## Product Review

## ICOM IC-728 and IC-729 Transceivers

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Unpacking a new radio is always exciting! There's the anticipation of trying out the latest technology, along with a bit of apprehension over learning how to make the best use of the features. There may even be some concern over finding all the right buttons to make the radio play properly. Mostly, though, the task of setting up a new radio should be *fun*.

ICOM's latest entry-level radios *are* fun. The IC-728 and IC-729 (which join the IC-725 at the low end of ICOM's MF/HF transceiver line) are small, light rigs. We tested an IC-728 and its twin, the IC-729 (an IC-728 with 46.2- to 61.1-MHz receiver coverage and transmit coverage of 50 to 54 MHz). Unless otherwise noted, this review applies to both radios.

#### Features

As the IC-728 is one of ICOM's entrylevel MF/HF platforms, you might expect it to lack features. Although this radio doesn't have all the bells and whistles of the higherpriced rigs, it doesn't lack as much as you might think. The rig receives from 30 kHz to 30 MHz, has a preamplifier and speech processor, flexible memory, VFO and scanning options, an interference-fighting passbandtuning circuit, and several other nice touches. Functions standard on most radios that you won't find in the IC-728 include a VOX circuit, an RF-gain control, a noise-blanker threshold control and complete function metering. In the IC-728, FM transceive operation and AM transmitting are options. (They're standard in the IC-729.)

The uncluttered front panel is ergonomically laid out. There's plenty of room between controls, and most of them are large enough to see and operate easily—even in mobile operation. The exceptions are a few of the push-button controls, which are small, but well-spaced. The adjustable-drag main tuning knob has a very good feel.

In addition to the usual two VFOs, the radio has 26 memories. Each memory stores operating frequency, mode and filter selection. Two pairs of memories also store separate transmit and receive frequencies for split operation. This provides a convenient way to store the operating frequencies you need to chase a DXpedition, for instance, or for storing the input and output frequencies of 10- and 6-meter FM repeaters.

You can easily switch between either VFO or the memories, equalize the VFOs, write a VFO frequency to memory, or put a memory frequency into a VFO—just like high-end radios. The memories are tunable, so you can use one or more as a temporary "scratch pad." You can change the stored



modes and frequencies as though the memories were VFOs.

The VFOs use a band-stacking register to store the last-used frequency, mode and filter information for each band. So, when you change bands, you come back to the same frequency, mode and filter you last used on that band. It's nice to see this feature in an entry-level radio.

Pressing the kHz, MHz or BAND buttons selects the main dial's function. These buttons toggle the functions on and off. A small arrow appears above the appropriate display digit(s) when one of these fast-tuning functions is selected.

Three push buttons select the six combinations of operating modes and filters. The SSB button alternately selects upper and lower sideband; the AM/FM button toggles between these modes; and the CW/N button toggles between the wide and narrow IF filters, if you've installed the optional 500- or 250-Hz CW filter.

Other features include an unadjustable but fairly effective noise blanker; a 20-dB attenuator; an RF preamplifier; fast or slow AGC time constants; and a speech processor. You adjust the processor level with a small front-panel knob. RF output is easily adjusted from about 10 watts to 100+ watts on each band (10 watts on 6 meters—see Tables 1 and 2 for specifics).

#### The Bottom Line

The IC-728 offers solid basic performance and features for its price. A small, lightweight package, it's well suited to mobile and portable operation. The IC-729, essentially an IC-728 with 6 meters, combines the '728's high points with wider receiver coverage, and performs unusually well on the 50-MHz band. With the **RIT** control, you can tune  $\pm 1.2$  kHz from the displayed frequency. Although the displayed frequency doesn't change as you adjust the **RIT** control, you can sum the offset with the VFO frequency by pressing the **FUNC**tion button and then hitting the **RIT** on/off button. So, if you've tuned a station with the **RIT** and want to set your transmit frequency to the same spot, just poke these two buttons, in that order. Zeroing the **RIT** requires you to manually center the knob.

One of the IC-728's most useful features is passband tuning (PBT). On SSB, the PBT control operates like IF shift in other radios. On CW, it varies the IF bandwidth—fully counterclockwise gives minimum bandwidth and fully clockwise gives wide-open selectivity for the selected filter. In both modes the control narrows IF bandwidth, giving interference reduction not available in most rigs in this class.

Because the IC-728 doesn't support FSK operation and thus requires you to use AFSK by feeding audio tones into the mike connector or a rear-panel accessory jack, the **PBT** control is especially useful in R'TTY and AMTOR operation. You set the radio for lower-sideband operation for these modes, so you can only use the SSB IF filter. The **PBT** circuit compensates for this limitation by letting you adjust the passband for minimal interference.

In addition to operating frequency, the main display shows which VFO is selected, operating mode, and memory channel that will be selected if you switch from VFO to memory operation. (This is also the memory that will be overwritten if you hit the **MW** button, so be sure to check the memory contents first to ensure this is the channel you want to use.)

The S meter doubles as an output-power meter during transmitting. The scales are

#### Table 1 ICOM IC-728 MF/HF Transceiver, Serial no. 001683 Manufacturer's Claimed Specifications Measured in the ARRL Lab Frequency coverage: Receive, 500 kHz-30 MHz; Receive, 30 kHz to 30 MHz; transmit, as specified. transmit, 1.8-2, 3.5-4, 7-7.3, 10.1-10.15, 14-14.35, 18.068-18.168, 21-21.45, 24.89-24.99 and 28-29.7 MHz. Modes of operation: AM, CW, FM, LSB, USB. As specified. Power requirement: 13.8 V dc ±15%; receive, 1.6 A max; At 13.8 V, receive, 0.95 A max; transmit, 15 A max. transmit, 20 A max. **Receiver** Receiver Dynamic Testing Receiver sensitivity (10 dB [S+N]/N), bandwidth not specified: Minimum discernible signal (noise floor) with 500-Hz IF filter: SSB and CW, 0.16 µV (-123 dBm). Preamp On -121.5 dBm 1.0 MHz. ~137.5 dBm 3.5 MHz 14.0 MHz -137 dBm -138.5 dBm 28.0 MHz AM (10 dB [S+N]/N, preamp on): 0.5-1.8 MHz, 13 µV (-85 dBm); Signal 30% modulated with a 1-kHz tone: 1 MHz, -105 dBm; 1.8-30 MHz, 2 μV (-101 dBm). 3.8 MHz, --120.5 dBm. FM (12 dB SINAD, preamp on): 0.5 μV (-113 dBm). Blocking dynamic range: Not specified. Blocking dynamic range with 500-Hz IF filter:\* Preamp Off 113 dB<sup>†</sup> 1.0 MHz 3.5 MHz 115.5 dB<sup>†</sup> 122.5 dB<sup>†</sup> 14.0 MHz 28.0 MHz 118.5 dB<sup>†</sup> Two-tone, third-order IMD dynamic range with 500-Hz IF filter:\* Two-tone, third-order IMD dynamic range: Not specified. Preamp Off 1.0 MHz 88.5 dB 3.5 MHz 90.5 dB 14.0 MHz 91.5 dB 28.0 MHz 85.5 dB

Third-order input intercept:<sup>‡</sup> Not specified.

S-meter sensitivity (µV for S9 reading): Not specified.

FM squelch sensitivity: Not specified.

Receiver audio output: 2.6 W into 8 Q (distortion not specified). Receiver IF/audio response: Not specified.

#### Transmitter

Transmitter power output: Adjustable from 10-100 W on CW, SSB and FM; 4-40 W on AM.

Spurious-signal suppression: >50 dB.

Third-order intermodulation distortion products: Not specified. CW keying characteristics: Not specified.

Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.

Composite transmitted noise: Not specified.

Size (height, width, depth):  $3.7 \times 9.5 \times 9.4$  inches; weight, 10.1 pounds.

\*Blocking dynamic range and third-order IMD dynamic range measurements were made at the ARRL Lab standard signal spacing of 20 kHz. <sup>†</sup>Noise limited.

\*Third-order input intercept (dBm) = MDS (dBm) + 1.5 × third-order IMD dynamic range (dB).

fairly easy to read, though the meter is on the small side.

#### Options

As mentioned earlier, the AM transmit/ FM transceive unit is an option in the IC-728 and standard in the IC-729. For 10- or 6-meter repeater operation, you may also need the UT-30 programmable tone encoder to access repeaters that require subaudible-tone encoding.

The CT-17 level converter provides the

interface between a computer's EIA-232-D serial port and the radio. With this interface (or a similar unit<sup>1</sup>) and the appropriate soft-

Several interfaces compatible with ICOM radios are commercially available. Others you radios are commercially available. Others you can build include ones described by Nigel Thompson, KG7SG, in "A Low-Cost PC Inter-face for ICOM Radios," *QST*, Jul 1992, pp 37-38; and Wally Blackburn. AA8DX, in "Everything You Always Wanted to Know about Hardware for Computer-Controlling Modern Radios," elsewhere in this issue. ware, you can select operating band and mode, change frequency and perform other control functions remotely from your computer.

Preamp Off

-121.5 dBm

--128.5 dBm ~128.5 dBm

-128.5 dBm

Preamo On

113 dB<sup>†</sup>

114.5 dB†

120.5 dB<sup>†</sup>

117.5 dB†

Preamp On

88.5 dB

88.5 dB

85.5 dB

Preamp On

11.25 dBm

-4.75 dBm

~2.0 dBm

--10.25 dBm

90 dB

Preamp Off

11.25 dBm

7.25 dBm

8.75 dBm

At 14 MHz: Preamp on, 18 µV; preamp off, 48 µV.

At -6 dB, PBT centered: SSB IF filter, 182-2277 Hz (2095 Hz);

AM IF filter, 64-2200 Hz (2136 Hz); 500-Hz IF filter (PBT at 3 o'clock), 638-1221 Hz (583 Hz); 500-Hz IF filter (Рвт at

Adjustable from 8 to 103 W (CW, SSB, FM); AM, as specified.

As specified. Meets FCC specifications for equipment in its power-

2.8 W into 8 Ω at 10% total harmonic distortion.

Output varies slightly from band to band.

AGC fast: S1 signal, 160 ms; S9 signal, 17 ms.

AGC slow: S1 signal, 17 ms; S9 signal, 17 ms.

--0.25 dBm

At 29 MHz, preamp on: --120 dBm.

9 o'clock), 674-1012 Hz (388 Hz).

output class and frequency range.

Transmitter Dynamic Testing

1.0 MHz

3.5 MHz

14.0 MHz

28.0 MHz

See Fig 1.

See Fig 2.

See Fig 3.

If you plan to use the '728 in a mobile installation (its small size and easy-to-use controls lend themselves nicely to this application), you may want the optional IC-MB5 mobile mounting bracket.

In keeping with the IC-728's budget price, ICOM shaved some extras long con-

# ICOM IC-729 MF/HF/VHF Transceiver, Serial no. 01168 Manufacturer's Claimed Specifications\* Measured in the ARRL Lab Frequency coverage: Receive, 500 kHz-30 MHz and 50-54 MHz; transmit, same as IC-728, plus 50-54 MHz. Receive, 30 kHz to 33 MHz and 46.2-61.1 MHz; transmit, as specified. Power requirement: Same as IC-728. 50-MHz transmit, 3.6 A max. Receiver Receiver Dynamic Testing Receiver sensitivity (preamp on, 10 dB [S+N]/N, bandwidth not specified): 50-54 MHz, SSB and CW. Minimum discernible signal (noise floor) at 50 MHz with 500-Hz IF filter: Preamp on, -141 dBm; preamp off, -137 dBm.

0.13  $\mu$ V (-125 dBm). FM (12 dB SINAD, preamp on): 0.3  $\mu$ V (-117 dBm). Blocking dynamic range: Not specified.

Two-tone, third-order IMD dynamic range: Not specified.

Third-order input intercept:\*\* Not specified.

Transmitter

Table 2

Transmitter power output: 50-54 MHz, adjustable from 1-10 W on CW, SSB and FM; 1-4 W on AM.

Spurious-signal suppression: >60 dB.

Third-order intermodulation distortion products: Not specified. Weight: 10.8 pounds.

\*Except where noted, IC-729 specifications are the same as those for the IC-728.

<sup>t</sup>Blocking dynamic range and third-order IMD dynamic range measurements were made at the ARRL Lab standard signal spacing of 20 kHz.

\*\*Third-order input intercept (dBm) = MDS (dBm) + 1.5 × third-order IMD dynamic range (dB).

sidered standard equipment on MF/HF transceivers. The most obvious of these is a carrying handle; it's optional.

The IC-728 is designed for use with ICOM's automatic antenna tuners. For operating in the 100-W range, the AT-160 MF/ HF tuner (reviewed separately) is the smallest and least expensive of these. A similar unit, the AT-150, includes an automatic selector for three antennas and a random-wire output. The IC-AT500 is rated for use with up to 500 watts, which makes it suitable for use with ICOM's IC-2KL amplifier. The AT500 includes an automatic selector for four antennas. A separate automatic antenna selector rated at 1 kW PEP, the EX-627, is also available.

ICOM offers several external speakers and three desktop microphone options. The hand-held mike included with the radio is adequate for most operating.

#### Instruction Manual

The 52-page instruction manual is well written and informative. With few exceptions, the manual answers how-to questions quickly. The front- and rear-panel descriptions cover basic operation. Page references with each control guide you to more detailed operating instructions later in the book.

The "Installation and Connections" section has clear diagrams illustrating the various connections required to integrate the '728 into your station. These diagrams include power connections, wiring for various amplifiers, antenna tuners and the connections for data-mode interfaces.

For the CW-key connector, the manual shows a  $\frac{1}{4}$ -inch, three-conductor plug using the tip and shield, with no connection to the

ring. It turns out that a two-conductor plug (with the shield grounded) also works.

50 MHz, 15-kHz filter: -122 dBm.

Transmitter Dynamic Testing

output class and frequency range.

as specified,

See Fig 4.

Blocking dynamic range at 50 MHz with 500-Hz IF filter:\*

Two-tone, third-order IMD dynamic range at 50 MHz with 500-Hz IF filter:<sup>†</sup> Preamp on, 85 dB; preamp off, 88 dB.

50 MHz: Adjustable from 1 to 11 W (CW, SSB, FM); AM,

As specified. Meets FCC specifications for equipment in its power-

50 MHz: preamp on, -13.5 dBm; preamp off, -5 dBm.

Preamp on, 111 dB<sup>‡</sup>; preamp off, 112 dB<sup>‡</sup>.

Unlike most current radios, the IC-728 doesn't come with a set of connectors to match the radio's rear-panel jacks. This is inconvenient because the rig uses three DIN jacks for many of its connections. Fortunately, these jacks use commonly available plugs.

Nearly half the manual is dedicated to detailed operating instructions. These instructions cover basic operating techniques as well as describing memory-channel and scanning operation in detail. Two pages of diagrams, tables and text describe how to use the radio's programmed- and memory-scan functions.

Separate fold-out sheets give a block diagram and a complete schematic diagram. Five manual pages are dedicated to maintenance and adjustment. Large diagrams illustrate disassembly procedures and highlight the various maintenance operations you can perform. These include replacing a fuse on the PA unit, resetting the CPU, and adding or removing diodes to configure the advanced scanning functions. Other internal adjustments you can make include the frequency calibration, CW sidetone level, RIT center position, PA idling current and BFO frequency.

The IC-728 uses a lithium battery for retaining memory information. Claimed battery life is 5 years, and when the battery dies the radio will transmit and receive normally, but loses information stored in the memories when it's powered down.

#### Under the Hood

You may be in for a surprise when you

pop the top cover off an IC-728. All you'll see is heat sink, plus a small speaker in the right front corner. The entire top half of the radio comprises the PA unit, built into this heat sink. A very quiet fan in the PA unit runs continually during transmitting. The radio gets only barely warm after several minutes of full-power, key-down operation. The radio is solidly built.

#### **On-the-Air Performance**

In many respects, the IC-728 performs surprisingly well for an entry-level transceiver. Its PBT circuit offers selectivity options unavailable in many radios. Its clean synthesizer chain gives you the feeling that you're using a higher-end radio. Operation is intuitive and logical; controls are wellplaced and feel right. The backlit display is easily readable from almost any viewing angle and under a wide range of lighting conditions.

You change bands by poking the **BAND** button and rotating the tuning knob. When you select AM or FM, the tuning step is automatically set to 1 kHz. You can also use the kHz button for quickly tuning through a band.

The default SSB and CW slow tuning rate is a pleasant 2 kHz per revolution in 10-Hz steps. You can also choose 20- or 50-Hz tuning steps for a 4- or 10-kHz per revolution rate, respectively. If you turn the tuning knob quickly, the tuning rate automatically doubles.

In the receiver's rated 500-kHz to 30-MHz tuning range, it has few receiver spurs ("birdies")—none of which move the S meter. The three loudest ones are at 9.0095, 12.6986 and 26.21465 MHz. None of the audible spurs are in the ham bands. Projected from the radio's small speaker, receiver audio is acceptably loud and clear. It's plenty loud for unobstructed listening in noisy environs, such as a car.

#### SSB

Reports indicate that the IC-728 produces high-quality transmitted audio with the stock microphone. The manual suggests setting the **MIC GAIN** and speech-processor **LEVEL** controls at a position between 10 and 12 o'clock for the supplied mike. The meter has no ALC or compression-level scales. Only the red **TX** LED tells you (vaguely) whether you're driving the transmitter appropriately. It should flicker a bit more brightly than normal on voice peaks. Our tests show that this produces good-sounding and clean transmitter audio with the stock microphone, but without a second receiver, it's hard to verify that the transmitter is adjusted properly.

#### CW

CW operation is generally smooth with the '728. The radio receives CW as LSB, which is somewhat unconventional; the CW offset is fixed at 800 Hz. The sidetone matches the offset. Split-frequency operation is simple and intuitive, as the appropriate controls are closely grouped on the radio's front panel.

Semi-break-in or manual-changeover CW operation is selected with a rear-panel push button. You can adjust the TR delay time with a recessed, rear-panel control. This control placement and type is seriously deficient—you need a screwdriver to adjust it! Unless you do all your CW operating in a narrow speed range, you'll find this to be inconvenient. At the shortest selectable TR delay in semi-break-in mode, the transmitter unkeys between dots at 20 WPM. This is close enough to full break-in for most operating. At the longest delay, the transmitter seems to stay keyed for an eternity (actually several seconds) after sending stops.

The receiver's AGC sounds pretty good. Fast AGC is slightly harsh on S9+ CW signals, but even SSB signals sound reasonably good with fast AGC. The rig's slow AGC is quite good.

Both of our review radios include 500-Hz CW filters. The monolithic filter is easy to install (a 5-minute job requiring only a Phillips screwdriver), and provides a useful selectivity improvement that all but the most casual CW operators will appreciate. Even with the narrow filter in line and **PBT** set for minimum bandwidth, however, the rig's selectivity isn't quite good enough for crowded bands. The 250-Hz filter thus seems like a more appropriate choice for serious CW operators.

Under crowded band conditions, the 500-Hz CW filter and the 20-dB attenuator work well against overload and interference. The RF preamp adds needed gain, especially on the high bands with crummy antennas. Otherwise, however, using the preamp makes the receiver so sensitive



Fig 1—Worst-case spectral display of the IC-728 transmitter during two-tone intermodulation distortion (IMD) testing. Thirdorder products are approximately 39 dB below PEP output, and fifth-order products are approximately 40 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 100 W PEP output at 14.25 MHz.



Fig 2—CW-keying waveform for the ICOM IC-728 in the semi-break-in mode. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output at 14 MHz.



Fig 3—Spectral display of the IC-728 transmitter output during composite-noise testing. Power output is 100 W at 14 MHz. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The scale 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 can be read directly from the photographs. The carrier, off the left edge of the photographs, is not shown. This photograph shows composite transmitted noise at frequencies 2 to 20 kHz offset from the carrier.

that it overloads rather easily.

#### Data Modes

Since the '728 has no provision for direct FSK operation, as mentioned earlier, you must use the sideband filters for data modes. Although this works fine for RTTY, the SSB bandwidth is too wide for crowded band conditions. The **PBT** control comes in handy here, though, letting you adjust the passband to minimize interference.

#### Broadcast and Shortwave Listening

Dave Newkirk, WJ1Z, observes that there's little difference in the rig's sound quality between AM received with the radio



Fig 4—Spectral display of the IC-729 fransmitter during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 48 dB below PEP output, and fifth-order products are approximately 44 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 10.1 W PEP output at 50 MHz. The IC-729 produces an outstandingly clean transmitted SSB signal at 50 MHz.

in its AM mode and AM received as SSB. This suggests that rather severe high-frequency audio rolloff is built into the radio to suppress hiss in the IF and audio chains. Our frequency-response tests bear this out. Even with this rolloff, audio-amplifier hiss is quite noticeable. The IC-728 also suffers from the same barn-door-wide AM filter used in the IC-725.<sup>2</sup> In short, the IC-728 isn't a highfidelity AM-broadcast receiver, but casual AM listeners will find it quite acceptable.

The radio's triple-conversion scheme uses a first IF around 70.45 MHz. (The exact frequency depends on the mode.) The second IF is at 9 MHz, and the third is at 455 kHz. In their 1C-728 ads, ICOM claims that triple

<sup>&</sup>lt;sup>2</sup>Product Review, "ICOM IC-725 MF/HF Transceiver," *QST*, Mar 1990, pp 38-41.

conversion offers inherently better performance than dual conversion. There's little evidence to support this claim, however. Some dual-conversion receivers perform better, and other triple-conversion receivers don't perform as well as the IC-728 where it counts: in *basic rudio performance*.

Along these lines, the IC-728 performs surprisingly well. Judging a book by its cover, we suspected that the IC-728 was a reskinned and slightly modified IC-725, which suffers from mediocre performance. This wasn't the fault of the radio's RF design, however: It, like the '728, has good sensitivity and dynamic range for a radio in its class. The problem in the '725 is largely the result of an unusually noisy synthesizer.

What we found in the '728's receiver is considerably better basic performance, especially on crowded bands, because of its much quieter synthesizer. More importantly, the IC-728's basic receiver performance numbers are among the best you'll find in the major entry-level market.

#### The IC-729 and 6 Meters

The IC-729 is presently the least expensive 100-watt MF/HF transceiver with 6 meters. Other than the inclusion of 6-meter coverage and 46-61 MHz reception, it's practically identical to the IC-728 (see Tables 1 and 2). Although the '729 puts out just 10 watts on 6 meters, the radio performs well enough to help you get acquainted with the band. Its sensitivity and dynamic range are adequate for almost all 6-meter operation—in fact, they're better than those of most dedicated 6-meter transceivers! To climb the ladder to higher transmitter power, you can choose from a variety of commercial amplifier alternatives.

#### Summary

ICOM has solid entry-level performers

in the IC-728 and IC-729. If you can do without the bells and whistles and tiltering options of higher-end radios, or if you're looking for a radio whose features don't require you to take a full-semester course in operating to learn and use it, take a careful look at the '728. It's a solid, lightweight radio that lends itself well to mobile and portable operation, although it lacks the CW keyer and internal antenna tuner that would qualify it as a station in a box. In ease of use, it's a hands-down winner.

Manufacturer's suggested retail prices: IC-728, \$1099; IC-729, \$1419; FL-100 500-Hz CW filter, \$81; FL-101 250-Hz CW filter, \$77; CT-17 computer-control interface, \$102; UI-7 AM/FM unit, \$75; UT-30 programmable tone encoder, \$19; SM-6 desk microphone, \$50; MB-5 mobile bracket, \$27. Manufacturer: ICOM America, Inc, 2380 116 Ave NE, Bellevue, WA 98004, tel 206-454-7619.

### **ICOM AT-160 Automatic Antenna Tuner**

The matching 100-watt antenna tuner for the IC-728 and IC-729, the AT-160 uses relay-selected inductor taps and motordriven capacitors to match loads with SWRs up to 3:1 on the 160- through 10-meter ham bands. The tuner uses control signals from the IC-728 to complete its automatic tuning. The AT-160 mounts to a bracket that you can attach to either side of the radio. All necessary hardware is included. The AT-160 also works with the IC-725 and -726 transceivers. Unlike the internal antenna tuners in most radios, the AT-160 gives you the advantage of being in line on transmit and receive, thus adding selectivity and its improved antenna-system match on receive.

A piece of coax, a seven-conductor cable and a four-wire power cable interconnect the radio and the tuner. Attach your antenna to the tuner, and the installation is complete. (If you like, you can install an SWR/power meter between the radio and the tuner.) You can also use the AT-160 with an ICOM EX-627 automatic antenna selector. In this case, another seven-pin DIN cable connects the tuner to the antenna selector. The EX-627 automatically selects one of up to six antennas depending on the operating frequency.

The AT-160 is so simple that almost anyone can use it. Simply press the **TUNER** button on the '728 and hold it for about 1 second. **TUNE** appears on the left side of the display, the radio goes into transmit, and the capacitor-drive motors whir briefly. You may also hear the relays (quietly) switching inductor taps. Within a few seconds, this activity stops, the radio goes back into receive, and you're ready to transmit at full power into a matched load.

You need to follow this procedure only once for each band. The next time you switch to this band and select the tuner, it automatically resets the tuner to the settings it has stored for that band. When you begin to transmit, the AT-160 fine tunes the antenna if necessary. Tuning works this way regardless of operating mode.

The instructions and specifications state that the AT-160 is designed to match an antenna with an SWR of 3:1 or less. This means the antenna should have an impedance between about 17 and 150  $\Omega$ . If you try to match an antenna that has an impedance outside the tuner's range, it will attempt to match the antenna for about 7 seconds. If the tuner can't achieve a match in this time, it turns itself off and sets the transceiver for tunerless operation, indicated as **THROUGH** on the radio's display.

The tuner worked well with a variety of coax-fed antennas. It matched a 10, 15 and 20-meter Yagi on 12 and 17 meters; a 40-meter dipole on all the higher-frequency bands; and a 3/8-wavelength 160-meter inverted L on all but the 14- and 18-MHz bands. It also failed to match the 40-meter dipole on 80 or 160 meters—but it did match an 80-meter dipole on 160 meters.

It turns out that ICOM's SWR-matching specification for the AT-160 is quite conservative. Spot checks showed that it could match loads with indicated SWRs as high as 10:1. Used as it's intended—mainly for "flattening" less-than-optimal, coax-fed antenna systems across ham bands for which they're intended—the AT-160 does the job quickly and quietly.

Manufacturer's suggested retail price: \$413. Manufacturer: ICOM America, Inc.