Product Review Column from *QST* Magazine

September 1993

Kenwood TS-50S MF/HF Transceiver

M^2 Enterprises EB-144 Eggbeater Antenna

Product Review

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Senior Assistant Technical Editor

Kenwood TS-50S MF/HF Transceiver

Reviewed by Rus Healy, NJ2L

Earlier this year, Kenwood set the world on its ear by introducing a new 100-watt MF/HF transceiver that few of us expected. Never has a manufacturer gone after the HF mobile market with such a sophisticated, full-featured radio in a box as small as the TS-50S. Undoubtedly by design, the TS-50S actually hits *two* markets: the primary one for mobile rigs, and another that covers such applications as Field Day, general portable operating and DXpedi-tioning. Then there's the growing number of licensees with restrictive living arrangements who need to get on the air in the lowest-profile way they can—both outside and inside their homes. So perhaps the TS-50S has opened another major radio market—making a lot of hams happy in the process.

Standard Features and Options

If you read just the TS-50S's list of features, you might think that you were reading about a full-size, traditional MF/HF rig. The rig includes many features common to its current big brothers, such as general-coverage reception, dual-VFO and split-frequency operation, AM, CW, FM and SSB capability, band-stacking registers, QSK and semi-break-in CW, IF shift, multiple scanning modes, 100 memories, a 20-dB attenuator and AIP (Advanced Intercept Point, a technique first used in the TS-950S). The rig also supports multiple menu-controlled features, such as CW normal and reverse (that is, CW reception on your choice of upper or lower sideband), CW offset (from 400 Hz to 1 kHz in 50-Hz steps), various tuning-step sizes, display-backlight intensity, and a selectable RIT range (1.1 or 2.2 kHz).

TS-50S options include a 500-Hz CW filter, two external antenna tuners (the AT-50 and AT-300), a temperature-compensated reference oscillator, computer interface, quick-release mounting bracket, and various desk mikes, speakers and power supplies. The rig is supplied with a power cord, hand microphone, mounting bracket and handle. The standard power cord is fused in both leads with automotive blade fuses—especially convenient for mobile operators.

Beyond its more obvious traits, the TS-50S features rock-solid mechanical construction: It's built around a cast-aluminum frame with integral heat-sink fins. A single circuit board supports most of the rig's AF and IF functions, and the final amplifier, filters and other RF circuitry are housed in a shielded enclosure at the rig's back end. Much of the control circuitry mounts behind the front panel. Daughterboards mounted to the main board contain circuits such as receiver band-pass filters, conserving valuable space. Most of the rig's boards make extensive use of surface-mount components.

You may wonder, as we did, how such a small radio can get rid of the heat generated by a 100-watt final amplifier. The answer is a midframe-mounted, thermostatically controlled, multispeed fan that pulls air into the front half of the rig and pushes it across the final-amplifier heat sink, efficiently cooling the entire radio. The rig's case stays cool to the touch during operation. Except at its higher speeds, the fan is so quiet that it's hard to tell when it's running unless you're listening for it. The rig protects itself against damage from excessive heat by reducing power output if the heat-sink temperature gets too high. Just the same, Kenwood recommends running the rig at 10 or 50 watts output for extended FM or RTTY transmissions.

The TS-50S lacks VOX for SSB operation. For a mobile rig, this wouldn't ordinarily surprise me, but Kenwood has included so many other higher-end radio features in the TS-50S that the omission of VOX circuitry is more conspicuous. To be fair, however, I can't fault a rig designed for mobile service for lacking a feature that just plain doesn't work well in most mobile installations.

During receive, the TS-50S draws about 900 mA from a 13.8-volt supply, which is appropriate for long-term battery operation.

> **The Bottom Line**
>
> The smallest 100-watt, 160- through 10-meter transceiver produced today, the TS-50S includes features and performance that make it an excellent value for today's on-the-go hams.

Automatic power shutoff is included, which could come in handy during mobile operation. If enabled, this feature turns off the rig if none of its controls have been used for three hours.

Operation and Performance

With today's prevalence of small cars, small size is very important in any mobile rig. So is simplicity of operation. The TS-50S has few front-panel controls—mainly, just those necessary for basic SSB operation. Many of the controls have multiple functions, however. For instance, the **UP** and **DOWN** buttons step the frequency in 1-MHz or 500-kHz increments when in MHz mode, and switch sequentially through the nine MF/HF amateur bands the rest of the time. Similarly, the **RIT** knob sets both the RIT offset and scan speed. (Speaking of RIT: The offset can't be cleared without recentering the knob or issuing the appropriate command when the rig is under computer control.)

The rig's liquid-crystal display also performs several functions. Aside from its main frequency display and bargraph meter for power output and received-signal strength, the LCD includes 26 annunciators that indicate the states of various functions. Another numeric display shows RIT offset, and a third shows memory channel and menu selections. Despite the display's busy appearance, it's neatly arranged and easy to read from most angles and under widely varying lighting conditions. Five levels of backlight intensity further increase display flexibility.

Software Control

You may have noticed the lack of several key controls on the TS-50S's front panel—among them a power-output knob and selectors for AGC and narrow filters. These func-

Table 1

Kenwood TS-50S 160-10 Meter Transceiver, Serial Number 41100902

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 0.5-30 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, 24.89-99, and 28-29.7 MHz.	Receiver, as specified; transmitter, amateur-band coverage as specified.
Modes of operation: AM, CW, FM, LSB, USB.	As specified.
Power requirement: 13.8 V dc ±15%, 20.5 A max (TX), 1.45 A max (RX).	At 13.8 V: transmit, 18.8 A max; receive, 0.79 A min, 0.97 A max.
Receiver	*Receiver Dynamic Testing*
SSB/CW receiver sensitivity (bandwidth not specified, 10 dB S+N/N): 0.5-1.5 MHz, 0.25 µV (−119 dBm); 1.5-1.7 MHz, 0.35 µV (−116 dBm); 1.7-30 MHz, 0.25 µV (−119 dBm).	Minimum discernible signal with 500-Hz IF filter: *AIP On* / *AIP Off* 1.0 MHz: −133 dBm / −140 dBm 3.5 MHz: −132 dBm / −139 dBm 14.0 MHz: −132 dBm / −139 dBm 28.0 MHz: −134 dBm / −140 dBm
AM (10 dB S/N): 0.5-1.5 MHz, 2.5 µV (−99 dBm); 1.5-1.7 MHz, 3.5 µV (−96 dBm); 1.7-30 MHz, 2.5 µV (−99 dBm).	10 dB S+N/N (signal 30% modulated with a 1-kHz tone, AIP off): 1 MHz, −112 dBm; 3.8 MHz, −110 dBm.
FM, 12 dB SINAD, 28-30 MHz: 0.5 µV (−113 dBm).	29 MHz, 12 dB SINAD, AIP off: −120 dBm.
Blocking dynamic range: Not specified.	Blocking dynamic range (500-Hz IF filter):* *AIP On* / *AIP Off* 1.0 MHz: 114 dB / 108 dB 3.5 MHz: 114 dB / 110 dB 14.0 MHz: 113 dB / 109 dB 28.0 MHz: 114 dB / 111 dB
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone IMD dynamic range (500-Hz IF filter):* *AIP On* / *AIP Off* 1.0 MHz: 91 dB / 87 dB 3.5 MHz: 90 dB / 86 dB 14.0 MHz: 90 dB / 88 dB 28.0 MHz: 91 dB / 89 dB
Third-order input intercept: Not specified.	*AIP On* / *AIP Off* 1.0 MHz: 3.5 dBm / −9.5 dBm 3.5 MHz: 3.0 dBm / −10.0 dBm 14.0 MHz: 3.0 dBm / −7.0 dBm 28.0 MHz: 2.5 dBm / −6.5 dBm
S-meter sensitivity: S9 signal at 14 MHz, 20 µV.	S9 signal at 14 MHz: AIP on, 99 µV; AIP off, 26 µV.
CW/SSB squelch sensitivity: Less than 2 µV.	As specified.
FM squelch sensitivity: Less than 0.32 µV.	As specified.
Receiver audio output: More than 2 W at 5% THD into 8 Ω.	2.23 W at 5% THD into 8 Ω.
Receiver IF/audio response: Not specified.	At −6 dB, **IF SHIFT** centered: SSB, 182-2107 Hz (1925 Hz); CW-N, 139-686 Hz (547 Hz); AM, 100-2100 Hz (2000 Hz).
Transmitter	*Transmitter Dynamic Testing*
Transmitter power output: CW, FM, SSB, 100 W; AM, 25 W.	CW, FM, SSB: Maximum output typically 102 W PEP, varies slightly from band to band; AM, typically 26 W carrier.
Spurious-signal and harmonic suppression: 50 dB.	As specified. The TS-50S meets FCC spectral-purity specifications for equipment in its power-output class and frequency range.
Third-order intermodulation distortion products: Not specified.	See Fig 1.
CW-keying characteristics: Not specified.	See Fig 2.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S1 signal, 24 ms; S9 signal, 24 ms.
Composite transmitted noise: Not specified.	See Fig 3.
Size (height, width, depth): 2.7 x 7.1 x 10.6 inches; weight, 6.4 lb.	

*Dynamic-range measurements were made at the ARRL Lab standard signal spacing of 20 kHz.

tions, like more than three dozen others, are controlled by the radio's *software* via two menus. You access these functions by holding the **F.LOCK** button for a few seconds, then dialing through the menu (by number, using the owner's manual as a reference). The VFO **A/B** button selects the active menu.

Who wants to go through such a tedious procedure select the AGC constants or put the narrow CW filter in line? Nobody I know. Fortunately, Kenwood implemented an easier way to save us from that frustration—and from having to memorize the menu functions by number! The MC-47S microphone supplied with the TS-50S supports up to four control functions. The buttons work much like software macros: You select the functions you want to control from the mike, and program them into the buttons. Once programmed, these buttons operate in parallel with the primary controls for those functions. In addition to the functions of almost every front-panel button, the mike buttons can operate *any* of the radio's menu-controlled functions. For example, I assigned the mike buttons to control transmitter power level, AGC and narrow/wide filter selection, and CW normal or reverse.

VFOs, Memories and Tuning

The rig's memories (and VFOs) store transmit and receive frequencies, mode, filter bandwidth, AIP, attenuator and AGC selections, and tone-encoder frequency (for FM CTCSS operation). I take advantage of the memory system's flexibility by storing two sets of data for each ham band in consecutive memories: At the low end of each band, I store a memory for CW. A second

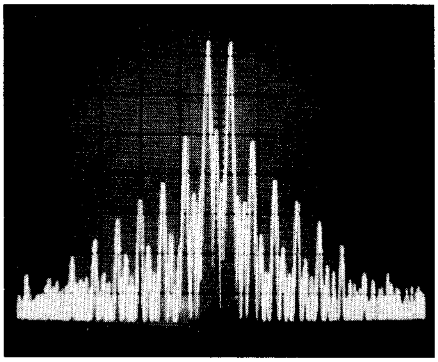


Fig 1—Spectral display of the TS-50S transmitter during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 30 dB below PEP output, and fifth-order products are approximately 42 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 100 W PEP output at 14.2 MHz.

memory, higher in the band, stores an SSB frequency and mode. Each memory includes the appropriate AGC speed. When I want to operate on a particular band, I can tune through the memories and pull the appropriate channel's data into the current VFO with the **M>V** key. This capability makes this radio one I can happily live with from day to day, whereas it would be less pleasant to do so if the VFOs and memories weren't so well-thought-out.

As you tune the radio, the appropriate frequency step is selected based on tuning-knob speed. Normally 5 Hz (just 500 Hz per knob revolution), the step increases to as much as 200 Hz when you really spin the knob. At typical tuning rates, the knob tunes at about 2.5 kHz per revolution—you have to turn it *very* slowly for the rig to tune in its smallest increment. In FM, the tuning-step range is 50 Hz to 2 kHz. Turned slowly, the knob tunes about 5 kHz per revolution.

Fast frequency excursions of a few tens or hundreds of kilohertz are somewhat cumbersome. Even when it's turned quite fast, the main-tuning knob doesn't get you from one end of the band to the other with great speed. Fortunately, the mike's **UP** and **DOWN** buttons tune the rig in increments you select in Menu A. The default is 10 kHz for all modes, but you can set the step to 10 Hz, 100 Hz, 1 kHz, 5 kHz or 10 kHz. One menu selection sets the CW and SSB tuning step, and another sets that for AM and FM. Holding the **UP** or **DOWN** key causes the rig to tune quite fast—about 650 kHz per second.

Just below its main tuning knob, the TS-50S uses a sliding lever that sets the knob to free-spin or applies an appropriate amount of drag for mobile operation. In its high-friction setting, this lever prevents sudden, unwanted frequency changes. In free-spinning mode, the knob feels pleasantly smooth and solid, especially considering its size.

External Devices

The TS-50S includes an ALC input and an amplifier-control line at rear-panel phono jacks. This is nice—and necessary, considering that the rig provides only three fixed output levels (10, 50 and 100 watts) for CW, SSB and FM operation. If you need a specific output level other than one of these (say, for driving an amplifier that requires 65 watts input), you'll need to apply a variable negative voltage to the ALC line as described in last month's Product Review column.[1]

The TS-50S mates via a single connector and control cable (and the antenna lead, of course) to the optional AT-50 and AT-300 antenna tuners. When in use, these options provide not just line flattening for transmit, but also additional receiver filtering, which helps increase the receiver's immunity to strong nearby broadcast stations and other out-of-band signals.

Like Kenwood's other current multimode radios, the TS-50S supports a computer interface (the optional IF-10D). The connector for this interface is beneath the radio's *bottom* panel, under a round access plug that you must remove to connect it. The interface cable mates with a small, multipin in-line connector mounted on the rig's main board.

The Receiver

The receiver's sensitivity is very good, which is especially important in mobile transceivers because they're usually used with low-gain antennas. The rig's receiver performance is otherwise *fairly* good. The optional 500-Hz filter helps a great deal. I consider it a must for serious CW operation.

The TS-50S includes only single-tier IF filtering, at a high IF (near 10.7 MHz instead of 455 kHz). Teamed with the radio's exceedingly compact design, this makes for some filter *blowby* (strong signals leak around the filters as you tune them out of the passband), especially during CW-narrow reception. (Leakage is clearly audible out to at least 7 kHz from extremely strong CW signals when tuning the TS-50S with its narrow CW filter selected.) Strong SSB signals are also copiable with the narrow CW filter in line. But the TS-50S reduces this effect by appropriate application of high-end audio rolloff. This, in conjunction with the radio's pleasantly quiet audio power amplifier, makes for excellent SSB copy, and good CW and AM reception, with little noticeable IF-amplifier hiss or audio muddiness during speaker and headphone listening.

The receiver's strong-signal performance isn't up to the standards set by higher-end radios, as Table 1 shows—but don't forget that we're talking here about a very compact, specialized radio that sells for about $1000. Its shortcomings become evident when you use the rig with relatively large, high antennas typical of many home and Field Day-type stations. On the other hand, its overall receiver performance is better than that of most high-end radios made a decade ago.

[1]R. Healy, "ICOM IC-737 MF/HF Transceiver," Product Review, *QST*, Aug 1993, pp 59-62.

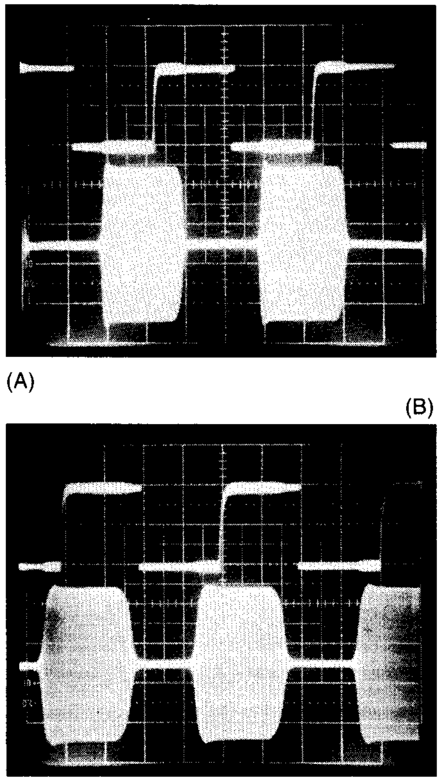


Fig 2—CW-keying waveform for the TS-50S in the semi-break-in mode (A) and the full-QSK mode (B). The upper traces are the actual key closures; the lower traces are the RF envelopes. Horizontal divisions are 20 ms (A) and 10 ms (B). The transceiver was being operated at 105 W output at 14 MHz.

To help you deal with strong signals, the TS-50S includes both AIP *and* a 20-dB attenuator. Together, these functions let you knock about 30 dB off the receiver's maximum sensitivity. This makes the radio usable in activities like 40-meter DXing, where, wide open, the rig is far more sensitive than necessary.

Two AGC decay constants, **FAST** and **SLOW**, are available in the TS-50S. The AGC works well in all modes. On CW, the AGC attack somewhat "hardens" signals that produce S-meter readings higher than 40 dB over S9, especially with the AGC set to **FAST**. (This can be eliminated by kicking in AIP and/or the attenuator, depending on conditions.) Some operators may find the TS-50's **SLOW** decay time somewhat long, especially during bandscanning or in roundtables where weak and strong stations alternate. The TS-50S came through WJ1Z's tough tune-in-full-carrier-shortwave-signals as-SSB test quite well. (Some radios crackle badly on modulation peaks during this test, especially with AGC set to **FAST**.)

The TS-50S's noise blanker, critical to the success of mobile HF operation, does its job well. Although its gain is fixed, the blanker cuts automotive ignition noise enough to allow relatively easy copy with weak signals—yet without intolerably distorting strong ones. Speaking of mobile operating, the receiver's audio amplifier and internal speaker (mounted to the radio's top cover) put out plenty of sound for easy copy during windows-down highway cruising in a fairly noisy car. Of course, if you mount the rig close to a dashboard or other obstruction, you'll undoubtedly want to use an external speaker.

For data modes, the TS-50S has a couple of nice touches. Although the rig doesn't include FSK or dedicated connections for a data controller, you can use it for RTTY, packet, AMTOR or other digital modes if you connect your communications processor to the front-panel mike jack as directed in the manual. You can select the 500-Hz filter (if installed) in SSB mode. Used in conjunction with the **IF SHIFT** control, this feature is very useful in crowded or noisy band conditions.

CW

Installing the optional CW filter is not particularly difficult, but requires a bit of transceiver disassembly, unplugging a PC board, soldering the filter in place and then putting it all back together. This procedure, which the manual describes quite clearly, took me about 20 minutes. But it's not as easy as installing the plug-in filters common to other Kenwood radios, so consider ordering the rig with the filter installed.

As mentioned earlier, the TS-50S's CW offset is adjustable from 400 Hz to 1 kHz. The sidetone unfortunately doesn't track the offset—it's fixed at about 800 Hz. Thus, you can't use the sidetone for spotting if you use something other than an 800-Hz offset (or its 400-Hz subharmonic).

Two TS-50S features are especially useful during reception: the choice of listening to CW on upper or lower sideband, and IF shift. Teamed with the narrow filter, these features give the rig surprising agility on crowded bands—it holds its own with much more expensive radios most of the time.

A menu setting lets you select the TS-50S's keyed-VOX delay in the following increments (in milliseconds): 0, 100, 200, 300, 400, 600, 800, 1000, 1400 and 1800. When set to 0 ms, the receiver recovers between keyed elements (full QSK). We found that the rig's keyed output becomes erratic at speeds over 30 WPM or so. We also received reports to this effect from other TS-50S users. Basically, although the sidetone may accurately reproduce your keying input, the rig's output may not. With keyed-VOX delays of more than 300 ms or so, the keying reproduction is excellent up to at least 60 WPM. But at shorter delay settings, the rig sometimes loses entire dots and dashes, and shortens others. On the air, the result is sometimes uncopiable CW signals.

Kenwood quickly located and fixed this problem by revising the radio's software. They plan to use the updated software in production starting later this year, but updating a current radio requires returning it to Kenwood. Contact their Customer Service Department at 310-639-7140 for instructions.[2]

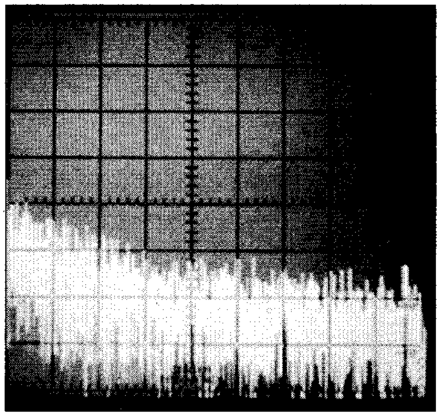


Fig 3—Spectral display of the TS-50S transmitter output during composite-noise testing. Power output is 100 W at 14 MHz. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The log reference level (the top horizontal line on the scale) represents –60 dBc/Hz and the baseline is –140 dBc/Hz. The carrier, off the left edge of the photograph, is not shown. This photograph shows composite transmitted noise from 2 to 20 kHz from the carrier.

The Manual

The TS-50S 60-page owner's manual is logically organized and well illustrated. It covers each subject reasonably well, but lacks examples. For instance, programming the microphone buttons (**PF1-PF4**) to perform commands could use more detailed treatment than the manual gives it: You get brief instructions and a list of the functions these buttons can be assigned. If you experiment with the radio, you'll find that there's a good deal more to it than meets the eye—these buttons give you considerable power to customize the radio for your needs. The manual doesn't market this capability as the valuable feature that it is.

As you'd expect, the TS-50S doesn't support a separate receive antenna or an external transverter. This is unfortunate (such a small rig is ideally suited for portable operation with transverters). This shouldn't rule out the rig's purchase for this application, however. You'd only have to perform a couple of fairly simple modifications to use it with a transverter or separate receive and transmit antennas.

Small Points

The rig's microprocessor can be reset in two levels, both of which are accessible from the front panel. One approach attempts to clear a glitch without resetting memories and other RAM-saved selections; the other is a full-blown reset that returns the radio to all of its factory-default settings. During the review period, I never needed to reset the rig.

You choose a 1.1- or 2.2-kHz RIT range in software. The RIT includes a subfeature that lets you look at the rig's frequency to the nearest 1 Hz (if we're to believe its display to this level). You can even perform this function from one of the programmable mike buttons, if you like.

Mike gain is set in software for SSB, AM and FM. You can select either of two factory-preset levels (the default is "low"), or adjust the mike gain internally as instructed in the manual. I found the default to be appropriate for Kenwood's stock TS-50S microphone and for other similar 600-Ω dynamic mikes.

Like Yaesu's FT-890 and -990, the TS-50S lets you shift the transmitter's carrier point in SSB—that is, the frequency spacing between the rig's sideband-filter center and carrier oscillator. This is just like IF shift for transmit: You can use it to adjust your transmitted signal's tonal balance. The shift range is –100 to +200 Hz, adjustable in 10-Hz steps via the menu system. Kenwood notes that changing the carrier point affects opposite-sideband suppression, so the manual suggests that you "minimize the use of this adjustment." In the Lab, we measured a worst-case opposite-sideband suppression of 35 dB (with a –100-Hz offset and a 300-Hz audio signal)—a degradation of 4 dB compared to that with no carrier-point shift. In practice, I found that the default carrier-point offset (0 Hz) provides good transmitted audio with my voice and the stock mike, so I didn't experiment with this feature.

In Sum

The TS-50S packs an almost incredible amount of features and good performance into a package that fits inside a briefcase. With few and minor exceptions, it executes its functions well and gives no hint to your contacts that it's such a diminutive radio. Appropriately priced for its market, the TS-50S has made a big splash—don't be surprised to see other manufacturers following Kenwood's example with small, 100-watt MF/HF rigs in the near future.

Thanks to Dave Newkirk, WJ1Z, and Jeff Bauer, WA1MBK, for their contributions to this review.

Manufacturer's suggested retail price: TS-50S, $1249.95; AT-50 automatic antenna tuner, $339.95; YK-107C 500-Hz CW filter, $104.95; MB-13 quick-release mounting bracket, $44.95; SO-2 TCXO, $159.95; IF-10D computer interface, $69.95; IF 232C level converter, $109.95. Manufacturer: Kenwood Communications Corp, PO Box 22745, Long Beach, CA 90801-5745, tel 310-639-4200.

[2]You can also dial Kenwood's telephone BBS (310-761-8284, 300-9600, N,8,1) for up-to-date information.

M^2 Enterprises EB-144 Eggbeater Antenna

Reviewed by Steve Ford, WB8IMY

It's a strange sight on the roof of my house, but looks aren't everything. When it comes to overall performance, the M^2 Enterprises EB-144 Eggbeater antenna *works*!

The Eggbeater gets its name from its uncanny resemblance to the mechanical devices of the same name found in kitchens. The EB-144 is a 2-meter, crossed-loop, omnidirectional antenna. Its two stainless-steel loops are only about 34 inches in diameter. They're held in place by a 28-inch-high fiberglass rod. Both ends of each loop are attached to a Delrin base using stainless-steel hardware.

The Eggbeater's mission differs significantly from that of most omnidirectional 2-meter antennas (verticals): It produces an omnidirectional pattern that is horizontally polarized at the horizon, ideal for 2-meter SSB and CW operating. Above the horizon, the pattern becomes right-hand *circularly* polarized—just what you need for satellite operation. By comparison, verticals are cross-polarized with respect to the 2-meter beams traditionally used for SSB and CW, significantly degrading their effectiveness for these modes. Also, verticals produce a deep null at the zenith (straight up), which makes them ineffective for satellite operation during the high-angle parts of satellite orbits.

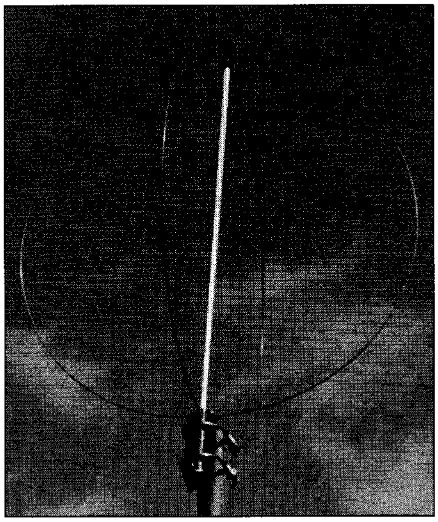
According to M^2's instructions, the Eggbeater can be mounted 10 to 12 inches above a metal ground plane. This increases the circular lobe significantly. Raising the antenna to 40 inches above the ground plane provides a similar improvement in the horizontal pattern. For this review, I simply installed the Eggbeater on my chimney in place of my vertical. I did not experiment with the ground-plane option, but it should work as M^2 claims, based on simple ground-reflection theory.

The EB-144 manual specifies a frequency range of 144 to 148 MHz with a maximum SWR of 1.5:1. In my installation, measured through a 50-foot RG-8 feed line, the antenna's SWR is essentially 1:1 across the band.

Weather-satellite enthusiasts will be pleased to know that the Eggbeater is usable down to 135 MHz for receiving purposes. With its overhead circular polarization, the antenna is well suited for receiving 137-MHz signals from polar-orbiting weather satellites.

Assembly and Installation

The Eggbeater is shipped with both loops bent in the middle and folded back upon themselves. They're secured with metal shipping straps. Removing the straps is a little ticklish because the compressed loops have a tendency to react like coiled springs. When released from their straps, they whip outward in both directions with surprising speed! The instructions wisely caution you to take great care when unpacking the loops.



The first assembly task is to restore the loops to their original circular shape. This is not as easy as it sounds. I used my hands initially, but I had to resort to pliers in the end. Despite my best efforts, slight kinks remained where the loops had been folded. The steel is too tough to delicately straighten with pliers; I'd have needed a vise to completely straighten the loops.

The next step is to thread both loops through holes in the plastic cap at the top of the vertical support. The fit here is very snug, and firm pressure is required to force the wires through.

The loose ends of the loops are secured to the base with stainless-steel Allen-head set screws. (M^2 supplies an Allen wrench and extra set screws with the antenna.) You just push the wires through the holes and tighten the set screws. The entire assembly took me 30 minutes, and most of that time was spent wrestling with the loops.

The base of the Eggbeater includes a 3/8-24 threaded hole designed to accept a standard mobile antenna mast. (One of this antenna's design applications is mobile SSB/CW operating.) I recommend using such a mast for home or mobile installations. I didn't have a mobile mast, so I used two **U** bolts to secure the Eggbeater base to my existing chimney mast. Two hose clamps would have worked just as well. If you try this approach, don't overtighten the **U** bolts or clamps.

The Eggbeater is supplied with a female UHF connector (SO-239) for the coaxial feed line. An N connector is also available. Including the time required to weatherproof the coaxial fitting, the Eggbeater installation took only 15 minutes.

Performance

I was asking a lot from my Eggbeater. Not only did I want enhanced 2-meter CW/SSB performance, I wanted to improve my signal profile on RS-10 and other satellites. I also wanted to maintain my full-quieting signal into the local repeaters and the packet network. That's not too much to ask from one antenna, is it?

My first pleasant surprise arrived with the appearance of the RS-10 satellite. With my vertically polarized antenna, I was accustomed to deep signal fades at several points during a typical pass. As the satellite moved into the nulls in the vertical's pattern, I often heard the result (or *didn't* hear it, as the case may be!) on the 10-meter downlink. The fades were particularly acute when the satellite was directly overhead, as expected.

The Eggbeater makes a *world* of difference on RS-10. To my astonishment, I accessed the satellite at 10 degrees above the horizon and held it *consistently* until LOS (loss of signal), at the other end of the pass. My puny 10-watt SSB signal was clearly audible on the downlink, and I worked several stations during that first 15-minute test.

Later that evening, I monitored an OSCAR 21 pass. (OSCAR 21's downlink is at 145.987 MHz.) Once again, I marveled at the signal's consistency. From the time I acquired the signal until I finally lost it, I heard *no fades whatsoever*. This is a stark

Table 2
M^2 Enterprises EB-144 Eggbeater Antenna

Manufacturer's Specifications	*ARRL Evaluation*
Frequency range: Transmit, 144-148 MHz; receive, 135-150 MHz.	As specified.
Input impedance: 50 Ω.	As specified.
SWR: 1.5:1.	Better than 1.2:1 from 144-148 MHz.*
Power handling: 1 kW maximum.	Not tested.
Wind survival: 100 mi/h maximum.	
RF input connector: Female UHF (SO-239) or N.	
Pattern: Omnidirectional.	
Polarization: Horizontal at horizon, circular at zenith.	
Size: 34 × 28 inches (H × W).	

*Measured through 50 feet of RG-8.

contrast to the performance of my vertical groundplane antenna!

The next big test was the June VHF QSO Party. Last year I used my groundplane and made all of three contacts on SSB—and those contacts required a major struggle. Surely the Eggbeater would provide an improvement.

Improvement is an understatement! During the first 30 minutes of the contest, I worked 20 stations throughout the New England and mid-Atlantic states. I received a solid 59 report from a station in Maine, 165 miles away. Soon thereafter, I made a CW contact with a ham at the southern tip of New Jersey—195 miles south of my location. Many of my contacts were surprised to learn that I was using a roof-mounted, omnidirectional antenna.

This is not to say that the Eggbeater is an optimized contest antenna. Serious VHF contesters use directional, rotatable antennas. Even so, a contest is the perfect environment to test a new antenna such as the Eggbeater. If the reports I received are any indication, the EB-144 does an outstanding job.

Then came my FM testing. With the Eggbeater's horizontal polarization at the horizon, I expected performance to suffer. The only question was, how much?

Out to a range of about 10 miles, my signal is full quieting into voice repeaters. My connections with local packet nodes and PBBSs are also reliable over the same distance. Beyond 10 miles, the differences between the Eggbeater and the vertical become apparent. Because of the mismatched polarization, distant repeaters and packet systems previously accessible with the vertical are now out of reach. Since essentially all of my FM voice and packet communications take place within a 10-mile radius, however, this doesn't pose a problem for me.

Summary

If you don't have the room or the budget for a steerable beam antenna for 2 meters, the Eggbeater offers an attractive alternative. Depending your local terrain, antenna height and output power, you can expect to enjoy reliable 2-meter CW and SSB conversations over considerable distances—perhaps a few hundred miles under good conditions. You should also be able to maintain good communications with local FM repeaters and packet stations.

The Eggbeater is tough to beat for satellite operating, too. It's the ideal antenna for the satellite beginner, offering good performance without the complications of multielement beams and azimuth/elevation rotators. M^2 Enterprises makes Eggbeater antennas for other bands, including 70 cm (420-450 MHz). With 2-meter and 70-cm Eggbeaters, you'd have a fine antenna system for the low-orbiting Pacsats such as OSCARs 16, 19, and 20-23.

If the Eggbeater's price seems a bit tough to swallow, don't forget that it's constructed of high-quality components. The Eggbeater is not only a good performer, it's built to last.

Manufacturer: M^2 Enterprises, 7560 N Del Mar, Fresno, CA 93711, tel 209-432-8873, fax 209-432-3059. Manufacturer's suggested retail price: $119.

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.

ICOM IC-737 MF/HF transceiver with internal antenna tuner and optional FL-100 and FL-252A 500-Hz CW filters (see Product Review, August 1993 *QST*). Sold as a package only. Minimum bid: $1020.

Lowe HF-150 LF/MF/HF receiver with optional frequency-entry keypad (see Product Review, August 1993 *QST*). Sold as a package only. Minimum bid: $488.

MFJ 9017 18-MHz QRP CW transceiver (see Product Review, July 1993 *QST*). Minimum bid, $110.

The following dual-band 144/440-MHz transceivers (see Product Review, June 1993 *QST*):

Alinco DR-600T. Minimum bid, $459.

ICOM IC-2410H. Minimum bid, $544.

ICOM IC-3230H. Minimum bid, $495.

Kenwood TM-732A. Minimum bid, $459.

Standard C5608DA. Minimum bid, $544.

Yaesu FT-5100. Minimum bid, $396.

Sealed bids must be submitted by mail and must be postmarked on or before September 27, 1993. Bids postmarked after the closing date will not be considered. Bids will be opened seven days after the closing postmark date. In the case of equal high bids, the high bid bearing the earliest postmark will be declared the successful bidder.

In your bid, 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. The successful bidder will be advised by mail. 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.

Please send bids to Bob Boucher, Product Review Bids, ARRL, 225 Main St, Newington, CT 06111.

A Simple Broadband Dipole for 80 Meters

(continued from page 30)

meters, is useful over a much broader range of applications and yields the lowest SWR over the band.

Summary

The simple broadbanding technique I've described here capitalizes on the common availability of coaxial cables that fit the application. It overcomes the narrow-bandwidth limitations of a conventional 80-meter, half-wave dipole without significant disadvantages. Even parallel dipoles for other bands may be fed with the same feed line.

The limitation of available coaxial cable parameters can be overcome by using the transmission-line resonator as a resonant transformer. Applying this technique is described in an upcoming *ARRL Antenna Compendium* article, "Broadband Matching Using the Transmission-Line Resonator."

This work has benefited from the support and encouragement of my wife, Barbara, N1DIS. Also, I must credit Andrew Griffith, W4ULD, for helping to turn my attention to the approach described here. After reading my *QST* article on match bandwidth of resonant antenna systems,[6] Andy noted that antenna systems should be viewed from their match to a 50-Ω transmitter, even if the feed line does not have a 50-Ω characteristic impedance. He showed examples of the narrowing of match bandwidth to make his point. In my response, published with Andy's letter in *QST*,[7] I pointed out that match bandwidth of an antenna system may actually be *increased* by selecting the right cable length and characteristic impedance. As an example, I showed in Fig 3 of that correspondence the large match bandwidth of a dipole fed with a ¾-wavelength, 75-Ω RG-11 cable. Note that this is the same case shown in Fig 3C of this article. Thank you, Andy!

Notes

[1] G. Hall, ed, *The ARRL Antenna Book*, 16th ed (Newington: ARRL, 1991), pp 9-1 through 9-12.

[2] M. W. Maxwell, *Reflections: Transmission Lines and Antennas* (Newington: ARRL, 1990), pp 18-1 through 18-6.

[3] See Note 2, p 15-19. I frequency-scaled Walt's data, which is equivalent to changing the wire length. This antenna has a Q of 13 and a resonant resistance of 65 Ω. I took into account the fact that the antenna's radiation resistance increases with frequency.

[4] F. Witt, "The Coaxial Resonator Match and the Broadband Dipole," *QST*, Apr 1989, pp 22-27.

[5] F. Witt, "The Coaxial Resonator Match," *The ARRL Antenna Compendium, Volume 2* (Newington: ARRL, 1989), pp 110-118.

[6] F. Witt, "Match Bandwidth of Resonant Antenna Systems," *QST*, Oct 1991, pp 21-25.

[7] A. Griffith and F. Witt, "Match Bandwidth Revisited," *QST*, Technical Correspondence, Jun 1992, pp 71-72.