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Kenwood TS-480HX
HF + 6m transceiver

Kenwood does not often bring out new HF transceivers, but when it does it is usually something a little different. This is certainly true of the new TS-480, to which Peter Hart gives his unique full technical review treatment.

The TS-480 is available in two versions; the TS-480SAT gives 100W output power and has a built-in antenna tuner, while the TS-480HX, the subject of this review, features 200 watts output power and has no tuner. These are separate models, the amplifier and tuner are not interchangeable between versions or retrofittable options.

Whereas a number of radios now feature detachable front panels, with the TS-480 the front panel incorporating the loudspeaker is a completely separate unit, common to both models and connected to the main body of the radio via a cable. The radio is provided with a selection of different mounting brackets and stands with both long and short separation cables to adapt to different installation requirements. The panel can be mounted remotely such as in a vehicle or for tabletop use particularly where space is at a premium or it can be mounted adjacent to the main unit with the supplied frame and carrying handle. In this way the radio is well suited to the different needs for home, vehicle or transportable use.

BASIC FUNCTIONS

The TS-480 operates from a 13.8V supply drawing around 40A for the higher power TS-480HX or 20A for the TS-480SAT. The higher-power model uses two combined power amplifiers each with a separate power lead. The power leads can either be connected to a common power source or to two separate supplies, providing the voltage difference between them is less than 1V. With only one power lead connected the radio operates on receive only. The main unit measures 179W x 70H x 278Dmm and weighs 3.2kg and the control panel measures 183W x 78H x

68Dmm and weighs only 0.5kg.

The receiver tunes continuously from 30kHz to 60MHz and the transmitter is enabled only within the exact amateur allocations. There are variants covering the American and European band allocations but only the American version transmits in the 60m band as standard. The maximum power output is nominally 200W on the HF bands and 100W on 50MHz, reducing to 5W minimum. Modes covered are USB, LSB, CW, FSK, AM and FM. FSK requires a digital RTTY input and the shifts and tone frequencies may be set via the menu. Reverse sidebands are selectable on FSK and CW.

All controls are mounted on the remote front panel which also contains the rear facing speaker and headphone jack. Apart from the 35mm rotary tuning knob and two other concentric rotary controls all other functions are selected by push buttons. These are multipurpose in most cases but fairly intuitive in their operation. The yellow backlit LCD panel is clear and bright and easy to read. A menu of some 60 items provides user selection or tailoring of many of the functions of the radio.

Setting the radio on frequency can be done in a variety of different ways.

The rotary tuning control tunes in 10Hz steps on SSB, CW and FSK modes with a tuning rate of 2.5, 5 or 10kHz per knob revolution. On AM and FM the rate is 10 times faster with 100Hz step sizes. A fine tune button reduces all these by a factor of 10. For faster tuning across the bands a click-step rotary can tune in a variety of mode-dependant step sizes and also a 1MHz step for coarse navigation. Finally, the frequency can be entered directly via numeric buttons. Both receive and transmit incremental tuning is provided (RIT / XIT) over a range of ±10kHz. Up / down keys scroll through the bands. An automode facility will automatically select the mode according to the frequency. A table of up to 32 frequency / mode relationships may be set which is sufficient to allocate CW, FSK and SSB sub-bands for all the bands with some for AM broadcast. This is very helpful and an alternative and possibly more flexible arrangement to band stacking used on other radios.

The usual A / B twin VFOs are provided with split frequency capability and a means to check and set the Tx frequency. Several button presses are needed, there is no quick split facility. There are a total of 100 memories which can be tagged with alphanu-

The TS-480HX control panel on its mounting bracket.
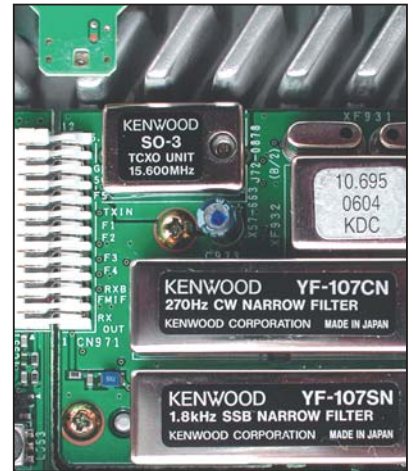
TS-480HX control unit and main unit.

Close-up of rear of main unit showing cooling fan.

Optional narrow IF filters installed.

meric names up to eight characters long and a one press store and recall quick memory feature for saving 10 frequencies on a stack. The usual comprehensive scanning features are provided allowing scanning across a frequency range or across the memories with various scanning parameters user selectable.

The main unit is fitted with twin fans for the higher power model and mini-DIN accessory sockets to interface to external linears, data terminals, PC sound card etc. The menu allows several different linear amplifier switching configurations including delayed transmission for slow changeover speeds. Twin antenna sockets on flying leads are provided and either can be switched to any band. Separate jacks for the internal keyer paddle and for external keying arrangements are also included. A 9-pin D connector interfaces directly to a PC serial COM port without the need for level conversion and this also provides direct connection to other

Kenwood radios for *PacketCluster* tuning and other data transfers. The radio is provided with a hand microphone fitted with a longer cable than normal for plugging into the main unit.

The receiver is a double conversion superhet with IFs of 73.095MHz and 10.695MHz with a third conversion on FM to 455kHz. DSP is used for audio filtering functions in both the receiver and transmitter circuitry. The main channel selectivity is achieved at 10.695MHz where a 2.4kHz bandwidth filter is fitted as standard. Up to two optional extra filters (1.8kHz, 500Hz or 270Hz) can be fitted for narrower bandwidths on SSB or CW / FSK. An optional TCXO (temperature compensated crystal oscillator) reference can also be fitted which provides frequency stability to within 0.5ppm.

ADDITIONAL FEATURES

Receiver features include selectable RF preamplifier / attenuator, all-mode squelch, fast / slow AGC, IF

shift to move the receive passband away from interfering signals and an IF noise blanker for ignition or pulse noise. DSP is used at audio to provide additional noise pulse elimination as well as multiple beat cancellation (audio notch) and background noise reduction. Two noise reduction modes are implemented as also used in previous Kenwood radios. The Line Enhancer method is particularly suited to SSB and is based on adaptive filtering. The Speech Processing / Auto Correlation (SPAC) method uses a statistical auto-correlation algorithm and is particularly effective for CW.

DSP is also used to provide audio filtering functions on receive and transmit. On receive, adjustable high cut and low cut filters are implemented on speech modes and narrow bandwidth bandpass filters on CW and FSK modes. Several bandwidth settings are selectable down to 50Hz on CW or 250Hz on FSK and these filters track the CW pitch setting. For data communication in SSB mode

KENWOOD TS-480HX MEASURED PERFORMANCE
RECEIVER MEASUREMENTS

FREQUENCY	SENSITIVITY SSB 10dBs+n:n		INPUT FOR S9	
	PREAMP IN	PREAMP OUT	PREAMP IN	PREAMP OUT
136kHz	2.0µV (-101dBm)	3.2µV (-97dBm)	280µV	700µV
1.8MHz	0.16µV (-123dBm)	0.40µV (-115dBm)	22µV	110µV
3.5MHz	0.14µV (-124dBm)	0.35µV (-116dBm)	22µV	100µV
7MHz	0.11µV (-126dBm)	0.28µV (-118dBm)	16µV	80µV
10MHz	0.14µV (-124dBm)	0.35µV (-116dBm)	20µV	100µV
14MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	18µV	90µV
18MHz	0.13µV (-125dBm)	0.35µV (-116dBm)	18µV	90µV
21MHz	0.13µV (-125dBm)	0.32µV (-117dBm)	16µV	90µV
24MHz	0.10µV (-127dBm)	0.32µV (-117dBm)	20µV	90µV
28MHz	0.10µV (-127dBm)	0.32µV (-117dBm)	20µV	90µV
50MHz	0.10µV (-127dBm)	0.35µV (-116dBm)	11µV	90µV

AM sensitivity (28MHz): 0.6µV for 10dBs+n:n at 30% mod depth
FM sensitivity (28MHz): 0.14µV for 12dB SINAD 3kHz pk deviation
AGC threshold: 0.6µV
100dB above AGC threshold for +1.5dB audio output increase
AGC attack time: 2 - 3ms
AGC decay time: 100 - 300ms (fast), 2 - 5s (slow)
Max audio at 10% distortion: 2.0W into 8 Ω
Inband intermodulation products: -30dB to -40dB

S-READING (7MHz)	INPUT LEVEL SSB	
	PREAMP IN	PREAMP OUT
S1	0.8µV	4µV
S3	1.4µV	6.3µV
S5	2.8µV	14µV
S7	8.9µV	45µV
S9	16µV	80µV
S9+20	130µV	630µV
S9+40	1.6mV	8mV
S9+60	20mV	100mV

IF FILTER	IF BANDWIDTH	
	-6dB	-60dB
2.4kHz SSB	2490Hz	4800Hz
1.8kHz SSB	2010Hz	4060Hz
270Hz CW	300Hz	840Hz
6kHz AM	7.4kHz	22.9kHz
FM	10.3kHz	21.2kHz
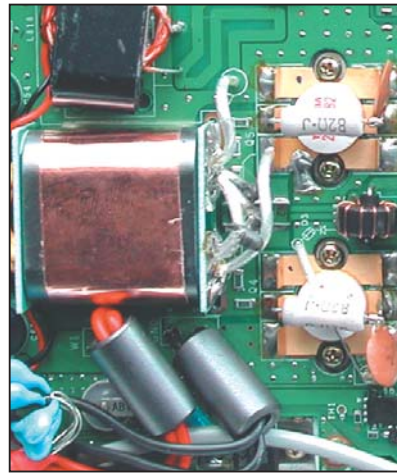
such as PSK31 or RTTY via a sound card, additional DSP audio filtering for narrower bandwidths and higher tone frequencies can be selected. However, switching back and forth between voice and data involves switching this filter on and off via the menu system which is a little cumbersome. On voice modes, several preset audio frequency responses (equalisers) are available for both the receiver and transmitter to suit different operator's voices or ears. The transmit audio bandwidth is switchable wide or narrow and DSP also provides a speech processor and automatic tuning / netting for CW signals.

Transmit features include variable output power from a few watts to 200W, speech processor, VOX, a transmission monitor, full or semi break-in and a full message keyer on CW. The keyer accommodates various paddle arrangements and speed compensated weighting and operates over the range 10 to 60WPM. Three

50 character message stores allow for interruption to insert contest serial numbers, for example, and may be set to repeat automatically.

An optional plug-in module for the TS-480 is the VGS-1 voice guide and storage unit. The voice guide provides voice readout of the frequency and several other settings for the front panel controls which are not announced as Morse characters. This includes the S-meter and can be a boon to those with impaired vision. The second use of this option is to provide an audio store. This can be used to record up to three 30-second messages for playback on air as CQ calls or contest exchanges for example. Store 3 will also record the receiver output continuously and retain the last 30 seconds. This can be stored and played back as desired or can be played on air to show a station what his signal sounds like.

Other features include a transmission timeout timer and automatic power off and interfacing for trans-

verters with 5W drive. The transverted frequency is displayed on the LCD but only three digits for the MHz are available. FM operation covers both wide and narrow deviations and has facilities for repeater access including CTCSS tones.

PC AND DIGITAL CONTROL

Kenwood provides a software control program, ARCP-480, which is downloadable free of charge from the Kenwood website (see 'Websearch' below). The download size is about 6MB. Full control of all the radio features may be made from a PC running *Windows 98* or later and I had this working satisfactorily with a 200MHz machine running *Windows 98*. Dual control from the radio panel or the PC is allowed and both displays track together. It is a different way of operating the radio but VFO tuning is faster and more responsive when implemented from the radio panel. There are few extra features on the PC software, a bargraph spectrum

Close-up of TS-480HX with top cover removed.

TS-480HX main unit.

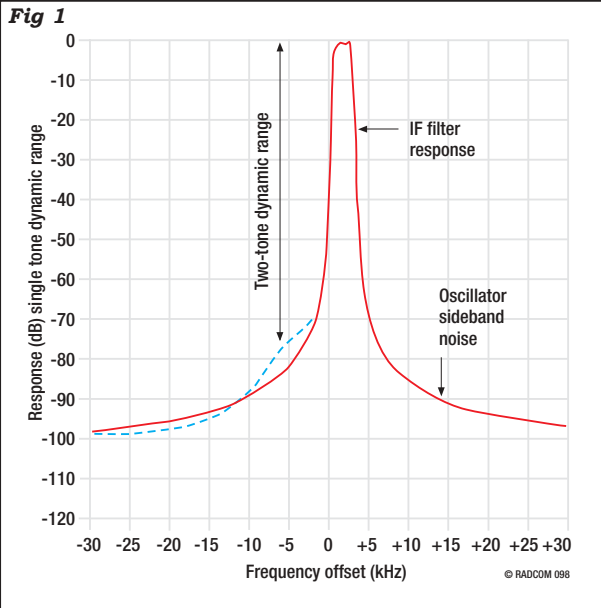*Close-up of TS-480HX with bottom cover removed. Detail of PA board.*

INTERMODULATION (50KHZ TONE SPACING)

Frequency	PREAMP IN		PREAMP OUT	
	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
1.8MHz	+10dBm	95dB	+24dBm	99dB
3.5MHz	+10dBm	96dB	+18dBm	96dB
7MHz	+9dBm	97dB	+22dBm	100dB
14MHz	+9dBm	96dB	+21dBm	98dB
21MHz	+8.5dBm	96dB	+23dBm	100dB
28MHz	+3dBm	93dB	+18dBm	97dB
50MHz	-5dBm	88dB	+15dBm	94dB

CLOSE-IN INTERMODULATION ON 7MHz BAND

Spacing	PREAMP IN		PREAMP OUT	
	3rd order intercept	2 tone dynamic range	3rd order intercept	2 tone dynamic range
3kHz	-36dBm	67dB	-21dBm	71dB
5kHz	-29dBm	71dB	-15dBm	75dB
7kHz	-22dBm	76dB	-7dBm	81dB
10kHz	-10dBm	84dB	+4dBm	88dB
15kHz	+7dBm	95dB	+16dBm	96dB
20kHz	+7.5dBm	96dB	+18dBm	97dB
30kHz	+8dBm	96dB	+19dBm	98dB
40kHz	+8dBm	96dB	+21dBm	99dB
50kHz	+9dBm	97dB	+22dBm	100dB

FREQUENCY OFFSET	RECIPROCAL MIXING FOR 3dB NOISE	BLOCKING PREAMP IN	BLOCKING PREAMP OUT
3kHz	78dB	-38dBm	-24dBm
5kHz	82dB	-38dBm	-24dBm
10kHz	89dB	-36dBm	-22dBm
15kHz	93dB	-24dBm	-10dBm
20kHz	95dB	-13dBm	+1dBm
30kHz	98dB	-4dBm	+8dBm
50kHz	103dB	-4dBm	+8dBm
100kHz	110dB	-4dBm	+8dBm
200kHz	116dB	-4dBm	+8dBm

Fig 1

Fig 1 selectivity plot showing Response (dB) single tone dynamic range vs Frequency offset (kHz). Labels: Two-tone dynamic range, IF filter response, Oscillator sideband noise. © RADCOM 098

display in scan mode is one bonus but advantage could have been taken to provide a comprehensive memory access system. However, it is free of charge so I cannot be too critical.

A second software control program available free of charge from the Kenwood website is the ARHP-10 Host program for the Kenwood Network Command System. This 5MB download enables the radio to be controlled remotely over a network such as a LAN or the Internet. In addition to the serial port connection, the transmit and receive audio lines from the radio are interfaced to the PC sound card and VoIP (Voice over Internet Protocol) is used to transfer the audio data across the link. The ARHP-10 is used at the radio end of the link with the ARCP-480 at the controlling end both running under Windows 2000 or XP. It remains to be seen what changes would be needed to current licensing conditions to make such operation acceptable.

A further feature addressed by the serial COM port is to provide a direct connection to the Kenwood TM-D700E 2m / 70cm radio. This enables incoming DX *PacketCluster* spots to be used to tune the TS-480 automatically on frequency. This set-up can also be configured to provide a cross-band repeater.

MEASUREMENTS

Measurements shown in the table were made with the review radio powered from twin 13.5V supplies. The review radio was fitted with 1.8kHz and 270Hz IF filter options. The receiver is very sensitive and overall gain high with an AGC threshold at 0.6µV. The sensitivity is lower at LF but adequate at 136kHz and lower

frequencies. Rejection of images, IFs and spurii was better than 90dB, a very good result. The third order intercept and dynamic range is excellent at wide spacings, on a par with the very best radios, but rather poor close in. Reciprocal mixing figures are fairly reasonable, rather better than some recent radio introductions but not as good as some Kenwood radios from the past. **Fig 1** shows the overall selectivity plot.

The transmitter performance was well up to scratch. SSB intermodulation products were generally quite reasonable and not significantly degraded by the speech processor with low levels of harmonics and spurious outputs. CW keying was very clean with low distortion and optimal rise and fall times although the first attack edge was noticeably sharper. Full and semi break-in gave identical results. The data switching envelope was also nicely rounded.

ON THE AIR

I used the TS-480HX in the home station with the control panel mounted on the tabletop panel bracket and the main unit tucked out of the way. I found it convenient to place the radio on the left side of the logging keyboard and tilted up at a steep angle which makes all controls easily accessible. It is useful to be able to move the radio around at will. The audio quality from the rear downward facing speaker was surprisingly good and very clean but as always so much better on headphones. I found the receiver performance to be excellent. I could detect no strong signal overload effects on 40m and the radio was very sensitive on the quiet bands. Good performance extended to AM broadcast and VLF time transmissions. It performed very well on 80m to VK, JA and W7 during the excellent

December conditions. The AF DSP filtering is also very effective but there is no substitute for narrower IF filtering on CW. The AGC can be captured by inaudible signals filtered out by the AF filter which pass through the wider IF filter. This is particularly noticeable with the low AGC threshold on this radio and results in a quietening when strong close-by signals are present. I would recommend fitting the 500Hz filter rather than the narrower 270Hz filter if only one CW filter is fitted. The narrower filter can only be selected when the DSP AF filter is narrowed to a similar bandwidth and for general use 270Hz is a little too narrow for my preference.

Transmitter quality reports on SSB were good as was CW performance on both full and semi break-in. Generally the user ergonomics are very good considering the limitations of a small panel and high number of features. Obviously much thought has gone into this aspect, although some operations such as memory access I found a little cumbersome.

CONCLUSIONS

Overall the TS-480HX is an excellent radio for use at home, in the car or transportable use. It is easy and convenient to use with an excellent receive and transmit performance. Computer and network control are added features. At 200W the extra power can be a major advantage when used standalone and can be particularly attractive for mobile and lightweight DXpeditions. However, if a linear amplifier is also used, the lower power TS-480SAT is preferable. Priced around £1000 - £1100 depending on model, the TS-480HX and TS-480SAT are available from most major suppliers.

My thanks to Kenwood Electronics UK for the loan of the review radio. ◆

TRANSMITTER MEASUREMENTS

FREQUENCY	CW POWER OUTPUT	HARMONICS	INTERMODULATION PRODUCTS 3rd order	INTERMODULATION PRODUCTS 5th order
1.8MHz	212W	-68dB	-34 (-28)dB	-46 (-40)dB
3.5MHz	216W	-65dB	-36 (-30)dB	-46 (-40)dB
7MHz	210W	-72dB	-34 (-28)dB	-46 (-40)dB
10MHz	212W	-70dB	-30 (-24)dB	-43 (-37)dB
14MHz	210W	-70dB	-32 (-26)dB	-46 (-40)dB
18MHz	210W	-70dB	-28 (-22)dB	-40 (-34)dB
21MHz	210W	-66dB	-31 (-25)dB	-41 (-35)dB
24MHz	212W	-73dB	-26 (-20)dB	-38 (-32)dB
28MHz	213W	-73dB	-26 (-20)dB	-38 (-32)dB
50MHz	105W	-68dB	-31 (-25)dB	-44 (-38)dB

Two-tone transmitter intermodulation product levels are quoted with respect to PEP, figures in brackets are with respect to either tone.

Carrier suppression: 65dB approx
Sideband suppression: 60dB @ 1kHz
Transmitter AF distortion: 1%
Microphone input sensitivity: 1mV
FM deviation: 4.3kHz (wide) 2.1kHz (narrow)
SSB/data T/R switch speed: mute-TX 14ms, TX-mute 4ms, mute-RX 24ms, RX-mute <1ms
NOTE: All signal input voltages given as PD across antenna terminal. Unless stated otherwise, all measurements made on USB, preamp switched in, normal default bandwidths and with two 13.5V supplies.