

● Neill G4HLX installing a toroid during the construction of the Elecraft K2 transceiver kit (see text).



order a K2. I was particularly attracted by the prospect of building it from a kit and I wasn't disappointed by my decision.

Built at a steady pace over the winter months, it was a real pleasure. The completed K2 has turned out to be a performer that entirely lives up to its reputation.

It's a very well thought-out design offering performance to seriously rival the top of the range of the 'big three' Amateur Radio equipment manufacturers. There's a full set of features to make it a joy to operate, albeit at low transmit power in its basic form.

The Concept

The Elecraft K2 in concept is a small, light, easily transported h.f. c.w and (optionally) s.s.b. transceiver covering, in its basic form, the 3.5, 7, 10, 14, 18, 21, 24 and 28MHz Amateur bands, with 1.8MHz an optional extra.

Output power is variable from 1 to over 10W. A 100W optional power amplifier (p.a.) is also now available. A 12V supply is required. (an optional internal rechargeable battery can be used for portable operation).

A true variable-width crystal filter

Building & Using The Ele

Neill Taylor G4HLX, well known for organising the PW 144MHz QRP contest...has recently enjoyed building a high performance kit transceiver. It was quite an experience and no surface mount devices were involved!

I've always thought of a soldering iron as an essential tool for Amateur Radio. It's just as important as a microphone or Morse key in my opinion!

However, an all home-constructed station is rare nowadays. If a high-performance station is required, with all the operational conveniences offered by modern transceivers, most Amateurs buy equipment made by one of the big commercial manufacturers.

Home construction is mostly confined to accessories and add-ons to a commercial rig at the heart of the station. Well, that's how G4HLX operated, until I came across the K2, an h.f. transceiver designed by **Wayne Burdick N6KR** and **Eric Swartz WA6HHQ**, and supplied as a kit by Elecraft, their small company in Aptos, California in the USA.

High Performance

According to the comments I'd heard, the K2 was a kit which provided high performance -

especially in the receiver. It also included all the main operational features that are needed on today's Amateur bands.

I couldn't believe it as I read of K2 users abandoning expensive commercial transceivers in favour of a kit! Yet these opinions were supported by lab measurements made by the **American Amateur Radio Relay League (ARRL)** and published in their journal *QST*. The article indicated quite superb receiver performance, with excellent sensitivity, third-order intercept point, and overall blocking dynamic range.

"The K2's receiver performance compares very favorably to that of the samples of the high-end radios we've recently examined"...so wrote ARRL's Lab supervisor **Ed Hare W1RFI** (*QST*, March 2000, complete with American spelling in the quotation!).

Since I was on the look-out for a portable rig, particularly one with a good receiver - high dynamic range and sharp intermediate frequency filters were a must - I decided to

is featured in the receiver. The dual variable frequency oscillators (v.f.o.s) have split-frequency capability, and three tuning rates. It also has RIT/XIT, and ten memories which also store mode and other settings.

An iambic c.w. keyer with a nine message memory is included. A menu system is used to set a range of configuration settings, and many of the settings are stored separately for each band.

Additional options include noise blanker, an active audio filter. A serial interface for computer control, and a versatile internal automatic antenna tuning unit (a.a.t.u) are available.

Substantial Project

Building the Elecraft K2 is a **substantial project and it's not really suitable for a beginner**. On the other hand, the clarity of the instruction manual, the standard of the printed circuit boards (p.c.b.s) and the quality of the components supplied, make it a straightforward process.

Experience has taught me...take

your time over construction, double-checking that everything is being done correctly! Completion of the basic K2 is estimated to take a total of about 40 hours - in my case it was a little less than this, divided into many sessions over several weeks.

No special tools are required, but it was a good excuse to buy a new temperature-controlled soldering iron. I also bought a new pair of side-cutters, good flush-cutting ones to trim component leads as close to the board as possible.

A standard multimeter is needed, but no special test equipment is required. **The K2 circuit itself contains all the measuring devices needed for testing and alignment.**

Unpacking the kit, **Fig. 1**, is a little daunting, there are so many bits! But they are well organised into labelled bags, and flicking through the instruction manual soon gives you a sense of confidence.

Incidentally, the manual **really is excellent**, with detailed, unambiguous step-by-step instructions, and helpful clear illustrations. To aid with identification of the components, the complete parts inventory includes photographs of most of them. (The manual is also

ensuring that everything has been done correctly. Early in the assembly, you complete the built-in digital voltmeter and frequency counter, to be used when setting-up.

Great Moment!

A great moment arrives...at the end of the second stage of the r.f. board assembly, when the receiver is working on the 7MHz band...you can connect up an antenna and hear signals!

When I got to the second stage...I was at once re-assured that I was building a superior receiver. Signals were being so clearly heard above a quiet background noise level (in contrast to the constant 'mush' of noise that I had become accustomed to) on 7MHz.

Toroids & Transformers

One of the more time-consuming aspects of construction is the winding of toroid inductors and transformers. **There are over 20 of these, Fig. 2**, although some have only a few turns. In fact I found they could be wound quite quickly, and again the instructions are very clear.

However, if you really can't face

maximum power output. The built-in power meter is quite adequate for this purpose.

Optional Modules

The optional module kits are up to the same standard as the main unit, and each came with similarly clear instructions. The s.s.b. board, which most owners will want to add, has a higher density of components than the other boards, and thus demands even more care in assembly. A really fine tip soldering iron is particularly useful here. **However, nowhere in any of the circuits are surface-mount components used, so the tricky business of handling and mounting these is avoided.**

I completed construction of the K2 and nearly all the optional boards, **Fig. 3**, with no problems whatsoever. Double-checking component placing before soldering (as recommended) caught any mistakes I'd made. Everything was finished without having to de-solder or correct anything!

All resistance checks and voltage measurements at every stage fell neatly in the range advised in the manual. It really couldn't have been any smoother.

craft K2 HF Transceiver

available to download from the Elecraft website).

Three Boards

The K2 circuitry is accommodated on three main p.c.b.s (plus any optional modules). They're connected by multi-pin plugs and sockets, and all input/output connectors are also on the boards. **So there's almost no wiring to do** - assembly is mainly the business of installing components onto the p.c.b.s. These are very good quality, with plated-through holes and component outlines and identifications printed on both sides.

The three main boards in the basic K2 are (1) **control board**, which has the microprocessor and related circuits, as well as the audio output stage; (2) the **front panel board**, which holds the display and control push-button switches and potentiometers; and (3) the **r.f. board**, which has the main transmitter and receiver circuits.

Construction proceeds in stages through the three boards, with tests to be performed at the end of each,

all the toroid winding, it's possible to buy them ready-wound from a third party supplier. **But my advice is just to get on with it and wind them** - it's 'good for the soul' in my opinion!

Alignment Straightforward

Alignment is done by making a few measurements and adjusting menu settings: for example, to correctly define the beat frequency oscillator (b.f.o.) frequency for each filter setting.

The process of v.f.o. linearisation for all the bands is handled entirely automatically by the microprocessor! You just select the appropriate menu item and sit back for a few minutes while the process is worked through.

Peaking of the bandpass filters for each band is done by adjusting trimmer and inductor cores for



A Problem?

If, however, I had problems...it was good to know that help was available. Firstly, there's the 'troubleshooting' section in the manual. Secondly,

● Fig. 1: "The kit looks a little daunting at first" says G4HLX "but it's beautifully packed and easy to identify". (see text).

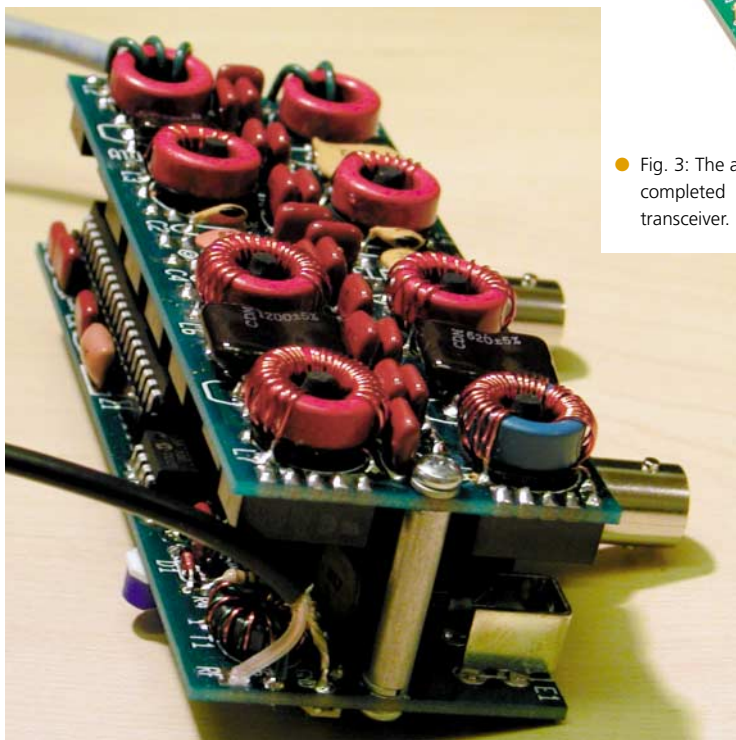
Elecraft's support service can be contacted by E-mail. Although I had no need to use this myself, it's clear from comments of people who've done so, that the service is prompt and efficient.

Thirdly, **there's the most useful resource of all:** the Elecraft E-mail list. This is an E-mail reflector to which anyone can subscribe, and exchange messages in a forum of many owners of Elecraft rigs.

Using the 'reflector'...you can post a query about anything about which you are uncertain, and get responses from others who have been through just the same problem. Even if you never have to do this, it's interesting to read the discussions on the E-mail list!

You may subscribe to the e-mail

- Fig. 2: Toroidal type inductors form an essential part of the kit construction. Troubled by toroids? Don't worry there's a way out! (See text).



list if you're just thinking about ordering a K2 kit. (You'll learn a lot from the discussions and experiences of other users!). You can subscribe on the website <http://mailman.qth.net/mailman/listinfo/elecraft> I selected the option for the 'digest' version (this sends a single daily E-mail compilation of all the day's messages).

The other invaluable resource for K2 constructors and operators is the Elecraft Web site, www.elecraft.com which contains a wealth of information.

What You Get

Now let's take a look at what you actually get for all this effort in constructing a K2! To start...the K2 is particularly well suited to the c.w. operator (s.s.b. is also well catered for...if you've included the s.s.b. option).

The v.f.o. is tuned by the main dial with a frequency step of 10, 50 or 1000Hz. Specific frequencies can be entered on the keypad. **Band Up/Down** buttons switch through all amateur bands from 1.8 to 30MHz (assuming the 1.8MHz option is installed). On each band the frequencies for both v.f.o.s A and B, are stored, and can be easily put into

Ten memories are available for storing frequencies and other settings.

Crystal Filtering

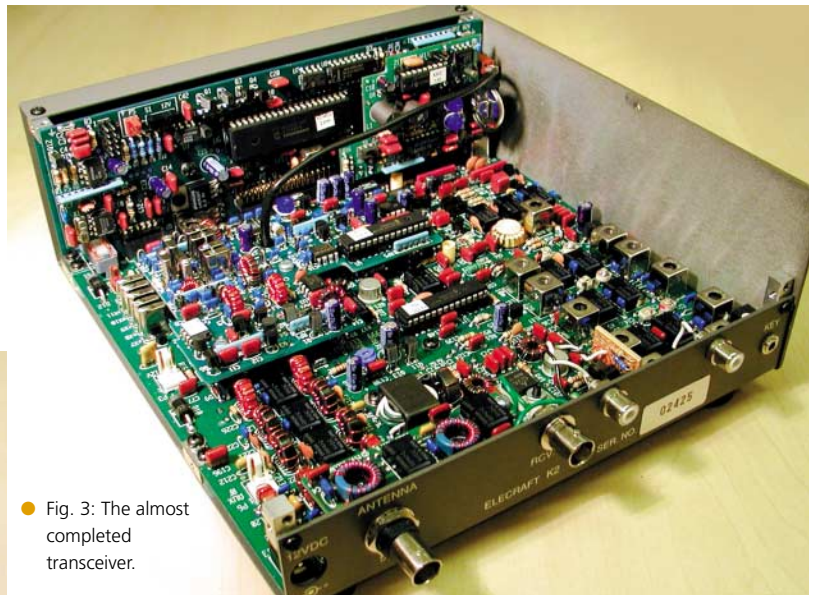
A key feature of the K2's receiver is the crystal filtering, provided by a variable-bandwidth 5-pole filter followed by a further 2-pole filter. All are at the single i.f. of 4.915MHz.

The bandwidth for c.w. can be set to any value from under 200Hz

level settable in the menu).

The internal iambic c.w. keyer can send at speeds from 9 to 50w.p.m., and has nine c.w. message memories which are easy to programme and to play back, including repeating and chaining of messages.

Each message memory is 250 bytes long, ample for CQ calls and standard QSO information. A fast play-back mode can be set whereby a single button press will start the



- Fig. 3: The almost completed transceiver.

to about 2kHz. Four values can be stored and easily selected by pressing the **XFIL** button which toggles through all four.

The optional s.s.b. board has its own 7-pole crystal filter of about 2.2kHz width - this is always used on transmit. However, while on s.s.b. receive you can chose four further settings selected by the **XFIL** button, either using the s.s.b. filter or the main variable-width filter.

For each of the settings a different carrier insertion frequency can also be set, permitting a kind of 'i.f. shift' as well as 'i.f. width' capability. All this can take quite a lot of setting-up to really optimise to your preferences...but by starting with the values suggested in the manual gives a configuration that's certainly good enough to get going with.

Solid State Switching

The K2's transmit/receive switching is all solid state, and provides smooth full break-in c.w. operation. Voice operated (VOX) transmission is available on s.s.b. (this option also includes an effective speech processor circuit, with compression

sending of a selected message. Various parameters of the keyer behaviour can be adjusted in the menu settings. Of course, a 'straight' key can be used instead if you prefer!

Power Output

Power output is continually variable from approximately 1 up to around 15W (maximum power varies by band and according to supply voltage). As the power control is turned, the display shows the requested output power (a nice feature), and similarly as the c.w. keyer speed control is turned, the w.p.m. value is displayed.

When the 'tune' button is pressed a carrier is sent and its measured output power is displayed. If the optional a.a.t.u. is installed, this shows both forward and reverse power, and a display of s.w.r. value is also possible.

The LCD Display

Normally the main l.c.d. display, **Fig. 4** on the completed and 'ready to go' transceiver) shows the operating frequency, of course, but by pressing the **Display** button, it will show the supply voltage and

total current consumption (very useful!). **A maximum current can be set via a menu option, and output power is then limited to keep the current below this value.**

If the optional audio filter module is installed, this also provides a real-time clock, so that another press of **Display** shows the current date and time. A vast range of menu settings can be displayed...and many settings and parameters can be adjusted this way.

There are two programmable front-panel buttons, which can be set to perform your choice of functions, to save delving into the menus for common operations. Also available is an optional computer I/O interface, allowing remote computer control of most of the K2's functions.

Audio Filter

The optional active audio filter provides a very narrow (80Hz) bandwidth which really pulls c.w. signals out of the noise. It can be switched in or out with a single button press, or can be configured to give either one or two stages of filtering. It also provides a low-pass filtering of received s.s.b. audio.

I've found that combining the sharp audio filter with a narrow setting of the crystal filter has enabled me to copy c.w. signals that are simply inaudible on my other transceiver (a current model from a Japanese manufacturer).

Another option is a noise-blanker, which is effective for pulse-type noise, such as car engine ignition interference, electrical motor noise, etc. It has two pulse-width settings and two threshold level settings, selectable by front-panel key presses. The K2's noise blanker eliminates ignition noise effectively.

If the 1.8MHz board is fitted, this also provides a separate receive antenna input. This is commonly used by 'Top Band' DX enthusiasts.

Internal Battery

The internal battery option is a 2.9Ah sealed lead-acid type. It's charged whenever an external supply of sufficient voltage is connected. Carefully design minimises the K2's current consumption and menu settings allow savings such as switching off

the l.c.d. display illumination and using only a single l.e.d. in the S-meter/power output indicator.

With the internal battery the K2 really is a compact unit (its size is 85 x 200 x 250mm). I found its portability very effective when I used it on a camping holiday in France, with a wire antenna slung over a nearby tree.

Despite relatively poor band conditions, I had good QSOs including several transatlantic, and



● Fig. 4: Ready to go...a home-brewed high specification transceiver (see text).

one very satisfactory contact with G3XGC/P in Cambridge who was using his K2 and an **indoor** dipole, exchanging 559/549 reports on 7MHz.

Automatic Antenna Tuner

The final *piece de resistance* is the automatic antenna tuner unit (a.a.t.u). This option (lots more toroids to wind!) matches a wide range of antenna impedances on all bands. The specification says it will match up to 10:1 s.w.r., and I found that this meant that any random length piece of wire could be matched.

It works by switching (with latching relays) a combination of 256 inductance values with 256 capacitance values in two configurations. Within a few seconds it finds the optimum combination, the measured s.w.r. being shown on the l.c.d. display.

The a.a.t.u. remembers the setting for each band, instantly recalling it when you later switch back to the band. I've used this very effectively with my random-length doublet fed with 300Ω ribbon cable and a 4:1 balun. The effect is like having a tuned multi-band antenna.

The a.a.t.u. also provides two separate antenna connectors (all r.f. connectors are BNC), so you can switch between two antennas by a single button press (this selection is also remembered on a per-band basis).

Transverter Bands

A feature I also particularly like is the definition of up to three extra **Transverter** bands (If enabled, they appear as extra bands above 28MHz). Ideal for use with v.h.f./u.h.f. transverters, the extra bands retain separate stored per-band settings like the normal bands, together with some specific items such as the frequency to be displayed and any offset to be

applied if the local oscillator in the transverter is not exactly accurate. I have used this very effectively with a 28/144MHz transverter and the effect is just as if the K2 has a 144MHz band.

The performance of this combination is quite superb. Using it in portable 144MHz contests, **the receiver certainly surpasses anything that I've used before, in 30 years of v.h.f. contesting.**

Good Design

Every aspect of the K2 appears to be the product of good design, and well thought-out functions that match what's actually needed for effective operation. (Not just the endless addition of the bells and whistles found on some other rigs).

The resulting simple but highly optimised design results in a performance that I believe would be hard to beat...even if I had an unlimited budget. Of course, K2 owners would like to say, it's not only the design, but the standard of construction that gives it the edge!

Purists may say that kit building is not true home-brew. But I can confirm that a great deal of satisfaction is to be had from using a good transceiver that you've constructed yourself. This was, of course, well appreciated in the days of Heathkit, and it's good to have it return now, in the days of Elecraft.

PDW

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Ordering Your Own K2

The K2 kit can be ordered online from the Elecraft website, www.elecraft.com for shipping directly from the USA. The basic K2 kit is currently priced at \$599, the s.s.b. option an additional \$89. The other options range from \$35 for the 1.8MHz board up to \$159 for the a.a.t.u. Delivery is additional to this, and of course UK Customs will impose an import charge (I was charged 17% VAT plus a Parcel Force administration fee). Adding all these costs together, at the exchange rate current in September 2002 you could expect to spend in the region of £520 for the basic kit, rising to around £880 for a K2 with all the options described in this article (i.e. omitting only the 100W p.a. and computer control interface).