The Peter Hart Review

TS-850S

Kenwood HF Transceiver

KENWOOD HAS, by tradition, offered the customer a wide choice in HF transceivers with an extensive range of models from the TS-1xx budget series to the TS-9xx top of the range models. For over five years, the TS-440S has held the middle ground and achieved a reputation as a popular and excellent radio for use at home or in the car. This year, Kenwood has launched two new HF transceivers in the middle price bracket. Recently, the TS-450S has been unveiled as a successor to the TS-440S and is similar in size. Earlier in the year, the larger TS-850S was unveiled as a 12V radio for base use. Although, the TS-850S has more features and is a little more expensive, there are many similarities in the functions and new features provided.

PRINCIPAL FEATURES

MANY OF THE FUNCTIONS of the TS-850S are implemented in a similar fashion to the top-of-the-range TS-950S (reviewed *RadCom* April 1990). The usual modes are provided - USB, LSB, CW, AM, FM and FSK. The FSK shift is selectable to 170, 200, 425 or 850Hz at power-on and also selectable for high tone or low tone operation. The receiver covers the frequency range 30kHz to 30MHz with the transmitter inhibited outside the exact amateur allocations. The review model covered the European allocation 1.81 - 2.0, 3.5 - 3.8, 7.0 - 7.1MHz etc, the model available in the US would cover the relevant US allocations.

Tuning is in 10Hz steps at 10kHz per revolution of the tuning knob on SSB, CW and FSK and in 100Hz steps at 50kHz per revolution of the tuning knob on AM and FM. An extra fine position may be selected giving 1Hz steps at 1kHz per revolution on all modes which can be useful for critical tuning on CW or RTTY. A separate small click-step rotary control allows rapid changes in frequency at 10kHz per step, 240kHz per revolution. This same control is used for memory selection. Up/down keys scroll through the amateur bands, or in 1MHz steps for general coverage operation if the 1MHz key has been selected. Each band store retains the last used frequency, mode, filter selection and front-end preamplifier status for each band setting.

The usual twin VFOs are incorporated which may be operated split, and a key (TF-SET) allows the transmit VFO to be rapidly selected for receive and/or tuning. Note that the band store retains the last used settings of both the A and B VFOs per band. A numeric keypad allows the frequency to be entered directly.

MEMORIES

100 memories are included which store frequency, mode, filter setting and front-end status for both single and split-frequency use. Ten of the memory channels will also store programmed scan setting limits. The usual storing and loading facilities are provided, including memory preview. A quick memory facility provides a simple single keystroke store and recall of up to five settings on a last-in first-out basis.

Scanning may be initiated in a variety of different ways, similar to the TS950; across the entire tuning range, across all active memory channels, between decade memory sectors or between up to ten stored programmable scan limits. The scan speed is adjustable and scan hold can be selected.

Receiver and/or transmitter incremental tuning (clarifier) operates over the rather narrow range of +/-1.27kHz in 10Hz steps or +/-2.54kHz in 20Hz steps. Larger offsets need split frequency working.

RECEIVER

Separate push buttons scroll through the available filters in the 8.83MHz and 455kHz IFs in a similar fashion to the TS-950S. The bandwidths are 6000, 2700, 500 or 270Hz at the 8.83MHz IF and 12000, 6000, 2700 or 500Hz at the 455kHz IF. The CW filters are an optional extra fitment and, if not fitted, are skipped in the scrolling. Other bandwidth filters are available for fitment but in this case the display legends will not be representative. Variable bandwidth is provided by slope tuning giving independent adjustment of the low and high frequency slopes of the IF passband. An IF notch is provided at the 455kHz IF but no AF filters.

The receiver front-end is switchable between normal operation at full sensitivity and AIP (Advanced Intercept Point) giving reduced sensitivity but improved strong signal handling. An additional 6, 12 or 18dB input attenuator may also be selected. Other receiver functions include three AGC speeds, twin noise blankers, all-mode squelch, tone control and the ability to select reverse sideband operation on CW and FSK. This is particularly useful on CW for moving adjacent channel interference when a narrow IF filter has not been fitted. The CW pitch may be set between 400Hz and 1000Hz in 50Hz steps.

TRANSMITTER

The transmitter power is variable from 20W up to 100W nominal. Transmit SSB features include an RF-based speech processor, monitor for transmission quality, VOX and an audio treble-boost switch. A particularly quiet fan is fitted and a sub-audible programmable tone encoder for operation with appropriate repeaters. On CW, full and semi break-in is provided and a built-in keyer. The keyer weighting is adjustable in 16 steps to give dot:dash ratios between 1:2.5 and 1:4.0. In addition, for the standard weighting of 1:3, auto-weighting can be selected to make this ratio either increase or decrease with speed. A 'bug' mode is also selectable giving automatic dots with manual dashes.

A Tune key provides two functions. On receive, it enables CW netting to be performed by 'zero-beating', effectively shifting the receive frequency by the pitch frequency and setting in the centre of the IF passband. On transmit, a carrier is generated at half power for tuning linears and ATUs. Note, though, that linears can only be tuned for best linearity and power output with full drive. Tuning at half power will result in 'flat-topping' and distortion.

DISPLAY

At first sight, the display appears to be a fluorescent panel as used with the majority of rigs. However, it is in fact a multicoloured backlit liquid crystal display. The brightness is similar to fluorescent units although the useable viewing angle is not quite as wide. The display indicates frequency and RIT/XIT to 10Hz resolution, memory number, mode, various status messages and filter bandwidth. Also included are two 30-segment bar me-

ters. One indicates signal strength / transmit power and the other indicates ALC / compression level / VSWR. A peak hold function may be selected.

The connectors on the rear panel provide the usual interfaces to a linear amplifier, data terminals for packet, RTTY or AMTOR, CW keyer and keying paddle, IF output for monitor scope, audio in/out, power etc. The VOX controls are also located on the rear panel. Four connectors are dedicated to interfacing to the DSP-100 DSP unit (see below) and another to the AT-300 remote auto-ATU. One omission appears to be the lack of a facility to connect an external receiver or an external receive antenna.

The TS-850S may also be used to drive a transverter. However, it is not a very convenient drive source if it is intended to use as an HF rig as well. The IF output is reallocated for transverter drive and the converter output is connected to the main antenna socket. There is little protection against transmitting into the back end of the converter receiver output. The display can be set to indicate frequencies directly on 50, 144 or 432MHz. However, this can only be done by performing a power-on setting operation after setting the rig to 28.00000MHz and the display will then not be useable on HF without performing another power-on reset. It would have been better to extend the UP/DOWN band keys to cover the VHF bands and provide the necessary interface connectors.

Most of the functions of the radio may be controlled from a PC via the IF-232C serial interface at 4800 bit/sec. The digital recorder (see later) and quick memory functions may also be operated from a remote keypad.

The parameters of some 35 of the radio's functions may be selected at power-on. These include enabling/disabling of beep and alarm tones, step sizes, display parameters, FSK and CW keyer settings, sub tones, recorder settings etc, etc.

OPTIONS

A number of internal options may be fitted. These include additional IF filters for CW and narrow sideband, voice synthesiser to announce frequency, high stability TCXO, auto-ATU matching up to 2.5:1 VSWR with band memories, and a digital recording unit. The digital recording unit will record three Morse messages up to 50 characters in length using the internal keyer or three voice messages of length 8, 8 and 16 seconds using the microphone. The messages may be chained but cannot be used to record the receiver output directly. One interesting accessory is the DSP-100 digital signal processor. This external unit provides functions similar to the unit fitted internally in the TS-950SD. DSP techniques are used to generate a higher quality transmit voice signal, an accurately shaped CW envelope (for minimum key clicks with user control over rise and fall times) and improved demodulation on receive. Front panel controls allow the audio filter bandwidths on both receive and transmit to be tailored. The unit can also be used to generate a DSB signal.

The rear panel provides a comprehensive range of connectors.

The transceiver came with a massive 202 page manual, 74 pages in English and the remainder in Spanish and French. Installation, operation and interconnection to accessories is reasonably well described using fold-out charts for each mode. Block and circuit diagrams are included with minimal information on maintenance and adjustments.

DESCRIPTION

THE TS-850S MEASURES 33.9cm (W) by 13.5cm (H) by 37.5cm (D) and weighs 10.9kg. The construction is conventional and a 7cm speaker faces upwards in the top of the case. A hatch in the top gains access to the digital recorder and voice synthesiser units.

The receiver is a triple conversion superhet with IFs of 73.05MHz, 8.83MHz and 455kHz. The transmit chain functions in reverse, generating SSB at 455kHz and mixing through 8.83MHz and 73.05MHz to final frequency.

MEASUREMENTS

ALL THE MEASUREMENTS were made powered from a 13.55V PSU and are detailed in the accompanying table. Additional comments are as follows.

S-METER CALIBRATION

The S-meter measurements are only approximate due to the resolution of the bargraph display. SSB, CW, AM and FSK gave the same results and the linearity was excellent. The FM result was, as usual, very poor.

SPURIOUS REJECTION

Rejection of all image and IF related responses was in excess of 100dB. This is an extremely good result. The receiver was also remarkably clear of other responses and particularly good close-in where many rigs tend to show up problems. No response was worse than 100dB down.

AGC

The attack time was constant at about 4ms although in the fast setting, there appeared to be some overshoot to the settling characteristic.

STRONG SIGNAL PERFORMANCE

The third order intercept varied somewhat from band to band and substantially higher figures were measured in the AIP position. The results are comparable with the TS-950S. The close-in dynamic range degrades but not as much as some other more expensive rigs and not until quite close-in. The reciprocal mixing performance is excellent, virtually identical to the TS-950S. The inband linearity measured with 200Hz tone spacing was better with slow AGC settings and improved markedly with the RF gain control turned down.

SELECTIVITY

The review radio was not fitted with any optional filters. The effective selectivity curve is shown in **Fig 1**.

POWER OUTPUT

The power output on CW, FSK and FM was similar and could be reduced to 10W with the power control or virtually zero with the carrier level also reduced. The power output reduced markedly as the load VSWR increased above 2:1. Note that the review rig was not fitted with the auto-ATU.

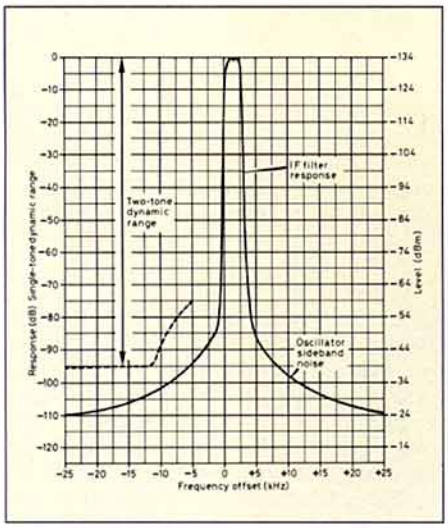

Fig 1: Effective selectivity curve on SSB.

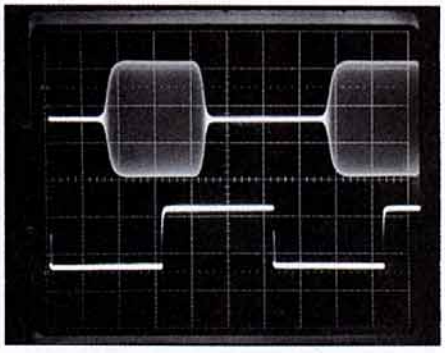

Fig 2: CW keying waveform at 40WPM. Horiz scale 10ms/div.

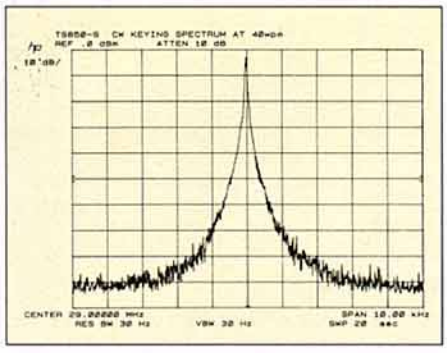

Fig 3: CW keying spectrum at 40WPM. Horiz scale 1kHz/div; vert scale 10dB/div.

KENWOOD TS-850S MEASURED PERFORMANCE

RECEIVER MEASUREMENTS

FREQUENCY	SENSITIVITY SSB 10dB s+n:n NOR	AIP	INPUT FOR S9 NOR	AIP
1.8MHz	0.16µV (-123dBm)	0.56µV (-112dBm)	22µV	112µV
3.5MHz	0.11µV (-126dBm)	0.35µV (-116dBm)	16µV	79µV
7MHz	0.11µV (-126dBm)	0.35µV (-116dBm)	16µV	79µV
10MHz	0.11µV (-126dBm)	0.35µV (-116dBm)	14µV	71µV
14MHz	0.14µV (-124dBm)	0.45µV (-114dBm)	18µV	89µV
18MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	20µV	89µV
21MHz	0.16µV (-123dBm)	0.45µV (-114dBm)	25µV	100µV
24MHz	0.09µV (-128dBm)	0.35µV (-116dBm)	18µV	89µV
28MHz	0.09µV (-128dBm)	0.35µV (-116dBm)	16µV	89µV

	INTERMODULATION (50kHz TONE SPACING) NOR		AIP	
FREQUENCY	3rd ORDER INTERCEPT	2 TONE DYNAMIC RANGE	3rd ORDER INTERCEPT	2 TONE DYNAMIC RANGE
1.8MHz	+4dBm	91dB	+11dBm	89dB
3.5MHz	+4dBm	93dB	+15dBm	94dB
7MHz	+8dBm	96dB	+21dBm	98dB
14MHz	+10dBm	96dB	+24dBm	99dB
21MHz	+15dBm	99dB	+26dBm	100dB
28MHz	-6dBm	88dB	+15dBm	94dB

FREQUENCY OFFSET	RECIPROCAL MIXING FOR 3dB NOISE	NOR	BLOCKING AIP	TX NOISE IN 2.5kHz BANDWIDTH
3 kHz	85dB	not meas	not meas	-75dBC
5 kHz	89dB	-31dBm	-13dBm	-83dBC
10 kHz	100dB	-28dBm	-10dBm	-90dBC
15 kHz	105dB	-10dBm	>+6dBm	-95dBC
20 kHz	108dB	-10dBm	>+6dBm	-96dBC
30 kHz	112dB	-10dBm	>+6dBm	-99dBC
50 kHz	117dB	-10dBm	>+6dBm	-100dBC
100 kHz	122dB	-10dBm	>+6dBm	-101dBC
200 kHz	127dB	-10dBm	>+6dBm	-103dBC

MODE	FILTER (8.83/455)	BANDWIDTH -6dB	-60dB
SSB,CW	2.7/2.7	2470Hz	3780Hz
AM	6/6	6520Hz	11.1kHz
FM	-/12	13.2kHz	21.7kHz

TONE SPACING (7MHz BAND)	3rd ORDER INTERCEPT	2 TONE DYNAMIC RANGE
5 kHz	-23dBm	75dB
10 kHz	-2dBm	89dB
15 kHz	+6dBm	95dB
20 kHz	+7dBm	95dB
30 kHz	+8dBm	96dB

S-READING (14MHz)	INPUT LEVEL SSB	FM
S1	0.9µV	0.9µV
S3	1.8µV	1.3µV
S5	4µV	1.8µV
S7	8.9µV	2.4µV
S9	20µV	3.4µV
S9+20	200µV	6µV
S9+40	2mV	10µV
S9+60	20mV	18µV

AM sensitivity (28MHz): 0.6µV for 10dB s+n:n at 30% mod depth
FM sensitivity (28MHz): 0.11µV for 12dB SINAD 3kHz pk deviation
AGC threshold: 0.6µV
100dB above AGC threshold for +1dB audio output

AGC attack time: 4ms approx for all speed settings
AGC decay time: 0.2-0.3s (fast), 0.8-1.4s (medium), 2-5s (fast)
Max audio before clipping: 1.3W into 8Ω at 1% distortion
Inband intermodulation products: -30 to -40dB (see text)

TRANSMITTER MEASUREMENTS

FREQUENCY	CW POWER OUTPUT	SSB(PEP) POWER OUTPUT	HARMONICS (3rd)	INTERMODULATION PRODUCTS 3rd order	5th order
1.8MHz	112W	120W	-63dB	-24dB	-38dB
3.5MHz	115W	120W	-63dB	-26dB	-38dB
7MHz	114W	120W	-65dB	-24dB	-40dB
10MHz	114W	118W	-63dB	-23dB	-48dB
14MHz	112W	117W	-68dB	-20dB	-36dB
18MHz	111W	114W	-70dB	-16dB	-32dB
21MHz	109W	112W	-69dB	-16dB	-32dB
24MHz	106W	110W	-70dB	-24dB	-33dB
28MHz	103W	108W	-75dB	-28dB	-32dB

Carrier suppression: 65 to 70dB
Sideband suppression: >70dB
Transmitter noise: see table above
Transmitter AF response at -6dB: 500 - 2600Hz
Transmitter AF distortion: <1%
FM peak deviation: 4.5kHz

Microphone input sensitivity: 3.5mV for full output
T/R switching speed (SSB): mute-TX 16ms, TX-mute 3ms, mute-RX 20ms, RX-mute <1ms
Power into load mismatch: 2:1 VSWR 58 - 99W, 3:1 VSWR 25 - 35W

NOTE: All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on SSB with the receiver front-end set to maximum sensitivity and operating from a 13.5V PSU. All two-tone transmitter intermodulation products quoted with respect to either originating tone.

SPURIOUS OUTPUTS

The second harmonic was generally some 10dB worse than the third which is given in the table. Non-harmonic spurious outputs were very low, at around 80dB or lower.

SSB PERFORMANCE

The PA intermodulation performance is poor compared with the performance achieved by higher voltage PA stages used in mains powered base stations. However, reducing power to 80W gave a noticeable improvement. The distortion degraded further with the compressor in circuit. Results with the DSP-100 were very similar although the audio bandwidth was of course adjustable.

CW KEYING PERFORMANCE

Fig 2 shows the keying spectrum at 40WPM and **Fig 3** the keying envelope. Full and semi-break-in gave similar results. The keying characteristic was near optimum with low distortion and narrow spectrum. Results with the DSP-100 in circuit were surprising. Except at the slowest rise and decay setting, the spectrum was considerably wider.

T/R SWITCHING SPEED

The receiver exhibited a particularly clean recovery and the results indicate entirely satisfactory operation on all data modes.

ON-THE-AIR PERFORMANCE

THE RADIO PERFORMED very well in all situations. The review rig was not equipped with CW filters and I must admit I really missed a good narrow filter at times. However, the slope tuning performed remarkably well and went a long way towards filling this gap. The notch filter was disappointing, rather too broad – a consequence of implementing this function at 455kHz as against another conversion to 100kHz as used in the top-of-the-range models. Both the HF and LF performance was good although the LF bands were very noisy during the review period. The receiver also performed very well on VLF (below 100kHz), unlike many radios, which is usually an indication of good synthesiser performance.

The reported transmit quality was excellent. The processor added real punch and with this operational, it was beneficial to select high boost. The CW transmission was narrow and click-free. The DSP unit did not seem to add much to the overall transmit performance.

The ergonomics were generally good and the VFO free of clicks. Synthesiser performance is excellent. However, the quality of the push keys was poor and there was a tendency for them to stick engaged. As a user of both SSB (with PTT not VOX) and CW, I do not like having to select VOX when on CW.

CONCLUSIONS

THE TS-850S IS A GOOD all-round performer for a mid-price radio. The list price is £1325 without ATU or £1473 inclusive of auto-ATU. The DRU-2 digital recording unit costs £88 and the DSP-100 is £429. I would like to thank Lowe Electronics of Matlock, for the loan of the equipment.

Peter Hart, G3SJX