# Icom IC-756PRO HF & 50MHz Transceiver

***Reviewed by Peter Hart, G3SJX****

SOMEWHAT OVER three years ago, Icom launched the IC-756, a high end HF + 6m base station which I reviewed in the May 1997 edition of *RadCom*. Very recently Icom have released the IC-756PRO, which from its number may convey the impression of just an upgraded version. The outward appearance is very similar, indeed the same solid multi-partitioned diecast chassis is used, with the same front and rear panels. Some of the buttons have been reassigned to provide additional features, but the mouldings are identical. However, internally the electrical architecture is very different, relying heavily on DSP for IF as well as AF processing functions and with a number of important new features added.

## PRINCIPAL FEATURES

THE IC-756PRO is 12V operated, with a peak current drain of up to 23A. It is a table-top size measuring 340 x 111 x 285mm and weighs about 9.6kg. USB, LSB, CW, RTTY, AM and FM modes are selectable, with normal or reverse sideband on CW and RTTY. RTTY is FSK with selectable mark frequencies, shifts and polarity, and requires a logic level input on transmit. For use with AFSK terminal units, AMTOR, PSK31, SSTV etc, voice modes are used. On all the voice modes, a long push of the mode key selects data and this mutes the microphone.

The receiver tunes continuously from 30kHz to 60MHz, with the transmitter enabled only within the exact amateur band allocation (make sure that you have the appropriate version for the country from which you wish to operate). Individual buttons select the bands, with a triple band-stacking register employed that is useful if you operate frequently on three modes, eg SSB, CW and RTTY. One of three last used frequency/mode combinations is returned for each press of the band key.

The smooth action tuning knob tunes in 10Hz steps at 5kHz per knob revolution, with auto speed-up on fast sustained tuning. Faster tuning rates for rapid frequency changes and slower rates for precision tuning are also provided. 101 memory channels are included with the usual facilities, and frequency and memory channel can be entered directly. A memo-pad feature allows frequencies to be quickly stored and recalled by a simple key press, on the basis of last-in, first-out. RIT and transmitter incremental tuning operate over a range of ±9.99kHz and various scan modes are implemented. Comprehensive switching manages access to the VFOs and split frequency operation. For repeater use, separate splits are programmable on HF and 50MHz and there is also a CTCSS tone encoder and decoder for repeater access or tone squelch operation.

The receiver front-end configuration may be optimised to suit different requirements, with two selectable preamplifiers, three levels of signal attenuation and a novel combined RF gain/all mode squelch control. Preamp 1 has a gain of about 10dB for use on all frequencies above 1.6MHz and preamp 2 is intended for use on 21MHz and above with a gain of about 16dB. The CW pitch is adjustable over the range 300-900Hz to suit personal preferences. A front panel pushbutton selects between two antenna sockets and also enables external receiver antenna. The last used antenna / external receive antenna combinations are stored with the band stores. It can be useful to be able to select external receive antennas automatically for the LF bands for loop antennas or for those fortunate to have access to Beverages. An auto ATU is built-in, matching up to 3:1 VSWR and covers all bands including 50MHz. Tuning settings every 100kHz are stored to enable rapid and accurate reselection.

The transmitter power is variable from about 2-100W on all bands and the analogue meter indicates power output, SWR, compression or ALC level. An IF DSP speech processor is provided with three bandwidth settings, treble and bass adjust, VOX and a transmit signal monitor. Full and semi break-in is available on CW, with a front panel control for adjustable delay.

The rear panel carries the usual interfaces, common to all Icom radios, for control of linears, ATUs, data terminals, etc. The standard Icom CI-V serial computer interface is provided with data

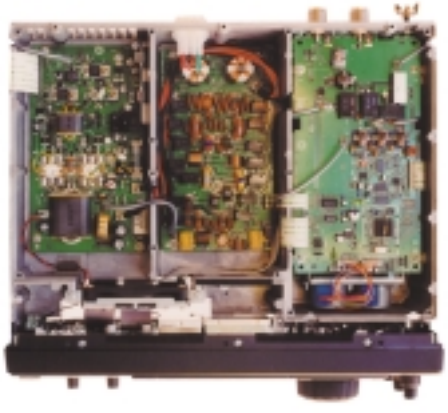
* *The Willows, Paice Lane, Medstead, Alton, hants GU34 9YA.*

**TRANSMITTER MEASUREMENTS**

| FREQUENCY | CW POWER OUTPUT | SSB(PEP) POWER OUTPUT | HARMONICS | INTERMODULATION PRODUCTS 3rd order | 5th order |
|---|---|---|---|---|---|
| 1.8MHz | 106W | 106W | -64dB | -30dB | -44dB |
| 3.5MHz | 108W | 108W | -64dB | -36dB | -45dB |
| 7MHz | 108W | 108W | -64dB | -28dB | -42dB |
| 10MHz | 108W | 108W | -64dB | -32dB | -42dB |
| 14MHz | 108W | 108W | -64dB | -22dB | -36dB |
| 18MHz | 108W | 108W | -60dB | -30dB | -40dB |
| 21MHz | 108W | 108W | -70dB | -35dB | -36dB |
| 24MHz | 108W | 107W | -70dB | -26dB | -36dB |
| 28MHz | 107W | 107W | -70dB | -22dB | -38dB |
| 50MHz | 104W | 103W | -70dB | -20dB | -36dB |

Carrier suppression: 25dB (see text) Sideband suppression: 70dB @ 1kHz
Transmitter AF distortion: <1% Microphone input sensitivity: 3mV for full output
SSB T/R switch speed: mute-TX 12ms, TX-mute 1ms, mute-RX 22ms, RX-mute 1ms

NOTES:
All signal input voltages given as PD across antenna terminal.
Unless stated otherwise, all measurements made on SSB with receiver preamp 1 switched in.
All two-tone transmitter intermodulation products quoted with respect to either originating tone.



**Top view with covers removed, showing PA, filters and ATU.**

transfer rates from 300 to 19200 baud, which also allows transceiving with other Icom radios. Two key jacks are fitted, the jack on the front panel for a keying paddle to control the internal keyer, and the jack on the rear panel for a straight key or external keyer. A transverter jack is also provided which outputs about -20dBm on transmit and functions as the receiver input on receive.

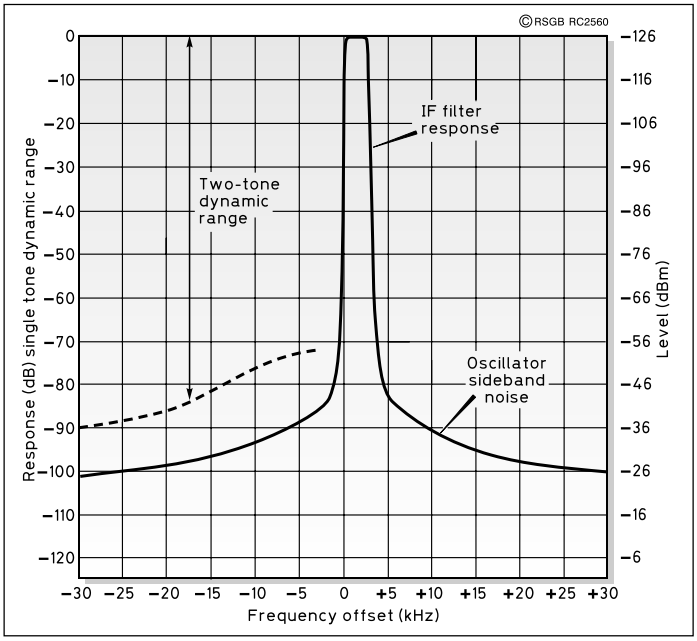



**Fig 1: Effective selectivity curve on USB.**

## DSP

THE MAJOR difference between this radio and the earlier IC-756 lies with the DSP circuitry. The IC-756 used a quadruple conversion superhet with the main selectivity achieved through crystal/ceramic filters at both the 9MHz and 455kHz IFs prior to feeding the DSP at 15.6kHz for demodulation and audio processing. The IC-756PRO is a triple conversion superhet with a first IF of 64.455MHz, a second IF of 455kHz with fairly broad (15kHz) selectivity and a third conversion to 36kHz to feed a 32-bit floating point DSP which provides all the IF filtering, demodulation and audio processing functions. The channel filtering is impressive, providing 41 different passband widths on CW and SSB from 50Hz to 3600Hz with shape factors superior to any crystal filters. There are 32 passband widths selectable on RTTY (50-2700Hz) and 3 each on AM (3, 6, 9kHz) and FM (7, 10, 15kHz). Three separate selectable bandwidths are available for each mode by a simple push of a front panel key, selectable from the available menu via the set-up routine.

The DSP also provides the twin passband tuning function which enables the filter sides to be both independently moved and narrowed. The AGC is also implemented by the DSP, with three separate time constants selectable from the front panel. These three values may be set from a menu of 13 different values (0.1 to 6s) and are set separately for all modes except FM. Two separate notch functions are provided in this transceiver, both using the DSP. A particularly effective manually-tuned IF notch with a depth of 70dB is included within the AGC loop, and hence does not result in desensitising with strong carriers. An auto-notch is implemented at AF and will automatically attenuate several beat notes, even if they are moving.

An adjustable DSP noise reduction system is included and there is also a conventional (not DSP) IF noise blanker for pulse type interference such as car ignition. The modulated transmit signal is also generated by the DSP, with adjustable bass and treble microphone equalisation and adjustable compressor.

## OTHER SPECIAL FEATURES

A DUAL-WATCH facility is incorporated via a second receiver. The two receivers use separate first mixers and synthesisers and a common signal path for all RF, IF and AF circuitry. Hence the second receiver will use the same IF bandwidth and mode and must be broadly within the same

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band, or for the higher frequencies, on adjacent bands. A balance control sets the gain of the two signal paths via PIN diode attenuators following the mixers. A single tuning control is used, assignable to either receiver and both receive VFO frequencies are continuously displayed together with the separate selected memories (active or not). A quick dualwatch function equalises the frequency of both receivers.

The IC-756PRO includes a built-in RTTY (baudot) demodulator and decoder circuit for displaying the received data directly on the display panel. This is a new feature, a first in any transceiver. The DSP provides a sharp two-tone dual peak filter demodulator limited to 2125Hz mark, 170Hz shift 45-baud RTTY. A tuning indicator is also provided on the display panel to assist with tuning RTTY signals.

A built-in full message keyer with some useful features for contest operation is provided for CW. 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 54 characters, with a provision to send automatically incrementing serial numbers and auto-repeat after a time delay. The message stores are programmed in text from front panel push buttons, not using the keying paddle.

The IC-756PRO also includes a digital voice recorder with four memory channels on receive and four on transmit. Each memory store is limited to a maximum message length of 15 seconds. This is useful for repeated CQ calls in long contests and other fixed contest messages. The transmit stores can be tagged with labels up to 20 characters long for easy identification on the display panel. As an optional extra, a voice synthesiser module can be installed.

## MEASUREMENTS

Measurements are given in the table when powered from a 13.8V supply with additional comments as follows. Note that I have now included the 136kHz band in my standard set of measurements.

### RECEIVER

With the higher gain preamp in circuit, preamp 2, the sensitivity on 21MHz and above was about 3dB better than with preamp 1. Note that no preamp is selectable on 136kHz. The S meter reading is independent of mode. The rejection of images and all IF frequencies was exceptionally good, in excess of 100dB. The initial AGC attack time was fast, but took around 200ms to settle the last dB.

The filter bandwidths shown in the table are just a representative selection from the 40+ filters available. The shape factors and steep skirts are really excellent, even with bandwidths down to 50Hz. This is where DSP scores, as these figures are unattainable with conventional IF filters. The reciprocal mixing performance is very good - better than the original IC-756 - and the overall dynamic range figures are reasonable. Even the close-in dynamic range is quite creditable (see **Fig 1**), considering that all the channel selectivity is in the final IF, a potential problem with this approach. The in-band intermodulation performance is exceptionally good.

### TRANSMITTER

The power output figures in the table were measured with the ATU out of circuit. The ATU introduced an additional loss of about 10%. The SSB carrier suppression with no modulation was greater than 80dB, but degraded to only 25dB with modulation. The CW rise and fall times were fairly sharp and there was about 30% character shortening at 40WPM on full break-in. There was no character shortening on semi break-in.

**RECEIVER MEASUREMENTS**

| | SENSITIVITY SSB 10dBs+n:n | | INPUT FOR S9 | |
|---|---|---|---|---|
| **FREQ** | **PREAMP 1 IN** | **PREAMP OUT** | **PREAMP 1 IN** | **PREAMP OUT** |
| 136kHz | - | 2.5µV (-99dBm) | - | 280µV |
| 1.8MHz | 0.18µV (-122dBm) | 0.45µV (-114dBm) | 18µV | 56µV |
| 3.5MHz | 0.18µV (-122dBm) | 0.45µV (-114dBm) | 18µV | 56µV |
| 7MHz | 0.16µV (-123dBm) | 0.35µV (-116dBm) | 14µV | 45µV |
| 10MHz | 0.16µV (-123dBm) | 0.35µV (-116dBm) | 14µV | 45µV |
| 14MHz | 0.16µV (-123dBm) | 0.35µV (-116dBm) | 13µV | 45µV |
| 18MHz | 0.14µV (-124dBm) | 0.35µV (-116dBm) | 13µV | 45µV |
| 21MHz | 0.16µV (-123dBm) | 0.40µV (-115dBm) | 14µV | 45µV |
| 24MHz | 0.16µV (-123dBm) | 0.40µV (-115dBm) | 16µV | 50µV |
| 28MHz | 0.16µV (-123dBm) | 0.45µV (-114dBm) | 16µV | 56µV |
| 50MHz | 0.22µV (-120dBm) | 0.45µV (-114dBm) | 20µV | 45µV |

AM sensitivity (28MHz): 1µV for 10dBs+n:n at 30% mod depth
FM sensitivity (28MHz): 0.3µV for 12dB SINAD 3kHz pk deviation
100dB above AGC threshold for +1dB audio output
Max audio before clipping: 1.5W into 8 ohm, 2W at 10% distortion
Inband intermodulation products: better than -50dB

AGC threshold: 1.3µV
AGC attack time: see text
AGC decay time: see text

| S-READING | INPUT LEVEL SSB | |
|---|---|---|
| **(7MHz)** | **PREAMP 1 IN** | **PREAMP OUT** |
| S1 | 1.6µV | 5µV |
| S3 | 2.5µV | 8µV |
| S5 | 4.5µV | 14µV |
| S7 | 8µV | 25µV |
| S9 | 14µV | 45µV |
| S9+20 | 63µV | 200µV |
| S9+40 | 800µV | 2.5mV |
| S9+60 | 6.3mV | 20mV |

| FILTER | IF BANDWIDTH | |
|---|---|---|
| | **-6dB** | **-60dB** |
| 10kHz | 10.9kHz | 16.2kHz |
| 6kHz | 6.6kHz | 10.8kHz |
| 2.4kHz | 2520Hz | 3560Hz |
| 500Hz | 515Hz | 1140Hz |
| 250Hz | 263Hz | 859Hz |
| 100Hz | 107Hz | 216Hz |
| 50Hz | 63Hz | 141Hz |

**INTERMODULATION (50kHz Tone Spacing)**

| | PREAMP 1 IN | | PREAMP OUT | |
|---|---|---|---|---|
| | 3rd order | 2-tone | 3rd order | 2-tone |
| Frequency | intercept | dynamic range | intercept | dynamic range |
| 136kHz | - | - | +16dBm | 84dB |
| 1.8MHz | +3dBm | 90dB | +13dBm | 92dB |
| 3.5MHz | +3dBm | 90dB | +13dBm | 92dB |
| 7MHz | +0dBm | 89dB | +11dBm | 92dB |
| 14MHz | +2dBm | 90dB | +13dBm | 93dB |
| 21MHz | +0dBm | 89dB | +13dBm | 92dB |
| 28MHz | -2dBm | 88dB | +14dBm | 92dB |
| 50MHz | -4dBm | 84dB | +13dBm | 92dB |

**CLOSE-IN INTERMODULATION ON 7MHz BAND**

| | PREAMP 1 IN | | PREAMP OUT | |
|---|---|---|---|---|
| | 3rd order | 2-tone | 3rd order | 2-tone |
| Spacing | intercept | dynamic range | intercept | dynamic range |
| 3kHz | -27dBm | 71dB | -18dBm | 72dB |
| 5kHz | -26dBm | 72dB | -17dBm | 73dB |
| 7kHz | -26dBm | 72dB | -16dBm | 74dB |
| 10kHz | -22dBm | 74dB | -12dBm | 76dB |
| 15kHz | -14dBm | 80dB | -4dBm | 82dB |
| 20kHz | -8dBm | 84dB | +3dBm | 86dB |
| 30kHz | -2dBm | 88dB | +9dBm | 90dB |
| 40kHz | +4dBm | 92dB | +12dBm | 92dB |
| 50kHz | 0dBm | 89dB | +11dBm | 92dB |

| FREQUENCY | RECIPROCAL MIXING FOR | BLOCKING | BLOCKING |
|---|---|---|---|
| **OFFSET** | **3dB NOISE** | **PREAMP1 IN** | **PREAMP OUT** |
| 3kHz | 83dB | -32dBm | -22dBm |
| 5kHz | 86dB | -32dBm | -22dBm |
| 10kHz | 92dB | -29dBm | -19dBm |
| 15kHz | 96dB | -21dBm | -10dBm |
| 20kHz | 98dB | -13dBm | -3dBm |
| 30kHz | 101dB | -7dBm | +2dBm |
| 50kHz | 106dB | -7dBm | +2dBm |
| 100kHz | 111dB | -7dBm | +2dBm |
| 200kHz | 115dB | -7dBm | +2dBm |

**LCD panel showing RTTY decoder display (full screen).**

## LCD DISPLAY PANEL

THE FRONT PANEL display uses a 5-in colour TFT LCD panel. Associated with this are seven buttons down the side and five function keys along the bottom. These buttons and keys are assigned functions according to context. The top half of the panel indicates all the frequencies, modes, split and dual-watch status, IF filters etc at all times. A graphical representation of IF bandwidth is also portrayed, responding also to PBT settings. The 24-hour clock time is also displayed and a timer with programmable on/off times may also be enabled.

The bottom part of the display has a number of functions. It can show the spectrum on either side of the receive frequency, with a selectable span from ±12.5 to ±100kHz. The current spectrum trace is shown in green, with a blue background trace for peak hold. Peak hold can be useful for monitoring transient openings on 50MHz. The transmit frequency is indicated for split operation or the sub receiver frequency for dual watch. A section of the memory bank can be displayed showing up to 13 consecutive locations. Alphanumeric names can be assigned for easy reference and it is a simple matter to scroll through, locate and select channels. This section of display also shows the set-up and message stores for the voice and CW keyers and decoded RTTY messages.

This radio has a host of user programmable settings. These are easily accessed and set, without constant reference to the manual, by the simple presentation in words and the assignable keys provided on the display. This same approach allows the memory keyer, scanning options and other functions to be set up in a very user friendly way.

## ON-AIR PERFORMANCE

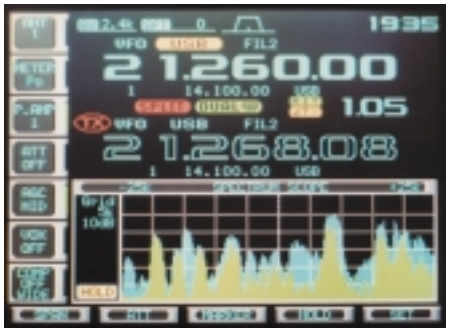
THE FIRST THING you will see when you turn on this radio is the start-up screen saying that the DSP is calibrating. This takes ten seconds. Overall I found the radio an excellent performer, easy to use after initial familiarisation and with all the features that anyone could possibly want and well implemented. The filters were really superb. The narrower filters offer some interesting possibilities for 136kHz DX and narrow data modes such as PSK31. The performance on 136kHz seemed very good and although I am currently without my LF antennas, several stations were heard on this band. The receive performance was very good on all modes, although some strong signal problems could be found on 40m with the preamp switched in circuit. I found the speaker somewhat restricted in frequency range and lacked bass response, with much better quality on headphones. The built-in RTTY decoder performed effectively and the spectrum display was particularly useful for monitoring 50MHz band activity. The transmit performance was good and CW break-in effective.

## CONCLUSIONS

The IC-756PRO is an excellent all-round buy for HF and 50MHz, packed with features and a good electrical performance. The list price is £2099 and, most importantly, there are no expensive extra filters needed for serious use on CW and RTTY.


## ACKNOWLEDGEMENT

I would like to thank Waters and Stanton PLC for the loan of the equipment. ♦

**LCD panel showing spectrum display.**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