The Peter Hart Review

HF-150

Lowe HF Receiver

IN A MARKET largely dominated by the Japanese suppliers, Lowe Electronics have successfully developed and sold a range of HF communications receivers. In November 1989, I reviewed the HF-225 receiver in this magazine. Since then two new models have appeared, the HF-235 for professional and commercial use and, more recently, the HF-150 budget priced receiver.

When it comes to buying an HF receiver, the SWL has two broad options; to buy a communications receiver or to buy a consumer short wave receiver. The mass-produced consumer short wave receivers offer good value for money but are really intended for broadcast listening on short whip antennas. For SSB use on the amateur bands and with larger antennas, they have major shortcomings. On the other hand, the communications receiver will cope well with all modes and requirements but at a relatively high cost and usually not as a self contained portable package.

The HF-150 is a true HF communications receiver, small enough to be classified as portable, robustly constructed and at a most attractive price.

PRINCIPAL FEATURES

THE HF-150 HAS CONTINUOUS frequency coverage between 30kHz and 30MHz. Eight modes of operation are provided - USB, LSB, AM with wide filters, AM with narrow filters and four synchronous AM modes. Two different IF bandwidths are provided, nominally 2.5kHz and 7kHz. These are not selectable by the user from the front panel but automatically set according to the selected mode.

HF broadcasting frequently suffers badly from the effects of selective fading. This results in the amplitude of the sidebands varying with respect to each other and to that of the carrier. In particular, if the carrier amplitude is reduced with respect to the sidebands, most conventional AM demodulators will generate severe distortion. The synchronous AM demodulator uses a product detector together with a narrow locking range phase locked loop to regenerate the carrier at constant amplitude. This gives a far superior performance under selective fading conditions. The HF-150 provides four different synchronous AM modes, two using DSB with the wider IF filter and two using SSB with the narrow IF filter. The mode to use depends on prevailing conditions - normal DSB for general AM use, hi-fi DSB where signals are strong, and SSB (lower or upper) under crowded band conditions.

Tuning is accomplished with the weighted spin-wheel knob which tunes in steps of 8Hz on SSB and synchronous AM or 60Hz on normal AM. This gives tuning rates of 1.6kHz per revolution on SSB or 12kHz per revolution on normal AM. Slower tuning rates are engaged for synchronous AM. If the tuning knob is rotated quickly, x6 or x8 speed-up is selected to increase the tuning rate. For larger changes in frequency, the spin-wheel may be used to increase or decrease the frequency in steps of 100kHz across the tuning range of the receiver. There is no separate band switch.

The receiver is also equipped with sixty memories which hold frequency and mode. There are three memory functions - preview, recall and store, controlled by the three function buttons on the front of the receiver. Memories are selected with the spin-wheel knob and the frequency contents are previewed leaving the received frequency unaffected.

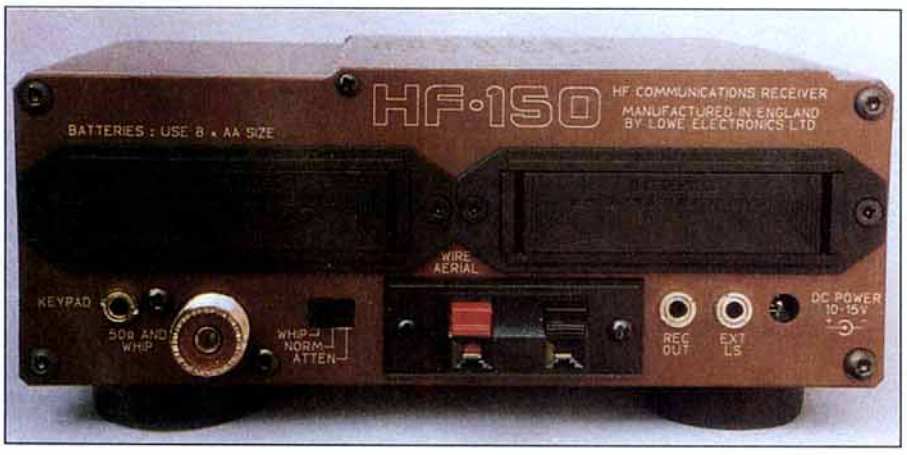
An optional keypad is available which plugs into a jack on the rear panel. This useful addition allows the frequency to be entered directly to the nearest kilohertz and also allows direct selection of the memories.

The receiver has been designed to function with a variety of different antennas. Two antenna sockets on the rear panel allow for the connection of wire antennas of nominal 600Ω impedance or an SO239 50Ω coaxial connection. An RF preamplifier is also selectable for short wire or whip antennas, and for strong signal conditions a 20dB input attenuator may be switched in circuit. An antenna slide switch on the rear panel selects between these various combinations.

A 7.5cm diameter speaker is fitted into the top of the case with provision for external speaker, phones and recorder output. This output, independent of the volume control, is at a suitable level for driving tape recorders, RTTY decoders etc.

A five-digit liquid crystal display is fitted. This indicates the frequency to 1kHz resolution or alternatively the memory number. At power-on, the display indicates 'HF-150' and with low battery voltage 'LoPr'. A number of other messages may be displayed such as 'STo' for store and the different modes during mode selection. A flag shows when memory mode has been selected.

The receiver operates from a nominal 12V supply and is supplied with a suitable small mains PSU. Alternatively, the receiver may be powered from internal batteries, either



The rear panel of the HF-150 is uncluttered whilst providing a number of useful facilities.

alkaline/manganese primary cells or nickel/cadmium rechargeable cells. Battery holders are fitted to accommodate eight AA sized batteries. When switched off, NiCd batteries may be recharged from an external supply and will take about 16 hours to fully recharge if completely discharged.

A 32-page A5 manual is provided with the receiver. This covers clearly how to operate the receiver and to obtain best results under various conditions. A full circuit diagram is included together with a circuit description and a particularly detailed equipment and performance specification. Useful advice is given on suitable antennas.

DESCRIPTION

THE RECEIVER IS VERY ROBUSTLY housed in an extruded aluminium case. The overall size is 185mm (W) by 80mm (H) by 175mm (D) and weighs approximately 1.3kg without batteries. The bulk of the circuitry is constructed on one PCB, with a second PCB behind the front panel containing the microcontroller, display and driver. The front panel has a very simple layout. Apart from the volume control and rotary tuning knob, the only other controls are three multifunction push buttons which select memory, mode and tuning rate functions. When selecting mode, two of the buttons scroll forwards or backwards through the eight possible mode combinations.

The receiver is double conversion with a first IF of 45MHz and a second IF of 455kHz. Signals from the antenna pass through a 30MHz low pass filter and into a high dynamic range active double balanced first mixer. There is no RF amplifier unless the whip preamplifier is selected and there are no signal frequency bandpass filters. The second mixer is a similar active double balanced mixer. The 45MHz IF crystal filter has a bandwidth of 15kHz with two switchable ceramic filters in the 455kHz IF for the main channel selectivity.

The local oscillator drive for the first mixer is provided by a simple single loop frequency synthesiser tuning in 1kHz steps. Smaller step sizes, down to 8Hz, are provided by shifting the frequency of the oscillator drive to the second mixer over a range of 1kHz using a D/A converter and varicap diode.

A single chip 8-bit microcontroller is used with internal ROM and RAM. The active frequency and mode settings and memory contents are stored in non-volatile EEPROM memory which does not require the use of a back-up battery. The receiver will power-up to the last used frequency and mode. The control system and software has been developed to allow the microcontroller to be put into an idle state as much as possible to minimise the pick-up of spurious noise from the control system.

MEASUREMENTS

ALL MEASUREMENTS WERE MADE with the receiver powered from the PSU provided with the receiver. Results are given in the accompanying table with additional comments as follows.

SPURIOUS REJECTION

Rejection of all IFs, sub IFs and IF images was better than 78dB, a perfectly adequate figure. There were very few other spurious responses.

AGC

The AGC attack time was a little long and had an extended tail, taking several hundred milliseconds to finally settle.

DISTORTION

One of the advantages of synchronous AM is lower distortion. This is only achieved when the tuning is accurately set.

STRONG SIGNAL PERFORMANCE

Considering the low cost and simplicity of this receiver, the third order intermodulation and reciprocal mixing performance are remarkably good. However, there is no front-end selectivity, which makes the receiver vulnerable to out-of-band second order intermodulation problems. For example, strong broadcast stations on the 25m and 31m broadcast bands intermodulating to give a signal on 21MHz (eg 11.7MHz + 9.5MHz = 21.2MHz). This parameter was not measured unfortunately.

SELECTIVITY

The selectivity measurement is only approximate. **Fig 1** shows the combined results of selectivity, reciprocal mixing and intermodulation.

POWER REQUIREMENTS

Using an external power supply, the current consumption varied from 130mA with low audio output up to 250mA with high audio. The receiver functioned down to about 8.5V, below which the synthesiser lost lock, although the voltage regulators lose regulation below 9.5V. The low power indication came on below 8.8V.

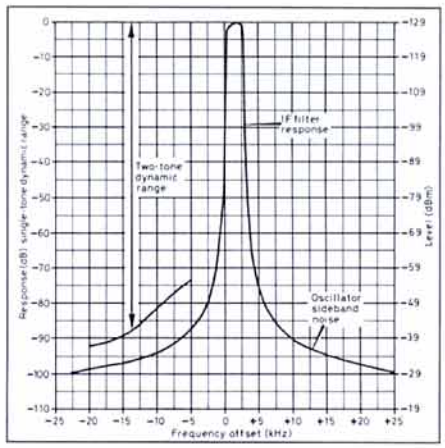


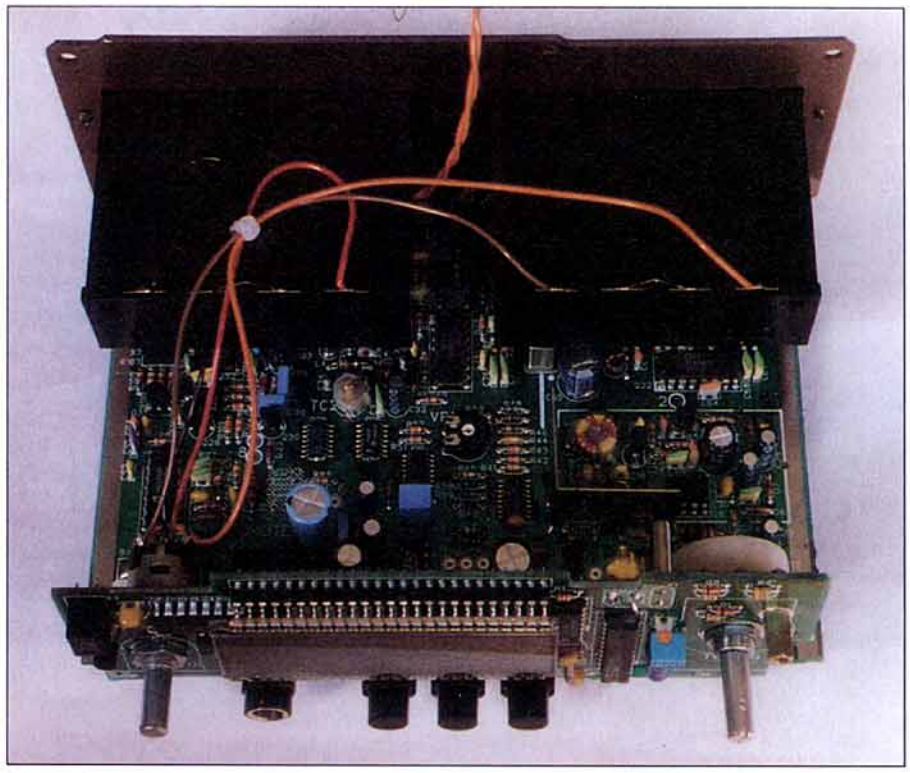
Fig 1: HF-150 effective selectivity curve on USB.

ON AIR PERFORMANCE

The receiver functioned very well under all conditions. The audio quality was particularly good on SSB and wider bandwidth AM and synchronous AM modes. The sensitivity was ample on the higher bands and the receiver coped well with crowded LF band signals. In this situation, it was usually desirable to switch in the input attenuator. There were no instances of second order intermodulation experienced, which is the danger with wideband front-ends, but tests were not exhaustive by any means. The receiver gave a good performance on the LF and VLF bands which is usually a sign of a good synthesiser.

Synchronous AM functioned well on selective fading signals and really helped on readability. With four different modes there is plenty of scope to achieve optimum results.

Tuning with 8Hz steps gave a very smooth result but seemed interminably slow on tuning speed. Although the speed-up feature functioned on AM, speed-up did not seem to operate on SSB. This may have been a fault



The receiver is built on two PCBs, a main board and one for the front panel.

LOWE HF-150 MEASURED PERFORMANCE

FREQUENCY	SENSITIVITY SSB 10dBs+n:n NORMAL	WHIP	IMAGE REJECTION
1.8 MHz	0.25µV (-119dBm)	0.14µV (-124dBm)	81dB
3.5 MHz	0.25µV (-119dBm)	0.13µV (-125dBm)	84dB
7 MHz	0.25µV (-119dBm)	0.13µV (-125dBm)	93dB
10 MHz	0.25µV (-119dBm)	0.13µV (-125dBm)	88dB
14 MHz	0.25µV (-119dBm)	0.13µV (-125dBm)	84dB
18 MHz	0.28µV (-118dBm)	0.14µV (-124dBm)	84dB
21 MHz	0.28µV (-118dBm)	0.13µV (-125dBm)	85dB
24 MHz	0.32µV (-117dBm)	0.13µV (-125dBm)	83dB
28 MHz	0.32µV (-117dBm)	0.13µV (-125dBm)	83dB

FILTER	BANDWIDTH -6dB	-60dB
NARROW	2600Hz	4600Hz
WIDE	6600Hz	10500Hz

FREQUENCY OFFSET	RECIPROCAL MIXING FOR 3dB NOISE
3 kHz	79dB
5 kHz	83dB
10 kHz	92dB
15 kHz	95dB
20 kHz	98dB
30 kHz	102dB
50 kHz	106dB
100 kHz	110dB
200 kHz	113dB

AM sensitivity (28MHz, 30% mod): 1.6µV NOR, 0.5µV WHIP

AGC threshold: 0.5µV approx

80dB above AGC threshold for +4dB audio output

AGC attack time: 7ms (see text)

AGC decay time: 2s

Max audio before clipping: 1.2W into 8Ω, 2.0W into 4Ω

Distortion at max audio: 1%

Distortion on AM at 70% mod depth: 3%

Distortion on AMS at 70% mod depth: 1-2%

Inband intermodulation products: -30 to -40dB

	INTERMODULATION (50kHz Tone Spacing) NORMAL		WHIP	
Frequency	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
1.8 MHz	+8dBm	92dB	-3dBm	88dB
3.5 MHz	+9dBm	92dB	-3dBm	88dB
7 MHz	+10dBm	93dB	-3dBm	88dB
14 MHz	+10dBm	93dB	-3dBm	88dB
21 MHz	+11dBm	93dB	-6dBm	86dB
28 MHz	+12dBm	93dB	-8dBm	85dB

TONE SPACING (7MHz BAND)	3rd ORDER INTERCEPT	2 TONE DYNAMIC RANGE
5 kHz	-19dBm	73dB
10 kHz	-7dBm	81dB
15 kHz	+5dBm	89dB
20 kHz	+8dBm	92dB
30 kHz	+9dBm	92dB
50kHz	+10dBm	93dB

NOTE: All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements were made on SSB with NOR antenna setting.

with the review sample. The keypad entry of frequency was extremely useful and I would regard this as an indispensable option. Clicks were audible every 1kHz when tuning the synthesiser but they were not particularly objectionable. This must be kept in perspective considering the price of the radio.

As I found with the HF-225, it is important to avoid placing the receiver close to mains powered equipment including its own AC PSU. A burble can be introduced onto received signals by AC mains fields coupling into the receiver VCO.

CONCLUSIONS

THE HF-150 CAN BE RECOMMENDED to the SWL searching for a true communications receiver at the lowest cost. Although it has a minimal set of features when compared with receivers costing twice as much, it is fully competitive in terms of performance. My only concern is the wideband front-end which may be prone to overload from out-of-band signals although no problems were experienced during the course of the review.

The receiver is manufactured in the UK and currently sells for £359 inc VAT. The KPAD-1 keypad is an extra £39.95 and other accessories include XLS-1 external speaker at £59.95 and AK-150 portable operation accessory kit at £39.95.

ACKNOWLEDGEMENTS

I WOULD LIKE TO THANK Lowe Electronics of Matlock, Derbyshire for the loan of the receiver.

Peter Hart, G3SJX

SINCE THE REVIEW was completed, Lowe Electronics have added two new optional accessories, the MB-150 mobile mounting bracket which caters for top or bottom mounting, at £29.95, and the IF-150 interface which plugs directly into the keypad socket and provides an RS-232 interface for remote control by computer. This is supplied with a ready to run software package and costs £39.95. The IF-150 is also suitable for the HF-225 receiver.