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The Yaesu FT-100 MF/HF/VHF/UHF All-Mode Transceiver

Hamtronics R139 Weather Satellite Receiver

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The Yaesu FT-100 MF/HF/VHF/UHF All-Mode Transceiver

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By the time this review appears, it will have been more than one year since Yaesu debuted its FT-100 "Field Commander" all-mode MF/HF/VHF/UHF transceiver at the 1998 Dayton Hamvention. At the time, it broke new ground as the first subcompact transceiver to stuff a huge portion of the amateur spectrum into a package whose size belies its multiple capabilities. In the interim, a competing manufacturer announced, then delivered, a subcompact transceiver of its own that's similarly—although not identically—endowed. So, the competition began heating up before either radio actually hit the street.

So now, we'll try to give you some idea of whether the FT-100 was worth the wait. Yaesu has imbued this—its premier entry in the subcompact transceiver class—with capabilities and qualities heretofore only found on its larger siblings and peers. Ignoring satellite capabilities for a moment, the FT-100 compares very neatly, feature-for-feature, with Yaesu's FT-847. At the same time, Yaesu has kept the cost of the FT-100 within reasonable reach.

Not only were we wowed by some of the things the FT-100 can do—and with how well it can do them—we're still awestruck with the whole concept of getting more and more into less and less. Within the decade, we've seen manufacturers cram all the HF bands plus general coverage receive into a box smaller than the original 2-meter mobile transceiver. They followed that act by adding VHF, and now UHF, capabilities, DSP, internal keyers, more power on VHF and UHF and other features. For now at least, Yaesu has bragging rights for having the smallest transceiver in the burgeoning subcompact, multiband, multimode market class. One can only wonder what we can expect the new millennium to bring.

As more and more hams seek the sorts of mobile or portable capabilities these subcompact transceivers make possible, this marketplace segment is becoming the one to watch. Let's take a look at the FT-100 so you can decide if it will turn up at the top of your "must-have" list. (How many more shopping days until Christmas?)

Front and Center

The front panel is crowded, although the bluish LCD display is large and easy to read from most angles. You can adjust the brightness level over a wide range. Some users with larger fingers might find it hard to press the desired button without also actuating an adjacent button. The important **UP** and **DWN** buttons—used to change bands—are sandwiched between the **MODE** and **FUNC** buttons. The **MODE** button steps through the operating modes. The **FUNC** button accesses the menus. More on those later.

The **CLAR/IF SHIFT** button—a little lighted bump almost hidden between the two rotary controls on the radio's left—is difficult to see and access. Pressing it activates the clarifier (RIT); pressing and holding it activates the IF shift. The tiny button illuminates green when RIT is enabled. Another sharp press takes you out of clarifier mode and extinguishes the green LED while leaving the IF shift enabled. So, you can envision lots of circumstances where you'd be pushing this particular button. It's really a shame that it's not more prominent and accessible.

You adjust both the clarifier and IF shift functions using the multifunction, detented **SELECT** knob (also the "fast tuning" knob for the FT-100). This single-button arrangement also precludes simultaneous access to both of these important functions. There is no separate RIT readout. When the **CLAR** button is enabled, you can adjust the receive frequency ±10 kHz, and the main frequency readout reflects the change in receive frequency.

The **IF SHIFT** goes *waaaay* out beyond what the little display icon shows, although you'll have to crank on the **SELECT** knob a bit more than you're likely used to. The IF **SHIFT** was *very* effective as an aid in dodging QRM. The FT-100 also includes a split function, accessible through the menu. It even permits crossband operation.

To tune in FM-type steps, press the **STEP** button to pick a step and use the little **SELECT** knob to do the actual tuning.

The smallish **MAIN DIAL** tuning knob is to the right of the display and between two vertical columns of function buttons. The knob's barely perceptible tuning dimple is a case where less really *is* less. Many users will find it insubstantial and unusable for twirling the control. It's too small except for the most dainty of index fingers. I found that I could manipulate the knob using my thumbnail, however. The knob is surrounded by a rubber grip ring.

The FT-100 does not offer the "fuzzy logic" feature available on some radios whereby the faster you turn, the faster you tune. Instead, you get a wide selection of mode-specific variable tuning step sizes for fine tuning, and use the 30-position detented **SELECT** knob for coarser changes. The **UP** and **DOWN** buttons can also be used to easily cycle through the amateur bands.

For the SSB, CW and the AFSK modes, successive presses of the **STEP** button result in main *tuning step* sizes of 1.25; 2.5; 5; 10; 25; 50 or 100 Hz. The current tuning step size

Bottom Line

For the money, Yaesu has packed a lot of operating pleasure into the FT-100 Field Commander transceiver. Perhaps good things *do* come in small packages.

Table 1

Yaesu FT-100, serial number 9D021081

Manufacturer's Claimed Specifications	***Measured in the ARRL Lab***
Frequency coverage: Receive, 0.1-30, 50-54, 76-108, 144-148, 430-450 MHz; 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, 28-29.7, 50-54, 144-148, 430-450 MHz.	Receive, 0.1-961 MHz (cell blocked)[1]; transmit, as specified.
Power requirement: Receive, 1.6 A; transmit, 22 A (100 W output).	Receive, 1.3 A; transmit, 17 A. Tested at 13.8 V.
Modes of operation: SSB, CW, AM, FM, AFSK.	As specified.
Receiver	*Receiver Dynamic Testing*
SSB/CW sensitivity, bandwidth not specified, 10 dB S/N: 1.8-30 MHz, <0.25 μV[2]; 50-54 MHz, <0.2 μV; 144-148, 430-450 MHz, <0.13 μV.	Noise floor (mds), 500-Hz filter: *Preamp off* / *Preamp on* 1.0 MHz: –132 dBm / –136 dBm 3.5 MHz: –133 dBm / –138 dBm 14 MHz: –133 dBm / –137 dBm 50 MHz: –130 dBm / –135 dBm 144 MHz: see note 3 / –142 dBm 432 MHz: see note 3 / –143 dBm
AM sensitivity, 10 dB S/N: 0.3-1.8 MHz, <32 μV[2]; 1.8-30 MHz, <2 μV[2]; 50-54 MHz, <2 μV; 144-148, 430-450 MHz, <2 μV.	10 dB (S+N)/N, 1-kHz tone, 30% modulation: *Preamp off* / *Preamp on* 1.0 MHz: 1.9 μV / 1.1 μV 3.8 MHz: 1.7 μV / 0.97 μV 50 MHz: 2.8 μV / 1.2 μV 120 MHz: see note 3 / 0.98 μV 144 MHz: see note 3 / 0.42 μV 432 MHz: see note 3 / 0.43 μV
FM sensitivity, 12 dB SINAD: 28-30 MHz, <0.5 μV; 50-54, 144-148, 430-450 MHz, <0.2 μV.	For 12 dB SINAD: *Preamp off* / *Preamp on* 29 MHz: 0.62 μV / 0.23 μV 52 MHz: 0.66 μV / 0.4 μV 146 MHz: see note 3 / 0.15 μV 440 MHz: see note 3 / 0.16 μV
Blocking dynamic range: Not specified.	Blocking dynamic range, 500-Hz filter: *Preamp off* / *Preamp on* 3.5 MHz: 128 dB / 121 dB 14 MHz: 130 dB / 125 dB 50 MHz: 116 dB* / 107 dB* 144 MHz: see note 3 / 113 dB 432 MHz: see note 3 / 113 dB
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone, third-order IMD dynamic range, 500-Hz filter: *Preamp off* / *Preamp on* 3.5 MHz: 92 dB / 88 dB 14 MHz: 94 dB / 91 dB 50 MHz: 94 dB* / 90 dB 144 MHz: see note 3 / 84 dB 432 MHz: see note 3 / 82 dB
Third-order intercept: Not specified.	*Preamp off* / *Preamp on* 3.5 MHz: +6.3 dBm / –5.7 dBm 14 MHz: +10 dBm / +4.2 dBm 50 MHz: +20 dBm / +1.2 dBm 144 MHz: see note 3 / –13 dBm 432 MHz: see note 3 / –16 dBm
Second-order intercept: Not specified.	Preamp off, +51.7 dBm; preamp on, +52.8 dBm.
FM adjacent channel rejection: Not specified.	20 kHz channel spacing, preamp on: 29 MHz, 77 dB; 52 MHz, 72 dB; 146 MHz, 72 dB; 440 MHz, 69 dB.

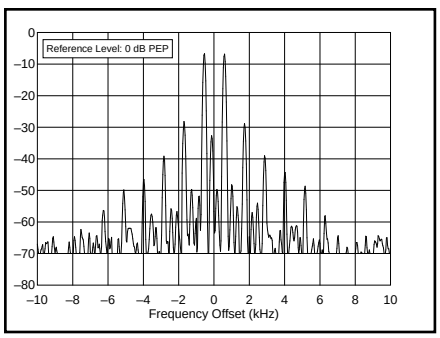

Figure 1—Worst-case HF spectral display of the FT-100 transmitter during two-tone intermodulation distortion (IMD) testing. The worst-case third-order product is approximately 30 dB below PEP output, and the worst-case fifth-order product is down approximately 40 dB. The transceiver was being operated at 100 W PEP output at 24.95 MHz.

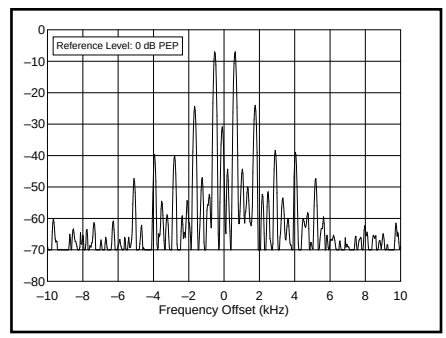

Figure 2—Worst-case VHF/UHF spectral display of the FT-100 transmitter during two-tone intermodulation distortion (IMD) testing. The worst-case third-order product is approximately 25 dB below PEP output, and the worst-case fifth-order product is down approximately 40 dB. The transceiver was being operated at 100 W PEP output at 50.2 MHz.

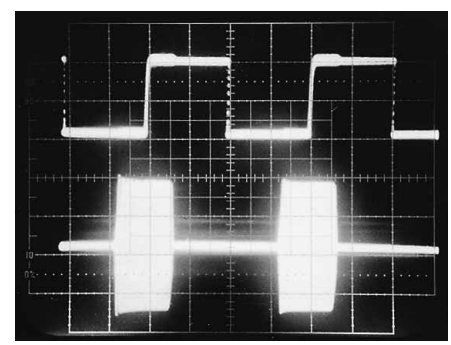

Figure 3—CW keying waveform for the FT-100 showing the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is approximately 60 wpm. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output at 14.2 MHz. Note the slight shortening of both dits.

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Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing, preamp on: 29 MHz, 72 dB; 52 MHz, 72 dB*; 146 MHz, 72 dB*; 440 MHz, 67 dB; 10 MHz channel spacing, preamp on: 52 MHz, 102 dB; 146 MHz, 86 dB; 440 MHz, 75 dB.
S-meter sensitivity: Not specified.	S9 signal at 14.2 MHz: preamp off, 32 μV; preamp on, 15 μV; 52 MHz, preamp off, 28 μV; preamp on, 6.5 μV; 146 MHz, preamp on, 5.8 μV; 432 MHz, preamp on, 4.3 μV.
Squelch sensitivity: SSB, 1.8-30 MHz, <2.5 μV; 50-54 MHz, <1.2 μV; 144-148, 420-450 MHz, <0.8 μV; FM, 28-30 MHz, <0.32 μV; 50-54 MHz, <0.2 μV; 144-148, 430-450 MHz, <0.16 μV.	At threshold, preamp on: SSB, 14 MHz, 1.8 μV; FM, 29 MHz, 0.06 μV; 52 MHz, 0.09 μV; 146 MHz, 0.05 μV; 440 MHz, 0.04 μV.
Receiver audio output: 1.5 W at 10% THD into 8 Ω.	1.7 W at 10% THD into 8 Ω.
IF/audio response: Not specified.	Range at -6 dB points, (bandwidth): CW-N (500-Hz filter): 419-953 Hz (534 Hz); CW-W: 305-2242 Hz (1937 Hz); USB-W: 223-2180 Hz (1957 Hz); LSB-W: 304-2329 Hz (2025 Hz); AM: 54-3409 Hz (3355 Hz).
Spurious and image rejection: 1.8-30 MHz, 70 dB; 50-54 MHz, IF rejection, 60 dB, image rejection, 70 dB; 144-148, 430-450 MHz, IF rejection, 60 dB, image rejection, 60 dB.	First IF rejection, 14 MHz, 101 dB; 50 MHz, 68 dB; 144 MHz, 95 dB; 432 MHz, 115 dB; image rejection,14 MHz, 113 dB; 50 MHz, 104 dB; 144 MHz, 80 dB; 432 MHz, 82 dB.
Transmitter	*Transmitter Dynamic Testing*
Power output: HF & 50 MHz: SSB, CW, FM, 100 W (high); AM, 25 W (high); 144 MHz, 50 W (high); AM, 12.5 W (high); 430 MHz, 20 W (high); AM, 5 W (high).	HF & 50 MHz: CW, SSB, FM, typically 97 W high, <1 W low; AM (see text); 144 MHz: CW, SSB, FM, typically 53 W high, <1 W low; AM (see text); 430 MHz: CW, SSB, FM, typically 20 W high, <1 W low; AM (see text).
Spurious-signal and harmonic suppression: ≥40 dB on HF for harmonics, ≥50 dB for spurious; ≥60 dB on VHF & UHF for harmonics and spurious.	HF, 40 dB; 50 MHz, 60 dB; 144 MHz, 60 dB; 430 MHz, 68 dB. Meets FCC requirements for spectral purity.
SSB carrier suppression: ≥40 dB.	As specified. >51 dB.
Undesired sideband suppression: ≥50 dB.	As specified. >63 dB.
Third-order intermodulation distortion (IMD) products: Not specified.	See Figures 1 and 2.
CW keyer speed range: Not specified.	5.6 to 57 WPM.
CW keying characteristics: Not specified.	See Figure 3.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, 15 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 11 ms; FM, 13 ms. Unit is suitable for use on AMTOR.
Composite transmitted noise: Not specified.	See Figures 4 and 5.
Bit-error rate (BER), 9600-baud: Not specified.	146 MHz: Receiver: BER at 12-dB SINAD, 1.2×10^{-3}; BER at 16-dB SINAD, 1.7×10^{-5}; BER at –50 dBm, $<1.0\times10^{-5}$; transmitter: BER at 12-dB SINAD, 3.1×10^{-4}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$. 440 MHz: Receiver: BER at 12-dB SINAD, 1.1×10^{-3}; BER at 16-dB SINAD, 1.5×10^{-5}; BER at –50 dBm, $<1.0\times10^{-5}$; transmitter: BER at 12-dB SINAD, 2.5×10^{-4}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$.
Size (HWD): 2.2×6.3×8.0 inches; weight, 6.6 pounds.	

Expanded Product Review Report Available

The ARRL Laboratory offers a detailed test result report on the Yaesu FT-100 that gives in-depth, technical data on the transceiver's performance. Request the *FT-100 Test Result Report* from the ARRL Technical Department, 860-594-0278; e-mail **mlevesque@arrl.org**. Members can see this on-line on our Member's Only Web site.

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.
*Measurement was noise-limited at the value indicated.
Third-order intercept points were determined using S5 reference.
[1]Receive sensitivity is reduced below 200 kHz, between 60 and 70 MHz and above 650 MHz.
[2]IPO off (preamp on).
[3]IPO not available above 70 MHz.

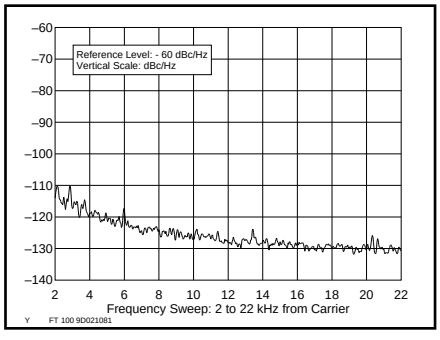

Figure 4—Worst-case HF spectral display of the FT-100 transmitter output during composite-noise testing. Power output is 100 W at 3.520 MHz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

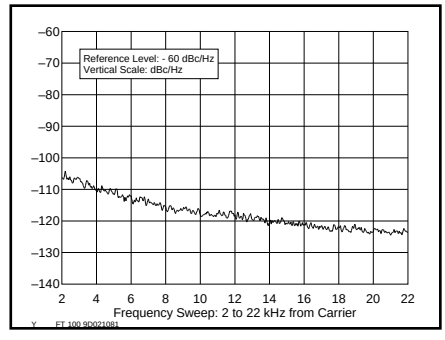

Figure 5—Worst-case VHF/UHF spectral display of the FT-100 transmitter output during composite-noise testing. Power output is 20 W at 432.02 MHz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

is indicated on the display. Press and hold the **STEP** button and the main tuning knob changes the frequency in 1-kHz steps, about as coarse as you'd ever want it on HF. The *tuning rate* of the main dial also is adjustable via the "dial pulse" menu. The default setting of 200 means one rotation of the main tuning dial generates 200 encoder "pulses." The alternative 100 setting effectively cuts the tuning rate in half. A front panel **LOCK** button disables the main tuning knob; but there's no mechanical drag adjustment.

In the above modes, rotating the **SELECT** knob tunes in 10 kHz steps. A quick press of the **SELECT** knob results in 1-MHz frequency steps. If you press and hold the **SELECT** knob for $^1/_2$ second, this same control will now tune in 10 MHz increments.

For AM and FM, the main tuning knob changes the frequency in 100-Hz steps. The **SELECT** knob is used to change the fre-

quency by your selected step size. For AM, six step sizes—including 9 kHz—are provided. For FM, seven step sizes between 5 and 50 kHz are available. For WFM, the main tuning knob tunes in 1-kHz steps, and you can choose between **SELECT** knob step sizes of 50 or 100 kHz.

In addition to **UP**, **DWN**, **MODE** and **STEP**, other front-panel buttons provide ready access to the DSP menu (**DSP**), memory or VFO (**VFO/MR**), **HOME** (a pre-programmed calling frequency) and **LOCK**. Concentric rotary controls let you adjust volume (**AF**) and either squelch (**SQL**) or RF gain (**RF**).

The S-meter is an LCD bar below the frequency readout. The calibration scale shows S1, 5, 9, +20 and +60. Intermediate readings are left to your imagination. The **MET** function button lets you select either an ALC scale or a tiny, horizontal line that represents SWR during transmit. The PO (power output) scale is always there during transmit. It is similarly vague, however. It displays 10, 50 and 100 W, although it's possible to adjust the power output along a continuum from practically nil to full output.

Menu Magic

Functions lacking dedicated controls are accessed using the four (**A**, **B**, **C**, **D**) function buttons arrayed immediately below the display. Depending upon the menu selected by the **FUNC** button the display lists the function of each of the four keys. There are nine menus in all, each containing a related functional group. Each press of the **FUNC** button steps through another group of up to four separate functions. For example, the **A/B**, **A=B**, **SPL** (split) and **QMB** ("quick memory bank") keys are in the same group, while **TON** (activates the CTCSS system), **DCS** (digital code squelch) and **ART** (Yaesu's proprietary Auto-Range Transponder mode) are in another. Functions related to the onboard keyer—**WRI** (write to memory), **PLY** (play memory), **BK** (activates break-in operation) and **KYR** (activates the built-in keyer) are together too. So are **IPO** ("intercept point optimization," a fancy way for saying the preamp is turned off), **ATT** (an 18-dB attenuator), **AGC** (fast, slow or auto) and **NB** (noise blanker).

Push and hold the button (**A**, **B**, **C**, **D**) for certain functions and you get the main menu item behind it. This is highly convenient. For example, press and hold the **TON** function button and you get the menu that lets you select the desired CTCSS tone. Press and hold the **PRO** (processor) function button and there's the menu that lets you adjust the compression level. This is much simpler than the methods other transceivers employ. I, for one, wished that Yaesu had followed this concept with the keyer speed adjustment. More on this later.

Users liked the fact that the menus were logically grouped with related functions. There's no searching around among several hidden or branching menus on the FT-100!

Breaking Up Is Hard To Do?

The FT-100 faceplate is remotable—practically a must these days as it becomes next to impossible to find places to mount radio gear in cars. That's good news, at least if you plan to install the FT-100 and leave it in place. The not-so-good news is that the separation cable (1) attaches to the faceplate (actually a mounting plate that, in turn, clips to the faceplate) and, at the other end, to the transceiver body with little screws, (2) uses a second separate wire for the microphone connection—the mike connects to the body behind the faceplate, and (3) requires running a *third* wire if you plan to install an extension speaker. All three wires, the face mounting plate and screws are included in the optional YSK-100 separation kit. A simple mobile mounting bracket, a mounting hardware pack and a mike hanger are included with the radio.

By comparison, the single wire IC-706 separation cable includes the microphone and headphone/extension speaker wiring, and you can install it in a snap (well, two snaps, actually). Yaesu's separation scheme reminded me of the one for the Alinco DX-70T (see "Product Review," *QST*, December 1995). Yaesu's multi-cable system and its screw-on connections might prove inconvenient for users who plan to use the FT-100 in a variety of fixed and mobile installations, such as for traveling, rather than leaving the rig in one place.

Missing from the front panel (or anywhere else on the radio) was a headphone jack. The *Operating Manual* says the radio's "extremely compact size" doesn't allow for one, perhaps defining the tip of the iceberg in the debate over "how small is too small?" (All but one of the competitors' slightly larger subcompact radios include separate jacks for headphones and an external speaker.) The manual gives details on how to lash up an attenuator to permit hooking up low-impedance headphones to the rear-panel extension jack. This, of course, makes use of both an external speaker and headphones a bit problematic, especially given the jack's location.

Taking Up The Rear

The rear panel of the FT-100 is pretty spare. Twin cooling fans replace the heatsink cooling fins that adorn most rear panels these days, a design feature that keeps the radio even more compact than the competition. Major connections—antennas, power, and **BAND DATA**—are deployed at the ends of pigtails, apparently another space-saving measure. Compared to bulkhead-mounted connectors, pigtail connections are vulnerable to numerous hazards may not be as reliable over the long haul. Only one pigtail is actually labeled with a metallized tag that reads "HF/50 MHz." It would be easy to imagine hooking up the wrong antenna to one of these, especially after the label tag falls off.

The **BAND DATA** jack is also used for connecting the optional CT-62 interface cable for controlling the radio with a personal computer. Yaesu does not offer a software package, but the manual does include information on the command set.

At a point when manufacturers appeared to be converging on the six-pin Molex-type connector as the standard for HF power connections, Yaesu employs a flat-bladed Jones type connector on the FT-100. It's quite sturdy, however.

The rear panel also provides a six-pin mini DIN-type **DATA** jack, for AFSK or FSK input from a TNC and for fixed-level receiver audio output, PTT and ground connections. Additionally, there are 3.5 mm jacks for accessory (ALC and T/R control for a linear), key and external speaker.

The twin fans coupled with internal heatsinking via the radio's mounting frame provide adequate cooling for the radio. The downside is that the fans are annoyingly loud and kick into high gear whenever you key the transmitter—even if it's just for an instant or if you have the power level turned all the way down. The fans continue to run for approximately 10 seconds after you return to receive. As one user put it: "The effect on practical operation is that the first 10 seconds of received audio always has to compete with the sound of the fans."

Digital Signal Processing Menu

The DSP menu is always available by pressing the dedicated **DSP** button, a thoughtful inclusion. The FT-100's DSP menu features are well thought out and just superb and include digital noise reduction (DNR), digital notch filter (DNF), and a digital band-pass filter (DBP). Incorporating DSP as a standard feature on a subcompact radio like this is a first and a very welcome addition.

Digital noise reduction ameliorates random noise. It works in all modes. The DNR is adjustable over a range via the menu. In the ARRL Lab, we measured only an average of 10 dB of noise reduction near the 1 kHz reference signal at the maximum menu setting (16), but we also noticed something a bit peculiar. While the NR in most other rigs is fairly flat across the audio spectrum, the NR in the FT-100 has a noticeable roll-off toward the upper part of the passband (2 kHz and higher), and there's a considerable amount of "ripple" in the frequency response.

The adjustable digital band-pass (DBP) filter is a wonderfully useful inclusion. There are separate, menu-settable parameters for setting the BPF high and low-cut frequencies for voice modes, plus a separate narrow DBP filter for CW, a terrific addition and totally unexpected on a radio this small.

In SSB, AM, FM and AFSK modes, you press and hold the **DBP** button to access the menu, then use the **SELECT** knob to adjust the high-frequency cutoff of the DSP low-pass filter. The range is between 1000 and 6000 Hz. An adjacent menu item lets you adjust the low-cut characteristics of the DSP high-pass filter between 100 and 1000 Hz.

On CW, you can set the BPF width at 60, 120 or 240 Hz. Even without the optional crystal filters, the 120 or 60 Hz setting is super—almost, but not quite, crystal filtering. Yes, I could still see nearby signals on the S

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meter, but I could not hear them. The AGC pumping was detectable, however. Add in the optional 500 and/or 300-Hz narrow crystal filters and it's a formidable combination.

On SSB, enabling the DNR and adjusting the DBP yielded a tremendous improvement in overall readability in the presence of adjacent-channel interference. Hit the **DNF** key to engage the auto notch. We found that its measured notch depth of around 20 dB does not exactly vanquish annoying heterodynes, but it does attenuate them. We'd prefer not to hear them at all, however.

Overall, the DSP features definitely are a job well done!

Howizzit? Howizzit?

The FT-100 receiver sounds very quiet. Punch in the DNR and tune and signals seem to spring out of nowhere. At one point, I had to check to make sure the antenna was hooked up. If there's a drawback to how this receiver sounds it's the internal speaker, another apparent victim of keeping the radio compact. It's pretty small and rather tinny-sounding.

If there is one feature to single out for special praise it's the noise blanker (NB). In short, it *works*. The FT-100 noise blanker is very effective, and its level is continuously adjustable from within the main menu—another plus. It worked well to eliminate noise from the furnace igniter, from a vacuum cleaner just a few feet from the antenna and from other pulse-noise sources. I hate to say that it made the noise blankers on my two subcompact transceivers—a Kenwood TS-50S and an "original" ICOM IC-706—look pretty sorry in comparison. While I was seeing S5 ignition noise on my TS-50S, the FT-100 was quiet as a mouse—and that was at the default NB setting. This was the case with the preamp on or off, too. Bravo, Yaesu!

After using the radio, we were not surprised to learn that the blocking dynamic range numbers topped those of the competition—130 dB on 20 meters with the preamp off. Two-tone, third-order IMD dynamic range numbers on HF were in the 90s and weren't noise-limited either (see Table 1). This is sweet icing on a radio of this genre.

The FT-100 hears very well too, at least on the amateur bands. It has a noise floor in the –130 dBm range on HF without the preamp (enabling the IPO turns off the receiver's preamp). Apparently, the preamp is *always* on for the 2-meter and 70-cm bands.

The FT-100 was not designed to be a satellite radio. Yaesu offers the FT-847 for that kind of operation. However, we were able to easily monitor several moderately strong packet satellites on 70 cm. We also were able to successfully make Mode A and Mode KA contacts. By the way, the radio is capable of 300 bps HF or 1200 and 9600 bps FM operation; you select the mode via the AFSK mode menu. You can only operate semi-duplex with the FT-100.

Extended receive sensitivity (measured in CW mode) also is good except on LF, (below 200 kHz or so) and around 70 MHz while using the HF/50 MHz antenna connection. By the way, the radio seems to switch from Antenna 1 (HF/50 MHz) to Antenna 2 at around 70.5 MHz, but it depends on which way you're tuning. Sensitivity is a bit reduced (worse than 1 μV) above 650 MHz, too.

The FT-100 covers the FM broadcast band, but on wideband FM (WFM) at 100 MHz, the radio is a bit deaf. We measured sensitivity at 8 μV. There's no sensitivity specification for this mode, however, and the radio heard local FM broadcast stations quite well with a very modest antenna connected.

The MH-36$_{B6JS}$ multi-button DTMF microphone comes standard with the FT-100. It includes **UP** and **DWN** buttons that will tune in the default step size. The **ACC** button is the same as the **HOME** button. The **P** button swaps between VFO and memory. Under the default settings, the **P1** button is a band down button, while the **P2** button is a band up button. You also can program the **P**, **P1** and **P2** buttons to control other functions.

Although the supplied mike includes a DTMF keypad, the radio does not feature direct keypad frequency entry.

We got good SSB audio reports, and the DSP TX EQ is a splendid feature! It offers three setting choices (for my particular voice characteristics, the #3 setting was the best). The radio includes VOX and an audio processor, features not found on all the competitors.

FM operation was simple and straightforward. Will the FT-100 supplant your need for a full-blown, dedicated FM mobile? It very well might, unless you're an FM power user. Yaesu imported to the FT-100 the *Smart Search* feature previously included on some of its FM mobiles. Smart Search automatically stores the frequencies of signals it intercepts during a search of the band. This is great for those who travel a lot and want to find a local repeater or two. Yaesu has included this feature on some of its dualband FM transceivers; this might be a first for a transceiver of this type, however.

CTCSS and DCS encode is built in. Decode can be added by installing the optional FTS-27 decode unit. Tone scan capabilities and the ability to use separate tones or codes for transmit and receive on the same frequency or repeater pair are not available.

The FT-100 even gives you some control over your FM deviation. You can select from among 2.3, 2.5 or 5.0 kHz via the main menu.

We got great FM audio reports. The press of a key puts you into repeater mode, and the FT-100 knows automatically whether the split is up or down. You set the actual split for each of HF, 50 MHz, 144 MHz and 440 MHz via the menu.

On CW, the keying reports we elicited by and large were favorable (see Figure 3). The only complaints were of some shortening or clipping of characters when transmitting at speeds higher than 30 WPM or so in full-break-in mode using the internal keyer. In an impromptu comparison, my group of CW connoisseurs ranked the FT-100 ahead of my "original" IC-706 in this regard.

The FT-100's built-in keyer was smooth and trouble-free. Its single memory bank holds up to 50 characters and is simple to program. Go to the CW menu, push the **WRI** function button until it beeps, and send the desired string. To play it back, push the **PLY** button.

Holding the **KEYR** button gets you to the menu that lets you select the type of keyer (it offers two iambic types, plus a "bug" setting, or no keyer). The ability to independently set dot and dash lengths in the EL1 keyer mode is a super addition for CW connoisseurs. I found this preferable to using the other available keyer mode (EL2) that offers automatic character spacing.

I, for one, wished that pressing and holding the **KEYR** button got you to the keyer speed, however, instead of keyer type. Keyer speed—one adjustment to which CW ops need quick, convenient access—is found elsewhere in the main menu. To get there, you push and hold the **FUNC** button to access the main menu, dial up menu 52, and use the main tuning knob to set the keyer speed by picking a number between 0 and 100. For some reason best known only to Yaesu, the number on the display does not reflect the actual keyer speed. Apparently, it's just a relative indication, so you'll have to guess how fast you're sending. We measured the keyer's range at approximately 6 to 57 wpm.

Adjusting the CW sidetone volume is more inconvenient, but if you operate CW from your car, you'll probably need to. It's just not loud enough to overcome road noise. This requires going inside the radio and adjusting VR1004 (marked **VR04** and located next to the speaker connection). Adjusting the beep level also means opening up the radio.

The FT-100 provides the ability to bump its CW output stream by up to 30 ms to avoid sequencing problems when using a linear amplifier or other device that's dependent on relay switching. We have not seen this on any other transceiver, at least not one in this price or size class.

Spectrum Scope

Compared to similar implementations by other manufacturers, the *Spectrum Scope* in the FT-100 is pretty rudimentary and much less useful. While it will work in other modes, it's really designed for use on FM. To enable it, you have to go into the main menu (as opposed to the function menu addressed via the **A**, **B**, **C** and **D** buttons). Possible choices are a single sweep, a sweep every 30 seconds or a continuous sweep.

Audio is muted during sweeps. In the single sweep mode, you can activate sweeps by pressing the **FUNC** button, even if you're out of the main menu. The scope display occupies the area normally taken up by the functional menu items above the **A**, **B**, **C** and **D** keys, so as long as the Spectrum Scope is enabled, you can't tell what menu you're in.

The Spectrum Scope scans 15 "channels" (depending on the step setting) above and below the operating frequency. Unclear is the minimum signal required to show up on the bar graph.

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Intercepted signals show up as vertical bars according to their relative signal strength. Given that this mode only works in FM and provides no way to tune to a particular signal, however, makes it less than very useful.

Power Output Conundrums

On the menu, output power levels for all bands are given as 0-100, even though the output on 2 meters is 50 W and the output on 70 cm is 20 W. Yaesu says the number selected represents "a percentage of the maximum" output power.

Speaking of power output, we discovered something quite odd when we checked our radio's power consumption in the ARRL Lab. While our FT-100 drew 17 A at full power—100 W—on HF, it drew 15 A at full power—50 W—on 2 meters, and it drew a whopping 10 A while generating full output—20 W—on 70 cm. The schematic reveals that the FT-100 uses a common output power module for VHF and UHF, so the resulting inefficiency appears to be an indirect consequence of design efforts to keep the radio small. Delving further, however, we determined that the radio also drew 10 A to put out 20 W on 20 meters!

Lab tests turned up some problems with AM transmit performance. The power output on all bands was erratic and the transmitted audio was severely distorted. A second unit tested worked properly on HF, but exhibited similar difficulties on frequencies above 50 MHz. At the time this review went to press, Yaesu was investigating. Since most amateur AM activity primarily involves the use of classic equipment, perhaps many will find this shortcoming inconsequential. A section discussing AM transmission is not included in the manual—the receiver works fine in the AM mode.

During our temperature chamber test, we found that power output on HF at the coldest temperature (–10° C/+14 F) dropped to about 20 W. Power output gradually recovered with internal warming while transmitting.

Optional IF Filters

The "standard" IF filter is 2.4 kHz. Optional crystal IF filters are available for the FT-100. For CW, you can get optional 300 or 500-Hz narrow crystal filter. A 6-kHz AM filter also is available, but apparently there are no optional IF filters for SSB. You can install two filters in the radio. This means you can have two CW filters or one CW and one AM filter installed at the same time.

Installing the filter(s) is a bit of a bear, however—more complicated than most filter installations. We won't outline the entire process but suffice it to say that it entails having to remove the screws securing a circuit board and removing the cables connected to it to allow the board to be lifted. Then, you have to solder the filter in place. In our original FT-100, a piece of cabling that prevented sufficiently lifting the board made the soldering job a bit riskier than necessary. In a somewhat later unit, this cable had been rerouted so it was no longer in the way.

Filter selection is via a main menu group. The choices are **6.0**, **2.4**, **500** and **300**. Filter selection is independent of mode, so it's possible to select the 500 or 300-Hz filter while in SSB mode. That's something you'll find very handy if you plan to operate in the PSK31 keyboard-to-keyboard mode that's becoming more popular by the week.

Also Worth Noting

As usual, Yaesu produced a great *Operating Manual* for the FT-100. It's compact enough to pack with the radio (competitors take note), yet thorough and easy to follow. The FT-100 package even includes a complete set of schematics.

The FT-100 has available an optional temperature-compensated high-stability reference oscillator (TCXO-8). This might be handy for those seeking improved frequency accuracy.

Final Final

It's trite but true: This radio contains features once found only in more-expensive transceivers. Yes, there's a bit of room for improvement here. Yes, a few operators may view some of its less-desirable aspects as major stumbling blocks. But, the FT-100 offers quite a lot in the plus column to outweigh any perceived deficiencies.

Manufacturer: Yaesu USA, 17210 Edwards Rd, Cerritos, CA 90703; tel 562-404-2700, **http://www.yaesu.com**. Manufacturer's suggested retail price, FT-100 $1689. Typical current street price, $1350. YSK-100 separation kit, $79; XF-117C 500-Hz CW filter, $157; XF-117CN 300-Hz CW filter, $157; XF-117A 6-kHz AM filter, $127; FTS-27 decode unit, $47; TCXO-8 high stability oscillator unit $99.

Hamtronics R139 Weather Satellite Receiver

Reviewed by Steve Ford, WB8IMY
QST Managing Editor

People see satellite weather images every day. With coffee in one hand and a TV remote control in the other, they watch ominous storm fronts marching across the continent as they hurry through their morning rituals. Or, they take a more leisurely approach and surf the Web to find the weather images of their choice. Most folks realize that satellites provide these images, but the magic behind the technology remains a mystery (one they waste little time pondering).

For hams, however, the direct pursuit of knowledge and mystery is our *raison d'être*. If we cared only to *communicate* with people in other nations, we'd pick up our telephones or connect to the Internet. Only a lunatic in love with the magic of wireless attempts to accomplish the same goal by assembling a radio station and throwing him or herself upon the mercy of a fickle ionosphere. Hams are not content to merely communicate through the instruments of multinational corporations, we want to generate and receive signals ourselves—with equipment *we* control and operate.

That's why weather satellite image reception remains a vibrant subset of the Amateur Radio hobby. Rather than wait upon the images that TV stations and the Web can provide, we prefer to go directly to the source and see them in real time!

Weather satellites can be divided into two groups: those that zip around the Earth in low polar orbits, and those that appear to hover in distant geostationary orbits. The polar orbiters are the most popular among hobbyists. These satellites transmit strong signals on frequencies easily received by VHF radios.

Russia, the United States and China have launched polar orbiting weather satellites. As they circle the globe these satellites are continuously transmitting visible light and infrared images of the ground and clouds below. They beam the images to Earth in what is known as the APT—Automatic Picture Transmission—format. It is a wideband (about 40 kHz) FM signal composed of sync pulses and varying audio tones. The Russian Meteor satellites transmit on 137.300, 137.400 or 137.850 MHz. The American NOAA birds transmit on 137.500 and 137.620 MHz.

If you have a 2-meter FM rig that can tune through the weather-satellite frequencies, you can often hear them. As they come into range you'll notice an odd tick-tock metronome-type sound. Unfortunately, most ham receivers don't have a sufficiently wide bandwidth to enable image reception. That's where the Hamtronics R139 comes in!

Bottom Line

The R139, a simple antenna, some software and a sound card equipped PC is all that's required for receiving real-time images directly from a variety of orbiting weather satellites.

Introducing the R139

The Hamtronics R139 weather satellite receiver is essentially a five-channel crys-

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Table 2
Hamtronics R139

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 137.3, 137.4, 137.5, 137.62, 137.85 MHz with supplied crystals.	As specified.
Modes of operation: WFM.	As specified.
Power requirements: 0.12 A (max volume), 10-15 V dc.	0.1 A (max volume, no signal), tested at 13.8 V dc.
Size (HWD): 2.3x4.9x4 inches; weight, 14.2 ounces.	
FM wide sensitivity (12 dB SINAD): 137 MHz, 0.2 μV.	137 MHz, 0.18 μV.
FM adjacent channel rejection: Not specified.	100 kHz spacing, 137 MHz: 48 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	100 kHz spacing, 137 MHz, 48 dB.*
Spurious and Image rejection: Not specified.	IF: 137 MHz, 105 dB; image, 53 dB.
Squelch sensitivity (threshold): Not specified.	At threshold: FM, 137 MHz, 0.05 μV.
Audio output: 1 W[1] into 8 Ω (THD not specified).	300 mW at 3.5% THD (max volume) into 8 Ω.

*Measurement was noise-limited at the value indicated.
[1]Maximum rating of the audio amplifier used in the circuit.

tal-controlled scanner that sweeps through the APT satellite frequencies mentioned above. The R139 offers the necessary bandwidth while maintaining low noise performance and good sensitivity. (I should note that the R139 could also be used as an "IF" for a microwave downconverter if you wish to capture images from the geostationary birds.)

Dual-gate FETs are at the heart of both the RF amplifier and mixer circuits. Five individual crystal oscillators are switched automatically (or manually) by a 4017 ring counter IC. Their signals are mixed to a 10.7 MHz IF, which is then processed all the way to low-level audio by a single IC (an MC3361). An LM380N provides the audio boost sufficient to drive a speaker.

The compact exterior of the R139 reflects the simplicity of the design. Sizeable **VOLUME** and **SQUELCH** controls dominate the front panel. Between and below the controls are five red LEDs numbered one through five. Small toggle switches select **POWER** and **AUTO** (scan) or **MANUAL** channel selection.

The rear panel offers a BNC antenna connector. The power, audio output, demodulator output and tape recorder controls are provided via a DB-9 socket. The choice of the DB-9 is a bit odd, but it's probably less expensive than installing separate connectors. It would have been helpful if Hamtronics had included a prewired DB-9 plug, but this is a minor nit to pick.

Setting up the R139

The Hamtronics R139 comes with an excellent manual, which makes installation and setup a breeze. The receiver requires 12 V dc and a small wall-module power supply is provided. You must wire the supply to the included DB-9 plug, which could be a problem for those unaccustomed to soldering wires onto small, multipin connectors. Just make sure you follow the manual diagram carefully. The same holds true for wiring the other DB-9 connections.

The first thing I did was to simply wire up a speaker and listen to a satellite pass. I used my satellite-tracking software to pinpoint the next NOAA-12 appearance and, sure enough, there it was—beeps, tick-tocks and all. Although my antenna was a small 2-meter Yagi in my attic, the satellite's signal was loud and clear. For most of my experiments with the R139, I used NOAA-12 and NOAA-14. Each satellite provides two overhead passes every 24 hours.

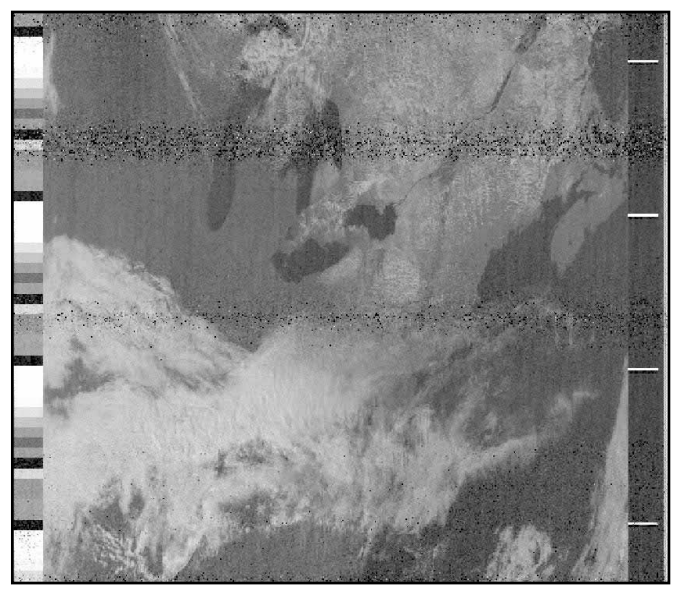
For the next NOAA-12 pass the following morning, I squelched the R139 and put it in the scanning mode. As NOAA-12 climbed to about 20° above the horizon, the R139 suddenly locked onto channel 3 (137.500 MHz) and the squelch opened to the rhythmic sound of the satellite.

Receiving and Demodulating Images

In the old days (prior to about 1996 or so) the only way to demodulate a weather satellite signal and display the resulting image on a computer was to use a stand-alone demodulator. Usually this took the form of yet another box that you placed beside your satellite receiver. And if you wanted to record images while you were away from home, you needed to have the means to store the signals, typically by using an audio tape recorder.

The R139 is equipped with a demodulator signal output line for those who still own hardware demodulators. It even includes a nifty tape-recorder control that "closes" a transistor switch whenever the squelch opens.

NOAA-14 at 3:21 AM. Night still blankets the upper Midwest and east coast, so this image was captured in infrared automatically while I slept! The satellite was passing behind my attic Yagi, which accounts for the noise in the signal. Even so, the image is fairly clear.



NOAA-12 crossed almost directly through the primary pattern of my antenna for this image. The Great Lakes and a large part of the Canadian Maritimes are clearly visible.

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But for those of us who own PCs with sound cards—and that is most PCs sold today—there is a much easier method. Everything the external demodulators and tape recorders used to do can now be accomplished with software. The program of choice, and the one that I use, is *WXSAT* by Christian Bock. You can find *WXSAT* on the Web at **http://ourworld.compuserve.com/homepages/HFFax/toc20.htm**. This ingenious piece of software uses the DSP power of the sound card and PC to demodulate weather satellite images. *WXSAT* displays and analyzes the images for you. It will even do sophisticated automatic image processing and storage of both the images and the audio files.

The Hamtronics R139 and *WXSAT* are a superb combination. Connecting the two was as easy as running a shielded audio cable between the R139 and my sound card input. I was able to leave *WXSAT* and the R139 running almost continuously, grabbing satellite images whenever the birds came within range. Since *WXSAT* is *Windows* software, you can multitask, too. Believe it or not, as I was typing the previous paragraph in *Word97*, *WXSAT* was receiving an image from the Meteor 3-5 satellite!

But how well does it work?

My meager station is far from ideal for monitoring weather satellites. Not only is my antenna in the attic, it is a fixed Yagi. This is a liability because my reception is limited to only that portion of each satellite pass that travels through my Yagi's pattern. Unless you can track the satellite throughout a pass using an azimuth/elevation rotator, a beam antenna does more harm than good. You are probably better off with an omnidirectional antenna such as a turnstile (Hamtronics sells these), eggbeater or quadrifilar.

My other liabilities include the fact that my antenna is close to my PC (enough birdies to make Alfred Hitchcock envious), and that fact that I don't have a receive preamplifier. Despite all this, the R139 did a remarkable job (see the sample images).

Conclusion

If you want to receive APT weather satellite images with your bare hands, you can't go wrong with the R139. It is a good receiver at an economical price. If you enjoy building, you can purchase the kit version of the R139 and save even more money.

Teachers should take note. The R139 is probably the least expensive means possible to expose your students to the awe and wonder of satellites. With the R139, the *WXSAT* software, a simple antenna and a desktop or laptop PC, students will be treated to an astronaut's view of their home planet. It's important to emphasize that the image they are seeing is not a stored picture that's hours or days old—it is a real-time snapshot taken from a spacecraft at the very moment that it's streaking over their heads! Radio doesn't get much more impressive than this. Ask any ham.

Manufacturer: Hamtronics Inc, 65 Moul Rd, Hilton, NY 14468; tel 716-392-9430; fax 716-392-9420; **jv@hamtronics.com**; **http://www.hamtronics.com**. Manufacturer's retail price, assembled with cabinet and 115 V ac adapter: $239; in kit form with cabinet and ac adapter: $189; in kit form less cabinet and ac adapter: $159.

SOLICITATION FOR PRODUCT REVIEW EQUIPMENT BIDS

[In order to present the most objective reviews, ARRL purchases equipment off the shelf from dealers. ARRL receives no remuneration from anyone involved with the sale or manufacture of 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. All equipment is sold without warranty.

ADI AT-201 2-meter FM handheld transceiver, serial number 7S40030019 (see "Product Review," December 1997 *QST*). Minimum bid: $90.

Alinco DJ-S11T 2-meter FM hand-held transceiver, serial number T003447 (see "Product Review," December 1997 *QST*). Minimum bid: $60.

Alinco DR-140TQ 2-meter FM mobile transceiver, serial number T003282 (see "Product Review," March 1999 *QST*). Minimum bid: $130.

ICOM IC-2100H 2-meter/70-cm FM mobile transceiver, serial number 004132 (see "Product Review," January 1999 *QST*). Minimum bid: $125.

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In your bid, clearly identify the item you are bidding on, using the manufacturer's name and model number, or other identification number, if specified. Each item requires a separate bid and envelope. Shipping charges will be paid by ARRL. Please include a daytime telephone number. The successful bidder will be advised by telephone or by mail. Once notified, confirmation from the successful bidder of intent to purchase the item must be made within two weeks. No response within this period will be interpreted as an indication of the winning bidder's refusal to complete the transaction. The next highest bidder will then have the option of purchasing the item. No other notifications will be made, and no information will be given to anyone other than successful bidders regarding final price or identity of the successful bidder. If you include a self-addressed, stamped postcard with your bid and you are not the high bidder on that item, we will return the postcard to you when the unit has been shipped to the successful bidder.

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