an input of ±6 kHz deviation.<br>For transmission (secure speech and/or hopping operation):<br>V OUT > CDR for RF input frequency below assigned centre frequency.<br>V OUT < CDR for RF input frequency above assigned centre frequency. |
| CIO | Serial Data Input/Output | 2SK3-B/1<br>2SK4-B/3<br>Front Assy<br>Assy (1) | Bidirectional line carrying pulse-width-modulated serial data at a nominal PRF of 4kHz.<br>0 is sent as ¼ period low (0 to +0.9 V), ¾ period high (+4.1 to +5.0 V).<br>1 is sent as ¾ period low (0 to +0.9 V), ¼ period high (+4.1 to +5.0 V). |
| CNO | Noise on (Test) | 2SK4-A/2 | 0 = 0 to +0.9 V = Normal operation<br>1 = +4.1 to +5.0 V = Noise on (as a result of pressing Test key T). |
| CPI | Pressel PTT | 2SK3-B/24 | 0 = 0 to +0.9 V = Transmit (or Talk on Intercom)<br>1 = +4.1 to +5.0 V = Receive (or Listen on Intercom). |
| CPL | Set Power LSB | 2SK4-B/10 | Keyboard / CPL / CPM / Output Power Level Requested / PA Output<br>Lo: 0 / 0 / 10 mW / 10 mW<br>n: 1 / 0 / 3 W / 3 W<br>Hi: 1 / 1 / 50W (if available) / 3 W |
| CPM | Set Power MSB | 2SK4-B/11 | 0 = 0 to +0.1 V<br>1 = +3.0 to +5.0 V<br>CPM<br>0 = 0 to +0.9 V<br>1 = +4.1 to +5.0 V<br>CPL |

Table 8.1 Glossary of Signals (Cont'd)

| TRACK CODE | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| CPS | Controlled PTT | 2SK4-B/8 | 0 = 0 to +0.9 V = Receive (or Intercom).<br>1 = +4.1 to +5.0 V = Transmit. |
| CRB | Rebroadcast Select | 2SK4-A/8 | 0 to +0.9 V = Normal operation.<br>1 = +4.1 to +5.0 V = Rebroadcast, Call or Intercom selected. |
| CSB | 16 kbit/sec Detected | 2SK4-B/12 | 0 = 0 to +0.9 V = 16 kbit/sec data not detected.<br>1 = +4.1 to +5.0 V = 16 kbit/sec data detected. |
| CSC | Battery-Save Waveform | 2SK4-B/9 | 0 = 0 to +0.9 V = Battery-saved supplies at 0 V.<br>1 = +4.1 V to +5.0 V = Battery-saved supplies at +9.5 V. |
| CSD | Relay Enable | 2SK4-B/2 | 0 = 0 to +0.9 V = Central Control (4F)/(4H) idling or receiving data on CIO.<br>1 = +4.1 to +5.0 V = Central Control (4F)/(4H) sending data onto CIO. |
| CSO | Any squelch or 16 kbit/sec Detected | 2SK4-A/9 | 0 = 0 to +0.9 V = No squelch open.<br>1 = +4.1 to +5.0 V = Tone, Noise or Hopping Sync. Squelch open or 16 kbit/sec detected. |
| CSS | Radio Squelch Selected | 2SK5/15 | 0 = 0 to +0.9 V = Squelch closed<br>1 = +4.1 to +5.0 V = Squelch open (due to Tone or Noise Squelch, or to Test key operated) when Synthesizer is locked. |
| CTX | Clear to Send, Any Squelch Open, or Intercom | 2SK4-A/7 | 0 = 0 to +0.9 V = No signal present (on Receive).<br>1 = +4.1 to +5.0 V = Clear to Send (on Transmit), Any Squelch Open (on Receive), or Intercom in operation. |
| CWR | Wideband Received Signal | 2SK4-A/18 | Analogue or unprocessed digital signal.<br>Level = 5 V peak-to-peak, centred on +4.5 V (nominal). |
| CWT | Audio/Digits Transmit Signal | 2SK3-A/18 | Not used on hopping clear speech.<br>Analogue or digital signal.<br>Level = 3.74 V peak-to-peak (nominal) when a signal of 2.83 mV peak-to-peak (nominal) is present on 1SK1/A or 1SK2/A, when in analogue mode (equivalent to 70% modulation).<br>= 5 V peak-to-peak (nominal) when a signal of 5 V peak-to-peak (nominal) is present 1SK1/A, when in digital mode. |

Table 8.1 Glossary of Signals (Cont'd)

<table>
<tr><th>ACK DE</th><th>FUNCTION</th><th>SOURCE</th><th>DESCRIPTION</th></tr>
<tr><td></td><td>Zeroise</td><td>Front Panel Assy (1)</td><td>0 = 0 V (DC Earth) = zeroise (CHAN switch set to Z and VOL ON/OFF switch set to OFF).<br>1 = open circuit = Normal operation (all other positions of CHAN switch).<br>} This zeroise option is not normally fitted.</td></tr>
<tr><td></td><td>DC Earth</td><td></td><td>0 V reference<br>Ground plane side of Motherboard (2); all DCE pins contact around plane and some tracks on lower side of Motherboard.</td></tr>
<tr><td></td><td>High Power Measurement</td><td>9 PL1/K</td><td>Analogue signal, generated by Vehicle Interface Unit and used by power Amplifier (9b)<br><br>Levels are as follows:<br><br>
<table>
<tr><th>AT MORE THAN:</th><th>AND LESS THAN:</th><th>POWER</th></tr>
<tr><td>0 V<br>+0.4 V to +0.6 V<br>+4.1 V to +4.3 V<br>+5.0 V to +5.2 V</td><td>+0.4 V to +0.6 V<br>+4.1 V to +4.3 V<br>+5.0 V to +5.2 V</td><td>< 10 W<br>10 W to 20 W<br>20 W to 40 W<br>> 40 W</td></tr>
</table>
(See also MPL, MPM)</td></tr>
<tr><td></td><td>High Power Select/ Available</td><td>9 PL1/J</td><td>Bidirectional line linking Vehicle Interface Unit and Power Amplifier (9b).<br>High Power Select generated by PA as an impedance of 10 kilohms to 0 V.<br>High Power Available generated by VIU as a +5 V supply through 2.2 kilohms.<br><br>
<table>
<tr><th></th><th></th><th></th><th>CHL</th><th>CPM</th></tr>
<tr><td>>+4.5 V</td><td>= High Power available (not selected)</td><td>=</td><td>1</td><td>0</td></tr>
<tr><td>+4.1 to +4.4 V</td><td>= High Power available (selected)</td><td>=</td><td>1</td><td>1</td></tr>
<tr><td>0 to +0.9 V</td><td>= High Power not available (VIU not connected)</td><td>=</td><td>0</td><td>X</td></tr>
</table>
(X = irrelevant)</td></tr>
<tr><td></td><td>Tone Squelch</td><td>2SK5/16</td><td>0 = 0 to +0.9 V = Tone Squelch closed.<br>1 = +7.5 V (nominal) = Tone Squelch opened by incoming Rx signal.</td></tr>
<tr><td></td><td>Keyboard Frame</td><td>Front Panel Assy (1)</td><td>0 = 0 to +0.9 V = No keyboard data being sent onto CIO.<br>1 = +4.1 to +5.0 V = Keyboard data being sent onto CIO.</td></tr>
<tr><td></td><td>Noise On</td><td>Front Panel Assy (1)</td><td>Generated by VOL - ON/OFF switch (*).<br>0 = 0 to +1.2 V = Noise on.<br>1 = +4.9 to +5.0 V = Normal squelch operation on Receive.</td></tr>
</table>

Table 8.1 Glossary of Signals (Cont'd)

<table>
<tr><th>TRACK CODE</th><th>FUNCTION</th><th>SOURCE</th><th>DESCRIPTION</th></tr>
<tr><td>KRS</td><td>Remote Select</td><td>Front Panel</td><td>Generated by CONTROL switch (REM).<br>0 = 0 to +0.9 V = Normal operation<br>1 = +4.1 to +5.0 V = Remote interface enabled (selected by remote switch).</td></tr>
<tr><td>KVO</td><td>Vehicle Battery Attached</td><td>9PL1/G</td><td>Generated by Vehicle Interface Unit.<br>Input signal level:<br><br>For battery voltage of 12 or 24 V = +9 V to +18 V.<br>For no battery connected, via 220 kilohms to 0 V.<br><br>Internal signal levels:<br><br>0 = 0 to +0.9 V = Vehicle battery not attached.<br>1 = +4.1 to +5.0 V = Vehicle battery attached.</td></tr>
<tr><td>MBL</td><td>Battery Measurement LSB</td><td>Rear Panel Assy (9)</td><td rowspan="2">Levels are as follows:<br><br><table><tr><th rowspan="2">MBL</th><th rowspan="2">MBM</th><th colspan="2">Battery Voltage</th></tr><tr><th>AT MORE THAN:</th><th>AND LESS THAN:</th></tr><tr><td>0</td><td>0</td><td>0 V</td><td>+9.9 V to +10.1 V</td></tr><tr><td>1</td><td>0</td><td>+9.9 V to +10.1 V</td><td>+11.4 V to +11.6 V</td></tr><tr><td>1</td><td>1</td><td>+11.4 V to +11.6 V</td><td>+13.0 V to +13.2 V</td></tr><tr><td>0</td><td>1</td><td>+13.0 V to 13.2 V</td><td></td></tr></table><br>0 = 0 to +0.9 V<br>1 = +7.0 to +9.0 V</td></tr>
<tr><td>MBM</td><td>Battery Measurement MSB</td><td>Rear Panel Assy (9)</td></tr>
<tr><td>MPL</td><td>Power Measurement LSB</td><td>Rear Panel Assy (9)</td><td rowspan="2">Power Output (W) | MPL | MPM<br><br>< 0.1 | 0 | 0<br>0.1 to 2.5 | 1 | 0<br>2.5 to 3.5 | 1 | 1<br>> 3.5 | 0 | 1 } for n selected<br><br>Synthesizer Unlocked | 0 | 0<br>Synthesizer Locked | 1 | 0 } for Lo selected<br><br>< 10 | 0 | 0<br>10 to 20 | 1 | 0<br>20 to 40 | 1 | 1<br>> 40 | 0 | 1 } for Hi selected<br><br>0 = 0 to +0.9 V<br>1 = +4.0 to +9.0 V<br>(See also HPM)</td></tr>
<tr><td>MPM</td><td>Power Measurement MSB</td><td>Rear Panel Assy (9)</td></tr>
</table>

Table 8.1 Glossary of Signals (Cont'd)

| ACK<br>GE | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| | Rx RF Signal Measurement LSB | 2SK5/18 | MRL MRM<br>No Signal 0 0<br>Weak Signal 1 0<br>Normal Signal 1 1<br>Strong Signal 0 1 |
| | Rx RF Signal Measurement MSB | 2SK5/19 | 0 = 0 to +0.9 V<br>1 = +6.6 V (nominal) |
| | Remote Control Unit Select | Front Panel Assy (1) | Generated by CONTROL switch (RCU).<br>0 = 0 to +0.9 V = Set used as a remote control unit.<br>1 = +4.1 to +5.0 V = Set used as a normal radio. |
| TRANS 1<br>TRANS 2<br>TRANS 3<br>TRANS 4<br>TRANS 5<br>TRANS 6 | Remote Transformer 1 to 6 | 2SK3-B/16<br>2SK3-B/17<br>2SK3-B/18<br>2SK3-B/19<br>2SK3-B/20<br>2SK3-B/21 | Remote Transformer is a sub-module of the Interface Unit 3<br>It has no connection to other units.<br>See also Table 8.4. |
| | IF Signal Input | 2SK6/14 | Frequency = 10.7 MHz<br>Level = Approximately +10 dB on Rx input signal. |
| | RF Connection, AMU to RFH | 1fPL2 | Generated by Antenna Matching Unit on Receive.<br>Impedance = 50 ohms (nominal).<br>Level = -119 to -118 dbm when -118 dbm present at RF socket (SK6). Variable DC present on centre of coaxial connector (source, Antenna Matching Unit; sink, RF Head), 15 mA on Receive, 0 mA on Transmit. |
| | RF Connection, MOD to PA | 8PL10 | Generated by Modulator (8) on Transmit.<br>Impedance = 50 ohms (nominal)<br>Level = 1 W (nominal) at 4.2 kHz nominal deviation when TMD is 3.5 V peak-to-peak (nominal). |

Table 8.1 Glossary of Signals (Cont'd)

| TRACK CODE | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| RTO | RF Connection, PA to AMU | Rear Panel Assy (9) | Generated by Power Amplifier (9) on Transmit.<br>Impedance = 50 ohms (nominal).<br>Level = 3 W/10 mW (nominal) at 4.2 kHz nominal deviation when TMD is 3.5 V peak-to-peak (nominal). DC present on centre of coaxial connector (source, Antenna Matching Unit; sink, Power Amplifier), 40 to 120 mA on Transmit, 0 mA on Receive. |
| SE | Signal Earth | 2SK6/13<br>2SK6/15 | Guard Earth around RIF output of RF Head (6) and input of IF Unit (5). |
| SK1/A<br>SK1/B<br>SL1/D<br>SK1/F<br>SK1/G | Audio interface with VIU | 1SK1/A<br>2SK3-B/9<br>2SK3-B/8<br>1SK1/F<br>2SK3-B/7 | See Table 8.2<br>When programming using an external device connected to 1 SK2, 1 SK1/F carries a serial data output from radio. |
| SK2/A<br>SK2/B<br>SK2/D<br>SK2/F<br>SK2/G | Audio interface with COMSEC | 1SK2/A<br>2SK3-B/14<br>2SK3-B/13<br>1SK2/F<br>2SK3-B/12 | See Table 8.3<br>When COMSEC is connected, 1SK2/F carries pressel input and bidirectional serial data. When programming using an external device connected to 1SK1, 12SK2/F carries a serial data output from radio. |
| SNAP | IF test output | IF Unit (5) | Signal level = 5 mV RMS (maximum) AC coupled.<br>Frequency = 10.7 MHz<br>Bandwidth = 20 kHz (approx.)<br>Impedance = 50 ohms |
| SYC | Synthesizer | 2SK4-B/5 | The rising edge is used to clock DATA (SYD) into a register when the Frame (SYF) is high.<br>0 = 0 to +0.1 V<br>1 = +4.9 to +5.0 V |

Table 8.1 Glossary of Signals (Cont'd)

| RACK ODE | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| YD | Synthesizer Data | 2SK4-B/6 | BCD - encoded frequency setting data.<br>0 = 0 to +0.1 V<br>1 = +4.9 to +5.0 V |
| YF | Synthesizer Frame | 2SK4-B/4 | The falling edge is used to transfer data into the Synthesizer (7)<br>0 = 0 to +0.1 V = Data on SYD invalid<br>1 = +4.9 to +5.0 V = Data on SYD valid. |
| YL | Synthesizer in Lock | 2SK7/16<br>2SK8/14 | Generated when both Synthesizer (7) and Modulator (8) are in lock.<br>0 = 0 to +0.9 V = Synthesizer or Modulator out of lock (frequency inaccurate).<br>1 = +4.1 to +6.5 V = Synthesizer and Modulator in lock. |
| YR | RF Output to Synthesizer (LO) | 2SK6/6 | Reference RF signal from Local Oscillator in RF Head (6).<br>Impedance = 100 ohms (load termination at Synthesizer).<br>Level = 508 to 700 mV peak-to-peak. |
| YT | RF Output to Synthesizer (MO) | 2SK8/4 | Reference RF signal from Master Oscillator in Modulator (8).<br>Impedance = 100 ohms (load termination at Synthesizer).<br>Level = 508 to 700 mV peak-to-peak. |
| 0 | Transmitter Modulation | 2SK4-A/24 | Analogue modulation level = 2.78 to 4.41 V peak-to-peak centred on +4.5 V for ±4.2 kHz deviation of RF carrier.<br>Data modulation level = 4.72 to 5.30 V peak-to-peak |
| E | Error Tone $\overline{\text{Control}}$ | Front Panel Assy (1)<br>2SK4-A/3 | Generated by either Central Control (4F)/(4H) or keyboard (1a).<br>0 = 0 to +0.9 V = Error detected.<br>1 = +4.1 to +5.0 V = Error Tone Generated 'off'. |
| H | Hailing Tone $\overline{\text{Control}}$ | 2SK4-A/4 | Used in hopping operation only.<br>0 = 0 to +0.9 V = Fixed Frequency Net Station detected.<br>1 = +4.1 to +5.0 V = Hailing Tone Generator 'off'.<br>Connected to +5 V when Central Control, Fixed (4F) fitted. |

Table 8.1 Glossary of Signals (Cont'd)

| TRACK CODE | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| TNI | Unready Tone $\overline{\text{Control}}$ | 2SK4-A/5 | 0 = 0 to 0.9 V = Transmit path not clear to send.<br>1 = +4.1 to +5.0 V = Normal operation (clear to send). |
| TNL | Call Tone $\overline{\text{Control}}$ | 2SK4-A/6 | 0 = 0 to 0.9 V = Call Tone requested.<br>1 = +4.1 to +5.0 V = Call Tone Generator 'off'. |
| TNX | Combined Tones and Sidetone | 2SK3-A/2 | Signal consists of Tones (when required) and Sidetone<br>Level of Sidetone = 0.86 V to 1.14 V RMS.<br>Level of Tones relative to Sidetone = Error : -15 dB to -9 dB<br>Call : -3 dB to +3 dB<br>Hailing and Unready : -23 dB to -17 dB |
| VT | Tuning Voltage | 2SK7/4 | Used by Modulator (8) to control frequency of Master Oscillator.<br>Used by RF Head (6) to control frequency of Local Oscillator.<br>Level = +6 to +85 V<br>Typical values:<br>+70 V = High end of frequency band on Receive.<br>+75 V = High end of frequency band on Transmit.<br>+8 V = Low end of frequency band on Receive.<br>+8 V = Low end of frequency band on Transmit. |
| 9V5BS | +9.5 V DC Battery Saved Supply | Rear Panel Assy (9) | Level = +9.25 to +9.75 V |
| 9V5BSRX | +9.5 V DC Battery Saved Supply, Receive Only | Rear Panel Assy (9) | Level = +9.25 to +9.75 V |
| 9V5C | Constant +9.5 V DC Supply | Rear Panel Assy (9) | Level = +9.25 to 9.75 V |
| 9V5TX | +9.5 V DC Supply, Transmit only | Rear Panel Assy (9) | Level = +9.25 to +9.75 V |
| 12S | +12 V DC Switched Supply | Front Panel Assy (1) | Level = +9.8 to +18 V (Manpack Station).<br>= +9.8 to +13 V (Vehicle Station). |
| 12U | +12 V DC Unswitched Supply | | Level = +10 to +18 V (Manpack Station).<br>= +10.1 to +13 V (Vehicle Station). |

Table 8.1 Glossary of Signals (Cont'd)

| RACK ODE | FUNCTION | SOURCE | DESCRIPTION |
|---|---|---|---|
| 5 V | +85 V DC Supply | 2SK7/12 | Level = +87 to +101 V |
| 50 Hz | 150 Hz Tone | 2SK7/11 | Level = 1.15 to 1.25 V peak-to-peak centred on +4.7 V for ±3 kHz tone deviation.<br>= 0.6 to 0.7 V peak-to-peak centred on +4.7 V for ±1.6 kHz tone deviation. |

Table 8.2 SK1 (AUDIO VIU) Signal Characteristics

| | WITH HANDSET | | WITH VIU CONNECTED | | WITH PROGRAMMING DEVICE CONNECTED | |
|---|---|---|---|---|---|---|
| | Signal | Characteristics | Signal | Characteristics | Signal | Characteristics |
| | Microphone input | Normal: 2mV EMF (typical) from a 300 ohm source. Whisper: sensitivity increased by 12 dB (approx). Input impedance: 300 ohms. | FLA input<br><br>Current programming input (FLA Select). | Level: 60mV EMF (typical) from a 300 ohm source. Input impedance: 300 ohms.<br>+9.5 V through 4.7 kilohms. Input impedance: 4.7 kilohms to 0 V. | Not used | |
| | Microphone earth | Direct connection to earth. | Microphone earth | Direct connection to earth. | Not used. | |
| | +12 V supply output | Switched by VOL-ON/OFF switch. Connected via 2.2 ohm thermistor (positive temperature coefficient). | Not used. | Connected to switched +12 V supply via 2.2 ohm thermistor | +12 V supply output | Switched by VOL-ON/OFF switch. Connected via 2.2 ohm thermistor (positive temperature coefficient). |
| | Phone output | 0.01 mW to 5 mW, depending on volume control setting. | FLA output | Level: 1 mW (typical), for load impedance = 300 ohms. | Not used. | |
| | Earth | Earth return, except for microphone. | Earth | Earth return, except for microphone. | Earth | Earth return. |
| | Pressel input | Transmit: less than 2 kilohms to 0 V (less than +2 V) maintained for greater than 1 ms. Input impedance: 18 kilohm resistor pull-up to +9.5 V. | Pressel input | Transmit: less than 2 kilohms to 0 V (less than +2 V). Input impedance: 18 kilohm resistor pull-up tp +9.5V. | Serial data input<br><br>Serial data input | $V_{LOW}$(0): +1 V (max) through 1 kilohm. $V_{HIGH}$(1): +8V (min) through 11 kilohms. Input impedance: 18 kilohm resistor pull-up to +9.5 V.<br>$V_{LOW}$(0): +2 V (max) $V_{HIGH}$(1): +4 V (min) for load impedance = 1.8 kilohms to 0 V. |
| | Phone output | As pin D. | FLA output | As pin D | Current programming input (Send Data Framing Pulse) | +8 V through 3.9 kilohms. (Necessary only if programming via remote lines is required.) |

Table 8.3 SK2 (AUDIO COMSEC) Signal Characteristics

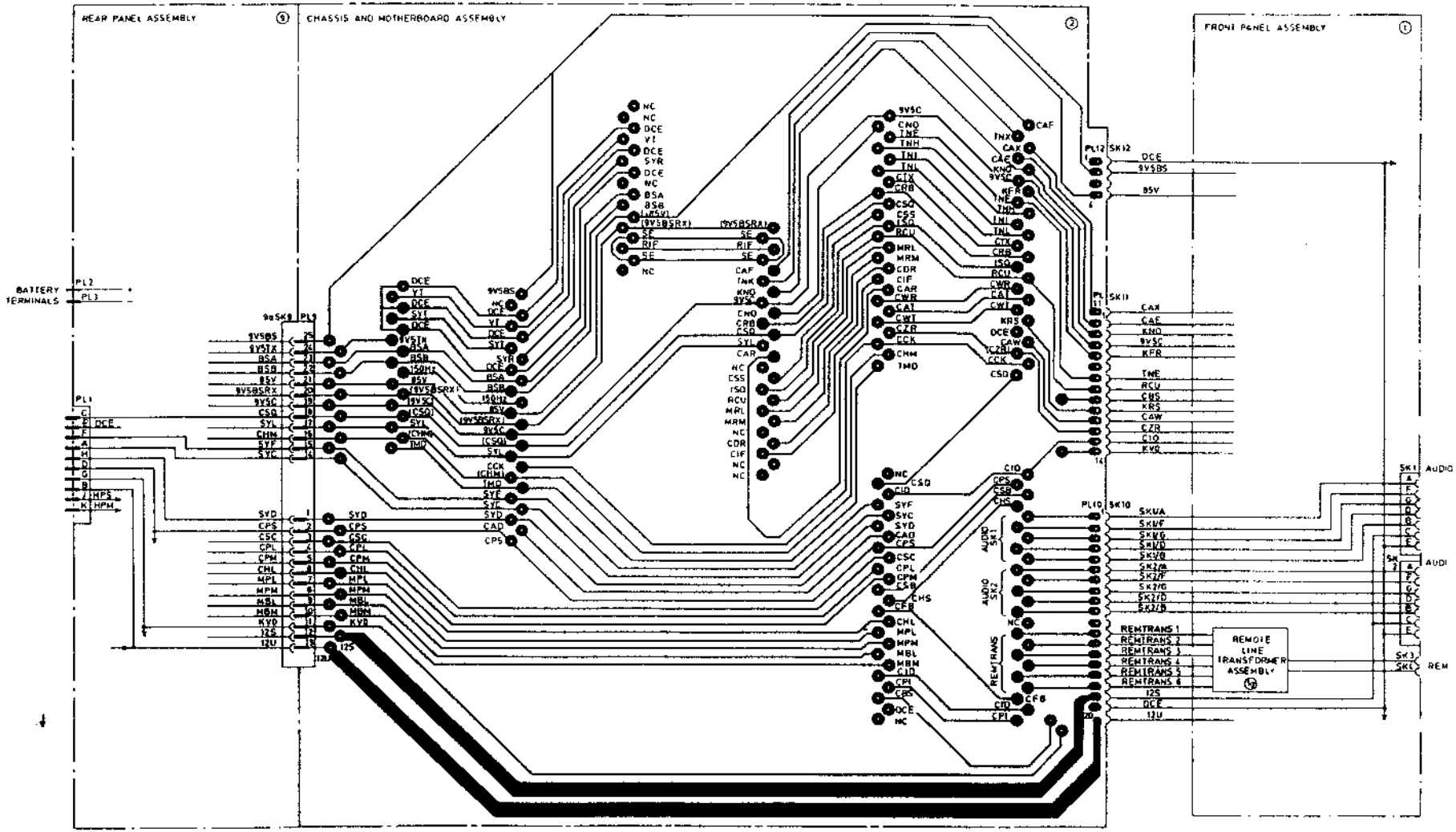
| WITH HANDSET CONNECTED | | WITH COMSEC CONNECTED | | WITH PROGRAMMING DEVICE CONNECTED | |
|---|---|---|---|---|---|
| Signal | Characteristics | Signal | Characteristics | Signal | Characteristics |
| Microphone input | Normal: 2 mV EMF (typical) from a 300 ohm source. Whisper: Sensitivity increased by 12 dB (approx.) Input impedance: 300 ohms. | FLA input (clear speech)<br><br>Digital input (secure speech) | Level: 60 mV EMF (typical) from a 300 ohm source. Input impedance 300 ohms. Current programming (FLA Select): +8 V through 3.9 kilohms. DC load, 4.7 kilohms to 0 V (equivalent to 1 mA).<br><br>Level: 5 V peak-to-peak centred on +4.5 V (+2 V to +7 V). Input impedance 4.7 kilohms to 0 V. | Not used. | |
| Microphone earth | Via 10 µF capacitor | Microphone earth Current programming input (Digital Select) | Via 10 µF capacitor. +8 V through 3.9 kilohms. input impedance: 4.7 kilohms to 0 V (equivalent to 1 mA). | Not used. | |
| +12 V supply output | Switched by VOL-ON/OFF switch. Connected via 2.2 ohm thermistor (positive temperature coefficient). | +12 V supply output | Switched by VOL-ON/OFF switch. Connected via 2.2 ohm thermistor (positive temperature coefficient). | +12V supply output | Switched by VOL-ON/ OFF switch. Connected via 2.2 ohm thermistor (positive temperature coefficient). |
| Phone output | 0.01 mW to 5 mW, depending on volume control setting. | FLA output (clear speech)<br><br>Digital output (secure speech) | Level: 1 mW (typical) for load impedance = 300 ohms.<br><br>Level: 5 V peak-to-peak centred on +4.5 V (+2 V to +7 V). for load impedance = 4.7 kilohms. | Not used. | |
| Earth | Earth return, except for microphone. | Earth | Earth return, except for microphone. | Earth | Earth return |

Table 8.3 (AUDIO-COMSEC) Signal Characteristics (Cont'd)

| PIN | WITH HANDSET CONNECTED | | WITH COMSEC CONNECTED | | WITH PROGRAMMING DEVICE CONNECTED | |
|---|---|---|---|---|---|---|
| | Signal | Characteristics | Signal | Characteristics | Signal | Characteristics |
| F | Pressel input | Transmit: less than 2 kilohms to 0 V (less than +2 V) maintained for greater than 1 ms. Input impedance: 18 kilohm resistor pull-up to +9.5 V. | Pressel input | Transmit: less than 2 kilohms to 0 V (less than +2 V) maintained for greater than 1 ms. Input impedance: 18 kilohms resistor pull-up to +9.5 V. | Serial data output | $V_{LOW}(0)$: +2 V (max)<br>$V_{HIGH}(1)$: +4 V (min)<br>for load impedance: 1.8 kilohms to 0 V. |
| | | | Serial data input | $V_{LOW}(0)$: +1 V (max)<br>through 1 kilohm.<br>$V_{HIGH}(1)$: +8 V (min)<br>through 1 kilohm.<br>Input impedance: 18 kilohm resistor pull-up to +9.5 V. | Serial data input | $V_{LOW}(0)$: +1 V (max)<br>through 1 kilohm.<br>$V_{HIGH}(1)$: +8 V (min)<br>through 11 kilohms.<br>Input impedance: 18 kilohm resistor pull-up to +9.5 V. |
| | | | Serial data output | $V_{LOW}(0)$: +2 V (max)<br>$V_{HIGH}(1)$: +4 V (min)<br>for load impedance: 1.8 kilohms to 0 V. | | |
| G | Phone output | As pin D. | Digital Output | Form: 16 kHz clock. Level: 6 V peak-to-peak (nominal). Connected via 2.2 µF capacitor. | Not used. | |
| | | | Current programming output | +9.5 V through 4.7 kilohms for either Tone Active, Squelch Open, Clear to Send, or Intercom.<br>for load impedance: 4.7 kilohms to 0 V. | | |

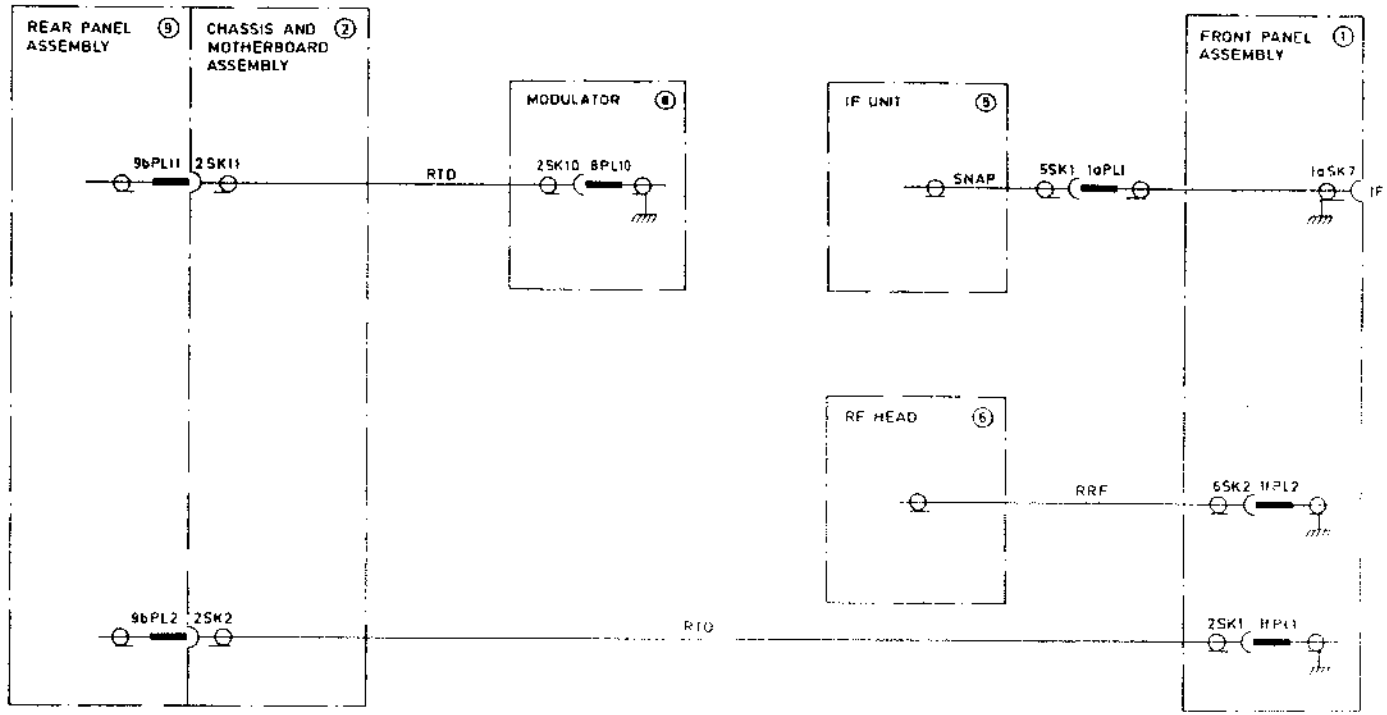
Table 8.4 SK3, SK4 (REM) Signal Characteristics

| Signal | Characteristics |
|---|---|
| Audio output | Level: 1.0 V RMS (nominal).<br>Load impedance: 300 ohms. |
| Digital output | |
| Secure speech | Level: 4 V peak-to-peak.<br>Load impedance: 300 ohms.<br>Source impedance: 150 ohms in series with 1 mH. |
| Control signals | Form: As for CIO (Table 8.1)<br>Level: 4 V peak-to-peak<br>Load impedance: 300 ohms<br>Source impedance: 150 ohms in series with 1mH. |
| Audio input | Level: 300mV (typical).<br>Input impedance: 300 ohms. |
| Digital input | |
| Secure speech | Rate: 16 kbit/s.<br>Level: 0.5 V peak-to-peak (min).<br>Input impedance: 300 ohms in series with 1 mH. |
| Control signals | Form: As for CIO (Table 8.1).<br>Level: 0.5 V peak-to-peak (min).<br>Input impedance: 300 ohms in series with 1 mH. |
| Tone signals for control | Three tone signals are used for control:<br>23.3 kHz, transmit control with analogue speech or delta-modulated speech. 32.0 kHz, transmit control with 16 kbit/s data or wideband analogue data. (These tones are sent in the form of 10ms bursts at a period of 512 ms).<br>18.3kHz, to activate the control circuits (continuous). |




Interconnection Diagram (Sheet 1)

Fig.8.1




NOTE : 2SK1, 2SK11 ARE INCLUDED IN 2SK9. SIMILARLY, 9bPL1, 9bPL11 ARE INCLUDED IN 9bPL11.



Interconnection Diagram (Sheet 2)

Fig.8.2

# CHAPTER 9

# FAULT LOCATION

## CONTENTS

# CHAPTER 9

# FAULT LOCATION

## INTRODUCTION

1. In the majority of cases, the presence of a fault in the radio will become apparent during the performance of the functional check procedures detailed in chapter 4. In paragraphs 2-9 a limited series of tests are described which use the absolute minimum of external equipment and make the best use of the Built In Test Equipment (BITE) provided with the BCC 66 H radio. For an alternative method of test using "Field Repair Test Kit" (FRTK) see paragraphs 10-12. These tests include tests applicable to both the Manpack Station (BCC 66H) and the Vehicle Station (VRQ 316). The purpose of both test procedures is to locate a faulty unit so that it can be replaced and then to check that the repaired equipment is serviceable.

## EQUIPMENT REQUIRED

2. (1) Jaguar V Radio BCC 66H - 1.

   (2) Battery Rechargeable MA 4025A - 2.

   (3) Whip Antenna 1.2 m or 2.4 m - 2.

   (4) Handset/Headset - 2.

   (5) Field telephone cable (D10 or similar) - as required.

   (6) Multimeter (e.g. Avometer) - 1.

3. If possible, the radio (item 2 (1)) should be a 'known good' set.

4. Ensure that the batteries (item 2 (2)) are fully charged, and that the antennas and handset/headsets (items 2 (3) and 2 (4)) are fully serviceable.

## FAULT LOCATION

5. Confirm that a fault is present by performing the functional check procedure of chapter 4.

6. If the fault is confirmed:-

   (1) Switch off the radio and remove the battery.

   (2) Remove the Sleeve Assembly and fit the Test Spacers as described in chapter 5.

   (3) Refit the battery and switch on the radio.

   (4) Re-establish the test conditions in being at the time the fault was detected.

7. Refer to the appropriate entry in table 4.1. Carry out any investigative actions detailed for the entry and fit new units as appropriate to the result of these actions; if no investigative action is given, fit new units as described. After fitting a new unit, repeat the failed functional check.

NOTE: When the table indicates that the fault may be situated in any one of a pair or group of units, these should be changed one at a time (preferably in the order given) and the check repeated following each unit change.

8. When the results of the check indicate that the fault has been rectified, repeat the whole of the functional check procedure. If further faults are detected, repeat the fault location and rectification process.

9. On satisfactory completion of the functional check procedure:

(1) Switch off the radio and remove the battery.

(2) Remove the Test Spacers and refit the Sleeve Assembly as described in chapter 5.

(3) Refit the battery and switch on the radio.

(4) Perform a talk-through check and confirm that the radio is still operating satisfactorily.

ALTERNATE METHOD

10. Equipment required:-

(1) Jaguar V Radio BCC 66H Qty 1

(2) Jaguar Field Repair Test Kit Qty 1

11. Carry out the preliminary checks as in paragraphs 5 and 6.

12. Refer to tests as detailed in Technical Manual for Jaguar Field Repair Test Kit.

TABLE 9.1 Fault Location

| REFERENCE (chapter 4, para.) | SYMPTOMS | INVESTIGATIVE ACTION | REMARKS |
|---|---|---|---|
| 11 (2) | 4-digit number displayed and Error Tone heard | | BITE has detected a fault. Suspect Unit 4H |
| 11 (4) | Error Tone cannot be cancelled | Monitor TNE (chap. 8).<br>TNE = 1.<br>TNE = 0. Switch off and check for short circuit between TNE line and chassis. | Suspect Unit 3.<br>If no short circuit is found, suspect unit 1 or Unit 4H. |
| 13 | No display | Check that +12 V d.c. supply is present at SK1/C. | If not supply is present, check the 12 V supply circuit (ON/OFF switch, flexible connectors, etc.) and the fuse fitted in Unit 9.<br>If the supply is present, suspect Unit 1. |
| | Incorrect display, Error Tone heard. | Check whether any portion of the display is flashing | Keyboard has detected a fault in the data which is flashing. Suspect Unit 4H or Unit 1. |
| | Incorrect display, Error Tone not heard. | | Suspect Unit 1. |
| 14 | Receiver noise not heard. | Monitor SYL (chap. 8)<br>SYL = 1.<br>SYL = 0. | Suspect Unit 3 or Unit 5.<br>Suspect Unit 7 or Unit 6. |

TABLE 9.1 Fault Location (continued)

<table>
<tr><th>REFERENCE<br>(chapter 4, para.)</th><th>SYMPTOMS</th><th>INVESTIGATIVE ACTION</th><th>REMARKS</th></tr>
<tr><td rowspan="3">15 to 19<br>inclusive</td><td>No bars displayed,<br>Unready Tone heard.</td><td>Monitor SYL (chap. 8).<br>SYL = 1.<br>SYL = 0.</td><td><br>Suspect Unit 9.<br>Suspect Unit 8 or Unit 7.</td></tr>
<tr><td>Incorrect number of<br>bars displayed</td><td></td><td>Suspect Unit 9 or Unit 1.</td></tr>
<tr><td></td><td></td><td>The purpose of the tests contained in paras. 15 to 19 is to confirm that the radio operates on each of the three frequency bands. If it does not, monitor BSA and BSB (chap. 8) to check that the frequency bandswitching control data is being generated correctly by Unit 7, as follows:<br><br><table><tr><th>Reference</th><th>Band</th><th>BSA</th><th>BSB</th></tr><tr><td>15<br>17<br>19</td><td>1<br>2<br>3</td><td>0<br>1<br>1</td><td>1<br>1<br>0</td></tr></table></td></tr>
<tr><td>20</td><td>Receiver noise not heard</td><td></td><td>Suspect Unit 5 or Unit 1</td></tr>
</table>

TABLE 9.1 Fault Location (continued)

| REFERENCE (chapter 4, para.) | SYMPTOMS | INVESTIGATIVE ACTION | REMARKS |
|---|---|---|---|
| 21 | Receiver noise not heard. | | Suspect Unit 4H or Unit 1. |
| | Continuous receiver noise heard. | | Suspect Unit 4H or Unit 1. |
| 23, 24 | Call Tone not heard but display correct. | | Suspect Unit 3. |
| | Call Tone not heard and display incorrect. | | Suspect Unit 1. |
| | Call Tone heard but display incorrect. | | Suspect Unit 1. |
| 28 to 37 inclusive | Talk-through check fails. | At one radio, operate Test key (T) and observe the received signal strength bar display while the other radio is transmitting. (Ensure that the other radio is 'on' and 'active' by observing the transmitting output power bar display at that radio). | If no bars are displayed, or audio/noise heard, at the receiving radio, suspect Unit 6, Unit 5 or Unit 1 in that radio.<br><br>If bars are displayed at the receiving radio but no audio/noise is heard, suspect Unit 5, Unit 4H or Unit 3 in that radio.<br><br>If bars are displayed at the receiving radio, but incorrect audio is heard, suspect Unit 8, Unit 4H or Unit 3 in the transmitting radio. |

TABLE 9.1 Fault Location (continued)

| REFERENCE (chapter 4, para.) | SYMPTOMS | INVESTIGATIVE ACTION | REMARKS |
|---|---|---|---|
| 40 to 47 inclusive | | | If the radio has competed the preceeding checks satisfactorily, but appears faulty during hopping frequency operation, suspect Unit 4H. |
| 48, 49 | Hailing Tone not heard. | Monitor CAD (chap. 8) at transmitting radio.<br>CAD = 1<br>CAD = 0 | <br><br>Suspect Unit 4H.<br>Suspect Unit 7 or Unit 8. |
| 54 | Display incorrect | | Suspect Unit 4H or Unit 1. |
| 57 | Erasure fails. | | Suspect Unit 4H or Unit 1. |
| 60 to 73 inclusive | | | If the radio has completed the preceeding checks satisfactorily, but appears faulty during remote working, suspect Unit 3 or Unit 1. |

# CHAPTER 10

# TEST EQUIPMENT

## CONTENTS



## Tables

# CHAPTER 10

# TEST EQUIPMENT

## INTRODUCTION

1. The tables which follow list the items of test equipment required to carry out the performance checks detailed in Chapter 11 of this handbook.

| ITEM | DESCRIPTION | SPECIFICATION | EXAMPLE | QTY |
|---|---|---|---|---|
| 1 | AF Signal Generator (Two tone) | Tone A frequency variable 10 Hz to 10 kHz<br>Tone B frequency variable 10 Hz to 100 kHz<br>Output level variable 0 to 1 V r.m.s. e.m.f.<br>Output impedance 300 ohms balanced<br>Tones A+B 0 to 1 V e.m.f, 300 ohms balanced<br>0 to 10 V e.m.f, 300 ohms or 50 ohms unbalanced | Racal-Dana 9063 | 1 |
| 2 | AF Voltmeter | Voltage Range: 0 to 10 V true r.m.s.<br>Frequency Range: Less than 100 Hz to more than 100 kHz<br>Input Impedance: 1 Mohm nominal | Racal-Dana 9300 (Switched Time Constant) | 2 |
| 3 | DC Power Supply | Range: 0 V to 18 V variable<br>Rating: 2 A<br>Source Resistance: not greater than 0.1 ohm<br>Ripple: not to exceed 10 mV peak-to-peak | Racal-Dana Twin Supply 9232Q | 2 |
| 4 | Digital Multimeter | To measure Resistance, DC Voltage and Current.<br>True r.m.s. AC voltage and current<br>Resistance ranges 0 to greater than 1 Mohm<br>Voltage ranges 0 to 100 V<br>Current ranges 0 to 2 A (extendable to 20 A max. with Current Shunt, e.g. Racal-Dana Accessory No. 91) | Racal-Dana 4002 | 2 |
| 5 | Frequency Counter/ Timer | Range: 0 to 100 MHz<br>Accuracy: 0.1 ppm<br>Input Sensitivity: 25 mV pd r.m.s.<br>Eight-digit readout<br>Timer up to 100 s, A/B selectable edge trigger. | Racal-Dana Model 9906/04A | 1 |

Table 10.1 Common Test Equipment (Continued)

| ITEM | DESCRIPTION | SPECIFICATION | EXAMPLE | QTY |
|---|---|---|---|---|
| 6 | Frequency Deviation Meter | Input Impedance: 50 ohms<br>Frequency Range: 30 to 100 MHz<br>Input Sensitivity: better than 10 mV r.m.s.<br>Spurious Deviation: More than 50 dB down on 10 kHz deviation.<br>Deviation Ranges: 0 to 3 kHz and 0 to 10 kHz | Racal-Dana Type 9008 | 1 |
| 7 | Oscilloscope | Dual trace, general purpose. Vertical deflection bandwidth, greater than 20 MHz, sensitivity better than 5 mV/cm. Display modes, main timebase, delayed timebase, main timebase intensified by delayed timebase. | Gould OS 3500 | 1 |
| 8 | RF Power Meter | Range: 1 mW to 10 W<br>Frequency range: greater than from 30 to 88 MHz<br>Input Impedance: 50 ohms | Hewlett Packard Type HP436A with HP 8482B Power Sensor | 1 |
| 9 | RF Signal Generator | Variable frequency to an accuracy of 0.1 p.p.m. Frequency deviation capability greater than 15 kHz peak. Frequency variable 5 MHz to 100 MHz, resolution 10 Hz. Modulation response, from less than 20 Hz to greater than 20 kHz. RF output variable over the range -130 dBm to +13 dBm. | Racal Dana Type 9084/04B | 1 |
| 10 | RF Voltmeter | Frequency Range: 10 kHz to 500 MHz<br>Voltage Range: 100 µV to 3 V r.m.s.<br>Input impedance (internal termination): 50 ohms<br>Impedance probe: 100 kohms nominal. | Racal-Dana 9301A | 1 |
| 11 | Data/Square Wave Generator | Square waves 9 V peak to peak 16 kBit/sec | Exact 119L | 1 |

Table 10.2 Special-to-Type Test Equipment

| ITEM | DESCRIPTION | REMARKS | EXAMPLE | QTY |
|---|---|---|---|---|
| 1 | VIU Interface | BCC Drawing 40090-100-10 | BCC Test Jig 1090 | 2 |
| 2 | Audio Interface | BCC Drawing 40091-100-10 | BCC Test Jig 1091 | 2 |
| 3 | 150 Hz Pass/Notch Filter | BCC Drawing 40092-100-10 | BCC Test Jig 1092 | 1 |
| 4 | 20/40 dB Tee Pad | BCC Drawing 40093-100-10 | BCC Test Jig 1093 | 1 |
| 5 | Simulator Antenna BCC 66 | BCC Drawing 40096-100-10 | BCC Test Jig 1096 | 1 |
| 6 | Data Measurement Test Jig, Two Radio | BCC Drawing 40020-100-10 | BCC Test Jig 1020 | 1 |
| 7 | Data Measurement Test Jig, One Radio | BCC Drawing 40030-100-10 | BCC Test Jig 1030 | 1 |
| 8 | 6 dB Fixed Attenuator | 50 ohms, DC to 50 MHz, rating 100 W continuous | Bird Tenuline 8343-060 | 2 |
| 9 | Programmer | | Racal MA 4073 | 1 |
| 10 | Attenuator Variable 0 to 110 dB | Steps of 1 dB, 50 ohms, DC to 50 MHz | Telonic 8143A | 1 |
| 11 | 300 ohm load | Mounted on BNC plug | | 1 |

# CHAPTER 11

# PERFORMANCE TESTS

## CONTENTS

## Tables



## Illustrations



## APPENDIX

# CHAPTER 11

# PERFORMANCE TESTS

## 1.0 INTRODUCTION

1.1 The performance tests given in this chapter are for the BCC 66H radio only. For details of the tests which should be applied to the COMSEC unit, the VIU, or any other item of ancillary or optional equipment, refer to the appropriate Technical Handbook (see Chapter 1).

1.2 It is recommended that the full range of tests is applied immediately following any major repair or overhaul. Individual tests may be conducted as required during fault location and minor repair and adjustment. Performance limits quoted are those obtained at normal test environment temperatures (15 to 30$^{o}$C).

### Test Equipment Required

1.3 The test equipment required is listed in Chapter 10.

### General Notes and Warnings

1.4 Throughout the procedures which follow:

(1) Unless otherwise indicated, the term 'radio' refers to the BCC 66H under test.

(2) The term 'any frequency' indicates any one frequency between 30 000 kHz and 87 975 kHz inclusive.

(3) To prevent interference with other Jagaur V radios undergoing test at the same time, Transmit frequencies should be multiples of 50 kHz and Receive Frequencies should be odd multiples of 25 kHz.

(4) When any selection is made at the keyboard, check that the correct display response is received.

(5) If an incorrect test result is obtained, unless otherwise indicated:

(a) Check that the radio and the test equipment are connected and adjusted as required for the test.

(b) Repeat the test.

(c) If the test result is still incorrect reject the radio as faulty.

(6) The test figures specified are conventional true-values and constitute fundamental terms of reference. The degree of accuracy and influence of measuring equipment must therefore be taken into consideration when verifying the performance of the equipment under test.

## 2.0 CURRENT CONSUMPTION

2.1 Connect the test equipment as shown in Fig. 11.1 and add the test equipment as shown in Fig. 11.3c. Set the d.c. supply voltage to 12.0 V with a current limit of 1.8 A.

NOTE: The test equipment layout diagram Figs 11.1 to 11.7 do not show Power Supply Voltage and current monitors connected as the recommended unit has these fitted internally. However the Vehicle Interface Unit interface (TJ1090) has facilities for connection of external voltage and current monitors should these be required.

2.2 Set the radio under test as shown in Fig. 11.8 line 1. Set the audio and VIU interfaces as shown in Fig. 11.9 line 2.

Receiver Current (Non Battery Save)

2.3 Key in any Receive Frequency. With the displayed frequency visible in bright daylight (or the equivalent) measure the dc supply current. It should not exceed 750 mA.

2.4 Measure the time taken after the final key operation, for the display to revert to alternately flashing bars at either end of the display. It should be 10 ±3 seconds.

2.5 Measure the d.c. supply current. It should not exceed 270 mA.

Receiver Current (Battery Save Condition)

2.6 Set the CONTROL switch to LOC ECON.

2.7 Measure the d.c. supply current. It should be cycling between 110 mA (maximum) and 270 mA (maximum).

NOTE: In economise mode, after transmission or reception of a signal the system holds in non battery save for 15 seconds (nominal) and then reverts to battery save.

2.8 Reset the CONTROL switch to LOC.

Transmitter Current (Medium Power)

2.9 Set the radio under test as shown in Fig. 11.8 line 1.

2.10 Set the Audio Interface and VIU Interface as shown in Fig. 11.9 Line 1.

2.11 Key in any frequency. Set the Audio Interface pressel to Tx and measure the supply current. It should be 1.7 Amp maximum. Release the pressel.

NOTE: Repeat the measurement for at least one frequency in each of the three RF bands eg. 30050, 44050, 64050.

Transmitter Current (Low Power)

2.12 On the Keyboard select Lo - Low Power.

2.13 Key in any frequency. Set the Audio Interface pressel to Tx and measure the supply current. It should be 1.0 Amp maximum. Release the pressel.

NOTE: Repeat the measurement for at least one frequency in each of the three RF bands e.g. 30050, 44050, 64050.

3.0 KEYBOARD EXERCISE - DISPLAY CHECK

3.1 Connect the test equipment as shown in Fig. 11.1 and add the test equipment as shown in Fig. 11.3c. Set the supply voltage to 10.50 V DC with a current limit of 1.8 A.

3.2 Set the radio under test as shown in Fig. 11.8 Line 1.

3.3 Set the Audio Interface and VIU Interface as shown in Fig. 11.9 Line 2.

3.4 Key Test (T) and release. Check that the display is illuminated and after 10 seconds nominal it reverts to an alternately flashing single horizontal bar at positions 1 and 8. (See also 2.4 Receive current).

3.5 Perform the sequence of checks detailed in Table 11.1 (steps 1 to 42). At each step of the sequence:

(1) Select the CHAN and VOL - ON/OFF switches and the keys as described for the step.

(2) On completion of the selection, confirm that the display and audio responses received are as specified for the step.

3.6 If an incorrect response is received at any step.

(1) Repeat the selection for the step.

(2) If the error persists, operate and release the Test key (T).

(3) If after several operations of the Test key the error still persists, the radio should be rejected as faulty.

NOTES 1. Unless otherwise indicated, the display response should not flash and should persist for 10 seconds nominal; at the end of that period, the display should revert to showing alternately-flashing, single horizontal bars at character positions 1 and 8. The audio response should remain unchanged until the next selection is made.

2. If a BITE error is detected at switch-on, Error Tone will be heard and the mode information (character positions 1, 7 and 8) should flash.

3. If the radio was in the Fixed frequency mode at switch-on, operation of the hH key may result in the BITE signalling the presence of a fault by initiating the Error Tone. The tone will also be generated if no hop code is held in the channel M memory. In the latter case, it should be possible to cancel the Tone by programming the channel as detailed in Steps 25 to 35 inclusive; if this programming is successfully completed, the steps concerned may then be ommitted from the later sequence.

4. Warning tones are defined in the Appendix.

Table 11.1 Keyboard and Display Self-Check

| STEP | SELECTION | | | RESPONSE | |
|---|---|---|---|---|---|
| | CHAN Switch | VOL-ON/OFF Switch | Keyboard | Display (Character Position 1 2 3 4 5 6 7 8) | Audio |
| 1 | M | | 4000, F, n, M | F 4 0 0 0 0 ⊓ ⊓ (see Note 2) | Receiver noise |
| 2 | M | Max. vol. | A-R, Lo | F 4 0 0 0 0 A L | |
| 3 | M | Max. vol. | Ic(held) | F 4 0 0 0 0 C L | Call Tone |
| 4 | M | Max. vol. | Ic(released) | F 4 0 0 0 0 I L | |
| 5 | M | Max. vol. | Hi | F 4 0 0 0 0 I ⊓ (see Note 3) | Error Tone |
| 6 | M | Max. vol. | n,Lo | F 4 0 0 0 0 ⊓ L | |
| 7 | M | Max. vol. | hH(once) | h 4 0 0 0 0 ⊓ L (see Note 4) | |
| 8 | M | Max. vol. | hH(twice) | H 4 0 0 0 0 ⊓ L | |
| 9 | M | Max. vol. | T(held) | = | Receiver noise |
| 10 | M | Max. vol. | T(released) | H 4 0 0 0 0 ⊓ L | |
| 11 | M | Max. vol. | F,3215 | F 3 2 1 5 0 ⊓ L | |
| 12 | M | Max. vol. | T,6897 | F 6 8 9 7 5 ⊓ L | |
| 13 | M | Max. vol. | T,01293 | F 3 ⊓ L | |
| 14 | M | Max. vol. | T | F 6 8 9 7 5 ⊓ L | |
| 15 | 1 | F | 3100 | 3 1 0 0 0 | |
| 16 | 2 | F | 3200 | 3 2 0 0 0 | |
| 17 | 1 | F | | 3 1 0 0 0 | |
| 18 | 3 | F | 3300 | 3 3 0 0 0 → | |
| 19 | 4 | F | 3400 | 3 4 0 0 0 | |
| 20 | 5 | F | 3500 | 3 5 0 0 0 | |

Table 11.1 Keyboard and Display Self-Check (Continued)

| STEP | SELECTION | | | RESPONSE | |
|---|---|---|---|---|---|
| | CHAN Switch | VOL-ON/OFF Switch | Keyboard | Display (Character Position 1 2 3 4 5 6 7 8) | Audio |
| 21 | 6 | F | 3600 | 3 6 0 0 0 | |
| 22 | 7 | F | 3700 | 3 7 0 0 0 | |
| 23 | 7 | OFF (for 10 seconds) | | | |
| 24 | 7 | Max. vol. | | F 3 7 0 0 0 ⊓ L | |
| 25 | 7 | H | 12345 | 1 2 3 4 5 1 | |
| 26 | 7 | H | ↑ | 2 | |
| 27 | 7 | H | 54321 | 5 4 3 2 1 2 | |
| 28 | 7 | H | ↑ | 3 | |
| 29 | 7 | H | 10101 | 1 0 1 0 1 3 | |
| 30 | 7 | H | ↑ | 4 | |
| 31 | 7 | H | 98111 | 1 1 1 4 | |
| 32 | 7 | H | T | 4 | |
| 33 | 7 | H | 76111 | 7 6 1 1 1 4 | |
| 34 | 7 | H | ↑ | | |
| 35 | C | H | 01010 | 0 1 0 1 0 | |
| 36 | 7 | B | 3525 | 3 5 2 5 0 | |
| 37 | 7 | Max. vol. | | F 3 7 0 0 0 ⊓ L | |
| 38 | Z | Max. vol. | | Blank | |
| 39 | 7 | Max. vol. | | F 0 0 0 0 0 ⊓ ⊓ | Error Tone |
| 40 | 7 | F | 3552 | 3 5 5 2 5 | |
| 41 | 7 | Max. vol. | | F 3 5 5 2 5 ⊓ ⊓ | |
| 42 | M | OFF | | | |

4.0 FREQUENCY ACCURACY AND CONTROLS

4.1 Connect the test equipment as shown in fig. 11.1 and add equipment as shown in fig. 11.3c. Set the audio and VIU Interfaces as per Fig. 11.9 line 1.

4.2 Set the power supply to 12.0 V DC with a current limit of 1.8 A.

4.3 Set the radio under test as shown in Fig. 11.8 line 1.

Frequency Accuracy

4.4 Key in any receive frequency. Set the pressel on the Audio Interface to Tx. Measure the frequency, check that it is within ±3 ppm of the selected frequency. eg. 50 MHz tolerance ±150 Hz.

Frequency Setting Controls

4.5 Key in each of the frequencies listed in turn. Following each selection measure the frequency of the RF output. Check that they are within ±1 kHz of the displayed frequency in each case.

- 3 0 0 0 0
- 3 1 1 0 0
- 4 2 2 2 5
- 5 3 3 7 5
- 6 4 4 5 0
- 7 5 5 5 0
- 8 6 6 5 0
- 3 7 7 5 0
- 3 8 8 5 0
- 3 9 9 5 0
- 8 7 9 7 5

4.6 Release the pressel on the Audio Interface (Rx position).

5.0 LOW BATTERY WARNING (BITE)

5.1 Connect the test equipment as shown in Fig. 11.2 and items as shown in Fig. 11.3c. Set the Audio and VIU Interfaces as per Fig. 11.9 Line 2. Set the radio under test as shown in Fig. 11.8 Line 1.

5.2 Set the power supply to 12.0 V DC with a current limit of 1.8 A.

5.3 Slowly decrease the DC supply voltage until a pulsed AF signal (receiver noise) appears on the Oscilloscope.

5.4 Measure the DC supply voltage and check that it is 9.7 V to 10.3 V. Reset the supply voltage to 12.0 V.

.4 Measure the signal to noise ratio (S+N/N) check that it is at least 10 dB.

.5 Repeat the measurement for three frequencies in each of the three RF bands. eg. 30025, 36375, 43175/ 43225, 51925, 62375/ 62425, 74125, 87975.

NOTES: 1 Measurement of Quieting (for definition see Appendix) and Signal to Noise will be affected by extraneous signals so a clear channel should be used. Clear channels may be located using 'quieting' with no RF signal applied. This will not change materially as the receiver frequency is varied unless interference is present. A channel with minimum quieting may be regarded as clear. This is particularly important when performing squelch closed tests.

2 Unless otherwise stated the RF signal generator will be adjusted to the selected receive frequency.

.0 SQUELCH OPERATION (AUDIO)

.1 Connect the Test Equipment as shown in Fig. 11.5 and 11.4c then set the radio under test as shown in Fig. 11.8 Line 1.

.2 Set the Audio and VIU Interfaces as per Fig. 11.9 Line 8.

NOTES: 1. DMM2 responds to any squelch as (CSQ monitored)

0 = no squelch open

5 V = any squelch open

2. Audio Interface monitor equipment displays received audio signals.

3. Initially set radio to noise on (*) to allow easy setting of Quieting and S+N/N values at which the squelch is to be tested. Reset VOL-ON/OFF to maximum volume when performing the tests.

.3 Key any receive frequency and check that the channel is clear.

Noise Squelch

(a) Open

.4 Set the RF signal generator to modulation off and the output level so as to give 10 dB quieting. Switch off the carrier. See para. 8.2 Note 3.

NOTE: For definition of quieting see Appendix.

.5 Switch the carrier on. Check that the squelch opens and CSQ is high state (5 V nominal). (Modulate the carrier with 1 kHz sinewave deviation ±6 kHz peak and observe COMSEC pins D or G on the CRO for squelch open.)

(b) Closed

.6 Switch off the carrier. Check that the squelch closes and CSQ is in low state (0 V).

Tone Squelch

(a) 150 Hz normal

8.7 Key A-R. Set the RF signal to modulation OFF and the output level so as to give 10 dB quieting.

8.8 Select CPS on the VIU Interface monitor switch and check using the DMM that CPS is in the high state (5 V nominal).

NOTE: In A-R mode carrier squelch (CSQ) will respond to any carrier, but will close again if 150 Hz tone or 16 kBits data is not detected within 250 msec nominal.

8.9 Select CSQ on the VIU Interface monitor switch. Apply squelch tone modulation at 150.0 Hz and deviation 1.3 kHz. Check that CSQ is high (5 V nominal).

(b) 147 Hz

8.10 Set the RF signal to modulation OFF and the output level so as to give 10 dB quieting. Apply squelch tone at 147.0 Hz and deviation 1.3 kHz.

8.11 Switch on the carrier and check that the squelch is open.

(c) 153 Hz

8.12 Repeat as per 147 Hz check (paras. 8.10, 8.11) but using 153 Hz.

9.0 AUDIO LEVELS

9.1 Connect the test equipment as shown in Fig. 11.5 and Fig. 11.4c.

9.2 Set the radio under test as shown in Fig. 11.8 Line 1.

9.3 Set the Audio and VIU Interfaces as per Fig. 11.9 line 9.

9.4 Key any receive frequency. Set the RF signal generator to -30 dBm (arbitrarily large) modulated with standard audio modulation (see appendix).

Fixed Level Audio (FLA)

9.5 Measure outputs as selected on the AF voltmeter, CRO and DMM as required. On the Audio Interface set SW1 to COMSEC and SW3 to pin D.

Measure COMSEC pin D, check that it is within 0.4 to 0.63 V rms.

9.6 Select VIU on SW1 and measure pin D. Check that it is within 0.4 to 0.63 V rms.

9.7 Select REM on SW4 and I/P monitor on SW7, measure and check that it is within 0.65 to 1.1 V rms.

Volume Control

9.8 Select NORMAL (SW4), and O/P monitor (SW7).

(a) Volume Control Maximum

Set the volume control to maximum. Using SW3 and SW1 select VIU socket pins D and G and COMSEC socket pins D and G in turn. Measure the output for each selection, check that they are not less than 0.88 V. The maximum difference between D and G of the same socket shall not exceed 2 dB.

(b) Volume Control W (Whisper)

Set the volume control to W. Using SW3 and SW1 select VIU socket pins D and G and COMSEC socket pins D and G in turn. Measure the output for each selection, check that they are within -30 dB ±2 dB relative to the equivalent measurement in volume maximum.

(c) Volume Control Intermediate Positions

Select intermediate positions in turn. Check that the level increase per step is between 6 and 9 dB.

DATA MODE

Set the test equipment as shown in Fig. 11.5 and add items as shown in Fig. 11.4d. Set the Audio and VIU Interfaces as per Fig. 11.9 line 10. Set the radio as shown in Fig. 11.8 line 1.

Key any receive frequency then set the RF signal generator to -30 dBm (arbitrarily large) and with standard data modulation (see Appendix).

On the Audio Interface set SW1 to COMSEC socket and SW3 to pin D. Measure using the CRO and check that logic 0 is 0 to 2 V and logic 1 is 7 to 9.5 V.

Set the Audio Interface to I/P monitor. Measure using the CRO and check that it is 3 V peak to peak ± 15%. Set the radio as shown in Fig 11.8 line 4. Set the audio and VIU Interfaces as per Fig 11.9 line 15. Add a 300 ohm load across the data input socket on the Audio Interface Box.

SENSITIVITY (DATA)

This test requires special-to-type measuring equipment a Bit Error Rate test set. The Data Measurement Test Jig One Radio TJ1030 measures BER. Instructions for performing the test are to be found in the test set manual. Ensure the radio is set as shown in Fig. 11.8 Line 1.

Key any receive frequency then set the RF signal generator to -113 dBm. Check that the Bit Error Rate is not greater than 1 in 10.

SQUELCH (DATA)

Set the test equipment as shown in Fig. 11.6 and add items as shown in Fig. 11.4d. Set the Audio and VIU Interfaces as per Fig. 11.9 line 11. Ensure the radio is set as per Fig. 11.8 line 1.

NOTE: 1. DMM 2 responds to any squelch (CSQ) and is not used for this test.

2. Pin G on the COMSEC socket is used to detect data squelch.

12.2 Set the RF signal generator modulation to OFF and the output level so as to give 10 dB quieting. Switch off the carrier.

12.3 Apply modulation from a data source and switch on the carrier. Check that the squelch opens (pin G on COMSEC socket high state).

NOTE: If the Data Measurement Test set is not available this test may be carried out using 8 kHz sine wave modulation with an accuracy of ±1 Hz.

## 13.0 HOPPING OPERATION

13.1 This test series requires two radios set up as a link in a controlled manner. The basic operating block diagram of the link is shown in fig. 11.7. Radio A is the transmitting radio and Radio B the receiving radio.

NOTES: 1. Radio B will be sensitive to external interference.

2. Care should be taken to minimise direct signal leakage from radio A to radio B.

3. Measurement problems due to leakage can be minimised by operating Radio A in low power (Lo).

13.2 Bit Error Rate (BER) measurements require the special-to-type equipment listed under Data Measurement Test Jigs. Measurement instructions for BER will be found in the technical manual for the BER test jig.

13.3 Connect the attenuator output to the (50 ohm) millivoltmeter and set the attenuator to obtain say -14 dBm (-20 dBm at B radio input when reconnected) on the millivoltmeter - note the attenuator setting. The attenuation to yield the desired signal level at B radio input may now be calculated (e.g. to obtain -111 dBm, increase by 91 dB (-111 + 20 dBm)).

## 14.0 HOPPING SYNCHRONISATION

14.1 Programme both radios to a frequency of 33250 (approximately the middle of hop band 1) and the same hop code.

14.2 Connect the test equipment as shown in Fig. 11.7. Set radios A and B power supplies to 12.0 V DC. Set the Audio and VIU Interfaces as per Fig. 11.9 line 1. Set both radios as per Fig. 11.8 line 3.

14.3 In fixed frequency mode set the level at radio B input to -111 dBm by using the method given in 13.3. Modulate radio A with 1 kHz.

### Initial Synchronisation

14.4 Set both radios off. Switch both radios on again, at radio A key hH twice (control station) and at radio B key hH once (out station). Arm the counter to start on the rising edge of CPS and stop on rising edge of the output of pin G of the COMSEC socket then reset the counter. Set the radio A pressel to transmit - the counter should start and run for not greater than 6.5 secs.

Resynchronisation

14.5 After initial synchronisation is achieved repeat the arming of the counter (as 14.4) and set radio A pressel to transmit. The counter should start and run for not greater than 200 msecs.

NOTE: After both initial synchronisation and resynchronisation tests check that Radio B receives the modulated tone.

15.0 HOPPING SENSITIVITY

15.1 The parameter to be measured is Bit Error Rate (BER). The measurement is to be performed at an RF input level to the B radio of -111 dBm. The BER shall not exceed 1 in 10. (See manual for method).

NOTE: If BER measuring equipment (Data Measurement Test Jig, Two Radio TJ1020) is not available the functioning of the radio in hop mode can be checked by carrying out a voice communication test at this signal level.

16.0 HOPPING TRANSMIT

16.1 Repeat the tests of 13, 14 and 15 but using the A radio (Transmitter) as the unit under test. Repeat the measurements with programming for each hop band in turn.

17.0 TRANSMITTER RF POWER OUTPUT

50 Ohms

17.1 Connect the test equipment as shown in Fig. 11.1 and add items as shown in Fig. 11.3 (a). Set the power supply for 12.0 V DC and the Interfaces as shown in Fig. 11.9 line 12. Set the AF signal generator to give 10 mV rms pd.

17.2 Set the radio as shown in Fig. 11.8 line 1. Key in a frequency of 30050 kHz and set the pressel to transmit.

17.3 Measure the power output, check that it is not less than 3 W. Measure the sidetone at pins D and G of the VIU and COMSEC sockets check that it is 0 to -3 dB relative to the receiver AF output obtained at the same pin. Release the pressel.

NOTE: Sidetone level needs only to be checked at one transmit frequency with the volume control maximum. Thereafter verify presence or absence of sidetone.

17.4 Check the power output for three frequencies in each band e.g. 30050, 36350, 43150 / 43250, 51950, 62350 / 62450, 74150, 87950.

Whip Antenna

17.5 Repeat the test as in paras. 17.1 to 17.4 except that the test equipment should be set as shown in Fig. 11.1 and Fig. 11.3(b). Measure the power at the output of the whip simulator - check that it is not less than 0.75 W.

18.0 TRANSMITTER MODULATION

18.1 Connect the test equipment as shown in fig. 11.1 and fig. 11.3 (d). Set the power supply to 12.0 V DC with a current limit of 1.8 A. Set the audio and VIU Interfaces as per Fig. 11.9 line 8. Ensure that the radio under test is set as per Fig. 11.8 line 3.

150 Hz Modulation

18.2 Set the deviation meter AF filter out and set the auxiliary filter to 150 Hz select.

NOTE: The 150 Hz tone frequency needs only to be checked once.

18.3 Key 36350 and set the pressel to transmit. Measure the 150 Hz frequency, check that it is 150 Hz ±1 Hz.

18.4 Measure the 150 Hz deviation, check that it is 2.5 to 3.5 kHz for the 3 kHz standard setting (or 1.3 to 2.0 kHz for the optional 1.6 kHz setting. Release the pressel.

18.5 Repeat the measurements of 18.4 at three frequencies in each band eg. 30050, 43150 / 43250, 51950, 62350 / 62450, 74150, 87950.

Audio Modulation (150 Hz tone rejected)

NOTE: If the variation of 150 Hz tone with channel frequency has been established it is sufficient to prove the remaining modulation functions at a single test frequency.

18.6 Set the deviation meter AF filter IN. Set the AUX filter to 150 Hz STOP. Set the radio under test as per Fig. 11.8 line 1. Set the Audio and VIU Interfaces as per Fig. 11.9 line 13.

18.7 Key 36350 and set the pressel to transmit.

(a) Audio Sensitivity (Max Volume)

18.8 Set the AF signal generator to 1 kHz nominal and vary the output to obtain a deviation of ±4.2 kHz peak. Measure the input signal amplitude on the AF voltmeter, check that it is within the range 0.50 mV to 1.50 mV rms pd.

(b) Audio ALC

18.9 Set the AF signal generator to 30 mV rms pd. Measure the deviation - check that it is not greater than ±7.8 kHz peak.

(c) Audio Sensitivity (Whisper)

18.10 Set the radio volume control to whisper (W). Vary the output of the AF signal generator to obtain a deviation of ±4.2 kHz peak.

18.11 Measure the input signal amplitude. Check that it is between 9 and 14 dB less than that observed in Audio Sensitivity in para. 18.8. Return the volume control to maximum.

(d) Audio Sensitivity (FLA mode)

.12 Select FLA on the Audio Interface. Set the AF signal generator to 1 kHz nominal and vary the output to obtain a deviation of ±4.2 kHz peak. Measure the input signal amplitude, check that it is between 28 and 32 dB greater than that observed in Audio Sensitivity in para. 18.8.

Remote Line Operation (Audio)

(a) Remote Line Sensitivity

.13 Set the Audio and VIU Interfaces as per Fig. 11.9 line 13. Set the radio under test as per Fig. 11.8 line 4.

.14 Set the AF signal source A tone to 1 kHz nominal and B tone to 23.30 kHz each with a level of 250 mV rms pd.

.15 Check that transmit has been initiated (indicated by Power Output and CPS high on the VIU Interface; deviation on the deviation meter (1 kHz) and sidetone - 1 kHz tone).

.16 Vary the 1 kHz tone output as necessary to obtain a deviation of ±4.2 kHz peak.

.17 Switch to A only (1 kHz) and check that the input signal amplitude is 250 mV rms pd ±25%.

NOTE: Removal of the B tone causes the radio to revert to the receive state. Check that the power output drops to zero within 1 sec nominal.

Data Modulation

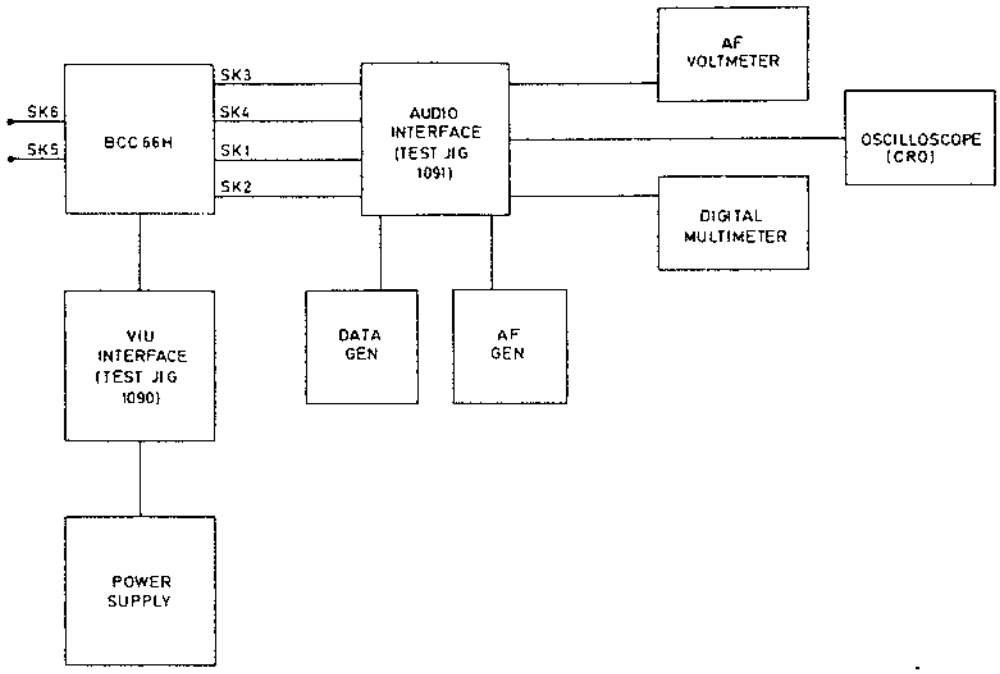
.18 Set the Audio and VIU Interfaces as per Fig. 11.9 Line 14. Set the radio under test as per Fig. 11.8 Line 3.

(a) Sensitivity Data

.19 Set the DATA source to give a 16 kB/s square wave centred on 4.5 V with a peak to peak swing of 5 V (2 to 7 V). Set the pressel to transmit. Check that the deviation is not less than ±5.5 kHz peak.

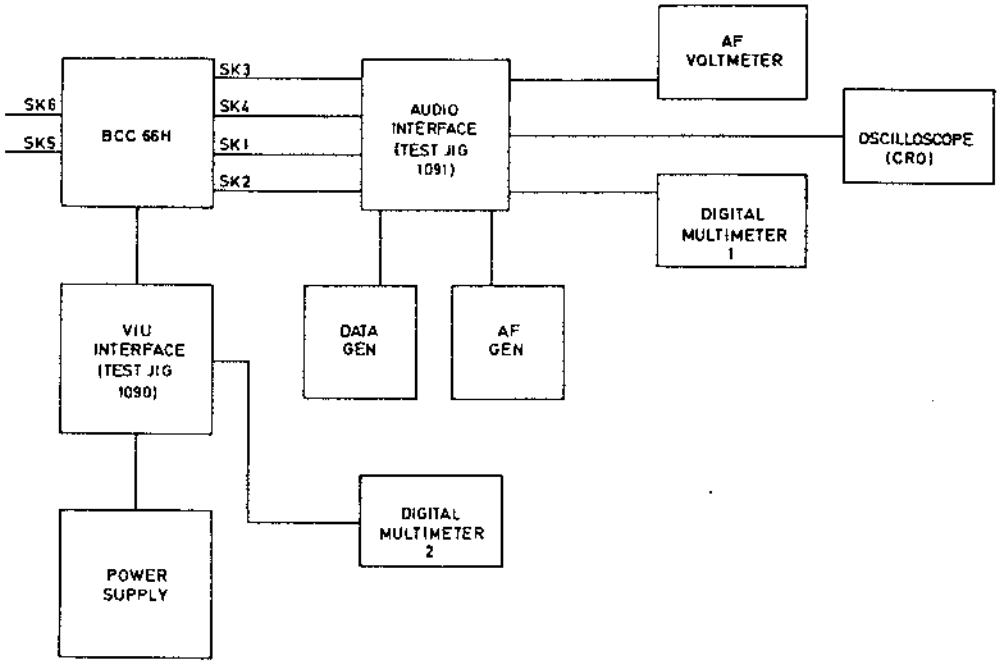
(b) ALC Data

.20 Increase the modulating signal to 9 V peak-to-peak (0-9 V). Check that the deviation is not greater than ±7.8 kHz peak.




Test Equipment Connections for Basic Transmit and Receive Tests

Fig 11.1




Test Layout to Monitor Connections with Vehicle Interface Unit

Fig 11.2

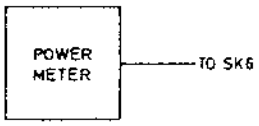



FIG.3a


FIG.3b

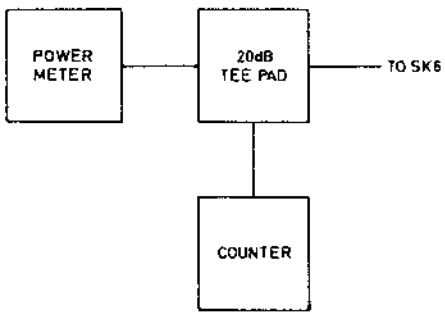



FIG. 3c

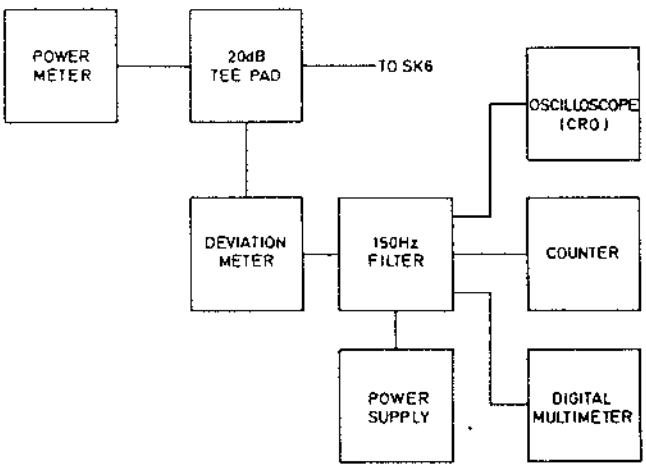



FIG. 3d

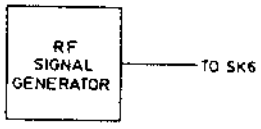



FIG. 4a

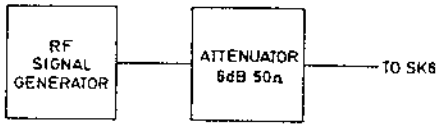



FIG. 4b

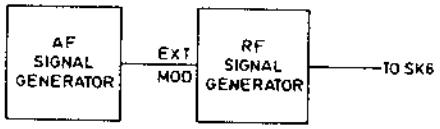



FIG. 4c

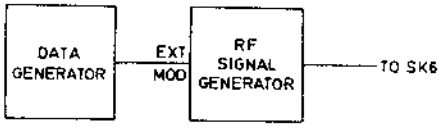
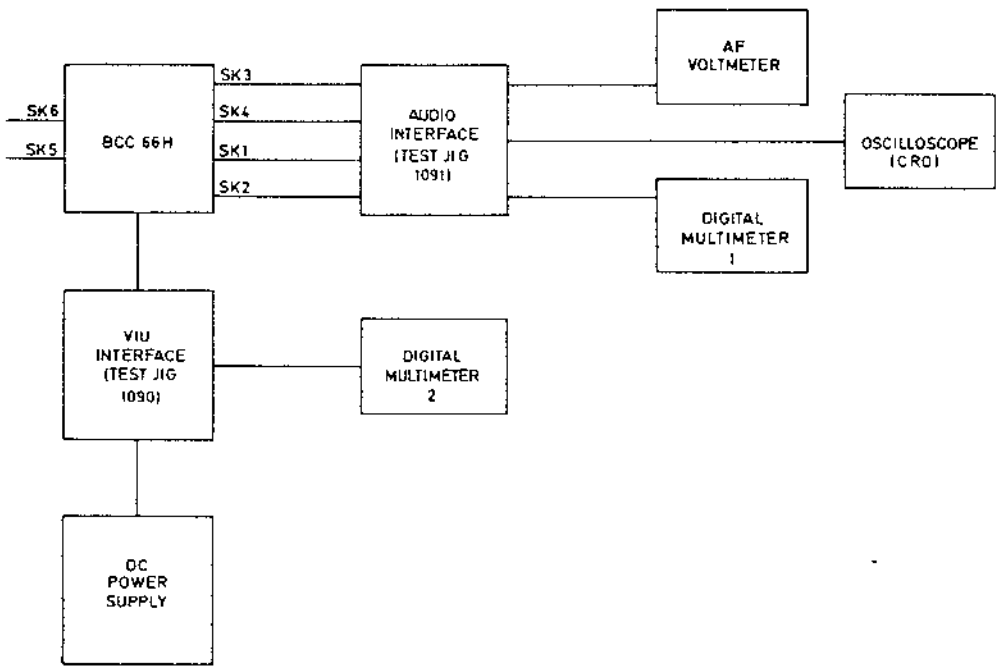
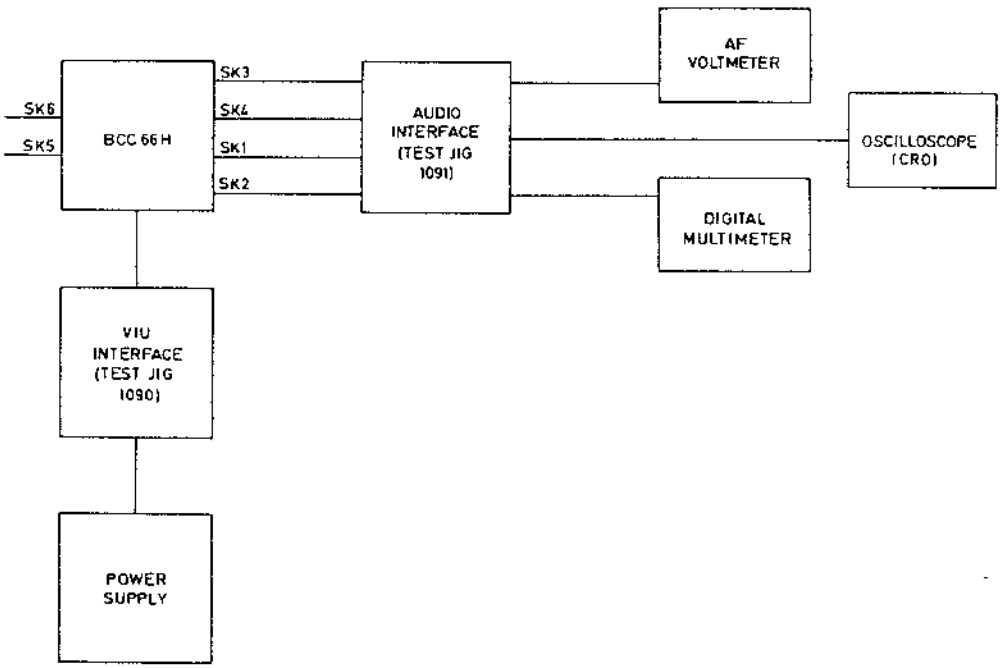


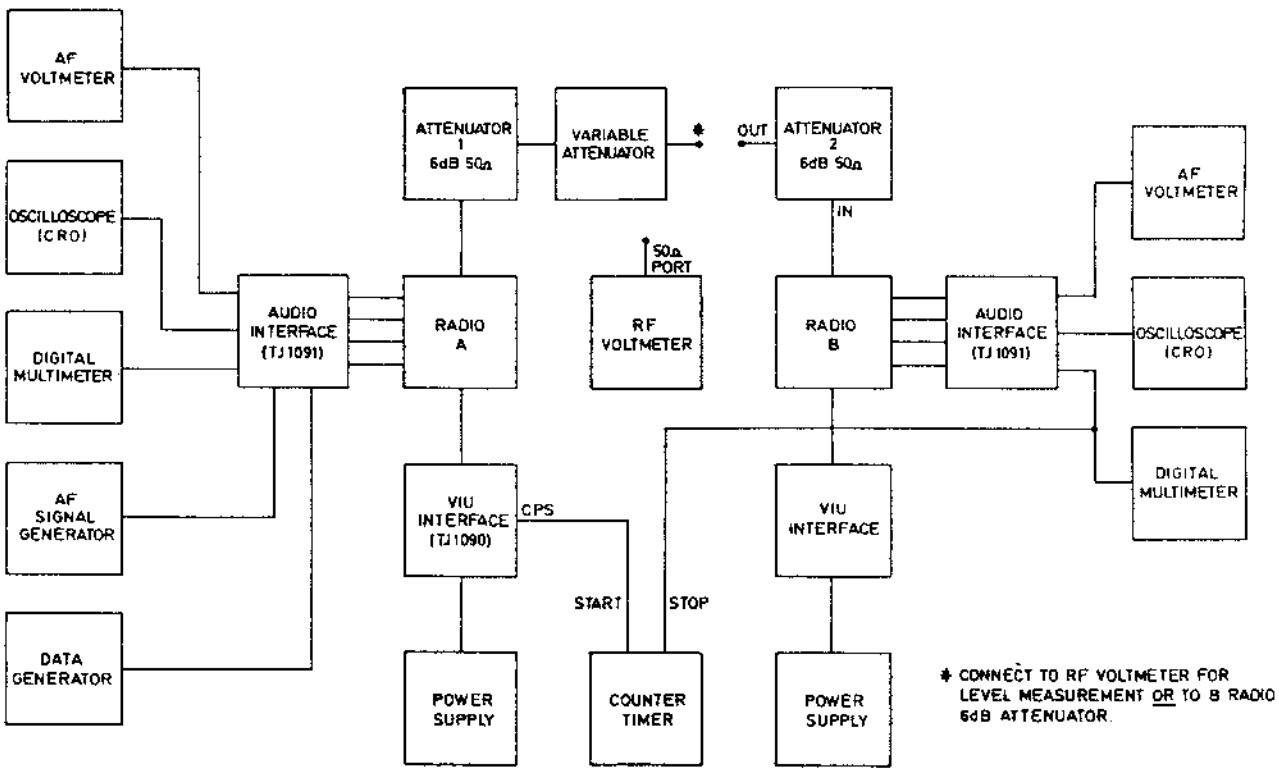

FIG. 4d






Receiver Sensitivity and AF Tests Fig.11.5


SK6
SK5
BCC 66 H
SK3
SK4
SK1
SK2
AUDIO
INTERFACE
(TEST JIG
1091)
AF
VOLTMETER
OSCILLOSCOPE
(CRO)
DIGITAL
MULTIMETER
VIU
INTERFACE
(TEST JIG
1090)
POWER
SUPPLY


AF VOLTMETER
OSCILLOSCOPE (CRO)
DIGITAL MULTIMETER
AF SIGNAL GENERATOR
DATA GENERATOR
AUDIO INTERFACE (TJ1091)
ATTENUATOR 1 6dB 50Ω
VARIABLE ATTENUATOR
RADIO A
50Ω PORT
RF VOLTMETER
VIU INTERFACE (TJ1090)
CPS
START
STOP
POWER SUPPLY
COUNTER TIMER
OUT
ATTENUATOR 2 6dB 50Ω
IN
RADIO B
VIU INTERFACE
POWER SUPPLY
AUDIO INTERFACE (TJ1091)
AF VOLTMETER
OSCILLOSCOPE (CRO)
DIGITAL MULTIMETER
* CONNECT TO RF VOLTMETER FOR LEVEL MEASUREMENT OR TO B RADIO 6dB ATTENUATOR.

| | CONTROL | CHANNEL | VOLUME | KEYBOARD |
|---|---|---|---|---|
| 1 | LOC | M | MAX | n, M, F |
| 2 | LOC | M | * | n, Lo, F |
| 3 | LOC | M | MAX | n, Lo, F |
| 4 | LOC | M | MAX | A-R, Lo, F |

Radio Settings

Fig. 11.8

| | AUDIO INTERFACE (TEST JIG 1091) | | | | | | | | VIU INTERFACE (TEST JIG 1090) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TX/RX SW2 | SYSTEM SW4 | LOAD SW8 | MONITOR I/P/O/P SW7 | SOURCE SW6 | LINE SW5 | SOCKET UNDER TEST SW1 | SELECT PIN 3 SW3 | MONITOR SW1 | LOCAL ON/OFF SW5 | KVO ON/OFF SW4 | HPS ON/OFF SW3 | HPM ON/OFF SW2 |
| | RX | NORMAL | 300 | O/P | OFF | LOCAL | VIU | D | OFF | OFF | OFF | OFF | OFF |
| | RX | NORMAL | 300/PHONE | O/P | OFF | LOCAL | VIU | D | OFF | OFF | OFF | OFF | OFF |
| | | | | | | | | | HPS | ON | OFF | ON | ON |
| | | | | | | | | | KVO | ON | ON | ON | ON |
| | | | | | | | | | HPM | ON | ON | ON | ON |
| | | | | | | | | | OFF | OFF | OFF | OFF | OFF |
| | | | | | | | | | KVO | ON | ON | ON | OFF |
| | RX | NORMAL | 300 | O/P | OFF | LOCAL | VIU | D | CSQ | OFF | OFF | OFF | OFF |
| | RX | FLA | 300 | O/P | OFF | LOCAL | As Req | As Req | CSQ | OFF | OFF | OFF | OFF |
| 0 | RX | FLA | 300 | O/P | DATA | LOCAL | As Req | As Req | CSQ | OFF | OFF | OFF | OFF |
| 1 | RX | NORMAL | O/C | O/P | OFF | LOCAL | COMSEC | G | CSQ | OFF | OFF | OFF | OFF |
| 2 | RX | NORMAL | 300 | O/P | AUDIO | LOCAL | VIU | D | CPS | OFF | OFF | OFF | OFF |
| 3 | RX | NORMAL | 300/PHONE | I/P | AUDIO | LOCAL | VIU | D | CPS | OFF | OFF | OFF | OFF |
| 4 | RX | NORMAL | 300 | O/P | DATA | LOCAL | COMSEC | D | CPS | OFF | OFF | OFF | OFF |
| 5 | RX | REM | 300 | I/P | DATA | LOCAL | COMSEC | D | CSQ | OFF | OFF | OFF | OFF |

OTES:
1. The terms HPS, KVO, CSQ, CPS and HPM used on the Monitor Switch of the VIU Interface are defined in Chapter 8
2. Power supply switch on the VIU interface box should be set to ext. PSU for all tests.



Audio and VIU Interface Settings

# APPENDIX

## CONTENTS

# APPENDIX

## RECEIVER SENSITIVITY

1. Receiver sensitivity is defined as the 'signal plus noise to noise ratio S+N/N caused by a 1.0 µV emf on-tune signal carrying standard modulation.

## QUIETING

2. Quieting is defined as the ratio of AF power output of the receiver with zero input signal applied, to the power output with a specified signal applied. Usually quoted as the difference in dB between the two observations.

## STANDARD AUDIO (TONE) MODULATION (Used to modulate RF Signal Generator)

3. Standard audio (tone) modulation is ±6 kHz peak deviation for a 1 kHz modulating frequency, together with a 150 Hz tone to a peak deviation of ±1.3 kHz.

NOTE: Standard modulation for BCC 66 equipments is 1 kHz tone only from external sources. The 150 Hz modulating tone is superimposed automatically as required.

## STANDARD DATA (DIGITAL) MODULATION

4. Standard data (digital) modulation is a peak deviation of ±6 kHz for frequency modulation by a 16 kbit/sec signal. The polarity of the modulating signal should be such that a logic 1 causes the frequency to increase and a logic 0 causes the frequency to decrease. At baseband, the logic 1 should be positive-going and the logic 0 should be negative-going. The 16 kbit/sec signal should be a pseudo-random sequence of specified length.

## WARNING TONES

5. (1) Error Tone. A continuous tone alternating between 2.0 kHz and 1.6 kHz (512 ms high frequency, 512 ms low frequency).

(2) Call Tone. A continuous 2 kHz tone.

(3) Low Battery Warning. Regular bursts of noise. In receive mode only 75 ms noise 570 ms off.

NOTE: For further information on warning tones see Chapter 1 fig. 1.4 and page 1-16.

# CHAPTER 12

# FIELD REPAIR PARTS LIST

## CONTENTS



## Illustrations

# CHAPTER 12

# FIELD REPAIR PARTS LIST

## INTRODUCTION

1. This chapter contains a list of spares recommended to be held for field servicing of BCC 66H. The list consists of mechanical items and electrical units and boards. The electrical items are as advocated in the Fault Location Tables in Chapter 8. For dismantling and re-assembly instructions see the relevant part of Mechanical Description and Servicing in Chapter 5.

## MAIN ASSEMBLIES AND UNITS (See Fig. 12.1)

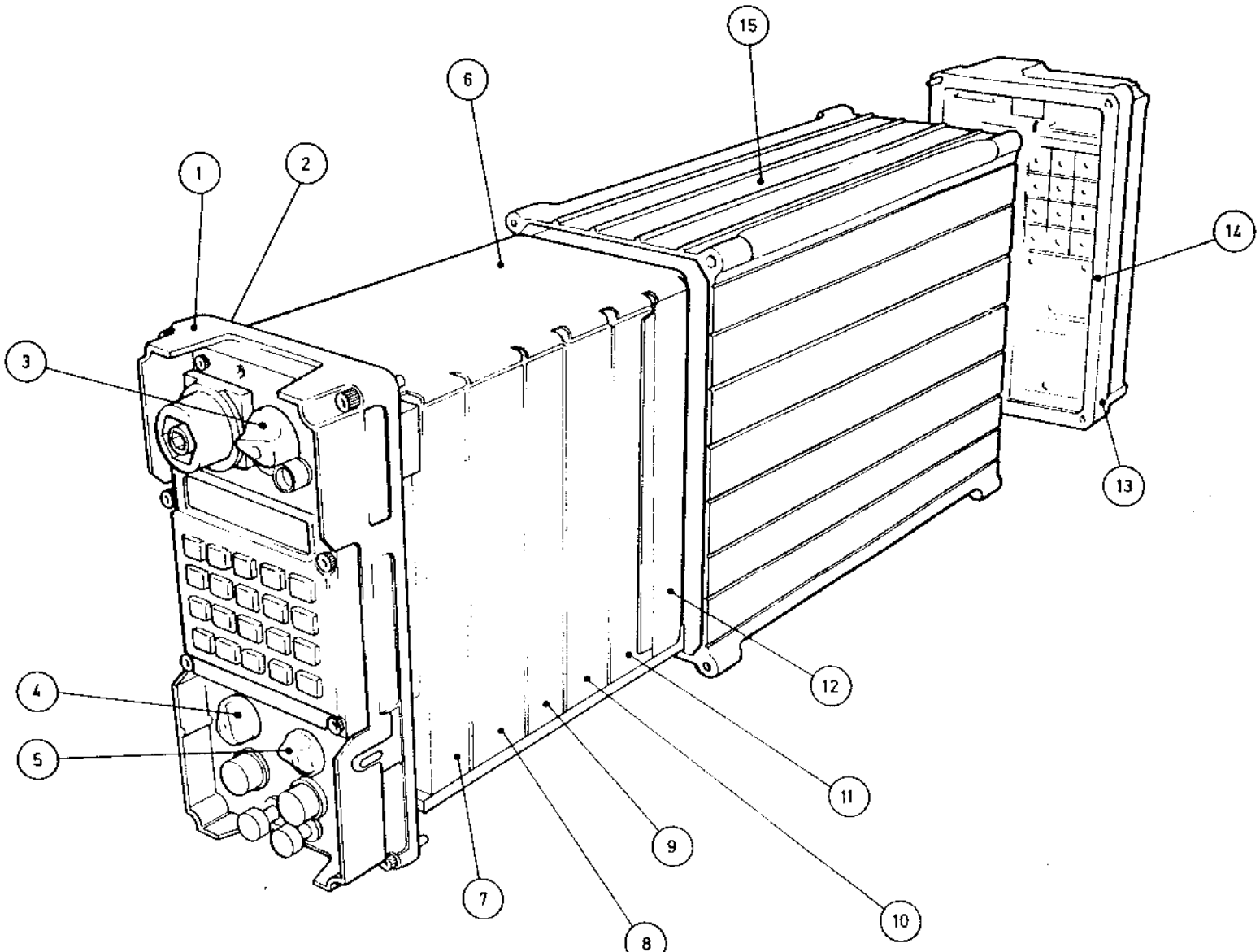
2.

| NO. | ITEM | PART NUMBER |
|---|---|---|
| 1 | FRONT PANEL ASSEMBLY (UNIT 1) | 49226-110-10 |
| 2 | Seal | 39226-796-10 |
| 3 | Knob Control Switch | 39226-609-10 |
| 4 | Knob Channel Switch | 39226-610-10 |
| 5 | Knob Volume On/Off Switch | 39226-611-10 |
| | Keyboard and Display Assy (See Fig. 12.2) | |
| 6 | CHASSIS AND MOTHERBOARD ASSEMBLY (Unit 2) | 49226-130-10 |
| 7 | INTERFACE (Unit 3) | 49226-140-10 |
| 8 | CENTRAL CONTROL HOP (Unit 4H) | 49226-210-09 |
| 9 | IF UNIT (Unit 5) | 49226-160-10 |
| 10 | RF HEAD (Unit 6) | 49226-170-10 |
| 11 | SYNTHESIZER (Unit 7) | 49226-180-10 |
| 12 | MODULATOR (Unit 8) | 49226-190-10 |
| 13 | REAR PANEL ASSEMBLY (Unit 9) | 49226-200-10 |
| 14 | Seal | 39226-796-10 |
| 15 | SLEEVE ASSEMBLY | 49226-560-10 |

## KEYBOARD AND DISPLAY ASSEMBLY (See Fig. 12.2)

3.

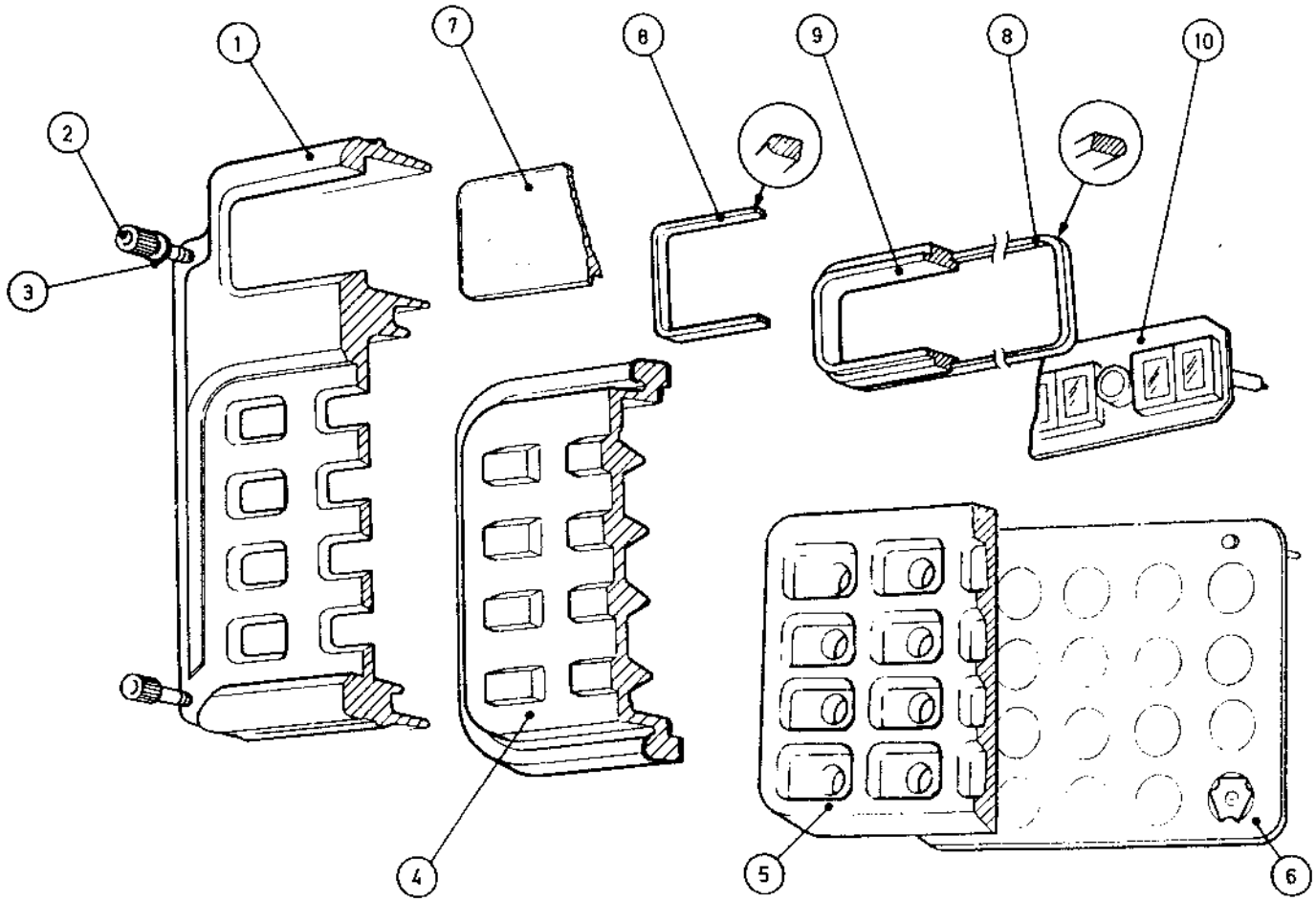
| NO. | ITEM | PART NUMBER |
|---|---|---|
| 1 | KEYBOARD COVER | 39226-614-10 |
| 2 | Captive Screw (quantity 4) | 39010-025-10 |
| 3 | Crinkle washers (quantity 4) | 21541-010-27 |
| 4 | KEYBOARD BOOT | 39226-623-10 |
| 5 | SUPPORT PLATE | 39226-622-10 |
| 6 | KEYSWITCH ASSEMBLY | 29226-266-10 |
| 7 | WINDOW | 29226-624-10 |
| 8 | WINDOW SEAL (quantity 2) | 39226-626-10 |
| 9 | SEAL RETAINER | 39226-625-10 |
| 10 | DISPLAY BOARD | 49226-122-10 |






Main Assemblies and Units- Field Spares

Fig.12




Keyboard and Display - Field Spares

Fig.12.2