NCJ Reviews: The Elecraft K2—A Contester's Perspective

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A new name has begun to appear on contesters' station descriptions. The Elecraft K2/100 and its QRP predecessor, the K2, are showing up in increasing numbers. This article explores why this diminutive rig is suddenly getting so much respect.

As a long-time fan of Wayne Burdick, N6KR, I was thrilled when he teamed up with Eric Swartz, WA6HHQ, in 1999 to launch Elecraft and build the K2. Wayne's earlier rigs were club projects with the Northern California QRP Club, a non-conformist group with fun meetings, exciting projects and a refreshing lack of paperwork. Wayne designed club projects including the Norcal 40, the Sierra and the SST. Each had signature characteristics including no-wire construction, low parts count, minimum power consumption, good reproducibility and a focus on the needs of QRP kit builders. The K2 promised what I had been waiting for—"big-rig" performance in a QRP kit. "Why," I reasoned, "must one settle for marginal AGC, missing bands, inadequate display information, basic selectivity and other tiny rig compromises in order to run low power at high efficiency?"

The K2 lived up to my expectations. Clearly competitive with typical manufactured radios, it was everything my QRP alter ego dreamed of. But was that all? It took a few years to convince me and the rest of the contesting community just how good the K2 really is. Most of us did not take the little rig seriously. I had a blast rag chewing and vacationing with it, but when a contest came along I reverted to the TS-930S and FT-1000MP out of habit and existing station cabling. We made the misguided assumption that their full feature sets were necessary, their monolithic, plug-in filters superior and their performance obviously better. But we were (I was) wrong. As the March 2000 review in *QST* showed, the diminutive K2 had specs unmatched by these heavy, high-end rigs and their peers.

Gradually, contesters began using the K2, not only in QRP events and categories but also as an exciter for 100-watt external amps, sometimes driving a kilowatt. By Autumn 2001 it was clear that Elecraft had a winner. A Team Vertical contingent of K2KW, N6BT, WØYK, KE7X and N6XG took five K2s to Jamaica to prove it in the 2001 CQ Worldwide CW DX Contest. Operating as six single-op, single-band entries with separate call signs from a single location,

Figure 1—Front view of the 100 W K2

they broke North American QRP records on five bands and World QRP records on four bands using only K2s and Force 12 vertical arrays set up Field Day-style along the beach. A return expedition in 2002 broke many of the new records again.

They were not alone. Alan Fryer, N3BJ/4, posted this comment on the cq-contest reflector: "After a few years of trying, I won the CQWW CW USA All Band QRP class in 2001. My rig was my original Field Tester K2 #78. The performance of the K2 in full tilt contest conditions is as good or better than any other rig I have ever used and I've used them all ... both at home and at MM and MS stations. The superior close-in dynamic blocking characteristics and the ability to accurately adjust the filters and BFO (using Spectrogram) gives the K2 a leg up on the commercial rigs." Alan broke 1000 Qs QRP, coming in sixth in the world with 1.2M points … from the U.S.

By the time the K2/100 and KPA100 retrofit kit became available, it was clear that this would be a competitive radio for high and low power categories as well as QRP. Team Vertical returned to Jamaica in May 2002 for the CQ WPX CW contest using K2/100s on 10, 15 and 80 meters. Again using temporary verticals, and with even less aluminum than used in the CQ WW effort, K2KW, N6BT,

WA6O, KE7X, WØYK, N6WG and N6XI drove 6Y2A to an apparent second place world-wide multi-multi. (Winning entry A61AJ had a square kilometer of permanent towers and many rigs and operators.) The K2 was clearly a highly competitive radio! A pair of K2/100s also found its way onto the WRTC-2002 operating position of N5KO and 9V1YC and home stations such as N4BP, NØSS, N6TR, K7UP and N5TW. A recent reflector thread elicited many proud reports of section and division awards won by K2 operators. It is a real radio.

What makes the K2 a winner? What could be done to improve it? This article attempts a subjective answer. This is not a scientific study. Read the ARRL and *CQ* reviews for that. Also, I am not familiar with all the competitive radios. I know the TS-930S and the FT-1000MP best, but I have done only casual side-by-side comparisons. I will simply describe the features and capabilities of the K2 that I believe are most relevant to contesting as others and I have observed them in action.

A Modular Radio

Elecraft sells two versions of the K2: a basic, 15-W rig and the K2/100 version, which outputs over 100 W. The base unit includes an internal memory

keyer, a four-position configurable crystal filter, dual VFOs and 80-10 m ham-band only, CW only coverage. An available "integration kit" converts the basic K2 to a K2/100 model. The power amplifier replaces the top cover of the base unit with no change in overall dimensions. You can exchange the QRP cover and the 100 W cover by removing six screws and exchanging four internal connectors.

This is definitely the most modular radio ever offered to the amateur community. To the basic K2 ($599), a contester of diverse interests would probably add the 100-watt amplifier ($359), SSB adapter ($89), 160 m/2nd receive antenna option ($35) and noise blanker ($35) for a total of $1117. Other options include an audio filter/real-time clock, QRP and 150-W automatic antenna tuners, internal battery for QRP, DB-9 control port for QRP K2s and a variety of matching cases and tilt stands. The QRP tuner fits inside the QRP cover. The 100-W tuner can be housed in a one-inch high accessory case that fits under the K2/100 or in a full-size case along with the PA. This remote PA option, documented by private individuals only, lets owners leave the PA/ATU box behind when they take the QRP base unit on the road.

Evaluation Criteria

I believe the following characteristics define a winning contest radio, in approximate order of importance:
• Receiver fundamentals
• Reliability, Serviceability and Support
• Ergonomics
• Computer compatibility
• Selectivity
• Transmitting characteristics
• Specialized considerations
(Receiver fundamentals are in clear first place above. The rest are tied for ninth!)

Let's take a look at the K2 through this lens:

Receiver Fundamentals

"If you can't hear 'em, you can't work 'em." Virtually all commercially available transceivers have adequate sensitivity, selectivity, and intermodulation distortion performance for rag chewing, non-competitive DXing, traffic handling and other operations on uncrowded bands with low levels of atmospheric noise. In a contest, however, overload immunity, crowded band performance and selectivity become critical and the K2 excels. Check out the lab work summarized by Larry Wolfgang, WR1B, of ARRL in his March 2000 *QST* review and reported in detail in the Expanded Report available at **www.arrl.org**. The K2 exceeded the performance of contesting benchmark radios including the FT-1000MP,
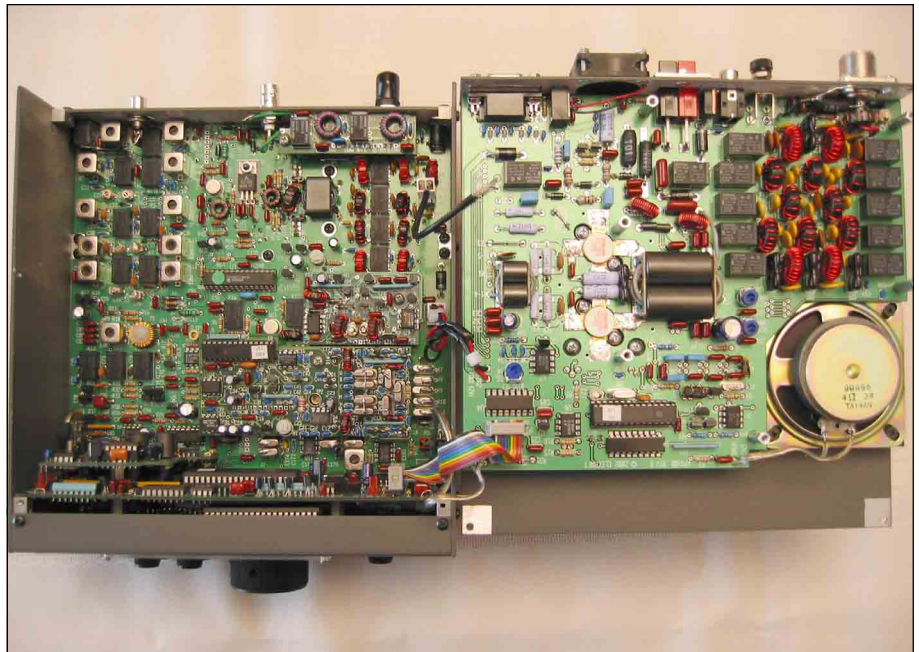

Figure 2—Inside the 100 W K2

TS-870, TS-930S, IC-756 PRO and others in most measurements. Elecraft provides a tabular comparison of published ARRL data at **www.elecraft.com**. Scott Prather, N7NB, reports additional lab results in his November 2002 CQ article. For an explanation of how low phase noise, excellent blocking dynamic range and IMD dynamic range help the K2 to excel on crowded bands, see the article by Tadeusz Raczek, SP7HT, in the Sept/Oct 2002 *QEX*. In the words of Ed Hare, W1RFI, "The best dynamic range ever measured in the ARRL Lab at 5 kHz spacing belongs to the Elecraft K2 on 20 meters."

A factor of increasing importance to contesters is noise protection. The noise blankers in most transceivers range from terrible to useless. I consider them to be the shame of the industry. Many fail to suppress noise effectively in any situation. Almost all become useless under crowded contest band conditions because they degrade receiver overload performance to unacceptable levels. The K2 has by far the best noise blanker I have ever heard for suppression of man-made noise, particularly from power line sources. Performance degradation is noticeable on a crowded band, but the radio remains usable. Note that noise blanker effectiveness varies with spectral composition and intensity and your results may vary.

It is worth noting that the K2 receiver is a single conversion design. While most manufacturers tout their triple- and quadruple-conversion schemes as "features," Elecraft has managed to deliver world-class performance with, and per-

haps because of, their simpler design. One downside—the 4.915 MHz IF results in natural CW reception on different sides of zero beat on the low and high bands. Unless you are "zero-beat ambidextrous," you will want to use CW NORMAL on some bands and CW REVERSE on others so that they all tune on the same side of zero beat. If you align the filters carefully, you will hear little difference in filter response because of this. The radio remembers your preferences, rendering this subtlety nearly transparent.

Reliability, Serviceability and Support

If all products had support like those from Elecraft, this would be a much more pleasant world. Elecraft's customers perform much of the support function themselves … very well! Imagine sending an e-mail inquiry and getting three on-target responses within hours. It happens daily on the Elecraft reflector. Gary Surrency, AB7MY, did such a good job of helping people this way that Elecraft hired him as their head of customer support! Gary monitors the reflector to make sure that questions receive good, timely answers. And when a question requires Gary or the designers themselves to respond, they do so promptly and concisely. This combination of volunteer and professional support is unique in the industry and highly effective. It also extends to new product design. Elecraft regularly solicits direct customer input and participation in the design of new products.

There is a company-served Web page devoted to Elecraft and third-party modifications, none of which alter the war-

ranty. E-mailed parts orders often ship the same day. Documentation is outstanding, explaining theory of operation and trouble-shooting techniques in enough detail that many non-engineers can determine the exact part or connection that is causing a problem. Nonetheless, reflector traffic shows that many Elecraft customers still ask first and debug later, perhaps because the advice tends to be so good!

Unlike many companies, Elecraft is not afraid to improve their product and then tell the world what they have done. After three years in the field, many user- and vendor-designed modifications have emerged. Elecraft recently announced K2 Rev. B incorporating the best of these changes and offers a set of inexpensive modification kits to upgrade any existing K2 to Rev. B standards.

Ergonomics

The K2 is small, but not so small that critical functions must be buried inside obscure menus, as they are on some portables. The ergonomics are actually quite good considering the size of the panel and the low price of the radio. However, Elecraft did make some compromises. For example, the RIT control is a pot, not a more expensive shaft encoder that could accommodate a RIT-Zero button. When running a pileup, it is best to use split mode in which the A=B button becomes equivalent to RIT-Zero. Also, this computer-controlled radio has trouble sending CW and adjusting RIT at the same time. Fortunately, sending wins and the only ill effect is a choppy side tone when tuning the RIT control while sending. The transmitted signal remains clean.

This lightweight rig does not have the rock solid mechanical feel of a '930 or an 'MP, but at five pounds plus power supply it does pretty well. Although the knobs are small and close, the main tuning knob can be adjusted for a rather nice feel. Nonetheless, some builders have substituted the heavier and slightly larger knob from a Yaesu FT-100 or a spinner knob available from Robert Parker, VE3RPF.

There are two VFOs but no second receiver. (On the other hand, you could purchase a second, basic K2 and still spend less than you would for many mainstream rigs. Hmmm.) The VFO controls are intuitive: A=B, Reverse A/B and Split. A=B is symmetric, setting the inactive VFO to the frequency of the active VFO. Reverse A/B can be persistent (quick push) or temporary (push and hold). I don't use these functions much in contests, but I am glad they are there for working split and for Slow Sunday Sweepstakes in a single-radio configuration.

I think microphone and headphone connectors should be on the rear panel to minimize front desktop clutter. Elecraft

Figure 3—Rear view of the 100 W K2

puts them on the front panel, just like everyone else. At least there is a speaker jack on the rear that you can use for headphones. The pin-out on the standard 8-pin mike connector is user-defined via jumpers, a nice touch. The manual documents jumper settings for the frustrating array of incompatible pin-outs adopted by the major manufacturers in their zeal to sell proprietary microphones.

One more nit – several items on the display blink to annunciate modes such as Split, RIT, XIT, Reverse Sideband and VOX. I don't like blinking, finding it distracting and non-intuitive. I prefer dedicated textual annunciators or labeled LEDs. An available mod supplements some of the blinkers with a miniature LED.

Other than my pet peeves, I think human factors engineer N6KR, a degreed cognitive science expert, did a great job of laying out control functions on the front panel and designing a sensible menu system. He also provided two front-panel button functions that are user-assignable to favorite menu items, another nice touch.

Computer Compatibility

The K2/100 includes a DB-9 serial port and it is optional for the QRP K2. (Caution: Use only the custom cable assembled per the instructions. A standard serial cable will not work.) *TRlog* V6.71 recognizes the K2 as a valid radio type and I used it comfortably in the CW and Phone SS contests. I used CT V9.4 during CW WPX, telling it that the K2 was a TS-50. Basic frequency track-

ing and setting functions worked fine with both loggers. CT got confused a few times, but power cycling the K2 restored everything. TRlog's Shift Key RIT function works strangely, as would be expected with an analog RIT control, and is best ignored. The K2 control protocol, based on Kenwood, is clearly documented and commands can be embedded in TR messages. There are no dedicated band data output lines for controlling antenna switches or band pass filters. Elecraft is working on a nifty external interface box that will address this issue.

Selectivity

Selectivity is good and flexible, even though the K2 lacks some of the selectivity enhancers to which we have become accustomed, such as IF shift / pass-band tuning, notch filters, continuously variable bandwidth, selectable monolithic filters in multiple IF stages and DSP. The filter scheme is based on two 7-pole crystal filters. One is variable-bandwidth, tunable from about 100 to 2000 Hz, primarily for CW use. The other is fixed-bandwidth, designed primarily for SSB and located on the SSB option board. During filter alignment you can position the filters in the pass-band and set the bandwidths of the general-purpose filter. Either filter can be used in any of four selectable filter setups per mode. I have been happy on CW with 700, 500 and 300-Hz nominal bandwidths plus the fixed 2.2-kHz filter. To simulate IF shift on SSB, I set up three versions of the K2's SSB crystal filter—one centered, one shifted up a bit and

one shifted down. I set the fourth available SSB filter position to use the adjustable bandwidth filter at 2.0 kHz, centered. I used all four settings during SS SSB. I think I need to do further work optimizing these filters for SSB contesting, but I don't expect them to work as well as the phone selectivity options on some of the more expensive rigs.

Some owners have reported satisfaction with filter bandwidths as narrow as 100 Hz. Others have complained that the skirts are not as steep as those of some of the plug-in filters for mainstream rigs. This is true but, personally, I like these skirts. An optional audio filter, curiously packaged with a real-time clock, provides two bandwidths of audio filtering, configurable for center frequency. I have used it very little.

The overall filter scheme is simple but adequate. What is lost in bells and whistles is compensated for in outstanding crowded band behavior. Many readers will be familiar with the infamous "mush" characteristic of at least one very popular contest radio. When listening to a pileup or even just a handful of adjacent stations on a crowded band, signals seem to blend together and become difficult to separate. With the K2, however, signals inside the pass-band stand out very well, allowing the "filter between the ears" to do its job, at least on CW. I have operated the K2 side by side with a major "mush" radio and the difference is quite pronounced. I find the K2 more pleasant to listen to, especially for extended periods and under crowded conditions.

Transmitting

CW keying is excellent thanks in part to a clever adaptive ALC algorithm implemented in firmware. The internal keyer works well and supports both Curtis A and B emulations. There is a simple mod that lets you connect an external keyer or computer at the same time, a rare and welcome capability. Keyer memories normally require two button pushes, but there is a way to trade off some lesser-used panel functions for some single-push memories. This would be helpful in field contests that do not justify carrying a computer or external keyer.

The QSK is superb, among the best I have ever heard. With most rigs, I use QSK in a contest only in critical pileup situations, giving my ears a rest by using semi-break-in most of the time. With the K2, I don't give it a thought, leaving the rig in full QSK at all times, and it sounds great. There is no audible difference when I move from QRP to 100 W to driving a QSK amplifier at 1.5 kW!

Elecraft designed SSB "tracking ALC" circuitry (not firmware) to handle a wide range of speech characteristics, antenna loads and operating environments. This does not change the fact that microphone matching is subjective, as with most radios. Some owners have used preamps to match various microphones to the K2 while others have enjoyed plug-compatibility with the same mikes. The Heil IC cartridge provides a warm sound with the K2 and Elecraft offers it in its own hand-held microphone. The Heil HC-4 contest/DX cartridge elicits the usual complaints from audiophiles when used with the K2. +5 V dc is available at the connector for electret mikes. The SSB option uses the same fairly narrow crystal filter for both receive and transmit. Some owners have modified it to increase transmitted audio bandwidth while others have been happy with it as is. Several owners have reported difficulty with the VOX characteristics. VOX gain is low and not adjustable and there is no anti-VOX circuitry. VOX delay is panel selectable at fixed values of 0.4 and 1.0 s. A firmware change under consideration at Elecraft may improve VOX behavior, particularly with low-output mikes.

There is no SSB monitor. You may or may not consider this a problem, depending on "how you drive." I usually like to hear myself. N6KR muses that additional circuitry could be devised to provide a monitor, a good project for the independent modification inventors out there.

SWR fold-back is fairly aggressive but not a problem when driving an amplifier or well-behaved antenna. Further improvement is in the works at Elecraft global software headquarters in Belmont, CA (a.k.a. the QTH of N6KR).

Specialized Considerations

Transmitter cleanliness is particularly important for multi-rig operation (SO2R, M/M, M/S, M/2) and in RF-saturated locations like Europe and Japan. In ARRL measurements, only the IC-756 PRO generated lower phase noise than the K2. Empirical observations at 6Y2A M/M HP were favorable, with no one reporting phase noise problems originating from the three K2s, all driving kWs. The 10M K2 suffered heavy noise from a JST JRC-245 operating outside the contest on 6 meters. K7UP enjoyed using a pair of QRP K2s for SO2R in the 2002 Sweepstakes and reported no noise problems.

For expeditions, size and weight are important. The K2 is a winner in this regard. A lot smaller than a breadbox and weighing in at five pounds, a fully tricked-out K2/100 fits in a corner of a suitcase. (Oh, for a correspondingly compact kilowatt!) The svelte Astron SS20 or Samlex 1223 20-A switching power supplies provide ample power. In the CW WPX at 6Y2A, we used the larger Astron SS30 supplies for headroom and mutual sparing—each could have powered two K2s although that was never necessary. Elecraft makes no attempt to sell a pro-

prietary or private-labeled power supply at an inflated price. They do recommend positioning a switcher well away from the rig. Ignoring this good advice, I have placed several different supplies within a foot of the K2 without noticing any interference. However, I have heard hash from cheap accessory power supplies placed directly above the rig.

The optional antenna tuners are not necessary if you are driving an external amplifier, but for QRP to 100-W operation into less than perfect antennas, they are wonderful. They are nearly identical electrically, differing mainly in the ratings of their parts. They use relay-switched fixed value components instead of motor-driven variables. They are fully automatic, searching for resonance and remembering the settings for each band/antenna port combination. Once you tune them, they reset instantly as you change bands and antenna ports. If you have both ATUs, one inside the QRP base unit and the other mounted remotely with the PA, the firmware transparently bypasses the QRP tuner and uses the QRO unit only. This seamless integration is just one of many firmware delicacies that I continue to discover as I use and adapt the K2.

The KPA100 has a tiny cooling fan on the back of the heat sink that is surprisingly shrill. Although I barely hear it through my Heil Proset, I do set the option that it cycles on and off as needed. At 6Y2A, our maiden voyage with the K2/100 to a tropical venue, we also used muffin fans on the heat sinks as a precaution but in retrospect it was probably not necessary. Driving typical amplifiers, the K2 loafs at 60-80 W output. In SS CW, I noticed that the heat sink was never too hot to touch for five or ten seconds. On SSB, it was barely warm. At 100 W, however, the heat sink can get hot enough that you don't rest your hand on it.

Firmware options accommodate RTTY and PSK31 and include additional user-defined filter settings. The Elecraft Website includes ample material on using the K2 on digital modes. I have not yet dabbled with them. It also has good transverter support, with target band frequency readout, and is beginning to show up as the IF in some VHF/UHF contest stations. Its low-noise, single conversion design should be an advantage here.

Both versions of the K2 have unusually low current drain on receive and excellent under-voltage tolerance on transmit. Compare 150-300 mA for the K2 or 350-550 mA for the K2/100 to the 1-3 A drawn on receive by traditional "big rigs." This makes Elecraft a natural choice for field operation on batteries or with small generators and limited fuel.

In the future, remote control may be-

come important to many of us. Although remotely controlled contest stations are few and new at this point, the K2 is a strong candidate. Freeware K2 Remote, available at the Elecraft Web site, lets you control the K2 from a PC via TCP/IP. This could be a direct connection, local area network, dialup circuit or the Internet. K2 Remote offers a nearly full-function, on-screen control panel. Elecraft encourages others to develop alternative remote control programs.

Visually impaired contesters will welcome another piece of Elecraft freeware, K2 Voice, which provides voice annunciation of K2 operating parameters. John Glass, NU6P, operated my K2 comfortably at Field Day 2001 without K2 Voice, but he agreed it would be good to have. Elecraft is also designing an audible annunciator that will not require a computer.

Building It

This radio comes as a kit, so there is one thing to consider when evaluating the K2 that you don't need to worry about with other contest rigs—building the thing. Good news, folks—Heathkit is back! Elecraft's meticulous attention to detail is similar to that of the late, great kit giant. The clear diagrams and extensive handholding bring back memories of the good old days. Even better, the instructions are less pedantic and verbose than those from Benton Harbor. On nearly every page I had one of those "Ah hah!" moments, marveling at some clever design wrinkle, assembly technique or particularly clear instruction. There are remarkably few errors, parts problems and inconsisten-

cies, thanks in part to Elecraft's prudent use of field-testing prior to production release. I participated in that test of the KPA100 and later built a production unit from scratch. The field test process was extremely valuable.

Assembly is in phases, with "smoke tests" along the way. Most of the test environment needed to complete the kit is built-in, so all you really need is a DMM and a receiver. Basic rig alignment is straightforward. Filter setup can be done by ear if your ear is good, but there is a nifty piece of software called *Spectrogram* (third party shareware, $40) that makes it easier and fun. You connect audio from the K2 to the audio input of your computer, run Spectrogram and see a plot of the rig's filter response. "Piece o' cake!"

For some, kit building is a pleasure and this facet of the K2 is welcome. For others it is drudgery or physically impossible. For them there is a cadre of builders who, for a reasonable fee, will build and align a K2. The Elecraft Web site lists many of them. Some hams are willing to build but dislike winding toroids. The K2 has lots of them and Elecraft service reports show that poorly tinned toroid leads are the leading source of construction problems. Therefore, Elecraft endorses a third-party supplier of pre-wound toroids. Personally, winding toroids does not bother me and I am getting better at stripping and tinning the enamel-coated wire!

This is not a kit for beginners because it is large and fairly dense. But any ham who has built a few simpler kits successfully can expect to complete a K2 without difficulty.

Bottom Line

I am convinced. The laboratory stats are impressive but, frankly, I prefer to let the radio speak for itself. It is the cleanest sounding of the three "serious" radios that I use regularly, particularly on CW. Although I bought it for the satisfaction of building a high performance QRP radio for traveling, it has now won a position as my CW rig of choice for home contesting and for any expedition.

I must confess to minimal phone contest experience with the K2. I used it in SS SSB 2002 and did not change my opinion about phone contesting in general. The rig performed well although I missed the pass-band tuning of the TS-930. I'm less certain about phone DX contesting, at least on 40m where a second receiver seems essential. But my K2 will certainly be Rig 2, and often Rig 1, as I grow into SO2R operation.

In terms of cost effectiveness, the K2 wins all the chips. For about $1100 you get better performance than rigs costing $2000, $3000 or more. You get the pride of contesting success with a rig you built yourself. You get copious advice and assistance on-line and you can enhance and repair it yourself. The K2 is an amazing accomplishment.

Thank you to N6KR and WA6HHQ of Elecraft for helping me to understand some of the design features and tradeoffs of their delightful rig. Thanks to WØYK and NØSS for editorial assistance, discussion and on-the-air tests. And thanks to those who are quoted or mentioned here, most of whom gave their permission. **NCJ**