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ICOM IC-765 160- to 10-Meter Transceiver

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ICOM IC-765 160- to 10-Meter Transceiver

Reviewed by Mark J. Wilson, AA2Z

In September 1988 *QST*, we reviewed the ICOM IC-761.[1] Although it was generally favorable, the review pointed out a number of rough edges we found. Some of these rough edges were matters of personal preference; others affected the performance and usefulness of the transceiver. Our IC-761 review suggested that ICOM smooth the rough edges and release a revised rig (perhaps as the IC-761A, much as ICOM improved the IC-751 and released the IC-751A). ICOM did that, and more, with the introduction of the IC-765.

The IC-761 review described the functions and operation of that radio in detail. Most of the information in that review applies to the '765 as well, so it won't be repeated here. Although the IC-761 and IC-765 are virtually identical in appearance, careful comparison shows some subtle—but important—differences. This review will concentrate on those differences.

The Synthesizer

One of the features we liked best about the IC-761 was its quiet synthesizer. Ironically, the biggest flaw we reported in the '761 review was a synthesizer-related problem. In a nutshell, when the IC-761's transmitter and receiver frequencies were offset more than about 500 Hz during QSK CW operation, the synthesizer lockup time was longer than the rig's TR-switching time, so the radio transmitted RF *before* synthesizer lock. This made for a chirpy signal and all manner of ugly spurious outputs. ICOM developed a fix that improved the situation dramatically, but didn't completely solve the problem.

I'm happy to report that ICOM has a new synthesizer design (introduced in the IC-781) that completely solves the QSK problems, yet is very quiet. When you tune the band with the IC-765, you don't hear clicks, pops and other synthesizer-generated garbage present in some other radios. In addition, we found no discrete spurs in any of the ham bands. The result is an exceptionally clean-sounding receiver, even under crowded band conditions.

Frequency Control

The '765 has the same large, white fluorescent display as the '761. The '765's display shows frequencies to the nearest 10 Hz (the '761's display resolved frequencies to the nearest 100 Hz). The display-calibration control, located on the front panel of the IC-761, is located under a panel on top of the IC-765. Unfortunately, ICOM didn't include a front-panel display-intensity control.

As in the IC-761, the '765's frequency display indicates carrier frequency in the AM, FM, SSB and CW modes (mark frequency for RTTY). Unlike the '761, the '765's control program is smart enough to keep the rig tuned to the same carrier frequency when jumping from mode to mode.

Normal tuning speed is a comfortable 5 kHz per revolution (10-Hz steps). If you prefer a more leisurely trip through the bands, you can change this to 2.5 kHz per revolution by means of an internal switch. A press of the **TS** button changes the tuning speed to 100 kHz per revolution (in 1-kHz steps) to speed up long-distance excursions. This scheme is a bit different from the '761, which switched to 25 kHz per revolution when the tuning knob was turned rapidly, and 500 kHz per revolution when the **TS** button was pressed.

I thought that the band-selection scheme on the '761 left a lot to be desired. That radio had no band switch; you could use the keypad for direct frequency entry, or the **UP/DOWN** switches to step through the bands. In the general-coverage mode, these switches moved the frequency up or down 1 MHz. In the ham-bands-only mode, these keys allowed you to step up or down to the next frequency band. Annoyingly, when you moved up or down to the next ham band, you always ended up about 50 kHz above the lower band edge.

For my style of operating, the '765's band switching scheme is right on target: It's flexible, yet easy to use. Like the '761, the '765 has a keypad and **UP/DOWN** switches to the right of the main tuning knob. Unlike the '761, the '765's keys have two labels (and two functions). During normal operation, the keypad serves as a band switch; there are keys for each amateur band from 1.8 through 29 MHz. Press the **1.8** key, and you're on the last frequency and mode you used on 160 meters. Press the **18** key, and you're on the last frequency and mode you used on 17 meters. If you prefer, you can still use the keypad for direct frequency entry: Simply press the **FUNC** switch and enter the new frequency (to 10-Hz resolution, if you like). The **UP/DOWN** switches move the frequency up or down 1 MHz.

Memory features are expanded in the IC-765. I really liked the '761's 32 tunable memories; the '765 is functionally the same, but has 99 memories. The IC-765's memory channels 1 through 89 can store frequency, mode and wide/narrow filter selection. Channels 90-99 offer a new feature: They can store separate transmit and receive frequencies for split-frequency operation.

The Receiver

Overall, the receiver in the IC-765 is similar to that in the '761. The test results in Table 1 are generally within a few decibels of those measured for the IC-761. There are two noticeable improvements, though: (1) Blocking dynamic range now ap-

[1] T. Miller, "Product Review: ICOM IC-761 160- to 10-Meter Transceiver," *QST*, Sep 1988, pp 36-41.

Table 1

ICOM IC-765 160-10 Meter Transceiver, Serial No. 02143

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 1.8-1.99999, 3.4-4.09999, 6.9-7.49999, 9.9-10.49999, 13.9-14.49999, 17.9-18.49999, 20.9-21.49999, 24.4-25.09999 and 28-30 MHz.	As specified.
Modes of operation: AM, USB, LSB, CW, RTTY, FM.	As specified.
Power requirement: 100-120 V ac. Receive, 80 W max (at 100 V); transmit, 650 W max (at 100 V).	Not measured.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity (preamp on, bandwidth not specified): SSB, CW and RTTY, 10 dB S/N: 0.1-0.5 MHz, 0.7 μV (−110 dBm); 0.5- 1.8 MHz, 1.0 μV (−107 dBm); 1.8-30 MHz, 0.15 μV (−123 dBm).	Minimum discernible signal (noise floor) with optional 250-Hz filters: 1.0 MHz — Preamp on; −126 dBm Preamp off 3.5 MHz −142 dBm; −135 dBm 14.0 MHz −142 dBm; −135 dBm
AM narrow, 10 dB S/N: 0.1-0.5 MHz, 4.4 μV (−94 dBm); 0.5-1.8 MHz, 6.3 μV (−91 dBm); 1.8-30 MHz, 1.0 μV (−107 dBm).	10 dB S+N/N: 1.0 MHz — Preamp on; −111 dBm Preamp off 3.8 MHz −124.5 dBm; −118 dBm 14.2 MHz −125.5 dBm; −119 dBm
FM, 12 dB SINAD: 28-30 MHz, 0.30 μV (−117 dBm).	12 dB SINAD: Preamp on, 0.26 μV; preamp off, 0.64 μV.
Receiver dynamic range: 105 dB (signal spacing not specified).	Blocking dynamic range†: Preamp on: 3.5 MHz, 148 dB; 14 MHz, 146 dB. Preamp off: 3.5 MHz, 152 dB; 14 MHz, 151.5 dB.
	Two-tone, third-order intermodulation distortion dynamic range†: Preamp on: 3.5 MHz, 98 dB; 14 MHz, 96 dB. Preamp off: 3.5 MHz, 99 dB; 14 MHz, 97 dB.
Third-order input intercept: Not specified.	Preamp on: 3.5 MHz, 5 dBm; 14 MHz, 2 dBm. Preamp off: 3.5 MHz, 13.5 dBm; 14 MHz, 10.5 dBm.
S-meter sensitivity (for S9 reading): Not specified.	Preamp on: 24 μV at 14 MHz. Preamp off: 65 μV at 14 MHz.
FM squelch sensitivity: <0.3 μV.	As specified.
Notch filter attenuation: Not specified.	More than 30 dB.††
Receiver audio output: More than 2.6 W at 10% distortion with an 8-Ω load.	As specified. 3.125 W at 10% total harmonic distortion (THD) with an 8-Ω load.
Receiver IF/audio response: Not specified.	365-2415 Hz at −6 dB with 2.2-kHz SSB filter.
Transmitter	*Transmitter Dynamic Testing*
Transmitter power output: 100 W max on SSB, CW and RTTY; 40 W on AM.	Output power: 111-124 W (CW, SSB, RTTY—output varies slightly from band to band); AM, as specified.
Spurious-signal and harmonic suppression: >60 dB below peak power output.	As specified. See Fig 1.
Third-order intermodulation distortion products: Not specified	See Fig 2.
CW-keying waveform: Not specified.	See Fig 3.
Transmit-receive turnaround time (PTT release to 90% audio output): Not specified.	S1 signal, 30 ms; S9 signal, 18 ms.
Composite transmitted noise: Not specified.	See Fig 4.
Size (height, width, depth): 5.9 × 16.7 × 15.4 inches; weight, 38.6 lb.	

†Blocking dynamic range and third-order IMD dynamic range measurements were made at the ARRL Lab standard signal spacing of 20 kHz.

††Test-equipment limitations inhibit ARRL Lab measurement of notch-filter attenuations of more than about 30 dB.

proaches *150 dB;* and (2) Blocking and IMD dynamic ranges vary only slightly *with the preamp on or off.* ICOM has scored a victory in designing the '765's preamplifier; its use *barely* degrades receiver dynamic range. Overall, the IC-765's is one of the five best receivers we've ever tested in the ARRL Lab.

A welcome addition is an attenuator that offers 10, 20 and 30-dB settings. Having these choices makes low-band operating much more enjoyable.

The IC-765's improved mode switches take the place of the IC-761's **FILTER** switch and the older rig's complicated filter-selection scheme. SSB selectivity is fixed at 2.2 kHz. Pressing the **SSB** switch toggles between USB and LSB. Press the **CW/N** switch once and you get the SSB filter (2.2 kHz). Press it again and you get the stock cascaded 500-Hz CW filters. Pressing the **CW 250Hz** switch kicks in optional 250-Hz filters in the 9-MHz and/or 455-kHz IFs. Although somewhat expensive, the 250-Hz filters have excellent ultimate rejection and a good shape factor.

The **RTTY/N** button toggles between the 2.2-kHz and 500-Hz filters. There is no provision for using the 250-Hz filters on RTTY. **AM/N** toggles between 6-kHz and 2.8-kHz filters. FM selectivity is fixed at 15 kHz. Pressing the **FM/TONE** switch twice enables a continuous subaudible tone for repeater access (the optional UT-30 tone encoder is required to use this feature).

The IC-765's switchable IF-shift circuit works in the CW, SSB and RTTY modes. The '765's IF shift moves the center frequency of the filter passband without substantially changing its width, attenuation or shape factor. (See "Rough Edges.") The IC-761's passband tuning (PBT) control, which narrowed the passband from the high or low side, was eliminated from the '765.

Optional IF filters are easy to install in the rig. Simply remove the cover, plug in the filter(s) and flip a switch for each installed filter. The whole operation takes about 15 minutes, case removal and reinstallation included, no matter how many

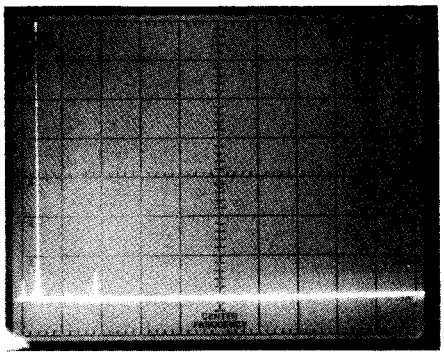


Fig 1—ICOM IC-765 worst-case spectral display. Horizontal divisions are 10 MHz; vertical divisions are 10 dB. Output power is approximately 121 W at 3.52 MHz. All harmonics and spurious emissions are at least 64 dB below peak fundamental output. The IC-765 complies with current FCC specifications for spectral purity for equipment in this power-output class and frequency range.

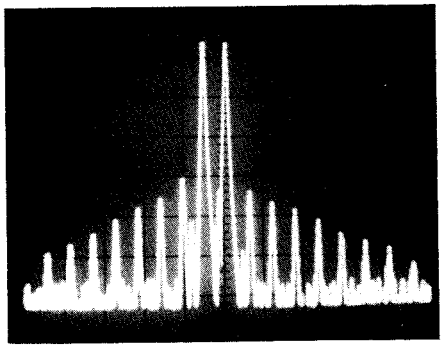


Fig 2—Worst-case spectral display of the IC-765 transmitter during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 40 dB below PEP output, and fifth-order products are approximately 45 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 100 W PEP output on 3.8 MHz.

filters you're installing.

The Transmitter

Figs 1 and 2 show the results of the ARRL Lab spectral-purity tests. All harmonics and spurious emissions are greater than 60 dB down (Fig 1). Two-tone IMD tests (Fig 2) show an improvement of a few decibels over the IC-761; third-order products are about 40 dB below PEP output. This is one of the cleanest transmitters we've tested.

One IC-765 feature I really like is the built-in antenna tuner. It's fast because it remembers and returns to the previous settings for a matched condition each time you change bands. The big change from the IC-761 is that the manual tuning controls for presetting the capacitors are gone; the radio automatically finds the best settings.

A minor gripe I had with the '761 was that the paddle input for the internal electronic keyer and the key line for an external keyer were handled by the same ¼-inch, three-conductor phone jack. The IC-765 has separate ¼-inch phone jacks for these functions, and you can connect internal and external keyers to the rig at the same time. This is useful when you're keying the rig with a paddle and a computer in parallel, as many operators do in contests.

ICOM has added a new function that many serious CW operators find essential: a **PITCH** control. Except for high-end Kenwood rigs and some others, most transceivers offset the transmitted CW signal a fixed amount (usually 600 to 800 Hz), yet many serious operators prefer an offset of 400 Hz or less. Ideally, the **PITCH** control should allow the operator to adjust the offset for personal preference, *and the sidetone pitch should match the offset.* But the IC-765's **PITCH** control does only half the job: It varies the offset from about 300 to 900 Hz, but the sidetone is fixed at 700 Hz. Here's one area where ICOM can improve the IC-765.

As shown in Fig 3, the IC-765's keying waveform is well-shaped. Like the IC-761, though, the '765's transmitted CW sounds choppy at moderate and high speeds during QSK CW operation. The IC-765 sounds better than the '761 on the air, but still has some sequencing problems. The dots are shorter in QSK mode than in VOX mode, but, as you'd expect, the sidetone weighting doesn't change. At higher speeds, I find a transmitted QSK signal with lighter-than-normal weighting easier to copy because there is more space between the dots, but the radio shouldn't change the weighting "behind your back"! Slightly increasing keyer weighting provides good keying during QSK operation, but it also increases the sidetone weighting. (The internal keyer's weighting is adjustable via a control under a panel on top of the rig.)

General Comments

During the review period, I used the '765 on SSB, CW and RTTY. The rig uses standard connectors (phone and phono jacks, mostly) and two DIN accessory jacks (for which plugs are provided), and the rear-panel layout is very clean, making for easy installation. AM-broadcast reception with the general-coverage receiver is a joy, although serious listeners will want to add the optional 6-kHz filter at the 9-MHz IF.

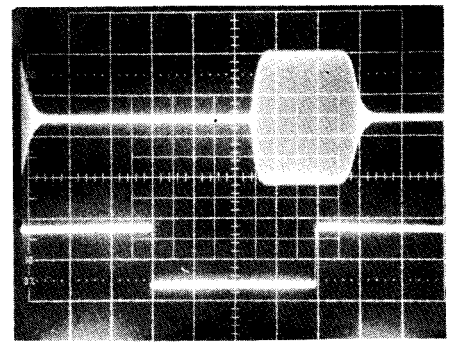
The only problem I encountered with the IC-765 occurred when I connected the radio to a power amplifier. The relay-control circuit in the '765 can switch loads up to 24 V dc (open circuit) and 1 A (closed circuit), or up to 120 V ac (OC) at 0.5 A (CC)—a big improvement over the IC-761. The amplifier's TR relay is rated at 12 V dc at 100 mA, so I was dismayed when, after keying the amplifier smoothly a couple of times, the rig's keying line shorted. ARRL Laboratory Engineer Ed Hare, KA1CV, traced the problem to an uninsulated key lead that lay directly on a PC-board ground trace in the rig. The PC board's solder mask was the only thing between the key line and ground, and the line shorted with use. Moving the wire a bit and adding heat-shrink tubing solved the problem. Apparently this was an isolated incident; other IC-765 owners haven't reported similar problems.

ICOM has improved their instruction manuals over the last few years. The 56-page IC-765 owner's manual is filled with illustrations and concise explanations of the transceiver's features. The explanations are generally clear, but don't provide much technical detail. Full schematics and block diagrams are included, but theory of operation isn't covered.

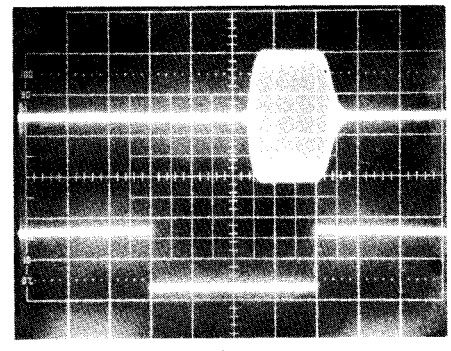
The transceiver's construction quality is excellent, and the rig has been trouble-free other than the amplifier-key-line failure.

Rough Edges

In the IC-761 review, we complained



(A)



(B)

Fig 3—CW-keying waveforms for the ICOM IC-765 in the semi-break-in mode (A) and the full-QSK mode (B). The lower traces are the actual key closures; the upper traces are the RF envelopes. Horizontal divisions are 5 ms. The transceiver was being operated at 121 W output on 14.02 MHz. The IC-765's CW keying shaping is good, but requires a keyer-weighting increase to preserve a 1:1 dot-to-space ratio at speeds above about 25 WPM in full-break-in mode.

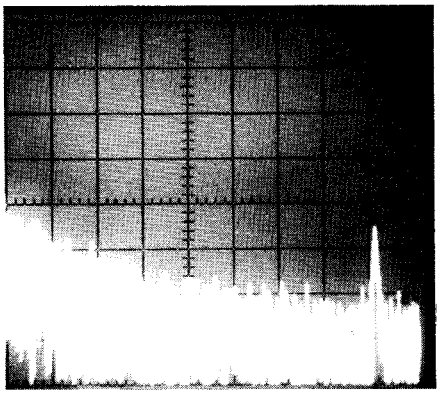
Table 2

IC-765 Dynamic-Range Measurements†

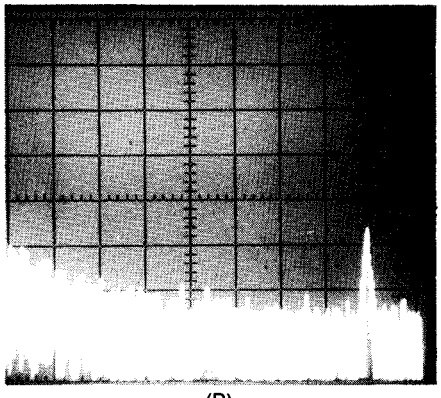
Signal Spacing (kHz)	Blocking DR (dB) IF Shift Off	Blocking DR (dB) IF Shift On	IMD DR (dB) IF Shift Off	IMD DR (dB) IF Shift On
5	120	91	85	73
10	130.5	105	90	88
20	151.5	139.5	97	95
50	152	152	99	99

†All measurements were taken at 14 MHz with the preamplifier off and the optional 250-Hz CW filter(s) selected.

about the rig's excessively hissy receive-audio amplifier. ICOM hasn't fixed this in the IC-765. For those with good high-audio-frequency hearing, the hiss is annoying, particularly when you're using high-quality headphones with broad frequency response.



(A)



(B)

Fig 4—Spectral display of the IC-765 transmitter output during composite-noise testing. Power output is 100 W at 3.52 MHz (A) and 100 W at 14.02 MHz (B). Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The scale on the spectrum analyzer on which these photos were taken is calibrated so that the log reference level (the top horizontal line on the scale) represents −60 dBc/Hz and the baseline is −140 dBc/Hz. Composite-noise levels between −60 and −140 dBc/Hz may be read directly from the photographs. The carrier, off the left edge of the photographs, is not shown. These photographs show composite transmitted noise at frequencies 2 to 20 kHz offset from the carrier.

As mentioned earlier, the IC-765 has a switchable IF-shift feature. When enabled, this function allows moving the filter passband, which is helpful in eliminating close-in interference. But the IF-shift circuit is flawed: As shown in the block diagram in the IC-765 owner's manual, IF shift is implemented by *removing the 9-MHz IF filters from the IF chain.* So the stock 500-Hz filter (or, if you have it, the accessory 250-Hz IF filter) in the 9-MHz IF is disabled when IF shift is turned on. The problem with this approach is that removing the 9-MHz IF filtering severely degrades close-in dynamic range. See Table 2 for particulars. The bottom line: During a CW contest, don't push in the **IF SHIFT** button! Under crowded band conditions, the advantage cascaded CW IF filters provide is *far* more valuable than what you get from the IC-765's IF shift.

Summary

Even with its many features, the IC-765 is one of the most straightforward radios I've used. The front-panel layout is relatively clean, and the basic controls are conveniently placed and work as I intuitively expect them to (even the memories are easy to use). It's big on basic radio performance, without a lot of useless frills.

I enjoy DXing, contests and other weak-signal work, so I appreciate the IC-765's quiet synthesizer and excellent receiver performance. And, I can connect the IC-765 to my computer for use with K1EA's *CT* (*Con*Test) program. In short, this radio is just about right for my interests and activities in Amateur Radio. I'll like it even better if ICOM fixes the CW **PITCH** control (the **PITCH** control in the IC-781 works correctly—what happened?) and modifies the IF-shift circuit so that you don't lose 9-MHz filtering to use that feature, but otherwise this radio is a winner. It will be interesting to see how long ICOM will continue to develop and refine this basic product before changing to a different platform.

Thanks to Dave Newkirk, WJ1Z, Bill Myers, K1GQ, and Rus Healy, NJ2L, who used the IC-765 and contributed to this review.

Manufacturer's suggested retail price: IC-765, $3149; FL-101 250-Hz filter (first IF), $73.50; FL-53A 250-Hz filter (second IF), $115. Manufacturer: ICOM America, 2380 116 Ave NE, Bellevue, WA 98004, tel 206-454-7619.

SOLICITATION FOR PRODUCT REVIEW EQUIPMENT BIDS

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The ARRL-purchased Product Review equipment listed below is for sale to the highest bidder. Prices quoted are minimum acceptable bids, and are discounted from the purchase prices.

Ten-Tec Omni V MF/HF transceiver, matching power supply/speaker, desk microphone, 500-Hz CW filters (6.3- and 9-MHz IFs) and 250-Hz CW filter (6.3-MHz IF). See Product Review, November 1990 *QST*. Sold as a package only. Minimum bid: $1690.

Sealed bids must be submitted by mail and must be postmarked on or before December 27, 1990. Bids postmarked after the closing date will not be considered. Bids will be opened seven days after the closing postmark date. In the case of equal high bids, the high bid bearing the earliest postmark will be declared the successful bidder.

In your bid, please clearly identify the item you are bidding on, using the manufacturer's name, model number, or other identification number, if specified. Shipping charges will be paid by the successful bidder, FOB Newington. The successful bidder will be advised by mail. No other notifications will be made, and no information will be given to anyone regarding final price or identity of the successful bidder.

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Strays

I would like to get in touch with...

☐ anyone who has attached an external VFO to a Yaesu FT-7 QRP rig for split-frequency transceive operation. Dale Hall, KBØWZ, PO Box 9609, Kansas City, MO 64134-0609.

☐ anyone who has software to transmit *Print Shop®* graphics via SSTV or fax using an MFJ-1278 and a Commodore C-64. I also need a stable design to use an Eimac 4-400 tube in grounded-grid HF service. Carter Rae, WA8YVM, 6366 W Stanley Rd, Mt Morris, MI 48458.

☐ anyone who has a schematic or manual for a Gonset model MSB-1 HF transceiver. Mario Gutierrez, WQ2F, 81 Clapham Ave, Manhasset, NY 11030.