Mark J. Wilson, K1RO, k1ro@arrl.org

## Product Review

# Kenwood TS-890S HF and 6-Meter Transceiver

Explore the *QST* Product Review Archive
**www.arrl.org/qst-product-review-and-short-takes-columns**
Search reviews by year or issue of publication, or by manufacturer's name.


*Reviewed by Mark Wilson, K1RO*
QST *Product Review Editor*
**k1ro@arrl.org**

The TS-890S slots into the middle of Kenwood's home station transceiver family, although in features and performance it's closer to the top-of-the-line TS-990S than to the TS-590SG. It covers 160 through 6 meters with a high-performance receiver on all bands and a very clean 100 W transmitter. There is one receiver, and it's a conventional down-conversion design with selectable roofing filters and DSP signal processing. The TS-890S is a fairly big desktop radio with a 7-inch TFT color display and large, nicely spaced front-panel controls. Voice guidance, which announces a number of operating parameters, and a high-stability oscillator are built in.

Typical of today's high-end transceivers, the TS-890S offers an astonishing array of features and customizable settings. The printed instruction manual is thorough, although there were times when I needed to play with the controls a bit to understand how to do something.

To learn more about specific features of interest to you, I recommend downloading the *Instruction Manual* from Kenwood's website. It offers color illustrations, and searchable text helps with locating information. There's also an active online group devoted to this radio at **groups.io/g/TS-890**.

## Initial Setup

The shipping box includes the TS-890S, a dc power cable, seven-pin and 13-pin DIN plugs for accessory jacks, a couple of fuses, a printed *Instruction Manual*, and a set of schematic diagrams. This radio doesn't include a microphone, but many good choices are available.

The rear panel (see Figure 1) isn't particularly crowded. The two SO-239 antenna jacks are switchable from the front panel and remembered for each band. The **KEY** connector is for using a paddle with the internal CW keyer, or for connecting an external keying device. (This functionality is duplicated on the front-panel **PADDLE** jack.) The **EXT.SP** jack provides plenty of audio for an external 8 Ω speaker.

There's an **RX IN** phono jack for use with a separate receive antenna, and that can be paired with the **RX OUT** phono jack to install an external bandpass filter, preamplifier, or other device in the receive path. I used the **RX IN** jack for listening on the low bands with my K9AY loop antenna.

### Bottom Line

Kenwood's TS-890S offers excellent RF performance on receive and transmit, and a wide range of features. The large front panel, nicely spaced controls, colorful display, and informative menus make it easy to interact with the radio.

Press the front-panel **RX ANT** button to switch between listening with the main antenna or receive antenna. The **ANT OUT** phono jack provides an antenna connection for a separate receiver. The **DRV** phono jack provides a low-level (1 mW) transmitter output for use with a transverter or for driving an external amplifier for the 630- and 2200-meter bands.

The seven-pin DIN **REMOTE** jack has connections for an external linear amplifier and is configured with the **LINEAR AMPLIFIER** menu. The solid-state switching option (Pin 7, **LKY**, on the **REMOTE** jack) is the one to use with modern amplifiers. Options are **ACTIVE LOW**, which will switch up to 50 V dc at 100 mA, or **ACTIVE HIGH**, which outputs 12 V at up to 100 mA.

If your amplifier control circuit exceeds those ratings, you can enable the transceiver's internal relay. Note that the TS-890S is silent when switching between transmit and receive using the solid-state amplifier switching, but clicking is audible when the internal relay is enabled.

The adjustable **TX DELAY** function introduces a delay between the time the amplifier control switches and RF output appears at the TS-890S

antenna jack. The delay setting should be longer than your amplifier switching time.

The 13-pin DIN **ACC2** jack provides connections for digital mode operation and includes an FSK RTTY keying input, PTT control, fixed-level audio input and output for sound card digital modes, and other functions.

The **DISPLAY** jack is a DVI connector for using an external monitor to show the contents of the TS-890S display. It looked great on my 20-inch wide-screen computer monitor using the 840 × 480 pixel setting.

The USB-A connector is used with a flash drive for saving radio configurations, recorded audio messages, and other data, or with an external USB keyboard for sending text or programming message memories on CW, RTTY, or PSK. There's a second USB-A connector on the front panel.

I didn't try the BNC connector for use with an external 10 MHz reference oscillator or the 3.5-millimeter **METER** jack for viewing S-meter and transmit metering levels on an external display.


**Figure 1** — The TS-890S rear panel.

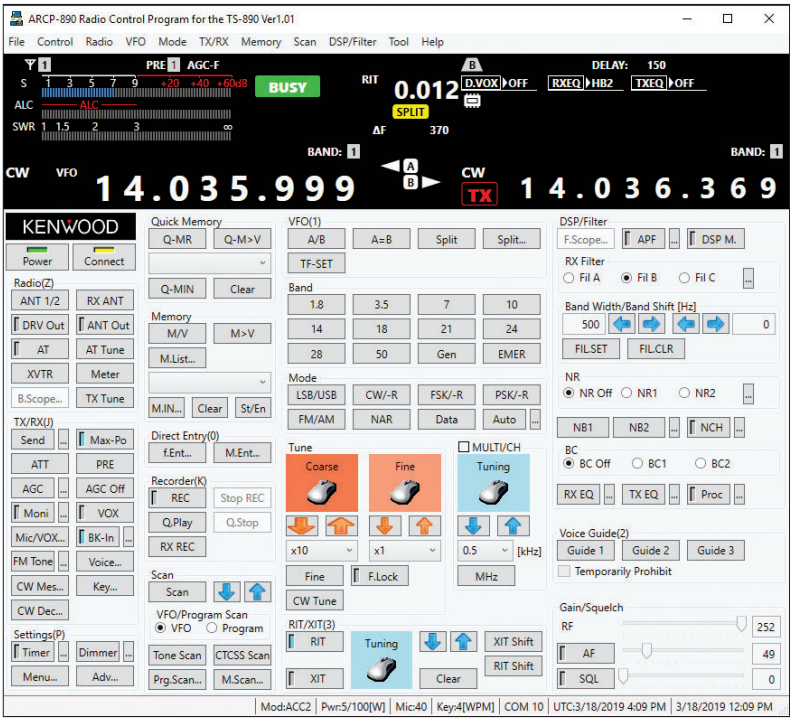



**Figure 2** — The companion *ARCP-890* Windows software can be used for adjusting most transceiver features or operating the radio remotely.

## Computer Control and COM Ports

The USB-B connector is for connection to your station PC. You can use it for radio control, digital mode audio input and output, interfacing with Kenwood's companion *ARCP-890* software, firmware updates, and so on.

To use the USB interface, before connecting the cable between radio and computer, you must download and install the Silicon Labs CP210x virtual COM port driver from Kenwood's website. Once this is installed, connect the TS-890S to your PC with a standard USB-A to USB-B cable and apply power to the radio. In your PC's **DEVICE MANAGER** screen, look under **PORTS (COM & LPT)** for **SILICON LABS CP210x USB to UART Bridge (COMxx)**. There will be two new virtual COM ports, one "standard" and the other "enhanced." Kenwood's online instructions show how to tell the difference.

I used the standard port (COM10 on my computer) and had no problems interacting with the radio using several logging and digital communications programs. The TS-890S also has a nine-pin RS-232 COM port that provides an alternative for computer control or interfacing with other station equipment, such as external antenna switches or band-pass filters. I used the USB connection with my station PC and the COM port for interfacing with my SPE solid-state automatic power amplifier. It all worked together seamlessly.

The *ARCP-890* software (see Figure 2) allows changing and saving many of the radio's settings. In conjunction with the Kenwood's Network Command System (KNS), it also allows remote operation of the radio over a home local area network (LAN) or via the internet. The rear-panel **LAN** jack is for an ethernet connection to a PC or router. The 73-page *Kenwood Network Command System Setting*

*Manual* available online shows how to set up and use this feature.

"Split Transfer A" allows interconnecting the TS-890S with a TS-590SG or TS-590S and then using the other radio as an external sub-receiver for split operation or dual-frequency reception. The radios share frequency and mode information via the COM port, and the antenna is shared through the **ANT OUT** and **RX ANT** jacks. (Note that you need to update the TS-590 firmware to use this feature; see **www.kenwood.com/i/products/info/amateur/software_download.html**.) "Split Transfer B" is a similar feature for older Kenwood transceivers.

## Interacting with the TS-890S

The 7-inch color display on the left side of the front panel shows a wealth of information about the radio (see Figure 3). There are several background color, function key label, frequency display font, and screen saver options available.

The meter in the upper left corner can be a very good virtual representation of an analog meter with a white or black background, or it can be a digital bar graph meter. Touch the screen on the meter face to run through the options. The meter presentation changes automatically to a space-saving bar graph when other features require screen space.

In addition to the usual frequency and mode information, there's a "filter scope" in the upper right corner that shows signals in the receive filter passband, along with the filter characteristics. Response is quick enough to use it as a tuning aid for CW, PSK, or RTTY signals. The graphic changes as the filter bandwidth is narrowed or widened.

There are seven function keys along the bottom of the screen, and another seven along the right side. Labels for these keys are displayed on the screen, and their functions change when different modes of operation and other features are selected.

While exploring various menus and function keys, I pressed the **SWL** button and was rewarded with a display reminiscent of the classic shortwave receivers I grew up with (see Figure 4). Frequency labels are in "megacycles," completing the retro look.

For many of the front-panel pushbuttons, press once to turn the function on and off, and press and hold to adjust settings for that function. For example, press the **AGC** button to switch among fast/mid/slow, and press and hold for a menu to adjust the time constant for each setting or turn AGC off.

Press the **MENU** button, and the lower half of the screen displays a series of menus that control the radio's functions and behavior. There are many choices in the menus, but descriptions are in plain English, and the top level has a useful list of the types of adjustments available in each group. After using it a couple times, I found navigating the menu system and selecting and changing menu parameters to be straightforward, using the function keys along the bottom and right side or the **MULTI/CH** knob.

Three **PF** (programmable function) keys can be customized for one-touch access to a wide variety of features from a very long list. For example, I set one **PF** key for the **TUNE** function (transmits an adjustable low-power carrier for tuning an amplifier or external antenna tuner).

## Band Scope

The TS-890S band scope uses a separate SDR-type receiver at the first IF, ahead of the roofing filters. With a press of the **SCP** button, you can switch among spectrum scope, combination spectrum scope/waterfall, or an extended (taller) spectrum scope/waterfall. You can also touch the screen to select signals in the band scope and the transceiver will tune there. A small version is available when other windows are active.

Frequency span can be as narrow as 5 kHz or as wide as 500 kHz. Waterfall scrolling speed is adjustable in four steps, taking about 45 seconds to fill the waterfall at the slowest

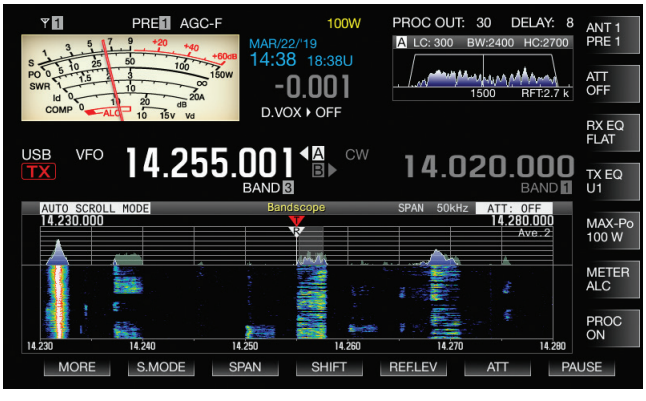



**Figure 3** — The TS-890S display during SSB operation with the spectrum display/waterfall window set to show 50 kHz of the 20-meter band.

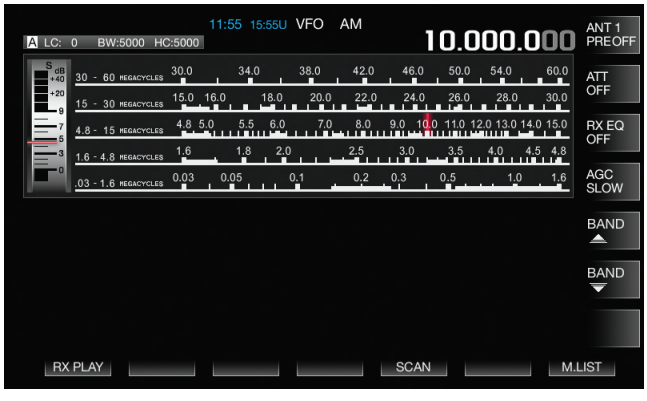
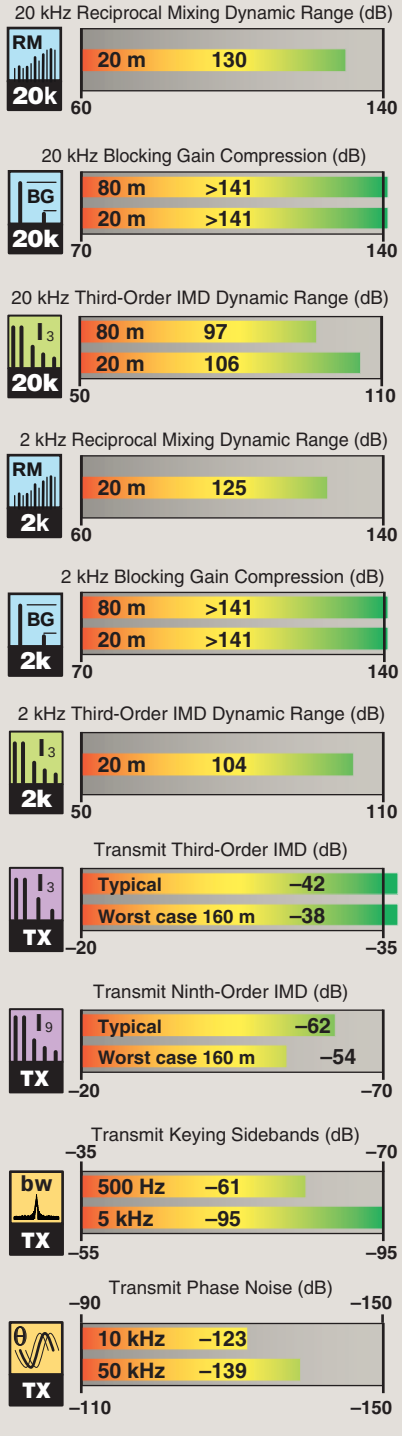



**Figure 4** — Listening to WWV on 10 MHz with the display set to SWL mode, emulating a classic shortwave receiver.

## Kenwood TS-890S Key Measurements Summary




**KEY:** QS1906-PR137

Measurements with receiver preamps off.
Bars off the graph indicate values over scale.

## Table 1
## Kenwood TS-890S, serial number B8830121

| Manufacturer's Specifications | Measured in the ARRL Lab |
|---|---|
| Frequency coverage: Receive, 0.03 – 60 MHz; transmit, 160 – 6 meter amateur bands, including 5.25 – 5.45 MHz. | Receive and transmit, as specified. |
| Power requirement: Transmit, ≤22.5 A (maximum). Receive, ≤2.5 A at 13.8 V dc (±15%). | At 13.8 V dc: Transmit, 18 A (typical), 10 A (AM) at maximum RF power output; 6.5 A at minimum RF output. Receive, 1.7 A (maximum brightness), 1.57 A (minimum brightness). Power off, 3 mA |
| Modes of operation: SSB, CW, AM, FM, FSK, PSK, SSB-DATA. | As specified. |

| Receiver | Receiver Dynamic Testing |
|---|---|
| SSB/CW sensitivity:<br>0.5 µV (0.13 – 0.522 MHz)<br>4.0 µV (0.522 – 1.705 MHz)<br>0.2 µV (1.705 MHz – 24.5 MHz)<br>0.13 µV (24.5 – 30, 50 – 54 MHz). | Noise floor (MDS), 500 Hz bandwidth, 500 Hz roofing filter:<br>*Preamp* *Off* *1* *P2*<br>0.137 MHz –130 –135 –137 dBm<br>0.475 MHz –129 –135 –138 dBm<br>1.0 MHz –113 –120 –122 dBm<br>3.5 MHz –131 –139 –142 dBm<br>14 MHz –131 –141 –143 dBm<br>50 MHz –129 –140 –143 dBm |
| Noise figure: Not specified. | Preamp off/1/2, 14 MHz: 16/6/4 dB; 50 MHz, 18/7/4 dB. |
| AM sensitivity: Not specified.<br>6.3 µV (0.13 – 0.522 MHz)<br>31.6 µV (0.522 – 1.705 MHz)<br>2.0 µV (1.705 – 24.5 MHz)<br>1.3 µV (24.5 – 30, 50 – 54 MHz). | 10 dB (S+N)/N, 1 kHz tone, 30% modulation, 5 kHz BW:<br>*Preamp* *Off* *1* *2*<br>1.0 MHz 14.9 6.68 5.30 µV<br>3.88 MHz 1.76 0.70 0.50 µV<br>29.0 MHz 2.02 0.62 0.45 µV<br>50.4 MHz 2.34 0.71 0.50 µV |
| FM sensitivity: Not specified.<br>0.22 µV (28 – 30, 50 – 54 MHz). | For 12 dB SINAD, 3 kHz deviation, 15 kHz BW:<br>*Preamp* *Off* *1* *2*<br>29 MHz 0.72 0.23 0.16 µV<br>52 MHz 0.86 0.32 0.20 µV |
| Spectral sensitivity: Not specified. | Band scope display, preamp off/1/2 14 & 50 MHz, –107/–122/–131 dBm. |
| Blocking gain compression dynamic range: Not specified. | Blocking gain compression dynamic range, 500 Hz BW:<br>*20 kHz offset* *5/2 kHz offset*<br>*Preamp* *Off/P1/P2* *Preamp off*<br>3.5 MHz >141/146/132 >141/>141 dB*<br>14 MHz >141/147/134 >141/>141 dB*<br>50 MHz >139/148/137 >139/>139 dB* |
| Reciprocal mixing dynamic range: Not specified. | 14 MHz, 20/5/2 kHz offset: 130/128/125 dB. |

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth, 500 Hz roofing filter)

| *Band/Preamp* | *Spacing* | *Measured IMD Level* | *Measured Input Level* | *IMD DR* |
|---|---|---|---|---|
| 3.5 MHz/Off | 20 kHz | –131 dBm | –34 dBm | 97 dB |
| | | –97 dBm | –9 dBm | |
| | | –68 dBm | 0 dBm | |
| 14 MHz/Off | 20 kHz | –131 dBm | –25 dBm | 106 dB |
| | | –97 dBm | –13 dBm | |
| | | –60 dBm | 0 dBm | |
| 14 MHz/P1 | 20 kHz | –141 dBm | –37 dBm | 104 dB |
| | | –97 dBm | –22 dBm | |
| 14 MHz/P2 | 20 kHz | –143 dBm | –46 dBm | 97 dB |
| | | –97 dBm | –30 dBm | |
| 14 MHz/Off | 5 kHz | –131 dBm | –26 dBm | 105 dB |
| | | –97 dBm | –13 dBm | |
| | | –60 dBm | 0 dBm | |
| 14 MHz/Off | 2 kHz | –131 dBm | –27 dBm | 104 dB |
| | | –97 dBm | –13 dBm | |
| | | –60 dBm | 0 dBm | |
| 50 MHz/Off | 20 kHz | –129 dBm | –29 dBm | 100 dB |
| | | –97 dBm | –12 dBm | |
| | | –61 dBm | 0 dBm | |
| 50 MHz/P2 | 20 kHz | –143 dBm | –44 dBm | 99 dB |
| | | –97 dBm | –25 dBm | |

| Manufacturer's Specifications | Measured in the ARRL Lab |
|---|---|
| Second-order intercept point: Not specified. | Preamp off/1/2: 14 MHz, +79/+67/+45 dBm 21 MHz, +71/+69/+81 dBm 50 MHz, +69/+69/+69 dBm |
| IF and image rejection: IF, ≥70 dB. Image, ≥70 dB (HF), ≥60 dB (50 MHz). | IF rejection: 7 MHz, 74 dB; 10.1 MHz, 66 dB; 14 MHz, 71 dB; 50 MHz, 69 dB. Image rejection: 14 & 50 MHz, 72 dB. |
| Noise reduction: Not specified. | For S-5 level, ≈8 dB; S-9 level, up to 25 dB. |
| FM adjacent channel rejection: Not specified. | Preamp 2 on: 29 MHz, 85 dB; 52 MHz, 82 dB. |
| FM two-tone third-order IMD dynamic range: Not specified. | Preamp 2 on: 20 kHz offset, 29 MHz, 73 dB; 52 MHz, 74 dB. 10 MHz offset, 29 MHz, 125 dB; 52 MHz, 121 dB. |
| Squelch sensitivity: Not specified. | FM, preamp 2 on: 29 MHz, 0.13 – 0.44 µV, 52 MHz, 0.18 – 0.62 µV. HF squelch, 0.47 – 251 µV. |
| S-meter sensitivity: Not specified. | S-9 signal, preamp off/1/2: 14 MHz, 79.4/19.3/5.24 µV 50 MHz, 141/29.5/9.32 µV Scaling: 6 dB per S-unit. |
| Notch filter depth: ≥70 dB. | Tunable notch filter, 50 dB; BC (auto notch) >70 dB; attack time 96 ms for one or two tones. |
| IF/audio response: Not specified. | Range at –6 dB points:‡ CW (500 Hz BW): 355 – 845 Hz; Equivalent Rectangular BW: 481 Hz; USB (2.4 kHz BW): 242 – 2,594 Hz; LSB (2.4 kHz BW): 242 – 2,595 Hz; AM (5 kHz BW): 123 – 2,987 Hz. |
| Audio output: 1.5 W or more at 8 Ω. | 1.93 W at 10% THD. 0.11% at 1 $V_{RMS}$. |
| Receive processing delay time: Not specified. | 16 ms. |
| **Transmitter** | **Transmitter Dynamic Testing** |
| Power output: 5 – 100 W (SSB, CW, FM); 5 – 25 W (AM). | SSB, CW, FM: 1.8 – 30 MHz, as specified; 50 MHz, as specified. AM: 1.8 – 30 MHz, 4.6 – 24 W; 50.4 MHz, 4.2 – 22 W. |
| RF power output at minimum specified operating voltage: Not specified. | At 11.7 V dc: 14 MHz, 79 W; 50 MHz, 81 W. |
| Spurious-signal and harmonic suppression: ≥55 dB (HF); ≥63 dB (50 MHz). | HF, >69 dB typical; 60 dB (worst case, 12 m); 50 MHz, 70 dB. Complies with FCC emission standards. |
| Third-order intermodulation distortion (IMD) products: Not specified. | 3rd/5th/7th/9th order, 100 W PEP: –42/–42/–51/–62 dB (HF typical) –38/–42/–46/–54 dB (worst case, 160 m) –38/–48/–51/–55 dB (50 MHz) At 50 W RF output: –40/–47/–60/–70 dB (14 MHz) –38/–48/–59/–70 dB (50 MHz) |
| CW keyer speed range: Not specified. | 4 to 60 WPM, iambic mode A and B. |
| CW keying characteristics: Not specified. | See Figures 5 and 6. |
| Transmit-receive turnaround time (PTT release to 50% audio output): Not specified. | S-9 signal, AGC fast, SSB, 30 ms; AGC fast, CW, full break-in, 14 ms. |
| Receive-transmit turnaround time (TX delay): Not specified. | SSB, 16 ms; FM, 15 ms (29 MHz), 13 ms (52 MHz). |
| Transmit phase noise: Not specified. | See Figure 7. |
| Amplifier key line closure to RF output: Adjustable, 5 – 40 ms (CW/FSK/PSK); 5 – 50 ms (SSB/FM/AM). | 12 ms when set to CW default value of 15 ms. |

Size (height, width, depth, including protrusions): 6.2 × 16.2 × 15.4 inches; weight, 34.8 lbs. Second-order intercept points were determined using S-5 reference.

*Blocking dynamic range exceeds these values. No blocking was observed with up to +10 dBm signal at the antenna jack, the maximum level used in ARRL Lab testing.
‡Default values; bandwidth is adjustable.

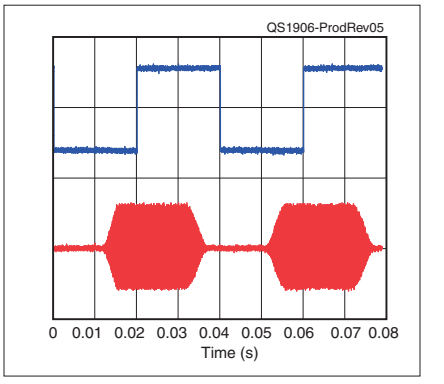



**Figure 5** — CW keying waveform for the Kenwood TS-890S showing the first two dits in full-break-in (QSK) mode using external keying and the default rise time setting. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output on the 14 MHz band.

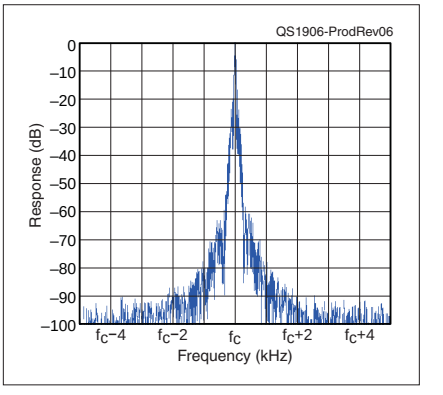



**Figure 6** — Spectral display of the Kenwood TS-890S transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying and the default rise time setting. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 100 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in decibels.

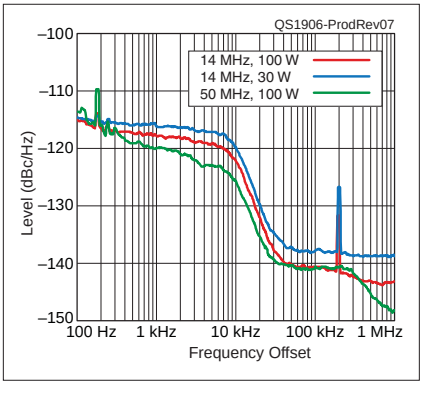



**Figure 7** — Spectral display of the Kenwood TS-890S transmitter output during phase-noise testing. Power output is 100 W on the 14 MHz band (red trace), 30 W on the 14 MHz band (blue trace), and 100 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows transmitted phase noise 100 Hz to 1 MHz from the carrier. The reference level is –100 dBc/Hz, and the vertical scale is 10 dB per division.

speed and about 5 seconds at the fastest. Scrolling mode options include fixed frequency width, automatic scrolling as you tune, and a centered mode that keeps the cursor in the center and moves the display. The band scope has its own attenuator to adjust sensitivity.

I found the band scope to be very sensitive and responsive, and used it a lot. I tended to leave it in auto-scroll mode to follow along as I tuned around. I really liked that the signals in the waterfall didn't smear or otherwise distort as I tuned; the waterfall just moved left or right with existing signals intact. The wider frequency spans are useful when looking for activity at quiet times. On a crowded band, such as during a CW or RTTY contest, setting the span to 5 kHz gives a detailed look at the tightly-packed signals.

Filter width is highlighted in the waterfall while tuning, and the highlight disappears when you stop tuning (although it still shows up in the spectrum scope). Change the filter bandwidth setting, and the width of the highlight changes. I found I could quickly tune from station to station on any mode using the band scope and the filter scope.

Press and hold the **SCP** button, and the display changes to an audio scope that displays two views of the waveform of received and transmitted signals. The display on the left is similar to what you would see on a spectrum analyzer, and the one on the right is similar to an oscilloscope.

## Receiver

The receiver is among the best measured in the ARRL Lab, as seen in Table 1 and described in the "Lab Notes" sidebar. It uses down conversion on all bands, with 15 kHz, 6 kHz, 2.7 kHz, and 500 Hz roofing filters standard (and 270 Hz optional).

Bandwidth filtering is adjustable at any time using the **HI/SHIFT** and **LO/WIDTH** controls, but it's convenient to set up filter choices for each mode and switch among them using the **IF FIL** button. Pressing and holding that button brings up a configuration screen where you can specify roofing, IF, and audio filter bandwidths, as well as skirt shapes (sharp/medium/soft), for each of two or three filters (menu selectable) for each mode. You can change the preset filter bandwidth at any time with the **HI/SHIFT** and **LO/WIDTH** controls, and return to the preset values by pressing **FIL CLR** button.

The TS-890S offers adjustable DSP noise reduction, noise blanker, and notch filter features. I live in a rural area without much power line or other man-made noise, and so I was not able to give the noise blankers a good workout. If noise is a problem for you, it would be worth checking comments from owners online at **groups.io**. The noise reduction worked well, although I heard some digital artifacts with the level turned up high enough to significantly reduce the background noise.

I found the automatic notch filter (called the *beat canceler*) to be very effective at reducing AM shortwave broadcast carriers on 40 meters in the evening. The manual notch filter is very effective in attenuating interfering signals in the passband. When it's engaged, a marker in the filter scope window shows the position of the notch in relation to the desired and interfering signals.

### Lab Notes: Kenwood TS-890S

*Bob Allison, WB1GCM, ARRL Laboratory Assistant Manager*

The Kenwood TS-890S transmitter greatly exceeds FCC spectral purity requirements, has narrow keying sidebands, and has relatively low transmit phase-noise characteristics. Transmit intermodulation distortion (IMD) is very good at full RF power output, as well as at half power — the 50 W typically needed to drive a linear amplifier. Though all linear power amplifiers generate their own distortion products, it is always desirable to have the cleanest possible exciter. At half power, the seventh- and ninth-order products are 60 and 70 dB below PEP, where they need to be the lowest to minimize interference to nearby stations.

The TS-890S dual-conversion receiver performance overall is excellent, with high reciprocal mixing (RMDR), blocking (BDR), and two-tone, third-order IMD (3 IMD DR) dynamic ranges. The lowest of the three dynamic ranges is 3 IMD DR, measured at 104 dB at 2 kHz spacing at 14 MHz. With the excellent blocking and reciprocal mixing characteristics, the TS-890S will hold up well during ARRL Field Day or other operating events when amateur transmitters are operating in close physical proximity.

In a quiet RF location (with low man-made noise), the Kenwood TS-890S will hear a pin drop on 6 meters, where sensitivity counts the most. AM sensitivity on the amateur bands is excellent, especially on 6 meters, where signals as low as 0.5 μV are readable. On 630 and 2200 meters, there is plenty of sensitivity to work with, especially when using receiving loops that lack a preamp, as well as a 1 mW transmitter output from the **DRV** jack.

Of note, the total harmonic distortion (THD) of the receiver audio is only a small fraction of a percent at a normal listening level. In addition to pleasant listening, that's very desirable for extended operating sessions when audio distortion can cause fatigue.

The receiver processing delay time is only 16 milliseconds, and the receiver recovers quickly for high-speed, full-break-in (QSK) CW operation. The signal strength meter uses a scale of 6 dB per S-unit, though it reads a little low with a 50 μV (S-9) signal at the antenna jack. Turning the preamp(s) on makes the S-meter read higher, but the induced signal voltage from the antenna is not higher. Finally, the current draw with power off is only 3 mA, which is very reasonable if using the TS-890S with a battery backup system.

The 18-band receiver audio equalizer (EQ) settings can be different for each mode. There are a number of preset options (off, flat, high boost, and so on), along with three user-customizable settings. Touch the screen to slide the level control for each audio segment up and down, or use the **+/–** function keys or **MULTI/CH** knob.

## Transmitter and Antenna Tuner

As shown in Table 1 and Figures 5, 6, and 7, the TS-890S transmitter is very clean, with low intermodulation distortion (IMD) products on SSB and very narrow CW keying sidebands. Transmitted phase noise is good. Note that the CW rise time is adjustable, and the waveform shown in Figure 5 is with the default 6-millisecond setting. As the rise time decreases, the keying waveform corners sharpen and the keying sidebands increase, potentially interfering with stations operating on nearby frequencies. Avoid the 1- and 2-millisecond settings.

The **POWER** control adjusts transmitter output power in 1 W or 5 W steps (menu selectable). Using the **MAX PO** feature, from a menu you can set the maximum power output separately for each band and for the SSB, CW, FSK/PSK, FM/AM, and SSB-DATA modes. For example, you might have a 6-meter amplifier that requires only 30 W drive maximum. Set the **MAX PO** limit for that band and you won't have to worry about accidentally overdriving it. The **TUNE** power described earlier is adjustable by band from this same menu.

The internal antenna tuner is rated for loads from 16.7 to 150 Ω (3:1 SWR). I had no trouble matching my antennas, most of which have an SWR of 2.5:1 or less across the band. My 160-meter inverted-**V** has an SWR close to 4:1 at the very top of the band, and the tuner matched that as well. Antenna tuner settings are memorized, so tuning is nearly instantaneous after the initial tune.

## Voice and CW Operation

The TS-890S offers upper and lower sideband, AM, and FM operation. I got a number of good audio reports using the INRAD W1 headset reviewed last month. The transmit equalizer works nearly identically to the receive equalizer described previously, and after adjusting everything using the transmit monitor, I recorded my transmit audio in another receiver to make sure I was happy with it. Transmit equalizer settings are used for all voice modes, and automatically turned off for the SSB-DATA modes. Transmit monitor settings are separate for voice modes, data modes, and FSK/PSK, and these are separate from the CW sidetone.

On SSB, the transmit filter bandwidth can be set from about 2,000 to 4,000 Hz by adjusting the **LOW CUT** and **HIGH CUT** menus. I just used the default setting of 2,800 Hz (100 – 2,900 Hz). Transmit filter bandwidth can be set separately for the SSB-DATA modes, up to 4,000 Hz.

Voice-operated transmit control (VOX) settings are separate for the various audio inputs — microphone, rear-panel **ACC2** jack, USB, and LAN — and VOX is available in the SSB-DATA modes. VOX delay time can be changed quickly with the front-panel **DELAY** knob.

Although band conditions did not allow me to try it, the TS-890S is equipped for 10- or 6-meter FM operation. Split-frequency offsets can be applied by using the two VFOs, and CTCSS tone encoding and decoding are available for repeater access.

You can record up to six voice messages for transmission, with a maximum recording time of 100 seconds total. You can also record received audio, with storage in the internal memory or on an external flash drive. File selection and playback options are handled via menus and function keys. I didn't see a way to play back recorded audio on the air.

The TS-890S supports full-break-in (QSK) or adjustable delay, semi-break-in operation. The transmit-receive switchover is silent — no annoying relay clicking unless you enable the amplifier control relay as described earlier. The built-in keyer can be adjusted from 4 to 60 words per minute. The eight message memories can include incremental serial numbers for contests.

A built-in CW decoder displays received CW signals in a window that replaces the band scope. This feature also allows use of a USB keyboard for sending CW, and shows the CW message memories in a small window on the right. I found that the decoder works best on strong, well-timed CW signals, and there is a slight delay in displaying the decoded signal.

## Digital Modes

The TS-890S offers a number of options for digital mode operation. The radio has an internal decoder for RTTY and PSK31 or 63, and you can plug in a standard USB keyboard to transmit on those modes. Connections are also available to use the radio with digital mode software running on an external PC.

### RTTY and PSK with the Internal Decoder

Press the **FSK/PSK** button once for RTTY or twice for PSK, then press **F3** to bring up the **DECODE** screen in the lower portion of the display (see Figure 8).

The left side of the screen displays received and transmitted text, with two lines of buffered text awaiting transmission below that. You can use the keyboard to compose your next transmission in the buffer while you are receiving a message, and then press F12 to transmit when it's your turn.

You can also use the keyboard to program eight message memories, which are sent by pressing the corresponding function key on the keyboard or on the radio's front panel. This is perfect for routine information

such as location, name, equipment, and so on. You could also use it to store RTTY contest exchange information, although I didn't see a way to include an incrementing contact number for contests that require one. Message memories are separate for RTTY, PSK, and CW.

As characters are sent from the buffer window, they change from white to red and appear in the upper window. Each time you switch between transmit and receive, the radio adds a line showing the transition, and it can include date, time, and frequency (menu settable). You can save RTTY, PSK, or CW communication screen contents to internal memory or a USB flash drive by turning on the Communication Log function. The log is essentially a running transcript of whatever sent and received text appears on the decoding screen.

The right side of the screen has a tuning indicator that can be switched between an FFT/waterfall and tuning scope display. Switch between the tuning indicator styles by touching that area of the screen. You can show a small version of the band scope above the **DECODE** window, or press **F7** (**EXTEND**) to increase the height of the **DECODE** window.

The internal RTTY and PSK features worked very well, decoding quickly and accurately. The tuning indicators were quite responsive and a joy to use. It took a few minutes to get used to tuning around for PSK stations, rather than clicking on signals in a wide waterfall using PC software, but the small spectrum scope above the **DECODE** window made it easy to locate stations on the band. Many operators will find the integrated features useful for RTTY and PSK conversations, as well as for DXing and casual RTTY contesting.

### Digital Modes Using External Devices

You can connect an external computer or terminal unit to the TS-890S radio through the **ACC2** connector on the rear panel. Connections for audio in and out, transmit-receive switching, and FSK RTTY keying are available. Audio levels can be set via menus and are independent of the mic gain and receiver volume controls. I used the **ACC2** connector to integrate the radio with my RTTY contesting setup, which includes *WriteLog* station management/logging software, *MMTTY* and *2Tone* software for decoding, and FSK keying through a COM port interface on my computer. The TS-890S default settings all worked fine, except that I needed to change the FSK keying polarity in a menu.

Through the transceiver's USB port, you can also set up a connection to the radio's internal sound card for digital modes, such as FT8, PSK, JT65, or AFSK RTTY, as well as SSTV — any of the "sound card modes." Setup couldn't be simpler. Install the virtual COM port software (as described earlier), then install a USB cable between radio and computer. When power is applied to the radio, Windows installs a driver and **USB AUDIO CODEC** shows up as a sound device on the computer. For FT8, I selected that device for receive and transmit audio in the *WSJT-X* **SETTINGS** menu, and set up the radio control screen. Then I checked the audio levels in *WSJT-X* and, if necessary, adjusted the receive audio output level in the TS-890S menu system to get into the recommended range. Next, I set TS-890S mode switch to USB and pressed **D** for data, and enjoyed many FT8 contacts using this setup.

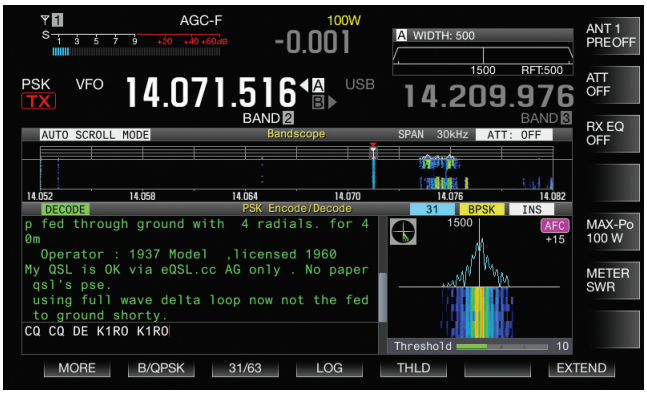



**Figure 8** — The PSK decoder screen shows up to seven lines of decoded text in green in the larger window, and two lines of text to be transmitted in white below that. The tuning indicator on the right can be switched to a vector scope. Note the small version of the band scope above the decode window, and the compact bar graph meter at the upper left.

## Wrapping Up

With its high-performance receiver, clean transmitter, and array of features for all modes, Kenwood's TS-890S appeals to a wide range of operators. The radio is highly customizable through its extensive menu system, and I found the default settings to be an excellent starting point. I could use the radio right out of the box, while I explored the many settings and options.

*Manufacturer:* JVCKENWOOD USA, Communications Sector, 1440 Corporate Dr., Irving, TX 75038; **www.kenwood.com/usa**. Price: $3,900.


**Visit https://youtu.be/1gNFh160RpE to see our review of the Kenwood TS-890S HF and 6-Meter Transceiver on YouTube.**