Reviewed by Peter Hart, G3SJX, The Willows, Paice Lane, Medstead, Alton, Hants GU34 5PR;
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The Icom IC-703 HF + 50MHz Transceiver

After Peter Hart had carried out his usual thorough lab measurements and tested the IC-703 in the shack, we sent Tom Robinson out and about with the transceiver and its portable accessories to try it in the field.

The IC-703 has been introduced by Icom to satisfy the growing interest in low power operation. It provides a fully featured HF + 50MHz transceiver with 5 or 10Ω output, tailored to the requirements of the Foundation Licence, and meeting the needs of the QRP enthusiast and the amateur who likes to operate portable. The outward appearance of the IC-703 is virtually identical to the well-established IC-706 series and operation and many of the features are very similar. However, under the bonnet the architecture, circuitry and layout are substantially different.

BASIC FUNCTIONS

The IC-703 is a compact radio measuring 167W x 70H x 235Dmm and weighing about 2kg (the manual has the dimensions incorrect). The front panel is detachable and may be operated remotely with an available separation cable. The microphone, which uses RJ telephone style connectors, may be plugged into either the front panel or the rear panel and an HM-103 electret hand microphone is provided as standard.

The radio is designed to operate with power supplies in the range 9 to 15.8V. Above 11V the transmitter provides 10W maximum power output. Below 11V, the transmit power is limited to 5W and power saving measures are automatically selected, principally by switching out the LCD backlight and button illuminations but also reducing the receiver current giving a lower dynamic range. Low current consumption has been a major consideration in the overall design of the radio and a power save mode which sequences to lower current with no signal is selectable. All power saving functions are user selectable. The transmit power output can be set to one of five maximum levels: 10, 5, 2.5, 1 or 0.5W and within these maximum levels the power output is fully adjustable down to less than 0.1W.

The receiver tunes continuously from 30kHz to 60MHz and the transmitter is enabled for segments around each of the amateur bands. LSB, USB, CW (normal and reverse), AM, FM and various data modes are provided. Data allows for both FSK and AFSK operation. FSK provides RTTY operation where the radio generates the tones from a digital input. AFSK is provided by SSB-data mode and is used for all audio tone interfaced modes.

Two main printed circuit boards contain the bulk of the circuitry. The lower board contains the power amplifier and output filters, auto ATU and controlling processor. The upper board contains all the remaining signal circuitry including DSP. The detachable front panel contains the control interface and display processors. Overall a rugged construction has been achieved without the need for a fan on transmit. A 6cm diameter speaker fits into the case top. A carrying handle is not provided but is available as an extra if needed, as is a mobile mounting bracket.

The receiver is a double superhet on all modes with IFs of 64.455MHz and 455kHz with the main selectivity being achieved using ceramic filters at 455kHz. One optional extra filter may be fitted from the available filters for narrow CW (250 or 500Hz), narrow SSB (1.8kHz) or wide SSB (3.3kHz). These are quite expensive but give excellent performance. A 500Hz CW filter was provided with the radio and was also useful on data modes. Note that the IC-706 is also double conversion on SSB/CW but with IFs of 69MHz and 9MHz and achieving main selectivity at 9MHz. Optional filters in this frequency range are cheaper.

Two multipin connectors on the rear panel allow interfacing to data terminals, linears and external auto antenna tuners. A 13-pin DIN plug with lead tails is provided, the other is a standard 6-pin mini-DIN. There is a separate connector for the Icom AH-4 tuner and set-up options allow appropriate control of external auto-tuners. The built-in tuner covers all bands from 1.8 to 50MHz for VSWRs up to 3:1 and adopts relay switched inductors and capacitors with memories for fast

tuning. The relays are latching types to minimise continuous power drain. The rear panel key jack accepts a keying paddle used in conjunction with the internal keyer, a straight key or an external keyer according to set-up options. The front panel headphone jack is switchable to provide external speaker output in addition to the external speaker jack on the rear panel. External computer control is included via the standard Icom CI-V serial interface which requires a level converter to RS-232C.

The radio is provided with a comprehensive 106-page manual but no technical description or circuit details are included other than the specifications. A basic operation section is included as a quick reference guide to assist beginners. Keep the manual to hand, as some of the more exotic functions are quite complex to use.

FEATURES

In addition to the usual dedicated controls and keys, four multi-function buttons below the display select most of the remaining functions of the radio. These functions are grouped into a number of scrollable menus. Two of these menus allow for user set-up and three access the wide range of radio features. The initial set-up mode, which accesses 43 of the set-up parameters, can only be accessed by turning off the radio, turning it on, setting the parameter, turning off and on again, which is a little long-winded.

The detented 40mm diameter main tuning knob has a friction adjustment lever but a somewhat dead feel. Tuning on SSB/CW/RTTY modes is in 10Hz steps / 3kHz per knob revolution or 1Hz steps / 300Hz per revolution with a faster and programmable tuning rate selectable. On CW and data modes it is possible to tune even slower at one quarter of the normal tuning rate. On AM and FM

The Field Trials

For the 'Field Trials', in addition to the IC-703 itself, Icom (UK) supplied the LC-156 multi-bag, BP-228 battery pack (and its 600mA charger) and OPC-581 separation cable. Because Icom's promotional literature states the IC-703 is partly aimed at Foundation licensees, all the field trials were conducted using SSB. In keeping with the IC-703's 'lightweight, go anywhere' ethos, all the equipment was easily carried to the sites by one person.

ACCESSORIES USED

The BP-228 9.6V 2800mAh NiCd battery pack weighs 1lb 9.5oz (715g) and took six hours to charge using the supplied charger. It performed well in the field, giving well over two hours of 75:25 receiving/transmitting and still allowed a further three hours of listening in the shack, at the end of which it still had spare capacity. During this period output was limited to 5W by the IC-703's effective power saving circuits. The supplied 100-240V battery charger has four interchangeable mains plugs; very useful for the world traveller. It has automatic charger circuits for both NiCd and NiMH packs and a button operated battery discharge function.

The LC-156 Multi-Bag is well made and well thought out. It has many features including a secure harness complete with chest strap and convenient hooks on the shoulder straps, front pouch, side pockets, controller case, six Velcro antenna fasteners, loops for holding the separation and power cables, padded area for the battery pack, and two, sealable, holes in the sides for running out leads to the antenna and the controller. It also has a built-in rain cover which folds neatly away when not in use. A minor criticism is that the Velcro antenna fastening straps are short. A 7/8in (22mm) diameter tube was gripped very securely but one of 1in diameter was not.

Close up of LC-156 bag with added antenna support frame.

FIELD TEST RESULTS

The field tests comprised two 'picnic table portable' and two pedestrian mobile (manpack) configurations.

The first test was also the most complex configuration: a W3EDP 84ft (25.6m) wire antenna plus counterpoises, 4:1 balun, 'curly tail' earth spike, 33ft (10m) and 18ft (5.5m) fibreglass support masts (conveniently sited trees are not available at the trial site), and a 7000mAh gelcell battery. The IC-703's internal ATU was able to tune this end-fed wire/counterpoise system on all bands from 80m to 10m via the balun. I measured the SWR band-by-band using an Autek RF1 analyser. The worst case SWR was 8:1 on 40m but the auto tuner effortlessly brought down the SWR to 1.3:1 or less, as measured with the IC-703's meter. This was a much better performance than I expected, given the specification's 3.0:1 SWR maximum.

Encouraged by this, I listened on the bands: 17m was almost dead and 20m not too lively. I heard a pile-up working JW6VJA (Svalbard) and gave him a call. He congratulated me on breaking the pile-up with 10 watts. A new DXCC country for me with my first IC-703 portable QSO! Contacts followed on 40 and 80m with favourable comments on the audio and signal strength. I tried 17m and worked VE9KEN in New Brunswick.

The DSP auto notch filter effectively eliminated 'tuner uppers' and the DSP noise reduction helped improve reception on 80m.

A more easily-erected 'picnic table' station used the Buddipole, a commercial coil-loaded dipole covering 40 to 10m supported on an 11.5ft (3.5m) fibreglass painter's pole fastened to an *in situ* wooden post. Again, the gelcell battery was used. The antenna was only 15ft above ground so I operated NVIS on 40m. The Buddipole does not require a tuner, but careful adjustment is needed to get a 1:1 SWR. The internal tuner on the IC-703 made light work of bringing an intentionally poorly adjusted Buddipole to less than 1.3:1.

The IC-703/Buddipole combination seemed to work as well as most of the other stations heard on 40m. 57 reports were typical from British, German, French and Russian stations and mini-pileups associated with special event stations and LX/PA1AT proved no problem.

For pedestrian mobile operation, the LC-156 multi-bag, OPC-581 separation

only a higher and programmable tuning rate is selectable together with 1MHz steps. At high tuning speeds auto speed-up is engaged fairly seamlessly. The receive frequency can be shifted independently of the transmit frequency using the RIT control on all modes except AM and FM over the range ±10kHz. Alternatively this control can be assigned to parallel the main tuning knob. Bands are selected by up/down buttons returning a single frequency per band.

The usual A/B twin VFOs are provided with split frequency capability, a check/set TX frequency and a quick split function. There are 99 regular memory channels and a further six for storing scan edge frequencies, and memories can be tagged with alphanumeric names up to nine characters long. There is a one press store and recall quick memory feature allowing five or 10 frequencies to be accessed rapidly providing the relevant menu line has been actively selected. Scanning features allow scanning between two programmed frequencies, across all non-empty memory channels or across selected memory channels. One memory channel can be designated as priority watch for repeated checking.

Receiver features include selectable RF preamplifier/attenuator, fast/slow AGC, IF noise blanker for ignition type noise and IF shift to move the receive passband away from interfering signals. Audio DSP provides a noise reduction facility and an automatic notch filter that has the capability of notching multiple and moving tones. Having incorporated DSP, it is surprising that more DSP features were not provided, eg audio filters. The DSP unit is fitted as standard in the UK but this is not necessarily the case in other countries. A combined RF gain/squelch control may be programmed to function as either an RF gain control or squelch separately on SSB/CW and AM/FM modes.

Transmit features include a speech compressor and VOX on SSB and full or semi break-in together with a full message keyer on CW. Keyer parameters are programmable and three message stores with up to 50 characters per store are provided together with contest serial number auto-incrementing and auto-repeat of messages.

For the FM operator, the radio is equipped with a CTCSS tone

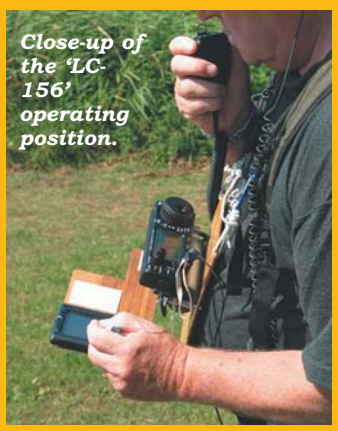
The 'Buddipole' portable site.

cable and BP-228 battery pack accessories were used, largely duplicating that shown in Icom's advertisement for this rig. QRP, coupled with small, inefficient antennas, is a recipe for disappointing pedestrian mobile performance so I decided to use my proven 13ft (4m) whip antenna. To support this adequately it was necessary to make a light frame and fasten it to the LC-156 using the bag's antenna fastening straps. While walking this bag/frame combination provided a stable antenna mount.

During an early morning seven-mile walk, 20m was open with lots of DX, including Hawaii. The best I could achieve though was a 56 from a station in Italy. The autotuner, again, had no problems tuning the whip. This configuration proved to be the lightest (12lb) and most comfortable pedestrian mobile backpack I have worn, and would provide a suitable arrangement for a dedicated QRPer. The breakthrough and RF feedback problem mentioned in Peter Hart's review did not occur on SSB but during a short CW test with the LC-156/BP-228 and short whip configuration feedback was noticeable.

One drawback of using the LC-156 in this way is that Icom suggests the IC-703's power output be limited to 5W, presumably to prevent the rig from overheating. However, I wanted to assess the rig's pedestrian mobile performance at its maximum 10W using a larger antenna. I therefore used my own ventilated backpack with its 15.25ft (4.65m) vertical antenna and the 7000mAh gelcell for the second pedestrian mobile trial.

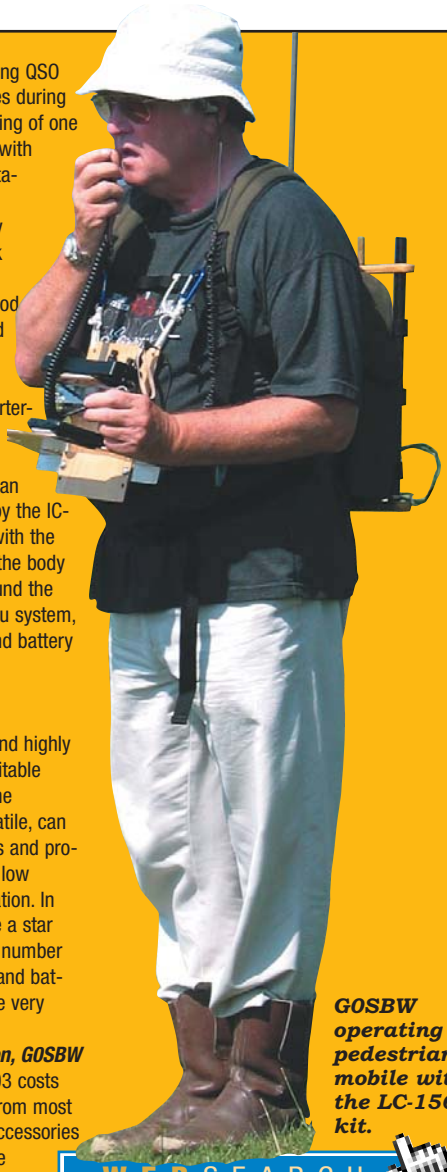
I was on parade at 0500UTC to catch the early morning DX. The internal autotuner worked faultlessly, tuning the whip/counterpoise system on all bands from 40m to 10m. The receiver managed to pull in weak signals from VK, ZL, South America, Alaska and USA West Coast. I did not manage to break any of the pile-ups so decided to put out my own CQ. I was surprised to have my call answered by VK5HK. The ensuing QSO lasted for more than 30 minutes during which he played back a recording of one of my transmissions. Contacts with Polish, German and local M3 stations followed.



Close-up of the 'LC-156' operating position.

In the evening I repeated my walk. 17m was open and weak DX was audible (Taiwan, USA), but not workable. I received good reports from Spain, Finland and Sweden, though.

Both the pedestrian mobile configurations used towed quarter-wave counterpoises and a 4:1 balun to complete the antenna systems. During these pedestrian mobile tests I was impressed by the IC-703's ergonomics. I operated with the control head on my chest and the body of the rig in the backpack. I found the large display, the sensible menu system, the auto tuner, SWR readout and battery voltage monitor a boon.



G0SBW operating pedestrian mobile with the LC-156 kit.

CONCLUSION

The IC-703 is a very capable and highly portable radio. Coupled to a suitable antenna it would be ideal for the Foundation Licensee. It is versatile, can be used in many configurations and provides an almost ideal basis for low power pedestrian mobile operation. In this respect the autotuner gave a star performance and there were a number of facilities such as DSP, SWR and battery voltage readouts which are very useful.

Tom Robinson, G0SBW

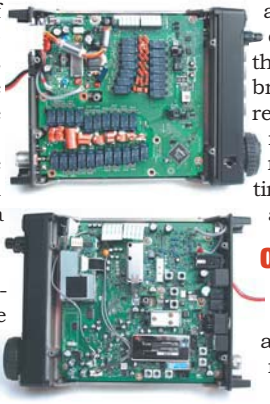
Editor's note: the Icom IC-703 costs around £599 and is available from most amateur radio suppliers. The accessories described by Peter and Tom are extra. Thanks to Icom (UK) for the loan of the transceiver and the auxiliary equipment.

WEBSEARCH

Icom (UK)	www.icomuk.co.uk
Buddipole	www.buddipole.com

encoder and decoder to provide repeater access and tone squelch operation. Repeater access makes use of the split frequency function and to avoid a complex set-up procedure each time a repeater is used, repeaters are best accessed from memory: memory channels store all necessary data.

Special features include a simple spectrum scope giving some indication on the LCD panel of signals on adjacent frequencies. The scan is programmable and the receiver muted whilst the scan is in progress. Antenna SWR can be displayed whilst on transmit. In addition, a simple plot of SWR against frequency can be made. The radio is fitted with a temperature compensated crystal oscillator (TCXO) as standard, which is an optional extra on most other radios. With a frequency stability of ±0.5ppm over the temperature range 0 to 50 °C negligible drift is guaranteed for the most critical digital modes.



IC-703 under bottom cover showing transmit PA and ATU. IC-703 under top cover showing signal circuitry.

ICOM IC-703 MEASURED PERFORMANCE

RECEIVER MEASUREMENTS

	SENSITIVITY SSB 10dBs+n:n		INPUT FOR S9	
FREQUENCY	PREAMP IN	PREAMP OUT	PREAMP IN	PREAMP OUT
1.8MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	18µV	50µV
3.5MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	18µV	50µV
7MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	18µV	50µV
10MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	16µV	45µV
14MHz	0.13µV (-125dBm)	0.32µV (-117dBm)	16µV	45µV
18MHz	0.11µV (-126dBm)	0.32µV (-117dBm)	16µV	45µV
21MHz	0.11µV (-126dBm)	0.32µV (-117dBm)	16µV	45µV
24MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	16µV	50µV
28MHz	0.14µV (-124dBm)	0.35µV (-116dBm)	18µV	50µV
50MHz	0.1µV (-127dBm)	0.16µV (-123dBm)	6µV	18µV

AM sensitivity (28MHz): 0.8µV for 10dBs+n:n at 30% mod dept. **FM sensitivity (28MHz):** 0.18µV for 12dB SINAD 3kHz pk deviation. **AGC threshold:** 1.6µV. 100dB above AGC threshold for <+1dB audio output increase. **AGC attack time:** 5ms (see text). **AGC decay time:** 150-300ms (fast), 0.5-1s (slow). **Max audio at 10% distortion:** 1.0W at 13.8V, 0.7W at 9.6V. **Inband intermodulation products:** -26dB to -36dB

S-READING	INPUT LEVEL SSB	
(7MHz)	PREAMP IN	PREAMP OUT
S1	1.8µV	5µV
S3	2.1µV	5.6µV
S5	2.8µV	8µV
S7	5.6µV	16µV
S9	18µV	50µV
S9+20	100µV	250µV
S9+40	800µV	2.5mV
S9+60	2.2mV	5.6mV

MODE	IF BANDWIDTH -6dB	-60dB
SSB, CW, AM-N	2640Hz	4550Hz
CW-500Hz	550Hz	1720Hz
AM, FM-N	9200Hz	17.6kHz
FM, AM-W	16.5kHz	27kHz

	INTERMODULATION (50kHz Tone Spacing) PREAMP IN		PREAMP OUT	
Frequency	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
1.8MHz	+1dBm	90dB	+9dBm	90dB
3.5MHz	+5.5dBm	93dB	+13dBm	92dB
7MHz	+1dBm	90dB	+10dBm	90dB
14MHz	+2dBm	91dB	+10.5dBm	91dB
21MHz	0dBm	90dB	+8dBm	90dB
28MHz	-2dBm	88dB	+6dBm	88dB
50MHz	-15dBm	81dB	0dBm	88dB

	CLOSE-IN INTERMODULATION ON 7MHz BAND PREAMP IN		PREAMP OUT	
Spacing	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
3kHz	-28dBm	71dB	-19dBm	71dB
5kHz	-24.5dBm	73dB	-15.5dBm	73dB
7kHz	-16dBm	79dB	-7dBm	79dB
10kHz	-12dBm	82dB	-3.5dBm	81dB
15kHz	-6.5dBm	85dB	+2dBm	85dB
20kHz	-0.5dBm	89dB	+9dBm	90dB
30kHz	+1dBm	90dB	+10dBm	90dB
40kHz	+1dBm	90dB	+10dBm	90dB
50kHz	+1dBm	90dB	+10dBm	90dB

FREQUENCY OFFSET	RECIPROCAL MIXING FOR 3dB NOISE	BLOCKING PREAMP1 IN	BLOCKING PREAMP OUT
3kHz	70dB	-34dBm	-25dBm
5kHz	75dB	-33dBm	-24dBm
10kHz	84dB	-20dBm	-11dBm
15kHz	88dB	-12dBm	-3dBm
20kHz	91dB	-9dBm	0dBm
30kHz	96dB	-8dBm	+1dBm
50kHz	101dB	-8dBm	+1dBm
100kHz	108dB	-8dBm	+1dBm
200kHz	114dB	-8dBm	+1dBm

TRANSMITTER MEASUREMENTS

	MAX CW POWER OUTPUT			INTERMODULATION PRODUCTS	
FREQUENCY	13.8V	9.6V	HARMONICS	3rd order	5th order
1.8MHz	10W	4.9W	-70dB	-25 (-19)dB	-42 (-36)dB
3.5MHz	9.7W	4.8W	-72dB	-28 (-22)dB	-46 (-40)dB
7MHz	9.6W	4.7W	-70dB	-22 (-16)dB	-41 (-35)dB
10MHz	9.9W	4.8W	-60dB	-30 (-24)dB	-48 (-42)dB
14MHz	10.1W	4.9W	-70dB	-30 (-24)dB	-46 (-40)dB
18MHz	10.3W	5.0W	-66dB	-30 (-24)dB	-46 (-40)dB
21MHz	10.4W	5.1W	-65dB	-30 (-24)dB	-46 (-40)dB
24MHz	10.5W	5.1W	-64dB	-26 (-20)dB	-46 (-40)dB
28MHz	10.6W	4.8W	-62dB	-30 (-24)dB	-46 (-40)dB
50MHz	10.4W	4.1W	-70dB	-20 (-14)dB	-34 (-28)dB

Two-tone transmitter intermodulation product levels are quoted with respect to PEP, figures in brackets are with respect to either tone. **Carrier suppression:** 40dB approx. **Sideband suppression:** >60dB @ 1kHz. **Transmitter AF response at -6dB:** 280 - 2700Hz. **Transmitter AF distortion:** 1%. **Microphone input sensitivity:** 3mV. **FM deviation:** 5.0kHz (wide) 2.4kHz (narrow). SSB T/R switch speed: mute-TX 36ms, TX-mute 2ms, mute-RX 15ms, RX-mute 3ms. **Note:** All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on SSB with a 13.8V supply.

MEASUREMENTS

Measurements were made with the radio powered from a 13.8V supply unless indicated otherwise and are summarised in the table. The current consumption on receive measured around 570mA at 13.8V with no power saving measures selected, reducing to about 300mA at 9.6V with the default power saving settings. On transmit, the current consumption was about 3.0A at 13.8V and full power (10W), switching to 5W max with supplies less than 11.5V and a further reduction to 2.5W max when the battery voltage dropped below 9.55V. At 9.6V 5W output the current consumption was about 2A. The radio continued to function down to about 8V.

The receive sensitivity was excellent except at LF and rejection of all images and spurii better than 80dB, an excellent result. AGC decay times were fine but the attack characteristic had significant overshoot to over 100ms. Third order intercept and reciprocal mixing figures were typical and fairly reasonable for a radio of this type and the overall selectivity and adjacent channel results are shown in **Fig 1**. At 9.6V reduced current, the third order intercept measured some 2 to 5dB lower. However, second order measurements yielded a surprising result. With two input signals at 7.1 and 7.2MHz, a response at 14.3MHz was obtained with signals as low as -55dBm. This is some 20-30dB worse than most radios and is likely to cause breakthrough from 40m broadcasters on the 20m band. Front-end blocking tests indicated the front-end selectivity to be fairly flat between 6.5 and 16MHz on these bands.

Transmit SSB intermodulation products were average but poor on some bands. The presented figures are for 13.8V operation, the 9.6V figures were in general 1-2dB worse. CW keying was fairly clean on semi break-in with fairly sharp rise and fall times. Full break-in showed a 16ms shortening of the character length limiting effective speed to around 30WPM. This shortening was also observed on the first character in semi break-in mode. Transmit/receive switching on data mode showed a clean result but a rather long time for the transmitter to achieve full output.

ON THE AIR

Checking out the IC-703 on the home station antennas gave good overall results. The receiver was sensitive and lively and generally coped well with the full range of signals. The 40m breakthrough on 20m predicted from the measurements was significant after dark but not during daylight and generally only above 14.3MHz. Switching in the attenuator largely removed the problem but of course reduces sensitivity just when it may be needed. In other strong signal situations, the receiver coped well. The audio quality on headphones was really excellent, and on the internal speaker good all round communications quality. Broadcast AM performance was also very good, particularly on headphones or external speaker.

On transmit excellent audio reports were received. CW semi and full break-in were effective and a pleasure to use at reasonable speeds but I did have a problem with RF getting into the keying line latching on to key down when using my long wire antenna entering the shack. No problems on SSB or with antennas further from the house and maybe some added filtering is needed on the keying lines.

CONCLUSIONS

The IC-703 performs admirably as a fully featured lower power and highly portable radio. Generally a good performer but some strong signal problems may be seen on 20m at times and CW keys may need filtering.

Peter Hart, G3SJX

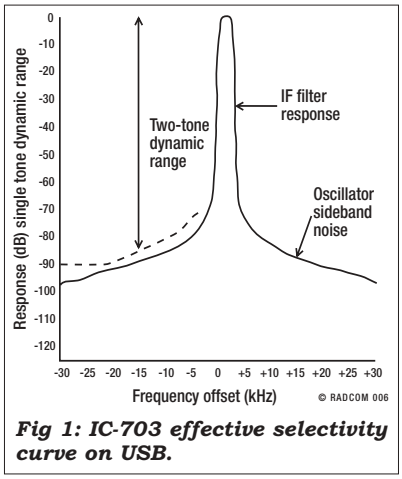


Fig 1: IC-703 effective selectivity curve on USB.