Yaesu FT-1000MP MARK-V Transceiver

Reviewed by Peter Hart, G3SJX*

FIVE YEARS AGO Yaesu introduced the FT-1000MP, at a time when the major manufacturers were all introducing new top-of-the-range HF transceivers with extensive DSP features. During the five years since its launch, the 'MP' has become firmly established as the transceiver of choice by many of the top DX operators and many of the big DXpeditions. Indeed it was my choice last year when I purchased a new transceiver to re-equip my own HF station, so naturally I was very interested to see how the new Mark-V version performed and how it compared with the original 'MP'. There are several significant changes to the new model and I will cover these in some detail, but the features common to the earlier model will be covered in less detail. Check out the original review in the January 1996 issue of *RadCom* for further information.

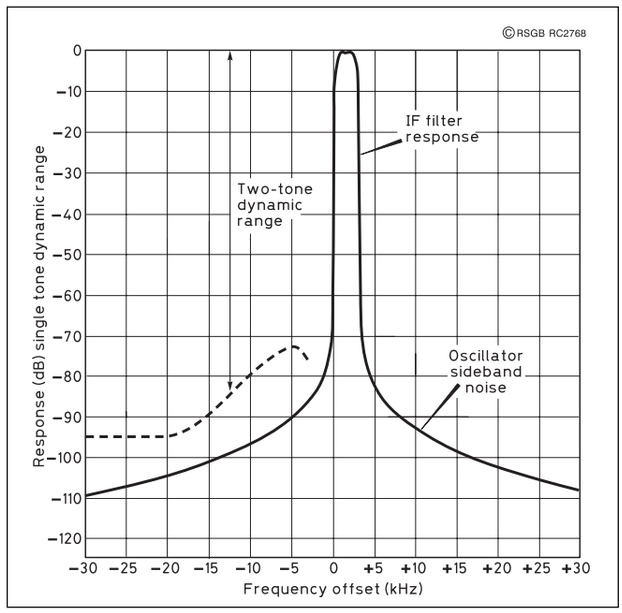

Fig 1: Effective selectivity curve on USB.

PRINCIPAL FEATURES

THE MARK-V FT-1000MP is a substantial base station radio incorporating two receivers each tuning 100kHz to 30MHz and with the transmitter covering 500kHz segments around the amateur bands. Apart from the common input bandpass filter, the two receivers (main and sub) adopt totally separate signal paths right through to the audio output, with separate synthesisers, IFs, filters, demodulators and AGC. The two receiver outputs may be fed to stereo headphones to copy the separate channels in different ears, which also yields various possibilities for diversity reception and spatial perception tuning. USB, LSB, CW, AM, FM, RTTY and PACKET modes are provided, with normal/reverse sidebands on CW, normal or synchronous tuning on AM, with SSB or FM modes on packet (FSK or AFSK) and USB or LSB modes on RTTY with FSK or AFSK interfacing.

There are several ways of setting the radio on frequency. Individual keys select the bands with double band-stacking registers, two rotary tuning knobs set the main and sub receivers tuning in a selection of step sizes down to 0.625Hz per step, a click step rotary tunes in larger steps for moving rapidly around bands, the frequency may be directly entered from the numeric keypad, and finally there is the shuttle jog tuning ring. This spring loaded tuning ring is concentric with the main tuning knob and tunes up or down at a rate dependent on how far the ring is turned. Both the main tuning knob and the tuning ring have been increased in size and weight with the Mark-V version and the tuning ring now carries two keys for activating new features (see later).

99 memories are provided, easy to select via a click-step rotary with all the usual memory-related features. The memories may be partitioned into groups and the sub receiver display is used to preview contents whilst still retaining active use of both the main and sub receivers. A quick memory feature allows five frequencies to be rapidly stored and recalled by single button pushes. Split frequency operation is aided by a number of initial split access states, and red and green LEDs above each tuning knob show which is currently in use for receive, transmit or dual receive. The usual RX/TX clarifier is provided, the usual comprehensive scanning facilities and, on FM, a single button selects repeater offset with full CTCSS access tones.

The main receiver is a quadruple conversion superhet, with IFs of 70.455MHz, 8.215MHz, 455kHz and 10.24kHz. The sub receiver is double conversion, with IFs of 47.21MHz and 455kHz. IF filter bandwidths of 250Hz, 500Hz, 2.0kHz and 2.4kHz are available at both the second and third IFs, with 6.0kHz at the third IF only. The standard

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model is fitted with both 2.4kHz filters and 500Hz filter for the second IF; the 250Hz, 2.0kHz and 500Hz third IF filters are optional extras, as also is a 500Hz filter for the sub receiver IF. The Mark-V uses a 10-pole Collins mechanical filter for the 2.4kHz third (455kHz) IF, which gives improved skirt selectivity compared with the original 'MP' 8-pole filter. The other difference between the two models is the way that the filters are selected. With the Mark-V three buttons select normal, narrow 1 or narrow 2 bandwidth settings, which are different for each mode and can be user set from the custom menu.

The Enhanced Digital Signal Processing circuit (EDSP) provides a number of additional filtering functions for both the receiver and the transmitter audio path, as well as digital modulation and demodulation to/from the 10.24kHz IF. On receive, EDSP provides four different filtering contours for improving readability under difficult conditions. These selectable contours provide a bandpass (see IDBT later), low, mid or high cut-off to the audio pass-band. Four audio peaking filters with steep sides and minimal ringing may be selected, giving bandwidths of 60, 120 or 240Hz on CW and an optimised bandwidth for data use. One of four different noise reduction algorithms may be implemented on receive, to improve readability under various conditions and an auto notch will effectively track and notch-out multiple heterodynes on SSB signals. On transmit, EDSP provides equalisation for four different microphone audio characteristics, as well as some filter tailoring to give the best audio quality depending on microphone and voice characteristics. Although all these functions were largely available on the original radio, user access to the functions has been greatly improved with the Mark-V by providing separate buttons for each, in particular the audio peaking filter which had to be set from the user menu in the original radio.

Three alternative receiver RF amplifiers may be selected, a wideband amplifier covering the whole receiver range, a tuned low gain amplifier covering 1.8-7MHz, and a high gain low noise tuned amplifier covering 24-30MHz. In addition, the RF amplifier may be switched out (IPO) or three levels of attenuation inserted. Other receiver functions include IF shift / width and IF notch, fast/slow AGC, variable CW pitch and noise blanker.

Apart from a completely new PA system, transmit features include an RF-based speech processor, full- and semi-break-in, VOX, variable power output, audio monitor and auto-ATU with band/frequency stores. A fully-featured contest memory keyer is also built in.

The multi-coloured fluorescent display is virtually identical to the original radio, just a couple of status indicators are changed. The display is a little dimmer than before, but the unlit segments are somewhat less obtrusive. Both VFO frequencies and clarifier are continuosly displayed with memory number, status indicators and five bargraphs for S meters, TX functions and tuning, all with or without peak hold.

The rear panel connectors are the same as the earlier model, providing twin selectable antenna sockets, twin key jacks, twin headphone jacks and interfacing to external receiver, external receive antenna, linears, remote tuners, data TNCs and the DVS-2 voice store. Transverters are accommodated with display of the transverted frequency and an RS-232C port allows direct computer control at 4800 baud. Although I did not have a chance to check out the computer interface, the command set and data protocols appear identical to the earlier version. 89 of the transceiver's settings are user programmable, even down to providing fine trimming of the various oscillator frequencies. This is largely the same as the earlier model but with some additions. Extensive facilities are included for data modes. Check out the earlier review for further information on all these aspects.

CHANGES INTRODUCED

PROBABLY THE MOST noticeable physical difference between the original radio and the

Mark-V is the large finned heatsink that dominates the upper rear section of the radio. Internally this is blown by a thermostatically controlled cross-flow fan, which engages when the temperature reaches 40°C. This heatsink is used to cool a new higher power PA which conservatively delivers 200W RF output power, although the power output can be reduced down to a level of a few watts. The PA in the Mark-V uses a push-pull pair of power MOSFETS operating from a 30V supply rail.

A unique feature of the Mark-V is the ability to switch the PA to class A operation for greatly improved linearity to achieve 75W output power with a claimed intermodulation distortion level of -50dB. The PA transistors dissipate 300W even when there is no RF output in class A, hence the need for the substantial heatsink. Linear amplifiers, and in particular valve linears, generally have a lower level of distortion products than the PA stages of most transceivers. Hence even when a linear is used, benefits will normally be seen in terms of a cleaner output signal if the PA in the transceiver is operated in class A. Everyone benefits from cleaner transmitter signals on the bands and most linears can be fully driven with around 75W of drive.

The original FT-1000MP operated from a 12V supply and contained an internal power supply for mains use. As a consequence of adopting the new higher power PA, the Mark-V needs both 30V and 12V and is provided with an external matching switched mode power supply. Considering its rated output, this 450W-rated supply is very light, and includes a built-in fan. Overall, the Mark-V without its power supply is 1kg lighter (at 14kg) than the original radio with built-in mains PSU. The size is the same (410 x 135 x 347mm).

Another new feature introduced into the Mark-V is the Variable RF front-end filter (VRF), which functions on bands from 1.8 to 14MHz. This provides a sharply tuned input preselector right at the input to the receiver, with a front panel peaking control. It uses relay switched capacitors and inductors, without any active switching devices. This ensures that no intermodulation products are generated within the filter, no matter how strong the incoming signals (within reason). This is ideal for eliminating second order intermodulation and blocking effects from extremely strong broadcast stations, or where several transmitter stations are co-sited in multi-multi-operator contests or DXpedition situations. VRF is activated by one of the buttons on the shuttle jog tuning ring.

The other button on the tuning ring activates the Interlocked Digital Bandwidth Tracking System (IDBT), another new feature with the Mark-V. The IDBT functions on SSB only and sets the bandwidth of the EDSP audio filtering to match exactly the net bandwidth of the IF filter, also tracking the settings of the IF shift

RECEIVER MEASUREMENTS

Frequency	Sensitivity SSB 10dBs+n:n Flat Amp	Tuned Amp	Amp Out	Input for S9 Flat Amp	Tuned Amp	Amp Out
136 kHz	-	-	1.1µV	-	-	80µV
1.8 MHz	0.2µV	0.4µV	0.5µV	28µV	50µV	80µV
3.5 MHz	0.2µV	0.45µV	0.56µV	28µV	63µV	90µV
7 MHz	0.22µV	0.35µV	0.45µV	32µV	56µV	80µV
10 MHz	0.18µV	-	0.45µV	28µV	-	80µV
14 MHz	0.2µV	-	0.45µV	25µV	-	80µV
18 MHz	0.16µV	-	0.45µV	20µV	-	90µV
24 MHz	0.2µV	0.11µV	0.56µV	28µV	7µV	110µV
28 MHz	0.22µV	0.11µV	0.63µV	28µV	6µV	110µV

AM sensitivity (28MHz): 0.8µV for 10dBs+n:n at 30% mod depth
FM sensitivity (28MHz): 0.13µV for 12dB SINAD 3kHz pk deviation
AGC threshold: 2.5µV — 100dB above AGC threshold for +1.5dB audio output
AGC attack time: 3ms (fast), 2ms (slow) — AGC decay time: 0.2-0.3s (fast), 2s (slow)
Max audio before clipping: 8ohm-1.6W, 4ohm-2.7W at 1% distortion
Inband intermodulation products: -26 to -40dB

S-Reading (7MHz)	Input Level SSB Pre-amp Out
S1	7µV
S3	9µV
S5	13µV
S7	20µV
S9	80µV
S9+20	900µV
S9+40	10mV
S9+60	110mV

Mode	IF Filter IF2/IF3	IF Bandwidth -6dB	-60dB
SSB Nor	2.4/2.4	2570Hz	3350Hz
CW Nor	2.4/2.4	2570Hz	3350Hz
CW Nar1	500/500	490Hz	940Hz
CW Nar2	250/500	355Hz	720Hz
AM / FM	Thru/6k	8020Hz	13.7kHz
AM Nar1	2.4/2.4	2570Hz	3350Hz

Intermodulation Performance (50kHz tone spacing)

Frequency	3rd Order Intercept Flat Amp	Tuned Amp	Amp Out	Two-Tone Dynamic Range Flat Amp	Tuned Amp	Amp Out
136kHz	-	-	+6dBm	-	-	81dB
1.8MHz	-5dBm	+10dBm	+22dBm	84dB	90dB	97dB
3.5MHz	+6dBm	+16dBm	+21dBm	91dB	93dB	95dB
7MHz	+13dBm	+16dBm	+18dBm	95dB	95dB	95dB
14MHz	+12dBm	-	+24dBm	95dB	-	99dB
21MHz	+11dBm	-	+13dBm	95dB	-	91dB
28MHz	+2dBm	-9dBm	+2dBm	88dB	85dB	82dB

Close-in Dynamic Range Measurements on 7MHz Band - Pre-amp Out (IPO)

Frequency Offset	3rd Order Intercept	Two Tone Dynamic Range	Blocking	Reciprocal Mixing For 3dB Noise
3 kHz	-9dBm	77dB	-14dBm	82dB
5 kHz	-14dBm	73dB	-14dBm	87dB
7 kHz	-12dBm	75dB	-8dBm	91dB
10 kHz	-5dBm	79dB	0dBm	95dB
15 kHz	+10dBm	89dB	>+6dBm	100dB
20 kHz	+18dBm	95dB	>+6dBm	104dB
30 kHz	+18dBm	95dB	>+6dBm	109dB
40 kHz	+18dBm	95dB	>+6dBm	112dB
50 kHz	+18dBm	95dB	>+6dBm	114dB
100kHz	+18dBm	95dB	>+6dBm	120dB
200kHz	+18dBm	95dB	>+6dBm	123dB

SSB TWO-TONE TRANSMITTER MEASUREMENTS

Frequency	Class AB SSB (PEP) Power O/P	Class AB Intermod. Products 3rd Order	5th Order	Class A SSB (PEP) Power O/P	Class A Intermod. Products 3rd Order	5th Order
1.8MHz	220W	-36 (-30)dB	-42 (-36)dB	88W	-41 (-35)dB	-56 (-50)dB
3.5MHz	195W	-34 (-28)dB	-42 (-36)dB	75W	-40 (-34)dB	-56 (-50)dB
7MHz	215W	-31 (-25)dB	-42 (-36)dB	85W	-54 (-48)dB	-60 (-54)dB
10MHz	212W	-38 (-32)dB	-44 (-38)dB	85W	-56 (-50)dB	-60 (-54)dB
14MHz	213W	-36 (-30)dB	-50 (-44)dB	86W	-52 (-46)dB	-60 (-54)dB
18MHz	211W	-28 (-22)dB	-54 (-48)dB	88W	-52 (-46)dB	-60 (-54)dB
21MHz	210W	-28 (-22)dB	-50 (-44)dB	89W	-49 (-43)dB	-58 (-52)dB
24MHz	212W	-29 (-23)dB	-44 (-38)dB	88W	-52 (-46)dB	-60 (-54)dB
28MHz	222W	-31 (-25)dB	-46 (-40)dB	92W	-48 (-42)dB	-60 (-54)dB

Intermodulation product levels are quoted with respect to PEP, figures in brackets are with respect to either tone.

Carrier suppression: >70dB — Sideband suppression: >80dB @ 1kHz
Transmitter AF distortion: <1% — Microphone input sensitivity: 1mV for full output
SSB T/R switch speed: mute-TX 10ms, TX-mute 5ms, mute-RX 24ms, RX-mute 2ms

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

and width controls. The net result is a 'brick wall' shape characteristic to the overall channel bandwidth, even with the channel narrowed considerably with the width control.

The front panel layout of the Mark-V is largely unchanged except for the addition of the new features and to improve access to the EDSP and other functions. The shift, width, notch and clarifier knobs have been made larger and these are no longer dual concentric controls.

MEASUREMENTS

THE FULL SET of measurements are given in the table. The review radio was equipped with the optional 250Hz filter at the second IF and 500Hz filter at the third IF and in the sub receiver. This is shown in the bandwidth measurements, which are for the IF only and not including EDSP. The 10-pole SSB filter has noticeably superior response. Due to the large number (11) of narrow bandwidth front-end filters, the FT-1000MP second order intermodulation result was some 10dB better than any other radio I have measured. With the VRF activated in the Mark-V, this improved further to the point where it was in many cases unmeasureable. The overall close-in dynamic range (see **Fig 1**) is very good, but is equalled (and in some cases bettered) by other radios.

On transmit, the new PA has excellent linearity. Even in class AB, results are better than most radios and in class A really excellent. CW keying was reasonably well shaped, but perhaps slightly sharp on the fall characteristic.

CW TRANSMITTER MEASUREMENTS

Frequency	CW Power O/P	Harmonics
1.8MHz	212W	-60dB
3.5MHz	200W	-65dB
7MHz	210W	-66dB
10MHz	210W	-66dB
14MHz	210W	-70dB
18MHz	211W	-68dB
21MHz	214W	-72dB
24MHz	210W	-65dB
28MHz	220W	-70dB

ON-THE-AIR PERFORMANCE

AS WITH THE earlier version, the new Mark-V FT-1000MP is a really excellent performer for the serious HF operator. Signal handling was excellent and the various selectivity functions including the new IDBT and the other interference-combating armoury of tools all performed very well. The overall ergonomics are even better implemented now with the Mark-V. Although I never experienced a situation during the brief period of the review where VRF really helped, measurements showed that for the multi-transmitter situation this should prove a real boon. Transmission quality was excellent and the high power PA coped well with extended use.

The FT-1000MP is potentially a good receiver for 136kHz. However, the power supply provided with the review radio was an early production sample and generated considerable hash on this band and long wave broadcast using close-by antennas. This was not observed during measurements using screened cables. Yaesu UK are confident that this would not be a problem with full production models in the UK.

CONCLUSIONS

THE NEW Mark-V FT-1000MP fully lives up to expectations. Improving on an established world-class design, the new version should fully meet the needs of the serious HF operator and in particular the multi-station DXpedition and contest groups. The current list price is £2799.

And finally, in case you were wondering, there was no Mark 2, 3 or 4 version of the FT-1000MP, the Mark-V relates to the five new features.

ACKNOWLEDGEMENTS

I WOULD LIKE to thank Yaesu UK for the loan of the radio. ♦