ELECRAFT KXIBC2 INTERNAL BATTERY CHARGER MODULE INSTALLATION AND OPERATING INSTRUCTIONS

INTRODUCTION

The KXIBC2 module is a C/10-rate charger for the KXBT2 Li-ion internal battery pack. Operation is simple, requiring only that a power supply be connected to the KX2 when charging is required. The radio may be on or off during charging. The KXIBC2 does not generate any RFI, so the radio may be used during charging if the power supply provides sufficient current for both charging and receive/transmit operation.

The KXIBC2 replaces the previous KXIO2 option module, retaining its RTC (real-time-clock) function. The RTC is powered by the internal battery or external power supply, and a supercapacitor is included to maintain RTC time during battery changes. Note: The KXIO2 module's two user-programmable open-drain outputs, AUX1 and AUX2, are not included in the KXIBC2.

KXIBC2 MODULE INSTALLATION

> If your KXIBC2 internal battery charger module was installed at the factory, you may skip to the **FIRMWARE CONFIGURATION** section (pg. 4). Otherwise continue below.

Preparing the KX2

IMPORTANT: Take proper ESD precautions when performing installation steps.

[ ] Make sure the KX2 is turned off and that there's no power supply connected to it.

[ ] Open the KX2 bottom cover, then unplug and remove the battery.

[ ] If a KXIO2 option module is installed, remove the two screws holding it to the left side panel, then unplug the module. It will no longer be used. If there is no KXIO2 module installed, your KX2 may have temporary hardware installed in the side panel that will need to be removed.

[ ] Remove the left side panel. *The two screws that secure the panel to the top cover are different from the two that retain the KXIBC2 or KXIO2 module.*

[ ] Plug in the KXIBC2 module as shown in **Figure 1**. Only three of the original four connectors are used with the KXIBC2 (the one not used will be obvious). Be very careful to not bend any of the pins. As you position the module, make sure its yellow LED protrudes through the hole in the rear edge of the enclosure.

[ ] Reinstall the left side panel using the screws removed earlier.

[ ] Secure the KXIBC2 module to the left side panel using the two screws removed previously (or screws supplied with the KXIBC2 kit). **Do not overtighten the screws.** This could damage the solder joints on the PC board's soldered-in threaded spacers.

Connecting the KXIBC2 to the RF Board

The KXIBC2 requires two connections the RF board. The two wires may be connected in one of two ways:

- **Method 1:** Solder the pin plugs directly to the "B" and "E" pads on the RF board as shown in **Figure 1**. This is the recommended method for field installation of the KXIBC2 module. Soldering the wires is acceptable, since it is very unlikely the module will ever have to be removed.

- **Method 2:** Solder pin jacks to the RF board's "B" and "E" pads as shown in **Figure 2**, slip on the supplied plastic sleeving, then plug in the two wires from the KXIBC2 module. This method is used for factory installation. However, installing a pin jack in the "E" pad can be very difficult. This is because the "E" pad's hole may be filled with solder, and it can be extremely hard to remove.
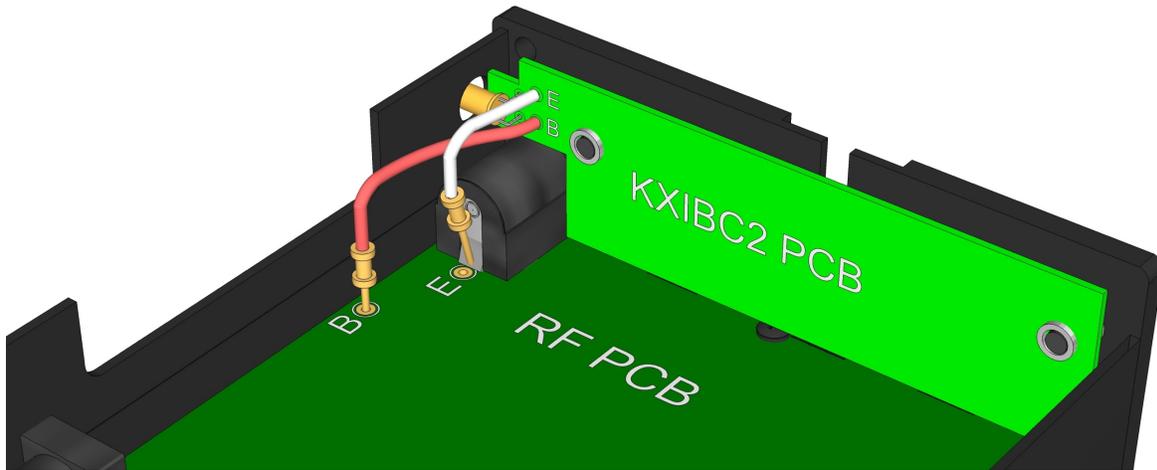

Figure 1

Method 1

Refer to the drawing above. The white and red wires and their attached pin plugs are pre-installed by the factory. The transparent tubing and pin jacks will not be used.

[ ] Solder the tip of the white wire's pin plug to the base of the DC input jack (black), near the "E" pad, the location shown. The "E" pad is electrically connected to the DC input jack, so it's OK to have solder flow onto the "E" pad as well.

[ ] Solder the red wire's pin plug to the "B" pad as shown above. **Do not insert the pin plug all the way into the hole.** It is only necessary to insert about .05" to 0.1" of the tip. (There are components on the control panel board in this area. Even though the pin plug is not long enough to cause a short, it's a good idea to only insert the tip part-way.)

→ Skip to the *Final Assembly* section.

Method 2

> **IMPORTANT:** This method is used for factory installation of the KXIBC2 module. However, **Method 1** is recommended for field installation. Method 2 requires removal of solder from the "E" pad, which can be difficult due to the large internal copper power plane.

Refer to the drawing below during installation. This shows the pin jacks, pin plugs, and wires associated with the KXIBC2.

Note: The pin jacks and pin plugs are actually both gold-plated. We show the jacks in silver here to differentiate them from the plugs. They are also shown covered with the supplied clear spaghetti tubing.
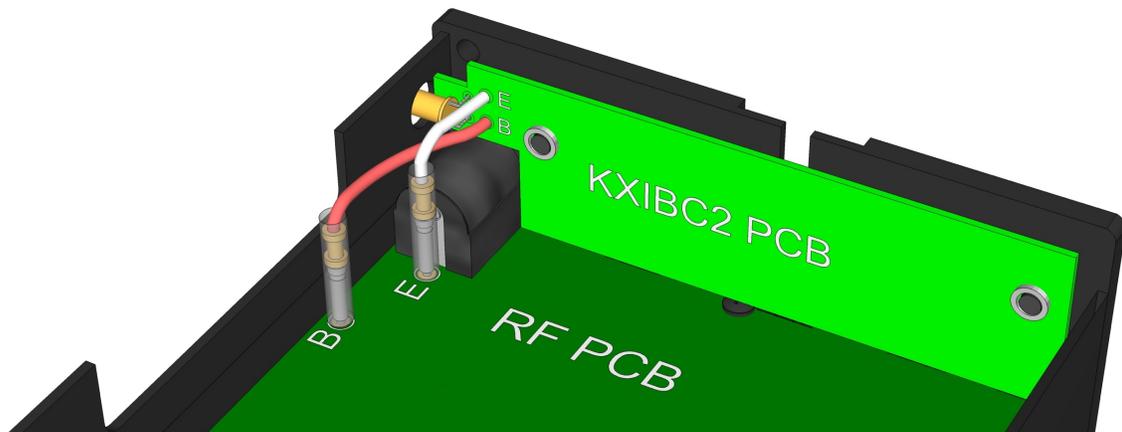

Figure 2

[ ] Locate the "E" pad on the RF PCB as shown above. If the pad's hole is filled with solder, you can use one of the following methods to remove it: (1) solder wick; (2) a vacuum desoldering tool; (3) inserting a fine-tipped stainless-steel pick tool to create a small hole in the solder (heat the tip of the tool with your iron). DO NOT USE A DRILL as this can leave solder fragments between the KX2's two circuit boards.

[ ] Solder a pin jack (Digi-key #ED1304-ND) to the RF board pad labeled "E" as shown in the illustration. **Make sure you correctly identify the "E" pad** before soldering.

[ ] Solder a pin jack to the RF board pad labeled "B".

[ ] Slip a 1/2" (13 mm) length of 1/8" (3 mm) clear tubing over each of the pin jacks on the RF board. **Do not shrink the tubing,** as this will make it hard to unplug the pin plugs if ever required.

[ ] Plug the KXIBC2's "B" and "E" leads (with pin plugs attached) into their like-named pin jacks on the RF board. DOUBLE-CHECK THE WIRE COLORS WITH THE DRAWING.

Final Assembly

[ ] Plug in the KX2's battery pack. Adjust the KXIBC2 wires so they remain clear of the battery pack's plug and wires. When unplugging the battery pack in the future, avoid bending the KXIBC2 pin-plug assemblies.

[ ] Re-install the KX2's bottom cover. You'll need to tuck the speaker cable connector in between the battery pack and top cover sheet metal.

FIRMWARE CONFIGURATION

Note: The following steps may have been performed at the factory. Verifying the settings is still recommended.

[ ] Turn on the KX2, then hold the MENU switch to enter the menu. Rotate the OFS/B knob to locate the FW REVS menu entry. If the µC firmware revision shown is earlier than 3.01, you'll need to use the *KX2 Utility* application to load the latest firmware (3.02 as of this writing). The utility can be downloaded from our KX2 firmware web page (start at https://elecraft.com/pages/firmware-software).

[ ] Locate the KXIO2 menu entry. Set it to NOT INST. This is necessary in case a KXIO2 option module had been installed prior to installing the KXIBC2.

[ ] Locate the KXIBC2 menu entry. Set it to NOR. This enables the KXIBC2's real-time-clock module, and also allows viewing of the battery voltage.

[ ] Locate menu entry TIME and use it to set the 24-hour time. You can use local or UTC time as desired.

USING THE KXIBC2

> **CAUTION: WE RECOMMEND USING THE KXIBC2 ONLY WITH AN ELECRAFT KXBT2 11.1 V LI-ION BATTERY PACK. The KXBT2 includes built-in charge and discharge current limiting to ensure safe operation.**

Normal Charging

KXIBC2 operation is simple: Just plug in the same power supply you would normally use to run the KX2. The yellow LED on the module will turn on until charging is complete. This can take from 1 to 10 hours depending on the battery's state of charge.

During charging, the radio can be either on or off, as the charger works independently. (If charge LED behavior seems incorrect, refer to the TROUBLESHOOTING section.)

For a full battery charge, use a 13.7 to 15 V supply. While charging voltages from 11-13.7 V can be used, the final level of battery charge will be limited if you use a lower voltage. For example if you charge from a 12.5 V supply, your KX2 battery may only acquire a charge of 30 to 50% or so. For camping or vacation outings you may wish to use a small 15 volt modular supply just for charging the internal battery. However,

such supplies may not be suitable for powering the radio due to supply noise and limited current capability.

Field recharging from a variety of sources is possible, including solar panels, depleted car batteries, lantern batteries, etc. If you're using a small solar panel on a day that's partially cloudy, you may notice the charge LED going off when clouds blocks the sun, then coming back on when the sun reappears. This will not adversely affect charging.

The KX2's internal battery and external supply are diode-ORed. This means that the radio will run from whichever has the higher voltage at a given time. If you're charging from a small supply or solar panel, you may find that the KX2 runs from that device during receive, but runs from the internal battery during transmit since the battery can source much higher current.

The KXIBC2 uses a **C/10** charging rate of approximately 250 mA. (In the equation, C refers to the internal battery's 2500 milliamp-hour rating.) This is a very safe charging level that works with a variety of charging voltage sources, generates very little heat, and doesn't require a noisy DC-DC converter.

Using An External Fast-Charger

If you're in a hurry, you can still remove the battery pack and charge it using the Elecraft KXBC2 fast charger. This unit charges the KXBT2 in 1 to 2 hours.

Voltage Monitoring

If the radio is on, you can monitor the battery voltage by tapping DISP and rotating VFO B until you find the "VBAT" display. Both this display feature and the module's real-time clock functions requires MENU:KXIBC2 to be set to NOR. NOTE: Firmware enforces KXIO2=NOT INST if KXIBC2=NOR, and vice-versa.

Real-Time Clock

The KXIBC2 has the same RTC features as the KXIO2. The clock IC runs from a very tiny amount of current supplied by either the internal battery or external supply. The circuit includes a very large capacitor that can keep the RTC IC running for a couple of minutes during battery swaps in the field. If the time becomes inaccurate, use the TIME menu entry to adjust it (see KX2 owner's manual).

TROUBLESHOOTING

Charging doesn't start (LED stays off) when external supply is connected: If the LED briefly blinks then turns off once when an external supply is connected, it's very likely charging did try to start but immediately terminated. It probably means the external supply voltage is too low or was unable to source enough current. The supply must be capable of supplying at least 300 mA for charging (radio off), and must be at least 1.1 V higher than the battery voltage. If the supply can source 1/2 A or more, first turn the radio on under battery power then connect the supply. Check BT and PS displays and make sure PS is 1V or more above BT. In reality, because of the series diode in the PS measurement path, the minimum will be more like 0.8V to 0.9 V above BT.

Charging stops (LED turns off) when radio is turned on during charging: The radio's inrush current causes a momentary drop in the external supply; this may trigger the low-overhead circuit (see THEORY OF OPERATION). At battery voltages below ~11.5 V, the LED will blink, but charging resumes if the radio is turned on. Above that, charging stops and the LED stays off. The remedy is to remove, then reapply external power.

Charging doesn't terminate (LED remains on permanently): Turn the radio on (if off). If the LED goes out when the radio is turned on, briefly remove external power and restore it to restart charging. Check the BT voltage display. If it's below 12.6 V, it's likely the battery is nearly charged and charging will end shortly. If the PS voltage display is less than 13.6 V, the charger circuit is running out of overhead and is providing less charging current to the battery, which can prolong charging. If BT gets above 12.8 V, the charger is very likely faulty. If this is the case, the external supply should be disconnected and the KXIBC2 removed for testing / repair. (**NOTE:** Disconnecting the 'E' wire from the RF board will prevent an external supply from charging the battery, but will still allow battery voltage monitoring [BT display]. The RTC will also continue to function.)

Charge LED Blinks: At battery voltages < 11.5 V or so, if the external supply is only about 1.0 V higher, the charge LED may blink, indicating insufficient charging voltage overhead. Some additional battery charging may still occur in this condition.

THEORY OF OPERATION

Please refer to the schematic diagram below.
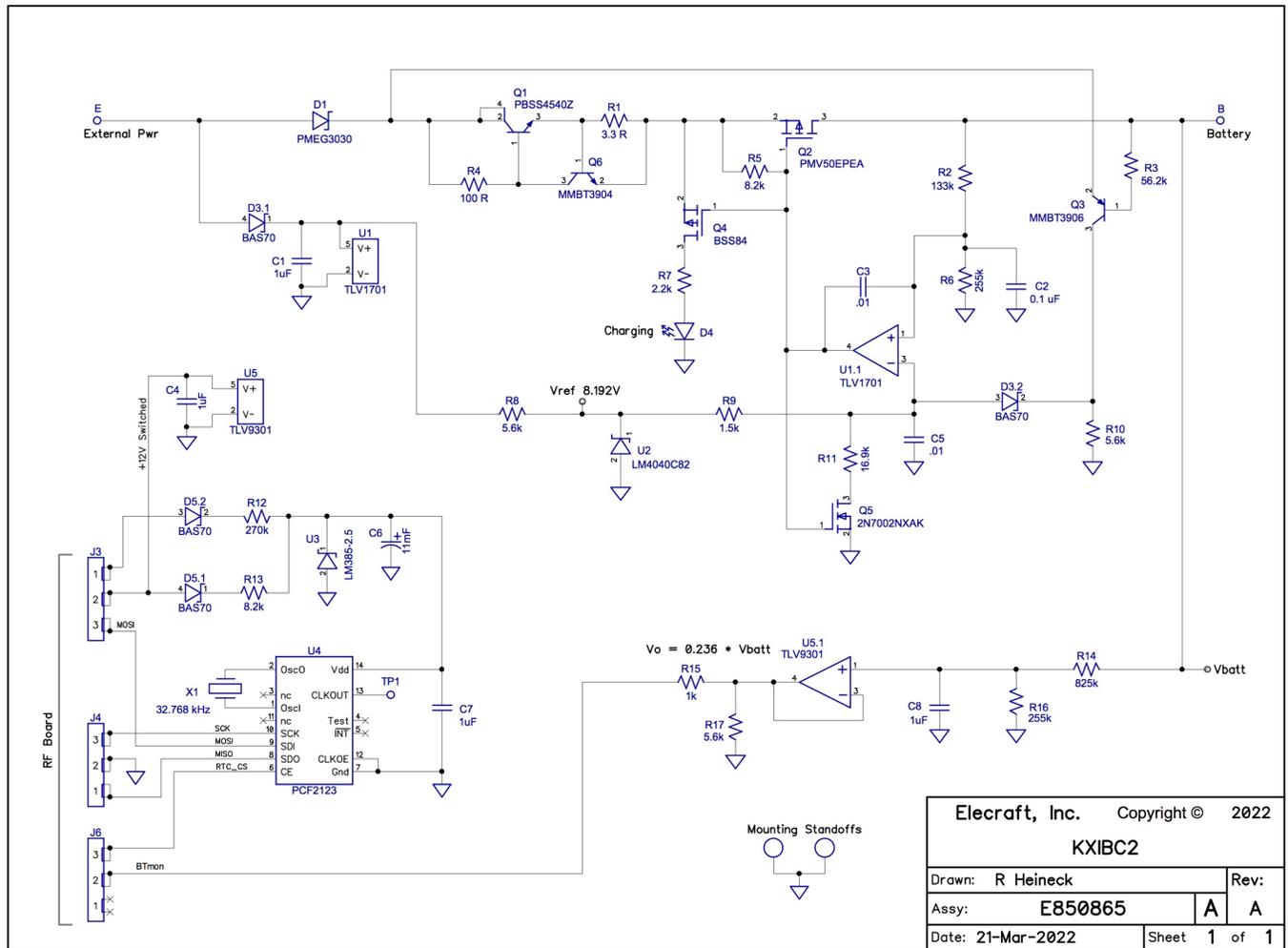
Overview

The KXIBC2 charges the internal battery at a low level constant current then stops when the battery voltage reaches 12.5 volts. Charge current is about 250 mA (C/10). Charging power is provided by an external supply plugged into the KX2 external power jack.

Charging will start as soon as an external supply is plugged in. The radio can be either on or off. The charge LED turns on when charging begins and will turn off when charging is complete.

The board plugs into the KX2 in place of the KXIO2 and requires two additional connections to the RF board. These are labeled 'E' and 'B' on the schematic, and provide direct connection to the positive pins of the external and internal (battery) power jacks, respectively. The KXIBC2 also provides the RTC function from the KXIO2.

Charging a fully depleted battery will take up to 10 hours, and the battery will be at approximately 90% of its rated capacity when charging ends.

NOTE: A comparison test showed that this is **more** charge than the KXBC2 external charger provides if the battery is pulled off the KXBC2 shortly after its CHARGING LED goes from red to green, but was **less** if the battery was left on the KXBC2 for a couple additional hours. However, NOT regularly charging to 100% will extend useful battery life. If the customer needs a faster charge than the KXIBC2 can provide, or wants maximum capacity, they can always use the external KXBC2 as before. The internal KXIBC2 is intended to make charging very convenient, while still providing reasonable performance.

Circuit Description

D1 provides reverse power protection and also prevents the battery from sourcing significant amounts of current to the external power jack.

Q1 and Q6 is a current limiting circuit. Current is largely set by the voltage drop across R1 equaling the drop across the base-emitter junction of Q6. As current increases past this point, Q6 collector current also increases, shunting Q1 base current through Q6, and reducing the current through Q1. Actual current will be somewhat dependent on the voltage differential across Q1, being slightly higher when charging starts, and decreasing as charging nears completion. Current begins to decrease quickly when the external supply voltage is less than 2 V above the battery voltage. At about 1.25 V differential, current will have dropped to about 100 mA.

Q2 functions as a high-side load switch that turns charging current to the battery on or off. When the gate is pulled low, the switch is turned on. Q4 works in parallel with Q2 to supply power to the LED.

U2 is a precision voltage reference that works with U1, a micro-power precision comparator, to shut charging off when the battery voltage reaches 12.45 V. About 1 V of hysteresis is provided by Q5/R11, so once charging terminates, it will not start up again until the battery voltage drops to about 11.5 V. The large ratio of C2 / C5 provides a kick-start to enable charging at higher battery voltages when an external supply is first connected.

Q3, with its coupling to U1 through D3.2, functions as an enable circuit that requires the external supply to be about 1 volt higher than the battery. This insures the current limiter has enough overhead to supply a minimum current to the battery. This keeps the charging LED off when the external supply voltage isn't high enough to source charging current. It also prevents a long-term low level trickle current from flowing when the external supply voltage is barely above the battery voltage, and the battery is below charge termination voltage.

U5 provides a scaled battery voltage to the KX2's MCU so it can display battery voltage separately from supply voltage. This circuit is only powered up when the KX2 is on. R17 keeps the battery from sourcing any significant voltage to the connected MCU I/O pin when the KX2 is off.

The circuit around U3 and U4 is the Real Time Clock, carried over from the KXIO2. U4 is the RTC circuit, and U3 is a 2.5 V shunt regulator. The path through R12 powers the clock from the internal battery or external supply when radio power is off, while the higher current path through R13 is active with the radio on. C6 will source enough current to keep the clock running if the battery is changed.