



IC-7000 WITH HM-171 MICROPHONE



## The next generation

*The Icom IC-7000 HF, VHF and UHF transceiver is a worthy successor to the popular IC-706, writes Peter Hart.*

More than ten years ago, Icom introduced the IC-706 transceiver as a low cost innovative design covering initially HF and VHF and later UHF bands in a small package and at an attractive price. The IC-706 has proved very successful, probably selling more than any other model. A versatile radio for use at home, in the car or taken on holiday, the IC-706 is still used by many as a second radio as well as for the main transceiver.

The IC-7000 has recently been launched as a replacement for the IC-706. Using the latest technology, this new radio offers a higher performance and an unsurpassed level of features in an ergonomic design even smaller than the model it replaces.

### BASIC FUNCTIONS.

The IC-7000 provides all the functions of a fully featured HF and 50MHz transceiver with a 2m and 70cm multimode together with coverage of broadcast FM and even VHF TV (PAL/NTSC) on some regional variants e.g. Japan. The radio measures 167 (w) x 58 (h) x 180 (d) mm, the same front panel dimensions as the IC-706 but the depth is 20mm less and the radio is slightly lighter at 2.3kg. The radio requires a nominal 13.8V supply and draws a maximum current of 22A. CE marked models marketed in the UK and Europe

have a separate filter box incorporated into the power supply lead.

The receiver tunes from 30kHz to 200MHz and from 400 to 470MHz although the sensitivity is not guaranteed across the whole range. The transmitter is enabled only within the amateur allocations with variants for different regions. 5MHz discrete frequencies are only enabled for transmit by default in the USA version and best accessed via the memories. 5MHz operation can be enabled by UK dealers on request (TV operation as well). LSB, USB, CW, AM, FM, RTTY and wideband FM modes are selectable with reverse sideband alternatives on CW and RTTY. Wideband FM (receive only) is selectable at all frequencies but is only meaningful for broadcast band 2 FM. The transmit power output is 100W maximum on HF/6m, 50W on 2m and 35W on 70cm, reducible down to about 1W with different power levels settable for HF, 6m, 2m and 70cm.

As with the IC-706 and other similarly styled radios, the front panel is detachable and may be operated remotely using a separation cable. The front panel is dominated by a large (45mm diameter) easy-to-use tuning knob with adjustable drag, and an eye-catching and very informative full-colour 2.5 inch TFT panel. Grouped around the panel are a number of push buttons. Eight are dedicated

individually to the most commonly used functions. Four are keys whose functions vary according to which mode and menu group are selected. There are nine menu group selections split into three banks of three which speeds access when the initial learning phase has been mastered. These function keys

select and adjust most of the features of the radio. In general, a short key push selects a function and a long key push accesses any adjustment or customisation of that function, all fully supported by comprehensive information displayed on the LCD. In addition to the push keys, there are two twin-concentric rotary controls also acting as push buttons – it's amazing just how many functions can be set from just two controls.

There are two SO239 antenna sockets on the rear panel, one for use with frequencies below 60MHz and the other for use above 60MHz. SO239 is rather marginal at UHF, type N is preferred and used in the Yaesu FT-857 and other radios at 432MHz. The rear panel also contains a 13-pin socket for connecting various accessories, 6 pin mini-DIN for interfacing on data modes, AH-4 external tuner control interface, CI-V remote control, CW key jack, external speaker and composite video signal output for viewing the display on a separate monitor or TV. The headphone jack is on the side of the detachable front panel and this can also be switched for external speaker output. The microphone plugs into the rear panel and uses an 8-pin RJ45 connector. Adaptor cables for different microphones and accessory units are available as options.

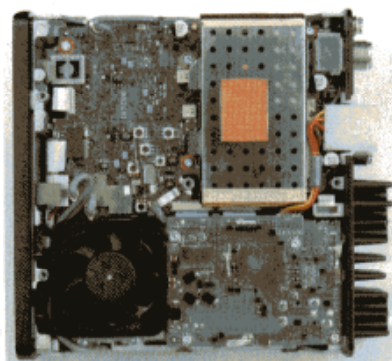
The radio is constructed on a sturdy diecast frame with integral front and rear panels and mainly small surface mount components. An internal 5cm square fan comes into operation when the temperature rises and a small 6cm diameter speaker fits in the case top. The receiver is a triple conversion superhet with a first IF of 124.487MHz, a second IF of 455kHz and a third IF of 16.15kHz which feeds the DSP unit where all signal processing and filtering functions are performed. Wideband FM uses a separate signal path. The high first IF means that the first LO synthesiser, a DDS, operates at a higher

frequency than normal. A high stability TCXO reference oscillator is built-in which achieves 0.5ppm stability over the operating temperature range of the radio. Three transmit power amplifier chains are used, visible on the lower PCB for HF/6m, 2m and 70cm. Further technical details were not available at the time of the review. The 155-page instruction manual is comprehensive but does not include block diagrams or circuit schematics.

The radio is provided with a hand microphone (HM-151) containing a wide range of keys. Many of the functions of the radio can be controlled from the microphone and in particular there is a set of individual band keys. The radio itself only has band up/down buttons. The advantage of using the microphone keys is that a triple band stacking register is employed returning one of three sets of frequency and mode for each press of the band key. This is useful when several modes are commonly used. Tuning may be accomplished from the microphone or, more conventionally, using the rotary tuning knob which tunes at 144 steps per revolution. On CW, RTTY and SSB the step size is 1Hz or 10Hz, with a faster programmable rate. On AM, FM and wideband FM, the rate is programmable separately for each mode with a faster rate in 1MHz steps. The programmable rates may be set in a number of steps between 10Hz and 100kHz, and on fast sustained tuning the tuning rate may be set to increase automatically.

There are a total of 503 memory channels; five banks of regular memories with 99 channels each; six scan edge channels; and two call channels. This should satisfy all envisaged possibilities. The usual memory functions are provided including alphanumeric tagging and channel listing. A separate quick access memopad stack for 5 or 10 stores is also included. The usual twin A/B VFOs with split operation functions are also provided, along with receive and transmit incremental tuning, pitch control on CW and the normal facilities for scanning.

**RECEIVER FEATURES.** Perhaps the most significant development since the IC-706 series is the inclusion of two DSP chips to provide all signal processing functions at



the IF and AF stages. IF passband widths between 50Hz and 3,600Hz are selectable on SSB and CW modes (41 settings), 50Hz to 2,700Hz on RTTY and 200Hz to 10kHz on AM. Both sharp and soft passband shapes are available as provided with the top-end IC-7800 and IC756PROIII. On FM three bandwidths are selectable: 7, 10 or 15kHz. Twin PBT allows either side of the filter passband to be shifted independently, shifting or narrowing the overall shape to assist in combating adjacent channel interference. A new dual manual notch filter is provided. This operates at IF inside the AGC loop and hence prevents desensitisation with strong carriers. The two notch filters may be set independently with wide, medium or narrow notch widths available. A separate auto-tuning notch filter operates at audio and tracks up to three beat tones even if they are moving.

DSP also provides a noise reduction facility which reduces the background noise level and can improve readability. A separate noise blanker eliminates pulse-type noise from car ignition systems. Both

FROM TOP:  
PHOTO 3: IC-7000 TOP VIEW WITH COVER REMOVED  
PHOTO 4: IC-7000 REAR PANEL  
PHOTO 5: IC-7000 DETACHABLE PANEL

systems are adjustable. The AGC is also implemented by DSP with three separate time constants selectable from a menu of 13 different values (0.1 to 8s) and are set separately for all modes except FM.

A switchable front-end preamplifier and a switchable 12dB attenuator allow the receiver to be optimised for weak or strong signals, and a combined RF gain control and squelch is also provided.

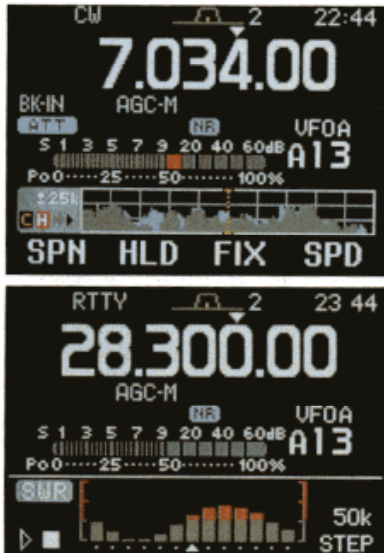
**TRANSMIT FEATURES.** Transmit features for SSB include the usual speech compressor, VOX and a transmission monitor. The audio transmit filter bandwidth may be set to wide, mid or narrow where the upper and lower bandwidth points are adjustable. By default the wide setting is 100Hz to 2,900Hz, mid setting 300Hz to 2,700Hz and narrow is 500Hz to 2,500Hz.

On CW, there is the usual provision for full and semi break-in and the drop back delay is adjustable. The keying envelope rise and fall times are adjustable between 2 and 8ms to accommodate both fast CW and minimum radiated bandwidth. There is no manual MOX transmit switch. This option is available only via CW break-in and PTT. There is also no internal ATU.

A full CW message keyer is included with some useful features for contest operation. The keyer operates over a wide range of speeds with adjustable weighting and a variety of keying paddle arrangements. Four memories will each store up to 55 characters with a provision to send automatically incrementing serial numbers and auto-repeat after a time delay. The message stores are programmed in text using the front panel pushbuttons and rotary tuning knob in a similar fashion to memory labelling.

On FM, the usual selective calling and repeater access facilities are provided including CTCSS tone squelch, DTCS digitally coded squelch, 1,750Hz tone burst and DTMF codes. Repeater duplex offsets are stored separately for HF, 6m, 2m and 70cm and are programmable over wide limits. Defaults return the standard offsets.

The IC-7000 display shows power output, SWR, ALC and compression level of the speech processor when on transmit. A multifunction display can be selected which shows all these simultaneously



CLOCKWISE FROM LEFT:  
PHOTO 6: IC-7000 BAND SCOPE DISPLAY  
PHOTO 7: THE MULTI-FUNCTION METER DISPLAY  
PHOTO 8: IC-7000 RTTY DECODER DISPLAY  
PHOTO 9: IC-7000 SWR PLOT DISPLAY

together with the temperature of the radio. The antenna SWR can be plotted graphically against frequency which can be useful to check antenna performance over the band. The measuring step is selectable from 10 to 500kHz and the number of steps from 3 to 13.

**AUXILIARY FEATURES.** A number of features are included to assist operation on data modes. The radio will interface to terminal units or TNCs using both analogue (AFSK) or digital (FSK) level signals. Keying parameters and tones are adjustable. A twin peak filter may be enabled with sharp peaks in the response at the mark and space frequencies. This aids copy under marginal conditions of heavy interference or weak signals. A built-in Baudot decoder will display standard 45 baud RTTY signals on the internal display without the need for an external terminal unit. The display is limited to 6 lines of 17 characters and also shows a tuning meter and waterfall display to accurately tune RTTY signals. There is no internal provision for generating data signals – a PC/terminal unit is required.

The IC-7000 also includes a digital voice recorder. This has four channels to carry transmit messages with a total length of 90 seconds recording time available. This can be used for CQ calls and other contest exchange messages. The transmit stores can be tagged with labels up to five characters long for easy identification in the voice recorder display screen. Up to 99 channels of receive audio may be recorded with a total length of 1,500 seconds or 120 seconds maximum per channel. This is significantly longer than offered by previous Icom radios. Not only is the audio

recorded but also the frequency, mode and recording date and time for future reference and an optional voice memo can be recorded with the received audio.

A simple spectrum scope function is also provided which will scan across a range of frequencies and display signal level, with or without a peak hold function which can be useful for identifying short duration signals. The band scope operates by fast switching the receiver circuitry back and forth between the main channel and the scope monitor channel. This gives a slight stuttering sound to the main audio but nevertheless provides a function simultaneous with the main receiver without the need of a second receiver.

Other features include a built-in calendar and 24-hour clock, auto switch-off timer, and a voice synthesiser for audible readout of frequency, mode and S-meter level.

**MEASUREMENTS.** The full set of measurements is given in the table (p25). Sensitivity holds well across the frequency range but drops sharply at LF. The noise figure was measured as 4.2dB on 50, 144 and 432MHz and 7dB on 28MHz. The rejection of IFs and images was generally very good, in excess of 100dB in most cases except the 124MHz IF rejection on 2m which was only 33dB. This falls inside the aircraft VHF band. Rejection of the second image at 910kHz above the

on-tune frequency was around 72dB. This represents the stopband leakage through the 124MHz IF filter. The AGC attack time was clean and around 2ms with slight overshoot. The decay times were a little longer than stated.

The third order intercept and dynamic range figures are on the low side for a radio of this type, poorer than the Yaesu FT-857 and some 10-20dB lower than for higher end base stations. The dynamic range deteriorated in particular very close in. Measurement of the skirts of the 2.4kHz and wider CW filter bandwidths was compromised by noise at -60dB (phase noise?), similarly for close-in blocking. This seemed incompatible with the fairly reasonable reciprocal mixing phase noise measurements. The overall selectivity and adjacent channel results are shown in Figure 1. The narrow CW bandwidths showed exceptionally narrow skirts, significantly better than the IC-756PROIII and IC-7800.

On transmit, the results are generally quite good. CW rise and fall characteristics are reasonable, distortion negligible on semi break-in but with slightly shortened characters on full break-in. SSB intermodulation products are a bit on the high side but fairly typical for a 12V radio of this type. Data switching times are fast.

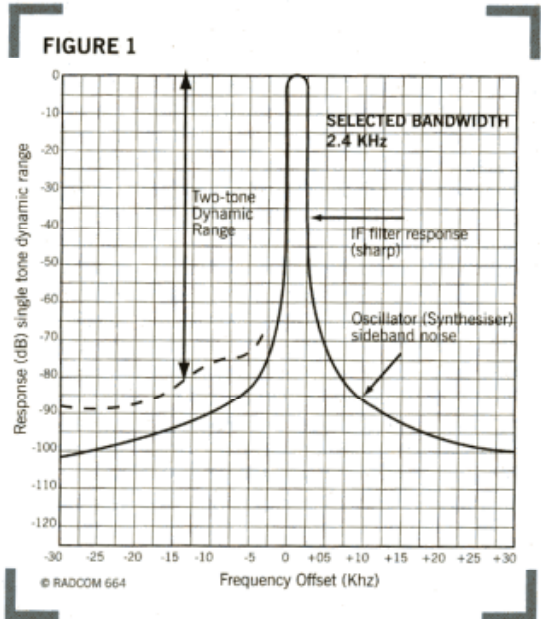


FIG 1. IC-7000 EFFECTIVE SELECTIVITY CURVE ON USB

**ON-THE-AIR PERFORMANCE.** With so many features and the limited front panel area, it is always a challenge with a tiny radio to produce a user-friendly layout. Icom has achieved a good ergonomic design with the IC-7000. Those who know the IC-706 will feel largely at home, others will need a little longer with the operating manual to become familiar with less used functions. I grew to like the IC-7000 a great deal and I particularly liked the display and the helpful and graphical menu screens. The features are extremely comprehensive and well implemented.

Overall, the performance was very good. The receiver had excellent sensitivity on the quiet bands but care was needed to select the correct degree of front-end gain. On 40m in the evenings, intermodulation could reach S9+30 with the preamplifier selected, reducing to S5 with the preamplifier out and totally clean with the attenuator switched in circuit. The filters were excellent, as was the PBT, and the dual notches were effective and easy to use. The audio quality from the internal speaker was communications quality, very readable but rather restricted in frequency response and with limited bass. On headphones, the quality was much improved but there was a low level high-pitched whistle audible at low listening levels. A passive external filter in the headphone lead would eliminate this.

On transmit, the CW keying was excellent and the full break-in was very clean. Audio quality reports on SSB with the HM-151 microphone were acceptable if the transmit bandwidth is kept at maximum but can be rather boxy at other settings. This seems to be a known effect with this microphone and has been investigated by audio expert Bob Heil, K9EID, and possible solutions are outlined on his website [www.heilsound.com](http://www.heilsound.com). Other microphones can give excellent results but do not have the control button flexibility. The audio transmission monitor has a rather low output.

**CONCLUSIONS.** The IC-7000 is a worthy successor to the IC-706. A good all-round performer and packed with features in a take anywhere package, it is available from Icom distributors at a price of around £1,000.

**ACKNOWLEDGEMENTS.**

I would like to thank Icom (UK) for the loan of the radio.

**ICOM IC-7000 MEASURED PERFORMANCE RECEIVER MEASUREMENTS**

Frequency	SENSITIVITY SSB 10dBs + n-n		INPUT FOR S9	
	Preamp In	Preamp Out	Preamp In	Preamp Out
136 kHz	-	20µV (-81dBm)	-	800µV
1.8 MHz	0.16µV (-123dBm)	0.56µV (-112dBm)	25µV	110µV
3.5 MHz	0.13µV (-125dBm)	0.40µV (-115dBm)	22µV	100µV
7 MHz	0.14µV (-124dBm)	0.45µV (-114dBm)	25µV	110µV
10 MHz	0.13µV (-125dBm)	0.40µV (-115dBm)	22µV	100µV
14 MHz	0.13µV (-125dBm)	0.40µV (-115dBm)	22µV	100µV
18 MHz	0.11µV (-126dBm)	0.35µV (-116dBm)	22µV	100µV
21 MHz	0.14µV (-124dBm)	0.45µV (-114dBm)	25µV	110µV
24 MHz	0.13µV (-125dBm)	0.40µV (-115dBm)	25µV	110µV
28 MHz	0.14µV (-124dBm)	0.45µV (-114dBm)	25µV	110µV
50 MHz	0.09µV (-128dBm)	0.18µV (-122dBm)	11µV	40µV
144 MHz	0.09µV (-128dBm)	0.22µV (-120dBm)	11µV	45µV
432 MHz	0.09µV (-128dBm)	0.22µV (-120dBm)	5.6µV	32µV

AM sensitivity (28MHz): 0.7µV for 10dBs+n-n at 30% mod depth  
 FM sensitivity (28MHz): 0.13µV for 12dB SINAD 3kHz pk deviation  
 AGC threshold: 1.4µV  
 100dB above AGC threshold for +1dB audio output  
 AGC attack time: see text  
 AGC decay time: see text  
 Max audio before clipping (8 ohm): 2.0W, 2.3W at 10% distortion  
 Max audio before clipping (4 ohm): 2.6W, 3.2W at 10% distortion  
 Inband intermodulation products: -40 to -60dB

FILTER	SHARP IF BANDWIDTH			SOFT IF BANDWIDTH		
	-6dB	-50dB	-60dB	-6dB	-50dB	-60dB
10kHz FM	10.5kHz	15.0kHz	15.9kHz	-	-	-
6kHz AM	6.1kHz	7.0kHz	7.3kHz	-	-	-
2.4kHz SSB	2545Hz	3660Hz	7800Hz	2280Hz	3380Hz	6200Hz
50Hz CW	511Hz	643Hz	780Hz	464Hz	644Hz	749Hz
250Hz CW	252Hz	332Hz	447Hz	154Hz	355Hz	472Hz
100Hz CW	104Hz	143Hz	176Hz	67Hz	141Hz	198Hz
50Hz CW	30Hz	46Hz	86Hz	36Hz	78Hz	104Hz

**INTERMODULATION (50kHz Tone Spacing) 2400Hz bandwidth USB**

Frequency	PREAMP IN		PREAMP OUT	
	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
1.8 MHz	-10dBm	82dB	+3.5dBm	84dB
3.5 MHz	-8dBm	85dB	+6dBm	87dB
7 MHz	-6dBm	85dB	+7.5dBm	88dB
14 MHz	-6.5dBm	86dB	+7dBm	88dB
21 MHz	-6dBm	85dB	+7.5dBm	88dB
28 MHz	-5.5dBm	86dB	+7.5dBm	88dB
50 MHz	-12dBm	84dB	-1dBm	87dB
144 MHz	-12.5dBm	84dB	-1.5dBm	86dB
432 MHz	-17dBm	81dB	0dBm	87dB

**CLOSE-IN INTERMODULATION ON 7MHz BAND 2400Hz bandwidth USB**

Spacing	PREAMP IN		PREAMP OUT	
	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
3 kHz	-40dBm	63dB	-28.5dBm	64dB
5 kHz	-25dBm	73dB	-13.5dBm	74dB
7 kHz	-25dBm	73dB	-12dBm	75dB
10 kHz	-22dBm	75dB	-10.5dBm	76dB
15 kHz	-13dBm	81dB	0dBm	83dB
20 kHz	-4dBm	87dB	+7.5dBm	88dB
30 kHz	4dBm	87dB	+7.5dBm	88dB
40 kHz	5.5dBm	86dB	+7.5dBm	88dB
50 kHz	-6dBm	85dB	+7.5dBm	88dB

FREQUENCY OFFSET	RECIPROCAL MIXING FOR 3dB NOISE	BLOCKING PREAMP IN	BLOCKING PREAMP OUT	S-READING INPUT LEVEL SSB (7 MHz)	
				Preamp In	Preamp Out
2 kHz	79dB	noise limited	noise limited	S1	2.2µV 10µV
3 kHz	82dB	noise limited	noise limited	S3	4.0µV 18µV
5 kHz	86dB	noise limited	noise limited	S5	7.0µV 32µV
10 kHz	91dB	-39dBm	-27dBm	S7	14µV 56µV
15 kHz	92dB	-34dBm	-22dBm	S9	25µV 100µV
20 kHz	98dB	-27dBm	-15dBm	S9+20	220µV 1µV
0 kHz	101dB	-10dBm	+2dBm	S9+40	2.2µV 10µV
50 kHz	104dB	-10dBm	+2dBm		
100 kHz	106dB	-10dBm	+2dBm		
200 kHz	107dB	-10dBm	+2dBm		

**TRANSMITTER MEASUREMENTS**

FREQUENCY	CW POWER OUTPUT	HARMONICS	INTERMODULATION PRODUCTS	
			3rd order	5th order
1.8 MHz	103W	-62dB	-28dB	-40dB
3.5 MHz	105W	-63dB	-28dB	-38dB
7 MHz	102W	-65dB	-28dB	-36dB
10 MHz	104W	-65dB	-32dB	-37dB
14 MHz	101W	-62dB	-36dB	-36dB
18 MHz	105W	-74dB	-30dB	-36dB
21 MHz	105W	-68dB	-28dB	-36dB
24 MHz	101W	-70dB	-31dB	-36dB
28 MHz	102W	-68dB	-26dB	-36dB
50 MHz	95W	-72dB	-27dB	-37dB
144 MHz	57W	-62dB	-28dB	-49dB
432 MHz	30W	<-70dB	-23dB	-40dB

Intermodulation product levels are quoted with respect to PEP.

Carrier suppression: >80dB  
 Sideband suppression: >80dB @ 1kHz  
 Transmitter AF distortion: <1%  
 Microphone input sensitivity: 7mV for full output  
 FM deviation: 2.2kHz  
 SSB T/R switch speed: mute-TX 10-15ms, TX-mute 2ms, mute-RX 15-20ms, RX-mute 1ms

**NOTE:**

All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on USB with 2.4kHz bandwidth sharp filter selected.