

# UPGRADING THE ELECRAFT K2 TO REVISION B

Rev. E, April 29, 2003

In October, 2002, the K2 transceiver was updated to incorporate many modifications that had been recommended by Elecraft or our customers. Any Revision A K2 (or Revision XC, 1999 Field Test) can be brought up to Revision B by making the changes listed in **Table 1**. K2s with serial numbers 3000 and higher already include all of the changes (except the recent *PLL Upgrade*, which is also discussed in this document). To determine which revision of the K2 you have, look at the RF board, near "ELECRAFT" label at the center.

Most of the items needed are supplied with the K2ATOBKT mod kit. Other mod kits and parts must be purchased separately as indicated in the table; these kits come with their own modification instructions. **Step 9** (AF GAIN control modification) does not require a mod kit, but you'll still need to obtain the associated application note (see page 8).

**If your present K2 firmware is older than revision 2.00A, you'll need a firmware upgrade (part # FWK2MCIO) in addition to any hardware mod kits. New firmware installation and realignment will be done in steps 11 and 12, after all desired hardware changes have been made. This ensures that calibration and test steps will only have to be performed once.**

**Table 1. Modification Steps**

<u>Modification Steps (do in order)</u>	<u>Board(s)</u>	<u>Part #</u>	<u>Pg.</u>	<input checked="" type="checkbox"/>
1. Firmware Revision Check and Parameter Save	RF	n/a	3	<input type="checkbox"/>
2. PLL Frequency Stability at 7182 kHz	RF	K2ATOBKT	5	<input type="checkbox"/>
3. Misc. RF Board Changes	RF	K2ATOBKT	6	<input type="checkbox"/>
4. 15/17 meter and 20/30 meter Band-pass Filters	RF	K2ATOBKT	7	<input type="checkbox"/>
5. BFO Temperature Stability	RF	BFOMDKT	7	<input type="checkbox"/>
5A. PLL Upgrade (Temperature compensated reference osc.)	RF	E850138	7	<input type="checkbox"/>
6. VFO ALC and 10/12 meter Band-pass Filter	RF	E850093	8	<input type="checkbox"/>
7. Second Crystal Filter Flatness	RF	XFILMDKT	8	<input type="checkbox"/>
8. First Crystal Filter Grounding	RF	n/a	8	<input type="checkbox"/>
9. AF GAIN Control Smoothness	All three	n/a	8	<input type="checkbox"/>
10. Misc. Control Board Changes	Control	K2ATOBKT	9	<input type="checkbox"/>
11. Firmware Installation	Control, RF	FWK2MCIO	10	<input type="checkbox"/>
12. Alignment and Test	Control, RF	n/a	10	<input type="checkbox"/>
13. Speaker Grille Cloth	n/a	E850089	15	<input type="checkbox"/>

**NOTE:** Not included are Rev. B board changes that accommodate the K60XV 60 meter adapter (**RF board:** VCO and 40-m low-pass filter). The K60XV manual describes these changes, which should not be made until the option is installed. Also not included are minor changes that have no impact on operation or performance (for example, **RF board:** R60 bias pot changed to a fixed 100-ohm resistor; **Control board:** switch S1 changed to a jumper block, P7).

## K2ATOBKT Mod Kit Inventory

The parts supplied with K2ATOBKT mod kit are listed below. Other mod kits referenced in Table 1 include their own parts lists.

Ref.	Description	Part	Qty
RF-C33	Capacitor, 2 pF ("2") or 2.2 pF ("2r2")	E530047	1
RF-C68	Capacitor, 10 pF	E530006	1
RF-C28,C29	Capacitor, 12 pF	E530058	2
RF-CPLL	Capacitor, 68 pF	E530007	1
RF-C174	Capacitor, 82 pF	E530038	1
RF-C30,C36	Capacitor, 470 pF ("471")	E530004	2
RF-C91	Capacitor, .001 $\mu$ F ("102")	E530001	1
CTRL-C12	Capacitor, .0027 $\mu$ F ("272")	E530055	1
RF-CRF, CTRL-C31	Capacitor, .047 $\mu$ F ("473")	E530025	2
CTRL-C42	Capacitor, 0.1 $\mu$ F ("104")	E530011	1
RF-D10	Diode, ultra low-drop Schottky, 95SQ015	E560009	1
RF-R50	Resistor, 1.5 ohms, 1/2 watt (brown-green-gold)	E500025	1
RF-R64,CTRL-R6	Resistor, 100 ohms, 1/4 watt (brown-black-brown)	E500010	2
RF-R1, R2	Resistor, 220 ohms, 1/4 watt (red-red-brown)	E500002	2
CTRL-R12	Resistor, 820 ohms, 1/4 watt (gray-red-brown)	E500001	1
CTRL-R7	Resistor, 1.78 k, 1/4 watt, 1% (brown-violet-gray-brown)	E500026	1
RF-RREFA, RREFB	Resistor, 10 k, 1/4 watt (brown-black-orange)	E500015	2
RF-R11	Resistor, 47 k, 1/4 watt (yellow-violet-orange)	E500067	1
RF-R18	Resistor, 1 M, 1/4 watt (brown-black-green)	E500024	1
RF-RFC11	Toroid, 20 turns #26 enamel on FT37-43 core	E680003	1
RF-RFC15	RF choke, miniature, 100 $\mu$ H (brown-black-brown)	E690013	1
CTRL-L1	Inductor, shielded, 82 mH ("823", dark gray, cylindrical)	E690015	1
Misc.	Enamel wire, #26, red (for RFC11)	E760002	3 ft.




**Caution:** Some parts in the K2 can be damaged by static discharge. While making modifications, use an anti-static wrist strap. Alternatively, you can touch a grounded, unpainted metal surface (do this often).



Updating the K2 to revision B involves a considerable amount of component removal. You will need a *full-size*, hand-operated vacuum desoldering tool. The Edsyn model AS196 Anti-Static Solder Sucker (\$25), is an excellent choice. **Before removing a component, straighten its leads on the solder side** (use a small tool while heating the solder joint). Next, clean out the holes using the desoldering tool. Finally, pull the component out, being very careful not to damage pads, plated-through holes, or traces on the top or bottom sides of the board.

# 1. Firmware Check and Parameter Save

Determine what revision of firmware you have by turning the K2 on while pressing and holding any switch. You'll see a display such as: **2.03d 1.07**. The number on the left is the firmware revision of the main microcontroller, U6 on the Control board. The other number is the firmware revision for the I/O controller (IOC), U1 on the RF board. Record both of the numbers here: **K2** \_\_\_\_\_ **IOC** \_\_\_\_\_.

 If your K2 firmware revision is older than **2.00A**, you'll need to install new firmware after making all desired hardware changes. You may need to install a new IOC in addition to the main microcontroller. This will be explained later.

Whether or not you plan to install new firmware, you should record your present configuration settings in **Tables 2 - 5**. The BFO frequencies (Table 5) will be needed if you make the Temperature Stability changes.

**Table 2. Menu Parameters**

Primary Menu		Secondary Menu (Rev. 2.00 up <sup>1</sup> )	
Entry	Param.	Entry	Param.
ST L		SLCH	
ST P		RATES	
T-R		DOT	
RPT		FPLY	
INP		PORT	
IAB		SPLT	
SSBA		Po28	
SSBC <sup>2</sup>	SSBC SSBCr	RTTY	
LCD		RTC	
GRPH		RIT	
OPT		ACC	
ATU		AT2/D19 <sup>3</sup>	
RANT		PA	
CAL	<b>Table 3</b>	TRN1	<b>Table 4</b>
PF1		TRN2	
PF2		TRN3	

<sup>1</sup> To switch between the **PRI** and **SEC** menus, tap **DISPLAY** after tapping **MENU**.

<sup>2</sup> If RTTY is set to **ON** (Rev 2.00 up), and **r** mode has been selected with **MODE**, the **SSBC** menu entry changes to **SSBCr**. Record both settings if applicable.

<sup>3</sup> If you have revision 2.03 or later firmware, the name of this menu entry is **D19**. Otherwise it is **AT2** (which was never used).

**Supplemental Menu Parameters:** The **DISPLAY** switch is used to access additional parameters when editing certain menu entries. These include *sidetone source* (**ST L** entry), *8R Hold mode* (**T-R** entry), *Auto-Detect mode* (**INP** entry), and *Fan mode* (**PA** entry, secondary menu). These will be set up appropriately during new firmware installation (page 10) and do not need to be recorded here.

**CAL Settings (Table 3):** To access CAL settings, use the primary menu to scroll to **CAL**, hold **EDIT** to edit the parameter, select a CAL function with the VFO knob, then hold **EDIT** again to activate the function. After recording the setting, tap **MENU** to exit, then tap **MENU** again and access the next CAL function in the same manner.

**Table 3. CAL Settings**

CAL Function	Parameter
OFF	n/a
FCTR	n/a
CUR	
TPA	n/a (stored by KPA100)
S LO	
S HI	
PLL	n/a (CAL PLL will be done later)
FIL	<b>Table 5</b>

**Transverter Band Displays (Table 4):** You'll only need to record these settings if you use the transverter bands. To access transverter band display settings, tap **MENU**, then tap **DISPLAY** to switch to the secondary menu, then scroll to the desired **TRNx** menu entry. Hold **EDIT** to access it. Tap **DISPLAY** to cycle through the five parameters for each transverter band display. To select the next transverter band setup, first tap **MENU** to return to scroll mode.

**Table 4. TRNx Band Displays (Rev 2.00 up)**

Xvtr #	On /Off	RF	IF	OFS	OUT
TRN1					
TRN2					
TRN3					

(see next page for Table 5)

**Filter and BFO Settings (CAL FIL, Table 5)<sup>4</sup>:** Before recording filter/BFO data, switch to any of the lower bands (160-17 m) so LSB/USB settings won't be swapped in CAL FIL. Connect the internal frequency counter cable to TP2 (BFO). To access filter and BFO settings, tap **MENU**, scroll to **CAL**, hold **EDIT** to access the parameter, and change it to **FIL**. Hold **EDIT** again to activate the **CAL FIL** function. Record filter bandwidth settings (e.g. **0.70**) for each mode and each filter. Cycle through the modes by tapping **MODE** and holding **CW REV** when appropriate; filters are selected using **XFIL**. (RTTY mode, **r**, and RTTY reverse are only available with revision 2.00 and up firmware. The associated secondary menu entry, **RTTY**, must be set to **ON**.) After all filter bandwidths are recorded, tap **BAND-** followed by **DISPLAY** to show the BFO frequency. Record the BFO frequencies (e.g., **4913.10**) for each mode and filter, as you did for the filter bandwidths.

**Table 5. Present Filter and BFO Settings (CAL FIL)**

Mode	FL1	BF1t	FL2	BF2	FL3	BF3	FL4	BF4
CW								
CW Rev.								
LSB								
USB								
RTTY								
RTTY Rev.								

<sup>4</sup> If you're not familiar with filter and BFO configuration, review the instructions for CAL FIL in the K2 Owner's manual, starting on page 85.

## 2. PLL Frequency Stability at 7182 kHz

Whenever the VFO is tuned to the 5 kHz band segment centered at about 7182 kHz, the PLL reference oscillator and VCO will be at exactly the same frequency. At this point, on a small percentage of K2s, coupling between the two oscillators can result in a "wavering" quality on both transmit and receive. *If your K2 exhibits this symptom, it must be corrected. It compromises signal quality, and may prevent VFO linearization (CAL PLL) from working correctly.*

### Frequency Stability Test

You'll first need to identify the segment of 40 meters over which the two oscillators are at the same frequency. Switch to 40 meters, LSB or CW mode, and tune to about 7182 kHz. Then activate **CAL FCTR** using the menu. Alternately insert the internal counter probe into **TP1** (VCO) and **TP3** (PLL reference oscillator), and make sure they indicate the *same frequency* (in the 12 MHz range). They'll be equal over some 5 kHz segment, typically 7179-7184, but possibly lower or higher<sup>5</sup>. (Note that you can tune the VFO while in **CAL FCTR**.) **Don't change modes or filters, as this will move the target range.**

Range: 7 \_\_\_\_ - 7 \_\_\_\_ kHz (mode: \_\_\_\_, filter: \_\_\_\_)

Listen to a few signals in this range to see if they exhibit the "wavering" sound. Compare them to signals outside the range. You can use another ham transmitter as a signal generator. (Don't change modes or filters.)

### Modifications to Cure Instability

The following modifications can be used to cure the instability, if required. Try them in order, and stop when the symptom disappears. All necessary parts are included in mod kit K2ATOBKT.

- Make sure C70 and C71 (VCO area) have the shortest possible leads.
- Solder a 68-pF capacitor (RF-C<sub>PLL</sub>) on the bottom of the RF board, between pins 13 and 12 of the MC145170, U4 (see Figure 1). Keep the lead length short.
- Add an RF choke in series with U4 pin 16. First locate point "X" in Figure 2. Cut the indicated small trace segment between pin 16 of U4 and capacitor C89 (on the top side). Next, solder a miniature 100- $\mu$ H RF choke (RFC15) across the cut as shown in Figure 3. Finally, solder a .001- $\mu$ F capacitor (C91) from pin 16 to ground.
- Remove C70 (4.7 pF).

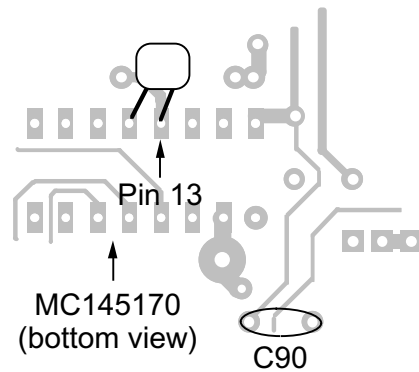


Figure 1

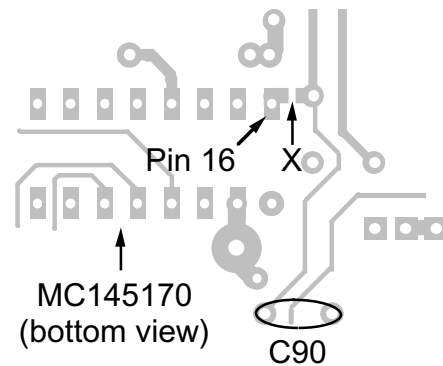


Figure 2

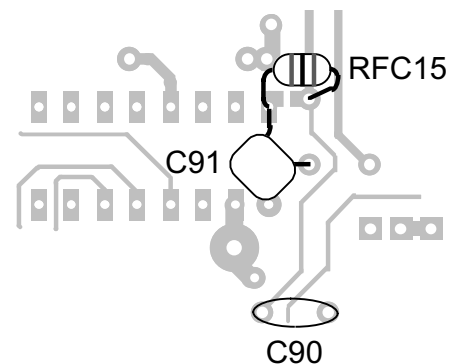


Figure 3

<sup>5</sup> Due to differences in the way old and new firmware did CAL PLL.

### 3. Misc. RF Board Changes

This step describes all RF board changes not covered elsewhere. Parts can be found in K2ATOBKT.

- Turn the K2 off. **Touch an unpainted, grounded metal surface.** Remove the top cover.
- Remove all options plugged into the RF board.
- Remove the two screws holding the Control board to the Front Panel board. Unplug the KAF2 if present.
- Remove the Front Panel assembly (there is no need to separate the panel from the PC board).
- Remove the bottom cover.
- Remove the rear panel/heatsink. Save all of the PA hardware, including the thermal pads.

#### Revision XC and older Rev. C K2s Only

The following steps apply to Rev. XC and some Rev. A K2s (prior to s/n 2000). Check the components to see if you already have the correct values installed.

- Change C68 (VCO area) from 4.7 or 5 pF to 10 pF. (Eliminates possible VCO problem on 160 meters.)
- Change R1 and R2 (near the key jack) from 470 ohms (or 1k) to 220 ohms. (Lowers the voltage seen by the K2 when a paddle is closed. With 1 k, noise immunity may be inadequate. The microcontroller's internal pull-up resistors can pull these lines up too close to the "0" logic threshold.)
- Change R50 from 1/4 watt to 1/2 watt (1.5 ohms, brown-green-gold). (1/4 watt in the driver emitter was too low to ensure adequate heat dissipation.)

**Note:** Other minor (preventative) design changes were made from revision XC to revision A. Except in rare cases, they will not significantly affect performance, and we recommend that they *not* be changed. These include: L31 from 12 to 10  $\mu$ H (PLL reference), C153 from 39 to 68 pF (TX mixer coupling), C162 from .01 to .047 (post-mixer amp), D9 from 1N34A to 1N5711 and R68 from 237 to 226 (RF detector).

#### Revision A and XC K2

- Change R64 (center of the board, near U1) from 470 to 100 ohms. (Improves auxBus noise immunity.)
- Change RFC11 from an RF choke to an FT37-43 toroid with 20 turns #26 enamel. Mount RFC11 on the bottom of the board with short leads. (Reduces unwanted S-meter activation, esp. on 17 meters.)

- Add C<sub>RF</sub> (.047, "473") on the bottom of the RF board as shown in Figure 4. One trace cut is required. (This capacitor is important if you have a KBT2 internal battery or KPA100 module. It prevents damage to the K2's low-pass filter relays in the event that the AUX RF and AUX DC cables are reversed. On the Rev. B RF board, the capacitor is C224.)

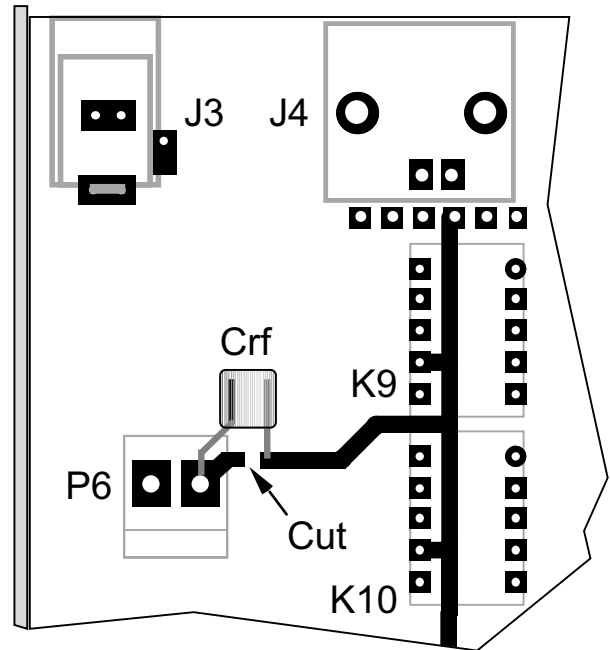


Figure 4

- Change D10, at the right edge of the RF board, from an SB530 to a 95SQ015. (The latter is an ultra-low-drop diode, having a drop of only about 0.1 to 0.2 volts. This reduces wasted power in the diode on transmit, nearly eliminates the discrepancy between external voltmeters and the K2's internal voltage display, and allows the use of a slightly lower voltage supply for recharging the KBT2 internal battery.)

#### Re-installing the Heat Sink

**Note:** Skip these two steps for now if you plan to make the bandpass filter changes on the next page.

- Inspect the thermal pads for Q7 and Q8. Brush away any aluminum fragments which might have become stuck to the pads.
- Re-install the rear panel/heat sink and PA hardware as described in the K2 owner's manual (Assembly, Part III).

## 4. 15/17 m & 20/30 m Bandpass Filters

See descriptions below. Band-pass filter realignment will be done following all hardware and firmware updates.

### *15/17 m Bandpass Filter*

These optional changes narrow the 15/17 m bandpass filter to improve image rejection. In Europe in particular, strong shortwave broadcast stations in the 16 MHz range may produce low-level image responses in the 15-m band with the original filter values.

- Change C30 and C36 from 330 to 470 pF ("471").
- Change C33 from 3 (or 3.3) pF to 2 (or 2.2) pF.

### *20/30 m Bandpass Filter*

This optional change adds 12-pF capacitors in parallel with each of the 20/30-m bandpass filter trim caps, which should eliminate any difficulty in aligning the bandpass filter on 20 meters. Some builders found that the 20-meter trimmers "topped out" before the peak was located.

- Solder 12 pF capacitors across C21 and C23, on the bottom of the board in the bandpass filter area. (These capacitors are designated C28 and C29 on the Rev. B RF board.)

### *Re-installing the Heat Sink*

Inspect the PA thermal pads and re-install the heat sink as described in the last two steps on page 6.

## 5. BFO Temperature Stability

This optional set of modifications reduces BFO frequency drift an average of 70-80%. The parts and documentation for the change are supplied with part # BFOMDKT.

- If you previously installed this mod kit, make sure that R19 (soldered to the bottom of the board in the PLL reference oscillator area) is 2.7 k. Some early BFOMDKT kits were sent out with 220 ohms for use at R19, which can cause PLL reference oscillator instability. (1.8 to 3.3 k can be used.)

**Note:** Skip to step 5A, at right (PLL Upgrade) if you've already installed BFOMDKT.

- If you have an older K2 (Rev. A or XC), you may have installed a large capacitor (150 pF or larger) at C174 due to inadequate BFO range. Increasing only the size of C174, without a proportional increase in C173, may cause excessive BFO injection and is no longer recommended. Restore C174 to its original value if applicable (82 pF; supplied with K2ATOBKT.)

**Note:** The crystals supplied with BFOMDKT should have adequate range with the standard capacitor value at C174 (82 pF). If the range is found to be slightly low, two supplemental capacitors (47 pF and 120 pF), which are supplied with BFOMDKT, can safely be added in parallel with C174 and C173. This is explained on page 12 as part of the BFO range test.

- If you have an older K2 (Rev. A or XC), you may have a 100 k RPACK at RP2. In this case, solder 10 k resistors (RREFA, RREFB) across RP2 pins 1-2 and pins 3-4, on the bottom of the board in the VCO area. (There's no need to remove RP2, which can be difficult. The two paralleled resistors will suffice.)

- Locate the instructions supplied with BFOMDKT. Put an "X" by the instructions covering installation of firmware, as well as BFO and PLL test and alignment. These steps will be skipped for now.

- Follow all instructions supplied with part # BFOMDKT, except those you marked with an "X" above.

## 5A. PLL Upgrade

The PLL Upgrade is a very important design change that was recently added to the K2 (s/n 3446 and later). It uses a thermistor to temperature-compensate the PLL reference oscillator, reducing drift by a factor of 5 to 10. This upgrade kit should only be installed if you have also made the BFO mod described above. The parts, small PC board, and documentation for this upgrade are supplied with part # E850138.

- Follow all instructions supplied with the PLL Upgrade kit, E850138, except those dealing with alignment and test. This will be done later.

## 6. VFO ALC & 10/12 m Bandpass Filter

This set of modifications enhances the VFO ALC circuit and narrows the 10/12 m filter. Without the mods, a small increase in VFO spurious output will sometimes occur when switching bands to or from 10 meters. This is usually significant only if the K2 is driving a KPA100 or other amplifier, but we recommend making the changes in all cases. The parts and documentation for this mod are supplied with part # E850093.

Follow all instructions supplied with the VFO ALC mod kit, E850093, *except* 10/12 meter bandpass filter alignment. Alignment will be done later.

If you have a rev. XC K2, you must also add R18 (1 M) to the VFO ALC circuit. Solder R18 on the bottom of the board, directly across the pads of C59.

## 7. Second Crystal Filter Flatness

This change flattens the K2's second crystal filter response, and allows the I.F. adjustment, L34, to be set optimally for both CW and SSB. As a result, a much better pitch match can be obtained on LSB and USB. The parts and documentation for this mod are supplied with part # XFILMDKT.

Follow all instructions supplied with XFILMDKT, except those instructions dealing with I.F. alignment, which will be done later.

## 8. First Crystal Filter Grounding

The instructions for grounding the crystals in the 5-pole first CW crystal filter (X7-X11) originally called for the wires to be soldered to the tops of the cans. A few builders subsequently determined that soldering the ground wires closer to the base of the cans resulted in better ultimate attenuation. Some builders also experimented with additional bypassing of filter control lines using surface-mount capacitors, but this appears to offer very little additional benefit, if any.

This change is optional. Most K2 builders who used top-grounding of the crystals in the first crystal filter found the ultimate attenuation to be completely satisfactory.



**In the following step, be careful not to overheat the crystals. Use a temperature-controlled iron, and limit soldering time to about 3 seconds per soldering attempt.**

There are two ground pads each for X7-X11, one on either side. Use bare wires (10 total) for grounding the crystals, but **do not** solder the wires to the *tops* of the crystals. The wires must be soldered to the *sides*, instead, about 1/4" (6 mm) up from the surface of the PC board.

## 9. AF GAIN Control Smoothness

The original "2-wire" AF gain potentiometer circuit is susceptible to mechanical potentiometer noise at the counter-clockwise end of its rotation. The "3-wire" modification used in the Rev. B K2 completely eliminates this problem, making AF GAIN adjustment smooth. The modification also allows the AF GAIN pot to completely turn off the audio when rotated fully counter-clockwise. In some cases, the old circuit would permit some residual signal to circumvent the potentiometer in this position.

This change is optional but recommended.

Follow all instructions in the application note, except those dealing with testing the new circuit, which will be done later. The application note can be found at:

[http://www.elecraft.com/Apps/K2\\_AF\\_pot/K2\\_AF\\_gain\\_app\\_note.htm](http://www.elecraft.com/Apps/K2_AF_pot/K2_AF_gain_app_note.htm) (HTML)

or:

[http://www.elecraft.com/Apps/K2\\_AF\\_pot/K2\\_AF\\_gain\\_app\\_note.pdf](http://www.elecraft.com/Apps/K2_AF_pot/K2_AF_gain_app_note.pdf) (PDF)



## 10. Misc. Control Board Changes

These changes improve various operating characteristics of the K2, as explained in each of the steps below. The parts for these changes are included in K2ATOBKT.

Change R6 from 470 to 100 ohms (brown-black-brown). (Improves auxBus noise immunity.)

Change R7 from 1.96 to 1.78k (brown-violet-gray-brown). (Improves current measurement accuracy.)

Change C12 from .001 to .0027  $\mu\text{F}$  ("272"). (Improves auxBus noise immunity.)

Change C42 from .01 to 0.1  $\mu\text{F}$  ("104"). (Stabilizes voltage display.)

Locate the trace on the top side of the board that runs directly between resistors R8 and R9 (Figure 5). Cut the trace. On the bottom side of the board, solder an 820-ohm resistor (gray-red-brown) between the two vias. You'll need to pre-trim the resistor's leads since it isn't possible to cut the lead that falls between R8 and R9. (Protects the microcontroller in the event that an RS232 signal is accidentally connected to the VRFDET line via the KIO2's or KPA100's AUX I/O connector. Designated R12 on the Rev. B Control board.)

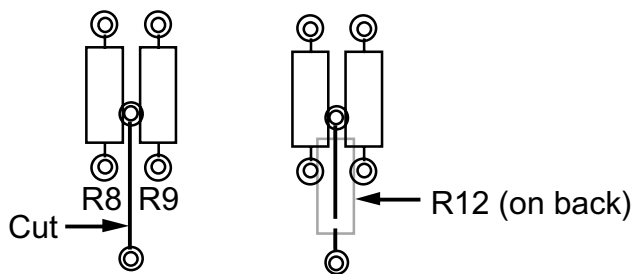


Figure 5

If you have an older K2 (Rev XC or A), C31 may be 0.1  $\mu\text{F}$  ("104"). Change C31 to .047  $\mu\text{F}$  ("473"). (Improves CW keying envelope shape.)

## Sidetone Modification

These optional changes provide a more pleasant-sounding sidetone.

Locate capacitor C24 (.0027  $\mu\text{F}$ ), which is on the right side of the Control board between RP7 and RP3. As shown in Figure 6, cut the trace on the top side of the board between C24 and pin 6 of RP7. On the bottom side of the board, solder a 47 k resistor (yellow-violet-orange) between these two pads. (Reduces digital switching noise in the sidetone; designated R11 on the Rev. B Control board.)

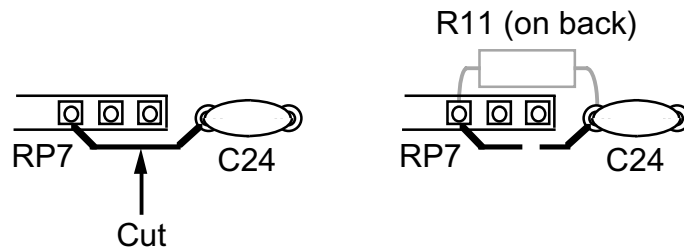


Figure 6

Locate RP5, the 10-pin, 470-ohm RPACK at the right side of the board. Solder an 82-mH shielded inductor ("823") on the bottom of the Control board between pins 7 and 10 of RP5. The leads of the inductor should be formed such that the body can be folded down flat against the PC board. (Designated L1 on the Rev. B board. Creates a low-frequency resonant tank in conjunction with C33, greatly attenuating harmonics of the sidetone. The resonant frequency is approximately 400 Hz, but the Q is quite low, so sidetone frequencies from 400-800 can still be used effectively.)

## RS-232 and Sidetone Source (KIO2/KPA100)

If either a KIO2 or KPA100 option is installed in the Rev. A or XC K2, the builder must make a few additional changes to the Control board. These changes are fully documented in the KIO2 and KPA100 manuals. (The sidetone generation is re-routed from pin 25 of the microcontroller, U6, to pin 4 of the quad D-to-A converter, U8. This allows pin 25 of U6 to be used for full-duplex RS232 communications.)

There is no need to make these changes until you add a KIO2 or KPA100. In a later step, you'll set up your K2's configuration based on whether or not you have at some point installed either of these options.

## AGC Threshold Control

R1 on the Control board sets the AGC threshold, which also establishes the K2's I.F. gain. On Rev. A and Rev. XC Control boards, R1 is fixed. A small number of K2 owners found that reducing the size of R1 slightly could optimize the AGC threshold setting and/or bring up the I.F. gain, so we used a trimmer at R1 on the Rev. B board.

We don't recommend replacing R1 with a trimmer on older K2s, for two reasons: the number of K2s that would benefit from it is quite small; and adding a potentiometer here is difficult because R1 is very close to the side panel.

After you've completed all hardware changes and have the K2 reassembled, you can test your AGC threshold to determine if a change in the value of R1 is warranted. This is covered in on page 14.

## 11. Firmware Installation

If you determined earlier (page 3) that your firmware must be replaced, complete the following steps. Otherwise skip to Alignment and Test (right column).

- Touch an unpainted, grounded metal surface.** Remove the old K2 firmware, U6 (Control board), using a small screwdriver to pry it gently out of its socket at both ends. Store it in a safe place.
- Straighten the leads of the new microcontroller (PIC18C452).
- Install the new microcontroller. Orient the notched or dimpled end of the IC with the notched end of its component outline.
- If your I/O controller (IOC) firmware is revision 1.05 or earlier, or if you were sent a new I/O controller by Elecraft (PIC16F872), remove U1 on the RF board. Store it in a safe place. Install the replacement IOC at U1.

## 12. Alignment and Test

### Re-Installation of Boards and Panels

- Reinstall the front panel assembly.
- Reinstall the Control board (and KAF2 option if applicable). Secure the Control board to the Front Panel board using the provided hardware.
- Reinstall the bottom cover.
- Reinstall all options that plug into the RF board.
- Reinstall the rear panel/heatsink if you have not done so already (last two steps on page 7).

### Firmware Configuration

- Turn on the K2. You may see **INFO 201** (for about 11 seconds) if you have installed new firmware. The sidetone may not be working at this point, and the filters and S-meter may not be calibrated.

If you saw **INFO 201**, you must re-enter all of your menu and CAL parameters as explained in the following steps. If you didn't see INFO 201, skip to Supplemental Menu Parameters (next page).

- Set up all primary menu entries using data recorded in Table 2 (page 3). **ST L** and **ST P** must be set up, even though you may not have any sidetone at this point. This will be corrected later.
- If your old firmware was older than revision 2.00, please read the "K2 Revision 2 Firmware" manual, which you should have received with the new firmware (you can also download it from our web site). This will explain what the secondary menu entries are used for, and how to access this menu.
- Set up all secondary menu entries from Table 2.
- If you have the K60XV option installed (60 meter adapter), set the **D19** secondary menu entry to **Y** (see K60XV manual). Otherwise leave **D19** set to **N**.
- Set up the **CAL CUR**, **CAL S LO**, and **CAL S HI** entries from Table 3. **CAL TPA** is stored by the microcontroller in the KPA100, if applicable, and does not need to be set up here. **CAL PLL** will be done later.
- If applicable, set up transverter bands (Table 4).
- Set up the filter bandwidths (but *not* the BFOs) for each mode using data from Table 5. The BFOs will be set up after the BFO range check.

## Supplemental Menu Parameters

The **DISPLAY** switch is used to access additional parameters when editing certain menu entries. Set up these parameters as follows:

Test your sidetone using the **ST L** menu entry. If the sidetone is missing, **EDIT** the **ST L** parameter, then tap **DISPLAY** to change the sidetone source. The default is **U8-4**, compatible with the Control board modifications required for the KPA100 and KIO2. If you have never installed a KIO2 or KPA100, the source should be set to **U6-25**.

"8R Hold" mode keeps the 8R (8 volts receive) line low between CW elements. This is now the default mode for 8R; it eliminates excessive T-R relay switching when the K2 is used with transverters or amplifiers. At present we don't know of any reason to set the 8R mode to "normal," where 8R is allowed to go back to 8 volts between CW elements. However, if you wish to select this mode, locate the **T-R** menu entry, **EDIT** its parameter, and tap **DISPLAY**. You'll see **8R nor** on the LCD.

"Auto-detect" allows you to connect a keyer, computer, or hand key to the K2 along with a keyer paddle. Auto-detect is normally on. To turn it off, locate the **INP** menu entry, **EDIT** its parameter, and tap **DISPLAY**. You'll see **ADET OFF**.

The default fan mode for the KPA100 option is **FAN nor**. If you prefer **FAN LoHi** or **FAN Hi**, locate the **PA** entry in the secondary menu, **EDIT** the parameter, and tap **DISPLAY** to select the desired mode.

## PLL Reference Oscillator Range Test

This test is necessary if you made the Temperature Stability modifications or changed any other components in the PLL reference oscillator.

- Make sure the bottom cover is securely attached, and that the K2 has been turned on for at least 5 minutes (operating at room temperature).
- Plug the frequency counter probe into P6 (Control board).
- Connect the probe tip to the PLL reference oscillator test point, TP3 (left-front corner of the RF board, near U4). **Note:** If an audio filter module is installed, you'll need to remove it to get to TP3.
- Using the menu, select **CAL FCTR**, then hold **EDIT** a second time to enable the frequency counter. The counter should show a frequency of 12090 kHz +/- 30 kHz. If it is **0000.00**, changing rapidly, or out of range, you could have a problem with the counter probe or the PLL Reference Oscillator.

When you're in frequency counter mode, the **BAND+** and **BAND-** switches can be used to check the range of the PLL reference oscillator. First, tap **BAND+** and write down the frequency reading in the space below (typically about 12097-12100 kHz). Then tap **BAND-** and write down this frequency reading (typically 12085-12092 kHz).

Ref. High Freq.    Ref. Low Freq.    Range (kHz)

\_\_\_\_\_

Subtract the lower frequency reading from the higher reading. The range must be between 9.0 and 15 kHz (if not, you may have a problem in the PLL reference oscillator, most likely with one of the components recently installed). Tap **MENU** to exit **CAL FCTR**.

If you removed an audio filter option temporarily to get to test point TP3, reinstall it now.

## BFO Test

The BFO will be tested in the following steps. You should do this test even if you did not make the Temperature Stability modifications.

- Make sure the bottom cover is securely attached.
- Switch to the 40-m band.
- Connect the frequency counter to the BFO test point (TP2), which is on the right side of the RF board near the crystal filter.
- Using the menu, activate **CAL FCTR**. The counter should show a frequency between 4908 and 4918 kHz.



If you see a reading of **0000.00** kHz or one that is changing rapidly, you may not have the frequency counter probe connected properly. Also inspect the leads of L33 carefully. They could be broken or poorly soldered.

When you're in frequency counter mode, the **BAND+** and **BAND-** switches can be used to check the range of the BFO. First, tap **BAND+** and write down the frequency reading below (typically about 4916-4917 kHz). Then tap **BAND-** and write down this frequency reading (usually about 4911-4913 kHz). Finally, calculate the BFO range (high - low) in kHz. Typical range is 4 to 5 kHz.

BFO High Freq. \_\_\_\_\_  
(must be 4916.3 kHz or higher)

BFO Low Freq. \_\_\_\_\_  
(must be 4912.7 kHz or lower)

Range (High - Low) \_\_\_\_\_  
(must be 3.6 kHz or more)

If your BFO range is slightly less than 3.6 kHz, and/or the low frequency is higher than 4912.7, your BFO crystals probably have higher than average Q. You can safely compensate for this by increasing the size of C174 and C173 in the BFO circuit. The Temperature Stability mod kit (BFOMDKT) includes two capacitors for this purpose, 47 pF to parallel with C174, and 120 pF to parallel with C173. If you didn't order this mod kit, you can use any temperature-stable capacitors (NPO, C0G, or N750 types) in the following ranges: 39-68 pF (in parallel with C174), and 100-180 pF (in parallel with C173).

If the BFO doesn't appear to be working, or its frequency range is shifted too high or too low, it may be due to one of the following:

- If you didn't calibrate the K2's internal frequency counter using an external counter, it may not be reading accurately. If possible, borrow an accurate counter and re-do the **4 MHz Oscillator Calibration** as described in the K2 owner's manual.
- If you installed the new BFO toroid at L33 (T44-7), look closely at its leads using a magnifying glass. The wire used is very small, and easily broken during installation.
- One or more of the capacitors in the BFO circuit could be of the wrong value.

## BFO Alignment

The following two steps will be necessary if you saw **INFO 201** on the display following firmware installation, *or* if you made the Temperature Stability modifications to the BFO.

- Make sure the bottom cover is securely attached.
- Set up the BFOs for all modes and filters using the frequencies from Table 5 (page 4). You'll have a chance later on to fine-tune the BFO settings.

## VFO Linearization

This procedure will be necessary if you installed new firmware *or* if you installed the PLL Upgrade (or made other changes in the PLL area of the RF board). **The procedure will be done only on 40 meters.** It should not be repeated on each band.

Allow the K2 to warm up at normal operating room temperature for at least five minutes. The bottom cover must be installed.

Plug the K2 frequency counter cable into P6 on the Control board. Connect the probe end to test point TP1 on the RF board (VCO, center-left side of the RF board).

Switch to 40 meters and set the VFO to about 7100 kHz.

Tap **MENU** and locate the **CAL** entry. Hold **EDIT**, then change the parameter to **PLL**. Hold **EDIT** again to begin the calibration procedure. You'll see a frequency in the 12 MHz range displayed, and the letter "d" will flash as the firmware records calibration data. After approximately 5-10 minutes, you'll hear a short tone, and **END** will be displayed. Tap any switch to clear this message.



If you see **INFO 232** at any time during VFO calibration, verify that you were on 40 m, with the counter cable at TP1.

You can check the VFO's accuracy using a signal at a known frequency (see page 98 of the revision C K2 manual). **Note:** In the Revision C manual, steps 8 and 11 on page 98 are incorrect for the new firmware. **CAL PLL** is now run only once, and only on 40 m.

Move the K2 counter cable to the BFO test point, TP2.

## I.F. Amplifier Alignment

If you made the recommended modification to the second crystal filter, L34 will need readjustment. L34, located near the right front corner of the RF board, is used to peak the output of the I.F. amplifier.

Using the wide end of the plastic tuning tool, adjust the slug in L34 until it is near the top of the can. **Stop turning the slug when it appears to be at the top or when you feel resistance.**

Turn L34's slug one full turn clockwise (down into the can).

Set the band to 40 meters using **BAND+** or **BAND-**. Select CW Normal and FL2 (700 Hz nominal bandwidth).

Make sure the RF GAIN control is fully clockwise (max. gain). Disconnect the antenna from J4, if one was connected.

Tap **PRE/ATTN** until the PRE annunciator turns on.

Connect a pair of headphones (stereo or mono) to the front panel jack, and turn the AF GAIN control to about midway.

Slowly tune the VFO to locate the weak internally-generated signal near 7000 kHz.

While listening to the signal at 7000 kHz, adjust L34 for best signal strength and lowest noise. This setting occurs at about 1 to 1.5 turns below the top of the can. (You can use your DMM on AC volts, at the speaker jack, to obtain a more sensitive indication.)

### Receiver Pre-Alignment, 10-30 meters

This step is necessary if you made any changes to the 10-30 m band-pass filters (steps 4, and 6, page 8). If you didn't make these changes, continue with Fine-Tuning Filter Settings, page 15.

- Switch to 20 meters and set the VFO for about 14100 kHz.
- Turn on the RF preamp by tapping **PRE/ATTN** until you see the PRE annunciator turn on.
- Use a signal generator or an antenna to inject a signal or noise at this frequency.



Since some inductors are shared between two bands, you must always align the bands in the order indicated. Always use this procedure if you re-align the filters later.

- Set C21 and C23 to their mid-points. Adjust L8 and L9 for maximum signal strength. (This step pre-sets C21, C23, L8, and L9 before final adjustment in the next two steps.)

**Note:** When switching to each of the remaining bands to be aligned, you'll need to inject a signal or use an antenna.

- Switch to 30 meters (10100 kHz) and turn on the preamp. Adjust L8 and L9 for maximum signal strength.
- Switch back to 20 meters (14100 kHz). Adjust C21 and C23 for maximum signal strength.
- Switch to 15 meters (21100 kHz) and turn on the preamp. Adjust L10 and L11 for maximum signal strength.
- Switch to 17 meters (18100 kHz) and turn on the preamp. Adjust C32 and C34 for maximum signal strength.
- Switch to 10 meters (28200 kHz) and turn on the preamp. Adjust L12 and L13 for maximum signal strength.
- Switch to 12 meters (24900 kHz) and turn on the preamp. Adjust C44 and C46 for maximum signal strength.

### Transmitter Alignment, 10-30 Meters

- Set the POWER control for 2.0 watts. Connect a dummy load at the antenna jack.
- Switch to 30 meters. Adjust L8 and L9 for maximum power output in TUNE mode. Avoiding using TUNE mode for more than 5 seconds at a time.
- Switch to 20 meters (14100 kHz) and adjust C21 and C23 for maximum power output.
- Switch to 15 meters (21100 kHz) and adjust L10 and L11 for maximum power output.
- Switch to 17 meters (18100 kHz) and adjust C32 and C34 for maximum power output.
- Switch to 10 meters (28200 kHz) and adjust L12 and L13 for maximum power output.
- Switch to 12 meters (24900 kHz) and adjust C44 and C46 for maximum power output.

### AGC Threshold Test

A few K2 builders found that their overall receive gain was too low because of a less-than-ideal AGC threshold setting. If you think you might benefit from a change in this threshold, follow the steps below. Otherwise, skip to the next page.

- Connect an antenna to the K2, and switch to a quiet band (one with little atmospheric noise). Turn AGC off by holding the **PRE/ATTN** and **AGC** switches together.
- If the level of background noise increases significantly with AGC off, even on a quiet band, you may benefit from an adjustment to the AGC threshold. Remove the Control board and temporarily substitute a potentiometer for R1, presetting it to R1's fixed value. Once you find a value of R1 that brings I.F. gain up slightly while not compromising AGC performance on large signals, you can install a fixed resistor of that value.
- If you did make a change to R1's value, you'll need to recalibrate **CAL S HI** and **CAL S LO** (owner's manual, page 84).

### *Fine-Tuning Filter Settings*

You can optionally fine-tune your BFO settings for each mode by ear or by using a computer-based tool such as Spectrogram.

If you have the KSB2 option (SSB adapter), and you made the recommended changes to the second crystal filter, you may wish to fine-tune the LSB and USB BFO settings so that the filters have the same noise pitch.

**Note:** Only the SSB BFO settings for FL2, 3, and 4 should be made in receive mode. The SSB BFO settings for FL1 should be made in transmit mode, either listening to your signal locally or having a nearby station listen for you. This is because FL1 is always used in transmit mode (and for receive, when selected), whereas FL2-4 are only used in receive mode. FL2-4 can be set up differently without affecting your transmitted signal. Refer to the KSB2 manual for more details.

### *AF GAIN Potentiometer Test*

The following two steps apply if you made the AF GAIN potentiometer smoothness modification.

Rotate the AF GAIN control slowly, near the counter-clockwise end of its rotation, while listening to a steady carrier (e.g., the internally-generated signal at 4.000 MHz). There should be no noticeable noise (crackles, etc.) as you rotate the control.

Set the AF GAIN control to its fully counter-clockwise position (minimum gain). You should hear complete silence, with no audio signal leak-through.

## **13. Speaker grille cloth**

Grille cloth (part #E850089) can optionally be added to your original K2 top cover. (The KPA100 module already has grille cloth for its speaker.)

Remove the speaker from the top cover. This may involve removing the battery option (KBT2) or other top-cover options. If you do have to remove a battery, be sure to turn the battery switch OFF using the rear-panel slide switch. Also, disconnect both leads from the battery terminals and cover the terminals with tape to prevent accidental shorts.

Trim the supplied grille cloth to the size of the speaker frame.

Place the #4 fibre washers (black) at each of the top cover's four speaker mounting holes. Trim the corners of the grille cloth so it just fits between the fibre washers, not touching them.

Place the speaker on top of the fibre washers and grille cloth. Secure it with four 3/8" (9.5 mm) screws, #4 lock washers, and 4-40 nuts. Do not over-tighten the nuts.

Re-install the top cover or KPA100 module.