Atreus Keyboard Assembly

1 Prerequisites

Before starting make sure your kit has all its parts:

- Case: top plate, switch plate, spacer[1], bottom plate
- Sandpaper: 100-220 grit and 1000-2000 grit waterproof
- Key switches: 42 tactile or clicky, 5 red optional
- Printed circuit board (PCB)
- A-Star Micro controller[2]
- Diodes[2]: 42
- USB micro cable
- Key caps: 40 normal, 2 long
- Screws and nuts: 8 each, 16mm M3 size
- Rubber feet

You'll also need to have these on hand:

- Can of spray lacquer or polyurethane (clear glossy recommended)
- Newspaper or other material to spray on
- Soldering iron and solder (lead-free not recommended)
- Wire cutters (not needed for presoldered kits)

The latest version of this document can always be found online.[3] If you are hand-wiring a board without a PCB, see the older assembly guide.[4] The photos in this guide depict Matias switches, (with rectangular switch stems) but you can use Cherry MX switches (with stems shaped like a +) as well.

---

[1]Your spacer may be one contiguous piece or split into 3 pieces.
[2]The controller and diodes will be attached to the PCB already in presoldered boards.
[3]http://atreus.technomancy.us/assembly.pdf
[4]http://atreus.technomancy.us/assembly-hand-wired.pdf

2 Sanding

Start by sanding with your rougher sandpaper. The top side of the top plate and the bottom side of the bottom plate are the only surfaces that are exposed to the touch once the keyboard is fully assembled, so these will need the most attention when sanding. You can sand the other surfaces as well just to get the scorch marks off, but you don't need to worry about how smooth the inner surfaces feel to the touch.

You may want to hold two pieces together while sanding for strength or placing it on a flat surface you don't mind scruffing up; too much pressure on a single plate could damage it. Be sure to get all the wood dust off the pieces before you go on. A clean tack cloth or other fine cloth works well.

Some people don't like the look of the exposed edges charred black from the laser cutter. You can choose to sand off the charring, or alternately cover it all with black ink from a sharpie marker for a more consistent look, or leave it alone.

3   Finishing

Once the case is sanded down all over with coarse sandpaper, find a good place to spray the lacquer or polyurethane. It should be outdoors or in a well-ventilated garage. Lay down the newspaper with the pieces of the case on top of it. Spray your first coat of lacquer to the face-up side of each piece. Try to use a steady hand and keep the path of the spray overlapping itself just a small amount as you go to and fro to minimize runs but still cover all the area. The evenness of the spray matters less on the internal surfaces of the case, so that's a good place to practice and get the hang of it.

Check the lacquer directions to see how long your particular product needs to dry; this can vary from half an hour to many hours. Once your first coat is dry, flip each piece over and spray the other side. Repeat for a second coat. After the second coat, you can ignore all surfaces except for the top of the top plate and the bottom of the bottom plate since only these are exposed to the outside. At this point you can take in the switch plate and continue the rest of the keyboard construction in between applying the other coats.

The outer surfaces should have between eight to ten coats applied total. As you get to the later coats, the end result will be smoother if you can keep them thinner. After your second-to-last coat dries, take your fine sandpaper and soak it in water, then sand over the top and bottom surfaces lightly. Add a final coat and buff it with a fine cloth. If you make any mistakes or are unhappy with the smoothness of the finish, let it dry and add another layer of lacquer, then try lightly sanding it again until you're satisfied. If you have some wood finishing oil, you can apply it with your fingers.
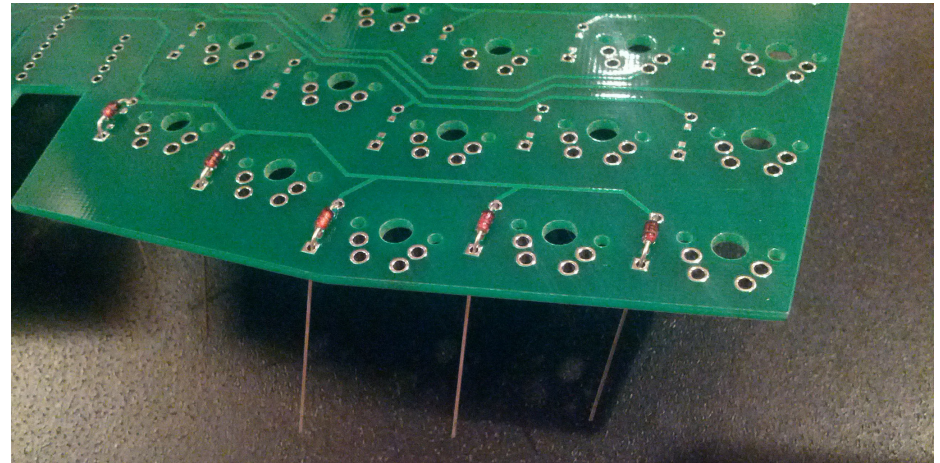
4   Diodes

If you've got a presoldered board, you can skip ahead to the "Switches" section.

If you've never soldered before, there are plenty of good introductions online.[5] Coat the tip of the hot iron thinly with some solder before you start. The key is to use the iron to heat both the hole and the lead sticking through it for a second or two, then bring in a dab of the solder. The solder should melt immediately if the joint is hot enough.

Take five diodes at a time and bend them into a U shape. Place them into the diode holes next to each switch slot on the unlabeled side of the board. Each diode has a black band on it; the band should be pointing in the direction of

---

[5]This one from Adafruit is great: https://learn.adafruit.com/adafruit-guide-excellent-soldering/tools

the arrow on the printed side of the board. Once all five are in, pinch the legs of the diodes together to keep them from falling out, then flip the board over and solder them in place. Make sure they don't protrude up more than necessary.


Once each set of diodes is soldered, trim the diode legs with wire cutters. Grip the diode leg as you trim it to keep it from flying across the room. Keep the diode legs; they will be needed in the next step. Repeat until each diode position is filled.
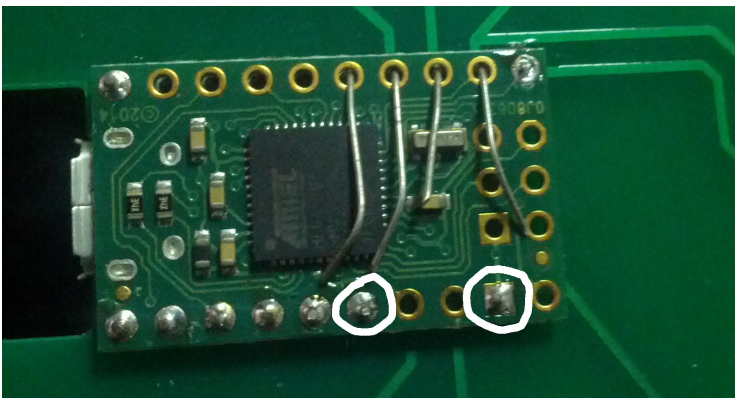
5   Controller

Once the diodes are in place, you can begin attaching the controller. If the controller came in a pink bag with its own header pins, you may be tempted to use them to connect the controller to the circuit board. Don't do this–they are too big and will prevent the case from closing when you're done. We will be using the diode legs we just trimmed instead.

First take the PCB with the labeled side down and fill the four corner holes in the center "A-STAR" section with solder. Insert diode legs into these holes while melting the solder. Then repeat the process for the other holes on the left, keeping them pointing as straight as possible. Leave the rest of the right side alone for now.
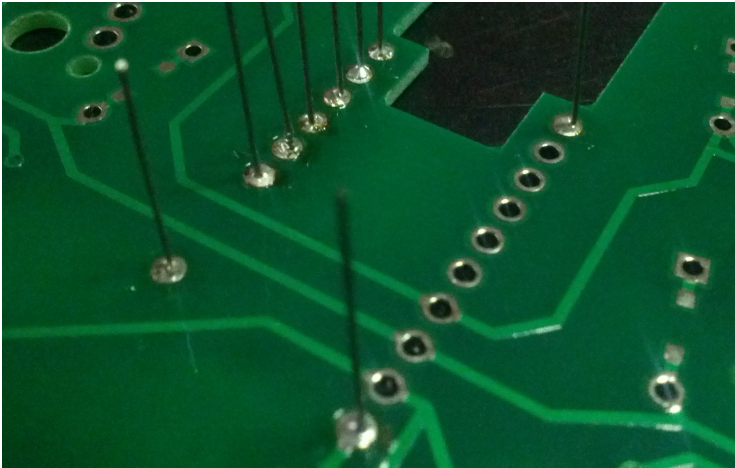
Fit the controller over the legs you've attached so far. Solder the four corner pins already connected to the PCB into the corners of the controller. (The bottom left corner is unused; the pin above it is used instead.) Try to ensure the controller is as close to the PCB as possible and not at an angle. Then solder the other left-side diode legs into the controller as well. Trim them all with your wire cutters when they are secure.

Eight right-side holes remain. For these, bend four diode legs at a time into an L shape, and insert them into four of the remaining holes. Flip the board over and solder the protruding diode legs to the PCB, then trim them down and flip the board back over. Straighten the diode legs, then solder and trim them. Repeat for the remaining right-side holes. From the PCB side, all the holes will be used, but from the controller side, there will be some unused.

Before you go on, take the time to double-check the solder joints on the controller. The solder should fill the hole completely without spilling over to adjacent holes. Also check that all the diodes are facing the correct direction with the black band pointing to the bottom of the board.

6   Firmware

Installing the firmware now isn't strictly necessary, but it will allow you to spot mistakes before the board is finished.

Plug in the USB micro cable into the controller, and plug the other side into your computer. Get a copy of the firmware `.hex` file [6] and `avrdude`. The first time you upload the firmware, you will have to use the hardware reset to enter the bootloader: take a diode leg or wire and touch one end to the reset pin and one end to the ground pin. (These are circled in the photo.) Touch them together twice in under a second and the LED underneath will begin pulsing in a different pattern from the original blinking. This indicates it has entered bootloader mode for 8 seconds.

While it's in the bootloader mode, run `avrdude -p atmega32u4 -c avr109 -U flash:w:atreus.hex -P /path/to/usb` from the directory containing the firmware[7]. The firmware should be uploaded, and it will start functioning as a keyboard once switches are connected. Next time you upload, you can use the reset key instead of touching the pins together.
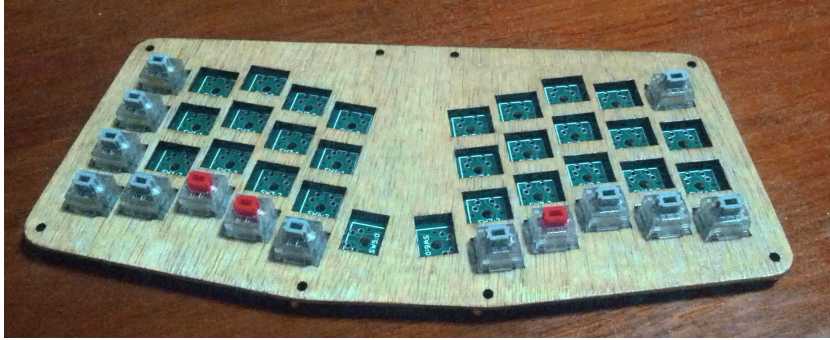
7   Switches

Next take four switches and place each switch in a corner of the switch plate. (The case layer with all the holes in it.) The switches should be oriented so that the side with pins is to the "north" of the board so they will fit into the holes in the circuit board. Put the switch plate face-down on the table with the pins sticking up.

Carefully fit the circuit board over the protruding pins with the labeled side down. Solder those corners to hold the circuit board and the switch plate together. The switches should be flush with the PCB. Take care that the switch pins are straight when you insert them; pushing in a switch with a pin that's a bit bent will bend it flat and prevent it from poking through the circuit board.

---

[6]Available at https://atreus.technomancy.us/tmk

[7]See the firmware readme for instructions about determining the USB argument and customizing the layout.

Next fill in the rest of the bottom row (SW1:3 through SW10:3) and the leftmost column (SW0:1 and SW0:2). If your kit has red linear switches which do not have any tactile bump, you can choose to use these for the modifier keys (shift, ctrl, alt, etc) or to leave the modifiers using the same switches as the rest of the board.[8] The modifiers on the bottom row are SW2:3, SW3:3, and SW8:3.

Solder the left and right pins of each of the switches you've placed so far, and then plug it in to a computer to test them to ensure that each row and column is connected back up to the controller correctly. Once you've confirmed this, solder the rest of the switches, but leave the middle two sideways ones for last.

Connecting the center two rotated thumb keys (SW5:0 and SW6:0) in kits with Matias switches requires a little bit of tweaking. (Cherry switches do not need this step.) The holes for the pins are not aligned quite under where the pins protrude. A little twisting will allow them to go in nicely. Note that the two switches must be twisted in opposite directions since they are oriented facing

away from each other. You can use pliers or even just your wire cutters to twist them.

8 Wrapping Up

If there's a misbehaving switch, it's often caused by a cold joint. Reflow the solder on both contacts of the switch and the diode. If an entire row or column is affected, it's probably the connection to the controller. You can follow the traces for the rows back to the middle, but the columns on the back of the board are obscured when the keyboard is assembled; you can see them in this PCB diagram[9]. Re-melting the controller's solder joint for the affected row or column is usually enough to get it working. If you still can't get it working, email me: `phil@hagelb.org`.

You may want to add strain relief by wrapping the USB cable with electrical tape or a zip tie at the point just below where it leaves the case. This will make it so pulling on the cable does not dislodge it from the controller.

After the switches are all in and tested, place the keycaps. They can take a fair bit of pressure to go on, so support the underside of the board while pushing them on. Once the caps are on, they are very difficult to remove again; don't try to pull them off without desoldering the switch first.

All that's left is to do is close the case by placing the spacer pieces and bottom plate on the keyboard while upside down, then putting some screws in. Flip it over and place the top plate on, then attach the nuts. If the controller was not attached close enough to the circuit board, it may be necessary to sand down the USB connector in order to close the case. If the rubber feet don't stay on with the provided adhesive, white glue may be needed to secure them.

Congratulations! Enjoy your new keyboard. It will take a considerable adjustment period to get used to it, but it should result in much more comfortable and effective typing. Also remember that you're encouraged to customize the layout to make it truly your own.

Happy typing!

---

[8]Since modifier keys are held down, they do not benefit from tactility like normal keys do, so some people find they prefer linear keys there, but this is a matter of personal taste.

[9]https://atreus.technomancy.us/pcb