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Elecraft KX2 HF QRP Transceiver

80 – 10 meter SSB, CW, and digital modes with fine performance in a tiny package.

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It's been quite a while since I last operated portable with battery power. During 2016, ARRL's National Parks on the Air (NPOTA) program caught my interest, and I decided to try some activating (operating portable from various National Park Service units) in addition to chasing (operating from home). Elecraft's KX2 HF QRP transceiver proved to be a worthy activating companion.

Overview

Several years ago, Elecraft introduced the KX3, a compact 160 – 6 meter transceiver offering excellent receiver performance, a 15 W transmitter, and many of the bells and whistles found on their K3/K3S desktop radio.[1] With SSB, CW, AM, FM, and digital mode capability, as well as a wide variety of options and accessories, the KX3 quickly became the radio of choice for many portable operators.

In 2016, Elecraft changed it up again with the KX2, a portable transceiver roughly half the size and weight of the KX3. Like the KX3, the KX2 is a software-defined radio (SDR) in a box with knobs and a display. It measures just 2.3 × 6.5 × 3.1 inches (including protrusions) and weighs 1.25 pounds, including the optional internal Li-ion battery.

The KX2 covers 80 through 10 meters on SSB, AM, CW, and digital modes. Power output is up to 10 W, and the receiver covers 500 kHz to 32 MHz (with reduced sensitivity below 3 MHz). The review radio included several options — KXAT2 internal antenna tuner, KXBT2 internal Li-ion battery and KXBC2 charger, MH3 hand mic, KXIO2 real-time clock module, and KXPD2 CW paddle.

On the left side are jacks for external power, a keyer paddle or external keyer, headphones, and an external microphone. (There's also an internal microphone near the AF GAIN control, so you can use the KX2 as a handheld transceiver.) The multipurpose ACC jack is used for communicating with a computer for firmware updates or for integration with logging software. This four-conductor 3.5-millimeter phone jack is also used to key external amplifiers or transverters and interface with the Elecraft KXPA100 amp. The antenna jack is a BNC on the right side.

A small (1-inch diameter), flat speaker is mounted to the bottom cover. Although this speaker is usable, I much preferred listening with headphones or an external speaker.

I won't cover every feature and nuance in this review, but it's worth downloading the KX2 manual from Elecraft's website to learn more.

Bottom Line

The Elecraft KX2 is a pocket-sized 10 W portable transceiver that gives up little in the way of features and performance.

Display and Controls

Front panel space is about evenly divided between an LCD on the top and controls on the bottom. The LCD shows a wealth of information, including frequency, mode, and control settings. It's quite legible and provides plenty of information during operation. I had no trouble reading the display outdoors, even on sunny days. The amber backlight can be turned off to conserve battery power.

The lower half of the front panel holds four knobs and 12 pushbuttons. The pushbuttons follow the usual Elecraft convention — press quickly for the main function or press and hold for half a second for the secondary function.

The knobs also have several functions. For example, the left-hand knob is AF GAIN. Press the knob quickly, and you

[1] J. Hallas, W1ZR, "Elecraft KX3 HF and 6 Meter QRP Transceiver," Product Review, *QST*, Dec. 2012, pp. 39 – 44.

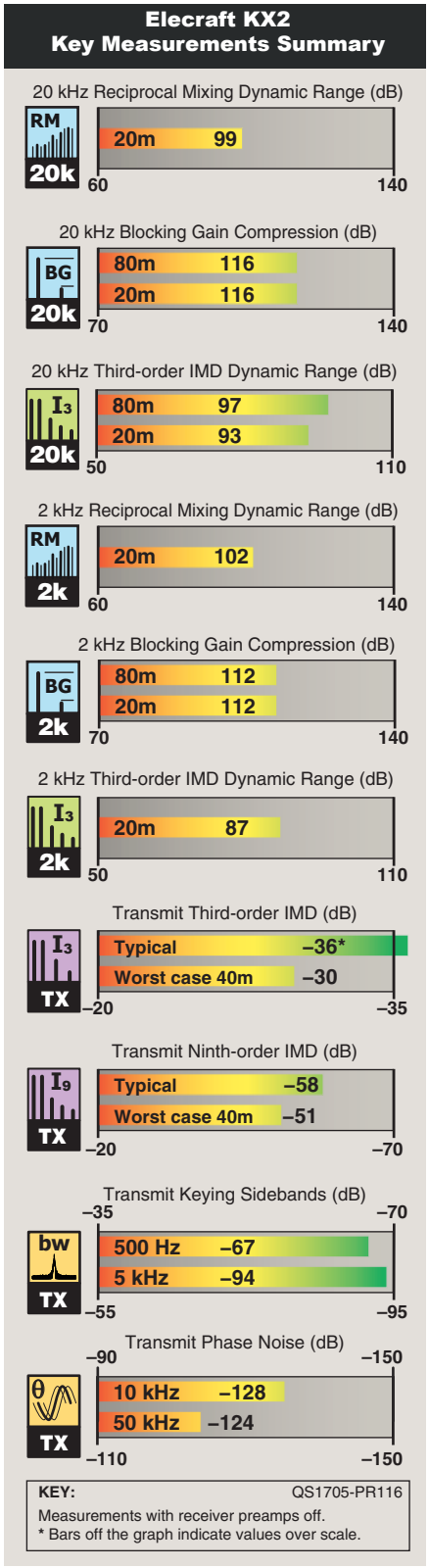

Table 1
Elecraft KX2, serial number 00374, firmware v2.69

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.5 – 32 MHz; transmit, 80 – 10 meter amateur bands.	As specified.
Power requirement: 8 – 15 V dc, 1 – 2 A typical in transmit; receive, 150 mA minimum typical (backlights off, preamp off, no signal).	Transmit: 2.2 A (10 W output) at 13.8 V dc; with 10.8 V internal battery, 1.81 A (5 W), and 1.05 A (1 W). Receive, 196 mA (no signal, max audio, max lights); 172 mA (no signal, max audio, no lights).
Modes of operation: SSB, AM, CW, DATA.	As specified.
Receiver	**Receiver Dynamic Testing**
Sensitivity (MDS): –136 dBm typical (preamp on).	Noise floor (MDS), 500 Hz BW: *Preamp off* / *Preamp on* 3.5 MHz –120 dBm / –134 dBm 14 MHz –124 dBm / –138 dBm 28 MHz –121 dBm / –134 dBm
Noise figure: Not specified.	Preamp off/on: 14 MHz, 27/13 dB.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1 kHz, 30% modulation, 6 kHz BW: *Preamp off* / *Preamp on* 3.8 MHz 4.0 µV / 1.0 µV 29 MHz 4.0 µV / 1.0 µV
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz BW: *20 kHz offset* / *5/2 kHz offset* *Preamp off/on* / *Preamp off* 3.5 MHz 116/111 dB / 112/112 dB 14 MHz 116/111 dB / 112/112 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 99/103/102 dB.

ARRL Lab Two-Tone IMD Dynamic Range Testing (500 Hz bandwidth)

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz/Off	20 kHz	–120 dBm –97 dBm	–23 dBm –14 dBm	97 dB
14 MHz/Off	20 kHz	–124 dBm –97 dBm –11 dBm	–31 dBm –18 dBm 0 dBm	93 dB
14 MHz/On	20 kHz	–38 dBm –97 dBm	–47 dBm –16 dBm	91 dB
14 MHz/Off	5 kHz	–124 dBm –97 dBm –10 dBm	–34 dBm –22 dBm 0 dBm	90 dB
14 MHz/Off	2 kHz	–124 dBm –97 dBm –72 dBm	–37 dBm –10 dBm 0 dB	87 dB

can adjust the sidetone/SSB monitor level. Press and hold the knob to turn on and adjust the noise blanker. The knob next to it adjusts keyer speed for CW and mic gain for SSB. Pressing this knob turns on a tone to help tune CW signals to the correct pitch. Press and hold this knob to adjust RF power output. The largest knob, near the center, controls the main VFO frequency (VFO A). It's also used along with other controls to adjust settings. The small knob to the right controls VFO B or the RIT if activated, and it is also used to adjust settings. Press it to clear the RIT.

Below the main frequency display in the LCD is an area called "VFO B." In addition to displaying the VFO B frequency, it's also used to show the RIT offset if the RIT button is pressed. Press the DISP button to display 24-hour time (with the KXIO2 installed), power sup-

Manufacturer's Specifications	Measured in the ARRL Lab
Second-order intercept point: Not specified.	Preamp off/on, 14 MHz: +53/+53 dBm; 21 MHz, +53/+53 dBm.
DSP noise reduction: Not specified.	15 dB.
Notch filter depth: Not specified.	Auto notch: 50 dB (single tone), 40 dB (two tones). Attack time: 490 ms.
IF/audio response: Not specified.	Range at –6 dB points, bandwidth:* CW (500 Hz): 330 – 875 Hz (545 Hz); Equivalent Rectangular BW: 577 Hz; USB: (2.4 kHz): 270 – 2716 Hz (2446 Hz); LSB: (2.4 kHz): 270 – 2716 Hz (2446 Hz) AM (5 kHz): 83 – 3300 Hz (6400 Hz).
Transmitter	**Transmitter Dynamic Testing**
Power output: 10 W PEP max (80 – 17 meters), 8 W PEP (12, 10 meters), ±1 dB.	CW/SSB, typically 0.1 – 10 W (80 – 17 m), 0 – 9.3 W (12, 10 m). AM, 0.1 – 2.6 W. At 8 V dc (minimum operating voltage), 0 – 5.3 W.
Spurious-signal and harmonic suppression: >50 dB.	58 dB (worst case, 28 MHz), typically >60 dB. Meets FCC requirements.
SSB carrier suppression: >50 dB typical.	>70 dB.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order, 10 W PEP: –36/–43/–55/–58 dBc (typical), –30/–39–53/–51 dBc (worst case, 40 m).
SSB transmit bandwidth: Not specified.	-6 dB points, 2.842 kHz, –30 dB points, 3.006 kHz.
CW keyer speed range: Not specified.	8 to 46 WPM; iambic mode A & B.
CW keying characteristics: Not specified.	See Figures 1 and 2.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S-9 signal, SSB, 68 ms; CW, 40 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 30 ms.
Receive processing delay time: Not specified.	28 ms.
Composite transmitted noise: Not specified.	See Figure 3.

Size (height, width, depth): 2.3 × 6.5 × 3.1 inches (including protrusions). Weight, 1.25 pounds (including battery).

Price: KX2, $750; KXAT2 antenna tuner, $180; KXBT2 Li-ion battery, $60; KXBC2 charger, $25; KXPD2 CW paddle, $110; KXIO2 real-time clock, $70; MH3 mic, $60; CS60 case, $40; CS40 case, $30.

Second-order intercept points were determined using S-5 reference.

*Default values; bandwidth and cutoff frequencies are adjustable.

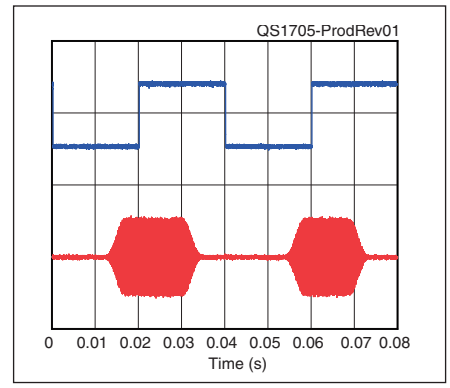

Figure 1 — CW keying waveform for the Elecraft KX2, showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 10 W output on the 14 MHz band.

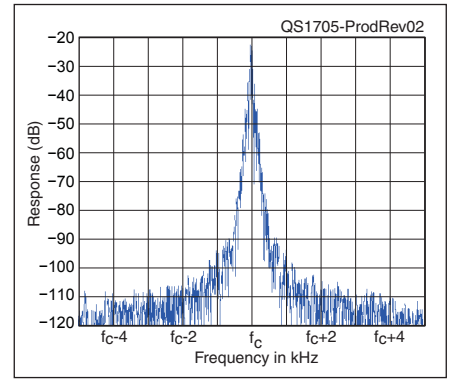

Figure 2 — Spectral display of the Elecraft KX2 transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 10 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is 10 dB/division.

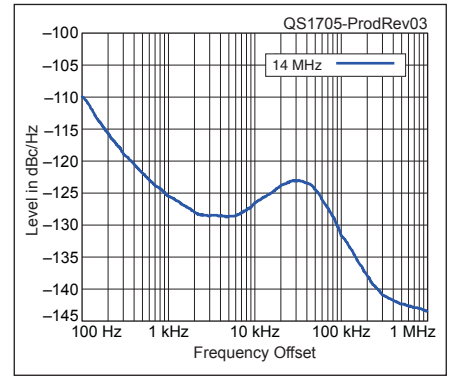

Figure 3 — Spectral display of the Elecraft KX2 transmitter output during phase noise testing. Power output is 10 W on the 14 MHz band. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is –100 dBc/Hz, and the vertical scale is 5 dB per division.

ply information, power amplifier temperature, and audio signal levels.

Press and hold the DISP button and enter the MENU mode to access more than 60 settings. Scroll through the menus using the VFO B knob and change the menu setting using the VFO A knob.

To change bands, press the BAND button, and use the VFO A knob to scroll through the bands. Press BAND again to make your selection. Press the MODE switch to step through SSB, CW, and AM modes. Press DATA to switch to digital modes.

Despite the radio's small size, I had no trouble accessing the controls during operation.

Software

Elecraft offers companion *KX2 Utility* software. It took just a few minutes to download and install the software on

my *Windows 10* computer (*Mac OS* and *Linux* versions are also available). The KX2 communicates with the computer via a supplied USB cable, and an RS-232 serial cable is available if you need that. Using the *KX2 Utility* FIRMWARE screen, I checked for firmware updates, downloaded the latest files from the Elecraft website, and installed them in the KX2. The whole process was painless, only requiring me to press a few on-screen buttons.

You can use the software to save and restore KX2 configuration settings, edit CW/data memories and the power-on banner, and set the KX2 time from the computer's clock. The utility also has a screen for calibrating transmitter gain and another that acts as a terminal program for editing and sending CW, RTTY, and PSK memories.

Power Requirements

The KX2 can be powered from an external dc supply, or from the optional 10.8 V, 2.6 Ah Li-ion battery. The internal battery must be removed from the radio for charging. It's accessed by turning two thumb nuts and removing the back cover, taking care with the wires running to the speaker mounted on the cover. Charging takes a couple of hours using the KXBC2 charger.

Although the KX2 does not include battery charging circuitry, you can plug in an external battery or power supply, and the radio will use whichever power source has the higher voltage. The VFO B parameter display includes power supply voltage, current draw, and amp-hours used since last reset. This will give you an idea of how much battery time remains. The minimum specified supply is 8 V, and there's a menu-adjustable low-battery warning that can be set for 8.2 – 13 V.

The KX2 transmitter will operate at 10 W with a fully charged internal battery, and the power output falls off as the battery voltage decreases. If the supply voltage is less than 12 V (and that includes a fully charged internal battery), the manual recommends operating at 5 W maximum in SSB and audio-based digital modes for best intermodulation distortion (IMD) performance.

As an experiment, I started a CW contest using a fully charged internal battery and the KX2 set for 10 W output. The KX2 metering indicated 12.2 V in receive and 11.2 V in transmit. I worked the contest hard, calling stations and CQing, and had just over 100 contacts in 2 hours of operating. After 2 hours, the battery voltage had dropped to 10.2 V in transmit, and I had used 1.01 Ah of the battery's 2.1 Ah capacity, so I still had plenty of operating time left. Of course, the battery lasts a lot longer in a more leisurely operating session.

I did notice that the right side of the KX2 got warm to the touch during extended transmitting periods, but PA temperature generally stayed below 40° C. The radio will reduce power output if needed to maintain a safe temperature.

CW Operation

As with the K3S and KX3, the KX2 offers a wide range of features for the CW operator. The internal keyer range is 8 to 46 WPM with adjustable weighting. Semi break-in and full break-in (QSK) operation were both smooth. CW pitch is adjustable from 400 to 800 Hz, and the sidetone sounds during adjustment.

We added the optional KXPD2 keyer paddle that attaches to the side of the radio, as shown in the lead photo. Once adjusted, I was pleasantly surprised at how well I could send with the KXPD2, and saw no need to take along a separate paddle. I did have a minor issue with the paddle when one of the contact posts loosened up while I was in the field, and I could not control the dits. I tightened the tiny Phillips-head screw that secures the post, and had no further problems with it.

Receive filter bandwidth is adjustable from 50 Hz to 2.8 kHz by pressing the FIL button and rotating the AF GAIN knob. Most of the time, I used settings in the 300 to 500 Hz range. There's also an audio peak filter (APF) for peaking up very weak signals that are in the noise.

The internal keyer has three message memories. To record, hit REC, and then select one of the memory pushbuttons (secondary functions of the PRE, FIL, and ATU keys) and send your message with the paddle. Memory contents can also be created or edited using the *KX2 Utility* software. To send, hit MSG and then the corresponding memory pushbutton. I used the memories quite a bit to call CQ or send exchanges during my NPOTA and contest operations, and wished that I could make playing the memories a primary button function (i.e., tap one button instead of two for playback).

Enabling the CWT feature in the menu system turns the right half of the z S meter into a visual tuning aid. Center the bar under the CWT label, and you're on frequency. Tapping the keyer speed knob generates an audible spot tone. If CWT is enabled, tapping that knob tunes in the signal automatically ("auto-spot"). There's also a CW decode feature that decodes transmitted and received CW. When enabled, decoded CW scrolls through the VFO B frequency display area. You need to pay attention, as you can see only the last seven characters decoded.

When the band was crowded with strong CW signals during a contest, I operated with my home station antennas. With headphones on, I heard weak, high-pitched signals from strong stations below my operating frequency. These signals were evident up to about 1.5 kHz above the main signal, depending on signal strength. Reducing signal strength by turning off the preamp or turning on the attenuator

reduced or eliminated the artifacts.

I did notice an interesting thing: The artifacts seem to be less noticeable with filter settings ending in 50 Hz — 250, 350, 450 Hz, for example. Changing from 500 Hz to 200 Hz did not seem to reduce the strength of the artifacts, but changing from 500 Hz to 450 Hz did reduce or eliminate them. In any event, they did not interfere with stations I was trying to copy.

Voice Operation

Mic gain and speech compression are adjustable using the CMP and ALC bar graph displays. You can also tailor your audio using an eight-band audio equalizer. I used my regular station transceiver to record some audio while I transmitted using the KX2's internal microphone and the optional MH3 hand mic. They both sounded pretty good, but I liked the MH3 better after I enhanced the high end by turning up the top four equalizer bands. I also thought that my voice sounded better with the compression turned up about a third of the way. Of course, everyone has different voice characteristics, so it's worth some time experimenting with these controls. When you're running 5 or 10 W, you want clean, good-sounding audio for best intelligibility.

The KX2 has a digital voice recorder with two 15-second memories. Operation is similar to the memory keyer. This is great for contesting or for calling CQ in the field and trying to get attention from a park or SOTA (Summits on the Air) peak.

In a firmware update, Elecraft added AM operation. I was able to listen to shortwave broadcast stations and amateur stations using AM on 80 and 40 meters. On transmit, the AM audio sounded quite good. However, you may find it difficult to make AM contacts with 5 or 10 W unless band conditions are good.

In SSB receive, filter bandwidth and passband tuning are fully adjustable. In addition, there's an automatic notch filter for getting rid of annoying carriers.

Digital Modes

For digital modes, the KX2 can be operated with a computer and sound card for RTTY, PSK, JT65, or any of the other popular modes. These are called DATA A and AFSK A modes, and sound card connections are made through the MIC and PHONES jacks. The manual strongly recommends using 5 W or less for all data modes, and the radio will reduce power to maintain a safe operating temperature. As mentioned before, the radio feels warm to the touch during extended transmitting periods, and you can keep an eye on the PA temperature.

As with the KX3 and K3S, the KX2 FSK D and PSK D modes support RTTY and PSK31/63 without the need for a PC. To transmit, send your message in Morse with the built-in keyer and the KX2 translates that and transmits FSK or PSK. For receive, decoded RTTY, or PSK, scroll through the VFO B frequency display area. As with the CW decoder, you can see only the last seven characters decoded.

During FSK D and AFSK A operation, the passband tuning switches to a dual filter, centered on the mark and space frequencies. Enabling CWT brings up a tuning indicator for PSK and RTTY.

If you have a PC connected, you can

Lab Notes: Elecraft KX2 HF QRP Transceiver

Bob Allison, WB1GCM, Assistant Laboratory Manager

The Elecraft KX2 has more than enough receive performance for a small, portable HF transceiver. Its lowest dynamic range at 2 kHz spacing is a respectable 87 dB (third-order IMD DR). As expected, the larger KX3 that we tested with its optional 1 kHz roofing filter did have better dynamic range. It is interesting to note that the reciprocal mixing dynamic range is lower at 2 kHz than it is at 20 kHz. This makes sense; it follows the same pattern as the transmit phase noise plot, which has a hump 20 kHz away from the carrier. Sensitivity is good, with an MDS level at a very sensible –124 dBm with the preamp off, just below "rural quiet" noise level (–120 dBm). The preamp does an ample job at 28 MHz, where it is needed the most.

On the transmit side, the phase noise is reasonably low, as are the typical transmit IMD products. Keying sidebands are also low. Overall, the KX2 will not cause interference to those tuned nearby and is an excellent candidate for use with an RF amplifier.

There are a few minor performance details worth mentioning. In the Lab, I heard a few birdies, not uncommon in a modern receiver. One birdie, at 3.5196 MHz, is just below where I normally perform tests on the 80-meter band. Most birdies are weak or inaudible with an antenna hooked up. The second-order intercept point is +53 dBm; not the best, but not bad. As a field radio, the user will more than likely never experience second-order products coming out of the speaker. This happens when there are two very strong signals that arrive at the receiver jack and add up in the front end, creating a phantom signal at the tuned frequency. For example, two equally very strong stations at 6 MHz and 15 MHz create a phantom signal at 21 MHz.

The KX2 functions in AM mode, transmitting a little over 2.5 W of carrier and 10 W PEP. I found the transmit audio quality to be excellent, but the receiver is not full AM. The carrier is clearly heard as a tone when tuning above and below the transmit frequency. The user must zero beat to null out the tone. Though not ideal, the zero beat step will ensure the user is on the same frequency as the station being heard. Because of the detection of the carrier, I was unable to directly measure AM sensitivity with our HP-339A distortion meter. AM sensitivity measurements are approximate.

I find it very interesting that Elecraft made the KX2 with the intention of walking *and* talking! There is a built-in microphone that sounds very good on the air. The user only needs to press the XMIT button to talk. Elecraft recommends the MFJ telescopic whip antennas (for 20 – 10 meters) for pedestrian portable operation. A magnetic loop is also a good match for the KX2.

After hours of fun, the batteries do wear down, but the radio is quite tolerant of low voltage with a minimum of 8 V dc.

view a lot more decoded text using the Terminal screen in the *KX2 Utility* software. The Terminal screen also offers 16 memories each for CW, RTTY, and PSK.

There was a RTTY contest in progress the first night I had the KX2. I switched to FSK D and found it easy to tune in and copy RTTY stations. Using the paddles, I called one of the big guns, and he came right back. QRP RTTY with no computer! I programmed two of the three RTTY messages with my call sign and exchange and proceeded to work more stations. I did have to watch the scrolling display carefully as call signs and exchanges came flying by.

I was also able to copy PSK31 stations using the PSK D mode. In PSK D, the auto-spot function works similar to the way it works in CW, and I found it easier to tune stations that way rather than by ear. Making PSK contacts this way is a bit awkward compared to the PSK software and waterfall display I usually use, but it does work.

Other Features

The KX2 includes a preamp and attenuator. Most of my operating was with less-than-ideal portable antennas, and I used the preamp most of the time. When operating with my home station antennas, I didn't use the preamp as much. In the presence of very strong signals, the KX2 automatically turns off the preamp and flashes HI SIG in the VFO B display area. It was rare to encounter signals strong enough to make this happen. The receiver is also protected from damaging signal levels (think nearby transmitters, such as during Field Day) through a menu-adjustable carrier operated relay.

In addition to the transmit equalizer described previously, the KX2 has an eight-band receive audio equalizer. Settings are separate for CW and SSB/AM. It also has adjustable noise blanking and noise reduction. The audio effects (AFX) setting, called DELAY, "creates an illusion of acoustic space," according to the manual. It's something better experienced than described, but when you're tuning down the band, signals seem to travel from ear to ear.

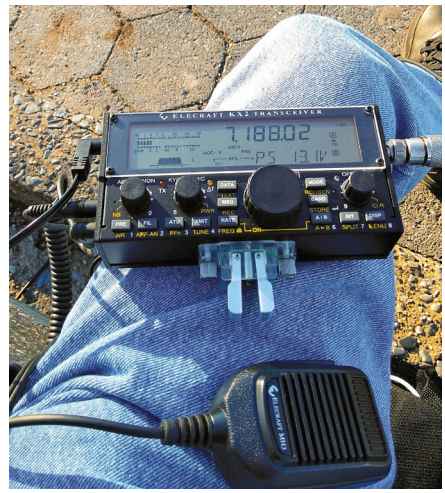

Figure 4 — No table? No problem. I comfortably operated for several hours from a park bench with the KX2 resting on one leg and my paper logbook on the other.

Split frequency operation with the KX2 works similar to many desktop radios. Press and hold the A/B button to equalize the two VFOs, and then press and hold the RIT/SPLIT button. The radio also has a "dual-watch" function that allows listening to both VFO A and VFO B simultaneously, one signal in each ear with stereo headphones or dual external speakers. There is a limitation — VFO B can be set to 7 kHz above or 23 kHz below VFO A's frequency. Beyond that, dual watch is disabled, but split frequency operation still works. Still, the dual-watch range works for most DX pileups.

Our review unit included the optional KXAT2 automatic antenna tuner. That worked great in the field with less-than-ideal portable antennas and short mobile antennas that tuned over a narrow frequency range.

Final Thoughts

During 2016, I took the KX2 along on a number of NPOTA operations away from home. It saw duty at sites ranging from the Appalachian Trail in Vermont to several urban sites in Manhattan and Boston.

I operated mostly CW, some SSB, with the internal battery for short operations and an external battery for longer excursions. The radio, mic, paddle, power cord, BNC-to-SO-239 antenna feed line adapter, and earphones all fit nicely in the CS60 carrying case from Elecraft. Once I had the antenna set up, I could be on the air in minutes. The radio fit comfortably on my thigh if I didn't have a table (see Figure 4).

After living with the KX2 for several months, it's easy to see why low-power and portable operators adore the KX3 and now the much smaller, but almost as capable, KX2.

Manufacturer: Elecraft, 125 Westridge Dr., Watsonville, CA 95076; tel. 831-763-4211; **www.elecraft.com**.

Visit https://youtu.be/Aquy26EreoY to watch an overview of the Elecraft KX2 HF QRP transceiver.