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Elecraft K4D HF & 50MHz transceiver

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Review

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After an extended period in development, the Elecraft K4 Transceiver is now available .

The Elecraft K4 transceiver was first unveiled at the Dayton Hamvention during May 2019. Aimed as a class-leading radio and the successor to the highly acclaimed and long-standing K3 series, it attracted a great amount of interest and many advance orders were placed with a projected release date later that year. However, the arrival of the Covid pandemic and the difficulty in obtaining key semiconductor chips scuppered these plans and delayed the start of deliveries until the spring of 2021. With a significant backlog of orders, radios are now arriving and I was fortunate to gain access to a sample to conduct this review.

It is still early days. The firmware used in the radios is under continuing development and review. Some of the functions and features are not yet fully implemented, as noted in the following paragraphs. As these become available, firmware upgrades are released and these are currently quite frequent. This review relates to the situation in October 2021 mainly with firmware version R19.

The Elecraft K4 front view is dominated by the display and this is central to the whole operation of the radio. At 7 inches diagonal in size, it is a full colour high-resolution LCD touch screen.

There are two fans recessed into the rear panel as well as many of the connectors. Those provided are very comprehensive using traditional connector types.

The K4 line-up

The K4 radio is available with a number of options. The basic radio is a direct sampling SDR transceiver covering the HF and 50MHz bands with a single 16-bit A-to-D converter and a single set of receiver front end filters. It has dual receive capability but the second receiver is somewhat limited as it shares the same filters and antenna as the main receiver. The K4D, which is the version reviewed, has a second set of front end filters and a second ADC and can provide two totally independent receivers using separate antennas to provide functions such as diversity reception. For the ultimate in signal handling, the K4HD provides a front end superhet module with narrow bandwidth roofing filters at 8MHz in a similar fashion to the hybrid SDR approach adopted in the Yaesu FTDX101 and some other high-end radios. As of October 2021, the K4HD is not yet available. The basic K4 can be upgraded at a later date to the K4D and similarly the K4D to the K4HD by user-installing the appropriate modules.

The K4 series can be provided with 10W transmit output power or with 100W output, and a wide range internal ATU is also an available option. This will match antennas with VSWRs up to 10:1. Space remains inside the cabinet to install a future VHF/UHF transverter module but details of this have yet to be announced.

A microphone is not provided with the K4 but the MH4 hand microphone is available as an accessory. Any microphone used with the earlier K3 and K2 series, such as the MH2, may also be used and pinning is compatible with Kenwood radios. The SP4 external speaker is also available and fully complements the K-line style. Use two speakers for the two receivers for the ultimate in luxury. Other K-line matching accessories include linear amplifiers for 500W or 1500W output and a separate K-Pod desktop controller. The K-Pod provides a high precision rotary controller similar to the main tuning drive and eight dual function programmable buttons.

The K3 series radios were available in a no-soldering kit format at reduced cost. A similar approach is planned for the K4 at a future date.

Basic functions

The K4 operates from a nominal 13.8V supply. It measures 355mm(w) x 132mm(h) x 317mm(d), including projections, with a tilting bail stand and weighs about 4.5kg. This is somewhat wider than the K3 but similar in height and depth. The receivers both tune from 100kHz to 54MHz and transmitter operation is limited to the amateur bands. The transmitter covers the US frequency allocations, ie to 4MHz on 80m and 7.3MHz on 40m and a particularly wide coverage on 60m of 5.0 – 5.6MHz.

Modes provided include USB/LSB, CW/CWreverse, AM and FM. There are four data modes. DATA and AFSK are audio based with AFSK optimised for RTTY. FSK and PSK use direct keying from a computer or a keyboard. PSK31 or PSK63 is accommodated and 45baud or 75baud on RTTY. Excellent facilities for data mode operation include dual-tone filters and display decoders for CW, RTTY and PSK modes. FM operation includes repeater shifts (not yet fully implemented) and CTCSS or DTMF tones.

The radio has the usual twin VFOs with

K4 top view with cover removed showing the PA, ATU and single board computer.

A/B switching and split frequency operations. VFO A controls the main receiver and VFO B controls the sub receiver. Both receivers have separate tuning knobs and independent and separate settings for all filtering and other functions.

Transverters are very well supported with the K4. In addition to the internal transverter when fitted, up to 12 external transverters are supported. Final frequency readout can be up to 99GHz, with 5mw of IF drive power and adjustable error offset. IF drive can be in the range 100kHz to 54MHz and this could also be used as a transmit drive source for the LF bands. The K4D can also provide independent dual receive from two external transverters or one with the HF signal.

The K4 is provided with a printed get-you-started manual. 43 pages in length, each page has a full-size colour panel view with brief instructions on which control to set and this is indicated on the picture. I found this really useful for initial setup. The full manual is shown on the front panel display and is accessed by a dedicated button. It is also available on the Elecraft website. Although largely complete, it is very compactly written and not very easy to find wanted information particularly if this is rather obscure. Word searching is usually needed as there is no index.

Front panel and controls

The radio is contained in a sheet aluminium case with modules and circuit boards accessible via the top or the bottom. The 65mm square built-in speaker fits in the top. It is quite chunky but there is no enclosed surround or acoustic wadding.

The front panel is dominated by the display and this is central to the whole operation of the radio. At 7 inch diagonal in size, it is a full colour high-resolution LCD touch screen and is very eye-catching. The main tuning knob is smooth to operate and is 50mm in diameter with finger ident. The smaller sub tuning knob is 25mm in diameter. Both will allow between 100 and 400 steps per revolution and tuning step sizes from 1Hz to 100kHz by simply touching the appropriate decade digit on the frequency display. Another rotary control sets the offset for RIT and XIT and some other functions. Three smaller rotary controls have multiple functions and set the receiver bandwidth, gain and squelch levels, transmit power and CW keying characteristics. Operation of the rotary controls and some of the pushbuttons is fairly similar to the K3.

Control of the remaining functions is shared between physical pushbuttons and context-sensitive soft keys on the display. Unlike the scrolling keys on the K3, band and mode selection is now accessed via a matrix grid on the display. Band stacking of three settings is available for each band. Eight soft keys along the bottom access many of the functions for the main and sub receivers, transmitter, display, menu and manual. Currently there are 73 selectable settings in the menu list. In addition to the touch screen, it is also possible to select items using a mouse plugged into any of the USB sockets. The mouse wheel can also be used to tune the radio or set any of the adjustable functions and sliders.

The display indicates the frequency of both receivers at all times together with associated bargraph S-meters and a multitude of messages, labels and icons. If not selected, the sub receiver frequency is dimmed. The panadapter is a key feature of the K4. It can display the spectrum and waterfall of one or both receivers simultaneously and has a host of setting possibilities. This includes the span width from 5kHz up to 368kHz, a wide range to the amplitude scaling in dBm or S-units, display averaging, peak hold, and noise blanking. The settings can be different on different bands and it is also possible to have the panadapter display on an external monitor with different settings to the main display. How the panadapter span relates to the VFO frequency can be set in several different ways such as tracking the VFO or how it responds when a span edge is reached.

Another useful feature of the panadapter is the Mini-Pan window. This window is displayed in place of the relevant S-meter and shows a narrow range of spectrum at higher resolution centred on the VFO frequency and is used to aid the fine tuning of signals.

Rear panel

There are two fans recessed into the rear panel with four step speeds increasing as the temperature rises. Apart from the microphone, headphones and a USB-A socket, all remaining connectors are located on the rear panel. The connections provided are very comprehensive using traditional connector types and avoid awkward to use items such as mini-DIN. There is no key jack on the front panel but twin jacks are on the rear for straight keying and for paddles. Headphone and microphone jacks are duplicated on the rear together with external speaker, audio line in and line out, and are stereo for the two receivers. Headphones and speaker can also be used at the same time. Jacks provide linear amplifier switching and PTT control from typically a foot switch.

The RF connections are very comprehensive. There are three SO239 antenna sockets with a fourth that will be used for VHF when the internal transverter is fitted. BNC sockets provide an input for a separate receive antenna and output to a separate receiver or alternatively to insert an inline external filter. Two more BNC sockets provide for external transverter IF input and output

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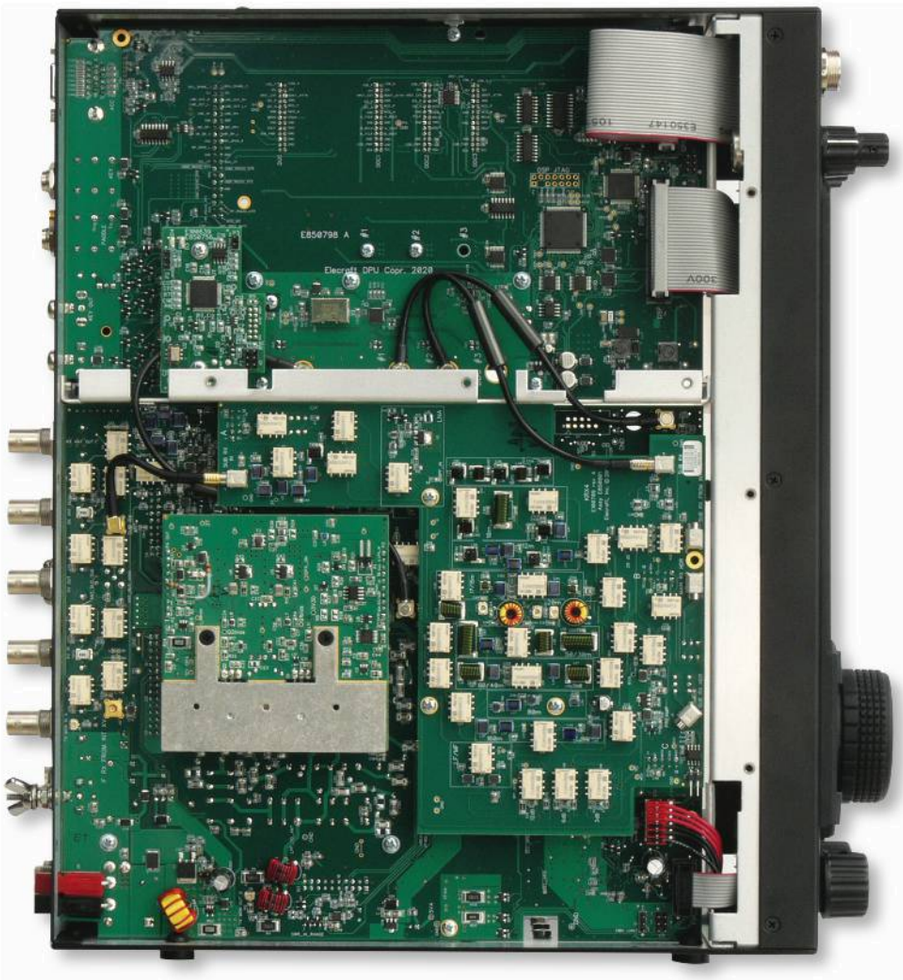


Elecraft K4 bottom view with cover removed showing main processing boards and 2nd receiver filters.

or the input can also be used for another receive-only antenna. The antenna feeds to both receivers can be set independently to any of the antenna inputs with settings stored separately for each band. Similarly the transmitter output can be set to any of the three antenna sockets per band. This really is a very comprehensive arrangement but can take some time initially to set up.

There are a total of three type-A USB jacks to connect a mouse, keyboard, memory stick or the K-Pod and a type-B USB jack to connect to a computer for radio control and soundcard I/O. Two virtual COM ports are automatically created when connected. An Ethernet port connects to a router or modem for full remote operation and firmware updating and an HDMI video connector allows an external monitor to be used. An RS232 connector provides alternative interfacing to a PC for control purposes.

A 15pin D-series accessory connector (as used in PCs for VGA video output) provides a host of I/O lines including band data, transverter control, FSK input, ALC etc. Although the radio includes a high performance TCXO claiming 0.25ppm accuracy, an external 10MHz reference can also be used as an alternative. For linear amplifiers suitably equipped with linearisation feedback, there is a sampling input for this purpose but this is still to be implemented.

Receiver features

The usual receive functions are all provided in a similar fashion to most other recent radios. There are 200 easily accessed and name-labelled memory channels and four quick access memories per band. Name labelling brings up the on-screen keyboard but an external keyboard can also be used. Scanning functions are planned but not yet implemented.

To accommodate different signal levels, the front end has two switchable preamplifiers and a third for the highest sensitivity on 24MHz and above. Also provided is a front end attenuator up to 21dB in 3dB steps, and RF gain and squelch controls. There are two settings for AGC, fast and slow, as well as off and the AGC is fully adjustable for decay rate, threshold, hold time and slope. A noise pulse rejection mode prevents AGC desensitisation on noise pulses. A fully adjustable noise blanker is included as well as a noise reduction system. Auto-tracking and manual notches are also provided and both can be used together on SSB. To improve strong signal intermodulation characteristics, dithering and randomisation is applied to the A-to-D converter. This results in a small reduction in sensitivity but can be switched off if needed.

There are three preset quick-select settings for the channel filtering bandwidth, stored separately for each mode. Each filter can be adjusted for bandwidth and shift or alternatively the upper and lower passband positions and the setting is displayed at all times. The bandwidth on all modes can be set as low as 50Hz and as high as 5kHz. On CW, a narrow bandwidth audio peaking filter is selectable with a bandwidth of 30Hz or 50Hz.

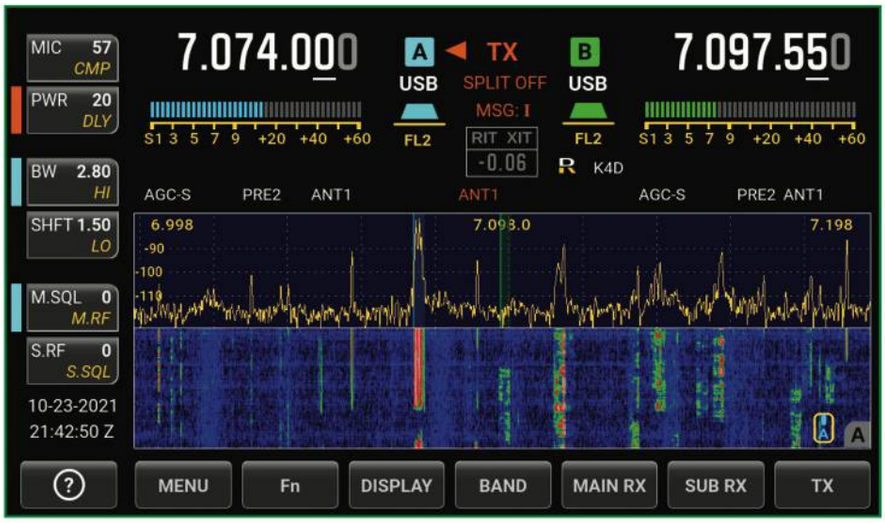
The passband can be tailored to suit using an 8-band graphic equaliser. Special audio effects can also be selected to ease copy in difficult situations when using stereo headphones. This includes simulated stereo and audio pitch mapping. Pitch mapping is particularly helpful on CW, spreading the audio signal from left to right according to pitch and can help with copying signals in pile-ups and reduce fatigue. Diversity reception can also be used with the K4D by using two different receive antennas connected to the two receivers and copying on stereo headphones. Again this can help in difficult situations.

Decoders for CW, RTTY and PSK modes are built-in. This displays either one or three lines of received text and a single line for the transmitted text with 62 characters per line. With an external keyboard connected, keyboard sending on CW, RTTY and PSK is also provided.

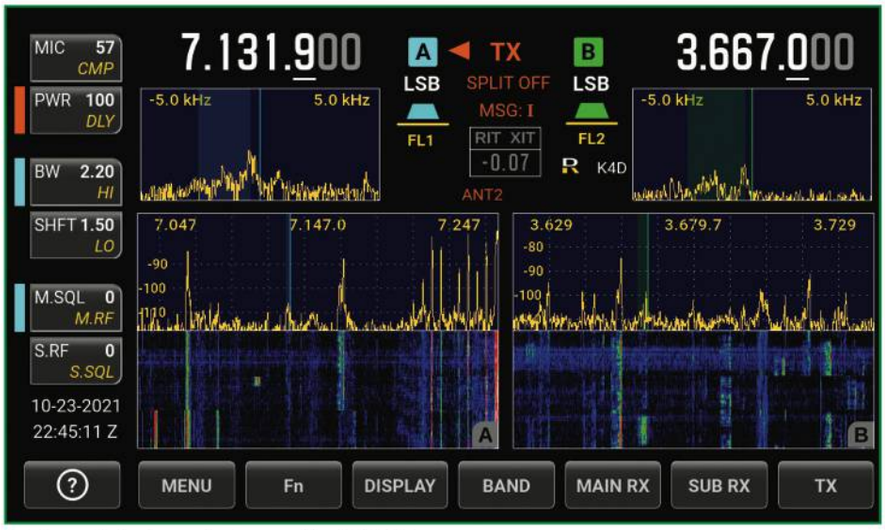
Transmit features

Transmitter power output is variable over the range from 100mW to 100W nominal and below 10W the high power PA is bypassed. The power control is very smooth and has excellent resolution, particularly at the lower levels. Separate power settings per band can be stored and when an Elecraft linear amplifier is also used, separate per band settings with amplifier on and amplifier off are also stored.

VOX, speech processor and a transmission monitor are provided on SSB and an 8-band graphic equaliser similar to that used in the receiver. On CW there is the usual provision for full and semi break-in with a front panel control for drop-back delay. A tune button provides a CW output on any mode at the set level or an alternative lower power level for ATU tuning purposes.



Display with single panadaptor.



Display with dual panadaptors and dual MPAN.

On transmit, the receiver S-meter is replaced by separate bargraphs displaying power output, antenna SWR, ALC and on voice modes, the compression level. Transmit/receive switching uses PIN diodes and hence is totally silent.

A built-in CW keyer operates over the range from 8 to 100wpm with a front panel speed control and adjustable weighting. Eight message stores are provided, each holding up to 60 characters. Messages can be chained and set to auto-repeat. They are programmed either from the on-screen keyboard or an external keyboard. Prosigns (eg "AR") can also be entered. The same message buttons used for the CW stores are also used for RTTY and PSK data modes in a similar fashion but on SSB this feature, the digital voice recorder, has not yet been implemented in the firmware. It will also allow recording of the receiver audio.

Measurements

The full set of measurements is shown in the table. The K4 is a little less sensitive than most radios but still entirely satisfactory for the HF bands. Most modern radios are generally more sensitive than they need to be. On the upper bands, use preamp 3 when band conditions are quiet. The sensitivity figures were measured with the dynamic range optimisation (dithering) enabled, the default option. With this switched out, sensitivity improves by about 2dB. If both receivers are active on the same antenna input the sensitivity reduces by about 3dB. The sensitivity remains flat from 1.8MHz down to 100kHz providing the receiver does not share the same antenna input as the transmitter. It was noticed in measuring sensitivity that there is a downward slope across the audio passband of about 7dB with low-level signals below AGC control.

It is difficult to give a precise figure for S-meter readings as the bargraph dwells for about 3-4dB at each bar level. Results centre around 50μV for S9 on most bands with about 5dB per S-unit and very linear up to 60dB over S9. The S-meter reading was constant, independent of the preamp setting. ADC overload occurred at about +10dBm with preamp off, -1dBm with preamp 1, -8dBm with preamp 2 and –21dBm with preamp 3, suggesting preamplifier gains of 11dB, 18dB and 31dB respectively.

Receiver spurious responses are extremely low: I could find none of significance. The AGC system is highly configurable but the default settings gave a good compromise with minimal overshoot but a small hole on the attack. Decay times were 200-500ms in the fast setting and 1-4s in the slow setting.

As with most direct sampling receivers, low-level intermodulation products appear when input signals are around 40dB below the ADC overload level and remain just a few dB above the noise floor as input levels increase until the overload level is approached. Enabling dither and randomisation in the ADC (dynamic range optimisation) removes these low-level products but degrades sensitivity slightly. In this situation, the intermodulation dynamic range measured 99 to 100dB in 500Hz CW bandwidth at all signal spacings even very close-in below 2kHz. This figure was consistent across all bands. With the dynamic range optimiser switched out, similar figures were measured if the low level products are ignored. In real-life situations and normal antennas, these low level products are masked by band noise except perhaps on the highest bands. These dynamic range figures are similar to other direct sampling radios using 16-bit ADCs and only bettered by the highest performing radios with superhet-based frontends. This is where the K4HD should score when available.

The reciprocal mixing phase noise figures are extremely good, slightly better than the K3S and only bettered close-in by the FTDX101. This allowed the channel filter skirts to be measured down to –80dB. At this level, the filter skirts are widening significantly and prevented measurement of reciprocal mixing at 1kHz offset. On really strong CW signals, bleed through into the opposite sideband can be heard.

The transmitter results are given for the power control set to maximum at 110W. Intermodulation products improve slightly at the 100W level. The speech compressor significantly worsens the third order products but the wideband products remain unchanged. The CW rise and fall times measured about 4ms with minimal distortion but with a slight lengthening of characters more noticeable at higher speeds. There are no first character problems with shortening

On screen keyboard display.

or power overshoot at any level. Full and semi-break-in give the same results. There is a menu-settable delay on keying (5-25ms) to allow for linear amplifier switching and the RF is correctly sequenced. The transmit composite noise output is very good but not quite as low as the K3S.

On-the-air performance

Initial impressions on using the radio for the first time are very positive with its colourful eye-catching display and user-friendly layout. It is a radio that needs some time to fully appreciate all its features and time spent learning how to use and access the various functions is essential. If you are a previous K3 user, the learning phase will be shorter as many of the controls are similar in concept and use. The introductory manual is a good first start but the full operating manual is quite clumsy to use. I found this more convenient to access as a pdf file on a separate PC rather than on the display. Another source of information and user help is to join the K4 Groups.io email group. This is a very active group and a great source of information and help from real experts. Elecraft founders Wayne Burdick, N6KR and Eric Swartz, WA6HHQ actively pursue issues and the Elecraft team address updates to the firmware when needed.

It takes 25 seconds from switching on before the radio is ready to use. Also there is a short delay of 6 seconds when switching off. I also noticed a slight delay responding to some key presses and a 5 second delay when headphones are unplugged before audio returns to the loudspeaker.

Once through the learning phase I found the radio is easy and a delight to use. The controls are well laid out, are of a good size and the tuning drives are excellent. The display is stunning and the panadapter screens are very clear and easy to use. They can show a large and accurate display range of over 100dB and can view signals well down to the noise floor. Although the touch-screen operates well, I generally preferred to use a mouse to access the display functions as it is more accurate to position than a finger. An external display screen can also be very helpful and this can display different information from the display on the radio, in particular different panadapter views.

In terms of performance the receiver was superb, quiet, yet sensitive and clean sounding with no trace of overload on strong signals. The audio quality was good particularly with headphones. The internal speaker was acceptable but somewhat restricted on bass response and I noticed some resonances on CW. Clean sounding results were achieved down through the broadcast bands to 100kHz. The filtering functions, notches, noise blanker and noise reduction all performed well and as expected. The CW filters were excellent; there was minimal ringing right down to 50Hz bandwidth, although skirt width might be an issue.

I was particularly impressed with the audio effects when used with headphones. Pitch mode on CW was very effective at spatially spreading the audio with multiple signals or QRM within the passband. Delay mode on SSB created an interesting presence to the signal. Difficult to describe, it needs to be heard to appreciate.

On transmit, the audio quality was good using an Elecraft MH2 microphone and can be tailored to suit needs. The compressor added some punch but was not particularly effective. CW QSK was very effective, very quiet with no changeover relays and clean in operation. The fans are very quiet, only operating when the heatsink temperature rises and with four speeds. I never experienced the fans operating at the higher speeds.

I connected the radio to my PC using the USB interface with no problems and used it with my main station log, Logger32. It also connected to WSJT-X and I had it running on FT8 with the audio lines connected via USB virtual COM ports.

During the course of this review there were two firmware upgrades released, R26 being the latest. These are very easy to install, simply by connecting the radio by Ethernet to your home router, or as in my case via the Ethernet port on a Wi-Fi range extender, and push the relevant buttons on the radio to install. That's it, no additional software needs to be installed or downloaded. Alternatively the firmware can be upgraded by downloading from the Elecraft website to a memory stick and installing via USB.

Conclusions

The K4 is indeed a very impressive radio. An excellent performer with very well implemented functions and a superb display, it is destined to take over from the K3S as the radio of choice for many DX enthusiasts, DXpeditions and contest stations. With some of the functions and features still to be finalised, it promises a great future. Still with a significant backlog of orders, Waters & Stanton is the UK agent, with prices starting around £4250 inclusive of VAT.

Acknowledgements

I would like to express my gratitude to Waters & Stanton for the loan of the Elecraft K4D for review.

First UK Demonstration

In September 2019, Eric Swartz, WA6HHQ gave the very first UK demonstration of the K4 at the premises of Waters & Stanton Ltd in Portsmouth. He then went on to demonstrate the K4 at the National Hamfest later that month. You can view a video of his talk on the Waters & Stanton YouTube channel, www.youtube.com/watch?v=r-PHL68WIdg&t=590s.

In 2020, Eric was the keynote speaker at the Online RSGB Convention. You can view that talk about the origins of Elecraft and the development of the K4 at www.youtube.com/TheRSGB.

Elecraft K4D Measured Performance

Receiver measurements

	Sensitivity SSB 10dBs+n:n			
Frequency	Preamp Off	Preamp 1	Preamp 2	Preamp 3
1.8MHz	2.0µV (-101dBm)	0.63µV (-111dBm)	0.35µV (-116dBm)	-
3.5MHz	2.0µV (-101dBm)	0.63µV (-111dBm)	0.35µV (-116dBm)	-
7MHz	1.3µV (-105dBm)	0.40µV (-115dBm)	0.22µV (-120dBm)	-
10MHz	1.4µV (-104dBm)	0.40µV (-115dBm)	0.20µV (-121dBm)	-
14MHz	1.3µV (-105dBm)	0.32µV (-117dBm)	0.22µV (-122dBm)	-
18MHz	1.6µV (-103dBm)	0.56µV (-112dBm)	0.82µV (-118dBm)	-
21MHz	1.8µV (-102dBm)	0.70µV (-110dBm)	0.40µV (-115dBm)	-
24MHz	3.2µV (-97dBm)	0.90µV (-108dBm)	0.22µV (-120dBm)	0.09µV (-128dBm)
28MHz	2.2µV (-100dBm)	0.70µV (-110dBm)	0.32µV (-117dBm)	0.10µV (-127dBm)
50MHz	4.0µV (-95dBm)	0.90µV (-108dBm)	0.40µV (-115dBm)	0.13µV (-125dBm)

Max audio at 1% distortion: 1.3W into 4Ω
Inband intermodulation products: better than -60dB

Bandwidth	Bandwidth			
Set To	-6dB	-60dB	-70dB	-80dB
USB 2.4kHz	2434Hz	2759Hz	2786Hz	5922Hz
CW 500Hz	495Hz	813Hz	839Hz	867Hz

	Reciprocal Mixing Dynamic Range 500Hz Bandwidth	
Frequency Offset	7MHz	21MHz
1kHz	see text	not measured
2kHz	116dB (-143dBc/Hz)	115dB (-141dBc/Hz)
3kHz	117dB (-144dBc/Hz)	116dB (-143dBc/Hz)
4kHz	119dB (-146dBc/Hz)	118dB (-147dBc/Hz)
5kHz	120dB (-147dBc/Hz)	119dB (-149dBc/Hz)
10kHz	125dB (-152dBc/Hz)	122dB (-151dBc/Hz)
15kHz	128dB (-155dBc/Hz)	123dB (-151dBc/Hz)
20kHz	129dB (-156dBc/Hz)	124dB (-151dBc/Hz)
30kHz	ADC overflow	125dB (-151dBc/Hz)
50kHz	ADC overflow	ADC overflow

Transmitter measurements

			Intermodulation Products wrt PEP	
Frequency	Max CW Power Output	Harmonics	3rd order	5th order
1.8MHz	114W	-55dB	-32dB	-36dB
3.5MHz	122W	-62dB	-34dB	-36dB
7MHz	121W	-70dB	-34dB	-36dB
10MHz	121W	-70dB	-48dB	-35dB
14MHz	120W	-50dB	-32dB	-39dB
18MHz	119W	-75dB	-32dB	-38dB
21MHz	119W	-75dB	-32dB	-42dB
24MHz	121W	-75dB	-32dB	-35dB
28MHz	120W	-80dB	-43dB	-36dB
50MHz	103W	-80dB	-27dB	-38dB

Intermodulation product levels are quoted with respect to PEP

Frequency Offset	Transmit Composite Noise 7MHz 100W O/P	Transmit Composite Noise 21MHz 100W O/P
1kHz	-74dBm/Hz (-124dBc/Hz)	not measured
2kHz	-80dBm/Hz (-130dBc/Hz)	not measured
3kHz	-87dBm/Hz (-137dBc/Hz)	not measured
4kHz	-90dBm/Hz (-140dBc/Hz)	not measured
5kHz	-91dBm/Hz (-141dBc/Hz)	-82dBm/Hz (-132dBc/Hz)
10kHz	-91dBm/Hz (-141dBc/Hz)	-83dBm/Hz (-133dBc/Hz)
15kHz	-91dBm/Hz (-141dBc/Hz)	-83dBm/Hz (-133dBc/Hz)
20kHz	-94dBm/Hz (-144dBc/Hz)	-87dBm/Hz (-137dBc/Hz)
30kHz	-96dBm/Hz (-146dBc/Hz)	-89dBm/Hz (-139dBc/Hz)
50kHz	-98dBm/Hz (-148dBc/Hz)	-91dBm/Hz (-141dBc/Hz)
100kHz	-99dBm/Hz (-149dBc/Hz)	-91dBm/Hz (-141dBc/Hz)

Microphone input sensitivity: 0.7mV for full output
Transmitter AF distortion: generally less than 0.1%
FM deviation: as per menu set
SSB Data T/R switch speed: mute-TX 24ms, TX-mute 5ms, mute-RX 40ms, RX-mute 5ms

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