Product Review Column from *QST* Magazine

January 1990

ICOM IC-781 160- to 10-Meter Transceiver

Conducted By James W. Healy, NJ2L
Assistant Technical Editor

ICOM IC-781 160- to 10-Meter Transceiver

Reviewed by Mark J. Wilson, AA2Z

One thing's sure about the IC-781: It made me a popular guy. There aren't that many $6000 transceivers out there, and the '781 is a real attention-getter. Whenever I mention that I'm checking out a '781, people ask, "What's it like?" or, "Is it really worth $6000?" or similar questions. When I took the radio to KY1H's house for a DX contest, everyone wanted to see it and give it a try. Even some jaded HQ staffers wanted to take the radio home to play with.

As with most high-end gear, the IC-781 has a long list of standard features. For starters, you can't miss the 5-inch amber CRT in the center of the front panel. Other not-so-obvious features are a new synthesizer using DDS (direct digital synthesis) techniques, a fast internal antenna tuner, memories and scanning galore, a sensitive general-coverage receiver, a built-in power supply and iambic keyer, and 500- and 250-Hz CW filters.

The IC-781 is big and heavy. Approximately the same size as the IC-761, the '781 is definitely a desktop radio. Weighing in at 51 pounds, it's not the right thing to buy for mobile or portable operation. The transceiver uses ac mains power only; there is no provision for 13.8-V dc operation (its final-RF-amplifier transistors operate at 28 V). If you like, you can attach the rack handles included in the accessories box for that high-tech look.

Front-Panel CRT

The first question most people ask is, "What does the CRT do?" The short answer is, "A lot." You can see sample CRT screens in the title photo and Fig 1.

Frequency and Mode Display

The top half of the screen, displaying frequency and mode information, is pretty straightforward. The following information is displayed for VFO A and VFO B: frequency (to 10 Hz); mode (**LSB, USB, CW, RTTY, AM, FM, DATA**); filter selection (**WIDE** or **NAR**row); and transmit and/or receive offset (to 10 Hz). **XMIT** is displayed next to the VFO you're transmitting on; this is usually VFO A—unless you're operating split, in which case the **XMIT** indicator moves next to the VFO B information. The **XMIT** indicator is highlighted when the '781 is transmitting. Also displayed is memory information, showing the selected memory number and the frequency, mode and filter selections stored in that memory. Information for the VFO (or memory) in use is displayed in a larger, bolder size than that for the second VFO, reducing confusion. I really like having all the information for both VFOs available at a glance.

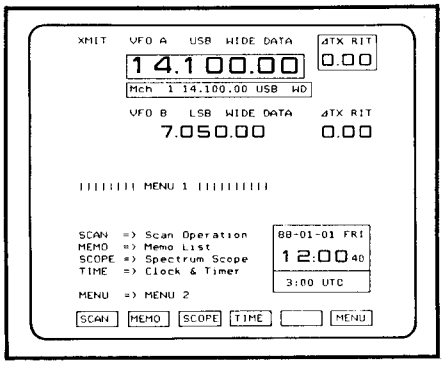


Fig 1—This view of the Menu 1 screen on the IC-781's multifunction CRT gives a hint of the variety of information it can display on its 17 different menus.

The Rest of the Display

The bottom half of the display is more complicated, because there are 17 different menus. Understanding the display is easier if you're familiar with basic computer operation and terminology. Fortunately, the manual devotes 13 well-illustrated pages to the menu displays.

Immediately below the CRT is a row of six function keys, **F-1** to **F-6**. Their functions change depending on the menu in use; highlighted labels on the CRT immediately above the keys tell what their current functions are.

F-6 always brings you back to the previous menu. There are two main menus. From Menu 1, **F-1** gets you into the scan controls. **F-2** brings you to the memory list, so you can see the frequency, mode and filter information stored in each of the 99 memories. I'll cover these screens in detail in "Memories and Scanning."

F-3 changes the lower half of the display to a spectrum scope—think "panoramic adapter"—that allows you to see signals ±25, 50 or 100 kHz from the frequency you're listening to. The scope also displays your transmitted signal, but there isn't enough detail to be able to tell if you're splattering. At first, I thought that the spectrum scope was a gimmick. After using it a while, though, I did find it useful. Although you can't really see lots of individual signals except on a quiet band, I found that I could quickly check to see whether a band was open, find a relatively clear area for CQing during contests or find pileups on DX stations.

F-4 gets you into the IC-781's elaborate clock and timer system. When either of the main menus or the clock/timer menu is selected, a box at the right of the screen shows the settings for the main clock and the secondary clock. The main clock display shows the current time (to the second), the day and date. The display for the secondary clock shows the time (hours, minutes only), and a user-programmable note. I set the main clock to UTC and the secondary clock to local time (with EST or EDT for the note). When other CRT functions are using the entire lower half of the screen, a small highlighted box immediately below the VFO B line shows the current main-clock time.

The '781's timer functions are reminiscent of those found on home electronics equipment. In the **SLEEP** submenu, you can program the radio to shut off after a defined period from 0 to 90 minutes, or you can program it to shut off at a specific time. In the **TIMER** submenu, you can program the IC-781 to turn on and off at up to five preset times, and to tune to a specific memory channel for those five periods. For

example, if you want to hear a WWV propagation forecast, you can program the IC-781 to turn on Monday at 1818Z, tune to memory channel 1 (which you've previously set to 10.0 MHz, AM, wide filter) and turn off at 1819Z. (It's like programming a VCR to tape your favorite programs while you're away.) In addition, the IC-781 has a control output for operation of a tape recorder.

When Menu 2 is selected, **F-1** brings up the **TERMINAL MONITOR** mode. In this mode, the bottom half of the CRT displays ASCII data sent to the **DATA-IN** jack on the rear panel. For example, you can display Baudot RTTY from a communications processor that has an RS-232-C output. I did not try this feature.

From Menu 2, **F-2** is used to set the parameters for ICOM's CI-V communication interface system. With the optional CT-17 level converter, you can control a number of the IC-781's functions from a personal computer. For example, programs such as Ken (K1EA) Wolff's *ConTest,* allow you to set the '781's operating frequency from the computer keyboard.

Menu 2, **F-3** allows you to choose the default filter selection (wide or narrow) for each mode. I set the defaults for narrow on all modes. It isn't possible to use the "AM wide" (6-kHz) filter in the IC-781's heterodyne-detected modes (CW, SSB, RTTY).

F-4 allows you to turn the band-stacking registers on and off. With this function enabled, the '781 goes to the last-used frequency when you return to a band. For example, if you are on 28.035, switch to 40 meters and tune to 7.233, and then switch back to 10 meters, you'll end up back on 28.035. With the band-stacking registers off, you'd end up on 28.233 MHz. Filter and mode selections are also stored in the band-stacking registers.

External Video Monitor

If you have a hard time reading the CRT on the '781's front panel, you can connect an external monitor. Video output (1 V P-P, 75 Ω) is available at the **DATA IN** jack on the rear panel. It works with any NTSC-type TV set with a video-input jack. The IC-781 drove an ARRL HQ Apple® //e monochrome monitor flawlessly.

Frequency Control

The IC-781's frequency display resolves frequencies to the nearest 10 Hz (0.01 kHz). An optional voice synthesizer provides audible confirmation of operating frequency. The frequency display indicates the carrier frequency in AM, FM, SSB and CW modes (CW signals must be tuned to the proper pitch for display accuracy); the mark frequency is indicated in the RTTY mode. The rig stays tuned to the same carrier frequency when changing modes.

The IC-781 has two VFOs and is capable of split-frequency operation. You can change frequency by turning the main tuning knob, or by entering a frequency directly on the keypad to the right of the CRT.

The radio tunes in 10-Hz steps at its slowest speed. Tuning speed is a comfortable 5 kHz per revolution, and it can be changed to 2.5 kHz per revolution by means of an internal switch. When you turn the tuning knob rapidly, the tuning rate steps up to 25 kHz per revolution. For large frequency excursions, 500 kHz per revolution (1-kHz steps) is available when **TS** (tuning speed) has been pressed.

A **LOCK** switch inhibits the main tuning dial (but not the keypad) to prevent an accidental QSY. (An internal switch causes the **LOCK** switch to inhibit the keypad as well.) The large main tuning knob is weighted and has a silky smooth feel. The manual shows how to adjust the tension on the tuning knob shaft to suit individual preferences.

If you need to go to a specific frequency, the fastest way to get there, generally, is by using the numeric keypad. For example, if you want to QSY to 14.195 MHz, press **1 4 . 1 9 5 ENT**er (You could also press **1 4 1 9 5 0 0** and avoid hitting the decimal key.) You don't have to enter trailing zeroes; entering **1 4 . 1 ENT**er brings you to 14.100 MHz. Similarly, if you want to move around in the same MHz range, start your entry with the decimal point. If you're on 28.025 MHz and want to QSY to 28.885, entering **. 8 8 5 ENT**er will get you there.

The keypad also serves as the band switch. Pressing the **CE** (clear entry) button toggles the keypad between band-switch and frequency-entry modes. Each of the digit keys (**0-9**) has two labels. When the keypad-entry mode is selected, yellow and red lighted labels show up in the center of each key. When the band-switch mode is selected, the lighted labels disappear, and you go by the white labels screened onto the upper left corner of each key. For example, the **1** key also selects 1.8 MHz, the **2** key, 3.5 MHz, and so on. It's a lot easier to read the lighted labels than the screened labels.

The VFO controls are arranged in a vertical row just to the right of the CRT. If you press the **A** button, you select the upper displayed frequency on the CRT. If you press the **B** button, you select the lower displayed frequency. When you have selected a VFO (A or B), you can change its frequency, mode and filter choice. So far, so good—now for the part that takes some getting used to.

Say you're listening to a rare DX station, working by call districts, on 10 meters. While waiting for him to get to your call area, you're listening to a local 75-meter net. You've got VFO A set to 3.925 MHz LSB and VFO B set to 28.345 MHz USB. This kind of operation is one reason we buy radios with two VFOs, right? On most radios, you'd press **A** to listen to the 80-meter net and **B** to listen to the 10-meter DX station. Not on the IC-781: *The IC-781 always transmits and receives on VFO A* (the upper displayed frequency) *unless you have selected split-frequency operation.* You must press the **CHANGE** key to swap the contents of VFO A and VFO B. This system takes some getting used to, but it works fine. One thing to watch out for, though: The **A=B** key makes the frequency, mode and filter settings of the other VFO identical to the *selected* VFO. This can be a problem if you want to make VFO B the same as VFO A—the VFO you're listening to—but have selected VFO B.

Split-frequency operation is accomplished by pressing the **SPLIT** switch. The controls are set up so that you always listen on VFO A and transmit on VFO B during split-frequency operation. You can press the **XFC** button to listen to your transmit frequency during split operation.

There are two sets of offset-tuning controls, one for each VFO. Offset range is ±9.99 kHz. In addition to the usual RIT, **ΔTX** (transmitter offset) and offset **CLEAR** controls, there's a momentary contact push-button switch called **+Δf**. This switch adds the offset (+ or −) to the VFO frequency, then resets the offset to zero.

Memories and Scanning

The IC-781's 99 memories store operating mode, filter selection and frequency. All 99 memories are tunable, so it's sort of like having 99 other "VFOs" in addition to VFO A and VFO B.

Memories can be selected by using the **MEMORY-CH UP/DOWN** buttons on the front panel, from the keypad, or from the **MEMO LIST** menu on the CRT. The front-panel controls are similar to those found on other radios: **M-WRITE** enters the contents of the selected VFO into the selected memory; **M-CLEAR** clears the selected memory; **VFO/MEMO** toggles between VFO and memory modes; and **M-VFO** reads the contents of the selected memory into the selected VFO.

The **MEMO LIST** menu is a useful feature. It allows you to scroll through the memories to see what's programmed into all 99 channels. You can select or clear a memory once you've found what you're looking for, and you can store a 10-character note with each memory channel.

Scanning

The IC-781's scanning features are amazing. All scanning functions are programmed from within the **SCAN OPERATION** menu on the CRT.

- In *programmed scan,* you set two frequency limits, and the IC-781 scans between them. Scanning stops when a signal breaks the squelch. Scanning speed is set by the **SCAN SPEED** control on the front panel. If you want the '781 to automatically continue scanning after stopping, press the **RESUME** button and adjust the **DELAY** control. In *fine programmed scan,* scanning slows down—but does not stop—when a signal opens the squelch.
- In *ΔF scan,* the '781 scans a selected area around the operating frequency. Choices are ±2.5, 5, 10, 20 and 50 kHz. In *fine ΔF scan,* scanning speed slows

down, but does not stop, when a signal breaks the squelch.

• In *memory scan,* the '781 scans all but the empty memory channels.

• *Selected memory scan* allows you to scan the memory channels in selected groups (you can program up to 9 different groups). For example, to check propagation, you could program all of WWV's frequencies into memory, assign them to group 1, and scan them. Note that you can assign memory channels to scan groups in any order you want (group 1 could be memory channels 2, 16, 37 and 85, for example) and change them at any time from the **MEMO LIST** menu.

Receiver

The IC-781 employs a quadruple-conversion scheme for SSB, CW, RTTY and AM, and triple conversion on FM. Intermediate frequencies of 46.51 MHz, 9.0115 MHz, and 455 kHz are used on FM, and a fourth IF of 10.695 MHz is employed in all other modes.

Signals can enter the receiver chain either from the SO-239 **ANT**enna connector or through the **RECEIVE ANT IN** phono jack, allowing use of separate receiving and transmitting antennas. Signals then pass through a filter (switched bandpass filters above 1.6 MHz, low-pass filters below 1.6 MHz). After filtering, signals travel directly to the first mixer (actually one of two mixers—see "Dual Watch"), to a switchable attenuator, or to a preamplifier.

Attenuator choices are 10, 20 or 30 dB —more than adequate for any conditions I encountered. The 10-dB-gain preamplifier is especially helpful on 10 and 15 meters. As shown in Table 1, sensitivity improves without sacrificing much strong-signal-handling capability. On many occasions I used the preamp to copy weak signals during crowded contest conditions. Although strong nearby signals sometimes caused the preamp to fold, more often than not, copy improved on the weak signals I was trying to hear.

Dual Watch

Naturally, a $6000 transceiver must offer some receiver feature that other rigs don't. In the '781, that feature is "Dual Watch." Dual Watch allows you to listen to two frequencies—one in VFO A, the other in VFO B—simultaneously. During Dual Watch operation, signals pass through the front-end filters and attenuator/preamp, and into two separate, identical first mixers. One mixer uses PLL A (VFO A) for its local oscillator; the other mixer uses PLL B (VFO B). Both signals then enter the post-mixer filter and travel through the rest of the receiver together.

The front-panel **BALANCE** control allows you to adjust the signal gain for the right balance between the two Dual Watch signals. (**BALANCE** actually controls the attenuation of two PIN-diode π attenuators in the first-mixer circuitry.) Turning the **BALANCE** control counterclockwise increases the attenuation on the VFO B mixer (making the VFO A signal louder), and vice-versa.

Dual Watch has limitations: (1) Both VFOs should be set to the same band, because the bandpass filter selected for the frequency in VFO A is in line for both signals; (2) The operating mode and filter choices are the same for both signals. (The only separate circuitry for the two signals is in the first mixer.) Dual Watch is *not* the same as having two rigs in the same box. For example, you can't transmit on both VFOs at the same time, listen on different bands and modes simultaneously, nor can you listen to one frequency while transmitting on another. Dual Watch *is* helpful, though: For example, during contests I could run stations on the main VFO while hunting for multipliers elsewhere on the band with the second VFO.

Flexible Filters

The '781 offers a number of different filter combinations. The radio comes from the factory with the following bandwidths: 6.0 or 2.6 kHz for AM; 2.4 kHz for SSB; and 2.4 kHz, 500 Hz and 250 Hz for CW and RTTY operation. FM operation uses a 15-kHz bandwidth. You have the choice of wide and narrow filters on AM, CW and RTTY (a wide SSB filter is optional). When you change modes, filter settings default to the choice you made from the **IF FILTER PRESET** menu on the CRT. You can change the filter settings at any time with the front-panel **WIDE** and **NAR** buttons. On CW and RTTY, you can also switch in 250-Hz filters in the 9-MHz and 455-kHz IFs (these filters may be used separately or together).

Other Receiver Features

The '781 offers three features, in addition to the IF filters, that really help on today's crowded bands. These features are passband tuning (PBT—actually variable-bandwidth tuning), a notch filter in the 10.695-MHz IF, and an audio peak filter (APF). The **PBT** and **NOTCH** controls function in all modes but FM, and the **APF** control works only on CW.

The IC-781 has "twin" PBT. One front-panel **PBT** control is for the 9-MHz IF; the other is for the 455-kHz IF. **PBT** narrows the passband from either the high side or the low side, and is very helpful for reducing QRM.

When the audio peak filter is switched in, you can use it to adjust the peak response of the audio filter between 500 and 1000 Hz. Although this filter sometimes helps reduce QRM and noise, I didn't use it much.

Four controls are used for the noise blanker. The **NB** switch activates a noise blanker that is fairly effective against ignition and power-line noises. This blanker works most of the time, but it has a hard time with the line noise I get on cold, dry, winter days. The '781's blanker is more effective than most, though. **NB LEVEL** varies the threshold of the blanker. **NB WIDE** is used for noise with long-duration pulses, such as the Soviet "woodpecker" over-the-horizon radar. Again, this blanker is effective much, but not all, of the time. The **BLK-WIDTH** is used to help remove echo noise from the woodpecker. Receiver dynamic range is degraded when the noise blankers are in operation—an effect common to most receivers.

The AGC in the '781 is excellent, a trait common to newer ICOM radios. What sets the '781 apart, though, is that the release time is continuously variable from the front-panel **AGC** control. Most other radios offer you a choice of two fixed release times, one fast and one slow. For casual SSB work with strong signals, I used a slower release. AGC action is smooth, and signals are easy to listen to. For CW and for SSB contesting and DXing, though, I set the AGC control for the fastest release time. The AGC doesn't thump, even at the fastest settings. Also, like the IC-761, the IC-781's AGC has depth. Strong signals sound louder than weaker ones, making it easier to dig out weak signals sharing the passband with stronger ones.

Transmitter

The '781's transmitter section deserves special mention because it produces more than 160 watts of *clean* power on all bands, thanks to 28-V finals and superior filtering. Typical numbers are shown in Table 1, and spectral photos are shown in Figs 2 and 3. Operating at its rated 150 W output, the '781's third-order IMD products are down 37 dB worst case (14 MHz). Harmonics and spurious radiation are down more than 60 dB on all amateur bands.

QRP fans will be happy to know that the IC-781's minimum power for CW, RTTY and SSB (with the compressor on) is in the milliwatt range. The **DRIVE** and **RF PWR** controls work together to allow smooth setting of output power anywhere from less than 1 W to more than 160 W.

The transmitter is SWR-protected. Power starts to fold back slightly when the antenna SWR reaches 1.3:1 or so. At 1.5:1, power folds back to 100 W, and it's 50 W at 2:1.

Antenna Tuner

The '781's built-in antenna tuner is very much like the tuner in the IC-761. It works on 160 through 10 meters. ICOM claims a matching range of 16.7 to 150 ohms, and a maximum tuning time of three seconds. It's fast!

Like the IC-761, the IC-781 allows you to preset tuner adjustments for your antennas for each band. When initializing these presets, you transmit at low power and let the IC-781 find the right match on its own. Once a match is found, you open a cover on the top panel of the transceiver, flip the **PRESET/AUTO** switch to **PRESET** and adjust a pair of potentiometers (one pair per band) until four illuminated LEDs go out. Repeat the process for each band. From then on, when you change bands, the tuning capacitors move to the preset positions and fine tune from there. The result is an automatic antenna tuner that works quickly and is

Table 1

ICOM IC-781 160-10 Meter Transceiver, Serial no. 1001

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receiver, 100 kHz to 30.0 MHz; transmitter, 1.8 to 2.0, 3.4 to 4.1, 6.9 to 7.5, 9.9 to 10.5, 13.9 to 14.5, 17.9 to 18.5, 20.9 to 21.5, 24.4 to 25.1, 27.9 to 30.0 MHz.	As specified.
Modes of operation: SSB, CW, FM, AM, RTTY.	As specified.
Power requirement: 100 to 120 V ac, 760 VA max on transmit, 150 VA max on receive.	Not measured.
Transmitter	*Transmitter Dynamic Testing*
Transmitter output power: Max 150 W PEP on SSB; 150 W on RTTY and FM; 75 W on AM.	Typically 181 W PEP on SSB; 170 W on CW, RTTY and FM; and 86 W on AM. Power output varies slightly from band to band.
Spurious-signal and harmonic suppression: >60 dB below peak power output.	See Fig 2.
Third-order intermodulation distortion products: Not specified.	See Fig 3
CW-keying waveform: Not specified.	See Fig 4.
Transmit-receive turnaround time (PTT release to 90% audio output with an S9 signal): Not specified.	25 ms, typ.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity (preamp on)	
SSB, CW and RTTY: (bandwidth not specified) <0.5 μV for 10-dB S/N from 0.1-0.5; <1 μV for 10-dB S/N from 0.5-1.8 MHz; <0.16 μV for 10-dB S/N from 1.8-30 MHz.	Minimum discernible signal (noise floor) with 500-Hz filter: *Preamp off:* 1.0 MHz, −129 dBm; 3.5 MHz, −137 dBm; 14 MHz, −134 dBm. *Preamp on:* 1.0 MHz, −129 dBm; 3.5 MHz, −141 dBm; 14 MHz, −140 dBm.
AM: (6.0-kHz bandwidth) <3.2 μV for 10 dB S/N from 0.1-0.5 MHz; <6.3 μV for 10 dB S/N from 0.5-1.8 MHz; μV for 10 dB S/N from 1.8-30 MHz.	6.0-kHz bandwidth test signal 30% modulated with a 1-kHz tone, preamp on: 1.0 MHz, −114 dBm (0.44 μV); 3.8 MHz, −125.5 dBm (0.12 μV); 14 MHz, −126 dBm (0.115 μV).
FM: (bandwidth not specified) <0.23 μV for 12 dB SINAD from 28-30 MHz.	0.21 μV for 12 dB SINAD at 29 MHz.
Receiver dynamic range: 100 dB (preamp on), 105 dB (preamp off).	Blocking dynamic range†: *Preamp off:* 3.5 MHz, 134.5 dB; 14 MHz, 134 dB. *Preamp on:* 3.5 MHz, 132.5 dB; 14 MHz, 132.5 dB.
	Two-tone, third-order intermodulation distortion dynamic range†: *Preamp off:* 3.5 MHz, 101 dB; 14 MHz, 102 dB. *Preamp on:* 3.5 MHz, 97 dB; 14 MHz, 99.5 dB.
	Third-order input intercept: *Preamp off:* 3.5 MHz, 14.5 dBm; 14 MHz, 19 dBm. *Preamp on:* 3.5 MHz, 4.5 dBm; 14 MHz, 9 dBm.
S-meter sensitivity (for S9 reading): Not specified.	42 μV at 500 kHz; 24 μV at 3.5 MHz; 30 μV at 14 MHz.
FM squelch sensitivity (28-30 MHz): <0.23 μV.	Preamp off: min, 0.1 μV; max, >0.3 V. Preamp on: min, 0.06 μV; max, >0.3 V.
Notch filter attenuation: >45 dB.	>30 dB.
Receiver audio output: >2.6 W at 10% distortion with 8-Ω load.	3.25 W at 10% total harmonic distortion (THD) with an 8-Ω load.
Receiver IF/audio response: Not specified	200-2875 Hz at −6 dB.
Size (height, width, depth): 5.9 × 16.7 × 16.2 inches; weight, 51 lb. Color: Black.	

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

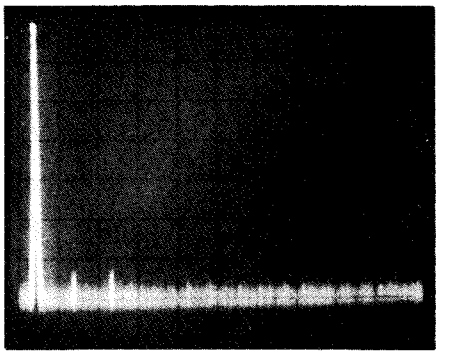


Fig 2—Worst-case spectral display of the ICOM IC-781. Horizontal divisions are each 2 MHz; vertical divisions are each 10 dB. Output power is approximately 156 W at 1.9 MHz. All harmonics and spurious emissions are at least 63 dB below peak fundamental output. The IC-781 complies with current FCC specifications for spectral purity.

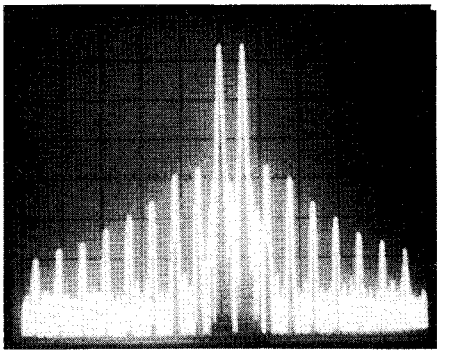


Fig 3—Spectral display of the IC-781 during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 37 dB below PEP output, and fifth-order products are approximately 39 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 2 kHz. The transceiver was being operated at 150 W PEP output on 14.2 MHz.

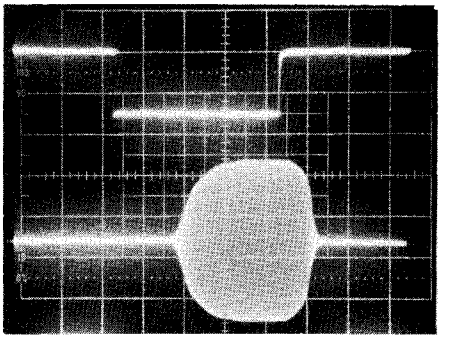


Fig 4—CW-keying waveforms for the ICOM IC-781 in the full-break-in mode. The lower trace is the RF envelope; the upper trace is the actual key closure. Each horizontal division is 5 ms. The IC-781's CW keying is extremely good.

almost transparent to the operator.

CW Operation

With the '781, ICOM introduced a feature that Kenwood owners have enjoyed since the TS-930 was introduced in the early 1980s: a front-panel **CW PITCH** control. This control allows you to vary the CW offset between 400 and 1000 Hz. Sidetone pitch automatically tracks the offset.

Both full-break-in (QSK) and semi-break-in operation are available. QSK operation is smooth, and receiver blanking is excellent. One complaint registered about the IC-761, a choppy transmitted signal in high-speed QSK operation, is much improved in the '781. I used a second receiver to listen to machine-sent CW from the '781 at speeds of up to 50 WPM, and I heard only a slight difference in character length between full- and semi-break-in. You can adjust your keyer weighting slightly to compensate for the shortened characters, but the '781's CW is easily copyable without doing so.

The transmitted CW waveform, shown in Fig 4, is well-shaped. There is no shortening of the first dit during full-break-in operation. On-air listening tests in a second receiver show that the '781's transmitted CW signal sounds great.

The IC-781 offers a built-in iambic keyer. To use it, plug your paddle into the front-panel **ELEC-KEY** jack, adjust the **KEY SPEED** control (range: 5 to 45 WPM) and send away. Keyer weighting is adjustable with an internal control. If you prefer to use your own keyer or straight key, plug it into the rear-panel **KEY** jack just as you would on any other rig.

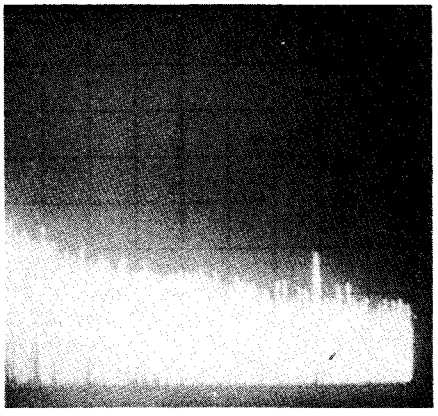
Phone

In addition to the usual **MIC GAIN** and speech-compressor controls, the '781 also offers a **MIC TONE** adjustment. You can use this control to tailor the transmitted audio to your voice and your microphone. It's worth experimenting with the **MIC TONE** control while listening in the monitor to find the best setting. I used a Heil HM-5 microphone and received good audio reports.

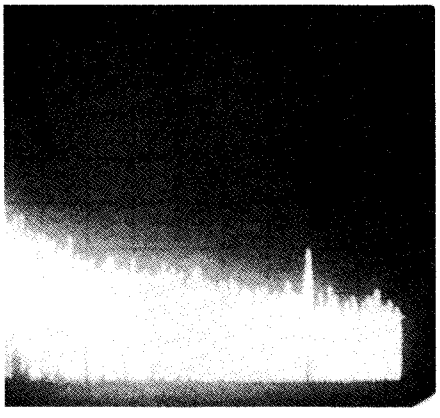
I really enjoyed making a few contacts on 10-meter FM. It's easy to access repeaters: Program the repeater's output frequency into VFO A, its input frequency into VFO B, punch the **SPLIT** button, and you're ready to go. You can monitor the repeater's input frequency by using the **XFC** button. The **TONE** switch enables a subaudible tone, factory set to 88.5 Hz. You can change the tone frequency to any of 38 standard tones by removing the covers and soldering some jumpers on a PC board.

Digital Modes

The '781 features FSK and AFSK operation, and all of the connections you need for your communications processor are available from the **ACC(1)** jack on the rear panel. I had no trouble connecting the '781 to my Tono EXL-5000. For FSK operation, switches inside the rig select 170, 425 or 850-Hz shift, high or low tones, and mark/space polarity.



(A)



(B)

Fig 5—Spectral display of the IC-781 transmitter output during composite-noise testing. Power output is 170 W at 3.5 MHz (A) and 170 W at 14 MHz (B). Each vertical division is 10 dB; each horizontal division is 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 in the photos) 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, which is 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.

For AFSK operation, all connections can be made through the microphone jack on the front panel as well. Pressing the front-panel **DATA** switch disables the mike input, so you can leave your mike connected when using your AFSK equipment with the rear-panel jack.

Synthesizer

As shown in Fig 5, the '781 has one of the quietest synthesizers we've measured in the ARRL Lab. There are no annoying pops, clicks or birdies. I didn't notice any phase-noise problems, even when the bands were filled with strong signals. Lockup time is fast, too: You can operate QSK at any frequency split, and the transmitted signal quality remains excellent. (Earlier ICOM radios had problems with transmitted-signal chirp and instability during QSK operation with frequency splits of more than a kilohertz or two. These problems occurred because the radios switched into transmit before the synthesizer locked.)

Operation

The first thing I noticed when opening the IC-781's box of accessories is that ICOM includes matching plugs for most of the radio's jacks. That sure made connections to the rest of my station a lot easier.

Although the front panel is packed with controls and indicators, important controls have large knobs and are easy to find and grasp. The front-panel layout is easy to get used to—remarkable, considering the number of different things this radio does. I highly recommend that you read the instruction manual, though, to familiarize yourself with the proper operation of the controls.

The amplifier key line terminates in a rear-panel phono jack. The keying relay is rated to handle up to 30 V dc at 1 A or up to 100 V ac at 0.5 A. Be sure to check your amplifier's manual or measure its keying voltage before connecting it to the IC-781. The ALC input is adjustable. It's set to work with amplifiers providing 0 to −4 V dc, so the '781 is compatible with most modern linear amplifiers. Use of the ALC connection is important with amplifiers employing high-mu triodes, such as an 8877 or a pair of 3CX800A7s. Such amplifiers require only 50 to 75 watts of drive for legal-limit output, and the '781 has more than twice that power on tap.

Connection to a VHF or UHF transverter is possible through the rear-panel **X-VERTER** jack. The output to this jack is activated by applying 2 to 13.8-V dc to a pin on the **ACC(2)** jack. If you're creative, it's possible to leave your transverter connected to the '781 and use the **ACC(2)** jack to switch between HF and VHF/UHF operation.

I used the IC-781 extensively on phone and CW during the 1989 contest season. The IC-781's receiver is among the best we've ever tested in the ARRL Lab, and this superior performance is evident in on-the-air use. The receiver is sensitive, especially with the preamp on, and it has impressively high dynamic-range figures. Most noticeable is the fact that the receiver is clean. When the band's full of strong signals, it's still possible to find a clear spot—without having to listen to a lot of low-level mixing products and phase noise found in some other radios.

The extensive memory system, receive-audio **BASS** and **TREBLE** controls, tape-recorder output and on/off control jack,

(continued on page 73)

Product Review

(continued from page 43)

and wide/narrow AM filters make for a versatile general-coverage receiver as well.

I do have two complaints about the IC-781: (1) Its fan, which comes on any time the radio is switched into transmit (and usually after 5 or 10 minutes of receive-only use), is noisy. It's not too much of a problem when you're wearing headphones, but it's annoying in a quiet room. (2) Some of the labels on front-panel push buttons are screened on—not engraved. Consequently, the labels on the often-used **CHANGE** and **XFC** buttons on the review radio have worn off during the review period, leaving shiny, unlabeled keys. ICOM should be able to do better here.

If you've read this far, you've probably guessed that I really like the IC-781. Although it's got a lot of bells and whistles—many of which I don't use a whole lot—the basic radio performance is outstanding. That's what really matters to me. Most hams (including me) won't be spending $6000 for an IC-781, so I'll be especially interested to see if some of its solid basic performance trickles down to less-expensive models like the IC-765.

SOLICITATION FOR PRODUCT REVIEW EQUIPMENT BIDS

[In order to present the most objective reviews, ARRL purchases equipment off the shelf from Amateur Radio dealers. ARRL receives no remuneration for items presented in the Product Review or New Products columns.—*Ed.*]

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.

Henry Tempo 3002A 144-MHz linear amplifier, s/n 60-162 (see Product Review, November 1989 *QST*). Minimum bid: $1645.

Sealed bids must be submitted by mail, and must be postmarked on or before January 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 wish to bid on, using the manufacturer's name, model number, or other identification number, if specified. Each item requires a separate bid and envelope. 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 by telephone to anyone regarding final price or identity of the successful bidder.

Please send bids to Kathy McGrath, Product Bids, ARRL, 225 Main St, Newington, CT 06111. QST