

Product Reviews

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QRPworks SideKar Decoder Edition

Product Review

Icom IC-7760 MF/HF and 6-Meter Transceiver

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Icom's high-end IC-7760 offers excellent performance and a wide range of features in an innovative package. The RF deck is a large black box bristling with connectors. It's connected to a separate control head through an Ethernet cable. The control head is just about the same height and width as the IC-7610, and the IC-7760 is similar to that radio in look and feel. The IC-7760 covers 160 through 6 meters with two independent, high-performance receivers and a 200 W transmitter rated for continuous duty. The transmitter features digital pre-distortion (DPD) technology for an exceptionally clean SSB signal, even at full power.

Operating modes include USB/LSB, AM, FM, CW, PSK, and RTTY. FT8/FT4 and other data modes are supported via the integrated USB port. Receive coverage is continuous from 30 kHz to 60 MHz. The 60-meter channels can be programmed into memories.

Documentation and Firmware

Icom includes a printed *Basic Manual* with the radio. This 100-page document includes everything you need to set up the IC-7760 and use it on the air on a variety of bands and modes. A 124-page *Advanced Manual* and other documents are available online (see **https://icomamerica.com/support/manual/?keyword=ic-7760**).

There have been several firmware updates since the IC-7760's introduction, with firmware files and a PDF document detailing the changes available online. Version 1.13 was released during the review period. It took just a few minutes to download the file and instructions, transfer the new firmware to an SD card, and follow the instructions on the radio's **FIRMWARE UPDATE** screen to perform the update. I backed up my current radio settings to the SD card before performing the update.

Initial Setup

In addition to the RF deck and controller, the IC-7760 package includes a desktop stand for the controller head, a 3-meter Ethernet cable, an ac power cable for the RF deck, and connectors for the CW key and accessory jacks. The RF deck includes an ac power supply, while the control head has its own small 15 V dc power supply.



The RF deck weighs about 35 pounds, and the control head is about 5 pounds. Once everything is connected, you don't need to touch the RF deck, so I placed it on a small stand underneath my operating table and connected it to the control head using the supplied cable. If needed, you can use a longer Ethernet cable or connect the RF deck and control head through a home network.

I have Wi-Fi extenders with Ethernet ports in my basement station and in my second-floor office. Both communicate with a router and fiber internet interface on the first floor. I plugged the IC-7760's controller into the extender in my office and connected the RF deck into the one in the basement. The transceiver's networking menus and the instruction manual show a lot of different options and settings for different situations. I just used the default settings and enabled **THE ROUTE INCLUDES WIRELESS LAN**. I was able to make contacts and monitor a needed DXpedition while working in my office.

Bottom Line

The IC-7760 direct-sampling transceiver is a fully featured, high-performing HF and 6-meter radio. Its innovative two-piece packaging offers flexibility for local or remote station configuration, and its DPD technology creates exceptionally clean SSB signals.



Figure 1 — The IC-7760 controller rear panel.

The IC-7760 was designed with remote operation in mind. It can be operated over the internet using up to five controllers (RC-7760 controllers are available separately). The IC-7760 can also be operated with Icom's *RS-BA1* remote-control software or other remote-control software. There's a lot of information about this available for download from Icom's website. See the *Advanced Manual*, the *IC-7760 Technical Report*, and the *IC-7760 LAN & Remote Connection Update*.

Control Head

The control head's front panel includes a high-resolution touchscreen and all of the controls for operating the radio. A smaller "sub screen" supplements the main screen. I thought that the control head stand could be improved with some way to adjust the tilt for a better viewing angle on the screen and front-panel controls.

A microphone and headphones connect to the front panel. The rear panel (shown in Figure 1) has connectors for external speakers for each receiver, as well as audio line in/out jacks.

You can connect a paddle for the internal CW keyer or an external keying device here or to the RF deck. The **SEND** jack can be used to control a power amplifier or other external device. The **EXT-KEYPAD** jack is for an external keypad to control transmit message memories.

A USB-B port is available for connecting a PC. After installing a USB driver from Icom's website, look in your PC's **DEVICE MANAGER** screen under **PORTS (COM & LPT)** for **IC-7760 SERIAL PORT A (CI-V)** and **IC-7760 SERIAL PORT B** to find COM port numbers to use with your software. I had an older version of Icom's USB driver on my computer for my IC-7300. This driver worked with the IC-7760, but the COM port labels didn't display properly. Updating the driver to the latest version took just a few minutes.

The controller also has two USB-A ports that can be used for connecting a keyboard, mouse, USB flash drive, or Icom's optional RC-28 remote encoder. If you have more than two USB devices, you can use a USB hub.

The **EXT DISPLAY** jack is a DVI-D connector for using an external monitor to show the contents of the IC-7760's main display. I tried it with a 20-inch widescreen computer monitor with good results. Many of today's monitors use HDMI and/or DisplayPort interfaces instead of DVI-D, but adapter cables are readily available.

RF Deck

The RF deck's rear panel (see Figure 2) includes four SO-239 antenna jacks. You can select antennas manually using the **ANT** button on the touchscreen, or use the **ANTENNA** screen to save selections for each band.



Figure 2 — The IC-7760 RF deck rear panel.



Figure 3 — The IC-7760 controller is about the same height and width as the IC-7610.

You can temporarily override automatic selections by touching the **ANT** button on the display. Temporary selections are indicated by a yellow star.

There's an **RX-ANT IN** BNC jack for use with a separate receive antenna, and that can be paired with **RX-ANT OUT** for a band-pass filter or preamplifier in the receive path. A long press of the **ANT** button on the display switches between listening with the main antenna or receive antenna.

The transverter (**X-VERTER**) jack is menu-enabled to provide a low-level transmitter output and receiver input. **REF IN** is for connecting an external 10 MHz reference signal. The **TUNER** connector below the **REF IN** jack is for an external automatic antenna tuner such as Icom's AH-730. (If you enable the external tuner in the menus, power output is limited to 100 W on **ANT1** to avoid damaging the external tuner.) The **REMOTE** jack is for providing CI-V frequency information to an external device such as Icom's IC-PW2 amplifier.

The RJ-45 connector labeled **CONTROLLER** is for the control head cable. The other, labeled **LAN**, is for connection to the control head through a local area network or for remote control using Icom's *RS-BA1* software or the radio remote head.

The **KEY** jack is for connecting a straight key, external CW keyer, or other keying device. I connected my computer keying output to this jack and connected a paddle for the internal memory keyer to the **ELEC-KEY** jack on the controller and used both options interchangeably.

Automatic level control (**ALC**) and transmit/receive switching (**SEND**) are for connecting a non-Icom amplifier. For the **SEND** jack, you can choose to use reed-relay (16 V 500 mA maximum) or solid-state switching (250 V 200 mA maximum). Both options offer silent amplifier switching. The **TX DELAY** menu introduces a delay of 10 to 30 milliseconds between the time the amplifier control switches and RF output appears at the IC-7760 antenna jack. This delay allows time for amplifier relay contacts to engage before the radio starts to transmit.

The eight-pin DIN **ACC1** jack provides connections for digital mode operation as an alternative to using the USB connection. This jack includes an FSK RTTY keying input, PTT control, fixed-level audio input and output for sound card digital modes, and other functions. The seven-pin DIN **ACC2** jack is primarily for interconnecting an Icom PW1 or PW2 linear amplifier.

The USB-B port could be used to output in-phase/quadrature (IQ) data for use with the free HDSDR software-defined radio application running on a PC (see **www.hdsdr.de**). Icom's website offers a comprehensive PDF document for setting up and using HDSDR with the IC-7760.

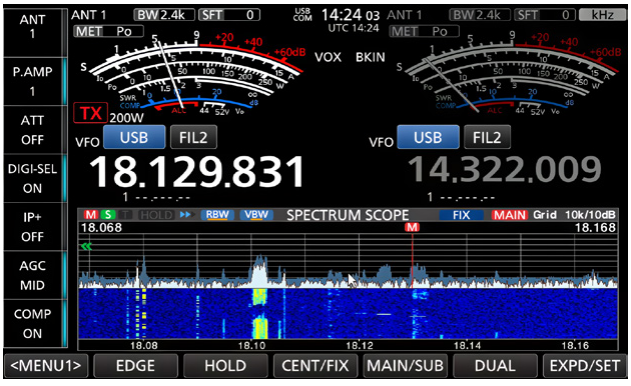
Controls and Display

The control head shown in Figure 3 looks similar to other Icom transceivers from the current generation. I have an IC-7300, and even though the IC-7760 does much, much more, I was able to navigate its front panel and menus right away. The transceiver has a long list of features and settings, but Icom has done a great job of organizing and labeling the menus so that it's usually not difficult to find what you're looking for.

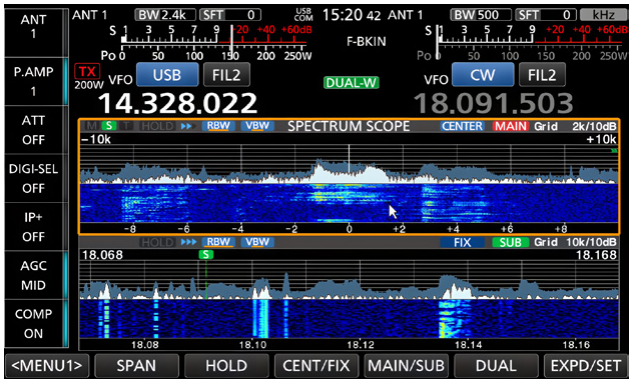
Main Display

The high-resolution touchscreen display is beautiful. Although it's densely packed with information and on-screen buttons, I found it highly readable. Brightness, frequency display font, and screen-saver options are adjustable.

On-screen buttons along the left side offer quick access to often-used features such as antenna selection and preamp/attenuator settings. Press the **MULTI** knob to pop up a menu for settings such as transmitter power, CW keyer speed, or mic gain. Press the hardware **FUNCTION** button below the display to pop up a screen for the notch filter, VOX, noise reduction, and other



4A



4B

Figure 4 (A and B) — The IC-7760 controller main screen. At (A), the main band is set to 17-meter SSB while the sub band is idling on 20-meter SSB. This view shows the beautiful simulated analog meters and a large band scope with good detail. At (B), the transceiver is in dual-watch mode, listening on 20-meter SSB and 17-meter CW simultaneously. The top band scope is for the main (left) receiver and is set to center mode looking at 10 kHz above and below operating frequency. The lower band scope, for the sub band, is in fixed mode and shows the entire 17-meter band. The main band controls the transmitter, but the main and sub bands can be swapped instantly using the **CHANGE** button on the front panel.

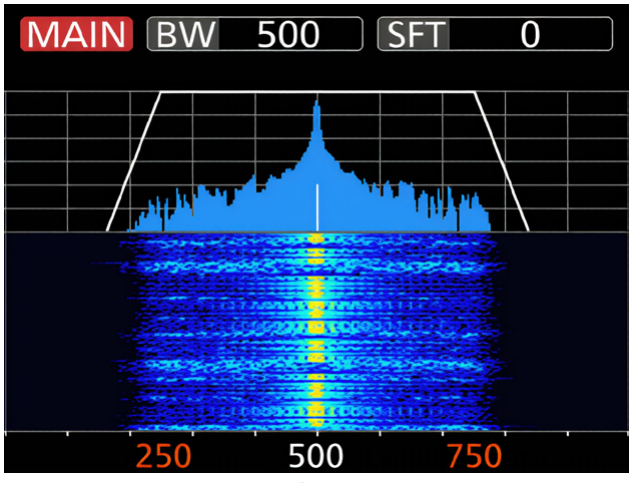
features. Button functions are tailored to the operating mode.

The main display splits the top section of the screen between the two receivers, called the main and sub bands. You can see key information at a glance. Icom does a great job with the simulated analog meters, but you can also choose a horizontal ("edgewise") meter presentation or a bar graph. The meter presentation changes automatically to edgewise or bar graph when other features require screen space. Another selection shows all of the metering parameters simultaneously.

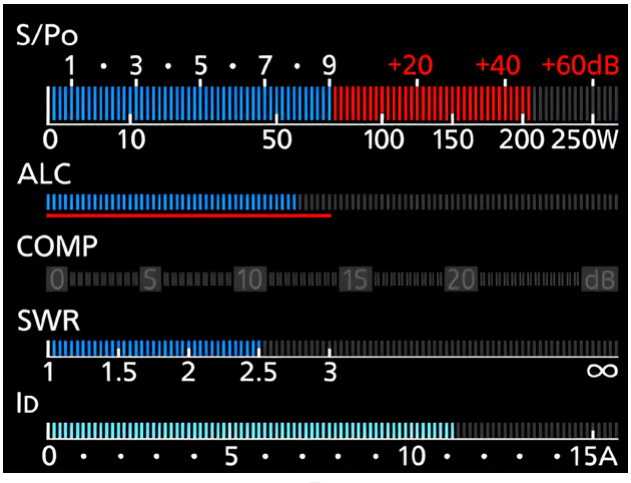
Band Scope

The IC-7760's band scope offers several options (see Figure 4). You can view the spectrum scope alone, a combination spectrum scope/waterfall, or a larger (expanded) spectrum scope/waterfall. A compact version of the band scope displays when other windows are active. You can touch the screen or use a mouse to select signals in the band scope, and the transceiver will tune there. I found using the mouse to be much more precise. Note that the mouse works only within the band scope and not other areas of the screen.

The **FIXED** display mode allows you to set up four fixed frequency ranges for each band and select among them using the **SPAN** control. The **CENTER** mode keeps the cursor in the center and moves the display within a span of ±2.5 to ±500 kHz of the center frequency. In the **CENTER** mode, waterfall signals smear as the display moves, but that can be minimized by using a



5A



5B

Figure 5 (A and B) — The sub screen **FILTER EFFECT** setting makes it easy to tune signals to the center of the filter passband (A). The multifunction meter setting (B) is useful for monitoring several transmitter parameters at a glance.

faster sweep speed. Enabling the **SCROLL** mode for either **FIXED** or **CENTER** mode automatically adjusts the frequency range up or down as you tune. Different color markers show the main and sub band frequencies and the transmit frequency. That's handy when trying to find a clear transmit frequency during split operation.

Touching the **MAIN/SUB** button switches the band scope between the main and sub receivers. Touching **DUAL** displays a separate, smaller band scope for each receiver. You can display the two band scopes horizontally or side by side.

I often used the band scope in **FIXED** mode with **SCROLL** enabled to focus on the band segment of interest or to look for any activity on a quiet band. With lots of signals on the air, I tended to use **CENTER** mode with **SCROLL** set to a narrow frequency range for more detail.

From the **MENU** screen you can enable an audio scope that displays two views of the waveform of received and transmitted signals. One scope display is similar to a spectrum analyzer, and the other is similar to an oscilloscope.

Sub Screen

A small touchscreen to the right of the main display has several useful functions. Push the **SUB DISP** button below the screen to scroll through the choices. Most of the time I used the sub screen to display a virtual band switch. Touch a band button to change bands, and touch again to cycle through three band-stacking memories. Press **F-INP** to enter a frequency directly, or press **GENE** to enter general-coverage receiver mode. The **MPAD** button next to the **SUB DISP** button is a quick-access memo pad that stores five or 10 frequencies, along with modes and filter settings.

The sub screen **FILTER EFFECT** selection displays a close-in view of the selected receive filter(s) in relation to signals in the passband (see Figure 5). You can visually tune a signal to the center of the passband or see the effects of IF and notch filter settings or passband tuning (PBT) adjustments. The third sub screen choice is another meter similar to the one on the main screen.

Receiver

The IC-7760 has two independent receivers with identical features and performance. ARRL Lab test results are shown in Table 1. Like Icom's other recent transceivers, the IC-7760 is based on a direct-digital sampling architecture. The analog-to-digital conversion (ADC) happens at signal frequency. To help prevent overloading the ADC, the IC-7760 uses 15 sharp band-pass filters in the front end to reject out-of-band interference.

The radio also offers a digital preselector (**DIGI-SEL**) as an additional tool to prevent ADC overflow from out-of-band signals. With **DIGI-SEL** on and the preamp off, the preselector is placed in front of the band-pass filters for best interference rejection. With the preamp on, the preselector is placed after the preamp and band-pass filters for best sensitivity.

The two receivers can operate on the same band, or on different bands and modes. Using the dual-watch (**DUAL-W**) feature, you can listen to both receivers at the same time. You can only transmit on the main band except during split-frequency operation. Pressing the **CHANGE** button toggles frequency, mode, and other settings between the main and sub bands. Push the **SPLIT** button and the transceiver transmits on the sub-receiver frequency. A long press of that button equalizes the settings of the two receivers.

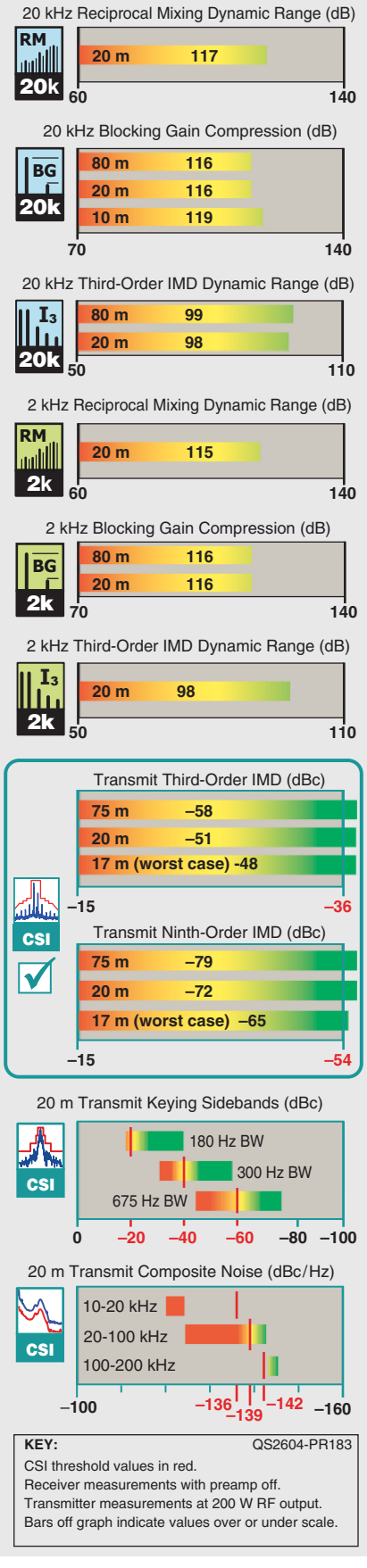
The IC-7760 has a single tuning knob that can be switched between receivers by touching the frequency area of the screen. If you prefer a separate tuning knob for each receiver, Icom's optional RC-28 encoder connects to the front panel through a USB cable and can be used to tune either receiver. I missed having a separate tuning knob for the second receiver during the review and would consider an RC-28 to take full advantage of the IC-7760's dual-watch and split-frequency capabilities.

The control head has separate top-facing speakers for the main and sub receivers. From the menus, you can choose to listen to one receiver in each speaker or headphone side, or mix audio from the main and sub receivers together in both speakers or both ears. You can also set up the external speaker jacks to listen to audio from the main and sub receivers separately or mixed. The internal speakers are so close together that I didn't hear much difference in the settings, but it was really obvious when listening via headphones. I thought that the internal speakers sounded fine, with plenty of clear audio.

Each receiver has its own volume control, and you can temporarily mute either one by pressing the knob. Menu-adjustable high-pass and low-pass filters tailor receive audio characteristics for each mode. In addition, there are bass and treble settings for each voice mode.

You can set up three bandwidth filters for each mode (SSB, SSB data, CW, PSK, RTTY, and AM). Switch among the filters by touching the **FIL** button on the screen. A long press of that button brings up a configu-

Icom IC-7760 Key Measurements Summary



KEY: QS2604-PR183

CSI threshold values in red.
Receiver measurements with preamp off.
Transmitter measurements at 200 W RF output.
Bars off graph indicate values over or under scale.

Table 1 — Icom IC-7760 HF Transceiver S/N 12001267, Main CPU Firmware 1.01

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.03 – 60 MHz; transmit, 1.800 – 54.000 MHz (amateur bands only).	Receive and transmit as specified.
Power requirements: Receive, 150 VA max; transmit, 800 VA max.	At 115 V ac: RF deck: Receive, 57 VA (46 W); transmit, 543 VA (440 W) at 200 W RF output; controller: 16 VA (9 W).
Modes of operation: CW, RTTY, AM, USB/LSB, FM, and PSK.	As specified.

Receiver

SSB/CW sensitivity (2.4 kHz BW, 10 dB S/N):
135/475 kHz band, +3 dBµV (1.41 µV) typ.
1.8 – 29.999 MHz, –16 dBµV (0.16 µV) typ.
50 MHz band, –18 dBµV (0.13 µV) typ.
P1 on for HF bands, P2 on for 50 MHz band.

Receiver Dynamic Testing

Noise floor (MDS), 500 Hz bandwidth (dBm/µV):

Preamp	*Off*	*1*	*2*
0.137 MHz	–120/0.22	–126/0.11	–128/0.09
0.475 MHz	–127/0.09	–136/0.04	–139/0.02
3.5 MHz	–129/0.08	–138/0.03	–142/0.02
14 MHz	–128/0.09	–137/0.03	–141/0.02
50 MHz	–127/0.10	–137/0.03	–141/0.02

AM sensitivity (6 kHz BW at 10 dB S/N):
0.5 – 1.79999 MHz: +16 dBµV (6.3 µV) typ.
1.8 – 29.9999 MHz: +6 dBµV (2.0 µV) typ.
50 MHz band: 0 dBµV (1.0 µV) typ.
P1 on for HF bands, P2 on for 50 MHz band.

10 dB (S+N)/N, 1 kHz tone, 30% modulation, 6 kHz BW (dBm/µV):

Preamp	*Off*	*1*	*2*
1.02 MHz	–102/1.75	–111/0.65	–114/0.46
3.88 MHz	–104/1.44	–113/0.48	–117/0.32
50.4 MHz	–102/1.70	–112/0.55	–115/0.38

FM sensitivity (15 kHz BW at 12 dB SINAD):
28.00 – 29.7000 MHz: –6 dBµV (0.5 µV) typ.
50 MHz band: –10 dBµV (0.32 µV) typ.
P1 on for HF bands, P2 on for 50 MHz band.

12 dB SINAD, 3 kHz deviation, 15 kHz BW (dBm/µV):

Preamp	*Off*	*1*	*2*
29 MHz	–108/0.88	–117/0.30	–122/0.18
52 MHz	–108/0.91	–118/0.29	–122/0.18

Reciprocal mixing dynamic range: Not specified.

Preamp off (dB):

Offset	*20 kHz*	*5 kHz*	*2 kHz*
3.5 MHz	116[1]	114	114
14 MHz	117[1]	116	115
50 MHz	118[1]	114	111

Blocking gain compression dynamic range: Not specified.

500 Hz BW:

	20 kHz Offset Preamp Off/1/2 (dB)	*5/2 kHz Offset* Preamp Off (dB)
3.5 MHz	116/114/110	116/116
14 MHz	116/114/111	116/116
50 MHz	119/117/113	119/119

Two-tone intermodulation distortion (IMD) testing (500 Hz bandwidth, IP+ on):

Band/Preamp	*Spacing* (kHz)	*Measured IMD Level* (dBm)	*Measured Input Level* (dBm)	*IMD DR* (dB)
3.5 MHz/off	20	–129	–30	99
14 MHz/off	20	–128	–31	98
14 MHz/1	20	–137	–39	98
14 MHz/2	20	–141	–42	98
14 MHz/off	5	–128	–31	98
14 MHz/off	2	–128	–31	98
50 MHz/off	20	–127	–29	98
50 MHz/1	20	–137	–40	99
50 MHz/2	20	–141	–38	103

Second-order intercept point: Not specified.

Preamp	*Off* (dBm)	*1* (dBm)	*2* (dBm)
14 MHz	+85	+85	+85
50 MHz	+71	+73	+73

FM adjacent channel rejection: Not specified.

15 kHz BW: 29 MHz, P1 on: 83 dB[2]; 52 MHz, P2 on: 91 dB[1].

FM two-tone third-order IMD dynamic range: Not specified.

	20 kHz Offset (dB)	*10 MHz Offset* (dB)
29 MHz, P1 on	90	>118
52 MHz, P2 on	90	118

Spectral display sensitivity: Not specified.

Waterfall: *Preamp*	*Off*	*P1* (dBm)	*P2* (dBm)
14 MHz	–144	–154	–158
50 MHz	–144	–148	–150

ration screen for adjusting IF bandwidth and skirt shape (sharp/soft) filters. The three FM filter bandwidths are fixed.

In addition to the bandwidth filters, twin passband tuning (**TWIN PBT**) is a great help in reducing or eliminating interference from nearby stations. Rotate the inner or outer knob to cut the upper and/or lower edge of the passband. A graphic pops up on screen to show filter shift values, and you can also observe the effect on signals in the passband using the **FILTER EFFECT** option on the sub screen. The manual notch filter offers wide, mid, and narrow settings, and it is effective in attenuating interfering signals. I found the automatic notch filter to be effective at reducing

S-meter sensitivity: Not specified.	
Notch filter: ANF attenuation > 30 dB (1 kHz single tone).	Up to 55 dB attenuation, 15 ms attack time.
DSP noise reduction: Not specified.	Up to 12 dB.
Squelch sensitivity: Not specified.	At threshold, P1 on: FM, 29 MHz, –119 dBm/0.25 µV; 52 MHz, –118 dBm/0.27 µV; SSB, 14 MHz, –102 dBm/1.78 µV.
Receive bandwidth:	Range at –6 dB points (bandwidth), filter type SHARP:
CW (BW = 500 Hz): > 500 Hz/–6 dB, <700 Hz/–60 dB	CW (500 Hz BW): –263 Hz to +262 Hz (525 Hz)
SSB (BW = 2.4 kHz): > 2.4 kHz/–6 dB, < 3.6 kHz/–60 dB	SSB (2400 Hz BW): 240 to 2750 Hz (2510 Hz)
AM (BW = 6 kHz): > 6.0 kHz/–6 dB, <15 kHz/–60 dB	AM (6 kHz BW): 119 to 3097 Hz (5956 Hz)
Receive processing delay time: Not specified.	3.6 ms.
Audio output: > 2.0 W (8Ω, ≤ 10% THD).	As specified. THD 0.35% at 1 V_{RMS}.
Transmitter	**Transmitter Dynamic Testing**
Power output: SSB/CW/FM/RTTY/PSK: 1 – 200 W; AM 0.25 – 50 W.	As specified.
Spurious signal and harmonic suppression: ≥50 dB HF band, > 66 dB 50 MHz band.	HF: typically, > 70 dB; worst case, 1.8 MHz, –52 dB; 50 MHz: > 66 dB. Complies with FCC emissions standards.

Transmit IMD products: Not specified.

CSI

@ 200 W PEP, DPD on (dBc/dB PEP):

Order:	*3rd*	*5th*	*7th*	*9th*
CSI Limit:	*≤ –36/–42*	*≤ –42/–48*	*≤ –48/–54*	*≤ –54/–60*
1.8 MHz	–57/–63	–67/–73	< –79/–85	< –79/–85
3.5 MHz	–58/–64	–67/–73	< –79/–85	< –79/–85
5.3 MHz	–55/–61	–65/–71	< –79/–85	–71/–77
7 MHz	–55/–61	–70/–76	< –79/–85	–77/–83
10 MHz	–58/–64	–65/–71	–73/–79	–75/–81
14 MHz	–51/–57	–63/–69	–65/–71	–72/–78
18 MHz[3]	–48/–54	–54/–60	–63/–69	–65/–71
21 MHz	–54/–60	–60/–66	< –79/–85	–71/–77
24 MHz	–53/–59	–65/–71	–71/–77	< –79/–85
28 MHz	–51/–57	–59/–65	–71/–77	–74/–80
50 MHz	–55/–61	–60/–66	–70/–76	< –79/–85
@ 100 W PEP, DPD on:				
14 MHz	–47/–53	–62/–68	–67/–73	–72/–78

See Figure A.

CW keyer speed range: Not specified.	6 – 48 WPM; iambic mode A&B.
CW keying characteristics: Not specified.	See Figures B and C.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast, SSB: 37 ms. S-9 signal, AGC fast, CW (full break-in): 45 ms.
Receive-transmit turnaround time: Not specified.	SSB, 67 ms; FM, 12 ms (29 MHz), 11 ms (52 MHz).
Amplifier key line closure to RF output time: Not specified.	CW: close, 7 ms; open, 9.2 ms (full break-in); 500 ms (semi-break-in) SSB: close, 65 ms; open, 6.7 ms

Transmit composite noise: Not specified.

Spacing:	*10 kHz* (dBc/Hz)	*20 kHz* (dBc/Hz)	*100 kHz* (dBc/Hz)
CSI Limit:	≤ –136	≤ – 139	≤ –142
14 MHz, 200 W	–120	–124	–141
51 MHz, 200 W	–116	–119	–137
14 MHz, 30 W	–117	–121	–135

See Figure D.

Size (height, width, depth, including protrusions): RF deck, 6.7 × 16.7 × 18.4 inches; controller, 4.6 × 13.7 × 5.2 inches.
Weight: RF deck, 34.8 pounds; controller, 5.1 pounds.

[1] "OVF" indicator was displayed, and test was stopped at the value shown.
[2] Noise limited at the value shown.
[3] Worst-case band. See Figure D.

annoying carriers. The audio peak filter (**APF**) peaks CW signals and brings them out of the noise. Filter level, passband width, and peak frequency are all adjustable.

The IC-7760 offers adjustable noise reduction, noise blanker, and notch filter features. I don't experience much power-line or other man-made noise where I live, so I didn't use the noise blanker much. I thought that the noise reduction worked well at lower settings, with little or no evident digital artifacts.

Transmitter and Antenna Tuner

The IC-7760's transmitter performance is shown in Table 1 and associated figures. Output power is adjustable in 1 W steps from less than 2 W to the full 200 W. From the **TX POWER LIMIT** menu, you can set the maximum power output separately for each band, with separate settings for the SSB data modes. This is helpful for use with amplifiers with drive requirements that vary by band, or to stay within the legal power limits on 60 meters. The RF deck has four internal fans that

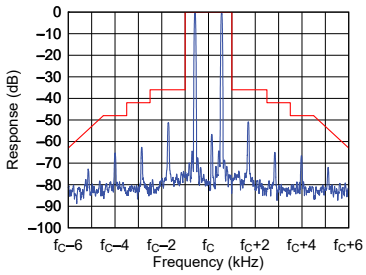


Figure A — The spectral display of the Icom IC-7760 transmitter output during two-tone third-order IMD testing on the 18 MHz band (worst case) at full power. DPD is enabled. This plot shows the transmitter output (blue trace) ± 6 kHz from the carrier. The red trace represents the maximum acceptable level for ARRL CSI compliance. The reference level is 0 dBc, and the vertical scale is 10 dB per division.

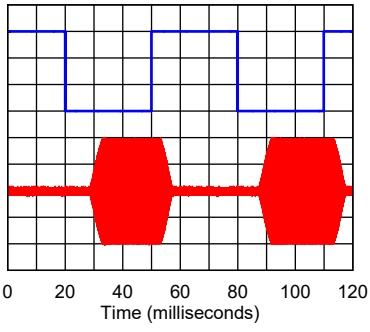


Figure B— CW keying waveform for the Icom IC-7760 showing the first two dits using external keying. Equivalent keying speed is 40 WPM. The upper trace is the key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 200 W output on the 14 MHz band using QSK set to the default 4 ms. The first-dit rise time is 3.0 ms; the fall time is 2.9 ms. The second-dit rise time is 3.1 ms; the fall time is 2.9 ms. The first-dit on delay is 10.5 ms; the off delay is 5.4 ms. The second-dit on delay is 9.3 ms; the off delay is 5.8 ms.

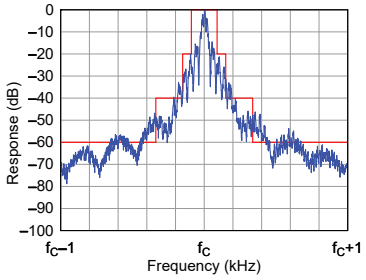


Figure C — The spectral display of the Icom IC-7760 transmitter during keying sideband testing. Equivalent keying speed is 40 WPM using external keying and the default rise time setting. The transmitter was being operated at 200 W PEP output on the 14 MHz band, and this plot shows the transmitter output (blue trace) ± 1 kHz from the carrier. The red trace represents the maximum acceptable level for ARRL CSI compliance. The reference level is 0 dBc, and the vertical scale is in dB.

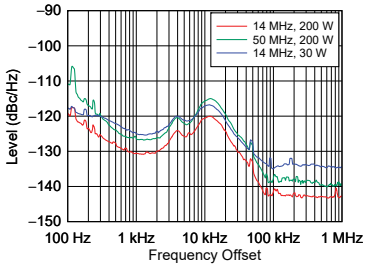


Figure D — The spectral display of the Icom IC-7760 transmitter output during composite noise testing. Power output is 200 W on the 14 MHz band, 30 W on the 14 MHz band, and 200 W on the 50 MHz band. The carrier, off the left edge of the plot, is not shown. This plot shows composite noise 100 Hz to 1 MHz from the carrier. The reference level is –90 dBc/Hz, and the vertical scale is 10 dB per division.

only ran during prolonged operation at full power. The fans are quiet, and with the RF deck located away from my operating position, I barely noticed the sound.

Note that the CW rise time is adjustable, with a default of 4 milliseconds. Other menu choices are 2, 6, and 8 milliseconds. I changed to 8 milliseconds for the cleanest CW waveform and keying sidebands.

The internal antenna tuner is rated for loads from 16.7 to 150 Ω (3:1 SWR). Initial tuning for a given frequency and antenna combination is quick. The tuner remembers settings, so operation is nearly instantaneous after the initial tune. I used the tuner on 40 meters, where my inverted **V** is cut for the low end of the band, and on 17 meters, where my multiband beam presents an SWR of about 2:1.

Voice Operation

As detailed in the Lab Notes, the IC-7760 incorporates DPD technology to reduce intermodulation distortion (IMD) products on transmitted SSB and AM signals. To use DPD, simply touch the **DPD** button on the **FUNCTION** menu. It's adjusted at the factory for proper operation when you're using the IC-7760 by itself, but you can check and readjust settings if needed from a menu.

Icom's IC-PW2 amplifier also incorporates DPD technology that integrates seamlessly with the IC-7760, but the manual doesn't discuss using the DPD feature with amplifiers other than the IC-PW2. To use the IC-7760 DPD with IC-PW2, connect a suitable cable between the ALC jacks on the IC-7760 and PW2, and follow the adjustment procedure described in the *Advanced Manual*. Adjustments are performed for each band at 500 W and 1000 W.

Transmit audio is adjustable with bass and treble settings in the menus. There are separate tone control settings for SSB, AM, and FM. SSB transmit bandwidth menu choices are **WIDE** (100 – 2,900 Hz), **MID** (300 – 2,700 Hz), and **NAR** (500 – 2,500 Hz), with adjustable high and low cutoff frequencies.

AM transmit power is adjustable from 0.25 to 50 W. As with the other modes, you can pre-set three AM receive filters with a maximum bandwidth of 10 kHz. The notch filter and twin passband tuning filters are effective in AM, and the AGC menu offers a wide range of adjustments for that mode. An interesting feature is **AUTO TUNE**, which automatically dials in a station if you tune close to the signal and press the button.

The IC-7760 is ready for 10- or 6-meter FM operation. For repeater operation, split-frequency offsets can be set in a menu. CTCSS tone encoding and decoding are available for repeater access, and you can use the tone scan feature to find the tone frequency in use. It's always fun to try 10-meter FM when the band is open.

Voice message memories are available in SSB, AM, and FM modes, with messages stored on an SD card. You can record up to eight messages for transmission, with a maximum recording time of 180 seconds per

Lab Notes

Beginning with this review, we are making a few changes to data reported in Table 1, the Key Measurements Summary, and the figures — all in line with the start of the Clean Signal Initiative (CSI) program. See "The Launch of the Clean Signal Initiative" for a discussion of the changes in detail, as well as a description of the CSI program.

The Icom IC-7760 was a pleasure to test here in the Lab. The same conveniences that apply to operating the unit in the shack (built-in power supply, remote control head) all made it enjoyable to test as well. It performed well with our test suite, and the results in Table 1 show across-the-board improvements on the performance of the excellent IC-7610. Both sensitivity and large signal handling were outstanding, with the radio maintaining its composure even when presented with very large test signals. Our tests are designed to push a receiver to extremes, even overload, and the only indication of the IC-7760 reaching the onset of overload was a front-panel indicator; audio quality was not impacted. Based on our test results, the transceiver should be a great contest radio.

From an RF perspective, the big news for the IC-7760 is the inclusion of Icom's digital DPD, which greatly reduces transmitter intermodulation products for voice modes like SSB and AM. Speech consists of multiple audio frequencies transmitted simultaneously, and these frequencies can mix together during transmission, generating additional undesired signals (called "intermodulation products") due to non-linearities in the transmitter's circuitry. Radio designers go to great lengths to make the transmitter's IMD products as small as possible with careful circuit design, especially of the power amplifier. Icom's DPD system takes this a step further; at the factory, the transmitter's distortion characteristics are modeled and applied "in reverse" by the IC-7760's DSP during transmission, thus dramatically reducing these IMD products. A quick glance at the transmitter IMD values in Table 1 confirms the significant improvement over a typical transceiver without this feature. The reduction in IMD products generally reduces a transmitter's total transmission bandwidth, making the IC-7760 a better neighbor on the air. In addition, expect clearer transmitted audio and less fatigue for the op on the other end of your signal. By the way, transmit IMD products are not generated for single-frequency modes like CW, so DPD does not offer any improvement for CW operating.

Though not new, the IC-7760 also includes the latest version of "IP+," Icom's implementation of dithering for receiver IMD improvement, and it works quite well. Table 1 indicates superior receiver IMD response with IP+ enabled. Depending on the band, enabling IP+ can reduce sensitivity by a couple of dB, though in most cases the presence of band noise will make this reduction in sensitivity a moot point.

— Rick Ciervo, W1CIE, ARRL Senior Laboratory Engineer



Visit the ARRL Learning Center at **https://learn.arrl.org/courses/125968/video_presentations/396237** to watch a members-only video of the Lab's test results.



Figure 6 — The RTTY decoder screen expanded version shows decoded text in green, transmitted text in red, and transmit/receive transitions in blue. I programmed the transmit memories with a CQ message and my exchange for the Makrothen RTTY Contest, and used a USB keyboard to enter the other station's call sign and other variable information. Buffered text to be transmitted would be shown in the lower portion. The tuning indicator on the right offered a fast response and made it easy to tune in stations. You can switch to a smaller decode window that allows room for a compact version of the band scope.

memory. You can name the memories and transmit using buttons on the **VOICE TX** screen. If you have a keyboard connected, you can play the memories using function keys. Voice memory level is adjustable so you can set it to match your microphone.

CW Operation

The IC-7760 supports full break-in (QSK) or adjustable delay, semi-break-in operation. The transmit-receive switching is silent. The built-in keyer can be adjusted from 6 to 48 words per minute. Eight message memories store 70 characters each and can include incremental serial numbers for contests. The keyer **EDIT** menu brings up an on-screen keyboard to edit memory content. You can send the memory content from the **KEYER SEND** screen or use function keys on an external USB keyboard.

Digital Modes

The IC-7760 has a lot to offer for digital mode operators. The simplest setup is using the transceiver's USB port and USB driver to connect with the radio's internal sound card for digital modes such as FT8, PSK, AFSK RTTY, or SSTV. You can also enable FSK RTTY keying using the **USB SEND/KEYING** menu. It took just a few minutes to set up *WSJT-X* software for the IC-7760, select **USB-D** mode, set the audio levels, and begin making contacts.

You can also connect a computer to the IC-7760 radio through the **ACC 1** connector on the rear panel or the **LINE IN**, **LINE OUT**, and **SEND** jacks. Connections for audio in and out, transmit-receive switching, and FSK RTTY keying are available.

The IC-7760 has an internal decoder for RTTY and PSK31 or PSK63 that works in concert with transmit memories and/or an external USB keyboard. This feature is great for DXing, making a few contest contacts, or casual conversations. Figure 6 shows the RTTY decode window with tuning indicator at the right. You can choose a screen with six decode lines and a compact spectrum scope above, or an expanded decode window with 11 lines.

You can use a USB keyboard to program eight message memories for RTTY or PSK, which are sent by pressing the corresponding function key on the keyboard or an on-screen button. You can use the keyboard and/or memories to compose your next transmission, and then press F12 to toggle transmit on and off. Whatever received and transmitted text appears on the screen can be saved to a log file on the SD card. The log is not formatted and requires transcription to a logging program for submission to Logbook of The World® or a contest sponsor.

On the Air

I enjoyed using the IC-7760 for several months. It was a pleasure to explore the radio's capabilities on all bands from 160 through 6 meters using SSB, CW, RTTY, and FT8/FT4. Despite the radio's vast feature set, I quickly got comfortable with the user interface. In addition to casual operating, I used it in several contests, including the CQ World Wide CW and SSB events. The extensive filtering and band scope options, along with dual-watch capability, made it easier to pick out weak signals on crowded bands. Transmit audio received high marks after tailoring the transmit tone and speech processor settings for my voice and microphone. Additional testing results are available online at *QST* in Depth (**www.arrl.org/qst-in-depth)**.

Final Thoughts

The IC-7760 is a full-featured transceiver with a wide range of features and excellent receive and transmit performance. Its DPD technology is a big step toward cleaner SSB signals, allowing stations to operate more closely without causing interference to nearby frequencies. The innovative packaging makes the most of available desk space and allows a number of remote and local station configuration options. Although the transceiver has myriad settings and adjustments, the controls and menus are well thought out and easy to access. Default settings are generally good, so you can start using the radio right away while perusing the manual for more details.

Manufacturer: Icom America, 12421 Willows Rd. NE, Kirkland, WA 98034, **www.icomamerica.com/amateur**. Price: $7,000.

See *QST* in Depth for More!

Visit www.arrl.org/qst-in-depth for the following supplementary materials and updates:

- ✓ Additional testing results
- ✓ A link to a video of ARRL Lab Digital RF Engineer John McAuliffe, W1DRF, discussing the Icom IC-7760's networking capabilities.

QRPworks SideKar Decoder Edition

Reviewed by Charles "Chip" Veres, KM4SJN
km4sjn@arrl.net

The QRPworks SideKar for the Elecraft KX2/KX3 and K3/K3S radios was reviewed in the November 2017 issue of *QST*. The SideKar Decoder Edition is compatible with more radios, including the CAT interface to the Icom IC-705 via Bluetooth.

In the May 2024 issue of *QST*, I reviewed the *MRP40* CW software. *MRP40* is a program for Windows that sends and receives Morse code. The SideKar Decoder Edition does the same thing, but in hardware. No computer is necessary to use it. It is small, rugged, light, and suitable for portable operation.

Sensitivity and Bandwidth

The SideKar audio input is peaked at 700 Hz. At that frequency, any signal above 10 mV at the headphones will decode, and 100 mV will give a more realistic headphone level. I highly recommend the headphone splitter so you can hear what you are doing. It is a $4.50 accessory, or you can make your own. The audio frequency response extends from 545 to 965 Hz at the –6 dB points, giving a total bandwidth of 420 Hz. That is fine for general CW work. These measurements were taken with a Polarad 336.3019.32 signal generator and a Signal Electric hand key from the 1920s.

Receiving W1AW

The SideKar was able to receive W1AW code practice at every speed they sent. Oddly, it seemed to be more comfortable at higher speeds. Thirty-five WPM was no challenge for it. At lower speeds, W1AW uses the Farnsworth method of sending letters quickly with extra space between them. Sure enough, the SideKar puts a word space between every letter. Every decoder I have tried (except human ears) has this questionable feature.

Getting in Tune

The SideKar does not have a tuning indicator. On my Icom IC-7100, I did two things to deal with this situation. I set the CW high-pass filter to 500 Hz and the CW low-pass filter to 1 kHz. Also, I set the combined sidetone and CW offset control to 700 Hz. I have an antenna switch that dumps the transmitter into a dummy load in case I want to hear the sidetone without creating interference.

The Keyboard

The keyboard supplied by QRPworks is a 2.4 GHz wireless keyboard from Tecknet. The (tiny) dongle to plug into the SideKar has its own place in the battery compartment. There is also a small, black on/off switch. This keyboard runs on two AAA batteries. The SideKar and keyboard are shown in the lead photo. There is a smaller keyboard available for backpacking operations.

Setting the Date and Time

The first thing I wanted to do after connecting the keyboard was to set the date and time. Alt-D on the keyboard is supposed to do that. Instead, it brought up a screen that says **ENTER SN:** and stuck there. I sent another email to Shel, KFØUR, at QRPworks. He promptly replied and told me to enter a specific code and the serial number of the SideKar. That got it working, and I was able to set the date and time.



A Real Test

I used the SideKar to log a few contacts in the IARU DX contest. On 10 meters, there was no problem. On 15 meters, again there was no problem. But on 20 meters, the band was so busy that the bottom 50 kHz had three stations on every kHz, all calling CQ. Not only was this too much for the decoder in the SideKar, but it's also too much for any decoder.

Under normal conditions (not in a contest), the SideKar does fine both transmitting and receiving. Like all automated CW equipment, it does best receiving signals generated by other computers. But in a bench test, it got above 90% of my hand-sent CW, and my fist is nothing to brag about. Again, an interfering station within 400 Hz of the one you intend to receive will stop the parade. You must cut it out with your rig's notch filter. The SideKar can't discriminate by pitch and speed like your ear can.

Useful Downloads

At least five useful files are available at **www.qrpworks.com**: the user manual for the SideKar itself, a message management utility (see Figure 7), an ADIF export utility, and the PDF manuals for the message utility and the ADIF utility. The utilities work with both Windows and MacOS. The message utility allows you to create and store several whole groups of messages and swap them at will with the 20 messages stored in the SideKar.

The SideKar has a micro-USB to communicate with the outside world. I thought, "No problem, I've got a couple of those cables laying around." So, I started the

Bottom Line

This QRPworks SideKar accessory is a good portable CW decoder for SOTA or POTA activation, and it is compatible with many radios.

ADIF export utility on my computer and tried to download my log. No action. With investigation I found out that some micro-USB cables are only for charging and lack the data conductors. I got a real USB cable and solved the problem. On Windows 10, the export utility puts the ADIF file in your **DOCUMENTS** folder.

Additional Details

The SideKar is a compact CW companion featuring a full-featured internal keyer that works with any paddle and uses the **KEY OUT** port to the rig's paddle input, or you can send CW directly from a keyboard. Its built-in logger can store up to 1,000 QSOs in the field and includes a time-saving feature that lets you insert a call sign into a canned message from the paddle or keyboard, automatically capturing it in the log — an especially useful feature for POTA, SOTA, and Field Day operations. In addition, the LCD display remains readable in full sunlight while offering an adjustable backlight for night use. The SideKar Decoder Edition can also be used as a training tool for learning to copy and send CW.

Conclusion

As I found out with my Icom IC-7100, the SideKar will work with any radio capable of sending CW, but connecting it to some rigs brings extra features — specifically, the Elecraft KX2/KX3, the Yaesu

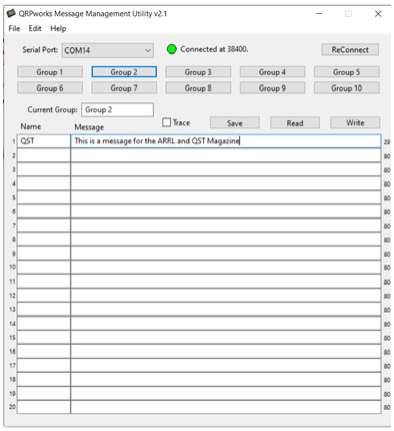


Figure 7 — The QRPworks SideKar screenshot of the message management utility at work.

FT-817/818/857/897, the QRP Labs QCX family, and the Icom IC-705. The Icom requires a Bluetooth adapter that is $50 from QRPworks. If you make the digital rig connection, you can record macros to change frequency, band, and mode from the keyboard. Also, if the rig has a built-in CW or PSK decoder, you can see its output on the SideKar screen.

Manufacturer: QRPworks, 2505 Kinderhook Ln., Colorado Springs, CO 80919, **www.qrpworks.com**. Price: starts at $349 with different packages available.