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## Elecraft K2 HF Transceiver Kit

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Senior Assistant Technical Editor

Okay, let's start out with a show of hands. How many of you have built a Heathkit? That's what I thought. Practically everyone who has been a ham for more than 20 years has assembled at least one of those classics—and the rest of you have had to listen to our reminisce about it. With detailed step-by-step instructions, you didn't have to be an engineer or even a practiced technician to successfully complete a Heathkit.

As an ever-increasing number of features were added to commercially built electronic equipment, and as the circuitry became more miniaturized and complex, it became harder and harder for Heathkit home-built products to compete with the automated assembly lines of the big electronics manufacturers. With diminishing cost savings, and a growing level of compromise in features, fewer and fewer people were building Heathkits.

I wish I had a nickel for every time I've heard someone lament that "No one can build their own gear anymore." A lot of hams are missing out on the fun of building in spite of the number of reliable mail-order parts suppliers and the numerous small companies that currently offer kits.

### No More Whining

Are you one of those who mourn the demise of Heath's Amateur Radio products line—or have you just been looking for that next suitable construction project? No matter. Roll up your sleeves and warm up your soldering irons, because Elecraft (that's pronounced like a combination of "elegant craft") has eliminated your reason for complaining.

With the first prototype shown at the Dayton Hamvention in 1998, the Elecraft K2 has been under development for several years. Wayne Burdick, N6KR, has designed several kit radios for the Northern California QRP Club over the years. In fact, Bob Dyer, KD6VIO, formed Wilderness Radio to distribute several of Wayne's kits. (The NORCAL/Wilderness Sierra project has been described in *The ARRL Handbook* for several years.) So when Wayne Burdick and Eric Swartz, WA6HHQ, teamed up to form Elecraft, everyone knew the result would be a fine radio!



The QRP community has always been a hotbed of activity for building and modifying gear. QRP operators work plenty of DX, operate contests and generally have fun ragchewing with other hams. Whether they choose 5 W or less than 1 W, these hams still find plenty of contacts and have tons of fun! While the K2 is not "just" a QRP transceiver, its roots are clearly there.

When the basic Elecraft K2 kit is completed, the result is a well-appointed CW transceiver that covers 80 through 10 meters and provides an adjustable power output level that ranges from hard-core QRP levels up to about 12 W. A memory keyer is even included! You can add an optional SSB adapter, a 160-meter module, a two-stage noise blanker, and/or an automatic antenna tuner for even more radio. Install the internal 2.9 Ah battery option and grab an antenna, key and/or microphone and you'll have a very compact, portable, self-contained system that is ready to go almost anywhere.

Elecraft plans to eventually offer an RF amplifier option for those who just have to have more power. A computer interface option is also on the way. Other options that are currently "in the works" include an Antenna Switch/SWR Bridge, an Audio

Filter for CW and a Transverter Interface. No telling what else might transpire when Wayne and Eric put their heads together.

### Building a Kit Radio

Let's start out with some kit building basics. ALWAYS follow the directions. Take an inventory of the parts before you start stuffing the circuit boards. This will help you become familiar with everything in the kit and will make it easier to locate any special hardware or components during the assembly process. This will also allow you to spot any missing parts, so that you can contact the manufacturer for replacements before you reach that step in the assembly process.

I spent nearly three hours inventorying this kit. There were no missing pieces.

You will need a clean, well-lit work area, a grounded, temperature-controlled soldering iron and a few basic tools—such as needle-nose pliers, close trimming wire cutters and an assortment of screwdrivers. An antistatic mat or grounded wrist strap is important for safe handling of static-sensitive transistors and ICs. Elecraft suggests that you use Kester 2% silver solder to build your kit. The solder is not included.

A digital multimeter is always a handy piece of basic test equipment. If your meter also measures capacitance, so much the better. This can be very useful for verifying component values before installation. Of course, the more and better your complement of test equipment, the easier it will be to align and—if necessary—troubleshoot the radio later, but a fully equipped test bench is not a requirement. In fact, during the course of the assembly, the

#### BOTTOM LINE

The Elecraft K2 represents a remarkable advance in the level of sophistication and performance available in a build-it-yourself format. While assembly will require some proficiency with basic electronics assembly techniques, with Internet access, valuable assistance can be as close as your keyboard.

**Table 1**

**Elecraft K2, serial number 00495**

**Manufacturer's Claimed Specifications**

Frequency coverage: Receive and transmit, 3.5-4; 7-7.3; 10-10.2; 14-14.5; 18-18.2; 21-21.6; 24.8-25; 28-28.8 MHz.<sup>1, 2</sup>

Modes of operation: USB, LSB, CW.

Power requirement: 8.5-15 V dc, receive, 0.25 A (no signal); transmit, 2.0 A, at 13.8 V.

Size (hwd): 3.4×7.9×9.9 inches; weight, 3.3 lb. With optional internal battery, 5.75 lb.

**Receiver**

SSB/CW sensitivity: preamp off, -130 dBm; preamp on, -135 dBm.

Blocking dynamic range: preamp off, 133 dB; preamp on, 125 dB.

Two-tone, third-order IMD dynamic range: preamp off, 96 dB; preamp on, 97 dB.

Third-order input intercept point: Not specified.

Second-order intercept point: preamp off and on, +70 dBm.

S-meter sensitivity: Not specified.

Receiver audio output: 2 W into 4 Ω, THD not specified.

IF/audio response: Not specified.

IF rejection: Not specified.

Image rejection: Not specified.

**Transmitter**

Power output: SSB, CW, 0.1-10 W.

Spurious-signal and harmonic suppression: 40 dB.

SSB carrier suppression: 40 dB or greater.

Undesired sideband suppression: Not specified.

Third-order intermodulation distortion (IMD) products:

CW keyer speed range: 9 to 50 WPM.

CW keying characteristics: Not specified.

Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.

Receive-transmit turnaround time ("tx delay"): Not specified.

Composite transmitted noise: Not specified

**Measured in the ARRL Lab**

Receive, 2.9-4.1, 6.5-7.3, 10-10.5, 13.2-14.7, 17.1-22; 23.2-30.4 MHz; transmit, as specified.

As specified.

Receive, 0.3 A (maximum volume, no signal);<sup>3</sup> transmit, 2.5 A (maximum), tested at 13.8 V.

**Receiver Dynamic Testing**

Noise floor (MDS), 700 Hz filter:<sup>4</sup>

	<i>Preamp off</i>	<i>Preamp on</i>
3.5 MHz	-133 dBm	-137 dBm
14 MHz	-131 dBm	-138 dBm

Blocking dynamic range (700-Hz IF filter):

	<i>Preamp off</i>	<i>Preamp on</i>
3.5 MHz	136 dB	127 dB
14 MHz	136 dB	128 dB

Two-tone, third-order IMD dynamic range (700-Hz IF filter):

	<i>Preamp off</i>	<i>Preamp on</i>
3.5 MHz	100 dB	95 dB
14 MHz	97 dB	98 dB

	<i>Preamp off</i>	<i>Preamp on</i>
3.5 MHz	+20.9 dBm	+5.1 dBm
14 MHz	+21.6 dBm	+6.9 dBm

14 MHz, preamp off, +75 dBm; preamp on, +76 dBm.

S9 signal at 14 MHz: preamp off, 115 μV; preamp on, 19 μV. 2 W at 0.6% THD into 4 Ω.

Range at -6 dB points, (bandwidth):<sup>5</sup>

CW-N: 625-1000 Hz (375 Hz)

CW-W: 211-1471 Hz (1260 Hz)

USB: 370-2222 Hz (1852 Hz)

LSB: 526-2000 Hz (1474 Hz)

Preamp off, 89 dB.

Preamp off, 74 dB.

**Transmitter Dynamic Testing**

SSB, typically 1-10 W; CW, typically 0.1-12 W.

44 dB. Meets FCC requirements for spectral purity.

51 dB.

>56 dB.

See Figure 1.

9 to 41 WPM.

See Figure 3.

S9 signal, 35 ms. Unit is suitable for use on AMTOR.

SSB, 23 ms.

See Figure 2.

All dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.

<sup>1</sup>Plus 1.8-2 MHz with 160-meter option.

<sup>2</sup>Receive range extends beyond the transmit range but performance there is not specified.

<sup>3</sup>Special settings for battery-powered operation can be engaged that reduce the receive current requirement to 153 mA.

<sup>4</sup>Refer to the IF/audio response data for the actual filter bandwidth.

<sup>5</sup>Filter passband ranges are adjustable (see text).

partially built K2 acts as a voltmeter, ammeter, frequency counter and wattmeter!

**Let's Get Started**

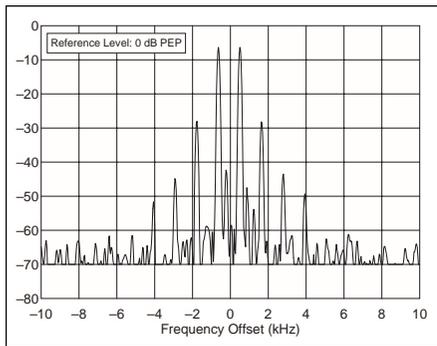
The K2 arrives neatly packed inside a small cardboard box. Inside you will find plastic bags labeled with the corresponding circuit board names: "Control," "Front Panel," "RF" and one bag with assorted hardware labeled "Misc." None of the

components are surface-mount. The cabinet panels, display, speaker and main tuning knob are wrapped in kraft paper to protect them from scratches or other damage.

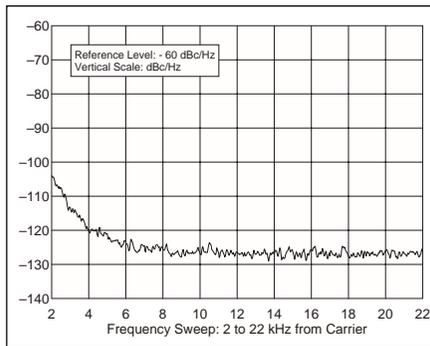
The *Owner's Manual* is a 162-page spiral-bound document. The detailed assembly and alignment instructions are definitely reminiscent of the legendary Heath manuals. There is currently a short list of manual errata, with clear instructions about

the required changes in the text. A separate sheet lists a few important precautions.

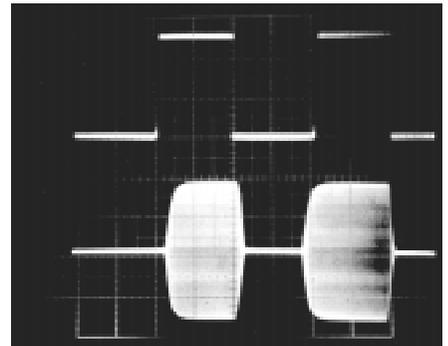
Some builders have reported completing their basic K2s in about 35 hours—I prefer to work at a more relaxed pace. If you simply stuff components on the boards and solder them in, you will learn little about the circuit and even less about electronics. By locating the components on the schematic diagram and tracing the circuit



**Figure 1—Worst-case spectral display of the Elecraft K2 transmitter during two-tone intermodulation distortion (IMD) testing. The worst-case third-order product is approximately 29 dB below PEP output, and the worst-case fifth-order product is down approximately 44 dB. The transmitter was being operated at 10 W PEP output at 28.350 MHz.**



**Figure 2—Worst-case spectral display of the Elecraft K2 transmitter output during composite-noise testing. Power output is 10 W at 3.52 MHz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.**



**Figure 3—CW Keying waveform for the Elecraft K2 showing the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 10 W output at 14.2 MHz.**

as you go, you can actually begin to understand how all these pieces come together to make a radio. Altogether, we spent close to 60 hours building the review radio, including the SSB adapter and noise blander options.

Assembly begins with the control board and the front panel (display) board. A photograph of the completed control board appears in Figure 5. Once these are finished, you are instructed to add a few components to the main board—the RF board—and then take some preliminary resistance measurements. Some of the enclosure panels are assembled and the RF board is temporarily installed. The display board and the front panel board are then plugged into the RF board in preparation for some initial power-on tests.

Wait. Did that say “plug in” these boards? Yes, that’s right. There are virtually no wiring harnesses or point-to-point wiring in the K2. All the connections between the subassembly circuit boards are accomplished with mating multipin connectors. Elegant!

Once I had reached this point I plugged in the power supply cable and—with fingers firmly crossed—pushed the ON button. ELECrAft popped up in the display, shortly followed by 7100.0! Success! It worked. Now to run through the first round of alignments... But wait. The buttons didn’t seem to be responding properly. I pressed a few buttons, held the **LOCK** button, then pressed it again to return to normal VFO operation. Now everything seemed fine—but there must be something that’s not quite right. Now what? It was 10 PM, and I wanted to work on it a bit longer. I sure couldn’t call Elecraft at that hour...

### Enter the Internet

Regis—I’ve decided to use one of my

“lifelines.” There’s a K2 e-mail reflector with lots of other builders on line. I wondered if anyone else had run into this problem. I fired off a quick message to the reflector and waited for a response.

I received a quick reply from Tom Hammond, N0SS. Tom is one of the “Field Testers” who built one of the first 100 K2 kits and provided lots of feedback and suggestions to Wayne and Eric. Tom told me to check the solder connections on the pushbuttons. A few other replies came in from builders who hadn’t run into this type of problem, but they encouraged me to make a more thorough visual inspection. It was getting late; I closed up shop for the night.

The following day I decided to give Wayne a call. He helped me narrow it down to the **A=B** and **RIT** switches. Wayne explained that two of the switch posts feed a signal through from one portion of the circuit board to another, and he believed that that was the source of my problem.

After reheating the posts and flowing on a bit more solder, the problem was solved.

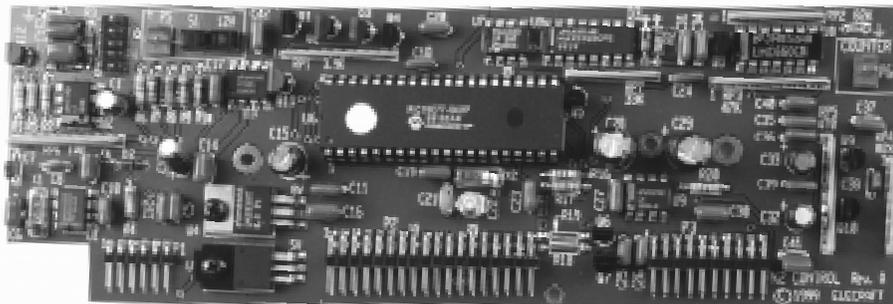
It is certainly possible to build a K2 without Internet access, but there is a wealth of information available there. In fact, this may be one of Elecraft’s most valuable assets. Many questions are answered by individuals who encountered similar problems. In addition, there are discussions about circuit modifications and updates from Elecraft.

The technical support from Elecraft is excellent. Wayne and Eric monitor the reflector, and if they see a question that wasn’t answered satisfactorily they will soon fire off a note with the corrections or clarifications. Of course for real tough problems, e-mail sent directly to Elecraft or a phone call to their technical support line is sure to get you the help you need. What other manufacturer lets you communicate directly with the design team?

Just monitoring the reflector can be



**Figure 4—The three main circuit boards and their corresponding parts bags. At this stage I had completed the control board and was working on the display board.**



**Figure 5—A closer look at the completed control board. The glass epoxy boards have plated through holes and the component identifications and locations are clearly silk-screened on the boards.**

quite informative. Someone mentioned that they really missed not having a dimple on the main tuning knob. Someone else noticed that the knob on their Yaesu FT-100 was about the same size. Subsequent postings indicated that the parts sales staff at Yaesu quickly learned that all these knobs were being ordered for Elecraft K2 radios—not Yaesu FT-100s. Within two days they had sold out their entire stock of replacements!

In another posting, a European builder circulated a question regarding degraded receiver performance after installing the noise blanker option. After several questions about measurements and hearing from a few others who had noticed a similar effect, Wayne and Eric went to work tracking down the problem. Their response? A change in the design of the noise blanker and an upgrade kit for the earlier version.

The optional noise blanker that we received with our initial K2 shipment several months ago was the “original” version. With it installed, our lab tests revealed reduced intermodulation distortion dynamic range and blocking dynamic range and a degraded third-order intercept point—even with the noise blanker deactivated. Elecraft provided us with the upgrade. Table 1 reflects the performance that we measured with the latest version of the noise blanker installed.

If you have Internet access, once you’ve

ordered your kit, I highly recommend that you subscribe to the reflector. Send an e-mail to [majordomo@qth.net](mailto:majordomo@qth.net) with **subscribe elecraft** in the body of the message. You can also view the list archives at <http://www.elecraft.com>.

### Back to Building

After completing the first-stage alignment and testing, the boards are removed from the partially completed enclosure and the remainder of the components are installed on the RF board. Most of your efforts will be in assembling the receiver section. Here you will wind your first toroidal inductors and transformers. The K2 contains a total of 14 toroidal inductors and six toroidal transformers. In addition, there is one transformer wound on a binocular core.

Because time was running short to complete this review for this special QRP issue, once I’d finished up the receiver section, I turned the kit over to Zack Lau, W1VT, for completion of the transmitter section and the final alignment. Zack reported no major difficulties, except that I had installed RFC3 in L16’s spot and vice versa. This caused some problems with the receiver on 40 and 80 meters. Once Zack located and corrected my error, everything was fine. In my defense, the label for RFC3 is directly between the locations for these

two inductors. Don’t let this happen to you! Be careful to identify the correct location for *every* part before you install it, and recheck before soldering.

### Alignment and Testing

The alignment steps involve adjusting a few tuned inductors and variable capacitors to set the voltage controlled oscillator and the various tuned circuits. The control software performs a procedure to linearize the VFO operation across the tuning range. You also adjust the crystal filter settings and the BFO settings for each mode and band.

The filter scheme is especially interesting. Most commercial transceivers come with a “stock” filter for sideband and a narrower filter for CW operation. In addition to these there is usually room to add one or two additional optional filters. The K2 uses a scheme of diode switching and software control to provide four crystal filter settings for each mode. These are adjustable, so you can tailor the bandwidths to suit your operating style. The factory default settings for CW are 1.5 kHz and 700, 400 and 100 Hz.

You also set up four filter bandwidths for SSB reception. The defaults are 2.2, 2.0, 1.8 and 1.6 kHz. (You can still receive SSB, RTTY and the data modes even with a basic “CW Only” K2).

If you should decide to add the SSB adapter, there is yet another filter—optimized for SSB operation at about 2.3 kHz. In that case, filter 1 is optimized for SSB transmit and filter 2 is optimized for SSB receive. Filter 3 can be set as a narrow bandwidth SSB filter. The default is 1.6 kHz. Filter 4 can even be set at a narrower bandwidth—useful for the data modes.

Some builders have reported confusion about the procedures for aligning the filters and BFO settings. When we followed the steps in the *Owner’s Manual* we came close, but the settings were not “perfect.” There have been several discussions about this on the e-mail reflector, including postings about programs to download that will allow you to use your computer’s sound card as an audio spectrum analyzer. Elecraft has indicated that they will be changing some of the procedures in the manual.

The K2’s control software includes extensive diagnostics. If you turn on the radio and the display shows “LOW BATT,” the software is telling you that the battery or power supply voltage is too low, a display of “HI-CUR” on transmit indicates that the user-programmable current level was exceeded, and so on. Troubleshooting charts are provided. This could be especially helpful if you run into difficulties getting the radio working initially.

#### How Did It Do in the Lab?

The technical performance of radios comes out during lab testing. Usually, the transmit IMD and receiver dynamic range results separate the toys from the big boys. Usually!

On SSB, this radio is clean. As seen in Figure 1, the high-order intermodulation products are quite good. The CW keying is nice, too, as shown in Figure 3. No key clicks from this baby!

But where the K2 really shines is in its receiver performance. On average, transceivers positioned in the upper tiers of the popular HF product lines (in the \$2000 to \$3500 price class) exhibit blocking dynamic range measurements somewhere in the vicinity of 130 dB and a two-tone, third-order dynamic range near 95 dB. The K2’s receiver performance compares very favorably to that of the samples of the high-end radios we’ve recently examined, turning in impressive 136/97 dB figures for these parameters.

The fact that a radio in this price class—and a home-built one at that—can stand proudly in such company is a remarkable accomplishment. This is the first-generation radio that Elecraft has produced. I can’t wait to see the next one!—*Ed Hare, W1RFI/QRP, ARRL Laboratory Supervisor*



**Figure 6—An internal view with the top cover removed. The display and control board plug into the RF board along its front edge. Note the almost total absence of point-to-point wiring. The rear apron is pre-punched for a wide variety of available and proposed optional accessories.**

### A Few Circuit Details

The K2 uses a modular design that allows flexibility and opportunities for future expansion. The display board provides the user interface, including the display and all the controls. The control board contains the main microprocessor, the dc control signal circuits, the AGC circuit and the audio amplifier. The RF board serves as a “motherboard” for these two boards and any optional boards. In addition to all the RF circuitry, this board contains the I/O controller and the latching relays that select the operating band.

The receiver is a single-conversion superheterodyne that employs double-tuned band-pass filters for each band. It uses a down-conversion scheme with an IF of 4.915 MHz. The individual band-pass filters provide superior IMD performance when compared to up-converting designs that often use a single low-pass filter to remove image products. Because the BFO is microprocessor controlled, its frequency is reset for USB and LSB reception as well as CW on either side of the carrier.

In transmit, the signal flow reverses, with the output signal going through the band-pass and low-pass filters. The RF amplifier can produce over 10 W and is designed to provide good immunity to high SWR. PIN-diode T-R switching results in silent QSK operation.

The microprocessor firmware controls just about every aspect of the K2’s operation. There are many routines that run behind the scenes. For example, the PLL reference oscillator is linearized on each band by an auto-calibration routine. The results of this routine are stored in EEPROM tables for use each time you turn on the radio. The firmware also supports features like built-in test equipment, a memory keyer, dual VFOs with split operation and frequency and band stacking memories. Provisions are included for a

variety of optional modules, such as the SSB adapter, the noise blanker, the automatic antenna tuner and so on. With just 8 kilobytes of memory in the PIC 16C77 microcontroller, it’s readily apparent that the control program code has been highly optimized!

The I/O controller is a coprocessor IC. The SSB adapter board carries its own coprocessor, as do some of the other optional modules. This has several effects. It simplifies the primary control circuitry and allows the accessory coprocessors to “go to sleep” when they aren’t needed, saving valuable current for battery operation. It also reduces the amount of digital noise on the RF board that might cause receiver interference.

Speaking of saving battery current, several other power saving features are worth mention. The S meter/RF output meter LED bargraph can be set to bar, dot or off. The LCD display backlighting can be turned off. With the LCD set for nighttime operation, the LED bargraph brightness is reduced slightly and when the LCD is set for daytime operation the LED bargraph is brighter to make it easier to see. Latching relays are used for all filter, VCO and option switching, so there is no relay current drain during normal operation. By careful power management, the total receive current requirement can be as low as about 150 mA. This is an order of magnitude lower than typical HF transceivers.

The K2 uses a PLL synthesizer IC and a wide-range, band-switched voltage controlled oscillator. A 12-bit DAC gives the fine-tuning steps on the VCO, which is the PLL reference oscillator. Three DPDT latching relays select one of eight VCO ranges for the synthesizer.

A 5-pole variable bandwidth crystal filter is used in front of the IF stage. (With the SSB adapter, a separate fixed filter is

switched in.) This filter is optimized for narrow bandwidths of about 200 to 500 Hz, but it can be adjusted wider or narrower if desired. A second two-pole crystal filter follows the IF amplifier. This filter can also be tuned, but over a smaller bandwidth range. The AGC signal is derived from the IF amp output using an auxiliary low frequency IF of about 150 kHz.

### The Finished Product

The completed K2 is an HF transceiver with many of the features that we have come to expect on the ready-built commercial rigs. The small-sized front panel has a nice ergonomic design that allows my big clumsy fingers to find the right controls without knocking all the other settings out of whack. The well-thought-out layout results in very intuitive operation.

The main tuning knob, in the center of the front panel, enjoys plenty of space around its perimeter. Four control knobs to the left side of the front panel adjust the keyer speed, the output power, the audio gain and the RF gain. One knob to the right of the main tuning knob controls transmit and receive incremental tuning.

The rest of the control operations are handled by push-buttons. Each button serves two purposes—one when you tap it briefly and another when you hold it in for a second. Labels above and below each button indicate these functions.

With these buttons you can step up or down through the bands, directly punch in frequencies, store and recall memories (ten memories are available), select the mode, choose VOX or PTT operation, switch between VFO A and B, equalize the VFO settings, select split frequency operation, reverse the transmit/receive frequencies momentarily and automatically scan for CW signals over a programmable frequency range. You can also activate the preamplifier and RF attenuator, select the fast or slow AGC (and even turn the AGC off!), cycle through the filter options and enable RIT and/or XIT. The **SPOT** key turns on the sidetone oscillator during receive so that you can match the received tone of a CW signal to your sidetone oscillator to ensure that you are tuned to zero beat. **CW RV** lets you listen on the opposite side of a signal.

The **MSG/REC** button provides access to the 9 message memories in the built-in electronic keyer. Hold this button to begin the memory record, then tap a number button and send the message you would like to store. When you pause for more than a few seconds (or if you tap the **MSG/REC** button again) recording stops. You play the memory contents by tapping **MSG/REC** and then the appropriate number button. Messages can also be repeated at a programmable interval.

Like most transceivers these days, the K2 uses a series of menu options to control other less-used functions. For example, by tapping the **MENU** button and then turning the tuning knob until “ST L” is shown, you can adjust the sidetone level. Dial up “ST P” and you can adjust the sidetone/receive offset pitch. The “INP” setting allows you to select either a straight key or the normal or reversed input from paddles, and “IAB” selects either Iambic A or Iambic B type keying. Iambic A is similar to Curtis Iambic A mode; Iambic B is similar to Super CMOS Keyer III mode.

You adjust the keyer speed by turning the **KEYER** knob. When you do, the display changes to show the speed in words per minute. The keyer speed adjusts between about 9 and 40 WPM. A second after you stop adjusting the keyer speed, the display changes back to show the operating frequency. Turning the **POWER** knob also brings up a display of the approximate output power setting. If you hold the **TUNE** button to activate this feature, the power measuring circuit displays the output power.

If you decide to install the SSB feature, you can configure the front panel microphone 8-pin mike connector to match those of several of the common commercial manufacturers. Pin-out tables are provided to make this easy. Both the microphone gain and the level of SSB processing can be varied in menu settings. VOX operation is also included.

## Operating Impressions

Anytime I begin to operate a new radio I feel a certain excitement. There is the thrill of checking out the features on the newest equipment, along with the knowledge that what gets reported in a *QST* Product Review will help readers decide if this radio suits their needs. There is also a certain amount of trepidation that I will miss some feature or overlook some shortcoming, and that my omissions will mislead someone. I normally spend time carefully reading the operating manual, and spend a LOT of time listening to the receiver before I try transmitting.

With the K2, however, I just wanted to get on the air and make contacts! Here is a radio that I built almost entirely with my own hands. For a ham, there is no anticipation sweeter than that of making the first contact using something you assembled—an antenna, a station or a transceiver. You feel as if you installed a little piece of your heart and soul during the assembly process.

It was the Saturday morning of the Michigan QRP Contest. I rolled the power back to just under 5 W and went searching

for activity on 40 meters. In a few minutes I had Maine, Maryland and Michigan in the log. Since this was a QRP contest, I guess those contestors were listening for weak stations, but this was much easier than I expected.

I decided to load the exchange in one of the keyer memories. The nine memories each have 153 bytes of storage, which is equivalent to about 100 to 150 Morse characters.

Later that day I tuned across a small pileup on 20 meters. Martti, OG2R was running stations from Finland. Several of the stations he worked told him about their amplifiers and antenna farms. Would the K2 and my tri-bander be able to make it? I had my doubts, but I cranked the power up to 10 W and tried a couple of calls anyway. On the third call he asked for “the station ending in Bravo!” Maybe there is something to this “K2 mojo” thing they are always referring to on the e-mail reflector.

During the week I checked into the 3905 Century Club net on 75 meters. The SSB receive audio was crisp and clear. I found it very easy to tune in stations for clear voice reception. While awaiting my turn to transmit on the net, a station in Ohio called Josephine, VE7JMC, in British Columbia. I was hearing her weak signals with some difficulty—about a 3 × 3. The station in Ohio could not copy his 3 × 3 report from Josephine, even though he announced that he was running 1 kW. No contact. When it came my turn to transmit, I decided to try VE7JMC. I sent Josephine a 3 × 3 report. When I copied my 2 × 2 report from her, I was grinning from ear to ear. Several other stations called me on their turn—they wanted my QRP contact!

I also checked into the Radio Amateur Society of Norwich (Connecticut) 10-meter net. Most of these local operators know my real voice, so I thought they would be a good source of transmit audio reports. They all reported good sounding transmit audio.

## A Few Minor Complaints

Surely there must be some shortcomings to the K2 operation? I found a few points where I might wish for something different.

The RIT/XIT frequency control does not have a center detent or other convenient way to zero the frequency. You have to adjust the knob so the frequency display shows no change when you toggle between RIT on and off. RIT clear would be a handy feature, especially for contest operation.

If you hit the AGC button the display shows either “FAST” or “SLOW,” and toggles between these two indications even when the AGC is turned off. It took me a while to notice that there is a flashing

decimal point to the right of the last digit on the display when the AGC is deactivated.

While there is a considerable amount of frequency coverage outside of the ham bands, true “general coverage” receive is not included.

The main tuning knob on the review unit exhibits a very slight eccentricity. I may need to adjust the tension or spacing between the cabinet front and the knob. Repositioning the knob a quarter or half turn on the shaft may reduce this effect or eliminate it altogether.

I don’t consider any of these nits major problems.

## Conclusion

The Elecraft K2 is probably not a good choice for a “first kit,” but several first-time builders have successfully completed it. Without some component handling and soldering skills though, you could easily damage a circuit board or make some other costly mistake. If you do decide to tackle this as a first kit, work carefully!

The camaraderie of the individuals participating in the e-mail reflector, the information available on Elecraft’s Web site and the level of technical support provided by the company all combine to form a recipe for success.

Once you’ve completed the kit, you’ll end up with a modern amateur transceiver that possesses a good variety of the most desirable bells and whistles and exhibits an overall level of performance that compares very favorably with factory-built transceivers that cost several times as much (see the sidebar on page 72).

Should the time come to make a repair or to try a circuit modification to further improve the performance, you’ll have the confidence to remove the covers, study the schematic diagram, and give it a go. You may not understand all of the design details nor know why a certain component was used in a particular location, but you assembled this radio yourself, and that can make it a little easier dive in.

I would like to thank Zack Lau, W1VT, for his help completing the kit. Thanks also to Mike Tracy, KC1SX, for his help with the lab testing and to Joe Bottiglieri, AA1GW; Rick Lindquist, N1RL; and Jean Wolfgang, WB3IOS, for their assistance with this review.

*Manufacturer:* Elecraft, Box 69, Aptos, CA 95001; 831-662-8345; fax 831-662-0830; <http://www.elecraft.com/>.

*Price:* K2 Kit (CW), \$549; SSB Option, \$79; Noise Blanker, \$35; 160-meter/2nd receive antenna input, \$29; Internal 2.9 Ah battery, \$79; Internal automatic antenna tuner, \$139.

# The Alinco DJ-V5TH Dual-Band FM Hand-Held Transceiver

Reviewed by Joe Bottiglieri, AA1GW  
Assistant Technical Editor

Alinco's latest product offering for the dual-band hand-held market, the DJ-V5T, has been taking a bit of ribbing for mimicking the physical design cues of Yaesu's FT-50RD, ICOM's IC-T8A or Kenwood's TH-G71A. These H-Ts are relatively short, husky little handfuls that use "clamshell" type construction—the battery packs attach to the back side of the chassis. But hold on a minute here... perhaps Alinco should be the company credited with *starting* this trend. Their DJ-F1T was one of the first H-Ts to sport this configuration—way back near the dawn of the last decade!

## Highlights and Features

The DJ-V5T is a "one band at a time" VHF/UHF transceiver. As is the case with most of the similarly positioned dual-band H-Ts offered by their competitors, dual simultaneous receive and full duplex crossband operation is not supported. If these capabilities are important to you, you'll find them in Alinco's top-of-the-line hand-held transceiver—the DJ-G5T.

Some of the DJ-V5T's most notable features include 200 memory channels with six-character alphanumeric tagging, separate VHF and UHF call channel memories, priority watch, independent CTCSS encode and decode frequencies, tone burst, DTMF paging, autodial memories, wire cloning and a good variety of scanning arrangements. For this review we purchased the "H" version—this particular package comes with a 9.6 V 600 mAh NiCd battery pack.

Unlike most of the presently available H-Ts, the current version of the DJ-V5T does not come with expanded receive coverage outside of the amateur bands. While the FM broadcast band (76 to 108 MHz WFM) is included, reception of AM aircraft, NOAA weather radio, VHF marine, public service and commercial radio frequencies is not supported. To its credit, the entire 420 to 450 MHz range is covered. Alinco has recently released some good news concerning this lack of receive frequency agility. I'll fill you in on the details later.

## A Jump Start

The 'V5 bucks the current trend towards the use of multiple menus for basic control operations—and this makes working the radio seem very intuitive. Once I had the transceiver unpacked and the battery charged, a careful look at the legends printed above the buttons and a few minutes spent poking the various keys and twiddling the knobs and I was up and running—without ever having to refer to the

*Instruction Manual.*

While I'll admit that I have a bit of an unfair advantage (I've had the opportunity to play around with more than my share of H-Ts over the years), I'm confident that anyone with a good basic understanding of repeater operation should be able to easily duplicate this feat.

A note for first time buyers of amateur FM equipment: if "repeater offset" and "CTCSS encode" are unfamiliar terms, do yourself a favor and find an Elmer to help you over the first few hurdles!

The manuals included with most of the current VHF/UHF gear will not provide detailed information on the fundamentals of repeater operation. You wouldn't rely on an automobile owner's manual for basic driver instruction—would you?

Possible sources for help range from local hams and radio clubs to Internet reflectors and discussion groups. You can also find excellent explanations and useful tips on an incredible range of Amateur Radio operating topics—including FM repeater and simplex operation—in *The ARRL Operating Manual* (ARRL order #6141) and *Ham Radio Made Easy* (ARRL order #5374).

The *Instruction Manual* that's packed with the transceiver is well organized. The instructions are clearly explained and nearly every section includes helpful diagrams. Alinco also supplies a complete and legible schematic.

## Control Arrangements

The 'V5's rotary encoder and volume control are a dual concentric knob set located on the left side of the top panel. The main knob controls the encoder; volume adjustments are made using the lower ring. These knobs are large, easy to grip and slightly tapered. Speaker/microphone jacks and a female SMA antenna connector are also positioned on the top panel.

The squelch can be set to one of six levels by pressing and holding a **MONI/SQL** button and dialing through the choices with the encoder.

A large LCD window is located on the upper portion of the front panel. It displays black segments on a gray background. The frequency digits and the icons that appear in the display are large enough for very easy viewing. A side mounted **LAMP** button will activate backlighting for both the display and the DTMF pad. Backlighting can be set to automatically switch off a few seconds after the last keystroke or to remain on until manually deactivated.

The middle section of the front panel includes a column of three oval-shaped buttons—**POWER**, **FUNC/LOCK** and **BAND/**

**SET**. To the right of these is a large speaker grill. A red/green transmit/busy LED indicator is positioned just above the grill.

The lower portion of the front panel contains the typical four-row four-column DTMF pad. Each of these keys has multiple assignments. The primary operations are printed in white lettering to the left of the buttons, the secondary operations—accessed by first pressing the **FUNC/LOCK** button—are printed in orange just above. All of the legends are easy to read and generally logically titled—**PO** for power output level, **T SQL** for CTCSS settings, **RPT** for repeater offset frequency and direction and so on.

There's only one menu—the "set" menu. This contains just six items—keypad beep, bell paging, auto power off, battery save, DTMF autodial transmit delay time and a "split" setting.

While the other operations in this menu are self-explanatory, the split feature is unique. When activated, split allows you to use a memory frequency for transmitting and the VFO frequency for receiving. This arrangement can be used for crossband half-duplex operation—AO-27 satellite communications is one example.

## Operating Impressions and the Lab Numbers

As I mentioned earlier, operating the DJ-V5T seems pretty straightforward.

### BOTTOM LINE

The Alinco DJ-V5TH dual-band H-T squeezes respectable performance and a nice selection of features into a compact, rugged looking chassis.



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**Table 2****Alinco DJ-V5TH, serial number T000670****Manufacturer's Specifications**

Frequency Coverage: Receive, 76-108 MHz (WFM), 144-148 MHz, 420-450 MHz; transmit, 144-148 MHz, 420-450 MHz.

Power requirements: 4.0-15.0 V dc; receive, 0.22 A; transmit, 1.6 A (maximum, high power).

**Receiver**

Sensitivity: 12 dB SINAD, VHF, 0.16  $\mu$ V; UHF, 0.18  $\mu$ V; WFM, 1.0  $\mu$ V.

Two-tone, third-order IMD dynamic range: Not specified.

Two-tone, second-order IMD dynamic range: Not specified.

Adjacent-channel rejection: Not specified.

Spurious response: 60 dB.

Squelch sensitivity: Not specified.

Audio output: 500 mW at 10% THD into 8  $\Omega$ .

**Transmitter**

Power Output: (H / L1 / L2), 6 / 1 / 0.5 W.

Spurious signal and harmonic suppression: 60 dB.

Transmit-receive turnaround time (PTT release to 50% of full audio output): Not specified.

Receive-transmit turnaround time ("tx delay"): Not specified.

Size (hwd): 3.8x2.3x1.6 inches; weight, 11.8 ounces.

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**Measured in ARRL Lab**

Receive and transmit, as specified.

Receive, 0.21 A (maximum volume, no signal); transmit, 1.4 A, tested at 13.8 V.

**Receiver Dynamic Testing**

FM, 12 dB SINAD, VHF, 0.14  $\mu$ V; UHF, 0.16  $\mu$ V; WFM, 100 MHz, 0.74  $\mu$ V.

20 kHz offset from 146 MHz, 52 dB,  
10 MHz offset from 146 MHz, 81 dB;  
20 kHz offset from 440 MHz, 51 dB,  
10 MHz offset from 440 MHz, 69 dB.

VHF, 69 dB.

20 kHz offset from 146 MHz, 55 dB;  
20 kHz offset from 440 MHz, 53 dB.

IF rejection, VHF, 96 dB; UHF, 143 dB;  
image rejection, VHF, 97 dB; UHF, 60 dB.

At threshold, VHF, 0.14  $\mu$ V; UHF, 0.16  $\mu$ V.

633 mW at 10% THD into 8 $\Omega$ .

**Transmitter Dynamic Testing**

146 MHz, 4.0 / 0.6 / 0.3 W; 440 MHz,  
3.4 / 0.6 / 0.3 W with EBP-46N battery pack;  
146 MHz, 5.5 / 1.1 / 0.4 W; 440 MHz,  
5.6 / 1.1 / 0.5 W with 13.8 V dc.

VHF, 65 dB; UHF, 60 dB. Meets FCC requirements.

Squelch on, S9 signal, VHF, 172 ms; UHF, 168 ms.

VHF, 450 ms; UHF, 540 ms.

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Nearly all of the control settings you'll typically need to program and use this radio can be easily located using just the keypad labels. You won't find yourself constantly scrolling through hidden menus searching for the particular setting you need to vary.

The receive audio—for both FM amateur reception and WFM FM broadcast band reception—is excellent. The level and quality of the audio is remarkable. I often found myself using the radio for listening to FM music and news broadcasts at my desk at work. Overall, the audio is more than loud and crisp enough for hand-held and mobile operations, and should be plenty adequate for even the noisiest public service applications.

The transmit audio was typically described as "communications quality." The low frequencies in your voice are somewhat attenuated. There is a two-level mike gain control. The "HI" setting seemed to work best for my voice level—but I know of a few particularly enthusiastic operators on our local repeater that could definitely benefit from the "LOW" microphone gain setting.

If you look over the lab data presented in Table 2 and compare these figures to the numbers that we measured on the other one band at a time dual-band H-Ts we've looked at recently, you'll find that the performance of the DJ-V5T stacks up very well to the competition.

It scores near the top of this class for amateur band receive sensitivity. The VHF two-tone third-order IMD dynamic range at 10 MHz offset also came in at the high end of the range. Couple this with decent IF and image rejection numbers and a very respectable adjacent channel rejection figure, and the DJ-V5T proves that it has what it takes to live up to Alinco's reputation for radios that will perform well even in tough RF environments.

The DJ-V5, with the snap on belt clip attached, is nearly 2 inches deep. As with a number of these clamshell-style radios, this can make right-handed operation challenging. Even with my fairly large hands, it is a bit of a stretch to hold the unit comfortably in my right palm and still be able to reach the PTT button with the tip of my index or middle finger. Left-handed use seems much easier—my thumb naturally lands in the proper position to operate the PPT, MONI/SQL and LAMP buttons, and even the POWER, FUNC/LOCK and BAND/SET buttons on the left side of the front panel are in easy left thumb range.

The volume control could use a bit more drag in its action (or perhaps a slight reduction in its diameter)—I often found myself inadvertently changing the volume setting while turning the rotary encoder. With the level of audio this radio is capable of, it can sure cause a scene when the

squelch breaks with the volume cranked up all the way!

**Imminent Improvements**

Alinco recently began advertising an improved version of this transceiver—and this will be great news for the scanner buffs among us. The new version will provide a vastly expanded receive range right out of the box (no surgery required)—an impressive 76 to 999 MHz range (yes folks, the cellular phone frequencies will be excluded)—and will also include the AM receive mode for those who enjoy aircraft band listening.

Alinco is offering this new version in a choice of two colors—either the traditional black plastic enclosure or a new "see through" shell. The plastic used in this one has a slight blue tint to it.

It looks like Apple Computers and the pager manufacturers may have started a bit of a design trend here... Is the ham radio market ready for such a stylin' transceiver? I guess we'll just have to wait and see.

*Manufacturer:* USA Alinco Branch, 438 Amapola Ave, Suite 130, Torrance, CA 90501; 310-618-8616; fax 310-618-8758; <http://www.alinco.com>.

Manufacturer's suggested retail price: \$350. Typical current street price: \$280.

*Bid solicitations for Product Review equipment appear on page 46.*

