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Kenwood TS-790A VHF/UHF Transceiver

Reviewed by James W. ("Rus") Healy, NJ2L

Kenwood's marketing of the triband TS-790A plays heavily on this transceiver's satellite capabilities. Considering the number of Amateur Radio satellites that are currently in service—and that just about anyone, anywhere, can put up satellite antennas and work neat stuff through them—that's probably a sound strategy. For those whose interests lie more in terrestrial and extraterrestrial weak-signal work and contesting, the rig's satellite conveniences aren't as important as a strong receiver, easy operation and a good balance of features. Fortunately, the Kenwood engineers who designed the TS-790A were also thinking of weak-signal operators and contesters when they designed this radio.

Standard Features and Options

Some of the TS-790A's features are common to most similar rigs. Among these features are direct frequency entry, computer-control capability, and selectable automatic mode and repeater-offset selection (according to ARRL band plans). Other TS-790A features, though, haven't often been offered in rigs in its class. For instance, the '790 can receive simultaneously on two bands—and can receive on one band *while you're transmitting* on another. It comes with a 500-Hz CW filter, two VFOs per band, relatively high power output (discussed later), a speech processor, and fast/slow receiver-AGC selection. The TS-790A also has Automatic Lock Tuning (ALT—a circuit designed to minimize drift during FM operation on the 23-cm band) and dual AF-gain and squelch controls (one set for each receiver). A 287-MHz IF input/output is also included to make 23-cm fast-scan-TV operation easy.

Coverage of the 144- and 430-MHz bands is standard on the TS-790A; the 1240- to 1300-MHz module is optional. Installing the 23-cm module is easy, requiring only plugging two wiring harnesses into the appropriate chassis-mounted connectors and installing the dozen-plus screws that secure the die-cast aluminum module to the radio's sturdy steel subchassis. It took me less than 15 minutes to unpack and install the 23-cm module, including replacing the rig's top cover. This process is expedited by good instructions and diagrams in the *TS-790A Instruction Manual.*

Kenwood has included a number of useful features common to the better MF/HF transceivers on the market. These include split-VFO operation and easy VFO manipulation (**A/B** selects the current VFO, **A=B** equalizes the settings of the two VFOs, **M/VFO** toggles between memory-channel and VFO operation). Each VFO stores frequency, mode, CW-filter selection, RIT status (but not the actual RIT offset) and frequency-step size. The TS-790A also has RIT and IF shift. In short, this rig is quite reminiscent of modern low-band radios; so much so, in fact, that most operators familiar with such rigs should have no trouble learning and using the '790.

The TS-790A is laid out well for operating on two bands at once. Audio from each receive channel can be routed to separate speakers or the two channels of stereo headphones, or it can be mixed and delivered via an external speaker or the radio's internal speaker. A front-panel push button selects monaural or stereo audio, and separate **AF** gain controls regulate the received-audio levels on each band. The radio's receivers can operate on any two of the installed bands.

The TS-790A has dual 100-Hz-resolution displays. The main display shows frequency, mode, filter selection (on CW), RIT offset and the status of several other functions pertinent to the main (transceive) band. The sub (receive-only) band display includes all the information that the main display shows, except RIT status and offset, CW wide/narrow filter selection, and split-VFO operation, none of which are available on the sub band. Both displays are easy to read from most angles and under essentially all lighting conditions.

The '790's multifunction analog meter is easy to read, as is the sub-band fluorescent S meter. Although somewhat slower in response than the analog meter, the sub-receiver meter agrees closely with the main receiver's analog meter and provides a useful visual indication of sub-band signal strength. This is important during simultaneous two-band reception; when you're listening to separately-regulated audio from both bands, a visual indication of relative signal levels on each band is useful. Neither meter is reliable for absolute signal-strength measurements (see the section called FM Operation, later in this review), but both meters are useful nonetheless.

Separate antenna connections are provided for each band. UHF connectors are used on the 144- and 430-MHz bands, and an N connector provides the 1296-MHz attachment point. The TS-790A can independently control power amplifiers for each band via a DIN jack on the rig's back panel. The control outputs are open-collector transistors that aren't capable of directly controlling high-current relay solenoids, although they can handle small relays or external transistors.

The only thing close to an RF-gain con-

Table 1
Kenwood TS-790A VHF/UHF Multimode Transceiver, Serial no. 0010613

Manufacturer's Claimed Specifications	Measured in ARRL Lab
Frequency coverage: 144-148 and 430-450 MHz standard; 1240-1300 MHz optional.	Transmit, as specified. Receive: 140-165 MHz, 430-450 MHz, 1240-1300 MHz.
Modes of operation: CW, FM, LSB, USB.	As specified.
*Receiver**	*Receiver Dynamic Testing**
Sensitivity (bandwidth not specified): Less than 0.16 μV (−123 dBm).	Minimum discernible signal (noise floor) with 500-Hz filter: 144 MHz, −143 dBm; 432 MHz, −142 dBm; 1296 MHz, −142 dBm.†
Dynamic range: Not specified.	Blocking dynamic range:‡ 144 MHz, 126 dB; 432 MHz, 111 dB; 1296 MHz, not measured.†
	Two-tone, third-order intermodulation distortion dynamic range:‡ 144 MHz, 79 dB; 432 MHz, 81 dB; 1296 MHz, not measured.†
	Third-order input intercept: 144 MHz, −24.5 dBm; 432 MHz, −20.5 dBm; 1296 MHz, not calculated.†
RIT range: CW/SSB: ±1.9 kHz; FM, ±9.9 kHz.	As specified.
S-meter sensitivity (μV for S9 reading): Not specified	144 MHz, 4.5; 432 MHz, 7.5; 1296 MHz, not measured.
SSB squelch sensitivity: Less than 0.20 μV.	144 MHz, 0.05-0.5 μV; 432 MHz, 0.3-1.1 μV.
Transmitter	*Transmitter Dynamic Testing*
Transmitter power output (watts):	

	CW/FM	SSB	—CW— Min	—CW— Max	—FM— Min	—FM— Max	—SSB— Min	—SSB— Max
144 MHz	45	35	4.4	50	4.2	48	3.2	37
430 MHz	40	30	4.0	44	4.0	44	3.2	35
1296 MHz	10	10	1.1	11	1.1	11	1.1	11

Manufacturer's Claimed Specifications	Measured in ARRL Lab
Spurious signal and harmonic suppression: 144 and 430 MHz, −60 dBc; 1240 MHz, −50 dBc.	As specified. See Fig 1.
Third-order intermodulation distortion products: Not specified.	See Figs 2-4.
Transmit-receive turnaround time (PTT release to 90% audio output, S1 and S9 signals): Not specified.	S1 signal, 19 ms; S9 signal, 16-19 ms.
Other	
Power requirement: 13.8 V, 2.5-15 A.	Receive: 2.1-2.2 A. Transmit low power: 4.5-5.1 A; transmit high power, 7.5 A (1240 MHz) to 13 A (430 MHz).
Receiver audio output: 1.5 W at 10% total harmonic distortion (THD) with an 8-Ω load.	1.8 W at 10% THD with an 8-Ω load.
Size (height × width × depth): 5.3 × 13.5 × 14.5 inches, 20.2 lb.	

*See Table 2 for FM receiver specifications and test results.

†Test-equipment limitations prevented measuring 1296-MHz receiver performance (except MDS, which was measured using the TS-790A's 287-MHz auxiliary IF input/output).

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

trol on the TS-790A is the front-panel **144 ATT** button. This switch usually toggles a 10-dB attenuator in and out of the 144-MHz receive line, but it can also be used to control an external 2-meter preamplifier, if desired.

The '790 comes with DIN plugs to match its accessory connectors, a power cable (fused in both leads) and a hand microphone with up/down frequency-control buttons. Options include a 13.8-V power supply (model PS-31) with a dual-speed, thermostatically controlled fan, a voice synthesizer, a computer-control interface (RS-232-C to TTL level converter), a programmable CTCSS decoder, external speakers, SWR/wattmeters, and other accessories and microphones.

Frequency Control

Getting the TS-790A on frequency is straightforward. The multifunction keypad just to the left of the tuning knob allows direct frequency entry, and the **BAND** key lets you select among the three bands. Either receiver can be easily programmed from the keypad or the **BAND** key by first selecting the desired receiver using the **MAIN** and **SUB** keys (indicators above these buttons shows you which receiver is selected). The **MHZ** button turns the main-tuning knob into a 1-MHz-step control, and the **CH.Q** button lets you tune in 5-kHz steps (1-kHz steps when the **STEP** function is activated). The main-tuning knob usually tunes the TS-790A in 20-Hz steps (10 kHz per knob revolution), and in 100-Hz steps (50 kHz per revolution) when the **STEP** function is enabled. The '790 senses knob-rotation speed and increases tuning rate when the knob is turned quickly. The RIT tunes in 20-Hz steps.

When the **CH.Q** button is pressed, a solenoid engages (with a *clunk*) a detent mechanism in the main-tuning knob's drive train, giving the radio a channelized feel. This is particularly useful for FM operation when the radio is set to tune in 5-kHz steps, and it's also the most convenient way to make quick frequency transitions of 100 kHz or so during SSB/CW operation.

The TS-790A's grouped function keys, **MAIN, SUB, A/B, A=B, MAIN ⇆SUB, VFO/M, BAND** and **MHZ**, are the center of activity. These controls typify the radio's front-panel layout: simple, uncluttered and easy to use. Most of the radio's controls are reasonably intuitive. For instance, the **MAIN ⇆ SUB** key swaps the contents of the main and sub receivers. Here's how that function is useful: The TS-790A transmits only on the main band, so if you're tuning two bands at once and you come across a station you want to work on the sub band, you need to swap the contents of the main and sub bands to work the station.

On the Air

As Table 1 reveals, the TS-790A's SSB

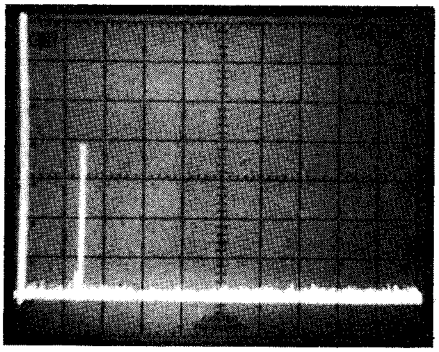


Fig 1—Kenwood TS-790A worst-case spectral display. Horizontal divisions are 100 MHz; vertical divisions are 10 dB. Output power is approximately 4.5 W at 144.2 MHz. The fundamental has been notched by approximately 32 dB to prevent spectrum-analyzer overload. All harmonics and spurious emissions are at least 64 dB below peak fundamental output. The TS-790A complies with current FCC specifications for spectral purity for equipment in this power-output class and frequency range.

Table 2
Kenwood TS-790A Receiver FM Specifications and Lab-Test Results

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*		
Sensitivity: Less than 0.22 μV (−120 dBm).	12 dB SINAD: 146 MHz, −124 dBm; 440 MHz, −124 dBm; 1296 MHz, not measured.†		
Squelch sensitivity: Less than 0.16 μV.		*Min*	*Max*
	146 MHz	0.2 μV	0.04 μV
	440 MHz	0.35 μV	0.1 μV
	1296 MHz	Not measured.†	

†See Table 1.

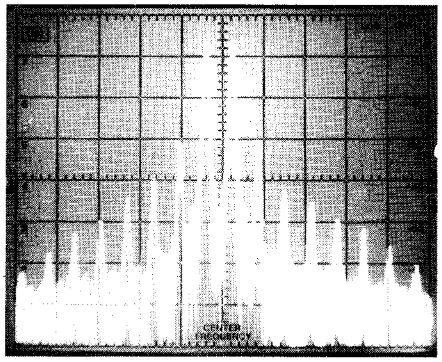


Fig 2—Spectral display of the TS-790A transmitter during two-tone intermodulation distortion (IMD) testing at 144 MHz. Third-order products are approximately 30 dB below PEP output, and fifth-order products are approximately 40 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 36 W PEP output on 144.2 MHz.

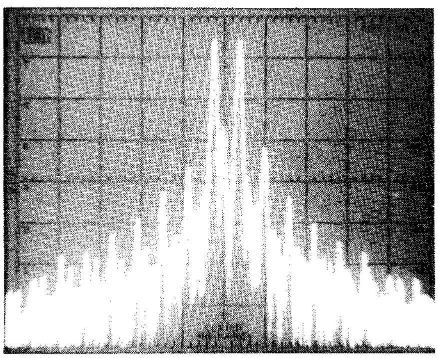


Fig 3—Spectral display of the TS-790A transmitter during two-tone intermodulation distortion (IMD) testing at 432 MHz. Third-order products are approximately 32 dB below PEP output, and fifth-order products are approximately 43 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 30 W PEP output on 432.2 MHz.

and CW receiver performance is a great improvement over most earlier multimode VHF/UHF radios. Specifically, the radio's blocking and IMD dynamic ranges are generally better than any other multiband VHF/UHF transceiver we've tested in the ARRL Lab.[1] As long as strong in-band signals are clean, it's possible to operate quite close in frequency to them with the '790, even with high-gain, low-noise preamplifiers ahead of the receiver. Although the '790's IMD dynamic range isn't as good as the current crop of MF/HF transceivers, it's better than most other VHF/UHF radios. With the wide range of signal amplitudes commonly found on VHF and UHF, wide blocking dynamic range is (arguably) more important than IMD dynamic range, and in this area, the TS-790A is far ahead of its competition. Its sharp, 20-kHz-wide first IF ("roofing") filter helps keep relatively distant in-band signals from degrading receiver performance. Although we lack the equipment needed to make quantitative receiver tests on the 23-cm band, in practice, the TS-790A performs almost as well on that band as it does on the 144- and 432-MHz bands.

Because the TS-790A is reasonably sensitive, it can be used without external receiving preamplifiers for some operation, but to wring the most performance from this radio, preamps are a must for any kind of weak-signal work—especially on 23 cm. The TS-790A's noise blankers (one in each receiver) are enabled by a single button. The blankers are effective against automotive ignition noise and radar signals, as long as these signals are above the blanker threshold. In many cases, such signals can be strong enough to be annoying, but still below the blanker threshold, unless external preamplifiers are used.

Preamplifier use is important for another reason. During weak-signal tropo work, many copyable signals are above the noise floor, but below the TS-790A's AGC threshold. This results in annoying changes in received-audio level as signals fade up and down. Preamplifiers push incoming signals above the AGC threshold, minimizing this problem.

[1]Yaesu's FT-736R (reviewed in May 1990 *QST*) performs comparably on 144 MHz.

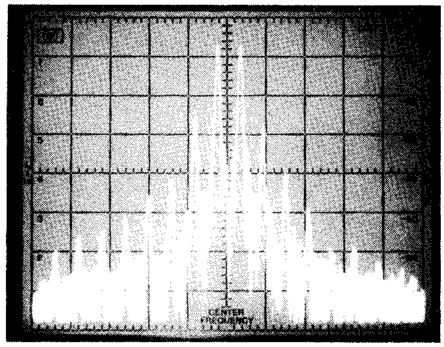


Fig 4—Spectral display of the TS-790A transmitter during two-tone intermodulation distortion (IMD) testing at 1296 MHz. Third-order products are approximately 25 dB below PEP output, and fifth-order products are approximately 40 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 10 W PEP output on 1296.1 MHz.

I used the TS-790A in several contests, including an ARRL September VHF QSO Party trip to a 3000-foot-ASL mountaintop in eastern New York (grid square FN21), where the radio performed quite well. From that location, I was quite close to a number of big-signal multioperator stations, but I was easily able to work stations close to them in frequency, even with external preamplifiers in line. When I was operating more than 10 kHz away from clean signals, I couldn't even tell they were there; only dirty signals caused me problems. The CW and SSB filters have good shape factors and high stop-band attenuation. In the past, it's been necessary to use purpose-built receive converters with strong HF receivers to get this kind of performance at VHF and UHF. The radio's many conveniences and ease of operation, particularly its quick band-change capability, make it a pleasure to operate for long periods.

Signal reports I received from other stations indicate that the '790's transmitted SSB audio is good, but that the speech processor decreases signal intelligibility. Using the processor also makes the rig's very touchy **MIC**rophone-gain control even more sensitive and difficult to adjust. Other TS-790A users have mentioned this also.

The TS-790's power levels are well suited to hilltop-portable operation (especially here in "The Corridor" between Boston and Washington, DC). Sporting 35-45 W on 2 meters, 30-40 W on 70 cm, and 10 W on 23 cm, the '790 has enough power for real DX QSOs with reasonably small antennas and favorable conditions. From most home stations, the rig doesn't produce quite enough power (except, arguably, on 1296, where considerably higher antenna gain is practical), but it has more than enough power to drive most solid-state and tube-type linear amplifiers. That's where one aspect of the rig's design got in my way. The power amplifiers I use require different relative drive levels, but the TS-790A has only one **RF PWR** control, so I had to use attenuators between the radio and the amplifiers. (The **RF PWR** control has about a 10:1 adjustment range, but having to adjust that control with each band change impairs the '790's great band-changing flexibility.)

Two-Band Operation

In both satellite and terrestrial weak-signal work, the TS-790A is quite capable. Select the active receiver using the **MAIN** and **SUB** keys, choose an audio mode (one receiver in each ear, for instance), then tune the active receiver. If you're working stations on the main band and you find a station you want to work on the sub band, hit the **MAIN ⇆ SUB** button, call and work the station, and poke the button again to get back to your main-band frequency. This is also quite handy for moving stations from band to band during contests. To make two-band operation easier, the TS-790A includes a **MUTE** button for each receiver. If you come across a weak station on one band while you're listening to a strong signal on another band, pressing the appropriate **MUTE** button cuts the strong signal's audio by a user-adjustable level that's factory-preset at 12 dB.

Because the receivers are entirely separate, you can tune one band while you're transmitting on another band. Even when I ran 500 W on 2 meters, I could tune 432 MHz—with the two antennas less than three feet apart on the same mast—with very little interference from the third harmonic of my 144-MHz signal. Steve Powlishen, K1FO, ran 1.5 kW into his 16-Yagi 432-MHz array and had similar results when tuning 1296 MHz; and his 23-cm Yagi is right smack in the middle of the 432 array! Of course, if you use an amplifier with relatively poor third-harmonic suppression, you may need to add output filtering to it to get similar performance during multiband operation.

One of the '790's most interesting and useful features is implemented by the **TRACE** button. Let's say you're tuning 144 and 432 MHz, looking for stations to work in a contest or during a tropo opening. Tune the main receiver to 144.200 and the sub receiver to 432.100, then press the **TRACE** button. The tuning knob now tunes both receivers simultaneously, doubling your tuning efficiency. Wherever you first come across a station to work, you can quickly do so and then continue tuning both bands. This function's only restrictions are that the same mode and frequency step must be used on both bands.

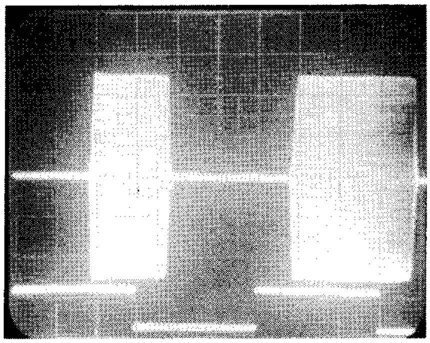


Fig 5—CW-keying waveform for the Kenwood TS-790A in the semi-break-in mode. The lower trace is the key closure; the upper trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 46 W output on 144.1 MHz. The TS-790A's CW keying shaping is generally good, but in VOX mode, the first element after key closure is shortened by approximately 11 ms.

Satellites

As mentioned earlier, the TS-790A is marketed as a satellite radio. It performs well in this service. In satellite operation, you select from a set of ten memories that store "loop frequencies" (the sum of uplink and downlink frequencies for a given satellite transponder). The factory stores transponder loop frequencies in three of these memories; you can program the remaining memories for loop frequencies of your choice. After you've selected a transponder you want to use, select the appropriate bands, tune the sub receiver to the desired downlink frequency and press the **SAT** key to separate the receiver and transmitter by the loop frequency. You can compensate for Doppler shift by tuning the main band (the uplink), or by changing the programed loop frequency, to keep your downlink frequency constant. Because the TS-790A's satellite mode uses the sub receiver for the downlink, you can't use RIT or the CW filter for satellite reception.

FM

In FM operation, the TS-790A works well, although this radio is clearly not optimized for this mode. Some operators consider the radio's discriminator and FM selectivity suboptimal. On FM, S1 to S9 on the meters is a fairly reasonable 26.5 dB, but S9 to S9 plus 40 dB is just *11.5 dB* (on both meters). This makes it difficult to peak an antenna on an FM station, because almost all signals put the S meter on the pin. Curiously, the S meters behave *just the opposite* on CW and SSB: S1 to S9 is only 16.5 dB, but S9 to an indicated S9 plus 20 dB is almost 40 dB, and it takes another 20 dB to push the meters to S9 plus 30 dB.

The '790's sensitive receiver, automatic repeater-offset selection, flexible scanning modes and high power output make it a capable FM rig, and it's easy to connect a TNC to the radio via a rear-panel DIN jack for packet-radio operation. The TS-790A's multiple scanning modes and two-band receiving capability make it useful for monitoring activity on several FM frequencies. In short, though, if you're looking for an FM-only rig, the TS-790A is overkill; there are better alternatives on the market.

Memories and Scanning

Of the TS-790A's 68 memories, 30 store frequency, mode, tone-squelch information and frequency step. Nineteen others store split-frequency information for duplex operation. Three memories hold the limits for programmed-scan operation, and six others (two for each band) store Priority Alert and Call frequencies; these functions operate like those of Kenwood's other scanning FM radios. (Programming the '790's memories is just like programming those of the TS-440S, '940S, etc.)

The TS-790A has three scanning modes: memory scan (all or selected memories), programmed scan and band scan. Like most other VHF/UHF multimode rigs, the '790 won't scan with the squelch open. Fortunately, the squelch threshold can be set low enough that most Q5 signals open it.

The Manuals

For the most part, the *TS-790A Instruction Manual* is well done. One notable exception is the description of satellite operation; if you're not familiar with such operation, the manual isn't very helpful. It takes quite a bit of practice to learn this radio's ins and outs in this mode. Fortunately, the instructions and diagrams on connecting external amplifiers and other accessories to the TS-790A are clear and simple to follow.

The Smooth...

In general, the TS-790A is highly refined. It has a great frequency-control scheme, good looks, efficient layout, Kenwood's hallmark smooth controls, and a very good receiver. It also has transmitted-signal cleanliness and keying shaping that rival current MF/HF transceivers. The rig also has excellent frequency stability and readout accuracy. The '790's fast AGC is good for weak CW and SSB signals.

To supplement what I've said about this rig's good points, here are a few of K1FO's observations:

• In moonbounce operation, the TS-790A is almost as good as an optimized receive converter and HF receiver, as long as enough preamplifier gain is used ahead of the receiver.

• The receiver is pleasantly free of birdies.

• No hum or rumble is present in received audio; the receivers are quite usable without external audio filtering, which can't be said of many other radios.

...and the Rough

You can't change modes on the TS-790A without changing the operating frequency somewhat. It's possible to tune a CW signal for an 800-Hz beat note in SSB, but when you switch to CW, the signal is offset by 1600 Hz. If you tune a CW signal for a 0-Hz beat note in SSB, you'll be right on frequency when you switch to CW. Switching from CW to SSB produces a similar problem. In weak-signal operation, frequent mode changes are common—sometimes you do so several times during a single QSO—so it makes sense for Kenwood to look into this.

The CW VOX can't be disabled, but the radio supports only PTT operation on voice modes. Some means of disabling the CW VOX would minimize the possibility of destroying a preamplifier by accidentally keying the rig before switching out the preamp.

The radio's ALT function is designed to operate like the AFC circuits in many TVs and FM-broadcast receivers. It tunes your receiver to follow drifting signals, but works only on 23-cm FM, and only on strong signals.

No receiver RF-gain controls (except the 10-dB 144-MHz attenuator) are included. This makes preamplifier switching and receiver-gain reduction cumbersome on 432 and 1296 MHz.

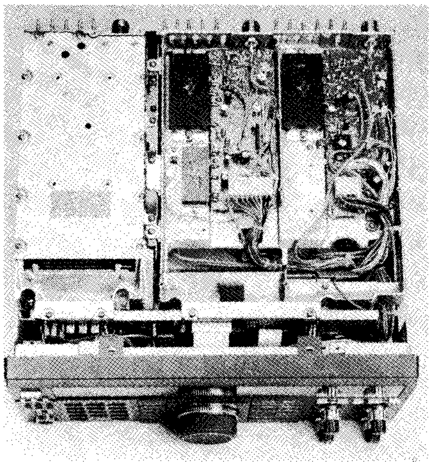
K1FO:

• Very strong SSB signals cause noticeable receiver-audio distortion. A similar problem exists at the turn-on threshold of the mute/busy LEDs for each receiver.

• The synthesizer pops annoyingly every 40 kHz on the 144- and 430-MHz bands, and every 80 kHz on the 1240-MHz band.

• The CW filter has about 13 dB of insertion loss, so input attenuation, preamp gain or audio gain must be modified when the CW filter is switched in and out. Some IF-amplifier noise is also apparent, especially when the CW filter is switched in, but this doesn't pose a major problem in copying weak signals.

• When you change modes between SSB and CW, the radio's transmitter output varies (power output is higher on CW than SSB, because the hybrid power amplifiers used in the '790 deliver more output when operated class C, as they are on CW and FM). Even though the radio has separate ALC inputs for each band, you have to remember to reduce power when you change from SSB to CW when you're using an external power amplifier.



An inside view of the TS-790A.

• The TS-790A's slow AGC is too slow for all but very strong signals.

A TS-790A Wish List

Even though the '790 is a good radio, it has some areas that, if paid some attention, would make the rig even better. In no particular order, here are some areas that could use improvement:

K1FO:

• Faster synthesizer lock-up time and 10-Hz tuning steps (instead of 20-Hz steps) would make the receiver sound and work better, especially in EME operation.

• A source of low-level 144-MHz output and a separate 144-MHz receiver input would make the TS-790A much more useful as an IF rig for bands that the '790 doesn't cover. 144 MHz has become a standard IF for microwave transverters, and such capability would enhance this radio's value, especially to multiband portable operators.

• IF-gain distribution should be such that there's no difference in audio level when the CW filter is switched in and out of the circuit.

• A medium AGC speed would be quite useful for moderately strong signals. It would also be useful to be able to turn off the receiver AGC.

• The receiver frequency and the transmitter power output should not vary when you change modes. The display should show the actual listening frequency on all modes (*not* the zero-beat frequency on CW).

• A choice of CW IF filters would be really nice (500 Hz is a bit too wide for EME operation).

NJ2L:

• The manual needs better instructions on satellite operation.

• Separate drive controls for each band, adjustable so that the **RF PWR** control's maximum setting gives a user-preset maximum output level on each band, would be a great addition for those who use external power amplifiers.

• Those of us who prefer to listen to CW at low frequencies (*much* less than 800 Hz) would appreciate a variable CW offset and a sidetone pitch to match it.

• Better speech-processor performance and **MIC**-gain control linearity would help on SSB—especially in barefoot operation.

• RIT and a CW filter in the sub-receiver IF chain would improve the '790's satellite and weak-signal performance.

• A tuning rate of 2.5 or 5 kHz per knob revolution (instead of 10 kHz) would make weak-signal CW operation easier.

These things basically amount to giving the TS-790A the performance and ergonomics of current MF/HF transceivers. After all, multiband VHF/UHF transceivers are intended to be used by operators who are just as demanding as MF/HF transceiver users; the application is simply slightly different. As is, the '790 isn't far from the mark.

Summary

In the TS-790A, Kenwood has done a good job of blending essential HF-transceiver features and flexibility with solid VHF/UHF performance into one compact package. At first blush, the TS-790A may seem inferior to Yaesu's FT-736R because it has only three-band capability. Looking closer, though, you'll see that the FT-736R can handle a maximum of only four bands at once, and doesn't have anything like the TS-790A's two-receiver flexibility (other than the '736's duplex satellite capability). The TS-790A's great receiver performance, higher power output, easier operation, comparable cost (similarly equipped) and better general polish give the '790 several advantages over the FT-736R. The TS-790A's 13.8-V operation can be an advantage or a hassle, depending on your application; in any case, it keeps power-supply heat out of the radio. The TS-790A warrants careful consideration for hams interested in multiband weak-signal and satellite operation. As with any major radio purchase, I suggest that you buy the manual from Kenwood (and those for any other rigs you're considering) *before* making a decision.

Manufacturer's suggested retail prices: TS-790A, $2000; UT-10 1240- to 1300-MHz module, $540; PS-31 13.8-V power supply, $200; VS-2 voice synthesizer, $63; TSU-5 CTCSS decoder, $51. Manufacturer: Kenwood USA Corp, 2201 E Dominguez St, Long Beach, CA 90801-5745, tel 213-639-4200.

Acknowledgement

Thanks to 432-MHz enthusiast Steve Powlishen, K1FO, for his critical look at the TS-790A, and for his comments.

RUTLAND ARRAYS FO-22 AND FO-25 432-MHz YAGI ANTENNAS

Reviewed by Mark Wilson, AA2Z, and Rus Healy, NJ2L

For many years, the most popular 432-MHz antennas were based on a design by Dick Knadle, K2RIW. The 'RIW antenna was extremely popular because of its light weight, low wind load, clean pattern and good overall performance in wet and dry weather. In recent years, with the availability of sophisticated antenna-analysis programs for personal computers, a number of new designs have emerged. Steve Powlishen, K1FO, described a series of high-performance 432-MHz Yagis in December 1987 and January 1988 *QST*, and in Chapter 32 of the latest *ARRL Handbook*. These antennas are optimized for good gain, extremely clean patterns and an excellent match. The Rutland FO-22 is the commercial version of Steve's 22-element design on a 14-foot boom; the FO-25 is Rutland's version of the 25-element, heavy-duty, 17-foot-boom model. Rutland worked closely with Steve on the construction of these antennas, and the results are finished products that are faithful to the original designs.

Table 3
Rutland Arrays FO-22 and FO-25 432-MHz Yagis

Manufacturer's Claimed Specifications	*ARRL Evaluation* FO-22	FO-25
Frequency of operation: 432 MHz.	As specified.	As specified.
Longest element: 13.6 in.	As specified.	As specified.
SWR: 1.14:1 typ.	Less than 1.2:1.	Less than 1.1:1.
Wind surface area: 0.78/1.5 ft^2.	Not measured.	Not measured.
Weight: Not specified.	4 lb.	7 lb.

Materials

Both antennas come with three-piece booms. The FO-22's boom comes in five-foot-long sections. The center section is made from 1-inch-diameter tubing, and 7/8-inch-diameter tubing telescopes into the ends of the center section. The boom-to-mast bracket consists of a single galvanized **U** bolt and saddle that accommodate masts up to 1½ inches in diameter. The FO-25's boom comes in six-foot pieces, with a 1¼-inch-OD center section and 1-1/8-inch outer segments. The boom-to-mast clamp is a 3/16-inch-thick aluminum plate with a pair of galvanized **U** bolts to hold the antenna to the plate, and a second pair for the mast. The FO-25 can be mounted to masts up to 2¼ inches in diameter. On both antennas, the boom material is top-quality 6061-T6 aluminum, and the boom-pinning hardware is stainless steel.

All parasitic elements are made from 3/16-inch aluminum rod. These elements mount through the boom and are insulated from it by ultraviolet-resistant black Delrin shoulder insulators. Galvanized keepers hold the elements in position. This time-tested construction technique was used in the K2RIW design and has been used successfully by several commercial manufacturers.

The driven element, which mounts through the boom like the other elements, is made from 3/16-inch brass tubing. A **T** match (made from solid copper wire) and ½-λ balun (made from 0.141-inch semirigid coaxial cable) is used to match each antenna to a 50-Ω feed line. Coaxial feeder attachment is done via a female N connector.

Construction

These antennas are shipped in surprisingly small cardboard boxes (about four inches square and slightly longer than the boom-section lengths). The boom sections, elements and hardware were all securely taped together, so there's no worry about miscellaneous parts getting lost in the packing material or falling out if the box gets damaged in shipping.

Accurate measurements and faithful reproduction of the original designs are keys to good performance from VHF and UHF antennas. Although Rutland has done most of the hard work—accurately locating holes in the boom and cutting the elements to the right lengths—you still need to take care in assembling the kits. You'll need a soldering iron, a screwdriver, a tool to push the keepers onto the elements, and—most importantly—a ruler with a millimeter scale. Fortunately, Rutland supplies the ruler and a piece of aluminum tubing with which to push the keepers into place.

The element lengths taper continuously from the reflector to the last director. They're *all* different lengths, and lengths vary by as little as 1 or 2 millimeters, so you must pay special attention to mounting the elements in the right order. Rutland makes this job *a lot* easier by placing all of the parasitic elements in the correct order on a wide piece of duct tape.

Centering the elements in the boom is simplified by the table of dimensions in the manuals accompanying each antenna. Element mounting involves these easy steps: (1) Slide a keeper onto the rod and position it within 3 mm of the dimension shown in the manual. (2) Place an insulator in one of the holes at the appropriate location in the boom. (3) Slide the element through the insulator and boom. (4) Repeat the process with the insulator and keeper for the other side, making sure to center the element before snugging down the keepers. The keepers are a tight fit, so it's important to work them gently along the rod to keep the element centered. The keepers slide one way only, so if you have a problem after both keepers are installed, you have to destroy a keeper to free the rod. Fortunately, Rutland includes several extra keepers and a few spare shoulder washers.

Much of the driven element **T** match is assembled at the factory. Final assembly requires installing the **T**-match wires, positioning the two brass shorting straps and soldering things in place. Drawings and detailed instructions are provided. The dimensions given in the manuals provided good matches, but before soldering, it's a good idea to check the SWR if you have access to a directional wattmeter that's accurate at 432 MHz.

The clear, well-illustrated and complete instruction manuals that come with these Yagis suggest painting the antennas (especially the driven-element assemblies) with three or four coats of clear weatherproof lacquer to help prevent corrosion. The wisdom of this step has been borne out by time: The antennas have held up very well, and there's no sign of corrosion that could impair performance.

Final Thoughts

The FO-22 has several attractions. It's a proven performer based on a mature design. The antenna's clean pattern is obvious immediately: There are several *very* loud locals, and being able to put them in a null helps tremendously in hearing weaker stations. The FO-25 shares these virtues. Both antennas break into three manageable and lightweight pieces for hilltopping, and the 3/16-inch elements are sturdy enough to withstand being carried around.

For fixed installation, the FO-22 is small enough that you can squeeze one in almost anywhere. If you want a bigger signal, the major advantages of the FO-22 over the FO-25 are size and weight: It's possible to put up a compact array of four or six FO-22s without unduly stressing a small tower or rotator, even if there are other antennas on the mast.

The FO-25 is decidedly more rugged than the FO-22, so it's a natural choice for rough climates where ice and wind are problems. The FO-25 survived several ice-and-wind storms with no damage, which is more than can be said for some of the other antennas that were mounted near it. For hard-to-access installations or bigger masts than the FO-22 can accept, the FO-25 may be a better choice, but for portable operation, you can't beat the size, weight, performance and cost of the Rutland FO-22.

Prices: FO-22, $95; FO-25, $125. Manufacturer: Rutland Arrays, 1703 Warren St, New Cumberland, PA 17070, tel 717-774-5298 (eves).

ADVANCED ELECTRONIC APPLICATIONS IsoLoop 14- TO 30-MHz ANTENNA

Reviewed by Doug DeMaw, W1FB

AEA's IsoLoop is a compact, lightweight loop antenna that covers all of the frequencies from 14 to 30 MHz. It's a novel antenna that should be of interest to campers, apartment dwellers, RV owners and others who need an unobtrusive HF antenna that can be erected in limited space. The IsoLoop is fed with 50-ohm coaxial cable and is rated to handle up to 150 watts of RF. A remotely controlled matching network eliminates the need for an additional antenna tuner.

The IsoLoop's conductor consists of ¾-inch-OD aluminum tubing. Tuning is accomplished by a control box that actuates a *big* variable capacitor located electrically opposite the loop's feed point. This capacitor and its stepper motor are housed in a weatherproof plastic box attached to the antenna.

A five-conductor control cable (the manual recommends using shielded cable) connects the capacitor/motor box on the antenna to the control box at the operating position. Five-pin DIN plugs are used at each end; AEA supplies two DIN plugs with the antenna, but no cable. (They also offer optional preassembled 50- and 100-foot cables.) The power supply for the system is a 12-V dc wall transformer.

Tuning Procedure

The two-tone-gray IsoLoop control box is small and straightforward to operate. Its center-off **TUNE** switch lets you bidirectionally adjust the variable capacitor in the loop. The **SPEED** potentiometer regulates the speed of the stepper motor that drives the capacitor. The most convenient way to tune the antenna is to use a relatively fast **SPEED** setting to get close to resonance (listening for maximum band noise from the receiver) at the chosen frequency, and then slow the motor down to minimize the SWR.

Jodi, KA1JPA, tries the IsoLoop on for size. *(NTØZ photo)*

Is the IsoLoop for Real?

"That's it?" she asked. My wife, Jean, has helped me install a lot of antennas over the years—everything from 40-meter Yagis to VHF arrays. Today's job was to steady the IsoLoop atop a 15-foot mast while I pushed three guy stakes into the ground.

"Yes, that's it," I replied, noting how insignificant the IsoLoop looked compared to the nearby monobanders towering over it. "Hmmm," I wondered, "Is this antenna for real?"

Earlier that week, I had seen the IsoLoop in the Product Review Editor's office. Foolishly, I asked Rus how it worked. Within minutes, the IsoLoop and its accessories were loaded in my Subaru hatchback. When was the last time you saw a fully assembled 20-meter antenna that fit in the back of a Subaru?

It took a while to get used to the IsoLoop's sharp tuning—it's easy to miss the resonance point when tuning this antenna. After a little experimenting, though, I was able to figure out how long to hold the **TUNE** switch (at the slowest **SPEED** setting) for excursions up and down the band. Even with experience, changing bands is a slow process because there is no indicator to show capacitor setting. I was able to achieve a 1:1 SWR on all bands except 10 meters; there, the best I could do was 1.5:1

What better way to inaugurate the IsoLoop than during the 1990 CQ Worldwide SSB DX Contest? The first station I called, DLØCS, came right back. Then OE6MBG, then YZ9OS. . .hey, am I on the right antenna? I spent about four hours each afternoon working the contest with the IsoLoop and a barefoot transceiver. The antenna seemed to work best on 15 meters, but I was able to work plenty of DX on 10 and 20 meters too. The final tally for eight hours operating: 197 QSOs, 46 zones and 96 country multipliers (including 62 different DXCC countries). Some 30 Japanese stations found their way into the lög, as did a few Pacific multipliers—not bad for a 3-foot-square loop on a 15-foot mast!

In the following weeks, I built a 15-meter dipole and mounted it at 15 feet for comparison. Much of the time, signals received on both antennas were within an S unit of each other—not always a significant difference when it comes down to the practical business of making QSOs. In some cases, the dipole was several S units better, and in a few cases the IsoLoop was superior. One thing's for sure: At my house, on 15 meters, the IsoLoop compared favorably to a dipole mounted at the same height.

For fun, I compared the IsoLoop to some beam antennas. Not surprisingly, there's a night-and-day difference between a five-element 10-meter monobander at 100 feet and an IsoLoop at 15 feet. The biggest difference is when the band is opening and closing, and on long-haul DX (working Japan from New England, for instance). Much of the difference is probably the relative heights of the two antennas. When the band is open, however, the IsoLoop closes the gap to within two to four S units on most signals. At times, signals arriving at high angles were actually louder on the IsoLoop than on the beam.

The bottom line: You may never be first through a pileup with the IsoLoop, but you can use it to make plenty of contacts and work lots of DX. I wish that AEA had offered this product back in my apartment-dweller days, when the best I could do was an "invisible" end-fed wire strung out the window of a second-floor apartment. I had stray-RF problems with that antenna, and it worked so poorly that I couldn't find much enthusiasm to get on the air. The IsoLoop would have been *much* better.

The IsoLoop suffered through three months of the pouring rain, ice, snow and drastic temperature changes typical of a New England winter. The aluminum parts exhibited normal oxidation, but the plastic housing for the stepper motor and tuning capacitor kept everything clean and dry. Tuned as recommended and used at its rated power input, the IsoLoop's tuning capacitor showed no internal signs of having been stressed. The housing is made of lightweight plastic, and I'm a little concerned about how it would hold up over the long term. The manual recommends spraying the plastic parts with "a good ignition wire sealant. . .to extend the ultra-violet protection from sunlight."

So, the answer is yes, the IsoLoop is for real. Now Jean wants to know if we can keep the IsoLoop and take down one of the towers in the side yard. Well. . .—*Mark Wilson, AA2Z*

Table 4
AEA IsoLoop HF Antenna

Manufacturer's Claimed Specifications	*ARRL Evaluation*
Frequency coverage: 14 to 30 MHz	As specified.
Maximum power: 150 W.	Not measured.
Dimensions: 32 inches per side.	Antenna, 30.5 × 34 inches; Control box: 1.75 × 3 × 3.5 inches (HWD)
Weight: 12 pounds.	As specified.
Bandwidth: Not stated (2:1 SWR points).	20 m, 20 kHz; 17 m, 32 kHz; 15 m, 32 kHz; 12 m, 93 kHz; 10 m, see text.
SWR: 1:1 via remote tuning.	As specified, except at 28 MHz (see text).

Because of the IsoLoop's relatively high Q, its bandwidth between the 2:1 SWR points is quite narrow. Therefore, you need to readjust the matching network as you change frequency. The 2:1 SWR bandwidth is 20 kHz at 14 MHz; 32 kHz at 18 and 21 MHz; and 93 kHz at 24.9 MHz.

On 10 meters, I could not adjust the antenna for an SWR lower than 1.7:1. The instruction book suggests changing the coaxial coupling loop's position with respect to the main loop to provide an acceptable SWR on all bands. AEA recommends orienting the coupling loop 45 degrees from the plane of the loop for best performance. The 10-meter SWR worsened when I moved the coupling loop away from a 45-degree relative position. Despite the problem on 10 meters, I was able to adjust the SWR to 1:1 on the other bands.

Performance

Antennas of reduced size, even if resonant and matched to the feed line, do not provide the efficiency of full-size antennas. The efficiency loss that goes with a reduced-size antenna is often an acceptable compromise when it is not convenient or possible to erect a full-size antenna, such as a dipole. Simply stated, a compromise antenna is better than *no* antenna! Hams are often willing to trade some signal strength for the ability to operate with a small antenna when they can't put up a full-size radiator.

My test setup consisted of a 20-meter dipole at 35 feet, a Bird wattmeter, step attenuator, antenna switch and a 150-W transceiver. I installed the IsoLoop on a 30-foot mast, about 70 feet away from the dipole. The loop was parallel to the ground to provide omnidirectional response and horizontal polarization. (If vertical polarization and a figure-8 radiation pattern are desired, you can mount the IsoLoop parallel to the mast.)

I spent several days and nights making comparisons between the two antennas while listening on all the ham bands the IsoLoop covers. I also used the IsoLoop to make QSOs on each band. Interestingly, signal strengths (transmit and receive) varied from identical with both antennas to as much as two S units less when using the IsoLoop; results depended on the time of day, heading to the other stations and propagation conditions. Certainly, the loop cannot perform as well as a beam antenna. On receive, I found that the IsoLoop rejected man-made noise about as well as the dipole.

Rough Spots

My IsoLoop came without the cross bar to which the antenna mast is bolted. A cross bar was ordered from AEA, and it took approximately a month to arrive. The cross bar I received had been used previously, as indicated by scratches and marks that were left by the U-bolt attachment hardware. AEA's Mike Lamb, N7ML, noted that we purchased one of the first IsoLoops made and that AEA then had no stock of spare parts. They now maintain a full inventory of spares, so such delays are history.

The instruction booklet's narrative is sparse, and no step-by-step assembly information is provided. Three drawings show you how to assemble the antenna. The various pieces of hardware are shown two-dimensionally, making it a slow process to identify the parts and put them where they belong. Putting the IsoLoop together, I experienced the same frustration that accompanies the assembly of many kids' toys, such as swing sets!

Construction

I am impressed with the quality of the materials used in this antenna. Aluminum castings are used to connect the loop halves and to join the coaxial coupling loop to the main loop. Type F coax connectors are used for attaching the coupling loop to the primary antenna. They should be weatherproofed to prevent oxidation. Coax Seal or flexible caulking compound can be used for this purpose.

Summary

I enjoyed assembling and testing the IsoLoop. I can recommend this antenna without reservation to my amateur friends who travel and take their ham gear with them—especially those who pull campers or drive motor homes. Those who live in apartments or housing developments with antenna restrictions should find the IsoLoop an acceptable alternative to hidden dipoles or verticals. Take care, however, to locate the IsoLoop where people and animals can't come in contact with it when you're transmitting.

Manufacturer's suggested retail price: IsoLoop with control box and wall transformer, $315. Manufacturer: AEA, 2006 196th St SW, Lynwood, WA 98036, tel 206-775-7373.

Feedback

☐ John Belrose, VE2CV, reports two problems in his February 1991 *QST* Technical Correspondence, "More on the Half Sloper." On p 41, in the second line of text in the first column, change "...toward 0° azimuth..." to "...toward 90° azimuth...." In the caption for Fig 3, the parenthetical statement in the first sentence should read, "(90° azimuth corresponds to the direction of the drooping wire away from the feed)."

☐ Charles Croatman, WB2ZKS, has brought to our attention that the telephone number listed for Daiwa Electronics in the February Product Review column is incorrect. The correct number is 703-938-8105.

☐ The telephone number given for Yaesu in the March 1991 *QST* FT-1000D review is no longer in service. You can reach Yaesu at their main number. 213-404-2700.—*NJ2L*

☐ Robye Lahlum, W1MK, calls our attention to "Effective Receiver Dynamic Range," Technical Correspondence, *QST*, Jan 1991, pp 38-39. The IMD level and effective IMD dynamic ranges shown in Figs 1B and 1C are incorrect. Because of the increased noise levels, the receiver can generate more distortion before it becomes noticeable. For Fig 1B, the IMD level is −47 dBm (not −56), which corresponds to a dynamic range of 63 dB (not 54). In Fig 1C, the IMD level is −33.4 dBm (not −36), which corresponds to a dynamic range of 75.8 dB (not 73.2).

☐ The frequency of the Utah Code Net was incorrectly listed on page 50 of the February issue ("CW Traffic Nets: Take the Plunge!" *QST*, Feb 1991, p 50.) The correct frequency is 3.710 MHz.