NCJ Reviews: The Elecraft K3 — First Impressions

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At the International DX Convention in Visalia earlier this year, Elecraft, **www.elecraft.com**, unveiled one of the best-kept secrets in ham radio manufacturing history — its new K3 transceiver! Although the Elecraft faithful for years have opined profusely on the company-sponsored e-mail reflector about hypothetical future products, even suggesting the unsurprising name "K3," as far as I can tell, not a word leaked out from the company or from its in-the-know advisors during the radio's three year gestation period.

Those advisors — about a dozen "focus group" members — include several avid contesters. We made our 'druthers very well known during the requirements specification and design phases, and off and on through the rest of the project. Field input has always been important

to Elecraft, and high-performance contesting definitely became a design point of the nascent K3. As the radio approached production release, contesters from the focus group were among the most vocal and vigorous field testers.

This article describes the radio from a contester's perspective and presents my initial impressions from participating in the field test. To meet *NCJ*'s deadline, I had to submit this review before field testing actually ended. The QRP test radio lacked the 100 W power amplifier, but it drove an Alpha 87A to 250-600 W depending on the band. The test unit also had no sub-receiver or noise blanker. The lack of a noise blanker presented a problem at times, but Elecraft has promised an NB for initial-production radios.

Many software features were in pre-

liminary form or not yet implemented, so this is, of necessity, just a first look. In some cases I refer to promised features in the present tense because Elecraft has committed to include them. Others I explicitly note as futures. Because this is a software-defined radio (SDR), the performance and feature set of production units may vary from what I report. Check back here and elsewhere in the coming months for updated comments and for lab test results on production units.

Releasing the K3 into the Amateur Radio marketplace will not be the end of the story. Elecraft plans a series of new features and improvements over the coming years, and you'll be able to download them to the radio in minutes via the Internet and your PC. There is *plenty* of unused program memory, so

Block diagram of the K3

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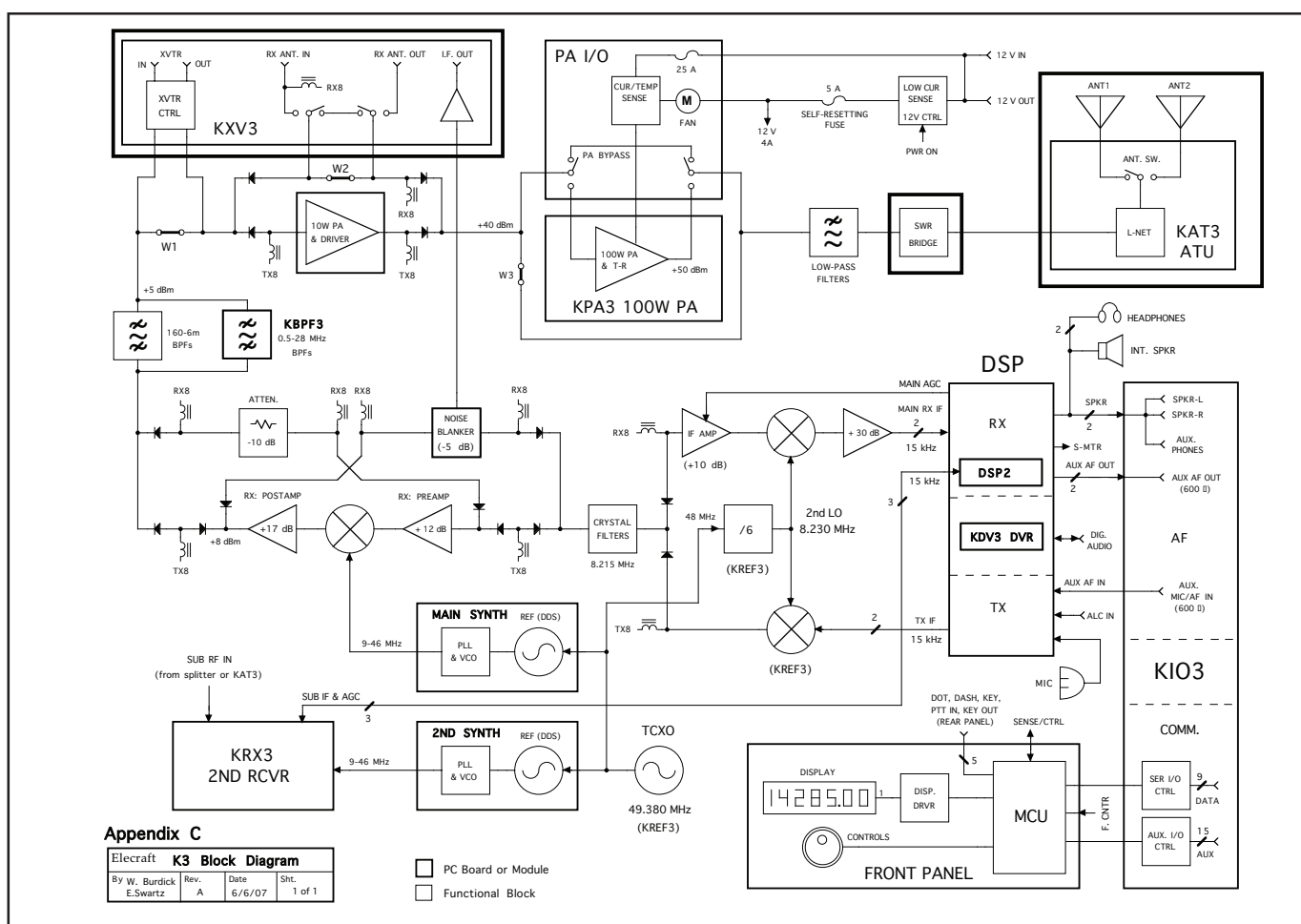
The K3 front panel
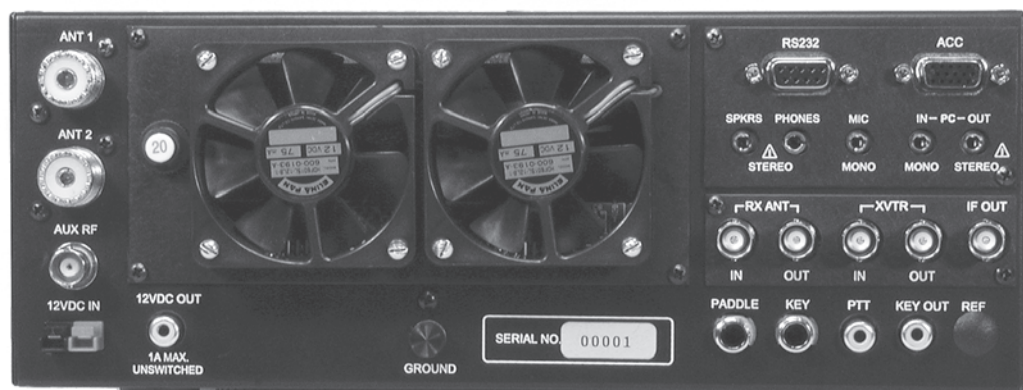
The K3 rear panel

Elecraft will not be limited in the scope of future improvements.

Design

Not at all an upgraded K2, the K3 is an entirely new radio and a new manufacturing concept. Whereas the K2 is an inexpensive, digitally-controlled, analog radio in kit form, the K3 is a mid-priced, factory-built digital radio with some interesting analog stages. While the K2 was born out of the QRP movement and later acquired an add-on 100 W amplifier and digital signal processing (DSP), Elecraft is introducing the K3 with a full complement of bells and whistles. Although it is available as a semi-kit — a box of manufactured boards and cabinetry that the purchaser can assemble without need of a soldering iron — the factory-built and factory-aligned boards assure that every radio will have identical performance and reliability expectations. The only tools required are a dummy load, Philips screwdriver and digital multi-meter.

Why did Elecraft deviate so radically from its kit-building roots? Some of the faithful were disappointed to learn that their soldering irons would sit idle during K3 assembly. Elecraft explains convincingly that its design goals were unachievable without using specialized components available only as surface-mount devices (SMD). The K3 uses enough SMDs (60%) that construction by most amateurs would be impractical.

In some prior small kits, Elecraft installed a few SMDs and let builders stuff the through-hole components. For an item as complex as the K3, this would make testing impractical at best — and probably inadequate. Therefore, it chose early on to implement the semi-kit concept that accommodates people's desires to assemble and understand the radio without compromising cost, performance, reliability or size.

Contesters can expect consistent operation, performance and reliability from all similarly-equipped K3s, plus a steady flow of innovation that they can download to upgrade their radios in the future. Solder jockeys can take heart that the K2 is not going away. It retains a prominent position in Elecraft's product lineup — still the hands-down champion of kit radios and still a contender for receiver performance honors.

The main contribution of the semi-kit aspect of the K3 has been to support the tradition of modularity the K2 pioneered. Elecraft offers no fewer than eight significant options for the K3 plus various plug-in filters and accessories. Primary options are the 100 W PA, automatic antenna tuner and full-clone second receiver. You can buy the K3 fully assembled, tested and aligned with your initial choice of options, and install more options yourself later. Or you can assemble it yourself in an estimated build time of six to eight hours. All field test units were factory assembled, so I haven't had that pleasure. If I buy a second K3, I'll enjoy assembling it myself.

Like the K2, the K3 receiver uses a low intermediate frequency (IF), avoiding up-conversion to a high IF where roofing filters must be relatively wide. But that's about where the similarity ends. The K3 is definitely a software-defined radio: Although it is fully functional without a general-purpose computer, its in-

N6XI operating the K3 in the 2007 IARU HF contest

ternal DSP handles all signal demodulation, and that, to my mind, makes it an SDR. The signal flow starts with ham band or optional general coverage bandpass filters, then mixes with a PLL local oscillator to produce the 8.215 MHz IF signal. That goes to selectable crystal roofing filters as narrow as 200 Hz, mixing down to 15 kHz for the DSP.

The 32-bit DSP implements adjustable filters using finite impulse response (FIR) algorithms at RF and infinite impulse response (IIR) algorithms at audio. It performs multi-mode detection and modulation, noise reduction, noise blanking, single-carrier manual and multi-carrier automatic notch filtering and adjustable AGC. It automatically switches analog roofing filters and implements audio filters to fit the DSP bandwidth, so the user only has to select passband width and position.

While the K2 relied solely on a switched bandwidth crystal filter plus an optional fixed-bandwidth filter on the SSB option board, the K3 relies on DSP filtering and provides plug-in slots for up to five roofing filters. These are the same well-regarded filters, mounted on a proprietary daughter board, that INRAD provides for the Yaesu FT-1000MP and other radios. By the way, the subtle filter tuning rituals required by the K2 are unnecessary with the K3; its filters are nearly plug-and-play.

Additional analog accompaniments to the DSP include a hardware noise blanker and supplementary AGC that cuts in only when extremely strong signals might overload the DSP. There is a microphone preamplifier ahead of the DSP's 8-band equalizer. It should be possible to use almost any microphone, including electrets powered via the transceiver's microphone jack. I used Heil's HC-4 "contest" and iC electret elements with no difficulty and received unsolicited reports of excellent audio.

The *QST* product review will report laboratory measurements of this new radio. In club presentations and preliminary specifications on its Web site, Elecraft highlights the K3's outstanding dynamic range, citing a third-order intermodulation distortion dynamic range of greater than 100 dB at 5 kHz spacing and in the low to mid-90s at 2 kHz spacing. That's comparable with anything else in the field.

Elecraft reports it's also measured best-of-breed blocking dynamic range of 140 dB at 5 kHz spacing. *Wow!* As this review went to press, final claimed specs were pending further testing.

Features

The little K2 remains a good contest rig, especially for expeditions and particularly on CW, but the K3 looks great on all modes. The substantially larger panel and display let Elecraft externalize functionality accessible only through menus in the K2 and add much more. The sub-receiver will make split operation, essential on 40 meter SSB, a pleasure.

The K3 generates substantially lower phase noise, making it friendlier in multi-transmitter environments and radio-dense neighborhoods. Ed, WØYK, tested this informally and found that neighbor K6XX could copy weak signals within 5 or 6 kHz and heard nothing outside of 7 kHz.

In addition to CW and SSB, the K3 includes FM, PSK31/63, RTTY FSK and AFSK and, appropriately configured, generates true double sideband AM (few contesters will use all these modes!). Like the K2, the K3 has user-programmable buttons that can perform menu functions. At this writing, there can be up to 10 re-mappable keys. The K3 also has the potential — not yet realized in firmware — to re-map *rotary* controls.

You can toggle full-break-in (QSK) independently of setting semi-break-in delay, a welcome improvement. The QSK provides true between-dots receive at high speed, and the operator can adjust rise and fall times too. You can upload and download personal configurations to store backups and unlimited individual operator preferences.

The K3 filter scheme is everything this writer wanted but didn't get in the K2. Front-panel knobs manage the DSP filters. We get the familiar WIDTH and SHIFT so helpful for CW operation and also the HIGH CUT and LOW CUT that are more natural on SSB. Two shared-function encoders perform this magic, and adjacent LEDs indicate their current functions. The radio's firmware defaults them by mode, but you can override that selection as conditions dictate. The display offers a graphical representation of approximate passband width and position.

The K3 has functional polish that the K2 lacks. For example, it contains a mic preamp and 8-band equalizer, enabling quality transmit audio customized to match almost any microphone, voice and passband preference. For SSB, it includes a monitor, the best VOX I've ever used and flawless anti-VOX. The radio covers 160, 60 and 6 meters out of the box.

The RIT/XIT control is an encoder, complemented by a clear button. Offset display is transitory but three LEDs indicate minus-zero-plus at all times.

Tuning direction and CW sideband are uniform on all bands, and the sideband is reversible. There is a standard pin-out serial port for rig control and to download firmware upgrades via an attached PC. Other features include stable power output, two large quiet fans and planned voice annunciation for visually impaired operators. Dedicated buttons control the standard Morse and optional voice memory keyers, and the DVK can record incoming signals.

A welcome addition to the Elecraft bag of tricks is the optional second receiver. It is a full clone of the primary receiver with all the same capabilities, including its own five roofing filter slots, band-pass filters, preamp, attenuator and dedicated DSP. I ordered mine with wider, gentler roofing filters than the main receiver because I like to search for DX listen frequencies that way, but you can configure the two receivers identically if you wish. The VFO controls (A>B, A/B, SPLIT) function identically with or without the second receiver, which uses VFO B settings when it is enabled. VFO B retains its own mode, pass-band shape and filter settings. The receivers are phase locked, which should be an advantage in diversity reception.

My test radio had the 8-pole 2.8 kHz SSB and 400 Hz CW roofing filters. Both were excellent, but 400 Hz is narrow for my taste, and I prefer something wider without having to switch to the SSB roofer. Wider filters are available, and I intend to try them. Thanks to the outstanding DSP filtering, the stock 5-pole filters may be all you need unless you live in "RF Alley" or have some other aggressive contesters in your neighborhood. Consider test flying the stock K3 before you order up a boatload of filters.

The automatic antenna tuner (ATU) fits inside the cabinet and continues the Elecraft tradition of relay-switched, fixed-value components. The rig remembers tuning settings and returns to them instantly as you switch bands. If you use the K3 to drive an amplifier, you can bypass the ATU or refrain from buying it in the first place.

Contesters may dismiss features like the tuning indicator and decode and display for CW and digital modes. The seven-character text display (VFO B area) is cool for casual QSOs but not what the RTTY contester needs, even with its scroll-back buffer. Similarly, although we may enjoy keying and monitoring in Morse without a keyboard while it comes out of the transmitter in digital mode, we won't use this competitively. On the other hand, passing out casual digital QSOs before and after a CW or SSB contest expedition without any auxiliary equipment or software is an intriguing added attraction. I know some no-code ops who might be enticed by the CW decode feature to pass out CW contest Qs, and it could make a viable code practice facility.

Ed, WØYK, and others worked diligently with Elecraft to ensure that the rig would excel as a RTTY contesting platform. A common user interface serves all digital modes including, at first, PSK31/63 and 60 WPM FSK/AFSK at several tones and shifts. It can also

copy CW and future modes are SMOP ("a simple matter of programming"). A single button selects the desired mode and appropriate parameters. The PITCH adjustment controls mark tone. As you narrow the bandwidth, the DSP switches automatically from a single filter bracketing both tones to separate filters around each tone. The MODE ALT button reverses sidebands for transmit and receive, and a programmable button can reverse the received signal alone for "upside down" copy. You can switch FSK input polarity and force LTRS and FIGS modes. Transformer-coupled LINE IN and LINE OUT connections to the sound card eliminate ground loop hum. In short, the K3 will be the most versatile digital mode radio ever offered, with an elegant user interface.

One popular feature notably missing from the compact K3 is a spectrum scope. There is simply no way to squeeze a useful panadaptor into a small panel that devotes adequate space for necessary controls (yes, I know, the IC-7000 pretends to do it, but it isn't very useful). Elecraft may offer an external bandscope accessory in the future. In the meantime, it's possible to feed the broadband IF output to a third-party panadaptor, or you can build your own based on SDR kits like Softrock from **AmQRP.org**. You need the KXV3 accessory for this, which also includes dedicated receive antenna and transverter I/O.

Integration

For contesters, system integration is as important and challenging as sub-system specifications. K3 designers heard a lot about the joys and frustrations of building SO2R and multi-multi stations and took pains to accommodate the complex interconnections and hostile RF environment in which we work. Mic and paddle inputs and audio output connectors located on the rear panel are helpful for cabling to an SO2R controller without big front-panel plugs and cables interfering with small, adjacent knobs. There is also a separate key input for an external key, keyer or computer. Dedicated, transformer-coupled, stereo line output and mono inputs connect directly to a computer sound card without external coupling devices. Gas-discharge tubes, PIN diodes, bleeder resistors and a carrier-operated relay on the various antenna inputs protect the receiver(s) from excessive RF.

CW and SSB monitor volume and delay are front-panel adjustable and independent. Amp keying is robust, tolerating 200 V/6 A with adjustable transmit delay to accommodate slow amplifier relays. I tested an old SB-221

with the K3, and it worked fine.

The rear panel is a study in clean layout. Power enters through Anderson Powerpole connectors, and an RCA jack powers a 12 V accessory. With the optional ATU, the K3 includes two antenna inputs, steerable by band to either or both receivers. Audio I/O, RS-232 and a 15-pin accessory connector are on one neat sub-panel, RF I/O on another and switching, such as key and paddle, on a third. These sub-panels are independently replaceable to accommodate future improvements. The RF connectors support RECEIVE ANTENNA IN and RECEIVE ANTENNA OUT, so you can insert external filters. The accessory connector provides access to many useful signals, including binary band data to drive a KRC2 or third-party decoder.

The K3 is not "SO2R in a box" because it mutes both receivers while transmitting. But since the sub-receiver is fully independent, you can monitor two bands simultaneously, optionally using different antennas. A second K3 without a sub-receiver would yield a cost-effective solution for true SO2R. With low transmit phase noise and accommodations for real-world station integration, the K3 has the features needed to build competitive contest stations.

Ergonomics

The K3 expands on the K2 tradition of excellent panel and display layout. Band, mode and transmit controls are in the upper left corner. Memory, VFO and receive controls are in the upper right. In the lower left are audio connectors, gain and filter controls. In the lower right are offset and sub-receiver tuning. The flywheel main tuning knob is very smooth. Drag adjustment was touchy on the field test units, but production units will sport a multi-level friction mechanism.

The amber transflective display is readable in most lighting conditions and at fairly wide angles. It isn't the multi-color TFT-LCD (thin film transistor liquid crystal display) beauty that some radios sport, but it is quite functional and easy on the eyes. LED intensity and LCD brightness, contrast and viewing angle all adjust independently.

There is plenty of RF and audio gain plus the 8-band equalizer to tailor the sound. The separate pre-amp and attenuator controls often are unnecessary because of the radio's huge dynamic range. Many radios hide monitor gain, tone, VOX controls, semi break-in delay and the like behind awkward top and bottom panels, practically inaccessible during a contest. The K3 puts them on the front panel or in the main menu where they are easy to adjust. VOX and

CW delay are independent, solving a major problem with some other radios, especially in multi-mode events like IARU or Field Day.

The K3 should weigh less than nine pounds fully tricked out with a 100 W PA, automatic ATU and sub-receiver. At 10×10×4 inches, the K3 is more than double the K2's volume, with a 77% larger front panel but only 56% larger footprint. It still looks like a midget compared to the mega-rigs on the market these days at nearly the price of a compact car. In contrast, the 55-pound ICOM IC-7800 weighs five times more than the K3 and has three times the footprint! The 33-pound Yaesu FT-2000 has three times the weight and volume of a K3. The 21-pound IC-756PROIII is about 50% larger than the K3 and even the compact Kenwood TS-2000 weighs 17 pounds. In my review of the K2 (see *NCJ,* March/April 2003), I said it could fit in a corner of a suitcase. Well, the K3 may need *more* of the corner, but it fits in the same suitcase along with power supply, accessories, tools and a little less clothing.

Contesting with the K3

To meet publication deadlines, I only had time for two contest trials. RAC Canada Day was my first opportunity to learn the controls in a contest context, but that event provided no pileups or band crowding. The IARU HF Championship offered a more realistic environment, but mediocre band conditions left me feeling that the radio had not yet been challenged. This may be more a credit to the rig than a complaint about Mother Nature!

Alaskan multi-op KL3R also used a K3 in the IARU event, and WØYK set up a team of Elecraft users in the July NAQP RTTY that included himself, AB7R and me, all using K3s. This was my first-ever RTTY contest, and I was delighted with how easily the K3 integrated with my computer for true FSK. All it took was a keying cable (DE9-DE15 with two resistor-transistor keying circuits "dead bug" style inside the DE-9 shell), another serial port and a stereo audio cable.

Controls and display were everything I expected. The layout worked well, and I never had to stare at the panel wondering where something was hidden. Gains were ample, and the combined DSP/analog filter controls worked well. I could move between CW and SSB with two button clicks, pre-selecting both VFO frequencies, mode, DSP and analog filters, preamp/attenuator, AGC speed and maybe more. Operation is intuitive, and I rarely had to access menus during the contests. Those few times I did were cases where I had neglected to map a pet parameter to a programmable function key. As I continue to "train" my K3, the menus will probably just fade away.

In subjective comparisons with the FT-1000MP, the K3 was a clear winner, although the two radios were similar in many situations. Weak signal detection with the K3 was equal or better every time. The sound quality with the K3 was more pleasant (and adjustable!) and signal separation in pileups was better. Hiss was much lower. I missed a NB, which, as noted, is coming later. The auto notch was not yet available either, but the manual notch was outstanding — deep, steep and smooth — and better than the MP's. I didn't miss the MP's rotary DSP shape switch, which requires changes with mode. While I prefer the MP's "shuttle jog" main VFO knob, I can live happily with the K3's speed-set buttons; I like its ability to change the main tuning knob rate.

The K3's rotary controls are slightly larger and a bit closer together than those on the MP, but the K3's pushbutton spacing is slightly wider. There are no rotary switches (the MP has four) so everything can be done by computer control.

During the IARU contest, my friend Jim, W6EU, about six miles away, obliged my request to "move in on me" to test the receiver's response to strong nearby signals. I was delighted with the results. On 40 CW, he was S9 + 50 dB but essentially inaudible at ±1 kHz. Although high band noise probably abetted this outstanding performance, the adjacent FT-1000MP suffered annoying clicks all the way to ±3 kHz despite its 4 kHz INRAD roofing filter. On the quieter 20 and 15 meter bands, interference was audible as far out as ±5 kHz, even though Jim's fundamental was "only" S9 + 40 dB. The K3 still won, but not as dramatically as on 40. On all bands it was easy to operate the K3 within 2 kHz of Jim as the clicks and IMD at those points were beneath most signals. In the other direction, Jim reported that he was comfortable within 1.5 kHz of my "40 dB ++" over S9 signal. For these tests the K3 used the 400 Hz roofing filter. The MP used its wider roofer and stock 500 Hz filters in its 8.215 MHz and 455 kHz stages. Both had preamp on and no attenuator. The K3 IF scheme, with its narrow roofers, fewer stages and DSP, really shines!

Steve, K6AW, and field tester Tree, N6TR, visited KL7RA for the IARU and operated as KL3R. Steve commented, "It is sure fun listening to this receiver!" Tree said, "The K3 is a wonderful rig. It is going to be 'my rig' for a long time." KL7RA looked inside the covers and asked "Where is the radio?!"

The K3 has more of a "big radio" feel than its little brother. Most controls are encoders rather than pots, and even these drive analog-to-digital (A/D) converters, so anything you can do from the front panel you can also do via an attached (and eventually via a remote) computer. The command set is a large superset of the basic Kenwood protocol, backward compatible with the K2. The VFO encoders provide up to 400 user-selectable ticks per turn, allowing smooth tuning with resolution as low as 1 Hz. Some of the smaller encoders include pushbutton switches. This helps the user interface but does compromise the "feel" of those knobs a bit.

The K3 also sounds like a "real" radio, something we cannot necessarily take for granted in the DSP era. Some contemporary radios exhibit a distinctive "remanufactured" sound that I dislike, replete with annoying digital processing artifacts. The K3 sounds like an analog radio but has the excellent pass-band agility, mode flexibility and features that DSP provides. It is a very quiet radio, yet with enough gain to avoid wimping out on the high bands. You can just hear band noise when you connect the antenna on a dead 6 meter band.

Support

From its inception, Elecraft has offered outstanding customer support. Even before it released the K3, the company posted superior spec sheets and FAQs than those of some competitors. The manual will be available online. Community support for earlier products via the reflector has been amazingly effective; enthusiastic, knowledgeable users are always there, eager to help out. Even tough problems tend to be resolved quickly by Elecraft support. Action to date affirms Elecraft's intention to continue this extraordinary and most-welcome tradition. There is no reason to expect less, and since the K3's manufactured boards will result in far fewer user-induced problems, response to other issues should be even better.

Elecraft designed the K3 for field assembly, which should make board replacement a fast and satisfying repair method. This capability alone should present ample challenge to competitors. Factor in Elecraft's proven commitment to continuous design enhancement and its stated plan to make available frequent downloadable upgrades and you have a unique partnership between a radio's vendor and its users.

Conclusion

In the exhibit halls in Visalia and at Dayton Hamvention® this year, Elecraft

stole the show. Eager attendees lined up three and four deep for a chance to twiddle the knobs and talk to designers Wayne, N6KR; Eric, WA6HHQ, and Lyle, KK7P. At the June NCCC meeting, Wayne and Eric held forth to a rapt audience, repeatedly replying to skeptical questions with "It's in there!" Lyle put on a similar show at Salmoncon, a Pacific Northwest QRP colloquium where three K3s were on display.

The K3's price is on target, ranging from $1400 for a QRP, all-mode, 160-6 meter modular kit to a little more than $3000 for a factory-assembled 100 W rig with full-performance second receiver, automatic ATU and some optional roofing filters. Compare this to street prices around $2600 for an FT-2000 or $3000 for an IC-756PROIII, both with compromise sub-receivers, or more than $10,000 for an IC-7800. Then compare performance specifications.

Thanks to Elecraft for helping me to appreciate the unique design of the K3 and to WØYK and others who contributed to this review. We are all having a lot of fun with this groundbreaking radio. Of course, only extensive testing in the fray will prove whether the K3 takes its place on the podium, but initial indications are positive, indeed. I'm betting on it! **NCJ**