

*The
Peter Hart
Review*

The YAESU FRG-100 HF Receiver



ALTHOUGH THE MAIN manufacturers introduce new transceiver models on a regular basis the launch of a new receiver is a relatively rare event and as a result HF receivers tend to be around for much longer. Yaesu have recently introduced a new mainstream HF receiver, the FRG-100, occupying the middle price ground with a good performance specification and plenty of features.

PRINCIPAL FEATURES

THE FRG-100 IS A 12V operated general coverage receiver covering the frequency range 50kHz to 30MHz. In the UK, the receiver is supplied with a small external mains PSU in a plastic moulded case (model PA-11C) but this may not be supplied in other countries. The PSU is shown as an option in the manual. The receiver covers USB, LSB, CW, CW-narrow (optional), AM and AM-narrow reception modes, plus FM when the optional FM unit is installed.

Tuning is via a 40mm diameter rotary tuning knob which tunes at a fixed rate independent of speed. This tunes in 10Hz steps at 5kHz per revolution on SSB and CW and in 100Hz steps on AM and FM at 50kHz per revolution. Pushing the FAST key increases the step size by a factor of ten and the tuning rate by a factor of ten or twenty, effectively giving up to 1000 steps per revolution of the knob. Apart from these default settings, the tuning step size in FAST mode can be programmed by the user for any increment from

100Hz to 100kHz in 100Hz steps. This may even be set independently for each mode! Hence the tuning step size could be set at 9kHz for the MW broadcast band, although the tuning rate would be rather fast at 4.5MHz or 9MHz per revolution of the knob!

UP/DOWN keys step the frequency in increments of 100kHz or 1MHz or alternatively may be set to step through the sixteen broadcast bands. In the broadcast band stepping mode, the last used frequency and mode is returned for each band. Unfortunately, there is no similar facility to step through the amateur bands.

A good balance of features and performance for ... this price bracket

Some very comprehensive memory and scanning facilities are built in. 52 battery-backed memories are provided, selected by a small click-step rotary control and the usual VFO/memory transfer and preview facilities are incorporated. The memories store frequency, mode and narrow filter selections. Direct tuning from the VFO is possible for all memories to anywhere within the tuning range of the receiver. A memory browse facility

allows empty memory channels to be skipped when checking. Two of the memory positions are used primarily to store band scan limits and a power-on setting allows the memories to be re-ordered in ascending frequency order.

Scanning may be initiated between two programmable frequency limits, across all occupied memory channels or in selectable groups. In the selectable group mode, the 50 principal memory channels are split into five groups (A,B,C,D,E) with ten channels in each e.g. A1, A2, A3, B6, E9 etc. This can be regarded as a matrix and it is possible to scan this matrix along either axis, e.g. all group A or all number 3 etc. It is also possible to skip memory locations during scanning and to scan any of the 16 broadcast bands from beginning to end. In all cases there are two choices of scan resume; time delay or carrier delay. A priority watch facility is also included, whereby any selected memory channel can be checked every five seconds for activity whilst the receiver is used in normal VFO or memory mode.

Both wide and narrow filters are included for AM operation. Narrow CW (250Hz or 500Hz bandwidth) requires an optional filter. There is no variable bandwidth, notch or AF filter provided but CW has the ability to select reverse sideband mode if adjacent signals are a problem. The AGC speed is selectable as fast or slow and a noise blanker is provided for man-made impulse noise. For strong signal situations, a front-end attenuator may be switched in circuit, selectable to 6, 12 or 18dB. There is no RF gain control, the squelch

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operates on all modes and the S-meter is a conventional analogue type.

The display is a back-lit liquid crystal panel with two settings for illumination. It is crisp and clear and indicates frequency to 10Hz resolution, time, memory channel number and various status messages such as mode, memory active, filter, scan and timer status etc.

The FRG-100 has two independently programmable clocks with 12 or 24 hour format [why don't more rigs have this? - Ed]. One can be set to local time and the other can be adjusted to UTC or any other time zone. The clock may be displayed in place of frequency and will also be displayed when the receiver is turned off provided it is still connected to a 12V power source. The FRG-100 can also be set to emit time pips at every hour, even with the receiver turned off, again provided the power is still connected. Timers are also provided, giving one on, one off and one sleep period. These will switch the radio on and off at the appropriate times and also, via a relay, a jack on the rear panel to control a tape recorder for example. This jack is also controlled by the squelch. Hence for the relay to be closed, the receiver must be on AND the squelch must indicate the presence of a signal. The clock circuits are battery backed and continue to function with the power removed.

There are many other lesser used functions provided in this receiver such as selectable CW beat-note, SSB carrier offset for best audio frequency response, variable beep tone and beep tone on/off, electronic setting and calibration of the reference oscillator etc. Many of the features such as step sizes, scan functions etc may be customised either at power-up or via a SET function.

Two antenna connectors are provided on the rear panel with a switch to select between them. There is a normal 50 ohm input and also an input for high impedance end fed antennas (450 ohm). Other rear panel connectors include power, external speaker, low level audio and remote switching. For use with a transmitter, the receiver may be muted by a short to ground contact. A computer control interface is provided conforming to the Yaesu CAT standard. This controls the usual VFO, memory, scanning and set mode functions and also includes clock, timer and reading of the S-meter.

A 39-page instruction manual is included together with circuit diagrams. A summary of all the operating functions is also contained on one side of a handy reference card which pulls out from under the radio. The other side of this card shows world time zones.

DESCRIPTION

THE FRG-100 IS A convenient size for a receiver; small and light enough to be used anywhere yet large enough to be ergonomically easy to use. The overall size is 238mm (W) by 93mm (H) by 243mm (D) and it weighs about 3kg. A steel chassis and back plate is used with a plastic overlay front panel and the circuitry is contained on three printed circuit boards. Two boards fit either side of the chassis plate. One board contains the RF, IF and AF signal frequency circuitry. The other board contains the frequency synthesizers

and microcontroller. This board also contains the plug-in lithium back-up cell. The third PCB is mounted behind the front panel and contains the LCD and driver, keys and switches. A two-piece steel wrap around case is used with the 6cm diameter speaker mounted in the top section.

The receiver is a double conversion superhet with IFs of 47.21MHz and 455kHz. There is no RF amplifier and both first and second mixers comprise push-pull pairs of FETs. The front-end is filtered by one of eight switchable bandpass filters. The 47MHz IF filter uses a cascaded pair of small monolithic dual crystal resonators and the main selectivity is achieved with ceramic filters at the 455kHz IF.

The frequency synthesiser section uses a combination of single loop mixer PLL with direct digital synthesis (DDS) and a second DDS is used to generate the 455kHz carrier/BFO signal. Four VCOs cover the tuning range of the receiver. A single microcontroller is used for all functions with on-chip ROM and RAM.

MEASUREMENTS

PERFORMANCE MEASUREMENTS were made with the receiver powered from the PA11C power unit supplied and are detailed in the table with additional comments as follows:

SENSITIVITY

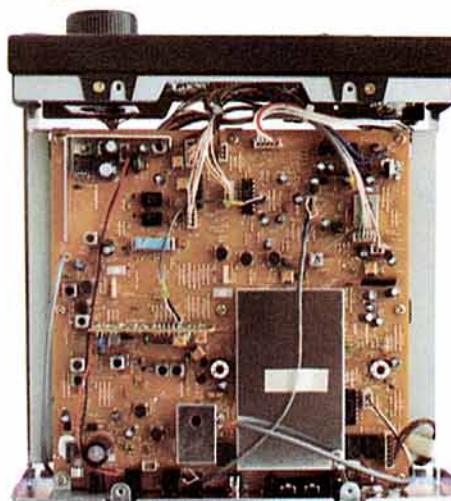
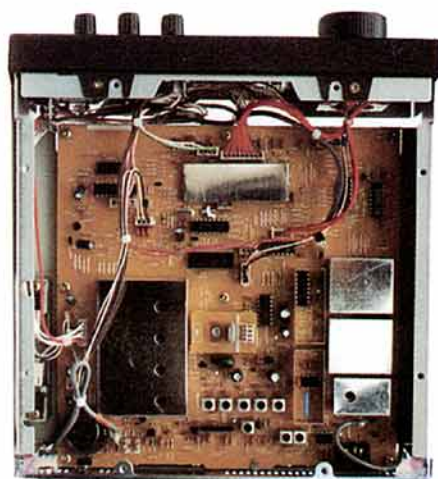
The receiver was slightly less sensitive than I would have expected. Indeed, the performance of the test model was marginally outside of the quoted specification above 20MHz. However, the sensitivity should be entirely adequate for all normal antennas.

S-METER CALIBRATION

The S-meter was considerably less sensitive than with most other receivers. Signals which are shown as S9 on most receivers would indicate S5 to S7 on the FRG-100. All modes, including FM, gave the same result.

AGC

The AGC action did not come into operation until 9uV, whereas most receivers are in the region of 1-2uV. This is probably due to a relatively low IF gain in the receiver and has the effect of making weak signals sound weaker than stronger signals. I personally do not mind this. The initial AGC attack time is fairly fast but had an extended tail taking up to 100ms to settle finally.



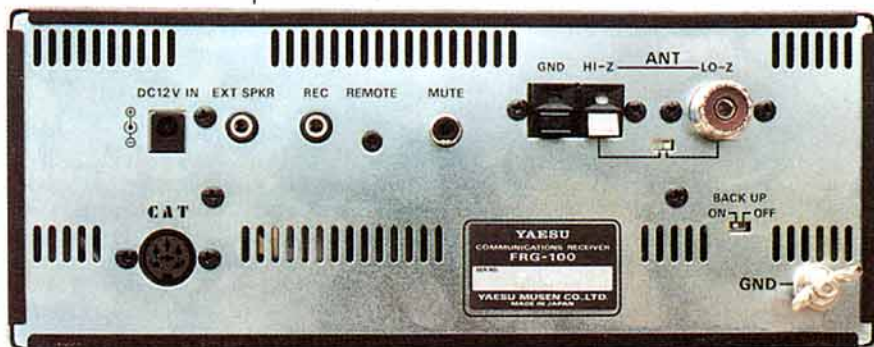
Top and bottom internal views.

SPURIOUS REJECTION

Rejection of the 47MHz IF was in excess of 85dB, the primary image better than about 70dB (see table) and all other responses in excess of 90dB. This includes the second mixer image and is a very good result. The manual lists four frequencies where internal 'birdies' may be found. In practice these were insignificant.

STRONG SIGNAL PERFORMANCE

The front end intercept and dynamic range are really quite good for a receiver in this price bracket. The close-in dynamic range degrades but is still acceptable as is the reciprocal mixing performance. The in-band linearity measured with 200Hz tone spacing was a



Sockets for coarse fed and long-wave aerials are provided, as is the YAESU CAT computer interface.

YAESU FRG-100 MEASURED PERFORMANCE

FREQUENCY	SENSITIVITY SSB 10 dB s+n:n	INPUT FOR S9	IMAGE REJECTION
1.8MHz	0.22µV (-120dBm)	560µV	69dB
3.5MHz	0.22µV (-120dBm)	560µV	71dB
7MHz	0.22µV (-120dBm)	630µV	69dB
10MHz	0.2µV (-121dBm)	560µV	74dB
14MHz	0.25µV (-119dBm)	800µV	72dB
18MHz	0.25µV (-119dBm)	800µV	88dB
21MHz	0.28µV (-118dBm)	900µV	87dB
24MHz	0.32µV (-117dBm)	1000µV	87dB
28MHz	0.35µV (-116dBm)	1000µV	86dB

S-READING (14MHz)	INPUT LEVEL
S1	10µV
S3	17µV
S5	40µV
S7	133µV
S9	630µV
S9+20	7.5mV
S9+40	42mV

MODE	IF BANDWIDTH -6dB	
SSB, CW	2700Hz	6500Hz
AM	8730Hz	16.9kHz
AM(N)	7540Hz	16.0kHz

AM sensitivity (28MHz): 1.6µV for 10dBs+n:n at 30% mod depth
 FM sensitivity (28MHz): 0.7µV for 12dB SINAD 3kHz peak deviation
 AGC threshold: 9µV
 80dB above AGC threshold for +2dB audio output
 AGC attack time: 3ms (see text)
 AGC decay time: 0.3 – 0.5s (fast), 1.5 – 2.5s (slow)
 Max audio before clipping: 1.5W into 8Ω, 2.4W into 4Ω
 Distortion at above levels: <1%
 Inband intermodulation products: -28 to -36dB (see text)

FREQUENCY	INTERMODULATION (50kHz TONE SPACING)	
	3rd ORDER INTERCEPT	2 TONE DYNAMIC RANGE
1.8MHz	+9dBm	93dB
3.5MHz	+8dBm	92dB
7MHz	+13dBm	96dB
14MHz	+14dBm	96dB
21MHz	+17dBm	97dB

TONE SPACING (7MHz BAND)	3rd ORDER INTERCEPT	
	3rd ORDER INTERCEPT	2 TONE DYNAMIC RANGE
3kHz	-22dBm	72dB
5kHz	-13dBm	78dB
8kHz	+1dBm	88dB
15kHz	+13dBm	96dB
>15kHz	+13dBm	96dB

FREQUENCY OFFSET	RECIPROCAL MIXING FOR 3dB NOISE	
	RECIPROCAL MIXING FOR 3dB NOISE	BLOCKING
3kHz	75dB	-24dBm
5kHz	80dB	-22dBm
10kHz	87dB	-7dBm
15kHz	91dB	+2dBm
20kHz	94dB	+2dBm
30kHz	99dB	+2dBm
50kHz	105dB	+2dBm
100kHz	113dB	+2dBm
200kHz	121dB	+2dBm

NOTE: All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on SSB.

below -50dB but reciprocal mixing limited measurement.

POWER REQUIREMENTS

In normal operating mode, the measured current consumption was about 760mA from a 12V supply. When switched off, with the clock and display active, the current consumption was about 140mA. The receiver continued to function down to a supply voltage of about 9.6V.

DIAL CALIBRATION

At room temperature, the frequency was within 30Hz at 28MHz.

ON AIR PERFORMANCE

THE RECEIVER WAS generally easy to use and performed very well on all modes and bands. Sensitivity was quite adequate on the now fairly quiet 28MHz band and the receiver coped well without strong signal problems on 7MHz and the lower broadcast bands. The audio quality was reasonable but I found it a little 'boxy'. The AM performance was good and the narrow filter about optimum. Many receivers use the SSB filter for narrow AM which I find is completely useless. The receiver also performed well down to VLF which is a sign of good synthesiser noise performance. Note that some early models were supplied apparently only tuning down to 130kHz. With these receivers, operation down to 50kHz can be permanently enabled by selecting SSB and FM at power-on.

Switching between broadcast bands was simple and rapid but, being primarily interested in the amateur bands, I missed not having a band change facility for these bands. As it had been done for the broadcast bands it could have been easily implemented for the amateur bands as well. One solution is to program the amateur bands into memory locations and use the memory tune facility, but this does not provide true band stores returning to the last used frequency on each band.

The tuning rate was about right but the tuning knob was a bit small for my liking. Implementing a full 1000 steps per revolution of the knob instead of 500 in normal tuning mode would have been even better. This resolution is available in fast mode. The synthesiser was click free with the exception of a 'muted pause' every 81.92kHz.

I very soon turned off the hourly annunciator for the clock. Over a period of 2 months, the clock gained 5 minutes.

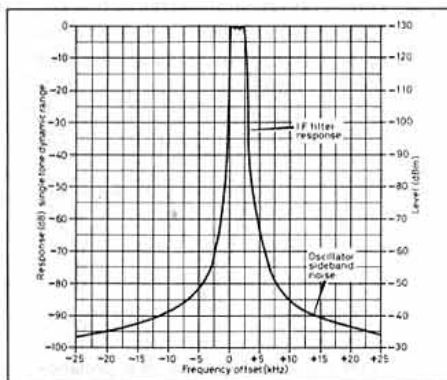
CONCLUSIONS

THE FRG-100 RECEIVER is a useful all-round performer. It is available from the usual Yaesu suppliers at a price under £600. It is easy to use and has a good balance of features and performance for a radio in this price bracket.

ACKNOWLEDGEMENTS

I WOULD LIKE TO thank South Midlands Communications Ltd of Eastleigh, Hants for the loan of the receiver.

Peter Hart, G3SJK



FRG-100 IF selectivity.

couple of decibels better with slow AGC than with fast.

I have recently been made aware of a problem prevalent in certain parts of the world where strong broadcast stations generate intermodulation due to the input filter switching diodes in the receiver. I checked the FRG-100 at 21.1MHz (test signals 11.6 and 9.5MHz) and 14.3MHz (test signals 7.2 and 7.1MHz). No response was obtained until input signals reached -20dBm, some 10dB better than the normal 50kHz spacing test. This seems a good result.

SELECTIVITY

The IF filter skirts seemed to widen rapidly