Yaesu FT-100 HF/VHF/UHF Transceiver

*Reviewed by Peter Hart, G3SJX**

Front view of the Yaesu FT-100.

THE FT-100 IS Yaesu's latest little won-der. Barely larger than an FM mobile rig, Yaesu have squeezed into its small case a fully featured all-mode radio delivering 100W on HF+6m, 50W on 2m and 20W on 70cm, a general coverage all-mode receiver from 100kHz to 970MHz and a wideband FM mode for band II broadcast reception.

Yaesu were the first to include 70cm in an HF + VHF transceiver with the FT-847, introduced about a year ago. Indeed the FT-847 also covered 70MHz for the UK market, but as will become clear later, this is not technically feasible with the FT-100. Icom introduced their IC-706 in 1995 as a tiny all-mode mobile for HF+6+2m. It was really quite ahead of its time and a trend-setter for the future. After a couple of improved versions, Icom have recently launched their IC-706MkIIG which includes 70cm and similar power levels to the FT-100. The two radios share many similar features, so expect serious competition. This review focuses on the FT-100.

Yaesu also have available a mobile antenna system, the ATAS-100, covering bands from 7 to 430MHz. The opportunity was also taken to check out the FT-100 with this novel antenna system.

PRINCIPAL FEATURES

THE FT-100 IS an ideal mobile transceiver measuring only 160 x 54 x 205mm and has many features particularly aimed at mobile operation. Weighing only 3kg it is also ideal for lightweight expeditions and is virtually lost inside aircraft cabin baggage. With a detachable front panel to deter car theft, it can also be operated with the front panel remotely mounted and hence squeezed into the smallest of spaces on the dashboard. A 6m separation cable is available for this purpose.

Although small in size, it is certainly not small in features. It is always a challenge with a small radio to provide simple and user friendly access to its many functions. Yaesu have approached this in the following way: some dedicated controls are essential, such as tuning, band change, volume, etc, which form the first priority level of control. The tuning control and a small click-step rotary select most of the 'variable' functions. Four buttons below the display select most of the remaining principal functions. A separate button scrolls this row of four keys to select one of nine groups of functions. The least used settings are accessed via the menu system. This is quite quick and simple to use, and enables some 66 of the radio's functions to be customised.

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The FT-100 is 12V operated, needing an external 25A PSU for mains use. It covers the usual modes of LSB, USB, CW (normal and reverse sideband), AM and FM, together with wideband FM for band II broadcast reception and an AFSK data mode.

The receiver tunes continuously from 100kHz to 970MHz and the transmitter is enabled only within the amateur allocations. The receiver does actually tune down to 30kHz, but is too insensitive for practical use below 100kHz.

Up/Down keys step between bands, returning the last used frequency, mode etc per band. Separate A and B VFOs per band return different sets of data, hence one can be used for CW frequencies and the other for SSB, which is fine until you wish to use both VFOs for split frequency operation.

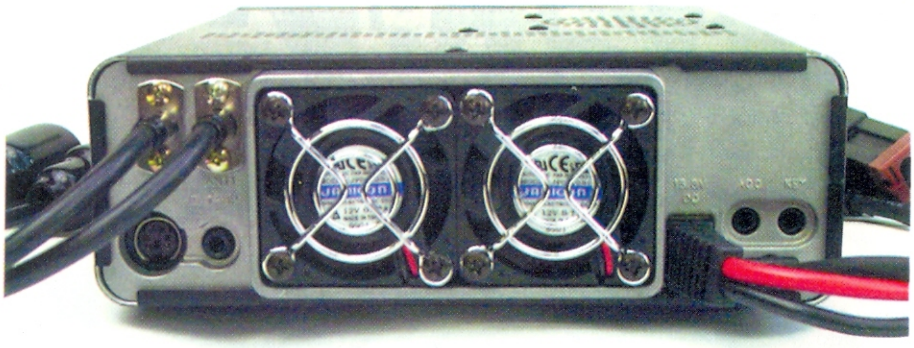
The main VFO uses a 38mm diameter tuning knob with finger indent, tuning in various step sizes from 1.25Hz to 1kHz with a relatively small 200 steps per knob revolution. On AM/FM the step size is fixed at 100Hz. A small click-step rotary is useful for moving the frequency rapidly around bands. The step size is fixed at 10kHz on SSB and CW, but programmable to different step sizes on AM and FM. This control also enables rapid stepping in 1 and 10MHz steps.

Detail of the liquid crystal display, showing the band scope along its bottom edge.

A huge number of memories are provided in the FT-100, each storing mode and other transceiver settings as well as the frequencies. There are 300 regular memories, partitioned into 6 banks of 50 memories each, 20 split frequency duplex memories, 5 quick memory banks, 4 home channels (one each for HF, 6m, 2m, 70cm) and 20 programmable scan limits. The quick memories allow frequencies to be quickly stored or recalled by a single key press on the basis of last in, first out. The usual memory transfer, preview and tune facilities are provided.

The radio is provided with a 2.4kHz IF filter for SSB, CW and data modes, but two additional filters may be optionally fitted. One of these is a 500Hz CW filter and the second can be either a 300Hz CW filter or a 6kHz AM filter. IF shift is provided which allows the passband to be shifted and a receive only clarifier operating over the range of ±9.99kHz. Other bandwidth enhancements or selectivity related features are provided by the audio-based DSP unit.

Other receive features include presettable CW pitch, an IF noise blanker for pulse type interference with adjustable level which is useful for mobile use, an all-mode squelch which can be optionally reassigned as an RF gain control, a switchable preamplifier and input attenuator, and selectable AGC speed. The AGC speed can be either fast or slow or automatically set for fast on CW and data modes with slow AGC for voice. The pre-amp switched out is described as IPO (Intercept Point Optimisation) but this and the input attenuator is only available on HF and 50MHz. The pre-amp is permanently engaged on the VHF and UHF bands.



The Power Amplifier is cooled by two fans mounted on the rear panel.

On transmit, the power output is presettable from 0 to 100% of the maximum, and separately for HF, 6m, 2m and 70cm. Moreover, the SSB, CW, FM and AM power levels may be set individually within the four band groupings. This can be very useful to prevent overdrive where several linear amplifiers are used for different bands. An AF speech processor is provided and a fully adjustable VOX. The audio characteristic from the microphone may be tailored by the DSP on all voice modes and additionally on SSB by adjustment of the carrier position.

The radio is supplied with a 108 page A5 manual which fully describes all its many features, installation and all aspects of operation. A set of loose circuit diagrams is included.

SPECIAL FEATURES

IN COMMON WITH most new radio designs, DSP is used to implement a number of useful audio based functions. On receive a 'brickwall' bandpass filter is available with independent high pass (100Hz - 1000Hz) and low pass (1000 - 6000Hz) cutoffs. On CW this becomes a peaking filter with a bandwidth of 60, 120 or 240Hz centred on the set CW pitch. An automatic tracking notch filter will remove one or more unwanted carriers. A noise reduction system is provided, based on the algorithms employed in the FT-920. Some 16 different settings provide optimum results under different circumstances. On transmit, the DSP implements a microphone equaliser with three selectable characteristics.

For CW use, a built-in iambic keyer allows for several modes of operation, adjustable dot:space and dash:space ratios and automatic character space. The keyer also includes a 50 character memory store for repetitive CQ calls. Both full break-in and semi break-in are provided, with adjustable recovery time. A novel feature of the FT-100 is that the entire CW envelope may be delayed from 0-30ms, to allow for linear amplifier switchover delays.

Data modes supported include LSB/USB RTTY, packet (300bps) and other SSB supported modes, and 1200/9600 bps FM packet. The usual range of shifts and tones are selectable. All interfacing is via a 6 pin mini-DIN connector on the rear panel. An eight pin mini-DIN connector on a flying lead interfaces to the VL-1000 linear, the FC-20 auto-ATU or via a level converter to the serial port of a PC for remote control (but only one at a time). The usual comprehensive PC control facilities are provided. Two antenna sockets are fitted on flying leads, one for HF and 6m and the other for VHF/UHF. The switchover point between the antennas appears to be 70.5MHz.

A useful facility, particularly for monitoring activity on 6m or VHF channels, is the spectrum scope. This is a barchart display of the activity on 15 channels above and 15 channels below the current on-tune frequency. For mobile use, automatic power off can be selected if there is no activity for 1-3 hours to avoid a flat battery, and also the transmission period can be limited (1-20 mins).

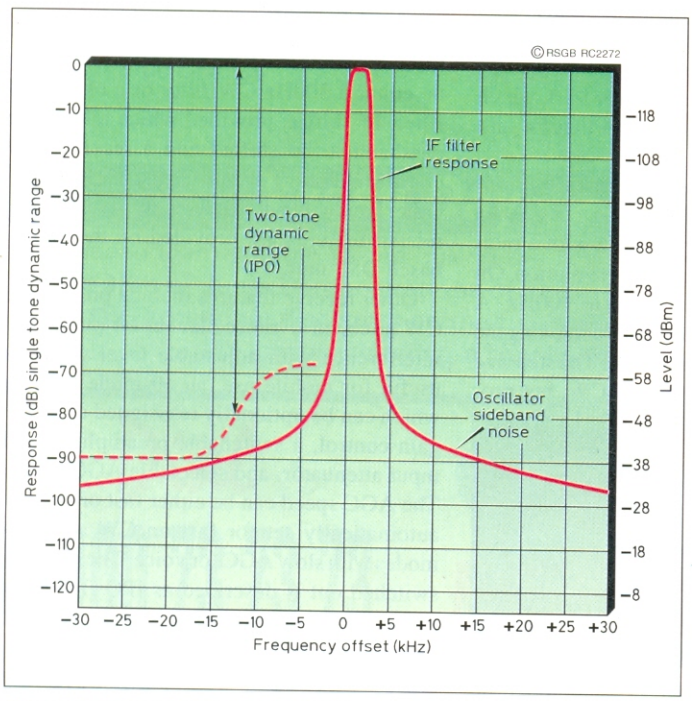


Fig 1: Effective selectivity curve on USB.

VHF/UHF FEATURES

A NUMBER OF features are aimed particularly at VHF/UHF FM operation. Repeater offsets are separately programmable for 10m, 6m, 2m and 70cm, and can be automatically selected according to the bandplan in use in the relevant region on 2m and 70cm. The transmit and receive frequencies can be reversed by a single key press to check for activity on a repeater input channel. A 1750Hz tone burst is built-in and a CTCSS tone encoder is provided for repeater access. For full CTCSS tone squelch operation or for monitoring the transmitted repeater CTCSS tone, the optional FTS-27 tone decoder module needs to be fitted.

A Digital Code Squelch (DCS) system is also built-in. This uses one of 104 selectable codes to implement a squelch controlled link and is more robust and less prone to false triggering than CTCSS. Complimentary to the DCS system is the ARTS (Auto Range Transponder System), which is also fitted. This uses DCS signalling to inform when you and another ARTS equipped station are within communications range.

A host of scanning related features are provided. Smart Search is a useful feature on FM for mobile operation. A scan is initiated above and below the VFO frequency and the first 40 active channels (20 higher and 20 lower) are loaded into special memory. This can be useful when travelling in a new area. Scanning can be initiated in VFO mode, up or down from any start frequency or between programmed limits. Memory channels including the QMB (quick memory banks) can be scanned sequentially up or down, and channels can be selected for skipping. Dual watch allows VFO-B to be periodically checked (every 1-10secs) whilst using VFO-A for normal communication purposes.

DESCRIPTION

THE FT-100 IS constructed around a substantial diecast frame with densely packed surface mount PCB assemblies on both sides of the frame. Screening has obviously proved a problem, as there is much added copper screening tape in critical areas. The frame provides the PA heatsink, which is also blown by twin axial fans on the rear panel. The speaker in the case top is very small at only 4.5cm diameter.

The receiver is a double conversion superhet on all bands, with IFs of 68.985MHz and 11.705MHz and a third conversion to 455kHz on FM. Wideband FM adopts a separate signal path from the 68MHz IF through 10.7MHz. The receiver front end uses three RF amplifier paths for HF, VHF and UHF, and two mixers (HF and VHF/UHF). The main selectivity is achieved at 11.705MHz with the 2.4kHz SSB

filter and optional filters when fitted. On AM and FM modes there is no selectivity at this IF, a through connection in place of the filter. Hence the bandwidth will be very wide on these modes, relying on the 68.9MHz filter for selectivity. The underside of the chassis is dominated by the PA board which contains two amplifier paths, one for HF/6m and the other for 2m/70cm.

The front panel display uses a backlit blue LCD panel to indicate the frequency to 10Hz resolution, legends for the multifunction keys, memory number and status indicators. The S meter uses a bargraph display of fairly coarse resolution and this indicates SWR or ALC as well as power output on transmit. The spectrum scope uses a barchart display in place of the key legends.

MEASUREMENTS

MEASUREMENTS ARE given in the table when powered from a 13.8V supply, with additional comments as follows.

RECEIVER

The receive sensitivity on the amateur bands is entirely adequate, although slightly reduced on 50MHz. Outside of the amateur bands, the receive sensitivity starts to degrade above 200MHz, reaching 5µV at 900MHz. Similarly, the sensitivity drops rapidly below 200kHz. Between 50 and 70MHz, the sensitivity drops rapidly, presumably a filter is incorporated to improve the 68MHz IF rejection, such that the sensitivity on the 70MHz amateur band is useless (800µV!). The S meter reading is very low compared with most radios, and is similar on all modes except wideband FM. An S9 reading on the FT-100 will generally be S9+10 to S9+20 on most other radios. The image and IF rejections were generally quite good (75-90dB), down slightly on 50MHz at 48dB for first IF rejection. The third order intercept and dynamic range figures are generally poorer than most radios.

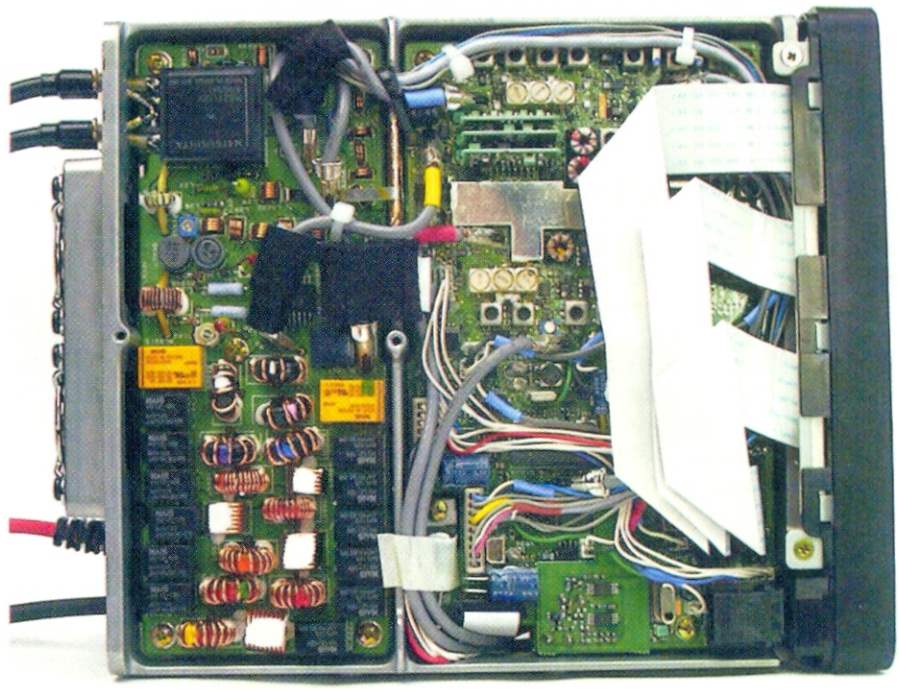
TRANSMITTER

On transmit, the current consumption at full output was around 17A on HF, 15A on 2m, 9A on 70cm and about 1A on receive. The two-tone transmit distortion was particularly poor on 2m, but as is usual a small reduction in power output makes a big improvement to distortion levels. The speech processor added some distortion, but only within the channel bandwidth and did not broaden the transmission. The CW keying characteristic showed very little distortion in semi break-in mode, with no first character shortening. On full break-in there was some slight character shortening at higher speeds, and in both modes the rise and fall times were a little sharp.

ON-AIR PERFORMANCE

I USED THE FT-100 from home, and in the car with the ATAS-100 antenna. As a mobile rig it performed extremely well. With such a small radio and so many features, it is difficult to get the user ergonomics comparable with a bigger radio, but Yaesu have achieved a good solution. Most features are generally quick to access and easy to use. However, I found the tuning knob rather small and with only 200 steps per revolution a lot of knob winding is inevitable. I found 25 or 50Hz steps a good compromise on SSB with 10 or 25Hz on CW. The button clusters around the tuning knob were rather closely spaced, but that is probably unavoidable. The small speaker is rather boxy and rattles at high listening levels. An external speaker can of course be used with better results. Note that there is no headphone jack. Headphones can be used with the external speaker socket in conjunction with a resistive attenuator.

The RF performance was generally good for a radio of this type. The sensitivity was good but some strong signal intermodulation problems were evident on the lower bands with reasonable sized antennas. This needed both the IPO selection (pre-amp switched out) and the input attenuator selected to give clean results on 10, 7 and 3.5MHz after dark. The AM broadcast quality was excellent but rather



Top view with cover removed.

YAESU FT-100 MEASURED PERFORMANCE

TRANSMITTER MEASUREMENTS

FREQUENCY	CW POWER OUTPUT	SSB(PEP) POWER OUTPUT	HARMONICS	INTERMODULATION PRODUCTS 3rd order	5th order
1.8MHz	90W	97W	-60dB	-24dB	-32dB
3.5MHz	92W	97W	-62dB	-22dB	-34dB
7MHz	92W	97W	-60dB	-20dB	-36dB
10MHz	92W	94W	-60dB	-24dB	-28dB
14MHz	92W	94W	-62dB	-24dB	-36dB
18MHz	92W	95W	-60dB	-24dB	-34dB
21MHz	92W	94W	-64dB	-24dB	-34dB
24MHz	92W	93W	-67dB	-25dB	-30dB
28MHz	92W	93W	-68dB	-27dB	-27dB
50MHz	92W	93W	-65dB	-24dB	-27dB
144MHz	53W	44W	-60dB	-12dB	-20dB
432MHz	21W	17W	<-70dB	-25dB	-35dB

Carrier suppression: 45dB
Sideband suppression: 65dB @ 1kHz
Transmitter noise: not measured
Transmitter AF response at -6dB: not measured
Transmitter AF distortion: 2%
Microphone input sensitivity: 4mV for full output
SSB T/R switch speed: mute-TX 10ms, TX-mute 1ms, mute-RX 15ms, RX-mute 1ms

All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on SSB with the receiver pre-amp switched in.
All two-tone transmitter intermodulation products quoted with respect to either originating tone. With respect to PEP, levels will be 6dB better.

wide, with strong broadcast stations audible over 40kHz of the band. The optional AM filter will cure this if AM broadcast is an important requirement. Similarly, on 2m FM, the presence of strong repeaters could be detected on the adjacent 25kHz channels. For serious CW use the optional 500Hz filter is a great help. However, the DSP CW filter is very effective as is also the bandpass filter on SSB. The noise reduction system can help in certain situations. The tracking notch filter was effective, but perhaps not quite as deep as some other radios and being implemented at audio will not prevent strong interfering signals desensitising due to AGC action.

The transmit performance was generally good, with complimentary reports on the audio quality. CW clicks were only just audible and break-in quite effective.

ATAS-100 ANTENNA

THE ATAS-100 IS a mobile antenna system which covers the 7/14/21/28/50/144/430MHz bands. It is not specified for 10/18/24MHz, but the manual states that satisfactory operation on these bands is usually possible. It comprises a 90cm thin whip antenna on top of a motorised loading coil base section which varies in length according to tuning. The overall length is between 1.4 and 1.6m, and the entire antenna weighs less than 1kg. The base of the antenna terminates in a UHF (PL259) male connector for attaching to a suitable base mount, which is not supplied as part of the antenna system. A good connection to the vehicle body-work is needed, hence a magnetic mount is not suitable. Also, magnetic mounts may not have sufficient holding power at high vehicle speeds with the wind surface area of the ATAS-100.

ATAS-100 mobile antenna, which is made to match the FT-847 and FT-100.

The ATAS-100 functions only with the FT-100 or the FT-847, as it uses the transceiver to provide the motor drive control via the antenna feed. If using an external power/VSWR meter, make sure there is no DC path across the antenna feedline. Tuning is controlled by the transceiver, tuning for minimum VSWR. This can take up to 2 minutes if well away from the tuning point, but in many cases takes just a few seconds as the microcontroller in the transceiver estimates the correct tuning direction. Tuning is not required on 2m or 70cm, the coil is nested at its minimum length, but note that if these bands are used with HF then the two antenna connectors need to be coupled with a diplexer.

With the ATAS-100 on my car I could achieve a good match on all bands, including 18 and 24MHz, but I did not achieve a good match on 10MHz. However, this is probably an unlikely band to use mobile. I found the antenna effective, it seemed to function as well as most mobile antennas and was a real convenience to change bands without changing antenna hardware. It can also be used as a fixed antenna, mounted for instance on balcony railings where no space is available for other antennas. The ATBK-100 counterpoise kit is available for this purpose.

CONCLUSIONS

FOR AN all-round HF/VHF/UHF mobile, the FT-100 is a very effective radio. Although it is tiny, it is packed with all the features of bigger radios with virtually no compromise on performance. Even for home station use, it represents the most cost effective way of equipping for HF through to 70cm.

The FT-100 is now becoming available at prices around £1249 inc VAT. The ATAS-100 mobile antenna system costs around £249 inc VAT.

ACKNOWLEDGEMENTS

I WOULD LIKE to thank Martin Lynch for the loan of the equipment. ♦

YAESU FT-100 MEASURED PERFORMANCE

RECEIVER MEASUREMENTS

	SENSITIVITY SSB 10dBs+n:n		INPUT FOR S9	
FREQ	PRE-AMP IN	IPO	PRE-AMP IN	IPO
1.8MHz	0.16µV (-123dBm)	0.28µV (-118dBm)	500µV	1.3mV
3.5MHz	0.18µV (-122dBm)	0.28µV (-118dBm)	400µV	1.3mV
7MHz	0.14µV (-124dBm)	0.18µV (-122dBm)	350µV	700µV
10MHz	0.11µV (-126dBm)	0.18µV (-122dBm)	400µV	800µV
14MHz	0.18µV (-122dBm)	0.28µV (-118dBm)	630µV	1.6mV
18MHz	0.18µV (-122dBm)	0.25µV (-119dBm)	560µV	1.3mV
21MHz	0.14µV (-124dBm)	0.28µV (-118dBm)	400µV	1.6mV
24MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	250µV	2mV
28MHz	0.14µV (-124dBm)	0.40µV (-115dBm)	500µV	2.2mV
50MHz	0.28µV (-118dBm)	0.50µV (-113dBm)	400µV	2mV
144MHz	0.10µV (-127dBm)	-	320µV	-
432MHz	0.10µV (-127dBm)	-	100µV	-

AM sensitivity (28MHz): 0.8µV for 10dBs+n:n at 30% mod depth
FM sensitivity (144MHz): 0.14µV for 12dB SINAD 3kHz pk deviation
AGC threshold: 1.8µV
100dB above AGC threshold for +2dB audio output
AGC attack time: 3-4ms
AGC decay time: 0.1-0.4s (fast), 0.5-1.5s (slow)
Max audio before clipping: 8Ω 1.6W, 4Ω 2.7W at 2% distortion
Inband intermodulation products: -25 to -30dB

S-READING (7MHz)	INPUT LEVEL SSB PRE-AMP IN	IPO
S1	2µV	4µV
S5	3.5µV	6.3µV
S9	350µV	700µV
S9+20	1.8mV	3.5mV
S9+60	25mV	50mV

MODE	IF BANDWIDTH 6dB	-60dB
SSB, CW, Data	2380Hz	4950Hz
AM, FM	17.6kHz	86kHz

INTERMODULATION (50kHz Tone Spacing)

	PRE-AMP IN		IPO	
Frequency	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
1.8MHz	-7.5dBm	84dB	+3dBm	87dB
3.5MHz	-5dBm	85dB	+6dBm	89dB
7MHz	-5.5dBm	86dB	+3dBm	90dB
14MHz	-0.5dBm	88dB	+10dBm	92dB
21MHz	-5dBm	86dB	+7dBm	90dB
28MHz	-4dBm	87dB	+12dBm	92dB
50MHz	+2dBm	87dB	+20dBm	95dB
144MHz	-18dBm	79dB	-	-
432MHz	-20dBm	78dB	-	-

CLOSE-IN INTERMODULATION ON 7MHz BAND

	PRE-AMP IN		IPO	
Spacing	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
3kHz	-35dBm	66dB	-30dBm	68dB
5kHz	-35dBm	66dB	-30dBm	68dB
7kHz	-33dBm	67dB	-28dBm	69dB
10kHz	-26dBm	72dB	-22dBm	73dB
15kHz	-10dBm	83dB	0dBm	88dB
20kHz	-5.5dBm	86dB	+3dBm	90dB
30kHz	-5.5dBm	86dB	+3dBm	90dB
40kHz	-5.5dBm	86dB	+3dBm	90dB
50kHz	-5.5dBm	86dB	+3dBm	90dB

FREQUENCY OFFSET	RECIPROCAL MIXING FOR 3dB NOISE	BLOCKING PRE-AMP IN	BLOCKING IPO
3kHz	75dB	-24dBm	-17dBm
5kHz	81dB	-24dBm	-17dBm
10kHz	87dB	-24dBm	-17dBm
15kHz	91dB	-17dBm	-10dBm
20kHz	93dB	-16dBm	-9dBm
30kHz	97dB	-15dBm	-8dBm
50kHz	102dB	-14dBm	-7dBm
100kHz	109dB	-14dBm	-7dBm
200kHz	115dB	-14dBm	-7dBm

HF ENTHUSIASM

Yaesu, Choice of the World's top DX'ers

FIELD COMMANDER

Over 40 years of experience in HF transceiver design has firmly established Yaesu as the choice of the world's top DX'ers. The knowledge that produced unequaled RF technology and design that is found in the State of the Art FT-1000MP can also be found in the miniature FT-100. The FT-100 while small in size 6.3" × 2.1" × 8.1"(160 W × 54 H × 205 D mm :w/o knob) is large in features and performance. This is accomplished by using the most advanced manufacturing techniques and component mounting technology. High Dynamic range RF front-end technology and Advanced Digital technology such as DSP sets a new standard of receiver performance for miniature HF transceivers. The single piece die cast frame, dual cooling fan system and revolutionary RF high power design technique keeps the FT-100 running cool and smooth in the most adverse operating environments. (TX Power output=100W HF, 50W VHF/20W UHF) The TX Equalizer offers crisp, clear and clean TX audio reproduction that until now was only found in top of the line HF base stations. The optional ATAS-100 (active tuning antenna system) ushers in a new age of mobile and field day operation (from HF to UHF frequencies). Add the optional ATBK-100 base kit (Good for limited space, simple setup.) and you've got a base station that ranks among the best in the world.

Features

- Frequency coverage:
  RX : 100 kHz-970 MHz
  TX : 160-6 m/144-146 MHz/430-440 MHz
- Power output : 100 W (160-6 m), 50 W (144 MHz), 20 W (430 MHz)
- DSP Bandpass Filter, Notch Filter, Noise Reduction, and Equalizer
- IF Noise Blanker
- IF Shift
- SSB, CW, AM, FM, AFSK, Packet (1200/9600 bps) operation
- Detachable Front Panel
- Two Antenna Jacks (HF/50 and 144/430)
- VOX
- Dual VFOs
- Available IF bandwidths of 6 kHz, 2.4 kHz, 500 Hz, and 300 Hz (6 kHz, 500 Hz, 300 Hz filters optional)
- Built-in Electronic Memory Keyer
- Speech Processor
- Built-in CTCSS and DCS for FM operation
- Automatic Repeater Shift and Auto-Range Transponder System
- Smart Search™ Automatic Memory Channel Loading System
- 300 memory Channels
- Quick Memory Bank (QMB)
- Bright LCD with multi-function display
- Optional FC-20 External Antenna Tuner
- Compatible with ATAS-100 Active-Tuning Antenna System. Add the optional ATBK-100 base kit

FIELD COMMANDER

FT-100

Ultra-Compact HF/VHF/UHF Transceiver

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Specifications subject to change without notice. Specifications guaranteed only within Amateur bands.Some accessories and/or options are standard in certain areas. Check with your local Yaesu dealer for specific details.

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