ELECTRICAL AND MECHANICAL
ENGINEERING REGULATIONS

TELECOMMUNICATIONS

WIRELESS SET
No. 48

Provisional Test
Procedure

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WIRELESS SET No. 48

PROVISIONAL TEST PROCEDURE

NOTE: This information is provisional and is supplied for the use of R.E.M.E. personnel pending the issue of more complete instructions. All errors of whatever sort should, therefore, be notified through the usual channels, to the War Office (M.E. 10).

1. The following is a copy of the test procedure adopted by the makers in the assembly section of the factory, and is included in these instructions for guidance only.

THE TRANSMITTER

Panel meter

2. (*a*) Check zero position of meter pointer; adjust exact zero.
(*b*) Insert battery plug.
(*c*) Meter switch in M.A. position, battery switch ON.
(*a*) Operation switch in CAL position, meter reads 50.
(*b*) Operation switch in NET position, meter reads slightly higher than in CAL position.
(*d*) Meter switch in I.G. position, meter reads 0.
(*e*) Meter switch in L.T. position, meter reads 350.
(*f*) Meter switch in H.T. position, meter reads 400 (blue line).
(*g*) Meter switch in A.F. position, meter reads 0.

Preset trimmer

3. (*a*) CALIBRATING trimmer slot in vertical position.
(*b*) NETTING trimmer slot in horizontal position.
(*c*) BUFFER trimmer slot in horizontal position.
(*d*) BUFFER coil slug screw about $\frac{1}{8}$" inside chassis wall.
(*e*) OSCILLATOR coil slug screw about $\frac{1}{4}$" inside shield cover.
(*f*) OSCILLATOR trimmer at maximum capacity.
(*g*) NEUTRALIZATION trimmer at about 75% capacity.
(*h*) Check M.O. and aerial tuning dials for exact line-up with marker when variable condensers are at maximum capacity.
(*i*) Check M.O. and aerial tuning dials for positive and smooth operation of vernier controls.

Crystal operation

4. (*a*) Battery switch ON.
(*b*) Operation switch in CAL position.
(*c*) Observe beat frequency between crystal harmonic and frequency standard in output of detector.
(*d*) Turn battery switch on and off four times and observe starting of crystal oscillator.
(*e*) Measure beat frequency with external B.F.O.

Oscillator alignment

5. (*a*) Operation switch in CAL position.
(*b*) Turn M.O. dial to 6 Mc/s.
(*c*) Turn detector dial to 6 Mc/s.
(*d*) Align OSCILLATOR slug screw for zero beat with 6 Mc/s harmonic of crystal oscillator in transmitter.
(*e*) Turn M.O. dial to 9 Mc/s.
(*f*) Turn detector dial to 9 Mc/s.
(*g*) Align OSCILLATOR trimmer for zero beat with 9 Mc/s harmonic of crystal oscillator in transmitter.
(*h*) Repeat (*b*) and (*g*) operations inclusive until no change in calibration of 6 Mc/s and 9 Mc/s occurs from any previous adjustment.
(*i*) Tune in beat note at 9 Mc/s and observe absence of beat note when operation switch is turned to NET position.

Dial lock electrical test

6. (*a*) Operation switch in CAL position.
(*b*) Turn detector dial to 9 Mc/s.
(*c*) Tune M.O. dial to zero beat at 9 Mc/s.
(*d*) Carefully turn dial lock thumb screw clockwise to lock dial in zero beat position.
(*e*) Measure deviation from zero beat with B.F.O.

Buffer adjustment

7. (*a*) Meter switch in M.A. position.
(*b*) Operation switch in PHONE position.
(*c*) Insert microphone plug—microphone switch ON.
(*d*) Observe panel meter reading—180.
(*e*) Meter switch in I.G. position.
(*f*) Tune M.O. dial to 6 Mc/s.
(*g*) Align buffer slug screw for maximum I.G. reading.
(*h*) Tune M.O. dial to 9 Mc/s.
(*i*) Align BUFFER trimmer for maximum I.G. reading.
(*j*) Repeat (*f*) to (*i*) operations inclusive until no change in I.G. readings occurs from any previous adjustment.
(*k*) If the I.G. reading is not at least 150 at this point, it may be necessary to adjust the neutralizing trimmer for a higher I.G. reading with the M.O. dial at 9 Mc/s, and then repeat (*f*) to (*k*) operations inclusive until the I.G. reading is above 150 when the M.O. dial is at 9 Mc/s.

Neutralization

8. (*a*) Turn M.O. dial to 9 Mc/s.
(*b*) Turn aerial switch tap to 5.
(*c*) Meter switch in AE position. See 7(*b*) and (*c*).
(*d*) Locate resonance of antenna by turning aerial tuning dial until meter reading is observed.
(*e*) Note number on aerial tuning dial at which maximum meter reading occurs.
(*f*) Meter switch in I.G. position.
(*g*) While observing meter pointer, "rock" aerial tuning condenser through resonance (as indicated by sudden *change* in I.G. reading) and at the same time adjust the neutralizing trimmer for a position which results in minimum *change* (not total reading) in I.G. reading as the aerial tuning condenser is tuned *through resonance*.

NOTE: Adjustment of the neutralizing trimmer may change the initial I.G. readings obtained by buffer adjustment: *i.e.*, the I.G. reading may be any value

between 20 and 240 when *minimum change* in reading occurs as aerial tuning condenser is tuned through resonance. Minimum change indicates neutralization is nearly complete, but the next operation may not be attempted unless neutralization is apparent while the I.G. reading is at least 180. Hence it may be necessary to repeat all operations in paragraph 7 and then (*a*) to (*g*) operations inclusive in paragraph 8.

Buffer alignment

9. (*a*) Repeat all operations in paragraph 7.
   (*b*) Tune M.O. dial to 9 Mc/s—I.G. should be 240.
   (*c*) Tune M.O. dial to 6 Mc/s—I.G. should be 200.

M.O. dial calibration at 6 and 9 Mc/s

10. (*a*) Repeat all operations in paragraph 5.

Netting adjustment

11. (*a*) Operation switch in phone position.
   (*b*) Microphone plug in—microphone switch ON.
   (*c*) Tune detector to 9 Mc/s.
   (*d*) Tune M.O. dial to zero beat with 9 Mc/s from frequency standard.
   (*e*) Turn microphone switch OFF.
   (*f*) Operation switch in NET position.
   (*g*) Align netting trimmer for zero beat with same 9 Mc/s signal from frequency standard.
   (*h*) Repeat (*b*) to (*h*) inclusive until zero beat between oscillator and 9 Mc/s frequency standard occurs in *both* PHONE and NET position of operation switch.

Final dial calibration

12. (*a*) Operation switch in CAL position.
   (*b*) Microphone switch off.
   (*c*) Repeat operations (*b*) to (*h*) paragraph 5.
   (*d*) Operation switch in NET position.
   (*e*) Turn on 100 kc/s frequency standard.
   (*f*) Observe calibration at every 100 kc/s dial division.
   (*g*) Use B.F.O. to measure beat frequency between frequency standard signal and M.O. in transmitter at point of dial calibration deviation.

Tuning constancy

13. (*a*) Operation switch in CAL position (Mike and Key out).
   (*b*) Tune detector dial to 9 Mc/s.
   (*c*) Tune M.O. dial counterclockwise to zero beat between M.O. and crystal 9 Mc/s harmonic (calibration should then be exact).
   (*d*) Tune M.O. dial to extreme minimum (counterclockwise) capacity.
   (*e*) Tune M.O. dial *clockwise* to 9 Mc/s *calibration* and measure beat frequency by calibrated B.F.O.

End point overlap of dial

14. (*a*) Operation switch in CAL position (Mike and Key out).
   (*b*) Use 10 kc/s output of frequency standard and count the number of 10 kc/s zero beats as the M.O. dial is tuned from zero beat 9 Mc/s to *minimum* capacity of variable condenser.
   (*c*) Repeat (*b*) to count the number of 10 kc/s zero beats from 6 Mc/s zero beat to maximum capacity of variable condenser.

Fine neutralization and interlock measurement

15. (*a*) Operation switch in C.W. position.
   (*b*) Insert key plug (microphone plug out), key switch ON.
   (*c*) Tune M.O. dial to 9 Mc/s.
   (*d*) Tune detector to observe beat note between M.O. and 9 Mc/s signal from frequency standard.
   (*e*) Connect dummy antenna.
   (*f*) Turn aerial switch to tap.
   (*g*) Turn meter switch to AE position.
   (*h*) Tune aerial condenser for maximum AE reading on meter and then detune to zero antenna current.
   (*i*) Tune aerial condenser through resonance and observe the change from zero beat to a beat frequency.
   (*j*) "Rock" aerial tuning condenser through resonance while adjusting the neutralizing trimmer for the setting which permits the lowest beat frequency to occur as the aerial condenser is tuned *through resonance.*
   (*k*) When 15(*j*) has been satisfied, repeat (*h*) to (*i*) operations inclusive and use B.F.O. to measure maximum beat frequency change from zero beat.

Output measurement, C.W. operation

16. (*a*) Repeat (*a*) to (*c*) operation inclusive of paragraph 15.
   (*b*) Connect dummy antenna and diode voltmeter.
   (*c*) Meter switch in M.A. position—reading should be 370.
   (*d*) Meter switch in AE position.
   (*e*) Test each AE switch tap position for resonance of antenna as aerial tuning condenser is adjusted. Select that combination of AE tap and aerial tuning condenser which results in maximum reading of diode voltmeter and panel meter.
   (*f*) AE meter reading should be *.
   (*g*) Measure power output at 9 Mc/s by referring to calibration curve of diode voltmeter.
   (*h*) Measure power output at 7·5 Mc/s.
   (*i*) Measure power output at 6 Mc/s.
   (*j*) Test keying by opening and closing key terminals and observing simultaneous action of diode voltmeter and AE current readings.

Output measurement, phone operation

17. (*a*) Turn meter switch to M.A. position—reading should be 170.
   (*b*) Operation switch in PHONE position.
   (*c*) Connect dummy antenna and diode voltmeter.
   (*d*) Insert microphone plug (microphone switch ON).
   (*e*) Turn meter switch to AE position.
   (*f*) Tune M.O. dial to 9 Mc/s.
   (*g*) Select aerial switch tap and aerial tuning condenser position which results in maximum reading on panel meter and diode voltmeter. AE reading should be*.
   (*h*) Measure power output at 9 Mc/s by referring to calibration curve of diode voltmeter.
   (*i*) Measure power output at 7·5 Mc/s.
   (*j*) Measure power output at 6 Mc/s.

Modulation and distortion test

18. (*a*) Repeat (*b*) to (*g*) operations (inclusive) of paragraph 17.

**No figure available at time of issue.*

(*b*) Connect oscilloscope (50pF series condenser) to dummy antenna and arrange to observe modulated carrier pattern on screen. (Direct connection to plates.)
(*c*) Feed 1000 c/s sine wave signal to microphone terminals.
(*d*) Reset aerial tuning condenser for maximum power into dummy antenna.
(*e*) Gradually increase modulation voltage input to microphone terminals while observing modulation pattern. Check 100%, and over, modulation capability.
(*f*) Reset modulation voltage input for exactly 100% modulation and examine pattern for sine wave characteristics.
(*g*) There should be no distortion of wave form from no modulation to 100% modulation.

THE RECEIVER

19. (*a*) Check dial position with variable condenser at maximum capacity.
(*b*) Check pre-set trimmers, volume control and switches.
(*c*) Check all trimmers for ease in adjusting.
(*d*) Check serial number on set and tags.
(*e*) Check A and B voltage and current with GEN. BATTERY switch in each position.
(*f*) Align I.F. trimmers for maximum response.
(*g*) Switch B.F.O. on, adjust B.F.O. for zero beat with 455 kc/s.
(*h*) Tap each tube lightly for noise and microphonics.
(*i*) Inspect oscillator interstage and antenna slug, trimmer screws for broken or defective slots.
(*j*) Check dial for smooth and positive action.
(*k*) Adjust oscillator trimmer and slug for dial calibration at 6 Mc/s and 9 Mc/s.
(*l*) B.F.O. on, tune dial to zero beat with 9 Mc/s signal. Lock dial and measure frequency shift from zero beat.
(*m*) Feed multivibrator signal and align antenna and interstage trimmers for maximum response at 6 Mc/s and 9 Mc/s.
(*n*) Tap set for noise and microphonics.
(*o*) Check locking devices on I.F. and B.F.O. trimmers.
(*p*) Final I.F. alignment for maximum response.
(*q*) Final B.F.O. alignment.
(*r*) Measure I.F. sensitivity.
(*s*) Feed 455 kc/s from signal generator. Adjust generator dial for maximum response on output meter. Switch B.F.O. on (modulation off), measure beat frequency.
(*t*) Test volume control.
(*u*) Test both phone jacks with low impedance plug.
(*v*) Check dial calibration at 6 Mc/s, 7 Mc/s, 8 Mc/s and 9 Mc/s. Check for normal image signals.

20. (*a*) Final calibration of dial using zero beat methods with 1 Mc/s harmonic calibrator signals.
(*b*) Tighten oscillator slug trimmer screw lock-nut.
(*c*) Final R.F. alignment and tracking.
(*d*) Tighten interstage lock-nut.
(*e*) Measure over-all sensitivity at 6 Mc/s, 7·5 Mc/s and 9 Mc/s.
(*f*) Test for noise and microphony when tapped.
(*g*) Check A and B current and voltage.
(*h*) Check calibration (zero beat method) at 6 Mc/s and 9 Mc/s using output of frequency standard.
(*i*) Measure maximum calibration error at any point between 6 Mc/s and 9 Mc/s.
(*j*) Measure end-point-overlap (dial range) at both ends of dial.
(*k*) Measure image rejection ratio at 9 Mc/s.
(*l*) Measure I.F. rejection ratio at 6 Mc/s.
(*m*) Test for noise and microphonics when tapped.
(*n*) Measure signal to noise power ratio at 9 Mc/s.
(*o*) Measure maximum undistorted power output as observed on C.R.O. and output meter.
(*p*) Check A.V.C. action with C.R.O.
(*q*) Feed ·1 V. from generator, volume control full, and check for overloading and blocking.
(*r*) Measure selectivity at X 10 and X 1000 inputs at 7·5 Mc/s.

PERFORMANCE TESTS ON PRE-PRODUCTION MODELS

21. The following test figures were taken on two pre-production models of the Wireless Set No. 48.

THE RECEIVER

Sensitivity

22. The R.F. input, 30% modulated at 400 cycles, required to give an audio output of one mW at a signal-plus-noise to noise ratio of 20 db, was measured using a 50 pF dummy antenna.

Frequency	R.F. input for one mW output
6,000 k/cs	Less than one μV
7,000 ,,	,, ,, ,, ,,
8,000 ,,	,, ,, ,, ,,
9,000 ,,	,, ,, ,, ,,

Image ratio

23. The figures obtained during the image ratio measurements were found to be dependent on the conditions under which the set was lined up. If the chassis is lined up out of the carrying case with the standard 50 pF dummy antenna, and is then inserted in the carrying case, the receiver antenna tuning circuit becomes partially de-tuned, resulting in degradation of the image ratio. The image ratios obtained under these conditions are :—

Frequency	Image ratio
6,000 kc/s	1300
7,000 ,,	700
8,000 ,,	400
9,000	225

24. When lined up and tested out of case, the image ratio is everywhere above the minimum figure of 250. In production this will be met in one of two ways. Either the set will be lined up in a dummy case with a hole in the side, permitting access to the receiver antenna circuit trimmer, or, alternatively, a dummy antenna more exactly representing the actual antenna circuit constants will be used.

I.F. rejection

25. The following figures for the I.F. rejection ratio were the lowest obtained.

Frequency	I.F. rejection ratio
6,000 kc/s	23,700
9,000 ,,	23,600

Selectivity

26. The selectivity was measured at 6 Mc/s and at 9 Mc/s.

Attenuation	Bandwidth at 6 Mc/s	Bandwidth at 9 Mc/s
6 db	5·5 kc/s	6 kc/s
20 db	15 ,,	17 ,,
40 db	29 ,,	34 ,,
60 db	49 ,,	60 ,,

Audio output

27. Maximum undistorted output = 60 mW
Maximum output = 70 mW

Fidelity

28. An overall fidelity measurement was made with the receiver volume control adjusted so that with a 3 μV R.F. input to the receiver, modulated 30% at 400, an audio output of 10 mW was obtained. The audio frequency was then varied, keeping the modulation depth constant at 30% and the audio output from the receiver measured.

Reference level : zero db at 400 = 10 mW.

Audio frequency	Response
200 cps.	− 3·0 db
300 ,,	− 0·6 db
400 ,,	0 db
600 ,,	+ 0·4 db
800 ,,	− 0·2 db
1,000 ,,	− 0·97 db
1,600 ,,	− 4·7 db
2,000 ,,	− 8·0 db
3,000 ,,	− 15·2 db
4,000 ,,	− 20 db

BEAT FREQUENCY OSCILLATOR

29. No spurious whistles were heard across the band. A clean beat note can be obtained with ·5 V R.F. input to the receiver, showing the absence of blocking.

THE TRANSMITTER

Power output

30. The following are average figures for the sender power output measured in a 50 pF 7·5Ω dummy antenna. The figures quoted are for C.W. operation.

Frequency	C.W. power output	Specification figure
6,000 kc/s	0·72 W	0·75 W
7,500 ,,	1·00 W	1·00 W
9,000 ,,	1·26 W	1·25 W

Frequency drift

31. The frequency drift at the end of a 5-minute run from a cold start at room temperature was measured.

Frequency	Frequency drift
6,000 kc/s	150 c/s
9,000 ,,	500 ,,

Netting

32. Electrically, the netting error is less than 100 c/s, providing care is taken not to disturb the master oscillator tuning dial when once set.

33. The transmitter interlock (reaction) is less than 300 c/s at all frequencies.

DIAL CALIBRATION

34. The M.O. Dial was first set to 9,000 kc/s with the P.A. circuit unloaded. The P.A. was then tuned, giving a frequency shift of a little under 300 c/s. The dial was next set by calibration to 6 Mc/s and the P.A. circuit again tuned to resonance. The emitted frequency was found to be within 3 kc/s of 6,000 kc/s.

Tuning constancy

35. The tuning constancy was tested by tuning by eye first from the low frequency side to 9,000 kc/s and then repeating the test from the high frequency side towards 9,000 kc/s. The frequency error obtained was 520 c/s in the first case and 175 c/s in the second.

MODULATION

36. The set was capable of approximately 100% modulation with 90% positive peak modulation, from the standard handset.

END