The Kenwood TS-2000 All-Mode Multiband Transceiver

Reviewed by Robert Schetgen, KU7G
Senior Assistant Technical Editor

The TS-2000 is Kenwood's long-anticipated reentry into an "arms race" that's been raging among amateur equipment manufacturers for several years now. The rivalry was touched off when 6-meter coverage started appearing as "standard equipment" in a few of the mid-level HF tabletop and mobile transceivers. Kenwood was no innocent bystander here; their HF plus 6-meter TS-680S was one of the rigs that may have started this whole thing in the first place.

Kenwood then seemed content to stand back while the competition progressively upped the ante. HF/6-meter rigs were followed by HF/6-meter/2-meter rigs, and then HF/6-meter/2-meter/70-cm rigs. Yaesu—with their FT-847—escalated the stakes further by rolling in full-duplex satellite capabilities.

A little over a year ago, Kenwood unveiled a mockup of the Amateur Radio equivalent of the 2-lb version of the Swiss Army knife. At that time, they still hadn't come up with a title for their proposed creation (among the general ham population, it temporarily held the *nom de plume* "Kenwood's Radio with No Name"). The premiere edition of the glossy sales brochure that outlined its capabilities and band coverage—handed out at Dayton Hamvention 2000—read like an inventory of a spoiled ham's toy box. Coverage on all of the current HF bands with general coverage receive?—*check*; 2 meters, 6 meters and 70 cm?—*but of course*; 1.2 GHz (optional *or* standard)?—*why not?*; DSP filtering?—*you bet!*; satellite capabilities?—*yup* (welcome to the new millennium, Bunky!); a built-in TNC for VHF and UHF (with DX packet cluster display and "go to" features)?—*got that*. Toss in an automatic antenna tuner; a CW memory keyer; Kenwood's exclusive CW "Auto-tune" feature; a TCXO; an integrated RS-232 level converter; a separate receive antenna jack; and—well—*yada yada*.

This rig is heftier than the current crop of multiband subcompacts, though. What if you're in the market for a mobile transceiver?—*No problem!* An optional compact mobile control head (the RC-2000) will plug right in for back seat or trunk mounted chassis setups. You can even buy a less expensive "silver box" version of the rig (the TS-B2000) and operate it using the mobile head.

Kenwood recently released a TS-2000X version. The 'X includes the 1.2 GHz module as standard equipment. And any of the versions—with or without the front panel display, buttons and knobs—can be fully controlled using a personal computer and Kenwood's optional ARCP-2000 PC software.

We purchased the "standard" TS-2000 tested in this review several months ago, intending to add the 1.2 GHz option as soon as it became available. We had initially hoped to include data and comments on 1.2 GHz performance in this review. The module—the UT-20—just recently became available, and the installation requires a trip to Kenwood's service facility for installation. Consequently, we'll save the 1.2 GHz information for a future column.

The Radio

The base-model TS-2000 covers 12 ham bands from 1.8 through 450 MHz. Transmit capabilities on the 222-MHz band are not provided, but the radio is capable of receiving signals there—and a healthy chunk of the LF, HF, VHF and UHF spectrums as well (see Table 1).

Bottom Line

The TS-2000 is the closest thing yet to a complete ham station between a single set of covers. Highlights include multimode transceive on up to 13 ham bands, a full range of VHF/UHF FM repeater and satellite operating features, and a built-in packet TNC.

The main receiver covers MF/HF from 0.03 to 60 MHz with IFs at 69.085 or 75.925 MHz, 10.695 MHz, 455 kHz and 12 kHz. The DSP-based filtering is in the 12 kHz IF. For reception of 118 to 512 MHz, the first IF is at 41.895 MHz. UT-20-equipped models also tune 1240 to 1300 MHz with a first IF of 135.495 MHz. Transmitter output is adjustable from 5 to 100 W on the ham bands between 1.8 and 148 MHz and 5 to 50 W on 70 cm (1 to 10 W on 23 cm when the UT-20 is installed). The maximum AM-mode output is 25 W from 1.8 to 144 MHz and 12.5 W on 70 cm (2.5 W on 23 cm).

The transceiver has a sub-receiver that functions on the AM and FM modes only (including packet) from 118 to 174 MHz and 220 to 512 MHz, with IFs at 58.525 MHz and 455 kHz.

The Manual

As an old-time model builder and programmer, I always reach for the manual first. This one is large, 143 pages. I spent a considerable amount of time just reading the detailed table of contents. The manual is designed to please anxious-to-get-on-the-air new owners. In only seven pages, it describes radio installation and provides examples of two typical first QSOs: HF/6 meters and VHF/UHF. This lets you get your feet wet and confirms that your new baby is functioning properly. With these initial "instant gratifications" delivered, the manual then moves on to a complete tour. The documentation packed with the transceiver includes eight schematics that are large enough to read (23×33 inches). [A PDF file of the manual is available on Kenwood's Web site: **www.kenwood.net**.—*Ed*]

Looking at just the illustration in the manual, the front panel looks pretty intimidating. My old eyes had trouble making out the key labels that it shows. Thankfully, the actual panel is about 4 times larger than the depiction in the book. Nonetheless, I wouldn't want to try operating this rig in a dimly lit room—at least not until I became intimately familiar with the location of the controls. While I give Kenwood credit for backlighting the keys (like a car stereo), many of the additional key assignments are printed directly on the front panel, and the vast majority of these keys perform multiple operations.

Transceiver Controls

This radio has many capabilities, and therefore, many controls: 55 keys, five single and three double (concentric) knobs. There are control groups to suit many specialized pursuits: DXing, satellite work, VHF/UHF operation and more.

At the center of the panel is a tuning knob with a diameter of almost two inches. I didn't notice it at first, but there's a tension lever under the knob's lower edge. With minimum tension, a flip sends the knob more than a turn; at maximum tension, it's difficult to turn the knob with a finger in the indentation.

A pair of knobs at the lower left set the DSP filter high and low edges. At the upper right, an **RIT/SUB** knob adjusts the RIT or XIT when those functions are on, and the sub-receiver frequency when they're off. Two concentric sets control the main-receiver AF and RF gain, squelch and notch (for the DSP beat-cancel function when it's set for manual control). A third controls the sub-receiver AF gain and squelch; pushing this knob switches the sub receiver on or off.

Last, we come to the knob for all reasons: **MULTI/CH**. In the VFO mode, this knob steps the operating frequency up or down rapidly by one of several user selectable steps. In memory-channel mode, this knob is used to select the memory channel. It also selects menus in the menu mode and works as a control for many functions that are evoked by front panel buttons, such as **CAR**rier level or **MIC** gain.

A Battalion of Buttons

If these buttons were all positioned in one rectangular grid, it would be very difficult to learn their use; luckily they're not. Several plateaus and shapes on the front panel serve to group the keys. Some keys are rectangular, some triangular; there are even ellipses and other odd shapes. All of these characteristics help our minds cope with the staggering number of controls.

Nonetheless, the functions of many keys are context sensitive. The **CLR** key (lower left of main tuning knob) exits from, aborts or resets various functions, erases memory channels or locks memory channels out of the scan list. Some keys need to be pressed twice to perform a single function: Keypad frequency entry requires that you press **ENT** to initiate the action and again to end it (if you don't enter enough digits to fill the display). To recall a satellite memory, you must press **VFO/M VFO/CH** to enable the **MULTI/CH** selection of a channel, and again, to return to the frequency-adjustable mode.

The front panel of the TS-2000 includes a **PF** (programmable function) key that can be assigned one of a variety of functions by the user. The radio comes with Kenwood's MC-43S basic hand microphone, but an optional mike—the MC-47—offers four additional programmable keys (optional desk mikes are also available).

Many of the control keys can be switched between the main and sub receivers. The portion under control is indicated by a **CTRL** icon on the main display. If the icon is near the main frequency display, the operating controls act on the main receiver. If the icon is near the sub-receiver frequency display, the operating controls act on the sub receiver. The selected transmission band is similarly indicated by the location of a **PTT** icon.

A Multitude of Menus

Aside from all of those buttons, there are also many menus—and menus of menus! Actually, most of these menus function simply as software switches that enable, disable or set some feature of the radio. There are 62 of these, and 10 of them have submenus that further define individual functions.

With this many settings, we need help to remember what's what. You enter the menu system by pressing the **MENU** button to the upper right of the main knob. When you do so, the active menu's number, setting and text "explanation" (a scrolling description) appear in the bottom line of the display. At this point, we can use the **MULTI/CH** knob to maneuver through the main menu. If a menu contains a submenu, the explanation will show "Push Sub." Menu settings are changed via the **+** and **–** buttons, located just to the right of the main tuning knob.

The settings of all of these menus are then stored in one of two main menus (A and B). This allows you to set up two different arrays of settings to tailor the radio for a particular purpose. (It's like those vehicles that remember the seat, mirror and steering wheel locations for two different drivers.) As the manual suggests, you might set up "Menu A" for DXing and "Menu B" for rag chewing, for example. In addition, you can set up a "Quick Menu" that contains only those functions you choose. This might contain the settings you change most often.

A Long LCD Display

The **DISP** key switches the display among the normal display, DSP filter settings and "Visual Scan" modes.

On the left side of the LCD is the meter display. On receive it is an S-meter, but it also shows the filter bandwidth. While transmitting it can indicate RF output power, ALC, SWR (this functions only from 1.8 through 50 MHz) and speech-processor level. Icons below the meter show which HF antenna jacks are active and whether the automatic antenna tuning unit is enabled on transmit, receive or both.

The larger main-receiver portion of the display and the smaller sub-receiver portion (to the right) each show the selected memory channel, frequency and a constellation of icons that indicate the various functions applicable to that receiver. Look for the **PTT** and **CTRL** icons at the upper left of each receiver's frequency display. They indicate which receiver receives inputs from the panel controls and the current transmission band. When the RIT, XIT or split functions of the main receiver are active, the sub-receiver display shows an appropriate icon and frequency information. The rectangular area below the main-receiver display is a dot-matrix screen that normally shows the operating mode, but also shows menu numbers and settings or the DSP filter configuration. A similar dot matrix area is located under the sub-receiver display.

In the DSP display mode, the dot-matrix screens show information about the state of the DSP filters. The display enters this mode automatically whenever the operator adjusts the filter controls.

In the "View Scan" mode, the dot matrix below the sub-receiver frequency display shows a small band scope that plots the relative strength of signals near the main-receiver frequency. The main-receiver dot matrix shows the mode and the number of channels to be scanned. You may choose to scan 31, 61, 91 or 181 channels on each side of the main-receiver frequency. The sub-receiver frequency display shows the frequency of the channel currently being scanned. Scanning can be paused to hear the current scan station by pressing the **DISP** key. A second press resumes scanning. View-Scan mode can also be used to scan memory channels rather than VFO channels.

Connections

Kenwood has covered all the bases here. The front panel has the standard **MIC** (8-pin) and **PHONES** (1/4-inch, two or three conduc-

Table 1
Kenwood TS-2000, serial number 20800064

Manufacturer's Claimed Specifications

Frequency coverage: Receive, 0.03-60, 118-174, 220-512 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.[1]

Power requirement: Receive, 2.6 A; transmit, 20.5 A (maximum).

Modes of operation: SSB, CW, AM, FM, FSK.

Measured in the ARRL Lab

Receive and transmit, as specified.

Receive, 2.1 A; transmit, 18 A. Tested at 13.8 V.

As specified.

Receiver

SSB/CW sensitivity, bandwidth not specified, 10 dB S/N: 0.5-1.7 MHz, <4 µV; 1.7-24.5 MHz, <0.2 µV; 24.5-30, 50-54 MHz, <0.13 µV; 144-148 MHz, <0.16 µV; 430-450 MHz, <0.11 µV.

Receiver Dynamic Testing

Noise floor (MDS), 500 Hz filter:

	Preamp off	*Preamp on*
1.0 MHz	–110 dBm	–118 dBm
3.5 MHz	–128 dBm	–138 dBm
14 MHz	–129 dBm	–137 dBm
50 MHz	–127 dBm	–142 dBm
144 MHz	–124 dBm	–140 dBm
432 MHz	–128 dBm	–143 dBm

AM sensitivity, 10 dB S/N: 0.5-1.7 MHz, <32 µV; 1.7-24.5 MHz, <2.0 µV; 24.5-30 MHz, 50-54 MHz, <1.3 µV; 144-148 MHz, <1.4 µV; 430-450 MHz, <1.0 µV.

10 dB (S+N)/N, 1-kHz tone, 30% modulation:

	Preamp off	*Preamp on*
1.0 MHz	16 µV	6.3 µV
3.8 MHz	1.8 µV	0.68 µV
50 MHz	2.8 µV	0.38 µV
120 MHz[2]	0.79 µV	N/A
144 MHz	3.1 µV	0.48 µV
432 MHz	2.3 µV	0.38 µV

FM sensitivity, 12 dB SINAD: 28-30 MHz, 50-54 MHz, <0.22 µV; 144-148 MHz, 0.25 µV; 430-450 MHz, <0.18 µV.

For 12 dB SINAD:

	Preamp off	*Preamp on*
29 MHz	0.57 µV	0.14 µV
52 MHz	0.66 µV	0.14 µV
146 MHz	1.1 µV	0.18 µV
440 MHz	0.75 µV	0.13 µV

Blocking dynamic range: Not specified.

Blocking dynamic range, 500 Hz filter:

spacing:	20 kHz *Preamp off/on*	5 kHz *Preamp off/on*
3.5 MHz	127/124 dB	103/101 dB
14 MHz	126*/121 dB*	103/98 dB
50 MHz	123/118 dB	100/94 dB
144 MHz	115/108 dB	94/89 dB
432 MHz	123/115 dB	97/93 dB

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

Two-tone, third-order IMD dynamic range, 500 Hz filter,

spacing:	20 kHz *Preamp off/on*	5 kHz *Preamp off/on*
3.5 MHz	94/96 dB	68/68 dB
14 MHz	94/92 dB	69/67 dB
50 MHz	94/89 dB	69/66 dB
144 MHz	89/86 dB	65/63 dB
432 MHz	86/86 dB	69/67 dB

Third-order intercept: Not specified.

Intercept:	*Preamp off/on*	*Preamp off/on*
3.5 MHz	+16/+14 dBm	–17/–28 dBm
14 MHz	+19/+4.2 dBm	–15/–29 dBm
50 MHz	+18/–4.0 dBm	–15/–35 dBm
144 MHz	+12/–8.1 dBm	–17/–38 dBm
432 MHz	+14/–9.5 dBm	–16/–39 dBm

Second-order intercept: Not specified.

Preamp off, +59 dBm; preamp on, +58.4 dBm.

FM adjacent channel rejection: Not specified.

20 kHz channel spacing, preamp on: 29 MHz, 79 dB; 52 MHz, 80 dB; 146 MHz, 75 dB; 440 MHz, 76 dB.

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

20 kHz channel spacing, preamp on: 29 MHz, 80 dB*; 52 MHz, 80 dB; 146 MHz, 76 dB; 440 MHz, 77 dB*; 10 MHz channel spacing, preamp on: 52 MHz, 113 dB; 146 MHz, 87 dB; 440 MHz, 81 dB.

S-meter sensitivity: Not specified.

S9 signal at 14.2 MHz: preamp off, 110 µV; preamp on, 24 µV; 52 MHz, preamp off, 170 µV; preamp on, 15 µV; 146 MHz, preamp off, 58 µV; preamp on, 5.4 µV; 432 MHz, preamp off, 63 µV; preamp on, 4.8 µV.

Squelch sensitivity: SSB, 0.5-1.7 MHz, <18 µV; 1.8-28.7 MHz, <1.8 µV; 50-54 MHz, 144-148, 420-450 MHz, <1.1 µV; FM, 28-30 MHz, <0.2 µV; 50-54 MHz, <0.2 µV; 144-148 MHz, 0.16 µV; 430-450 MHz, <0.1 µV.

At threshold, preamp on: SSB, 14 MHz, 1.7 µV; FM, 29 MHz, 0.12 µV; 52 MHz, 0.09 µV; 146 MHz, 0.06 µV; 440 MHz, 0.06 µV.

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Receiver audio output: 1.5 W at 10% THD into 8 Ω.	2.3 W at 10% THD into 8 Ω.
IF/audio response: Not specified.	Range at –6 dB points, (bandwidth): CW-N (500 Hz filter): 551-1042 Hz (491 Hz); CW-W: 288-1717 Hz (1429 Hz); USB-W: 445-2356 Hz (1911 Hz); LSB-W: 471-2269 Hz (1798 Hz); AM: 146-2476 Hz (2330 Hz).
Spurious and image rejection: 70 dB.	First IF rejection, 14 MHz, 90 dB; 50 MHz, 86 dB; 144 MHz, 95 dB; 432 MHz, 118 dB; image rejection, 14 MHz, 89 dB; 50 MHz, 69 dB; 144 MHz, 86 dB; 432 MHz, 88 dB.
Transmitter	***Transmitter Dynamic Testing***
Power output: HF & VHF: SSB, CW, FM, 100 W high; 5 W low; AM, 25 W high, 5 W low; UHF: SSB, CW, FM, 50 W high, 5 W low; AM, 12.5 W high, 5 W low.	HF & 50 MHz: CW, SSB, FM, typically 104 W high, 3.7 W low; AM, typically 25 W high, 3.3 W low; 144 MHz: CW, SSB, FM, typically 98 W high, 4.0 W low; AM, typically 22 W high, 3.0 W low; 430 MHz: CW, SSB, FM, typically 51 W high, 6.8 W low; AM typically 12 W high, 3.0 W low.
Spurious-signal and harmonic suppression: HF, ≥50 dB; VHF & UHF, ≥60 dB.	HF, 55 dB; 50 MHz, 63 dB; 144 MHz, 69 dB; 430 MHz, 69 dB. Meets FCC requirements for spectral purity.
SSB carrier suppression: ≥50 dB.	As specified. >53 dB.
Undesired sideband suppression: ≥50 dB.	As specified. >62 dB.
Third-order intermodulation distortion (IMD) products: Not specified.	See Figures 1 and 2.
CW keyer speed range: Not specified.	10 to 63 WPM.
CW keying characteristics: Not specified.	See Figure 3.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, 18 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 10 ms; FM, 10 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, 7.9×10^{-5}; BER at 16 dB SINAD, $<1.0\times10^{-5}$; BER at –50 dBm, $<1.0\times10^{-5}$; transmitter: BER at 12-dB SINAD, 1.7×10^{-4}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$. 440 MHz—Receiver: BER at 12-dB SINAD, 2.9×10^{-4}; BER at 16 dB SINAD, $<1.0\times10^{-5}$; BER at –50 dBm, $<1.0\times10^{-5}$; transmitter: BER at 12-dB SINAD, 1.5×10^{-4}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$.

Size (HWD): 4.2×11.1×14.6 inches; weight, 17.2 lb.

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]1240-1300 MHz transmit and receive with UT-20 1.2 GHz module.

[2]AM aircraft on sub receiver only.

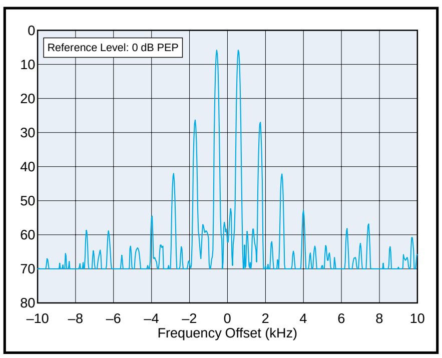


Figure 1—Worst-case HF spectral display of the TS-2000 transmitter during two-tone intermodulation distortion (IMD) testing. The worst-case third-order product is approximately 27 dB below PEP output, and the worst-case fifth-order product is down approximately 42 dB. The transceiver was being operated at 100 W PEP output at 1.85 MHz.

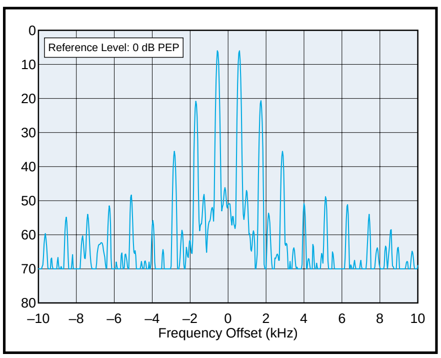


Figure 2—Worst-case VHF/UHF spectral display of the TS-2000 transmitter during two-tone intermodulation distortion (IMD) testing. The worst-case third-order product is approximately 22 dB below PEP output, and the worst-case fifth-order product is down approximately 36 dB. The transceiver was being operated at 100 W PEP output at 50.2 MHz.

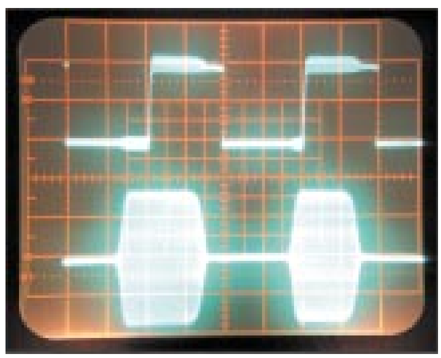


Figure 3—CW keying waveform for the TS-2000 showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. The transceiver was being operated at 100 W output at 14.02 MHz.

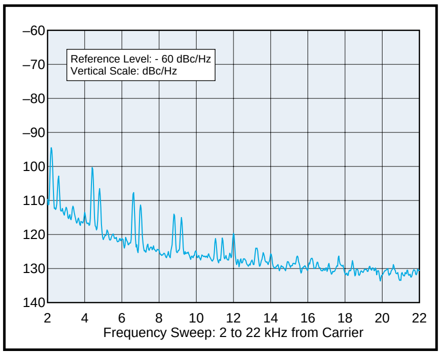


Figure 4—Worst-case HF spectral display of the TS-2000 transmitter output during composite-noise testing. Power output is 100 W at 3.52 MHz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

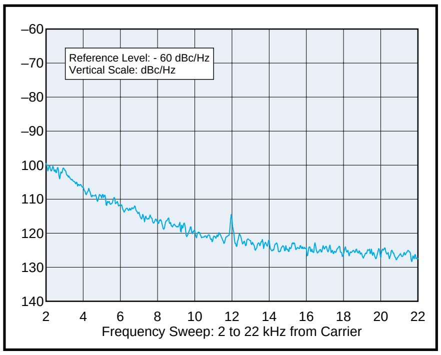


Figure 5—Worst-case VHF/UHF spectral display of the TS-2000 transmitter output during composite-noise testing. Power output is 50 W at 430.02 MHz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

tors) connections. On the back are several antenna connectors (**ANT1** and **ANT2** for HF and **50 MHz**, **HF RX ANT**, **ANT 144**, **ANT 430**). All are SO-239s except the **RX ANT** (it's a phono jack) and **ANT 430**, which is an N connector. When installed, the UT-20 has its own antenna connector on a pigtail. Although the TS-2000 has an internal automatic antenna tuning unit, it also has a back-panel 6-pin **AT** connector for Kenwood's now-discontinued AT-300 tuner.

There are two external speaker connectors (1/8-inch, two conductors) on the rear panel. One of these outputs mutes the internal speaker and the other does not. Menus numbers 16 and 17 control the mixing/separation of the main and sub receiver audio signals at these connectors and the **PHONES** jack. A "diversity" speaker setup helps you separate an ongoing QSO from secondary audio, and ignore the secondary audio when desirable.

The TS-2000 offers two CW keying jacks as well. One (1/4-inch, three conductors) takes paddle input to the internal keyer. The second (1/8-inch, two conductors) accepts keying from a manual key, external keyer or a PC keying line.

There is no shortage of accessory connectors. A **COM** connector accepts a standard DB9 cable for connection to a PC. (No interface is needed!) There's a **PANEL** connector for the optional RC-2000 remote-panel kit. The **REMOTE** (7-pin DIN) connector accommodates an HF amplifier. **EXT CONT** (8-pin DIN) provides amplifier control connections for 50, 144, 430 or 1200-MHz amplifiers. **ACC2** (13-pin DIN) offers a host of connection points for interfacing an external TNC, MCP or RTTY device, or a computer sound card.

DSP Functions

There are many. The filtering scheme is wonderfully flexible. There are no optional filters, and I didn't miss them.

CW bandwidth is adjustable from 2 kHz to 50 Hz (250 to 1500 Hz for FSK). While working CW, I was constantly using the **LO/WIDTH** control to adjust the bandwidth, from 1 to 2 kHz for tuning to 400-500 Hz for operating, and as narrow as 80 Hz for crowded conditions. (Band noise kept the 50-Hz width from being useful for me.) The **HI/SHIFT** control adjusts the IF shift.

In voice modes (AM, FM, SSB) both the passband low (0 to 1000 Hz) and high (1400 to 5000 Hz) cutoff points are adjustable.

The notch filter, auto and manual beat-cancel functions worked well. I tuned W1AW's bulletin signal from about 15 miles away and was able to almost eliminate it with each of these features. It was amazing to listen to the auto beat cancel function chase the signal as I changed frequency.

The noise-reduction modes—**NR1** (line enhancement), and **NR2** (correlation time)—were sometimes helpful. It takes some practice to get best advantage from these features.

Satellite Operations

I've dabbled a bit with satellite operation over the years, but I decided to hand the rig over to Steve Ford, WB8IMY—our resident satellite expert—and have him share his impressions. Here's what he had to say:

"The Kenwood TS-2000 performed admirably in the satellite mode. I had no difficulty making contacts through the OSCAR 29 satellite, as well as OSCAR 14. The full duplex function was flawless and the automatic uplink/downlink VFO tracking (referred to as "Trace" in the TS-2000) makes using even inverted-transponder birds such as OSCAR 29 a breeze. You can store all of your favorite satellite frequency combinations in one of the TS-2000's many satellite memories for quick access.

"With 50 W output on 70 cm, you may not need an external RF power amplifier with the TS-2000 to uplink to the new OSCAR 40 satellite in Mode U/S—assuming that you use a reasonable antenna (such as an eight-element Yagi). For the 2.4-GHz downlink, the TS-2000's ability to display the actual target receive frequency (rather than the IF signal frequency from the receive converter)—up to 19.999 GHz—is a blessing. I used the TS-2000 in combination with a small dish antenna and receive converter to monitor OSCAR 40's 2.4-GHz transponder. It performed well, although I occasionally found myself cranking up the audio to fairly high levels to copy faint signals.

"If you intend to couple the TS-2000 to an external amplifier to run serious power for other weak-signal modes, be aware that the TS-2000 only provides an open-collector NPN transistor switch (rated at 20 V and 20 mA) for amplifier control. This may be insufficient to switch some amplifiers, although adding an external relay would solve this problem. If you're in doubt about your amplifier's requirements, check with its manufacturer."

Memory Functions

There are 300 memory channels to store frequency, mode, bandwidth and many other aspects of operation. Each memory channel can be tagged with a seven-character alphanumeric identifier. The channels can be divided into up to 10 groups (0 through 9), and more than one group can be selected for recall or scanning. Memory channels can be selected for storage or recall by scrolling through the list via the **MULTI/CH** knob or the mike **UP/DWN** buttons. Channels may also be selected directly by entering the appropriate memory number with the numeric keypad.

Memories 0 through 289 are general memories. Memories 290 through 299 store start and end frequencies that might be used to control scanning or to restrict VFO tuning via the main dial. Neat feature! This might be used to ensure that you remain within the frequency allocation of your license class on a particular band.

Quick Memory

The TS-2000 has 10 scratch-pad locations that hold a snapshot of the current operating conditions. This includes the frequency and mode of both VFOs and the sub receiver. These also retain the on/off/selection status of RIT, XIT, filter bandwidth, noise blanker, DSP noise reduction, beat cancel, auto notch and other various transmit and receive functions. In order to store or recall quick-memory locations, both the main and sub receivers must be in the VFO mode, even when the sub receiver is switched off. Quick Memory is a stack system. If all quick memories are full and **M.IN** is pressed, the new data storage will cause the oldest data set to be lost.

TNC Capabilities

The TS-2000 sports a built-in TNC (AX-25) that's primarily intended to support the PCT (Packet Cluster Tune) and Sky Command II+ features.

It's important to note that Sky Command II+ system—a feature that allows near complete control and operation of this transceiver remotely (over the air) using Kenwood's TH-D7A VHF/UHF handheld or TM-D700A VHF/UHF mobile—is not presently legal for use in the United States. Kenwood has recently filed a Petition for Rulemaking with the FCC, requesting that they consider adopting a change in Section 97.201(b). This rule limits "auxiliary station" operation to frequencies above 222.15 MHz. (Unfortunately, the current Sky Command system employs 2-meter frequencies to transmit the TS-2000's receive audio back to the handheld or mobile radio.)

Other Features

The **TF-Set** key momentarily swaps the transmit and receive frequencies so that you can be sure it is clear before transmitting. You can also then easily change the transmitting frequency if you wish. This is helpful for FM repeaters, satellite operation and working DX splits.

FM Repeaters

The TS-2000 is well equipped for FM repeater operation—it's very nearly as feature-packed as Kenwood's most deluxe dualband FM handhelds and mobiles. It is capable of dual in-band receive (VHF/VHF, VHF/UHF or UHF/UHF) and cross-band repeat, and has an automatic repeater-offset feature. Memories can store frequency offsets, alphanumeric tags and access tone information. Digital Code Squelch (DCS) operation is also supported, and CTCSS and DCS tone scan is provided. DTMF—for autopatch and repeater control—requires an optional DTMF microphone, the MC-52DM. The transceiver can store up to ten 16-digit DTMF sequences, and each can be alphanumerically labeled.

MULTI/CH = Tuning Convenience

Here's that knob again! It makes tuning changes very convenient. The user can select channel sizes that set the tuning rates for this control. Its rate is stored for each mode in each band range (HF/50 MHz, 144, 430 and 1200 MHz). The channel can be from 1 kHz to 100 kHz for various modes below 60 MHz. By pressing the **1 MHZ** key, you can change frequency by 1 MHz for each detent of **MULTI/CH**. (You can also reprogram these steps to be 100 kHz or 500 kHz.)

Transmit Signal Characteristics

The TS-2000 permits several adjustments to the transmit audio in addition to speech compression. There are six user-selectable audio bandwidths from 2.0 to 3.0 kHz. Menu #21 sets one of six audio-response curves: off, high boost, formant pass, bass boost, conventional and user defined. The user curve is custom designed using the optional ARCP software.

CW Characteristics

Several capabilities of the TS-2000 particularly cater to CW operators. We can select full break-in or semi break-in keying with delays from 50 to 1000 ms. Full break-in on this rig is a pleasure. It's quiet enough that the TR switching is not distracting. The CW offset and sidetone are adjustable in 50-Hz steps from 400 to 1000 Hz.

Pressing **FUNC** then **RIT/CW TUNE** causes the receiver to adjust its frequency (or the RIT if that function is active) so that the received signal's pitch equals (within 50 Hz) that selected for the sidetone (offset). This effectively zero beats the received CW signal automatically. To use this function, you must select a filter bandwidth less than 1 kHz.

Menu #37 selects whether the receiver automatically compensates for the mixing scheme change when you change the mode from SSB to CW. You can tune a CW signal in the SSB mode and not lose it when you switch to CW! Couple that with Menu #36: In full break-in mode, operating the keyer automatically changes the mode to CW and transmits: hunt and pounce! That's a nice feature!

There is a built-in three-memory (about 50 characters each) keyer with adjustable weighting. Message-memory playback is interruptible to insert contest serial numbers and such. Menu #30 sets whether the playback is ended or paused when interrupted by keying. When storing a message in memory, the display shows a gauge indicating how much memory remains. Messages may be automatically repeated at intervals from 0 to 60 seconds.

For those who prefer a "Lake Erie swing," the keyer has a "bug" mode in which dahs are keyed manually and the dits are made automatically. The message memories cannot be recorded while in the bug mode, however.

RIT and XIT

RIT and XIT each have a ±20 kHz range. They normally tune in 10-Hz steps, but can be fine tuned in 1-Hz steps. They work only on the main receiver. Pressing the **CLEAR** key (not **CLR**!) resets the offset to zero. They do not have independent settings, so changes to one affect the other. Thus, it makes no sense to use them simultaneously. Unfortunately, Packet Cluster Tune mode locks RIT and XIT out. If you want them, you must kill **PCT** first.

AGC

The digital AGC permits adjustment of the AGC delay in 20 steps, as well as switching it off completely. You can set separate AGC delays for each mode: SSB, CW, FSK and AM. For CW, I needed the AGC at its fastest setting for the S-meter to follow the incoming signals.

VOX

VOX can be switched on or off, VOX mike level and delay can be set separately for each mode, except FSK.

Speech Processor

The speech processor level can be independently set for each mode: USB, LSB, FM or AM. It does a good job, as shown by my experience with ZK1NFK (see "On the Air").

On the Air

I found the front panel surprisingly easy to learn and use. An initial pass through the menu system took about five minutes (without the manual in hand) and the prompts were adequate to set up most functions without research. Jumping around the bands with the **+** and **–** keys, tuning dial (both normal and fine mode) and the **MULTI/CH** knob was a breeze. There was a lot of QRN, so I became familiar with the noise blanker, DSP and filter controls. The noise blanker did a good job.

DSP **NR1** and **NR2** kill noise, but I often couldn't copy the station I was seeking with the noise removed. You can set their operating levels from the front panel. In the noisy conditions that I experienced, the CW filters sounded hollow, but they were useful down to 80 Hz wide. They offered great on-the-spot flexibility.

I was so interested in the CW auto-tune feature that I quickly programmed it into the **PF** key for easier access. When I used it on the air, however, I found that there was seldom a single signal in the passband. Even when there was a single signal, the auto-tune feature sometimes missed it. It may have been a product of the noisy on-air conditions I encountered, but CW auto-tune successfully tuned about one signal in four attempts. The

SSB-to-CW frequency correction feature worked flawlessly.

My favorite feature is the DX Packet Cluster Tune. I'm not an avid DXer and never before had access to the DX Packetcluster. I got the local frequency from Product Review Editor Joe Bottiglieri, AA1GW, and the feature is easy to set up. At first, I enabled its auto-tune function, but sometimes the DX spots came in so fast that the radio was continually jumping among DX stations. I soon switched auto-tune off (although transmitting switches it off automatically) and selected Morse callsign announcements. I never had any idea how much DX activity there is! There were even spots for 50 MHz activity and the International Space Station, NA1SS.

You can't argue with success! In the first few hours on a very noisy (QRN) night, I worked NØTU/M QRP CW, HK8RQS in Colombia and ZK1NFK, Manihiki Island. These last two were pileups. ZK1NFK was working folks all over North America, but I dialed in the speech processor and got through with my lowly (and low) 20-meter dipole on my seventh call. I'm impressed.

Our thanks to Steve Ford, WB8IMY; Ed Hare, W1RFI; and Mike Tracy, KC1SX of the ARRL Lab Staff for their assistance in preparing this review.

Manufacturer: Kenwood Communications Corp, 2201 Dominguez St, Long Beach, CA 90801; 310-639-5300, fax 310-537-8235; **www.kenwood.net**. Manufacturer's suggested list price: TS-2000, $2599.95; TS-B2000 ("silver box" version),

ARRL Lab Data Table Change

Beginning with this Product Review, the test data table includes something new—receive dynamic range and intercept points for a narrower than standard spacing: 5 kHz. We try to keep data tables in *QST* as consistent as possible for the logical reason that it makes comparing various radios easier. Therefore, when someone proposes a change in testing—or additional testing—a good reason must be supplied to justify the extra time and publication space. Needless to say, such changes are not approved very often.

One of the things that I have received feedback on from a number of hams is that other stations close in frequency to the one they are trying to listen to can present major difficulties. In contests, strong stations in your area may abound, and if someone located nearby is several kilohertz up or down the band, has his beam pointed in your direction and is running a kilowatt, you will certainly know it! If you are working a pileup for that rare DX and the operation is split, you will be listening just a few kilohertz from a large crowd of folks all trying to get through at the same time. Of course, these are examples of extreme cases, but there are certainly others.

The ARRL Lab standard spacing of 20 kHz is a good compromise between narrow and wide dynamic range performance, but it doesn't characterize crowded conditions very well. In our *Expanded Test Result Reports* (available on the members section of our Web site or via mail), we show (graphically) receive dynamic range over a range of frequencies, from about 200 kHz away to 1 kHz away from the desired signal frequency. This "swept" data gives a much more complete picture of a receiver's dynamic range than any single number can, but the graphs would take up too much page space to publish in each transceiver review that appears in *QST*. Examples of these graphs appear to the right. Note that these particular graphs differ from those in the Expanded Reports in that: (1) Data for two transceivers is shown and (2) Noise-limit markings have been omitted for clarity.

Why did we choose 5 kHz specifically? First, it is a spacing commonly used for "close-in" dynamic range testing by several independent sources, so it has become something of a standard. Second, as previously noted, 5 kHz is a common split in DX operations, so there is precedent there. Last, many multiple-conversion receivers start out with a relatively broad "roofing" filter in the first IF (for substantial cost savings, among other reasons) and this narrower spacing can give a better indication of the performance of later receiver stages. It is important to note that, for the majority of rigs, the "skirts" of the roofing filter are outside of the 5 kHz range so the rejection normally provided by this filter is not being shown.

For an example of 5 kHz dynamic range test results from several example transceivers, refer to Table 2.

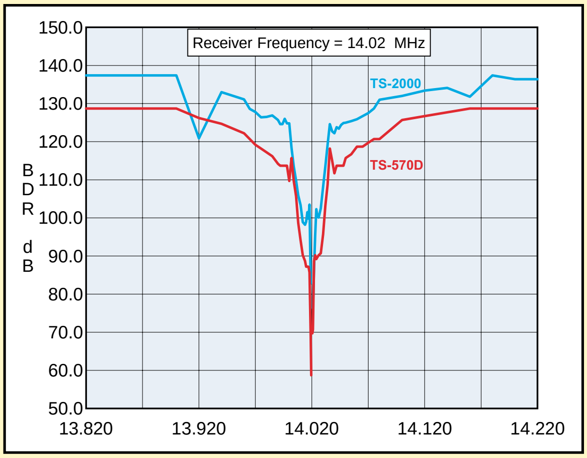
It is important to note that no single test result can stand alone as an indicator of overall receive performance. Always try to obtain as much information as possible to get the "big picture" when comparing different radios. Also note that the wide range of values that appear in this table are in part due to differences in receiver architecture, which is a whole other issue to consider in itself.

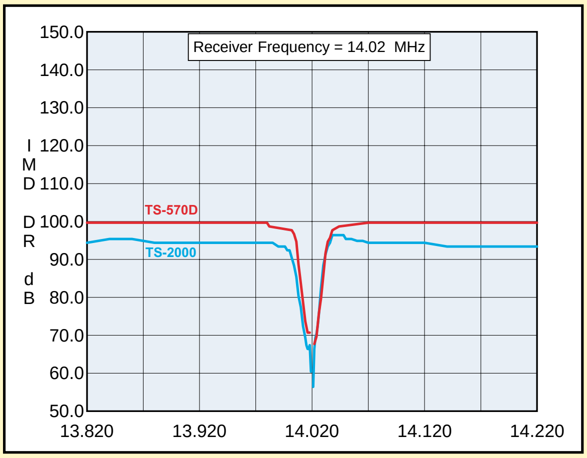
As always, the ARRL Lab welcomes feedback and discussion of test data and methods.

73, Michael Tracy, KC1SX
ARRL Lab Test Engineer

Table 2
Dynamic Range Measurements at 5 kHz Spacing for Several Current HF Transceivers

	5 kHz Dynamic Range (dB)	
Transceiver	*Blocking*	*IMD*
Elecraft K2	126	88
ICOM IC-706MKIIG	86	74
ICOM IC-746	88	78
ICOM IC-756PRO	104	80
ICOM IC-775DSP	104	77
Kenwood TS-570D	87	72
Kenwood TS-2000	99	67
Ten-Tec Omni 6+	119	86
Yaesu FT-847	82	73
Yaesu Mark-V FT-1000MP	106	78





$2199.95; TS-2000X (with 1.2 GHz module installed), $3299.95. Typical current street price: TS-2000, $2300; TS-B2000; $1850; TS-2000X, $2750. List prices of selected optional accessories: RC-2000 Mobile Controller head with cabling, $385.95, ARCP-2000 *Windows* PC control program on CD-ROM, $82.95; UT-20 1.2 GHz module (sold and installed by Kenwood Service), $549.95; DRU-3A Digital Recording Unit, $139.95; VS-3 Voice Synthesizer (announces operating frequency only), $39.95.

The Video-Lynx 434 Micro ATV Transmitter

Reviewed by Joe Bottiglieri, AA1GW
Assistant Technical Editor

If your objective is to rapidly deliver a large amount of information in an easy-to-digest format, full-motion video is tough to beat. Radio links carrying video can be extremely useful tools in amateur public service and emergency communications applications; terrific attention grabbers at ham radio demonstrations; a great way to swap shack views and home-spun videos with other hams; and a high-tech payload for balloons, kites, rockets, robots or R/C models.

Getting your feet wet in this aspect of our hobby may not be as expensive as you think. Most hams *already own* a video receiver that's capable of displaying 70-cm amateur television signals: a "cable ready" TV! Just connect a suitable 70-cm receive antenna to the cable input jack of the television, dial up *cable* channels 57 through 61, and you're got a basic ATV receiving system. (ATV-optimized receivers and downconverters, however, will outperform the cable receiver in a TV set.)

How about transmitting? There's a wide selection of ATV transmitting equipment available, but if your intended applications involve short-range simplex operation, a Video-Lynx 434 might fit the bill.

The '434 is a low-power ATV transmitter in a tiny package; it's just slightly larger than the 9-V battery typically used to power it. It transmits an amplitude modulated video signal on 433.97 MHz (cable TV channel 59).

The transmitter's circuitry is entirely encapsulated in potting resin. A 9-V battery connector, a BNC antenna jack and a female phono "Video In" socket are mounted on pigtail cables. The only control on the device is a recessed video linearity adjustment screw. There are no provisions for sending an audio subcarrier along with the video.

Video Sources

The transmitter accepts SMPTE standard video (NTSC or PAL) at 1 V P-P. Most video sources—such as camcorders, VCRs and the small black and white and color "surveillance" cameras—have a "Video Out" jack that supplies this signal.

Bottom Line

The Video-Lynx 434 is a tiny, low power video transmitter that can serve in a variety of short-range ATV assignments.

I purchased a tiny color camera from an electronics surplus store for under $80. Black and white cameras are available for much less.

Power Considerations

A standard 9-V battery provides power for the Video-Lynx 434. I found that a fresh alkaline battery would power the transmitter for about $3^1/_2$ hours. If longer operating periods are desired, the documentation suggests using nickel hydride or lithium batteries, or connecting an additional 9-V battery in parallel. A 9-V power supply can also be employed, but be careful—the '434 circuitry does not include reverse polarity protection.

I was pleased to discover that my camera will work at 9 V dc. (The wall transformer dc power supply that came with it outputs 12 V.) This allows me to run both the transmitter and the camera—albeit for a short time—from a single battery.

Station Identification

As always, you'll need to identify properly. For my tests, I simply positioned my QSL card in a corner of the camera's field of view.

Antennas and Signal Path Are the Key

As is the case with any radio communications system, the antennas and the propagation path are major factors in determining the effective range of the system. The documentation that comes with the transmitter includes plans for a simple ground plane antenna. With the ground plane connected to the '434 and the stock telescoping whip on an ICOM IC-R3 communications/video receiver (see "Product Review," *QST*, Feb 2001) I was able to view clear video over a line-of-sight path of up to about 300 yards.

If you need greater range, directional antennas—at one or both ends of the path—will help tremendously. A cross-reference chart in the manual provides "theoretical system performance" for various combinations of transmit/receive antennas. These include ground planes, 5-element Yagis and 25-element Yagis. Range figures shown in the chart were calculated using the typical specifications of a Video-Lynx 434 transmitter and a PC Electronics TVG-4G downconverter/receiver. With 25-element Yagis at each end of the path, the maximum theoretical "snow-free" line-of-sight range is 8 miles. Your actual results, of course, will vary.

Conclusion

The small size and simple, rugged construction of the Video-Lynx 434 video transmitter make it an attractive choice for short range video links.

Manufacturer: Videolynx, 19910 Bramble Bush Dr, Gaithersburg, MD 20879; **www.transmitvideo.com**; **videolynx@transmitvideo.com**. Manufacturer's suggested list price: $120. Typical current street price: $99. The Video-Lynx 434 is available from PC Electronics, 2522 Paxson Ln, Arcadia CA 91007; 626-447-4565, fax 626-447-0489; **tom@hamtv.com**; **www.hamtv.com**; and MFJ Enterprises Inc, PO Box 494, Mississippi State, MS 39762; 800-647-1800/662-323-5869, fax 662-323-6551; **www.mfjenterprises.com** (MFJ catalog number MFJ-8704).

Table 3—Video-Lynx 434

Manufacturer's Claimed Specifications	Measured in the ARRL Lab
Transmit frequency: 433.97 MHz (± 50 kHz).	433.98 (carrier frequency).
Power requirement: 9 V dc, 30-40 mA.	60 mA, tested at 9 V.
Modulation type: AM.	As specified.
Power output: 50-100 mW PEP.	63 mW.
Spurious signal and harmonic suppression: ≥40 dB.	As specified.
Size (HWD): $^5/_8 \times 2^1/_4 \times ^1/_2$ inches; weight, 1.4 oz.	