Equipment Review

Kenwood TS-890S

HF, 50 and 70MHz transceiver

The front panel of the TS-890S, Kenwood's latest HF+ radio.

The TS-890S is Kenwood's latest HF+ radio. It is modelled on the TS-990S and adopts a similar operating style, user interface and extensive feature set.

Aimed as a top-flight DX and contest radio for base station use, it is smaller and lighter than its bigger brother. Incorporating a single receiver and requiring a 12V power supply, it delivers 100W transmit output power, and as a bonus has extended VHF coverage up to and including the 70MHz band in the European model.

Basic functions

The TS-890S measures 410mm(w) x 158mm(h) x 387mm(d) and weighs about 16kg. The receiver tunes from 30kHz to 74.8MHz in the European model, with the transmitter enabled on the amateur bands. In the UK, transmit operation on 5MHz is not standard out of the box but can be enabled by Kenwood dealers. It is a simple link cut and fully described on the web. A low-level drive output is also provided, giving about 1mW transmit signal on the 136kHz and 472kHz bands, as well as the HF and VHF bands for transverter drive.

The usual modes are provided; SSB, CW, FSK (RTTY), PSK, AM and FM (wide and narrow), with reverse sidebands selectable on SSB, CW, FSK and PSK and with AFSK data on SSB, FM and AM. Modes can be selected automatically according to band plans by setting up a mode-frequency map, and auto switching to CW transmission whilst on SSB can also be enabled.

The radio is provided with a power cable, accessory plugs and an instruction manual but no microphone. Kenwood hand and desk microphones are available as extras. The instruction manual is very comprehensive and although written in a compact style with a small typeface and with small diagrams, it still runs to nearly 200 pages. An alphabetic index would be helpful.

A full set of circuit diagrams is also included. Printed on three large sheets of paper ,the size sets quite an eyesight challenge. The instruction manual, circuit diagrams and a separate PC Control Command reference manual are also available to download from the Kenwood website.

Radio design and architecture

Unlike other recent introductions, the TS-890S does not adopt direct digital sampling but uses a high performance down-conversion superhet architecture based on the main receiver of the TS-990S. The first IF is at 8.248MHz with roofing filter bandwidths of 500Hz, 2.7kHz, 6kHz and 15kHz fitted as standard, selected either manually or automatically according to mode and channel bandwidth. An optional 270Hz filter may also be fitted. The second IF is at 24kHz (36kHz on FM) to feed the DSP for all subsequent processing. The receiver uses a switching H-mode first mixer and 18 diode-switched input bandpass filters to cover the total frequency range. A switchable preamplifier with nominally 10dB or 20dB gain is included in the front end and a three-step attenuator, 6/12/18dB. The transmit signal path uses an up-conversion IF at 71.75MHz (41.75MHz on the 4m band) before conversion to final frequency. Transmit/receive switching uses diodes in the transmit path and reed relays in the receive path, giving virtually silent in operation even with full QSK.

The local oscillator feed uses a PLL / DDS combination and a divider to achieve

There are multiple connectors on the rear panel of the TS-890S.

low phase noise. When an oscillator output is divided by an appropriate low-noise divider, the close-in phase noise is improved theoretically by 6dB per octave. Although a higher frequency oscillator is needed to produce a wanted output frequency and this in itself will have an inferior noise performance, this is more than offset by the use of a divider if correctly engineered. In the TS-990S the local oscillator VCO operates at around 100MHz with a divider in the 4 to 10 region. The TS-890S carries this approach much further with a VCO around 3.2GHz. On 14MHz the divider is 144 and the improvement over the earlier radio is very significant. A 0.1ppm TCXO reference ensures high stability. Alternatively the radio can operate from an external 10MHz reference.

A 32 bit floating-point DSP is used to provide all IF channel filtering, demodulation, noise reduction, audio processing and AGC functions. It is also used to generate the transmit signal and associated processing functions. A second similar DSP is used by the band scope.

The radio is very solidly constructed with shielded modular units around a substantial diecast frame and this explains why the radio is heavy. The PA has a large finned heatsink and two internal fans keep the radio cool. These are very quiet and only operate when the temperature rises, very rarely indeed under normal use. A single 7.5cm speaker fits in the case top.

Front panel and controls

The front panel is well laid out with most functions accessible in a logical way. Individual buttons select the bands with a band memory where 1, 3 or 5 last used combinations of frequency, mode and other settings is returned for each press of the band key. Individual buttons also select the modes and other buttons give direct dedicated access to the most often used functions.

The high resolution TFT colour touch-screen LCD measures 7 inch diagonal and is clear, sharp and bright with a good viewing angle. Seven hardware buttons along the bottom of the display and a further seven up the side are context sensitive according to which functions and features are currently selected and these are labelled on the display. The upper part of the display shows frequencies, meter, bandwidth settings, audio spectrum plot and status messages at all times. The lower part of the display is used for a variety of purposes including spectrum and waterfall scans, audio scope display, message panels for the CW and data decoders, menu access and setup, graphical displays used in the various setup screens, and memory channel listing. The size and amount of screen space allocated to each depends how many displayed functions are active at any one time. It can get quite crowded. The display is touch-sensitive when displaying spectrum scans and will tune the radio to the touched area. Other touch-selected functions include the meter and various audio and data decode settings. The meter can emulate an analogue style or a bargraph format and can display various measurement parameters on transmit, such as power output, SWR, temperature etc.

The menu system is extremely comprehensive with over 200 items in the main menu and sub menus with every conceivable parameter available for user selection and adjustment. The high-resolution display makes access easy, straightforward and unambiguous. Many parameters are adjustable via bargraphs and other forms of graphical displays. Two entirely separate sets of parameters may be stored, configuration A or configuration B. This can be useful for optimising different operating environments such as contesting and local rag-chewing or for field day operation where two operators have different preferences for the way the radio is set up. Configurations and message stores can be saved to external USB memory. Quick access to commonly selected menu items or many other settings including some otherwise inaccessible functions can be assigned to any of the programmable keys. There are three programmable function keys on the front panel and a further eight keys may be accessed via a (home constructed) keypad connected via the rear panel. The up/down keys on the microphone can also be reassigned for this purpose. My preference is to allocate one function key to enable TUNE.

The radio is fitted with a 55mm diameter tuning drive, weighted and smooth in operation. With 1000 steps per revolution and 10Hz steps this provides precise tuning with fast frequency navigation. On AM and FM the step size is 100Hz. Fine-tuning at one tenth of these rates is selectable and lower steps per revolution if desired. Rapid tuning in a variety of mode dependant step sizes is performed by a small click-step rotary control MULTI and this is also used extensively to select menu items, memory channels and other settings and functions. Selectable auto-speedup on fast tuning and rapid navigation in 1MHz steps are also provided. The frequency may be entered directly using the band keys as a numeric keypad and a history list of the last 10 frequencies entered this way is stored for rapid recall. There are the usual twin VFOs together with split frequency operations and TF-SET transmit frequency checking.

Rear panel

There are two antenna sockets on the rear panel, selectable by band, and separate in/out sockets to connect a separate receive-only antenna, a separate receiver, transverter or extra front-end filters. Twin key jacks, one on the rear panel and one on the front, are each configurable for different keying arrangements. A 13-pin connector provides audio and interfacing lines for the Data modes and other accessories, and a separate DIN connector is used for linear control. This provides control for both fast QSK linears using semiconductor switching, and older style slower linears that need higher voltage or current control using relay switching. Menu items allow separate switching characteristics for HF, 50MHz and 70MHz but there is only one linear control line. A dedicated connector interfaces to the AT-300 external ATU but there is no separate direct access to band data.

There are two USB-A connectors, one on the front panel and one on the rear, to connect a USB keyboard or external memory and a USB-B connector on the rear primarily for computer control and audio lines. The usual 9-pin D connector COM port is provided, a LAN Ethernet connection, a DVI

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The bandscope and waterfall screen.

The CW decoder and bandscope screen.

as well as on transmit.

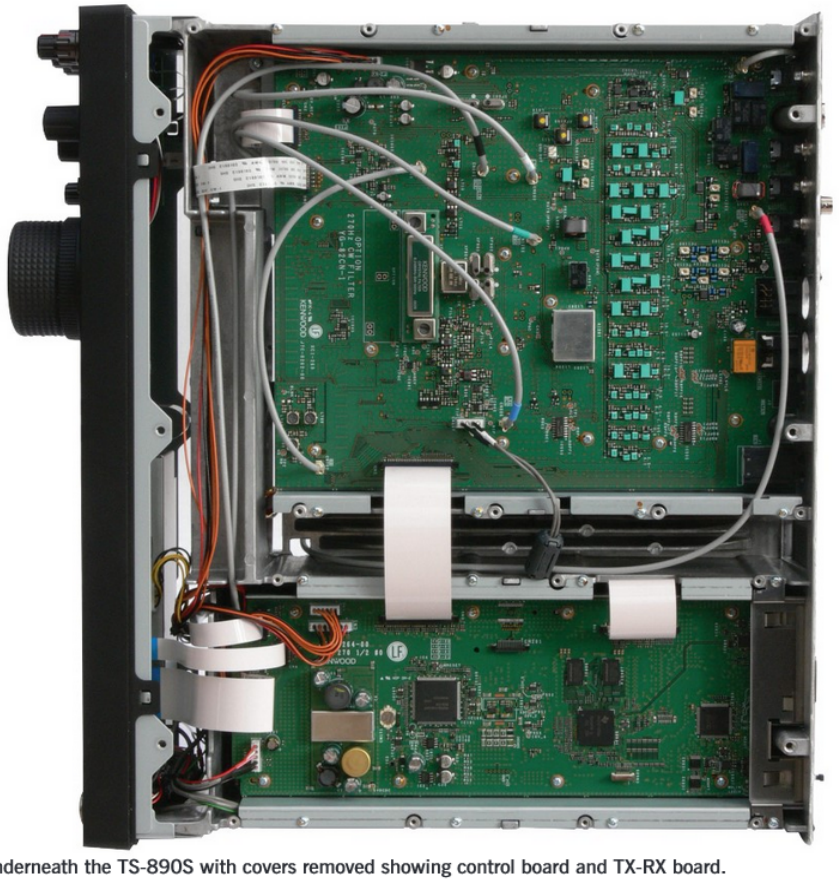
On voice modes VOX, speech processor and a transmission monitor are provided and the audio bandwidth may be tailored by adjusting the low cut and high cut response. In addition an audio equaliser may be enabled, which has 18 selectable profiles similar to the receiver equaliser. The speech processor may be configured for hard or soft operation. On FM, receive and transmit tone decoders and encoders are provided for CTCSS operation and repeater access and these can use different frequencies.

On CW the rise and fall times of the keying envelope are settable from 1 to 6ms and there is the usual provision for full and semi break-in with the drop back delay adjustable from the front panel. An electronic keyer is built-in with various operating modes. It operates over the speed range 4 – 60 WPM with the speed in WPM indicated on the display. The weighting can be varied and made to increase or decrease with speed. Eight message stores are also provided storing up to 50 characters each and can be programmed from the paddle, the function keys, MULTI control or from a USB keyboard. Automatically incrementing serial numbers are allowed and messages can be set to repeat after a delay. The message stores are controlled from front panel keys.

Data modes

The TS-890S includes fully featured built-in encoders and decoders for RTTY, PSK and also CW operation. The 7 inch display allows a good amount of space for decoded messages and effective tuning aids and together with an external keyboard connected this makes stand-alone operation on data modes much more enjoyable. With a large external monitor it is even more effective. In extended mode 12 lines of received data are displayed with 43 characters per line and 3 lines of transmit data, together with a choice of FFT scope displaying audio spectrum and a waterfall or X-Y and vectorscope tuning aids. In non-extended mode received data reduces to 7 lines on the display.

PSK operation allows both BPSK and QPSK modes with either PSK31 or PSK63. A host of configurable setups is provided, tone frequencies, shifts, UOS, AFC, tone reversal etc. The text buffer for transmission will store up to 4300 characters and there are eight 70-character message stores for each mode. Incoming messages can be saved to external USB memory.



Underneath the TS-890S with covers removed showing control board and TX-RX board.

Bandscope

A versatile scope display is incorporated into the TS-890S that provides various combinations and sizes of bandscope spectrum with or without waterfall and an audio scope. The displayed range of the bandscope is 80dB and there are three modes of operation. In centre mode it displays the spectrum centred on the receiver frequency with spans from 5kHz to 500kHz. In fixed mode it provides fixed spans within each band between presettable limits. In auto-scroll mode, probably the most useful, the spans are fixed but when the receiver reaches the edge of the displayed range the span is reset to place the receiver frequency in the centre of the span range. The spectrum and waterfall data on adjacent spans can also be computed so that when a step is made in the span range, the waterfall history for that range is immediately visible. The reference level can be set independently for each band and markers indicate the receiver and transmit frequencies. The display can be paused, averaged or maximum-held to assist in different situations. Touching the bandscope display with your finger will tune the radio to the touched area.

An audio scope function can also be enabled. This functions on both receive and transmit and shows the audio waveform, spectrum and a waterfall display of the spectrum. The frequency span, level and sweep time are adjustable.

Additional features

A voice message store is provided recording short messages for repetitive transmit calls such as CQ calls or recording the receiver

audio. There are six channels available for short messages with a total recording time of 100 seconds. Messages can repeat automatically after a time interval.

On receive there are two modes of operation. With 1GB of internal memory, up to 9 hours of receiver audio can be recorded per file and with external USB memory, up to 18 hours per file can be recorded with the number of files only limited by the memory size. In addition, the last 10, 20 or 30 seconds of receiver audio is temporarily stored and may be permanently stored and played back at the touch of a button. So if copy is very difficult or missed it can be played back as many times as needed. Stored as .WAV files, the audio can be transferred to a PC or played back on the radio where the usual CD audio-style navigation buttons (fast forward, pause etc) are provided.

For use with transverters, the display can be set to indicate the transverted frequency up to a maximum of 4.2GHz and any offset to a resolution of 100Hz. The transmit drive source for the transverter in most cases will use the low-level 1mW drive output which disables the transmitter PA but there is a menu option to use the PA at its lowest power level (5W). Make sure you avoid transmitting into the transverter IF output when the transverter is disabled by using the receive-only input on the radio.

Other features include clock displays and timers and timed recording, power-on messages and screen saver. The voice guide provides voice readout of the status of various radio settings including the frequency, meter readings and virtually any other settings and key presses, and can be a great help for those with impaired vision.

The radio is fully supported by Kenwood's suite of software, ARCP-890 and ARHP-890 and the Kenwood Network Command System (KNS) for full remote operation from a PC or via the internet, and via radio with the Sky

Kenwood TS-890S measured performance

Receiver Measurements

	SENSITIVITY SSB 10dBs+n:n			INPUT FOR S9		
Frequency	Preamp Off	Preamp 1	Preamp 2	Pre Off	Preamp 1	Preamp 2
1.8MHz	0.32µV (-117dBm)	0.14µV (-124dBm)	0.1µV (-127dBm)	63µV	22µV	5.6µV
3.5MHz	0.32µV (-117dBm)	0.14µV (-124dBm)	0.1µV (-127dBm)	63µV	22µV	6.3µV
7MHz	0.32µV (-117dBm)	0.14µV (-124dBm)	0.09µV (-128dBm)	70µV	22µV	6.3µV
10MHz	0.35µV (-116dBm)	0.16µV (-123dBm)	0.1µV (-127dBm)	70µV	22µV	6.3µV
14MHz	0.35µV (-116dBm)	0.13µV (-125dBm)	0.09µV (-128dBm)	70µV	20µV	5.6µV
18MHz	0.35µV (-116dBm)	0.14µV (-124dBm)	0.1µV (-127dBm)	70µV	22µV	6.3µV
21MHz	0.35µV (-116dBm)	0.14µV (-124dBm)	0.1µV (-127dBm)	70µV	22µV	6.3µV
24MHz	0.35µV (-116dBm)	0.14µV (-124dBm)	0.09µV (-128dBm)	70µV	22µV	5.6µV
28MHz	0.35µV (-116dBm)	0.16µV (-123dBm)	0.1µV (-127dBm)	70µV	25µV	7µV
50MHz	0.45µV (-114dBm)	0.16µV (-123dBm)	0.1µV (-127dBm)	140µV	35µV	10µV
70MHz	0.63µV (-111dBm)	0.16µV (-123dBm)	0.14µV (-124dBm)	180µV	32µV	11µV

AGC threshold Preamp on: 0.7µV
100dB above AGC threshold for 1dB audio output increase
AGC attack time: 5ms
AGC decay time: adjustable 100ms to 8s
Max audio at 1% distortion: 1.9W into 8 ohm
Inband intermodulation products: -35 to -60dB see text

S-Reading	Input Level USB		
(7MHz)	Pre Off	Preamp 1	Preamp 2
S1	3.5µV	1.1µV	0.28µV
S3	7µV	2.2µV	0.63µV
S5	16µV	5µV	1.4µV
S7	32µV	10µV	2.8µV
S9	70µV	22µV	6.3µV
S9+20	700µV	220µV	63µV
S9+40	7mV	2.2mV	630µV
S9+60	70mV	22mV	6.3mV

Bandwidth/Roof	Bandwidth (Medium Slope)			
Set To	-6dB	-60dB	-70dB	-80dB
USB 2.4kHz/2.7kHz	2505Hz	3716Hz	3888Hz	4070Hz
CW 500Hz/500Hz	506Hz	730Hz	776Hz	837Hz

NOTE: All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made with receiver preamp switched out, on USB with 2.4kHz bandwidth and 2.7kHz roofing filter and on CW with 500Hz bandwidth and 500Hz roofing filter.

Intermodulation (50kHz Tone Spacing) on USB. 2.4kHz bandwidth with 2.7kHz roofing filter

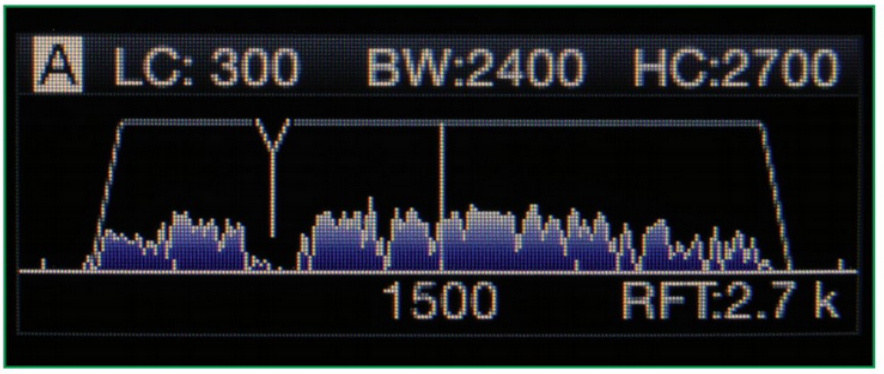
	Preamp Off		Preamp 1		Preamp 2	
Frequency	3rd order Intercept	2 tone Dynamic range	3rd order Intercept	2 tone Dynamic range	3rd order Intercept	2 tone Dynamic range
1.8MHz	+30dBm	105dB	+18.5dBm	102dB	+3.5dBm	94dB
3.5MHz	+33dBm	107dB	+18.5dBm	102dB	+3.5dBm	94dB
7MHz	+37.5dBm	110dB	+17dBm	101dB	+2.5dBm	94dB
14MHz	+37dBm	109dB	+17.5dBm	102dB	+4dBm	95dB
21MHz	+38.5dBm	110dB	+17dBm	101dB	+3.5dBm	94dB
28MHz	+38.5dBm	110dB	+19.5dBm	102dB	+8dBm	97dB
50MHz	+33dBm	105dB	+16.5dBm	100dB	+5dBm	95dB
70MHz	+31.5dBm	102dB	+16.5dBm	100dB	+11dBm	97dB

Frequency Offset	Reciprocal Mixing Dynamic Range 500Hz BW 7MHz	Transmit Noise 7MHz 100W O/P
1kHz	115dB (-142dBC/Hz)	-121dBC/Hz
2kHz	127dB (-154dBC/Hz)	-121dBC/Hz
3kHz	128dB (-155dBC/Hz)	-121dBC/Hz
4kHz	130dB (-157dBC/Hz)	-122dBC/Hz
5kHz	130dB (-157dBC/Hz)	-122dBC/Hz
10kHz	130dB (-157dBC/Hz)	-124dBC/Hz
15kHz	130dB (-157dBC/Hz)	-129dBC/Hz
20kHz	131dB (-158dBC/Hz)	-133dBC/Hz
30kHz	131dB (-158dBC/Hz)	-137dBC/Hz
50kHz	131dB (-158dBC/Hz)	-141dBC/Hz
100kHz	132dB (-159dBC/Hz)	-144dBC/Hz

Transmitter Measurements

	CW Power	Intermodulation Products		
Frequency	Output	Harmonics	3rd order	5th order
1.8MHz	104W	-62dB	-42dB	-40dB
3.5MHz	108W	-62dB	-50dB	-40dB
7MHz	106W	-75dB	-45dB	-40dB
10MHz	107W	-68dB	-39dB	-44dB
14MHz	107W	-64dB	-38dB	-43dB
18MHz	107W	-70dB	-41dB	-40dB
21MHz	107W	-72dB	-40dB	-40dB
24MHz	107W	-70dB	-40dB	-38dB
28MHz	106W	-65dB	-32dB	-40dB
50MHz	104W	-72dB	-37dB	-42dB
70MHz	53W	-75dB	-45dB	-44dB

Intermodulation product levels are quoted with respect to PEP.
Carrier suppression: >80dB
Sideband suppression: >80dB
Microphone input sensitivity: 0.2mV for full output
Transmitter AF distortion: Less than 0.1%
FM deviation: 1.9kHz narrow / 3.6kHz wide
SSB Data T/R switch speed: mute-TX 15ms, TX-mute 6ms, mute-RX 25ms, RX-mute 4ms



The IF filter display showing passband, audio spectrum and notch.

Command System II. This includes packet cluster tuning and crossband repeaters.

Measurements

The full set of measurements is given in the table. The sensitivity remains flat down to LF and only starts to reduce below 100kHz. Sensitivity is reduced by about 20dB over the medium wave broadcast band. The S-meter calibration showed about 3.5dB per S unit and was very linear over the whole range. All modes were the same including FM.

The rejection of IFs and images was typically around 70dB, a little lower on 70MHz. Other spurious responses and birdies were very low, none of significance. The AGC attack characteristic was clean with no overshoot but inserted a hole of about 5ms in the signal, often seen in DSP implemented systems, and this can impair signal copy in noisy situations.

The strong signal performance of the receiver is excellent, similar to the TS-990S, with front-end IP3 approaching +39dBm on some bands and intermodulation limited dynamic range approaching 114dB in 500Hz bandwidth. Close-in, the dynamic range holds well with similar figures down towards the skirts of the roofing filter. Front-end blocking measured in excess of +20dBm with the preamplifier switched out showing the receiver can handle very strong signals. Inband linearity was reasonable but somewhat dependent on tone spacing.

The reciprocal mixing phase noise figures were really excellent, the highest performance of any top-class contest radio available. The new Kenwood synthesiser design results in a 20dB improvement close-in over the TS-990S. This result allowed the IF filter skirts to be measured down to a level of about –90dB with relative ease and, as is usually seen with most DSP implementations, the filters exhibited a clean response and excellent shape factor.

On transmit, the power output was well up to specification but the auto ATU reduced power by about 10 to 15%. Two-tone distortion products were low and the processor was clean with negligible effect on wideband products. For a 12V operated power amplifier, these are some of the best results I have measured on any radio. The audio was very clean with low distortion and quite tolerant of high ALC levels and overdrive.

CW rise and fall shapes were fine with negligible distortion or character shortening at 40 WPM even in full break-in. The default setting of 6ms for rise and fall time is ideal and there was no power overshoot at low power levels. There was a 15ms delay on keying (both up and down) to allow for linear switching. Linear control by relay added a further 15 to 30ms on key-down for slow linears and this results in first character shortening. AM transmit was clean with low distortion.

The transmit noise output at full power is better than the TS-990S and indeed most radios on the bands which is a welcome improvement but does not match the receiver noise performance. The noise at lower power and low modulation levels was a little higher and this is fairly normal with many radios due possibly to the ALC system.

The transverter drive output measured 1mW at low distortion and with low spurii. It can be driven higher but distortion increases significantly. The harmonic output is low except on 136kHz where it was only –15dB.

On-the-air performance

The radio is quite intuitive to use straight out of the box but to get the most from the myriad of functions requires some time with the manual close to hand. The front panel layout is quite logical and the controls are well grouped. The tuning is smooth and positive and the various functions are easy to access. I really appreciated the useful and clear information presented on the various display screens. On switch-on, it takes 5 seconds for the radio to power up and during that time it can display a start-up message.

As with most modern radios, the performance was impeccable on strong and weak signals and in crowded conditions. The filters and notches were excellent and the internal speaker had good volume and frequency response with no rattles. Clean performance extended down to LF with the time-code transmissions and in the AM broadcast bands.

The two noise reduction modes were effective in certain circumstances and quite aggressive in operation but tended to produce a digital sound with strange artefacts if overdone. They were not as good as some at lifting weak CW signals from the noise or improving overall readability. Similarly, the noise blankers did not seem as effective as some other radios at suppressing electric fence and other pulse noise.

On transmit, the audio quality was reported as being excellent using the MC-43S hand microphone. The processor was clean and added extra punch. On CW the keying and the sidetone were clean and with full break-in it was possible to listen between characters up to around 20 WPM although there was a slight thump returning to receive. T/R switching is silent unless the relay is used for linear switching. I ran the transmitter key down at full power for over 30 minutes before the fans operated and then they only operated for a short period and were barely audible.

The bandscope is a big improvement over earlier radios particularly in the way that the waterfall is implemented in auto-scroll mode with adjacent span stores and a fixed, not a following, display – difficult to explain, you need to see it and try it out. The touch screen tuning worked fairly well provided the span was kept fairly low and on CW having auto-tune selected helps. On data modes the decoder and functions were effective and even the CW decoder seemed better than many, providing the CW signal was clean and machine sent.

Conclusions

The TS-890S is an impressive radio. Its performance is excellent and the level of built-in features and functions is second to none.

For a single receiver radio it is quite large and heavy, which appeals to many for home station use but this also makes it easy and enjoyable to operate. Recently reduced to around £3,500, it is still quite pricey but it is a quality unit.

Acknowledgements

I would like to express my gratitude to Kenwood Electronics UK for the loan of this radio.