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Kenwood TS-950SD MF/HF Transceiver

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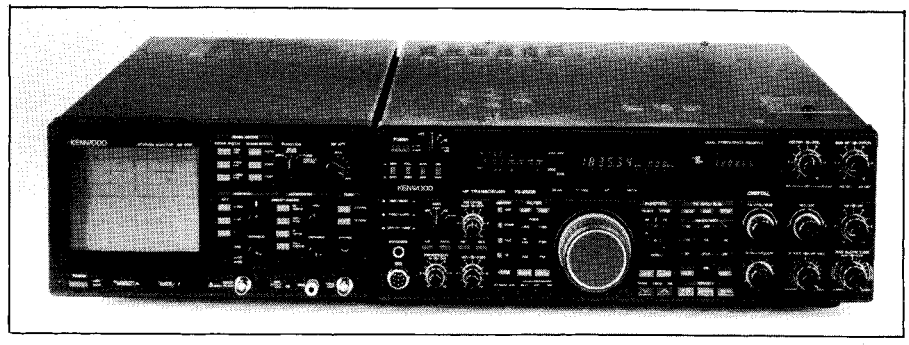
Reviewed by James W. ("Rus") Healy, NJ2L



The TS-950SD is aimed at the most performance-minded segment of the Amateur Radio transceiver market: serious contesters and DXers. These hams take their radio hobby *seriously*. They expect a lot of their equipment, and they're willing to pay a lot for good performance. The '950 is a "power-user" rig, but it also appeals to others in ham radio—just as Ferraris and Porsches appeal to many of those who drive Ford Escorts and Toyota Corollas.

You expect many things of a transceiver in this price class: excellent basic radio performance; added features that not only *promise* a lot—but *deliver* it; absolute reliability; refinement; and, perhaps as important as any of these, intuitive, familiar operation—a good user interface. In short, any rig that costs well over three thousand dollars in 1991 has to deliver what it promises—and what people expect from it.

Is the TS-950S a worthy successor to the TS-940S and TS-930S? Absolutely. But there's still plenty of room for improvement.

Standard Features

The TS-950SD has a lot of standard features, including simultaneous dual-frequency reception; a built-in temperature-compensated crystal reference oscillator (TCXO); receiver coverage from 100 kHz through 30 MHz; an automatic antenna tuner; full QSK; IF filters galore; an internal keyer; 100 memories that store transmit and receive frequencies, mode and filter selections, tuner settings and CTCSS tone (if applicable); computer controllability; a final amplifier that's rated at 150 W output (for over an hour) on CW, SSB and RTTY; and scanning functions to suit almost any taste. The only optional IF filters for the TS-950SD are 1.8-kHz and 270-Hz units for the 8830-kHz IF.

The TS-950SD also has many features that haven't appeared in Kenwood's radios before. One is audio digital signal processing (DSP). The '950 uses DSP in its audio variable-bandwidth-tuning circuit (**AF VBT**) and AF slope tuning on receive, and in generating transmitted signals. DSP filtering improves rejection of the unwanted sideband on transmit, allows selection of high and low cutoff frequencies of the transmitted SSB signal, and offers selection of fast or slow CW-signal rise and fall times. FSK signals are also generated by the DSP unit.

The main difference between the TS-950S and the '950SD is that the D-suffix model comes with the DSP module, the TCXO, and four IF filters that are optional for the '950S. A voice synthesizer that announces the displayed frequency is optional on both versions.

Installing the IF filters is easy, requiring only a Phillips screwdriver and a few minutes. Installing the optional DSP unit (if purchased separately) is similarly easy, and you don't even have to take the covers off the rig to do it: The DSP-10 screws to the bottom of the cabinet and connects to the rig via two rear-panel jacks.

Memories and Scanning

Ninety of the TS-950S's battery-backed-up 100 memories can store the frequencies of the two VFOs, mode, filter selection, and CTCSS (continuous tone-coded squelch system) tone frequency and status (on/off). The other 10 memories are used for programmed scanning, and each can store mode, filter selection and high/low frequency limits for the programmed-scan range. The '950's memory-manipulation scheme is much like that of the TS-440S and other current Kenwood radios, and is well explained in the instruction manual.

The TS-950S has three scanning modes. In Memory Scan mode, the rig scans the memory channels, skipping any that have nothing stored in them. It also skips any memories that you have locked out. In Group Scan operation, the rig scans one or more groups of 10 consecutive memory channels (00-09, 30-39, etc). More than one group can be scanned sequentially. During Programmable Band Scan, the radio scans between the lower and upper scan limits you've selected. In all the scanning modes, scan speed is adjustable by turning the **RIT/XIT** knob during scanning. The display shows the relative scan speed.

Controls and Connections

The '950's control scheme is quite similar to that of the TS-940S, but this rig's added features required lots of new controls on a front panel that's about the same size as the '940's. Kenwood managed to keep the front panel suitably uncluttered, in part by doing away with the '940's analog meter in favor of a cleverly designed multicolored fluorescent multimeter. The meter shows final-amplifier current, received-signal strength, power output, ALC level, speech-compressor level and SWR (not all at once). Received-signal strength and power output are shown by default; I usually used the display to show SWR and ALC during CW operation, and ALC and compression level during SSB work.

The '950 has a built-in computer interface. It's just like the '940's interface: A 4800-bps serial port that uses TTL signal levels (0 and +5 V). If you want to control the '950 via an EIA-232-D (aka RS-232-C) serial port, such as the one on your IBM® PC or compatible machine, you'll need to use a level converter, such as Kenwood's $99 (list) IF-232C. (The cable required to connect the computer and the IF-232C isn't included in that price, nor is the 12-V supply needed to operate the level converter.)

CW Keying

The TS-950S has an internal, adjustable-speed-and-weight keyer that functions well. Its sequencing is designed to complement the rig's QSK switching.

The '950's CW keying is generally good, although, curiously, the CW dot length varies. This effect isn't noticeable on the air, but it's visible on a scope. The DSP unit on the TS-950SD allows selection of one of two CW rise-/fall-time combinations. The faster rise time is best suited to high-speed (more than 25 WPM) CW operation. The '950's keying shaping is smooth and click-free.

In early TS-950s, internal keying sequencing provided objectionably shortened characters during QSK CW operation. This problem existed with either external or internal keying sources. On the air, at speeds over 20 WPM or so in QSK mode, keying became unacceptably light. Kenwood has fixed this problem in later production rigs by changing the microprocessor-control software, and will modify earlier radios to eliminate this problem. Contact Kenwood

Table 1

Kenwood TS-950SD 160-10 Meter Transceiver, Serial no. 1010616

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 0.1-30 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, 24.89-24.99, 28-29.7 MHz.	Receive, as specified; transmit, 1.62-2, 3-4, 6.5-7.5, 10-10.5, 13.5-14.5, 18-18.5, 20.5-21.5, 24-25, and 27.5-30 MHz.
Modes of operation: AM, CW, FM, FSK, LSB, USB.	As specified.
Power requirement: 120 V ac. Receive, 110 W max; transmit, 700 W max.	Not measured.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity (bandwidth not specified): SSB, and CW, 10 dB S+N/N: 0.1-0.15 MHz, 2.5 μV (−99 dBm); 0.15-1 μV (−107 dBm); 0.5-1.62 MHz, 4 μV (−95 dBm); 1.62-30 MHz, 0.2 μV (−121 dBm).	Minimum discernible signal (noise floor) with 500-Hz (1st IF) and 250-Hz (2nd IF) filters: 1 MHz, −126 dBm; 3.5 MHz, −143 dBm; 14 MHz, −142 dBm.
AM (10 dB S/N): 0.1-0.15 MHz, 25 μV (−79 dBm); 0.15-0.5 MHz, 10 μV (−87 dBm); 0.5-1.62 MHz, 32 μV (−77 dBm); 1.62-30 MHz, 2 μV (−101 dBm).	10 dB S+N/N (6-kHz IF filters, signal 30% modulated with a 1-kHz tone): 1 MHz, −111 dBm; 3.8 MHz, −123 dBm; 14.2 MHz, −125 dBm.
FM, 12 dB SINAD: 28-30 MHz, 0.5 μV (−113 dBm).	12 dB SINAD: wide filter, 0.3 μV; narrow filter, 0.31 μV.
Receiver dynamic range (type, bandwidth and signal spacing not specified): 105 dB	Blocking dynamic range (500-Hz [1st IF] and 250-Hz [2nd IF] filters, AIP circuit off):† 3.5 MHz, 138.5 dB; 14 MHz, 139 dB.
	Two-tone, third-order intermodulation distortion dynamic range (500-Hz [1st IF] and 250-Hz [2nd IF] filters):† 3.5 MHz, 99 dB; 14 MHz, 101 dB.
Third-order input intercept: Not specified.	3.5 MHz, 5.5 dBm; 14 MHz, 9.5 dBm.
S-meter sensitivity (for S9 reading): Not specified.	35.5 μV at 14 MHz.
CW/SSB squelch sensitivity (1.62-30 MHz): Less than 0.5 μV.	As specified.
FM squelch sensitivity: Less than 0.32 μV.	As specified.
Notch filter attenuation: More than 45 dB.	More than 30 dB.††
Receiver audio output: More than 1.5 W at 10% distortion with an 8-Ω load.	As specified. 2.1 W at 10% total harmonic distortion (THD) with an 8-Ω load.
Receiver IF/audio response: Not specified.	290-2376 Hz (SSB) at −6 dB (2.7-kHz IF filters selected).
Transmitter	*Transmitter Dynamic Testing*
Transmitter power output: 150 W max, 20 W min on SSB, CW FSK and FM (110 W max from 28-29.7 MHz); 40 W max on AM.	Output power: 139-179 W (CW, SSB, FSK, FM—output is typically more than 160 W and varies slightly from band to band); AM, as specified.
Spurious-signal and harmonic suppression: >40 dB below peak power output	As specified. (See Fig 1.)
Third-order intermodulation distortion products: Not specified.	See Fig 2.
CW-keying waveform: Not specified.	See Fig 3.
Transmit-receive turnaround time (PTT release to 90% audio output): Not specified.	S1 signal, 15 ms; S9 signal, 22 ms; AGC off, 14 ms.
Composite transmitted noise: Not specified.	See Fig 4.
Size (height, width, depth): 6.1 × 16.15 × 17.6 inches; weight, 50.6 lb.	

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

††Test-equipment limitations inhibit ARRL Lab measurement of notch-filter attenuations of more than about 30 dB.

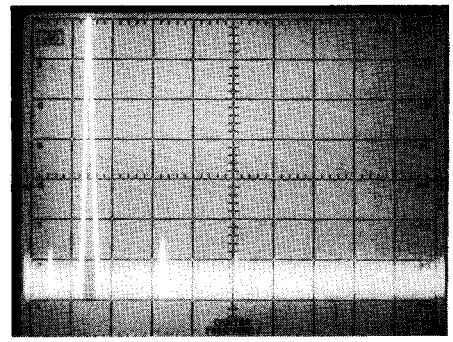


Fig 1—Kenwood TS-950SD worst-case spectral display. Horizontal divisions are 10 MHz; vertical divisions are 10 dB. Output power is approximately 150 W at 3.51 MHz. All harmonics and spurious emissions are at least 55 dB below peak fundamental output. The TS-950SD complies with current FCC specifications for spectral purity for equipment in this power-output class and frequency range.

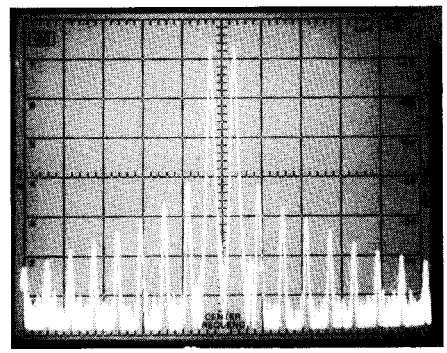


Fig 2—Worst-case spectral display of the TS-950SD transmitter during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 42 dB below PEP output, and fifth-order products are approximately 46 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 150 W PEP output on 14.25 MHz.

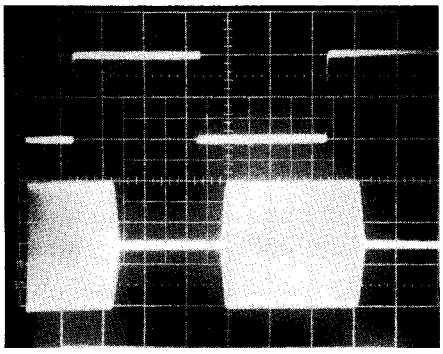
Service for details.[1]

Like the TS-930S and TS-940S, the TS-950S has a **PITCH** control (centered at 800 Hz) that allows varying the CW offset ±500 Hz of the center frequency, and causes the sidetone pitch to track the offset. I like this feature, because I prefer a 350-Hz offset to the fixed 700- or 800-Hz offsets in most rigs.

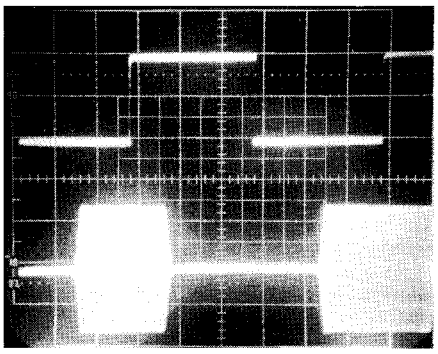
Frequency Control

Frequency selection with the '950 is straightforward. The two most common ways of changing frequency (aside from the main-tuning knob) are both implemented from the keypad to the right of the main-tuning knob and VFO-manipulation keys. You can select the band by pressing the appropriate band key on the keypad, or you can enter frequencies directly into the '950 (with 10-Hz resolution) by pressing the **ENT** key, selecting the frequency on the keypad, and pressing **ENT** again. During direct frequency entry, the numerals on the keys are illuminated, which keeps things from getting confusing (as they often do when keys have multiple labels, for instance). If you enter a frequency that the radio doesn't cover, it sends OVER in Morse code from the speaker or headphones.

[1]Kenwood encourages use of their telephone BBS for technical (and other) inquiries. It's at 213-761-8284 or 213-761-8292 (modem parameters: 2400 bps, 8 data bits, no parity, 1 stop bit). You can also call their Service Department at 213-639-7140 between 8:30 AM and 5:00 PM Pacific Time.



(A)



(B)

Fig 3—CW-keying waveforms for the TS-950SD in the semi-break-in mode (A) and the full-QSK mode (B) after modification by Kenwood. The upper traces are the actual key closures; the lower traces are the RF envelopes. Horizontal divisions are 5 ms. The transceiver was being operated at 150 W output on 14 MHz. The TS-950SD's CW keying shaping is good, but dot length is shortened in QSK mode.

Separate controls allow bidirectional frequency transitions in 5, 9 or 10-kHz and 500-kHz or 1-MHz steps. (The 5-kHz steps are great for tuning through international shortwave-broadcast bands, where channels are spaced every 5 kHz.) The main-tuning knob's default rate is 10 kHz per revolution. The sub-receiver tuning knob operates at 4 or 40 kHz per revolution.

On-the-Air Performance

This rig went through a lot during the review period. I used it in numerous contests, took it to other stations, drove five or six different amplifiers with it (with no trouble) and had about a dozen other hams try it. The radio has traveled hundreds of miles and has been responsible for more than 7500 QSOs, mostly accrued in CW and SSB contests. It's been absolutely reliable.

Receiving

In the basic performance department, the TS-950's receiver is top shelf. It handles incredible signal levels with poise, has a reasonably quiet audio-output chip, and is not limited by phase noise. Operationally, this rig is a joy to use. It has Kenwood's hallmark smooth, properly weighted controls; a familiar adjustable-intensity fluorescent display that's a direct descendant of those in the TS-930S and '940S; modern, pleasant styling; and the right frills.

The AGC in the '950's main receiver is excellent. With a choice of three decay speeds, you can select an AGC setting for almost any circumstance. I used the **FAST** position for CW work and the **MID** setting for SSB contesting. For casual SSB operation, the **SLOW** setting is appropriate. The AGC can also be turned off.

An interesting TS-950S first is the Advanced Intercept Point circuit. Pressing the **AIP** button substitutes a unity-gain RF-amplification stage for the main RF amplifier, improving dynamic range under strong-signal conditions. ARRL Lab tests show that this circuit reduces sensitivity by about 10 dB, increases blocking dynamic range by about 5 dB and increases IMD dynamic range by 1 to 3 dB.[2] In practice, the AIP circuit's operation isn't perceptibly different from that of the 10-dB attenuator.

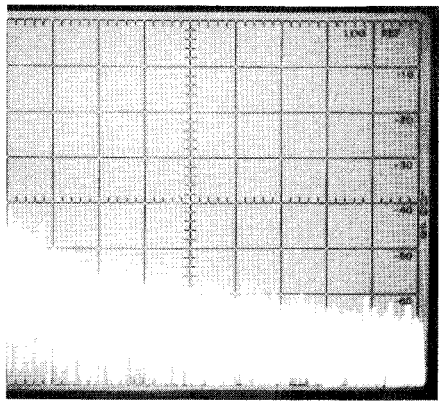
I had an annoying problem late in the review period that I eventually traced to my proximity to a broadcast station. Using the TS-950SD with my 86-foot-long center-fed dipole caused incredible trash (S9 plus 20 dB) to be generated in the receiver from at least 10 MHz through 30 MHz. Switching in the 10-dB attenuator completely eliminated the problem; the AIP circuit did not. An external antenna tuner that reduced the broadcast station's signal to an indicated S3 also did away with the problem, but because the '950's internal tuner is in line only on transmit, it didn't have any effect on the QRM.

A call to Kenwood brought the answer. Close to my home (3 miles away) is a strong AM broadcast station (WPOP, 1410 kHz, 5 kW) that produces so much fundamental energy on my antenna that it saturates a filter and its diode switch in the rig. Kenwood has a fix for this bug; contact Kenwood's Service Department for details.[3]

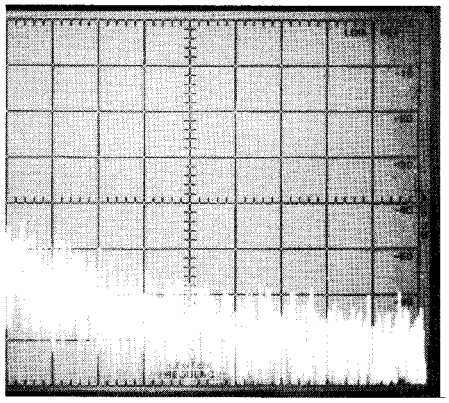
AM-broadcast reception with the TS-950S is a pleasure. Received-audio fidelity is superb, especially with the widest IF filters selected. Kenwood's low-noise, low-distortion audio amplifier makes a big difference.

The '950 has two kinds of noise blankers. The narrow-pulse-width blankers in the main and sub receivers are designed for impulse noise (such as ignition noise); the wide-pulse-width blankers are mainly intended to get rid of over-the-horizon radar (OTHR). The Soviet "Woodpecker" wasn't in operation during the review period, so I couldn't test the wide blankers. The main receiver's narrow blanker is effective against most ignition and motor-generated noises, and doesn't substantially degrade receiver dynamic range under most conditions. I almost never needed the noise blanker in the sub receiver, but it, too, is reasonably effective on ignition noise.

[2]On 20 meters, the AIP circuit increases the third-order input intercept from 9.5 to 23 dBm.
[3]See note 1.



(A)



(B)

Fig 4—Spectral display of the TS-950SD transmitter output during composite-noise testing. Power output is 150 W at 3.52 MHz (A) and 150 W at 14.02 MHz (B). Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The scale on the spectrum analyzer on which these photos were taken is calibrated so that the log reference level (the top horizontal line on the scale) represents −60 dBc/Hz and the baseline is −140 dBc/Hz. Composite-noise levels between −60 and −140 dBc/Hz may be read directly from the photographs. The carrier, off the left edge of the photographs, is not shown. These photographs show composite transmitted noise at frequencies 2 to 20 kHz offset from the carrier. The TS-950S has very good composite-transmitted-noise characteristics.

The TS-950SD's **AF VBT** control, like the **IF VBT** control, narrows the passband about the CW signal you're receiving. As mentioned earlier, this is a function provided by the DSP unit, and it works reasonably well, but is no substitute for narrow IF filters used in accord with the **IF VBT** control. The '950 also includes concentric **SSB SLOPE TUNE** controls that let you independently cut high- and low-frequency received-audio response. As mentioned earlier, in the TS-950SD, the DSP unit provides an AF slope-tune circuit that tracks the IF slope tuning, giving extra selectivity at audio. **IF VBT**, the slope-tune controls and the IF notch filter are the most-used and most effective interference-

reducing controls on this radio.

Dual-Frequency Reception

The TS-950S is Kenwood's first MF/HF radio with the ability to listen to two frequencies at once. This feature is intended to let you hunt multipliers while running stations on another frequency, to listen in the range where a DX station is looking for calls, and so on. Even though it has limitations, the dual-frequency-receiving function is useful. It allows simultaneous monitoring of two independently controllable receivers, and the sub-receiver frequency is displayed in smaller, yellow-green fluorescent digits to the right of the main-receiver frequency. You can't tune the sub receiver more than 500 kHz from the main-receiver frequency, and no optional filters are available for the sub receiver; you're stuck with a 2.4-kHz-wide filter. But for SSB DXing and contesting, that's not a limitation. What *is* a snag is the sub receiver's frequency-manipulation scheme. See "Rough Edges."

The sub receiver's AGC is not nearly as smooth as that of the main receiver; strong SSB signals, for instance, sound somewhat "crunchy" in the sub receiver. On the other hand, the sub-receiver audio is so different from that of the main receiver that you can mentally separate the main- and sub-receiver signals if your hearing is good and your analog (mental) signal processor is sharp. Unless you're one to spend lots of time listening to the sub receiver, you may never even notice this audio characteristic; it took the highly trained ears of a real receiver fanatic (WJ1Z) to explain exactly what I was hearing.

Many of the main receiver's interference-fighting controls don't function in the sub receiver, including: **IF VBT**, **NOTCH** and **SSB SLOPE TUNE**. The sub receiver has no effect on the received-signal-strength meter.

One advantage that the TS-950S has over the ICOM IC-781 and the Yaesu FT-1000D is that the '950's sub-receiver frequency and the second VFO are independent during split-frequency operation. All three frequencies are displayed simultaneously. In my opinion, however, the ability to control all three frequencies independently is more confusing than useful. During split operation, I almost always wanted to be listening on my transmit and main-receiver frequencies anyway, so I simply locked the sub-receiver and transmit-VFO frequencies together by means of the **TF-W** key.

Transmitting

One of Kenwood's design goals for the TS-950S was extremely good transmitted audio. Through the use of a 48-V-operated final amplifier and audio DSP, they achieved this: the '950 has first-rate and extremely clean audio at its rated 150-W-PEP output level (see Fig 2, the worst-case audio output). At the lower output levels used to drive most legal-limit amplifiers, the rig is even cleaner. The '950's RF speech processor adds considerable "punch" without sacrificing quality. I got consistently good audio reports when using the rig.

The rig's built-in RF-output monitor is an excellent tool for adjusting the transmitted-audio controls—it samples your signal at RF, just before the final amplifier, and uses the sub receiver's IF chain to detect and monitor your transmitted signal (on all modes), instead of deriving the monitor signal at audio or one of the IFs, where transmitted-signal cleanliness is seldom compromised. Adjusting the TS-950's transmitted SSB audio for maximum punch and cleanliness is easy using the front-panel ALC and compressor-level indicators in accord with the monitor circuit. It helps me comply with my operating philosophy: *Cleanliness before loudliness.*

The '950's 160- through 10-meter automatic antenna tuner is fast, quiet and intelligent: It remembers its previous settings for each ham band and returns to them automatically, so unless you use different antennas (or amplifiers) on some bands, the tuner adjusts itself in well under a second. In early units, the tuner didn't perform this function exactly as it should have, but Kenwood fixed that in the spring of 1990; those with affected radios should contact Kenwood's Service Department[4] for information on getting this problem fixed. The tuner's range is rated at 20-150 Ω, which is wide enough to cover most requirements of an internal tuner; I even used the '950's tuner to match three clip leads in series, hung in a third-story window, while I rushed to work LY2ZO one summer evening on 15-meter CW!

Pluses

Kenwood gets my gratitude for allowing selection of any filter in the 8830- and 455-kHz IFs, *regardless of mode.* Ditto for the rig's simple, intuitive filter-selection scheme: You press the **8.83** button to step through the 8830-kHz IF filters, and the **455** button to do the same at the 455-kHz IF.

Although the '950 uses some rather obscure connectors (6, 7, 8 and 13-pin DIN jacks, for instance), it comes with a mating plugs for every jack on the radio. (Nice touch.) Connecting a separate receiving antenna is a snap, as is hooking up a VHF/UHF/microwave transverter. (The receive-antenna line and a low-level transmit line are looped out and back through pairs of phono jacks on the rig's back panel.)

The '950's keypad, mode and VFO controls have green backlighting that is effective and easy on the eyes, even in dark rooms. The rig's dual-speed cooling fan is unobtrusive; you don't even know it's running when you're wearing headphones. Another nice touch Kenwood made in the '950 is allowing the RIT and XIT to be adjusted, cleared, and turned on or off while you're transmitting.

Rough Edges

I consider the TS-950's frequency-control scheme to be cumbersome. In basic receiver operation, this isn't a problem; the VFOs are really easy to use, as all you need do is select which VFO you want to transmit on and which you want to receive on. The rig simultaneously shows you both frequencies and, by means of arrows on the main display and LEDs in the VFO-selection buttons, which VFO is which.

The snag is in the sub receiver's frequency-manipulation scheme. Loading the desired frequency into the sub receiver is nonintuitive, and there's no way to directly enter (from the keypad) the sub-receiver frequency. You can either turn on the sub receiver and tune the desired frequency, or you can enter (or tune) that frequency into one of the VFOs and then write it to the sub receiver. The knob for changing the sub-receiver frequency is small and nondistinct. It's surrounded by seven other similar controls, and it doesn't resemble the main-tuning knob. I frequently grabbed the **RIT/XIT** knob when I wanted to tune the sub receiver, and vice versa.

Another snag with the sub receiver: Kenwood has made no straightforward provision for listening to the main receiver in one ear and the sub receiver in the other (or in separate external speakers) when you're using stereo headphones. (These signals are available as low-level fixed outputs at a 13-pin DIN jack on the rear panel, but you'd have to amplify them externally to use them.) The AF gains of the two receivers are controlled by separate knobs on the rig. This makes it difficult to distinguish the source of a signal, especially on the second night of a 48-hour contest! Far better here would be a single AF-gain control to set the audio level in your headphones, and a separate balance control. A choice of mixed or separated stereo audio at the front-panel **PHONES** jack would make the sub receiver a lot more useful. (Kenwood did this in their TS-790A VHF/UHF multimode rig; why not in the '950?)

As a CW operator, my biggest problem with the TS-950's sub receiver is its lack of a CW filter. Because you're limited to 2.4-kHz selectivity in the sub receiver, and because there's no reasonably easy way to spatially divide the audio from the main and sub receivers (giving your brain an advantage in separating the signals), turning on the sub receiver negates the signal-to-noise-ratio advantage of using narrow CW filters in the main receiver. For instance, let's say you're using the cascaded 500-Hz IF filters to copy a weak DX station working split on a crowded band. Then you want to use the sub receiver to find the frequency where he's listening. When you turn on the sub receiver and advance its audio gain to a usable level, the wide-bandwidth sub-receiver audio mixed with the narrow-bandwidth main-receiver signal in your headphones ruins the signal-to-noise ratio of the DX station. So, you can either ride the sub-receiver audio gain or use the two VFOs like you would in most radios, switching back and forth as necessary. Of course, this is no problem in SSB operation, where the main-receiver audio is also 2+ kHz wide. The *TS-950S*

[4]See note 1.

Technical Information manual states that the AF VBT circuit can be used to narrow the sub receiver's passband to "approach a bandwidth of 500 Hz," but that control also affects the main receiver, so its usefulness is limited in avoiding this problem.

The rig's internal/external keyer switch is on the back panel. This is unfortunate; it virtually locks you into using an external keyer in parallel with your computer's keying output. There's only one jack for an external keyer or paddle, so you're left to interconnect your keying sources externally.

This curious statement is found under "Notes" in the instruction-manual section on dual-frequency receive operation: "Some combinations of transmit and receiver frequencies might result in an internal heterodyne signal (birdie). This is not a defect and is caused by certain frequency relationships." Sure enough, there are plenty of frequency combinations that cause this. Usually a strong birdie shows up in the main receiver, but occasionally two birdies (one in each receiver) are audible. On 10 meters, some birdies are S6 or louder. In practice, I didn't find this to be a serious limitation, but there were times when I had to turn off the sub receiver to keep a birdie from clobbering a station I was trying to copy.

The '950's fluorescent multifunction display flickers annoyingly when you turn any knob that affects the display, and during transmitting. This occurs regardless of display intensity, and is present in three TS-950s I've used. Not all of those who used the '950 during the review period noted this, so it may not bother you.

Setting power output requires adjustment of two controls: **CAR** (carrier level) and **PWR**, but only **PWR** is on the front panel. The **CAR** control is located under a hatch on top of the rig. Shifting from 100+ W to 5 W or less means adjusting the very touchy **CAR** control to keep the ALC in the prescribed region.

The TS-950's 6-kHz AM filters have *very* wide skirts.[5] Congestion in today's amateur and shortwave bands calls for much tighter AM selectivity than the '950 provides. The considerably tighter 8.83-MHz AM IF filter available for the Kenwood R-5000 receiver would help the situation a lot, but it can't be installed in the '950! WJ1Z opines that the TS-950's wide AM selectivity is out of keeping with this transceiver's price class. It's jarring to hear 5-kHz shortwave-broadcast heterodynes on a multikilobuck radio with no wide-AM-filter options.

The Manuals

Kenwood's instruction manuals have come a long way over the years. The TS-950 comes with an 80-page owner's manual (complete with a US Amateur Radio frequency allocation table). The owner's manual, although not originally written in English, is more polished than some of the earlier Kenwood manuals I've seen. It contains reasonably good descriptions of this radio's trickier functions, such as sub-receiver frequency control and memory operations, and has concise listings of the power-on function selections, although some of these aren't well described. For instance, you can set the "slide-rule" display under the main frequency display to reflect either 100 kHz or 1 MHz of frequency coverage, choose the default frequency step for the **M.CH/VFO CH** knob (5, 9 or 10 kHz), set the **UP/DOWN** key increments to 1 MHz or 500 kHz, choose the FSK shift (170, 200, 425 or 850 Hz), and select the multimeter's average or peak-and-hold function, if you like. The instruction manual also contains a large block diagram and page after page of schematics, but the theory of operation is sparse. The 270-page service manual (not included with the rig, but available from Kenwood's Parts Department [tel 800-637-0388]), covers this base quite thoroughly, however, with many pages of text and lots of diagrams.

A 21-page computer-control manual is also supplied with the '950. This is mainly a programmer's reference, but it also contains important information on connecting the '950 to the IF-232C or a computer with a TTL-level serial port. I'd like to see Kenwood add some BASIC program listings to this manual so that Joe Ham can easily experiment with the '950's computer-control capabilities.

A third document, *TS-950S Technical Information,* is also available through Kenwood Parts. This 63-page manual provides a wealth of practical information about the workings of the TS-950S, including block diagrams and other graphics to bolster text descriptions of many of the radio's functions. This manual contains a considerable amount of information that's not in the instruction and service manuals. Anyone considering buying a radio in this class should get a copy of this manual from Kenwood.

The SM-230 Monitor Scope

This slick accessory is designed for use with the TS-950 and other Kenwood radios. (In most of its modes, it works with any radio with an 8.83-MHz IF.) The SM-230 functions as a 5-MHz oscilloscope, an RTTY tuning indicator, a band scope, a transmitted- and received-signal monitor, and a two-tone generator for transmitter testing. Unlike the earlier SM-220, the SM-230 comes with the built-in panadaptor necessary for band-scope use. All the cables needed to connect the SM-230 to the TS-950S come with the '230, as does a detailed, 22-page instruction manual with operating examples and a short trouble-shooting section.

During receive operation, you can use the monitor to quickly show you whether a band is open, and if so, where the activity is. It's a great way to locate the receiving frequency of a split-frequency DX station, too. Bandwidths of 25, 100 and 250 kHz are available; the center of the display graticule is the receiver frequency (you can adjust this with the horizontal-position control). In dual-frequency receive operation, the monitor scope shows you, by means of a small pip on the screen, where the sub receiver is tuned relative to the main receiver. (This function works only when the bandwidth is set at 25 kHz.) You can connect the output of your legal-limit MF/HF amplifier to the SM-230 and monitor your transmitted signal. (The SM-230 functions with transmitted signals up to 150 MHz, but is limited to signals of 100 W or less between 30 and 150 MHz.)

The SM-230 and the TS-950S look and work great together. My only reservation about the SM-230 is its cost: Suggested retail is $1000, and most dealers are selling it for about 10% less than that as I write this.

In Sum

The TS-950SD is a very good radio, but it's not free of rough spots. Kenwood has done a wonderful job of making a suitably frilly rig with great basic-radio performance and good general polish, but I think the user interface needs some work. In my opinion, to use this radio effectively, you really need to have the manual handy at all times. Considering how many contacts I made with the review rig, that became a bother.

If you're planning to buy a new transceiver, especially one that costs over $3000, I suggest that you order the instruction manuals for each radio you're considering. Most of these manuals cost $20 or less, which is a small investment to make, considering the money you're thinking of laying out. The manuals give you a good idea what a radio can and can't do, and provide a valuable supplement to a trial run during a visit to your local Amateur Radio convention or equipment dealer and to the information in *QST* product reviews.

This review included gathering opinions and other assistance from many active hams (mostly contesters and DXers). Thanks to Dave Newkirk, WJ1Z; Pete Chamalian, W1RM; Vince Sgroi, K1RM; Gene Frohman, K1RU; Chet Slabinski, N8RA; Lou Cohen, K1YR; Jim Kearman, KR1S; Rich Assarabowski, K1CC; Tom Frenaye, K1KI; Larry Wolfgang, WA3VIL; Mark Wilson, AA2Z; and Chuck Hutchinson, K8CH, for their valuable input.

Manufacturer's suggested retail prices: TS-950S, $3300; TS-950SD, $4400; SM-230, $1000; YK-88CN-1 optional 270-Hz-wide, 8.83-MHz IF filter, $85; YK-88SN-1 1.8-kHz-wide, 8.83-MHz IF filter, $85; DSP-10 digital-signal-processing unit (optional on TS-950S; standard on TS-950SD), $600; IF-232C serial-port level converter, $99; VS-2 voice synthesizer, $63; SP-950 external speaker with audio filters, $110. Manufacturer: Kenwood USA Corp, PO Box 22745, 2201 E Dominguez St, Long Beach, CA 90801-5745, tel 213-639-4200.

[5]The 455-kHz IF filter is 6 kHz wide at −6 dB and 15 kHz wide at −50 dB; the 8.83-MHz IF filter is 6 kHz wide at −6 dB, 26 kHz wide at −50 dB and *32 kHz* wide at −60 dB.