Test Report

The Heathkit Model RA-1 Basic Amateur Bands Receiver

Reviewed by D. V. NEWPORT (G3CHW) *

THE Heathkit Model RA-1 is the first amateur bands only receiver to be produced in the U.K. by Daystrom Ltd. It is available either in kit form or assembled and is housed in a cabinet measuring 13¾ in. wide × 11½ in. deep and 6½ in. high.

The receiver supplied for review was ready built, but the instruction manual is typical of the Heathkit standard and is designed to make construction as simple as possible. Assuming the ability to solder, no difficulty should arise, particularly as the complete front-end is supplied aligned and tested.

Including the h.t. rectifier and voltage stabilizer, a total of eight valves are used (two of them dual purpose), plus two germanium diodes for a.g.c. rectification and the second detector.

The RA-1 is a single conversion superhet in which an ECH81 is used as a combined mixer/oscillator. This arrangement is always prone to " pulling " to an extent dependent on frequency and amplitude of the incoming signal. Rotation of the r.f. gain control is also likely to produce a slight change of oscillator frequency. The use of separate oscillator and mixer valves are, for these reasons, preferred,† but were not incorporated in the RA-1 for economic reasons and because the frequency shift was not considered to be excessive. This appears to be true in practice and no embarrassment was noticed when listening during the 1963 B.E.R.U. Contest. Such as it is, the frequency pulling is much more evident when the receiver is in an overloaded condition, which may occur when " netting " with a high level v.f.o. adjacent to the receiver.

The heart of this receiver is the coil-pack which has been specially produced for Daystrom Ltd. by Electroniques (Felixstowe) Ltd. This, combined with a modern EF183 r.f. amplifier and the ECH81 mixer/oscillator, enables a sensitivity and signal-to-noise ratio equal to many more expensive receivers to be obtained. In this respect the measured performance was at least twice as good as that claimed by Daystrom.

The mechanical indexing‡ of the bandchange switch was checked and a figure as low as 10 c/s at 30 Mc/s was measured. It was noted, however, that although the receiver settled down to reasonable stability within about 10 or 15 minutes, switching to one of the three h.f. bands produced another warm-up drift period. The maximum amount observed was 5 kc/s in five minutes after which the receiver settled down again. This may be a function of the negative temperature coefficient of the capacitors used on each oscillator range. Most of the drift occurred during the first minute or so and was not therefore unduly trying. It may be mentioned here that these tests were made with a highly accurate frequency

The Heathkit Model RA-1 amateur bands receiver. The cabinet is finished in silver and green. The panel controls (reading from the top left) are aerial trimmer, calibration adjustment, r.f. gain, bandswitch, b.f.o. on/off, sideband selection switch, main tuning, a.v.c. on/off, noise limiter and a.f. gain. The phones jack is at the bottom right-hand corner of the front panel.
(Photo by courtesy of Daystrom Ltd.)

counter capable of discriminating to within ± 0·1 c/s up to 220 Mc/s. On this type of equipment, drift is seen which otherwise is seldom noted. Ambient temperature was 68°F.

A mechanical shock test was also applied with remarkably good results: excluding crystal controlled receivers, in the writer's experience only the Racal RA.17 is better. An s.s.b. station was tuned in at 3·7 Mc/s and blows of some force aimed at the mains transformer, that component being the one least susceptible to physical damage. The s.s.b. signal was copied throughout the shock period with reasonable ease. A similar series of tests applied to the station AR88 produced inferior results. In fact, when pounding the RA-1, the frequency shift of the AR88 (on the same bench) was greater. Try this test on your receiver and v.f.o.!

The counter was also used to determine the degree of oscillator shift with no input signal. Complete rotation of the r.f. gain control produced a change of 100 c/s at 30 Mc/s and 30 c/s at 21 Mc/s. On all other bands no significant change was recorded.

An oscillator trimmer is brought out to the front panel for scale set purposes and provision is made for the installation of a plug-in 100 kc/s crystal calibrator which is available as an accessory.

As only one r.f. stage is used, an i.f. of 1620 kc/s has been adopted to ensure reasonable image rejection. The aerial input is suitable for both balanced (80 ohm) feeders and end-fed wires. Two i.f. amplifiers, employing an EF183 and the pentode portion of an ECF82, provide high gain and a half-lattice crystal filter utilizing two Cathodeon crystals helps to shape the response curve. In this respect s.s.b. requirements have been favoured and the designer, an active amateur, would seem to have given s.s.b. considerable thought.

The b.f.o. (the triode portion of the ECF82) is fitted with a three position switch permitting selection of upper or lower sideband with the centre position as b.f.o. zero. This facility can therefore be used to assist in single signal reception of c.w. and is probably a better operating aid than a continuously variable b.f.o. In the test receiver the b.f.o. beat note on either sideband was a little too high for concentrated reception of c.w. and the writer preferred to use the centre zero and slightly detune the receiver until a suitable heterodyne note was obtained. This point has now been dealt with by the manufacturer and capacity values across the switch adjusted to produce a more favourable beat note.

An OA81 is used as a conventional diode detector and provision is made to adjust the level of b.f.o. injection to

* *38 Huckford Road, Winterbourne, Bristol.*

† R.S.G.B. *Amateur Radio Handbook*, pages 83 and 84.

‡ Indexing refers to the location of the switch contacts by the switch mechanism and is a measure of how much oscillator tuning is affected by switching from one band to another and then back to the original point of measurement.

TABLE 1

Performance

	Claimed	Measured
Sensitivity	2 microvolts for 10db signal to noise ratio	1 microvolt or better for 10db signal to noise ratio at 30 per cent modulation
Image Rejection	40db or better	42 db at 30 Mc/s 61db at 21 Mc/s
Selectivity (Total Bandwidth)	No claims	— 6db 2·4 kc/s —10db 3·4 kc/s —20db 5·8 kc/s —30db 7·8 kc/s —40db 9·8 kc/s —50db 12·0 kc/s —60db 14·1 kc/s —70db 16·5 kc/s —80db 19·0 kc/s One hump, the peak of which was 52db down, was spaced 27·7 kc/s h.f. of the centre frequency.

Valve and Semiconductor Complement

R.F. Amplifier EF183	A.G.C. Rectifier OA81
Mixer/Oscillator ECH81	Noise Limiter EB91
First I.F. Amplifier EF183	First Audio Amplifier and Output Stage ECL86
Second I.F. Amplifier and B.F.O. ECF82	H.T. Rectifier EZ81
Detector OA81	Stabilizer OA2

Frequency Ranges

1·7 to 2 Mc/s	14·0 to 14·5 Mc/s
3·5 to 4 Mc/s	21·0 to 21·5 Mc/s
7·0 to 7·3 Mc/s	28·0 to 30·0 Mc/s

suit the operator's favourite band. This is achieved by fitting a value of h.t. dropper resistor in the b.f.o. anode circuit dependent on the sensitivity of the band for which optimum results are required. This is of especial interest for s.s.b. reception and is a desirable facility to cover the almost absolute certainty of sensitivity variation from 1·8 to 30 Mc/s. Ideally, perhaps, continuously variable injection should be the aim but, due to Miller effect, the h.t. dropper cannot be replaced by a simple variable resistor. If it were, the b.f.o. centre zero would shift. More complex circuitry to avoid this would not be economical but as in other receivers a reasonable compromise can be made. Daystrom Ltd. recommend and supply suitable values with the kit for any required characteristic and information is detailed in the instruction book.

Another OA81 diode is used as the a.g.c. rectifier and an on/off switch is fitted. An S meter is also incorporated, but this is of limited range and, in the writer's opinion, can only be regarded as a tuning meter.

An EB91 double diode is used in the variable noise limiter which was found to be effective on impulse noise and Loran.

An ECL86 acts as first audio amplifier and power output stage and provides adequate power. The speaker output impedance is 3 ohms and a 600 ohm outlet is provided for 'phones. When the latter are plugged in, the speaker is automatically disconnected. An external speaker is required.

Receiver muting is achieved by applying heavy negative bias to the r.f. and i.f. stages. This is short-circuited to earth during receive periods, terminals being provided at the back of the receiver for this purpose. These would normally be closed by a pair of contacts on a transmit/receive relay or by a permanent shorting link where there are no transmitting requirements. The advantage of this arrangement is that all the receiver valves are left running in a normal condition and risk of drift due to h.t. switching is avoided.

The internal power supply employs an EZ81 rectifier and resistance-capacitance smoothing. The receiver is designed for mains inputs of 110-240 volts a.c., 50-60 c/s. The a.c. consumption is 50 watts.

In view of its comparatively small size and weight the RA-1 should have an especial appeal to those who are interested in portable operation or do not wish to be lumbered with a large and heavy receiver. For portable or mobile operation a supply of 250 volts h.t. at 65 mA and either 6 or 12 volts l.t. at 3·5 A is required. The h.t. and l.t. lines are brought out to an octal socket which is arranged so that the internal power supply is disconnected when the receiver is in use with a separate power pack. Since the RA-1 is small enough to be fitted into many vehicles, this facility should be attractive to mobile operators, especially as the mechanical stability is of a very high order.

Performance figures and other relevant data are given in Table 1.

Operation

For comparison it was felt desirable to use a good quality receiver that is as familiar as possible, and recourse was made therefore once again to the AR88. This particular receiver is maintained at a high standard and, the writer likes to think, is above average.

Any signal heard on the AR88 was heard at least as well on the RA-1, except under conditions of severe QRM. The low frequency end of 7 Mc/s is regarded as " QRM Alley " and it is apparent that whilst the selectivity of the RA-1 is adequate for most purposes it is insufficient for the serious c.w. operator. However, a socket on the rear apron is provided for the connection of a *Q*-multiplier. The writer has no doubt that with the addition of this accessory the receiver will give a very good account of itself under most conditions.

During listening tests, no greater difficulty was found in resolving s.s.b. than any other mode of transmission, although it must be admitted that the writer is not new to s.s.b. reception techniques. No actual reception tests were possible on 10m due to the poor state of the band and lack of signals.

A slide rule tuning dial provides about 5 in. of scale length on each frequency range and with a dual 5 : 1 and 25 : 1 reduction drive, tuning was found to be smooth and adequate. On the model tested the drive was a little stiff, but freed after a short period of operation. Despite the inevitable use of a nylon cord drive in a receiver in this price range, no backlash whatsoever was apparent or indeed measurable.

Accessories

Accessories available for the RA-1 are a plug-in crystal calibrator (Model CL-1) providing calibration signals at 100 kc/s intervals, a *Q*-multiplier for 1620 kc/s and a matching loudspeaker cabinet and 7 in. × 4 in. speaker.

The Heathkit Model RA-1 basic amateur bands receiver is manufactured by Daystrom Ltd., Gloucester, and costs £39 6s. 6d. in kit form or £52 10s. assembled.