

## Icom IC-703 A Top Receiver Candidate

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(Update June 2006 – sensitivity figures)



### Introduction

Small HF receivers with excellent MW performance are not common. In fact, I can think of only one likely candidate, the AOR AR7030. I had one for several years and it was an excellent performer, especially with some filter replacements, but with somewhat restricted ergonomics. It wasn't exceptionally sensitive either, it tended to lag behind my NRD-525 during daytime MW DX with weak signal levels.

Some time ago I got an Icom IC-746Pro which was modified for MW reception. This is truly an awesome radio. But quite large, and heavy, at least if you want to travel with it. Last autumn I started to look at other Icom transceivers to find out if there were smaller candidates for a Top Receiver.

When I found that they had a QRP rig named IC-703, I started to investigate further. And yes, it did seem like this could be modified into an excellent MW rig. Responses from the IC-703 Yahoo reflector were unanimous about its receiving qualities. So I started following what few IC-703 auctions there were on Ebay, and on the third try I ended up with one for USD 375. Not bad, considered that the design is relatively novel (introduced in 2003) and the US street price is around USD 700. As many of you will know, I am not a radio amateur so I am not concerned about the transmitter part of a transceiver. So whereas a radio amateur would refer to these devices as "transceivers", I merely use "receivers".

### Specifications, the Icom way

According to Icom, the IC-703 is a double superhet with the 1<sup>st</sup> IF on 64455 khz and 2<sup>nd</sup> IF on 455 kHz. It has 30 kHz – 60 Mhz general coverage. It receives USB, LSB, AM, FM, CW, RTTY and has 99 regular memory channels. It can work with anything from 9 to 15.8VDC; below 11.0VDC it turns automatically into "battery mode" to save energy. It has a roofing filter of 15 kHz which is also the "Wide" AM bandwidth. The "Normal" AM bandwidth is supplied from a muRata CFWS455G filter, nominally 9 kHz. The SSB filter is a standard muRata CFJ455K5, around 2.5 kHz.

Sensitivity figures from Icom are always extremely conservative; so conservative I wonder why

they bother. Anyone looking for a sensitive receiver would be put off by their official information. MW AM sensitivity is stated as 13uV. Modulation not given. As with Icom's other models, there is a 10dB attenuation pad built in<sup>1</sup>. AM sensitivity above 1.6 Mhz is given as 2.0uV (preamp on).

The IC-703 offers an auto-notch and noise reduction function through the optional (but pretty much standard) UT-106 DSP unit. As many will know, the UT-106 is available for many other Icom transceivers and receivers. The receiver also enjoys passband tuning (PBT) – alas not in AM mode.

Physically it is near perfect. It weighs in at 2.0 kg/4.4 lbs without PSU, and it measures 167x58x200 mm (WxHxD). It draws little current as long as it's not transmitting; a 1A PSU will be more than enough for 13.6VDC.

### **Specifications, real**

The following data was measured by Dallas Lankford, who volunteered to undertake the somewhat dubious task to see if it was possible to modify the IC-703, and who did the actual mods. Sensitivity above 1.6 Mhz was measured to around 0.6uV (AM, 9 kHz bandwidth, 30% modulation, 400 Hz signal, preamp on). Below 1.6, sensitivity was around 1.6uV on 1599 kHz and around 2.0uV on 510 khz (still preamp on).

### **Modifications necessary to make it a Top Receiver**

Well, the sensitivity figures were better than anticipated. Still, close to 2uV sensitivity is not good enough for DX-ing weak signals in RF-clean areas. So, we needed to remove the attenuation pad. We also needed to improve selectivity. A 9 kHz AM bandwidth is totally useless for DX-ing, and the 2.5 kHz SSB filter could need a supplement. Luckily, Icom had facilitated the installation of an optional xtal filter. I decided to go for a relatively wide one, the FL-257 which has a nominal bandwidth of 3.3 kHz. These filters are expensive – USD 160 at US ham retailers and considerably more in Europe. I was lucky enough to find one on Ebay Taiwan for USD 125. Dallas provided me with a 6.5 kHz AM filter which was pin-for-pin compatible with the 9 kHz filter.

A third subject to modification was the AGC. The IC-703 has "Fast" and "Slow" AGC speeds, but no "Off" position. The "Fast" setting was ok, but "Slow" was driving pretty much in the fast lane with only 1 second.

A general comment on receiver modifications: With the advent of increasingly smaller parts, modifying has become an option for the chosen few. Add to the picture the increased parts density necessary when designing and manufacturing small receivers, and you are in a situation where only those with the best skills and best equipment can undertake tasks like this. The average DX-er should not get involved in this line of work. Alas, this also means that very few (if any) IC-703's will be modified similarly to mine, unless a professional chooses to do so (such as Kiwa Electronics).

The three mods outlined above were completed by Dallas Lankford. The attenuation mod and AGC-mod (which wasn't crucially necessary) were very difficult to perform, although there may be a simpler way to do the attenuation mod. Replacement of the 9 kHz AM filter was more (but not entirely) trivial. Installing the FL-257 was trivial, although Dallas worried about potential short-circuit traps on the board where the filter was placed. We discussed at one stage to replace the 15 kHz roofing filter with the now-available 9 kHz filter. However, the parts density around the 15 kHz filter was discouraging – and one of the pins of the 9 kHz filter was damaged during removal so we did not go through with this.

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<sup>1</sup>The only exception I know is the R-75 receiver, whose attenuation pad is only 3dB

## **The New Icom IC-703**

After completing the mods, sensitivity figures on MW were much more satisfactory; 0.6uV on 1599 kHz and 0.8uV on 510 kHz (preamp on). This was measured with 9 kHz bandwidth so with the standard 6 kHz bandwidth sensitivity should be even a tad bit better. (*See Update, page 5*) Sensitivity is basically the same as my 746Pro and marginally lower than my NRD-525 and R390A.

I now have two SSB/ECSS bandwidths: 2.5 kHz and 3.6 kHz (the FL-257 measured 3.6 kHz not 3.3 kHz but that is not important). I also have three AM bandwidths: 3.6 kHz, 6.5 kHz and 15 kHz. Yes – OK I have two AM bandwidths. Nobody would use 15 kHz for AM, it is an FM thing.

## **Performance**

Numbers is one thing, performance another. How does it handle the competition from excellent receivers like the IC-746Pro. The 746Pro has by and large become my reference receiver with regards to audio quality and selectivity. It is very sensitive too, after removing the attenuation pad and enabling the preamp.

## *Ergonomics – user interface*

Keeping the excellent user interface of the R-75 and 746Pro while reducing the front panel's area to less than a third must have been challenging. Yet they have for the most part succeeded. Of course, the numeric keypad had to go so there is no direct frequency entry anymore. Tuning steps (0.1, 1, 5, 9, 10, 12.5, 20, 25, 100 kHz – AM/FM can also be tuned in 0.01 khz and 1 Mhz steps) can be set as easy as before with the TS button. The four Mode buttons in the 746Pro have been reduced to one in the IC-703 but with little loss in user friendliness. One cycles through the modes USB/LSB – CW – RTTY/SSB-D – AM/FM by pushing the Mode button – but when in SSB mode one toggles between USB and LSB by holding the button one second. Very intuitive. And you can in fact choose to disable modes so that you don't have to cycle through all the modes if you use only one or two. There are three function buttons and one Menu button below the display; by pushing the Display button one can cycle through the menu choices. Again: Very intuitive, although it requires more button-pushing than on the R-75 or 746Pro. For the radio amateurs, there are Up and Down buttons on the extreme right which allows the user to cycle through the HAM bands. The friction of the tuning wheel is adjustable, however it is never free-running and I miss that a bit.

Being able to use pre-set tuning steps is very important for serious DX. You need to be able to access a frequency fast, and to land "spot on" without having to fine-tune the last 10's Hz. When DX is hot, tuning is wasting time. Wasting time is losing DX. It appears that Icom has the best tuning solution of all major HF receiver manufacturers. Other receivers like the JRC NRD-545 also have tuning steps incorporated, but much less intuitively.

The Mode and TS buttons are located very near the tuning wheel, in fact so close that one can accidentally move it and change frequency when pushing the Mode or TS button, especially when using one's right hand. But if you are in tuning step mode, you don't need the tuning wheel at all. By choice in Setup, you can tune by using the memory selector M-CH instead. Just push the Lock button first. This is quite a handy feature, since the steps are dented. This function is implemented on the similar-sized IC-706MkIIG and IC-7000 as well, and is so useful it's a pity that it's not available on the 746Pro or R-75.

When using the Passband tuning, there is a graphic display of the offset, but only when adjusting the control. Once set in an offset position, there is no graphic indicator that tells you that PBT has been engaged, other than the relatively hard to see red knob index. And why on earth didn't Icom enable PBT on AM???

Display light is adjustable – full, dim and off – as are button back-lights. You can choose to have

confirmation beeps on, or as I prefer, off. If you like the beeps on, you can adjust audio level. You can install the standard Icom voice synthesizer which allows the IC-703 to be used by visually impaired DX-ers.

### *Audio quality*

I have earlier praised the audio quality of the 746Pro. I was much less impressed with the R-75 in this respect, especially on SSB/ECSS. So how does the IC-703 fare? Exceptionally well in fact, especially in AM but I was impressed by the ECSS audio too. The 2.5 kHz filter can by reason of design never bring about a wide audio frequency response, but when engaging the FL-257 I was surprised by the richness of the audio. Contrary to the 746Pro though, there is no way of adjusting bass and treble – a downside it shares with the IC-706MkIIG and the new IC-7000. That said, my personal audio taste does not require any adjustments so maybe Icom succeeded in making the correct audio blend. It does however have a certain hissy sound if you use hi-fidelity headphones or speakers. My hi-fi Sennheisers needed a low-pass filter (such as the Lankford-designed ELPAF) to keep audio pleasant, or I could use headphones with narrower frequency response such as the Kenwood HS-6, nominally 100 Hz - 10 kHz.

The quality of the line-out is equally important. It seemed to work well, except a very weak but still noticeable repetitive hiss. This is easy to remove by way of a low-pass filter but really shouldn't have been there. I am not absolutely certain if the repetitive hiss is a problem with IC-703's in general or if it is just my IC-703.

### *Audio – AGC*

The AGC settings play a major role in audio recovery. I found that when using the wide SSB filter in presence of interference, there was a tendency of "pumping" audio, more so than on the 746Pro. Maybe it was "hanging" more than the 746Pro AGC – I have experienced similar on the RA6790GM which has a "hang" AGC but the similarity may be purely coincidental. Otherwise, the AGC works very well. Voices are well defined, even if there are two or more stations on the frequency simultaneously.

### *Noise handling*

Most (all?) analogue Icoms come with an incorporated Noise Blanker, and most (all?) are sold with the "optional"<sup>2</sup> UT-106 DSP unit installed. The UT-106 provides an automatic audio notch filter and a noise reduction circuit which can be adjusted by the operator. They are, when engaged, rather transparent in use, or at least that is the purpose. Unfortunately, the auto-notch filter does affect the recovered audio, and does that so much that I do not want it to be on except when needed. When the auto-notch and the NR circuit is on simultaneously, the effects are clearly audible and audio is degraded. eHam reviews confirm this observation. This unit was also used in my R-75 (which I do no longer have) and I do not recall that the impact was as pronounced on the R-75. But I may remember wrong, and at least one R-75 owner commented to me that he prefers to have the UT-106 switched off when not needed. I have not yet had situations where the noise reduction or noise blanker have been necessary. Heterodynes are quite effectively killed by the notch filter.

### *Selectivity*

Comparing with similar bandwidths on the 746Pro, my conclusion is that the IC-703 provides excellent selectivity. On AM, the ceramic 6.5 filter reproduced audio just as well as the 6.7 kHz 746Pro AM filter (nominal 6 kHz). A strong 680 KBRW amidst very strong Europeans on 684 and 675 was my test dummy at the time. An inferior filter with insufficient ultimate rejection would be revealed by this test. The FL-257 filter works as a Narrow AM filter, and works well although audio is a bit muffled by my standards. If interference necessitates narrower AM bandwidths, I tend

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<sup>2</sup> Sold separately for a whopping USD 140 in the US, even more in Europe, so assure yourself it is included if you buy an IC-703 (or any other analogue Icom for that matter).

to go to ECSS instead where the treble response is much better for the given bandwidth.

And speaking of ECSS, the (measured) 3.6 kHz FL-257 is just as selective as the 3.6 bandwidth on the 746Pro, except as I mentioned above, intelligibility may sometimes be moderately hampered by "pumping" effects. The CFJ455K5 2.5 kHz filter isn't very good audio-wise but speech stands out well, so it is a good "Narrow" ECSS alternative when interference is tough. There is no significant difference between 2.5 kHz on the IC-703 and a 2.5 kHz bandwidth on the 746Pro. During situations with severe slop though, I find the 746Pro to have a slight edge on intelligibility.

### *Sensitivity*

With figures on MW from 0.6 to 0.8uV (preamp on), there is nothing wrong with the sensitivity of the IC-703. Only the NRD-525 and the EAC R-390A of my receivers can provide better figures, and then only marginally. I don't think I will hear a station on, say the NRD-525, that I can't hear equally well on the IC-703. If you don't care much for MW, or you spend your listening time in an area with high RF levels, the stock 1.6uV or thereabout<sup>3</sup> on MW may be sufficient.

### *Strong signal handling*

According to measurements by Dallas Lankford, IP2 above 1.6 Mhz is typically +83 dBm, while IP3 will be between 0 dBm and +40 dBm for preamp on, depending on if signals are within a "band" of the front end filtering or not. IP2 inside re-sensitized MW is typically +25 dBm (preamp off) and +15 dBm (preamp on). IP3 inside MW is typically 0 dBm (preamp off) and -8.5 dBm (preamp on). The latter numbers suggest that in a high-density RF area, you may experience intermod on MW<sup>4</sup>. I haven't experienced intermod on MW, and I have not had any more problems with my nearby Loran C transmitter (250 kW on 100 kHz, 10 km away with beverage antennas pointing directly towards the transmitter) with the IC-703 than with any other receiver in my shack. But there are radios with heftier front ends out there.

### **Conclusion**

The Icom IC-703 is a very capable MW receiver once it has undergone some necessary, but difficult modifications – the removal of the attenuation pad but equally important the installation of relevant IF filters. The IC-703's advantage over the R-75 is mobility and power requirements. The IC-703 is relatively inexpensive in used condition, around the R-75 level I suppose, but more expensive new than a discounted R-75. A modified IC-703 is not likely to hear stations that a modified R-75 can't hear, so for that matter an R-75 may be an equally good investment. And its front end may not thrive in high RF level areas. But if you want to have a very small, flexible radio, with excellent audio quality, the IC-703 is a very good alternative.

### **Update June 2006 – Sensitivity figures**

Finally got round to measure sensitivity with the "new" 6.5 kHz AM filter. It is as sensitive as it gets on MF and HF. Parameters AM, 30% modulation, 6.5 kHz bandwidth, preamp on, the IC-703 had very uniform 0.5uV or better sensitivity figures from around 1000 kHz and upwards all the way to 30 Mhz. Decreased slightly to around 0.75uV at 510 kHz. LF sensitivity is a joke... barely acceptable on the higher parts (1 uV at 350 kHz) but decreasing with frequency to a pedestrian 16 uV at 150 kHz. At 100 kHz it is another 20dB worse. Don't even think of buying an IC-703 if you plan to work LF frequencies.

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<sup>3</sup> ARRL measured the sensitivity on 1020 kHz as 2.34uV, same parameters.

<sup>4</sup> So maybe Icom thought they had a reason for de-sensitising the MW spectrum