Do It Yourself: Klingon Bird of Prey
Wing LEDs

The following document will attempt to walk you through the installation of the WingLED boards necessary to update the typical 1994 Hallmark Star Trek Klingon Bird of Prey (herein refered to as KBOP) so it can be easily installed in a Star Trek: The Next Generation pinball machine. Please note the Author of this document is not responsible for any damage you do to yourself or your property. **Duplication of this document is not permitted without written consent.**

Tools/Materials Needed:

- 1994 Hallmark KBOP
- Soldering Iron
- Solder
- Dremel or Drill
- 1/16" drill bit
- #6-32 x 1/4" screw
- Xacto knife
- Reuse KBOP wiring harness

The pair of WingLED provide all the necessary circuits to directly power your KBOP from the Pinball machines 6.3VAC GI circuit. A simplified wiring diagram is provided in Figure 1 below.

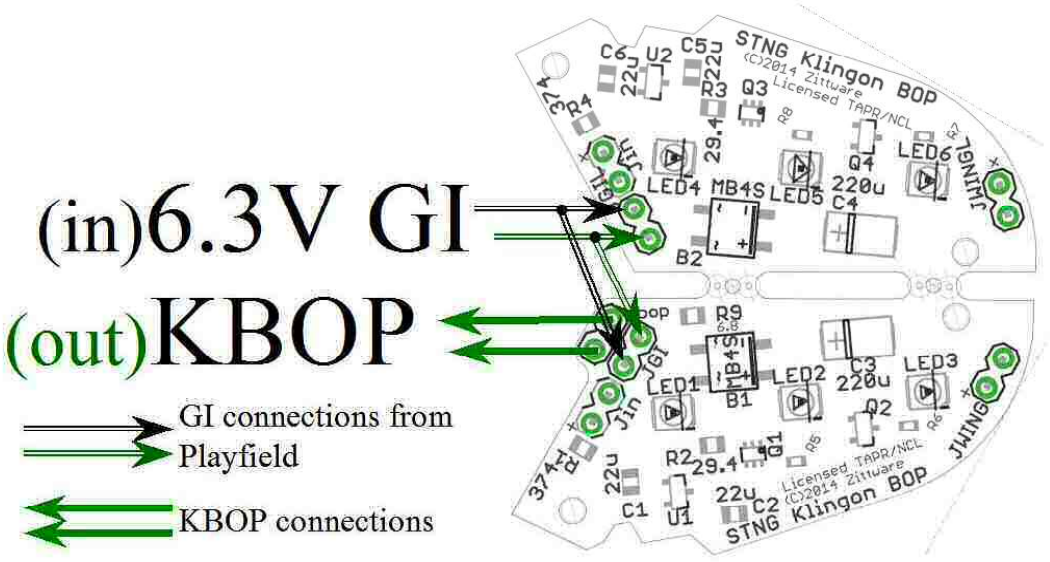


Figure 1 simplified KBOP Wiring

Here is how your board should look fresh out of the package:

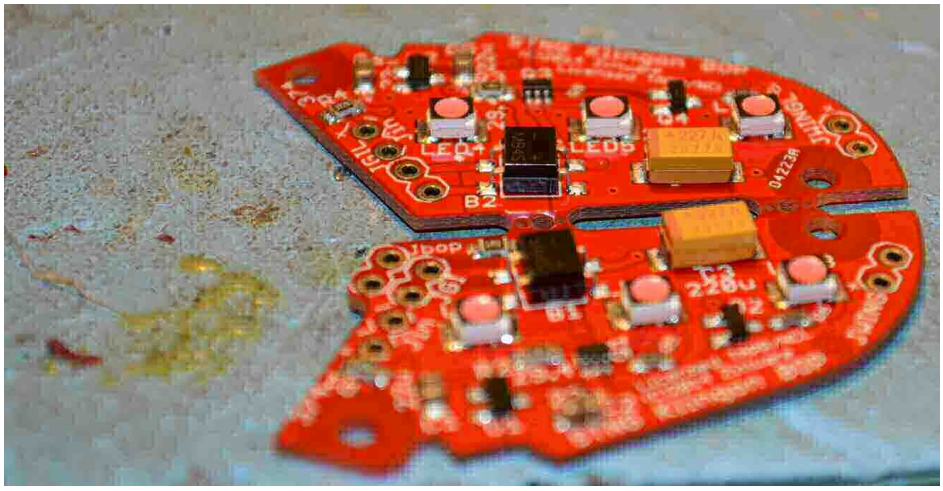


Figure 2 virgin WingLED pair

1) Begin by snapping the two boards apart. They should easily snap along the holes in the center of the FR4 material. Once the boards are snapped; clean the "mouse bites" off the PCBs using a dremel or belt sander. This will make the boards look clean when attached to the KBOP.

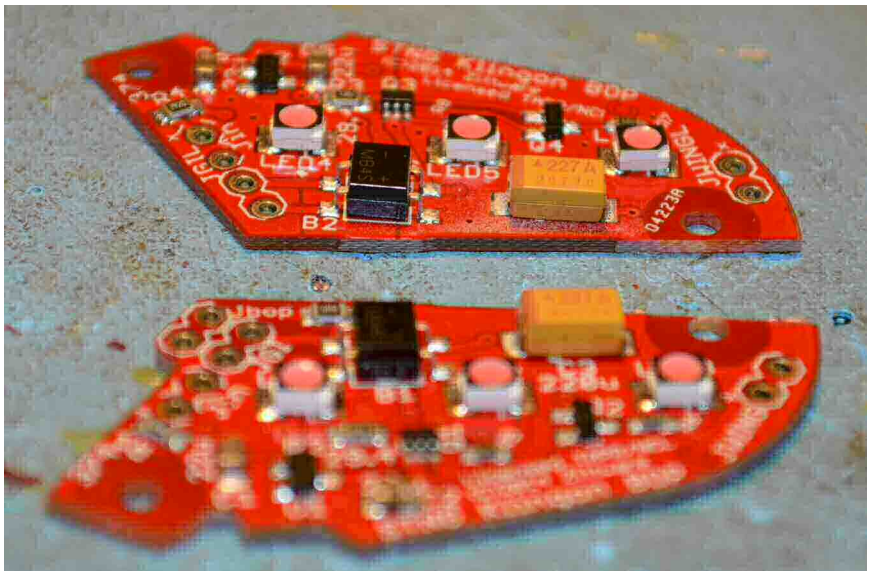


Figure 3 Separated Boards

2) Start with the right wing (as viewed from driver of ship). Flip the KBOP over and line up the right pcb on the bottom graphic of the wing. This is the lower board in Figure 3. It has the extra Jbop connector on the PCB. The board should fit over red graphic on the right wing. Line it up and mark the drill hole locations using the xacto knife or other sharp tool. Using your 1/16 drill bit; drill out each hole.

Figure 4 Drill screw pilot holes

The author uses a coin door key behind the wing to prevent the drill bit from punching completely through the wing or into a finger.

3) With the pilot holes drilled; thread the holes using a #2-56 3/16" screw. It is easier the thread the hole without the PCB moving on you. Once you've threaded both holes on the right wing; go ahead an attached the right pcb to it's wing using 2 of the #2-56 screws.

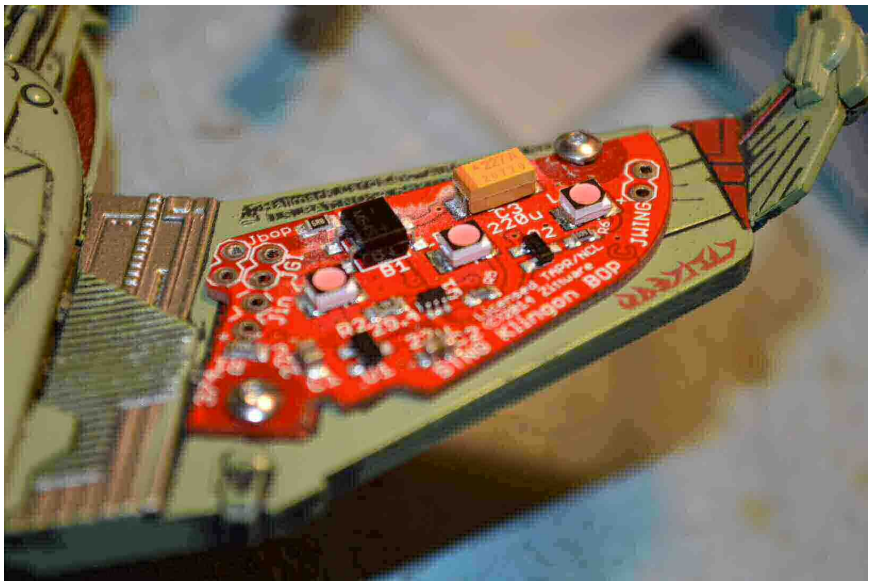


Figure 5. Right PCB attached

4) Repeat the pilot holes using the 1/16" bit and tap them for the Left wing. Go ahead and attach the PCB to the Left wing.

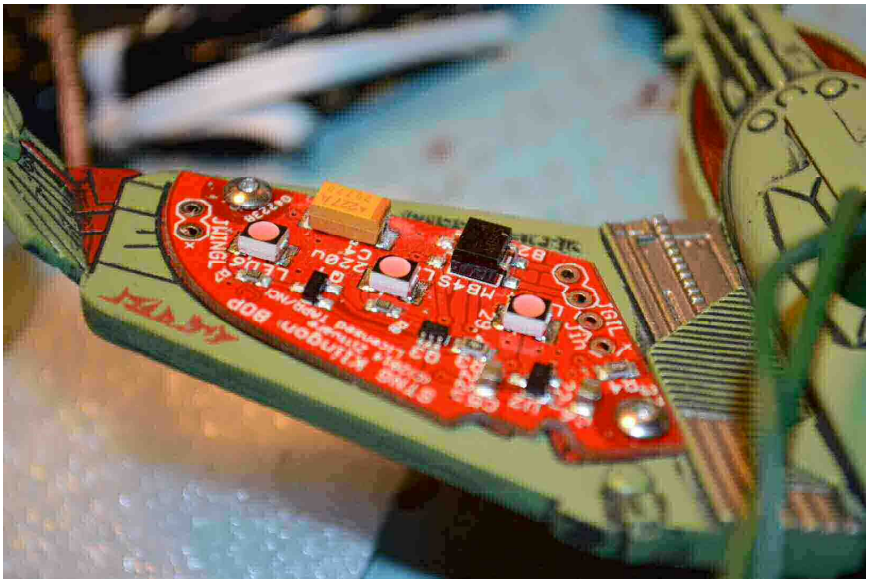


Figure 6. Left PCB attached

5) Measure the KBOP's Christmas socket leads so they easily reach the Jkbop connection on the left PCB. With enough slack cut the excess wire so it will be hidden under the ship. The author cuts these leads with about 1" of wire from the bottom of the ship. strip the wire and tin it in preparation for soldering to the J_{kbop} connection.

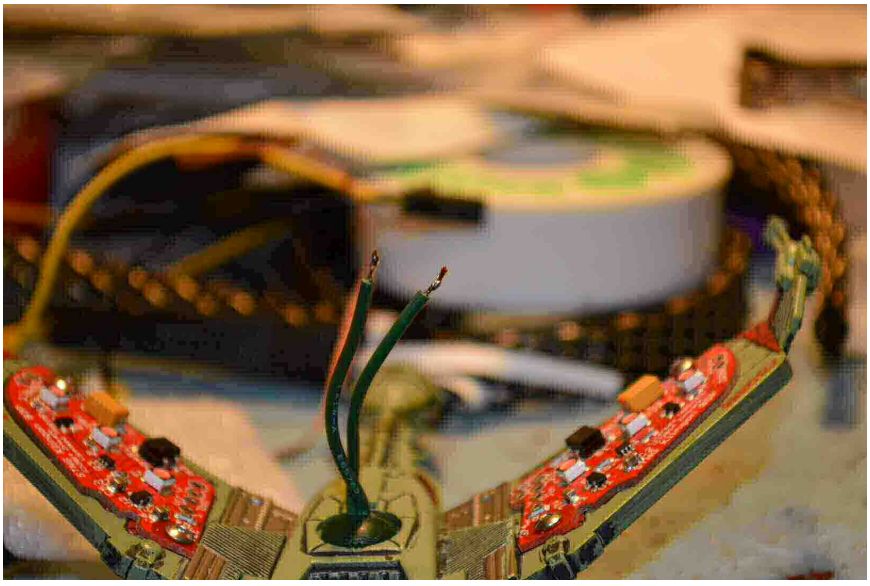


Figure 7. Cut KBOP wire @ ~1inch

6) Solder the KBOP wires to J_{kbop} on the right-wing PCB. You want just enough bare wire to cover the width of the PCB; to much bare wire leads to shorts. Polarity of these wires does not matter as the ship does not require a specific DC voltage.

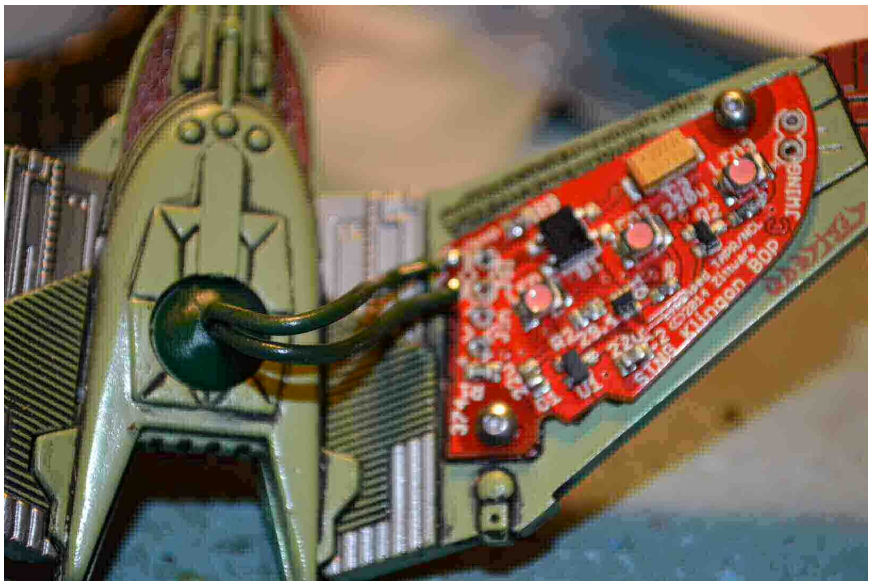


Figure 8. Solder KBOP to $\mathbf{J_{kbop}}$

Technical note: The ship is protected with a 6.8ohm series resistor (R9) as driven by the GI input connection. This limits the current in the ship and protects it's LEDs from burning out.

7) Next, desolder your existing KBOP harness from your old ship and re-solder it to the J_{GI} connection on the right-wing PCB. STNG has a 6.3VAC GI, so polarity does not matter when soldering to the PCB. Again, limit the bare wire in length so that possible shorts to adjacent connections is minimized.

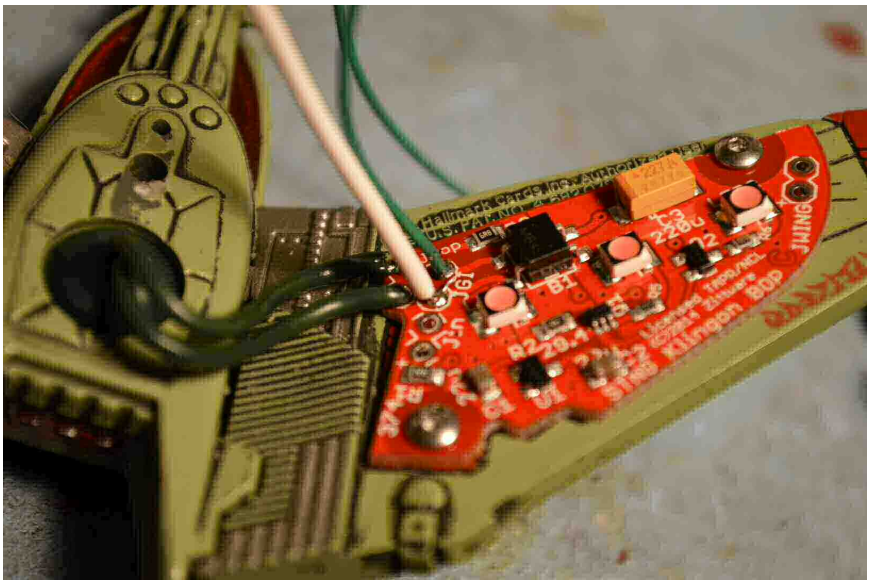


Figure 9 Solder old GI harness to RightWing PCB @ $\mathbf{J_{GI}}$

Technical note: The PCB has a Full Wave Bridge at BR1 and BR2; which converts the 6.3VAC to DC which feeds the LEDs with a constant current source. If you do not have an existing harness; you can create your own with parts from digikey.com: The Table below has part numbers for the GI connection. You'll need to source your own wire; perhaps green and white to match the original harness.

Quantity	Digikey PN	Manufacturer's PN	Description
1	WM1220-ND	0003062023	CONN PLUG 2POS .062
2	A14016-ND	794018-1	CONN PIN 24-30AWG TIN CRIMP
~8in			Green wire
~8in			White wire

8) Final electrical assembly involve jumping from the Right-Wing's to the Left-Wing's . Using a small amount of rework wire; jumper from the Right to left wings. Again polarity doesn't matter as the left wing also has a FWB rectifier.

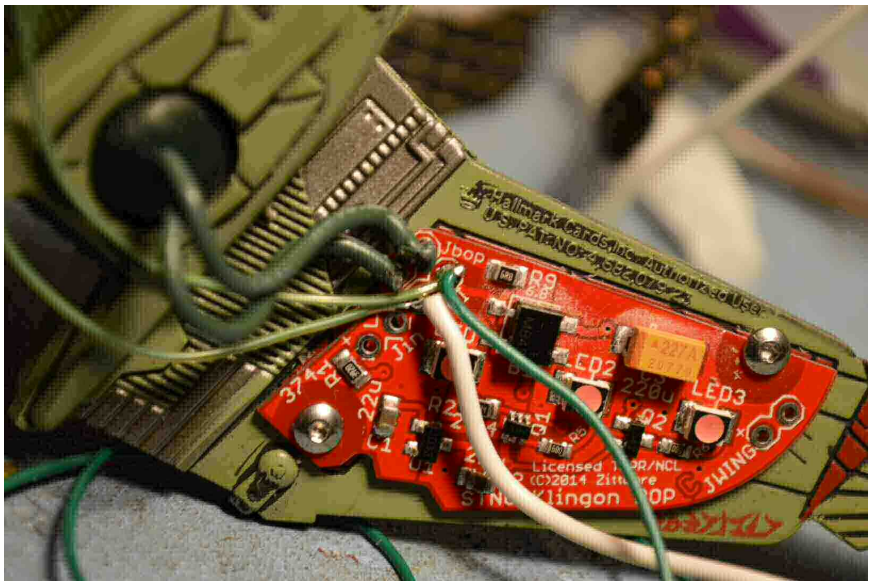


Figure 10 $\mathbf{J_{GI}}$ Jumper Right-Wing PCB

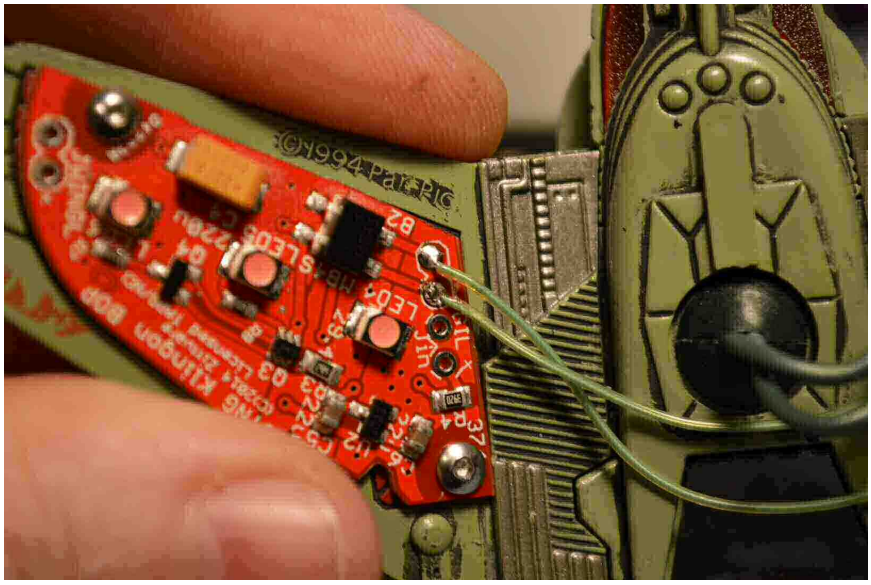


Figure 11 $\mathbf{J_{GI}}$ Jumper Left-Wing PCB

9) With the jumper in place; secure the rework wire using hot glue or some other adhesive. This is to keep the wire close to the body of the ship so it cannot be noticed from the player of the pinball machine.

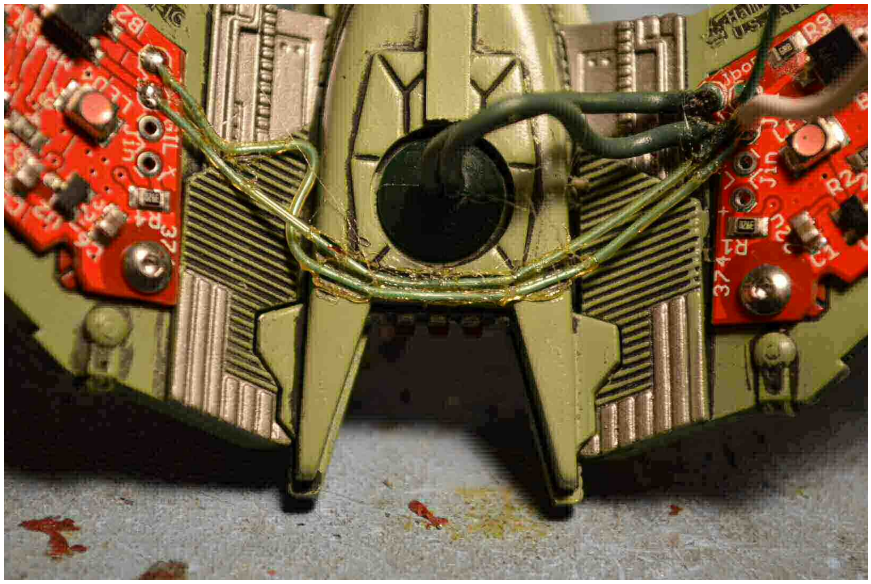


Figure 12. Secure jumper wires

Note: The Author uses a heat activated adhesive rework wire which is green in color and has a meltable jacket used to secure it to PCBs and other surfaces.

10) At this point, The electrical work is complete. You can attached the wiring harness (**J_{GI}**) to a 5VDC bench-top power supply or a 6.3VAC transformer to test before you put in it the machines.

If you use a 5VDC source; you'll notice that depending on where the postive rail goes into the KBOP; the engines will flash in addition to the front cannons. If you swap the input pins; the bottom yellow LED will lite steady and the cannons and engines won't light. In all cases; the WingLEDs will light, regardless of polarity. For best results; test both to ensure your ship is functional.

If you use a 6.3VAC source, all LEDs will operate. IE cannons and engines flash and the bottom yellow LED will lite.

11) Now we move on to the final mechanical modifications of your KBOP. Using an xacto knife; carefully remove the cover hiding the KBOP screw hole. This cover is generally attached with a pin and glue system. Just slide the blade under the cover and gently pry the cover and it will pop off.

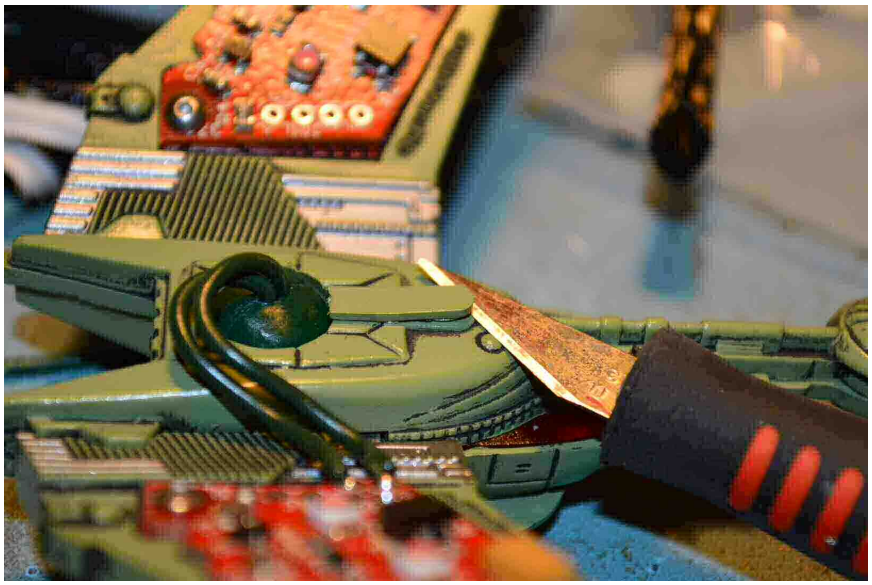


Figure 13. Pry off screw cover

12) With the cover removed; you have access to the screw hole. Using at #8-32 1/4" screw; tap the inside of this hole. This screw and hole will be used to attach the KBOP to the existing wireform bracket in your machine.

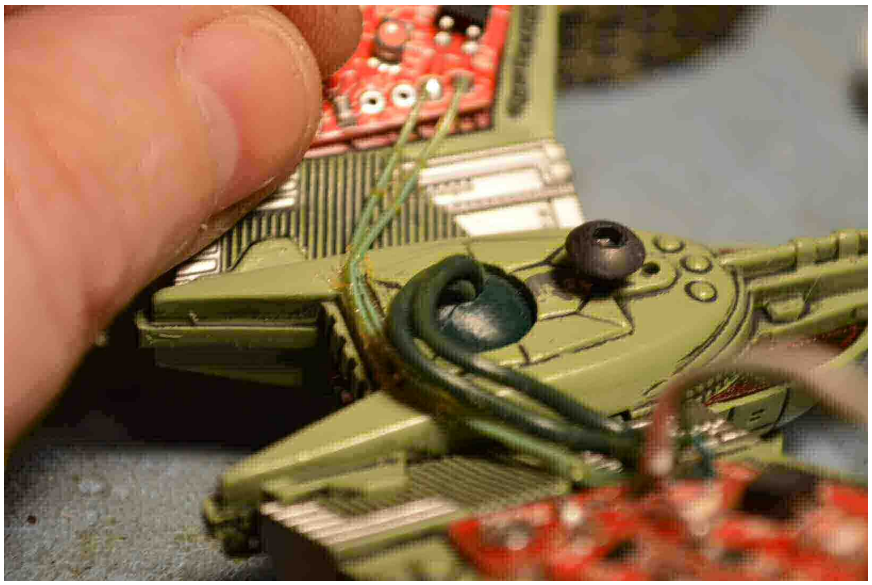


Figure 14. Install Bracket screw

13) The final step is to remove the gold ornament hook/ring with a pair of plyers. You can pull it out by pulling straight away from the ship with a gentile twisting motion.

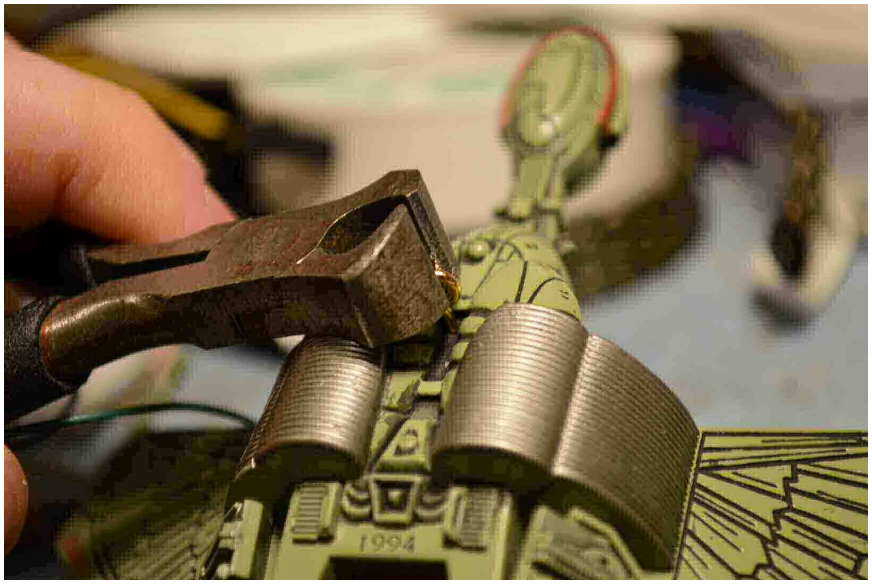


Figure 15. **Remove Hanging Hook**

Congrats; you've completed the modification for the Hallmark Bird of Prey w/ WingLEDs. Just install the KBOP on your existing wireform bracket and tie wrap the wire harness to the wireform for a finished look.

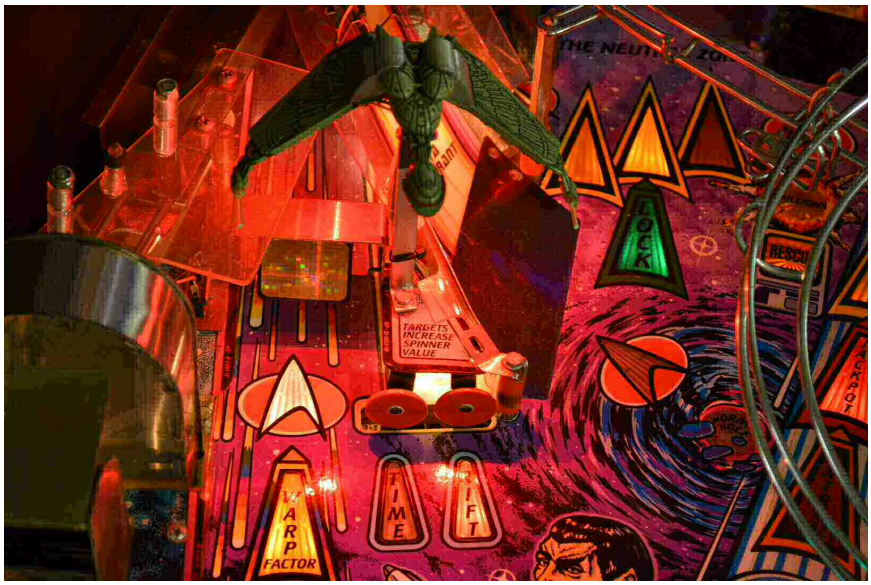
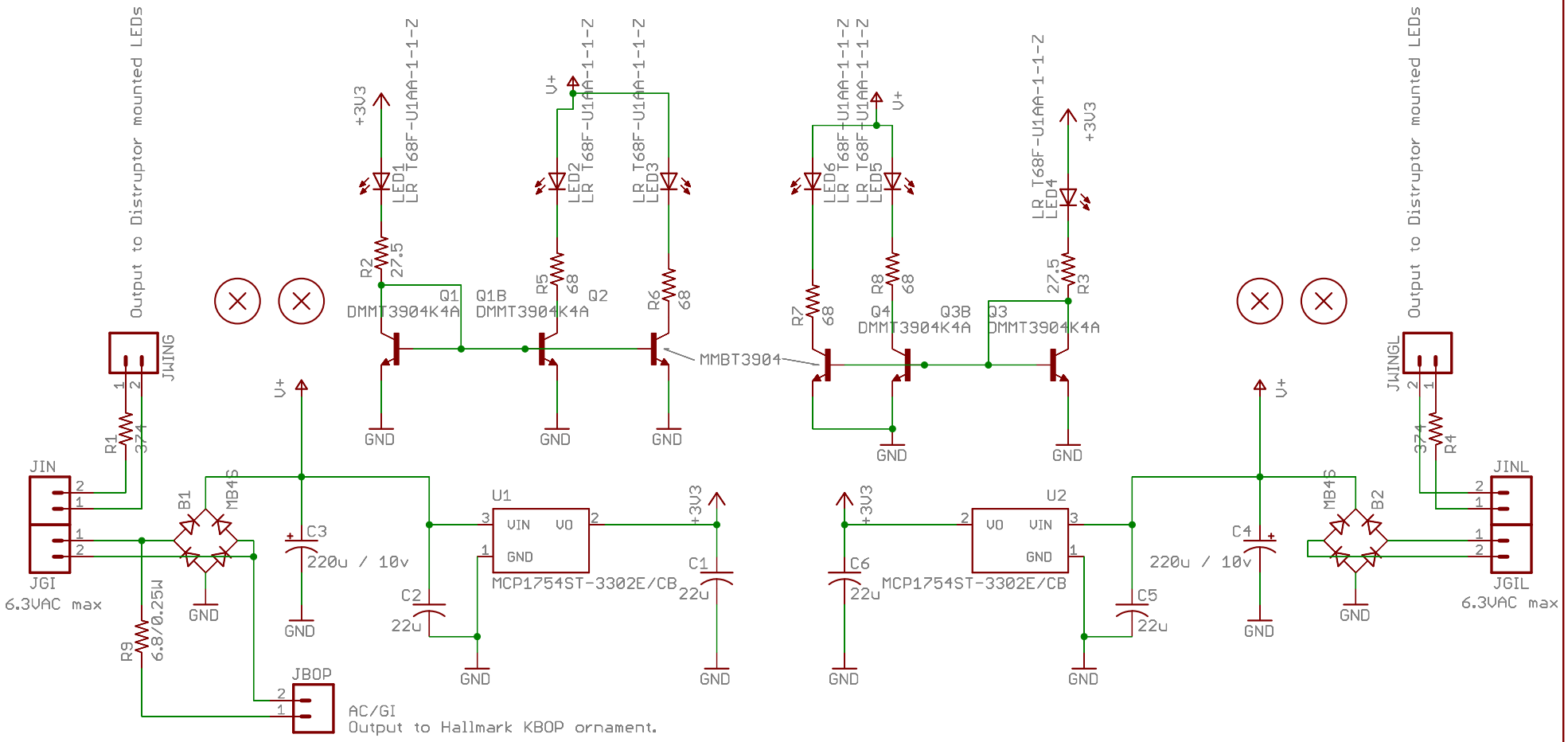


Figure 16. **Final Installation**

Appendix A: WingLED Schematics

Schematics are provided for the sole purpose of enabling custom modifications of the PCB or as an understanding of what each connector does. Providing these schematics comes with no warranty and is NOT a license to duplicate this work of art for commercial purposes. You must follow the TAPR/NCL license and obtain written consent from the Author to duplicate the work. Modification of the PCB voids any warranty.



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Version 1.0 (May 25, 2007)

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