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Product Review

Elecraft K4D HF/6M SDR Transceiver

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I must admit from the start that I have been an enthusiastic owner of a K3 (and P3 panadapter) for many years and have a level of familiarity with, and a cautious appreciation for, the Elecraft approach to the user interface. I was so eager to try the new K4 that I offered to review the unit. Like many other new K4 owners, ARRL placed an order in the fall of 2019 and began a nearly 2-year wait for our K4 to arrive.

The sound quality of the K4 is improved for both SSB and CW, as one would expect from Elecraft, with their legacy of incremental improvements and upgrades to both the K3 and K3S. The K3S was a total upgrade of the K3, and the K4 can be considered in a similar way — plus the inclusion of the P3! The performance of this radio exceeds that of its predecessors by nearly every measure and is confirmed in the various performance measurements. Elecraft has not only improved the performance on all modes, but they have added new features, too.

We received the K4 in mid-September 2021, and our Lab staff dutifully took the brand-new radio out of the box and began performing our standard battery of tests. Everything seemed to work as one might expect, and no anomalies were initially noted (more on this later). Most of these objective tests measure specifications to see if they match the manufacturer's claims, and that is standard for each category of radios. You will find the results side by side with the manufacturer's specifications in Table 1. These tests are not subjective operational evaluations for the most part.

Description

My first observation was that the K4 combines both the K3S and P3 into a single lightweight unit (~10 lbs), which is still relatively small compared with other radios in the K4's performance class. Not coincidentally, it is the same size as the matching Elecraft KPA1500 linear amplifier reviewed in the March 2019 issue of *QST*.

The K4 is a direct-sampling software-defined radio (SDR) with a more advanced signal processing compared with the K3S and P3. It includes a modular hybrid architecture, making the K4 hardware upgradable from the basic model to the higher-end version, the K4HD. Future hardware implementations are anticipated, like an internal VHF/UHF module (not available at the time of this review). Because it's an SDR, new software is also modular, and many upgrades are to be expected. Keep in mind that the automatic antenna tuner (ATU) is an option for any of the K4 models.

This radio is modern, featuring high-tech capabilities like a full remote control via its integrated Ethernet port without any need for an external PC. The internal display can be projected on an external monitor, and it's 4K! The displays on the K3 and K3S predecessors were utilitarian and efficient, but this new display is beautiful in addition to being even more useful.

Bottom Line

The Elecraft K4 is a high-performance, HF/6-meter SDR with a user interface that feels both familiar and modern. Its modular hardware and software architecture open up many possibilities for future add-ons, so what we see is only the beginning.

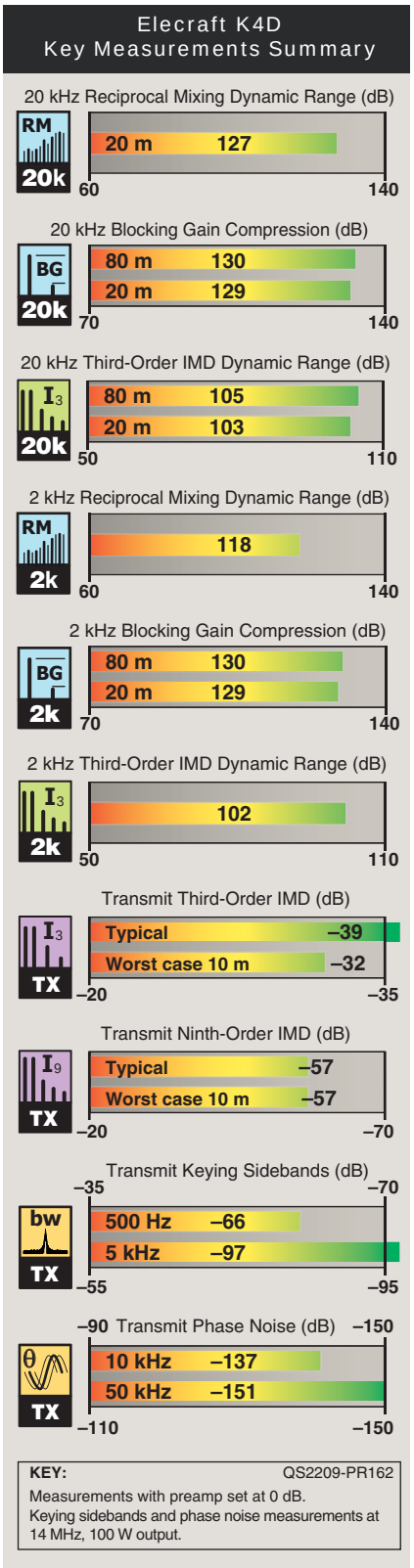

Table 1
Elecraft K4D, Serial Number 0305, Firmware Version R30

Manufacturer's Specifications

Frequency coverage: Receive, 0.100 – 54 MHz; transmit, 160 – 6-meter amateur bands.

Power requirement: 11 – 15V dc. XMIT, 4 – 24A; RX, 2 – 3A

Modes of operation: SSB, CW, AM, FM, data. Text modes: CW, PSK31/63, RTTY

Measured in the ARRL Lab

98.943 kHz – 54 MHz. Transmit, 160 – 6-meter amateur bands; 60 m, 5.0 – 5.6 MHz

At 13.8 V dc: Transmit, 21.5 A (typical), at maximum RF power output; 3.8 A at minimum RF output; Receive, 2.5 A. Power off, <1 mA

As specified.

Receiver*

SSB/CW sensitivity: 0.1 – 23 MHz, Pre 0/1/2, –118/–128/–135 dBm; 23 – 54 MHz, Pre 0/1/2/3, –118/–128/–135/–141 dBm

Noise figure: Not specified.

AM sensitivity: Not specified.

FM sensitivity: Not specified.

Spectral sensitivity: Not specified.

ADC overload level: +8 dBm, preamp off.

Blocking gain compression dynamic range: Not specified.

Reciprocal mixing dynamic range: Not specified.

Receiver Dynamic Testing

Noise floor (MDS), 500 Hz bandwidth.†

Preamp	*Off*	*1*	*2*	
0.137 MHz	–117	–120	–125	dBm
0.475 MHz	–119	–130	–134	dBm
1.02 MHz	–120	–131	–136	dBm
3.5 MHz	–118	–129	–134	dBm
14 MHz	–120	–131	–137	dBm
Preamp	*Off*	*1*	*2*	*3*
50 MHz	–119	–130	–140	–145 dBm

Preamp off/1/2,14 MHz: 27, 16, 10 dB
Preamp off/1/2/3, 50 MHz, 28, 16, 7, 2 dB

10 dB (S+N)/N, 1 kHz tone, 30% modulation, 5 kHz BW:†

Preamp	*Off*	*1*	*2*	
1.02 MHz	4.7	1.4	0.73	µV
3.88 MHz	6.5	1.7	0.94	µV
Preamp	*Off*	*1*	*2*	*3*
50.4 MHz	7.1	1.8	0.65	0.30 µV
29.4 MHz	5.6	1.5	0.67	0.33 µV

For 12 dB SINAD, 3 kHz deviation, 20 kHz BW:†

Preamp	*Off*	*1*	*2*	*3*
29.0 MHz	2.3	0.64	0.28	0.13 µV
52.0 MHz	2.9	0.77	0.27	0.12 µV

Panadapter and waterfall display: 14 MHz, –140 dBm; 50 MHz, –145 dBm (maximum sensitivity).

As specified.

Blocking gain compression dynamic range, 500 Hz BW:*

	20 kHz offset	*5/2 kHz offset*
	Preamp 0/1/2	*Preamp 0*
3.5 MHz	130/132/130	130/130 dB
14 MHz	129/128/126	129/129 dB
50 MHz	*Preamp 0/1/2/3*	*Preamp 0*
	129/129/128/125	128/128 dB

14 MHz, 20/5/2 kHz offset: (Preamp 1) 127/121/118 dB

ARRL Lab Two-Tone Intermodulation Distortion (IMD) Testing (500 Hz bandwidth)

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz/0	20 kHz	–117 dBm	–12 dBm	105 dB
		–97 dBm	–4 dBm	
		–86 dBm	0 dBm	
14 MHz/0	20 kHz	–120 dBm	–17 dBm	103 dB
		–97 dBm	–10 dBm	
		– 70 dBm	0 dBm	
14 MHz/1	20 kHz	–129 dBm	–25 dBm	104 dB
		–97 dBm	–14 dBm	
14 MHz/2	20 kHz	–134 dBm	–30 dBm	104 dB
		–97 dBm	–17 dBm	
14 MHz/0	5 kHz	–120 dBm	–18 dBm	102 dB
		–97 dBm	–10 dBm	
		–70 dBm	0 dBm	

Manufacturer's Specifications — Measured in the ARRL Lab

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
14 MHz/0	2 kHz	–120 dBm –97 dBm –70 dBm	–18 dBm –10 dBm 0 dBm	102 dB
50 MHz/0	20 kHz	–114 dBm –97 dBm –74 dBm	–8 dBm –4 dBm 0 dBm	106 dB
50 MHz/3	20 kHz	–145 dBm –97 dBm	–42 dBm –27 dBm	103 dB

Second-order intercept point:* Not specified.	Preamp 0/1/2 14 MHz, +83/+83/+83 dBm Preamp 0/1/2/3 50 MHz, +85/+85/+21/+23 dBm
DSP noise reduction: Not specified.	No signal, 14 dB; S5 signal, 12 dB S3 signal, 8.5 dB
FM adjacent channel rejection: Not specified.	Preamp 0/2/3/3, 94/95/94/95 dB Preamp 0/1/2/3, 94/95/92/94 dB
FM two-tone third-order IMD dynamic: range: Not specified.	20 kHz offset: 29 MHz, Preamp 0/1/2/3: 94/95/94/95 dB†† 50 MHz, Preamp 0/1/2/3: 94/95/92/94 dB†† 10 MHz offset: 29 MHz, Preamp 0/1/2/3: 101/99/101/100 dB†† 52 MHz, Preamp 0/1/2/3: 106/106/104/106 dB††
Squelch sensitivity: Not specified.	FM, preamp 2, 29 MHz, 0.3 µV to 24 µV; preamp 3, 52 MHz, 0.1 µV to 10.1 µV.
S-meter sensitivity: Not specified.	S-9 signal: Preamp 0/1/2, 14 MHz, 51, 51, 56 µV Preamp 0/1/2/3, 50 MHz, 61, 50, 56, 46 µV Scaling: 6 dB per S-unit.
Notch filter depth: Not specified.	Tunable notch filter, normal, 25 dB; Auto-notch, 48 dB.
IF/audio response: Not specified.	Range at –6 dB points: Unit performed as specified at all bandwidth settings.
Receive processing delay time: Not specified.	8 ms,††† 35 ms.

Transmitter — Transmitter Dynamic Testing

Power output: 1 – 100 W (AM, SSB, CW, FM)	SSB, CW, FM, AM: As specified.
RF power output at minimum specified.	At 11.0 V dc: HF, 79 W; 50 MHz, 72 W.
Spurious-signal and harmonic suppression: standards. >50 dB, >60 dB on 6M.	As specified. Complies with FCC emission.
Third-order IMD products: Not specified.	3rd/5th/7th/9th order, 100 W PEP: –39/–37/–47/–57 dB (HF typical) –32/–35/–47/–57 dB (worst case, 10 m) –42/–35/–45/–70 dB (50 MHz) At 50 W RF output: –35/42/57/63 (14 MHz) –35/38/63/60 (50 MHz)
CW keyer speed range: Not specified.	8 to 100 WPM, iambic mode A & B.
CW keying characteristics: Not specified.	See Figures A and B.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast, SSB, 25.8 ms.
Receive-transmit turnaround time (TX delay): Not specified.	SSB, 25.2 ms; FM, 12.0 ms.
Transmit phase noise: Not specified.	See Figure C.
Amplifier key line closure RF output: Selectable, 5 to 25 ms.	As specified. As set by TX DLY menu setting.

Size (height, width, depth, inclu. protrusions): 4.5 × 13.5 × 10 inches; weight, 10 lbs.

*Second-order intercept points were determined using S-5 reference.
†Dynamic-range optimization off.
††Measurement was noise limited at values shown.
†††CW/QSK mode (stored DSP pipeline audio).

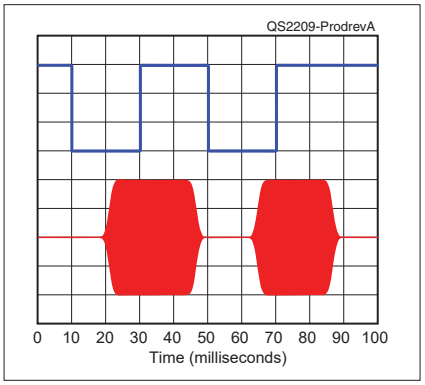

Figure A — A CW keying waveform for the Elecraft K4D showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output on the 14 MHz band, using QSK set to 8 ms. The first-dit rise time is 2.6 ms and the fall time is 2.8 ms. The second-dit rise time is 2.7 ms and the fall time is 2.4 ms. The first-dit on delay is 11.1 ms; off delay, 17.7 ms. The second-dit on delay is 14.2 ms; off delay, 17.7 ms.

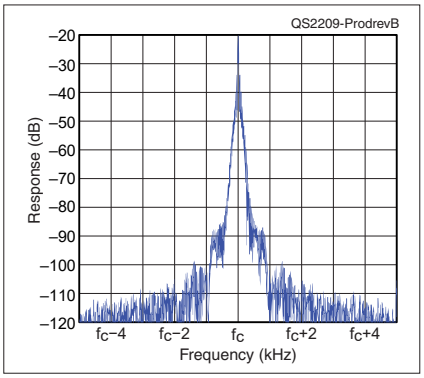

Figure B — The spectral display of the Elecraft K4D transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying and the default rise time setting. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 100 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

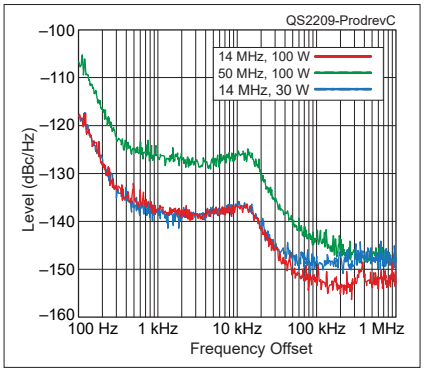

Figure C — The spectral display of the Elecraft K4D transmitter output during phase-noise testing. Power output is 100 W on the 14 MHz band (red trace), 30 W on the 14 MHz band (blue trace), and 100 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows phase noise 100 Hz to 1 MHz from the carrier. The reference level is –100 dBc/Hz, and the vertical scale is 10 dB per division.

You can also organize the screen layouts independently for the internal and external displays. You can connect a keyboard and mouse, wired or wireless (with a dongle), directly on one of the radio USB type-A ports (one in the front, two in the back) and use the mouse instead of the touchscreen, or use both if you wish. It also has a USB type-B port to connect to a computer, which can be used for digital modes and CAT control. It has an RS-232 COM port as well.

The keyboard connected to the K4 can be used to operate text modes directly on the unit. It currently supports CW, PSK31/63, and RTTY.

The radio rear panel (see Figure 1) includes many ports, and some are not accessible unless you have the corresponding hardware module installed. Please consult the product manual for more information.

For more details you can download the K4 manuals from the manufacturer's website (**https://elecraft.com/pages/k4-high-performance-direct-sampling-sdr-manuals**).

Please note that the reviewed version was the K4D.

The Centenary of the Transatlantic Tests Event

Coincidentally, we had a significant operating event coming up at W1AW in cooperation with the Radio Society of Great Britain (RSGB), and it was decided that we would use our new K4 to make some commemorative QSOs for the centenary of the Transatlantic Tests, held in early December 2021, 100 years after the original Transatlantic Tests. For more information about this event, visit **www.arrl.org/transatlantic**.

The Lab staff did not report any issues with the K4, so it was quickly pressed into service in this very visible role. Why so visible? Well, we wanted to stream the operation on the internet and offer greater visibility for this important anniversary event. The K4 has new unique capabilities for separate fixed-level audio and video (HDMI) outputs that allowed us to integrate the actual video from the K4 into the streaming of the event without having any impact on the on-the-air operation, or to use a camera to show the radio's front panel. It worked well and looked great, as you can see in the video at **https://youtu.be/Xe-QilwudTc.**

The transatlantic event was a strictly 160-meter CW event, so the use of the K4 was considered ideal, along with being a "made in the USA" radio. This was in homage to the good-natured UK versus USA competitive tone of the original transatlantic challenge.

Figure 1 — The Elecraft K4D rear panel.

Operating the K4D

The K4D is probably not a radio that should be recommended to a beginner without plenty of mentoring. While it can do most of the things you might want, understanding how to orchestrate all of the options will take some thought and planning.

In order to streamline becoming familiar with the K4, I strongly recommend viewing the videos on the Elecraft YouTube channel (**https://youtube.com/c/ElecraftChannel**). You'll gain a better understanding of the radio's operation and more details on the new feature set in the K4. In one of them (K4 Demo & Q&A), Eric Swartz, WA6HHQ, one of the cofounders of Elecraft, provided a comprehensive introduction to the K4's new features, which proved invaluable later. Eric included a discussion of some features not yet implemented in the current version of the firmware. He showed the message displayed ("Implementation in Progress") when a user attempts to access one of those future capabilities, as shown in Figure 2. This was a good thing to know when using the K4 in our transatlantic commemoration event, as we would find out later.

While different from many other radio brands, Elecraft's logical approach, once mastered, makes a great deal of sense for efficient operation. The K4 is still a bit larger than the K3, but about 4 inches narrower than the K3/P3 combination. The new display on the K4 is pleasing, with a color touchscreen and high-performance visual interface. As it was observed in the review of the K3S, the user interface was "not the easiest to learn" (see the reviews of the K3 and K3S in the April 2008 and January 2009 issues of *QST*, respectively). The K4's new touchscreen addresses much of that learning curve using visual cues and reminders. The high-resolution screen, along with the intelligent use of multi-function buttons adjacent to the screen, works extremely well and makes many of the frequently accessed parameters easily within reach.

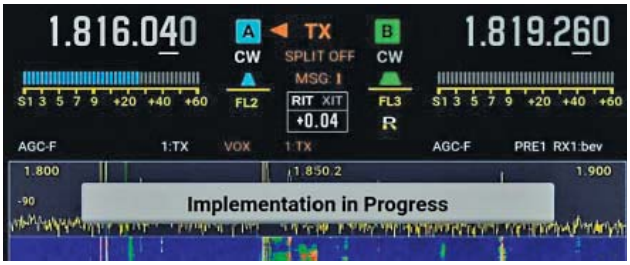

Figure 2 — The Elecraft K4D showing the message, "Implementation in Progress," when a user attempts to access one of those future capabilities not yet implemented.

Many of the functions available on the touchscreen (see Figure 3) are also available on discrete buttons located elsewhere on the front panel. This gives you options for controlling the K4. On the multi-function buttons, the functions can vary on each button depending on the mode of operation, but the labels make their primary and alternative functions very clear.

The DSP filtering in the K4 is on par or better than the crystal filters in the K3. Elecraft has announced an upgraded version of the K4D, the K4HD, which will have a dual superheterodyne module, with two crystal filters for each of its two receivers — one for SSB/data bandwidth and one CW. At the time of this review the availability and price are still pending.

Firmware Updates

During the event, and to our surprise, it became apparent that the firmware in our new K4 needed to be updated to enable a routine feature of RF gain. Yes, it's a simple feature, but its lack of presence was not noticed until this critical time. The K4 apparently had a firmware in it that was useful for performing initial manufacturing tests but didn't enable all of the radio's standard functions. In the urgency to operate the transatlantic event, the original firmware version was not noted. However, as Elecraft says in the new, "fully illustrated" manual, "since the K4 is an SDR, Elecraft can provide updates to its signal processing algorithms with software changes rather than by adding new hardware." This is an understatement. The upgrade process is easy and only took a few minutes, even during the heat of the battle. After the quick and successful upgrade, we finished the rest of the event, with RF gain fully functional and working as expected. Lesson learned. A good thing to do is to check the version of firmware in your brand-new radio and update it to the latest production version to make sure you have all of the latest features enabled. The lab tests were redone with the latest firmware version at the time of this review.

Figure 3 — The Elecraft K4D 7-inch color touchscreen.

Not long after the RF gain experience, there was talk about a new beta firmware to be released, which was purported to be significant enough to delay our review of the K4, and it did.

Technical Support

In addition to occasional updates from the factory, daily support for users of Elecraft radios is provided by individuals who work for Elecraft and many others who are not in their employ but instead are essentially volunteers helping out other Elecraft radio owners. In the weeks since this all transpired, there have been thousands of individual messages posted on the multiple lists supporting Elecraft products or the K4 specifically.

Users post exhaustive guides on how to accomplish many different functions. This was true of the K3 and is also now true of the K4. To my knowledge, no other modern radio has this level of knowledgeable community support and benevolent sharing of learned operational knowledge. It is something for which a potential purchaser should plan on signing up in order to get the most value from their investment in a world-class transceiver like the K4. In addition to these in-depth guides, much more fundamental support is readily available, as well, through the various email reflectors and support groups.

As we found, the K4 follows the traditions established by the K3 and K3S of making incremental improvements over time, primarily through firmware upgrades. From time to time, Elecraft offered upgraded circuit boards, and ultimately, they did a complete hardware overhaul of the K3 that resulted in the K3S. Is there a K4S on the horizon? Perhaps. In the meantime, you can keep your K4 up to date via the fully automated firmware update process.

Lab Notes

The state-of-the-art technology and constantly improving performance of the Elecraft K4D kept me busy in the ARRL Lab! Table 1 and the Key Measurements Summary show consistently "green" performance across the board.

In January, the ARRL Board of Directors approved the "Clean Signal Initiative" program, to set a high standard of transmitter performance to help clean up the bands from transmit IMD splatter, key clicks, and transmitted phase noise, to name a few examples. Although the program is not yet ready to feature the K4D under its banner, performance such as the third-order transmit IMD and 5 kHz spacing keying sidebands is stellar.

The SDR implementation is also state-of-the-art, with the use of bandpass filters in the receive chain to help the receivers work well in multi-transmitter environments. The design makes use of multiple FPGAs and multiple DSP chains to implement or improve functions like diversity reception and strong-signal performance. For more information about the design, see **https://Elecraft.com** for details.

Notably, Elecraft has implemented controlled-envelope single sideband compression to greatly enhance talk power. This was first described in an article by David Hershberger, W9GR, in the November/December 2014 issue of *QEX*. The Lab's preliminary measurements showed an impressive increase in talk power of about 8 dB. This is the equivalent of adding a 500 W amplifier to a 100 W transmitter, without the increase in the electricity bill.

Conclusion

Overall, the K4 is a fine radio as it is, especially with the current firmware revisions. Improvements, refinements, and other new capabilities are likely to become available periodically. Staying in touch with Elecraft support groups is recommended in order to keep up with new capabilities and for the latest news on new features in development. The Elecraft staff members listen to their users, and you may even end up contributing to the future developments of the K4 through your comments and observations.

The transatlantic event was a lot of fun for those on both sides of the pond. We installed a North East Beverage receiving antenna just for this event, and being able to switch between it and the high dipole at 120 feet was very useful. Stations in Europe that we could not detect on the transmit antenna were easily copied on the Beverage. They do work. The K4 lets you switch numerous antennas from the front panel controls.

Manufacturer: Elecraft, Inc., 125 Westridge Dr., Watsonville, CA, 95076, **www.elecraft.com**. Price: K4D (reviewed model), $5,499.95; different versions of the K4 are also available starting at $3,599.95. The K4HD price is to be announced.