

CHAPTER 5DETAILED TESTINGContents

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CHAPTER 5

DETAILED TESTING

GENERAL

1. These tests are intended to assist in fault finding should the transceiver fail to meet a specified parameter during the tests to specification. The following tests should be made with the transceiver removed from its case (four allen screws behind the handles) and connected to a power supply unit.

NOTE Earth or common connections for test equipment should be made to an earth point on the main p.c. board or the board being tested. Earth connections must not be made to the chassis of the transceiver.

TEST EQUIPMENT

2. The test equipment listed below will be required. A suitable instrument is shown in brackets but instruments having equivalent characteristics may also be used.

- (a) RF Signal Generator (Marconi TF 144H)
- (b) AF Signal Generator (Marconi TF 2100)
- (c) Oscilloscope (Tektronix 454)
- (d) Frequency Counter
- (e) Audio VTVM (Heathkit Model IM-38)
- (f) Wattmeter, 50W (Bird Thru-line)
- (g) 50 ohm dummy load
- (h) Variable Power Supply, 12V d.c. at 6A
- (i) Multimeter (AVO 8)
- (j) Crystals, type CR69/U at the following frequencies:
 - 12,700MHz (1 off)
 - 15,700MHz (1 off)
 - 17,700MHz (1 off)
 - 18,500MHz (1 off)
- (k) 100k ohm 0,5W carbon resistor
- (l) 0,01 μ F 10V capacitor

TRANSCEIVER CURRENT MEASUREMENTS

3. Measure supply currents as follows:

- (1) Set the front panel controls:

GAIN - fully clockwise
Mode - OFF
BAND - LP 3.5 - 8
others - Immaterial

- (2) Remove FS1.

- (3) Connect the power supply unit to PL1 pins 2 (positive) and 1. Set for a 12V output.

- (4) Connect the h.m.t. to either front panel AUDIO socket.

(5) Connect the multimeter across FS1 fuse holder and check the following currents.

Mode switch	BAND switch	Current	Remarks
REC	LP	40 to 55mA	With PTT Switch operated
SSB	LP	350 to 400mA	
BK CW	LP	350 to 400mA	
CW	LP	350 to 400mA	
AM	LP	350 to 400mA	
SSB	HP	550 to 750mA	

(6) Release the PTT switch, remove the multimeter and replace the fuse.

POWER SUPPLY CHECKS

Regulator Output

4. Check the regulated and switched power supplies:

- (1) Connect the multimeter between main p.c. board pin 3 (positive) and a convenient earth point on the board (not to chassis). Multimeter to read 9,0V \pm 0,05V. If it does not, adjust RV11 for this reading.
- (2) Connect the multimeter positive to board pin 17 and check for a voltage of 9,0V \pm 0,1V.
- (3) With the mode switch at SSB and the BAND switch at LP operate the PTT switch and check that the 9V at pin 17 disappears.
- (4) Connect the multimeter to board pin 33 and check for 9,0V \pm 0,1V.
Release the PTT switch.

5. If any of the above readings are not obtained the figures in the Table below may be used as a guide to the levels which can be expected around the power supply circuits. The measurements were made with a multimeter.

Transistor	DC Voltages			Remarks
	c	b	e	
VT31	9,8V	7,5V	6,9V	Mode switch to REC Mode switch to SSB BAND switch to LP PTT switch operated
VT32	11,3V	9,8V	9,0V	
VT33	9,0V	9,6V	9,0V	
VT34	9,0V	0,3V	0V	
VT35	0,3V	0,8V	0V	

DC Converter Output

6. Check the voltage at the converter output pin:

- (1) Set the BAND switch to HP and the mode switch to SSB.
- (2) Connect the multimeter between a convenient earth point and Converter pin 6.
- (3) Operate the PTT switch and check for a multimeter reading of approximately 36V. Release the PTT switch.



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7. If the above reading is not obtained the following readings, which were taken with a multimeter and the transceiver set for high power SSB Transmission, may be used as a guide to the levels which can be expected around the circuit.

Transistor	DC Voltages			Remarks
	c	b	e	
VT29	12V	-1,3V	0V	With PTT switch operated
VT30	12V	-1,3V	0V	

RECEIVER TESTS

Audio Circuits

8. Check the audio circuits as follows:

- (1) Set the front panel control:

MODE switch - REC
 GAIN control - fully clockwise
 CHANNEL switch - channel 1
 NET control - central
 LSB - USB switch - LSB A
 BAND switch - LP 3,5 - 8
 TUNE control - immaterial

- (2) Connect the h.m.t. to either of the front panel AUDIO sockets.

- (3) Connect the 100k ohm resistor in series with the AF signal generator output lead. Connect the lead to the junction of R40 and C42. (This point is marked PROD DET on the p.c. board). Set the signal generator

frequency - 1kHz
 output - zero

- (4) Connect the VTVM to VT9 collector.

- (5) Increase the signal generator output for a reading of $0,31V \pm 0,03V$ on the VTVM.

- (6) Connect the VTVM to board pin 27 and adjust RV2 for a reading of 0,15V.

- (7) Check as follows:

VTVM to	Measurement
VT9 base	5mV max.
VT8 collector	5mV max.
PROD DET	4mV max.
VT8 base	2mV max.

- (8) Remove the signal generator and VTVM.

9. If the above figures are not obtained, the following voltages, taken with a multimeter, may be used as a guide to the levels which can be expected around the circuits.

Transistor	DC Voltages			Remarks
	c	b	e	
VT8	4,4V	0,75V	0,1V	Measured with the transceiver on receive
VT9	4,0V	7,7V	7,8V	
VT10	9,0V	3,6V	3,5V	
VT11	0V	3,4V	3,5V	

Crystal Oscillator (VT16) and Oscillator Buffer (VT19) Checks

10. Check the two circuits as follows:

- (1) Connect the oscilloscope to D14 anode (marked '02' on the main p.c. board).
- (2) Check for a signal with an amplitude of 1,8V minimum, peak to peak.
- (3) Fit the 15,700MHz crystal into position 1 of the A bank on the Crystal Board.
- (4) Connect the oscilloscope to D20 anode. (marked '01' on the main p.c. board).
- (5) Check for a signal with a peak to peak amplitude of 2,0V minimum.

11. Should the above readings not be obtained the figures in the table below may be used as a guide to the levels which can be expected in a correctly operating circuit.

Transistor	DC Voltages			Remarks
	c	b	e	
VT16	8,6V	2,6V	2,0V	Measured with the transceiver on receive
VT19	8,6V	2,6V	2,0V	

Receiver IF Amplifier Tests

12. Check the 10,7MHz amplifiers as follows:

- (1) Connect the VTVM across pins 2 and 3 of the remaining AUDIO socket.
- (2) Connect the 0,01 μ F capacitor in series with the r.f. signal generator output lead.

Signal generator settings:

frequency - 10,7015MHz
modulation - none
output - zero

- (3) Connect the signal generator output lead to each of the following points in turn. At each point:
 - (i) Set the signal generator output control to the point which gives a 0,15V reading on the VTVM.
 - (ii) Check that the signal generator output is within the limits given in the table.
 - (iii) If the output is not obtained tune the coil indicated for maximum reading on the VTVM and carry out (i) and (ii) again.

Signal Generator		If not obtained
lead to	output	
VT7 col	6,4mV approx.	T8
VT7 base	300 μ V max.	
VT6 col	1,3mV max.	T7
VT6 base	29 μ V max.	
VT5 col	110 μ V max.	T6
VT5 base	3,5 μ V max.	
VT4 col	3,0 μ V max.	



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- (4) Connect the signal generator to the input of the LSB filter (this point marked 'F1A' on the p.c. board) and set the signal generator output to 2,8 μ V.
- (5) Check that the VTVM reads 0,15V. If the reading is above or below this figure:
 - (i) Tune T5 for maximum reading on the VTVM.
 - (ii) Adjust RV5 for a VTVM reading of 0,15V.
13. If the set does not meet the specified requirements the following figures, taken with a multi-meter, may be used as a guide to the levels which can be expected around the circuits.

Transistor	DC Voltages			Remarks
	c	b	e	
VT5	8,9V	2,0V	1,3V	Measured with the transceiver on receive
VT6	8,9V	2,0V	1,3V	
VT7	8,9V	1,6V	1,2V	
VT17	2,0V	0V	0V	

Receiver RF Circuits

14. Check the r.f. circuits as follows:
 - (1) Connect the r.f. signal generator (still with the 0,01 μ F capacitor in series with the output lead) to the junction of T2 secondary and the image suppression filter (this point marked 'TP4' on the p.c. board).
 - (2) Reset the signal generator frequency to approximately 5MHz. Adjust the output and frequency controls for a 1kHz tone in the h.m.t. earpiece and a reading of 0,15V on the VTVM.
 - (3) Connect the signal generator output to the junction of the image suppression filter and T3 (marked 'TP3' on the p.c. board). Reset the output for a reading of 0,15V on the VTVM and check that the signal generator output is 30 μ V maximum.
 - (4) If the above reading is not obtained, tune T4 for maximum output on the VTVM and recheck as in (3).
 - (5) Connect the signal generator output to TP4 (see (1)), reset the output for a reading of 0,15V on the VTVM and check that the signal generator output is 30 μ V maximum.
 - (6) Remove the 15,700MHz crystal from the A1 position.
 - (7) Connect the frequency counter to VT4 collector.
 - (8) Set the mode switch to AM operate the PTT switch and check for a counter reading of 10,7015MHz \pm 2Hz. If necessary, adjust C64 for this reading.
 - (9) Disconnect the counter, reset the mode switch to REC and replace the 15,700MHz crystal in position A1.
 - (10) Connect the signal generator to the points given in the table below in turn. At each point:
 - (i) Set the signal generator output to give a reading of 0,15V on the VTVM.
 - (ii) Check that the signal generator output is within the limit given in the Table.

Signal Generator		Remarks
Lead to	Output	
VT3 col	100 μ V max.	*Junction T1 and D1 anode. Adjust TUNE control for max. on VTVM and reset sig. gen. for 0,15V on VTVM
VT3 base	2 μ V max.	
TP5*	2 μ V max.	
50 ohm socket	2 μ V max.	

15. If the results are not obtainable, the following measurements, made with the multimeter, may be used as a guide to the levels which can be expected around VT3.

Transistor	DC Voltages			Remarks
	c	b	e	
VT3	8,5V	1,7V	1,0V	Mode switch to REC and BAND switch to TUNE

Signal to Noise Ratio

16. Check the signal to noise ratio with the test set up used for the r.f. checks:
- (1) Set the r.f. signal generator output to 1 μ V and note the reading in dBs on the VTVM.
Call this dB1
 - (2) Temporarily remove the carrier input to the set. (on the TF 144H signal generator this can be achieved by operating the INTERRUPT CARRIER control). Note the new reading in dBs on the VTVM and call this dB2
 - (3) Calculate the signal to noise ratio from the following:

$$S+N/N = \text{dB1} - \text{dB2}$$
 To be not less than 10dB
 - (4) Reset the signal generator frequency to 10,7025MHz and set its output to 2 μ V.
 - (5) Check that the reading on the VTVM does not exceed 300mV. If it does, adjust C9 for minimum reading and recheck.
 - (6) Replace the 15,700MHz crystal in position A1 with the 18,500MHz crystal.
 - (7) Set the signal generator frequency to approximately 7,8MHz and adjust the frequency control for maximum reading on the VTVM.
 - (8) Set the signal generator output to give a reading of 0,15V on the VTVM. Signal generator output to be not greater than 2 μ V.
 - (9) Repeat (1) to (3) above. Signal to noise ratio to be not less than 10dB.
 - (10) Replace the 18,500MHz crystal in position A1 with the 12,700MHz crystal.
 - (11) Set the BAND switch to LP1,6 - 4.
 - (12) Set the signal generator frequency to 2MHz and adjust the frequency control for maximum reading on the VTVM.
 - (13) Set the signal generator output to give a reading of 0,15V on the VTVM. Signal generator output to be not greater than 2 μ V.
 - (14) Repeat (1) to (3) above. Signal to noise ratio to be not less than 10dB.
 - (15) Set the mode switch to OFF. Remove all test equipment. Replace the crystal in position A1 with a crystal of the required operational frequency.

Multivibrator

17. The remaining circuit in the receiver is the multivibrator. A fault on this circuit will be shown when it is impossible to tune the set on receive. No particular tests for this circuit are given but the following figures, taken with a multimeter, may be used as a guide to the levels which can be expected around the circuit.

Transistor	DC Voltages			Remarks
	c	b	e	
VT1	0,55V	0,28V	0V	mode switch at REC and BAND switch at TUNE
VT2	5,0V	0,6V	0V	

TRANSMITTER TESTS

Note: Unless otherwise stated each transmitter measurement is made with the PTT switch operated.

Crystal Oscillator Check

18. Check the crystal oscillator frequency:

- (1) Connect the power supply unit to PL1 pins 2 (positive) and 1. Set for a 12V output.
- (2) Connect the wattmeter and dummy load to the 50 ohm antenna socket.
- (3) Connect the h.m.t. to either of the front panel AUDIO sockets.
- (4) Remove the crystal (if any) in position 1 of bank A on the Crystal Board.
- (5) Set the front panel controls:
 - mode switch - AM
 - GAIN control - fully clockwise
 - CHANNEL switch - channel 1
 - NET control - central
 - LSB-USB switch - LSB A
 - BAND switch - LP 3.5 - 8
 - TUNE control - fully clockwise
- (6) Connect the counter to VT4 collector and check for a reading of 10,7015MHz \pm 2Hz. If necessary adjust C64 for this reading.
- (7) Disconnect the counter.

Carrier Suppression

19. Check carrier suppression as follows:

- (1) Set the mode switch to SSB.
- (2) Connect the oscilloscope to VT4 collector and check the amplitude of any vestigial carrier. To be not greater than 20mV.
- (3) If the amplitude is high reduce by the following method:
 - (i) Note the amplitude of the carrier shown on the oscilloscope.
 - (ii) Turn C69 clockwise by not more than 5°.
 - (iii) Adjust RV4 for minimum amplitude on the oscilloscope and note this amplitude.
 - (iv) If it is less than that noted in (i) continue as in (ii) and (iii) until the minimum carrier level is found.
 - (v) If the amplitude is greater than in (i) carry out (ii) and (iii), turning C69 anti-clockwise until the minimum amplitude is found.

Side Tone Circuits

20. Check that sidetone is fed to the h.m.t.:

- (1) Set the BAND switch to TUNE and (with the PTT switch operated) check for a clear tone in the earpiece. RV3 may be adjusted if a distorted tone is heard.
- (2) Connect the oscilloscope to the junction of R40, C42 (PROD DET) and check for a signal of 0,7V peak to peak.

Overload Protection Circuit

21. Connect the multimeter to pin B (junction R128, C23) of the main p.c. board and check for a reading of $5,3V \pm 0,3V$.

ALC Circuits

22. Check the ALC circuits as follows:

- (1) Fit the 15,700MHz crystal into the A1 position on the Crystal Board.
 - (2) Connect the multimeter to VT18 collector and check for a reading of $2,7V \pm 0,2V$.
 - (3) Adjust the TUNE control for maximum output on the wattmeter. If this is not 12,5W:
 - (i) Adjust RV7 for this value.
 - (ii) Readjust the TUNE control for maximum output.
 - (iii) Continue in this manner until maximum output is 12,5W.
23. If any of the above readings cannot be obtained the following figures, taken with a multimeter, may be used as a guide to the levels which can be expected around VT18.

Transistor	DC Voltages			Remarks
	c	b	e	
VT18	2,7V	0,4V	0V	on low power s.s.b. transmission

Transmitter Amplifier Circuits

24. Check the amplifier circuits as follows:

- (1) Connect the oscilloscope to each of the following points in turn and check that the levels are as shown in the table. (Note that with the BAND switch at TUNE, operating the PTT switch brings the transmitter into the high power condition).

Oscilloscope to	Peak to Peak Voltages	Remarks
VT4 col	1,5V to 3,0V	All measurements with PTT switch operated.
VT24 base	1V	
VT24 col	12V to 16V	
VT25 base	1V	
VT25 col	12V to 16V	
VT20 base	2,1V	
VT20 col	80V	
VT21 base	2,1V	
VT21 col	80V	
VT22 base	2,1V	
VT22 col	80V	
VT23 base	2,1V	
VT23 col	80V	
RL1 pin 7	120V	

- (2) Set the BAND switch to HP 3.5 - 8.
- (3) With the $0,01\mu F$ capacitor in series with the output lead connect the r.f. signal generator to VT26 emitter.

Signal generator settings:

- frequency - 5,0MHz
- modulation - none
- output - 50mV approx.

- (4) Adjust the TUNE control for maximum output on the wattmeter.
 - (5) Increase the signal generator output for a reading of 12,5W on the wattmeter. Signal generator output at this point to be approximately 200mV. Return the signal generator output to zero.
 - (6) Connect the signal generator to VT27 base.
 - (7) Increase the signal generator output for a reading of 12,5W on the wattmeter. Signal generator output at this point to be approximately 25mV.
25. If any of the above figures are not obtained the voltages around the circuits, taken with a multimeter and shown in the table below, may be used as a guide to the levels which can be expected.

Transistor	DC Voltages			Remarks
	c	b	e	
VT4	8,3V	1,6V	0,9V	All measurements taken on SSB low power transmission
VT20	11,3V	0,63V	0,03V	
VT21	11,3V	0,63V	0,03V	
VT22	11,3V	0,63V	0,03V	
VT23	11,3V	0,63V	0,03V	
VT24	12V	0,65V	0,01V	
VT25	12V	0,65V	0,01V	
VT26	11,2V	2,7V	0,75V	
VT27	11,8V	2,1V	1,2V	
VT20	36V			
VT21	36V			On SSB high power transmission.
VT22	36V			
VT23	36V			

Transmitter Audio Circuits

26. Check the audio circuits as detailed below:

- (1) Connect the a.f. signal generator to pins 1 and 3 (common) of the remaining AUDIO socket.

Signal generator settings:

- frequency - 1kHz
- output - To give 12,5W on wattmeter
(Adjust TUNE control for maximum output)

- (2) Check for the voltages given in the table below

Measuring Instrument	Measuring point	Voltage
VTVM	Junction R40, C42 (PROD DET)	120mV to 390mV
VTVM	VT13 base	120mV to 155mV
Oscilloscope	VT14 col	1,4V p to p
Multimeter	D9 anode	0,5V to 1,2V
Multimeter	main board pin b	4,8V to 5,3V

- (3) Disconnect the a.f. signal generator.
27. If any of the readings are not obtained the following figures, taken with a multimeter, may be used as a guide to the levels which can be expected around the audio circuits.

Transistor	DC Voltages			Remarks
	c	b	e	
VT12	7,0V	2,2V	1,5V	Measurements taken with mode switch to BK CW and PTT operated
VT13	2,2V	1,3V	0,7V	
VT14	3,5V	1,0V	0,3V	
VT15	5,0V	0,8V	0,1V	

Mode Outputs Check

28. Check the power outputs at the following mode switch positions:
- Set the mode switch to BK CW and adjust the TUNE control for maximum output on the wattmeter. To be 12,5W minimum. Note the actual reading.
 - Set the LSB - USB switch to USB A and note the reading on the wattmeter. To be within 0,2W of the reading noted in (1).
 - Check for the following power outputs on the modes given in the table below:

Mode switch	BAND switch	Wattmeter reading	Remarks
BK CW	LP 3.5 - 8	3W approx.	Adjust the TUNE control for maximum output before taking each reading
AM	HP 3.5 - 8	2W to 4W	
Replace the 15,700MHz crystal in position A1 with the 17,700MHz crystal			
BK CW	HP 3.5 - 8	12W min.	
BK CW	LP 3.5 - 8	1,5W to 4W	
AM	HP 3.5 - 8	1W to 2W	

Replace the 17,700MHz crystal in position A1 with the 12,700MHz crystal

Mode switch	BAND switch	Wattmeter reading	Remarks
AM	HP 1.6 - 4	4W to 8W	
BK CW	HP 1.6 - 4	6W to 8W	
BK CW	LP 1.6 - 4	1,4W to 2W	

Meter Setting

29. Set the mode switch to SSB and the BAND switch to LP 1.6 - 4. Operate the PTT switch and check that the meter needle is between the two dots in the centre of the scale. If it is not, adjust RV10 for this reading.